Electricity by Intermittent Sources

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Introduction
In this paper we describe the major characteristics of an electricity supply system being predominantly composed of the scalable renewable energy (RE) forms wind and photovoltaic (PV) power. The analysis is mostly based on the actual data of 2013 from the German electricity system. The 2013 data will be scaled to larger shares of RES in the electricity production up to the 100% case where RES generate as much electricity as consumed during a year. The 100% case is then analysed according to the proper mix of wind and PV power, the extent of installed power, the remaining residual back-up power, the dynamics of the back-up system, the size of storage, the conditions for demand-side-management (DSM), the CO2-reduction in comparison to other supply forms and finally with regard to some cost issues. Similar results are presented for some European countries so that a rough picture emerges on the viability of RES in a European frame. Specifically, the necessary interconnection capacity is addressed.

Discussion
Electricity production from wind and solar radiation is easily possible in a society which agrees to the corresponding use of land, accepts the impact on its cultural landscape, and finances the necessary infrastructure. RES require, however, large power installations. The necessary investments can be reduced if the proper mix of wind and PV power is considered. Under peak conditions, this generating power is nearly capable of meeting the EU demand. For a total supply by intermittent sources, about 74% can be directly used; the rest is surplus which would be, in case of Germany, sufficient to supply Poland. A back-up system fills the low-power periods of RES. The power savings in this technology is about 12 %. Large storage capacity both in energy and power handling capability is necessary collecting surplus and replacing the back-up system of thermal power stations. The 100%-case operated completely CO2 free requires a storage, which seems to be beyond any chance of realization. A strong reduction of specific CO2 release for electricity production can be achieved by the application of RES. The technical effort is, however, tremendous if the release level of those countries should be met, whose electricity supply mix consists of nuclear and hydro power. The conditions for DSM are unfavourable. Owing to the PV contribution, surplus incurs during the day whereas the high-cost period can be expected for the night. The most consequent application of DSM is to expand the economic activities into the weekends. The replacement of the national RES supply field by a European one is beneficial because the requirements in back-up power, surplus handling and storage capacity drop notably. Specifically the intermittency of wind is smoothed in this case. The interconnection has to increase, however, much above the present realisations which might be a challenge specifically for those countries which are needed in an EU-wide supply system but do not much benefit from it.

Conclusions and/or Outlook
Because of their limitations and shortcomings, the most obvious question will be whether and how an electricity system based on variable sources can be improved or replaced. This will be a question classically posed to research and engineering because these disciplines have found the ways in the past to liberate mankind from the imponderabilities and perils of nature.

References:
[1] Wagner F.; Electricity by intermittent sources: An analysis based on the German situation 2012; Eur. Phys. J. Plus 129 (2014) 20.
[2] Wagner F.; Considerations for an EU-wide use of renewable energies for electricity generation; Eur. Phys. J. Plus 129 (2014) 219.