EFFECT OF DYNAMIC ELECTRICITY TRANSMISSION TARIFFS ON INVESTMENT ALLOCATION

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Introduction

Growing penetration of the renewable energy sources into the electricity supply causes changes in the operation of the electricity transmission grid. Solar and wind units affect seasonal and daily schedules of the electricity transmission. For this and other reasons several European countries have introduced transmission tariffs that have time differentiation. Power producers and consumers which have to pay for the transmission services are optimizing their profits considering such tariffs. As a result they may decide to invest more in energy storage systems and electricity generation units located closer to electricity consumers. Transmission grid owners may change plans of grid expansion. Among other effects such changes affect adequacy of electricity supply. In this paper we investigate how introduction of dynamic tariffs change investment distribution between generating capacity, energy storage systems and transmission grid expansion.

Method

In order to understand how introduction of dynamic tariffs influences investment choices of energy producers we have developed a bi-level model of the European electricity market. The lower sub-problem is a market clearance problem. It is a mixed-integer linear problem with an objective to maximize welfare function subject to power balance, capacity and ramp speed constraints. Reactive power flows and voltage constraints are ignored. Each European country is represented by a single node. Schedule of the energy storage systems and response of the flexible demand units are additional variables. For each country for every hour of a sample year nodal marginal prices and values of the international power flows are computed. Those values serve as an input for the upper sub-problem.

The upper sub-problem is a profit maximization problem. Each country is assumed to spend a fixed amount of money investing in power production capacity, energy storage and transmission infrastructure. Profits of the generating companies and transmission grid owners will depend on the values of the newly build capacities. Profits for each European country are maximized independently subject to the power balance, capacity and ramp speed constraints. We compare investment choices made when dynamic tariffs are present with the choices made in a situation with static tariffs only. Changes in transmission tariffs are thus linked with changes in investment allocation.

Results

The proposed algorithm proves that dynamic tariffs have an effect on the investment allocation. It provides numerical links between changes in transmission tariff policies and investment allocation.

Conclusion

Introduction of the dynamic electricity transmission tariffs changes investment decisions made by generating companies and transmission grid owners. Among other effects such changes may influence adequacy and security of power supply. This paper presents one algorithm how to numerically evaluate dependency of transmission tariffs on investment changes. Those algorithms have to be employed when transmission tariff policies are being developed.

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