GFN capabilities in the energy sector

May 2023

∇•(**gfn**)

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
- 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
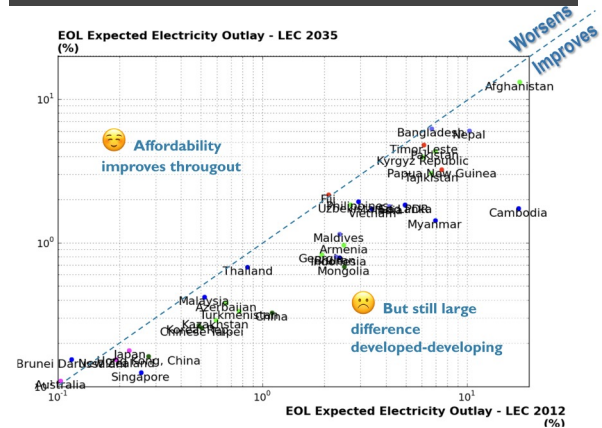 - El Salvador

Energy indicators

- Large-scale study for **<u>all</u>** 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

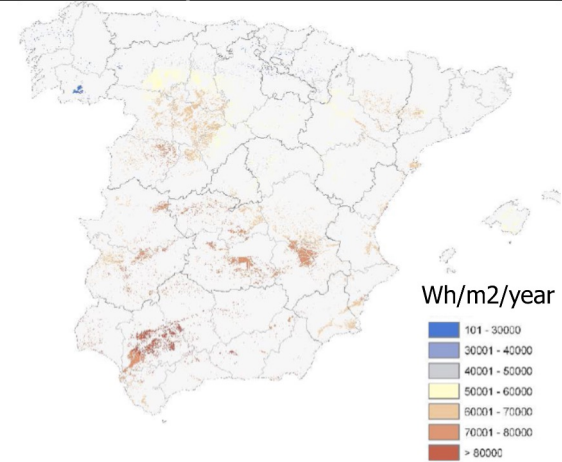Energy security in Central Asia
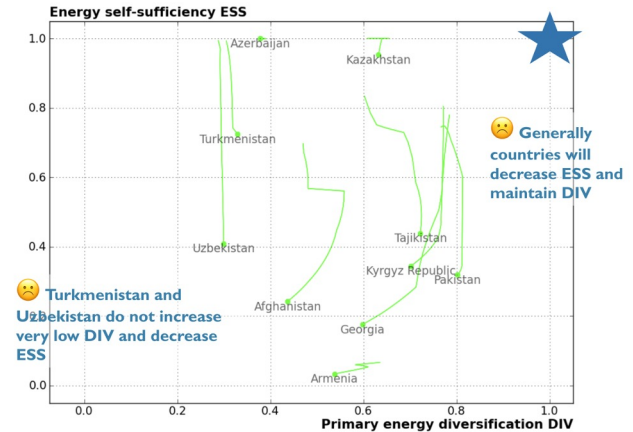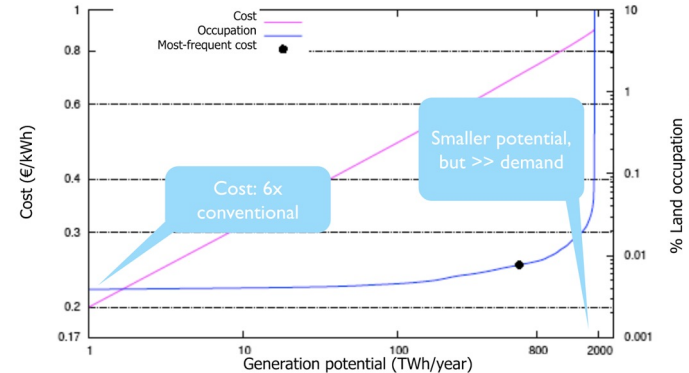

Energy affordability

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

Wh/m2/year

	101 - 30000
	30001 - 40000
	40001 - 50000
	50001 - 60000
	60001 - 70000
	70001 - 80000
	> 80000

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

Cost: 6x conventional

Smaller potential, but >> demand

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
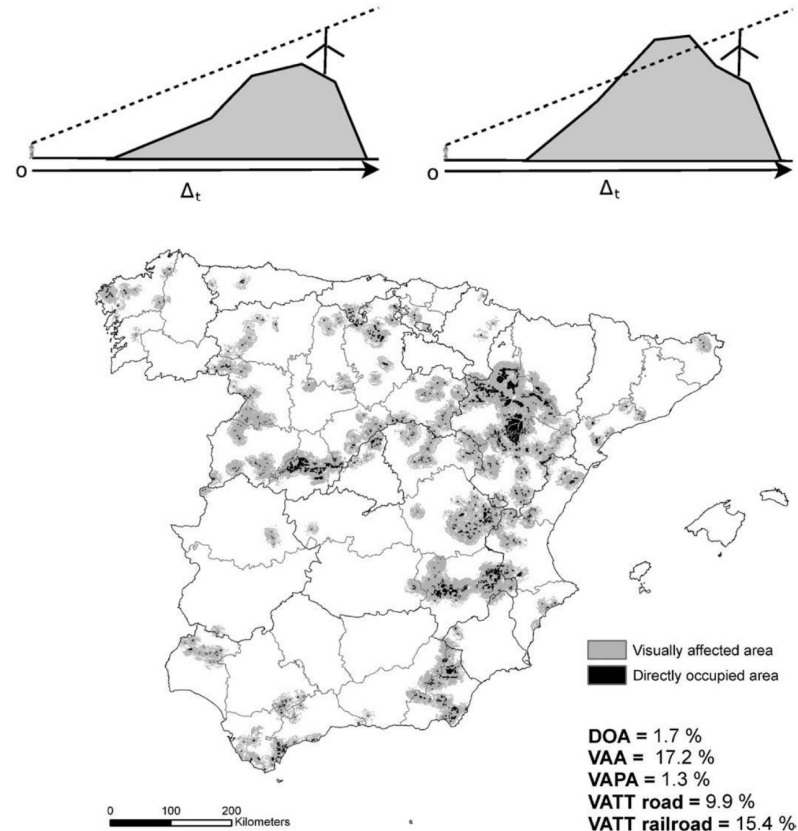 - Visually-Affected Travel Time

DOA = 1.7 %
VAA = 17.2 %
VAPA = 1.3 %
VATT road = 9.9 %
VATT railroad = 15.4 %

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

Assessment of social impacts

Biomass exploitation strategies

- Economic, Environmental and Social Effects of Biomass Exploitation Scales

- Comparing impacts of different scales of biomass pellets plants in the territory:
    - Economic
    - Environmental (eg. CO_2 emissions)
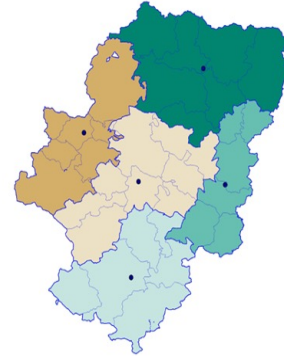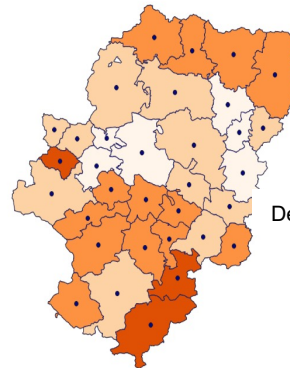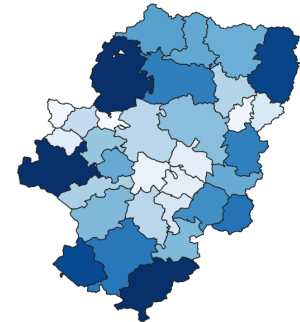   - Social (eg. job creation in depopulated areas)
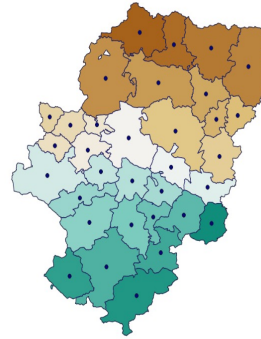
Small plants   Mid-size plants   Large-size plants

Demographic situation
- Good
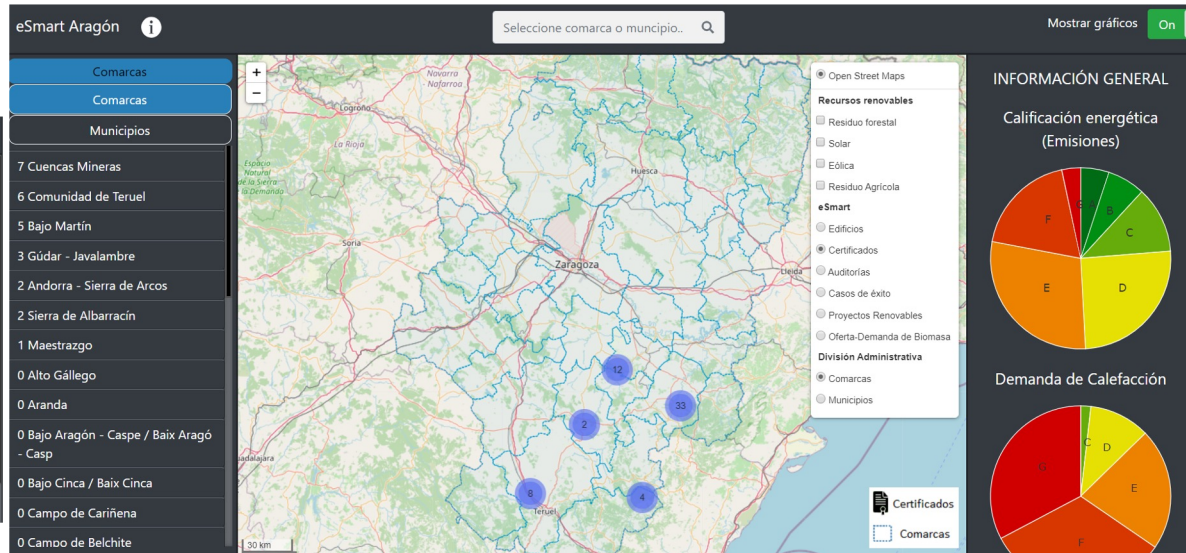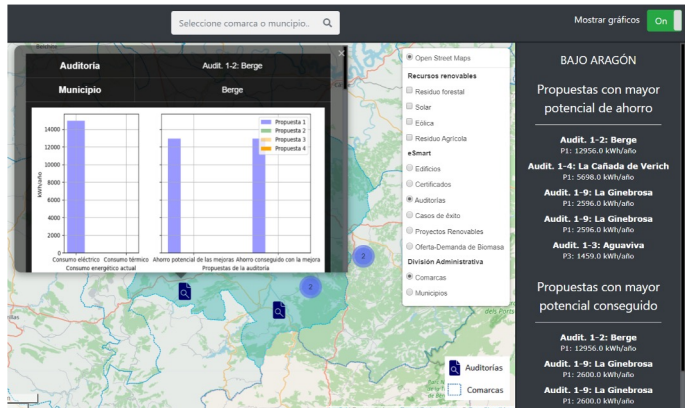- Normal
- Bad
- Severe

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Full-time jobs

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
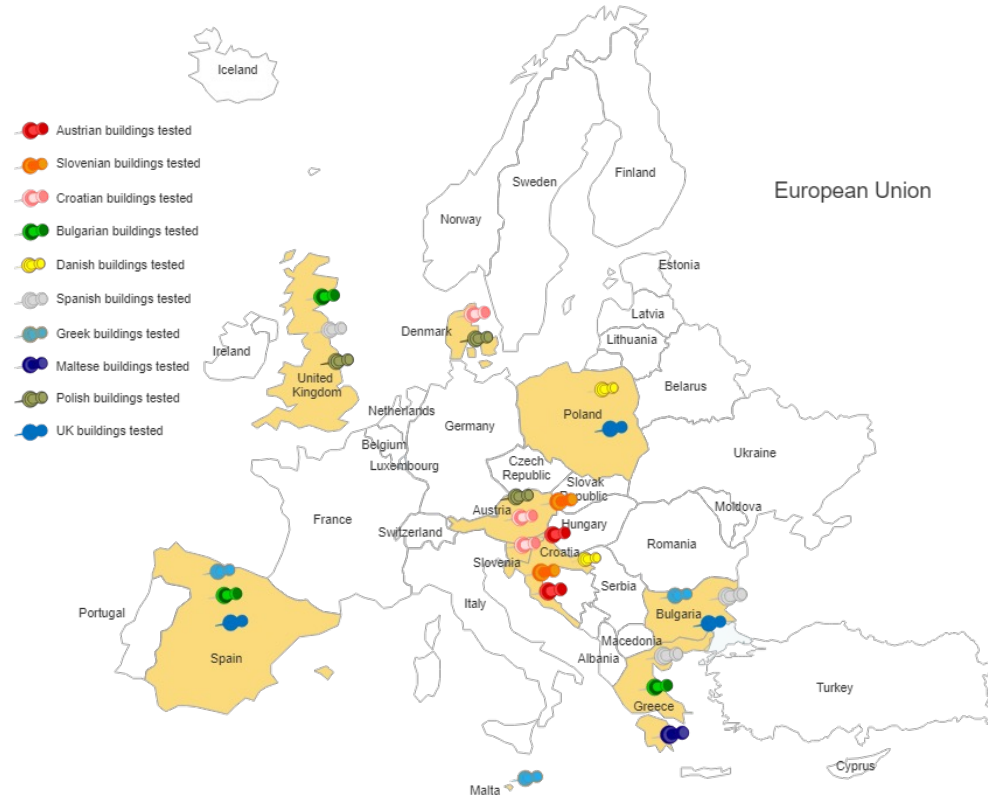- Extrapolation of results at regional/national levels

PrioritEE project: Prioritise energy efficiency measures in public buildings
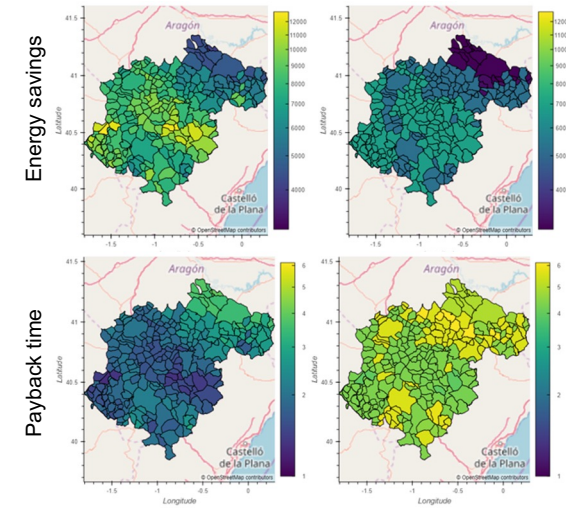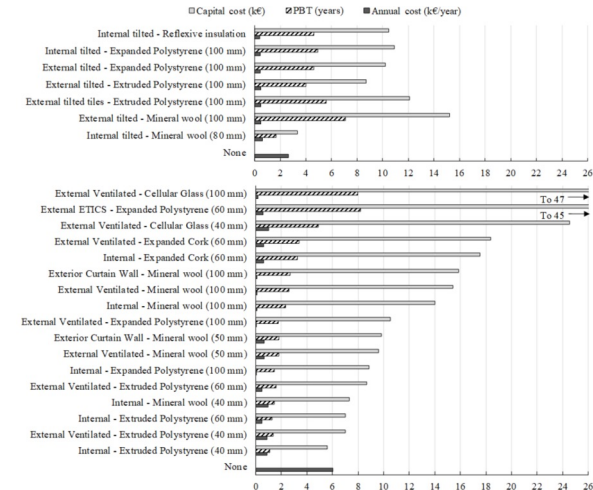
Energy Performance Certificates

- Coordinators of crossCert: Cross-Assessment of energy certificates in Europe

- https://www.crosscert.eu/

- Supporting the Next-Gen of Building Energy Performance Certificates

Austrian buildings tested
Slovenian buildings tested
Croatian buildings tested
Bulgarian buildings tested
Danish buildings tested
Spanish buildings tested
Greek buildings tested
Maltese buildings tested
Polish buildings tested
UK buildings tested

crossCert
Next-generation of Energy Performance
Assessment and Certification

CrossCert: Cross-Assessment of energy certificates in Europe

Knwoledge Exchange Platforms

- Design of knowledge exchange platforms regarding energy topics
- https://crosscert.unizar.es/

CrossCert: Cross-Assessment of energy certificates in Europe
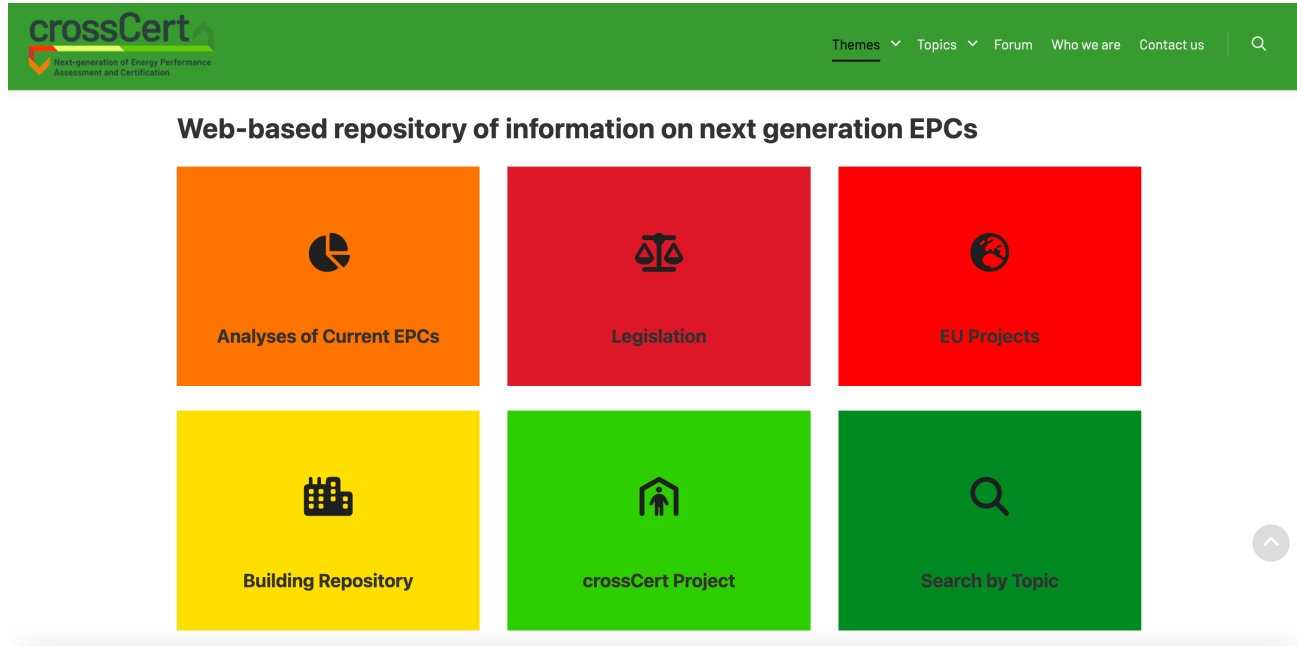
Building integration of energy generation

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

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

Building energy models and energy demand
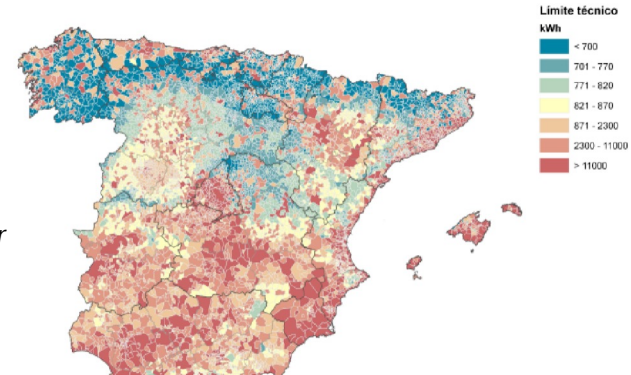
Technical limit for rooftop PV, kWh/year

Urban Wind

■ Development of reduced order models and machine learning for the high resolution wind forecast (e.g.urban environments)
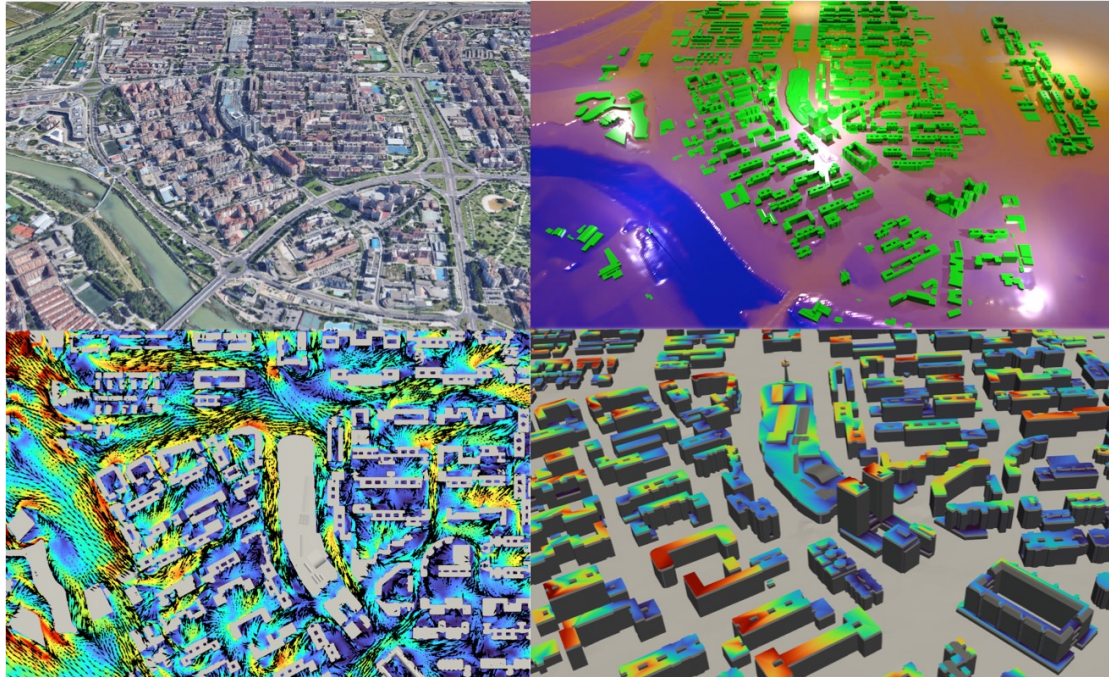
Hybrid Multiphysics Digital Twins

- 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
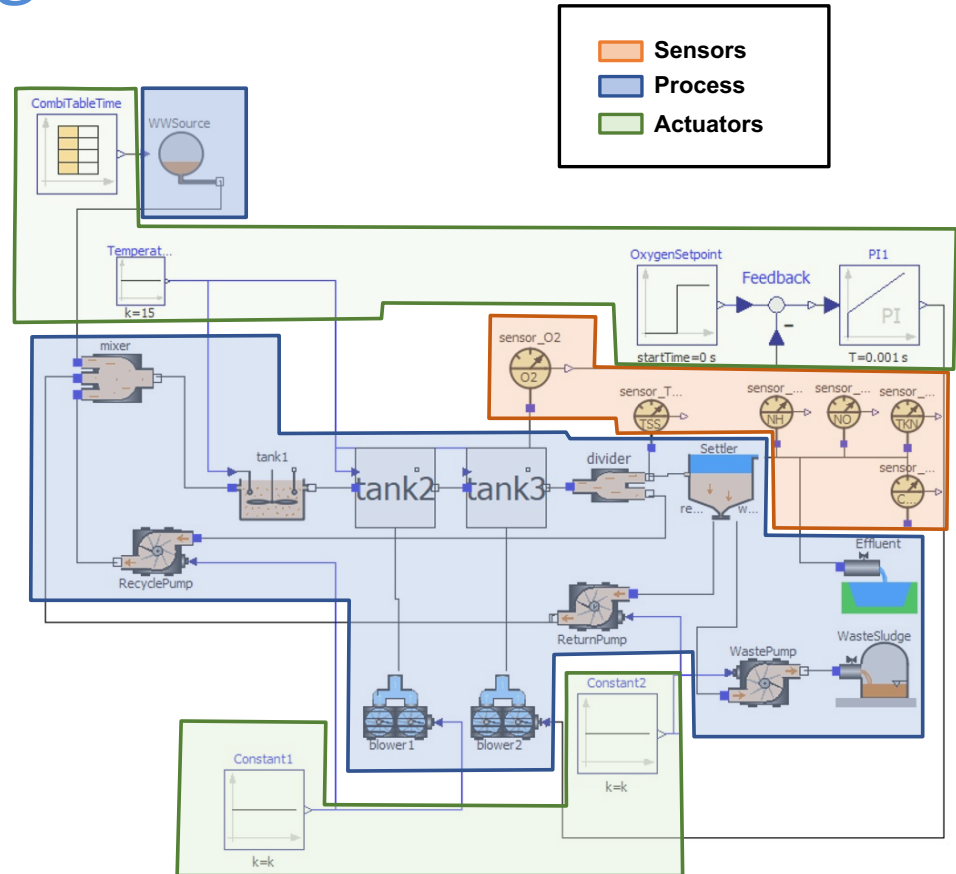
Hybrid Multiphysics Digital Twins

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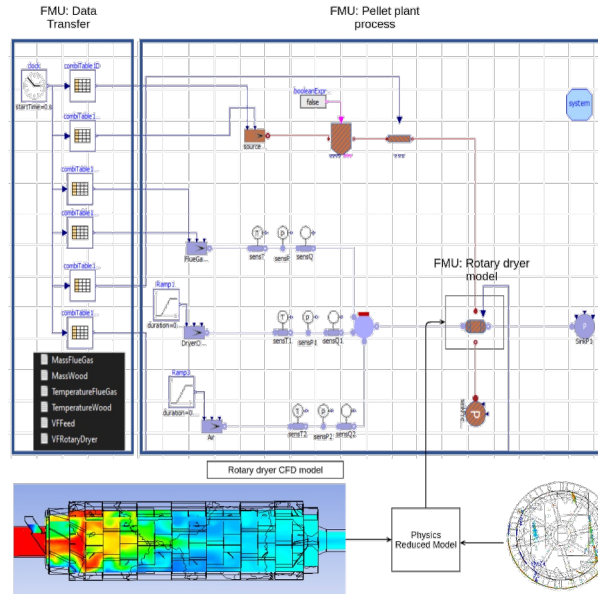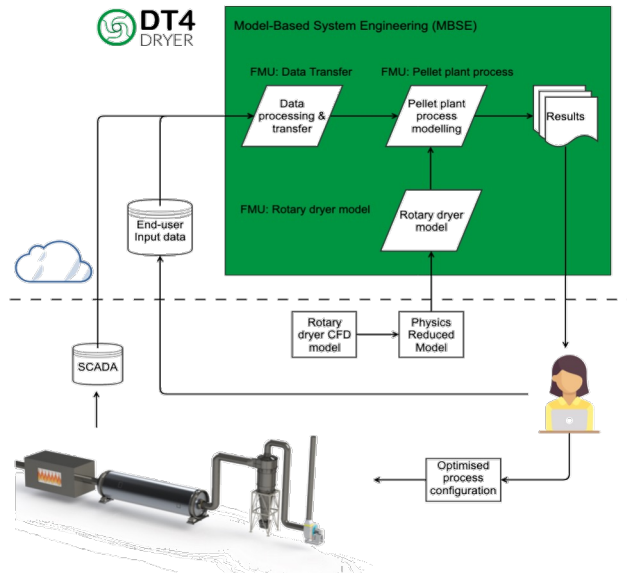
Research lines

- Capacity Building in Energy issues (PrioritEE, PrioritEEPlus, Interreg MED)

- Energy systems planning at national / regional / local level

- Smart Platforms (esmart aragon - https://esmartaragon.org/)
- Building sector (Energy Certificates, Energy Model, Digital Twins, Ventilation, HVAC, Renewable Energy Integration)
  - CrossCert coordinators - https://cordis.europa.eu/project/id/101033778
- 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
- Energy – Social interactions:
  - Determining the social impacts (jobs creation, land occupation, visual impact) of renewable energy deployment

More info

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