

The impacts of climate change on the energy systems with the POLES model

**Silvana Mima
GAEL-CNRS**

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1. Background
 2. Modelling the impacts under future climate change on the energy systems
 1. Impact of climate change on the power generation :
 1. Hydropower generation
 2. PV
 3. Wind (onshore, offshore)
 4. Efficiency in thermal power production (fossil or nuclear plants)
 2. Impacts of CC on heating and cooling energy demand in the residential and service sector
 3. Need for data processing
 4. Conclusions

Background

1. Climate cost project (2011)
2. Peseta (2013-2014)



Mima S, Criqui P. The Costs of Climate Change for the European Energy System, an Assessment with the POLES Model, *Environmental modeling and assessment*, (2015). vol. 20, n° 4, pp. 303-319

Ciscar J-C , Dowling P., Integrated assessment of climate impacts and adaptation in the energy sector (2014) *Energy Economics*

Dowling P. "The impact of climate change on the European energy system" *Energy Policy* (2013) 406-417)

Impact of climate change on hydroelectricity production

Currently we rely on information about hydro power potential available in the literature and the changes in the run offs provided by East Anglia.

Two modifications of the POLES model must be underlined:

1. climate change impacts on available capacity factor for existing hydropower capacities which permits to calculate the impact in terms of hydro generation and
2. changes of the hydropower technical potentials on the construction of the new capacities.

We use the study realized by Lehner et al. (2005) with estimates of the impact of climate change on hydro power potential for Europe at a country level. Authors calculate the influence of climate change on the gross hydropower potential as well as its impact on the already developed hydropower capacity

Potential impacts of the CC on efficiency of wind power plants

Wind power load factor = Wind power load factor wo cc x (average wind speed current year / average wind speed 2015)

Potential impacts of the CC on efficiency of PV power plants

Electrical efficiency = Electrical efficiency at normal cell temperature x (1 - 0.0045 (temp - 25°C))

Electrical efficiency w cc = PV efficiency wo cc x (1 - 0.0045 x (DD current year - DD 2015) / 365).

Potential impacts of the CC on thermal power production (fossil / nuclear plants)

Analyses of changes in water regimes are also relevant for the identification of the potential impacts on thermal power production, either by fossil or nuclear fuels

These impacts encompass limitations of production during extreme weather events and changes in the cooling technologies, with corresponding extra initial investment

Technological change and cooling choices - economic, environmental and performance tradeoffs:

1. Other new technologies (humid or dry air cooling for instance) ?
2. Moving the power plants to the coasts to use sea water ?

Impacts of CC on heating and cooling demand in the residential and service sector

Based on estimates from literature (Isaac and vanVuuren, 2008), the final consumption for substitutable energy in the residential sector is split into two parts:

1. the demand that is affected by climate change (thermal comfort, heating and cooling) and
2. demand that is not (hot water, cooking)

The climate change impacts on heating demand in the Residential and Service sector is then based on heating degree days (**HDD**) provided by East Anglia for contrasted CC scenarios (A1B and E1 sc)

Impacts of CC on cooling demand in the residential and service sector

The method proposed to model the impact of climate change on residential cooling demand is based on the paper of McNeil and Letschert.

The air-conditioning equipment rate is the multiplication of the air-conditioning energy consumption by dwelling with air-conditioning availability taking into account a saturation rate:

1. Residential Air Conditioning Availability depends on revenues, following a logistic S-curve
2. The air-conditioning energy consumption by dwelling depends on the cooling degree days, but also strongly on income (equation derived from Isaac, Van Vuuren, and from McNeil)

Need for data processing

1. Socio-economic assumptions for 9 experiments : pop, gdp or more???
2. Climate assumptions : emission profiles???
3. Climate data by POLES regions

Conclusions

Many uncertainties remain including the potential for extreme events that may threaten energy supply. This calls for further research for making the results robust and useable for policy makers

It is necessary to keep in mind too, the limits of a sectoral modeling approach. This may call for a future connection with other hydrological models, biomass

The key area considered for adaptation is for cooling demand. A wide range of options that could reduce future cooling demand in Europe have been examined including policies to influence demand, or improve the efficiency or uptake of technology.

However, a key factor in adaptation is the uncertainty involved. Buildings have long life-times and will be affected by climate change in the future.