Research & Innovation Needs for Smart Grid Transition

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ISGAN Annex 7 & Clean Energy Solution Center Webinar
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Introduction

- **Presentation of the 10-year ETIP-SNET R&I roadmap covering 2017-2026**
  - Support DG Energy in defining a European R&I strategy in the area of SET Plan activities relative to smart grids and integration of energy storage,
  - Service contract → Grid+Storage project,

- **Focus on socio-economic R&I activities at distribution level**

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Outline

- EU policy framewok
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The European energy policies

- **Main drivers of energy policies of the European Union (EU)**
  1. reduce GHG emissions → decarbonize the European economy,
  2. security of supply and,
  3. economic growth.
- **27 countries with different energy systems**
- **Evolving regulatory framework(s): the energy packages (EP)**
  - directives addressing the unbundling of the energy sector (gas and electricity) [1st EP, 90s],
  - directives addressing the promotion of renewables and cross-border electricity exchanges + update of the rules for the energy markets [2nd EP early 2000s]
  - specific directives updating the common rules for the internal market in electricity and gas [3rd EP, 2009]
  - Recast of the existing directives and regulations for putting energy efficiency first, achieving global leadership in renewable energies and providing a fair deal for consumers [Clean Energy for all Europeans package, 2016].

The European energy policies

- **The landscape of the energy system has deeply changed:**
  - new market players have emerged: generators, traders, retailers, service providers,
  - regulated market makers (transmission system operators and distribution system operators),
  - NRAs (National Regulatory Authorities) in Member States (MS),
  - and ACER (the Agency for Cooperation of Energy Regulators).
- **An integrated European energy market,**
  - in order to provide the energy consumers (households, businesses and industries) with secure, sustainable, competitive and affordable energy.
- **which creates intensive R&I needs for the power system**
  - the progressive integration of non-dispatchable generation (mainly wind and PV power) and the advent of pan-European electricity markets challenges the stakeholders to find organisational solutions to operate the electricity grids within the stability limits and at affordable costs.

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European R&I energy policies

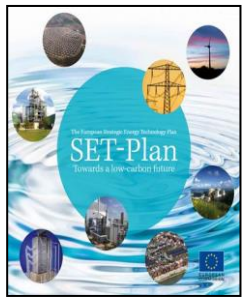
2008: The SET Plan

-20 % GHG Emissions

20% Renewable Energy

20 % Energy Efficiency

binding



2014: Towards an Integrated Roadmap

- Individual Technologies → Energy system
- Policy challenges
  - Consumer at the centre
  - Energy efficiency (demand)
  - System optimisation
  - Technologies (supply)

-47 % GHG Emissions

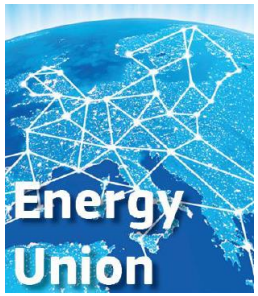
27% Renewable Energy

27 % Energy Efficiency

Not binding

2015: Energy Union – Priorities

- Energy security, solidarity and trust
- A fully integrated European energy market
- Energy Efficiency (EE) first: moderation of demand
- Transition to a low-carbon society: decarbonising the economy,
- **Research, Innovation and Competitiveness**



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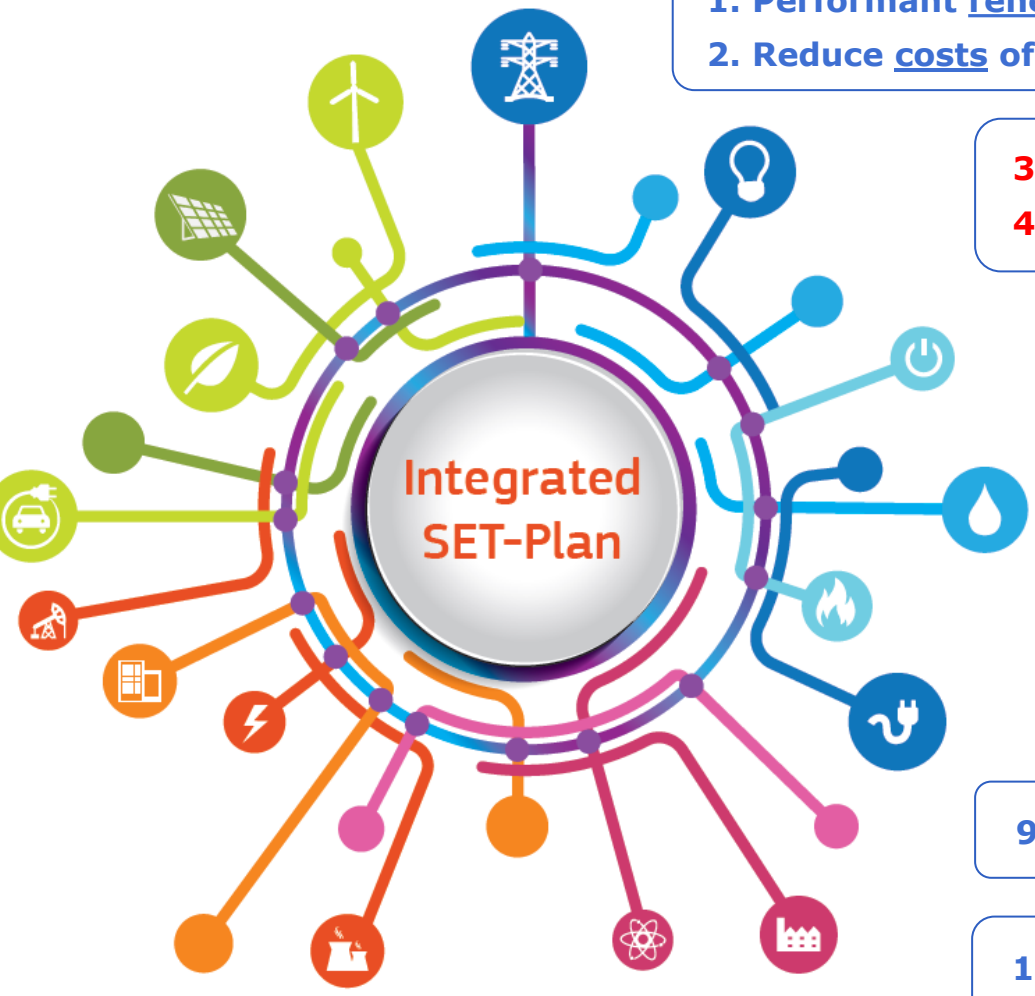
The New Strategic Energy Technology Plan



1. Performant renewable technologies integrated in the system
2. Reduce costs of renewable technologies

3. New technologies & services for consumers
4. Resilience & security of energy system

5. New materials & technologies for buildings
6. Energy efficiency for industry

7. Competitive in global battery sector (e-mobility)
8. Renewable fuels

9. Set up R&I activities applying CCS and CCU

10. Maintain safety level & improve efficiency in nuclear energy

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The R&I and competitiveness pillar

R&I needs according to Energy Union (EU) strategy

- Lead on the next generation of renewable technologies and energy storage solutions.
- Prioritize smart grid and smart home solutions: promote increased energy efficiency at any stage of the value chains of all the electricity, gas, heat systems.
- Improving the effectiveness of R&I programmes by effectively combining EU and Member State programmes around common goals and deliverables.

The Grid+Storage R&I roadmap is in line with the EU strategy

→ it aims at taking the electricity grid and energy storage players together to design an integrated R&I roadmap for the period 2017-2026.

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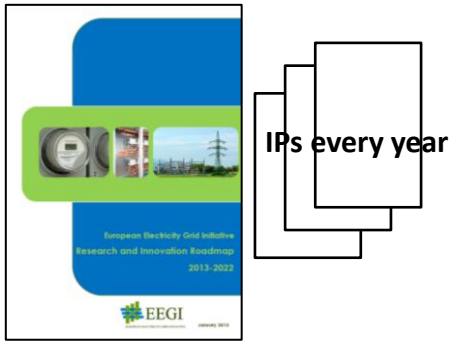
From the EEGI and the ETP SG to the ETIP-SNET

Electricity system
Integration of RES

Electricity system
Integration of storage + other flexibilities
Integration with other energy networks

Energy system as a whole

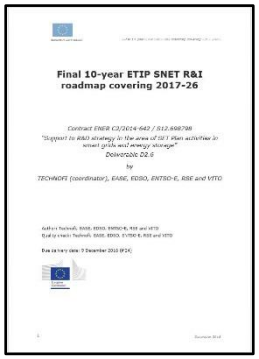
EEGI roadmap 2013-2022



IPs every year

ETIP-SNET roadmap 2017-2026

IP 16-18



IP 17-19

EEGI roadmap 2019-2028

IP 19-21

IP 18-20

IP 21-23

IP 20-22

EEGI
EUROPEAN ELECTRICITY GRID INITIATIVE

EEGI
EUROPEAN ELECTRICITY GRID INITIATIVE
SMARTGRIDS

ETIP SNET

ETIP SNET

GRID+

GRID+ STORAGE

INTENSYS4EU

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Consultation and monitoring

- **The *10 year (2017-2026) ETIP SNET R&I roadmap***
  - A consolidated and balanced stakeholder viewpoint for the future R&I needs of the electricity networks, through consultations and "regional" workshops

  → *several versions of the RIR, accounting for improvement proposals coming from the power system community and the energy system community as a whole*

  - Based on a monitoring/review of national, European and international R&I activities

  → *Measure of the coverage: the specified R&I activities cover new knowledge needs not (or partially) addressed at the time of the monitoring/review*

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Nine regional workshops

WS	Date	Location	Attendees	Projects presented
N°1	25-26 Nov 2015	Lille, France	36	6
N°2	12-13 Jan 2016	Riga, Latvia	40	7
N°3	26-27 Jan 2016	Helsinki, Finland	37	6
N°4	9 Feb 2016	Athens, Greece	56	8
N°5	15-16 Feb 2016	Madrid, Spain	84	11
N°6	24-25 Feb 2016	Vienna, Austria	16	4
N°7	29 Feb-1 Mar 2016	Rome, Italy	28	7
N°8	9-10 Mar 2016	Munich, Germany	32	11
N°9	15 Mar 2016	London, UK	105	12
			434	72

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Main inputs from the regional workshops

- **Main inputs from the national stakeholders regarding storage integration**
  - Need for **integrated designs** in order to optimize investments with the maximum coverage in terms of functionalities and potential benefits
  - **Multiservice business models** might be a solution provided that the system services brought by storage are valued on a fair basis
  - **Flexibility cannot be ensured only by storage technologies**: storage must always be compared against other possible flexibility options
  - Market players: lack of **clear regulatory framework** and of **market mechanisms** that give visibility for investments
  - Regulated players: **network operators confirm that they could own and operate grid-localized electricity storage devices**: more R&I needed to grasp the value brought by storage devices and the respective role of the players.

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Monitoring process

Build a representative sample of projects

- **553** projects: available info, budget, consistency, geographical coverage, system integration, etc. → **123** monitored projects + (**52** international projects).

Projects assessed by achievements in a generic questionnaire (DB)

- Achievements (specific results) correspond to the lowest scale of the analysis and were defined by the experts during interviews.

Features of the achievements

- What is the typology (nature) of the achievements ?
- What is the estimated impact of the achievement on a maturity scale (TRL)?
- For each achievement, what is the foreseen implementation?
- For each achievement, what are the next steps ?
- For the next steps, what is the time line and which route(s)?

Coverage analysis

- 🟢 Very well covered, 🟡 Partially covered, 🔴 Minor coverage or no coverage at all

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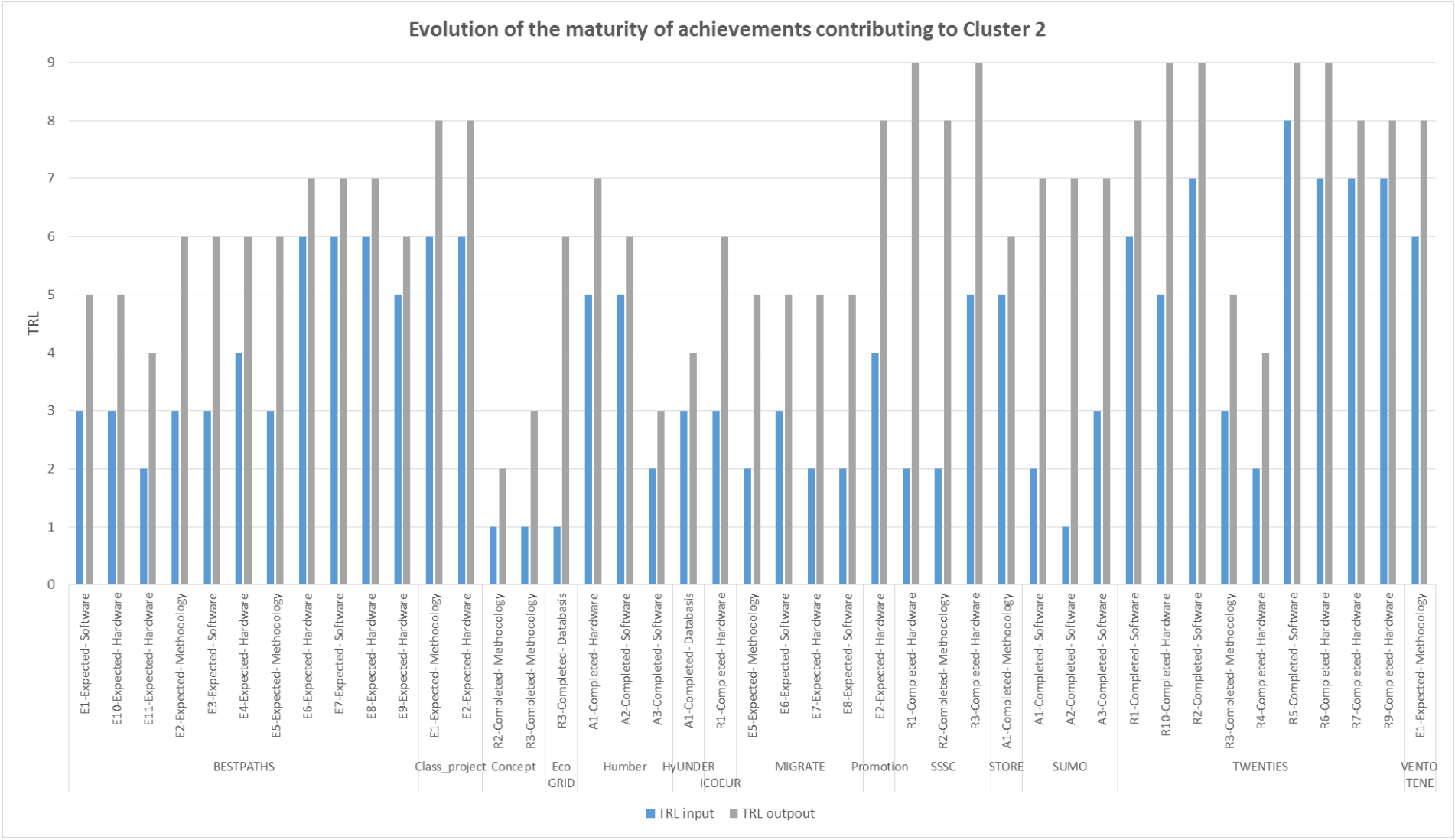
Monitoring process: example

Evolution of the maturity of the achievements



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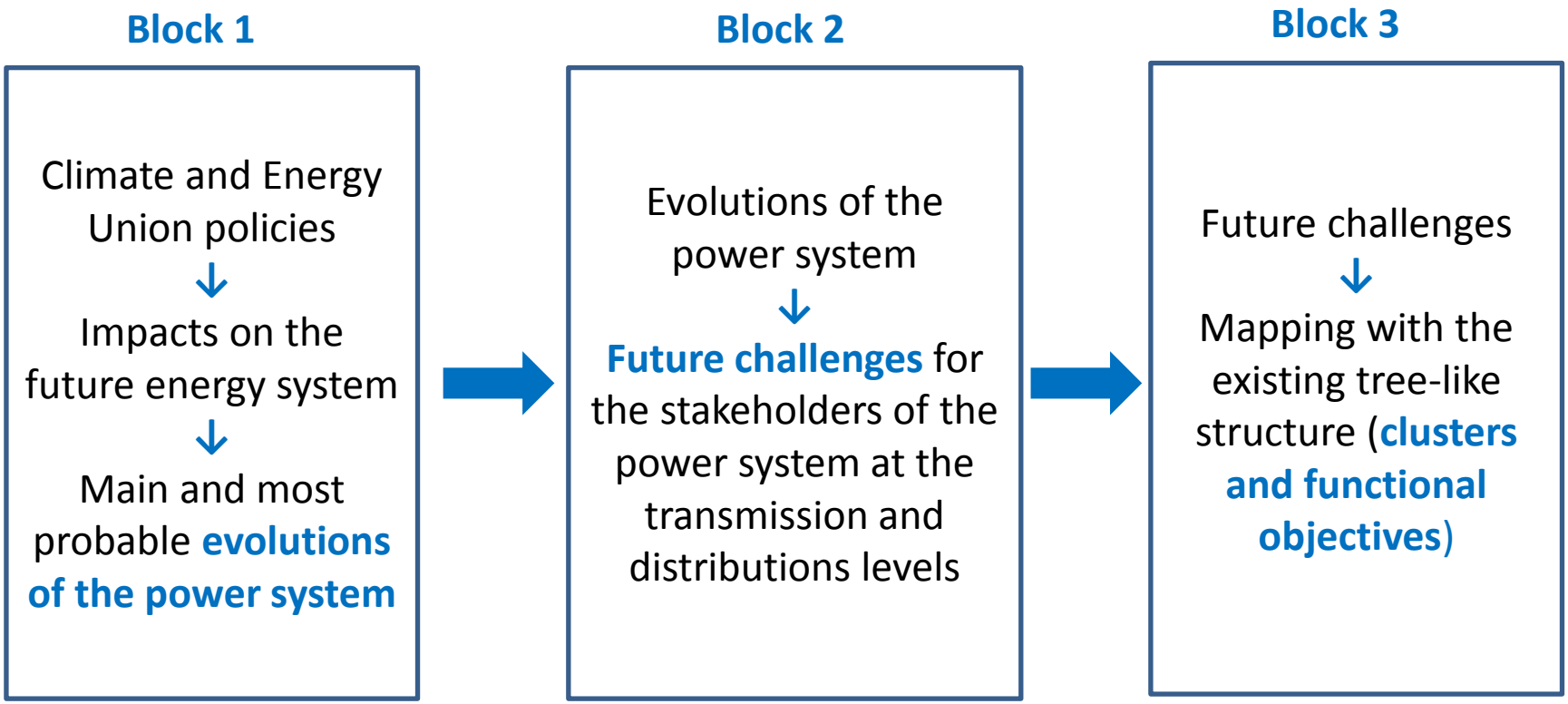
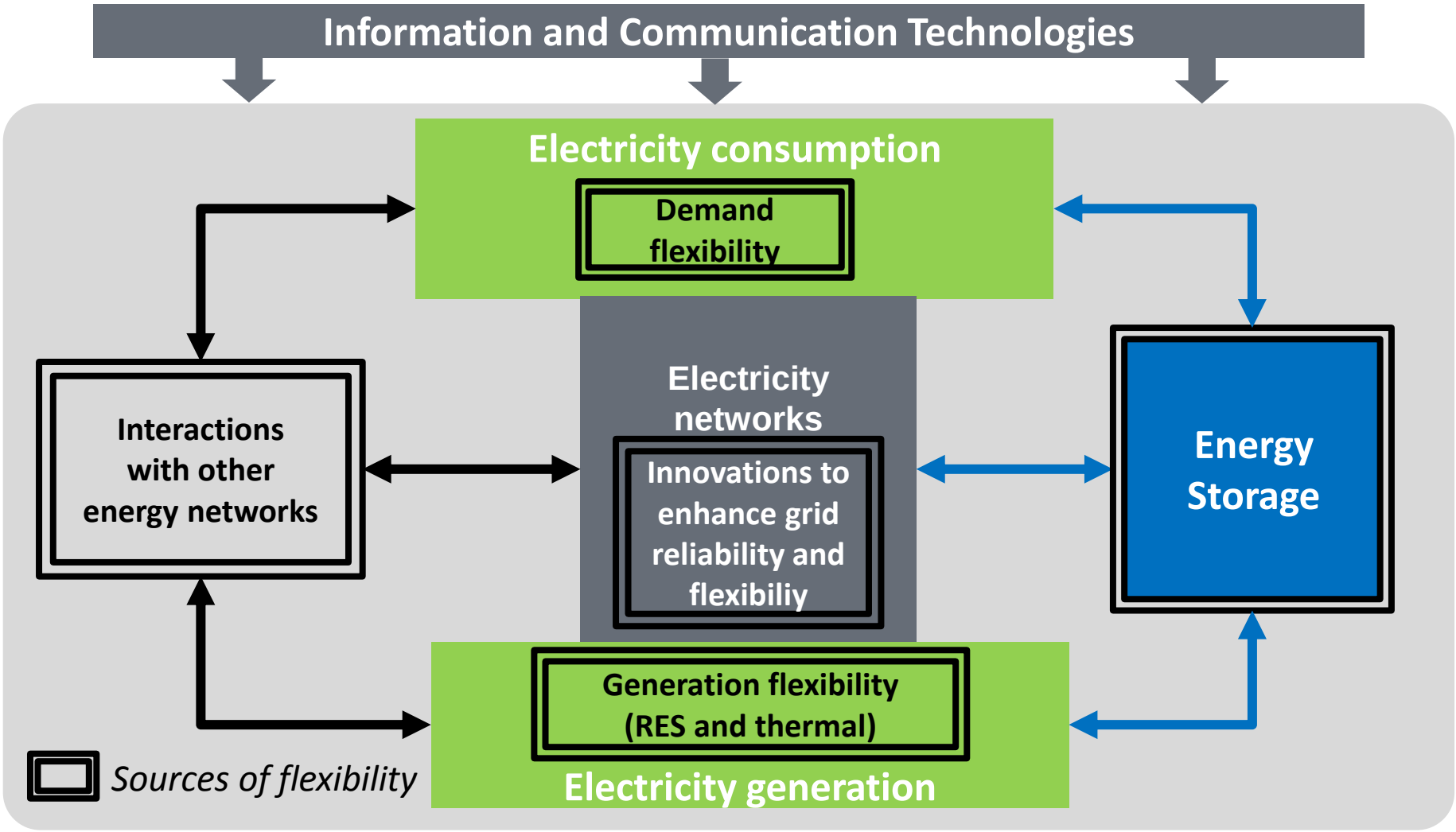
From EC policies to the new structure of the RIR

▶ The R&I roadmap involves three main building blocks



Electricity network = backbone of the energy system

Offers flexibility solutions and enables the integration of all flexibility means



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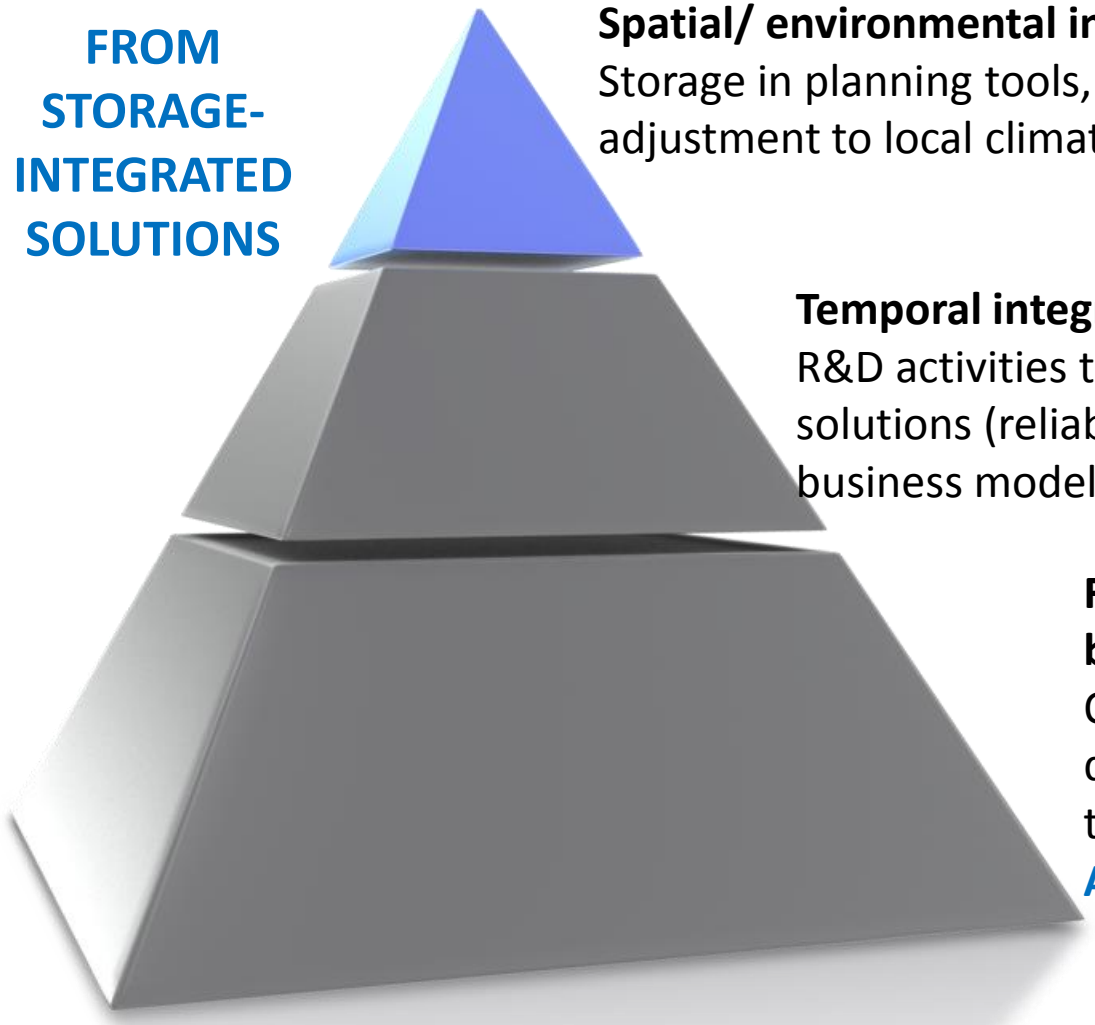
Integration issues: example of storage

FLEXIBILITY FROM STORAGE-INTEGRATED SOLUTIONS



Spatial/ environmental integration of storage-based solutions
Storage in planning tools, fine-tuning of optimal scale, adjustment to local climates and to specific areas. **Aim TRL: 7- 9.**

Temporal integration of storage-based solutions
R&D activities to shape the life cycle cost of integrated solutions (reliability, techno-economic performances, business models). **Aim TRL: 6-8**

Functional integration of storage-based solutions into the system
Optimal mix, interfaces, experimental data and simulations to validate end-to-end functionalities.
Aim TRL (op): 5-7

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Structure of the former roadmap: activity oriented clusters

- The former EEGI 2013-2022 R&I roadmap structure

Transmission clusters		Distribution clusters
C1: Grid Architecture	C6 Joint TSO/DSO R&D Activities	C1: Integration of Smart Customers
C2: Power Technologies		C2: Integration of DER and New Uses
C3: Network Operation		C3: Network Operations
C4: Market Designs		C4: Network Planning and Asset Management
C5: Asset Management		C5: Market Design

- Two-level tree-like structure : clusters and functional objectives within each clusters that are technology agnostic

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Structure of the new roadmap

- **Keep the two-level tree-like structure (clusters and functional objectives) with substantial modifications in order to consider**
  - the SET Plan environment and the EC climate and energy policies,
  - the cross-cluster nature of many projects,
  - the integration of storage and all other flexibility means in the power system,
  - the integration of the power system in the energy system,
  - retail markets (empower customers).
- **TSO/DSO activities are integrated in the functional objectives when relevant !**
- **Storage integration: R&I activities in almost all transmission/distribution, clusters and functional objectives.**
- **Integration in the energy system**

Structure of the new roadmap: transmission and distribution - challenge oriented

Challenge oriented clusters for transmision systems
C1: Modernization of the Network
C2: Security and System Stability
C3: Power System Flexibility from Generation, Storage, Demand and Network
C4: Economic & Efficient Power System
C5: ICT and Digitalization of Power System

Cross-cutting challenges for distribution systems
Challenge1: Upgrading of the Network
Challenge2: Power System Reliability
Challenge3: Power System Flexibility
Challenge4: ICT and Digitalization
Challenge5: Market Design
Challenge6: DSO Regulatory Environment

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Active demand response

Market design

- Study possible new incentive mechanisms to promote large scale participation on AD schemes, or explore the possibility of mandatory cutbacks during peak consumption times in order to guarantee grid reliability and stability.
- Design adapted incentives […] accounting for the end consumer's acceptance of load flexibility and maximizing their participation in AD-based schemes ([…] tariffs).
- Study the rebound and deferral effects and provide reliable models to predict them so as to provide DSOs with methods to anticipate their impacts on network operations.
- Recommendations to enable the integration of active demand in electricity markets (retail and wholesale) with a fair burden sharing and reward for all stakeholders based upon quantified business models.

DSO regulatory involvement:

- Recommendations to cope with possible commercial and regulatory barriers that could impede the implementation at a pan-European scale of active demand solutions.

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EE from integration of smart homes and buildings

Market design

- Market rules (and the associated regulatory framework) to help customer participate in retail markets (energy efficiency offers) in a transparent and non-discriminatory way, with a special attention to data privacy.
- Business models for all stakeholders (especially retailers and aggregators) promoting energy efficiency at the end-user level (in relation with AD response, cf. D1).
- Further study customer acceptance and involvement for energy efficiency measures by taking into account the full environment, i.e. ergonomics (ICT environment), market (price signals), and behavior (rebound effects and arbitrage between comfort and wealth).

DSO regulatory involvement:

- Propose new regulatory options in a context of lower energy volumes.

System integration of small DER

Market design

- Recommendations for valuation of ancillary services brought by distributed PV systems (possibly through self-consumption or when connected to storage devices).
- Recommendations for the participation of prosumers in electricity markets (including the studies of local energy markets).
- Incentive schemes and contractual mechanisms for prosumers for short time DER control hand over to DSOs for grid management purposes.

DSO regulatory involvement:

- Recommendations for the access to generation data of prosumers.
- Regulatory framework for temporary use of distributed DER for grid management purposes.

System integration of medium DER

Market design

- Recommendations for valuation of ancillary services brought by DER (e.g. voltage control, active and reactive power control, etc.).
- New market rules (replacing feed-in tariffs) for the deployment of renewables with propositions for new remuneration schemes.

DSO regulatory involvement:

- Networks codes for DSOs defining the allowed interactions with the different market players during operations.

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Integration of storage in network management

Market design

- CBA tools to compare storage with other flexibility means (network reinforcements and new lines, demand management, connections with other energy networks, flexible generation, etc.) including environmental and social aspects (LCA).
- Multiservice business models for storage integration with a focus on the valuation and remuneration schemes of the system services brought by storage (regulations and market mechanisms to be studied and implemented).
- Study and demonstrate the integration of Power2heat solutions for balancing and storage; with a focus on dynamic compensation between heat and electricity.

DSO regulatory involvement:

- Investigate the needs for new regulatory mechanisms addressing storage ownership and operations for markets players and DSOs.

Infrastructure to host EV/PHEV – Electrification of transport

- **Market design**
  - Tariff schemes and incentives to promote optimized charging and facilitate customer engagement.
  - Demand response: market mechanisms for V2G applications.
- **DSO regulatory involvement:**
  - Regulatory issues regarding market design and network regulation to efficiently integrate electric vehicles in electricity grids (system services).

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Integration with other energy networks

Market design

- Demonstrate the business case for producing:
  - heat when residual loads are low with e.g. large-scale heat pumps (green electricity) or individual electrical boiler (green electricity);
  - electricity (gas-fired or biomass fired CHP units) when residual loads are high.
- Market simulators coupling the electricity, gas and heat markets, building upon flow-based methods and simulation tools.
- Market design (and the associated regulatory framework) for e.g. thermal storage for participation in electricity and heating markets.

DSO regulatory involvement:

- None.

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Conclusions

R&I road mapping exercise has allowed energy stakeholders:

- Enlarging the R&I scope to consider all flexibility means: RES and thermal generation, grid, demand response, **storage**
- Enlarging the R&I scope beyond the electricity system (interactions with gas and heat networks , integration of energy storage technologies into the power system)
- Addressing a single overarching goal, i.e. ***to optimize the European welfare brought by the electricity value chain while ensuring the proper level of reliability within the energy system of the EU28*.**

R&I activities related to energy storage are urgent:

- Technology providers: still a substantial and urgent need for R&I focus on storage technologies to reach market maturity.
- Market players: which **regulatory framework** and **market mechanisms** give visibility to encourage storage investments?
- Regulated players: how **could system operators own and operate electricity gird-localized storage devices** when competitive markets do not exist or do not capture the full value brought by storage?

Thank you for your attention!

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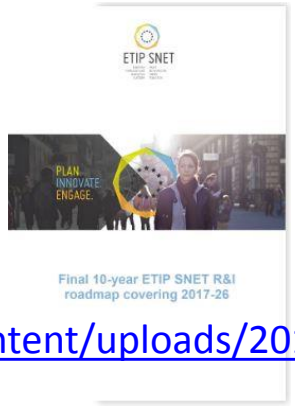

http://www.etip-snet.eu/wp-content/uploads/2017/03/Final_10_Year_ETIP-SNET_RI_Roadmap.pdf

http://www.gridinnovation-on-line.eu/