The 2-CAP Energy Atlas in a nutshell

Designing Positive Energy Buildings Workshop

16th February 2022

Iván Luque Segura, Research Fellow, RMIT-Europe

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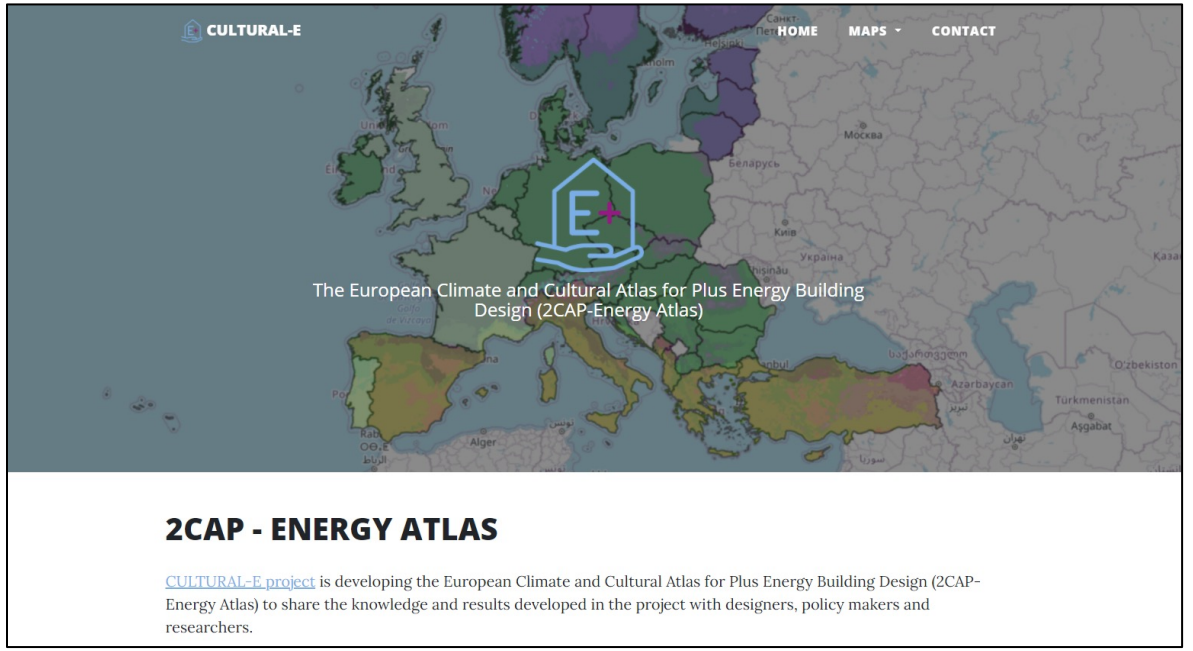
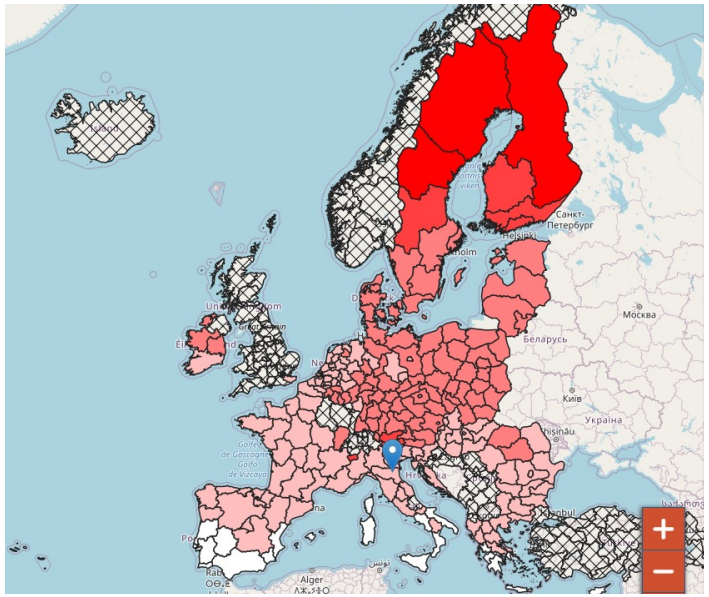
2CAP-Energy Atlas – Presentation Outline

1. **Starting points and key concepts**
2. **The 2CAP-Energy Atlas in a nutshell**
3. **Exploring the Atlas**



https://cssprocapi01.eurac.edu/ce_atlas/index.html

Starting points and key concepts towards the European Climate and Cultural Atlas for PEB Design (2CAP-Energy Atlas)

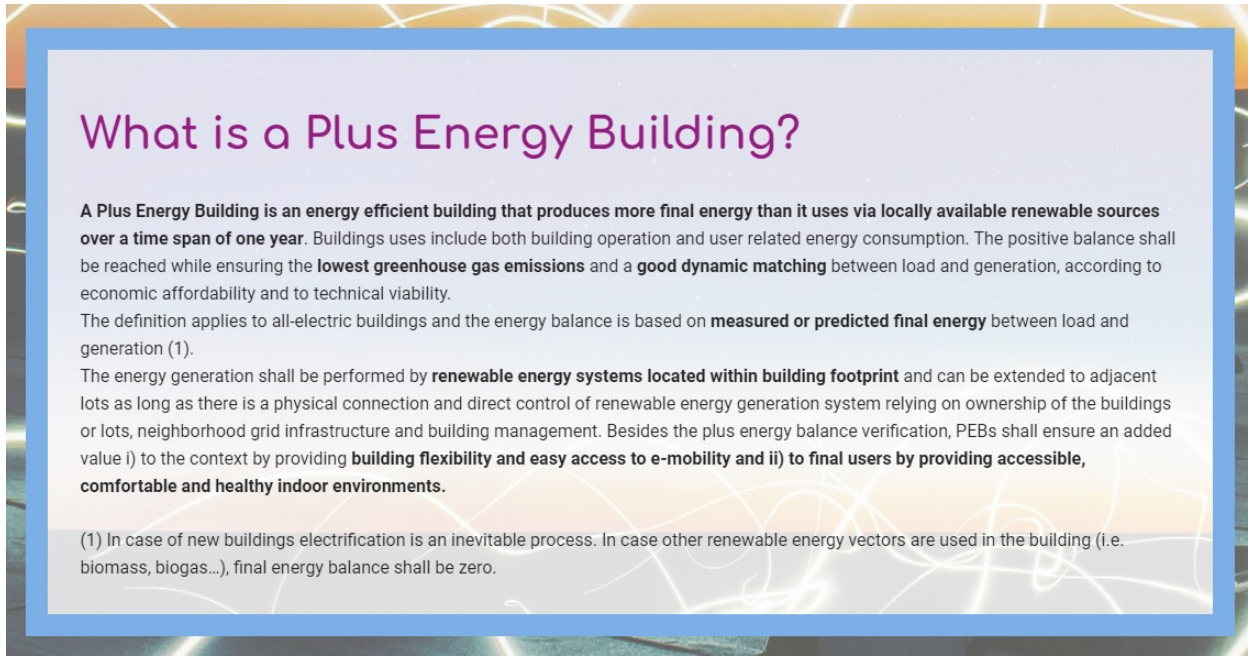


Starting points and key concepts

towards the European Climate and Cultural Atlas for PEB Design

- **How the Atlas could contributes into the PEB definition of Cultural-E :**

1. Alignment with a **'…viable and tailored concept of Plus Energy Buildings (PEBs)'.**
2. **Providing** information to all buildings uses, both building operation and **user related energy consumption.**
3. **Accounting for a positive balance** and ensuring **a good dynamic matching** between load and generation.
4. **Supporting a better accuracy of the energy balance predictions.**
5. **Hosting measured data on final energy** between load and generation **in PEB Demos.**
6. **Adding value** i) to the context by **providing building flexibility assets** and ii) to final users by providing **accessible, comfortable and healthy indoor environments**.



Starting points and key concepts

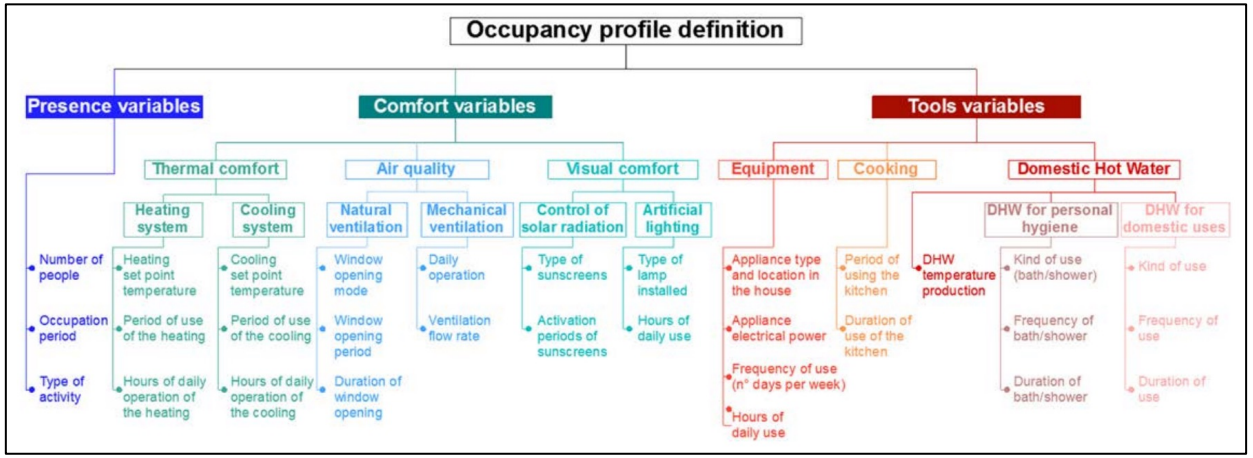
towards the European Climate and Cultural Atlas for PEB Design

- **How to tackle user energy demand by means of integrating its complexity into PEB design?**

User behaviour prediction models and simulation-aided building design could conflict with the energy demand concept from a social sciences perspective, instead both approaches become complementary and will drive some light on how integrating user energy-related practices into the design process.

- **How should the existing energy performance 'gap' -which is uncertain and multidimensional- be addressed by the Atlas?**

In addition to user-centric design approaches, modelling the scope and effects of user behaviour (window, shading, lighting operation, thermostat adjustment, appliance use, clothing adjustment, etc) enables to mitigate the EPG for a successful PEB design.



Source: *Reference procedures for obtaining occupancy profiles in residential buildings. Marilena De Simone M. et al. (2018) IEA EBC Annex 66 – Subtask A Deliverable*

'Currently, the scope of the metrics used **OB Modelling is limited to energy and comfort aspects**, which are normalised by building features **instead of occupant related factors'.**

Ref: Mahecha Zambrano, Juan & Filippi Oberegger, Ulrich & Salvalai, Graziano. (2021). Towards integrating occupant behaviour modelling in simulation-aided building design: Reasons, challenges and solutions. Energy and Buildings. 253. 111498. 10.1016/j.enbuild.2021.111498.

Starting points and key concepts

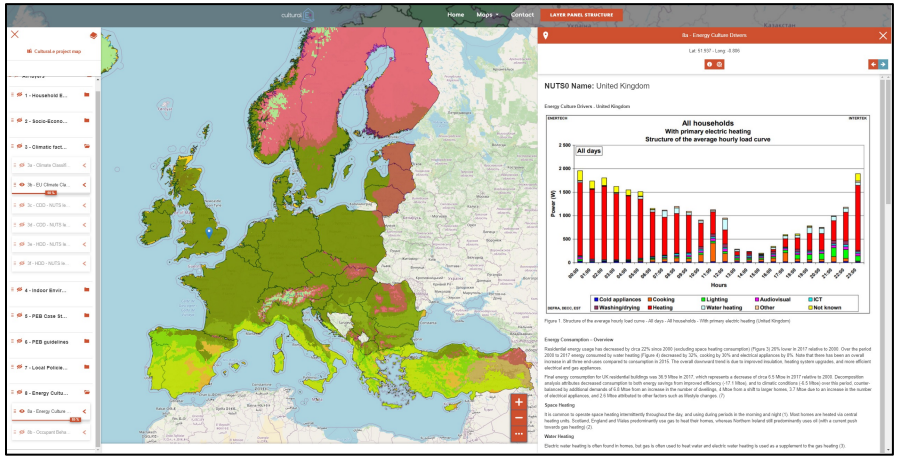
towards the European Climate and Cultural Atlas for PEB Design

With the aim to transfer the socio-cultural and climatic factors that directly affect building energy performance into an Atlas at EU level, specific user-focused layers have been designed, such as:

(i) **the 'Energy Culture Drivers' layer**

(ii) **the 'Occupant Behaviour Modelling' layer**

(iii) **The 'Indoor Environmental Quality aspects' layers group**



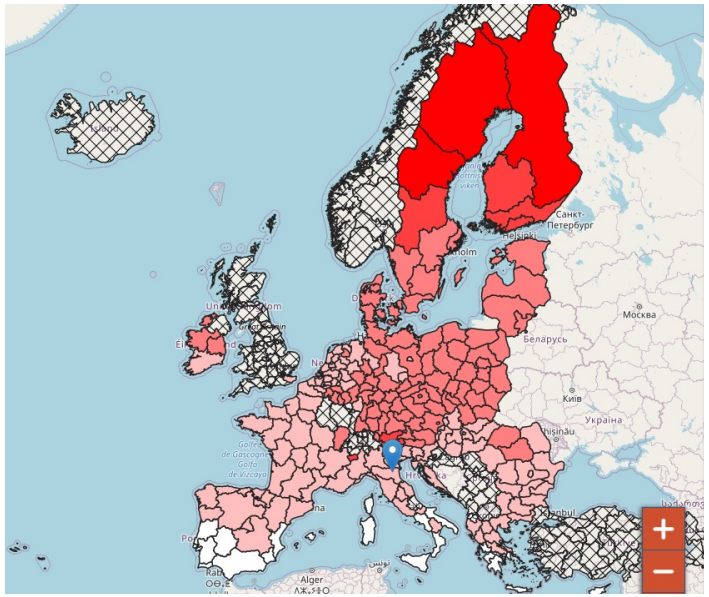
'Introducing **human behaviour to BPS is fundamental for achieving accurate simulation results** and their resulting predictions for energy consumption and comfort assessment'

Ref: Experimental study on occupants' interaction with windows and lights in Mediterranean offices during the non-heating season. Naspi, F. et al. (2017). Building and Environment. 127. 10.1016/j.buildenv.2017.11.009.

' …**not assign the occupants a priori as the main culprits responsible for the Energy Performance-Gap**, but as partners in a collective endeavour to enhance the energy performance of the built environment.'

Ref: The Role of Occupants in Buildings' Energy Performance Gap: Myth or Reality? Mahdavi, A et al. Sustainability 2021, 13, 3146. https://doi.org/10.3390/su13063146

The 2CAP-Energy Atlas in a nutshell



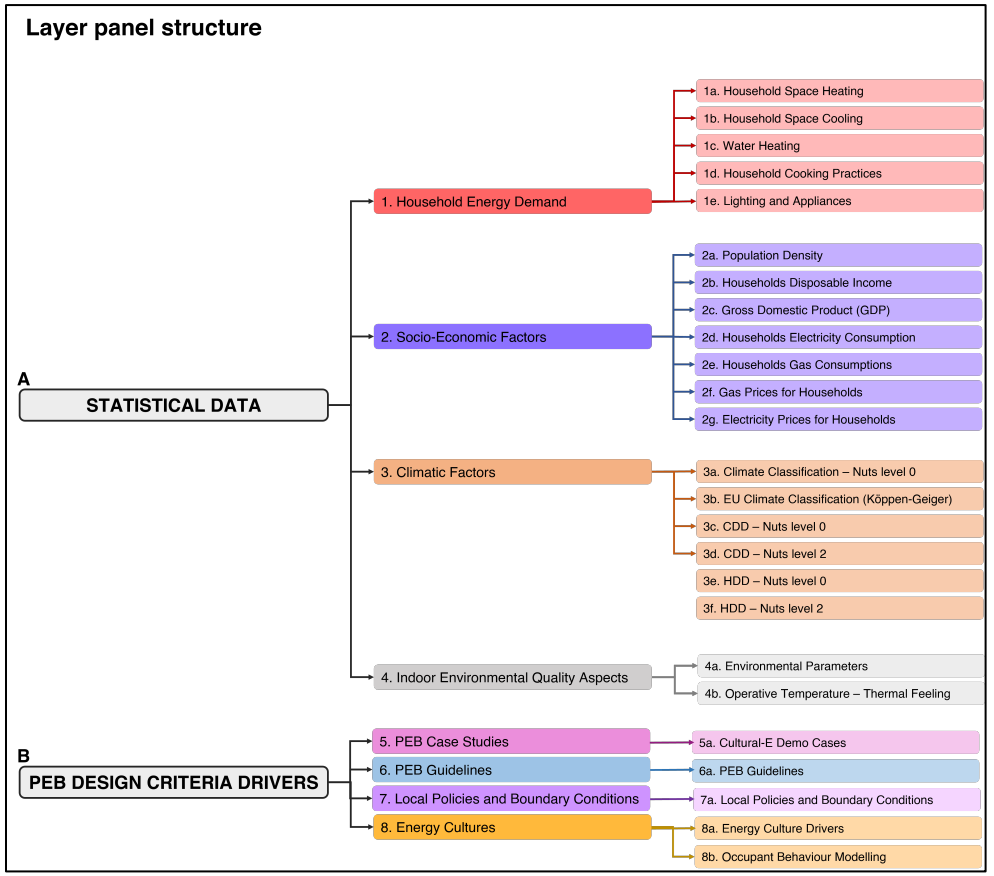
2CAP-Energy Atlas – Main Features

The 2CAP-Energy Atlas, a data visualization library, **intends to be perceived as a comprehensive set of information sources which add questions and provide key inputs to building designers' daily practices.**

The tool is backed up on a **GIS online interface** which aims to make **results from the Cultural-E project complementary to stakeholders and the building science community**, as well as to enable constant updating. The Atlas' main group of layers are:

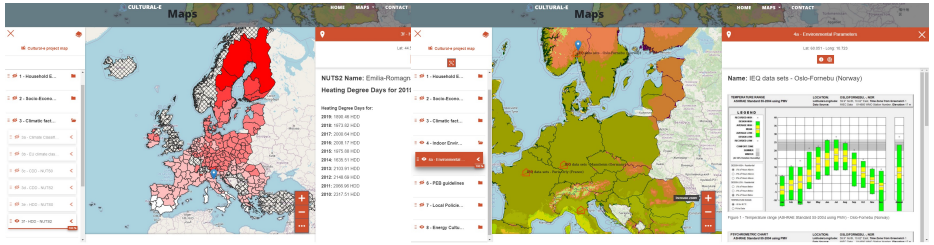
A. Cultural and Climatic statistical data.

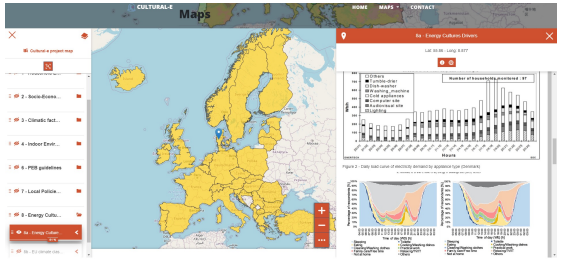
B. PEB design criteria drivers.



2CAP-Energy Atlas – Main Features

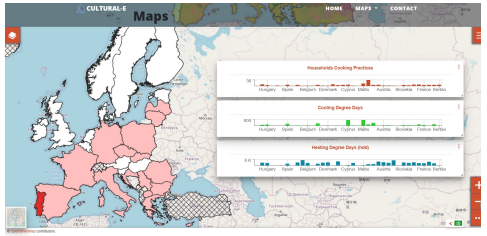
- **NUTS2, NUTS0 (Nomenclature of Territorial Units for Statistics) and geo-referred locations.** Pointing at a specific territorial unit, the tool will open information-boxes with data on the various categories





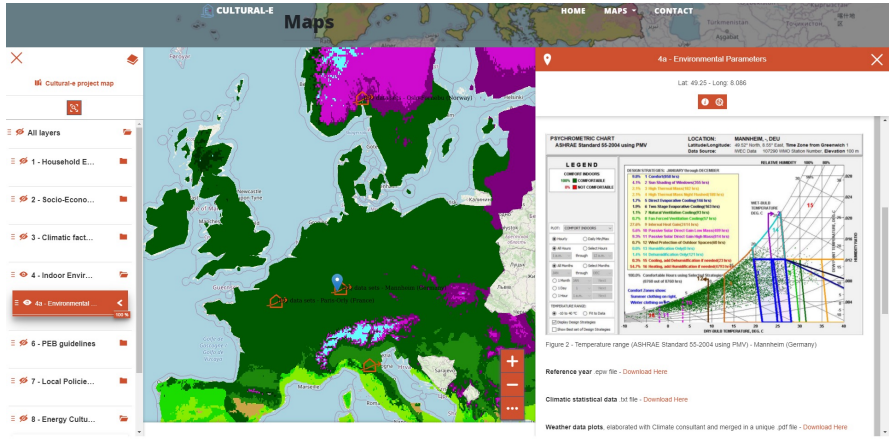
- **Data analytics.** The Atlas functionalities enable an operative data analysis, meaning that various kinds of contents, options and features provide key insights into design principles and criteria for PEB design.

- **Geographical representation of cultural, climate, economic and policy elements important for the building sector.** This includes consumption data, and uses and types of energy dynamics with a special focus on PEBs.



2CAP-Energy Atlas – continues update

- **The Atlas is a continues evolving tool** which will integrate forthcoming project results into dedicated map layers, such as:
  - Building technologies for PEB;
  - Simulations-aided design approaches (on going);
  - PEB solutions-sets;
  - IEQ and user comfort aspects (on going),
  - Co-impacts for PEBs;
  - Demo building outcomes and monitoring process



Energy Cultures Layer Group

Household dynamics – efficiency trends – occupant behaviour models

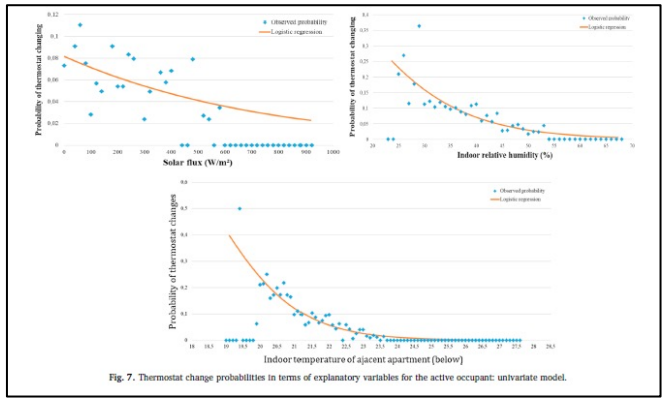


Fig. 7. Thermostat change probabilities in terms of explanatory variables for the active occupant: univariate model.

Ref: Experimental and numerical study to evaluate the effect of thermostat settings on building energetic demands during the heating and transition seasons. Belazi, Walid et al. (2019). Applied Thermal Engineering. 152. 10.1016/j.applthermaleng.2019.02.020.

ITALY

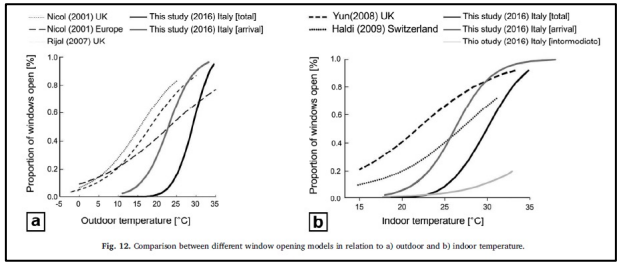


Fig. 12. Comparison between different window opening models in relation to a) outdoor and b) indoor temperature.

Ref: Experimental study on occupants' interaction with windows and lights in Mediterranean offices during the non-heating season. Naspi, F. et al. (2017). Building and Environment. 127. 10.1016/j.buildenv.2017.11.009.

DENMARK

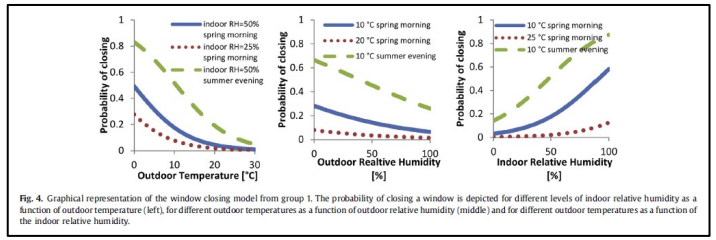


Fig. 4. Graphical representation of the window closing model from group 1. The probability of closing a window is depicted for different levels of indoor relative humidity as a function of outdoor temperature (left), for different outdoor temperatures as a function of outdoor relative humidity (middle) and for different outdoor temperatures as a function of the indoor relative humidity.

Ref: Window opening behaviour modelled from measurements in Danish dwellings. Andersen, Rune et al. (2013). Building and Environment. 69. 101-113. 10.1016/j.buildenv.2013.07.005.

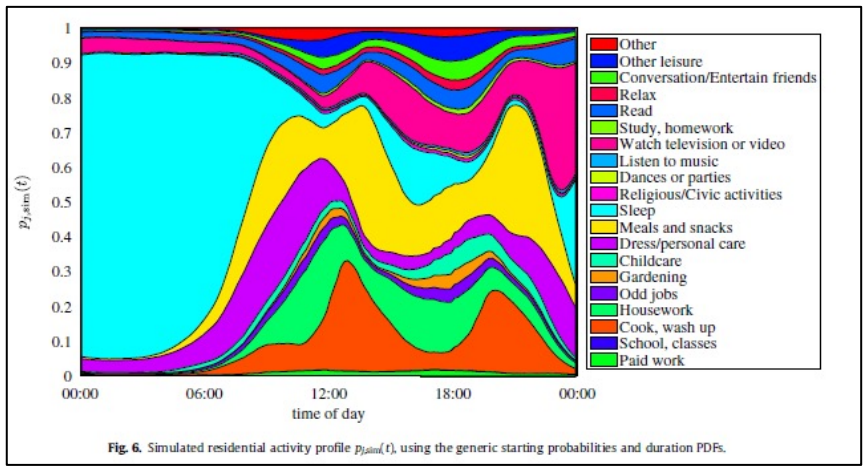
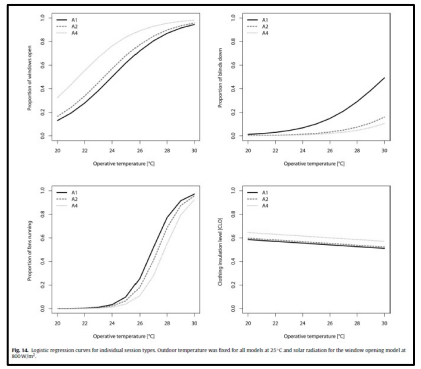


Fig. 6. Simulated residential activity profile $p_{j,sim}(t)$, using the generic starting probabilities and duration PDFs.

FRANCE

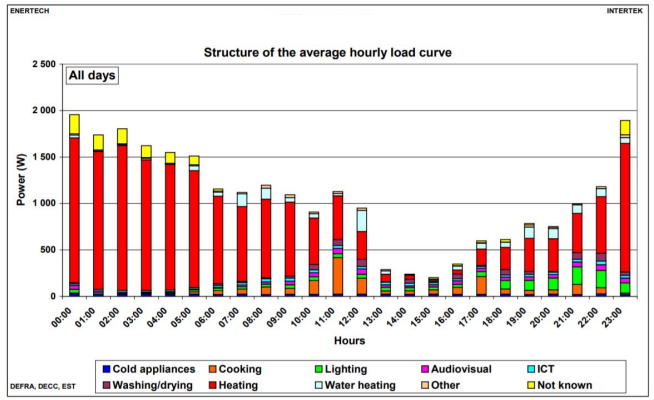
Ref: A bottom-up stochastic model to predict building occupants' time-dependent activities. Wilke, Urs et al. (2013). Building and Environment. 60. 254–264. 10.1016/j.buildenv.2012.10.021.

GERMANY



Ref: A bottom-up stochastic model to predict building occupants' time-dependent activities. Wilke, Urs et al. (2013). Building and Environment. 60. 254–264. 10.1016/j.buildenv.2012.10.021.

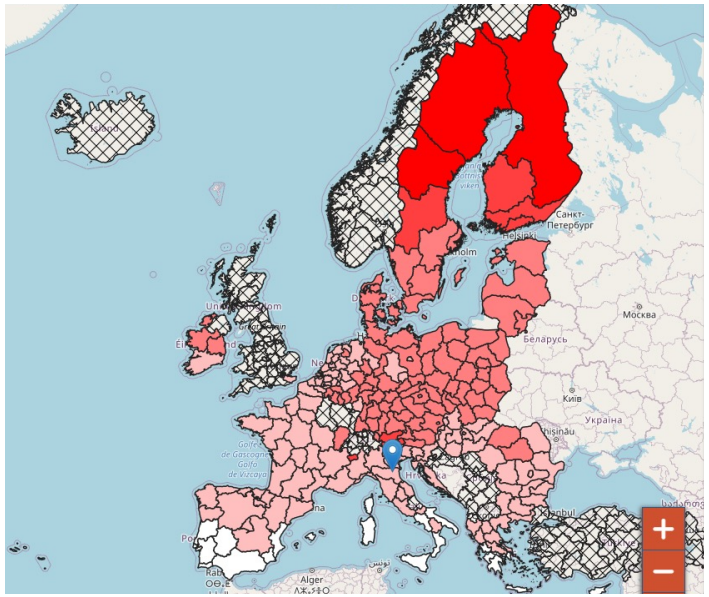
UK



Ref: Household Electricity Survey: A study of domestic electrical product usage. Zimmermann, JP. et al. (2012). AEA group (assets.publishing.service.gov.uk/R66141HouseholdElectricitySurveyFinalReportissue4)

Exploring the 2CAP-Energy Atlas

https://cssprocapi01.eurac.edu/ce_atlas/index.html



Thank you for your attention!

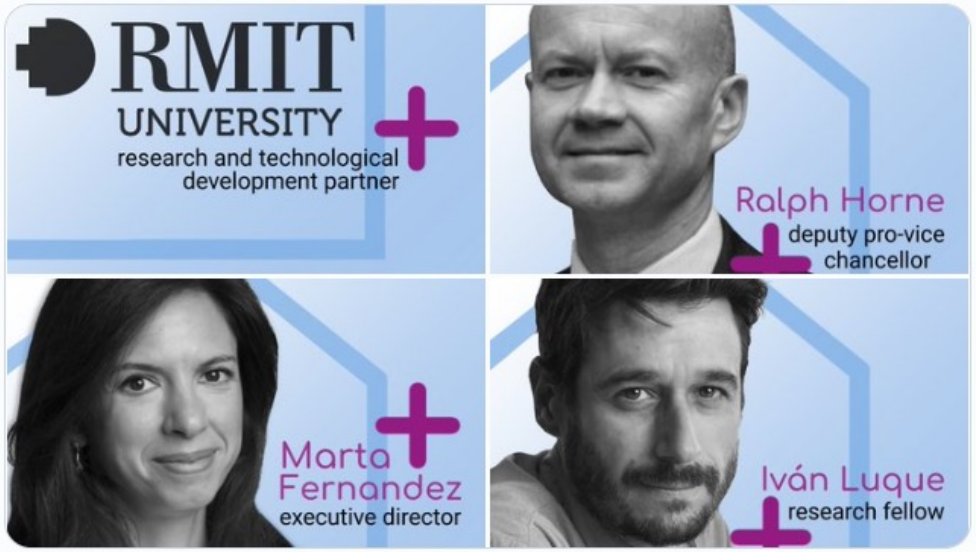
Contact

Iván Luque Segura

RMIT-Europe

Ivan.luque.segura@rmit.edu.au

Researcher Fellow



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2-CAP Energy Atlas -Interactive activity-

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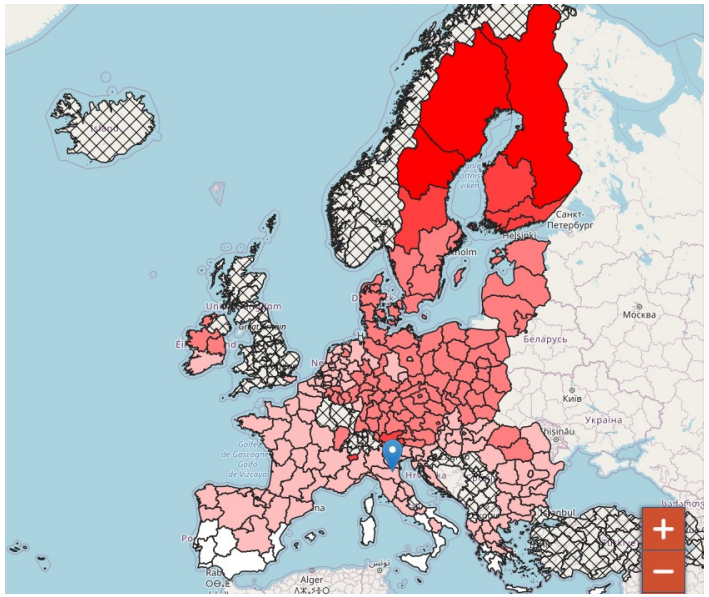
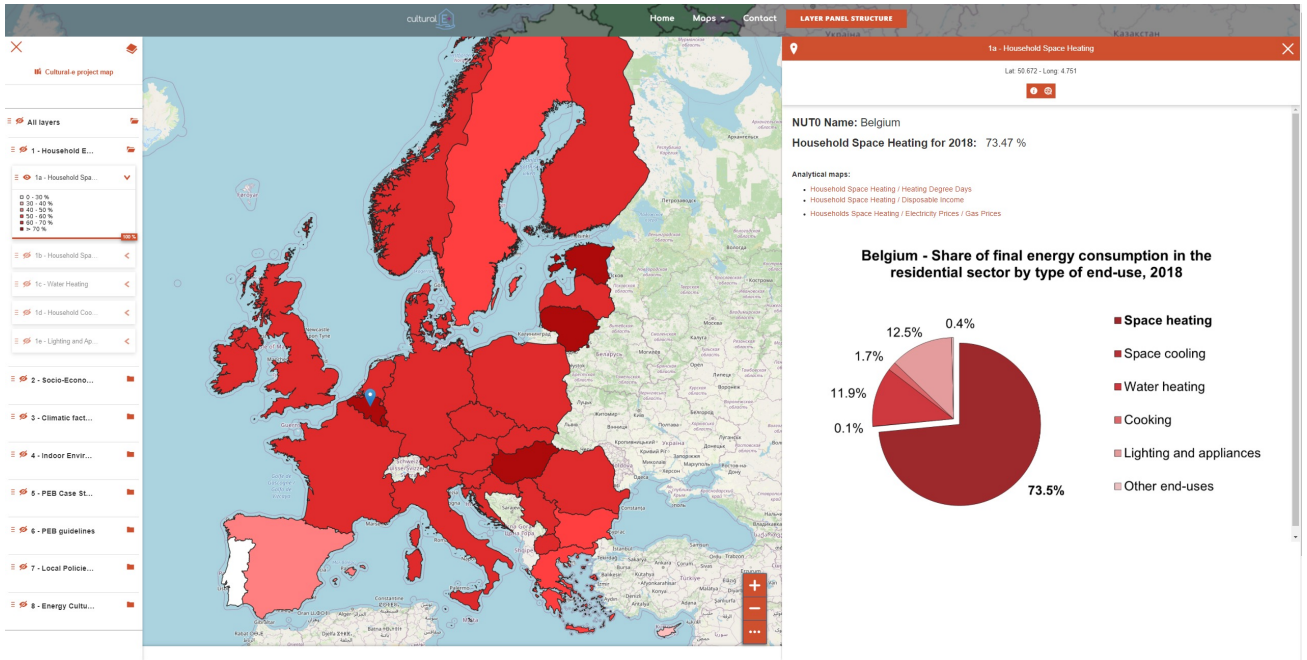
2CAP-Energy Atlas – interactive exercise

Interactive activity [Guided exercise focused on data provision and design criteria for PEB design throughout the 2CAP-Energy Atlas tool -in early stages of the building design process. A structured poll questionnaire will be distributed with the aim to collect participants' feedback on the tool functionalities and the information sourced] – RMIT, UNIVE, EURAC



Atlas interactive exercise (i)

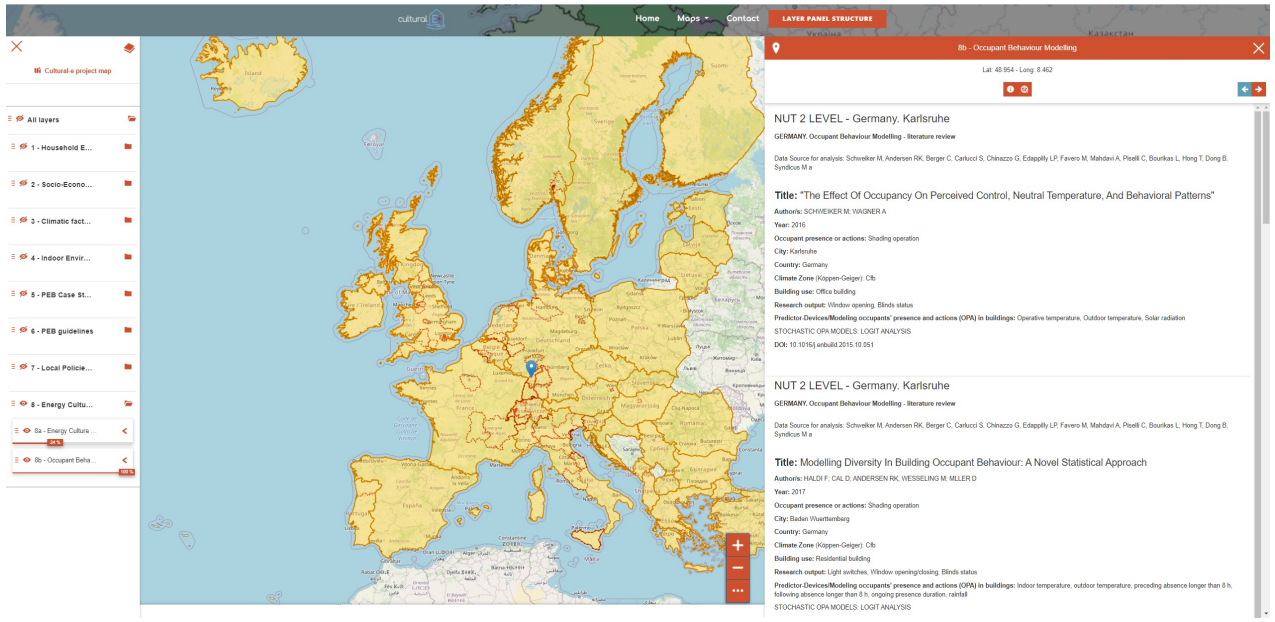
1. **Locate your building project**
2. **Explore the various layer groups**



Atlas interactive exercise (ii)

3. **Identify available OPA models in your selected location and categorise them by the type of user building interaction -** ***Occupant Behaviour Modelling Layer-*****.**

    1. **Appliance use**
    2. **Clothing adjustment**
    3. **Lighting operation**
    4. **Presence**
    5. **Shading operation**
    6. **Thermostat adjustment**
    7. **Window operation**



- How could PEB design integrate and react upon the energy trade-off facing end-users' daily practices on comfort, cleanliness and convenience bases?
  - ❑ By applying User-centric design and Human-computer interaction approaches
  - ❑ Throughout the integration of OB modelling into simulation-aided design
  - ❑ By restricting user control over the building systems
  - ❑ Other

- What is the gap between the available methods/tools and the required insights which make a PEB project successful?
  - ❑ There is no gap
  - ❑ Existing tools do not allow the integration of specific OB Models
  - ❑ Existing tools do not provide outcomes which may support an improved design accounting for users' perception and behaviour
  - ❑ Other

Thank you for your attention!

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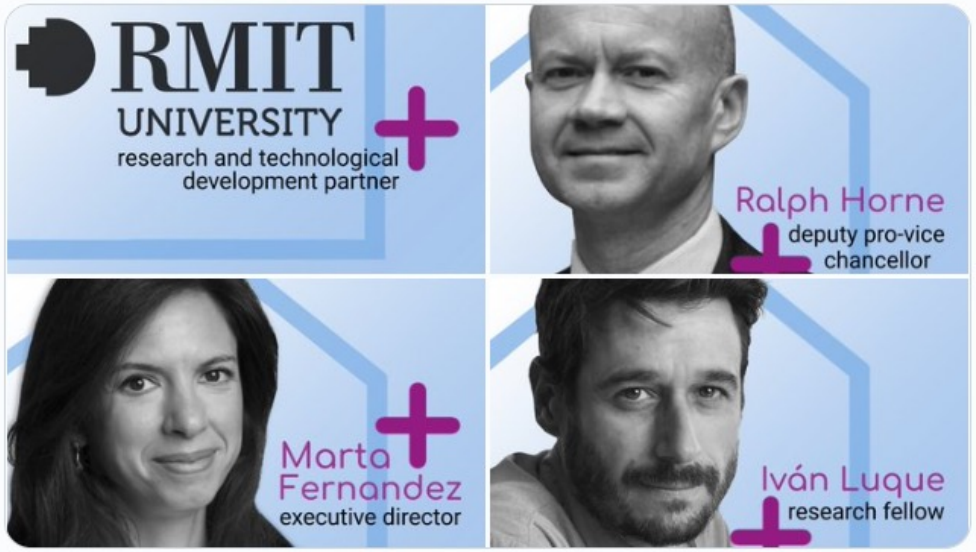
Ivan.luque.segura@rmit.edu.au

Researcher Fellow



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