

Enhancing Energy Efficiency and Climate Robustness in Iranian Residential Buildings



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Research motivations:

Iranian residential buildings face significant energy consumption, surpassing the global average by approximately five times. Urgent action is needed to enhance energy efficiency and climate robustness. While optimizing the building envelope's thermal transmittance is crucial, blindly lowering U -values may not always suffice. It is important to understand how optimal design will evolve under climate change.

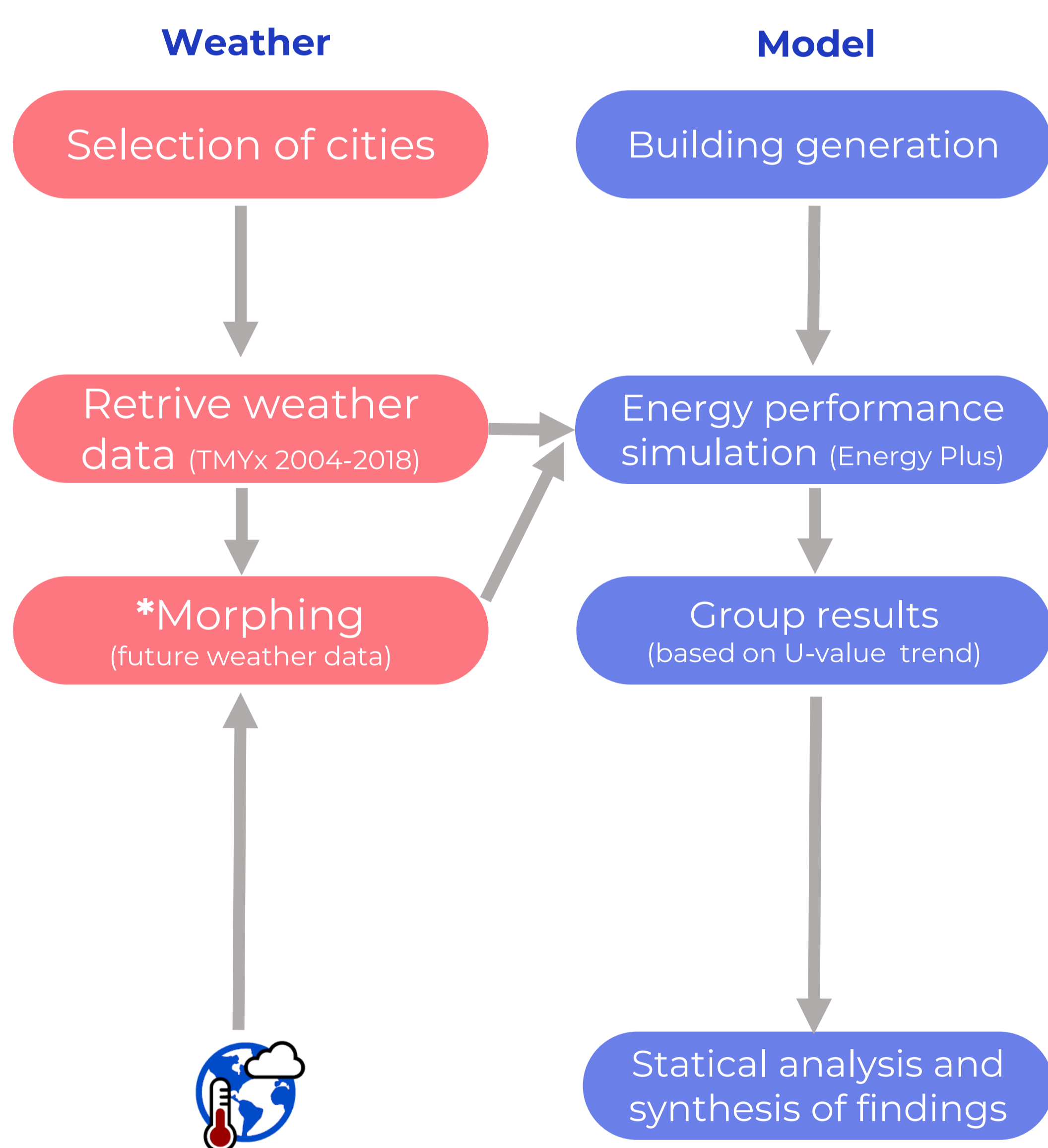
Objective:

The aim of this research is to establish a comprehensive understanding of energy efficiency and climate robustness in Iranian residential buildings by examining the thermal performance. Specifically, the study aims to identify regions where buildings are at risk of underperformance due to the increasing harshness of climate conditions.

The research also seeks to determine the extent to which thermophysical properties, particularly thermal transmittance (U -value) of building envelopes, need to change to remain optimal in the face of future climate scenarios.

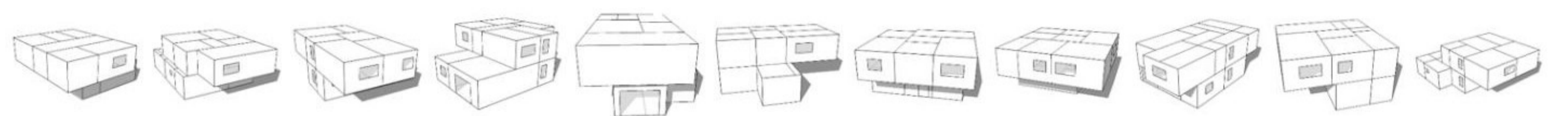
Methodology:

The study utilizes a generative design approach to assess the energy demand for heating and cooling for a diverse set of randomly generated buildings. The U -values of the building envelope elements are randomly assigned and simulated for 21 locations in Iran, considering the present and two future timeframes (2050 and 2080) with the help of a novel Future Weather Generator tool.

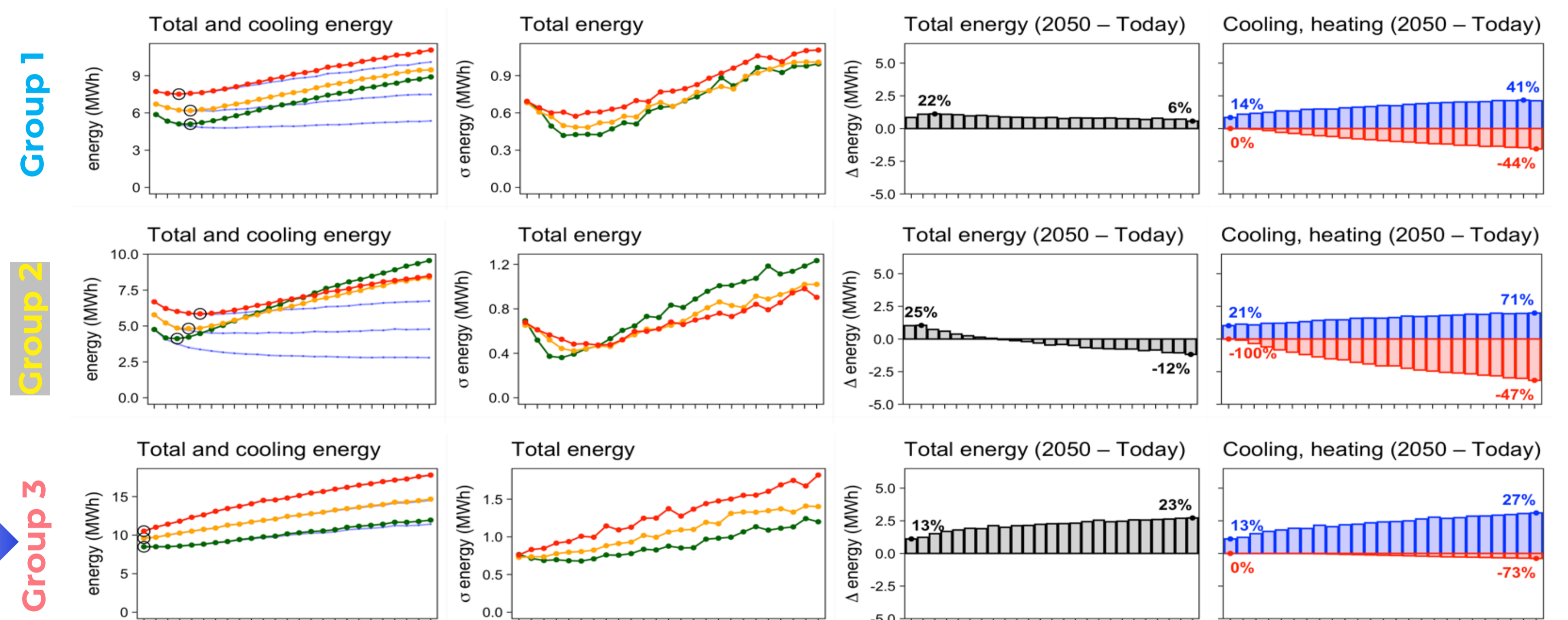


* Future Weather Generator tool was used to morph today's typical meteorological weather to match the EC-Earth3 data for the SSP5-8.5 scenario.

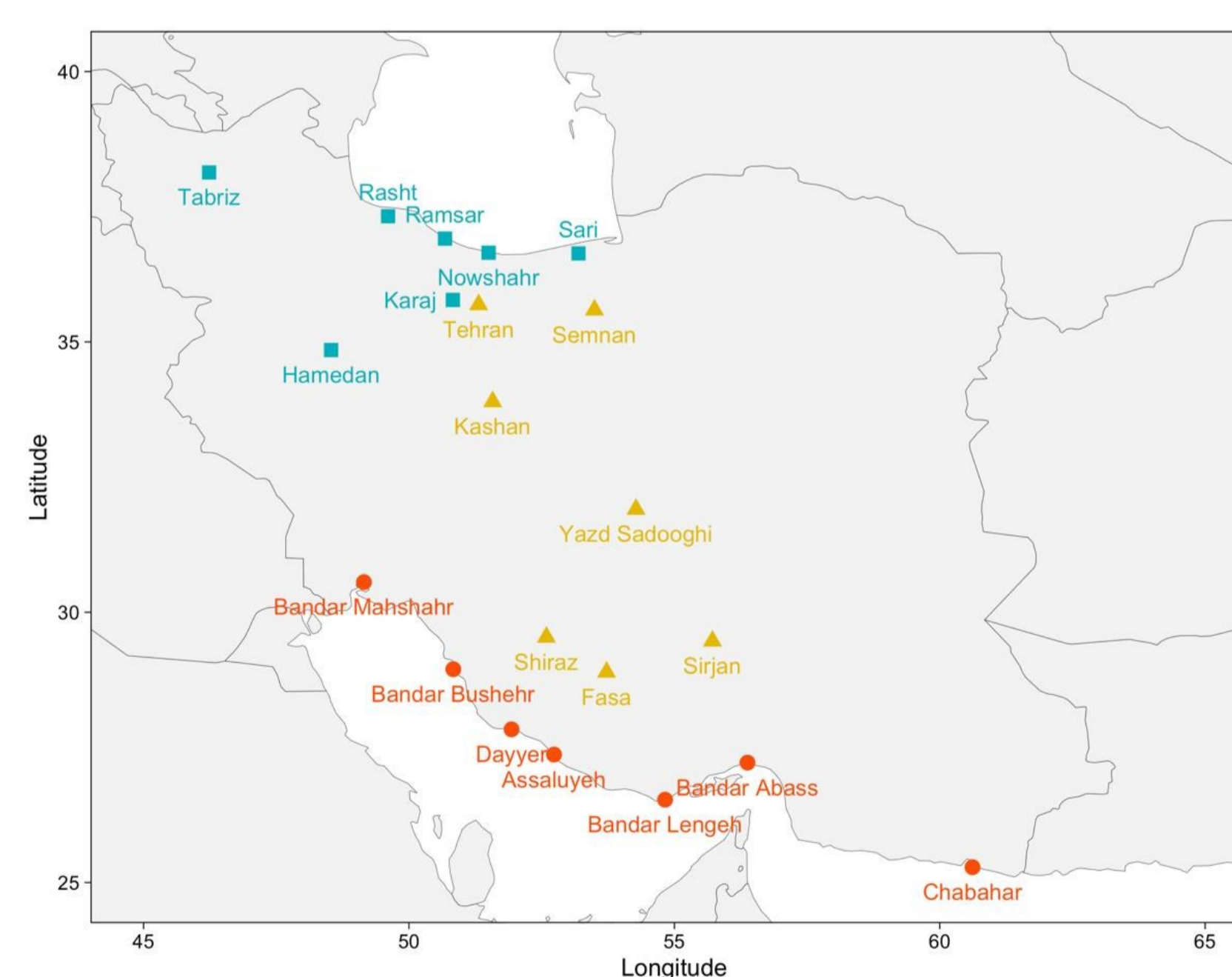
Results:



Sample of 12,000 buildings with random geometries and varying U -values generated using EPSAP generative design method.



Comparison between present-day (green lines), 2050 (orange), and 2080 (red) timeframes, black circles indicate the ideal pair of U -values.



Locations grouped by the trend of the ideal U -values.

- Present-day ideal U -values may increase energy demand in the future;
- Future ideal U -values will be higher, equal, or lower in different regions, depending on their current dominant energy need;
- The trends in ideal U -values over time clearly define three regions in Iran, higher values for cities in **Group 1**, lower in **Group 2**, and the lowest possible in **Group 3**;
- Since not all locations will be affected equally by global warming, each region will require specific design decisions.

Future works:

Future work extend analysis to include multi-story apartments and assess the effectiveness of national building codes in light of climate change impacts, providing a comprehensive framework to enhance energy efficiency and climate robustness in residential buildings.

Outputs :

Rodrigues E, Fereidani NA, Fernandes MS, Gaspar AR. Climate change and ideal thermal transmittance of residential buildings in Iran. J Build Eng 2023;74:106919. <https://doi.org/10.1016/j.jobbe.2023.106919>.

Rodrigues E, Carvalho D, Fernandes MS. Future Weather Generator morphs current weather for performance simulation of buildings in the future. 2022. <https://adai.pt/future-weather-generator/>.

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