GFN capabilities in the energy sector

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Numerical Fluid Dynamics Group
University of Zaragoza, Spain

GFN in a nutshell

- Experience in a vast array of **multidisciplinary tools**, including: GIS, numerical weather prediction tools, hydrological models, building energy modelling software, OpenModelica, CFD software and energy modelling tools such as LEAP, TRNSYS
- We have cooperated with Industry, with governments and with non-profit, non-government development agencies.
- Participation in **more than 10 European projects**, and coordinators in four of them.
- More than **70 publications** in JCR journals
- **National delegate in Task 60 of the IEA**, Solar Heating and Cooling programme (Application of PVT collectors, https://task60.iea-shc.org/).
- Last projects:
  - 3GSol project – Solar hybrid PVT collectors of high efficiency integrated within a trigeneration system for the food-processing industry
  - PrioritEE project - Prioritise energy efficiency measures in public buildings
  - CrossCert coordinators: Cross Assessment of energy certificates in Europe

Modelling national energy systems

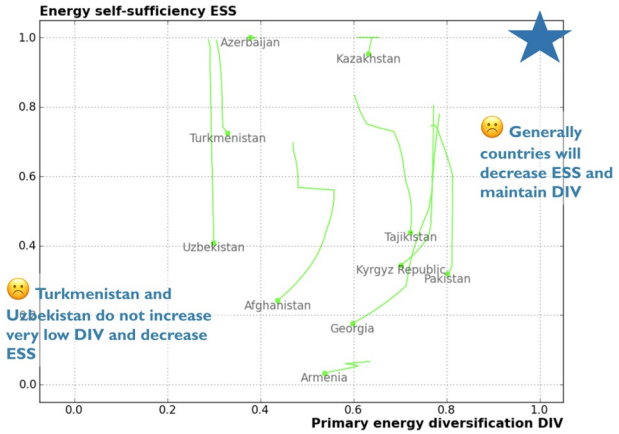
- Bottom-up models of national energy systems using LEAP:
  - Spain
    - https://www.sciencedirect.com/science/article/pii/S0360544216300457
  - Kazakhstan
    - https://www.adb.org/sites/default/files/project-document/76385/44402-012-reg-tacr-01.pdf
    - https://www.sciencedirect.com/science/article/pii/S0360544214005337
  - Uzbekistan
    - https://www.adb.org/sites/default/files/project-document/76386/44402-012-reg-tacr-02.pdf
    - https://www.sciencedirect.com/science/article/pii/S0360544215003825
  - China
    - https://www.adb.org/publications/asias-energy-challenge-key-issues-and-policy-options
  - India
    - https://www.adb.org/publications/asias-energy-challenge-key-issues-and-policy-options
  - El Salvador

Energy indicators

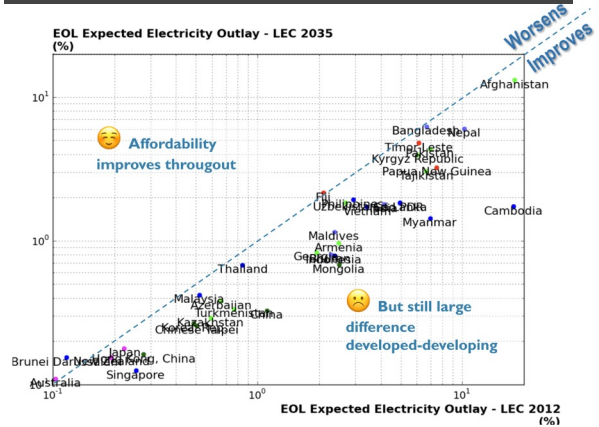
- Large-scale study for **all** Asia-Pacific countries:

  Sustainability | Affordability | Security
- Quantitative!
- Calculation of indicators 2013-2035
- For Asian Development Bank, Manila
- Many extensions possible, eg energy poverty, energy starvation

Energy security in Central Asia



Energy affordability

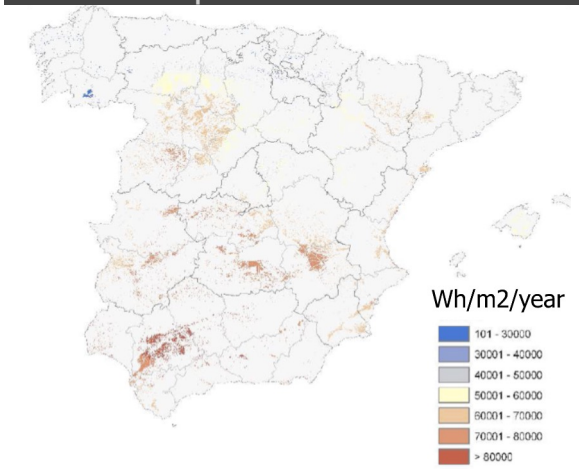


Renewable energy potential

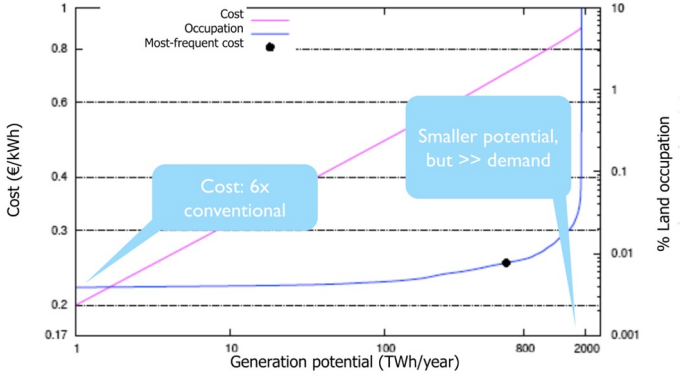
- Estimation of renewable energy potential and cost in Spain
  - Methodical, wide ranging
  - Solidly grounded in data
- All renewable energies:
  - Wind -- Onshore, offshore
  - Solar -- PV, thermoelectric [thermal]
  - Biomass, [biofuels]
  - Residues -- biomass, urban, water treatment plants, industrial
  - Hydro -- Large, small
  - Wave
- Maps of potential:

  physical | geographical | technical
- Cost-generation curves

Parabolic trough thermal-solar: Technical potential

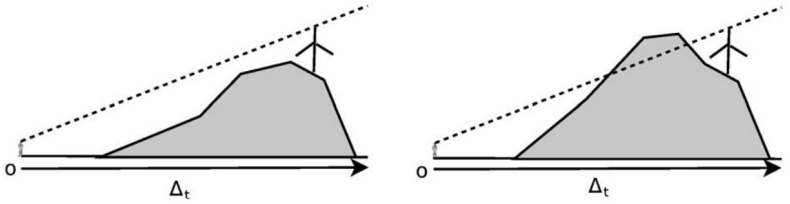


Parabolic trough thermal-solar: Cost-generation-occupation curve



Assessment of social impacts

- Determination of objective indicators for the visual impact of large scale deployment of renewable energy
  - Directly Occupied Area
  - Visually-Affected Area
  - Visually-Affected Populated Area
  - Visually-Affected Travel Time



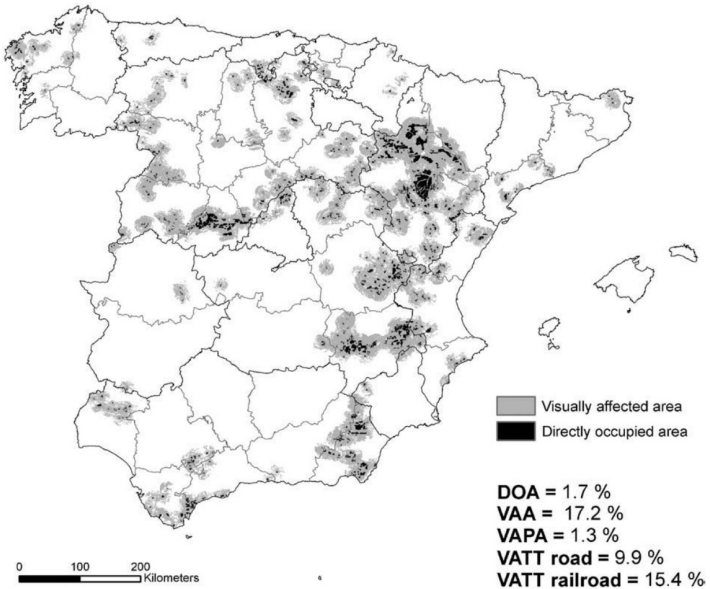
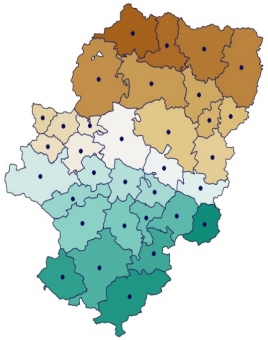


Fig. 2. Visibility map for a scenario generating 50 TWh/year of wind energy (installed power: 32 GW).

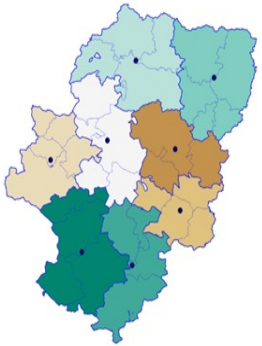
Assessment of social impacts

- Economic, Environmental and Social Effects of Biomass Exploitation Scales
- Comparing impacts of different scales of biomass pellets plants in the territory:
  - Economic
  - Environmental (eg. CO2 emissions)
  - Social (eg. job creation in depopulated areas)

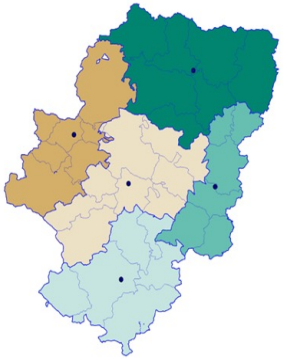
Biomass exploitation strategies



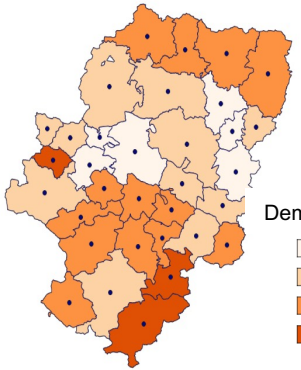
Small plants

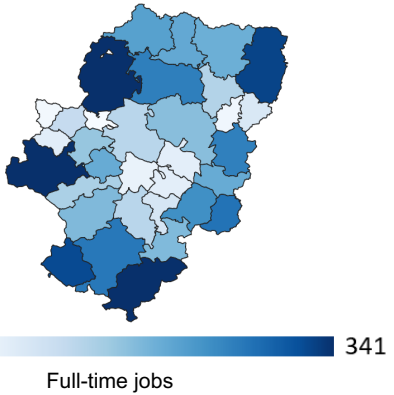


Mid-size plants



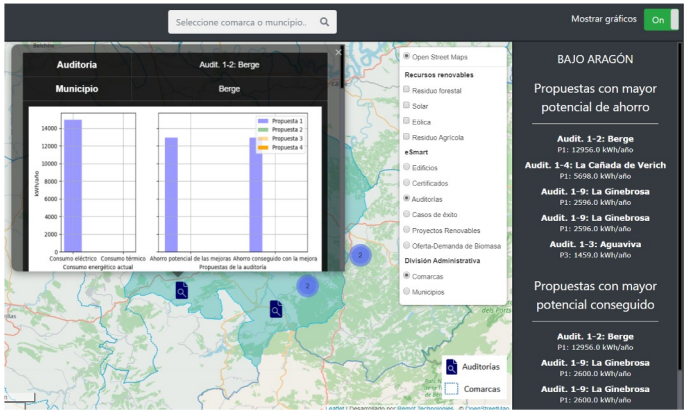
Large-size plants

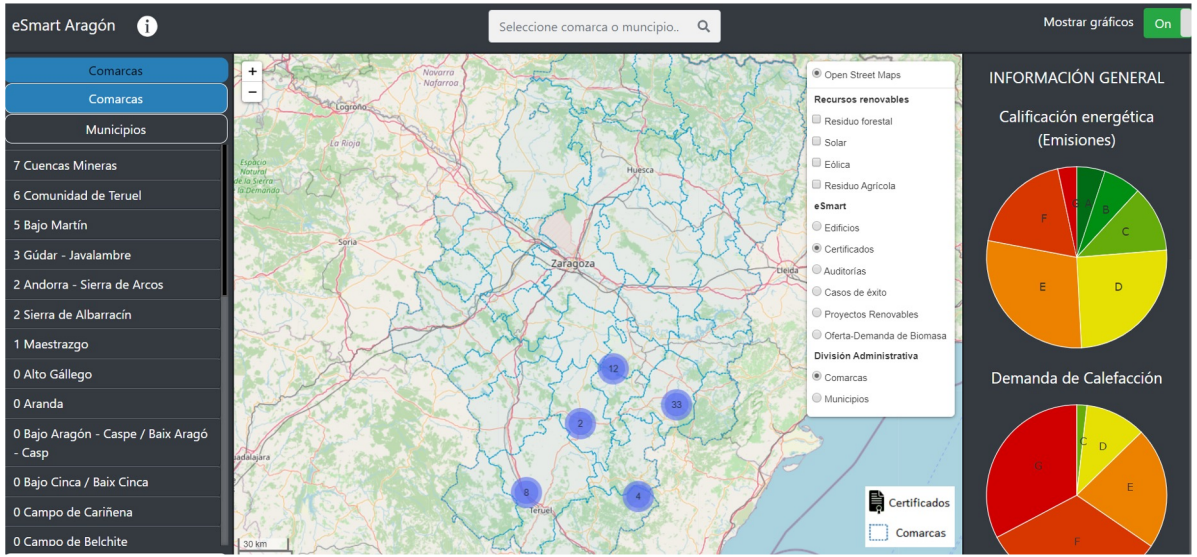




Energy data as a policy driver

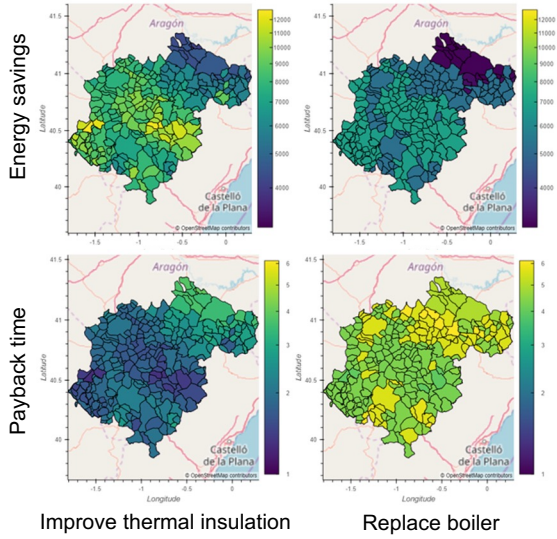
- Development of databases and user-friendly apps to gather the energy performance of buildings, energy audits and renewable energies installed in municipalities/regions
- Support the decision-making process concerning energy issues and the implementation of energy efficiency measures (e.g. for Energy Action Plans, SEAP/SECAPs)

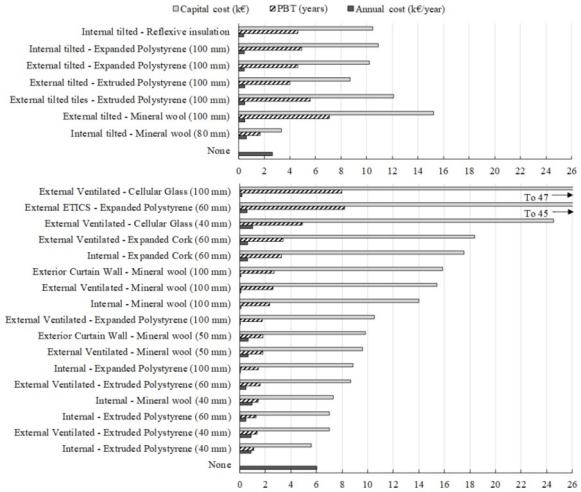




Energy efficiency of buildings

- Analysis of buildings' energy demand and performance
- Modelling the building energy performance (e.g. thermal losses estimation, lighting analysis) integrated with GIS
- Techno-economic assessment of energy efficiency measures at building level
- Extrapolation of results at regional/national levels

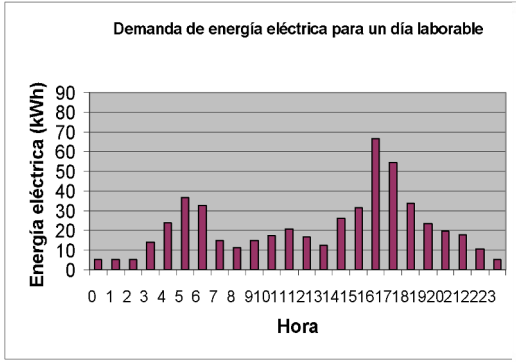


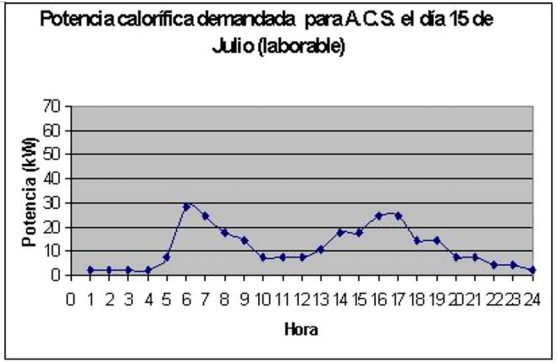


Building integration of energy generation

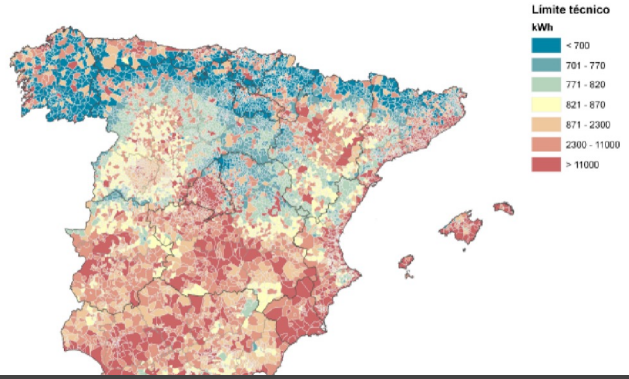
- Building energy demand modelling
- Distributed energy generation
- Large-scale availability of roof-top area for solar applications

Building energy models and energy demand





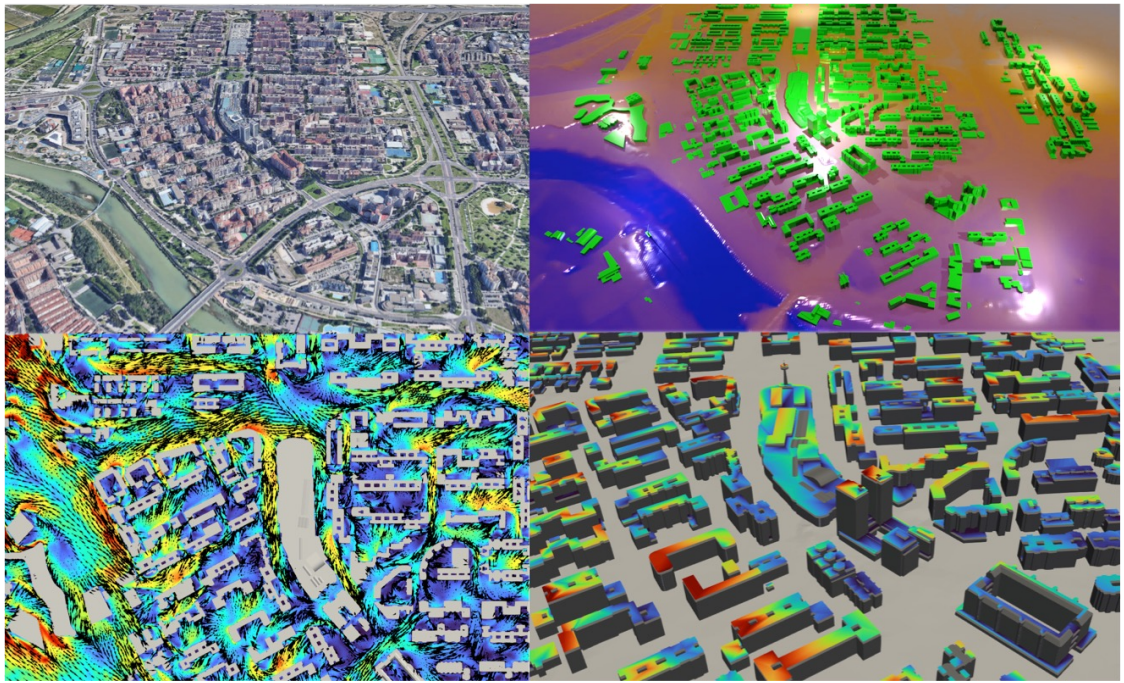
Salvador Izquierdo, Marcos Rodrigues, Norberto Fueyo: A method for estimating the geographical distribution of the available roof surface area for large-scale photovoltaic energy-potential evaluations, Solar Energy 85 (2011) 208–213



Technical limit for rooftop PV, kWh/year

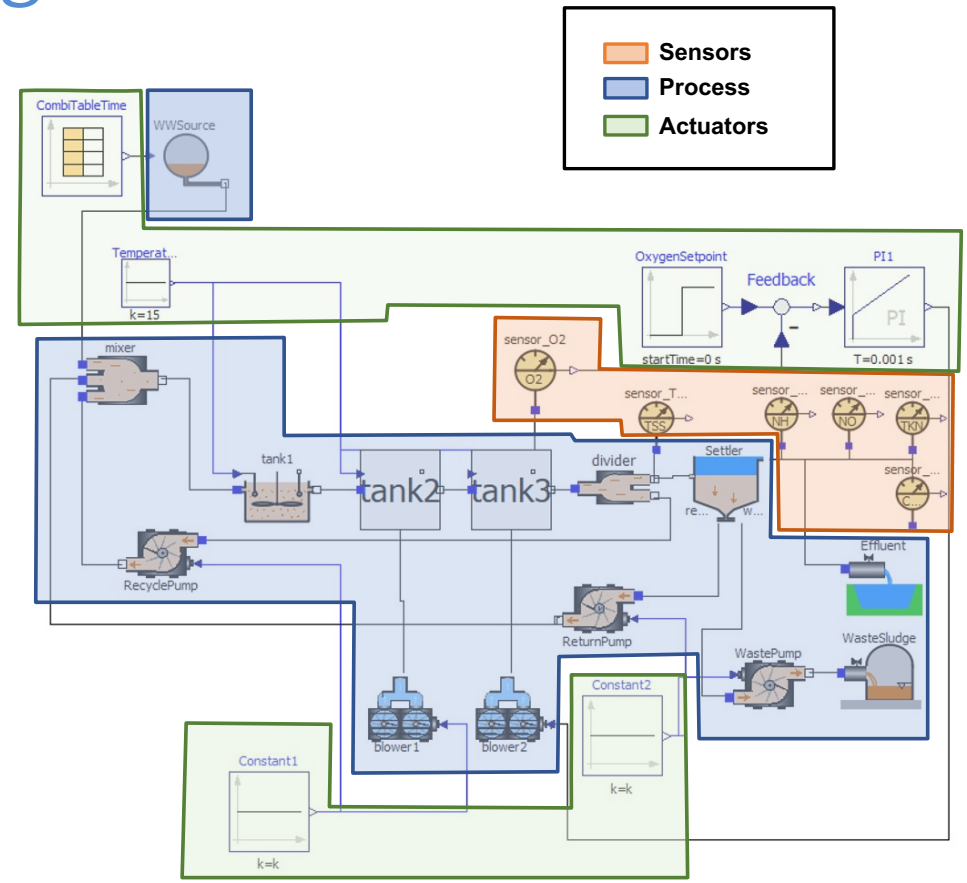
Urban Wind

- Development of reduced order models and machine learning for the high resolution wind forecast (e.g.urban environments)



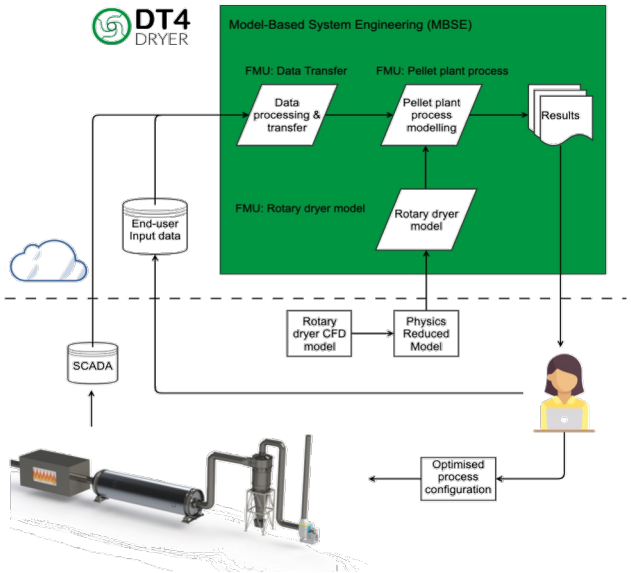
Hybrid Multiphysics Digital Twins

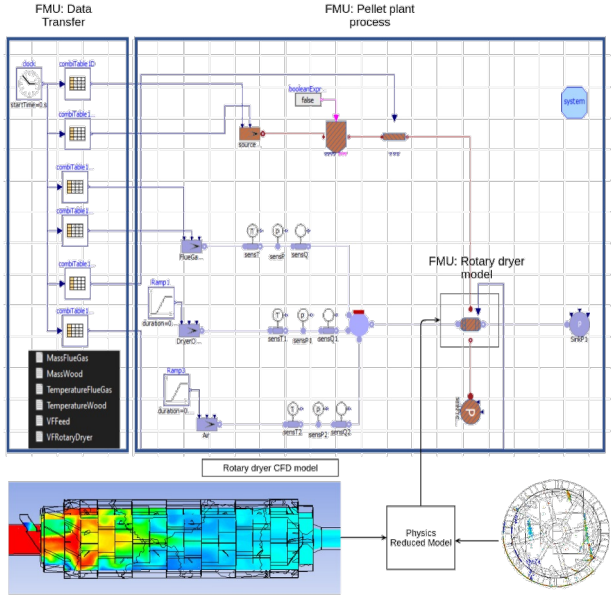
- Development of this type of digital twins based on Model Based System Engineering (MBSE) techniques / co-simulation
  - Alliance with other organizations (IoT companies, etc.)
  - We embed our real time models in digital platforms, virtual sensors, digital twins
  - Highly replicable/adaptable



Hybrid Multiphysics Digital Twins

- DT4DRYER: digital twin for Rotary Dryers
- DigitBrain project: https://digitbrain.eu/2nd-wave-of-digitbrain-experiments/dt4dryer/





Research lines

- Capacity Building in Energy issues (PrioritEE, PrioritEEPlus, Interreg MED)
- Energy systems planning at national / regional / local level
- Smart Platforms and knowledge hubs: https://crosscert.unizar.es/
- Building sector (Energy Certificates, Energy Model, Digital Twins, Ventilation, HVAC, Renewable Energy Integration)
  - CrossCert coordinators – https://www.crosscert.eu/
  - Home appliances: Computational Fluid Dynamics application to the applicances design
  - Collaboration with industrial manufacturer at national level
- Circular Economy
  - Analysis of Energy – Circular economy interactions
- Solar PVT
  - Collaboration with industrial manufacturer at national level
- Energy – Social interactions:
  - Determining the social impacts (jobs creation, land occupation, visual impact) of renewable energy deployment

More info

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- Web: gfn.unizar.es

Topics of interests

5 January 2023

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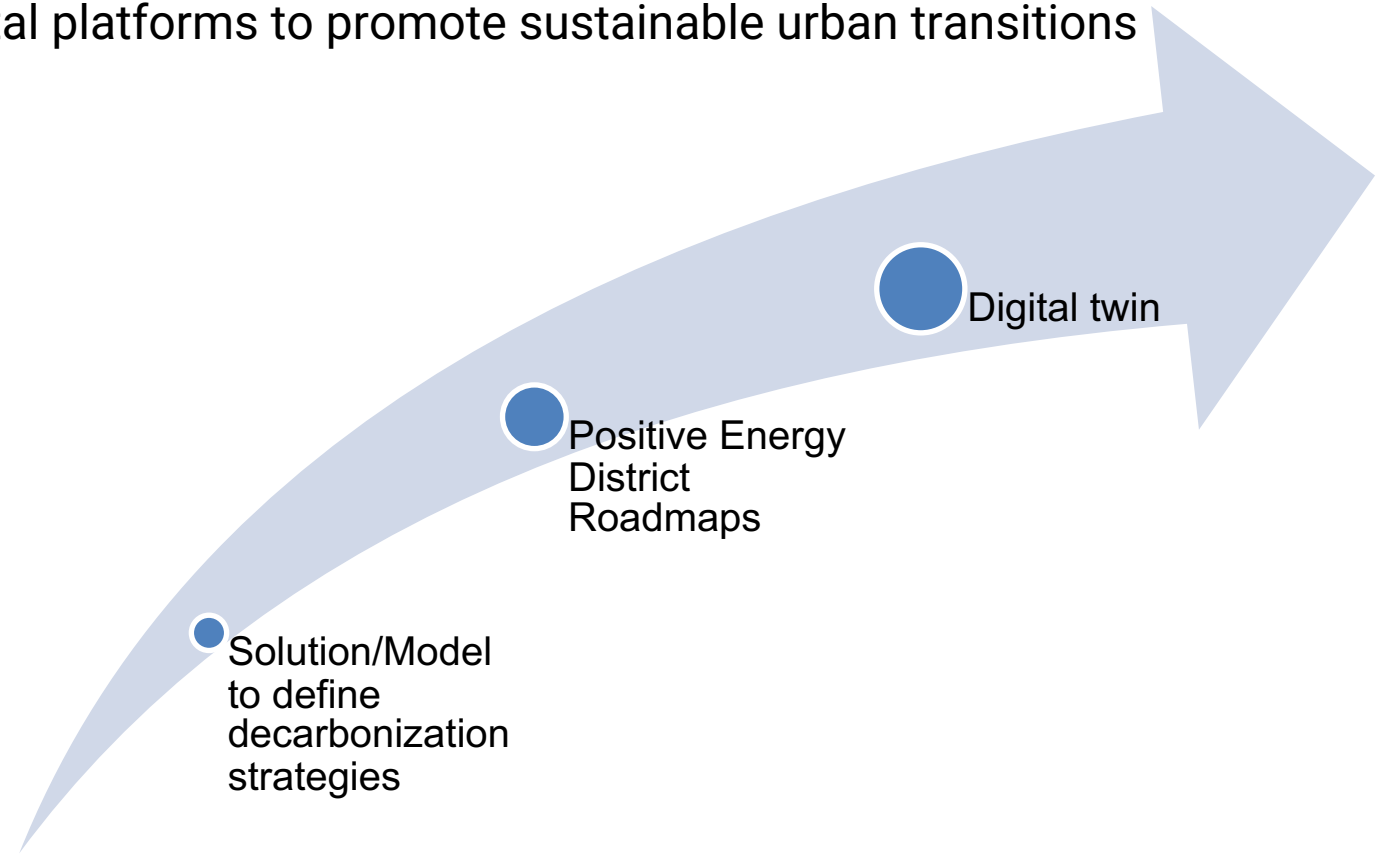
Digital platforms to promote sustainable urban transitions

- Digital platforms to promote sustainable urban transitions



Opportunities

- Driving Urban Transition (DUT) (https://dutpartnership.eu/)
- CET partnership (https://cetpartnership.eu/)
- HORIZON-CL5-2024-D4-02-05: Digital solutions to foster participative design, planning and management of buildings, neighbourhoods and urban districts (Built4People Partnership) - Sep 24
- HORIZON-MISS-2023-CIT-01-02: Positive clean energy district (PED) digital twins – from modelling to creating climate neutral Cities - Abr 23
- Interreg Europe – Jun 23

Other topics

- Digital twin or tools for renewable generation & management
- Urban wind (small wind energy, ventilation)
- National energy systems (pathways to decarbonization)
- Thermal processes, heat transfer (ad-hoc CFD methods)