UNIDO

Egypt National Cleaner Production Center
مركز تكنولوجيا الإنتاج الأنظف

مركز تحديث الصناعة
INDUSTRIAL MODERNISATION CENTRE

Ministry of Trade & Industry
وزارة التجارة والصناعة

SOLAR Heating
for Industrial Process
Together Toward Efficient Production

Summary Report

Roadmap for strengthening the quality of locally manufactured products and components related to solar water heaters and solar thermal technologies in Egypt

2020

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Acknowledgment

Utilizing Solar Energy for Industrial Process Heat in Egyptian Industry (SHIP) project herby express special thanks and gratitude for the consortium of Chemonics Egypt Consultants and Swiss Solar Technology Institute (SPF) for developing this report and the associated roadmap. This report would not have been possible to undertake without their valuable support and dedication.

SHIP also expresses its sincere gratitude to private sector companies and stakeholders who participated in interviews and focus groups as well as workshops. Their sincere efforts and openness in sharing knowledge was crucial for the success of the roadmap development.

The Roadmap was developed under the supervision of the United Nations Industrial Development Organization (UNIDO) within the scope of Utilizing Solar Energy for Industrial Process Heat in Egyptian Industry (SHIP) project. The project is funded by the Global Environmental Facility (GEF) and implemented by UNIDO in cooperation with the Ministry of Trade and Industry of Egypt (MTI).

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List of Abbreviations

CE	Chemonics Egypt
DCF	Data Collection Form
ECA	Egyptian Customs Authority
EEAA	Egyptian Environmental Affairs Agency
ENCPC	Egypt's National Cleaner Production Centre
ETC	Evacuated Tube Collector
FPC	Flat Plate Collector
GEF	Global Environment Facility
GOEIC	General Organization for Export and Import Control
GSWH	Global Solar Water Heating
ICA	Industrial Control Authority
IDA	Industrial Development Authority
ILOs	Intended Learning Outcomes
IMC	Industrial Modernization Centre
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
JV	Joint Venture
JEDI	Jobs and Economic Development Impact
KPI	Key Performance indices
NILP	National Industry Localization Program
NPV	Net Present Value
NREA	New and Renewable Energy Authority
NUCA	New Urban Communities Authority
PVTD	Production and Vocational Training Department
ROI	Return on Investment
SME	Small and Medium Enterprises

SPF	Institute Fur Solar technik
SWH	Solar Water Heating
ToR	Terms of Reference
TVET	Technical and Vocational Education and Training
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
W.r.t	With Respect To

Executive Summary

A consortium of Chemonics Egypt Consultants (CE) and SPF Institute for Solar Technology has been awarded by the United Nations Industrial Development Organization (UNIDO) the "Provision of services related to roadmap for strengthening the quality of locally manufactured products and components related to solar water heaters and solar thermal technologies in Egypt" in the framework of the GEF-funded "Solar Heat for Industrial Processes" project.

The consortium has assessed the Solar Water Heaters (SWH) market as well as the value chain for the local manufacturing of SWH and solar thermal technologies in Egypt highlighting both potential and barriers, based on which a roadmap for strengthening the local manufacturing capacity for SWH and solar thermal technologies in the short, medium and long terms was developed.

Considering the residential, commercial and industrial markets together, Egypt's SWH market readiness can be seen as "emerging", yet with the potential to become "strong", should specific actions targeting the barriers in the markets be taken. Establishing a subsidy program for SWH installations, designing SWH loan programs, setting SWH targets on the national level, designing national outreach campaigns, setting building mandates in all sectors, developing system installer certification and an active association for SWH would increase Egypt's SWH market readiness.

Egypt's SWH market has experienced constant growth in market sales from 2011 to 2014, then the market has started to grow at almost 9% annually until 2018. The current annual market sales amount to 4.5 million USD with approximately 4,000 SWH units covering an area of around 16,200 m^2. About 80% of the current market sales are imported SWH systems and 20% are locally manufactured, while there are no exports. The current market size represents only 5% of the estimated technical annual market size which amounts to about 90 million USD. The industrial sector represents about 25% of the total technical market size with a value of 22 million USD per year, the commercial sector represents 14% with a value of about 12.4 million USD, while the residential sector represents the largest portion with a share of 61% and a value of 55 million USD. Likewise, in terms of units, the residential sector accounts for the vast majority of units (80%). Adding to the technical local market size of 90 million USD the export market of 114 million USD, the total technical market size for the local manufacturers amounts to 204 Million USD annually.

The competitiveness of manufacturing SWH systems key components in Egypt was assessed with respect to manufacturing capabilities required for high quality manufacturing and manufacturing cost related factors. Egypt has high potential for locally manufacturing the mounting structure and the storage tank with its auxiliaries; while the flat plate collector (FPC) and the evacuated tube collector (ETC) are not promising for local manufacturing in the short term. In the short term, assembling the FPC locally is more cost competitive than importing it. In the medium term and after market growth and stability, the manufacturing of FPC locally can compete with imported items.

Feasibility studies for the four manufacturing opportunities in the SWH market were developed by the consultant team:

- Locally Manufacture of Enamel Coated Storage Tank and Mounting Structure including Back-up Heat Element
- Locally Manufacture of Storage Tank and Mounting Structure including Back-up Heat Element, Outsourcing of Enamel Coating Process
- Locally Assemble of Flat Plate Collector and Manufacture of Mounting Structure
- Locally Manufacture of Flat Plate Collector and of Mounting Structure.

These feasibility studies are applicable also to existing local manufacturers of parts of the SWH value chain looking for upgrading by increasing the share of the local product in the SWH value chain. A summary of the different feasibility studies is shown in the table below. It does not make much sense to compare between the 4 feasibility studies since the market requires the existence of all types of manufacturing possibilities to ensure its sustainability.

Business opportunity	Initial CAPEX (EGP)	Payback	IRR	Net Present Value (EGP)	Profitability Index
BO #1: Locally Manufacture of Enamel Coated Storage Tank and Mounting Structure including Back-up Heat Element	22,010,000	3.3	37.0 %	2,381,119,000	19.9
BO #2: Locally Manufacture of Storage Tank and Mounting Structure including Back-up Heat Element Outsourcing Enamel Coating Process	4,260,000	2.7	52.2 %	284,067,000	81.8
BO #3: Locally Assemble of Flat Plate Collector and Manufacturing Mounting Structure	2,060,000	4.6	25.8 %	72,301,000	43.5
BO #3: Locally Manufacture of Flat Plate Collector and Manufacturing Mounting Structure	13,160,000	5.6	14.8 %	62,748,000	6.7

Short, medium and long term manufacturing potential could be addressed if the barriers on the road were paved by the appropriate actions. The barriers hindering the local SWHs manufacturing can be classified into 4 main groups according to the impact on the local SWH market. The mapping of actions groups with respect to barriers groups are presented below to ensure that the roadmap actions comprehensively address the four identified barriers groups as well as the four sides of the SWH market, demand, supply, financial services and market regulations.

Key Actions Groups	Key Barriers Groups
Group 1: Raise Quality of locally manufactured SWHs and associated services	Group 1: Demand on local SWH products
Group 2: Increase Demand on SWHs	Group 2: Demand on SWHs
Group 3: Improve Competitiveness of Locally Manufactured Products	Group 3: Competitiveness and Finance
Group 4: Enhance The Market Quality of Products and Services	Group 4: Market Quality

To capitalize on the opportunities and overcome the barriers, 21 actions are recommended encompassing a variety of tools (regulatory tools, financial actions, capacity building and know how transfer, data dissemination and awareness raising) and addressing the four sides of the SWH market. According to timeframe, actions were classified as short term actions (up to 1 year) i.e. the starting phase, medium term actions (1 to 3 years) i.e. building up the base, and long term actions (3 to 5 years) for the acceleration then the consolidation of the scene.

This is a summary report backed by detailed reports and analyses leading to the roadmap. For further details and access to more detailed data please reach out to SHIP project.

Now | Short Term (now – 1 year) | Medium Term (1 – 3) Years | Long Term (3 – 5) Years

Get Started

Improve Competitiveness of Locally Manufactured Products

- Streamlining Customs on Key Imported Components (Adjust HS Code)
- Revise Customs Values for Specific Components
- Disseminate Roadmap Findings of Manufacturing Opportunities and Market Data
- Improve Access of Local Manufactures to Financial Institutes

Raise Quality of Locally Manufactured Product and Associated Services

- Upgrade Quality Control and Quality Assurance Measures
- Improve Access to Testing Facilities for Product Development and Quality Control Services
- Capacity Building for Labors
- Develop Vocational Programs on Selected Manufacturing Processes
- Access to International Experts
- Joint ventures with international firms

Enhance The Market Quality of Products and Services

- Certification for Installers and Designers
- Capacity building for Installers and Designers
- Student Exchange Programs
- Develop Curriculum at Universities for Design and Manufacturing

Increase Demand on SWH

- Enhance Marketing and After Sales Services
- Business Development and Marketing
- Implement Demonstration Projects and Disseminate Results
- Organize Awareness Campaign for Consumers on Benefits of SWHs
- Disseminate and maintain market data
- Provide Capital Subsides (Grants) for Selected Consumer Segments
- Improve Access to Low Interest Loan for Selected Consumer Segments

Introduction

A consortium of Chemonics Egypt (CE) and SPF Institute for Solar Technology has been awarded the "Provision of services related to roadmap for strengthening the quality of locally manufactured products and components related to solar water heaters and solar thermal technologies in Egypt".

The project aims at achieving four main objectives:

- **Objective 1:** Assess the local market for the manufacture, supply and distribution of solar thermal technologies in Egypt,
- **Objective 2:** Analyse the value chain for the local manufacturing of solar water heaters and solar thermal technologies focusing in Egypt,
- **Objective 3:** Identify the needs of the industries and component manufacturers in relation to capacity building, technology upgrades and investment, and
- **Objective 4:** Develop a roadmap for strengthening the local manufacturing capacity for solar water heaters and solar thermal technologies

Part A describes the assessment of the overall market taking into consideration manufacturing, supply and distribution of the SWH in Egypt. In addition, this part addresses the existing market size (import/export) and the estimation of the technical annual market size in Egypt.

Part B describes the assessment of the SWH value chain for the locally manufactured products/components in Egypt. In addition, this part addresses the assessment of the SWH manufacturing systems in Egypt, identification of barriers to entry for manufacturing, and proposed list of interventions/actions. This part concludes by pointing out the key components that have high potential for local manufacturing in Egypt as well as implementation outline.

Part C describes the recommendations to ensure quality of SWH components manufacturing, assessment of SWH main components skill gaps and recommended capacity building and trainings. This part also discusses four different scenarios for manufacturing, upgrading and assembling by presenting feasibility studies.

Part D describes the finalized list of key actions and responsible stakeholders as well as the final shape of the roadmap with identification of actions in the short, medium and long terms.

Part A: Market Analysis of Solar Water Heaters and Solar Thermal Technologies in Egypt

Chapter 1. Egypt's Market Readiness for SWH

Chapter 1 describes the tool that was used to assess and evaluate the current situation of the solar water heaters markets in Egypt. The segmentation is based on application and end-users' needs determined mainly according to target temperature and demand profile. The market readiness and recommendations to increase it are discussed.

1.1. SWH End-Markets

The target temperature is the main determining factor for the selection of solar thermal collector, while demand profile affects the selection between thermosiphon system and forced system.

Figure 1.1 gives an overview of the range of process temperatures in different industrial sectors and the most suitable collector technology. This figure is adapted to indicate the residential and commercial sectors as well. SHIP project roadmap is concerned about low and medium temperature applications up to 90 °C by using evacuated tube collector (ETC) or flat plate collector (FPC).

Figure 1.1 Overview of collector types based on their operating temperature and application in industrial, residential and commercial sectors (purple lines) [2]

1.1.1. Residential Use

The use of solar thermal collectors in single family and multi-family houses is the most common and widespread application worldwide. The solar heat is used for domestic hot water, space heating or to heat swimming pools. In latitudes with a high solar radiation throughout the year, solar thermal systems can cover 100% of the domestic hot water demand [3].

1.1.2. Commercial Use

A big potential for the use of solar heat can be found in the commercial and services sector (hotels, laundries, restaurants, sports centres, airports etc.) as well as the agricultural sector. The solar heat can be used for the supply of hot water, space heating, warm water for washing and cleaning, or heat for drying.

1.1.3. Industrial Process Heat

Solar process heat has great potential for solar thermal applications. The potential for the use of solar thermal plants for process heat depends overall on the consumption of the selected processes, their temperature requirements and above all the solar radiation at the respective location. Table 1.1 lists the main industrial processes that benefit from solar thermal technologies and the corresponding temperature ranges. The most suitable processes that can be found in various industries are preheating of raw materials, pasteurization, sterilization, washing, drying, boiler feed water and the supply of hot water and steam as well as space heating in industrial buildings.

Table 1.1 Overview of temperature ranges for different industrial applications [4]

Industry	Process	Temperature range [°C]
Food and Beverage	Drying Washing Pasteurizing Cooking Sterilization Heat treatment	20-180 40-80 60-110 70-170 110-160 40-60
Textile	Washing Bleaching Dyeing	40-80 60-100 100-160
Chemical Industry and Pharmaceutical	Cooking Distill Other chemical processes	95-105 110-300 120-180
Paper	Drying Boiler Feed water Bleaching	60-100 40-90 130-150
Automobile	Painting Drying	160-220 80-100
Other sectors	Preheating of water Heating of industrial space	30-100 30-80

When integrating a solar system to provide heat for an industrial process it is necessary to identify the optimal integration point. However, due to the high complexity of the industrial heat supply, it is often a difficult task that requires experience with such systems. The IEA SHC Task 49 [2] has developed a guideline that provides guidance to planners of solar thermal process heat systems, energy consultants and process engineers by describing integration concepts and a general procedure to identify integration points.

1.1.4. Current Situation

Regarding the industrial sector, most of the factories in Egypt are consuming natural gas or diesel as fuel for fire tube steam boilers. Currently, the fuel is not subsidized for the industrial sector, the industrial sector pays 5 USD/MBTU for the natural gas and 0.32 USD/Litre for diesel (based on 5.8 EGP/Litre and exchange rate of 1 USD = 18 EGP). Around 13 SWH systems have been installed from 2002 to 2012, and are used for preheating the boiler feed water.

The situation in the commercial sector is quite different cause of the variation within the sector according to the application (hotels, schools, mega malls and hospitals), as well as the geographical location. The main sources of energy for this sector are electricity, natural gas and diesel, for which the commercial sector is not subsidized. The commercial sector pays 5 USD/MBTU for the natural gas, 0.32 USD/Litre for diesel (based on 5.8 EGP/Litre and exchange rate of 1 USD = 18 EGP) and 0.058 USD/kWh medium voltage (based on 1.05 EGP/kWh and exchange rate of 1 USD = 18 EGP).

1.1.5. Solar Water Heating Systems Feasibility in Egypt

The consultant team has investigated the feasibility for each system according to the sub-sector of implementation. As shown in Figure 1.2, assuming that the solar collector replaces electric water heaters, the hotel sub-sector has promising payback and IRR for both the thermosiphon and forced system, due to the increase in the cost of electricity. Although schools have the same electricity cost as hotels, the payback will be higher and the IRR lower, due to the different consumption profile and less working days. In malls and residential sector, the thermosiphon system has an average payback of 4.2 years and IRR higher than the discount rate; while the forced system has a payback higher than 6 years. This is considered not to be feasible financially in the local market, even if from a technical point of view the forced system should be used in malls instead of the thermosiphon.

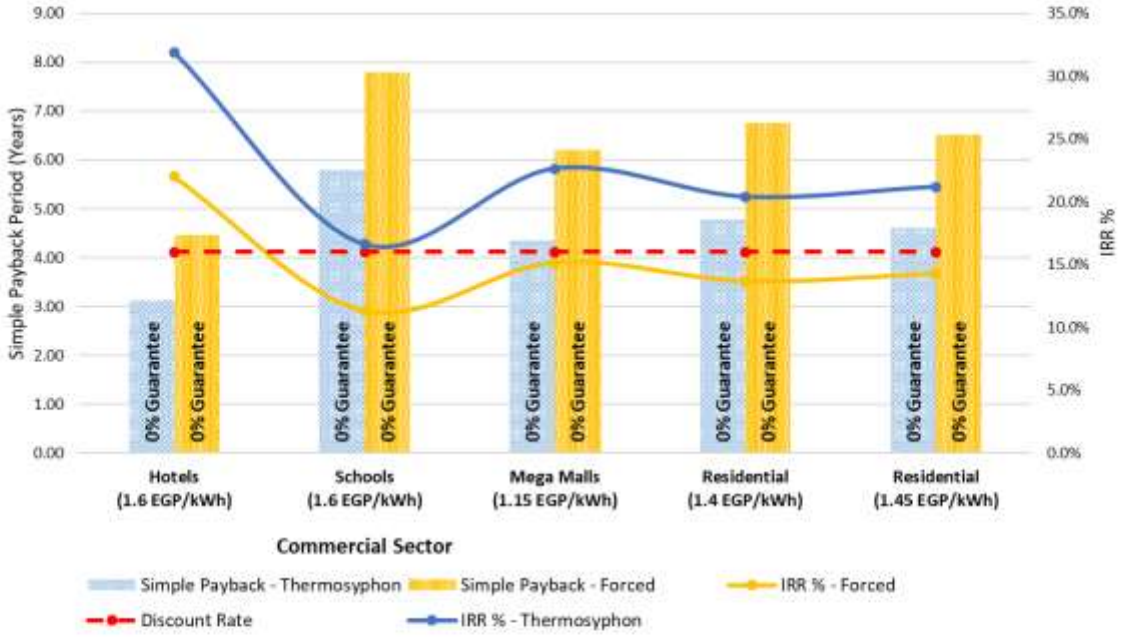

Figure 1.2 SWH system implementation feasibility according to end market in Egypt

As for the industrial sector, the feasibility of SWH systems is affected by many factors, such as type of industrial process, location, production profile, demand profile, alternative fuel, type of technology, available roof area, type of roof area, solar fraction and target working temperature. All such factors make the feasibility analysis unique to each system.

As shown in Figure 1.3, systems with payback of less than five years are a unique business case with limited replicability. For newly installed systems, the payback could vary from 10 to 18 years. This is based on 30 cases of SWH already installed in the Egyptian industry mapped by UNIDO in addition to cases from Chemonics Egypt industrial clients. Finally, it is worth noting that the feasibility of the system should not be judged by the number of years of simple payback but rather by considering IRR and NPV.

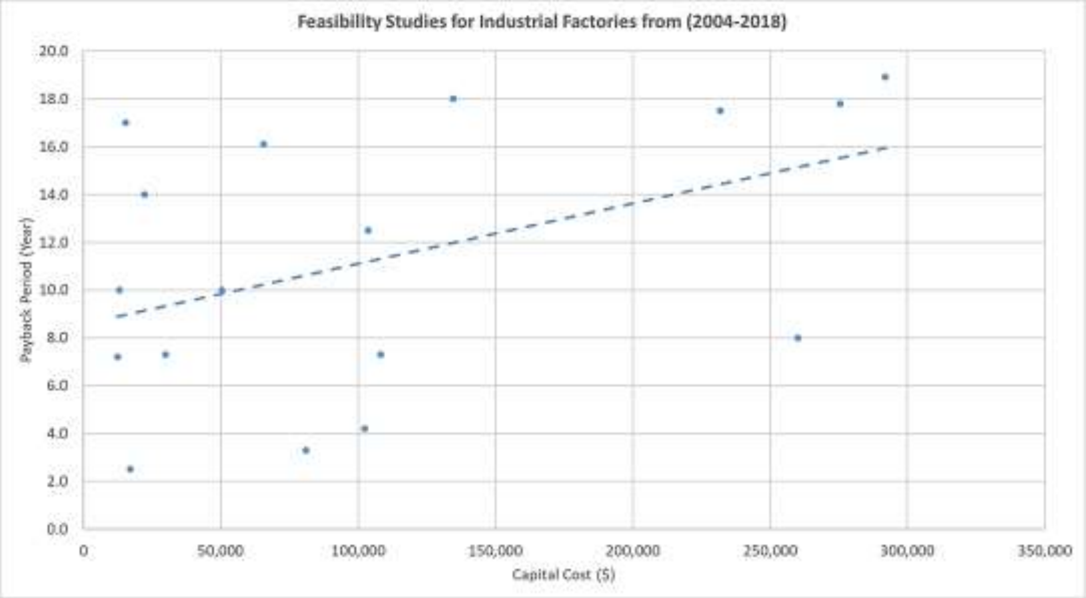

Figure 1.3 SWH system implementation feasibility for industrial end market in Egypt

1.1.6. Market readiness: In-depth Analysis

The SWH TechScope methodology was used to assess Egypt's SWH market readiness. Based on the scores of Egypt's different market segments, the opportunities and challenges facing the SWH market players can be identified. Sources of input data include literature review of published reports, 22 conducted surveys, in addition to analysis and calculations carried out by the consultant team. The score range is 0-5 where the score 0 indicates an emerging market, 2-3 good market, 3-4 strong market, and 4-5 very strong market.

The calculated overall scores of the Egyptian industrial, residential and commercial sectors are 1.91, 2.05 and 2.14 respectively. With a scoring ranging from 1.31 to 2.14, the Egyptian markets can be seen as emerging, yet with the potential to become strong markets, should specific actions targeting the barriers in the markets be taken (Figure 1.4) as recommended in this report.

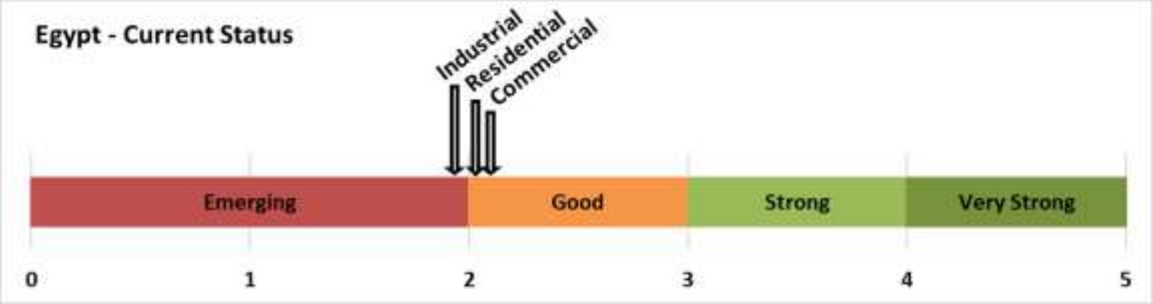

Figure 1.4 Current situation of residential, commercial and industrial markets in Egypt

Figure 1.4 indicates that the three end-markets – residential, commercial and industrial – have similar scores concerning finance and business climate parameters. All 3 markets have no specific financial incentives nor SWH loan programs. The difference in the scores between the market segments arises from the difference in the ***SWH supporting framework***, mainly presence of ***Building Mandates,*** and the ***National Conditions.***

Table 1.2 Market readiness tool parameters scores for residential, commercial and industrial sector for Egypt

Parameter	End Market Sector		
	Residential	Commercial	Industrial
I. SWH Supporting Framework	0.125	0	0
II. National Conditions	1.042	0.832	0.82
III. Finance	0.625	0.625	0.625
IV. Business Climate	0.47	0.47	0.47
Total Score	2.14	2.05	1.915

Building Mandates: the residential market is the only sector with a building mandate for installing SWH according to the new and urban communities' law. Although this law is not yet fully enforced, its presence gives an advantage to the residential sector based on the SWH TechScope methodology.

National Conditions: the sub-indicators ***payback period***, ***market penetration*** and ***fuel subsidy*** are the main determinants of the score differences. Based on the feasibility studies developed by the consultant team, the payback period is a strength for the residential sector as it has the shortest payback period, followed by the commercial sector, and finally the industrial sector with the longest payback period, thus representing one of the main challenges in this market segment. The penetration of SWH in the market is the highest in the residential sector, followed by the commercial sector (mainly hotels), and finally the industrial sector. The fuel subsidy is still applied in the residential sector representing a barrier for more penetration of SWH in the sector, while subsidies have been removed for the industrial and commercial sectors.

As shown in the below figure, the Egyptian overall score for residential market readiness lays at the beginning of the ***"Good"*** markets. Comparing the Egyptian residential score to other international scores developed by the UNDP project for Albania, Chile, Mexico, Lebanon and India in 2015, and by the consultant for Tunisia based on 2019 data,[1] the Egyptian residential sector readiness is still far away from all the other countries (Figure 1.5).

Detailed comparative analysis of the parameters shows that Egypt has a very weak SWH supporting framework, weak Business Climate, while it has average National and Finance conditions. Lebanon and India have the highest scores in the SWH supporting framework due to SWH targets announced by the government, financial incentives for system installations, SWH loan programs, outreach campaigns, and building mandates (partial). Chile has the lowest score, with financial incentives for system installations in addition to outreach campaign. Concerning the National Conditions, the minimum and maximum scores are those of Mexico and Chile, Egypt's score is in a medium position. Chile's strengths are energy consumption growth in the residential sector, SWH growth, short payback period and completely removal of subsidies. While Egypt has a clear competitiveness in the solar insolation and high score in the residential energy consumption growth, it got a medium score

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[1] The consultant team calculated a score for the status of the residential sector in Tunisia based on the review of published reports. Tunisia has been used as a benchmark for Egypt, given the fact that it is characterized by similar conditions and that many actions have been taken in the past years to strengthen the market as clearly indicated by the score classifying Tunisia as strong market.

concerning SWH growth and payback period, while scored 0 with regard to heating fuel subsidy for the residential sector as it is still subsidized. Finally, as for the Business Climate, Egypt's scored close to the lower limit. Egypt has a strong advantage due to enforcing product certification; however, the complete absence of installer certification and industry association in SWH are the main barriers for a stronger SWH business climate.

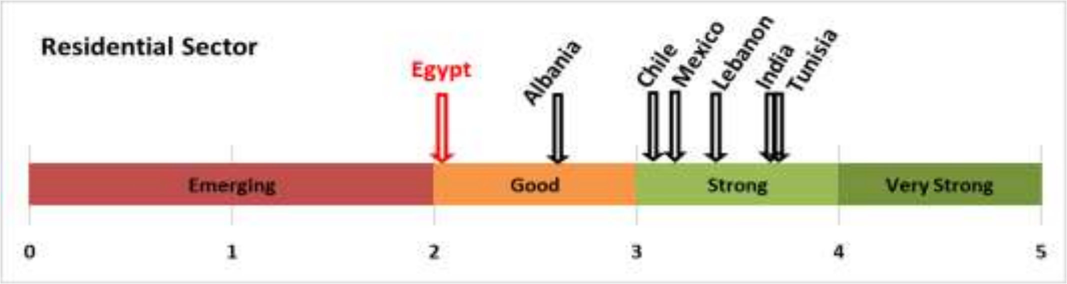


Figure 1.5 Current situation of residential market in Egypt compared with the GSWH project countries and Tunisia

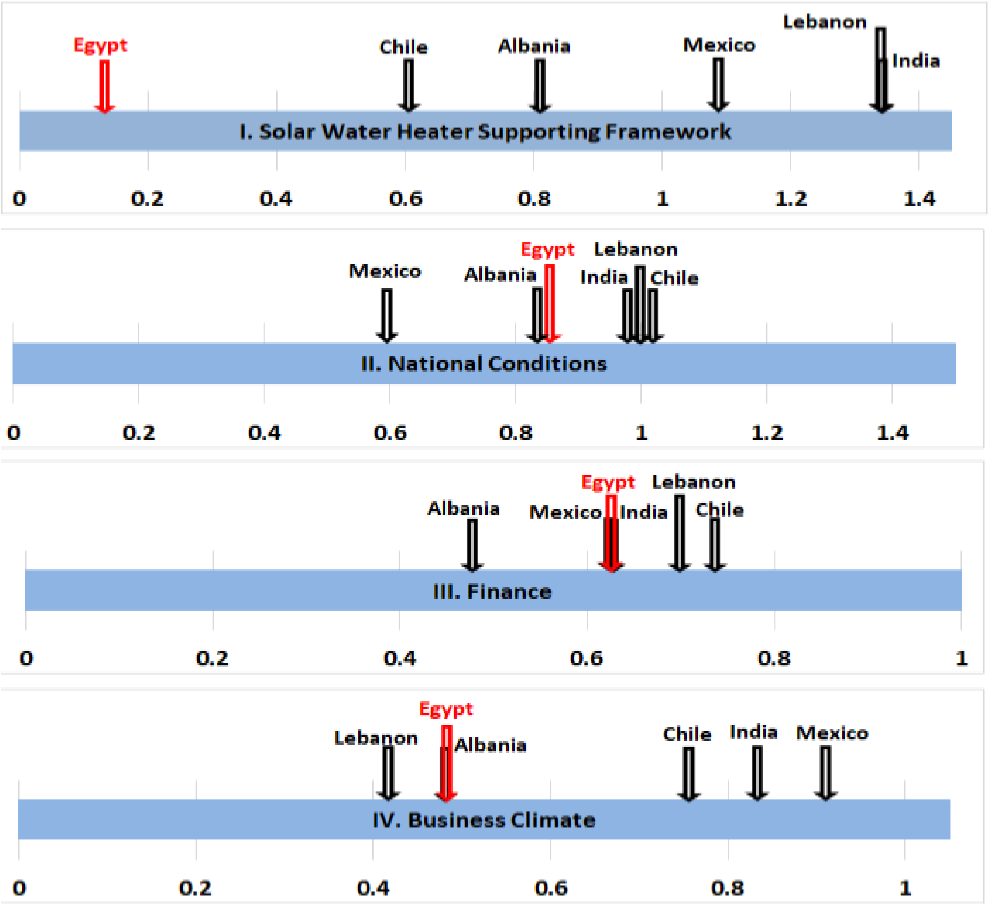


Figure 1.6 SWH market gap analysis for each interdepend parameter for Egypt and GSWH project countries

1.2. Recommendations to Improve Egypt's Score within the Three End-Markets

Egypt's SWH market readiness score can be improved by taking actions targeting the barriers identified in the score analysis, mainly in the SWH Supporting Framework and Business Climate (Figure 1.7 8).

The intervention with the highest impact is **establishing a subsidy program for SWH installations** (SWH supporting framework), which will improve all sectors' scores by 0.4 representing 8% of the score. Other actions/interventions aiming at strengthening Egypt's SWH framework include **designing SWH loan programs, setting SWH targets on the national level, designing national outreach campaigns, and setting building mandates in all sectors**. These actions will improve the scores in total by another 18.5%.

The actions to overcome gaps in Business Climate are **developing system installer certification and an active association for SWH**. These actions will improve all sectors' score by 8%.

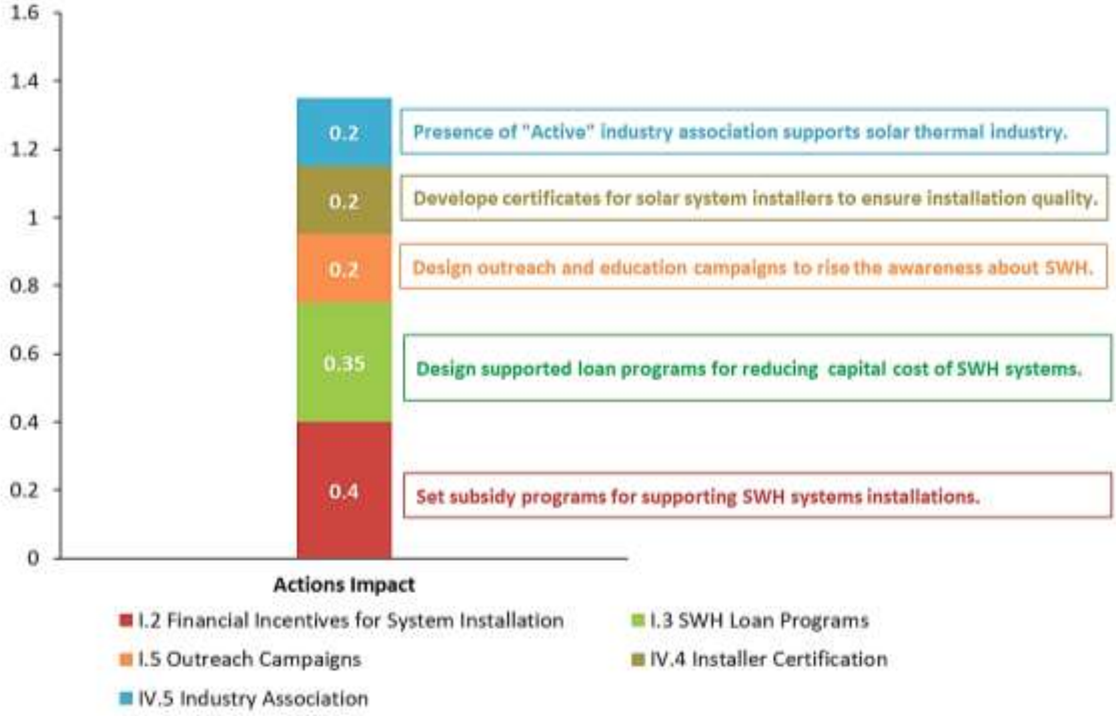


Figure 1.7 Recommended intervention to increase the overall score of Egypt market

The overall scores' increase in market readiness is 34.5%. This will bring the market readiness from "critically" good to "strong" (Figure 1.8). The recommended actions/interventions will increase Egypt market readiness overall score by 65.8%, it will increase the score from 2.05 to 3.4. The residential sector market is the readiest with a current score of 2.14 that can increase to 3.49 if interventions discussed above are implemented. The least ready market is the industrial one with a current score increase from 1.92 that can increase to 3.27 if interventions discussed above are implemented.

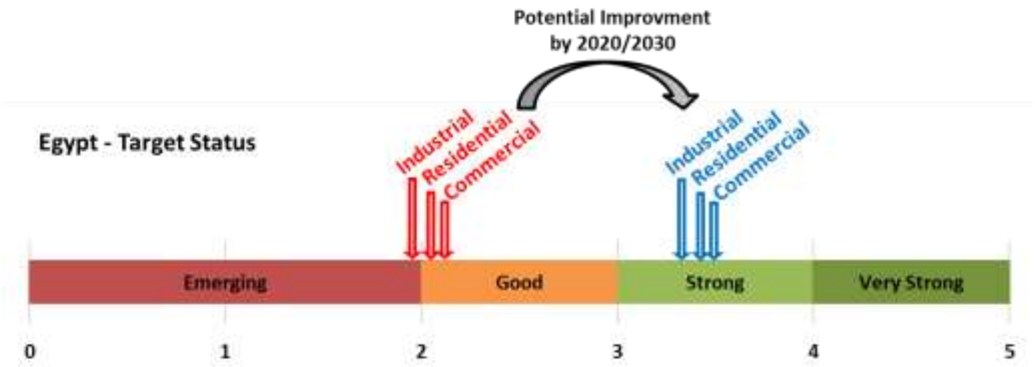


Figure 1.8 SWH market target status for Egypt

Chapter 2. Egypt’s SWH Market Segmentation and Potential Market Size

After having assessed the market readiness, it is crucial to identify the SWH market players. Moreover, Chapter 2 assesses the local market size (both current and technical) as well as the export market size.

2.1 SWH Market Players – Current Situation

The consultant team has identified the companies active in the SWH local market through either importing SWH systems or locally manufacturing them. The SWH manufactures (systems/components) identified are 14 and the suppliers and distributers 17. The SWH suppliers import mainly from Greece, Turkey or China. The SWH manufacturers import some components, while manufacture locally the rest. More details on the SWH value chain components will be addressed in chapter 3.

2.2 SWH Market Sales & System Cost – Current Situation

The Egyptian market of SWH systems has experienced constant growth in market sales from 2011 to 2014, then the market has started to grow at almost 9% annually until 2018. **The current annual market sales amount to 4.5 million USD with approximately 4,000 SWH covering an area of around 16,200 m^2**.

Figure 2.1 shows that about 80% of the current market sales are imported SWH systems and 20% are locally manufactured, while there are no exports of SHW systems.

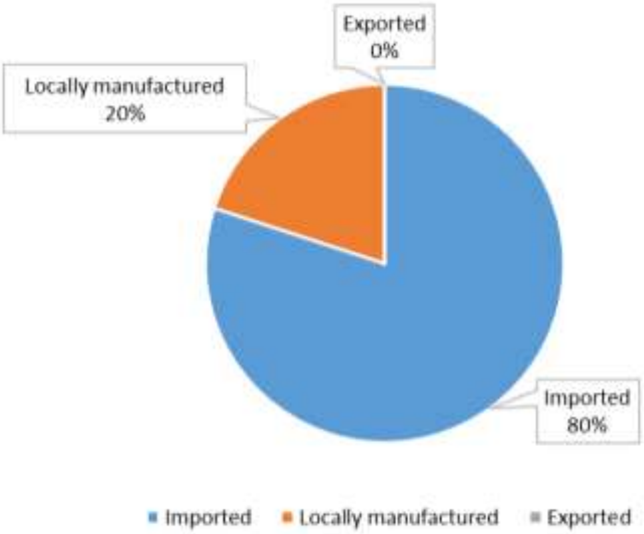


Figure 2.1 Current SWH market sales

2.3 Estimated SWH Market Size & Sales

2.3.1 Commercial Technical Local Market Size

The commercial end-market consists of hotels, mega malls, schools and hospitals. Regarding the hotel sub-sector, **the total annual technical market size is about 8.7 million USD** with the bulk (60%) located in Red sea and Sinai areas (Figure 2.2) due to large number of hotels in these areas, followed by Cairo and Giza area. The consultant calculated the market size for eight governorates, Suez, Luxor, Aswan, North Coast, Giza, Cairo, Red sea and Sinai, that represent a **total annual area of 45,600 m^2 and 10,100 units** based on 300 litre capacity per unit, as shown in Figure 2.3.

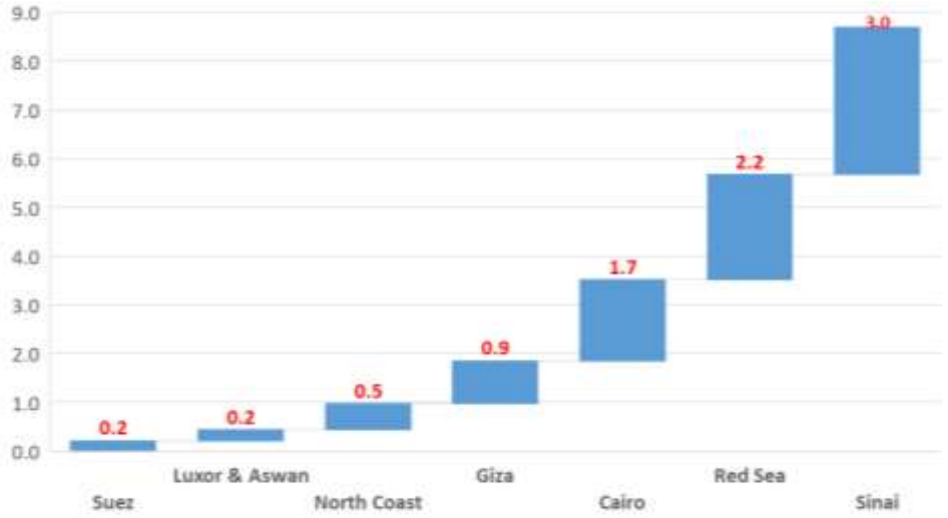


Figure 2.2 Annual technical market size in hotel end-market, USD value

Figure 2.3 Annual technical market size in hotel end-market, number of units

Regarding the hospitals and schools subsectors, the annual technical market size was also calculated based on both forced SWH and thermosiphon SWH for a total of **5.3 million USD**. Regarding mega malls sub-sector, where according to best practices it is recommended to install forced SWH system, the annual market size has a value of **1.3 million USD**. In Table 2.1 the annual market size for hospitals, mega malls and schools is presented based on number of systems (units), required free area (m^2) and USD value.

Table 2.1 Detailed market size data for hospitals, mega malls and schools

Sub-sector	Type of System	Number of units	Area (m^2)	Value Million (USD)
Hospitals	Thermosiphon (300 lit.)	1,410	6,330	1.9
	Forced (4 m^3)	110		2.5
Mega Malls	Forced (4 m^3)	40	3,330	1.3
Schools	Thermosiphon (300 lit.)	290	1,300	0.4
	Forced (15 m^3)	6		0.5

2.3.2 Industrial Technical Local Market Size

In the industrial sector, the total annual market size is calculated based on the number of steam boilers that are located in the Egyptian industrial zones. The industrial sector accounts for 22 million USD of the total annual market size as shown in

Figure 2.4, with an average total number of 580 systems per year, representing an average total required annual area of 54,750 m2 , as shown in

Figure 2.5.

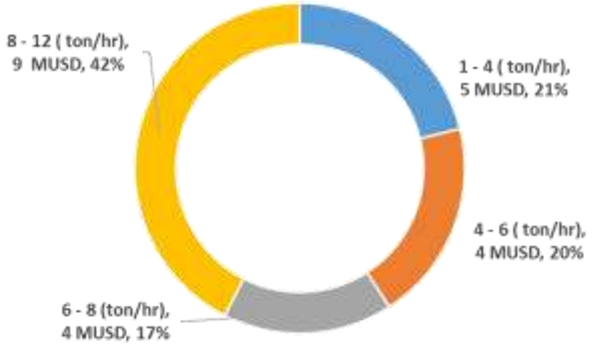


Figure 2.4 Annual technical market size in industrial sector according to boiler category, USD value

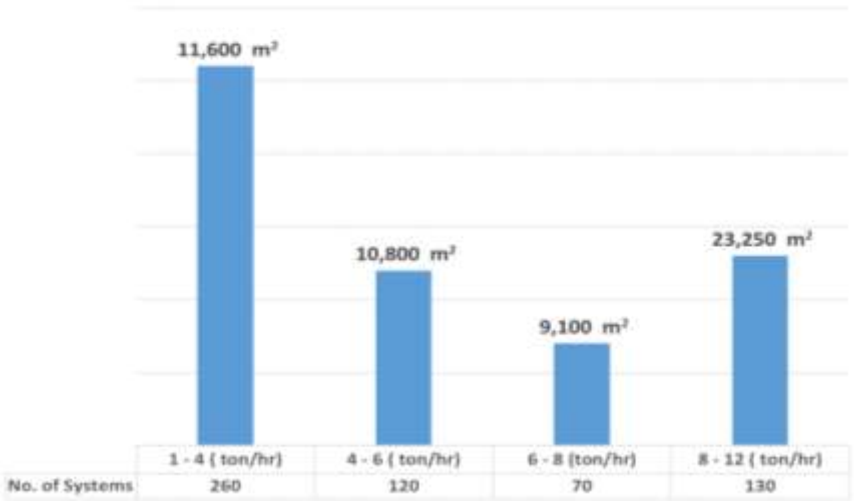


Figure 2.5 Annual technical market size in industrial sector according to boiler category, area and no. of units

2.3.3 Residential Technical Local Market Size

The residential technical annual market size is divided into two main segments according to the electricity tariff, as shown in Figure 2.6. For the highest segment (not subsidized), the market size is about **16 million USD**, which is equivalent to 29% of the residential end-market size and 18% of the total technical annual market size. For the second segment (still subsidized), the technical market size is about **39 million USD**, which represents 71% of the residential end-market size and 43% of total technical annual market size.

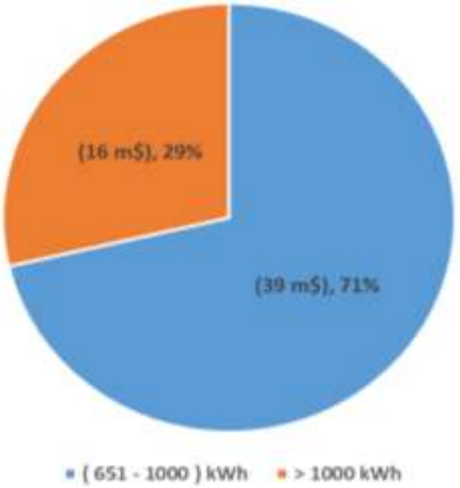


Figure 2.6 Annual technical market size in residential end-market according to electricity tariff, USD value

In total, the residential sector represents around 40,400 units, thermosiphon SWH with flat plate collector with capacity assumed at 300 litres, equivalent to 182,000 m^2 area. In Table 2.2, the annual market size is represented in number of systems (units), required free area (m^2) and USD value.

Table 2.2 Residential sector technical market size (no. of units & area)

Residential Sector (Thermosiphon)	Value Million USD	Number of units (300 lit)	Area (m^2)
(651 - 1000) kWh	39	28,800	129,700
(0 – 1000) kWh	16	11,600	52,100
Total	55	40,400	182,000

2.3.4 Total Technical Local Market Size

Based on the analysis presented above, it can be concluded that **the current market size of 4.5 million USD represents only 5% of the estimated technical market size of about 90 million USD annually**. As shown in Figure 2.7, the market size of the **industrial sector represents about 25% of the total market size with a value of 22 million USD per year,** which is technically feasible. The annual market size for the **commercial sector is about 12.4 million USD, which represents 14% of the total market size in Egypt**. The largest portion goes to the **residential sector with 55 million USD, about 61% of the total annual market size in Egypt**.

As for the number of systems to be installed according to the technical market size, shown in Figure 2.8, the residential sector represents the majority of units with 80% of the total systems. This provides a useful indication to the stakeholders to start focusing on improving human resources related to the applied technologies.

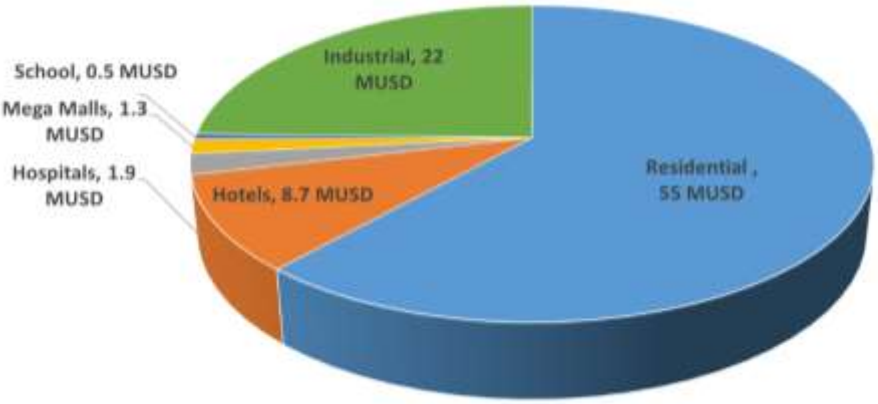


Figure 2.7 Total technical market size by sector, USD value

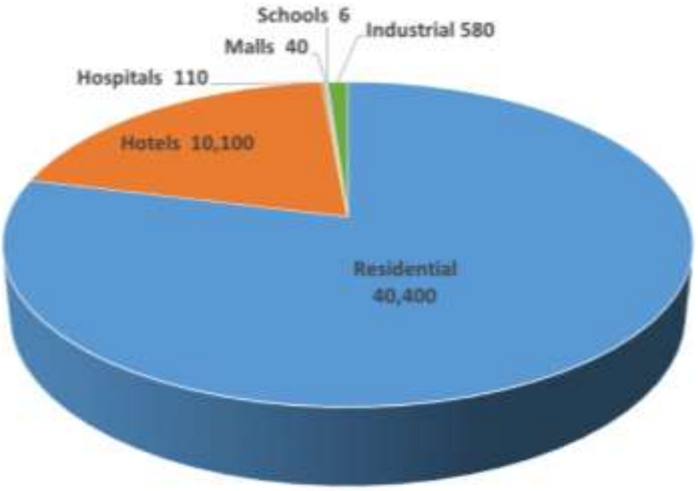


Figure 2.8 Potential number of system according to technical market size, Number of units

As shown in Figure 2.9, if all the technical market size is captured, SWH systems would create savings of 129,910 MWh annually in the residential sector (56% of the total technical energy savings); 61,490 MWh in the industrial sector (27% of the total savings); and 40,400 MWh in the commercial sector (17% of the total savings, with 14% in hotels, 1.9% in hospitals, 1% in mega-malls, and 0.4% in schools).

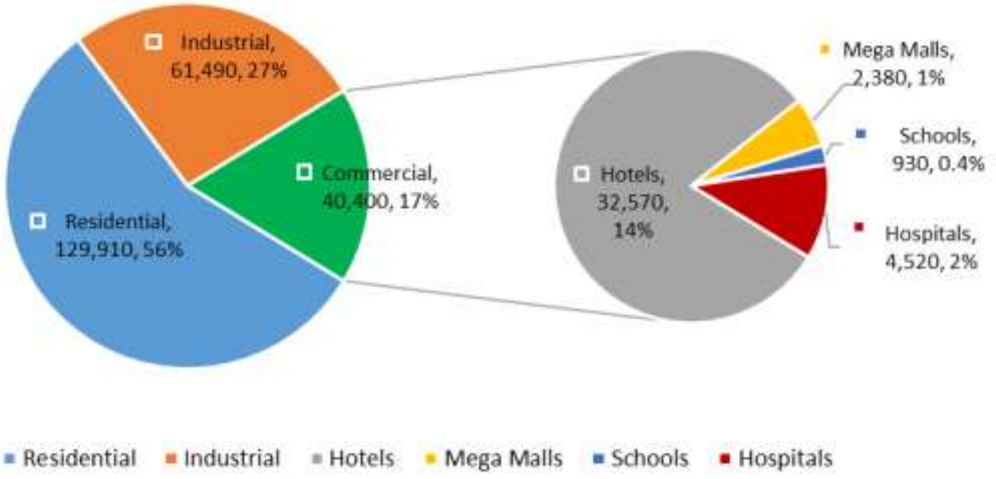


Figure 2.9 Potential technical annual energy savings in MWh

2.4 Projection of Market Growth Scenarios

Market growth scenarios were developed based on experience with renewable energy market and products in Egypt, economic conditions, and opinion of interviewed stakeholders. Stakeholders could not provide a projection but rather a qualitative sense of the market.

The three following scenarios were developed:

- **Maintained growth** (baseline scenario). This scenario projects the market to grow at the same rate it has been growing over the past 2 years. This is considered the worst-case scenario. This scenario provides the lowest market projection in 2030 by assuming a continuous rate of increase of 10% reflecting growth from 2016-2018. The market will grow to annual sales of 7.5 million USD by 2030 from a base of 4.5 million USD in 2018.

- **Improved growth** (moderate accelerated growth scenario) due to improved economic conditions and removal of subsidies without any actions/interventions to improve market readiness. This scenario is more likely to occur than the previous one. The removal of subsidies improves the feasibility of SWH and hence increases the sales of the systems and the investment in SWH. Given that the expected increase in energy pricing is to an average of 10% for the next three years and an additional 3% after that, it could be assumed that the market will grow annually at 10% for the coming three years, and then at 13% annually. This leads to annual sales of 16 million dollars by 2030 (**double the baseline scenario**).

- **Rapid growth** is expected if market readiness is improved as per UNIDO’s recommended actions/interventions. If the market readiness mimics the situation in Tunisia, the market in Egypt is expected to follow the growth experienced in Tunisia. The market in Tunisia grew, after programs to stimulate SWH have been enacted, by 85% for 4 consecutive years then went back to a 10% growth. Assuming the same occurs in Egypt, the market size would be 78 million USD, **almost 5 times larger than the maintained growth scenario**.

2.5 Potential SWH Export Market Size

The following six countries were considered for the benchmarking analysis with Egypt: Algeria, Saudi Arabia, Jordan, Lebanon, Morocco and Tunisia. All these countries have more or less available statistics, information and statistics.

The IRENA Arab strategy (June 2014) [8] provides data about the SWH installed capacities for the year 2012 (Table 2.3).

In Table 2.4 an estimation of the country level target, the market size and the maturity of the technology for each selected country is presented with the aim of providing insights to the Egyptian industries on the opportunity to export SWH systems.

Table 2.3 Installed SWH capacity in Arab Countries, [8]

Country	Installed capacity MW_{th}	Installed capacity m^2
Egypt (2012)	525	750,000
Jordan (2012)	350	500,000
Lebanon (2012)	245	350,000
Morocco (2012)	245	350,000
Palestine (2012)	120	160,000
Saudi Arabia	25	36,000
Syria (2010)	420	600,000
Tunisia (2012)	438	625,000

Table 2.4 Summary for the potential market in Arab Countries

Country/objective	Market size	Government support	Opportunity
Algeria/2020 **122,000 m² for individual & 60,000 m² for forced systems**	Projected as 100,000 m² per year to 2030	ALSOL Program provides direct financial support up to 45% of the cost of individual SWH and up to 35% for collective solar heating installation through the National Fund for the control of energy (FNME).	Yes: Egyptian industry can focus on Algerian market in the mid and long term
Jordan/2020 **1.2 million m²**	Currently, 60,000 m² per year	No financial mechanism, no direct Incentives	Yes: High level of energy prices and current development of SWH
Lebanon/2020 **1 million m²**	Currently, 50,000 m² per year	The market is growing and expanding with very optimistic and achievable targets. The government is offering 0% interest rate loans with 200$ subsidy per system for the residential sector. Larger system can benefit from soft loans for periods up to 14 years. There are plans to enforce mandatory SWH installation	Yes: Egyptian industry can benefit from the Lebanese market development due to the existing market and situation of the energy sector
Morocco/2020 **800,000 m²**	Currently, 50,000 m² per year	No financial mechanism, no direct Incentives	Yes: Egyptian industry can benefit from the Moroccan market as Morocco is part of SHAMCI network
Saudi Arabia/2020 **Est: 200,000 m²**	10,000 to 20,000 m²	No financial mechanism, no direct Incentives Mainly for heating water in commercial and domestic sector	Not for the moment, except large scale installations
Tunisia/2020 **1.4 million m²**	100,000 m² in both residential and commercial sectors	The PROSOL program aims to promote the development of the solar energy sector through financial and fiscal support. PROSOL includes a loan mechanism for domestic customers to purchase SWH and a capital cost subsidy provided by the Tunisian government. The major benefits of PROSOL are: • More than 30,000 Tunisian households install SWH per year • Creation of jobs opportunities in the field of technology supply and installation service and reduction of GHGs emissions. • Reduction of dependence on imported energy	Yes: Egyptian industry can benefit from the Tunisian market as it has an interesting size, is sustainable and quality driven. 20% of the installed capacity is imported, the potential for Egyptian industry is about 20,000 m² representing 6,000 to 8,000 system (4 million US$ turnover).

2.1.1 Potential Export Market Size

Error! Reference source not found. shows the annual market size for countries in the MENA region. gypt has the highest local market size as well as potential for export to countries in the region.

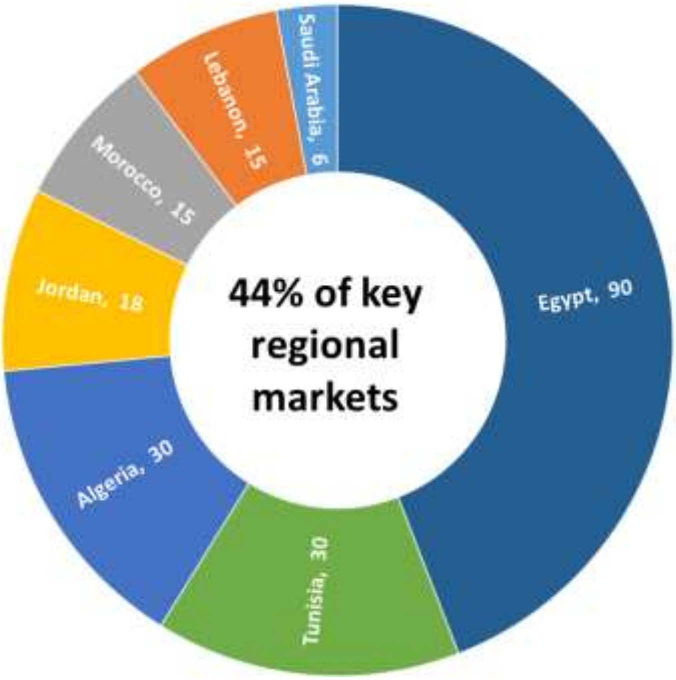


Figure 2.10 Technical annual export market size, Million USD

Two categories of countries can be identified:

- Mature market: Tunisia, Lebanon, Jordan and Morocco, these countries constitute the first immediate target of the Egyptian industries for exportation of Egyptian manufactured SWH, which have to fulfill the technical requirements of these countries. The yearly size of the regional market is 260,000 m².
- Non-mature market: Algeria and Saudi Arabia, due to local energy prices, these countries do not have a developed SWH market, they can constitute a mid-term target for the Egyptian industries. Once these countries will develop the SWH market, 200,000 m² should be added to the first target group.

Local manufacturers of SWH in Egypt have a total technical market size of **90 Million USD annually for the local market** and of **114 Million USD annually for the export market.** Therefore, **the total technical market size for the local manufacturers amounts to 204 Million USD annually.**

Part B: Detailed Analysis of the Local Manufacturing Value Chain for Solar Water Heaters and Solar Thermal Technologies in Egypt

Chapter 3. SWH Value Chain Assessment

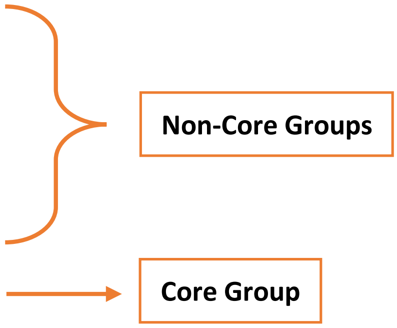
Chapter 3 addresses the SWH value chain components, provides a market review to be able to determine the local market SWH supply chain, and illustrates the Egyptian manufacturing base of SWH value chain components.

3.1 SWH Value Chain Components

3.1.1 SWH value chain Components

The following five main groups are identified:

- Group 1: Metals group,
- Group 2: Non-metals group,
- Group 3: Coatings,
- Group 4: Auxiliaries,
- Group 5: Main components.



Non-Core Groups:

Group 1, metals group, is composed of all metal materials that are used in manufacturing SWH components. This group contains steel sheets with different thickness and surface roughness, stainless steel, aluminium (sheets and frames), and copper in form of tubes or sheets.

Group 2, non-metals group, is composed of non-metal material and items, which are thermal insulation material, e.g. sheets or pipes, glass sheets with different transmissivity coefficient including low iron tempered glass.

Group 3, coatings, is composed of different coating materials used in the SWH systems. The SWH value chain contains three coatings:

- Internal coating: enamel coating, stone coating or other alternative local coating,
- External coating: electrostatic coating,
- Absorber coating: selective absorber coating, black Chrome or black-matt coating.

Group 4, auxiliaries, is mainly composed of control and fittings. Control consists of all means of control within the SWH system (e.g. temperature sensor, pressure gauges, control cards, wiring, control platform), while fittings consist of all parts of the SWH system network and safety (e.g. piping, valves, pump, pressure temperature valve, relief valve, Mg rod, gaskets).

Core Group:

Group 5, main components, is composed of the core components of the SWH value chain, i.e. mounting structure, storage tank, flat plate collector (FPC) and evacuated tube collector (ETC).

Mounting structure supports the assembly of the storage tank with the collector, it should be well designed and it should withstand the outdoor conditions.

Storage tank can be combined with internal heat exchanger in the closed SWH systems, or the heat exchanger can be separated from the tank as in the forced SWH systems. Storage tank consists of rolled steel sheets and welded with internal coating, covered with insulation material that is shielded by rolled galvanized steel sheet.

Flat plate collector (FPC) is the SWH system heart, since it is responsible for absorbing solar radiation and transferring energy to the working fluid (most probably water or other alternative fluid according to the application). A simple definition is the collector being a heat exchanger between Sun and working fluid. The assembly of FPC consists of back-sheet, thermal insulation, absorber (copper tube and fins), glass sheet and aluminium frame, as shown in details in Figure 3.1.

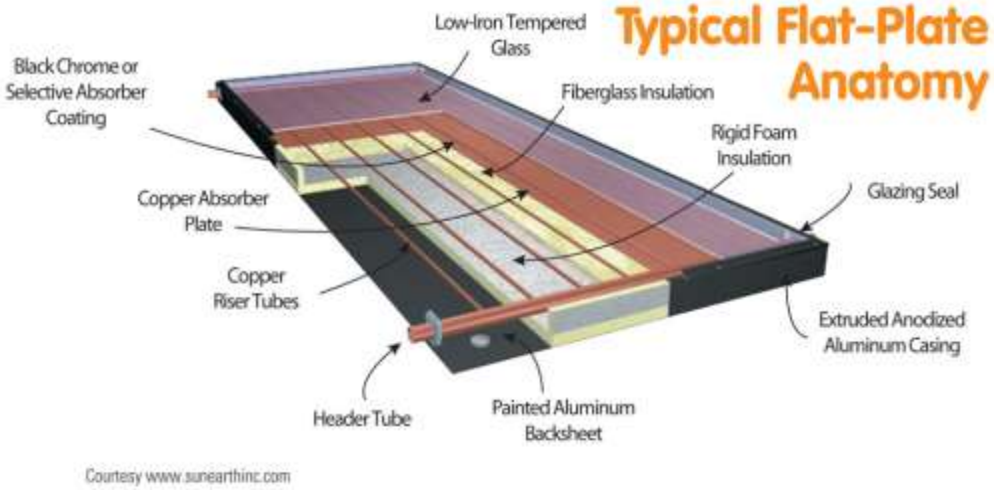


Figure 3.1 Flat plate collector typical breakdown components [9]

Evacuated tube collector (ETC) is the last component in the SWH value chain, it is similar to FPC but uses a different configuration for absorbing solar radiation. Figure 3.2 shows the components used to assemble ETC, It consists of manifold and heat pipe (glass tubes, copper tube and absorber plate), as illustrated in Figure 3.2.

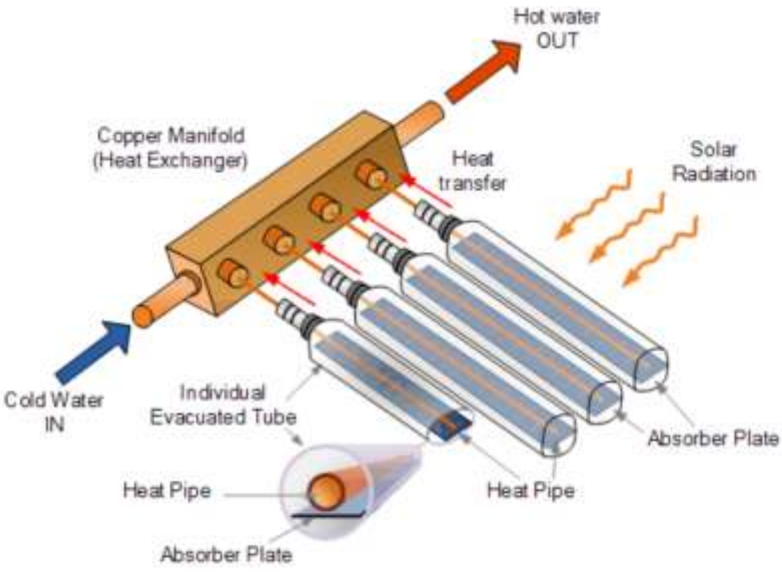


Figure 3.2 Evacuated tube collector typical breakdown components[2]

Each solar thermal collector type has its own characterization and maximum output temperature. The collector selection depends on several factors that will be addressed in Chapter 4.

Table 3.1 identifies the required input for each component according to each group.

Table 3.1 Required inputs of each main component in the system

		Main Components			
		Mounting Structure	**Storage Tank**	**Flat Plate Collector**	**Evacuated Tube Collector**
Metals	Steel Sheets	√	√		
	Stainless Steel Sheets		√		
	Aluminum			√	
	Copper		√	√	√
Non Metals	Insulation		√	√	
	Glass			√	√
Coatings	Internal Coating		√		
	External Coating		√		
	Absorber Coating			√	√

The SWH value chain components and the linkages between the different groups of the SWH value chain are shown in Figure 3.3, which represents the feeding materials and components needed to manufacture the complete SWH system. Components with orange background indicate input materials, while components with light blue background are assembled by using the input materials.

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[2] Source of Picture - https://www.alternative-energy-tutorials.com/

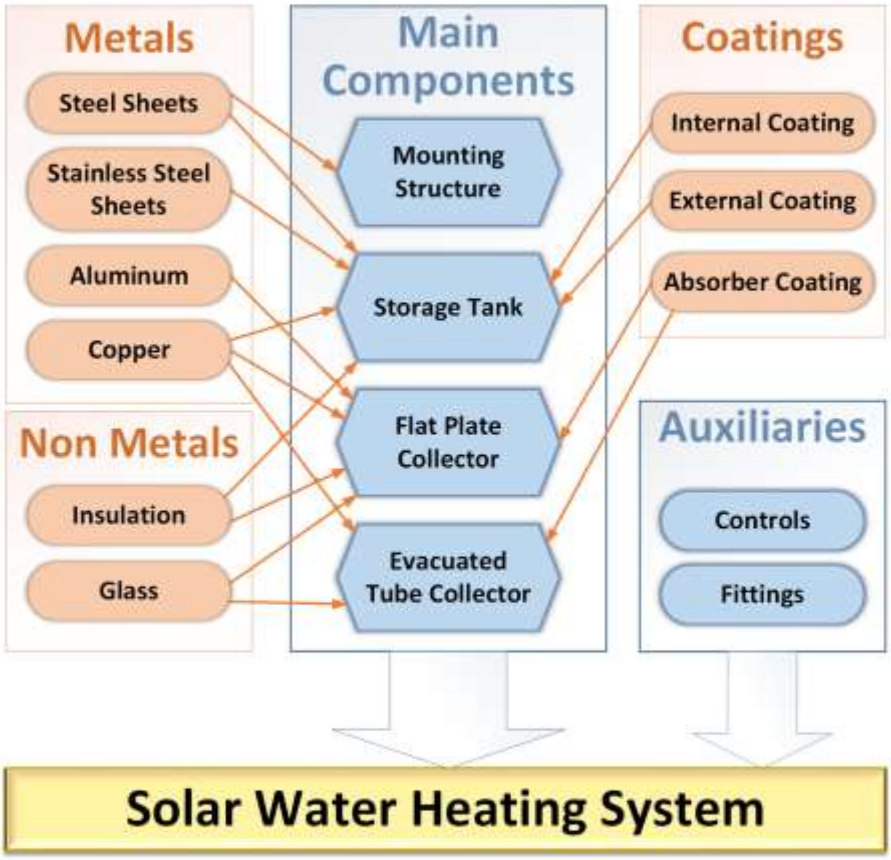


Figure 3.3 Value chain components of solar water heating system

Later in Chapter 5, the assessment of local manufacturing of the SWH value chain components and quality of the supply materials will be illustrated as a part of the analysis of the technical competitiveness of the components for local manufacturing.

3.2 Local Market Review of SWH Value Chain Manufacturing Companies in Egypt

3.2.1 SWH Value Chain Manufacturing Companies

The SWH value chain analysis was conducted for the local market based on the surveys done with the stakeholders, desk review and analysis of industrial databases. Gaps were identified in lower level of components:

- Fittings, especially the pump: in the local market there is no manufacturer that provides the pump meeting the requirements that could withstand the required operating at high temperature → **Does not meet requirements**
- Magnesium rod
- Control system.
- Evacuated tube collector

} **No available local manufacturer**

3.2.2 Identification of Private Sector Leaders

Private sector companies that can develop the market for local manufacturing through the SWH system value chain in Egypt have been identified based on site visits, workshops and focus group discussions attended by the market players, as this is crucial to ensure the sustainability of the roadmap and implementation of its actions.

3.3 Egyptian Manufacturing Base of SWH Value Chain Components

An analysis of local manufacturing of SWH value chain components was carried out with the aid of 14 surveys and literature reviews. This analysis consists of three ranges: the medium range refers to components dominated by local manufacturing, the low range to components mainly imported, and the high range to components fully locally produced.

The analysis, as represented in Figure 3.4, shows that the control system (including pump station, temperature and pressure sensors, etc.) is mainly imported, the copper and pipe fittings are imported, while machining is done by the Egyptian industry. The Egyptian industry has an advantage in piping system and aluminium sheets since these industries are well established and are part of other industries.

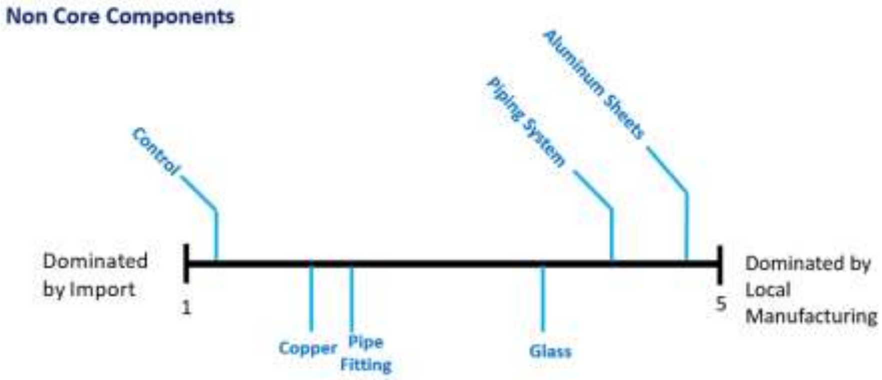


Figure 3.4 Value chain analysis of non-core component

Two additional analyses were conducted for the core group, one focusing on the storage tank and mounting structure, and the other one on solar water collectors (FPC and ETC). As represented in Figure 3.5, most of the storage tank components are available in the local market, except for stainless steel and magnesium rod that are fully imported, and at the same time there are suppliers that import ready manufactured tanks. The Egyptian industry has an advantage in galvanized steel and mounting structure since these industries are well established and are part of other industries.

Regarding solar water collectors, as represented in

Figure 3.6, most of the FPC components are in the medium range (dominated by local manufacturing), despite the components quality; while the ETC components are in the low range (components are mainly imported), since technology of manufacturing is not available in the local market and massive production rate of the evacuated tubes is needed (one million tubes per year). The roadmap will address the competitiveness of manufacturing each component as compared to importing.

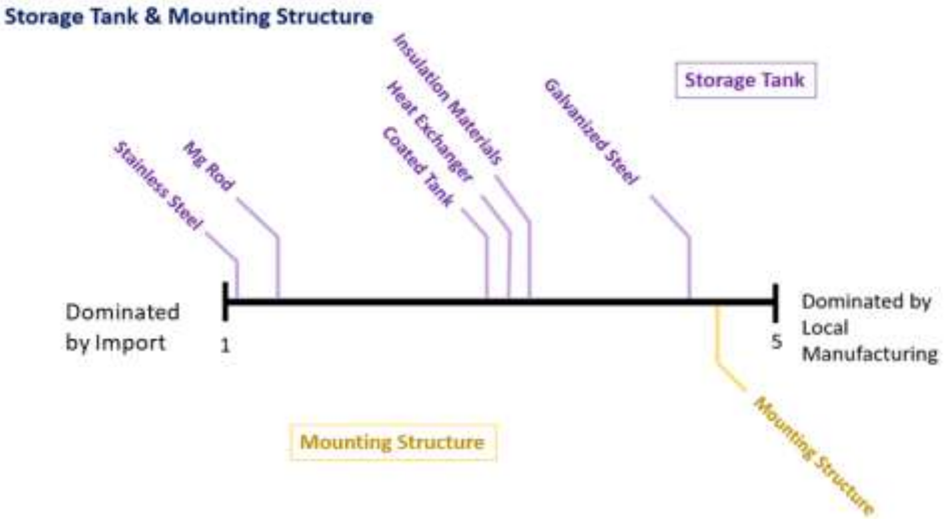


Figure 3.5 Value chain analysis of storage tank & mounting structure

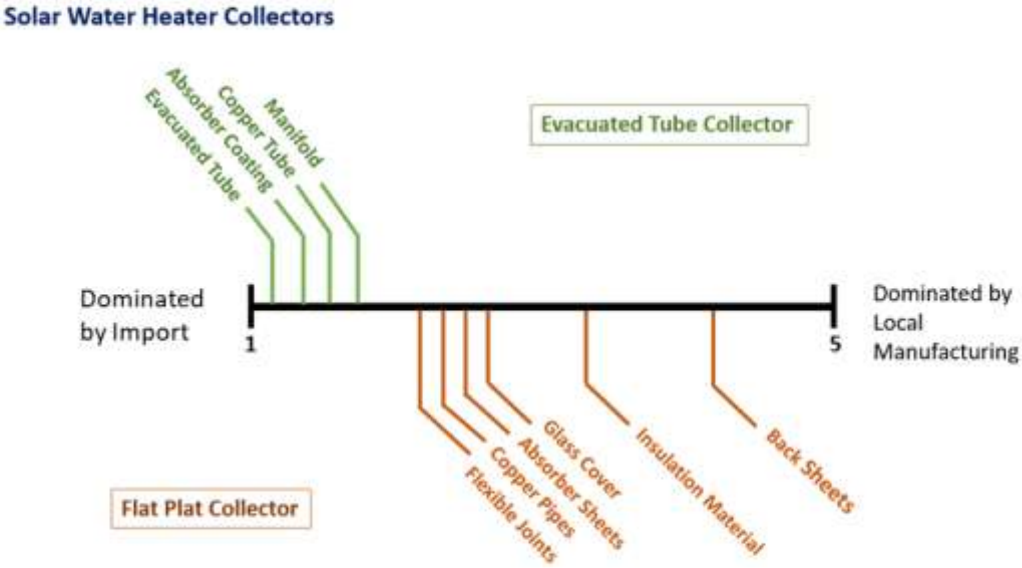
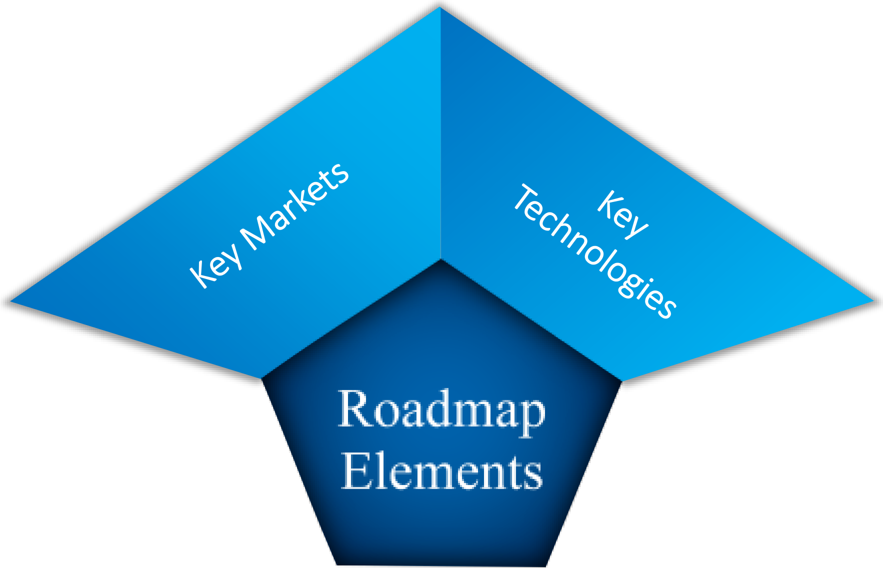


Figure 3.6 Value chain analysis of solar water heater collectors

Chapter 4. Key SWH Technologies Assessment and Mapping of Potential Targeted Market Segments



Chapter 4 identifies the key technology suitable for each sector.

4.1 SWH Systems Classification

Existing SWH systems worldwide are mainly two types: thermosiphon system and forced circulation system.

4.1.1 Thermosiphon (Natural Convection) Systems

Many small domestic solar hot water systems are the so called gravity-driven systems such as Thermosiphon systems or integrated collector storage systems. They make use of the fact that warm water is lighter than colder water and the natural convection in the collector when it is not installed horizontally. In the case of Thermosiphon systems, the tank is usually placed directly at the top of the collector or very close and slightly above. The heated water enters the tank at the top and colder water at the bottom then flows back to the bottom of the collector. As it does not need controllers and pumps, this system operates very efficiently and completely without electricity. Small Thermosiphon systems are the cheapest solar thermal water heating systems available.

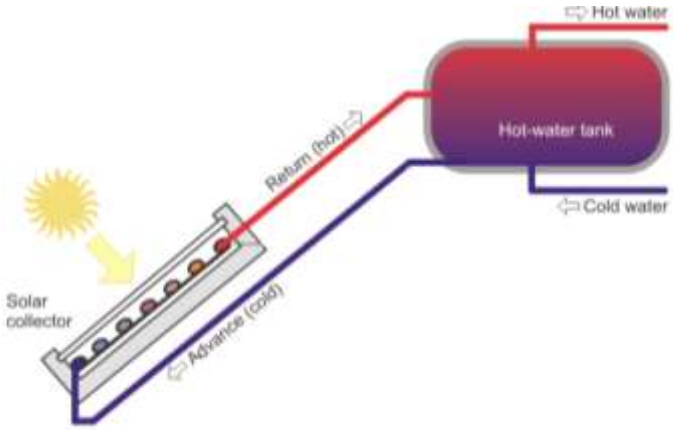


Figure 4.1 Functional diagram of a Thermosiphon system[3]

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[3] Source of picture is in - https://www.volker-quaschning.de/articles/fundamentals4/index.php

4.1.2 Forced Circulation Systems

Forced circulation systems use sensors and a controller to determine if and when a pump is to circulate the heat transfer fluid through the collector. If the temperature in the collector is higher than that in the tank and if the temperature in the tank is still below boiling point, the pump is switched on to transport the heat from the collector to the tank. Forced circulation systems are more complex but allow for a much more flexible system design.

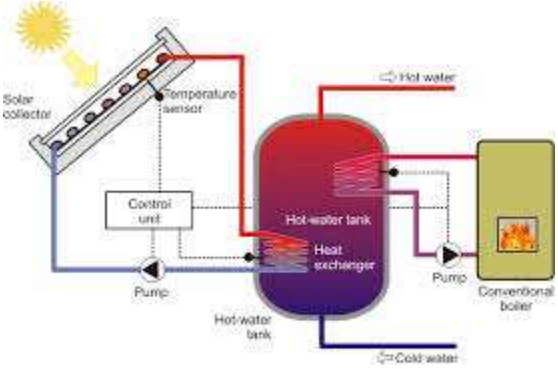

Figure 4.2 Functional diagram of a forced circulation system[4]

4.2 Solar Thermal Collector Classifications

The basic functionality of a solar thermal collector is the conversion of solar irradiation into heat. This happens when the sun heats the absorber of the solar collector, which is connected to a hydraulic circuit to transport the heat transfer medium (HTF) to a heat sink (heat storage, heat exchanger or direct process). The various solar technology concepts are based on different approaches to deliver heat at the desired operating temperatures.

4.2.1 Collector Characterization

The performance of a solar collector depends on its thermal and optical behavior determining the amount of irradiation that is effectively transformed into useful heat. Therefore, losses can be classified into

- **Optical Losses,** which depend on the glass transparency and absorber surface absorptivity
- **Thermal Losses,** which depend on the insolation and the temperature difference between absorber and ambient.

In order to avoid these losses, several different technologies, components and materials have been developed throughout the years leading to more efficient collectors. The performance of a collector is described by an efficiency curve, Figure 4.3, which depends on the operating temperature, the ambient temperature and the total irradiation.

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[4] Source of picture: https://www.volker-quaschning.de/articles/fundamentals4/index.php

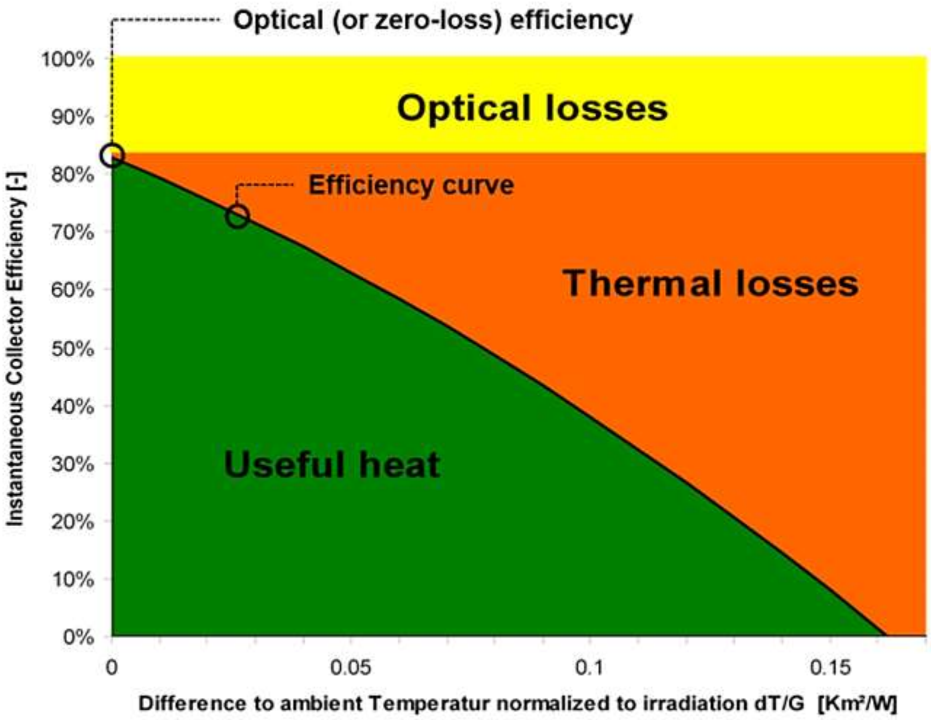


Figure 4.3 Solar collector efficiency curve [11]

4.2.2 Stationary Collectors

Stationary (non-tracking) collectors are used traditionally for hot water or space heating purposes in the residential sector for the low temperature range. These collectors do not use optical concentration and are mounted stationary at one position. The most common stationary collectors are:

- Unglazed collectors
- Flat plate collectors
- Evacuated tube collectors
- Photovoltaic Thermal (PVT) Hybrid Solar Collectors

4.2.3 Tracking collectors

In order to achieve high operating temperatures (>100°C) in the collector, concentrating collectors focus the direct radiation component of the sun through mirrors onto a receiver. The collector must track the sun with one or two axes. The higher the solar radiation is concentrated, the higher is the temperature that can be reached at the receiver. At the same time, the concentration factor also increases the demands on the tracking accuracy. Even with concentrating collectors, suitable measures for minimizing heat losses (selective absorber coating, vacuum insulation of the receiver, insulation of the piping) are important in order to achieve good efficiencies at high operating temperatures. The most common concentrating collectors are:

- Parabolic trough collectors
- Linear Fresnel Collector
- Scheffler Dish Collector

4.3 Key Technologies

4.3.1 Results of Key Technology Assessment Tool for Egypt

Key technologies related to each sector were defined based on the assessment tool that was developed by the consultant and the results validation. Some sectors have more than one key technology according to the application within the sector. The assessment results are as follows:

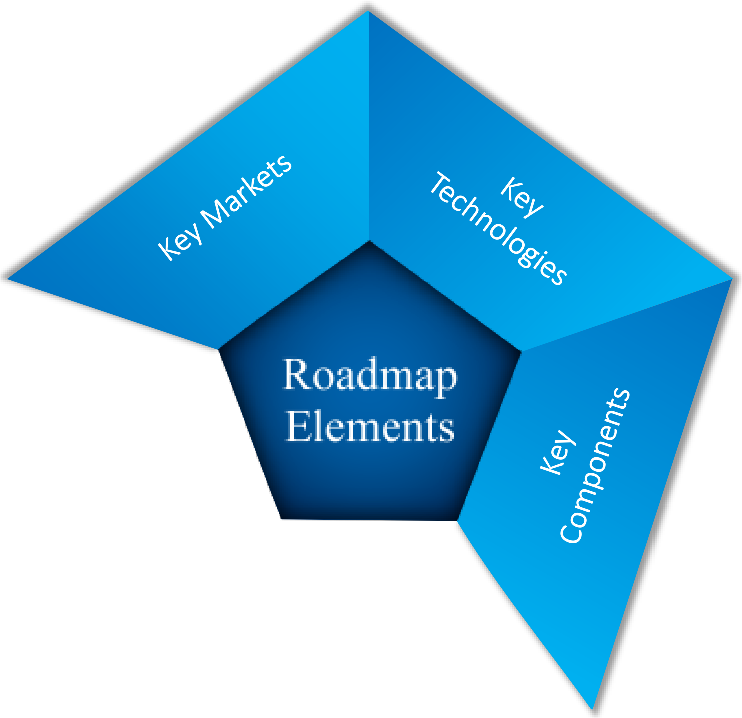
- **Industrial Sector:** Low & medium temperature → ETC – Closed system – Forced
- **Residential Sector:** (1-4) families (Villas) → FPC – Closed system – Thermosiphon
  (5<) families (Buildings) → FPC/ETC – Closed system – Thermosiphon
- **Commercial Sector:** Hospitals, Malls & Schools → FPC/ETC – Closed system – Forced
  Hotels → FPC – Closed system – Thermosiphon
  → ETC – Closed system – Forced

The analysis shows the Egyptian market would be best served by closed system due its robustness and capacity to perform well under various water quality and conditions. Consistency of water quality is a challenge for solar thermal systems sold in Egypt.

The collector type, whether FPC or ETC, is related to the application and level of temperature required by the demand side; while the system type, whether forced system or Thermosiphon system, is related to demand flow rate and time response.

Mostly, the Thermosiphon system in Egypt is equipped with FPC, while the forced system is equipped with ETC.

Chapter 5. Key Component Selection for Local Manufacturing



Chapter 5 describes the SWH system cost structure, followed by the technical and cost competitive assessment of manufacturing potential of the SWH systems in Egypt.

5.1 SWH System Cost Structure

It is clear from the data collection (about 7 surveys, literature review and experts) that the main components in the SWH system cost structure are storage tank, collector, mounting structure. This cost breakdown does not include energy and labour costs. Figure 5.1 illustrates each component cost as a percentage of the SWH system average cost structure.

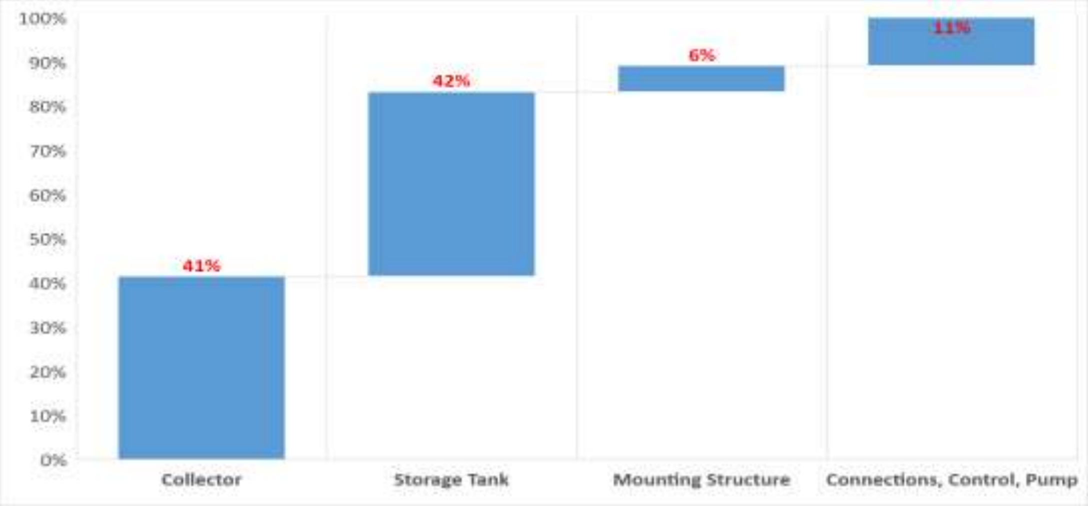


Figure 5.1 SWH system average cost structure

5.2 Competitiveness of Manufacturing SWH Systems Key Components in Egypt

The competitiveness of manufacturing SWH systems key components in Egypt was assessed with respect to manufacturing capabilities required for high quality manufacturing and manufacturing cost related factors.

5.2.1 Manufacturing Capabilities Competitiveness Assessment

With regard to the capabilities of the manufacturers in Egypt to produce key components in the SWH value chain, the analysis was based on a tailored Competitiveness Assessment Tool developed by the consultant for the purpose of this assignment. The tool was built on the Porter's Five Forces model, which provides a framework for companies to identify competition within their industry as well as the industry's strengths and weaknesses (Porter, 1979) [13].

The competitiveness assessment tool results are presented in three main groups: value chain inputs, local market performance in various manufacturing processes, and manufacturing processes for the value chain components.

Value chain inputs were assessed according to their local manufactured availability and quality in the local market. Figure 5.2 illustrates the linkages between raw materials and main value chain components. From the availability and quality points of view, Egypt has a strong steel industry especially low carbon steel sheets and electrostatic coating industry, which are used for external coating for storage tanks and mounting structure (solid green line in the figure below). Egypt has weak enamel coating industry, which is used for internal coating for storage tanks (dotted red line in the figure below). Input raw materials, such as stainless steel, selective absorber coating, thermal insulation, copper pipes, aluminium sheets and low iron glass sheets, exist in the local market with high quality but are mainly imported (solid red line in the figure below).

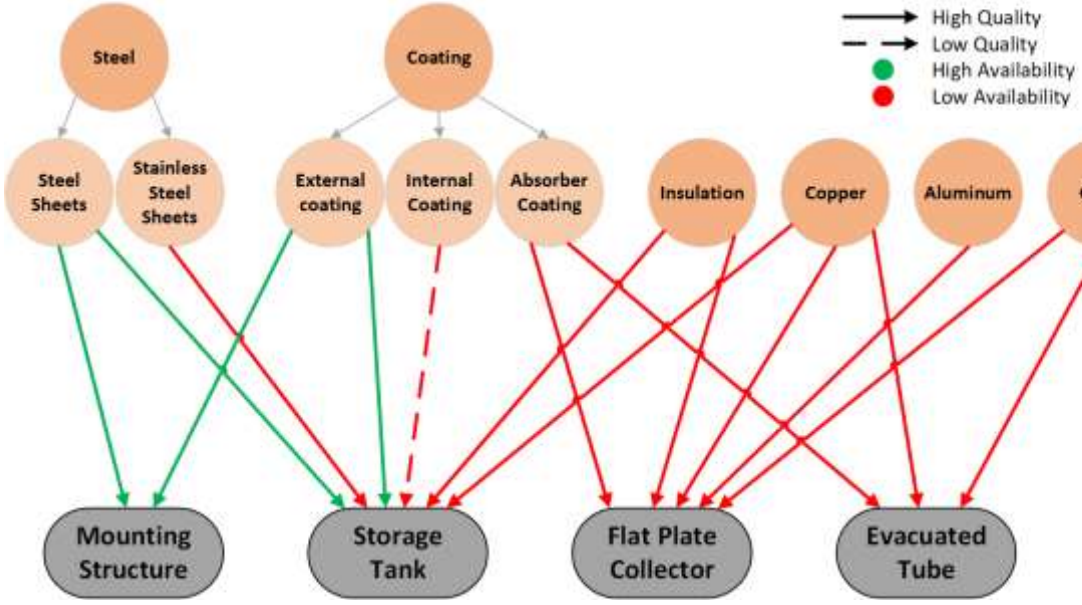


Figure 5.2 Value chain input assessment

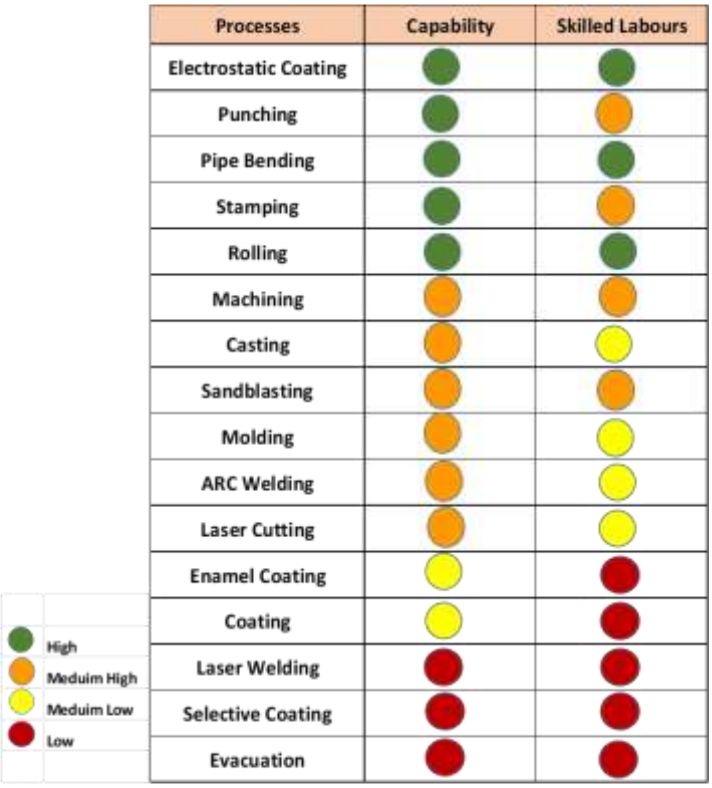
Table 5.1 shows the performance of various manufacturing processes of the main components of the SWH system value chain in terms of capabilities and availability of skilled labours. Egypt has a strong edge on several manufacturing processes, such as electrostatic coating, punching, pipe bending, stamping and rolling. There is potential for improving the capabilities and skills level of existing labour in machining, casting, sandblasting, molding, arc welding and laser cutting. Egypt has shortage of both capabilities and skilled labour in laser welding, selective coating, and evacuated tubes manufacturing processes. The manufacturing processes needed for each key component were also identified (Table 5.2).

Combining the assessment of the manufacturing processes with that of the value chain components (Figure 5.3) shows that **Egypt has high potential for local manufacturing of mounting structure and storage tank**, with issue related to internal enamel coating and laser welding that need to be improved from the points of view of capabilities and availability of skilled labours; **followed by local manufacturing of FPC**. On the other hand, there is no competitive advantage in manufacturing evacuated tubes within the short term.

Table 5.3 presents the gaps in each key component with respect to the 7 indicators of the assessment tool. The main gap for the storage tanks is the quality and availability of input materials, while for the FPC and ETC, there are weaknesses in terms of availability of suppliers, synergetic markets and skilled labours. This means that **FPC and ETC are not promising for local manufacturing in the short term**.

The storage tank has the highest potential for local manufacturing because of the availability of synergetic markets, capabilities, specialties, needed skills and high component value as part of SWH system value according to cost structure. The gap identified is low availability of main input materials especially coating input materials.

Table 5.1 Manufacturing processes performance assessment



Processes	Capability	Skilled Labours
Electrostatic Coating	🟢	🟢
Punching	🟢	🟠
Pipe Bending	🟢	🟢
Stamping	🟢	🟠
Rolling	🟢	🟢
Machining	🟠	🟠
Casting	🟠	🟡
Sandblasting	🟠	🟠
Molding	🟠	🟡
ARC Welding	🟠	🟡
Laser Cutting	🟠	🟡
Enamel Coating	🟡	🔴
Coating	🟡	🔴
Laser Welding	🔴	🔴
Selective Coating	🔴	🔴
Evacuation	🔴	🔴

🟢	High
🟠	Meduim High
🟡	Meduim Low
🔴	Low

Table 5.2 The manufacturing processes needed per each key component

		Main Components			
Processes		Mounting Structure	Storage Tank	Flat Plate Collector	Evacuated Tube Collector
Machining		√			
Stamping		√	√	√	
Molding			√	√	√
Pipe Bending			√	√	
Laser Cutting			√	√	
Welding	ARC Welding	√	√		
	Laser Welding			√	√
Coating	Enamel Coating		√		
	Selective Coating			√	√
	Electrostatic Coating		√		
Punching			√		
Rolling			√		
Casting			√		
Sandblasting			√		
Evacuating					√

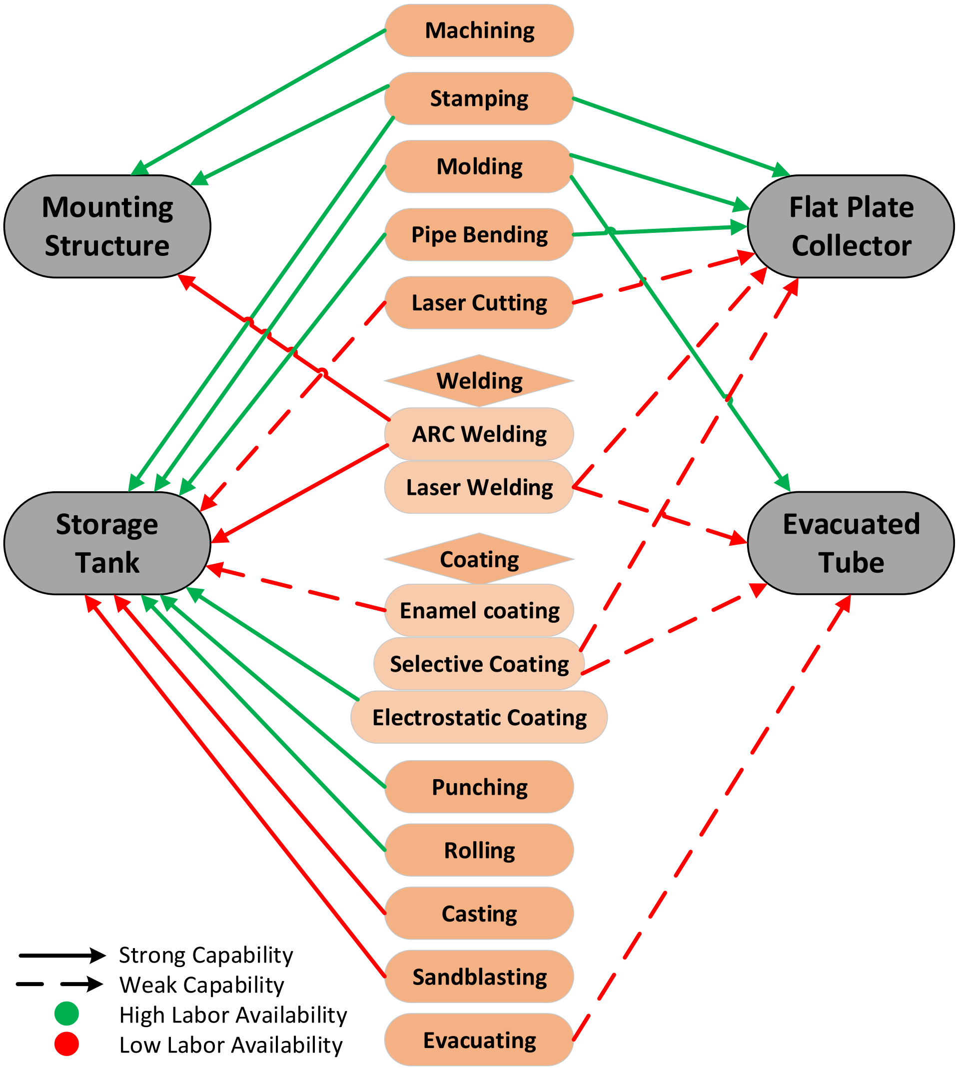
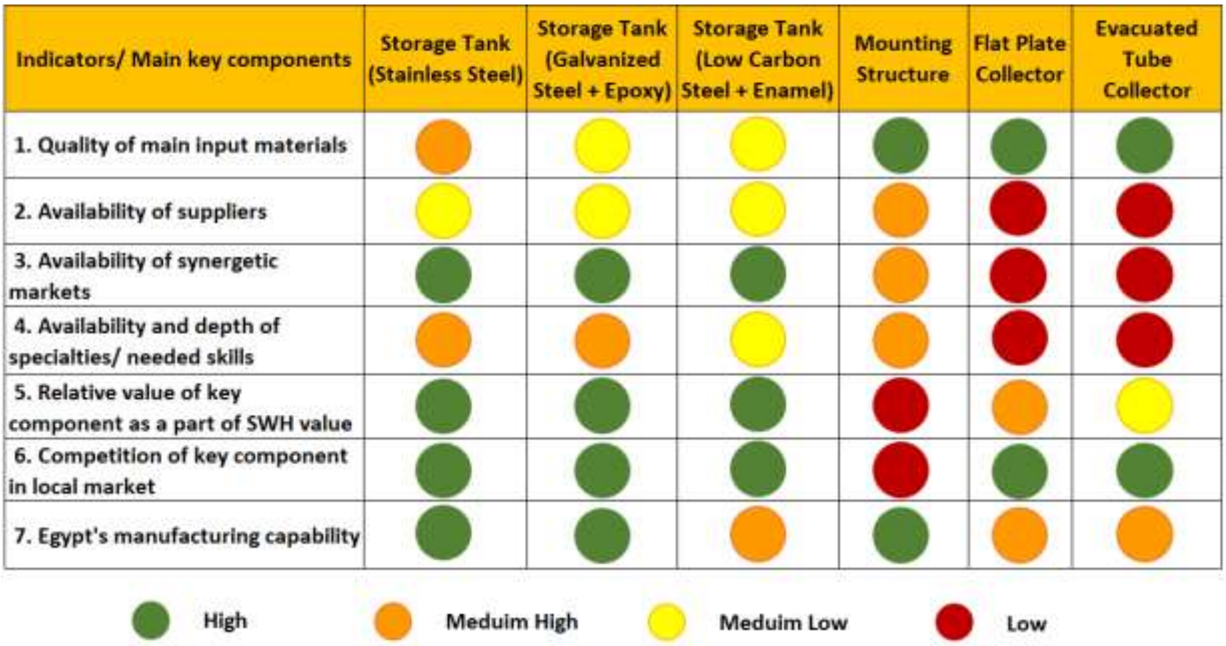


Figure 5.3 Linkages between components and manufacturing processes

Table 5.3 Final assessment of key component tool



Indicators/ Main key components	Storage Tank (Stainless Steel)	Storage Tank (Galvanized Steel + Epoxy)	Storage Tank (Low Carbon Steel + Enamel)	Mounting Structure	Flat Plate Collector	Evacuated Tube Collector
1. Quality of main input materials	🟠	🟡	🟡	🟢	🟢	🟢
2. Availability of suppliers	🟡	🟡	🟡	🟠	🔴	🔴
3. Availability of synergetic markets	🟢	🟢	🟢	🟠	🔴	🔴
4. Availability and depth of specialties/ needed skills	🟠	🟠	🟡	🟠	🔴	🔴
5. Relative value of key component as a part of SWH value	🟢	🟢	🟢	🔴	🟠	🟡
6. Competition of key component in local market	🟢	🟢	🟢	🔴	🟢	🟢
7. Egypt's manufacturing capability	🟢	🟢	🟠	🟢	🟠	🟠

🟢 High 🟠 Meduim High 🟡 Meduim Low 🔴 Low

Figure 5.4 shows the final results of the competitiveness assessment tool for the key components of the value chain scaled based on the final score on the range from emerging to very strong.

There are two scenarios resulting from the assessment as shown in the figure below. **The first scenario (S1) is manufacturing of FPC and the second scenario (S2) is assembly FPC**. The first scenario -S1- is qualified as emerging because of low availability of suppliers, synergetic markets, specialties and needed skills for manufacturing, while the second scenario -S2- is qualified as good because skilled labour in welding processes is the only needed for the assembly process.

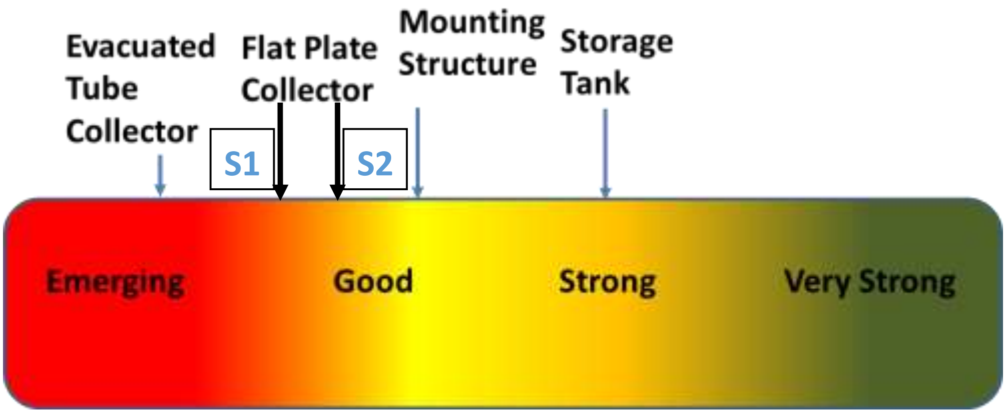


Figure 5.4 SWH main components local market manufacturing potential, S1) FPC manufacturing, S2) FPC assembly

Moreover, the assessment shows that SMEs have the potential to be integrated in the SWH manufacturing market especially in the feeding industries, since the feeding industries have strong capabilities and high availability of skilled labour in addition to the availability of high quality input materials.

SMEs can compete and play an important role in the local manufacturing of mounting structure and storage tank, since the manufacturing processes are not complicated and are customized with wide range of production capacities, and availability of skilled labour is not an obstacle according to the analysis above.

The only process that might be challenging for SMEs is the internal coating for the storage tank by using enamel coating. This process is likely to be centralized in production within few large market players taking on the investment. The reason being that enamel coating process requires high CAPEX (this will be addressed in chapter 9) and hence needs large scale production and market concentration.

As for the FPC, SMEs have great opportunities for assembling the FPC by importing the absorber and glass sheet to ensure high system performance. Capabilities and human resource are available in the local market. With capacity building for human resources, the manufacturing of FPC will be achievable.

The analysis and results of the assessment of the manufacturing capabilities and input materials in local market for the SWH value chain components in Egypt were validated through surveys with stakeholders.

5.3 Cost Competitiveness Assessment

Analysis of the cost takes into account the energy cost, raw material, labour cost, shipping, taxes and customs.

With regard to FPC, Egypt can compete locally in manufacturing components such as back sheet, insulation, aluminum sheet, fittings, which after adding labor cost and other overheads represent 47% of the system total value, while still needs to import absorber and low-iron glass sheets that represent 53% of the manufacturing cost of the FPC, Figure 5.5.

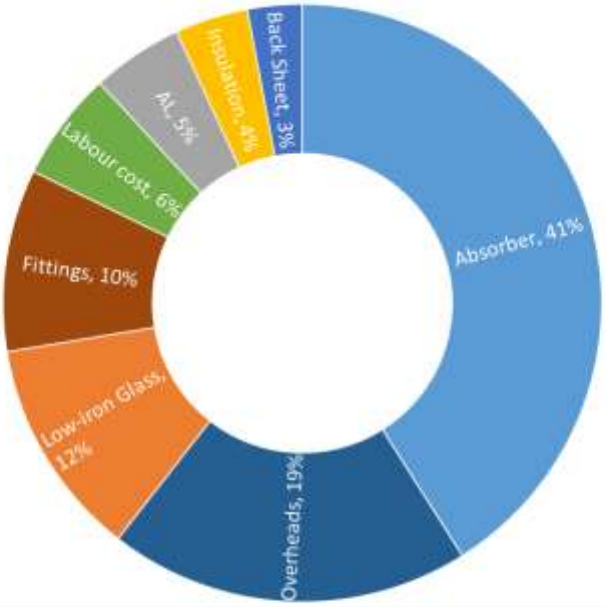


Figure 5.5 Breakdown of Flat Plate Collector Manufacturing Cost

Advantages of locally manufacturing storage tanks are higher than FPC, since **Egypt is locally manufacturing input materials that represent 72% of the total storage tank manufacturing cost** including labor cost and overheads. The rest, 28%, of the storage tank manufacturing cost is divided among relief valve (12%) and Mg rod (2%) which are imported, gasket and copper fittings (14%) which can be locally manufactured but quality control measures must be applied (Figure 5.6).

Figure 5.6 Breakdown of Storage Tanks Manufacturing Cost

5.3.1 Local Manufacturing Potential Options

Different scenarios were developed according to manufacturing competitiveness and cost structure. The scenarios vary in the degree of manufacturing versus assembling

- Mounting structure manufacturing
- Storage tank manufacturing, including back-heating element
- Flat plate collector assembly, importing absorber and glass sheet
- Flat plate collector manufacturing

As shown in Figure 5.7, local manufacturing of storage tank and mounting structure has potential in the short term. Assembly of the FPC locally is more cost competitive than importing it. In the medium term and after market growth and stability, the manufacturing of FPC locally can compete with imported items with not less than 5% reduction in manufacturing cost.

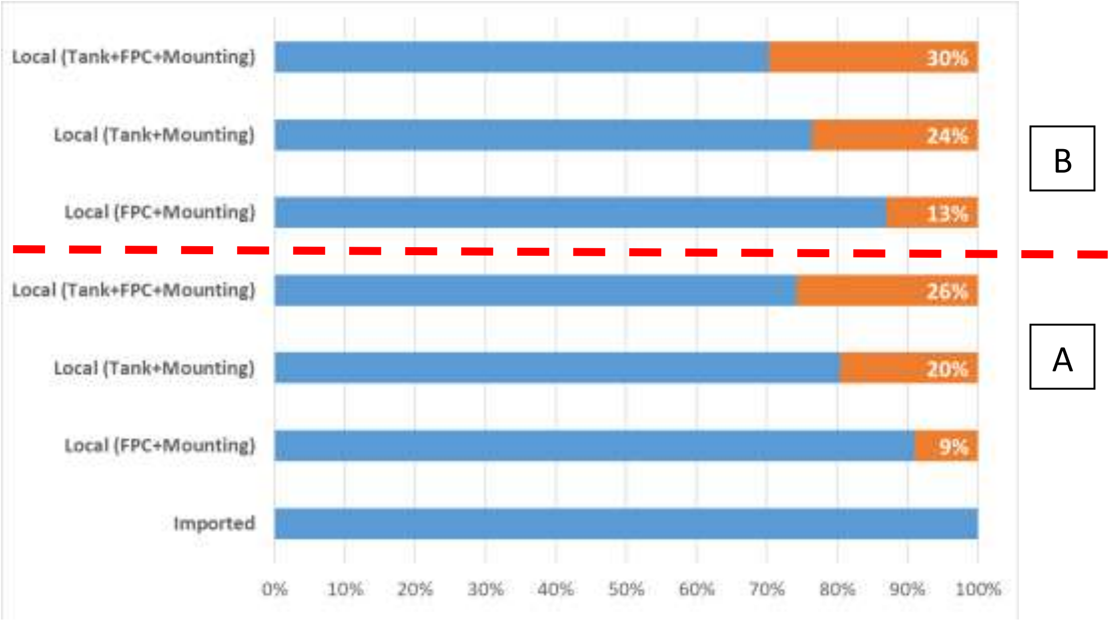


Figure 5.7 Local manufacturing SWH system competitiveness analysis, a) Current market conditions, b) Larger market and optimized product (Future)

5.4 Market Size by SWH Value Chain Component

It is important to identify and estimate the addressable technical annual market of each component and input material of the SWH value chain. This is also crucial for the local feeding industries to be able to upgrade production to absorb the generated demand.

The potential market size of storage tank and FPC amounts to 38 Million USD and 37 Million USD respectively, for the steel sheets amounts to 18.5 Million USD, and for the absorber sheets to 15.5 Million USD (Figure 5.8). The rest of SWH value chain components with technical market size lower than 10 million USD per year are the following:

- Mounting structure: 5.5 million USD
- Glass sheets: 3.7 million USD
- Aluminium frame: 1.9 million USD
- Thermal insulation: 1.5 million USD

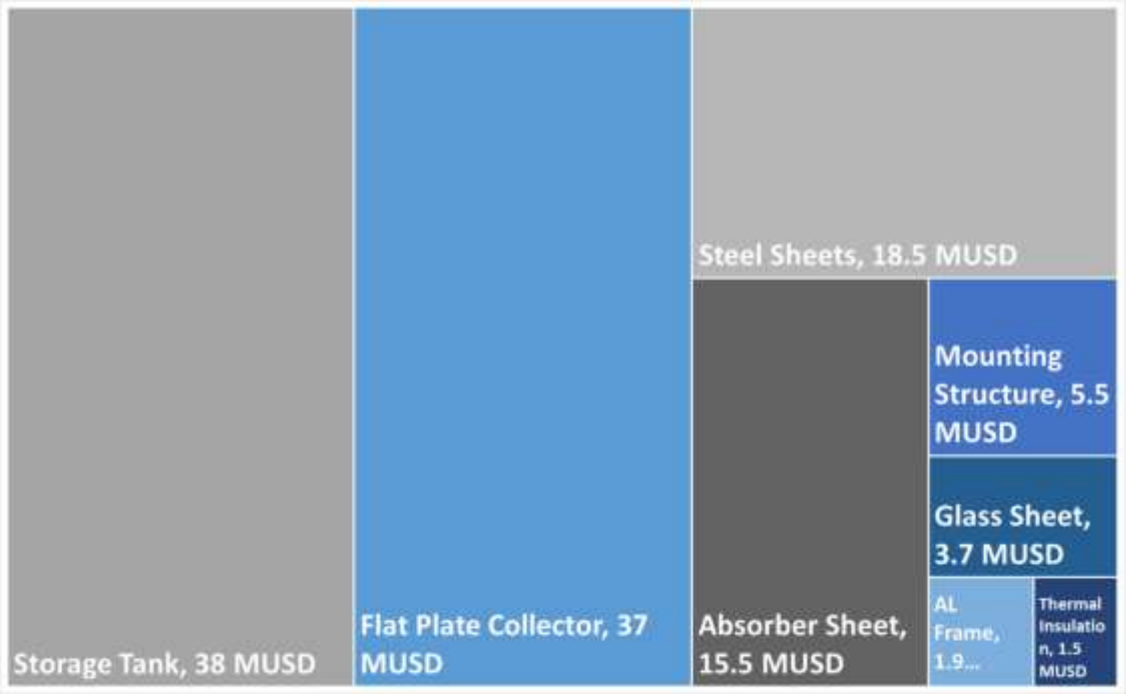
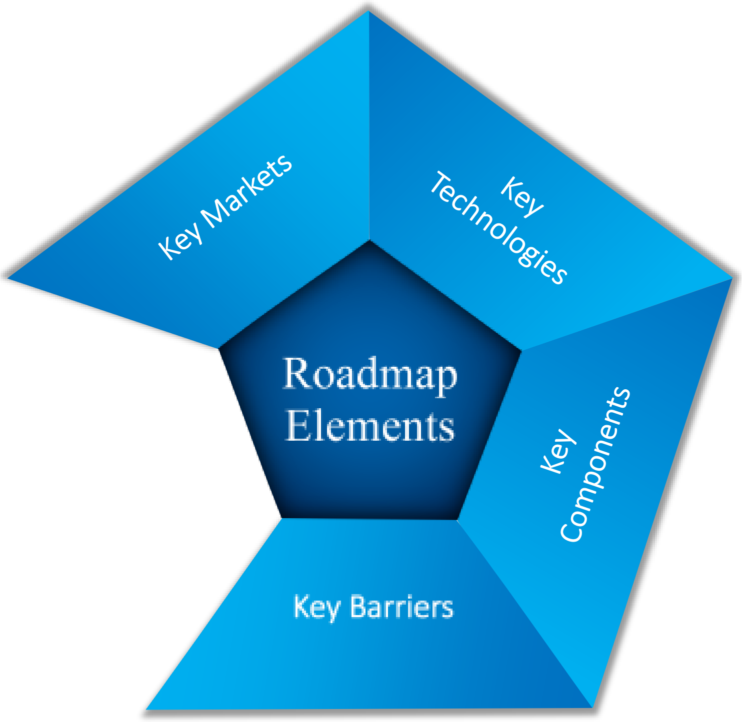


Figure 5.8 SWH value chain component addressable market size, USD value

Chapter 6. Barriers to Strengthening the Quality of Locally Manufactured Products and Components Related to SWHs and Solar Thermal Technologies in Egypt



The assessment discussed above proves that promising opportunities exist for Egypt in solar thermal components manufacturing with regard to the market, manufacturing capabilities and manufacturing cost competiveness. However, the current state of the local manufacturing of solar thermal components is lagging behind the potential promising opportunities. Chapter 6 identifies the barriers that hinder the local manufacturing of SWHs key components.

6.1 Barriers Identification

The main obstacles in the SWH local manufacturing roadmap have been identified through engaging the main players in the SWH ecosystem. Detailed scores for the different barriers are presented in Figure 6.1.

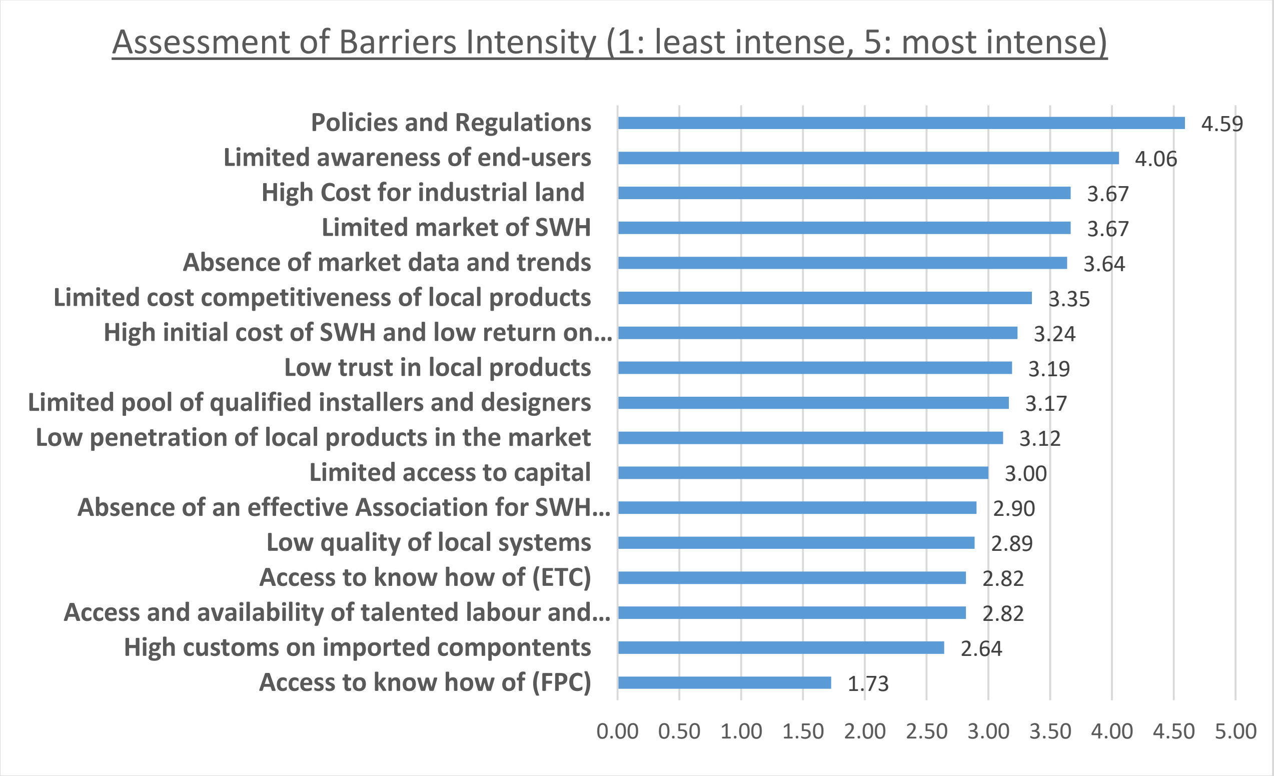


Figure 6.1 Barriers in deepening SWH system local manufacturing in Egypt

The barriers were mapped on a heat map chart representing the intensity of the barriers versus the agreement on this barrier based on the conducted surveys (Figure 6.2). The barriers are shown on the heat map with colour spectrum from red (warm) to green (cold). The red area represents barriers of highest intensity and agreements, while the green area the barriers of least intensity and agreement. Barriers in the red zone can be moved to the green zone by introducing targeted actions.

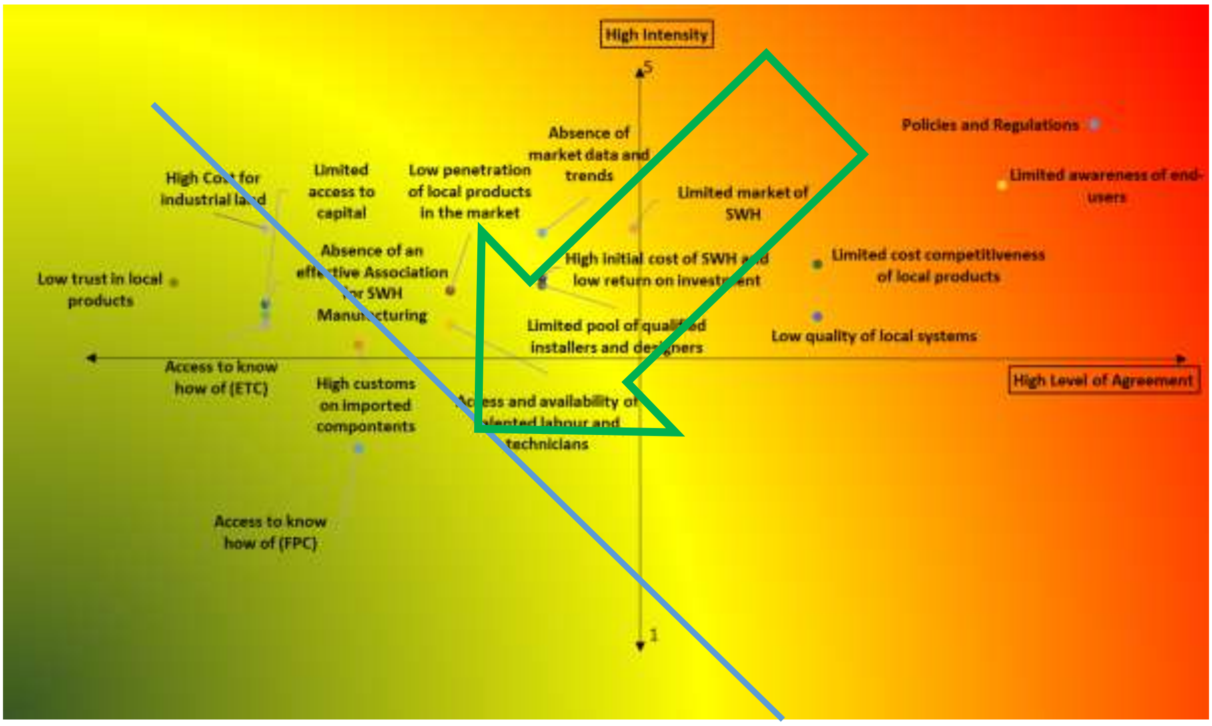


Figure 6.2 Barriers mapping against strengthening of local manufacturing of SWH according to entities' surveys

The high intensity barriers were in some cases rephrased and merged resulting in **10 main barriers** that were classified into 4 main groups representing all the SWH ecosystem, as shown is Figure 6.3.

Figure 6.3 Groups of main identified barriers

6.1.1 Barriers Related to Competitiveness and Finance

Low cost competitiveness and difficult access to finance affect both local and imported SWH products. Compared to other energy alternatives (natural gas and electricity), solar thermal heating is of high initial cost and low return on investment in different market segments. Moreover, there are no announced subsidies or grants, from neither the government nor the banking sector, that could support the end-users and improve SWH competitiveness. A well-designed financial supporting mechanism always appears as a main success factor internationally, as in the cases of Tunisia, Lebanon and South Africa.

While the high initial cost is a common barrier for both local and imported SWH, the challenge increases for local products as they suffer from low cost competiveness in the SWH market. The imported SWH systems benefit from 0% customs as per the Authority of Egyptian Customs laws, with an HS code of 84/19/19/90/00. However, there is no clear HS code identification in the Egyptian Customs for the SWH system key components. This makes importing the whole SWH system more attractive and easier than importing certain components and locally manufacturing others. Local SWH factories buy their raw materials and input components at relatively high costs including custom duties, as these inputs are generally common to other industries and cannot be easily identified as SWH or renewable energy manufacturing inputs to make use of any customs benefit or release. This barrier represents a risk for the manufacturing roadmap proposed in this report as the roadmap depends on having a mix product between imported and locally manufactured SWH components.

Furthermore, manufacturing activities for solar thermal components face limited access to capital due to lack of clear and accurate financial studies. Generally, non-traditional industries such as renewable energy are perceived as high risk by the financial institutions.

6.1.2 Barriers Related to Market Quality

The guaranteed quality of the solar thermal product itself as well as system designers and installers is a main obstacle for this emerging market.

For the quality of the product, many efforts have been exerted to control it. This includes SHAMCHI certificate and a ministerial decree from the Ministry of Trade and Industry in 2018 based on which all locally manufactured SWH must be SHAMCHI certified and imported SWH must be certified by SHAMCHI or Solar Key Mark.

Limited pool of qualified installers and designers is another barrier for achieving high quality SWH market for both imported and locally manufactured SWH. There is no Egyptian certification for any of the personnel that works in the solar thermal market. In addition, and as a new technology, the curriculum in engineering and technical institutes lack deep courses that provide the know-how and skills required for design and installation of solar thermal components. There are no certified training courses widely available. The Egyptian solar thermal market also lacks the presence of best practice demonstration projects that could represent a benchmark for high quality design, installation and maintenance practices.

Manufacturing of SWHs is not considered a complicated process and the skills required for accomplishing it are common to other well-established Egyptian industries (discussed in details in chapter 5). However, there are special critical manufacturing skills which require more training, namely in enamel coating, laser cutting and producing and applying of selective coating. The local SWH factories also need to build their capabilities in upgrading and optimizing the manufacturing process itself.

6.1.3 Barriers Related to Demand on SWH

Targeted end-users in different market segments are not aware of the SWH product. This includes the lack of basic understanding of the different technologies, the selection criteria of the suitable technology for the applications, the basic quality requirements, the maintenance and operational needs as well as the simplest financial indicators. General end-users even mix up the SWH with the photovoltaic panels used for electricity generation, being the latter more known, popular and welldemonstrated. Lack of awareness limits the demand even within the users with suitable feasibility for the solar thermal systems.

At the same time, SWH companies do not have creative and informative marketing schemes that could fill the gap in the customers' awareness. SWH suppliers and manufacturers themselves suffer from absence of reliable data and trends. This unclear vision negatively affects their business decisions in expanding in the market and investing in manufacturing.

6.1.4 Barriers Related to Demand on Local SWH products

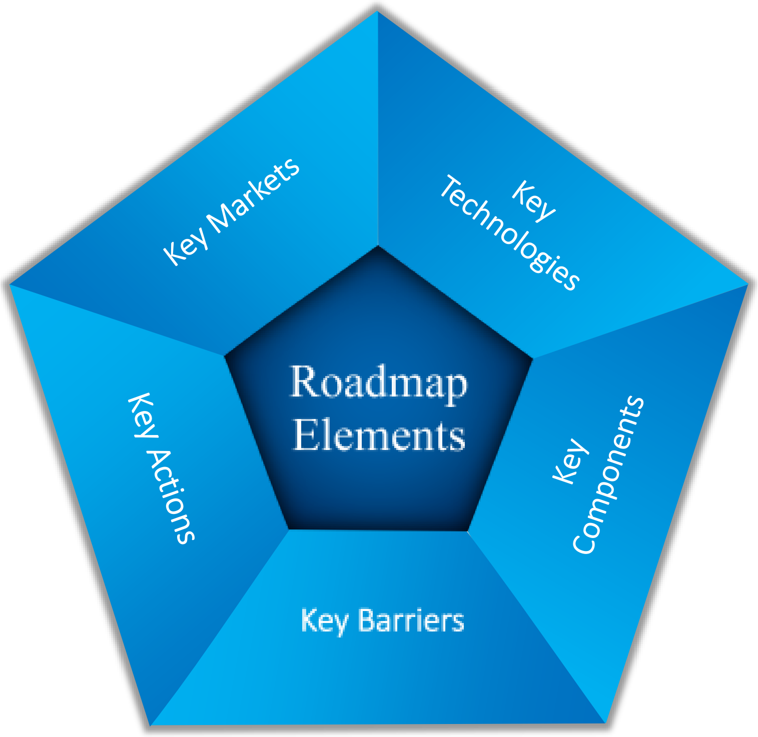
Generally, the current SWH market is limited in Egypt as previously discussed. Within this limited market, the locally manufactured SWH products suffer from low penetration and difficulties in reaching the targeted customers leaving their sales way behind the imported SWH. In the business model of the SWH local manufacturer, there is no separate line between the responsibility/task of manufacturing the product and its marketing.

Considering the fact that most of the factories can be considered SMEs, customers are worried about the factories' abilities to provide high quality aftersales services especially in the markets far from the head offices in Cairo, namely the touristic segments in Red Sea.

Low trust in local Egyptian SWH products arises from different factors. One of the factors is the negative general perspective towards locally manufactured products, especially for new and not well-established ones. Another factor is the negative experiences with local SWH in the early eighties when the SWHs were firstly introduced to the Egyptian market without clear measures to ensure the product quality. Encouraging the Egyptian manufacturers to get accredited certification for quality control and rely on testing laboratories in upgrading the quality of their products can increase the customers' trust.

Part C: Assessment of the Capacity Building, Technology Upgrade and Investment Need of Industries

Chapter 7. Technicality of Manufacturing SWH System Components (Quality and Needs)



Chapter 7 addresses the manufacturing requirements to improve quality of SWH system components.

7.1 Manufacturing SWH Components Quality

7.1.1 Main SWH System Components Quality Control

According to the analysis done in chapter 5, the main components of SWH system that are suitable for local manufacturing based on their competitiveness (process capacity and cost structure) are:

- Mounting structure
- Storage tank equipped with heat exchanger, including back-up heat
- Flat plate collector

Below a detailed analysis for manufacturing mounting structure, storage tank, and FPC as well as assembling of FPC will be presented. The analysis is shown in the form of a recommendation card, which covers input materials, specification, key manufacturing process, inspection for quality control.

7.1.1.1 Quality of Mounting Structure Manufacturing Boundaries

Table 7.1 Recommendation for manufacturing mounting structure

Item	Details	
Input Material	Steel angles, steel bolts, epoxy coating, paints	 *Figure 7.1. Mounting structure sample*[5]
Specification	• Steel Angles: 4 cm with 2-3 mm thickness • Steel bolts: diameter 10 – 14 mm • Epoxy Coating: Outdoor, withstand water and humidity • Paints: Outdoor, withstand water and humidity • Average weight: 20 kg	
Key Manufacturing Process(es)	• Surface cleaning for steal angles • Metal bending	
Quality Control Inspection	• Well stress distribution • Withstand minimum weight of 45 – 50 kg/m^2 • No unpainted areas • No cracks around ends and side of steel angles	
Note	• Avoid using welding instead of assembling by steel bolts • Importance of covering epoxy coating by outdoor paints	

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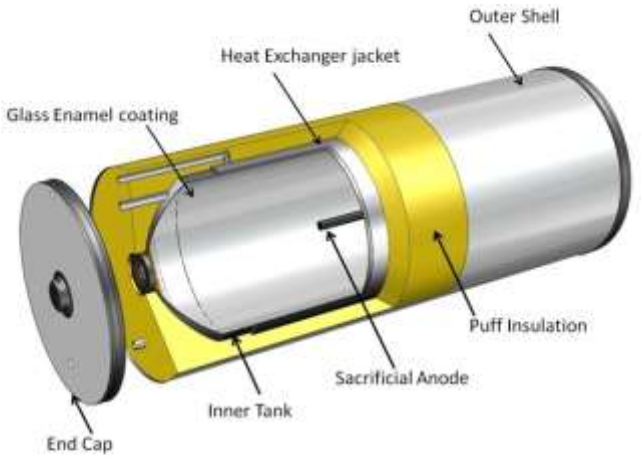
[5] Source of picture - http://www.phoenixsolar.co.in/module-mounting-structure.php

7.1.1.2 Quality of Storage Tank Manufacturing Boundaries

Table 7.2 Recommendation for manufacturing storage tank

Item	Details	
Input Material	• Inner tank: Low-carbon steel sheets • Outer tank: galvanized steel sheets • Thermal insulation between inner and outer tanks • Inner tank: internal coating • Outer tank: external coating • Copper tubes/Stainless steel tubes (Heat exchanger and back-up element)	 *Figure 7.2. Sample of double jacket storage tank*[6]
Specification	• Low-carbon steel sheets (inner tank): 2.5 - 3 cm thickness • Galvanized steel sheets (outer tank): 0.5 – 0.7 cm thickness • Thermal insulation: PU Foam density (50 – 70) kg/m^3, 40 – 50 mm minimum thickness • Internal coating: enamel coating with minimum thickness of 250 µm • External coating: Electrostatic coating, outdoor • Average weight: 28 kg	

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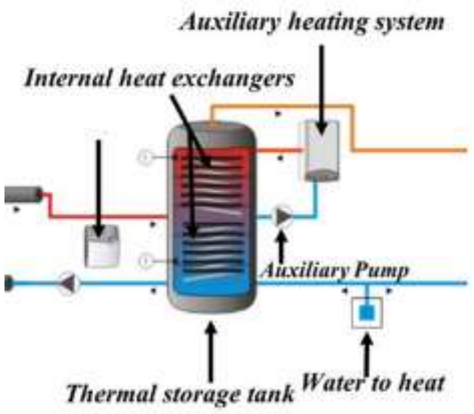
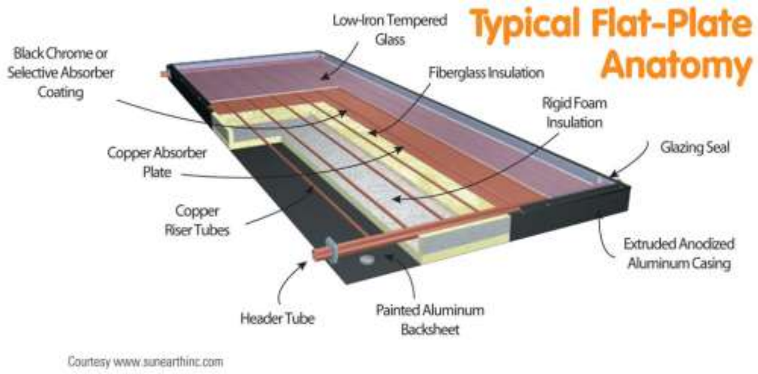
[6] Source of picture - https://www.mr10.in/coating-tank-material-water-heater/

Item	Details	
Key Manufacturing Process(es)	• Surface cleaning (sandblasting or degreasing by using chemicals) • Rolling (inner and outer tank) • Arc welding • Enamel Coating (Inner tank) • Thermal insulation curing time (in case of using foam) • Bending (Heat exchanger and back-up element)	
Quality Control Inspection	• Well stress distribution due to good rolling process • Leakage test at pressure of 10 bar gauge by using air or water • Thermal leakage test to ensure well distribution of thermal insulation (Well curing time) • Knocking test to ensure well distribution of thermal insulation (Well curing time) • No cracks at welding areas of the inner steel tank • Enamel coating thickness inspection	*Figure 7.3. Sample of embedded coil Storage tank [17]*
Note	• Not recommended to use other inner coating, to be compatible with exporting requirements • Avoid using thermal insulation sheets with aluminium foil since separation of the foil will occur and toxic gases will be released. This will affect the performance and distribution of the thermal insulation • Avoid using stainless steel sheets as material for the inner tank • Avoid using galvanized steel sheets as material for inner tank • Ensure the minimum enamel coating of 250 µm	

7.1.1.3 Quality of Flat Plate Collector Manufacturing Boundaries

Table 7.3 Recommendation for manufacturing flat plate collector

Item	Details	
Input Material	• Aluminium sheets (Back sheet) • Absorber • Thermal insulation • Glass sheets • Aluminium bars (Frame) • Gasket • Glue material • Fittings	 Courtesy www.sunearthinc.com *Figure 7.4. Sample of flat plate collector [9]*
Specification	• Aluminium sheets: 0.5 – 0.7 mm thickness • Absorber: Fins (Copper of Aluminium) with thickness of 0.1 – 0.2 mm, tube (Copper: 1/4, 3/8, 1/2 inch), tubes are laser welded with fins, selective coated • Thermal insulation: Foam density (50 – 70) kg/m^3, 40 – 50 mm minimum thickness • Glass Sheets: Low-iron tempered glass with thickness of 3 – 4 mm • Gasket (Anti-leakage): Rubber (E.P.D.M), withstand temperature up to 150 ^{o}C • Glue material: Outdoor, withstand temperature up to 150 ^{o}C • Fittings: Copper, withstand temperature up to 150 ^{o}C • Average weight: 40 kg	
Key Manufacturing Process(es)	• Surface cleaning of back sheet • Pipe bending • Arc welding • Laser cutting • Laser welding (in case of absorber manufacturing) • Thermal insulation curing time (in case of using foam)	

Quality Control Inspection	• Leakage test at pressure of 10 bar gauge by using air or water • Thermal leakage test to ensure well distribution of thermal insulation (Well curing time) • Knocking test to ensure well distribution of thermal insulation (Well curing time) • Copper fittings should withstand 10 bar gauge test • Acquiring Solar Key Mark or SHAMCI label	
Note	• Avoid using traditional glue material • Ensure good ventilation at the back side of the flat plate collector • Using ultra-clear glass sheet instead of low-iron will reduce collector efficiency by around 5% • Avoid using steel absorber tube of fins • To maximize collector efficiency, use of selective coated absorber is better than black matt coated absorber • Avoid using thermal insulation sheets with aluminium foil since separation of the foil will occur and toxic gases will be released. This will affect the performance and distribution of the thermal insulation.	

7.1.2 Main SWH System Components Quality Control

Below is a summary of the required control inspection tests and equipment to ensure the high quality of manufactured components.

Table 7.4 Equipment and tools needed for components quality control

Quality Control Tests	Reason	Requirements
Well stress distribution	Simulation should be done during design phase. Visual inspection is to be done to ensure no existence of irregular rounded ends.	Trusted simulation tools e.g. ANSYS.
Leakage test	It is done to ensure perfection of welding and no existence of cracks within the body.	Leakage test bench, it could be done by using air or water as filling fluid. The test is used to be done at pressure of 10 bar.
Thermal leakage test	It is used to ensure well distribution of the thermal insulation.	Thermal measurement of the outer surface of a sample could be done by using any measuring temperature equipment, e.g. IR thermometer, thermal camera etc.
Knocking test		Experience with such test could be replaced by thermal leakage test.
Enamel coating thickness	It is used to ensure well distribution of the internal enamel coating.	Ultrasonic thickness detector.

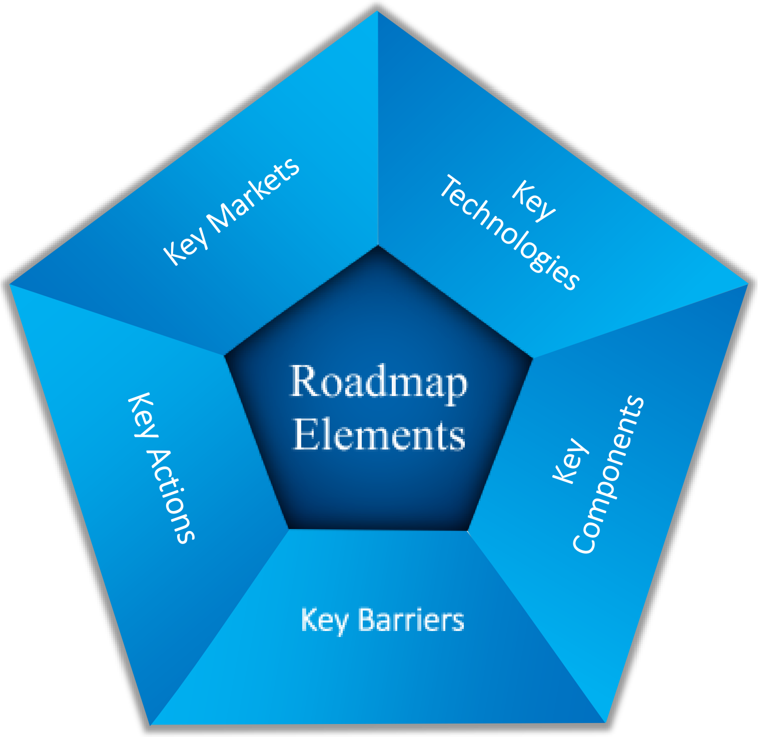
7.1.3 Main SWH System Components Manufacturer Assessment

Building on the analysis of the manufacturing capabilities competitiveness presented in chapter 5 and the SWH system main components that are suitable for local manufacturing (storage tank, mounting structure and FPC), an assessment of the SWH system feeding industries and the manufacturers of SWH system components was conducted. Table 7.5 shows the gaps related to manufacturing of SWH in Egypt and recommended actions to be taken to develop the local manufacturing of SWH and ensure sustainability of the system, addressing both technical needs and business development needs. Part of these gaps and recommendations have been discussed previously in the report and will be addressed in details in Chapter 9.

Table 7.5. Gaps and recommendations for feeding industries and SWH components manufacturer

Item	Needs	Constrains	Recommendations
Manufacturing Processes	Laser welding, selective coating, enamel coating	High initial investment and absence of sustainable growing market	• Improve access of local manufacturers to financial institutions • Provide capital subsidies (grants) for selected consumer segments • Improve access to low interest loan for selected consumer segments
Skilled Labor	Laser welding, selective coating, enamel coating, laser cutting, arc welding, molding, casting.	Availability of skilled labors, high daily rates given by other industries.	• Capacity building for labors • Develop vocational programs on selected manufacturing processes
Manufacturing Entity	Production process flow and acquiring ISO certification.	Inconsistence flow for production processes.	• Access to international experts • Joint ventures with international firms
Product Certification	Acquiring Solar Key Mark or SHAMCI label	End-market awareness and high cost of testing.	• Improve access to testing facilities • Upgrade quality control and quality assurance measures
After-sales	Bad reputation of using SWH in Egypt.	Availability of skilled technicians and installers.	• Enhance marketing and after sales services • Implement demonstration projects and disseminate results • Certification for installers and technicians • Capacity building for installers and technicians
Business Development	Manufacturing feasibility studies and installation of SWH system feasibility.	Availability of designers and experts.	• Provide support in business development and marketing • Support student exchange programs • Develop curriculum at universities for design and manufacturing

Chapter 8. SWH Investment Opportunities Feasibility Studies



As discussed in chapter 5, based on technical and financial aspects, in the short term it is feasible to manufacture locally the mounting structure and storage tank with its auxiliaries, as well as assemble locally the FPC; while in the medium term, it is feasible to manufacture locally the FPC. Chapter 8 presents the results of the feasibility analysis of the different scenarios for manufacturing SWH components.

8.1 Manufacturing SWH Components Feasibility

Feasibility studies for the four manufacturing opportunities in the SWH market were developed by the consultant team, through an analysis of demand and supply, manufacturing process, infrastructure, risks and mitigation measures:

- BO #1: **Locally Manufacture of Enamel Coated Storage Tank and Mounting Structure including Back-up Heat Element**

- BO #2: **Locally Manufacture of Storage Tank and Mounting Structure including Back-up Heat Element, Outsourcing of Enamel Coating Process**

- BO #3: **Locally Assemble of Flat Plate Collector and Manufacture of Mounting Structure**

- BO #4: **Locally Manufacture of Flat Plate Collector and of Mounting Structure**.

These feasibility studies are applicable also to existing local manufacturers of parts of the SWH value chain looking for upgrading by increasing the share of the local product in the SWH value chain.

The general macroeconomic assumptions used to develop the four business opportunities feasibilities are as follows:

- CPI Inflation annual average: 16%
- Equity: 100%
- Cost of capital: 21.09%
- Terminal Growth of Company: 2%
- Tax rate: 22.5%

A summary of the different feasibility studies is shown in. It does not make much sense to compare between the 4 feasibility studies since the market requires the existence of all types of manufacturing possibilities to ensure its sustainability. Market dynamics must include both centralized and decentralized factories. For example, enamel coating is recommended to be a centralized industry while assembling FPC and manufacturing storage tank without coating could be a decentralized industry.

Table 8.1. Conclusion of the proposed business opportunities

Business opportunity	Initial CAPEX (EGP)	Payback	IRR	Net Present Value (EGP)	Profitability Index
BO #1: Locally Manufacture of Enamel Coated Storage Tank and Mounting Structure including Back-up Heat Element	22,010,000	3.3	37.0 %	2,381,119,000	19.9
BO #2: Locally Manufacture of Storage Tank and Mounting Structure including Back-up Heat Element Outsourcing Enamel Coating Process	4,260,000	2.7	52.2 %	284,067,000	81.8
BO #3: Locally Assemble of Flat Plate Collector and Manufacturing Mounting Structure	2,060,000	4.6	25.8 %	72,301,000	43.5
BO #3: Locally Manufacture of Flat Plate Collector and Manufacturing Mounting Structure	13,160,000	5.6	14.8 %	62,748,000	6.7

A summary of the proposed business opportunities for the local manufacturing of the main components of the SWH value chain by using payback and IRR is shown in Figure 8.1.

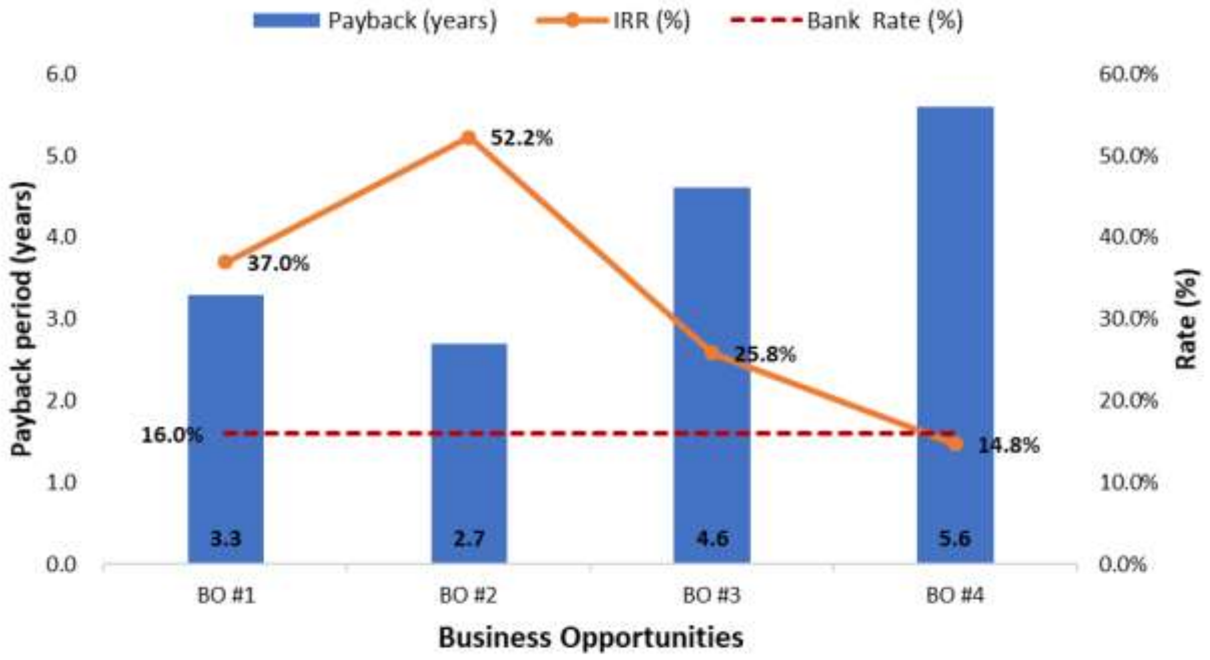
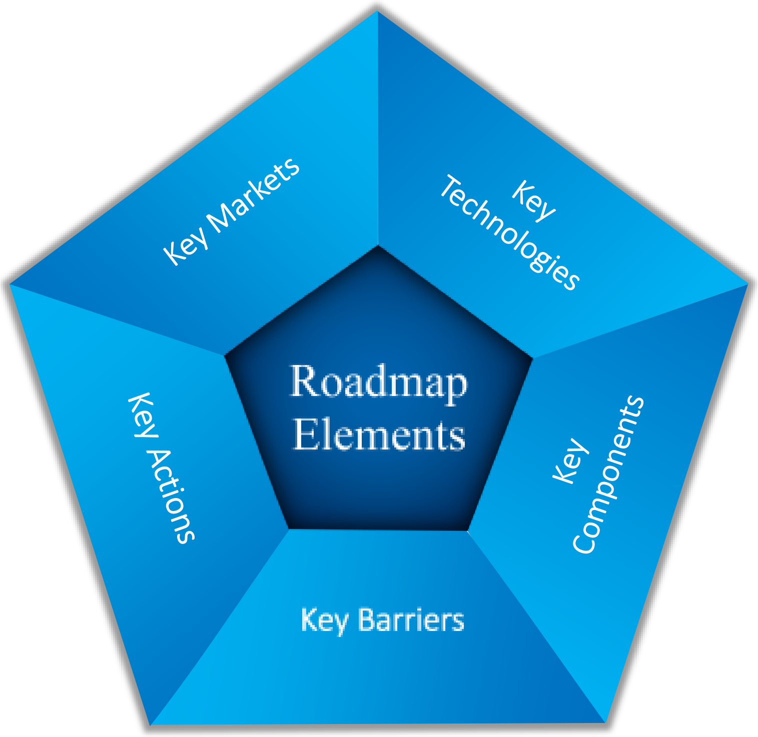


Figure 8.1. Summary of payback and IRR of the proposed business opportunities

Part D: Development of a Roadmap for Strengthening the Local Manufacturing of Solar Water Heaters and Solar Thermal Technologies and Related Components in Egypt

Chapter 9. Actions for Developing SWH Local Market



The analysis conducted has proved that Egypt has a significant potential for manufacturing high quality SWH in terms of both cost structure and manufacturing capabilities (Chapter 5). Short, medium and long term manufacturing potential could be addressed if the barriers on the road were paved by the appropriate actions. The barriers hindering the local SWHs manufacturing were captured and analysed in chapter 6. In this chapter, the action plan to capitalize on the opportunities and overcome the barriers are discussed in details, together with the implementation timeframe and govrernance.

9.1 Development of Key Actions Groups and Main Action plan

The identified barriers were grouped into 4 main groups according to the impact on the local SWH market. The mapping of actions groups with respect to barriers groups are presented below to ensure that the roadmap actions comprehensively address the four identified barriers groups as well as the four sides of the SWH market, demand, supply, financial services and market regulations.

Table 9.1 Main group of actions vs. main groups of barriers

Key Actions Groups	**Key Barriers Groups**
Group 1: Raise Quality of locally manufactured SWHs and associated services	Group 1: Demand on local SWH products
Group 2: Increase Demand on SWHs	Group 2: Demand on SWHs
Group 3: Improve Competitiveness of Locally Manufactured Products	Group 3: Competitiveness and Finance
Group 4: Enhance The Market Quality of Products and Services	Group 4: Market Quality

A total of 21 actions are recommended (Figure 9.2), encompassing a variety of tools addressing the four sides of the SWH market (

Figure 9.1). Two regulatory tools are suggested: regulations related to adjusting HS codes and streamlining customs (Action Group 3), and for installers/designers certifications (Action Group 4). Three financial actions are suggested: grants, low interest loans for selected consumers' segments, and subsidies (Action Group 2 and Action Group 3). Ten actions about capacity building and know how transfer are proposed. Six actions for data dissemination and awareness raising interventions are suggested: demonstration projects, outreach campaigns and dissemination of roadmap findings (Action Group 1 and Action Group 2).

Figure 9.1 Roadmap actions implementation tools

The consultant team has developed an action plan to capitalize on the opportunities and overcome the barriers. In Figure 9.2, an overview of the actions and implementation timeframe is presented. The actions will be explained in details throughout the next sections. According to timeframe, actions were classified as: short term actions (up to 1 year) i.e. the starting phase, medium term actions (1 to 3 years) i.e. building up the base, and long term actions (3 to 5 years) for the acceleration then the consolidation of the scene.

Figure 9.2 Overview and timeline of recommended actions

9.2 Key Actions for Developing SWH local Market

Eighteen actions are led by stakeholders and 7 by private sector. Five actions are based on linkages and connections. Nineteen actions are to be started in the short and medium term during the implementation of the roadmap (Figure 9.3).

Figure 9.3 Analysis of the roadmap actions

Action group 1, raise the quality of locally manufactured products and associated services, consists of 5 actions: access to international experts, access to testing facilities, capacity building for labour, joint ventures with international firms, vocational programs, upgrade quality control/assurance (Figure *9.4*).

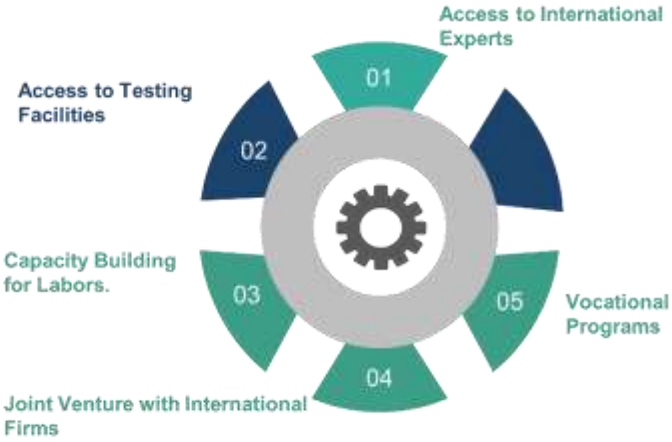


Figure 9.4 Group 1: Actions to raise the quality of locally manufactured products and associated services with number of sub-actions in each

Action group 2, **increase demand on SWHs**, consists of 7 actions: awareness raising, market data, demonstration projects, grants for consumers, access to loans for consumers, business development and marketing, enhance marketing and after sales (Figure 9.5).

Figure 9.5 Group 2: Actions to increase the demand on SWH with number of sub-actions in each

Action group 3, improve competitiveness of locally manufactured products, consists of 4 actions: streamline customs, revise customs values, disseminate identified manufacturing opportunities, and improve access to finance for local manufacturers (Figure 9.6).

Figure 9.6 Group 3: Actions to improve competitiveness of locally manufactured products with number of sub-actions in each

Action group 4, **enhance the market quality of products and services**, consists of 4 actions: certification for installers and designers, capacity building for installers and designers, student exchange programs and developing university curricula (Figure 9.7).

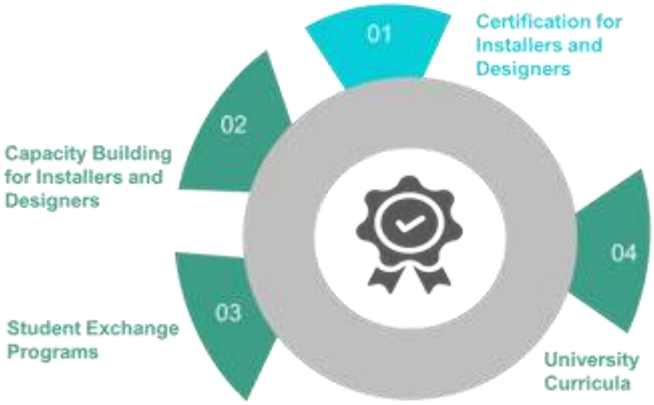


Figure 9.7 Group 4: Actions to enhance the market quality with number of sub-actions in each

The roadmap will illustrate for each action various sub-actions. Each sub-action will be defined by responsible stakeholders, lead stakeholder, duration for implementation, recommendations and threats.

Responsible stakeholders will have the responsibility to act and implement the sub-action with no conflict with other stakeholders within the roadmap.

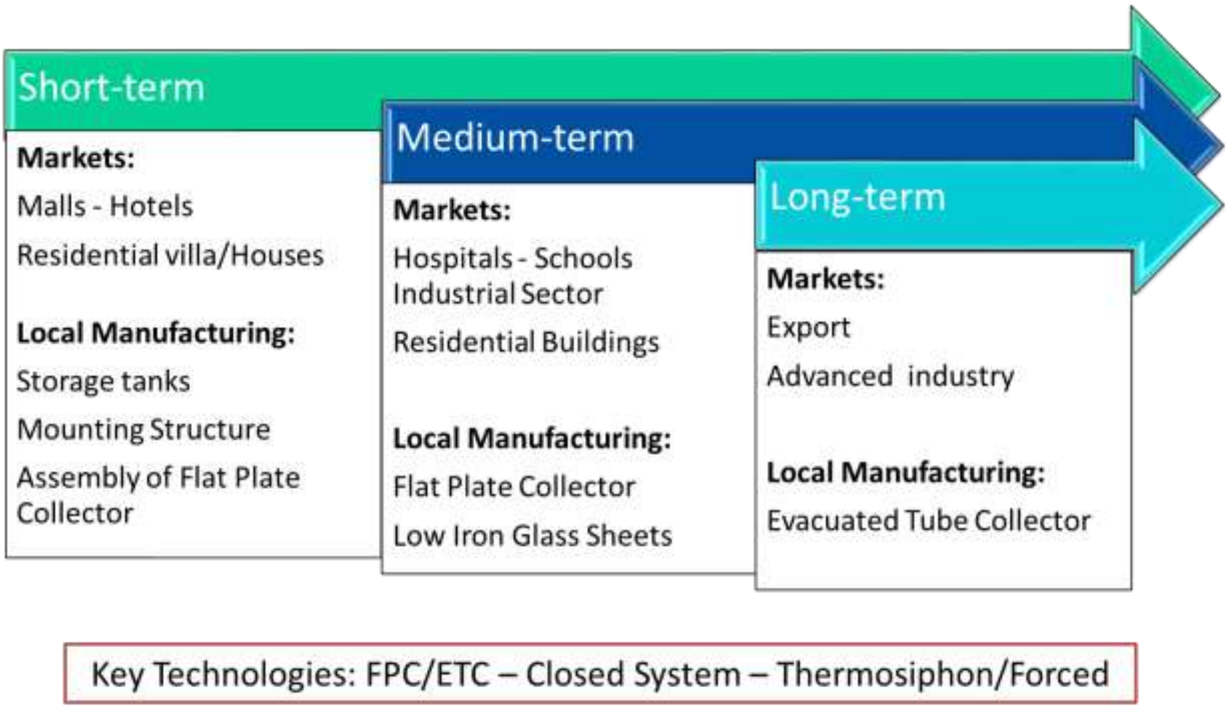
The lead stakeholder is the main stakeholder who is responsible in front of the steering committee to ensure progress in implementation of the sub-action, invite participants meetings, and follow up on each responsible stakeholder within the sub-action.

The duration of implementation was estimated by the consultant team and then endorsed by each responsible and lead stakeholder.

For each action, a list of recommendations is defined by the consultant team to ensure successful implementation of the action. Some actions could face threats during implementation due to conflict with other market constrains.

Details of each phase are in project documents.

The below figure illustrates the target markets, technologies and components for strengthening the SWH local manufacturing in the short, medium, and long term.



9.3 Governance

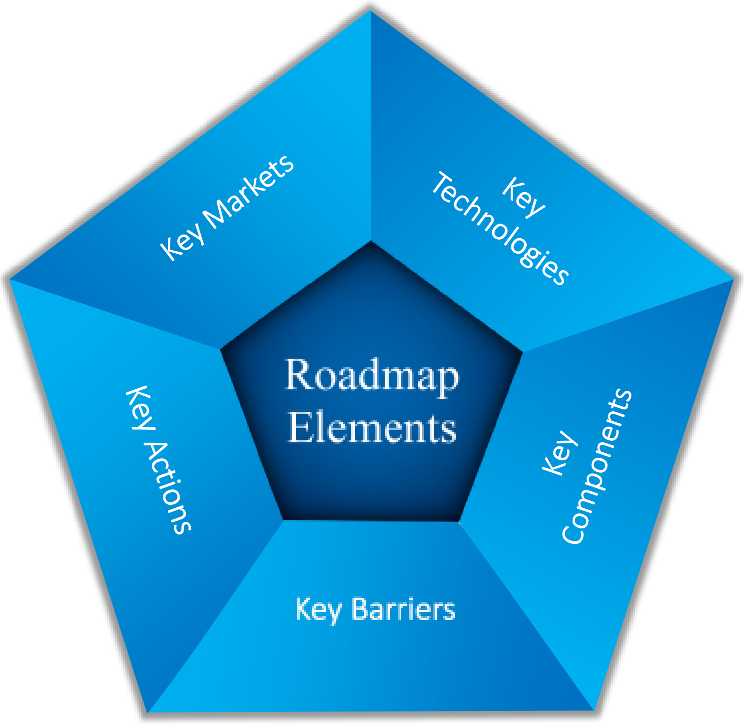
The roadmap governing structure will depend on a standalone steering committee that can continue working after the conclusion of the SHIP project.

The main roles of the steering committee are the following:

- Coordinate the roadmap activities
- Follow up on implementation
- Streamline initiatives

The committee will be chaired by UNIDO until the end of SHIP project, co-chaired by IMC that will be initially host and co-chair and then lead after the conclusion of the SHIP project. Private sector representatives and key public stakeholders will be within the main structure of the committee. UNIDO/IMC will be responsible for the committee structure, duties and responsibilities, action plan, as well as for organizing the committee meetings. The committee will meet biannually in the first 2 years, then meetings will be quarterly in the years 3-5.

Chapter 10. Estimate of the Benefits of Income Generation, Job Creation and Skill Development



Chapter 11 concludes the report by assessing the environmental and job creation impact of realizing the technical market size for SWH in Egypt.

10.1 Environmental impact

10.1.1 Replacement of the heating source used

Different types of energy are used for water heating applications in each sector, which can be replaced by SWH systems. Table 10.1 summaries these heating sources and their CO_2 emissions factors:

- Electricity, consumed in electric heaters in residential and some commercial sectors. Solar water heating can replace these electric heaters.
- Natural gas or diesel, consumed in steam or hot water boilers in industrial and some commercial sectors. Solar water heating can reduce fuel consumption of either natural gas or diesel boilers by preheating the feed water into the boiler.

Table 10.1 CO_2 emissions factors for the different types of traditional heating sources used for heating water[7]

SOURCE OF HEATING	UNIT	TCO_2
ELECTRICITY	kWh	0.000544
NATURAL GAS	m^3	0.002279
DIESEL	m^3	2.85862

10.1.2 Equivalent Conversions

The potential reduction in CO_2 emissions from replacing all traditional sources of water heating can be represented using different equivalence conversions as follows:

Table 10.2 Different equivalency conversion factors for CO_2 emissions

Source	Unit	TCO_2
Oil barrels	Barrel	0.4486
Coal	ton	2.3654
Gasoline	m^3	2.85862
Railcar of coal	Railcar	223.68
Gasoline tanker truck	Truck	35.55
Passenger car drive	km	0.00034
International flights	Passenger.km	0.0966
Incandescent bulbs	Bulb/year	0.03036

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[7] D. R. Gómez et al., “Volume 2: Stationary Combustion,” 2006 IPCC Guidel. Natl. Greenh. Gas Invent., 2006.

Propane cylinder	Cylinder	0.04076
Smartphones charged	Smartphone	0.000007672
Hotel stay	Room	0.0678
Urban trees	Tree	0.06

10.1.3 Results of environmental impact

Installing solar water heating for the targeted markets in the residential, commercial and industrial sectors will achieve a total reduction in CO_2 emissions by 105,000 tCO_2 corresponding to 231,800 MWh savings in thermal energy. It is obvious that since the residential sector represents the majority of the potential technical market size, it is also the sector accounting for the majority of the total saved energy and in CO_2 emissions.

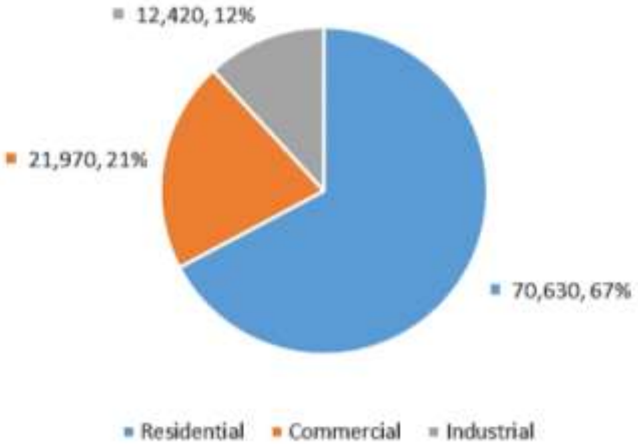

Figure 10.1 CO_2 emissions reduction percentage by each sector

The environmental impact of implementing the pre-mentioned market size of each sector in terms of CO2 emissions reductions, taking into account general equivalence factors, and thermal energy savings is presented in Figure 10.2.

Figure 10.2 Equivalent conversions for the total CO_2 emissions reduction

10.2 Job Creation

According to IRENA (2018)[8], global renewable energy employment reached 10.3 million jobs in 2017 compared with 2012, an increase of 5.3 %. Employment is created across all phases, from construction and implementation, manufacturing of value chain components, till operation and maintenance of renewable energy systems.

The employment generated can be categorized into direct and indirect jobs. SWH systems are produced by people working in SWH factories to manufacture the storage tank and all other components, all the job created to produce SWH systems are direct jobs. Moreover, SWH systems also create jobs in other industries such as the steel and coating industries that are used in SWH components manufacturing, and this are indirect jobs.

The employment factor approach is a method to measure direct jobs, i.e. the number of jobs created per unit of produced product or service. The relation between direct and indirect jobs depends on the development level of the respective industry. If the industry is domestically integrated, i.e. most intermediate goods are also domestically produced, the factor is typically around two; meaning that the amount of indirect jobs created are much as that of direct jobs. If most inputs are imported, the

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[8] IRENA, “Renewable Energy and Jobs - Annual Review 2018, International Renewable Energy Agency, Abu Dhabi,” no. December, pp. 1–28, 2018.

amount of jobs created decreases[8]. Applying the employment factor approach to estimate the employment impact, the measure is job per capacity installed expressed in physical units, such as megawatt for heat-producing technologies (MW_{th}), or square meter solar water heater collector surface.RECREE[9] developed a tool to calculate the employment in renewable energy based on available data. This tool is based on different online calculations tools such as JEDI model, database from IRENA and ILO Green Jobs website.

In Table 10.3, the employment factors are derived dividing jobs in Egypt per square meter of SWH collector surface. Construction and installation phase is the one that needs large number of labourers per square meter, followed by operation and maintenance phase, while the manufacturing phase creates the least number of jobs.

Table 10.3 Employment factor of Solar Water Heaters for Egypt

Employment Factor of Solar Thermal for Egypt – RECREE ,2017		
(Jobs/m^2)	Construction and installation	11.03
	Manufacturing	0.0043
	Operation and maintenance	0.8

The number of jobs per phase and sector can be calculated based on technical annual market size for the three main sectors in square meter of SWH collector areas (Table 10.4 and Table 10.5)

Table 10.4 Technical Annual Market Size in m^2

Technical Annual Market Size in m^2	
Malls	3,330
Hospitals	6,330
Schools	1,300
Hotels	45,600
Industrial	54,750
Residential	182,000

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[9] A. L. Ulrike, B. Maximilian, H. Anhar, and Youssef, “The Socio-Economic Impacts of Renewable Energy and Energy Efficiency in Egypt Local Value and Employment,” Rcreee, 2017.

Table 10.5 Number of jobs in each phase for each sector

Number of Jobs / Phase	Mega Malls	Hospitals	Schools	Hotels	Industrial	Residential	Total
Construction and installation	36,730	69,820	14,330	502,960	603,890	2,007,450	**3,235,180**
Operation and maintenance	2,660	5,060	1,040	36,480	43,800	145,600	**234,640**
Manufacturing	14	27	6	195	235	780	**1,257**

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