ENERWAT project: some preliminary results

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ENERWAT project: some preliminary results

- In a time where scarce resources and climate change are a concern, it is important to define water and energy efficiency strategies that minimize the damaging impact on the environment.

- It is therefore necessary to develop research work to quantify and characterize consumptions, in order to define strategies for the rational use of water and energy.

- Water and energy systems have been treated independently. However, the consumption of water directly affects the consumption of energy, and therefore consumptions are closely related.

- ENERWAT project was developed, with a multidisciplinary project that counts on the participation of researchers from different areas at the University of Trás-os-Montes and Alto, and aims to give a step forward on this matter.

Aims to….

- Characterize the energy consumption associated with domestic water consumption in rural and urban areas, identifying the factors influencing these consumption.
    - By survey
    - And *in situ* measurements of dwellings located in both types of environments

- Create a simulator of water and energy consumptions.

ENERWAT tasks

1. State of the art;

2. **Design and application of a survey, data treatment and analysis;**

3. **On-site instrumentation and monitoring for the acquisition of water and energy consumption, in rural and urban environments;**

4. Definition of a consumption simulator;

5. Economic analysis;

6. Practical recommendations and dissemination of results.

The Survey

- Collection of water and energy consumption data
- Analysis of 80 variables (socio-demographic, economic, household characterization, among others)
- Find the factors that in rural and urban environments may justify the differences found in water and energy consumptions.

| Categories	Collected information
1. Characterization of the household	Number of members; age; qualifications; professional activity; family income.
2. Dwelling characterization	Environment location (rural or urban); area and typology of housing.
3. Energy consumption	Energy source used; electrical equipment; total energy consumption.
4. Water consumption	Type of water supply, number and duration of baths / showers, total water consumption.
5. Clothes washing	Washing machine; class of machine efficiency; number and duration of uses; hand wash.
6. Dish washing	Dishwasher; class of machine efficiency; number and duration of dishwasher use; hand wash.

The Survey
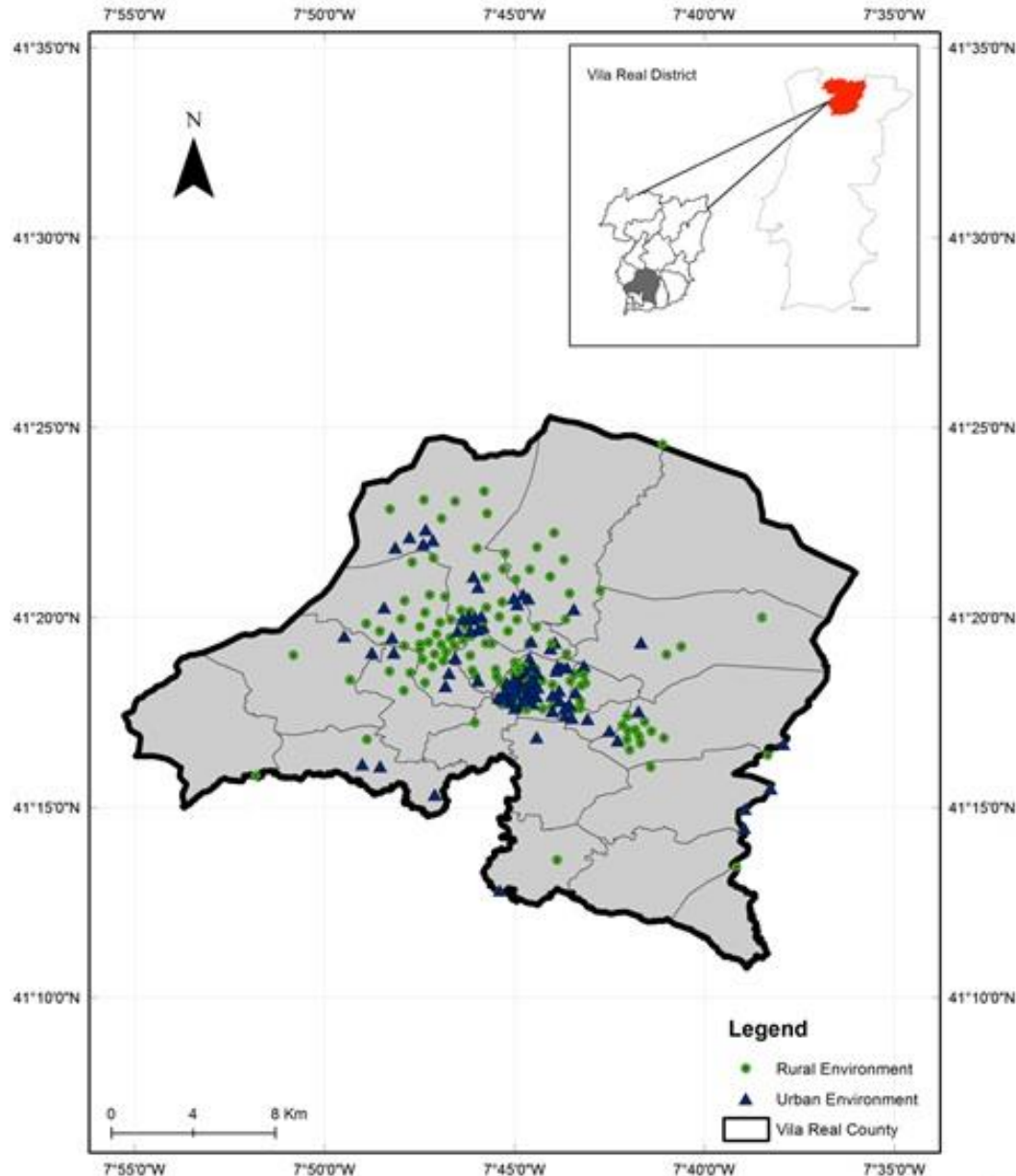
- Vila Real County is located in Northern Portugal, with 378.80 km^2 divided between urban and rural land classification
- This county has 20 parishes, 8 mainly urban (40%) and 12 mostly rural (60%), according to the National Statistical Institute (INE, 2015).
- A total of 256 households were surveyed (N=256). However, 11 surveys were discarded due to missing data.

The Survey

- Regarding water and energy consumption it was questioned, what was the range of values that were paid per month of water, electricity and natural gas.

- For the other sources of energy used (firewood, pellets, briquettes, diesel, bottled LPG, etc.) the annual expenses were requested.

- Monthly costs (€) (in the case of water, electricity and natural gas) were converted into monthly consumption (m³, kWh), based on the EMARVR collection form and EDP Vila Real.

- In the particular case of electric power, the normal and double tarif consumption was calculated separately.

- The mode of monthly and annual average consumption was calculated for rural and urban environments.

- For the remaining energy sources, the annual consumption value (toe - tonnes of oil equivalent) was calculated using the amount spent (€) and quantity (kg, l) using the conversion factors available for the various types of energy.

The Survey
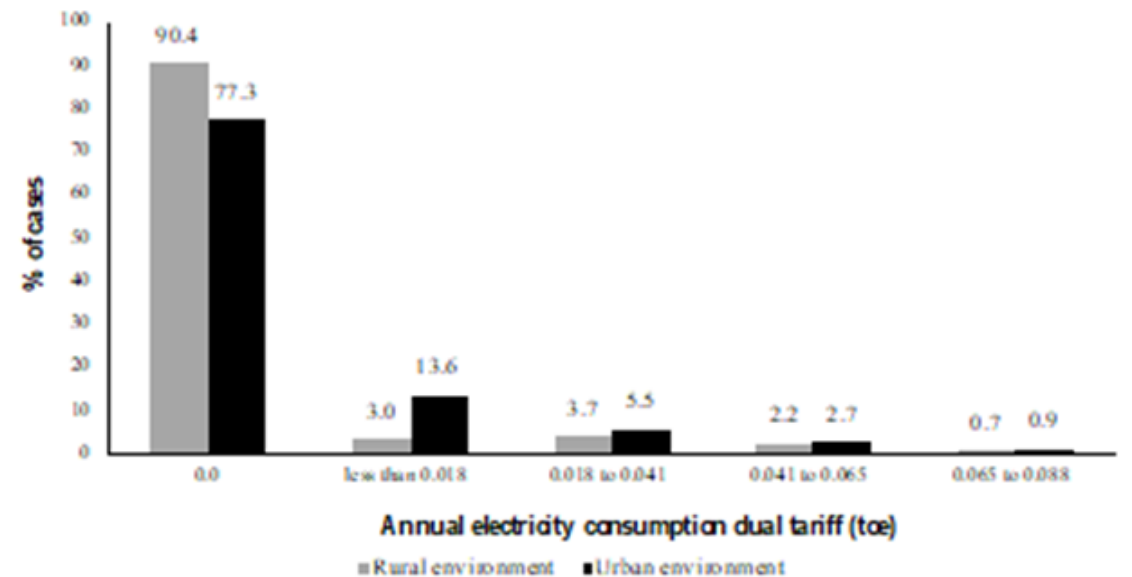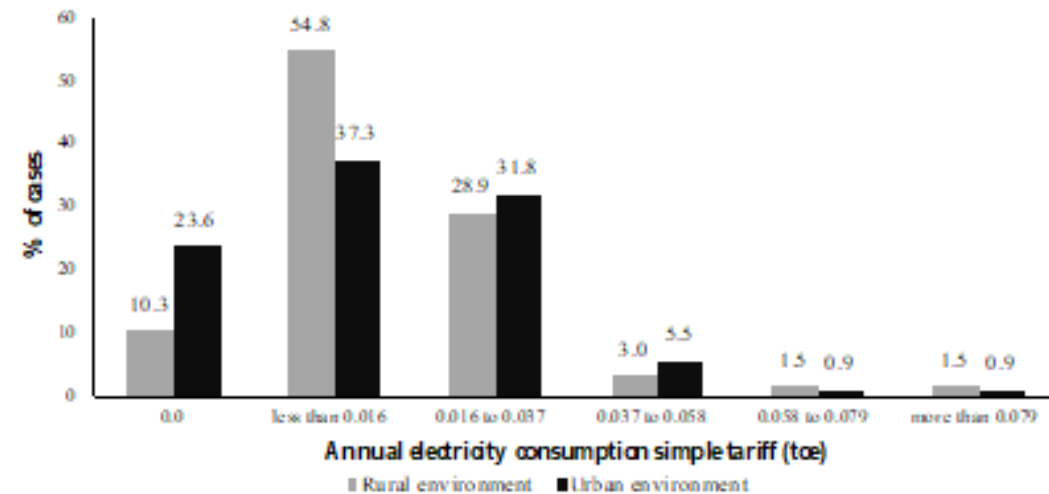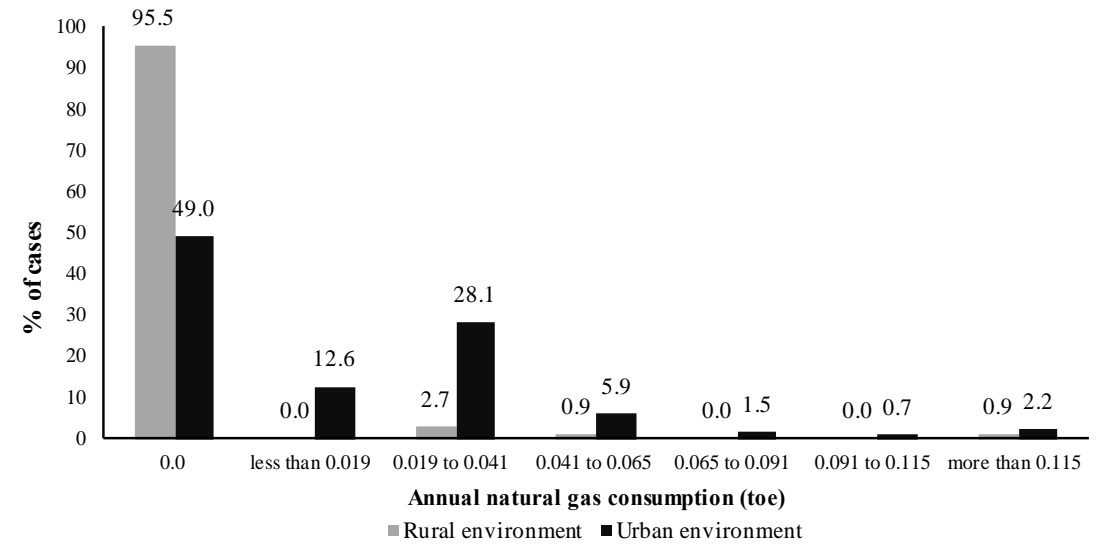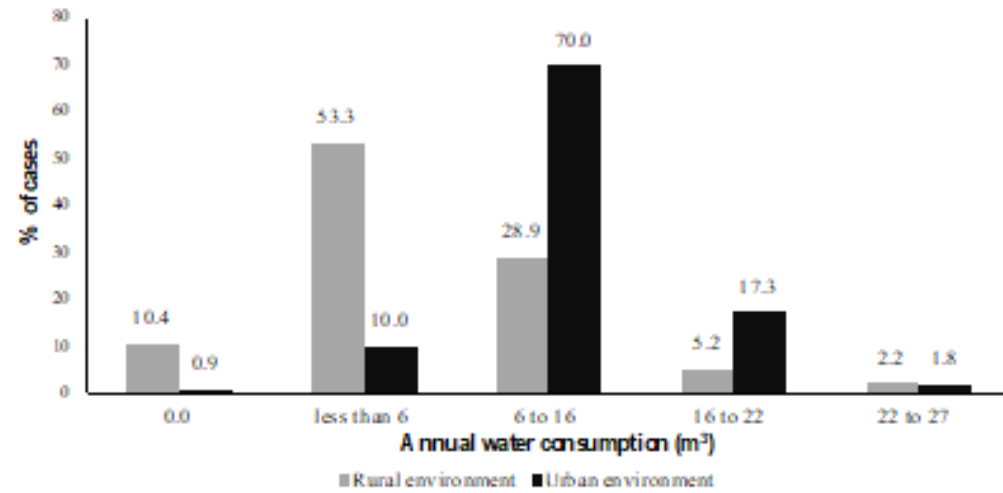
The Survey

- After the survey application in rural and urban areas and the data statistical treatment, 42 variables remained as truly differentiating factors of rural and urban environments and so as possible determinants of water and energy consumptions(Mann-Whitney-Wilcoxon test and the Chi-square test of homogeneity).

- All the 42 differentiating variables that result from this study may be able to justify the differences of consumptions found .

The Survey

Which are the factors that may explain the differences in water and energy consumptions in urban and rural environments?

Check for updates

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HIGHLIGHTS

- Factors that may support differences in water and energy consumptions in rural and urban areas
- Where found significant differences between rural and urban environments
- Descriptive data analysis and statistical inference (ST) are performed.
- Started with 80 variables after ST only 42 remained as differentiating factors

GRAPHICAL ABSTRACT

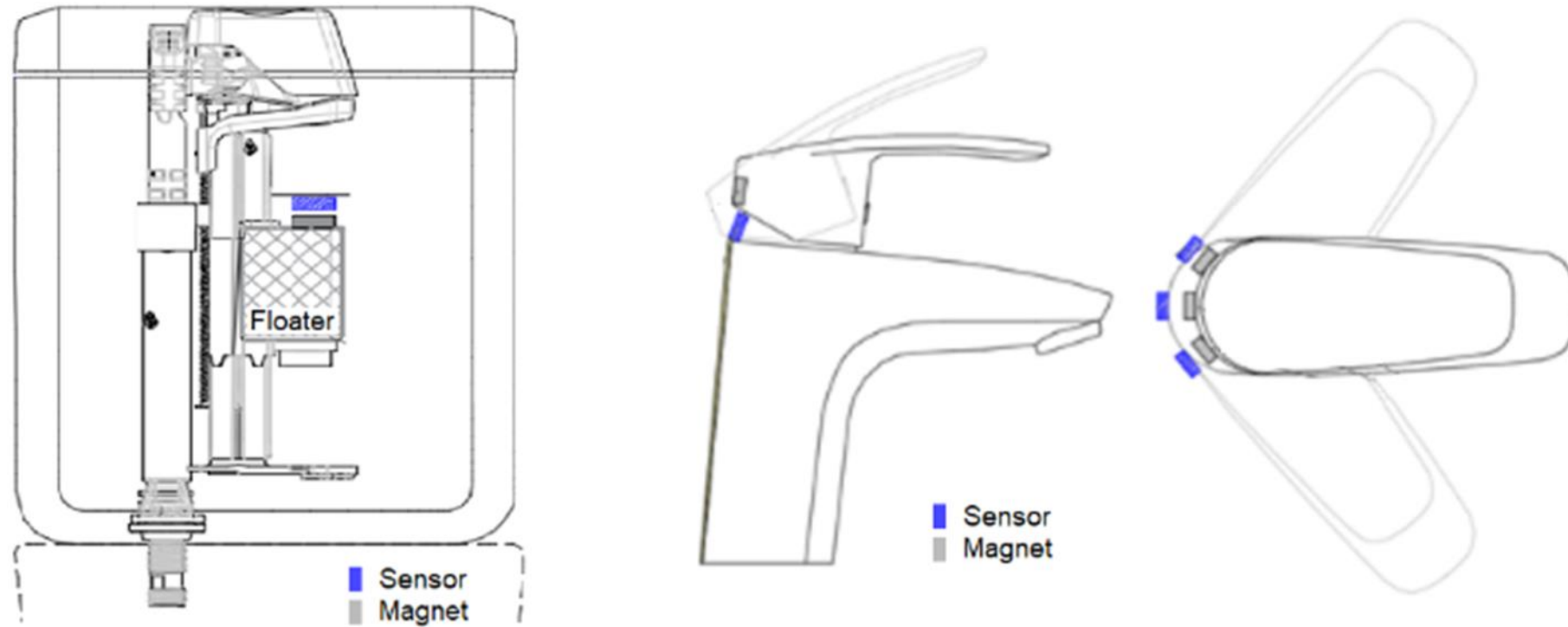# On-site instrumentation and monitoring for the acquisition of water and energy consumption

- The overall project (ENERWAT) involves one year of measurements, in 9 different households (4 in rural and 5 in urban environment) still in progress.
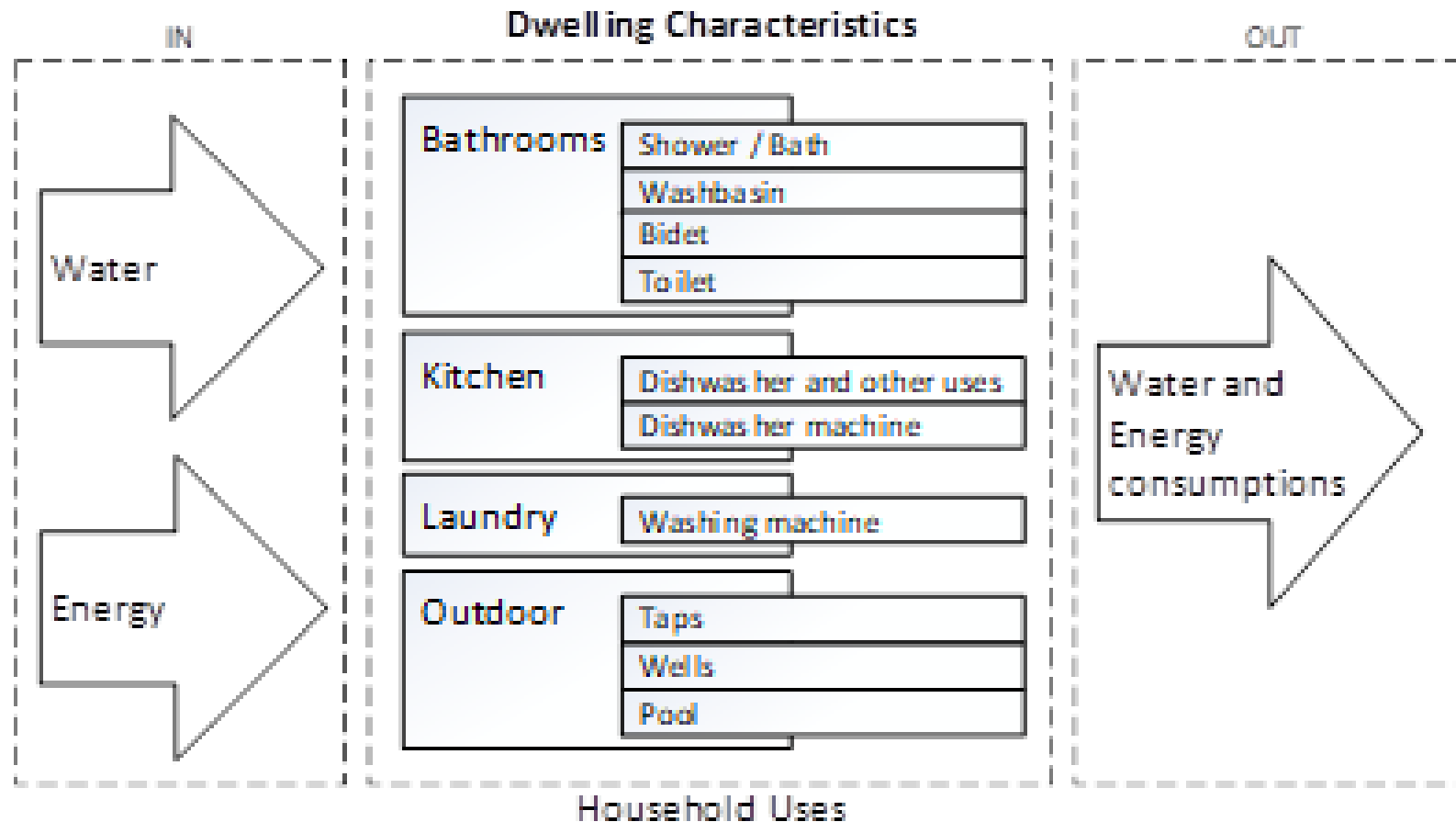
On-site instrumentation and monitoring for the acquisition of water and energy consumption

- A continuous measurement of the water and energy consumptions was carried out in situ using WATERS system (defined by the ENERWAT project).

- The acquisition system is composed by three main components: central nodes, sensors and cables, and central server (Cunha, A. et al, 2017).
  - Nodes are small board computers (SBC) placed at each dwelling strategic sectors. They are responsible for acquire data from sensors, store it locally and periodically transmit it to the central server through a secure channel (VPN).

- Sensors are responsible for convert physical events into electrical signals. It was decided to use only two types of sensors: On/off sensors and webcams for reading water and energy consumptions from the dwellings meters. Cables are used to connect sensors to nodes.

On-site instrumentation and monitoring for the acquisition of water and energy consumption

Placement of sensors on taps and toilet flush

On-site instrumentation and monitoring for the acquisition of water and energy consumption

## From water to energy: low cost water & energy consumptions readings

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On-site instrumentation and monitoring for the acquisition of water and energy consumption
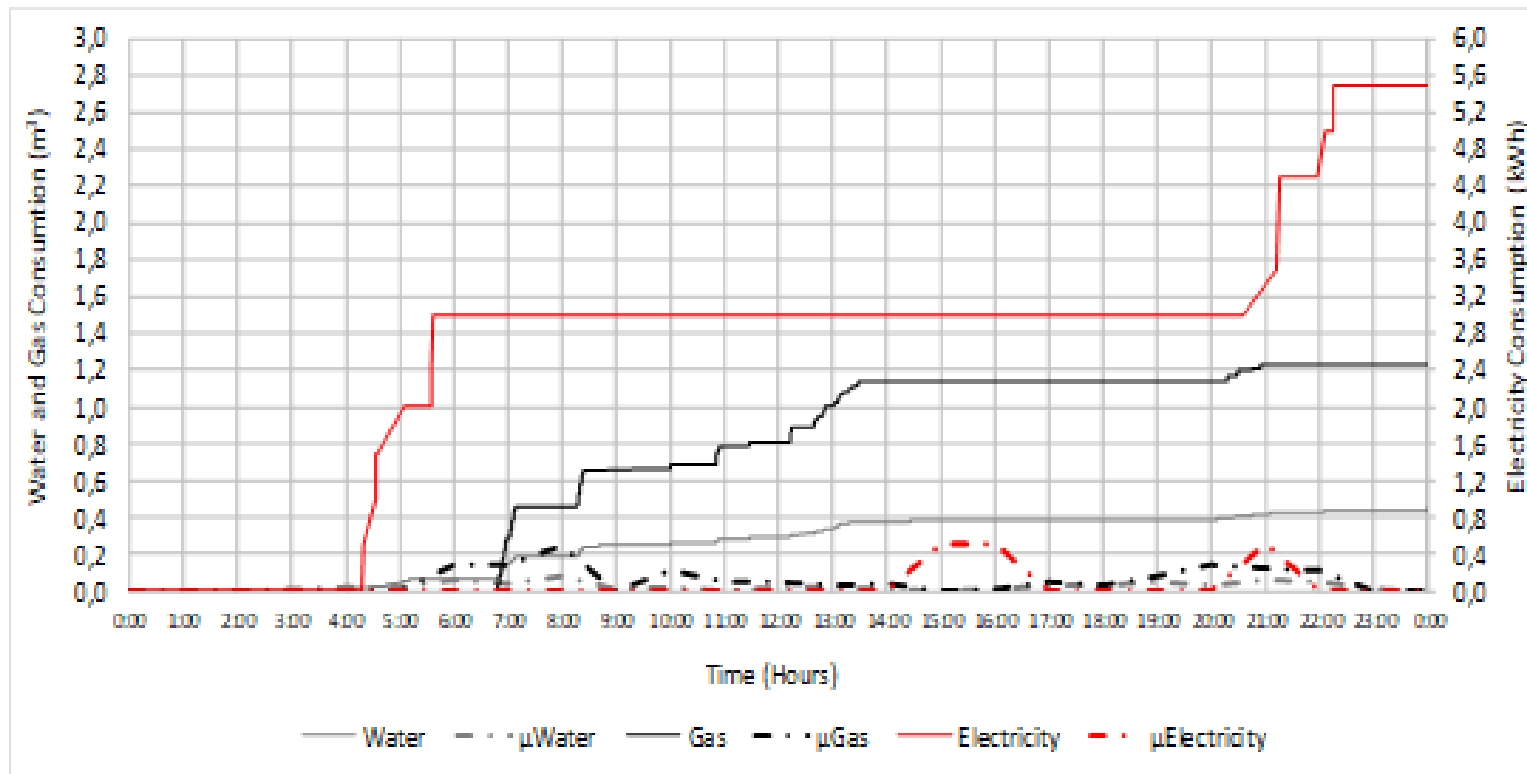

example of the type of results that can be obtained through the instrumentation and monitoring of household consumption

Values of hourly and average hourly (μ) of water, electricity and gas

On-site instrumentation and monitoring for the acquisition of water and energy consumption

An example of the daily consumptions per person of water and energy (gas and electricity) in the domestic devices monitored.
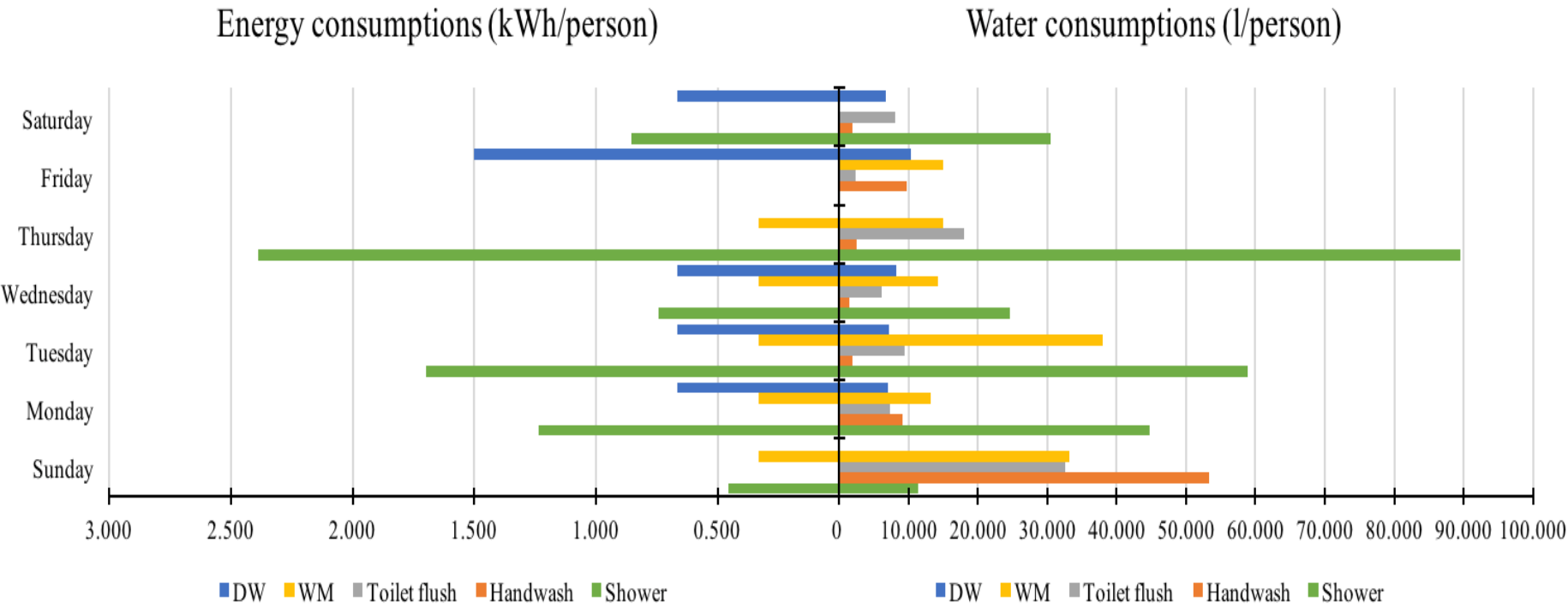
Final remarks

- The preliminary results revealed by the surveys indicate differences between domestic consumption of water and electricity, between rural and urban areas.

- There appears to be some seasonality in the data collected.

- The data collected by the survey reveal significant differences between the sociodemographic variables in the rural and urban environments, and it is important to understand if and what are the predominant variables in the differences found in the consumption of water and energy, work in progress at the moment.

- In the future it would be interesting to extend the application of the survey to other regions of the country in order to identify the main differences between the different regions.

Final remarks

- The work developed so far allows the continuous collection of data in situ through a simple monitoring system.

- The system allows identifying the water consumption devices used, the consumption of water (hot or cold), the period of use and the source of energy used (electricity or gas) and their consumption.

- In May, next year a seminar will be held with the dissemination of the results of the project.

- This project will contribute to the knowledge and will allow the advancement of science in this area and also the definition of new strategies for the efficient management of "water" and "energy" resources.

ACKNOWLEDGEMENTS

Thank you

http://enerwat.utad.pt