Inter-Sector Inter-Region Energy Model: Estimating Investment Projects in Energy Sector of Russian Economy

Topic:
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The paper discusses an approach to a long-term inter-sector and inter-regional analysis of interactions between a national economy and its energy production segment. It is based on an optimization multi-sector multi-regional model (OMMM) which includes a natural block of energy production, processing and transportation (OMMM-Energy) . At present, this version combines 45 products of different economic sectors including 8 ones of an energy sector (rough oil, gas and coal, two kinds of petroleum products, coal processing, electricity and heat), and 6 Russian macro-regions; it is a composition of two sub-models for 2 time periods: 2008-2020 and 2021-2030. Each of the sub-models treats time changes in simplified manner â€“ it means that all the variables are defined for the last year of the period and the variables of the basic year are fixed as exogenous ones.

The dynamics of investments into fixed capital is treated as non-linear functions being adapted with the help of linearization techniques.

A basic advantage of the OMMM-Energy is a combination of different approaches such as the input-output, inter-regional and energy balances. This allows evaluating the complex effects and efficiencies of the policy measures undertaken in the spheres of production, processing and consumption of energy. Previously, the model was applied to evaluating economic consequences of the:

â€¢ concentration of energy-intensive productions and gasification in the South Siberia regions;
â€¢ fast development of nuclear energy in the national economy;
â€¢ a reduction of energy intensity of production in the national economy;
â€¢ wide application of heat pumps technologies in the different regions of the national economy;

and many others but less significant issues.

The next section of the paper briefly describes a history of how the Soviet Union applied and later Russia continued to apply the input-output interregional analysis and OMMM, and what are their basic characteristics in comparison with IO, IRIO and MRIO approaches. The section 3 discusses both methodology and history of developing the original OMMM resulted in an OMMM-Energy version of the model. The sections 4-5 are devoted to setting and analyzing the problem of energy intensity in Russia and other world economies which we call â€œEnergy intensity puzzleâ€•. Section 6 presents some results of our analysis conducted by applying the model, and finally, the last section presents our conclusions.

The latest calculations carried out on the basis of OMMM-Energy were aimed at identifying permissible and economically justified cost limits of installed electricity generation facilities using renewable energy sources (RES). We made several variants of calculations for each of the region specified in OMMM-Energy to analyze how power generation from renewable sources (RES power generation) could impact on the national economy and regions of such power generation. The technique applied is â€“ the different technologies of RES power generation (RES technologies) were incorporated into the models; on the base of priori guesses, the upper bound of a presumable volume of power generated by untraditional capacities were set; investment intensities of power generation were set with their initial values referred to standard power generation technologies used by traditional thermal stations; and then investment intensities were step-by-step increased to the level when the RES technologies become uncompetitive to traditional ones and, therefore, unavailable in the solution of the problem. So, two ranges of costs per unit of generation capacity were obtained for each region. The first one is such that power generation from renewable sources

is obviously efficient and its application is limited only by technological and natural conditions. Another range is that one when RES technologies can compete with traditional ones and the choice of sources and RES technologies depends on the certain technological, natural, and economic conditions.

To summarize our RES generation efficiency analysis, we have found out that there are two levels of justified cost limits of installed electricity generation for the regions included in the model. The first one equals to USD 2100 per 1 kW, which equals to USD 2100 per 1 kW, which means that, given the estimated long-run average conditions, the production technologies of electric energy derived from RES requiring investment per 1 kW that are lower the specified level seem to be economically feasible and could dominate traditional generating technologies. Thus, their application is constrained rather by technical and natural conditions. The second level of cost limits equals to USD 3100 per 1 kW for European Russia and up to USD 3900 for Western Siberia.