



# 2016 Solar PV Status Report for Lebanon







# 2016 Solar PV Status Report for Lebanon

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Note: The information contained within this document has been developed within a specific scope, and might be updated in the future.



## ACKNOWLEDGMENTS

The United Nations Development Programme (UNDP) would like to thank both the Global Environment Facility (GEF) and the Lebanese Ministry of Energy and Water (MoEW) for their generous donation that enabled the Small Decentralized Renewable Energy Power Generation (DREG) Project to be realized. UNDP would also like to thank all its partners including the Lebanese Center for Energy Conservation (LCEC), the EU-funded UNDP CEDRO Project, Électricité du Liban (EDL), the UNDP Low Emission Capacity Building (LECB) Project at the Ministry of Environment (MoE), Banque du Liban (BDL), the Council of Development and Reconstruction (CDR), the Lebanese renewable energy companies which participated in the survey for this report, and all other institutions that work closely with this project.

## FOREWORD



**CÉSAR  
ABI KHALIL**

At a time where our economy is facing low growth due to the surrounding turmoil, the solar PV sector in Lebanon is becoming, year after year, a reliable source of job creation and economic growth. Investments in solar PV in 2016 alone totaled \$24 million whereas the cumulative investments to date reached \$58 million. This resulted in the creation of 55 local solar PV companies since 2008 which employ more than 600 Lebanese professionals.

All this data pertaining to this sector is accessible thanks to the 2016 Solar PV Status Report for Lebanon being launched this year in its second edition. The report builds on last year's data and adds the all-new 2016 data while introducing new key indicators as well.

I urge the private sector to invest in solar PV technology since it has demonstrated that it can be both economically and environmentally beneficial by lowering operational costs and reducing pollution at the same time.

**César Abi Khalil**  
Minister of Energy and Water



## ABSTRACT



The Small Decentralized Renewable Energy Power Generation (DREG) Project is funded by the Global Environment Facility (GEF) and implemented by the United Nations Development Programme (UNDP). The project is nationally executed by the Ministry of Energy and Water (MoEW) in coordination with the Lebanese Center for Energy Conservation (LCEC).

The project's objective is to reduce greenhouse gas emissions through the removal of barriers to widespread application of decentralized renewable energy power generation.

The 2016 Solar Photovoltaic (PV) Status Report for Lebanon, developed and published in its second edition in 2017, highlights the status and the growth of the solar PV market by presenting and analyzing all its available data.

Solar cells, also called photovoltaic (PV) cells, convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the PV effect.

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 2016. 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, 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

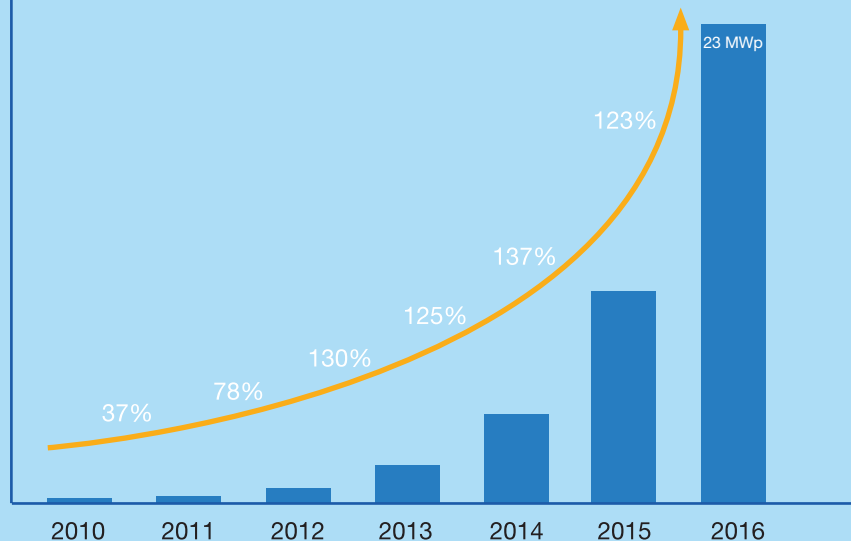
Lebanon's energy generation by EDL reached in 2016  
**13.17 TWh**

Lebanon's power generation installed capacity by EDL equaled  
**2,131 MW**  
by the end of 2016

2010-2016 PV capacity grew by an average of

**105%/yr**

SOLAR PV YEAR-OVER-YEAR GROWTH RATE



**PV capacity growth rate increased from 37% in 2011 to 123% in 2016**

**New PV projects growth rate increased from 26% in 2011 to 48% in 2016**



Number of new PV projects increased from

**19 in 2011**  
**296 in 2015**  
**343 in 2016**

PV capacity in 2016:

**1.07%**  
of total EDL generation capacity  
**0.26%**  
of total EDL electricity generation

Total Investment in PV up to the end of 2016

**\$57.4m**

Average price for PV is falling

**\$7,093/kWp in 2010**  
**\$2,709 in 2015**  
**\$1,875 in 2016**

**74% in 7 years**

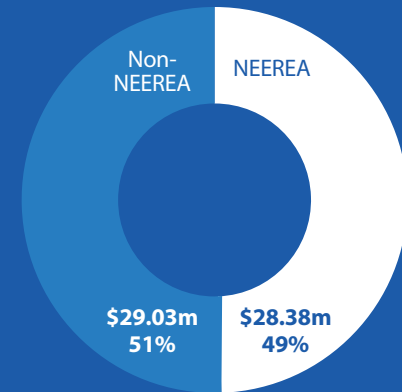
Total cumulative investment in PV increased from **\$2.45m** in 2010 to **\$57.41m** in 2016

2016 Investments:

**NEEREA: \$14.01m**  
**Non-NEEREA: \$9.83m**

**Total: \$23.84m**  
compared to  
**\$16.23m** in 2015

Solar PV Investment



Average price for the fastest-growing project type, On-grid/ Grid-tied/Online, decreased by

**42% from 2015 to 2016**

#### Top 4 sectors leading the PV market

Industrial	6.29 MWp	Up from 1.6 MWp
Commercial	4.4 MWp	Up from 2.03 MWp
Residential	4 MWp	Up from 1.7 MWp
Public	3 MWp	Up from 1.44 MWp

#### Top 4 Governorates leading in PV

Mount Lebanon	8.48 MWp	Up from 3 MWp
Bekaa	5.28 MWp	Up from 1.8 MWp
Beirut	3.59 MWp	Up from 2.4 MWp

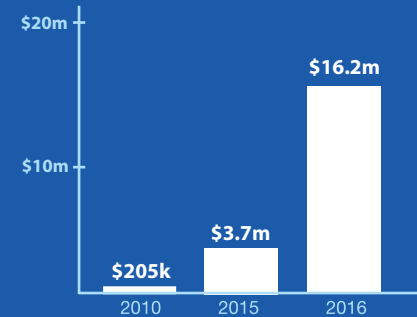
#### Top 3 PV project types in the market:

On-grid/Grid-tied/Online with **12.73 MWp** at **55%**

On-grid with batteries/grid-interactive with **2.80 MWp** at **12%**

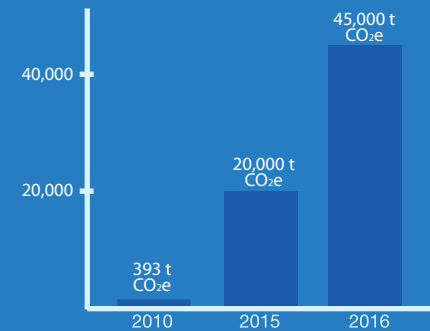
Solar PV Pumping with **2.55 MWp** at **11%**

#### Estimated Monetary Savings from PV Projects



These are the savings achieved by the operators of PV systems

#### Estimated Emissions Savings from PV Projects





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## TABLE OF ACRONYMS

<b>BDL</b>	Banque du Liban
<b>CDR</b>	Council for Development and Reconstruction
<b>EDL</b>	Electricité du Liban
<b>GEF</b>	Global Environment Facility
<b>kW</b>	Kilo-watt
<b>kWh</b>	Kilo-watt-hour
<b>kWp</b>	Kilo-watt-peak
<b>LECB</b>	Low Emission Capacity Building Project
<b>MoE</b>	Ministry of Environment
<b>MoEW</b>	Ministry of Energy and Water
<b>MW</b>	Mega-watt
<b>MWh</b>	Mega-watt-hour
<b>MWp</b>	Mega-watt-peak
<b>NEEREA</b>	National Energy Efficiency and Renewable Energy Action
<b>PV</b>	Photovoltaic
<b>TWh</b>	Terra-watt-hour


## TABLE OF TERMS

<b>Decentralized Energy</b>	Decentralized energy is produced close to where it will be used rather than at a large plant elsewhere and sent through the national grid.
<b>Electricity Generation</b>	Electricity generation is the amount of electricity a generator produces over a specific period of time.
<b>Generation Capacity</b>	Generation capacity is the maximum electric output an electricity generator can produce under specific conditions.
<b>On-grid/Grid-tied/Online</b>	Electricity generation is the amount of electricity a generator produces over a specific period of time.
<b>On-grid with batteries/Grid-interactive/Dual-mode</b>	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.
<b>Hybrid/Multisource</b>	This refers to systems that include the parallel operation of PV with one or more sources (e.g. PV-Diesel).
<b>Off-Grid/Stand-alone/Autonomous</b>	These systems work independent of 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.
<b>Off-grid with generator back-up</b>	Same as off-grid, but the battery bank can be recharged by another generator (e.g. Diesel back-up genset).
<b>PV/Solar pumping</b>	Same as off-grid, but the battery bank can be recharged by another generator (e.g. Diesel back-up genset).

## 2016 HIGHLIGHTS

- ☀ Newly installed solar PV capacity set a record in 2016 with an additional **12.71 MWp** installed; bringing the total installed capacity to approximately **23 MWp**. This indicates a triple-digit growth for **4** consecutive years and a **112%** growth rate over 2015's addition. With Lebanon's solar PV distributed generation target set at **100 MWp** by 2020 as per the National Renewable Energy Action Plan (NREAP), the market needs to add a little over **19 MWp** in 4 years. Given the market's growth rate to date, reaching the **100 MWp** target should be possible.
- ☀ The Industrial Sector recorded the highest solar PV capacity growth rate of over **250%** with **6.29 MWp** total installed capacity by the end of 2016 compared to just **1.74 MWp** in 2015. Given that the peak demand in industries occurs during the day when the sun is shining, industries have been heavily investing in on-grid solar PV systems which do not require the use of costly batteries but consume the electricity directly instead. This is a significant market development and an indicator of the economic and environmental benefits of decentralized renewable energy systems.
- ☀ Solar PV electricity generation increased from **0.11%** of the total annual electricity generation by EDL in 2015 to **0.26%** in 2016. This is equivalent to **34.3 GWh**. With Lebanon's solar PV distributed generation target set at **160 GWh** by 2020 as per the National Renewable Energy Action Plan (NREAP), the market needs to add **125.7 GWh** of renewable energy generation in **4 years** or equivalent to **84.4 MWp** of added capacity.



- 
- ☀ The average turnkey price for solar PV fell from **\$2,709** per kWp in 2015 to **\$1,875** in 2016. Equipment prices such as panels, inverters, racking equipment, and control and monitoring equipment have gotten cheaper globally coupled with a reduction in soft costs such as finding new customers, installation, maintenance, and other administrative costs. These global price drops which were met with higher demand for the technology locally resulted in a continued downward price trend. Locally, Decree 167/2017 calls for a reduction between 10% and 50% in customs duties for any individual or legal entity importing goods to be used to avoid, reduce, or eliminate pollution. When local PV companies start benefitting from this reduction, prices are forecasted to further continue their descending path.
  - ☀ In 2016, total investment in the solar PV sector grew by **71%** from the previous year; totaling over **\$57 million**. This meant that 2016 saw an additional **\$23.84 million** in new investments introduced into the market. This is largely thanks to the NEEREA loan programme that provided **\$14 million** out of the total new investments; nearly **60%**. This is an indicator that these types of soft loans are beneficial for the Lebanese renewable energy market. In addition, this increase in demand for NEEREA loans in 2016 compared to 2015 is an indicator of NEEREA's success.
  - ☀ **5** Lebanese solar PV companies were working in the sector before 2008. This number started growing steadily from **13** companies in 2010 to **55** companies by the end of 2016. At least **600** new jobs were created in this sector. This new indicator introduced in this year's report quantifies the positive effect renewable energy can have on the local job market. The job creation figures coupled with the increased investment in solar PV clearly show that this sector can contribute to economic growth. When other renewable energy applications such as utility-scale solar PV farms and wind farms become operational, the growth in job creation is expected to further increase.



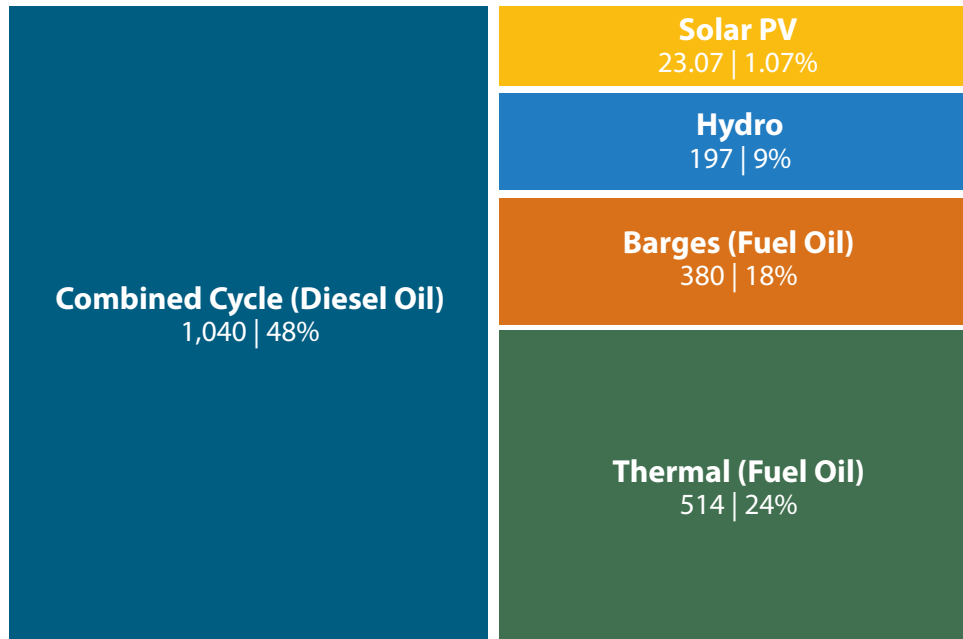
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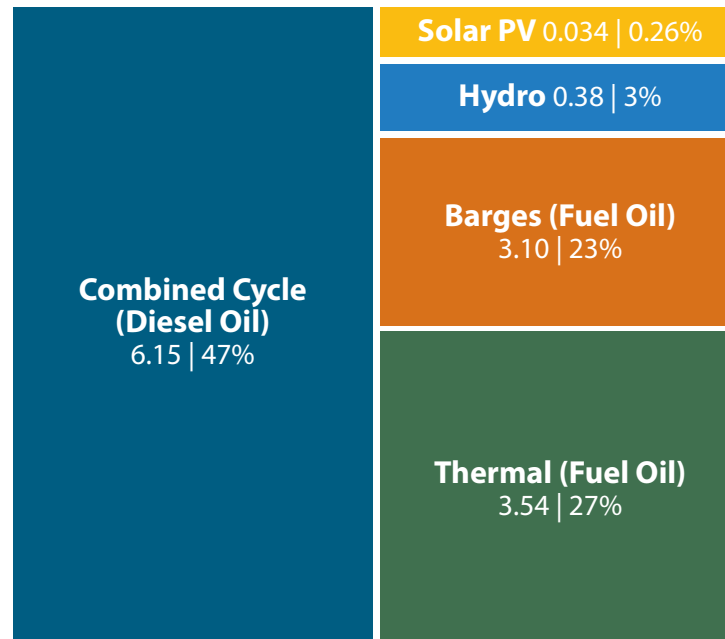
**LEBANON  
ELECTRICITY  
BACKGROUND  
INFORMATION**

## LEBANON'S 2016 ELECTRICITY GENERATION CAPACITY (MW | %)



EDL's share of the total electricity generation capacity equaled 2,131 MW while the Solar PV's share equaled 23.31 MWp (1%).

## LEBANON'S 2016 ELECTRICITY GENERATION (TWh | %)



EDL's share of the total electricity generation equaled 13.17 TWh while the solar PV's share equaled 0.035 TWh or 0.26% of the total electricity generation by EDL (up from 0.11% in 2015).

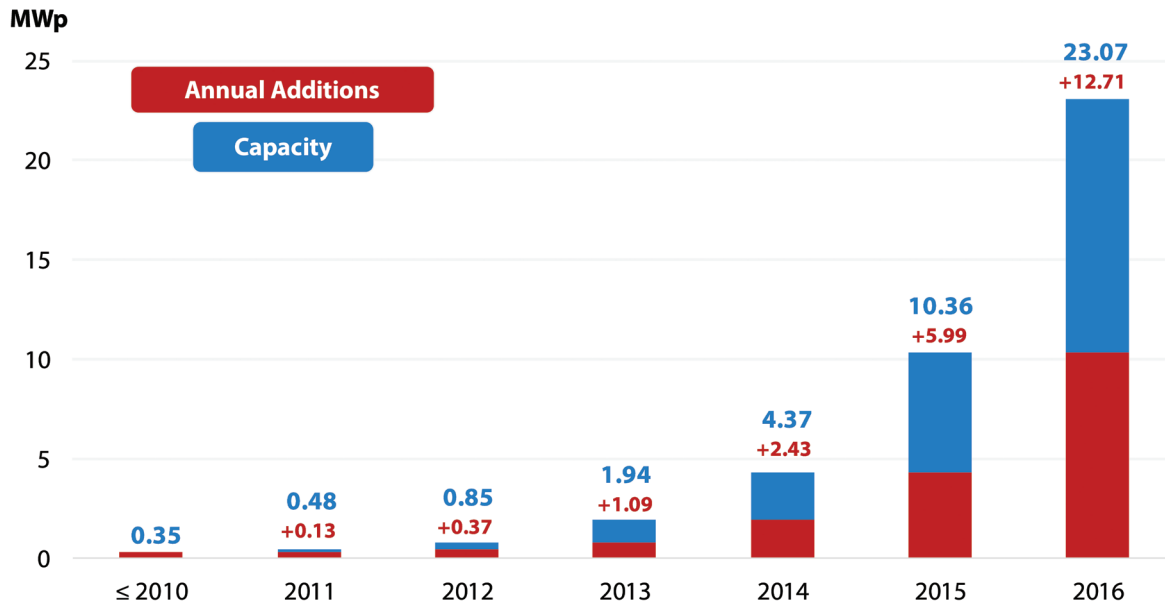
With solar PV added to Hydro, the renewables' share of the total annual electricity generation in 2016 is equal to 3%.



2

SOLAR PV  
ELECTRICITY IN  
LEBANON

## SOLAR PV CAPACITY AND ANNUAL ADDITIONS

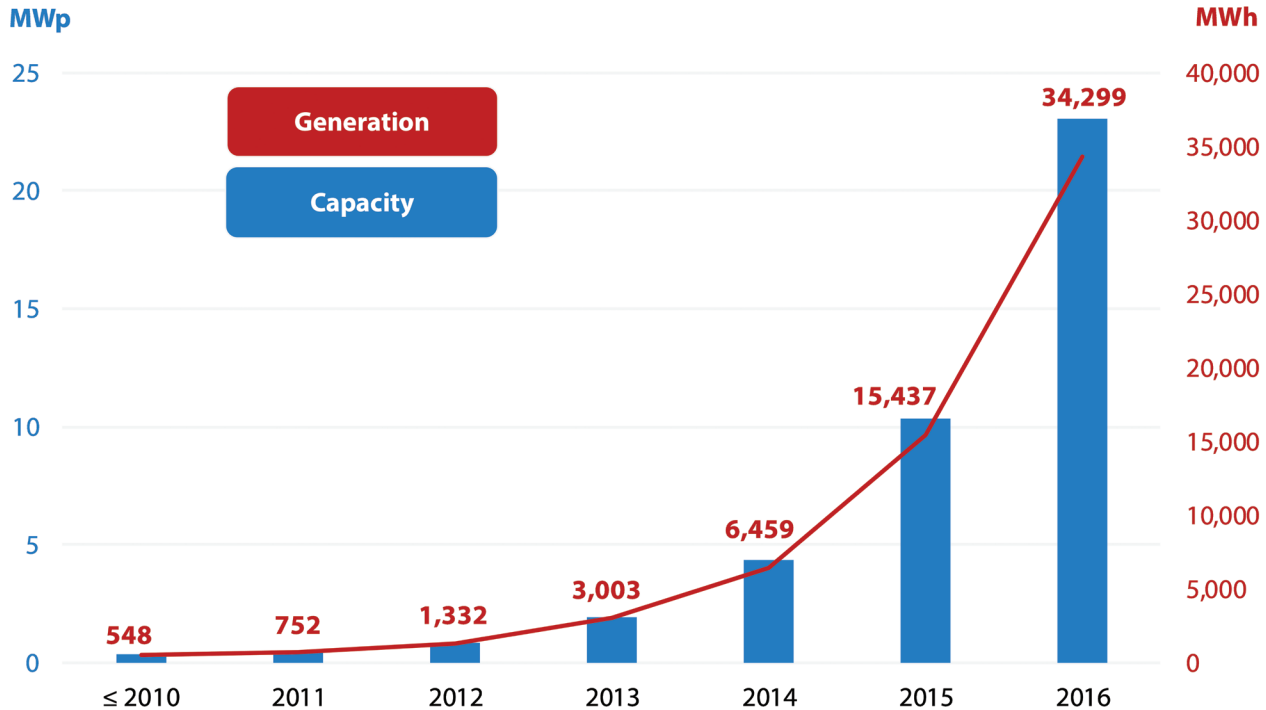


The solar PV installed capacity was 350 kWp in 2010 and reached 23.07 MWp by 2016.

This figure includes the Beirut River Solar Snake Project (1.08 MWp) and the Zahrani Oil Installations Project (1.09 MWp) whereas the remainder comes from decentralized systems (20.9 MWp).

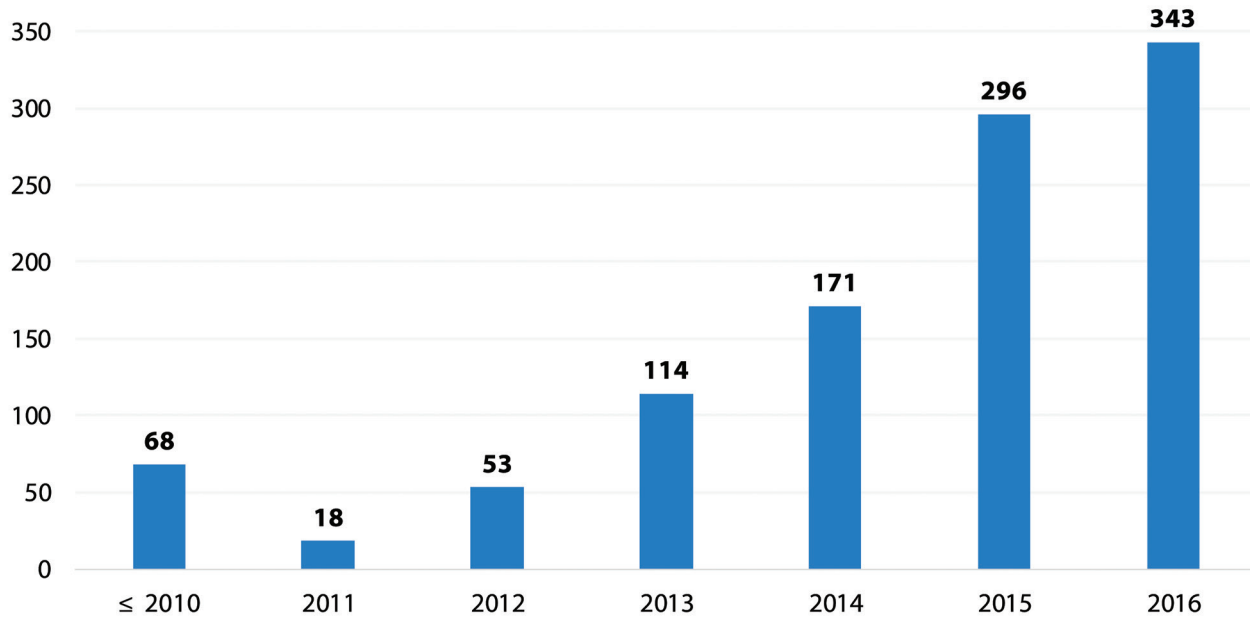


## SOLAR PV CAPACITY AND GENERATION



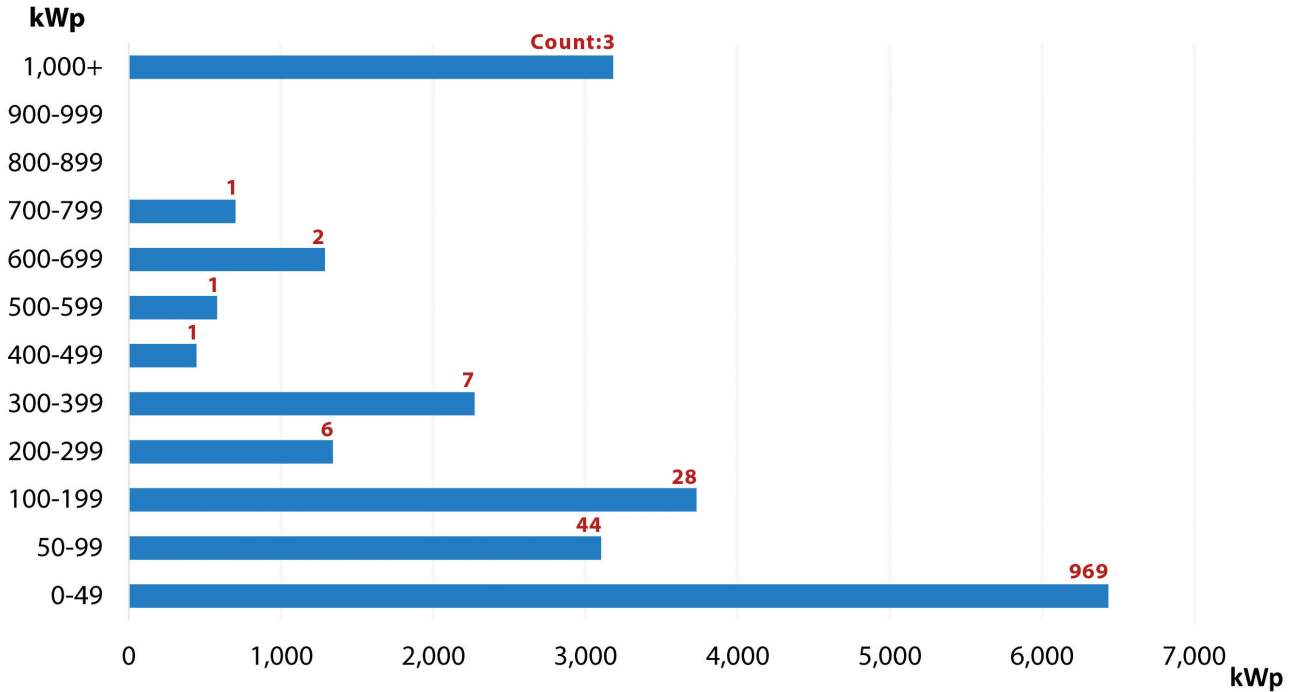
Around 34,000 MWh of solar PV electricity was generated in 2016 which constitutes 0.26% of the total annual electricity generation by EDL.

## SOLAR PV ANNUAL NEW PROJECTS COUNT



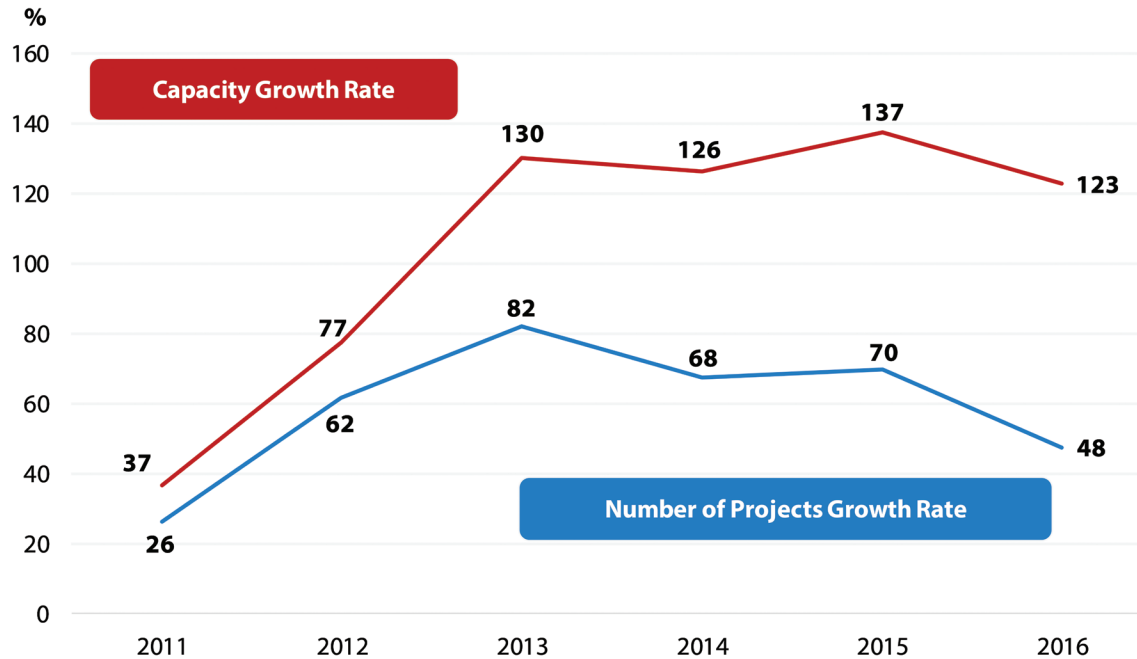
The number of new solar PV projects increased from 296 in 2015 and to 343 in 2016.

## SOLAR PV CAPACITY AND COUNT BY PROJECT SIZE GROUPS



Small-sized projects, up to 49 kWp, dominate the market in terms of capacity (28%) and count (91%).

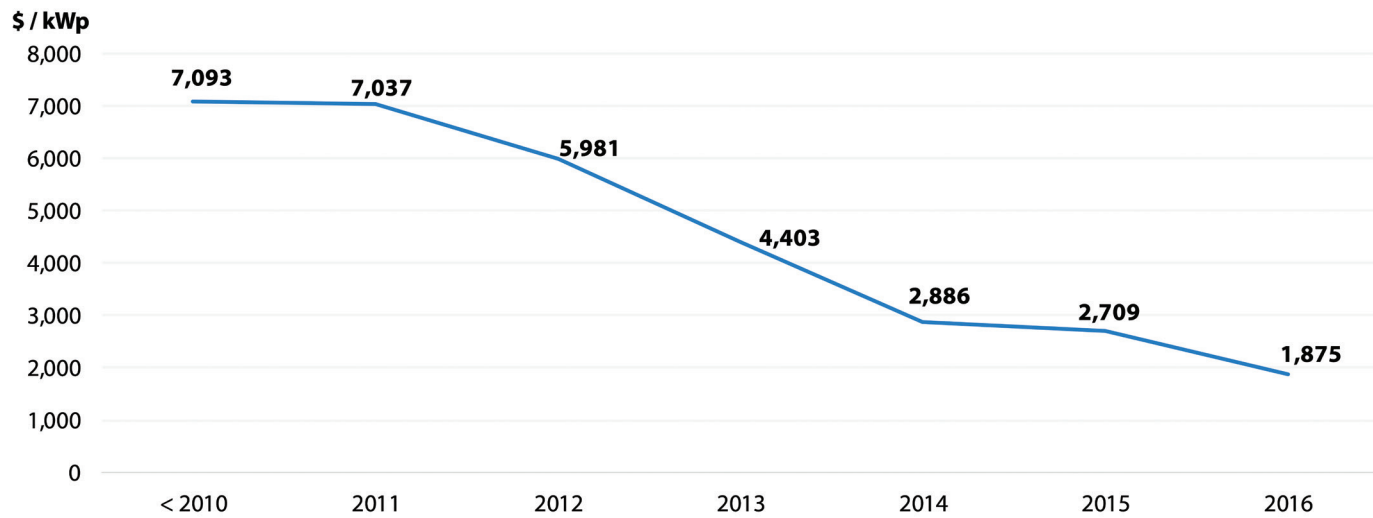
## SOLAR PV CAPACITY AND NUMBER OF PROJECTS YEAR-OVER-YEAR GROWTH RATE



The year-over-year growth rate for the solar PV capacity increased from 37% in 2011 to 123% in 2016. The year-over-year growth rate for the number of new solar PV projects increased from 26% in 2011 to 48% in 2016.

This indicates that the average size of each project increased from 5 kWp in 2010 to 37 kWp in 2016.

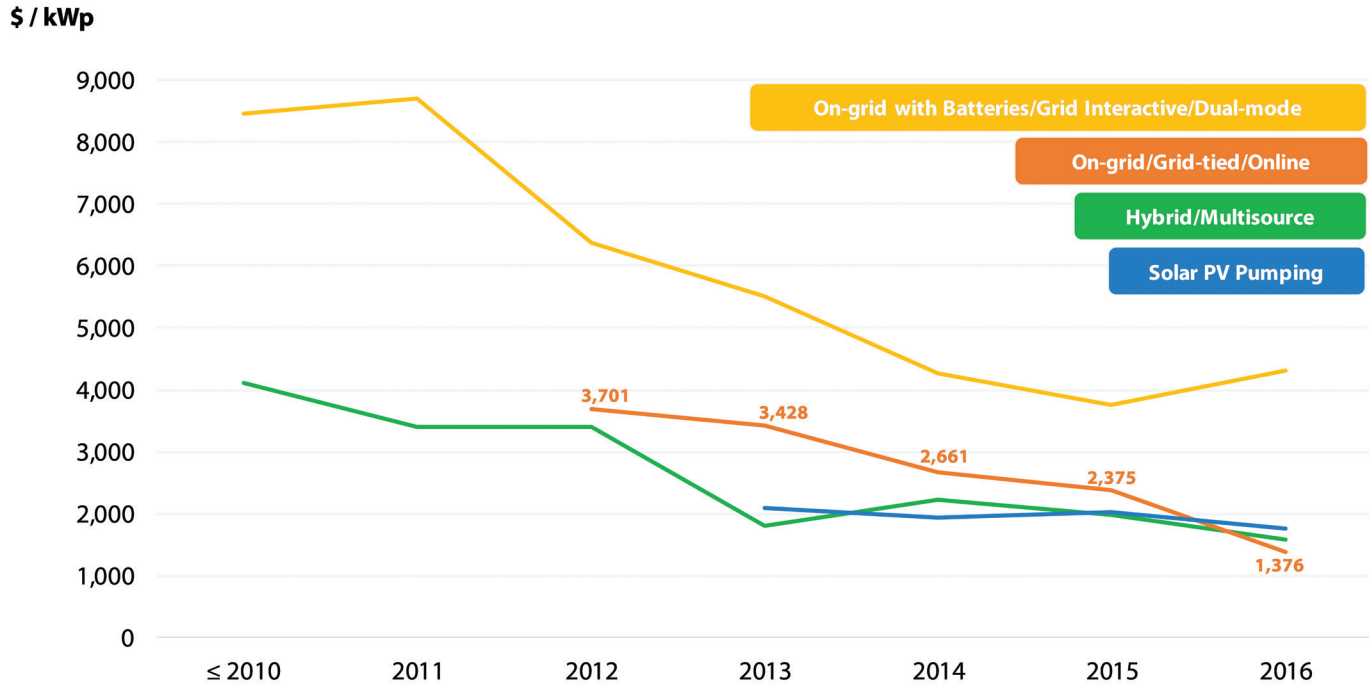
## YEARLY AVERAGE SOLAR PV TURNKEY PRICE



The turnkey price for solar PV has been falling steadily year after year from \$7,093 per kWp in 2010 to \$1,875 in 2016.

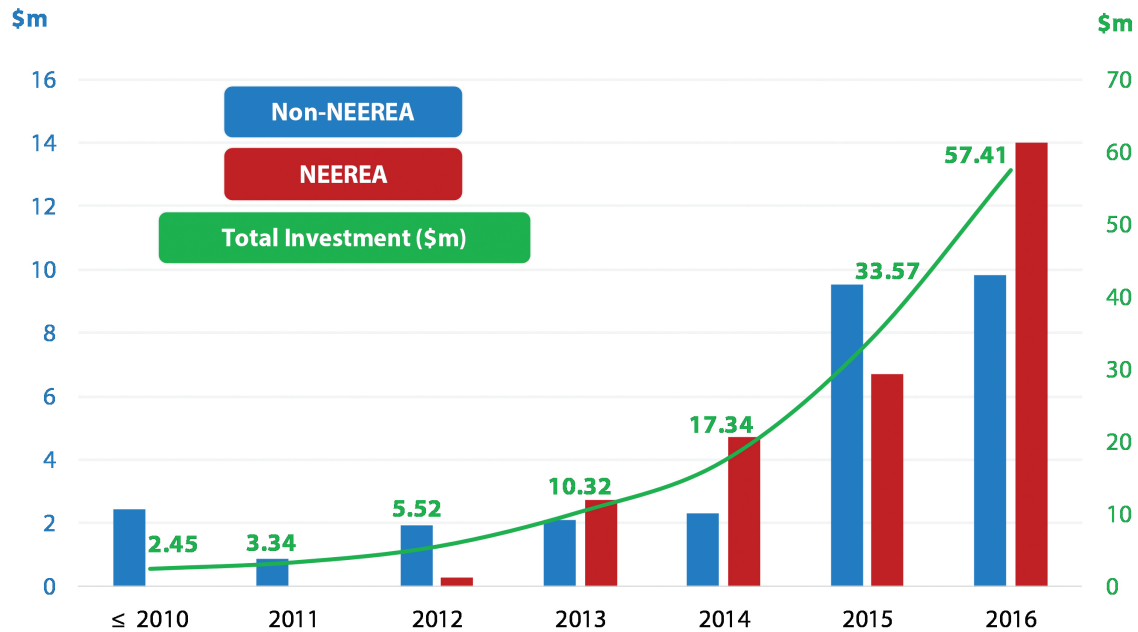
This constitutes a price drop of 74% in a span of seven years.

## YEARLY AVERAGE SOLAR PV TURNKEY PRICE BY PROJECT TYPE



The average turnkey price for the fastest growing project type, On-grid/Grid-tied/Online, fell by 42% in a single year from 2015 to 2016.

## SOLAR PV INVESTMENT

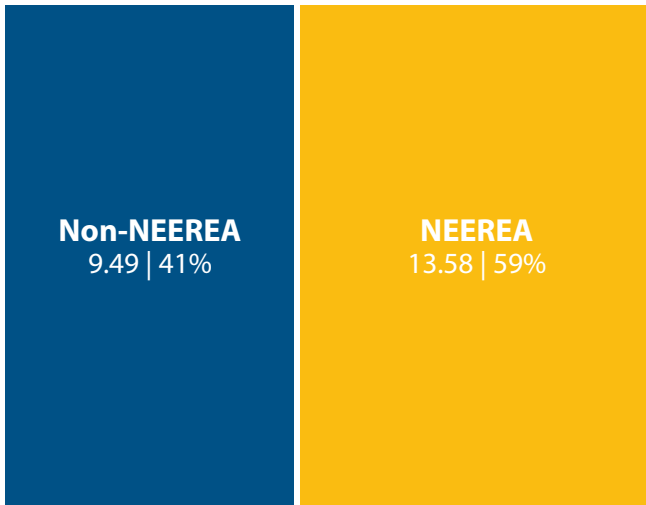


The total cumulative investment in the solar PV sector increased from \$2.45m in 2010 to \$57.41m in 2016.

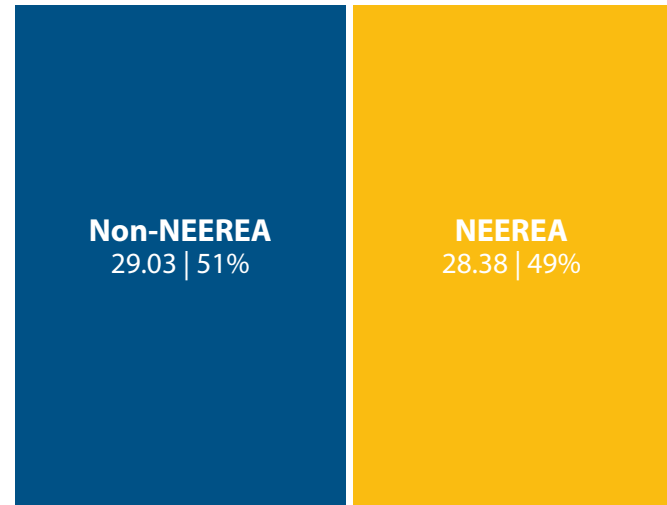
Investments coming through NEEREA totaled \$14m in 2016 whereas non-NEEREA investments reached \$9.83m for a total of \$23.84m as compared to \$16.23m in 2015.

## SOLAR PV INVESTMENT

Capacity Share per Source of Funding (MWp | %)



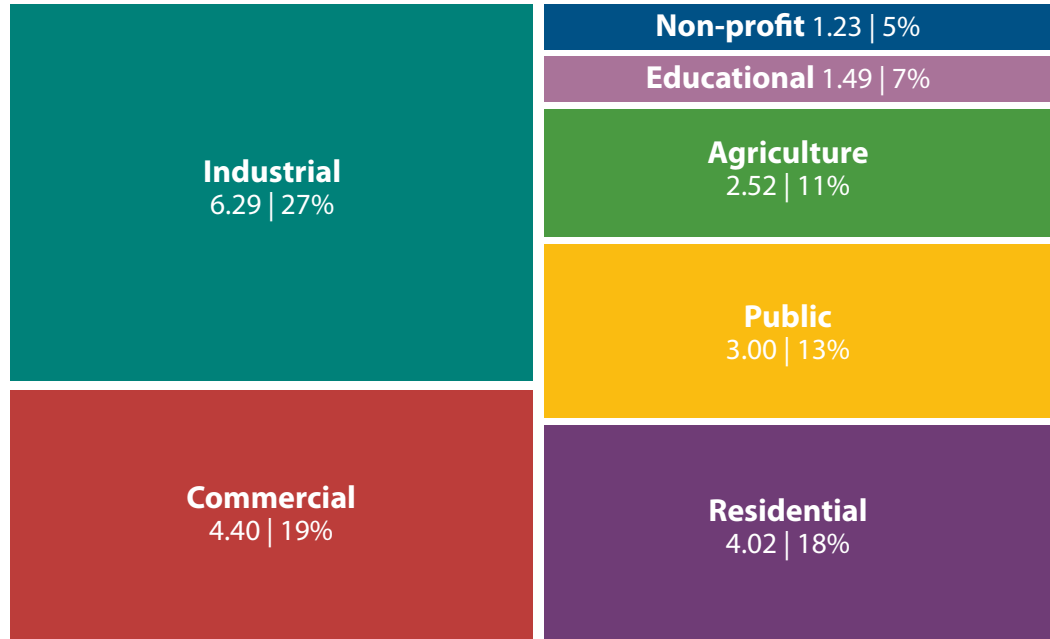
Funding Share per Source of Funding (\$m | %)



59% of the installed solar PV capacity to date is funded by NEEREA for a total investment of \$28.38m whereas the remaining 41% of installed capacity was funded by non-NEEREA investments totaling \$29.03m.



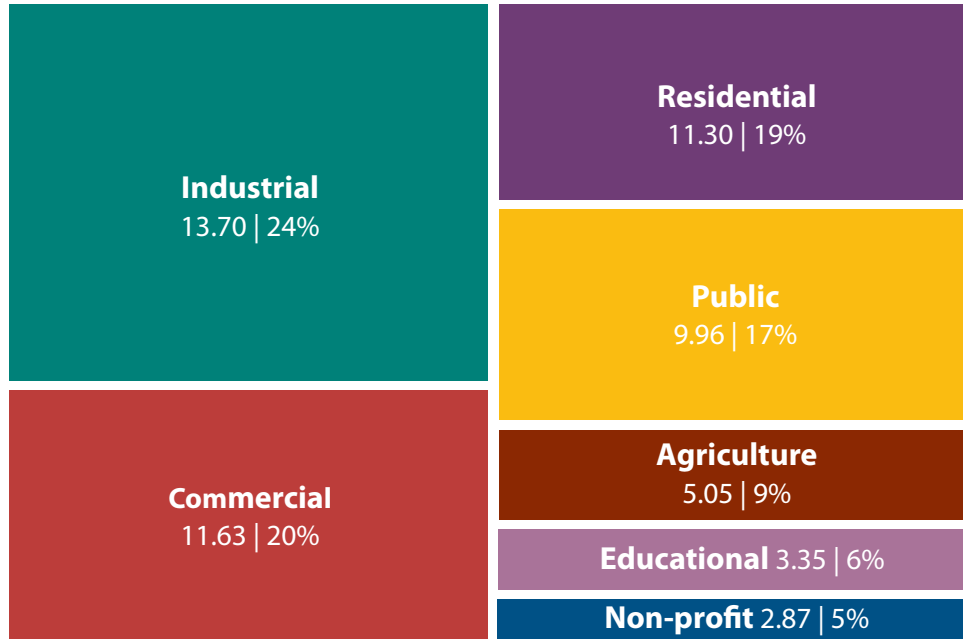
## SOLAR PV CAPACITY BY SECTOR (MWp | %)



The top 3 sectors leading the solar PV market in Lebanon in installed capacity are the Industrial sector with 6.29 MWp, the Commercial sector with 4.4 MWp, and the Residential sector with 4 MWp.

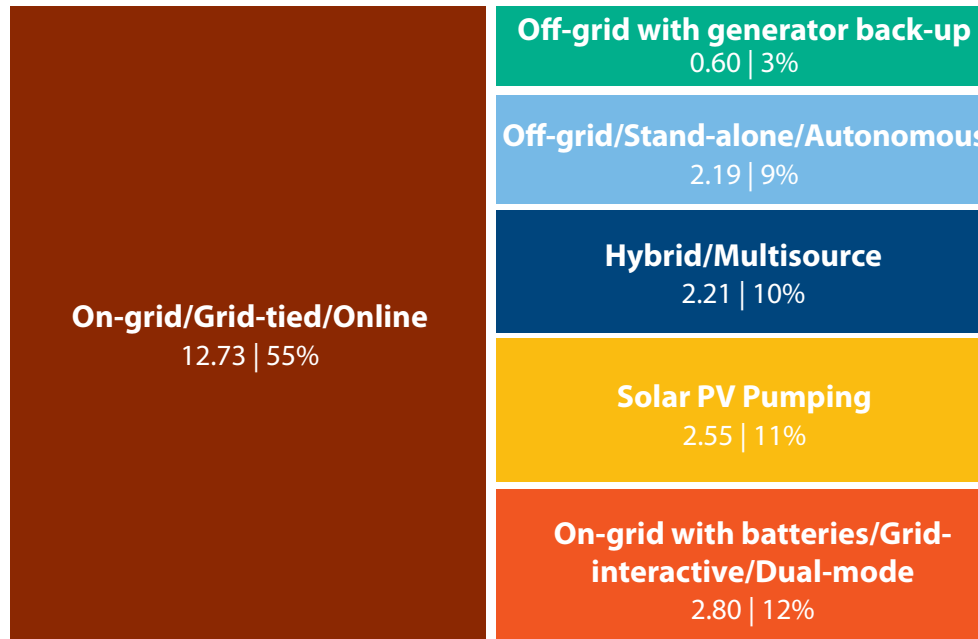
The Industrial sector recorded the highest growth from 1.74 MWp to 6.29 MWp (262%) in a single year.

## SOLAR PV CAPACITY BY INVESTMENT (\$m | %)



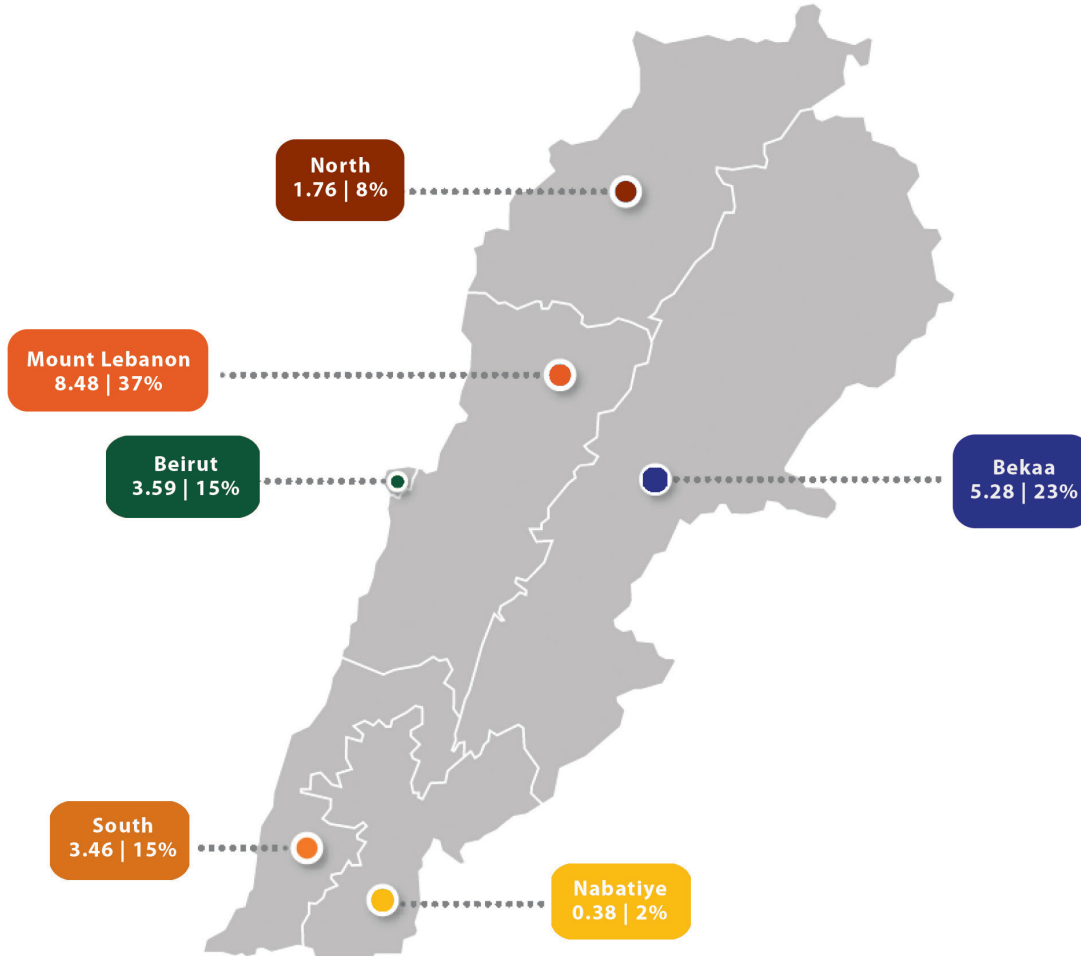
The top 3 sectors leading the solar PV Market in Lebanon in investment are the Industrial sector with \$13.7m, the Commercial sector with \$11.63m, and the Residential sector with \$11.3m.

## SOLAR PV CAPACITY BY PROJECT TYPE (MWp | %)



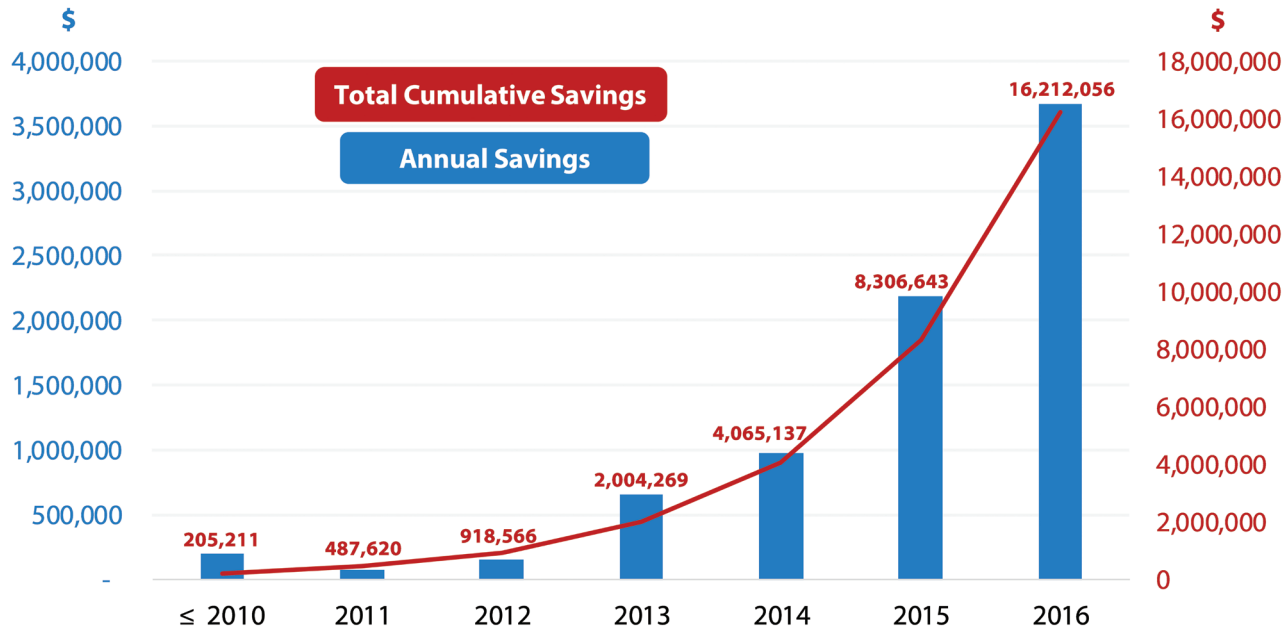
The Top 3 project types prevailing in the solar PV Market in Lebanon are On-grid/Grid-tied/Online with 12.73 MWp, On-grid with batteries/Grid-interactive/Dual-mode with 2.8 MWp, and Solar PV Pumping with 2.55 MWp.

## SOLAR PV CAPACITY BY GOVERNORATE (MWp | %)



The top 3 Governorates leading the solar PV Market in Lebanon are Mount Lebanon with 8.48 MWp (up from 3 MWp), Bekaa with 5.28 MWp (up from 1.8 MWp), and Beirut with 3.59 MWp (up from 2.39 MWp).

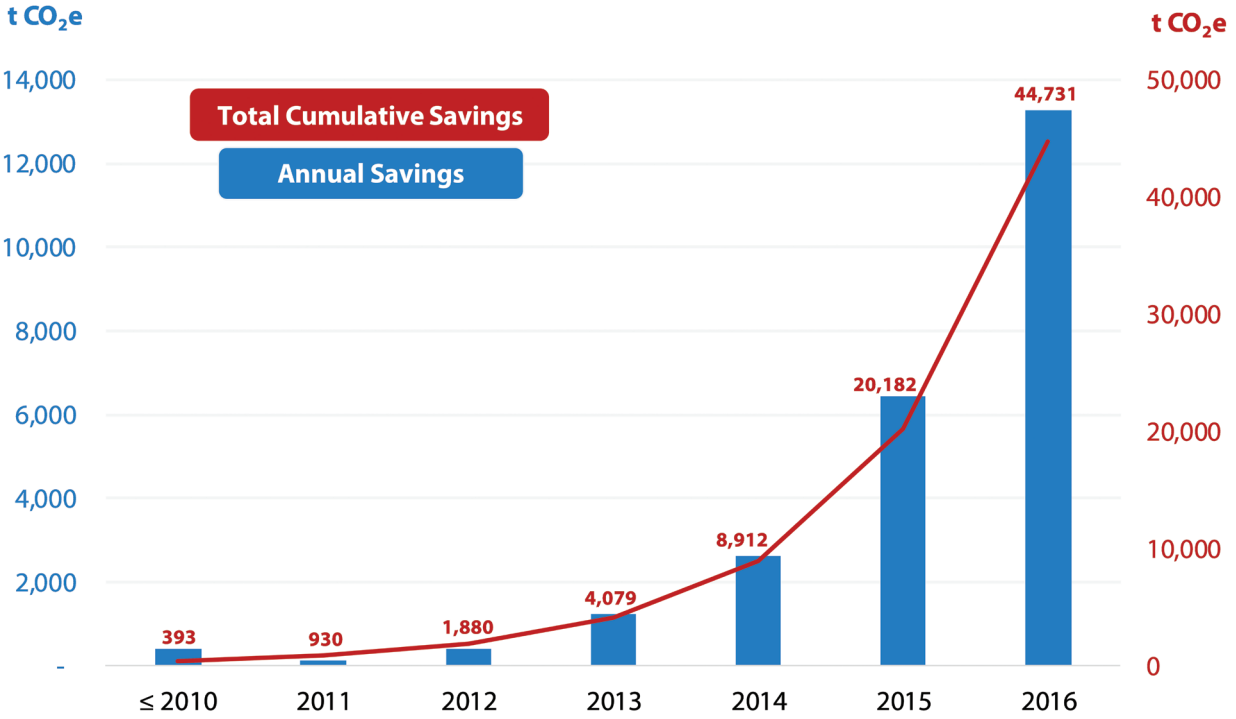
## SOLAR PV ESTIMATED MONETARY SAVINGS



The estimated monetary savings from all the solar PV projects in Lebanon grew from \$205k per year in 2010 to \$3.7m per year in 2016. The cumulative savings by the end of 2016 amount to \$16.2m.

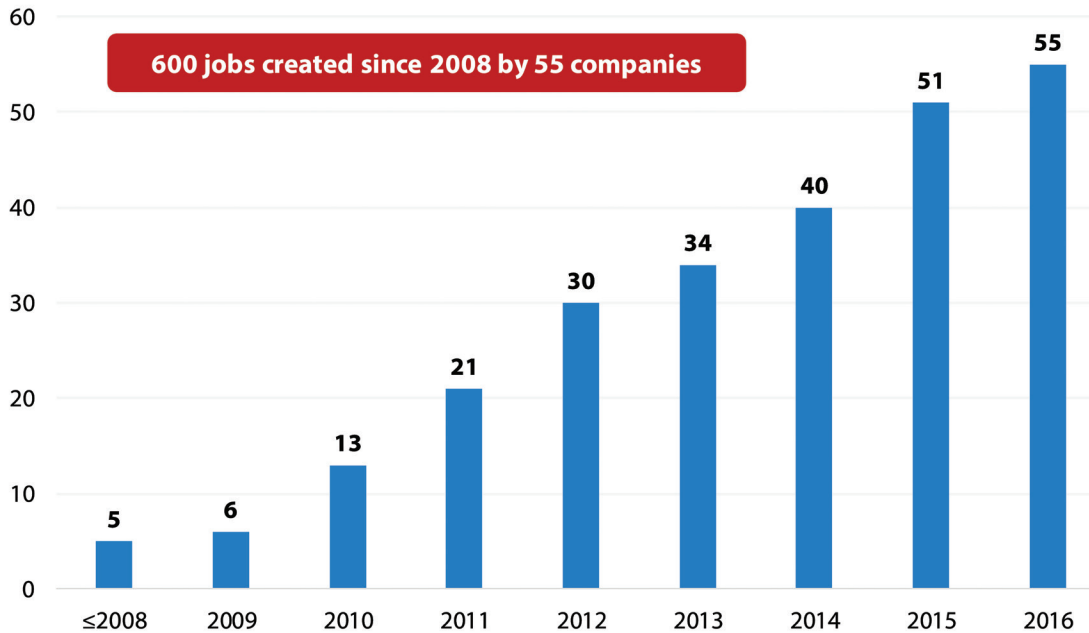
These are the savings achieved by the operators of solar PV systems in Lebanon by deferring a portion of their electricity consumption from the grid and diesel generators to solar PV generation.

# SOLAR PV ESTIMATED EMISSIONS SAVINGS



The estimated emissions savings from all the solar PV projects in Lebanon grew from 393 t CO<sub>2</sub>e per year in 2010 to 44,731 t CO<sub>2</sub>e per year in 2016. The cumulative savings by the end of 2016 amount to 81,107 t CO<sub>2</sub>e.

## CUMULATIVE SOLAR PV COMPANIES IN LEBANON



5 Lebanese solar PV companies were working in the sector up until 2008. This number started growing steadily from 13 companies in 2010 to 55 companies by the end of 2016. At least 600 jobs were created throughout.

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

## LIST OF PARTICIPATING LEBANESE SOLAR PV COMPANIES

Acemco	Elements Sun & Wind	Manalco Power	RJR
AEMS SAL	Elie Abdelnour & Co	Matta Energies	Salem International
Al Diyar for Engineering Contracting & Trading	EMCA	MB Est	Sharp Minds - E24
AlBina SAL	EMTC	ME Green	Smart Age
Altaka - Albadila	FREE SAL	Midware Data Systems – ECOsys Division	Smart Energy Tech
Arina Energy	Future Power	Narinc Micro	Solar Panoramic
ASACO	GAPS	Nicolas Electric	Solar Wind Middle East
Beta Engineering	GP Stellar	NovaEnergia SAL	Solarnet
GENPRO ENERGY CO	Green Essence Lebanon	Panoramic Solar	Solec Energy
Control Panel	Green Power Energy SARL	Phoenix Energy	Sowrika
CTI SARL	HEHT	Plemicor Industries	Staunch Machinery
DAWTEC	I Energy	Power & Green SAL	YelloBlue
DCE SAL	Katranji	Renewable Med Energies	YellowEco Energy SARL
Earth Technologies			











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