Arising sector-coupling business models supporting the transition to a low-carbon economy in Europe – Findings of the PLANET project

Forschungsgemeinschaft
für Elektrische Anlagen und Stromwirtschaft e.V.

28. – 30.10.2020 Sustainable Places 2020

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In a nutshell

- **Name:** PLANET - Planning and operational tools for optimising energy flows and synergies between energy networks
- **Duration:** November 2017 - October 2020
- **Programme:** H2020-LCE-2016-2017 (COMPETITIVE LOW-CARBON ENERGY)
- **Topic:** LCE-05-2017 – Tools and technologies for coordination and integration of the European energy system
- **Budget:** 4 m€
- **Partners**: POLITECNICO DI TORINO (Italy) – Projet Managment

  CERTH (Greece), FGH e.V. (Germany),

  HYPERTECH (Greece), IREN (Italy), ISMB (Italy),

  ITM POWER (United Kingdom), MERIT (Belgium),

  SOREA (France), VaasaETT (Finland), VTT (Finland)

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The challenge

EU to cut greenhouse gas emissions to 80% below 1990 levels by 2050

Power sector has the biggest potential for cutting emissions

More renewable energy generation is needed.

BUT:

How can this be accomplished without endangering system reliability and stability?

Sector coupling –

Conversion of electrical energy and its storage in other energy carriers provides flexibility to the grid while increasing green heat and gas production

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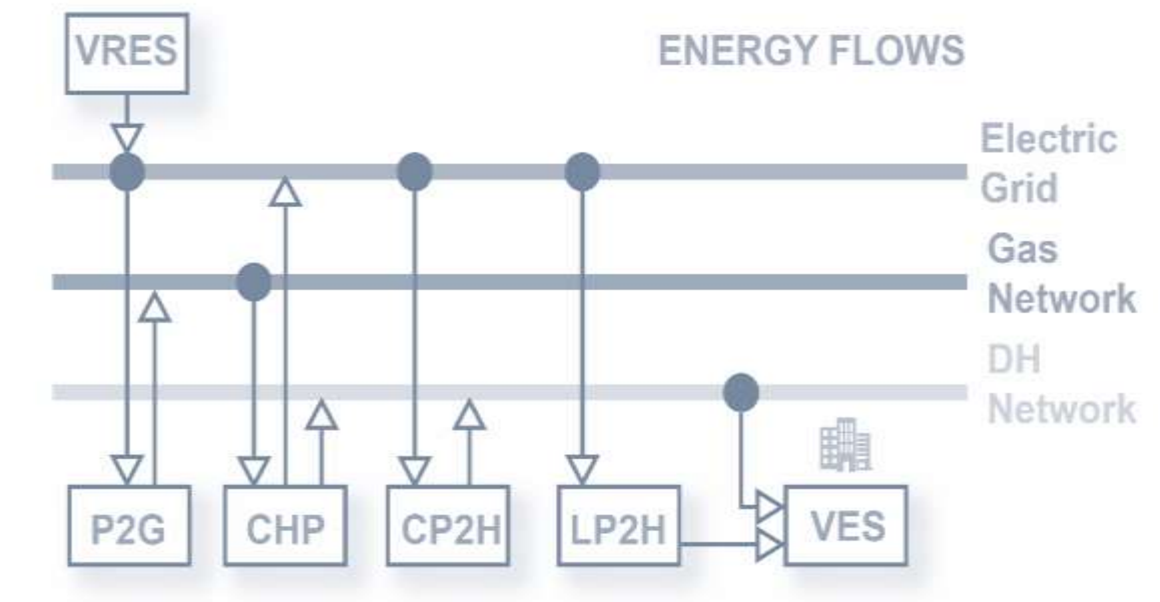
The objective (1/2)

Help Smart Grid actors to guide future network planning activities by developing an ICT-enabled Decision Support System that can identify feasible sector coupling pathways in order to alleviate grid infrastructure deferral while permitting large-scale RES penetration.



Functional scheme of coupling the energy sector with the heat and gas sector

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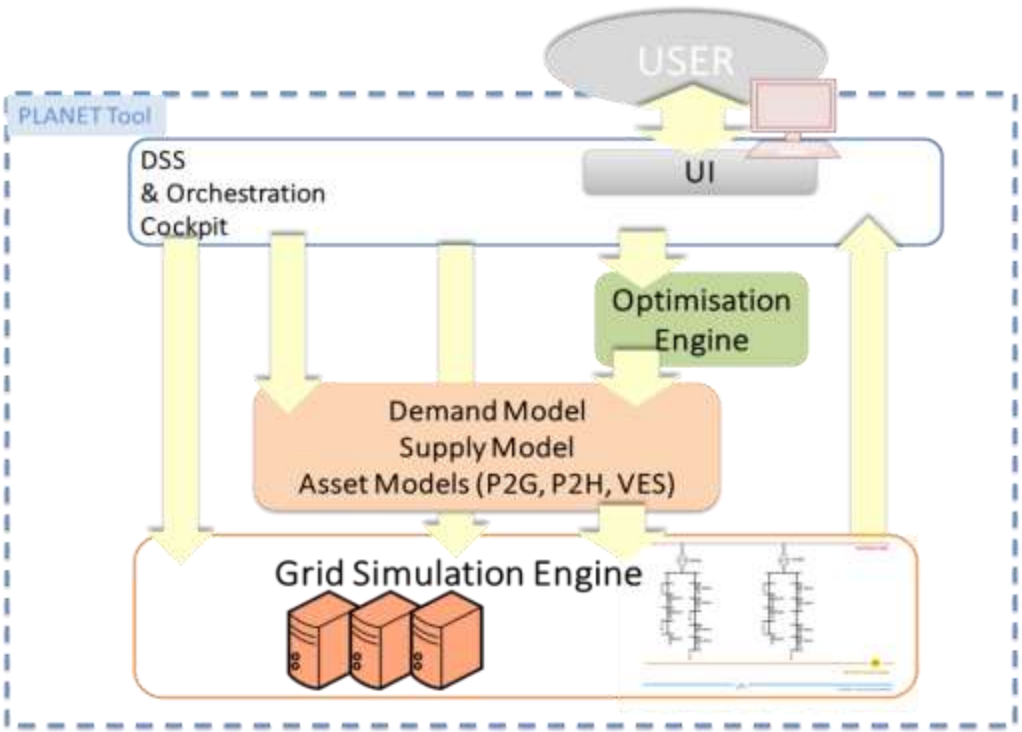
The objective (2/2)

The PLANET holistic optimization framework serves both long-term network planning objectives and day-ahead operational planning objectives through a demand response platform that allows the DSOs to optimize power flows through flexibility forecasts from the available assets and optimal control setpoints.



PLANET ICT-enabled Decision Support System

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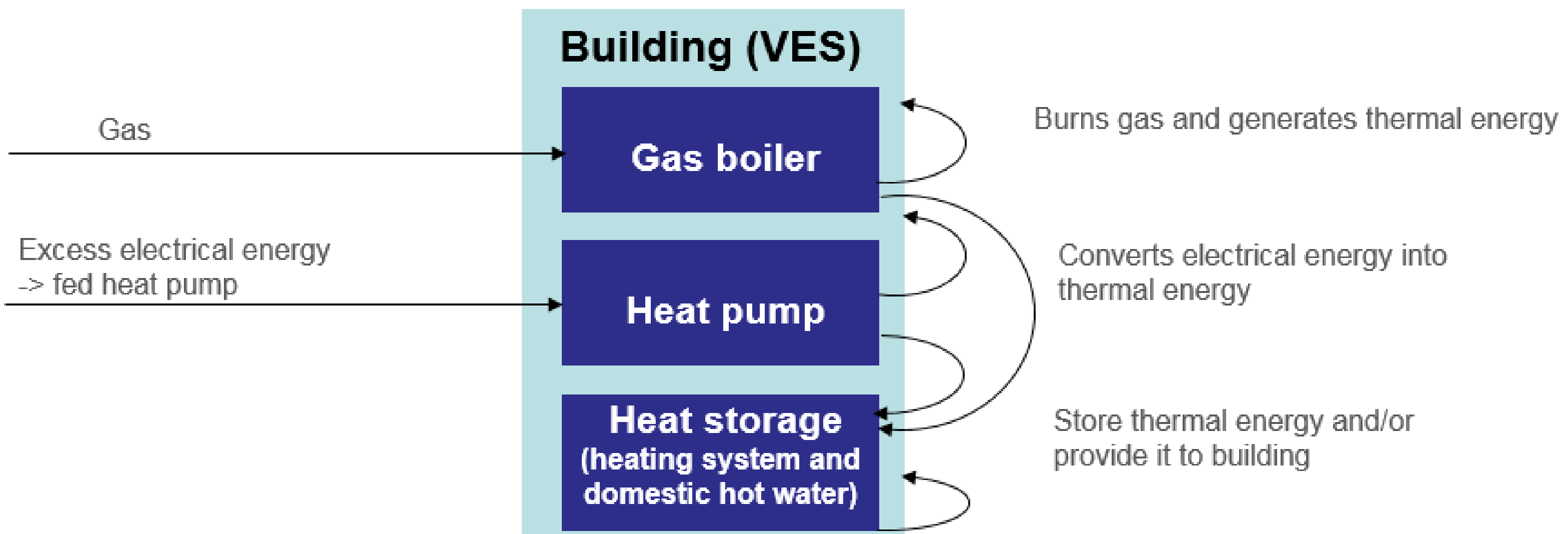
The five major PLANET Use Cases (1/2)

- Power-to-gas deployment for system control
- Virtual Energy Storage in buildings for provision of flexibility via electricity demand shifting
  Identify and apply time shiftable electrical load profiles for heating purposes of buildings (VES) and hence making use of the building's flexibility (inherent thermal inertia of the building and the possible availability of small heat pumps (P_{el}< 100kW).



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The five major PLANET Use Cases (2/2)

- **Small-scale cogeneration for e-grid stabilisation and heat generation**
  Aim: Support the electric grid in times when RES generation drops abruptly and unexpectedly. The imbalance caused by RES can be compensated by ramping up the generation of combined heat and power units.
- **Centralised heat-pumps for hot water storage in district heating plant facilities**
  Aim: focus on high power heat pumps as main device for solving electricity network congestion issues and providing ancillary services such as balancing and dispatching.
- **Utilization of P2G process to reduce industrial emissions and to produce SNG for green district heat production**

  Aim: Districts with carbon intensive industries integrate P2G in their sites to absorb carbon stemming from flue gases and hereby reduce carbon dioxide emissions. The waste heat from P2G can be fed into the district heating network to increase the options for green heat and the produced SNG is fed into the gas network in order to use it for green heat production at the peak green heat demand time.

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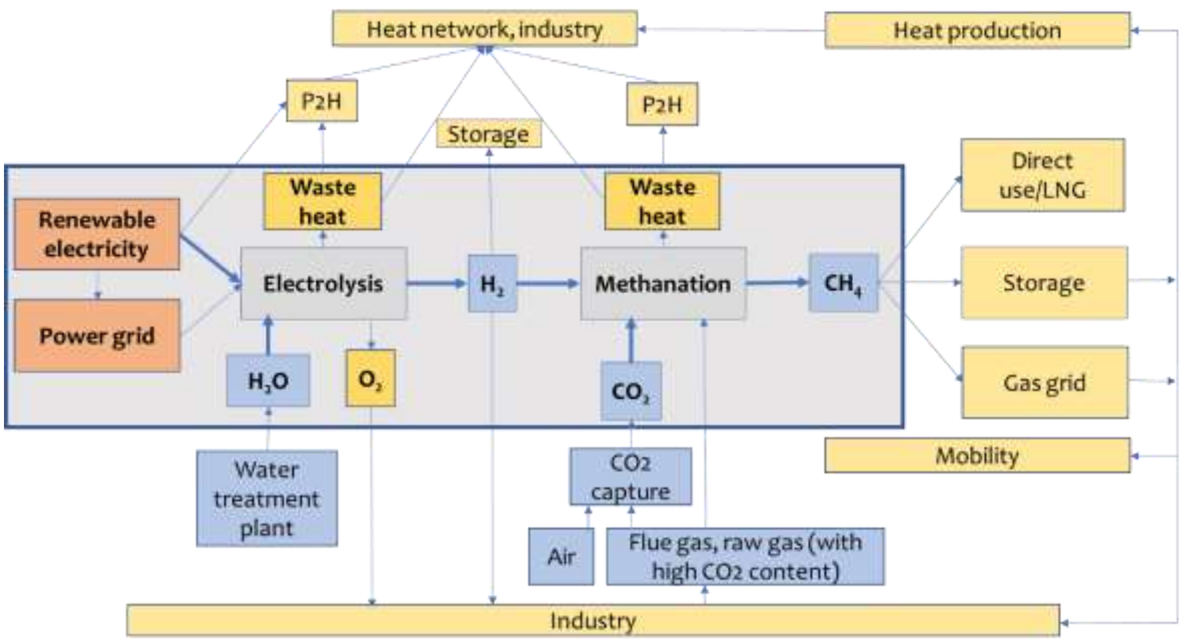
The PLANET Business Cases (1/2)

- Grid congestion management
  based on the Use Case “Power-to-gas deployment for system control”
- Virtual Utilization of P2G process to reduce industrial emissions and to produce SNG for green district heat production



Schematic diagram of P2G asset and its operational boundaries

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The PLANET Business Cases (2/2)

- Centralised P2H and Heating grid level P2H
  based on the Use case “Centralised heat-pumps for hot water storage in DH plant facilities”

  Well-monitored centralized and decentralized P2H applications serve as a bridge between heat and power production, while increasing the renewable energy utilization in heating. When the renewable heating fuels’ availability and price outlook might be uncertain, heat pumps secure an affordable production by exploiting low energy prices. Centralized heat pumps can also serve the power grid in controlling over voltages and managing congestion by curtailing electricity to the heat grid that has a larger buffer capacity. Smart thermal grids can also exploit heat storages in absorbing surplus electricity. Typically used hot water tanks have good short term storage efficiencies.

- Combined heat and power and heat storage
  based on the Use case “Small-scale cogeneration for e-grid stabilisation and heat generation”

  Flexible utilization of the CHP units combined with the thermal storage capacity of the district heating grid and thermal storages could efficiently facilitate higher shares of wind power integration. Another option is to rethink the energy system and use small-scale cogeneration for grid stabilisation, which can typically be building or building block level units combining heat storages with stationary internal combustion engines, stirling engines or fuel cells. According to [46], the merit order favouring CHP production is not necessarily the most effective option in decarbonisation of the energy system, but it can be beneficial if CHP unit serves as reserve capacity while heat pumps produce the base load heat to the system.

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Conclusions

- Overall, in an integrated energy system comprising all three carriers, the decoupling of demand and supply through conversion of electricity into other energy sources increases the degree of substitutability between them.
- This allows end-users to cover basic needs such as heating through different energy sources (either gas or electricity) which enhances energy market competitiveness in a prosumer-centric frame.
- In order to exploit the described unleashed business opportunities, novel regulation has to incentivize the adoption of capital-intensive conversion technologies as key enablers of cross-network coordination.

Contact

- PLANET Website: https://www.h2020-planet.eu/
- Disclaimer: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773839.
This presentation reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.
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