LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

2018
SOLAR PV STATUS REPORT FOR LEBANON

DATA COLLECTOR

Ms. Joanna Andraos (LCEC Intern)
Mr. Mazen Cheikh (LCEC Intern)

AUTHORS

Ms. Melda Jabbour (LCEC Team Leader – Programmes Engineer – Technical Support Unit to the Central Bank (NEEREA))
Mr. Wissam Farhat (Energy Consultant)

REVIEWERS

Mr. Pierre El Khoury (LCEC General Director)
Ms. Joumana Sayegh (LCEC Associate Director – Engineering & Planning)

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FOR MORE INFORMATION:

Lebanese Center of Energy Conservation, **www.lcec.org.lb**
Note: The information contained within this document has been developed within a specific scope, and might be updated in the future.

ACKNOWLEDGMENTS

The Lebanese Center of Energy Conservation **(LCEC)** would like to thank all its partners including Électricité du Liban **(EDL)**, Banque du Liban **(BDL)**, the Lebanese renewable energy companies that participated in the survey for this report and all other institutions that contributed to the data presented in this report.
LCEC would also like to thank the **UNDP-DREG** Project which developed the first, second, and third versions of the Solar PV Status Report that enabled this fourth edition of the report to be prepared and published.

FOREWORD

Thanks to considerable advancements during 2019, the renewable energy market in Lebanon continues to witness an impressive growth: the Ministry of Energy and Water has signed in 2018 three Power Purchase Agreements (PPA) to build 226 MW of wind farms; the Ministry is currently considering offers to choose 12 utility-scale solar PV farms all over the country; and new bids to build solar PV systems, wind farms, and solar systems with storage will be soon released. With all these advancements, Lebanon's target of 12% renewable energy by 2020 is within reach.

Furthermore, Lebanon's national objective by 2030 is to reach more than 5,000 MW of renewable energy installations, with main focus on large solar photovoltaic systems and wind energy. Yet, small decentralized or rooftop solar PV systems are not to be neglected. While a lot of efforts have been invested to promote large-scale projects, the Ministry is keen to keep moving forward with smaller solar applications. In 2018, the decentralized solar PV sector saw an additional $13 million of investments which is a promising sign that consolidates the growth of this sector year after year. It is very significant to note that the decentralized solar PV market has continued its growth to reach 56.37 MW of installations.

It gives me a real pleasure to share the "2018 Solar PV Status Report for Lebanon", a reference document that remains the go-to source for accurate data pertaining to this sector where all key indices and metrics are presented and analyzed for easy referencing and better decision-making. The Ministry of Energy and Water is utilizing this report to continue supporting the solar PV sector in Lebanon by setting the right policies and removing any barriers standing in the way of achieving our 2020 target.

According to the report, by the end of 2018, the decentralized solar PV sector was worth more than $105 million while reducing 18,000 tons of CO_2e in greenhouse gas emissions per year with total cumulative savings of 147,000 tons of CO_2e. Equally important, the number of companies working in this sector grew to 66 while creating direct employment for 750 persons at least.

I do hope that the decentralized solar PV sector will keep growing year after year. The Ministry is fully dedicated to push further the development of this sector, by working on creating new incentives as well as new enforcement measures. We want to see solar PV systems flourishing on every rooftop all over the regions of Lebanon. Together, we will make this happen.

Nada Boustani

MINISTER OF ENERGY AND WATER

ABSTRACT

This report is nationally prepared by the Lebanese Center for Energy Conservation (LCEC). The LCEC aims to carry on the work of UNDP-DREG Project in the development of the "Annual Solar PV Status Report for Lebanon", with the objective to establish and produce market monitoring reports on the installed capacity and electricity produced from decentralized renewable energy in Lebanon.

The report's objective is to present the widespread application of decentralized renewable energy power generation, mainly using Solar Photovoltaic technology, that aims towards reducing greenhouse gas emissions.

The 2018 Solar Photovoltaic (PV) Status Report for Lebanon, developed and published in its fourth edition in 2019, highlights the status and the growth of the solar PV market by presenting and analyzing all its available data.

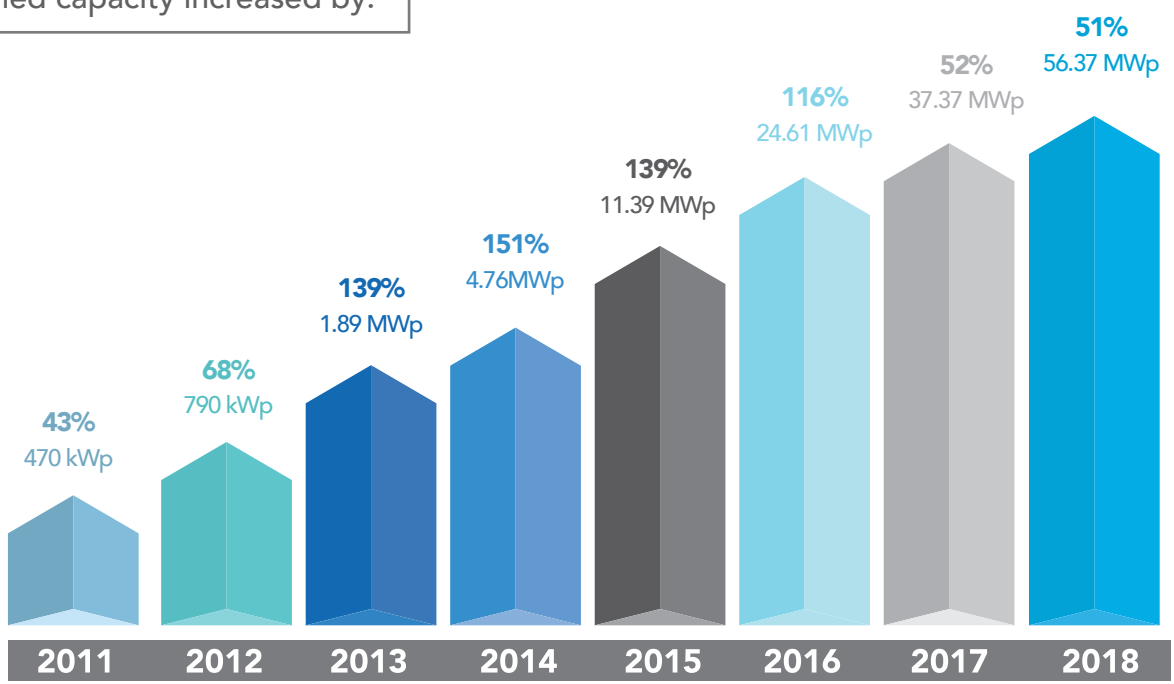
This report is based on data collected from participating Lebanese solar PV companies with installed and operational systems all over Lebanon until the end of 2018 in both the private and the public sectors including the PV projects implemented through NEEREA financing. The analyzed data enables the understanding of the solar PV market growth in Lebanon over time through various indicators such as installed capacity, energy generation, number and type of projects, amount of investments, monetary and environmental savings, financial incentives and geographical location.

The Solar PV Status Report for Lebanon has become a yearly collaborative publication reporting on the market's growth for the previous year. This in turn will enable decision makers and stakeholders to align their efforts to continue supporting the market and sustaining its healthy growth.

EXECUTIVE SUMMARY

LEBANON'S ENERGY GENERATION BY EDL REACHED **15.17 TWH** IN 2018[1].

In 2010, Lebanon's solar PV installed capacity equaled **330 kWp**.
The installed capacity increased by:



From 2010 until the end of **2018**, the cumulative installed solar PV capacity grew by an average rate of **95%** per year.

[1] Source: EDL

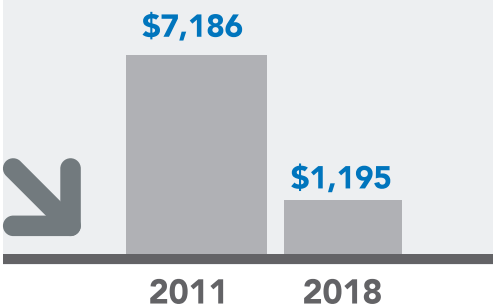
	2017	2018	
	0.37 %	0.55 %	PERCENTAGE OF TOTAL ENERGY GENERATION BY EDL
	82,09 M	104,8 M	CUMULATIVE INVESTMENT IN THE SOLAR PV
	386	322	NUMBER OF PV PROJECTS
	52 %	51%	YEAR-OVER-YEAR GROWTH RATE OF THE SOLAR PV CAPACITY

EVOLUTION THROUGHOUT THE YEAR

25 PROJECT IN **2011**

322 PROJECT IN **2018**

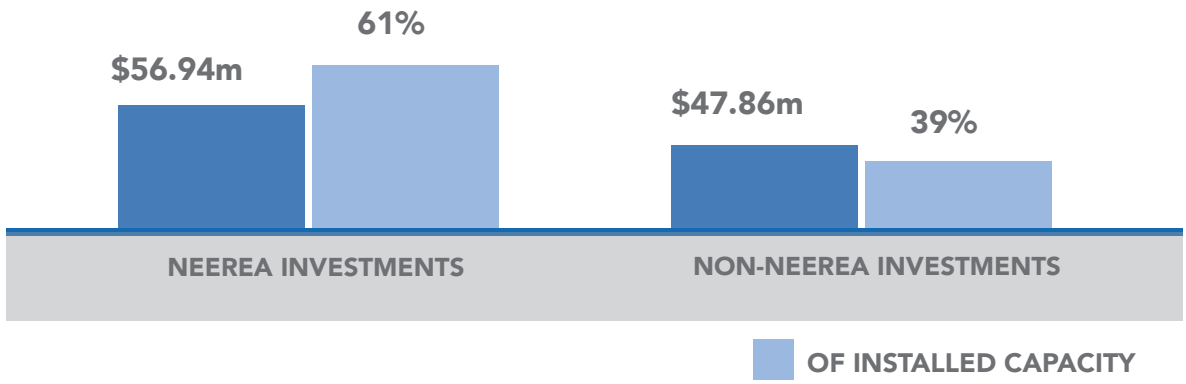
83% DECREASE
IN TURNKEY PRICE FOR SOLAR PV



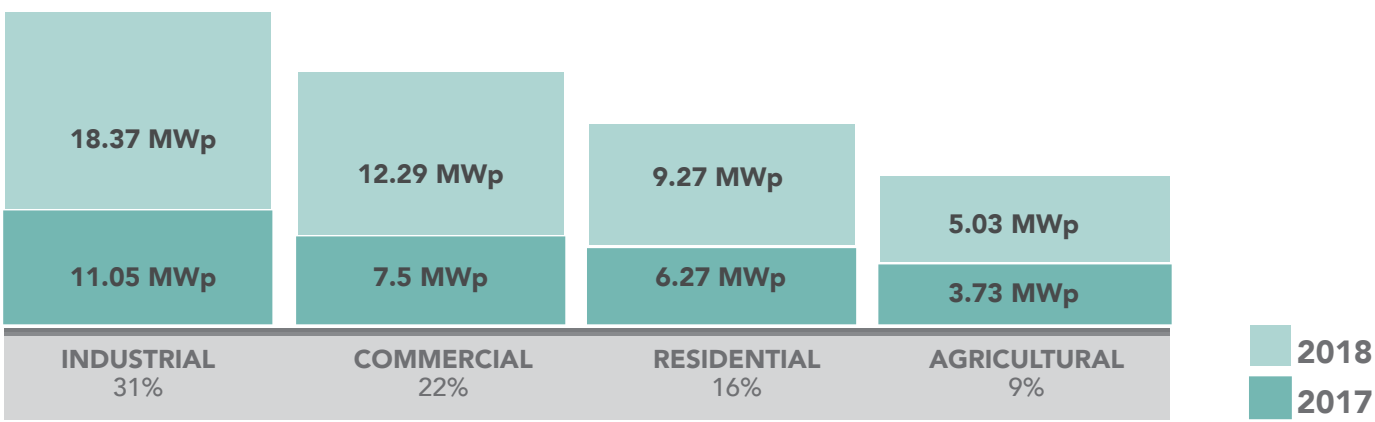
2018
GROWTH RATE FOR THE SOLAR PV

[2] Source: IEA

Investments coming through NEEREA totaled **$13.18m** in 2018 whereas non-NEEREA investments reached **$9.53m** for a total investment of **$22.71m**.



THE TOP **4 SECTORS** LEADING THE SOLAR PV MARKET IN LEBANON ARE:

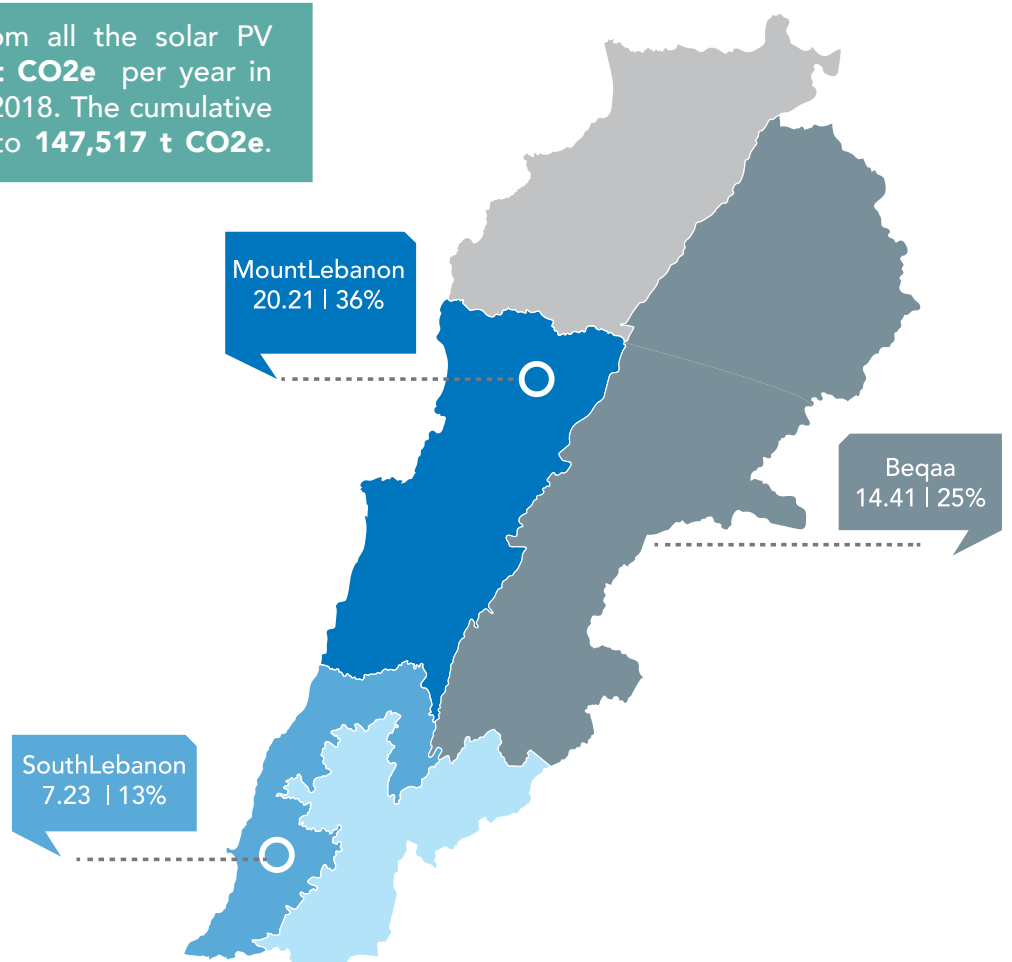


The Top 3 project types prevailing in the solar PV Market in Lebanon are On-grid with **35.17 MWp** at **63%,** On-grid with batteries with **6.84 MWp** at **12%,** and Solar PV Pumping with **5.07 MWp** at **9%.**

The estimated monetary savings from all the solar PV projects in Lebanon grew from **$200k** per year in 2010 to **$4.68m** per year in 2018. The cumulative savings by the end of 2018 amount to **$45.42m**.
These are the savings achieved by the operators of solar PV systems in Lebanon by deferring a portion of their electricity consumption from the grid and diesel generators to solar PV generation.

The estimated emissions savings from all the solar PV projects in Lebanon grew from **377 t CO2e** per year in 2010 to **18,824 t CO2e** per year in 2018. The cumulative savings by the end of 2018 amount to **147,517 t CO2e**.

THE TOP **3 GOVERNORATES** LEADING THE SOLAR PV MARKET IN **LEBANON**



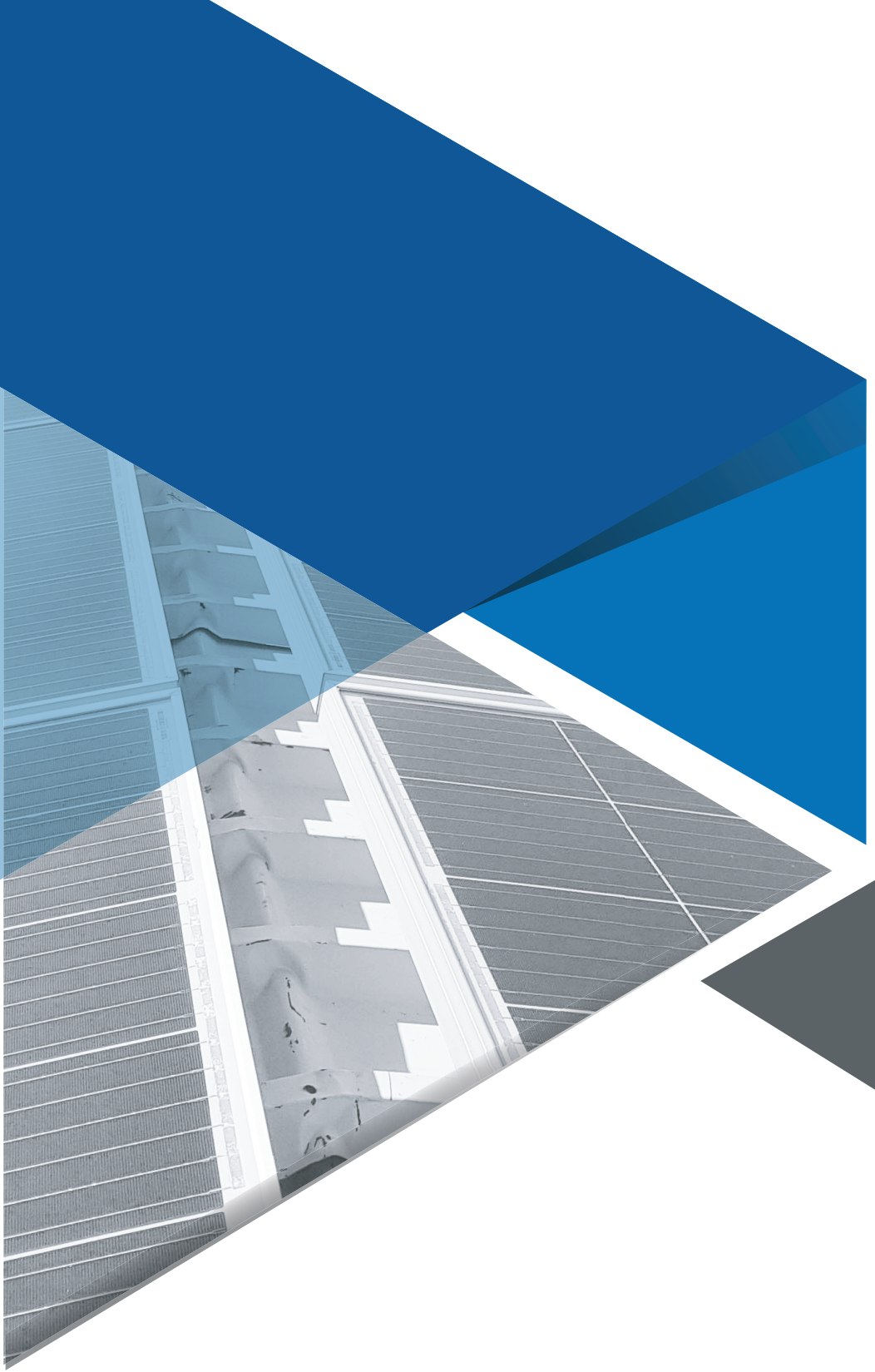


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TABLE OF ACRONYMS

BDL	Banque du Liban
EDL	Electricité du Liban
kW	Kilo-watt
kWh	Kilo-watt-hour
kWp	Kilo-watt-peak
LCEC	Lebanese Center for Energy Conservation
LECB	Low Emission Capacity Building Project
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MW	Mega-watt
MWh	Mega-watt-hour
MWp	Mega-watt-peak
NEEREA	National Energy Efficiency and Renewable Energy Action
PV	Photovoltaic
TWh	Terra-watt-hour
UNDP-DREG Project	United Nations Development Program-Decentralized Renewable Energy Generation Project

TABLE OF TERMS

DECENTRALISED ENERGY	Decentralised energy is produced close to where it will be used rather than at a large plant elsewhere and sent through the national grid.
GENERATION CAPACITY	Generation capacity is the maximum electric output an electricity generator can produce under specific conditions.
ELECTRICITY GENERATION	Electricity generation is the amount of electricity a generator produces over a specific period of time.
ON-GRID	These systems require connection to the grid in order to operate. For decentralized systems, in the case where PV production is greater than the local demand load, the surplus is injected into the grid via net-metering. In times of blackouts, the PV system usually operates in parallel with back-up generators (most commonly diesel gensets). These systems are also known as Grid-tied and Online
ON-GRID WITH BATTERIES	These systems combine the features of the on-grid and off-grid systems as they operate like the former whenever the grid is present and switch to the operation of the latter should the utility's availability become compromised. These systems are also known as Grid-interactive/Dual-mode.
HYBRID	This refers to systems that involve the parallel operation of PV with one or more "grid-forming" sources (e.g. PV-Diesel) without any actual connection to the EDL grid (also known as Multisource).
OFF-GRID	These systems work independent of a grid, stand alone. Batteries are an integral part of this configuration. PV will feed the local loads and charge the batteries thereby ensuring a fully autonomous operation.
OFF-GRID WITH GENERATOR BACK-UP	Same as off-grid, but the battery bank can be recharged by another generator (e.g. Diesel back-up genset).
SOLAR PV PUMPING	These systems consist of a direct connection to a DC pump or through an inverter to feed an AC pump, instantly providing all the available power collected by the PV modules directly to the load. The system can be upgraded to include batteries.

2018 HIGHLIGHTS

- Whereas 2017 saw an addition of **12.75 MWp**, 2018 witnessed the addition of **19 MWp** of solar PV capacity bringing the total installed capacity to **56.37 MWp**. With Lebanon's decentralized solar PV target set at **100 MWp** by 2020 as per the National Renewable Energy Action Plan (NREAP), the market needs to add **43.63 MWp** in 2019. With **61%** of the installed capacity so far being funded by NEEREA, BDL's subsidized funding is key to reach the 2020 target for decentralized solar PV. In addition, the current appetite for international banks such as EBRD, AFD and EIB to provide lending in Lebanon through local commercial banks for sustainable projects, including the decentralized renewable energy projects will definitely play an important role in achieving the 2020 targets.

- Decentralized solar PV electricity generation increased from **0.37%** of the total annual electricity generation by EDL in 2017 to **0.55%** in 2018. This is equivalent to **83.59 GWh** in 2018. With Lebanon's decentralized solar PV generation target set at **160 GWh** per year by 2020 as per the National Renewable Energy Action Plan (NREAP), the market needs to add **76.41 GWh** of decentralized solar PV electricity generation in 2019.

- Same as the year 2017, the Industrial sector achieved the highest solar PV capacity addition of **7.32 MWp** during 2018 thereby bringing the total installed capacity to **18.38 MWp** for the sector. This is partially due to the increase in the cost of oil witnessed in 2018 which created a bigger incentive for industrialists to reduce their diesel consumption by investing in and operating on-grid solar PV systems. The savings achieved by offsetting diesel with PV is creating all-year-round net positive cash flows and payback periods of six years or less. The higher the cost of oil trends, the bigger the savings are going to be.

2018

- The average turnkey price for solar PV continued its decline from **$1,557** per kWp in 2017 to **$1,195** in 2018; a drop of **23%** which exceeds the global cost drop rate[3] of 10-15% per year. The major contributor to this drop remains the drop in the cost of equipment, but local competition during 2018 due to the economic situation significantly increased as well due to numerous tenders by various national and international stakeholders which helped bring the prices down as well. To better grasp the positive impact these price reductions have on the market, a **$100,000** investment in 2011 would have developed a **14 kWp** system. The same investment achieves **84 kWp** in 2018.

- In 2018, the total investment in the solar PV sector grew by **22%** from the previous year; totaling over **$104.8 million**. This means that 2018 saw an additional **$22.71 million** in new investments introduced into the market. This is largely thanks to the NEEREA loan programme which provided **$13.18 million.** This is another indicator that highlights the importance of the NEEREA facility to ensure that the market can continue to expand and grow.

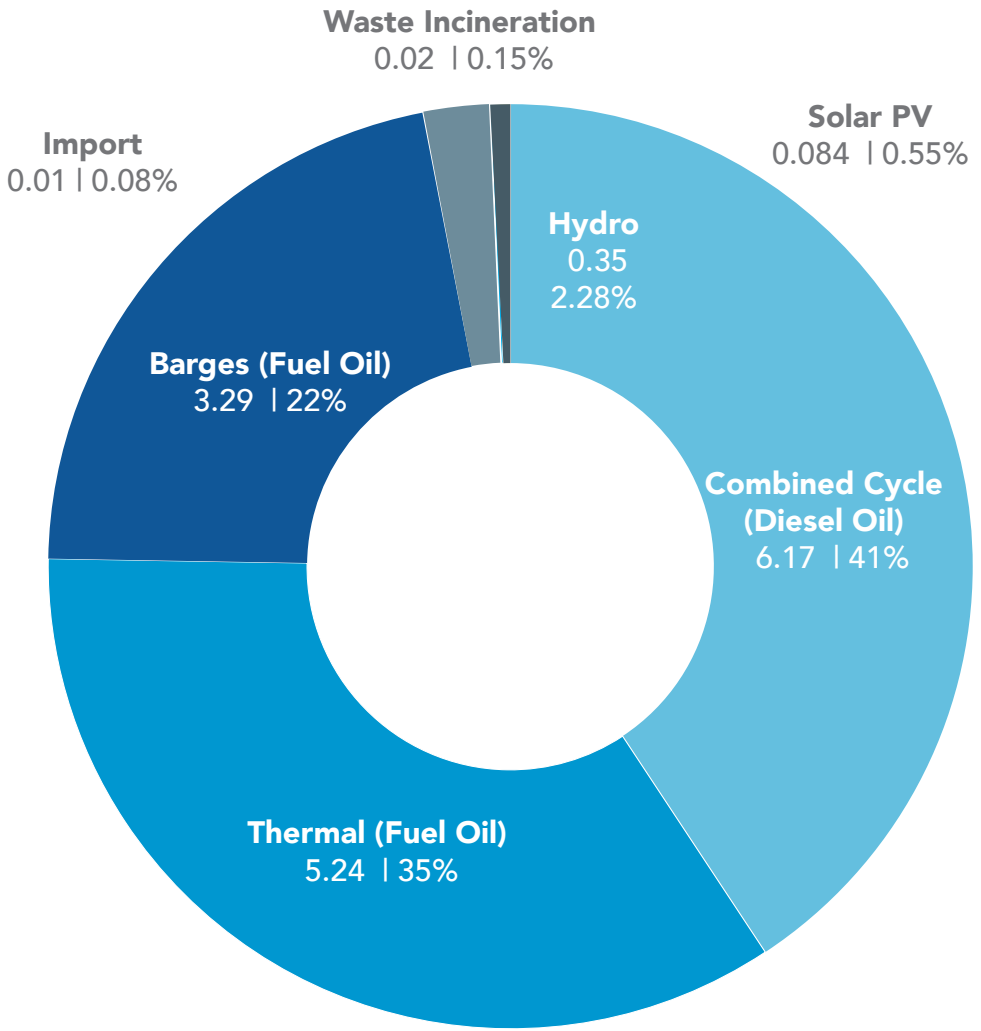
- **7** Lebanese solar PV companies were working in the sector up until 2008. This number started growing steadily from **14** companies in 2010 to **66** companies by the end of 2018. At least **748** new jobs were created in this sector.

[3] Source: IRENA

LEBANON

ELECTRICITY BACKGROUND INFORMATION

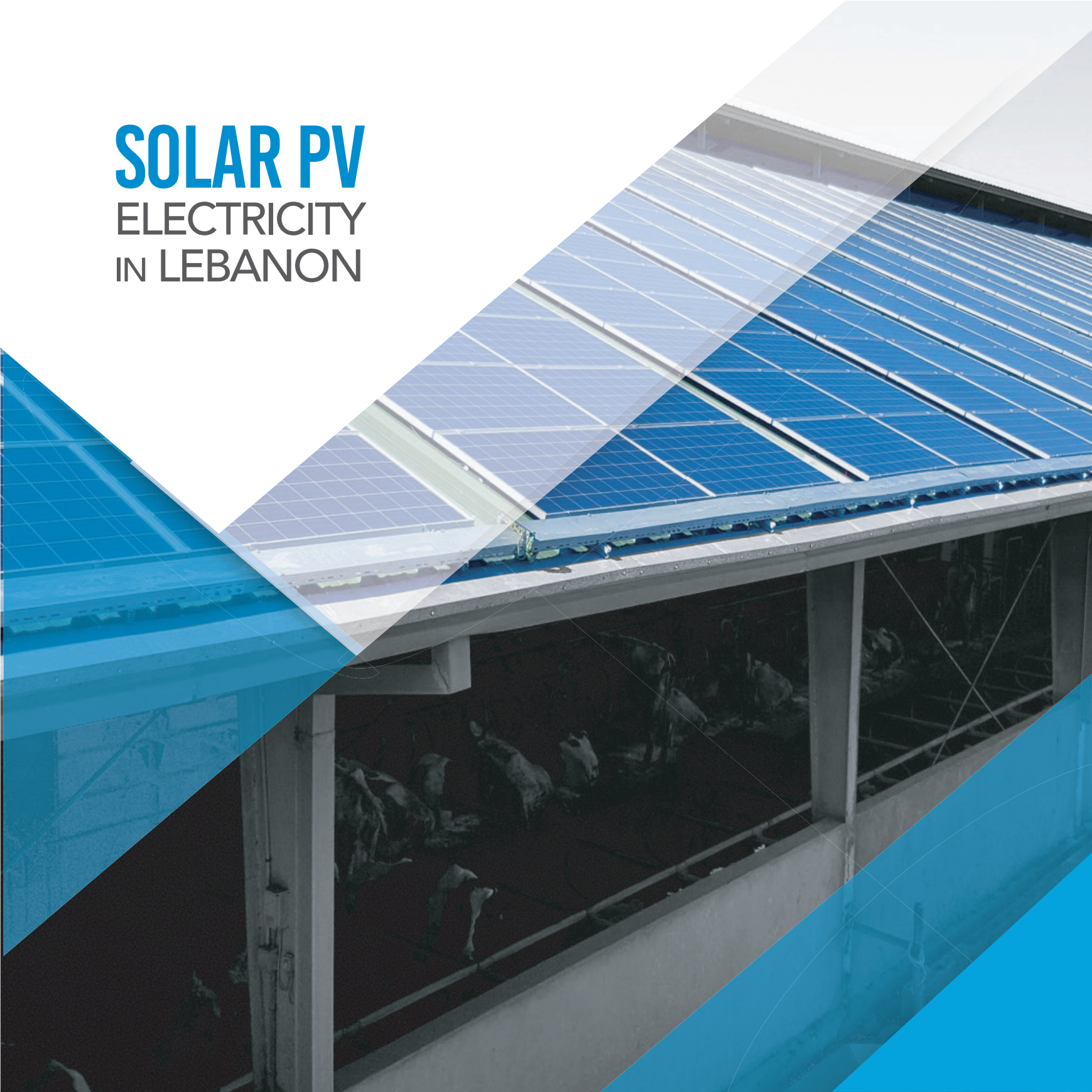
LEBANON'S 2018 ELECTRICITY GENERATION (TWH)



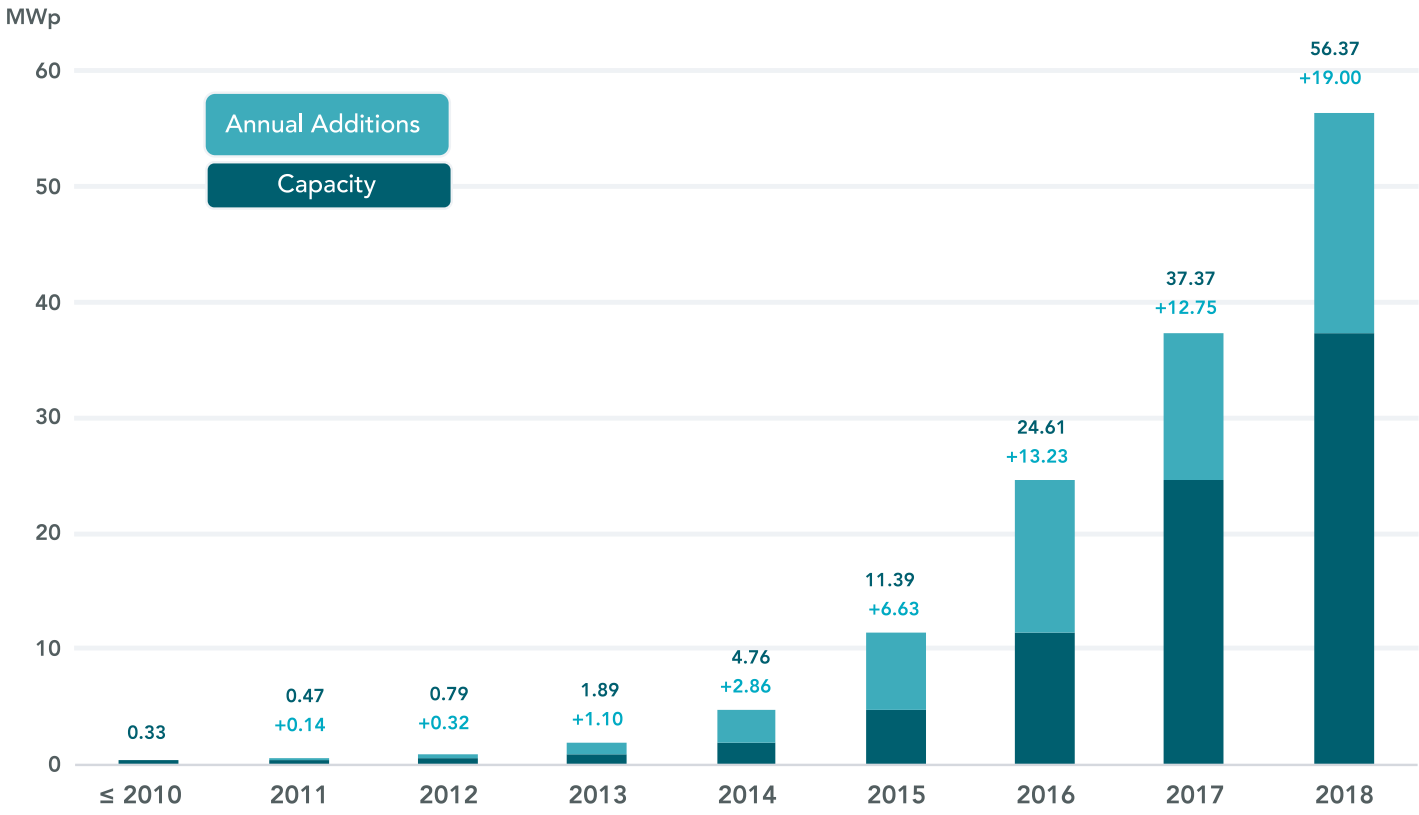
EDL's share of the total electricity generation equaled 15.17 TWh while the solar PV's share equaled 0.084 TWh or 0.55% of the total electricity generation (up from 0.35% in 2017).

With solar PV added to Hydro and Waste Incineration, the renewables' share of the total annual electricity generation in 2018 is equal to 2.98%.

SOLAR PV
ELECTRICITY IN LEBANON



SOLAR PV CAPACITY AND ANNUAL ADDITIONS



19 MWP OF SOLAR PV INSTALLED CAPACITY WAS ADDED IN 2018 TO REACH A TOTAL OF **56.37 MWP**

This figure includes the following public projects implemented by the MEW:

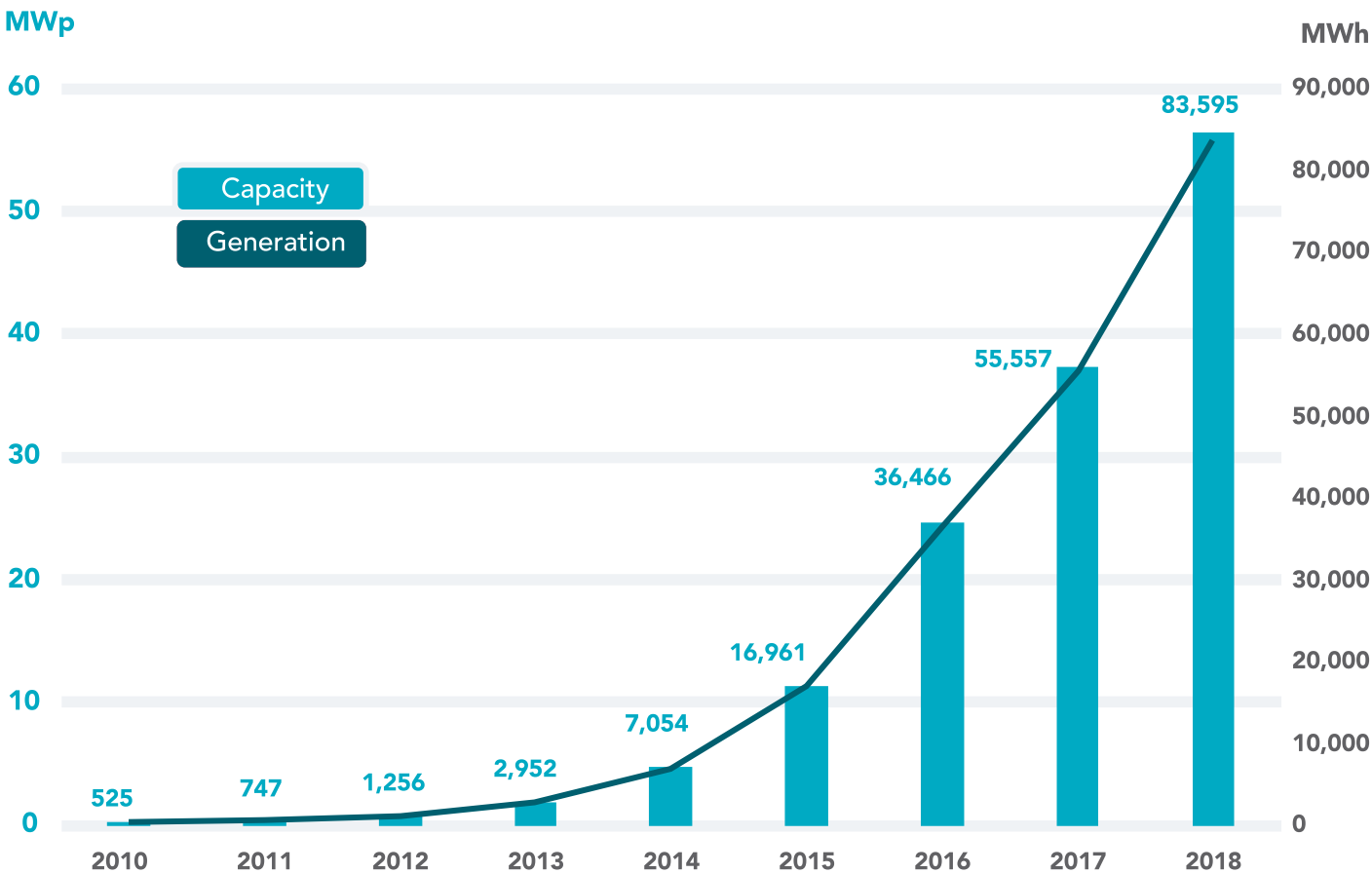
- The Beirut River Solar Snake Project (1.08 MWp)
- The Zahrani Oil Installations Project (1.09 MWp)
- The Ministry of Energy and Water (135.30 kWp)
- Directorate of Engineering and Planning – LAF (155.70 kWp)
- El Helou Barrack (32.30 kWp)
- Lebanese Army Health Dispensary of Qobbeh (54.40 kWp)
- Lebanese Army Health Dispensary of Ablah (54.40 kWp)

As well, two projects implemented through the Council for Reconstruction and Development (CDR):

11 Solar Water Pumping Sites in the Baalbeck Union of Municipalities– Total of 1.4 MWp
Solar Street Lighting in 3 Unions of Municipalities in the Bekaa – 800 PV Street lighting poles

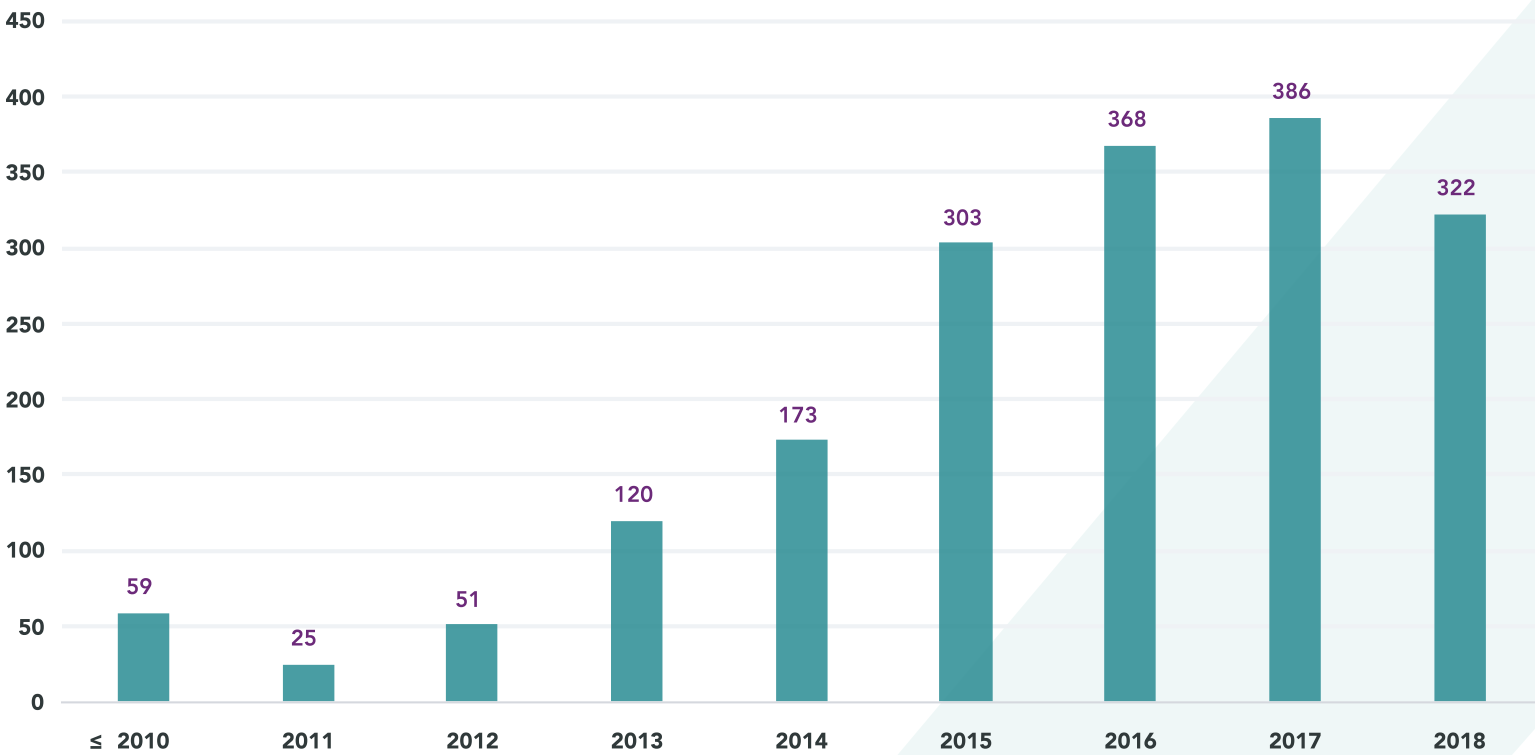
In addition to small scale projects in several municipalities, PV Street lighting, Public Hospitals and schools, the Ministry of education, etc.

SOLAR PV CAPACITY AND GENERATION



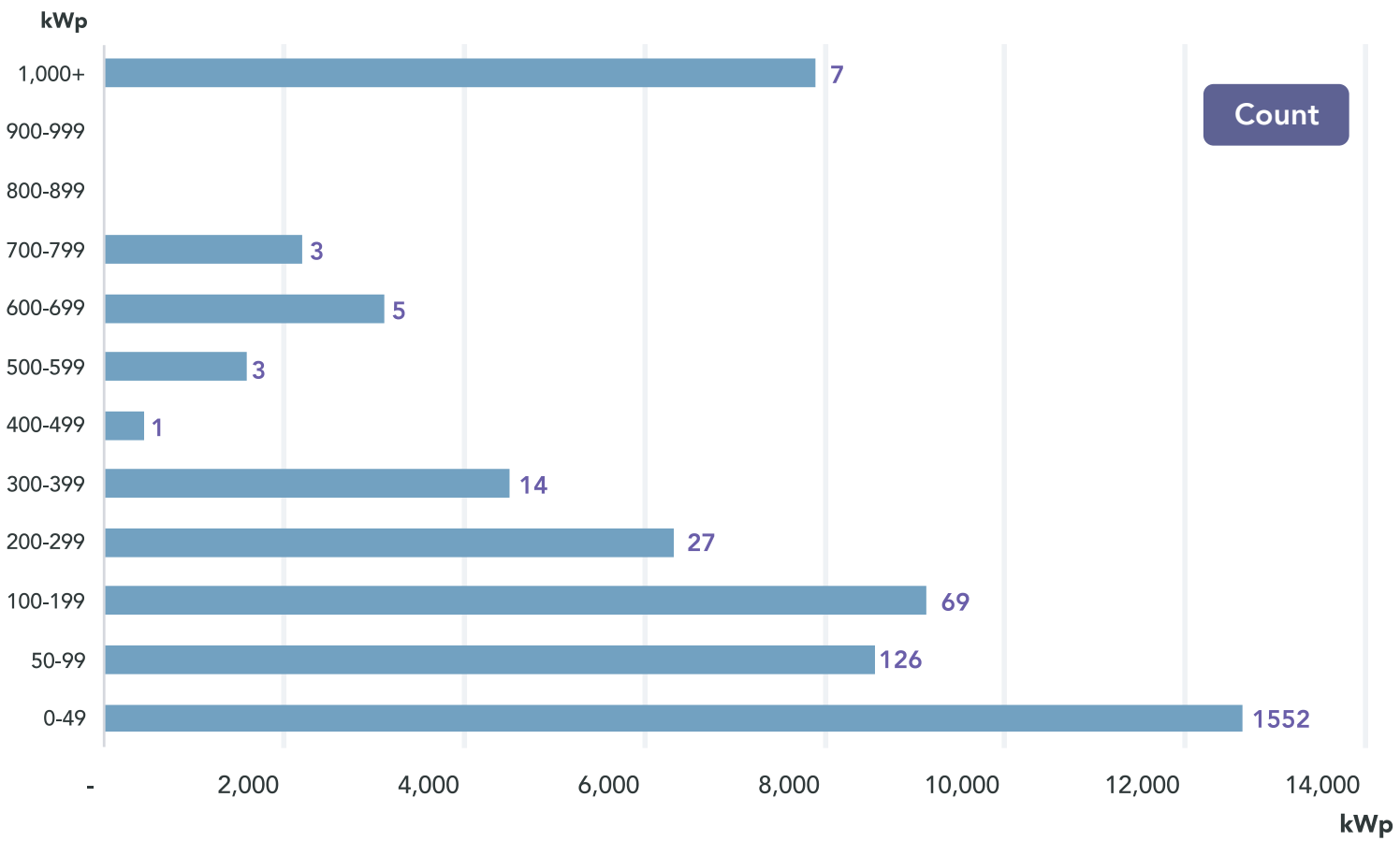
Solar PV electricity generation increased from 55,557 MWh in 2017 to 83,595 MWh in 2018 which constitutes 0.55% of the total annual electricity generation by EDL.

SOLAR PV ANNUAL NEW PROJECTS COUNT



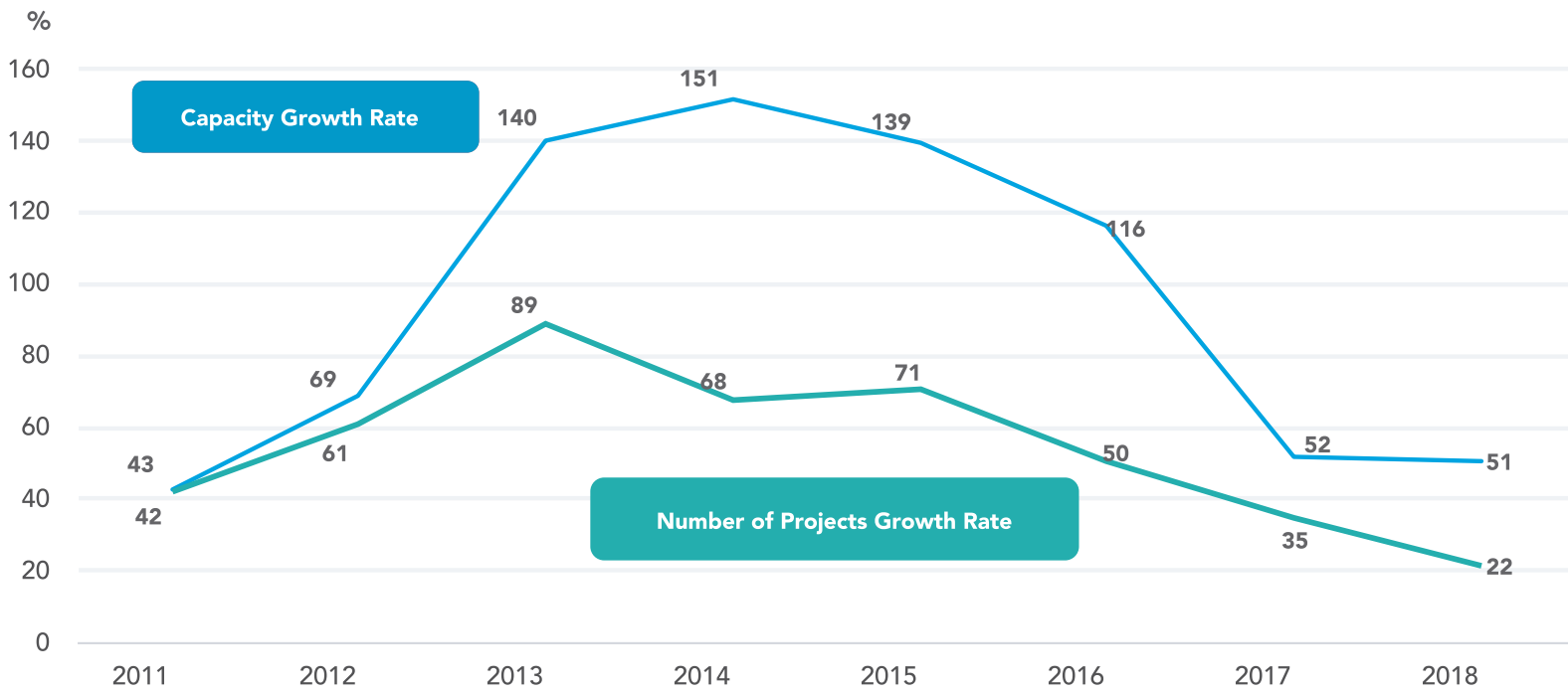
The number of new solar PV projects dropped from 386 in 2017 to 322 in 2018.

SOLAR PV CAPACITY AND COUNT BY PROJECT SIZE GROUPS



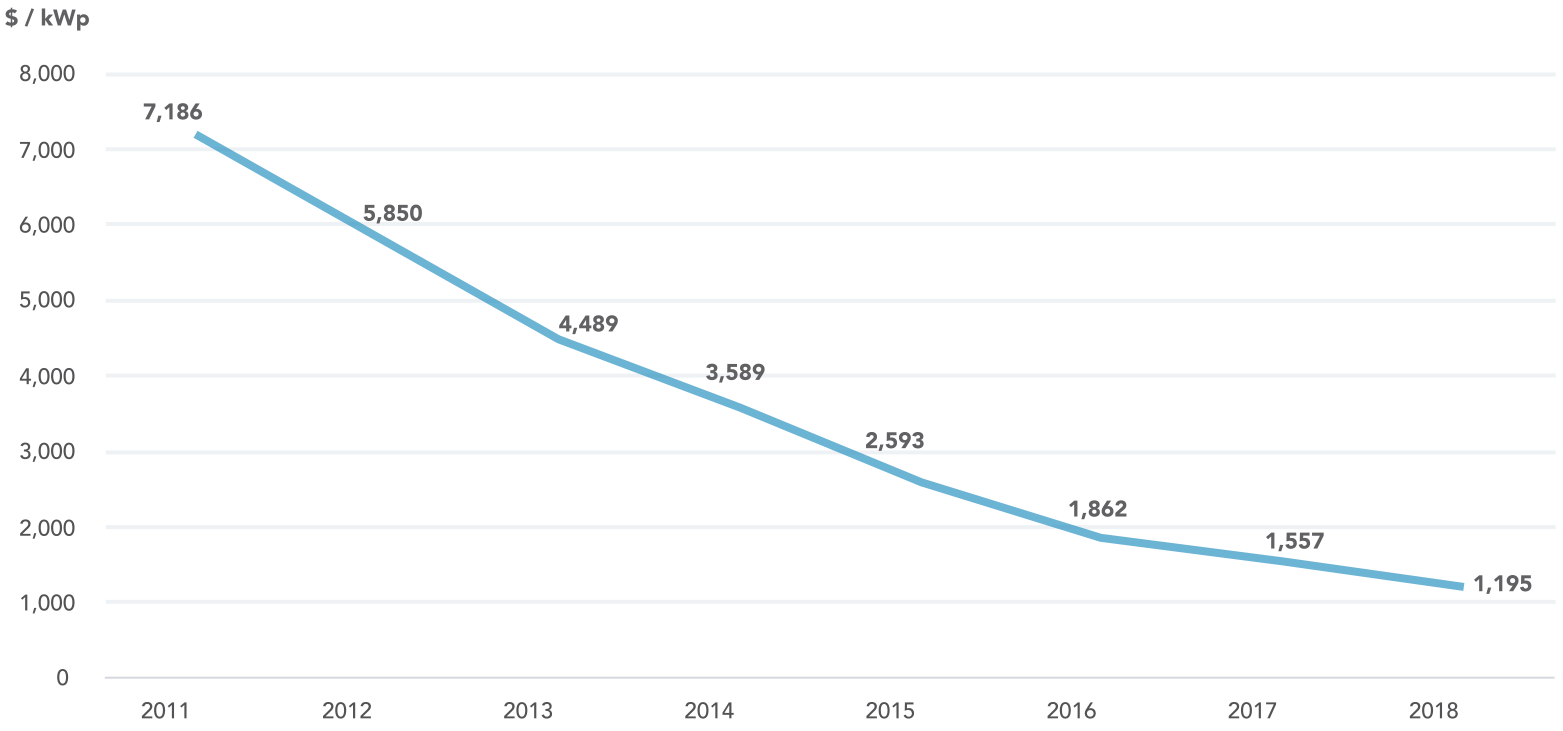
The total number of solar PV projects reached 1,807 by the end of 2018. Small-sized projects, up to 49 kWp, dominate the market in terms of capacity (23%) and count (86%).

SOLAR PV CAPACITY AND NUMBER OF PROJECTS YEAR-OVER-YEAR GROWTH RATE (%)



The year-over-year growth rate for the solar PV capacity remained close to the one in 2017, at 51% for 2018
The year-over-year growth rate for the number of new solar PV projects dropped by 37% in 2018.

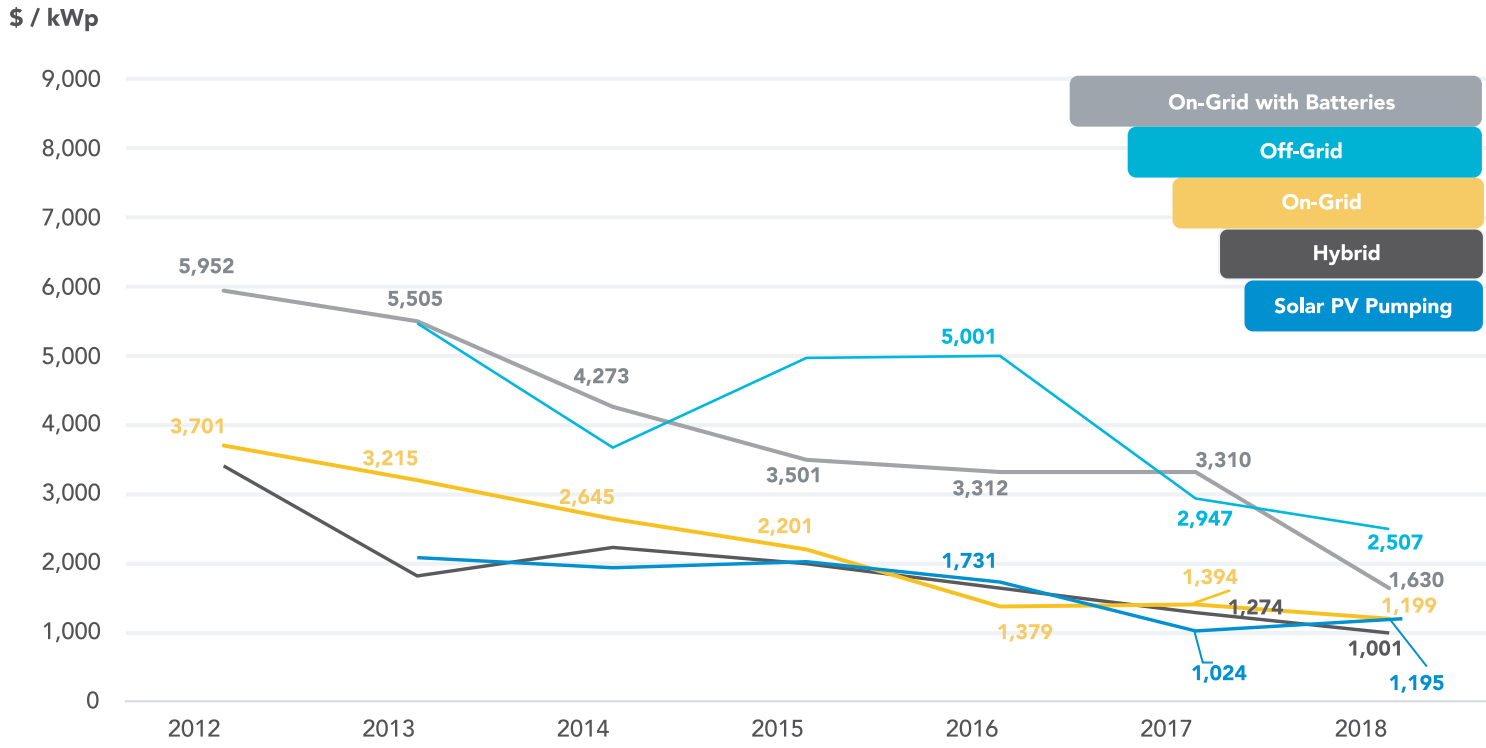
YEARLY AVERAGE SOLAR PV TURNKEY PRICE ($ / KWP)



The turnkey price for solar PV continued its steady decrease from $7,186 per kWp in 2011 to $1,557 in 2017 to $1,195 in 2018.

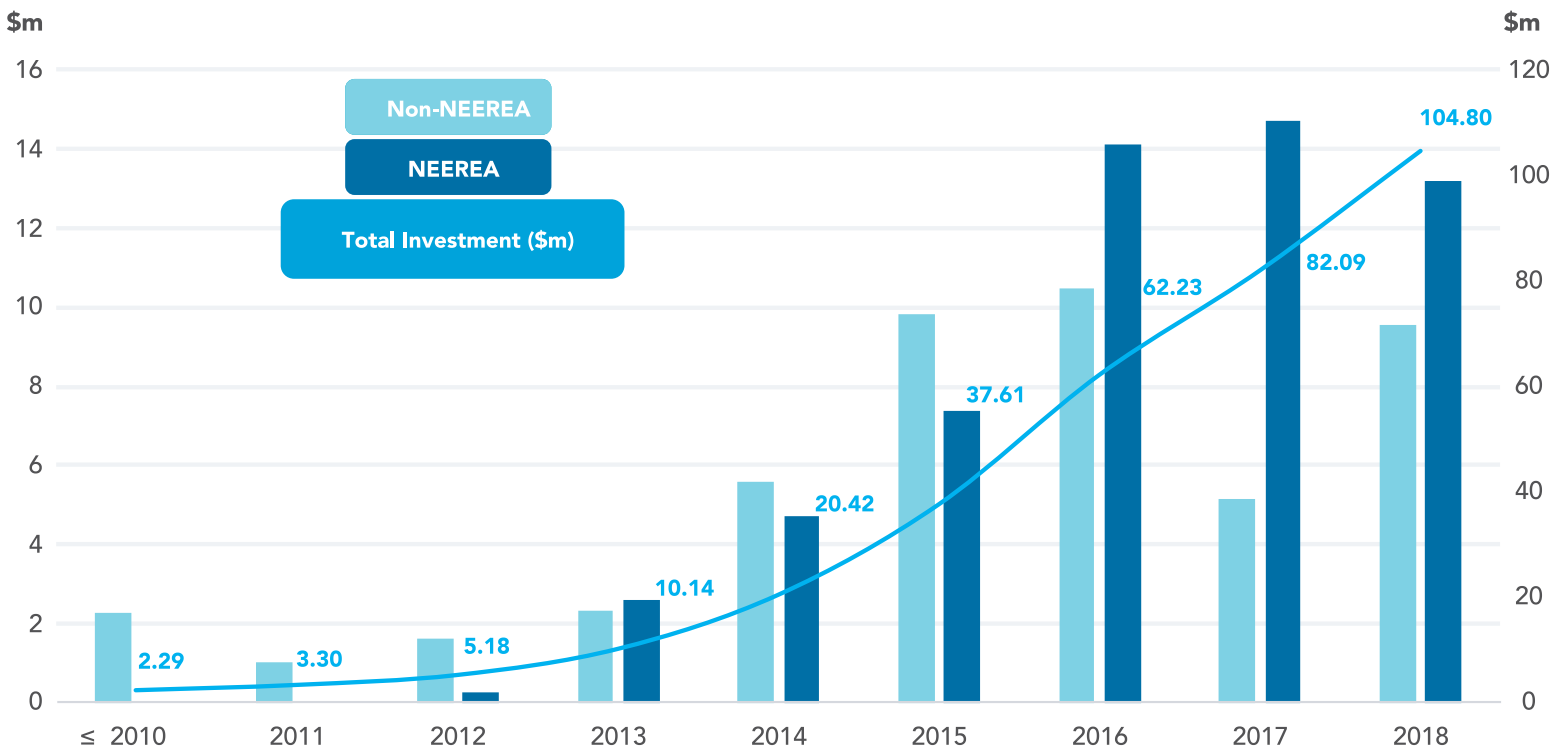
This constitutes a price drop of 83% in a span of Eight years.

YEARLY AVERAGE SOLAR PV TURNKEY PRICE BY PROJECT TYPE ($ / KWP)



The average turnkey price for On-grid with Batteries Solar PV projects decreased by 50% in a single year from 2017 to 2018.

SOLAR PV INVESTMENT ($M)

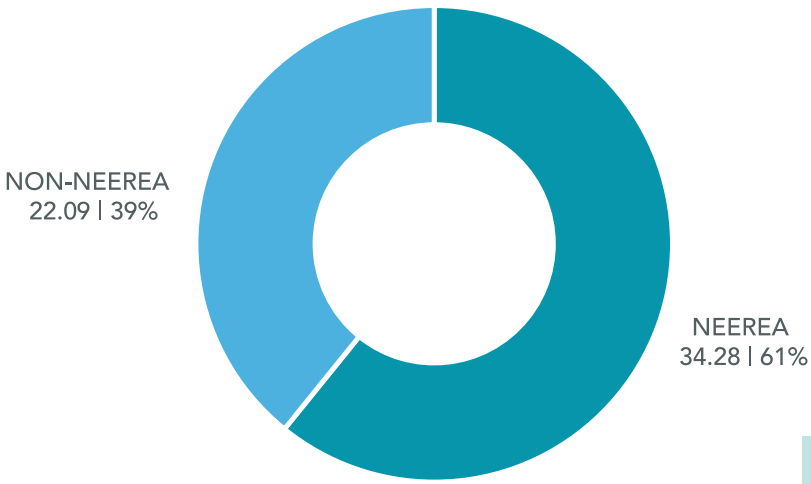


The total cumulative investment in the solar PV sector increased from $2.29m in 2010 to $104.8m in 2018

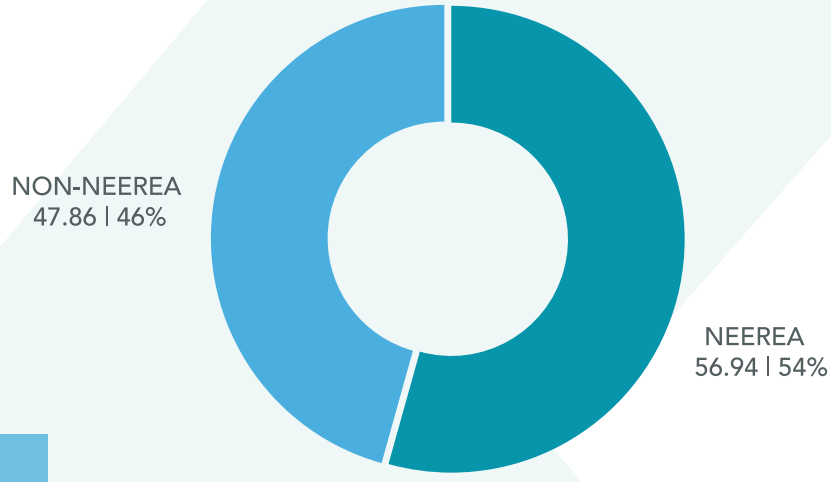
Investments in 2018 reached $23.8m thanks to $13.18m from NEEREA and $9.53m from non-NEEREA investments.

INVESTMENT IN SOLAR PV ($M)

Capacity Share per Source of Funding (MWp | %)

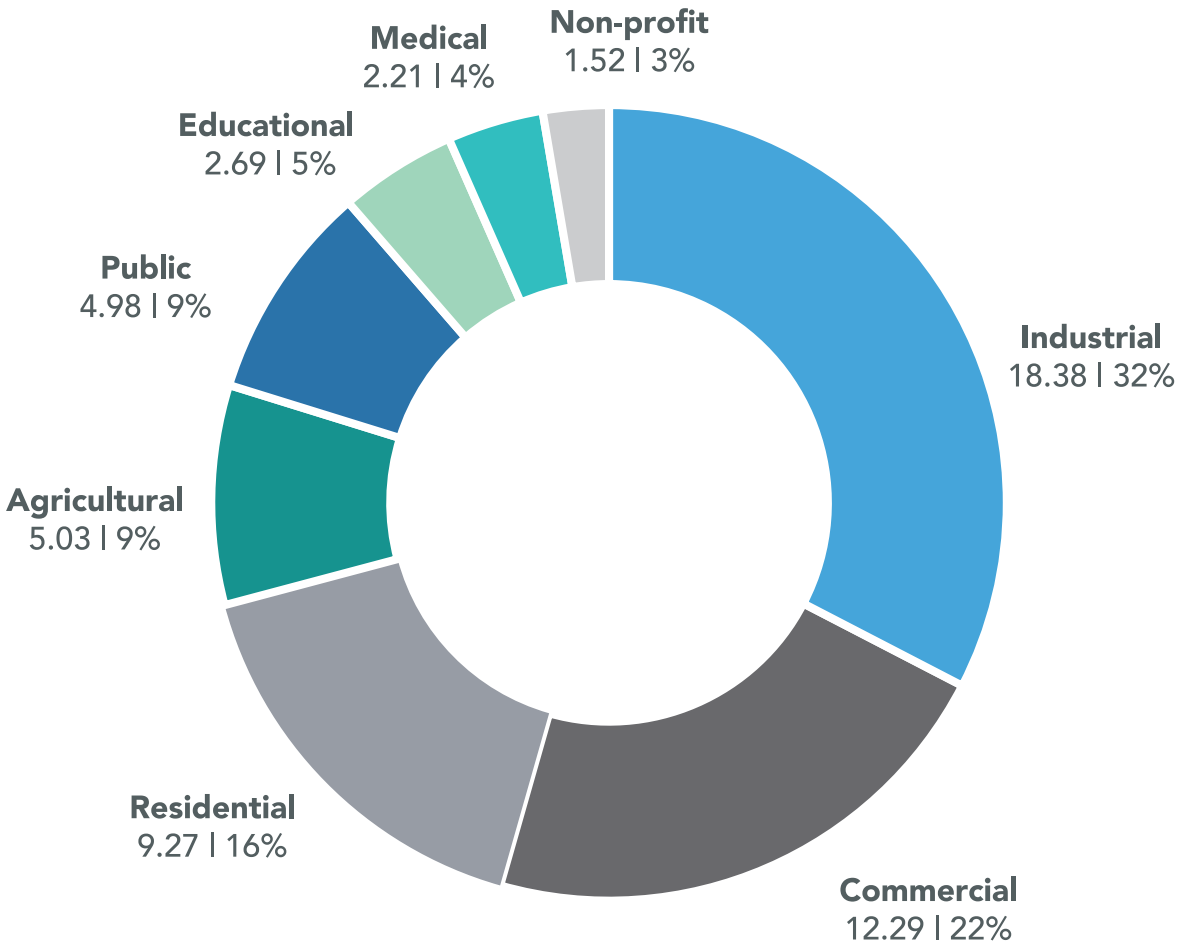


Funding Share per Source of Funding ($m | %)



61% of the installed solar PV capacity to date is funded by NEEREA for a total investment of $56.94m whereas the remaining 39% of installed capacity was funded by non-NEEREA investments totaling $47.86m.

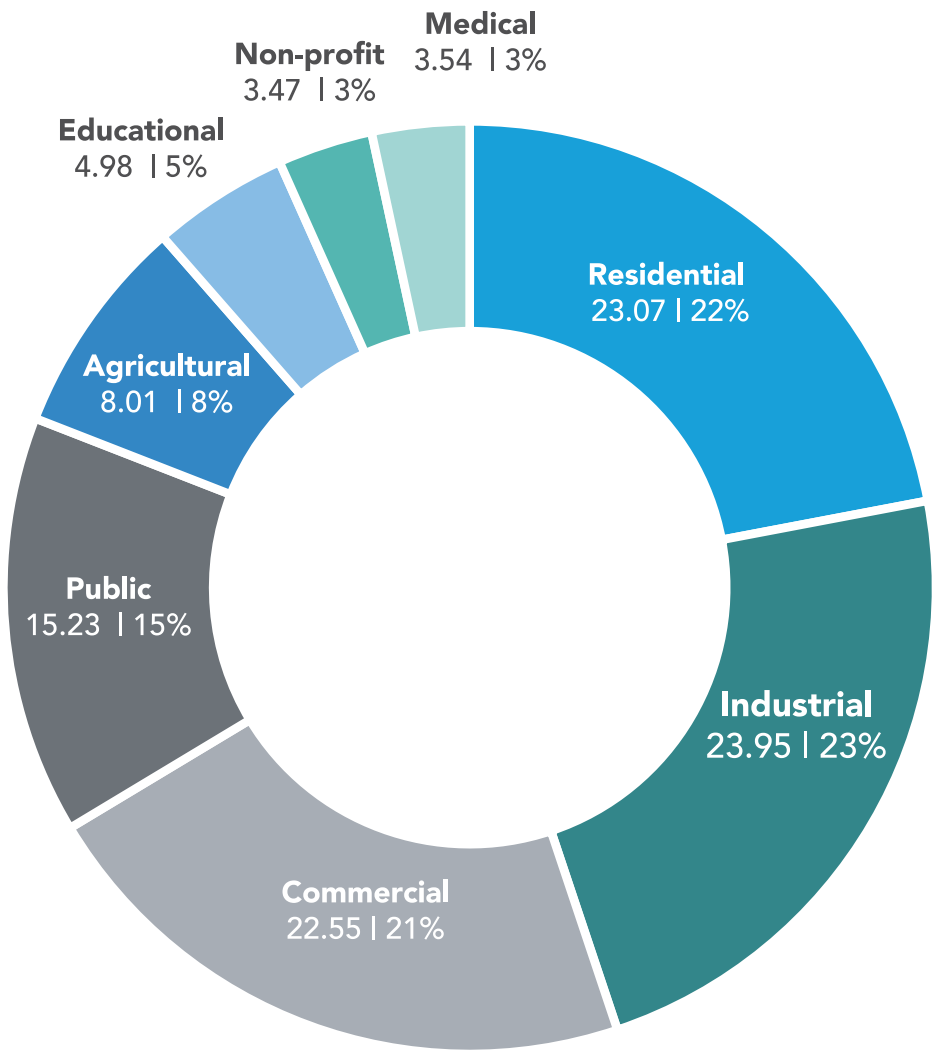
SOLAR PV CAPACITY BY SECTOR (MWP | %)



The top 3 sectors leading the solar PV market in Lebanon in installed capacity are the Industrial sector with 18.38 MWp, the Commercial sector with 12.29 MWp, and the Residential sector with 9.27 MWp.

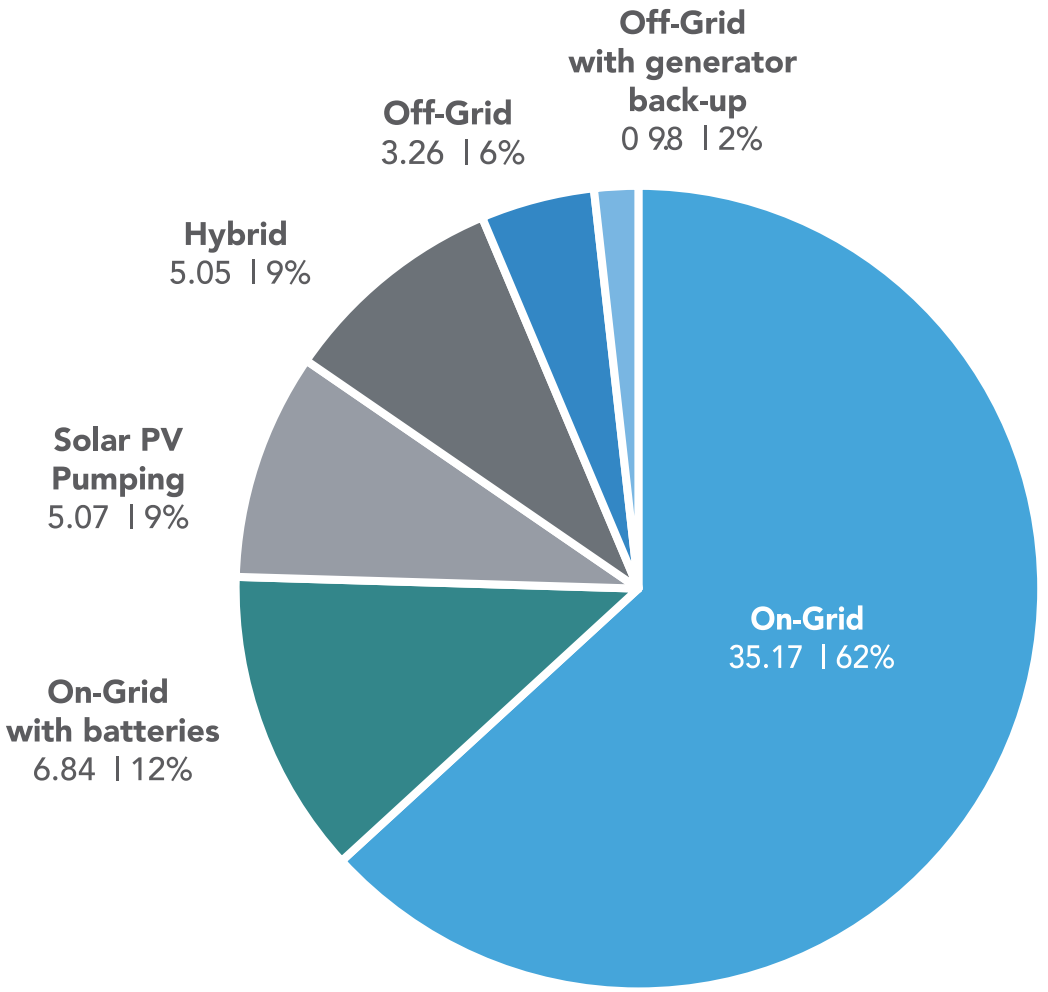
The Industrial sector continued to record the highest growth from 11.05 MWp to 18.38 MWp (32%) in a 2018 only.

SOLAR PV CAPACITY BY INVESTMENT ($M | %)



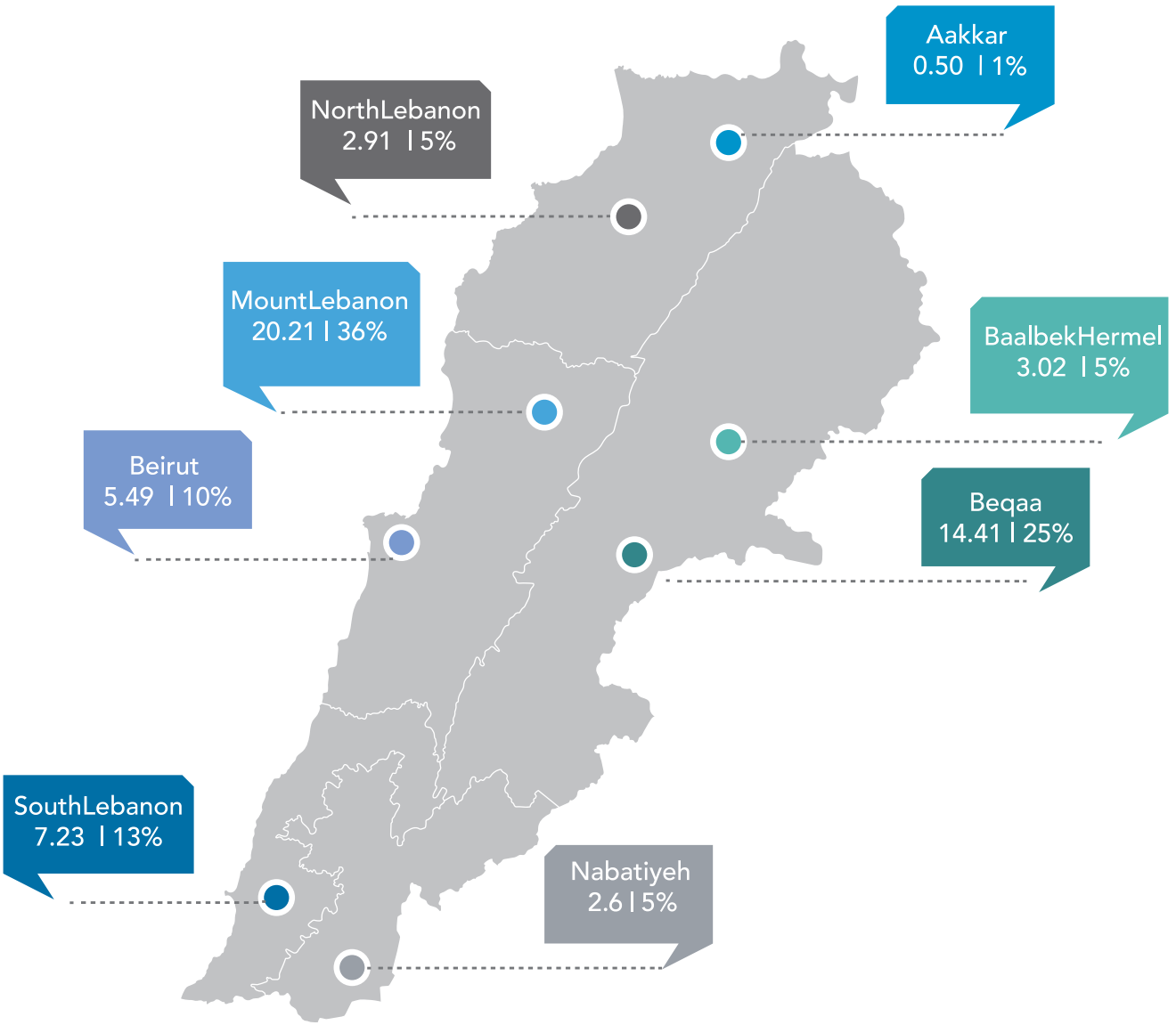
The top 3 sectors leading the solar PV Market in Lebanon in investment are the Industrial sector with $23.95m, the Residential sector with $23.07m, and the Commercial sector with $22.55m.

SOLAR PV CAPACITY BY PROJECT TYPE (MWP | %)



*The Top 3 project types prevailing in the solar PV Market in Lebanon are On-grid with **35.17 MWp**, On-grid with batteries with **6.84 MWp,** and Solar PV Pumping with **5.07 MWp.***

SOLAR PV CAPACITY BY GOVERNORATE (MWP | %)

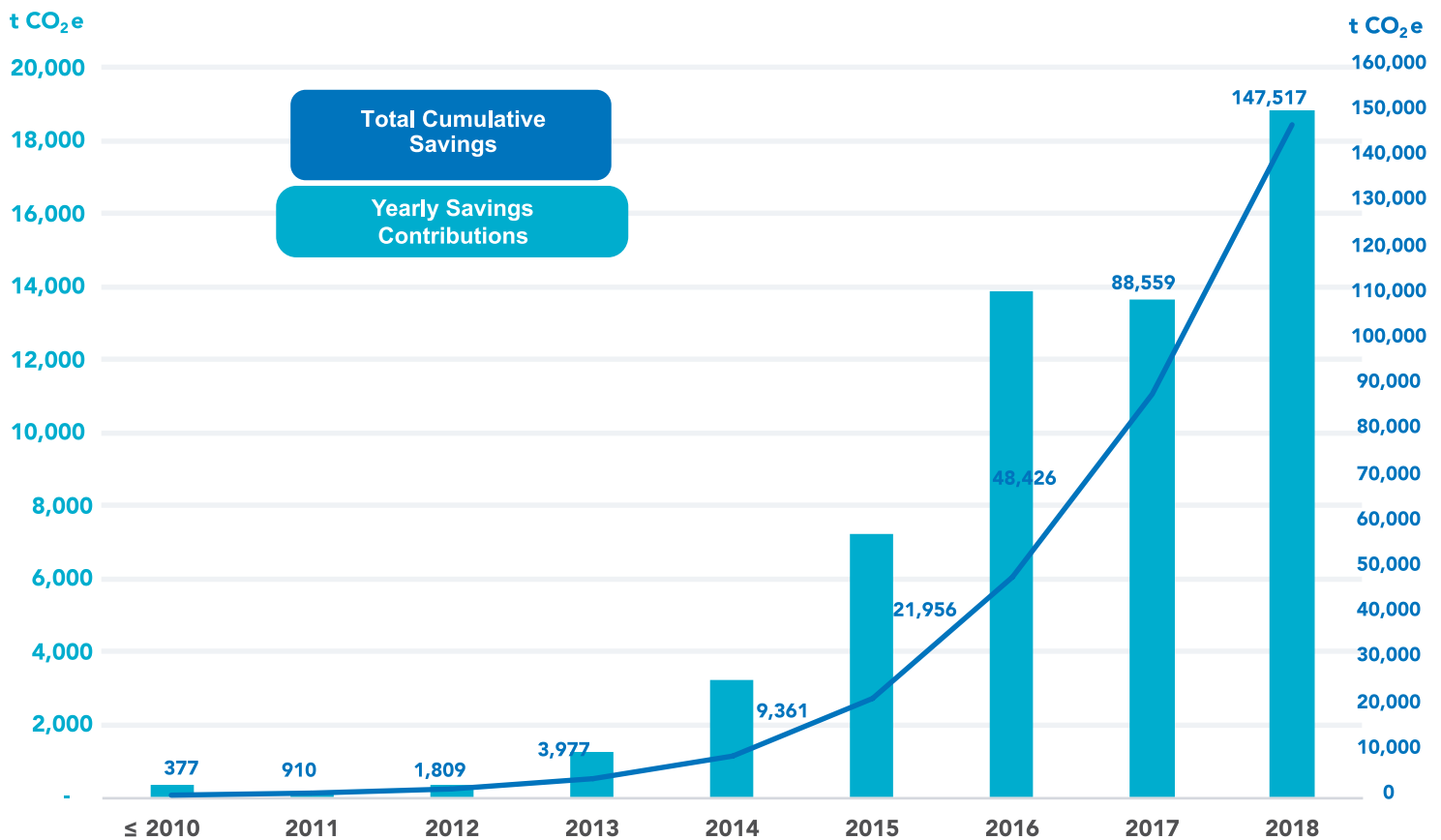


*The top 3 Governorates leading the solar PV Market in Lebanon are Mount Lebanon with **20.21 MWp**, Beqaa with **14.41 MWp**, and South Lebanon with **7.23 MWp.***

SOLAR PV ESTIMATED MONETARY SAVINGS ($)

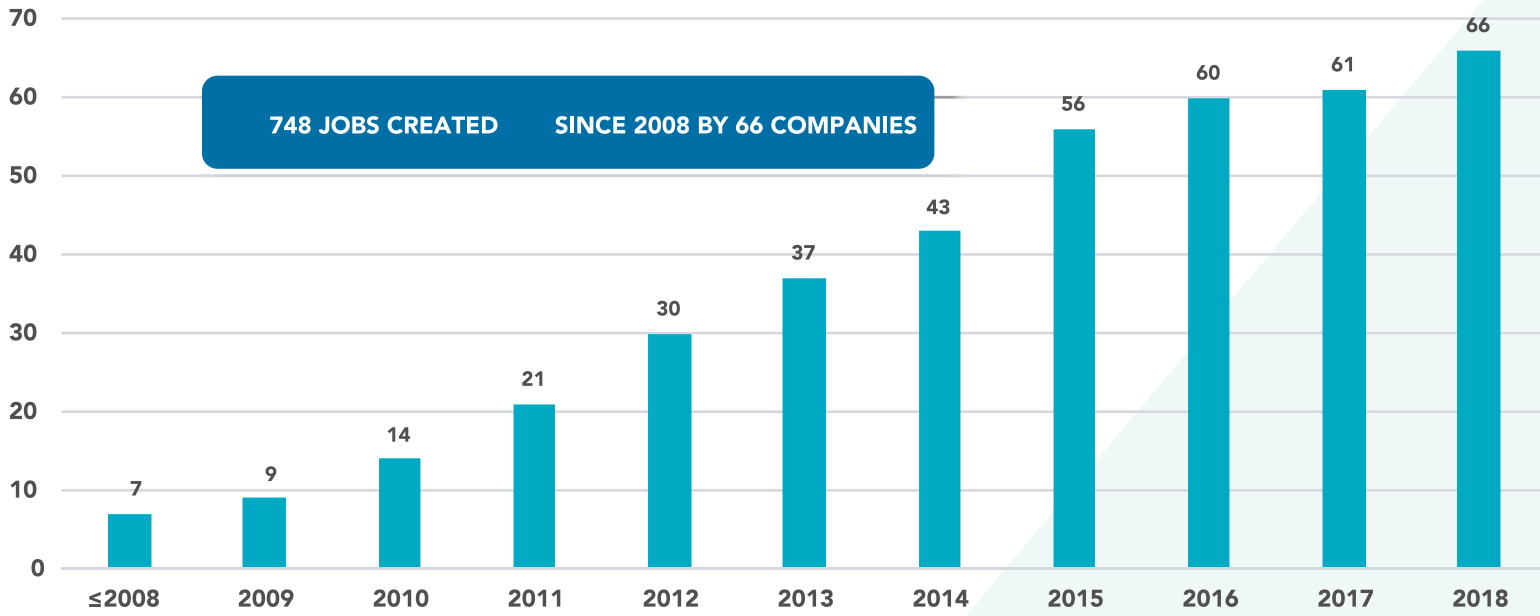
The estimated monetary savings from all the solar PV projects in Lebanon grew from $200k per year in 2010 to $4.6m per year in 2018. The cumulative savings by the end of 2018 amount to $45.4m.

SOLAR PV ESTIMATED EMISSIONS SAVINGS (T CO2E)



The estimated emissions savings from all the solar PV projects in Lebanon grew from 377 t CO2e per year in 2010 to 18,824 t CO2e per year in 2018. The cumulative savings by the end of 2018 amount to 147,517 t CO2e.

CUMULATIVE SOLAR PV COMPANIES IN LEBANON



7 Lebanese solar PV companies were working in the sector up until 2008. This number started growing steadily from 14 companies in 2010 to 66 companies by the end of 2018. At least 748 jobs were created throughout.

** Companies that chose not to participate in the data collection conducted for this report could not be accounted for.*

TAKEAWAY POINTS

For the market to reach the 2020 targets of **100 MWp** and **160 GWh** per year for decentralized solar PV, the NEEREA financing is a key action. In addition, the current appetite for international banks such as EBRD, AFD and EIB to provide lending in Lebanon through local commercial banks for sustainable projects, including the decentralized renewable energy projects will definitely play an important role in achieving these targets.

The industrial sector continues to dominate the solar PV market with **18.38 MWp** of installed capacity.

Investing in solar PV continues to be more affordable year after year with the average turnkey price dropping to **$1,195** in 2018. In addition, in March 2018, the Lebanese Customs exempted imported solar PV panels from customs duty.

With **61%** of total capacity and **54%** of total investments facilitated by NEEREA, the latter remains the market catalyzer it was designed to be.

The solar PV sector's positive effect on job creation is clear with at least 748 jobs created since 2008. Significantly more jobs will be created when Lebanon starts building its first utility-scale PV farms.

LIST OF PARTICIPATING LEBANESE SOLAR PV COMPANIES

A ENERGY CORNER	ENERCELL	LEBANON POWER SYSTEMS SAL	SMART AGE
ACEMCO S.A.L.	ELEMENTS SUN & WIND	LTEIF	SMART ENERGY TECH
AEMS SAL	EEG	MANALCO POWER	SMART GREEN POWER
AK ENERGY / RJR	ELIE ABDELNOUR&CO	MATTA ENERGIES	SMARTECH
ALBINA SAL	ELIE ABOU JAOUDEH	MB EST	SOLAR WIND M.E.
AL-DIYAR FOR ENGINEERING CONTRACTING & TRADING	EMCA	ME GREEN	SOLARIS GREEN ENERGY
ALI ABBAS	EMTC	METACS	SOLARNET
ALTAKA - ALBADILA	FREE SAL	MIDWARE DATA SYSTEMS - ECOSYS DIVISION	SOLEC ENERGY SOLUTIONS
ALTERNATIVE ENERGY A DIVISION OF DPC LEBANON	FUTURE POWER / RJR	NARINCO MICRO	SOWRIKA
AQUARIUS	GAPS	NICOLAS ELECTRIC	SUN FOR FREE
ARINA ENERGY	GHADDAR MACHINERY CO.	NOVAENERGIA SAL	SWITCH
ASACO	GOGREEN	PANORAMIC SOLAR	T.G.M ELECTRONIC
BENTA POWER TECH	GP STELLAR	PESCO ENERGY	TAKOM ENERGY
BETA ENGINEERING	GREEN ENERGY S.A.R.L.	PHOENIX ENERGY	THE GREEN PACT
BLACKBOX SARL	GREEN ESSENCE LEBANON	PLEMICOR INDUSTRIES	YAZBEK SOLAR SYSTEM
CEDRA NEON	GREEN POWER TECH	POWER & GREEN SAL	YELLOBLUE
CENPRO ENERGY CO	GREEN-MENA	POWERTECH	YELLOWECO ENERGY
CONTROL PANEL S.A.R.L.	GREENWISE ENERGY	RCG INTERNATIONAL	
CORPORATE BUSINESS SOLUTION	HABASH E&HT	RENEWABLE MED ENERGIES	
CTI / RJR	HASSAN ISSA TRADING- ISSA ELECTRIC	RJR	
DAWTEC	HEHT	SALEM INTERNATIONAL	
DCE SAL	HOUSE OF TECHNOLOGY	SALEM INTERNATIONAL	
E.K.T (KATRANGI BROS)	I ENERGY	SFR ENERGY	
EARTH TECHNOLOGIES	IJAZI INVESTMENT COMPANY	SHAMOUN POWER GROUP	
EAS GREEN ENERGY	KK & ES	SHAPASH	
ECOSYS-MDS	KYPROS	SHARP MINDS (E24)	

LEBANESE REPUBLIC
MINISTRY OF ENERGY AND WATER

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

The Lebanese Center for Energy Conservation (LCEC)

LCEC Main Office- Ministry of Energy and Water, Corniche du Fleuve, First Floor, Room 303 - Lebanon

LCEC Engineering Office- 5th Floor, Nassif Bldg., 240 Badaro Street- Lebanon

Telephone: 01-569101/01-565108