PV already among the cheapest forms of electricity

PV LCOE in Europe to be almost halved again from 2014 to 2030

The cost of photovoltaic (PV) systems has decreased dramatically over the past years. Parity with retail electricity and oil-based fuels has been reached in many countries and market segments, and wholesale parity is approaching at some markets. The concept of Levelised Cost of Electricity (LCOE) is used for making fair comparisons with electricity prices and the cost of other power generation technologies. In this report, LCOE is defined to be the generation cost, i.e., including all the costs involved in supplying PV power at the point of connection to the grid. PV LCOE is based on PV system capital (CAPEX) and operational (OPEX) expenditure and includes the costs and profit margins of the whole value chain including financing, project development, manufacturing, installation, operation and maintenance.

PV system CAPEX can be divided into two parts: the modules and the Balance of System (BoS). For decades, module prices have very closely followed the so-called learning curve, which means that each time the global cumulative PV generation capacity doubles, the price of modules decreases by about 20%. This development is expected to continue during the next decades, mainly because of better manufacturing processes, less use of materials and continuously improving module efficiencies which will also drive down the BoS cost.

According to the hi-Ren Scenario of International Energy Agency (IEA) Solar Photovoltaic Energy Technology Roadmap (2014 edition), the cumulative global PV capacity would increase from the end of year 2014 figure of 178 GWp to about 1700 GWp by 2030. Applying this volume growth, the historic learning rate and an average 0.4%-point annual average efficiency improvement, PV CAPEX would decrease by about 45% from 2014 to 2030. During the same period, PV system OPEX is expected to decrease by about 30%. Figures 1 and 2 show the PV LCOE at six European locations with four system sizes and different real Weighted Average Costs of Capital (WACC). All prices are given in 2014 real euros. Note that London and Stockholm are represented by the same columns since both locations have the same average annual yield or peak load hours.

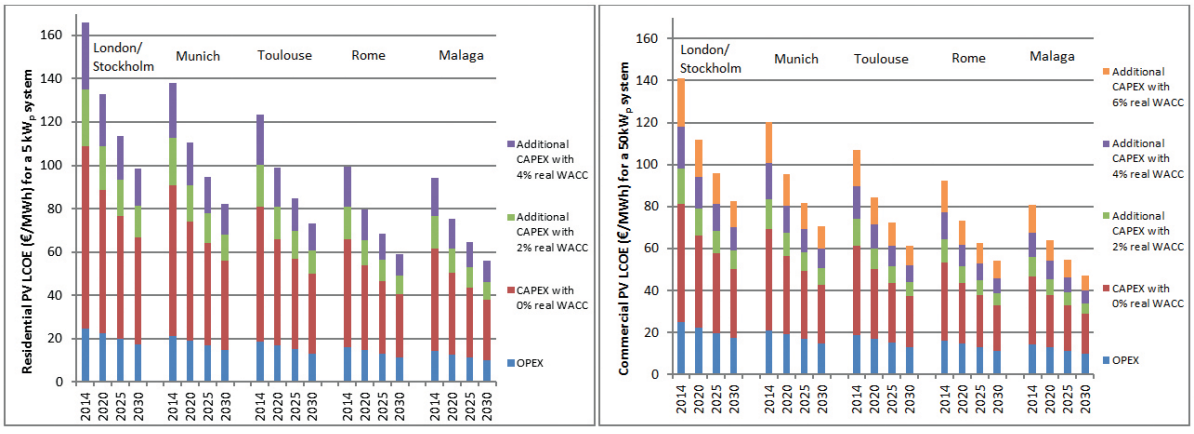

Figure 1. PV LCOE (in 2014 €) at six European locations with different real WACCs for 5 kWp residential (left) and 50 kWp commercial (right) rooftop system. CAPEX for commercial system 2014 1.28, 2020 0.98, 2025 0.83 and 2030 0.71 €/Wp; for residential system 27% higher + VAT; OPEX 2014 20, 2020 18, 2025 16 and 2030 14 €/kWp/a; yield London/Stockholm 870, Munich 1020, Toulouse 1150, Rome 1330 and Malaga 1520 kWh/kWp/a; system lifetime 30 a, degradation 0.5%/a. Note that 4% real WACC corresponds to 6.1% nominal WACC with 2% annual inflation.

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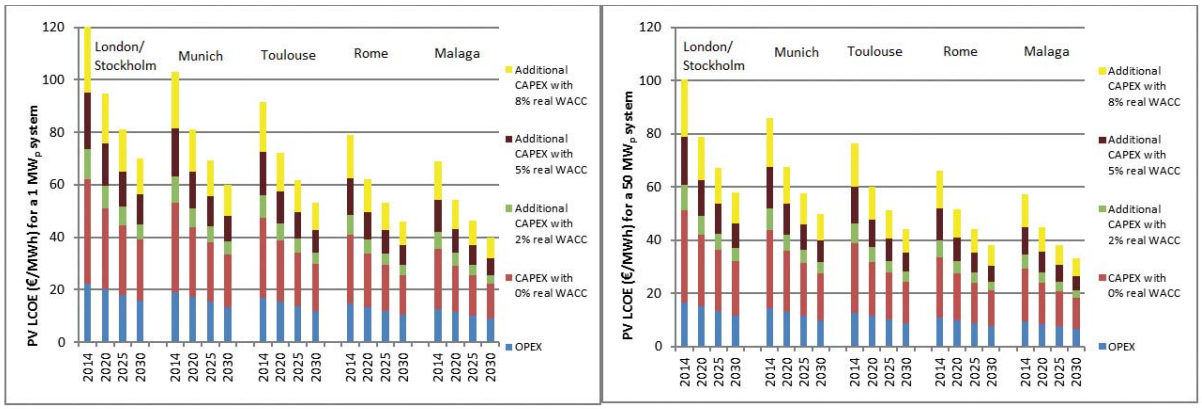

Figure 2. PV LCOE (in 2014 €) at six European locations with different real WACCs for 1 MWp (left) and 50 MWp (right) ground-mounted systems. CAPEX for 1 MWp system 2014 0.98, 2020 0.74, 2025 0.63 and 2030 0.53 €/Wp and OPEX 2014 20, 2020 18, 2020 16 and 2030 14 €/kWp/a; for 50 MWp system CAPEX 15% and OPEX 25% lower; yield London/Stockholm 960, Munich 1120, Toulouse 1260, Rome 1460 and Malaga 1680 kWh/kWp/a; system lifetime 30 a, degradation 0.5%/a. Note that 5% real WACC corresponds to 7.1% nominal WACC with 2% annual inflation.

If compared with the average household retail electricity prices in 2014 (e.g., in Sweden 200 and in Germany 300 €/MWh, including taxes), residential PV electricity is already clearly cheaper in all selected countries. When comparing with the average wholesale (spot market) electricity price in 2014 (e.g., 52 €/MWh in Italy and 42 £/MWh in the UK), large-scale PV electricity is already competitive in Italy and by 2025 it will be in the UK if 5% real WACC is used. It must be noted that 5% real WACC equals 7.1% nominal WACC with a 2% annual inflation.

Sensitivity analysis

It can be seen from the figures that cost of capital has a significant influence: PV LCOE doubles with a real WACC of 8% compared with 0%. The benefit of scale can also be seen: a small residential system (5 kWp) has about double LCOE compared with a large ground-mounted system (50 MWp). Location is also important: LCOE in London or Stockholm is about 75% higher than in Malaga because of lower solar irradiation. Figure 3 shows the relative sensitivity of PV LCOE on different input parameters including also CAPEX, OPEX, system lifetime and degradation. It can be seen that location and cost of capital are the most influental parameters. Even a faster/slower global volume growth or learning rate is not as significant. It can be concluded that the levelised cost of PV electricity will most likely to be halved again by 2030 and it will continue to decrease following the improvements in technology, material use and manufacturing processes.

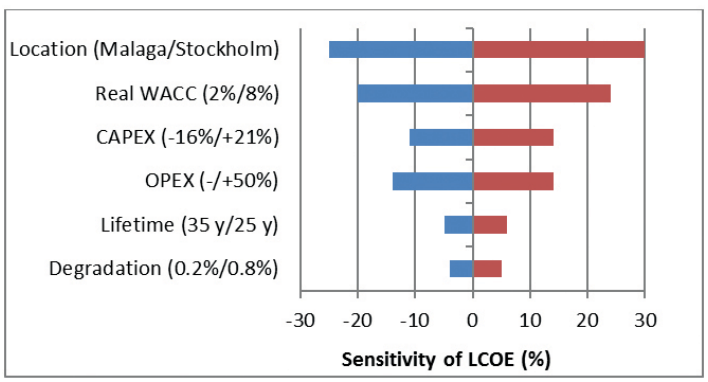

Figure 3. Sensitivity of PV LCOE in 2030 on location, real WACC, CAPEX, OPEX, system lifetime and degradation compared with a 1 MW ground-mounted system in Toulouse with 5% real WACC, base CAPEX and OPEX (see Fig. 2), 30 years lifetime and 0.5% annual degradation.