Generation expansion planning with high shares of variable renewable energies

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Abstract

Worldwide, the utilization of Renewable Energies (REs) for electricity generation is growing rapidly driven by the increasing fears of fossil fuels depletion, the price volatility of these
fuels and the necessity of reducing the Green House Gas (GHG) emissions to preserve the
environment. On the other hand, REs especially the Variable Renewable Energies (VREs) like wind
and solar power suffer from intermittency in its output generation. This intermittency can introduce
severe technical and economic problems for the power systems with high penetration from these
energies. This intermittency should be mitigated not only during the system operation phase but also
during power system planning phase. For this purpose, the classical power system planning
methodologies and models should be upgraded to account for this intermittency in a way to find the
optimum solutions to mitigate it. In this regard, this paper will focus on developing a new Generation
Expansion Planning (GEP) model to find the optimum mix of dispatchable generation technologies
that can allow the integration of VREs into the power system while mitigating the technical and
economic impacts of its intermittency. In addition, a number of new concepts related to generation
mix flexibility, VREs capacity credit and role of system operating reserve in integrating VREs will
be revisited. Then, the developed GEP model will be applied to a case study handling the future
expansion scenarios of VREs in the Egyptian grid. Results obtained show that, increasing the share
of VREs in the grid will shift the mix of new generation capacities from the least cost and low
flexibility options into more expensive and flexible generation options.

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