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80% Reduction of Greenhouse Gas Emissions: Analysis of Czech Energy Industry Development Until 2050

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Summary

- The goal of European Union's Energy Roadmap 2050 is to reduce greenhouse gas emissions (GHG) by 80% compared with the baseline of 1990. The presented paper evaluates the implications of several pathways to reach this goal, and compares them to the existing State Energy Policy (MPO 2015b), which may lead to a reduction of greenhouse gas emissions by 66.5%.
- Using the TIMES energy partial equilibrium model, we analyse the reference scenario based in the existing State Energy Policy *(SEK)* and three alternative low-emission scenarios that will reach the 80% GHG emission reduction target by 2050, which follow three different pathways of the nuclear energy developments (*N35*, *N45* and *N-opt*). In all the scenarios, the resulting technology and fuel mix is a product of total production costs minimisation, with respect to the exogenous technological constraints. The cost minimization does not include any external costs of energy transformation, and, therefore, cannot be taken as social optimum considering all costs and benefits associated with energy transformation.
- The *SEK* reference scenario envisages a net electricity consumption growth up to 80 TWh by 2050. Due to a higher share of electric vehicles, the low-carbon scenarios operate with a net electricity consumption growth up to 83 TWh by 2050.
- The *N-opt* low-emission scenario leaves the choice of the technology mix exclusively on market mechanisms (with the goal to minimise production costs). The low-emission scenarios *N35* and *N45* envisage a political decision to build new nuclear reactors; they differ only in the projected lifespan of Dukovany nuclear power plant, and the commissioning date of the new nuclear reactors.
- The EU ETS system of emission allowances trading is not an effective instrument for achieving the 80% cut in greenhouse gas emissions; to achieve the target, emissions must be progressively reduced also in sectors not included in the EU ETS. The target of 80% also cannot be achieved without a significant reduction in the consumption of lignite.

- The trend in primary energy consumption is declining in all scenarios. In 2050, the *SEK* reference scenario operates with a 16% drop in primary energy consumption compared with 2020, down to 1,506 PJ*;* the low-emission scenarios project a drop of 24% in *N35* and *N45* and 34% in *N-opt*. Compared with *SEK,* the low-emission scenarios envisage a significant decline in the consumption of lignite, hard coal and liquefied fossil fuels; on the other hand, they project an upswing in the consumption of biomass, biogas and other renewable sources of energy, and a slight rise in the consumption of natural gas. In the *N-opt* scenario, the production gap left by the decommissioned Dukovany nuclear power plant is filled mainly with renewables and natural gas.
- The total average yearly annualized not-discounted (real) costs of whole energy system are projected to grow mainly driven by capital expenditure. In the *SEK* scenario, the total costs are envisaged to grow by 80%, from EUR 30 billion in 2020, to EUR 53 billion in 2050. The differences in the costs between individual scenarios are not significant until 2030. In 2035-2045, the cost differences in the scenarios are influenced mainly by the decision to build new nuclear capacity. In 2050, the total costs of the low-emission scenarios *N35* and *N45* are EUR 2.7 billion higher compared with the *SEK* scenario (counting in the cost of renewal of the vehicle fleet to electric vehicles). The *N-opt* scenario results in generally lower costs compared with *N35* and *N45*. *N-opt*, compared with *SEK,* predicts total costs which are EUR 2.2 billion higher in 2050.
- Discounted at the rate of 7.5% per annum, the present value of the total costs for the whole period 2020-2050 are EUR 508 billion in *SEK*. The total discounted costs in the low-emission scenarios *N35*, *N45* and *N-opt* are EUR 2.6, EUR 0.7 and EUR 0.6 billion higher, respectively, than *SEK,* which is only a marginal difference of 0.1-0.5% compared to the costs of the reference case.
- Reducing CO_2 emissions leads also to a reduction of other pollutants, which has a positive impact on the quality of air. The presented paper evaluates these ancillary effects of climate change mitigation policies. We focus mainly on the effects of SO2, NOx and particulate matter emissions which are the product of energy conversion. The application of ExternE methodology, specifically the impact pathway analysis, allows us to quantify the negative effects of air pollution on human health and on the environment, which emerge in the different policy scenarios we consider in our paper. The external costs are significant: EUR 31 billion for the whole period 2020-2050, which corresponds to approximately 17% of the GDP in 2015. The costs progressively decline over time, also in the reference scenario which describes the policy measures adopted in the State Energy Policy (MPO 2015b). In the *SEK* scenario, external costs attributable to air pollution go down from EUR 1,082 million in 2020 to EUR 659 million in 2050. All low-emission scenarios (operating with a reduction of 80% GHG) will help mitigate negative impacts on human health and on the environment, despite the fact that the scenarios envisage a higher volume of electricity generation, to satisfy the higher demand driven by e-mobility. The technology mix used to generate electricity will be a major factor influencing the degree of negative externalities. External costs of the scenario which does not operate with any development of the nuclear capacity (*N-opt*) are EUR 357 million lower for the whole period 2020-2050 compared with *SEK,* while the scenarios which calculate with new nuclear generation capacity (*N35* and *N45*) have even lower external costs – by EUR 1,449 million compared with *SEK*. This comparison does not account for the benefits of reducing external costs in transport by replacing fossil fuels with electricity for powering vehicles, and the external costs of the nuclear energy, which fall sharply, in particular in the *N-opt* scenario.