



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

Project public presentation

Last update: October 2018





Context

Expected evolutions of the electricity system...

- EU 2020 and 2030 targets for the reduction of greenhouse gas emission
- Increasing share of variable renewable energy sources
- Expected increase of electricity demand (new usages such as electric vehicles, heat pumps)

... will lead to new risks and needs

- ➔ New or increased system risks in terms of quality and security of the electricity supply, congestion, system stability, curtailments, impossibility to cover the electricity demand at some periods of time, etc.
- ➔ Needs for more flexibility, more active involvement of all the stakeholders and more collaboration... at all levels (from distribution to pan-European)
- ➔ Need to harness the service provision capabilities of both centralized and decentralized resources in a coordinated way (including both consumers and producers resources).

Enhanced synergies between different energy carriers appear now as one of the possible means to provide flexibility to the electricity system but also to drive efficiency and business innovation in the energy sector as a whole.



MAGNITUDE: a Horizon 2020 project

Call H2020 - LCE-05-2017 : “Tools and technologies for coordination and integration of the European energy system”.

Development of **technologies, tools and systems** for:

*“**Synergies between electricity, gas and heat networks**, associated business and market mechanisms and analysis of existing regulatory aspects”*

NB: technologies for hydrogen production and storage are excluded.

- EC funding: 4 M€
- Duration: 3.5 years - from October 2017 to March 2021
- Coordinator: EDF



MAGNITUDE Target
















MAGNITUDE aims to develop **business and market mechanisms** as well as supporting **coordination tools** to provide **flexibility to the European electricity system**, by increasing and optimizing **synergies between electricity, gas and heat systems**.

MAGNITUDE will hence:

- Provide flexibility options to support **variable RES cost-effective integration** and **decarbonization** of energy system
- ... and to enhance **security of supply**
- Bring under a **common framework**, technical solutions, market design and business models
- Contribute to the **ongoing policy discussion** in the energy field

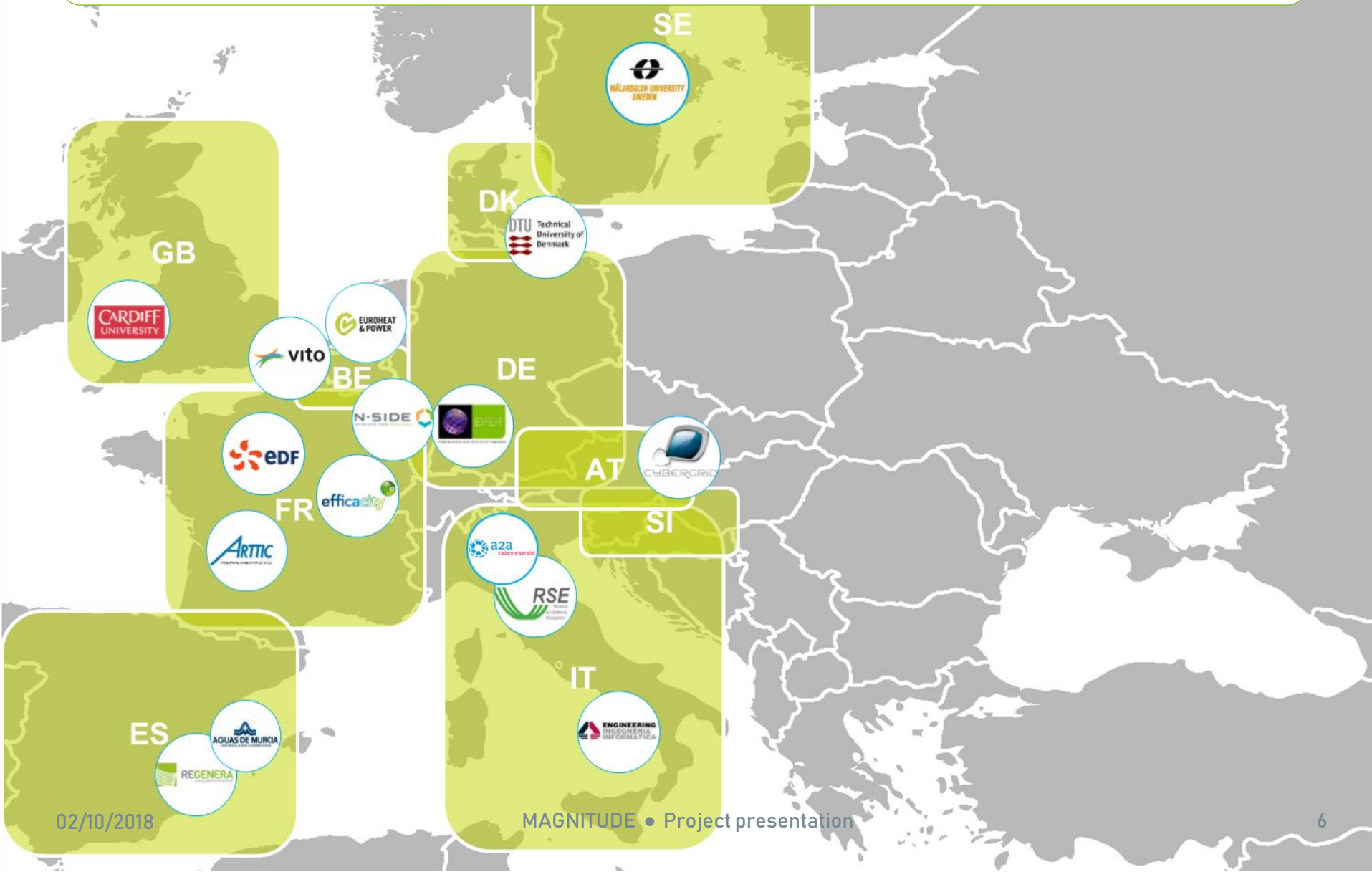


Consortium: a complementary and comprehensive expertise

	Country	Organisation profile	Energy sector			Orientation	
			Power	Heat	Gas	Technology	Market
	France	International utility					
	Spain	Retailer					
	Belgium	Industrial association					
	Italy	Local multi utility					
	Spain	Local utility					
	Austria	Aggregation solution provider					
	Italy	Data solution provider					
	Belgium	Market solution provider					
	Belgium	Consulting/research					
	Italy	Consulting/research					
	France	Consulting/research					
	Germany	Consulting/research					
	United Kingdom	University					
	Sweden	University					
	Denmark	University					



Consortium: 16 partners from 9 countries





MAGNITUDE objectives

1 - ENABLE

- ➔ Provide **tools and models to enable the provision of flexibility** to the electricity system from the integration of multi energy systems' operation.

2 - EXPLOIT

- ➔ Develop **business and market mechanisms to exploit the full potential VALUE** of the flexibility provided.
- ➔ Identify potential **regulatory barriers**.

3 - VALIDATE

- ➔ Validate the solutions on **7 real life case studies** of multi-energy systems of different sizes and technological features, located in 7 European countries (Austria, Denmark, France, Italy, Spain, Sweden, United Kingdom).

4 - MAXIMIZE THE IMPACT

- ➔ Disseminate project results, achievements and lessons learnt towards the **stakeholders in the electricity, heat and gas sectors**
- ➔ Propose recommendations and contribute to the **definition of policy strategies in a pan-European perspective**.



MAGNITUDE approach

- Select **most relevant flexibility services towards the electricity system** to be provided by Multi-Energy Systems, which allow to
 - increase the share of RES,
 - avoid curtailment of variable RES,
 - enhance security of supply,
 - increase trading between energy sectors.
- Study the actual **flexibility options that the identified technologies and systems can provide** to the electricity sector as well as their compatibility with the current regulation and market design.
- **Simulate and optimize the control strategy** to improve the operations of such technology systems to maximize the flexibility provision.
- Propose **improved market designs for synergies maximization** that will be modelled in a **market simulation platform** for the project case study countries.
- **Quantify the benefit of pooling flexibilities** from decentralized multi energy systems through **an aggregation platform**.
- Exploit the achieved results by developing **policy strategy and recommendations** - including technology, market, business models, and regulation – and related considerations for feasibly increasing synergies between networks in representative EU countries



Electricity system stakeholders
Service Buyers

MAGNITUDE concept

Other market
participants

E - Market
or Service
layers

Aggregation

EMS

EMS

Techno

Techno

Techno

Techno

?

Which market
coupling ?

G - Market
or Service
layers

Gas system
stakeholders

H - Market
or Service
layers

Heat system
stakeholders

Multi-energy systems (MES)



Electricity system stakeholders
Service Buyers

MAGNITUDE concept

Other market
participants

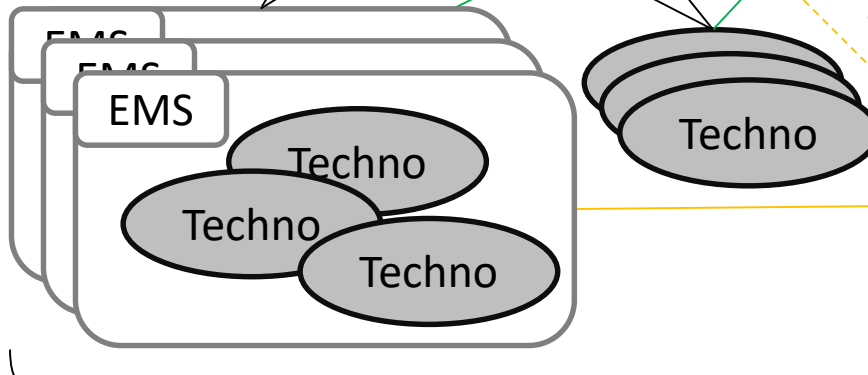
E - Market
or Service
layers

Which market
coupling ?

Aggregation

G - Market
or Service
layers

Gas system
stakeholders



Multi-energy systems (MES)

Multi-energy systems

- Flexibility providers
- Optimisation and control of MES technologies
- Different purposes, technologies and set-ups
- “Centralised”/Decentralised
- With or without EMS (Energy management system) or equivalent
- Mainly connected to distribution network



Electricity system stakeholders
Service Buyers

MAGNITUDE concept

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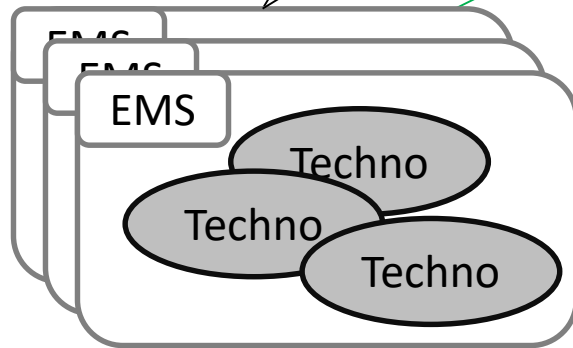
Aggregation

Aggregation

- Collect requests and signals from the market and/or flexibility service buyers
- Gather the flexibility of a portfolio of MESS
- Propose offers to the market and/or service buyers
- Role carried out by a deregulated player: retailer, Balance Responsible Party,... or a separate player

Gas system
stakeholders

Heat system
stakeholders



Multi-energy systems (MES)



Electricity system stakeholders
Service Buyers

MAGNITUDE

Electricity markets

- All types of commercial relationships (organized markets, call for tenders, bilateral negotiations)
- Different market layers and associated services
 - Energy markets
 - Balancing and frequency regulation
 - Congestion
 - Capacity requirement

Other market participants

E - Market
or Service
layers

Aggregation

EMS

Techno

Techno

Techno

Techno

?

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Heat system
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Multi-energy systems (MES)



Electricity system stakeholders
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Which market
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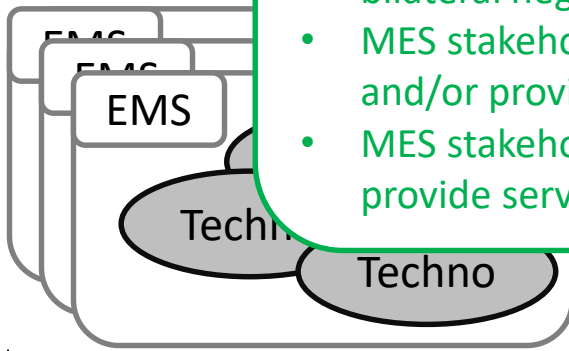
Gas system
stakeholders

Gas and heat markets

- All types of commercial relationships (organized markets, call for tenders, bilateral negotiations)
- MES stakeholders procure and/or provide heat and/or gas
- MES stakeholders may also provide services

Heat system
stakeholders

H - Market
or Service
layers



Multi-energy systems (MES)



Electricity system stakeholders
Service Buyers

MAGNITUDE concept

Coupled multi-carrier markets

- Innovative designs to be proposed and compared
- Focus on energy markets (day-ahead, intraday)

Other market participants

E - Market
or Service
layers

Aggregation

G - Market
or Service
layers

Gas system
stakeholders

EMS

EMS

Techno

Techno

Techno

Techno

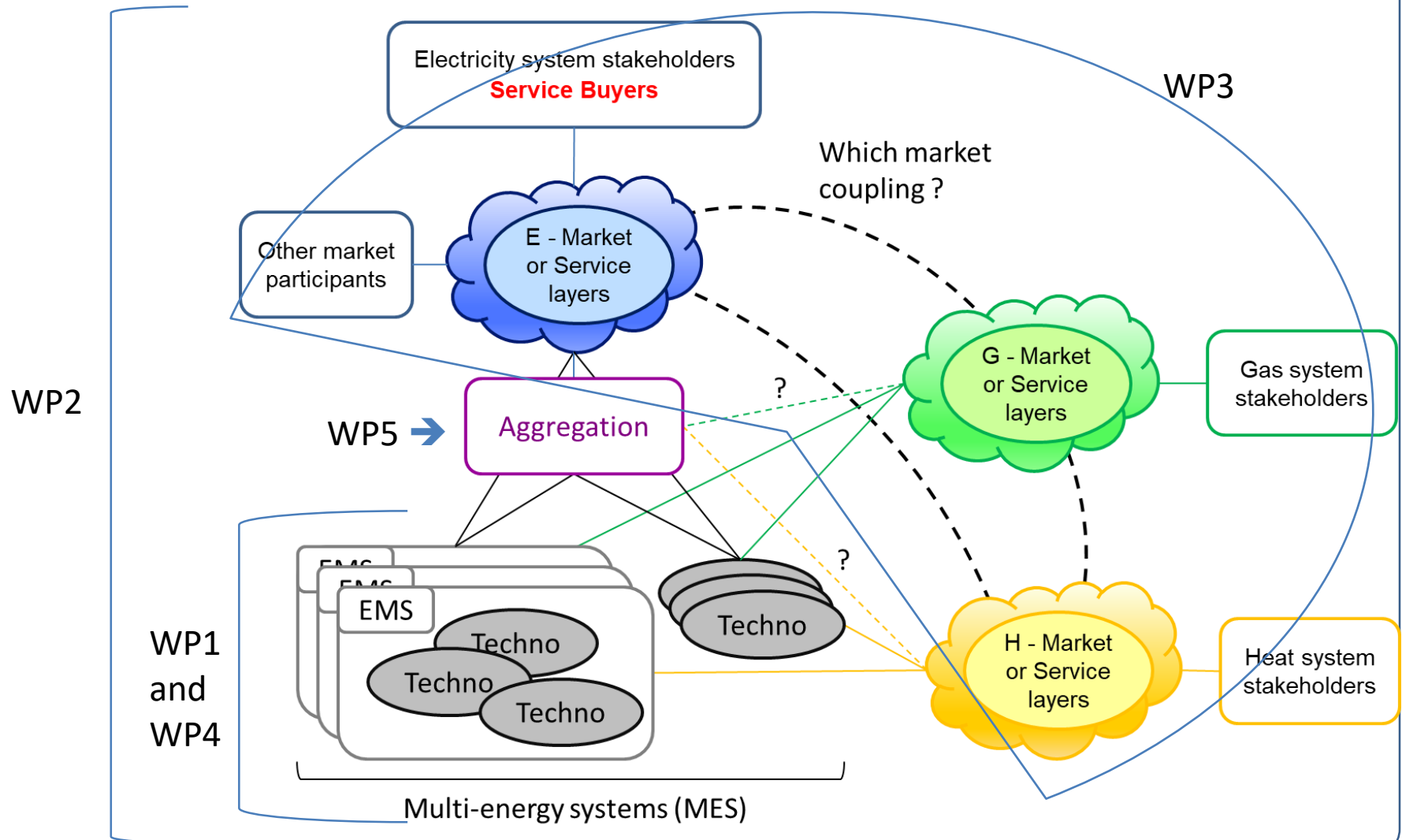
H - Market
or Service
layers

Heat system
stakeholders

Multi-energy systems (MES)

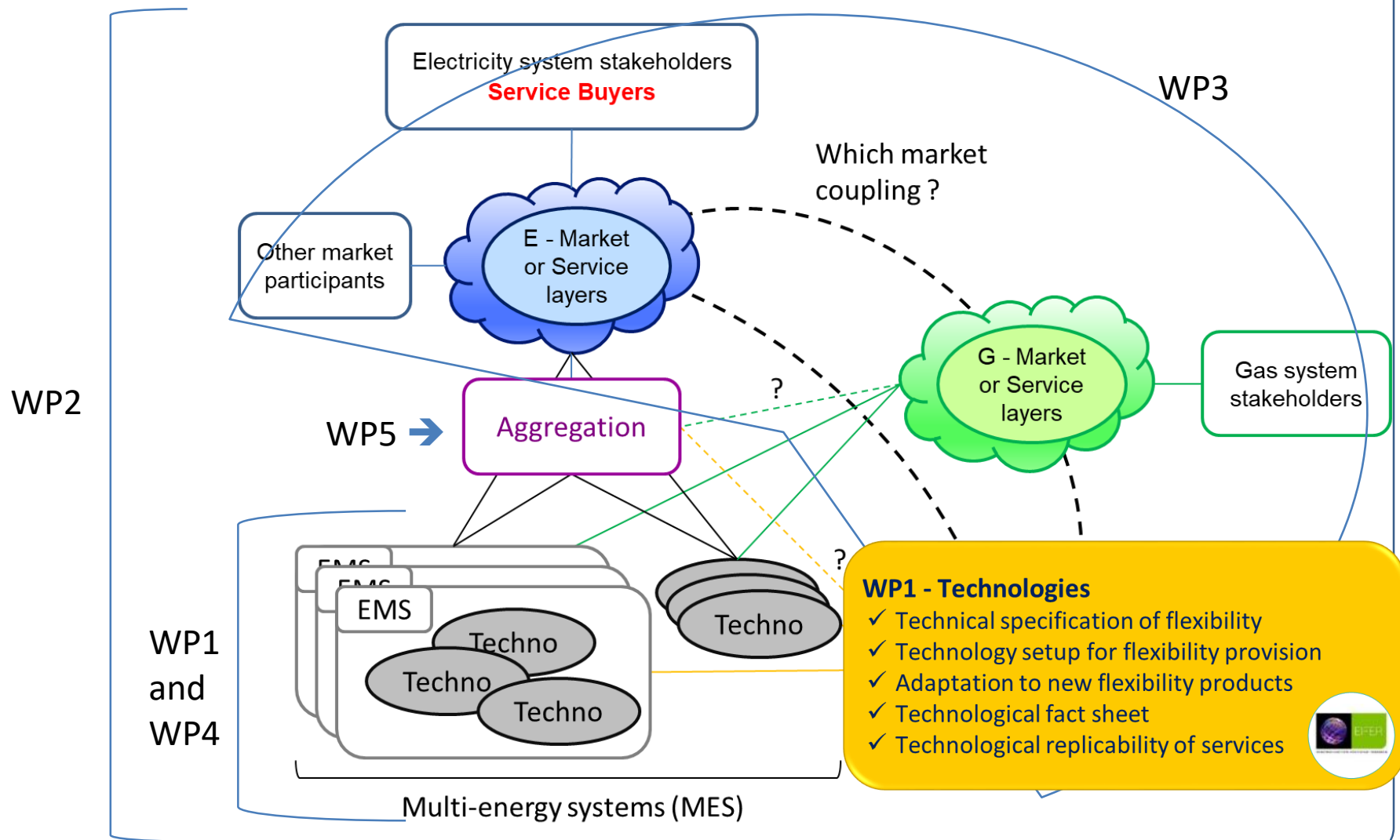


MAGNITUDE Work Packages



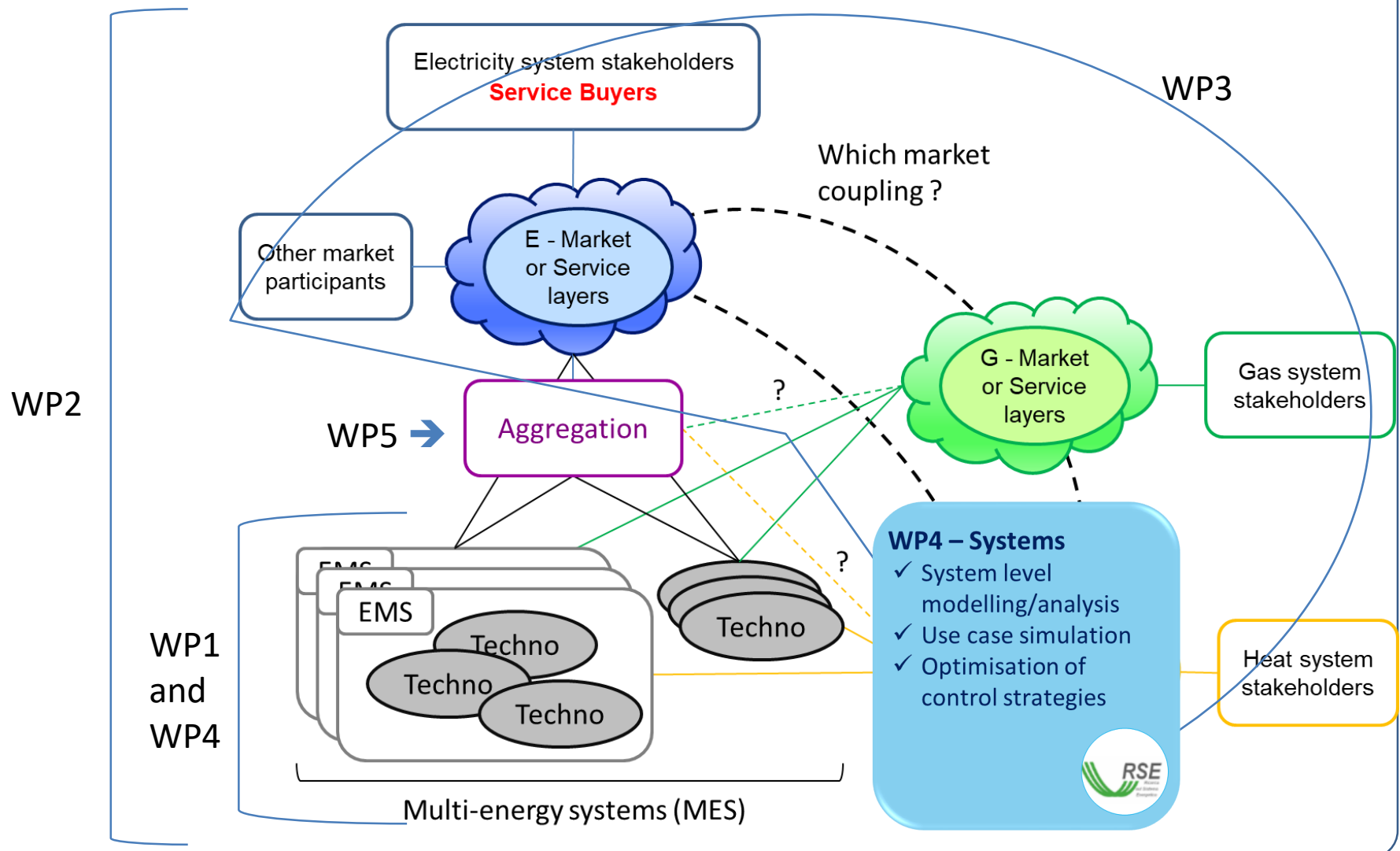


MAGNITUDE Work Packages



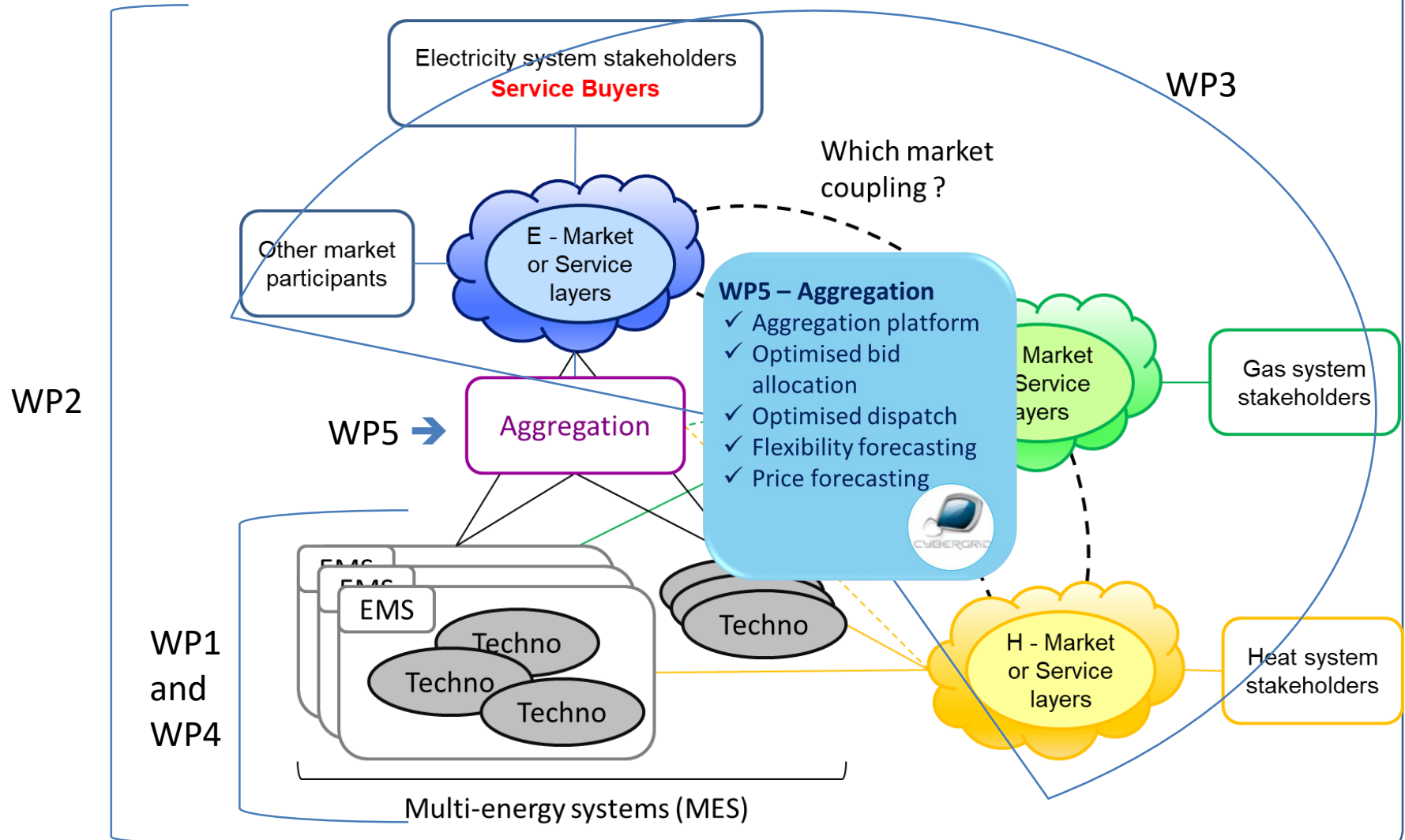


MAGNITUDE Work Packages



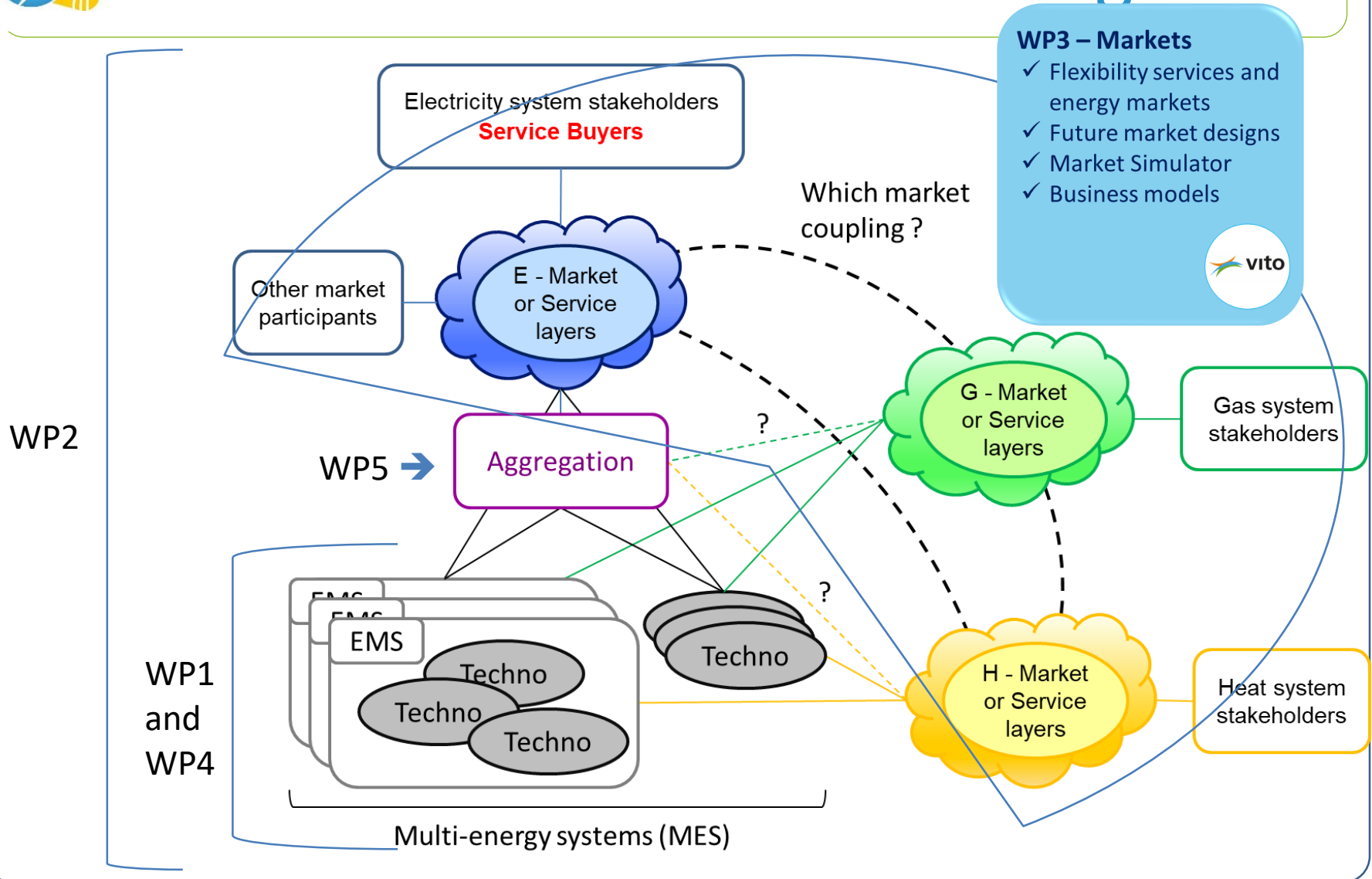


MAGNITUDE Work Packages



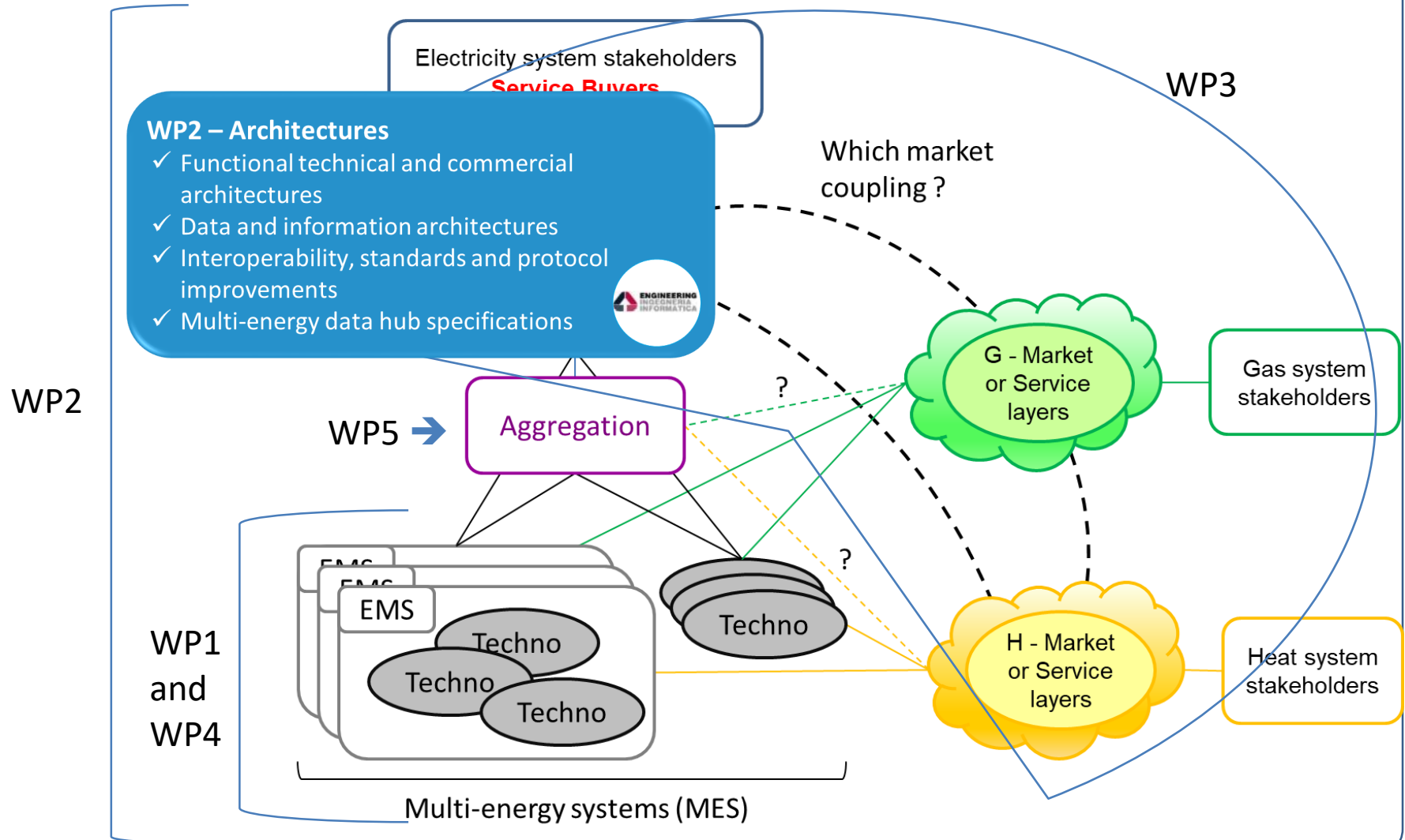


MAGNITUDE Work Packages





MAGNITUDE Work Packages





MAGNITUDE Work Packages

WP6 – Case studies

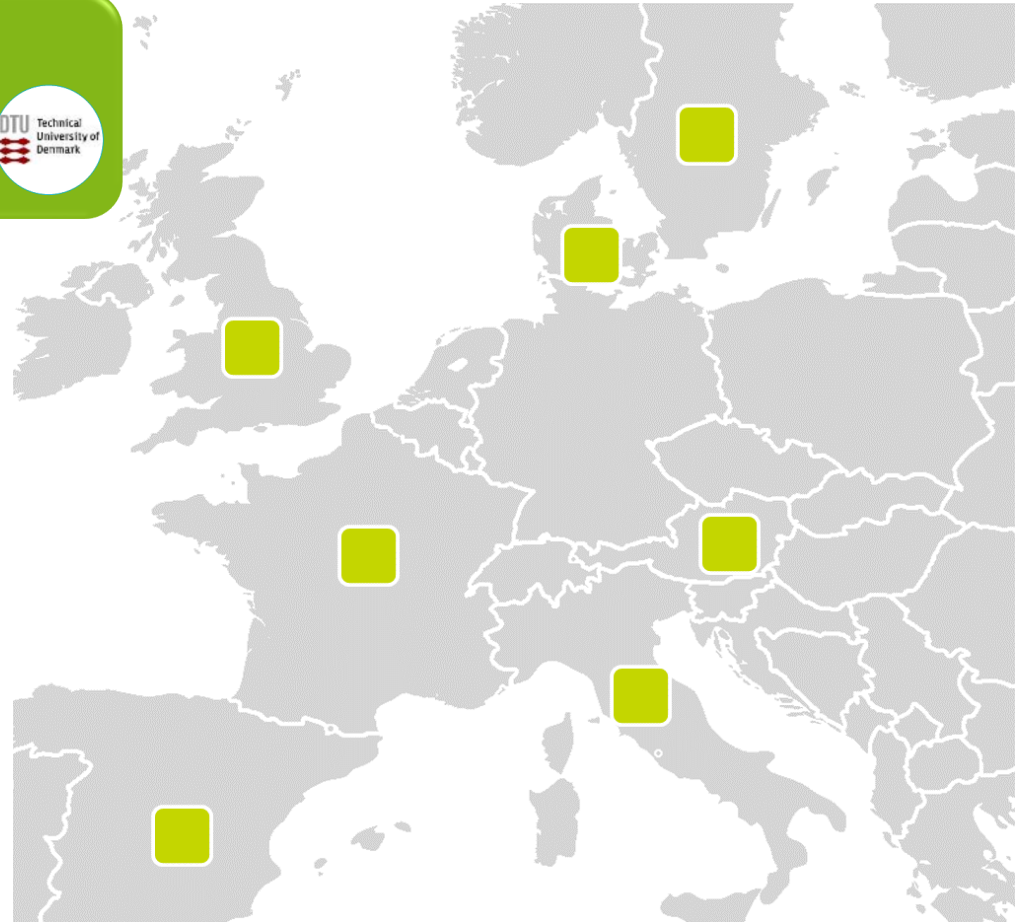
- ✓ Case study data management
- ✓ Scenario definition and data generation
- ✓ KPIs definition/monitoring
- ✓ Assessment of integrated solutions



7 real life case studies with different:

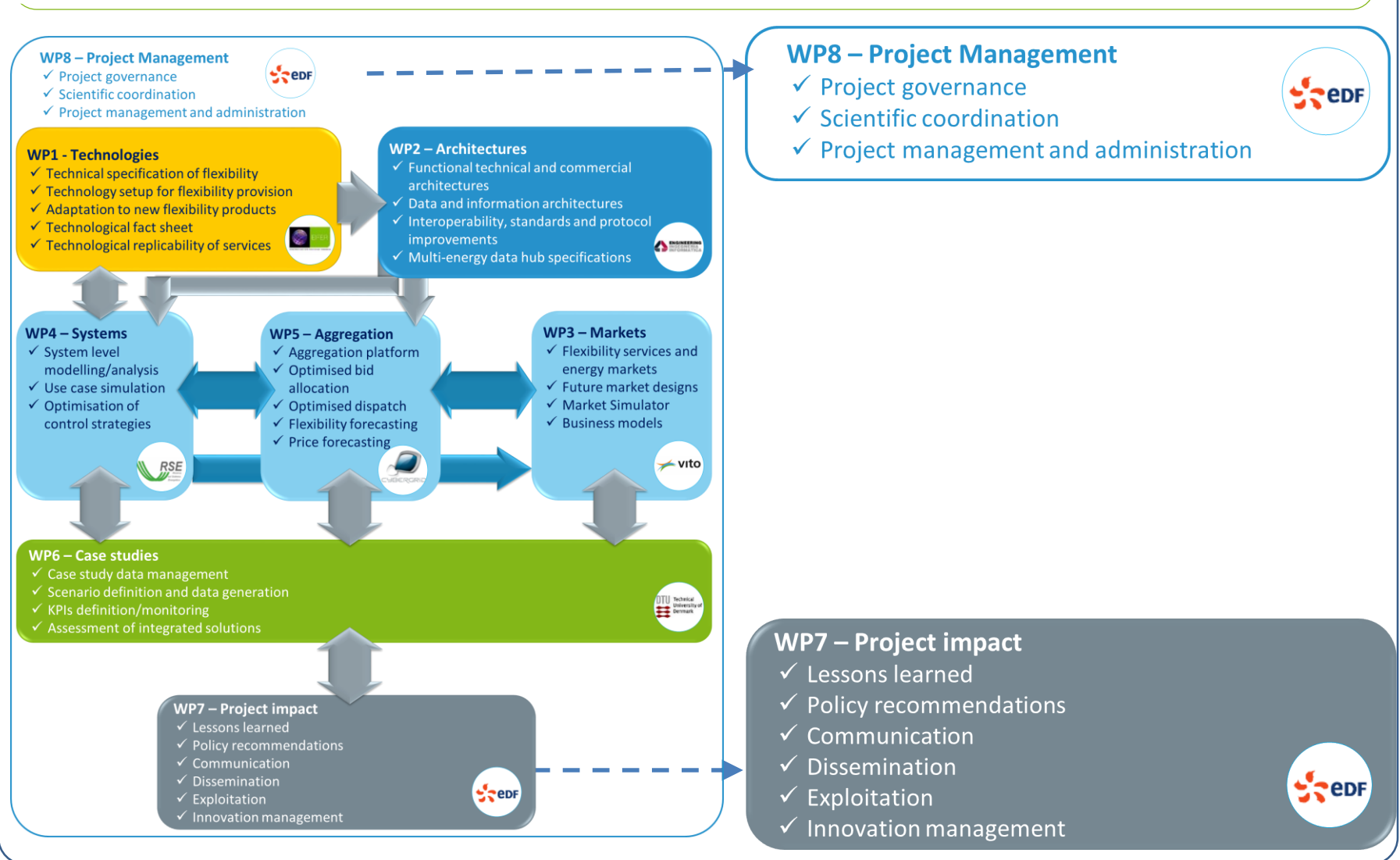
- Regulatory frameworks
- Contracts
- Core businesses
- Sector-coupling technologies
- Business models
- Relationship between stakeholders

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





MAGNITUDE WP structure





MAGNITUDE Case studies

7 real life case studies covering:

4 main MES categories

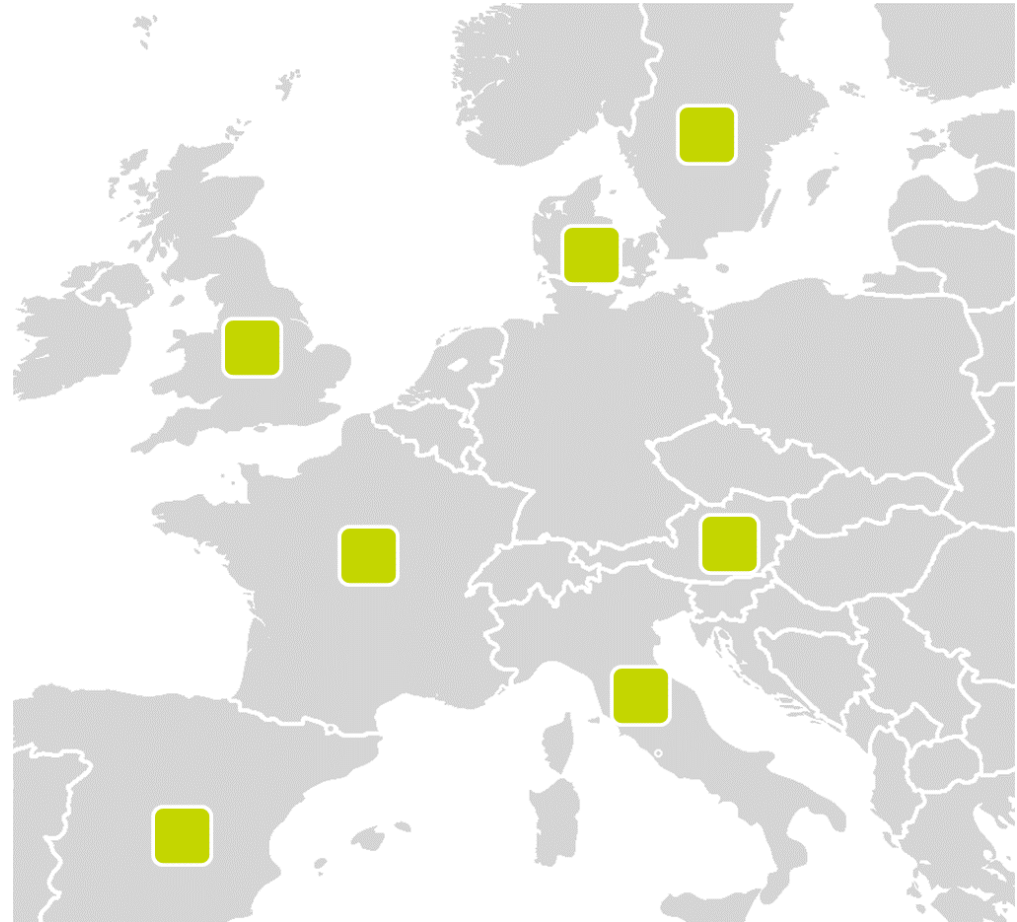
- Large industries
- Large commercial and/or public sites
- District heating/cooling
- Small individual units

Two main flexibility levers

- Fuel shift
- Storage capability

7 countries

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





MAGNITUDE Case studies

Case Study	Technologies										Networks		
	Biomass boiler	Gas boiler	Steam turbine	Gas turbine	Gas engine	Chiller	Thermal energy storage	Heat pump	Electric boiler	Anaerobic digestion	Electricity	Heating/cooling	Gas
Mälarenergi Sweden													
Paper mill Austria													
Hofo Denmark													
ACS Italy													
Neath Port Talbot, UK													
EMUASA Spain													
Paris Saclay France													



Expected results and next steps

Overview of **the flexibility services to the electricity grid**, and benchmark of markets and regulations for electricity, gas and heat - D3.1

Evaluation of **future market designs** for multi-energy systems - D3.2

Cartography of the **case studies** and flexibility services provided by heating/cooling, storage and gas **technology and systems** to the electricity system – D1.1

MAGNITUDE technical and commercial **functional architectures** to maximize flexibility provision by MES – D2.1

Methodology for multi-energy system simulation, technical specifications for model development at system and technology level – D4.1

Specifications of Multi Energy Aggregation platform for provision of flexibilities – D5.1

MAGNITUDE **KPIs** – MS

2018

D: deliverable
MS: milestone



Expected results and next steps

Technological characterization and evolution:

- Technology and case studies **factsheets**: technical characteristics and associated technological and regulatory constraints – D1.2
- Technological **adaptation/development** to support service provision – D1.3

Specifications of:

- Multi-energy **Data Hub** – D2.2
- Multi-energy **market simulator** – D3.3

Tools for:

- Multi energy system **modelling, simulation** and analysis – D4.2
- Optimized market allocation of flexibilities (**flexibility trading**) – D5.2
- Tools for **aggregation** of multi energy carrier flexibilities – D5.3

Project **KPIs** and associated evaluation **methods or processes** – D6.1

MAGNITUDE mid-term **public workshop**

2019



Expected results and next steps

Tools:

- **Optimization tools and algorithms** for maximization of flexibility provision by MES under defined scenarios – D4.3
- Multi energy **aggregation platform** for provision of flexibilities – D5.4
- Multi-energy **market simulator** – D3.4
- **Interoperability adaptation layer** (software data transformers) – D2.3

Simulation of the case studies under baseline and future scenarios - MS

2020

Assessments:

- **Business model evaluation** of case studies for simulated markets – D3.5
- Opportunities and barriers for **replicating** the flexibility products and project results from a **technological point of view** in selected countries – D1.4

Evaluation, dissemination and exploitation:

- Final **evaluation of the integrated system**: market, system, aggregation – D6.2
- Project findings and **lessons learnt** (D7.3) and **exploitation** plan (D7.5)
- **Policy recommendations** from a EU perspective - D7.4
- Final MAGNITUDE **public Workshop** – MS

2021



THANK YOU FOR YOUR ATTENTION



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MAGNITUDE website – coming soon

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Edoardo Corsetti (RSE), Christoph Gutschi (CYBERGRID),
Henrik Bindner (DTU), Emma Da Silva (ARTTIC),
Na'ama Agmon-Licht (ARTTIC), Regine Belhomme (EDF)

APPENDICES

WP DETAILED DESCRIPTIONS



WP1 – Technologies (1/2)

Services from synergies among multi carrier networks

WP Leader:



(DE), Nicole Pini

Objectives

- **Identify** which **flexibility services** can be provided by the different “cross-sector” technologies.
- **Identify** possible **bottlenecks** and constraints to the service provision, according to **technological** barriers and current **system design**.
- Describe and **quantify how** the “cross-sector” technologies and systems identified in the case studies can **provide** the described **flexibility services**.
- Identify and **quantify technological development needed** to maximise the exploitation of the flexibility services.
- Evaluate the **replicability** of the studied services and products on **national scale** in the countries represented in the consortium.



WP1 – Technologies (2/2)

Main expected outcomes

2018

- **Cartography of the flexibility services provided by heating/cooling, storage and gas technology and systems to the electricity system**

Description, benchmarking and technological barriers: description of the flexibility services that could be provided by the different electrical, heating, storage and gas technologies and cases studies

2019

- **Technology and case studies factsheets**

Factsheets with the technical characteristics enabling the provision of the identified flexibility services, with the associated technological and regulatory constraints

- **Technological adaptation to flexibility products and guidelines for development**

Description of the needed technological development to support the provision of services identified in WP3

2020

- **Opportunities and barriers for replicating the studied flexibility products and market designs in selected countries**

Valorisation of the results from the other WP evaluating cross-national replicability, from a technological point of view.



WP2 - Architectures (1/2)

Functional technical and commercial architectures for service provision and data management

WP Leader:  **ENGINEERING
INGEGNERIA
INFORMATICA** (IT), Diego Arnone

Objectives

- Define and deliver the **key functional and technical architectures** for MAGNITUDE's technical and commercial developments.
- Design an overall **standardized interface architecture for multi-energy data hubs**, based on emerging standards, protocols and state-of-the-art data models.
- Develop **prototypes** of light, **interoperable and standardized interfaces** for data management for multi-energy applications requirements.



WP2 - Architectures (2/2)

Main expected outcomes

2018

- **MAGNITUDE technical and commercial functional architecture**

Design of the MAGNITUDE high level simplified role models and high level organizational structure to maximize flexibility provision and to guide project developments.

2019

- **Multi-energy Data Hub Specification**

Specifications for the design of standardized interfaces for data management and optimal data exchange between the different actors involved in the flexibility service provision.

2020

- **Interoperability adaptation layer**

Development of an “adaptation layer” (software data transformers) for enabling the needed level of interoperability between multi energy systems and the relevant stakeholders, under constraints of technical and organizational standards, for a secure, efficient and reliable energy service provision.



WP3 – Markets (1/2)

Market design and business models for cross system integration

WP Leader:  (BE), Kris Kessels

Objectives:

- Identification of **actual market design** and regulatory shortcomings
- Investigation and evaluation of **future market designs**
- Specification of **market products, bid types** and **clearing mechanisms**
- Development of a **multi-energy market simulator**
- Quantification of **potential business models** under different market designs



WP3 – Markets (2/2)

Main expected outcomes

2018

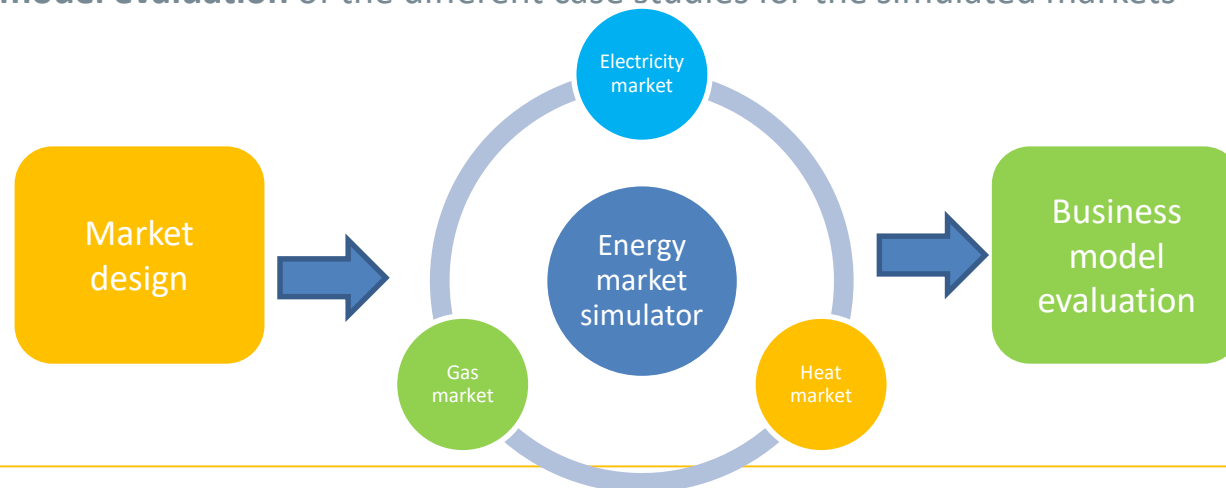
- Benchmark of **markets and regulations for electricity, gas and heat** and overview of **flexibility services to the electricity grid**
- Evaluation of **future market designs** for multi-energy systems

2019

- **Specification** of the multi-energy market simulator

2020

- **Multi-energy market simulator**
- **Business model evaluation** of the different case studies for the simulated markets





WP4 – Systems (1/3)

Simulation and optimization of integrated energy systems

WP Leader:



(IT), Edoardo Corsetti

Objectives

- Develop a unified **methodology for simulation and optimization of MES** in order to assess flexibility from relevant use cases based on the real life case studies
- Develop steady state, sequential steady state and dynamic analysis **models and tools** for assessing the operational and technical constraints of specific flexibility services and products
- Develop **optimization strategies to operate energy systems** satisfying the KPI, provided by WP6 (i.e., reduction of operational costs, CO2 content, avoid renewable resource curtailment, security of supply)
- Test and assess new configurations of systems and market rules as defined by WP1



WP4 – Systems (2/3)

Main expected outcomes

2018

- **Methodology for multi-energy system simulation**

Technical specifications for the model development at system and technology level, harmonizing the temporal and spatial scales of models and their interconnections

2019

- **Tools for multi energy system simulation and analysis**

Tools and methods for the simulation and analysis of multi energy system's behavior and constraints for the provision of the identified flexibility services to the grid

2020

- **Optimization of flexibility provision from multi carrier system**

Development of optimization tools and algorithms for the maximization of flexibility provision under forecast scenarios, new market design and new products for multi energy nodes and systems



WP4 – Systems (3/3)

USE CASE

CHP

Heat
pumps

Heat
storage

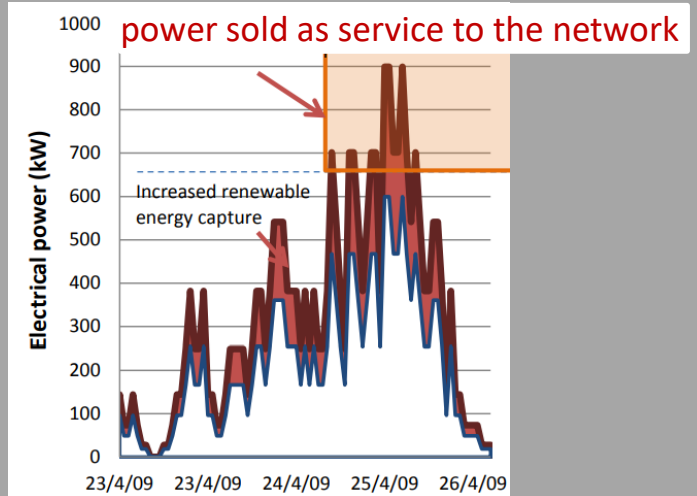
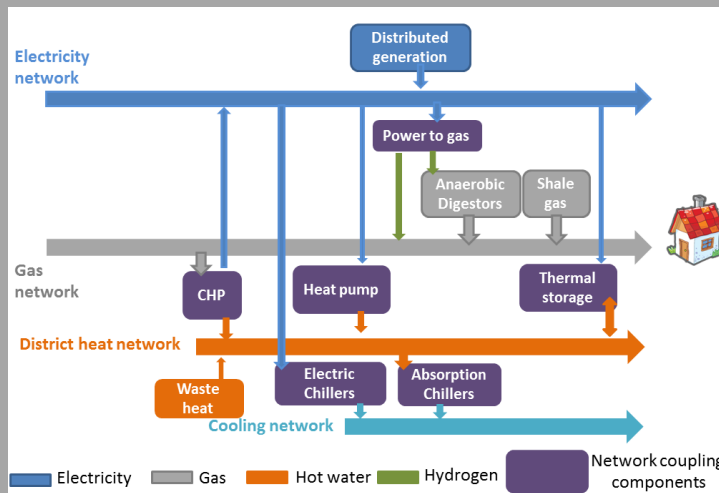
Power-to-
Gas

Absorption
chillers

technologies

Provision
secondary
reserve ($P[t,\tau]$)

services (products)



modelling
(technologies and systems)

simulation
(model validation)

optimization of
operational models



WP5 – Aggregation (1/3)

Tools for multi energy aggregation

WP Leader:



(AT), Christoph Gutschi

Objectives

- Develop novel ICT **tools for the aggregation of flexibility services** to the power system gained from innovative utilization of synergies between multi energy carrier systems
- Perform **joined testing** by linking the multi energy aggregation platform to the simulation and optimization tools developed in WP4 as well as the market simulator developed in WP3
- Provide **simulation results** for the business case analysis in WP3



WP5 – Aggregation (2/3)

Main expected outcomes

2018

- **Specifications of Multi Energy Aggregation platform for provision of flexibilities**
Detail specifications for all the tools developed in WP5 including APIs and test cases.

2019

- **Tools for optimized market allocation of flexibilities**
ICT tools for decision support of flexibility trading
- **Tools for multi energy carrier aggregation**
ICT tools for management of multi-energy flexibilities

2020:

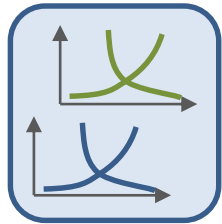
- **Multi energy aggregation platform for provision of flexibilities**
ICT tools integrated into an aggregation platform (accessible for consortium) and public report



WP5 – Aggregation (3/3)

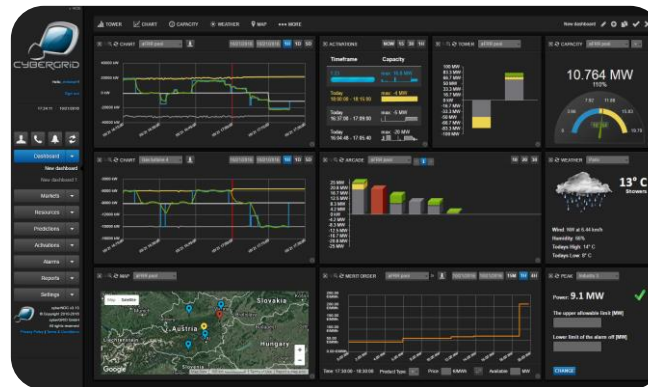
The Multi-Energy-Aggregation Concept:

Forecasting Tools



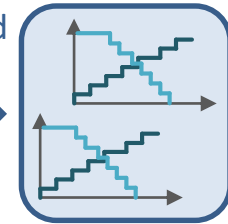
Price
Forecasts

Aggregation Platform



Energy Markets

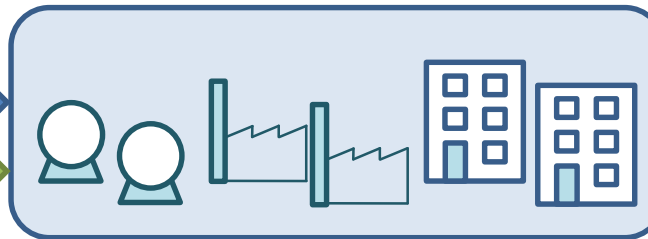
Optimized
Bidding



Trading
Results

Flexibility
Forecasts

Power
Gas



Real-time
Measurements

Real-time
Dispatch

Pool of Multi-
Energy-Assets

Heat



WP6 – Case Studies (1/2)

Evaluation of integrated systems and case studies

WP Leader:  Technical University of Denmark (DK), Henrik Bindner

Objectives

- Establish **coherent foundation of data** from systems and interconnection components **of the case studies** for model validation
- Provide synthetic coherent **configurations and input data**
- **Data management** of acquired and generated data
- Develop analysis **methods/tools for evaluation of KPIs**
- Carry out **assessment of integrated solutions**



WP6 – Case Studies (2/2)

Main expected outcomes

2018

- **MAGNITUDE KPIs**
- **Consolidated case study sets**

2019

- **KPIs and assessment procedure:** specified project KPIs and the methods or processes for evaluating them

2020

- **Coherent datasets for baseline and future scenarios evaluation**
- **Simulation of the case studies under the baseline and future scenarios**

2021

- **Final evaluation of the integrated system:** market, system, aggregation platform



WP7 – Project Impact (1/2)

Lessons learnt, policy strategy and exploitation

WP Leader:  (FR), Regine Belhomme

Objectives

- **Disseminate the project results** among the public and private stakeholders
- Ensure and **strengthen dialogue** between electricity, heating and gas networks related operators and service providers
- **Monitor the MAGNITUDE Advisory Board** and in particular foster and strengthen privilege relationships and ensure that its members' recommendations feed the project
- Ensure **cooperation** with other related projects (H2020, national, regional)
- **Issue policy and regulatory recommendations** towards an integrated and transnational approach for multi energy system integration
- **Manage the innovation** generated in the project
- **Prepare the exploitation** of the project results



WP7 – Project Impact (2/2)

Main expected outcomes:

2018

- **Communication and dissemination plan** of the project results.
- **Dissemination materials and tools**, including Public Website, Project Leaflet, Newsletters, Press Releases.
- **First meeting of the MAGNITUDE Advisory Board**: this board will ensure that the consortium appropriately addresses the influence of external factors on MAGNITUDE.
- **Data management plan**: for the management life-cycle for all data collected, processed or generated.

2019

- **Mid-term MAGNITUDE public workshop** to disseminate the project achievements and results

2021

- **Lessons learnt**, based on direct learnings and findings from the project and its case studies
- **Policy recommendations**, addressing market mechanisms, regulation and standardisation from a EU perspective to feed into the Energy Market Design 2030-2050 discussion
- **MAGNITUDE Exploitation plan**, describing the plans of the participants to move the technology forward including next steps, key milestones and the corresponding investments vs. business perspectives
- **Final MAGNITUDE Workshop**, to communicate on the final results, project achievements, lessons learnt and recommendations