Slido.com

Plenary 4 #EMP_E2020

SECTOR INTEGRATION – DECARBONISATION THROUGH MULTI-ENERGY CARRIER INTEGRATION

Session Organisation

Agenda

- Sector integration from the multi-energy system operator and aggregator perspective
  - Christophe Gutschi, cyberGRID
- Small and medium prosumers in flexibility market: Planet pilot and some highlights of IREN related innovation activities
  - Federico Boni Castagnetti, IREN
- Impact of sector coupling - some exemplary aspects from heating and power-to-gas
  - Dieter Most, Siemens
- The whole system approach: a regulatory perspective on sector integration
  - Luca Lo Schiavo, ARERA – Italian Authority for energy
- Q&A session
  - Sli.do

Slido.com

#EMP_E2020

Choose 'Plenary 4'

emp-e 2020, Plenary 4 - Sector integration

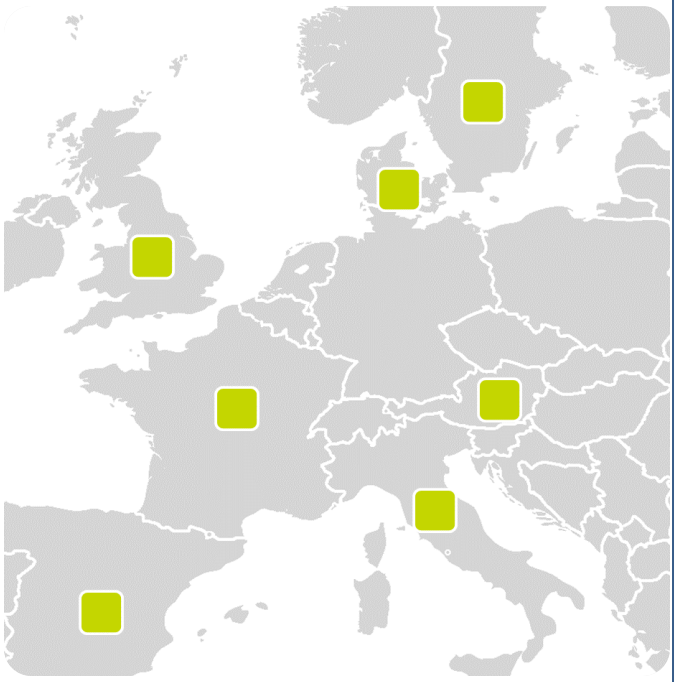
Oct. 7th, 2020

Christoph Gutschi, cyberGRID

SECTOR INTEGRATION FROM THE MULTI-ENERGY SYSTEM OPERATOR AND AGGREGATOR PERSPECTIVE

The MAGNITUDE project

- The Magnitude Project aims at investigating the potentials of **Multi-Energy-Systems (MES)** to provide flexibility for integration of renewables into the electricity network.
- Funded by the European H2020 programme; Call H2020 - LCE-05-2017 *"Tools and technologies for coordination and integration of the European energy system"* […] developments for *"**Synergies between electricity, gas and heat networks**, associated business and market mechanisms and analysis of existing regulatory aspects"*
- The investigations focus on 7 real life case studies
  - Steel industry and gas network (UK)
  - Pulp & paper industry (Austria)
  - District heating and systems and supply (Italy, Denmark)
  - District heating and cooling systems (France, Sweden)
  - District heating supply (Italy)
  - Wastewater treatment and sewage gas exploitation (Spain)
- The analyses include:
  - Technical simulations and improvements
  - Aggregation and market participation
  - Business models and cost-benefit-analyses
  - Drivers and barriers, policy strategy and recommendations
  - Improved market designs



The MAGNITUDE principle

Source: wikipedia.org

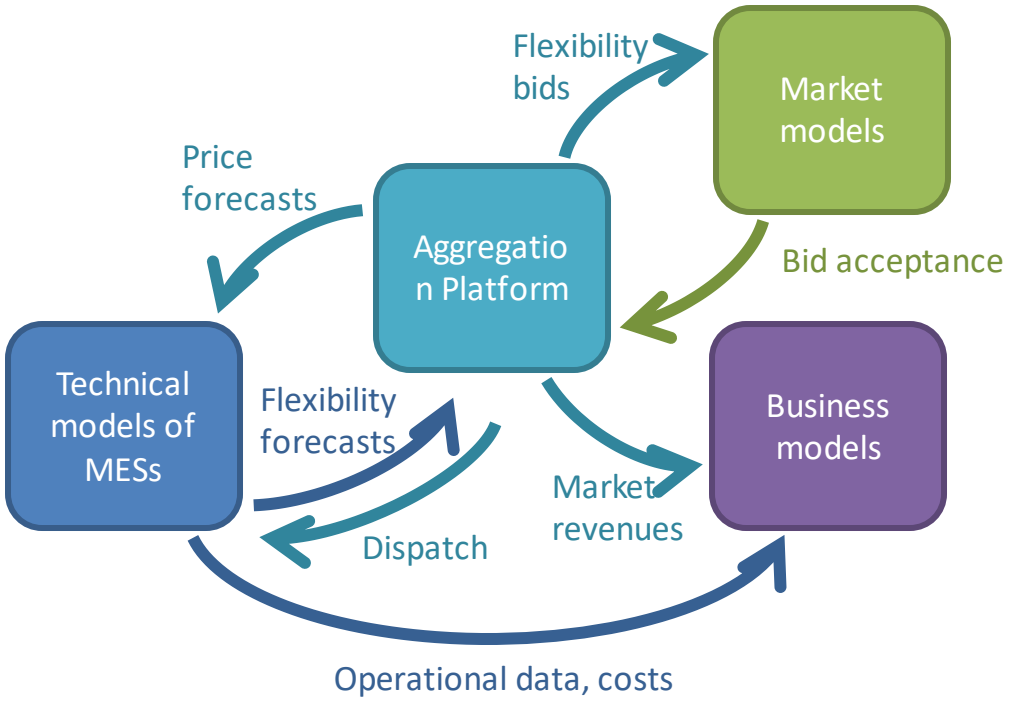
Imbalance of generation and consumption → **MES** → **Gas grid, gas storage**

MES could help balancing the electricity grid, by local storage or shifting imbalances to more resilient networks of gas and heat. Storage of heat or gas is easier than storage of electricity, e.g. gas can be stored on the long term (several months) in exploited gas fields.

Electricity Natural gas	**MES** normal operation	
Electricity Natural gas	**MES** upward (positive) balancing	
Electricity Natural gas	**MES** downward (negative) balancing	

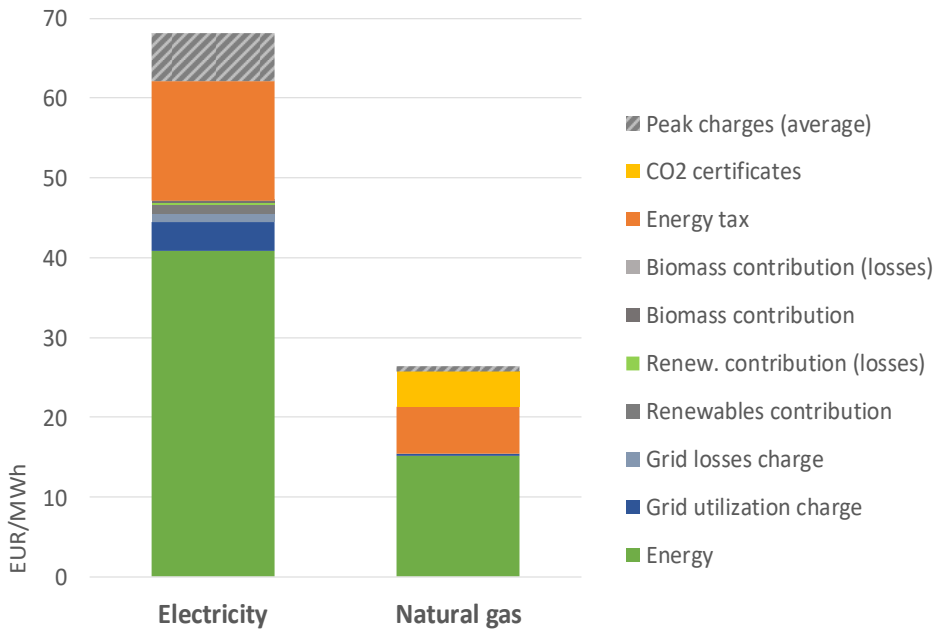
Simulation of MES operation and trading

- In MAGNITUDE, we investigate if the existing market services and mechanisms are appropriate to exploit the flexibility potential of MES for the electricity system.
- Investigated markets: day-ahead, intraday, mFRR, aFRR, FCR, redispatch, capacity
- We aim to simulate workflows and decisions close-to-reality.
- Dealing with uncertainty of the aggregator and MES operator is a special aim.



Costs of consumed energy

- Energy consumers need to pay the market price of energy plus overhead costs.
- A low market price of energy does not result in proportionally low costs for the energy consumer.
- Our analyses indicate that peak load tariffs are a barrier for MES to dissipate excess feed-in from renewables.
- Focusing on efficient energy markets will not be sufficient to facilitate flexibility provision by MES.
- Grid tariffs, energy taxes and renewable support schemes also need to be redesigned!



Example: Specific energy costs of an industrial consumer in the medium voltage network in Austria in 2019.

Challenges in providing flexibility by MES

MES and market services

- Product definitions (bid duration, gate closure, minimum bid size, bid increment, symmetry, ramp rates, …)
- Restrictions of technologies for ancillary services provision
- Missing harmonization in EU limits replicability of ICT solutions
- Increasing complexity of business processes
- Liquidity of intraday markets

Energy system regulation

- Rules for aggregation services undefined
- Complex structure of costs and tariffs for consumers.
- Transparency issues in district heating system in some countries.

Technology, engineering

- Mechanical stress due to frequent switching (increased maintenance)
- Rebound effects
- Start-up issues (duration, current)
- Minimum load levels (CCGT, CHP)
- Transport issues (connection capacity)
- Update of control and communication systems required
- Does not match with industrial process.

MES optimization

- Complex processes that involve several energy carriers converted by generators, consumers and storages devices

Modelling & simulation

- Limited access to market data

THANKS FOR YOUR ATTENTION!

Magnitude

Contacts

Project Coordinator
Regine Belhomme
EDF
T + 33 (0)1 78 19 41 24
regine.belhomme@edf.fr

MAGNITUDE Office
Elizabeth Haddad
ARTTIC
magnitude-arttic@eurtd.com

MAGNITUDE website
https://www.magnitude-project.eu/

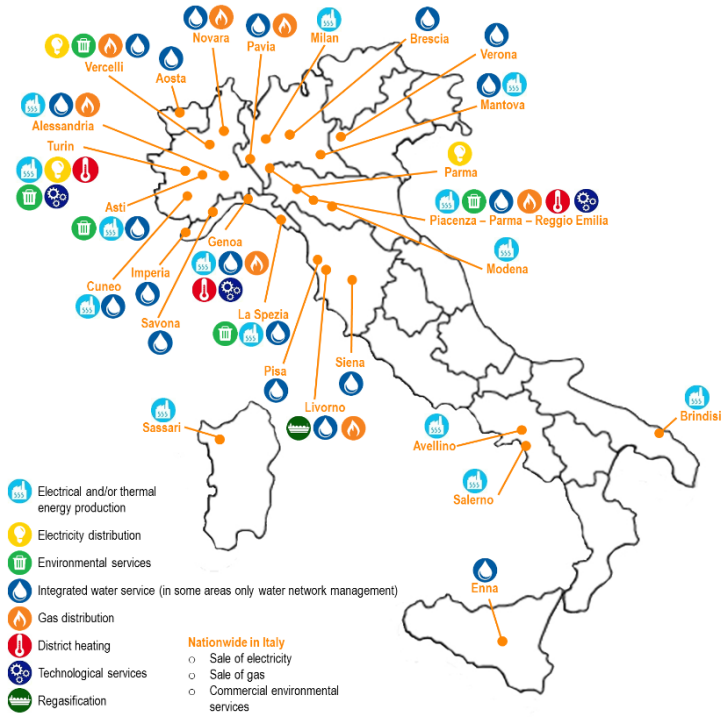
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 774309.

Small and medium prosumers in Flexibility Market: Planet pilot and some highlights of IREN related innovation activities

EMP-E – Plenary Session 4

07/10/2020

Iren in a nutshell



about 8,000 employees

7 mln customers in our territories

1.7 mln customers in the energy sectors

2.3 mln customers in the environmental sector

2.9 mln customers in the integrated water cycle

1st operator in Italy
for the district heating

3rd operator in Italy
in the integrated water cycle

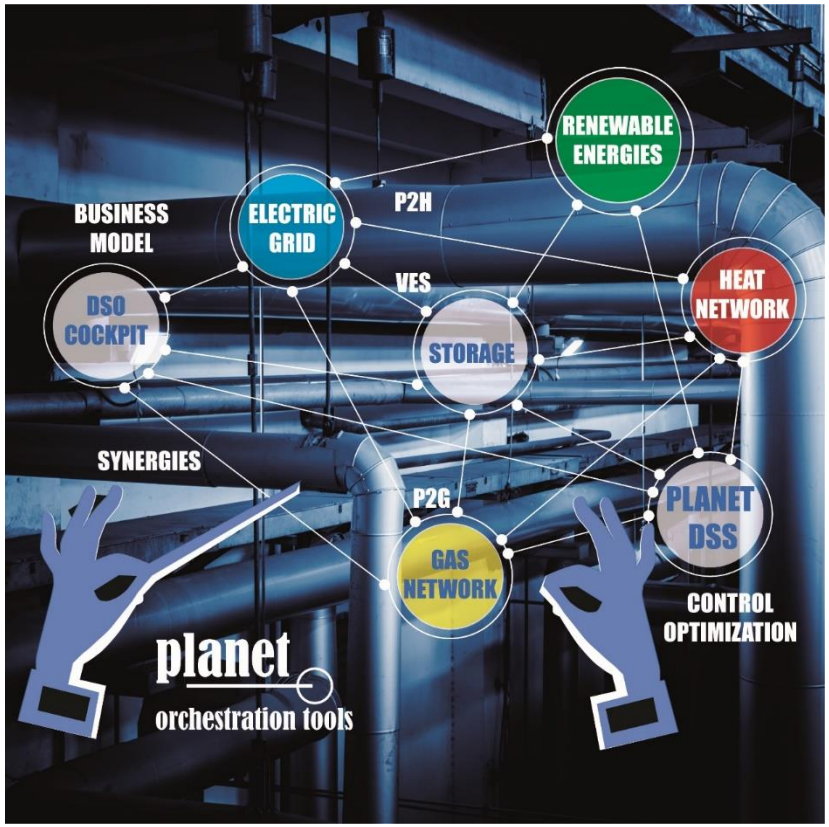
3rd operator in Italy
in the environmental sector

The Vision

«PLANET is driving towards decarbonization of the whole energy system and tackling the intermittency challenges of renewable energy source through network integration»

OBJECTIVES

- Facilitate the full **integration of increasing renewable energy** in the electricity grid.
- **Global coordination of energy networks** (electricity, gas, heat) and assets with special focus on energy storage and conversion technologies.
- **Constraints** verification, including overloading and voltage limits violation, in the electrical distribution grid



IREN pilot - 1

Public building in Turin with different uses (offices, social services, community ….)

Address: Via De Sanctis, n.12 - TURIN

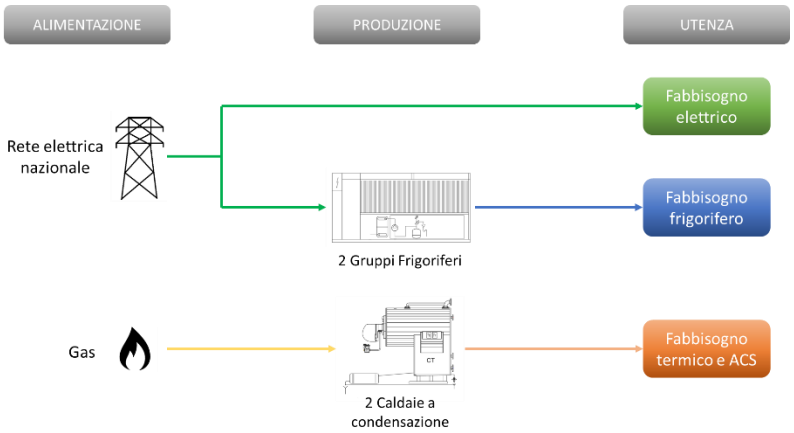
Volume = 17.400 m3

Objectives:

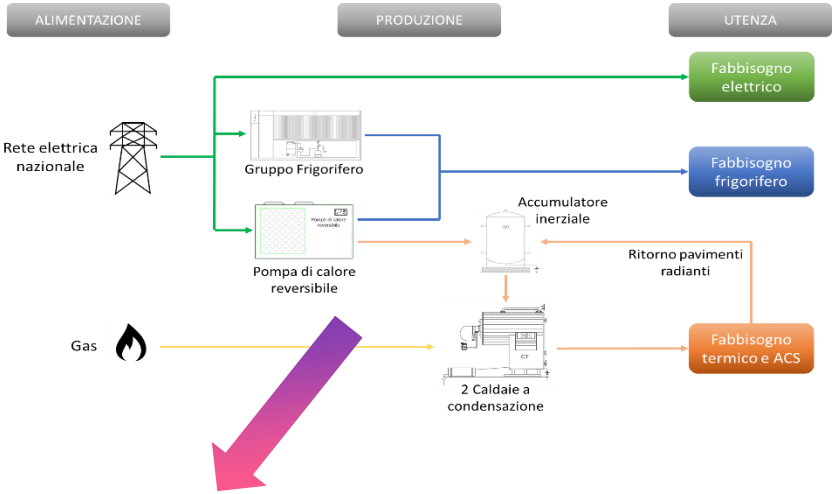
- Granting internal comfort to inhabitants/users
- Optimal scheduling of loads during normal plant operation
- Computation and actuation of flexibilities offered on the Dispatching Market
- Control actions needed to keep the peak power consumption limited

IREN pilot - 2

BEFORE



AFTER



Operation & energy market flexibility

Other innovation projects

Dealing with balancing issues, flexibility provisioning and prosumer participation in energy markets

V2G eVolution2Grid

Vehicle to Grid

Bilanciamento reti elettriche

Mobilità elettrica

CHESTER

Power-to-Heat-to-Power

Fluctuating RES

Thermal RES and TLR

5G-SOLUTIONS

5G network

Smart city

Demand side management

Smart charging

PUMP HEAT

FLEXIBILITY

Cogeneration combined cycle

RES integration

Heat Pumps

INCIT-EV

EV

Charging stations

Park-and-ride

Energy flexibility

STORE&GO

Power-to-gas

RES integration

Green H2

methane

iren

Impact of Sector Coupling

Some Exemplary Aspects from Heating and Power-To-Gas

… District Heating

… Coupling of Gas and Electric Grid via Power-to-Gas

EMP-E 2020, 7th October 2020
Dieter Most, Siemens AG, Corporate Technology

SIEMENS
Ingenuity for life

A cost optimized scenario for Europe shows that 90% CO_2 emission reduction is achievable with today's available, mature technologies and if the full potential of sector coupling and co-operation is realized.

warming stripes - global mean temperatures per anno from 1850 – 2018 (source: Ed Harris [1])

Global Challenge	Megatrend	Identified Levers
Decarbonization	Electrification	I Ramp up Renewables
	Sector Coupling	II Phase-out Fossil in Electricity
	Decentralization	III Decarbonization of Decentral Heating
	Rise of Flexibility	IV Phase-out Fossil for Central Heating
	Digitalization	V Efficient Space Cooling
		VI Electric & Thermal Storage
		VII Electrification of Transport
		VIII Alternative Fuels
		IX Efficient ICT

Cost optimized scenario for Europe (integrated multi-modal Energy system)

plan4res

~90% CO_2 emission reduction is achievable with today's available, mature technologies and …

… if the full potential of sector coupling and pan-European co-operation is realized

What if not an 'optimal pathway' is pursuit ..

In the case of delayed or excluded low cost decarbonization measures (e.g. from sector coupling; thermal storage), then …

… new technologies (e.g. carbon negative technologies, hydrogen, …) will play a significant role for target achievement

… and this comes at increased costs!

District Heating Grids are economical feasible and will have a growing share … and may provide storage and flexibility options

plan4res

Heating accounts for about ~47% of final energy demand of the EU

Within the next two decades we have two big challenges for heating awaiting along the transition pathway

- **Replacement of heat obligation from phased-out fossil power plants**
- **Replacement of phased-out of oil boilers in space heating**

Everybody is talking about biomass or 'green' gas boilers for heating or power-to-heat, but District Heating (DH) stands its ground. It is future proof and can ...

… implement heat of **heat recovery from Industry / Commerce**

… district heating networks is essential for heat from heat recovery, geothermal & heat from waste incineration

… implement heat of **heat recovery new opportunities in future**

… e.g. waste heat from data centers, power-to-gas units, etc.

… provide **cheap storage of sur-plus energy & flexibility**

… using power-to-heat and inexpensive thermal storage technologies able to store energy from hours to weeks

… be an **alternative to gas boilers and grid extension**

… natural gas might only a temporary bridge technology on the way from coal to gas to fully decarbonized heating and gas for heating might be next to phase out.

… be gradually **upgraded to Power-to-Heat**

… if heat suppliers (Industry, local power plants) are no longer available or are phased-out; or if an increased share o RES is integrated

From our modeling studies of the pan-European energy system

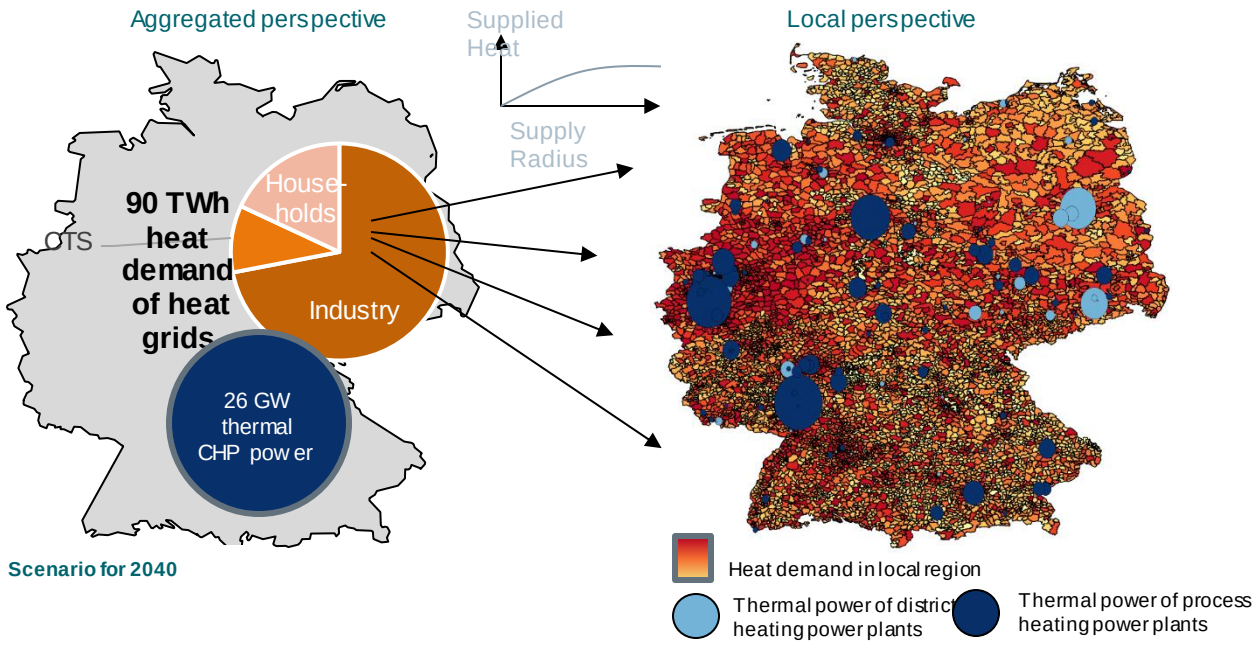
Despite all efforts in savings, e.g. by insulation of housings, district heating is economical feasible and will have a growing share to ~12 .. 15% in space heating and low-temperature heat supply

Matching of new heat suppliers and consumers on regional level is necessary to find feasible replacement for the heat obligation of phased-out fossil power plants

Challenge: Replacement for heat supply after coal phase out in the next 10 to 15 years
- Large District Heating grids supplied by co-generating heat and power plants

Importance of co-generating power plants for the heat supply

- Local dependency of power plants and heat grids
  - → **Matching of heat supplier and consumer necessary**
- ➢ Aggregated perspective may not be sufficient
- ➢ Individual allocation of power plant sites to heating with differentiation in district and process heating necessary

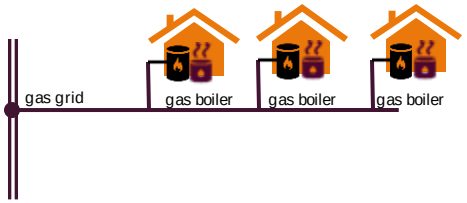


Local heating networks might be an alternative to individual gas boilers or power-to-heat as replacement for oil boilers

Challenge: In the next two decades many European countries are phasing out oil boilers for decentral heating – what is better, replacement by gas boilers or shift to power-to-heat?

Individual Decentral Gas Boiler
w/ decentral hot water storage

Risk of Stranded Assets

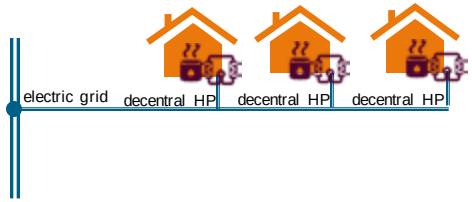


gas grid extension necessary

- **risk of stranded assets** if phase out of fossil gas for heating follows oil phase out
- **no flexibility option** for the local electricity grid
- **no storage option** for the local electricity grid

Individual Decentral Heat Pump (HP)
w/ decentral hot water storage

Individual fast solution;
Limited options to provide flexibility/storage services

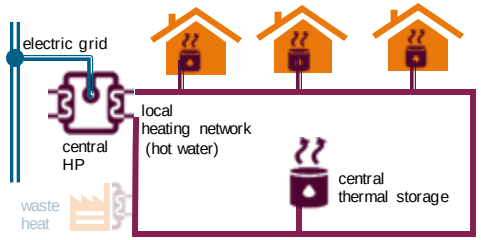


(maybe) extension of the electric grid necessary

- **Limited storage option** for the local electricity grid
- **Limited flexibility option** for the local electricity grid
- but, both only via remote control of many small HPs possible (risk of customer acceptance)
- Risk of cheap but inefficient HPs maybe predominant

Local Heating Network (Hot Water)
w/ efficient central heat pump
w/ cheap central hot water storage,
e.g. 'Pit Storage'

Future proof & implementation of waste heat
Plus option to provide flexibility/storage services to the system



implementation of local heating network

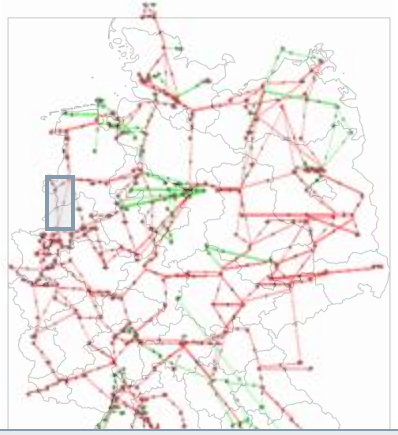
- but no extension of the electric grid necessary
- **provides storage option** for the local electricity grid
- **provides flexibility option** for the local electricity grid
- both options can be controlled by local municipality (less risk of customer acceptance)
- central HP can easily be exchanged, e.g. by CHP, …
- **other heat sources can be integrated in parallel**

Deeper understanding of how much H_2 that we can inject into the gas transport grid as well as of bottlenecks in the gas transportation system

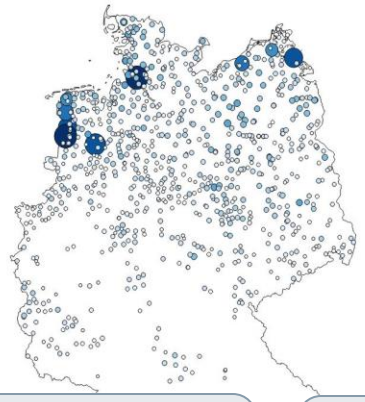
P2G as 'cure' for electric grid issues?

Coupling of Gas Grid Model and Electric Grid Model to assess constraints and limitation from the gas grid

Electric Grid (model) + Location & Operation of Gas Power Plants
simulation (& optimization)



Define Location and Operation Schedule of Power-to-Gas Units



Gas Grid (model) with Location and Operation of Gas Demand and Supply

simulation (& optimization ??)

- Grid Infrastructure Gas and Electric
- Location of Gas Demand and Supply
- Location and Operation of Power Plants
- Location and Operation of Power2Gas
- Location and Operation of Gas Storages

- From existing infrastructure perspective:
  How much H_2 can we inject into the pipelines?
- From newly established services perspective:
  Where should we place P2G facilities?

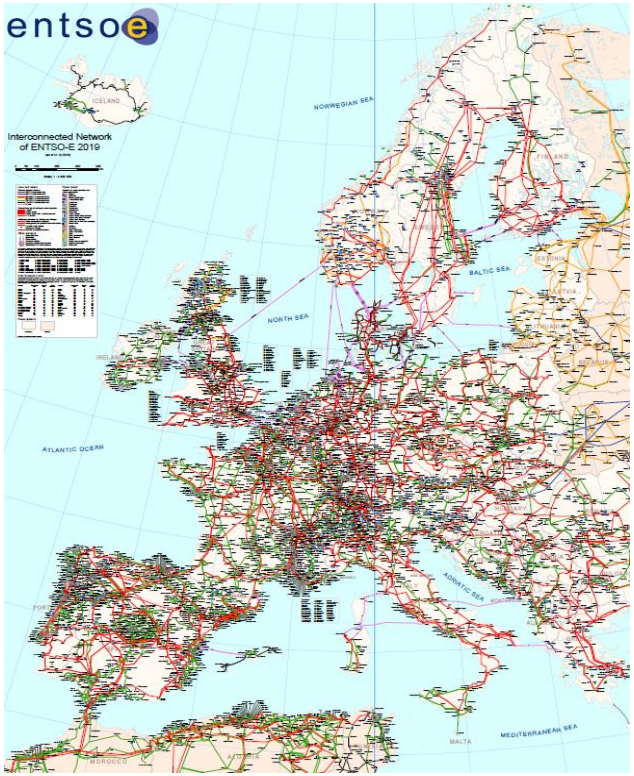
Output: Feedback to the electric grid & multi-modal investment model

- **Identified Bottlenecks and Infeasibilities**
- **List of Change Requests**

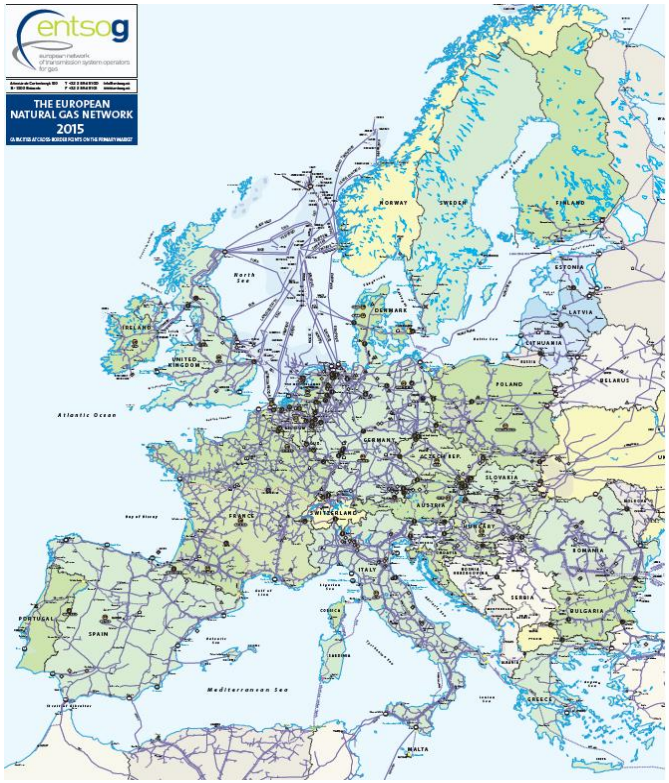
plan4res SIEMENS Ingenuity for life RWTH AACHEN UNIVERSITY

Coupling of gas grid and electric grid models on pan-European scale … is ambitious, but necessary when dealing with power-to-gas

plan4res



- Location and Operation of power plants
- Location and Operation of Power2Gas
- Location and Operation of Gas storages
- Location of Gas Demand and Supply



plan4res SIEMENS Ingenuity for life RWTH AACHEN UNIVERSITY

SIEMENS

Final Key message: Sector Coupling is a cornerstone of decarbonization ... and modelling of integrated energy systems necessary

... find out more about our project

plan4res
www.plan4res.eu

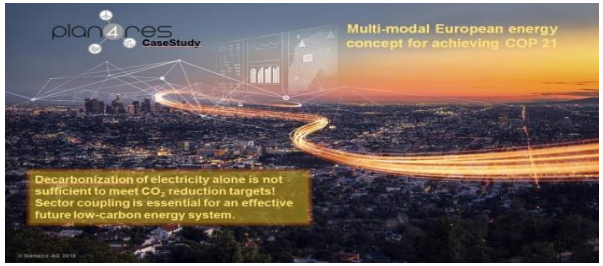
RWTH AACHEN UNIVERSITY · Imperial College London · ZIB · ICOOR · Hewlett Packard Enterprise · eDF · SIEMENS Ingenuity for life

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773897.

Case Study

Integrated multi-modal pan-European energy concept for achieving COP 21 targets w/ perfect foresight, considering sector coupling of electricity, heating and cooling, mobility, fuel/gas and coupling of gas network and electric grid

www.plan4res.eu/wp-content/uploads/2019/06/plan4res-Definition-Case-Studies-Summary-CS1.pdf



Multi-year, aggregated view — Focus year, disaggregated view

Multi-modal investment model (EU pathway)	Disaggregation + EU commitment model	Transmission Grid operation model	Gas Grid operation model
SIEMENS Ingenuity for life	RWTH AACHEN UNIVERSITY	RWTH AACHEN UNIVERSITY	ZIB

Dr. Dieter Most
SIEMENS Ingenuity for life
Corporate Technology,
Research Group
Energy System Modeling

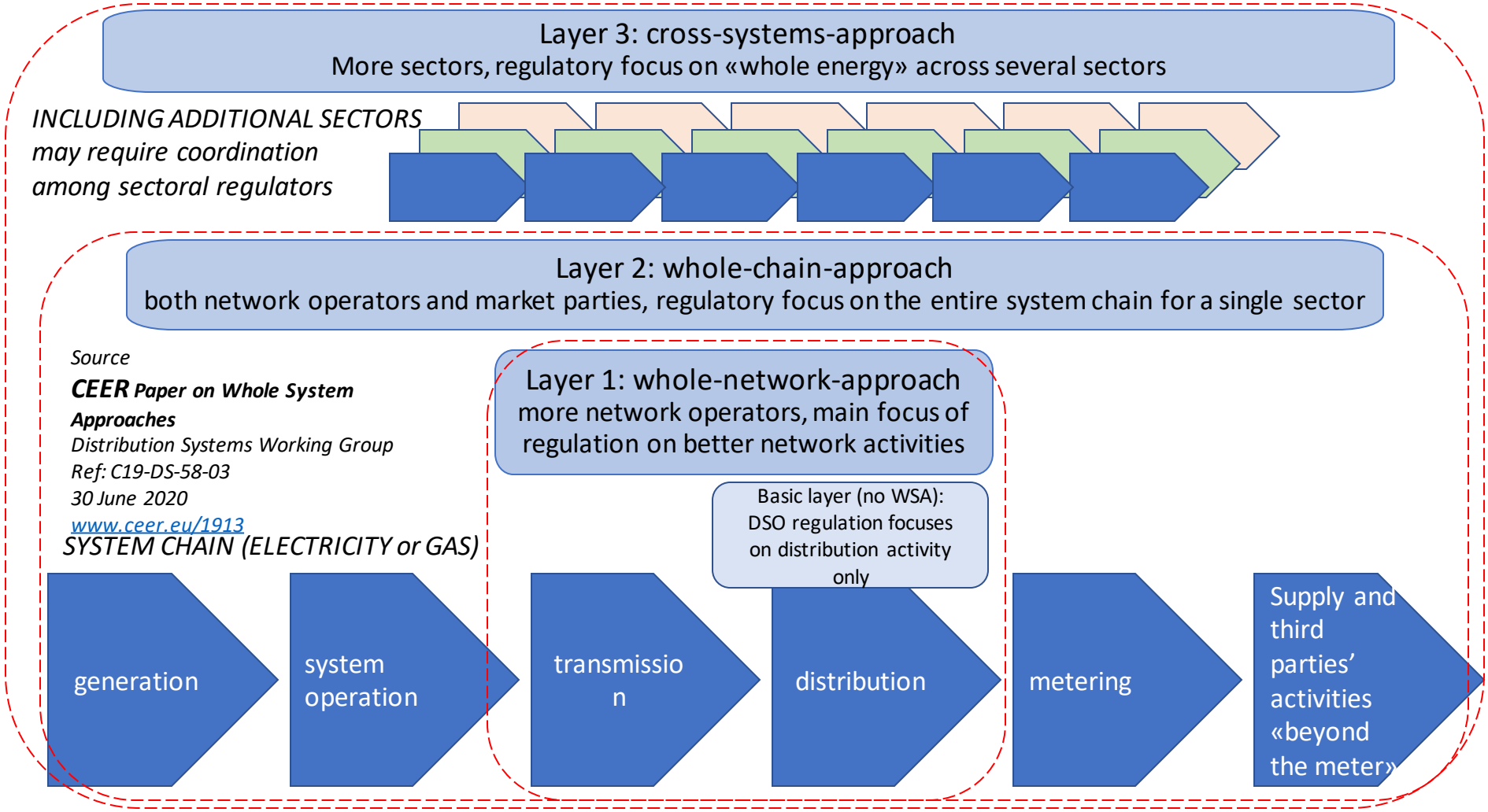
Lothar Wyrwoll
RWTH AACHEN UNIVERSITY
Institute IAEW
Chair of Transmission Grids and Energy Economics

Dr. Inci Yueksel-Erguen
ZIB
Department AI²M
Applied Algorithmic Intelligence Methods

ARERA
Autorità di Regolazione per Energia Reti e Ambiente

Whole System Approach:
a regulatory perspective on sector integration

Luca Lo Schiavo
ARERA – Italian Regulatory Authority for Energy and Environment
Dep't Energy Infrastructure Regulation
7 October 2020


Layer 3: cross-systems-approach
More sectors, regulatory focus on «whole energy» across several sectors
INCLUDING ADDITIONAL SECTORS
may require coordination
among sectoral regulators
Layer 2: whole-chain-approach
both network operators and market parties, regulatory focus on the entire system chain for a single sector
Source
CEER Paper on Whole System Approaches
Distribution Systems Working Group
Ref: C19-DS-58-03
30 June 2020
www.ceer.eu/1913
Layer 1: whole-network-approach
more network operators, main focus of regulation on better network activities
Basic layer (no WSA):
DSO regulation focuses on distribution activity only
SYSTEM CHAIN (ELECTRICITY or GAS)
generation
system operation
transmissio n
distribution
metering
Supply and third parties' activities «beyond the meter»

REGULATORY INITIATIVES WITH WHOLE SYSTEM APPROACH

- **Innovation: pilot projects and pilot regulations**
  e.g. Pilot projects for P2X (consultation phase)
  www.arera.it/allegati/docs/20/039-20.pdf
  e.g. Pilot regulation for aggregation of distributed resources (trial)
  www.arera.it/allegati/docs/20/321-20.pdf

- **Cost Benefit Analysis: joint scenarios (electricity – gas – other fuels)**
  e.g. Analysis of energy infrastructure development in Sardinia
  www.arera.it/it/operatori/Sardegna_RSE.htm

- **Incentive Regulation**
  e.g. digitalization and synergies among different public services
  www.arera.it/allegati/docs/19/005-19dieu_elaborato.pdf

Plenary 4

SECTOR INTEGRATION – DECARBONISATION THROUGH MULTI-ENERGY CARRIER INTEGRATION