Energy markets: optimization of transport infrastructure [*]

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Markets of natural gas, oil and electricity play an important role in economies of many countries. Every such market includes its own transmission system. Consumers and producers are located at different nodes, and transmission capacities of the lines between the local markets are limited. The share of transport costs in the final price of the resource is typically substancial, so the problem of transport systems optimization is of practical interest. Vasin, Dailova (2014) determine the optimal transmission capacity for a two-node market. The present study considers a general problem of social welfare optimization with account of production costs, consumers utilities and costs of trasmission capasities increments. The complexity of the problem concerns with substancial fixed costs related to expansions of transmitting lines. If the set of expanded lines were given, the problem would be convex and could be solved by standard methods. However, under a big number of lines the efficient search of the set requires special tools. In general the problem of transport system optimization is NP-hard (Guisewite, Pardalos,1990). Vasin,Dolmatova (2016) determine conditions for submodularity or supermodularity of the social welfare function on the set of transmitting lines for some types of networks. These properties provide a possibility to apply the known efficient optimization methods (see Khachaturov, 1989). However, they typically do not hold. We introduce more general concepts of competitive and supplementary transmitting lines which permit to develop similar methods for determination of the optimal set of expanded lines. For tree-type markets we establish conditions such that every pair of lines is either competitive or supplementary.