Externalities in the game of generator rescheduling on electrical power transmission networks

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Abstract

An electrical transmission network consists of producers, consumers and the power lines connecting them. We build an ideal (lossless) DC load flow model as a game over a graph with the producers and consumers located at the nodes, each described by a maximum supply or desired demand, and the power lines represented by the edges, each with a given power transmission capacity and admittance value. Today we see transmission networks that are highly connected within and beyond borders. As a result a network will typically connect several groups of nodes (both producers and consumers) that are otherwise rather independent accounting units. While the connectivity of the network is an important safeguard against power shortages, contribute to a more efficient production of electricity, it also means that the flow of the current is not obvious immediately resulting in a complex system with widespread externalities. To model this, we study the problem of coalition formation over this network. The network is fixed, the coalition formation concerns the nodes only. We allow arbitrary coalitions – convexity is thus not a requirement, – but require the total inlet/outlet within a coalition to be in balance. For given coalition configuration, values of supply and demand and for the given characteristics of the network the optimal power flow is uniquely determined, maximizing the amount of the total energy transmitted by the network: This maximization of the total transmitted power with these constraints is formulated as a linear programming problem. If we assume that generators are interested in selling as much energy as possible, and consumers are interested in buying their ideal amount, the values of the characteristic function for a given configuration can be determined from the resulting nodal in and outlet flows. According to the physical properties of the network, the interactions between a

party of players usually affects third party coalitions, which may result both in negative (through increasing the overall load of the network), and positive (better utilization of available transmission lines in one coalition thus attenuating the network load on other lines) externalities.
Keywords: Cooperative Games, Energy transmission networks, Partition function form games, Externalities