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WP6 “Innovative financial schemes and market stimulation tools to spread energy efficiency and distributed solar energy technologies”

Innovative Financing Mechanism to Strengthen the Promotion of Distributed Solar Energy Technologies in Egypt (Solar Water Heaters)

Hamed Korkor

June 2015



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Acronyms

WP	Work Package
SWHs	Solar Water Heaters
NREA	New and Renewable Energy Authority
DSETs	Distributed Solar energy Technologies
LE	Egyptian Pound
\$	US Dollar
IPPs	Independent Power Producers
MTOE	Million Tons Oil Equivalent
TCF	Trillion Cubic Feet
LPG	Liquefied Petroleum Gas
BCF	Billion Cubic Feet
KWh	Kilo Watt hour
MW	Mega Watt
MERE	Ministry of Electricity and Renewable Energy
PV	Photo Voltaic
mtoe	Million tons of oil equivalent
KW	Kilo Watt
GW	Giga Watt
PWh	Peta Watt hour
FEI	Federation of Egyptian Industries
m ²	Meter Square
OME	Observatoire Méditerranéen de l'Energie
MEP	Mediterranean Energy Perspective
CAPMAS	Central Agency for Public Mobilization and Statistics
m ³	Cubic meters
R & D	Research and Development
USD	United States Dollar
CBE	Central Bank of Egypt
GDP	Gross Domestic Product
OECD	Organization for Economic Cooperation and Development
SMEs	Small and Medium Enterprises
CSP	Concentrated Solar Power
CO ₂	Carbon dioxide
UNEP	United Nations Environment Program
EGPC	Egyptian General Petroleum Corporation
EGAS	Egyptian Natural Gas Holding Company
MERE	Ministry of Electricity and Renewable Energy
Kg	Kilogram
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
NUCA	New Urban Communities Authority
CNG	Compressed Natural Gas
OVSRRP	Old Vehicles Scrapping and Recycling Programme
SEDA	Solar Egyptian Development Association
IMELS	Italian Ministry for Environment Land and Sea
ESCOs	Energy Service Companies
EEU	Energy Efficiency Unit
IDSC	Information Decision Support Center
STEG	Tunisian Company of Electricity and Gas (Société Tunisienne de l'Electricité et de Gaz)
ANME	Agence Nationale pour la Maîtrise de l'Energie
NEEREA	National Energy Efficiency and Renewable Energy Action
BDL	Central Bank of Lebanon

EDL	Lebanon Electricity
LCEC	the Lebanese Center for Energy Conservation
EIB	European Investment Bank
EU	European Union
NGVs	Natural Gas Vehicles
GCR	Greater Cairo Region
PPP	Public Private Partnership
MoI	Ministry of Interior
MoF	Ministry of Finance
CDM	Clean Development Mechanism
EEAA	Egyptian Environmental Affairs Agency
CPA	Component Project Activities
NGOs	Non-Governmental Organizations
EYPTERA	Egyptian Electric Utility and Consumer Protection Regulatory Agency
EEHC	Egyptian Electricity Holding Company
JCEE	Egyptian-German High Level Committee on Renewable Energy, Energy Efficiency and Environmental Protection
MFTI	Ministry of Foreign Trade and Industry
EOS	Egyptian Organization for Standardization
UNDP	United Nations Development Programme
WB	World Bank WB
UNEP	The United Nations Environmental Programme
SEC	Supreme Energy Council
MOPIC	Ministry of International Cooperation
PPA	Power Purchase Agreements
PACE	Property Assessed Clean Energy
RPS	Renewable Portfolio Standard
REC	Renewable Energy Certificate
NPV	Net Present Value
IRR	Internal Rate of Return
ICS	Integrated Collector Storage
CHS	Convection Heat Storage Unit CHS

1. Introduction:

Egypt is facing great challenges for the development of energy sector in order to fulfill the escalating energy demand necessary for social and economic development which estimated on average during the last decade at more than 4% for oil, 10% for natural gas and 7% for electricity annually. With limited depleted oil and natural gas resources that constitute about 96% of total primary energy consumption, it becomes imperative that Egypt's energy strategy and policies be pivoted and directed towards diversification of energy supply with solar energy as one of the main available abundant energy resources that can play an important and vital role to achieve that goal. Among the main challenges facing the achievement of that goal is the relatively high upfront cost of solar energy technologies in addition to heavily subsidized conventional energy prices that make such technologies as infeasible alternative for conventional energy resources and of less attractiveness to energy consumers.

The current report presents different tasks and activities that have been performed under work packages WP 6.1b of MED DESIRE project which aims at identifying and designing an innovative and appropriate incentive tool to strengthen the promotion of distributed solar technologies in Egypt. This activity will be followed by the implementation of activities of WP 6.1C of the project that aims at integrating the identified and proposed financial incentive tool into the existing regulatory framework in consultation with local relevant authorities and stakeholders.

Based on comprehensive assessment and feasibility analysis to determine the most appropriate distributed solar energy technology to be considered and identify the target sector for its utilization and implementation with the support of the proposed financing mechanism, Solar Water Heaters (SWHs) technology has been chosen for promotion in the residential sector. A common consensus on that conclusion has been achieved also in consultation with New and Renewable Energy Authority (NREA), referent project partners and stakeholders and WP6 coordinator.

In order to accomplish the previous mentioned tasks and activities, it was essential for study consultant to:

- Coordinate with other experts working on MED DESIRE project and contributing to the specific tasks, both for the development of the studies and for the scheduling of missions (data collection, roundtables, decision makers and stakeholders consultation, etc.), based on the instructions provided by WP6 Coordinator.
- Coordinate with the experts working on the same task in Tunisia and Lebanon, in order to define methodologies consistent at “regional level”, as much as possible, as well as the results and findings obtained under WP4 and WP5 and WP6.

The specific tasks of WP6.1b as shown from appendix (1) include the following implemented main activities:

A. Project kickoff and Preparatory Activities:

The main objective of that preparatory phase of the project was to have a constructive dialogue among different partners, stakeholders and policy makers in coordination with WP6 coordinator in order to get preliminary common consensus on:

- Proposed scope and methodology of performing WP 6.1 (b-c),
- Identification of the most appropriate and targeted solar energy technologies to be considered.
- Identification of the most appropriate and targeted sectors to be considered for the incubation and development of the proposed solar energy technologies.
- Assessment of the energy context and status of solar energy market in Egypt.

The assessment of the previous mentioned issues were conducted in coordination and collaboration with project WP6 coordinator, NREA project management team and concerned managers and in light of the prevailing local energy context, committed energy policies and strategies, announced solar energy plans and expected future energy mix.

The previously mentioned kickoff and preparatory phase milestones have been achieved through:

- Literatures review on most of the previously mentioned issues in addition to assessment of some solar energy technologies financial mechanisms implemented in Egypt and other countries in the region particularly Tunisia, and Lebanon.
- Questionnaire that has been sent to several concerned Stakeholders for identifying the most appropriate financing mechanism for the widespread of distributed solar energy technologies in Egypt, mainly SWHs, existing barriers that might hinder their market and expansion, etc. as shown from appendix (2).
- Interviews and meetings with key stakeholders (managers and concerned staff within NAREA, local banks and financing institutions, solar energy technologies suppliers and clients, etc.) as shown from appendix (3).

B. Task 6.1b: Elaboration of Egypt's specific options of an innovative financial mechanism for distributed solar energy technologies:

In order to achieve that target, the implemented activities categorized into three main sub tasks or activities as follows:

Sub task 6.1b.1. Assessment of the current solar energy market that include:

- Distributed solar energy technologies market analysis.
- Targets and strategies analysis.
- Assessment of existing mechanisms.
- Recommendation and proposal for a distributed solar energy technologies promotion.

Sub task 6.1b.2. Potential of solar energy market development that include:

- Analysis of financial and economic profitability.
- Identification of the most suitable beneficiary sector to be targeted.
- Identification of public administrations, local agencies, utilities, market players and financial institution to be involved.

Sub task 6.1b.3. Identification of the most appropriate financing mechanism that include:

- Definition of methodology and criteria for model selection.
- Economic Assessment.
- Technical and social sensitivity analysis.
- Stakeholders and decision-makers consultation.
- Definition of the financial mechanism.

The current report on “**Design**” of the financial mechanism covers mainly the following issues and activities:

- Identification of the most suitable solar energy technology to be promoted in Egypt.
- Identification of the most suitable beneficiary sector to be targeted.
- Identification of the most suitable financial mechanisms for SWHs to be potentially adopted in the regulatory framework.
- Detailed design of the incentive tool.

Based on the analyses made to define the targeted appropriate distributed solar energy technology for the design of the proposed innovative financing mechanism in Egypt and the consensus achieved among different concerned stakeholders to consider SWHs as the targeted DSETs and residential as the targeted sector therefore, the current report focus on the utilization of SWHs in the residential sector.

The following sections present the work that have been done in line with the study technical proposal or Terms of Reference as described before and shown in appendix (1).

2. Assessment of the Current Solar Energy Market:

The assessment of current solar energy market in Egypt (Sub task 6.1b) includes performing the following main activities:

- Distributed solar energy technologies market analysis.
- Targets and strategies analysis.
- Assessment of existing mechanisms.
- Recommendation and proposal for a distributed solar energy technologies promotion.

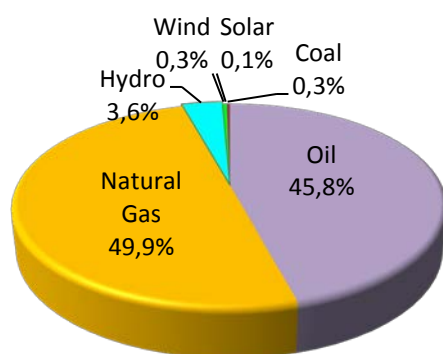
In assessing and analyzing Distributed Solar Energy Technologies DSETs market in Egypt, mainly Solar Water Heaters SWHs it might be useful and essential to perform that analysis in the context of energy situation and energy market in Egypt.

2.1. Egypt's Energy Situation: ^{[1] [2] [3]} The energy sector in Egypt is characterized by:

- High reliance on depleted petroleum energy (oil and natural gas) in satisfying social and economic development plans energy needs.
- High growth rates of energy consumption of more than 4% for petroleum products, 10% for natural gas and 7% for electricity annually during the last decade.
- Heavily subsidized energy prices that led in addition to high growth of energy demand as previously mentioned to tremendous increase in total subsidy that reached LE 128 billion in 2012/2013 for petroleum energy and LE 27 billion for electricity.
- Imports of large quantities of crude oil and oil products which accounted for 12.3 million tons in 2012/2013 with a value of \$11 billion in order to diminish supply demand gap.

Primary Energy Consumption: As shown from figure (2.1), total primary energy consumption in Egypt accounted for about 76 Million Tons of Oil Equivalent (MTOE) in 2012/2013 of which oil and natural gas represent 95.7% compared to 3.6% for hydro, 0.3% for coal and only 0.4% for renewable (wind 0.3% and solar 0.1%).

Figure (1.1) Primary energy consumption by energy type 2012/2013 ^{[1] [2] [3]}



Source: EGPC, EGAS and MERE.

Proven Oil and Natural Gas Reserves: During the same year 2012/2013, total proven reserves of oil and natural gas estimated at about 15.8 billion barrels of oil equivalent of which 4 billion barrels as crude oil and condensates and 11.8 billion barrels as natural gases (equivalent to 66 trillion cubic feet TCF of natural gas).

Oil and Natural Gas Production: Average daily oil production during the same year 2012/2013 accounted for 666 thousand barrels of which 49% produced from the Western Desert compared to 22% from the Gulf of Suez, 6% from the Mediterranean and 1% from the Delta region. Meanwhile, natural gas daily average production accounted for 610 million cubic feet in addition to about 6.6 thousand barrels as condensates. The Mediterranean Sea represented 72% of total natural gas production during the same year compared to 22% for the Western Desert, 5% for the Delta region and 1% for Gulf of Suez and Sinai.

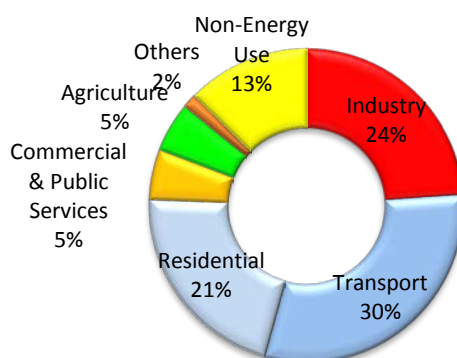
Oil Products Consumption: accounted for 34.1 million tons in 2012/2013 of which 4.2 million ton of LPG, 6.1 million ton of gasoline, 0.6 million tons of kerosene and turbine, 12.8 million ton of diesel and gas oil, and 9.2 million ton of fuel oil with the rest as lube oils, asphalt, etc.

Natural Gas Consumption: accounted for 52.2 billion cubic meters in 2012/2013 (equivalent to 1842 billion cubic feet or about 5 billion cubic feet per day) with the electricity sector as the major consumer with a share of 57% compared to 28% for industry, 11% for petroleum, 3% for residential and commercial sectors and 1% for transportation. As a result of the petroleum sector fuel switching policy that aims at replacing liquid petroleum fuels by natural gas total number of residential natural gas customers reached 5.5 million in 2012/2013 compared to 12.6 thousand commercial customers and 2.1 thousand industrial customers.

Oil Imports: due to the insufficient production of crude oil and oil products total petroleum imports accounted for 12.3 million tons in 2012/2013 with a value of \$11 billion. Diesel fuel, LPG and gasoline represented the main imports with quantities of 4.9, 2.1 and 1.2 million tons during the same year respectively. The corresponding values of imports estimated at \$4.6 billion for diesel, about \$2 billion for LPG and \$1.3 for gasoline.

Final Energy Consumption: accounted for about 56 MTOE in 2012 with transport sector as the major energy consumer with a share of 30% compared to 24% for industry, 21% for residential 5% for each of the commercial and agriculture sectors, and 13% for non energy use, mainly for fertilizer production with the reminder percentage for other sectors as shown from figure (2.2).

Figure (2.2) Final energy consumption 2012



Electricity Market:

Source: International Energy Agency Statistics, Egypt's Energy Balance 2012.

The Egyptian electricity market is dominated by the Egyptian Electricity Holding Company, which is state owned and comprises sixteen affiliated companies including production, distribution and transmission companies. The holding company owns over 90% of Egypt's

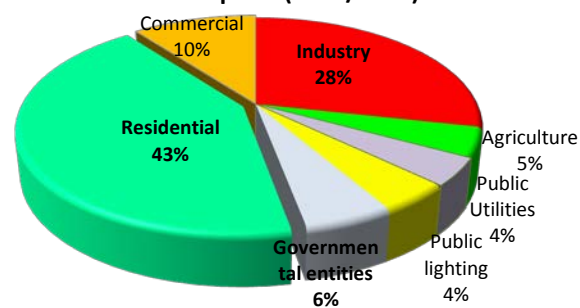
generating capacity and the distribution and transmission also remain under the state owned monopoly. Private generation of electricity was authorized by the 1996 Law No. 100 however IPPs are still few and account for only 7% of the total produced power, none of which is renewable energy. The regulation of the electricity market is handled by the Egyptian Electric Utility and Consumer Protection Regulatory Agency (EgyptEra). The following is a brief description of the electricity market in Egypt.

Electricity Generation: accounted for 165 billion KWh in 2012/2013 of which thermal generation (using natural gas, fuel oil and diesel as fuels) accounted for 91% compared to 8% for hydro, 0.8% for wind and only 0.2% for solar. Total installed capacity for electricity generation accounted for 30 Mega Watt (MW) of which 550 MW as wind installed capacities and 20 MW as solar thermal installed capacities.

Electricity Consumption: accounted for more than 140 billion KWH in 2012/2013 as shown from figure (2.3) with the residential sector as the major electricity consumer with a share of about 43% compared to 28% for industry, 10% for commercial, 6% for governmental entities, 5% for agriculture, and 4% for each of public utilities and public lighting.

Renewable Energy Expansion Plans: in the context of its plans and policies to diversify electricity generation, the Ministry of Electricity and Renewable Energy MERE has set a target of 20% as renewable energy share of total electricity generation in 2020 (equivalent to 7200 MW) of which 3000 MW as wind installed capacities, 3500 MW as concentrated solar power installed capacities and 700 MW as photovoltaic PV installed capacities.

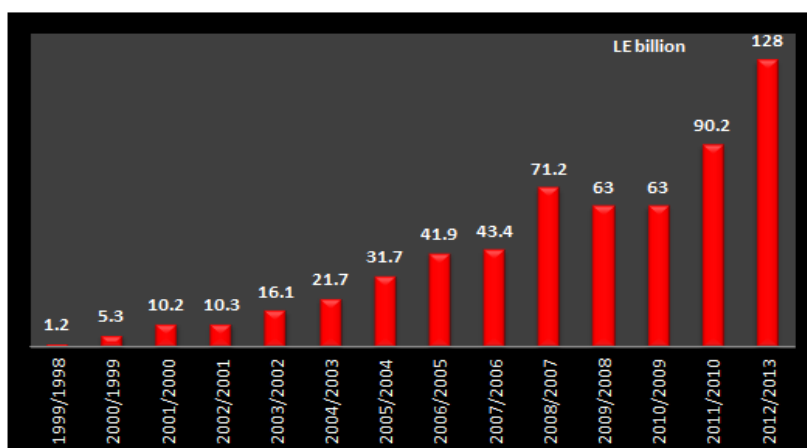
Figure (2.3) Sectors share of total electricity consumption (2012/2013)



Energy Prices and Subsidies: energy prices in Egypt had witnessed low levels for a long period of time which led in addition to the energy demand growth to escalating energy subsidies that reached LE 128 billion in 2012/2013 for oil products and natural gas (figure 2.4) and about LE 27 billion for electricity as mentioned before. Meanwhile, the heavily subsidized energy prices didn't encourage consumers to conserve its usage or to switch to alternative renewable energy resources particularly solar for several applications in different sectors as its usage for water heating and electricity generation. In that regard it worth mentioning that Egypt is currently implementing a gradual reform of energy subsidies, whereby it substantially decreased subsidies for gasoline, diesel, and natural gas and adopted a five-year plan to phase out subsidies in the electricity sector. The plan was officially endorsed by the Egyptian Cabinet according to the Prime Minister Decree No. 1257 for the year 2014. The Decision approved annual tariff increase for most user segments on July 1st each year until 2018. The residential segments will experience annual tariff increases between 10% and 20% per year. By implementing these tariff increases, the Egyptian government hopes to completely eliminate

the electricity subsidy by 2019. However, today only 10% of power demand is generated through renewable energy.

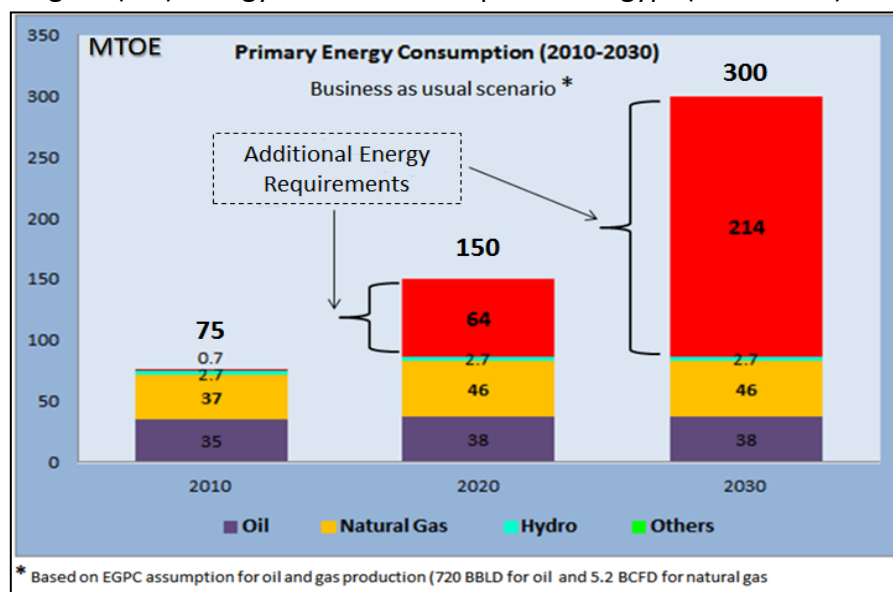
Figure (2.5) Petroleum energy subsidy development



Future Energy Demand:

By reviewing total energy consumption development during the last three decades, it becomes obvious that total energy consumption in Egypt almost doubled each decade. Therefore, Egypt's primary energy consumption is expected to increase from about 75 mtoe in 2010 to reach about 300 MTOE by 2030 which means additional energy requirements of about 64 mtoe in 2020 and 214 mtoe in 2030 as shown from figure (2.6), a situation that necessitates exerting extensive efforts for the exploitation and development of both oil and natural gas resources in addition to energy diversification and the harness of all available other energy resources such as renewable mainly wind and solar energy.

Figure (2.6) Energy demand development in Egypt (2010-2030)



Source: Based on author analysis and elaboration.

2.2. Solar Water Heating Technology Market Analysis:

Distributed solar energy technologies comprise mainly Photovoltaic systems (PVs) for electricity generation of up to 500 KW capacity, and Solar Water Heating systems (solar thermal applications). PV systems that normally utilized for electricity generation can either be roof or ground mounted. Based on the analyses made to define the targeted appropriate distributed solar energy technology for the design of the proposed financing mechanism in Egypt and the consensus achieved among different concerned stakeholders to consider SWHs as the targeted DSETs and residential as the targeted sector, the current report focus on the utilization of SWHs in the residential sector. In that regard and in order to analysis the SWH market in Egypt it might be useful to shade light first on global SWHs market.

2.2.1. Solar Water Heating Market Worldwide: ^[4]

Total solar hot water capacity worldwide had achieved a tremendous growth during the period (2004-2013) which accounted for about 3.3 folds from 98 GW_{th} in 2004 to 282 GW_{th} in 2012 and 326 GW_{th} in 2013 with an average annual growth rate of about 14.3 % during that period (2004-2013). Meanwhile, the growth during the year 2013 estimated at about 15.6% equal to 44 GW_{th} as an addition to solar water heating capacity in that year only. China, Turkey, India, Brazil, and Germany are considered as the top five countries worldwide that have the largest solar water heating capacity. Regarding solar water heating generation, China, United States, Germany, Turkey, and Brazil are the top five countries worldwide. China was also the main driver of the world SWHs market accounting for about 80% of global market and maintained its lead in the manufacturing of solar thermal water heaters. On the other hand, SWHs markets in Europe continued to slow. Meanwhile, international attention to quality standards and certification continued; driven by its importance in the development of SWHs market on one hand and largely in response to high failure rates associated with cheap tubes from China on the other one. Table (2.1) presents global solar water heating collectors' capacity/ additions, and the top 12 countries in 2012.

Table (2.1) World Solar water heating collectors capacity/additions and top 12 countries in 2012

COUNTRY	ADDED 2012			TOTAL 2012		
	GW _{th}			GW _{th}		
	Glazed	Unglazed	Total	Glazed	Unglazed	Total
China	44.7	0	44.7	180.4	0	180.4
United States	0.2	0.5	0.7	1.9	14.3	16.2
Germany	0.8	0	0.8	11.4	0.4	11.8
Turkey	1.1	0	1.1	10.8	0	10.8
Brazil	0.4	0.4	0.8	4.2	1.6	5.8
Australia	0.2	0.5	0.6	2.1	3.0	5.1
India	1.0	0	1.0	4.5	0	4.5
Austria	0.1	~0	0.1	3.1	0.4	3.4
Japan	0.1	0	0.1	3.1	0	3.1
Israel	0.2	~0	0.2	2.9	~0	2.9
Greece	0.2	0	0.2	2.9	0	2.9
Italy	0.2	0	0.2	2.4	~0	2.4
Rest of World	4.3	0.3	4.6	28.2	4.0	32.1
World Total	54	1.7	55	258	24	282

Source: Renewable Energy Policy Network for the 21st Century (REN21), Renewable 2014- Global Status Report, May 2014.

2.2.2. Solar Water Heating Market Development in Egypt: ^[5] ^[6]

Egypt was among the first countries that utilized solar energy for different applications including its usage for water heating. In 1912, the first solar thermal plant was built in Maadi district in Cairo to provide power for a series of large water pumps for irrigation. Since then, the government efforts and initiatives during the seventies and the eighties of the last century resulted in the instillation of few hundreds of solar water heaters particularly in rural areas. For example, during the eights the Ministry of Electricity imported one thousand flat plate solar water heaters with different capacities and installed it at different areas of Egypt with the aim to promote that technology in the market and to identify its economic and environmental benefits for energy consumers and the whole economy. That initiative was accompanied by the establishment of the first company for the manufacture of solar water heaters. Unfortunately, those initiatives didn't have any positive impact on solar energy market sustainability. ^[5] In 1991, the solar atlas for Egypt was issued indicating that the country enjoys 2900-3200 hours of sunshine annually with annual direct normal energy density of 1970-3200 kWh/m² and technical solar-thermal electricity generating potential of 73.6 Peta Watt hour (PWh). Currently, available solar energy technologies in Egypt include photovoltaic cells, solar water heating, and solar thermal technology that might be used for both electricity generation and water desalination and it is consider as an advantage taking into consideration water supply deficit that Egypt is facing. ^[6]

At the same time, there are 22 companies that are listed in the registry of the Federation of Egyptian Industries (FEI) and have amongst its scope of activities the production and/or the imports of solar thermal technology. About 12 to 14 of those companies are currently estimated to be permanently active with the rest acting as importers. Estimates of total number of installed solar water heaters over the last 20 years accounted for about 700 thousand of which 400 thousand are currently in operation with total collector surface area of 800 thousand m², corresponding to a capacity of 560 thousand KW_{th} most of which exist in new settlements or cities. ^[7] About 90% of operated SWHs are flat-plate collectors, 90% of which are thermo-siphon type. In that regard, it is worth mentioning that according to the minister of housing decree number 401 for the year 1987, a solar obligation was introduced that requested the installation of solar water heaters in residential buildings at new cities or settlements and include the design for their use. Unfortunately, that solar obligation was not yet generally applied or enforced. ^[8] Therefore, and in spite of the favorable climatic conditions that Egypt enjoys; the lack of supportive policies and measures for the development of distributed solar energy technologies market including SWHs during the last few decades in addition to the numerous barriers that have been exist were behind the humble number and growth of installed SWHs in Egypt that did not exceed 1.5% during the period (2000-2009) as shown form table (2.2).

Table (2.2) SWHs Deployment in Egypt

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average Annual Growth (%)
349	355	360	365	370	376	382	388	394	400	1.5%

Source: OME, MEP Egypt, 2009.

However, solar water heaters are currently used in domestic, commercial and tourist hotels with varying degrees of success. The hotels and resorts in Sharm El-Sheikh, the Red Sea and the Northern Coast areas are considered among the most important areas with great potential for solar energy utilization for water heating. According to New and Renewable Energy Authority NREA, current solar water heaters installed capacity in Egypt estimated at an equivalent of 300 MW. It is worth mentioning that the role of NREA with respect to solar water heaters market in Egypt was limited to conducting performance tests for solar water heaters and monitor its market and did not extend to the promotion and marketing for that technology on commercial scale.

2.2.3. Specifications and Standards of SWHs:

Specifications and codes for solar water heaters in Egypt have been set up as follows:

- Standard No. 1634 of 1987 which includes two sections, the first for technical definitions and the second for solar water heating systems.
- Standard No. 1634 of 1988 that includes section three related to solar flat plate collector components and section four that relates to thermal tank or reservoir.

In addition, the Egyptian General Authority for Specifications and Quality in collaboration with NREA issued the following specifications:

- Standard No. 5990 – 1 of 2007 for testing thermal performance and differential pressure of solar panels.
- Standard No. 6,302 of 2007 for testing solar systems performance characteristics in addition to its annual performance (without stand by electrical heater).

By the beginning of 2009, NREA set also the Terms of Reference for the modernization of outdoor testing lab for solar thermal systems according to international standards ISO 9806 (1, 2, 3), ISO/CD 9459 (4), ISO 9459 (2, 3, 5). NREA is currently conducting all tests for solar water heaters and its components in addition to providing the necessary certificates for its quality and all the technical support and expertise needed in that regard. Available tests for solar water heaters in the solar thermal test lab include proficiency testing, low pressure tests, and static pressure testing.

2.2.4. Local Manufacture of Solar Water Heaters: ^[5]

There are approximately 12 companies engaged in the manufacturing and supply of solar water heaters as mentioned before. Approximately 56% of solar water heaters components materials are totally imported from abroad, 33% are partially imported while only 11% are produced locally. Table (2.3) presents locally manufactured and imported components of solar water heaters. It should be noted that solar water heaters are manufactured with volumes or capacities module of 80, 150, 300, 500, and 750 liters per day, most of which are flat plate solar collectors with natural flow thermo-siphon. The manufacturing companies can also manufacture larger capacities of solar water heaters or those of forced or active flow systems if requested.

Table (2.3) locally manufactured and imported SWHs components

Materials	Local	Imported
Glass	Tempered	High Transparent
Absorption Surface	copper sheets & stainless steel pipes	Copper pipelines and welded copper sheets
Paints	Locally available	Special Paints
Frame	Ionized Aluminum	
Insulation	Locally available materials (e.g. polyurethane)	
Tank	Galvanized steel – Magnesium or stainless steel poles	
Pipes	Polypropylene	

2.2.5. Solar Water Heating Market Context and Main Issues:

In assessing solar water heating market in Egypt it is also of great value to shade light on the following important issues: ^[5]

- The existence of several factors and drivers that could enable the Egyptian solar water heating market to be a promising one, particularly if suitable environment materialized and supportive policies and measures for the establishment of strong industrial base are implemented through facilitating the transfer of the corresponding technology and techniques to the Egyptian market. Among those factors are the existence of a strong scientific base, the availability of many international universities in addition to local universities that gives great opportunities and ability for the transfer, diffusion and development of better technologies of solar water heating systems, the establishment of the Regional Centre for Renewable Energy and Energy Efficiency (RECREEE) in Cairo, etc. In that regard and with respect to feeding industries to the manufacturing of SWHs, except for some selective paints, all the raw materials necessary to manufacture SWHs are available in Egypt.
- Natural flow or thermo-siphon flat plate solar water heaters collectors are considered as the most common types of solar water heaters used in Egypt although some installed systems do not operate efficiently due to lack of quality, appropriate maintenance, and awareness about their optimal method of operation which all led to the bad reputation of that technology.
- SWHs technologies have not yet succeeded in proving their positive economic advantages to users in Egypt yet in order to make it more attractive and competitive in comparison with traditional systems of water heating (electricity, LPG, and natural gas heaters).
- The sustainability of solar water heating market needs great efforts from SWHs manufacturers and other stakeholders and partners.
- According to the Central Agency for Public Mobilization and Statistics (CAPMAS), there is a large potential for the expansion of SWHs market in Egypt to reach one million square meters (about 500 thousand units) compared to 400 thousand units or about 800 m² currently within 5 years and that the shares of different types of water heaters in the Egyptian market are 20% of gas heaters, 30% for electric heaters, and 50% for LPG heaters. Accordingly, expected savings in energy consumption per million square meters of solar water heaters could reach up to 310 million kWh of electricity, 32 million m³ of natural gas, and 61 thousand tons of LPG.
- Comparing the size of expected market of solar water heaters in the near future with current market size, there is a need to expand the existing manufacturing capabilities of solar water

heaters production by about 25,000 square meters per year, which indicates the need to allocate investment for that activity or to import the additional SWHs from abroad.

- Supporting the local manufacturing of SWHs systems could play a vital role in its market growth and reaching an ultimate target of 100% of their components manufacture locally. This could be achieved through an integrated plan based primarily on the following main impellers:
 - The provision of innovative financing mechanisms to support SWHs systems technology.
 - The implementation of effective programmes and plans to support SWHs systems.
 - Research and Development (R&D) in order to improve their efficiency in line with local conditions, reduce its cost, and increase the competitiveness of its local manufacturing to achieve local demand self-sufficiency and exports abroad.
 - Activate and enhance the implementation of previously issued resolutions, decrees, legislations and laws in order to support its deployment.
 - The implementation of several awareness and information campaigns and programmers on different economic and environmental advantages of using such systems.
 - The development of the necessary SWHs technologies infrastructure necessary to support its market growth.

Table (2.4) shows the various activities to be carried out in that area and the role of the various institutions and stakeholders in Egypt in that regard.

Table (2.4) Role of different institutions and stakeholders in SWHs manufacturing activities

	Policies & Strategies	Laws & Regulations	Financing	Marketing & Distribution	Installation & Maintenance	Testing & Accreditation	Awareness & Education	Licensing	Innovation, Research & Development	Know How & Experience Transfer
Government (Cabinet & SEC)	x	x								
Parliament	x	x								
Ministry of Electricity and Renewable Energy	x	x	x				x	x		
New and Renewable Energy authority	x	x	x	x	x	x	x	x	x	x
Electricity Regulator and Consumer Protection Agency	x	x						x		
SWHs Manufacturers			x	x	x		x		x	x
Ministry of Finance	x	x	x							
Ministry of International Cooperation			x						x	x
Ministry of Housing and New Communities	x	x								
New Urban Communities Authority NUCA		x								
Ministry of Environment	x	x	x	x			x			
Energy Efficiency Unit at IDSC	x	x	x	x			x		x	x
Research Centers									x	x
International Related Entities (e.g. UNDP, UNEP, WB, GIZ, etc.)	x		x				x		x	x
Universities and Research Institutions									x	x

2.2.6. Solar Water Heaters Costs:

The initial cost of SWHs in the Egyptian market varies depending on the type, quality and country of origin. In general, the initial cost of a SWH range between \$520 - \$1800, about LE 4000 - 14,000 depending on the type and capacity of the SWH. ^[9] Based on SEDA estimates; total cost of SWH of 200 liters storage capacity (collector surface area of 2 m²) can range between \$ 655 -917 for local manufactured (about LE 5000-7000) and \$ 1180-1704 for imported SWHs (about LE 9000 – 13,000) depending on the type and origin of the SWH. For the case of utilizing SWHs in the residential sector the cost of a good quality standard flat plate collector SWH of 200 liters capacity (2 m² collector surface area) can reach \$880 (CIF price) equal about LE 6700 at the prevailing exchange rate of 7.63 LE/\$. Taking into consideration imposed custom duties, sales taxes and other inland costs such as transportation, handling and storage, etc. that cost could reach about \$1180 (LE 9000).

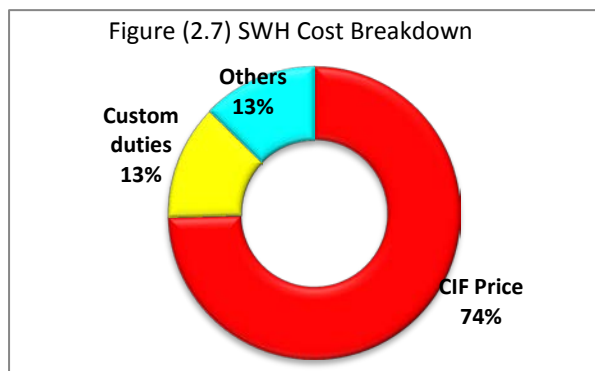
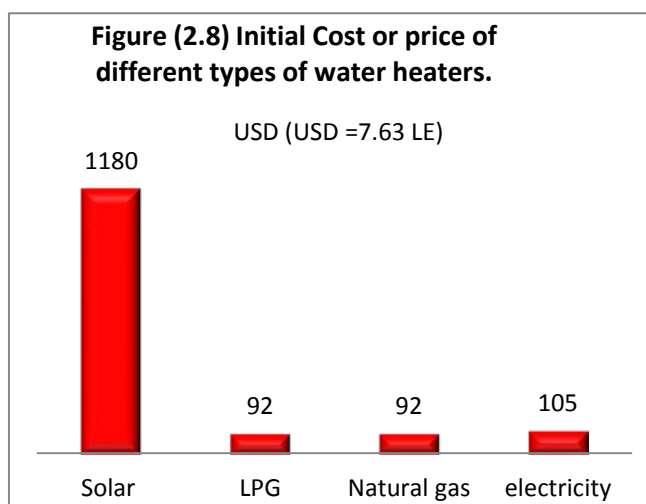


Figure (2.7) presents different cost items share of total cost of SWH.

Therefore, in case of implementing an ambitious national programme for the promotion of SWHs technology in the residential sector in Egypt a SWH initial cost of about \$1180 (LE 9000) could be considered. Meanwhile, it worth to mention that the initial cost or price of SWHs is considered also relatively high compared to the price of alternative water heaters (LPG, natural gas and electricity) that range on average for about LE 700 (\$92) for LPG and natural gas water heaters and about LE 800 (\$105) for electric water heater as shown from figure (2.8) which again make SWH as an infeasible alternative to traditional water heaters for most of energy consumers in Egypt.

In case of considering central water heating systems as the case of multi-story building the initial cost of SWHs can be reduced by more than 50% per apartment as the economies of scale are significant. ^[9]

Based on average daily hot water consumption of about 50 liters and the average size of family of 4 persons, solar water flat plate collector of surface area of 2 m² and capacity of 200 liters is found to be reasonable for most of families in Egypt.



2.2.7. Barriers for SWHs Market Development in Egypt: ^[10] ^[11]

Several barriers that can hinder the development and promotion of DSETs market including SWHs exist in Egypt. These can be characterized as technical, institutional, regulatory, awareness, social, financial, economic and political & policy barriers. Examples of these barriers include:

1. **High investment cost:** compared to traditional systems (electric, LPG and natural gas) water heaters, SWHs cost are considered relatively high. As an example and as mentioned before, while a typical domestic SWH of 2 M2 area (200 liters capacity) flat plate collector with reasonable quality and performance may cost on average about LE 9000 (\$1180) an electric water heater may cost LE 800 (\$105). This also the case for the cost of LPG and natural gas water heaters that makes SWHs infeasible alternative to replace them. To overcome this barrier and narrow the cost gap between SWHs and other traditional thermal water heaters innovative incentive mechanisms, policies, and measures are needed.
2. **Mistrust and doubts about the quality and performance of SWHs:** the bad reputation gained on the implementation of SWHs in Egypt during the last decades since the 1970s as a result of lack of awareness, lack of implementing mandatory high quality standards, and certification schemes were among the reasons for that situation.
3. **Low energy prices and large subsidies given to conventional energy sources:** is considered as one of the main barriers for the delay of SWHs market development and promotion in Egypt. In addition to the negative economic and environmental impacts of imposing low energy prices on the whole Egyptian economy which is reflected as examples in the inefficient use of energy consequently high demand growth rates and the increase in energy subsidies that reached LE 128 billion (about \$28 billion) for petroleum energy in the year 2012/2013 and about LE 27 billion for electricity, low energy prices discourage consumers from switching to new and carbon free DSETs technologies such as PVs and SWHs. One of the recommended policies to overcome this barrier in addition to raising prices of conventional energy is to shift that subsidy totally or partially from conventional fossil fuels to different renewable energy sources and technologies including SWHs.
4. **Lack of synergies among different SWHs stakeholder** which negatively impact the development and growth of SWHs market. In order to overcome that barrier, there is a need for stronger cooperation and collaboration among different stakeholders at the institutional and regulatory level.
5. **Lack of reliable data, information and statistics on different aspects related to SWHs market:** as an example there is a lack on the cost of different types or models of existing SWHs in the market, their performance and quality, etc. Therefore, it is essential to establish a robust and reliable database for SWHs market and technologies on the national and international levels.
6. **Unavailability of enough space for SWHs installation on buildings' roofs:** the inefficient and misuse of available space area on buildings roofs is considered as one of the main barriers that limit opportunities for SWHs market development and growth in Egypt as most of the space area is utilized for water storage tanks and satellite dishes. In order to overcome this barrier there is a need for more awareness and accurate planning for the

optimal utilization of available space area on buildings' roofs and to strict implementation of existing building codes.

- 7. Political and Policy barriers:** although there is huge potential for solar energy resources exploitation, however, the absence of support policies for the enforcement and implementation of existing building codes, decrees that support the installation of SWHs in new buildings such as the Minister of Housing and New Settlements' decree number 401 for the year 1987, and considering renewable energy utilization including solar among the government top priorities of implemented energy strategies and policies was among the most important barriers that slow down SWHs market growth.
- 8. Lack of appropriate incentives for SWHs manufactures and clients.** Examples in that regard include exemption of imported SWHs and its components from custom duties and sales tax, the absence of attractive financing mechanisms with good terms and conditions such as low interest rate, reasonable loans repayments periods, low collateral requirements, simple procedures, etc.
- 9. Social barriers:** include as examples:
 - A. High buildings shadow: the population high density particularly in big cities like Cairo in addition to the scarcity of empty land have led to high buildings which in turn are preventing the possibility of installing SWHs on building roofs in many areas.
 - B. Most of the customers are not aware about the benefits and advantages of SWHs utilization and the proper way for its usage. In that regard, it is worth mentioning that some of the customers run their SWHs dry for long periods of time.
 - C. Some SWHs manufacturing companies were producing low performance and low durability SWHs which led to bad reputation of this technology.

Moreover, in order to overcome SWHs market's barriers in Egypt it is necessary also to:

- Increase private sector involvement,
- Provide attractive incentives for market support from the government,
- Overcome many economic, financial, legislative, institutional, technical, and information barriers and obstacles that might hinder SWHs market development,
- Develop the appropriate and effective innovative financing mechanisms necessary for SWH purchase and installation by different clients.

More detailed barriers are shown in appendix (4).

2.2.8. The Financing Market and Banking Sector in Egypt: ^[12] ^[13]

The financing market in Egypt is regulated and controlled through the Central Bank of Egypt (CBE) which is a national reserve bank. In addition, there is a state regulatory authority for the Cairo Stock exchange. Since the establishment of the first bank in 1956, the banking system in Egypt has gone through many stages of development that include the emergence of the private sector and joint venture banks during the period of the open door policy in the 1970s. Moreover, the banking system has undergone major reforms, privatization, and mergers and acquisitions since 1991 up to day which is supervised and regulated according to internationally accepted standards with the aim of creating an efficient banking system that offers better quality serves. The banking sector consists of commercial banks, which are local banks and non-local banks. It also includes specialized banks and financial institutions operating in the fields of

investment and credit for industry, agriculture, housing and rural development. The banking system currently comprises 57 state owned commercial banks which includes 28 commercial banks, four of which are state-owned, 26 investment banks (11 joint venture banks and 15 branches of foreign banks), and three specialized banks. In addition, there are branches affiliated to these banks and institutions. Although private and joint venture banks are growing, many remain relatively small with few branch networks. State-owned or nationalized banks account for 85% of bank accounts in Egypt and around 60% of the total savings. The penetration of banking is low in rural areas at only 57 % of households.

A recent study performed by MED DESIRE Project team that covered Egypt, Lebanon, and Tunisia, highlighted the following issues with respect to the banking system in Egypt: ^[14]

- The private sector credit to Gross Domestic Product GDP and loan to deposit ratios in Egypt accounted for 31% and 48% respectively compared to 90% and 36% for Lebanon and 75% and 118% for Tunisia respectively; reflecting the weak level of banking intermediation in the previously mentioned areas. The low private sector credit to GDP ratio in Egypt could be attributed to different reasons that include the liquidity problem in the banking system.
- The high transactions costs associated to Small and Medium Enterprises SMEs lending.
- The demanding collateral requirements which hinder SMEs access to credits.
- Low percentage of adult with an account in formal financial institutions that account for about 10% in addition to low number of bank branches per 100 thousand inhabitants all over the country that account for only about 4.6%. The corresponding figures for Lebanon and Tunisia are 37% and 23% respectively for adult with accounts in formal financial institutions and 31.5% and 21.1% for bank branches per 100 thousand inhabitants respectively.
- In addition to the international financial and economic crisis, the Arab Spring heavily negatively impacted economies in the Arab region including the banking systems. In Egypt and Tunisia for instance, the impact was magnified by the closure of some banks for a period of time.
- The structure of financial sector has significantly changed after the revolution. In particular the excess of liquidity has been now absorbed by the public debt. The Central Bank has intervened number of times in order to ensure a sufficient supply of liquidity to the inter-bank market. In addition, there is an increasing gap in terms of foreign exchange and this may turn to squeeze the lending activities in favor of private sector. However, despite the macroeconomic poor performance, the banking system has not been destabilized even in front of the increase of the sovereign risk.
- The demand of private sector has declined since the beginning of 2011 as the economy slowed down and as a consequence of the increased demand of the public sector has increased.
- The confidence in banking sector remains good even though the ratio of loan to deposit fell below 50%. This gives an indication of the constraints faced by the banking sector and the reduced opportunities to expand their lending activities to private sector.
- Credit to the private sector accounted for about 40-42% of GDP in the first half of 2010 which is below the average of OECD countries (110%) but it is in line with the performance

of many countries at the same stage of development. However, the deposits available are some 100% of GDP but are not transformed into loans to the productive sectors. The loan-to-deposit-ratio in 2010, for instance, was about 52%. At the same time, the percentage of credit lent to the private sector is declining over the years. While before the financial crisis (mid-2008) the loans to private business were around 50%, afterwards the ratio declined to some 40-42% (year 2010 as previously mentioned). During the same period, loans to public sector increased significantly.

According to World Bank observers, the increase in lending to the government tends to reflect banks difficulty in identifying profitable projects and their cautious investment policies. The lending practice is conservative, the regulations are quite inconsistent and this impacts heavily on private sector apart from diverting the banking system capacities to fund the public deficit. Another reason is that, historically, the government funds the budget deficit via domestic borrowing. Currently, some 80% of the government debt is held of domestic banks and this situation crowds out the private sector.

- With respect to the distribution of private sector loans, a closer look reveals that the private sector is not only generally underserved, but that it also suffers from an extremely skewed loan distribution. According to Central Bank figures (excluding loans below EGP 30,000, USD 5360), 0.2% of lending clients represent half of total loan value for commercial banks.
- Large corporate loans represent up to 70% of total loans for banks, which limits diversification and raises risks.
- Banks tend to lend more to traditional sectors, where relations, collateral and repayment patterns are well established, which slows down the shifting of resources to new economic sectors and the emergence of dynamic enterprises.
- The main problems identified with regard to loan appraisals, and credit policies are generally relevant to staffing and training issues as well as internal procedures and screening rules. Relationship-based lending and poor internal standards, as well as lacking credit risk evaluation skills and shortcomings in remuneration or incentives policies lead to the previously outlined loan concentration and credit rationing for small business and households.
- Improving access to finance for MSMEs is one of the key reform challenges in the financial sector. Loans to SMEs account for only 6% of total banking loans. Poorly developed credit bureaus and weak contract enforcement are among the key obstacles to the further development of MSME finance.
- Constraints to lending to MSMEs appear more related to the institutional capacity and risk appetite of the private banking sector, as well as low bankability and low financial literacy of MSMEs, rather than liquidity.
- In addition, banks are highly selective in their lending practices, and mid-sized and smaller companies find it difficult to get funding from the banking sector, whereas the financing needs of larger corporate are generally adequately met.

2.3. SWHs Targets and Strategies Analysis and Thermal Applications:

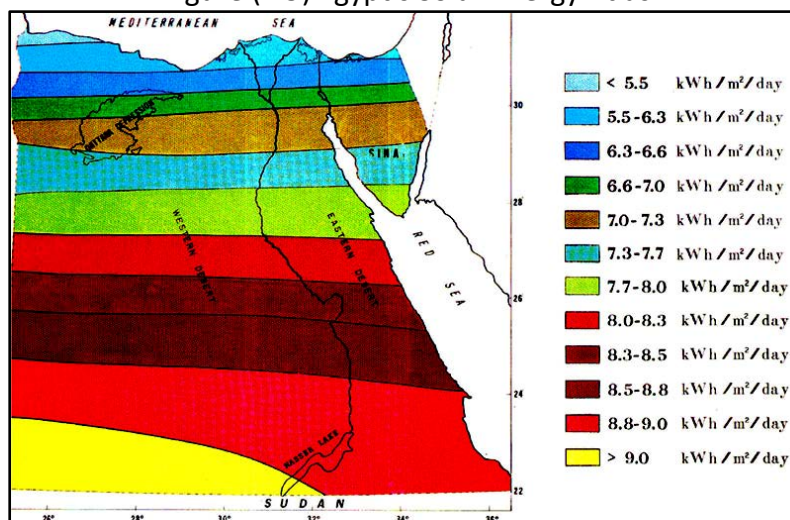
Unlike other types of solar energy technologies such as PVs and Concentrated Solar Power CSP that have well defined targets, there is no specific targets, plans and strategies for the development of solar water heating market in Egypt in spite of the vital role it could play in reducing electricity, LPG and natural gas consumption in residential, commercial and industrial sectors. Therefore, in assessing the targets and strategies of SWHs in the residential sector it is essential to shade light on solar energy resources and thermal applications in Egypt in addition to residential sector consumption of different energy commodities as illustrated in the following section.

2.3.1. Solar Energy Resources in Egypt:

As previously mentioned Egypt enjoy favorable conditions for the utilization solar energy resources. In addition to utilizing wind energy for water pumping, there are several locations with wind speed suitable for electricity generation. Solar energy radiation or intensity ranges between 2000 to 3200 KWh/m²/year from the north to the south of Egypt as shown from figure (2.9) with sunshine duration of about 9 to 11 hours per day making Egypt as one of the most appropriate and best regions in the world for utilizing solar energy for electricity generation in and thermal heating applications including SWH.^[15]

In that context, the first solar thermal power plant was constructed at Kuraymat area with a total capacity of 140 MW as integrated combined cycle power plant including 20 MW as solar component and 120 MW as gas fired combined cycle plant. The Total area of the integrated solar field is about 644 thousand square meters (m²) with total solar collector area of 1920 m² containing 53760 mirrors. The total annual savings of conventional fuels as a result of utilizing solar energy for electricity generation in Kuraymat power plant estimated at about 10 thousand tons per year and consequently avoided CO₂ emissions estimated at about 20 thousand tons.^[16]

Figure (2.9) Egypt's Solar Energy Atlas



2.3.2. Solar Water Heaters Targets and Strategies:

The New and Renewable Energy Authority (NREA) estimates of total installed area of solar water heaters SWHs in Egypt is of about 750 thousand square meters (m²) equivalent to about 375 thousand SWHs each of 2 m² collector surface area. Currently, NREA cooperate with the tourism sector to spread the utilization of renewable Energy applications in tourist communities, including the promotion of solar heaters utilization in hotels and tourist villages in the Red Sea and South Sinai governorates through **EGYSOL** project which is implemented in co-operation between Egyptian Government, Italian Government, and the United Nations Environment Program (UNEP). The project aims to implement a mechanism that support financing the dissemination of solar water heaters in hotels and resorts in the previous mentioned Governorates with total cost of 500,000 US Dollar. Specifically, the project aims to:

- Install about 5000 m² of water solar heating system.
- Save about 4000 tons of oil equivalents.
- Reduce about 12000 Tons CO₂ annually.
- Provide technical capacity building for staff in the field of solar water heating.

By the end of 2012/2013, about 2350 m² of solar water heaters in 21 Hotels have been erected.

2.3.3. Residential Sector Energy Consumption: ^{[17] [3]}

The residential sector is considered as the major LPG and electricity consumers in Egypt. As shown from table (2.5), the residential sector represented 99.4% of total LPG consumption in 2012/2013, about 43% of electricity consumption and about 3% of total natural gas consumption during the same year. Electricity represented the largest share of residential sector total energy consumption of about 67% compared to 26% for LPG, 7% for natural gas and insignificant or negligible share for kerosene which is used in some rural areas for cooking and water heating.

Table (2.5) Residential sector petroleum products, natural gas and Electricity consumption (2012/2013 - 1000 TOE) *

	LPG	Kerosene	Natural Gas	Total Petroleum & NG	Electricity	Grand Total
Domestic	4748.6	4.5	1271.0	6024.1	12079.6 (59.8 BKWH)	18103.7
Total	4776.8	6.8	43570.1	48353.7	28320.4 (140.2 BKWH)	76674.1
Residential sector share of total consumption (%)	99.4%	65.1%	2.9%	12.5%	42.7%	23.6%
Fuels share of residential sector total energy consumption (%)	26.2%	0.0%	7.0%	33.3%	66.7%	100.0%

* include commercial.

Source: EGPC, EGAS & MERE.

2.3.4. Residential Sector Electricity Consumption:

The residential sector electricity consumption accounted for about 60 GWh in 2012/2013 representing 43% of total electricity consumption in Egypt during the same year which accounted for about 140.3 GWh as shown from figure (2.10). Meanwhile, total number of residential customers connected to electricity grid accounted for about 24 million representing 80% of total number of electricity customers in Egypt during the year 2012/2013 that accounted for about 30 million. Figure (2.11) and table (2.6) presents residential sector total number of electricity customers disaggregated by different electricity tiers in 2012/2013 in addition to the corresponding electricity tariff or prices as of July 2014. ^[3]

Figure (2.10) Sectors share of total electricity consumption in Egypt (2012/2013)

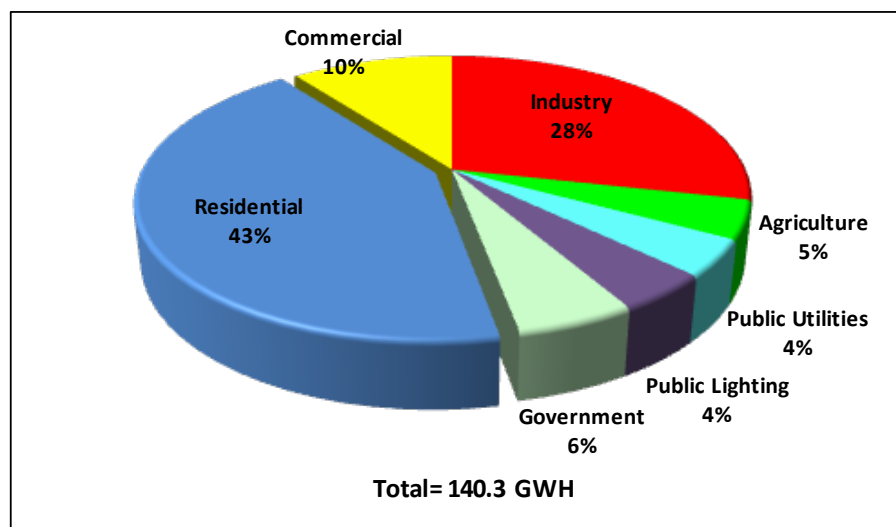


Figure (2.11) Residential sector electricity consumers by tier (2012/2013)

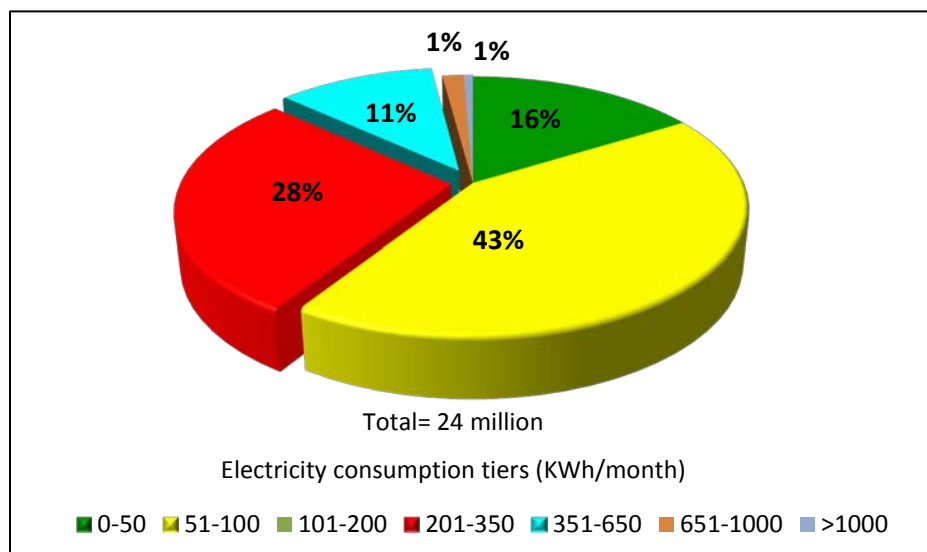


Table (2.6) Electricity prices or tariff by different tiers of consumption (1/7/2014)

Electricity Tariff or Prices			
2012/2013	Starting 1/7/2014		
(LE/KWh)	Consumption Tiers (KWh/month)	(LE/KWh)	(\$ Cent/KWh)*
0.05	0-50	0.075	0.98
0.11	51-100	0.145	1.90
	101-200	0.16	2.10
0.16	201-350	0.24	3.15
0.24	351-650	0.34	4.46
0.39	651-1000	0.60	7.86
0.48	>1000	0.74	9.70

* One \$ (100 cents) = LE 7.63.

2.3.5. Electricity Consumption for Water Heating in the Residential Sector in Egypt:

As it is well known, electricity is consumed in the residential sector by different home appliances to achieve specific activities such as lighting, air conditioning, space heating, refrigeration, watching TVs, listening to radio, and ironing, etc. This in addition to water heating which is considered as one of the major electricity consuming activities in the residential sector particularly in urban areas. In that regard, several studies indicate that electric water heaters are responsible for at least 25% of total electricity consumption by any house. As an example, for an electric water heater of capacity of 50 liters and a power of 1000 W that operates for 5 hours per day on average, it will consume 150 KWh per month representing about 30% of total electricity consumption by a middle income class family that consumes on average for about 400 kWh monthly.

On the national level, one of the studies estimated that electricity consumption for water heating in Egypt accounts for about 6000 GWh annually, representing 6% total Egypt's electricity consumption and 2500 MW of grid peak load (equivalent to the capacity of 2-3 standard thermal power plants). Assuming that hot water demand in residential areas would be satisfied 100% by solar energy, 4.5 Million tons of CO₂ equivalent GHG emissions could be avoided each year (resulting from direct and indirect fuel consumption).^[18]

The low and stagnant prevailing electricity prices during the last few decades in addition to the relatively low cost of electric water heaters combined with the high up-front cost of SWHs and the existence several barriers for its market expansion in addition to the unavailability of LPG and natural gas networks in some areas of the country were among the drivers for the increase in electric water heaters production in Egypt that reached more than 1.1 million units in 2009/2010 as shown in table (2.7).

Table (2.7) Development of electric water heaters production in Egypt
(2002/2003-2011/2012)^[19]

Year	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	Average Annual Growth (%)
Number (units)	429	558	662	785	660	899	705	1157	619	579	3.4%

2.3.6. Residential Sector Consumption of Petroleum Products and Natural Gas:

LPG is considered as one of the most important petroleum products which are used on large scale for cooking and water heating in the residential sector in both urban and rural areas. At the same time, kerosene is used for such activities in some rural areas in addition to LPG but with very minor and insignificant quantities as shown from table (2.5). Natural gas is also one of the most important fuels consumed in the residential sector for cooking and water heating in urban areas, where in recent years there has been a significant increase in the rates of residential units connection to natural gas grid in light of the prevailing government and petroleum sector policies and strategies that aimed at further expansion of natural gas usage as a fuel in different sectors to replace petroleum liquid fuels including LPG in domestic and commercial sectors. The implementation of that policy resulted in the expansion of natural gas network or grid to reach more than 35 thousand kilometers with the number of residential customers connected to it about 5.5 million by the end of 2012/2013.

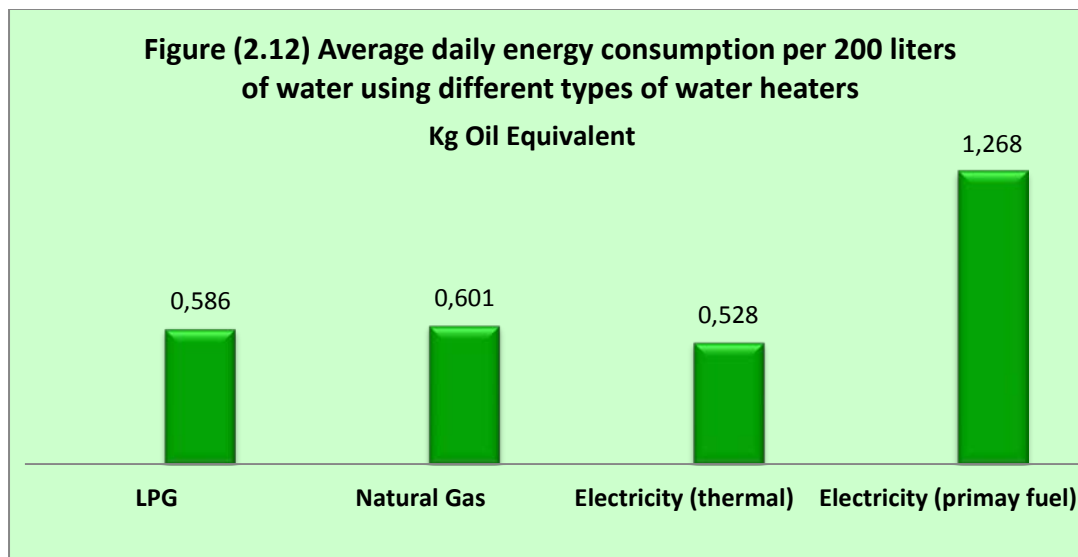
It is worth mentioning that, in addition to the usage of electricity, LPG and natural gas for water heating in the residential sector as previously mentioned, LPG and natural gas are used for cooking in the same sector, and that electricity, LPG, natural gas, and diesel fuel are used for water heating in the commercial sector (hotels, restaurants, hospitals, etc.) in addition to their usage in some buildings in the government sector.

2.3.7. Total Number of Water Heaters in Egypt: ^[20]

Based on estimates of the Central Agency for Public Mobilization and Statistics (CAPMAS) of average ownership of different types of water heaters (LPG, natural gas and electricity) by total number of families in the whole Egypt and in rural and urban areas which accounted for 47%, 27.4% and 71.1% respectively and according to the actual number of families living in those regions, total number of different types of water heaters in Egypt estimated at about 9.6 million unit of which about 6.6 million units are in urban areas and about 3 million in rural areas.

Figure (2.12) shows the average daily energy consumption by different types of water heaters presented in kg oil equivalent per one water heater. As shown from that figure, it is quite obvious that the consumption level of electric water heater (based on primary fuel requirements to generate the necessary electricity for heating the same water quantity) is two times that for natural gas and for LPG water heaters.

Therefore, based on total number of electric water heaters that equals 3 million heaters and the average daily specific electricity consumption of about 1.268 Kg oil equivalent and average use of hot water of about 240 days per year; total annual energy consumption by one electric water heater estimated at about 0.9 million tons of oil equivalent. The corresponding annual energy consumption of each of LPG and natural gas water heaters estimated at about 0.4 million tons of oil equivalent.



2.3.8. The Ministry of Electricity and Renewable Energy Strategy:

The enhancement of renewable energy utilization is considered as one of the main impellers of the Ministry of Electricity **Energy Strategy** that comprise the following main goals: ^[21]

- Optimize the use of available energy sources taking into consideration the environmental protection.
- Provide electricity at suitable and affordable prices and with best quality.
- **Expand utilization of new and renewable energy resources.**
- Support villages and cities electrification and complete electrifying the urban areas and low population communities.
- Interconnect the Egyptian electrical grid to African west and east neighboring countries.
- Boost local manufacturing contribution in designing, implementing, and manufacturing electrical equipments.
- Diversify electricity generation fuel resources.
- Restructure electricity sector to optimize investments and improve electrical services.
- Utilize modern and advanced technical systems in electricity sector's operations and activities.
- Develop the skills of engineers and technicians working in the electricity sector.
- Export Egyptian expertise in design, manufacture, negotiation, construction, and operation of electrical projects.
- Take advantage of soft loans and obtain the best terms.

In order to achieve those goals, the work mechanism of the Ministry of Electricity and Renewable Energy comprise:

- Set and implement policies & plans in the fields of electricity generation, transmission and distribution to be up to date with the most technical and scientific proven developments and technologies.
- Follow up and monitor different activities to provide electrical power for the social and economical development to support the government's framework and plans.
- Suggest tariff of electrical power to the cabinet.

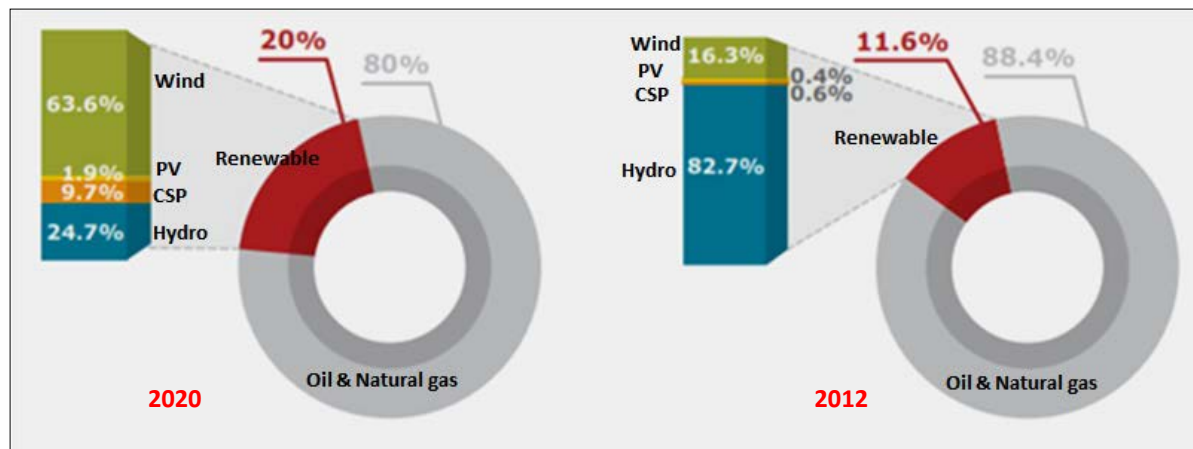
- Supervise study and implementation of important electrical projects.
- Set data and statistical systems related to electricity in all fields.
- Provide the technical support, consultancy, and experience to Arab countries in the electrical field.

2.3.9. Future Solar Energy Plan:

The Ministry of Electricity and Renewable Energy Plans include renewable energy share of 20% of total electricity installed capacity by the year 2020 of which 63% as wind energy (7200 Mw), 12% as solar energy (1320 MW) and 25% as hydro energy (2800 Mw).^{[22] [23]}

Figure (2.13) presents electricity installed capacity by type in the years 2012 and 2020.

Figure (2.13) Electricity generation by type (2012 & 2020)



Source: "Renewable Energy at Glance", RCREEE, 2013.

Moreover, in July 2012, the Egyptian Solar Plan has been approved by the Cabinet, which targeting to install about 3500 MW capacity by 2027 with private investment share of 67% including enhancement of relevant local industry.

2.3.10. Estimates of Residential Sector Hot Water and Energy Demand:

According to the Central Agency for Public Mobilization and Statistics (CAPMS) latest published edition of "family budget survey of the year 2012/2013" that covered 24863 family in different governorates in Egypt representing different income classes, water heaters ownership or degree of saturation estimated at about 27.4% for rural areas, 71.3% for urban areas and 47% for all Egypt. Based on estimates of total number of families all over Egypt and in rural and urban areas as presented in table (2.8) which estimated at more than 11 million in rural areas, 9 million in urban areas and 20 million in all Egypt, and on the degree of water heaters ownership, as mentioned before, total number of water heaters estimated at about 10 million in the whole country of which about 7 million in urban areas and 3 million in rural areas.

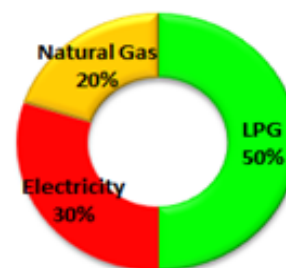
Table (2.8) Estimates of number of families and water heaters in Egypt (2013) ^[24]

Area	Urban	Rural	Total Egypt
Population (thousand inhabitant)	36213	48416	84629
Number of families	9285	11003	20149
Degree of water heaters saturation	71.3%	27.4%	47%
Estimated number of water heaters	6620	3014	9634

Source: CAPMS, "Family Budget Survey of the year 2012/2013".

According to percentage share of different types of water heaters as shown from figure (2.14) which is 50% for LPG water heaters, 20% for natural gas water heaters and 30% for electric heaters, total number of different types of water heaters estimated at about 5 million for LPG water heaters, 2 million for natural gas, and 3 million for electric water heater.

Figure (2.14) SWHs by type share



Total = 10 million

2.3.11. Residential Sector Hot Water Demand:

Based on the assumptions shown in table (2.9), residential sector total annual hot water demand disaggregated by assumed time of hot water use have been estimated to range between 240 to 730 billion liters. The corresponding total energy demand has been also estimated to range between 1 - 3 MTOE, table (2.10) and figure (2.15).

As shown also from table (2.10) different energy forms share of total water heating estimated at 64% for LPG, 33% for natural gas and 3% for electricity.

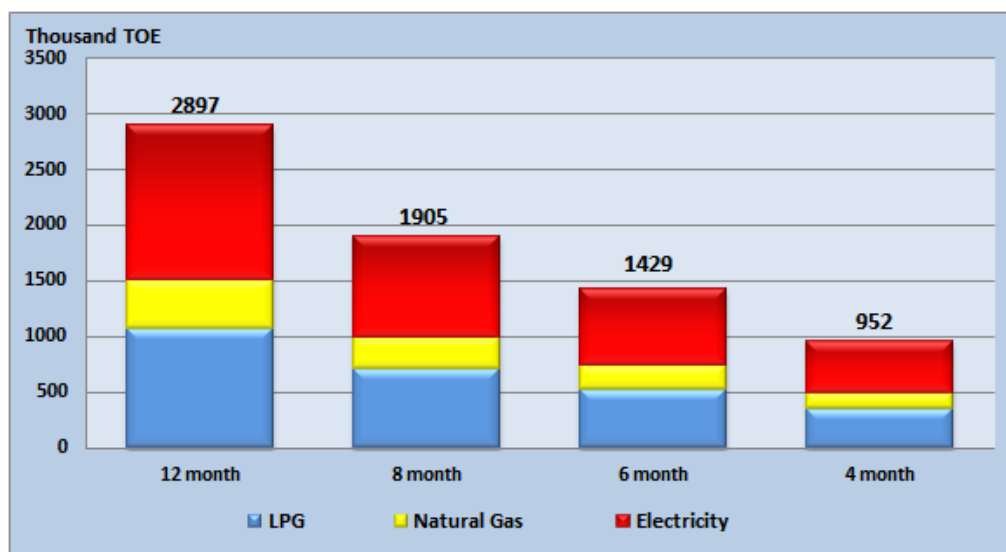
Table (2.9) Assumptions for residential sector hot water demand estimates and the corresponding fuel requirement in 2015

Total number of water heaters in Egypt	10 million
Total number of water heaters in urban areas	7 million
Total number of water heaters in rural areas	3 million
Average daily water demand per person	150 liters/day
Average daily hot water demand per person	50 liters/day
Average daily hot water demand per family	200 liters/day
Number of persons per family	4 persons/ family
Amount of electricity required to heat 200 liters 25 °C (from 20 °C to 45 °C)	6.1 KWh/day
Amount of LPG required to heat 200 liters 25 °C (from 20 °C to 45 °C)	0.519 kg /day
Amount of natural gas required to heat 200 liters 25 °C (from 20 °C to 45 °C)	0.681 M3/day

Table (2.10) Energy demand for water heating

Hot water Usage Period (month)	Hot water consumption (billion liters)	LPG ('000 tons)	Natural Gas (million m3)	Electricity (million KWh)	('000 TOE)			Total
					LPG	Natural Gas	Electricity	
12	730	947	497	6707	1070	439	1389	2897
8	480	623	327	4410	703	288	913	1905
6	360	467	245	3307	528	216	685	1429
4	240	311	164	2205	352	144	456	952
Share at 8 month time use of hot water					33%	17%	50%	100%

Figure (2.15) Residential sector hot water energy demand



2.3.12. Residential Sector Future Hot Water and Energy Demand:

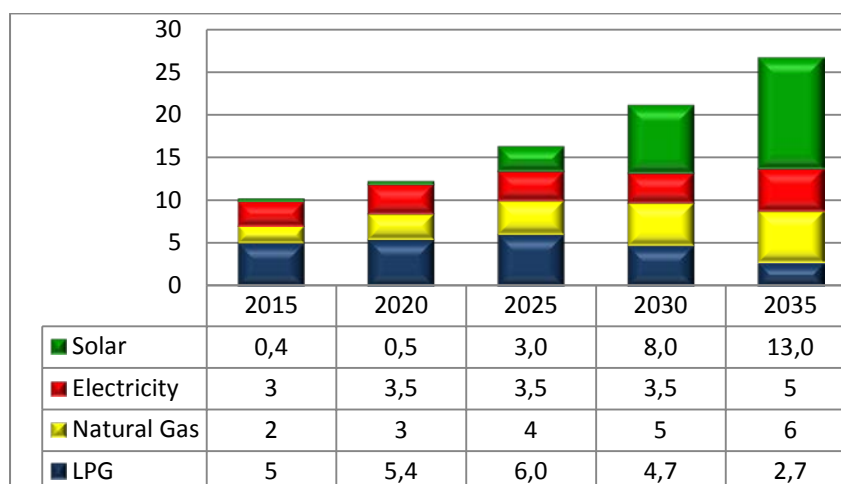
The level of hot water consumption in the residential sector depends on several factors the most important of which are population growth, percentage of population that has access to hot water, income and standard of living, availability of energy and the corresponding cost, etc. Based on hot water consumption levels in 2015 as a base year in addition to the following assumptions, hot water demand in the residential sector in addition to the corresponding energy demand have been estimated during the coming year till 2035 as shown from table (2.11).

Assumptions:

- Population (2015) = 90 million
- Population average annual growth rate = 2%
- Percentage of population that has access to hot water = 46% in the year 2015 (equivalent to 41.6 million or 10.4 million families). it is estimated that this percentage will reach 80% in the year 2035 as a result of expected improvements in income and living standards.
- Average daily hot water consumption per person= 50 liters (200 liter per family composed of 4 persons).
- Average annual usage period of hot water= 240 days (8 month).
- A declining in LPG water heaters number over the forecast period as a result of fuel switching policy that aims at expanding natural gas network, accordingly the number of natural gas heaters is expected to increase. This is in addition to the expected increase of SWHs use.
- SWHs to represent almost half the total number of water heaters by the year 2035. Other drivers beyond that assumption include the shortfalls of LPG supply and importance to decrease imports of LPG.

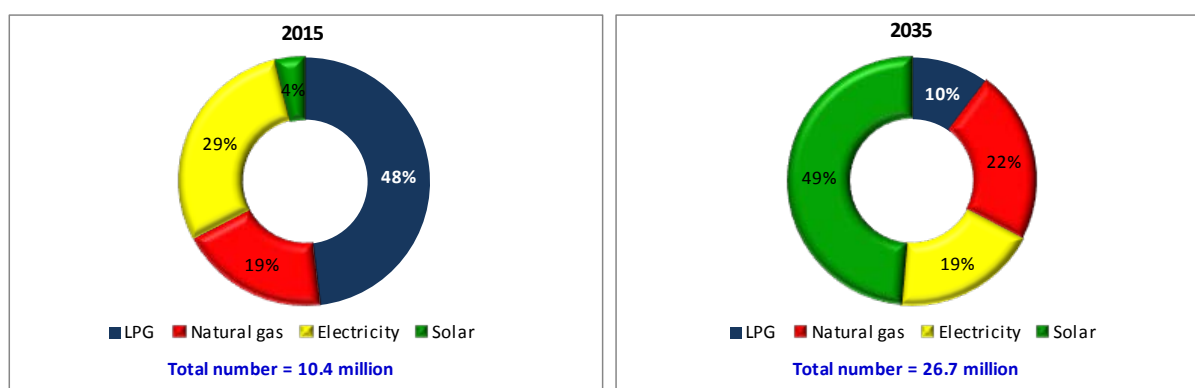
Figure (2.16) presents total number of SWHs development during the period (2015-2035) disaggregated by different types of SWHs while figure (2.17) show the growth share of SWHs on the expense of other types of water heaters.

Figure (2.16) Number of water heaters development (2015-2035) – (million)



Source: Author own elaboration.

Figure (2.17) SWHs total number by type share (2015 – 2035)



Source: Author own elaboration.

Based on the previously mentioned assumption; total population estimated to increase from 90 million in 2015 to about 134 million in 2035. Accordingly, total hot water demand is expected to increase from about 497 billion liters in 2015 to about 1284 billion liters in 2035 and the corresponding total energy demand to increase from about 2 MTOE in 2015 to about 5.3 MTOE in 2035 of which SWHs represent a share of about 47% compared to 7% for LPG water heaters, 17% for natural gas water heaters and 29% for electric water heaters as shown from table (2.11) and figures (2.18) & (2.19).

Table (2.11) Population, hot water and energy demand development (2015-2035)

	2015	2020	2025	2030	2035
Population (million)	90	99	110	121	134
Hot water demand (billion liters)	497	598	790	1017	1284
Total number of water heaters (million) of which:	10.4	12.4	16.5	21.2	26.7
LPG, natural gas & electricity heaters number (million)	10	11.9	13.5	13.2	13.7
SWHs number (million)	0.4	0.5	3	8	13
Total energy demand (MTOE)	1.98	2.63	3.06	3.98	5.27

Figure (2.18) Energy demand for water heating (2015-2035)- (MTOE)

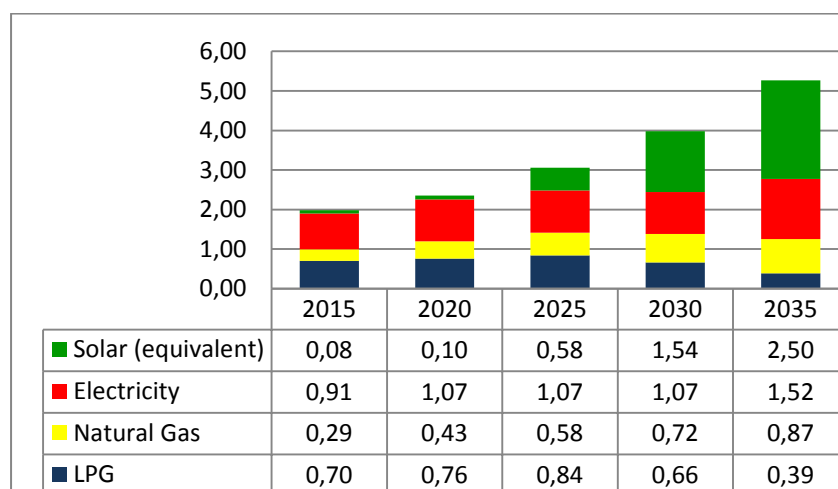


Figure (2.19) SWHs share of hot water total energy demand (2015 – 2035)



Other estimates with respect to SWHs market potential indicates that Egypt population is expected to reach about 102 million by 2030 of which about 19.4 million are expected to be as new inflow in urban areas. According to the New Urban Communities Authority (NUCA), the current population residing in new communities in Egypt account for about 7 million people and it is expected to reach 17 million when the new cities development is completed. Moreover, NUCA is estimating that in case there will be good cooperation with the private

sector a total of about 240,000 new housing units could be constructed annually in new urban communities during the coming ten years which could be accommodated by SWHs. Taking into consideration the possibility of the installation of SWHs in existing residential units that figure can reach 300,000 annually. This is in addition to about 20 to 50 thousand m² surface areas of SWHs (about 10 to 25 thousand SWHs) annually as a potential in the hotel sector. ^[25]

2.4. Assessment of Existing Financing Mechanisms:

One of the important steps of the methodology of designing the most appropriate innovative financing mechanism and incentive tool to promote the market of distributed solar energy technologies in Egypt, namely the SWHS is to review, assess, and analysis the existing implemented successful financial mechanisms and incentive tools not only in Egypt but also in some countries in the region and the globe. It might also be useful to review similar mechanisms and tools implemented to promote the market of other technologies such as the use of Compressed Natural Gas CNG as a fuel in vehicles to replace gasoline and diesel and the Old Vehicles Scrapping and Recycling Programme (OVS RP), etc. The following section highlights some of those mechanisms and financing tools.

2.4.1. Assessment of Existing Financing Mechanisms in Egypt:

Performing that activity was achieved through several activities and initiatives that include:

1. The preparation of a questionnaire to assess different SWHs market stakeholders and concerned entities' views and evaluation of existing and implemented financing mechanisms.
2. Direct interviews with some SWHs market stakeholders and partners such as SWHs manufactures, suppliers, banks, etc.
3. Literature review of the most important and successful implemented mechanism in Egypt and some countries in the region.

The following is a brief on different performed activities in that regard and the main outcomes and conclusions achieved.

2.4.1.1. The Preparation of a Questionnaire to Assess Different SWHs Market Stakeholders Views and Evaluation on Existing and Implemented Mechanisms:

As previously mentioned the main objective of that activity is to evaluate different SWHs market stakeholders' views on implemented financial mechanisms and define the main barriers that hinder its promotion and growth. The main issues, topics and questions covered by that questionnaire which is presented in appendix (2) include:

- General Information on contact person responsible for collecting questionnaire data.
- Questions related to the status of solar energy market in Egypt which include issues and question on:
 - Major barriers and challenges facing solar energy market development.

- Extent to which financing of solar energy projects is considered as a major barrier or challenge.
- Identification of implemented financing Mechanisms or incentives for the promotion of solar energy technology distribution that cover the following items and topics:
 - a. The design of the financing mechanisms (its name, objective, targeted consumers, sectors and technology, barriers that the mechanism attempt to address or overcome e.g. high upfront cost), the criteria that the beneficiaries of the mechanism should meet in order to gain access to the necessary finance and how do they evaluate it, the application process to benefit from the financing mechanism (various steps/ procedure that the beneficiaries have to go through in order to benefit from the mechanism in financing their solar energy projects cost), the availability of guidelines or procedures for the application process of the financing mechanism and the approach of its publicity (either through brochures, website or both), existence of any supporting policies or measures, targets that the mechanism must meet (e.g. number of units/customers financed, total amount of finance, etc), average size of the solar system to be financed, average size of the finance, description of the financing mechanism.
 - b. Implementation of the financing mechanism: the items covered include length of time that the application process takes until approval on finance realized, process of handling the application (either in house/internally or through a third party), approach for finance terms, disbursement of funds (installments or as a lump sum) and when, most important barriers that the mechanism is facing (technical, financial, legal, institutional, awareness, etc.), risks attributed to finance providing, number of clients/customers benefited from the finance mechanism and the sectors they are belonging or related to, extent to which the supported implied policies and regulations affect mechanism utilization and if they need any modifications or adjustments, suggestions for improving and strengthen the mechanism and accordingly enable greater uptake of solar energy systems and market development.

In that regard it worth to mention also that the results of the survey performed in 2014 within the activities of Energy Sector Policy Support Programme, Technical Assistance to Support the Reform of the Energy Sector in Egypt (TARES) that covered more than 100 SWHs market players and stakeholders have been also considered in this report.

2.4.1.2. Interviews with Some SWHs' Market Stakeholders:

Several interviews with main SWH market stakeholders such as NREA, banks, suppliers, installers, associations (e.g. SEDA), etc. have been conducted with the aim to"

- Assess the status of SWH market in Egypt,
- Define implemented financing mechanisms and their views on it,
- Determine their opinions on the most important features and elements that should be considered on designing the proposed new financing mechanism.
- Define the main targeted DSETs and sectors to be considered.

The meeting concluded that it is important to have a generic financial mechanism that focus on Solar Water Heaters (SWHs) applications in residential sector. Meanwhile, the proposed mechanism should be smart and flexible enough to be modified and to be applicable for other DSETs such as PV systems and other sectors (e.g. commercial, hotels, etc.) afterwards.

Appendix (3) presents summaries of different meetings and interviews. Moreover, the outcomes and results of MED DESIRE technical mission to Egypt during July 2014 have been also reviewed and incorporated within the analysis and conclusions made in the current report.

2.4.1.3. Literature Review of the Most Important and Successful Implemented Mechanism in Egypt and Some Countries in the Region:

In order to guarantee the successfulness of the design and implementation of the proposed innovative financing mechanism for SWHs it was essential to review the existing and implemented similar financing mechanisms and incentive tools not only in Egypt but also in other countries in the region such as Tunisia and Lebanon. The ultimate goal of that activity was to define the main objective of each mechanism, its design features, stakeholders and partners involved in its design and participating in its implementation, main barriers and challenges that faced its effective implementation and consequently the promotions of SWHs market and how it were overcome. That activity extended also to review implemented innovative financing mechanism and incentive tools for the promotion of other technologies rather than DSETs such as the utilization of Compressed Natural Gas (CNG) as a fuel for vehicles to replace gasoline and diesel fuels, the Old Vehicles and Scrapping and Recycling Programme (OVS RP). The following is a brief description of some of these financing mechanisms and incentive tools.

2.4.2. Implemented Financing Mechanisms and Incentive tools for the promotion of DSETs including SWHs Market in Egypt:

As previously mentioned Egypt was among the first countries to utilize renewable energy for different applications including the use of solar energy either for electricity generation or thermal heating including water heating in several sectors such as residential, commercial and industry since long time ago. However, the lack of appropriate incentives and effective financing mechanisms to overcome several barriers among of which is the high upfront cost of distributed solar energy technologies including SWHs was one of the reasons for the limited development and promotion of DSETs market in Egypt including SWHs.

Realizing the huge potential of renewable energy resources in Egypt including solar energy and the vital role it could play in satisfying social and economic development energy needs and to relief pressure on depleted petroleum energy resources, it becomes imperative for the government of Egypt to consider the development and deployment of renewable energy resources including solar among its strategic policies and priorities and to alleviate the necessary incentive and allocate the necessary finance and investments for their market promotion. The following section highlights some of the implemented financing mechanisms for the promotion of DSETs in Egypt such as EGYSOL and Egy-Sun.

2.4.2.1. EGY SOL: ^[26] ^[27]

The Solar Water Heating System Facility in Egypt for Hotels (EgySol) has been launched through the cooperation framework between the United Nations Environment Programme UNEP, Italian Ministry for Environment Land and Sea IMELS, and the Egyptian New and Renewable Authority NREA to build a sustainable long-term framework for the solar water heaters market in Egypt. The project is targeting hotels and resorts both existing and under construction, in the Red Sea and South Sinai governorates. The initial target is to cover 40 Hotels. EgySol is based on public-private partnership which includes capacity building of local institutions, technical qualification of suppliers, a capital cost subsidy of 25% and a decreasing maintenance cost subsidy over a four-year term. ^[27]

EGYSOL is established with the aim to replace conventional energy (electricity, LPG, natural gas) by solar energy produced through solar water heating systems (SWHSs) into the Egyptian hotel sector. EGY SOL has been designed to build a sustainable long-term framework for the solar water heaters market in Egypt.

EGYSOL designed by UNEP is performing its actions through the following strategy:

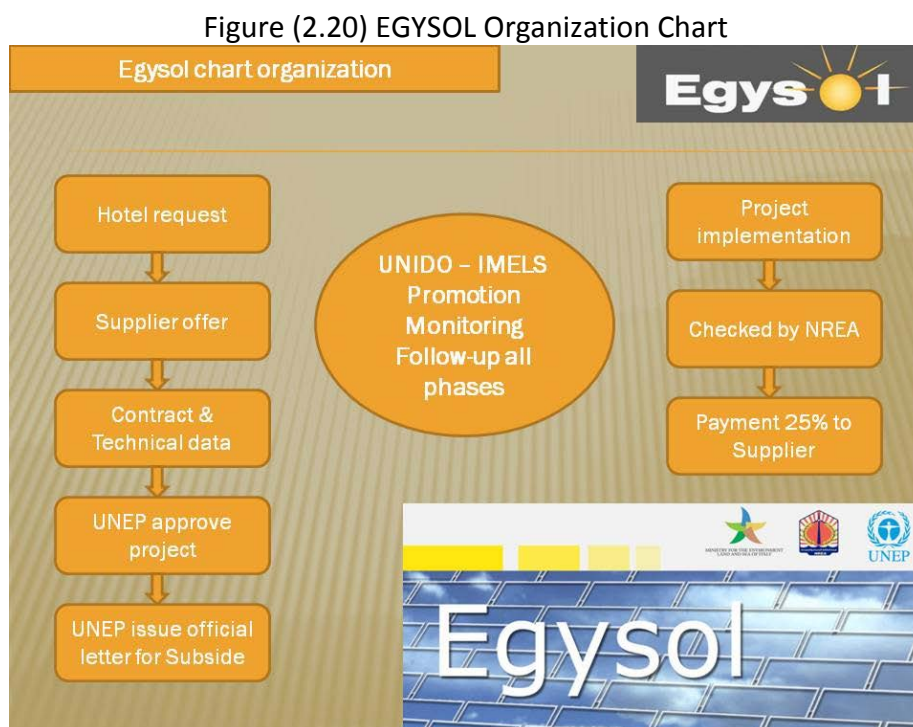
1. **End-User support facility:** An end-user financial support mechanism has been designed to stimulate the use of SWHSs in the hotel sector. The support facility has two components:
 - A capital cost subsidy of 25% to SWH installations (up to 250 m² for each hotel), to be granted to the hotel.
 - A decreasing maintenance cost subsidy over a four-year term (4 USD /m²/yr) for the maintenance cost component for the first two years of operation (after the year of warranty), and (3 USD/m²/yr), for the remaining two years, to be granted to the hotel in order to assure the long-term quality functionality of the installed systems.

Each SWHSs supplier is allowed to install up to 1,000 m² of SWHSs, while each hotel is allowed to have up to 250 m² of SWHSs.

2. **Quality Control and Checking:** The eligibility of SWHS suppliers to participate to EGY SOL has been defined by setting standards for the solar equipment to be installed. Also, SWH designers, suppliers and installers have been required to have a minimum experience settled in working years and projects executed. Furthermore, NREA implements on-site missions to hotels for the technical review of the following:
 - SWHS's consistency with the initial project.
 - Quality of the installed SWHS, its different components and its safety & control equipments.
 - SWHS's performance under the actual operational conditions.
3. **Training:** A training course has been organized to improve the technical knowledge of SWHS suppliers, maintenance & operation technical staffs. The training course included the following components:
 - Introduction to SWH technology.
 - Technology selection criteria.

- Fundamentals of solar energy, systems components.
- Installation, commissioning, operation and maintenance for SWH collective installations.
- Design criteria, examples of solar thermal plants.
- Plant components, examples of natural & forced circulation plants.

Figure (2.20) is an organization chart for EGYSOL.



2.4.2.2. Egy-Sun: ^[28]

Egy-Sun is an efficient lighting and PV integrating systems initiative for public buildings. The Strategic objective of the Initiative includes:

- Creating an encouraging market environment for promoting the use of “efficient lighting and PV integrated systems” in buildings and utilities in Egypt.
- Paving the road for the establishment of relevant local industries and Energy Service Companies ESCOs that can create thousands of job opportunities.

The **direct targets** of the Initiative include:

- The implementation of 100 to 150 projects of the integrated efficient lighting and PV systems in public buildings by mid 2016.
- Installing a total capacities ranging from 5 to 8 Mw, reducing consumption by 27 to 43 GWH per year leading to a reduction of fuel consumption by mid 2016 to range from 5430 to 8680 TOE per year.

Implementation Methodology: The initiative is implemented within the framework of the EEU/IDSC/COM activities included in the national “Energy Sector Policy Support Program”. It will be achieved through a series of cooperation protocols between the IDSC and the beneficiaries.

The ***obligations of different partners and stakeholders*** of the initiative include:

Obligations of the energy Efficiency Unit (EEU) at the Egyptian Cabinet and the Information and Decision Support Center (IDSC):

- Providing all necessary technical services for the implementation of the first phase of the initiative through providing the technical support:
 - Site investigation and defining the degree of appropriateness.
 - Preparation of project technical specifications and Request for Proposals (RFPs).
 - Technical support for the beneficiary while evaluating the offers.
 - Training of the employees working in related fields.
- Affording the costs of:
 - Technical and logistical services related to technical support factors.
 - 50% of the costs of the equipment supplied to any of the projects but not exceeding LE 300,000 for each site.

Obligations of the beneficiary:

- Defining the designated sites for the project and providing the data required by the EEU.
- Carrying out of all necessary actions to prepare the site for the installation process.
- Public tendering and offer analysis with the technical assistance of the EEU.
- Getting the approval to connect with the electricity grid from competent electrical distribution companies.
- Contract execution, supervision of the implementation and receiving of the equipment till operation trials.
- Follow up actions and all necessary maintenance measures in the contracts and following up the efficient operation of the units.
- Providing the EEU periodically with performance assessment to be used in the evaluation of the initiative outcomes.
- Direct costs for site preparation.
- Provide 50% of the costs of the equipment and installation processes.

A cooperation protocol is to be signed between the IDSC and the beneficiaries for the definition of the obligations of the parties for the implementation of the initiative.

2.4.2.3. Tourism Green Hotels Program: A concessional loan focused on the hotel industry with the goal to reduce energy consumption and promote green tourism. National Bank of Egypt offers the loan at an interest rate of 6-7% repaid over 7 years. The mechanism has only recently been launched and has been modeled from the PROSOL Tunisia programs with a focus currently on solar hot water heaters.

2.4.3. Implemented Financing Mechanisms in Some Countries in the Region:

There have been several successful implemented innovative financing mechanisms and incentive tools for the promotion of DSETs in the region and the whole world. The following section shade light on some of these mechanisms.

2.4.3.1. PROSOL – Tunisia: ^[29] ^[30]

PROSOL is an innovative financial mechanism designed to remove the main financial, technical, and organization barriers against the development of solar market (SWHs & PVs). The starting date of the imitative was in 2005. It is a combination of Loans, Credit, Grants, and Subsidy which consists of:

- The provision of a public subsidy of 200 TND for (1 – 3) m² SWHs and 400 TND for SWHs from (3 – 7) m² to lower the price of SWH acquisition and improve profitability to the final consumer.
- Granting the consumer a bank loan repayable over a five years period, and through STEG electricity bill to facilitate consumer access to SWHs.
- A system of quality control for upstream and downstream suppliers and their products marketed within the program to ensure the after-sale service and improve SWH brand image.

Partners:

- ANME: provides the subsidy and manages the program and ensure its promotion.
- Commercial Bank (Attijari Bank) provides the loan to the consumer through a line of credit over a 5 years period.
- STEG provides credit recovery on electricity bills and provides the security for the loan repayment.
- Consumer adheres to the program and is committed to meet its requirements.
- Suppliers and Installers acknowledged by ANME ensure supply, installation and after sale service of SWH approved by ANME.
- Professional Union: provides supervision of the profession and participates in the implementation of measures.

Accompanying Measures:

- Tax incentives for SWH import and manufacturing.
- Quality control of equipment and services.
- Training of operators.
- Communication to promote the program.

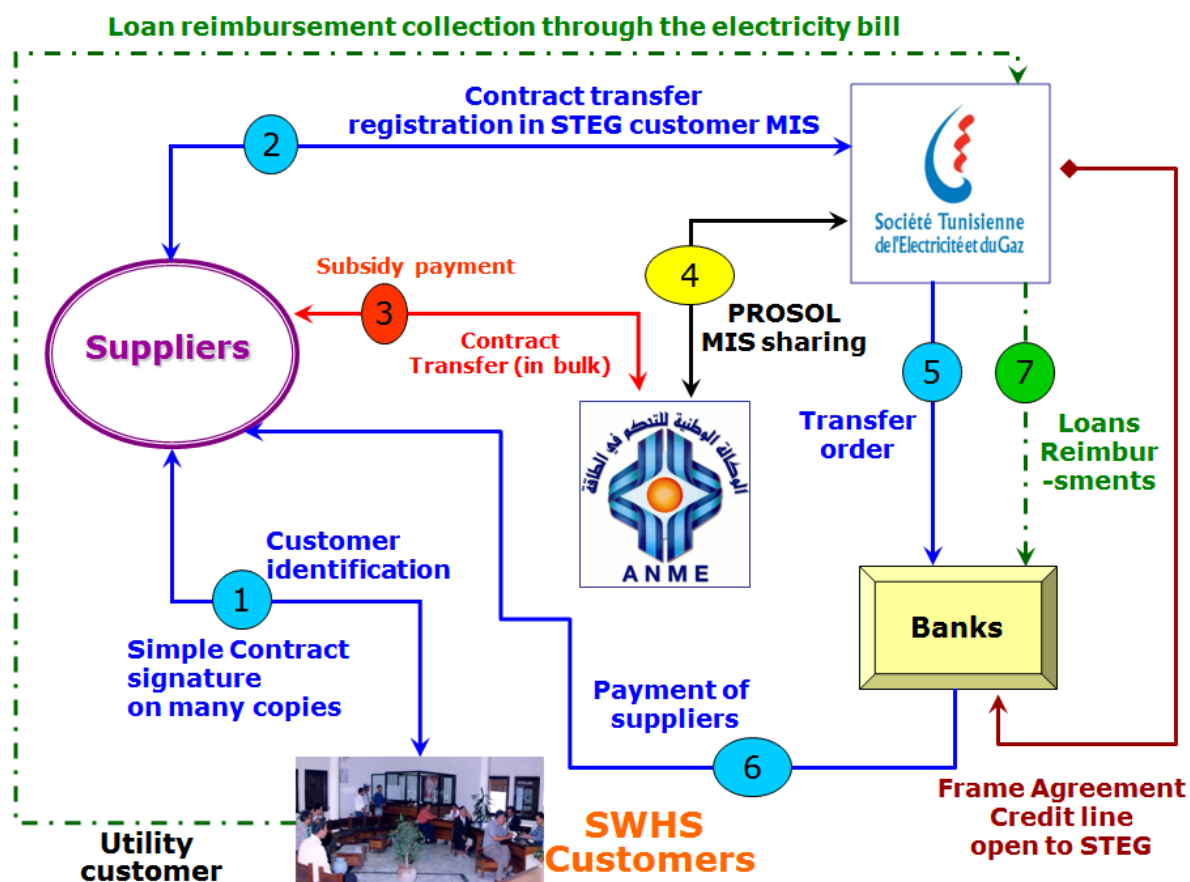
The programme ***implementation procedures*** are as follows:

1. Banks grant loans to producers of SWHs, who transfer these loans in turn to households.
2. Producers sell their SWH systems directly to households and offer at the same time the facility for financing the system.

3. Repayment of the solar water heater occurs via the monthly electricity bill of the public power utility (*STEG*).
4. Over a period of 5 years, households are charged constant amounts monthly for loan repayment via the electricity bill. Thereby, the risk of default can be reduced extremely.
5. The amount of the monthly rate depends on the SWH that needs to be paid.
6. Monthly rates are covered by energy savings, in the ideal case completely, but at least partly, so that the household has not to pay a higher invoice amount as it was the case before borrowing.
7. *STEG* collects monthly payments and transfers the total amount to the main bank, which in turn divides the money to the credit-allocating banks.
8. Households repay the credit amount plus interests, which was originally received by the producer. The interest rate of such a loan is 7% and thus below market level. At the beginning of the *PROSOL*-programme in March 2005 the interest subsidy was as well 7%, so that households had not to pay any interests. Since April 2006, the interest subsidy was reduced to 4%, resulting in an interest rate for households of 3%. During next years a phase-out of the interest subsidy is foreseen aiming at achieving a subsidy-free loan market.

Figure (2.21) is a schematic presentation of Prosol Programme.

Figure (2.21) Schematic Presentation of Prosol Programme



Promotion coverage: The promotion programme is limited to private households. The promotion is incumbent on restrictions that only a limited number of producers are allowed to

participate in the promotion programme. Moreover, households may choose between a system with a tank volume of 200 or 300 liters.

Application: Households interested in a solar water heater may first contact the preferred producer. In a next step, a standard application form for the promotion needs to be filled out together with the installer. Besides this form, the only requisites are an up-to-date bill from *STEG* and a proof of identity. This shows that the household does not need to enter a bank for applying to the programme. Application and approval are rather carried out directly by the producer. Installation of the system by the installer can occur immediately. A waiting period is not required.

Origin of budget: Total funds of the *PROSOL*-programme amount to 2 million US\$ and are provided by the Italian Ministry of Environment and Territory. Thereby, 1 million US\$ is used by *UNEP* for interest subsidies and another million by *ANME* as capital cost subsidies.

Promotion payment: Payment of the promotion for the customer occurs in a decrease of the interest rate. This reduces the interest charge to be beard by the household.

Campaigns/ Information strategies: Besides commercials in TV and advertising over radio, the publicity campaign included as well announcements in several print media. In banks and governmental buildings the programme was promoted with leaflets and posters. Moreover, a raffle was initiated, where solar water heaters were provided gratis by producers. Additionally, seminars about solar water heaters were organized. The campaign was arranged and co financed by *ANME* and *UNEP/DTIE*.

Quality assurance: In the frame of the programme, a quality-verification was carried out by *ANME*. Technical requirements were published in a so-called performance specification sheet. In addition, *ANME* performed installation checking. Moreover, *ANME* is responsible for technical attendance of the project and may cancel producers from the list, which contains producers approved for the programme. Another element in the course of quality assurance provided by the programme is training for installers of solar water heaters.

2.4.3.2. National Energy Efficiency and Renewable Energy Action (NEEREA- Lebanon): ^[31]

NEEREA is a national financing mechanism initiated by the Central Bank of Lebanon (BDL) in collaboration with the Ministry of Energy and Water (MEW), the Ministry of Finance (MoF), UNDP, the European Union (EU), and the Lebanese Center for Energy Conservation (LCEC).

Objective: The main **objective of NEEREA** is to support the financing of environmentally sustainable projects, including Energy Efficiency (EE) and Renewable energy (RE) implementations, by offering **soft loans** to eligible and feasible projects in Lebanon. NEEREA does so by allowing private sector entities including individuals, SMEs, or even corporate bodies to apply for subsidized loans for any type of EE and/or RE projects.

The **creation, development and implementation of NEEREA** have clear and important benefits. The advantages are mainly distributed among 3 beneficiaries, namely banks, users and the national economy. The **bank** gets more cash by freeing up a part of the required reserves at the Central Bank, thereby enhancing its green vision and promoting corporate social responsibility. The **user** is usually provided with a long term soft loan at 10% of market rate and is guaranteed to have high quality technical and financial propositions. The **National Economy**

on a larger scale, benefitted from leveraging local investments (reaching around 128 Million USD until May 2014) and will leverage more than 330 Million USD in the coming 5 years, which decreases the burden on the Lebanese institutions and industries. Most importantly, NEEREA is promoting the renewable energy industry in Lebanon and contributes to creating sustainable jobs. In addition to the users' benefits presented above, NEEREA mechanism also provides households interest-free loans for solar **water heaters** over a 5-year period to be secured by Lebanese commercial banks. Furthermore, customers who purchase a system that is in compliance with a specific set of quality criteria can in their turn benefit from the 200 USD from the Ministry of Energy and Water MEW to be discounted from the total price. Moreover, consumers that install small renewable energy systems can offset the cost of power purchased from the utility (EDL) through Net Metering. This works by installing a meter that records the bidirectional energy flow, allowing the excess power to be transmitted to the grid. The exported energy from the system is then subtracted from the imported energy and the net output is calculated and billed by the utility (EDL).

Funds: NEEREA loans to the private sector are mainly subsidized by Central Bank of Lebanon BDL via two financial mechanisms, one being by exempting the lending banks from reserve requirements, or by granting those banks a special loan at 1% against NEEREA loans. In addition final beneficiaries who are eligible under the Government Subsidy Program managed and subsidized by BDL too, will receive an additional subsidy of 4.5% on interest rate. Hence the price of a NEEREA loan will range approximately between 0% and 1%. In 2014, the loans ceiling (envelope) reached 400 million USD. This envelope is supposed to be renewed yearly conditional on NEEREA success; hence, the importance of NEEREA relies on its sustainability. According to LCEC, NEEREA loans will be exceeding 250 million USD and possibly higher in 2015. Furthermore, the European Investment Bank (EIB) and the Agence Française de Développement (AFD) had agreed with BDL on a 90 million euro credit line, that will be signed with the Lebanese Government, ratified by the Lebanese Parliament, to be managed and subsidized by BDL, hence added to the NEEREA mechanism for the next 15 years.

Involved Parties: The main parties involved are as follows: First, as the national financing institution, the BDL sets the operation framework and offers the benefits to different banks. Second, the Ministry of Energy and Water sets the strategic guidance and priority towards EE and RE. Third, the Ministry of Finance defines the subsidies on interest rates for the different sectors of the economy. Fourth, the LCEC is considered as the technical consultant to the BDL, reviewing loan applications, and setting quality control criteria. Besides these main parties, the NEEREA mechanism is also characterized by the presence of other parties such as the European Union (EU), who offered the BDL 12 Million Euros to encourage SMEs in applying for NEEREA, and the United Nations Development Program (UNDP) who partnered with BDL to offer technical support, training, marketing, and awareness raising activities. The most important and effective involved parties however are residential, commercial, non-profit and industrial users who can benefit from long term loans at low interest rates to finance their RE and EE projects through NEEREA.

Loans Amount: NEEREA allows private sector entities such as individuals, SMEs, corporate bodies, residential, commercial, not-for-profit and industrial organizations to apply for subsidized loans for any type of EE and/or RE projects. The ceiling for these green loans, which

are of low interest rate for a total repayment period of up to 14 years including a grace period of 4 years, is 20 million USD. The greens loans are provided through any of the Lebanese commercial banks, which are considered as other important involved parties, to directly reach the end user. New projects, on one hand, can benefit from a repayment period of up to 10 years, beginning after the end of the grace period ranging from 6 months to 4 years. Re-modeling existing projects, on the other hand, can benefit from a repayment period of 10 years, including the grace period ranging from 6 months to 2 years. Re-modeling projects means adding energy efficient or renewable energy solutions for existing facilities. The EU is also contributing to green loans by offering a grant equal to a percentage from the approved loan amount under NEEREA. This grant will be 15% for non-subsidized sectors and 5% for subsidized sectors (Industry, Tourism and Agriculture), granting a loan ceiling of 5 million USD only. If the approved loan amount of a project for a non-subsidized sector is equal to 8 million USD, the EU grant will be 15% of 5 million USD, meaning 750,000 USD. The eligible parties for the EU grant are SMEs composed of less than 400 employees, tertiary buildings and NGOs. Funds are allocated to the project after LCEC approves the technical study proposed. The grant money allocated would be disbursed upon final execution and after technical validation by LCEC.

NEEREA Overall Procedure: Clients seeking to implement energy conservation measures directly at their own premises apply to commercial banks where they have to submit the required documents as well as a technical report on the proposed solutions (feasibility study including technical, financial, and environmental analysis). The loan request is then studied and submitted to the BDL for approval on a green loan. Once it passes by BDL, it is sent to LCEC for verification and approval by their Technical Support Unit that is dedicated to offer technical assistance in the evaluation of the eligibility of submitted loans. The BDL reviews the results of LCEC analysis and sends the results back to the commercial bank that then informs the client whether the loan is granted or rejected. If granted, the client can proceed to implement technical solutions recommended by ESCO or by suppliers themselves. This standard process takes around two months based on the quantity of applications and availability of information. Action would be taken if final execution diverges from original plans. On the other hand, projects and loan requests that do not exceed 20,000 USD do not require the direct approval of BDL; hence the report is directly sent from the commercial banks to the LCEC.

2.4.4. Other Implemented Financing Mechanisms and Incentive Tools for Promoting the Market of other Technologies Rather Than DSETs in Egypt:

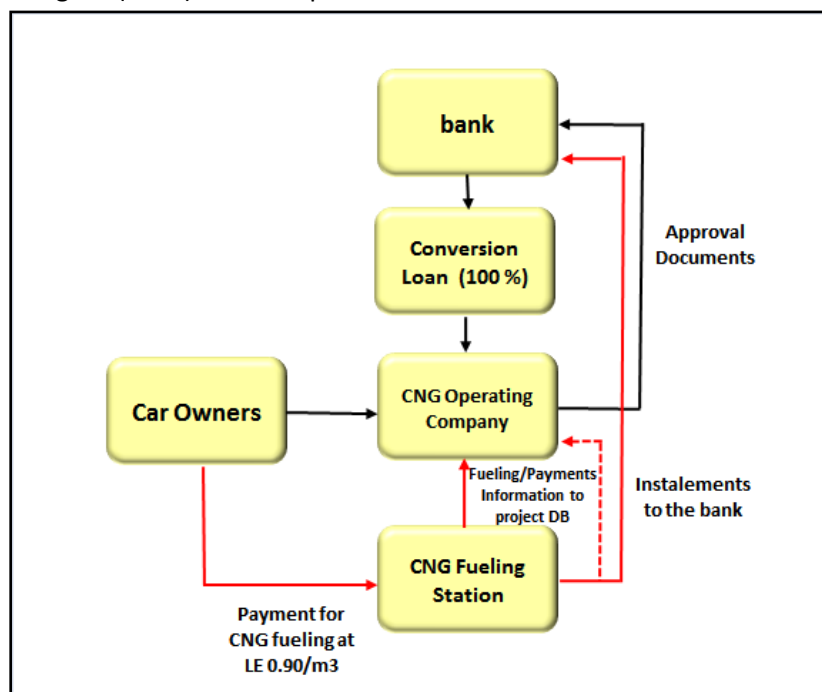
There are several incentive tools and financing mechanisms that are implemented in Egypt to promote the market of other technologies rather than DSETs among of which is The **Smart Card System** for vehicles conversion to operate using Compressed Natural Gas CNG instead of gasoline and diesel fuels and the Old Vehicles Scrapping and Recycling Programme (**OVS RP**). The following is a brief description of both mechanisms.

2.4.4.1. The Smart Card Programme:

The main **objective** of the programme is to overcome the high upfront cost of vehicles conversion to use CNG instead of gasoline and diesel fuels consequently reduce the consumption of those fuels and the imports of large quantities of it from abroad in addition to

reducing pollutants emissions and improve the quality of environment. In order to achieve that objective, the Ministry of Petroleum (MoP) in collaboration with one of the local commercial banks and Natural Gas Vehicles (NGVs) operating companies developed the Smart Card programme. The programme as presented in figure (2.22) allows vehicle's owners to get the necessary loans to convert their vehicles to CNG from the bank and pay the conversion cost, that range between LE 5000 to 6000, in the form of monthly installments with favorable interest rate.

Figure (2.22) Simlified presentation of the smart card framework



The system is introduced to the market according to the ministry of petroleum decree no. 120 for the year 1994 that specify the cost of converting gasoline vehicles to compressed natural gas (CNG) by LE 5000 and the price of CNG at LE 0.45 per cubic meter (m3).

The Smart Card system is a combination of loan, equity, and incentives (price of CNG is 50% of gasoline price). Two types of financing mechanism are implemented; the first is a 100% loan of the total investment or conversion cost (LE 5000) from one of the commercial banks while the second as a loan plus equity each of 50% of the total investment or conversion cost (i.e. LE 2500). A discounted interest rate of 6% annually compared to 9% as a prevailing commercial interest rate. Therefore, estimated payback period for the case of taxi vehicles that represent almost 70% of converted vehicles population is about 6 months for the case of 100% loan and 2 years for the case of loan and equity case. The average daily consumption by vehicles is considered as one of the main dominant factors of system design.

System incentives and advantages include the price differential between CNG and gasoline (CNG price is 50% of gasoline price), participated vehicles owners can get a bank account, the risk associated to the loan from the bank is minimized through insurance from one of the

insurance companies, it is fully automated in order to minimize effort, time consumed and minimize and avoid human errors, etc.

Smart Card Procedure: The procedure of the smart card programme is very simple as follows: Car owner who would like to convert his car can contact any of the NGVs operating companies and fill a simplified questionnaire that contains some personal information in addition to his approval to join the smart card programme. After getting the necessary approvals, the bank transfer the total cost of conversion to NGVs operating company and issue the smart card to vehicle owner who use it each time he fuel his car with CNG. The car owner has to pay 0.90 LE/M3 of CNG (equivalent to the price of one liter of gasoline 80) until he payback the total cost of the conversion then he start to pay the cost of CNG which is 0.45 LE/M3 and enjoy the price differential between both fuels. Based on the prevailing prices of CNG and gasoline, the monthly savings to car owner could range between LE 500 to 1750 per month depending on the type of gasoline utilized and the millage travelled by the vehicle represented in gasoline consumption levels. Therefore, the average payback period of vehicle conversion cost to CNG estimated at about 4 month to about 1 year.

2.4.4.2. Old Vehicles Scrapping and Recycling Programme (OVSRP):

The programme was designed and launched in 2009 with the aim to help old vehicles car owners in Greater Cairo Region (GCR) to scrape, recycle and replace their vehicles with new ones in order to overcome problems associated to the operation of old vehicles in areas with heavy traffic and high population density such as traffic jams, increase in fuel consumption and pollutants emission. The program is considered as the first UNFCCC's transport-based implemented CDM project worldwide which is financially supported by the World Bank Carbon Fund. The GCR's taxis are considered as the main target for the first phase of program implementation. Consequent phases will consider other old mass transport vehicles such as minibuses, trucks and buses in addition to other regions such as Alexandria, Delta, etc. According to the programme design, owners of old taxi vehicles of more than 20 years are voluntarily to surrender their vehicles for managed scrapping and recycling in exchange for financial incentives which is used for the purchase of a new and fuel-efficient vehicle under a closely monitored process.

The program is based on Public Private Partnership (PPP) and comprises several stakeholders including the Ministry of Finance (MoF), the Ministry of Interior (MoI), 2 local banks, 5 vehicles manufacturing companies, an insurance company, an advertising company, old vehicles owners, the Clean Development Mechanism Awareness and Promotion Unit (CDM AP) affiliated to the Egyptian Environmental Affairs Agency (EEAA), and the World Bank Carbon Finance Unit. The set up of the program characterized by the well defined role and responsibilities of all stakeholders, its design as one-stop-shop approach which facilitates performing all program activities that range from old vehicles inspection and scrapping to financing and purchasing new vehicles at the same site. In addition, it is based on classifying and grouping a specific number of Component Project Activities (CPA) as a project with each of the CPA extended for a 10 years period. The total number of scrapped and recycled vehicles through the program implementation during the period April 2009 to the end of 2013 accounted for more than 49

thousand vehicles. Key important issues that have been considered in the set up and design of the programme which guaranteed its success in addition to the potential for its replication include: its well setup and design, the success in building up strong and effective partnership between different stakeholders, the provision of effective financial mechanism and economic incentives that helped overcome the high upfront investment cost barrier, the utilization of one-stop-shop approach as mentioned before, maintaining a degree of flexibility which allow for periodical changes to be made on the program based on vehicles owners feedback from performed surveys and interviews, careful program planning and close monitoring. Total cost of the programme estimated at US\$ 620 million (LE 3.5 billion) during its duration, the period (2010-2018).

As previously mentioned, the success of implementing the OVSRP so far is attributed to its design and set up characteristics in addition to the package of **incentives** provided by different stakeholders that include the following:

- The MoF provides a grant of LE 5000 for each scrapped vehicle, bear the costs of scrapped vehicles, sales tax for new vehicles, custom duties fees for the components of new manufactured vehicles and provide the necessary guarantee for loans from local banks.
- Local banks provide loans for old taxi owners to purchase new vehicles of a maximum LE 70 thousands for 60 installments over 5 years period with an interest rate of 7.5% compared to 9% as prevailing market interest rate.
- Vehicles manufacturing companies and suppliers offer lower prices for new vehicles (25% less than market price), provide spare parts and the maintenance for new vehicles at reduced cost (a discount of 30% is given to spare parts).
- The insurance company provides insurance against theft, fire, and accidents at an interest rate of 3.25% compared to 6.25% as prevailing market interest rate.
- The advertising agency that has an exclusive right to advertize on new vehicles pay a monthly advertising cost of LE 550 for 5 year period for the benefit of taxi vehicles owners.

It is worth mentioning that with the support of the previous mentioned incentives, taxi vehicles owners can pay back their vehicles loans in less than 6 years.

According to the project results, scraping and recycling of 49 thousand old taxi vehicles and replacing it by new and fuel-efficient ones will result in GHGs emission reduction of about 1.3-2.3 million tons of CO₂e during the period (2013-2018) depending on the kilometers traveled by vehicles each year. Based on the project duration as a CDM project for 28 years (2009-2037) and assuming program market price of USD 11 per each CER generated till 2013 and of USD 6 per CER after 2013, total revenue from the generated CERs during the program period is expected to range from USD 15.8–27.8 million which will be utilized for supporting program cost. In addition, the performed environment and social impact assessment of the program concluded the following benefits as examples: reduction in traffic jams and congestions and consequently the economic losses associated to it, providing more new job opportunities (10500 as direct jobs and 1000 as indirect jobs with generated net daily income of about LE 85 for each new job), raising the income of taxi owners by about 40% and taxi drivers by 100% through the creation of additional vehicles operation shifts and reduction of vehicles fuel

consumption and maintenance costs (each taxi owner is expected to get an average monthly income of LE 1500 compared to LE 900 for the old taxi), business development of participating stakeholders such as vehicles manufacturing companies and banks, improving life conditions for taxi drivers as a result of improving their economic conditions, providing opportunities for the establishment of new Small and Medium Enterprises (SME), improve air quality and hence the Egyptian citizen's life and health conditions, upgrade taxi fleet in addition to public transport buses and minibuses in later phases of program implementation, enhance the capabilities, skills and knowledge of existing staff of program stakeholders such as banks on different aspects and approaches relevant to attracting investment and the implementation of programs and projects for climate change mitigation, air quality improvement and sustainable environmental management, and more importantly the formulation of cost effective financing mechanism which could be used as a model for attracting and allocating necessary finance and investments for similar programs and projects in the transport sector and in other economic sectors. In addition, an annual fuel subsidy saving of about LE 399 million will be gained as a result of the operation of new efficient vehicles and the retrofit of significant portion of it to run using CNG.

2.4.4.3. Natural Gas Connection to Residential Units:

The financing mechanism for natural gas connection to the residential sector homes was created in the framework of the Egyptian Ministry of Petroleum policy that aims at the replacement liquid fuels such as LPG, fuel oil and diesel in different sectors and applications by natural gas. Total cost of connecting natural gas to residential units account currently for about LE 6800. The customer pays LE 2650 in cash and the rest of gas connection cost (LE 3150) through a loan of 48 installments (to be paid through monthly gas bill over 4 years) at an interest rate of 6% annually compared to privileging commercial interest rate of at least 9%. It includes the cost of the service line (from the main gas pipeline to the residential building), the cost of external installations (wall mounted pipelines), and the cost of internal installations including the gas meter). For the case of compounds and villas which are owned by high income classes' clients, the client bears also the cost of the external natural gas pipeline. Unlike the case of the smart card financing scheme, there are more than one bank participating in the financial mechanism. It is worth mentioning that buildings owned by high income owners such as villas are not subject to natural gas connection cost subsidy. As a result of the efforts made to expand natural gas national grid since the early 1980s in the context of the ministry of petroleum and the Egyptian government fuel switching policy in addition to the previous mentioned financing mechanism for natural gas connection to residential units, total number of residential units connected to natural gas grid account for more than 5.5 million currently.

2.5. Recommendation and Proposal for Promoting SWHs in Egypt: ^[32]

Based on the previously mentioned analysis of SWHs market in Egypt it becomes obvious that in order to promote that market several initiatives, measures and policies have to be considered and implemented taking into account the following issues and actions:

- Importance to take advantage of the successful experiences of other countries.
- The vital role that government commitment could play towards the development of solar energy through:
 - Raising awareness among the public on the benefits associated with the use of solar energy in general and SWHs in particular.
 - Existence of a sustainable market by providing concessional financing systems for end users.
 - Government support for SWHs manufacturers.
 - Implementation of a number of successful pilot and demonstration projects for the installation of SWHs.
 - Stimulating the market by providing an easy finance scheme for the end-user.
 - Adopting demonstration sites.
- Importance to increase spending on Research and Development (R & D) of SWH systems technologies in order to provide appropriate material for industry, improve the performance and efficiency of SWHs systems and to simplify their designs.
- Preparation of specifications and quality standards of SWHs systems, storage tanks and various other combinations of such systems.
- Setting up the necessary legislation such as binding decisions of using solar energy for water heating in new cities and resorts, villas, hotels, etc. in addition to registering manufacturers of solar collectors and storage tanks which are approved.
- Market supervision and monitoring in order to ensure the quality of the materials used and the good performance of solar water heaters.
- Enhance and support the role of the Solar Energy Development Association (SEDA) in developing SWHs market in Egypt in addition to overcoming all technical and non-technical barriers and obstacles that may hinder achieving that target.
- Importance to alleviate and make use of all existing necessary resources that could facilitate SWHs techniques transfer such as the existence of a strong scientific base, the existence of many international and national universities that gives great opportunities and ability for the transfer, diffusion and development of better technologies and systems used in the field of solar water heating in line with local conditions.
- Enhance the role of the Regional Centre of Renewable and Energy Efficiency (RCREEE) in promoting DSETs market including SWHs in the Arab region and Egypt.
- The Government can play a significant role in creating the necessary mechanisms for pooling knowledge and skills available to civil society and to avoid delays in the transfer of technology and achieve success.
- The civil society institutions, including Non-Governmental Organizations (NGOs) can participate in creating a social infrastructure that could contribute significantly in the transfer of solar energy technologies.

- The importance of creating effective mechanisms for a network of manufacturers, producers and users of SWH systems (e.g. joint research cooperation agreements, exhibits, meetings, exchange of information, pilot projects, etc.).
- The importance of effective partnership between all parties concerned with SWHs issues at the local and regional level (e.g. public-private partnership).
- The importance of strengthening and supporting the available technical institutions.
- Importance to remove taxes and customs duties on various components and equipments for solar water heating systems.
- Providing the necessary financial incentives for users of SWHS in addition to financing credit lines at low interest rates.
- The preparation of quality Labels for products and equipment of SWH systems.
- The promotion of education in the area of renewable energy including SWH systems.
- The implementation of effective programmes to raise awareness of the benefits and uses of renewable energy including SWH systems.
- Increase prices and alleviate subsidies of conventional energy (electricity, natural gas, LPG).
- Registration of collectors and solar water storage tanks and the manufacturers and operators in the field of installation.
- The establishment of testing and training unites.
- Preparation of specifications and quality standards for collector and storage tanks.
- Importance of taking decisions with the aim to make use of solar energy a legal obligation for New Cities, Resorts, villas, Hotels, etc. in addition to listing of approved solar collectors and storage tanks manufactures and installers.
- Importance to set up a very clear road map for the development of SWHs market in Egypt through the implementation of the following measures:
 - Creating the government commitment to solar energy through performing awareness campaigns and publicity, stimulating the market and adopting demonstration projects and programmers.
 - The establishment of new testing facilities and supporting the existing ones in the national institutions such as NREA and in addition to the development and enforcement of a set of specifications and quality standards for SWHs' collectors, storage tanks and installations.
 - Supporting the research and development of SWHs technologies in order to:
 - Adopt local available materials to be used for these technologies.
 - Increase efficiency and durability.
 - Promote simplicity.
 - Reduce production costs.
 - Allow for incorporating SWHs when designing new buildings.
- Develop a framework of incentives to support SWHs manufacturing and potential consumers.
- Importance to assign the proper subsidy to SWHs as it can divert energy consumption pattern and consequently lead to better utilization of scarce energy resources.
- The Ministry of Trade and Industry to provide SWHs manufacturers with attractive incentives and better financing terms, potential tax credits and may be export advantages. Moreover, the ministry has to set up binding targets with monitoring, adopt the necessary

framework for support mechanisms including solar regulations, phasing-out subsidies and engaging banks in providing loans.

- Importance to perform training and awareness campaigns on medium term base and involve all stakeholders in different relevant activities (e.g. the design of awareness campaigns, educational tools and training programmers).
- Importance to set specific targets for the promotion of SWHS market supported by the necessary policies and strategies.
- Importance to provide the necessary incentives and effective financial mechanisms in order to facilitate access to appropriate finance.
- Supporting the local manufacturing of SWHs systems could play a vital role in its market growth and reaching an ultimate target of 100% of their components manufacture locally. This could be achieved through an integrated plan based primarily on the following main impellers:
 - The provision of innovative financing mechanisms to support SWHs systems technology.
 - The implementation of effective programmes and plans to support SWHs systems Research and Development (R&D) in order to improve their efficiency in line with local conditions, reduce its cost, and increase the competitiveness of its local manufacturing to achieve local demand self-sufficiency and exports abroad.
 - Activate and enhance the implementation of previously issued resolutions, decrees, legislations and laws in order to support its deployment.
 - The implementation of several awareness and information campaigns and programmers on different economic and environmental advantages of using such systems.
 - The development of the necessary SWHs technologies infrastructure necessary to support its market growth.

3. Potential of SWHs Market Development:

The assessment of solar energy market development in Egypt (Sub task 6.1b) includes performing the following main activities:

- Analysis of financial and economic profitability.
- Identification of the most suitable beneficiary sector to be targeted.
- Identification of public administrations, local agencies, utilities, market players and financial institution to be involved.

3.1. Analysis of Financial and Economic Profitability of SWHs:

3.1.1. Financial and Economic Profitability on National, SWHs Manufacturing and Consumers

Levels:

In case of utilizing solar energy for water heating, it replaces in addition to electricity conventional fuels mainly oil products (LPG, diesel and fuel oil) and natural gas in different sectors such as residential, commercial (hotels, hospitals, restaurants, etc.), governmental building and industry. Hence, the promotion of SWHs market in Egypt is expected to have several financial and economic benefits and profitability on both national and SWHs manufactures and consumers' levels. Examples in that regard include the following:

On the national level expected financial and economic benefits and profitability include:

- Significant savings of conventional energy, mainly electricity, LPG and Natural gas as a result of replacing conventional water heaters by SWHs; consequently reduce the associated energy subsidy. In that regard, based on an average annual consumption of hot water of 240 days, total annual energy savings per one SWH in case of its replacement to electric, LPG and natural gas water heaters estimated at 1470 KWh of electricity, 0.125 ton of LPG and 164 m3 of natural gas. Consequently, the **avoided annual subsidy cost** of electricity, LPG and natural gas per one SWH estimated at LE 1117 (about \$146), LE 349 (about \$46) and LE 300 (about \$39) respectively.
- Reduction of LPG imports which exceeds 2 million tons annually with a cost estimated at \$2 billion in 2012/2013.
- Reduction of fuel oil and diesel fuel imports needed for electricity generation and water heating in other sectors rather than residential such as commercial and industrial sectors. During the year 2012/2013 total diesel fuel imports accounted for more than 4.6 million tons with a value of \$4.9 billion as shown from table (3.1).
- Reduction of natural gas demand consequently increasing the possibility of allocating occurred savings in natural gas to more value added activities such as the production of petrochemical products. It worth to mention that the value added of utilizing one m3 of natural gas in the petrochemical industries is almost 15 times that in case of its usage for electricity generation or as a fuel for a cement kiln.
- Avoiding the emission of significant quantities of pollutants consequently reduce associated damage costs and negative impacts on peoples' health and the whole environment.

- Avoid large investments needed to add additional installed capacities for electricity generation, LPG and natural gas facilities in order to cope with the escalating energy demand for different sectors and activities including that for water heating. In that regard estimates of energy savings as a result of the replacement of traditional water heaters (electric, LPG and natural gas) by SWHs indicates that daily energy saving per each SWH account for about 6.1 KWh, 0.519 kg of LPG and 0.681 M3 of natural gas respectively. Therefore, in case of utilizing 100 thousand SWHs electricity savings could reach about 146 million KWh annually (assuming time use of hot water of 240 days/year) which means the avoidance of constructing a power plant of about 28 MW installed capacity and accordingly the avoidance of an associated investment of about \$29 million.
- Creating new job opportunities and reducing unemployment problem. In that regard it is worth mentioning that for each 10-12 SWHs produced a one new job is created. ^[25]
- Provide banks and financial institutions with new opportunities and channels for financing projects and making use of available financial reserves.

Table (3.1) Oil products imports in 2012/2013

	K tons	\$ million	%
crude oil	2919	2238	20%
LPG	2077	1962	18%
Diesel	4902	4629	42%
Fuel oil	1006	654	6%
Gasoline	1193	1263	12%
Others	167	207	2%
Total	12264	10953	100%

Source: EGPC.

On SWHs manufacturers level expected financial and economic benefits and profitability include as examples:

- Expand SWHs manufacturers market and consequently expected sales and profits.
- Help SWHs manufacturers to improve quality and efficiency of their products as a result of having more access to existing and proposed SWHs testing and accreditation facilities; accordingly increase their competitiveness in local, regional and international SWHs markets.
- Help SWHs production companies, suppliers and installers increase their staff capabilities and hence their competitiveness in the market through making use of available capacity building and training opportunities.
- Increase cooperation and collaboration with national and international concerned entities.
- Improve their knowledge and knowhow through access to available established and proposed databases and experience of other companies at national and international levels.

On the consumers level expected financial and economic benefits and profitability include as examples:

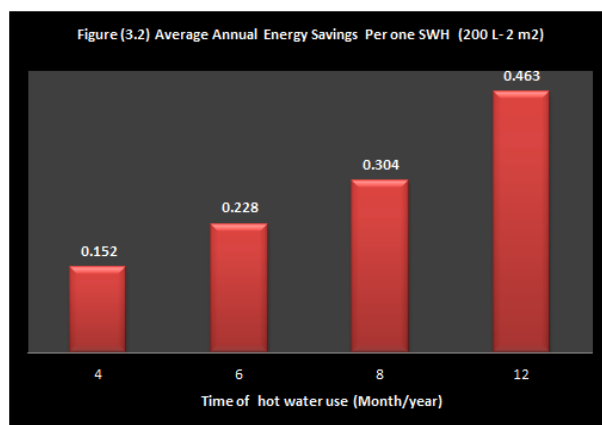
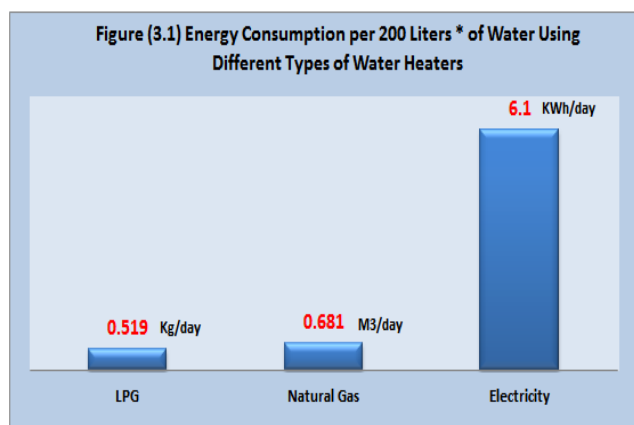
- Savings in fuel cost.
- Achieved energy savings costs could be directed to cover other consumer's expenditures such as health and education, hence positively improve their social and economic situation.
- Avoid problems related to fuel supply shortfalls as the case of electricity blackouts and LPG availability and handling, etc.

The following section presents details on some of the previously mentioned financial and economic profitability aspects and issues.

3.1.2. Energy Savings and Avoided CO2 Emission as a Result of Utilizing Solar Energy for Water Heating in the Residential Sector:

As previously mentioned energy savings as a result of utilizing SWHs instead of conventional water heaters; mainly electricity, LPG and natural gas depends on several factors among of which are the time use of water heater, hot water temperature, efficiency of water heater, amount of hot water consumption, etc.

According to the basic assumptions considered in calculating the average annual amount of hot water consumption per family and the average daily energy consumption of electric water heater as presented in figure (3.1) total annual energy savings per one unit of commonly used SWH of typical capacity of 200 liters (equivalent of 2 M2 SWH collector surface area) instead of electric water heater in the residential sector is calculated to range between 0.2-0.5 TOE depending on the time of use of hot water as presented in figure (3.2).



In addition, based on expected annual fuel savings quantities as a result of replacing a typical electric water heater by SWH and CO2 emission factors of natural gas and fuel oil (as the fuels utilized for electricity generation), total annual avoided CO2 emission per one SWH estimated to range between 0.4 – 1.1 ton CO2 (depending on the time use of hot water) for the case of natural gas and 0.5 – 1.5 ton CO2 (depending on the time use of hot water) for case of fuel oil as shown from figure (3.3).

Assuming that the reasonable average time use of hot water is 240 days per year, total annual avoided CO2 emissions by one SWH estimated at about 0.7 and 1 tons of CO2 for the case of utilizing natural gas and fuel oil as fuels for electricity generation respectively. Accordingly,

total annual avoided damage cost estimated at \$56 (about LE 427) and \$80 (about LE 610) for both cases respectively.

Figure (3.3) Total annual avoided CO2 emission per one SWH (case of utilizing natural gas and fuel oil for electricity generation)



3.1.3. Impact of the Widespread and Expansion of SWHS Market:

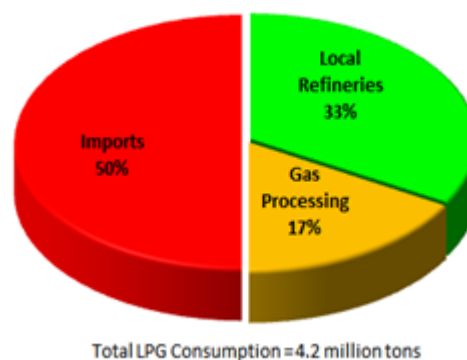
In order to assess the financial and economic profitability of SWHs market growth in Egypt it is assumed that a national programme that aims at installing 100 thousand SWHs over five year period (about 20 thousand annually) has to be implemented. Therefore, energy savings that range between 15.2 to 46.3 thousand TOE are expected depending on the time use of hot water. In case of hot water time use of 8 months per year total annual energy savings estimated at 30.4 thousand TOE. Consequently, total annual avoided CO2 emissions and the corresponding damage cost estimated at 71 thousand tons of CO2 and \$5.7 million (LE 43.5 million) respectively in case of utilizing natural gas as a fuel for electricity generation and 98.5 thousand tons of CO2 and \$7.9 million (about LE 60 million) respectively in case of utilizing fuel oil as a fuel for electricity generation.

Moreover, from the **national perspective** replacing LPG, diesel fuel, fuel oil, and natural gas by solar energy for water heating in different sectors including residential will have in addition to direct fuel savings and energy consumption reduction tremendous financial and economic profitability and positive impacts among of which is the avoided subsidy of fuels consumed. In that regard, the significant savings of conventional energy, mainly electricity, LPG and Natural gas as a result of replacing conventional water heaters by SWHs; consequently reduce the associated energy subsidy.

Among the important drivers for utilizing SWHs instead of conventional water heaters are the following reasons:

- As shown from figure (3.4), almost 50% of total LPG quantities consumed annually in Egypt that accounted for about 4.2 million tons in 2012/2013 were imported from abroad, compared to 33% as quantities produced from local refineries and 17% from natural gas processing facilities.
- Total LPG imports during the year 2012/2013 accounted for about 2.1 million tons with a value of \$1962 million (about \$2 billion). ^[1]
- The residential and commercial (hotels, resorts, hospitals, restaurants, etc.) sectors consumed about 99.4% of total LPG consumption in 2012/2013 with the rest consumed by other sectors mainly industry. It is worth mentioning that LPG is used in the residential and commercial sectors for water heating and cooking activities.
- Based on estimates of one of the studies performed for the assessment of solar thermal application in some countries of the Arab region, ^[11] electricity consumption for water heating in different sectors in Egypt accounts for about 6000 GWh annually, representing 6% total Egypt's electricity consumption and 2500 MW of grid peak load (equivalent to the capacity of 2 to 3 standard thermal power plants). Assuming that hot water demand in residential sector would be satisfied 100% by solar energy, 4.5 Million tons of CO₂e GHGs emissions could be avoided each year; resulting from direct and indirect fuel consumption.
- Significant savings of conventional energy, mainly electricity, LPG and Natural gas as a result of replacing conventional water heaters by SWHs; consequently reduce the associated energy subsidy. In that regard, based on an average annual consumption of hot water of 240 days, total annual energy savings per one SWH in case of its replacement to electric, LPG and natural gas heaters estimated at 1470 KWh of electricity, 0.125 ton of LPG and 164 m³ of natural gas. Consequently, the avoided annual subsidy of electricity, LPG and natural gas per one SWH estimated at LE 1117 (about \$146), LE 349 (about \$46) and LE 300 (about \$39) respectively.

Figure (3.4) LPG Consumption by source 2012/2013



3.2. Identification of the Most Suitable Beneficiary Sector to be targeted:

The potential for Solar Water Heating SWH utilization identified mainly to exist in residential, commercial, governmental and industrial sectors.

3.2.1. Utilization of SWHs in the Residential Sector:

SWHs are utilized in the residential sector in addition to traditional LPG, natural gas and electricity heaters to heat water necessary for washing, bathing and cooking. The average daily water needed to cover the previous mentioned activities in the residential sector estimated at about 200 liter per person of which 50 liters in the form of hot water normally at an average temperature of 45 °C. The

latest edition of the family budget survey published by the Central Agency for Public Mobilization and Statistics (CAPMS) that covered about 25 thousand families representing different income classes and regions in Egypt highlighted the following important main conclusions and indicators:

- The average annual family expenditure of the whole sample covered by the survey estimated at more than LE 26 thousand with varying levels in urban and rural areas. While it is of about LE 37.7 thousand on average in urban areas, it is only of about LE 25.6 thousand in rural areas of Upper Egypt which is considered as the lowest in the whole country.
- As shown from figure (3.5), families with an average annual expenditure of more than LE 20 thousand represent about 61% of total number of families while that of less than LE 20 thousand represent the reminder which is 39%.
- About 18% of family annual expenditure is made or spent to cover different house expenditures (food, medical care, transport, communications, housing expenditures which include energy commodities consumption cost, as shown from figure (3.6).

Figure (3.5) Families Distribution According to Annual Expenditure (LE)

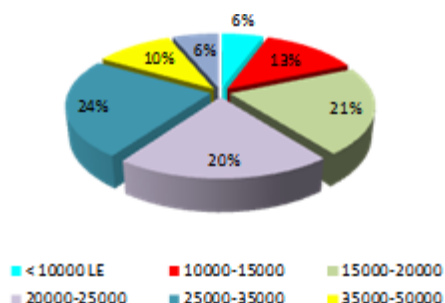


Figure (3.6) Annual Expenditure According to Type

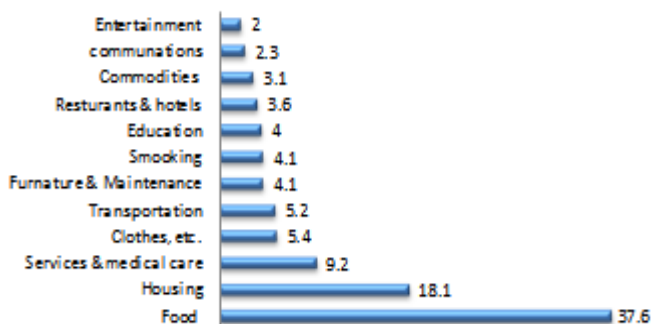
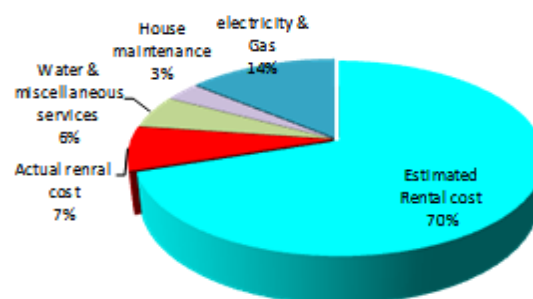


Figure (3.7) Families Expenditure According to Different Activities



- Expenditure on different energy commodities (mainly LPG, natural gas and electricity) represent about 14% of total annual family expenditure as shown from figure (3.7). ^[33]

3.2.2. Utilization of SWHs in the Commercial Sector:

As the case for the residential sector, SWHs are utilized in addition to traditional LPG, natural gas and electricity heaters in the commercial sector (hotels & resorts, restaurants, hospitals, malls, etc.) for heating water necessary for different applications and activities such as cooking, washing, bathing, etc. However, in large commercial entities such as hotels, resorts, and hospitals; small to medium size boilers are utilized for supplying hot water requirements with diesel and natural gas as the main fuels.

3.2.3. Utilization of SWHs in the governmental Sector:

Unlike the case of residential and commercial sectors, SWHs are not yet significantly utilized in the governmental sector in Egypt for heating water purposes. Electric and LPG water heaters on the other hand are the main water heaters which are broadly utilized in that sector for water heating activity.

3.2.4. Utilization of SWHs in the industrial Sector:

The Industrial sector is considered as one of the most important economic sectors not only from the economic development point of view but also as one of the major energy consuming sectors with electricity, natural gas, fuel oil and diesel as the main energy commodities consumed by that sector. According to performed surveys on industrial sector pattern of energy consumption on the national level, Industrial Process Heat (IPH) represents about 56% of total industrial sector energy consumption with textile, food and chemical sectors represent 23%, 33% and 7% of total industrial sector process heat respectively compared to 33% and 4% for metallic and refractory sectors respectively. Based on available and published data on the pattern of energy consumption in the industrial sector through performed surveys at national as mentioned before the textile, food and chemical sectors are considered as the most appropriate and eligible industrial sub-sectors for utilizing solar energy instead of conventional energy for IPH. Moreover, SWHs could also be utilized in other sectors such as petroleum and petrochemical industries for different water heating applications such as heating boilers feed water in order to save conventional energy and improve plants energy efficiency, general performance and economics.

3.2.5. Identification of the Most Suitable Beneficiary Sector to be targeted:

In the context of the previously performed analysis of current energy situation in Egypt and targeted sectors for SWH and based on consultations made with key SWH market stakeholders the residential sector has been chosen as the targeted sector for wide implementation of SWHs technology. The reasons behind that conclusion in addition to what have been mentioned include:

- The relative importance of the residential sector as one of the main energy consumers. As shown from Table (3.2) and figures (3.8 - 3.9), the residential sector is considered as one of the major energy consumers in Egypt as it represent 21% of total final energy demand, 43% of total electricity consumption, 99.4% of total LPG consumption, and about 1% of total natural gas consumption in Egypt.

Table (3.2) Residential sector energy consumption 2012/2013

	Natural Gas	LPG	Electricity
Unit	Billion M3	K ton	MKWH
Residential Sector Consumption	0.522	4175	59757
Total Consumption	52.2	4200	140257
Share %	1.0%	99.4%	42.6%

Figure (3.8) Sectors share of total final energy in Egypt (2012)

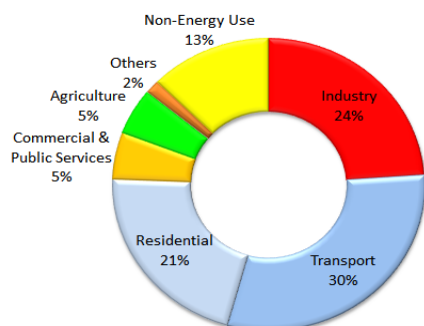
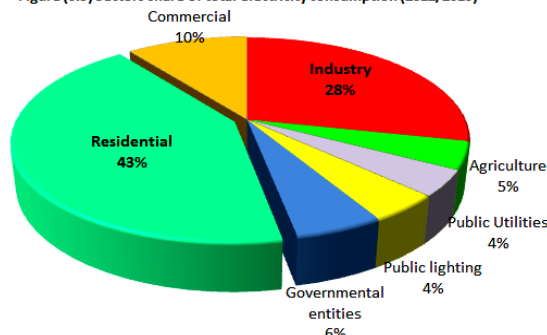


Figure (3.9) Sectors share of total electricity consumption (2012/2013)



- The electricity blackouts that Egypt faced during the last few years as a result of insufficient power installed capacities and shortfalls of fuel supply to power plants, mainly natural gas in addition to diesel and fuel oil of which large amounts are imported from abroad that cost the Egyptian economy massive amounts of foreign currency. In that regard it is worth mentioning that total oil and oil products imports in the year 2012/2013 accounted for about \$11 billion of which about \$4.6 billion for diesel and \$0.7 billion for fuel oil.
- About 50% of LPG consumption is imported from abroad with a cost estimated at about \$2 billion in 2012/2013.
- Low prevailing electricity and LPG prices that conveys negative signs to consumers on their real value and accordingly doesn't encourage them to conserve energy.
- Large potential of solar energy sources harness and exploitation as solar energy intensity range between 2000–3200 KWh/M2/year with solar sunshine duration of 9-11 hours/day.
- The expected large increase of hot water demand in the residential sector as a result of population growth that accounted for more than 2% annually. In that regard it worth to mention Egypt's population is expected to increase to reach about 110 billion in 2025 and about 134 billion in 2035. Accordingly, total hot water demand for the residential sector is expected to increase from 0.5 billion m³ in 2015 to reach about 1.6 billion m³ in 2035.
- Accordingly, total energy consumption or demand for heating water in the residential sector is expected to increase from about 2 million tons of oil equivalent (mtoe) in 2015 to

about 5.3 mtoe in 2035. Figure (2.16) in page 27 presents different types of water heaters share of total water heaters number development during the period (2015-2035) and the corresponding total energy demand during the same period respectively. It worth to mention that a target of about 50% of SWHs share of total water heaters in the residential sector in the year 2035 is assumed.

3.3. Identification of Public Administrations, Local Agencies, Utilities, Market Players and Financial Institution to be involved:

Key important SWHs market players and stakeholders in Egypt are responsible for performing several activities that aims at the promotion and development of SWH market in Egypt. The most important entities and SWHs market players include the Ministry of Electricity and Renewable Energy (MERE), the New and Renewable Energy Authority (NREA), the Egyptian Electric Utility and Consumer Protection Regulatory Agency (EYPTERA), the Egyptian Electricity Holding Company (EEHC), the Ministry of Housing and New Settlements, the New Urban Communities Authority NUCA, the Solar Egyptian Development Association SEDA, the Supreme Energy Council (SEC), the Ministry of Finance (MoF), the Energy Efficiency Unit EEU, The Egyptian-German High Level Committee on Renewable Energy, Energy Efficiency and Environmental Protection JCEE, the Ministry of Environment (MoE), the Egyptian Environmental Affairs Agency (EEAA), the Ministry of Foreign Trade and Industry (MFTI), the Egyptian Organization for Standardization (EOS), the Ministry of International Cooperation (MoIC), the Ministry of Investment (Mol), etc. In addition, several international organization and entities are participating in implementing different renewable energy activities including solar energy and SWH activities. Examples of these entities include the United Nations Development Programme (UNDP), GIZ, the World Bank (WB), the United Nations Environmental Programme (UNEP), the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), etc. The following section highlights the main objectives, mandates and activities of the most important key players and stakeholders of SWH market in Egypt.

The **Ministry of Electricity and Renewable Energy (MERE)**: established in 1964 with the main objectives to provide electricity to all consumers all over the country and optimize the use of available energy sources taking into consideration the environmental protection. Other mandates of the MERE include supervising all activities related to energy projects, suggesting electricity prices, publish data and statistics relating to electricity production, transmission and distribution, consumption, and prices, etc.

- The **New and Renewable Energy Authority (NREA)** established in 1986 to act as the national focal point for expanding efforts to develop and introduce renewable energy technologies to Egypt on a commercial scale together with implementation of related energy conservation programs. Other activities of NREA include:
 - Renewable energy resource assessment.
 - Research, development, demonstration, testing and evaluation of the different renewable energy technologies focusing on solar, wind and biomass.
 - Implementation of renewable energy projects.

- Proposing the Egyptian standard specifications for renewable energy equipment & systems, and conducting tests to evaluate their performance under the Egyptian prevailing conditions, hence issuing respective licensing certificates.
 - Rendering of consultancy services in the field of renewable energy.
 - Technology transfer and development of local manufacturing of RE equipments.
 - Education, training, and information dissemination.
- The **Egyptian Electric Utility and Consumer Protection Regulatory Agency (EGYPTERA)** established in 1997 with the primary task to balance the interests of electricity producers, electricity providers and end users. It is supposed to ensure a reliable long-term supply of electricity while promoting and supervising environmental protection and operational reliability in the energy sector. It is also responsible for licensing the construction and operation of electricity generation, transmission and distribution facilities as well as for electricity trading.
 - The **Solar Egyptian Development Association (SEDA)** that has been established as an outcome of the Solar Water Heater (SWH) Innovation Network which was developed by the Egyptian German Private Sector Development Programme (PSDP). It is considered as a platform which represents all stakeholders in the solar thermal industry; government, private sector, system designers, installers, manufacturers, traders, industry experts, academics, research and development. In 2009, nine companies were active in this business area in Egypt: four companies were manufacturers and installers, and five companies were importers and installers of SWH systems.
 - The **Egyptian Environmental Affairs Agency (EEAA)**: was initially established in 1982 and restructured in 1994. The EEAA serves as the executive arm of the Ministry of Environment. The agency's activities are financed by the Environmental Protection Fund, which is funded by donations and grants by national and foreign organizations, as well as fines and compensation awarded by courts of law. Principal functions of the agency include the formulation of environmental policies, the development and monitoring of projects and the implementation of pilot projects. EEAA is also the national authority in charge of promoting environmental topics between Egypt and third parties.
 - The **Supreme Energy Council (SEC)**: Established in 1979 and is reformed in 2006 according to decree number 1395 with the main objective to develop energy strategies in support of Egypt's economic and social development policies as well as efficiency objectives. Other activities of the SEC include Energy resources management, energy production and consumption patterns, providing guidance to energy reform activities, and handling market emerging issues, etc.
 - The **Energy Efficiency Unit** at the IDSC: established according to the Prime Minister's Decree in May 2009 with the main objective of coordinating and stream lining national energy efficiency activities. Other activities of the unit include:
 - Policy and technical assistance to the SEC to coordinate efforts across Ministries.
 - Collecting and reviewing relevant information.
 - Drafting policy and position papers on priority topics: energy efficiency, renewable energy, subsidy reform, restructuring, natural gas and bio-fuels.
 - Help develop an implementation roadmap for energy efficiency in Egypt.

- Leverage available resources to meet current needs.
- The **Egyptian Electricity Holding Company (EEHC)**: established with the main objective to provide continuous and safe supply of electricity to all types of consumers on economic bases and according to international performance standards taking into consideration all environmental, social and economic determinants. In addition, it is responsible to coordinate, supervise and monitor the activities of its affiliated companies in the field of electricity production, transmission and distribution.
- The **New Urban Communities Authority NUCA**: established in 1979 according to the law number 59 of that year to be responsible for:
 - Creating new urban communities and settlements that help guarantee social and economic security and stability in Egypt.
 - Redistribute population out of the narrow strip of the Nile valley.
 - Establish attractive zones for population and industrial activities out of the existing cities and villages.
 - Help limit degradation of cultivates land
- The **Egyptian Organization for Standardization EOS**: Established according to the Presidential decree number 29/1957 with the main objective to participate in Egyptian industrial development by providing Data and different standardization and quality control studies for investors, industrial and national decision makers. Other objectives and mandates of EOS include setting industrial products norms and standards, continuous developments of Egyptian industrial products standards to comply with the international specifications and standards in order to increase its competitiveness.
- The **Ministry of Finance**: established with main objective of balancing fiscal stability in addition to economic growth and social justice. Other objectives include:
 - Maintaining a stable macroeconomic/macro-fiscal framework and sound public finance.
 - Securing a competitive and efficient private sector.
 - Promoting a fair and efficient tax and incentives system.
 - Promoting trade liberalization with a view to promoting economic efficiency and international competitiveness thus create stronger basis for long-term economic development.
 - Simplifying and liberalizing customs procedures.
 - Achieving more efficient government spending.
 - Improving the quality and the cost effectiveness of public services.
- The **Ministry of Investment**: Established in 2004 with the main objective to reform the investment climate in Egypt, further develop non-bank financial services, and introduce a comprehensive Asset Management Program to State-Owned Enterprises (SOEs).
- The **Ministry of International Cooperation (MOPIC)**: established with the main objective to conclude loan and grant agreements with Egypt's development partners for financing development projects of priority which render direct services to its citizens.
- The **Regional Center for Renewable Energy and Energy Efficiency (RCREEE)**: based in Cairo. Besides Egypt, other Arab members of the RCREEE are Algeria, Bahrain, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Palestine, Sudan, Syria, Tunisia and Yemen. RCREEE formulates and disseminates policies in support of RE and EE in the region

and provides a platform for the regional exchange on policy issues and technological questions. In addition, RCREEE encourages the participation of the private sector to promote the establishment of a regional RE and EE industry.

- The **Egyptian-German High Level Committee on Renewable Energy, Energy Efficiency and Environmental Protection JCEE**: is a bilateral Egyptian-German initiative which works as a platform for energy policy discussion, developing initiatives for investment as well as institutional projects, awareness and capacity building activities and establishing contacts and exchange between the two countries.

Moreover, there are several international organizations and entities that contribute to the development of different renewable energy activities and initiatives in Egypt including SWHs among of which are the United Nations Development Programme UNDP, the United Nations environmental Programme UNEP, the World Bank WB, the GIZ, AFD, the Global Environment Facility GEF, European Investment Bank EIB, European Bank for Restructuring and Development EBRD, etc. Appendix (5) presents the mandates of some of these entities.

4. Identification of the Most Appropriate Financing Mechanism:

The identification of the most appropriate financing mechanism (Sub task 6.1b.3) includes performing the following activities:

- Definition of methodology and criteria for model selection.
- Economic Assessment.
- Technical and social sensitivity analysis.
- Stakeholders and decision-makers consultation.
- Definition of the financial mechanism.

Before identifying the methodology and criteria for selecting the most appropriate financial mechanism for the promotion of SWHs in Egypt it might be useful to shade light on general approaches for financing DSETs including SWHs in addition to supportive policies.

4.1. Definition of Methodology and Criteria for Model Selection:

4.1.1. General Approaches for Financing SWHs:

There are three major approaches for financing renewable energy projects in general and Distributed Solar Energy Technologies DSETs including Solar Water Heating SWH in particular. These are buying, leasing and purchase agreements. [34] [35]

Buying: means purchasing of DSETs s from an approved contractor or manufacture either through paying the upfront cost of the system or the technology as direct cash or through a loan from a bank. In such a case the buyer own the system which most manufactures guarantee for up to 25 years.

Leasing: According to this approach the client is allowed to rent the DSET system from a company for a set period of time. Generally, the client pays a fixed monthly rate no matter how much energy the system produces each month. Therefore, the, customers can get the benefits of owning the solar system without paying the capital costs.

Power Purchase Agreements (PPA): is in general similar to leasing, where a third party owns and maintains the DSET system on client behalf. In the case of electricity generation from PV systems, the client agrees to pay for the electricity generated at a rate per kilowatt-hour (kWh) specified in his agreement.

Other Definitions or Classification of DSETs Financing Mechanisms: ^[36]

Sometimes, financing mechanisms for distributed solar energy technologies or the options through which solar energy technologies customers can finance their solar energy systems are classified as home equity loans, power purchasing agreements, solar lease, and property assessed clean energy.

Home Equity Loans: Is a mechanism through which solar energy systems customers go through their lenders to finance their solar energy systems. It is one of the most common approaches through which homeowners can finance their solar systems.

Property Assessed Clean Energy (PACE): In that financing mechanism solar customers have the option to finance their solar systems through their local governments. Local governments can create **property tax finance districts** to issue loans for energy efficiency and renewable energy such as solar PV and SWH systems. PACE allows local governments to provide low-cost, 20-year loans to eligible property owners seeking to install these technologies. The solar customer then pays more on the annual property tax bill to repay the loan. The loans are permanently fixed to real property, so that residents do not need to worry about their system's break-even point and can pass the loan payments on to subsequent buyers of the property.

4.1.2. Financing Mechanisms Supportive Policies:

In order to guarantee the successful implementation of DSETs financing mechanism it is important to implement a set of supportive and integral policies and measures such as energy prices increase and subsidy removal, tax incentives, regulatory measures, etc. As an example, for the case of utilizing DSETs such as photovoltaic systems to generate electricity either for grid or off-grid projects it is necessary to have some supportive policies and measures such as net metering and feed-in-tariff. For the case of SWHs economic incentives for SWHs clients, developers, installers, and manufacturers could be a good example in that regard. The following section sheds light on some of the policies that are utilized for supporting the implementation of financing mechanisms for the promotion of PVs and SWHs markets.

4.1.3. Supporting Incentives for the Promotion of SWH Systems Market: ^[9]

There are several supporting incentives that could be provided to either SWHs manufacturers, installers in addition to final consumers to help reduce the up-front cost for SWHs and make it economically feasible and attractive which include the following:

4.1.3.1. Incentives for the Final Consumers:

Grants on the initial cost of SWH:

Considered as the most appropriate, effective, and attractive incentive for the final consumer in Egypt and consequently the promotion of SWHs market taking into consideration the standard of living and the average income level of Egyptian citizens. Moreover, it becomes more suitable and workable in case of international financial support from different donating agencies and financial institutions to promote green energy technologies.

Subsidy on the interest rate on loan:

The prevailing interest rate of loans from commercial banks that account on average for about 9% or even more is considered as one of the main barriers for allocating the necessary finance for DSETs installation of SWHs. Therefore, subsidizing that interest rate to about 4%-5% or even more could be an effective tool and incentive to overcome the relatively high up-front cost of SWHs. That subsidy could be easily allocated through support from different financial donors and available green funds.

Reduce Taxes on the Purchase of SWHs:

Tax deduction of SWHs purchase cost is considered also as one of the most effective tools for overcoming the up-front cost of DSETs which is quite popular in many European countries. For the case of Egypt that tool could be more appropriate and applicable for a small segment of residential energy consumers who representing only 2% of total electricity customers and characterized by being high income classes and relatively high taxed households.

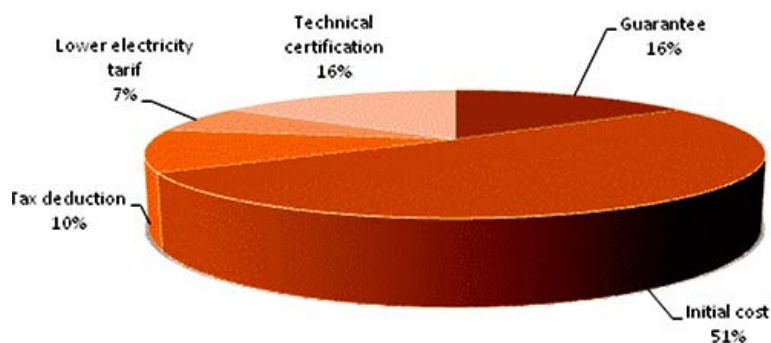
Lower Electricity Tariff: ^[9]

Providing electricity at reduced prices or tariffs for households with SWHs installments could also be an effective tool for the widespread of SWH market. However, in light of the prevailing reform programme of energy prices and subsidy removal including that for electricity that option might be of lower priority for the time being.

The outcomes of performed survey in the 2014 to investigate different SWHs market stakeholders and players views on the main barriers for SWHs market development as shown from figure (4.1), indicates that ***reducing the initial cost of SWHs is considered as the best available supportive economic tool that could help overcome the high initial cost of SWHs consequently promote its market.***

Apart from the previously mentioned financial incentives, two other non-economic incentives are considered helpful, these are providing a valid guarantee over a reasonable period of SWH's lifetime and providing a technical certification for the SWHs and its installation.

Figure (4.1) Promotion means for the final consumers, as perceived by the market ^[9]



Source: EU, Incentives and other Support Measures for Solar Water Heaters, Deliverable 9.b: Technical Assistance to Support the Reform of the Energy Sector, Arab Republic of Egypt, 2014.

4.1.3.2. Incentives for SWHs Developers or Installers:

The results of the previously mentioned performed survey in the year 2014 that covered 100 SWH market stakeholders and players indicate that the incentives for SWHs developers and installers are a ***mixture of economic and regulatory incentives*** which include the following:

- A tax exemption grass period of two years for SWHs household project if all the household units covered by the project are equipped by SWHs.
- The allowance for an increase in built surface area and height.
- The establishment of a dedicated credit line to cover the incremental cost of renewable energy systems.
- The provision of training for the engineers and technical staff.
- The enhanced application of the Green Pyramid certification scheme, as a way to promote the “green” character of developments.

It is worth mentioning that the survey results, indicates that the impact of the previously mentioned incentives are fairly equal and that the regulatory measures are more important than the fiscal ones.

4.1.3.3. Incentives for SWHs Manufactures:

The main problems facing SWHs manufactures are mainly linked to quality and small quantities produced annually through assembling which causes consequently high cost and prices. In order to overcome those problems through automation of SWHs industry the following measures and incentives are recommended to be offered to SWHs manufactures without subsidizing them directly.

- Support for the certification of SWH to be carried out by the Solar Systems Laboratory of NREA and also to apply voluntary labeling schemes.
- Support for applied research and development activities that should be carried out in cooperation with major Egyptian universities and research facilities and centers, as part of a national programme to advance expertise in the field, but also as part of EU co-operation programmes.
- Establishment of a legal framework that promotes joint ventures with foreign companies active in the field of solar systems, so that technology and expertise can be transferred to Egyptian manufacturers.
- Reduction in the import taxes for specific components, like selective absorbers.

4.1.4. Approaches for the Promotion and Development of DSETs and SWHs Markets: ^[38]

There are several approaches for the development and promotion of distributed solar energy technologies among of which are the following that might be applicable for SWHs:

A. Incentive systems: include the following:

1. Tax incentives

A number of tax incentives conducive to the emergence of renewable energy can be implemented. Some will focus on reducing costs and improving the relative competitiveness of renewable energy technologies by providing indirect tax subsidies. Others consist of direct tax concessions. It can be then: Tax credits for investment, property tax exemptions, tax credits for production, sales tax rebates, and exemptions from excise taxes (e.g. VAT), etc. Usually applied in industrial projects, some of these reductions can also be applied to the residential sector (e.g. the case of France).

2. Indirect tax benefits

This is a classical approach providing benefits on indirect taxes on renewable energy equipment and more generally energy efficient equipment: exemption from VAT and customs duty on import. During the initial phase of the contract, this measure provides an inexpensive incentive for governments, because the base of its application is still low in the country. This type of measure has existed for several years in Tunisia for example.

3. Direct tax benefits

It is in this case given to investors in RE projects benefits in terms of tax revenue (or profits for corporations).

4. Tax credit for investment

Part of the investment is tax deductible. A tax credit can be applied to the tax base or the tax due. In the second case (tax due), it is obviously more favorable. A tax credit involves a possibility of reimbursement by the State to the taxpayer. It can only be applied to certain categories of taxpayers. However, it can (and should) have limits.

5. Tax credits for the production or reduction of sales, energy, carbon, excise, VAT, etc.

Alternative systems of tax credit on the sale of renewable electricity, energy assessment, carbon saved or VAT paid can be implemented. These are then applied to the amount of electricity generated during the year (and not the amount of the investment).

6. Tax Reduction

Tax cuts may apply in the same way as tax credits. They apply to the final tax but unlike tax credits, they do not induce repayment in case of exceeding of taxation.

7. Energy Production Payment

It is a system of direct government payment per unit of renewable energy produced. This is an incentive system of subsidy type for a limited duration, modifiable (since it depends on fiscal policy that is revised annually) and variable, non-contractual (as opposed to the feed-in tariffs). This system can therefore be of limited duration so as to encourage the emergence of a market without incurring the government in a long-term policy.

8. Public subsidy

These are incentives in the form of direct grants to investments in renewable installations. They aim to reduce investment costs for the user in order to make investment in renewable energy more profitable and therefore more attractive. They can also affect the bank interest rate subsidy to reduce financing cost and improve the profitability of the facilities in question. The subsidy payment may be made directly by the government (Public Treasury) or a dedicated state agency. In order to ensure the sustainability of the incentive system, the subsidy origin may be backed by public funds fed by taxes, which will ensure stable resources for the incentive.

B. Specific Funding Mechanisms:

It is most often a combination of mechanisms including several types of measures, but in a coherent way. In fact, in addition to the public subsidy, the mechanisms often rely on credit systems which duration is long enough to be adapted to the ability of households' payment. The credit system is most often backed upstream to a line of credit which rate and maturity duration are concessional. In addition to the concessional line of credit, the State may decide to

subsidize interest rates to make credit more accessible to users. Finally, the credit can be distributed directly by banks, but it can cause three main constraints:

- The household bankability rate which is often low in developing countries,
- High transaction costs in banks credit management (instruction and collection), given the small amounts of credit,
- The default risk may be higher, in the absence of guarantees provided by households.

To overcome such constraints, some countries (in the case of Tunisia, Kenya, South Africa) use electrical distributors for repayments through electricity bills, but also as guarantee payment agencies using the lever of household disconnection from electrical connection in case of default payment. ^[38]

4.1.5. Methodology and Criteria for Innovative Financing Mechanism Selection:

In order to define the appropriate financing mechanism for the promotion and deployment of SWHs market in Egypt it was necessary to set a methodology and criteria for model design and selection. A performed study in 2014 to assess 13 implemented financing mechanisms to promote DSETs in Morocco, Tunisia, Jordan and Egypt indicates that there are specific elements and issues that should be considered on setting the methodology and criteria for DSETs financing mechanisms design, implementation and market impact. ^[39]

At the **design stage**, the methodology and criteria for financing mechanism characterization include the following elements and items:

1. The degree of mechanism appropriateness to targeted consumer.
2. The degree of mechanism appropriateness to targeted technology.
3. Clarity of the mechanism purpose and explanation of benefits and risks of utilization.
4. Targets of the mechanism.

At the **implementation stage**, the elements of the methodology and criteria for financing mechanism characterization include the following elements and items:

1. Administrative procedures for implementation.
2. Fund disbursement.
3. Technical, financing, and administrative capacity.

With respect to **market impact**, the methodology and criteria for financing mechanism characterization include the following elements and items:

1. Barriers addressed.
2. Utilization of the mechanism by targeted consumers.

Regarding the **design** of investigated and assessed financing mechanisms; the study indicates that most of the mechanisms performed well with respect to its appropriateness to the targeted consumer. The good understanding of most of the involved organization on how to attract the targeted consumers in addition to the backing of central and development banks that enable "soft loans" to be offered were among the different reasons for the observed well

performance of most of implemented financing mechanisms. However, the high collateral requirements of some banks were among the reasons that prohibited consumers to make use of the available financing mechanisms.

With respect to the appropriateness of investigated and assessed financing mechanisms for target technology; the study indicates that the majority of implemented financing mechanisms offered loan terms that were in line with targeted technology payback period and finance amount that could cover the technology costs. Moreover, the clarity of the purpose and explanation of the benefits of the mechanism was lacking within some of the financing mechanisms. Except for the Tunisian PROSOL mechanism, all other investigated financing mechanisms lacked any solid targets such as the amount of DSET to be developed or number of the systems to be funded.

With respect to the **implementation** of investigated and assessed financing mechanisms, the study indicates the following:

- The administrative proceedings were almost a common issue across most of the investigated mechanisms and that streamlining of these procedures and reducing the reporting steps could facilitate and enhance the requested finance approval process and consequently increase the effective utilization of the financing mechanism.
- The initial technical capacity of many commercial banks was low and negatively impacted the approval for loans for renewable energy technologies. In that regard, offering technical assistance in order to increase the technical capabilities and knowledge of concerned commercial banks staff in combination with allocating the appropriate finance credit lines could alleviate that problem.
- The timing of disbursement of necessary funds is considered a vital and crucial factor in the success of financing mechanism implementation. While the disbursement of some funds could be paid according to project progress, others only paid at the end or the completion of the projects. Late disbursement of funds has been proved to be one of the dominant factors and reasons for a lack of adoption of financing mechanisms.

With respect to **market impacts**, the study indicates that except for the Tunisian PROSOL financing mechanism, there was a lack of utilization across other mechanisms in investigated countries. Contextual factors as well as previously assessed design and implementation issues were considered among the factors that limited the utilization of the existing financing mechanisms. In order to overcome the previously mentioned barriers for financing mechanisms implementation and increase their adaption, the study suggested the following

Recommendations:

- A. With respect to the design and implementation features of the financing mechanisms:
 - It is important to improve the technical capacity of concerned staff. This could help in assessing the risk associated to renewable energy projects design and implementation. In addition, it could help lowering the collateral requirements for projects implementation; increase the number of potential consumers and consequently the diffusion of solar energy technologies.

- Importance to increase the interaction between financial institutions and solar energy entities and organizations which could be considered as a part of the capacity building process.
- Importance of streamlining administrative procedures to reduce transaction costs of different stakeholders and consequently increase the utilization of the financing mechanisms.
- Disbursement of funds should not be at the end of project implementation. Rather, it should be in line with project implementation progress and milestones. This will provide more attractiveness of the mechanism to the end consumer in addition to giving funds providers (financers) more control on the use of funds in addition to securing and guarantee that the project will achieve its targets and objectives.
- Importance of collaboration between different stakeholders and partners (public sector, private sector, financing sector, and industry entities and organizations) in the design, implementation of financing mechanisms. This will ensure that all technical, financial, market and policy aspects are covered and consequently facilitate better-tailored design and implementation of the financing mechanisms, increase their adaption and success implementation. ^[39]

In designing the proposed financing mechanism for solar water heaters SWHs in Egypt, the previous mentioned issues and elements of the methodology and criteria for mechanism characterization and selection have been considered. More specifically, the following issues, concepts and determinants for the success of the proposed financing mechanisms have been considered during the design phase of the mechanism and supported by the performed financial, economic, social and technical assessment and analysis:

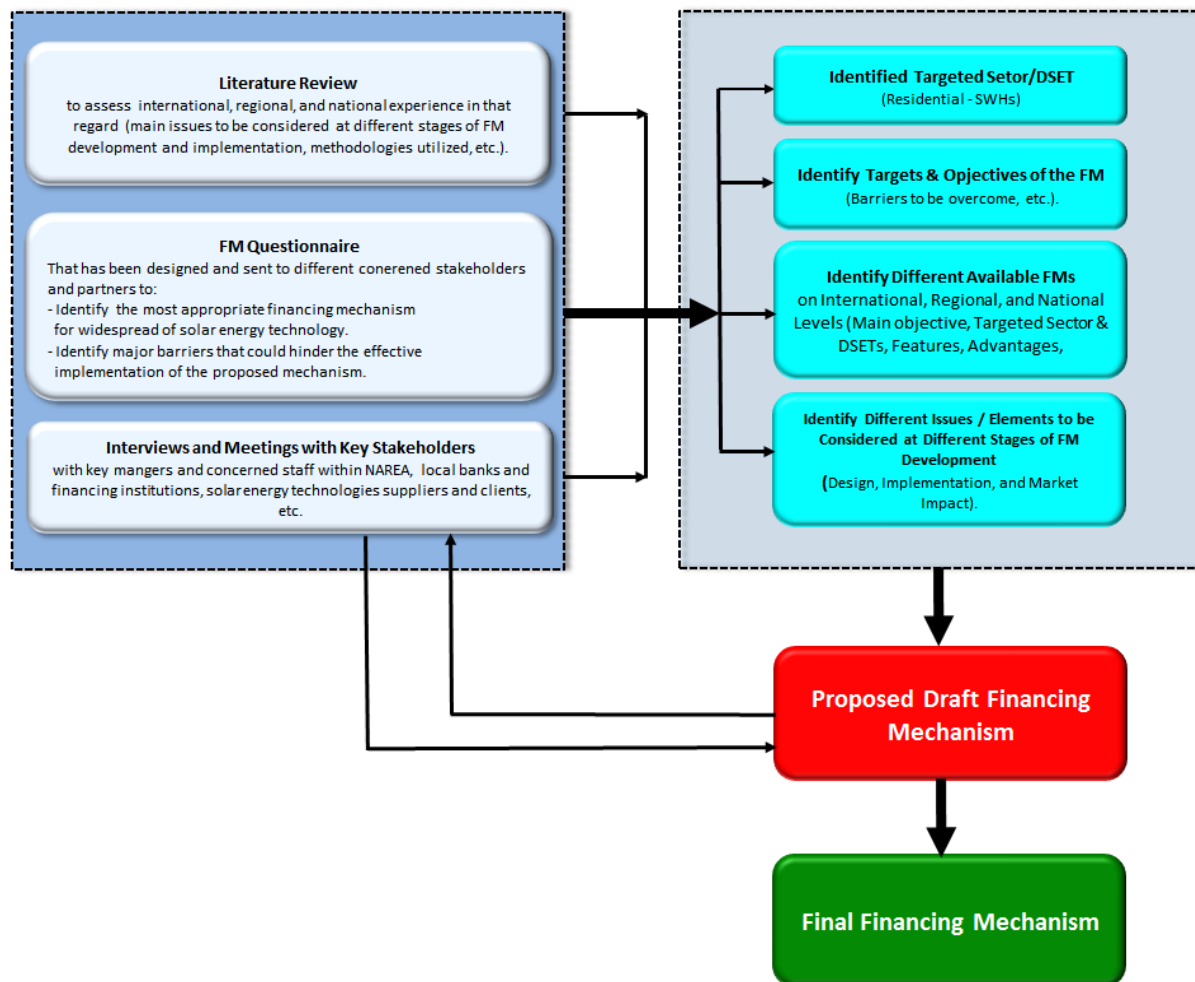
- Importance of good understanding of most of involved organization in the initiative on how to attract the targeted consumers.
- The financing mechanism should be backed by central and development banks which enable "soft loans" to be offered.
- Importance to minimize or avoid collateral requirements needed by some banks involved in the initiative.
- Loan terms have to be in line with targeted technology payback period and finance amount that could cover the technology costs.
- The financing mechanism is linked to solid targets such as the amount of SWHs to be installed or number of the systems to be funded.
- Importance of streamlining the administrative proceedings and reducing the reporting steps in order to facilitate and enhance the requested finance approval process.
- Disbursement of the necessary funds has to be made according to project progress.
- Technical assistance to concerned commercial banks and financing institutions staff has to be offered in order to increase their technical capabilities and knowledge.
- Contextual factors have to be considered.
- Importance of collaboration between different stakeholders and partners.

Figure (4.2) is a simplified schematic presentation of the criteria and methodology followed for identifying and selection of the appropriate financing mechanism for SWHs in Egypt. As shown from that figure, the criteria and methodology include the following main steps:

1. **Literature Review** to assess international, regional, and national experience in that regard. Important outputs and milestones of that activity include the identification of main issues to be considered at different stages of financing mechanism development and implementation, methodologies utilized, main barriers that could hinder the successful implementation of the DSETs financing mechanisms including that for SWHs and how it could be overcome.
2. **The Financing Mechanism Questionnaire** (presented in appendix 2) has been designed and sent to different concerned stakeholders and partners with the aim to:
 - Assess already implemented financing mechanisms in Egypt.
 - Help identify the most appropriate financing mechanism for widespread of solar energy technology in Egypt.
 - Identify major barriers that could hinder the effective implementation of the proposed mechanism.
3. **Interviews and Meetings with Key stakeholders** managers and concerned staff within NAREA, local banks and financing institutions, solar energy technologies suppliers and clients, etc. The main objective of that activity was to get common consensus among different stakeholders on the proposed financing mechanism targets, design, role, and responsibilities of different stakeholders involved in addition to:
 - Proposed scope and methodology of performing WPs 6.1 (b-c).
 - Identification of targeted solar energy technologies and Sectors.
 - Assessment of the energy context and status of solar energy market in Egypt.
4. As a result of the previous mentioned activities, the following **outputs and milestones** have been achieved:
 - Identification of the targeted sector and solar energy technology which are the residential sector and solar water heaters.
 - Identification of the targets and objectives of the proposed financial mechanism (e.g. barriers to be overcome, number of SWHs to be installed, etc.).
 - Identification of some of the implemented financial mechanisms on regional and national levels (main objective, targeted sector and DSETs, features, advantages, disadvantages) with particular emphases on the most successful ones, etc.
 - Identify different issues and elements to be considered at different stages of financial mechanism development and deployment (design, implementation, and market impact).
5. As a result of the previous mentioned steps, a proposed draft financial mechanism for the promotion of SWHs in Egypt is developed and presented to the most important stakeholders and project partners.
6. The comments and feedback from different stakeholders have been taken into consideration in setting the final version of SWHs financing mechanisms.

The following section presents some of the proposed mechanisms.

Figure (4.2) DSETs Financing Mechanism Selection Methodology and Criteria



4.1.6. Alternative Designs for SWHs Financing Mechanisms:

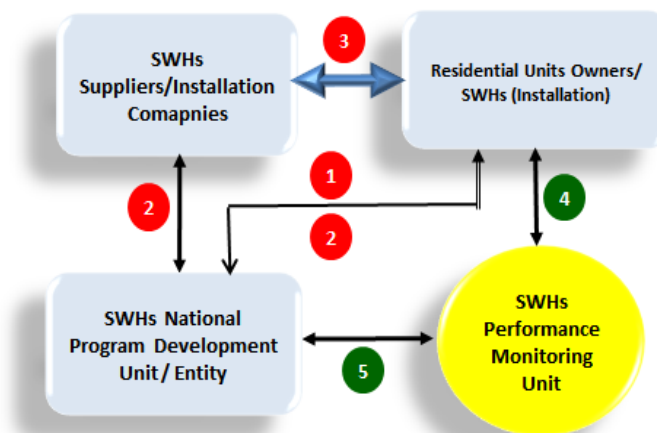
Based on the previous mentioned criteria for the identification and selection of SWHs financing mechanism in Egypt several versions have been proposed reflecting different concepts and features as follows:

1. Financing Mechanism based on 100% Equity:

In that case it is assumed that the market of SWHs is expected to be driven mainly by energy prices increase and that the cost of the SWHs is paid directly from consumers or clients to SWHs suppliers or installers. It is obvious that this mechanism could be utilized in new building, particularly in new cities and settlements where consumers can afford the relatively high upfront cost of SWHs without any need to have any sort of loans from banks or support and subsidy from the government due to the high standard of leveling of population segment living in those areas. Other recommended alternative in that regard is to add the cost of SWHs to the cost of new building or purchased apartments. In order to guarantee the proper quality of

installed SWHs and consequently its effective performance it is recommended that the program should involve in its structure a monitoring unit which is affiliated to NREA to be responsible for monitoring the performance of the whole program. Furthermore, an after sale service agreement for the maintenance and monitoring the performance of the installed SWHs systems has to be signed between the customers and nominated maintenance and service company by NREA with appropriate and attractive terms and conditions (reasonable maintenance cost or fee, regular maintenance visits and checks, etc.). Figure (4.3) is a simplified structure of that financing mechanism alternative.

Figure (4.3) Financing Mechanism based on 100% Equity



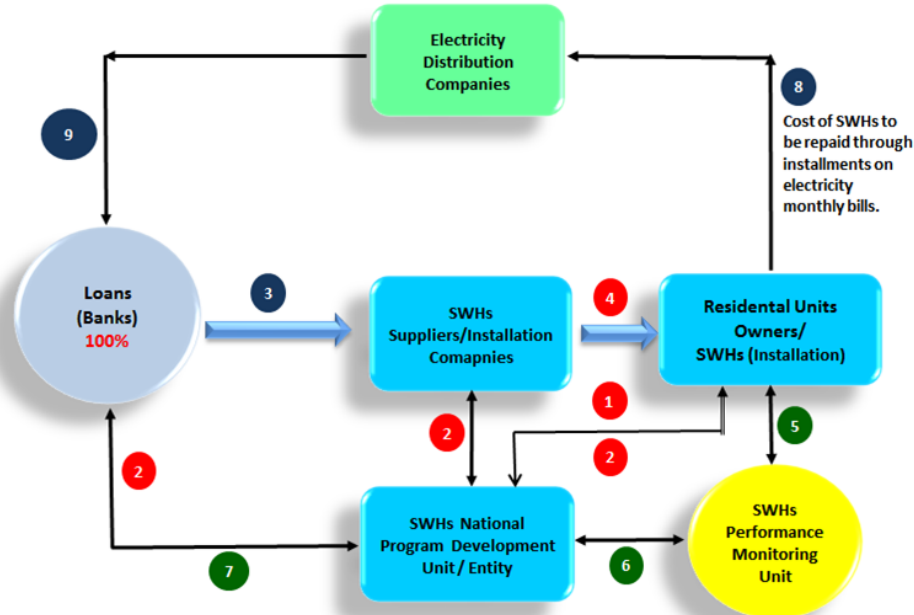
2. Financing Mechanism Based on 100% Loan:

In that case and as shown from figure (4.4) the consumers can get loans from participating commercial banks in the national programme to cover the upfront investment cost of SWHs according to normal prevailing lending conditions such as interest rate and repayment periods of loan that account for about 9% and 5 years respectively. Meanwhile, the loan could be repaid as equal monthly installments through the electricity or natural gas bills.

In order to guarantee the proper quality and performance of installed SWHs it is recommended that the program should involve in its structure a monitoring unit that is affiliated to NREA to be responsible for monitoring the performance of the whole program.

As the case of the previous mentioned financing mechanism structure an after sale service agreement for the maintenance and monitoring the performance of the installed SWHs systems has to be signed between the customers and nominated maintenance and service company by NREA with appropriate and attractive terms and conditions (reasonable maintenance cost, regular maintenance visits and checks, etc.) as previously mentioned.

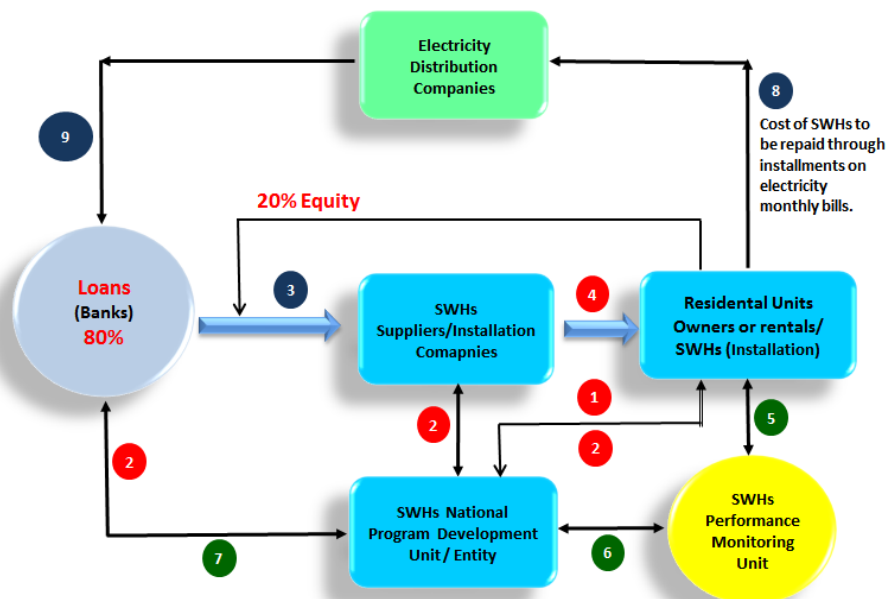
Figure (4.4) Financing Mechanism based on 100% loan



3. Financing Mechanism Based on 80% Loan and 20% Equity:

The proposed mechanism in this case is the same as that previously mentioned except for considering 20% of total SWHs cost is in the form of equity to be paid by the client at the purchase of the SWH. Figure (4.5) is a simplified structure of that financing mechanism alternative.

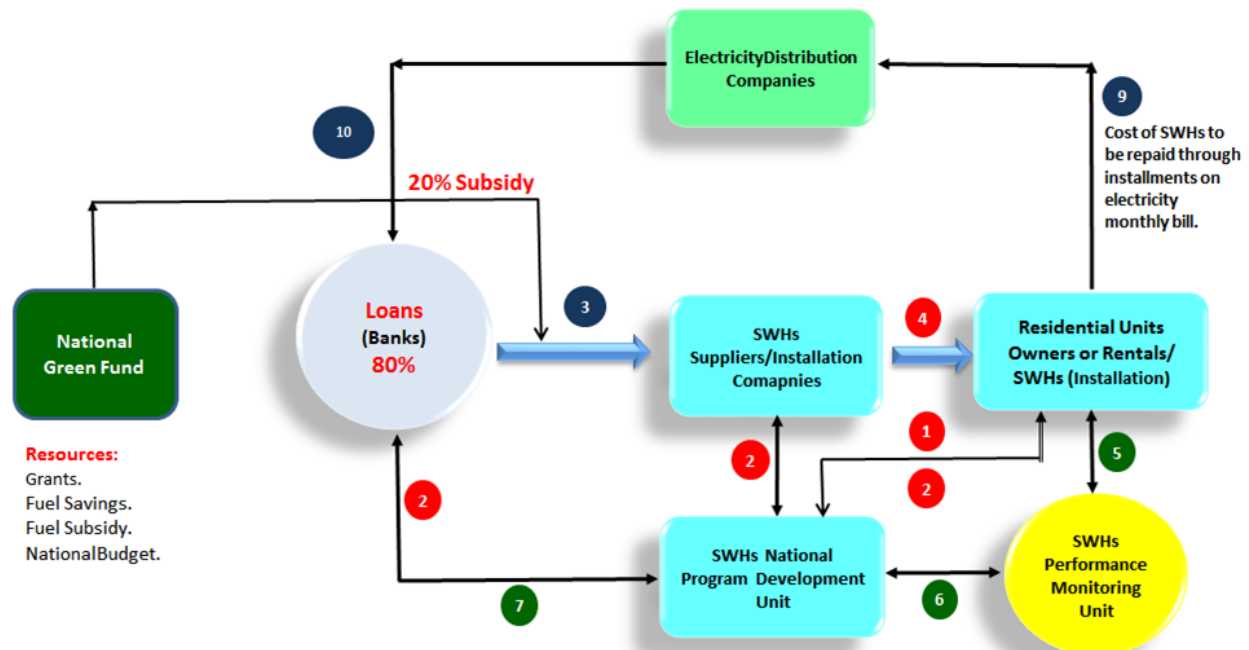
Figure (4.5) Financing Mechanism based on 80% Loan and 20% Equity



4. Financing Mechanism Based on 80% Loan and 20% Subsidy (the proposed mechanism):

The structure of this mechanism is the same as the previously illustrated mechanism except that a subsidy of 20% of total initial cost of the SWH (instead of the 20% equity in the former mechanism) has to be paid through a national green fund which is financed through national and international grants, conventional fuels savings and avoided subsidy costs, the national budget, etc. This structure is the recommended financing mechanism to be utilized. Detailed description of the mechanism is presented in section (3). Figure (4.6) is a simplified structure of that financing mechanism alternative.

Figure (4.6) Financing Mechanism based on 80% Loan and 20% Subsidy



4.2. Economic and Financial Assessment:

4.2.1. Economic Assessment:

In conducting economic assessment for SWHs in Egypt it is essential to perform that activity not only in the context of SWHs market situation and development but also in the context of the whole energy situation in Egypt taking into consideration different dominating parameters and factors that affect SWHs market development such as prevailing energy prices, existing institutional and regulatory framework, adopted energy strategies and policies, implemented and proposed incentives, barriers that could hinder market expansion and new energy technologies penetration, etc. Therefore, it might be useful to refer to the analysis made in section (2) of this report which deals with solar energy market assessment in Egypt and to shed light on some of the most important issues discussed based on which we can reach the following important conclusions regarding economic parameters that impact the growth of SWHs market in Egypt.

- SWHs can't compete with conventional or typical water heaters (electric, LPG and natural gas) based on financial terms only particularly in light of the prevailing low energy prices and the high upfront cost of SWHs compared to their prices.
- In order to make SWHs attain their market potential there is a need to develop and implement several technical, economic, regulatory and institutional market initiatives and policies. As an example, on the manufacture or supply side of SWHs there is a need to develop systematic programmers for technical efficiency and quality assurance in addition to invention promotion. On the demand side, there is a need to overcome several barriers such as lack of awareness among consumers, lack of market development incentives for targeted and potential clients in addition to heavily subsidizes of conventional energy sources.

To perform a full economic assessment of SWHs in Egypt it is necessary to start with conducting a financial assessment that reflects mainly SWHs client's perspectives and deals with the direct benefits and costs of that technology measured in monetary terms at prevailing market prices. Then a full economic assessment in line with social perspectives has also to be performed which incorporate in addition to financial terms and analysis any positive or negative externalities attributed to the use of SWHs such as the value of avoiding the emissions of GHGs and other pollution damage.

4.2.2. Financial Assessment of SWHs: ^[32]

As the case of any enterprise or entity whether it is public or private that often faced with the opportunity of generating a stream of future benefits (either in the form of cash payments or avoided costs); performing financial assessment of utilizing SWHs in Egypt relied mainly on a set of techniques that is utilized to evaluate such situations which collectively called cash flow analysis. These techniques include the Net Present Value **NPV**, the Internal Rate of Return **IRR** in addition to the **payback period** techniques.

Payback Period:

The payback period technique is considered as the simplest and straight forward technique utilized for financial assessment. It is simply defined as the number of years in the future when the sum of the expenses (negative cash flows) is equal to the sum of the revenues (income) or savings (positive cash flows). If the expenses are all made upfront and the revenues or savings are gained consistently year-to-year, the payback period is defined and simply calculated according to the following equation:

$$\text{Payback Period} = \text{Investment} / \text{Income or savings}$$

It is worth mentioning that as the expected future savings of utilizing SWHs might be unlikely constant and as it ignores the time value of money, the payback period technique might not be in general the appropriate technique to be utilized. However, it is usually considered in performing different financial analysis including the current for SWHs as it could give a quick and rough judgment on the viability of utilizing SWHs, due to its simplicity, clarity and pervasiveness in buyer's minds. Moreover, the payback period technique is considered as a critical element in the consumer adaption decision process.^[41]

Net Present Value:

The net NPV technique is more complex than the payback period technique. However, it provides better information on the visibility of performing and implementing projects. It recognizes the value of time; a dollar today is worth more than a dollar in the future. The NPV technique uses the time value of money to convert a stream of annual cash flow generated by a project to a single value at a chosen discount rate. It is simply presented according to the following equation:

$$\text{Net Present Value (NPV)} = \text{Present Value of Revenues} - \text{Present Value of Costs}$$

- If the ***NPV of a project is greater than zero (NPV > 0)***; this means that the revenues of the project earns more than the costs. In other words, the NPV in that case represents how many present value monetary unit will be returned to the investor above and beyond those that will be returned at the minimum rate of return.
- If the ***NPV of a project is equal to zero (NPV = 0)***; this means that the revenues of the project earns as much as its costs. In other words, there are enough revenues or benefits to cover the costs of the project at a rate of return that is equal to the minimum rate of return required by the investor.
- If the ***NPV of a project is less than zero (NPV < 0)***; this means that the revenues of the project earns less than the costs. In other words, the returns of the project implementation are less than the minimum required returns and therefore the project has to be dropped from further consideration.

As shown from the following mathematical formula, the NPV is simply the sum of all cash flows (positive or negative) and or discounting future cash flows for the time value of money.

$$NPV = \sum_{t=0}^n \left(\frac{C_t}{(1+r)^t} \right)$$

Where:

t: the time of the cash flow.

n: the total time of the project

r: the discount rate (the rate of return that could be earned on an investment in the financial market with simple risk).

C_t : the net cash flow (the amount of cash) at time t

Internal Rate of Return IRR:

The IRR of a series of cash flows is the discount rate that would set the NPV to zero. It commonly used for projects acceptance or rejection decisions.

In conducting the financial assessment for SWHs, the following assumptions and issues were considered:

- SWH to be utilized instead of electric heater. The reasons beyond that assumption include in addition to the widespread of electric water heaters the high growth of electricity demand with the existence of insufficient capacity for power generation, the GHGs emissions from power plants, etc.
- Several financial terms have been considered for both the SWHS and electric heaters. These include mainly; the initial costs, electricity savings, and electricity prices for the residential sector. Table (4.1) presents the most important data and assumption utilized in the financial assessment of the feasibility of SWHs in Egypt.

Table (4.1) basic data and assumption utilized for the financial assessment

Size of SWH (Liters)	200
Cost of SWH (LE)	9000
Of which: loan (LE)	7200
Subsidy/(grant) (LE)	1800
Average electricity consumption for electric heater (KWh/day)	6.1
Electricity Savings (KWh/year) based on 240 days/year.	1470
Life time of SWH (year)	15
Life time of electric water heater (year)	10
Interest Rate (%)	10
Discount Rate (%)	10
Loan period (years)	5

It worth to mention that electricity prices utilized for the current financial assessment are the average of the fourth and the fifth tiers of electricity prices for the residential sector in Egypt (201 – 650 KWh/month) as shown from tables (4.2 & 4.3). The reasons beyond choosing those tiers of residential electricity tariffs for the current sensitivity analysis are:

- The two tiers represent together about 40% of total residential electricity customers number in the year 2012/2013 and 95% of total number of electricity customers of the last four tiers whom are utilizing electricity for water heating and can afford its cost.
- Electricity consumers under those tiers are mainly medium income classes' consumers whom are using electricity for water heating in addition to LPG and natural gas and can afford the cost of electricity consumed by electric water heaters.
- Those are the tiers that are still subsidized after the last electricity increase in July 2014.

It is worth mentioning that utilized electricity prices for the sensitivity analysis for the period (2015-2019) are the prices announced by the Ministry of Electricity and Renewable Energy MERE on July 2014 according to its plan for electricity price increase during the coming five years. The prices after the year 2019 are estimated based on an annual increase of 2.5%.

Table (4.2) Electricity Prices (PT/KWh)*

Tiers of electricity consumption (KWh/month)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
up to 50	7.5	9	10	11	12	12.3	12.6	12.9	13.2	13.6	13.9	14.3	14.6	15.0	15.4
51-100	14.5	17	19	21	23	23.6	24.2	24.8	25.4	26.0	26.7	27.3	28.0	28.7	29.4
101-200	16	20	26	31	37	37.9	38.9	39.8	40.8	41.9	42.9	44.0	45.1	46.2	47.4
201-350	24	29	35	45	55	56.4	57.8	59.2	60.7	62.2	63.8	65.4	67.0	68.7	70.4
351-650	34	39	44	50		56.4	57.8	59.2	60.7	62.2	63.8	65.4	67.0	68.7	70.4
651-1000	60	68	71	76	86	88.2	90.4	92.6	94.9	97.3	99.7	102.2	104.8	107.4	110.1
> 1000	74	78	81	86		88.2	90.4	92.6	94.9	97.3	99.7	102.2	104.8	107.4	110.1
Average price of tiers 4 & 5	29	34	39.5	47.5	55	56.4	57.8	59.2	60.7	62.2	63.8	65.4	67.0	68.7	70.4
Average Price of tiers 4 & 5 (Cent/KWH)	3.8	4.5	5.2	6.2	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0	9.2

* Based on MERE announced prices in 1/7/2014 for the period (2015-2019). PT: Piaster (one LE=100 pilasters)

Electricity prices to increase by 2.5% annually after 2019.

Table (4.3) Electricity tariff structure and distribution of residential consumers in 2012/2013

Electricity Tariff Tiers (KWh/month)		Residential Customer Number	%	Electricity Tariff			
				2012/2013	Starting 1/7/2014		
				(LE/KWh)		(LE/KWh)	(\$ Cent/KWh)*
1	0-50	3892652	16%	0.05	0-50	0.075	0.98
2	51-200	10309453	43%	0.11	51-100	0.145	1.90
					101-200	0.16	2.10
3	201-350	6662086	28%	0.16	201-350	0.24	3.15
4	351-650	2668636	11%	0.24	351-650	0.34	4.46
5	651-1000	351270	1%	0.39	651-1000	0.60	7.86
6	>1000	151837	1%	0.48	>1000	0.74	9.70
Total		24035934	100%				

* USD = LE 7.63

The costs of SWH and electricity prices were chosen to study their impact on the viability of utilizing SWH instead of electric heaters. The following is a brief description of performed financial and economic assessment.

4.2.2.1. Payback Period:

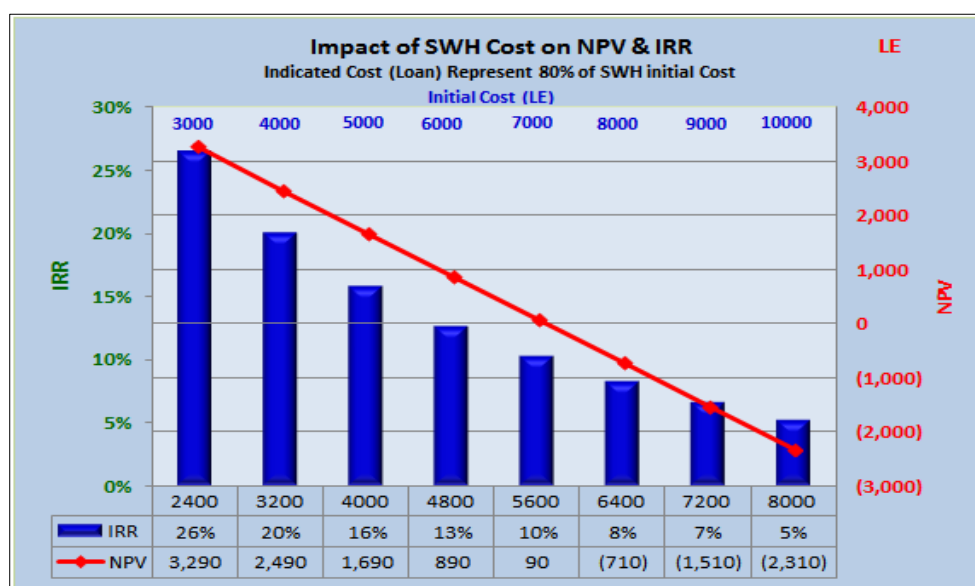
The simple payback period technique has been utilized to get quick judgment on the financial feasibility of utilizing SWH instead of electric water heater. Based on the cost of the SWH (LE 9000) and the expected annual electricity savings a payback period of total SWH investment or cost estimated at about 12 years (about 18 month).

4.2.2.2. Net Present Value and IRR:

4.2.2.2.1. Impact of SWHs Cost on its Financial and Economic Feasibility:

Both the NPV and IRR techniques have been utilized to assess the feasibility of utilizing SWHs instead of electric water heaters at different SWHs initial costs assuming 20% of that cost to be paid as a grant from the government and 80% as a loan from banks at an annual interest rate of 10% and repayment period of 5 years. Based on the assumption considered as illustrated in table (4.1) and according to the results obtained through the calculations of both the NPV and the IRR as shown from figure (4.7) SWH is found to be a viable financial alternative to replace electric water heaters at a total cost of LE 7000 with NPV of LE 90 and IRR of 10%. At lower costs of SWH it is obvious that SWH becomes more viable and competing alternative to electric water heater as higher positive values of NPV and IRR were observed or obtained. As an example NPV and IRR calculations achieved a values of LE 890 and 13% respectively at a total cost of SWH of LE 6000 and LE 1690 and 16% respectively at a total cost of SWH of LE 5000 as shown from the same figure. Controversy, SWH of total cost of more than LE 7000 is found to be infeasible and not competitive alternative to electric water heater. As an example at SWH total cost of LE 8000 NPV achieved a negative value of LE 710 and IRR of only 8%. The corresponding figures at SWH total cost of LE 9000 are estimated at -1510 and 7% respectively.

Figure (4.7) Impact of SWHs cost on NPV and IRR



4.2.2.2.2. Impact of Electricity Price on SWHs Financial and Economic Feasibility:

Electricity price has also proved to be an important financial parameter in the decision process of utilizing SWH instead of electric heaters. As shown from figure (4.8a) SWHs of a total cost of LE 9000 (of which LE 1800 as a grant or subsidy and LE 7200 as a loan from one of the banks at interest rate of 10% and repayment period of 5 years) are found to be a viable financial alternative to replace electric water heaters at electricity price of not less than LE 0.65/KWh with NPV and IRR of LE 110 and 10% respectively. With higher electricity prices, it is obvious that SWH becomes more viable and competing alternative to electric water heater as higher positive values of NPV and IRR are observed. On the other hand, at lower electricity prices of less than LE 0.65/KWh SWH becomes non viable financial alternative to electric water heater; accordingly make SWHs less attractive to consumers.

With lower interest rate on the loan of 5% SWHs (of the same cost LE 9000) are found to be a viable financial alternative to replace electric water heaters at electricity price of not less than LE 0.48/KWh with NPV and IRR of LE 47 and 5% respectively as shown from figure (4.8b). With electricity price of LE 0.64 or more SWH becomes more viable alternative with more positives values of NPV and IRR of 10% or more as shown from the same figure (4.8b).

Figure (4.8a) Impact of electricity price change on NPV and IRR

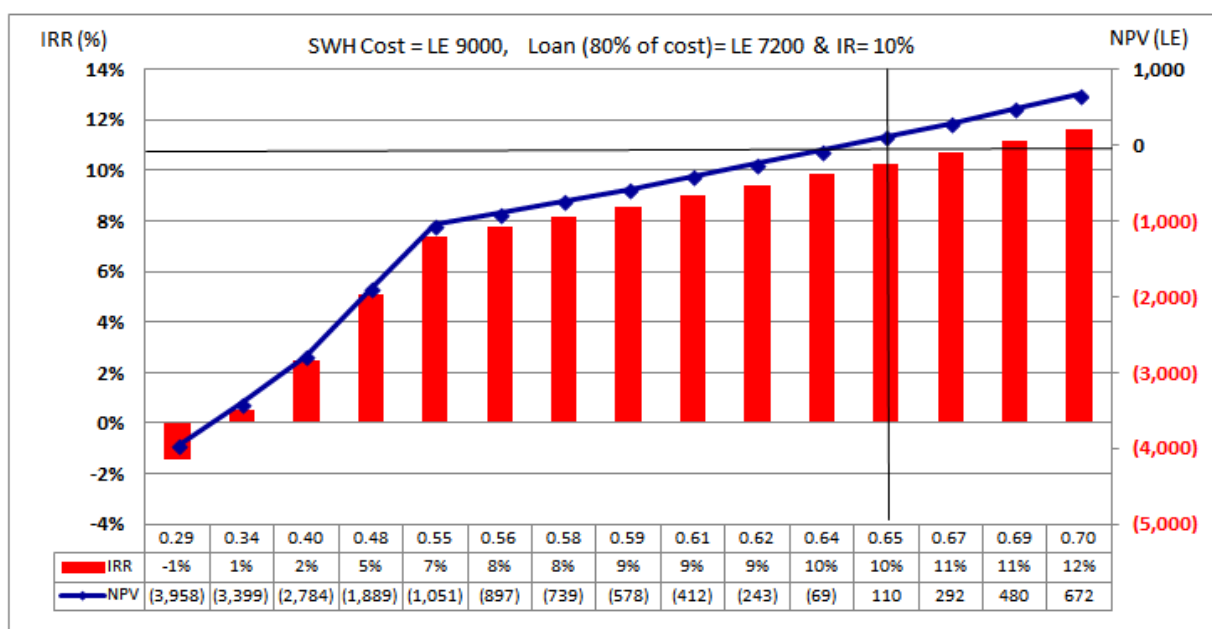
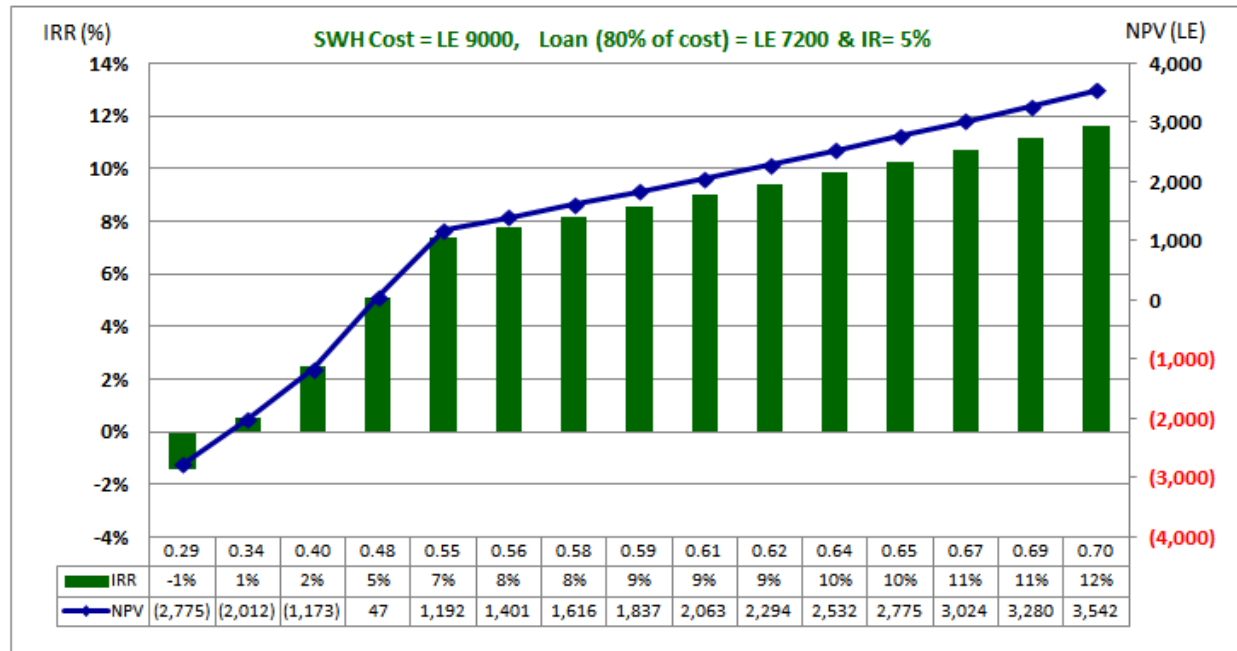


Figure (4.8b) Impact of electricity price change on NPV and IRR



4.2.2.3. NPV and IRR Sensitivity Analysis (Impact of Electricity Price Change):

Electricity Price Change and Cost of SWHs SA:

In performing the sensitivity analysis to assess the impact of changing values of some important key parameters on the financial viability and competitiveness of utilizing SWHs instead of electric water heaters, the previous mentioned basic assumptions as shown in table (4.1) have been also considered. To achieve that target the NPV, the IRR and the payback period techniques have been utilized.

The main parameters considered in the current sensitivity analysis are the cost of SWHs and the retail electricity prices of the residential sector as previously illustrated. The initial cost of SWHs for 8 scenarios have been considered for values of LE 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10000. At the same time 8 scenarios for electricity prices ranging between 0.29 - 0.70 LE/KWh have been also considered. The 16 combination of SWH cost and electricity prices scenarios were examined using the NPV and the IRR approaches or techniques. The results of the sensitivity analysis assessment are shown in table (4.3) and figure (4.9) for the NPV technique and in table (4.4) and figure (4.10) for the IRR technique.

As shown from those tables and figures, SWH total cost should be LE 4000 or less at the current prevailing electricity average price for the targeted residential consumer (customers of electricity tariff tiers of monthly consumption of 200 to 650 KWh) which is LE 0.29/KWh in order to be a feasible alternative for water heating instead of electric water heaters. For SWHs of a total cost of LE 9000 electricity price should be LE 0.65/KWh or more in order to be a viable alternative for water heating as a positive NPVs and IRR of 10% or more can be achieved.

Table (4.3) NPV results for the sensitivity analysis to assess the impact of electricity price change

SWH Cost (LE)		Electricity Price (LE/Kwh)														
Total	Loan (80%) at IR=10%	0.29	0.34	0.40	0.48	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.69	0.70
		NPV (LE)														
3000	2400	842	1,401	2,016	2,911	3,749	3,903	4,061	4,222	4,388	4,557	4,731	4,910	5,092	5,280	5,472
4000	3200	42	601	1,216	2,111	2,949	3,103	3,261	3,422	3,588	3,757	3,931	4,110	4,292	4,480	4,672
5000	4000	(758)	(199)	416	1,311	2,149	2,303	2,461	2,622	2,788	2,957	3,131	3,310	3,492	3,680	3,872
6000	4800	(1,558)	(999)	(384)	511	1,349	1,503	1,661	1,822	1,988	2,157	2,331	2,510	2,692	2,880	3,072
7000	5600	(2,358)	(1,799)	(1,184)	(289)	549	703	861	1,022	1,188	1,357	1,531	1,710	1,892	2,080	2,272
8000	6400	(3,158)	(2,599)	(1,984)	(1,089)	(251)	(97)	61	222	388	557	731	910	1,092	1,280	1,472
9000	7200	(3,958)	(3,399)	(2,784)	(1,889)	(1,051)	(897)	(739)	(578)	(412)	(243)	(69)	110	292	480	672
1000	8000	(4,758)	(4,199)	(3,584)	(2,689)	(1,851)	(1,697)	(1,539)	(1,378)	(1,212)	(1,043)	(869)	(690)	(508)	(320)	(128)

Figure (4.9) NPV results for the sensitivity analysis to assess the impact of electricity price change

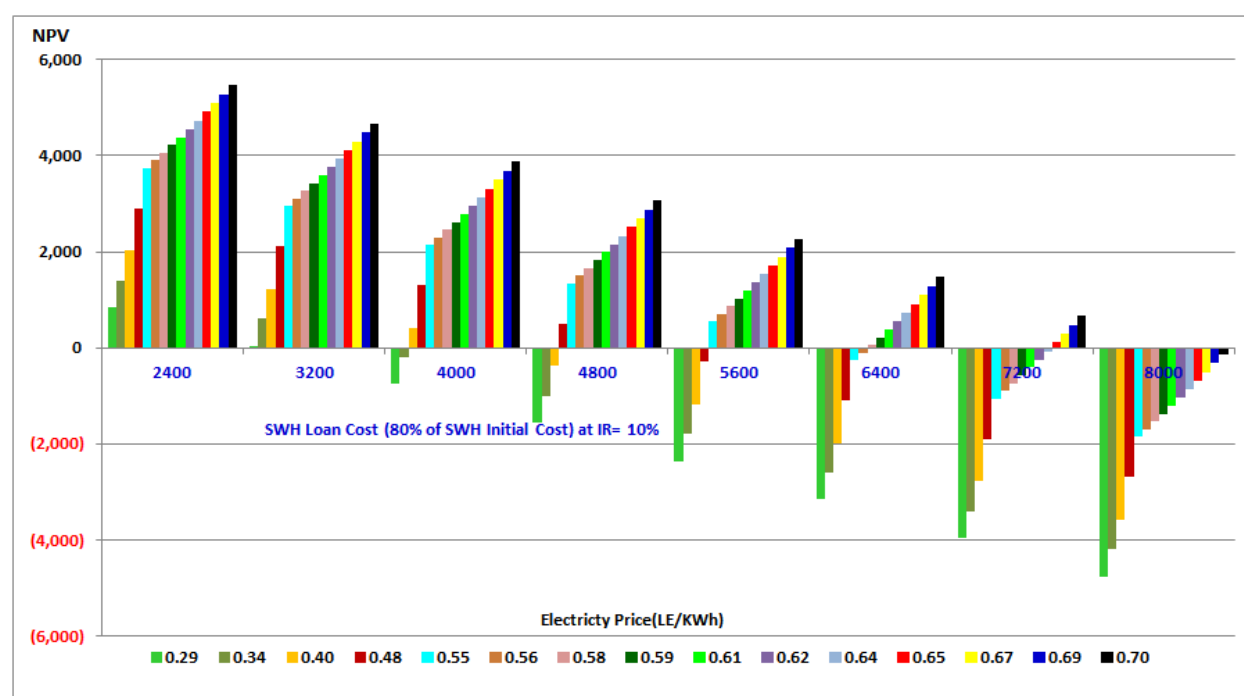
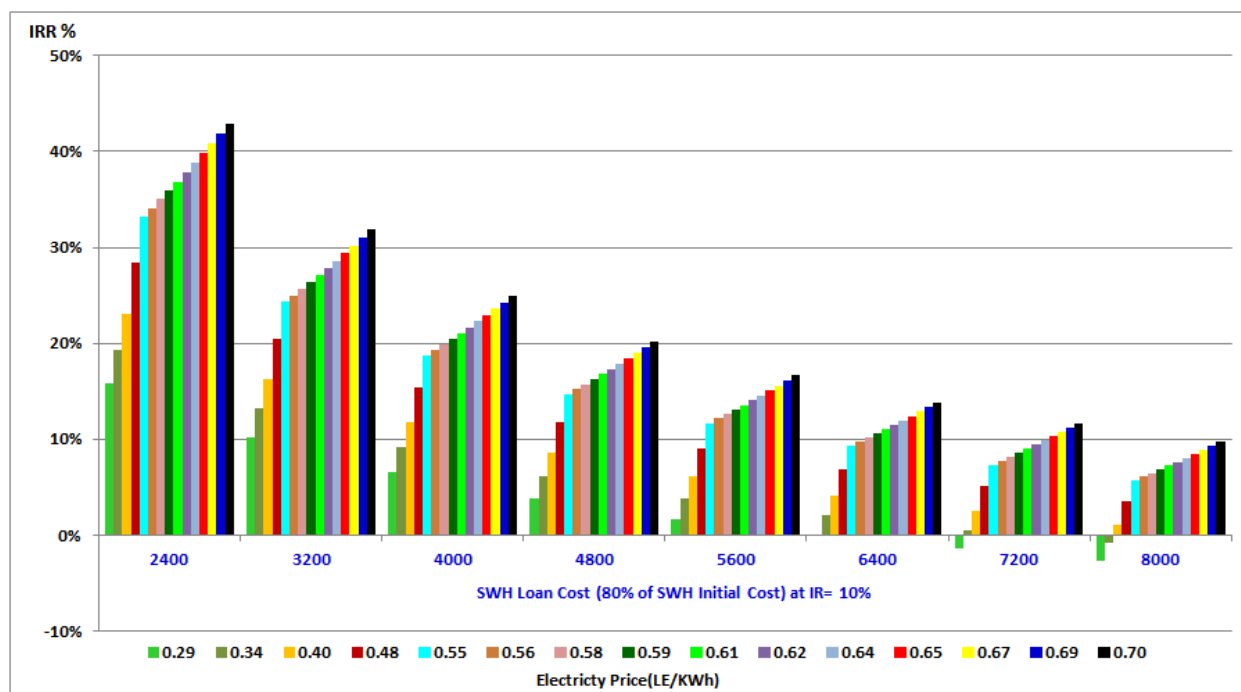


Table (4.4) IRR results for the sensitivity analysis to assess the impact of electricity price change

SWH Cost (LE)		Electricity Price (LE/Kwh)														
Total	Loan (80%) at IR=10%	0.29	0.34	0.40	0.48	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.69	0.70
		IRR %														
3000	2400	16%	19%	23%	28%	33%	34%	35%	36%	37%	38%	39%	40%	41%	42%	43%
4000	3200	10%	13%	16%	20%	24%	25%	26%	26%	27%	28%	29%	29%	30%	31%	32%
5000	4000	7%	9%	12%	15%	19%	19%	20%	20%	21%	22%	22%	23%	24%	24%	25%
6000	4800	4%	6%	9%	12%	15%	15%	16%	16%	17%	17%	18%	18%	19%	20%	20%
7000	5600	2%	4%	6%	9%	12%	12%	13%	13%	14%	14%	15%	15%	16%	16%	17%
8000	6400	0%	2%	4%	7%	9%	10%	10%	11%	11%	11%	12%	12%	13%	13%	14%
9000	7200	-1%	1%	2%	5%	7%	8%	8%	9%	9%	9%	10%	10%	11%	11%	12%
1000	8000	-3%	-1%	1%	4%	6%	6%	6%	7%	7%	8%	8%	8%	9%	9%	10%

Figure (4.10) IRR results for the sensitivity analysis to assess the impact of electricity price change



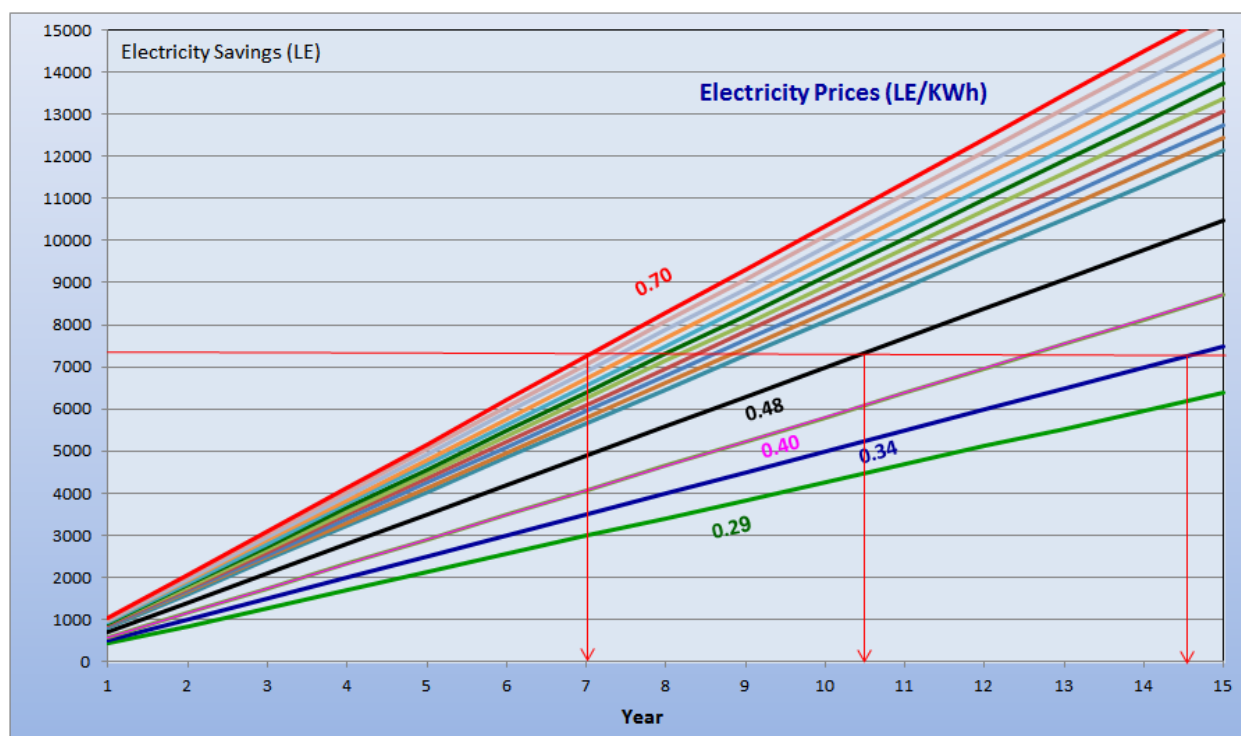
4.2.2.4. Payback Period Sensitivity Analysis:

In addition to utilizing the NPV and the IRR techniques in conducting sensitivity analysis, the payback period technique has also been utilized to assess the impact of electricity price change on the payback period of SWH investment cost.

As shown from figure (4.11) at electricity price of 0.29 LE/KWh which is considered heavily subsidized; a payback period of more than 15 years (the expected lifetime of SWH of total investment cost of LE 9000) is expected which means that SWH will not be a viable alternative for water heating at such electricity price and loan conditions (IR of 10% and repayment period of 5 years).

By increasing the price to reach 0.70 LE/KWh (non- subsidized price) an acceptable payback period of about 7 year is obtained indicating the financial feasibility of SWH of total initial cost of LE 9000 at that price level which means the importance of moving forward in implementing the current electricity price reform policy which is considered as a vital measure to promote SWH market in Egypt.

Figure (4.11) Sensitivity analysis for the payback period



4.2.2.5. Interest Rate Sensitivity Analysis:

As the **interest rate** is considered as one of the most important factors that impact the feasibility and decisions of purchasing SWHs, the previously mentioned sensitivity analysis has been performed for calculating the NPV and the IRR at an interest rate of 5% instead of 10%. As it is obvious from tables (4.5) and (4.6), higher NPV and IRR values can be obtained at an interest rate of 5% even at higher SWH initial cost. As an example, at SWH total cost of LE 9000 positive NPV can be obtained at electricity prices equal to or higher than LE 0.48/KWh as shown from the same tables. At the same cost of SWH (LE 9000), IRR values of 10% or more can be obtained at electricity prices equal to 0.64 LE/KWh or more as shown from table (4.6).

Table (4.5) NPV results for the sensitivity analysis (at IR=5%)

SWH Cost (LE)		Elect. Price (LE/Kwh)														
Total	Loan (80%) at IR=5%	0.29	0.34	0.40	0.48	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.69	0.70
		IRR %														
3000	2400	2,025	2,788	3,627	4,847	5,992	6,201	6,416	6,637	6,863	7,094	7,332	7,575	7,824	8,080	8,342
4000	3200	1,225	1,988	2,827	4,047	5,192	5,401	5,616	5,837	6,063	6,294	6,532	6,775	7,024	7,280	7,542
5000	4000	425	1,188	2,027	3,247	4,392	4,601	4,816	5,037	5,263	5,494	5,732	5,975	6,224	6,480	6,742
6000	4800	(375)	388	1,227	2,447	3,592	3,801	4,016	4,237	4,463	4,694	4,932	5,175	5,424	5,680	5,942
7000	5600	(1,175)	(412)	427	1,647	2,792	3,001	3,216	3,437	3,663	3,894	4,132	4,375	4,624	4,880	5,142
8000	6400	(1,975)	(1,212)	(373)	847	1,992	2,201	2,416	2,637	2,863	3,094	3,332	3,575	3,824	4,080	4,342
9000	7200	(2,775)	(2,012)	(1,173)	47	1,192	1,401	1,616	1,837	2,063	2,294	2,532	2,775	3,024	3,280	3,542
1000	8000	(3,575)	(2,812)	(1,973)	(753)	392	601	816	1,037	1,263	1,494	1,732	1,975	2,224	2,480	2,742

Table (4.6) IRR results for the sensitivity analysis (at IR=5%)

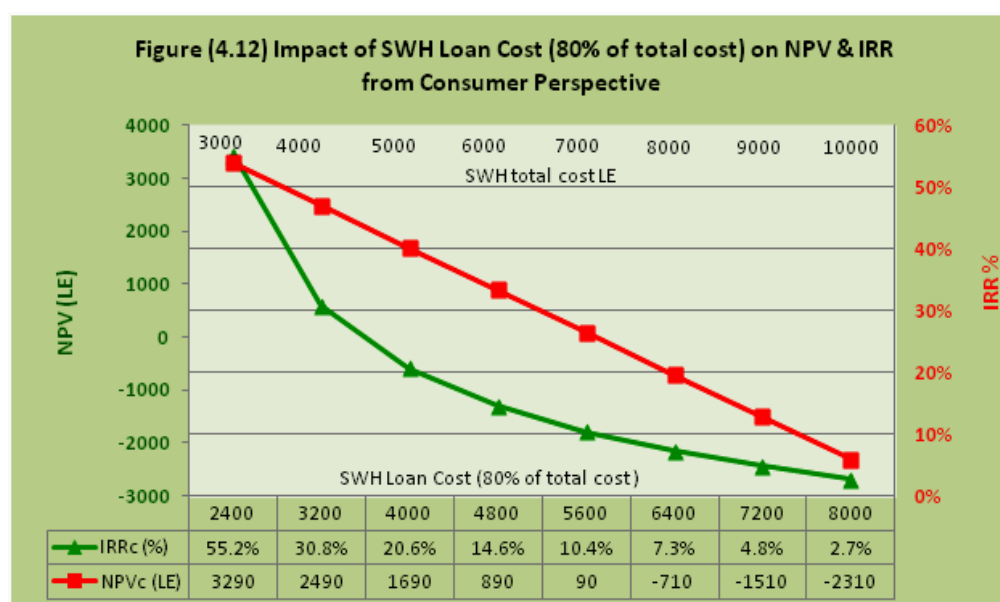
SWH Cost (LE)		Elect. Price (LE/Kwh)														
Total	Loan (80%) at IR=5%	0.29	0.34	0.40	0.48	0.55	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.69	0.70
		IRR %														
3000	2400	16%	19%	23%	28%	33%	34%	35%	36%	37%	38%	39%	40%	41%	42%	43%
4000	3200	10%	13%	16%	20%	24%	25%	26%	26%	27%	28%	29%	29%	30%	31%	32%
5000	4000	7%	9%	12%	15%	19%	19%	20%	20%	21%	22%	22%	23%	24%	24%	25%
6000	4800	4%	6%	9%	12%	15%	15%	16%	16%	17%	17%	18%	18%	19%	20%	20%
7000	5600	2%	4%	6%	9%	12%	12%	13%	13%	14%	14%	15%	15%	16%	16%	17%
8000	6400	0%	2%	4%	7%	9%	10%	10%	11%	11%	11%	12%	12%	13%	13%	14%
9000	7200	-1%	1%	2%	5%	7%	8%	8%	9%	9%	9%	10%	10%	11%	11%	12%
1000	8000	-3%	-1%	1%	4%	6%	6%	6%	7%	7%	8%	8%	8%	9%	9%	10%

4.2.2.6. Cost benefits Analysis of utilizing SWHs instead of Conventional Water heaters from the Consumer and the Government Perspectives:

A. Impact of SWH Loan Cost on NPV and IRR:

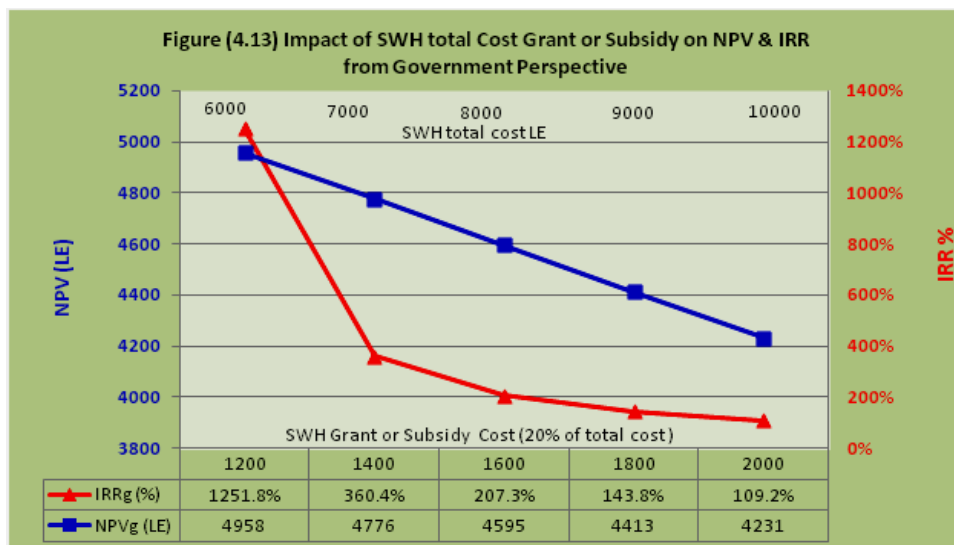
A1. From Consumer Perspective:

In addition to the previously highlighted analysis for assessing the financial and economic feasibility of utilizing SWH instead of conventional water heaters, mainly electric water heater, a cost- benefit analysis has been performed from the consumer and the Egyptian government perspectives. As shown from figure (4.12) consumer investment to purchase SWH of up to LE 5600 (representing 80% of total SWH cost which is LE 7000) is expected to be economically feasible alternative for consumer for water heating compared to electric water heating as a positive NPV of LE 90 and more than 10% as IRR are expected. For SWH total cost of more than LE 7000 investing in purchasing SWH becomes economically infeasible alternative for water heating from consumer perspective as negative NPV and lower percentage of IRR of less than 10% are expected to be obtained as shown from the same figure.



A2. From the Government Perspective:

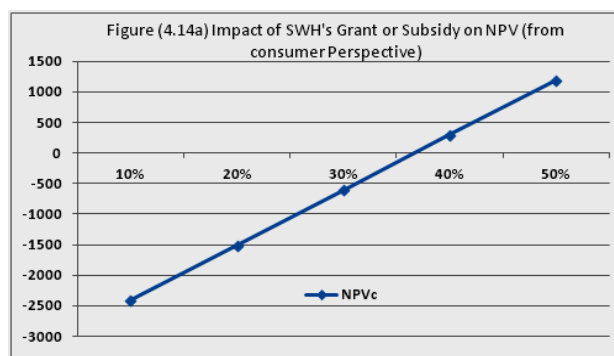
Subsidizing SWHs proves to have a positive impact at any cost of SWH as shown from figure (4.13) as positive NPVs and IRRs are expected to be achieved. In that regard, it worth to mention that the subsidy calculations are based on the real cost or price of electricity that accounted for 1.05 LE/KWH (0.14 \$/KWH).



B. Impact of SWH Grant or Subsidy Cost on NPV:

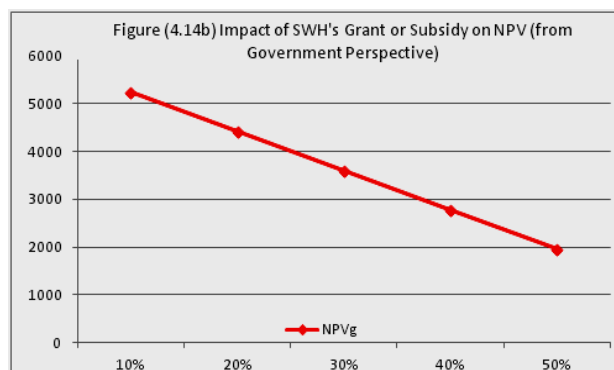
B1. From Consumer Perspective:

As shown from figure (4.14a), only at grant or subsidy of more than 40% of total SWH cost of LE 9000, positive NPVs are expected.



B2. From Government Perspective:

As shown from figure (4.14b), for grant or subsidy of 10% - 50% of total SWH cost of LE 9000, positive NPVs are expected although it is declining with the subsidy or the grant percent increase of total SWH cost.



C. Impact of SWH Grant or Subsidy Cost on IRR:

C1. From Consumer Perspective:

As shown from figure (4.15a), only at grant or subsidy of 40% or more of total SWH cost of LE 9000, higher value of IRR of 10% or more are expected.

C2. From Government Perspective:

As shown from figure (4.15b), higher values of IRR are expected for grant or subsidy of 10% - 50% of total SWH cost of LE 9000, although it is declining with the subsidy or the grant percent increase.

Impact of SWH Cost on NPV & IRR from Consumer Perspective:

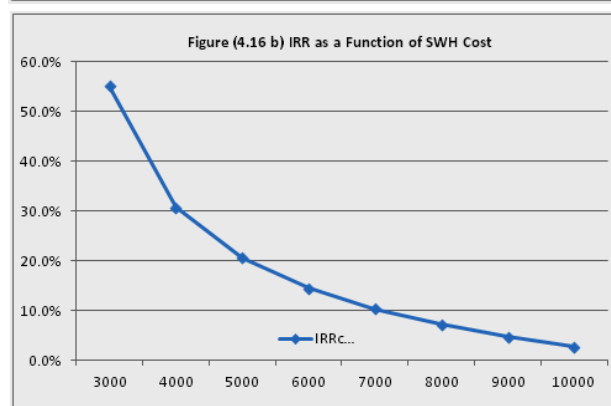
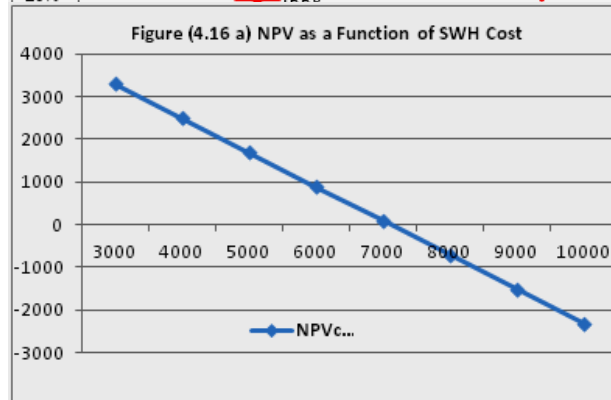
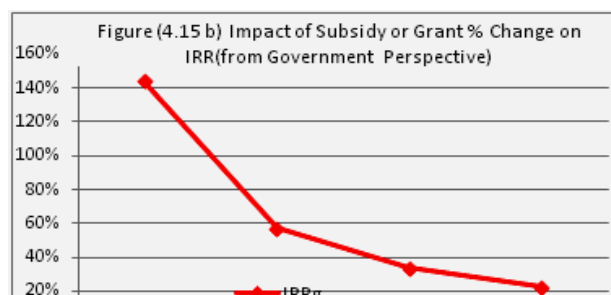
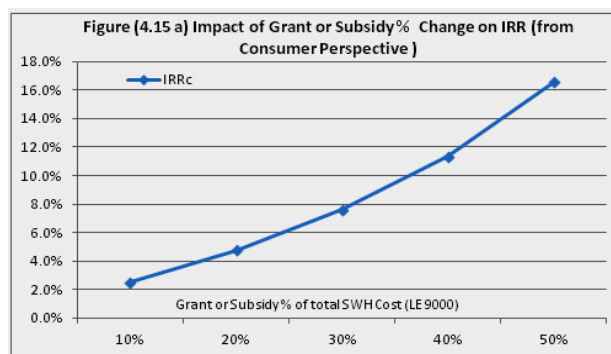
D1. Impact of SWH Cost on NPV from Consumer Perspective:

As shown from figure (4.16a), positive NPVs are expected for SWH cost of less than LE 7000.

D2. Impact of SWH Cost on IRR from Consumer Perspective:

As shown from figure (4.16b), an IRR of 10% or more is expected for SWH cost of LE 7000 or less.

As a conclusion, the previous analysis prove the expected positive financial and economic impacts to the Egyptian government through subsidizing the initial cost of SWHs in order to promote its market and make it as an attractive alternative to conventional water heaters. The Tunisian experience in that regard (avoided subsidies of conventional fuels for water heating) were among the key success factors for convincing Tunisian Government to adopt PROSOL programme in 2004 as described in details in section (2.4.3.1).



4.2.2.9. Avoided CO2 Emissions:

In addition to the economic benefits of utilizing SWHs instead of electric, LPG and natural gas water heaters, several environmental and social benefits can be also achieved that include the avoidance of large quantities of pollutants and GHGs emissions in case of utilizing carbon based or conventional fuels such as LPG and natural gas for direct water heating or fuel oil, diesel, coal and natural gas for electricity generation required for water heating. Moreover, taking into account the avoided damage costs of pollutants emissions in addition to social benefits that could be gained in case of utilizing SWH instead of conventional fuels water heaters; the financial feasibility as previously illustrated will be improved which is reflected in higher and positives values of NPV, higher values of IRR and reduced payback periods. The following section presents the expected avoided GHGs emission as a result of utilizing SWH of a capacity of 200 liters instead of electric heater.

As previously mentioned and shown from table (4.1) total electricity annual savings as a result of utilizing 200 liter capacity SWH instead of electric water heater estimated at 1470 KWH (based on 240 days of hot water consumption per year). At an average rate of fuel consumption of about 213 gram of fuel oil equivalent/KWh (207 gram of oil equivalents) according to the MERE estimates for the year 2012/2013, total annual fuel savings per one SWH estimated at 0.304 TOE/year. Based on emission factors of Carbon Dioxide CO₂ for natural gas and fuel oil as given in table (4.7), total avoided annual emissions of CO₂ estimated at 0.7 and 1 tons of CO₂ respectively. ^[3]

Table (4.7) CO₂ emission factors by fuel (Kg of Pollutant/TJ of Fuel)

Energy Form	LPG	Fuel Oil	Natural gas	TOE
CO ₂ (ton/TJ)	63.1	77.4	56.1	48.9
Heat content (TJ/1000 ton)	47.3	40.4	48.0	41.9
CO ₂ (ton/TOE)	2.6	3.2	2.3	2

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

4.2.2.10. Avoided Damage Cost:

Taking into consideration the damage cost on the national level due to pollutants emission that include as an example the cost of people illness, cost of absence from work, etc., avoided damage cost as a result of utilizing **one SWH** instead of an *electric water* heater estimated at about \$56 (about LE 427) and \$80 (about LE 610) in case of utilizing natural gas and fuel oil for generating electricity required for one electric heater per year respectively (Based on estimated damage cost of \$80/ton of CO₂e according to "ERM study on reviewing energy in Egypt", 2003). No doubt that this amount of avoided damage cost could have several positive social and economic impacts. This could be easily investigated and proved in case if that cost is incorporated as positive cash flows in the previously mentioned NPV and IRR calculations.

Moreover, needless to mention other expected positive social and economic impacts that could occur in case of success to promote and expand solar water heaters market in Egypt. Examples

in that regard include the creation of more new jobs accordingly decrease the rate of unemployment, improve the economic situation of large segment of population, allocate significant portion of forgone expenses on health care to mitigate illness (occurred as a result of pollutants emissions) and to other important activities such as education, poverty alleviation, transportation, decrease illiteracy, environment preservation and improvement, etc.

4.2.2.11. Avoided Subsidy:

As previously mentioned significant savings of conventional energy, mainly electricity, LPG and natural gas could be attained as a result of replacing conventional water heaters by SWHs; consequently reduce the associated energy subsidy. In that regard, based on an average annual consumption of hot water (of 240 days), total annual energy savings per one SWH in case of its replacement to electric, LPG and natural gas heaters estimated at 1470 KWh of electricity, 0.125 ton of LPG and 164 m³ of natural gas. Consequently, the avoided annual subsidy of electricity, LPG and natural gas per one SWH estimated at LE 1117 (about \$146), LE 349 (about \$46) and LE 300 (about \$39) respectively. The following are the assumption based on which the previous mentioned estimates have been made:

- **For electricity:** average sales price= LE 0.29/ KWh and average cost of electricity delivered to consumers= LE 1.05/ KWh (includes production plus transmission & distribution costs).
- **For LPG:** an opportunity cost of (\$ 450/ton of LPG) has been considered.
- **For natural gas:** an opportunity cost of (8 \$/million BTU) has been considered.

4.3. Technical and Social Sensitivity Analysis:

In performing the technical and social sensitivity analysis for SWHs in Egypt it is essential to take into consideration the most important issues and parameters that impact its market development and growth. While some of these parameters are related to SWHs types, characteristics and cost others are related to climate conditions, buildings design and architecture, customers' standard of living and income, habits of life, etc. The following is a brief description of some of these parameters and issues.

4.3.1. Solar Water Heaters Types or Systems:

There are three main types of solar water heaters. These are the flat-plate, the evacuated tube and the concentrating collectors.

Solar water heaters can also be classified into two main types or categories according to their water flow system. The first known as **the active systems** in which an electric pump is utilized to circulate the heat transfer carrier fluid mainly water as shown in Figure (4.12). The second type, known as **the passive system**, where no electric pump is used but rather water flow naturally based on the thermal convection phenomenon as shown in figure (4.13).

While the first type (the active system) is characterized by being more efficient but rather more expensive, the second type (the passive system) is cheaper but less efficient than the first type.

Moreover, there are several other types of solar water heaters with different designs depending on a set of characteristics that distinguish them according to the following:

- The type of collector.
- The installation position of the solar collector (on the roof top of the building or on the ground).
- The hot water tank position relative to the solar collector.
- Method of heat transfer through the use of heat exchanger (open or closed loop circuit).
- The use of photovoltaic cells for generating electricity needed for the operation of water circulation electric pump.

The following is a detailed description of different types of passive and active solar water heating systems.

Figure (4.12) Active SWHs Systems

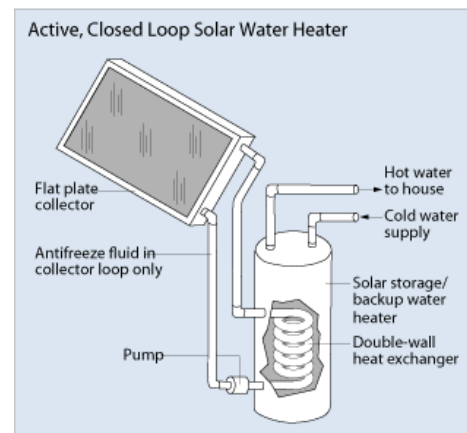
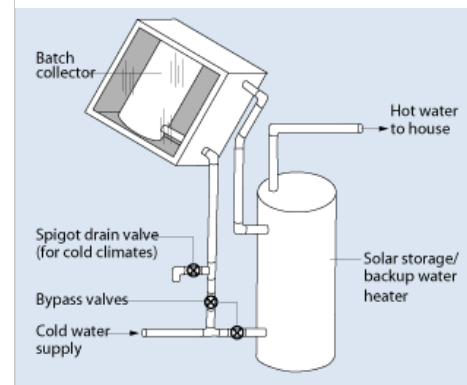


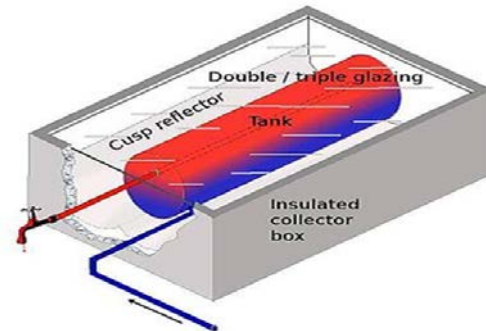
Figure (4.13) Passive SWHs Systems



I- The Passive Systems: that relay on water gravity and thermal convection phenomenon in water circulation. This type contains several designs including:

- **Integrated Collector Storage (ICS) SWH:** in that type the tank works as a water reservoir and as a solar collector at the same time as shown from figure (4.14). Although this type of solar water heaters is characterized by simplicity, efficiency and low cost, it works only at regions or areas of moderate climate.
- **Convection Heat Storage Unit (CHS) SWH:** consists in addition to the water reservoir tank of either a flat plate or evacuated tube collectors and relies on convection phenomenon for circulating hot water to the top of the water tank. This type is characterized by being more efficient than the ICS type and can be used in areas with less sun shine. Sometimes this type of solar water heaters is known as the compact system because both the solar collector and water storage tank mounted on the same chassis.

Figure (4.14) ISC SWHs Systems



Solar water heaters passive systems can also be classified into two other types or categories depending on the type of the heat transfer carrier of solar heat (either water or non-toxic and non-freezing liquids in very cold climates) which are the open and the closed circuits SWHs systems.

- **Direct (open loop) Passive system:** in this type of SWHs the circulating water between the collector and hot water tank is utilized from the main feed water line to the building. It worth to mention that this type of SWHs is not suitable for regions of cold climate.
- **Indirect (Closed loop) Passive system:** In this type of SWHs a non-toxic and non-freezing liquids are used as heat transfer carrier for transferring the suns' heat to water in the reservoir tank through heat exchanger.

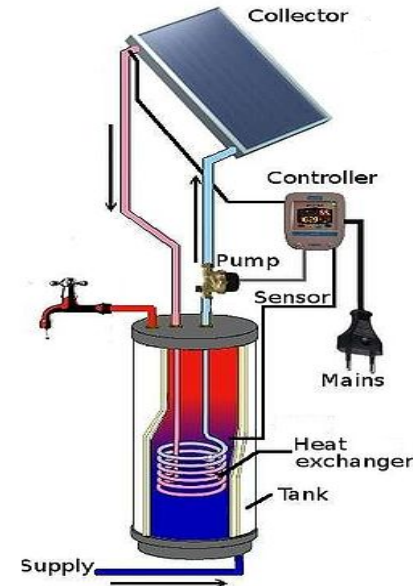
In general, all SWHs passive systems are characterized by its simplicity as no electrical or mechanical components exist. Consequently, its maintenance is simple and could be performed with less cost. However, it is less efficient than the active systems.

2-The Active Systems: This type of SWHs is relying on electric pump for water circulation between the solar collector and the hot water reservoir tank as previously mentioned. This type of solar water heaters can also be classified according to the method of heat transfer from the heat transfer carrier fluid to water into two main categories or types, the direct and the indirect active systems.

Direct Active Systems: Where water flow directly between the solar collector and the water tank using an electric water pump powered through a photovoltaic panel.

Indirect Active Systems (IAS): in that solar water heating system a liquid is used as a heat transfer carrier instead of water and heat from the sun is transferred from the liquid to water in the reservoir tank through a heat exchanger. The heat transfer liquid is circulated between the solar collector and the hot water reservoir tank using an electric pump which is powered either from normal electricity supply to the building or from photovoltaic panels as shown from figure (4.15). In that case the electric pump should be designed to operate on DC electric current.

Figure (4.15) IAS SWHs Systems



Based on average daily hot water consumption of about 50 liters and the average size of family of 4 persons, a solar water flat plate collector of surface area of 2 m² and capacity of capacity 200 liters is found to be reasonable for most of families and the residential sector units in Egypt.

4.3.2. Cost of Solar Water Heater:

The cost of existing SWHs in the Egyptian market varies depending on the type, quality and country of origin. In general, the initial cost of SWH range between LE 4000 to LE 14,000 (\$520-\$1800) depending on the type of the SWH (LE 4000 for thermo-siphon SWH with galvanized steel water tank and LE 14000 for thermo-siphon SWH with stainless steel water tank). A SWH initial cost of about \$1180 considered to be relatively high compared to the average annual income level of most of the Egyptian families which range between \$3000- \$5000 accordingly make SWHs as an unaffordable choice for most of the consumers. ^[24]

Meanwhile, the initial cost or price of SWHs is considered also relatively high compared to the price of alternative water heaters (LPG, natural gas and electricity) that range on average for about LE 700 (\$92) for LPG and natural gas water heaters and about LE 800 (\$105) for electric water heater as shown from figure (2.8), page (13) which again make SWH as an infeasible alternative to traditional water heaters for most of energy consumers in Egypt.

In case of considering central water heating systems as the case of multi-story building the initial cost of SWHs can be reduced by more than 50% per apartment as the economies of scale are significant. ^[9.]

In light of the previously mentioned analysis a solar water flat plate collector of surface area of 2 m² and capacity of capacity 200 liters is found to be reasonable for most of families in the residential sector in Egypt.

From the **social perspective**, the development and growth of solar water heaters market in Egypt is expected to have tremendous social benefits in addition to the economic and environmental benefits as previously mentioned. Among expected social benefits is the creation of long-term new job opportunities in different relevant SWHs industry aspects and activities such as engineering, manufacturing, marketing, distribution, installation,

maintenance, etc. In that regard it worth to mention that worldwide employment in the year 2011 estimated at 5 million people in renewable industry either directly (manufacturing, installation, distribution, etc.) or indirectly through as an example jobs related to the industry such as suppliers of certain items and components of SWHs as the case of copper smelting plants that supplies pipes and some other components of SWHs to the SWHs industry.

Based on a an average number of one job per 10 solar water heaters produced, the proposed national program of installing 100,000 SWHs over 5 years period (as an example) is expected to create about 10 thousand new jobs. Moreover, the development of SWHs market in Egypt will be combined by the creation of new Small and Medium Enterprises SMEs that will result in significant advancements in existing technologies and led to drastic improvements in living standards particularly for lower income classes in urban and rural areas. In addition, the creation of new jobs through the expansion of SWHs market in Egypt will contribute to relief the unemployment problem and reduce its associated negative impacts such as number of crimes and public security instability.

However, there are several social barriers that can hinder the development of SWHs market in Egypt which include as examples:

- A. High buildings shadow: the population high density, particularly in big cities like Cairo led to high buildings which in turn are preventing the possibility of installing SWHs on building roofs in many areas.
- B. Most of the customers are not aware about the benefits and advantages of SWHs utilization in addition to the proper way for its usage. In that regard, it worth to mention that some of the customers run their SWHs dry for long periods of time.
- C. Some SWHs manufacturing companies were producing low performance and low durability SWHs which led to bad reputation of this technology.

4.4. Stakeholders and Decision-Makers Consultation:

The main objective of this activity is to share different stakeholders their views and opinion on the proposed financing mechanism, particularly on the most important elements and parameters considered during its design such as the initial cost of SWHs, percentage share of loan and subsidy of total SWH cost, interest rate value, loan disbursement and repayment methods, scale of the proposed SWHs' programme to be implemented on the national level, etc. Achieving that goal is materialized through direct contacts with some SWHs market key stakeholders and players in addition to organizing a meeting at NREA building that was attended by representatives of SWHs suppliers and manufacturing companies, banks, New Communities Authority NUCA, Solar Energy Development Association (SEDA), the Egyptian Industries Federation (EIF), Energy Efficiency Unit at IDSC, and NREA. Based on the discussions, issues raised and feedback from the meeting attendees, the assumptions considered on the design phase of the proposed financing mechanism have been revisited consequently the design of the mechanism has been adopted.

4.5. Definition of the Financing Mechanism:

4.5.1. Objective:

The main objective of the proposed financing mechanism is to overcome the high upfront cost of SWHs in Egypt hence enhance the growth of its market.

Other associated objectives and targets of the proposed mechanism include:

- Addressing different economic, financial, social and environmental benefits associated to the utilization of SWHs instead of traditional water heaters (electric, LPG and natural gas) and the growth of its market to consumers, SWHs manufactures and installers in addition to the whole economy.
- Help making the installation of SWHs as a habitual design element in new buildings.
- Help achieve sustainable development in Egypt through attaining more energy security, environment protection and preservation, creating more jobs, technological development and improve living standards.
- Help overcome other barriers (technical, regulatory, social, etc.) that hinder the development and growth of SWHs market in Egypt.

In order to make these targets and objectives achievable it was necessary to consider the previously mentioned factors and elements that guarantee the success implementation of the proposed financing mechanism as presented in section 3 of this report which is reflected at the same time in its main features hereinafter and considered during its design and implementation phases.

4.5.2. Targeted DSETs, Sectors and Consumers:

Based on the previously mentioned performed analysis on energy situation and the SWHs market in Egypt; solar water heaters and the residential sector have been chosen as the targeted DSETs and sector for the proposed financing mechanism implementation respectively. Customers living in new cities and settlements such as new Cairo and 6th of October city, etc. are considered as the main targeted customers or clients.

4.5.3. Financing Mechanism Target:

The main target of the proposed financing mechanism is to install 100,000 SWHs in new buildings of the residential sector in new cities and settlements over 5 year's period which means 20,000 SWHs annually.

4.5.4. Financing budget:

Total initial budget estimated at about **LE 900 million (\$118 million)** for the first phase of implementing the national programme for SWHs market development in Egypt that extends for 5 years period. Of that finance LE720 million (about \$94 million) is in the form of loans from some of the local banks representing 80% of SWHs total investment or initial cost and LE 180 billion (about \$24 million) in the form of subsidy or grant representing 20% of SWHs total

investment or initial cost that can be allocated to the programme through available grants from international financing donors and the Green Energy Fund. Sources of the National Green Energy Fund include in addition to grants from international donors, expected conventional fuels savings and avoided subsidies phasing out, national budget, etc.

4.5.5. Main Actors and Stakeholders:

Include mainly the New and Renewable Energy Authority NREA, the Ministry of Electricity and Renewable Energy at the same time), Commercial banks, SWHs manufactures, suppliers and installers, Electricity Distribution Companies, the Egyptian Electric Utility and Consumer Protection Regulatory Agency (EYPTERA), the Ministry of Finance (MoF), the Ministry of International Cooperation (MoIC), New Urban Communities Authority (NUCA), the Ministry of Industry (MOI) and the Residential Sector Energy Consumers.

4.5.6. Main Features of the Financing Mechanism:

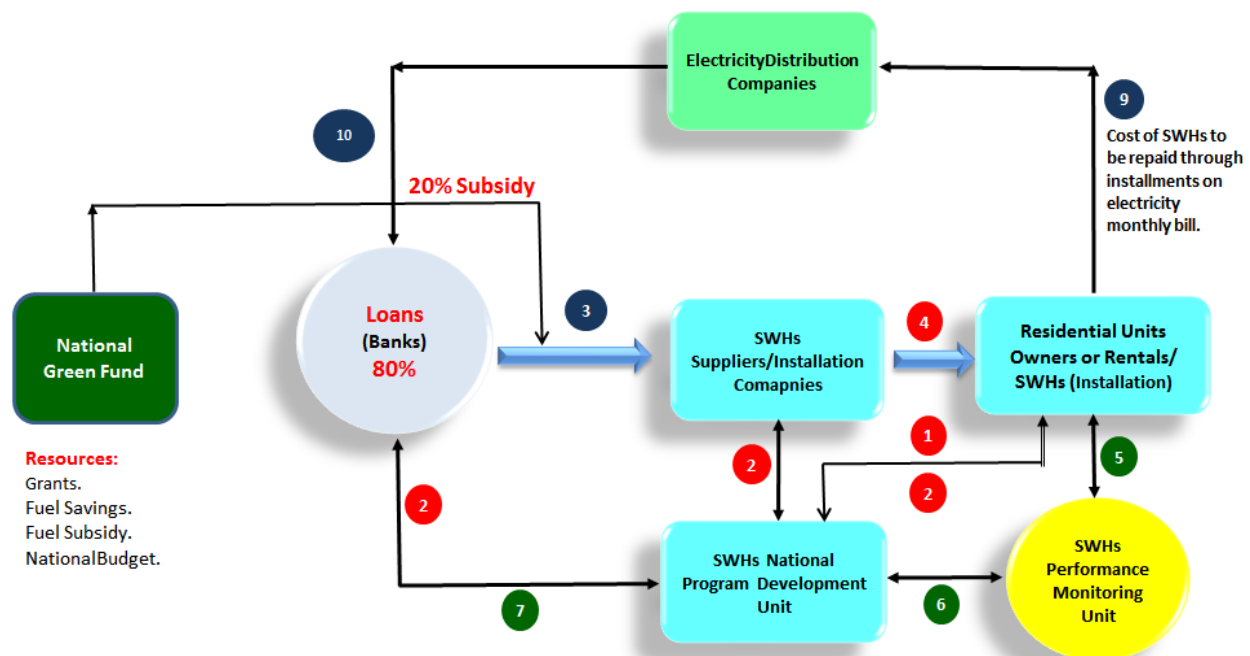
- A combination of loan and subsidy (80% of total SWHS initial cost or investment as a loan and 20% as a subsidy) with no initial down payments.
- The subsidy is made to curb the high prevailing interest rate on loans which equal on average 9%.
- Subsidy can be made through available grants from international donors, the Green Energy Fund that comprise costs of conventional fuel's savings and subsidy removal as its main financial resources in addition to the national budget.
- Loan repayments are in the form of monthly equal installments to be paid through electricity monthly bills over 5 years period (60 month).
- Loan disbursement is in line with SWH installation and start operation progress.
- The utilization of one stop approach which means minimizing the need for long procedures.
- Clear, simple, minimum and straightforward procedures.
- Minimum or no collateral requirements.
- The implementation of the financing mechanism is accompanied by performing awareness and publicity campaigns through different available tools (e.g. TV, radio, news papers, brochures, leaflets and programme web-site).
- Quality assurance in addition to better monitoring, reporting and verification (MRV) throughout the different phases of financing mechanism and the whole SWEHs national programme implementation which is considered as a vital and crucial issue.
- Clear, reliable and effective criteria for selecting eligible customers to participate in the national programme for SWHs and get access to loans needed for the purchase and installation of SWHs.

4.5.7. Overall Procedure and the Role of Main Stakeholders and Partners:

Figure (4.16) is a simplified schematic diagram of the structure of the proposed financing mechanism. As shown from that figure the procedure of the financing mechanism include the following main steps:

1. Customer (household unit's owners or rentals) willing to install solar water heaters in their units can contact the national programme development unit affiliated to NREA and fill a simple application form to join the programme. The application form contains some general information on applicant such as name, address, job, income level, etc.
2. The programme unit study the client's application and once it find that the client is eligible to participate in the programme and benefit from available finance informs him in addition to the lending bank and SWHs supply and installation company on its approval.
3. The lending bank and the national green fund to disburse the equivalent initial cost or investment of SWHs (loan plus subsidy) in addition to other disbursements through a line credit to SWHs supply and Installation Companies according to the achieved progress of SWHs installation and operation.
4. SWHs supplying companies to install SWHs according to the preset and approved specifications, norms and standards.
5. Once the SWH is commissioned and starts operation appropriately, the programme monitoring unit to inform the national programme development unit and consequently the lending bank and the Green Energy Fund which in turn transfer the last disbursement to SWHs supplying or manufacturing Company and installers.
6. Household or residential unites' owners or rentals to repay back the cost of SWHs on equal monthly installments through the electricity bills.
7. Electricity Distribution Company to transfer collected money to lending bank.

Figure (4.16) SWHs Financing Mechanism Structure



4.5.8. Role of Main Actors and Stakeholders:

New and Renewable Energy Authority NREA:

- Supervise the whole national programme activities through its affiliated programme development and monitoring units.
- Guarantee the quality and high performance of installed SWHs through assurance of their compliance to the best national and international standards and through their testing in NAREA's testing lab and facilities.
- Accept and give approvals to SWHs applicants (via its affiliated programme development unit) through simple and a well defined selection and acceptance criteria.
- Monitor SWHs cost disbursements from participating banks and the Green Energy Fund to SWHs suppliers and installation companies through its affiliated programme development and monitoring units according to the progress in SWHs installation and operation commissioning.
- Perform awareness and information dissemination campaigns for SWHs in cooperation with other partners such as SWHs manufacturing companies in order to clarify and shed light on its financial, economic, social and environmental benefits and advantages to consumers, manufacturers, installers and the whole economy.

Banks:

Provide the necessary loans (80% of total initial cost or investment) for purchasing and installation of SWHs at favorable terms and conditions (appropriate interest rates, long repayment periods of loans, minimum or no collateral requirements, simple procedures, etc.).

National Green Energy Fund Unit:

Provide the necessary subsidy (20% of total initial cost or investment) of SWHs. Disbursements of the subsidy should be in line with progress of SWHs supply, installments and operation. As previously mentioned the financial resources of the unit comprise grants from international donors, conventional fuels and subsidy savings, the national budget, etc.

SWHs Suppliers, Installation and Maintenance Companies:

- Supply SWHs at favorable prices, high quality and performance according to prevailing norms and standards.
- Guarantee the high quality and performance of SWHs operation at normal conditions and along its expected lifetime.
- Provide all necessary resources in order to perform the programme according to the preset plans and due times.
- Install SWHs according to the best available practices and standards.
- Provide the necessary maintenance to SWHs at appropriate time and according to high quality and regular schedules through after sale service agreements to be signed with SWHs owners.

Ministry of Finance:

- Allocate a portion of the national budget, conventional fuel and subsidy savings costs to the National Green Fund.
- Provide some of the necessary supportive incentives such as imported SWHs and its components custom duties exemption, sales tax reduction or exemption, etc.
- Guarantee the loans and subsidies.

Ministry of International Cooperation:

- Attract green energy funds from international donors.
- Allocate some of the donated finance to the National Green Fund.
- Help transfer international know how, knowledge and experience in the area of SWH technology to local market stakeholders.
- Attract international concerned entities to participate in the process of capacity building in different areas relevant to SWH technology.
- Help attract international investors to invest in SWHs industry in Egypt and financing relevant initiatives and programmes.

Ministry of Industry:

- Lay down the ground for national and international investors to participate in the manufacture of SWHs according to the international norms and standards.
- Set the national norms and standards for SWHs manufactures, installation and operation through its affiliated Egyptian General Authority for Standardization and Quality in cooperation with NREA, the Egyptian Electric Utility and Consumer Protection Regulatory Agency (EYPTERA), SWHs manufactures and installers in addition to other concerned entities and organizations.

4.5.9. Benefits of Implementing the Proposed Financing Mechanism for SWHs in Egypt:

The creation, development and implementation of the proposed financing mechanism in Egypt are expected to have many benefits and advantages. The advantages are mainly distributed among 3 beneficiaries, namely banks, users and the national economy.

- The **banks** will get more cash by freeing up a part of its reserves, thereby enhancing its corporate social responsibility.
- The **users** will be usually provided with a long term soft loans for the purchase of solar water heaters at appropriate interest rate that will be repaid over 5 years period. In addition, they are guaranteed to have high quality technical and financial propositions. Moreover, energy savings as a result of utilizing SWHs instead of conventional water heaters (electric, LPG and natural gas) will help the user to offset the cost of energy purchased from electricity, LPG and natural gas utilities or distribution companies. Moreover, these savings could be directed to other important expenditures such as health care, education, etc. and help raising their living standards.
- The **National Economy** on a larger scale will be benefitted from leveraging local investments. Most importantly, the implementation of the financing mechanism will help promoting

renewable energy industry in Egypt and contributes to creating sustainable jobs in addition to strong base industry.

Others detailed benefits are presented in section 3 of this report.

4.5.10. Proposed National Initiative (Programme) for the Development of SWH in the Residential Sector in Egypt:

This initiative is assumed to be implemented in the context of a national program for the development of SWHs in different sectors in Egypt including in addition to the residential sector the industrial, commercial, touristic, and governmental sectors. As previously mentioned the residential sector has been chosen due to several reasons among of which are the following:

- The escalating and high growth rate of energy demand of that sector.
- Large quantities of LPG consumed for water heating that most of which are mainly imported from abroad. This in addition to the large quantities of electricity and natural gas consumed by that sector for water heating and other activities.

Main Objective: Support the promotion of SWH technology through its implementation in residential buildings in new cities and settlements.

Partner and Stakeholders: include mainly NREA, SCE, Ministry of Finance, Ministry of Industry and Trade, Ministry of Housing and New Settlements, New Urban Communities authority NUCA, SWHs local manufacturers, suppliers and importers, SWHs installation and maintenance companies, SWHs Association (SEDA), Financing Institutions (banks, donors), Ministry of finance MoF, Clients, etc.

The main **features and characteristics of the initiative** include:

- The installation of **100 thousand unites of SWHs** in one or two of the new cities or residential settlement areas.
- The selected buildings could be either new or equipped ones with similar architecture characteristics (e.g. 5 stories or floors/2 unite per each floor).
- The SWH systems chosen are flat plate collectors stand alone at high quality (performance-sustainability- reliability and compatibility to local conditions) and with reasonable cost.
- No government control role but rather a coordinating and monitoring one. However, the commitment and support of the government is considered as a vital element to the success of the initiative.
- NREA to play the coordination and monitoring role in order to guarantee the success of the initiative or the national programme.
- The financing institutions (banks and donors) to play the major role in financing the investment cost of the programme or the initiative.
- The private sector to play the major and leading role in implementing the initiative.
- Well defined role and responsibilities of all stakeholders.
- NUCA to be responsible for the identification and selection of the targeted regions and buildings of the residential sector.

- The proposed financing mechanism to be utilized is designed taking into account the following main objectives and features: to be attractive for all stakeholders, subsidized loans (from National Green Fund) with 5 years payable period, simple procedures, minimum financial burden on clients and beneficiaries, SWHs are exempted from any taxes such as custom duties and sales tax, minimum collateral requirements, etc.
- Significant incentives for all stakeholders.
- Capacity building, awareness campaigns, powerful institutional arrangements and institutions, integrity and strong cooperation and collaboration between different stakeholders as it considered as vital drivers for the sustainability and the success of the initiative.
- Overcoming different barriers (technical, financial, economic, social, legal, institutional, etc.) that could hinder the implementation of the initiative should be considered as one of the main concerns in the design of the initiative, its approach and procedures for implementations, measures and policies to be taken in order to guarantee its success and sustainability.

Main Assumptions:

- Number of SWHs to be installed: 100 thousands over 5 year's period (20,000 annually).
- Number of buildings to be equipped with SWHs: 10000 (5 floors/2 flats).
- Amount of hot water consumed per person = 50 liters/day (200 liter/family).
- SWHs Type: flat plate collector.
- Annual electricity savings = about 1470 KWh/one SWH/year and 147 Million KWh for 100,000 SWHs (based on 6.125 KWh/day as electricity consumption for heating water needed for one family and based on 240 days/year as an average for hot water use).

Programme Budget and Expected Savings and Subsidies:

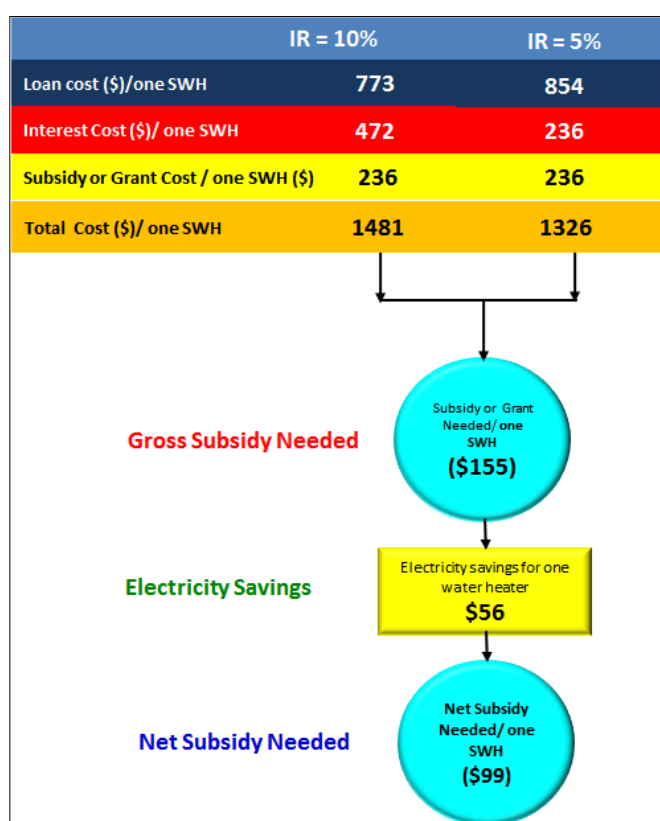
Based on an average initial cost of \$1180 per one SWH (LE 9000); total initial cost of the programme for the installation of 100 thousand SWHs estimated at \$118 million. In case of assuming 80% of the total cost to be provided through a loan from one of the commercial banks at an annual interest rate on loan of 10% and 20% as a subsidy or grant from the government through the National Green Energy Fund (NGEF), total programme cost estimated at \$148 million of which \$77 million as the loan principal and \$47 million as the loan interest cost over 5 years period in addition to about \$24 million as the grant or subsidy. The corresponding costs for one SWH are \$1481, \$773, 472, and \$236 respectively.

In case of an interest rate of 5%, total programme cost estimated at \$133 million of which \$85 million as the loan principal and \$24 million as the loan interest cost over 5 years period in addition to \$24 million as the grant. The corresponding costs for one SWH are \$1326, \$854, \$236 and \$236 respectively. Therefore, the subsidy needed to reduce the interest rate on SWH loan from 10% to 5% estimated at \$155 per one SWH. Accordingly, in order to reduce the cost of the loan to make it attractive to SWHs' customers a total gross subsidy of \$155 per one SWH or \$15.5 million for the 100 thousand SWHs over 5 year period is needed, mainly to cover the cost gap between the loan cost at 10% and 5% interest rates as shown from figure (4.16). In

case of taking into consideration the cost of electricity savings as a result of utilizing solar water heating instead of electricity water heater (which equal \$56 per one SWH over 5 years) it is obvious that the net subsidy needed to reduce the loan interest rate from 10% to 5% is reduced to about \$99 per one SWH over 5 years as shown from figure (4.16).

In general, net energy saving as a result of installing 100 thousand SWHs estimated at about 30 thousand TOE per year resulting in the avoidance of emitting 70 thousand tons of CO₂ annually. Meanwhile, avoided damage cost of CO₂ emissions estimated at \$5.6 million annually (about LE 43 million). Moreover, about 10000 direct and indirect job opportunities are expected to be generated as a result of programme implementation.

Figure (4.16) Cost breakdown of one SWH and subsidy needed to reduce Interest rate on loan for its purchasing from 10% to 5%.



Expected Benefits from Implementing the Programme of Installing 100 thousand SWH:

Energy savings (Thousand TOE /year):	30
Avoided CO ₂ emission (thousand ton CO ₂ /year):	70
Avoided damage cost (million \$/year):	5.6
Avoided damage cost (million LE/year):	43
Expected number of Jobs to be created (job):	10000

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Appendix (1)

Technical Proposal for Performing WP6.1 (b-c) of MED DESIRE Project

Innovative Financing Mechanism to Strengthen the Promotion of Distributed Solar Energy Technology in Egypt

Subject: Call AM0600 – 04/07/2014

1. Background:

Egypt is facing great challenges for the development of energy sector in order to fulfill the escalating energy demand that reached 5% for oil, more than 10% for natural gas and more than 7% for electricity. With limited depleted oil and natural gas resources which constitute 95% of total primary energy supply, it is imperative that Egypt's energy strategy and policies should be pivoted and directed towards diversification of energy supply with solar energy as one of the main available abundant energy resources that could play an important role to achieve that goal.

The current proposal presents different tasks and activities that will be performed under work package 6.1 (b-c) of MED DESIRE project which aims at transferring best practices concerning the adoption of solar energy technologies at Mediterranean Sea Basin level.

2. Main objective of the mission and activities to be performed:

The main objective of consultant mission include identification and design the most suitable incentive tool to strengthen the promotion of distributed solar technologies in Egypt and to draft a proposal to integrate the identified incentive tool into the existing regulatory framework, in consultation with local relevant authorities and stakeholders.

The incentive tool will be tailored for public and/or private implementation, according to the possibilities offered by the regulatory framework of Egypt and to the strategic direction provided by MED DESIRE WP6 Coordinator and New and Renewable Energy Authority NAREA task referent.

The main activities and tasks to be carried out by the consultant mainly comprise the following:

- 1) Elaboration of country specific options of an innovative financial mechanism for distributed solar energy technologies with a specific focus, resulting from a feasibility study for the identification of the most suitable solar energy technologies / sectors / targets to be promoted in Egypt according to the regulatory framework of the country and to the strategic direction provided by MED DESIRE project referent and local partners.
- 2) Formulation of implementation modalities in collaboration with local agencies, utilities and financial institutions (local banks, IFIs, etc.).

3. Methodology:

In order to accomplish the required tasks, the consultant:

- Will coordinate with other experts working on MED DESIRE project and contributing to the specific tasks, both for the development of the studies and for the scheduling of missions (data collection, roundtables, decision makers and stakeholders consultation, etc.), based on the instructions provided by WP6 Coordinator.
- Will coordinate with the experts working on the same task in Tunisia and Lebanon, in order to define methodologies consistent at “regional level”, as much as possible, as well as the results and findings obtained under WP4 and WP5 and WP6.

4. Work Plan:

The specific tasks of the assignment will include:

Project kickoff and preparatory activities:

The main objective of that preparatory phase of the project is to have a constructive dialogue among different partners, stakeholders and policy makers in coordination with WP6 coordinator in order to get preliminary common consensus on:

- Proposed scope and methodology of performing WP 6.1 (b-c),
- Identification of the most appropriate and targeted solar energy technologies to be considered.
- Identification of the most appropriate and targeted sectors to be considered for the incubation and development of the proposed solar energy technologies.
- Assessment of the energy context and status of solar energy market in Egypt.

The assessment of the previous mentioned issues will be conducted in coordination and collaboration with project WP6 coordinator, NAREA project management team and concerned managers and in light of the prevailing local energy context, committed energy policies and strategies, announced solar energy plans and expected future energy mix.

The previously mentioned kickoff and preparatory phase milestones are expected to be achieved through:

- Literatures review on most of the previously mentioned issues in addition to assessment of some solar energy technologies financial mechanisms implemented in Egypt and other countries such as Tunisia, Morocco and Jordan.
- Interviews and meetings with key managers and concerned staff within NAREA, local banks and financing institutions, solar energy technologies suppliers and clients, etc.
- Questionnaire to be sent to concerned Stakeholders for identifying the most appropriate financing mechanism for widespread of solar energy technology.

Task 6.1b: Elaboration of country specific options of an innovative financial mechanism for distributed solar energy technologies:

In order to achieve that goal, the proposed activities to be performed under that task could be categorized to three main sub tasks or activities as follows:

Sub task 6.1b.1. Assessment of the current solar energy market:

- Distributed solar energy technologies market analysis.
- Targets and strategies analysis.
- Assessment of existing mechanisms.

Sub task 6.1b.2. Potential of solar energy market development:

- Analysis of financial and economic profitability.
- Identification of the most suitable beneficiary sector to be targeted.
- Identification of public administrations, local agencies, utilities, market players and financial institution to be involved in each MPC.

Sub task 6.1b.3. Identification of the most appropriate financing mechanism:

- Definition of methodology and criteria for model selection.
- Economic Assessment.
- Technical and social sensitivity analysis.
- Stakeholders and decision-makers consultation.
- Definition of the financial mechanism.

Task 6.1c: Formulation of implementation modalities in collaboration with local agencies, utilities and financial institutions (local banks, IFIs):

The main objective of that task will be to identify the appropriate procedures needed to facilitate the implementation of the proposed financial mechanism efficiently and effectively. That will comprise identification of different steps, tasks and activities to be performed in light of the framework of the proposed financial mechanism, partners and stakeholders roles and responsibility; etc. The proposed activities to be performed under that task could be categorized into two main sub activities as follows:

Sub task 6.1c.1. Manual of procedures elaboration:

1. Development of a manual of procedures including the steps, tasks, roles for each partner.
2. Definition of relevant partners roles and responsibility:
 - Identify the partners to be involved in the financial transactions (Local agencies, Banks, Providers, Installers, etc.) and the articulations among them in the use of the financial resources.
 - Suggest an effective distribution of costs among the main partners in the system and define the source of funding.
 - Identification of the other beneficiaries to be involved in the system to be implemented such as Consultants, Controlling offices, etc.

Sub task 6.1c.2. Validation process:

- Organization of validation process through round tables and meetings to be conducted with various parties, including government institutions in order to validate the proposal.

Table (1) MED DESIRE Project WP 6.1(b-c) Timeline (total duration of 10.5 month*)

Tasks	Months	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
Sub task 6.1b.1. Assessment of the current solar energy market: - Distributed solar energy technologies market analysis. - Targets and strategies analysis. - Assessment of existing mechanisms. - Recommendation and proposal for a distributed solar energy technologies promotion.												
Sub task 6.1b.2. Potential of solar energy market development: - Analysis of financial and economic profitability. - Identification of the most suitable beneficiary sector to be targeted. - Identification of public administrations, local agencies, utilities, market players and financial institution to be involved.												
Sub task 6.1b.3. Identification of the most appropriate financing mechanism: - Definition of methodology and criteria for model selection. - Economic Assessment. - Technical and social sensitivity analysis. - Stakeholders and decision-makers consultation. - Definition of the financial mechanism.												
Draft "Design" Report.												
Final "Design" Report.												
Sub task 6.1c.1. Manual of procedures elaboration: - Development of a manual of procedures including the steps, tasks, roles for each partner. - Definition of relevant partners roles and responsibility: - Identify the partners to be involved in the financial transactions (Local agencies, Banks, Providers, Installers, etc.) and the articulations among them in the use of the financial resources. - Suggest an effective distribution of costs among the main partners in the system and define the source of funding. - Identification of other beneficiaries whom will be involved in the system to be implemented such as Consultants, Controlling offices, etc.												
Sub task 6.1c.2. Validation process: Organization of validation process through round tables and meetings to be conducted with various parties, including government institutions in order to validate the proposal.												
Validated process.												
Proposal for decision makers.												
Final document & report.												

* Starting December 2015 and ending before September 15th, 2015.

5. Deliverables and Reporting:

As a result of the tasks 6.1b and 6.1c, the expert(s) shall produce the following reports:

Report on “**Design**” containing:

- Identification of the most suitable solar energy technology to be promoted in Egypt.
- Identification of the most suitable beneficiary sector to be targeted.
- Identification of the most suitable financial mechanisms in innovative distributed solar energy technologies (focus on the identified specific sector) to be potentially adopted in the regulatory framework.
- Detailed design of the incentive tool.

Report on “**Implementation**” containing:

Proposal to integrate the identified incentive tool into the existing regulatory framework to strengthen the promotion of solar technologies integration in the identified beneficiary target group, describing:

- Operational steps.
- Managing body.
- Definition of relevant partners and their roles and responsibility.
- Role and responsibilities of other relevant partners.
- Modality of funds provision to the end-user.
- Main documents requested and detailed rules of treatment of files
- Monitoring tool.
- Comprehensive flow-chart of the mechanism.

In addition, the expert(s) shall produce:

- A proposal for decision makers drafted in an appropriate form to directly integrate the identified incentive tool into the existing regulatory framework on solar energy.
- A report describing meetings and round tables held and their key conclusions, including consultations with the local authorities and financial institutions.

The timetable for deliverables is as follows:

Task 6.1B - Draft “Design”	February 2015	1 deliverable	40 m-d
Task 6.1B - Report “Design”	April 2015	1 deliverable	
Task 6.1C - Draft “Implementation”	August 2015	1 deliverable	50 m-d
Task 6.1C – Report “Implementation” 1. Proposal for decision makers 2. Report on stakeholder and decision makers consultation	October 2015	3 deliverables	

Appendix (2)



Innovative Financing Mechanism for the Promotion of Distributed Solar Energy

Technology in Egypt

Questionnaire for identifying the most appropriate financing mechanism for widespread of solar energy technology

1. General Information on contact person responsible for questionnaire data collection:

Name:

Job Title:

Organization or Entity Name:

Tele. (Office):

(Mobile):

Email:

2. Status of Solar Energy Market in Egypt:

2.1. What are the major barriers and challenges facing solar energy market development in Egypt?

2.2. To what extent/degree financing of solar energy projects is considered as a major barrier or challenge?

High: ☐

Medium: ☐

Low: ☐

3. Financing Mechanisms Utilized or Implemented for the promotion of solar energy technology distribution?

3.1. Design of the Financing Mechanisms :

Name of the financing mechanism:

Objective:

Targeted consumers/sectors - (e.g. residential, commercial, industry, SMEs, etc.):

Targeted Technology - (PV, SWH, CSP, etc.):

Barriers that the mechanism attempt to address or overcome (e.g. the high upfront cost):

Description of the financing mechanism:

The criteria that the beneficiaries of the mechanism should meet in order to gain access to the necessary finance (please describe):

How do you evaluate the implemented criteria?

Excellent: ☐ Very Good: ☐ Good: ☐ Fair: ☐

Why? - (please mention reasons for your evaluation):

The application process (please describe the various steps /procedure that the beneficiaries have to go through in order to benefit from the mechanism in financing their solar energy projects):

Are there any available guidelines or procedures for the application process or the financing mechanism?

Yes: ☐ No: ☐ If yes:

Is it published in brochures or a website or both? Brochures: ☐ Website: ☐

Is it clear and to what extent? Yes: ☐ No: ☐

Very clear ☐ to some extent: ☐ Not clear: ☐

How do you evaluate the application process?

Excellent: ☐ Very Good: ☐ Good: ☐ Fair: ☐

Why? - (please mention reasons for your evaluation):

What is the feedback of the customers (the beneficiaries) on the application process? (Please describe if any):

Is the mechanism is supported or backed by other financial institutions (e.g. the central bank, donors, etc.)? And if so what the type of support and how it is provided?

What are the targets that the mechanism must meet? E.g. number of units /customers financed, total amount of finance, etc.

Average size of the solar system to be financed:

Average size of the finance:

3.2. Implementation of the Financing Mechanism:

How long the application process takes until approval on finance realized?

..... Weeks months

Are applications handles in house (internally) or does a third party deals with them?

How the finance term determined?

How are the funds disbursed and when? As installments ☐ as a lump sum ☐

At the beginning/start of the project ☐ at the end of the project ☐ related to the progress/stages of the project ☐ others ☐ (please mention)

What are the most important barriers that the mechanism is facing? (Please specify)

Technical barriers:

- a)
- b)
- c)

Financial barriers:

- a)
- b)
- c)

Legal barriers:

- a)
- b)
- c)

Institutional barriers:

- a)
- b)
- c)

Awareness barriers:

- a)
- b)
- c)

What are the risks attributed to finance providing (if any)?

How many clients / customers benefited from the finance mechanism? Which sectors they are belonging or related to (residential, commercial, industry, SMEs, etc.)?

To what extent the supported implied policies, regulations, etc. affected the mechanism utilization or demand on it?

Net-metering: Large: ☐ Moderate: ☐ fair: ☐

Feed in Tariff: Large: ☐ Moderate: ☐ fair: ☐

Others (please specify): Large: ☐ Moderate: ☐ fair: ☐

Do the implemented policies need any modifications or adjustments? Yes ☐ No: ☐

If yeas what are the proposed modifications or adjustments? (Please mention)

What is your suggestions for improving and strengthen the mechanism and accordingly enable greater uptake of solar energy systems and market development?

Appendix (3)

MED DESIRE Project – WP.61b (Innovative Financing Mechanism for

Distributed Solar Energy Technologies DSETs)

Meeting with Concerned Experts

Date: Thursday January 15th, 2015

Time: 3:00 PM – 5:00 PM

Location: Maadi

Participants: Eng. Emad Hassen, Energy Advisor (Ministry of Tourism), and Dr. Korkor

Main Issues and Topics Discussed:

- Dr. Hamed presented to Dr. Emad Hassen the main objectives, structure and components of MED DESIRE project.
- Dr. Emad Hassen highlighted the following main issues:
 - The major barriers and challenges facing solar energy market development in Egypt are the cost, quality and follow-up of solar energy technologies or systems projects.
 - The proposed financing mechanisms to be utilized or implemented in the tourism sector for the promotion of solar energy technology distribution is mainly a co-investment mechanism for hotels with the main objective is to facilitate fuel switching from Diesel or electricity to solar energy.
 - The targeted distributed solar energy technologies are PV and solar water heating systems with hotels as the main target sector.
 - The main barriers that the mechanism attempt to address or overcome are the first or upfront cost investment, compliance with nationally-approved standards and imposing on-going maintenance.
 - The Government of Egypt (GOE) will implement several pilot projects as proof-of-concept to jointly invest with existing hotels throughout Egypt in the replacement of traditional water heating systems with solar technology and in the development of PV systems to provide part of the hotel electric energy use. These co-investments by the GOE will be repaid by the hotel based on a fixed charge of one U.S (dollar per room/night occupied).
 - The criteria that the beneficiaries of the mechanism should meet in order to gain access to the necessary finance include the following: providing co-investment, show reasonable occupancy levels in previous years, committing to repayment to the GOE and procuring according to provided standards
 - The main targets that the mechanism must meet are 100,000 hotel rooms in 5 years period.
 - The average size of the solar system to be financed is 150 liters SWH's and 0.50 to 1 megawatt PV plants.

Date: Sunday January 25th, 2015

Time: 10:00 AM – 1:00 PM

Location: Sonesta Hotel

Participants: Dr. Korkor and Mr. Franco

Main Issues and Topics Discussed:

- Mr. Franco highlighted MED DESIRE project objective, structure and main components.
- Dr. Hamed made two presentations, the first on the technical proposal for performing Work Packages WP 6.1 (b-c) and the second on the main issues that should be considered on the design of the proposed distributed Solar Energy technologies innovative financial mechanism. Other issues covered include:
 - Experience of other countries such as Tunisia, Lebanon in implementing innovative financing mechanisms for the deployment of distributed solar energy technologies,
 - Similar implemented mechanisms in Egypt (e.g. EgySol).
 - Financing mechanisms for the deployment and development of other technologies market in Egypt such as the utilization of Compressed Natural Gas (CNG) as a fuel for vehicles and Old Vehicles Scrapping and Recycling Program (OVSRP), etc.
 - Targeted DSETs, sectors and proposed innovative financial mechanism.

After discussion both Dr. Korkor and Mr. Franco have a common consensus that it is important to have a generic financial mechanism that focus on Solar Water Heaters (SWHs) applications in residential sector. Meanwhile, the proposed mechanism should be smart and flexible enough to be modified and to be applicable for other DSETs such as PV systems and other sectors (e.g. commercial, hotels, etc.).

Date: Monday January 26th, 2015

Time: 9:00 AM – 11:30 AM

Location: New and Renewable Energy Authority (NREA)

Participants: Dr. Korkor, Mr. Franco, and Eng. R. Abd El Kader

Main Issues and Topics Discussed:

- Dr. Hamed made two presentations, the first on technical proposal for performing Work Packages WP 6.1 (b-c) and the second on the main issues that should be considered on the design of the proposed distributed Solar Energy technologies innovative financial mechanism. Other issues covered include:
 - Experience of other countries such as Tunisia, Lebanon in implementing innovative financing mechanisms for the deployment of distributed solar energy technologies,
 - Similar implemented mechanisms in Egypt (EgySol).

- Financing mechanisms for the deployment and development of other technologies market in Egypt such as the utilization of Compressed Natural Gas (CNG) as a fuel for vehicles and Old Vehicles Scrapping and Recycling Program (OVSRP), etc.

After discussion Dr. Korkor, Mr. Franco and Eng. R. AbdEl Kader concluded that it is important to have a generic financial mechanism that focus on Solar Water Heaters (SWHs) applications in residential sector. Meanwhile, the proposed mechanism should be smart and flexible enough to be modified and to be applicable for other DSETs such as PV systems and other sectors (e.g. commercial, hotels, etc.).

Date: Monday January 26th, 2015

Time: 12:00 PM – 12:30 PM

Location: New and Renewable Energy Authority (NREA)

Participants: Eng. Omnya Sabry (NREA Vice Chairman), Dr. Korkor, Mr. Franco, and Eng. R. Abd El Kader

Main Issues and Topics Discussed:

- At the beginning, Eng. Omnya sabry welcomed both Mr. Franco and Dr. Korkor.
- Mr. Franco informed Eng. Omnya about the status of the project progress.
- Dr. Korkor shade light on the proposed methodology on performing WP 6.1b and that due to time constrain and efforts made to gather information and main stakeholders opinion and views on different issues relevant to DSETs market in Egypt (e.g. main drivers and barriers for development, implemented financing mechanisms, etc.) it becomes obvious and to focus on the design phase of the financing mechanism and to organize a meeting or a workshop for the main concerned stakeholders (banks, DSETs suppliers and installers, etc.) after finishing that phase in order to present the mechanism and get theirs feedback and comments and consider it on preparing the final mechanism.
- Also, both Dr. Korkor and Franco informed Eng. Omnya Sabry about their agreement that it is important to have a generic financial mechanism that focus on Solar Water Heaters (SWHs) applications in residential sector. Meanwhile, the proposed mechanism should be smart and flexible enough to be modified and to be applicable for other DSETs such as PV systems and other sectors (e.g. commercial, hotels, etc.) and she agreed.

Date: Monday January 26th, 2015

Time: 1:00 PM – 2:30 PM

Location: Ministry of Electricity and Renewable Energy Authority (MERE)

Participants: DR. Anhar Hegazy (Director of Energy Efficiency Unit, Cabinet), Dr. Korkor, Mr. Franco, and Eng. R. Abd El Kader.

Main Issues and Topics Discussed:

- Mr. Franco made a short introduction to MED DESIRE project.
- Dr. Hamed highlighted the main tasks to be performed under WP6.1b and reviewed Egypt's experience regarding the design and implementation of solar energy and other technologies financing mechanisms such as the smart card for encouraging vehicles owners to convert their vehicles to use CNG in addition to gasoline and diesel fuels, the OVSR project in addition to successful implemented financing mechanisms in other countries such as Tunisia and Lebanon.
- Dr. Hegazy highlighted the following main issues and conclusions based on her wide experience and knowledge of renewable energy technologies:
 - Not all technologies could fit specific scale of finance.
 - It is important to look for different technology/application options or alternatives.
 - There is a need to have specific criteria for assessing the appropriate DSET for specific application or sector.
 - Solar Water Heaters (SWHs) could be implemented in buildings, tourism and industrial sectors with priority to be given for governmental building in the building sector.
 - In all sectors, it is important to differentiate between governmental or public and private projects.
 - Cost of solar technologies to be added to the cost of new buildings or household units.
 - Importance of political support to guarantee the success of the deployment of DSETs and the associated financing mechanisms.
 - The recently implemented Feed-in-Tariff mechanism is very attractive for PV systems less than 500 KW as the sale price of kWh produced from such systems is much higher than the cost of production of one kWh from conventional electricity production technologies.
 - Important to create a fund and the client should pay the cost of the DSETs to the fund. Meanwhile, and in order to guarantee the sustainability of fund it is important to put it in a bank to get revenues.
 - Importance to have small interest rates on loans from banks.
 - Awareness could play an important and vital role in the success of financing mechanism implementation. Sometimes, it could be important than finance.
 - Small scale PV systems (either connected or not connected to the national electricity grid) have enormous applications.
 - Energy efficiency measures and policies have to be implemented before the deployment of DSETs. Both policies have to be implemented together.
- In addition, Dr. Hegazy shades light on Shamsic Ya Misr program that aims at promoting the deployment of solar energy technologies all over Egypt. The following are the main characteristics of the program:
 - The program comprises two main components; energy efficiency and renewable energy promotion.
 - The main targeted sector is the governmental buildings (total of about 70 thousand).
 - Efficient lighting (LED Lamps) and PV systems (less than 20 KWs) are the main technologies to be deployed. The PV systems will be installed in two sites per each governorate.

- Main barriers and problems faced program implementation include the lack of well trained and capable persons, lack of qualified companies for PV systems supply, installation and maintenance. In order to overcome all those barriers and problems it was important to consider training as one of the main important activities of the program in addition to the need for creating a unified contract model and qualify the participating solar energy companies in cooperation with NREA. In general, in order to avoid problems that might rose during program implementation it is important to identify constraints and try to overcome it during the program or project implementation.
- Marketing is vital for the success and effectiveness of DSETs.
- Need to implement Net Metering in addition to Feed-in-Tariff policy or imitative.

Date: Monday January 26th, 2015

Time: 3:00 PM – 5:30 PM

Location: Egyptian Company for Gas Services (ECGS)

Participants: DR. Mahmoud Badran (Chairman, ECGS and Former Chairman of Natural Gas Vehicles Company), Dr. Korkor, and Mr. Franco.

Main Issues and Topics Discussed:

- Dr. Korkor and Mr. Franco informed Dr. Badran on the main objectives of MED DESIRE project, its components, approach and methodology of implementation with particular emphasis on WP 6.1(b-c).
 - Dr. Badran shade light on two major financing mechanisms which are being implemented in the Egyptian market; the first for the promotion of natural gas utilization as a fuel for vehicles (the Smart Card System or Mechanism) and the second for the development of natural gas connections to residential buildings and units. The following are the main characteristics of the previous mentioned financing mechanisms and relevant important issues raised by Dr. Badran.
- A. *Financing mechanism for converting gasoline vehicles to use CNG (The Smart Card System):***
- The system is introduced to the market according to the ministry of petroleum decree no. 120 for the year 1994 that specify the cost of converting gasoline vehicles to compressed natural gas (CNG) by LE 5000 and the price of CNG at LE 0.45 per cubic meter (m3).
 - The system is a combination of loan, equity, and incentives (price of CNG is 50% of gasoline price).
 - Two types of implemented financing mechanism; the first as 100% loan of the total investment or conversion cost (LE 5000) from one of the commercial banks while the second as a loan plus equity each of 50% of the total investment or conversion cost (i.e. LE 2500).

- A discounted interest rate of 6% annually compared to 9% as a prevailing commercial interest rate.
- Therefore, estimated payback period for the case of taxi vehicles that represent almost 70% of converted vehicles population is about 6 months for the case of 100% loan and 2 years for the case of loan and equity case.
- The average daily consumption by vehicles is considered as one of the main dominant factors of system design.
- System incentives and advantages include the price differential between CNG and gasoline (CNG price is 50% of gasoline price), participated vehicles owners can get a bank account, the risk associated to the loan from the bank is minimized through insurance from one of the insurance companies, it is fully automated in order to minimize effort, time consumed and minimize and avoid human errors, etc.

B. Financing mechanism for natural gas connection to residential units:

- Total cost of connecting natural gas to residential units account currently for about LE 6800. The customer pays LE 2650 in cash and the rest of gas connection cost (LE 3150) through a loan of 48 installments (to be paid through monthly gas bill over 4 years) at an interest rate of 6% annually compared to privileging commercial interest rate of at least 9%.
- The total cost of gas connection includes the cost of the service line (from the main gas pipeline to the residential building), the cost of external installations (wall mounted pipelines), and the cost of internal installations including the gas meter). For the case of compounds and villas (high income classes clients), the client bears also the cost of the external natural gas pipeline.
- Unlike the case of the smart card financing scheme, there are more than one bank participating in the financial mechanism.

Date: Tuesday January 27th, 2015

Time: 12:00 PM – 2:00 PM

Location: Solar Energy Development Association (SEDA)

Participants: Eng. Khaled Gasser (Chairman, SEDA), Eng. Waeel Madkour (Executive Director, SEDA), Ms. Asmaa Ismail (Head of Communication & Marketing Unit, SEDA), Dr. Korkor, and Mr. Franco.

Main Issues and Topics Discussed:

- At the beginning of the meeting, Mr. Franco highlighted some issues related to the training activities of the project.
- Dr. Hamed highlighted the main activities to be performed under WP6.1.(b-c) and asked Eng. Gasser and SEDA representatives on their experience with implementing several solar energy technologies projects and their views about the main important factors that could guarantee the appropriate design and implementation of DSETs financing mechanisms.
- In that regard, Eng. Gasser made the following important points:

- All solar energy technologies partners and stakeholders are ready to participate in any effective national solar energy program.
- Need to have attractive measures and policies that encourage participation in the development and deployment of solar energy technologies projects and programs.
- Interest rate of distributed solar energy technologies should be in the range of 2%-4%.
- Need to have a central fund (to be hosted by the Central Bank of Egypt) for the implementation and deployment of DSETs projects. The main objective of the fund should be to cover the difference between the proposed interest rate on investment cost of the DSET (about 2%-4%) and the prevailed commercial interest rate (about 9%).
- The most attractive market segments for the deployment of DSETs projects currently are the tourism and residential sectors.
- The Tunisian financial mechanism (PERSOL) is considered as the best model for DSETs.
- Quality is a vital and important issue for the success of any implemented DSETs project.
- Electricity savings as a result of utilizing solar water heater instead of electric water heater estimated at about 5000 KWh yearly (based on an average daily electricity consumption of one electric heater of about 2 KWh/day and average yearly operating days of about 250 days. Based on the total number of electric water heaters to be replaced by solar water heaters avoided electricity installed capacity estimated at about 7200 MW.

Date: Thursday January 29th, 2015

Time: 9:00 PM – 10:30 PM

Location: Regional Center for Renewable Energy and Energy Efficiency (RCREEE)

Participants: Eng. Maged Mahmoud (Head of Projects and Technical Affairs, RCREEE), Mr. Yazan Samara (Strategy/Investment Senior Advisor RCREEE), and Dr. Korkor.

Main Issues and Topics Discussed:

- Mr. Franco highlighted on two main components of MED DESIRE project; 1) the design and implementation of an innovative financing mechanisms for DSETs; and 2) Training and Standardization that will include setting standards for PV in Egypt.
- Dr. Hamed highlighted the main activities to be performed under WP6.1.(b-c); the design and implementation of an innovative financing mechanisms for DSETs and asked both Eng. Maged and Mr. Samara on their experience and views on implemented similar financing mechanisms in some countries in the region.
- Eng. Maged highlighted the following important issues:
 - There is no any program for certifying and accreditation of qualified engineers and technicians on different aspects related to DSETs.
 - Hence, NREA works on qualifying DSETs companies.
 - There are some initiatives for the deployment of SWHs and PV systems in the industrial sector in Egypt through the efforts exerted by the Office of Environmental Obligations affiliated to the Egyptian Industries Federation in cooperation with the World Bank.

- The concept of adding the cost of solar systems on the cost of new building wasn't successful in Egypt due to low quality of erected systems as a result of poor bidding procedures and systems specifications.
- There is an agreement between Cairo Bank and the Arab Organization for Industrialization for the manufacture and supply of PV systems.
- Need to review the successful implemented financing schemes in Tunisia and Lebanon.
- Importance to precisely select the targeted DSET and sector.
- Importance to study well the national context and to link the proposed financial mechanism to it and to renewable energy action plan.
- The problem associated to PV systems is the existence of different financial schemes target different sectors.
- Awareness is considered as an important issue for the success of solar energy technologies implementation.
- NREA should play an important and very critical role regarding the development and deployment of renewable energy.
- The financial mechanism should have specific targets and integrate implemented financing mechanisms.
- Mr. Samara highlighted the following main issues:
 - Importance to consider the Ministry of Housing project on energy efficiency practices within innovation.
 - Need to have a general and broad based financing scheme or mechanism.

Date: Monday January 29th, 2015

Time: 11:00 PM – 12:00 PM

Location: New and Renewable Energy Authority (NREA)

Participants: Dr. Mohamed El Khyat (Sector General Manager, NREA) Dr. Korkor, Mr. Franco, and Eng. R. Abd El Kader.

Main Issues and Topics Discussed:

- Both Mr. Franco and Dr. Korkor informed Eng. El khyat on the results and outcomes of their meetings with different stakeholders of the MED DESIR project in Egypt and that most of them have a common consensus that it is important to have a generic financial mechanism that focus on Solar Water Heaters (SWHs) applications in residential sector. Meanwhile, the proposed mechanism should be smart and flexible enough to be modified and to be applicable for other DSETs such as PV systems and other sectors (e.g. commercial, hotels, etc.) and she agreed.
- Dr. El khyat agreed upon that conclusion.
- Mr. Franco highlighted also on the following issues:
 - EgySole project is facing some difficulties due to the tough situation that the tourism sector is facing.

- Energy prices are considered as an important element in the success of any financing mechanism.

Date: Monday January 29th, 2015

Time: 12:15 PM – 12:30 PM

Location: New and Renewable Energy Authority (NREA)

Participants: Dr. Mohamed El Sobky (NREA Chairman), Eng. Omnya Sabry (NREA Vice Chairman), Dr. Mohamed El Khyat (Sector General Manager, NREA), Dr. Korkor, Mr. Franco, and Eng. R. Abd El Kader.

Main Issues and Topics Discussed:

- Mr. Franco and Dr. Korkor informed Dr. El Sobky on the results and outcomes of their meetings with different stakeholders of the MED DESIR project in Egypt including NREA project team and that most of them have a common consensus that ***it is important to have a generic financial mechanism that focus on Solar Water Heaters (SWHs) applications in residential sector. Meanwhile, the proposed mechanism should be smart and flexible enough to be modified and to be applicable for other DSETs such as PV systems and other sectors (e.g. commercial, hotels, etc.) and she agreed.***
- Dr. El Sobky agreed upon that conclusion.
- Dr. Korkor told Dr. El Sobky that he will do his maximum effort to finalize the draft report on the design of the proposed financing mechanism by the end of the first week of March. Then a round table or workshop for presenting the draft report and the design of the financial mechanism will be organized by NREA in the mid of next March and most of the main concern stakeholders will be invited to attend. The comments and the feedback from different stakeholders will be considered in the preparation of the final financial mechanism design report which is expected to be sent to the project management unit by the end of next March.

Appendix (4) Main barriers that hinder the development and expansion of SWHs market in Egypt

Political & institutional barriers	- Lack of commitment to testing standard for materials used or SWHs systems. - Poor implementation and enforcement of decisions taken and decrees issued such as the Minister of Housing decree No. 401 of 1987, and building codes for the 2009 which, if applied, could contribute to the development of the use of SWH in residential areas. - The absence of political support for such technologies. - The lack of long-term strategic planning for those uses. - In the framework of the work to secure energy supplies renewable energy is not considered as one of the basic options available. - Non-participation of the private sector as appropriate in the development of the use of renewable energies including solar water heating. - National economic plans do not cover renewable energies as a target sectors that should be given priority due to potential of savings in public expenditure and improve environmental conditions. - Limiting the role of new and renewable energy authority NREA on tests, research and development more than dissemination and application of SWH technology. Lack of existing policies and systems for renewable energy in addition to detailed plans for research and development to increase the dissemination and exploitation of renewable energy. - Limited institutional capacity. - Limited research and development activities in addition to demonstration projects for renewable energy and SWHs. - The number of companies engaged in the manufacture and installation of solar water heaters is relatively small. - Lack of government commitment to support the development of SWHs industry. The absence of the role of the State in creating a market for SWHs and through outreach to consumers, endogenous capacity building for manufacturers and installers of SWHs. - Lack of institutional system to encourage the proliferation of such systems and technologies in addition to the lack of required expertise, well trained and skilled labor.
Economic barriers	- Relatively high investment cost of SWH systems compared to conventional water heaters which use electricity, natural gas and LPG. - Subsidized prices of conventional energy (electricity, natural gas and LPG) reduce the competitiveness of SWHs with conventional technologies. - Lack of cooperation between universities, research centers and companies in order to improve the performance and lower the cost of solar water heaters. - High cost of SWHs in addition to high taxes and customs imposed on their components.
Financial barriers	- Lack of incentives to use renewable energy, such as tariff exemptions and tax cuts. Lack of incentives for both users and manufacturers. - The absence of soft finance or loans with longer payment periods. - The lack of sufficient knowledge and awareness among financial institutions and their employees about these systems and technologies and approaches to evaluate its investment and various renewable energy technologies. - The inability of some renewable energy technologies including SWH systems to achieve economic competitiveness with alternative technologies, especially under the prevailing energy prices and subsidy of conventional fuels. - The lack of appropriate mechanisms for financing of renewable energy projects, such as grants, loans, Treasury bills, certificates of carbon, renewable energy fund and others.
Legal barriers	- Lack of Government attention to the development of renewable energy including solar water heating systems is considered as one of the constraints that lead to the absence of effective legislation and supporting the development of such uses. - Absence of legislative framework of standards for the quality of the raw materials and SWHs, testing, certification and accreditation of SWHs manufactures and installers. - Absence of legislation and regulations that could support the deployment of SWH technologies

	and renewable energy in General. - Lack of follow-up to the implementation of the decision of the Minister of housing no. 401 of 1987 on the use of solar water heaters in cities and new communities. - Government's lack of attention to the development of renewable energy including SWHs and the absence of effective legislation and support for the development of such uses. - Absence of mandatory actions to test materials or produced SWHs.
Market and regulatory barriers	- Low size of SWHs market with the lack of participation of the private sector. - Population growth limit available space for the installation of SWHs on the roof of buildings. - The low level of performance, efficiency and flexibility of some produced SWHs discourage customers to switch for their use. - Lack of cooperation between universities and research centers with producers and manufacturers of SWHs and which didn't led to any improvement in the performance and efficiency of heaters produced and cut costs. - Lack of availability of specific raw materials needed for the manufacturing of SWHs which to import them from abroad. - SWH systems have not yet succeeded in proving the positive environmental and economic advantages to the user so as to make it more attractive and competitive in comparison with traditional systems for water heating (electricity, gas heaters and LPG). - The sustainability of SWHs requires great efforts of manufacturers and other interested parties involved in the industry which is missing at the moment.
Technical barriers	- Low productivity of SWHs and unavailability of some knowhow. - Lack of specialized companies in operation, maintenance and control of SWHs quality. - Lack of sufficient budgets for research and development and investment in renewable energy equipment manufacturing. - Lack of training for human resources. - The existence of many problems associated with research and development in SWHs techniques and technologies and associated scientific and technical issues.
Awareness barriers	- Lack of awareness and information on technologies for solar hot water systems. - Bad reputation of some technologies for SWHs among large segment of users and consumers which impedes and prevents their spread. - Lack of accurate data and research on various aspects of renewable energy and SWHs use. - Lack of appropriate technical and scientific research studies prepared by universities, research centers and non-governmental civil society organizations, NGOs and others. - Lack of awareness and information on the importance and benefits of new and renewable energy including SWH.
Social barriers	- Population led to the height of buildings consequently the possibility of blocking sunlight from SWH systems for long periods during the day therefore results in low efficiency. - Production of some SWHS with low quality, efficiency and lower specifications led to bad reputation of SWHs that discourage consumers to switch to SWHs.
Capacity building barriers	- Lack of specialized consultancy human resources at high degree of efficiency. - SWHs operating companies have the ability to conduct feasibility studies on demand and installed but with little economic assessment and determine the least economic cost. - The curricula of many local engineering colleges show little interest in new and renewable energy technologies including solar water heating. - The majority of managers in the field of new and renewable energy, lack of adequate training in the area of business development. - Lack of skilled labor and specialized training centers.

(Source: H. Korkor, *Solar Water Heaters Development in Egypt*, May 2011).

Appendix (5) International Renewable Energy Stakeholders

Entity	Establishment	Mandate/ Main Objectives	Main Activities/Services
The World Bank (WB) http://www.worldbank.org/	- Established in 1944. - Headquartered in Washington, D.C. - Have more than 10,000 employees in more than 120 offices worldwide.	Financial and technical assistance to developing countries around the world. The WB is not a bank in the ordinary sense but a unique partnership to reduce poverty and support development. Two goals for the world to achieve by 2030: - End extreme poverty by decreasing the percentage of people living on less than \$1.25 a day to no more than 3%. - Promote shared prosperity by fostering the income growth of the bottom 40% for every country.	1. Financial Products and Services: - The WB provides low-interest loans, interest-free credits, and grants to developing countries. These support a wide array of investments in such areas as education, health, public administration, infrastructure, financial and private sector development, agriculture, and environmental and natural resource management. Some of the bank projects are co-financed with governments, other multilateral institutions, commercial banks, export credit agencies, and private sector investors. - The WB also provides or facilitates financing through trust fund partnerships with bilateral and multilateral donors. Many partners have asked the Bank to help manage initiatives that address needs across a wide range of sectors and developing regions. 2. Innovative Knowledge Sharing: - Support the developing countries through policy advice, research and analysis, and technical assistance. - Support capacity development in the countries the bank is serving. - Sponsor, host, or participate in many conferences and forums on issues of development, often in collaboration with partners. To ensure that countries can access the best global expertise and help generate cutting-edge knowledge, the Bank is constantly seeking to improve the way it shares its knowledge and engages with clients and the public at large. Key priorities include: Results: the bank continues to sharpen its focus on helping developing countries deliver measurable results. Reform: the bank is working to <u>improve every aspect of its work</u>: how projects are designed, how information is made available (<u>Access to Information</u>), and how to bring our operations closer to client governments and communities. Open Development: the bank offers a growing range of free, easy-to-access <u>tools, research and knowledge</u> to help people address the world's development challenges. For example, the <u>Open Data website</u> offers free access to comprehensive, downloadable indicators about development in countries around the globe. The bank have also made <u>World Bank Live</u>—live discussions open to participants worldwide—a key part of our Spring and Annual Meetings with the <u>International Monetary Fund</u>.
GIZ		GIZ offers customized solutions to complex challenges. GIZ is an experienced service provider and assist the German Government in achieving its objectives in the field of international cooperation. GIZ offer demand-driven, tailor-made and effective services for sustainable development.	1. Tailored services: Demand-driven, tailor-made and effective services for sustainable development. To ensure the participation of all stakeholders, GIZ apply a holistic approach based on the values and principles upheld in German society. This is how GIZ facilitate change and empower people to take ownership of their own sustainable development processes. In doing this, GIZ is always guided by the concept of sustainable development, and take account of political, economic, social and ecological factors. GIZ support its partners at local, regional, national and international level in designing strategies and meeting their policy goals. 2. Developing solutions: GIZ operates in many fields: economic development and employment promotion; governance and democracy; security, reconstruction, peace building and civil conflict transformation; food security, health and basic education; and environmental protection, resource conservation and climate change mitigation. GIZ also support its partners with management and logistical services, and act as an intermediary, balancing diverse interests in sensitive contexts. In crises, GIZ carry out refugee and emergency aid programs. As part of its services, GIZ also second development advisors to partner countries. Through programs for integrated and returning experts, GIZ place managers and specialist personnel in key positions in partner countries. Also GIZ promote networking and dialogue among actors in international

			cooperation. Capacity development for partner-country experts is a major component of its services, and offers its programs participant's diverse opportunities to benefit from the contacts they have made. GIZ also give young people a chance to gain professional experience around the world – exchange programs for young professionals lay the foundations for successful careers in national and international markets. 3. Other Services: Trade, climate change mitigation and adaptation, sustainable urban mobility, vocational training adapted to labor market needs, fund management, development partnerships with the private sector, stakeholder dialogues – we offer our clients a wide range of services, methodologies and approaches. Our projects testify to the effectiveness of our work.
UNDP http://www.eg.undp.org/	1966	• Help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. • Coordinates global and national efforts to reach World leaders have pledged to achieve the Millennium Development Goals, including the overarching goal of cutting poverty in half by 2015.	• Helping countries build and share solutions in four main areas: 1. Poverty Reduction and Achievement of the MDGs 2. Democratic Governance 3. Crisis Prevention and Recovery. 4. Environment and Energy for Sustainable Development • Encourage the protection of human rights and the empowerment of women, minorities and the poorest and most vulnerable. • Providing new measurement tools, innovative analysis and often controversial policy proposals. • Administers the UN Capital Development Fund, which promotes microfinance in 48 least developed countries; and UN Volunteers, which fields over 7,300 volunteers from 160 countries in support of peace and development through volunteerism worldwide.
UNEP http://www.unep.org/	Established in 1972	• “To be the leading global environmental authority that sets the global environmental agenda, that promotes the coherent implementation of the environmental dimensions of sustainable development within the United Nations system and that serves as an authoritative advocate for the global environment”. • Acts as a catalyst, advocate, educator and facilitator to promote the wise use and sustainable development of the global environment.	UNEP work encompasses: • Assessing global, regional and national environmental conditions and trends • Developing international and national environmental instruments • Strengthening institutions for the wise management of the environment.
GEF http://www.thegef.org/gef/home	Established in October 1991	“To assist in the protection of the global environment and to promote environmental sustainable development.”	• Provide new and additional grants and concessional funding to cover the "incremental" or additional costs associated with transforming a project with national benefits into one with global environmental benefits. • Provides grants for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. • Serves as financial mechanism for the following conventions: ✓ Convention on Biological Diversity (CBD) ✓ United Nations Framework Convention on Climate Change (UNFCCC) ✓ Stockholm Convention on Persistent Organic Pollutants (POPs) ✓ UN Convention to Combat Desertification (UNCCD)

		✓ <u>Minamata Convention on Mercury</u> ✓ Supports implementation of the Protocol in countries with economies in transition. Areas of Work: The GEF work focuses on the following main areas: • Biodiversity • Climate Change (Mitigation and Adaptation) • Chemicals • International Waters • Land Degradation • Sustainable Forest Management / REDD + • Ozone Layer Depletion The GEF also works on several cross-cutting issue and programs: • Results & Learning • Earth Fund and Public Private Partnerships • Capacity Development • Small Grants Programme • Country Support Programme • Gender Mainstreaming.
USAID http://www.usaid.gov/		Extending a helping hand to people overseas struggling to make a better life. • Provide assistance to develop the markets of the future. • Developing partnerships with countries committed to enabling the private sector investment that is the basis of sustained economic growth and create jobs. • Help stabilize countries and build responsive local governance. • Ease the transition between conflict and long-term development by investing in agriculture, health systems and democratic institutions. • Help countries transition from violence and prevent conflict in the first place. • Invest in ideas that work to improve the lives of millions of men, women and children by: ✓ Investing in agricultural productivity so countries can feed their people ✓ Combating maternal and child mortality and deadly diseases like HIV, malaria and tuberculosis ✓ Providing life-saving assistance in the wake of disaster ✓ Promoting democracy, human rights and good governance around the world ✓ Fostering private sector development and sustainable economic growth ✓ Helping communities adapt to a changing environment ✓ Elevating the role of women and girls throughout all our work.