LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

THE EVOLUTION OF THE SOLAR WATER HEATERS MARKET IN LEBANON

2012-2017 and beyond

July 2019

FOREWORD

Back in 2010, then-Minister of Energy and Water Mr. Gebran Bassil launched a national initiative to develop the use of solar water heaters in Lebanon with the theme “a solar water heater for every citizen”. This initiative resonated with the work that the United Nations Development Programme (UNDP) was doing at that time to promote solar water heaters in partnership with the Ministry of Energy and Water. During that year, the Ministry pledged the objective of reaching 1 million square meters of solar water heaters by 2020.

Since then, Lebanon has witnessed a remarkable momentum in the installation of solar water heaters all over the country. This momentum continues today, 9 years after the first initiative launched in 2010. The development of solar water heaters is one main contributor to the national objective to reach 12% of renewable energy by 2020.

This current report presents- using a quantitative and qualitative methodology- the development of the solar water heater market in Lebanon between 2012 and 2017, ending with the recommendations on how to boost the market until we reach our 2020 objectives. On behalf of the Ministry of Energy and Water, it gives me great pleasure to witness this report seeing the light.

The Ministry reiterates its commitment to develop not only solar water heaters in the country, but also all types of renewable energy, including solar, wind, and hydroelectricity. Special attention will be given by the Ministry to develop the technology of heat pumps.

This report shows that we are on the right track, although more efforts need to be invested to complete the last mile of the race. Thanks to the subsidized loans offered by the Central Bank of Lebanon (BDL), the market will keep moving forward. With the support of all national players and international friends, we are sure that our efforts will lead to achieving the national targets set for our country.

Nada Boustani Khoury
Minister of Energy and Water

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A major part of this report is based on the quantitative data and results compiled within the report entitled "The Residential Solar Water Heater Market in Lebanon 2012-2015" prepared in April 2016 by the LCEC within the scope of the MED-DESIRE project (Mediterranean Development of Solar Initiatives and Renewable Energies, co-funded by the European Union through the ENPI CBC MED program), with contribution from Mr. Rani Al Achkar, Mr. Majd Chaaya (then-LCEC Intern), Mr. Mohammad Hammad (then-LCEC Intern), and Mr. Haykal Khalil (then-LCEC Energy Engineer).

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Abbreviations

BDL	Banque du Liban (Central Bank of Lebanon)
BLC	Banque Libanaise pour le Commerce
BLF	Banque Libano-Française
BLOM	Banque du Liban et d'Outre-Mer
BSL	Bank of Syria and Lebanon
CL	Crédit Libanais
CO_2	carbon dioxide
COP	Conference of Parties
EDL	Electricité du Liban
EE	Energy Efficiency
FNB	First National Bank
FP	Flat Plate
GEF	Global Environment Facility
GHG	greenhouse Gas
HTF	Heat Transfer Fluid
IBL	Intercontinental Bank of Lebanon
ICA	International Copper Association
IRI	Industrial Research Institute
JTB	Jammal Trust Bank
kton	kilo (1,000) ton
kWh	kilowatt-hour
L	liters
LCEC	Lebanese Center for Energy Conservation
MED-DESIRE	Mediterranean Development of Support schemes for solar Initiatives and Renewable Energies
MEW	Ministry of Energy and Water
MWh	megawatt-hour
NEEAP	National Energy Efficiency Action Plan
NEEREA	National Energy Efficiency and Renewable Energy Action
NREAP	National Renewable Energy Action Plan
QSWHC	Qualified Solar Water Heater Companies
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RE	Renewable Energy
SHAMCI	Solar Heater Arab Mark and Certification Initiative
SKM	Solar Keymark
SLCB	Syrian Lebanese Commercial Bank
SWH	Solar Water Heater
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars
VT	Vacuum Tube
WEC	World Energy Council

Executive Summary

In 2009, at the 15th session of the Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen, Denmark, the Lebanese Government made a pledge to develop renewable energy (RE) to reach 12% of the projected total electricity and heating demand in Lebanon by 2020. For this, the Lebanese Center for Energy Conservation (LCEC) and the Ministry of Energy and Water (MEW) developed multiple plans that were outlined in *The National Energy Efficiency Action Plan for the Republic of Lebanon-NEEAP 2011–2015 (LCEC, 2012) and The Second National Energy Efficiency Action Plan for the Republic of Lebanon-NEEAP 2016–2020 (LCEC, 2016) and The National Renewable Energy Action Plan for the Republic of Lebanon 2016–2020* (NREAP) (LCEC, 2016). These reports detail how the energy efficiency (EE) and RE goals will be reached. NREAP includes targets for different RE technologies, including solar water heaters (SWHs). The target for SWHs is based on the Global Solar Water Heating Market Transformation and Strengthening Initiative, a joint program launched in 2009 by the United Nations Development Programme (UNDP) and United Nations Environment Programme (UNEP) and funded by the Global Environment Facility (GEF) and the International Copper Association (ICA).

According to NREAP, SWHs should reach an installed surface area of 1,054,000 m^2 in 2020. This study assessed progress toward goals for installed capacity of SWHs and the evolution of the Lebanese SWH market. Recommendations on how to improve the market are proposed along with an estimation of their impact.

In November 2010, a financial incentive program ("the SWH Program") was put in place to motivate potential Lebanese SWH customers. The SWH Program is still operational. It consists of low interest loans for all SWH systems (these loans were made at a 0% interest rate in November 2010 after which the mechanism was restructured and the interest rate increased as detailed in Annex 1) and a 200 US dollar (USD) subsidy only for qualified systems included on the LCEC list of qualified solar water heater companies (QSWHC). This list is issued quarterly on the LCEC website. In addition to qualified systems, some systems or components on the list are labelled as "passing". Passing systems are not eligible for the USD 200 subsidy.

As of December 2017, the total installed surface area of SWHs in Lebanon exceeds 608,000 m^2. Of this surface area, more than 390,000 m^2 (with a total capacity that exceeds 25 million liters [L]) were installed after beginning of the SWH Program.

Vacuum tubes (VT) and flat plates (FP) are the prevailing SWH technologies used in Lebanon. VT SWHs represent 65% of the market. Both technologies have advantages and disadvantages, but two features seem to lead to a preference for VT over FP SWH technology in Lebanon: (1) VT uses less space and (2) VT can heat a larger quantity of water in the same surface area.

Lebanese SWH companies are experiencing a reliable market; demand for SWHs is constant in most years and growing in others. A significant portion of the SWH market is manufactured in Lebanon and imported components come mainly from three countries: China, Germany, and Turkey.

In terms of installed number of SWH systems and installed capacity, Mount Lebanon has the highest share of the SWH market, followed by the North while the South comes in last place. The top five districts in number of installed SWH systems are Metn, Nabatieh, Koura, Beirut, and Kesrouan. Together, they represent 43.2% of the total market, while the five lowest ranking districts combined represent 1.6% of the market. It should be noted that Beirut, the most populated area in Lebanon where almost half of the Lebanese population lives, has almost a 10^{th} of the total installed Lebanese SWH systems. Beirut suffers from land scarcity as it consists mostly of high-rise apartment buildings and has limited roof space on which to place SWHs. This issue can be overcome by combining heat pump technology with SWHs.

Other districts such as Hasbaya, Hermel, Jezzine, Rashaya, and Western Bekaa are lacking in development of SWHs and could provide opportunities for SWH companies. These districts seem to be gaining slowly in market share; therefore, a plan to boost their solar economy could be beneficial.

The commercial banks have played an important part in the success of the SWH Program. Lebanese banks have granted low interest loans for installation of 14,398 SWHs. In addition to the loans, the USD 200 subsidy was also used to support installation of 7,262 of these SWHs, representing a total subsidy of USD 1,452,400 by December 31, 2017.

Energy production from SWHs in Lebanon contributes to the achievement of RE targets and national commitments for reduction in greenhouse gas (GHG) emissions. Up to 2017, SWHs have reduced energy production in Lebanon by 239,820 megawatt-hours (MWh)/year (y) and offset the yearly emission of 156 kilotons (ktons) of carbon dioxide (CO_2). This sector has also created more than 1,000 jobs in Lebanon since its launch in 2010.

Unfortunately, the trend for the SWH market in Lebanon is reaching a plateau, if not a drop. As such, further incentives and introduction of regulatory tools are crucial to regain an upward growth in the market.

In the coming years, it is recommended that a solar ordinance be implemented to increase installation of SWHs. A solar ordinance will force developers to incorporate SWHs at the design phase, resulting in better design of rooftops that are equipped with SWHs and eliminating the need of end users to bear the upfront cost of installing this technology at a later stage.

Consumer awareness campaigns should be ongoing to educate potential customers about SWHs and inform them that they are one of the most affordable thermal renewable energy technologies.

Increasing the reliability of the SWH systems could also boost the market by increasing confidence in the technology. This could be done by implementing effectively regional quality assurance actions, such as the Solar Heater Arab Mark and Certification Initiative (SHAMCI) that is currently being developed. SHAMCI is a beneficial program for strengthening the market, especially for local manufacturers as they will be able to have certified products at lower costs than usual. It would push them to enhance the quality of their products as required for the certification.

1. Introduction

During Conference of Parties (COP) 15 in Copenhagen, Lebanon pledged to increase the renewable energy (RE) share in its energy mix to 12% of the projected total electricity and heating demand in Lebanon by 2020. The Lebanese Center for Energy Conservation (LCEC) developed The National Renewable Energy Action Plan for the Republic of Lebanon 2016–2020 (NREAP) (LCEC, 2016) to help reach the set target for 2020. LCEC is set to tackle the energy problem on multiple fronts, utilizing multiple technologies to achieve the 12% goal. Among these technologies, solar water heaters (SWHs) have a target of 1,054,000 m^2 installed surface area by the end of 2020.

This study focuses on the impact of the SWH Program, currently implemented through low interest loans and subsidies, since its initiation in late 2010. It also provides guidance on the required future actions needed to maintain and strengthen the momentum of the SWH market.

2. Technology Overview

SWHs heat water using solar energy instead of conventional water heating using diesel, gas, biomass boilers or electric resistance elements. Lebanon has about 300 sunny days per year and more than 8–9 hours of sunshine per day (United Nations Development Programme [UNDP], 2013). The use of SWHs in this case will lead to offsetting the use of more than 80% of fossil fuels used for heating water.

There are two prevailing types of technology: flat plate (FP) collectors, which consist of a glazed collector containing copper tubes where the heated fluid passes and heats an absorbing material, and vacuum tube (VT) collectors which consist of multiple tubes that are made of two concentric glasses with vacuum between them, an absorber that collects the heat, and a medium where the fluid passes in order to gain the heat.

While FP collectors have a lower profile and are simple in design and thus easier in maintenance, VT collectors are more efficient in cloudy conditions, more compact than FP, and can withstand higher wind forces.

3. Background

3.1 Financing Mechanism

The Global Solar Water Heaters Market Transformation and Strengthening Initiative, funded by the Global Environment Facility (GEF) and managed by the UNDP was a turning point for the SWH sector in Lebanon. This initiative set an ambitious goal of installing 1,054,000 m^2 of thermal solar collectors by 2020. This goal was incorporated within The National Energy Efficiency Action Plan for the Republic of Lebanon-NEEAP 2011–2015 (Lebanese Center for Energy Conservation [LCEC], 2012) and The National Renewable Energy Action Plan for the Republic of Lebanon 2016–2020 (NREAP) (LCEC, 2016).

A national financing mechanism was developed by the Banque du Liban/Central Bank of Lebanon (BDL) to help the sector grow through multiple economic incentives. This mechanism enables private Lebanese banks to grant low-interest loans to be repaid over a period of five years for SWH systems that cost less than USD 5,000. These loans were made at a 0% interest rate in November 2010 after which the mechanism was restructured and the interest rate increased as detailed in Annex 1. Furthermore, loan applicants are eligible for a USD 200 subsidy/rebate from MEW if the SWH system is (1) bought from a company included in the LCEC list of qualified solar water heater companies (QSWHCs) and (2) the product itself was qualified. This subsidy/rebate is transferred from BDL (from a USD 1.5 million fund dedicated by the MEW to the SWH Program) to the loan applicant's bank account. If the project price is greater than USD 5,000, the loan applicant can submit a request to benefit from the National Energy Efficiency and Renewable Energy Action (NEEREA) financing mechanism, which offers subsidized loans for energy efficiency (EE) and RE projects. These loans have very low interest rates and can be repaid over a 14-year period including a 4-year grace period.

3.2 Rating of SWH Companies and Products

LCEC issues the QSWHC list quarterly on its website. The list not only contains information on the qualified companies, but also on their products. On the latest versions of the QSWHC list, the products are listed under two categories: qualified and passing.

The qualified products are eligible for the USD 200 subsidy/rebate; the passing products are not. A star-based system is used to rate both the companies and their products. Company and product ratings are based on information provided during the qualification process. Points are awarded under seven categories/ sections as described below.

3.2.1 General Information (70 pts)

In this section, companies are awarded points based on their type of registration, years of operation, annual turnover, and number of skilled employees.

3.2.2 Company Experience (220 pts)

In this section, companies are asked to provide information on the number, sizes, and characteristics of SWH systems they have installed. Awarding of points is based on the number of small-scale systems installed (less than, or equal to 500 L), the number of large-scale systems installed (higher than 500 L), and the total hot water production of all the systems installed. The company is awarded 50 bonus points if they manufacture part or all of their products in Lebanon.

3.2.3 Staff and Employees (70 pts)

In this section, companies are awarded points for the number of full-time and part-time engineers, technicians, and installers they employ.

3.2.4 Staff Qualification and Experience (170 pts)

The academic background, experience, and certifications of the company's owner, engineers, technicians, and installers are evaluated and points awarded accordingly.

3.2.5 Products (295 pts)

This section focuses on the quality of the products sold by the company. It is divided into subsections. These subsections include verification of the certifications provided, the quality tests completed, the material used, and the quality of the auxiliaries.

The products are awarded points based on their certifications and a set of tests to ensure a minimum quality standard of the product. For instance, if the product holds a Solar Keymark (SKM), it is awarded 50 points. Other points are given for the material used for the inner tank and its suitability for hot water for domestic use. The material of the inner tank is of high importance, and the product will not be qualified if it is not suitable for hot water applications, even if it passes the final qualification grade. Points are also given if the tank, controller, and sensors are certified and if the pipes and valves are suitable for extreme temperatures and pressures. Anti-calcification measures are also valued and awarded points if they are included in the system.

3.2.6 Company Reputation (175 pts)

Previous clients are contacted to inquire about their satisfaction with the company's services and products' performance. After contacting the clients and gathering the required statistical sample, customer feedback is calculated and points awarded to the company accordingly. In this section, the quality of the systems installed by the company is assessed and maintenance contracts are also taken into consideration and are evaluated relative to their amount in USD.

3.2.7 Bonus Points (200 pts)

This section is added to enhance energy awareness and technical skills of the companies. A portion of these points are awarded to companies that are members of professional organizations, such as the World Energy Council (WEC). Points are also given to companies that have products tested at the Industrial Research Institute (IRI) and to companies that have attended seminars organized by LCEC.

3.2.8 Qualification

Points earned in all sections are added to obtain a company's final score and points earned in specific sections determine star ratings for companies and products. If a company's final score is higher than 400, its products are listed as passing. If the final score is higher than 700, the products are listed as qualified (and eligible for the USD 200 subsidy/rebate). Table 1 lists the point ranges for products eligibility for the QSWHC list and for the subsidy/rebate.

Table 1. Company Final Score

Points earned	Products eligibility
< 400	Not included on the QSWHC list
400 → 700	Passing
> 700	Qualified

Points earned in all sections except the products section count toward a company's star rating as shown in Table 2, which lists the point ranges for company star ratings. A product's star rating is directly related to the points in the product section. Table 3 lists the point ranges for product star ratings.

Table 2. Company Star Rating System

Points earned	Star rating
< 400	0
400 → 500	1
500 → 600	2
> 600	3

Table 3. Product Star Rating System

Points earned	Star rating
< 150	0
150 → 200	1
200 → 250	2
> 250	3

For example, if a company earns 300 points in all sections except the products section and 120 points from the products section, such company would have zero star rating and zero product start rating per Table 2 and Table 3. But since the final score of the company is 420 (higher than 400), then per Table 1, it would appear as passing on the QSWHC list.

Version 20 of the QSWHC list (dated June 28, 2018) includes 61 companies (see Table 4 for the star rating distribution) and more than 400 components. Of the 61 companies listed, 42 companies have a minimum of one system listed as qualified (eligible for the USD 200 rebate/subsidy), while 19 companies have systems listed as passing (not eligible for the USD 200 rebate/subsidy).

Table 4. Star Rating Distribution

No. of companies	Star rating
24	0
20	1
13	2
4	3

Note that this list does not include all companies in the SWH sector in the Lebanese market; some companies choose not to apply to the qualification process.

3.3 Data, Assumptions, and Limitations

This market study is based on data received by LCEC from the 61 companies listed on the QSWHC list along with other information received from previous studies and data gathering. Specifically, this study is based on The Residential Solar Water Heaters Market in Lebanon in 2011 (Shehadeh, 2012) and The Residential Solar Water Heater Market in Lebanon 2012–2015 (Mediterranean Development of Support schemes for solar Initiatives and Renewable Energies [MED-DESIRE]/ LCEC, 2016). The overall number of installations for 2017 is extrapolated based on the previous trends noticed from 2012 to 2015, taking into account all companies working in the SWH field, including companies that do not appear on the QSWHC list.

The assembled data is comprehensive and includes information such as month and year of installation, type of financing, component manufacturer and its country of origin, system type and its use, collector type, collector area, capacity, project's monetary value, and location of the installation. Along with this information, LCEC keeps a log of the loans sent by the banks to LCEC to be checked for their subsidy eligibility. This log is used to study the influence of the low interest loan and subsidies on SWH market development.

Some companies did not provide all needed information about systems sold. For this reason, this study was completed using only the information companies provided. Some companies included in the study stopped operating in the SWH field during the study period, while others started operation after 2010. All company information received is incorporated in this study to show a full picture of installed SWH capacity for the years 2010 to 2017.

4. Market Study

4.1 Cumulative SWH Installations

In 2017, 10,472 systems were installed, having a total surface area of 49,799 m^2 and increasing the total installed SWH surface area in Lebanon to 608,529 m^2. More than 390,000 m^2 of this surface area was installed after initiation of the SWH Program in 2010, and most of the installations occurred between 2011 and the end of 2017. Between January 1, 2010 and December 31, 2017, 434,541 m^2 were installed, representing 85,060 systems with a capacity of 27,733,366 L and an overall investment of USD 153,650,283. Taking these numbers into account, the average system installed in Lebanon during this period has a collector area of 4.8 m^2, a capacity of 338 L, and costs USD 1,877. These numbers were compiled based on data available at the LCEC and on The Residential Solar Water Heaters Market in Lebanon in 2011 (Shehadeh, 2012) Figure 1 shows the distribution of these systems by type of financing—systems financed privately and systems financed via the low interest bank loan. SWH systems installed using the low interest loans are further categorized as subsidized or unsubsidized (by the USD 200 rebate).

This figure indicates that the SWH Program was used to install 16% of the SWH systems installed between 2010 and 2017, signifying that the Lebanese consumer considers this technology well established and sees economic benefits even without the available financing (low interest loans) or subsidies (USD 200 rebate). The number of systems taking advantage of the low interest loan is obtained from banks that cooperate with LCEC and that are listed in paragraph 4.9.

Figure 1. Distribution of SWH Systems by Financing Type.

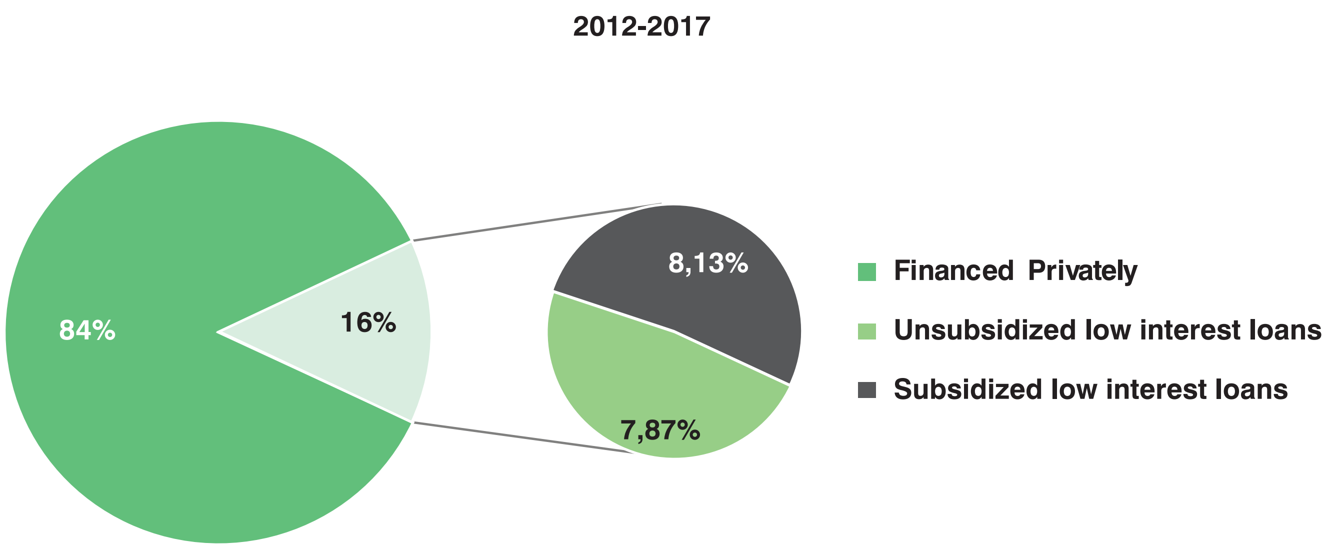
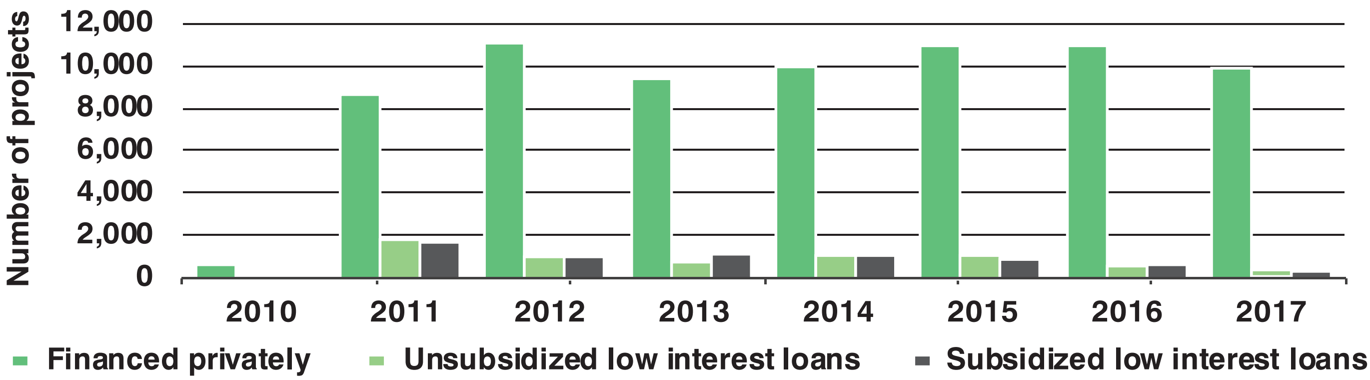


Figure 2 displays the distribution of the projects by financing type and year. The number of loans fell in 2016 and 2017. One of the main reasons for this decrease is that the market began to see this technology as profitable even without the economic incentives. In addition, the 2017 fall may have been caused by changes made in the subsidization scheme by BDL for all types of subsidized loans during this year.

Figure 2. Distribution of SWH Systems by Financing Type and by Year.



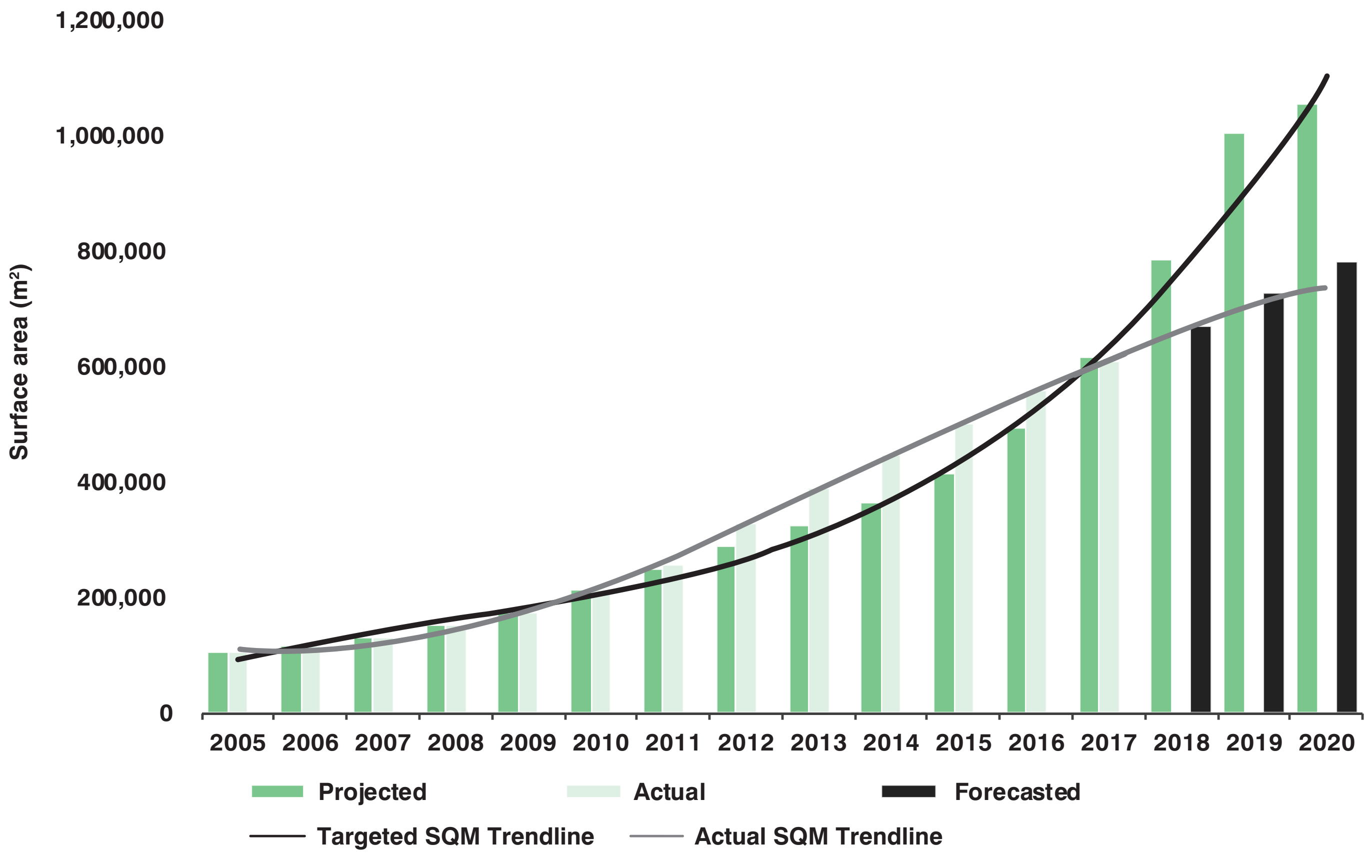
When the SWH Program was launched, a target of 1,054,000 m^2 was set for 2020. As Figure 3 demonstrates, the installed capacity surpasses the projected one for each year until 2016. In 2017, the installed capacity is 4,500 m^2 less than the targeted capacity, only slightly less but alarming nonetheless given the trend.

The gap between the forecasted installed capacity (as per market trends) and the targeted installed capacity (as per the SWH Program targets) increases for the years 2018 to 2020. In 2020, the forecasted capacity is 25% less than the targeted capacity. This is assumed to be due partly to market saturation and partly to lack of enforcement, as Lebanese real estate developers lack motivation and are not forced to install SWHs in new projects. As such, corrective actions must be taken to readjust the market and help it grow to the target size.

Awareness campaigns should be relaunched to educate Lebanese end-users about the importance of installing SWHs and new support schemes developed for the sector. Solar ordinances should be put into action forcing new residential, commercial, and industrial buildings to be equipped with SWHs. The overall look at the market should be revised to include air-to-water heat pumps and a combination of these heat pumps with SWHs, since heat pumps were not included in the initial 2020 goal.

The market is currently at a steady state where every year almost 50,000 m^2 are installed. To strengthen the market, it is important to support the locally manufactured products in order to have more affordable systems introduced to the market. While working to support local manufacturers, a quality and safety scheme is developed. This scheme needs to be actively enforced to maintain a high quality of products and open opportunities for global trade.

Figure 3. Installed Surface Area vs. Targeted and Forecasted Installed Surface Area.



4.2 Installations Since the Implementation of the Solar Water Heater Program

From this point on, this study focuses on the share of the SWH market that is a direct result of implementation of the SWH Program. Only data gathered from QSWHC, and not the whole Lebanese market, is used.

Generally, and while 14% of the Lebanese market benefited from the SWH Program during the study period, half of the SWH installations during the study period were by QSWHC, this is because a large number of systems installed by QSWHC were paid for in cash.

Figure 4 reveals the steady increase in the installed SWH surface area since 2010. Between the launch of the SWH Program and the end of 2017, QSWHC installed more than 195,000 m^2 amounting to a capacity exceeding 13,300,000 L. These installations drove investments of approximately USD 68 million in six years.

Figure 4. Cumulative SWH Surface Area Installed by Qualified Companies since October 2010.

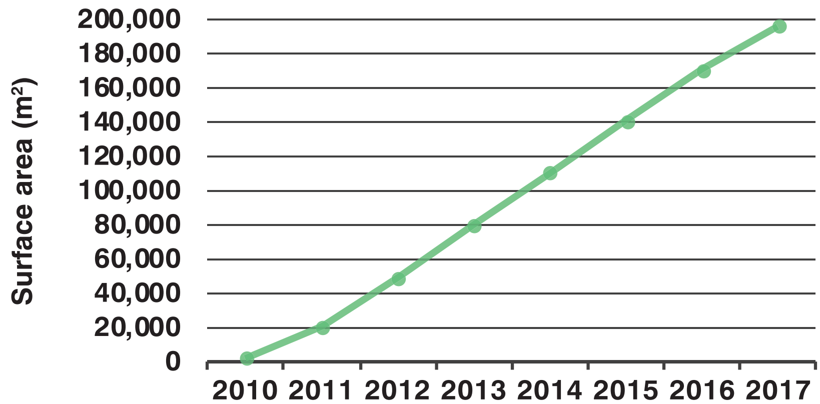


Figure 5 details the cumulative SWH capacity from 2010 through 2017, while Figure 6 shows the investments made in SWHs by customers through qualified companies during the same period. This trend reveals the continued preference of the Lebanese consumer for solar thermal solutions that provide water almost 300 days a year versus intermittent electricity provided by the National Utility and private generator subscriptions, which are often capped at a current capacity of five amperes (A), that may not be enough to withstand the capacity of a boiler's electric resistance element.

Figure 5. Cumulative SWH Capacity Installed by Qualified Companies since October 2010.

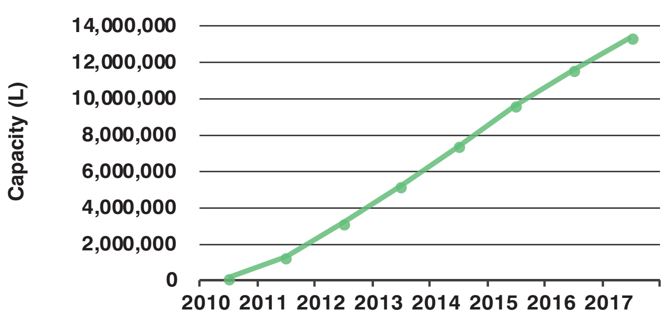
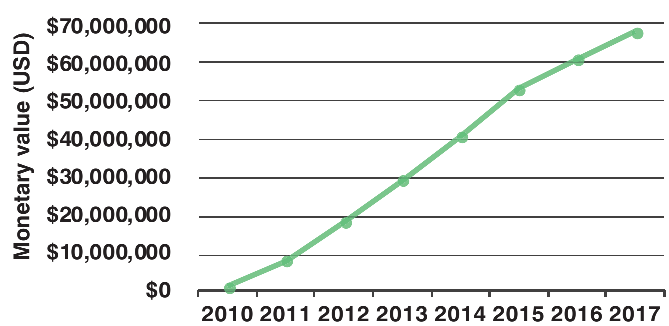


Figure 6. Cumulative Capital Invested in SWH through Qualified Companies since October 2010.



The average price of a SWH has decreased since 2010, indicating confidence in the market is increasing and companies are competing to gain market share. The following figures detail the average price in two scenarios, the first in Figure 7, which represents all systems installed by QSWHC, and the second in Figure 8, which illustrates the evolution of the average price of systems under 500 L capacity installed by QSWHC; systems that are mostly residential.

Figure 7, detailing the average price for all systems installed by QSWHC, a fluctuation is observed with the price over the years but with a clear overall tendency to lean for lower prices. This indicates that large-scale systems (greater than 500 L in capacity) are also witnessing a price fall due to the growing market, availability of competition, and to the proven technology that has demonstrated its cost benefits. Figure 8 details the evolution in the price of small-scale systems (less than 500 L in capacity). Since 2010, the price of small-scale systems is decreasing at a lower rate than at the start of the SWH Program which is due to the maturity of the technology in the market and the lack of competition between QSWHC to gain higher market shares.

Figure 7. Average System Price for all SWH Installations.

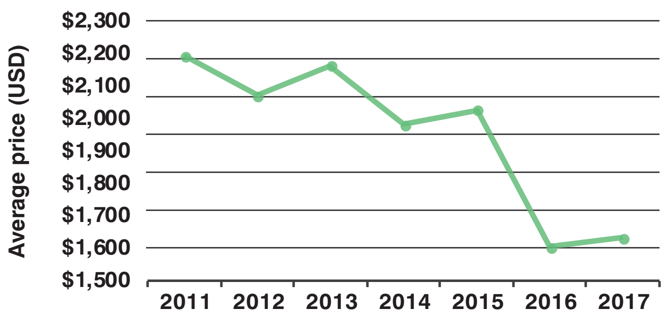
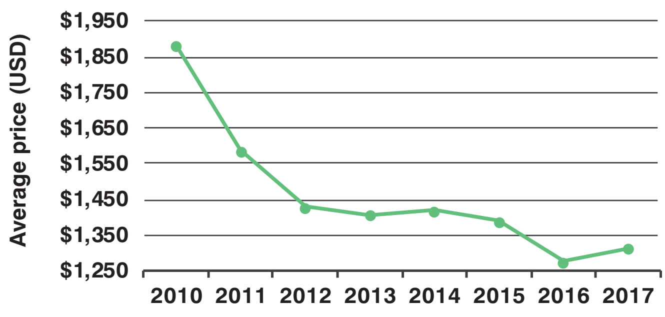


Figure 8. Average Small Scale SWH System Price.



4.3 Companies' Performance

4.3.1 Companies' Sales Evolution

Figure 9 and Figure 10 show the sales evolution of the QSWHC for FP and VT SWH systems from 2010 through 2017. Graphs in these figures are normalized and reflect the evolution and the trend of the QSWHC's sales. Most QSWHC have witnessed an incremental growth, and most QSWHC were not in operation in 2010. This signals a steady increase in the market size as well as a gradual increase SWH's in confidence in the products and in the installers.

Figure 9. Evolution of FP SWH Collectors Sales for Companies 2010-2017.

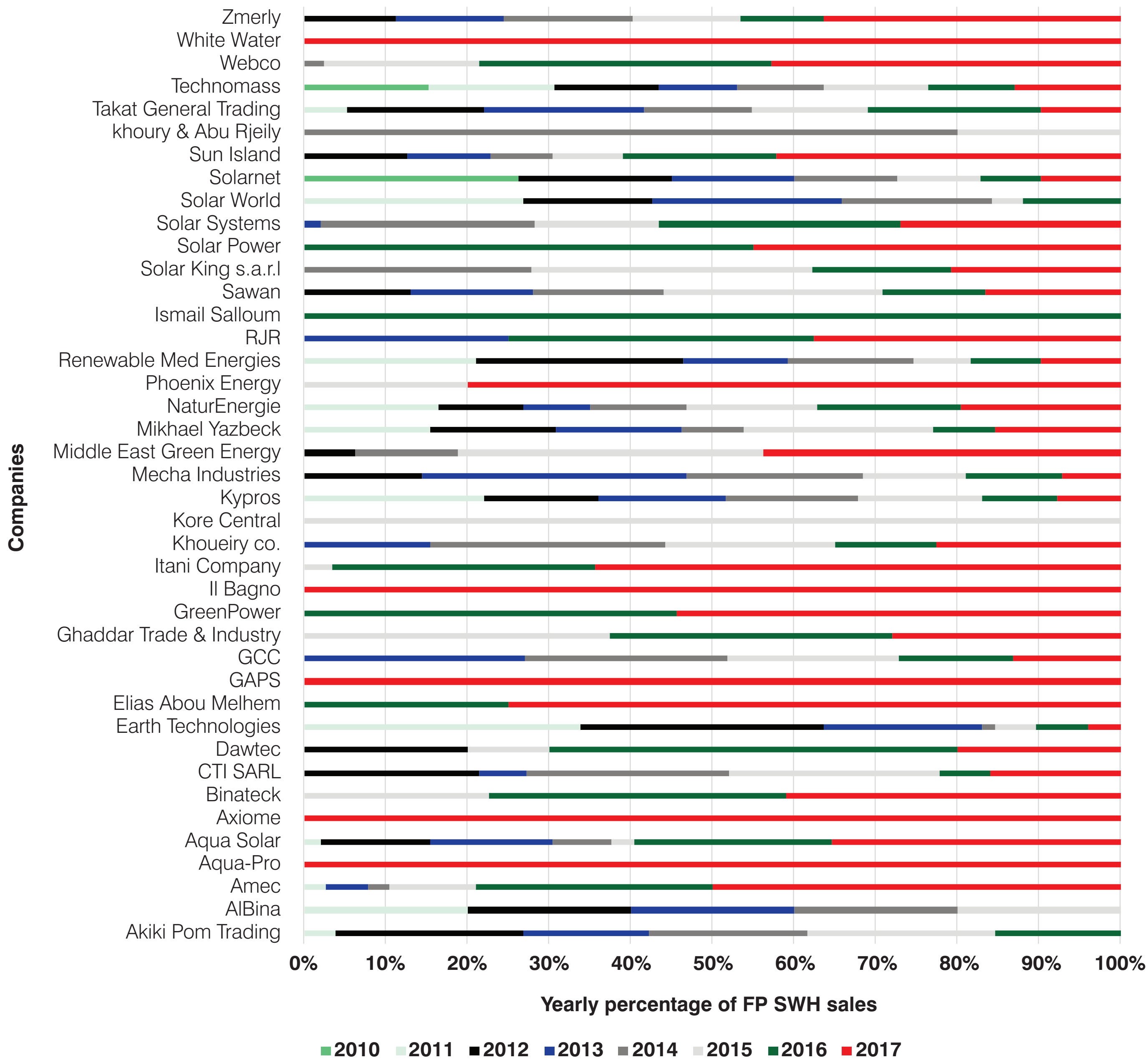


Figure 10. Evolution of VT SWH Collectors Sales for Companies 2010-2017.

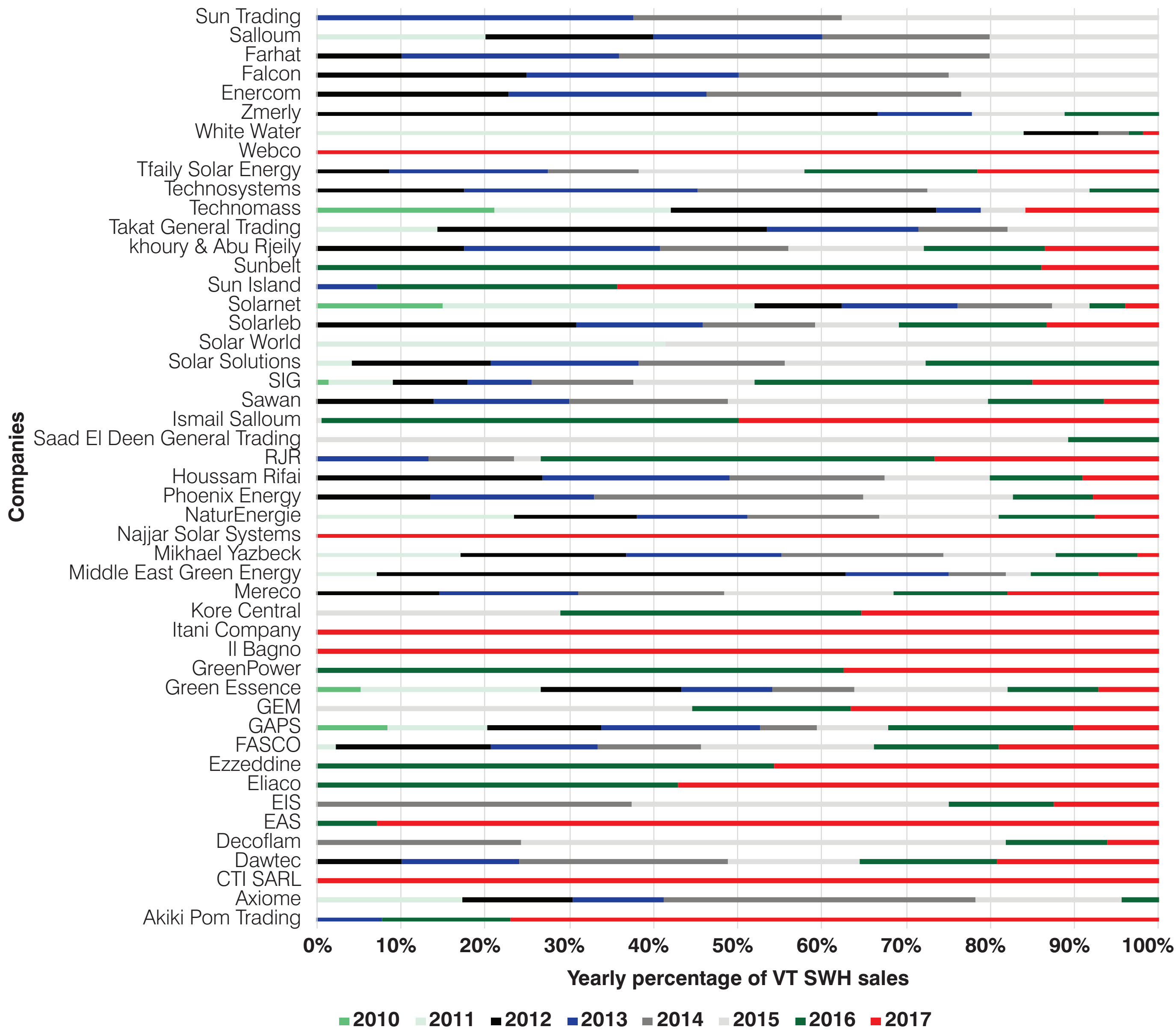
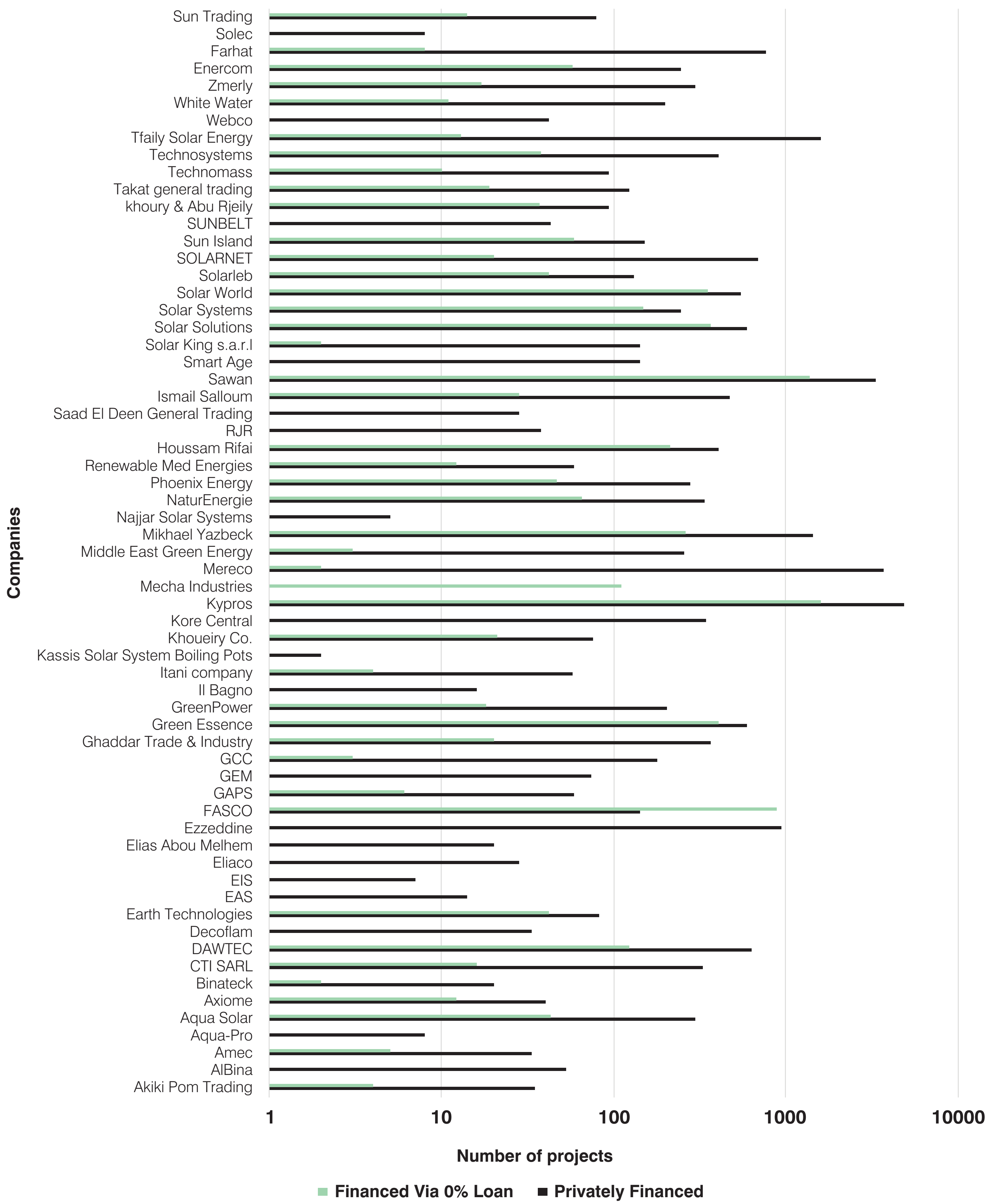


Figure 9 and Figure 10 include some companies who do not have any sales in 2016 and/or 2017. While some of these companies did not submit their most recent files, others show a decrease in the quantities sold from year to year, leading the companies to stop their activities in the SWH field.

4.3.2 Financing Mechanism by Company

In Figure 11, systems installed by each of the companies throughout the period 2010 to 2017 are divided by financing type between privately financed and financed via zero interest loans. It is important to note that that graph is on a logarithmic scale, thus visual effects cannot be taken into consideration and the numbers' order of magnitude can be extracted from the graph. As can be seen, systems financed via low interest loans constitute an important part of the market for QSWHC, averaging around 33% of their total sales. Thus, the SWH Program demonstrates itself as a driver for the market and helps in promoting SWHs to customers with lower economic status. Almost half of these loan recipients also received the USD 200 subsidy, making a total of 7,262 systems and a total reimbursement sum of around USD 1.45 million.

Figure 11. Number of SWH Systems Installed by Company Based on Financing Type.

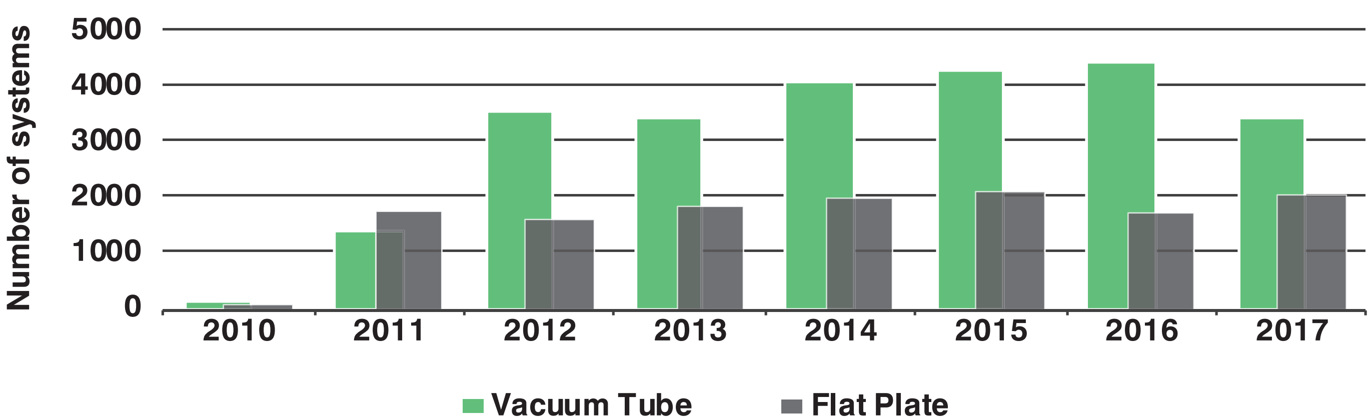


4.4 Technology Market Share

4.4.1 Number of Instaled SWH Systems

Figure 12 details the evolution of the number of installed projects by QSWHC since the SWH Program began. Per this figure, FP collectors dominated the market with a 56% market share in 2011. In 2012, VT collectors gained a lot of market share, reaching 65%, and showed an annual increase of almost 30% up to 2016. The VT collector market witnessed a drop of 22.3% of installed projects in 2017 as compared to 2016, while number of installed FP collector projects increased by 18.1% during the same period. But it is notable that overall sales were almost constant between 2012 and 2017. The decrease in 2017 is thought to be caused by some companies not updating their 2017 records and to the disruption of all of the subsidized loans in Lebanon, which affected QSWHC directly.

Figure 12. Number of SWH Systems by Collector Type, 2010-2017.



In order to have a broader look at the QSWHC market, the technology market share is further analyzed into small-scale systems and large-scale systems. Small-scale systems have a capacity smaller than 500 L and are mostly installed for residential applications. Large-scale systems have a capacity greater than 500 L and are mostly used for industrial and commercial applications. Figure 13 gives the number of systems installed by technology for small-scale systems, while Figure 14 gives the number of systems installed by technology for large-scale systems.

Figure 13 shows that for small-scale systems, and since 2012, the market share for VT collectors is nearly double the FP market. While Figure 14 shows that for large-scale systems, and since 2012, the market share of VT is almost the same as FP collectors, albeit it is worth noting that the market share for large-scale systems is less than 10% of the number of the small-scale systems, indicating a very small market in terms of number of systems.

Figure 13. Number of Small Scale SWH Systems by Technology, 2010-2017.

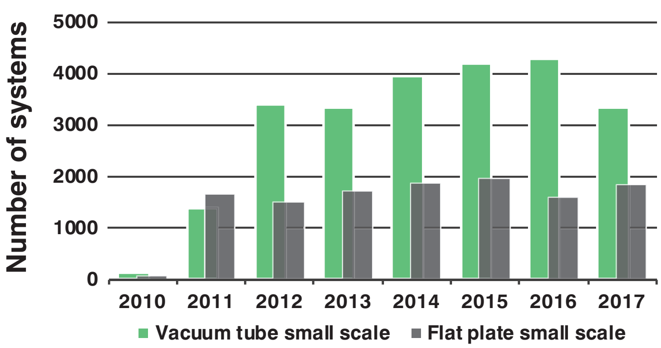
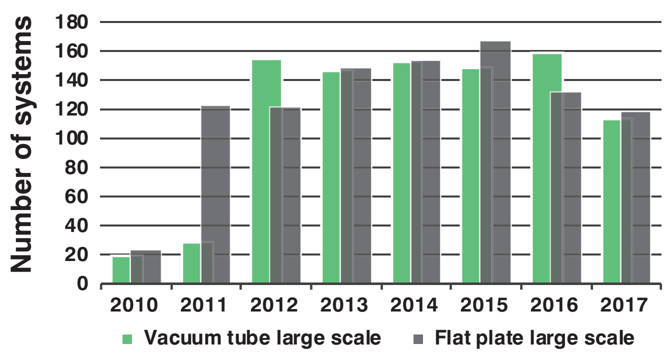


Figure 14. Number of Large Scale SWH Systems by Technology, 2010-2017.



4.4.2 Installed Surface Area and Capacity

Figure 15 shows that both VT and FP technologies had a steep increase in installed surface area between 2010 and 2012. From 2012 to 2014, both technologies had a similar installed surface area. However, in 2014, the gap between VT and FP increased and installed capacity for VTs increased until 2017.

Figure 16 shows that VT has a higher capacity installed between 2010 and 2017 than FP; however, in 2017 the gap between the two technologies gets smaller. To better understand the differences, the average surface area per system and average capacity per system are calculated for both small- and large-scale systems and presented through Figure 20.

Figure 15. Installed SWH Surface Area by Technology, 2010-2017.

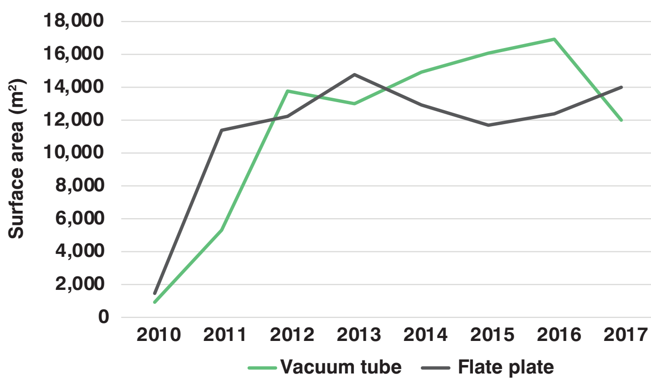
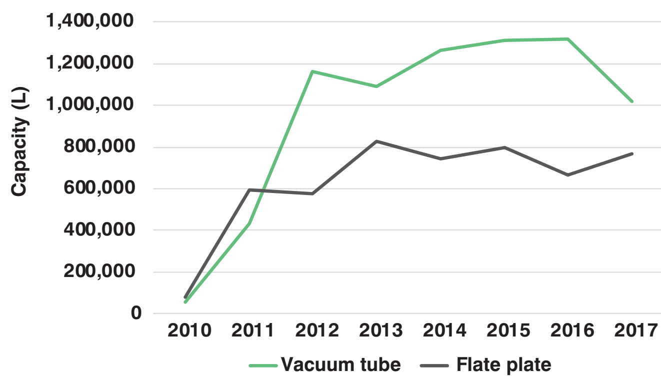


Figure 16. Installed SWH Capacity by Technology, 2010-2017.



Comparing the two technologies in the small-scale systems category for their average surface area and capacity per system, Figure 17 shows that VT SWH systems require a lower average surface area per system than FP, while FP SWH systems have a higher installed surface area per system.

Figure 18 shows VT SWH systems have a higher average capacity per system. The difference in the capacities declines in 2016, while the gap in the average surface area increases. This indicates that the average consumer is going for larger systems than before, and this is primarily caused by decreases in system prices, making them more appealing to the Lebanese consumer who seeks larger systems to meet a larger portion of its needs.

Figure 17. Average Area per SWH System by Technology for Small Scale Systems, 2010-2017.

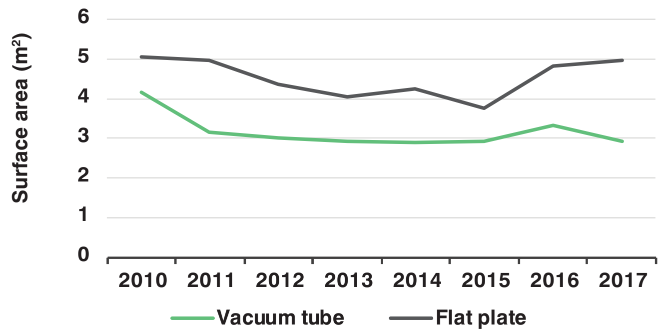


Figure 18. Average Capacity per SWH System by Technology for Small Scale Systems, 2010-2017.

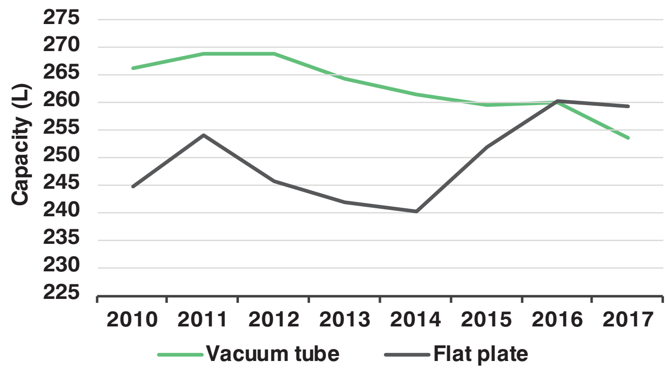


Figure 19 shows that large-scale FP SWH systems are normally bigger in area than large-scale VT SWH systems. Figure 20 shows that large-scale FP SWH systems also have a higher average capacity (in liters) than VT systems. Due to few installations of large-scale systems, evident fluctuations can be seen within the graph. Large-scale systems have an overall average area of around 35 m²/system and a capacity of around 2,000 L/system.

Figure 19. Average Area per SWH System by Technology for Large Scale Systems, 2010-2017.

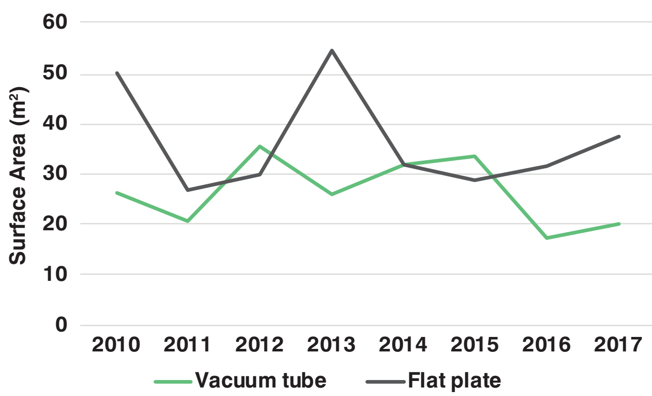
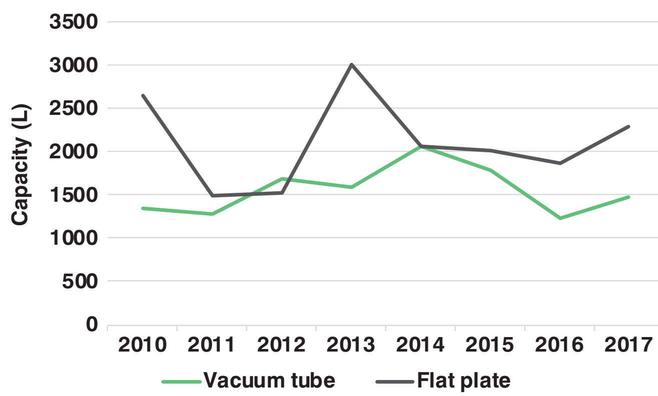


Figure 20. Average SWH Capacity by Technology for Large Scale Systems, 2010-2017.



To gain a better understanding of the performance of small- and large-scale systems, the average capacity per square meter of each technology was calculated and displayed in Figure 21. In this figure, small-scale VT SWH systems have a higher capacity per square meter of installed systems than small-scale FP SWH systems. Both systems increased in efficiency (in terms of capacity per surface area) up to 2011–2012, then showed steady performance until 2016 when a drop in performance was noticed. However, this could be associated with significant imports of modular design (tank capacity vs. modular solar panels), from a number of large importers, skewing the results.

Figure 22 displays the average capacity per square meter of technology in large-scale systems. The performance of both technologies is inconsistent. This is due to a limited number of large-scale systems per technology (<10% of small-scale systems). Therefore, the results cannot be used to analyze a trend and this graph is inconclusive.

Figure 21. Average SWH Capacity per m² by Technology for Small Scale Systems, 2010-2017.

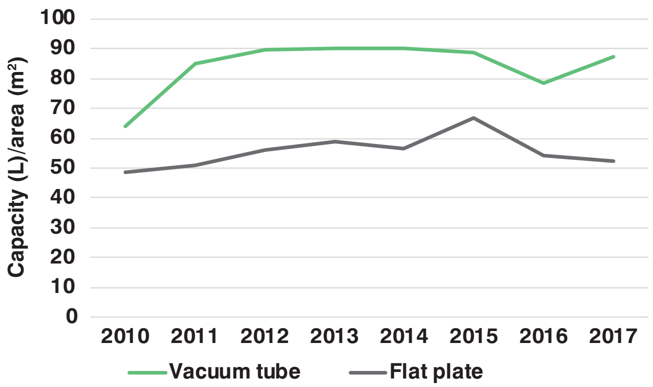
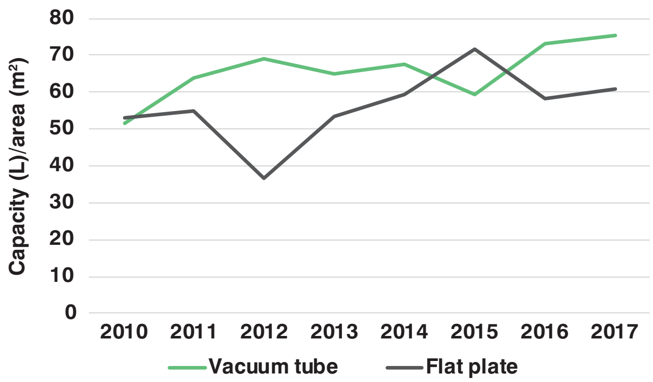


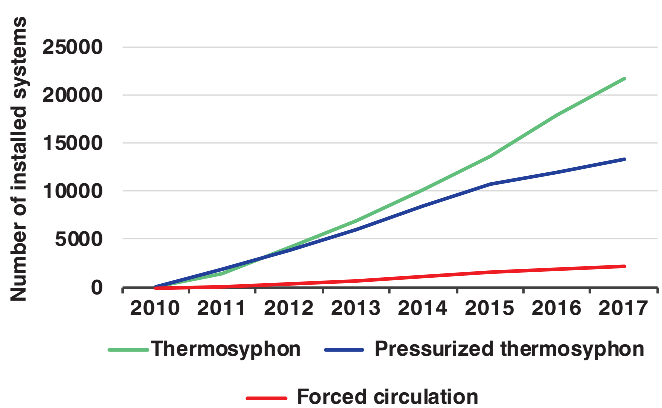
Figure 22. Average SWH Capacity per m² by Technology for Large Scale Systems, 2010-2017.



4.5 SWH Installations by Type

In this study, thermosiphon, pressurized thermosiphon, and forced circulation systems are reviewed. A thermosiphon system operates by gravity. The hot water tank is installed directly above the SWH panels. Water circulates from the cold water tank to the SWH and then to the usage port, without the need for pumping. In this system, the cold water tank has to be placed higher than the SWH, and the SWH should be higher than the highest water faucet to be used. In the pressurized thermosiphon system, the water tank is at the same level as the SWH, thus a pump should be used to force the water to go from the cold water tank to the SWH. In the forced circulation system, the solar panel is on the roof while the hot water tank is in a separate place in the house or facility. Then, a pump is used to circulate heat transfer fluid (HTF) from the solar panel to the hot water tank. Figure 23 illustrates the cumulative number of systems (by type) installed by QSWHC in the Lebanese market between 2010 and 2017. Thermosiphon systems are the most widely used systems as a typical Lebanese household is able to install a SWH on its roof and tends to elevate the cold water tank to increase water pressure. Pressurized thermosiphon systems come in second while forced circulation systems come in last with less than 2,250 installed systems.

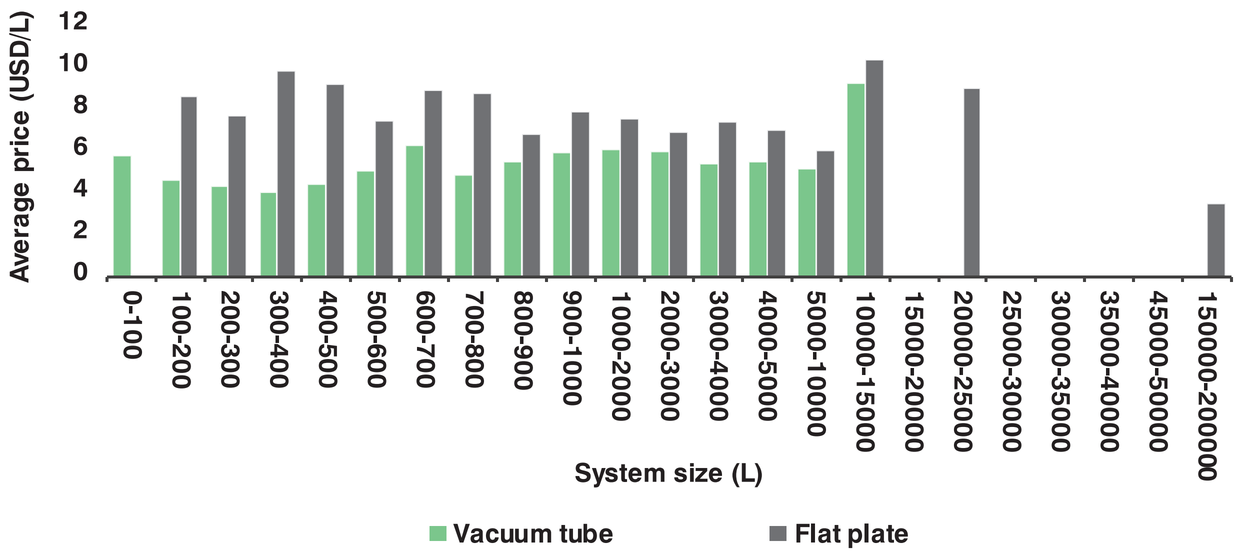
Figure 23. Cumulative Installations by SWH System Type.



4.6 Prices per SWH System Type

Figure 24 shows the price per liter for each range of systems. To plot this graph, the market was segregated into multiple brackets based on the size of the systems with an interval of 100 L in capacity. In each bracket, the average price was gathered for the projects by collector type: VT or FP. In this figure, the overall trend of cost decreases when the project's size increases for both technologies up to 500 L. It should be noted that for projects larger than 500 L the price fluctuates. This could be associated with higher fixed costs, increased design requirements, and the small number of systems of this scale. As such, cost trends cannot be identified.

Figure 24. Evolution of the Average Price per Technology by SWH System Size.



After seeing the effect of the system type on the price of the systems, the average price of each type was calculated and represented in figures 25 through 27. Figure 25 indicates the average price by technology and system type for the QSWHC market. This figure shows that a pressurized thermosiphon FP system and a forced circulation FP system are 4% and 20% respectively more expensive than a thermosiphon FP system, while a pressurized thermosiphon VT system and a forced circulation VT system are 36% and 57% respectively more expensive than a thermosiphon VT system. Figure 26, gives the average price by technology and system type for small-scale systems, while Figure 27 gives the average price by technology and system type for large-scale systems. In all of the systems, it is obvious that thermosiphon systems are the cheapest, followed by pressurized thermosiphon systems, then forced circulation systems. It is also noticeable that in general, VT systems are cheaper than their FP counterparts.

Figure 25. Average Price per Liter by SWH Technology and by System Type.

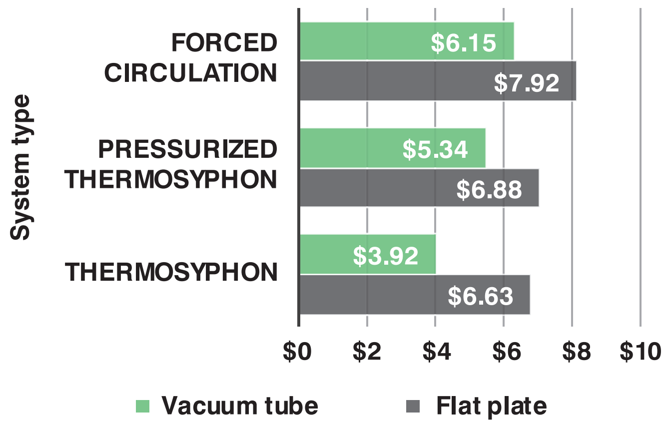


Figure 26. Average Price per Liter by SWH Technology and by System Type for Small Scale Systems.

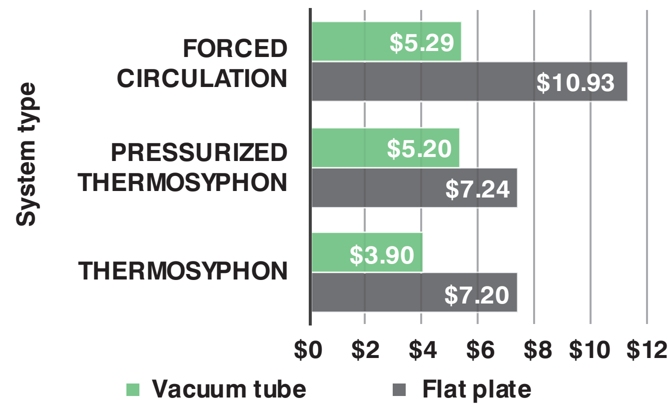
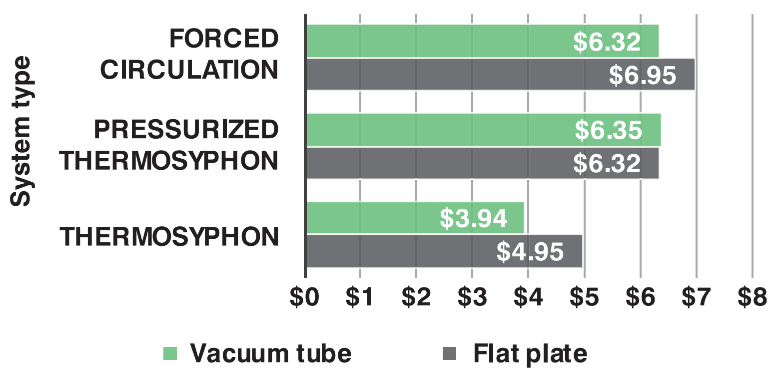


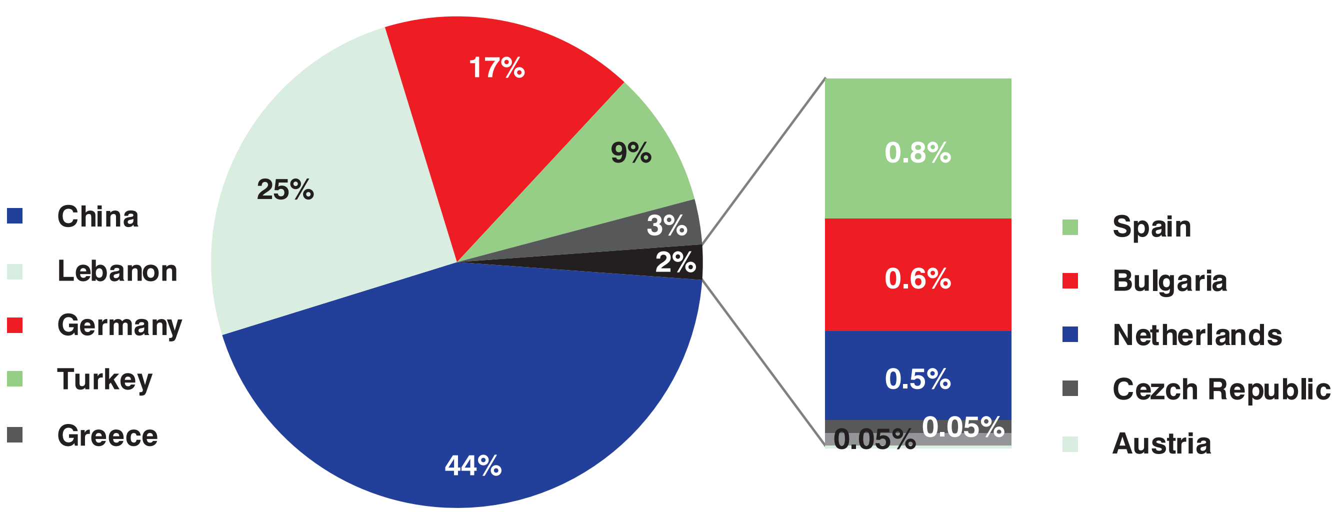
Figure 27. Average Price per Liter by SWH Technology and by System Type for Large Scale Systems.



4.7 System Countries of Origin

QSWHC who replied to the survey were asked to provide the system country of origin. Survey results showed that a significant portion of systems is manufactured in Lebanon, but some systems and components were imported primarily from 10 countries (listed alphabetically): Austria, Bulgaria, China, Czech Republic, Germany, Greece, Italy, Netherlands, Spain, and Turkey. The total number of imported components surpasses the number of systems, as a single system may have an imported panel from one country while the tank is from another country. Figure 28 shows the breakdown by country of origin for the different shares of components entering the Lebanese market from each of the 10 countries and from Lebanon. China represents the largest share as it has the biggest number of installed tanks and panels in Lebanon. Lebanon ranks second place, followed by Germany, then Turkey. These four countries represent 96% of the total QSWHC market, while the other countries have a combined share of 4%.

Figure 28. Shares of Each Country from the Total Number of Components in the Lebanese Market.



4.8 Geographical Distribution

4.8.1 SWH Companies Allocations

In this section, the top 10 companies in QSWHC market share are listed in all the Lebanese governorates. In Beirut, Kypros and Sawan dominate the QSWHC market with a combined share of more than 57% of the number of installed systems (see Figure 29). In the Bekaa, Solar Solutions is the leading company followed by Green Essence and Houssam Rifai (see Figure 30). These three companies form 74% of the SWH market in the Bekaa region. In Mount Lebanon, the market is led by Kypros with 19% of the overall installations, while other companies have a well distributed range of systems amongst them (see Figure 31). In Nabatieh, Mereco leads the market, followed by Tfaily Solar Energy (see Figure 32). Together these two companies dominate the market in Nabatieh with a big margin compared to other companies. In the North, there are three main actors in the market (see Figure 33). Sawan has the biggest share of installed systems, followed by Kypros and Salem International Group. These three companies combined have a total market share that exceeds 74%. In the South, three distributors dominate the market with a combined market share exceeding 60%. FASCO has the biggest number of installed systems, followed by Ezzeddine and then Mereco (see Figure 34).

Kypros is the only company that is among the top 10 companies in all the governorates and leads the list in both Beirut and Mount Lebanon.

Figure 29. Top 10 Companies in Beirut.

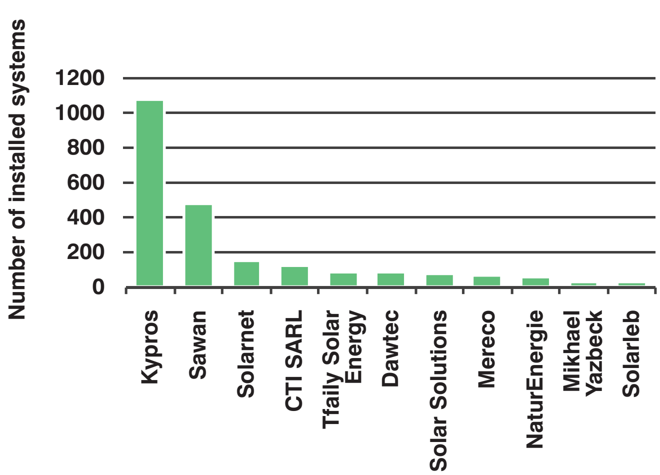


Figure 30. Top 10 Companies in Bekaa.

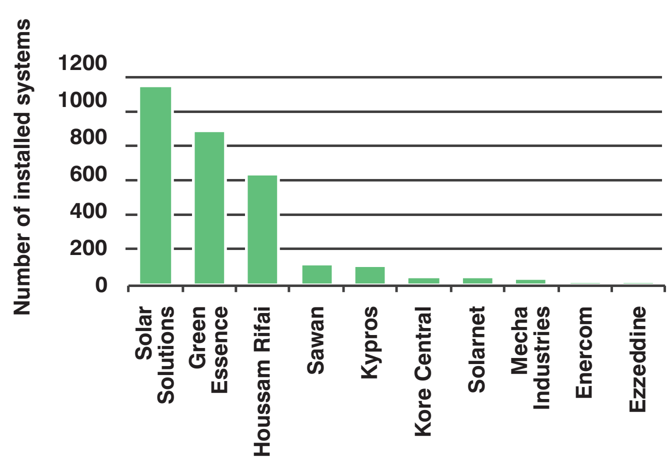


Figure 31. Top 10 Companies in Mount Lebanon.

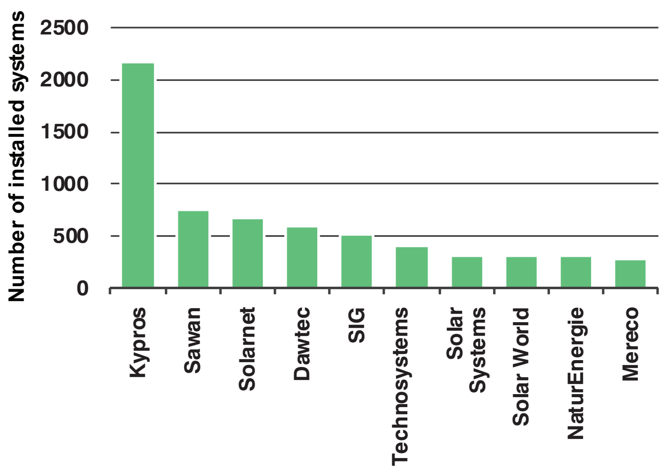


Figure 32. Top 10 Companies in Nabatieh.

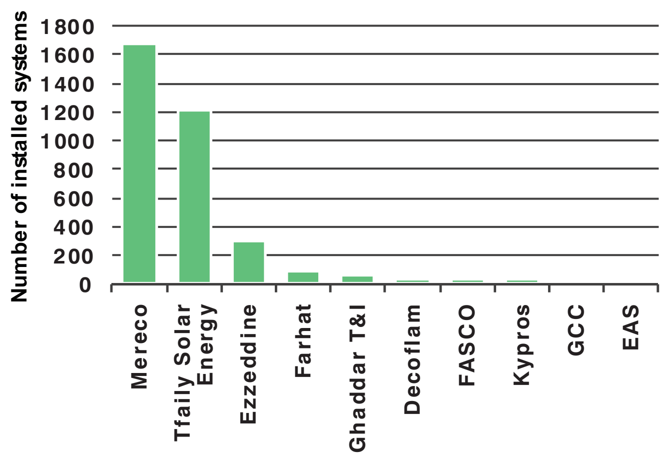


Figure 33. Top 10 Companies in the North.

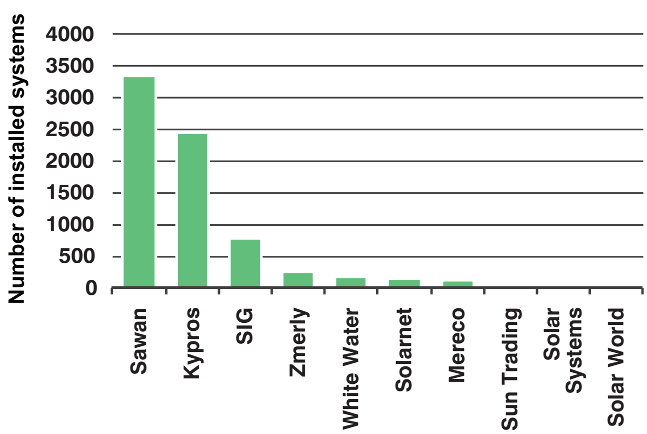
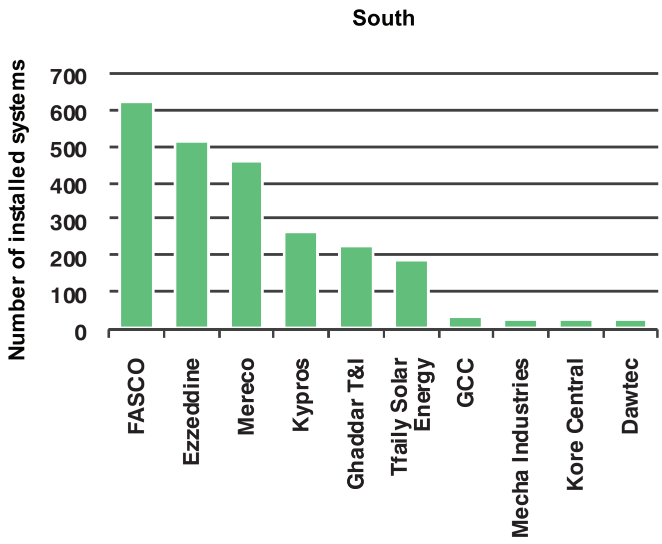


Figure 34. Top 10 Companies in the South.



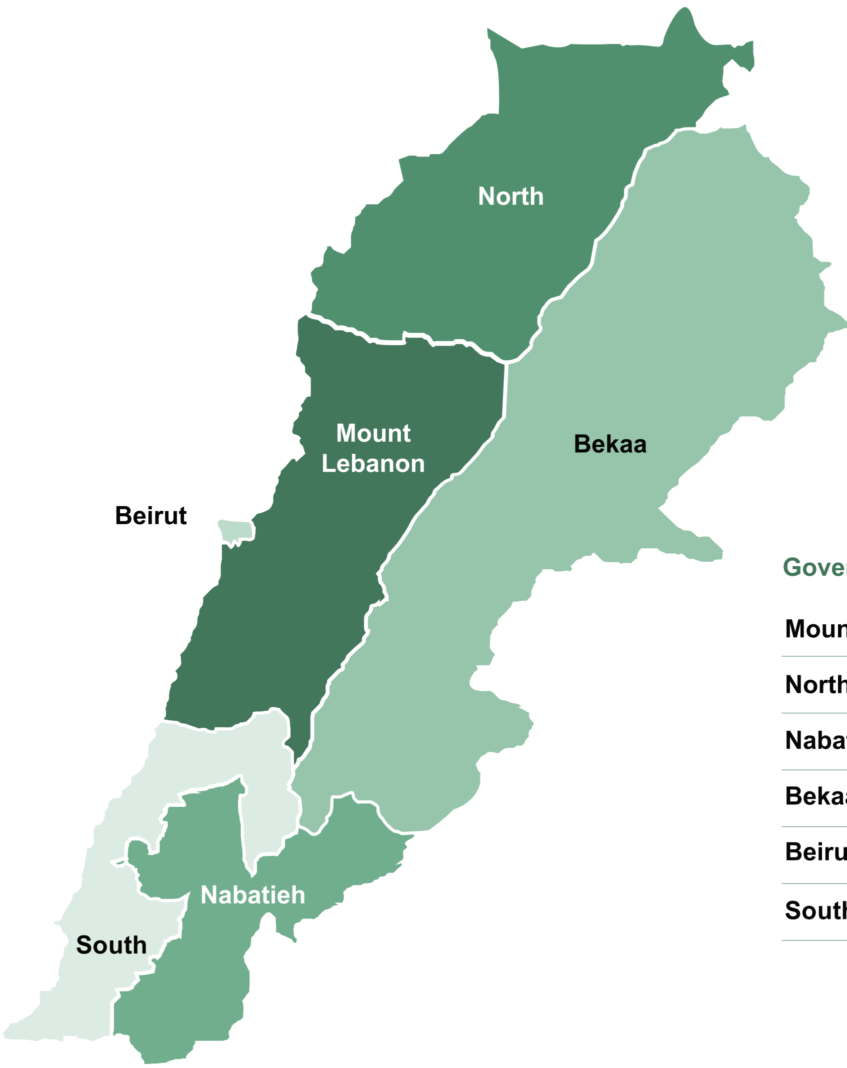
4.8.2 Geographical Distribution of the QSWHC Market in Lebanon Within Governorates

Figure 35 shows the distribution of the number of systems in the six Lebanese governorates. Mount-Lebanon ranks first with a 33.2% share of the Lebanese market, followed by the North with 26.2%, Nabatieh with 14.9%, Bekaa with 10%, Beirut with only 8%, and the South comes in the bottom ranking with 7.7% of the total market share.

Figure 36 shows the ranking of the governorates related to the installed capacity in each one. In this figure, Mount-Lebanon has a share of 42.5% of the total installed capacity. The North in the second place has a share of 23%. Beirut is in the third place with a market share of 13.1% of the installed capacity, while Nabatieh has 7.9% of the installed capacity share and comes in fifth place right after the Bekaa governorate which has 8.2% of the installed capacity. The South comes in last with a total of 5.3% of the installed capacity.

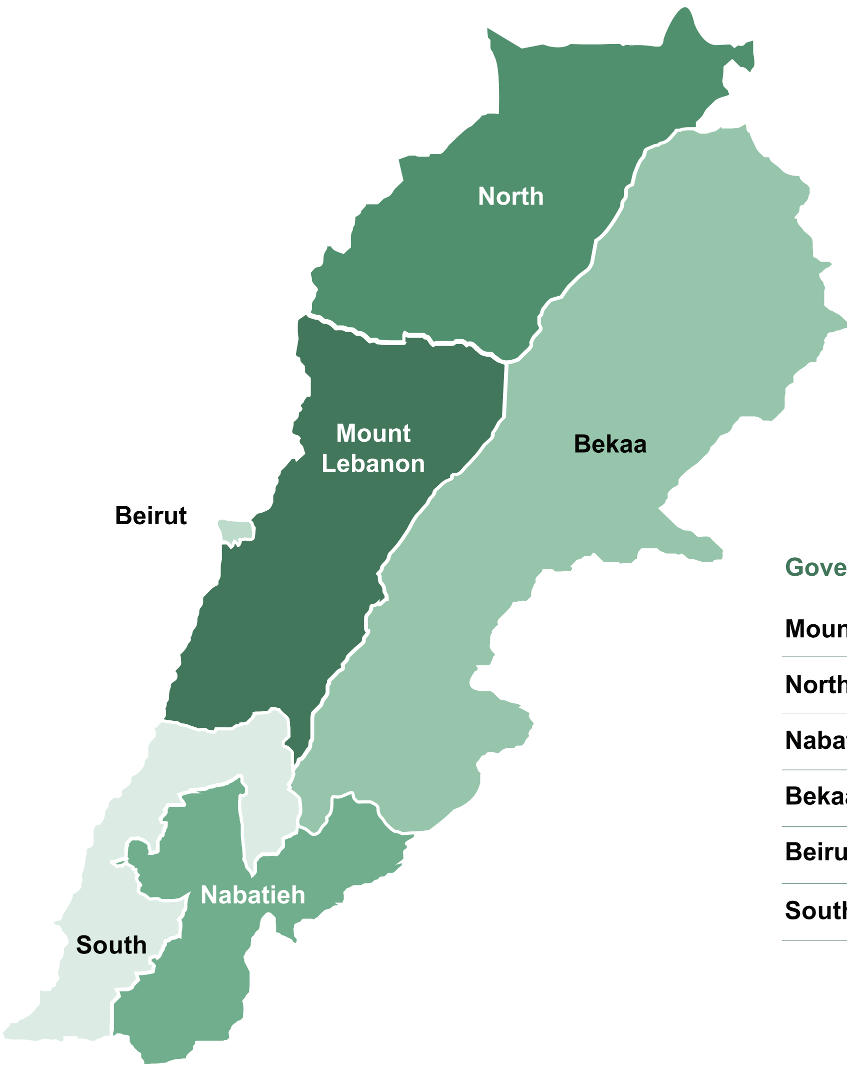
The differences seen in the market share percentage between the number of installed systems and the capacity installed illustrates a trend in the market where the most urbanized governorates (Beirut and Mount-Lebanon) tend to install systems with higher capacities (mostly collective systems), while less populated areas (Bekaa, Nabatieh, North, and South) tend to install smaller capacities (individual SWHs) as they have a lot of roof spaces that they can benefit from. A commonality between the two tables was that the South held the lowest percentage in both studies, and this indicates that attention should be given to this market so it can develop in harmony with the other governorates. Companies should have a high interest to invest in this area as it is the less developed in means of SWH systems.

Figure 35. Number of Systems Installed in Each Governorate With a Graphic Representation on the Map.



Governorates	No. of systems	Percentage
Mount Lebanon	11,241	33.2
North	8,866	26.2
Nabatieh	5,061	14.9
Bekaa	3,385	10.0
Beirut	2,697	8.0
South	2,611	7.7

Figure 36. Installed Capacity in Each Governorate With a Graphic Representation on the Map.

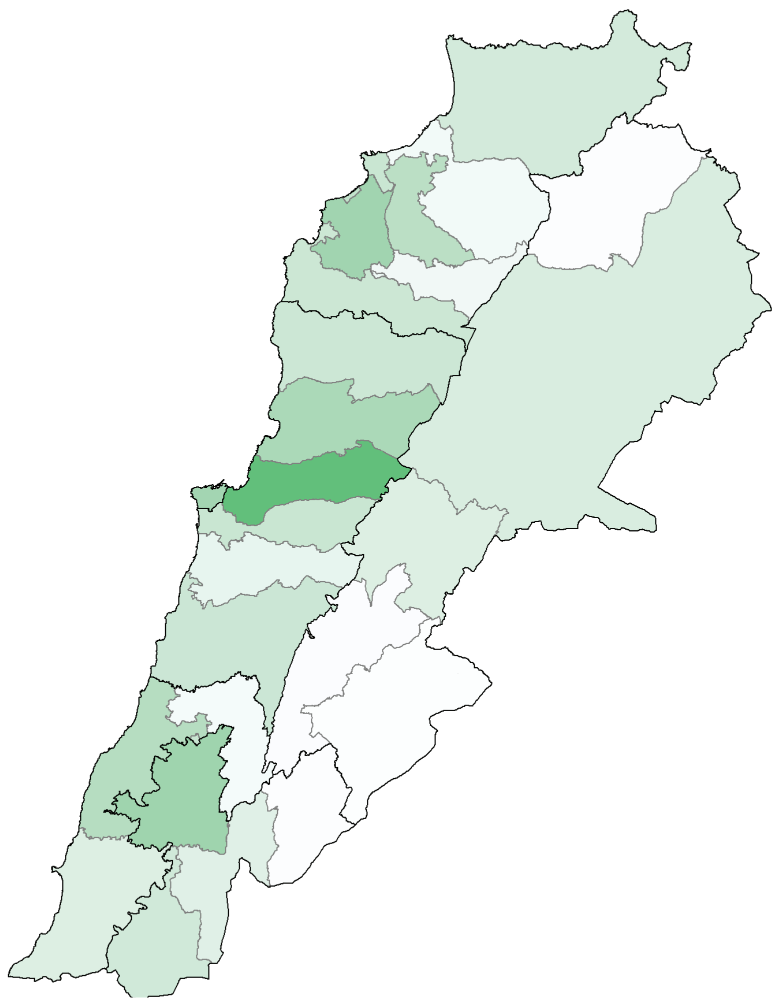


Governorate	Capacity (L)	Percentage
Mount Lebanon	3,604,305	36.7
North	2,456,135	25
Nabatieh	1,196,732	12.2
Bekaa	1,132,260	11.5
Beirut	995,202	10.2
South	431,245	4.4

4.8.3 Geographical Distribution of the QSWHC Market in Lebanon Within Districts

The table shown in Figure 37 represents the number of installed systems in each of the Lebanese districts. These numbers include the installations by all companies in different districts. Metn comes in first with a total share of 12.9% of the Lebanese market. The top five districts—Metn, Nabatieh, Koura, Beirut, and Kesrouan—have a combined share of 43.2% of installed systems in the QSWHC market while the lowest 10 districts amount only to 11% of the QSWHC market share. This indicates that there should be an awareness campaign that targets these areas that have not yet seen a satisfying development in the SWH sector.

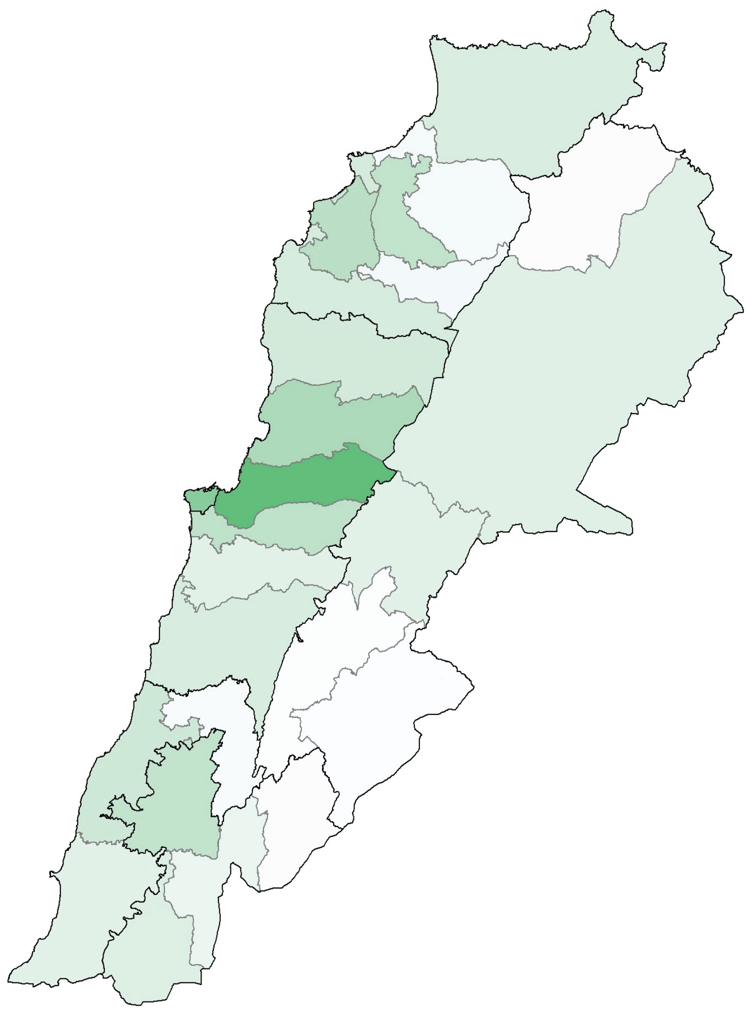
Figure 37. Number of Systems Installed in Each District With a Graphic Representation on the Map.



District	No. of systems	Percentage
Metn	4137	12.9
Nabatieh	2570	8.0
Koura	2490	7.7
Beirut	2450	7.6
Kesrouan	2244	7.0
Saida	1958	6.1
Zgharta	1804	5.6
Baabda	1406	4.4
Tripoli	1401	4.4
Chouf	1361	4.2
Batroun	1341	4.2
Jbeil	1318	4.1
Bint Jbeil	1191	3.7
Akkar	1117	3.5
Baalbek	987	3.1
Tyr	883	2.7
Zahle	881	2.7
Marjeyoun	804	2.5
Aley	607	1.9
Bcharre	375	1.2
Miniyeh-Danniyeh	342	1.1
Jezzine	285	0.9
Western Bekaa	95	0.3
Rashaya	68	0.2
Hermel	43	0.1
Hasbya	27	0.1

Figure 38 represents the installed capacity in each of the districts of Lebanon. Beirut has increased its rating from fourth place in the number of installed systems to second place in installed capacity right after Metn. This expresses a tendency in Beirut to opt for bigger systems as the spaces are restricted on the existing buildings and people may tend to go for central hot water systems in buildings with high occupancy rates. Nabatieh dropped from second place in the number of installed systems to eighth place in installed capacity. This represents a tendency for clients in Nabatieh to go for small individual systems.

Figure 38. Installed Capacity in Each District With a Graphic Representation on the Map.



District	Capacity (L)	Percentage
Metn	1,636,899	14.9
Beirut	1,217,619	11.1
Kesrouan	862,951	7.9
Koura	718,175	6.5
Baabda	672,534	6.1
Nabatieh	637,425	5.8
Zgharta	629,745	5.7
Saida	483,367	4.4
Jbeil	449,265	4.1
Tripoli	415,540	3.8
Batroun	403,256	3.7
Chouf	397,086	3.6
Akkar	382,640	3.5
Bint Jbeil	329,385	3.0
Baalbek	315,145	2.9
Tyr	289,995	2.6
Aley	286,390	2.6
Zahle	284,841	2.6
Marjeyoun	218,295	2.0
Bcharre	116,630	1.1
Miniyeh-Danniyeh	95,310	0.9
Jezzine	74,680	0.7
Western Bekaa	30,690	0.3
Rashaya	20,260	0.2
Hermel	11,930	0.1
Hasbya	8,230	0.1

4.9 Cooperation of the Banking Sector

Twelve banks have cooperated with BDL, MEW, and LCEC since the beginning of the initiative (listed alphabetically): Al Ahli Bank, Bankmed, Banque Libanaise pour le Commerce (BLC), Banque Libano-Française (BLF), Banque du Liban et d'Outre-Mer (BLOM), Bank of Syria and Lebanon (BSL), Crédit Libanais (CL), Fransabank, First National Bank (FNB), Intercontinental Bank of Lebanon (IBL), Jammal Trust Bank (JTB), and Syrian Lebanese Commercial Bank (SLCB). Since the initiation of the low interest loan, 14,398 loans were made by these banks and 7,262 of these loan recipients benefited from the USD 200 rebate from MEW. This means that USD 1,452,400 was injected by the MEW to the SWH market in order to push it forward and maintain a steady growth in the market. Figure 39 shows the number of subsidized loans given by the banks and the number of rebates also received by the banks. BLF leads the loan market with 3,887 loans made since the beginning of the SWH Program. BLOM comes in second with 2,559 loans, and Bankmed comes in third with 1,769 loans. BLF has the highest number of loans that benefitted from the rebate with a total of 1,387 loans. BankMed comes in close second with 1,354 loans that received the USD 200 rebate, although it stopped giving these loans since the second half of 2012. BLOM has given 1,155 loans that were eligible for the rebate. BLC has the highest percentage of loans approved to get the rebate with an approval rate of 77.1%. This signifies that BLC relies heavily on the QSWHC list issued by LCEC as one of the criteria for the loan approval.

Figure 39. Number of Loans vs. Number of Subsidized Loans by Bank.

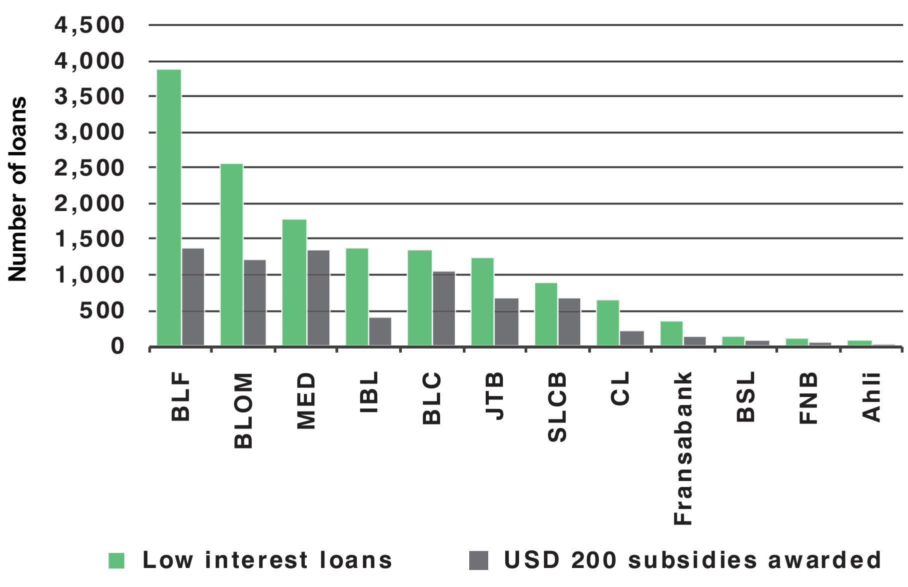


Figure 40, Figure 41 and Figure 42 show the percentage of the loans given by the banks in each governorate. BLF ranks first in four out of the six governorates. BLOM is the dominant bank in Beirut followed by BLF and Bankmed. In the Bekaa and South governorates, BLF has the largest share, followed by Bankmed and BLOM. In Mount Lebanon, BLF is leading the board with BLOM tightly following them and then Bankmed. In Nabatieh, SLCB has the lead followed by Bankmed while JTB comes in third place. In the North, BLF disbursed the highest number of loans, followed by IBL and BLC.

Figure 40. Share of Installed Projects by Bank in Beirut and Bekaa.

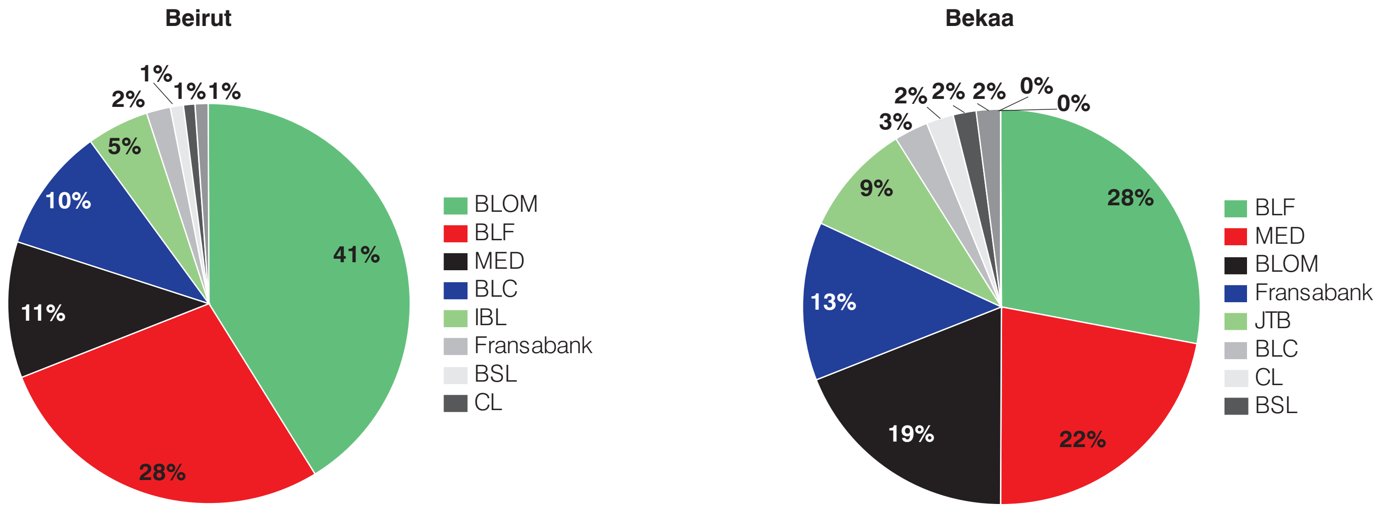


Figure 41. Share of Installed Projects by Bank in Mount Lebanon and Nabatieh.

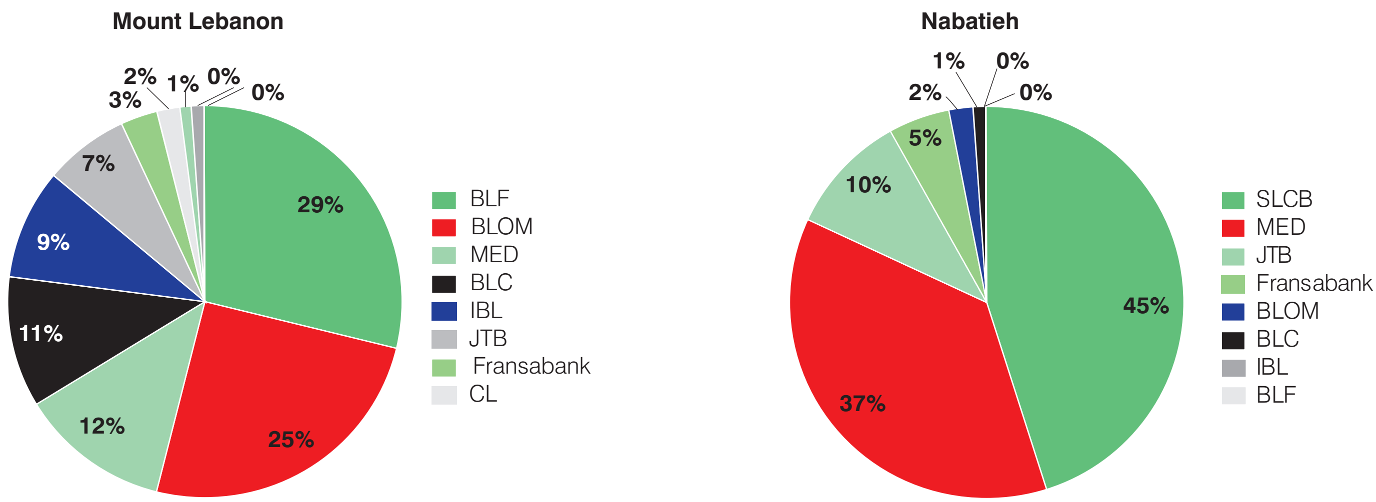
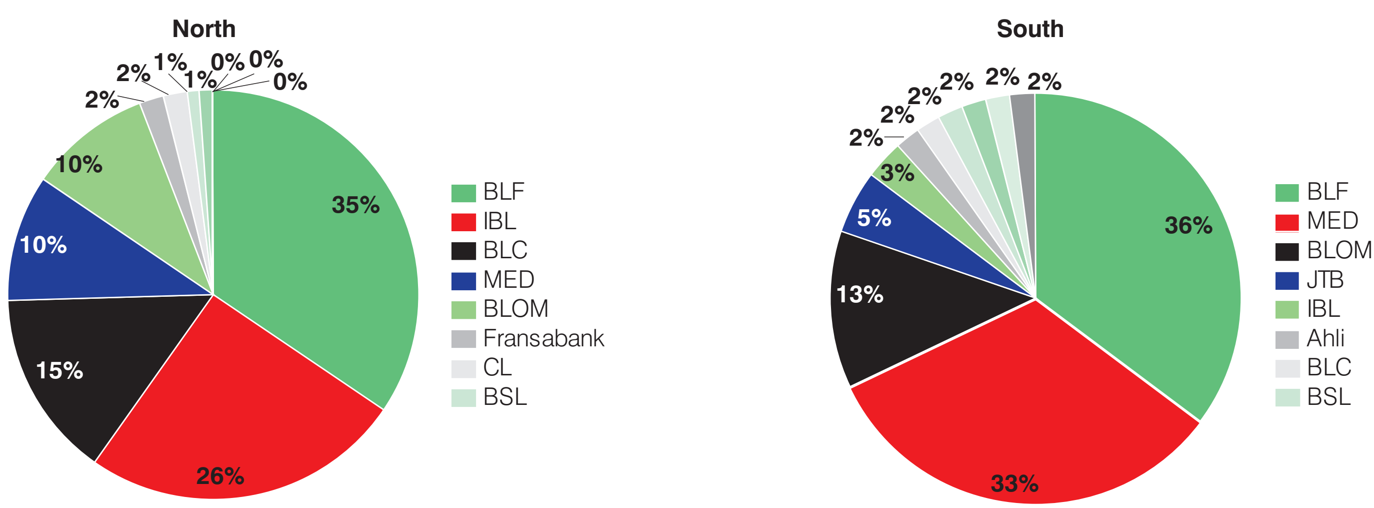


Figure 42. Share of Installed Projects by Bank in the North and the South.



5. Economic, Environmental and Social Impact

According to a study completed by LCEC, concerning the energy and financial performance of a solar hot water system in a single family dwelling published in 2009, a 208 L thermosiphon system saves 1,776 kilowatt-hours (kWh)/year(y) of electricity (LCEC, 2009). This indicates that a liter of installed SWH offsets the consumption of 8.54 kWh/y.

Using this number and installed capacity in liters, the yearly energy savings was calculated for all systems installed by QSWHC, just the QSWHC-installed systems that benefited from low interest loans, and, finally, for all systems installed in the Lebanese market between 2010 and 2017. This data is presented in Table 5.

Table 5. Energy Savings by Consumers from SWH System Installations, 2010–2017

Category	Capacity (L)	Energy savings (kWh/y)	Offset CO_2 production (ton CO_2/y)
Systems installed by qualified companies	12,734,981	108,756,738	70,691.88
(Of which systems financed via the low interest loan)	(2,762,387)	(23,590,785)	(15,334)
Systems installed by other entities	15,458,591	132,016,367	85,810.64
Overall Lebanese market	**28,193,572**	**240,773,105**	**156,502.52**

The 2010 Policy Paper for the Electricity Sector (Bassil, 2010) states that 15% losses occur during power transmission and distribution from the plant to the consumer. Taking this into consideration, the overall energy production offset in the production plants becomes 283,262,476 kWh/y. This could be translated as actual energy savings at the level of Electricité du Liban (EDL) electricity generation. This amount of energy is roughly equivalent to 1.9% of the total yearly energy generation at EDL.

In 2011, a grid emissions factor for Lebanon was calculated. It was equivalent to 0.65 kg of CO_2 per kWh produced (United Nations Framework Convention on Climate Change, 2012). This represents a 15.33 kton reduction in CO_2 by systems financed with low interest loans and a 70.69 kton reduction in CO_2 by QSWHC-installed systems. The total CO_2 emissions reduction for the Lebanese market between 2010 and 2017 was 184.12 ktons.

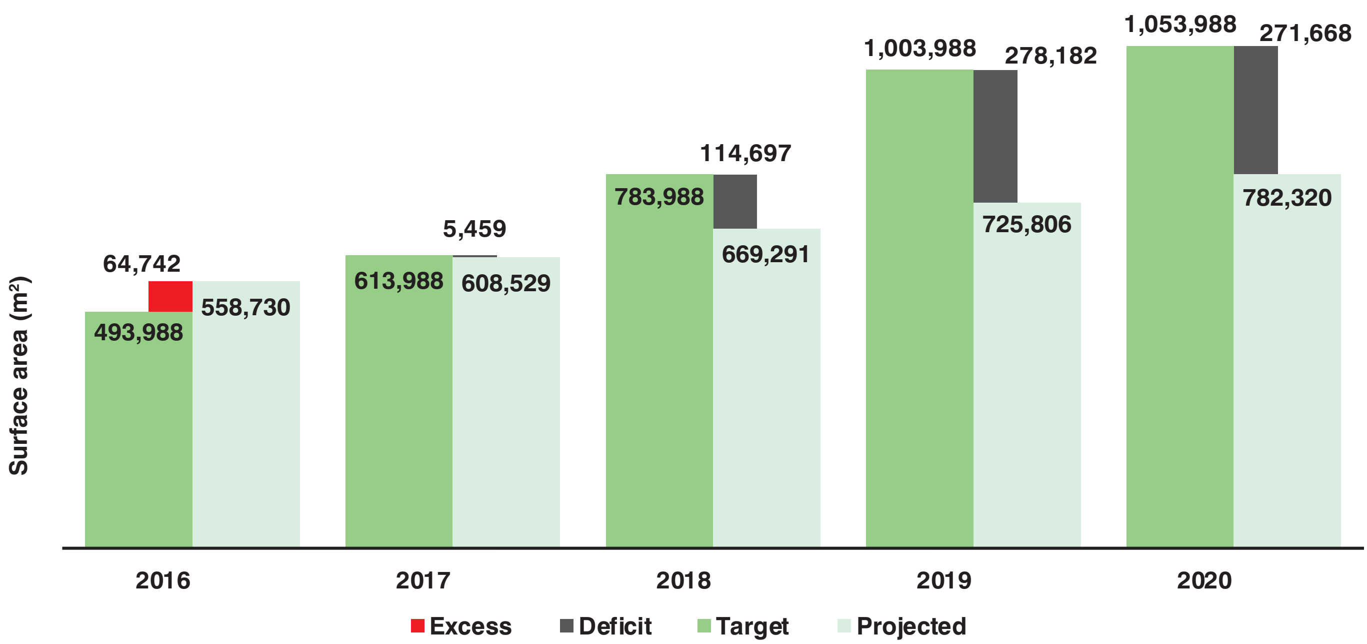
By December 2017, QSWHC and their affiliates are employing around 900 skilled engineers, technicians, and laborers. Taking into consideration the overall number of installations, from qualified and non-qualified companies, the employment level in the SWH sector could be estimated at 1,600 jobs.

6. Conclusion and Future Work

The Lebanese market has become well-developed since the implementation of the Global Solar Water Heating Market Transformation and Strengthening Initiative, which led to the installation of almost 610,000 m^2 by December 2017. Nine percent of the installed market benefited from SWH Program low interest loans, and half of this share benefited from the USD 200 subsidies/rebates, but recently the program's share of the market has been decreasing while the market has kept the same size. This shows that the market is gradually becoming independent of the SWH Program.

Figure 43 shows the targets for installed SWH surface area set for 2018–2020, projections for installations based on the market's development from the past 7 years, and expected deficit in meeting the targets. The graph also shows that 2016 was the last year in which solar water heater installations exceeded the target and that the Lebanese market reached a plateau of yearly SWH installations in 2017. Combining the previous information indicates that the goal for 2020 will not be reached if business-as-usual scenario continues, and if no actions are taken to strengthen the market and help push it to meet the targets. The projected deficits and the plateau in use of financial incentives mark an important turning point in 2017, suggesting a need to move from financial incentives to enforcement.

Figure 43. Comparison of the Target and Projected SWH System Installations by Surface Area, 2016-2020.



6.1 Solar Ordinances

One of the main barriers facing SWH deployment is the fact that building developers tend to neglect this aspect, as they see it as an additional upfront cost that will not bring them any profit (MED-DESIRE, 2015). On the other hand, when the end user buys a unit from these developers, they see the installation of a SWH as a hassle, because they have to check roof availability and normally end up paying an additional amount to connect the SWH installation to their unit. This problem can be avoided by implementing solar ordinances in the Lebanese market.

Solar ordinances are regulations that oblige the designers of new buildings to have a minimum share of the heating demand supplied by solar energy (European Solar Thermal Industry Federation, 2018). A solar ordinance will act as a lever to the SWH industry to reach the set target for 2020. It will also help give the market a boost, as such the suppliers would be able to expand their markets and promote their efforts on new buildings.

Some regions in Lebanon have not witnessed the same rate of growth in the SWH industry as others. Mount Lebanon alone accounts for one third of the market, while Beirut, the most populated area in Lebanon—where almost half of the Lebanese population lives, has almost one tenth of the overall installed Lebanese SWH projects. Beirut suffers from land availability as it consists mostly of high-rise buildings that have limited roof space on which to place SWHs for each apartment. Other regions, like the South of Lebanon, lack development in terms of SWHs and could be a potential market as there should be a lot of opportunities in the region. Other regions seem to be gaining slowly in market share; therefore, a plan to boost their solar economy could be beneficial.

In order to see the effect that a solar ordinance will have on the Lebanese market, the relationship between areas of new development and SWHs was examined. Data from The First Energy Indicators Report of the Republic of Lebanon, specifically the data for real estate development from 2005 to 2015 and its projections, are used to calculate the potential installed SWH surface areas for 2019 and 2020 for each of the economic sectors as a direct result of implementing a solar ordinance (LCEC, 2018). The results are shown in Table 6.

Table 6. Potential Installed SWH Surface Area (in m^2) After Implementation of a Solar Ordinance

Year	Residential	Offices	Commercial	Hotels	Hospitals	Education	Total
2019	202,358.2	819.9	3,204.9	3,296.0	10,947.6	24,241.1	244,867.7
2020	202,749.4	821.5	3,211.1	3,302.4	10,968.8	24,288.0	245,341.1

The installed surface area for SWHs through December 2017 was 608,529 m^2. Adding to it the SWH installations expected from adoption of a solar ordinance and assuming business-as-usual market growth of 50,000 m^2/y for the years 2018, 2019 and 2020, expected SWH installations should reach approximately 1,248,708 m^2, adding 490,200 m^2 to the current projections

In parallel, awareness campaigns should be continuously performed to keep potential customers educated about the benefits of SWHs and its status as the most affordable thermal renewable energy technology on the market.

6.2 Awareness Raising in the “Least-ventured” Districts

As was shown in Figure 37 and Figure 38, some districts have a very low SWH penetration rate. This could be due to the fact that SWH companies do not have a strong presence in these districts. Another important factor may be the architectural integration problem, as houses in the least-ventured districts tend to be heritage houses with sloped-roof tiling. It is more challenging to install SWHs on sloped, tiled roofs. In addition, the owners of these houses may see SWHs as an esthetic nuisance to their cultural heritage. To overcome this obstacle, additional efforts should be taken to raise resident awareness and build installer capacity to integrate SWHs within existing buildings without affecting architectural identity.

6.3 Promotion of Air-to-water Heat-pumps in Highly Urbanized Areas

SWH technology can be a good solution for sustainable water heating, but in some urban applications like high-rise buildings, roof space is limited and may not allow installation of enough SWH capacity to serve all of the buildings’ hot water demand. This issue can be overcome by combining heat-pump technology with SWHs. Air-to-water heat pumps are systems that transfer heat from outside air to heat water inside buildings.

Air-to-water heat pumps can be installed within units to overcome the space availability constraint, and they can provide hot water at lower operational cost than conventional water heating technologies.

In addition, awareness campaigns should be undertaken to encourage consumers to embrace this relatively new technology in the Lebanese market.

6.4 Promotion of Quality Certification and Trust in the Technology

Another way of boosting the market is by joining regional certification and quality assurance actions that are under development, such as the Solar Heater Arab Mark and Certification Initiative (SHAMCI). SHAMCI is a beneficial program for local manufacturers as they will be able to have product certification at lower costs than usual and it would push them to enhance the quality of their products, as this is required for the certification. It will also create trust in the technology and systems in the market.

The IRI in Lebanon would be responsible for testing the products and, thus, should have the latest equipment to ensure that SWH systems undergo all relevant tests. A plan is currently being developed, with the assistance of the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), to help, Egypt, Jordan, Lebanon, and Tunisia reach the specifications requested for the certification scheme. Many other Arab countries have expressed interest in joining the program.

6.5 Effect of Proposed Measures

As detailed earlier, applying a solar ordinance will lead to the installation of approximately 490,200m^2 by 2020. Considering the average system in Lebanon has a SWH surface area of 4.8 m^2 and a capacity of 338 L as mentioned in Paragraph 4.1, a solar ordinance will lead to the installation of an additional 34,518,250 L. This is equivalent to an energy saving of approximately 294,750 MWh/year and CO_2 emissions savings of 191.6 ktons.

Awareness campaigns will help increase the amount of projects, especially in the least-ventured areas and, in particular, in the four districts that did not reach 100 installed projects. Awareness campaigns should be more specific and give more details about SWH technology as the Lebanese consumer is already familiar with the technology overall. Points such as the integration of SWHs within the existing architecture should be highlighted to overcome aesthetic concerns. As a significant number of Lebanese houses, especially in rural areas, have sloped, red, tile roofing, such a campaign should explain the possibilities for integration of SWHs into these buildings without nuisance. This will lead to a bigger acceptance of SWH projects as consumers will see technology's benefits without the aesthetic nuisance.

Locally produced products represent 25% of SWH components in the market. These products do not usually have a certification. Implementing a certification scheme such as SHAMCI or another international scheme, will promote these products and allow them to increase their market share since the quality of their products will be certified by a renowned certifying body. The certification will provide the end user with quality assurance at competitive prices and thus will promote the sale of local products.

Adding the existing installed surface area to the projected market through 2020 and the solar ordinance prediction, the total installed SWH surface area will amount to 1,248,708 m^2 by the end of 2020. This exceeds the set target by around 200,000 m^2. This forecasted number will lead to a yearly savings of approximately 743,000 MWh/year and almost 483 ktons of CO_2 emissions. Adding the effect of awareness campaigns and certification schemes will lead to a bigger installation as well as setting even more ambitious targets for the coming years.

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Annex 1

Evolution of the SWH low interest loan:

Circular (Article, point, bullet)	Date	Applicable Interest
236 (18)	25/11/2010	0%
313 (1,3,3)	14/1/2013	0.75% in Lebanese Pounds
386	7/3/2015	One-time 0.4% fee
387 (9)	7/3/2015	One-time 0.4% fee
475	19/10/2017	@ 75% of Federal Fund Rate (FFR)
482	27/12/2017	@ 100% of FFR
485	1/2/2018	USD BDL Index (6.5%) -4.75%=1.75%
486	20/2/2018	USD BDL Index (6.5%) -4.5%=2%
492	11/5/2018	Libor 1 year -0.52%=2.49%
515	30/1/2019	Libor 1 year -0.52%

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