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Implications of extreme temperatures and socio-economic development on power markets' peak demand across the world

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Relevance: Extreme temperature events, both heatwaves and cold spells, can put pressure on power systems' reliability by pushing power demand to record highs. Within the literature assessing the impacts of climate change on the energy sector, gathering new evidence on the drivers of peak load is a pressing issue for multiple reasons. First, peaks in power load must be accommodated by exceptional ramp-up requirements of power generating units, so that in the future adapting to climate change may involve the construction of plentiful under-utilized peak generation plants, putting pressures on the decarbonization goals and increasing stranded assets risks. Furthermore, peak load shocks induced by extreme temperatures can coincide with reduced transmission and distribution capacity, further challenging the operation of electricity grids [1].

Both the empirical and modeling literature assessing the impacts of climate change on the energy sector have generally focused on aggregated electricity demand rather than on its peaks. Few available empirical studies investigate how extreme events can affect peak demand focus on industrialized countries and estimate reduced-form models, that hold adaptation, economic growth, technology, and current infrastructure constant [2,3]. Our paper aims to fill this gap by identifying if and how climatic and socio-economic drivers can affect the magnitude of the peak load response to extreme weather events.

Methods: We assess these interrelated dynamics by exploiting high-frequency power demand data collected from load balancing authorities. Specifically, we assemble a novel dataset spanning for the last two decades across more than 100 power markets, comprising both countries (European Member States, Asian and African countries) and large sub-national regions (power markets in Japan, Australia and Russia and Federal States or Provinces in the US, Canada, Brazil and India). The dataset includes: i) daily peak and total load; ii) daily population-weighted exposure to weather from 3 hourly near surface temperature data at 0.25 degrees gridded resolution; iii) quarterly and yearly regional statistics and indicators on demography, economy, education and innovation. We investigate how daily peak load responds to extreme temperatures by adopting a suite of time-series and panel econometric methods that fully exploit the high-frequency and sub-national disaggregation of our dataset.

Results: Utilizing the innovative methodological framework proposed, we: i) identify how peak load responds to temperature extremes in different regions; ii) test if and how such response can be modulated by regional climatic and socio-economic characteristics; iii) derive cost implications

due to the amplification of peak demand deriving from future increases in the intensity and frequency of extreme events.

References:

[1] Yalew, S. G., van Vliet, M. T., Gernaat, D. E., Ludwig, F., Miara, A., Park, C., ... & Van Vuuren, D. P. (2020). Nature Energy, 5(10), 794-802.

[2] Auffhammer, M., Baylis, P., & Hausman, C. H. (2017). PNAS, 114(8), 1886-1891.

[3] Wenz, L., Levermann, A., & Auffhammer, M. (2017). PNAS, 114(38), E7910-E7918.