Costs of meeting international climate targets without nuclear power

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(1) Overview

For many countries, nuclear power has long been considered a key ingredient to meeting electricity demand and achieving greenhouse gas emission targets. According to Joskow and Parsons (2012) the main nuclear electricity producing countries, i.e. the USA, Japan and France, had already extended or were planning to extend the licenses and operating lives of most existing power plants prior to the Fukushima accident. New power plants were under construction in Finland and France, and planned in Japan, the UK, the USA, Russia, India, South Korea, Taiwan, Egypt, Israel, Saudi Arabia, or Turkey. China, in particular, had announced to increase its share of nuclear power to increase its share of nuclear power generation by 2020 from 1% to 6%.

Since the Fukushima Daiichi accident in March 2011, support for nuclear has declined in many countries. As an immediate reaction, several countries, including India, Pakistan, Russia, Spain, the USA and the EU, announced stress tests for existing nuclear power plants. Italy renounced a planned return to nuclear power via referendum, and China declared a memorandum for permits for new power plants. Arguably, the strongest initial reaction could be observed in Germany, Belgium and Switzerland, where governments decided to phase-out nuclear by 2022, 2025 and 2034, respectively (see also Skea et al. 2013).

In this paper, we assess the impact of a potential global nuclear phase-out on the costs of meeting international climate policy targets for 2020. Methodologically, our analyses rely on simulations with a global partial equilibrium model, which allows for a wide range of electricity generation technologies and for a differentiated assessment of impacts for numerous countries. Our simulations take into account that a phase-out of nuclear may alter countries' baseline emissions and restrict their options to mitigate GHG emissions. We also allow for the trading of emission certificates across countries to assess the impact of the phase-out of nuclear power on certificate prices, countries' revenues from certificate trading and on domestic mitigation efforts. Further, we analyse the outcomes of nuclear phase-out when trading of certificates is limited to countries that have committed to a second Kyoto period.

(2) Methods

For the baseline and policy simulations we employ POLES, which is a world simulation model for the energy sector. POLES is a techno-economic model with endogenous projection of energy prices, a complete accounting of demand and supply of energy carriers and associated technologies. The model includes, among others, 30 different power generation technologies for 57 different countries/regions, and accounts for CO2 and other GHG emissions. This high level of regional disaggregation allows to a very large extent for a country-specific modeling of technology availability.

POLES has been employed to generate a reference baseline and a nuclear phase-out baseline. Both baselines rely on the same macroeconomic assumptions. The reference baseline has been calibrated on the energy balances of the 'Current Policies" scenario in the World Energy Outlook 2010 (IEA 2010). In the nuclear phase-out baseline no new nuclear power capacities will be built, and existing nuclear capacities are progressively decommissioned over the next four decades. Although by 2050 not all nuclear power plants are phased-out, the production of electricity from nuclear power plants is reduced to about 1% (i.e. 500TWh) of global power generation, compared to 11% in the WEO reference baseline. In 2020, nuclear power accounts for 11% of global power generation in the WEO reference baseline, but only 8% in the nuclear phase-out baseline.

Our policy scenarios include GHG emission targets for Annex I and non-Annex I countries for 2020 that are deemed consistent with meeting the 2°C target. For these GHG emission targets, we consider two certificates trading scenarios. For the policy scenarios the aggregate emission target for Annex I countries for 2020 is taken from the proposal by the European Commission (2009), which assumes emission reductions of 30% below 1990 levels. While, in principle, there are many ways of splitting the target between Annex I countries, we chose the simplest type of burden-sharing rule: each Annex I country faces a uniform reduction rat of 30% below 1990 levels. For non-Annex I countries the targets are derived from their NAMAs submitted under the Copenhagen Accord/ Cancun Agreements, i.e. only non-Annex I countries which submitted a NAMA (NAMA-NAI) face emission targets in our policy analyses. In case of China and India, which provided CO2 emission intensity targets, the targets are calculated using emissions and real (2005) GDP based on market exchange rates. The efficiency targets pledged translate into emission reduction targets for 2020 that correspond to the baseline emissions. Our policy analyses distinguish between an all trade scenario and a KP2 trade scenario. In the all trade scenario, all Annex I countries are allowed to trade emission certificates among each other, i.e. they may exchange Assigned Amount Units (AAUs). In the KP2 trade scenario, only those Annex I countries are allowed to trade AAUs, which have committed to a second Kyoto period. Those countries are Australia, Belarus, Croatia, the EU, Iceland, Kazakhstan, Liechtenstein, Monaco, New Zealand, Norway, Switzerland and the Ukraine. In both trading scenarios non-Annex I countries may sell offsetting credits (CERs) to any Annex I country. The Annex I countries face a limit in the use of CERs to fulfil their reduction targets which is set to 20% of the emission reductions below baseline. Further, the Annex I countries allowed to trade in either scenario need to fulfil at least 50% of the required emission reductions below baseline domestically.

(3) Results

All trade scenario: Since trading between Annex I countries is not limited, they face equal marginal abatement costs of 61€/tCO_2 in the WEO reference baseline, unless their domestic quota is binding. The nuclear phase-out results in an increase in the price of AAUs of about 24% (76€/tCO_2). The increase reflects the (small) increase in required GHG emission reductions in the nuclear phase-out scenario compared to the reference scenario (baseline effect) and the fact that nuclear power plants are no longer available as a mitigation option (mitigation cost effect). Similarly, the price of CERs is about 19% higher in the nuclear phase-out scenario (30€/tCO_2) compared to the WEO scenario (26€/tCO_2). The vast majority of CERs are generated in China and India, reflecting both rather lenient emission targets and large potentials of low-cost mitigation options in these countries. An analysis of the emission reductions and pattern of compliance shows that for countries that employ nuclear power, the impact of the nuclear phase-out on the domestic compliance share is governed by two countervailing effects. First, the mitigation cost effect results in a lower domestic compliance share, ceteris paribus. Second, higher prices for AAUs render additional domestic mitigation options profitable, leading to a higher domestic compliance share, ceteris paribus. For countries that do not rely on nuclear power, only the second effect matters. As a consequence, for most countries the nuclear phase-out is associated with a higher domestic compliance share. As expected, the USA and the EU, where the uniform 30% reduction target implies the largest required emission reductions below baseline of all Annex I countries, also carry the highest compliance costs. The USA also faces the largest increase in absolute compliance costs due to the nuclear phase-out (+21 billion€). In comparison, Japan faces the highest relative increase in compliance costs (+58%). If measured as share of GDP compliance costs are quite modest, e.g. between 1.5% and 2% in Australia and Canada and 0.3% to 0.4% in the EU and Japan. A decomposition of the changes in compliance costs in baseline effect and mitigation cost effect illustrates that the effects of a nuclear phase-out differ across countries depending on the share of nuclear in the power mix and on the importance of nuclear compared to other domestic mitigation options (see Fig. 1).

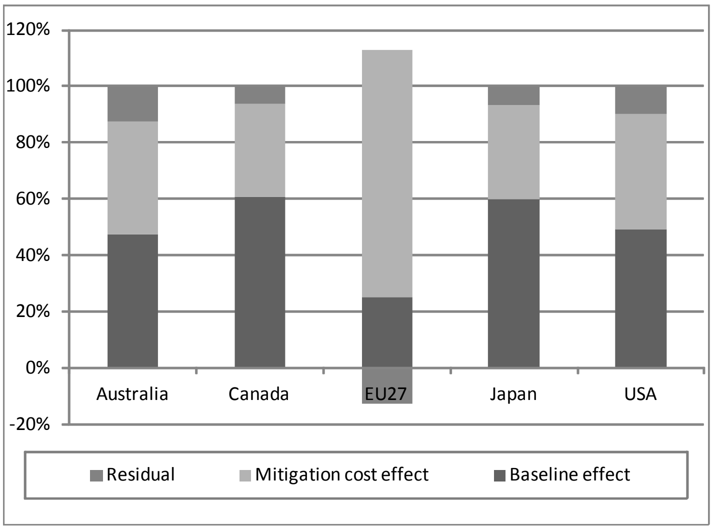

Fig. 1: Baseline effect and mitigation cost effect in 2020 (all trade scenario)

(4) Conclusions

In sum, our results on the costs of climate policy corroborate the thrust of the existing literature which typically finds the costs of complying with the 2°C target to be rather small. Our results further support those studies in the literature, which conclude that a slow deployment or a phase-out of nuclear energy only leads to a modest increase in global compliance costs, in particular, if trading of certificates is allowed.

References

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