Simulation of the energy demand for a social house in Argentina: Sensitivity to interventions and climate change

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MOTIVATION

As one-third of the energy demand in Argentina corresponds to the residential sector, there is an urgent need to improve the energy efficiency of buildings

- *Energy consume is strongly dependent on the house design and the climatic conditions of the place where the house is located*
- *In central-east Argentina, where mean temperature is expected to keep rising and warm spells to be more frequent, longer and severe [1], climate conditions may cause overheating of buildings, discomfort and sanitary problems*
- *Santa Fe province (Argentina) has an advanced project to classify buildings according to their energy performance. Nevertheless, impact studies are incipient [2], and the sensitivity of energy requirements to climate change is an unaddressed topic*

Our aim is to analyze the behavior of a social dwelling in Rosario (Santa Fe, Argentina), to define design improvements, and estimate projected changes in the energy demand for climatization

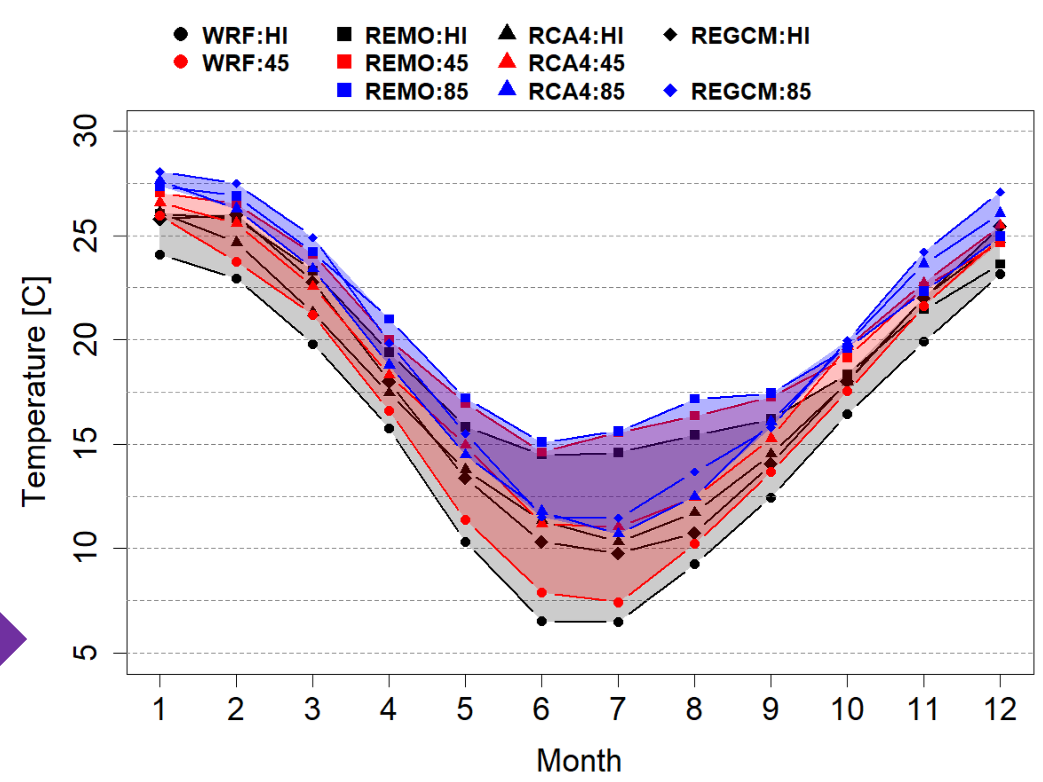
DATA AND METHODOLOGY

Energy simulations were performed using Energy Plus (E+) model [3] forced by:

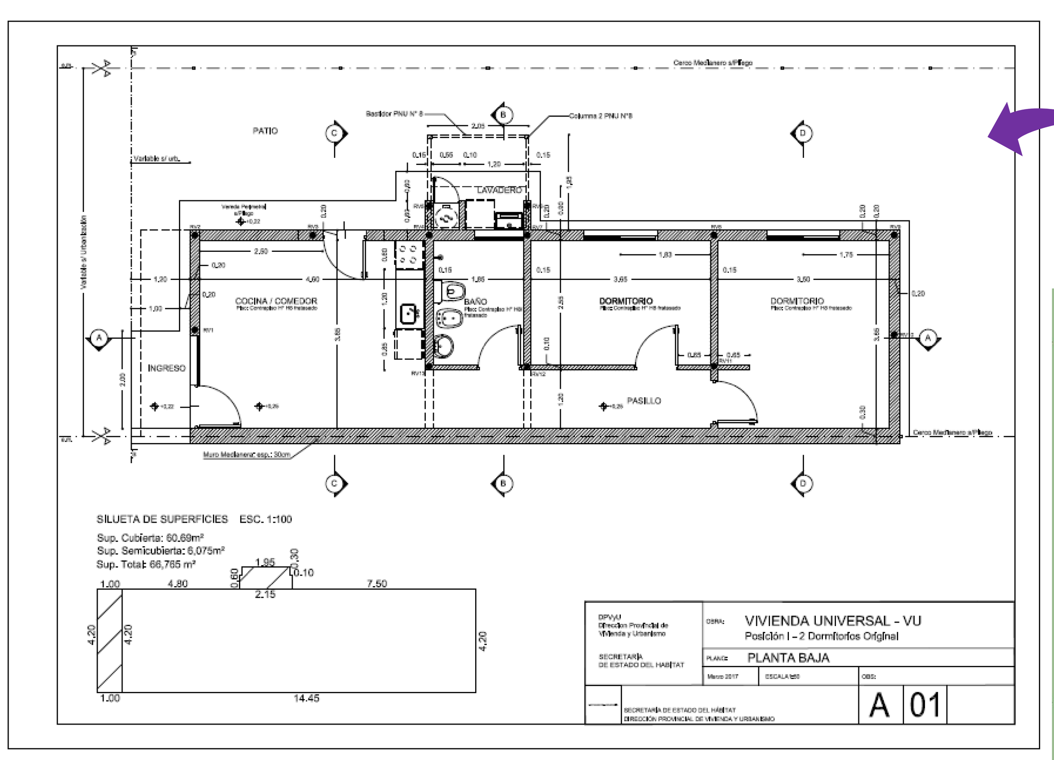
- the building design and the physical properties of its materials (e.g., conductivity, density)
- a full-year climate file of hourly data of several climatic variables (e.g., dry-bulb temperature, specific humidity, wind, short wave radiation)

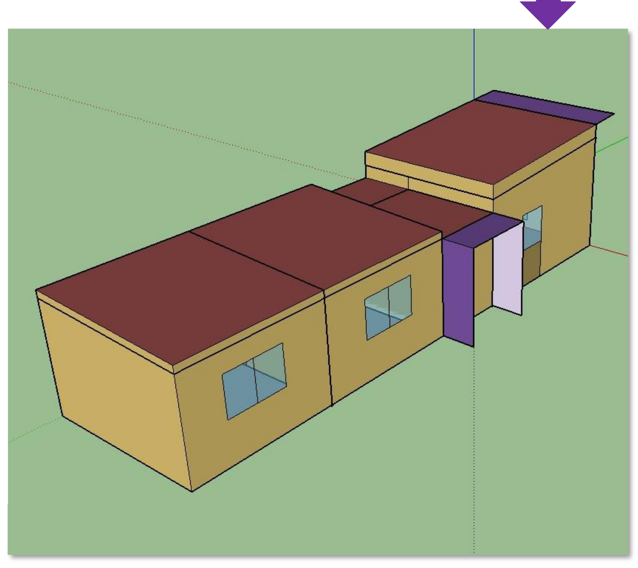
Outputs of 4-CORDEX's RCMs [4] were adapted to force E+ with present and projected climate conditions for Rosario,

- present climate (1985-2005)
- future climate (2045-2065), scenarios RCP4.5 & RCP8.5



The spread of the annual cycle of mean surface temperature as spanned by models and scenarios





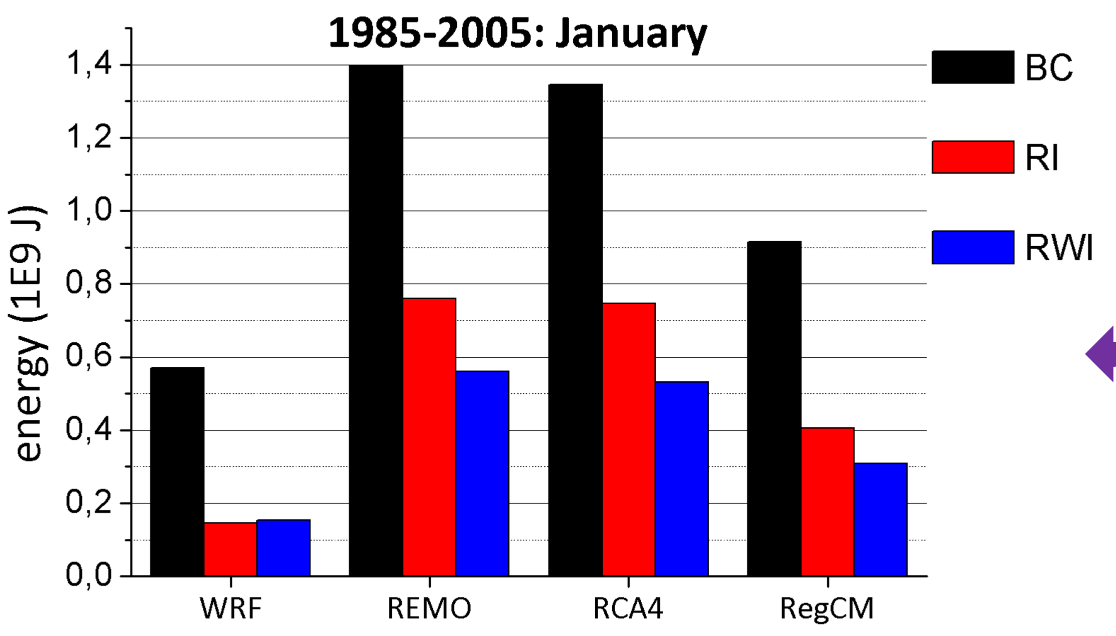
The floor plans and design of a social dwelling were provided by Santa Fe´s Department of Urban Development

We estimate the energy needed to maintain the house's temperature below 26 °C during warm months (a comfort value for domestic use) [5].

Experiments for present climate: (i) a base case (BC) where the house's specifications remained unchanged, (ii) a roof intervention (RI) where insulation in roofs was increased to comply with Rosario's legislation [6] and (iii) a roof-wall intervention (RWI) where insulation in walls was also increased to comply with such legislation.

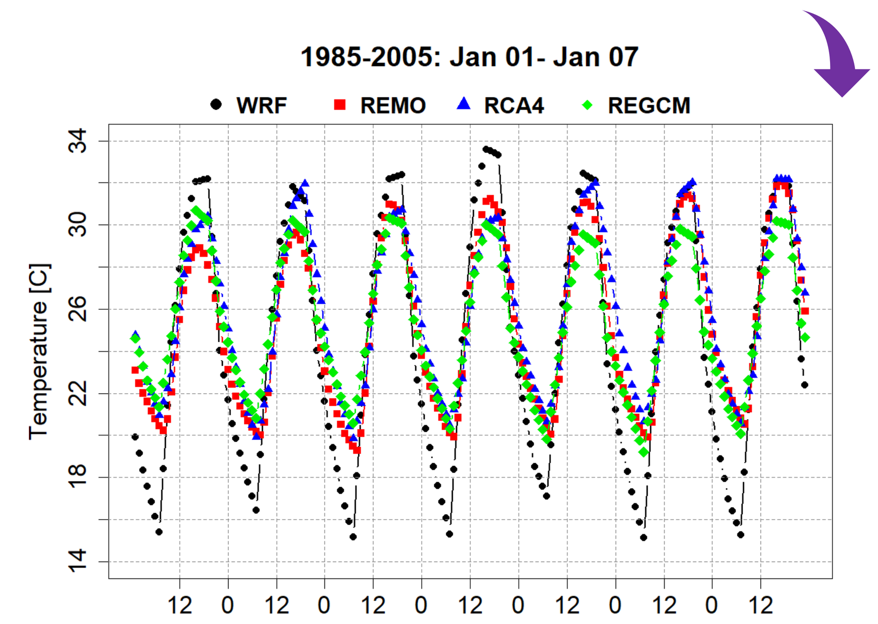
Climate change experiments: consider the RWI, forced by climate change scenarios from RCMs, according to the RCP4.5 and RCP8.5 emission scenarios.

RESULTS



The roof intervention diminishes (~50%) the energy required to cool the house. The best performance is when interventions are in roof and walls

Exception is WRF… which presents a diurnal cycle with high amplitude. Understanding this requires further analysis

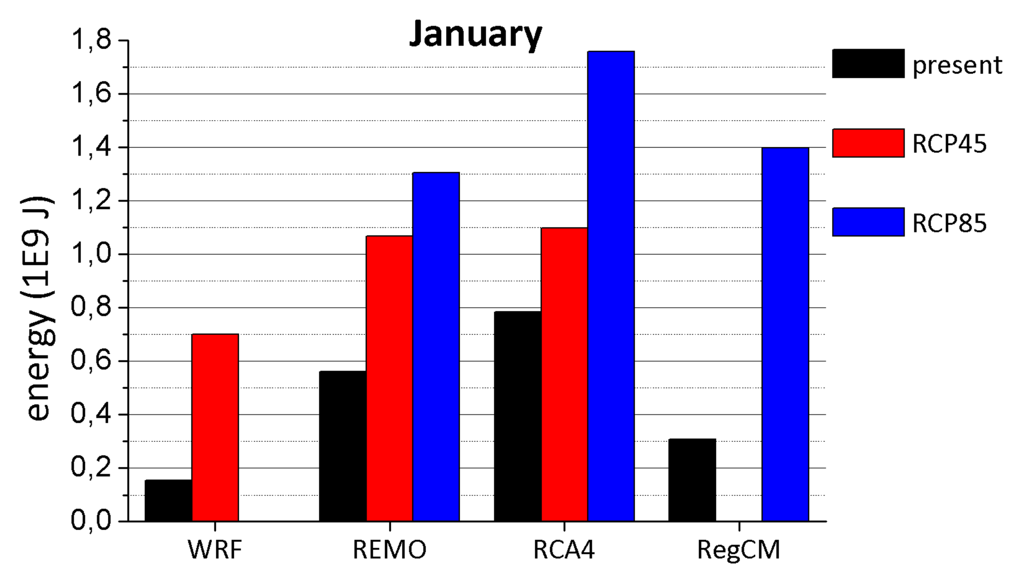


The changes in the energy demand due to changes in the mean climate conditions are evaluated for the RWI house.

All the experiments reproduce a raise in the energy needed for cooling the house under future climate projections

Ranges of increases:

- RCP4.5: 40% to 350 %
- RCP8.5: 130% to 350%

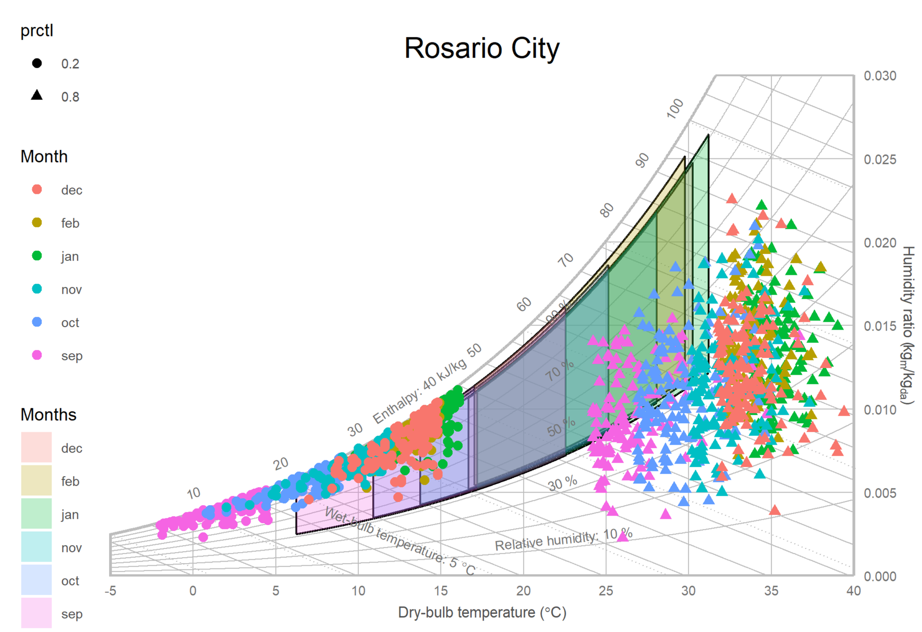


PRELIMINARY CONCLUSIONS

- It is possible to reduce energy demand for climatization of a social dwelling in summer, if the house is properly insulated
- The energy needed for cooling a well-insulated house is expected to highly increase in the near-future
- Although numbers differ, mean energy demand for the house climatization, will rise between 40% to 350% in the near-future
- Therefore, it is essential to incorporate climate change impact studies when planning and designing the built environment to prevent the collapse of the energy sector

NEXT STEPS INCLUDE

- To implement further design improvements (Givoni´s [7] diagram for Rosario City)
- To study the role of the amplitude of the diurnal and the annual cycle of temperature
- To study peaks on demand due to climatic extremes
- To move from rural to urban environment



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