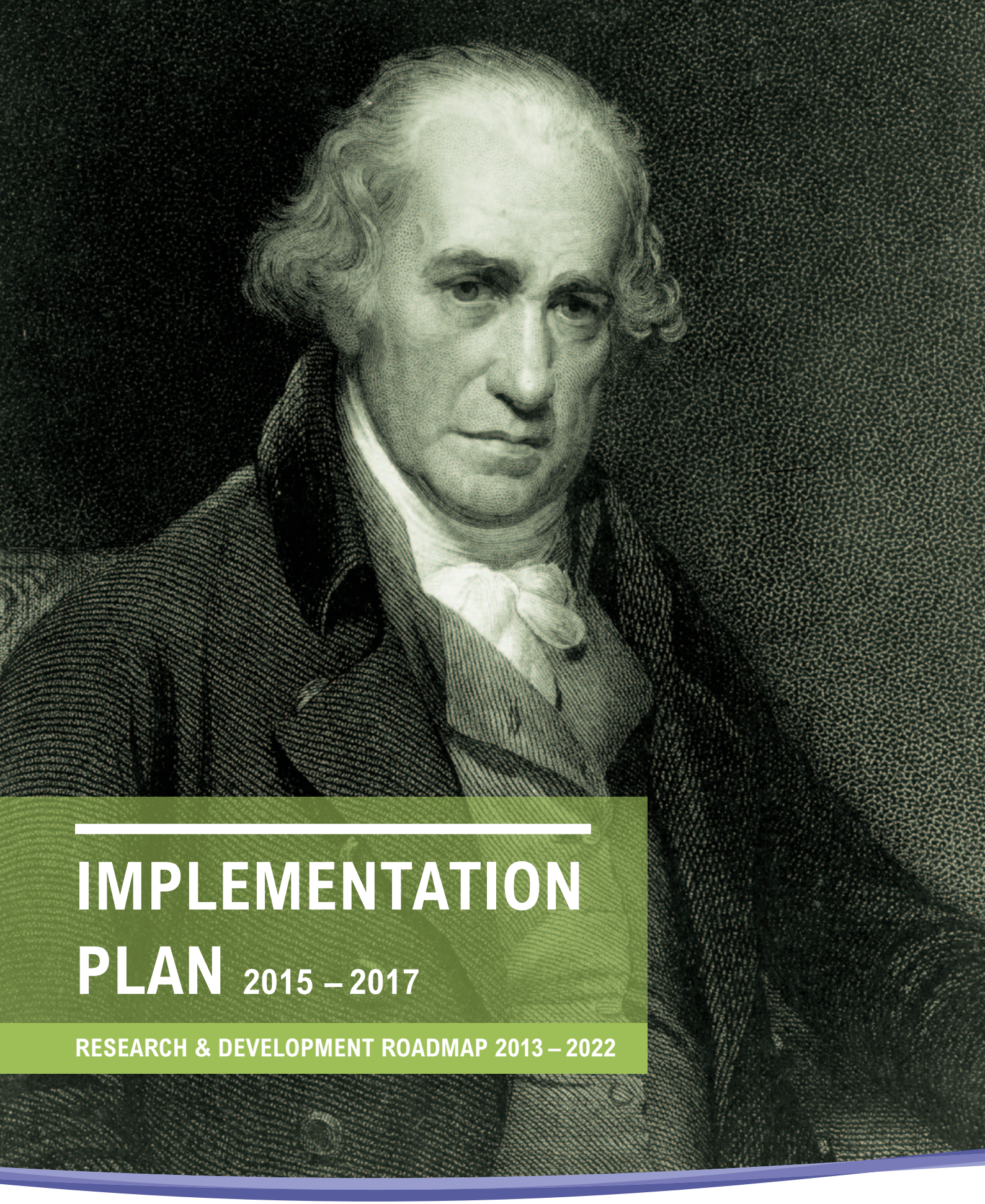


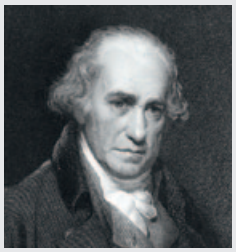
IMPLEMENTATION PLAN 2015 – 2017

RESEARCH & DEVELOPMENT ROADMAP 2013 – 2022

European Network of
Transmission System Operators
for Electricity

entsoe

"True greatness is when your name is like ampere, watt, and fourier – when it's spelled with a lower case letter." Richard Hamming



JAMES WATT
(19 January 1736 – 25 August 1819) was a Scottish inventor and mechanical engineer whose improvements to the Newcomen steam engine were fundamental to the changes brought by the Industrial Revolution in both his native Great Britain and the rest of the world. He developed the concept of horsepower and the SI unit of power, the watt, was named after him.

RICHARD HAMMING
(February 11, 1915 – January 7, 1998) was an American mathematician whose work had many implications for computer science and telecommunications. He was a founder and president of the Association for Computing Machinery.

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CONTENTS

INTRODUCTION

GUIDE FOR READERS

This Implementation Plan is targeted at decision-makers, funding institutions, manufacturers, research institutes and other stakeholders. It offers general discussion and clarification of R&D priorities. Readers interested in our R&D projects over the next years will find specific details in the appendices.

BACKGROUND

ENTSO-E Implementation Plan contains practical implementation details for the ENTSO-E R&D Roadmap. It is issued every year and outlines R&D activities for a three-year period as stipulated in the ENTSO-E R&D Roadmap 2013–2022.

In December 2012, ENTSO-E published the first edition of the Implementation Plan 2014–2016 along with the R&D Roadmap 2013–2022. ENTSO-E is now issuing the Implementation Plan 2015–2017, which contains a detailed background on R&D projects planned for 2015 while outlining suggested R&D areas for 2016 and 2017.

With its regular updates and annual editions, this Implementation Plan is an instrument of flexibility to deal with the new operating and planning challenges ensuing from the on-going paradigm shift in the entire sector.

OBJECTIVES

The Implementation Plan addresses the transmission aspects of the EEGI Implementation Plan and covers the R&D chain from applied research to demonstration and implementation of projects. Interaction with stakeholders in developing and completing this Implementation Plan is an iterative and flexible process during which the critical R&D requirements are identified and specific activities are prioritised. GRID+ is a special project to closely coordinate DSO activities with these priorities and thus to ensure consistent and efficient development of the European electricity grid at all levels.

The Implementation Plan is also an instrument for contributing qualified concepts and expertise to the European Commission's policy on R&D funding. In this role, it helps to identify topics for proposals to the Horizon2020 Program.

RATIONALE AND PROCESS IN DEFINING PRIORITIES

CHANGES IN ENERGY POLICY CONTEXT AND TECHNOLOGY DEVELOPMENT

The worldwide paradigm shift in electricity systems is particularly evident in Europe with its high energy demands coupled with a political desire to counteract climate change. Europe is urgently seeking technological and engineering solutions to these new problems.

The European Union has activated several instruments and plans such as the SET Plan to cope with this situation. As prescribed by the Integrated Roadmap, it is essential to make an effort to address all of the innovative energy technologies that can potentially serve and benefit industry and citizens.

Electricity networks will inevitably play a central role by first optimising their utilisation of existing assets and then implementing a super-grid to enable bulk flows and energy exchanges in pan-European and even intercontinental energy markets.

This will require the integration of novel technologies such as high voltage direct current (HVDC), superconducting, extra high-voltage systems as well as carefully re-designed market mechanisms.

The role of DSOs is evolving and the means of coordinating with neighbouring TSOs should be articulated in order to take advantage of services that could be mutually delivered.

PROCESS OVERVIEW

The Implementation Plan has three main levels: concepts, topics and projects (see Figure 1). The rationale and process of the mentioned documents are described in detail.

The figure 1 displays the various levels of the Implementation Plan. Since it is the key link between the Roadmap and specific R&D projects, it helps to ensure that theoretical concepts can evolve smoothly into practice.

Starting at the bottom of the pyramid, concepts are initially identified that can potentially provide solutions in three to four years. These concepts are selected from all Roadmap research fields by assessing their priorities.

In subsequent releases of the Implementation Plan, the concepts will evolve until they become specific R&D topics. These topics represent a filtering of the most urgent concepts. They are then translated into separate projects where detailed R&D tasks are addressed in pursuit of specific targets by ad-hoc consortia that pool the resources of multiple stakeholders.

Particular attention has been placed on maintaining consistency with respect to ENTSO-E's general priorities and coordinating with the GRID+ project. External stakeholders have also collaborated and given their feedback to this edition.

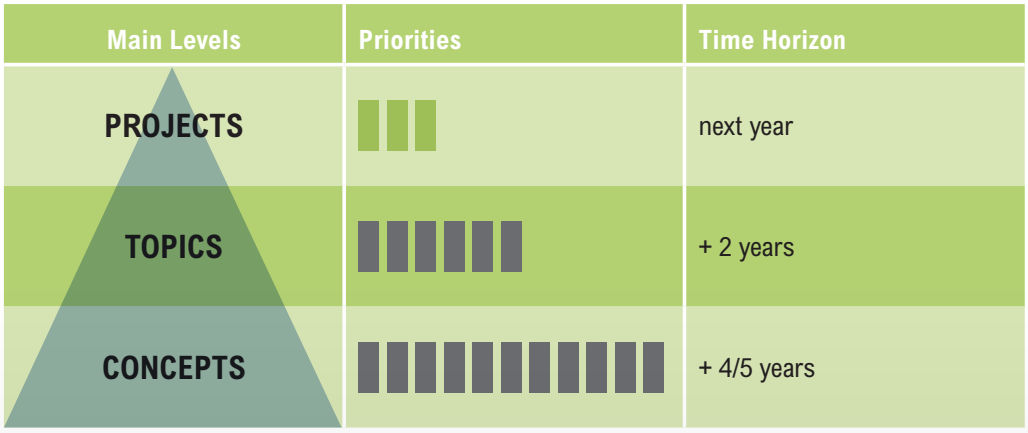


Figure 1: Timeframe of the R&D Implementation Plan

In particular, this edition has included distribution system operators (DSOs), manufacturers, and the Agency for the Cooperation of Energy Regulators (ACER). Moreover, the present edition elaborates on how to achieve mutual integration and synergies in accordance with the SET Plan/EEGI Integrated Roadmap currently in discussion at the European level.

Figure 2 illustrates the iterative R&D process within the ENTSO-E framework. The ENTSO-E R&D Roadmap, released every five years, defines the overarching research fields for the coming decade. It strives to list all technical, economical and socially acceptable solutions needed to cope with the challenges facing pan-European transmission.

Since its long-term focus is on framework development, this high-level Roadmap does not offer a practical implementation strategy for R&D. This is instead covered by the ENTSO-E R&D Implementation Plan. Based on the Roadmap structure, it describes concepts and specific R&D topics that must be tackled in the short and medium terms. With a clear focus on just a few prioritised topics per year, the Implementation Plan represents a crucial step in making innovation happen. One central feature of the overall process is reviewing, which is handled by dedicated monitoring at all three research levels. Feedback from the review makes it possible to continuously update priorities and improve work.

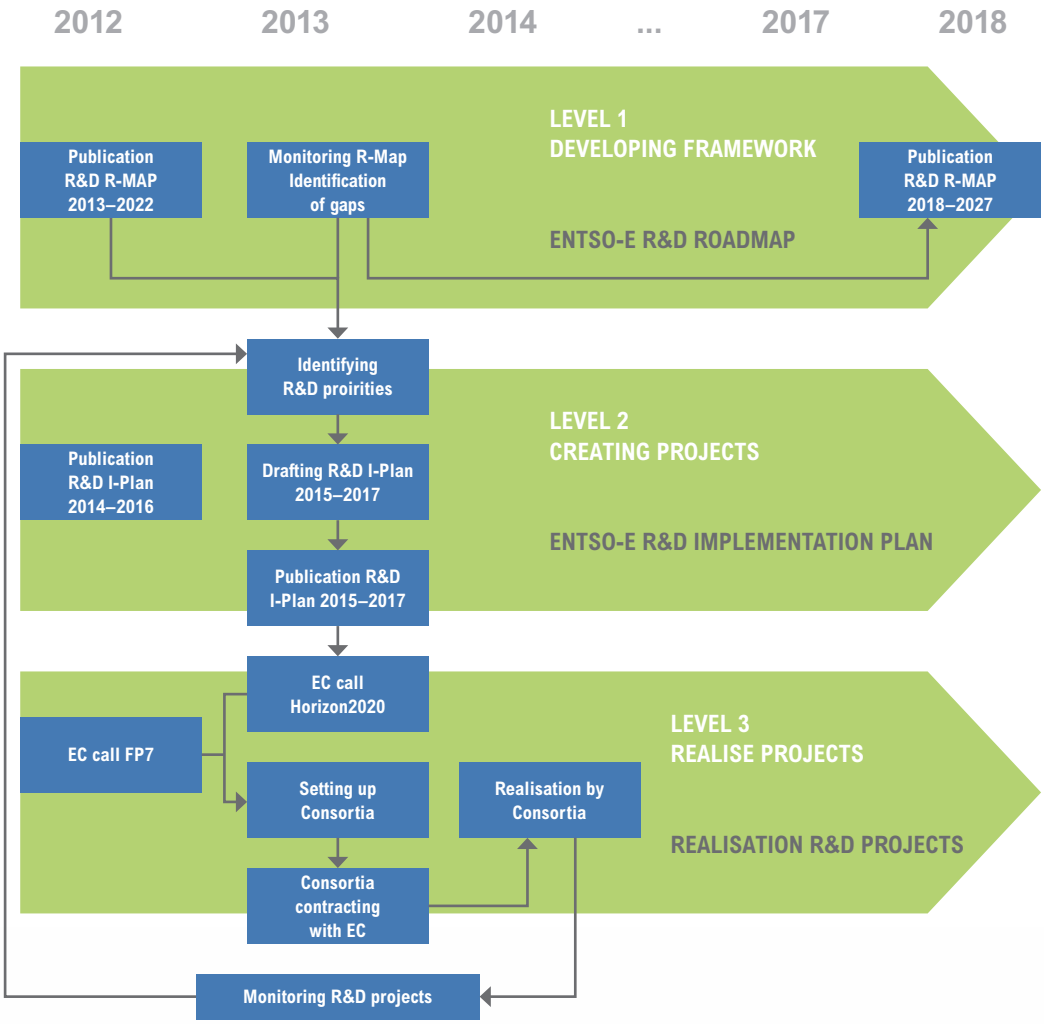
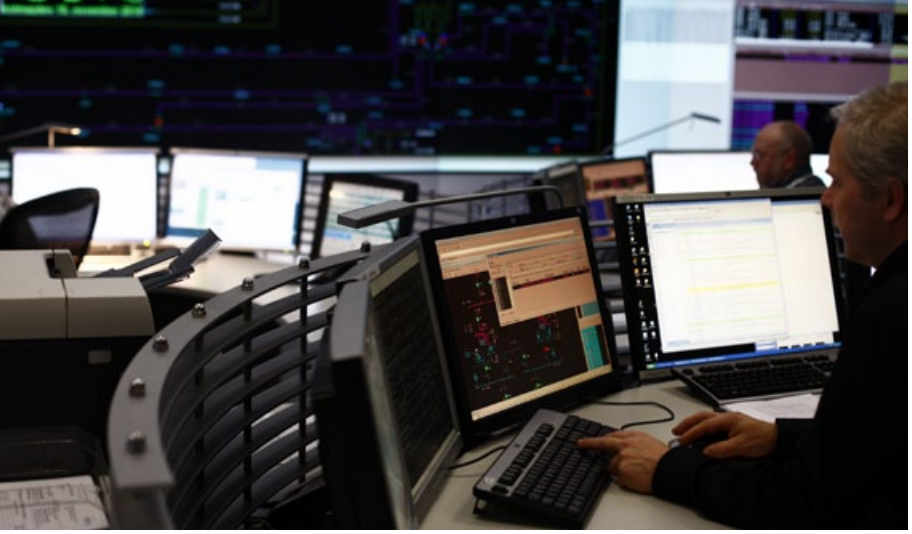


Figure 2: Process of making R&D Implementation Plan

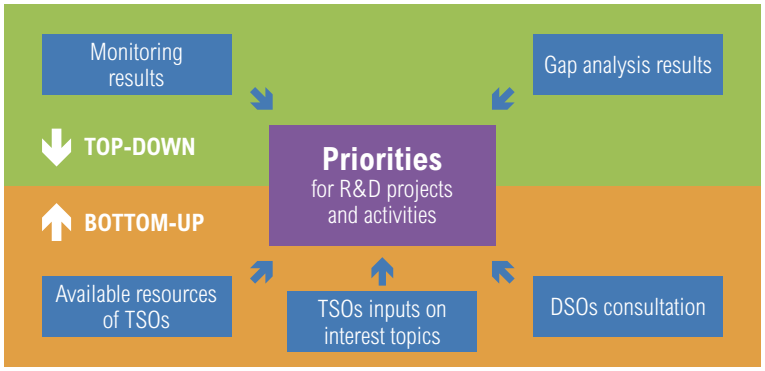
GRID+ is a FP7 EU co-funded project, created to provide operational assistance for the European Electricity Grids Initiative (EEGI). The EEGI is one of the European Industrial Initiatives in the Strategic Energy Technology Plan (SET Plan) which proposes a European research, development and demonstration (RD&D) programme to accelerate innovation and the development of the electricity networks of the future in Europe. This project serves to coordinate and provide support in resolving the five critical issues facing electricity systems: costs, benefits, KPIs, knowledge sharing and financing involving all stakeholders. This establishes a rational, fluid, and stable EEGI workflow so that the 2020 European goals can be achieved.



The two-level approach with the R&D Roadmap and R&D Implementation Plan ensures that:

- a stable and reliable framework will be established for the next five years,
- all R&D needs of the transmission system will be covered,
- implementation options remain flexible through yearly updated realisation plans,
- priorities will be correctly identified so that R&D is launched at the right time,
- real needs remain the focus and no "flat-rate research" is performed,
- R&D solutions will continue to progress through monitoring and knowledge-sharing.

Figure 3: Different drivers are considered when defining the Implementation Plan



RATIONALE FOR DEFINING PRIORITIES

This present Implementation Plan also builds on input received from TSOs through surveys carried out during 2013, the R&D Committee, direct requests to TSOs and dedicated workshops.

With 41 TSOs within ENTSO-E, it can be a challenge to find consensus on priorities for R&D projects and activities. To ensure an open and fair process, the final priorities must be defined using a balanced combination of top-down and a bottom-up approaches that conforms to the Roadmap and reflects TSO interests and priorities.

The top-down approach is a product of the monitoring and gap analysis in R&D Roadmap 2013–2022 carried out by the WG Monitoring and Knowledge Sharing. Since the Functional Objectives are defined to support the European energy and climate goals, the top-down approach is closely linked with the EU political goals of security of supply, 80–95 % utilisation of fossil-free energy by 2050, and establishment of an Internal Electricity Market (IEM) by 2014.

On the other hand, the bottom-up approach better reflects the present needs of individual TSOs since R&D priorities differ across Europe. The various member states operate at different technological levels and the topographies of transmission grids and types of electricity production vary substantially from country to country.

If a stringent top-down approach were used, the Functional Objectives with the largest proportion of 'not started' activities would be prioritised. Monitoring of Roadmap 2013–2022 (see page 8) has indicated that strong efforts are still required to establish projects within Cluster 4: Market Design, Cluster 5: Asset Management, and Cluster 6: Joint TSO/DSO R&D Activities.

Individual TSOs or groups of several TSOs may, however, have other more urgent requirements that are not reflected in the monitoring process. Therefore, priorities from the top-down process must be balanced with actual TSO requirements. Moreover, TSO involvement in implementing the ENTSO-E R&D Roadmap is limited by a lack of available resources (financial and manpower). R&D activities are often overwhelmed by operation and planning due to their more urgent nature.

In order to define the priorities and to find a balance between top-down and bottom-up approaches, monitoring and gap analyses are now expanded with the input and interests of the TSOs (Figure 3). Within the Research and Development Committee (RDC), there has been a process wherein TSOs suggest project topics of interest and estimate what resources are available. A dedicated workshop was held to define the needs for Eastern European TSOs, who are new to this process.

DSO priorities have also been taken into account and Cluster 6 specially dedicated to this purpose.

The resulting list of prioritised topics given in Section 4 is therefore a result of a complex and comprehensive process. Groups of TSOs have committed themselves to work on these topics in collaboration with qualified partners such as universities, manufacturers and DSOs.

WHERE WE ARE TODAY

ROADMAP FRAMEWORK

As stipulated in the R&D Roadmap 2013–2022, Clusters, Functional Objectives and budget estimations are detailed in Table 1 for quick reference.

Cluster		Functional Objectives	Budget estimation (€ Million)
C1 Grid Architecture	T1	Definition of scenarios for pan-European network expansion	20
	T2	Planning methodology for future pan-European system	20
	T14	Towards increasing public acceptance of transmission infrastructure	30
C2 Power Technologies	T3	Demonstration of power technology to increase network flexibility and operation means	100
	T4	Demonstration of novel network architectures	120
	T5	Interfaces for large-scale demonstration of renewable integration	130
C3 Network Operation	T6	Innovative tools and methods to observe and control the pan-European network	50
	T7	Innovative tools and methods for coordinated operation with stability margin evaluation	30
	T8	Improved training tools and methods to ensure better coordination at the regional and pan-European levels	25
	T9	Innovative tools and approaches for pan-European network reliability assessment	20
C4 Market Designs	T10	Advanced pan-European market tools for ancillary services and balancing, including active demand management	30
	T11	Advanced tools for capacity allocation and congestion management	25
	T12	Tools and market mechanisms for ensuring system adequacy and efficiency in electric systems integrating very large amounts of RES generation	20
C5 Asset Management	T15	Developing approaches to determine and to maximise the lifetime of critical power components for existing and future networks	30
	T16	Development and validation of tools which optimise asset maintenance at the system level, based on quantitative cost/benefit analysis	30
	T17	Demonstrations of new asset management approaches at EU level	75
C6 Joint TSO/DSO R&D Activities	TD1	Increased observability of the distribution system for transmission network management and control	45
	TD2	The integration of demand side management at DSO level into TSO operations	70
	TD3	Ancillary services provided through DSOs	50
	TD4	Improved defence and restoration plan	45
	TD5	Methodologies for scaling-up and replicating	40
		Total	**1005**

Table 1: list of clusters and functional objectives of the R&D Roadmap 2013–2022

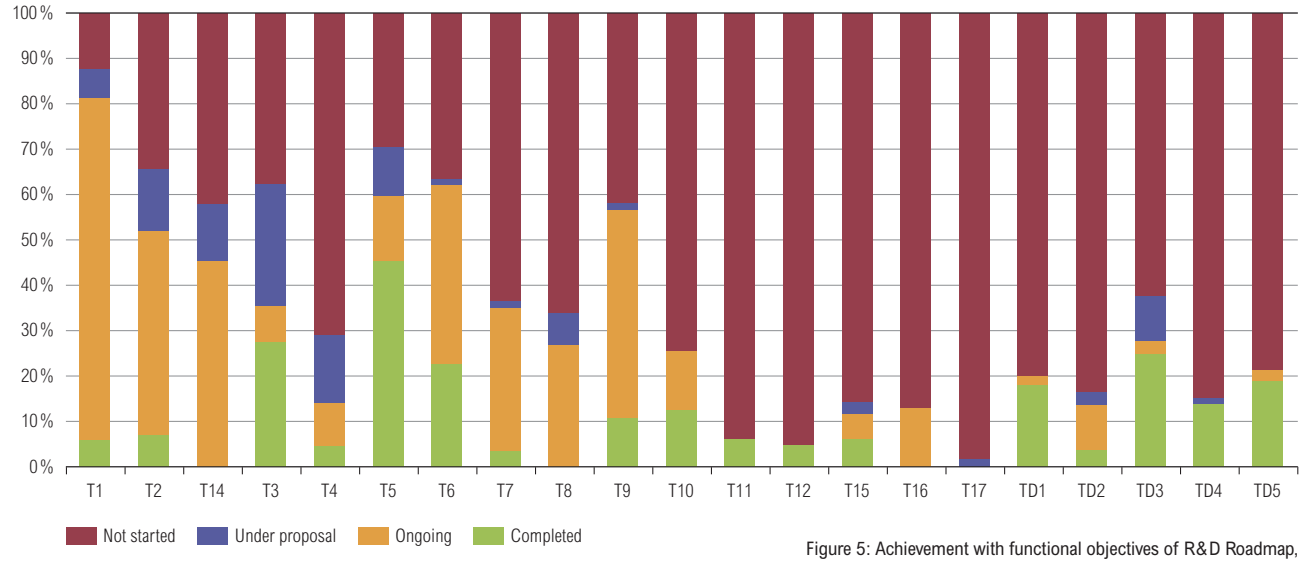


Figure 5: Achievement with functional objectives of R&D Roadmap, survey in May 2013

MONITORING OF R&D ACHIEVEMENTS

Figure 4 shows the overall fulfilment of each cluster and of the R&D Roadmap as a whole. The fulfilment levels are grouped into four categories: completed, ongoing, under proposal, and not started. The results are taken from Monitoring Report 2013, which is assessed from responses from the coordinators of projects related to the R&D Roadmap. 38 projects were shortlisted for monitoring due to being based in Europe (European or state-funded), relevant to TSOs, and focussing on ongoing, proposed or recently finished projects (2010 onward). The degree of completion is calculated from the amount of budget spent, the number of tasks performed, the results achieved and a comprehensive estimate from the project coordinator. Projects flagged as 'completed' serve as a good proxy to know which activities have been well covered. The 'not addressed yet' flag suggests potential gaps in upcoming R&D actions.

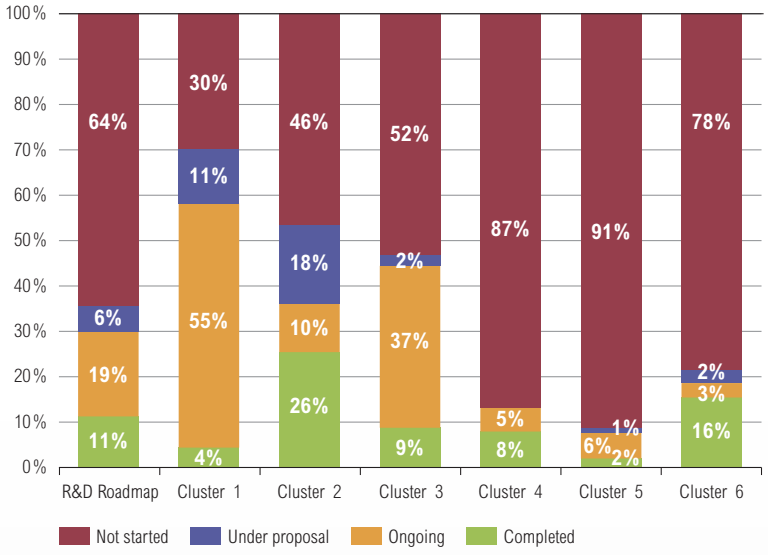


Figure 4: Achievement with clusters of R&D Roadmap, survey In May 2013

The results show that a significant proportion of the R&D Roadmap has already been addressed. 11 % of the R&D Roadmap is completed, approximately 19 % of the work is ongoing and 6 % is under proposal. However, huge effort is still needed to cover 64 % of 'not started'.

The breakdown into single clusters (Figure 5) shows that the majority of work has been allocated to Clusters 1 to 3 while Cluster 5 lags behind followed by 4 and 6. The lack of work in Cluster 4 might be due to insufficient resources dedicated to developing the European target models (Day Ahead and balancing markets). Cluster 5 has only been introduced very recently (in terms of R&D). Cluster 6 is performing a little better than Clusters 4 and 5 but it requires much more coordination since TSOs and DSOs must work closely together. Moreover, since every single DSO in Europe is active nationally or in much smaller regions, this often makes the establishment of pan-European projects even more challenging.

The monitoring results come from R&D Roadmap 2013–2022, while the results included in the previous Implementation Plan 2014–2016 are taken from 2011 R&D Plan Update. Since they refer to different project bases, the two are not directly comparable.

R&D PRIORITIES AND TOPICS FOR 2015–2017

GENERAL DIRECTIONS

With the current resource availability, TSOs will only able to launch one large-scale demonstration and two to three collaborative R&D projects each year. It is important not to overlook national projects. However, there are also large disparities across TSOs in terms of number of National R&D projects launched per year.

More resources must be spent on R&D in the future to ensure compliance with the R&D Roadmap within the specified timelines. This comprises work in all clusters even though more focus should be placed on clusters 4, 5 and 6.

The previous graphs clearly indicate that more resources are needed for Functional Objectives T11, T12, T15, T16 and T17 but also for T4, T8 and, to some extent, T10. Likewise, TD1, TD2, TD3, TD4 and TD5 must not be neglected.

However, most Functional Objectives have different resource requirements and some of them suffer from a lack of expertise. Therefore, an optimal trade-off must be found between the needs and the available resources in order to set priorities.

ENTSO-E has collected the opinions of its members to define priorities in line with both the urgency (for making progress with some topics) and the capacity of TSOs to commit resources for completing new projects.

It is also important to realise that the Functional Objectives have only been defined as titles or main topics. Their deployment into practical projects will entail a set of more specific tasks. These can also undergo modifications to meet urgent TSO needs. Thus, they must remain flexible in order to adapt to existing tasks and accommodate new ones.

SPECIFIC TOPICS AND CONCEPTS

The priorities and suggested topics are shown in the following table and have been determined through a proper mix of top-down and bottom-up approaches on the basis of:

- Roadmap framework, which serves as a reference until the next update;
- Monitoring past and ongoing projects, consequent gap analysis vs. Roadmap targets;
- TSO expectations, R&D programs and resource limitations.

As a result, R&D topics in 2014 are focused on increased system flexibility and increased operation efficiency. To continue with these R&D activities, the following topics will be added in subsequent years:

- 2015: Improved exploitation of existing grid resources through smarter asset management, network control and protection as well as through system controllability;
- 2016/2017: Improved coordination between boundary grids (distribution networks and neighbouring TSOs) targeting system reliability and market issues.

Table 2 displays the proposed topics, their timing and relevant Functional Objectives from ENTSO-E R&D Roadmap 2013–2022. Topics for 2014 are reported only as a reminder of previous edition of Implementation Plan, for comprehensiveness of vision.

Topic	Titles	Functional Objectives
	TOPICS 2014	
Topic 1 – 2014	Demonstration of future smart HV substations	**T3,** T6
Topic 2 – 2014	Novel cross border balancing market mechanisms and tools for ensuring system reliability	**T10,** T11, T9
	TOPICS 2015	
Topic 1 – 2015	Inertia, control and protection of large power systems with a large amount of inverter-based components	**T6,** TD1, T5
Topic 2 – 2015	Methods and tools to optimise asset management	**T15,** T16, T17
Topic 3 – 2015	Demonstration of power load control mechanisms at TSO and DSO levels	**TD2,** T6, TD5
	CONCEPTS 2016	
Concept 1 – 2016	Realisation of ultra-high-voltage lines with partial underground cabling	**T3, T4, T14**
Concept 2 – 2016	Ancillary services provided through DSOs and Aggregator Agents	**TD3,** T10, T12, TD2
	CONCEPTS 2017	
Concept 1 – 2017	Data & information management for system operation and asset management	**T6,** T15, T16, T7, T9
Concept 2 – 2017	Advance tools for new market models	**T11,** T8, T10
Concept 3 – 2017	Improved defence and restoration plan	**TD4,** TD5
Concept 4 – 2017	Market modelling and system adequacy assessment for long-term planning	**T2,** T12

Table 2: List of topics and concepts

Main functional objectives are in bold; other functional objectives are supported ones

REALISATION STRATEGY

BUDGET AND FINANCING

In order to realise successfully the R&D Implementation plan, sufficient funding and resources must be arranged. This is an open issue, with differentiated structures and modus operandi in each country. TSO costs and investments are typically remunerated through regulated tariffs levied on final consumers.

As defined in the third energy package, ENTSO-E has a legal mandate to perform R&D. The ACER's opinion to the previous Implementation Plan 2014–2016 aligns with the same direction . However, the costs for R&D activities are not yet remunerated via electricity tariffs in almost countries. In the Thor study on regulatory funding for TSO R&D projects , Sumicsid issued a fair opinion on the matter. ENTSO-E members are discussing with regulators to realise a suitable R&D scheme for TSO to support strengthening competence and innovation process.

The European and national funding are needed as stated clearly in the R&D Roadmap 2013–2022. The funding schemes not only provide financial means to implement the roadmap and realise the implementation plan, they also encourage TSOs to work together and cooperate with other types of partners. This will stimulate scaling-up, replication and dissemination of the results.

Indeed, the R&D covered in ENTSO-E Roadmap is geared towards international cooperation programs that are intended to have priority over national or company research programs. Therefore, the relevant added value lays mostly in synergies, pooling of resources, and diffusion of best practices and previous achievements. This approach deserves and requires EU support, also in the form of funding.

ACER has suggested that when R&D activities are not supported by EU funding through calls for project proposals, priority subjects should be pursued directly by ENTSO-E and/or single/groups of TSOs. http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER%20Opinion%2011-2013.pdf

Thor project, Regulatory Funding of Transmission System Research and Development in ENTSO-E Countries, 2013, Sumicsid, http://sumicsid.com/reg/papers/thor_white_paper_final.pdf

STRATEGIC PLANNING OF RESOURCES AND POSSIBLE TASK SHARING

Given the limited available resources, tasks and workload should be fairly and efficiently distributed between ENTSO-E members; however, resources are a known constraint, so concentrating each member's workforce on a few projects is one way to achieve efficiency.

Current commitments to national or EU projects have been considered as a given input when assessing the available resources for the upcoming Implementation Plan: TSOs will prepare their long-term planning of resources available for work in 2015–2017 according also to the collaborative projects defined at ENTSO-E level.

KNOWLEDGE SHARING AND RESULT DEPLOYMENT

Knowledge sharing is essential for bringing awareness of the current state of expertise to interested stakeholders. It is also important to consider scaling up and replication at the stage of proposal development. Furthermore, an assessment of specific applications stemming from accomplished R&D projects is also needed. This will help bring R&D results to improve daily businesses and create extra services.

SUMMARY AND CONCLUSIONS

This second issue of the Implementation Plan builds on the monitoring results of Roadmap achievements, new or updated inputs from TSOs and other stakeholders. The ACER specific indications expressed in its qualified opinion on previous Implementation Plan are considered. Awareness of resource constraints affects the number of topics introduced per year. Finally, the definition of the Implementation Plan also considers as a link to the upcoming European SET Plan Integrated Roadmap and Horizon 2020.

The Implementation Plan has been defined combining top-down and bottom-up approaches: it follows the R&D Roadmap and reflects the upcoming needs and priorities of TSOs and stakeholders.

The rolling time-span approach in this Implementation Plan aims to establish a continuous learning process. Hence, while some projects are already being executed, new topics are can be identified and initiated. Important R&D topics and concepts highlight the ambition of TSOs to tackle the upcoming challenges and achieve the European energy policy targets.

The Implementation Plan and Roadmap will only be successfully realised if they are followed by a set of consistent and operational plans with specific projects financed via European, national or public/private funding.

Manpower and financing remain a stringent constraint; the issue of incentives to TSOs for carrying out R&D activities and recovery of associated costs is well known, albeit not solved.

The detailed list and description of topics for year 2015 and suggested concepts/ topics for year 2016 and 2017 are given in Appendix 1–3.

APPENDIX 1– R&D TOPICS IN 2014 (REMINDER)

Topic 1 – 2014	Demonstration of Future Smart HV Substations
Main Functional Objective	T3
Supported Functional Objectives	T6, T17
Motivation	The integration of large amounts of renewable generation and emergence of new services will require major upgrades and reinforcements within the pan-European power system. At the same time, in order to implement smart grids, intelligent substations will be required.
Content/Scope	The goal of this topic is to demonstrate the potential of innovating solutions connected to upgrading and building of HV substations, and to examine new functions based on innovative digital technologies. Integration of renewable energy sources and other ancillary services will require major upgrades and reinforcements. This tasks looks at in the short term at substations which will have to be upgraded with limited space for new equipment. For the longer term, solutions for new substations with low investment and maintenance costs will be examined. Integration also requires a smarter grid for flexibility. In order to implement the smart grids concept intelligence within substations is desirable. This allows for a gradual implementation of this concept without having to make sudden dramatic changes centrally. Smart substations make it easier to change settings and automated systems remotely. Additionally, they could process greater amounts of data to make it easier for central control centres to implement advanced functions such as wide are protection schemes.
Funding Scheme	Collaborative project with a predominant demonstration component
Expected Impact	• Reduced environmental impact • Lower investment and maintenance costs • Improved quality of supply • Better integration of renewable energy sources
Additional Information	The consortium should be led by European TSOs with strong involvement from manufacturers
Proposal Duration	3–4 years
Total Budget	€ 70–100 million (1 consortium, several demonstrations)

Topic 2 – 2014	Novel cross border balancing market mechanisms and tools for ensuring system reliability
Main Functional Objective	T10
Supported Functional Objectives	T11, T16
Motivation	In order to realise an integrated European energy market it is important to facilitate cross border trading. Moreover the large scale integration of variable renewable energy generation increases the need for cross border balancing
Content/Scope	The aim of this project is to design and demonstrate a cross-border balancing market design which fulfils the requirements of the Network Codes for Load Frequency Control and Reserves and for Balancing. It should integrate local balancing resources by finding the appropriate price signals and increase system reliability and efficiency. Different balancing process will be investigated, with a focus on the frequency restoration process. The optimal allocation of cross-border capacity with respect to security, technical requirements and geographic locations are also important areas to examine. The impact of the resulting market design on the roles and responsibilities of the different market players, will be assessed. The market design can also be examined using with a small-scale real-time demonstration project.
Funding Scheme	Collaborative project at a regional scale
Expected Impact	• More efficient balancing markets • Better integration of renewable generation due to greater flexibility • An evolution of control center and generation demand side technology for better system security
Additional Information	The consortium should be led by European TSOs and a strong involvement of research centers. Involvement of DSOs, Balancing Service Providers could have an added value.
Proposal Duration	3 years
Total Budget	€ 10–20 million

APPENDIX 2 – R&D TOPICS IN 2015

Topic 1 – 2015	Inertia, control and protection and inertia of large power systems with large share of inverter-based components
Main Functional Objective	T6
Supported Functional Objectives	TD1, TD5
Motivation	The integration of large amounts of renewable generation with power electronic interfaces and addition of HVDC links into the power system will necessitate a review of the operation and control of transmission networks.
Content/Scope	The goal of this topic is to investigate how power systems will behave when the transmission network is fed by large amounts of inverter-based generation, and identify what must be done to allow this equipment to be integrated into the system safely. More and more components in the European power system are based on power electronics. This equipment feeds harmonic current into the system and in some cases could lead to unstable behaviour and impair the reliability of the power system. Entire areas might potentially be fed only by inverter-based generation, such as from HVDC offshore energy. Therefore, fault detection, power system stability and control, de-rating of transformers due to higher harmonics and harmonic distortion must all be studied. Appropriate tools and methods for building models must be identified for this purpose. Current control and protection schemes must be reviewed and may need to be redefined to allow stable, reliable and economic operation of the network.
Funding Scheme	Collaborative project, research and technological development
Expected Impact	• Maximising the volume of renewable generation input while keeping the system stable. • Anticipation of future potential problems. • Clarification of how this may lead to new control/projection schemes and definition of grid connection rules.
Additional Information	The consortium should be led by European TSOs with strong involvement of university and research centres
Proposal Duration	3 years
Total Budget	€ 6–9 million (1 consortium)

Topic 2 – 2015	Methods and tools for optimising asset management
Main Functional Objective	T15
Supported Functional Objectives	T16, T17
Motivation	The necessity for new theoretical research and development of innovative practical methods of refurbishing and rehabilitating the European power grid and optimising asset lifetimes while taking into account network development.
Content/Scope	Asset management has a decisive impact on network performance in terms of quality and security of supply and consequently on the electricity market. Innovative methodologies developed in this project will allow costs and benefits to be assessed accordingly to different management strategies and propose a risk-based approach for estimations at the system level. By implementing smart maintenance, higher levels of flexibility will be possible. One challenge is to develop a standardised approach for life duration modelling so that the behavioural database can be expanded. One of the main goals will be to discover the most beneficial asset management strategy per euro paid out.
Funding Scheme	Collaborative project, research and technological development
Expected Impact	• Efficient solution for optimising asset maintenance costs during operation, while increasing the performance of existing assets; • Easier integration of renewable generation due to the greater flexibility of grid provided by the optimal asset management; • Greater grid capacity for the electricity market leading to a more efficient market; • Data requirements and software architectures needed for new asset management tools.
Additional Information	The consortium should be led by European TSOs with a strong involvement of university and research centres
Proposal Duration	3 years
Total Budget	€ 10–20 million (1 consortium)

Topic 3 – 2015	Demonstration of power-load control mechanisms at TSO and DSO level
Main Functional Objective	TD2
Supported Functional Objectives	TD5, T8
Motivation	Integration of high volumes of intermittent generation will necessitate implementation of new technologies to add value to demand response and raise awareness about consumption flexibility and foster active customer participation in the energy market.
Content/Scope	The main objective is to develop processes, profiles, platforms and standards for commercial actors to generate localised offers that can be activated by the relevant DSO, TSO or market operators. To this purpose, the goals to be achieved by Demand Response (DR) and eventually distributed energy storage must be defined, and joint planning tools and models must be developed. A range of demonstrations must then be performed, with broad coverage, for different loads and different countries, to show the impact of integrating DR on a pan-European level. The impact on system stability and market efficiency can be studied, and the requirements for implementing such programs can be determined. The potential benefits of flexible grids and products are energy savings, lower costs and increased network security through improved cooperation and communications between the participating parties (TSOs, DSOs end customers, etc.).
Funding Scheme	Collaborative project with a predominant design (30 %) and demonstration (70 %) component.
Expected Impact	• Load control provided by distributed resources, which allows TSOs and DSOs to plan and operate the network efficiently and economically, and also to reduce grid congestion. • An increased level of flexibility in planning and operation of the network, which will help for enhancement of RES integration at pan-European level while maintaining security of supply.
Additional Information	Main contributors will be: TSOs, DSOs, manufacturers, ICT solution providers, consumers, research institutes, aggregators, renewable generators, energy service providers and regulatory authorities.
Proposal Duration	4 years
Total Budget	€ 60 million (more consortia)

APPENDIX 3 – R&D CONCEPTS FOR 2016 AND 2017

Concept 1 – 2016	Realisation of ultra-high-voltage lines with partial underground cabling
Main Functional Objectives	T3, T4, T14
Supported Functional Objectives	T2, T5
Motivation	The Ten-Year Network Development Plan indicates the urgent necessity of expanding the current pan-EU transmission grid in order to meet the European energy policy goals. The main driver of grid expansion is the huge increase in production from RES. Since RES inputs are often situated far away from consumers, this results in large power flows through transmission networks. Furthermore, public acceptance of infrastructure projects is another issue for Member States. This induces public expectance to minimise the visibility of infrastructure. Cable links for EHV/UHV do not yet ensure adequate capacity at a reasonable cost. For the reasons stated above, TSOs require new transmission technologies that: • Can provide greater capacities • Can be easily integrated into existing grids, especially in existing corridors • Can be utilised in densely populated areas

Content/Scope	R&D is necessary to investigate and demonstrate the integration of high-capacity technologies in meshed networks and in densely populated areas. Even though ultra-high voltage AC and DC transmission lines have already been demonstrated around the world, R&D is still necessary to learn how to confront the challenges stated above. This concept will provide new knowledge and experience of the advantages offered by new technologies for the densely meshed European transmission system. It will also lead to new and improved equipment for urban applications and demonstrate the benefits of high-capacity corridors from the technical and public acceptance points of view. The potential of bundling with existing infrastructures will also be investigated. Tasks: • Launch the implementation of UHV transmission in Europe (foster political discussion, create public acceptance, trigger necessary legal additions, technical standardisation) • Technical development and demonstration of UHV AC solutions (500 kV to 750 kV) • Development of new OHL tower designs for UHV applications (flexible for AC/DC and various voltage levels, optimised electro-magnetic fields, compact design etc.) • Development of new conductors for UHV applications (in contrast to worldwide applications, special focus shall be placed on noise reduction as well as high capacities) • Develop concepts for UHV applications in existing routes • Implement demo projects • Develop cable solutions for partial cabling in densely populated areas – XLPE cables for DC +/- 500 kV – Reduction of losses – Reduction of trench width to gain space compared to OHL – Technological development to increase reliability and reduce costs – Innovative maintenance concepts for cable with quick reaction times • Implementation of AC UHV pilot project in meshed network including maintenance concepts for AC UHV • Development of solutions for bundling line routes with existing infrastructure – E.g., using GIL or partial cabling – Demonstrate applicability of new innovative transmission technologies (super-conducting cable etc.)
Funding Scheme	Collaborative projects
Expected Impact	Readiness for application solutions with strong energy transmission links useable in meshed networks, densely populated areas, improved public acceptance
Additional Information	Links to other projects with focus on similar FOs will be considered. Focus will be on innovation and demonstration – i.e., new knowledge and equipment
Proposal Duration	4 years
Total Budget	€ 50 million

Concept 2 – 2016	Ancillary services provided through DSOs and aggregator agents
Main Functional Objective	TD3
Supported Functional Objectives	T10, T12, TD2
Motivation	The objective is to create new market design and new incentive mechanisms and address technical aspects so that TSOs receive new ancillary services from DSOs, based on DER, RES and load control.
Content/Scope	This goal requires implementation of the tasks below: • Novel ways of providing ancillary services through loads, RES and their impact on transmission networks; the highly variable and unpredictable nature of DER and RES places new constraints on these ancillary services. • Simulation environments to demonstrate the viability and options of ancillary services provision by aggregated loads and RES at the DSO level. • Models, test facilities and true operation of enhanced grid systems with exchange of ancillary services in common TSO/DSO cooperation. • Mechanisms which stimulate Demand Response to aid system operation in challenging (congested) areas with high RES inputs. • New actors and market models that enable DER to provide ancillary services, taking network reliability in consideration. • New market tools to stimulate RES involvement, active demand and storage systems, and thus ensure system reliability. • New models that describe products and services to be tested on selected segments of customers and their impact on future ancillary services in the presence of large-scale DER and RES integration. • New market models that account for the price-sensitive nature of loads and consequently their increased flexibility.
Funding Scheme	Collaborative project with predominant TSO/DSO joint contributions
Expected Impact	Evolution of grid code, based on ancillary services that could be provided at DSO level. For example, increased levels of DER in distribution networks could lead to more active contributions from DSOs and service providers with respect to active and reactive power reserves and network restoration. Thus, the inherent flexibility in demand response effectively assists ancillary services and can be traded on the market.
Additional Information	Main contribution: TSOs, DSOs, manufacturers, ICT providers, service providers, traders, generation companies, RES industry, aggregators, regulators
Proposal Duration	2016–2020
Total Budget	€ 50 million (more consortia)

Concept 1 – 2017	Data and information management for system operation and asset management
Main Functional Objective	T6
Supported Functional Objectives	T15,T16, T7, T9
Motivation	Necessity for a new approach of managing enormous volume of information and data generated throughout the electricity system
Content/Scope	Set out a methodology for managing the information and data currently available: technical specifications of different assets, lifetime characteristics, maintenance and operational practices, data and information coming from measurement, protection and monitoring devices, as well as from metering devices (generation and demand connection points, including metering for contracted and activated reserves). Data acquisition, updates, storing/archiving and cleaning methodologies should be investigated so that high-quality data and information can be used for different applications e.g., for dynamic simulations and security assessments, help system operators in decision processes and for asset management purposes, both at the component and system level. Experience feedback methods should be proposed in order to learn from best data and information management practices.
Funding Scheme	Collaborative project
Expected Impact	Increase the quality and reliability of the data and information that TSOs use to manage their assets and operate their systems.
Additional Information	Link with iTesla, Umbrella, Garpur
Proposal Duration	4 years
Total Budget	€ 20–40 million

Concept 2 – 2017	Advance tools for new market models
Main Functional Objective	T11
Supported Functional Objective	None
Motivation	Pan-European power flows within a free energy market plus massive integration of variable RES resulting in local and regional bottlenecks, necessitating a fair charging mechanism for capacity use.
Content/Scope	The aim is to develop new capacity calculation methods for medium to long-term horizons (week, month, year, multi-year ahead) and congestion management approaches in accordance with a new comprehensive and reliable methodology being developed for the pan-European transmission network. Relevant tools should also be developed to support capacity allocation and congestion management. Stakeholders such as TSOs, market operators, regulators and market players have cooperated in establishing the broad lines of a target model for the European Electricity market. Many details and technical issues need to be further developed particularly for capacity allocation and congestion management. These must account for new approaches of combining preventative and corrective measures for reliability assessment, and allow more precise estimations of the system state due to accurate, synchronised and high-sampling rate measurements. The consortium should include a relevant number of TSOs.
Funding Scheme	Collaborative project
Expected Impact	The results of this project should allow correct predictions of available capacities in transmission lines and cross-border interconnections so that they can be efficiently allocated to market actors. The completion of the internal market leads to increasing electricity flows and these are responsible for congestions particularly at cross-border connections. In view of the difficulty of building new lines, it is important to exploit existing connections to the maximum of their physical capacity. Advanced congestion management principles, methods and tools will correctly indicate to the market where true network congestions physically exist and should therefore minimise societal losses due to limited network capacity.
Additional Information	TBD
Proposal Duration	TBD
Total Budget	TBD

Concept 3 – 2017	Improved defence and restoration plan
Main Functional Objective	TD4
Supported Functional Objective	T9, T7, T6
Motivation	Need for different types of generation and demand technologies to participate actively in defence and restoration plans, not only centralised generation, but also DER and DR.
Content/Scope	• To develop a methodology of assessing the risk of breakdowns during reconnection, for different kinds of technologies, in order to maintain an appropriate level of security. • To investigate the impact of micro-grids and islanding capabilities into defence and restoration plans. • To investigate the contribution of DER for system restoration and its contribution to immediate power reserves; this is relevant from the TSO perspective (e.g., black start capability and coordination of wind turbine generators). • To develop simulation tools for interactive system restoration including advanced forecast tools developed in TD1 for wind, solar PV and other variable RES. • To propose operational procedures regarding defence and restoration plans with DSOs in the presence of high volumes of DER. • To train operators on the evolution of national regulatory schemes in order to foster coordination efforts. • To address regulatory and technical challenges that implement restoration plans at the pan-European level.
Funding Scheme	Collaborative project
Expected Impact	New operational procedures for improved defence and restoration plan will allow reducing the economic impact of major disturbances and threats.
Additional Information	Link with Garpur and After
Proposal Duration	2 years
Total Budget	€ 20–30 million

Concept 4 – 2017	Market modelling and system adequacy assessment for long-term planning
Main Functional Objective	T2
Supported Functional Objective	T1, T12
Motivation	Need for a better approach to address the uncertainties in the future energy mix and market mechanisms for long-term planning purposes
Content/Scope	Based on the outcomes and lessons learned from the e-Highway2050 project, a methodology and associated tool need to be developed for the integration of long term market scenarios & simulations for grid development purposes, notably: • Design and demonstrate new methods, tools and processes for assessing long-term market scenarios and system adequacy. • Build on existing experiences and tools (PSM, SPARK, ANTARES, etc.) to anchor the know-how and lessons learned in the business while building new market models to reflect the future EU market framework for grid development purposes. • Take into account the impact on consumption and generation of technologies such as Demand Response, electric vehicles and storage so as to anticipate this when developing the grid; develop forecasting techniques including correlation effects (wind, solar, Demand Response, storage, etc.). • Build on these experiences and more specifically deal with the trade-off between a bottom-up approach and a top-down approach to identify the gaps and find the right approach to fill these gaps (including the challenges involved in collecting data).
Funding Scheme	Collaborative project
Expected Impact	Methodology and prototype tool for better incorporation of market modelling in the long-term planning and decision-making process
Additional Information	Link with e-Highway 2050
Proposal Duration	4 years
Total Budget	€ 20–30 million

APPENDIX 4 – CURRENT STATUS OF R&D ROADMAP

No	Project	Budget (€ million)	EC funding (€ million)	Start date	End date
1	EWIS	4.0	4.0	June 2007	October 2009
2	Pegase	13.6	8.6	July 2008	June 2012
3	Safewind	5.6	4.0	May 2008	April 2012
4	Realisegrid	4.2	2.7	September 2008	February 2011
5	Susplan	4.8	3.4	September 2008	August 2011
6	iCoeur	4.8	1.9	January 2009	May 2012
7	Optimate	4.3	2.6	October 2009	September 2012
8	Twenties	56.8	31.8	April 2010	March 2013
9	Ecogrid.eu	20.7	10.3	March 2011	February 2015
10	After	5.1	3.5	September 2011	August 2014
11	GRID+	4.0	3.0	October 2011	September 2014
12	iTesla	19.4	13.2	January 2012	December 2015
13	Umbrella	5.2	3.9	January 2012	December 2015
14	eHighway2050	13.1	9.0	September 2012	January 2016
15	GARPUR	10.9	7.8	September 2013	September 2017
16	InspireGrid	3.6	2.0	October 2013	December 2016
17	Best Paths	66.0	35.5	March 2014	March 2017
	Total	**246**	**147**		

ABBREVIATIONS

AC	Alternate Current
ACER	Agency for the Cooperation of Energy Regulators
DC	Direct Current
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
EEGI	European Electricity Grid Initiative
EHV	Extra-high voltage
ENTSO-E	European Association of Transmission System Operators for Electricity
FO	Functional Objective
GIL	Gas-Insulated Lines
HVDC	high voltage direct current
ICT	Information Communication Technology
OHL	Overhead line
RES	Renewable Energy Source
R&D	Research and Development
SET PLAN	Strategic Energy Technology Plan
TSO	Transmission System Operator
RDC	Research and Development Committee
UHV	Ultra-high voltage
XLPE	Cross-linked polyethylene

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NOTE

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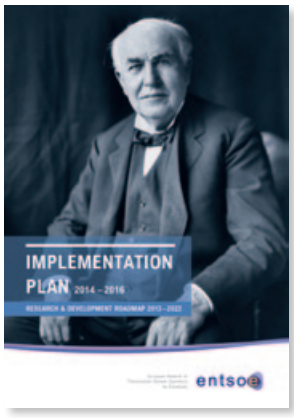

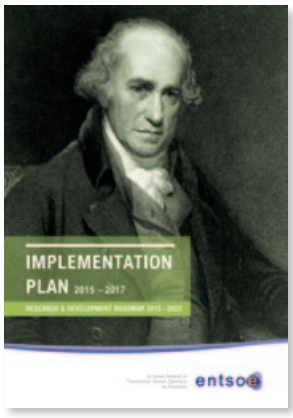

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