Marginal Cost of the “Energiewende”: a proposal for a cost-efficient path towards the Energiewende based on a revision of the concept of *levelised cost of electricity* in the context of the transition of the German power system

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(1) Overview

The massive increase of the German Renewable Energy Law surcharge at the beginning of 2013 has started intensive discussion on the instrument for promoting renewable energy. In this context, at the end of January Federal Environment Minister Altmaier presented proposals for a so-called electricity price brake. The proposals focus on the one hand on a limitation in the increase in the surcharge in the future and on the other hand on a modified distribution of the resulting costs (EEG surcharge). Interestingly, focussing on a cost-efficient expansion of power generation from renewable energies is not addressed at all in the current debate. This paper addresses this issue and proposes a new methodology for identifying a cost-efficient path for expansion on the way to an energy transition.

(2) Methods

The focus is not placed on "theoretical" power generation costs of wind or photovoltaic systems as they are used regularly in the discussion (also frequently referred to as levelised cost of electricity). Rather, the approach is based on the total average costs of the directly usable quantity of electricity of the last installed plant (referred to as TAC-LP). The reason for using this perspective is the fact that as part of an energy transition, the high levels of capacity of wind power or photovoltaics increasingly leads to surpluses that cannot be directly used, thus generating higher costs. The methodological approach is shown in Figure 1.

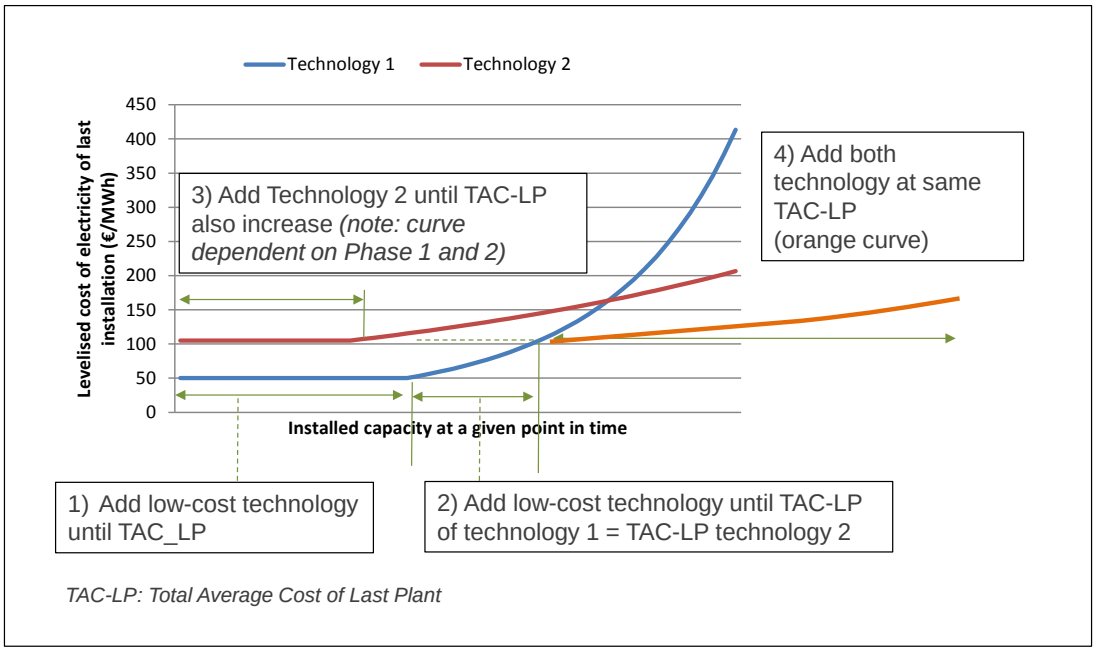

Fig. 1: Cost-efficient development path of two supply-dependent technologies with independent evaluation of the respective cost curves

At the same time, the paper evaluates for the first time the interaction of different supply-dependent technologies (wind power and PV) in the analysis of the electricity production costs: In systems with a high proportion of such technologies, construction of a new, additional system affects the costs of another further system of the other technology, as the respective residual-load curve changes, i.e. the remaining electricity demand. The analysis of electricity production costs in isolation from the corresponding electricity system thus leads to suboptimal results for the composition of the system of plants and the structure for power generation.

(3) Results

The new methodological approach is applied the Germany in a numerical analysis. For the load curve as well as for wind power and photovoltaics, the feed-in profile from 2011 is used. To calculate the residual load, the installed capacity of wind power and PV from 31.12.2012 was selected. The analysis is performed in accordance with an hourly resolution, i.e. 8760 hours per year to be considered. Biomass and hydropower as supply-independent technologies are not taken into account. Electricity storage was not investigated as well. It is assumed here that for the evaluation of the cost-efficient development path, storage is not relevant. Both technologies have as an output the same physical electricity, which would need to be stored. It is therefore assumed that the cost of storage is not dependent on whether the electricity comes from wind power or PV systems. Finally, network bottlenecks are neglected that actually exist today at the local level.

The numerical analysis for the energy revolution in Germany shows, for different cost scenarios, that for a cost-effective development path of renewable energy, the focus for the coming years should be placed solely on onshore wind energy (at least an additional 85 GW above the current level). Only after this additional capacity has been installed do windows open up for additional photovoltaic capacity, even when photovoltaic costs are assumed for today that are not expected until the year 2030. Depending on the annual expansion rate of onshore wind energy, there should be no further installation of photovoltaic systems for the next 20 to 30 years. Figure 2 provides an idea on underlying new developed cost curves.

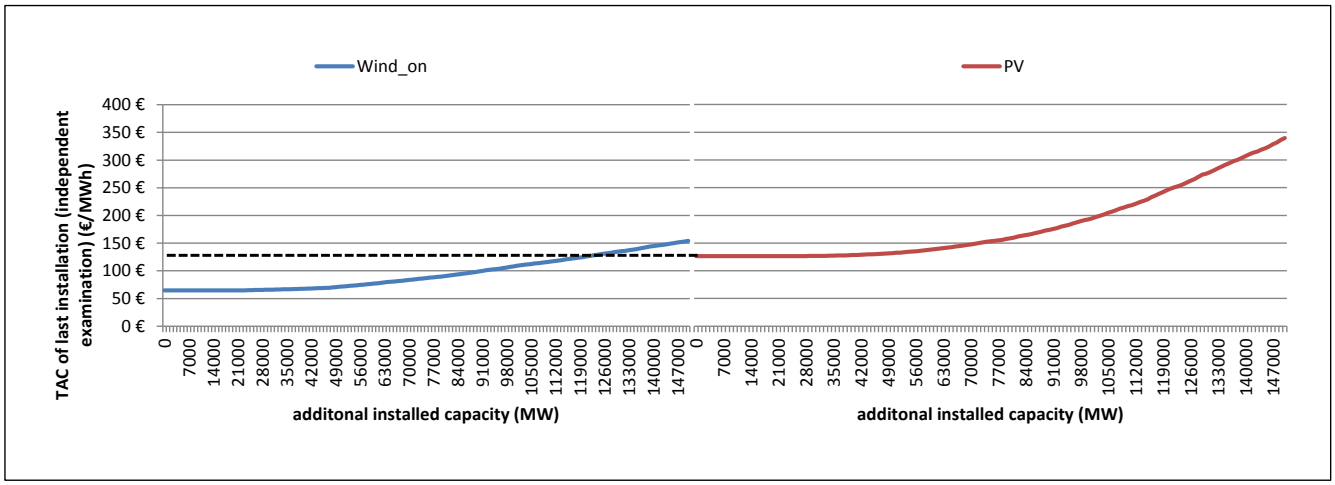

Fig. 2: Total average cost (TAC) of directly usable energy in the development of onshore wind power and PV in Germany with independent evaluation of both technologies (feed-in and load profile from 2011; installed wind and PV capacity as of 31.12.2012, Costs based on F-ISE, 2012)

(4) Conclusions

In the context of the transition of energy systems from fossil-fuel or nuclear based generation capacities towards high share of fluctuating renewable sources such as wind and photovoltaics the concept of levelised cost of electricity needs to be reconsidered: Increased energy surplus changes value and cost of power from the respective last installation. The value itself depends inter alia on the residual load curve which itself depends on the installed capacities.

A numerical analysis for Germany shows the focus for a cost efficient “Energiewende” should be on wind energy onshore for the next 20 years or so.

Reference

F-ISE (2012) Stromgestehungskosten Erneuerbare Energien, Fraunhofer ISE, Freiburg, Mai 2012.