Bringing flexibility provided by multi-energy carrier integration to a new MAGNITUDE

Regine Belhomme, EDF

Policy Workshop, March 18th, 2021

This project has received funding from the European Community’s H2020 Framework Programme under grant agreement No 774309

Why flexibility?

Expected evolutions of the electricity system…

- EU targets: reduction of greenhouse gas emissions, integration of renewables, increased energy efficiency
- Electrification of energy usages (e.g. electric vehicles, heat demand, etc.)

Risks in terms of: quality and security of supply, congestion, system stability, curtailments, system adequacy, etc.

Needs:

- **more flexibility and active involvement** of all the stakeholders at all levels
- service provision capabilities of **both centralized and decentralized resources** in a coordinated way (incl. consumers and producers resources).

Enhanced synergies between different energy carriers:

- **provide flexibility** to the electricity system
- **drive efficiency** and **business innovation** in the energy sector

The MAGNITUDE project

Project target: develop

- **optimization** and **coordination tools**
- **business** and **market mechanisms**

to provide **flexibility** to the European electricity system, by enhanced **synergies between electricity, gas and heating/cooling systems.**

- Support **cost-effective integration of renewables** and enhance **security of supply**
- Bring under a **common framework**, technical solutions, market design & business models
- Contribute to **ongoing policy discussions** in the energy field

MAGNITUDE is a Horizon 2020 European project

- Research and Innovation Action
- Duration: 10/2017 → 05/2021
- Coordinator: EDF
- EC funding: 4 M€

Consortium: 16 partners from 9 countries

A complementary and comprehensive expertise

	Organisation profile
EDF	International utility
REGENERA	Retailer
EUROHEAT & POWER	Industrial association
a2a calore e servizi	Local multi utility
AGUAS DE MURCIA	Local utility
CYBERGRID	Aggregation solution provider
ENGINEERING INGEGNERIA INFORMATICA	Data solution provider
N-SIDE	Market solution provider
vito	Consulting/research
RSE	Consulting/research
efficacity	Consulting/research
eifer	Consulting/research
CARDIFF UNIVERSITY	University
Mälardalen University Sweden	University
DTU Technical University of Denmark	University

Multi-energy systems: 7 real-life case studies

Main MES categories

- Large industries
- District heating/cooling networks
- Distributed units

3 main flexibility levers

- Fuel shift
- Storage capability
- Demand response

7 countries

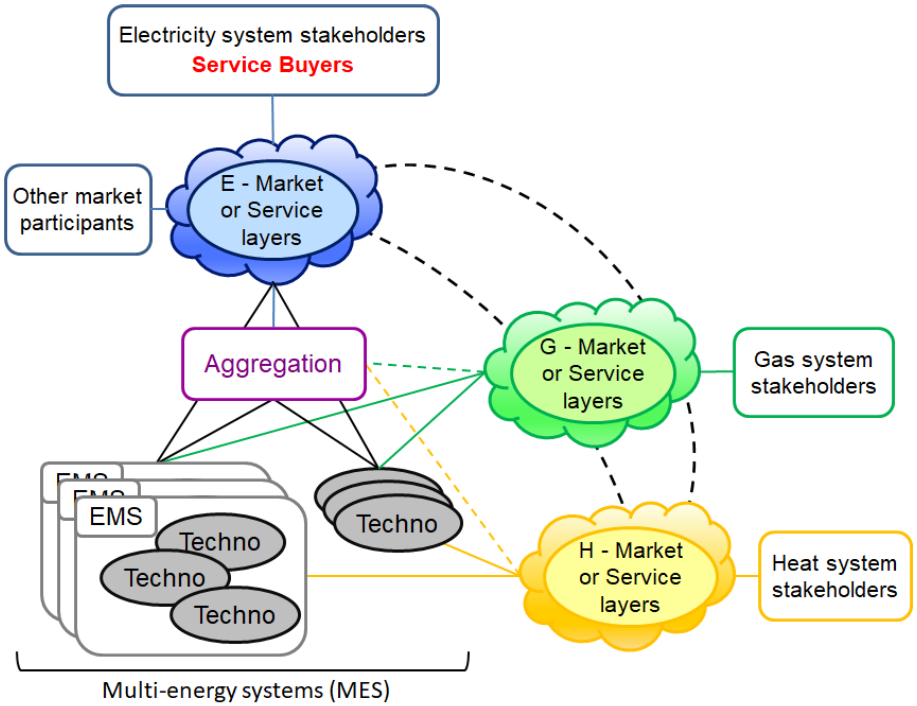
- Austria, Denmark, France, Italy, Spain, Sweden, United Kingdom

Different regulatory frameworks, core businesses, sector-coupling technologies, stakeholders and business models

Mälarenergi **Sweden**	District heating and cooling networks
Paper mill **Austria**	Integrated pulp and paper mill
HOFOR **Denmark**	Distributed units at consumers' + district heating network
ACS **Italy**	Milan district heating network
Neath Port Talbot, UK	Steel industry, CCGT and large RES
EMUASA **Spain**	Wastewater treatment plant
Paris Saclay **France**	District heating & cooling networks + distributed units in substations

MAGNITUDE main results

- MAGNITUDE technical and commercial **functional architectures**
- **Flexibility services** provided by Multi-Energy Systems (MES) to electricity system
- **Flexibility capabilities** of cross-sector technologies and MESs
- **Simulation and optimization of control strategies** of technologies and MES to maximize flexibility provision
- **Aggregation** of flexibilities of decentralized MESs
- **Innovative market designs** for synergies maximization, implemented on a **market simulation platform**
- **Assessment of integrated system** (MES, aggregation, market)
- **Business models** for MES and aggregator
- Multi-energy **data hub**
- **Policy strategy and recommendations** in a pan-European perspective



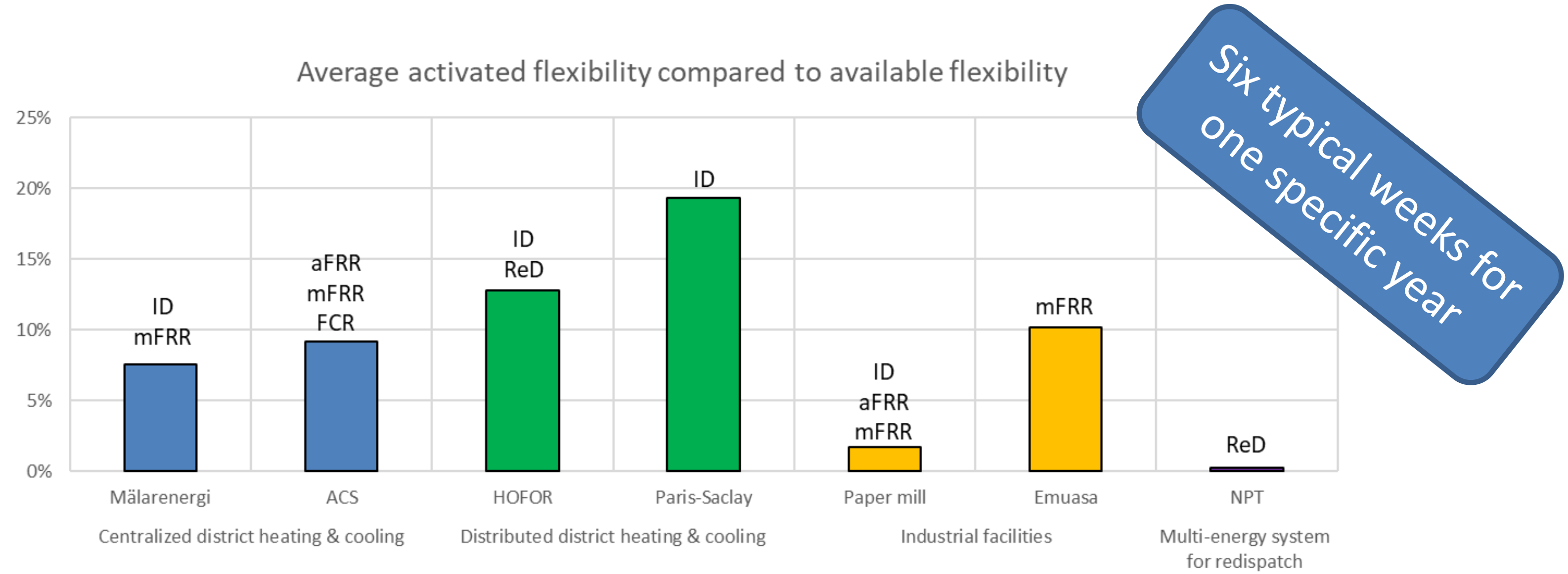
MAIN LESSONS LEARNT

Multi-energy systems can provide flexibility

- and already do so for some of the considered case studies (e.g. ACS, Austrian paper mill) most often through an “internal” or “external” aggregator

Potential for MES to participate in energy markets, frequency ancillary service procurement and congestion management in local markets

Results show that flexibility provision strongly depends on technologies in MES site, the process and operation strategies



Technological perspectives

Technical limitations due to intrinsic flexibility capabilities of technologies with respect to market products requirements (e.g., full activation time, minimum duration of service provision, symmetric product)

- Key characteristics need to be **known and monitored**
- **Integrated management** of different technologies at site level (EMS)
- **Aggregation** of MES and other resources

Increased operating costs due to flexibility provision:

- **Deviation/change in operation** plan can lead to increased operating costs
- Participation if **sufficient remuneration** to cover extra costs

Priority to satisfy the needs of the main/core process, e.g. supply heat or cooling to consumers, produce paper or steel, treat wastewater, etc.

Technological perspectives

Introduction or increase of storage (heat, cooling, steam, gas)

- **Increases flexibility capability**: [add a few %] to [multiply by > 5]
- Oversizing may reduce profitability ➔ **compromise** to be found

District heating and cooling:

- **Highly seasonal nature** with strong constraints for some seasons

Long-term operation efficiency

- Limitation of the **lifetime of the equipment** (e.g. frequent starts and stops and load ramps)

Interconnections with external networks

- Capacity of the networks may impose limitations on **the maximum amount of power** that the MES can exchange

Markets & service procurement mechanisms

Similarities between countries for day-ahead & intraday energy markets in electricity system but still **country specificities**

Large diversity for balancing and frequency regulation services

- market clearing, product definitions (FAT, bid duration, minimum bid size, …)
- **harmonization initiatives of TSOs** (FCR cooperation, PICASSO, MARI, TERRE)

Even larger diversity for capacity requirement mechanisms and congestion management

Rather heterogeneous situations for gas markets and heat networks

- For heat networks from **one area to the other** and **from one MES to the other**.
  - **No unbundling, no "organized market"** as such, **inherently local systems**

Very fast evolving field!

➔ Account for **specificities both at national and local scales** and closely monitor **evolutions**

Markets & service procurement mechanisms

Rules or requirements limiting service provision by MES in some countries

- Restrictions on **some technologies** or **aggregation,** high **thresholds** to access some markets

Intraday market issues in some countries

- Lack of liquidity
- Insufficient difference with respect to day-ahead market prices

Remuneration of frequency regulation services

- **Remuneration only for energy** activated by TSO → risk for providers
- **Remuneration of capacity and energy** (hybrid markets)

Increased costs due to network tariffs, retail prices, taxes,…

- Price of energy plus other costs: network charges, taxes, charges/contribution for RES

Need for improved:

- **Compatible incentive schemes**, (e.g. DSOs; RES support schemes vs flexibility provision)
- **Coordination between network operators**: (e.g. DSOs and TSOs; between energy carriers)
- Attractiveness of **flexibility remuneration**

Stakeholders

Similar roles in electricity, gas, heating & cooling systems:

➔ synergies between the three sectors

But different characteristics for system operation and market aspects

- time constants, inherent resilience, dynamic behaviours
- operation needs and requirements
- gate closures, etc.

Large diversity of stakeholders with deeply different professional culture

- **Complexity and multiplicity** of interactions/transactions
- Increased complexity of business processes
- Needs for awareness raising, learning and training

Roles
Producer
Consumer
Transmission network operator
Distribution network operator
Balance responsible
Supplier
Storage provider
Metering-related roles
Regulator
…

Innovative market designs

With decoupled energy carrier markets

- Physical and economic **dependencies** not explicitly taken into account
- Imperfect forecasts can lead to **loss of profit** for conversion technologies, and **lost opportunity** for market participants.

With integrated multi-carrier day ahead market

- **Dependencies** between various carriers explicitly considered
- New order types and constraints allow market participants **to describe their technical limitations and cost structures**
- **Economic efficiency** can be increased

However

- **Higher computational time**
- **More information** to be shared with the market operator
- **Organizational changes** are required
- **Cost-benefit analysis** of possible implementations is required

THANK YOU FOR YOUR ATTENTION

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MAGNITUDE website – coming soon

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EU GREEN DEAL: WHAT NEXT FOR SECTOR INTEGRATION?

10:00 – 11:10 18TH MARCH 2021

PLAN.
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ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Introduction to ETIP SNET new Sector Coupling Whitepaper

Laurent SCHMITT, Vice-Chair
March 18th, 2021

Sectorial Integration Challenges

- **Multi-vector heterogeneous sector coupling**
  - Power, gas, heat and liquid fuels, transportation, etc…
- **Bi-directional renewable integration in power & Cross Sectorial decarbonation**
  - Increased renewable share in the Power system through seasonal storage, decarbonation of flexibility services supplied to the Power Grids
- **Very different technology readiness levels**
  - Electrical technologies (e.g. within heating, PV, storage and EVs) have high TRLs while new e-fuels require research, development and demonstration
- **Regulations need to be aligned and further developed to support cross sectorial system efficiency & decarbonation**

New System of Systems approach

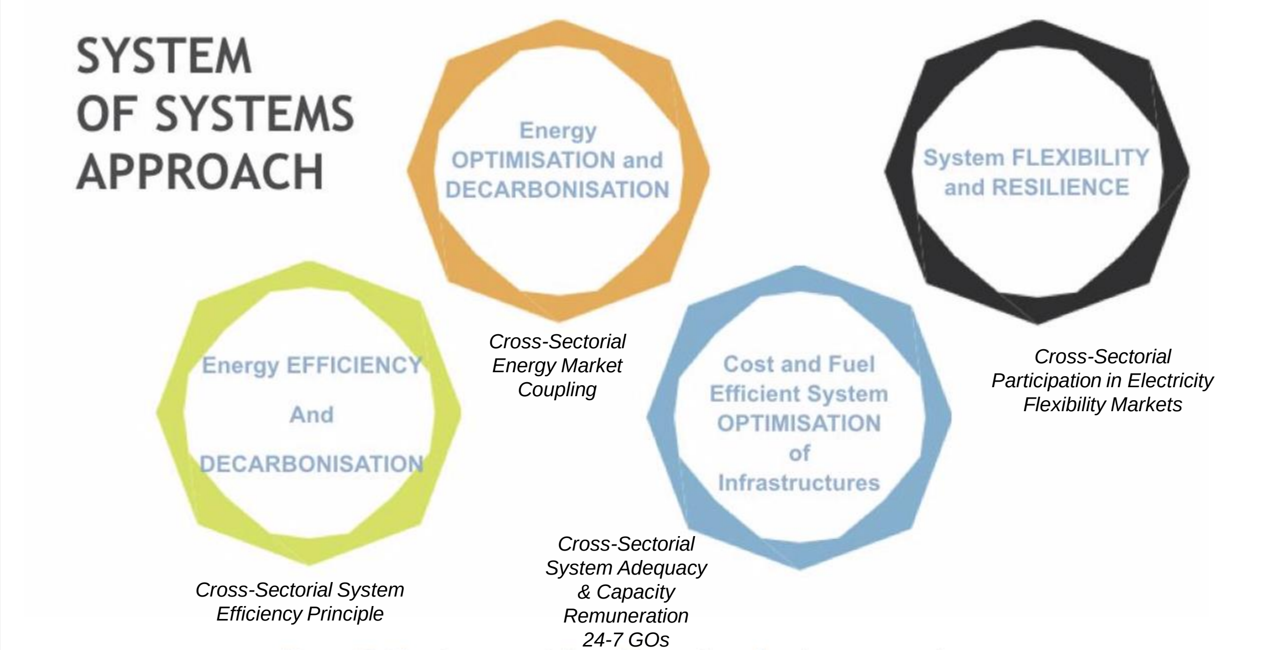


Figure 15. Visual representation of the system of systems approach

Strategic Cross-Sectorial Optimization Objectives

Key Policy Recommendations

- Foster cross-sector and cross-countries level playing fields, removing unnecessary or double taxation on electricity, incentivising Power-to-X solutions.
- Encourage stakeholder cooperation through multisided cross sectorial platforms while coupling them to a revamped EU Emission Trading Scheme
- Boost electricity and gas sector integration for new products such as electrolytic hydrogen and renewable gases to be traded through an updated European gas market.
- Develop new ICT backbones / digital integration layers to support the new system of system approach, develop an harmonized cross sectorial role models and APIs across sectors

PLAN.
INNOVATE.
ENGAGE.

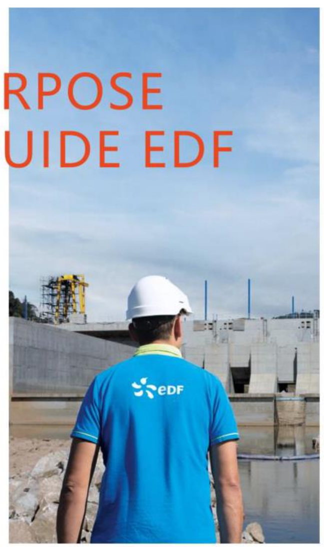
ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM SMART NETWORKS FOR ENERGY TRANSITION

Thanks!

WHAT NEXT FOR SECTOR INTEGRATION?

POLICY DEBATE – MAGNITUDE PROJECT
18th March 2021



A PURPOSE
TO GUIDE EDF

« Build a net zero energy future with electricity and innovative solutions and services

to help save the planet and drive weelbeing and economic development »

Sector integration: how to make it happen?

- Prioritise direct electrification and foster innovative electric solutions for consumers
- Level playing field for all flexibility providers and key role of hydropower as flexible renewable and mature storage technology
- Clear definitions and framework for renewable and low carbon hydrogen based on GHG emissions throughout the production process
- Energy taxation principles which reflect the contribution of energy carriers to climate change;

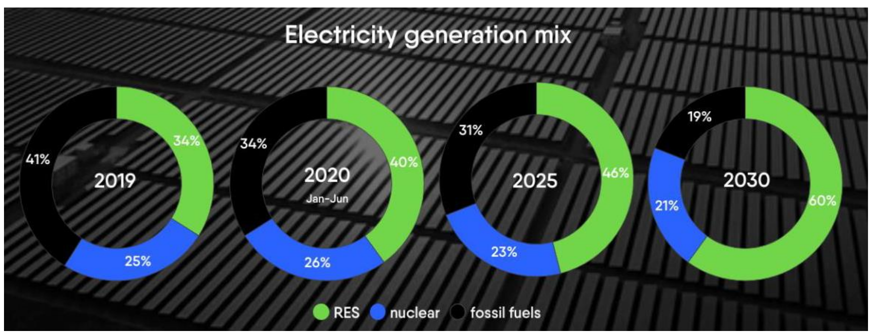
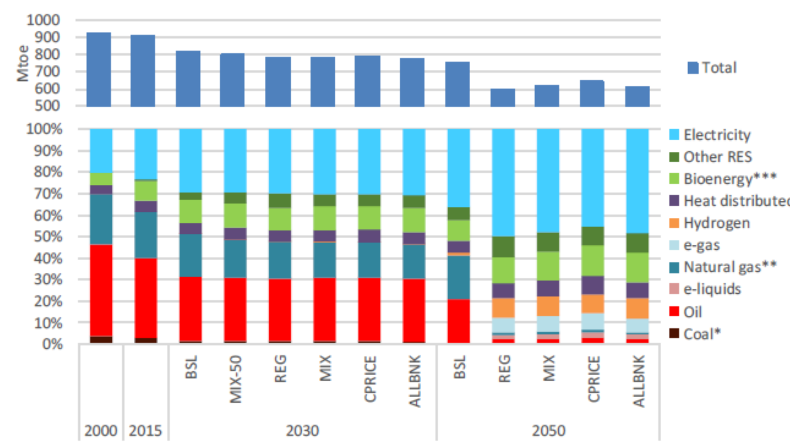


Figure 6: Final energy demand by energy carrier



Sector integration in real life - Flexitanie, the first large-scale V2G project in the Occitania region, aims at the deployment of 100 V2G EVSEs.

- EDF, the Occitania region and ADEME are joining forces to **build the largest virtual battery based on electric vehicles** in France with the **deployment of 100 V2G EVSEs** and compatible Nissan vehicles in companies in the region.
- After a 12-month roll-out (July 20-June 21), EVSEs will be operated by DREEV during 3 years **to provide services to the grid**.
- EDF and ADEME will monitor the project to **measure the integration of the V2G solution in companies** in the region, to **remove obstacles to its deployment** and to **study its positive impact for the development of renewable energies** in the Occitania region.

Online Policy Workshop – 18th March 2021

WHAT’S THE STATUS ON THE GROUND?
11:20 – 12:30

CONGRESS
EUROHEAT & POWER
Vilnius 2021

www.ehpcongress.org

Online & Onsite (3) 4-5 May

Online March – July

VIRTUAL THURSDAYS
WARM-UP SERIES
14:00 – 15:00 18 March 2021
Episode 3 – LOOSEN UP!

Decarbonizing our energy sector through system integration and flexibility provision

Marina Galindo Fernández, Tilia

Jan Ingwersen, ENTSOG

Olivier Lebois, ENTSO-E

WHAT'S THE STATUS ON THE GROUND?

11:20 – 12:30 18TH MARCH 2021

ENERGY INTEGRATION: FROM POLICY TO ACTION

Session 2: What's the status on the ground? A local perspective

Marina Galindo Fernández – Senior Manager

https://tilia.info
@TiliaGmbh

18/03/2021

DECARBONISING HEATING AND COOLING, AN EU PRIORITY

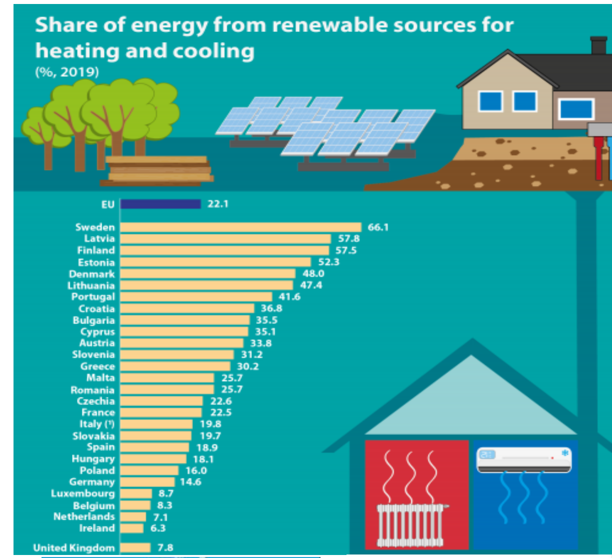
THE KEY ROLE OF DHC: FROM ACTION TO POLICY

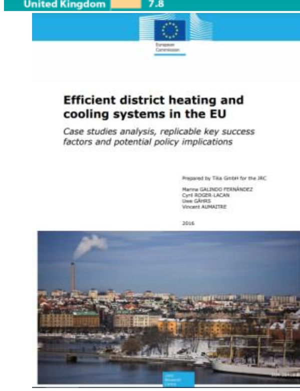
- ☐ **Heating and cooling (H&C)** has been given a more important role in the new EU energy transition strategy established by the EU Green Deal and its associated communications

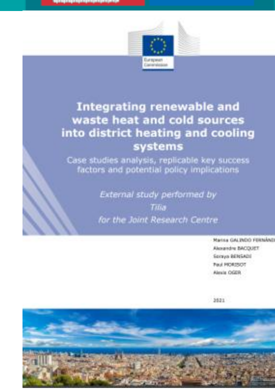
- ☐ **District heating and cooling (DHC) is one of the main infrastructures allowing decarbonisation through smart sector integration, and often proves the strongest leverage at local level for deep energy decarbonisation**
  - Efficient integration of a wide range of renewable energy sources (RES) and (excess) waste heat and cold sources
  - Energy efficiency in buildings
  - Evolutive systems
  - Flexibility to the electricity grid

- ☐ **Public and policy awareness on DHC advantages and DHC uptake remains low** in the EU, while countries where this solution has been largely adopted are amongst the best performers in H&C decarbonisation

➔ **Science-to-Policy studies for the JRC on how RES and waste heat and/or cold sources can be integrated into DHC networks**
(from case studies, including Tilia projects)







INTEGRATING RES AND WASTE H&C SOURCES INTO DISTRICT HEATING & COOLING SYSTEMS

Decarbonising H&C in districts and communities

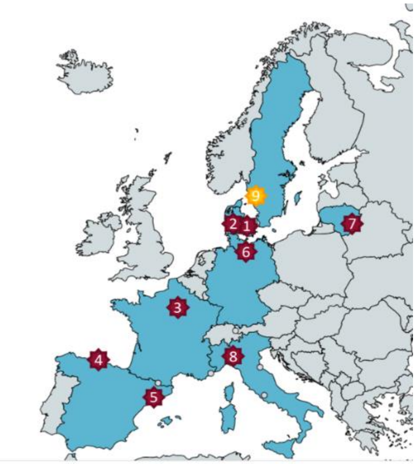
DHC grids as a backbone to…

- ☐ Develop sustainable and evolutive local energy strategies
- ☐ Use local and renewable energy sources, including excess heat/cold and surplus RE
- ☐ Value synergies across sectors and energy carriers
- ☐ Build collaborative models and empower energy communities
- ☐ Supply sustainable cooling

Case studies

1. Taarnby (DK)
2. Jaegerspris (DK)
3. Paris-Saclay (FR)
4. Mieres (ES)
5. Barcelona (ES)
6. Hamburg (DE)
7. Vilnius (LT)
8. Milan (IT)
9. Gothenburg (SE)

Interviews contributing to the Conclusion, but no in-depth study in the report



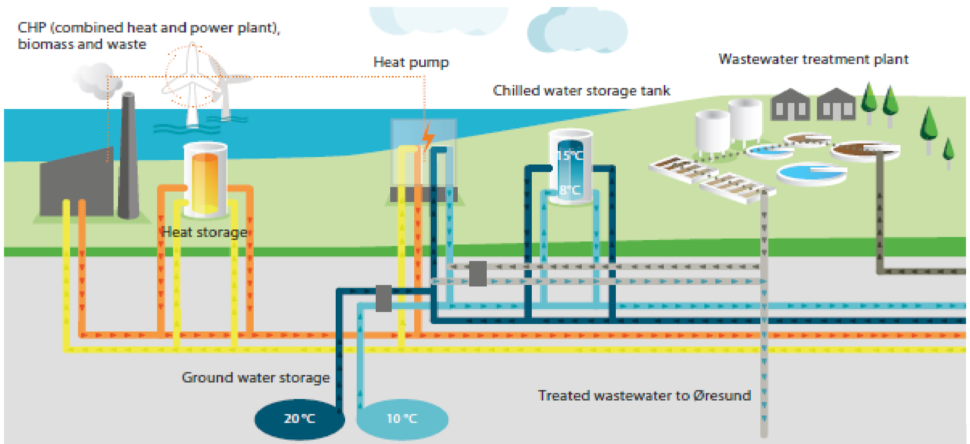
Country	Case Study	Installed capacity	Renewable Energy Sources	Waste Heat/Cold Sources	RES share
	Taarnby DHC	DH: 60 MW DC: 6.5 MW	Renewable electricity; Thermal storage; Biomass	Ambient energy (Wastewater)	91%
	Jægerspris DH	20.1 MW	Solar thermal; Thermal storage; Ambient energy (from the air)	CHP (gas-fuelled)	56%
	Paris-Saclay DHC	DH: 37 MW DC: 10 MW	Geothermal energy	Data centers; Laboratory	60%
	Mieres DH	4.1 MW	Geothermal energy from a closed colliery		98%
	Barcelona-Districlima DHC	DH: 79 MW DC: 113 MW	Renewable electricity; Thermal storage; Ambient energy (from the sea)	Waste-to-energy	91%
	Hafencity DH (Hamburg)	28,3 MW	Biogas	Industrial heat; Thermal storage	90%
	Vilnius DH	1,707 MW	Biomass	In 2021; Waste-to-energy	55%
	Milan DHC	DH: 901 MW DC: 7,5 MW	Geothermal energy	Industrial heat; Waste-to-energy	68%

Examples of decarbonization synergies with the electricity and gas sectors

Link to report: https://publications.jrc.ec.europa.eu/repository/handle/JRC123771

CASE STUDY TAARNBY(GREATER COPENHAGEN)

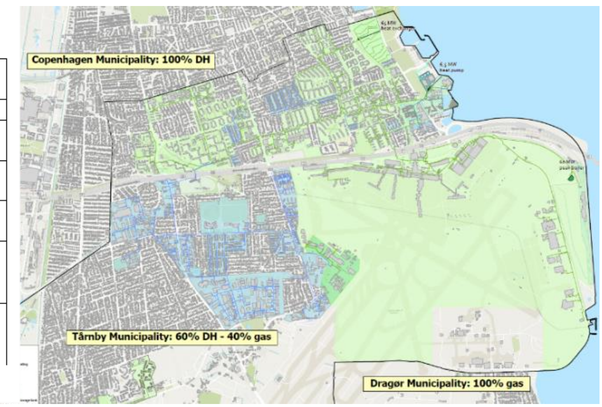
Smart sector integration of heating, cooling, electricity and water



Key facts and figures*

DH market share	100 % of the supplied area
RES share	91 %
CO_2 emissions (heating)	61 Kg/MWh
Installed capacity	DC: 6.5 MW DH: 60 MW
Energy production	DC: 3.5 GWh/y DH: 45 GWh/y
Km network (double-pipe)	DH: 28 km DC: 1.5 km
Supply/return temperature	DH:75-80/45 °C DC: 8/16 °C

* Phase 1, CO_2 including CO_2 from waste



Some Key Features of Taarnby DHC system

- ✓ **High local value creation** (20-year socio-economic internal rate of return = 41%)
- ✓ **Synergies of combined heating and cooling**, even higher when combined with the ground source cooling (Aquifer Thermal Energy Storage - ATES)
- ✓ **Synergies with the wastewater treatment plant**: waste heat recovery, hosting the energy plant ("smart cities have smart backyards")
- ✓ **Thermal storage systems** (chilled water tank, ATES, and storage facilities within Greater Copenhagen's system) enable DHC to act as a **flexible electricity consumer**
- ✓ Optimal operation taking into account **electricity price signals**

Barriers for Sector Integration in Denmark

- ➢ **Building regulations** favouring individual solutions at building level (through Primary Energy Factors), and requiring additional thermal insulation for buildings connected to DHC
- ➢ **Electricity taxes for heating and comfort cooling,** recently reduced in Denmark, where 50% of the electricity is based in RES
- ➢ **Electricity tariffs not valuing demand response**, e.g. connection fees for electric boilers are the same as for non-flexible consumers
- ➢ **Uncertain future for CHP plants** (no capacity market), which today provide balancing services and complement heat pumps

CREATING MEASURABLE VALUE

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CREATING MEASURABLE VALUE FOR INDUSTRIES, CITIES AND COMMUNITIES

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18 March 2021

Magnitude – Energy Integration: From Policy to Action

What’s the status on the ground?

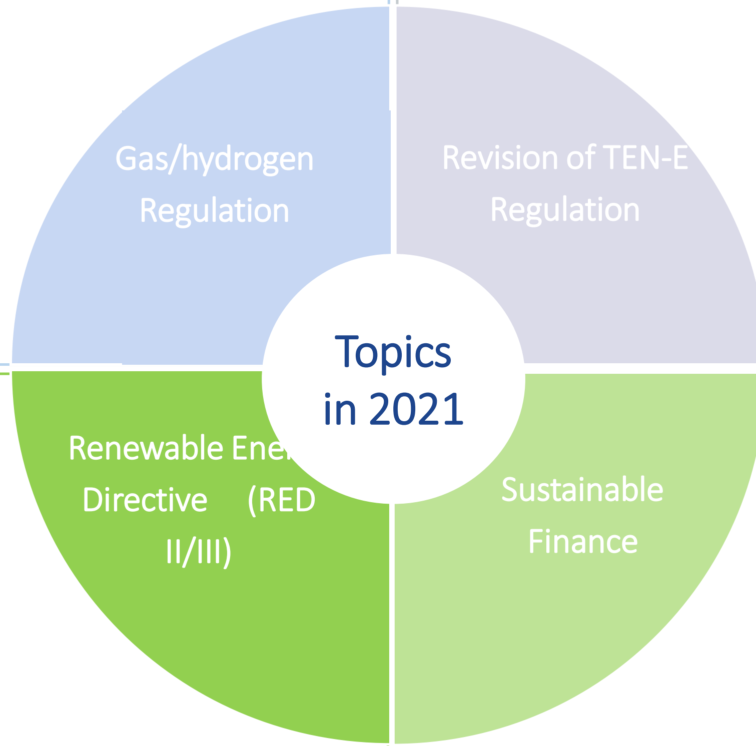
18 March 2021 11.20-12.30 CEST

Jan Ingwersen, ENTSOG General Director

Regulatory Challenges for Sector Integration in 2021

Integration of gas and hydrogen regulation
Hydrogen infrastructure should share similar regulatory principles as gas infrastructure

Developing future gas and hydrogen infrastructure
Integrated planning and investment processes to enable efficient infrastructure development.



Supporting use of renewable and low-carbon gases
Create EU-wide scheme for Guarantees of Origin for all gases to facilitate cross-border trade.

Facilitating investment in renewable and low-carbon gases
Ensure transparency and technology-neutrality among energy carriers.

ENTSOG's Engagement in the Energy Transition

European Clean Hydrogen Alliance

- Coordination of Round Table on Transmission and Distribution
- Working with business/ industrial partners on EU Hydrogen Strategy
- Efficient funding of key strategic projects
- Identification of barriers for project progress – financially, regulatory etc.

TYNDP Scenarios

- Joint development of scenarios with ENTSO-E
- Joint Stakeholder Forum for Scenarios
- Updating CBA methodology
- ENTSOG & ENTSO-E Interlinked Model

Advisory Panel for Future Gas Grids

- How to decarbonise the gas grids?
- Discussion of key issues facing gas infrastructure
- Exchange with stakeholders across gas value chain
- Develop consensus and identify challenges

Prime Mover Group – Guarantees of Origin

- Supporting creation of harmonised EU-wide GO system
- Develop role of TSOs in the GO system

Prime Mover Group – Gas Quality and Hydrogen

- Improving uptake of hydrogen in gas grids
- Forum for exchange on projects and research

Thank you for your attention

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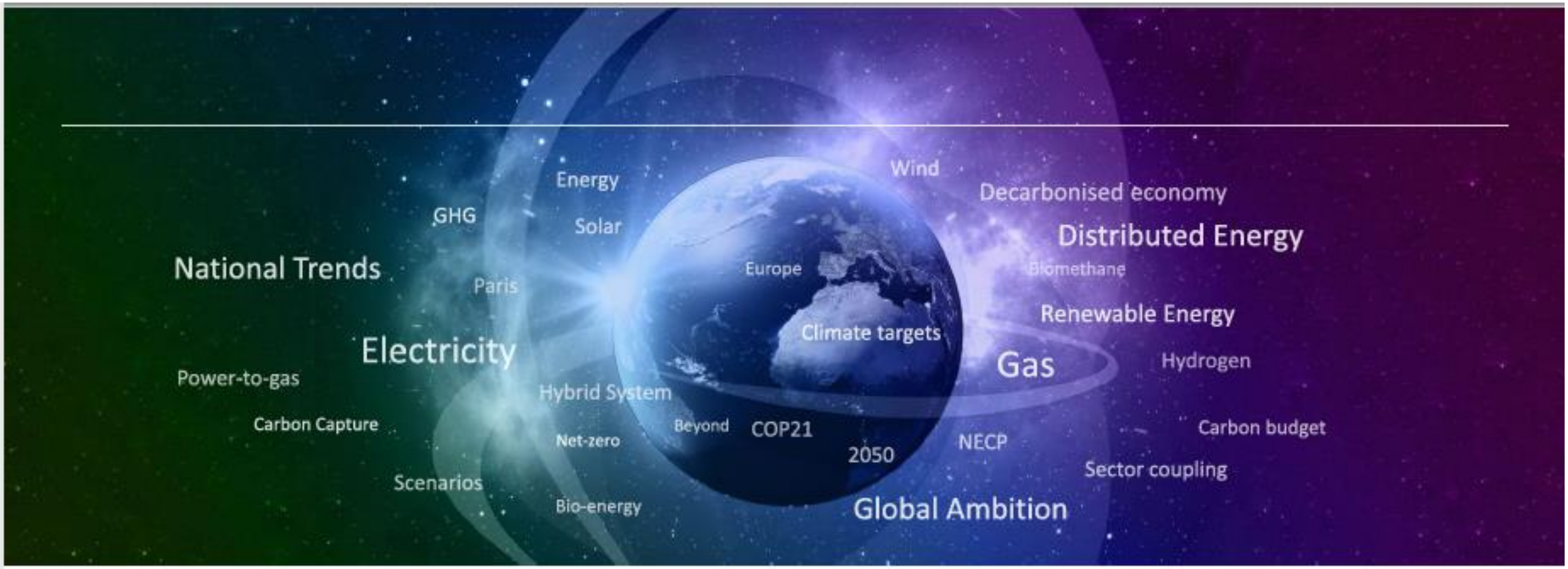

Sector coupling in TYNDP Scenarios

Magnitude policy workshop - Energy Integration: From Policy to Action

18 March 2021

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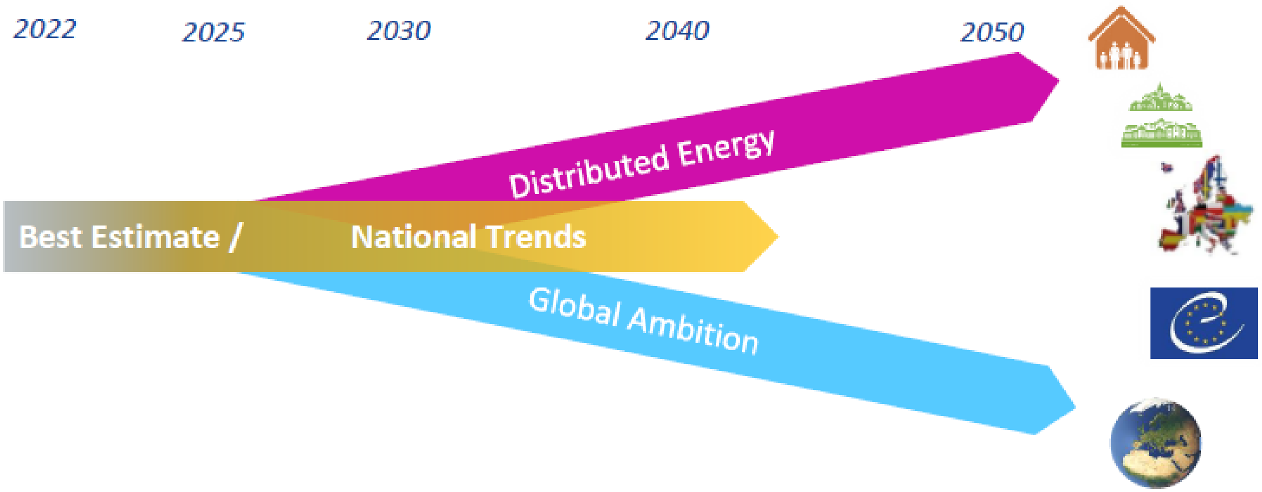
TYNDP 2022 Scenarios joint development by ENTSO-E and ENTSOG



European autonomy (RES, P2X) **with renewable and decentralised focus** (prosumers, local municipalities)

Reflecting the latest national policies and strategies

Global economy (import of methane and hydrogen) **relying on low-carbon centralized options** next to RES

Reaching carbon neutrality with a high RES share induces more sector coupling as a way:

- To reduce emissions in hard to abate sectors
- To provide an additional flexibility source

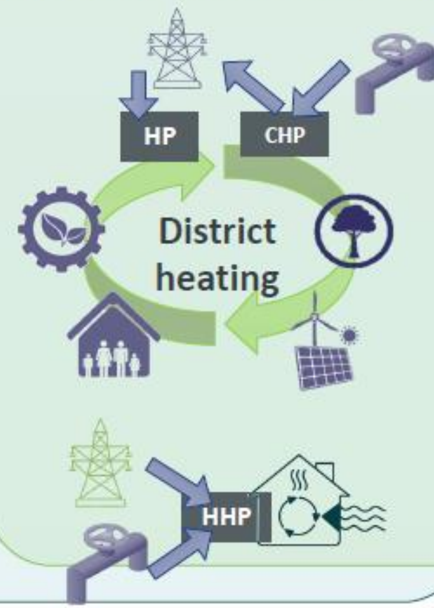
Combining higher RES share and lower imports likely reinforce the role of sector coupling

The many dimensions of sector coupling

Energy carrier coupling

- Gas-fired power generation
- Wide range of electrolysis configurations
- Modelling H2 infrastructures (network and storage)

Power-to-Heat, CHP and Hybrid HP at the crossroad



Distribution scale

Capturing Solar / Battery / EV / prosumers / DSR at distribution scale

We are already in action with challenges ahead

TYNDP 2020 Scenarios	→	TYNDP 2022 Scenarios
19% DH market share with a biomass focus in DE and HP focus in GA		Draft storyline report proposes a range as wide as 15-35% Climatic flexibility of district heating HP should be captured

Sector coupling aims at unlocking potential for further optimization of the energy system

Even at prospective study level, identifying and modelling sector coupling is not for free:

- The identification of the partners having the knowledge
- Setting the appropriate way of working and expert resources on both sides
- A smart modelling approach to avoid adding up the complexities of each sector
- Representative data at European perimeter with at least country granularity

District heating, gas and electricity transmission associations have engaged in this challenging and stimulating path to ensure long term and continuous progress

Thank you for your attention