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

Project public presentation

Last update: March 2021

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

Context

Expected evolutions of the electricity system…

- EU targets for the reduction of greenhouse gas emissions and increased share of variable renewable energy sources
- Electrification of energy usages (such as electric vehicles, heat demand, etc.)

… will lead to new or increased risks and needs

➔ New or increased system risks in terms of quality and security of the electricity supply, congestion, system stability, curtailments, difficulty to cover the electricity demand at some periods of time, etc.

➔ Needs for more flexibility, more active involvement of all the stakeholders… 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 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.

- Research and Innovation Action
- EC funding: 4 M€
- Duration: 44 months, October 2017 - May 2021
- Coordinator: EDF

MAGNITUDE Target

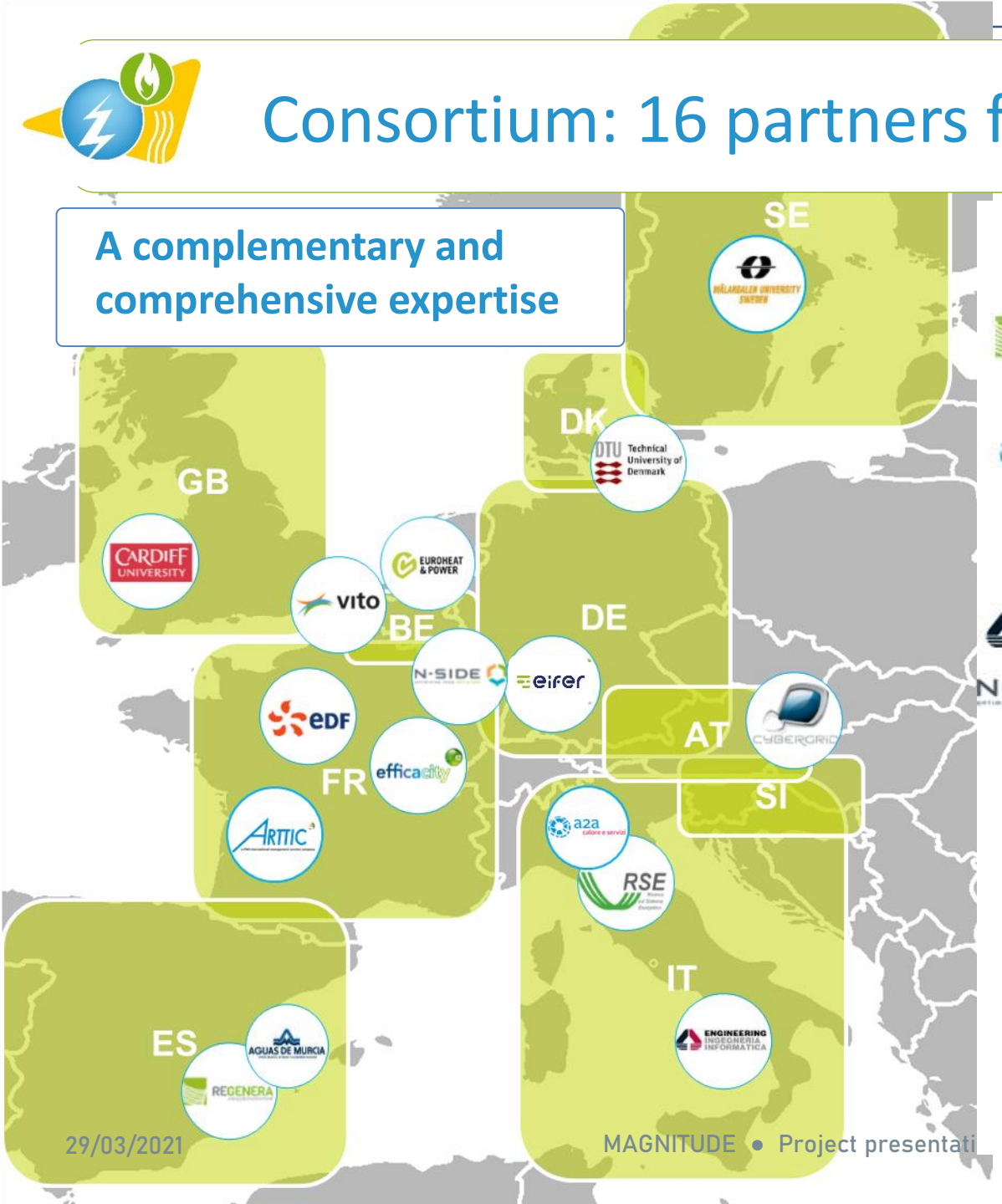
MAGNITUDE aims to develop **business and market mechanisms** as well as **optimization and coordination tools** to provide **flexibility to the European electricity system**, by increasing and optimizing **synergies between electricity, gas, heating and cooling systems.**

MAGNITUDE will:

- 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: 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
	University
DTU Technical University of Denmark	University

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

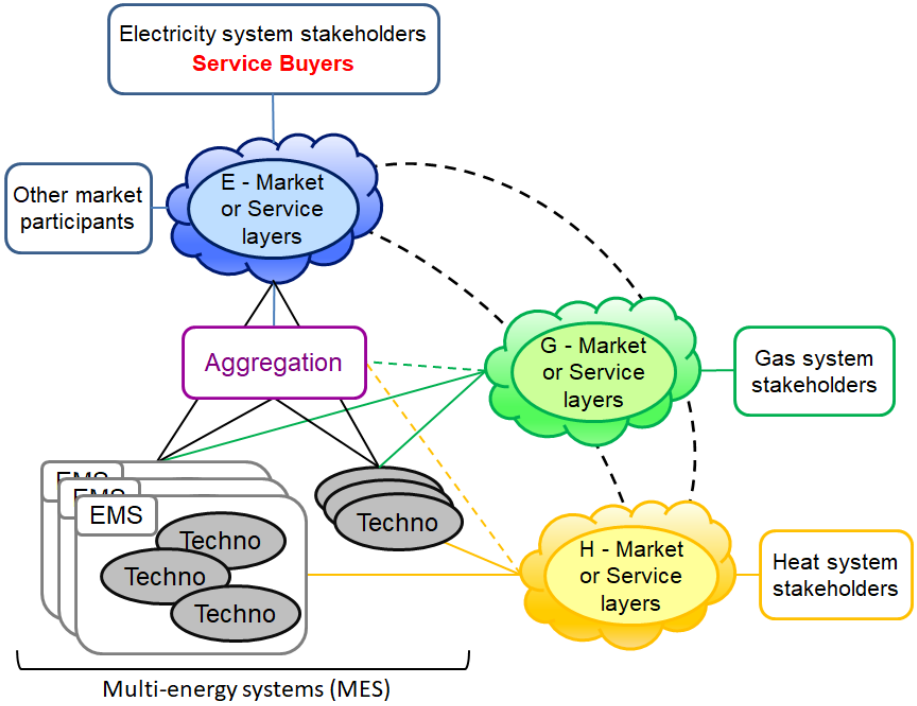
- Validate the solutions on **7 real life case studies** of multi-energy systems of different sizes and technological features, located in 7 European countries (Austria, Denmark, France, Italy, Spain, Sweden, United Kingdom).

4 - MAXIMIZE THE IMPACT

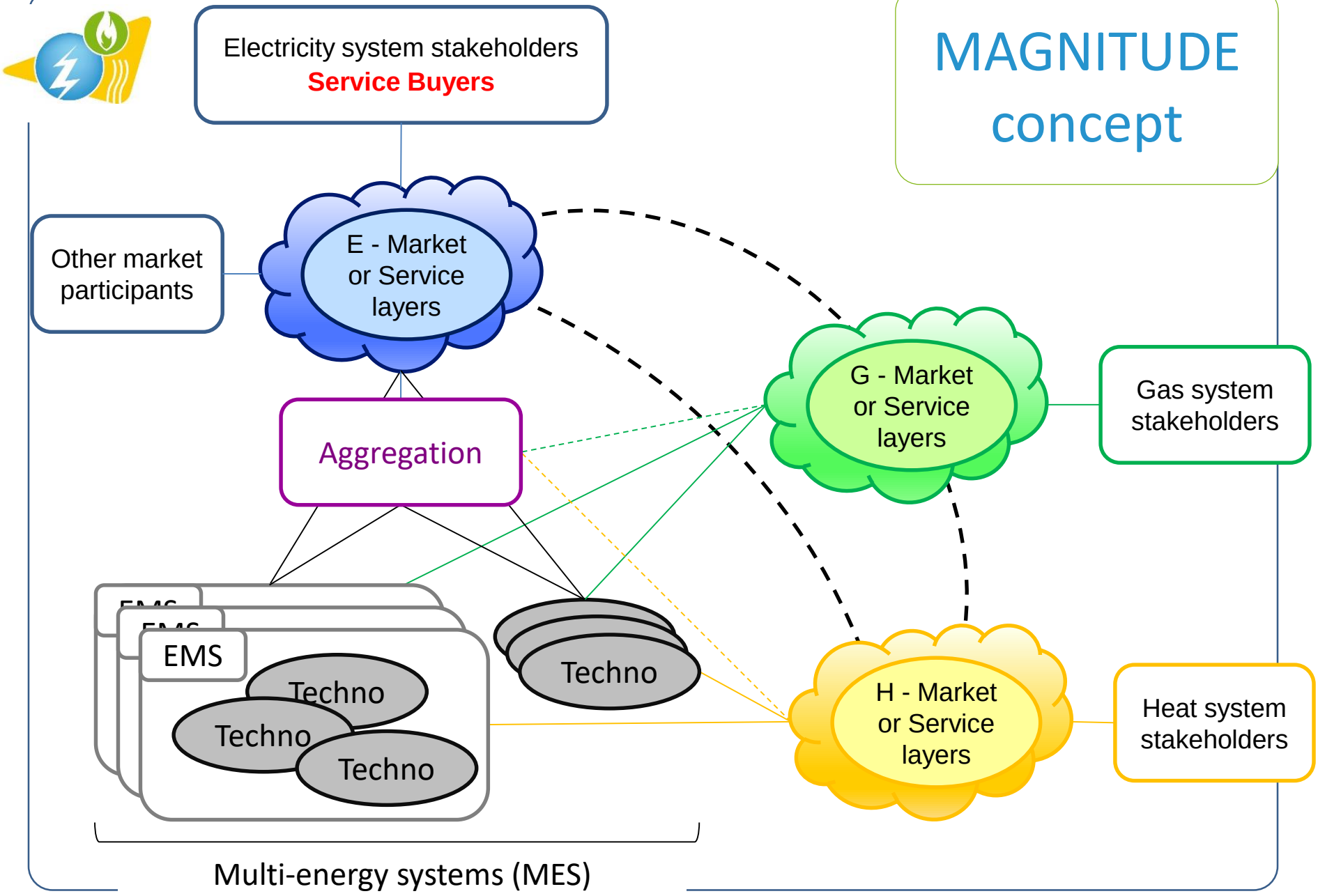
- Disseminate project results, achievements and lessons learnt towards the **stakeholders in the electricity, heat/cooling and gas sectors**
- Propose recommendations and contribute to the **definition of policy strategies in a pan-European perspective.**

MAGNITUDE approach

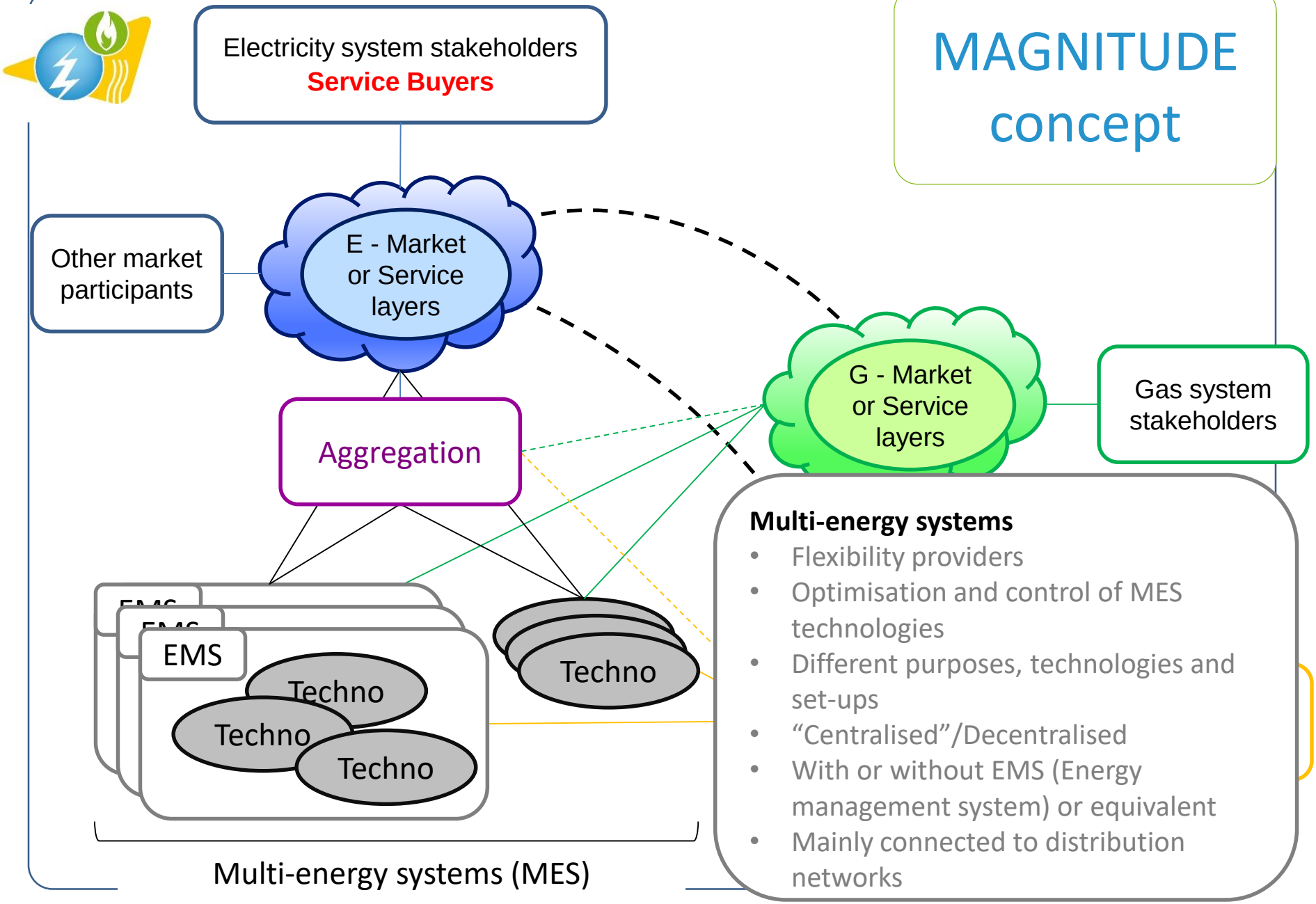
- **Flexibility services** provided by **Multi-Energy Systems** (MES) to electricity system
- **Flexibility capabilities** of **cross-sector technologies** and **MESs**
- **Simulation and optimization of control strategies** of technologies and systems to maximize flexibility provision
- **Aggregation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



MAGNITUDE concept



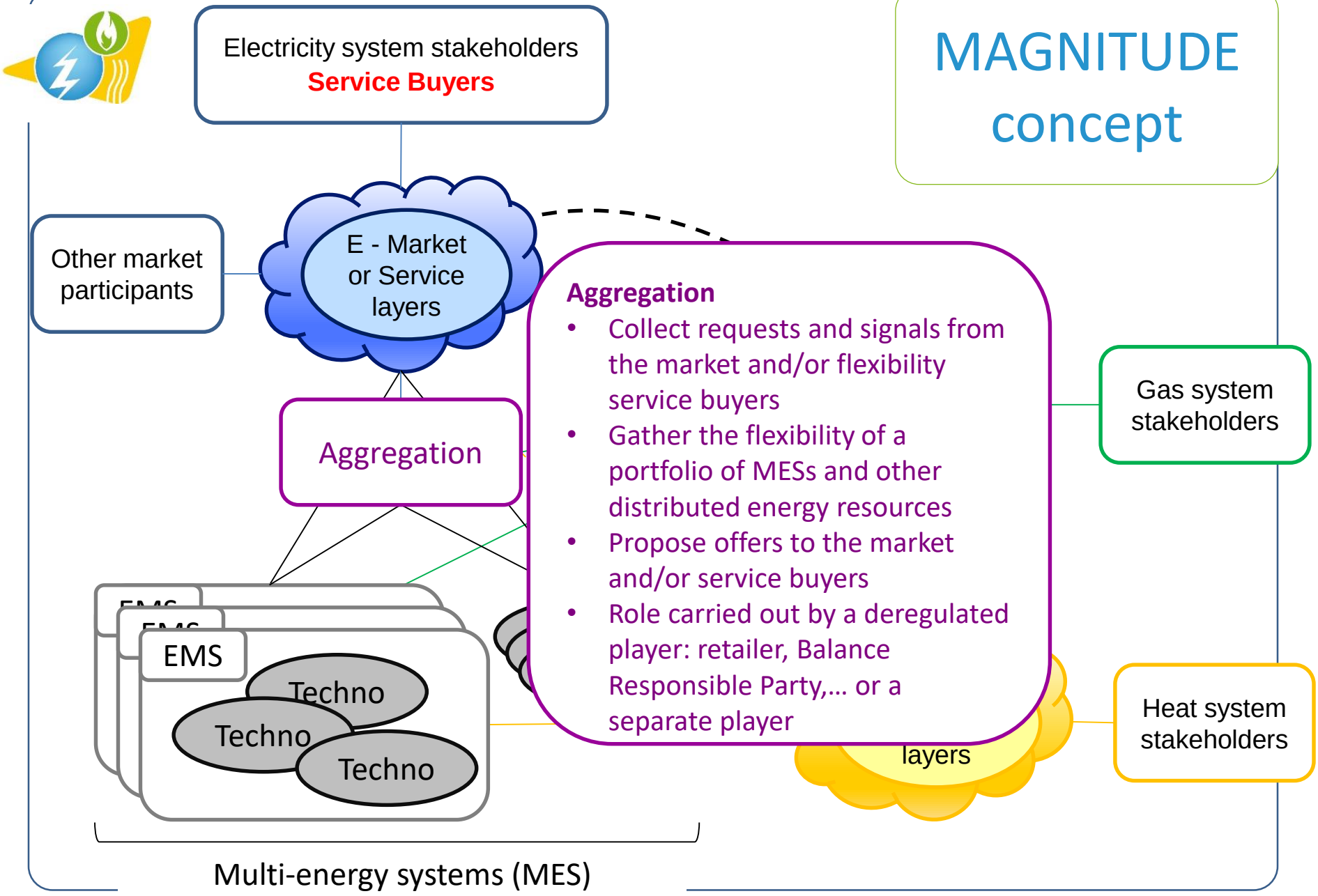
MAGNITUDE concept



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 networks

MAGNITUDE concept



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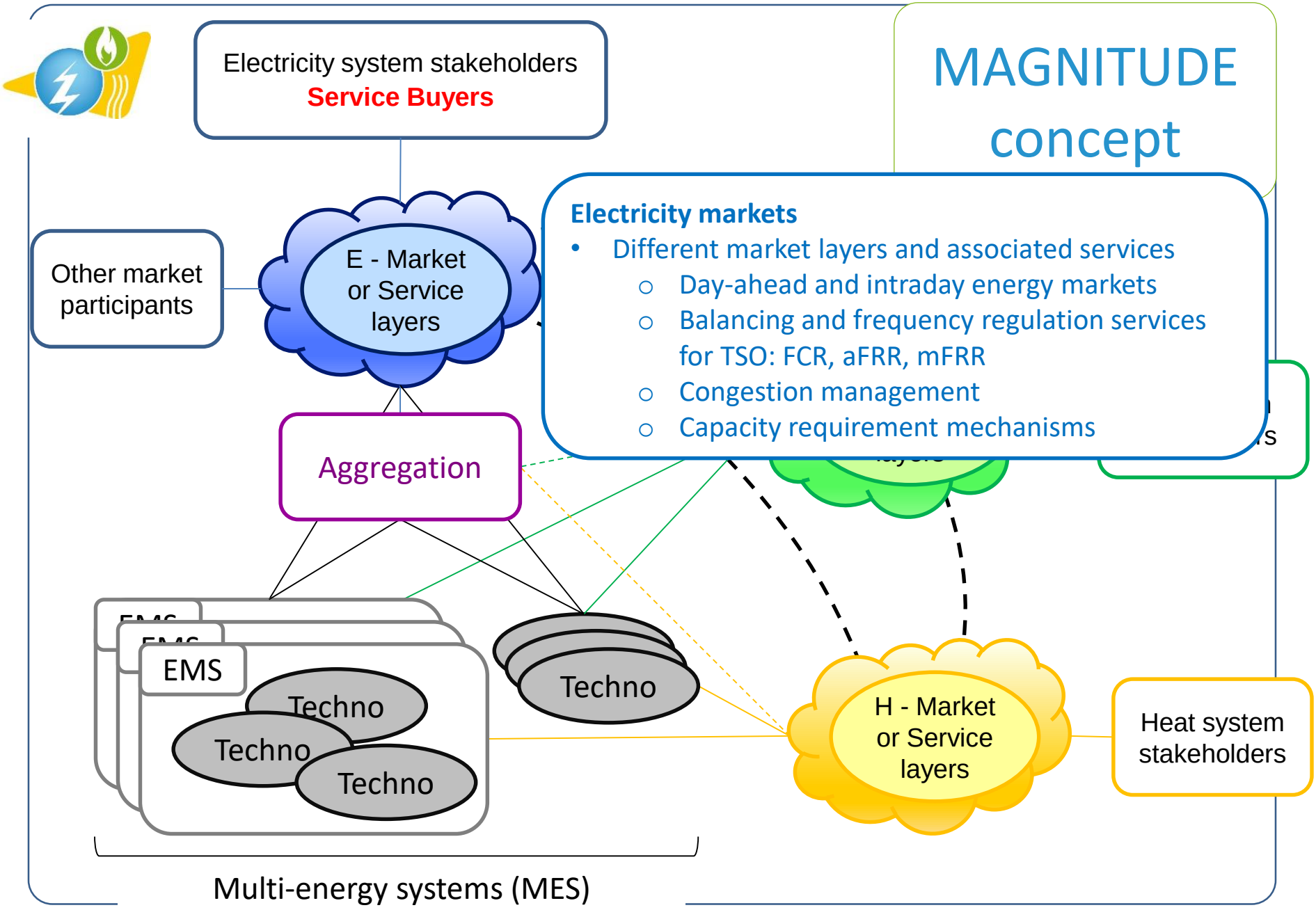

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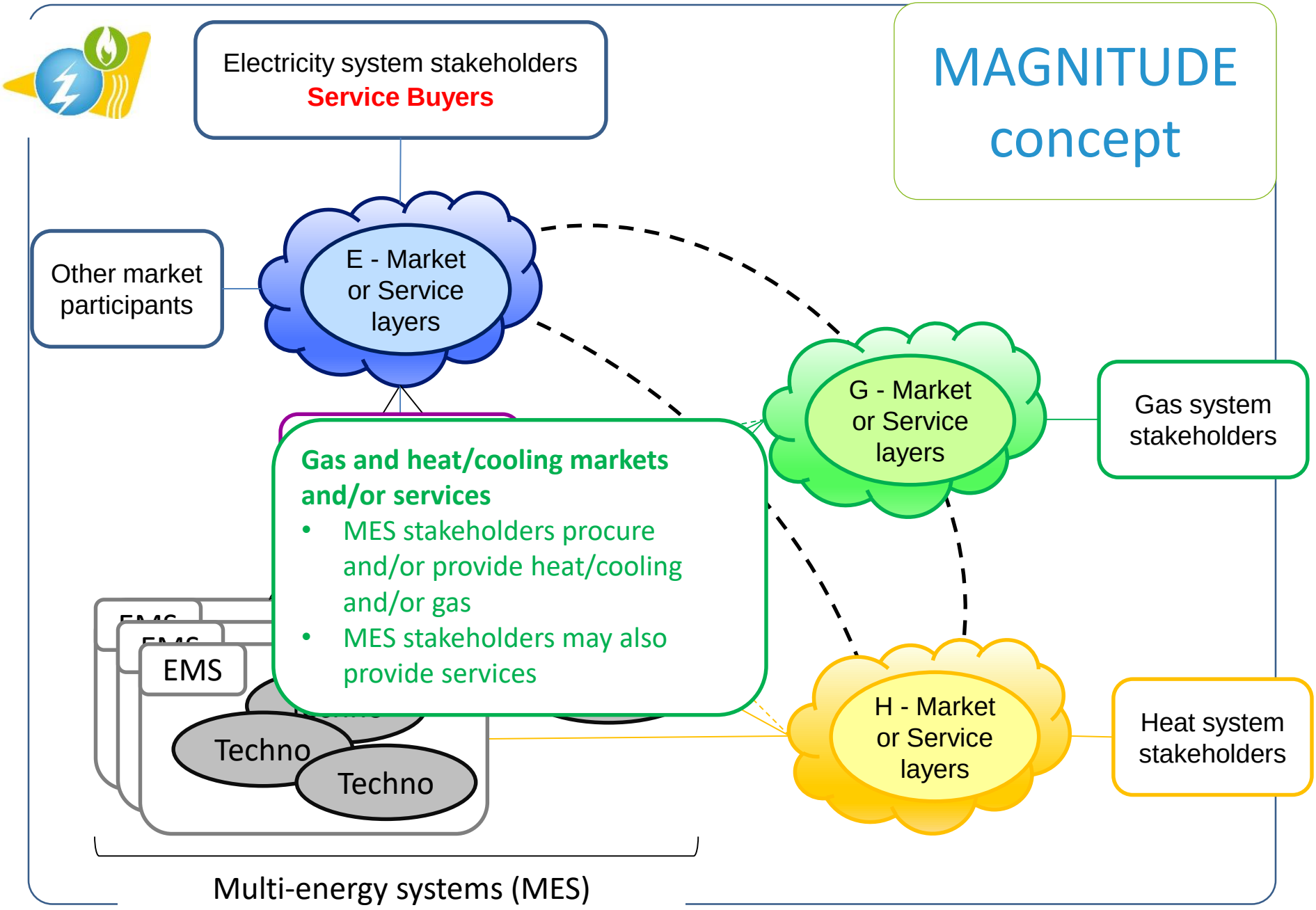

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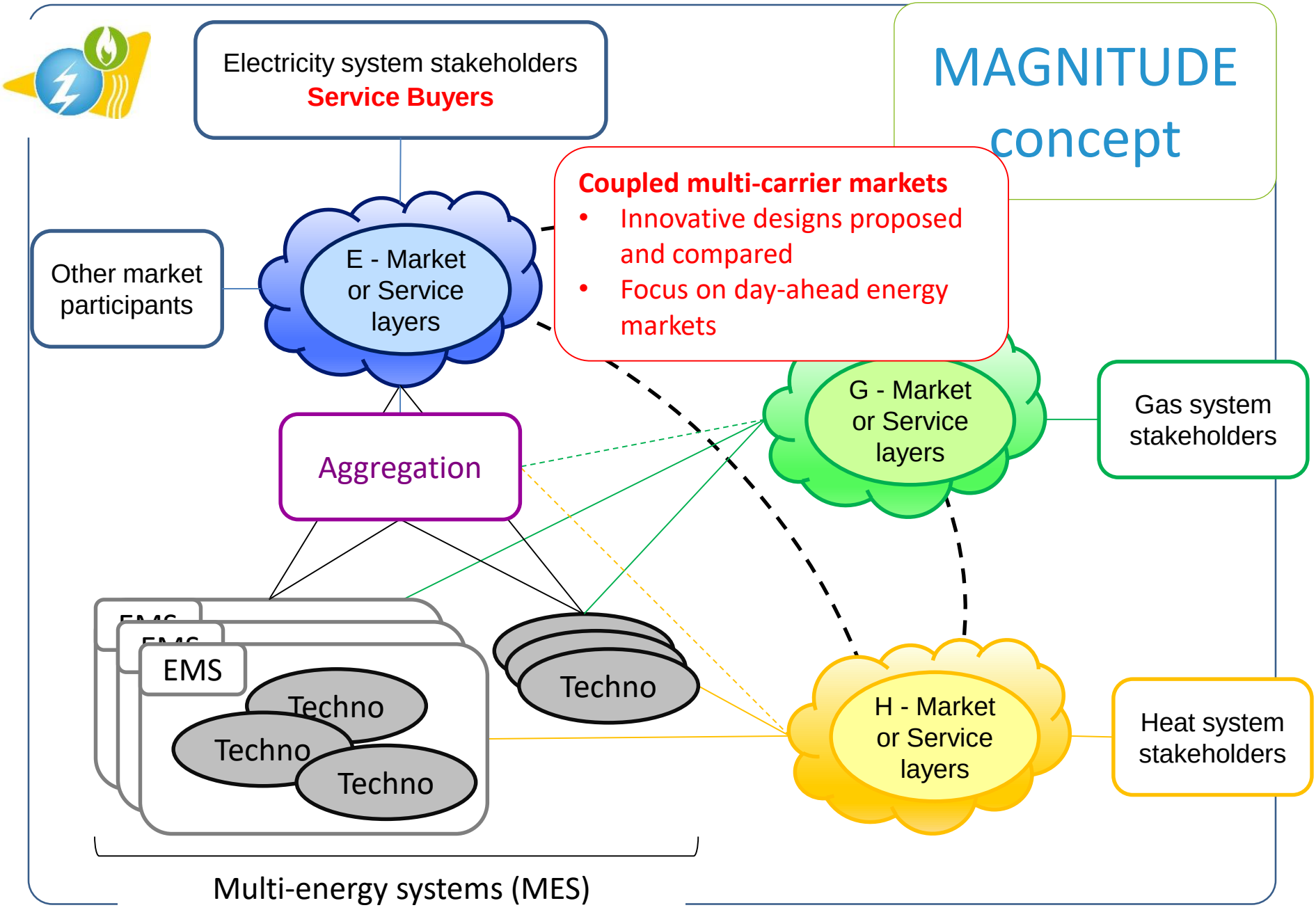
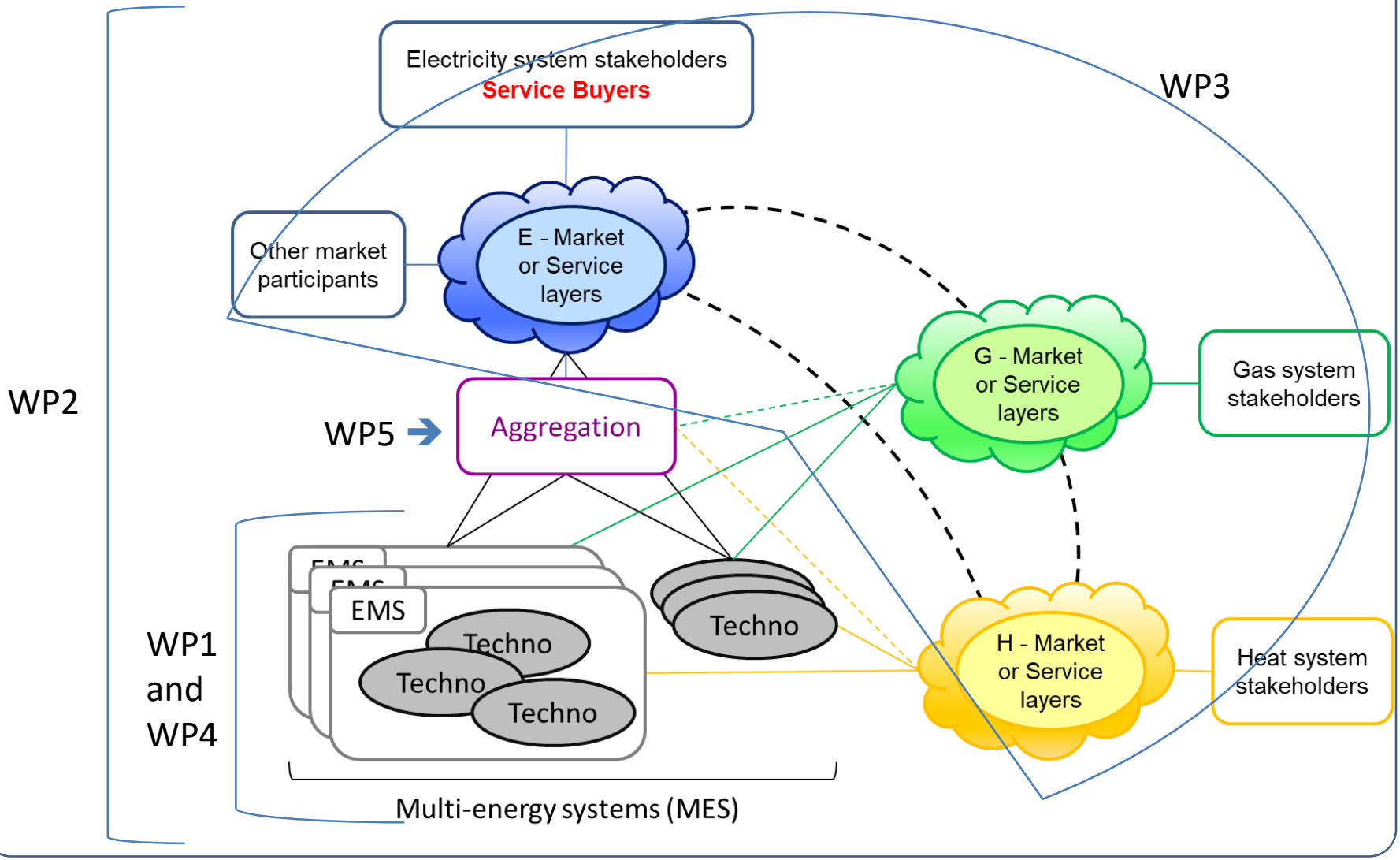


MAGNITUDE Work Packages



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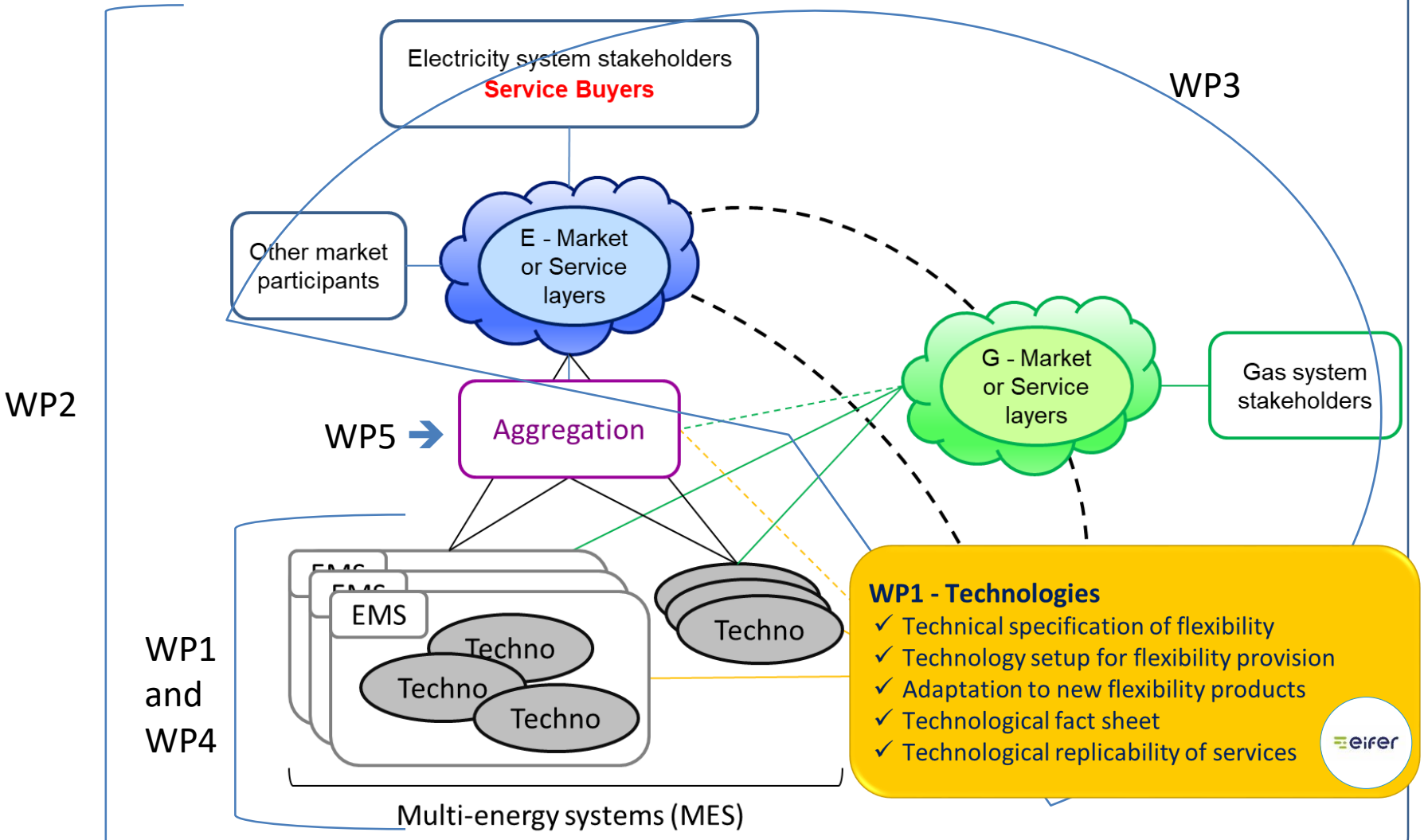

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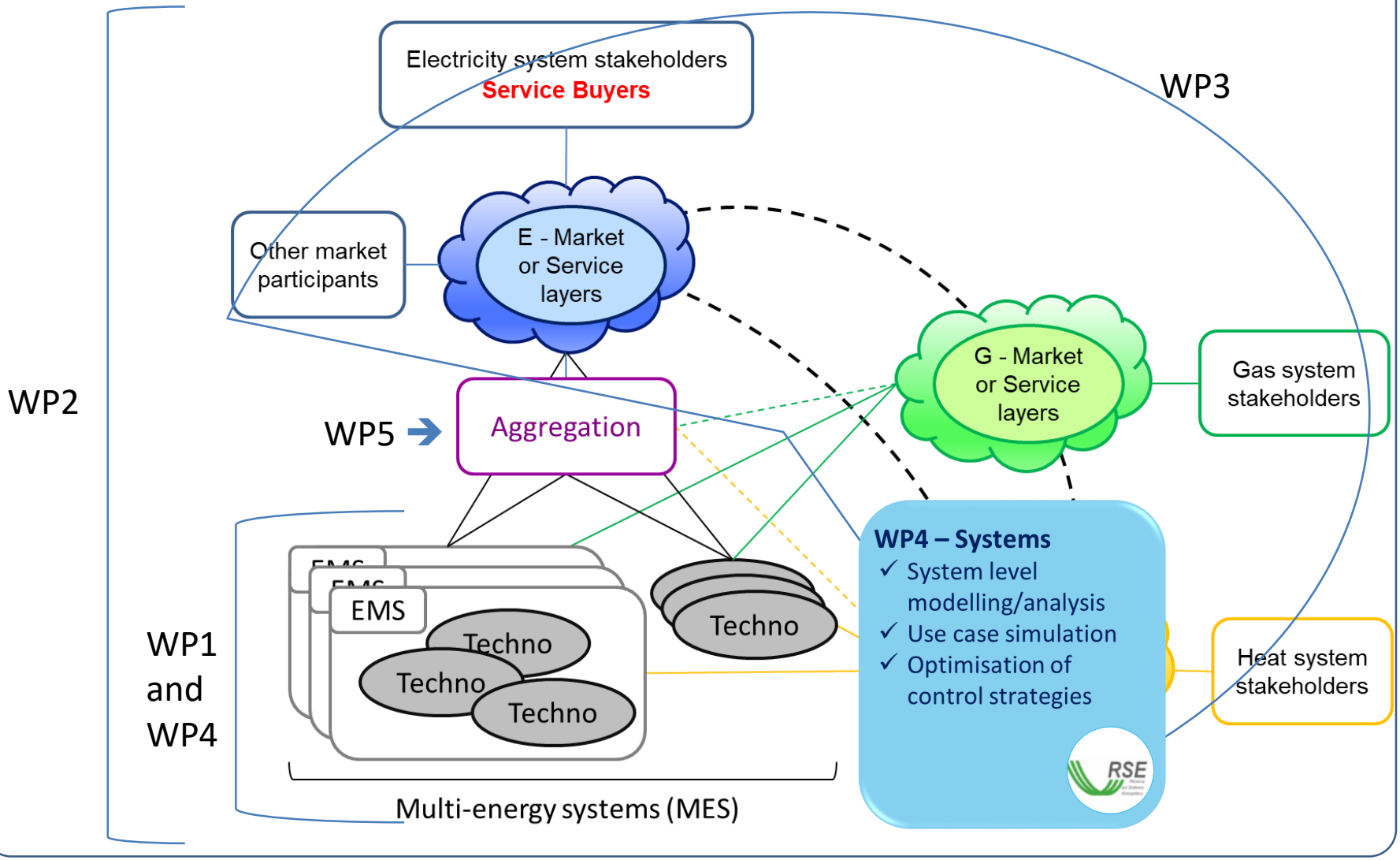

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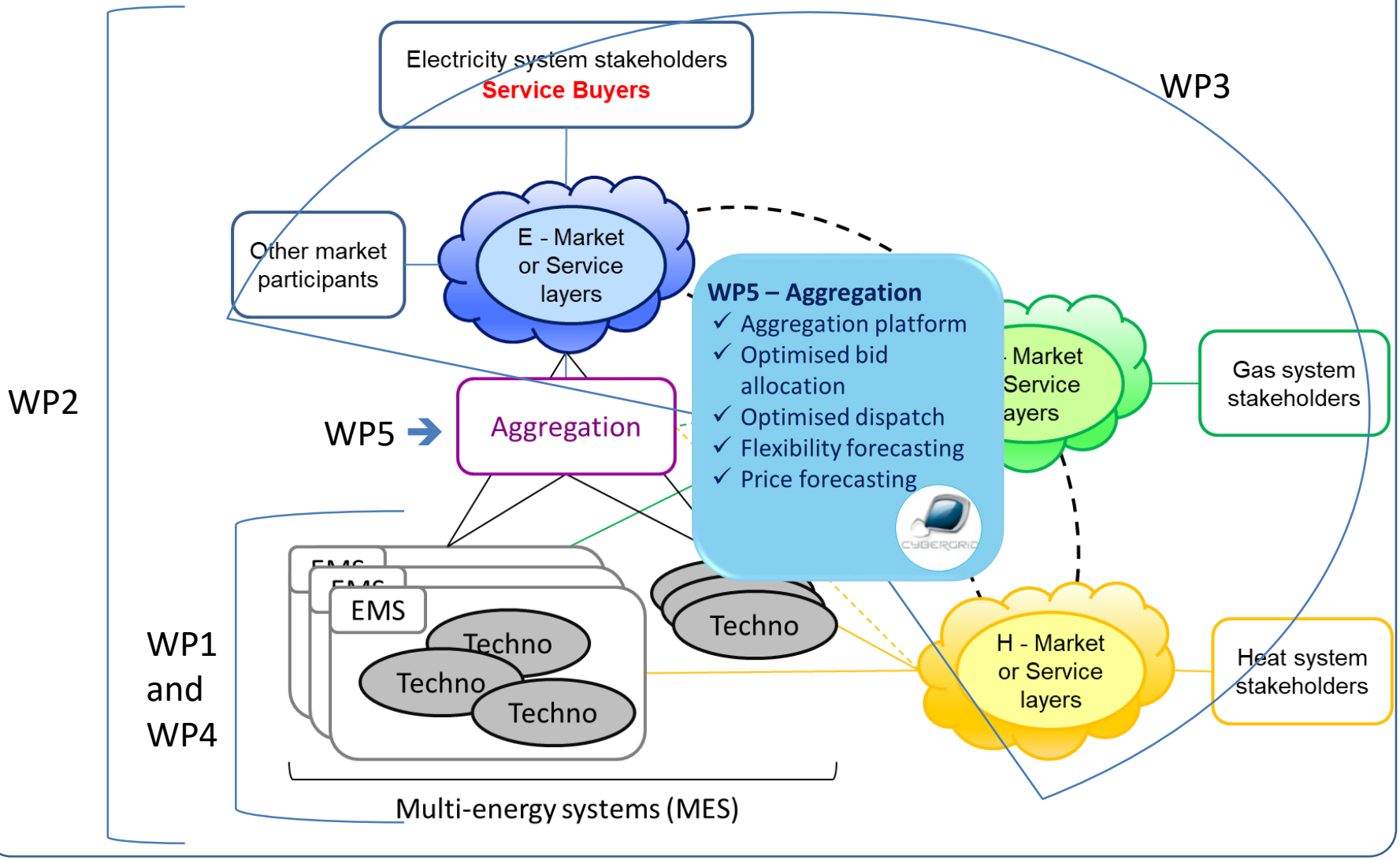

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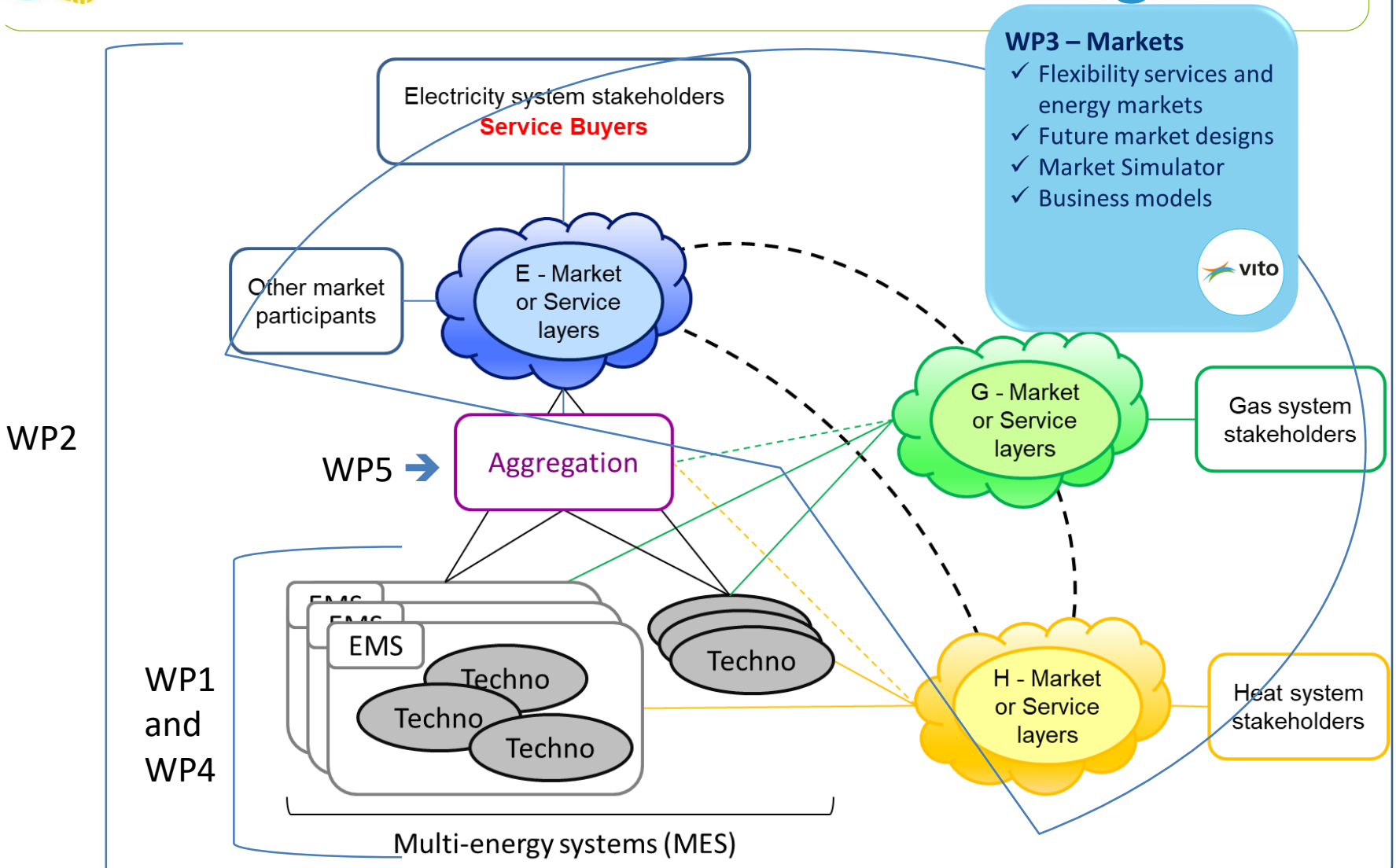

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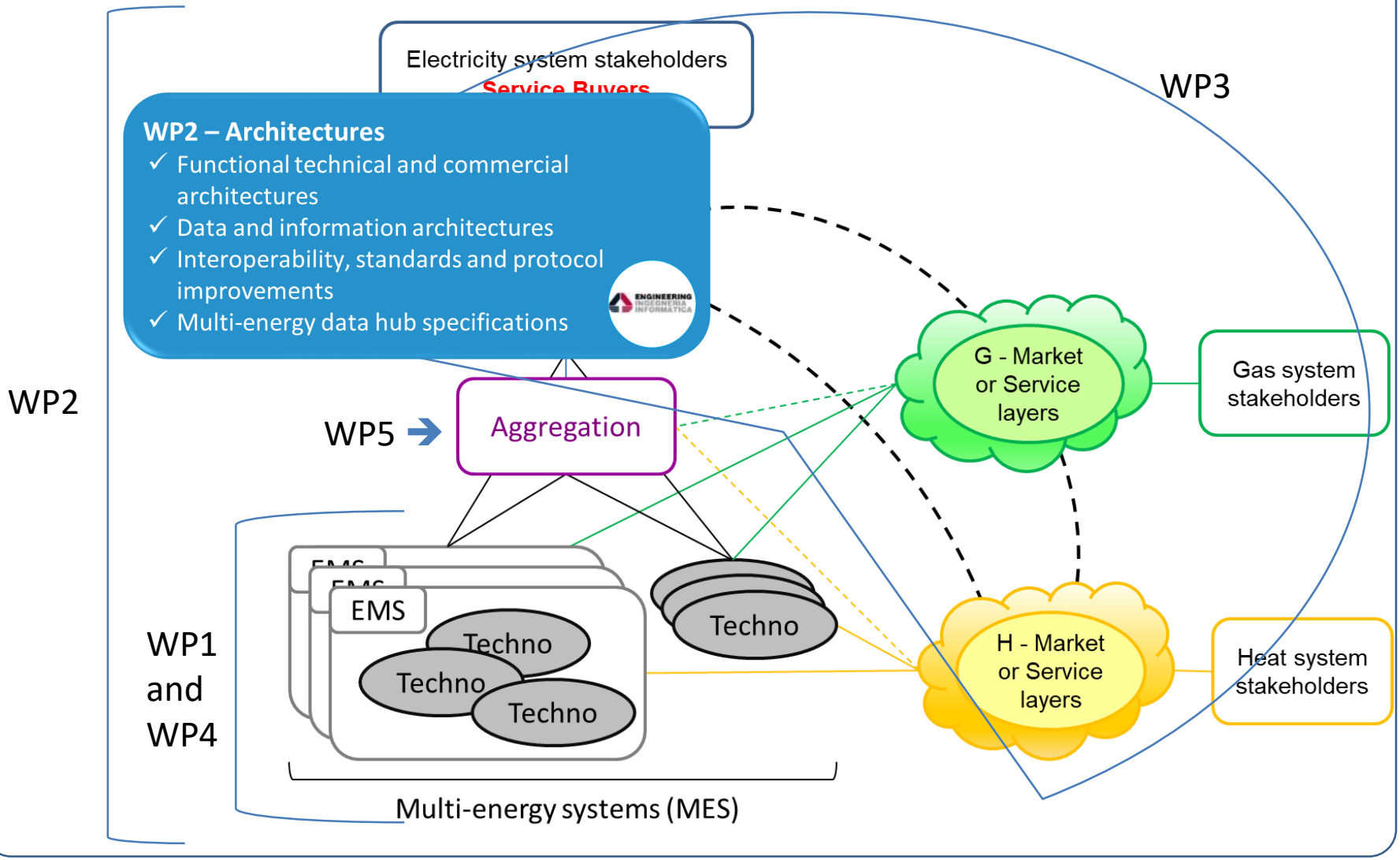


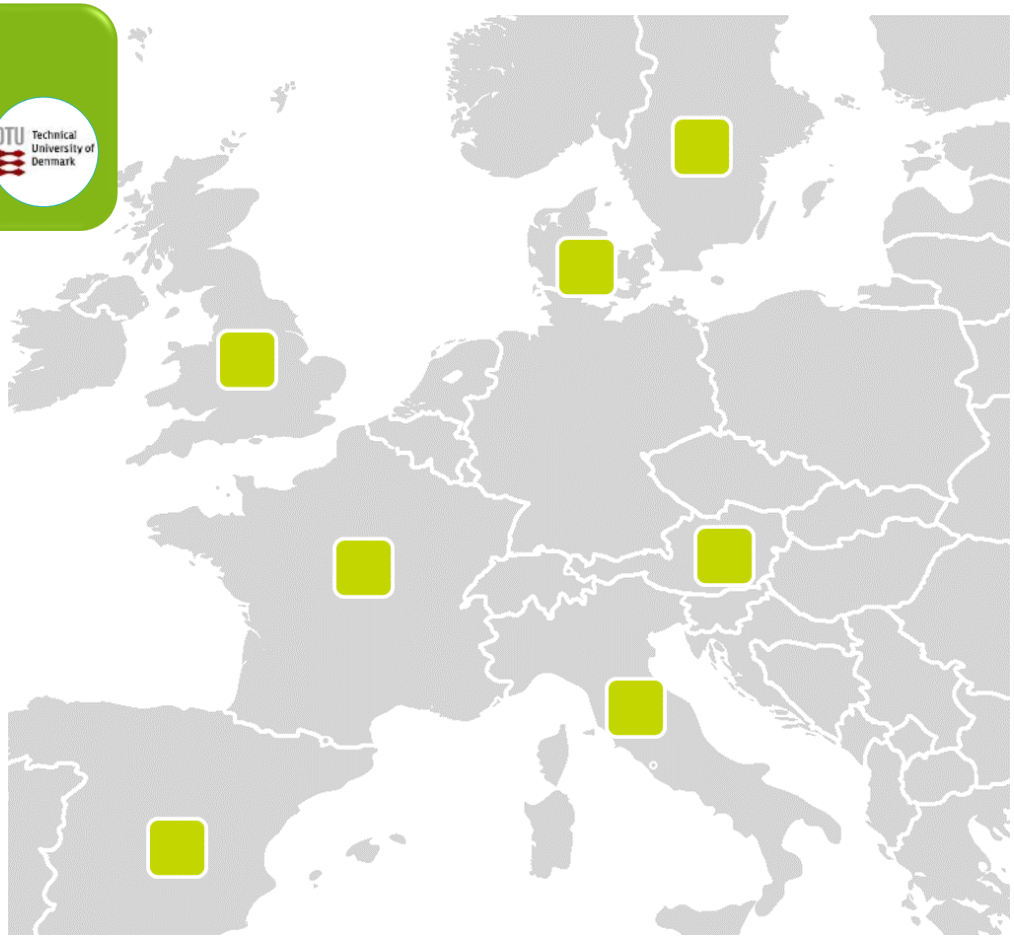
MAGNITUDE Work Packages

WP6 – Case studies
- ✓ Case study data management
- ✓ Scenario definition and data generation
- ✓ KPIs definition/monitoring
- ✓ Assessment of integrated solutions

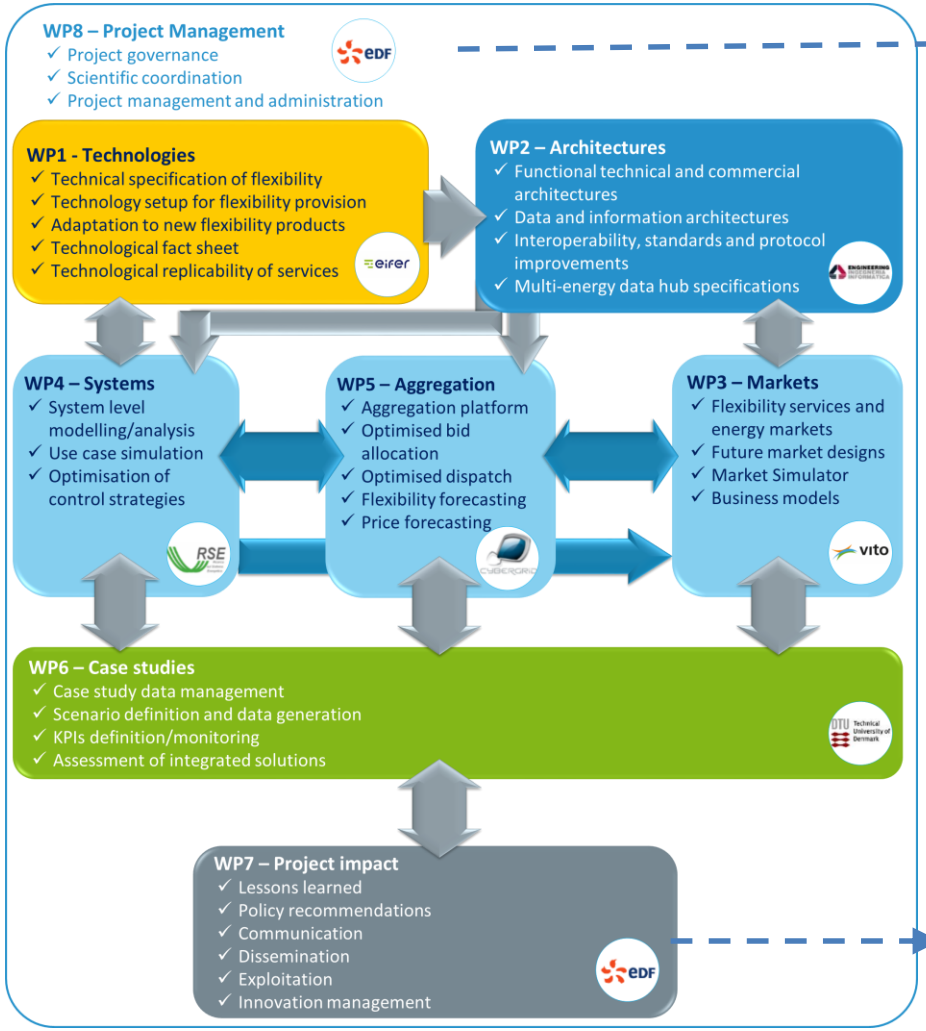
DTU Technical University of Denmark

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



WP8 – Project Management
- ✓ Project governance
- ✓ Scientific coordination
- ✓ Project management and administration

WP7 – Project impact
- ✓ Lessons learned
- ✓ Policy recommendations
- ✓ Communication
- ✓ Dissemination
- ✓ Exploitation
- ✓ Innovation management

MAGNITUDE Case studies

7 real life case studies covering:

3 main MES categories

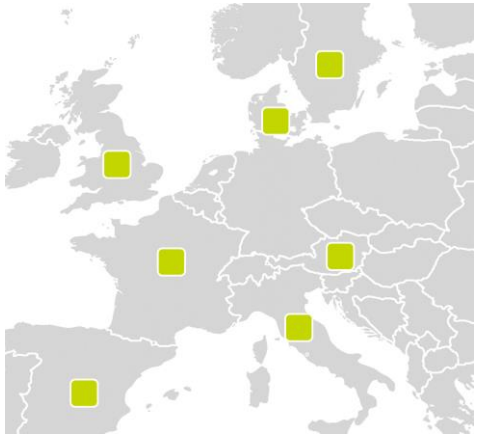
- Large industries
- District heating/cooling networks
- Distributed units

3 main flexibility levers

- Fuel shift
- Storage capability
- Demand response

7 countries

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



Case study Country	Purpose
Mälarenergi Sweden	District heating and cooling
Paper mill Austria	Integrated pulp and paper mill
HOFOR Denmark	Distributed units + district heating
ACS Italy	Milan district heating
Neath Port Talbot, UK	Industrial MES sites and large RES
EMUASA Spain	Waste water treatment plant
Paris Saclay France	District heating & cooling + distributed units

MAGNITUDE Case studies

Case Study	Technologies										Energy vectors			
	Bio-mass boiler	Gas boiler	Steam turbine	Gas turbine	Gas engine	Chiller	Heat pump	Electric boiler	(Bio)-Gas storage	Thermal Energy Storage	Heat	Cold	Gas	Electricity
Mälarenergi	■		■			■	■			■	■	■		■
Paper Mill	■	■	■							■	■		■	■
HOFOR							■	■		■	■			■
ACS		■			■		■	■		■	■		■	■
Neath Port Talbot	■	■	■	■									■	■
EMUASA		Biogas			■				■				■	■
Paris Saclay		■					■			■	■	■	■	■

Project Results - Deliverables

Technological characterization and evolution

- **Cartography of the case studies and flexibility services** provided by heating/cooling, storage and gas technology and systems to the electricity system – **D1.1**
- **Technology and case studies factsheets**: technical characteristics and associated technological and regulatory constraints **– D1.2**
- **Technological adaptation** to flexibility products **and guidelines for development** – **D1.3**

Services and markets

- **Overview of the flexibility services to the electricity grid**, and benchmark of markets and regulations for electricity, gas and heat - **D3.1**
- **Future market designs** for multi-energy systems - **D3.2**

Concepts and functional architectures

- MAGNITUDE **technical and commercial functional architectures** to maximize flexibility provision by Multi-Energy Systems (MES), and high level **business use cases** – **D2.1**

Project Results - Deliverables

Tools for data exchanges and interoperability

- Multi-energy **Data Hub Specification** – **D2.2**
- **Interoperability adaptation layer** (software data transformers): adaptation layer for interoperability between MES and the relevant stakeholders – **D2.3**

Tools for market simulation

- **Specification** of the multi-energy market simulator – **D3.3**
- **Multi-energy market simulator** – **D3.4**

Tools for MES simulation and optimisation

- **Methodology for multi-energy system simulation**, technical specifications for model development at system and technology levels – **D4.1**
- Tools for Multi energy system **simulation** and analysis – **D4.2**
- **Optimization** of flexibility provision from **multi-carrier systems** – **D4.3**

Project Results - Deliverables

Tools for aggregation

- **Specifications of Multi Energy Aggregation platform** for provision of flexibilities – **D5.1**
- Tools for optimized **market allocation of flexibilities** (flexibility trading) – **D5.2**
- Tools for multi energy carrier **aggregation** – **D5.3**
- **Multi energy aggregation platform** for provision of flexibilities – **D5.4**

Assessments and evaluation

- **Opportunities and barriers for replicating** the studied flexibility products and market designs in selected countries – **D1.4**
- **KPIs and assessment procedure – D6.1**
- **Evaluation report:** assessment of the integrated system (MESs, aggregation platform, market simulation) – **D6.2**
- **Business model evaluation** of the different case studies for simulated markets – **D3.5**

Project Results - Deliverables

Dissemination and exploitation

- Communication and dissemination plan - **D7.1**
- Communication materials and tools – **D7.2**
- MAGNITUDE **lessons learnt** – **D7.3**
- MAGNITUDE **policy recommendations** addressing market mechanisms, regulation and standardization from a EU perspective - **D7.4**
- MAGNITUDE **exploitation plan** - **D7.5**
- **Data Management Plan – D7.6**

THANK YOU FOR YOUR ATTENTION

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

Magnitude

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

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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: eifer (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

- **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
- **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
- **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

- **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.
- **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.
- **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

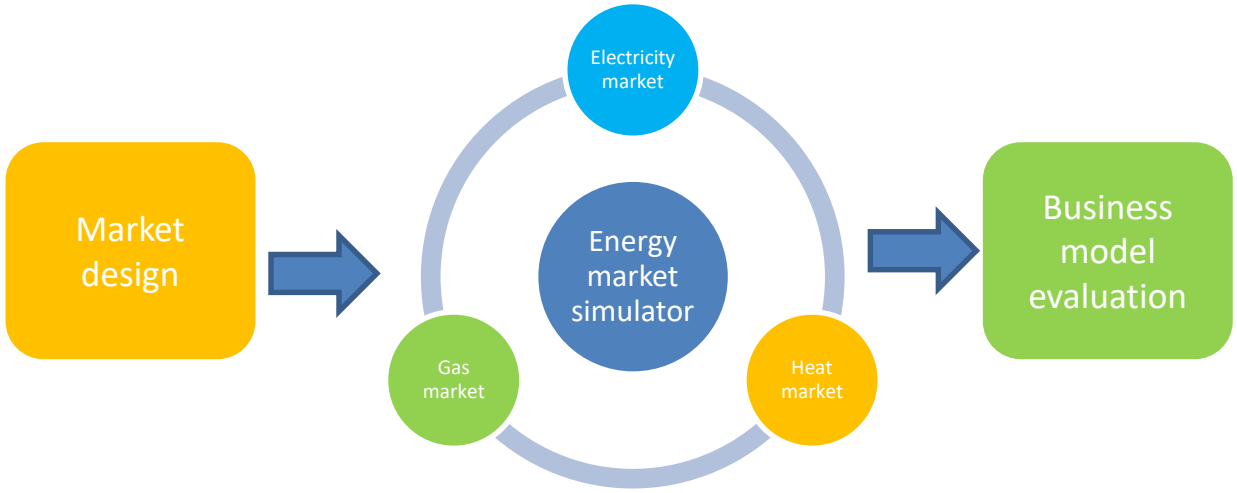
Objectives:

- 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

- 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
- **Specification** of the multi-energy market simulator
- **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: RSE Ricerca Sistema Energetico (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

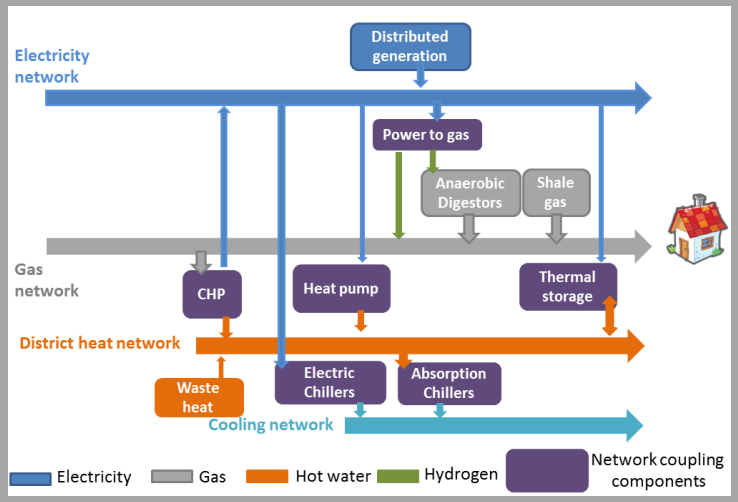
- **Methodology for multi-energy system simulation**
  Technical specifications for the model development at system and technology level, harmonizing the temporal and spatial scales of models and their interconnections
- **Tools for multi energy system simulation and analysis**
  Tools and methods for the simulation and analysis of multi energy system's behavior and constraints for the provision of the identified flexibility services to the grid
- **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

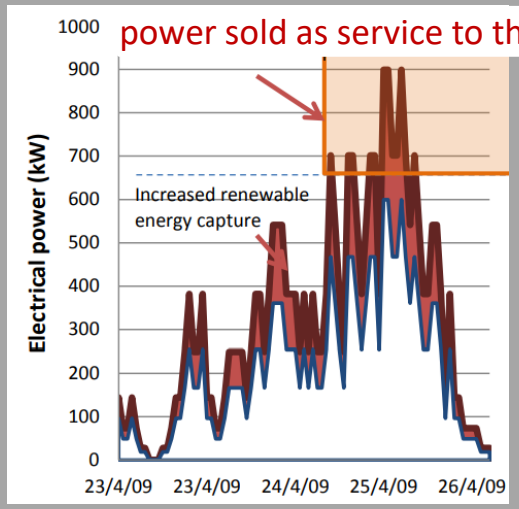
WP4 – Systems (3/3)

USE CASE

technologies: CHP | Heat pumps | Heat storage | Power-to-Gas | Absorption chillers

services (products): Provision secondary reserve (P[t,τ])





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

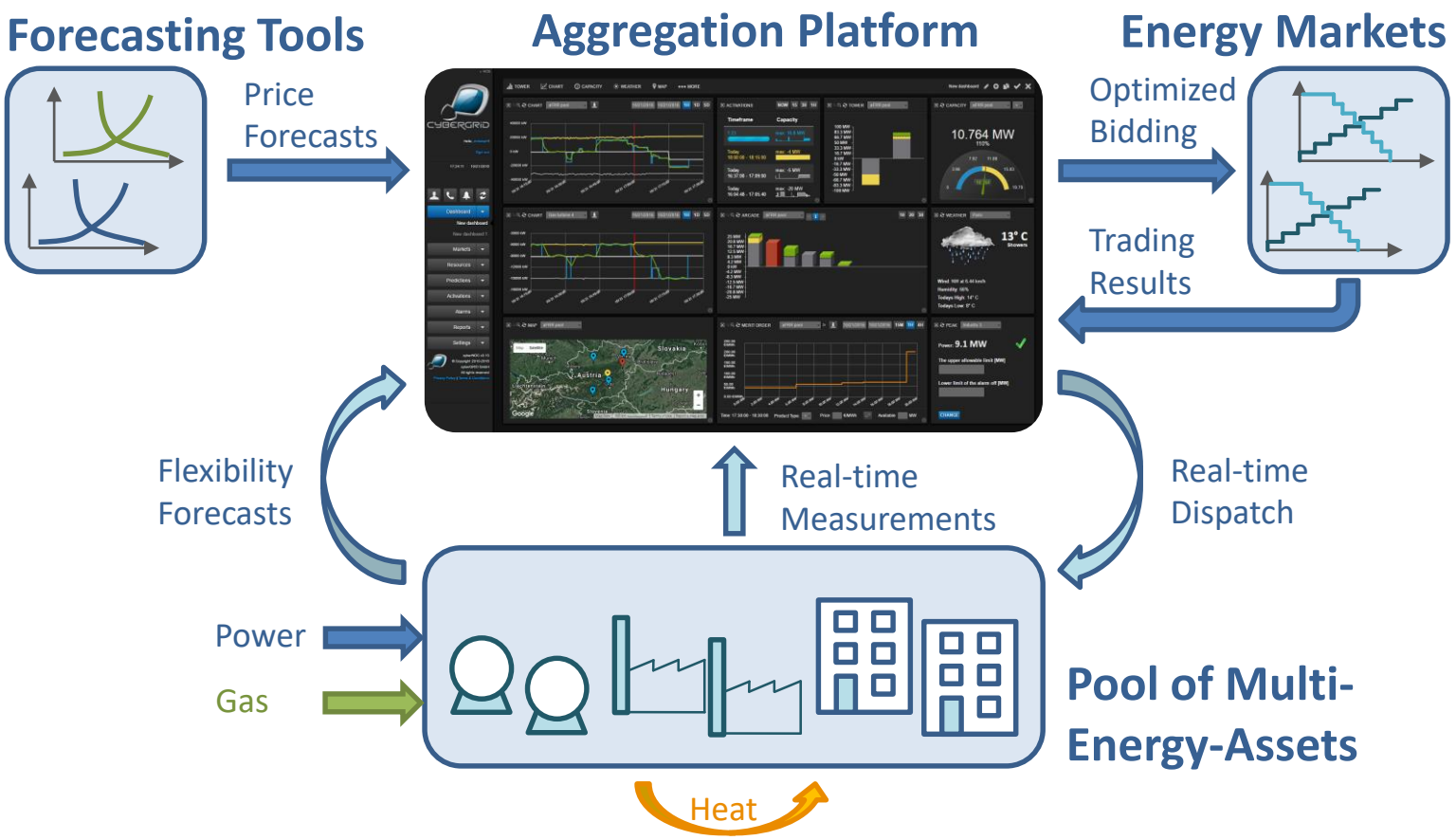
WP5 – Aggregation (2/3)

Main expected outcomes

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



WP6 – Case Studies (1/2)

Evaluation of integrated systems and case studies

WP Leader: DTU 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

- **MAGNITUDE KPIs**
- **Consolidated case study sets**
- **KPIs and assessment procedure**: specified project KPIs and the methods or processes for evaluating them
- **Coherent datasets for baseline and future scenarios evaluation**
- **Simulation of the case studies under the baseline and future scenarios**
- **Final evaluation of the integrated system**: market, system, aggregation platform

WP7 – Project Impact (1/2)

Lessons learnt, policy strategy and exploitation

WP Leader: EDF (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:

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