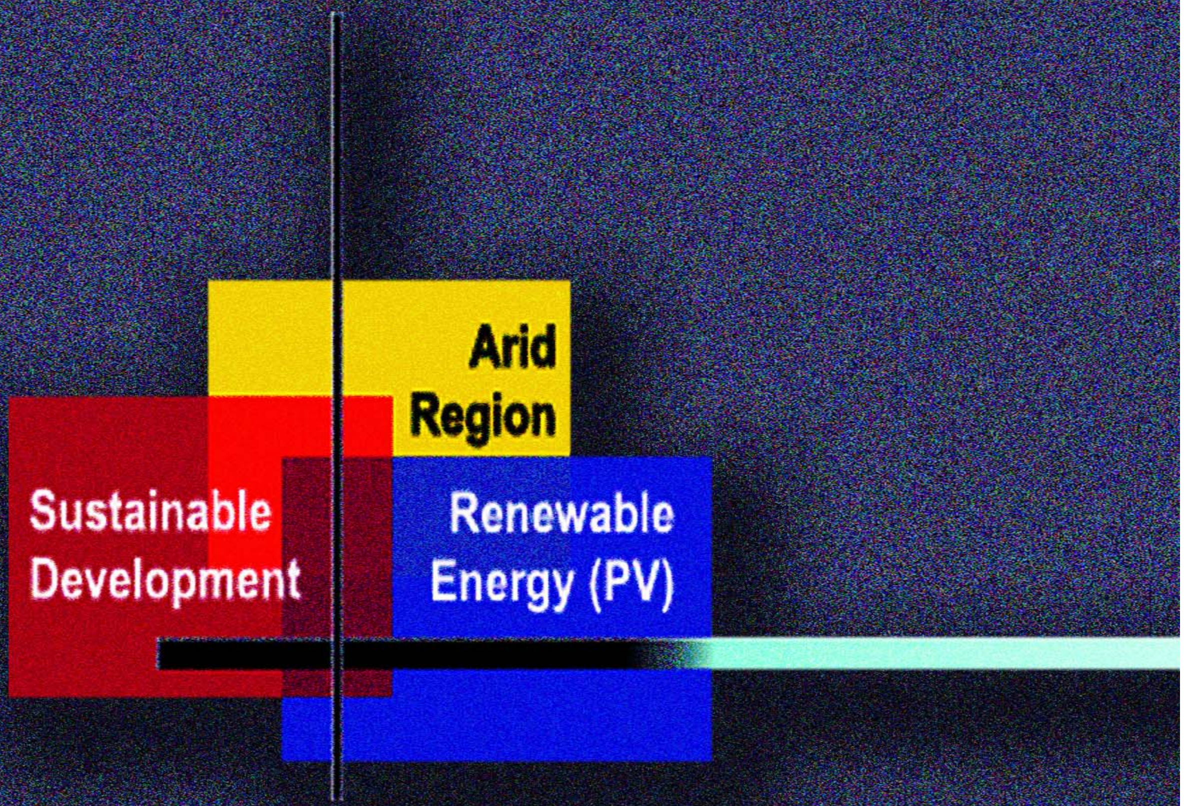
SI Städtebau-Institut
Universität Stuttgart

Development Concepts and
Implementation Strategies for New Settlements

RENEWABLE ENERGY AND SUSTAINABLE URBAN DEVELOPMENT IN HOT ARID REGIONS

Case of Egypt

Mohammad Abd-Elaal



Development Concepts and
Implementation Strategies for New Settlements

RENEWABLE ENERGY AND SUSTAINABLE URBAN DEVELOPMENT IN HOT ARID REGIONS

Case of Egypt

Von der Fakultät Architektur und Stadtplanung
der Universität Stuttgart zur Erlangung der Würde eines
Doktors der Ingenieurwissenschaften (Dr.-Ing.)
genehmigte Abhandlung

Vorgelegt von

M.Sc.-Ing. **Mohammad Refaat Mohammad Abd-Elaal**
Aus Kairo, Ägypten

Hauptberichter: Prof. Dr.-Ing. **Franz Pesch**
Mitberichter: Prof. Dr.-Ing. **Eckart Ribbeck**

Tag der mündlichen Prüfung: 11.12.2008

SI Städtebau-Institut

Universität Stuttgart
2008

Dedication

For my mother, father and sisters, to whom I owe everything in my life,

For my wife and children, the candles of my life,

For my grandmother, aunt Fatma , aunt Zinab and aunt Rokia.

Acknowledgments

I owe a debt of gratitude to Prof. **Franz Pesch** my supervisor for giving me the chance to do my Ph.D. study at Stuttgart University, and for his guidance contributions, continuous concern, help and advice, which facilitated the process of shaping this study, and for facilitating all the difficulties that I had faced.

I am also grateful to Prof. **Eckart Ribbeck,** for being the co-examiner of the thesis, and for his valuable comments.

I would like, also, to thank Prof. **Stefan Behling** for his valuable comments and information concerning the case study of MASDAR Development.

I am also so grateful to Prof. **Tarek Aboelata** (Cairo University), Prof. **Mostafa Abd-Elhafiez** , Prof. **Mohamed Atwa** and Dr. **Ahmad Fathy** (Suez Canal University) for facilitating the difficulties that I had faced at the beginning of my scholarship, helping in data collecting , and for their valuable comments and advices.

Special thanks for all members and my associates at the Architectural Department - the Faculty of Engineering in Port Said, for their continuous concern and support.

I am, also, so grateful for my country, Suez Canal University, and the Department of Architecture and Planning - Faculty of Engineering - Port Said, for providing me the scholarship to make this work. Furthermore, I would like to thank the Cultural Office members of the Egyptian Embassy in Berlin, and the Cultural Relationship Dept. - Faculty of Engineering in Port Said for their co-operation and friendly help.

My foremost thanks are to all members of my family specially my mother, father, sisters, my wife & her mother and father, and Alaa for their support and help.

I am so grateful to my wife Reeman for her patience at all times and her continues help, and for my sisters Reham, Walaa, and Wesam for the careful reading of the English text.

Last but not the least, I would like to thank all my friends and all the people who have helped me during this scholarship, namely: Abdo Mashaly, Eva Williams, Claudia Wesiak, Hossam Hamed, Hazem Abu Saleh, Christine Vauhnik, Mostafa Algandi, Emad EL-Den Ali, and Mohamed Ayoub.

Mohamad Abd-Elaal, Stuttgart,11.12.2008

شكرا جزيلا.. *** VIELEN DANK *** MANY THANKS

Abstract

Arid regions are an important part of the world as they cover more than 40% of the land surface and they can provide sufficient opportunities for extensive development. However, urban development of these regions is facing a set of problems. This is besides the development barriers due to the arid regions climate associated with a set of economical, social, administrative, and physical problems.

The Egyptian arid regions are also suffering from these problems, which affected its urban development. Nowadays, it became so important to adopt new development approaches for these regions, as it became the main target and only solution for the overloaded population in the Egyptian old valley.

On the other hand, the role of renewable energy resources to achieve sustainability in arid regions became so clear. This is especially after the recent researches, which have approved that depending on large-scale solar energy developments in arid regions will be one of the most promising sources of energy in the near future, not only for these regions' energy demands, but also for providing energy for the neighbor-regions such as Europe. This is besides the global direction to transform cities and settlements into new power stations, through integrating renewable energy applications intensively in urban-scale schemes. This is also as a tool to achieve a general sustainable development, not only at the level of urban development.

Therefore, the main objective of this research is to make a connection between the hot arid regions urban development and renewable energy e.g. photovoltaics (PV), to delineate urban integrated renewable energy e.g. Urban Integrated Photovoltaics (UIPV) as a new approach for building new sustainable settlements in hot arid regions. The study assumes that applying this approach can play a major role in developing communities of the hot arid regions. Furthermore, the study claimed that developing arid regions' communities within the concept "urban development integrated renewable energy" will offer suitable solutions for their current major urban problems, and this can be a new urban development approach for the Egyptian arid regions communities.

In this realm, the research introduces a model for the Urban Integrated Photovoltaics (UIPV) and it has been used as a tool to analyze the Egyptian case study of New Toshka city, as an Egyptian trial for developing an UIPV community, with reference to another two UIPV cases; case of the OECD countries, and MASDAR city – the UAE. This is in order to set up the main guidelines for establishing an UIPV development in the Egyptian arid regions.

List of Abbreviations

AC	Alternating Current.
ADFEC	Abu Dhabi Future Energy Company
AREEP	Association for Renewable Energy and Environment Protection
AUC	American University in Cairo
BIPV	Building Integrated Photovoltaics.
BOS	Balance of System
CAMPS	Central Agency for Public Mobilization and Statistics
CCD	The United Nations Convention to Combat Desertification
CCD	Convention to Combat Desertification – The United Nations
CDI	Communications Development Incorporated, Washington, D.C.
CEC	California Energy Commission.
CERT	Committee for Energy Research and Technology
CPAS	Center of Planning and Architectural Studies (Egypt)
CSP	Concentrating Solar Power
CURE	Cities Using Renewable Energies
DC	Direct Current.
DLR	Deutsche Forschungsanstalt für Luft und Raumfahrt
DOE	Department of Energy ,USA
DSWH	Domestic Solar Water Heating
ECSCT	European Conference on Sustainable Cities & Towns.
EERE	Office of Energy Efficiency and Renewable Energy- Department of Energy - US
EEREN	Energy Efficiency and Renewable Energy Network
EGSMA	Egyptian Geographical, Surveying and Mining Authority
EIA	Energy Information Administration , USA
EIA-PVPS	IEA Photovoltaic Power Systems Programme
EIP	Energy Integrated Projects
ESCWA	Economic and Social Commission for Western Asia
EU-MENA	Europe, the Middle East and North Africa
FAO	Food and Agriculture Organization , UN
GDP	Gross domestic product
GDRC	Global Development Research Center.
GHG	Greenhouse Gases
GNI	gross national income
GOUD	General Organization of Urban Development
GUC	German University in Cairo
HVDC	High Voltage Direct Current
ICLEI	International Council on Local Environmental Initiatives
IEA	International Energy Agency.
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
ISES	International Solar Energy Society
IUCN	The International Union for Conservation of Nature
IUSSP	International Union for the Scientific Study of Population
LGP	Length of Growing Period
MENA	"Middle East & North Africa" Region
NGO	Non-Governmental organization.
NRC	National Research Center
NREA	New and renewable Energy Authority (Egypt)
NREL	National Renewable Energy Laboratory U.S.A.
NUCA	New Urban Communities Authority
OECD	Organization for Economic Co-operation and Development
ORC	Organic Rankine Cycle.
ORTEE	Ontario Round Table on Environment and Economy.

OTEC	Ocean Thermal Energy Conversion
PLACE3S	Planning for Community Energy, Economic, and Environmental Sustainability.
PV	Photovoltaic.
R&D	Research and Development.
RE	Renewable Energy
RES	Renewable Energy sources
READ	Renewable Energies in Architecture and Design
RSVP	Renewables for Sustainable Village Power
RTD	Research Technology and Development
SCN	Sustainable Communities Network.
SD	Sustainable Development
SIEP	Settlement Infrastructure and Environment Programme.
SIS	State Information Service-Egypt
TCPA	Town And Country Planning Association.
TREC	Trans-Mediterranean Renewable Energy Cooperation
TREIA	Texas Renewable Energy Industries Association
UIVP	Urban Integrated Photovoltaics
UN	United Nations.
UNCHS	United Nations Center for Human Settlements.
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment Development.
WCLSF	World Congress of Local Governments for Sustainable Future
WEC	World Energy Council
WECS	Wind Energy Conversion Systems

EJ	Exa-joules
GWh	Gigawatt Hour
J	Joule
J/Cm^2	Joule per Cm^2
kWe	Kilowatt Electric
kWh	Kilowatt Hour
kWh/Y	Kilowatt Hour per Year
kWp	Kilowatt Peak
MTOE	Million Tons of Oil Equivalent
MWp	Megawatt Peak
TW	Trillion Watt
W	Watt.
Wp	Watt Peak

Contents

INTRODUCTION

o BACKGROUND

The age of industrialization and its great goals, the global scheme of world trade and its achievements, indeed, the promise of universal progress – all have been powerfully boosted by the modern use of fossil fuels. A brilliant set of utopian scientific, social, political, and economical visions has resulted from this, and great achievements were made for a worldwide minority. Yet, the dark sides of the fossil fuel economy appeared. These are including social development inequities, urbanization crises, global military instability, local and regional environmental disasters, global climate change and associated costs and risks.

Therefore, the economical, social, and environmental benefits of using energy efficiently and using new sources of renewable energy are now widely recognized. This is because of the fatal triad of carbon emissions induced climate change, fossil fuel depletion and mounting environmental damage due to the use of oil. Therefore, coal cities will have to be powered differently. The use of renewable and spread micro-power systems is already on the rise today but the current speed of change is much too low to meet global goals in time to avert serious crises. In addition, besides introducing solar and other renewable energy technologies, cities will also have to be reengineered by their transport and land-use systems, their facility and urban design principles and the use patterns.

Thus, cities face the new challenges largely without national guidance and some seek to go beyond individual technology applications, single structures, or limited urban areas. Therefore, the most hopeful visions describe entire cities as net renewable energy producers. This idea needs a rethinking of urban-regional alliances as well as an adoption of increasingly firm industry promotion practices. Increasingly, urban leaders seek to grapple with this issue of innovation within mainstream urban management systems.

o TOPIC OF RESEARCH

Arid regions' developers have the past and present experiences, especially in the developing countries, to look at. In these countries, most existing conditions and experiences are inherited from the past generations, and some may go back to old time.

For example, in the last two decades, a new Egyptian strategy for building new settlements has been created. As a main line of this development strategy, the Egyptian government looks at expansion from the old Valley as the tool, which would cause rejuvenating the whole country and would stress the extraordinary ability to make civilization. Such radical changes in the scope of physical development and the related new extensions beyond the old valley do not mean stopping to develop existing communities; particularly those recently built new communities. It should means that consistent efforts will be sustained, to achieve the suitable sustainable development approaches for supposed future new communities. Even though, the current development approaches remain as same as the old ones with the same goals. They are including offering large number of communities as a tool to meet the increased rate of population as, in the forefront, a political market solution for the current Egyptian society problems. The authorities aimed at building this large number of communities without equal regard to choice of location, improvement in quality, the existing problems or financing necessary amenities. This is besides mainly that most opportunities for such growth occur in remote and physically difficult hot arid region areas. This is besides the existing main problems of the Egyptian society: low income; bad environmental conditions; lack of employment chances; poverty, and the strong tenacity of living in the existing built area. Therefore, because of neglecting these problems, the current Egyptian urban development approaches would not be suitable to give the solutions for these problems.

On the other hand, since the energy crises of the 1970s, the relation between energy development and the urban development process has been a subject of noticeable interest. Recently, there is a global belief that two major dangers confront the world's cities and city regions within these existing and coming generations, and they will affect the global urban system as a whole: fossil fuel depletion and man-made climate change. There is little disagreement in the current literature that if these dangers are not swiftly and effectively met, their impacts will deeply affect all industrial world and mega-city systems and hit hard the fast-growing, major urban agglomerations of the developing world. Therefore, urban communities are increasingly regarded as settings for coordinated policy implementation efforts aimed at global renewable energy technology introduction programs. This is because of the widespread benefits due to: the integral nature of energy in communities, where efficiency gained in one sector lead to related improvements in other sectors. This is beside the fact that the urban areas offer enormous potential for easing the demand for energy-intensive materials and increasing the efficiency of resource use.

In this realm, the thesis attempts to make a connection between the hot arid regions urban development and renewable energy e.g. photovoltaics (PV), to delineate urban integrated renewable energy e.g. Urban Integrated Photovoltaics (UIPV) as a new Approach for building new sustainable settlements in hot arid regions. The study assumes that by applying this approach, which considers sustainability as an ecological approach that means thinking about whole community system and urban development, with all their interconnections, affects, and feedback loops, can play a major role in developing communities of the hot arid regions. Furthermore, the study claim that developing arid regions' communities within the concept “urban development integrated renewable energy “ will offer suitable solutions for their current major urban problems. In this realm, the study will particularly concentrate on Egypt, as one of these regions type. On the other hand, the study focuses on photovoltaic as one of the important renewable energy resources because of:

- Many studies that have been developed in the last years, consulted that to overcome the serious future energy problems, the international community should work immediately in mega-actions programs and projects to integrate uses of solar and photovoltaics applications into our communities urban development.

- Photovoltaic represents one of the main renewable energy resources in arid region. This is due to the high rates of solar radiation, and the long times of exposure to sun allover the year. Therefore, arid regions, in general, have a great opportunities using photovoltaic in a cost-effective schemes.
- Recently, many urban-scale projects allover the world have been developed depending on photovoltaics. Also, Egypt has tried to develop some communities using this source of energy. However, unlike the intentional examples, these trials have affected with many obstacles, and therefore, the aim of the study is to evaluate these trials with reference to the international examples.
- Unlike vast all the other forms of active renewable energy applications, using photovoltaic affected the process of urban development and building design at all levels.

o FORMULATION OF THE RESEARCH QUESTION AND HYPOTHESIS

The main question in the research is:

"Can integration of renewable energy and urban planning development and design be a new 'Approach' for building new sustainable communities in hot arid and semi-arid regions, and especially in Egypt?"

The question is therefore comprised of three main themes:

- Hot arid regions urban development.
- Ecological sustainability approaches.
- Urban integrated renewable energy planning and development.

To answer the research main question covering the above themes, more sub-questions can be formulated:

- What is an arid region and what are its characters?
- By which approaches have hot arid regions developed in the last decades?
- What are the problems facing their development?
- Is there a need to find new urban development approaches for hot arid regions communities?
- What is renewable energy integrated urban planning?
- What is the relation between renewable energy and sustainable development?
- Can renewable energy development e.g. PV play an essential role in solving the problems of community development in arid regions? Also, can this role be considered as a new sustainable approach for urban development?
- How can renewable energy e.g. PV be integrated in urban planning and design process?
- Can this approach be the suitable sustainable approach to develop the new future Egyptian communities?

In relation to the research questions, some hypotheses can be formulated to focus the research in the right direction. The study argues that:

- Hot Arid regions communities and especially the new communities face a set of ecological and socio-economical problems, which have to be solved within the process of urban development, to realize sustainable urban development.
- This sustainable urban development could not be achieved without devising new sustainability urban development approaches that are depending on the

belief that the current economical and socio-political system must be re-structured within the urban development process. Using renewable energy e.g. PV is one of these approaches.

- Urban integrating renewable energy e.g. urban integrating photovoltaics, can be a new ‘Ecological Approach’ for building new sustainable settlements in hot arid and semi-arid regions, particularly in Egypt, and this should be done with reference to a complete system or development model such as UIPV development model.

o METHODOLOGY

In order to cover all the sides of the research topic, three main approaches have been taken:

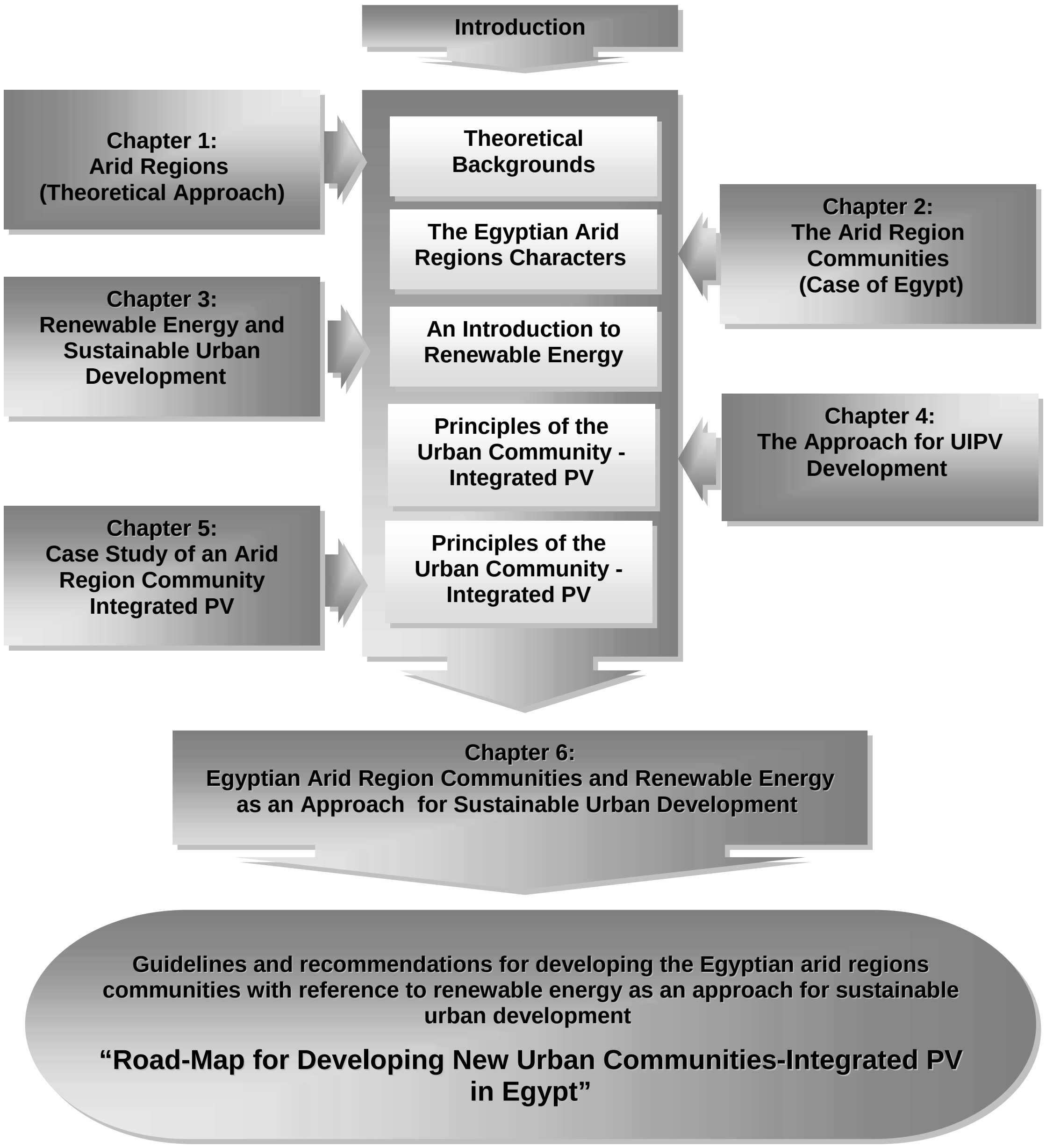
Theoretical approach, which shows and define the thesis main terms: arid regions, sustainable development, renewable energy, and urban integrating renewable energy e.g. urban integrating photovoltaics development. This is as a try to point up some of the valuable characters, which will play a major role to justify the research topic.

Historical approach, which demonstrates the concepts and characters of the Egyptian hot arid region and these regions' communities during history. This is as a tool to show their urban development, which will help to describe the basic guidelines of their new urban developments future.

Analytical approach, which gives an analysis, depending on the outputs of the theoretical and historical approaches for using renewable energy e.g. PV as an approach for sustainable urban development in the Egyptian hot arid region communities.

o Structure of the Study

The study consists of introduction and six main chapters:



Structure of the Study

Introduction: justification of the research, the objectives of the study and research methodology adopted.

Chapter 1 - *Arid Regions (Theoretical Approach)*: A theoretical approach to identify hot arid regions, all its characters, various components, correlations, and practical procedures with emphasis on its urban development policies and strategies. This is to point out the problems facing the urban development of these regions.

Chapter 2 *- The Arid Region Communities (Case of Egypt):* The arid region communities in Egypt are a part of the Egyptian urban movement. This chapter, therefore, concentrates on the urban development movement in Egypt, particularly, development history of the arid regions communities within the frame of the Egyptian urban development. Furthermore, the study analyzes the current Egyptian urban policies and strategies, and the impact of these polices and strategies on the development approach of the arid regions communities in Egypt. This is as a tool to demonstrate the basic characters of these communities and the urgent need to set up a new approach for urban development to achieve sustainability.

Chapter 3 - *Renewable Energy and Sustainable Urban Development:* In this chapter, the study demonstrates the renewable energy, in general, as an approach for sustainable development. This is through proving and defining renewable energy as a main element of any sustainable development process.

Chapter 4 - *The Approach for UIPV Development*: In this chapter, the study sets up an approach for “UIPV Development” (Urban Integrated Photovoltaic) in arid regions. In order to find the suitable one, the study presented and analyzed the recent approaches of “UIPV Development”, and it gathered all of them into one model for UIPV Development. This is with references to the experiences of the OECD (Organization for Economic and

Co-operation and Development) countries in this area.

Chapter 5 - Case *Study of an Arid Region Community Integrated PV*: In this chapter, the study gives a full case study for a new UIPV Development in arid regions, MASDAR Development- Abu Dhabi, which is analyzed using the UIPV development model.

Chapter 6 - *Egyptian Arid Region Communities and Renewable Energy as an Approach for Sustainable Urban Development*: This part discussed renewable energy development and particularly PV as an approach for urban development for the Egyptian hot arid region communities. This is through using the UIPV development model that has been developed in chapter 4. The study will give an analysis of some of the current innovations and case studies, which are theoretically developing new urban communities in the Egyptian hot arid region, and consider the role of renewable energy as a part of the process of urban development. Also the study represents a comparison between the case of Egypt and the other two cases that have been discussed in chapter 4 and 5, to find out the barriers facing the development process of UIPV in Egypt. Then, in this manner a plan (road map) for UIPV development in Egypt is represented as final conclusion for the study.

An Introduction to Arid Regions

Chapter I

This chapter is a theoretical approach to; identify the hot arid regions, all its characters, and point out the problems facing the urban development of these regions.

1.1. Arid Regions

"During the past decades and recently, there has been an upsurge interest in the regions with degrees of aridity of the world. Population growth, urban expansion, the need for more food and for alternative energies, and the 'discovery' of desertification, all have led to a search for new regions in which settlements may be placed" (Golany, 1983, p1). Arid lands, therefore, are an old/new frontier with the potential of providing sites where most of these issues can be met – if we aim to innovate planning and design.

More than one third of our planet is made up of zones with varying degrees of aridity. The origin, structure, and dynamics of the arid systems are as diverse as the effects of man's activities upon these systems. These arid systems are shared by around 50 countries, forming a colourful mosaic of social, economic, and environmental situations.

These regions, which cover about 40% of the land surface of the planet, are characterized by sensitive ecosystems that are particularly vulnerable to both natural and man-induced changes. These regions are inhabited by almost one billion people, many of whom live in developing nations, and who are directly dependent on arid and semi-arid lands' natural resources (IUCN, 2003).

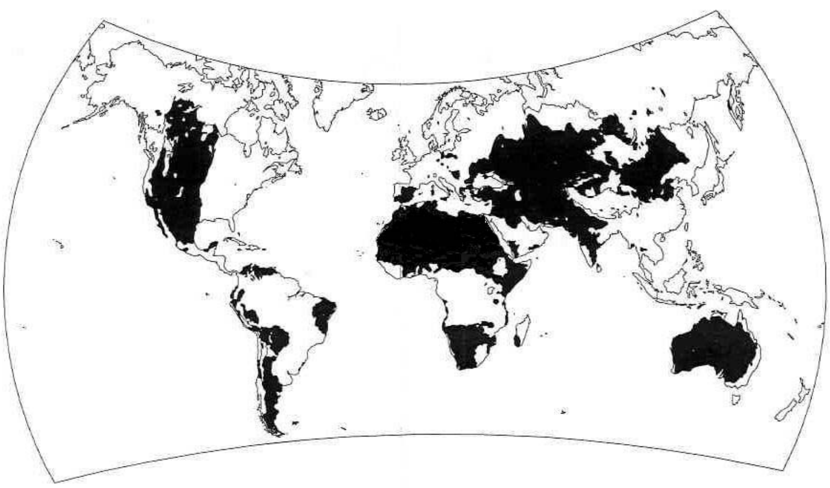


Fig. 1-1: Arid zones of the world
Source: After world atlas of desertification

1.1.1. Definition of Arid Regions

Arid lands are part of drylands. Drylands are areas with limited water resources (White, 2003). Therefore, the first aspect of drylands is based on their climatic character. Rainfall is scarce, unreliable, and concentrated during a short rainy season with the remaining period tending to be relatively or absolutely dry. High temperatures during the rainy season cause much of the rainfall to be lost in evaporation, and the intensity of tropical storms ensures that much of it runs off in floods. Water supply is not only meager in absolute terms but also of very limited availability for human and natural uses.

BOX 1-1 Definitions , Arid Regions

In earth science, a region that is very dry and has little vegetation. Aridity depends on temperature, rainfall, and evaporation, and so is difficult to quantify, but an arid area is usually defined as one that receives less than 250 mm/10 inch of rainfall each year.

Source: After world atlas of desertification

As a result, the two dominant characteristics of drylands climates are aridity and variability. Several classifications of drylands have been developed. The FAO typology for example, is based on agro-climatic zones defined according to the Length of Growing Period - LGP (production perspective) (FAO, 1999).

Drylands are also defined as terrestrial areas with a ratio of mean annual precipitation to mean annual potential evapotranspiration of less than 0.65, excluding Polar Regions and some high mountain areas with a cold climate year-round that meet this criterion but have completely different ecological characteristics. The United Nations Convention to Combat Desertification (CCD) has adopted this definition of drylands. UNEP (1997) estimates that over 47 % of the world's land surface are classified as arid lands (excluding cold climate regions). However, it must be recalled that drylands boundaries are neither static nor abrupt, so that precise delimitation of drylands areas remains elusive (UNEP, 1999, p. 3).

Table. 1-1: Arid zones by aridity index

Zone	aridity index (PPT/PET)
Hyperarid	< 0.05
Arid	0.05 - 0.20
Semi-arid	0.20 - 0.50
Dry-Subhumid	0050 - 0.65
Humid and Moist Sub-humid	0.65 – 1.00
Humid	1.00 <

Source: UNDP, 2004.

In total, the world is divided into six aridity zones (Table 1-1): hyper-arid, arid, semi-arid, dry sub-humid, moist sub-humid, and humid. Each zone is defined by a ratio (or aridity index) of mean annual precipitation (PPT) to mean annual potential evapotranspiration (PET). Drylands in concern to the CCD include those lands with an aridity index between 0.05 and 0.65 (excluding polar and sub-polar regions). Ratios of less than 0.05 indicate hyper-arid zones; Ratios of 0.65 or greater identify humid zones.

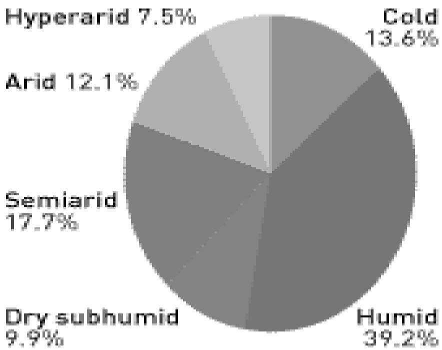
1.1.2. Aridity Zones Distribution

Aridity zones cover almost 61 million square kilometers of the globe. These aridity zones spread across all continents, but are found most predominantly in Asia and Africa (Table 1-2, Fig. 1-2). Many developing countries are composed of extensive arid and/or semi-arid areas, where the needs of the rapidly increasing population have often led to a great interest in development of these regions.

Table. 1-2: The global land area by aridity zone (%)

Zone	% of the Global Land Area
Hyper-arid	7.5
Arid	12.1
Semi-arid	17.7
Dry-Subhumid	9.9
Humid and Moist Sub-humid	39.2
Cold (polar)	13.6
Total	100

Source: After world atlas of desertification, 1997.



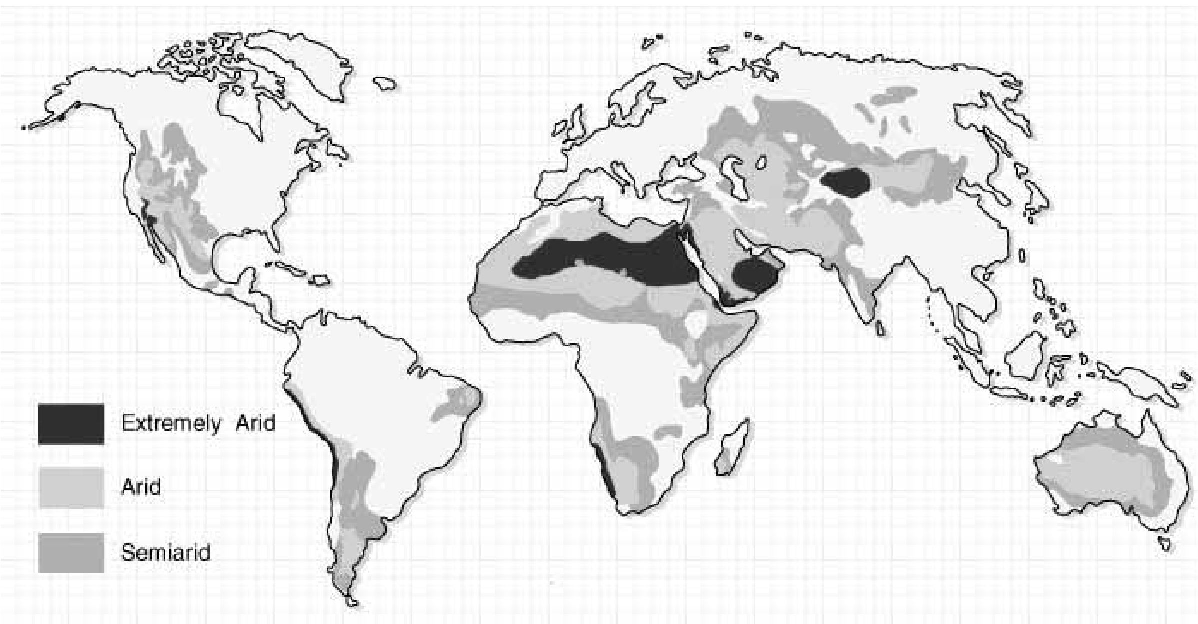


Fig. 1-2: Arid zones distribution (Hyper Arid, Arid and Semi-Arid Zones)

Source: www.engr.arizona.edu/

1.1.3. Arid Regions Characters

Arid lands are the largely unfenced, unfrosted parts of the planet, where low and erratic rainfall makes the land unsuitable for cultivation. The land is used for grazing domesticated animals and set aside for wild animals. Human population density is generally low, except around water sources or the focus of economic activity such as minerals. However, sophisticated nomadic and pastoral cultures often thrive in the marginal land, some of which is suitable for cultivation if irrigated, making it a potentially valuable resource, where water is available. Arid regions have great biological value. They are the original homes of many of the world's most important botanical medicines, resins and oils, as well as many animal and bird species.

The climate of arid regions is the main factor that affects such regions. The climate is varying between the different types of arid regions. Table (1-3) summarizes the main environmental characters of the three types of arid zones: hyper-arid, arid, and semi-arid zones. Their climatic characters can be summarized in the following:

(a) Temperature: arid regions are characterized by a mean maximum day temperature in shade around 45°C during summer (some times, shade temperatures of over 50°C may be reached) and between 20-30° in winter. At night, it is around 25°C during summer, and between 10-20°C in the cool season. Diurnal range of 20°C is uncommon.

(b) Humidity: Humidity is generally low. The real humidity (RH) fluctuates with air temperature. It can range between below 20 % in afternoon to over 40% at night. However, Maritime areas of the arid regions experience high humidity between 50 and 90%.

(c) Rainfall: Rains are few and they are ranged between the types of the arid zones. In addition, they sometimes start at high altitudes, but evaporate before it reaches the ground. (Fig. 1-3)

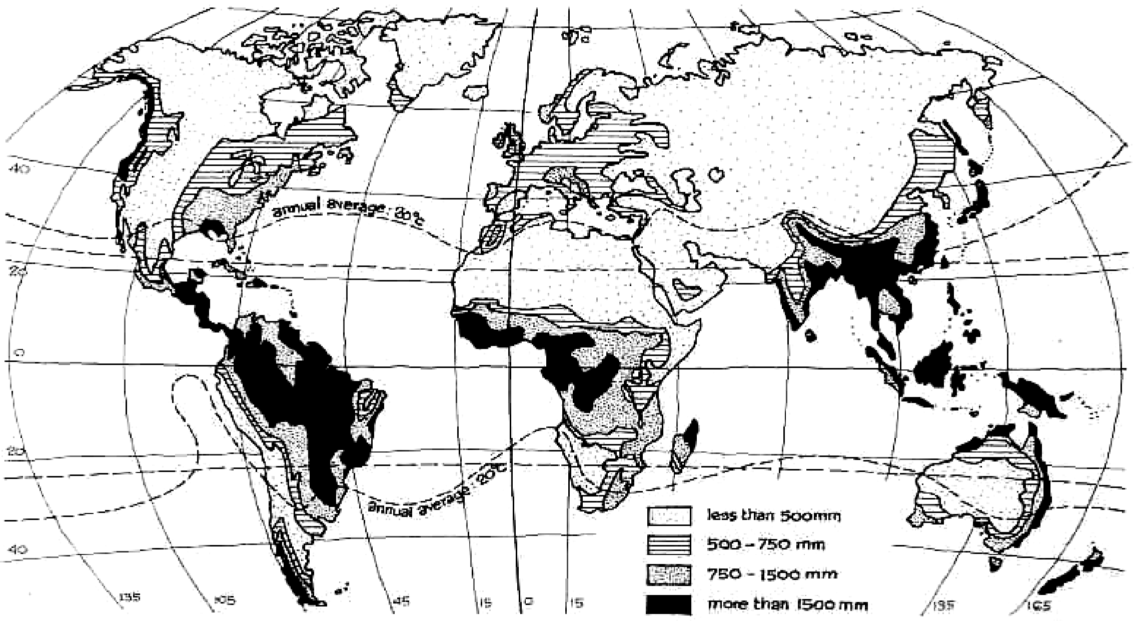


Fig. 1-3: The global annual precipitation

Source: Konya, 1980, p.17.

(d) Sky condition and solar radiation: The sky is without cloud for the greater part of the year, but dust haze and storms are frequent, mainly in the afternoon. Direct solar radiation is intense and is augmented by radiation reflected from the barren, light-colored terrain.

(e) Wind: Winds are usually local. They are generally low in morning increasing towards noon to reach its maximum in the afternoon, and they frequently accompanied by whirlwinds of sand and dust.

According to these environmental features, "Materials and structures can crack as a result of the high diurnal temperature difference. Dust and sand-storms, in addition to being a considerable nuisance, have a harmful effect on building materials"(Konya, 1980, p.23).

In addition, arid regions soils are unusually vulnerable to degradation. New soil forms only very slowly in these arid environments, and salts tend to build up owing to infrequent rains. The dry sparsely covered topsoil is easy victim to erosion by wind or by the rains when they do come. Regions susceptible to such erosion include the desert margins of North and Southern Africa, the Great Plains and pampas of the Americas, the steppes of Southeast Europe and Asia, the Australian “outback” and the Mediterranean margins (Harrison, 2001).

Table 1-3 :Hyper arid ,arid and semi-arid zones: types and their characteristics

	Hyper arid	Arid	Semi - Arid
Area % Of land Surface	➢ 7.5%	➢ 12.1%	➢ 17.7%
Kind Of Life	➢ are almost completely devoid of any life	➢ some sparse vegetation cover	➢ climatic elements are low enough to encourage a permanent flora and fauna
Degree Of Aridity	➢ a very high degree - (below 60)	➢ between (40 and 60)	➢ between (20 and 40)
Rainfall	➢ very low, and so seldom, even over a 12 month cycle. less them 100 mm./year	➢ is low, coming usually as thunderstorms censing floods <100 - 250 mm/year	➢ can be expected, 250 - 500 mm./year
Temperature	➢ the extremes during the day, followed often by cold nights. ➢ A wide diurnal temperature range	➢ extremes are still a common feature	➢ lower than other types
Humidity	➢ extremely low	➢ is proportionally limited and dew is available in addition to the total volume of water available.	➢ tends to be high relatively
Evaporation	➢ rates can exceed 3000 mm./ year	➢ extremes are less intense	➢ rate is lower
Cloud' Cover	➢ almost nil	➢ about 90%of the year, the sky is clear	➢ slight cloud cover
Soils	➢ are very primitive, loose rocks or sand, and are very susceptible to weathering and erosion	➢ are poor but in certain areas they become richer, the surface of the land is still loose rocky	➢ are well - structured, hold greater volumes of water, the surface soil is held firmly by plant roots
Plants	➢ Ephemerals, deep rooted, very sparse plant cover	➢ Ephemeral, annual grasses, deep rooted scrub, sparse plant between plants	➢ Ephemerals, Annual and perennial grasses, deep and shallow rooted scrub, large trees, good plant cover, no or small spaces between plants

Source: After Ahmad,1985

1.1.4. Man in Arid Zones

Money (1982) divided people in the arid zones into three overlapping cultural/technological levels: (Fig 1-4 a&b)

(1) Small groups of people like the Bushmen of the Kalahari and the Australian aborigines.

(2) Pastoral nomads in the dry lands of northern Arabia, the Sahel, northern Kenya and elsewhere: many are semi-nomads who, in the course of their annual wanderings, seasonally cultivate selected areas.

(3) Many millions live a settled life in a relatively moist environment within an arid zone-about an oasis, on a floodplain or delta, or in an area irrigated by water brought from afar.

Fig. 1-4a&b: Nomads settlements in arid zons. black tents of qashgasi, iran.

Source:Behling,2000,p. 67

However, this has changed now and about 20% of the world population lives in desert cities located in arid or semi-arid regions. The distribution patterns of this population vary within each region and among the aridity zones comprising arid lands. Regionally, Asia has the largest population who live in arid regions, both in terms of numbers and percentage: over 786 million people, or about 23 % of the region's population. Africa has nearly the same percent of people living in arid regions 24 % although the total number is less than Asia's; nearly 157 million. South and North America has about 18 % of its population in arid regions, approximately 119 million (Table 1-4).

Yet, some of the highest population densities in the world are found in the semi-arid and dry sub-humid zones of India. (White, 2003)

Table 1-4: Population in arid lands by continental Grouping

	Estimated Population 1994 (Millions)	(%)
Africa	~ 157	~ 24
America	~ 119	~ 18
Asia	~ 786	~ 23
Europe	~ 16	~ 5
Australia	~ 2	~ 6
World	~ 1317	~ 20

Source: White, 2003.

1.2. Potentials of Arid Regions

There is a belief that arid regions are dry and useless areas where nobody lives. This is because of many popular misconceptions, such as they are empty and unproductive places where people are unable to survive, that they cannot support plant and animal life, and that they are always dry, with drought of the main hardship on survival. In fact, arid regions have supported people’s livelihood for thousands of years. Today, arid regions are home to approximately one billion people worldwide and support modern cities such as Cape Town, and Teheran. In addition, arid regions represent challenges to plant and animal survival, but many species have evolved with special adaptations that allow them to cope with the climate and variable water supplies. (White, 2003 & WRI, 2002, p.3).

In general, it is important to understand arid regions and the development opportunities they provide in order to change the previous misconceptions, and to formulate the development schemes according to proven possibilities. Recently, many considerable advances have been made in order to investigate the resources and potentials of arid regions. Largely inspired by United Nations, many regional institutions have carried out careful surveys of what is available and what can be done to improve these regions in the future.

Nasr (2000) claimed that these regions can provide sufficient opportunities for extensive development, and Golany (1982) has summarized them and he discussed its associated issues (Table 1-5). The table shows that arid regions have many opportunities particularly in areas of agriculture, mineral excavations, tourist expansion, industry, and renewable energy, and that they can play a beneficial role in any process of urban development for such regions.

Table 1-5: Summary of arid zones resource potentials and their usage

Resource potential	Usage	Associated issues
Agriculture	Production of food ▪ with dripping irrigation ▪ in greenhouses Production of livestock feed and graze Development of industrial agriculture Establishment of fisheries ▪ with brackish water ▪ with seawater ▪ with recycled or mixed water	▪ High cost of water ▪ Necessity for highly regulated water supply system ▪ Possibility of high wages for imported labour ▪ Low priced land with high fertilization requirements ▪ Requirement of advanced technology ▪ Good market during off-seasons ▪ Provision of more than one crop per year ▪ Development of food factories ▪ Support of a healthy economic base, Stabilization of employment, Strengthening of regional cooperation Stimulation of development of infrastructure ▪ Possibility for artificial water bodies with improvement of climate
Recreation	Centres for tourists ▪ for archeological sites ▪ for unique geological parks Areas for hunting Health centres for asthmatics, arthritics, etc. Recreational facilities for vacationers	▪ Need for improvement of transportation, social services, facilities, hotels, restaurants and other amenities ▪ Investment for infrastructure ▪ Potential for seasonal economy
Solar radiation	Development of dehydrated food industry Production of energy ▪ solar energy to electricity ▪ solar ponds to steam for low pressure turbines	▪ Necessity of technological advancement and skill ▪ Reduction of daily household electrical consumption
Wind energy	▪ Energy for household consumption	▪ Instability of supply ▪ Support of early independency ▪ Reduction of imported energy
Air navigation	▪ Crossing routes and centres for national and international navigation ▪ Centres for military and civilian training Stations for astronomic observation	▪ Visibility of pollution and increased negative effects of pollution
Mining	▪ Centres for exploitation of natural resource	▪ Possibility of environmental deterioration and high cost of infrastructure
New settlements	▪ Centres of urban development ▪ Villages for agrarian industrial labour and families ▪ Villages for recreational facilities ▪ Villages for mining labour and families	▪ Support of infrastructure of the villages in the region ▪ Necessity of research on the suitable settlements and configuration of houses ▪ Necessity of construction of lengthy and expensive infrastructure networks ▪ Reduction of nomadism ▪ Population issues of interregional shifts ▪ Improvement and stabilization of economy ▪ Seasonal fluctuation of population Improvement of services ▪ Disruption of ecology and environment, Insecurity of economic base, Transience of population and culture

Source: Golany, 1982

1.3. Characters of Human Settlements in Arid Regions with Reference to the Traditional Arid Settlements

Early civilizations of the world evolved in arid regions such as Mesopotamia, Egypt, the Indus Valley, other parts of the Middle East, and western South America. Thus, the earliest human housing complexes developed in regions where dwellings were designed especially to respond to these climatic stresses, and through their history and early urban centers they deal with limitation of resources and they were concerned about conservation of the environmental characteristics. Later, when these ancient civilizations began to plan their cities, they continued to follow and improve those basic precepts.

Fig. 1-5: Settlements around the world, 3500-1500 B.C.

Source:Behling,2000,p. 79

On contrary of modern architecture, which is based on industry, economy and technology, traditional architecture in arid region is rooted on real needs in quality, material, and spiritual points of view, avoiding any unnecessary building spaces. Besides these valuable features, it permits the architect to focus on deep and highly exquisite human feelings and artistic imaginations. Therefore, a valuable traditional architecture has an eye on both the utility and the form of the building.

Major problems, which have caused people in arid regions to seek relief in shelters during history, are a burning sun, very high daytime temperature, low night temperature in very hot summer days, cold and dry winters, little rainfall, small amounts of water and dusty storms. Therefore, traditional architecture is distant from luxury, extravagant expenditures and is healthy and simple, and on the other hand based on utility and form of the building, and its material, dimensions and the building forms are directly related to the region's climate, economy, culture and physical needs.

1.3.1. Policy and Strategies of Urban Development

As a branch of arid region architecture, the traditional settlement has thought to alleviate the unpleasant impact of arid weather. Therefore, the main policy that has affected the process of development of such settlements was how to reduce the effect of the arid environment on the settlement. These have achieved through two main levels; the settlement urban form and design, and Building design level. A variety of ways and means combined to achieve this policy, including building materials and forms, site selection and orientation.

1.3.2. Principles of Traditional Communities in Arid Regions

1.3.2.1. Compact Form

Climate, in particular, produces certain easily observed effects on architectural forms." (Fathy, 1986.p.4). According to Golany (1982 &1983) Compactness has been the typical characteristic of the desert houses and the urban form of settlement throughout history (Fig 1-6,7). Although there were many factors contributing to this compactness, He has seen it as a practical response to the climatic stress of the desert.

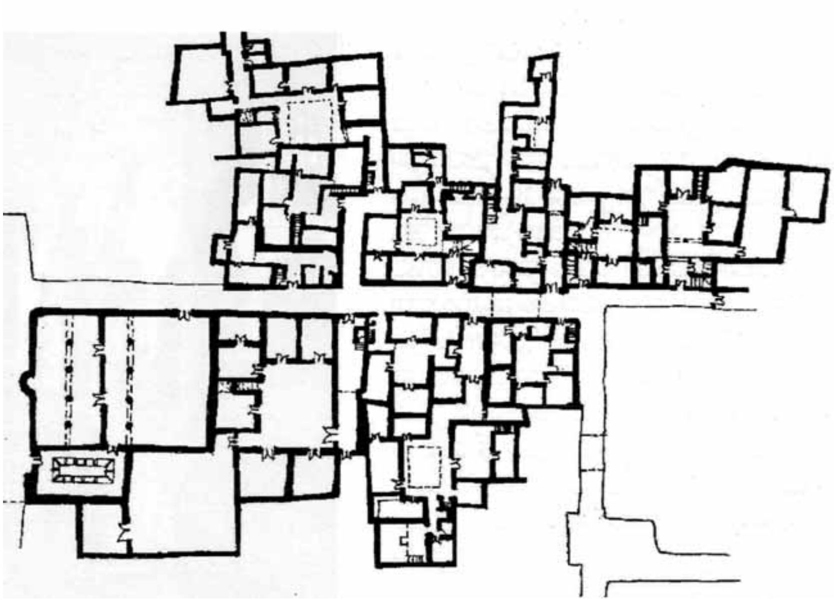


Fig. 1-6: The compact form, group of houses

Source: Alnaem, 2004, p. 60

In addition, compactness of arid regions' communities does not mean high density or reduction in size of the average housing unit. Rather, it is the result of careful and thoughtful design, which introduces the benefits of social interaction of the inhabitants in a comfortable environment (Whitehead, 1985, p 558).

Fig. 1-7: The town of Arbella, an example for the compact Pattern: A very early settlement in Mesopotamia has been inhabited for more than five thousand years.

Source: Behling, 2000, p. 81

The arid compact urban form has many advantages such as:

- it responds to the problems introduced by the desert climate conditions (Fig. 1-9),
- consumes less energy for heating and for cooling and minimizes heat exchange,
- reduces cost of design, construction and maintenance,
- reduces the size of the infrastructure network and establishes a relatively quiet environment;
- has less impact on the environment,
- provides proximity between various land uses and offers integrated land uses with minimum land-use segregation,
- intensifies social interaction among different age groups, and
- introduces clustering around protective pedestrian networks and community services.

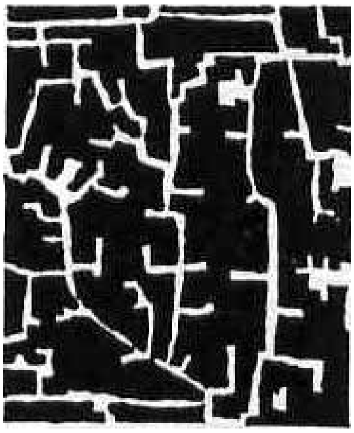


Fig. 1-8: The typical urban pattern.

Source: Abd-Elkader, 1997, p. 78.

Fig. 1-9: General view of the urban form of Khorasan village , Iran

Source: Beazlel,1982,p.11.

1.3.2.2. Orientation

Orientation is one of the major principles, which must be carefully determined because of the severity of the climate of arid regions. In order to achieve that, orientation has been determined at the two main levels, building design and community urban form. On the other hand, it have been determined through two types of orientation; orientation to the sun and to the wind.

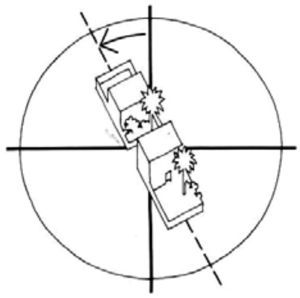


Fig. 1-10: The traditional orientation of building.

Source: Golany, 1983, p.103.

At both levels of building design and community urban form, selecting a suitable position for building is one of the most effective ways to reduce the impact of hot and arid weather regions, which is constant of wind and solar radiation (Fig. 1-10).

As an example for orientation to the sun, in dry/warm regions such as Egypt (Fig. 1-11), and southern Iran, the preferable site is that facing north, northwest, or northeast. In the arid zone of southern Iran, for example, all the house balconies face northward. The building angles may vary between 15 to 35 degrees and practically in ancient building architecture rarely such an angle was violated (Fig. 1-10).

Fig. 1-11: El-Lahun (1800 B.C.) was an ancient Egyptian city of barracks to house the army of people responsible for construction the pyramid complex. Roads are east-west oriented.

Orientation to wind in arid regions has two goals. Firstly, orientation is a tool for air ventilation (Fig.1-12, 14, 15). Ventilation in the arid zone is desired in order to create cooling temperatures. Ancient and contemporary experience introduces a variety of evaporative cooling techniques such as water dripping at the window, fountain or body of water in the courtyard (Fig. 1-13) as in Iran or Spain, watering the porous, volcanic tuff stone paving the courtyard such as in Turkey, and porous clay water jars placed at the end of the air shaft as is the practice in Mesopotamia.

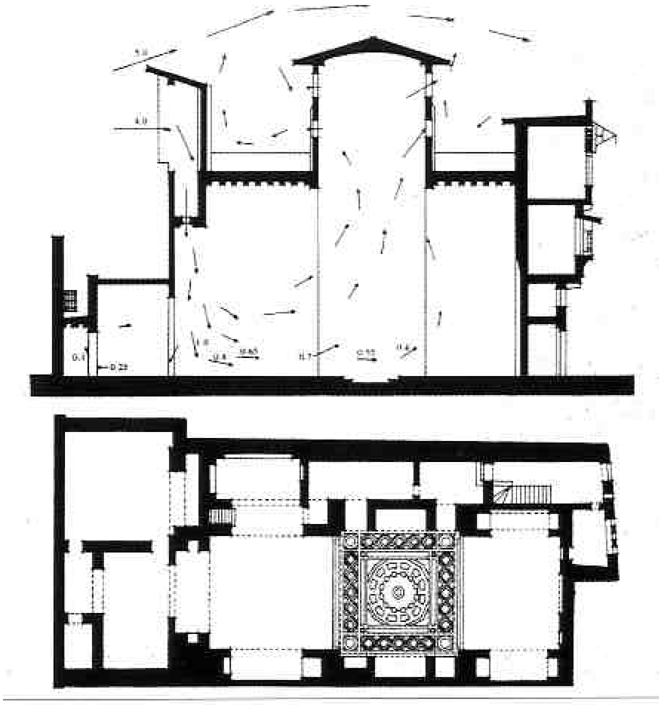


Fig. 1-12: The Villa Al-Kua, Irak. The typical design of islamic house, which has wind tours (malkaf) and wind escapes. A malkaf is a shaft rising high above the building with an opening facing the prevailing winds. It traps wind from high above the building, where it is cooler and stronger, and channels that current down into the building. This technique has long been employed in vernacular buildings of the steppe.

Source: Behling, 2000, p. 185

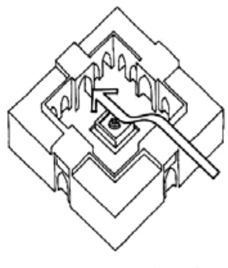


Fig. 1-13: This enclosed garden court in the Lake Palace, Udaiour, is located in the heart of the cetral Indian desert region of Rajasthan.

Source :(left) Saini, 1980, p. 80
(Top) Golany, 1983, p. 101.

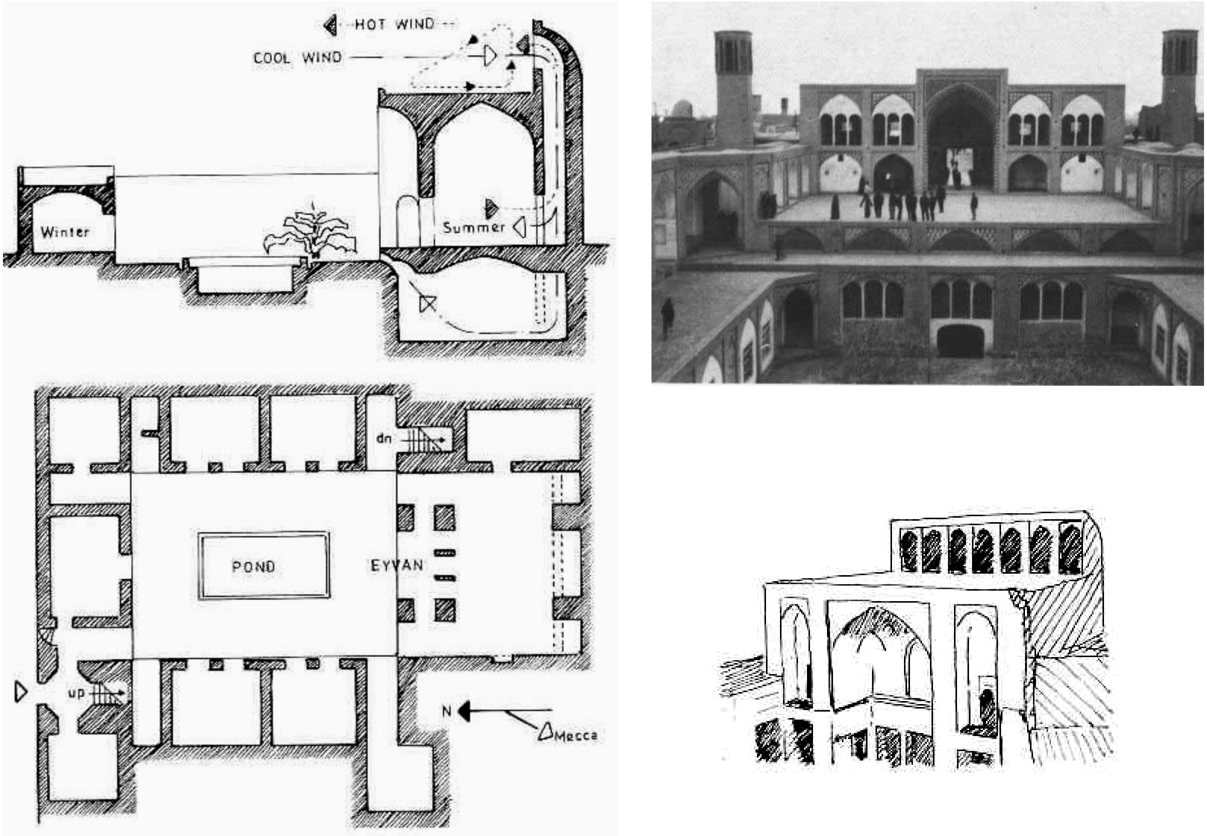


Fig. 1-14: The Iranian Wind Trap (Badgir): The entrance of wind trap is normally faces the wind leads the cool wind into inner chambers, and the dry wind blowing outside the wind trap channel cools the hot air which the air trap receives from the roof. While allowing the warm air to escape, (due to difference of air pressure in the air trap channel) the air trap adjusts and balances the inside temperature. The air outlet at the roof is installed in a place which suffers low pressure and is capable to suck the air and let out the warm air when the wind blows. When the hot wind is blowing on its body, the air trap acts as a big air duct. Therefore, the wind trap and the air outlets (channels) absorb the cool air and expel the warm air. The air trap can be built at four or eight directions. It depends on the velocity of wind and the financial condition of the family to choose the directions of the air trap.

Source: Diagrams; Golany, 1980,p 38.
Foto; Golany, 1983, p.103.

Fig. 1-15: Another form of the Irnain wind trap (Badgir): :Four – sided badger, Sirjan, Iran the wind leads

Source: Golany, 1983, p. 132

Secondly, orientation is a tool for avoiding storms and dusty winds, which form a traditional character of an arid zone. This is through the orientation and design of the building, and through the orientation and form of the urban network (Fig. 1-16).

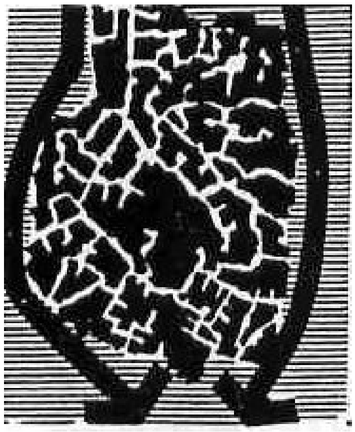
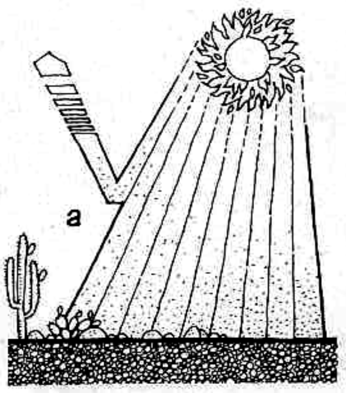


Fig. 1-16: Orientation and form of the urban network in Settlements of arid regions help to avoid winds.

Source: Abd-Elkader, 1997.p.87.

1.3.2.3. Building Materials and Form

Golany (Whiethead, 1985) claimed that in arid areas, due to the high temperature of air, the earth quickly releases most of the heat accumulated throughout the day. Consequently, the air temperature drops sharply, immediately after sunset, reaching very low temperatures toward dawn, in drastic contrast to the extremely hot temperatures of the preceding afternoon, as one of the characteristics of arid regions is this difference in temperature between day and night (Fig.17 a&b). On the other hand, the earth functions also as a heat retainer. Although the relatively thin upper layer of earth that was affected by the diurnal heat gives up most of its heat throughout the evening and night, some heat does remain. This small but steady wave of heat moves downward into the earth slowly, eventually exhausting itself at a depth of approximately 10 meters.



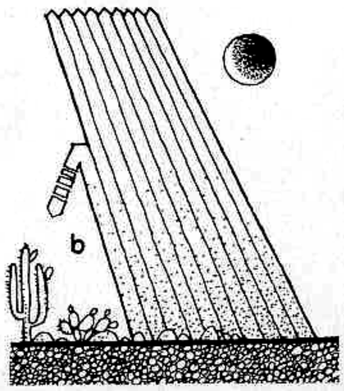


Fig. 1-17a&b: In arid regions, a large percentage of the sun radiation reaches the ground at the day time, and most of it, however is lost at night.

Source: Konya, 1980, p.10.

Ancient people of arid regions have understood these two processes and brought two main notable results; the aboveground houses, and housing below and partially below ground.

- Above-ground houses in desert areas are constructed with walls ranging from 0.5 to 2 meters thick, and sometimes consisting of two stone walls sandwiching a mass of earth and gravel (Fig. 1-18,19).
- Housing belowground and partially belowground. Here, too, thoughtful construction could result in cool summers and warm winters for the inhabitants, with minimal bad effects from the extreme diurnal temperature range (Fig. 1- 20, 21, 22).

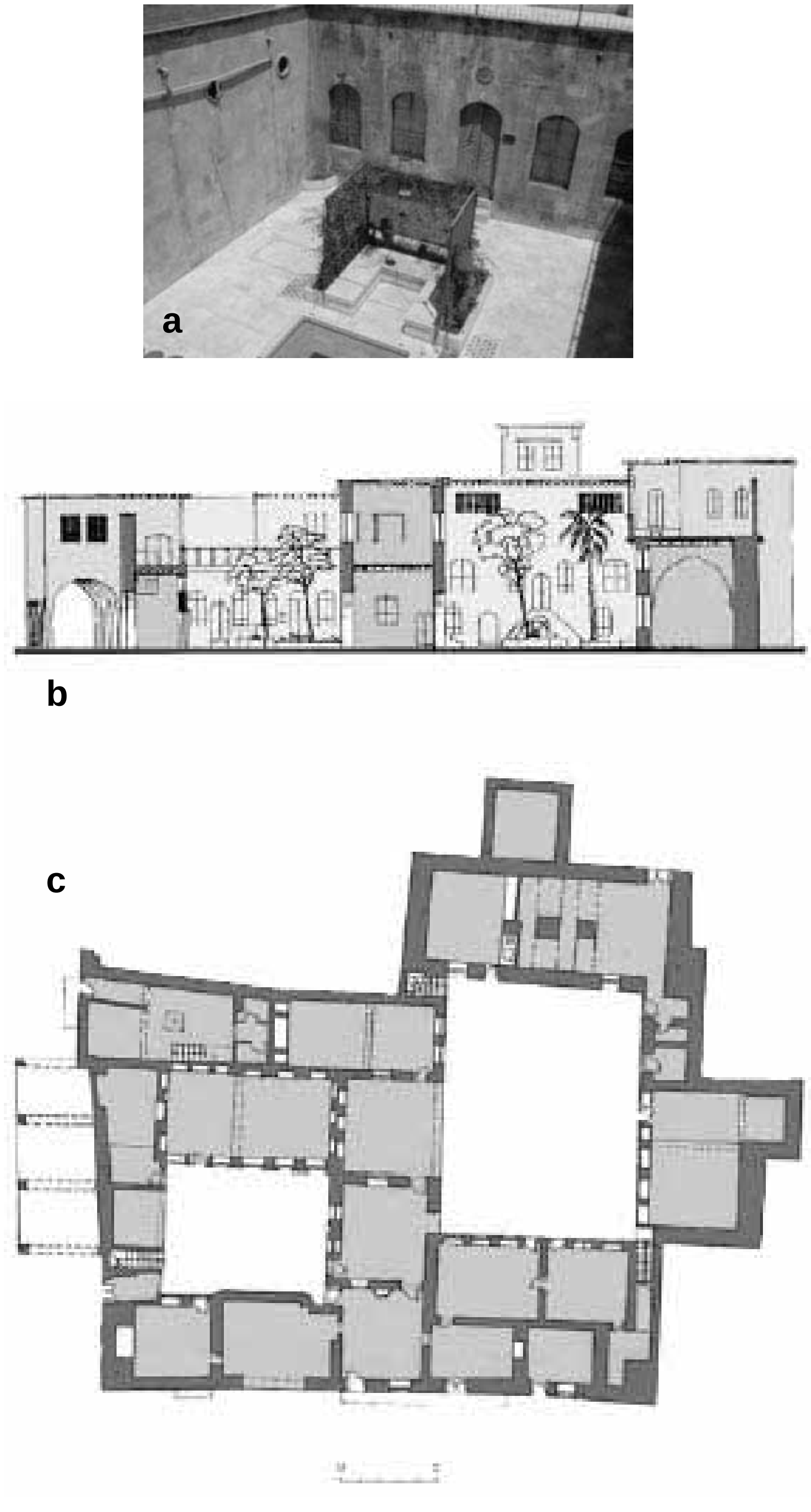


Fig. 1-18 a & b & c :
The above-ground houses: The Urban House with Courtyard.
One of the most common building types in Syria is the traditional courtyard house.
This building type is characterized by a small number of relatively small openings in the external façade, and a large number of openings that open onto the inner courtyard. Traditional houses vary in size and luxury level, and inner spaces vary in number and size from house to house, although they all have one common feature: the open courtyard gives the occupant a feeling of privacy and privileges the relations between the individuals of the family, who develop a strong attachment for the house.
The inner courtyard is a garden and the center of household activities: all the rooms are set around it and open onto this gathering place. In large and medium sized houses, a fountain is placed in the center of the courtyard and freshens the air; trees are also grown in many traditional courtyards, adding shade and life to this exclusive area.

Source: CURPOS

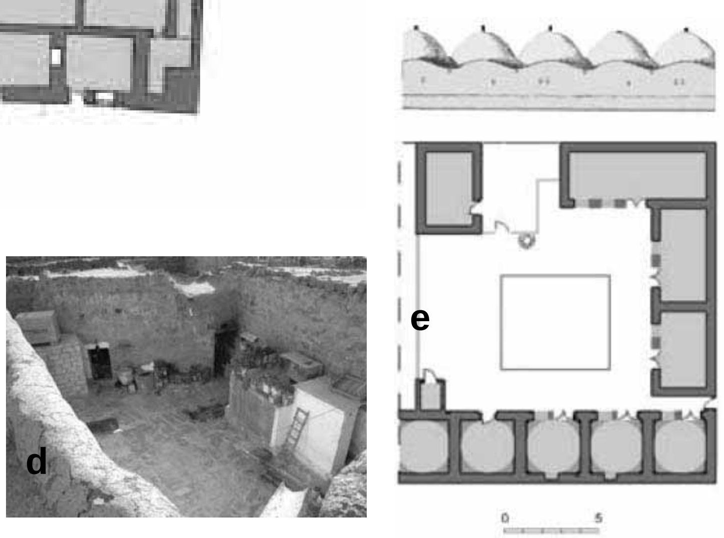


Fig. 1-19 d & e: The above-ground houses Syria, city of Sfireh. Example for mud structures and the use of mud cupolas in roofing. This type is based on the use of one main unit, 4x4m, covered with a cupola and repeated around the inner courtyard.

Source: CURPOS

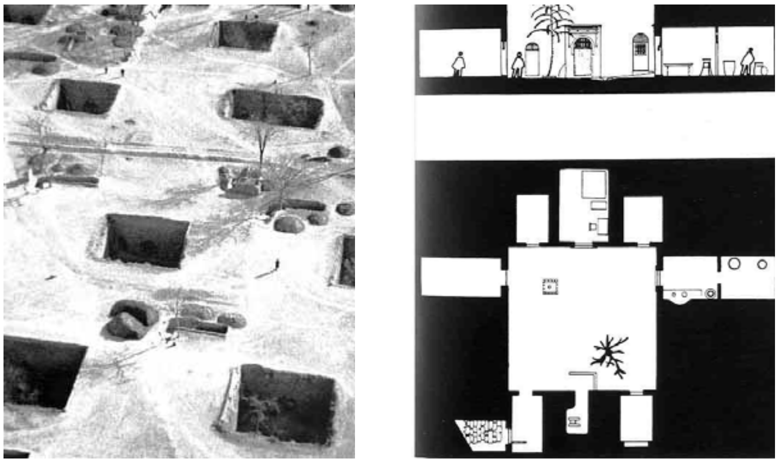


Fig. 1-20: Dwelling below ground, Tungkawn, China. Earth is not only cheaper but is also a better insulation material for heat retention in winter and keeping cool in summer. The interior of a cave dwelling can be 8 to 15 degrees Celsius cooler in summer and up to ten degrees Celsius warmer in winter. The construction of such dwellings causes very little damage to the environment as the earth surface is generally untouched. Caves facing south are traditionally reserved for the head of the family and the elderly. Those facing west are occupied by children, and kitchen and utility areas generally face east. The north-facing caves usually serve as latrines and pigsties.

Source: Behling, 2000, p. 53

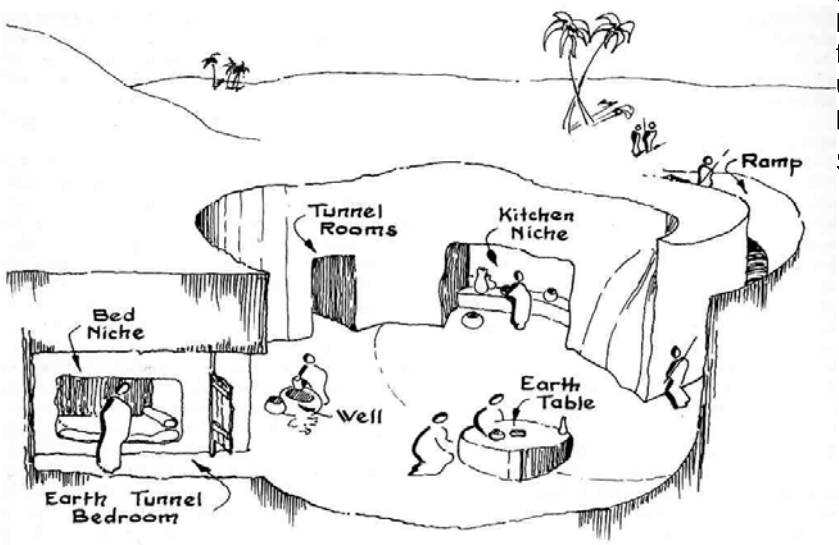


Fig. 1-21: Schematic representation of a Sahara underground house.

Source: Golany, 1980, p. 94.

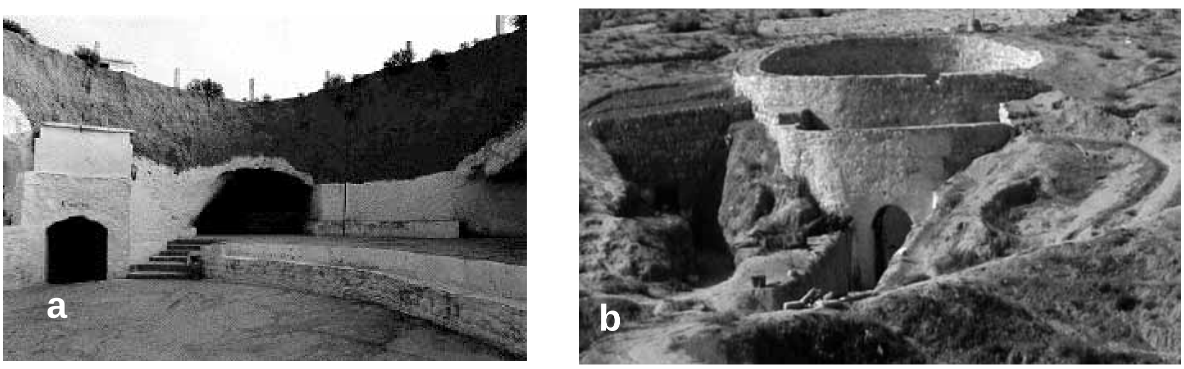


Fig 1-22 a&b: The Cave Homes of Matmâta. On the slope of a hill, the cave village of Matmâta is located. At this place the Berber people dig their homes out of the ground for more than 1000 years. There are more than 100 underground houses. The houses are built around artificial craters, 5 to 10 meters deep, with doors and windows in the steep walls towards the crater. Those craters look like a patio or a Roman atrium, and the lower part of the walls is often painted white. Sometimes several of those craters are connected by a labyrinth of tunnels. But most of the houses are a single crater with several rooms around, used for living, sleeping or storing food.

Source: Moore et al, 1995, p. 24

At both of the noted types, heat gain and heat loss is an integral part of the design process and best design solution cannot respond to outdoor climatic stress if the proper building materials are not selected. These building materials used in arid regions enjoyed the following features (Biyuk, 1999):

- They were often produced locally, which proves that in the ancient times, the residents resorted to domestic material and self-sufficiency.
- They were resistant against high temperature and prevented the heat to penetrate into the inside.

In addition, many different forms and methods in making walls, ceilings and roofs have been taken such as poured mud rammed walls, adobe (sun-burned bricks) ,fire-burned bricks, earth walls supported by wooden walls on one or both sides and thick earth walls sustained by stone walls on one or both sides. Using these materials provide many advantages: it allows flexibility in material management, it supports creativity and variation of forms, it has the color of its surroundings, and so the buildings integrate themselves harmoniously with the environment, it is commonly available and it is economically affordable by all social groups.

In addition, this type of construction, such as an earth wall, is extremely durable. On the long run, the investment value of a structure made of earth is greater than that of many other materials. However, “despite all these positive practicalities of earth architecture, two negative images are associated with it; namely, its use by poorer social groups with low technology, which carries with it a certain status, and inefficient and unhealthy design, especially in rural communities. Also, much earth architecture has been practiced in arid-land regions, and has been historically associated"(Whiethead, 1985, p 555).

Fig. 1-23: Puddled mud walls, Iran.
A) Mud is shaped by hand without use of forms.
B) Mixing is done on the ground adjacent to where the mixture will be placed. A corner pole and line is used to maintain direction and level.
C) Build-up to the wall is done in sequence, allowing earlier courses to dry. In the background, note difference between brick wall and puddled mud wall.

Source: Golany, 1980, p. 101

Beside the role of material, the form of the building in an arid climate is another important character for such region architecture. The form of any building in arid regions includes many architectural features. Their main function is to maximize the total shadows in order to minimize the effect of weather on the building.

For example, keeping the building's roof non-smooth is helping to reduce the temperature that penetrates the roof. The convexity of the roof causes the second and third sections of the room to receive less temperature than the first section and this minimizes the amount of temperature transmitted from an arch type of semi-cylindrical roof (Fig. 1-24, 25). This is as if the surface of the roof is all-smooth, the sun heat would be equally distributed on the entire surface.

In addition, the convexity of the roof increases the velocity of the wind that automatically decreases the amount of temperature absorbed by the roof. An arch or semi-cylindrical roof can also easily transfer the accumulated heat from daytime below the roof at nights and gets cool sooner than a smooth roof.

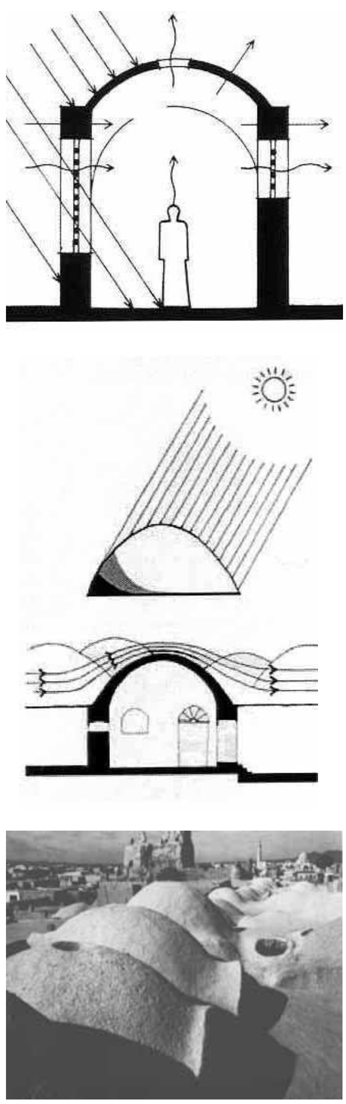


Fig. 1-24: The roof form helps to reduce the effect of heat and wind in arid regions.

Source: Ghanbran, 2004, p. 79 & Golany, 1980, p.77.

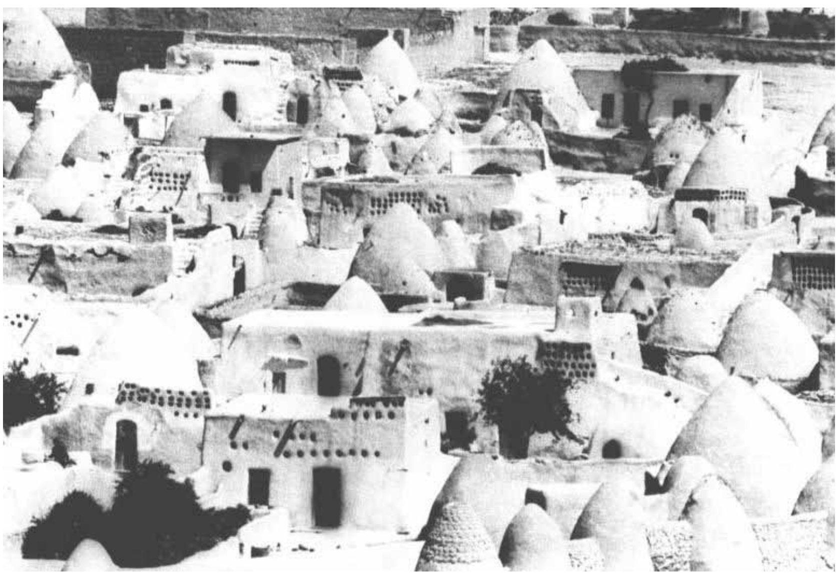


Fig. 1-25: A compact mud settlement in Syria with a complex urban texture.

Source: Saina, 1980, p.97.

1.3.2.4. Urban Network

Urban networks such roads and paths within an arid urban community, are a major factor in shaping such communities. This is because their channels for air movement and heat exchange and the significant role for establishing the community climate in an arid region, as parallel networks design supports air movement and dusty winds when surfaces are not paved. Such a wind can cause an accumulation of garbage, effect heat exchange, and bring cool wind at night and hot winds during the day (Golany,1983). Therefore, the path networks of communities in arid regions have been developed with many spatial characters that prevent both the direct exposure to the sun and the movement of the dusty winds. This is through:

Fig. 1-26: Narrow paths to provide shadow. Town of Yazd,Iran.

Source: Golany, 1983, p. 75

- The proportions of the path: Narrow and winding streets produce minimal heat exchange, and therefore, they are normally shadowed and cooled in the daytime and are warm at night (Fig. 1-26),
- The orientation of the paths, which is usually designed east-west causes shadowing (Fig. 1-27), and
- Covering paths through both architectural and natural elements (Fig. 1-28, 29).

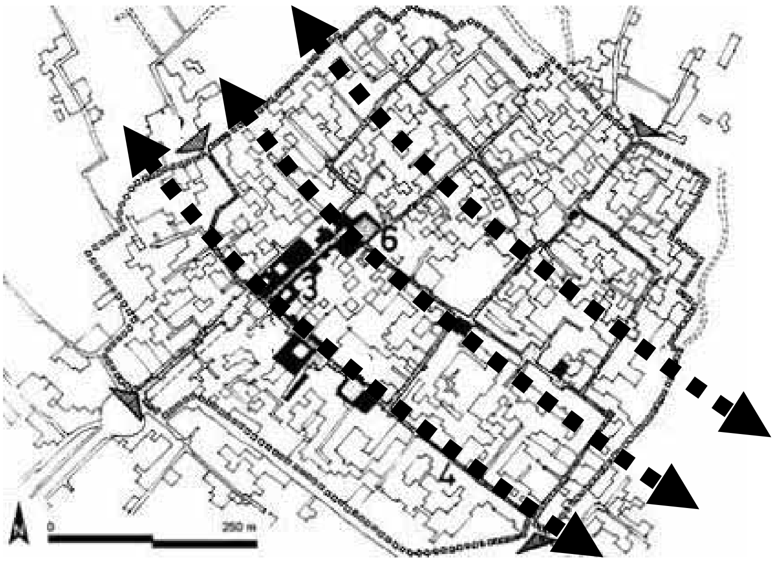


Fig. 1-27: Settlements around the world, 3500-1500 B.C.

Source: after Ghanbran, 2004, p. 23

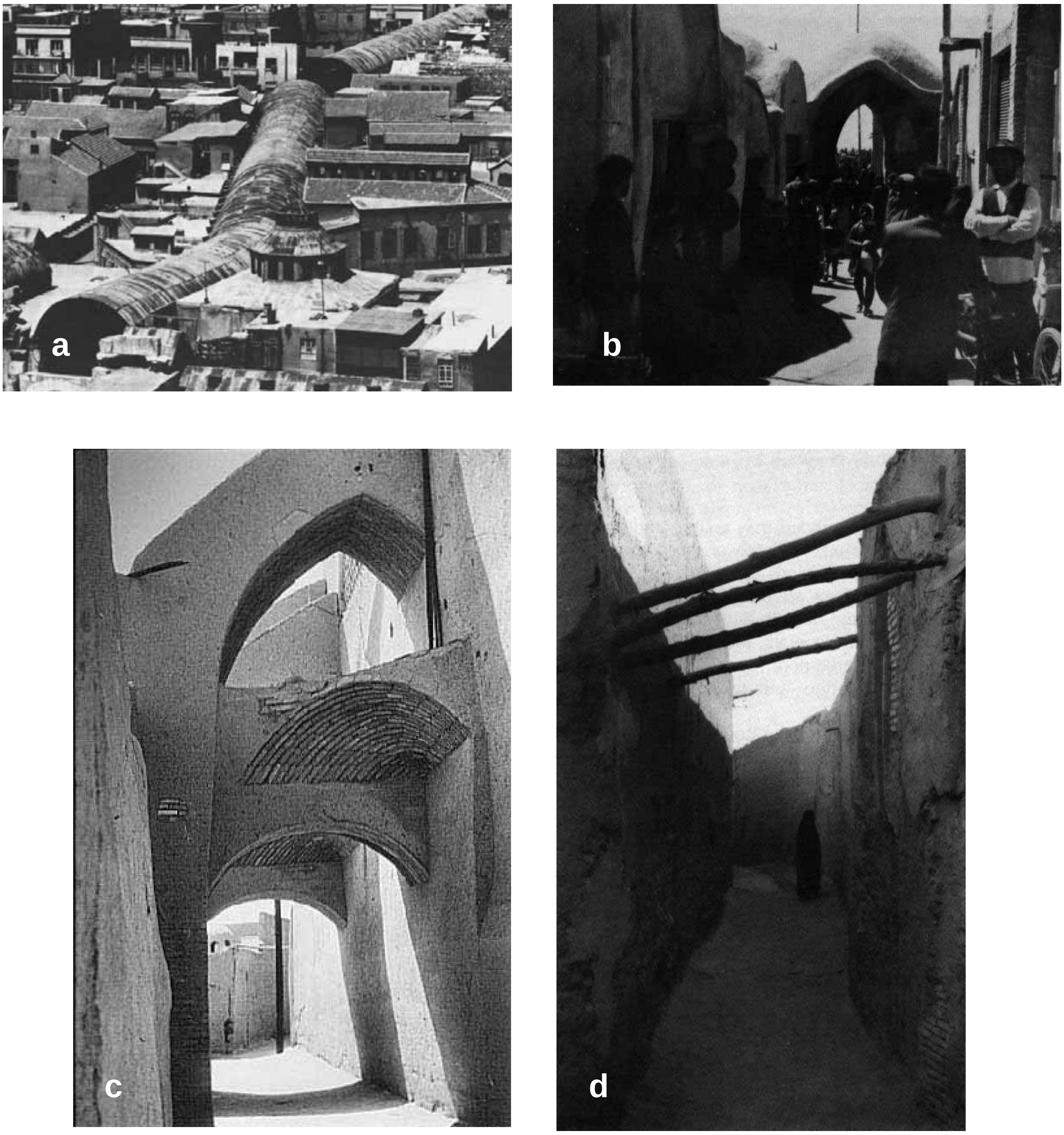


Fig. 1-28: Four types of the paths in the traditional town.
a) The arcade In Damascus, Syria, is covered with a continuous roof to provide shade.
b) Local bazaar street, Sirjan, Iran.
c) Narrow path in Yazd and crossed by buttresses.
d) Sample traditional Narrow paths, Yazad

Source: Saini, 1980, p.95 & Golany, 1983, p.129, 134,136 & Ferdowsian, 2002, p.139.

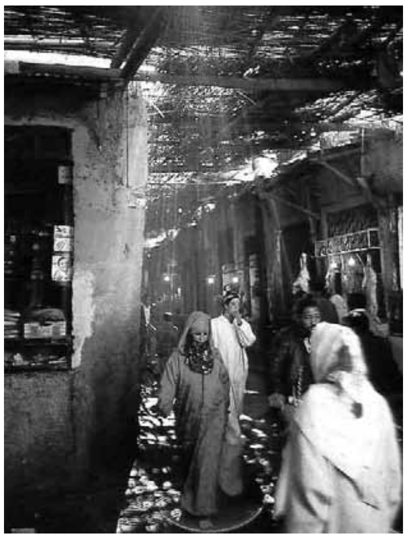


Fig. 1-29: Narrow streets with their ranks of tall buildings keep out the sunlight and the fierce sand-laden winds, and stripes of shadow cool shoppers in a Moroccan bazaar. Roof screens filter the sun's rays, and the contrast is extremely welcomed.

Source: Behling, 2000, p.66.

1.3.2.5. Open Space Pattern

The concept of open space in the arid communities is essential based on climatically, socially and aesthetically aspects. They are including two types of open spaces; the outdoor open space (public open space) and indoor open space (private open space). The importance of these spaces is to help in reducing the effects of the arid weather. However, the second type of these spaces is considered as one of the most important characters of arid communities such as the patio or courtyard. They play as an important tool for ventilation and creating a livable indoor space (Fig. 1-30).

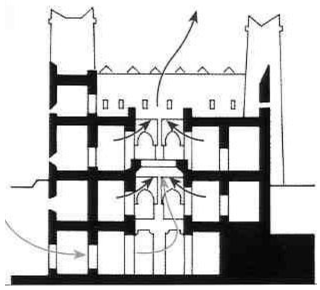


Fig. 1-30: The courtyard houses help in ventilation.

In the arid weather, the courtyard serves as a dynamic space of day activities. It is set in the middle of the building and is normally square or rectangular in form and at times corners grow arched (Fig. 1-31). It connects the apartments in the buildings, provides lighting and air to its rooms, serves as children's playground, is used for daily chores such as washing and assembly of elders beside the pool or the garden in summers, and the corners serve as storage spaces for preserving extra furniture. The pool and gardens in the yard, its limited area and lofty surrounding walls and trees provide ample shade in daytime and coolness in the evening (Fig. 1-34, 35, 36).

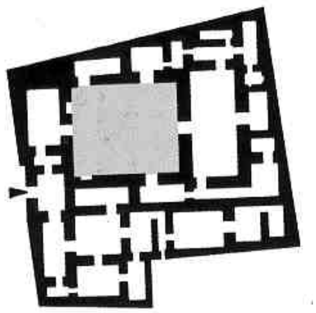


Fig. 1-31: The typical Babylonian houses. Houses around courtyards.

Source: Behling, 2000, p. 81.

Fig. 1-32: The courtyard house, Yazad, Iran

Source: Golany, 1980, p.128.

Fig. 1-33: The courtyard, the typical character of houses of Yazd City, Iran

Source: Ghanbran, 2004, p. 23

Fig. 1-34: The courtyard, trees and water, the most important design tools for inner spaces.

Source: Ferdowsian, 2002, p.131

Fig. 1-35: The courtyard, Agadir, Morocco.

Source: Archnet, Web site

Fig. 1-36: The courtyard , Arab House Restoration ,
Granada, Spain.

Source: Archnet, Web site

1.3.2.6. Site Selection

For traditional communities, site selection for new dwellings in the arid regions was an evolutionary process performed through practical observation in the field and in consideration of the day-to-day applications and needs. However, the criterion for site selection has included many aspects and according to Golany (1983), they became main guidelines for selecting sites of arid regions communities such as the climatic comfort, seasonal and diurnal; Physiography, and Hydrological considerations to avoid erosion.

In conclusion, according to Konya (1980) the settlement and buildings must be adapted to summer conditions, especially, the problem of protection from intense radiation from sun, ground, and surrounding buildings, besides protection from sand and dust storms. Compact planning for groups of buildings is necessary to provide mutual shading and minimum exposure. Enclosed, compactly planned and inward looking buildings with patios and courtyards are therefore most suitable. Orientation: larger dimensions and windows should face north and south, and the worst orientation, west east, can be used for non-habitable spaces to form a thermal barrier. Rooms can be deep, should ideally open on to patio or indoor courtyard. Outdoor areas must be enclosed, inward looking, contain plants, be cooled by water and be shaded for most of the day. In this regard, paved paths are preferable. Windows and ventilation openings should be relatively small, particularly on outside walls, and should be shielded from direct radiation and glare. Roofs should be solid, heat storing and Double roof may be used in order to lower the direct effect of the sun.

1.4. Urban Planning for Arid Regions Communities: New Trends

During The twenty century, new approaches for developing arid regions communities have been formulated. They can be divided into 2 stages; before the 70s; and during and after 70s.

Before the 70s. The first stage had begun within the middle of the twenty century, when there was a new understanding for the vernacular and traditional architecture, and its communities. At this time, many architects and planners have discovered how successful this architecture type is, in solving problems of arid region environments. This is through the intensive use of means of passive architecture, which enables the arid community to face the stress of an arid environment. They have studied all the traditional characters of these communities and they began to use it as design guidelines for arid regions urban development. This movement towards using concepts of traditional architecture had shaped many architectural directions. They can be grouped into; direction of using traditional concepts with the same traditional solutions, and direction of developing arid regions urban communities without consideration to the effect of the climate aspects, or using some traditional concepts, only, within new solutions.

Fig. 1-37: Example for Fathy's work: Sadruddin Aga Khan House, Egypt. Plan and elevations.

Source: Fathy, 1986.

For the first group, architecture of "Hassan Fathy" - “Architecture for the Poor" is a good example. He utilized ancient design methods and materials, and integrated knowledge of the rural Egyptian economic situation with a wide knowledge of ancient architectural and town design techniques. He trained local inhabitants to make their own materials and build their own buildings. Climatic conditions, public health considerations, and ancient craft skills also affected his design decisions. Based on the structural massing of ancient buildings, In addition, he incorporated dense brick walls and traditional courtyard forms to provide passive cooling. He had thought that although change is inevitable but" changing a single item in a traditional building method will not ensure an improved response to the environment, or even an equally satisfactory one" (Fathy, 1986, p.8).

Fig. 1-38: Using the traditional materials with the traditional forms. New Bariz, Egypt: the village's market.

Source: Richards, 1985, p.129.

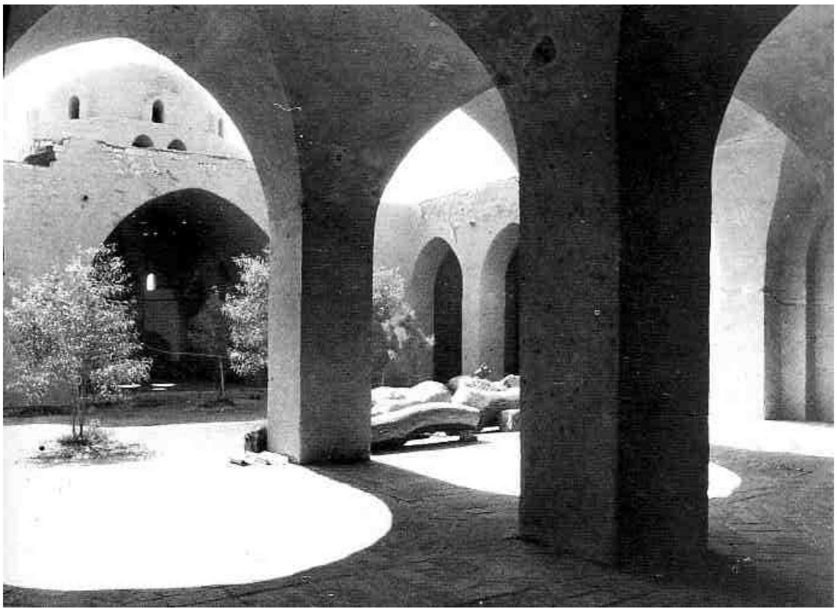


Fig. 1-39: New Gourna, Egypt: The courtyard of the mosque.

Source: Richards, 1985, p.111

As for the second group, they tried to develop arid regions urban communities without consideration to the effect of the climate aspects, or they used some traditional concepts such as building design forms, using elements that maximize the shade and shadows, cooling concepts…etc. without a complete vision. They used these concepts to get its benefits in reducing the environmental conditions, but in a set of new architectural solutions. This is in order to meet the needs of the modern live. However, many of the architecture applications of this direction failed to give a complete comfort, which can be gained within the traditional architecture. This is due to the use of some materials, such as concrete.

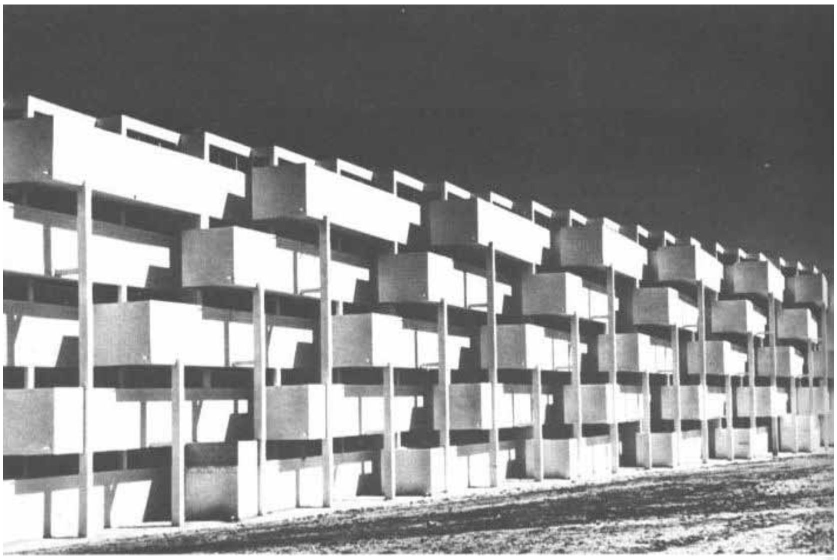


Fig. 1-40: Low-cost high-rise flats in Casablanca, Morocco, have been designed by architect. The higher ceilings achieved by staggering of floors virtually turn each balcony into a semi-open courtyard.

Source: Saini, 1980, p.110.

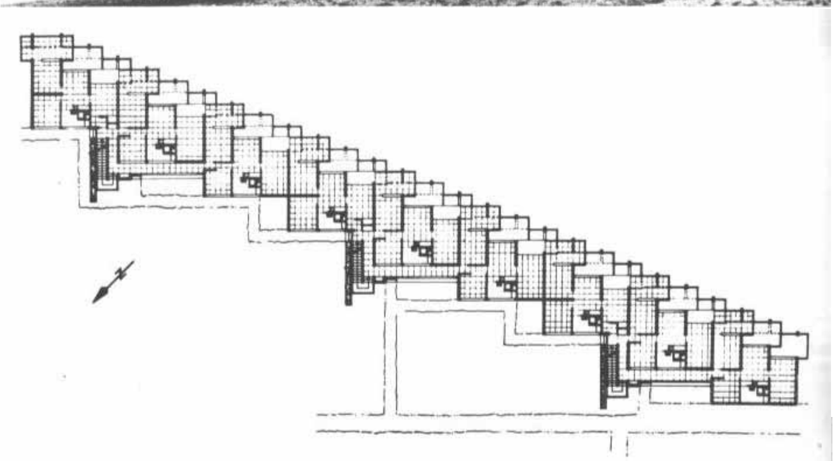


Fig. 1-41: The plan of low-cost high-rise flats in Casablanca, Morocco

Source: Saini, 1980, p.110.

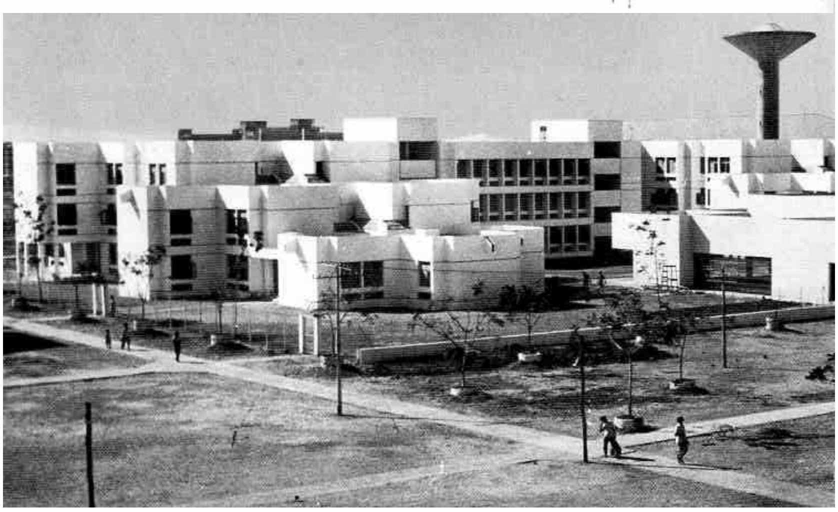


Fig. 1-42: C.M. Correa & et al (India): typical image of the public housing in developing countries at the end of 60s and 70s.

Source: Kultermann, 1980, p.118.

During and after the 70s. During the 70s , the 80s and 90s there was a great interest in how to change arid regions community to face the necessity for developing characters and design principles of these communities in order to suite the new needs of the modern community.

At that time, there was a belief that developing arid regions is a good solution for the rapid increasing of population in the existing urban cities. This is besides the need for using such regions potentials, which offer new chances for economic development, especially in developing countries. Therefore, needs to develop arid regions have exceeded the traditional development programs in order to develop new and modern urban communities. This period has characterized by the broad interest in climatic design and passive and low-energy construction standards, which had begun at the early 70s (Rosenlund, 1995, p.59). The authorities at that time have dealt mainly with fundamentals of climate and comfort, environmental design, materials, techniques, strategies for climatic design, infrastructure, and planning (Box1-2).

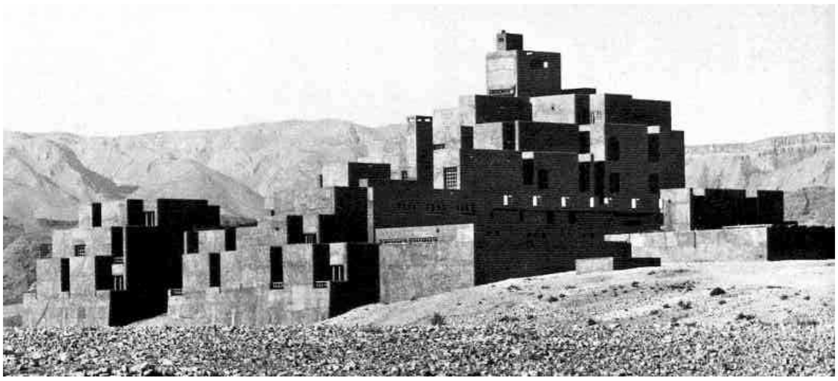


Fig. 1-43: A. Faraoui & P. de Mazieres: Hotel of Boulmane du Dades, Morocco, 1972-1974.

The compact building design with the minimal exposure to the outdoor.

Source: Kultermann, 1980, p.70.

Fig. 1-44: L.V. Locsin: House of citizens in Makati, Manila,1974.

Using principles and means to maximize shading, and the courtyard helping in ventilations and to change the indoor climate.

Source: Kultermann, 1980, p.158.

Fig. 1-45: R. Chadirji (Irak): The court-house as main concept for housing development.

Source: Kultermann, 1980, p.98.

<u>BOX 1-2 The authorities climatic design .</u>

- Givoni (1969/1976) '*Man, Climate and Architecture*': he takes a physical/physiological approach to the issue and steps outside the main stream of contemporary literature referred to above. He covers climate, comfort, building materials, orientation and isolation, ventilation, climate adaptations, heating/cooling… etc.
- Lippsmeier (1969/1980) *'Tropenbau -Building in the Tropics'* , 'energy crisis' : he was one of the 'Olgyay school'. He recognized both climate and culture as factors for building form. He had created a need to analyze and discuss the new technological objectives for building. The main parts of his work treated the characteristics of tropical regions, climate, design factors, materials, and techniques, strategies for climatic design, infrastructure and planning.
- Koenigsberger et al.(1974) *'Manual of Tropical Housing and Building - Part 1: Climatic Design*' they used the Mahoney tables as main design tool, where filling in climate data leads to some basic principles for building design. Computer calculations are mentioned, but the lack of user-friendly interfaces at that time is identified as a major constraint to their use as powerful design tools.
- Konya (1980) *'Design Primer for Hot Climate':* Like the others, he treats not only fundamentals of climate and comfort, environmental design, materials and technology, but also hazards such as sand and dust, storms and earthquakes. Vegetation plays an important role in the presentation, and he considered the surroundings of the house in relation to the indoor environment. Much of the theory is based on Olgyay (1963), such as that of comfort and solar radiation.

Source: after Rosenlund, 1995, p.61-65.

In addition, some authorities treated other approaches. They argued that climate is not the only problem in an arid region, and in order to deal with these regions, there is a need to develop complete approaches, which consider all sides of arid regions development, as economical and social sides, as well as the environmental problems caused by the climate of an arid region.

For example, at the beginning of the 80s, Golany (1983) claimed that if arid-zone community is to be a pleasant place for its citizens to live and work, and if it is to be truly responsive to the world crisis in energy resources, a careful consideration to all aspects of its development must take place. Thus, urban development in arid regions should not be looked upon as an isolated issue, and it must be a part of a general and overall policy involving economical, social, physical change and implementation (Box1-3).

BOX 1-3 Urban development in arid region according to Golany .

According to Golany, urban planning in arid regions should consider a lot of principles, which are gained through studying the traditional arid regions communities. However, he referred that in order to achieve a real development for such regions, new bases for policies and strategies should take place as the following:

- The economy of a developed arid zone should be diversified and not solely dependent on agriculture or the dominant natural resources. Diversification in employment leads to social heterogeneity and stabilizes the regional economy.
- Resources (such as the climate), which have been rediscovered in the arid zone and are beginning to be developed, should be further exploited. In addition, some economic activities, for which the resources are not available locally, should be brought into the region to support its economy.
- Comprehensive planning is most desirable for the proper development of the region. It is necessary to introduce comprehensive planning rather than build spontaneously or plan one aspect at a time. A long-range comprehensive plan, which forms a cohesive part of national goals and policy, is essential on a regional and local basis. Such plans guarantee continuity and persistence in the development. The mutual ties between the national and the regional goals will not only support the development of the arid zone financially but also morally and otherwise.

Source: after Golany, 1982, p.12.

However, existing urban development approaches in general, above all in developing countries, have focused mainly on the physical sides of the urban development, and on how to maximize the use of potentials, which are provided in arid regions. As a result, a set of problems have occurred at the level of community development, and at the other related levels as environmental and socio-economical levels. This is besides the problems due to the climate of arid regions.

Consequently, there are recent calls to create new approaches of urban development for such regions. The aim of these calls is to reconstruct the urban development approaches for arid regions communities in a way that solve all their problems, which do not focus only on the environmental problems at the first place.

In this sense, the UNEP in its report "The global drylands imperative"(UNEP, 2003) claimed that the well-being of present and future human populations in drylands, and arid region as a part of the dry lands, depends on ecologically sustainable and socially equitable ways of living. In order to achieve this, there is a need to move away from a one-size-fits-all approach and move toward a more suitable adaptive management strategy that embraces, understands, and respects the complexity of drylands. Management strategies need to work within the dynamics of the drylands, not 'fight' against it.

Therefore, the contributions of participants at The IUSSP conference held in Amman, Jordan "*Population and Environment in Arid Regions*" (Findlay, 1996), have gone far beyond presenting a purely academic assessment of the problems associated with population and environment in arid lands. They identified policies, which are needed to be addressed, and proposed more sensitive management strategies to deal with the problems facing people of these regions. They claimed that it is necessary to form some broad assessment of the resources of these regions, resources which include the physical, technical, financial and human, and upon the exploitation of which depend on the nature and form of settlements. They claimed, also, that population growth presents particular geographical challenges to arid environments, with demographic pressures leading to demands not only for enhanced food production systems, but also for increased fuel resources and other alternative sources of livelihood. They found that according to all problems facing the development of arid regions, their solutions should not only affect the extent of localized building and planning activity but should affect the whole question of regional and national planning.

In conclusion, "we have now entered the 'Urban Era', with half of the world’s population living in cities and the urban population growing by 60 million people each year. The challenge of our era is to rebuild our global cities in a sustainable way. New approaches are needed to be taken in land use, planning, urban design, transportation system development, infrastructure development, energy policy, and building design" (Harris, 2005). In this regard, without neglecting the experiences that we have form the traditional arid regions communities or the knowledge gained over the last decades, there is a need to renovate the existing development approaches that are dealing with urban development for arid region. In order to achieve sustainable development for arid regions communities, these approaches should cover all development sides such as economical and social sides as well as the physical and urban sides.

1.5. Problems Facing the Process of Urban Development in Arid Regions

Arid zones must be considered in terms of their complementary interrelations with other ecological zones. In this sense, they exhibit much potential for sustainable development. However, they have suffered from many problems, which affected its development. These problems are linked, in the first place, with their environment.

An arid zone is unbearably hot during the day, but chilly if not cold at night. Therefore, hot dry zones are defined as areas of low humidity and high solar radiation, where cooling of the skin by evaporation can occur, and where dehydration and dust are the two main threats to human comfort. This also influences plants and animals and has a negative impact on buildings and human settlements. Therefore, this variation in temperature has an influence on the type of building materials, and high evaporation rates influence areas of green and cultivated land ... etc. This is besides the lack of water and the difficulty of providing enough water to maintain human, animal and plant lives. This is besides strong winds, which, together with sands, cause sudden sandstorms that are destructive to plant, and animal lives. They also lead to the movement of sand dunes in certain directions.

Another problem is the geographical location; they are mostly widespread areas and due to their harsh natural conditions, it is difficult and costly to reach or penetrate them. This geographical isolation leads to a cultural isolation of their inhabitants. This was, in turn, reflected on the technological standard of the various activities; industries, agriculture and irrigation systems. It was also reflected on the social, structural, cultural, educational and habits standard.

These environmental problems caused by arid regions climate besides the existing urban development approaches, which have focused mainly on the physical sides of the urban development, have led to a set of economical, social, administrative and physical problems, which have been connected with urban environment poverty, dispersed human settlements, poor infrastructure, and low urban densities with few job chances. This is besides, desertification; high vulnerability to drought, geographical and political isolation; lack of services - especially health and education (UN, 2004 & &Nasr, 2000 & Ahmed, 1985).

This group of problems varies from one country to another and reflects the economic, political, social and cultural situation, the technological standard and the extent to which various planning policies are applied (Fig. 1-47).

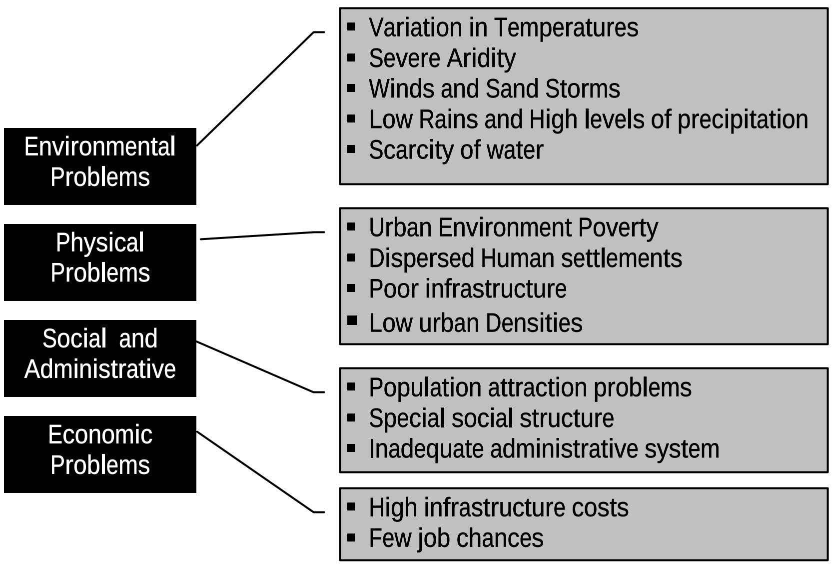


Fig. 1-46: Summary of the problems facing the process of development in arid regions.

Source: After UN, 2004 & &Nasr, 2000 & Ahmed, 1985

.

1.6. Conclusion

Arid regions cover about 40% of the land surface of the planet and they are characterized by sensitive ecosystems that are particularly vulnerable to both natural and man-induced changes. Now they are inhabited by about 20% of the world population. These regions can provide sufficient opportunities for extensive development as they have many opportunities particularly in fields of agriculture, mineral excavations, tourist expansion, industry and renewable energy, that they can play a beneficial role in any process of urban development for such regions.

Climate of arid region is the main factor that influences such regions. Therefore, the main policy, which has affected the process of development of such settlements, was how to reduce the effect of the arid environment on the settlement. Urban development approaches in general, especially in developing countries, have focused mainly on the physical sides of the urban development, and on how to maximize the use of these regions potentials. As a result, a set of problems have occurred at the level of community development, and at the other related levels as environmental and socio-economical levels. This is besides problems due to the climate of arid regions, which have led to a set of economical, social, administrative, and physical problems, and which have been connected with urban environment poverty, dispersed human settlements, poor infrastructure, and low urban densities with few job chances. Therefore, without neglecting the experience that we have got from the traditional arid regions communities or the knowledge gained over the last decades, there is a need to renovate the existing development approaches that are dealing with urban development for arid region. In order to achieve sustainable development for arid regions communities, these approaches should cover all development sides such as economical and social sides as well as the physical and urban sides.

Chapter 2

Arid Region Communities
Case of Egypt

Arid regions communities in Egypt are a part of the Egyptian urban movement. This chapter, therefore, will concentrate on the urban development movement in Egypt, particularly, development history of the arid regions communities within the frame of the Egyptian urban development. Furthermore, it will analyze the current Egyptian urban policies and strategies, and the impact of these polices and strategies on the development approaches of the arid regions communities in Egypt. This is as a tool to demonstrate the basic characters of these communities and the urgent need to set up a new approach for urban development to achieve sustainability.

2.1. Introduction for Urban Development in Egypt

2.1.1. General Review

2.1.1.1. Geographical Location

Egypt is a Middle Eastern country in the northeast corner of Africa. Egypt is bordered by the Mediterranean Sea to the north; Gaza Strip, Israel and the Red Sea to the east; Sudan to the south; and Libya to the west. The area of Egypt is 1,001,449 Km^2. The country's greatest distance from north to south is 1,024 kilometers, and from east to west, 1,240 kilometres. Egypt's natural boundaries consist of more than 2,900 kilometres of coastline along the Mediterranean Sea, the Gulf of Suez, the Gulf of Aqaba, and the Red Sea. Cairo, Egypt’s capital, has 16 million inhabitants, and Alexandria, the country’s second largest city, has a population of 5.5 million (CIA, 2005).

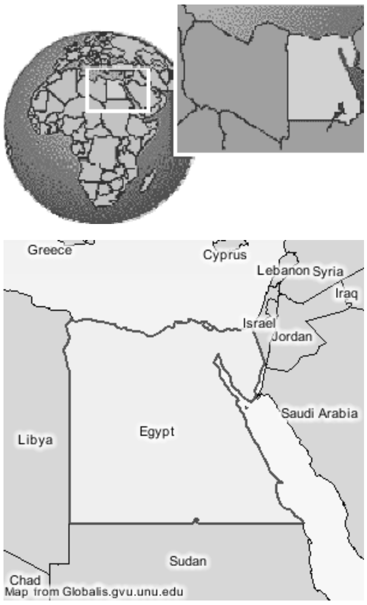


Fig. 2-1: The location of Egypt.

Source: globalis, 2006

Egypt is mostly desert, as most of the country lies within the wide band of the arid regions that stretches from Africa's Atlantic coast across the continent and into south-west Asia. The main physiographic feature of the country is the Nile River, which flows from south to north through Egypt for about 1600km. It shapes the only 35,000 Km^2 (about 3.5% of the total land area) that are cultivated and permanently settled. Egypt geologically is divided into four major physical regions: the Nile Valley and Delta, the Western Desert, the Eastern Desert, and the Sinai Peninsula. The Nile Valley and Delta is the most important region because it supports 90% of the population for being the country's only cultivable land.

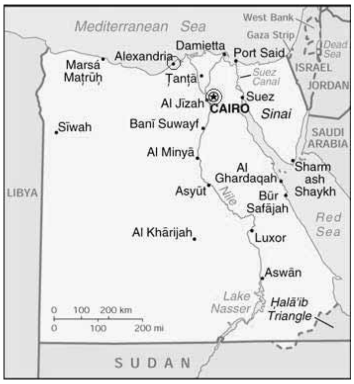


Fig. 2-2: Map of Egypt

Source: USA.gov, n.d..

2.1.1.2. People

Egypt is the African's second largest country in population. According to the recent estimations in 2006, Egypt’s population totaled 78 million and it will reach about 85 million by 2015 (fig.2-4). Most of Egypt's inhabitants (about 90%) live in the Nile Valley and delta, and the rest of the country (about 96% of Egypt's total land area) is

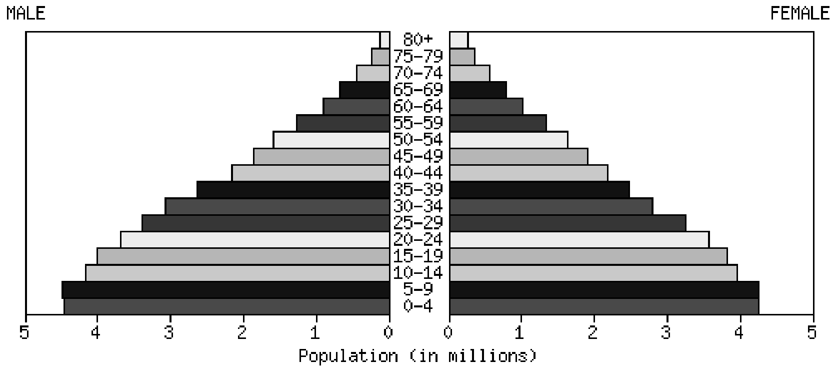


Fig. 2-3: Egypt population pyramid 2005

Source: Nation Master, 2007.

sparsely populated (Fig. 2-5). About 44% of the population is concentrated in urban areas and the rest in some 4,000 villages (CAPMS, 2004, p.24). The population distribution problem is obvious in some areas, such as Cairo, which have a density of more than 100,000 people/ Km^2. In addition, there are some villages of more than 30,000 people. At the same time, thousands of square kilometers in the deserts are vacant of population. Therefore, redistribution of the population concentrated in the Nile Valley, is one of the fundamental goals of the demographic policy in Egypt. (Merdan, 1999, p.37

Merdan (1999) argued, also, that population growth can be an ecological problem, because it can lead to problems such as pollution or depletion of resources. Therefore, an increase in population might require more intense exploitation of resources or more technological development with pollution as a side effect. This is besides the increased population in a specific location may be harmful to human well-being. Therefore, unless the Egyptian programme of new urban development is able to absorb most of this increase in population, it will not be possible to solve the over concentration problems.

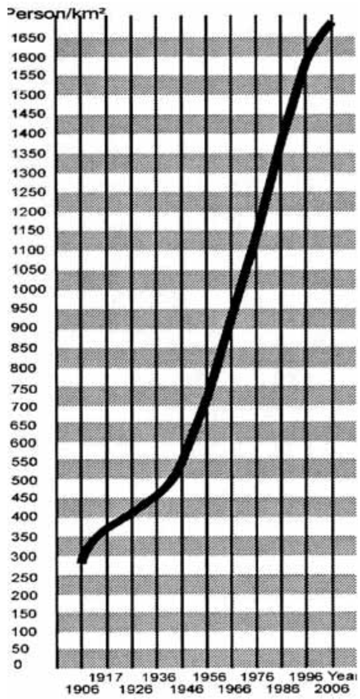


Fig. 2-4 : Egypt population density according to the inhabited area 1896-2006.

Source: Merdan,1999,p.37.

Table 2- 1 Demographic evaluation of Egypt (1000)

year	1950	I960	1970	1980	1990	2000	2006	2015	2025
Population	21 834	27 840	32 285	43 749	59 333	67 884	78 887	84 425	94 777

Source: After Ali, 2003 & SB, 2001

Table 2-2 Average annual population growth rate

year	1950-1955	1960-1965	1970-1970	1980-1985	1990-1995	1995-2000	2000-2005	2010-2015
Growth Rate	2,46	2,51	1,92	2,57	2,01	1.82	1,67	1,26

Source: After Ali, 2003 & SB, 2001 & CAPMS,2004

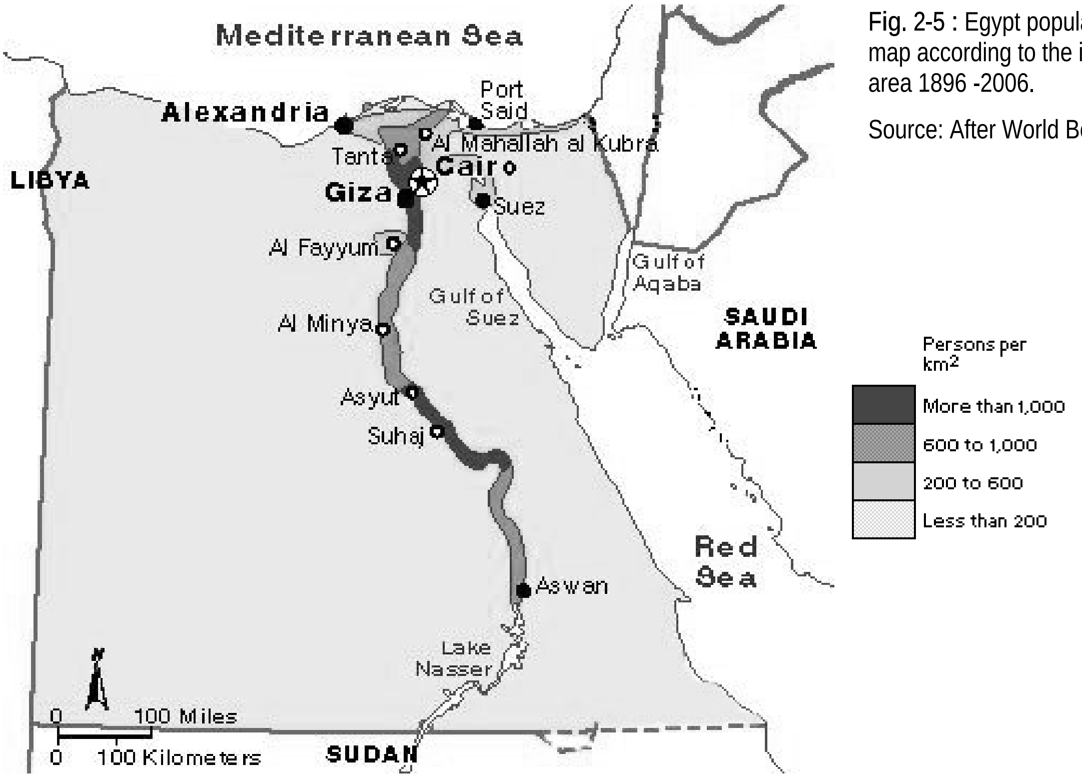


Fig. 2-5 : Egypt population density map according to the inhabited area 1896 -2006.

Source: After World Book,2005.

2.1.1.3. Economy

Before the revolution of 1952, Egypt's economy depended mainly on agriculture. Since then, other economical development sectors have been developed, and at present Egypt exports oil, finished textiles, canned food, cars…etc. The Suez Canal is considered an important source of revenue as an average of 70 ships cross it daily and pay fees. Tourism is also a main part of the economy. In addition, there is an effort to increase the cultivable land, of the country using new irrigation methods in the desert to be a base for new agriculture industries. Also the sector of mining and its industries form a main element in the Egyptian economy (Table 2-3 & Fig. 2-6).

Table 2-3: Economical production in Egypt for 1998

Economical activities	% of GDP produced	Number of workers	% of all workers
Manufacturing & mining	25	2,111,200	13
Trade, restaurants, & hotels	19	2,226,900	14
Agriculture & fishing	17	4,822,700	30
Community, government, & personnel services	16	4,136,200	25
Transportation & communication	9	954,100	6
Finance, insurance, & real estate	6	440,500	3
Construction	5	1,287,100	8
Utilities	2	203,400	1
Total	100	16,182,100	100

Source: World Book 2005 After International Labour Office; International Monetary

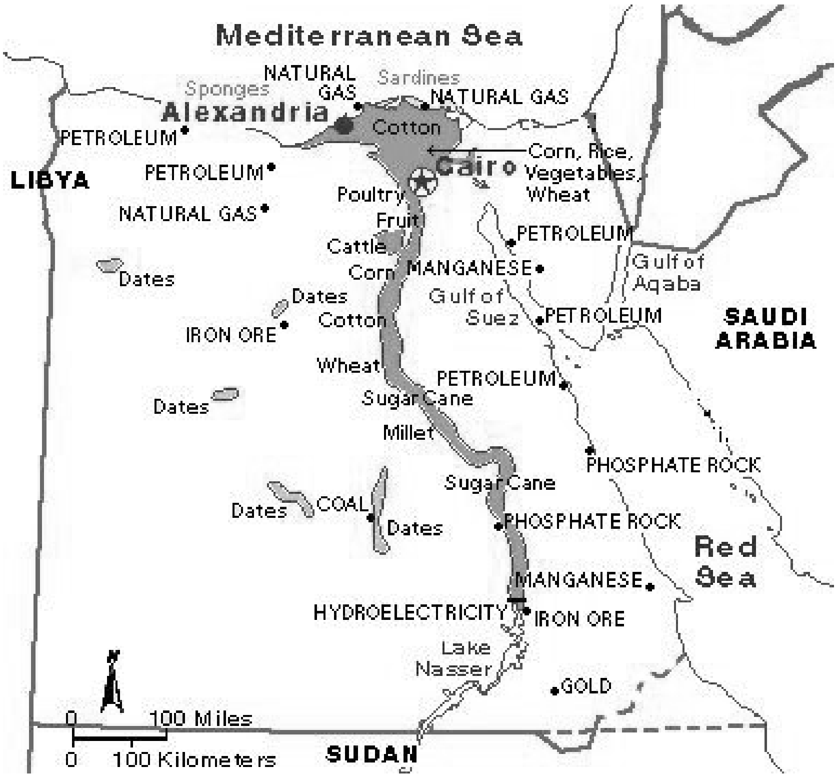
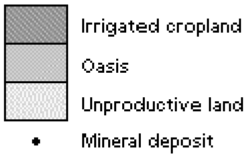


Fig. 2-6: Economical production

Source: After World Book, 2005.



2.1.2. Urban Development in Egypt

2.1.2.1. Administrative Hierarchy of the Process of Urban Development

The process of urban development in Egypt registered a hierarchal development system divided into four levels: central level; regional level; governorates level; and local level. However, the power of decision-making is concentrated at the first level (Fig 2-7).

(a) Central Level:

It is the level of the government and the ministry of housing, infrastructure, and new urban communities. The power of decision-making is concentrated at this level.

(b) Regional Level:

Egypt is divided into seven urban regions. Each region is a homogeneous area with a particular set of associated conditions, weather of the land, the climate, or the people. Each region has its own characteristics that vary with the culture of the community itself. These regions are as follows: Greater Cairo, Alexandria, Suez Canal, Delta, Upper Egypt, Asyout, and Lower Egypt (Merdan, 1999, p.47) (Fig.2-8).

(c) Governorates Level:

Egypt is divided into twenty-six governorates, which include four city governorates: Alexandria, Cairo, Port Said and Suez; the nine governorates of Lower Egypt in the Nile Delta region; the eight governorates of Upper Egypt along the Nile River south from Cairo to Aswan; and the five border governorates covering Sinai and the deserts that lay west and east of the Nile (Fig 2-9).

(d) Local Level:

It can be called the settlement level. It contains metropolises, cities, and rural districts of any governorates. They have, within the government boundaries, a spatial hierarchy according to their type, either urban or rural and according to their size.

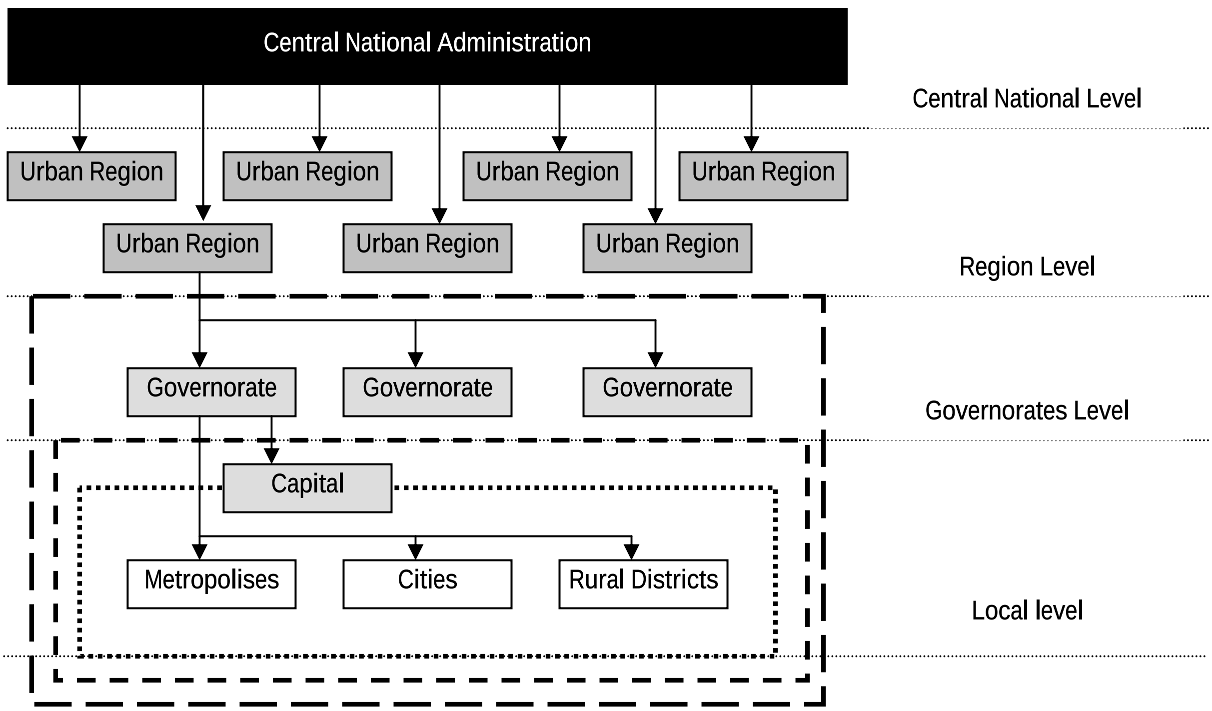


Fig. 2-7 : levels administrative hierarchy of the process of urban development

Source: Researcher

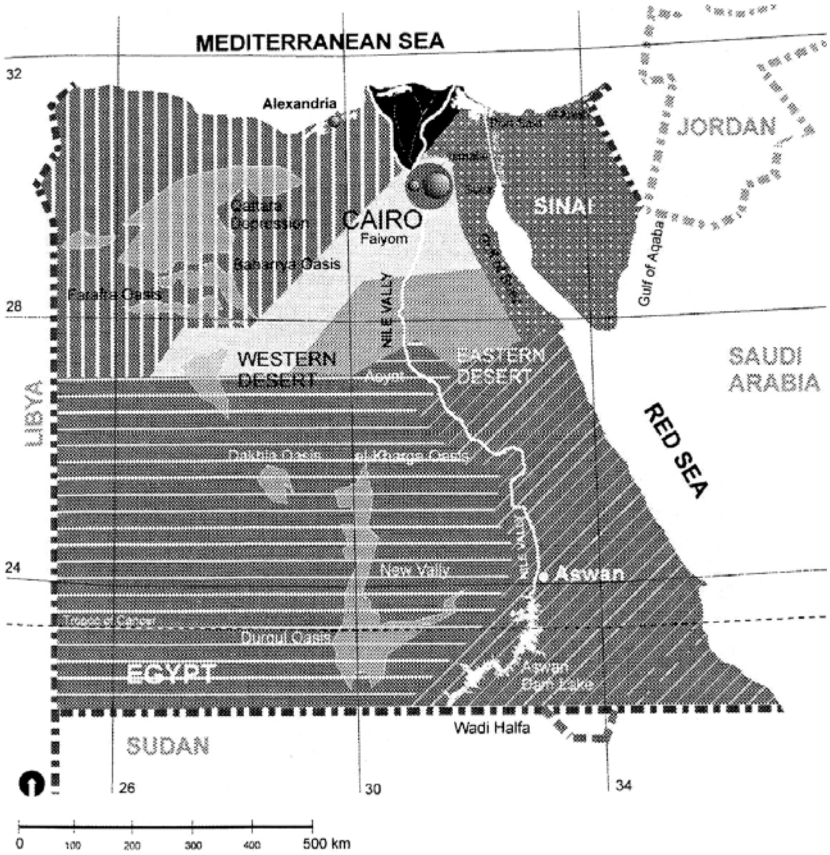


Fig. 2-8: Urban regions of Egypt

Source: Merdan, 2005, p.47

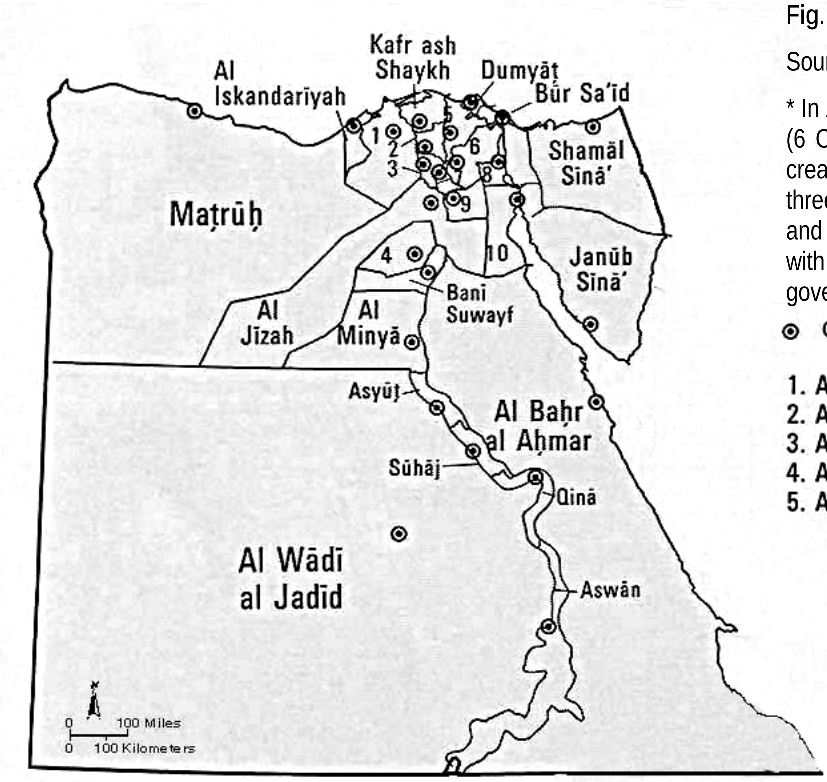


Fig. 2-9: Governorates of Egypt *

Source: University of Texas,2006.

* In April 2008 two new governorates (6 October und Helwan) have been created by changing the borders of three old governorates (Cairo, Giza and Al Fayyum). Till now, no maps with the borders of the new governorates are available.

⊙ Governorate capital

1. Ad Daqahlīyah
2. Al Buḥayrah
3. Al Fayyūm
4. Al Gharbīyah
5. Al Ismā'īlīyah
6. Al Minūfīyah
7. Al Qāhirah
8. Al Qalyūbīyah
9. Ash Sharqīyah
10. As Suways

2.1.2.2. Directions of Development

The major aspect of the development strategy, according to State Information Service Egypt (SIS) (1997), is to expand from the old valley as the tool that would cause rejuvenating the whole country and would emphasize its extraordinary capacity to make civilization. In this realm, new directions for urban development towards outside the valley have been created. According to the Egyptian strategy, they are divided into two main directions. The first is to Sinai, where the Nile water will be soon flowing eastwards and westwards through Al-Salam Canal spreading out, as ever before, construction and urbanization. The second is to the south of Egypt, where work is performed to extend the Nile water into the core of the Western Desert. This is besides the strategy of development of the northern and eastern coasts for tourism and redevelopment of the existing built areas in the valley.

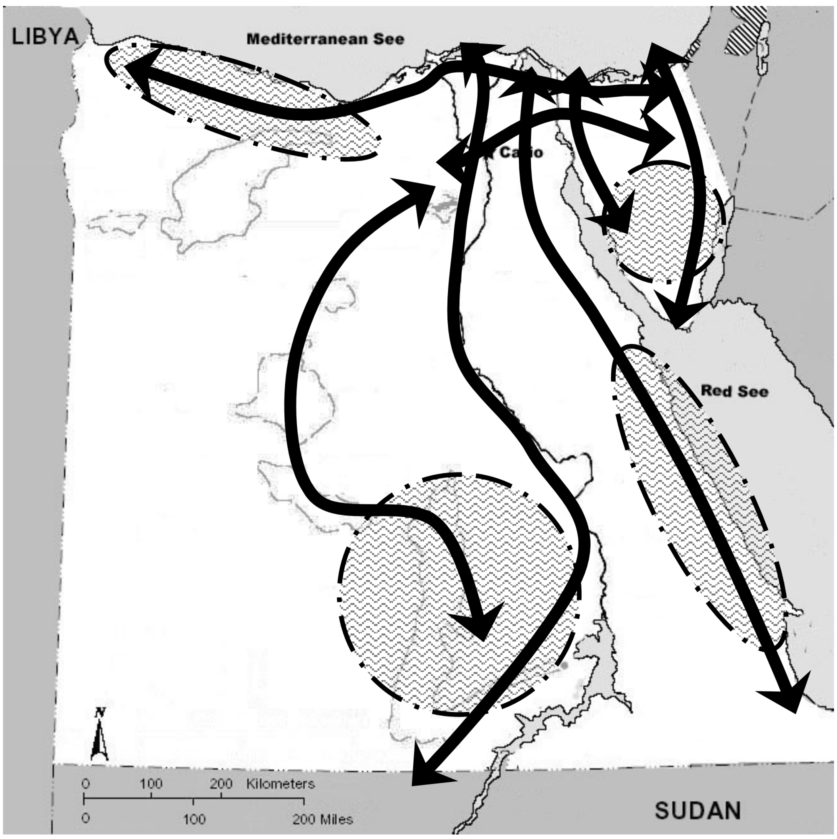


Fig. 2-10: Urban development directions of Egypt

Source: Researcher

2.1.2.3. Urban Policies and Strategies

With the increasing worsening in urbanization status in residential areas, it was so necessary to adopt a new conception for rural development, which is based on more developed and more comprehensive vision. In this context, new ideas were formed such as: desert invasion, spreading urban scope through the total country's area.

As this was the vision after the October War in 1973, the Egyptian government approved a new strategic plan, and it was presented in a working paper "October Working Paper". In this paper, the government defined the outlines of a strategic plan for social and economical development policies. The national urban development strategy was a part of this working paper, as "the authorities dealing with urban development in Egypt are working within the context of the national level of policies" (Merdan, 1999, p. 55).

The *October Working Paper* stressed on the importance of creating new development axis with new urban communities to accommodate the population growth and to attract new economical activities. The important objectives of this strategic plan, the October Working Paper stressed on (Shalaby, 2003, p.3 & Merdan, 1999, p 55-56. & Ali, 2003.p.56-57):

- Rapid economical development through setting up new industrial bases that gathered the governmental sector and the private sector to improve national production and income.
- Establishment of new urban centres outside the Nile River valley and the Delta, whenever industrialization is well located as main economical activity, to relieve population pressure from existent urban areas.
- Development of the Egyptian urban and economic structure through diversification of the national economical base pillars and encouraging the private sector participation in the national economy movement.

- Evolution of the basic national resource of social wealth that is the human force, through provision of diversified job opportunities in various economical fields such as industry, tourism, and wholesale with the same level of attention given to the agricultural field.
- Utilization of coasts and unsuitable desert areas for agriculture through spreading of diversified new communities all over these areas to exploit their hidden potential and natural wealth.
- Construction of new communities with integrated services, utilities, and economical activities, in front of the existing major cities to absorb their population surplus and to attract their in-migration waves to relieve the existent pressures over their services, utilities, and activities.

Based on this main outline of the Egyptian strategies and policies, the Egyptian government established the "Organization on New Urban Communities", in 1979, as a part of “the Ministry of Housing, Utilities, and Urban Communities” to be responsible for developing new cities in Egypt. This organization also established a "New City Development Council" in each new city to be responsible for developing and managing. Based on the urban development strategy, the Egyptian new cities have been established to achieve political, economical, and social objectives (Box 2-1).

In general, the urban development strategy is based on two main items, which include development of desert areas besides Improving of the existing urban structure. (Ministry Of Housing, Infrastructure and New Communities, 2000, p. 10)(Fig. 2-11)

BOX 2-1 The Objectives of the Egyptian Urban Development Strategy .

According to Shalapy (2003), The Egyptian new cities have been established to achieve the development objectives, which include:

Political Objectives:

- Solving the urban problems of rapid urbanization explosion, unrestricted sprawl, high rates of population growth, and over-concentrated population in the traditional areas.
- Accommodating the increasing population growth and encouraging migration of people from old cities to the new ones to solve the problems of old cities.
- Protecting the agricultural land from continuous encroachment by urban and industrial expansion through providing alternative urban poles that are attractive for industrial activities.
- Opening new gates to develop and to encourage development outside the traditional populated area that does not exceed 4% of the country's total area through creating integrated development growth poles with diversified economic bases.

Economic Objectives:

- Supporting and enhancing the national economy through the creation and development of effective diversified economic bases able to increase the gross domestic production and provide suitable job opportunities.
- Enhancing the national economy through paying special attention to export-oriented industrial projects by encouraging the industrial activities that are able to penetrate international markets and compete other products, in order to increase the foreign currency stock.
- Encouraging and supporting the industrial activities with certain types that produce particular products able to replace imported products, in order to save the limited foreign currency stock.
- Encouraging the private sector to participate more effectively in establishing and supporting the new communities' industrial base, especially small-scale industries.

Social Objectives:

- Improving the living standards in existing urban areas namely, providing better housing, adequate community facilities, and infrastructure and acceptable environmental quality, after evacuating of these areas from their over-population and redeveloping their urban components.
- Creating new job opportunities in order to solve the problem of unemployment, which is considered one of the main social problems.
- Providing social and physical services, which would raise living standards and provide proper living environment for different sectors of population.

Source: Shalaby, 2003, p.3-4.

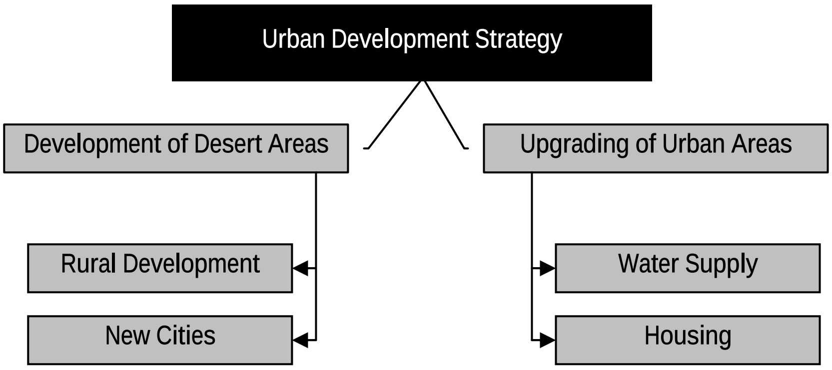


Fig. 2-11: The two main directions of the Egyptian urban strategy

Source: Ministry Of Housing, Infrastructure and New Communities, 2000, p. 10

Developing Distant Areas. Distant areas are those areas that did not get enough attention during the last period, such as Western Northern Coast, Suez Canal, Red Sea Coast, Sinai Peninsula, New Valley in Western Desert. The aim of utilizing those areas was to exploit its economical potential and creating more job opportunities for the increasing population. Among the plans dedicated for those areas are:

- The strategy of the development of Sinai,
- Regional plan for developing eastern Northern Coast,
- Regional plan of the Red Sea Governorate,
- Strategic plan of developing habitat in New Valley South Egypt, and
- The strategy of the development for Upper Egypt Region.

Establishment of New Cities. These are the cities established in desert areas to act as new urban centres and growth poles away from the narrow crowded valley, in an attempt to redistribute the population among the whole area of the country. In this context, 17 new urban cities were established, to which half a million feddan were allocated. These 17 new cities are planned to attract 6 million inhabitants, providing 200,000 job opportunities, and contribute 20,000 million pound to the GDP in both industrial and agricultural sectors.

Recently, to achieve goals of the development strategy, Egypt's plan for development and construction until the year 2017 has been developed. The plan included new 44 urban communities including these already established new communities. The New urban communities are divided into three stages that are planned to assimilate 12 million inhabitants (Fig.2-12) (Table 2-4). They Include:

- ***The First Stage***: includes the 17 cities that are already established which include the first three generations of the Egyptian new towns. This stage has begun by the middle of 1970s, when the Egyptian government started the first step in developing new urban communities by introducing Tenth of Ramadan as the first new city in Egypt in its modern era (Shalaby, 2003).
- ***The Second Stage***: includes the 14 cities that are still under constriction
- ***The Third Stage***: includes the 28 cities that are still being studied

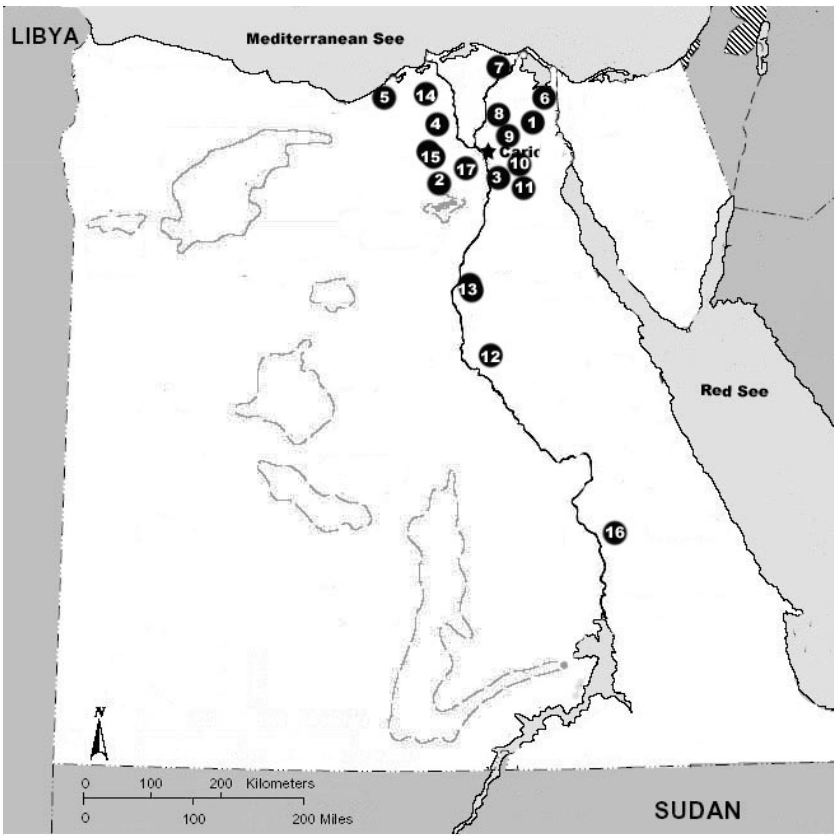
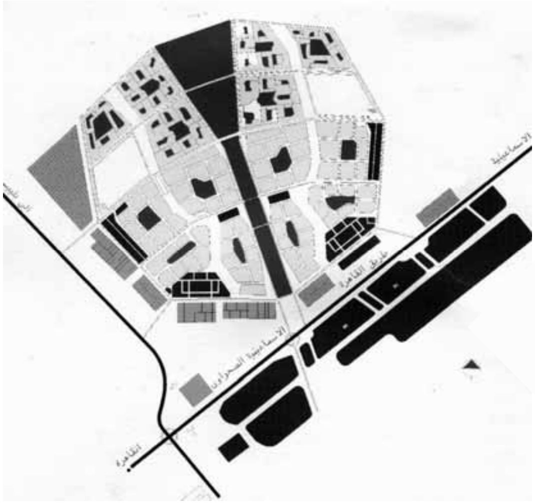


Fig. 2-12: The first generation of new towns in Egypt

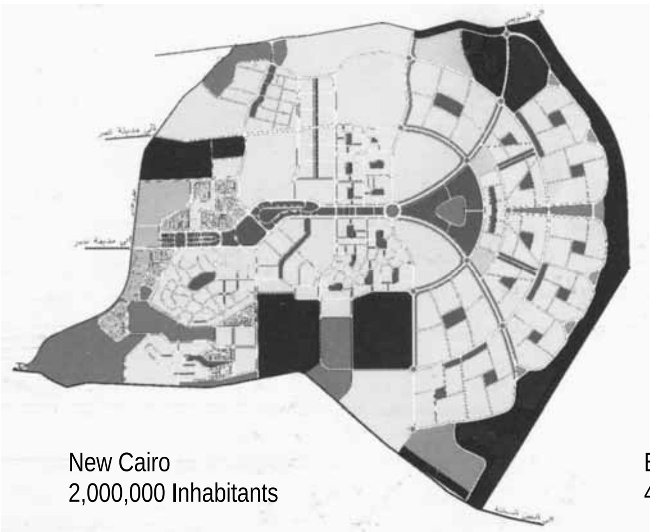
1 10th of Ramadan
2 6th of October
3 15th of May
4 Al Sadat
5 New Borg El-Arab
6 New Salheya
7 New Domiat
8 Badr
9 Al-Obour
10 Al-Sherouk
11 New Cairo
12 New Beni-Sweif
13 New Menia
14 Al-Noubaria
15 Sheikh Zayed
16 New Asiout
17 New Teeba

Source: Researcher after Merdan, 1999, p.58.



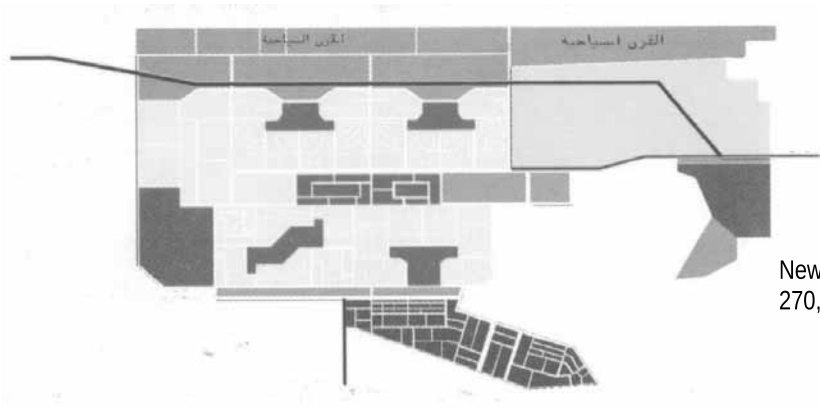
10th of Ramadan
500,000 Inhabitants

6th of October
550,000 Inhabitants



New Cairo
2,000,000 Inhabitants

Badr
420,000 Inhabitants



New Domiat
270,000 Inhabitants

Fig. 2-13: Examples of the new Egyptian towns

Source: Ministry Of housing, Infrastructure and New Communities, 2000.

Table 2-4: The Egyptian new communities (The new strategy till 2017)

	First Generation	Second Generation	Third Generation
1	10th of Ramadan	El Farafra	South Sidi Barani
2	6th of October	New Akhmeim	South Marsa Matrouh
3	15th of May	New Sohag	South Dabaa
4	Al Sadat	East El Tour/ Ras Mohamed	South Sidi Abd Rahman
5	New Borg El-Arab	Al-Amal	Wadi Netroun / Alamin
6	New Salheya	New Fayoum	El-Wahat / El-Alamin
7	New Domiat	New El-Kharga	Nourth Siwa
8	Badr	New Dakhlia	East Siwa
9	Al-Obour	East Oyeinat	El-Bewity / Siwa
10	Al-Skerouk	New Kena	Technology Valley
11	New Cairo	New Nagei Hamadi	New Rafah
12	New Beni-Sweif	New Aswan	New Nakhl
13	New Menia	New Edfo	Abou Zeneima
14	Al-Noubaria	Toushka	Tarik Wadi Feran
15	Sheikh Zayed		West Zaafrana
16	New Asiout		Bani Mazar / Raas Ghareb
17	New Teeba		Fayoum / Alexadaria road
18			Koraimat / Zaafrana
19			El-Fashn / Bani Mazar
20			Dairout
21			El- Wahat / El- Barania
22			Dairout / El- Farafra Road
23			Western City / Asiout
24			Beer Mor
25			Wadi El Allaki
26			Karkar
27			Shark El-Bohairat
28			West Karoun Lake

Suorce: after EnCube,2005

In addition, according to Shalaby (2003), the existing new cities can be divided into four main types according to their economical bases. They are industrial cities, residential and service cities, agricultural cities, and mixed purposes cities. Table (2-5) shows types of the new existing cities.

Table 2-5:Types of the Egyptian new towns according to the economical bases

Industrial Cities	Residential and Services Cities	Agricultural Cities	Mixed Purposes Cities
10 of Ramadan	Fifteenth of May	New Salheya	6 of October
Al Sadat	Al Shorouk	New Nobariyah	New Domiat
New Borg Al Arab	New Menia		Al Obour
Badr	Al Sheikh Zayed		New Cairo
New Bani Sweaf	New Teeba		
New Asiout			
Al Amal			

Source: Shalaby, 2003, p. 11

2.1.3. Development Problems in Egypt

2.1.3.1. Population Problem

The population problem in Egypt has many faces. Therefore, it is considered as one of the serious problems facing the process of urban development in Egypt. We can divide it into two main categories: population increasing problems; and population migration problems.

(a) Population Increase and Rapid Urbanization;

Population increasing problems are a direct effect to the recently rapid rate of population growth. Although this growth rates decreases recently, it is still form a serious problem. This is because of the limited agriculture opportunities combining the increasing growth rate. This increase is because of a constantly high birth rate combined with a steady declining death rate. Thus, land availability has not been enough to meet the needs of growth. In addition, cultivated land area has dramatically decreased in comparison with this rapid population increase (table 2-1 & 2-2).

(b) Population Densities:

Most of the Egyptian population is concentrating intensively on the narrow Nile Valley, whose area does not exceed 3.5% of the total area of the country. About 74 million (in 2006) forming about 95% of the total population, are concentrated in the valley. The rest 4 million, about 5% of the population — live on 96.5% of the area of the country (CAMPS, 2004). The problem will become clearer by analyzing population densities nationally, which are varying dramatically if arid zones are included. In addition, excluding the desert, they are considered one of the highest in the world (Table 2-6).

In addition, because of internal migration, the density in urban areas is increasing more rapidly than that in rural areas. For example, while the density in rural areas increased by about 28% (1960 - 1976), it increased by more than 60% in urban areas (Ahmad, 1985, p.36).

Table 2-6: Density in Egypt

Average total density in Egypt	37p./km2
Average total density in the valley	1022p./km2
Density in the desert	0.27p./km2
Density in Cairo (highest density)	3737p./km2
Ratio between the density in Cairo to that in the whole valley	23 times
Ratio between the density in Cairo to that in the desert	97914 times
Ratio between the average density in Egypt to that in valley	0.036 times
Ratio between the average density in Egypt to that in desert	137 times
Ratio between the density in the valley to that in the desert	3785 times
Ratio between average density in Egypt to that in Cairo	0.015 times

Source: Ahmad,1985, p.37

(c) Rural to Urban Migration:

Migration from rural to urban areas is one of Egypt's major problems. While the urban population increased by more than 600% between 1907 & 1976, the rural population increased by 127% only. This is because of spatial imbalances and their social, economical, and cultural implications (Ahmad, 1985, p.37).

The flow of migration is mainly to Cairo as a centre of all services. It is together with Alexandria absorbs more than 73% of the internal migration on the national level. Therefore, about 55% of the urban population (1996) are concentrated in it (CAMPS, 2004, p.33-34). This leads to the unbalance in the population distribution structure, and if this trend will continue, it will increase the development obstacles.

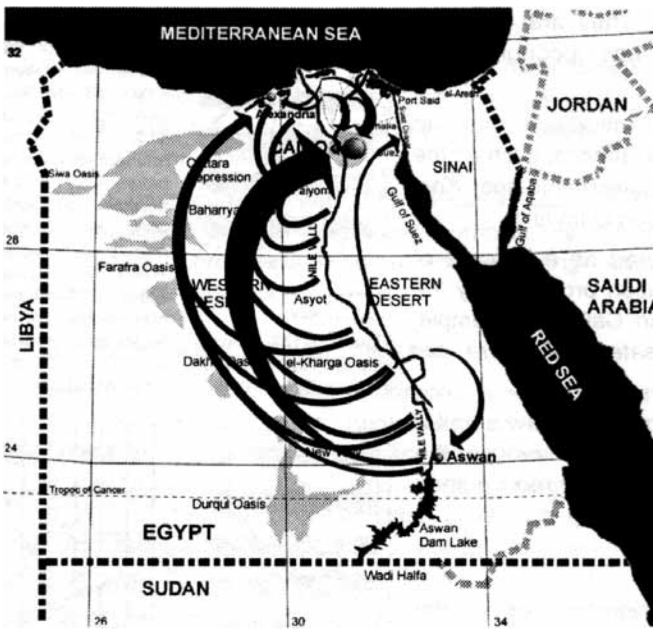


Fig. 2-14: The internal migration directions in Egypt.

Source: Merdan, 1999, p.39.

2.1.3.2. Economical Problems

Economical problems are the second aspect, which affected heavily the process of development in Egypt. One of the important problems in the Egyptian economy is consumption explosion, especially in consuming accessory goods, which increased recently dramatically. The relatively low Egyptian GDP ($92.6 billion - 2005 est.), and GDP - per capita ($4,400 - 2005 est. – rank 132 worldwide) becomes clear when it is compared with the other countries (CIA, 2005). This can explain fast all aspects of the economical problems in Egypt. It includes low individual income/poverty, unemployment, decrease agricultural land, and insufficiency of food supply.

In addition, many estimations and studies show that a problem of energy will appear in the next two or three decades. This is because of two reasons. Firstly, energy demand in Egypt is growing rampantly, especially that population will reach about 85 million by 2015, and this will affect dramatically oil exports and the prices, which is already noticed nowadays (Fig.2-15). Secondly, the actual estimations, which show that the Egyptian oil reservoirs will end by 2020. This means that there is a need to develop new sources of energy, and this should be started from today. Besides, the way we live in our communities should be readapted to face this problem.

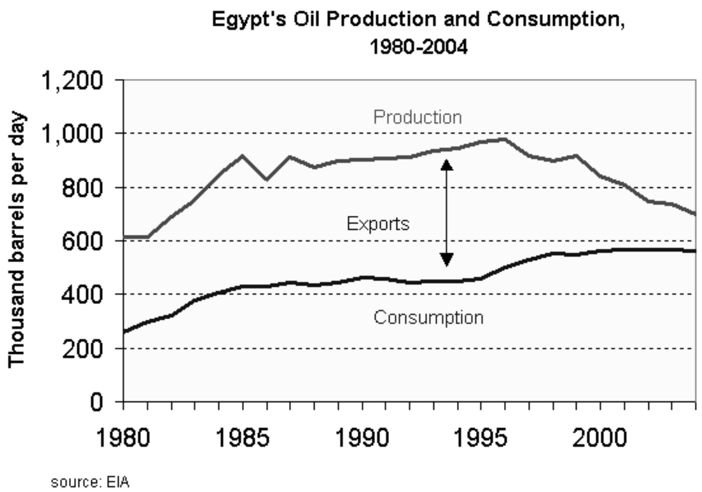


Fig. 2-15: Egypt oil production and consumption 1980 – 2004

Source: Esser, 2005

(a) Low Individual Income/Poverty

It is an important indicator of the situation of the Egyptian economy. According to CAMPS, only 20% (2005 est.) of the Egyptian families live below the absolute poverty line. However many studies show that the real ratio is between 45-60% as their average annual income does not exceed 2 $/ person/day (especially after the last changes of the Egyptian economical system). This rate varies according to the location. It is about 9% in urban areas, 47% in rural areas, and about 52% in Upper Egypt. Also, comparing with the other indicators show that the average Egyptian GDP and GNI are under the Lower-middle-income group (Fig. 2-16).

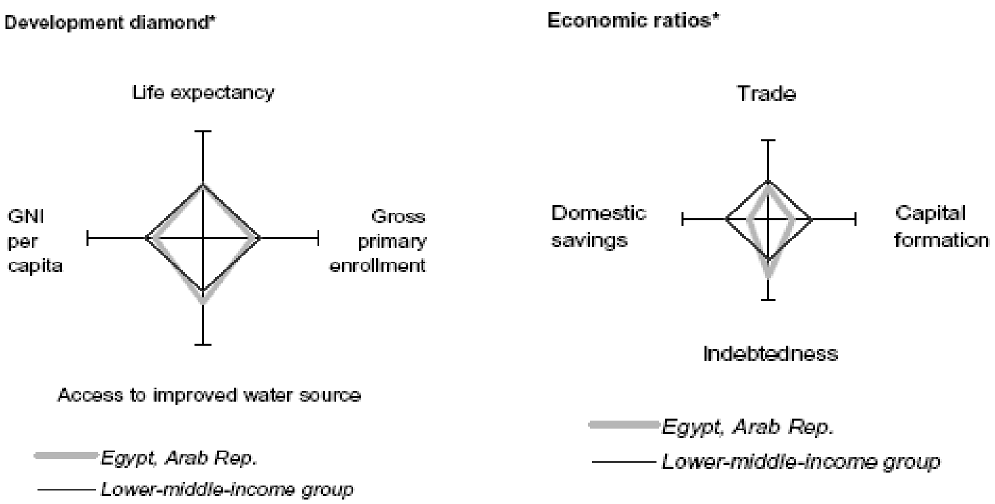


Fig. 2-16 above: Economical indicators of Egypt: the indicators show that both the GDP and GNI are under the lower-middle-income group.

Source: World Bank, 2005

(b) Employment and Unemployment

It is considered as the most important problem that threatens the social system in Egypt, as it is concentrated mainly among the young people and graduates of intermediate and higher education (more than 55% of total unemployment). Unemployment continues to linger in rural areas accounting for 52 % of the total unemployment in 1998 (Table 2-7). At the same time, job chances concentrated mainly in the relatively rich governorates (Cairo, Giza, and Alexandria) account for two-thirds of the demand. This stresses on the importance of creating employment opportunities and establishing production projects.

Table 2-7: Labour force distribution & unemployment (1998) and labour market demand (2001-2005): By education status

Sector	Labour Force Thousand	%	Unemployment Thousand	%	Labour Market Demand Thousand	%
Illiterate	7192	33	135	8	-	-
Read & Write	2076	9	73	4	-	-
Below Intermediate	3522	16	143	8	531	66
Intermediate	5305	24	947	55	28	4
Abo\e Intermediate	1267	6	181	11	108	13
University & Higher	2705	12	242	14	138	17
Total	22061	100	1721	100	805	100

Source: CAPMAS,2004

(c) Decrease in Agricultural Land:

It is a result of urban encroachment and growth, which is the sprawl of urban uses on agricultural land whether in rural or urban areas. Till early the 80s, the rate of decrease of agricultural land under urban uses is about 40 - 60 thousand feddans/year (Ahmed, 1985). This is a serious figure especially if compared with land reclamation rates. Thus, the sufficiency of food supply affected badly, which can be noticed by regarding the yearly crop imports for example (Fig. 2-18)

Fig. 2-17 : The sprawl of urban uses on agricultural land, an example from El Delta, Egypt.

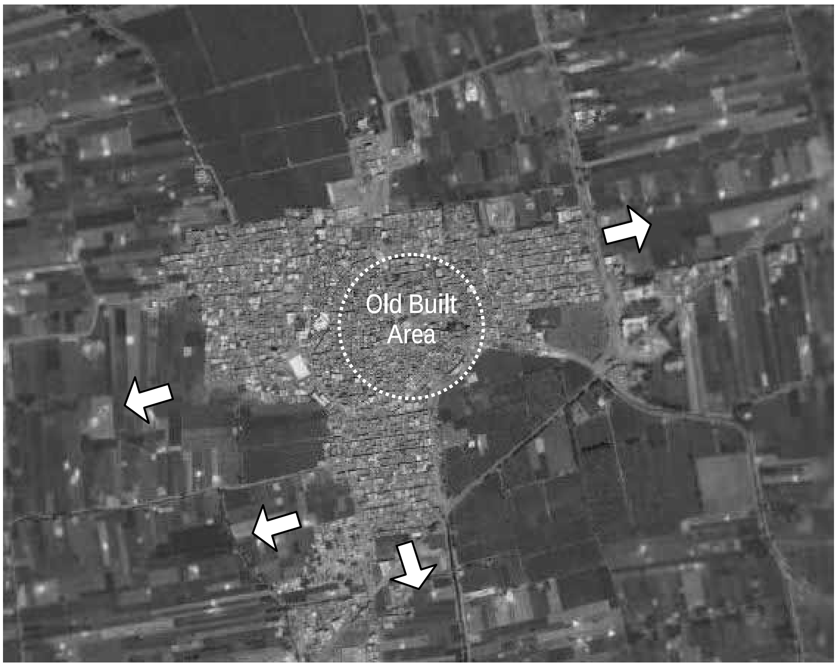


Fig. 2-18 : The sprawl of urban uses on agricultural land.

Source : Researcher using Google Earth, 2006

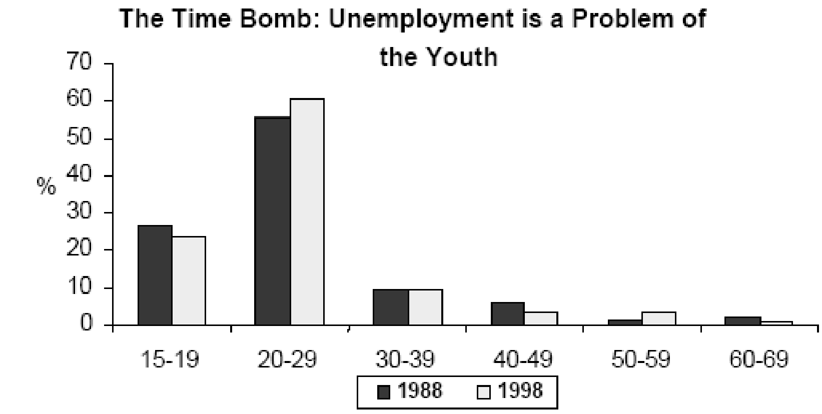


Fig. 2-19 a: Unemployment is concentrated among the graduates of intermediate education (55% of total unemployment) for whom the prospects of finding jobs are not promising.

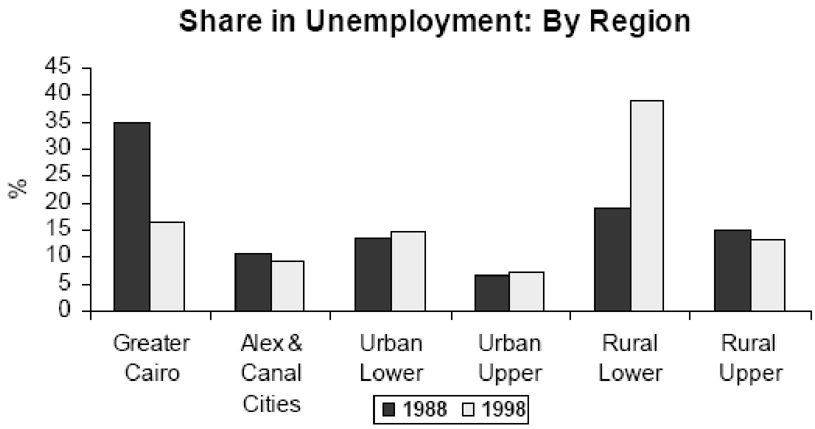


Fig. 2-19 b : Unemployment continues to linger in rural areas accounting for 52 percent of the total unemployment in 1998

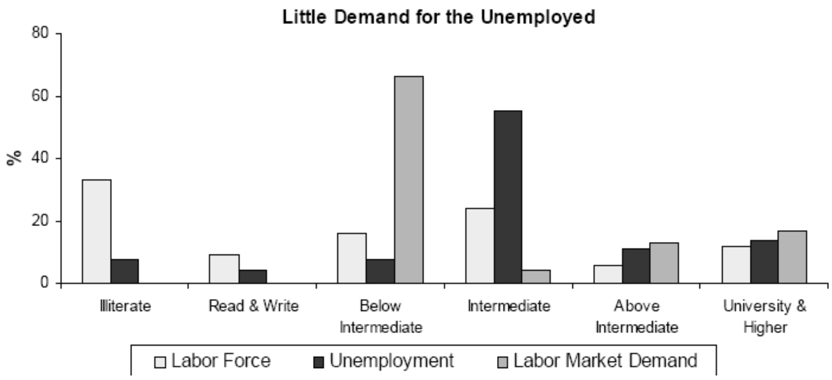


Fig.2-19 c above: The majority of the unemployed are not likely to be demanded: the labordemand for the major unemployment category (those with intermediate education) is minimal (4%) although they represent 55 percent of the unemployed. The bulk of demand (66%) is for unskilled labor (below intermediate education), with only 17 percent of the demand for graduates of higher education

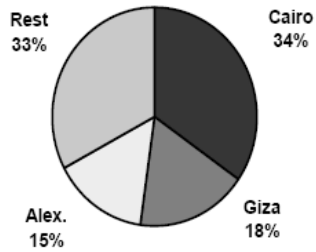


Fig. 2-19 d above: Greater Cairo and Alexandria Dominate New Demand.
Geographical distribution of demand strengthens present disparities: spatial distribution of demand favors relatively rich governorates (Cairo, Giza, and Alexandria account for two-thirds of total demand), with little demand for deprived governorates in the Delta and especially in Upper Egypt where unemployment is higher than the national average.

Fig. 2-19 a, b.c,d : An overview for the Unemployment Problem in Egypt

Source: Radwan, 2002,p.p. 3-12.

2.1.3.3. Conclusion

Urban development in Egypt faces many problems including population and economical problems that threaten its progress. Thus, any policies for the future development should deal with it seriously. In this manner, the traditional policies, which are depending on the potentials of Nile Valley, will not be suitable for the existing challenges. "This basically stresses the importance of establishing urban centers away from the valley with new economical activities and better services. The most effective means of attracting people to new settlements is by providing job opportunities, good services, and suitable living conditions. In addition, it is equally necessary to adequately develop rural areas as a means to curbing rural migration to urban areas" (Nasr, 2000, p. 32). In this realm, the Egyptian arid regions and deserts could play a vital and basic role. This is because of several reasons (Meselhy, 2001 & Ahmad, 1985, p.39 & Nasr,2000):

- Most of the natural resources on the national level lay in the arid regions,
- Arid regions are the only available place for any new urban development process,
- Arid regions development would achieve an ecological balance on the national level,
- As the Egyptian arid regions are virgin lands, it is possible to apply adequate modern technology,
- Arid regions development would reduce the problems of the valley as it would conserve the existing agricultural land in the valley and absorb the over urban and rural population growth,
- possibility to control and direct the planning process in the Arid regions is more than in the valley, and
- About 96.5% of the Egyptian lands are arid regions and they do not have the complicated accumulating problems of the valley. The other 3.5% have been ultimately used and reached the over-saturation degree.

2.2. The Egyptian Arid Regions

2.2.1. General Characters

2.2.1.1. Geographical Characters

Vast all lands of Egypt are almost arid lands. According to geographical location and its elements, which contain sea boundaries and the River Nile, the Egyptian arid region, is divided into four main geographical parts: The Nile Valley and Delta region; The Western Desert; The Eastern Desert; and Sinai Peninsula (Fig. 2-20). However, the first part according to its physical structure, which contains the River Nile, is considered as non--desert region called the "River Nile Region". Generally, all of them have different characters. Table (2-8) summarizes the main characters of the desert regions.

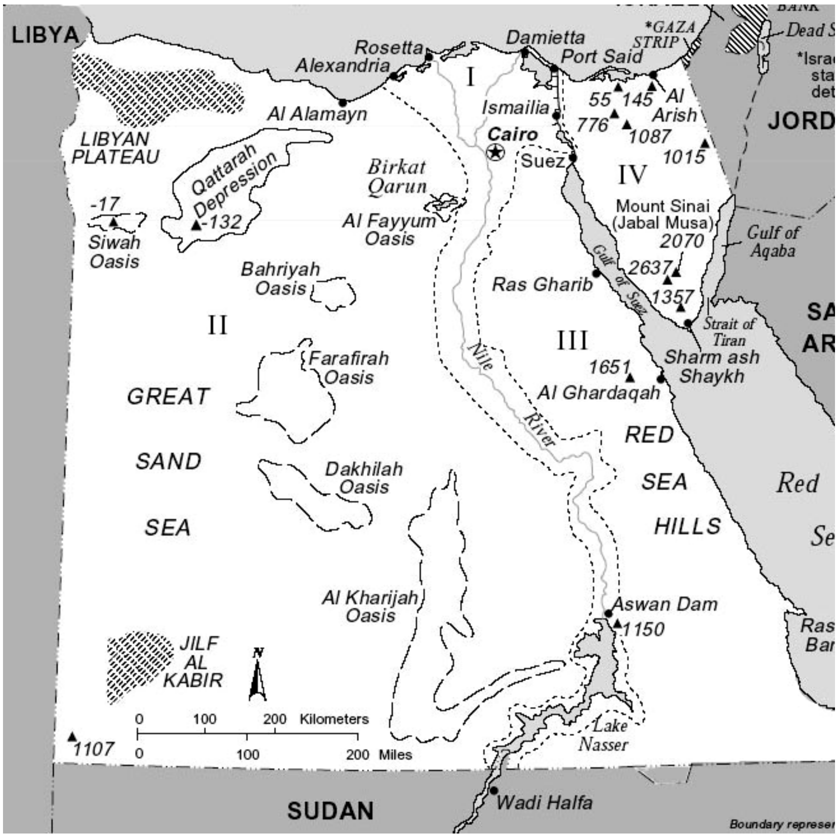


Fig. 2-20: Egypt geographical parts

National boundary
Region boundary
National capital
Populated place
Suez Canal
Spot elevations in meters
I Nile Valley and Delta
II Western Desert
III Eastern Desert
IV Sinai Peninsula

Source: after Wikipedia, 2005.

(a) The Nile Valley and Delta Region:

It extends along the course of the Nile River that measures about 1,600 kilometers in Egypt. Just north of Cairo, the river splits into two main branches and forms a delta, which is about 240 kilometers at its base along the Mediterranean Sea, and about 160 kilometers from north to south, and it forms with the valley most of Egypt's farmland. Without the precious water of the Nile, Egypt would be little more than a desert wasteland. In the southern part of the valley, the Aswan High Dam provides water for irrigation of the lands along the Nile. It also prevents severe damage from the Nile's annual flooding. Lake Nasser, a huge lake created behind the dam, catches and stores the floodwaters. The High Dam allows Egyptians to cultivate usable farmland more thoroughly. But the dam also collects most valuable soil. As a result, this soil is no longer deposited on the farmland that borders the Nile (world Book, 2006).

(b) The Western Desert:

It is a part of the huge Sahara of northern Africa. It covers about 68% of Egypt's total area (Merdan, 1999). The Western Desert consists almost entirely of a large, sandy plateau with some ridges and basins, and pit-shaped areas called depressions. The Qattara Depression, Egypt's lowest point, drops 133 meters below sea level. It contains salty marshes, lakes, and badlands (regions of small, steep hills and deep gullies). In addition, some small villages occupy scattered oases in the desert.

(c) The Eastern Desert:

It is also a part of the Sahara at the east of the River Nile. It rises eastward from the Nile as a sloping, sandy plateau for about 80 to 130 kilometers, and then turns into a string of rocky hills and deep valleys. The land in this region has not any cultivation opportunities. Therefore, the Eastern Desert is as a completely uninhabited, except the coastal region of the Red Sea.

(d) The Sinai Peninsula:

The division lies east of the Suez Canal and the Gulf of Suez. It consists of a flat, sandy coastal plain in the north, a high limestone plateau in the central area, and mountains in the south. In addition, it contains Egypt's highest point, "Jabal-Katrinah", which rises 2,637 meters above sea level. In addition, the Sinai Peninsula has valuable oil deposits.

Fig. 2-21 : Egypt geographical parts, aerial views

Source: Researcher Using World Wind, 2006

Table 2-8:The egyptian deserts and their key characteristics

	WESTERN DESERT	EASTERN DESERT	SINAI DESERT
▪ **Area and %**	681000 ~ 68%	225000 ~ 22%	61000 ~ 7%
▪ **% of desert population**	48	14	38
▪ **Population growth**	decrease	nearly constant	Increase
Density (person/km)	0.28	0.25	2.6
▪ **Climate**	hyper- hot dry	hot dry	hot dry
▪ **Rainfall (mm/year)**	less than 5	5-100	9-50
▪ **Evaporation**	More than 5000	2000-5000	4000
▪ **Topography**	Mountains and depressions highest point:Al Uwainat 1000m lowest point: Al Qattara (-134 m.)	hills and mountains highest point: Al Shayeb hill (2187 m.)	mountains and hills highest: St. Catherine hill point
▪ **Surface slope**	Least slopes: from south to north and from west to east	Medium slope: from south to north	steep slope: from south to north
▪ **Erosion/valleys and** ▪ **depressions**	Depressions phenomenon – air erosion	Valleys - water erosion	Valleys - water erosion
▪ **Most important valleys & depressions**	depressions: Al Kharga, Al Dakhla, Al Farafra, Al Baharya, Siwa, Al Qattara, Al Fayoum, Al Natrun Al Rayan	Valleys: Al Alaqy, Qena, Assiut, Tarfa, Safaga, Khorait, Doaeib, Arba, Al haramat, Al Gafra, Shoaeith	Valleys: Al Arish, Sedr, Baabaa, Gharandal, Ghazala, Firan, Zolaiqa Al Hassana
▪ **Water availability**	Most dry and poor-biggest a mount of underground water (96% of Egypt's wells)	Coastal rain sere underground water (2.5% Egypt's wells	Coastal rain smallest amount of underground water (1.5%
▪ **Dominant settlement pattern**	Sedentary settlements/rural	Temporary settlements/ urban/ nomads	Sedentary settlenents/rural/ nomads
▪ **Economical activities**	Agriculture, pastor age, mining,	Pastoraoe, agriculture, mining, petroleun	Pastorage, mining, petroleum
▪ **Most important settlements**	Al Kharga, Mout, Balat, Al Buait' Siwa, Kasr Al Farafra, Boulaq, Pariz, Borg Al Arab, Al Tahrir province, Al Alarrain, Msrsa Matrouh Al Saloum	Al Chardaka, Safaga, Al Qusseir, Ras Benias, Al Ain Al Sokhna	Al Arish, Al Tor, Bir Al Abd, Rafah, Sheikh Zuwaiid, Nakhl, Sharm Al Sheikh, Dahab

Source: After Ahmad,1985 & Meslhy 2001

2.2.1.2. Classification:

Egypt is perhaps the most arid country in North Africa. According to FAO (2005), the hot desert ecosystems cover all of Egypt and extend south to latitude 12 ^{o}N in Sudan. Such hot ecosystems are either arid or hyperarid and it is possible to distinguish between three main hyperarid and two arid provinces (Fig.2-21).

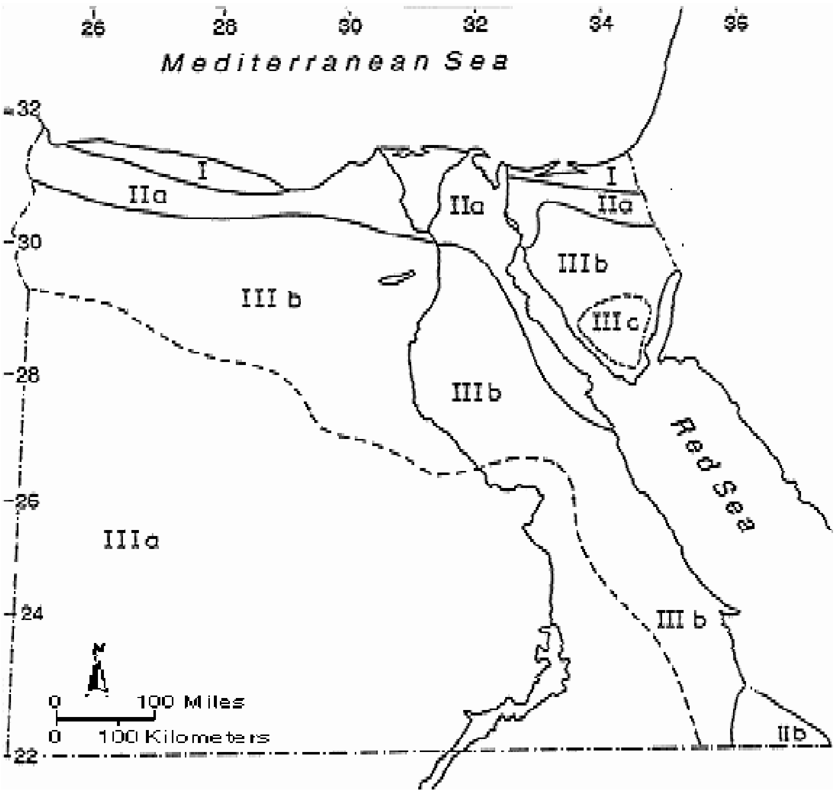


Fig. 2-22: Egypt ecosystems.
I semi-arid provinces;
II arid provinces;
III hyperarid provinces .

Source: FAO, 2005.

From an ecological point of view, Egypt is the meeting point of floristic elements belonging to at least four ecological regions: the African Sudano- Zambesian; the Asiatic Irano-Turanian; the Afro-Asiatic Saharo-sindian and the Euro-Afro-Asiatic Mediterranean. This is with consideration to climatic, geomorphological, and phytogeographical variations (FAO, 2005). According to these variations, the characters of the Egyptian arid regions are changing with the geographical location, and into eight main ecological territories divided, two of which have subdivisions. (Fig. 2-22)

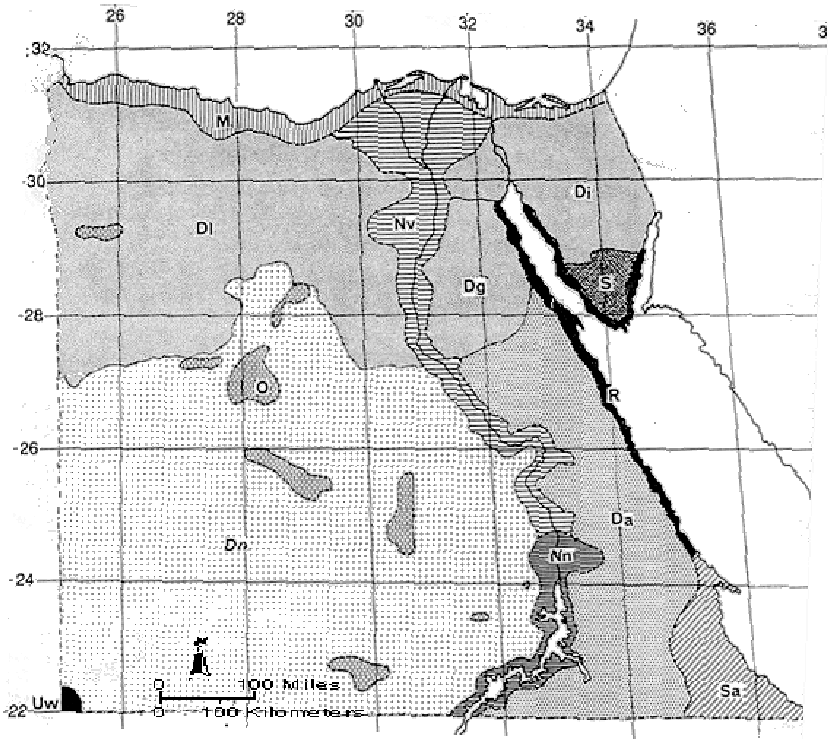


Fig. 2-23: Egypt: ecological territories

M, Mediterranean coastal belt. D, Deserts including:
Dl, Libyan Desert;
Dn, Nubian Desert;
Di, Isthmic Desert;
Dg, Galala Desert;
Da, Arabian Desert.
N, Nile land including: Nv, Nile Valley; Nn, Nubian Nile
O, Oases, of Dl and Dn, including the Kisseiba-Shabb area of the latter.
S, Sinai mountainous region between the Gulfs of Suez and Aqaba.
R, Red Sea coastal plains including those of Dg, Da as well as those along the Gulfs of Suez and Aqaba.
Sa, Sahelian scrub in Gebel Elba mountainous block, its coastal plains along the Red Sea, and their extension westwards through Da, Uw, Massif of Gebel Uweinat and the intersecting wadis

Source: FAO, 2005.

2.2.1.3. Climate

(a) Temperature:

Throughout the Egyptian arid regions, days are commonly warm, hot or too hot, and nights are cool. However it is generally warm in the costal regions and north of the Nile Valley. Egypt has only two seasons: a mild winter from November to April and a hot summer from May to October. The only differences between the seasons are variations in daytime temperatures and changes in prevailing winds. Temperatures vary widely in the inland desert areas, especially in summer, when they may range from 7° C at night to 43° C during the day and it reached sometimes 49° C especially in the southern and western desert. During winter, temperatures in the desert change less dramatically, but they can be as low as 0° C at night and as high as 18° C during the day. In the coastal regions, temperatures range between an average minimum of 14° C in winter and an average maximum of 30° C in summer. (Metz, 1990 & Merdan, 1999).

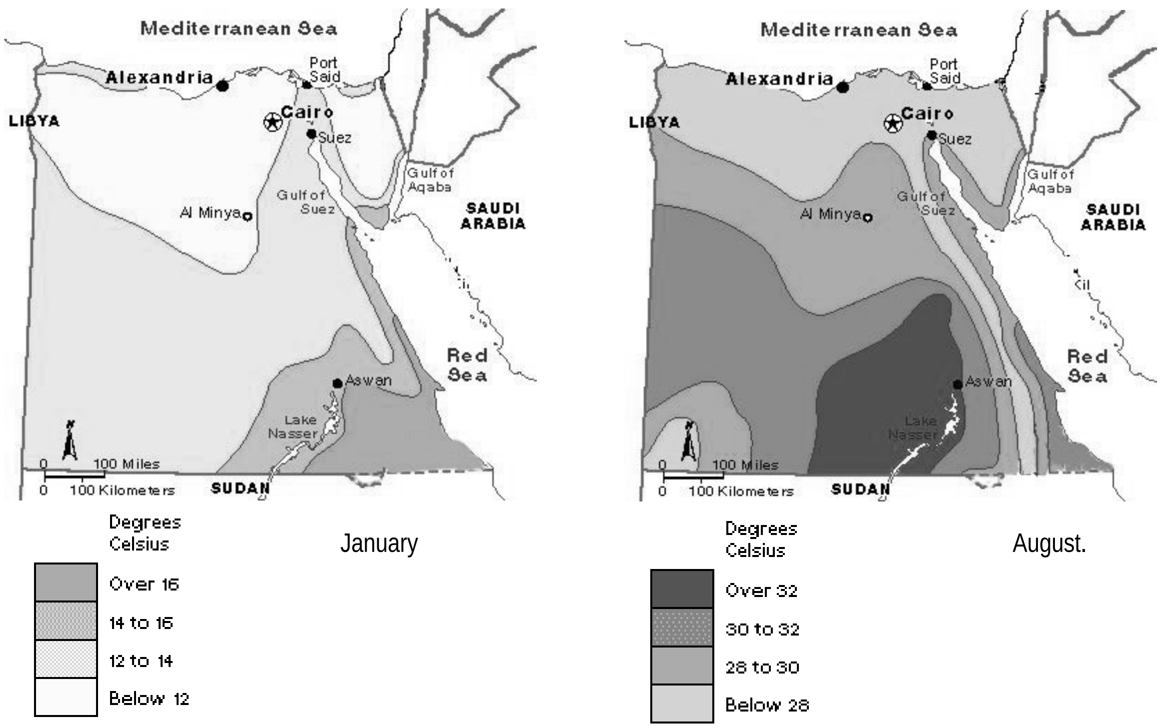


Fig. 2-24: Temperature for January and August.

Source: After World Book, 2006.

(b) Precipitation:

Vast all of Egypt receives less than 80mm of precipitation yearly in most areas. Winter rainstorms occasionally strike the Mediterranean coast, about 200mm of rainfall each year. Inland, rainfall decreases. Moving southward, the precipitation decreases suddenly. For example, Cairo receives a little more than 25mm of rain each year. Southern Egypt receives only a trace of rain each year, and some areas will go years without rain. Sinai receives more rainfall than the other desert areas. It receives about 120mm yearly in the north, and the region is dotted by numerous wells and oases, which support small population centers (Metz, 1990 & Merdan, 1999).

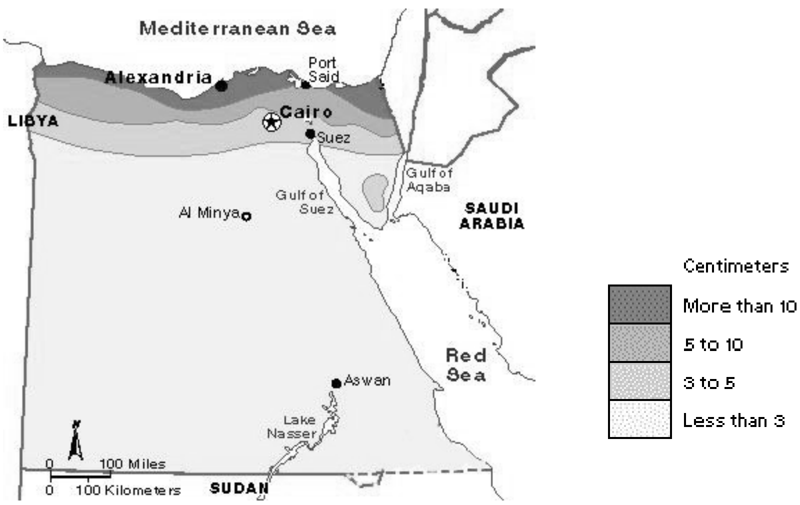


Fig. 2-25: Egypt annual precipitation.

Source: After World Book, 2005.

(c) Wind:

A phenomenon of Egypt's climate is the hot spring wind that blows across the country. Around April, a hot windstorm called the "khamasin" sweeps through vast all of Egypt. It is driving winds blowing large amounts of sand and dust at high speeds. The khamasin may raise temperatures as much as 20° C in two hours, and the wind reach 150 Km/h. It blows intermittently and may continue for days, cause illness in people and animals, harm crops, and occasionally damage houses and infrastructure (World book, 2006 & Merdan, 1999).

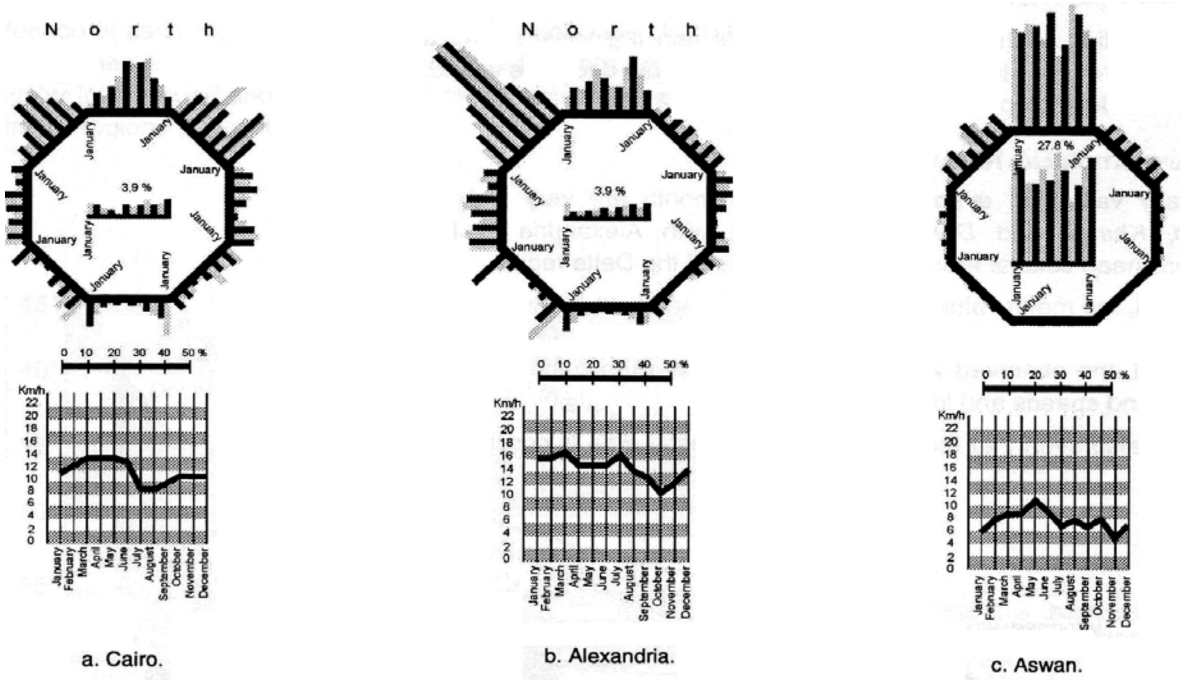


Fig. 2-26 : The wind speed and direction for three Egyptian cities lie in different climatic regions.

Source: Merdan, 1999, p.31.

(d) Solar Radiation

In general and theoretically, All the Egyptian lands have a good solar radiation exposure with an average estimations of the annual average between 9 and 11 of sunshine hours/day and with a high averages of global solar radiation(Abd-Eaal,2002,p.189)(Fig.2-27 & Fig. 2-28)

However, there are differences in the radiation value between Upper and Lower Egypt because of the clouds cover, which reduce the amount of radiation value to 2000-2250 kwh/m^2/year in Upper Egypt. However, the sky in Lower Egypt is almost clear during the year and the sunrays are almost straight to the earth's surface, which increase the radiation value to over 2500 kWh/m^2/year. (Merdan, 1999, p.29 & Sayed, 1991)

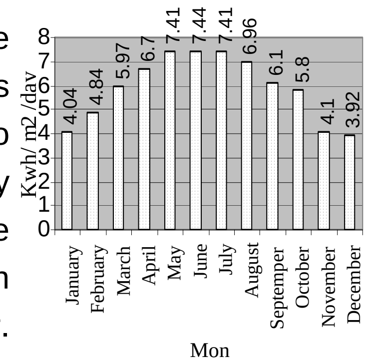


Fig.2-27: The annual average of the global solar radiation on a horizontal surface (for Egypt).

Source: After Saad, 1994, p.113.

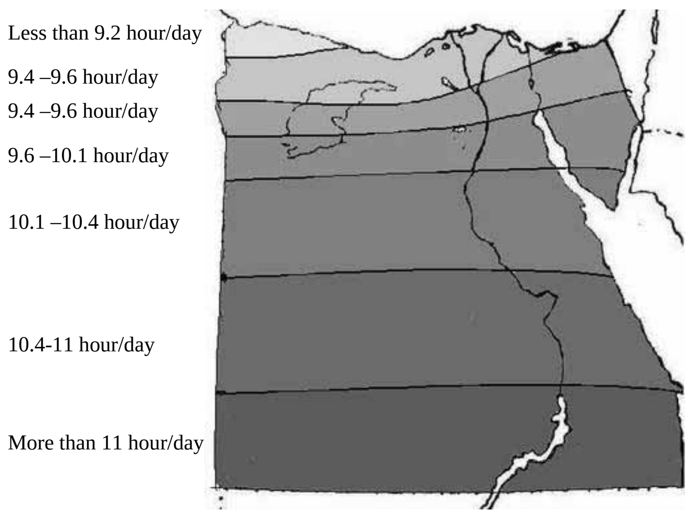


Fig. 2-28: The annual average for the No. of sun shine hours /day.

Source: After NREA.1991, p.101.

(e) Evaporation and Relative Humidity:

According to varying air temperatures form month to month, the values of evaporation for each month are very high in Upper Egypt at Aswan, Kharaga and Dakhla, in contrast with Alexandria in Mediterranean coastal area and in the middle of the delta region. However, the Mediterranean coastal area is considered the highest zone in the mean values of relative humidity and it increases eastwards, and it decreases rapidly southwards. For example, it reaches 70% at Alexandria and 27% at Aswan (Merdan, 1999, p.33).

2.2.2. Potentialities of the Egyptian Arid Regions.

Egyptian arid regions have great potentialities. They offered the opportunity to set up productive arid region settlements in several fields of interest, particularly in areas such as agriculture, mineral excavations, and industry. According to Meselhy (2001), Nasr (2000) and Ahmad (1985) the main potentialities including the flowing:

2.2.2.1. Agriculture

Egyptian arid regions have many potentialities, which make it suitable for the agriculture and cultivation purposes. Those are including water supply available from underground water, rainwater from the north-east or the north-west coasts, or water that can be transferred from the Nile. Therefore, many land reclamation projects have mainly been located and developed in desert lands in the last forty years, like the projects in the Western Desert, the Eastern Desert, and Sinai.

2.2.2.2. Mining

Mining was a prominent Egyptian activity in the Eastern Desert and Sinai. Nevertheless, in the 1950's, many mines were closed and mining activities were limited to extract iron in Aswan and Bahareyah as well as some petroleum mineral activities in the Eastern Desert and Sinai. In the seventies, because of modern technology, the mining activities and the exploration process were increased once again and the Western Desert became an important area for mining. "The mineral resources in the Egyptian desert are basically, petroleum to the north of the Western Desert, uranium in the south-west of the Western Desert, and rare minerals in the middle of the Eastern Desert. There is also gold, silver, magnesium, potassium, and salt in the Western Desert. These mineral resources significantly boost the Egyptian economy" (Nasr, 2000, p.28).

2.2.2.3. Tourism

Tourism in Egypt has many potentialities because of the country's rich culture and history, as well as its location and climate. Along these lines, the Egyptian arid regions have various potentialities for all types of both international and domestic tourism. Thus, tourism could play an important role in augmenting the national economy.

2.2.2.4. Industrial Potentialities

Industry is considered one of the main cornerstones of the Egyptian economy. Arid regions can offer great opportunities. For example, food industries could be located close to land, which has been reclaimed for agricultural purposes. The dairy industries could be located close to the pastures. However, industries, which need specific raw materials, could be nearby relevant mineral sites.

2.2.2.5. Renewable Energy

Egyptian arid regions have several natural resources. This is including the new, clean, and renewable energy sources such as solar energy and wind energy. Solar energy could be used to produce electricity, to cool air, and to heat water for domestic and industrial purposes. The strong wind in the Egyptian deserts could also be used to produce electricity. The northwestern coast and the Red Sea coast are among the most suitable locations for using wind energy.

2.2.3. The Egyptian Arid Regions Communities

2.2.3.1. Historical Review

There are several causes effected the pattern of settlements in the Egyptian arid regions such as the natural resources in contrast to the fertile Nile delta, and the absence of road networks, as well as security and defense needs. These combined causes lead to centralizing human settlements in the valley, and thus deserts were used only for defense (Nasr, 2000, p.33). However, by the beginning of the 20th century this has been changed. Generally, urban settlement development history of the Egyptian arid regions can be divided in 5 stages: before1869; from 1869 to early of the 50s; from middle of the 50s to 1974; and from1974 to middle of the 90s; and from the middle of the 90s until now.

- **Old Stage: Before1869**

This stage extends to the deep of the Egyptian history, and it is characterized by the strong pull towards the Nile valley. It has been characterized also by the plenty of the vernacular trails and treatments to overcome the hard futures of the arid climate. This has appeared through all the steps of this stage, begging with pharaohs' cities until the Islamic period.

- **The Early Planned Urban Communities: From 1869 to Early of the 50s**

During this period, Egypt has formed experiences in building and developing new communities, which referred to the digging of Suez Canal and constructing its cities that is considered the first significant development outside the Nile valley. The Canal soon became a pinnacle of economic growth, as development in surrounding areas rapidly flourished, and new cities such as Ismailia and Port Said were developed. These were cities, which depended economically on commerce and secondary industries. However, agricultural activities in this region have been developed later after Ismailia Canal had been constructed.

Then, Suez Canal region became one of the most attractive regions for development outside the Nile valley. In addition, it was considered as a good example of how large-scale projects such as canal extension, road constructions, and land reclamation, are important in the desert development process (Ahmad, 1985).

In addition, in 1905 the Egyptian government granted a concession to a Belgian company to develop the Ain-Shams oasis into a modern town called Heliopolis, which has now become a part of Cairo. This project is considered an ideal and successful model for a new residential extension in the desert. The site was 10 km northeast the capital. The company focused on erecting the main infrastructure at the first stage. This is besides services such as transportation (tramcar), electricity, water, and parks (Nasr, 2000).

- **After the Egyptian Revolution: From Middle of the 50th to 1974**

This period formed an important part of the modern history of Egypt, and a great development took place. However, in 1967, development plans were affected by the 67 war, and as a result, all desert development projects were stopped. Three major desert development projects have been developed, Al Tahrir Province -1953"; the "New Valley project-1959"; and erecting The Aswan High Dam (Fig. 2-29 & Fig. 2-30). According to Nasr (2000) and Meselhy (2001), Al-Tahrir Province was the first large-scale desert development project with ambitious social and economical goals. The project aim was to increase agricultural land to increasing national income, to create new job opportunities for young university graduates and minor laborers, and to boost employment rates.

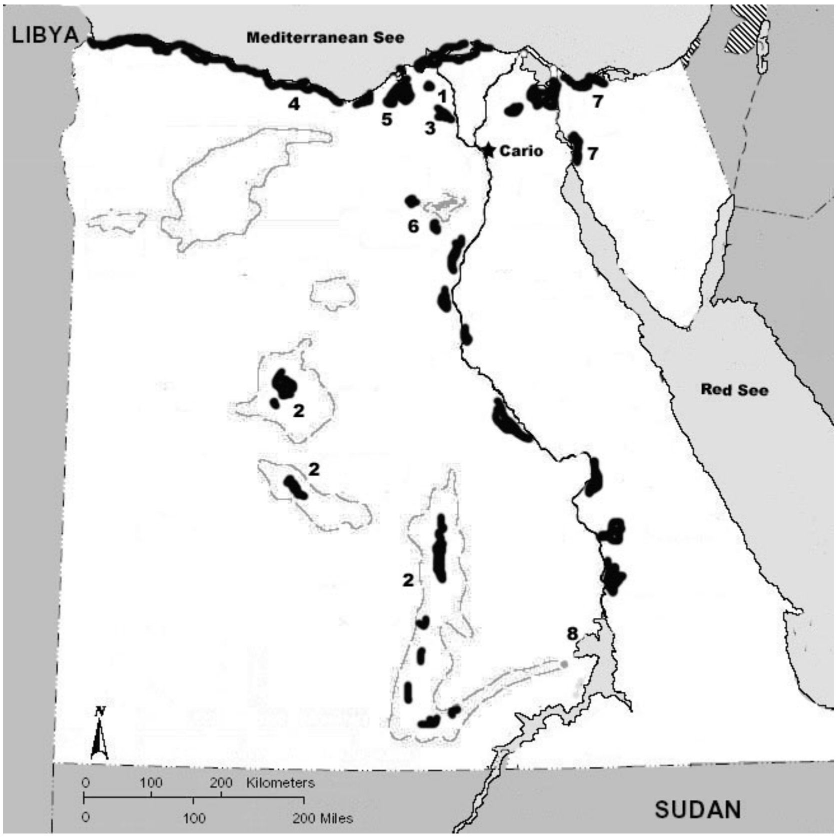


Fig. 2-29: The projects of the General Organization for Desert Development.

1 Al Tahrir Province
2 New Valley
3 Wady Al Natron
4 North/west Coastal Zone
5 Mariut
6 Behera And Faiyum
7 Sinai
8 Nubian Resettlement

Land Reclamation and New settlements Projects

Source: After Mountjoy, n.d., p.243.

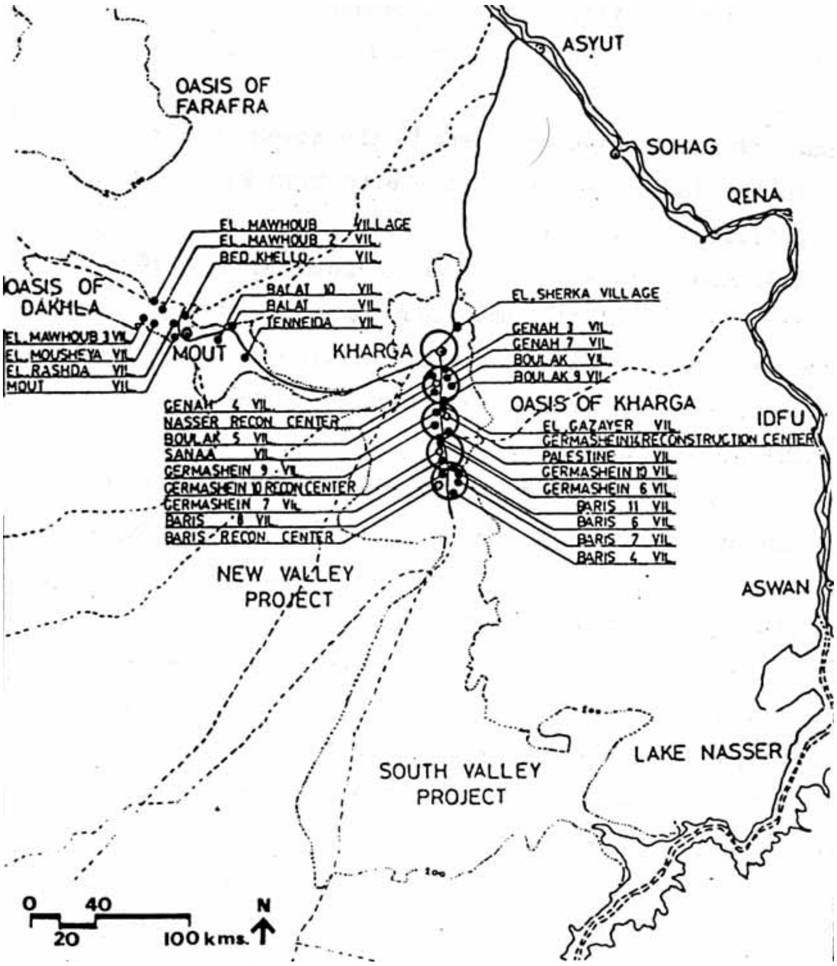


Fig. 2-30: Distribution of the new Valley project.

Source: Sabry, 1977, p.243.

The project site extended between the south-west of Delta along Beheira Governorate and the Natrun Valley. It was chosen close to the Nile Delta, since it was the first attempt by Egyptians at desert development. Nile water and underground water supplied the project through Al-Tahrir Canal, which was dug from the Nile branch of Rashid. As well as this type of projects, many other projects followed erecting the High Dam. These include horizontal expansion in agriculture, generation of electricity to serve development projects and new communities, resettlement of Nubians in Kom-Ombo, and the iron mines project in Baharya oasis.

- **Age of the New Towns Development: From1974 to Middle of the 90s:**

By the beginning of this period, new set of policies have been registered. In April 1974, the basic guidelines for a national policy were outlined in a paper called "October Working Paper". The main objective of the paper was to draw a new population map of Egypt, highlighting that urbanization covered only about 3% of the Egyptian lands that time. It stressed on the urgent need for creating new settlements based on new economical activities and to provide the settlers with job opportunities, services, and better living conditions. Thus, as it was hoped, this would motivate people to move to the new settlements (Hegab, 1984).

During this period, the government addressed implementation using two policies. Firstly, building new towns in the desert to balance out population distribution in the existing urban and rural areas, besides offering new jobs and diverse new activities. Secondly, building and setting up new productive settlements in the desert, offering young people favorable job opportunities, mainly agricultural, which were called "youth villages". The aim of this policy was to encourage young university graduates to move away from the Nile Valley to the desert. It, also, aimed at establishing new self-sufficient settlements based on a proper socio-economic basis to raise the standard of living of the new settlers and increase national income. Such policies, however, do not always achieve the wished goals for several reasons (Nasr, 2000).

The first generation of new towns was started in 1978, like 10th of Ramadan City (1978), Sadat City (1978), and 6th October City (1979). In the late of eighties, ten new urban settlements were planned in the desert around Cairo to absorb the population from the crowded areas as an alternative to the slums and informal housing. However, the objective of these settlements was changed, and they became high-standard housing areas.

- **Age of Mega Development Projects: From the Middle of the 90s till now:**

This stage is an extension of the previous one, but it is characterized by the change towards creating new mega development nodes outside and far from the exiting urban context of the Valley. These nodes act as poles to attract the process of development and investment to the desert, and help to create new urban communities outside the valley in the depth of the Egyptian desert.

Thus, this process – according to the Egyptian Government – will help increasing the percentage of populated areas from 5.3% at the end of 20th century to 25% of Egypt's total area. This aim, also, at reaching a new urban and production map that can achieve balanced development in Egypt's various provinces and ensure ideal exploitation of all available, but not yet exploited resources in desert areas rich with promising natural elements. These projects are centralized in two areas, namely Southern Egypt, and Suez Canal and Sinai (SIS, 2003). It will also help creating productive agricultural, industrial, touristic, and mining projects, thus opening vast prospects for investment against several privileges for all to set up production, service, and infrastructure projects necessary for these new communities. Box (2-2) gives a review of these major mega projects.

BOX 2-2 The Egyptian Mega Projects .

1- Toshka Project

Toshka project is designed to create a new delta in the south of the Western Desert parallel to the Nile, adding 540,000 feddans to the cultivated area, to be irrigated by Nile water and comprising various economic activities.

2- East Owainat Project

East Owainat project, a major development venture in the Southern Valley, is located in the southwestern part of Egypt's Western Desert. The project aims at reclaiming and cultivating an area of 230,000 feddans totally depending on subterranean water reservoir available in the project area.

Moreover, clean agricultural techniques will be applied to produce pollutant-free crops suitable for exportation. Up to June, 2003, about 47,000 feddans were cultivated and infrastructure for 380 wells was implemented. Scientific method was applied in selecting the crops, the most significant of which are: potatoes, medicinal herbs, fruits and grains that suit regional climate. Production yielded quite promising results and was totally exported. The 10-year project has total investment cost of LE 3.5 billion and is expected to provide 20,000 job opportunities.

3- Al-Salam Canal Project

It will help adding in cultivable area about 620,000 feddans depending on the Nile water mixed with agricultural drainage water at Al-Salam Canal and its branches extend over a length of 262 km. It is divided into two phases: Phase I (West of Suez Canal) and Phase II (East of Suez Canal and Sinai)

4- Sharq Al-Tafria' Project

Sharq Al- Tafria' mega project, located east of Port Said at the northern-western corner of Sinai, and it has started 6 years ago. It covers an area of about 220 km^2 bounded to the north by the Mediterranean Sea over a length of about 22 km^2.

5- The Project of Development Northwest Suez Gulf

The implementation of Northwest Suez Gulf project started in 1998. It comprises a huge hub port and a free economic zone, covering an area of 288 million m^2. The project provides about 250,000 new job opportunities.

6- Valley of Technology Project

Implementation of the Valley of Technology Project, the first of its kind in the Middle East, it has started in 1995. It is planned as a centre for hi-tech industries as well as feeder and complementary industries, research laboratories and training centers.

The project will help increasing investment opportunities in various development areas especially the Canal zone and Sinai and attract foreign capital and investments.

The project is located on the east bank of Suez Canal at the northwestern access to Sinai Peninsula covering an area of 16,500 feddans. It is being carried out in four phases at an investment of 12 billion US Dollar. Work in phase I started over an area of 215 feddans at a cost of about LE 60 million.

Source: after SIS, 2003.

2.2.3.2. Characters of the Egyptian Arid Regions Communities

Urban communities of the Egyptian arid regions are divided into three main types. According to Meselhy (2001, p.378), they include, traditional communities, ecological-designed urban communities, and extraneous urban communities.

(a) Traditional Communities

They are those communities that have been designed and developed through their original inhabitants. Thus, they were designed in harmony with the surrounding environment. In addition, the consecutive processes of trial and vernacular self-creation have developed the main features of these communities.

Mutt, Elbawety, and Elkaser villages are examples for these communities that have been built in the Egyptian oases of the western desert.

The main factors of these traditional communities are the discrete social characters. These characters control aspects of living in the community at all levels. Therefore, the way of development varies form one community to another. However, this should reflect the identity of the society and respect the privacy of the socio-culture life. In addition, the effect of the climate is the second main factor. This affects not only characters of the house but also all the features of the community. Therefore, compactness has been the typical characteristic of its houses and the urban form of settlement in total. Houses were made of bricks, which were made of mud and chopped straw. They mixed the mud and straw and then poured the mixture into molds. The molds were placed in the sun to bake into hard bricks. The windows were little small square holes in the wall that were high. Some of the houses had brickwork grills, which softened the sun's glare or unpleasant brightness. They were used to keep out the dust, heat, and glare. The open court is the typical element of the houses,

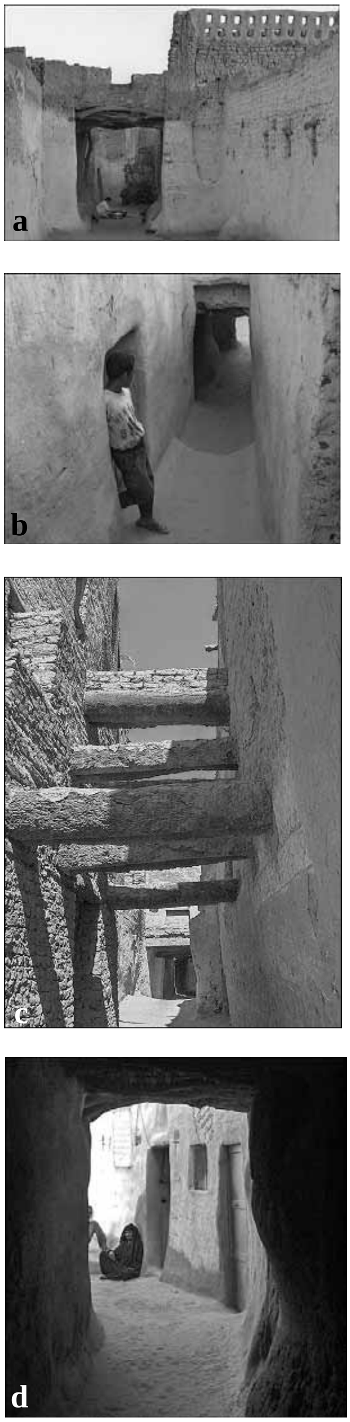


Fig. 2-31 a,b,c,d: Old Egyptian vernacular communities - compact urban form, narrow paths, shaded streets, and depending on the local materials for construction.
Source: Kjeilen, 2008.

and it acts as the major element for ventilation besides being a place for the day-activities. Roads and paths were narrow and winding paths produce minimal heat exchange. In addition, shading methods are used to cover as much as possible. (See also chapter 1)

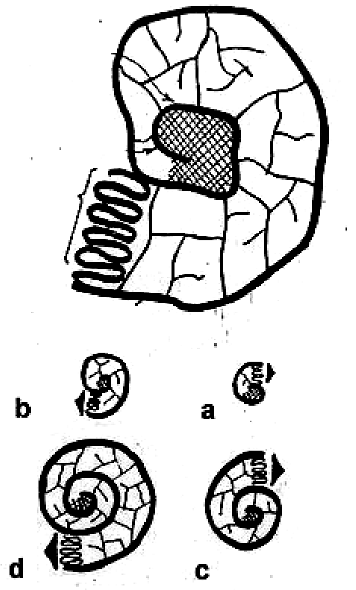


Fig. 2-32: The Development of Mutt village.
Source: after Afifi, 1985, p. 75

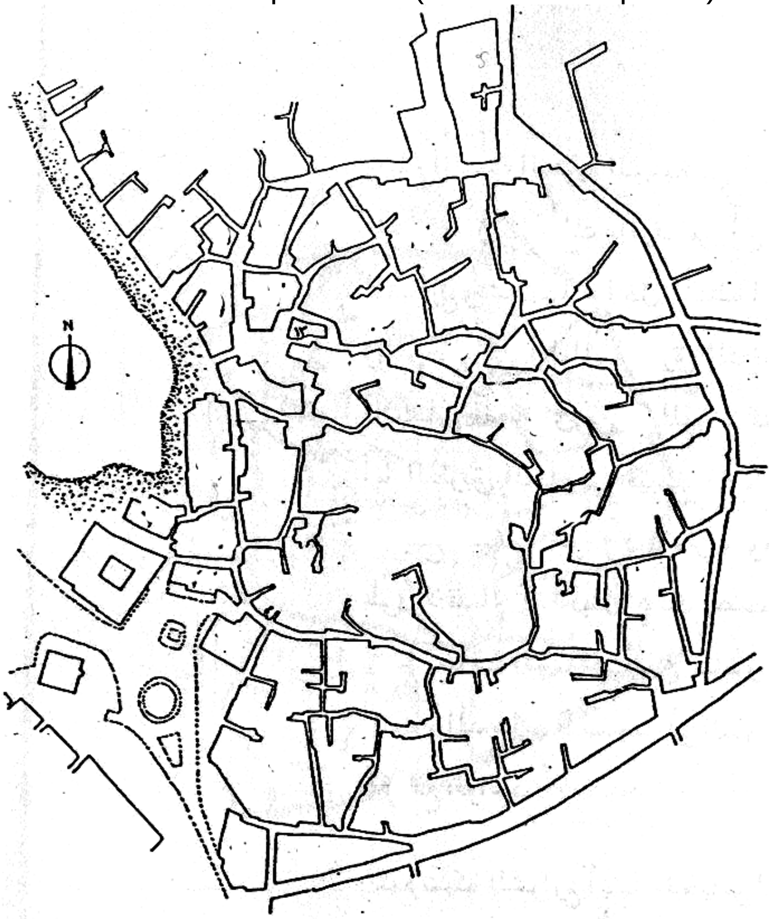


Fig. 2-33: The old village of Mutt – The urban form
Source: after Afifi, 1985, p. 89

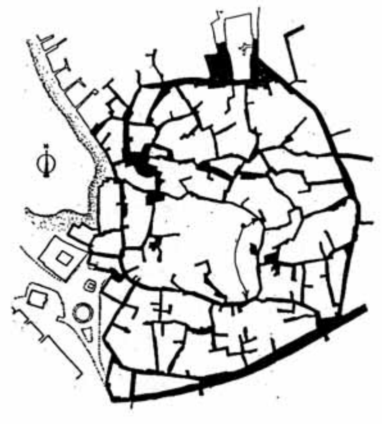


Fig. 2-34: Street pattern
Source: after Afifi, 1985, p. 87

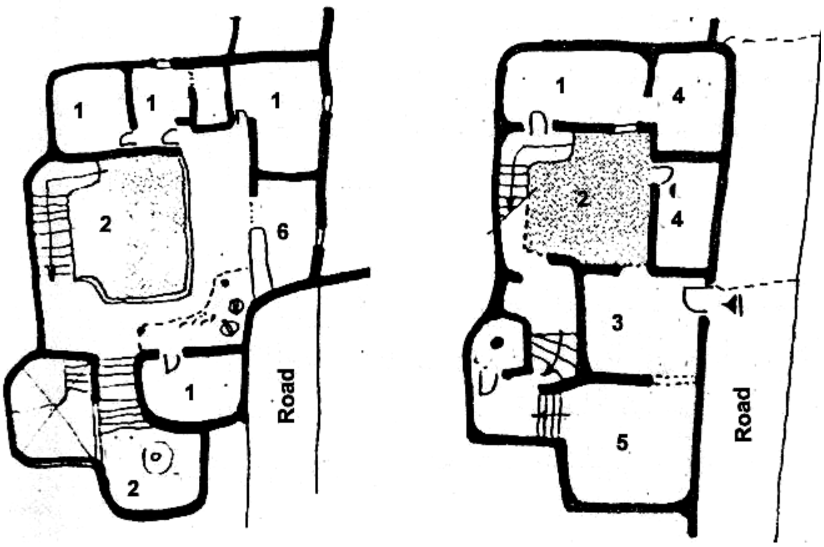


Fig. 2-35: An example for the houses of Mutt.

1) Room
2) Open court
3) Entrance
4) Storage room
5) Animal room
6) Kitchen

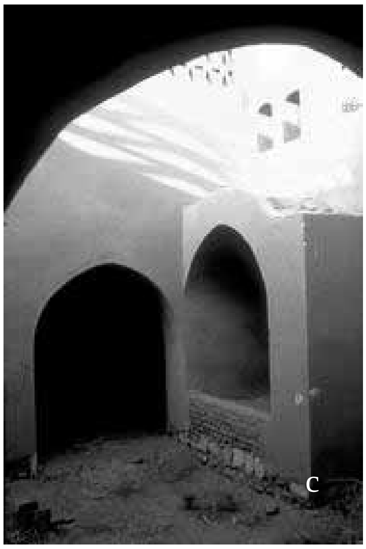
Source: after Afifi, 1985, p. 82

(b) Ecological-Designed Urban Communities

They are the result of the well analysis and understanding of the traditional communities. They were developed by many architects and urban communities developers, who have a consciousness with the environmental specialty of this type of communities.

New Paris is a famous example for these communities in Egypt. New Paris is a small village in an oasis in the New Valley. It is located six kilometers away from the oasis of old Rodriguez.

This project has adopted by the famous Architect Hasen Fathy , and he had developed it with reference to his vision " Building for the poor". He had used a set of environmental architectural and urban designs relating to the old Egyptian vernacular architecture and method of construction. This is including the compact urban context, architectural forms and building materials. As a result, he had succeeded to make a difference of about 16^{o} c between inside and outside the buildings.



However, people refused to move to the new village for a reason absent from the awareness of the architect and may not have been able to avoid. People rejected this transfer to the new village because they imagined that they would move to a set of graves. Hasan Fathy had used a method of construction and architectural forms like the doom, that the people residing the oases using to build their cemeteries.

However, his project is considered to be one of the best examples for the ecological-designed urban communities in Egypt though the failure of the project to attract people.

Fig. 2-36 a,b,c,d: New Paris village.
a) Shaded Paths
b) Compact urban form with narrow streets
c) The open court, a typical element for house design
d) using of the traditional forms and architecture elements

Source: Archnet.net, 2007

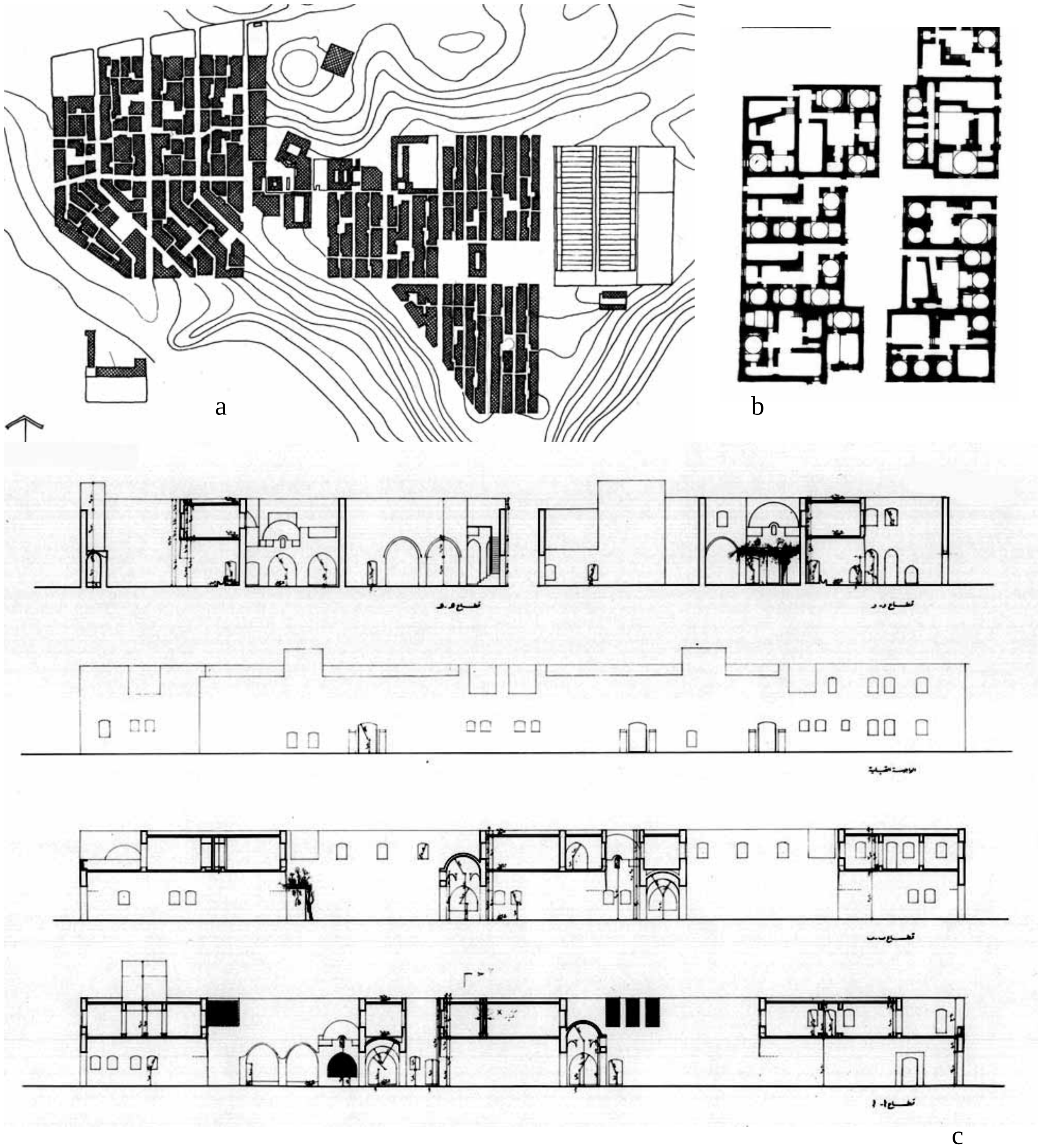


Fig. 2-37: a,b,c,: New Paris village.

a) General layout of the village, the compact design of the urban form that help protecting the community from the arid climate.
b) An example for the houses clusters.
c) Examples for the elevations and cross sections of village market.

Source: Smith, 1998, p. 4
Archnet.net, 2007

(c) Extraneous Urban Communities

They are those communities that were developed without any consideration to the environmental aspects of arid regions. According to Meselhy (2001), they can be considered as exotic indiscriminate attempts to develop arid region communities. He claimed, also, that the majority of the new towns and villages developed in the last century could be classified under this type.

From another point of view, these communities can be classified into three types; the new towns such as 10th of Ramadan and 6th of October, the new small settlements and villages such as villages of youth in the western desert, new high standard small communities.

The first two types have been affected with the national urban development strategy that is depending mainly on solving the urban problems of rapid urbanization explosion and trying to create more new job opportunities and homes. In order to achieve that, many aspects have been neglected through the process of urban development (Box 2-4).

The second type represents vast all the small villages, which have been developed in the last 3 decades in the Egyptian desert. Great part of them was built in the new development regions that are characterized by their extreme arid climate. Therefore, the ecological factors were the main factors that are supposed to be taken in account. Many of the conceptual designs of these communities were developed with reference to this fact. However, they were always changed in the stage of preparing the final documentations and construction due to economical constraints (Box 2-5).

The third type, are the new high standard small communities, which form a huge set of new communities that have been developed around the Greater Cairo and El-delta regions. They have been built through the private sector. The main aim of these communities is to offer a high standard of living, services, and communities.

Fig. 2-38: Examples of the new housing projects in Egypt.

Source: Ministry of Housing, 2000.

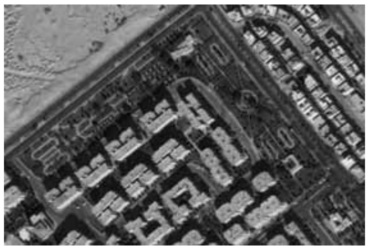


Fig. 2-39: 6th of October city, satellite layout of a part of a housing area.

Source: Researcher, Google Earth, 2007

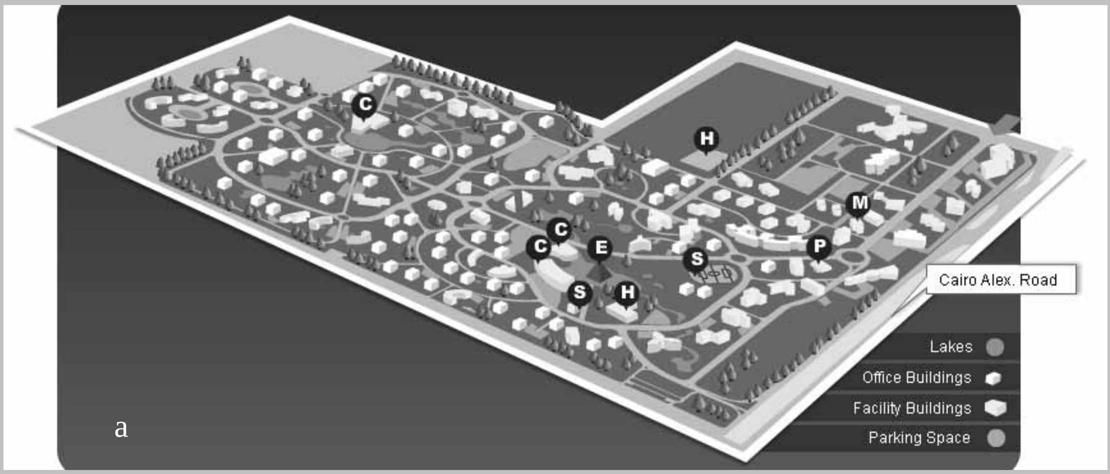
BOX 2-3 More information .

For more Information see 2.1.2. and Merdan, 1999.

Companies stayed behind these projects have used this direction as a method for marketing their project. In order to achieve this aim, a set of non-arid regions architectural and urban design models have been imported from Europe and USA. (See Box 2-4 and 2-6)

BOX 2-4 : An example for extraneous urban communities: 3rd Type - The Smart Village - Cairo .

Smart Village - Cairo, first fully operational Technology and Business Park in Egypt, accommodates multinational and local telecommunications and information technology companies, financial institutions and banks, together with governmental authorities on three million square meters in the west of Cairo (Smart village, 2007).
It depends on a non-compact urban pattern that maximizes the effect of the climate on the components of the project. On the other hand, the architectural design of buildings is depending on using glass as main architectural element. Also the landscape did not give a suitable design solution that can provide the user the shaded places.



(a) 3D Layout of the project

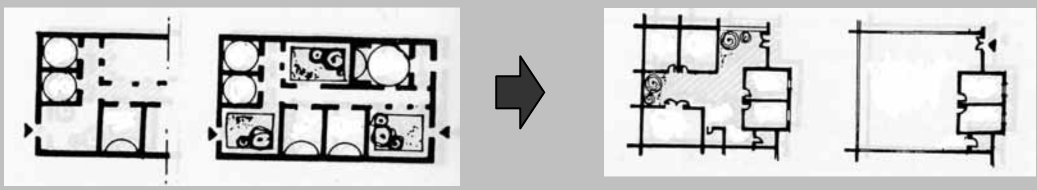
(b) & (c) Example of building design

(d) The project landscape

Source: After Smart Village, 2007.

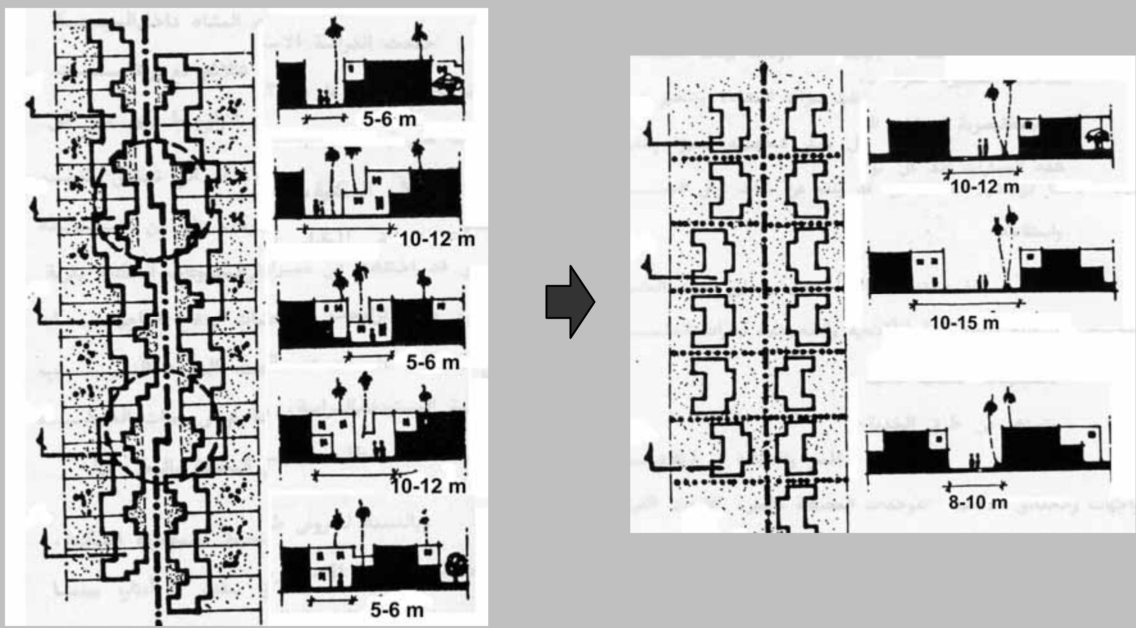
BOX 2-5 : Examples for extraneous urban communities: 2nd Type

- **Farmer Housing Farafra Oasis – Western desert:**

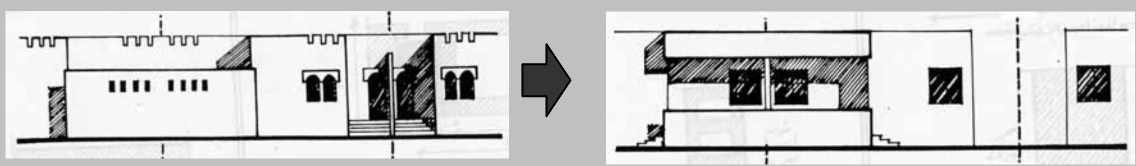


The design introduced by the consultant designer depending on an ecological strategy by using natural materials and environmental concepts and architectural elements such as dooms. At the construction phase, the design had been replaced with another one using un-ecological design forms besides the construction material, which was concrete.

- **Elsalam village Sinai:**



(a) Urban paths design



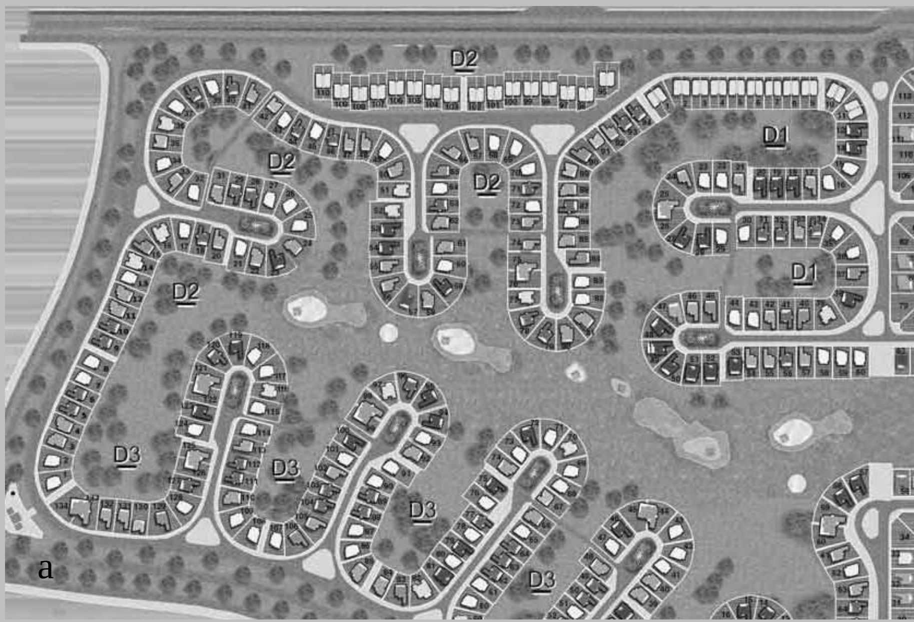
(b) Elevations design

Paths design introduced by the consultant designer depending on using the form of paths to create local spaces to help creating shaded areas. Also, units design helping to maximize shading , and he narrows windows to minimize the glare effects. At the construction phase, all these aspects were neglected, and another forms have been used. Usually, this is happened in order to minimize the construction costs.

Source: After Seleman, 1990.

BOX 2-6 : An example for extraneous urban communities: 3rd Type - Al-Rabwa District

Al Rabwa is located within Al Sheikh Zayyed district, 4 km from 6th October City. According to the project developer (Al Rabwa , 2007), the idea of building Al Rabwa was brought forth due to the urgent need to spread out and away from the city. The design concept is to gather a set of units around a wide landscape, which in this case a golf area. The architectural design is depending on importing a set of foreign architecture solution and forms. This strategy of architectural and urban design was the typical prototype of many urban projects in Egypt in the last decade.



(a) Layout of the project

(b) & (c) Example of building design

(d) (e) the project landscape: The house landscape and district landscape.

Source: After Al Rabwa, 2007.

2.2.4. Impact of the Egyptian Urban Policies on the Development of Arid Region Communities

Along the urban development history of arid regions in Egypt, lot of attempts has been developed to create the suitable arid urban environment. This includes11 attempts:

- Suez Canal region
- North-Delta development
- Regional development of Nasser Lake
- New towns
- Satellite subsections and towns
- New twin-cities of the Nile valley old cities
- Development of north coast
- New agriculture communities near the Delta
- Development of the new valley in western desert
- Re-settlement of nomads
- Defense urban development

However, they were developed within many directions without a clear vision to concentrate all these efforts in order to achieve sustainability. They were extraneous spatially without any development relations.

Therefore, Meselhy (2001) claimed that, except the attempt of Suez Canal region and the new valley, all policies and attempts for developing the Egyptian arid regions have failed to achieve their goals, and this including the population transfer target. This result is depending on nine factors such as policies for achieving the population transfer target, the characters of the target urban community, achieved targeted economical structure, and the social and environmental effects. According to his analysis, Suez Canal region and the new valley have achieved about 60 to70 % of their goals. At the same time, all the other developments have achieved not more than 50% of their goals. For example, New towns have achieved about 40%, while new twin-cities achieved only about 23% of the planned goals.

Shalaby (2003) has analyzed the situation of the new towns. He found that, till 2000 vast all the of them achieved less than 15% of the target population and less 46% of the target job chances. (Table 2-9)

This failure to achieve target goals of the Egyptian urban policy helps to maximize the effects of problems facing the whole process of development in arid region. These problems include the typical arid regions problems as:

- Climatic factors
- Desertification
- Administrative problems
- Population attraction problem
- Out-migration (population expulsion)
- Isolation
- Weak communication and transportation networks
- Dispersed human settlements
- Deficiency in services / utilities
- Low / scattered densities

On the other hand, many obstacles face more than one of the current main projects, which are considered according to the development authority the main axis for the urban development outside the old valley. Big parts of both of Toshka project and east of Port Said project have been terminated. They have been reevaluated, and the authority decided that to cancel about 30% of Toshka project beside main parts of east of Port Said project. However many urban experts see that the rest of this projects will not be able to attain the target goals, at least in the near future.

Table 2-9. Planned growth and actual growth of Egypt's new cities

City	Target Population	1996[1] Population	% Achieved	2006[2] Population	%Achieved
Tenth of Ramadan	500,000	47,833	9.57	80,035	16
Sixth of October	500,000	35,354	7.07	104,811	20.9
Al Sadat	500,000	18,619	3.72	30,975	6,2
New Borg Al Arab	510,000	7,051	1.38	26,817	5.2
New Salehiya	70,000	8,140	11.63	11,993	17.1
New Domeat	270,000	6,520	2.41	18,183	6.6
Fifteenth of May	250,000	65,560	26.22	64,629	25.8
Al Obour	500,000	997	0.20	27,321	5.4
Badr	430,000	248	0.06	10,833	2.5
Al Shorouk	500,000	N.A.	N.A.	13,541	2.7
New Cairo	1,500,000	34,703	2.31	78,031	5.2
New Bani Sweaf	420,000	208	0.05	12,052	2.8
New Menia	156,000	68	0.04	2.772	1.7
New Nobariyah	305,000	885	0.29	3,213	1
New Assuit	130,000	N.A.	N.A.	935	.7
New Teeba	140,000	N.A.	N.A.	398	0. 3
Al Sheikh Zayed	450,000	N.A.	N.A.	19,900	4.4

City	Target Jobs	2000[1] Jobs	%Achieved	2006[2] Jobs	% Achieved
Tenth of Ramadan	150,000	105,266	70.18	47,505	31.6
Sixth of October	150,000	69,373	46.25	58,516	39
Al Sadat	165,000	18,354	11.12	14,085	8.4
New Borg Al Arab	150,000	17,876	11.92	14,597	9.6
New Salehiya	18,000	4,452	24.73	5,455	30.5
New Domeat	75,000	3,821	5.09	8,196	10.9
Fifteenth of May	Residential Only	N.A.	N.A.	N.A.	N.A.
Al Obour	84,000	2,700	3.21	14,428	17.2
Badr	90,000	4,990	5.54	5,124	5.6
Al Shorouk	N.A.	N.A.	N.A	6,942	N.A.
New Cairo	N.A.	N.A.	N.A.	46,321	N.A.
New Bani Sweaf	35,000	1,150	3.29	5,078	14.2
New Menia	46,000	N.A.	N.A.	1,605	3.4
New Nobariyah	10,000	279	2.79	1,756	17
New Assuit	35,000	N.A.	N.A.	577	1.7
New Teeba	N.A.	N.A.	N.A.	193	N.A.
Al Sheikh Zayed	N.A.	N.A.	N.A.	11,495	N.A.

City	Target Units	2000[1] Units	% Achieved	2006[2] Units	%Achieved
Tenth of Ramadan	100,000	63,685	63.69	68,371	68.8
Sixth of October	300,000	155,139	51.71	N.A.	N.A.
Al Sadat	100,000	19,062	19.06	22,137	22
New Borg Al Arab	102,000	10,041	9.84	22,432	22
New Salehiya	14,000	4,004	28.60	10,961	71.4
New Domeat	54,000	27,628	51.16	33,133	61
Fifteenth of May	36,000	35,834	99.54	36,434	100
Al Obour	100,000	34,010	34.01	40,026	40
Badr	86,000	20,284	23.59	21,381	24.7
Al Shorouk	100,000	38,190	38.19	27,764	27.7
New Cairo	300,000	82,833	27.61	108.220	36
New Bani Sweaf	84,000	11,309	13.46	11,462	13.6
New Menia	31,200	3,814	12.22	4,597	14.5
New Nobariyah	61,000	1,980	3.25	3,940	6.5
New Assuit	26,000	2,912	11.20	3,458	13
New Teeba	28,000	1,537	5.49	2,046	7
Al Sheikh Zayed	90,000	35,770	39.74	32,876	35

1) After Shalaby, 2003, p.p.7-10, 2) The CAPMS,2007

2.3. The Egyptian Arid Regions Communities and Visions for the Future

As noted before, arid regions in Egypt can be a major factor to support the process of development generally, not only urban development. This is beside the fact that there are no other alternatives. In order to incorporate these regions in the national policies and strategies of Egypt, many visions of their development have been created. They include many attempts from the state authority, developers, and individuals. These visions can be classified into two major directions: vision of the Egyptian authority and the new parallel valley vision

2.3.1. Vision of the Egyptian Authority

It is the vision of the government. Within this vision, the state authorities see that some mistakes have been done while the strategies of the new towns have been applied. They think, also, that with some changes this strategy can achieve their target goals. In this manner, the existing strategy and map of urban development have to be reevaluated. However, the old valley will remain having the power, and will be so in the future. The arid regions and their communities will be developed to be able to attract population from the valley, and the plans for their economical bases will be supported. However, the relations of dependency on the old valley will stay the same. The old valley will remain the center of development, infrastructure, decision-making …etc.

In order to achieve that, the national authority moved within two approaches (Fig. 2-40):

The first is to support the already built new towns. For example, the "Ministry of Housing and Urban Development" prepared new plans for rebinding already constructed new town with the existing urban centers through fast transportation means as a tool to give them an advantage to attract the over-population in the valley.

Also, it develops new systems of financing to help young peoples moving to the new town. In addition, it will continue supporting the directions of the future developments towards the new mega poles in the desert as in Toshka and Sinai.

The second is to find solutions to the over-loaded population, mainly, in the small communities such as rural villages, which distended on the limited agriculture land in the valley. Therefore, the "Ministry of Housing and Urban Development" announced that, it prepares an action plan to help more than 4000 rural villages, which have boundaries with the desert, to extend over their desert backgrounds.

In conclusion, according to this vision the old central valley will remain a center for all services.

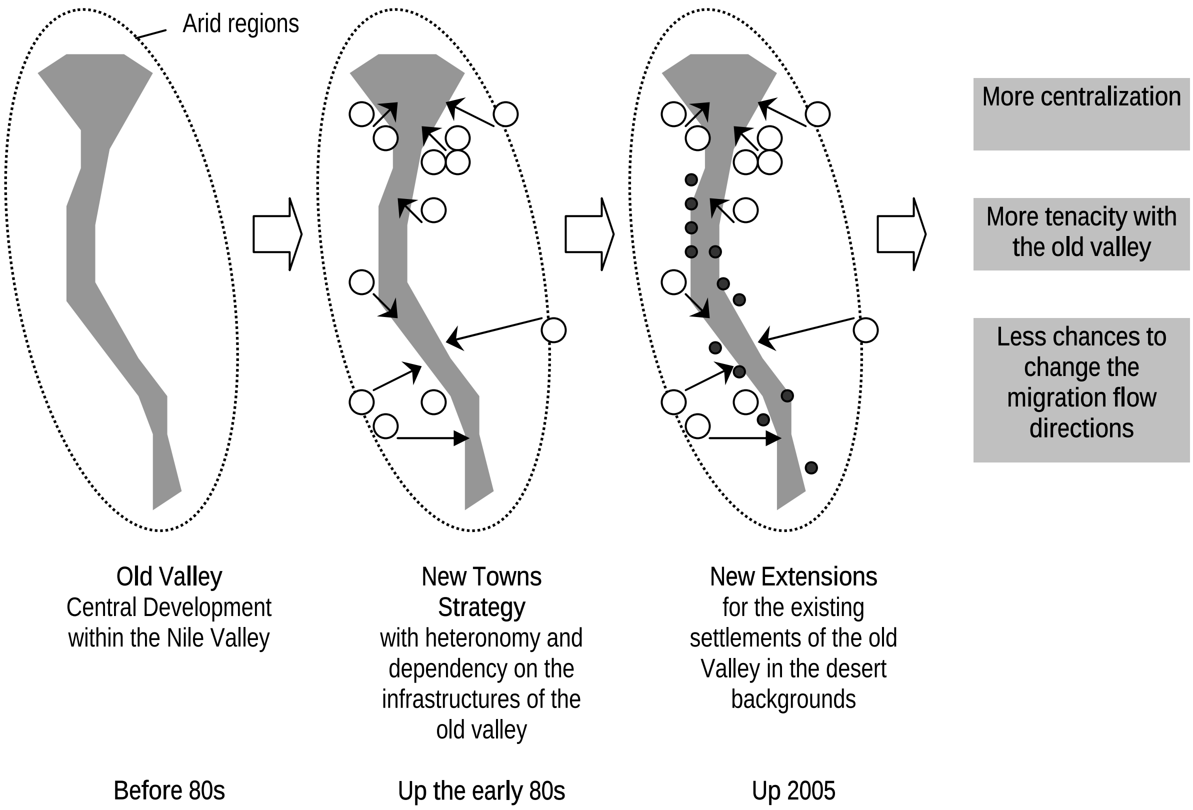


Fig. 2-40: Vision of the Egyptian authority for developing arid regions and solving the existing problems of urban development in the Nile Valley from the 80s till now.

Source: Researcher

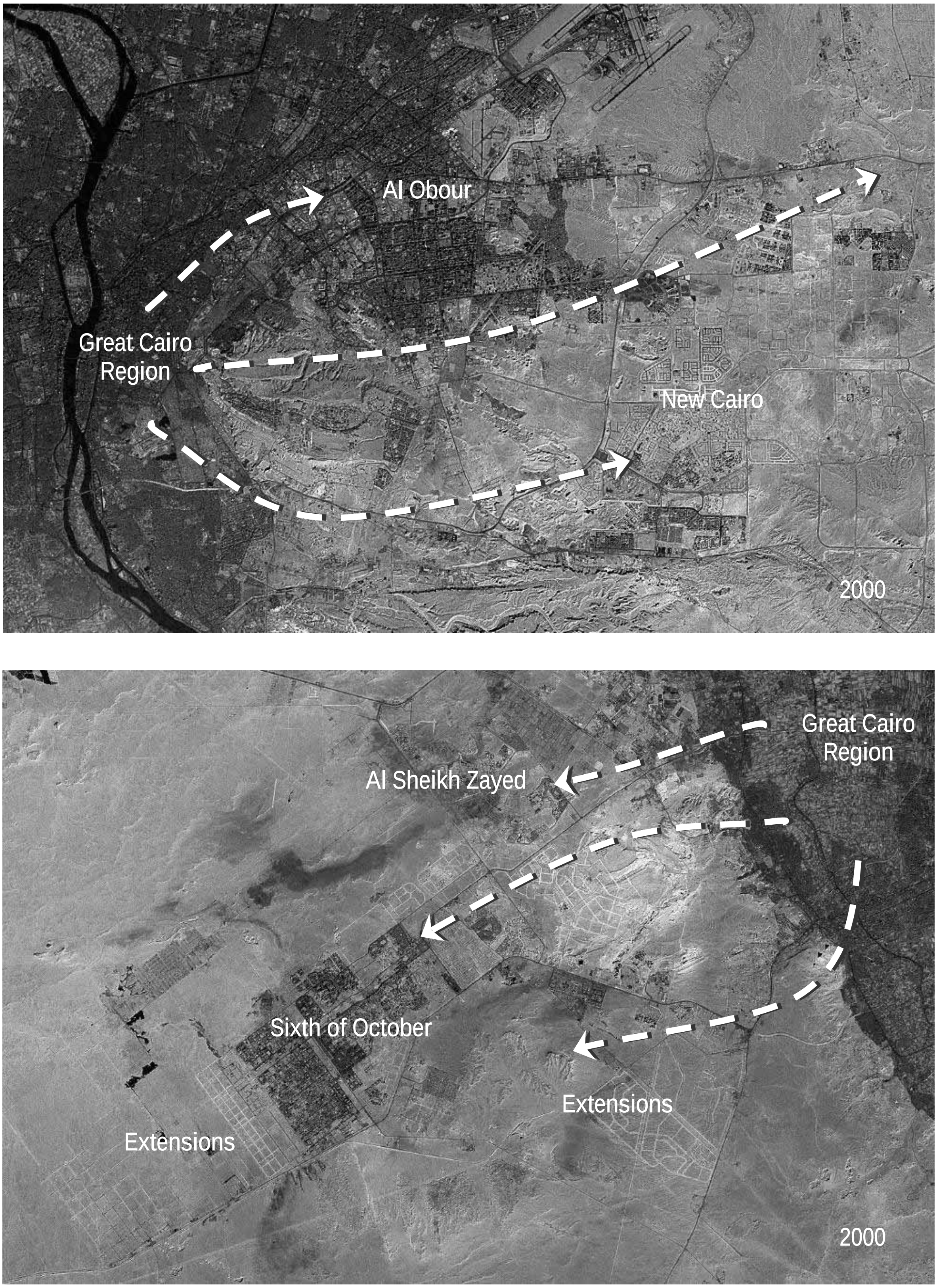


Fig. 2-41: Vision of the Egyptian authority

As an example, the new communities surrounding the great Cairo will be able to absorb the over loaded population from the Greater Cairo Region.

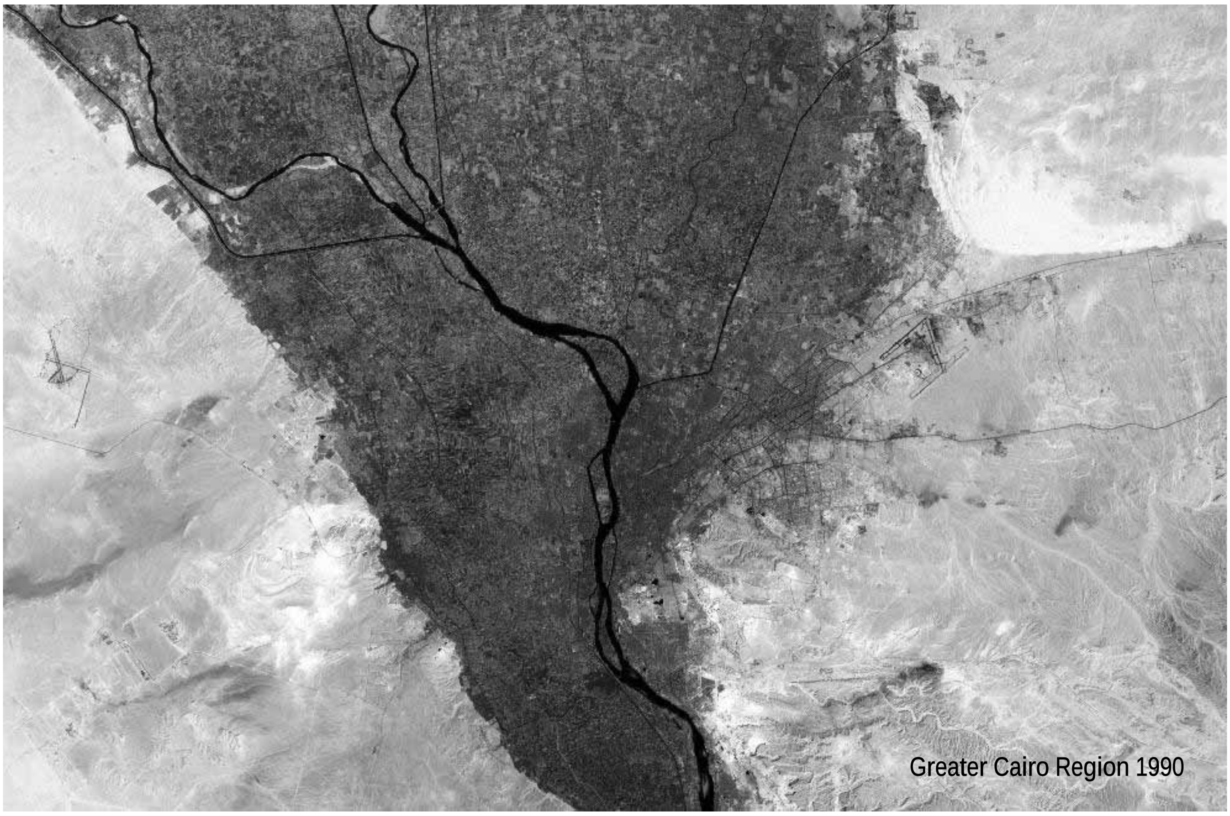
Source: Researcher using NASA World Winds 2005.

2.3.2. The New Parallel Valley Vision

Meselhy claimed that there are four main points that should be taken in account in order to put up any policy of arid regions development. They are dealing mostly with rebuilding the development relations among the old valley arid regions. They should, also, control the relation between the existing urban centers and the target new urban communities in arid regions. Firstly, the process of development for arid region should be free from the central dependency development on regional level. Secondly, arid regions should avoid the polarization of central urban areas. This regarding our new communities experience proved that they - the old central urban areas- affect badly the process of buildup of new urban communities (see Fig.2-42). Finally, the process of development for arid region should profit from internal migration poles and their direction. With reference to these points, the model of urban development in arid regions should fulfill the following:

- be environmentally planned and designed, with an environmental regional extensive context,
- developed within a new strong and well-bonded mobility and transportation axes,
- should have a self-dependant economical bases,
- their economical structures should be unitary and should have limits of agriculture self-dependant.

Figure (2-43) shows the mechanism of urban development in the Egyptian arid regions according to Meselhy. It should depend on exploiting from the existing repellent circumstances in the valley to maximize the profit from the internal population migration. At the same time, it should maximize profiting from arid regions potentials, such as tourism and renewable energy in forming their process of development. In addition, the distances between the old valley and locations of the new urban areas should be carefully studied. These distances affect the ability of the development areas to attract population



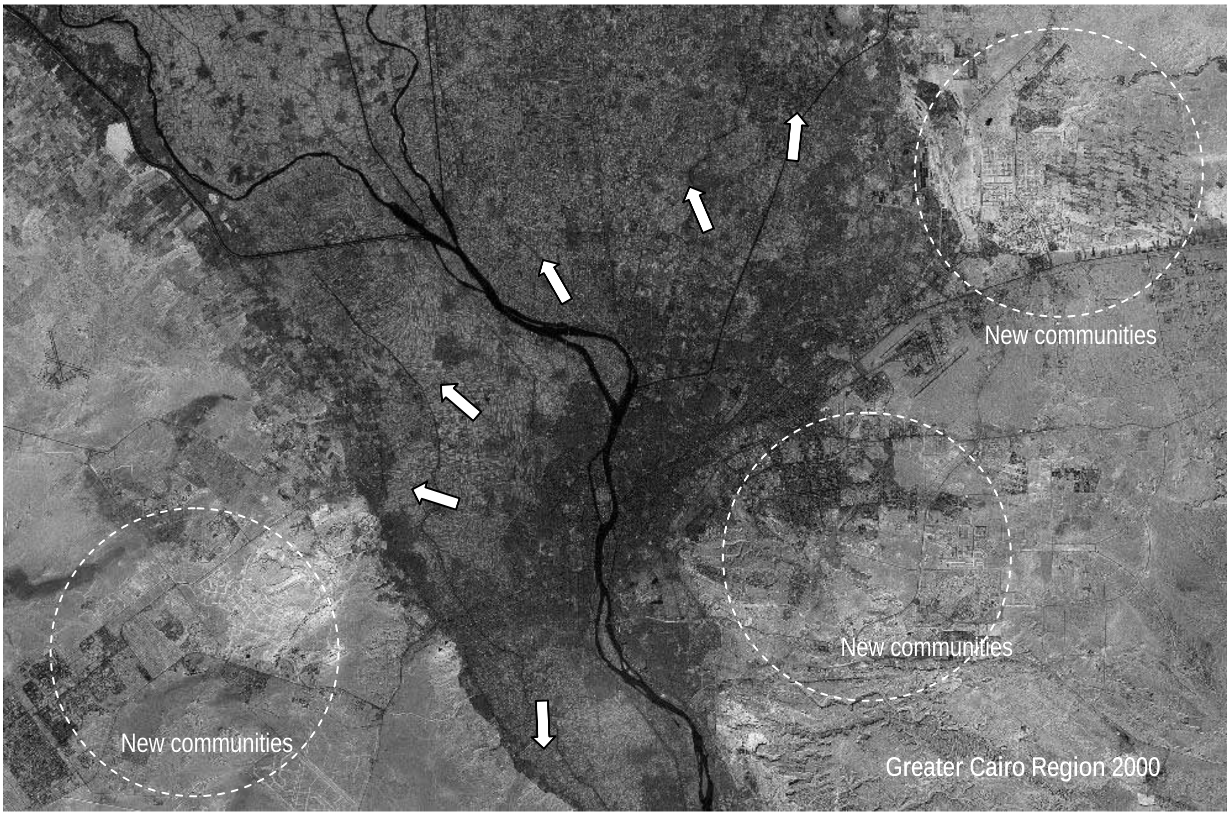


Fig. 2-42: The Greater Cairo region 1990 and 2000 aerial views
Photos show that old region is still extended over the agriculture land, at the same time; many new towns surrounding it are already developed to meet the rapid growth rate of its population. Regarding table (2-2) the achieved population capacity of these towns reached not more than 26% (in the best cases), while the achieved housing units capacity reached more than 50% in a case as Sixth of October

Source: Researcher using NASA World Winds 2005.

from the urban centers in the Nile Valley, and at the same time they should not be short to avoid the negative attraction effects of the existing urban centers.

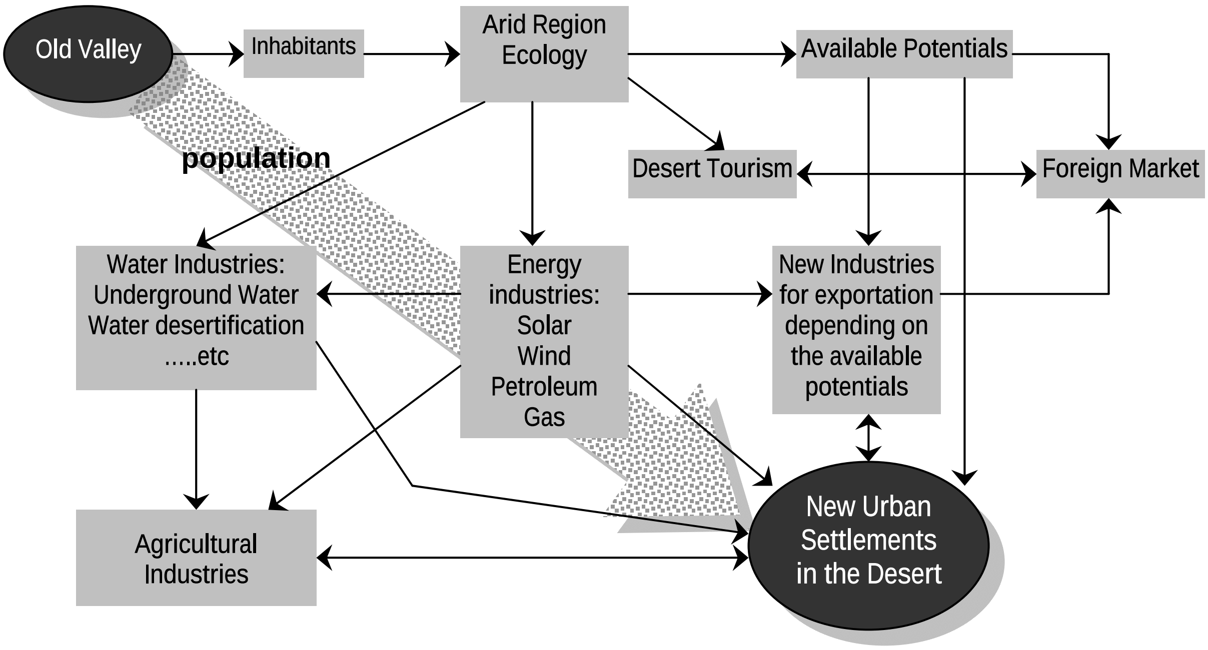


Fig. 2-43: The mechanism of urban development in the Egyptian arid regions according to Meselhy.
Maximizing the profit from the internal population migration, maximize profiting from arid regions potentials such as tourism and renewable energy in forming their process of development.

Source: Researcher after Meselhy, 2001, p.381.

From the other point of view, one of the most important problems of the Nile valley is the efficiency of its infrastructures and mobility networks. It is generally low, and these networks have to be developed in order to meet the existing and future needs of economical development. For example, the head of the Egyptian society (2006) claimed that these low efficiency networks have affected badly the development process of Toshka project, in addition to the regional development of Upper Egypt and the area south to Aswan. As well, almost all parts the Nile Valley have the same over loaded population problem. Therefore, many new urban developments have been created along the valley, especially in Upper Egypt in order to minimize the migration to Greater Cairo region.

As a result for all noted above, the solution is to create a new axis of development through the arid regions surrounding the Nile Valley. It should be parallel along the old valley. This is the new parallel valley vision developed by Elbaz (Elbaz, 2005). According to Elbaz (2005), it should be a new main axis of development, which can offer an equal development chances along the Nile Valley. It depends on creating a new strong network of urban centers and mobility networks in the Western Desert parallel to the Nile Valley. The distance between the new axis and the Nile Valley will vary according to the topology (from 10 to 80 Km). The new Axis will be connected to the valley through secondary mobility networks with about 11 connections (Fig 2-44).

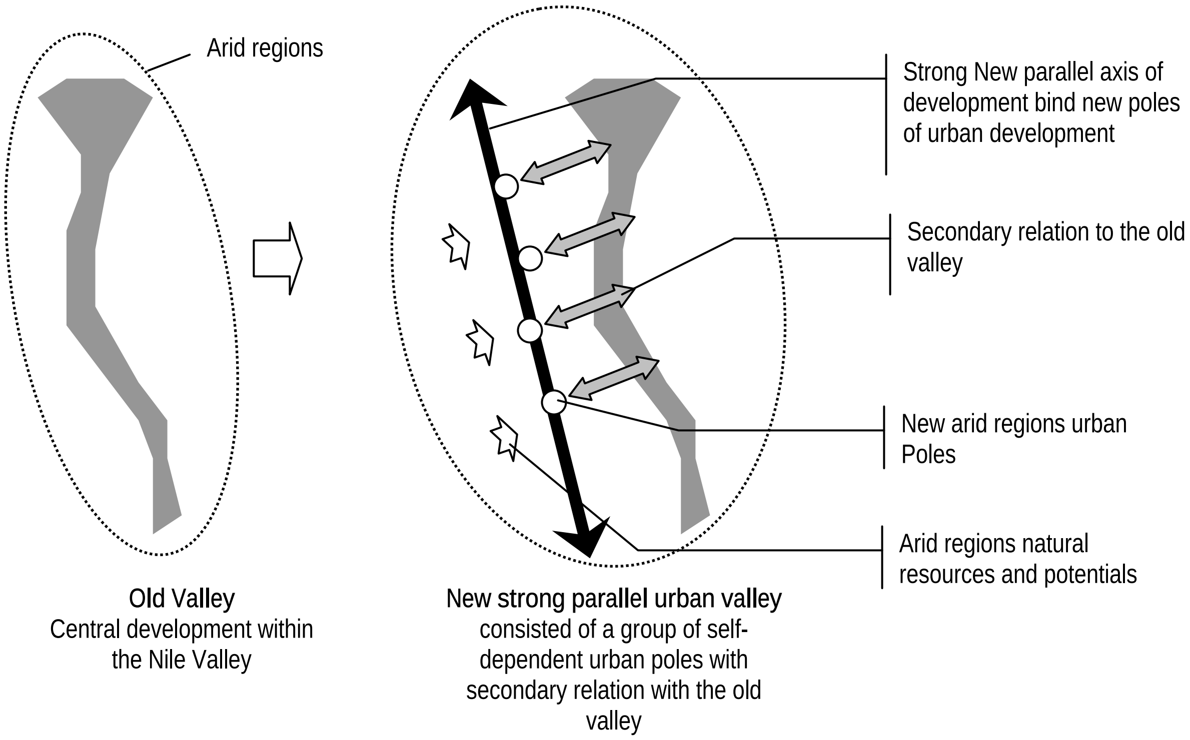


Fig. 2-44 The new parallel valley vision developed by Elbaz

Source: Researcher

Through this structure of the new development axis, many goals will be achieved including that:

- It will create a new set of arid regions communities that are strongly connected and have a relative potential at the level of regional urban development.
- It will connect these communities with all natural resources and areas with development potentials in the western desert from one side, and with the internal consumers allover the Nile Valley and the exporting infrastructures form the other side. This will help them to create their own economical bases.

- It will connect them with the major centers of populations in the old valley, which will help attracting the flow of migration.

This development vision can be an important tool for urban development for the Egyptian arid regions, as it has successful experiences in Egypt. The Suez Canal region is one of these experiences, and also, the case of the Cairo-Alexandria Highway. (Fig. 2-45)

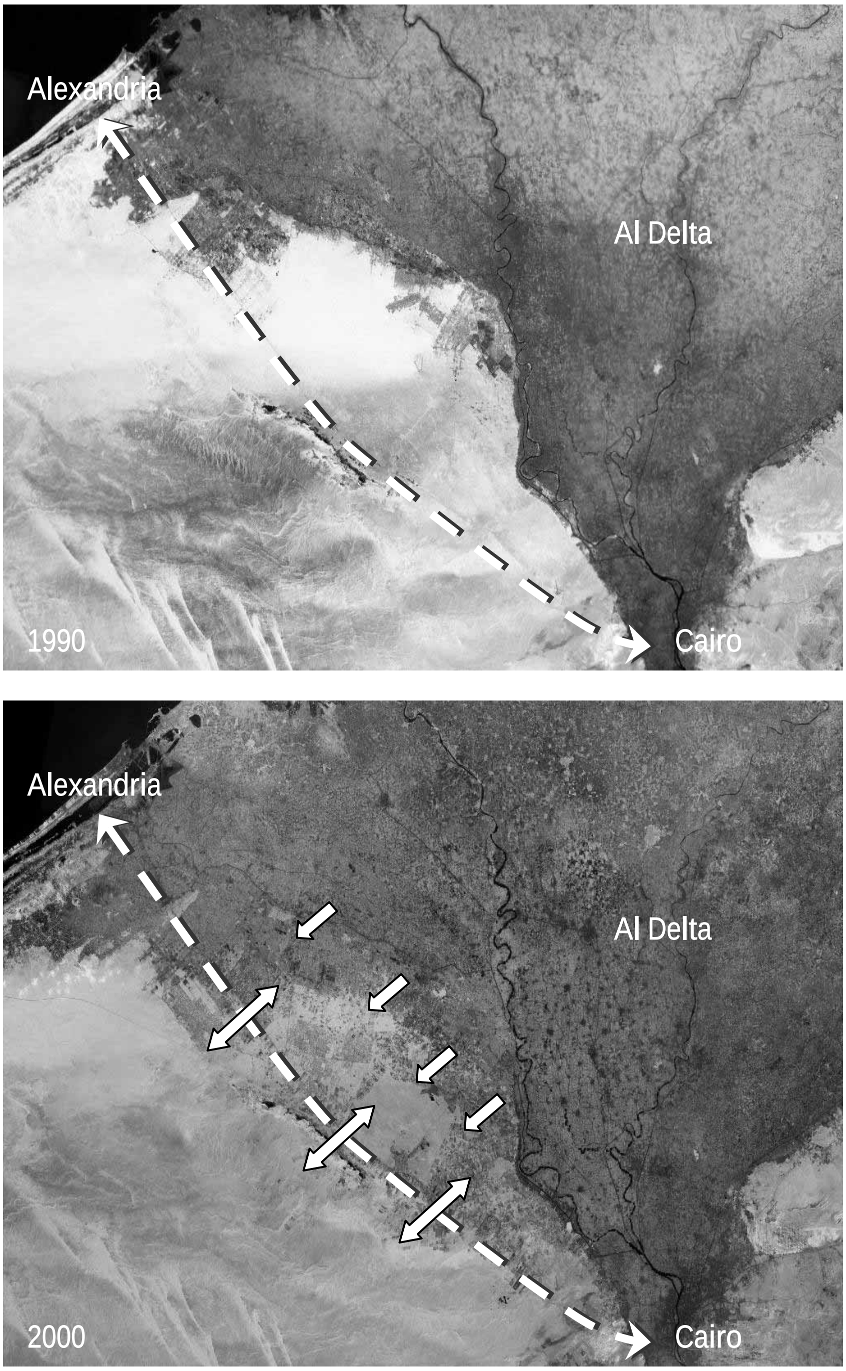


Fig. 2-45: Cairo-Alexandria highway in 1990 and 2000. The area surrounding the high-way is now full of new projects and recreation projects. Also the boundaries of the delta is moving towards the Highway, through recreation projects

Source: Researcher using NASA World Winds, 2006.

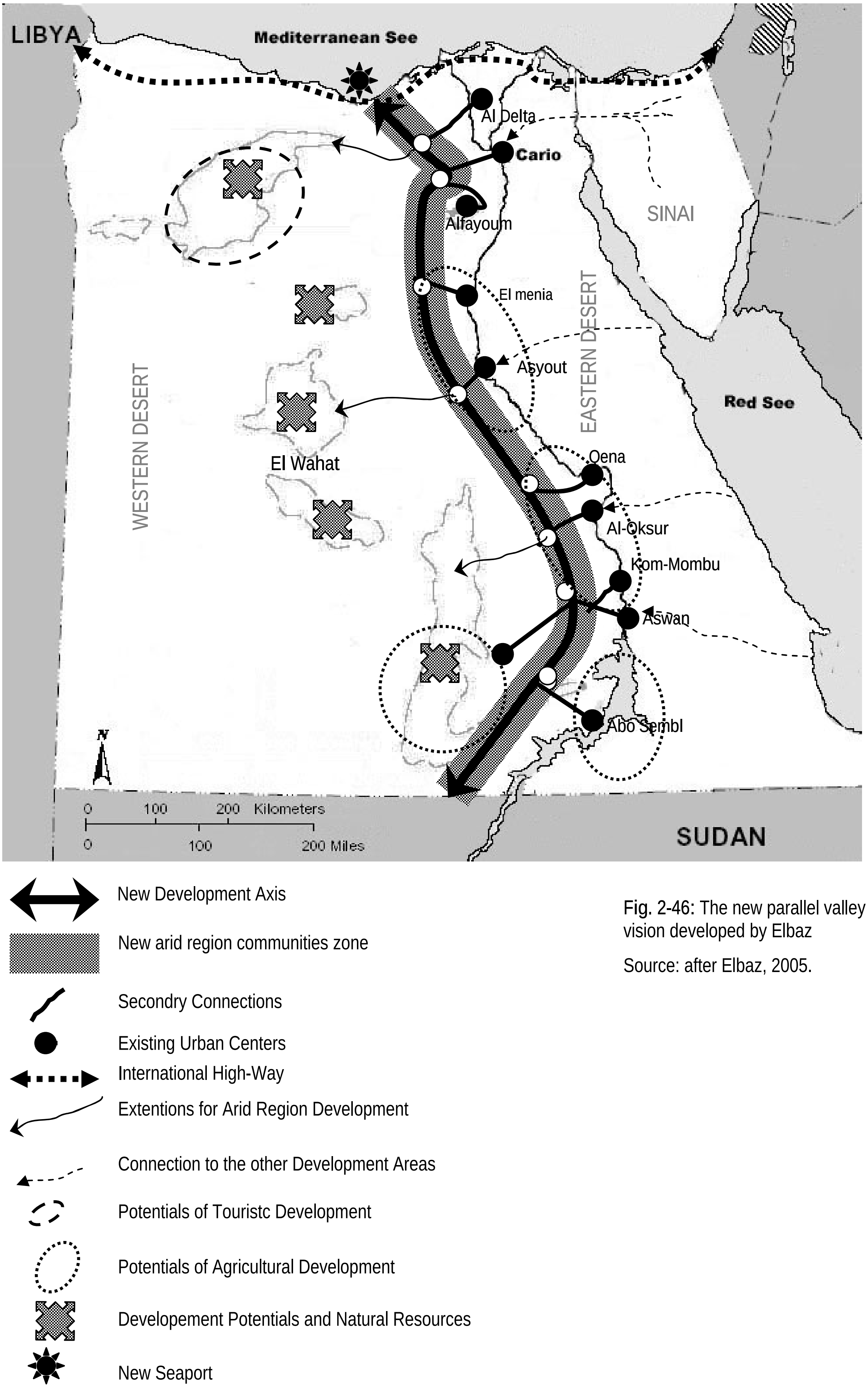


Fig. 2-46: The new parallel valley vision developed by Elbaz

Source: after Elbaz, 2005.

Thus, according to Ahmed (1985), Meslhy (2001), Gollany (1982), and others, this type of effective utilization of Egyptian arid regions could provide a vital solution to the major economic and social problems of Egypt. However, there are several factors encouraging desert development as the natural resources.

In this realm, Kurokawa (2003) in his book “Energy from the Desert" developed another vision for development of arid regions including the Egyptian ones. It stresses on the importance of utilization from renewable energy to develop not only the built environment but also all the other aspects of development in an arid region. He stresses mainly on the role that photovoltaic systems and especially large ones can play. According to the study, using these systems can be done at two levels, the local level of an urban community as an integrated urban design process, and at the regional level as regional large-scale projects. He claimed that this will help, for example, creating new industries, products and markets, local employment, resource diversification, reduced fuel consumption, reducing air pollution, reducing power station land and water use, and …etc. This means that developing arid regions and their communities depending on this type of renewable energy can help creating self-dependant communities, which have strong environmental economical bases, and with a new set of life standards. Therefore, it will play a role to attract population.

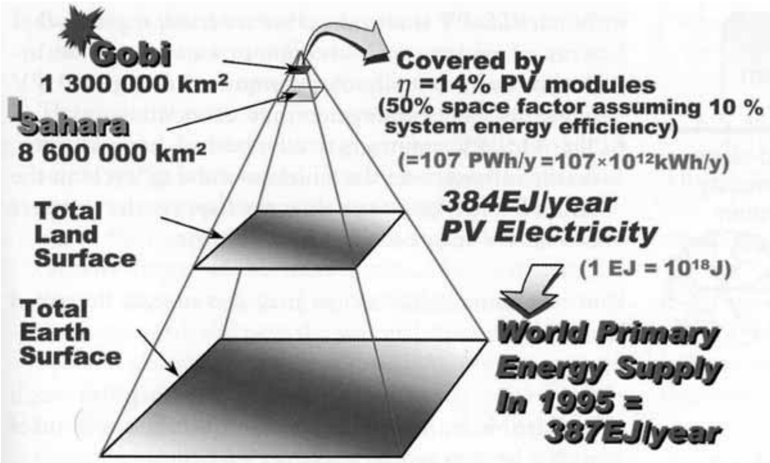


Fig. 2-47: The solar pyramid show how can using photovoltaic systems can help producing all the world needs from electricity.

Source: Kurokawa, 2003, p.xxi

2.4. Conclusion: Egyptian Arid Region and the Approach for Sustainable Development

Egypt is one of the countries, which are almost arid regions. Excluding the Nile Valley and coastal regions, more than 90% of the total area is arid regions. Therefore, most of its inhabitants concentrated in Nile Valley and Delta, Suez Canal region, and other spared zones, which are about 4-6 % of Egypt's total area. According to the estimations, this situation should be changed and new directions for urban development outside the valley should be created. This is because of the problems that are facing the process of development, and which getting worse by the increasing in population density in the valley.

Therefore, a new set of policies for urban development have been generated since 1974. The aim of these policies is to direct the population increasing and the development outside the old valley towards arid regions surrounding it. These occur through firstly developing distant areas as Western Northern Coast, Suez Canal, Red Sea Coast, and Sinai Peninsula; secondly establishing new urban centers and growth poles away from the narrow crowded valley.

Thus, the Egyptian arid regions and deserts could play a vital and basic role in the process of urban development as it is the only available place for any new urban development process, and it contains most of the natural resources. However, such type of regions has its especial environmental characters, which should be taken in account in any process of development.

Historically, the Egyptian modern experience in developing arid regions has started by the digging of Suez Canal and constructing its cities, which is considered the first significant development outside the Nile Valley. Arid region communities in Egypt can be divided into three types, which include; traditional communities, ecological-designed urban communities, and extraneous urban communities. Traditional communities have been designed and developed through their original inhabitants in harmony with the surrounding environment. However, they can not face the demands of the modern society, as in case of Siwa oasis. In contrast, is the extraneous urban communities, which include vast all the existing new communities and settlements. This is because of the urban policies, which have focused at quantities of the new settlements created, while it should consider how to attract the over population in the valley through new standards of living. Therefore, there is a need for a new development approaches that can ingather the potential of the traditional communities without neglecting the demands of the modern societies.

In this realm, studies proved that, the existing policies and patterns of urban development for arid regions should be changed. They, also, stressed on the importance of developing the new communities away from the traditional polarization of the old valley in a self-dependant pattern. Therefore, the vision of the new parallel valley can change the map of Egypt, regarding that, it will create a new axis of urban development extends along all of Egypt. In addition, integrating the new and renewable energy can play a major role in this process.

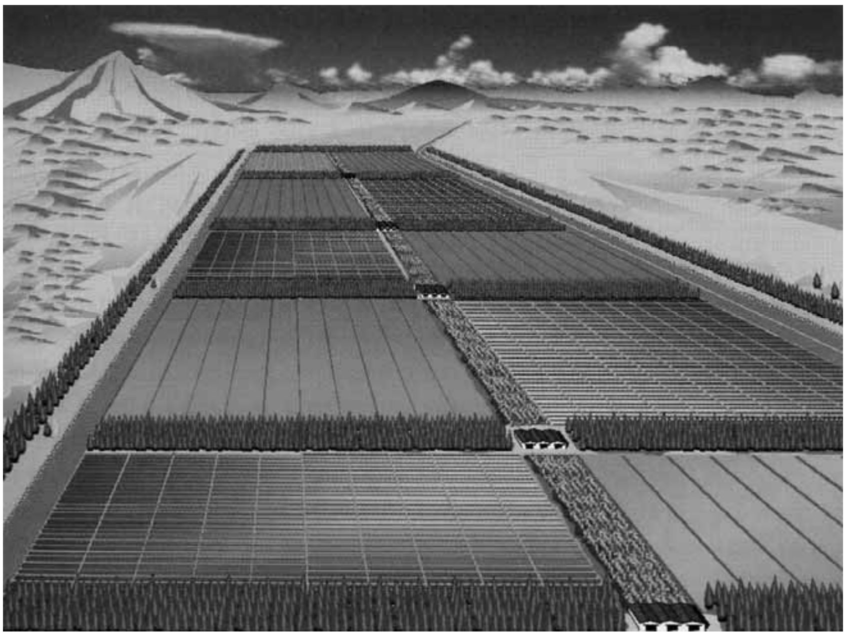


Fig. 2-48: Arid regions development according to Kurokawa

Source: Kurokawa, 2003, p.69

Chapter 3

Renewable Energy and Sustainable Urban Development

This chapter is an introduction for renewable energy, and it defines its role to achieve sustainability. In addition, it sets up the reasons, why renewable energy and especially photovoltaic can be a suitable approach for sustainable urban development in arid regions.

3.1. Renewable Energy as an Approach for Urban Development

3.1.1 Sustainable Development and the Definition of the Ecological Sustainability

The word sustainability has become a popular catchphrase in the nineties. The emergence of the environmental movement has brought this concept to the forefront of environmental policy in this decade. However, it has many definitions and meanings, depending on one's perspective (Box 3-1). Regardless of the different perspectives, all advocates of sustainability have one common general goal; the capability of humankind to maintain itself over time (Hsin, 1996).

BOX 3-1: Definition of sustainable development .

There is a measure of agreement about the principles of sustainable development though less coherence on the practical definitions and implementation of the concept. The principles include some or all of the following (Smith,1998, p. 17):

- Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (the Brunthland definition)
- Development and consumption that ensure we have within our environmental means sometimes expressed as living on 'interest' from the environment rather than 'capital'.
- Development that is based on a strong sense of equity and social justice, large differentials in income and wealth globally and within the developed world are not compatible with the principle of living within environmental capacity limits.
- A requirement that we should not 'trip' critical environmental thresholds such as levels of greenhouse gas emissions that trigger irreversible climate change or levels of pollution that damage the respiratory health of children,
- A preference for the involvement and participation of individuals, communities and organizations at every level in taking ‘ownership' of the problems and developing strategies for solving problems as ‘stakeholders’ rather than bystanders.

Ecological sustainability (Fig. 3-1), asserts the belief that the current structure and mindset of our society is unsustainable, and to approach sustainability, a new way of thinking must take place. The current economical and socio-political system must be re-structured. "Ecological sustainability is, therefore, the task of finding alternatives to the practices that got us into trouble in the first place; it is necessary to rethink about agriculture, shelter, energy use, urban design, transportation, economics, community patterns, resource use, forestry, the importance of wilderness, and our central values." (Cowan, 1996, p. 5)

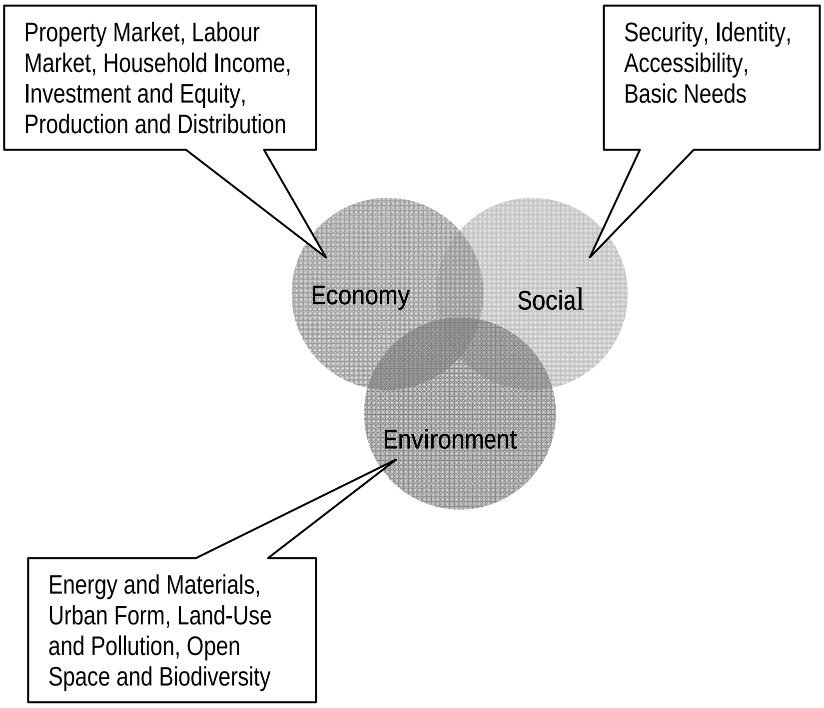


Fig. 3-1:Ecological sustainability and the scope of built environment.

Source: Smith, 1998, p. 4

3.1.2 Renewable Energy and Sustainable Development

Since the energy crisis of the 1970s, the dynamic interaction between energy systems and community development has been a subject of notable interest. There was a belief that “at all levels of special resolution, from local to regional scale, energy systems influence special structure, and land-use patterns in part determine levels of energy consumption. An important implication of this relationship is that land-use policies may have significant consequences for future energy consumption” (Owen, 1988).

This was certainly the view at the end of the twenty century , when all possible means of reducing energy consumption were on the political agenda, and the planners were being urged to reexamine all their precepts to see where they are based on; the unlimited availability of natural finite resources; to consider the energy implications of their proposals with a view to adopting schemes of low energy systems ; and to “devise and use methods for reorganizing the activities of society into more efficient spatial relationship” (Brown,1990).

Recently, Droege (2002) claimed that two major dangers will confront the world's cities and city regions within this exiting and coming generations, threaten the global urban system as a whole: fossil fuel depletion and man-made climate change. There is little disagreement in the current literature that if these are not swiftly and effectively met, their impacts will deeply affect all industrial world and mega-city systems and hit hard the fast-growing, major urban agglomerations of the developing world.

In order to examine this problem, many scenarios constructed linking energy scenarios and sustainable development pathways have emerged in recent years. Scenario construction is the conceptual and analytical tool frequently used to build a shared understanding of sustainable future worlds. Scenarios are neither predictions nor forecasts; they are merely internally consistent cognitive models of how the world could look like in the future. (Schwartz, 1991). The International Institute for Applied Systems Analysis (IIASA) and the World Energy Council (WEC) jointly undertook a five-year study entitled Global Energy Perspectives (Venema, 2004). The key objectives of the IIASA-WEC study were to integrate near-term strategies (up to 2020) with long-term possibilities (up to 2100), and to ensure consistency, reproducibility and transparency with a unified methodological framework linking databases, models and assumptions. Three basic scenarios span a wide range of possible global futures in the IIASA-WEC study A, B and C (Box 3-2) .Table 3-1 provides a qualitative summary of the high sustainability scenarios for several key indicators.

BOX 3- 2 Scenario A, B, C .

Scenario A: "High-growth" with vigorous economic development and rapid technological advance. One of the variants in this scenario ("A3") includes many features consistent with sustainable development.

Scenario B: "The middle course" with intermediate economic growth and modest technological improvements.

Scenario C: "Ecologically-driven" incorporating aggressive environmental and energy taxes for simultaneous environmental protection and North-South wealth transfer.
Scenario C includes two variants ("Cl and "C2") that assume new renewable energy technology with and without nuclear energy respectively. Both case C scenarios assume heavy decentralization of energy systems, reliance on local solutions and relatively greater investment in end-use sectors rather than new generation
Source:After Venema, 2004

Table 3-1: Sustainability indicators for three energy scenarios in 2020 and 2100 compared with 1990

Indicator of sustainability	1990	Scenario A3	Scenario B	ScenarioC1
Eradicating poverty	Low	Very high	Medium	Very high
Reducing relative income gaps	Low	High	Medium	Very high
Providing universal access to energy	Low	Very high	High	Very high
Increasing affordability of energy	Low	High	Medium	Very high
Reducing adverse health impacts	Medium	Very high	High	Very high
Reducing air pollution	Medium	Very high	High	Very high
Limiting long-lived radionuclide	Medium	Very low	Very low	High
Limiting toxic materials	Medium	High	Low	High
Limiting GHG emissions	Low	High	Low	Very High
Raising indigenous energy use	Medium	High	Low	Very High
Improving supply efficiency	Medium	Very high	High	Very High
Increasing end-use efficiency	Low	High	Medium	Very High
Accelerating technology diffusion	Low	Very high	Medium	Medium

Source: Venema ,2004, p.9

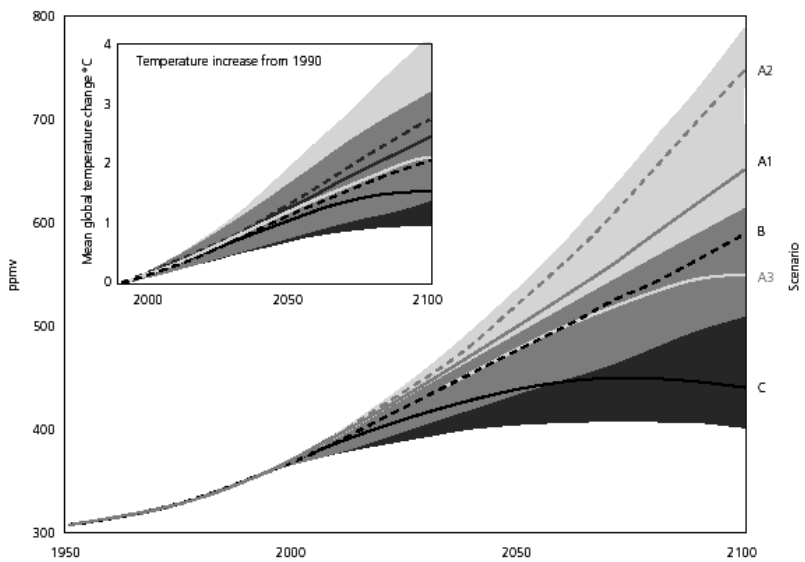


Fig. 3-2: Projected atmospheric concentrations and temperature increases for IIASA-WEC scenarios.

Source: Venema, 2004

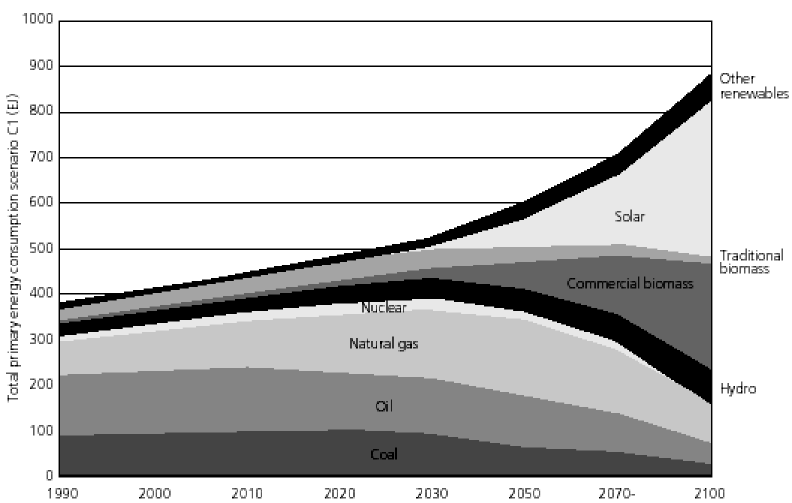


Fig. 3-3: Global primary energy consumption (EJ), IIASA-WEC scenario c1.

Source: Venema, 2004

Table (3-1) shows that among all the three scenarios, according to Indicators of sustainability, scenario c provides the chance to achieve sustainable development such as eradicating poverty, reducing relative income gaps, reducing air pollution. On the other hand, Fig. 1-48 & Fig1-49 show that projected atmospheric concentrations and temperature increase will be increased in the future if we do not develop new programs of development depending on renewable energy, and therefore, there is a need to reconstruct the principles of living in our communities in order to increase the role of renewable energy.

Thus, according to Venema (2004), the study has proved that the case of scenario C is the most compatible case with principles of sustainable development. In addition, scenario's authors have claimed that this scenario is the best way in order to achieve the aimed sustainable development, specially, in developing countries.

On the other hand, with the beginning of sustainable development concepts, the term of sustainable community has appeared, In this regard , ORTEE’s Sustainable Communities Working Group has identified twelve principles to be considered by communities that are beginning to address the question of sustainability. (Richardson, 1994):

- Recognizes that growth occurs within some limits and is ultimately limited by the carrying capacity of the environment,
- Values cultural diversity,
- Has respect for other life forms and supports bio-diversity,
- Has shared values among the members of the community (promoted through sustainability education),
- Employs ecological decision-making (e.g., integration of environmental criteria into all

BOX 3-3 Definitions .

Sustainable urban development

Is a process of change in the built environment that fosters economic development while conserving resources and promoting the health of the individual, the community, and the ecosystem.

Source: Richardson ,1989.

municipal government, business and personal decision-making processes),

- Makes decisions and plans in a balanced, open and flexible manner that includes the perspectives from the social, health, economic and environmental sectors of the community,
- Makes best use of local efforts and resources (nurtures solutions at the local level),
- Uses renewable and reliable sources of energy,
- Minimizes harm to the natural environment, and
- Fosters activities, which use materials in continuous cycles.

With reference to these principles, there is a need to consider natural resources and renewable energy in city planning, because "by linking energy use and city planning, city planners can improve the quality of life in their cities while providing significant dollar savings to city government, citizens, and the business community. Why not formally extend energy planning into every aspect of metropolitan life?" (DOE, 1996, p.1).

Therefore, cities, towns and other urban communities are increasingly regarded as settings for coordinated policy implementation efforts aimed at global renewable energy technology introduction and carbon emissions reduction programs. This is because of the widespread benefits due to three main reasons; firstly, the integral nature of energy in communities, where efficiency gained in one sector lead to related improvements in other sectors” (CEC, 1997). Secondly, “the urban areas offer enormous potential for easing the demand for energy-intensive materials and increasing the efficiency of resource use” (CDI, 2000). Finally, “there is a need for a ‘Sustainable Energy’, which will be “an integrated approach to the provision of energy services that can meet people's social, economic and environmental needs and facilitate the achievement of broader International development targets” (UNDP, 2000).

As a result, careful international efforts is being done by the international community in order to achieve the changing to 'Solar City', "the urban community which embraces a path of integrating solar energy technologies or other renewables as well as efficiency measures into the broader of the community-wide planning strategy aimed at climate-stable greenhouse-gas emissions by 2050" (Droege, 2002). Developing these communities depending on using renewable energy will enable them to achieve the best use of renewable energy resources and, on the other hand, offer a new set of industries and economies, which are involving in renewable energy applications.

3.1.3 Renewable Energy and its Potentials for Sustainable Community Urban Development

There is much debate about how to define and distinguish renewable energy from non-renewable, it is defined as "Sustainable Energy" (Box3-4) sources that cause relatively few environmental impacts and have a lesser risk to human health. They include technologies such as solar photovoltaic energy, solar thermal energy, wind power, low impact hydropower, geothermal energy, and biomass energy'. It also defined as " Any energy resource that is naturally regenerated and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources."(TREIA, 2004).

> BOX 3-4 Definitions .
> Sustainable Energy
> Energy sources that do not pollute the atmosphere, water and soils in irreparable or harmful ways.
>
> Source: Abd-Elaal, 2002.

According to the development authorities, this importance comes through many key benefits of integrating them within any development process, and they include:

3.1.3.1 The Contribution of Renewable Energy to Climate Change

Emissions of anthropogenic greenhouse gases, mostly from the production and use of energy, are altering the atmosphere in ways that are affecting the climate. As stated in the third assessment report of the IPCC, there is new and stronger evidence that most of the warming observed over the last fifty years is attributable to human activities, and that significant climate change would result if 21st century energy needs were met without a major reduction in the carbon emissions of the global energy system during this century.

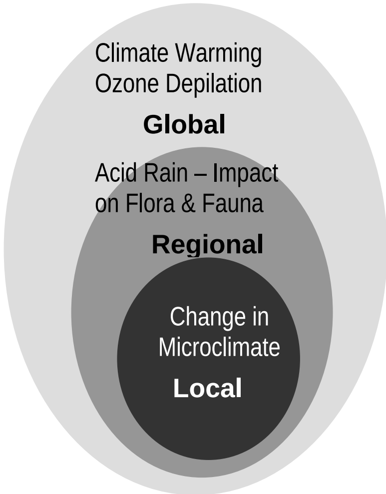


Fig. 3-4: Ecological sustainability and the scope of built environment.

Source: Smith, 1998, p. 4

Therefore, Goldemberg (2004) claimed that it is a serious challenge to sustainable development and the main strategies to prevent it are the following:

(a) more efficient use of energy, especially at the point of end use in buildings, transportation, and production processes,

(b) increased reliance on renewable energy sources.

3.1.3.2 Innovations, Local Market, and Employment

As a good evidence, the rapidly growing renewable energy industries and service sectors in many countries show that the efficient promotion of such new technologies offers great opportunities for the development of energy markets with locally or regionally oriented value chains and thereby, for the creation of new jobs (Table 3-2). Thus, development of renewable energy can be a key feature in regional development with the aim of achieving greater social and economic cohesion within the community.

Table 3-2. Direct jobs in energy production. (These numbers were obtained from a variety of sources and include jobs involved in operating the generating stations as well as the jobs involved in producing and maintaining the equipment.)

Sector	Petroleum	Offshore oil	Natural gas	Coal	Nuclear	Wood energy	Hydro	Minihydro	Wind	Photovoltaics	Bioenergy (from sugarcane)
Jobs - year / Terawatt-hour (fuel production + power generation)	260	265	250	370	75	733 – 1067	250	120	918– 2,400	29,580 – 107,000	3,711-5,392

Source: After Goldemberg , 2004, p5

3.1.3.3 Diversification of Energy Supply, Energy Security, and Prevention of Conflicts about Natural Resources

The cost of maintaining energy security in today's industrialized countries comes at high, but usually hidden, costs that find expression in military and security spending. The volatile world market prices for conventional energy sources, in particular oil, have great risks for large parts of the world's economic and political stability, with sometimes-dramatic effects on energy-importing developing countries. In this context, renewable energies can help to diversify energy supply and to increase energy security. It should increase the economic benefits that result from transformations in energy trading patterns (Goldemberg, 2004).

3.1.3.4 Poverty Reduction through Improved Energy Access and Gender Aspects

Energy is fundamental for economic growth. Access to reliable energy services can directly contribute to enterprise development and income-generating activities if other raw materials and markets are accessible. In addition, increased use of renewable energy in combination with energy efficiency can help reducing both dependence on fossil fuels and imports, contributing to a more stable macroeconomic environment.

3.1.3.5 Health Related Impacts

The main pollutants emitted in the combustion of fossil fuels are sulphur and nitrogen oxides, carbon monoxide and suspended particulate matter. Ozone is formed in the troposphere from interaction among hydrocarbon, nitrogen oxides, and sunlight. The environmental impacts of a host of energy-linked emissions, including suspended fine particles and precursors of ozone and acid deposition, contribute to local and regional air pollution and ecosystem degradation. Human health is threatened by high levels of pollution from fossil fuel combustion.

In addition, many authorities defined other benefits of integrating renewable energy into the process of urban development. For example, Kurokawa (2003) summarized the non-energy benefits that can be gained through integrating systems of photovoltaic within the process of urban development (Table 3-3). Regarding these benefits, it is clear that integrating a renewable energy system such as photovoltaic can affect the community at all levels of development. This covers not only the level of energy development, but also the other levels as urban and architectural, environmental, socio-economical and electrical level.

In conclusion, integrating renewable energy within the process of urban development will play a key role not only at the level of physical needs of the settlement, but also to achieve the international development targets, which adopted by bilateral and multilateral development agencies (Box 3-5). These targets aim worldwide at reducing poverty, improving access to education, empowering women through equality, reducing infant and maternal mortality rates, slowing population growth through contraception and implementing national strategies for sustainable development (Wilkins, 2002, p.24).

Table 3-3: Summary of non-energy benefits that can add value to PV systems
Source: Kurokawa, 2003.

Category	Potential values
Architectural	Substitute building component; multi-function potential for insulation, waterproofing, fire protection, wind protection, acoustic control, delighting, shading, thermal collection and dissipation; aesthetic appeal through colour, transparency, non-reflective surfaces; reduced embodied energy of the building; reflection of electromagnetic waves; reduced building maintenance and roof replacements.
Socio-economical	New industries, products and markets; local employment for installation and servicing; local choice, resource use and control; potential for solar breeders; short construction lead-times; modularity improves demand matching; resource diversification; reduced fuel imports; reduced price volatility; deferment of large capital outlays for central generating plant or transmission and distribution line upgrades; urban renewal; rural development; lower externalities (environmental impact, social dislocation, infrastructure requirements) than fossil fuels and nuclear; reduced fuel transport costs and pollution from fossil-fuel use in rural areas; reduced risks of nuclear accidents; symbol for sustainable development and associated education; potential for international co-operation, collaboration and long-term aid to developing countries.
Environmental	Significant net energy generator over its lifetime; reduced air emissions of particulates, heavy metals, $C0_2$, $N0_x$, $S0_x$, resulting in lower greenhouse gases; reduced acid rain and lower smog levels; reduced power station land and water use; reduced impact of urban development; reduced tree clearing for fuel; reduced nuclear safety risks.
Electrical	kWh generated; kW capacity value; peak generation and load matching value; reduction in demand for utility electricity; power in times of emergency; grid support for rural lines; reduced transmission and distribution losses; improved grid reliability and resilience; voltage control; smoothing load fluctuations; filtering harmonics and reactive power compensation.

Box 3.5: International development targets

- A reduction by one-half in the proportion of people living in extreme poverty by the year 2015.
- Universal primary education in all countries by 2015.
- Demonstrated progress towards gender equality and the empowerment of women by eliminating gender disparity in primary and secondary education by 2005.
- A reduction by two-thirds in the mortality rates for infants and children under age five and a reduction by three-quarters in maternal mortality, both by 2015.
- Access through the primary healthcare system to reproductive health services for all individuals of appropriate ages as soon as possible and no later than 2015.
- The implementation of national strategies for sustainable development by 2005, so as to reverse current trends in the loss of environmental resources at both global and national levels by 2015.

Source: Wilkins, 2002

3.2. Renewable Energy Resources and Applications:

Generally, according to Boyle (2004, p.11-14), renewable energy can be defined as energy obtained from the continuous or repetitive currents of energy recurring in the natural environment, or as energy flows which are replenished at the same rate as they are used. All forms of renewable energy are a direct or indirect form of solar radiations. Figure 3-5 summarizes the origins and magnitudes of the earth's renewable energy sources, and make it is clear that their principal source is solar radiation.

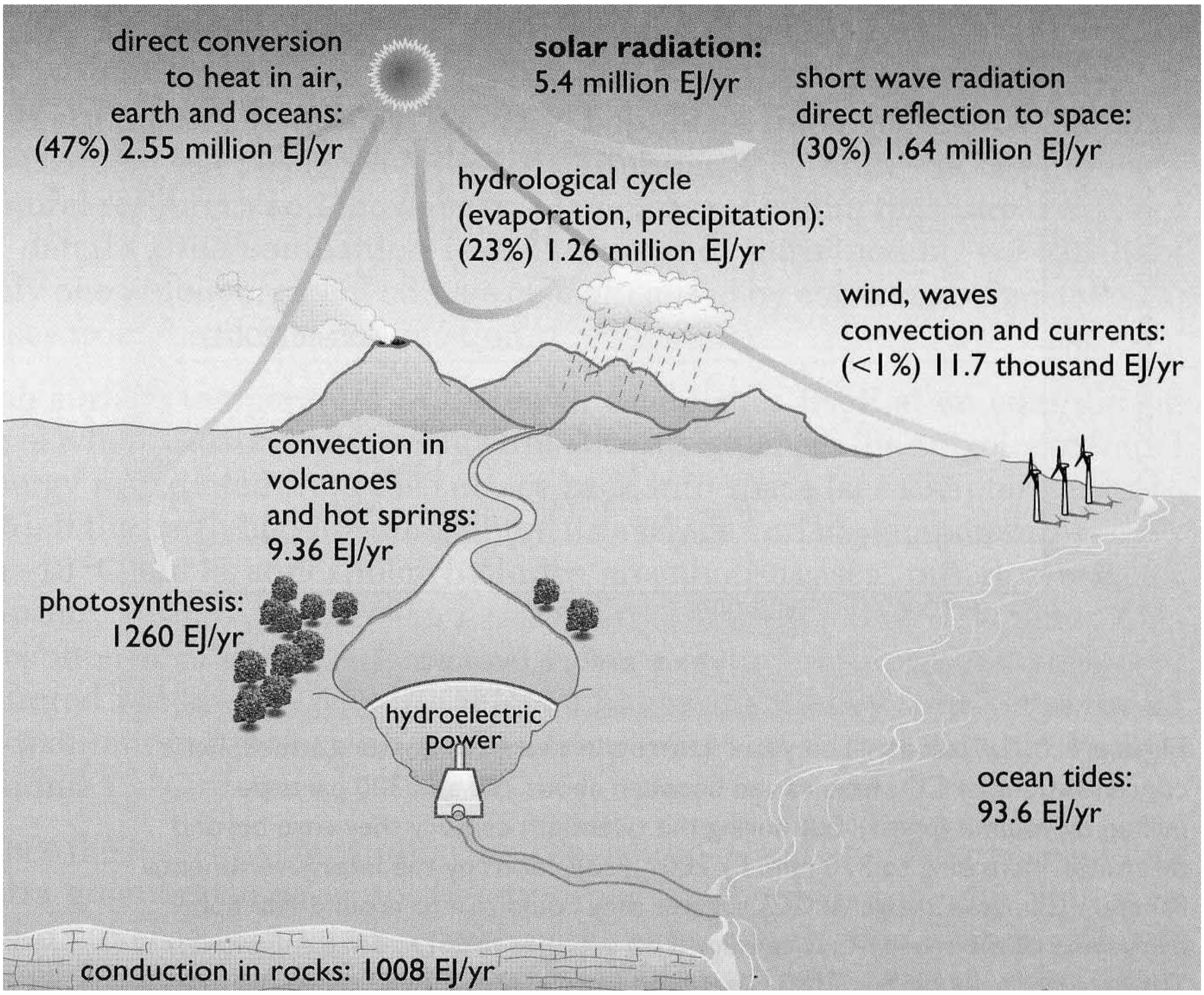


Fig. 3-5: The origins and magnitudes of the earth's renewable energy sources.

Source: Boyle, 2004, p. 12

Solar energy is the radiant energy produced in the sun because of nuclear fusion reactions. It is transmitted to the earth through space in quanta of energy called photons, which interact with the earth's atmosphere and surface. The strength of solar radiation at the outer edge of the earth's atmosphere when the earth is taken to be at its average distance from the sun is called the solar constant, the mean value of which is about 2 calories / min / cm^2. The intensity is not constant, however; it appears to vary by about 0.2 % in 30 years. The intensity of energy actually available at the earth's surface is less than the solar constant because of absorption and scattering of radiant energy as photons interact with the atmosphere.

In addition, renewable energy resources can be divided into two main categories according to their applications; active applications and passive applications.

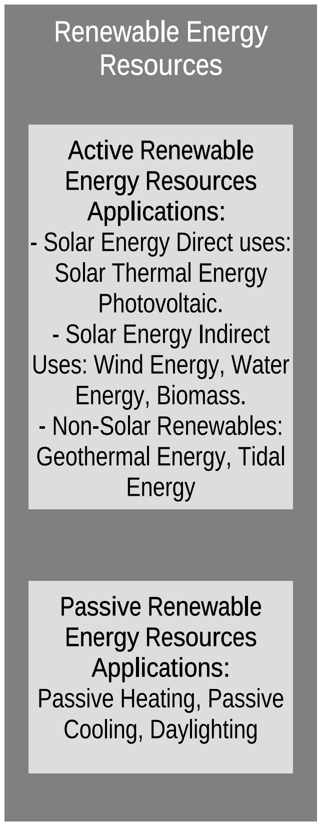


Fig. 3-6: Renewable energy resources and applications.

Source: Researcher

3.2.1. Active Renewable Energy Resources Applications:

They are those applications developed to generate heat or electricity. They contain all forms of renewable energy in three categories.

3.2.1.1. Solar Energy: Direct uses

Solar radiation can be converted into useful energy directly, in various forms of energies and using various technologies.

(a) Solar Thermal Energy

It is a technology for transforming solar energy to heat. Solar thermal collectors are divided into low, medium, or high temperature collectors. Low temperature collectors are flat plates generally used to heat at a small scale. Medium-temperature collectors are also usually flat plates but are used for creating hot water for residential and commercial use. High temperature collectors concentrate sunlight using mirrors or lenses are generally used for electric power production.

- Low-Temperature Solar Thermal Systems: Domestic Solar Water Heating (DSWH)

Simple solar distillation units, comprising a horizontal tray, with a sloping glass roof to collect the distillate, have been known for many years but their application is very limited. Active solar systems, using simple collectors of the "flat plate" type are sometimes used; either alone or in conjunction with passive solar design, for house heating or cooling but the major use of these collectors is for domestic hot water. They are usually installed on the roof or porch of the house. The tilt is fixed so that the installation is virtually maintenance-free. Where an electricity grid exists, backup by electricity is customary. Commercial and industrial installations are feasible, but are not yet very common.

Fig. 3-7: Simple collectors of the "flat plate" type; Apartment building, Germany.

Source: Herzog, 1998,p.63

- Medium-Temperature Active Solar Thermal Systems

These systems, operating at temperatures up to 350^{o} C, are usually based on one-axis tracking parabolic mirror, focusing on a linear absorber. Such systems have been proposed for the production of steam for industry and a number have been built in different countries. In principle, the system may be used for driving turbo-generators to produce electricity but the economic viability was, until recently, very questionable.

Fig. 3-8: One of nine solar electric energy generating systems at Kramer Junction, California.

Source: .powerfromthesun.net, 2008.

- High-Temperature Active Solar Thermal Systems

These systems can be called concentrating solar power technologies, as they all depending on using reflective materials such as mirrors to concentrate the sun's energy. This concentrated heat energy is then converted into electricity. These technologies can be classified into many categories such as trough collectors, /engine systems, and solar (power) towers.

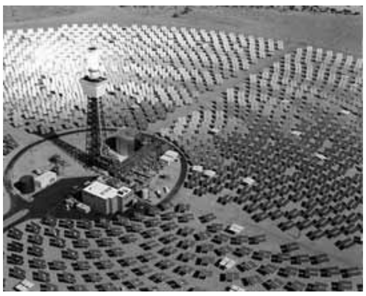


Fig. 3-9: An example for solar (power) tower.

Source: Triple pundit, 2007.

(b) Photovoltaic (PV)

"The term photovoltaic energy is used to describe those processes in which solar radiation is converted directly to electricity without first being converted to heat or chemical forms. It is based on the property of certain solid materials (the semiconductors) to generate electrical current when illuminated by light" (Dostrovsky, 1988, p. 95.).

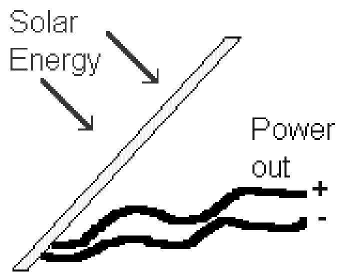


Fig. 3-10: Solar cells convert light directly into electricity.

Source: Solar Power, 2008.

Photovoltaics, whereby incident solar radiation is converted directly into Direct Current (DC) electricity, silently and without pollution, could claim to be the simplest and most elegant technology to make use of the power of the sun. Solar cells or solar modules (which comprise an assembly of small cells to produce a larger unit) can be assembled into arrays to provide electrical power from milliwatts to megawatts. The DC may be converted, if desired, into Alternating Current (AC) by means of static inverters, made practical by recent developments in power electronics.

PV systems are easy to install and, because of their simplicity, require minimal maintenance. This, together with their freedom from re-fuelling, provided the initial market impetus for terrestrial use of PV, particularly for applications where modest amounts of power were required in areas remote from a conventional source of electricity. Given all these advantages, it may seem surprising that solar Photovoltaics have not yet to make an impact as a major energy source. However, a number of technical, economic, and structural barriers have still to be overcome for PV to achieve significant penetration of the overall energy market. PV will be discussed in details in the next chapters.

3.2.1.2. Solar Energy: Indirect Uses

Solar radiation can be converted to useful energy indirectly, via other energy forms.

(a) Wind Energy

Wind energy, in common with other renewable resources, is broadly available, but diffuse. It was widely used as a source of power before the industrial revolution. In the course of this revolution, wind energy was displaced by fossil fuels, because the use of these fuels was cheaper and more reliable. The first oil crisis, however, triggered renewed interest in wind energy technology for grid-connected electricity production, water pumping and for power supply in remote areas. In recent years, this interest has been stimulated by environmental problems and the threat of a global climate change related to the use of conventional energy sources (WEC, 1994, p.147).

Fig. 3-11: An example for a wind energy Farm. Some of the over 4000 wind turbines at Altamont Pass, in California.

Source: Wikipedia, 2004.

"Winds are driven by the uneven absorption of solar energy by the surface of the earth. Therefore, wind is often classified as a form of solar energy that has been converted, by a huge (and low-efficiency) global thermal engine, to the kinetic energy of the moving air. Of the total solar energy intercepted by the earth, which is about 5.6 million EJ/year, it is estimated that about 110,000 J are dissipated in the total wind system" (Ramage, 1997, p. 104).

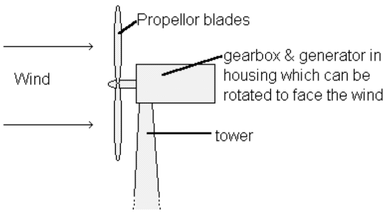


Fig. 3-12: Concept of the wind turbine.

Source: Solar Power, 2008.

(b) Biomass Energy

With reference to the WEC definitions (WEC, 1994) biomass is a term used in the context of energy to define a range of products derived from photosynthesis. Annually, through photosynthesis, solar energy equivalent to several times the world's annual use of energy is stored in the leaves, stems and branches of plants. Of the various renewable sources of energy, biomass is thus unique in that it represents stored solar energy. In addition, it is the only renewable source of carbon, and is able to be converted into convenient solid, liquid, and gaseous fuels.

Historically, biomass was the sole source of energy for humankind for most of its evolution, to be replaced only in the last two centuries by the fossil fuels. Now, biomass is again being reexamined as a substitute for these same fossil fuels that displaced it earlier. In addition, biomass is the world's fourth largest energy source in the last two decades. It contributes nearly 14% of the world's primary energy and is the most important (35%) source of energy in developing countries where up to 75% of the world's people live (Dostrovsky, 1988, p.104).

Biomass energy can be generated by many methods such as; direct combustion of forest residues, co-firing with coal at existing coal plant, anaerobic digester gas with waste from pig farm , anaerobic digester gas from sewage treatment, and landfill gas (as communities develop) (Renegy Holdings,2007).

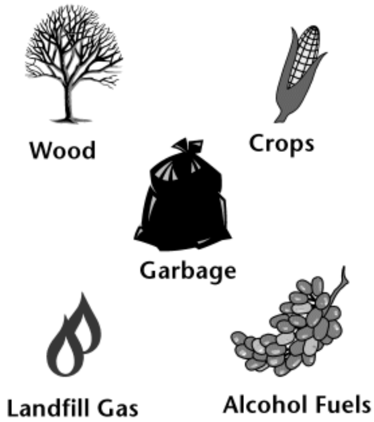


Fig. 3-13: Types of biomass resources.

Source: EIA, 2006.

(c) Water Energy

Humankind has used the energy of falling water for many centuries, at first in mechanical form and since the late 19th century by further conversion to electrical energy. Historically, hydropower was developed on a small scale to serve localities in the vicinity of the plants. With the expansion and increasing load transfer capability of transmission networks, power generation was concentrated in larger units, and to benefit from the economies resulting from development on a larger scale. Sites selected for development tended to be the most economically attractive; in this regard, higher heads and proximity to load centers were significant factors. For this reason, development was not restricted to large sites and hydro station today range from less than 1 Mwe capacity to more than 110,000 Mwe. In addition, the efficiency of hydroelectric generation is more than twice that of competing thermal power stations.

However, some problem related to climate changes can affect this resource of energy in the future. For example, in Egypt, the waterpower from the "High Dam" represents the major rescues of energy. The recent environmental studies have found the climate changes will affect badly the amount of water of the River Nile.

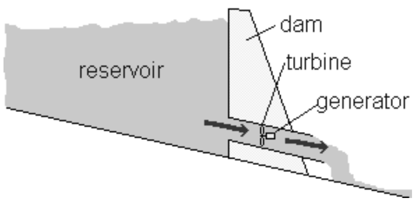


Fig. 3-14: Concept of the water energy :A dam is built to trap water, usually in a valley where there is an existing lake. Water is allowed to flow through tunnels in the dam, to turn turbines and thus drive generators.

Source: Solar Power, 2008.

3.2.1.3. Non-Solar Renewables

They are sources of renewable energy that do not depend on solar radiation. They are including geothermal and tidal energy.

(a) Geothermal Energy:

Geothermal energy is renewable heat energy from deep in the earth. It originates from the earth's molten interior and the decay of radioactive materials, Heat is brought near to the surface by deep circulation of groundwater and by intrusion into the earth's crust of molten magma originating from great depth. In some places, this heat comes to the surface in natural streams of hot steam or water, which have been used since prehistoric times for bathing and cooking. By drilling wells, this heat can be trapped from the underground reservoirs to supply pools, homes, greenhouses, and power plants. According to the WEC (WEC, 1994, p.235), the quantity of this heat energy is enormous; it has been estimated that over the course of a year, the equivalent of more than 100 watt hour peak (Whp) of heat energy is conducted from the earth's interior to the surface. But geothermal energy tends to be relatively diffuse, a phenomenon which makes it difficult to tap.

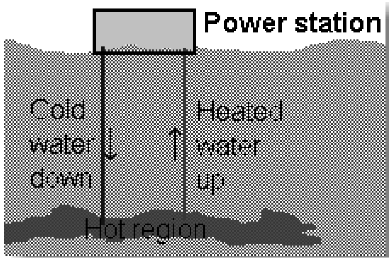


Fig. 3-15: Concept of the geothermal energy:
Hot rocks underground heats water to produce steam.
We drill holes down to the hot region; steam comes up, is purified and used to drive turbines, which drive electric generators. There may be natural "groundwater" in the hot rocks anyway, or we may need to drill more holes and pump water down to them.

Source: Solar Power, 2008.

Generally, in order to make geothermal heat in deep layers of rock usable, a medium is required for transporting it to the surface. There are two basic options for this. The first, depending on that medium is already available underground in the form of steam or hot water. This is brought to the surface by means of a borehole, is cooled off through use, and then fed back in again. The second, there are hot rocks underground. In order to be able to extract heat from these, water is pumped down deep, where it is heated and brought up to the surface again in a process called "hot dry rock".

There are various technological developments available for using this source of energy to provide heat or to generate cooling or electricity. These include heat pumps, geothermal collectors, geothermal probes, energy piles and also concrete construction components that are in contact with the soil.

(b) Tidal Energy

Tidal energy is a one of many sources of energy from oceans. Energy transferred to the oceans from the rotational energy of the earth through gravity of the sun and moon, and retained by long-period waves. These work rather like a hydroelectric scheme, except that the dam is much bigger. The largest tidal power station in the world is in the Rance estuary in northern France. It was built in 1966.

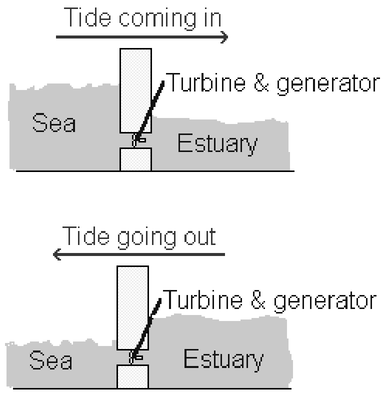


Fig. 3-16: The typical concept of the tidal energy plant.

Source: Solar Power, 2008.

3.2.2. Passive Renewable Energy Resources Applications

Using renewable energy in a passive form is depending mainly on building and urban design. It is usually called passive solar design or passive bioclimatic design. (See chapter 1)

These applications have the potential to supply a large proportion of the energy needs for a properly designed building or community. However, although developing a building to incorporate passive renewable energy is possible, it is often slightly expensive. The best opportunity for using passive renewable energy systems is in new construction. Before the proliferation of fossil fuels, architects routinely designed buildings to utilize available solar energy for heating, cooling and lighting. Recent advances in technology and building materials have greatly expanded the tools for architects to work with, and thus the potential for passive renewable energy systems is much better. Passive renewable energy systems, while often seen as "low-technology", represents in many cases, the cleanest, and least expensive possible source of useful energy for buildings. Passive renewable energy building features can be used to heat and cool buildings, as well as to provide light. The best time to incorporate these systems in a building is during the initial design.

Passive renewable energy can often be included in new buildings without significantly adding to construction costs, while at the same time providing energy savings of up to 40%. Designing the buildings we live and work in, to capture the ambient energy of the sun through passive solar features, is one of the least expensive and most environmentally friendly methods of providing our energy needs (Baird, 1993).

3.2.2.1. Passive Heating

"The passive solar heating design is the direct gain system in which the sun shines directly into a building, heating it up. The sun's heat is stored by the building's inherent thermal mass in materials such as concrete, stone floor slabs, or masonry partitions that hold and slowly release heat" (EEREN, 2001). With indirect gain systems, thermal mass is located between the sun and the living space. An isolated gain system is one where the system is isolated from the primary living area, such as a sunroom or solar greenhouse with connective loops into the living space.

3.2.2.2. Passive Cooling

There are varieties of ways in which the sun's energy, indirectly, can be used to cool the interior of buildings. The two most common methods of passive solar cooling are the use of vegetation (trees and vines) and natural ventilation (wind). Painting buildings a light color to reflect sunlight and keep them cool is also often considered a passive solar construction technique.

For example, Baird (1993) claimed that deciduous trees, planted around the exterior of a building, could cool a building by directly shading it from the sun. Trees also reduce local air temperatures by several degrees through evapo-transpiration. For example, Ivy trees and vines growing on the walls of a building serve the same purpose, but to a lesser degree. In cities, increased tree planting can also reduce the "urban heat island" effect. In the summer, cities are often several degrees hotter than the surrounding countryside because of sunlight hitting all the roofs and paved areas. An added bonus of deciduous trees is that they lose their leaves in the winter thus allowing passive solar heating, while still providing a wind-block, which reduces heating requirements. Careful attention to the placement of windows, which open interior partitions, can greatly increase the natural flow of air through a building, by capturing the prevailing winds. In climates with hot days and cool nights, nighttime ventilation can be used to cool the thermal mass of a building. A building with good insulation and a high thermal mass may then stay cool during the day. As with passive solar heating, fans may be used to encourage this ventilation.

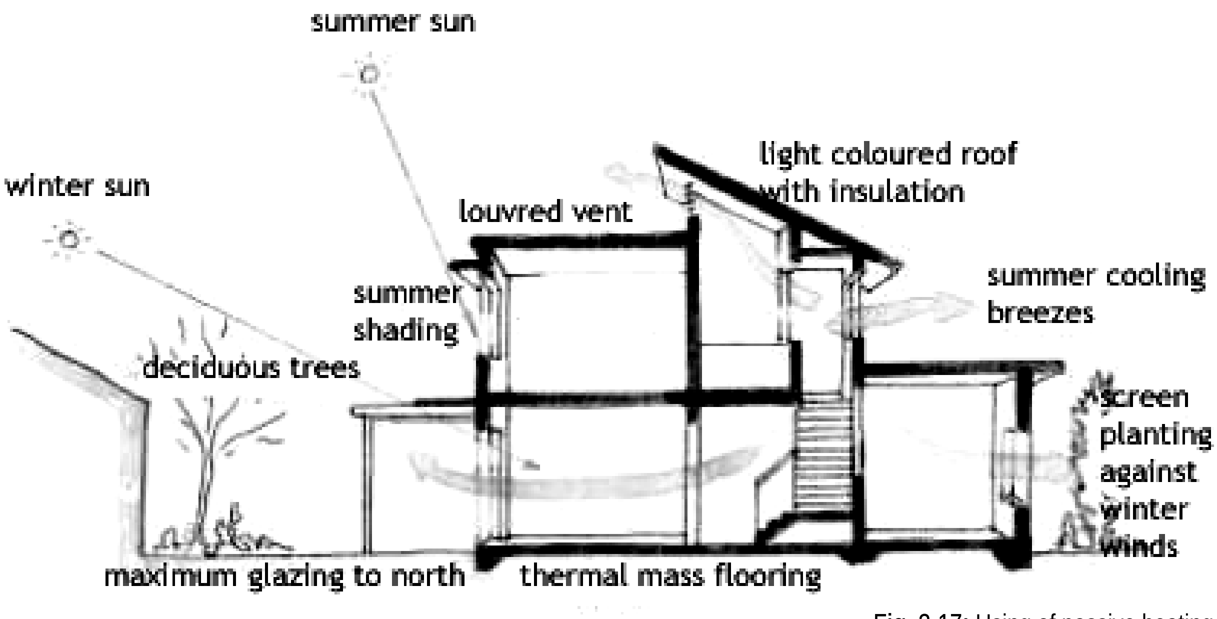


Fig. 3-17: Using of passive heating and cooling strategies.

Source: Smarter Homes, 2008

3.2.2.3. Daylighting

"Daylighting is the use of sunlight to replace electric lighting in a building" (EEREN, 2001). There is no technology at the current time capable of storing sunlight for release later. Daylighting is therefore, most valuable in applications such as office buildings where most of the lighting demand occurs during the day. Windows provide light for the perimeter of buildings while atria, light-shelves and light-pipes, can transmit daylight into the interior of buildings. In combination with electronic "photo-sensor" controls, which adjust electric lights according to light levels, daylighting features can drastically reduce the amount of electricity required to light a building.

3.3. Photovoltaic as an Approached for Urban Development

As noted in this chapter, renewable energy can be used in many forms and applications. However, in the next chapters, the study will focus on using photovoltaic as an approach for urban development for arid regions and especially in Egypt. This is because of the following reasons:

- Many studies that have been developed in the last years, consulted that in order to overcome the serious future energy problems, the international community should work immediately in a mega-actions programs and projects to integrate uses of solar and photovoltaics applications into our communities urban development. This is as an initial tool to help both of European and African countries at the same time (Box 3-6 & 3-7)

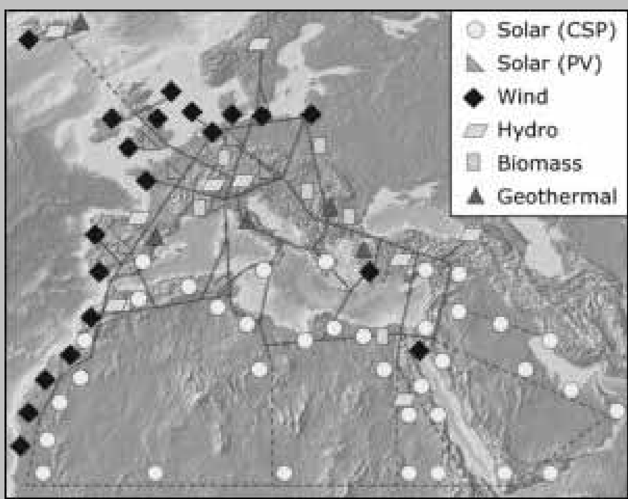
BOX 3-6 Photovoltaic in Arid regions .

For more information see: The Trans-Mediterranean Renewable Energy Cooperation (TREC) http://www.trec-eumena.net/ ,and Kurokawa (2002), Energy From The Desert: Feasibility of Very Large Scale Photovoltaic Power Generation

BOX 3-7 An example for the international studies for solar and photovoltaics applications: The TREC project

Euro-Supergrid with a EU-MENA-Connection: Sketch of possible infrastructure for a sustainable supply of power to Europe, the Middle East and North Africa (EU-MENA).

The DESERTEC concept of TREC is to boost the generation of electricity and desalinated water by solar thermal power plants and wind turbines in the Middle East and North Africa (MENA) and to transmit the clean electrical power via High Voltage Direct Current (HVDC) transmission lines throughout those areas and as from 2020 (with overall just 10-15% transmission losses) to Europe.



Source: TREC, 2006

- Photovoltaic represents one of the main renewable energy resources in arid region (see Fig.3-18). This is due to the high rates of solar radiation, and the long times of exposure to sun allover the year. Therefore, arid regions, in general, have a great opportunities using photovoltaic in a cost effective schemes.

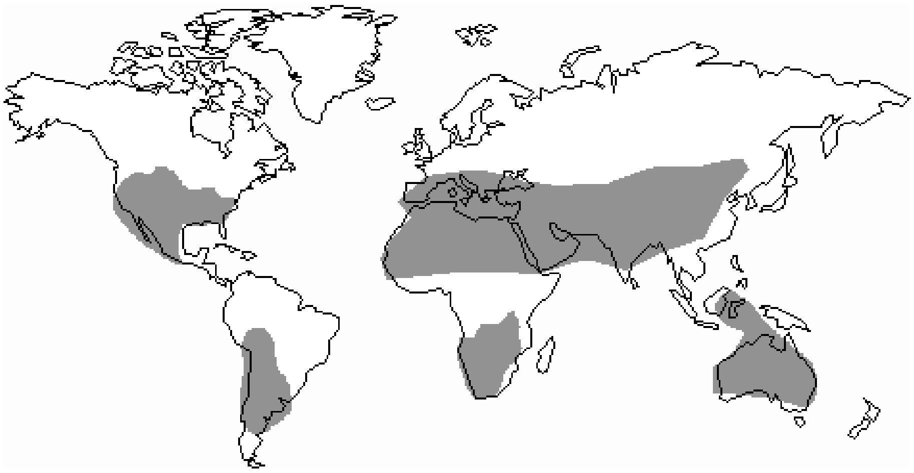


Fig. 3-18: Arid regions have great opportunities using solar energy and photovoltaic in a cost effective schemes.

Source: power from the sun, 2008.

- Recently, many urban developments scale allover the world have been developed depending on photovoltaics. In addition, Egypt has tried to develop some communities using this source of energy. However, unlike the intentional examples, these trials have affected with many obstacles, and therefore, the aim of the study is to evaluate these trails with reference to the international examples.

- Unlike vast all the other forms of active renewable energy applications, using photovoltaic affected the process of urban development and building design at all levels. (Fig.3-19)

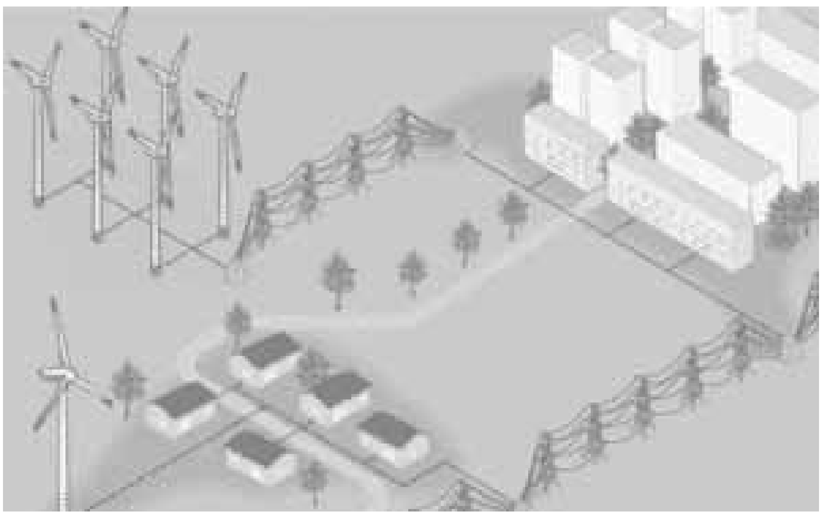


Fig. 3-19: Wind energy farm: An example for using a form of renewable energy. The process of energy production is done at the regional level. Then energy or power is transported to the urban context.

Source: Smarter Homes, 2008

3.4. Conclusion: Renewable Energy and the Approach for Sustainable Urban Development in Arid Regions

As noted before (see Chapter 1&2), in order to achieve a sustainable urban development for communities and specially in arid regions, it is not enough to build up urban development approaches and policies, which are dealing only with the environmental problems caused by the climate of those communities. In contrast, these regions development have to consider development approaches that respect all other development sides, especially, social and economical sides, which are affected with many problems upsetting the existing development programs, particularly in developing countries.

In this regard, and with reference to the principles of sustainable development and sustainable community, renewable energy can play a major role in order to achieve the sustainable urban community in arid regions. This is due to the integral nature of energy in communities, where efficiency gained in one sector lead to related improvement in other sectors. Also because of energy's pervasive influence in a community, creating a plan for its efficient use is a good strategy for simultaneously accomplishing other community goals (CEC, 1997)

Therefore, renewable energy integrated urban development approach is a suitable development approach for community development in arid regions because of the following reasons:

- It is, according to the development authorities, more contributing to the three pillars of sustainable development; the economy, the environment and social well-being. This means that it will provides a complete set of solutions for the problems of such regions such as; urban environment poverty, dispersed human settlements, poor infrastructure, and low urban densities with low job chances.

- These approaches wouldn't create any contrast urban strategies to the necessary traditional urban strategies of arid regions communities, as Urban development of arid region demands especial consideration concerned with the climate design principles at both levels of the community and building (passive urban planning and building design) (see Chapter I). This is because that renewable energy integrated urban development approach is associated with regular passive design strategies as a tool for energy conservation.

Therefore, urban integrated photovoltaic development approach can be an approach for achieving all the development goals of arid regions communities, not only at the urban level but also all the other development levels. Besides, it will help creating communities that are more comfortable through the parallel applications of passive urban planning and building design. (Fig 3-20)

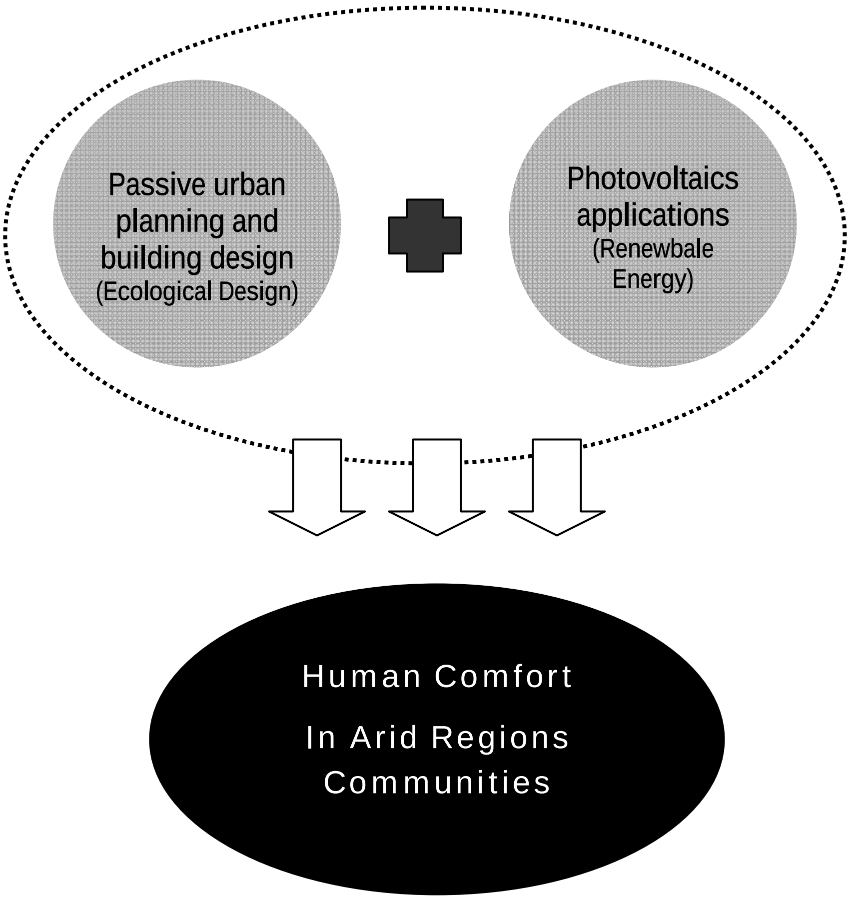


Fig. 3-20: Achieving human comfort in arid regions communities

Source: Researcher

The Approach for UIPV Development

Chapter 4

4.1. Photovoltaics

4.2. The Approach Required for a Community-Integrated PV

4.3. The Model of UIPV Development

4.4. Conclusion

In this chapter, the study tries to set up an approach for "UIPV Development" (Urban Integrated Photovoltaic) in arid regions. In order to find the suitable one, the study presented and analyzed the recent approaches of "UIPV Development", and it gathered all of them into one model for UIPV Development. This is with reference to the experiences of the OECD (Organization for Economic and Co-operation and Development) countries in this area.

4.1. Photovoltaics

4.1.1. An Introduction:

PV is emerging as a major power resource, steadily becoming more affordable and proving to be more reliable than utilities. Photovoltaic power promises a brighter, cleaner future for our children. Solar energy began to be used more than 100 years ago, in the middle of the industrial revolution. Early solar power plants were built to produce steam to power the machines of factories. Around that time, Edmond Becquerel discovered the photovoltaic effect. Photovoltaic is the production of electricity straight from the sun. Werner Siemens continued to research photovoltiacs after Becquerel. Photovoltaic power did not really become too popular, because it was very inefficient at creating electricity at that time.

The invention of the transistor and semiconductor made photovoltaic power much more efficient. Photovoltaic power became more practical. Today, solar panels are 12% efficient, which is four times greater than only a few years ago. Solar power is still used in two forms. One is thermal solar, where the heat of the sun is used to heat water, which drives turbines or other machinery to create electricity. The other is photovoltaic, where electricity is produced directly from the sun with no moving parts. As right now, solar energy only counts for 1% of all used and demanded fuel. That is because installation of solar panels can be expensive. But solar energy demand is growing very fast. On an average, the demand for solar energy goes up 25% per year, compared to 2% for fossil fuels.

Photovoltaic (PV) is an important energy technology for many reasons. As a solar energy technology, it has numerous environmental benefits. As a domestic source of electricity, it contributes to the nation's energy security. As a relatively young, high-tech industry, it helps to create jobs and strengthen the economy. As it costs increasingly less to produce and use, it becomes more affordable and available. In addition, few power-generation technologies have as little impact on the environment as photovoltaics. As it quietly generates electricity from light, PV produces no air pollution or hazardous waste. It does not require liquid or gaseous fuels to be transported or combusted, and because its energy source - sunlight - is free and abundant, PV systems can guarantee access to electric power.

4.1.2. Uses of Photovoltaic (PV Systems)

PV for Cottages and Residences

In general, PV systems are an economical option for remote cottages and residences. In most remote areas, it is impossible to connect to the electrical grid and, in many cases; expensive fossil fuel is brought in to generate electricity. If the residence is tied to the existing grid, PV will give you the autonomous source of electricity that might be needed during a power outage.

PV for Mobile and Recreational Applications

Recreational vehicles, boats, and expeditions can also benefit from the clean and quiet operation of portable PV systems to recharge batteries.

PV in Agriculture

PV systems are used effectively worldwide to pump water for livestock, plants, or humans. Since the need for water is greatest on hot sunny days, PV is a perfect fit for pumping applications. PV is also used to power remote electric fences on farms.

PV for other Applications

PV systems can be adapted to suit any requirement. For instance, PV cells are used in calculators and watches. As well, telecommunication equipments, highway construction signs, parking lights and navigational warning signals are excellent applications for PV.

4.1.3. Photovoltaic Technology

4.1.3.1. The Photoelectric Effect

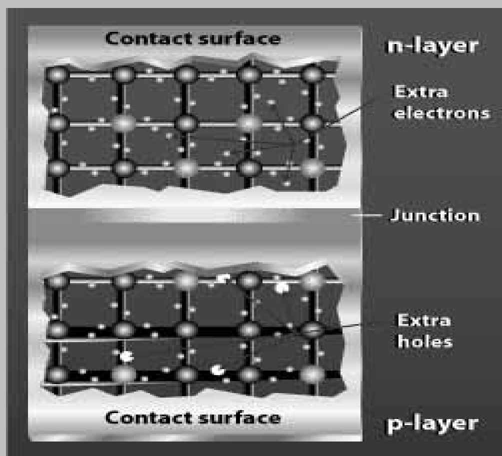
In 1839, Edmond Becquerel discovered the process of using sunlight to produce an electric current in a solid material. Nevertheless, it took more than another century to truly understand this process. Scientists eventually learned that the photoelectric or photovoltaic (PV) effect caused certain materials to convert light energy into electrical energy at the atomic level.

BOX 4-1 :The photoelectric effect .

The photoelectric effect is the basic physical process by which a PV cell converts sunlight into electricity. When light shines on a PV cell, it may be reflected, absorbed, or pass right through. But only the absorbed light generates electricity.

The energy of the absorbed light is transferred to electrons in the atoms of the PV cell. With their new found energy, these electrons escape from their normal positions in the atoms of the semiconductor PV material and become part of the electrical flow, or current, in an electrical circuit. A special electrical property of the PV cell—what we call a "built-in electric field"—provides the force, or voltage, needed to drive the current through an external "load," such as a light bulb.

To induce the built-in electric field within a PV cell, two layers of somewhat differing semiconductor materials are placed in contact with one another. One layer is an "n-type" semiconductor with an abundance of electrons, which have a negative electrical charge. The other layer is a "p-type" semiconductor with an abundance of "holes," which have a positive electrical charge.



Although both materials are electrically neutral, n-type silicon has excess electrons and p-type silicon has excess holes. Sandwiching these together creates a p/n junction at their interface, thereby creating an electric field.

When n- and p-type silicon comes into contact, excess electrons move from the n-type side to the p-type side. The result is a buildup of positive charge along the n-type side of the interface and a buildup of negative charge along the p-type side.

Because of the flow of electrons and holes, the two semiconductors behave like a battery, creating an electric field at the surface where they meet - what is called the p/n junction. The electrical field causes the electrons to move from the semiconductor toward the negative surface, where they become available to the electrical circuit. At the same time, the holes move in the opposite direction, toward the positive surface, where they await incoming electrons.

Source: EERE, 2007.

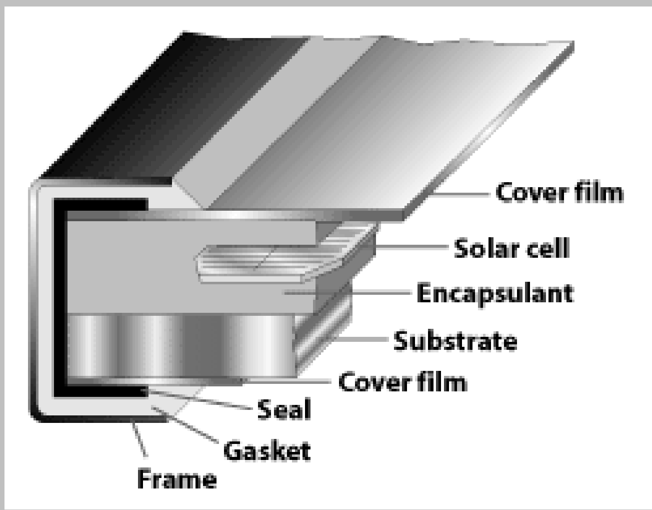
4.1.3.2. Photovoltaics Types:

(a) Flat-Plate PV Systems

The most common array design uses flat-plate PV modules or panels. These panels can either be fixed in place or allowed to track the movement of the sun. They respond to sunlight that is either direct or diffuse. Even in clear skies, the diffuse component of sunlight accounts for between 10% and 20% of the total solar radiation on a horizontal surface. On partly sunny days, up to 50% of that radiation is diffuse. Moreover, on cloudy days, 100% of the radiation is diffuse.

BOX 4-2 : Typical flat-plate module

One typical flat-plate module design uses a substrate of metal, glass, or plastic to provide structural support in the back; an encapsulated material to protect the cells; and a transparent cover of plastic or glass.



Source: EERE, 2007.

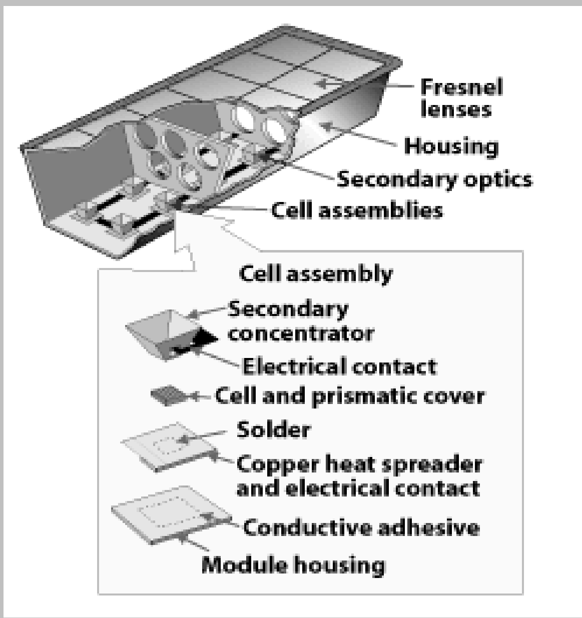
The simplest PV array consists of flat-plate PV panels in a fixed position. The advantages of fixed arrays are that they lack moving parts, there is virtually no need for extra equipment, and they are relatively lightweight. These features make them suitable for many locations, including most residential roofs. Because the panels are fixed in place, their orientation to the sun is usually at an angle that practically speaking is less than optimal. Therefore, less energy per unit area of array is collected compared with that from a tracking array. However, this drawback must be balanced against the higher cost of the tracking system.

(b) Concentrator PV Systems

The primary reason for using concentrators is to be able to use less solar cell material in a PV system. PV cells are the most expensive components of a PV system, on a per-area basis. A concentrator makes use of relatively inexpensive materials such as plastic lenses and metal housings to capture the solar energy shining on a large area and focus that energy onto a smaller area, where the solar cell is. One measure of the effectiveness of this approach is the concentration ratio - in other words, how much concentration the cell is receiving.

BOX 4-3 : Basic concentrator PV unit

A typical basic concentrator unit consists of a lens to focus the light, cell assembly, housing element, secondary concentrator to reflect off-center light rays onto the cell, mechanism to dissipate excess heat produced by concentrated sunlight, and various contacts and adhesives. Notice that the module depicted uses 12 cell units in a 2x6 matrix. These basic units may be combined in any configuration to produce the desired module.



Source: EERE, 2007

Several advantages of concentrator PV systems, as compared to flat-plate systems, can be enumerated. Concentrator systems increase the power output while reducing the size or number of cells needed. An additional advantage is that a solar cell's efficiency increases under concentrated light. How much that efficiency increases depends largely on the design of the solar cell and the material used to make it. Another advantage is that a concentrator can be made of small individual cells. This is an advantage because it is harder to produce large-area, high-efficiency solar cells than it is to produce small-area cells.

4.1.4. Photovoltaic System Components:

Photovoltaic System

A complete system includes different components that should be selected taking into consideration the individual needs, site location, climate and expectations. In this section, the study reviews the components' function and several different system types.

Major PV System Components

The functional and operational requirements will determine which components the system will include. It may include major components as; DC-AC power inverter, battery bank, system and battery controller, auxiliary energy sources and sometimes the specified electrical loads. (Natural Resources Canada , 2001)

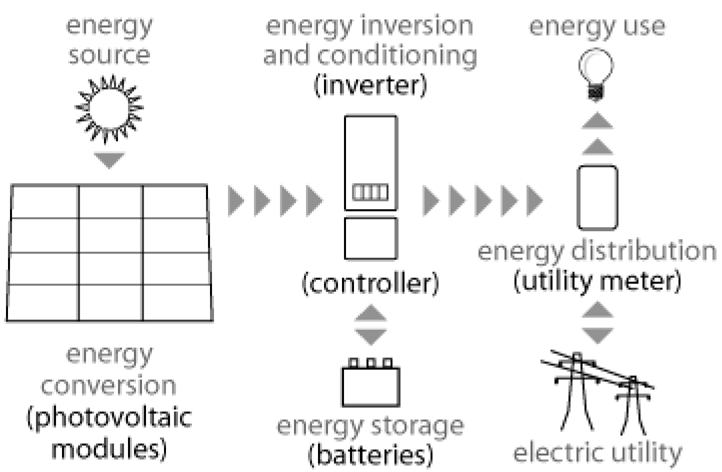


Fig. 4-1: Major PV system components.

Source: Natural Resources Canada, 2001.

PV Modules - convert sunlight instantly into DC electric power.

Inverter - converts DC power into standard AC power for use in the home, synchronizing with utility power whenever the electrical grid is distributing electricity.

Battery - stores energy when there is an excess coming in and distribute it back out when there is a demand. Solar PV panels continues to re-charge batteries each day to maintain battery charge.

Utility Meter - utility power is automatically provided at night and during the day when the demand exceeds the solar electric power production.

Charge Controller - prevents battery overcharging and prolongs the battery life of the PV system.

In addition, an assortment of balance of system hardware; wiring, overcurrent, surge protection and disconnect devices, and other power processing equipments.

4.2. The Approach for UIPV Development

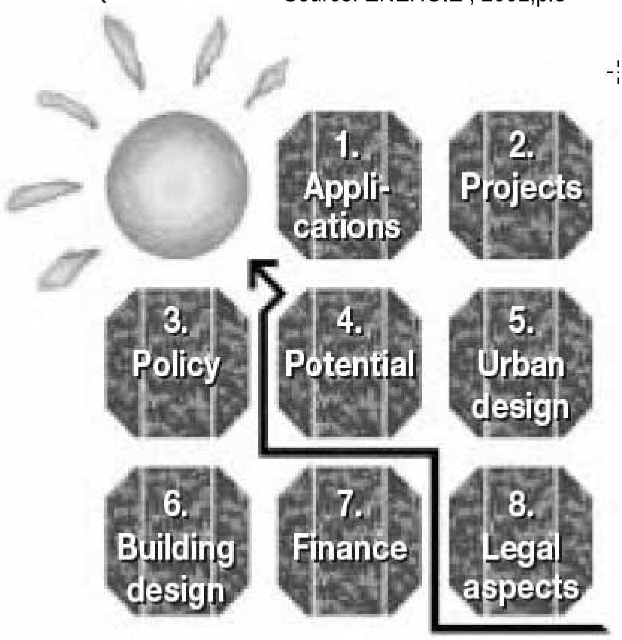
Recently so many approaches have been developed for the UIPV community (Urban Integrated Photovoltaic). In this point, the study reviews these approaches in order to reach and develop a model for the UIPV development that can be used for developing arid regions communities.

4.2.1. The Solar City Guide (2001)

In 2001, the report Solar City Guide – New Solution for Energy Supply was completed with the support of the European Commission - Directorate-General for Energy and Transport and The Swiss Federal Office for Education and Science. The report and the other additional local reports, which have been released later, focused on the approach from the urban design and buildings perspective and thus represents the 'user' or the 'demand side' requirements. Therefore, the guides have been developed with a strong focus on integration of photovoltaics in buildings in the urban context. (PV City Guide, 2007) Therefore, the objective of this guide is to provide actors within local and regional authorities as well as related professionals (urban designers and developers, project developers and builders) with the necessary information and instruments to define, evaluate, plan and implement photovoltaic projects in an urban environment. (ENERGIE , 2001,p.3) To achieve this objective, the report has formulated an approach consists of 8 elements or key topics. (ENERGIE , 2001,p.9) (see Fig. 4-2 & box 4- 4)

Therefore, this approach of UIPV is depending on a cumulative process beginning with the technology and its applications. It insisted also on the importance of integration that should be created between the process of urban planning and the other renewable energy related issues.

Fig. 4-2: The way for the UIPV according to The solar city guide
Source: ENERGIE , 2001,p.3



BOX 4-4 :The elements of the UIPV according to the Solar City Guide .

Projects: Municipalities and local actors can play a crucial role and facilitate the management of photovoltaic projects and benefit from the attractive features of solar electricity.

Policy: Lessons learnt from projects show how local policy in urban and energy planning can set an attractive framework and network for successful deployment of photovoltaics in the local environment.

Potential: In relation to strategies for sustainable development, a way of assessing the potential for photovoltaic use within the local building stock is shown. Throughout Europe - and not only in the South as one might think - building integrated photovoltaics can considerably contribute to the electricity supply.

Urban design: The relationship between the key urban design factors and their implications for exploiting the photovoltaic potential is explored by providing examples and comparisons.

Building design: Photovoltaic elements not only meet the requirements of any good building material, i.e. mechanical strength, water tightness, sound proofing, thermal insulation, shading and fire protection but also offer various and high-value architectural solutions thanks to their versatility and expressive force.

Finance: Photovoltaic installations can be competitive in a wide range of application areas. However, although costs continue to fall, photovoltaic bulk power is presently more expensive than any other conventional bulk power production. Due to the benefits of photovoltaics, regional, national and local programmes promote photovoltaics by providing market incentives and financial support. Local initiatives can take advantage of these programmes and participate in accelerating the transition from innovative technology to fully cost-effective grid electricity supplied products and projects.

Legislation: legal aspects are also an important issue for projects and policy. Local public entities can play an important role by defining an adequate legal framework. This guide aims to provide a concise yet comprehensive introduction to the world of photovoltaics by making reference to the wide ranging experiences, expertise and exemplary projects available throughout Europe. More detailed information, references and links to web sites can be found on the PV City Guide project web site.

Applications: The photovoltaic industry is experiencing a boom growing 30 % annually with an associated increase in the range and variety of products and design solutions available tailored to even more urban applications and demanding requirements. All such applications have one of two functions. They either function as a solar power station and feed electricity into the grid or they autonomously power remote applications avoiding the expense of digging for grid-connection.

Source: after ENERGIE , 2001,p.9

4.2.2. The Roadmap for the Development and Market Introduction of PVT Technology: The 15th Symposium 'Thermische Solarenergie' (2005)

This approach has been announced in the workshop at the European PVSEC of the 15th Symposium 'Thermische Solarenergie' . Zondag (2005) introduced a 'roadmap for the development and market introduction of PVT technology'. The aim of this roadmap is to maximize the PVT role in the urban context of our cities. He claimed that the work on PV-Thermal has up till now largely focused on technical issues. However, both the workshops and the results of the PVT studies emphasize that non-technical issues should also receive the attention they deserve. In particular, installation issues, financing issues, testing guidelines, training, and education (from awareness on policy maker level to design guidelines for engineers) should receive much more attention. (Zondag & et al, 2005, p.2)

BOX 4-5 PVT .
In PVT technology, heat is extracted from PV cells. In this way, a device is made that produces both electricity and heat.
Suorce: (Zondag & et al, 2005)

The elements of this roadmap can be divided into four main sectors: policy makers and banking sector; Technical issues (R&D institutes and Manufacturers); Marketing issues (manufacturers and marketing companies); Building integration issues (Manufacturers and building companies). (Fig. 4-3)

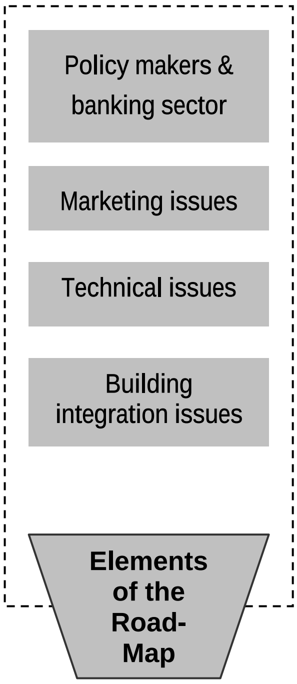


Fig. 4-3: Roadmap for the development and market introduction of PVT technology.

Source: Researcher

- policy makers and banking sector such as: developing low-cost financing schemes suitable for PVT to lower the upfront costs, such as inclusion of the costs of the system in the mortgage, and carry out demonstration projects to show the performance of PVT in real buildings, to make clear to the general public (including policy makers, end-users, installers and architects) what the potential of PVT is, in terms of module performance, systems design and integration issues.
- *Technical issues* (R&D institutes and Manufacturers) such as increasing the optical efficiency, minimizing reflection losses from the PV

over the entire solar spectrum, and obtaining spectral selectivity, and develop standards for performance testing and reliability testing of PVT.

- *Marketing issues* (manufacturers and marketing companies) such as: detailed marketing studies into interesting PVT markets, and detailed market research on the drivers and barriers relevant for the intended end users and their reasons to consider the application of PVT.
- Building integration issues (Manufacturers and building companies) such as: developing plug-and-play methods to integrate PVT systems into the building construction, and surveys to detect the demands of architects and end users with respect to aesthetics and integration of the PVT into the building design.

4.2.3. Renewable Energy Development and the Process of Urban Development

This approach refers to many trials that have been sitting up to readapt the relations between the process of urban development and the renewable energy to be an urban integrated renewable energy development. In this sense, there is a need to consider energy in city planning. Department of Energy-USA (DOE) claims that ”by linking energy use and city planning, city planners can improve the quality of life in their cities while providing significant dollar savings to city government, citizens, and the business community. Why not formally extend energy planning into every aspect of metropolitan life?" (DOE, 1996, p.1). In addition, Owens claimed, “the case for including an energy dimension in the urban development process is compelling. Not only is energy a crucial resource, but it is associated with serious environmental effects at all scales” (CEC, 1997, p.3).

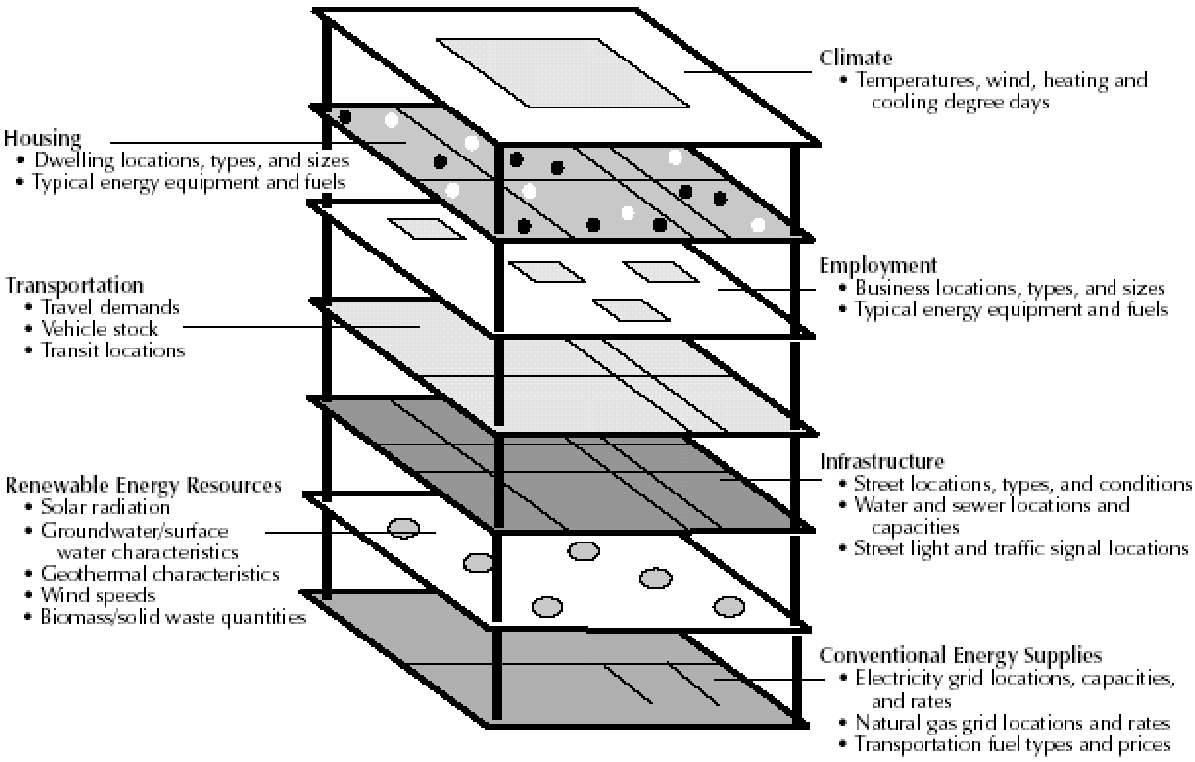
For example, according to the PLACE3S (Planning for Community Energy, Economic, and Environmental

Sustainability) study, cities can improve their economies, environments, and quality of life by intentionally conserving all forms of energy and promoting reliance on renewable resources in planning and design choices. These widespread benefits are due to the integral nature of energy in communities, where efficiency gained in one-sector leads to related improvements in other sectors. Also because of energy's pervasive influence in a community, creating a plan for its efficient use is a good strategy for simultaneously accomplishing other community goals (Fig.4-4). Therefore, renewable energy and PV should form a layer from those that produce the process of urban development.

This approach, therefore, is depending mainly on the traditional urban development process, but with attention to the role of renewable energy.

Fig. 4-4: The integration between energy resources and the other planning layers in the planning process according to PLACE3S study

Source: CEC, 1997, p.7.



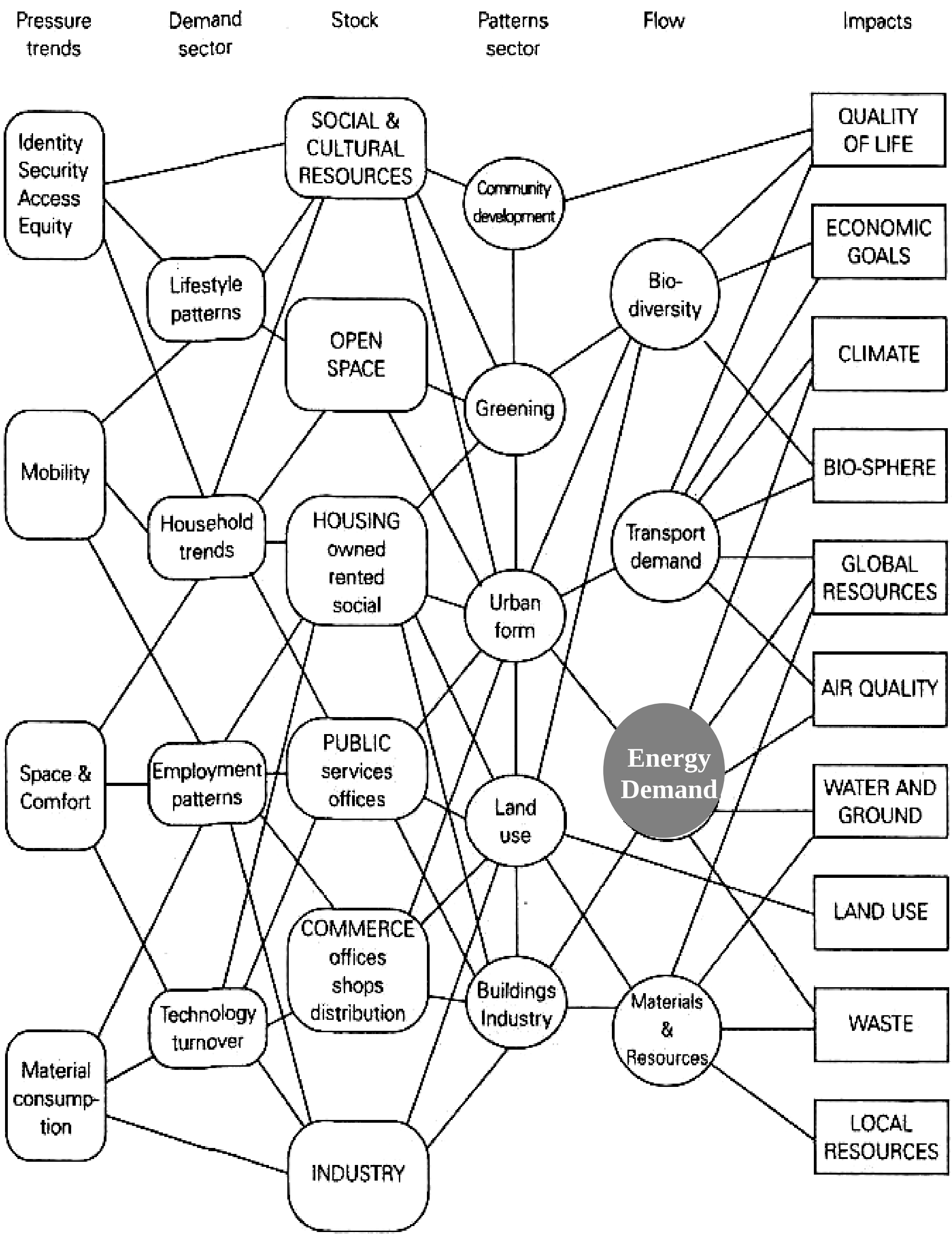


Fig. 4-5: The built environment: Role of energy demands in its general model.

Source: After Smith, 1998, p.5

4.2.4. Urban Integrated Renewable Energy as a Creative, Local, Balance-Seeking Process.

According to his study “Sustainable Communities Depending on Renewable Energy”, Abd-Elaal (2002) claimed that we should recognize that the process of UIPV development is not an unchanging process, but a creative, local and balance-seeking process extending into all areas of local decision-making. It provides ongoing opinions in the management of the community on which activities are driving the urban ecosystem towards balance. In this balance, it is remarkable the role, which energy can play at the level of planning process, which come through readapting the inputs of the process of urban planning and which play the major impulse in order to achieve their policies, which depended mainly on energy supply from renewable energy.

Thus, there are some basic urban issues that have to be readapted including two main categories, which can be classified as, urban planning issues and energy technology issues. All of these come with the coverage of sustainable development policies in order to sustain the needed changes of the planning process, as it will need a hard effort especially in the economical dimensions. In order to achieve that, such process of development should be done within a special platform. This platform has the ability to gather all the actors of an urban integrated renewable energy. Therefore, the study has shown that finding a “Renewable Energy Institutional Frameworks” is the initial step. This is by building a system with a set of rules, which will help making globalization more positive force for improving the process of development. This is due to the complexity and multiplicity of the developing process poles of an urban integrated renewable energy. This new environment must promote greater international cooperation, particularly in the areas of finance, which can be a big obstacle. (See Fig. 4-7).

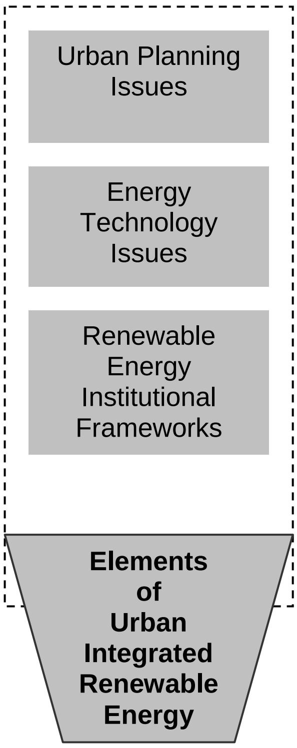


Fig. 4-6: The sustainable planning process and the sustainable energy-aware urban context according to Abd-Elaa.

Source: Researcher

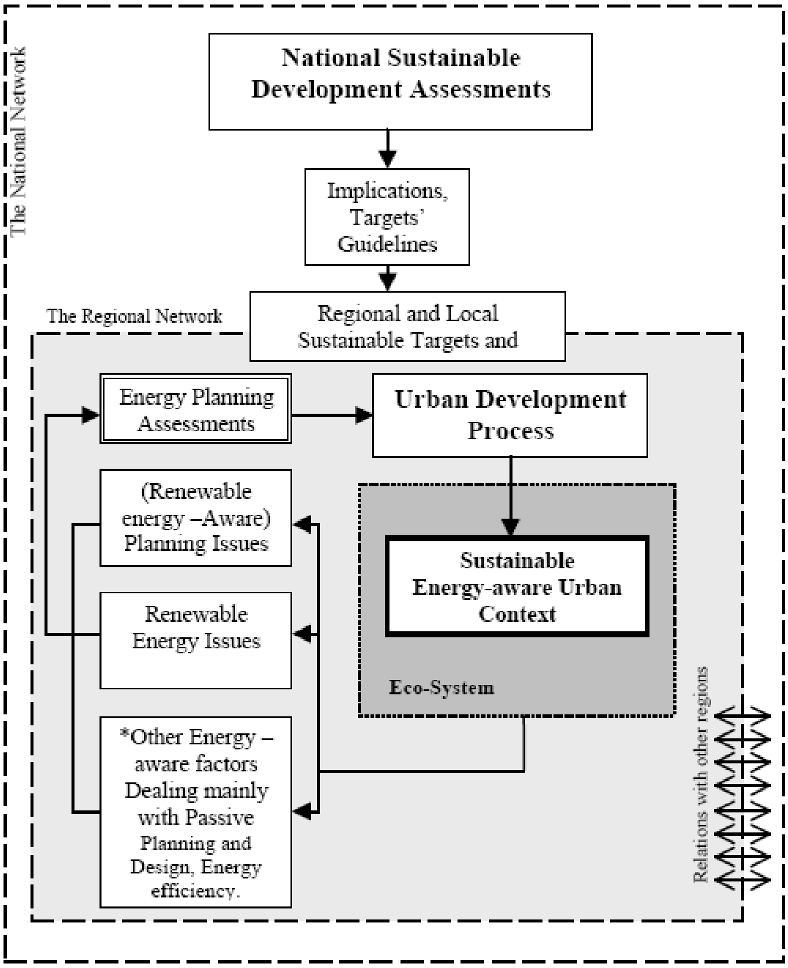


Fig. 4-7: The sustainable planning process and the sustainable energy-aware urban context according to Abd-Elaal

Source: Abd-Elaal , 2002 ,p.170

4.2.5. Solar Cities: European Habitats of Tomorrow

The European Solar Cities Project (EU Solar Cities) is a project supported by the European Commission. It aims at promoting the wider and large-scale use of renewable energy (RE) within the context of long-term planning for sustainable urban development (EU Solar Cities, 2007a). It is a study that addresses the planning and application of technologies for utilizing renewable energy sources, and the rational use of energy - also referred to as energy efficiency - in an urban context, with reference to their relevance for reducing CO_2 emissions. In this way, the project team aims to provide general encouragement to cities to move towards sustainable energy provision and initiating the "Solar City" transformation process. A "Solar City" is seen as a city that has made a firm commitment to clear and ambitious emissions reduction targets, also recognizing that RE resources can contribute to this in a substantial manner. (EU Solar Cities, 2007b)

In order to achieve this aim, specific city networks have been studied, and a range of good practices recommended for replication have been identified, and present a guide to urban actions that contribute to sustainability in cities. The study has identified main indicators that affected cities in the development process of urban integrated renewable energy. These indicators are regarded as important in ensuring the overall effectiveness of the activities and strategies, from the perspective of the project team. The indicators were also used as a basis for developing a rating system for the selected practices, to enable an overall ranking of the GDPs. (EU Solar Cities, 2004). It includes six main indicators: technology developed or tested financial mechanisms & subsidies, education & training, awareness & campaigns, policy & standards, and economic advantages & job creation (Fig. 4-8).

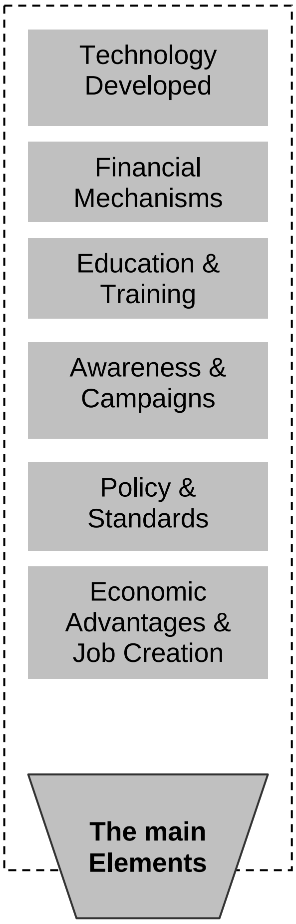


Fig. 4-8: Indicators that affected cities in the development process of urban integrated renewable energy

Source: Researcher

According to these indicators, city activities were structured according to a framework of four target sectors within a city: residential sector, public sector, industry sector, and transport sector.

Thus, according to this study, in order to develop any city depending on renewable energy, there are many key factors have to be taken in account, and they have to be recognized and they should affect all levels of the city development. This is including not only the urban level, but also the other levels of development such as economical level, educational level…etc.

In addition, the study addressed the role of the development frameworks as a main actor in the urban integrated renewable energy development process. The study named these frameworks as ‘the city network ’.

	Technology Developed / Tested	Financial Mechanisms (incl Subsidies)	Education & Training	Awareness & Campaigns	Policy & Standards	Economic Advantages / Job creation
Residential sector						
Public sector						
Industry sector						
Transport sector						

Source: EU Solar Cities ,2004.p.2-3

Table 4-1: EU Solar Cities: Good practice matrix

4.2.6. UIPV as a Programme of Development

According to this approach, the process of urban development depending on renewable energy is a complicated process, and it deals with many different development poles. Thus, such process of development should be done within a complete organized system. It should cover all sets of policies and strategies of the development process. These policies and strategies, for example, according to Droege (Eurosolar, 2001) can be defined in five levels, in which cities and towns for such policies can promote better practice. They are; direct legislation and standards, the provision of incentives and disincentives, corporate capital asset practice, power purchasing and pricing, institutional reform and improved strategic and general planning practices, and community action development, industry alliances, information and education (see Fig. 4-9).

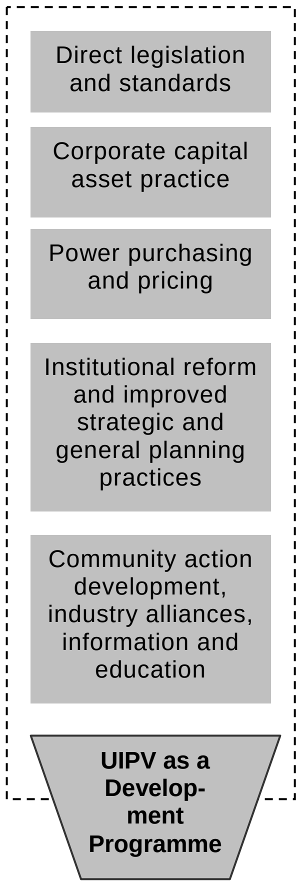


Fig. 4-9: UIPV as a programme of development.

Source: Researcher

Droege (2007) in his book “Renewable City: A Comprehensive Guide to an Urban Revolution” addressed the solar city progamme as an example.

Solar City progamme is academic urban

committee constantly search for new planning and management models, and an advisory tool to assist towns, cities and city regions in fully integrating renewable energy technologies, as well as energy conservation and efficiency measures, in order to achieve globally sustainable greenhouse gas emission levels and lower reliance on fossil fuel. It is based on a methodology developed for this purpose, using international best practice as guidance. , (Droege, 2007, p.217)

This approach, therefore, insists on two main facts. Firstly, the process of development for an urban integrated renewable energy should mention the role of the development framework, which control steps of the development process, and manage the work between its different poles. Secondly, the process of development should be done within a special set of policies and strategies

4.2.7 A Vision for Photovoltaic Technology - PV-TRAC

This is an important study developed by the Photovoltaic Technology Research Advisory Council (PV-TRAC) with the support of the European commission. The aim of the study is to draw the main guidelines to create the vision for the future of photovoltaic in the European cities. The study has insisted on the role of European PV Technology Platform that has been created in order to reach the PV vision. It advocates that the PV technology platform is the preferred vehicle to mobilize and pursue PV-related initiatives, programmes, and policies bringing together all relevant stakeholders from science, industry, and policy areas. Thus, according to the study, implementation of the PV platform will strongly increase the efficiency of the efforts currently under way and accelerate the development of the European PV sector. However, the council, in particular, recommends that the PV technology platform should: (PV-TRAC, 2005.pp. 9-10)

BOX 4-6 PV-TRAC .
The Photovoltaic Technology Research Advisory Council (PV-TRAC) was formed in 2003 under the auspices of Loyola de Palacio and Philippe Busquin (the former European Commissioners for Energy & Transport and Research). The council's vision report presents the current state of photovoltaics and looks ahead towards the year 2030. it was noted that photovoltaic electricity could become competitive with conventional utility peak power in southern Europe by 2010 and in most of Europe by 2030.

Suorce: PV-TRAC, 2005, p. 7

- Implement the Strategic Research Agenda, in which the main PV research and technological development issues for the coming decade are addressed. To achieve the technology goals, enhanced research investment and continuity of effort are needed.
- Strongly coordinate ongoing PV research activities in Europe with the help of a mirror group representing all the member states.
- Facilitate the coherent implementation of deployment measures (incentives, industrial, environmental, social and education). Promote, as a transitional measure over the next decade, a coordinated regulatory framework that takes the specific aspects of PV into account.
- Foster joint initiatives between researchers, industry, member states, and the EU develop a robust communication plan, as part of a continuous dialogue involving a broad range of stakeholders.
- Strengthen the relationships with developing countries in order to bring affordable electricity services to the population of these countries.

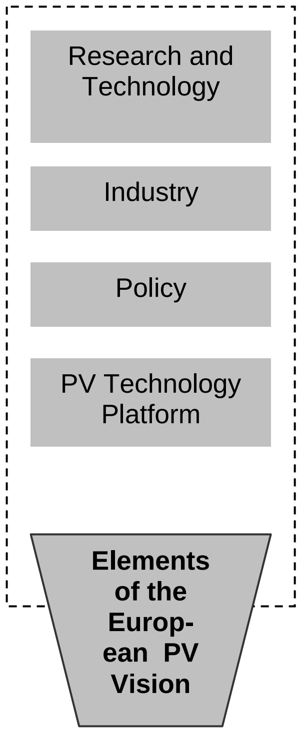


Fig. 4-10: Elements of the European PV Vision according to PV-TRAC

Source: Researcher

Therefore, in broad terms, a strategic action plans necessary to achieve the vision. This action plan will need to be developed in the future in more details, to better encompassing what should be done, by whom and in what timeframe. The proposals presented here cover three main areas of intervention: research and technology; industry; and policy. In addition, these three areas should be connected more strongly than they are today, by the establishment of the PV technology platform (See Fig.3-10). A strong connection is needed to accelerate the process because technology development is not a sequence of linearly connected activities, but rather a parallel process with pronounced interdependencies. (PV-TRAC, 2005.pp. 9-10)

4.2.8. Discussion: The Approach for UIPV

The development process of “Urban Integrated Photovoltaic” and “Urban Integrated Renewable Energy” in general is a complicated process. This is due to the form of such process, which depended on a wide numerous actors and issues. Therefore, all the pervious presented development approaches insisted on this fact. However, it can be noticed that all of them have tried to cover all these poles, actors, and issues with their supposed approach for integrating PV with their cities future. This is by depending some times on the development policies, development networks, or within the traditional process of urban development with reference to renewable energy.

However, the process of UIPV, and according to the practices and the actual experiences in this field, is a combination of all these approaches.

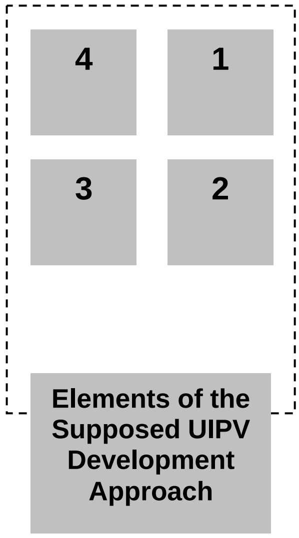


Fig. 4-11: Elements of the supposed UIPV development approach.
1- Development Framework
2- Development Policies
3- Urban Planning & Development
4- Building Design

Source: Researcher

In this manner, the approach of the development process of UIPV should integrate all of those elements. Thus, from the review of the previous approaches, the main elements of the UIPV development approach can be concluded in four major categories: development framework, development policies, urban planning, and building design. These four elements can involve all aspects of the UIPV development process. They can form, also, the model for such development. (Fig 4-11)

Along these lines, the study assumes that in order to achieve success for any development process of an UIPV, a development approach consisted of this four elements have to be developed. In the next point, the study analyzes these four elements with reference to the experiences of the OECD counties, as tool to build a complete vision for the development model of the UIPV, in order to use it as basic for the UIPV development approach in arid regions.

4.3. Elements of the Development Model of UIPV

4.3.1. Development Framework

As “Institutional and legal arrangements at national, regional and international levels provide the overall structure for achieving sustainable development. A goal of agenda 21 is greater cooperation and policy integration among international and national institutions, in order to rationalize the legal regimes at various levels and to ensure better, participatory and more informed decision-making” (Economic and Social Council, 2001,p.33). In this manner, one of the important elements of any development process for UIPV is that they are all have been developed through an institutional frameworks like Eurosolar, European Commission, IEA, …etc. with support and the cooperation of the different universities, local ministries and NEGO. These frameworks play an initial role as they promoting the continuous development of these projects. In general, the complexity and multiplicity of the developing process poles of these projects type are the force reasons, which make the role of institutional framework bodies so initial. Recently, they do a great effort for achieving the solar community (community using 100%renewable energy).

By reviewing studies in this area, there are some main features for these types of development frameworks. According to EU Solar Cities (2004) , Droege (2007) and EIA (2007), these features including the framework structure, scope of development, power to act , decision making , and the Institutional role.

4.3.1.1. Case Study: IEA-PVPS

The IEA Photovoltaic Power Systems Programme (PVPS) is one of the collaborative R&D agreements established within the IEA, and since its establishment in 1993, the PVPS participants have been conducting a variety of joint projects in the application of photovoltaic conversion of solar energy into electricity.

BOX 4-7 IEA .
The International Energy Agency, based in Paris, is an autonomous agency linked with the Organization for Economic Co-operation and Development (OECD). The IEA is the energy forum for 26 member countries. IEA member governments are committed to take joint measures to meet oil supply emergencies. They have also agreed to share energy information, to co-ordinate their energy policies and to co-operate in the development of rational energy programs.

Source : www.iea.org

Framework Structure

The structure of IEA-PVPS program is divided into two levels; the executive committee and individual research projects. The overall programme is headed by an executive committee composed of representatives from each participating country, while the management of individual research projects (Tasks) is the responsibility of operating agents. The twenty-one PVPS members are: Australia, Austria, Canada, Denmark, EPIA, European Union, France, Germany, Israel, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States. Individual research projects (Tasks) are divided into twelve tasks. The objective of these tasks is to develop and create policies, strategies, and solutions in a specific research area. They are including the following:

- Task 1. Exchange and Dissemination of Information on PV Power Systems,
- Task 2. Performance, Reliability and Analysis of Photovoltaic Systems,
- Task 3. Use of PV Power Systems in Stand-Alone and Island Applications,
- Task 4. Modeling of Distributed PV Power Generation for Grid Support,
- Task 5. Grid Interconnection of Building Integrated and other Dispersed PV Systems,
- Task 6. Design and Operation of Modular PV Plants for Large Scale Power Generation,
- Task 7. PV Power Systems in the Built Environment,
- Task 8. Very Large Scale PV Power Generation Systems,
- Task 9. PV Services for Developing Countries,
- Task 10. Urban Scale PV Applications. Begun in 2004,
- Task 11. PV Hybrid Systems within Mini-Grids,
- Task 12. Environmental Health and Safety Issues of PV.

Development Scope

According to the EIA (2006), the programme's development scope is to enhance the international collaboration efforts, which accelerate the development and deployment of photovoltaic solar energy as a significant and sustainable renewable energy option. The underlying assumption is that the market for PV systems is gradually expanding from the present niche markets of remote applications and consumer products, to the rapidly growing markets for building-integrated and other diffused and centralized PV generation systems. This market expansion requires the availability of and access to reliable information on the performance of PV systems, technical and design guidelines, planning methods, financing, etc. to be shared with the various actors.

The IEA-PVPS programme aims to realize the above scope by adopting the following objectives related to reliable PV power system applications for the target groups: governments, utilities, energy service providers and other public and private users: (EIA-PVPS, 2004,pp.1-3)

1. To stimulate activities that will lead to a cost reduction of PV power systems applications,
2. To increase the awareness of their potential and value and thereby provide advice to decision makers from government, utilities and international organizations,
3. To foster the removal of technical and non-technical barriers of PV power systems for the emerging applications in OECD countries,
4. To enhance co-operation with non-OECD countries, and address both technical and non-technical issues of PV applications in those countries.

Decision Making

According to the structure of the EIA-PVPS programme, it consisted of set of research & development networks, and they are supported by a political level represented by the countries headed the programme.

Therefore, the program acts as a key tool to connect the level of research and the level of political decision making at the political level. This gives the programme a wide ability to reform its tasks' results and recommendations into a physical development plans. In addition, IEA PVPS indirectly contribute to cost reduction by undertaking or supporting activities such as: sharing the activities and results of national RD&D programmes, objective information and operational experience, creating and facilitating networks as well as providing guidelines. (EIA, 2007)

4.3.2. Policies and Strategies Level

In order to introduce improved ways of adopting renewable energy technologies into the process of urban planning, policies of urban development have to contribute to climate-stable practice in the building environment, urban design, land-use planning and infrastructure development, and proper industry development as well as strengthen local governmental efforts to build enlightened community performance and household preferences (Eurosolar,2001,p97).

Pageni (1996) has formulated and reconstructed all of these into one model for decisional strategies and the urban policies, depending on energy technologies integrated development. He summarized it into four fundamental approaches. These four approaches have different urban policy consequences. They are, also, neither better nor worse, according to choosing either one approach or another, but they can all be equally significant and effective when pursuing the objectives for a better urban quality. These four fundamental approaches are (Fig. 4-13 a &b):

- **Top-down approach** - Related mainly to the activity of governments and/or institutions when introducing new regulations, as well as when reducing regulatory and procedural impediments.
- **Bottom-up approach** - Organizing the needs of a community and preparing the policies, which comply with these needs.
- **Demand-side approach** - Concerning end-uses of citizens and their needs: mobility, housing, quality of life, economic opportunities, healthy environment …etc.
- **Supply-side approach** - Refers to the capability of the market to organize the production of goods and technologies, which respond to consumers' needs.

Furthermore, he claimed that the urban policies, depending on energy technologies integrated development, are not exclusively “top down” or “bottom up”, or only “supply-side” or “demand-side”. The policies are an articulate combination of the four approaches and can be expressed in a Cartesian diagram, in which, the X-axis refers to the 'Supply-Demand', and the Y-axis refers to the 'Top down-Bottom up'. (Fig. 4-13a)

This combination of the four approaches should have a multi-targeted strategy, which will involve the fulfillment of all the development goals: (Fig. 4-13 a &b)

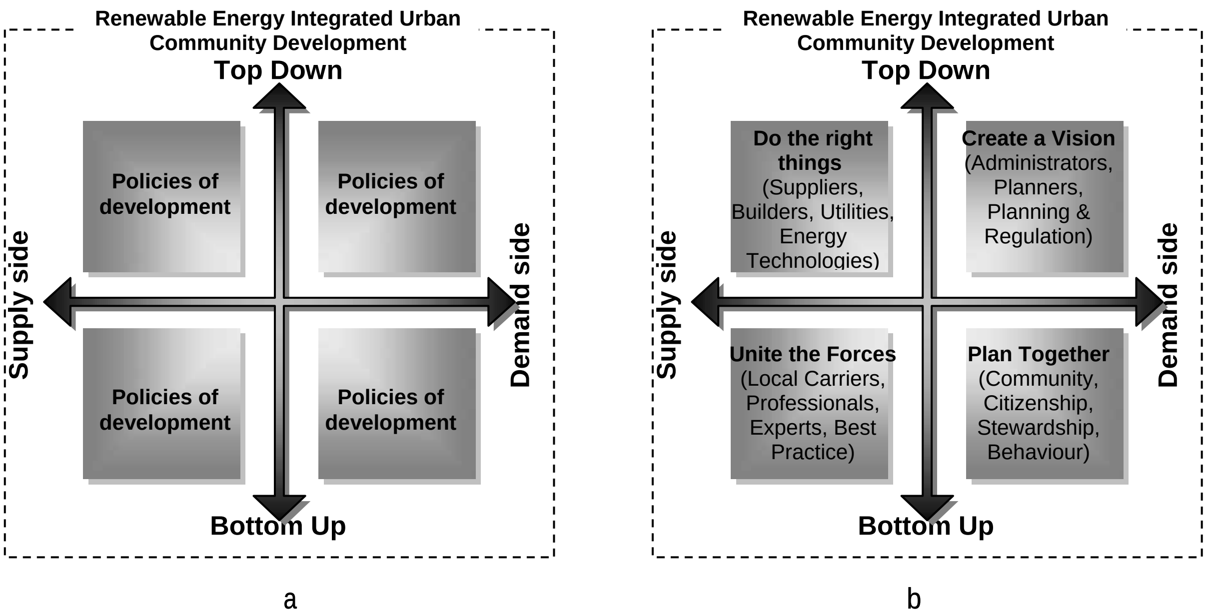


Fig. 4-13 a&b: Urban policies, depending on energy technologies integrated development: integrated policies for effective urban strategies.

Source: After Pageni, 1996.

Also Fernandes (2001, pp.38-46) supported this vision in his study “Solar Energy in the Urban Planning Process”. He claimed that in order to achieve urban development depending on renewable energy, there is a need to support the relations between all the actors. This needs new model of policies that can cover not only the process of urban planning as traditional process but also all the poles of UIPV development. He reformulated the UIPV development policies of Pageni. It is including planning and regulations, energy and building technologies, involvement and partnership, best practice

This means that policies of urban development, depending on renewable energy technologies integrated development in contrast to the traditional urban policies, it "asks for an integrated vision and for a very well lubricated consensus building facility both through a democratic approach and by the contribution of open minded competent actors. That is what urban sustainability is about" (Fernandes, 2001, p41).

Case Study: The Solar City Program (IEA)

The new ‘Solar City’ program is a cutting-edge initiative to broadly advance renewable energy technologies in cities worldwide, specifically for the purpose of long-term urban greenhouse emissions reduction. This is a collaborative, scientifically supported market development program nurtured within the framework of the International Energy Agency (IEA). Thus, Solar City's mission is to advance coordinated research and development initiatives in support of the leading towns, working towards the targeted and broad introduction of renewable energy technologies. Therefore, the solar city program is in this realm, the program that provides a set of development policies, strategies, and advanced research and development support frameworks that interface with a number of international networks and local programs, and it helps in:

- Urban renewable energy technology integration and business development,
- Advancing whole-of-city and regional development integration methods and
- Targets and baseline model development in an objective international context.

BOX 4-8 Solar City .
Is an advisory service to assist towns, cities and city regions in fully integrating renewable energy technologies, as well as energy conservation and efficiency measures, in order to achieve globally sustainable greenhouse gas emission levels and lower reliance on fossil fuel. It is based on a methodology developed for this purpose, using international best practice as guidance.

Suorce: solarcity.org

4.3.2.1. Solar City Program Scope

It is concerned with renewable energy development for cities and city regions, aimed at short- and long-term greenhouse gas emissions targets with special attention to solar applications in the built environment, in the context of a broad mandate to work with, and on behalf of all renewable energy technologies and systems that are relevant to urban applications.

Solar City: According to IEA (IEA,2000), it is an urban community which embraces a path of integrating solar and other renewable energy technologies as well as efficiency measures into a broader, community-wide planning strategy aimed at climate-stable greenhouse-gas emissions levels by 2050. The program is divided into three main subtasks, and the objectives of this program are to:

- Contribute to the goal of making cities environmentally more sustainable,
- Support reduction of urban greenhouse gas emissions in an appropriate time-frame, as measured on a per-capita basis and at a globally sustainable level,
- Further knowledge about the role of cities – and that of their civic and business communities – in fossil fuel use reduction and global climate stabilization,
- Further knowledge about the role of innovative solar and other renewable energy systems in making cities not only environmentally more sustainable due to a reduced reliance on fossil fuel but also economically viable in the long run due to technological innovation, business development and employment generation,
- Further knowledge about urban planning tools and organizational arrangements suitable to transform cities,
- Further knowledge about the barriers in achieving sustainable energy practice at the urban level, and
- Help overcoming the barriers and support the accelerated phasing in of renewable energy technology in cities as well as their businesses and industries.

These general goals are being translated directly into three Subtasks; every task tries to build up a set of policies and strategies in a different direction: (IEA, 2000 & Droege, 2007)

- City strategies and planning tools
- Baseline studies, targets and scenarios
- Renewable energy technology and business development

Subtask A: Solar City Strategies

The objective of this subtask is to identify local planning and development approaches that are conducive to the introduction of solar and other renewable energy technologies, as an energy-conscious community development approach. The program has achieved this objective by addressing issues of strategy, planning tools, organizational arrangements, legislation and standards, incentive structures, public information and exemplary municipal practice. On the other hand, while this subtask places an emphasis on the introduction of solar and other renewable energy technologies, it also takes in account the potential of reformed land use, transport and urban design and planning practice (Droege, 2001).

In general, subtask A is to integrate the outcomes of subtasks B and C, of municipal target setting and of industry reform promotion, into a coherent structure and outcome stream without interfering with their integrity. This is to manifest itself in the generation of 'Solar City Plans' in the partner cities.

Subtask B: Targets, Baseline Studies and Scenario Development

This task aimed at two main objectives. The quantification of urban emissions , which involves the assessment, development, application and maintenance of city- and region-wide emissions inventories, to gauge both current urban energy production and consumption performance, and the establishment of a uniform reporting format is a third objective (Droege, 2007,p.233).

Therefore, comparable baseline conditions are required to measure performance over time, evaluate future solar and other renewable energy technology policy and investment paths in terms of their energy and greenhouse gas emissions reduction benefits. This format document also contains a lexicon of terms used in the discussion of task issues so that non-expert can interpret subtask activity more easily (Droege, 2007, p.233).

Subtask C: Renewable Energy Technology Systems, Business and Industry Development

Objectives of this subtask include (Droege, 2007, p.p.239-240):

- To work with cities in advancing renewable energy technologies and systems,
- To help promoting the renewable energy industry, in a way that not only can serve the future employment base of the city, but also be a model for the rest of the national urban system. The emphasis is on research into and development of market approaches to urban technology system development and deployment, through pricing, investment and purchasing policies; and information, exemplary action and other means,
- To develop, evaluate and implement suitable alternative strategies for the informed and broad introduction of solar and other appropriate renewable energy technologies as part of a comprehensive community portfolio, for the use by city governments, municipal utilities, businesses, industries, and households. Special emphasis will

be on micro-generation and distributed low-energy production in buildings, facilities and urban systems, and

- To focus on what city governments can do in collaboration with industry and constituent urban communities to understand the urban potential and advance the use of renewable fuels for industry and transport; the generation of electricity in quantity, such as solar power stations, wind, biomass, geothermal and hydro; with special emphasis on the development and deployment of technology development strategies in industrial and residential consumer-oriented application, such as stand-alone power generators, heat pumping, photovoltaics, solar hot water and solar cooling.

The results of all the previous three subtasks introduced a complete vision of the suitable policies and strategies, through subtask B, which should be taken in account in order to achieve the solar community, besides supporting knowledge about the role of ingenious solar and other renewable energy systems in changing cities. (Fig. 4-14)

All these subtasks had been developed under a complete framework structure consists of many international urban and industry networks: like International Solar Energy Society (ISES), International Council on Local Environmental Initiatives (ICLEI), Eurosolar and Energie-Cités. This is beside the support of 26 governments world wide.

As result, the progamme introduce a set of policies and strategies that cover the four elements of UIPV policies according to Pageni and Fernandes.

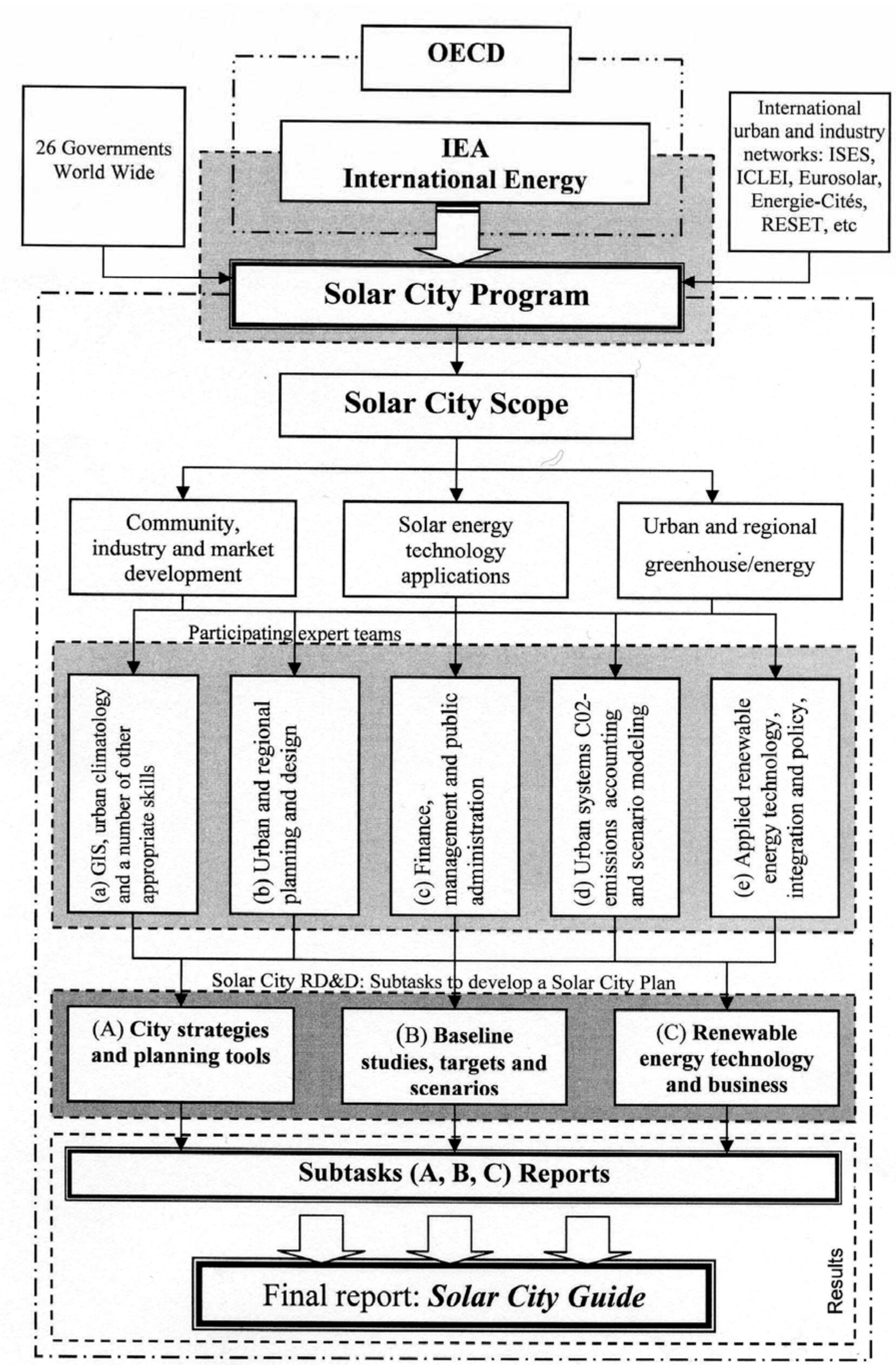


Fig. 4-14: Summary of the solar city programme policies and framework

Source: Abd-Elaal, 2002, p.167

4.3.3. Planning & Development Level

In this point, the study will depend on the outcomes of the PVPS-Task 10 programme, as it creates a complete vision for applying photovoltaics at the level of urban planning. This is through linking aspects of building design, and urban planning and development with all the other aspects related to any process of UIPV development.

Task 10 - Urban-Scale PV - is a part of The International Energy Agency PV Power Systems programme (PVPS). It is an international collaborative task bringing together architects, builders, financial experts, utility personnel, municipal planners, the solar industry, and the educational sector to address the economic, institutional, planning, and technical issues necessary to mainstream the use of PV in the urban environment. (Herig, 2004, p.1) The aim is to combine and expand on the successes in photovoltaics of all members of the PVPS program to make photovoltaic solar electricity commonplace in the urban environment. Thus, an integrated approach linking all stakeholders is used. This approach recognizes that optimizing good design and solar thermal and PV potential and maximizing their synergies will require cooperation of a number of the implementing agreements (particularly the photovoltaic power systems, the solar heating and cooling, and the energy conservation in buildings and community systems). (EIA-PVPS, 2006 & EIA- PVPS, 2007)

Therefore, according to Herig (2004) the objective of task 10 is to enhance the opportunities for wide-scale, solution-oriented application of PV in the urban environment as part of an integrated approach that maximizes building energy efficiency, solar thermal and photovoltaics usage. This will be accomplished through: (Herig, 2004, pp.1-2 & EIA-PVPS ,2006 & EIA- PVPS, 2007)

- making connections between the building design and development industry;
- offering recommendations for stakeholders to remove barriers to mass market uptake of photovoltaics,
- developing system components, design and applications with the largest global market penetration potential, including aesthetic values as well as the mechanical and energy related values,
- expanding successful tools (models, roadmaps, guides, system integration, etc.) and analysis relevant to the needs of the emerging global markets,
- identifying gaps in currently available information and developing products to fill those gaps,
- developing materials and holding events targeted at meeting the needs of specific groups of stakeholders, and
- providing continuous communication, promotion and education throughout the period of the task.

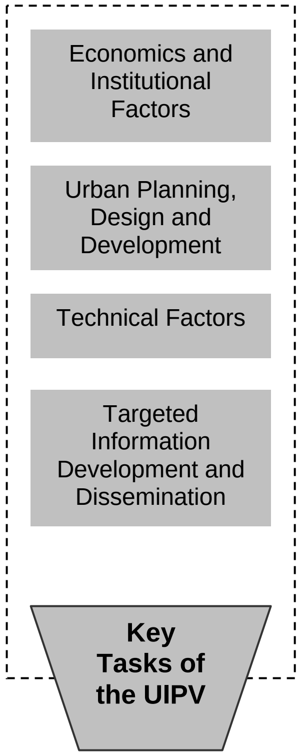


Fig. 4-15: Key tasks of the UIPV according to EIA –PVPS, Task 10.

Source: Researcher

In order to achieve that, the PVPS- task 10 program is divided into 4 key subtasks (Fig. 4-15):

Subtask 1: *Economics and Institutional Factors*: It aims at defining the global solar market through economic and other market drivers, which including, for example, value analysis, barriers resolution, market drivers, and market roadmap. Thus, it will help developing products for end-users to look beyond the single-ownership scenarios to the larger multiple end-users value. In this way, utility tariffs, community policy, and industry deployment strategy can be used to create scenarios, which combine all end-users values to the PV system investor. A matrix of end-user by values will be developed to justify sustained market drivers. (EIA-PVPS, 2006)

Subtask 2: *Urban Planning, Design, and*

Development: It will develop the guidance for integrating photovoltaics into standard building design models, tools, practices, and community energy infrastructure planning, and this includes two main items: integrating PV development and design practices, and urban Planning. For that reason, it focuses on infrastructure planning and design issues needed to achieve the vision of a significantly increased uptake of PV in the urban environment. Also, it integrates PV with standard community building practices by: developing guidance for integrating PV standards into whole building design models, rating tools, and building development practices. In addition, more stress will be placed on the building integration properties of PV for efficiency gains, and integrating PV and the whole community energy infrastructure elements into urban planning practices through a guide providing processes and approach for setting quantifiable urban-PV goals and objectives in the planning process. (Herig, 2004, p.3)

Subtask 3: *Technical Factors:* It focuses on technical and infrastructure challenges related to BIPV. It concentrates on technical development factors for mainstream urban-scale PV. Large-scaled urban integration of BIPV systems faces technical challenges related to synergetic use as building material and for energy supply purposes. Other challenges such as involve the potentially negative impact on the grid and obstacles posed by the regulatory framework. Therefore, the aim of this subtask is to demonstrate best practices and to advocate overcoming those barriers associated with extensive penetration of BIPV systems on urban scale through building a BIPV industry, products and projects, codes and standards, electricity networks, and a market driven approaches. (EIA-PVPS, 2007)

Subtask 4: *Targeted Information Development and Dissemination*: In order to insure the continuous development of the UIPV revolution, it will carry out the information dissemination of all deliverables produced in

Task 10. This is through developing and creating educational tools; marketing competition; marketing approaches and consumer aids, stakeholder perceptions, continuous communication/results; and demonstration projects. (Herig, 2004, pp.3-4)

Hence, according to the PVPS-Task10, in order to achieve successful integration of photovoltaics at the level of urban planning, four main key topics should be mentioned: economics and institutional factors, urban planning, design and development; technical factors, and targeted information development and dissemination.

4.3.3.1. Case Study: Nieuwland - Amersfoort City, the Netherlands

- **Urban Context**

Amersfoort is a city in the central part of the Netherlands, about 50 km from Amsterdam and 20 km from Utrecht, having excellent railway connections. Amersfoort has about 122,000 inhabitants. Nieuwland is a new housing area of the city of Amersfoort. It was developed by a public-private partnership called 'Overeem', in which the city authorities worked with property developers and construction companies to develop the area. The total settlement of Nieuwland comprises some 5000 dwellings for about 11,000 residents. (Energie-Cités, 2002, p. 1)

Fig. 4-16: The location of Nieuwland - Amersfoort City

Source: Energie-Cités,2002,p. 1.

The Project

The 1.3 MWp project was developed by REMU as a follow-up to these pilot projects. Together with the Overeem developer consortium and the urban designer working on Nieuwland, an appropriate section of Nieuwland was selected. The main criterion was that it should be large enough for one compact PV site with PV on all buildings. The urban design should allow sufficient south-facing roofs with limited shading.

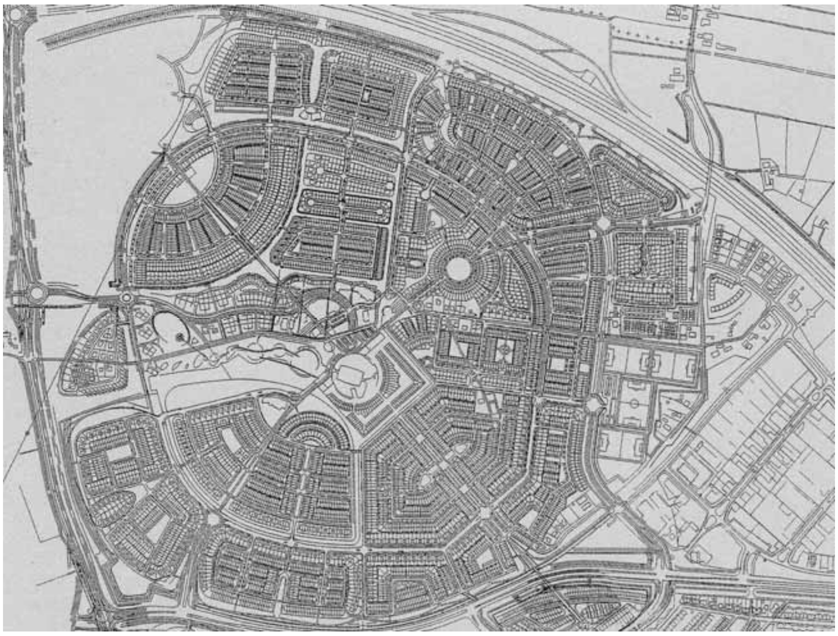


Fig. 4-17: Nieuwland - Amersfoort city, the layout of the city

Source: Gunßer, 2000, p.102

Fig. 4-18: Nieuwland - Amersfoort City, an aerial view.

Source: Thomas. , 2001, p.61

The urban designer formulated a design that allowed for sufficient roof space facing south in order to install more than 1.3 MWp PV. In addition, an information package was prepared for the property developers and architects involved in this section of Nieuwland. The development of this information package was an important aspect of the project; it assisted in learning how to co-operate in a standardized way with large numbers of developers and architects on a large-scale project.

Therefore, the aim of the project was the full-scale demonstration of a 1.3 MWp PV system in an urbanized area through the realization of 500 PV houses grouped together in Nieuwland, Amersfoort's new housing area. In detail, the project furthermore aims at (EIA, 2006):

- demonstration of the technological and architectural potential of BIPV,
- reduced BIPV costs in terms of both module costs (economy of scale) and BOS-costs (through optimized integration),
- enhanced system performance through optimized design and improved quality control and commissioning procedures,
- establishment of an infrastructure for future co-operation between building companies, utilities, town planners and PV industry, essential for maturing BIPV technology,
- a contribution to the confidence of local authorities as well as project developers, architects and building industry of quality aspects of PV.

The project has introduced an urban context with many different types of building integrated PV. They included residential and non-residential buildings.

Solar energy on fifty rented dwellings: The first type was 114 rented houses with 50 of them using combined solar power. The developer has used 5.6 m^2 of solar collectors on the roof of each house, situated next to the ridge, and below them are the solar cells – 22.5 m^2/house. A row of windows below the solar cells provides direct solar radiation into the houses and forms a separation between the energy roof and the tile roof lower down. There have been many tests on impermeability to water, wind load, thermal shock, and durability. The current gained from the solar cells – about 82,500 kWh/y altogether is supplied to the main electricity network while the hot water is used in the houses themselves.

Fig. 4-19: Solar energy on fifty rented dwellings

Source: PV-Datapass,2007

*Nineteen owner occupied homes with solar power***:** As a method of investigation for the possibilities of furthering solar energy in the private property sector, REMU has installed solar roofs on 19 luxury owner-occupied houses in one of Nieuwland's districts. Therefore, the houses are private property while the solar panels belong to REMU. The relationship between both parties has been set out in agreements with the building company and the individual occupant. For them, the solar panels act as a waterproof roof covering, and therefore they pay nothing for construction and maintenance of this structure. In response, the owner must prevent the panels from being overshadowed and may not make any changes to the roof, and once the owner wants to replace the solar panels, there are special agreements. Also, REMU can access the roofs in the events of faults occurring and is responsible for any leakage.

Fig. 4-20 a&b&c&d:
Different houses integrated PV, Nieuwland - Amersfoort City
Source: PV-Datapass,2007.

Non-residential buildings: They are including mainly two primary schools were made to integrate solar panels. The first was fitted with 196 solar panels and other one having a roof with 124 ‘AC modules’. These modules have a small inverter on the back, which means that each panel provides alternating current to the grid. Both installations together generate about 8,000 kWh/Y. To visualize energy consumption and production, the schools have displays showing current and cumulative data and comparisons with target figures. They are hung up in central points in the schools, (visible therefore to everyone) in order to actively illustrate the performance of the installations. (Energie-Cités, 2002, p.2)

According to the EIA, one of the most benefits of this project was that although PV was still not a common trend in the Holland, the 1.3 MWp project has increased the acceptance of building integrated PV, not only by the general public but also by professional parties like city developers, property developers, architects and building companies. The project has also persuaded property developers and architects to promote PV as a building component that can give a house an aesthetic surplus value. Some of the architects have already applied PV in other projects at their own initiative. (EIA, 2006)

The Netherlands and the UIPV Development

One of the keystones behind the success of the project is the national PV programme that is supported in the Netherlands. According to Swens (EIA-PVPS, 2006) this programme developed within a Dutch policy that aimed at and supported the implementation of proven and almost competitive renewable energy technologies to realize the short term Kyoto and European targets. Because of this policy and the continuous renewable energy programmes, the Dutch policy was focused not only on the traditional aspects related to the foundation of such renewable energy programmes, but also on price reduction through research and technology development

(RTD) leading to an implementation on the longer term.

In addition, a complete set of RTD projects that were supported through the EOS (Energy Research Subsidy) programme. The programme consists of five sub-programmes aiming at new ideas, fundamental research, knowledge transfer, demonstration, and unique opportunities respectively. It includes research projects cover all the four main topics of and UIPV development according to the PVPS-TASK10. They are: (EIA-PVPS, 2006, p.79)

- NEO: New Energy Research, converging on new, unconventional ideas. This programme is mainly intended for inventors. The programme covers all new energy options.
- EOS LT: Long-term energy research, converging on a selected range of promising energy saving-or renewable energy technologies, with expected serious impact between 2020 and 2050.
- ES: Collaboration projects, converging on technology transfer from research to industry, in order to convert technologies into products. This programme replaces the energy part of the IS (Innovation Subsidy for Collaboration Projects) programme, which appeared ineffective for energy technologies.
- EOS Demo: Projects, converging on testing and demonstrating new energy saving- or renewable energy applications in a realistic user environment.
- Transition UKR: “Unique Opportunities Scheme”, converging on improvement of material- and energy use and on the application of renewables, in general and biomass, in particular.

As a result, supporting development plans and programmes such noted above, give the UIPV programme in the Netherlands the ability to cover the key topics required for the process of development of such projects.

4.3.4. Building Level

4.3.4.1. BIPV: Energy Technologies

PV systems are generally divided into three categories: off-grid PV system, grid-connected distributed PV system, and grid-connected centralized PV system.

Off-Grid PV Systems: They named also as ‘stand-alone PV power system’. They are designed to operate independent of the electric utility grid, and are generally designed and sized to supply certain DC and/or AC electrical loads. They include two types. The first type is off-grid domestic PV system. This system installed to provide power mainly to a household or village that is not connected to the utility grid. Therefore, a means to store electricity as lead-acid batteries is used. It can also provide power to domestic and community users via a ‘mini-grid’, often as a hybrid with another source of power. The second is off-grid non-domestic PV system. This type is used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. , which are not connected to the utility grid. (Natural Resources Canada, 2001 & Davidson, 2005)

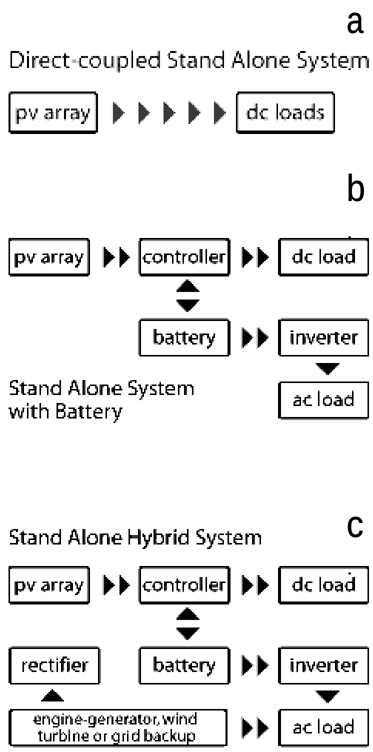


Fig. 4-21 a&b&c: Three different variations for Off-grid PV system.

Source: Natural Resources Canada, 2001.

Grid-connected Distributed PV Systems: They are designed to operate in parallel with and interconnected with the electric utility grid. Such systems may be on or integrated into the customer’s premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers … etc. They may be specifically designed for support of the utility distribution grid. (Davidson, 2005)

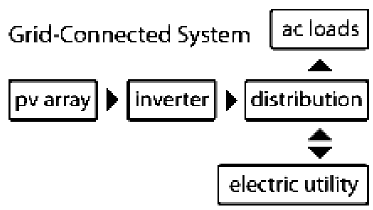


Fig. 4-22: Grid-connected distributed PV systems.

Source: Natural Resources Canada, 2001.

Grid-connected Centralized PV Power System: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development. (Davidson, 2004)

4.3.4.2. BIPV: Integration Concepts

Building Integrated Photovoltaic (BIPV) systems are both electric generating systems and part of the building shell. Examples of BIPV systems are roofing, atriums, and shade screens that integrate PV modules into their design. Besides generating electricity, integrated BIPV systems can also enhance a building’s beauty, visibility, and prestige. BIPV systems offer many advantages compared to adding a PV system into an existing building. BIPV systems: (WisconSUN, 2007)

- Require no additional support structures because they use the building’s frame
- Have limited additional construction expenses
- Are easily designed to provide day lighting, heat control, and other benefits
- Can be easily designed in an aesthetically appealing manner to maximize visibility or educational impacts.
- Can be financed as part of the entire building .In addition, a BIPV system is usually less expensive than a retrofit. This is because the PV panels replace building materials such as roofing, thus avoiding the cost of those materials.

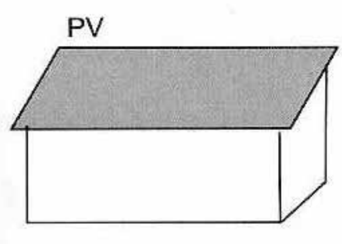


Fig. 4-23 : PV roofing.
Source: Hagmann , 2002.

There are several ways to integrate PV into a building’s design that can be divided into four main categories: roofing, facades, atriums, skylights and greenhouses, and shade systems (Wolter, 2003)

(a) PV roofing

Often the most convenient and appropriate place to put the PV array is on the roof of the building. PV roofing system is a double function concept. PV array may be mounted above and parallel to the roof surface with a standoff of several inches for cooling purposes. Sometimes, such as with flat roofs, a separate structure with a more optimal tilt angle is mounted on the roof.

In addition, PV roofing systems can perform the functions of a roof, such as water tightness, drainage, and insulation, and at the same time producing electricity. PV tiles are generally used on flat roofs while PV slates, shingles and standing seam units are used on sloped roofs. Generally, PV on flat rooftops will generate less electricity than PV on south-facing sloped roofs.

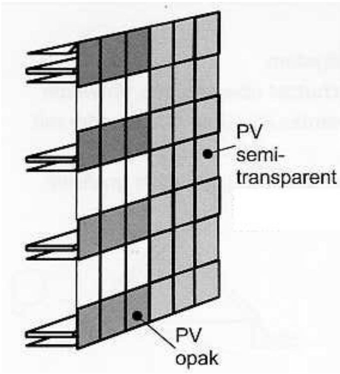


Fig. 4-24: PV facades.

Source: Hagmann , 2002.

(b) PV Facades

Besides generating electricity, PV facades must look appealing and protect the building from weather. PV-facades systems can be integrated with windows, daylighting, and shading schemes to provide multiple benefits. The typical PV- facade is vertical and faces southward. For example, vertically oriented PV panels at the latitude have much reduced electricity output compared to panels sloped toward the sun. The reduction is greatest in the summer when the sun is high in the sky; this is also when electricity is most valuable. To overcome this problem, facades can be sloped using a saw tooth design. (Wolter, 2003, p.3)

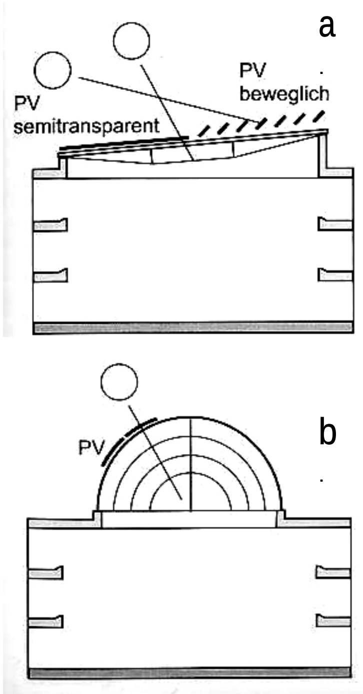


Fig. 4-25 a&b: Two different variants for PV Atria, skylights.

Source: Hagmann , 2002.

(c) PV Atria, Skylights, and Greenhouses

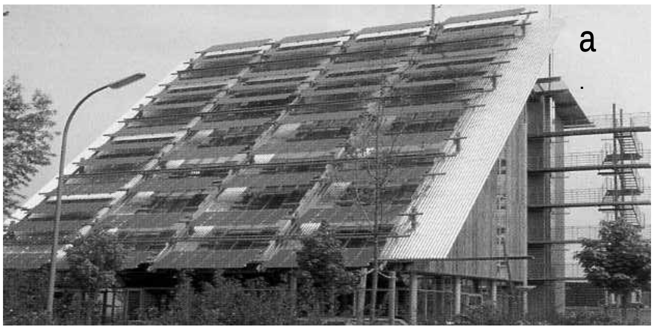
These glazing systems, though best suited for small capacity PV systems, are very visually appealing and provide great visibility. Because skylight, atrium and greenhouse glass is often heavily tinted to minimize glare, semitransparent PV glazing can make a good substitute. The glazing panels consist of PV material attached to the glass. Many off-the-shelf PV modules are suitable for this application. However, open-to-air PV atriums are especially economical because the PV modules do not require extra ventilation.

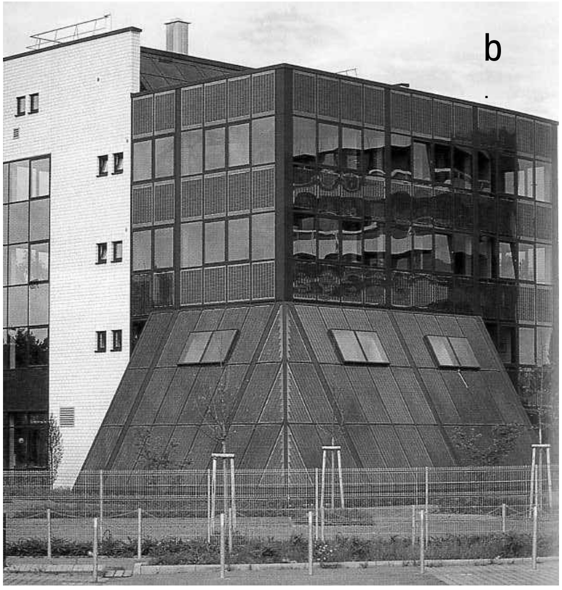
(d) PV Shade Systems

An alternative to roof mounting is to mount the system as a shade structure. A shade structure may be a patio cover or deck shade trellis where the PV array becomes the shade. These shade systems can support small to large PV systems. PV shade systems provide a large area for generating electricity, also reduce solar heating in the summer, which cuts cooling loads, and glare. Shade systems cost less than other BIPV systems because extra ventilation of the PV modules is not needed. Besides, they can be retrofitted onto existing buildings or integrated into a new building's design.

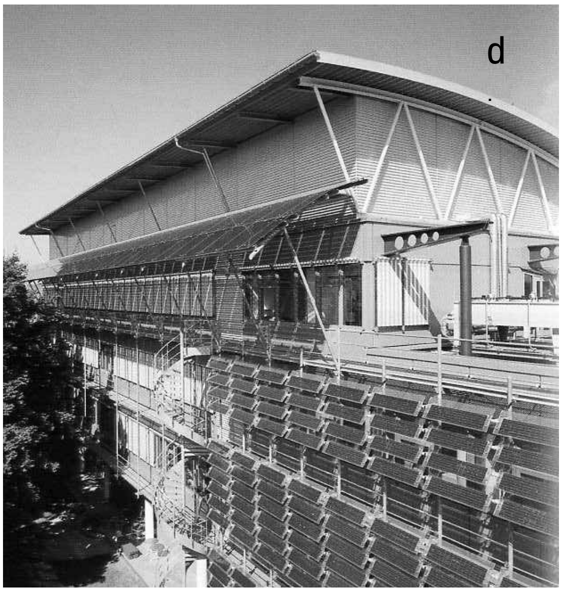
Fig. 4-26 a&b&c&d: Examples for the different variants to integrate PV into a building.

Source: Hagmann , 2002,p.268 & 309 & 348 & 360


a


b


c


d

a. Power Station, konstanz, Germany

b. Education Building, Boxtel, The Netherlands

c. Administration building, Troisdorf, Germany

d. Klinisch – Molekularbiologisches center, Erlangen, Germany

4.3.4.3. BIPV and Building Types

(a) Residential Buildings: The Double Residence - New Housing District Nieuwland - Amersfoort

It is one of the key models of the new housing district Nieuwland - Amersfoort 1.3 MWp PV Project. It is a double residence with an annual energy consumption that is fully covered by an integrated solar energy system. The houses are low-energy houses, while the energy roofs are producing sufficient energy on a yearly average to fulfill the energy demand of the houses. Therefore, it is considered as one of the first modern 'zero-energy' houses with PV, and paved the way for attention and promotion for low-energy and zero-energy housing. (PV-Database, 2007)

Fig. 4-27: Residential buildings, the double residence new housing district, Nieuwland.

Source: Hagmann , 2002.p.276

Architectural Concept*:* According to the PV-Database (2007), architecture concept of the project depends on a central element “the atrium”. It is a large open area at the heart of the building, which allows the sun to shine deep into the house, and all the living functions are situated around it. The architecture of the houses is also largely determined by the conspicuous roof construction. In addition, various types of solar systems have been incorporated: solar thermal collectors, normal PV solar modules, both double- and single-glazed transparent panels, ordinary double glazing and sunblind.

Fig. 4-28 a&b: The double residence new housing district, Nieuwland.

Source: PV- Database, 2007.

The Energy Concept*:* It is based on three key elements: reduction of energy consumption, use of sustainable energy and use of building materials from sustainable sources. Electricity is generated by 78 m^2 of solar panels for each of the two houses, and 15 m^2 of transparent panels located above an atrium. These PV panels are connected by 5 inverters to the local grid. In addition to the energy measures, several other environmental measures have been taken. (PV-Database, 2007 & EIA-PVPS, 2007)

(b) Non- Residential Buildings:

- Mont-Cenis Academy, Germany:

Urban Context. The Mont-Cenis Academy is an entire urban district, which has been developed to be the continuing training academy in Herne – Germany. It is located at the centre of the Ruhr area and at the heart of the region dedicated to the “Internationale Bauausstellung Emscher Park” (International Architectural Exhibition). It is also an important part of the IBA 'Emscher Landscaped Park' project, a series of green spaces developed in the last ten years to improve the quality of life in the Ruhr region. The building became one of the Ruhr region's new landmarks and serves as the functional and urban centre in Herne.

Fig. 4-29: Mont-Cenis Academy, Germany.

Source: PV-database,2007.

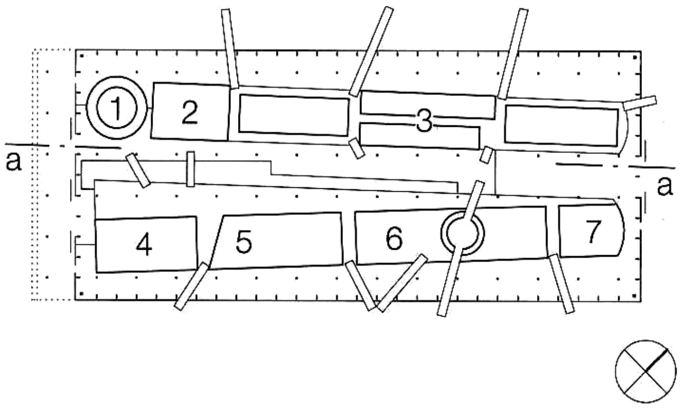


Fig. 4-30 : Mont-Cenis Academy, Germany, the plan.

Source: Schittich, 2003 p.142

1 Library
2 District administration
3 Hotel
4 Community centre
5 Restaurant
6 Academy
7 Academy administration

Fig. 4-31: Mont-Cenis Academy, Germany, aerial view.

Source: www.scheutensolar.com, 2007.

The Project. The initial design idea was to create a large glazed hall with a cloud-like roof structure that would act as a "micro-climatic skin" and generate passive solar energy. It covers about $12400m^2$ (176m in length, 72m wide and 15m high). The building includes not only the academy itself, but also many other functions including seminar facilities, meeting rooms, accommodation facilities, a restaurant, a gymnasium, a library, a civic hall and leisure facilities. All These various functions are accommodated in self-contained structures set within the outer enclosure (Prasad, 2005, p.82). As a result of the protection against the elements afforded by the skin, and the passive solar energy of this form of construction yields, the hall space is in the nature of an outdoor environment with an especially mild climate (Schittich, 2003, p.142).

The 2.50-3.20m^2 photovoltaic modules integrated in the glazed roof function not only as a power-generating system. Through the nature of their cells and the density to which they were laid, the units also regulate the shading and indoor climate within the outer skin and help to prevent overheating. In the areas over the internal building volumes, the modules are laid to a density of 86%, thereby providing the requisite sun shading. In the transitional areas to the areas of clear glazing, a density of 58% was achieved by increasing the spacing between PV modules; this decreases the contrast in brightness and creating a finely graduated lighting environment. In the central zone, the glass roof was constructed without solar cells to ensure good day lighting rates in the areas below. This zone contains also large numbers of opening lights, which serve as means of ventilation, which improves not only the indoor climate, but also increases the effectiveness of the solar installation, which would not work efficiently if the internal space were overheated. As a whole, the photovoltaic modules cover about 9,300 m^2 of the roof area in addition to 800 m^2 of the south-west facade. Therefore, the Academy is considered as the world's largest solar power plant integrated in a building - with a total capacity of 1 MW and an energy supply of approximately 750,000 kWh/a. (Schittich,2003,p.142-143 & Prasad,2005,p.882-84 & IEA,2007)

Fig. 4-32: Mont-Cenis Academy, Germany, the PV roofing.

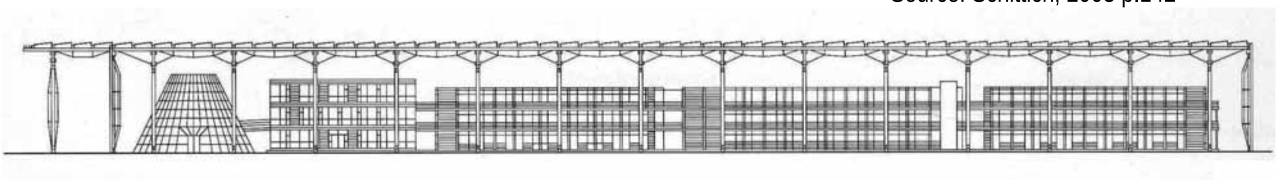
Source: www.scheutensolar.com, 2007

Fig. 4-33: Mont-Cenis Academy, Germany, the PV roofing detail.

Source: Schittich, 2003 p.142

Fig. 4-34: Mont-Cenis Academy, Germany, the conceptual section.

Source: Schittich, 2003 p.142



The Environmental Concept. One of the main aspects of this project is the environmental strategy. Prasad (2005) divided the main lines of this strategy into:

- Generation of passive solar energy by the use of the micro-climatic envelope of the greenhouse.
- Generation of active solar energy for heating water and the production of PV electricity.

This is besides the utilization of easily recyclable ecological building materials and construction techniques, decontamination of the existing polluted soil, and collection of rainwater and re-use of groundwater, collection of gas escaping from former mine shafts used for urban heating.

According to IEA (2007), this turns out that building integrated PV successfully allow to control the interior climate of this large micro-climatic glass house. The intake of solar heat and light is controlled perfectly for the different zones of the building by the choice of different cell densities of the PV-modules of the overhead glazing. Also for large projects like this one, the integration of PV in the glass envelope turned out to be a good choice to replace conventional shading systems as they not only provide shade but also act at the same time as weather skin and PV-Generator.

Fig. 4-35: Mont-Cenis Academy, Germany, detail of the frame construction.

Source: www.scheutensolar.com, 2007.

Fig. 4-36 a&b: Mont-Cenis Academy, Germany, the internal design.

Source: www.scheutensolar.com, 2007.

- Solar Office, Doxford International Businiss Park, UK

Urban Context. The Solar Office at Doxford International Business Park is an office building, near Sunderland in the north east of England, designed for Akeler Services Ltd and It was completed in 1998. The building was designed on a 32-hectare park and the design addresses all the environmental and energy conservation issues currently being addressed in buildings. It is one of the first buildings to incorporate building integrated photovoltaics and is one of only a few to adopt a holistic energy strategy. (Jones, 1998, p.1)

Fig. 4-37 : Solar Office, Doxford International Business Park, facade.

Source: Prasad , 2005,p.86

The Project. The building is a 4,600 m^2, three-storey commercial building. It was constructed to a 'shell and core' specification, and was fitted out to suit the specific requirements of the occupying tenant. According to Jones (2000), it was designed to minimize the use of energy while its external fabric was designed to replace a significant amount of the energy that is used. This formula for energy self-sufficiency was used as one of the key building blocks for future global sustainability. The glazed south facade has a fully integrated 73 kWp photovoltaic array. This is expected to provide about 55,000 kWh of electrical energy yearly, which is representing between 25% and 30% of the expected total electrical consumption. In summer, when it generates more than is required, the surplus is exported to the national grid.

Fig. 4-38: Solar Office, Doxford International Businiss Park, the main entrance

Source: Prasad, 2005,p.

The building is ‘V’ shaped in plan with the extreme ends of the ‘V’ splayed away from each other and a central core located at the apex of the ‘V’. The facade was aligned to face to south and sloped at 60° to the ground without compromising internal planning. This configuration provides good solar radiation at this northerly latitude. The inclined and sealed facade overcame the potential problems of dazzle and of noise from passing traffic on the adjacent trunk road. The office windows was placed facing north, northeast and northwest, obviating the need for elaborating solar protection. In addition, placing the car-park was placed in front of the building ensured that the solar facade would not be overshadowed. (Prasad, 2005, p. 155)

The Environmental Concept. The main objective of the environmental design was to find a symbiosis between the low energy measures and those needed for photovoltaic installation (Jones, 1998, p.2). In this realm, two main aspects were taken in account. Firstly, the photovoltaic facade requires as much sunshine falling on it as possible and therefore introduces the risk of interior spaces being overheated. Secondly, how to integrate a passive strategy for natural ventilation and cooling.

Therefore, the introduction of the solar facade required an entirely different strategy. A 600 m^2 of 100 x 100 mm solar cells had been integrated. A balance had to be developed between maximizing solar irradiance and shielding the interior from unwanted solar gains, providing good internal daylight levels, providing views out, minimizing glare, providing reasonable thermal insulation, and concealing the PV associated wiring and junction boxes - all within a tight budget. The outcome was a proprietary curtain wall/roof structure incorporating (Prasad, 2005.p. 157):

- horizontal bands of clear glazing,
- semi-transparent PV modules where the cells that make up the module are themselves banded and graded to allow diminishing intensities of daylight to enter the interior, and
- opaque PV modules where 80-90 % of the daylight is excluded by the tight packing of the cells.

BOX 4-9 Stack Effect
(Stack effect is the rising of currents of air that are warmer, thus less dense and more buoyant than surrounding air)

Suorce: Prasad, 2005.p. 156

The office depth was limited to 15 m to allow for cross-ventilation. In addition, a cooling strategy was developed to use the two options for natural driving forces , the wind and stack effect. The stack effect is promoted by the PV facade itself. As the temperature rises at the back of the facade, due to solar gain, a current of warm air rises to roof level, helping to draw air out of the adjacent office spaces. Mechanical vents have been installed at the bottom and top of the facade to help encouraging this airflow and to keep the PV arrays cool. Wind passing over a roof creating a negative pressures (suction), helping to draw air across the floors and up out of the building. There is also a danger that wind can blow in through the vents and reverse this airflow. To ensure constant suction in windy conditions, the rooftop air outlets are located in a sheltered trough (to counter southwest and northeast winds) surmounted by transverse baffles to cope with winds blowing along the trough. (Prasad, 2005 & Thomas, 2001 & Jones 2000)

Fig. 4-39: Solar Office, Doxford International Business Park, facade from inside the building.

Source: PV-Database, 2007.

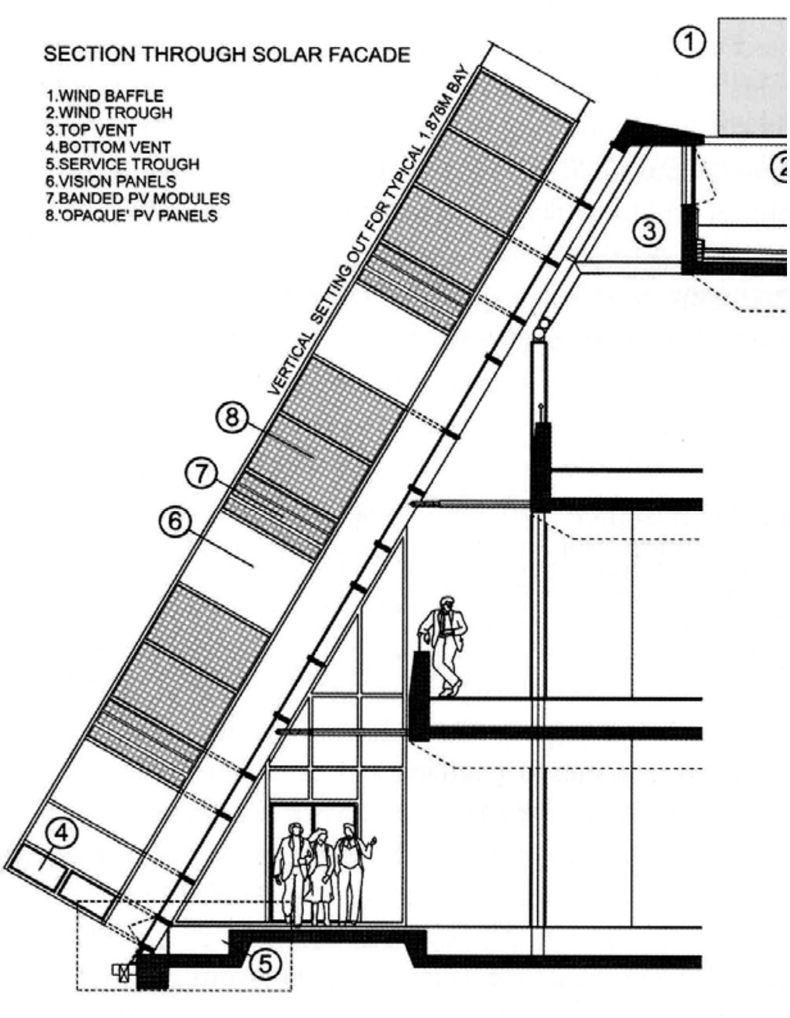


Fig. 4-40: Solar Office, Doxford International Business Park, conceptual section.

Source: Prasad , 2005, p.92

(c) Non Building Structures

Photovoltaic can be integrated in “non-building structures” and most elements of the urban space. This is including structures such as bus shelters, streetlights and sound barriers…etc. The potential for using PV in non-building structures in the built environment is large, even in a modern society where the electricity network is well developed. This is because of the fact that the cost of a small PV supply can be less than the cost of extending and connecting a nearby electricity supply cable. However, designs for PV systems integrated into non-building structures need to consider a range of functional and environmental criteria like shading, orientation, visual impact and technical requirements. (Johannesson, 2001, p.5)

Photovoltaic Pergola, Andalusia Technology Park, Spain. It is designed with objectives to provide shading along a walking path, to demonstrate the feasibility of using different orientation and tilt angles for the PV modules, and to analyze the architectonic behavior of PV laminates (structural and mechanical aspects). The design of the PV fields has a singular "zig-zag" shape; also the inverters room has a special design for aesthetical reasons. Monitoring of the PV system has been implemented using a novel concept based on wireless communication.(PV-Database,2007& Isofoton,2007)

Fig. 4-41 a&b: Photovoltaic pergola installed in the Andalusia Technology Park in Malaga

Source: Isofoton. , 2007.

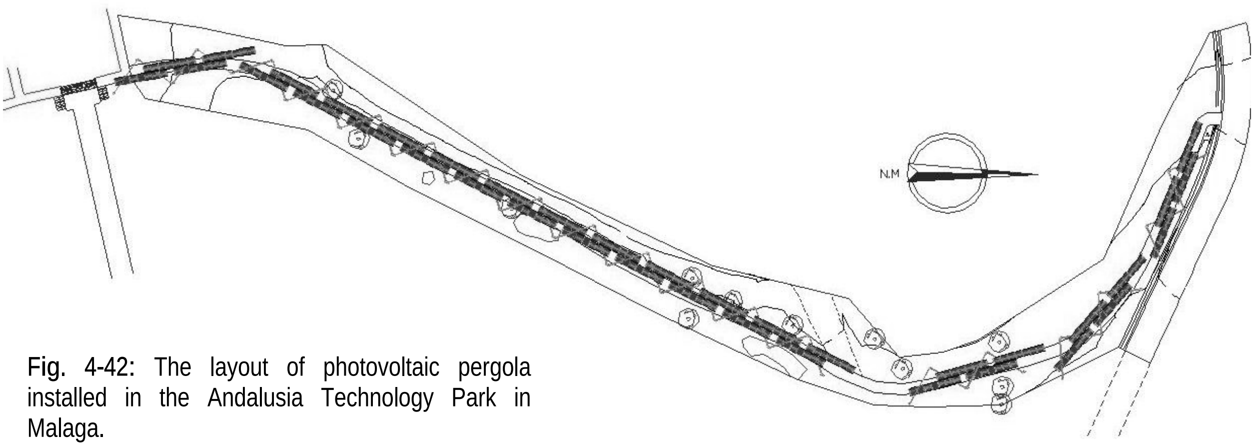


Fig. 4-42: The layout of photovoltaic pergola installed in the Andalusia Technology Park in Malaga.

Source: Isofoton. , 2007.

Environmental Education Center - As Pontes. The environmental education center of “As Pontes” develops management programmes and systems to improve the environmental quality, through activities such as conferences, courses, and workshops. It includes series of small buildings located around a circular patio, which is covered by a skylight of wood structure (multilaminated wood, with very low environmental impact) divided in 10 equal pyramidal sectors. The northern part (5 sectors) is completely glazed, whereas the southern part (the remaining 5 sectors) is partially covered with semi-transparent PV modules. Because the glazed skylight surface is big enough to provide natural light to the patio, conventional distance between the solar cells in the PV modules has been used. (PV-Database, 2007 & VIDURSOLAR S.L., 2007)

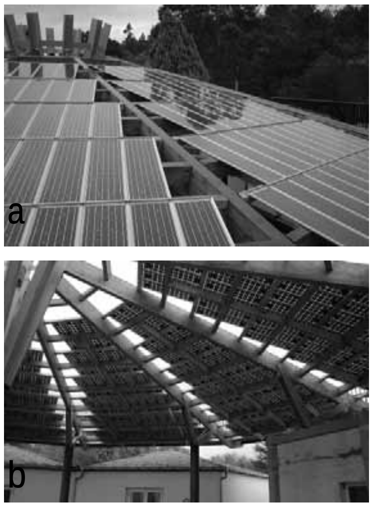


Fig. 4-43 a&b: Environmental education center - As Pontes.

Source: VIDURSOLAR S.L. ,2007.

PV Noise Barrier A27. Netherlands. It is a PV sound barrier built aside the A27 in “De Bilt”. It has a length of 550 meter and carries a grid-connected PV system of 55 kWp. The PV panels are installed on top of the lower (concrete) part of the sound barrier, in such a way that they contribute to the noise reducing properties of the sound barrier. It consists of 1116 PV modules, which are coupled through a 40 kW inverter to the grid. Therefore, it can be considered as a small power plant. The practical experiment showed that PV panels can be used for sound barriers, while the combined functions of energy production and noise reduction can be a cost-effective application of solar energy in the future. (PV-Database, 2007 & Novem, 2007)

Fig. 4-44: PV noise barrier A27. Netherlands.

Source: Novem ,2007.

4.3.4.4. BIPV and Environmental Strategies

One of the benefits of using photovoltaics in building design and renewable energies in general, is that it always associated with environmental design strategies. The purposes of these strategies are to reserve energy consumption, make the building suitable for its environment, and to achieve the thermal comfort for the users. These strategies are always designed from the early beginning of any project-integrated photovoltaic.

For example, Solar Village ParcBIT , Palma de Mallorca, Spain. It is an expansion area of Palma de Mallorca conceived by the Balearic government as a milestone in what the future Balearic development must rely upon. The project objective was to integrate energy exploitation technologies in the process of urban planning as a tool to create more sustainable community. (Landabaso, 2001 & Brophy, 2000, p.7-8) A passive solar solutions for heating and cooling have been incorporated as site elements during the planning process, and additional implementation in buildings have been encouraged by the local regulations adopted at the Master Plan. Thereby the energy demand is reduced by 70%, and a better comfortable urban environment is created.

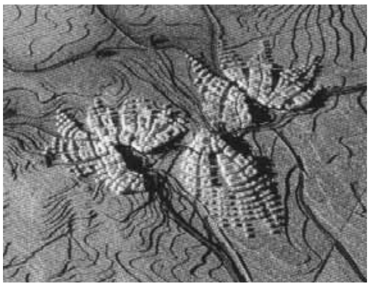


Fig. 4-45: Solar Village ParcBIT' the city model.

Source: Herzog, 95, p.176

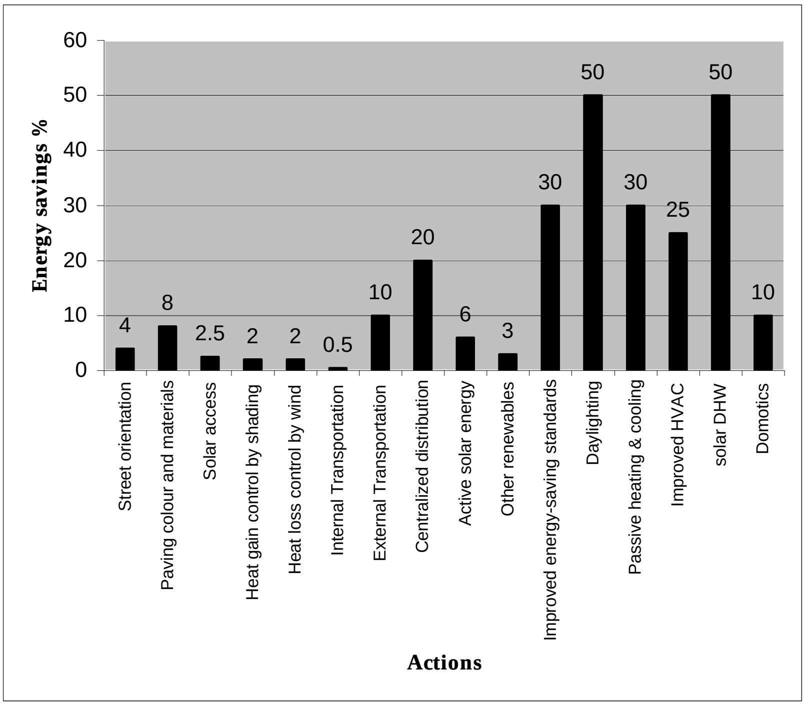


Fig. 4-46 The percentage of energy savings due to the use of renewable energy and solar passive design in ParcBIT

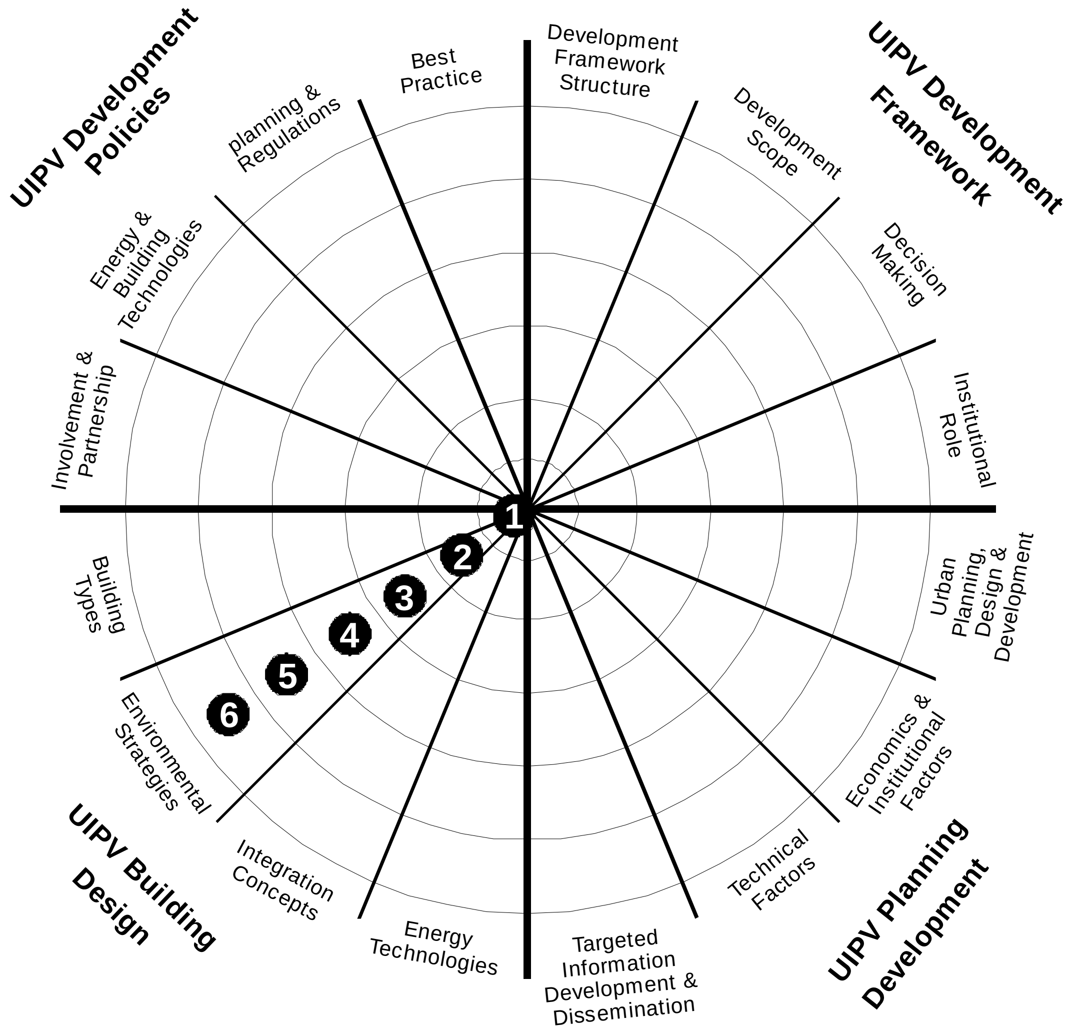
Source: Abd-Elaal,2002,p.150.

4.3.5. Discussion: The UIPV Development Model

With reference to the analysis for the approach required for a community-integrated PV and the development model elements supposed by the study for the UIPV development (see points 3.2. and 3.3.), the study suppose that the UIPV development model consists of the next elements and sub-elements:

- UIPV Development Framework
  - Framework Structure
  - Scope of Development
  - Power to Act (Decision Making)
  - Institutional Role
- UIPV Development Policies
  - Planning and Regulations
  - Energy and Building Technologies
  - Involvement and Partnership
  - Best Practice
- UIPV Planning & Development
  - Economics and Institutional Factors
  - Urban Planning, Design and Development
  - Technical Factors
  - Targeted Information Development and Dissemination
- UIPV Building Design
  - Energy Technologies
  - BIPV: Integration Concepts
  - BIPV and Environmental Strategies
  - BIPV and Building Types

Through the process of UIPV development, every element of it has its development steps. These steps refer to a stage of development. In this manner, the study divided it into six stages or levels that are including: Need level, Thinking level, Preparing & Development level, Implementation level, Evaluation level, and After Evaluation level. (See Fig. 4-47)



UIPV Development Process Levels

1. Need level
2. Thinking level
3. Preparing & Development level
4. Implementation level
5. Evaluation level
6. After Evaluation level

Fig. 4-47: The supposed model for UIPV development process.

Source: Researcher.

Thus, the study will use this model as a tool to examine the UIPV development process of the case of the OECD countries as it discussed in the previous points. In addition, it will, also, use the model to analyze a case study of an arid region UIPV development. Results of this analysis will be used for the case of Egypt in the next step of the research.

4.3.6. The UIPV Development Model of the OECD Countries.

With reference to the European Solar Cities project (EU Solar Cities) that has studied the PV development in the urban context of OECD countries (see Appendix I) , and the previous review of the elements of the UIPV development model using cases form the OECD countries (see point 4.3.) ,the UIPV development model is represented in the next figure (Fig 4-48)

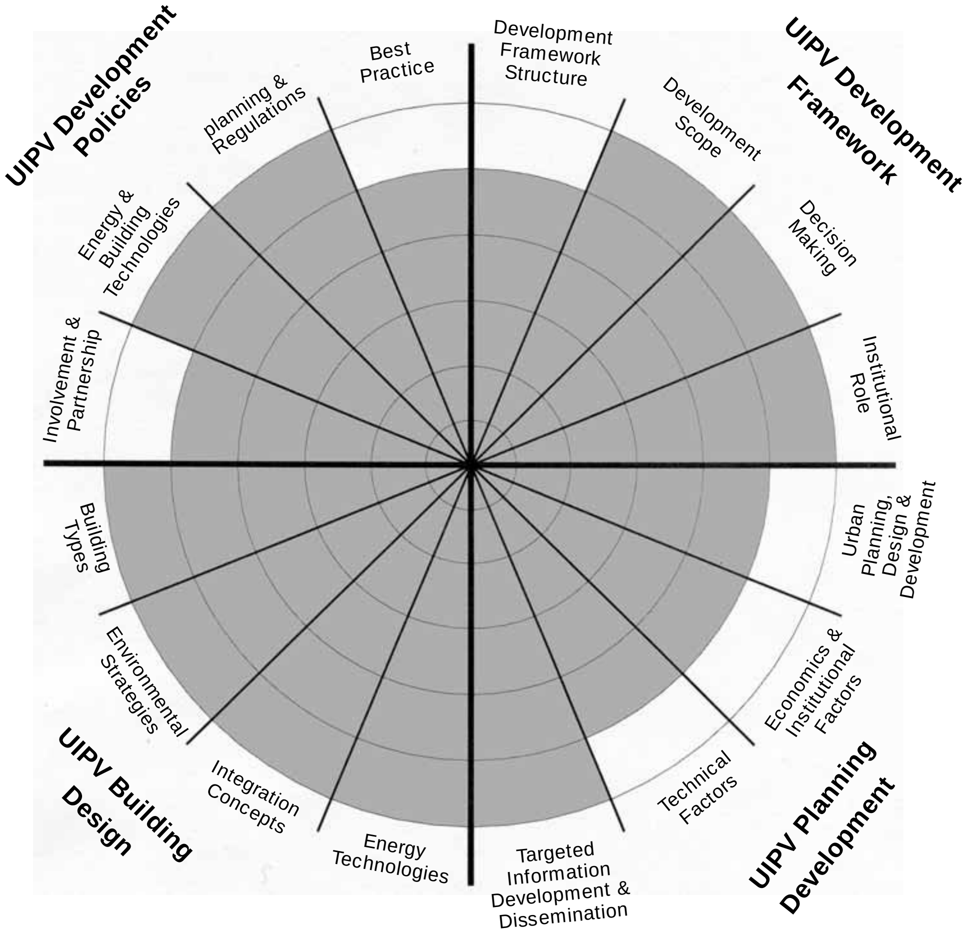


Fig. 4-48: The OECD model for UIPV development process.

Source: Researcher.

According to the model, the OECD countries have succeeded to develop their UIPV covering all the main elements required to an UIPV development process. In addition, it shows that they reached now the “After Evaluation” stage for most elements. This can be explained through the role that the cooperation in the field of UIPV development and policy making within a well organized networks.

4.4. Conclusion

PV is emerging as a major power resource, steadily becoming more affordable and proving to be more reliable than utilities. Photovoltaic power promises a brighter, cleaner future for next generations. Photovoltaic (PV) is an important energy technology for many reasons. As a solar energy technology, it has numerous environmental benefits. However, in order to integrate this technology into the process of urban development and UIPV development process, urban development approaches must take place. These approaches have to cover not only the urban issues but also all the other issues related to such development process.

In this manner, by reviewing the recent approach of UIPV development, the study concluded that four main elements must take place in any UIPV development process, which includes development framework, development policies, planning and development, and building design.

By analyzing these elements with the experience of the OECD countries, the study formulated a development model for UIPV, which is used as tool to analyze any UIPV development.

Case Study of an Arid Region Community Integrated PV: The MASDAR Development (UAE)

Chapter 5

In this chapter, the study gives a full case study for a new UIPV development in arid regions, MASDAR Development- Abu Dhabi, is analyzed using the UIPV development model.

5. Case Study of an Arid Region Community Integrated PV: The MASDAR Development (UEA)

5.1. Introduction:

The United Arab Emirates (UAE) is a constitutional federation of seven emirates; Abu Dhabi, Dubai, Sharjah, Ajman, Umm al-Qaiwain, Ras al-Khaimah and Fujairah. The federation was formally established on 2 December 1971. Less than half of the inhabitants of the UAE are Arabs; there are also Persians, Baluchis, Indians, and Westerners. Only about 20% of the UAE's population is native citizens. The nonnative population is mostly from east and Southeast Asia, and was attracted by the employment provided in the UAE with its petroleum revolution. According to the estimations, the population of the United Arab Emirates is about 2,563,000 (2005 EST.)

Fig. 5-1: The UAE location
Source: emirates.org, 2007.

Industries involving the area's oil and natural-gas deposits are still critical to the increasingly diversified economy, however international banking, financial services, regional corporate headquarters, and tourism also playing an important role. The traditional occupations of fishing and pearling are still practiced.

5.1.1. Location

United Arab Emirates occupies a total area of 83,600 square kilometers, along the southeastern tip of the Arabian Peninsula between 22°50 and 26°N and between 51° and 56°25 E. Qatar lies to the west and north-west, Saudi Arabia to the west and south and Oman to the north, east and south-east.

Fig. 5-2 : The UAE map
Source: emirates.org, 2007.

5.1.2. Physical Features

The UAE has 734 Km of coastline, 644 Km along the Arabian Gulf and 90 Km bordering the Gulf of Oman. Therefore, the UAE is a country of contrasting landscapes although four-fifths of the UAE’s land area is arid desert. Along the Arabian Gulf coast are offshore islands, coral reefs and salt marshes, whilst stretches of gravel plain and barren desert characterize the inland region.

The western interior of the federation, most of which is Abu Dhabi territory, consists mainly of desert interspersed with oases. One of the largest oases is Liwa, beyond which is the vast Rub al-Khali desert, or Empty Quarter, which stretches beyond the UAE's southern border. To the east lie the Hajar Mountains chain which reach north into the Musandam peninsula at the mouth of the Arabian Gulf. The rocky slopes rise to 1300 meters within UAE territory, falling steeply to the UAE's East Coast on the Gulf of Oman where a fertile alluvial gravel plain separates the precipitous mountains from the ocean. To the northeast, a fertile gravel plain also separates the mountains from the coast around Ras al-Khaimah. (emirates.org, 2007)

5.1.3. Climate

The UAE lies in the arid tropical zone extending across Asia and North Africa. However, climatic conditions in the area are strongly influenced by the Indian Ocean, because of its borders at the Arabian Gulf and the Gulf of Oman. This explains why high temperatures in summer are always accompanied by high humidity along the coast. There are noticeable variations in climate between the coastal regions, the deserts of the interior, and mountainous areas. (emirates.org, 2007)

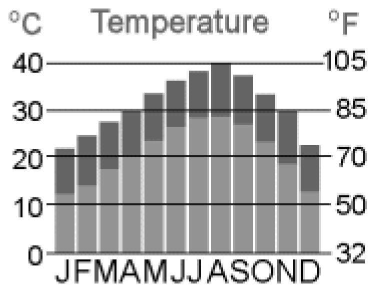


Fig. 5-3 : The UAE annual temperature

Source: emirates.org, 2007.

(a) ***Temperature***. From November to March daytime temperatures average of 24°C. At night, temperatures are slightly cooler, averaging of 13°C and less than 5°C in the depth of the desert. Summer temperatures are very high, and can be as high as 48°C inland, but it is lower by few degrees in coastal.

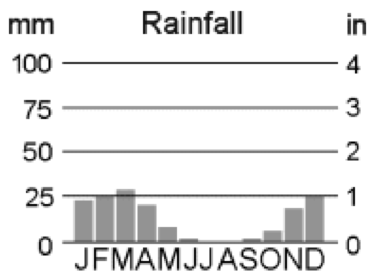


Fig. 5-4 : The UAE annual rainfall

Source: emirates.org, 2007.

(b) ***Humidity.*** Humidity in coastal areas averages between 50 and 60 %, reaching over 90 % in summer and autumn. Inland, it is far less humid.

(c) ***Winds.*** Local northwesterly winds named "*shamal*" frequently come during the winter, bringing cooler windy conditions. Prevailing winds, which are influenced by the monsoons, vary between south or southeast, to west or north to north-west, depending upon the season and location.

(d) ***Rainfall.*** Although some changes recently, the UAE has an average rainfall is low at less than 6.5 centimeters annually, more than half of which falls occur in December and January.

5.2. Urban Development in the UAE

The discovery of oil had played a major role in the history of the process of urban development in the UAE. With reference to this, urban development in the UAE can be divided into three main ages. They are the vernacular age, modern age, and the late modern age.

Fig. 5-5 : The UAE, oil field. Discovery of oil had played a major role in the history of the process of urban development in the UAE

Source: emirates.org, 2007.

5.2.1. The Vernacular Age

It can also be defined as "the age before the discovery of oil". It was the age of the vernacular settlements that were small and primitive. They were usually located close to intersections of trading routes or strategic coastal areas. Abu Dhabi was a small village where coastal tribes settled. Al Ain was an oasis village rich with water and palm trees. Its dry weather attracted coastal settlers during the hot humid summer season. Because of its location on the entrance of the curving creek (Khoor), Dubai acquired an important position and was able to develop an outstanding trading centre with India for pearl and goods. Other small villages were located in the routes of trading or near significant coastal areas (Mahgoub, 1997).

Residential areas containing houses were spread apart allowing different tribal clans to cluster together and expand their territory as needed. Public areas were available for each cluster allowing social activities to take place. According to Mahgoub (1997), the vernacular houses in the region are divided into three types:

The Traditional Tent. It was home and shelter for the Bedouins during the winter season. It was carried over camels during travelling. Made of animals' skin and hair, it was easy to fold, unfold and move around.

Al Arish. During the summer season, the Bedouins used to live in shelters called Al Arish, which were made of palm tree leaves. Al Arish was made of two parts: (1) the main area 2x4 meters used for sitting and sleeping, (2) a small area, 2x2 meters used for cooking, storage and raising of animals. The Bedouins considered Al Arish their second home after the tent.

Courtyard Winter Houses. They were built near coastal areas, while summerhouses were mainly around palm tree farms. The courtyard was an important feature of the house; it occupied half the area of the traditional house. The courtyard was restricted to family activities and women socialization. It was used by women to move between house parts and perform cooking activities. It provided privacy for women to conduct their social activities, eating, and sleeping during the hot summer season.

5.2.2. The Modern Age

After the discovery of oil and the economic prosperity enjoyed by the country, there was an urgent need to build new cities with new buildings to meet the new demands of the people. Therefore, planning departments were established to work on planning cities and villages.

Cities had expanded rapidly because of the speedy dependency on cars and other means of transportation. This uncontrolled expansion transformed major cities into metropolitan areas and changed the traditional life style into a modern one. The government constructed several public housing projects in different parts of the country. Houses were built and handed to citizens after completion of construction. The design of these houses was not suitable for the cultural values and needs of the inhabitants, especially Bedouins who were forced to settle

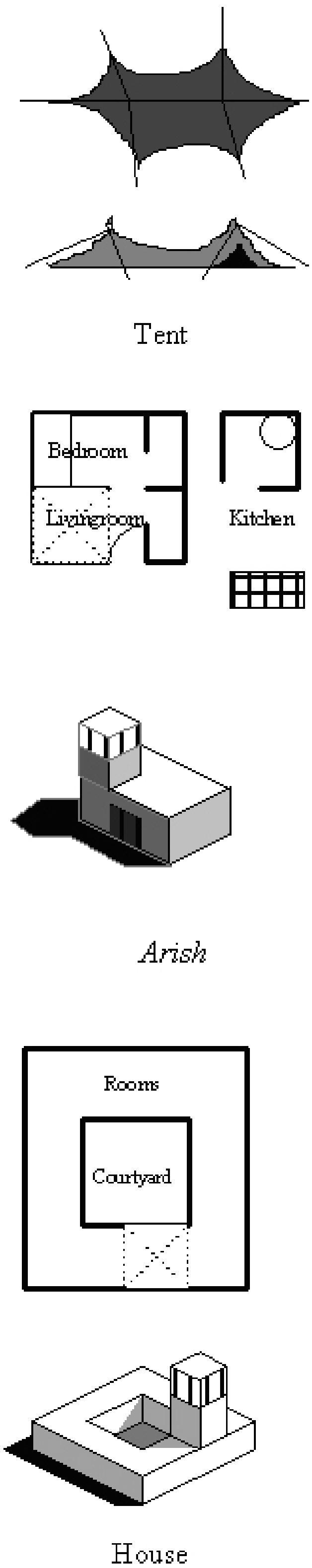


Fig. 5-6: The UAE, the traditional types of housing.

Source: Mahgoub, 1997.

in these projects. The owners had to make informal additions and changes to the houses to satisfy their needs. (Mahgoub, 1997)

The seventies and eighties witnessed the use of imported architectural styles, construction systems and building materials. Architects from other Arab countries were invited to design buildings. They applied their education, knowledge and training in other parts of the world on the design of these buildings. Following that period, architects from western countries played a larger role in design and construction of new buildings. The use of reinforced concrete, new building materials, air-conditioning and construction technology dominated the practice of architecture. (Mahgoub, 1997)

5.2.3. The Late Modern Age

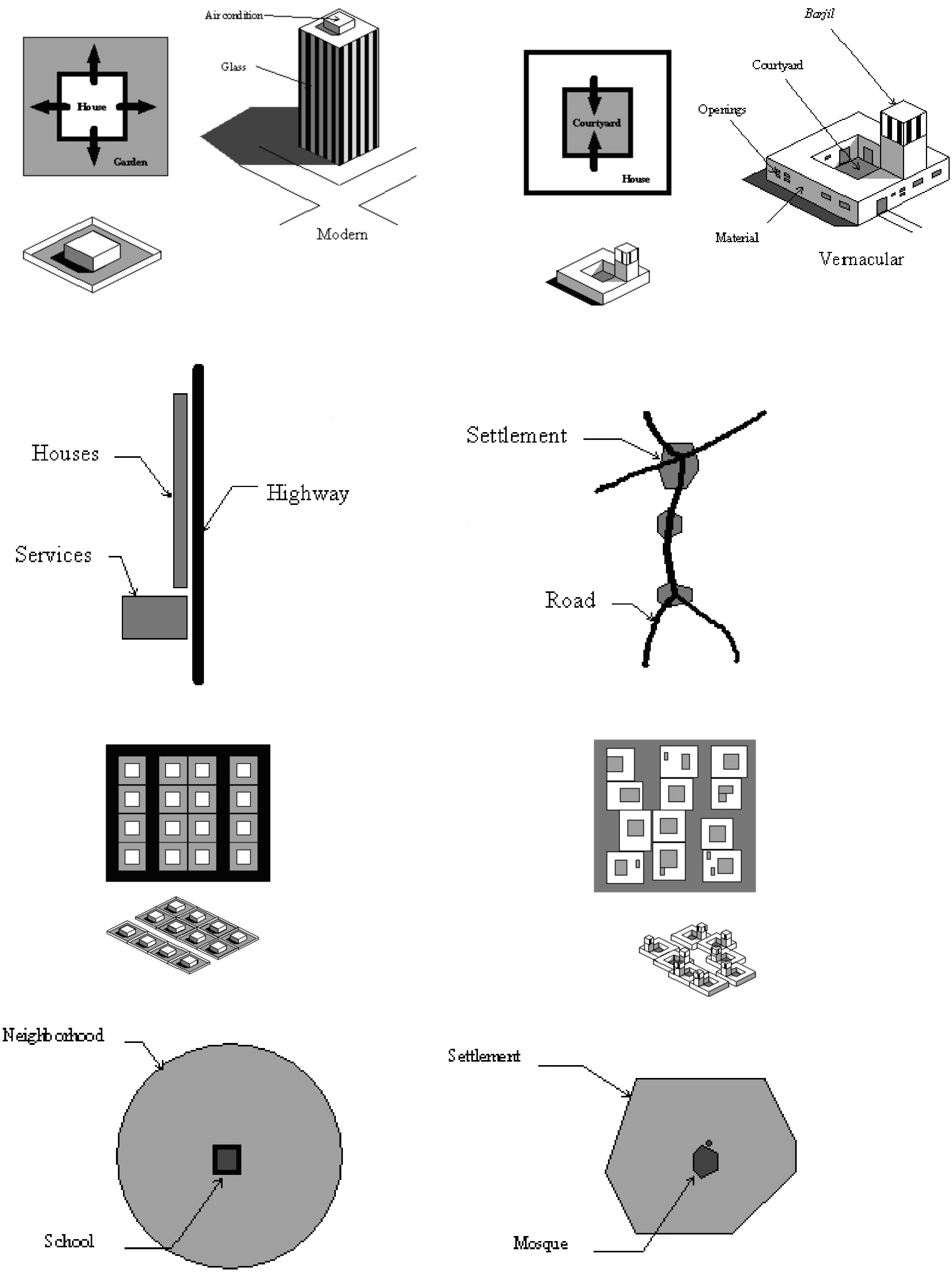
It began during the nineties and by the beginning of the 21st century. A new trend emerged in the Nineties with a goal to revitalize the architectural heritage of the past and use its features to stress identity and architectural style. Many of the buildings, which were built during the seventies, were replaced by new buildings using architectural features assumed to be more related to the region. This age characterizes also with trying to apply all the last technologies possible besides some environmental directions in urban planning and building design, in order to achieve sustainability.

Fig. 5-7: The UAE cities today.

Source: Jebreili, 2007.

Fig. 5-8: Aerial view of Dubai, with Abu Dhabi highway through its middle.

Source: Mellor, 2007.



The actual City

The vernacular city

Fig. 5-9: The UAE, the urban context, a comparison between the past and the actual situation.

Source: after Mahgoub, 1997.

5.3. The Project of MASDAR

5.3.1. Introduction

Abu Dhabi is the second largest city of the United Arab Emirates. It is also the capital and largest city of the region of Abu Dhabi, which is the largest of the seven emirates of the United Arab Emirates by size. In April 2006, Abu Dhabi took a bold and historic decision to embrace renewable and sustainable energy technologies. It has established the Masdar Initiative, a global cooperative platform for open engagement in the search for solutions to some of humankind's most pressing issues: energy security, climate change, and truly sustainable human development.

According to MASDAR (2007d), the key objective of Masdar Initiative is to position Abu Dhabi as a world-class research and development hub for new energy technologies, while ensuring that Abu Dhabi maintains a strong position in world energy markets.

A related objective is to drive the commercialization and adoption of these and other technologies in sustainable energy, carbon management and water utilization. Therefore, Masdar will play a decisive role in Abu Dhabi's transition from technology consumer to technology producer. The goal is the establishment of an entirely new economic sector in Abu Dhabi around these new industries, which will assist economic diversification and the development of knowledge-based industries. In addition, the Masdar Initiative offers a proactive response to today's energy and environmental challenges. It is being driven by the Abu Dhabi Future Energy Company (ADFEC), a company wholly owned by the government of Abu Dhabi through Mubadala Development Company. (MASDAR, 2007d)

The Project "MASDAR Development" is a part of Masdar Initiative. It is a zero-carbon, zero-waste city, and it will be opened in late 2009. The development is a unique, integrated "Green Community" in the heart of Abu

BOX 5-1 MASDAR

The word Masdar means "the Source" in Arabic. This Initiative will be the source for an impressive range of innovative Abu Dhabi-based industries and research to position Abu Dhabi as a global leader in clean energy and sustainable development.

Abu Dhabi's Masdar initiative will lead, manage and execute activities relating to the agreement. Masdar is a multi-billion dollar, multi-faceted response to the need for a global focus on the development of advanced energies and sustainability-related technologies.

Source: MASDAR, 2007d & MASDAR , 2007f.

Dhabi, which uses the traditional planning principals of a walled city, together with existing technologies to achieve a zero-carbon and zero-waste sustainable development. The city will house the MASDAR Institute of Science and Technology, the graduate science and research Institute currently being established in co-operation with MIT, research facilities, world-class laboratories, commercial space for related-sector companies, light manufacturing facilities and a carefully selected pool of international tenants who will invest, develop, and commercialize advanced energy technologies. The city will also host MASDAR's offices, residential space for employees, as well as a science museum and educational facilities. (MASDAR, 2007n)

Fig. 5-10: The MASDAR development: an arial perspective

Source: Foster, 2007.

Projects already activated in Abu Dhabi development include both photovoltaics (PV) and concentrating solar power (CSP), providing MASDAR with broad coverage of the solar sector. In addition, MASDAR's PV projects in development include a world-scale polysilicon factory in Abu Dhabi, which will provide the feedstock for additional activities such as PV cell and module manufacturing. Photovoltaics allow the direct conversion of sunlight into electricity – this is as one of the most promising technologies in renewable energy. The global PV industry was estimated at 2 gigawatts (GW) in 2006 and is growing at 30% annually, making it one of the most attractive and high-growth international industries. (MASDAR, 2007p)

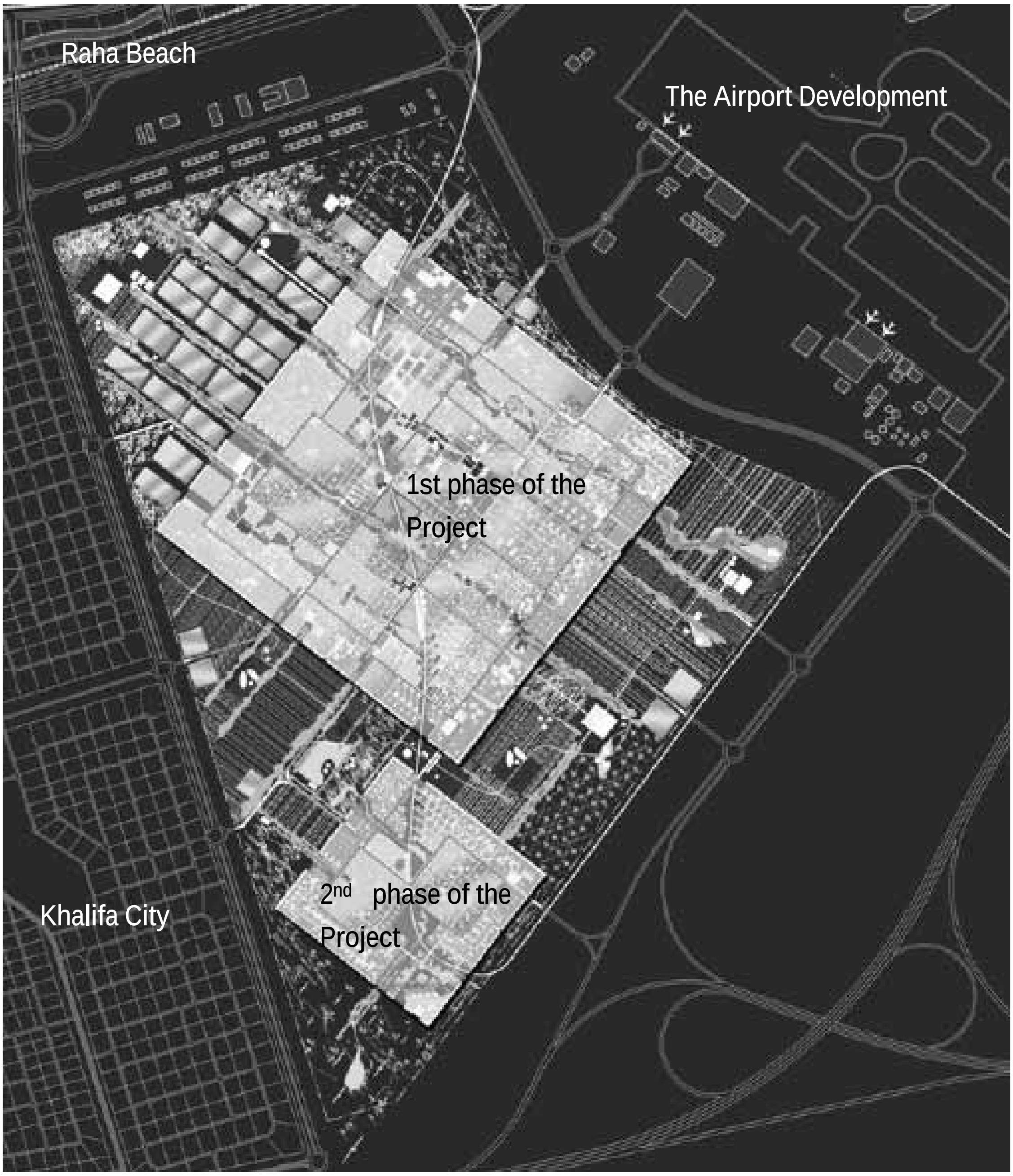


Fig. 5-11: The MASDAR Development master plan

Source: After WSP, 2007, p.2.

According to Foster & Partner (2007), the principle of the MASDAR development is a dense walled city to be constructed in an energy efficient two-stage phasing that relies on the creation of a large photovoltaic power plant, which later becomes the site for the city's second phase, allowing for urban growth yet avoiding low density sprawl.

The city will be car free, powered by renewable energy with services digitally managed and providing real time information. With a maximum distance of 200m to the nearest transport link and amenities, the compact network of streets will encourage walking and it is complemented by a personalized rapid transport system. Shaded walkways and narrow streets will create a pedestrian friendly environment in the context of Abu Dhabi's extreme climate. Surrounding land will contain wind, photovoltaic farms, research fields and plantations, enabling the city to be entirely self-sustaining. (Foster & Partners, 2007)

The process development of MASDAR project can be divided into 5 stages. (Fig. 5-12)

The first stage. Stage of concentrating the PV power Station. This power station will be the main source of power during all the other construction stages of the city. in addition, it will be an extension area for the city in the future.

The second stage. The construction of the city will begin with two main elements; the university and the developing unit, and they will be the core of the city of MASDAR.

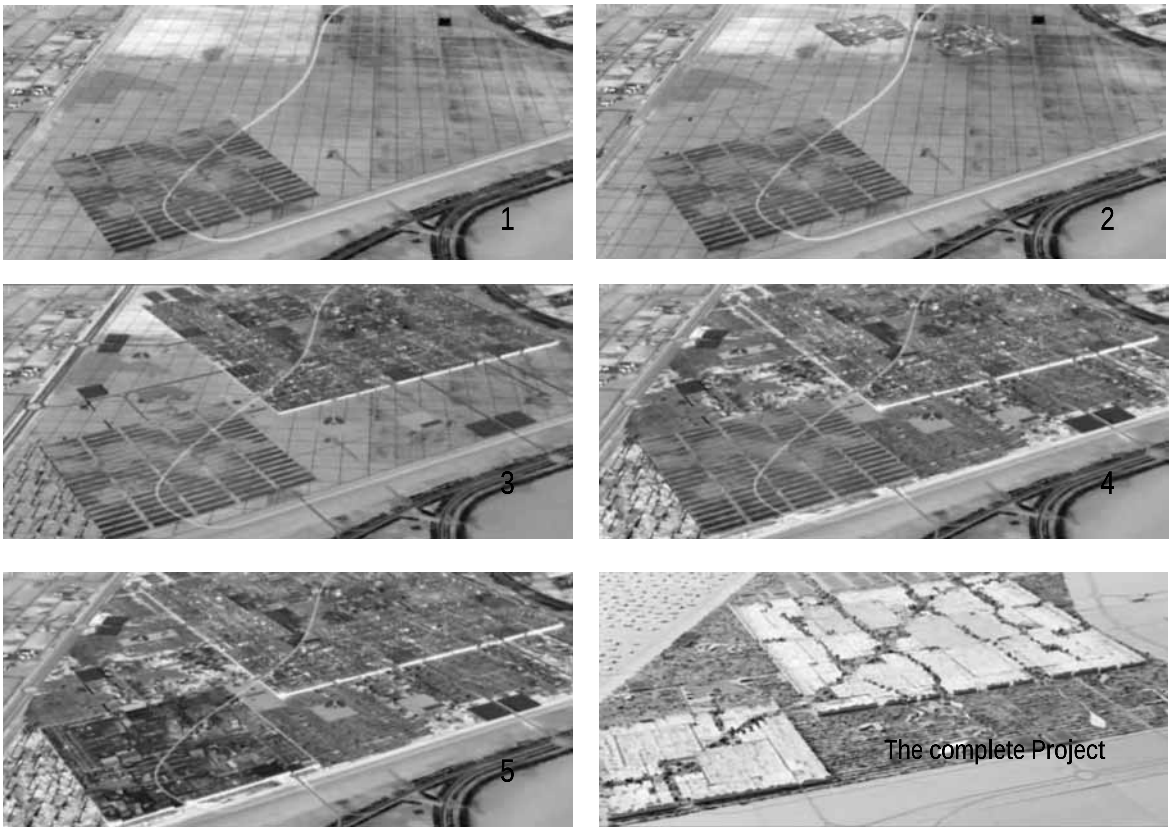
The third stage. All the other parts of the city will be completed. The urban planner and architectural designer will develop the city with a design strategy that gather both the fundament of the traditional and environmental concepts of design for such arid region, and in the same time all means of new technologies of solar and other renewable energy technologies.

The fourth stage. A new separate small solar power stations will be constructed all around the city to support the other solar system will be integrated with the construction of parts and building types of the city during the 2nd and the 3rd stages. In Addition, the new landscape will be constructed around the city. It will act as a buffer zone of the city, and it will help to reduce the effect of the winds come from the desert.

The fifth Stage. The main power station of the 1st Stage will be replaced with a new extension of the city of MASDAR.

Fig. 5-12: The MASDAR Development, stages of the development process.

Source: MASDAR, 2007u.



5.3.2. MASDAR Development and the UIPV Model of Development

5.3.2.1. Development Framework

(a) Development Framework Structure

One of the important remarkable constraints that affected the process of development of the MASDAR project is that the Abu Dhabi and the UAE is still in the beginning of constructing its capacities in the field of UIPV communities. Therefore, the UAE and Abu Dahbi try to build their capacities and their development framework in two stages. At the first stage, to achieve goals of development, they openly engage partners who share the vision, resources and commitment necessary for progress in this new era of cleaner energy and more sustainable use of natural resources. Therefore, they are attracting the best international partners – corporate, academic and financial - in every aspect of MASDAR. In return, they offer to them a uniquely supportive environment for successful collaboration (MASDAR, 2007d). For example, they actively investing into international solar companies, and most recently investing in the German thin-film PV Company Sulfurcell. With regard to concentrating solar power, MASDAR is in the process of contracting the United Nations Environmental Program (UNEP) to conduct a comprehensive solar energy resource assessment to evaluate the potential of large-scale CSP projects in Abu Dhabi.

Therefore, in this stage, the authority of the UAE depended on a development framework that consists of the authority of the UAE itself with the private sector in the UAE with cooperation with the international development networks and institutes in the filed of UIPV.

At the second stage, the city of MASDAR will be finished and all the sectors of the MASDAR initiative will be completed. They will become the core of the UIPV development framework in the UAE. This is side by side with the cooperation with international UIPV community.

This will be achieved as they intend to move fast and with maximum efficiency, achieving dynamic results by creating successful associations and partnerships with global investors, energy and industrial corporations, academic institutions and researchers of international repute. They are making significant investments in new technologies, research and specialist education to assist Abu Dhabi's expansion into more knowledge-based industries. There is clearly much to accomplish, and they are committed to deliver tangible and substantial results through MASDAR's broad scope for partnership and cooperation. (MASDAR, 2007d)

According to MASDAR, the Key components of this local Development Framework, are the components of MASDAR at same time which include: (MASDAR, 2007g,h,I,j,u)

- **The MASDAR Institute:** A graduate level education and research institution offering Masters and PhD programs in science and engineering in the core energy and sustainability-technology themes of the MASDAR initiative. The Institute is a non-profit, independent entity established with the assistance of the world renowned Massachusetts Institute of Technology (MIT), under a cooperative agreement signed in December 2006.
- **The MASDAR Research Network:** it is a unique collaborative research framework between the MASDAR Institute and leading global scientific research institutions. The aim of this network is to create a nucleus of excellent scientific research in advanced energy and sustainability technologies. It leverages the core research, strengths of each partner to accelerate innovation and commercial development of the most promising technologies. The Network's partners include Imperial College London, UK; RWTH of Aachen, Germany; University of Waterloo, Canada; Tokyo Institute of Technology, Japan; Columbia University, USA and the German Aerospace Center (DLR).
- **The Innovation and Investment Unit:** The Innovation and Investment Unit drives the commercialization and adoption of advanced energy and sustainability technologies. The unit has identified three strategic thrusts. The first is the MASDAR Clean Tech Fund, a $250 million private equity fund launched in partnership with Credit

Suisse and Consensus Business Group in November 2006. The second is the Sustainable Technologies and Advanced Research (STAR) program, which invests in near-commercial technologies suitable for demonstration-level projects. The third is the MASDAR Business Incubator, which assists start-ups and entrepreneurs, nurtures them into commercially viable businesses.

- **The Carbon Management Unit:** Spearheading the development of carbon emissions reduction and monetization projects under the Clean Development Mechanism (CDM) of the Kyoto's Protocol in the MENA region. It is actively developing a broad portfolio of carbon-related projects in oil & gas, heavy industry, renewable energy and waste management, together with various government and industry partners.
- **The Special Projects Unit:** Developing large-scale capital-intensive energy and technology projects of strategic importance to MASDAR and the broader economic diversification of Abu Dhabi's economy. The unit is actively 'kick-starting' new industries in renewable energy via Abu Dhabi-based production ventures and international acquisitions. Priority sectors include polysilicon, photovoltaics, hydrogen power, energy storage and biofuels.

(b) Development Scope

The MASDAR Initiative aims to play a unique role in that evolution – representing a leading Middle Eastern oil-producing nation that is proactively engaging the world's best minds and organizations to envision a cleaner, more sustainable future. The initiative embraces a spirit of purpose and focus. Through extensive series of meaningful achievements, MASDAR aims to make an enduring impact on Abu Dhabi, the region and the global community. By providing the leadership, platform and resources to create new ideas, breakthrough technologies and the commercial basis for their widespread adoption, MASDAR will also demonstrate Abu Dhabi's continued contribution to the global community. Through MASDAR, the global community is invited to participate in the collective search for creative solutions to some of humankind's most pressing concerns: energy, the environment, and the sustainable use of vital natural resources. (MASDAR, 2007e)

(c) Decision Making

According to the development framework structure, it includes all the levels of development at the national and local levels in the UAE and Abu Dhabi. This includes the political, financial, industrial and educational levels. Therefore, the development process of MASDAR city is done within a set of regulations. In addition, this gives the final structure of the development framework the power of decision-making.

(d) Institutional Role

From the beginning of the project of MASDAR, The authorities of Abu Dhabi and the UAE have designed the process of development of MASDAR city through a set of institutional frameworks. At every stage of the development process, these Institutional frameworks have their role.

For example, the project is supported from the authority of Abu Dhabi and the UAE , and the complete project is being driven by a special institutional framework "the Abu Dhabi Future Energy Company (ADFEC)", a company wholly-owned by the government of Abu Dhabi through Mubadala Development Company. This institutional framework is responsible of all the stages of development, and it arranges all the relations with all the other institutional frameworks involve in the process of development at the national and international levels. (MASDAR, 2007u)

After completing the process of development of the city of MASDAR, a new set of institutional frameworks will play the main role to continue the process of UIPV development in the Abu Dhabi and in the UAE generally. These institutional frameworks are the MASDAR initiatives.

5.3.2.2. Policies and Strategies

MASDAR Development is a part of national strategy in the UAE includes 16 primary initiatives, in addition to 25 secondary ones, adding that all the initiatives aim at adopting the best energy policy, the best water consumption practices and the best way to uplift the performance of this vital sector. (UAE Interact, 2007)

As a result, MASDAR is a strategic initiative with four primary objectives. The first is to help driving the economic diversification of Abu Dhabi. The second is to maintain, and later expand, Abu Dhabi's position in evolving global energy markets. The third is to position their country as a developer of technology, and not simply an importer. The fourth is to make a meaningful contribution towards sustainable human development. (MASDAR, 2007d)

Therefore, the “MASDAR” Initiative focuses on the development and commercialization of advanced and innovative technologies in renewable energy, energy efficiency, carbon management and monetization, water usage and desaltation. It will be based on the following four elements: (MASDAR, 2007s)

- An innovation center to support the demonstration, commercialization and adoption of sustainable energy technologies,
- A world-class university offering specialist graduate programs in renewable energy and sustainability, in partnership with leading international universities and research institutes,

- A specialized development company focused on the commercialization of emissions reduction, and clean development mechanism solutions as provided by the Kyoto protocol on climate change,
- A special economic zone tailored to hosting institutions, which will invest in development and production of renewable energy technologies and products.

Regarding initiative with four primary objectives and its elements, the project and the MASDAR Initiative, will represent four directions policies. These policies will cover not only the urban sides of development, but they will cover all the other aspects of an UIPV development process.

5.3.2.3. Planning & Development Level

According to Foster & Partners (2007), MASDAR Development is a new 6 million square meter sustainable development that uses the traditional planning principles of a walled city, together with existing technologies, to achieve a zero carbon and zero waste community. Also, according to MASDAR (MASDAR, 2007n), it will be a living example of sustainable development. The MASDAR city will combine the talent, expertise and resources to enable the technological breakthroughs necessary for truly sustainable development. The city will provide up to 1,500 companies with an attractive package of incentives, including a one-stop-shop program of government services, transparent laws,100% foreign ownership, tax-free environment, intellectual property protection and proximity to nearby manufactures, suppliers and markets. (MASDAR, 2007n) Therefore, by establishing sustainable local PV manufacturing capacity, Abu Dhabi is leveraging its financial and human resources effectively into the high tech., highly skilled industries of the future. (MASDAR, 2007p)

In addition, it is an ambitious project that will attract the highest levels of international expertise and commerce, and it providing a mixed-use high-density city. This is through the development programmes that include a new university, the Headquarters for Abu Dhabi's Future Energy Company, special economic zones, and an Innovation Center.

From another point of view, Abu Dhabi and the UAE have begun to raise the awareness of their citizens and modifying the educational systems in order to make the term "Renewable Energy" a familiar part of their live.

Fig. 5-13: The MASDAR Development, the urban context, a high density urban context.

Source: WSP, 2007.

Fig. 5-14: The MASDAR Development, using wind power parallel to the PV.

Source: MASDAR, 2007u.

5.3.2.4. Building Level

(a) Energy Technologies

The project try to make a model for the city that use many parallel PV system types at the same time. They including centralized PV grid-connected power stations, grid-connected building integrating PV systems, and stand-alone non-structural PV systems for the elements of the urban space. In addition, the project registers a smart strategy depending on set of other renewable energy resources besides the intensive use of PV including wind energy power station, and biomass energy (as a tool to wangle wastes of the city.). Therefore, the energy strategy of the project is considered as a complete heat and power generation strategy depending on PV and other renewable energy resources.

Fig. 5-15: The MASDAR Development, the interior of commercial building with PV Atrium.

Source: MASDAR, 2007.

(b) BIPV: Integration Concepts and Building Types

In order to maximize the power generation form PV, PV is used as a basic element for the design process. PV will be integrated into all building types of the project. In addition, it will be used intensively at the level of urban design as tool for shading.

(c) BIPV and Environmental Strategies

Though the key concept of using PV is to achieve the self-dependent community that produce its demand of energy, PV is used in the MASDAR Development as an environmental strategy to provide inhabitants of the city a comfortable environment in an arid region community. This is through readapting the traditional treatments used in designing arid region by using new forms and design models with reference to PV applications.

Fig. 5-16 a&b : The MASDAR Development , applying the traditional concepts of traditional arid urban context, within new tech. models using PV Modules .

Source: MASDAR, 2007.

Fig. 5-17: The MASDAR Development, design of an urban space.

Source: MASDAR, 2007.

Fig. 5-18: The MASDAR Development, an urban space with PV modules.

Source: MASDAR, 2007.

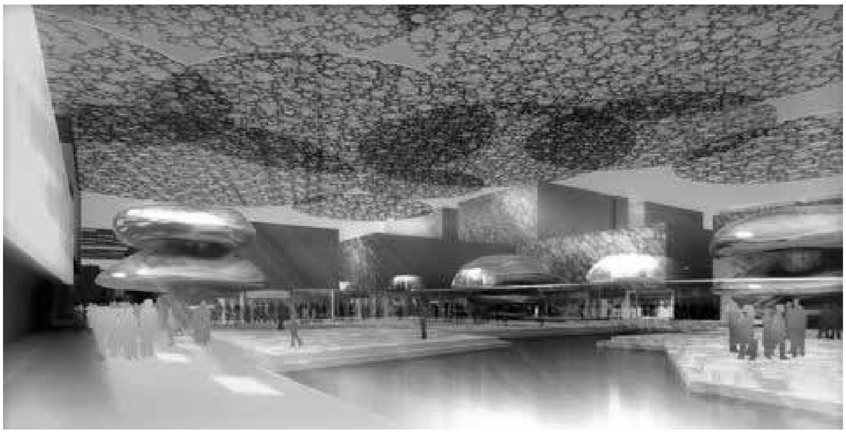


Fig. 5-19: The MASDAR Development, using new PV design concepts to provide shaded areas.

Source: MASDAR, 2007.

5.3.2.5. Discussion: The UIPV Development Model of MASDAR

MASDAR city is developed to be the prototype of the UIPV for the arid regions communities. Reviewing the previous analysis of the project with reference to the elements of the UIPV development model supposed by the study, it is clear that the process of development of the project represent a complete UIPV model. However, the project is only in the beginning phases, and though the fact that the UAE experience is not complete yet, Abu Dhabi and the UAE have succeeded in building their capacities in this field. This is in two stages. At the first stage, the UIPV development model is depending on the full co-operation with the most powerful experiences and capacities worldwide in order to build the local capacities that will take place in the second stage.

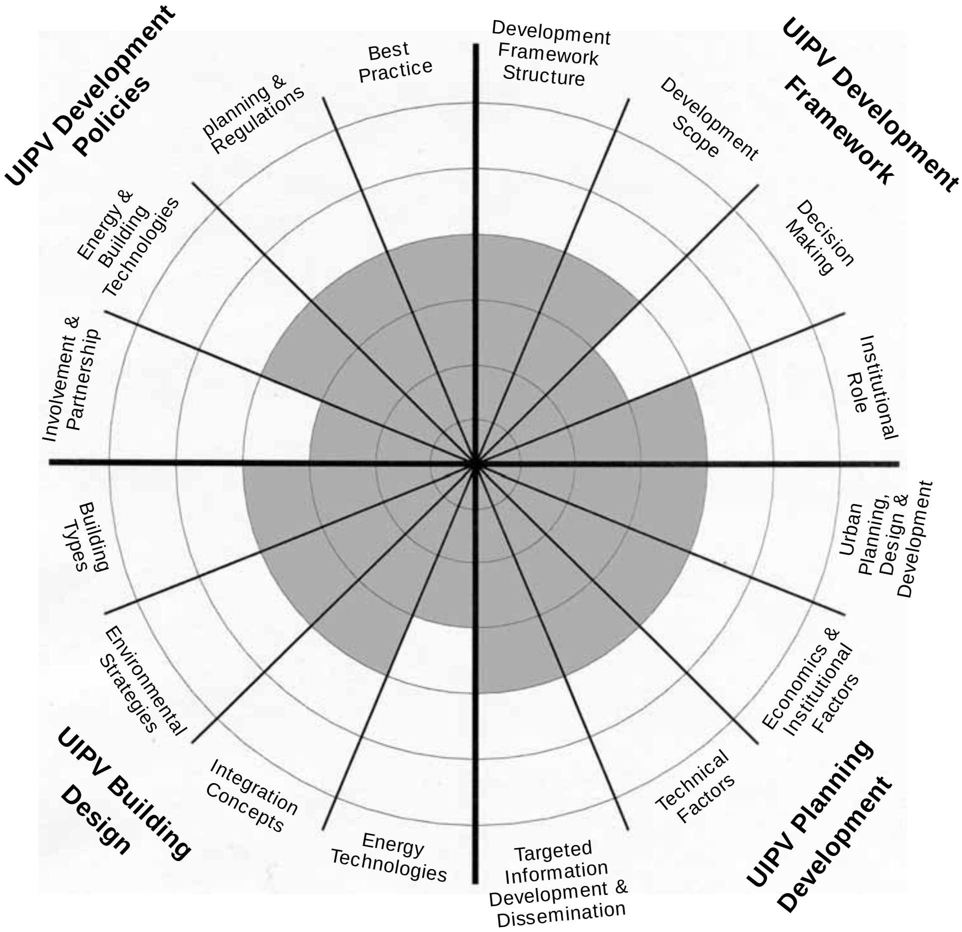


Fig. 5-20: The MASDAR Development , the UIPV development model of MASDAR.

Source: The researcher

In this manner, a complete development framework is being established with clear development scope and has the power of decision making that strengthens the institutional role of the participating bodies in the UIPV development process. This is sustained with a set of development policies, which includes all sectors, rather than the urban development sectors alone. These policies, also, linked the actors of the UIPV development not only at level of the project, but also at the levels of local and national levels. At the level of UIPV planning, MASDAR tries through establishing a set of new institutes, industrial projects, international co-operation…etc. to build a new strong economy sector that will sustain a continuous UIPV development process. At the same time, it sets up new urban and design models that suites the local development constraints. Also, new reforms have been taken at the level of education and awareness programmes to cover all stages of the educational system. At the level of UIPV building design, the MASDAR development will provide new models for the arid region's building that respects the restrictions of the environment, and at the same time integrates the high PV technologies.

In conclusion, the MASDAR Development can be considered as a model for building an arid community within the frame and environmental aspects of urban planning and building design of the traditional arid region community, but with a new set of models that gives it the ability to integrate the new PV technologies.

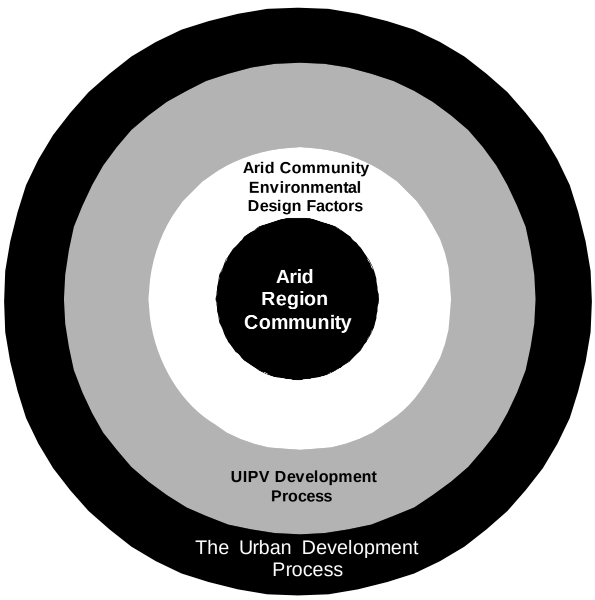


Fig. 5-21 : The MASDAR Development , the environmental concept of MASDAR, using PV tech. as tool to create new traditional designs integrated PV.
Source: The researcher

5.4. Conclusion

The case of MASDAR Development, which is the first complete UIPV development in the arid regions, gives a good example in this field. By analyzing this case using the UIPV development model, and comparing it with the model of the case of the OECD countries, it was clear that UIPV could be a suitable development approach for communities of arid regions. In conclusion, the MASDAR development can be considered as a model for building an arid community within the frame of the environmental aspects of urban planning and building design in traditional arid region community, but with a new set of models that gives it the ability to integrate the new PV technologies.

Therefore, developing arid regions communities from the view of renewable energy integrated approach, demands urban development policies that integrate all actors in one developing process, which means that the role of urban planner and building designer should be reviewed with reference to roles of the other actors. In addition, the UIPV development approach can be a suitable approach for sustainable urban development in arid region. It will help developing these regions communities not only at the urban level, but it will affect also all the other development levels specially the economical and environmental levels. In addition, it will give the urban planner and building designer a creative tool by gathering the traditional principles of arid regions urban planning & development, and the new energy technologies applications into new arid region communities' urban models and design solutions.

Egyptian Arid Regions Communities and Renewable Energy: An Approach for Sustainable Urban Development

Chapter 6

This chapter discusses renewable energy development and particularly PV as an approach for urban development for the Egyptian hot arid region communities. This is through using the UIPV development model that has been developed in chapter 4. The study will give an analysis for one of the current innovations, which are theoretically involved in developing new urban communities in the Egyptian hot arid regions, and consider the role of renewable energy in the process of urban development. Also, the study represents a comparison between the case of Egypt and the other two cases that have been discussed in chapter 4 and 5, in order to find out the obstacles facing the development process of UIPV in Egypt.

6.1. Renewable Energy in Egypt

6.1.1. Egypt and Energy Problems

According to Antipolis (2007, p4), the energy sector is playing a vital role in Egypt's economy. However, the Egyptian government currently faces a real challenge to make a strategic choice between satisfying the over increasing national primary energy demand (depending on more than 94% oil and gas), which is being offered to end-users with subsidized prices, and maintaining a certain level of hard currency revenues from oil and gas exports at world prices, even with a growing risk of accelerated depletion rates of national proven reserves. Thus, according to the estimations of different studies, it is expected that if current practices in the energy sector will continue as it is, Egypt will become a net oil importer during the near future. This tendency if continues should certainly lead to a non-sustainable energy future that government and citizens should work hand in hand from now to avoid its occurrence. (See 2.1.3.2. and Fig 2-15)

In this realm, securing energy demand on continuous bases is a vital element for sustained development plans. In view of the limited fossil fuel reserves, the depleted nature of the fossil fuel, the growing concerns about the pollution from the conventional power plants and their negative impacts on the environment, Egypt has given due consideration to the promotion of its indigenous renewable energy resources mainly solar, wind and biomass. (Aboulnasr, 2002, p.1) Therefore, “it was a strategic orientation for the electricity and power sector strategy to develop usages of new and renewable power sources and reinforce local capabilities to produce, develop and utilize new and renewable energy equipment in various applications” (SIS, 1999:Energy section). This orientation comes also in the document of “Egypt and the 21st Century” as a tool for protecting the Egyptian environment through using clean technology, clean energy and recycling resource (SIS, 1999: Environment section).

6.1.2. Renewable Energy Resources in Egypt

(a) Solar Energy Resources

As the average estimations have showed, Egypt has an annual average of 9 to 11 of sunshine hours /day and with high averages of global solar radiation (see Fig.2-27 & Fig. 2-28). Generally, Egypt enjoys an abundance of solar energy. The average annual Egyptian direct radiation varies between 1,900 and 2,600 kWh/m^2/year, it varies from the northern to the southern solar radiation from 1,970 to 3,200 kWh/m^2/year. The total sunshine varies from 3,200 to 3,600 hours per year.

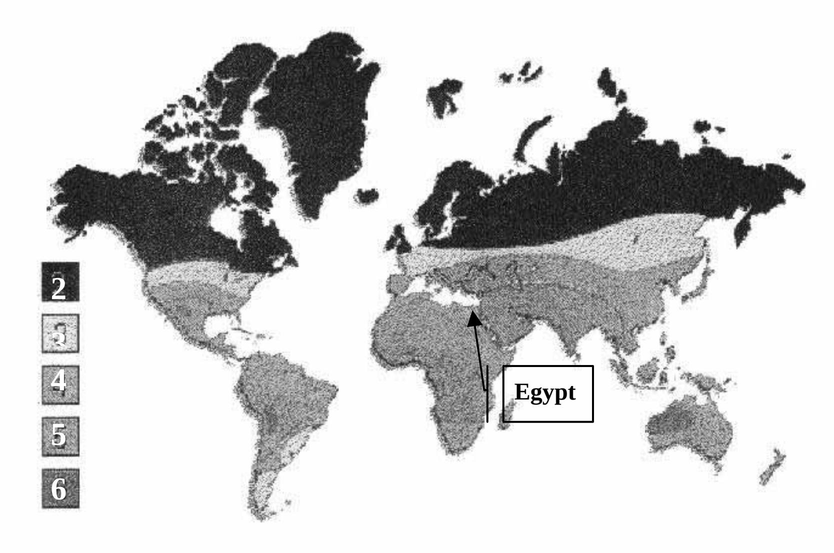


Fig. 6-1: The world global solar radiation map (Kilowatt/ m^2 /day)

Source: NREA, unpublished paper

(b) Wind Energy Resources

Egypt has a good range of the high winds, particularly on the Red Sea coast, where the annual average wind speed at the Gulf of Suez coast is 10 meters / second. The Oweinat southern/western desert can be considered the area with the second strongest winds, with an average wind speed of around 7 meters / second. Lower utilizable wind speeds are recorded on the northern coasts and other areas.

Fig. 6-2: 225 MW wind farm at Zafarana:
The 1st stage consists of 105 turbines of Nordex N43, 600 kW each, 3 blades of 43m rotor diameter placed over a tubular tower of 40m height.

Source: NREA, 2006

(c) Biomass Resources

Biomass resources for both rural and urban areas have been the subjects of several studies. Over 20 million tons of agricultural residues are produced in Egypt annually in addition to very large quantities of urban wastes, which vary between 0.5 to 0.7 kg / capita / day, depending on the location and type of economic activity. Biogas from the sugar-cane industry and rice husks offers two important sources of energy for the processing industries. About 70 % of the estimated annual production of 3 million tons of biogas are used as fuel on the sugar production sites and 40,000 tons of rice husks are used off-site as fuel in-red brick making.

(d) Hydro Resources

Hydro resources have already been used in Egypt for water management and electricity generation. Four main large-scale plants were built with 2,805 MW capacities. They produced 19.6 % of the country's electric power generated in I997/98. Assessment studies have found that there are 19 feasible sites for the construction of mini and micro hydro systems along the banks of the River Nile. The water head varies between three and five meters in four sites, while the other sites have water heads of between 1.3 and 2.1 meters. The total estimated capacity for the mini-hydro plants to be installed would be 200 MW in 2005.

Fig. 6-3: The High Dam, Aswan. One of the main sources of energy in Egypt.

Source: Google Earth, 2007

(e) Other Resources

In addition, limited low-grade geothermal resources are present in Sinai and the southern Red Sea coasts. However, because of this low potential, geothermal energy is not included in the renewable energy plans for Egypt.

Table 6-1: Estimation of the used renewable energy resources in Egypt by year 2000.

Give estimation used renewable energies. * Year 2000 source NREA and NIP. **In 1000 T.O.E./Year. DWH= Domestic water heating. IPH= Industrial process heating. EG= Electricity generation. NA= not available.	Solar	Wind	Biomass	Geothermal	Small-hedro	Total
Estimation of the potential * **	DWH 250 IPH 650 EG 115	Pumping 15 EG 225	Rural 70 Urban 60	NA	NA	1385
%	18 47 8.3	1 16.3	5 4.4	-	-	
Total	73.3	17.3	9.4			100

Source: M. Karagioras, 1995.

6.1.3. Renewable Energy Development in Egypt
6.1.3.1. Development Strategies, Policies, Planning and Achievements:

In early 80's, while formulating the strategy of the Egyptian power sector, the planning for renewable energy was considered as an integral part of the national energy planning process. Therefore, the national strategy for the development of energy conservation measures and renewable energy applications was formulated in 1982 as an integral element of national energy planning. This strategy has been revised and updated in view of the projections for possible RE technologies/application options, financing sources and investment opportunities in this field. In addition, a set of policy issues and plans that directed towards encouraging development had been also adopted.(see Box 6-1)

Table 6-2 and 6-3 demonstrates the results and the future targets of this strategy at the level of thermal electricity generation and wind energy.

Table 6-2: Solar thermal electricity generation plan

5 Years Development Plans	Installed Capacity (Mw)			Cumulative Capacity (Mw)	Energy Generation Annual energy at the end of the period Twh/Year
	No. of Plants	Power Capacity (Mw)	Total Capacity (Mw)		
1997-2002	-	-	-	-	-
2002-2007	1	127	127	127	0.9
2007-2012	1	300	300	427	2.7

Source: Aboulnasr ,2002, p.7

Table 6-3: Wind farms planned installed capacities and electric energy generation

5 Years Development Plans	Installed Capacity (Mw)			Cumulative Capacity (Mw)	Energy Generation Annual energy at the end of the period Twh/Year
	Red Sea	East of Oweinat	Total Capacity		
1997-2002	68	—	68	68	0.26
2002-2007	347	50	397	465	1.75
2007-2012	90	—	90	555	2.1

Source: Aboulnasr ,2002, p.7

BOX 6-1 : Renewable Energy Development in Egypt .

Policy:
To achieve the strategic goals, and to satisfy the energy needs outlined in the country's development plans, the Government of Egypt adopted the following policy measures- in the middle of 1980s':

- To support renewable energy as an integral element within the energy mix of Egypt,
- To support and promote identification of energy conservation and efficiency improvement options, particularly in the industrial, electrical and domestic sectors,
- Identification of short and long-term programs for renewable energy development and utilization based on technologies that are approaching maturity, and have a wide-scale replication,
- Identification of appropriate mechanisms and formation of specialized bodies to implement effectively national plans in the field of renewable energy,
- Maximization of the utilization of renewable energy for electricity generation as appropriate and
- Adapting, to the extent possible, measures that can help the energy sector to reduce any negative environmental impact.

Strategy:
The national strategy targets are the following:

- To save 10 % of the projected energy consumption by year 2007 through the implementation of energy conservation measures and improvement of the efficiency of existing facilities,
- To develop renewable energy technologies to supply 3-5 % of national primary energy by year 2007, mainly from solar, wind and biomass applications. (Since hydropower resources are already utilized to supply about 23 percent of current electric energy consumption in Egypt, they are not taken into account in the renewable energy strategic objectives).
- Currently, the strategy targets to satisfy 3% of the peak load by R. E. sources by 2021/2022, with additional contributions in other energy applications.

Planning:
The strategy also called for the development of renewable energy resources through specific measures for development activities including:

- Intensifying research development, demonstration and testing of the different technologies,
- Transferring technology, developing local industry and applying mature technologies,
- Coordinating national efforts and actions towards the realization of the strategic objectives,
- Establishing testing and certification facilities and developing local standards and codes and
- Developing, promoting and educating through training and dissemination of information programs.

Source: After NREA, 2007 & ESCWA, 2000

6.1.3.2. Renewable Energy Development Framework

Egypt has an early start to consider the importance of renewable energy. Since 70's, different institutions and organizations have developed programs in this field. Such programs were coordinated through the RE supreme council.

In this realm, various programmes have been developed to achieve the national strategic goals, these programmes are coordinated through the specialized councils representing the different connected ministries and organizations, which provides an inventory of the major Egyptian institutions, and which are active in the field of renewable energy development. It can be noticed that they cover the whole spectrum of activities required for its promotion mainly as an energy development approach in order to cover resource assessment, research and development, renewable energy demonstration and field testing; commercial status, technology transfer and local manufacturing, field application of mature technologies, standards, testing , certification , education and training.

To support and enhance the institutional capabilities for renewable energy development and as a result of the growing interest and activities in this field, the New and Renewable Energy Authority (NREA) was established in Egypt in 1986 to provide a focal point for expanding efforts to develop and introduce renewable energy technologies in Egypt on a commercial scale, together with implementation of related energy conservation

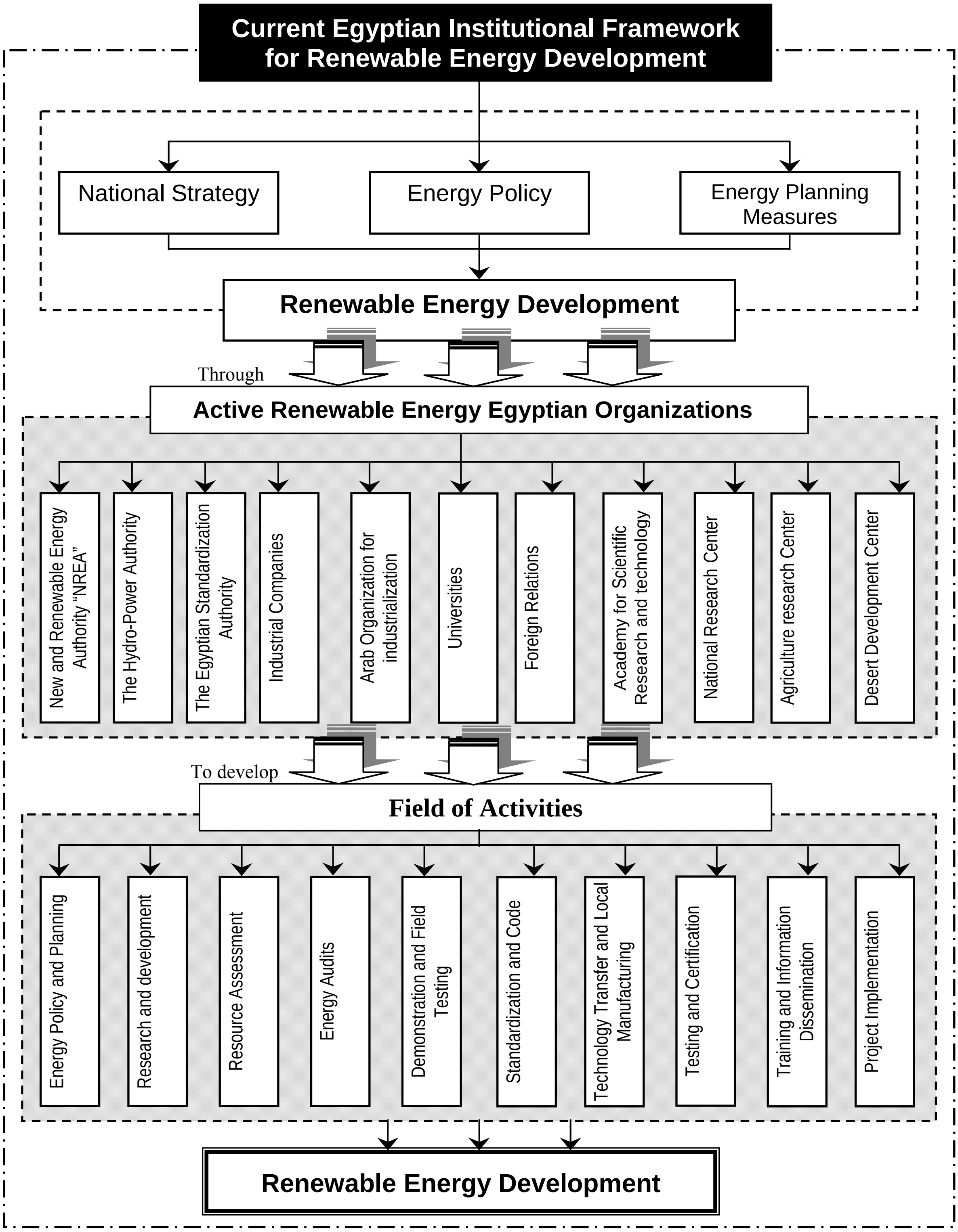
Fig. 6-4: New & Renewable Energy Authority (NREA), Cairo.

Source: NREA, 2006,p.6.

programmes (ESCWA, 2000, p.64). Thus, the NREA is responsible for planning and implementing renewable energy programmes in coordination with other concerned national and international institutions within the framework of its mandate.

Fig. 6-5: Summary of the current Egyptian institutional framework for renewable energy.

Source: Researcher (After ESCWA, 2000 p.p.62-65.)



6.2. PV in Egypt

6.2.1. PV Applications in Egypt

According to the investigations of the NREA(NREA, 2006), Aboulnasr (Aboulnasr, 2002,p.2) and many other studies, most of the Egyptian photovoltaic applications were demonstrated and field tested as water pumping, desalination, clinical refrigerators, village electrification... etc. Some applications including telecommunications and both remote desert roads lighting and billboards lighting on those roads as well as applications for use in remote desert small loads, are all already commercialized. It is estimated that the PV systems installed capacity is presently close to 5 MW peak in the country.

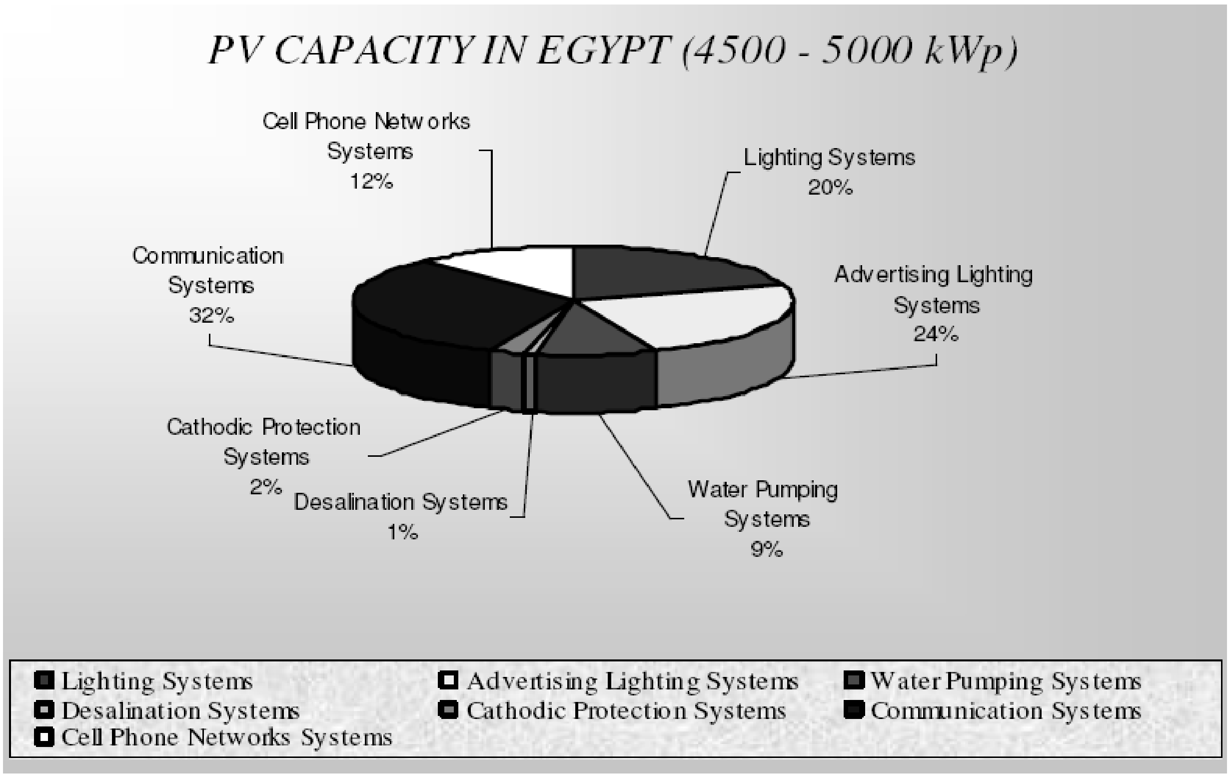
Fig. 6-6: Egypt, Using PV for street lighting and for sings.

Source: Fekry, 2006.

There are about seven companies working in the field of PV solar systems in Egypt, some of them working in PV modules assembly by production capacity 500 kWp/year. Recently, according to the NREA, the production capacity is almost stopped, due to import of complete systems including PV modules and other components from other countries.

Fig. 6-7: PV capacity in Egypt by sector.

Source: NREA, 2006, p.16.



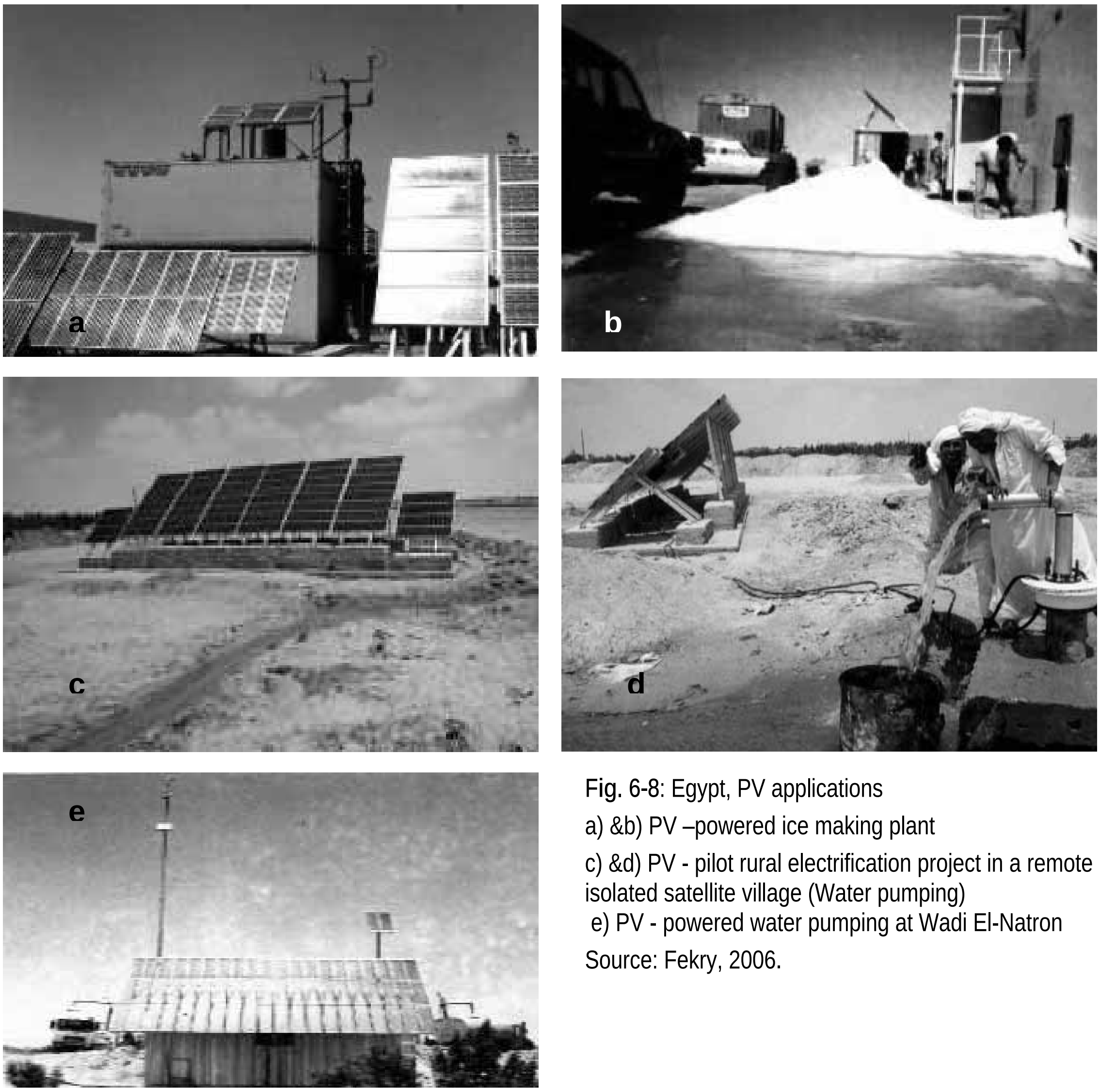


Fig. 6-8: Egypt, PV applications
a) &b) PV –powered ice making plant
c) &d) PV - pilot rural electrification project in a remote isolated satellite village (Water pumping)
e) PV - powered water pumping at Wadi El-Natron
Source: Fekry, 2006.

According to Ramadan (2007), the future prospect of PV projects in Egypt developed with supporting of the NREA including:

- About 121 rural villages are suitable for PV electrification due to the lack of access for lighting, potable water, medical centers and telecommunications.
- The estimated installed capacity is 1.2 MWp.
- Replacement of some diesel generators, which are working, only for 4-6 hours /day at night in some isolated areas.
- PV pumping systems can be used for irrigation in the desert areas far from the national grid.

6.2.2. Community-Integrated Renewable Energy in Egypt: A Historical Review

In the late of the 70s, the interest in renewable energy sources started with a promotion for replacing the depleting commercial sources but now the interest has taken a more important dimension that renewable energy sources are clean sources with no harmful effect on the environment. It had begun with small test field studies for the potential for practical use of PV in rural developments. Generally, according to El-Hefnawi (2005, pp.24-25), there are four main field studies addressing integrated approach to rural community development. They are; the Desert Development Center at Sadat City, Basaisa project in Al-Sharkiya Governorate, the project at Meet Abou-El Kom village in Al-Menoufia Governorate, and the pumping system at Nobareya. All of them have used photovoltaics but for with different applications within the community upgrading plans.

6.2.2.1. Desert Development Center

In 1981, two photovoltaic systems were installed with a capacity of a 10 kW peak system, which was necessary to power the center's headquarter building. The second was an AC submersible pump at Sadat City. In addition, a 3 kW peak DC system exclusively devoted to power a deep well pump as well as a booster pump for irrigation. The main objective of this case was to test these systems, monitor their performance, and demonstrate their feasibility as a major activity of the energy group of the Desert Development Center.

6.2.2.2. AUC-Basaisa Village Integrated Field Project

This case was an important case. This is because that it demonstrated the importance of the awareness of the community to accept the new technology. After a long discussion between the project team and village inhabitants in the common hall “Mandara” of the village, small PV systems were installed. The systems had included: light for training and education classes, TV for community club, radio recorder, slide projector, loudspeaker for the mosque, portable and fixed irrigation pumps, PV powered video training system and lately a medical refrigerator.

6.2.2.3. Meet Abou-El-Kom Village Project

This project was supported by president EL-Sadat in 1979 in order to upgrade his home village. The PV systems have included small PV applications; loudspeaker for the mosque 280 W peak, 1.47 kWp for two medical refrigerators in the village health clinic , and PV array (170 Wp) for colored TV in the youth club in the village.

6.2.2.4. Nobareya Pumping Project

It was a portable photovoltaic water pumping testing unit that has been installed at west Nobareya (about 130 km from Cairo) to drip irrigate an area of 3 feddans. The project was developed within the frame of the Egyptian-German cooperation (represented by the New and Renewable Energy Authority (NREA) and the “Deutsche Forschungsanstalt für Luft und Raumfahrt” (DLR)

6.2.2.5. The Actual Vision

Though all of pervious projects were developed with support of various institutes as the Desert Development Center, the American University in Cairo (AUC), the National Research Center (NRC), and countries such as Germany, all of them was directed to upgrade existing communities. Now after the economical changes, and the actual situation of the national and international energy demand, new directions have started in Egypt in order to maximize the role that PV can play in the process of urban development, specially for the new arid and extremely arid Egyptian communities that will be developed in the desert according to the new Egyptian development map (see Fig 6-9).

In this realm, the Egyptian authorities have decided to make a contribution of this vision within the development of the region of Toshka and its new communities. This is as a tool to create a new set of self-dependent communities in the field of energy, and to use the potentials of these regions of solar radiations.

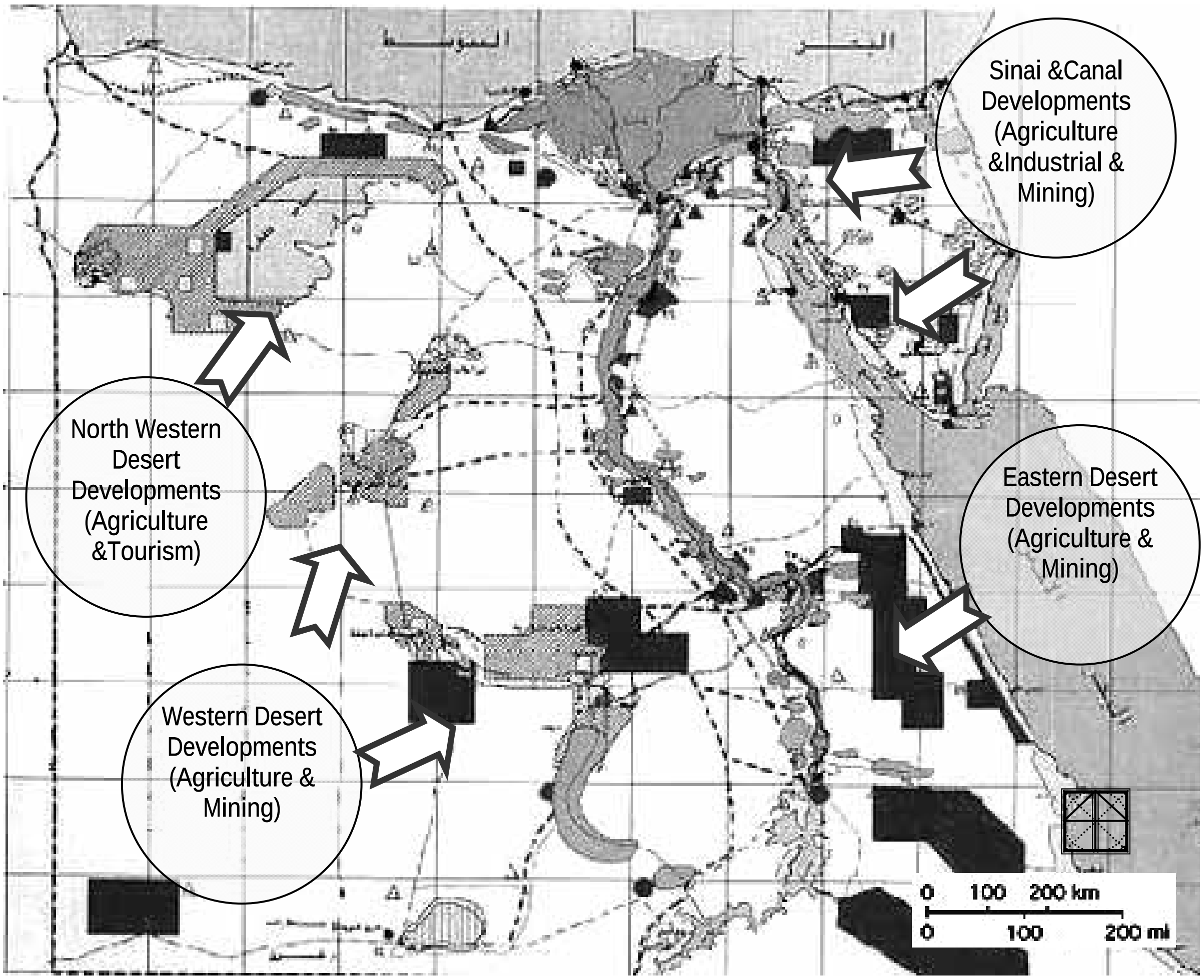


Fig. 6-9: Egypt 2017, according to the new development map and directions

Source: Researcher after SIS, 1997a.

6.3. PV and New Arid Regions Communities in Egypt: Toshka New Urban Communities

6.3.1. Introduction

Toshka is a part from a governmental program known as “Egypt’s mega-projects”, which are developed by the Mega-Projects Ministerial Committee that was formed to oversee the increase of habitable land from 5 % to 25 % of the country’s total area by 2017.

The Toshka project is an ambitious project to create a second Nile Valley, redirecting 10% of the country's allotment of water from the Nile via a massive irrigation scheme. Thus, “Toshka and the Southern Egypt Development Project” aims at developing and extending agricultural production, creating new jobs and population centers away from the narrow confines of the Nile Valley. Therefore, it has been called, also, "Egypt's hope for the 21st century", but installing modern irrigation systems on such a scale is costly and takes time. Inevitably, funding constraints have had an effect over the years, though at the end of June 2005, 90% of the project infrastructure was described as completed.

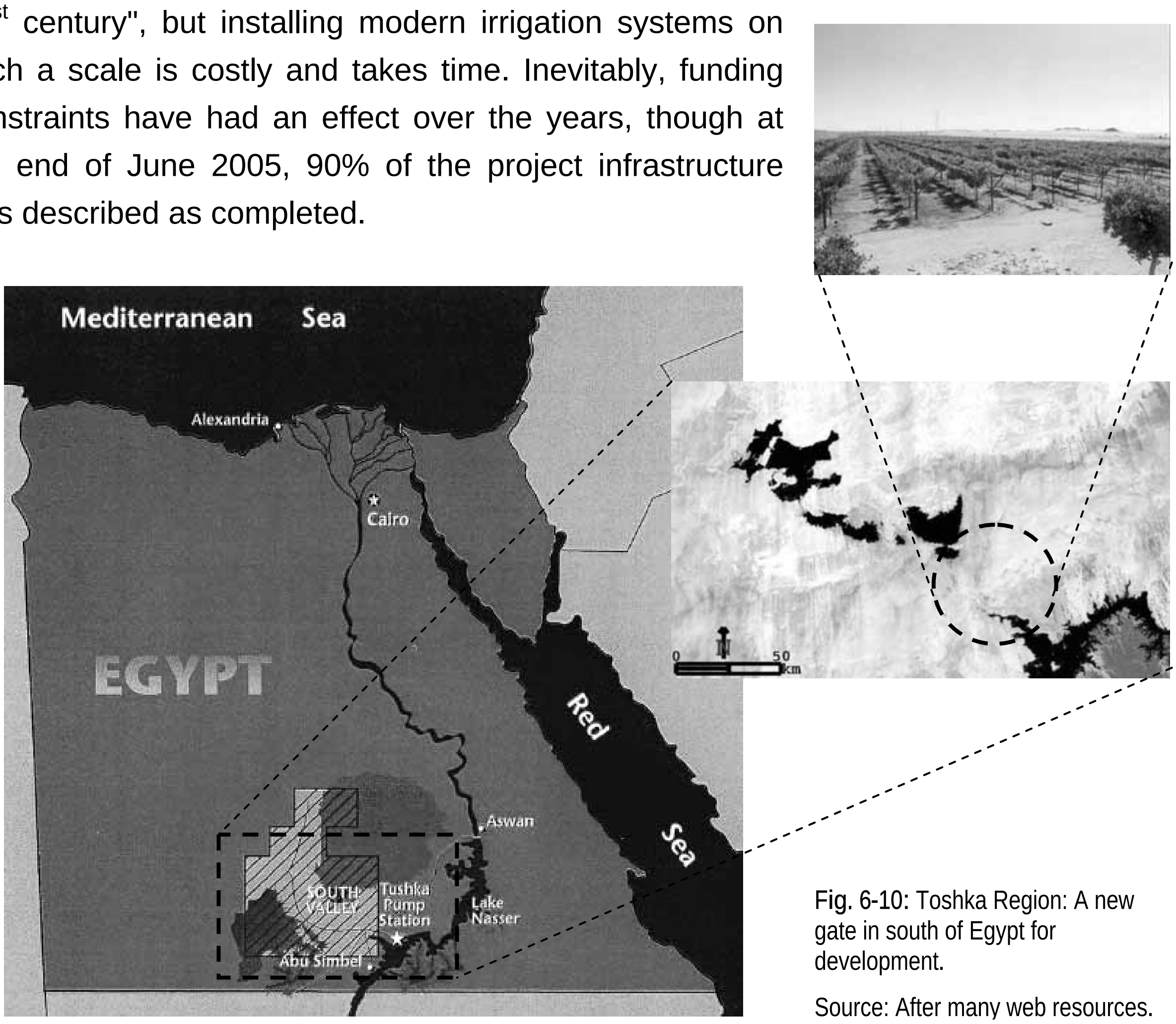


Fig. 6-10: Toshka Region: A new gate in south of Egypt for development.

Source: After many web resources.

BOX 6-2: Toshka Project : Definitions .

The Toshka Project: is an integral part of a much larger, mega project, the Southern Valley Development Project (SVDP), that aims at doubling the amount of cultivated land in Upper Egypt through developing the Toshka, East El-owenat, and the New Valley Oases (Ministry of Water Resources and Irrigation, 2000).

The Toshka Region: is located southwest of Aswan, about 1000 Km south of Cairo.

Toshka City: is a new metropolitan city that is planned to serve a future population of 5 million.

Toshka Depression: is a natural depression in that area with an average diameter of 14 miles and a storage capacity of 1,665 billion ft^3. Toshka Bay is a shoot off Lake Nasser towards Toshka.

Toshka Spillway: is a free spillway discharging the water of Lake Nasser when it exceeds its highest storage level of 620 ft. It is a 14-mile long, manmade canal connecting Toshka Bay with the Toshka Depression and works as a safety valve for Lake Nasser, upstream of the High Dam.

Toshka Canal: is the heart and soul of the Toshka Project. It is a new canal conveying the excess water of Lake Nasser that is pumped into it through a giant pumping station that elevates the water about 175 ft. The water then flows through the canal to reclaim and irrigate 534,000 new acres in the western desert of Egypt.

Source: El-Hag-Gar, 2001.
Map: NASA, 2005.

6.3.2. Project Characters

6.3.2.1. Location

The Toshka Region is located southwest of Aswan, about 1000 Km south of Cairo. Toshka Depression is a natural depression in that area with an average diameter of 14 miles and a storage capacity of 1,665 billion ft^3.

Fig. 6-11: The location of Toshka Region.

Source: After USA.gov, n.d..

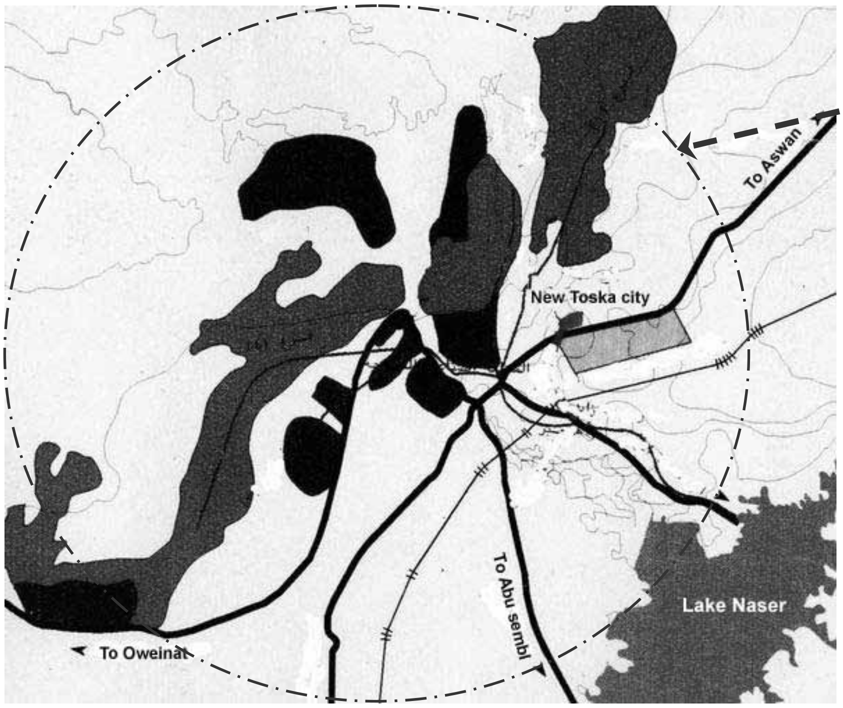


Fig. 6-12: The location of New Toshka City.

Source: After Ebadah, 1999.

6.3.2.2. The Project Objectives

The main objectives of the project are: adding new areas of agricultural land lying in the Southern Valley region that will help establishing new agricultural and industrial communities based on exploiting the agricultural raw material available in the new land, attracting and retaining a workforce, dealing with the problem of overpopulation in the old Nile Valley, building an efficient network of main and side roads in accordance with the development objectives and plans, and promoting tourism activities in such regions rich in ancient monuments. (Wahby, 2004). This is as a result for a comprehensive study that was conducted over an 8 million feddans revealing the following; 510,000 feddans were graded

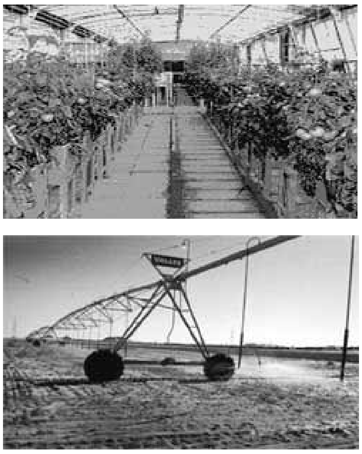


Fig. 6-13: The agriculture development in Toshka Region.

Source: Ministry of Irrigation, 2008.

class 1 for agriculture activities, the total arable land in the Western Desert is nearly 7.5 million feddans, and the total underground water ranges between 3.5 and 4.0 billion cubic meters/year.

BOX 6-3 : Toshka project objectives .

- Add 54.000 acres of arable land through irrigation by the new canal
- Create a base for the integrated development of the surrounding area
- Build sustainable communities to accommodate some 2 million people by 2037
- Establish livestock, poultry, and fish breeding projects to meet local and export demands
- Enhance agro-industrial activities
- Construct or upgrade transportation systems: road, rail, air, and water
- Develop tourist sites
- Extract metals and minerals following a carefully designed ecological plan
- Expand oil exploration
- Capitalize on availability of renewable energy

Source: Wahby, 2004.

6.3.2.3. The Project History

The Toshka project was officially opened at a ceremony on Jan. 9, 1997, it is also called the “New Delta" project. Similar plans for a “New Valley" were put forward in the recent past at the 1960s. Development of western desert oases has been backed, based on drawing water from the Nubian aquifers. These are the same types of water deposits lying beneath the Sahara, which are being trapped for the source of Libya's Great Man-Made River Project.

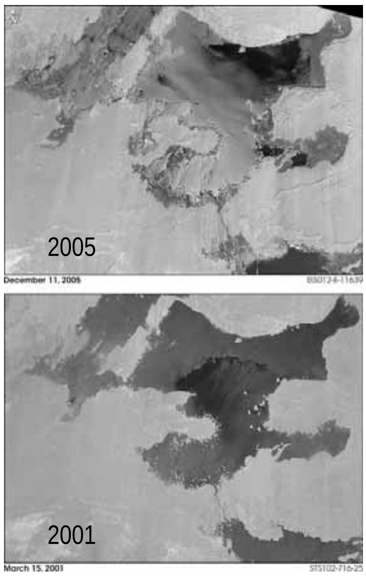


Fig. 6-14: Toshka lakes in 2001 and 2005. They deepening on the over flow water from Lake Nasser.

Source: NASA, 2005

In the 1970s, president Anwar Sadat's administration backed the idea of permanently filling the Toshka Depression, which is designed to take the over flow from

Lake Nasser, and build a canal to irrigate projects in the New Valley. The first time the Toshka overflow canal, which was completed in 1978, came into use, was on 6 Oct. 1996, when the level of Lake Nasser, behind the Aswan Dam, reached the record high of 178.10 meters above sea level.

Now, with the new Toshka Project, the government plans to take some 5 billion cubic meters of water out of Lake Nasser yearly. Under the terms of the 1959 Nile-water sharing agreement with Sudan, in which Egypt's annual entitlement is 55.5 billion cubic meters, Egypt would then offset the Lake Nasser withdrawals by limiting use elsewhere, which the government has said that it can be done by several means, including recycling treated wastewater, and improving agricultural methods in the Delta.

6.3.2.4. Components of the Project

***Mubarak Pumping Station*.** The Mubarak Pumping Station is situated adjacent to Lake Nasser and has a discharge capacity of 1.2 million m³/hr. Its innovative design places the pump-house like an island in a lake - completely surrounded by water with 24 vertical pumps arranged in two parallel lines along both sides.

Fig. 6-15: Mubarak Pumping Station

Source: Tvedt,2008.

Sheikh Zayed Canal. Forming the second key element of the project, the canal was named in recognition of the $100 million donation to the project, made through the Abu Dhabi development fund, by the United Arab Emirates. The decision to use a canal rather than a pipeline appears to have been driven by the volume of water involved, though obviously this has ramifications regarding loss by evaporation, particularly in the region's hot summer. Seepage loss has been addressed by lining the canal with layers of cement and sand, concrete and polymer sheeting with a final coat of protective paint.

Fig. 6-16: Sheikh Zayed Canal

Source: Znined,2008.

4 Sub-canals. They are the main sub-irrigation-canals that carry the water from main canal (Sheikh Zayed

Canal) to the different development areas of the project with a total length of about 200,000 Km. They serve about 120,000 Feddans of agriculture lands (Fig. 6-17).

The Toshka Development Sub-regions. They are divided into four main strategic development sub-regions besides a fifth sub-region, the Eastern sub-region (Abo Simpl Region). They are including (Fig. 6-17):

- East northern sub-region (Al-Amal): 120,000 Feddans ,78,000 inhabitants
- Northern sub -region (Al-ragaa): 102,000 Fedden , 68,000 inhabitants
- West northern sub -region (Al-Monagah): 140,000 Feddans , 89,000 inhabitants
- Western sub-region (Al-Salam): 140,000 Feddans , 86,000 inhabitants

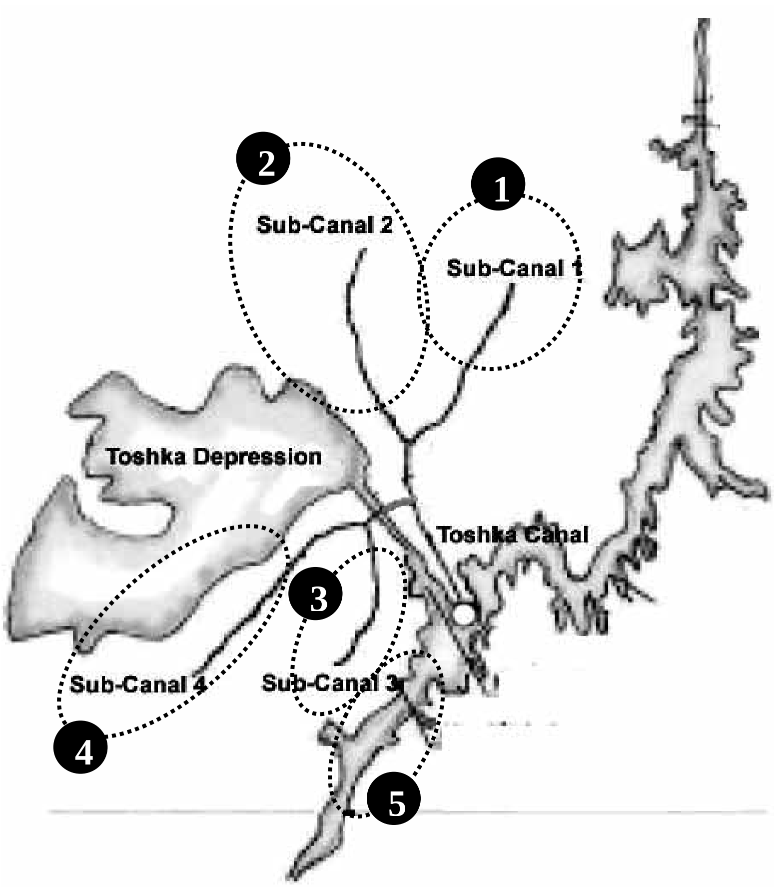


Fig. 6-17: Toshka Region: The sub canals and development regions.

1 - Al-Amal
2 - Al-ragaa
3 - Al-Monagah
4 - Al-Salam
5 – Abo Simbel

Source: Researcher

6.3.2.5. Urban Pattern

The idea of the project of Toshka is depending on creation of a set of communities with a hierarchal system and distribution. These communities are forming a connection network for a wide network of smaller agricultural centers. Therefore, the communities of Toshka region are divided into 4 levels.

- **Toshka City:** The capital, it acts as the administrational center of the Toshka region. It will contain all the central administrational, industrial and civil services that are needed for the region. It is supposed to accommodate about 80,000-100,000 inhabitants. It will also contain an airport. The city is also supposed to play an initial role connecting the development process of the region with the other components of the south Egypt development project.
- **4 Regional Services Centers:** They are the second level of communities. They are supposed to act as a sub-regional service centers for the Toshka region. Each community is supposed to accommodate 25,000-30,000 inhabitants.
- **6 Local Agriculture Industries Centers:** They are communities that will be developed to provide the secondary services for a smaller network of 6-8 small villages. It will act as a primary center for the agriculture Industries depending on the products of the small villages. Each community is supposed to accommodate 8,000-12,000 inhabitants.
- **48-52 Small Villages:** They are forming the basic units of the urban network of Toshka region. Each village will be a center for an agriculture area, and the distance between them will not exceed 6-10 Km. Each village will accommodate 3,000-4,000 inhabitants.

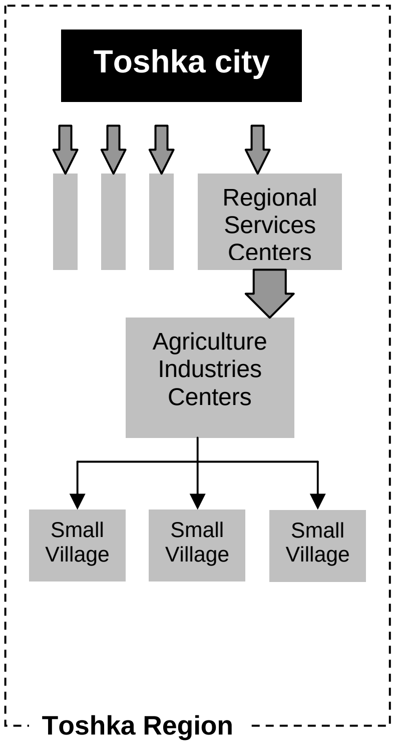


Fig. 6-18: Toshka Region. The urban communities' structure.

Source: Researcher

6.3.3. Toshka City Project

6.3.3.1. Introduction

The Toshka city is developed to become a center and the capital of the Toshka development region, and its four developing sub-regions.

The city is supposed to accommodate about 80,000-100,000 inhabitants in four phases:

- *1st phase (2007-2022).* It is the phase of the city construction and preparing. At the end of this phase, the population of the city is aimed to reach about 17,000 inhabitants.
- *2nd phase (2022-2032).* By the beginning of this phase, a great part of the economical base will be finished. This is including agriculture and industrial bases, and the city will be able to attract more people to move from the old valley. By the end of this phase, the population is supposed to be about 47,000 inhabitants.
- *3rd phase (2032-2037).* By the beginning of this phase, the demographical profile of the city will begin to be completed. Therefore, the development in this step will be concentrated to strengthen the services networks and to introduce more services opportunities. This is as a tool to support the migration to the city. At the end of this phase, the total population is supposed to be about 65,000 inhabitants.
- *4th phase (after 2037).* The city reaches a stable development stage and the population will increase normally.

6.3.3.2. Urban Development Process and Scope

The urban development process of this city has an initial role, because not only that New Toshka city is the capital of the region and it is supposed to be the central point of the main services of the region, but also, it is supposed to be the basic model for the further urban development in the region.

Therefore, the Egyptian authorities have defined the project of the New Toshka city as a keystone with a main objective to create a new urban community that respect the constraints of the region, as it is an arid region, and its climate and environmental conditions form the main factors, which affected it. In addition, the project should benefit from all the natural resources of the region, which are including the region capabilities of renewable energy.

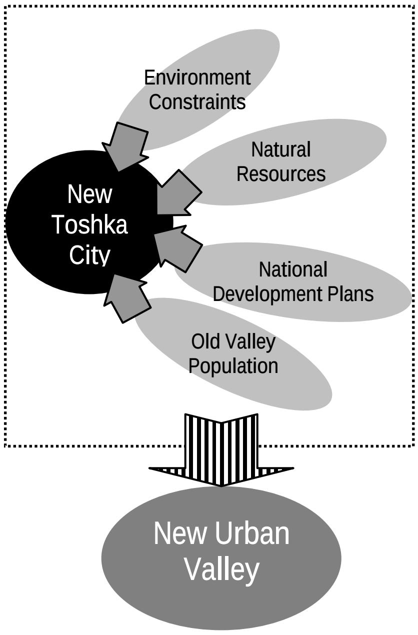


Fig. 6-19: Toshka City. Development Scope.

Source: Researcher

This was the development scope of the Egyptian authorities and development experts and many studies claimed that it should be considered through the process of development of the New Toshka city. Therefore, New Toshka city should be developed as an arid region community with a renewable energy integrating strategies.

6.3.3.3. The Project Stages

The development process of Toshka city can be divided into three stages. They are including; creating development concept, official planning and design, and constructing the city.

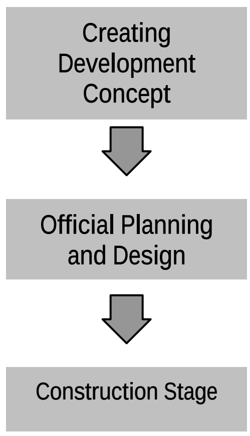


Fig. 6-20: Toshka City. The project stages.

Source: Researcher

(a) Creating Development Concept

It has begun at the 90s. The aim was to set up the main guidelines of the urban development of the city. This is through many efforts such as officially and individual studies, conferences,..etc. in addition to two design competitions**.**

These two design competitions can be considered the most important step in this stage. The first one was supported from the Egyptian New Urban Communities Authority (NUCA) and the second was supported by the council of energy development. The aim of both of them was to introduce a variety of new ideas and concepts for Toshka city to be a base for the Egyptian authorities in the second stage. Many Egyptian architects have participated, mostly young architects. However, according to the jury of the competitions, the results were not as hoped.

Most of the participated architects have focused only on creating an arid region community with respect to environmental and climate conditions. In addition, the juries have claimed that most of the participated projects were regenerated copies from the old models. Though most of the participated had underlined the importance of creating a self-dependent community using renewable energy e.g. PV, none of them has given a concept or a model for achieving this vision.

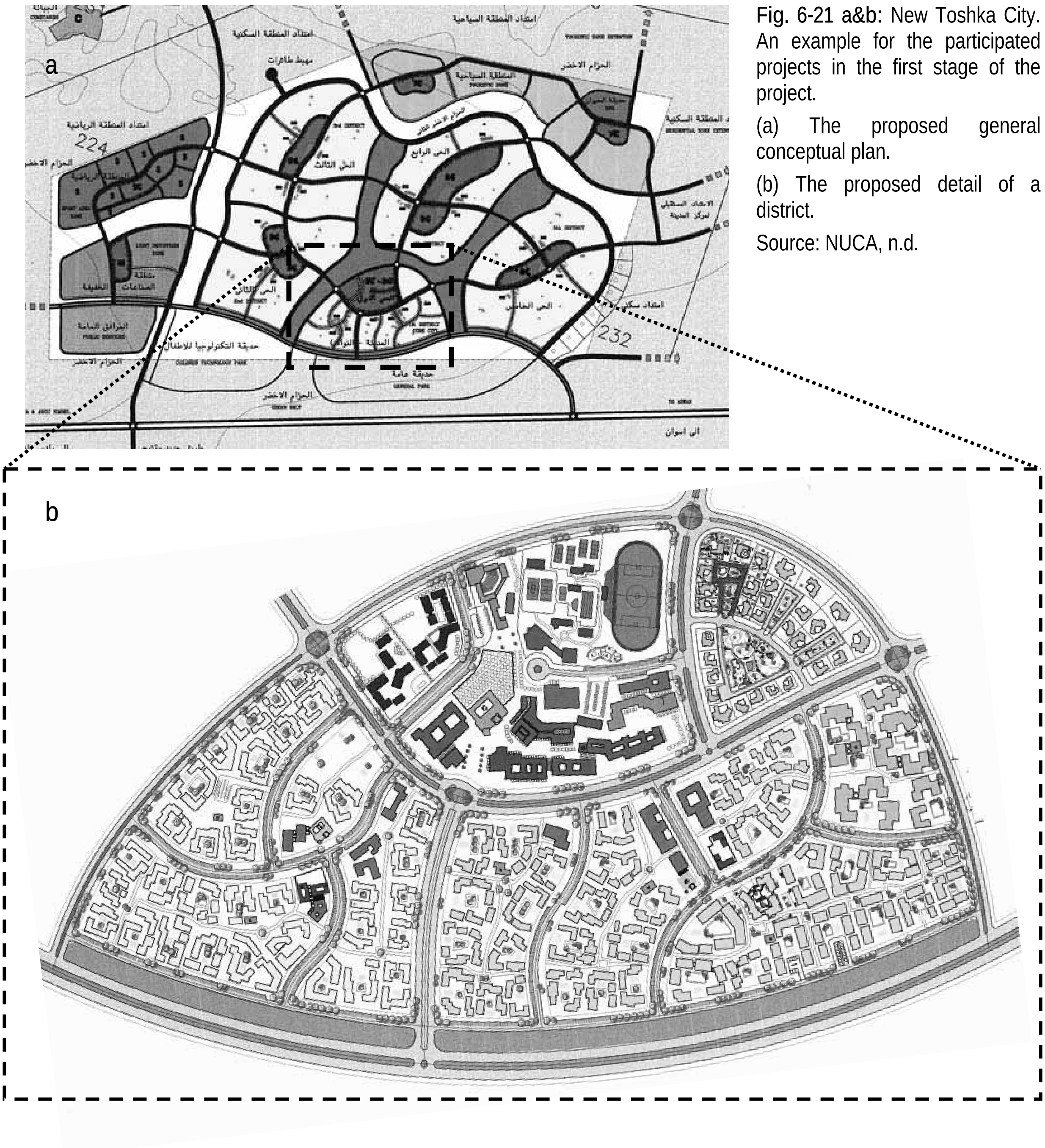
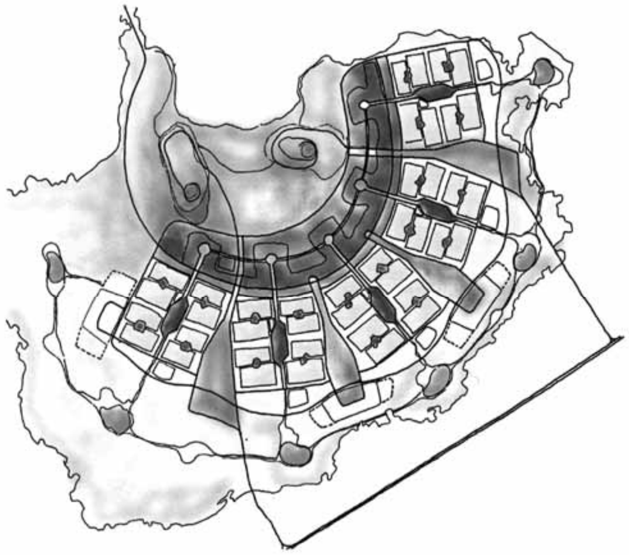


Fig. 6-21 a&b: New Toshka City. An example for the participated projects in the first stage of the project.

(a) The proposed general conceptual plan.

(b) The proposed detail of a district.

Source: NUCA, n.d.



(a) The proposed general conceptual plan.

Fig. 6-22 a&b&c: New Toshka City. An example for the participated projects in the first stage of the project.

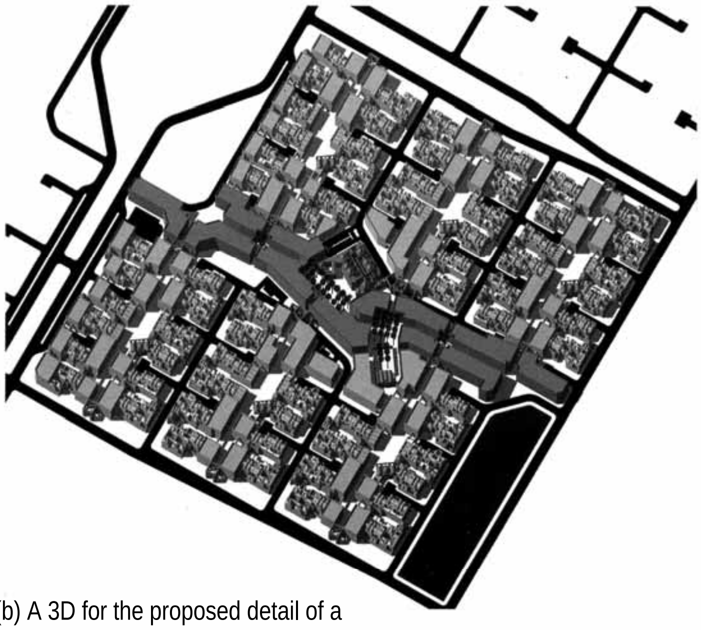
Depending on using traditional character and architectural elements.

(a) The proposed general conceptual plan.

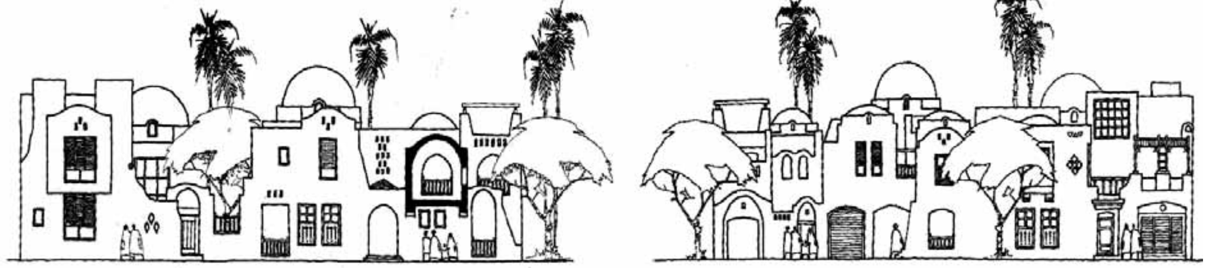
(b) The proposed detail of a district.

(c) Elevations.

Source: Ebadah, 1999, p.54



(b) A 3D for the proposed detail of a district.



(c) Elevations: Using of the traditional elements.

(b) Official Planning and Design

The project is now in this stage. The Egyptian general authority for urban planning and development is responsible to prepare the urban planning and design final concepts, plans, designs, and documents. The master plan has already finished, this is besides the basic studies including the city relations in the urban context of the Toshka region. However, due to many political and financial obstacles, this stage is temporary stopped. In addition, it is remarkable that the authority have depended mainly on the role of urban planners and architectural designers. This is through the normal urban planning process without considering how the renewable energy e.g. PV can be integrated in the future city. According to the authority, this will be discussed through the next stages of the project. However, the process of integrating renewable energy and PV will be so difficult. This is because of neglecting its role from the early stages of the city planning and design, which will affect the opportunities of PV integration.

(c) Construction Stage

As noted before, the process of construction of the new city is supposed to be divided into four phases and they will be continued tell 2037.

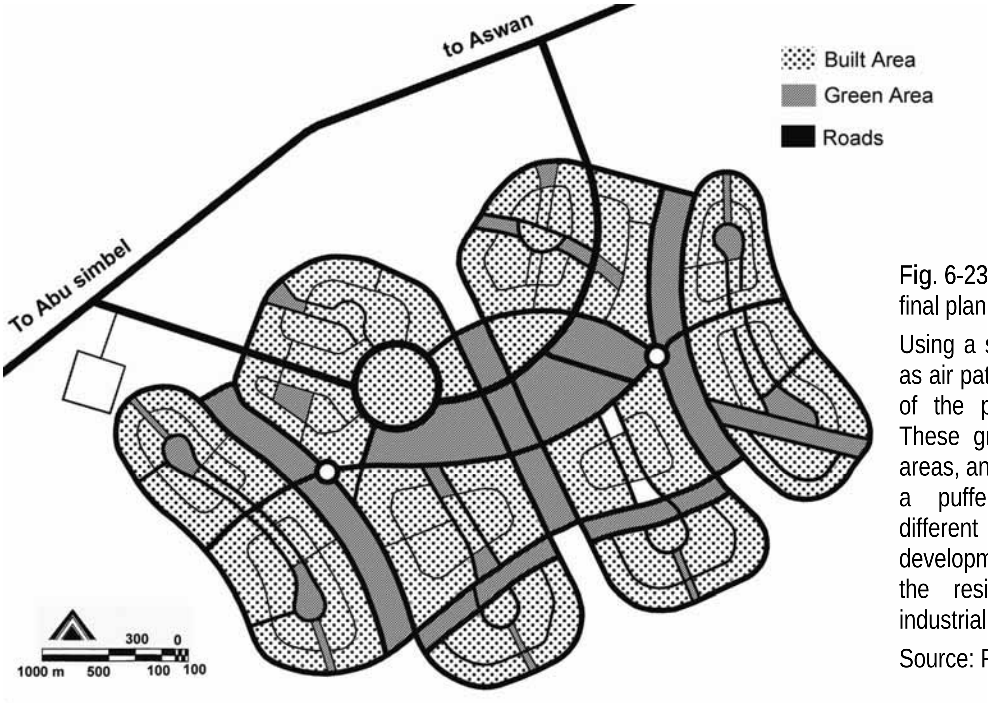


Fig. 6-23 : New Toshka City. The final planning concept.

Using a set of green areas at act as air paths to maximize the effect of the preferred air movement. These green sets hold the built areas, and at the same time act as a puffer zone between the different stages of the city development, and between both the residential and the industrial area.

Source: Researcher

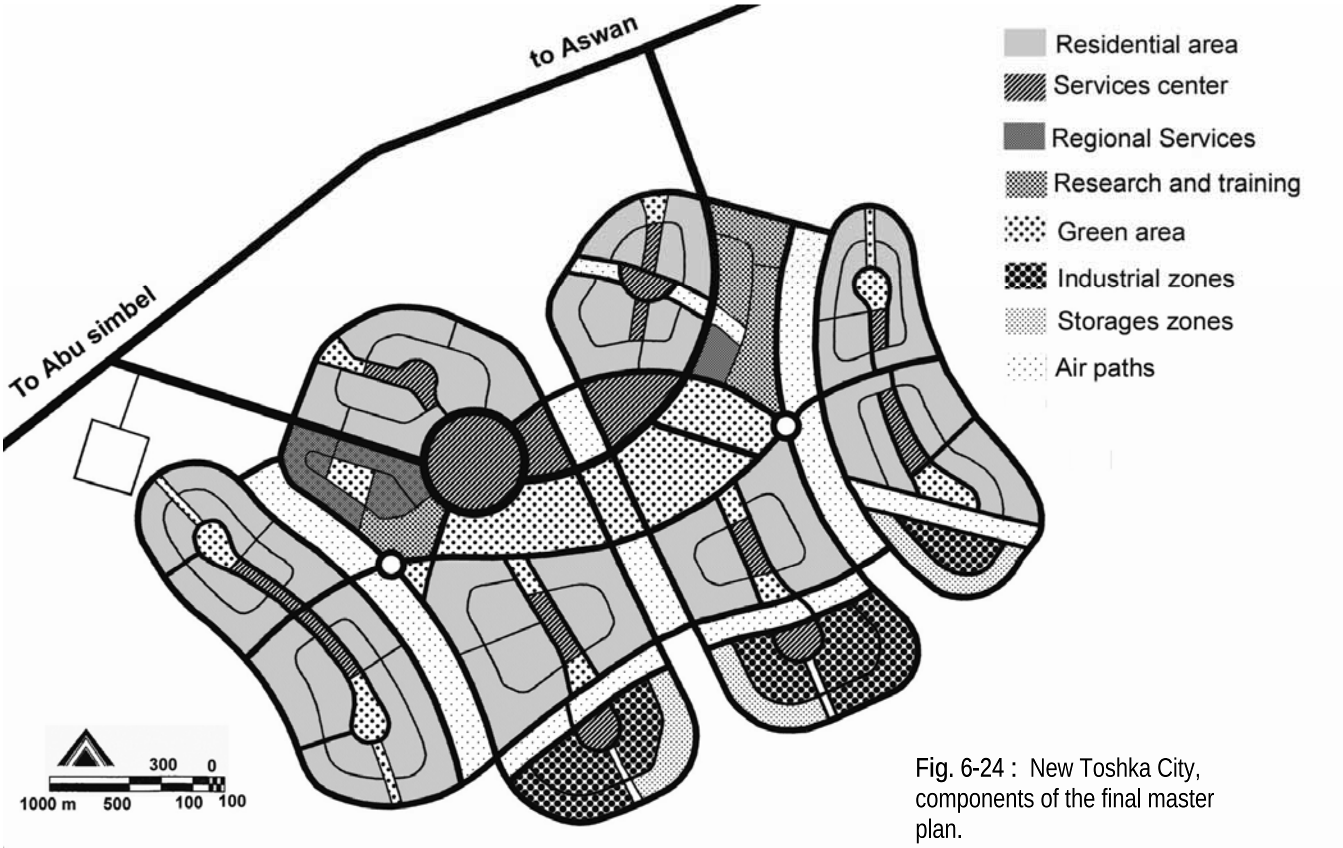


Fig. 6-24 : New Toshka City, components of the final master plan.

Source: Researcher

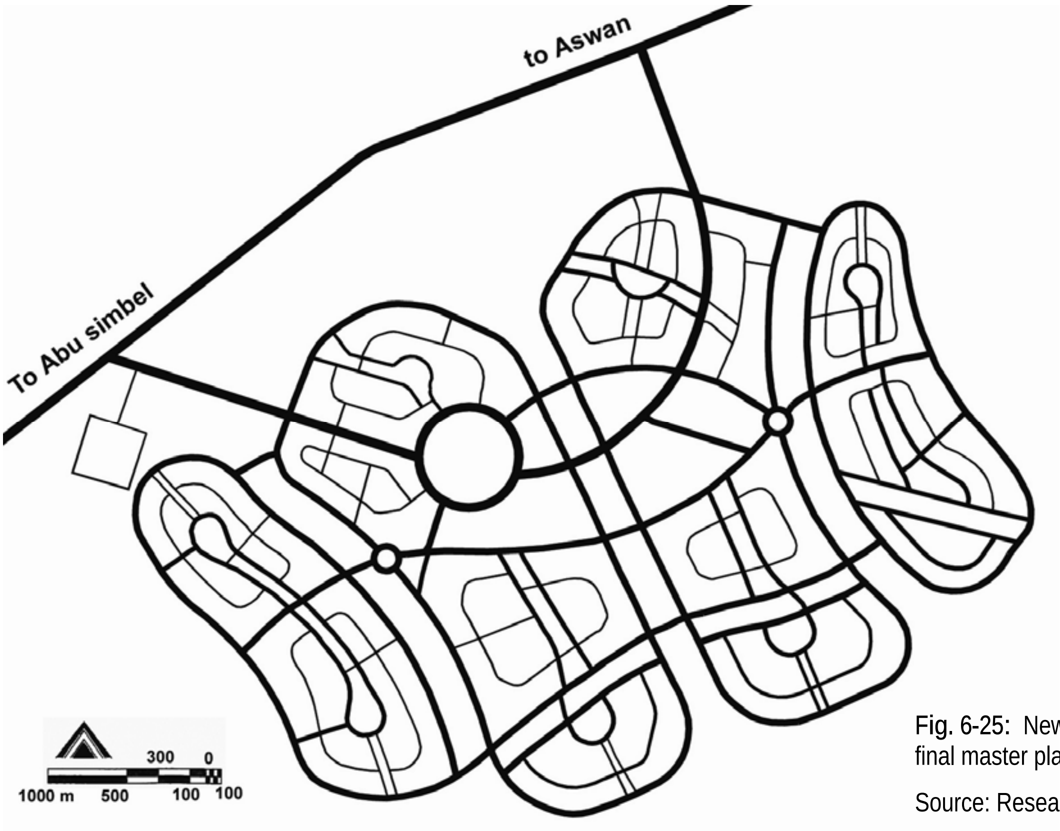


Fig. 6-25: New Toshka City, The final master plan, road system.

Source: Researcher

6.3.4. Toshka New Urban Communities: The UIPV Development Model

6.3.4.1. The Project Analysis

(a) Development Framework

The development framework of the New Toshka city is depending mainly on the Egyptian official sector. This is including many ministries and authorities such as Housing Ministry, Agriculture Ministry, New Urban Communities Authority (NUCA), and the Council of Energy Development. This is besides universities and individuals, who are sharing with their individual studies. The Egyptian NUCA is the real authority that controls the process of urban development, and the role of the other sectors that involving in the energy and PV development is actually limited.

Therefore, the development of New Toshka city is being done through the normal Egyptian urban development process, though the project development scope is registered as a new set of development concepts, such as integrating renewable energy applications, which needs the co-operation of many other sectors.

On the other hand, the actual framework has a limited power to act. This is because of the political system that controls the process of decision making, which is depending on a central structure (see Fig. 6-20 & 6-26). This has affected, in general, the development scope of the project. In addition, it affected the institutional role, and the co-operation between the different players of the city development process.

Therefore, it can not be considered as a real development framework, that can develop the New Toshka city, and the Egyptian urban communities in general, with reference to renewable energy resources e.g. PV applications, especially by noting that the only real current Egyptian renewable energy development

Framework focuses only on energy sector development (see Fig.6-5).

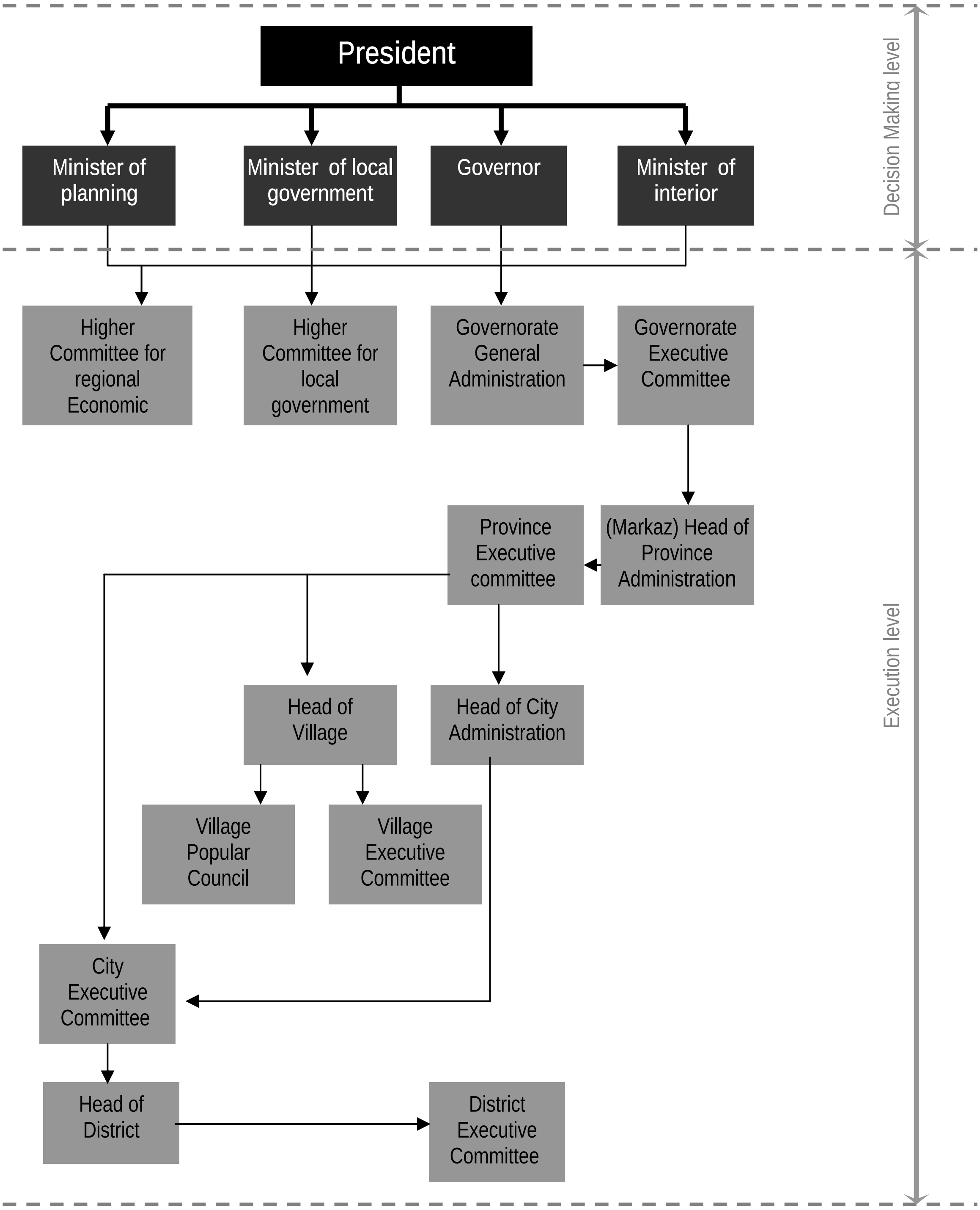


Fig. 6-26: Local urban authorities in the Egyptian government.

Source: Researcher after Merdan, 1999, p.55

(b) Policies and Strategies of Development

The city of New Toshka is a part from the Egyptian national urban plans for the future. Therefore, it is affected with its national development policies and strategies. It is one of many solutions for the over-loaded population in the old valley. Thus, the main aim is to offer new urban centre that can attract the inhabitants and provide them with jobs and home chances, at the first place.

On the other hand, no special policies have been developed for the city as an UIPV community. Therefore, it is affected also with the national energy development policies and strategies for renewable energy. These policies concentrated mainly on developing renewable energy applications at the regional level, such as wind farms, solar fields...etc.

As a result, the city is affected with two different parallel development policies without coordination between both of them, as a key tool for UIPV communities. In addition, no changes have been made at the level of urban and planning regulations, renewable energy and building technologies, or to strengthen the relations between national urban development process and national renewable energy e.g. PV market.

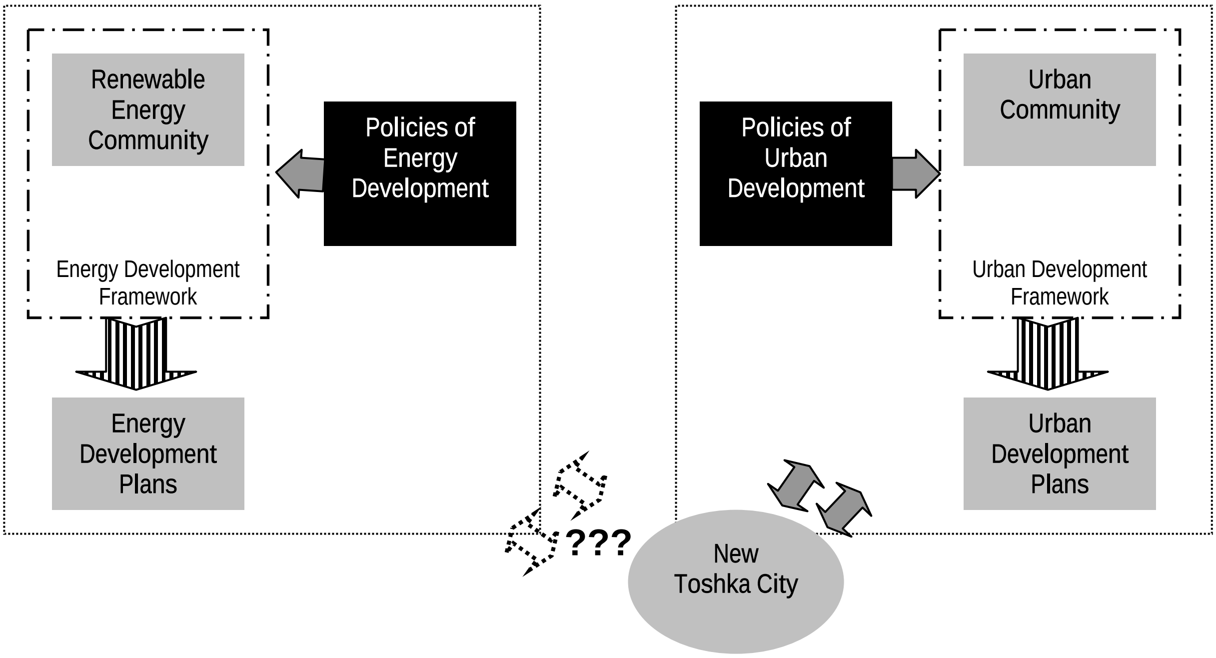


Fig. 6-27: Toshka City. Different parallel development policies affected the project.

The figure shows the missing relations between both of the urban development and renewable energy policies

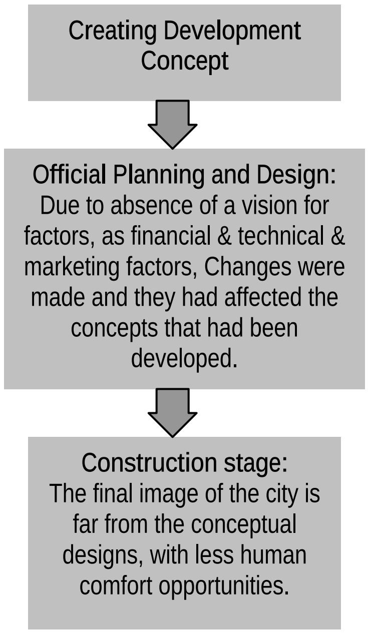
Source: Researcher

(c) Planning & Development Level

Actually, there is no actual available information about the details of the urban design of New Toshka, as the project is now temporary stopped due to some financial and political problems. Nevertheless, with reference to the models that have been introduced at the first stage, it is expected that the final designs will not exceeded the traditional designs, which are already used to develop Upper Egypt urban communities. This is because of two reasons. Firstly, the urban models introduced by the competitions, depending on design strategies that demand construction costs that are high than what could be accepted by the Egyptian authorities. Secondly, the actual development process of New Toshka is being done within the same Egyptian official development process and through the same urban development sectors. In addition, the role of renewable energy has been neglected through the recently published national energy code for buildings, which represents the official building regulations.

On the other hand, there are no plans to gather the process of urban development with new renewable energy and PV industrial and marketing schemes. Therefore, many companies working in the field of PV have already stopped.

In addition, the development process of the project has not associated with training or awareness of renewable energy programs, especially for these groups dealing with the city urban development. As noted before, this has affected the results of the first stage of the project – the stage of creating the urban and design concepts. As well, by showing the development process of architectural education programs provided in Egypt, we can find that it has no real changes that can help the urban planners and architects to deal with the New Toshka project with references to PV or renewable energy as an integrated urban process. This is the same at the public awareness level.



(a) The normal Egyptian process of urban development.

(b) New Toshka: process of urban development.

Fig. 6-28 a&b: A comparison between the normal Egyptian process of urban development and urban development process of New Toshka City.

Source: Researcher

(d) Building Design

Through the first phase of New Toshka development, vast all the participated projects have suffered from a non-clear vision about using PV applications and the other types of renewable energy, though, many of them have induced conceptual studies. This is clear by showing the integrations models that have been developed. They had not exceeded a partial use of PV and solar collectors. They have neglected how can PV play a role in reshaping the architectural designs, and how can PV or the renewable energy integrating with an arid region urban community, for example, at least as shading elements.

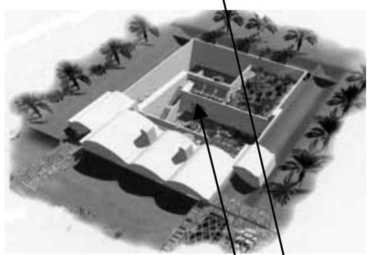
Therefore, the environment strategies in this stage were not complete, and they have registered only some old development schemes, which motion the traditional characters of an arid region community. This is without applying the development scope of the project, which aims at integrating PV and renewable energy application at the building level. In addition, they have not given any models for the different uses of PV or the other renewable energy applications according to the building types of the project, that contains beside the housing area, public services and administration buildings, industrial area…etc.

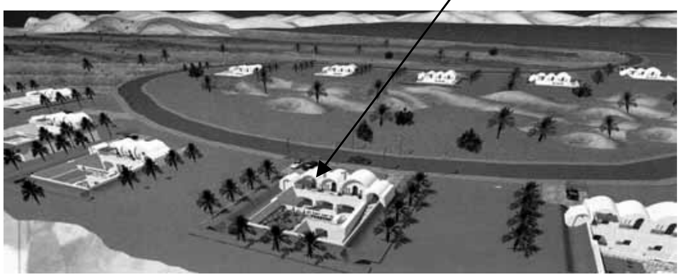
In the second phase "official planning and design", the NUCA is preparing the final urban development plans and designs. They have decided to leave studying integrating renewable energy and PV for further studies in the next stages of the project, according to the NUCA. This means that the photovoltaic and other renewable energy applications will not exceed the add-ones or regional applications such as energy farms. In addition, it means that integrating these applications will not be done in complete economical schemes that can reduce the urban fabric costs, through replacing, for example, building materials, and forms.

Fig. 6-29 : New Toshka City. An example for the participated projects.

A partial and limited concepts for using solar energy and PV applications.

Source: CPAS, 1999, p.p. 20-21.





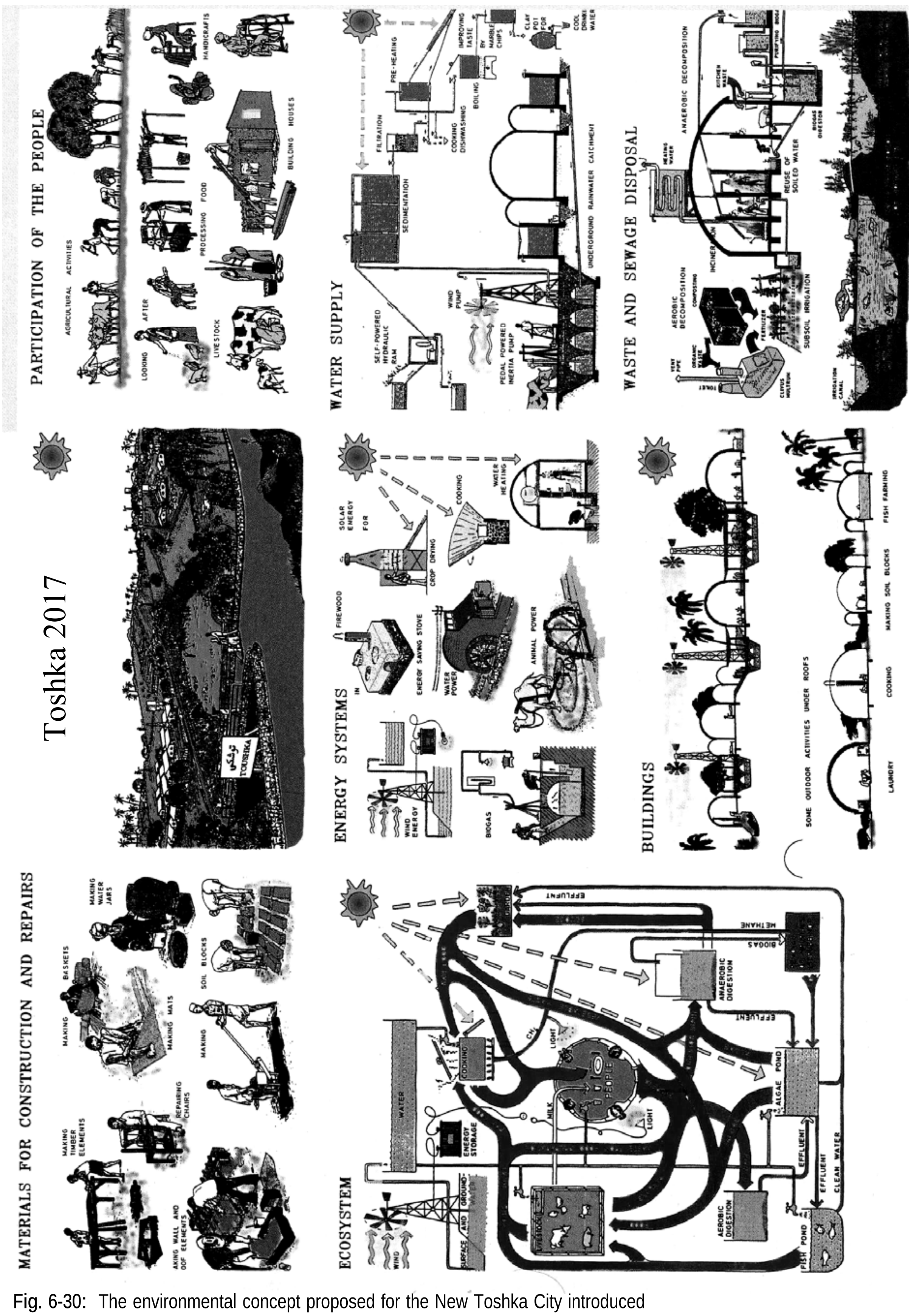


Fig. 6-30: The environmental concept proposed for the New Toshka City introduced by one of the participated designs at the first stage of the project.

Source: Ebadah, 1999, p.57

Fig. 6-31 a&b&c: New Toshka City. An example for the participated projects in the first stage of the project.

Depending only on the traditional characters and elements.

Source: NUCA, n.d.

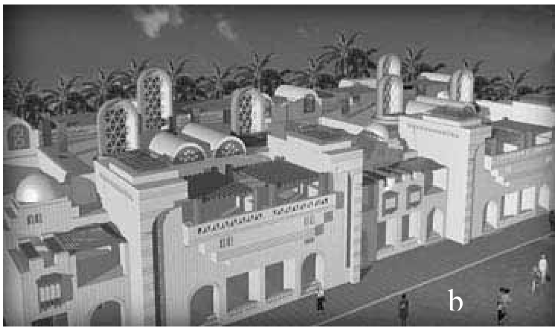


Fig. 6-32 a&b&c: New Toshka City. An example for the participated projects in the first stage of the project.

Trying to develop the traditional characters and elements of design.

Source: NUCA, n.d.

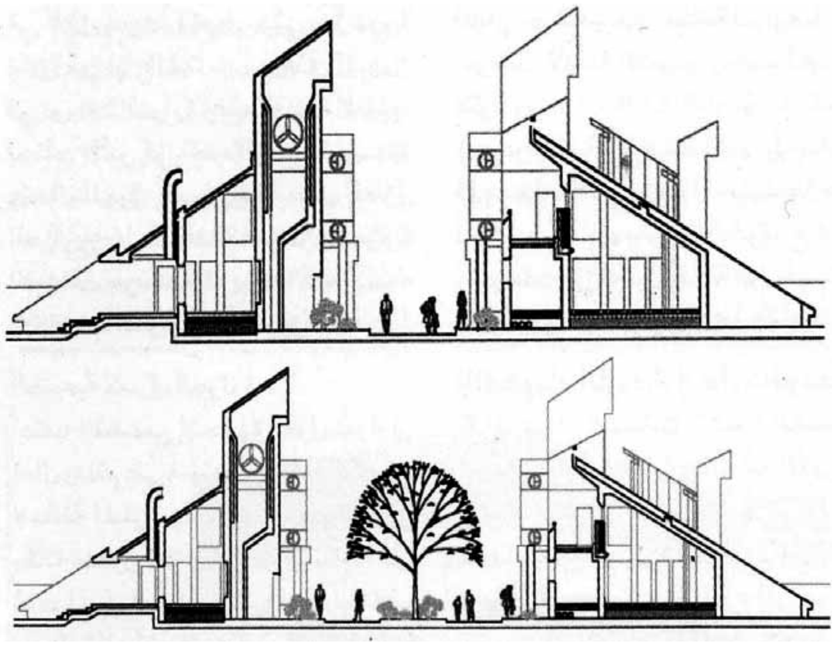


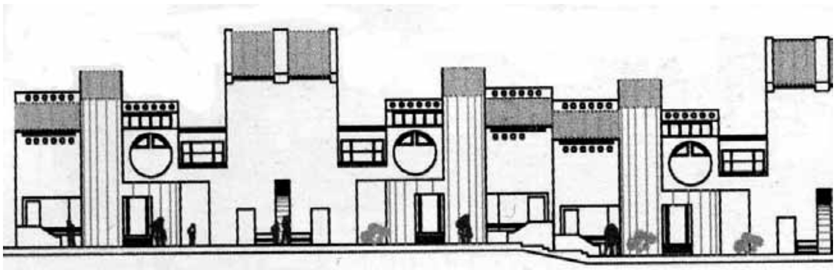
Fig. 6-33 a&b&c: New Toshka City. An example for the participated projects in the first stage of the project.

A better understanding for both the environment constraints and the need to integrate the use of solar energy applications. This is through some new architectural solutions. However, integrating of these applications is still limited.

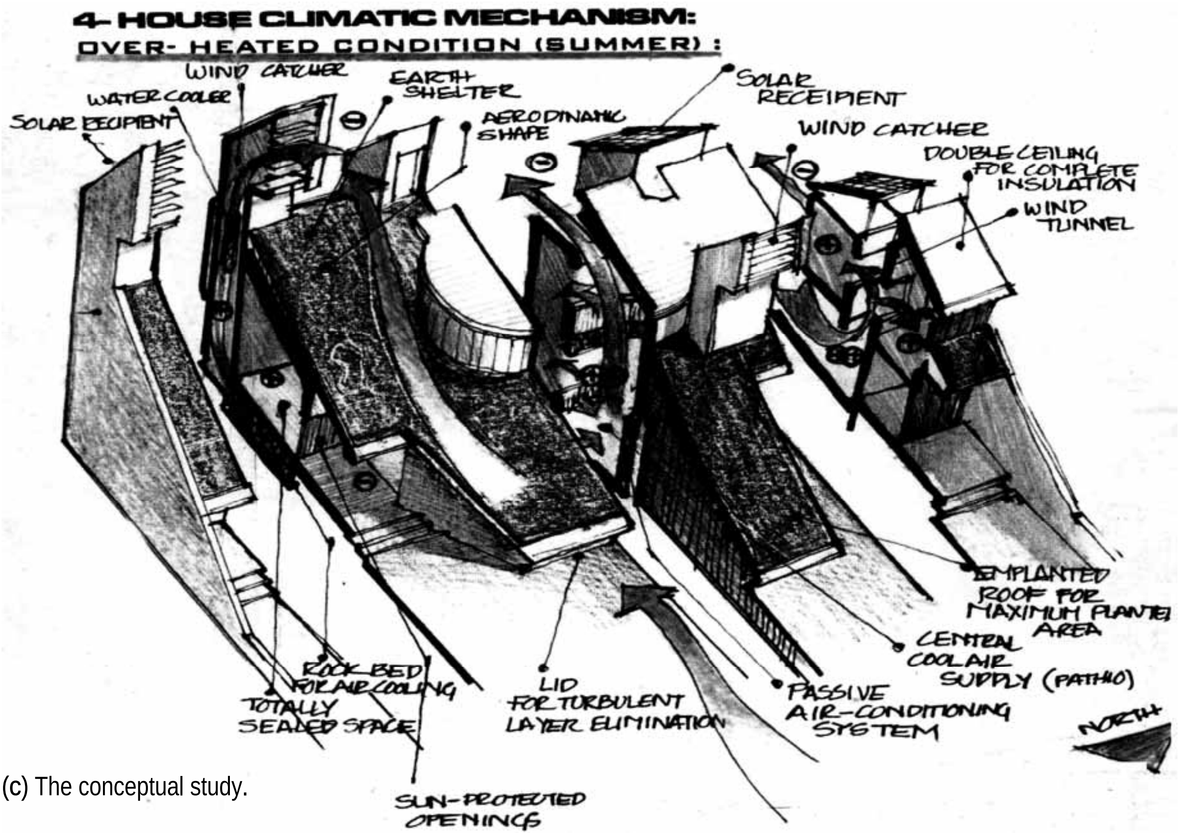
This can be explained by the absence of the role of the renewable energy experts

Source: CPAS, 1999, p. 1, 17.

(a) A conceptual cross-sections: Using traditional architecture elements within new designs, such as wind towers.



(b) A conceptual cross-sections: Using the sloped parts of the elevation to place solar energy applications such as PV or solar collectors.



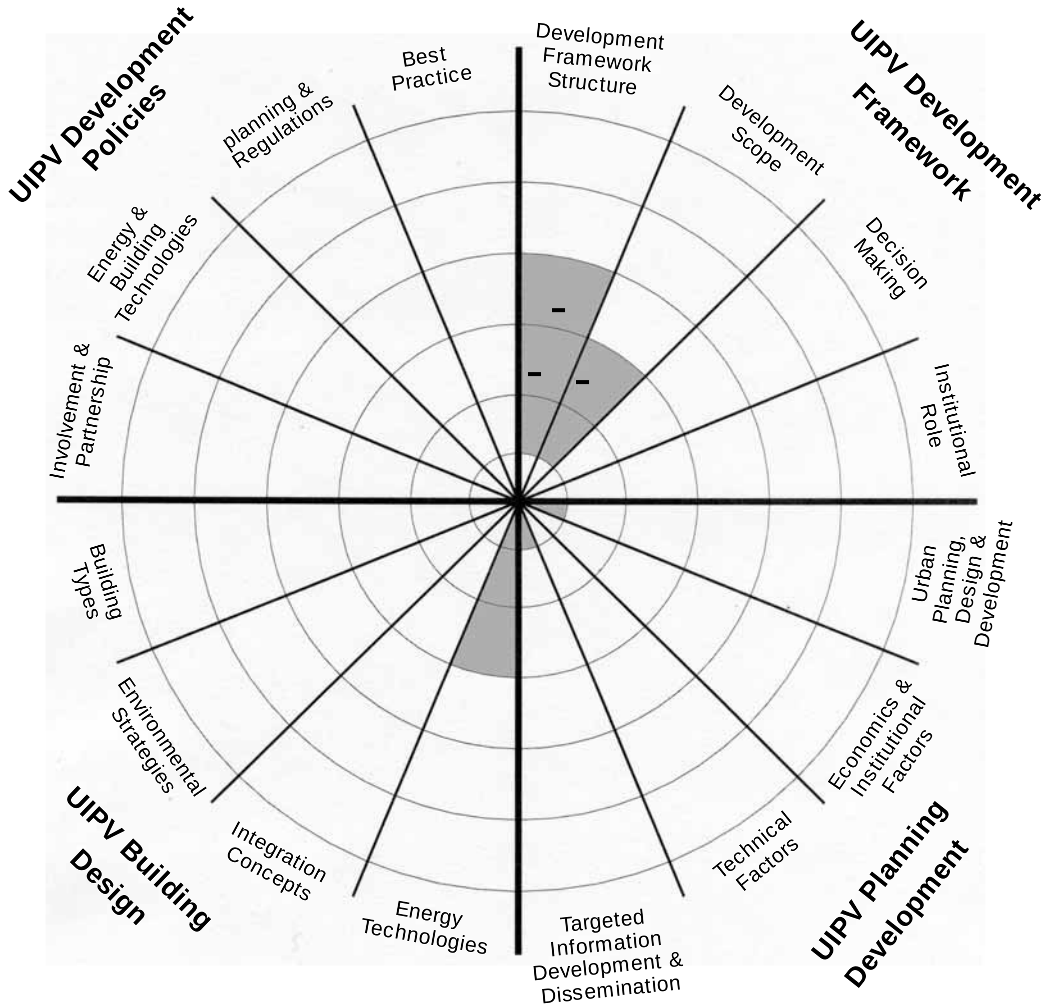
(c) The conceptual study.

6.3.4.2. The UIPV Model of Urban Development in Toshka

Through the previous analysis of the project with reference to the elements of the UIPV development model that is supposed by the study, it is clear that the urban development process of the project represents an incomplete UIPV model. It is suffering from the absence of its initial elements at the four sectors of the UIPV model. Also, the absence of the development framework role can be considered as the main reason, which has affected developing New Toshka city as an UIPV project at all the other levels. This is because of depending on the traditional Egyptian urban development framework which in this case is the NUCA, and its weak relation with the renewable energy development framework represented by new and renewable energy authority (NREA). (See Fig. 6-34 and 6-35)

Fig. 6-34: Toshka City. The project according to the UIPV model UIPV model.

Source: Researcher



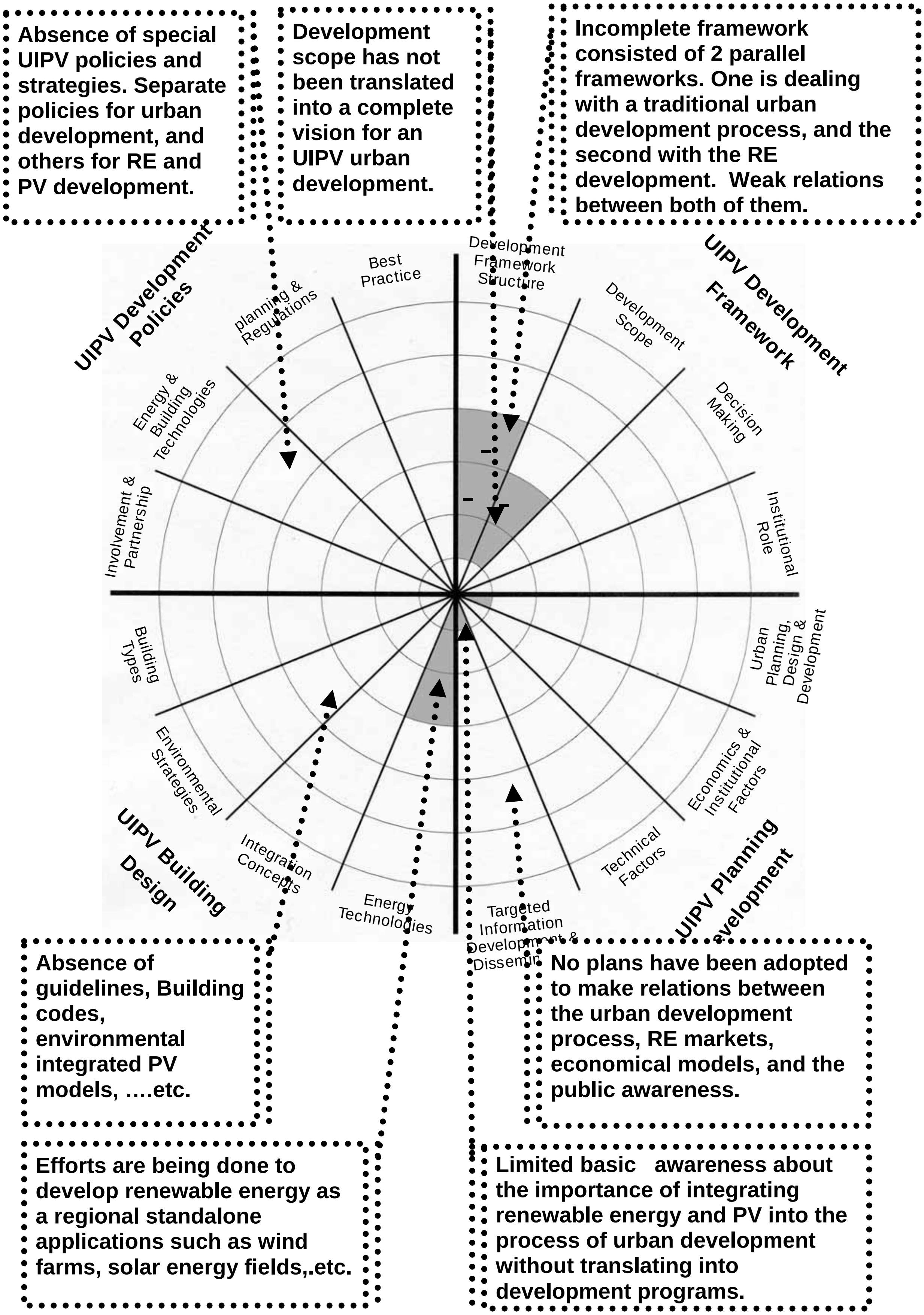


Fig. 6-35: Toshka City. Analysis of the project according to the UIPV model.

Source: Researcher

6.4. Discussion: Renewable Energy & PV and the Approach for Sustainable Urban Development in the Egyptian Arid Regions – A Development Road Map

6.4.1. Egypt According to the UIPV Model

In conclusion, according to the Egyptian UIPV model (Fig. 6-34 & 6-35) , the Urban development depending on PV and renewable energy in Egypt is suffering mainly from the absence of the correct UIPV institutional framework. This is besides the absence of core specialized authorities and institutes that can be responsible for such urban development that is the key constraint hampering the formulation of appropriate policies, strategies, plans and programs to promote the use of PV and renewable energy with their different applications through the process of urban development and also to follow its implementation.

Also, while PV, like vast all renewable energy, has no or limited operating costs, yet it suffers from high investment costs and low or no volume of sales, associated with a total absence of adequate financing schemes. This is due to the dispersed potential users and the structure of the local market, which has no coordinated effort between the government, local authorities and manufacturers, as well as national and international financing institutions form one side, and the urban development authorities with all players involved in the process of urban development in Egypt from the other side. In addition, there is a lack of information, communication dialogue, and co-ordination between the development actors. In addition, the main actors -government, utilities and bankers, urban developers,…etc.- who should be involved in the process of UIPV development projects, are not fully aware of the benefits related to such type of development, and of the prospects for improvement and cost reduction of the technologies due to the mass integration schemes and production. Besides how this would contribute to local job creation, limit the need for foreign currencies, and ensure cost reductions due to cheaper labour and the absence of import taxes Also, how to promote the Egyptian market in order to achieve high volumes and low costs through the mass uses within the urban development projects.

6.4.2. The Case of New Toshka with Reference to the OECD Countries and MASDAR UIPV Models

This is clear by comparing between the case of new Toshka city, cases of MASDAR development and the OECD countries using the UIPV model. Fig. 6-36 shows the difference between the three cases. The success of the two cases of MASDAR development and the OECD

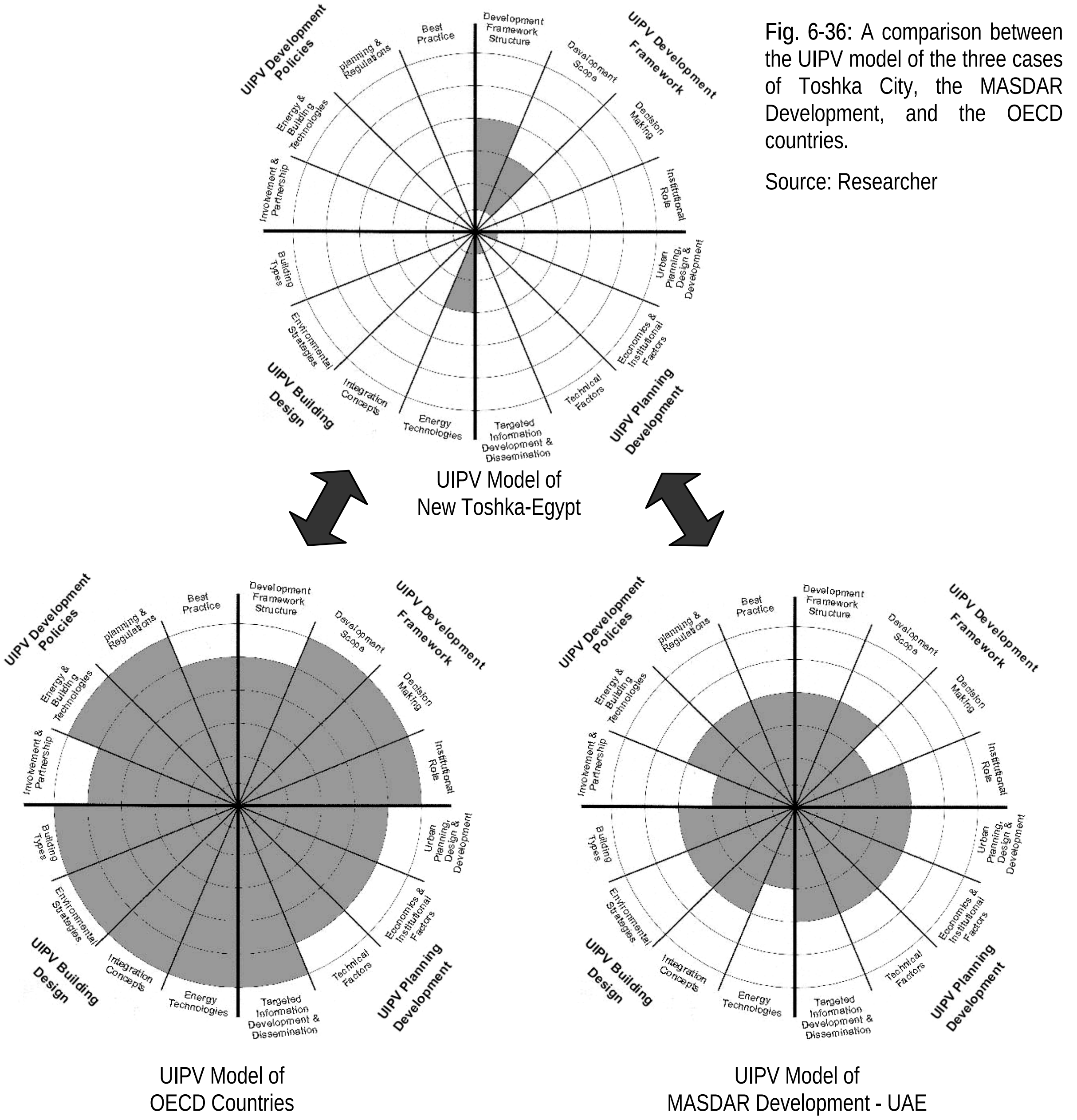


Fig. 6-36: A comparison between the UIPV model of the three cases of Toshka City, the MASDAR Development, and the OECD countries.

Source: Researcher

countries and the failure of case of New Toshka development are explained by the characters of their UIPV models.

In case of MASDAR development, Abu Dhabi and the UAE have succeeded in building their capacities in this field. This is through depending on the full co-operation with the most powerful experiences and capacities worldwide to build the local capacities in the first stage that will take place in the second stage of the project. (Fig. 6-37)

Thus, a complete development framework is being established with clear development scope and has the power of decision making that strengthen the institutional role of the participating bodies in the UIPV development process. In addition, this is sustained with a set of development policies that includes all sectors not only the urban development sectors. The objective of these policies is to link all the actors of the UIPV development not only at level of the project, but also at the urban development levels locally and nationally. In addition, through the set of new institutes, industrial projects, international co-operation…etc., a new strong economy sector that will aid a continuous UIPV development process is being built. This is helping to set up the new urban and design models that suites the local constraints of development. Thus, new reforms have been taken at the level of education and awareness programs to cover all stages of the educational system. Finally, at the building design level, the MASDAR development is depending on using PV and other renewable energy applications as main tools that will provide new models for the arid region building, which respect the restrictions of the environment, and at the same time integrates the high PV technologies.

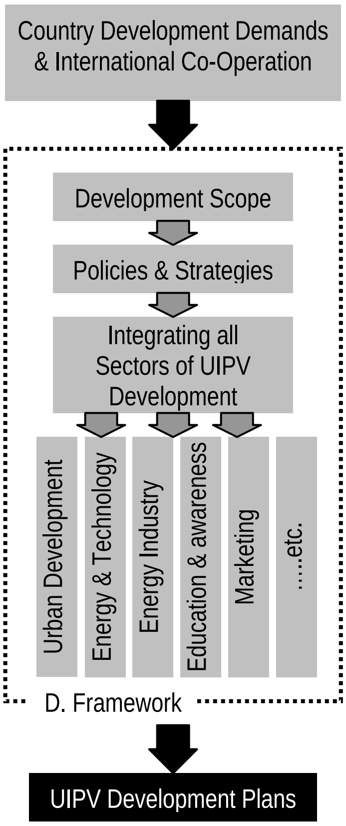


Fig. 6-37: MASDAR Development, The way towards an UIPV development process,

Source: Researcher

In case of the OECD Countries, through their long experience, many concepts and examples for integrating PV and renewable energy within different development frameworks have been developed. As a result, for the characters of this type of development, and through international co-operation programs, new visions of development scope and frameworks such as IEA -PVPS program have been established. Now, they play the initial role to govern and sustain integrating PV applications and renewable energy in general within the urban development process. This is through a complete system that contains all the actors and sectors that can be involved in such process.

Thus, they have succeeded to develop an UIPV model covering all the main elements that are needed for an UIPV development process. In addition, they reached now the "After Evaluation" stage for most of the UIPV elements. This can be explained through the role that the cooperation in the field of UIPV development and policy making within a well organized networks. (See chapter 4)

In case of New Toshka city – Egypt, according to the future development plans, and the expected increase of energy demands that is associated with reserves decreasing in the traditional national energy resources, a vision for shifting to use renewable energy resources in the last decades has appeared. In addition, recently, calls for supporting integrating these energy resources e.g. PV into our urban communities have appeared, and New Toshka city was supposed to be one of the first Egyptian communities that registered this vision. However, this has not been associated with a suitable development system, e.g. an UIPV development model. Through the urban development process of the city, and generally the direction to integrate PV and other renewable energy into the Egyptian communities, the vision of establishing a UIPV model was neglected, and this initial step has been overcome (see Fig. 6-39). As a result, a lack of awareness, suitable development framework, UIPV policies,..etc. is noticed. This explains, for example, dependence on the environmental constraints only in the stage of creating the development concept of the city, as the main approach for urban planning and building design.

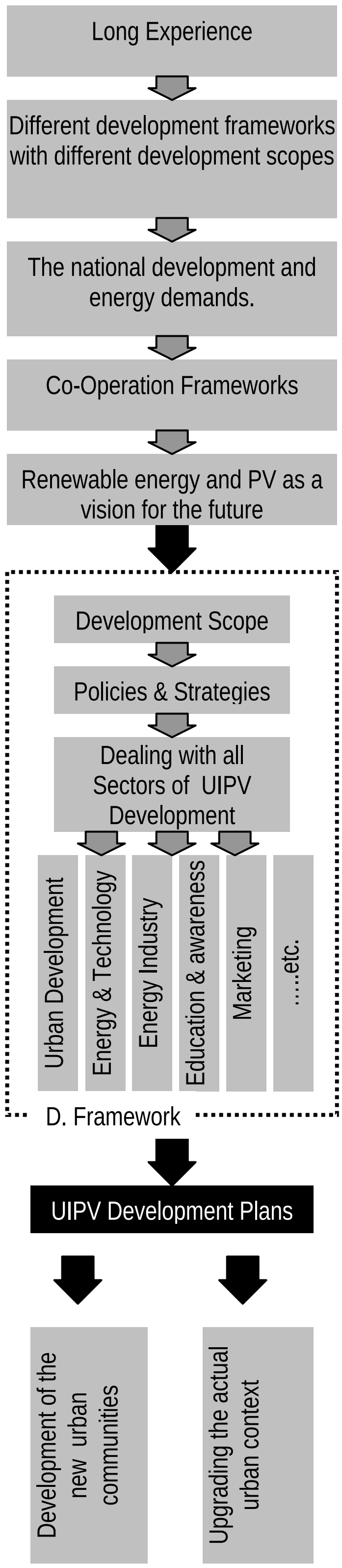


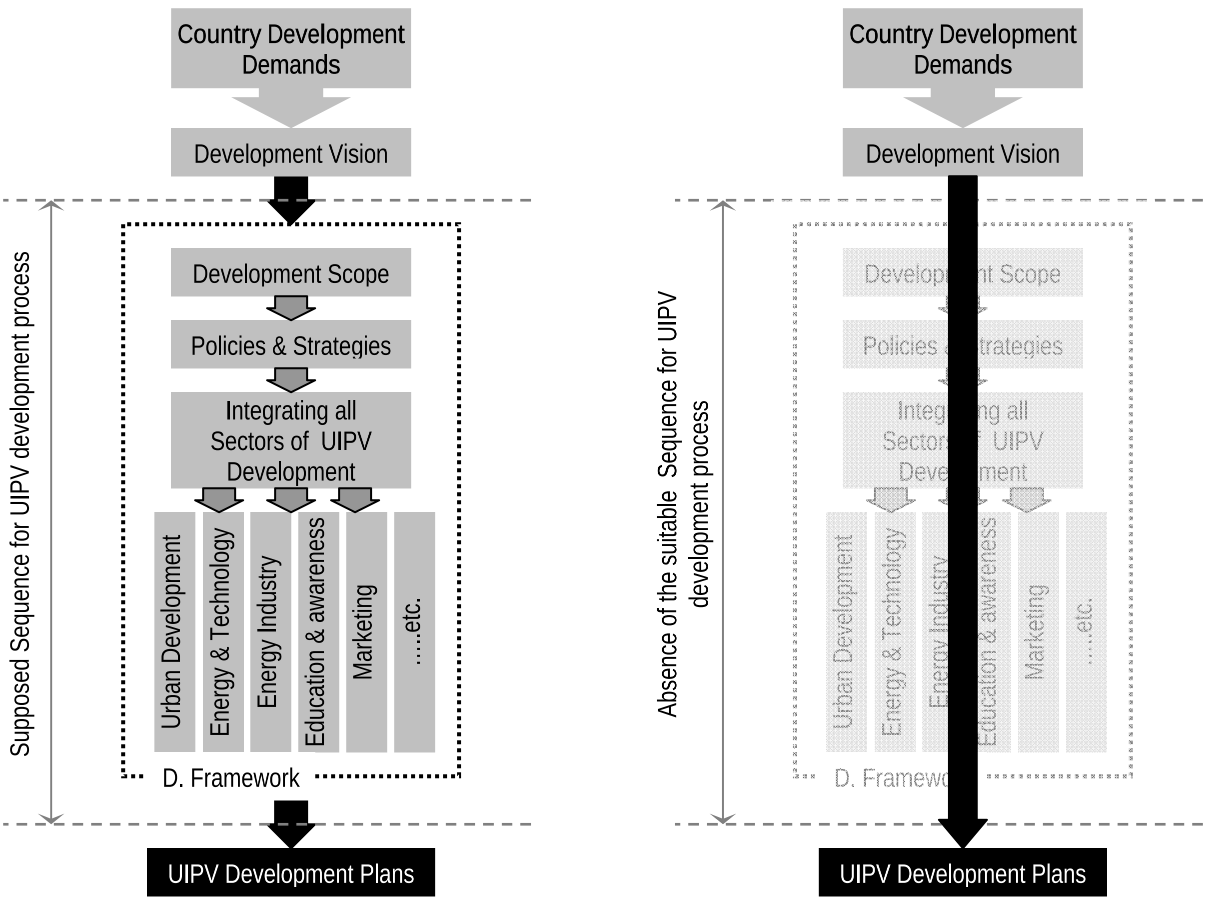
Fig. 6-38: The OECD countries, the way towards an UIPV development process.

Source: Researcher

In conclusion, by comparing case of New Toshka with the first two cases of MASDAR development and the OECD countries with reference to the UIPV model, it will be difficult to achieve a successful UIPV development process without preparing a well-organized suitable urban system as an initial step. This is the main difference between the two first cases and the case of Egypt. Tables (6- 4 & 5 & 6 & 7) summarize the difference between the three cases with reference to the UIPV model.

Fig. 6-39: Egypt and the way towards an UIPV development process.

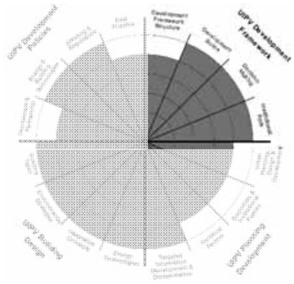
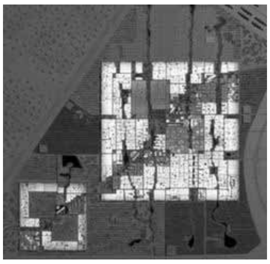
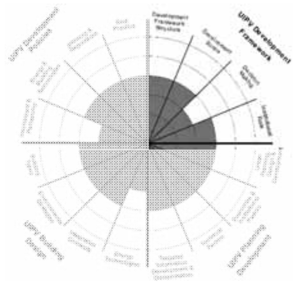
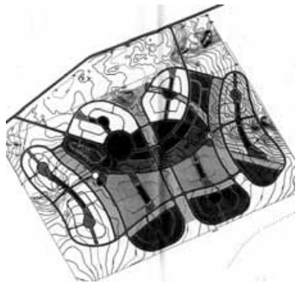
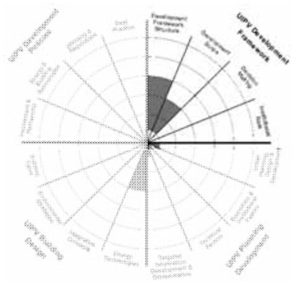
Source: Researcher



(a): New Toshka – Egypt, the way supposed to achieve an UIPV development process, which should depend on offering a complete UIPV model.

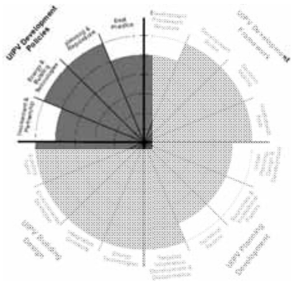
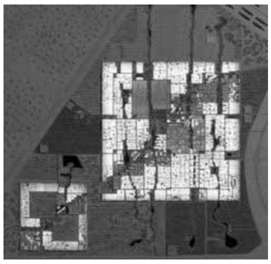
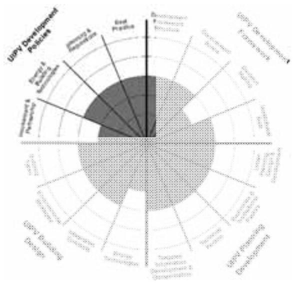
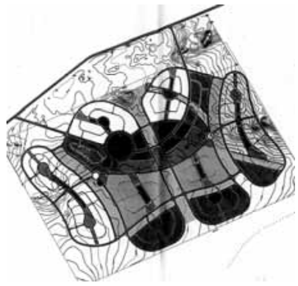
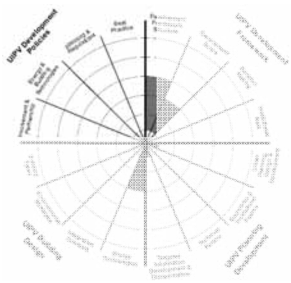
(b): New Toshka – Egypt, the actual sequence to achieve an UIPV development process that has neglected the importance of the role of establishing a UIPV system as a basic step for achieving UIPV communities

Table 6-4: Analysis with reference to the OECD and MASDAR UIPV model: Development Framework

UIPV Model	The OECD Countries	MASDAR Development - UAE	New Toshka city - Egypt
Development Framework	 	 	 
Framework Structure	Covers all sectors of both urban and renewable energy development, strong relations with the political and decision makers' level.	Private and official structure consists of all the development sectors at both urban and energy levels.	No real framework for UIPV. A separate framework for urban development with weak relation with the available renewable energy structure.
Scope of Development	Covers all sectors of both urban development and energy development with a complete vision to the economical sector.	Achieving a complete development at all sectors covering urban and renewable energy development.	Aim mainly at achieving a UIPV community without a clear vision for the other sectors related to an UIPV development process.
Power to act (Decision Making)	Have the ability to change codes, laws. Have relations with the political sector and the power to affect it.	Have the ability to make decisions, with co-operation of the political sector.	Affected with the political level and cannot sustain the process of the UIPV development.
Institutional role	Well distribution of duties. A complete co-operation at the institutional level.	Clear distribution of tasks. Co-operation between all sectors at the local, national and international levels.	Weak relations between the urban and renewable energy institutions.

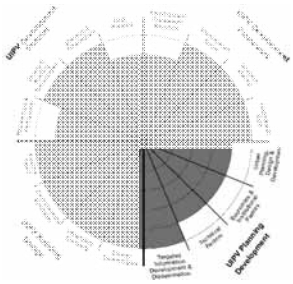
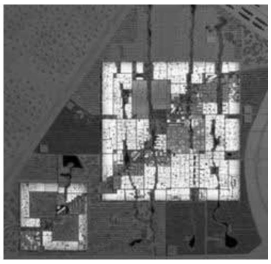
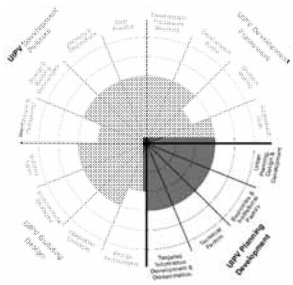
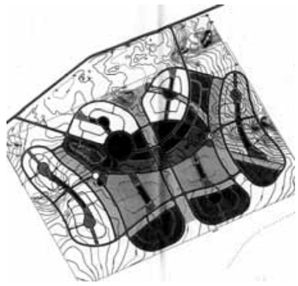
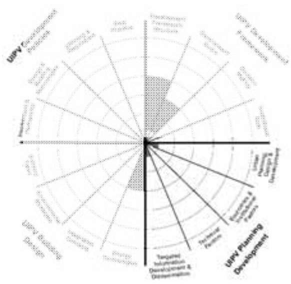
Source: Researcher

Table 6-5: Analysis with reference to the OECD and MASDAR UIPV model: Policies & Strategies.

	The OECD Countries	MASDAR Development - UAE	New Toshka city - Egypt
UIPV Model Policies and Strategies	 	 	 
planning and Regulations	Governmental & institutional activities to introduce new regulations, as well as reducing regulatory and procedural impediments.	New urban laws and regulations. Innovative technologies in renewable energy, energy efficiency, carbon management ,..etc.	No changes at the level of urban and planning regulations. The same are used.
Energy and Building Technologies	Organizing community needs and preparing policies that comply with them, then translating them into applications.	A world-class university offering specialist graduate programs in renewable energy and sustainability.	Developing renewable energy applications only at the regional level.
Involvement and Partnership	Detection end-uses of citizens and their needs. Plan together (community, citizenship, stewardship, and behavior).	Awareness, educational policies and reforms. Sharing decision making process with the private sectors.	A central decision making process.
Best Practice	Unite the forces of local carriers, professionals, and experts at both the official and private sectors.	Partnership with leading international universities, research institutes and companies.	Limited vision with no effect in the urban development process.

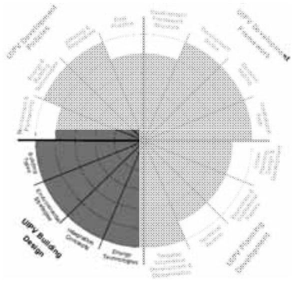
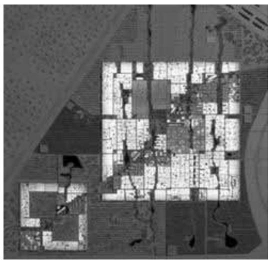
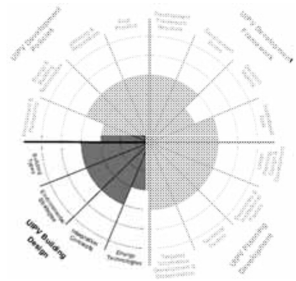
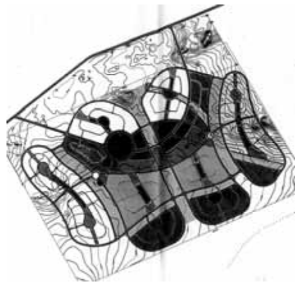
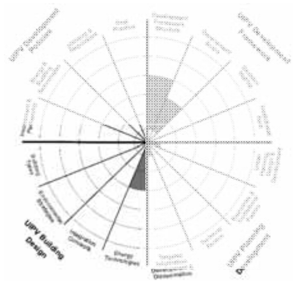
Source: Researcher

Table 6-6: Analysis with reference to the OECD and MASDAR UIPV model: Planning & Development

	The OECD Countries	MASDAR Development - UAE	New Toshka city - Egypt
UIPV Model Planning & Development	 	 	 
Economics and Institutional Factors	Variations in financial schemes. Official supporting programmes. Co-operation between official and private sectors.	Establishing sustainable local PV manufacturing capacity, financial and human resources effectively into the high tech.	No economical vision or studies for an Egyptian UIPV community.
Urban Planning, Design ,Development	Guidelines to integrate PV into standard design models, tools, practices, and community energy infrastructure planning	Developing new environmental urban development models.	Designs not exceeded the traditional designs that are already used to develop the Upper Egypt urban communities.
Technical Factors	Continuous research and development process about technical factors for mainstream urban-scale PV.	Attract the highest levels of international expertise. Co-operation Project with the international PV development community.	No plans to gather the urban development process with new renewable energy, PV industrial and marketing schemes.
Targeted Information Development	Public awareness programmes. New educational programmes. Supporting institutional research programs, ..etc.	Raising the awareness of their citizens and modifying the educational systems. New university for RE Studies.	Absence of awareness, information and materials, education programmes, institutional co-operation.

Source: Researcher

Table 6-7: Analysis with reference to the OECD and MASDAR UIPV model: Building Design.

	The OECD Countries	MASDAR Development - UAE	New Toshka city - Egypt
UIPV Model Building Design	 	 	 
Energy Technologies	Wide variations of PV systems. Continuous research to develop more new applications.	Using many parallel PV system types. Centralized PV power stations, building integrating PV stand-alone non structural PV.	Absence of awareness about the wide variety of PV technologies and their applications in the urban context.
Integration Concepts	Depending on using PV systems in the construction elements, in environmental solutions, and according to economical models.	PV is used as a basic element for the design process. Creating new architectural and urban design integration models.	Limited partial use of PV system and RE applications. Only add-ones applications.
Environmental Strategies	Environmental solutions, maximize daylight , controlling ventilation, cooling and heating integrated designs…etc.	Readapting the traditional treatments used in arid region by using new forms and design models with reference to PV applications	Depending only on some old development schemes that motion the traditional characters of an arid region community design.
Building types	Integrated into all building types, residential, commercial, industrial, non-structure building, landscaping…etc.	Integrated into all building types, used intensively in urban design as tool for shading.	Only partial limited integration studies for residential buildings.

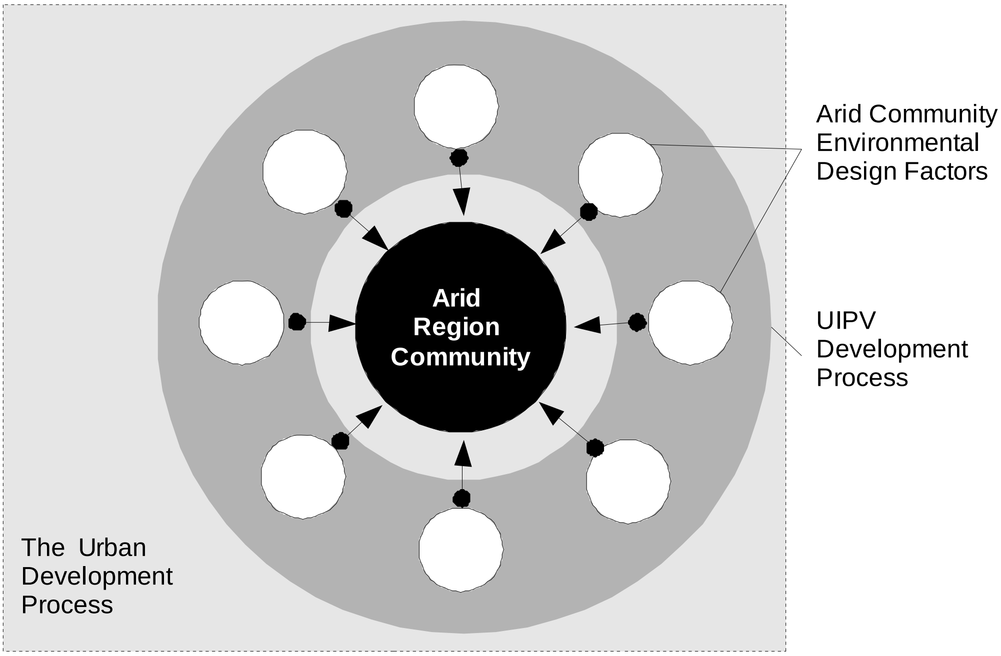
Source: Researcher

6.4.3. New Toshka and MASDAR Development with Reference to Arid Regions Planning and Design Environmental Constraints.

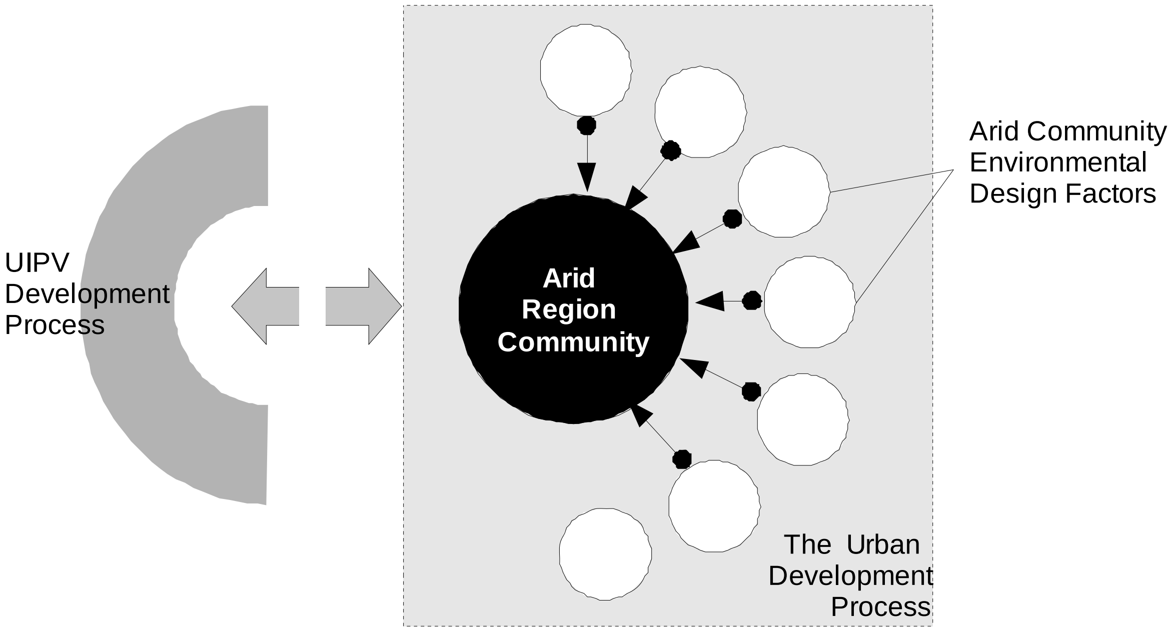
One of the advantages of integrating PV and other RE applications into the process of urban planning , is the parallel associated environmental and passive design strategies, which are necessary as they play a major role in decreasing the community energy consumption.

In case of MASDAR development, despite using PV to achieve the self-dependent community that produces its demand of energy is the key concept, PV is used, also, as an environmental strategy that provides the inhabitants with a comfortable environment in an arid region community. This is through readapting the traditional planning and building designs schemes, by using new forms and design models with reference to PV applications. Therefore, MASDAR Development is a model for building an arid community within the frame and environmental aspects of urban planning and building design of the traditional arid region community, but with a new set of models that gives it the ability to integrate the new PV technologies. (Fig.6-40)

In case of New Toshka city, it was clear through the official development scope of the project and studies introduced at the competition stage how is the importance of creating urban models that respect the environmental constraints of the region and at the same time provides solutions for integrating PV and renewable energy applications. However, the environmental concepts that have been introduced, have depended only on using the traditional design schemes of the arid communities without mentioning the need to integrate them with PV applications to create new planning and design models for the Egyptian arid regions urban integrated PV communities . (Fig.6-40)



(a) Case of MASDAR Development. The environmental concept of MASDAR, using PV tech. as tool to create new traditional designs integrated PV.



(b) Case of New Toshka city. The environmental concept of the project is depending only on using the traditional design solutions of the arid communities without mention the need to integrate them with PV applications in order to create new planning and design models for the Egyptian arid regions.

Fig. 6-40 a&b: A comparison between the environmental concept of MASDAR - UAE and New Toshka city – Egypt.

Source: The researcher

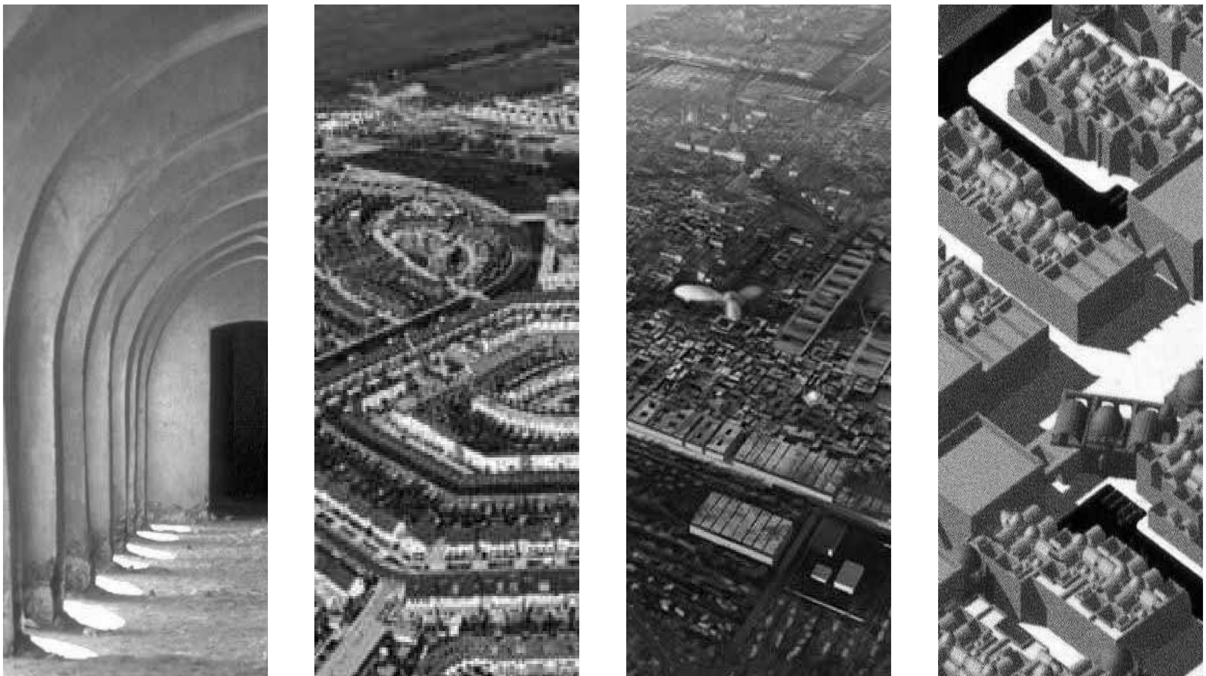
6.4.4. The Approach for Sustainable UIPV Development in the Egyptian Arid Regions

From the previous analysis, it is clear that in order to achieve an UIPV development; a complete development system should be adapted and acts as a sequence for UIPV development process. In cases of the OECD countries and the UAE, this system is formulated or is being established, and they are covering all or most sides of an UIPV development. Therefore, regarding their actual UIPV development processes, the future of UIPV development in these countries will continue achieving more success. Unlike these examples, is the situation of the Egyptian UIPV development that is according to the UIPV model is suffering from the absence of a complete system and visions for the UIPV development, and will affect it badly in the future, if no action is taken to change this situation. (Fig.6-41 & Fig. 6-42)

Fig. 6-41: The UIPV developement in Egypt with refrence to the other cases.

Due to the absence of information and qualified capabilities, the visions of arid regions UIPV settlements in Egypt with reference to the results of the Toshka city competition is still depending on copying the old models. This is unlike, for example, the case of MASDAR, where the new combination of arid region settlements characters and the new technologies of renewable energy and PV are used.

Source: Researcher after Archnet 2008,& Thomas. , 2001 & ivyworld.de, 2008 & Ebadah, 1999.



Arid Regions Settlements	UIPV Settlements	UIPV Settlements MASDAR	Visions of Arid Regions Settlements Toshka City
Egypt 60s	OECD C. 2008	UAE 2008	Egypt 2008

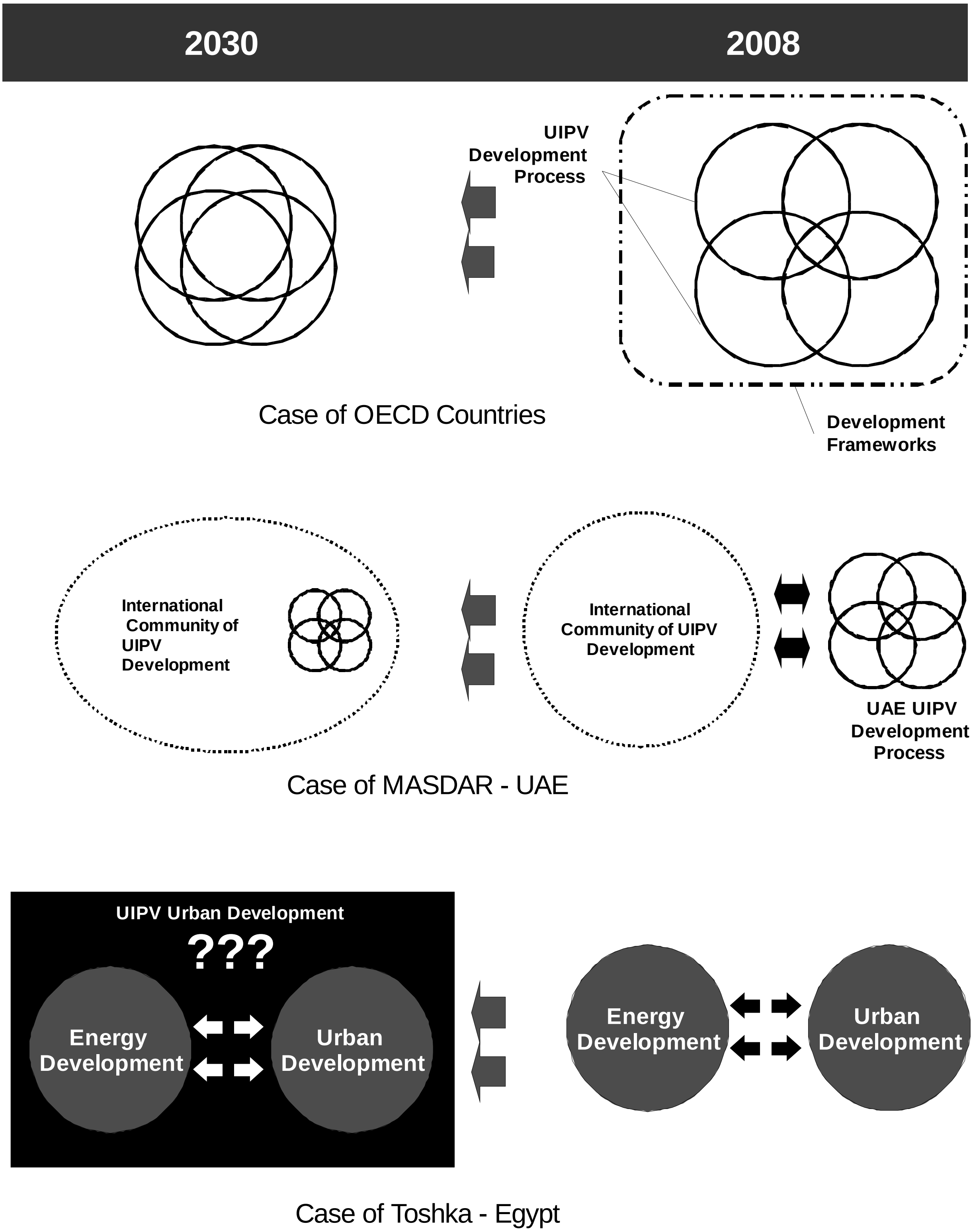


Fig. 6-42: The UIPV development model: the present and future situations.

The comparison between the UIPV model (present and future) of the three cases of Toshka City, the MASDAR Development, and the OECD countries shows that Egypt will stay has the same problem to achieve an UIPV development. This is because of the twin development schemes that deal with urban development and energy development without any relations in-between in contrast to the other two cases of MASDAR and OECD countries.

Source: Researcher

6.4.4.1. The UIPV Development Road Map

In order to achieve a real UIPV development in Egypt a suitable sequence and a complete system for the UIPV development process should be established. However, there are many differences between case of Egypt and the other two cases. Mainly, in the case of the OECD countries, they are depending on long experiences with well-constructed development capacities in this field. This is besides the financial capabilities due to the international co-operation. In case of the UAE, its unlimited financial capabilities play a major role in transferring the experiences and knowledge within a huge set of mega-urban- projects and co-operation development programs.

In case of Egypt, unlike the UAE, financial resources are limited, especially with reference to the actual national urgent development programs. However, Egypt enjoy bases in human resources, research capabilities, separate institutional frameworks.. etc., that can be a good base for establishing such development , if sustained with a government and public support, besides the suitable sequence for UIPV development process at the national level; and co-operation at the international level. (Fig 6-43)

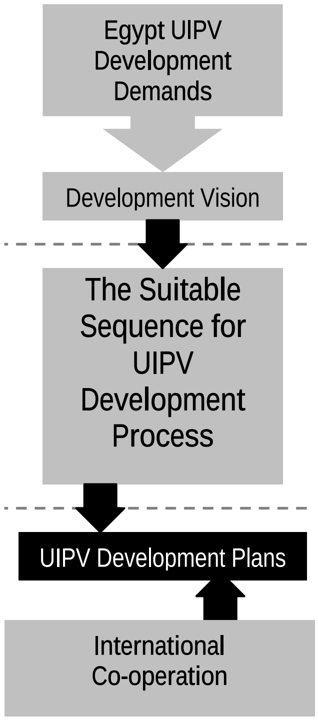


Fig. 6-43: The methodology for establishing an UIPV development in Egypt.

Source: Researcher

Therefore, establishing UIPV development in Egypt should be done considering this fact. In this manner, the study introduces a development plan or “A Road Map” for establishing such urban development in Egypt aiming at reaching a complete UIPV development by 2015 (see Fig. 6-55). As up 2020, Egypt will face serious challenges in the energy sector due to oil depletion, and the decreasing in the natural gas receives.

This development plan is divided into three stages. During every stage, the steps of establishing the national UIPV development are done through a development mechanism, which is changed within every stage. The development plan is, also, consider the role of the development co-operation at both the regional and international levels. (See Fig.6-44)

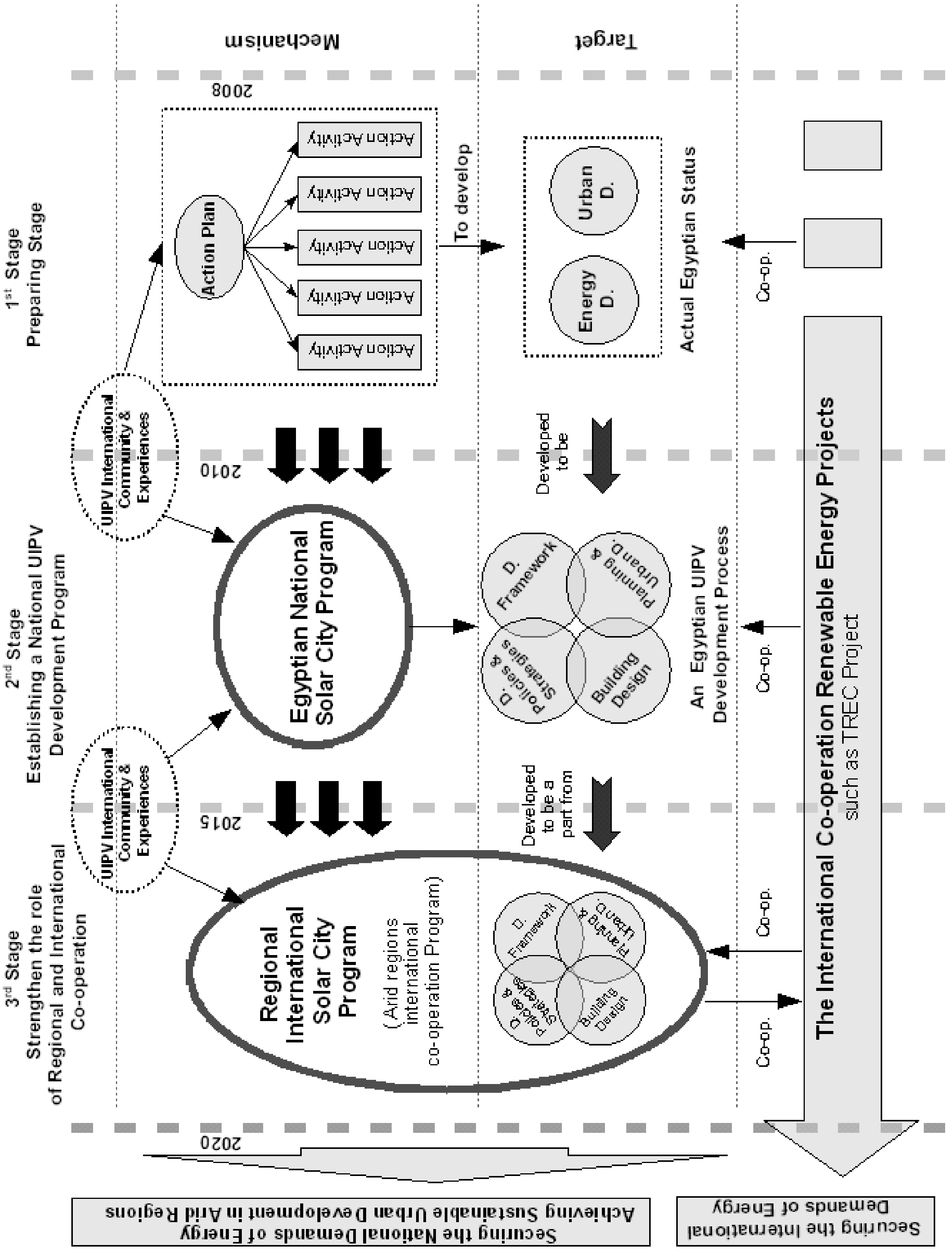


Fig. 6-44: Renewable energy & PV and the approach for sustainable urban development in the Egyptian arid regions – the development plan “Road Map” for establishing an UIPV development in Egypt.

Source: Researcher

(a) 1st Stage - The Preparing Stage:

In order to support the political decision, institutional reforms, increasing the awareness needed …etc, the objective of this stage is to prepare the Egyptian urban environment for the establishment of a national UIPV development process in the second stage. To achieve that, an action plan with action activities is needed as the mechanism for the development pin this stage. These action activities will be directed to:

- Increase the public awareness, and preparing the people to accept the new technology. This is through providing the information, and supporting BIPV and UIPV pilot project. For example, using PV integrated design for the buffer zone that will be constructed around the Greater Cairo. Many studies offered from international consultants in this manner. In addition, encouragement users of the new high-standard communities developed nowadays to integrate PV applications in their home. This is through, for example, land-taxes advantages. This will be so important in sustain a PV industry in Egypt.
- Sustain establishing the initial UIPV development framework and an Egyptian solar city program.
- Developing new training and educational programs concerning in this field, especially for urban planner, architectural designer, and renewable energy engineers.
- Sustain establishing new renewable energy and PV industry in Egypt.

By the end of this stage, it is supposed that the way will be free for readapting the national urban development process and its associated mechanisms in order to begin the necessary agreements, regulations...etc needed for establishing the new UIPV. Besides, the plan for a national solar cit program

(b) 2nd Stage - Establishing a National UIPV Development Program:

The objective of this stage is to establish a national UIPV development in Egypt. This is within a scope of complete UIPV development model that covers both the urban and energy development, besides the other related sectors of such development process. This will include; UIPV development framework, UIPV development policies, UIPV planning & development, and PV & building design.

A national solar city program will be the development mechanism in this stage. Such renewable energy development programs, according to Droege (2007) will help adapting the process of urban development to be transformed into a building and urban integrated renewable energy development (see 4.3.2.). In case of Egypt, the program will be the major creation tool for a national UIPV development, but this should be done hand in hand with the international co-operation. This is through readapting the international experiences in this field with reference to the arid regions constraints, and can also be done through the mega renewable energy projects offered to connect Europe and North Africa such as TREC project (see BOX 3-7).

With reference to the international experiences and international BIPV development programs such as the Solar City program and EIA-PVSP, to be completed, this stage is supposed to take about 5 years. By the end of this stage, it is supposed that full development strategies, guideline models, and plans for development of the Egyptian arid new urban communities as UIPV settlements, besides models for upgrading the existing urban centers. This should be done with considering the constraints of the arid region environmental conditions.

(c) 3rd Stage - Strengthen the Role of Regional and International Co-operation:

The objective of this stage is to strengthen the co-operation between the national UIPV development process and the other regional UIPV in the Middle-east and north of Africa, as they all have the same environmental conditions and the same arid climate , which will affect the final solutions and development schemes for these regions. This will help decreasing the financial sides. In addition, it can begin overlapping with or parallel to the 2nd stage after establishing its basic phases. This will give the whole development plan more advantages, especially after the relative advanced stages and experiences reached by some countries in the Middle-east such as in the UAE after the MASDAR development. Therefore, a supposed regional solar program will be the development mechanism in this stage. This is beside the role of the local UIPV development program at the national level.

The final target of this stage is to build a regional UIPV development framework. It will help not only developing research process of UIPV development at the regional level or establishing a physical UIPV communities at the local level, but it will also help to arrange and direct the co-operation schemes with the international community. In addition, it will help supporting the other countries to begin their own UIPV development programs, especially, with consideration of the need to sustain the technology transferring process for the developing countries. This will help not only the arid regions countries to achieve a general development , but it will help, also, Europe to have an unlimited secure source of energy without the daily risks associated with the international oil economy. This is through a mega remarkable energy network. This will also sustain in creating general European security reducing the illegal migration, through the new chances of life standard that will be offered for people in south through the new industries , markets , job chances, new communities with new urban standard...etc.

6.4.4.2. Egypt and the Future UIPV Development Model

The results of the pervious development plan or "Road Map", will be establishing an Egyptian UIPV development for urban communities in arid regions. This should recognize the four sides of UIPV development. This is including:

(a) UIPV Development Framework

The actual movement for creating new communities depending on renewable energy and PV is depending on two parallel development frameworks; one for urban development and the second for renewable energy development. This should be changed and a new UIPV development framework should be established. Establishing this framework should consider the following:

Framework Structure. It should contain both of the currant two-development frameworks, besides all the other players involving in such development process. This is including, for example, industry sector, marketing, financing, and banks, NGOs …etc. In addition, the relation between all of these players should be readapted especially with reference to the governmental level.

Scope of Development. It should not be limited within creating communities integrated PV. It should consider that the process of UIPV development is a tool to achieve a general country development, which includes not only the urban sector, but also the other development axes. This should be translated at the levels of urban market, industry sector, jobs creation …etc.

Power to Act (Decision Making). The new development framework should have the power of decision-making. This is through the ability to change codes, laws. In addition, it should be developed with strong relations with the national political level and have the power to affect it. Therefore, this development framework should be administrative self-dependent and not a part of the ministry of housing, so as not to be affected with any financial or administration obstacles by the ministry.

Institutional Role. Well distribution of duties and a complete co-operation at the institutional level will be one of the major duties of this framework, besides the coordination between the research institutes and the governmental, industrial, and financial community.

(b) UIPV Development Policies

A new set of polices and strategies should be developed. This is through:

Planning and Regulations. Implementation of planning process through introducing new regulations, that can maximize the intensive use of PV and RE in both new and existing urban communities. This should be done through co-operation between the governments, institutions, NGOs, as well as energy developers, urban planners and architectural designers.

Energy and Building Technologies. Organizing the needs of a community and preparing the policies, which comply with these needs. This is by offering the suitable solutions for energy and building technologies.

Involvement and Partnership. Maximizing the role of considering end-user of citizens and their needs. This is as tool for citizens' involvement and partnership in the process of UIPV development. This should cover their demands from mobility, housing, quality of life, economic opportunities, healthy environment, etc.

Best Practice. Building the country's capacities, that can be able to deal with and create the national development plans with reference to the new development approach, and which can translate this to a production process, which respond to national development needs and suites the constraints of the Egyptian market.

In addition, all these four axes of development policies should be done through the national UIPV development framework, and with reference to its development scope, which consider not only the technical sides of energy applications, but also the environmental constraints due to special characters of the Egyptian arid regions.

(c) UIPV Planning & Development

Establishing a UIPV development framework side by side to the supposed UIPV policies should control a new process of urban development, which will be translated at an urban-scale integrated PV and renewable energy through the following:

Economics and Institutional Factors. New development schemes and products for end -users to look beyond single-ownership scenarios to the larger multiple stakeholder “settlement” value. This is what will lead to new dimensions for the national solar market through economic and other market drivers. In this manner, new PV-based economical and financial models for building and urban market should be developed. In addition, new utility tariffs, community policy, and industry deployment strategy can be used to create the new economical scenarios.

Urban Planning, Design and Development. Special urban –scale guidance should be developed. This should cover how to integrate photovoltaics into planning and design models, tools, practices, and community energy infrastructure planning. In addition, stress should be placed on integrating PV and the whole community energy infrastructure elements into urban planning practices through a guide providing processes and approaches for setting quantifiable environmentally aware urban-PV to achieve the needed goals and objectives of the arid region planning process.

Technical Factors. The technical development factors of mainstream urban-scale PV are the main barriers, as large-scale urban integration of PV systems faces technical challenges related to its synergistic use as a building material and for energy supply purposes. On the other hand, technical factors related to the planning, infrastructure and building codes have to be taken in account.

Targeted Information Development and Dissemination. This is one of the main aspects that should begin immediately. It will be the base for building the qualified human capabilities that will be involved in the new development process as a whole. In addition, it should also be directed to increase the public awareness, which plays an initial role - according to the Egyptian experiences. In this manner, new educational modules should be developed especially for urban planner and architectures besides the renewable energy developers. The international UIPV community co-operation can help through experiences and knowledge transferring strategies.

(d) PV Building Design

Involving the urban planner and architectural designer side by side to the renewable energy and PV experts should be done in order to achieve the following:

Energy Technologies

More effort should be done for developing more economical PV systems, as the financial aspects form one of the main barriers facing the penetration of such technologies in the urban community, especially for a developing country such as Egypt. In this manner, sustaining the Egyptian researches being done now to develop new chemical PV modules will introduce a good solution, as this new type will be characterized with its lower cost. This will help supporting the transformation to enhance the use of PV in building design.

BIPV: Integration Concepts. Till now, despite of some so limited examples, the Egyptian experiences in using PV systems is concentrated on few small remote-uses such as water pumping or street signs...etc. This is due to the absence of role of the urban planner and architectural designer, and that the whole PV development process in Egypt is done through only the Egyptian energy authorities. Thus, this should be changed, and by involving the urban planners and architectural designers, more new PV integration models can be achieved. In this manner, two key aspects can help; new urban architectural educational modules, and the international experiences.

BIPV and Environmental Strategies. PV should be used as an environmental strategy that provides the comfortable environment in the arid regions community. Thus, it will be needed to readapt the traditional planning and building design schemes, and enhancing the use of new PV-based forms and design models. In this manner, Egypt should benefit from the experiences gained through the project of MASDAR city as a model for building an arid PV-based community within the frame and environmental aspects of urban planning and building design of the traditional arid region community.

BIPV and Building Types. Though PV can be integrated into every building type, PV integration concepts and opportunities can vary from one building type to another. Therefore, new models for using building integrated PV for the Egyptian building types that suites the constraints of the Egyptian arid regions environmental conditions should be developed.

Also, concentrating on the public building at the first stages will be , according to the Egyptian experiences, more better ,and will help increasing the public awareness with PV technology.

6.4.4.3. A Solar City Program for Egypt

As noted before, a solar city program will be the development mechanism, by adopt an “arid regions solar city path or program”, which will form the tool to establish an UIPV in Egypt for arid region communities at both of the new and exiting communities. This is through main tasks that are including, according to Droege (2007); city strategies and planning tools; baseline studies, targets and scenarios; and renewable energy technology and business development. The program will help offering the knowledge about urban planning tools and organizational arrangements suitable to transform cities and communities into UIPV communities. This is besides offering the knowledge about the role of innovative solar and other renewable energy systems in making cities environmentally more sustainable.

6.5. General Conclusion

The study has shown that arid regions are an important part of the world as they cover more than 40% of the land surface and it can provide sufficient opportunities for extensive development as they have many advantages particularly in fields of agriculture, mineral excavations, tourism expansion, industry, and renewable energy. However, urban development approaches in general, especially in developing countries, have focused on the physical sides of the urban development, and mainly on how to maximize the use of these regions potentials. As a result, a set of problems have occurred at the level of community development, and at the other related levels as environmental and socio-economical levels. This is besides the development barriers due to the arid regions climate associated with a set of economical, social, administrative and physical problems. This is also besides urban environment poverty, dispersed human settlements, poor infrastructure, and low urban densities with few job chances.

The Egyptian arid regions are also suffering from these problems, which affected its urban development. Nowadays, it became so important to adopt new development approaches for these regions, as they become the main target and only solution for the overloaded population in the old valley. Especially that, though the continuous efforts and sets of urban development strategies and plans during the last decades, we have not gained the hoped results until now.

From another point of view, the study has also demonstrated the role of renewable energy resources to achieve sustainability and particularly in arid regions. This is especially after the recent researches, which have approved that depending on large-scale solar energy developments in arid region will be one of the most promising sources of energy in the near future, not only for these regions' energy demands but also for providing energy for the neighbor-regions such as Europe. This is besides the global direction to transform cities and settlements into new power stations, through integrating renewable energy applications intensively in urban-scale schemes. This is also as a tool to achieve a general sustainable development , not only at the level of urban development, due to the integral nature of energy in communities, where efficiency gained in one sector lead to related improvement in other sectors.

In this realm, the study has shown that urban integrated photovoltaic (UIPV) development can be an approach for achieving all the development goals of arid regions communities, not only at the urban level but also at all the other development levels. Besides, it will help creating communities that are more comfortable. This is through the parallel application of passive urban planning and building design. However, by demonstrating the recent approach of UIPV development, the study concluded that four main elements must take place in any UIPV development process, which includes development framework, development policies, planning and development, and building design.

In addition, the study has used these four elements to develop an UIPV model. This is in order to use it as a tool in analyzing the research case studies and in comparing them with the Egyptian situation to define the barriers facing the Egyptian trials to establish an Egyptian UIPV development. The study has introduced two case studies beside the Egyptian one. They are including case of the OECD countries and MASDAR city – the UAE.

With reference to UIPV model, the study has found that, in the case of the OECD countries they have succeeded to develop an UIPV model covering all the main elements that are needed for an UIPV development process. This explains the success of the new project to integrate PV at both levels of BIPV and UIPV scale. In the case of MASDAR city, Abu Dhabi and the UAE have succeeded to begin building their capacities in the field of UIPV development through a full co-operation with the most powerful experiences and capacities worldwide. They have sustained the UAE to build its local capacities in the first stage, and which will take place in the second stage of the project, and the other UIPV projects according to the country development strategy in the future. In addition, the study has proven through this example that there is no collision between developing arid region communities as an UIPV communities and applying the initial characters and passive planning design strategies needed for achieving human comfort in such regions communities.

Finally, through analyzing the case of UIPV in Egypt and the trial of New Toshka city with reference to the UIPV model and by comparing it to the pervious two case studies, the study has found that there is a total absence for a real UIPV development in case of Egypt. This is what had affected the whole UIPV development process. Therefore, it will be difficult to achieve a successful UIPV development process in Egypt without preparing the urban system as a well organized suitable UIPV model as an initial step. In addition, this should be done with reference to the environmental design constraints of the Egyptian arid regions through a well-prepared passive design aware strategies and models to decrease the energy demands, and to achieve the human comfort. This will also act as a tool to make a balance between the arid region communities' energy demands and the needed scale of PV integration. In this manner, depending on the results of the previous case studies and international approaches for UIPV development besides the UIPV model developed in chapter 4, the study has introduced a development plan for achieving UIPV development in Egypt that can be a "Road Map" for the next decades.

6.6. General Recommendations

First, the change for establishing a real complete UIPV development in Egypt will be a new approach for urban development, which will be associated with several complicated barriers. Therefore, a special supporting from a special framework beyond the governmental support will be necessary. In this realm, I recommended a coalition consist of all the Egyptian architectural departments at all the Egyptian universities with the New and Renewable Energy Authority (NREA), and Environmental Research Institute – Ain Shams University. This coalition should sustain a “White Paper” for establishing an UIPV in Egypt. This “White Paper” can be the first pushing-forward-element in the first stage of the development plan, which has been introduced in the study.

In addition, to sustain establishing such UIPV development in Egypt, I recommended the following:

- There is a need for action plans to direct the architectural planning education to begin integrating special modules concerning the topics of renewable energy, building integrated photovoltaics (BIPV), urban integrated photovoltaics (UIPV), urban integrated renewable energy...etc. In addition, it is recommended to give more stress on such topics for postgraduate studies.
- There is a need for innovative public awareness programs. This issue was the main reason for the failure of vast all the trials to integrate renewable energy applications, especially PV application, in the Egyptian communities.
- There is a need to begin special projects, studies and discussions about the renewable energy financing model, as it is one of the major elements affected the penetration of such applications in any country.
- In order to support an Egyptian PV industry at the first stages of the UIPV development plan, a set of

innovative advantages for the end-user of such development should be offered. This is as a tool to encourage the people to use these applications.

- There is an urgent need to sustain the renewable energy industries especially PV industry. This will play an initial role to make renewable energy applications more economical in the future, especially by supporting the mass-production schemes that can be associated with the urban development process.
- For example, the actual energy code for building contains only four sentences concerning renewable energy in general. Therefore, the actual building and urban codes and regulations should be reviewed and adopted with consideration to renewable energy and PV applications.
- More stress should be done on the role of international co-operation in this field. In this realm, more efforts can be done to sustain the process of knowledge and technology transferring from countries with experiences in the field. The foreign universities in Egypt can play a role in this process, for example, the German University in Cairo (GUC). It can provide educational modules, workshops gathering with the German experts, planners and architects with experiences in this field, with the Egyptian planners and architectures. Not only that, but it can also act as a gate for the German PV manufactures and industry leaders for the Egyptian market. This is especially with the actual Egyptian advantages offered for the foreign investment.

Appendix I

EU Solar Cities :Good Practice Matrix

An example for the OECD cities: “Freiburg im Breisgau” matrix

Source: EU Solar Cities , http://sc.ises.org

	Awareness & Campaigns	Economic Advantages / Job Creation	Education & Training	Financial Mechanisms / Subsidies	Policy & Standards	Technology Developed / Tested
Industry Sector	Development of the ‘SolarRegion Freiburg	Development of the ‘SolarRegion Freiburg Job creation in the RE industry	Job creation in the RE industry	City cooperation with local utility badenova	Development of the ‘SolarRegion Freiburg’	Development of the ‘SolarRegion Freiburg’
	Awareness & Campaigns	Economic Advantages / Job Creation	Education & Training	Financial Mechanisms / Subsidies	Policy & Standards	Technology Developed / Tested
Public Sector	Involvement of the local Agenda 21 office City cooperation with local utility badenova Development of the ‘SolarRegion Freiburg’ City support for role of environmental NGOs Cooperative wind and solar energy projects	Development of the ‘SolarRegion Freiburg	None	City cooperation with local utility badenova	City cooperation with local utility badenova Development of the ‘SolarRegion Freiburg	Development of the ‘SolarRegion Freiburg’
	Awareness & Campaigns	Economic Advantages / Job Creation	Education & Training	Financial Mechanisms / Subsidies	Policy & Standards	Technology Developed / Tested

Residential Sector	Involvement of the local Agenda 21 office City cooperation with local utility badenova Development of the ‘SolarRegion Freiburg’ City support for role of environmental NGOs Development of new districts - Vauban and Rieselfeld Cooperative wind and solar energy projects	Development of the ‘SolarRegion Freiburg’ Job creation in the RE industry	Involvement of the local Agenda 21 office Cooperative wind and solar energy projects	City cooperation with local utility badenova Development of new districts - Vauban and Rieselfeld Cooperative wind and solar energy projects	Development of the ‘SolarRegion Freiburg’	Development of the ‘SolarRegion Freiburg’ Development of new districts - Vauban and Rieselfeld Cooperative wind and solar energy projects
	Awareness & Campaigns	Economic Advantages / Job Creation	Education & Training	Financial Mechanisms / Subsidies	Policy & Standards	Technology Developed / Tested
Transport Sector	Development of the ‘SolarRegion Freiburg’ Implementation of a sustainable transport concept	Implementation of a sustainable transport concept	None	None	Implementation of a sustainable transport concept	None

DEUTSCHE ZUSAMMENFASSUNG

Entwicklungskonzepte und Implementationsstrategien für neue Siedlungen

Erneuerbare Energie und nachhaltige urbane Entwicklung in ariden Regionen

Ägypten

o Thema

Seit dem Ende des 2. Weltkrieges nahm die Bevölkerung in den ariden und semiariden Regionen sehr stark zu. An dieses Wachstum gekoppelt ist eine urbane Entwicklung, die bisher überwiegend auf westliche Muster ausgerichtet ist. Nachhaltige Konzepte, die an die geschichtlich gewachsene Bautradition und Stadtkultur anknüpfen, haben in den letzten Jahrzehnten – einige Modellprojekte ausgenommen – kaum eine Chance gehabt.

In den letzten beiden Jahrzehnten hat die ägyptische Regierung eine neue Strategie für die Siedlungsentwicklung erarbeitet, die eine Expansion außerhalb des alten Niltals anstrebt. Mit der Realisierung dieser Strategie wird sich das Land enorm weiter-entwickeln. Die Pläne zur Ausweitung der Siedlungsfläche über das alte Niltal hinaus dürfen jedoch nicht dazu führen, dass die Entwicklungsprozesse in den bestehenden Gemeinden abgebrochen werden. Es müssen die Bemühungen beibehalten werden, nachhaltige Entwicklung gleichermaßen in die bestehenden wie in die zukünftigen Gemeinden zu implementieren.

Nach Lage der Dinge besteht ein großes Risiko, dass die Wohnungsversorgung der schnell wachsenden Bevölkerung dazu führt, dass die Balance zwischen wirtschaftlichen, ökologischen und sozialen Zielen etwas aus dem Blick gerät und vordergründige politische Erfolge ohne nachhaltige Effekte angestrebt werden.

So weisen die von der Regierung geplanten Siedlungen ohne ein Eingehen auf die örtlichen Bedingungen, ohne Berücksichtigung ökologischer Kriterien und ohne soziale und finanzielle Konzepte keineswegs in die Zukunft. Schwierig ist überdies, dass sich große Siedlungsgebiete für die wachsende Bevölkerung nur in entfernten oder klimatisch problematischen Trockengebieten realisieren lassen. Weiterhin sind die bestehenden Hauptprobleme der ägyptischen Gesellschaft nicht zu vergessen: niedriges Einkommen, schlechte Umweltbedingungen, hohe Arbeitslosigkeit und wirtschaftliche Armut. Aufgrund der Vernachlässigung dieser Probleme erscheint der jetzige urbane Entwicklungsansatz für die Lösung der gesellschaftlichen Probleme der ägyptischen Gesellschaft nur bedingt geeignet.

Eine besondere Chance würde darin liegen, den seit der Energiekrise der siebziger Jahre deutlich gewordenen Zusammenhang zwischen den energetischen Ressourcen und der urbanen Entwicklung in den Fokus der Stadtentwicklung zu stellen. Inzwischen ist es unübersehbar, dass sich die zukünftigen Generationen mit zwei globalen Risiken auseinandersetzen werden müssen, die die urbane Entwicklung bedrohen werden: die Erschöpfung der fossilen Kraftstoffe und die durch Menschen induzierten Klimaveränderungen. Es besteht in der aktuellen Literatur kaum Uneinigkeit darüber, dass diese Gefahren - wenn ihnen nicht schnell und effektiv entgegengewirkt wird - Auswirkungen auf die gesamte industrielle Welt und das urbane System haben werden und dass die Ballungszentren der sich entwickelnden Welt besonders hart betroffen sein werden. Daher wird sich die Stadtgesellschaft nicht zuletzt in den heißtrockenen Gebieten als Schauplatz für die überfällige alternative Politik erweisen; eine Politik, die insbesondere auf die Einführung erneuerbarer Energien setzt. Die Vorteile liegen auf der Hand: Im Rahmen synergetischer Konzepte können nachhaltige Energie- und Stoffkreisläufe realisiert werden und das enorme Potential der heißtrockenen Gebiete kann unmittelbar genutzt werden.

Ausgehend von diesen Überlegungen stellt die Dissertation eine Verbindung zwischen der urbanen Entwicklung in heißtrockenen Gebieten und den erneuerbaren Energien (z. B. Photovoltaik - PV) her. Im Zentrum der Arbeit steht der Ansatz, die urban integrierte Photovoltaik (UIPV) als neuen Ansatz für den Bau zukunftsweisender Siedlungen zu bestimmen. Dabei geht die Studie davon aus, dass dieser Ansatz die Entwicklung der Gemeinden in heißtrockenen Gebieten beflügeln könnte. Weiterhin besagt die Studie, dass die Entwicklung von Gemeinden in ariden Zonen innerhalb eines Konzepts „Urbane Entwicklung mit integrierter erneuerbarer Energie" passende Lösungen für die jetzigen urbanen Hauptprobleme anbietet.

In ihren räumlichen Bezügen konzentriert sich die Studie auf Ägypten. Aufgrund übertragbarer geographischer, geologischer und klimatischer Bedingungen gilt Ägypten aber auch als Beispiel für die heißtrockenen Gebiete insgesamt. Aufgrund der besonders intensiven Sonneneinstrahlung liegt es nahe, sich im energetischen Bereich auf die Photovoltaik als eine der wichtigsten erneuerbaren Energiequellen zu konzentrieren. In letzter Zeit versucht auch Ägypten, einige Gemeinden zu gründen, die Solarenergie nutzen. Im Unterschied zu den bekannt gewordenen internationalen Beispielen werden diese Versuche durch Hindernisse beeinträchtigt. Daher ist es das Ziel der vorliegenden Studie, diese Anfänge in Beziehung zu internationalen Beispielen zu setzen.

- Zentrale Fragestellung

Im Zentrum der Dissertation steht die Frage: Kann die Integration von Konzepten zur Nutzung erneuerbarer Energien mit Konzepten zur urbanen Entwicklung eine neue ökologische Qualität beim Bau von neuen zukunftsfähigen Siedlungen in heißtrockenen Regionen, insbesondere in Ägypten, erreicht werden?

Die Fragestellung berührt drei Untersuchungsebenen:

- urbane Entwicklung in heißen ariden Regionen,
- ökologisch nachhaltige Ansätze,
- urbane integrierte erneuerbare Energieplanung und Entwicklung.

Bezogen auf diese Untersuchungsebenen werden folgende Fragen formuliert:

- Was ist eine aride Region und wodurch ist sie charakterisiert?
- Welche Ansätze wurden in der Entwicklung der heißen ariden Regionen in den letzten Jahrzehnten berücksichtigt?
- Welche Probleme sind in ihrer Entwicklung aufgetreten?
- Besteht ein Bedarf, neue urbane Entwicklungsansätze für heiße aride Regionen bzw. Gemeinden zu finden?
- Wie kann erneuerbare Energie in die urbane Planung integriert werden?
- Was ist der Zusammenhang zwischen erneuerbarer Energie und nachhaltiger Entwicklung?
- Kann eine erneuerbare Energieentwicklung, z. B. PV, eine wesentliche Rolle bei der Lösung der Probleme der Siedlungsentwicklung in ariden Regionen spielen? Entwickelt sich hier ein ökologisch nachhaltiger Ansatz in der urbanen Entwicklung?
- Kann dieser Ansatz ein passender und nachhaltiger für die Entwicklung neuer ägyptischer Gemeinden sein?

In Verbindung mit diesen Fragen werden folgende Hypothesen formuliert:

- Gemeinden in heißen ariden Regionen, insbesondere die neuen Gemeinden, stehen einer Anzahl von ökologischen und sozio-ökonomischen

Problemen gegenüber, die innerhalb des urbanen Entwicklungsprozesses gelöst werden müssen, um eine nachhaltige urbane Entwicklung zu ermöglichen.

- Diese nachhaltige urbane Entwicklung kann nicht ohne die Festlegung von neuen nachhaltigen urbanen Entwicklungsansätzen erreicht werden, welche auf der Überzeugung beruhen, dass das jetzige wirtschaftliche und sozial-politische System innerhalb des urbanen Entwicklungsprozesses restrukturiert werden muss. Die Benutzung von erneuerbarer Energie, z. B. PV, könnte einen konsensfähigen Einstieg in die erforderlichen Reformen ermöglichen.
- Urbane integrierte erneuerbare Energie, z. B. urban integrierte Photovoltaik, kann ein neuer „ökologischer Ansatz" beim Bau von neuen zukunftsfähigen Siedlungen in heißen ariden und semi-ariden Regionen, insbesondere in Ägypten, sein. Dies soll unter Bezugnahme auf ein komplettes System oder Entwicklungsmodell, wie das UIPV-Entwicklungsmodell, untersucht werden.

o Untersuchungsmethode

Um die Untersuchungsziele abzudecken, werden drei methodische Ansätze gewählt:

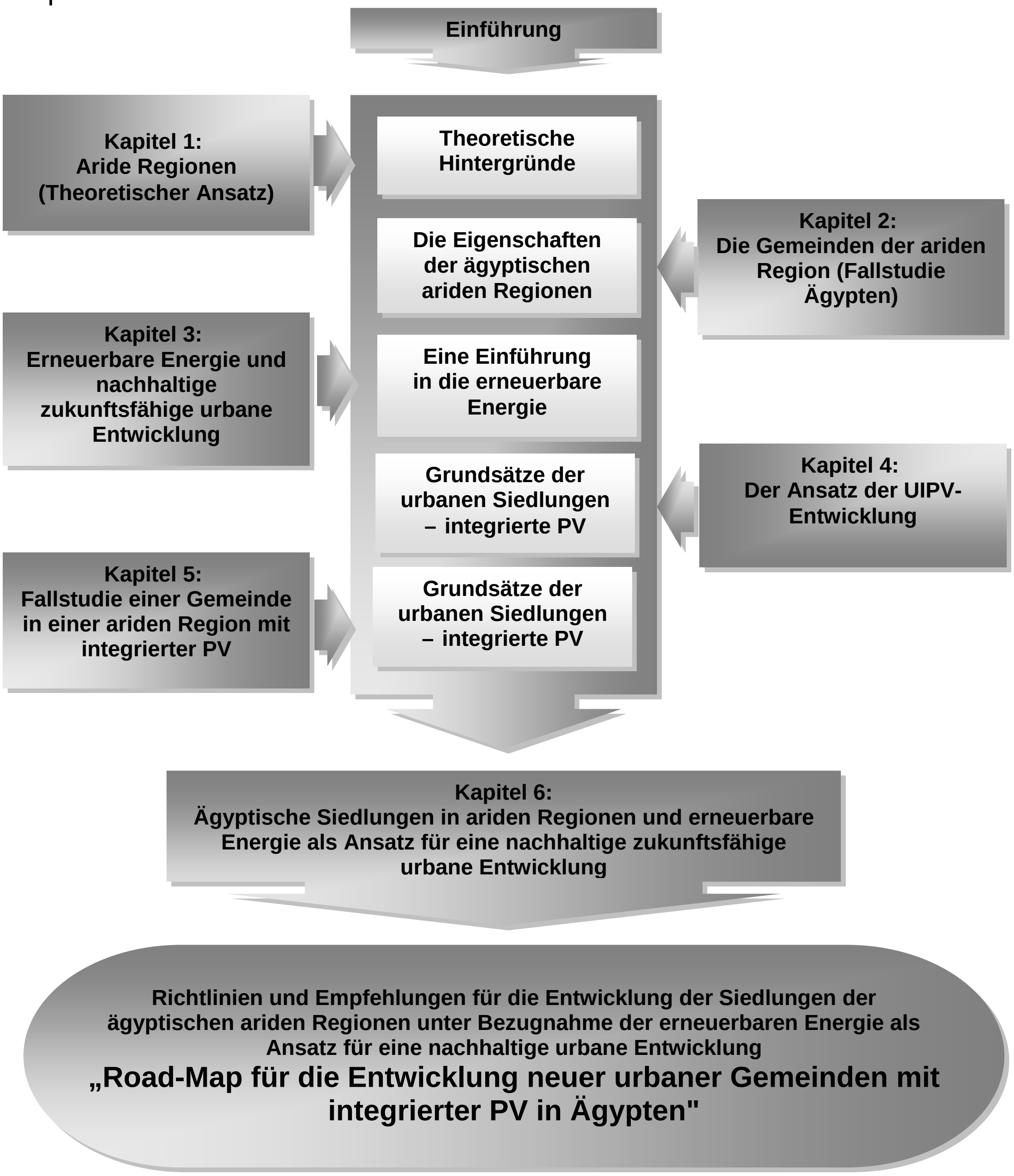
Der theoretische Ansatz, welcher die Dimensionen der Dissertation auslotet und die wesentlichen Begriffsdefinitionen liefert: aride Regionen, nachhaltige und zukunftsfähige Entwicklung, erneuerbare Energie und urbane integrierte erneuerbare Energie, z. B. Entwicklung urbaner integrierter Photovoltaik.

Der historische Ansatz, welcher die städtebaulichen und gebäudebezogenen Konzepte in den heißen ariden Regionen, insbesondere Ägyptens, und die Siedlungsentwicklung im Laufe der Zeit behandelt.

Der analytische Ansatz, welcher eine Analyse gemäß der Ergebnisse der theoretischen und historischen Ansätze der Nutzung von erneuerbaren Energien, z. B. Photovoltaik, als Ansatz für eine nachhaltige zukunftsfähige urbane Entwicklung in den Gemeinden der ägyptischen heißen ariden Regionen darstellt.

o Struktur und Aufbau der Untersuchung

Diese Studie umfasst eine Einleitung und 6 Hauptkapitel:



Struktur der Studie

Einführung

Am Anfang der Dissertation wird ein Überblick gegeben über die urbanen Herausforderungen in den heiß-trockenen Gebieten, die Zielsetzungen der Studie und die gewählten Methoden.

Kapitel 1: Aride Regionen (Theoretischer Ansatz)

Ausgehend von einschlägiger Literatur werden die Merkmale der heißtrockenen Zonen bestimmt, ihre Eigenschaften und Komponenten dargestellt. Der Schwerpunkt liegt hier auf der Ebene urbaner Entwicklungspolitik und -strategien. Es wird deutlich, vor welchen Problemen die urbane Entwicklung in diesen Regionen steht.

Kapitel 2: Die Gemeinden der ariden Region (Fallstudie Ägypten)

Die Gemeinden der ariden Regionen in Ägypten sind Gegenstand staatlicher Stadtentwicklungspolitik. Daher konzentriert sich dieses Kapitel auf die urbane Entwicklung in Ägypten, insbesondere auf die geschichtliche Entwicklung der Gemeinden in den ariden Regionen. Des Weiteren analysiert die Studie die jetzige ägyptische Städtebaupolitik und deren Auswirkung auf die Entwicklungschancen in den Gemeinden der ariden Regionen. Hier wird deutlich, wie dringlich die Festlegung eines neuen Ansatzes für die nachhaltige urbane Entwicklung ist.

Kapitel 3: Erneuerbare Energien und nachhaltige zukunftsfähige urbane Entwicklung

In diesem Kapitel werden die Möglichkeiten zur Nutzung erneuerbarer Energien in der Stadtentwicklung aufgezeigt. Es kann verdeutlicht werden, dass die Nutzung neuer Energiequellen – von Photovoltaik und Windkraft bis zu Biomasse und Wasserkraft – sich perfekt in eine Konzeption nachhaltiger Stadtentwicklung einfügt.

Kapitel 4: Der Ansatz der UIPV-Entwicklung

In diesem Kapitel beschreibt die Studie den Ansatz für die „UIPV-Entwicklung" (urbane integrierte Photovoltaik) in ariden Regionen. Die Grundlage bieten die jüngsten Ansätze der „UIPV-Entwicklung" der OECD-Länder (Organisation für wirtschaftliche Zusammenarbeit und Entwicklung).

Kapitel 5: Fallstudie von Gemeinde in einer ariden Region mit integrierter PV

In diesem Kapitel wird die Fallstudie einer neuen UIPV-Entwicklung in ariden Region vorgestellt, z. B. die Siedlung MASDAR in Abu Dhabi, welche anhand des UIPV-Entwicklungsmodells analysiert wurde.

Kapitel 6: Ägyptische Siedlungen in ariden Regionen und erneuerbare Energien als Ansatz für eine nachhaltige zukunftsfähige urbane Entwicklung

Dieser Teil untersucht die Entwicklung der erneuerbaren Energien, insbesondere PV, als einen Ansatz für die urbane Entwicklung in Gemeinden der ägyptischen heißtrockenen Regionen. Hier wird das UIPV-Entwicklungsmodell angewandt, das in Kapitel 3 entwickelt wurde. Die Studie liefert eine Analyse laufender innovativer Projekte. Außerdem wird die Rolle der erneuerbaren Energien als strategisches Element in der urbanen Entwicklung beschrieben. Der Vergleich des ägyptischen Ansatzes mit den vorher untersuchten Fallstudien belegt, vor welchen Hürden das UIPV-Entwicklungsmodell in Ägypten steht. Abschließend wird in diesem Kapitel eine Road Map für die UIPV-Entwicklung in Ägypten vorgestellt.

List of References

- Abd-Elaal, Mohammad (2002) Sustainable Communities Depending on Renewable Energy, M.Sc. Thesis, Faculty of Engineering, Cairo University, Giza.
- Abd-Elkader, Nasmat & Eltony Said (1997) Urban Patterns, n.p.,Cairo.
- Aboulnasr , Sherif (2002) Renewable Energy In Egypt Strategy, Achievements and Plans, NREA, Cairo
- Ahmed, Ahmed R. (1985) Development and Planning of Arid Zone of Egypt, M.Sc. Thesis, Faculty of Engineering, Cairo University, Cairo.
- Ali, Emad El-Den(2003) VISUAL DESIGN GUIDELINES, Ph.D., Faculty of Engineering, Stuttgart Uni., Stuttgart.
- Alnaem, Mashary(2004)The Traditional Architecture: "El-Ehsaa" example, Albenaa Magazine, Vol.163, Riyadh.
- Baker, Randall (1980) The Arid Zones: Resources, Research and Land Management, Development Studies OCCASIONAL PAPER, Uni. Of East Anglia
- Boyle, Godfery (2004) Renewable Energy: Power for a Sustainable Future, Oxford university Press, Oxford.
- British Petroleum Company (BP) (2002) 2002. BP Statistical Review of World Energy (51st Ed. ed.), BP
- Brown, L. & Jacobson, J. L.(1990) Land Use and Urbanization: Ecological and Economic Factors, Transaction Publishers, New Brunswick
- Brown, L. & Jacobson, J. L.(1990) Land Use and Urbanization: Ecological and Economic Factors, Transaction Publishers, New Brunswick.
- CAPMS – Central Agency for public mobilization and Statistics (2004) The Statistical Year Book: 1995-2003, CAPMS,Cairo.
- CDI & UNDP (200) world energy assessment: Energy and the Challenge of Sustainable Development, Bureau for Development Policy, New York.
- CDI & UNDP (2000) world energy assessment: Energy and the Challenge of Sustainable Development, Bureau for Development Policy, New York.
- CEC (1997) The Energy Yardstick: Using PLACES to Create More Sustainable Communities, U.S. Department of Energy, California.
- CEC(1997) The Energy Yardstick: Using PLACES to Create More Sustainable Communities: Executive Summary, U.S. Department of Energy, California,
- Cowan, Stewart & Sim Van Der Ryn (1996) Ecological Design , Island Press, Washington D.C.
- CPAS – Center of Planning and Architectural Studies (1999) Toshka City Design and Planning Competition: a review, Alem Al Bena'a, CPAS, Cairo.
- David Faiman (2004) Encyclopedia of Energy: Impacts of Energy Development in Arid Environments, Ben-Gurion University of the Negev, Beer-Sheva.
- Davidson, Sarah (2005) Task 1 Exchange and Dissemination of Information on PV, power systems, National Survey Report of PV Power, Applications in the United Kingdom 2004 IEA, The UK Department of Trade and Industry, Chineham.
- DKonya, Allan (1980) Design Primer for Hot Climates, The Architecture Press Ltd, London.
- DOE-Technical Information Program (1996) Linking Energy Use and City Planning, DOE Office of Energy Efficiency and Renewable Energy, Portland.
- Dostrovsky, I.(1988) Energy and the Missing Resource – A View From the Laboratory , Cambridge Uni. Press, Cambridge.
- Droege, Peter (2002) Task 30 Solar City: Solar Heating and Cooling Implementing- Final Draft V

2.1, AgreementIEA (International Energy Agency), n.p..
- Droege, Peter (2007) The Renewable City: A comprehensive guide to an urban revolution, Willy & Sons, London.
- Dürrschmidt, Wolfhart (2004)Renewable Energies: Innovation for the Future, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Berlin
- Ebadah, Galal (1999) Toshka City Design and Planning Competition, Madina, Issue10, Cairo.
- EIA-PVPS (2006) Annual report 2006: Implementing Agreement on Photovoltaic Power Systems, EIA, Fribourg.
- ElBaz, Farouk (1984) Deserts and Arid Lands, Martins Nijhoff Publishers, The Hague.
- Elbaz, Farouk (2005) The New Parallel Valley Away for Development in Egypt, TV Programme By AlJazeera, AlJazeera, Doha, 21.09.2005.
- EL-Hefnawi ,Said H. (2005) Photovoltaics Applications and Research in Egypt and Marketability of PV in Developing Countries, V o l u m e 1,ISECO Science and Technology Vision, n.p.
- ENERGIE (2001) The Solar City Guide – new solution for Energy Supply, EUROPEAN COMMISSION, Barcelona.
- Energie-Cités (2002) Photovoltaic: Amersfoort - The Netherlands, Energie-Cités, n.p.
- Enrique Campos-lopez & et al (1983) Natural Resources and Development in Arid Regions, Westview Press,USA.
- EU Solar Cities (2004) Solar Cities :European Habitats of Tomorrow - Good Practice Guide, European Commission, DG TREN, EESD Programme, n.p.
- Eurosolar (1996) 5th European Conference – Solar Energy in Architecture and Urban Planning : Building a new Century, Bonn
- Eurosolar (2001) 6th European Conference – Solar Energy in Architecture and Urban Planning: The city –a solar power station, Bonn
- Eurosolar e.V.(2001) The City – A Solar Power Station, Eurosolar, Bonn
- FAO (1999) Cultivating Our Futures - BACKGROUND PAPERS, Netherlands,
- Fathy ,Hassan (1986) Natural Energy and Vernacular Architecture, the United Nations , the University of Chicago Press, Chicago.
- Fekry ,Khaled M. M. (2006) Renewable Energy in Egypt, Grid-Connected Projects,International Grid Connected Renewable Energy Policy Forum Connected Renewable Energy Policy Forum Mexico city.
- Ferdowsian , Fereshteh (2002) Modern and Traditional Urban: Design Concepts and Principles in Iran, Ph.D., Faculty of Architecture, Stuttgart Uni. ,Stuttgart.
- Findlay, Allan M. (1996) Policy and Research Paper N°10: Population and Environment in Arid Regions, International Union for the Scientific Study of Population (IUSSP), n.p..
- Ghanbran , Abdul Hamid (2004) Iranische Basare im Wandel , Ph.D., Faculty of Architecture, Stuttgart Uni. ,Stuttgart.
- Golany,Gideon S.(1980) Housing in arid lands, Architectural Press, London.
- Golany,Gideon S.(1982) Desert planning, the Architectural Press, London.
- Golany,Gideon S.(1983) Design for Arid Regions, van Nostrand Reinhold compny Inc., n.p..
- Goldemberg, José (2004) The Case for Renewable Energies: Thematic Background Paper International Conference for Renewable Energies, Bonn.
- Grassi, Angela & et al (2000) How to Integrate Renewable Energies in European Cities, ETA, Florence.
- Gunßer, Chistoph (2000) Energiesparsiedlungen: Konzepte, Techniken,realisierte Beispiele,Callway, München.
- Hagemann, Ingob.(2002)Gebäudeintegrierte Photovoltaik: Architektonische Integration der

Photovoltaik in die Gebäudehülle, Rudolf Müller, Köln.
- Hamad, Mahmoud (n.d.) , an analysis for the home of Elbahria Oasis: part 2, Alam Albinaa, Cairo,Vol.207.
- Hamad, Mahmoud (n.d.) , an Analysis for the home of Elbahria Oasis: part 1, Alam Albinaa, Cairo,Vol.206.
- Harris , Jeremy (2005) Building Sustainable Cities – Its All About Design, the second international symposium on the topic of Urban Design in Arid Regions, The School of Architecture at the University of Arizona, Arizona.
- Harrison ,Paul ,et al (2001) Deserts and Drylands, Population and Ecosystems, AAAS Atlas of Population and Environment, University of California Press,
- Hegab, M. Salah-Eldin (1984) new Towns Policy, Cairo.
- Herzog, Thomas (1998) Solar Energy in Architecture and Urban Planning, Prestel, München.
- Hsin, Robert (1996) Guidelines and Principles for Sustainable Community Design- A study of sustainable design and planning strategies in North America from an urban design perspective, M.Sc. thesis Florida A&M University, School of Architecture, Florida.
- IEA International Energy Agency (2006) , IEA-PVPS ANNUALREPORT 2006, Implementing Agreement on Photovoltaic Power Systems, IEA, n.p.
- IFAD (2000) IFAD Technical Advisory Division Staff Working Paper No. 29, International Fund for Agricultural Development ,Rom.
- IUCN (2003) Sustaining Environment and Development in The World's Arid And Semi-Arid Lands, Guidelines for Extractive Industries in Arid and Semi-Arid Zones, Draft for Consultation, n.p..
- Johannesson, Michael (2001) PV in Non Building Structures- a design guide, EIA-PVPS: Task7,EIA, Stockholm.
- Johansson, Thomas B., et al (2004) The Potentials of Renewable Energy: Thematic Background Paper International Conference for Renewable Energies, Bonn.
- Jones, David Lloyd (2000) The solar Office Doxford International, the Energy Technology Support Unit, np.
- Jones, Lloyd, etal (1998) The Solar Office: A Solar Powered Building With A Comprehensive Energy Strategy, at the 2nd World Conference on Photovoltaic Solar Energy Conversion, Vienna,
- Konya, Allan (1980) Design Primer for Hot Climates. Architectural, London.
- Kultermann, Udo (1980) Architekten der Dritten Welt,DuMont Buchverlag, Köln.
- Kurokawa, K. (2003) Energy from the Desert: Feasibility of Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems, James & James, London.
- Meselhy, Fathy (2001) The Egyptian deserts and desert Development: 3rd Part, El monofia.
- Ministry of Housing, Infrastructure and New Communities (2000) Mubark and Urbanism, Ministry of Housing, Infrastructure and New Communities, Cairo.
- Money,D.C.(1982) Arid lands Characteristics and Development, Evans Brothers limited, n.p..
- Moore, Suzi & Moore, Terrence (1995) Under the Sun: Desert Style and Architecture, Bulfinch Press Book, Boston.
- Mountjoy, Alan B. (n.d.) Egypt Cultivates her Desert, Geographical Magazine, n.p.
- Nasr, Mervat (2000) Integrated Desert Development towards Sustainable Settlement, Ph.D. study, Faculty of Engineering, Cairo Uni., Cairo.
- Natural Resources Canada (2001), An Introduction to Photovoltaic Systems, Natural Resources Canada, Ottawa.
- Novem (2007) PV Noise Barrier A27 – Netherlands, Novem,

- NREA (2006) Annual Report, NREA, Cairo.
- NREA (the New and Renewable Energy Authority-Egypt) (1991) Solar Atlas-Egypt, NREA, Cairo.
- NUCA (n.d.) New Toshka City: examples from the Competition, NUCA, Cairo.
- Owenes, Susan (1987) Energy Planning and Urban Form, Poin Limited, London.
- Pagani, Roberto(1996) Urban Strategies and Energy Technologies: managing bottom-up change, Preparatory Working Group for the Building Sector, European, Brussels.
- Prasad, Deo & Snow, mark (2005) Designing with Solar Power: a source Book for Building Integrated Photovoltaics (BiPV), Earthscan, London.
- PV-TRAC - the Photovoltaic Technology Research Advisory Council (2005) , A Vision for Photovoltaic Technology , Directorate-General for Research Sustainable Energy Systems, Belgium
- Radwan, Samir (2002) Employment and Unemployment in Egypt: Conventional Problems, Unconventional Remedies, The Egyptian Center for Economical Studies, Cairo.
- Ramadan, A.Rahman(2007) NREA Activities and Plans, NREA , Cairo.
- Ramage, Janet (1997) Energy-A guidebook, Oxford Uni. Press, Oxford.
- Richards,J.M.(1985) Hassan Fathy, Concept Media Pte Ltd, London.
- Richardson, N.(1989) Land Use Planning and Sustainable Development in Canada, Canadian Environmental Advisory Council, Environment Canada, Ottawa.
- Richardson, Nigel H. (1994) Making Our Communities Sustainable: The Central Issue is Will, Hygeia Consulting Services, Toronto.
- Robin P. White & Janet Nackoney (2003) Drylands, People, and Ecosystem Goods and Services: A Web-Based Geospatial Analysis, World Resources Institute, N.P..
- Roslund, Hans(1995) Design for Desert- An architecture's approach to passive climatistion in hot and arid regions, School of Architecture, Lund Uni, n.p..
- Saad, Fatma(1994) The New and Renewable Energy in Egypt, A Study in the Energy Geographical Status, Ph.D. Thesis, Ain-Shams University, Cairo (Arabic)
- Sabry, Sami (1977) possible Physical Attempt to Redevelop Egypt, Cairo University, M.Sc., Faculty of Engineering. Mater Thesis, Cairo.
- Saini, Balwant Singh (1980) Building in Hot Dry Climates, John Wiley Sons, Chichesrer.
- Sayed, R. (1991) the Application of Lightweight Structure under the Climatic Conditions in Egypt, M.Sc., ASU, Cairo
- Schittich ,Christian (2003) Solar Architecture :Strategies • Visions • Concepts , in DETAIL, Institut für internationale Architektur-Dokumentation GmbH & Co. KG , München.
- Schwartz, P. (1991) The art of The Longview: the Global Scenario to 2005, DoubleDay, New York.
- Seleman , Mahmoud (1990) New Urban Communities in desert Areas, Ph.D. study, Faculty of Engineering, Cairo Uni., Cairo.
- Shalaby, Ahmed (2003) Stratgic Urban planning: Managing Egypt's New Cities, Ph.D. study, Faculty of Engineering, Cairo Uni., Cairo.
- Shearer ,Walter & Sultan, Abd-el-rahman(1986) Natural Energy and Vernacular Architecure: Principles and Examples with Refrence to Hot Arid Climates, The Uni. of Chicago Press, Chicago.
- Sick, Frisdrich & Erge Thomas (1996) Photovoltaics in Buildings: A Design Handbook for architects and Engineers, IEA, James & James, London.
- Smith, Maf & etal(1998) Greening the built environment, Earthscan Publications Ltd, London.
- Stewart Cowan & Sim Van Der Ryn (1996) Ecological Design , Island Press, Washington D.C.

- Stphen T. Hopkins & Douglas E. Jones (1983) Research guide to the arid lands of the world, Oryx Press, Arizona.
- Thomas, Randall (2001) Photovoltaics and Architecture, Spon Press, London.
- TREC (Trans-Mediterranean Renewable Energy Cooperation) (2007) Global energy and climate security through solar power from desert, TREC, n.p.
- UN (1992) NGO Documents for the Earth Summit: Non-Governmental Organization Alternative Treaties at the '92 Global Forum, UN.
- UNDP (2000) World Energy Assessment: Energy and the Challenge of Sustainable Development, Bureau for Development Policy, New York.
- UNDP (2004) The Global Drylands Imperative: Increasing Capabilities Through An Ecosystem Approach For The Drylands, UN.
- UNDP, UNDESA and WEC (2003) World Energy Assessment Overview Update.
- UNEP & CBD (1999) Assessment of the Status and Trends and Options for Conservation and Sustainable Use of Terrestrial Biological Diversity, Fourth Meeting, Montreal, Canada.
- UNEP (1997) United Nations Environment Programme. World Atlas of Desertification, 2nd edition. Edited by N. Middleton and D. Thomas. London.
- UNEP (n.d.); UNEP/GRID Documentation Summary: Global Humidity Index from GRID and UEA/CRU.
- UNEP/ GRID (1991) United Nations Environment Program/Global Resource Information Database.
- University of Arizona (2005) The Second International Symposium on the Topic of Urban Design in Arid Regions. School of Architecture at the University of Arizona, N.P.
- UNSO/UNDP (1997) An Assessment of Population Levels in the World's Drylands: Aridity Zones and Dryland Populations. Office to Combat Desertification and Drought. New York.
- Venema , Henerry David& Cisse, Moussa (2004) Seeing the Light: Adapting to Climate Change With Decentralized Renewable Energy in Developing Countries, IISD, Canada.
- Venema , Henerry David& Cisse, Moussa (2004) Seeing the Light: Adapting to Climate Change With Decentralized Renewable Energy in Developing Countries, IISD,Canada.
- Wahby ,Wafeek S. (2004) Technologies Applied in the Toshka Project of Egypt, The Journal of Technology Studies, Volume XXX, Number 4, Ipswich.
- WEC (1994) New Renewable energy Resources-A guide to the future, Clays Ltd., England.
- White ,Robin P. ,et al (2002) An Ecosystem Approach to Drylands: Building Support for New Development Policies, World Resources Institute, Washington Dc.
- Wilkins, Gill (2002) Technology Transfer for Renewable energy: Overcoming Barriers in Developing Countries, The Royal Institute of International Affairs. Earthscan, London.
- Wolter ,Niels (2003) Options for Integrating PV into Your Building, WisconSUN, n.p.
- World Bank (2005) Egypt, Arab Rep. at a glance, World Bank, n.p.
- WRI, (2002) An Ecosystem Approach to Drylans: Building Support for New Development Policies, Washington.
- WSP (2007) MASDAR Development: Project Case Study report, WSP, London.
- Yair, Aaron & Berkowicz, Simon (1989) Arid and Semi-Arid Environments, Catena Verlag, Germany.
- Zondag, H.A. & el ta, (2005) A Roadmap for the Development and Market Introduction Of PVT Technology, 15. Symposium Thermische Solarenergie, Bad Staffelstein .

Web Resources

- Al Rabwa (2007) Al Rabwa Project.
  http://www.al-rabwa.com/index.html
- AME (2007) Masdar launches the world's first city targeting zero-carbon and zero-waste, AME Info - the ultimate Middle East business resource, Dubai.
  http://www.ameinfo.com/119398.html
- Archnet,The Aga Khan Award for Architecture, Web site
  http://archnet.org
- Bach, F.R., Graudal, L. & Moestrup, S.(1991) The FAO Project on Genetic Resources of Arid/Semi-arid Zone, n.p..
  www.fao.org/docrep/ u5200e/u5200e08.htm
- Baird, Stuard (1993) Passive Solar Energy: Energy Fact Sheet, Energy Educators of Ontario, ICLEI Web.
  http://www.iclei.org/efacts/passive.htm
- Baird, Stuard (2001) Photovoltaic Cells: Fact Sheet, ICLEI Web.
  http://www.iclei.org/efacts/photovol.htm
- Baker ,Marcia Merry(1997) Mubarak: Toshka Project Opens Way Towards New Civilization In Egypt
  http://american_almanac.tripod.com/toshka.htm
- Biyuk Qorbani (1998) Coordination of Traditional Architecture with National Requirements: Kerman; Cultural, Social & Economic.
  www.netiran.com
- Boreland ,Matt,(2007) Current and Future Photovoltaics, Centre for Renewable Energy Systems Technology, Loughborough University.
  http://eprints.ecs.soton.ac.uk/14403/1/current_and_future_photovoltaics_.pdf
- CBD-Convention on Biological Diversity (2004) Dry and Sub-humid Lands Biodiversity Definitions, Montreal.
  http://www.biodiv.org
- CIA (2005) CIA World Fact Book, Egypt, 22.12.2005.
  http://www.cia.gov/cia/publications/factbook/
- CIA (2006) Fact Book : Egypt, 23.02.2006, n.p.
  http://www.cia.gov/cia/publications/factbook/geos/eg.html
- CORPOS,Typologies of Traditional Buildings in Syria, data base web site.
  www.meda-corpus.net/
- Dingemanse ,Mark(2004) Lake Nasser location, created by Dec 28, 2004
  http://en.wikipedia.org/wiki/Image:Lake_Nasser_location.png
- DOE(1996)Technical Information Program; Linking Energy Use and City Planning, DOE Office of Energy Efficiency and Renewable Energy, Portland.
  www.eren.doe.gov/cities_counties/enrgyuse.html
- EERE - Department of Energy's Office of Energy Efficiency and Renewable Energy (2007) Solar Energy Technologies program , web site.
  http://www1.eere.energy.gov/solar/index.html
- EEREN(2001) Solar technologies, U.S. Department of Energy,USA.
  http://www.solaraccess.com/education/solar.jsp
- EIA (2008) IEA PVPS Task 2 and Task 10 Educational Tool.

http://www.bipvtool.com/

- EIA- PVPS (2007), Taske 10: Task 10 Status Report Urban scale PV applications, EIA.
  http://iea-pvps.org/ar04/task10.htm
- EnCube (2005) Egypt: A New Urban Development Strategy, 23.5.2005.
  http://www.MisrCities.com
- Energy Information Administration(2006) Annual Energy Review 2006
  http://www.eia.doe.gov/kids/energyfacts/sources/renewable/biomass.html#environment
- Esser, Charles (2005) Egypt: Egypt Country Analysis Brief, EIA, n.p.
  http://www.eia.doe.gov/emeu/cabs/egypt.pdf
- EU Solar Cities (2007a) The European Solar Cities Project, European Commission, DG TREN, EESD Programme, Web Site.
  http://sc.ises.org/
- EU Solar Cities (2007b) Solar Cities :European Habitats of Tomorrow - Introduction, European Commission, DG TREN, EESD Programme, Web Site.
  http://sc.ises.org/introduction.html
- FAO (2005) Gateway to the National Information on Land, Water And Plant Nutrition – Egypt, (26 May 2005).
  http://www.fao.org/ag/agl/swlwpnr/reports/y_nf/egypt/home.htm
- Foster & Partners (2007) MASDAR Development , Foster + Partners web Site, London.
  http://www.fosterandpartners.com/Projects/1515/Default.aspx
- Globalis (2006) Egypt map
  www.globalis.gvu.unu.edu
- Herig, C. & et al(2004) Mainstraining PV in the Urban Landscape - Activities of the new Task 10 IEA PVPS Implementing Agreement, 19th European Photovoltaic Solar Energy Conference and Exhibition, Paris.
  http://iea-pvps.org/products/download/pap10_041.pdf
- Herzog, Thomas(1994) European Charter for Solar Energy in Architecture and Urban Planning: A document was drawn up in the context of READ (Renewable Energies in Architecture and Design) project, Nuclear-Free Future Awar, München.
  www.nuclear-free.com/
- Hsin, Robert(1996) Guidelines and Principles for Sustainable Community Design- A study of sustainable design and planning strategies in North America from an urban design perspective, M.Sc. thesis Florida A&M University, School of Architecture, Florida.
  www.state.fl.us/fdi/edesign/news/9607/thesis/thesis.htm
- IEA-PVPS (2008) Task 10: Urban-Scale Photovoltaic Applications.
  http://iea-pvps-task10.org/
- IFAD- The International Fund for Agricultural Development (2006) Rural poverty Portal: Rural poverty in Egypt.
  http://www.ruralpovertyportal.org/english/regions/africa/egy/
- Index-Mundi(2006) Egypt Statistics, 22.03.2006. < http://www.indexmundi.com/>
- Isofoton (2006) PV Pergola in the Andalusia Technology Park, Isofoton, Madrid
  http://www.isofoton.com/
- Jebreili, Kamran (2007) What Drew Halliburton to Dubai,Time.com, wep page.
  http://www.time.com
- Kjeilen, Tore (2008) LookLex Ltd.
  http://lexicorient.com/egypt/intro5.htm
- MASDAR (2007a) The MASDAR Initiative, MASDAR Initiative, Abu Dhabi.

http://www.masdaruae.com
- MASDAR (2007b) Introduction, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/introduction.aspx
- MASDAR (2007c) The MASDAR Massege, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/c-message.aspx
- MASDAR (2007d) Invitation from CEO, MASDAR, Abu Dhabi. http://www.masdaruae.com/text/invt-ceo.aspx
- MASDAR (2007e) The Way Forward, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/forward.aspx
- MASDAR (2007f) About MUBADALA, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/mubadala.aspx
- MASDAR (2007g) The MASDAR Institute, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/institute.aspx
- MASDAR (2007h) MASDAR Research Network, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/r-network.aspx
- MASDAR (2007i) The Innovation & Investment, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/i-investment.aspx
- MASDAR (2007j) The Special Projects Unit, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/spl-projects.aspx
- MASDAR (2007k) The Carbon Management Unit, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/carbon-management.aspx
- MASDAR (2007l) MASDAR r's Special Free Zone (SFZ), MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/spl-free-zone.aspx
- MASDAR (2007m) Abu Dhabi and Spain Sign Advanced Energies Research Agreement, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=23
- MASDAR (2007n) MASDAR Launches the World's First City, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=22
- MASDAR (2007o) Abu Dhabi Addressing Global Energy Challenges, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=15
- MASDAR (2007p) MASDAR Brings Advanced Solar Technologies, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=3
- MASDAR (2007q) MASDAR Spearheads Carbon Management Program In The Middle East, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=11
- MASDAR (2007r) Abu Dhabi launches $250 million clean tech fund, among world's largest dedicated to sector, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=1
- MASDAR (2007s) Abu Dhabi Economy to Benefit from New Sustainability and Renewable Energy Initiative, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=9
- MASDAR (2007t) MASDAR Brings Advanced Solar Technologies, MASDAR Initiative, Abu Dhabi. http://www.masdaruae.com/text/news-d.aspx?_id=3
- MASDAR (2007u) MASDAR Development – Documentary film, MASDAR Initiative, Abu Dhabi.

http://www.masdaruae.com/text/v-files.aspx
- Mellor, Chris (2007) Emirates Photo Gallery, Lonely Planet Images, Wep page. http://www.lonelyplanet.com/worldguide/united-arab-emirates/images?imgNum=0
- Metz,Chapin (1990) A Country Study: Egypt, Library of Congress, 12.04.2005, n.p.. http://rs6.loc.gov/frd/cs/egtoc.html
- MUBADALA (2007) MASDAR Launches the World's First City Targeting Zero-Carbon and Zero-Waste , MUBADALA, Abu Dhabi. http://www.mubadala.ae/en/content/press_103.asp
- Nasa(2005) http://spaceflight.nasa.gov/gallery/images/station/crew-12/html/iss012e11654.html
- Nation Master (2007) http://www.nationmaster.com/country/eg/Age_distribution
- Power from the sun (2008) Power From The Sun. http://www.powerfromthesun.net
- PV City Guide (2007) The Solar City Guides, Web Site. http://pvcityguide.energyprojects.net/
- PV-database (2007) Introduction, EIA,Web Site. http://www.pvdatabase.org/
- PV-database (2007a) Balanced Energy Houses Nieuwland , EIA,Web Site. http://www.pvdatabase.org/
- Renegy Holdings (2007) What is Biomass? http://www.renegy.com/biomass.html
- Richardson, Nigel H. (1994) Making Our Communities Sustainable: The Central Issue is Will, Hygeia Consulting Services, Toronto. www.web.net/ortee/scrp/20/23vision.html
- SIS - State Information Service-Egypt (2006) http://www.sis.gov.eg/Fr/Publications/Livreannuel/livre2006/110103000000000011.htm
- Smart Villages(2007) http://www.smart-villages.com/docs/about.aspx
- Smarter Homes (2008) Design overview. http://www.smarterhomes.org.nz/design/design-overview/
- Solar Power (2008) energy Resources. http://home.clara.net/darvill/altenerg/index.htm
- TREIA-Texas Renewable Energy Industries Association (2004), Web-Site. www.treia.org
- Triple pundit (2007) The Fort Collins Dilemma: Nuclear or Solar? November 29. http://www.triplepundit.com/pages/the-fort-collins-dilemma-nucle-002746.php
- Tvedt, Terje (2008) Toshka, Egypt, Panopticon. http://panopticon.no/projects/vis/135/1/
- UNDP (2004) What are the Drylands, UN. www.undp.org/drylands/what-are.htm
- UNEP- United Nations Environment Programme(2008) Atlas of Our Changing Environment http://na.unep.net/digital_atlas2/webatlas.php?id=130
- University of Texas(2006) Maps Collections http://www.lib.utexas.edu/
- USA.gov (n.d.)Background Note: Egypt www.state.gov

- Vidursolar S.L. (2007) Cubierta Fotovoltaica En Manresa, Vidursolar S.L.,Barcelona. http:www.vidur.es
- Water Resource Associates (2006) Arid Zone Hydrogeology, web site. www.watres.com/topics/ tp-arid-hygeogy.html
- White ,Robin P. & Nackoney , Janet (2003). Drylands, people, and ecosystem goods and services: A web-based geospatial analysis. www.wri.org
- Wikipedia (2004) Image:Wind energy converter. http://en.wikipedia.org/wiki/Image:Wind_energy_converter5.jpg
- Wikipedia (2005) Image: Egypt Regions and Boundaries , 24.Aug.2005. http://en.wikipedia.org/wiki/Image:Egypt_regions_and_boundaries.png
- WisconSUN (2007) Options for Integrating PV Into Your Building http://www.ecw.org/wisconsun/learn/learn_options.shtml
- World Book (2006) Egypt. http://www.worldbook.com/
- World Future Energy Summit (2007) The MASDAR Initiative, World Future Energy Summit, Abu Dhabi. http://www.wfes08.com/page.cfm/link=7
- Yasser Mahgoub (1999) Architecture in the United Arab Emirates, Wep page. http://victorian.fortunecity.com/dali/428/uaearch/uaearch6.htm#Vernacular%20Architecture
- Znined, Hassan (2008)Zweifelhaftes Projekt im ägyptischen Niemandsland, Deutsche Welle, Bonn. http://www.dw-world.de

`

List of Figures

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

List of Tables

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 6

List of Boxes

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

الجافة الحارة من جهة ، وتحقيق تنمية مستدامة من جهة أخرى سواء علي مستوي التنمية العمرانية أو علي مستوي باقي مجالات التنمية ، كما لن تقف هذه التنمية عند الحدود المحلية لتلك المناطق بل ستمتد إلى خارجها.

وقد شهدت مصر مؤخرا اهتماما بهذا الاتجاه ، خاصة مع اتجاهات التنمية العمرانية الجديدة خارج الوادي الضيق من خلال مشروعات التنمية العمرانية مثل مشروع تنمية توشكي .

لذلك فان الهدف الرئيسي للدراسة هو التعرف على إمكانية ربط عمليات التنمية العمرانية في المناطق الحارة الجافة وتطبيقات الطاقة المتجددة وخاصة تطبيقات الخلايا الفولطية داخل منظومة تنمية عمرانية معتمدة على الطاقة المتجددة (UIPV) كمدخل لتحقيق مجتمعات عمرانية مستدامة معتمدة على الطاقة المتجددة في المناطق الجافة الحارة (وفى مصر على وجه الخصوص) .

وفى هذا الإطار تقترح الدراسة نموذج لتلك المنظومة من خلال دراسة وتحليل وإعادة تركيب للعديد من الدراسات والمشروعات السابقة في هذا مجال ، ودمجها داخل نموذج تحليلي ولذلك لاستخدامه كأداة مقارنة بين محاولات التنمية العمرانية اعتمادا على الطاقة المتجددة في مصر ،و نموذجان آخران إحداها لمدينة من مدن المناطق الحارة (مدينة مصدر – ابوظبى – الإمارات) وذلك بهدف التوصل إلى مجموعة المؤشرات الإرشادية التي يمكن استخدامها لتحقيق نموذج مصري ناجح لعمليات التنمية العمرانية المعتمدة على الطاقة المتجددة ، كما تقدم الدراسة "خارطة الطريق" لتحقيق مثل هذه التنمية في مصر.

هيكل الدراسة :
تتكون الدراسة من ستة فصول كالتالي :

الفصل الأول: مدخل نظري لدراسة المناطق الجافة الحارة.

الفصل الثاني: مجتمعات ومدن المناطق الجافة الحارة – حالة مصر.

الفصل الثالث: الطاقة المتجددة والتنمية العمرانية المستدامة .

الفصل الرابع: نحو مدخل إلى التنمية العمرانية المعتمدة على الطاقة المتجددة .

الفصل الخامس: دراسة حالة لأحد مدن المناطق الجافة الحارة والمعتمدة على الطاقة المتجددة .

الفصل السادس: المناطق الجافة الحارة المصرية والطاقة المتجددة كمدخل لتحقيق تنمية عمرانية مستدامة.

مداخل التنمية واستراتيجيات التطوير للمدن الجديدة
الطاقة المتجددة والتنمية العمرانية المستدامة في المناطق الحارة الجافة
(دراسة حالة مصر)

م / **محمد رفعت محمد عبد العال**
المدرس المساعد بكلية الهندسة – بورسعيد
جامعة قناة السويس

مجال الدراسة :
تهدف الدراسة إلى الوصول إلى مدخل منهجي لتنمية المجتمعات العمرانية في المناطق الحارة الجافة اعتمادا على الطاقة المتجددة (مع ذكر خاص للخلايا الفولطية) وذلك من خلال دمج تطبيقات الطاقة المتجددة داخل منظومة التنمية العمرانية كمدخل لتحيق الاستدامة ، وتركز الدراسة بصفة خاصة على مصر كأحد الدول الواقعة داخل المناطق الحارة الجافة.

التعريف بمشكلة الدراسة :
تشكل المناطق الحارة الجافة جزء هام من العالم حيث تغطى أكثر من 40% من مساحة الأرض ، وقد زادت أهميتها في السنوات القليلة الماضية لما يمكن أن تقدمه من إمكانيات تنموية في للمستقبل .
إلا أن التنمية العمرانية المرتبطة بهذه المناطق تواجه الكثير من الصعوبات إلى جانب المعوقات المرتبطة بالخصائص الطبيعية و الجغرافية لمثل هذه الأقاليم مثل المناخ ، وهو ما يؤدى إلى العديد من المشاكل الاقتصادية والاجتماعية والعمرانية ،،،،،،، الخ.
والمناطق الحارة الجافة المصرية جزء من المناطق الحارة الجافة وتواجه نفس تلك التحديات والتي تؤثر بشكل مباشر على خطط التنمية العمرانية في جمهورية مصر العربية علما بان أكثر من 90% من مساحة مصر تقع داخل حدود تلك المناطق، لذا أصبح من الهام تطوير مداخل جديدة لتنمية هذه المناطق في مصر من منظور عمراني متكامل ومستدام حيث أصبحت تلك المناطق الهدف الاساسى و الحل الوحيد للزيادة السكانية المتطردة داخل الوادي القديم وما يصاحبها من مشكلات .
ومن ناحية أخرى تنامي الاتجاه إلى استخدامات الطاقة الجديدة والمتجددة كمدخل اساسى لتحقيق الاستدامة خاصة على مستوى الأقاليم الجافة الحارة لما تتمتع به من مصادر متنوعة للطاقة المتجددة، خاصة بعد تأكيد العديد من الدراسات على انه بالاعتماد على شبكات عملاقة من مصادر الطاقة المتجددة - والتي يمكن أن تنمي داخل هذه الأقاليم - يمكن الوصول إلى مصدر دائم ومتجدد للطاقة داخل المناطق

Abd-Elaal , Mohammad Refaat Mohammad
M.Sc.-Ing.
Architect and Urban Designer

He was born in 1974, Cairo – Egypt. He is a lecturer at Architectural and Planning Department, Faculty of Engineering, Suez Canal University. In 1997, he gained the Bachelor's degree (B.Sc.) in Architecture with a cumulative rate of appreciation "Very Good with Honour Degree" from the Faculty of Engineering - Cairo University. In 1998, he had finished the preparation studies of the Master Degree, and in 2002, he gained Master of Engineering in Architectural Engineering - Town Planning (M.Sc.) from the Faculty of Engineering Cairo University. Thesis' title was "Sustainable Communities Depending on Renewable Energy". In addition, he had gained a practical experience through his work in many famous Egyptian architectural offices.

In addition, he had received awards from; the Architecture and Urban Design Group - Architectural Department - Cairo University, and the Egyptian Architects Society – Cairo.

Development Concepts and Implementation Strategies for New Settlements

RENEWABLE ENERGY AND SUSTAINABLE URBAN DEVELOPMENT IN HOT ARID REGIONS

Case of Egypt

Mohammad Abd-Elaal

Arid regions are an important part of the world as they cover more than 40% of the land surface and they can provide sufficient opportunities for extensive development. However, urban development of these regions is facing a set of problems. On the other hand, the role of renewable energy resources to achieve sustainability in arid regions became so clear. This is especially after the recent researches, which have approved that depending on large-scale solar energy developments in arid regions will be one of the most promising sources of energy in the near future.

Therefore,the main objective of this work is to make a connection between the hot arid regions urban development and renewable energy e.g. photovoltaics (PV), to delineate urban integrated renewable energy e.g. Urban Integrated Photovoltaics (UIPV) as a new approach for building new sustainable settlements in hot arid regions. The study claimed that developing arid regions' communities within the concept "urban development integrated renewable energy" will offer suitable solutions for their current major urban problems, and this can be a new urban development approach for the Egyptian arid regions communities.

In this realm, the study introduces a model for the Urban Integrated Photovoltaics (UIPV) and it has been used as a tool to analyze the Egyptian case study of New Toshka city, as an Egyptian trial for developing an UIPV community, with reference to another two UIPV cases; case of the OECD countries, and MASDAR city – the UAE. This is in order to set up the main guidelines for establishing an UIPV development in the Egyptian arid regions.

Universität Stuttgart SI Städtebau-Institut