European Commission

# Climate change and electricity production

**PESETA IV assessed the impacts of climate change on electricity production by hydropower, wind, solar, nuclear and other thermal power plants. The effects of climate change were assessed on the power system of nowadays ("static" scenario) and the power system of 2050 in line with 2°C mitigation efforts ("dynamic" scenario). In northern Europe, substitution effects from increasing availability of cheaper hydropower, could result in lower production costs, while in southern Europe production costs could increase due to reduced water availability. Climate change impacts on energy in the rest of the world show a negligible spill-over effect on Europe. Improved cooling technologies have the potential to strongly reduce the negative effects of water scarcity on electricity production, particularly for nuclear plants in southern Europe.**

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## EU+UK level production

As wind and solar are not strongly impacted directly by climate change, the expected impacts on power production from these two sources is relatively limited (Figure 1). However, there is a large increase in hydropower production at the EU+UK level. On the contrary, nuclear power reduces significantly.

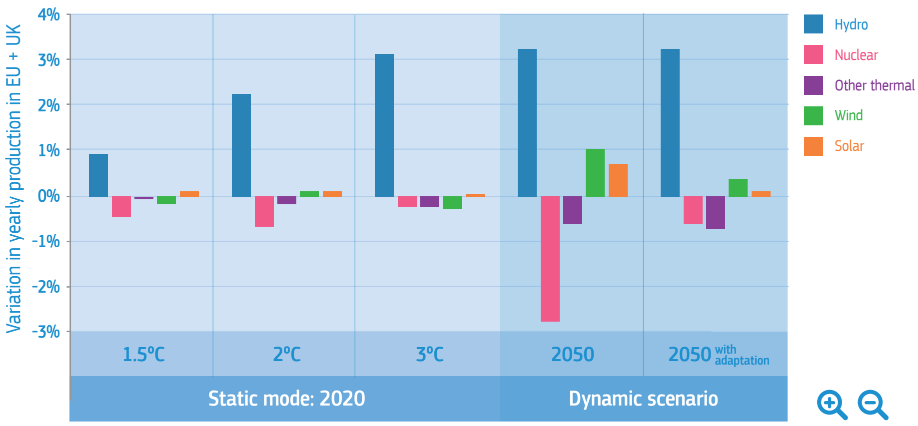


Figure 1. Climate change impacts on electricity production in EU+UK (ensemble median), for 1.5, 2 and 3°C global warming imposed on today's power system (static scenario), and impacts of 2°C warming on the 2050 power system (dynamic scenario) with and without adaptation of water cooling. Note: "other thermal" designates biomass, coal, gas and oil plants.

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**KEY MESSAGES**

## Regional differences in production

In northern EU, increasing water availability leads to more power production by hydro and less by other thermal sources. In southern EU, reduced water availability leads to less hydro and nuclear power production.

## Production costs

Electricity production costs are pushed up in southern EU and down in northern EU.

## Minor impacts on solar and wind

For the EU+UK as a whole, wind and solar are not significantly impacted by climate change.

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## About PESETA IV

The JRC PESETA IV project aims to better understand the biophysical and economic consequences of climate change. It does this by using projections of climate change for Europe from several climate models along with a set of climate change impact models. The project covers several sectors that are relevant to society and the natural environment, such as freshwater, agriculture, and coasts.

**ec.europa.eu/jrc/en/peseta-iv**

*Joint Research Centre*

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## Regional differences in production

Climate change results in contrasting patterns of electricity production between northern and southern Europe.

The overall increase in hydropower across the EU+UK is dominated by increasing water availability in northern Europe, where there is a high installed capacity for hydropower. Since hydropower has a lower marginal cost, it undercuts the demand for power from other energy sources in this region. In the static scenario, hydropower mainly substitutes for biomass in Sweden, coal in Finland, oil in Lithuania and gas in Latvia. This leads to annual economic benefits in northern Europe of around 1.3 €billion (2015 values) with 3°C warming.

In southern Europe, however, a projected reduction in water availability negatively affects hydropower and nuclear production, especially in summer. Thermal plants act as a substitute for hydropower and nuclear in the Iberian Peninsula. Here, in order to ensure demand in periods of reduced hydro and nuclear power, the thermal power capacities in reserve have to increase production. This is more expensive than hydro and nuclear power generation, which means that production costs in southern Europe increase by around 0.9 €billion per year (2015 values) with 3°C warming (static scenario). In the dynamic scenario, this effect is less because of the increased development of wind and solar that contribute to filling the gap left by hydropower and nuclear.

The contrast in projected production costs between northern and southern Europe due to changes in water resources and hydropower production could be balanced by expanding inter-regional electricity interconnections.

## Adaptation

In the dynamic scenario with adaptation (Figure 1), the energy mix in 2050, which is in line with 2°C climate mitigation, will adapt and develop in response to the impacts of climate change. Nuclear production is particularly reactive and climate change impacts could be almost completely avoided with a switch to less water-intensive cooling technologies (a reduction of -0.6% compared to -2.8%, see Figure 1), especially in southern parts of Europe. Other thermal plants do not show a similar benefit of these adaptation measures, either because they do not operate at full capacity or because they are already using efficient cooling technologies.

## Spill-over effects

The main impact of climate change on electricity production at the global level is a decrease in fuel consumption and fuel prices because of lower heating demand in buildings. Lower fuel prices could potentially create a slight increase in demand in Europe, which would be covered by reserve capacities of thermal plants as well as some decentralised solar capacities. The spill-over effects from the rest of the world (in the “static” scenario) appear negligible for all sources of electricity production considered by PESETA IV, at less than 0.1%.

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### Approach

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PESETA IV used the energy model POLES (Prospective Outlook on Long-term Energy Systems) in combination with climate projections and hydrological simulations (which were also used to assess water resources, droughts and river floods in PESETA IV). Changes in water resources were used to assess hydropower production and cooling for nuclear and other thermal plants, changes in wind for wind energy, and changes in temperature for the efficiency of solar panels.

Two main scenarios were considered. Firstly, the impacts of 1.5, 2 and 3°C global warming on the 2020 power system (“static” scenario) were assessed, assuming no adaptation. The spill-over effects on the EU+UK caused by climate change impacts on energy production in the rest of the world were also assessed in this scenario.

The energy model was also run as a “dynamic” scenario until 2050, corresponding to 2°C compatible mitigation efforts and a changing technical and socioeconomic context according to the ECFIN Ageing Report. Adaptation was also explored in this dynamic setting by assessing the potential of open recirculating cooling (evaporating towers) and dry cooling.

The assessment did not incorporate the effects of climate extremes. Increasing drought conditions with global warming in southern and western regions of Europe will result in growing economic losses in the energy sector, while increased river and coastal flooding could result in higher direct damage to energy infrastructures in flood prone areas.

**For all PESETA IV publications - https://ec.europa.eu/jrc/en/peseta-iv**