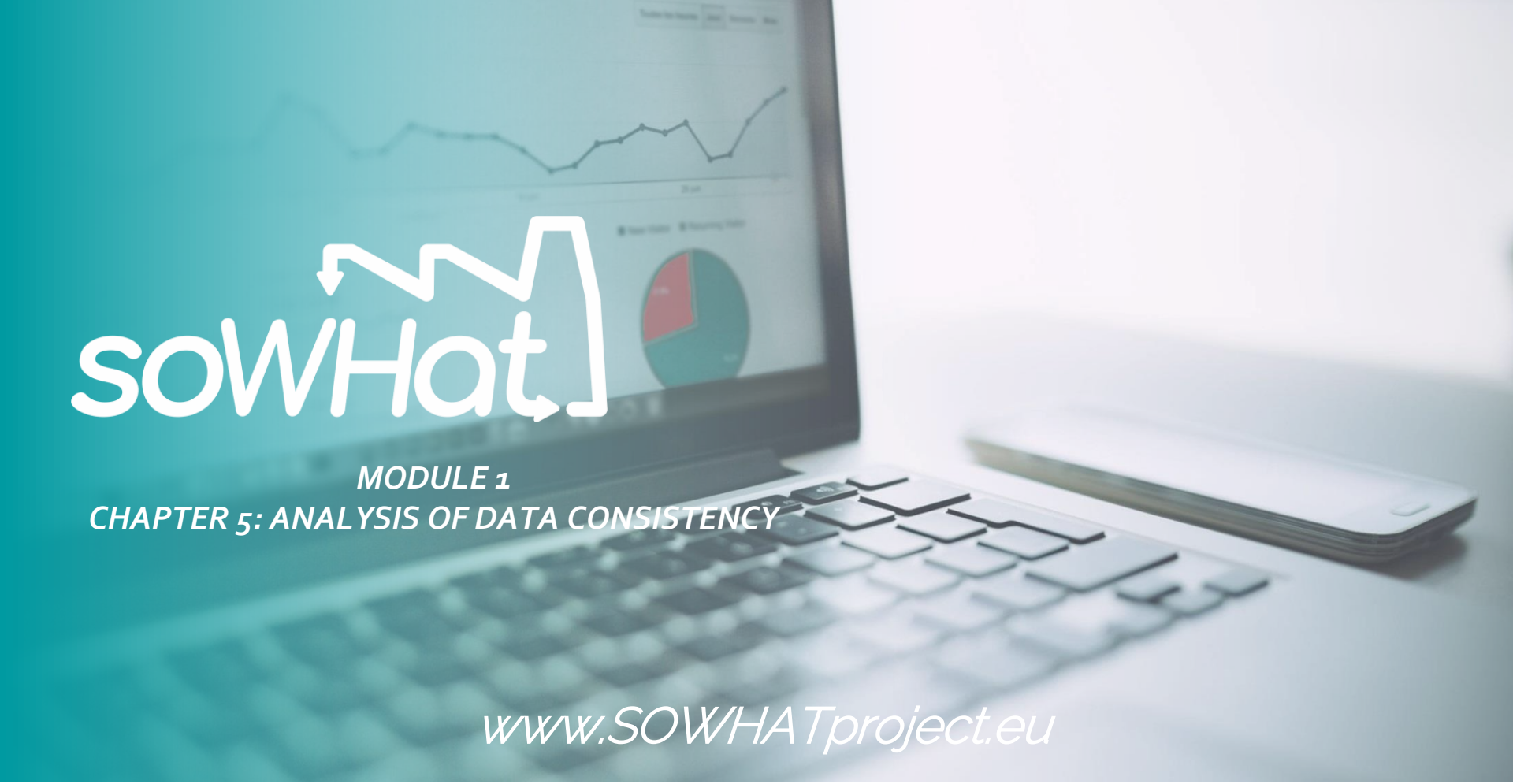

MODULE 1
CHAPTER 5: ANALYSIS OF DATA CONSISTENCY

www.SOWHATproject.eu

This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 847097

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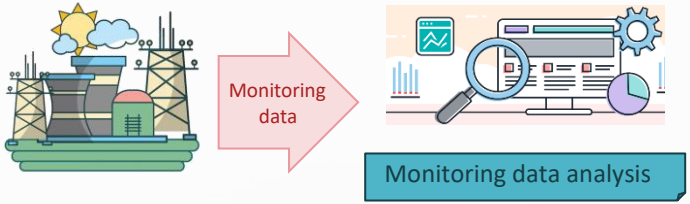
Introduction

- High-level information and details linked to the simulation environment of industrial waste heat and cold recovery
- Possible checks and evaluation of the consistency of data.



study & understanding of the demo

Data analysis and error correction

Adaptation to required formats

- This phase is crucial to obtain high-quality data
- In this module simulation environment, data will be adequate to analyse the heat potential of that particular industry and indeed, to be able to generate a real quality thermal production profile based on that waste heat monitoring data.

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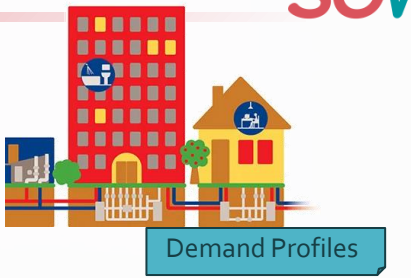
Introduction

Demand profiles for different type of consumers (residential, services, industrial…) who will benefit from this waste heat can be predicted (in the event that real profile demands were not given).

Analyzed Monitoring data



Demand forecasting tools

City Energy Analyst

focuses more on a detailed building model

LoadProfileGenerator

based on the demand of people behaviour of the household

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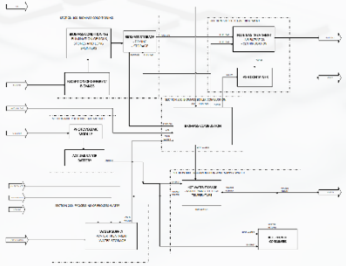
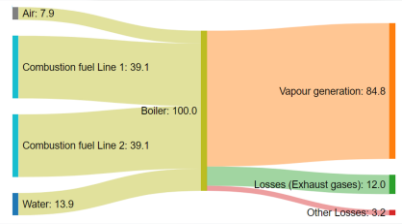
First study of the simulation environment

- Quality and quantity of explanatory documentation provided with monitoring data
- Level of complexity of the industrial settles
- Standardization of the production process of the industry
- Professional background of people in charge of the study

Methods and sources for this first study

- Consultations to **energy audits**
- Organization with **flow diagrams**
- **Sankey diagram** elaboration





I. Bernal and F. Morentín, "'Monitoring Management System', SO WHAT H2020 Project, Deliverable 5.1," 2022. [Online]. Available: www.sowhatproject.eu.

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Data analysis and error correction

Monitoring data analysis

- Definition of the **format** in which data is received
- Establishment of an **operation schedule**
- Adaptation and standardization of the **frequency** of monitoring data
- **Quality preliminary** analysis of the data
- Data **consistency** analysis
- **Error correction**

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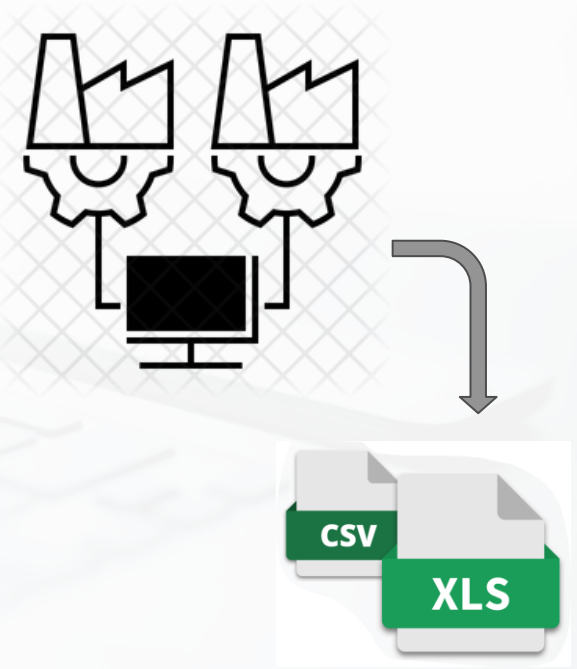
Data analysis and error correction

Definition of the format in which data is received

Data is originally generated in some type of Supervisory Control and Data Acquisition (SCADA) characteristic of each industry or software programs in the same line.

The process usually follows the same steps:

- Data is collected in some Data Base (DB)
- After that, it is exported from there in a manual or automatic way (In some cases the exportation is done directly from this SCADA)



Possible barriers with data directly from SCADA

- Not an ease of understanding the data written
- Number and variables names
- Frequency in which they are recorded

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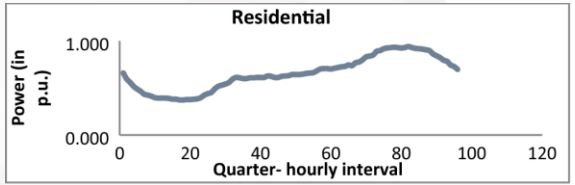
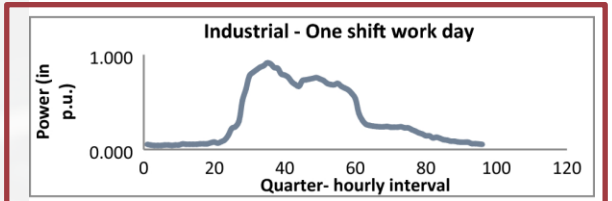
Data analysis and error correction

Establishment of an operation schedule

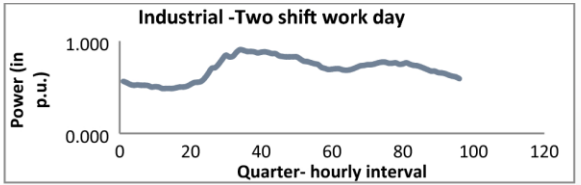
- Establish the particular industry operating schedule
- Take into account suspensions for maintenance and upkeep stops
- Also work regime (shifts) and holidays or vacations



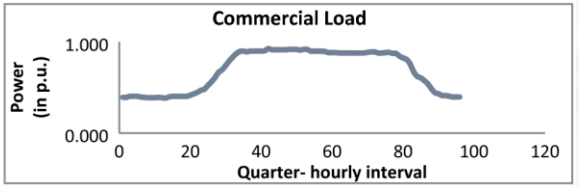
a Typical Load profile for residential load



b Typical Load profile for Industrial- one shift workload



c Typical Load profile for Industrial- two shift workload.



d Typical Load profile for commercial load

A. Jain, A. Mani, and A. S. Siddiqui, "Network architecture for demand response implementation in smart grid," Int. J. Syst. Assur. Eng. Manag., vol. 10, 2019, [Online]. Available: https://link.springer.com/article/10.1007/s13198-019-00891-w/figures/5.

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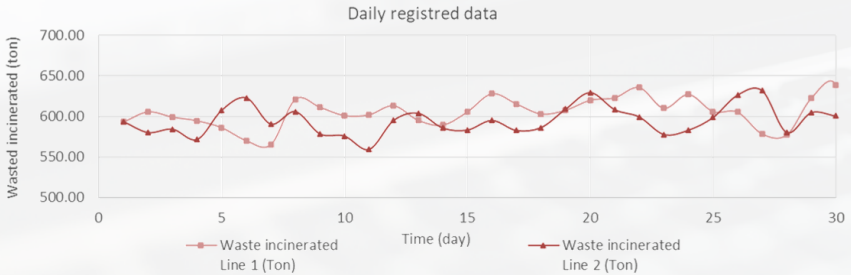
Data analysis and error correction

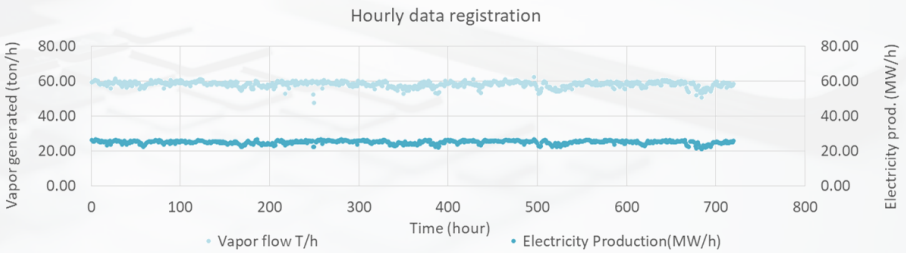
Adaptation and standardization of the frequency of monitoring data

Depending on the sensor, technology or equipment you required to monitor, the frequency of the recorded data would be higher or lower and even more, not all variables will need to be recorded with the same sampling frequency: variables with high variability are usually recorded more frequently compared to slower variables.

An adaptation of the data to a homogeneous frequency will favour its analysis, otherwise the sections of quality preliminary analysis and data consistency will be more difficult to develop.



Variable with low variability (recorded with lower frequency)



Variable with high variability (recorded with higher frequency)

I. Peña and F. Morentín, "'Monitoring Management System', SO WHAT H2020 Project, Deliverable 5.1," 2022. [Online]. Available: www.sowhatproject.eu.

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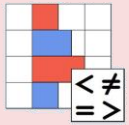
Data analysis and error correction

Quality preliminary analysis of the data

It is important to develop a first variability check of each of the variables to check for significant imbalances

This would show if the data have different orders of magnitude and negative values where it does not make sense.



USEFUL TIP:

Use of color conditional formatting to highlight information in Excel (or other software available) and is very useful for a quickly analyzing of variability of the data, relation between variables, sudden changes in the list, values that are not in appropriate range, etc.

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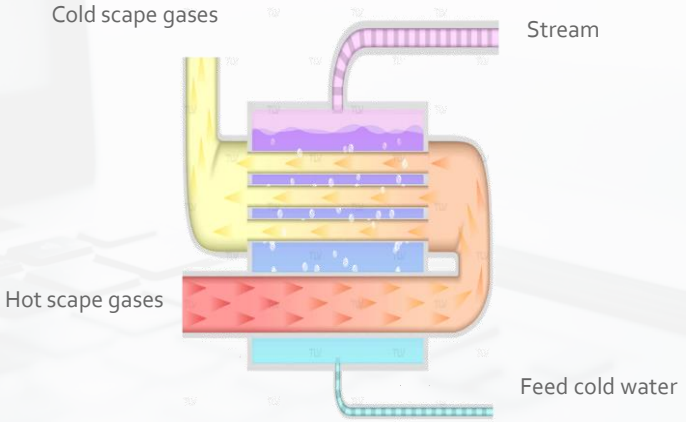
Data analysis and error correction

Data consistency analysis

- Study of the consistency in the data between actions in the process that occur simultaneously or actions that are dependent on others
- Consistency in the inlets and outlets flows;
- Understand and pay attention to the trends of related variables (e.g. energy produced and consumed);
- Special attention to the seasonality (summer vs. winter) this is important to understand if the process and the monitoring data are valid for the aim of the project.



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Data analysis and error correction

Error correction

- For those errors that have been due to the manual process of exporting the database, the first step will be to re-request a dump of that data
- Missing data of a period of time from the complete list
- Estimation of variables with approximated correction.
- Construction of simulated data from other variables to fill in gaps.

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Adaptation to appropriate formats

- Correct monitoring data frequency (daily, hourly, minute, etc.);
- Unit transformation to the universal system or the one needed in the tool;
- With all the errors fixed;
- With correct format of decimal or thousand separators;
- Valid name of the variables in order to be read by the tool.

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Estimation of users demand

Once industry capacity has been analyzed and its heat generation potential, demand forecasting tools are recomended to create users energy profiles, so a comparition between energy production and demanded is establish.

LoadProfileGenerator (LPG) tool

City Energy Analyst (CEA) demand profile generator

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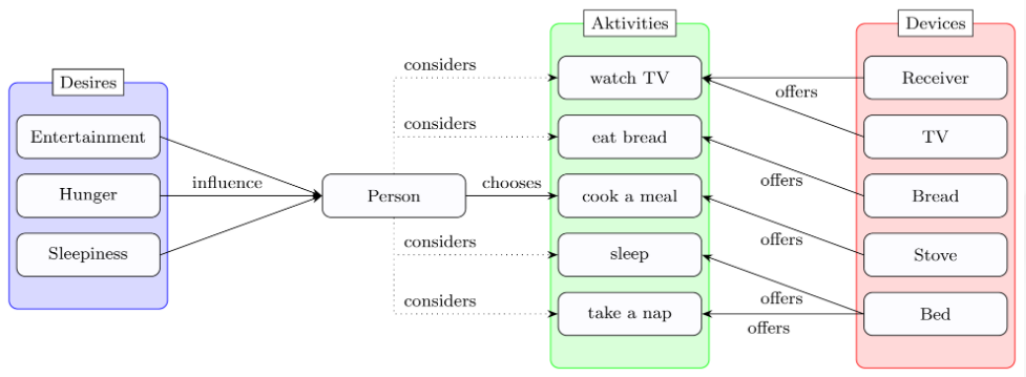
Estimation of users demand

LoadProfileGenerator tool (LPG)

LoadProfileGenerator creates load profiles based on a behaviour simulation of the people in a household. This means that the programme estimates what people are doing at each point in time and based on that, it calculates device usage and the resulting energy usage.

- More than 100 devices pre-configured based on market research
- The profiles are generated for hot water, cold water, electricity and gas
- For heating and cooling demand there is a simple degree day model



"LoadProfileGenerator official page," 2020. https://www.loadprofilegenerator.de/ (accessed Jul. 02, 2022).

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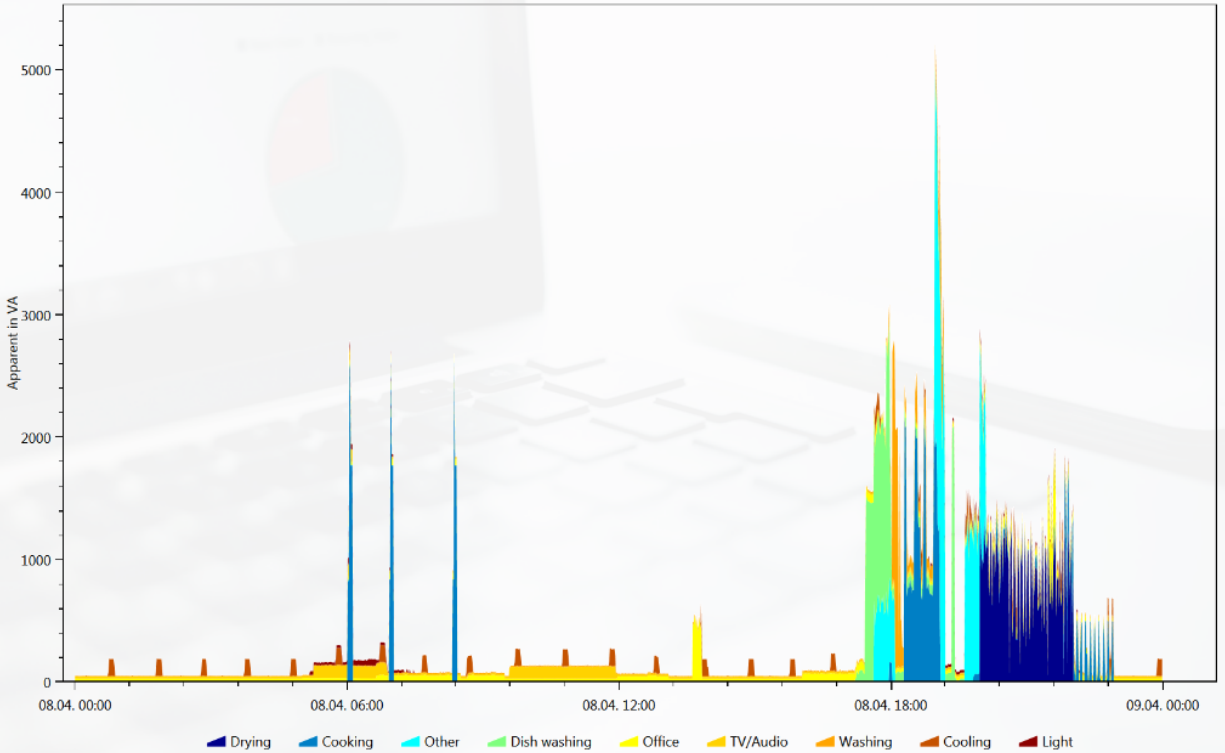
Estimation of users demand

LoadProfileGenerator tool (LPG)



LoadProfileGenerator
example of demand profile

"LoadProfileGenerator official page," 2020. https://www.loadprofilegenerator.de/ (accessed Jul. 02, 2022).

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Estimation of users demand

City Energy Analyst (CEA) demand profile generator

City Energy Analyst is an urban building simulation platform that combines knowledge of urban planning and energy systems engineering in an integrated simulation platform.

Collection of tools for the analysis of urban energy systems, one of the tools useful for this training module es the **dynamic demand forecasts**.

Inputs for data management: archetypes, weather, surroundings, terrain and street helper

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Estimation of users demand

City Energy Analyst (CEA) demand profile generator

Inputs for demand forecasting: building solar radiation, building schedules

Types of uses profiles such as: **coolroom, residential, foodstore, gym, hospital, hotel, industrial, laboratory, library, museum, office, parking, restaurant, school, swimming and university.**

Default monthly/ yearly multiplier schedule (Hospital use-type)

HOSPITAL	1	2	3	4	5	6	7	8	9	10	11	12
Monthly multiplier	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Default day/ hourly occupancy schedule (Hospital use-type)

HOSPITAL OCCUPANCY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Weekday	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.8	1	1	0.9	0.7	0.8	1	0.9	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.4
Saturday	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.8	1	1	0.9	0.7	0.8	1	0.9	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.4
Sunday	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.8	1	1	0.9	0.7	0.8	1	0.9	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.4

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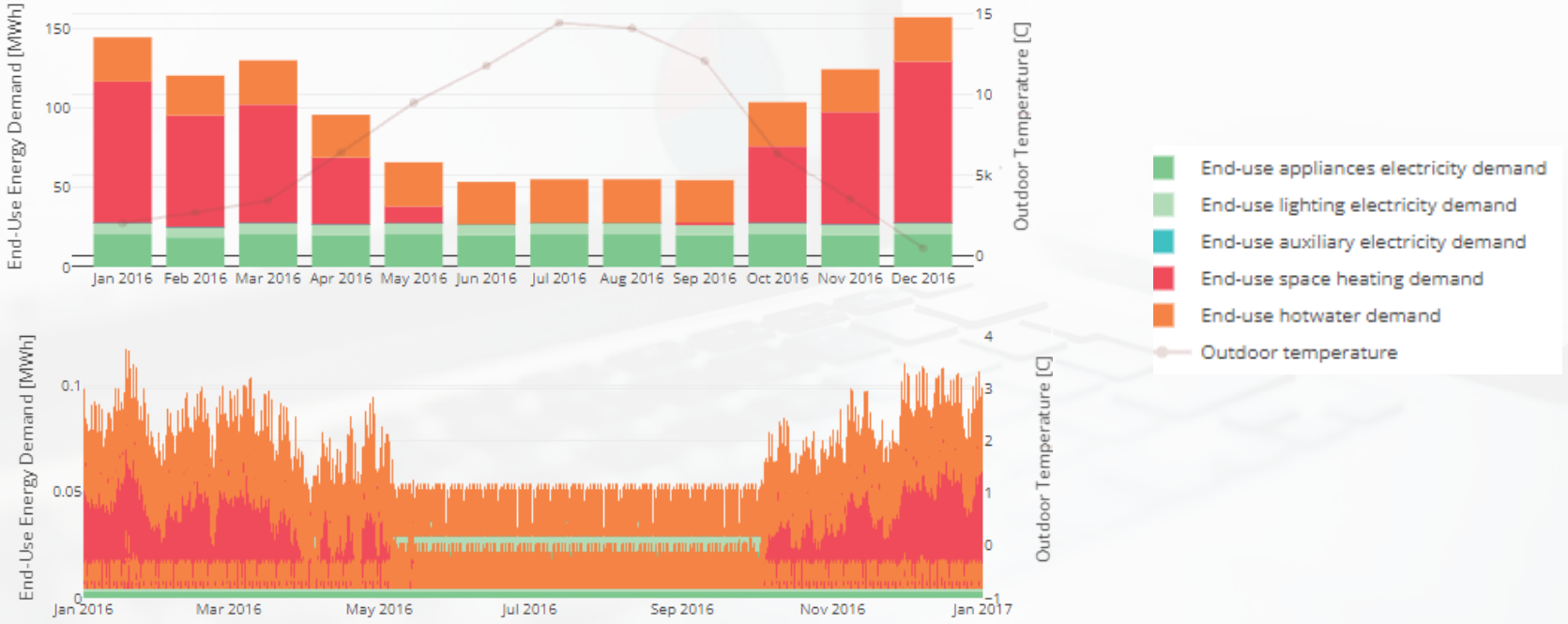
Estimation of users demand

City Energy Analyst (CEA) demand profile generator



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THANK YOU FOR YOUR PARTICIPATION

SOWHAT TEAM

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