LCEC

LEBANESE CENTER FOR ENERGY CONSERVATION

المركز اللبناني لحفظ الطاقة

LEBANESE REPUBLIC

MINISTRY OF ENERGY AND WATER

THE 2019 SOLAR PV STATUS REPORT FOR LEBANON

MARCH 2021

Photo of the 220 kW solar photovoltaic system installed by the LCEC on the rooftop of the Wheat Silos at the Port of Beirut. The project was commissioned ten days before the terrible Port explosion that shook the country on 4 August 2020. The system was fully destroyed. LCEC will keep installing new systems.

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The Lebanese Center for Energy Conservation (LCEC) is the national energy agency for Lebanon. LCEC is an association within the Lebanese Ministry of Energy and Water (MEW) with a financially and administratively independent statute. LCEC acts as the technical arm of the Lebanese Government, specifically the Ministry of Energy and Water in all issues related to energy efficiency, renewable energy, and green buildings.

05 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 for their support in the preparation of this report. Specifically, the LCEC would like to thank Électricité du Liban (EDL), Banque du Liban (BDL), and all the renewable energy companies that participated in the survey for this report and all other institutions that contributed to the data presented herein.

LCEC would also like to thank the UNDP-DREG Project which developed the first, second, and third versions of the Solar PV Status Report and that enabled the fourth and the present fifth edition of the report to be prepared and published.

FOREWORD

Thanks to considerable advancements during 2019, the decentralized solar photovoltaic market in Lebanon continues to witness an impressive growth: 22 MW of rooftop solar PV applications were installed in 2019, increasing the total cumulative applications to around 78 MW. With a set target of 100 MW of solar PV applications by end of 2020, it looks probable that Lebanon will meet this target despite the very tough situation that our country is facing.

Nevertheless, the Ministry of Energy and Water will need to concentrate its efforts to push the solar market forward. Developed in partnership and with the full support of the International Renewable Energy Agency (IRENA), the Lebanon Energy Outlook 2030 projects a challenging objective of having 500 MW of solar rooftop applications by 2030. While a lot of effort has been invested during the last decade to promote such projects, the Ministry is aware that more needs to be done to keep moving forward with rooftop solar applications. In addition to all the environmental benefits and the money-saving advantages, rooftop solar applications create remarkable momentum in the national economy. According to this report, total investment in the rooftop solar sector reached $125.83 Million up to the end of 2019. We expect that investments in rooftop solar PV applications will exceed $400 Million during the next decade.

The Ministry is also dedicated to push forward other large-scale solar projects all over the country based on Power Purchase Agreements to be signed with the private sector. Only with such big projects, Lebanon will be able to reach its target of 30% renewables by 2030. While it gives me a real pleasure to share the "2019 Solar PV Status Report for Lebanon," I do hope that the rooftop solar PV sector will keep growing year after year. We want to see solar PV systems flourishing on every rooftop all over Lebanon. Together, we will make this happen.

Raymond Ghajar
Minister of Energy and Water

ABSTRACT

This report is prepared annually by the Lebanese Center for Energy Conservation (LCEC) to report on the development of rooftop solar PV applications at the national level. **The LCEC intends to develop the "Annual Solar PV Status Report for Lebanon" through establishing and producing annual market monitoring reports on the installed capacity and electricity produced from decentralized renewable energy across Lebanon.**

The objective of the report is to present comprehensive data relevant to the distribution of the implemented decentralized solar photovoltaic projects in Lebanon, mainly privately owned systems, with the aim to reduce the environmental impact of fossil fuels.

The 2019 Solar Photovoltaic (PV) Status Report for Lebanon, developed and published in its fifth edition in 2021, 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 local participating solar PV companies with installed and operational systems across different regions until the end of 2019 in both the private and the public sectors including the PV projects implemented through the NEEREA national financing mechanism. 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, value of investments, monetary and environmental savings, financial incentives, and geographical distribution.

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 enables decision-makers and stakeholders to align their efforts to continue supporting the market and sustaining its healthy growth.

ABSTRACT

EXECUTIVE SUMMARY

01 Lebanon's energy generation by EDL reached 15.39 TWh in 2019[1].

02 In 2010, Lebanon's solar PV installed capacity equaled 330 kWp.

THE INSTALLED CAPACITY INCREASED BY:

- 43% to equal 470 kWp in 2011
- 68% to equal 790 kWp in 2012
- 139% to equal 1.89 MWp in 2013
- 151% to equal 4.76 MWp in 2014
- 139% to equal 11.39 MWp in 2015
- 116% to equal 24.61 MWp in 2016
- 52% to equal 37.37 MWp in 2017
- 51% to equal 56.50 MWp in 2018
- 39% to equal 78.65 MWp in 2019

03 From 2010 until the end of 2019, the cumulative installed solar PV capacity grew by an average rate of 89% per year.

04 Solar PV electricity in 2019 represented 0.73% of the total annual electricity generation by EDL (up from 0.55% in 2018).

05 Total investment in the solar PV sector up to the end of 2019 reached $125.83 Million[2].

06 The number of new solar PV projects per year increased from 25 in 2011 to 360 in 2019.

[1] Source: EDL

[2] All numbers in United States Dollars ($) in this report are based on the exchange rate of 1,500 LBP/$.

EXECUTIVE SUMMARY

07 The year-over-year growth rate for the solar PV capacity has decreased from 51% in 2018 to 39% in 2019. The number of new solar PV projects increased from 326 in 2018 to 360 in 2019.

Lebanon's growth rate of 39% in 2019 has considerably risen above the global growth rate of 14%[3].

08 The turnkey price for solar PV has been falling steadily year after year from $7,186 per kWp in 2011 to $935 in 2019.

This constitutes a price drop of 87% in a span of nine years.

09 The total cumulative investment in the solar PV sector increased from $2.29 Million in 2010 to $125.83 Million in 2019.

10 54% of the installed solar PV capacity to date is funded by NEEREA for a total investment of $64.75 Million whereas the remaining 46% of installed capacity was funded by non-NEEREA investments totaling $61.08 Million.

11 Investments coming through NEEREA totaled $7.71 Million in 2019 whereas non-NEEREA investments reached $13.01 Million with a total investment of $20.72m.

[3] Source: IEA

EXECUTIVE SUMMARY

12 The Top 4 sectors leading the solar PV Market in Lebanon are:

- The Industrial sector with 25.54 MWp at 33% (up from 18.40 MWp)
- The Commercial sector with 15.71 MWp at 20% (up from 12.38 MWp)
- The Agricultural sector with 10.56 MWp at 13% (up from 5.03 MWp)
- The Residential sector with 10.48 MWp at 13% (up from 9.29 MWp)

13 The Top 3 project types prevailing in the solar PV Market in Lebanon are On-grid with 45.74 MWp at 58%, Solar PV Pumping with 12.71 MWp at 16%, and Hybrid/-Multisource with 9.93 MWp at 13%.

14 Top 3 Governorates leading the solar PV Market in Lebanon are Mount Lebanon with 27.19 MWp at 35%, Beqaa with 20.44 MWp at 26%, and South Lebanon with 8.28 MWp at 10%.

15 The estimated monetary savings from all solar PV projects in Lebanon grew from $200,000 per year in 2010 to $6.42 Million per year in 2019. The cumulative savings by the end of 2019 amount to $66.56 Million.
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.

16 The estimated emissions savings from all solar PV projects in Lebanon grew from 377 tCO_2e per year in 2010 to 21,697 tCO_2e per year in 2019. The cumulative savings by the end of 2019 amount to 225,124 tCO_2e.

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BDL	Banque du Liban
EDL	Électricité du Liban
kW	Kilo-watt
kWh	Kilo-watt-hour
kWp	Kilo-watt-peak
LCEC	Lebanese Center for Energy Conservation
LAF	Lebanese Armed Forces
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.
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/Du-al-mode.

TABLE OF TERMS

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 Multi-source).
OFF-GRID	These systems are standalone, working independently from a grid. 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.

2019 HIGHLIGHTS

While 2018 saw an addition of 19.11 MWp, 2019 witnessed the addition of 22.15 MWp of solar PV capacity bringing the total installed capacity to 78.65 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 21.35 MWp in 2020.

Decentralized solar PV electricity generation increased from 0.55% of the total annual electricity generation by EDL in 2018 to 0.73% in 2019. This is equivalent to 111.71 GWh in 2019. With Lebanon's decentralized solar PV generation target set at 160 GWh per year by 2020 as per NREAP, the market needs to add 48.29 GWh of decentralized solar PV electricity generation in 2020.

2019 HIGHLIGHTS

Like 2018, the industrial sector achieved the highest solar PV capacity addition of 7.13 MWp during 2019 thereby bringing the total installed capacity to 25.54 MWp for the sector. This is partially due to the increase in the cost of oil witnessed in 2019 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 cashflows and pay-back periods of six years or less. The higher the cost of oil trends, the bigger the savings are going to be.

The average turnkey price for solar PV continued its decline from $1,197 per kWp in 2018 to $935 in 2019; a drop of 22%. The major contributor to this decrease remains the fall in the cost of equipment. Moreover, local competition during 2019 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 had on the market, a $100,000 investment in 2011 would have developed a 14 kWp system. The same investment achieves 107 kWp in 2019.

2019 HIGHLIGHTS

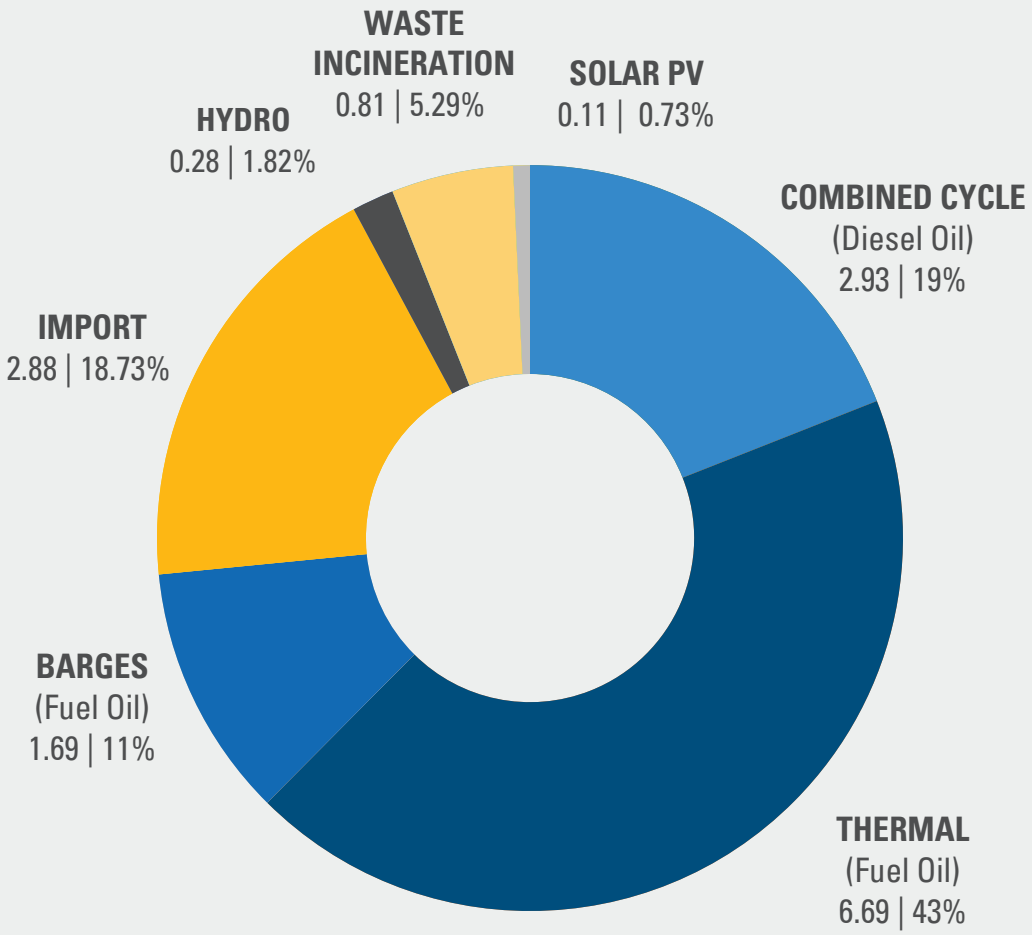
In 2019, total investment in the solar PV sector grew by 20% from the previous year; totaling over $125.83 Million. This means that 2019 saw an additional $20.72 Million in new investments introduced into the market. This is largely thanks to the NEEREA loan programme which provided $7.71 Million or 37% of overall investments. 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. However, because **7** companies did not respond to the 2019 survey, we will consider that the total number of active companies is **59** by the end of 2019.

At least **653** jobs were active in the PV sector at the end of 2019 in comparison to **748** active jobs at the end of 2018, witnessing a **9%** decrease.

1. LEBANON ELECTRICITY BACKGROUND INFORMATION

LEBANON'S 2019 ELECTRICITY GENERATION (TWh)

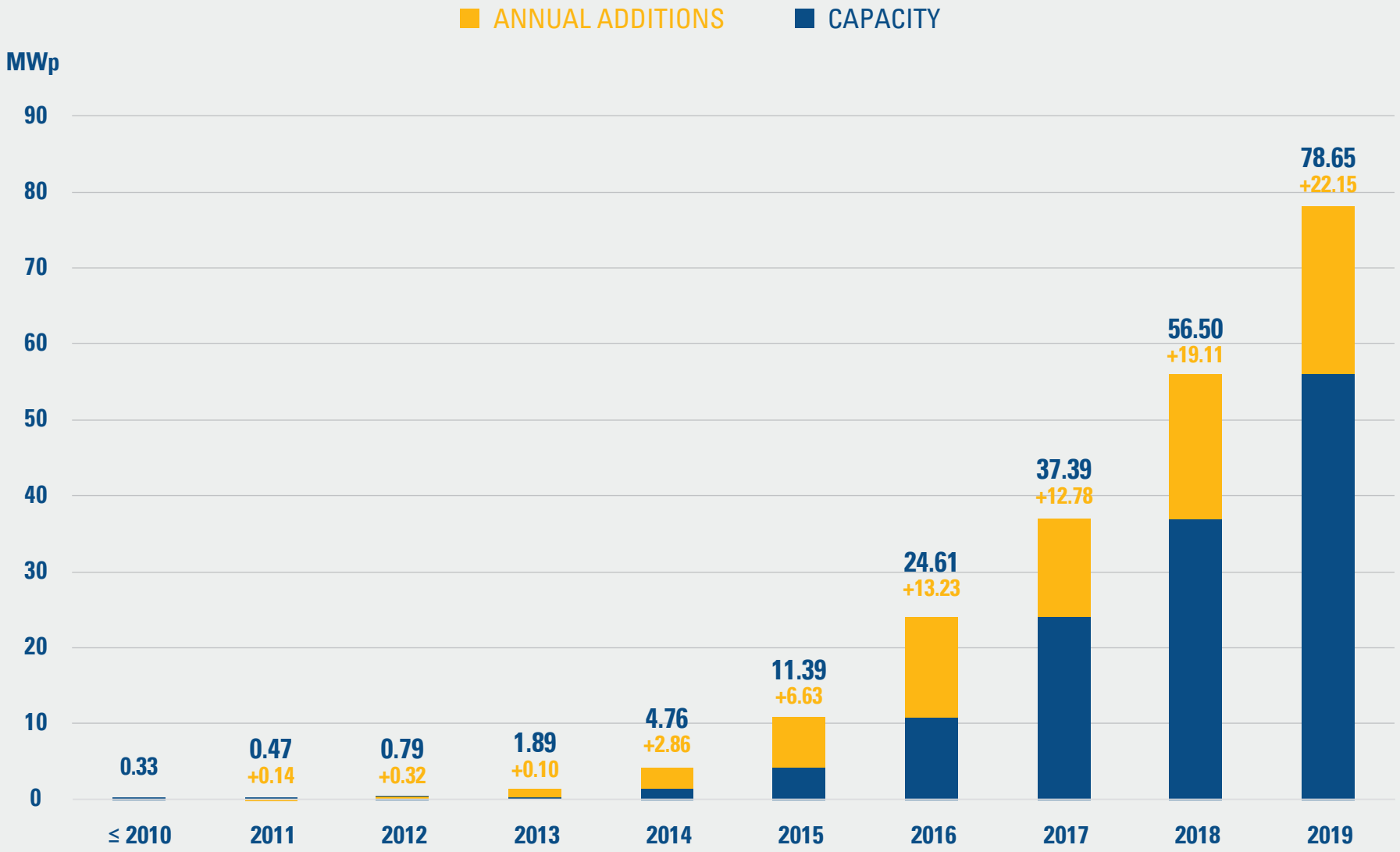


EDL's share of total electricity generation equaled 15.39 TWh while the solar PV share equaled 0.112 TWh or 0.73% of total electricity generation (up from 0.55% in 2018).

With solar PV added to Hydro and Waste Incineration, the share of renewables of the total annual electricity generation in 2019 is equal to 7.83%.

2. SOLAR PV ELECTRICITY IN LEBANON

SOLAR PV CAPACITY AND ANNUAL ADDITIONS



SOLAR PV CAPACITY AND ANNUAL ADDITIONS

Around 22.15 MWp of solar PV installed capacity was added in 2019 to reach a total of 78.65 MWp.

This figure includes two new public projects implemented by the MEW in 2019:

- Ministry of Economy and Trade – Wheat Silos – Beirut Port (220 kWp)
- Casino du Liban – Jounieh (309 kWp)

And the previously implemented projects by the MEW during the past years:

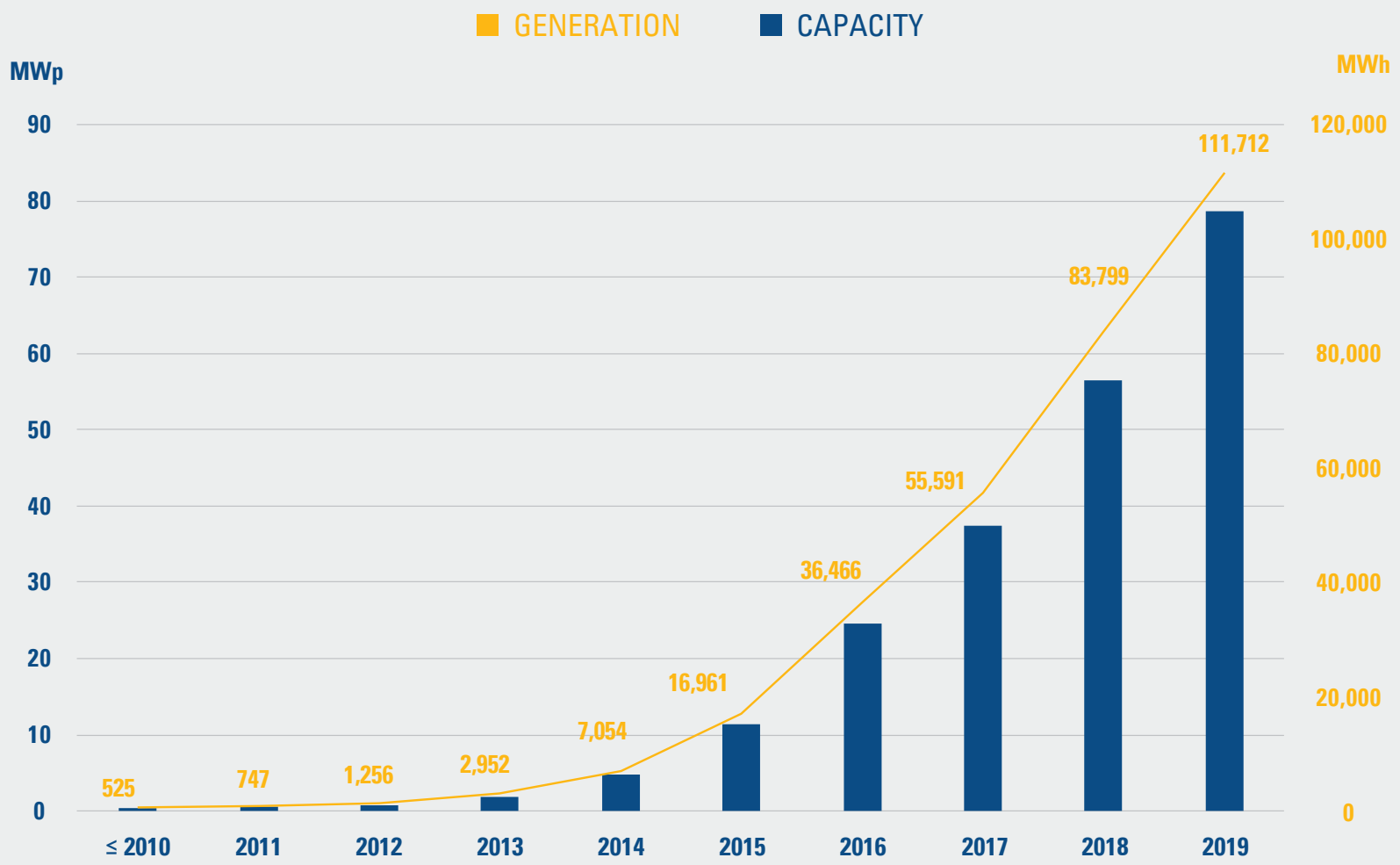
- The Beirut River Solar Snake Project (1.08 MWp)
- The Zahrani Oil Installations Project (1.09 MWp)
- The Ministry of Energy and Water (135.30 kWp)
- Directorate of Engineering and Planning – LAF (155.70 kWp)
- El Helou Barrack 32.30 kWp)
- Lebanese Army Health Dispensary of Qobbeh (54.40 kWp)
- Lebanese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

In addition, two projects were implemented through the Council for Development and Reconstruction (CDR):

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

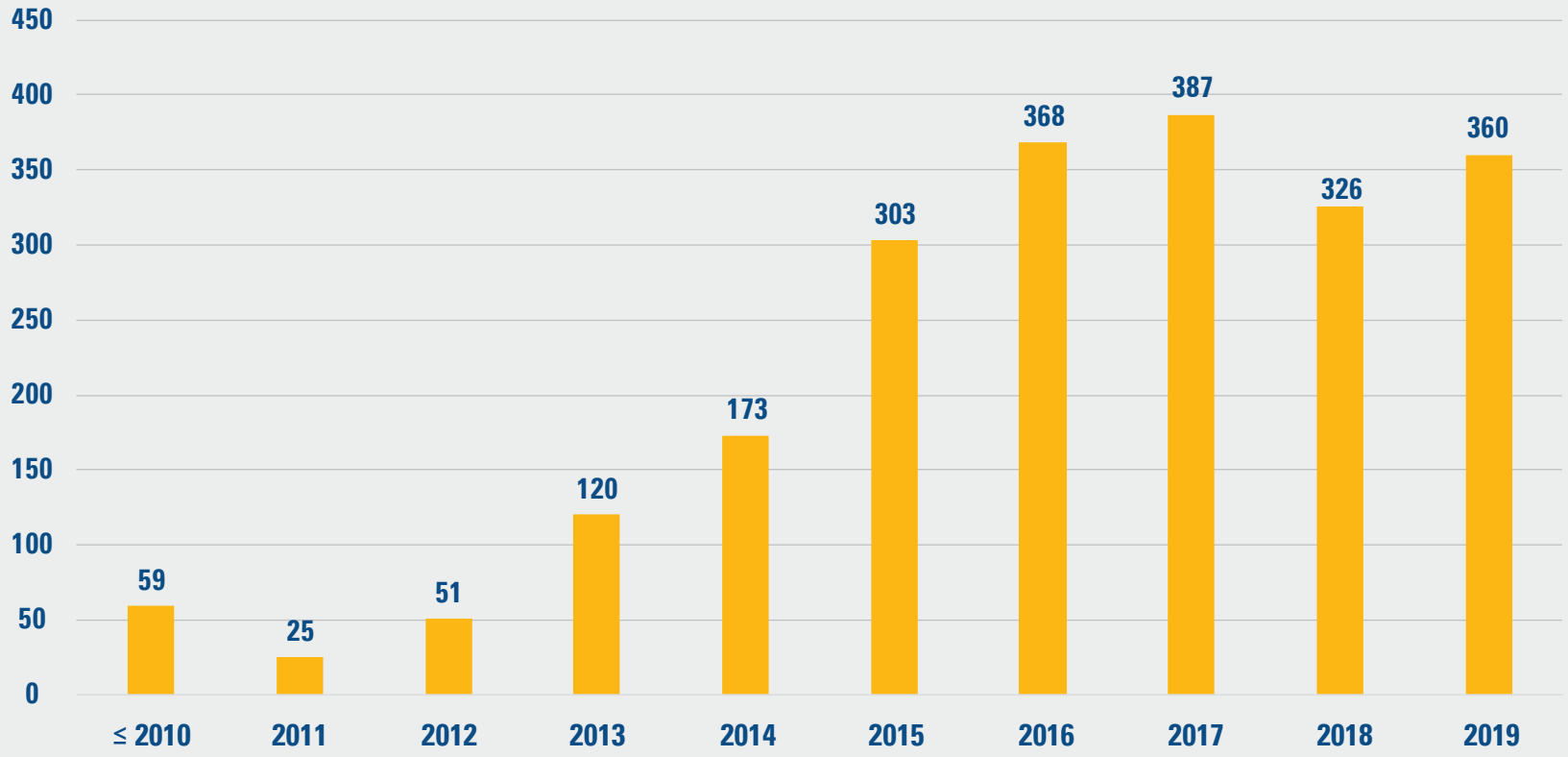
These are added to small scale projects in several municipalities, as well as PV Street lighting in Public Hospitals and schools, and the Ministry of Education, among others.

SOLAR PV CAPACITY AND GENERATION



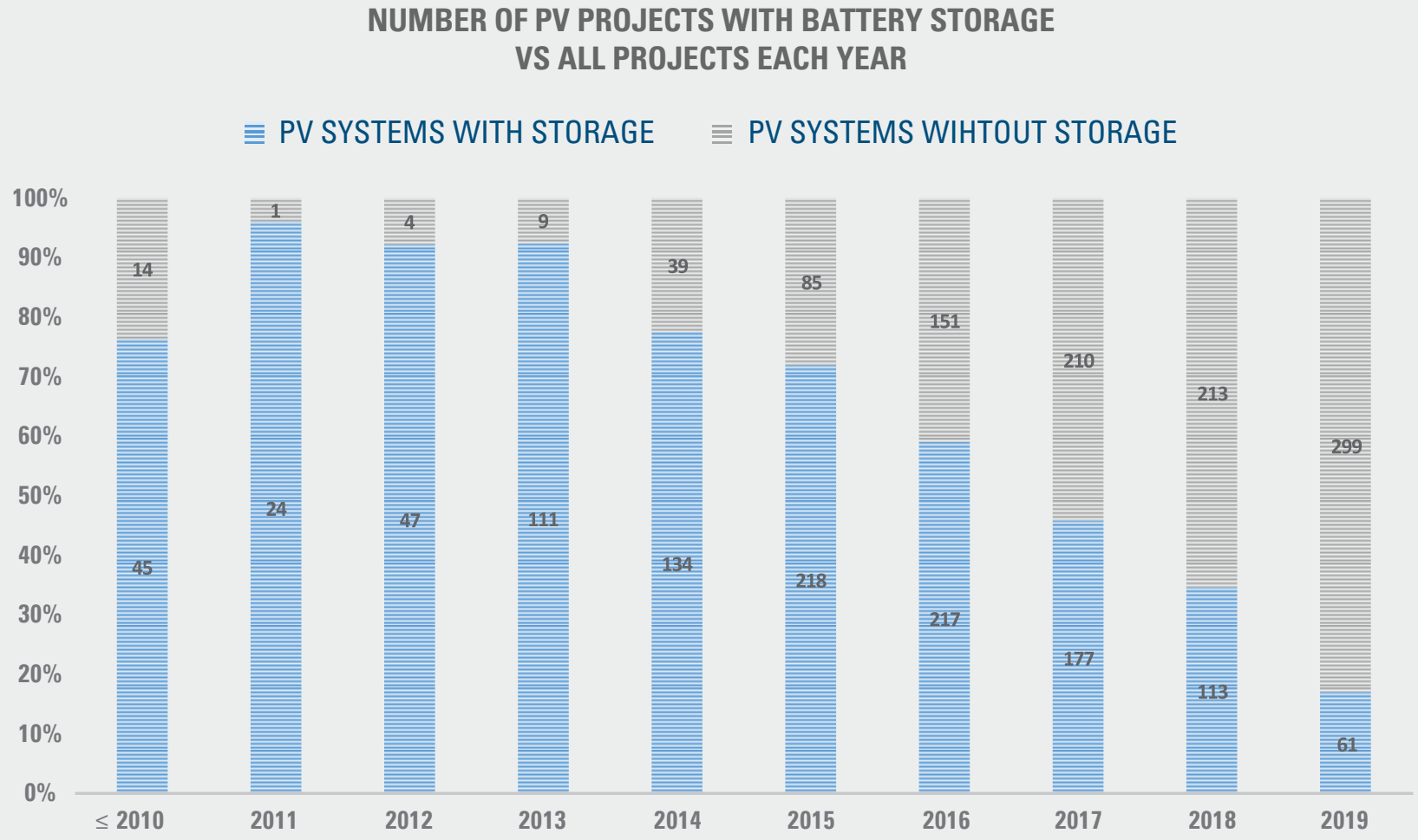
Solar PV electricity generation increased from 83,799 MWh in 2018 to 111,712 MWh in 2019 which constitutes 0.73% of the total annual electricity generation by EDL.

SOLAR PV ANNUAL NEW PROJECTS COUNT



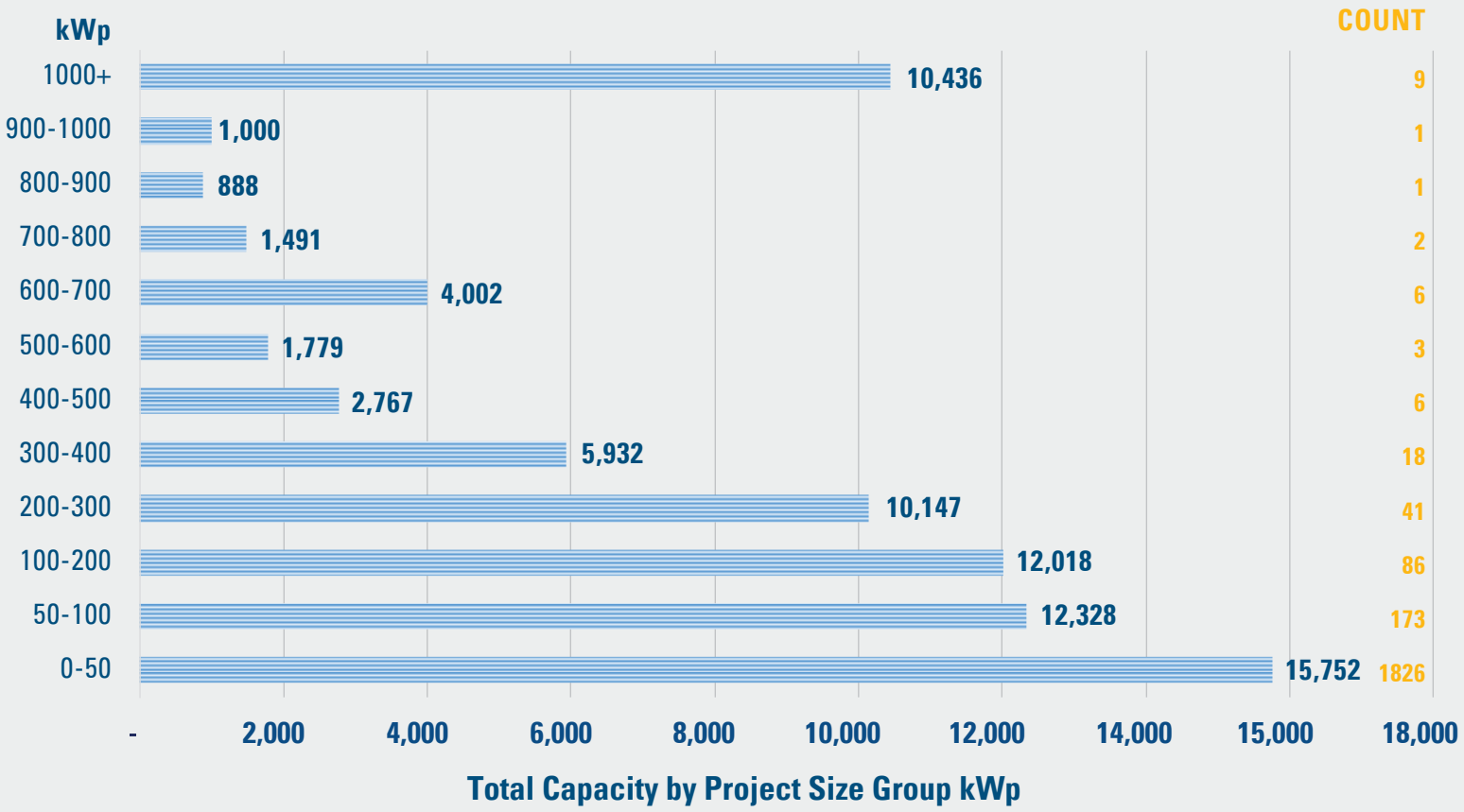
The number of new solar PV projects increased from 326 in 2018 to 360 in 2019 but still below 387 of 2017.

SOLAR PV WITH BATTERY STORAGE VS ALL PROJECTS ANNUAL COUNT



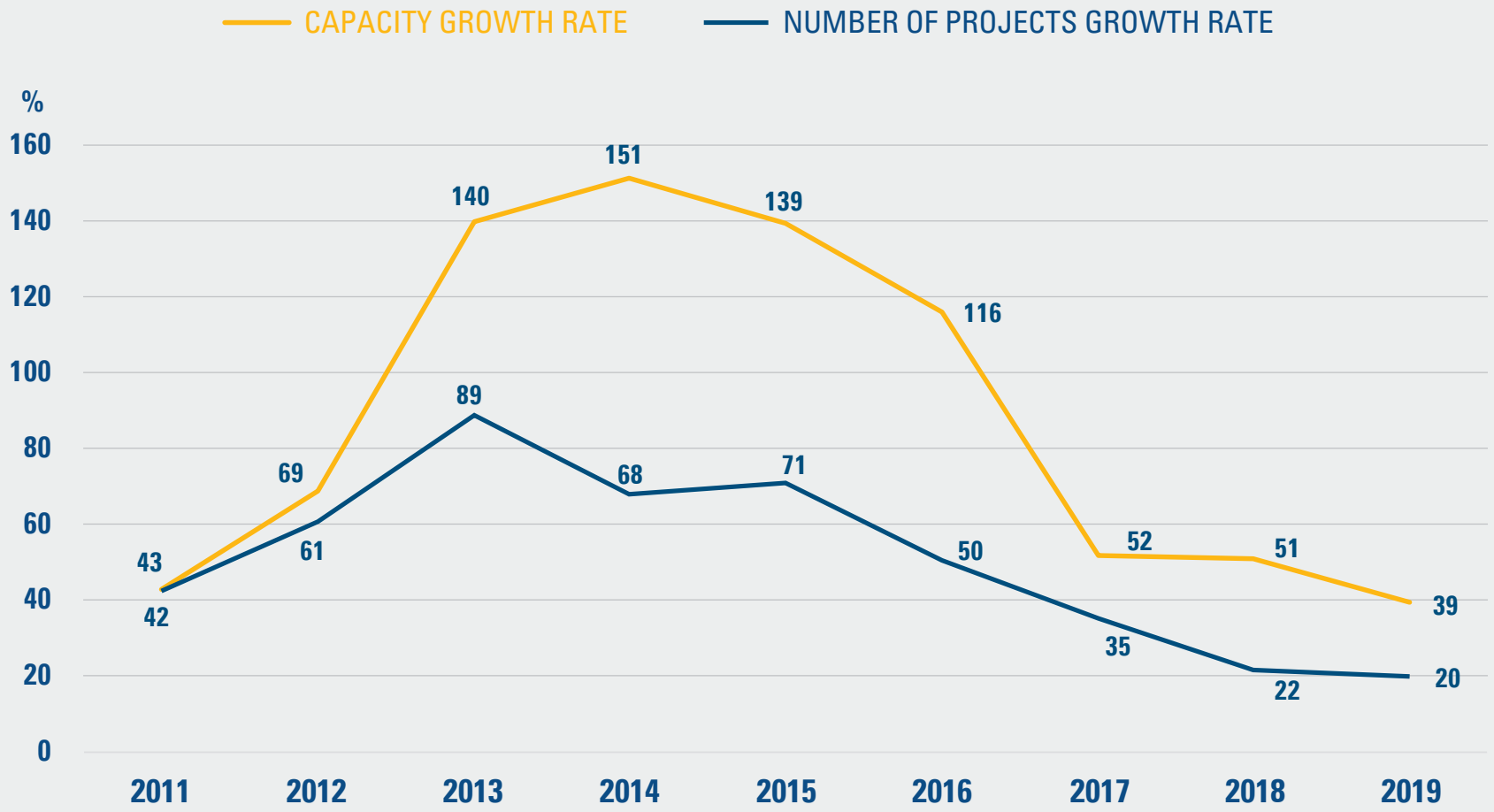
The share of solar PV projects with storage is decreasing year-on-year to reach only around 20% in 2019.

SOLAR PV CAPACITY AND COUNT BY PROJECT SIZE GROUP



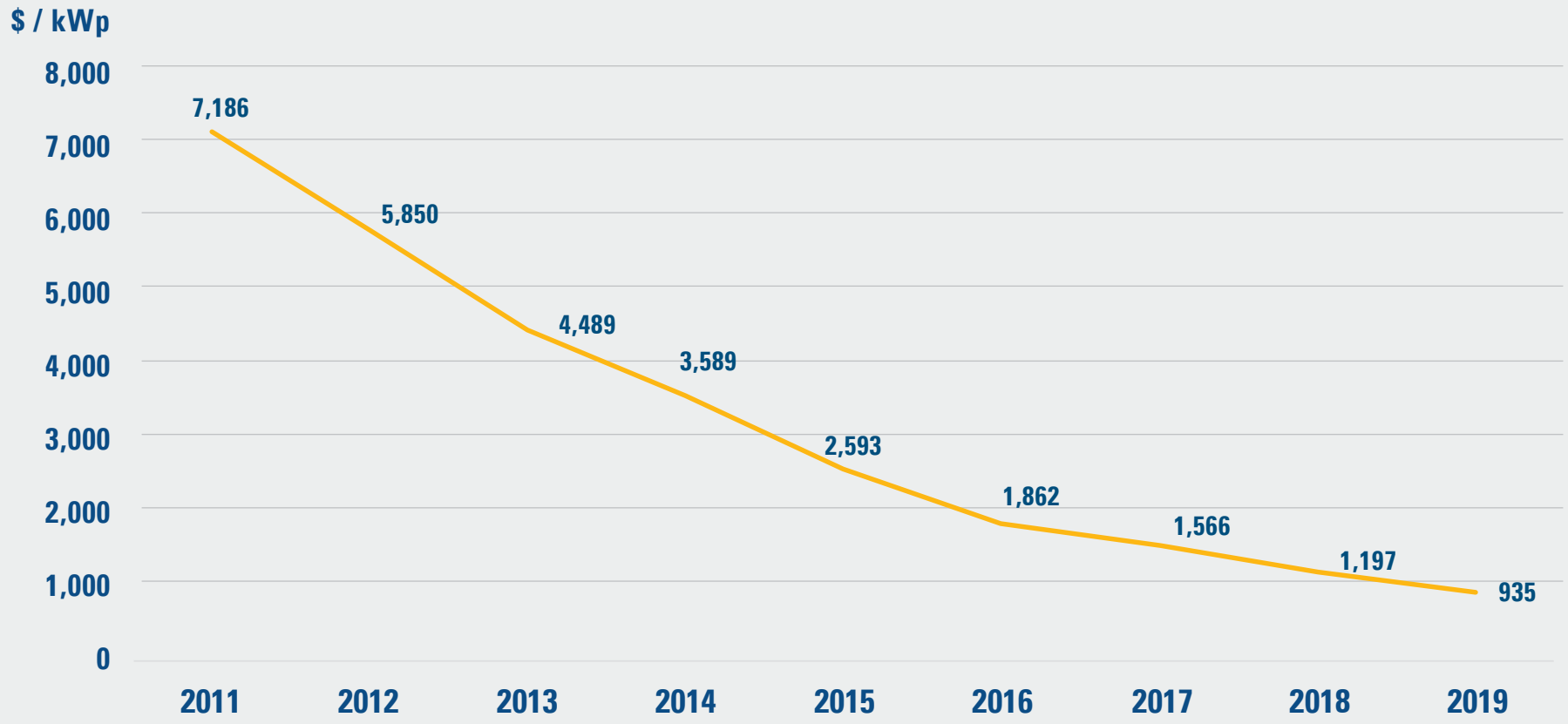
The total number of solar PV projects reached 2,172 by the end of 2019.Small-sized projects, up to 50 kWp, dominate the market in terms of capacity (20%) and count (84%) with a total of 15.80 MWp installed capacity.

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



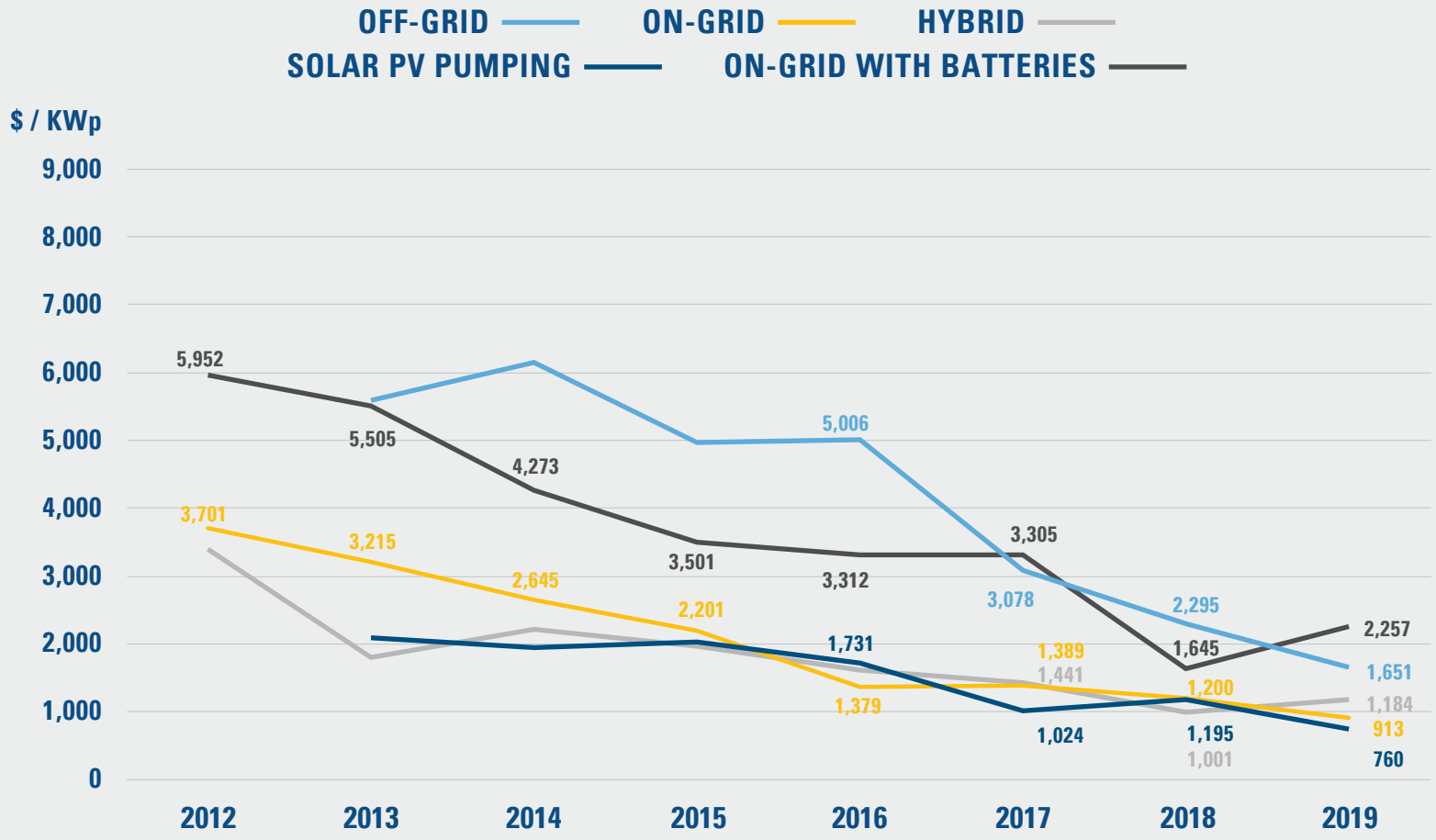
The solar PV capacity growth rate fell from 51% in 2018 to 39% in 2019.
The year-on-year growth rate for the number of new solar PV projects remained at 20% in 2019.

YEARLY AVERAGE SOLAR PV TURNKEY PRICE ($/kWp)



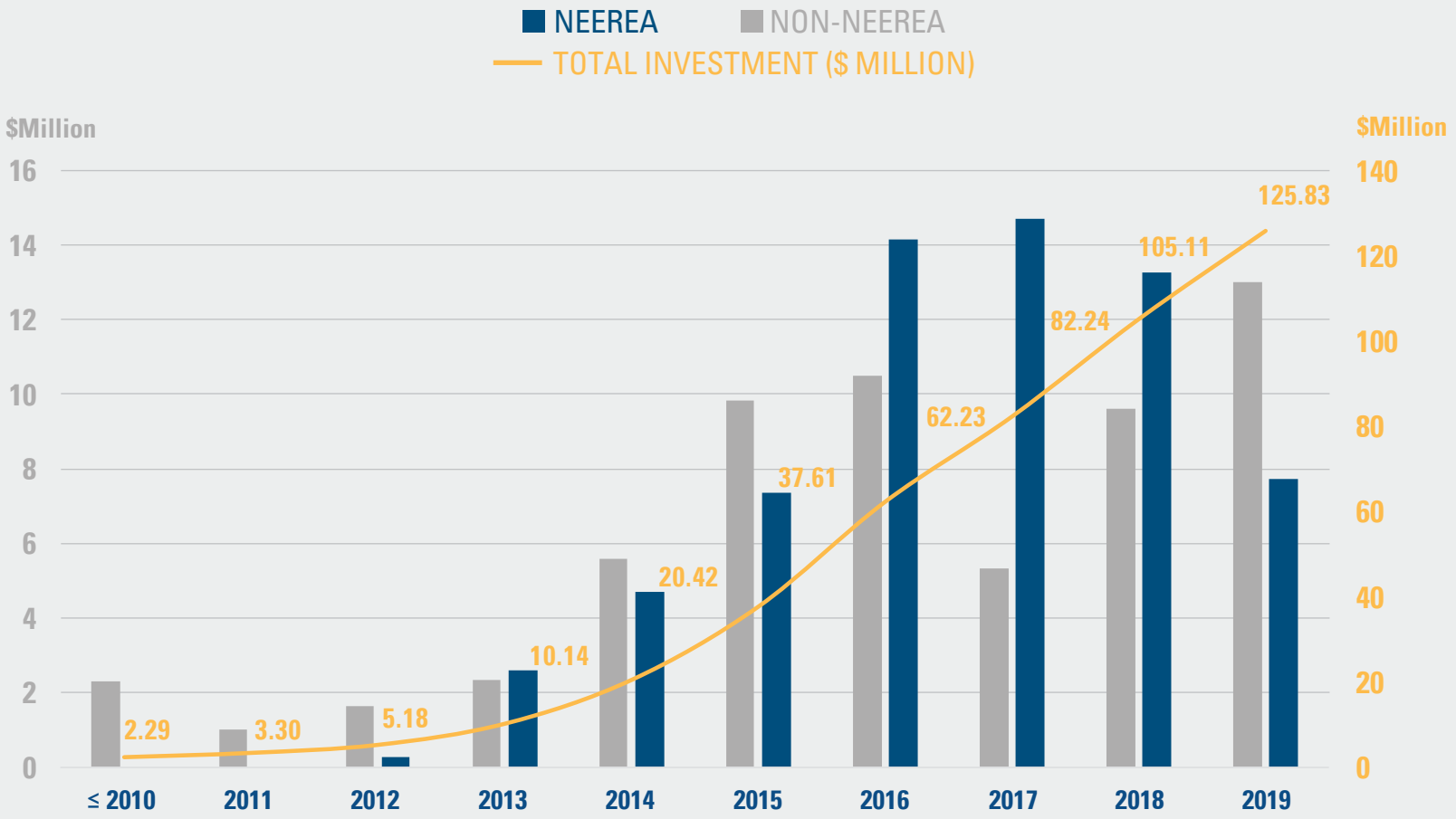
The turnkey price of solar PV continued its steady decrease from $7,186 per kWp in 2011 to $935 in 2019. This constitutes a remarkable price drop of 87% in a span of nine years.

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



The average turnkey price of on-grid with batteries solar projects increased by 37% in a single year in 2019 due to the introduction of Lithium-ion batteries and the tendency to attain independent power supply by increasing battery bank capacity, especially in households.

SOLAR PV INVESTMENT ($MILLION)

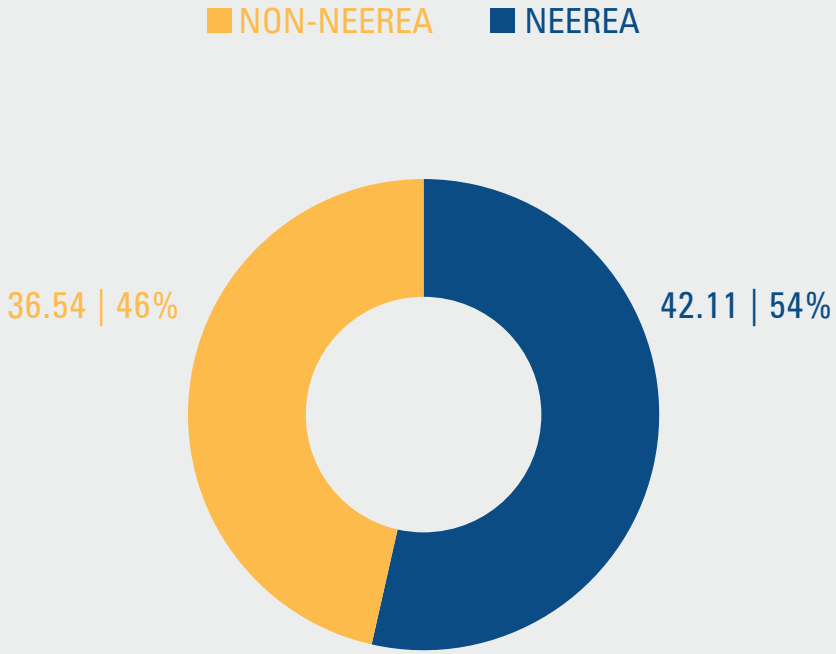


Total cumulative investment in the solar PV sector grew from $2.29 Million in 2010 to $125.83 Million in 2019.

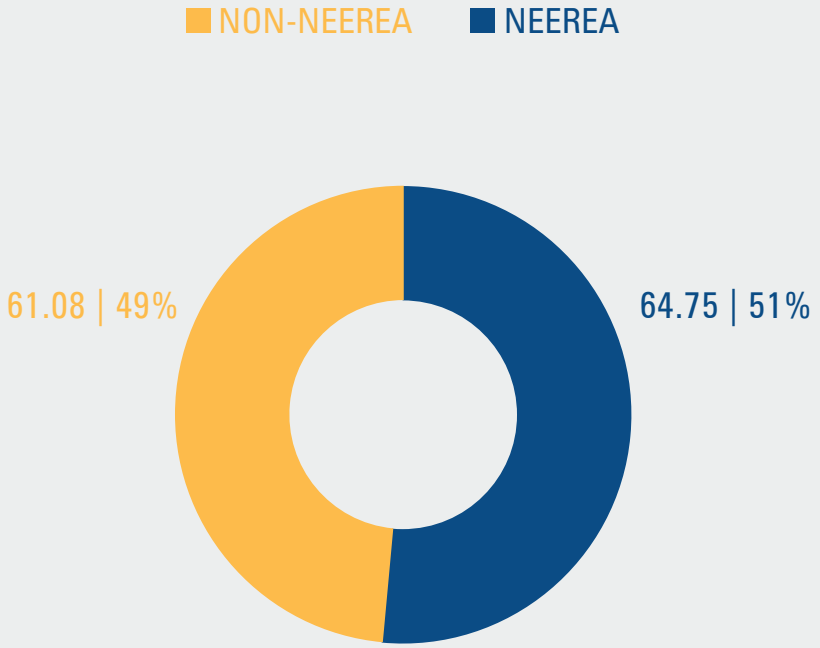
Despite the economic situation in the country, investments reached $20.72 Million in 2019 distributed between NEEREA investments ($7.71 Million) and non-NEEREA investments ($13.01 Million).

INVESTMENT IN SOLAR PV ($MILLION)

Capacity Share per Source of Funding (MWp | %)

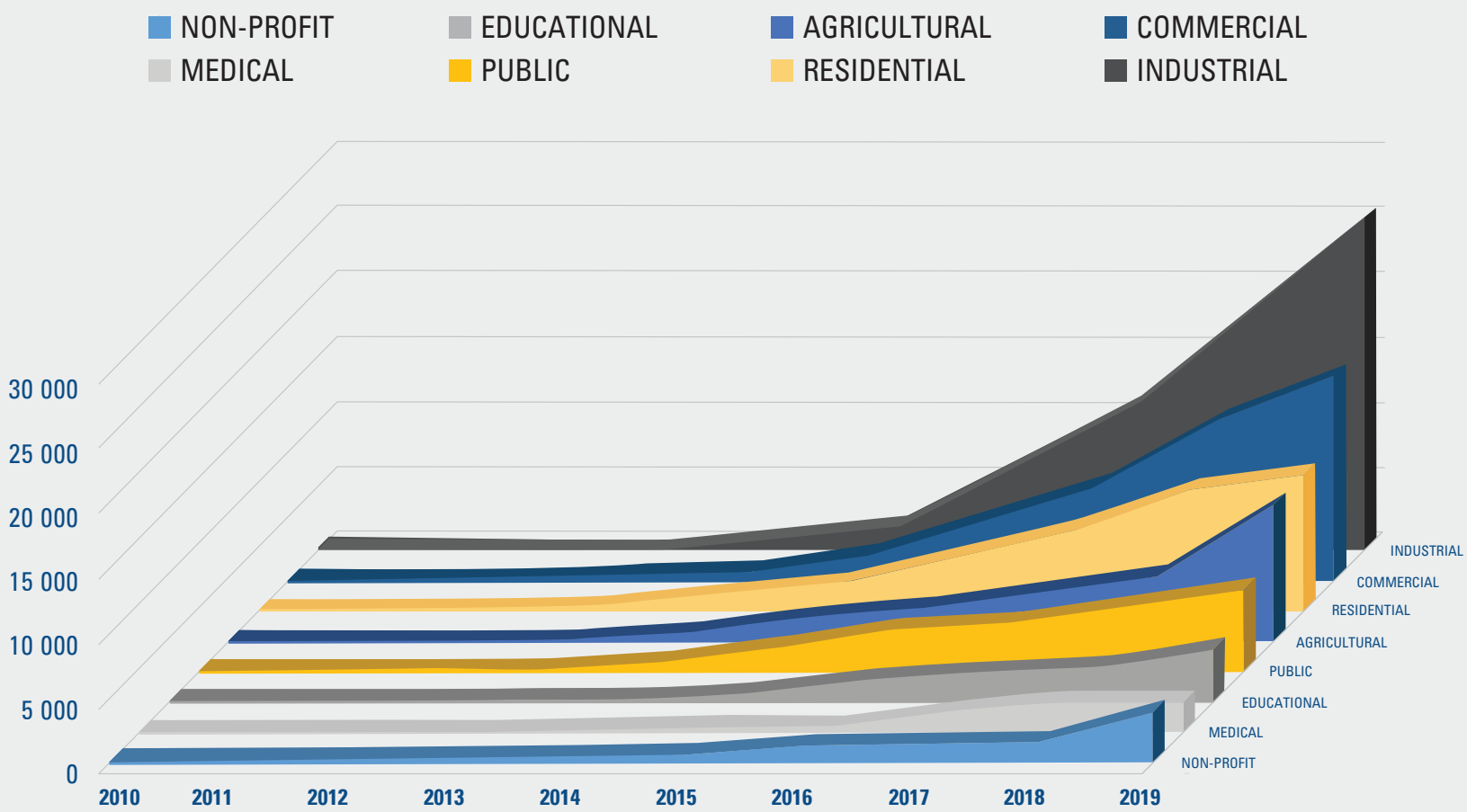


Funding Share per Source of Funding ($Million | %)



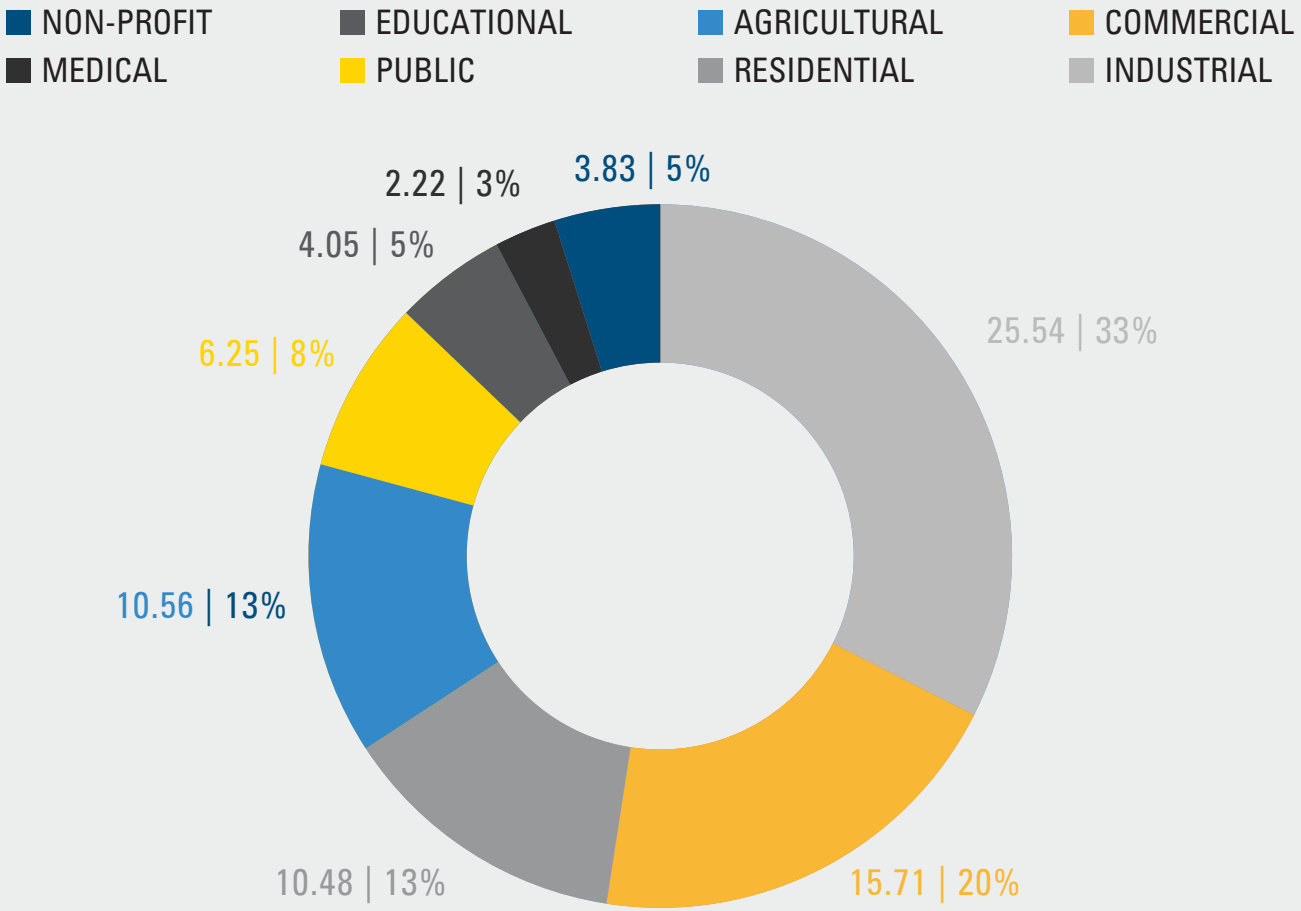
More than half of the installed solar PV capacity to date is funded by NEEREA for a total investment of $64.75 Million whereas 46% of installed capacity was funded by non-NEEREA investments totaling $61.08 Million.The Lebanese market has started to behave independently of the subsidy program which shows that awareness raising activities are successfully delivering the message to the public.

YEARLY INSTALLED CAPACITY BY SECTOR (kWp)



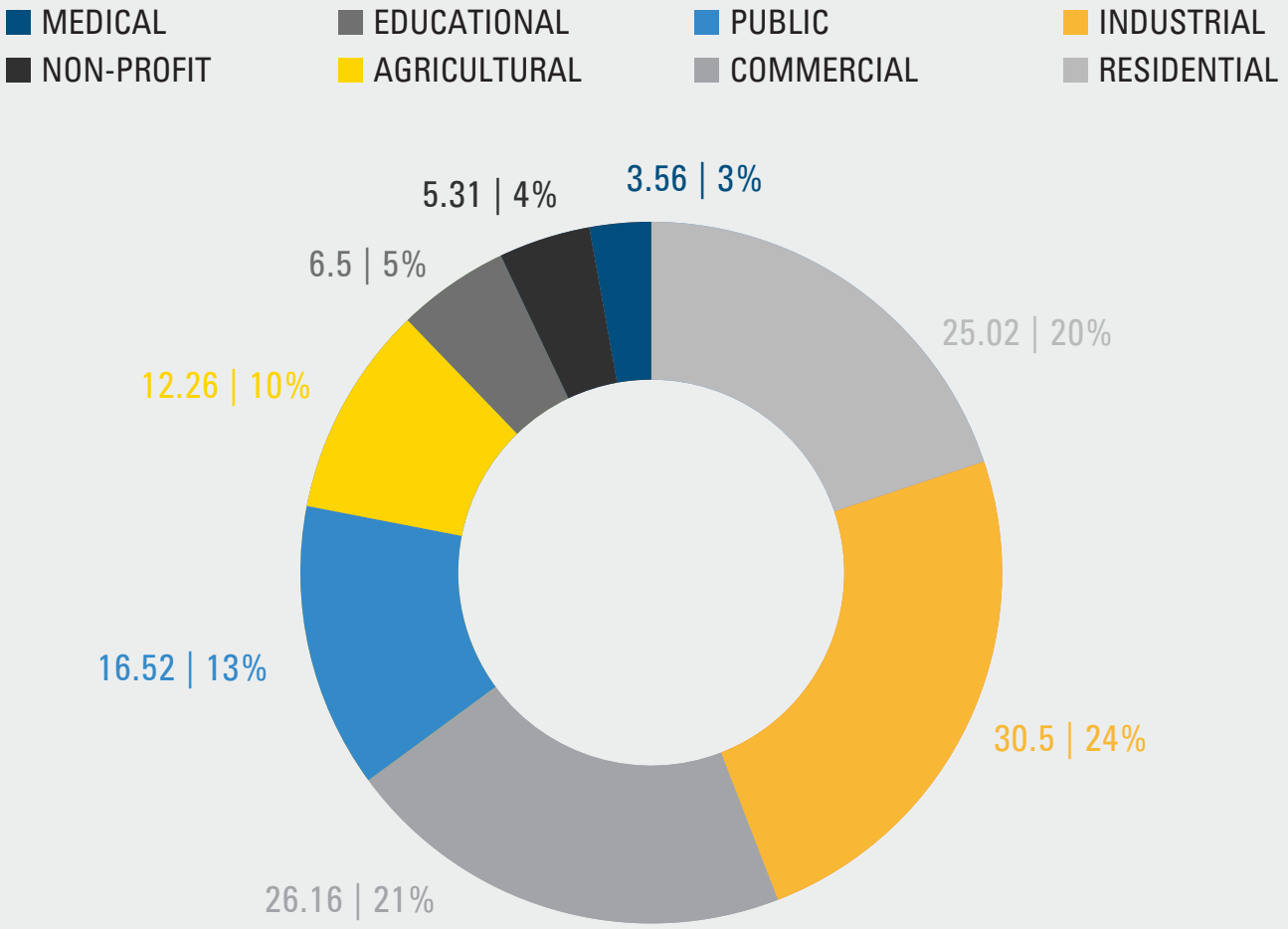
During 2019, the Agricultural, Educational, and Non-profit sector recorded a growth of 426%, 324%, 1,290% respectively, compared to the year before. The Industrial sector on the other hand has been growing gradually year after year. The Medical sector saw minimal growth while remaining sectors remained stable.

SOLAR PV CAPACITY BY SECTOR (MWp | %)



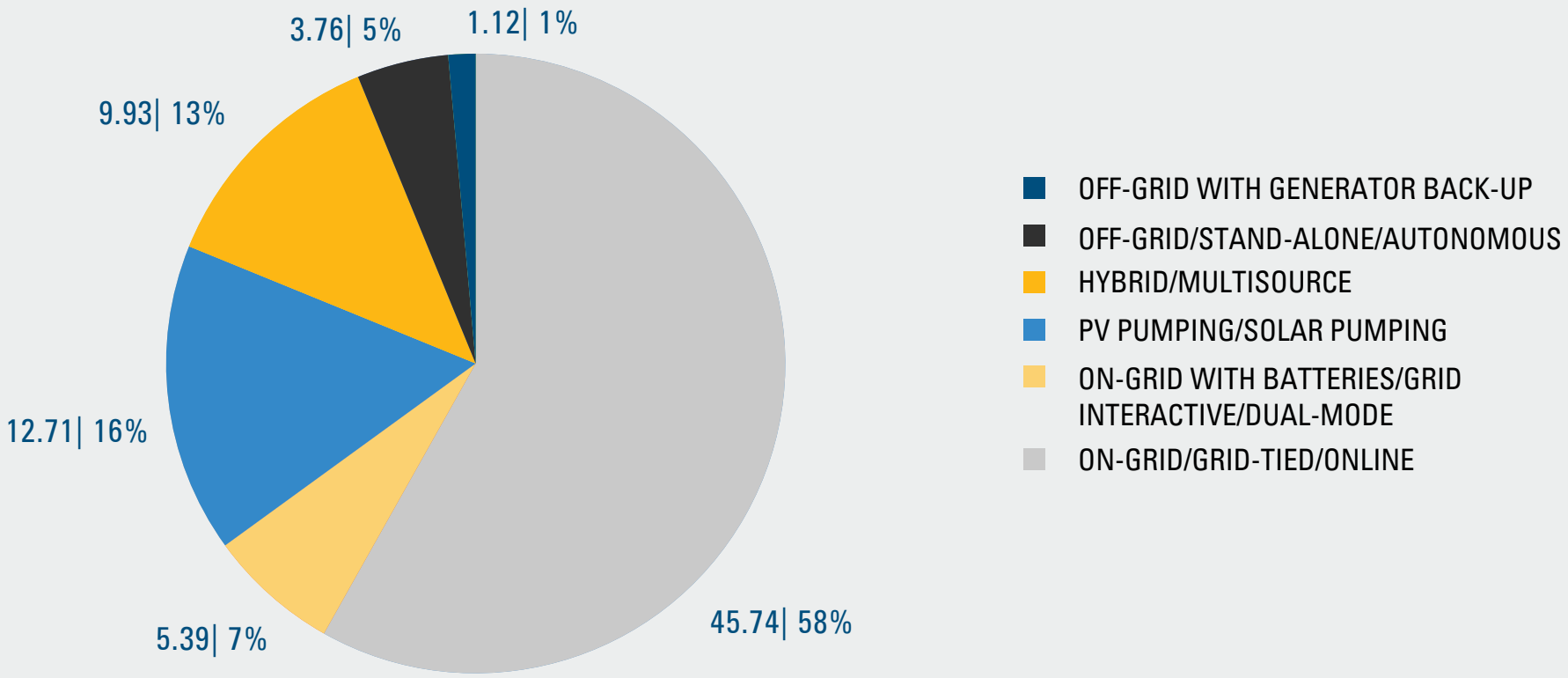
The top 3 sectors leading the solar PV market in Lebanon in installed capacity are the Industrial sector with 25.54 MWp, the Commercial sector with 15.71 MWp, and the Agricultural sector with 10.56 MWp (which more than doubled in 2018). The Residential sector is not far behind from the Agricultural sector.

SOLAR PV CAPACITY BY INVESTMENT ($MILLION | %)



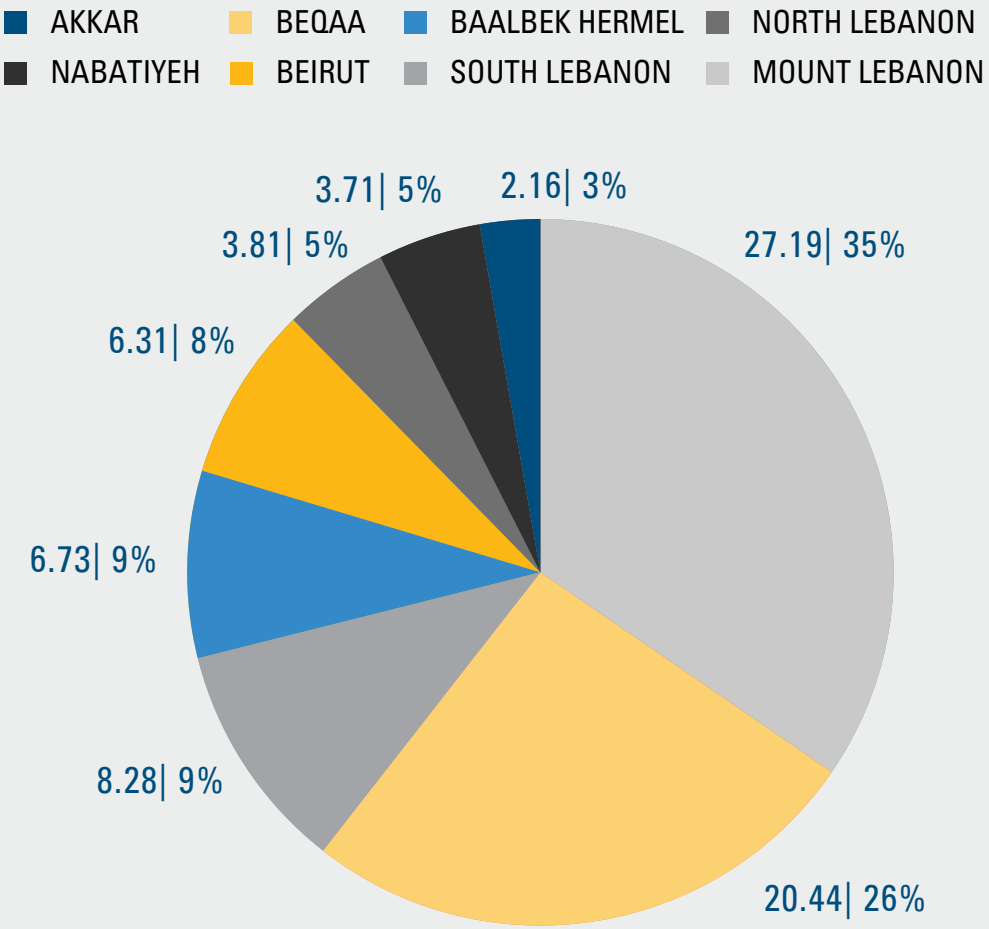
Just like 2018, the top 3 sectors leading the solar PV market in Lebanon in terms of investment are the Industrial sector with $30.5 Million, the Commercial sector with $26.16 Million, and the Residential sector with $25.02 Million.

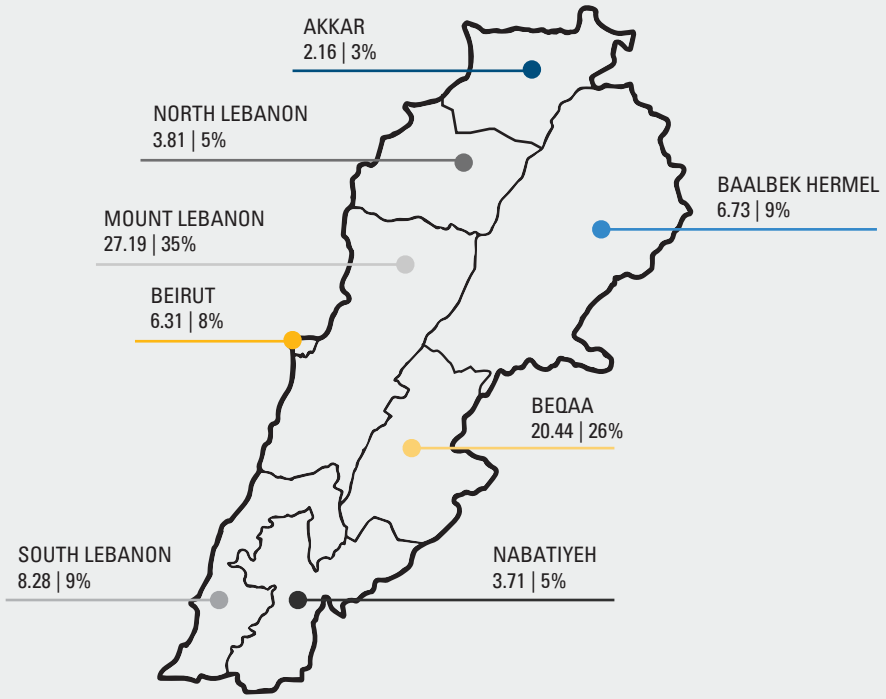
SOLAR PV CAPACITY BY PROJECT TYPE (MWp | %)



The top 3 project types predominant in the solar PV market in Lebanon are still On-grid with 45.74 MWp, Solar Pumping with 12.71 MWp, and Hybrid/Multisource with 9.93 MWp.

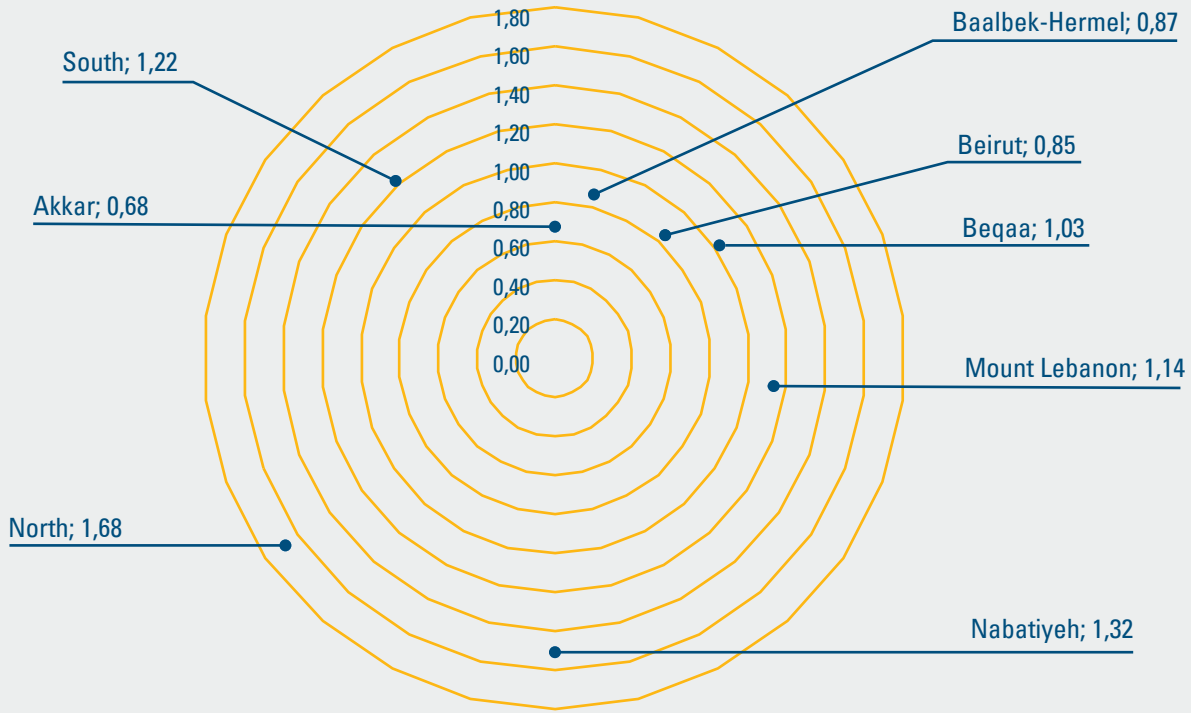
SOLAR PV CAPACITY BY GOVERNORATE (MWp | %)





The top 3 governorates leading the solar PV market remained Mount Lebanon with 27.19 MWp, Beqaa with 20.44 MWp, and South Lebanon with 8.28 MWp.

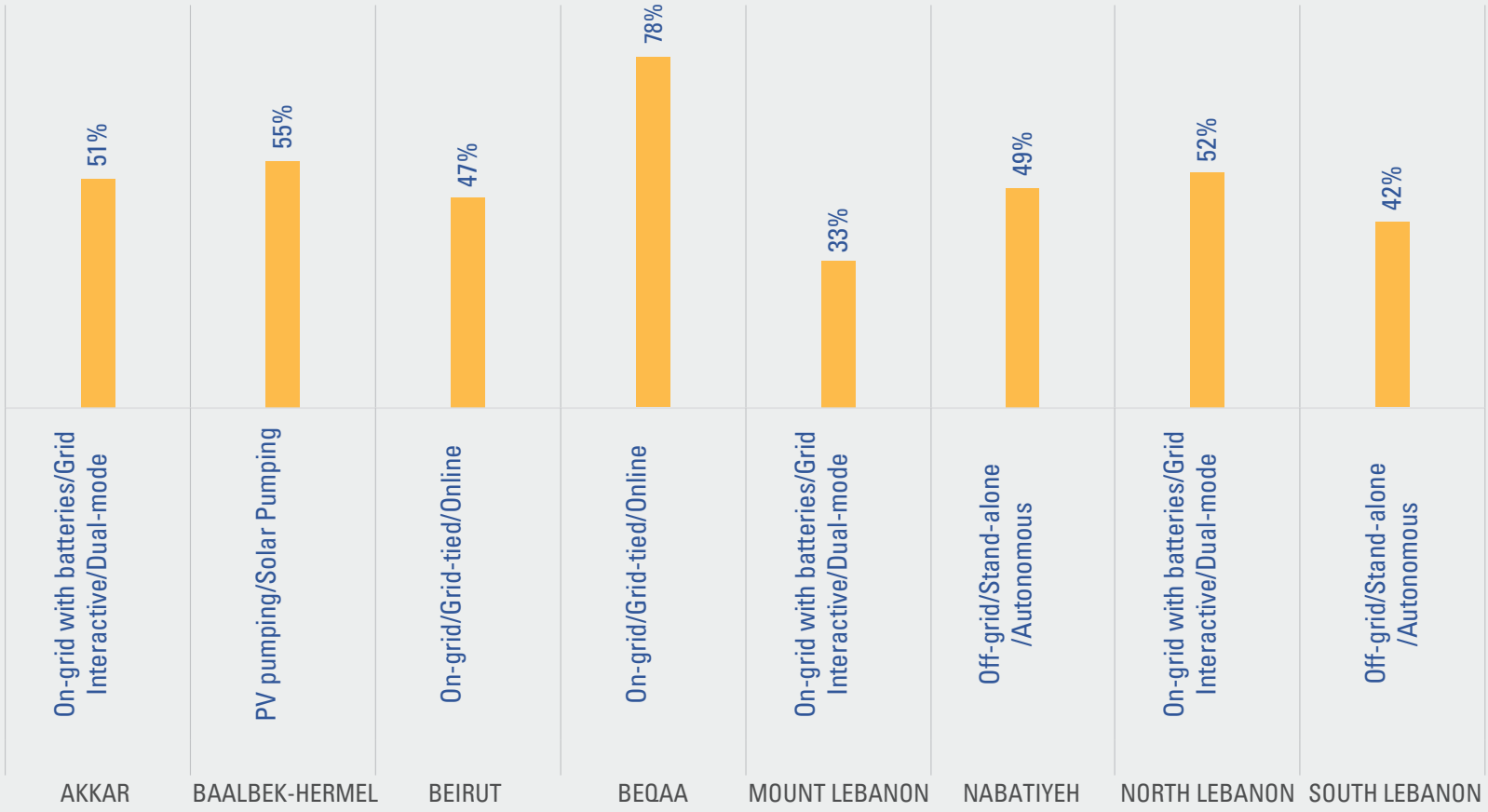
AVERAGE SYSTEM COST BY GOVERNORATE IN 2019 ($MILLION/ MWp)



The least expensive solar PV systems in the country in 2019 were implemented in the 3 governorates of Akkar, Beirut and Baalbek Hermel.
The pricing of the system is linked to the number and the type of systems that are predominant in each governorate.

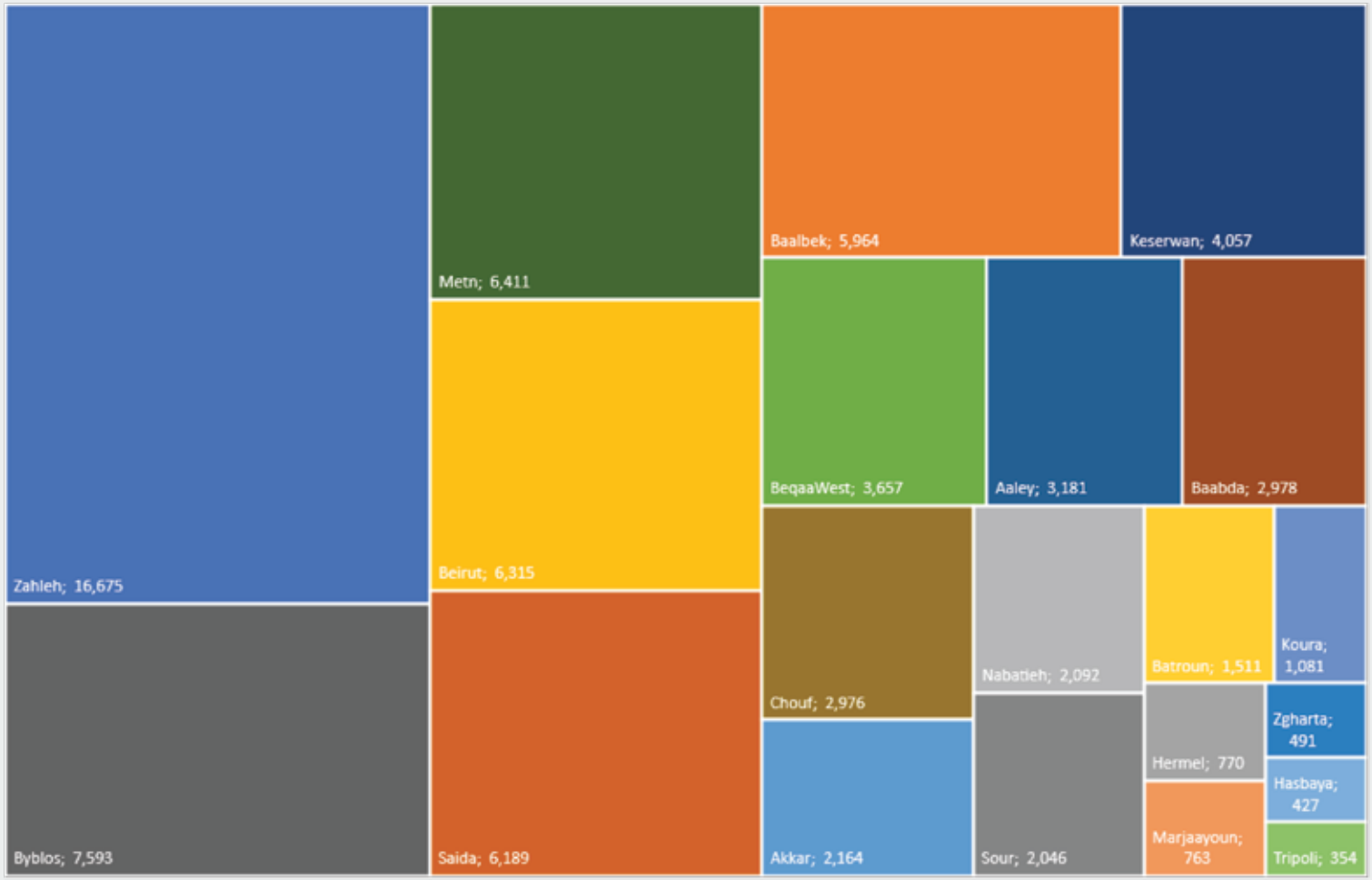
PV SYSTEM TYPES BY GOVERNORATE

NUMBER OF PV PROJECTS WITH BATTERY STORAGE VS ALL PROJECTS EACH YEAR



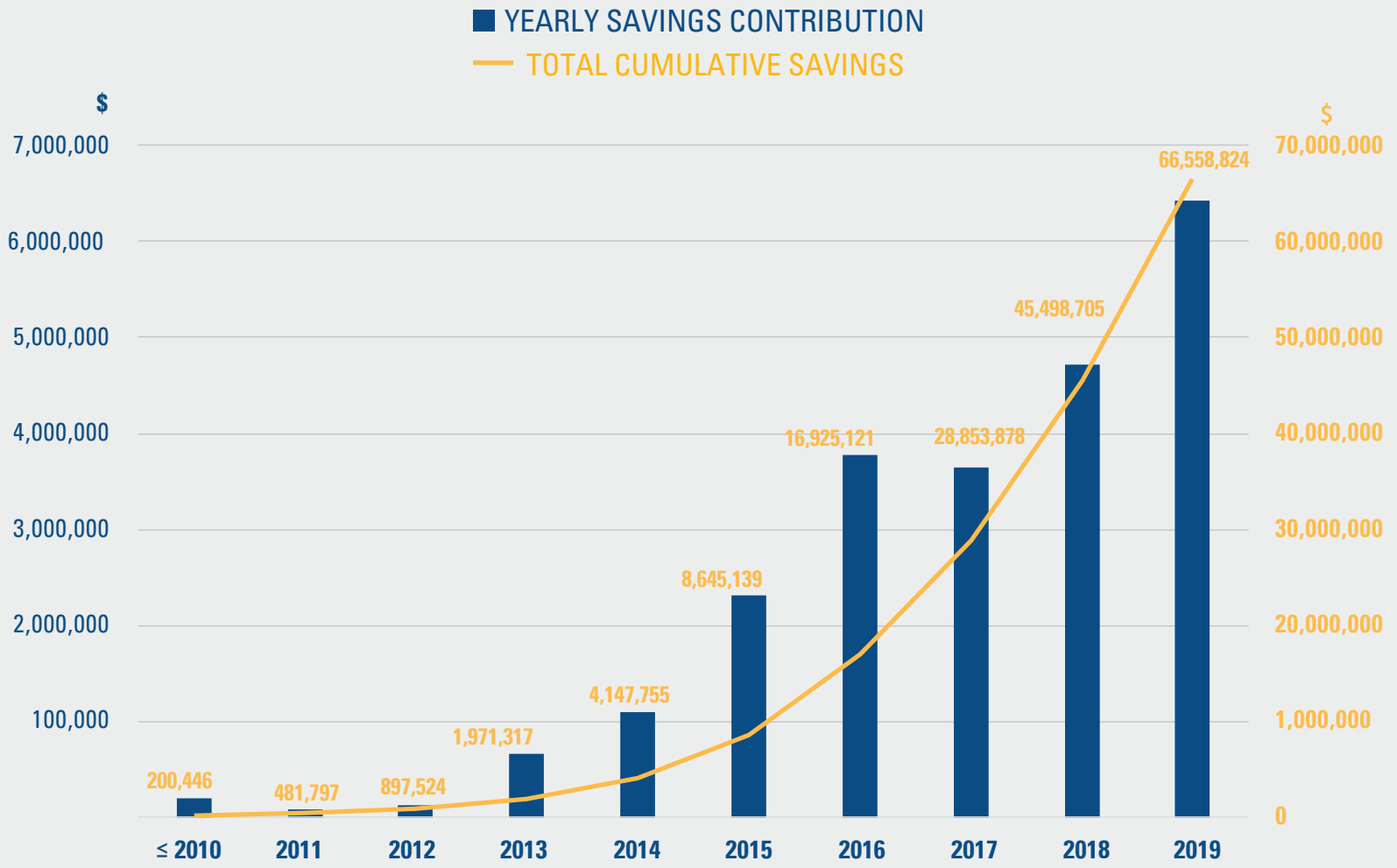
The agricultural aspect of Baalbek Hermel governorate made Solar Pumping PV systems the predominant system type in the region. On the other hand, a relatively better electricity supply in Beirut and Beqaa (Zahleh area specifically) is reflected by the predominance of On-Grid PV systems. This could be compared with a poor quality of supply in other regions which is reflected in the necessity of battery storage.

SOLAR PV CAPACITY BY DISTRICT (MWp)



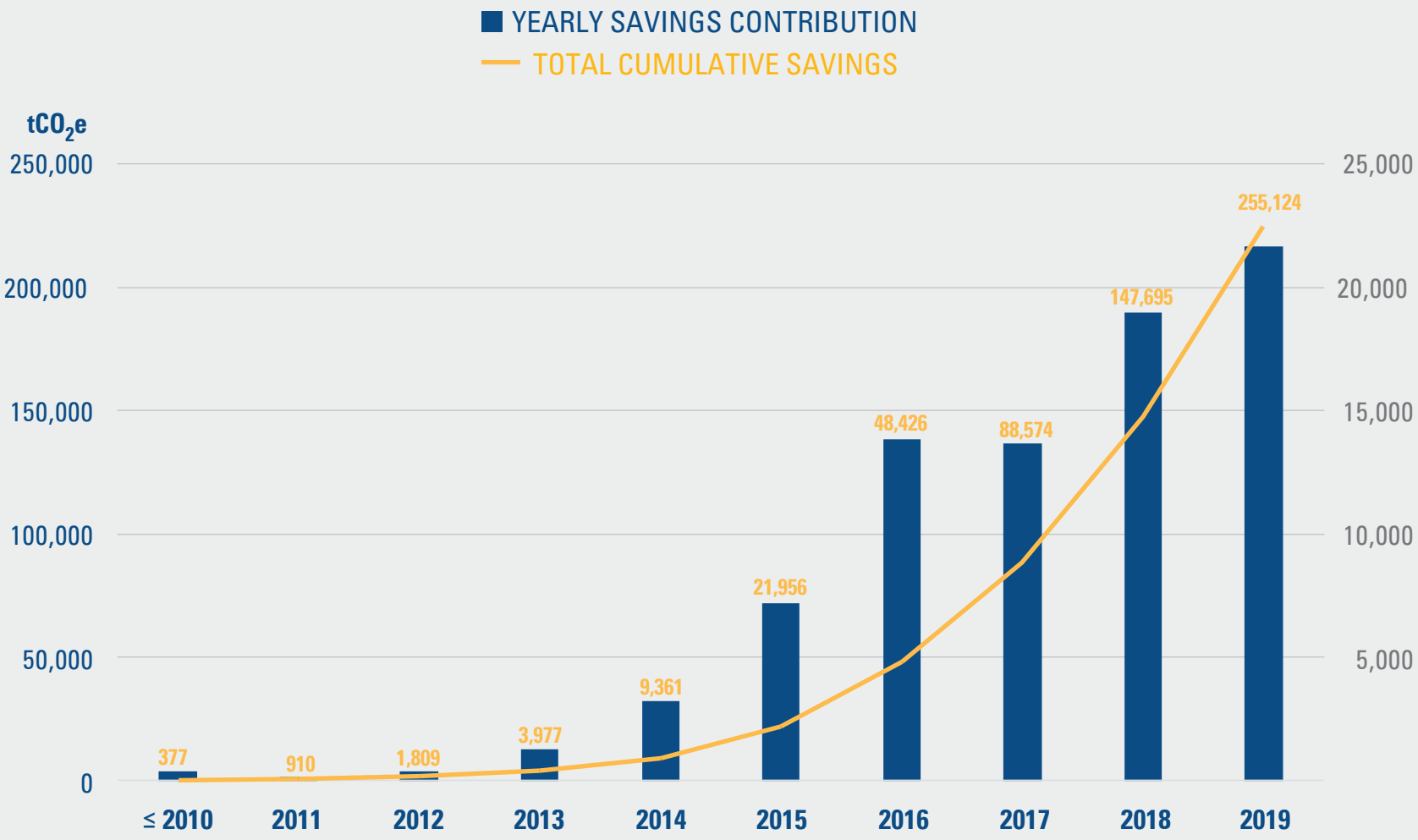
The top 3 districts leading the solar PV market in Lebanon are Zahleh with 16.68 MWp, Byblos with 7.59 MWp, and Metn with 6.41 MWp.

SOLAR PV ESTIMATED MONETARY SAVINGS ($)



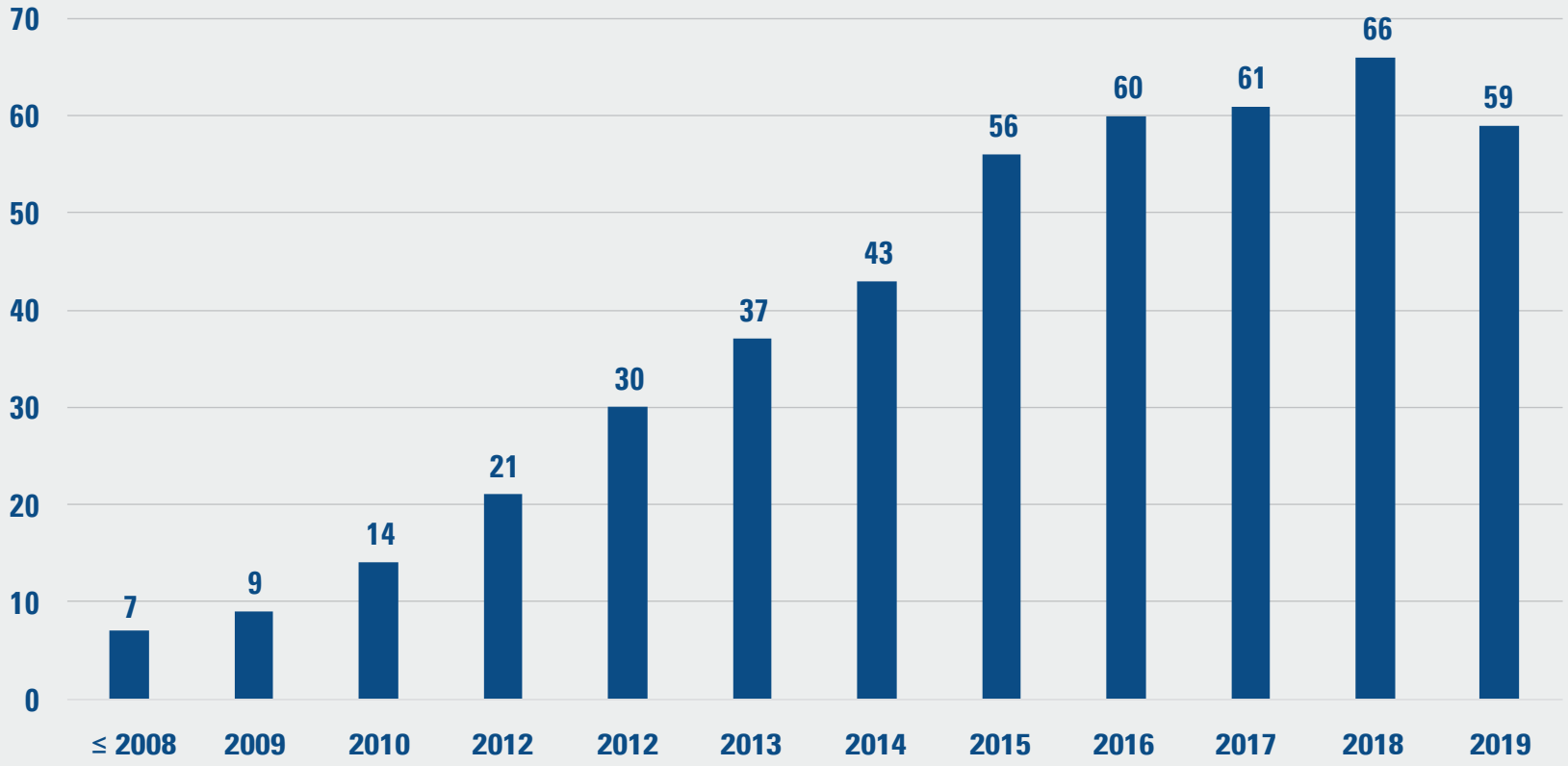
The estimated monetary savings from all solar PV projects in Lebanon grew from $200,000 in 2010 to $6.42 Million in 2019. The cumulative savings by the end of 2019 amounted to $66.55 Million.

SOLAR PV ESTIMATED EMISSION SAVINGS (tCO_2e)



The estimated emission savings from all solar PV projects in Lebanon grew from 377 tCO_2e in 2010 to 21,697 tCO_2e in 2019. Cumulative savings by the end of 2019 amounted to 225,124 tCO_2e.

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 out of which 7 companies were not responsive by the end of 2019.

* 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 requirement. 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 certainly play an important role in achieving these targets. All that is left is the willingness of commercial banks to lend the private sector in order to achieve national targets.

The industrial sector continues to dominate the solar PV market with 25.54 MWp of installed capacity.

Investing in solar PV continues to be more affordable year after year with the average turnkey price falling to $935 in 2019.

Despite the 2019 job reduction, the solar PV sector's positive effect on job creation is significant with at least 653 jobs created since 2008 and still active till end of 2019.

Considerably more jobs will be created when Lebanon starts building its first utility-scale PV farms.

Despite all the barriers, our belief in our ability to reach the chartered targets stems from the continuous investment of the private sector in sustainable technologies aiming to satisfy in-house energy needs as they look towards becoming independent energy producers thanks to the positive image of the decentralized solar PV fulfilled over the past years.

LIST OF PARTICIPATING ACTIVE LEBANESE SOLAR PV COMPANIES

Acemco SAL	EEG	Jubaili Bros	SFR ENERGY
AEMS SAL	Elements Sun & Wind	Kypros	Smart Age
AL-Diyar for Engineering Contracting & Trading	Energies- Sport- Sante ESS sarl	Lebanese Sustainable Energy	Solar Wind M.E.
Alternative Energy Group SAL	Est. Georges Azar	Lebanon Power systems sal	SOLARNET
Aquarius	FREE SAL	ME Green	SUN FOR FREE
Arina Energy	Future Power	Middle East Green Energy	SunFeed
Benta Power Tech	GP Stellar	Nicolas Electric	TAKOM ENERGY
Corporate Business Solution	Green Energy s.a.r.l.	NovaEnergia sal	TGM electronic
CTI SARL	Green Essence Lebanon	Phoenix Energy	Yelloblue
Dawtec	Green Power Generation	Plemicor Industries	ZAK
Earth Technologies	Green Power Tech	RJR	
EAS green energy	GreenWise Energy	Saccal Systems S.A.L.	
ECOSys-MDS	I Energy	Salem International	

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

LEBANESE REPUBLIC
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