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CLIMATE CHALLENGES FOR EUROPEAN CRITICAL INFRASTRUCTURE PROTECTION: NUCLEAR POWER AND WATER SUPPLY

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OVERVIEW

During the heat waves in 2003 and 2006 nuclear power plants in several European countries had to reduce or shut down production due to reduced access to cooling water, regulation on maximum temperature of the return water and other limitations in the cooling system. Such nuclear power supply disruptions may have a significant impact on the energy supply security in Europe as nuclear power accounts for 28% of total power supply[1], each nuclear reactor accounts for a considerable amount of power and nuclear reactors are typically located in the same geographical area with access to the same source of cooling water.

One way of addressing this risk of energy supply disruptions is through the application of supranational legislation and action plans, like what is being developed in the European Programme for Critical Infrastructure Protection (EPCIP) and the corresponding legislation. In the 2005 Green Paper on the EPCIP [1], the need to help reducing threats directed towards critical infrastructures like for example energy and water supply was acknowledged. Such threats may come from terrorism, natural disasters and accidents.

In this paper we build a case for including climate-induced disruptions of electricity supply in the EPCIP and suggest how EPCIP should be amended to better cope with such threats.

METHODS

First, we use historical data and climate model projections to build a strong case for policy coordination across Member States. We use a GIS map to illustrate how the summer temperature will change in important nuclear power locations from the reference period 1950-2000 to 2050[2]. A similar illustration is made with respect to the frequency of heat-waves now and in the future.

Second, we use the simulation model KASIM developed by Forschungszentrum Jülich [2] to demonstrate the interdependencies between water supply and electricity supply, and argue that there is a need for policy coordination across such subsectors in EPCIP.

Third, we develop indicators as to how heat waves impact on power production as a mean for guiding policy decisions within the EPCIP framework. Based upon detailed nuclear production data for all European countries from the Power Reactor Information System (PRIS) database, we estimate a logistic regression model where production loss due to environmental causes outside the plant's control is regressed on temperature as well as other relevant variables.

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[11] EU 27. Source: EU Energy in figures 2010.

[2] The data is provided by http://www.worldclim.org/. The temperature data are Tmax-values for August, A2A scenario, calculated by CCCMA (IPPC, 3rd Assessment report).

RESULTS

During a few summer months in 2003, production were reduced at 17 nuclear power plants in Germany, Spain, France, Finland, Romania, Slovenia and the Czech Republic. Further 9 nuclear power plants had cooling problems, but got exemptions from legal requirements. Significant changes in trade patterns between France and the rest of EU also helped alleviate the situation. In the future, the heat wave in 2003 will become more or less the rule.

Simulations on the KASIM model is used to analyse the relation between temperatures, access to water and nuclear power production. We estimate how the production of nuclear power may be reduced for a given increase in ambient temperature or a given reduction in water intake. These simulations are done for a nuclear power plant with a design capacity of 1250 MW and for two different cooling technologies; a closed circuit cooling system and a once- through cooling system. Here we also discuss how a change in cooling technologies and capacities may help overcome the climate challenge.

The estimated regression models are used to predict how the probability of production loss due to environmental causes increases with outdoor temperature. By including cooling technology and plant size as explanatory variables, we show how the vulnerability for temperature may be reduced by switching from a once-through to a closed circuit cooling system.

CONCLUSIONS

Our paper build a case for incorporating climate-induced disruptions of nuclear power supply into the EPCIP program and suggests amendments in this framework like focusing on cross-sector issues and developing impact indicators. Furthermore, the EPCIP program is focused on how to protect the infrastructures against threats, ignoring the equally important issue of resilience [1]. That is in addition to discuss how countries can *avoid* these impacts by choosing better locations to build new thermal plants, investing in more cooling capacity, or investing in different cooling technologies, policy makers should also discuss how countries can *adapt* to these impacts by investing in more spare production capacity and/or more network capacity?

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