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Is the IEA still underestimating the potential of photovoltaics?

Photovoltaics (PV) has become the cheapest source of electricity in many countries. Is it likely that the impressive growth observed over the last decade – every two years, capacity roughly doubled – will be sustained, and is there a limit to the growth of PV? In a recently published article (Creutzig et al 2017), we tackle this question by first scrutinizing why past scenarios have consistently underestimated real-world PV deployment, analyzing future challenges to PV growth, and developing improved scenarios. We find that if stringent global climate policy is enacted and potential barriers to deployment are addressed, PV could cost-competitively supply 30-50% of global electricity by 2050.

A history of underestimation

Any energy researcher knows that projecting energy use and technology deployment is notoriously challenging, and the results are never right. Still, the consistent underestimation of PV deployment across the different publications by various research groups and NGOs is striking. As an example, real-world PV capacity in 2015 was a factor 10 higher than projected by the IEA just 9 years before (IEA, 2006).

A main reason for this underestimation is strong technological learning in combination with support policies. PV showed a remarkable learning curve over the last twenty years: On average, each doubling of cumulative PV capacity lead to a system price decrease of roughly 20%. With substantial support policies such as feed-in-tariffs in many countries including Germany, Spain and China, or tax credits in the USA, the learning curve was realized much faster than expected, which in turn triggered larger deployments. These factors together have led to an average annual global PV growth rate of 48% between 2006 and 2016.

Can continued fast growth of PV be taken as a given? We think not. Two potential barriers could hinder continued growth along the lines seen over the last decade, if they are not addressed properly: integration challenges, and the cost of financing.

Integration challenge: Many options exist

Output from PV plants is variable, and thus different from the dispatchable output from gas or coal power plants. However, power systems have always had to deal with variability, as electricity demand is highly variable. Thus, a certain amount of additional variability can be added to a power system without requiring huge changes, as examples like Denmark, Ireland, Spain, Lithuania or New Zealand show: In these countries wind and solar power generates more than 20% of total electricity, while maintaining a high quality of power supply (IEA, 2017).

Under certain conditions wind and solar can even increase system stability. In fact, the size of the integration challenge largely depends on how well the generation pattern from renewable plants matches the load curve. Accordingly, in regions with high use of air conditioning such as Spain or the Middle East, adding PV can benefit the grid: On sunny summer afternoons when electricity demand from air conditioning is high, electricity generation from PV is also high.

As the share of solar and wind increases beyond 20-30%, the challenges increase. Still, there are many options for addressing these challenges, including institutional options like grid code reforms or changes to power market designs in order to remove barriers that limit the provision of flexibility, as well as technical options like transmission grid expansion or deployment of short-term storage (IEA, 2014a). None of these options is a silver bullet, and each has a different relevance in different countries, but together they can enable high generation shares from photovoltaics and wind of 50% and beyond.

Financing costs: international cooperation needed

Many developing countries have a very good solar resource and would benefit strongly from using PV to produce the electricity needed for development. However, because of (perceived) political and exchange rate risks as well as uncertain financial and regulatory conditions, financing costs in most developing countries are above 10% p.a., sometimes even substantially higher.

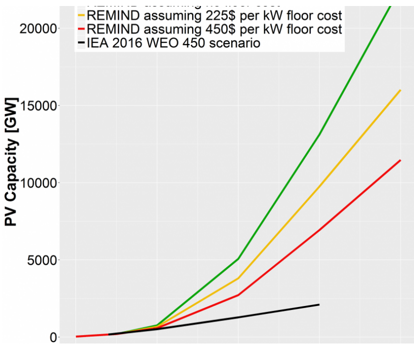
Why does this high financing cost matter for PV deployment? One of the main differences between a PV plant and a gas power plant is the ratio of up-front investment costs to costs incurred during the lifetime, such as fuel costs or operation and maintenance costs. For a gas power plant, the up-front investment makes up less than 15% of the total (undiscounted) cost, while for a PV plant, it represents more than 70%. Thus, high financing costs are a much stronger barrier for PV – the IEA calculated that even at only 9% interest rate, half of the money for PV electricity is going into interest payments (IEA, 2014b)!

Clearly, reducing the financing costs is a major lever to enable PV growth in developing countries. Financial guarantees from international organizations such as the Green Climate Fund, the World Bank or the Asian Infrastructure Investment bank could unlock huge amounts of private capital at substantially lower interest rates.

Such action could help to leapfrog the coal-intensive development path seen, e.g., in the EU, US, China or India. Replacing coal with PV would alleviate air pollution, which is a major concern in many countries today – in India alone, outdoor air pollution causes more than 600,000 premature deaths per year (IEA, 2016a).

Substantial future PV growth possible if policies are set right

How will future PV deployment unfold if measures to overcome the potential barriers integration and financing are implemented? To answer this question, we use the energy-economy-climate model REMIND and feed it with up-to-date information on technology costs, integration challenges and technology policies. The scenarios show that under a stringent climate policy in line with the 2°C target, PV will become the main pillar of electricity generation in many countries.



Energy-economy-climate model REMIND

We find a complete transformation of the power system: Depending on how long the technological learning curve observed over the past decades will continue in the future, the cost-competitive share of PV in 2050 global electricity production would be 30-50%! Our scenarios show that the IEA is still underestimating PV. The capacity we calculate for 2040 is a factor of 3-6 higher than the most optimistic scenario in the 2016 World Energy Outlook (IEA, 2016b).

We conclude that realizing such growth would require policy makers and business to overcome organizational and financial challenges, but would offer the most-affordable clean energy solution for many. As long as important actors underestimate the potential contribution of photovoltaics to climate change mitigation, investments will be misdirected and business opportunities missed. To achieve a stable power system with 20-30% solar electricity in 15 years, the right actions need to be initiated now.

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