The Heating and Cooling Gap in Southern European cities: A Challenge for Climate Mitigation

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Questions

- What is the energy performance gap for space heating and cooling in Portuguese dwellings, at very high spatial scale?
- How do climatization patterns affect the gap?
- What is the impact of bridging the energy gap on CO₂ emissions?

Context

- People spend about 90% of their time inside buildings, mostly in their own homes.
- In European Union, low income households, poor building construction and high energy costs: 50 to 125 million people are not able to ensure indoor thermal comfort (heating & cooling, H&C) in their households (2).
- Heatwaves put in risk populations' health (3,4,5), and require increasing energy need for cooling. Future climate change scenarios carry an increase in the number and intensity of heat waves for this region (5,6).
- Portugal is a good case study:
  - Located at Southern Europe, targeted as one of the most likely climate impacted regions (7).
  - Ageing building stock with low energy performance, decentralized low efficiency climatization systems and low rates of climatization systems, mainly cooling
  - High levels of energy poverty (8,9): 24% of the population are unable to keep their homes warm during winter, whilst during summer, 36% cannot keep their homes cool (10).

Methodology

Energy performance gap acts as a proxy for thermal comfort and energy efficiency assessment.

- Step 1 – Nominal final energy needs for space H&C estimated from 191 different building typologies (e.g. buildings' area, walls type, bearing structure). Geographical explicitness: 18 different climatic regions, and all 3092 Portuguese civil parishes (administrative territorial units smaller than a city).
- Step 2 – Real energy consumption for H&C estimated from climatization systems ownership data, municipal statistics on energy consumption and data from energy matrices per type of end use for different Portuguese geographic regions.
- Step 3 – Energy performance gap (%) estimated from the difference between Nominal and Real final energy consumption. Alternative Conservative case assessed, assuming more realistic regional average cooled/heated areas and climatization equipment operating hours.
- Step 4 – CO₂ emissions related to energy consumption increase for bridging the performance gap are computed for both cases and compared to current energy consumption associated emissions.

Results

Real case: 600 kWh per capita; Nominal case: 7415 kWh per capita; Conservative case: 1373 kWh per capita

Heating Gap: Nominal case [24/h day & 100% area]
- 20% of spatial units with no gap.
- Average national heating gap reduced from 99% to 52%.

Heating Gap: Conservative case [11/h day & 50% area]
- No cooling gaps are offset.
- Average national cooling gap reduced from 97% to 76%.

Cooling Gap: Nominal case [24/h day & 100% area]

CO₂ Emissions from H&C – comparison between Cases

Discussion and Conclusions

- Energy performance gap results from behavioral climatization patterns, occupants’ habits and schedules, without jeopardizing indoor thermal comfort, and also from energy poverty levels of population groups.
- The potential increase of energy consumption (and emissions) for adequate indoor thermal comfort, red flags a problem for climate mitigation goals.
- Energy efficiency increase in both buildings and equipment and the increased use of passive measures (shading and insulation) for southern European countries are key to reduce energy needs.
- Thermal comfort requires investment in local renewable energy sources to prevent impacts on CO₂ emissions.
- Results combined with socio economic data of the building occupants can be further developed to track vulnerable consumers and to support national and local energy efficiency policies and instruments.

References: