Future residential electricity consumption under climate change in France: application of a fine-granularity thermosensitivity model.

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Objective & Background

The residential sector is the leading electricity consumer in France, representing more than one-third of the final electricity uses. As a major contributor to the energy demand, this sector must implement a pathway to reduce energy demand and greenhouse gas emissions. However, the relevance of related policies may depend on the correct estimation of the evolution of future Residential Electricity Consumption (REC) under future climate. Future REC has already been studied at the national scale. However, since the important determinants of the future REC, such as evolution in the use of AC and the meteorological conditions, especially the temperature, have a large geographical variability, REC should be studied locally.

Method

To project the French REC in a warmer climate at a fine spatial scale, a linear thermosensitivity model fitted by annual observed electricity consumption data and historical temperature is applied at the smallest French geographic census unit named Ilots Regreoupés pour l'Information Statistical (IRIS), which divides the territory into meshes of about 2000 inhabitants per unit cell. Once the current electricity sensitivity is fitted for each IRIS, the future REC is computed by applying the model to temperature projections under climate change scenario RCP8.5 up until 2100 based on 5 CORDEX climate simulations. At the same time, extreme cases of two non-climatic factors related to the use of Air-Conditioning (AC, the AC adoption rate and electricity sensitivity in cooling conditions) are also studied for future cooling needs.

Principal Findings

If only the temperature evolves, the results show that the future REC should decline with decreasing heating needs in most cells but with spatial variability and an increase in the REC for some cells. Results also show a larger disparity within administrative regions containing between a few hundred and a few thousand IRIS than between administrative regions, which justifies that future REC studies based on climate projections should be studied locally. Including AC scenarios may modify the REC negative trend in more parts of France: the REC is expected to increase in the South-East. Such an increase in electricity demand due to AC usage may have detrimental effects, not only because the total REC may increase by 4\% by 2040 and even 45\% until 2100 under the most extreme AC scenario and should thus emit more greenhouse gas, but also because the use of AC is expected to increase outdoor temperature and the heat island effect.

Conclusion & Discussion

Further studies need to focus on alternative solutions to improve inhabitants' comfort during heat waves, such as large-scale urban greening and white-coated buildings, to reduce potential AC uses, especially for the regions that may face an increase in REC. Also, the thermal performance of the building, as well as the energy efficiency of AC appliances, need to be improved in those regions. Our study can help quantify the range of improvement needed to maintain at least energy demand for cooling unchanged in a warmer climate.