Influence of Climate Policy and Market Forces on Coal-fired Power Plants: Evidence on the Dutch market over 2006-2014

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Executive summary

Many governments aim to reduce the dependence on coal-fired generation to decrease carbon emissions. Governments in large emitting regions such as the European Union, the United States and China have formulated targets to strongly reduce carbon emissions in the near future. In order to reach these ambitious targets, the portfolio of generation techniques within power markets needs to change. More specifically, governments are stimulating renewable energy, while discouraging the role of coal-fired power plants. At the same time, power markets have been created leaving the actual decisions concerning electricity production to power firms. Yet, the liberalization of energy markets implies that individual electricity producers themselves decide to what extent particular types of power plants are utilized. This firm-level decision-making process regarding the electricity portfolio on the one hand and the societal policy ambitions regarding the generation mix on the other, creates challenges for government policies.

This paper analyzes the tension between climate policy objectives and policies to foster competition in energy markets, specifically for the Dutch power market over 2006-2014. The Dutch market has faced many changes in the economic and policy environment over the past decade. It moved from a centralized system, with coordinated decisions on investments, dispatch and prices, to a market system at the end of 1990s. The Dutch government has implemented a number of climate policy measures to influence the decisions of energy producers and consumers, such as stringent regulations on air pollution, taxes on energy consumption, subsidies promoting renewable energy generation, and making the electricity industry subject to the EU Emission Trading System (ETS). In 2013, the Dutch government and a large number of societal stakeholders, including the electricity producers, concluded the so-called 'Energy Deal', which is an agreement to foster energy efficiency, renewable energy and emission reduction. In 2015, the Dutch government announced plans to close all coal-fired power plants by 2025.

Using a unique dataset containing hourly plant-level data on the Dutch electricity market, we examine whether these measures based on climate policy objectives have affected the utilization of coal-fired power plants over 2006-2014. First of all, we analyze aggregated numbers on the annual contribution of coal and gas-fired power plants to the Dutch market. Next, we analyze to what extent coal-fired power plants were dispatched compared to gas-fired power plants. We test whether a change in the supply of flexibility can be observed between coal and gas-fired power plants. We also examine a scenario in which coal-fired power plants are non-existent and how

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this absence of coal-fired power plants may influence the electricity price. Finally, we examine the role of CO_2 prices. We determine the break-even price of CO_2, which is the price of CO_2 where electricity producers are indifferent between dispatching a coal-fired or gas-fired plant.

We find that the decentralized decisions regarding the dispatch of power plants by electricity producers is strongly influenced by relative fuel prices of coal and gas, despite the existence of climate policies. However, despite its low levels in the past, the price of CO2 in the ETS exhibited a negative effect on the dispatch of coal-fired power plants and a positive effect on the dispatch of gas-fired power plants. Hence, the price of CO_2 triggers the substitution of coal-fired plants by gas-fired plants.

Contrary to what might be expected, we find that an increase in German renewable-electricity production raises production by the Dutch conventional power plants, in particular coal-fired plants. Hence, this shows a paradox in which more renewable-energy production in one country stimulates fossil-fuel production in a neighboring country, although both countries are closely connected. This finding is related to the impact of renewables on uncontrolled loop flows.

Moreover, in spite of the implementation of a number of climate-policy measures meant to foster the transition of the energy system, coal-fired power plants have become more important in the Dutch market since 2006. The increase in their contribution to total production could be expected given the changes in the relative fuel prices, but coal-fired power plants also became more important for providing flexibility. Although gas-fired plants are technically better equipped to offer flexibility, it is important to acknowledge that coal-fired plants increasingly appear to be able to supply this service to the market.

A measure to reduce the share of coal-fired generation which is currently considered in a number of countries is to force power firms to close these plants. This is at odds with decentralized decision-making in the power industry. Given the current constraints on cross-border capacity, such an intervention in the power market likely results in considerably higher prices for consumers as well as costs for societies compared to a market-based intervention directed at changing the incentives for power producers.

We learn that an increase in CO_2 price levels gives an incentive to electricity producers to use gas-fired power plants instead of coal-fired plants. Looking at the short-term dispatch decisions as well as the realized volatility in relative fuel prices since 2006, we conclude that in each year a CO2 price of 40 euro/ton would have been sufficient to provide incentives for power producers to dispatch a gas plant instead of a coal plant. This price is the top of the range of realized break-even values of the CO_2 price, which is between 7-43 euro/ton over the period since 2006. Hence, internalizing the external (CO_2) costs by raising the CO_2 price is the appropriate measure to align the principles of a market-based power industry and the wish to implement effective climate-policy measures at relatively low costs.

Another issue is how to realize such an increase in the price of CO_2. Reducing the cap in the ETS on top of the already implemented annual reduction would be the most straightforward measure, although this depends on a delicate political process in the European Union. A national price floor in the scheme does have an effect on the domestic level of emissions, but unfortunately not on the

European level emissions. Hence, looking for European answers to the need to further reduce the cap within the Emissions Trading Scheme remains required.

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