JUNE 4, 2025

#EU GREEN WEEK

EU Green Week Partner Event

Untangling water-energy-food systems at local level – The case of CitySelfy project

Luís P. Dias, Júlia Seixas, Monica Truninger, Ana M. Vales
Luísa Schmidt, Rosário Oliveira, João Graça

NOVA SCHOOL OF SCIENCE & TECHNOLOGY
CENSE center for environmental and sustainability research
U LISBOA UNIVERSIDADE DE LISBOA
ICS INSTITUTO DE CIÊNCIAS SOCIAIS

CitySelfy

THE WATER-ENERGY-FOOD NEXUS: BUILDING RESILIENCE TO GLOBAL CHALLENGES

NexusNet

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

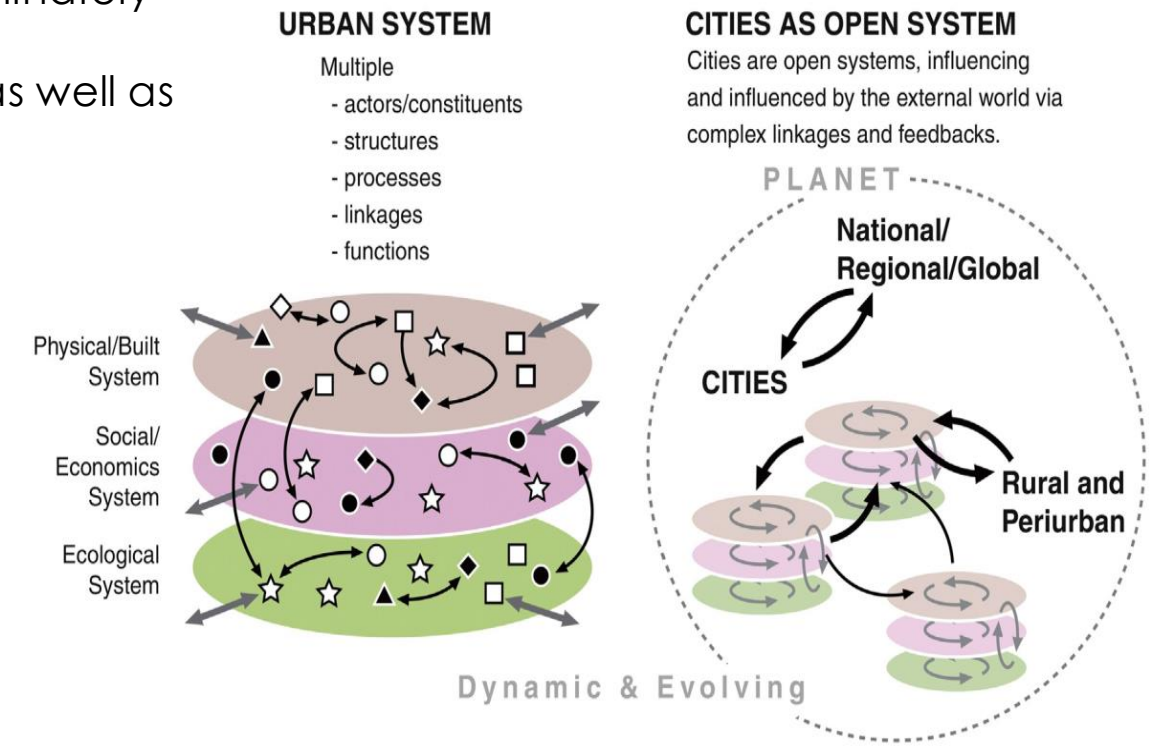
Context and challenges

Water, energy and food are **essential for human well-being and sustainable development**, and their availability and production are highly **interconnected**.

- Water is used along the entire food supply chain, but predominately at production and consumption phase.
- Energy is required to produce, transport and distribute food as well as to extract, collect, transport and treat water.

WEF nexus debate has emphasized the importance of better understanding the interconnected resource systems and the need for **integrated management paradigms**

Innovative approaches and modelling tools are necessary to **support city planning** and compliance with climate change mitigation goals.



Urban system structure and interlinkages

(source: (Bai, Xuemei, Richard J. Dawson, Diana Ürge-Vorsatz, Gian C. Delgado, Aliyu Salisu Barau, Shobhakar Dhakal, David Dodman, et al. 2018. "Six Research Priorities for Cities and Climate Change." *Nature*. Nature Publishing Group. https://doi.org/10.1038/d41586-018-02409-z.

Research objetives

Alternative **future pathways**, corresponding to different levels of **resources self-sufficiency**, of **climate mitigation**, and other scenarios, will be assessed in terms of its **impact in the sustainability.**

TIMES modelling **tool to provide WEF resources dynamic integrated assessment.**

Essential insights on the relation between self-sufficiency and sustainability at the local scale

Cascais municipality

Cascais energy strategy is under development and aligned with national level targets, namely the 2030 National Energy and Climate Plan (NECP).

Cascais has developed **carbon neutrality roadmap.**

Located in a region with **high vulnerability to climate change related impacts**.

- **109k households**
- **97.4km^2**
- **210 361 inhabitants**

Methods and tools

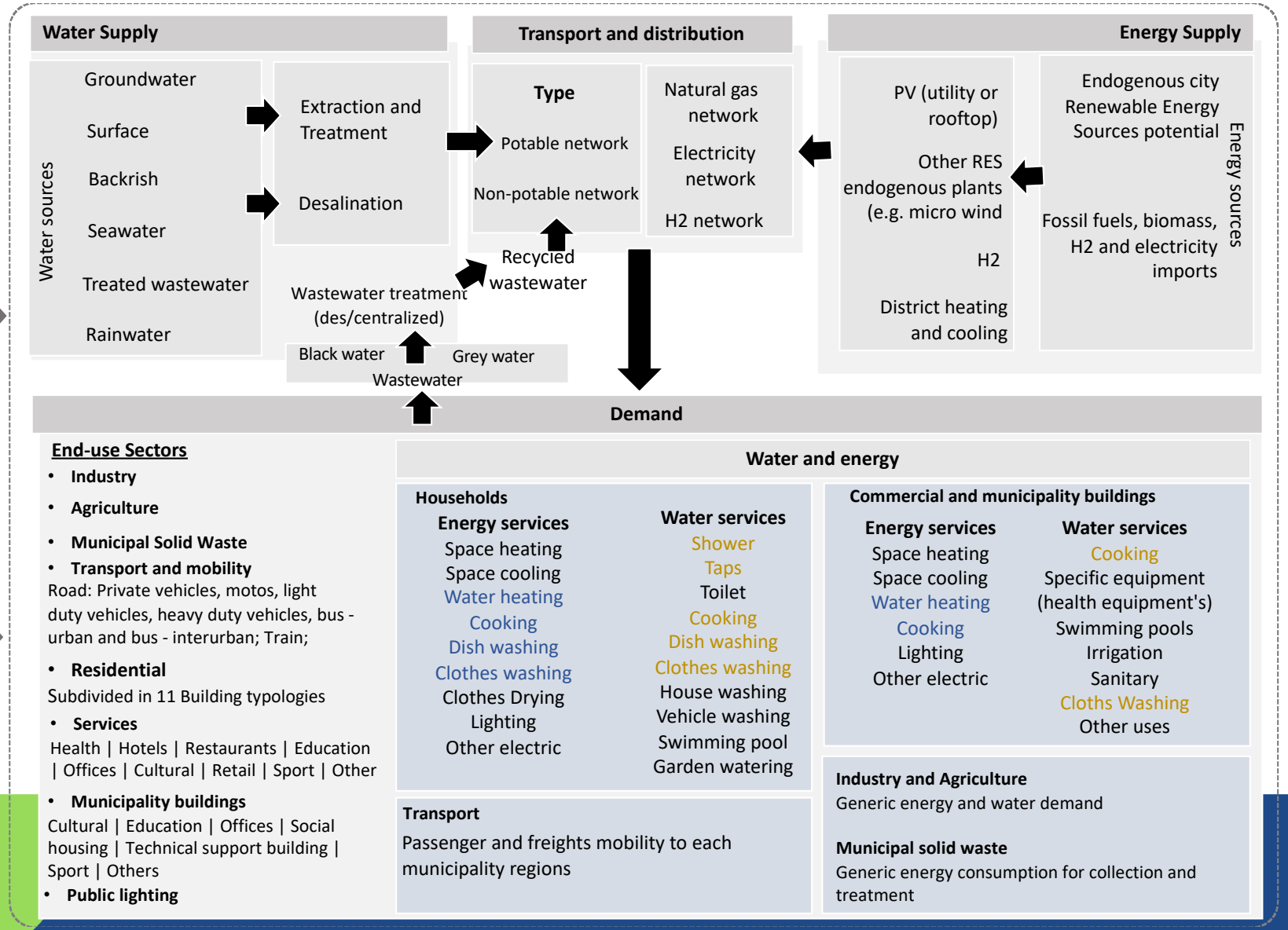
CitySelfy project was developed using an i**nterdisciplinary framework combining technical-economic modelling with social dimensions**.
The **TIMES_CityWEF model** was created to simulate medium- and long-term scenarios for **optimizing local Water-Energy-Food (WEF) resources**. - model emphasizes both technology adoption and behavioral changes in consumption patterns.

Socio-economic data was collected through:
- A survey of over 600 residents
- Targeted interviews
- Stakeholder Workshops
- Focus groups with local stakeholders

This data supported:
- The characterization of WEF system components
- The development of scenarios to evaluate cost-effectiveness and sustainability of pathways to climate neutrality by 2050

Scenario narratives incorporated:
- Socio-environmental preferences
- Technological acceptance by the community

TIMES_CityWE model overview
water and energy supply, transport and demand



Outcomes for future scenarios

Optimal technological mix (supply and demand side):
Capacity
Investment and O&M costs
End-use technologies

Energy flows and prices
Electricity
Energy consumption
Energy intensity indicators

Environmental
Greenhouse gases
Air Pollutants
Carbon footprints

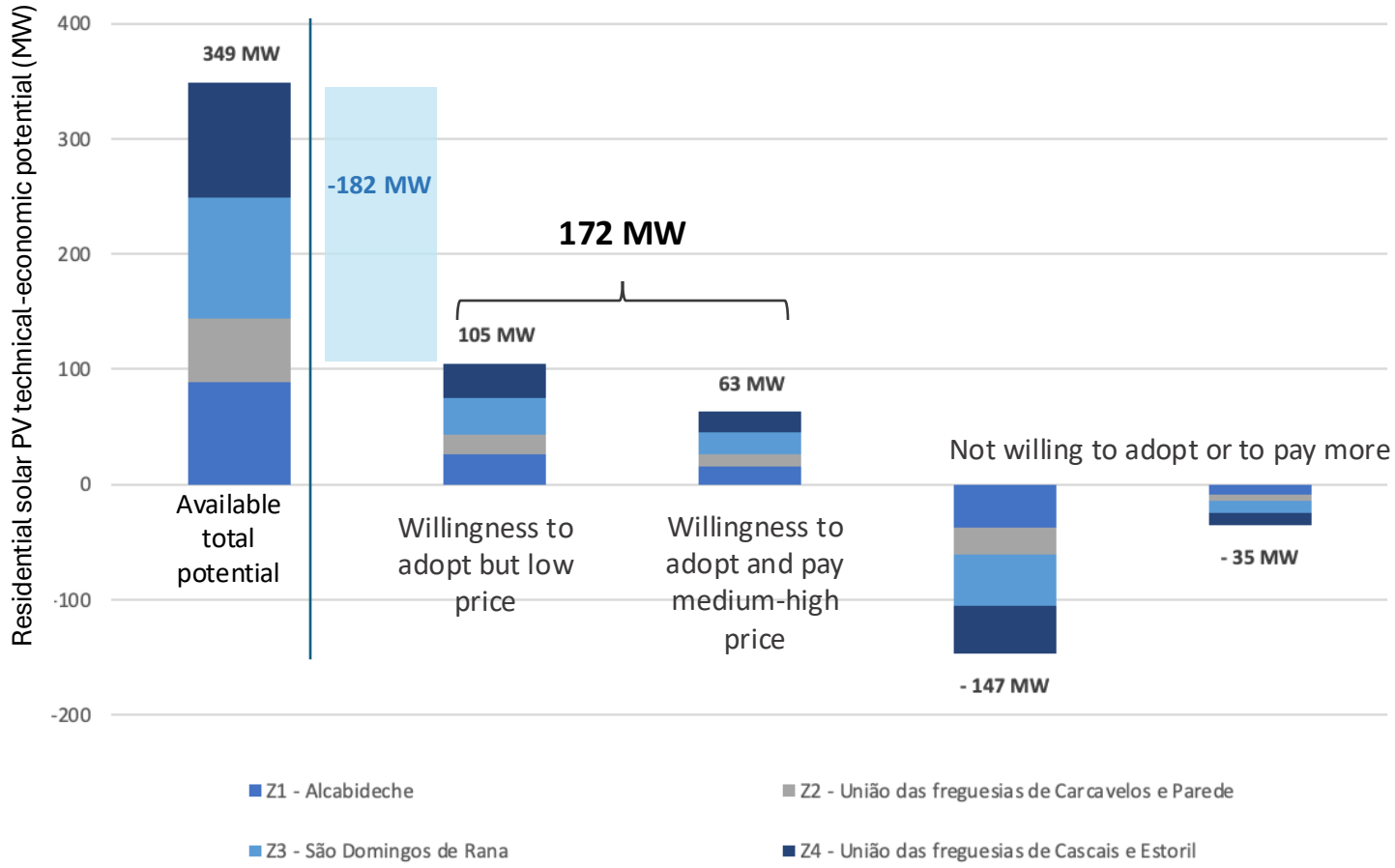
Source: Dias, L. P. and Seixas, J. (2024) Net-Zero Carbon as a Cost-Effective Enabler of Water and Energy Self-Sufficiency. (Under review: Sustainable Cities and Society Available at SSRN: https://ssrn.com/abstract=4971576 or http://dx.doi.org/10.2139/ssrn.4971576

#EUGREENWEEK

Modelling citizens Willingness to adopt vs Willingness to pay for renewable and local electricity production

- Survey results:

Around **60%** of local population are willing to purchase/acquire DRES-E
In average, residents are prone to pay **12.4% more for DRES-E**

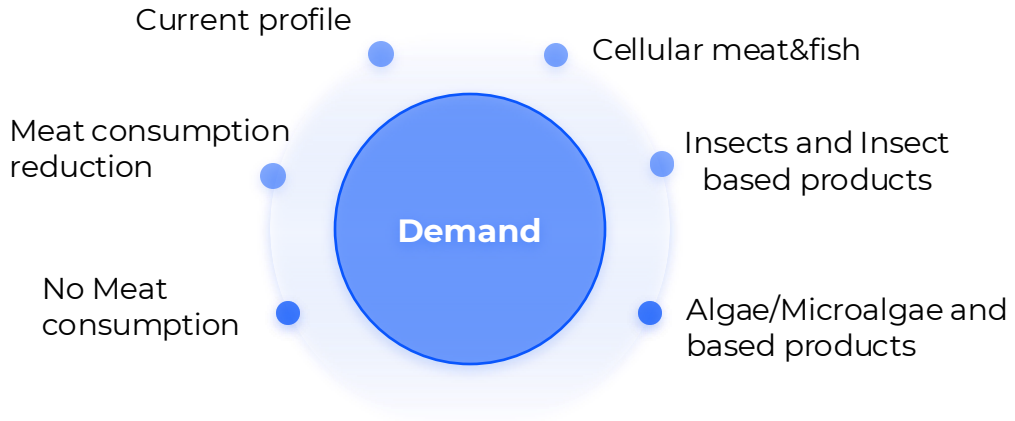


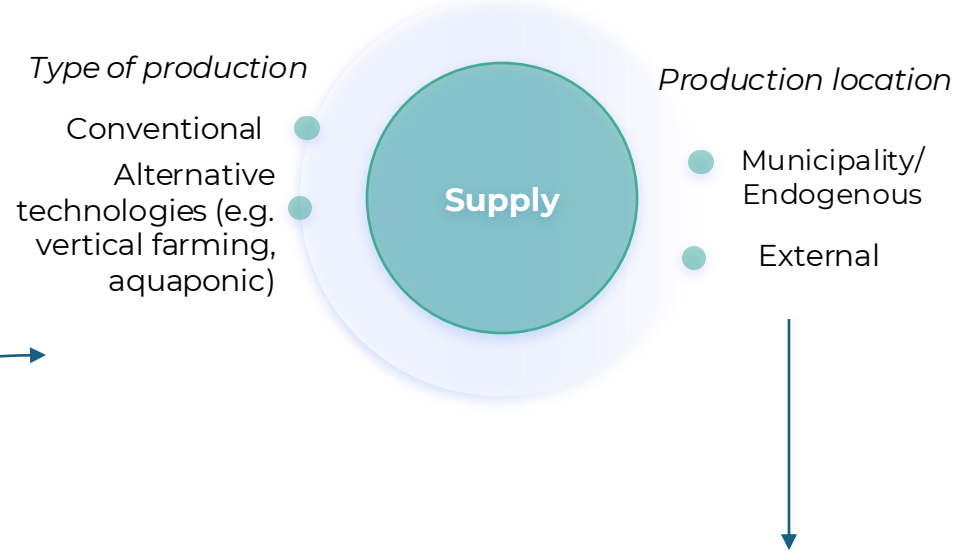
TIMES City_WE Run results

- Municipality **electricity self-sufficiency** potential: from around 80% to **43%** due to **Higher electricity import** necessity;
- Higher GHG emissions: +3% in 2030;
- Higher **external vulnerability** for compliance of **carbon neutrality objectives**: dependence on GHG footprint of imported electricity
- Higher **energy system cost of 6**% due to electricity imports-> delay residential sector electrification in 2030;

#EUGREENWEEK

Food System Scenarios



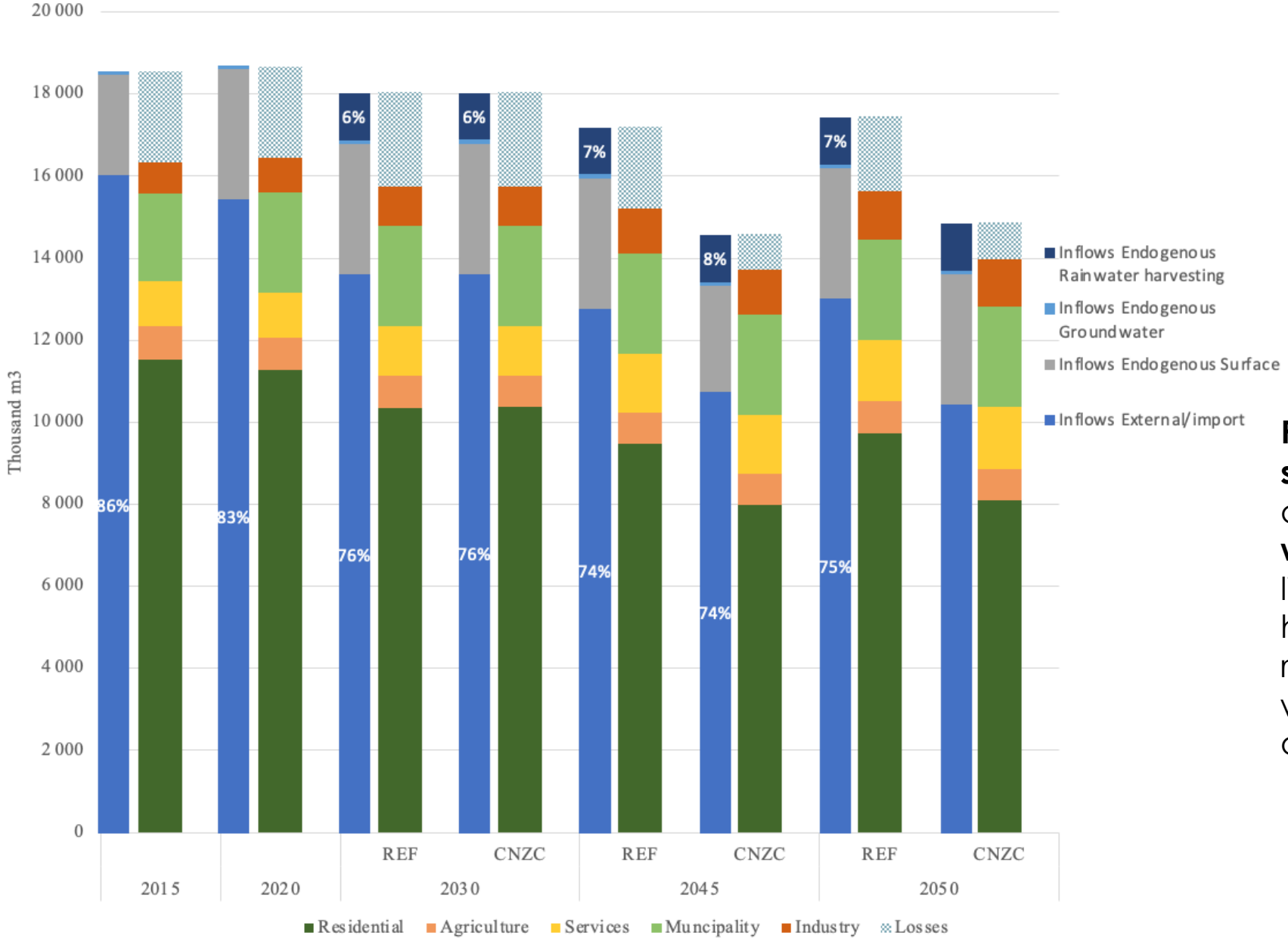


605 local citizens survey

Legumes (such as beans): currently 1% is produced in the municipality

Fish: Currently 9% consumption from local capture; 2050 assuming WtC local food products 35% from the municipality through alternative sources such as cell or aquaponics

Water system configuration



Rainwater harvesting became **a significant water source**, accounting up to **8% of total water inflows**, despite being limited to non-potable uses in households, due to its ability to reduce energy consumption for water supply in comparison with other available options

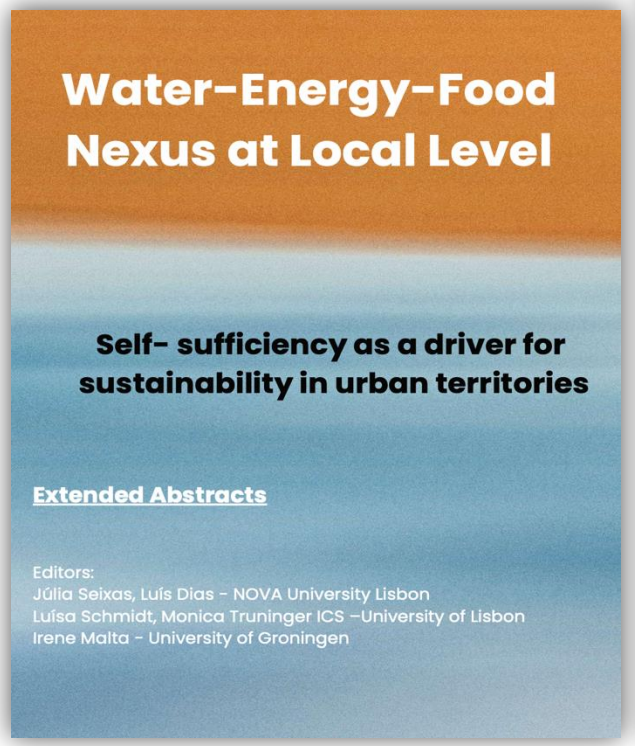
#EUGREENWEEK

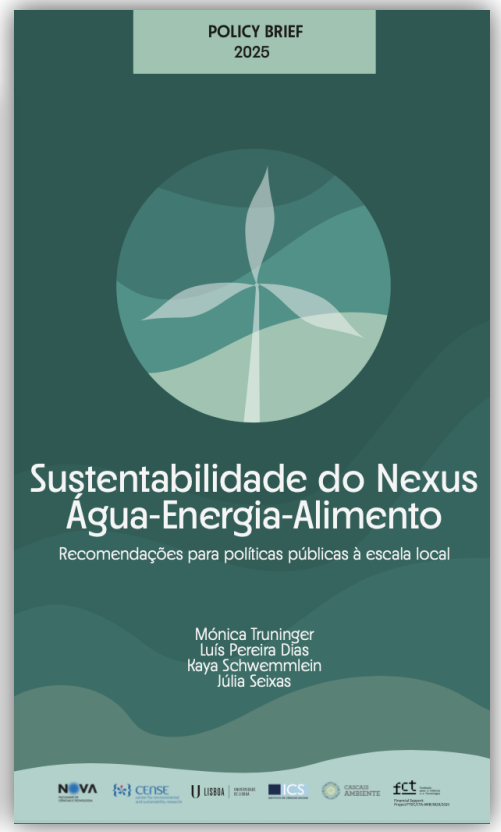
Insights

City sustainable transitions face complex and interdependent challenges
Integrated modelling provide benefits to reduce lock-ins and enhance synergies between water-energy and food systems.

Techno economic models tend to focus on technology and cost-efficacy transitions disregarding other **determinants such as consumer behaviour** and citizen socio-economic conditions that can hamper or limit the transition process.

Citizens surveys can offer important information/data to support modelling exogenous assumptions. Although it can be perceived as a soft model integration it provides robust representation of **Citizens behaviour/preferences** and socio-economic conditions that in turn can have high impact on various component of energy transition and benefit into inform local policy and decision-making





Thank you

Luís P. Dias

@ luisdias@fct.unl.pt

W https://cityselfy.webhost.fct.unl.pt

CitySelfy

CENSE center for environmental and sustainability research

NOVA SCHOOL OF SCIENCE & TECHNOLOGY

ICS INSTITUTO DE CIÊNCIAS SOCIAIS

U LISBOA | UNIVERSIDADE DE LISBOA

FCT Fundação para a Ciência e a Tecnologia

Financial support: Project PTDC/CTA-AMB/6629/2020