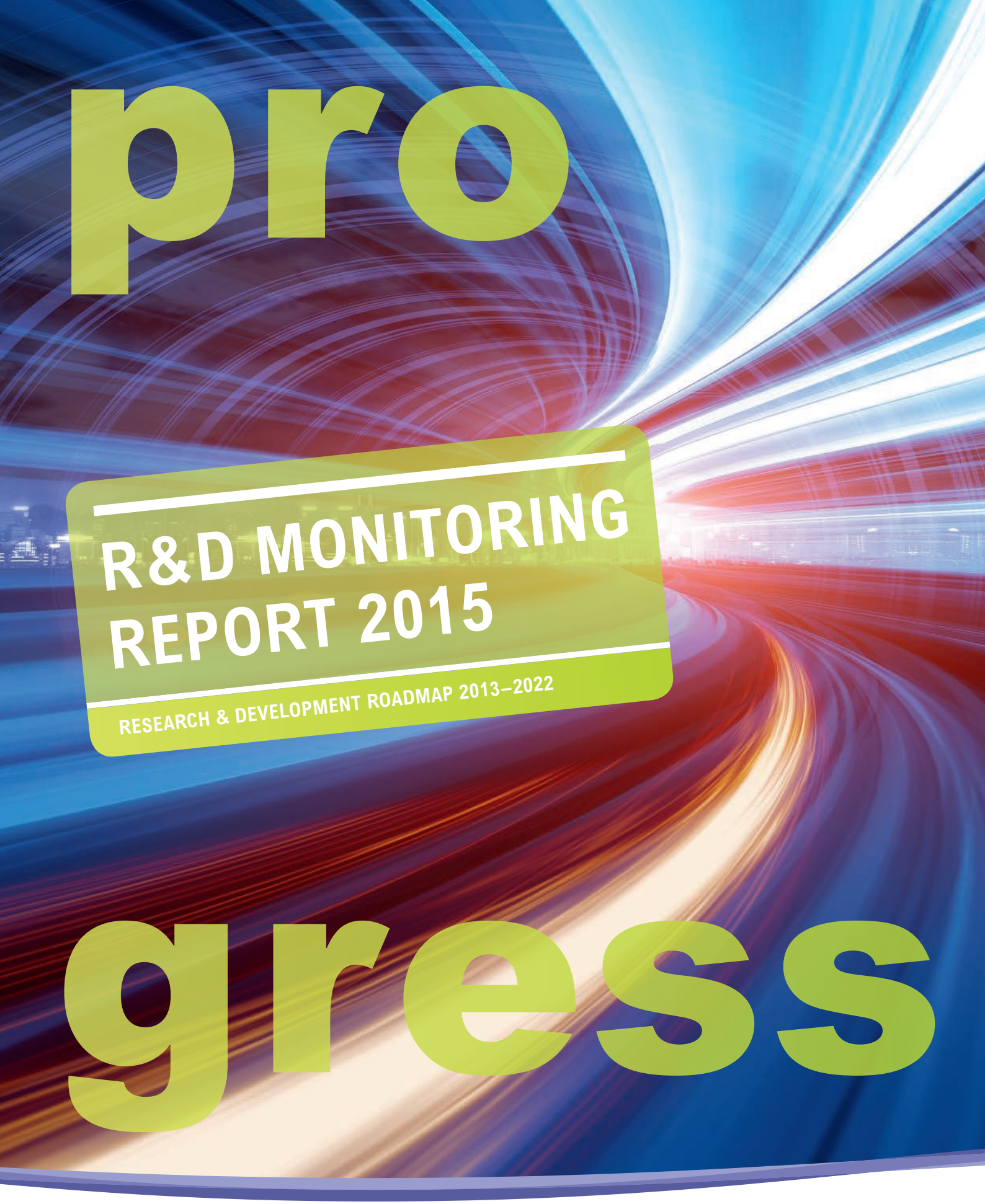


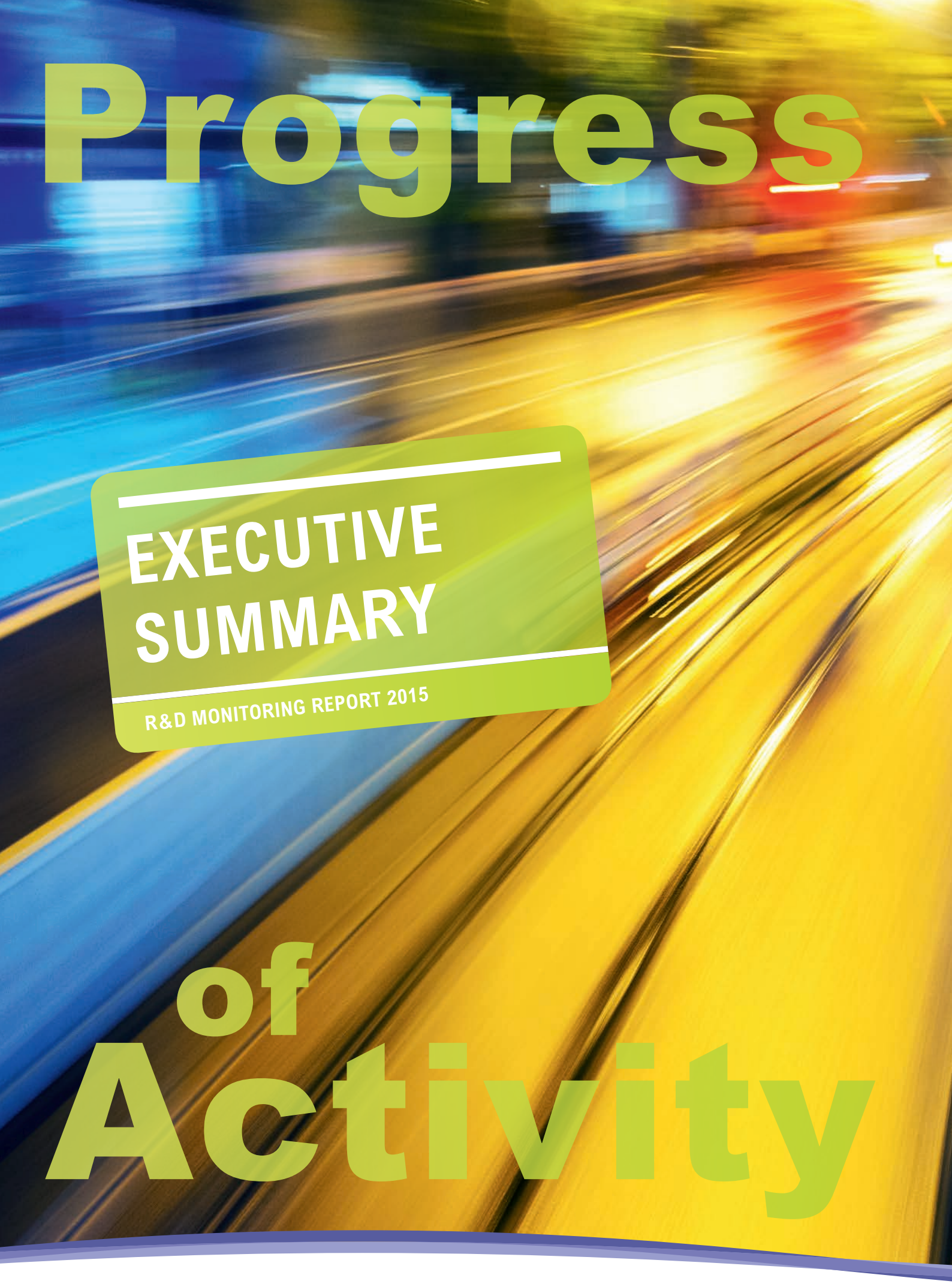
R&D MONITORING REPORT 2015

RESEARCH & DEVELOPMENT ROADMAP 2013–2022

European Network of
Transmission System Operators
for Electricity

entsoe

CONTENTS


Progress
EXECUTIVE SUMMARY
R&D MONITORING REPORT 2015
of Activity

The R&D Monitoring Report 2015 aims to assess the progress of European TSO-related research and development (R&D) activities defined in the R&D Roadmap 2013–2022. The report disseminates knowledge and informs regulators, funding institutions, research community and other stakeholders about recent R&D achievements.

There have been major R&D achievements to facilitate the massive integration of renewable energy sources into the system, e.g., by the improvement of wind forecasts, better assessment of required reserves, and the implementation of innovative tools to support the decision-making process for system operators. Also, a newly developed set of management and control concepts facilitates the safe integration of electric vehicles into the European electricity system. New tools support the long-term planning of the European electricity system and the simulation of cross-border interaction, while several initiatives aim at reducing the environmental and social effect of power infrastructures.

HIGHLIGHTS:

- The completion of the R&D objectives set by the R&D Roadmap 2013–2022 has considerably progressed, from an estimated 11 % of completion in 2013 to 38 % today. An additional 17 % is already underway. The degree of completion is higher for activities related to grid architecture, power technologies, and network operation.
- This report considers 71 R&D projects. This is almost double the number of projects considered in the R&D Monitoring Report 2013. Of these 71 projects, 33 have a European dimension and 38 are national.
- For the first time, this report identifies 16 major R&D results as the most promising for short-term deployment by 2020. This goes from a technology that maximises the utilisation of the existing electricity grid to the linking of offshore wind parks to the mainland by building a meshed offshore grid.

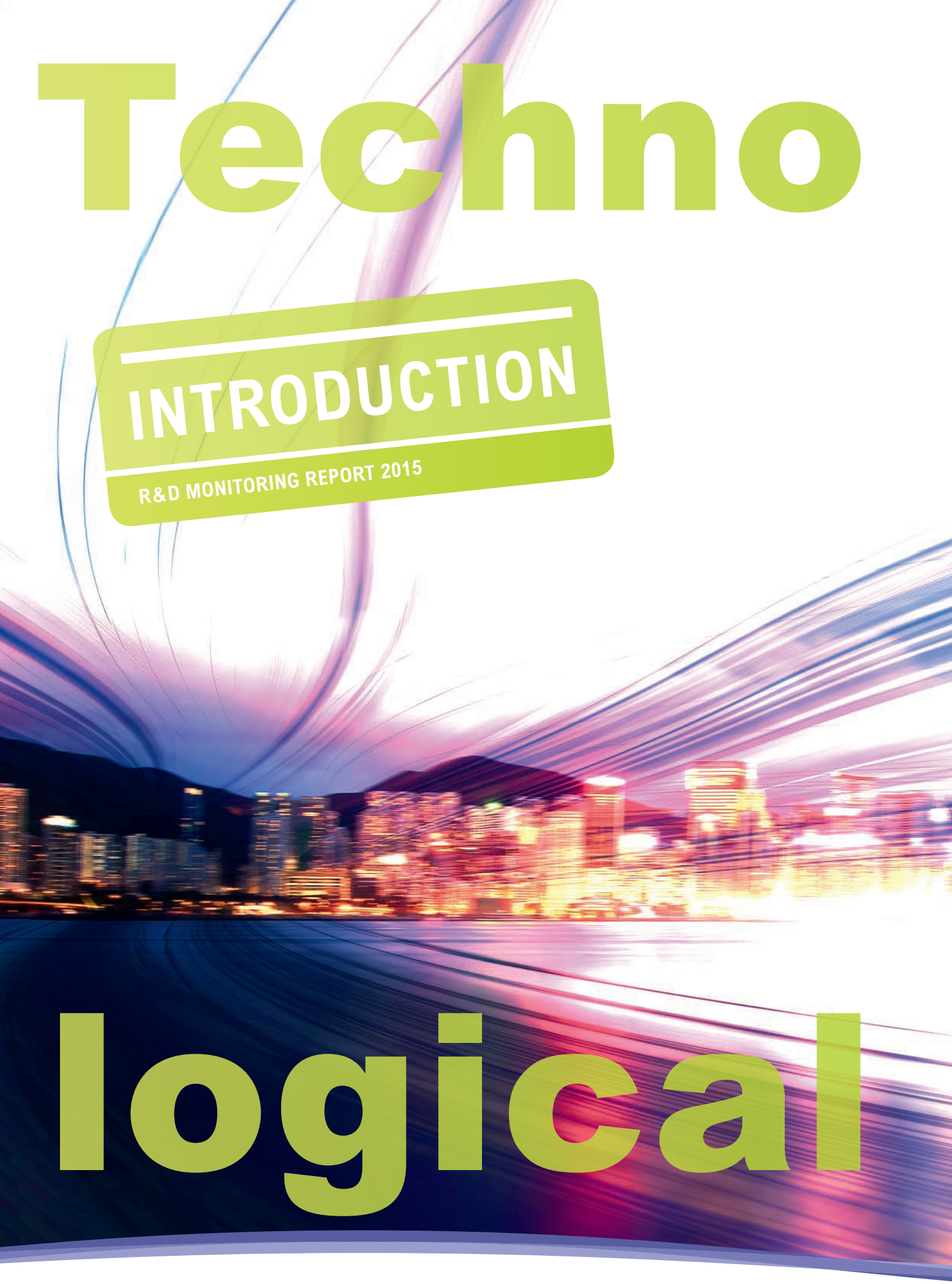
Sharing and disseminating new knowledge produced in the framework of R&D activities is vital for an efficient deployment of the solutions developed in the Roadmap. To achieve these goals, R&D projects also require constant support with respect to financing, time, and resources.

The results of this R&D Monitoring Report will be used to apply corrective measures and assign action priorities for the R&D Implementation Plan 2017–2019 and a new R&D Roadmap, both to be released in 2016.

Techno

INTRODUCTION

R&D MONITORING REPORT 2015



logical

The energy system is evolving, and TSOs are at the centre of accelerating technological innovation. New grid equipment technologies, innovative modelling methods, and grid architecture are needed to follow up on the objectives of a secure, sustainable, and competitive internal energy market. ENTSO-E coordinates innovation activities of TSOs to ensure that the future grid is up to the challenge.

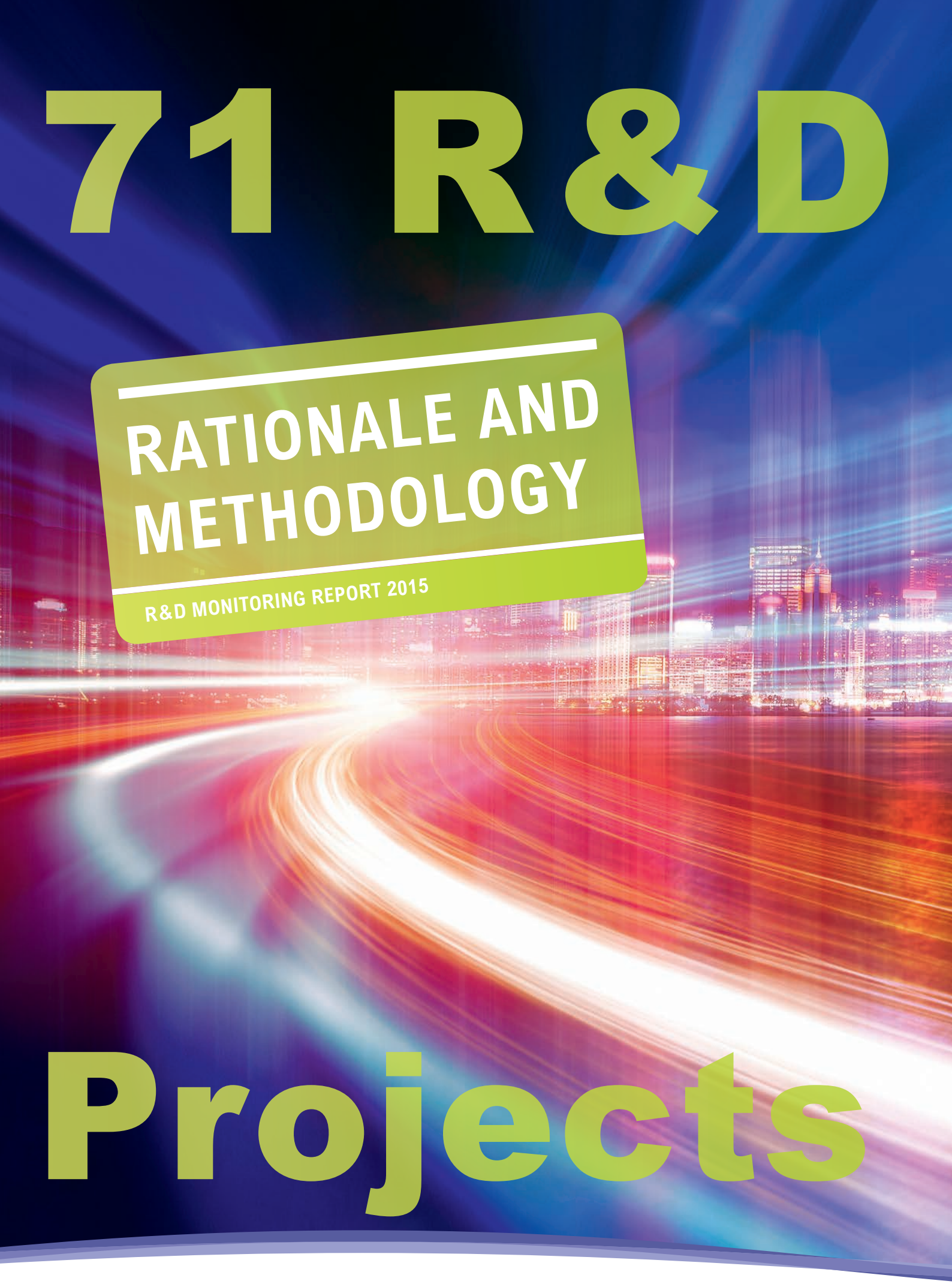
This report assesses the research and development activities performed by TSOs and partners, within the context of the R&D Roadmap 2013–2022.

OBJECTIVES

The main objective of this report is to inform stakeholders – regulators, European and national institutions, and distribution system operators to name but a few – about recent R&D activities and to disseminate knowledge. Furthermore, it allows TSOs to monitor their progress in pursuing the objectives set by the R&D Roadmap 2013–2022. Based on this information, ENTSO-E will write the specifications for the R&D Implementation Plan 2017–2019 and define a new update of the R&D Roadmap, which is planned to be published in 2016.

CONTENT

The report begins with background information on the monitoring process and concentrates on overall recent R&D achievements, deployment potential, gap analyses, and recommendations for subsequent years. The report concludes with details on recent R&D achievements for each cluster and the complete results from the project surveys in Appendix 1, and information on each project in Appendix 2.


71 R&D
RATIONALE AND METHODOLOGY
R&D MONITORING REPORT 2015
Projects

SURVEY OF R&D PROJECTS

As shown in detail in Appendix 2, a total of 71 R&D projects are considered for this report. We selected the projects that we deemed to be relevant to TSOs and that are being performed within Europe. Furthermore, all projects under consideration are funded either through the European Commission, by Member States or directly by TSOs. The division of European versus national is on the basis of funding and not on the scope of activities or partnership in a consortium.

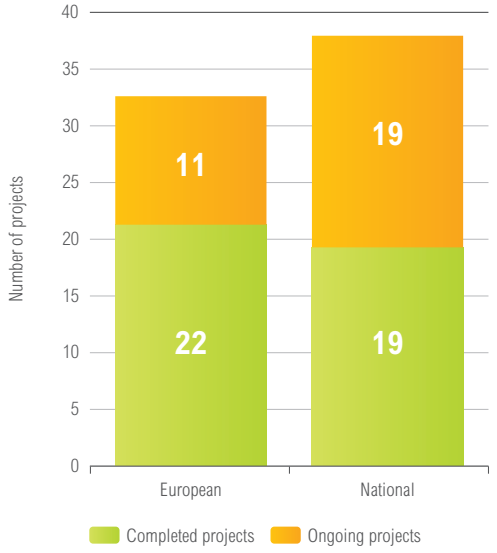


Fig. 1: Status distribution of selected R&D projects

CLUSTERS AND FUNCTIONAL OBJECTIVES

The monitoring exercise aims at checking the progress and achievement of the R&D Roadmap. The R&D activities required to address the challenges of a rapidly shifting energy paradigm are grouped into six distinct, yet interdependent clusters. These clusters facilitate collaboration between stakeholders while providing a shared repository of ideas. This not only prevents redundant R&D but is also highly cost effective and exploits synergies inherent in Europe.

Each cluster is broken down into a group of functional objectives on issues requiring collective management to prevent redundant R&D and thus ensure complete coverage. The functional objectives are subdivided into multiple specific tasks. Specific tasks are addressed by a range of European and national R&D projects, whereby each project may cover one or even several specific tasks and in turn apply to multiple functional objectives and clusters.

METHODOLOGY OF MONITORING

The monitoring methodology applied in this report is similar to what was used in the R&D Monitoring Report 2013. As in the previous edition, our assessments are based on the R&D Roadmap 2013–2022. The quantification of the fulfilment percentage is done in the same direction without applying any weighting factors among clusters. The process includes three steps: gathering information, processing information, and packaging results.

ENTSO-E's Working Group on Monitoring and Knowledge Sharing (WG MKS) gathers the information via a questionnaire sent to project coordinators whose projects are related to the objectives contained in the R&D Roadmap, both at the European and national levels. The questionnaire is designed to gather information in relation to the contribution of each project towards different specific tasks of functional objectives, timing, and budget status. It has been updated to comply with the objectives of the R&D Roadmap 2013–2022.

The information is then consolidated to give a complete overview of the progress towards achieving the goals set by the R&D Roadmap.

The results indicate how each project contributes to its corresponding specific tasks, functional objectives, and clusters. As a result, it is possible to assess the completion statuses of specific clusters and functional objectives and ultimately the achievements of the entire roadmap. Furthermore, project coordinators are asked to assess project efficiency and effectiveness as well as their milestone achievements and budget scenarios.

Finally, the completion status of each functional objective, cluster, and the roadmap are then determined by assigning percentages to the following progress indicators:

- **Completed** – percentage of objectives that have been successfully finished;
- **Ongoing** – percentage of objectives that are currently being worked on;
- **Proposed** – percentage of objectives that have been proposed but are awaiting approval; and
- **Not started** – percentage of objectives where no work has commenced or been proposed.

The progress indicators for each specific task of a functional objective are averaged to obtain the progress status of the functional objective itself. No weighting is applied to the progress indicators of the clusters. Accordingly, each functional objective within a cluster contributes equally to the overall progress status of the cluster, just as each cluster contributes equally to the progress of the roadmap as a whole.

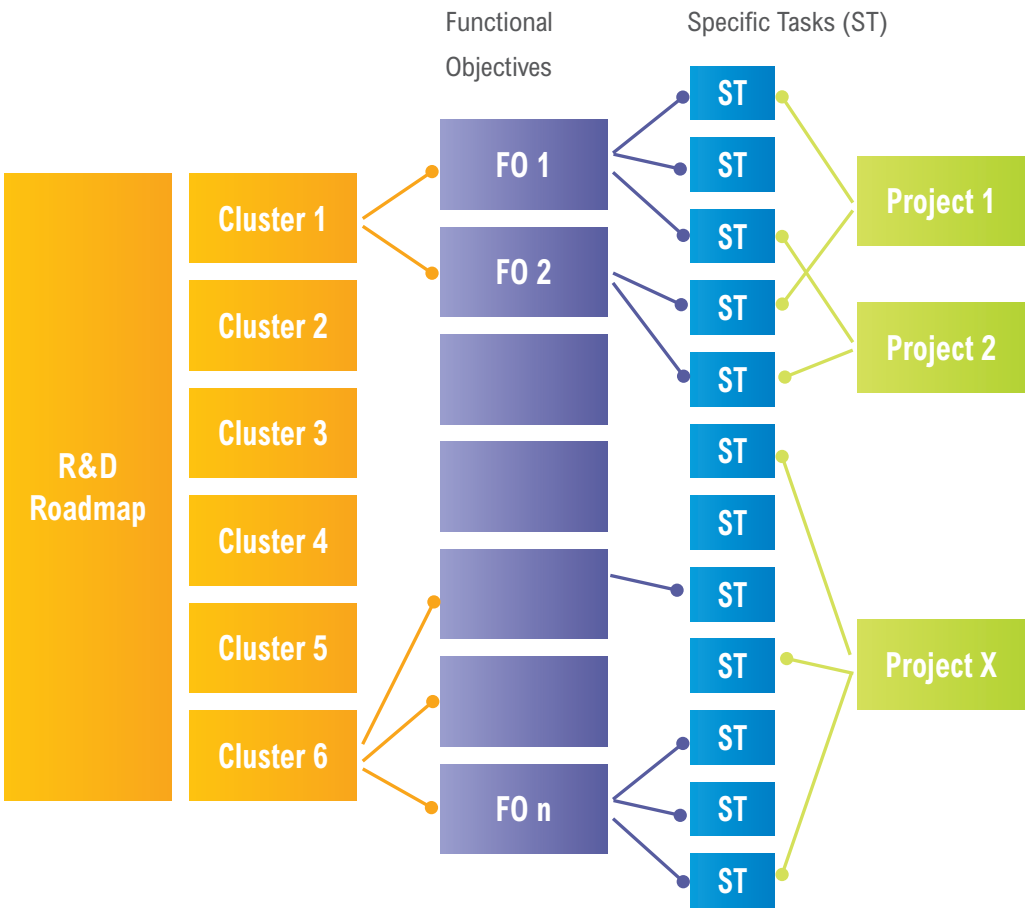


Fig. 3: Structure of the R&D Roadmap

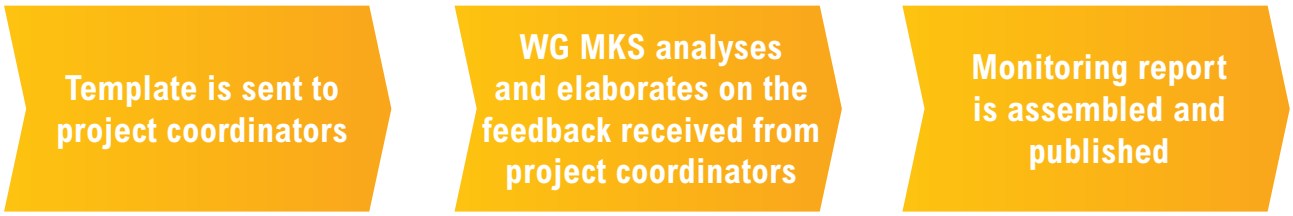


Fig. 4: Process of the monitoring exercise.


Moving
R&D
ACHIEVEMENTS
R&D MONITORING REPORT 2015
Forward

The results of the monitoring analyses show that the completion of the objectives set in the R&D Roadmap 2013–2022 has progressed considerably since 2013 from an estimated 11 % of completion to 38 % as of today.

NOTABLE FACTS:

1. The number of monitored projects in this report is 71, compared to the 38 projects monitored in the R&D Monitoring Report 2013.

   a. Important European projects have been successfully completed since 2013 or have been newly incorporated into this report, and their results have become available (AFTER, BestGrid, eBadge, EcoGrid EU, e-Highway2050, GridTech, ICOEUR, iTesla, LIFE, Merge, Real-Smart, SEETSOC, Umbrella, and Twenties), in addition to many national projects.

   b. New European projects were funded and have started since the R&D Monitoring Report 2013 was published (Best Paths, e-Storage, evolvDSO, FutureFlow, INCREASE, Migrate, Promotion, and Smartnet).

2. There have been major achievements to facilitate the massive integration of renewable energy sources into the system, e. g, by the improvement of wind forecasts, the use of probabilistic approaches, better assessment of required reserves, and the implementation of innovative tools to support the decision-making process for system operators.

3. A new set of management and control concepts to facilitate the safe integration of electric vehicles into the European electricity system has been developed, using as much renewable generation as possible, including a suite of simulation tools capable of analysing the effect and adequacy of different integration scenarios.

4. New tools support the long-term planning of the European electricity system, providing options for a pan-European grid architecture under different scenarios, including a combination of distributed generation, demand management, storage, and innovative transmission technologies (FACTS, HVDC, UHVAC, etc.), and paying specific attention to the integration of large quantities of renewable energy sources. >>

5. There have been studies on the feasibility and effect of the development of an offshore grid system in the North Sea and on the integration of wind energy into the European system.

6. New tools support the simulation of cross-border interaction, including power flow exchange, frequency regulation, reserve sharing, wide-area monitoring, and data exchange definition and procedures.

7. Several initiatives aim at reducing the environmental and social effect of power infrastructures as well as to increase public perception and acceptance.

CLUSTER PROGRESS

Figure 5 provides an overview of progress of the R&D Roadmap and its clusters compared to 2013, as it was published in the R&D Monitoring Report 2013.

Figure 6 provides an update on the progress towards completing the R&D Roadmap and its clusters, at the end of 2015. The estimated percentage of completion is 38 %, while an additional 17 % is already underway (i. e., over half of the technical objectives are covered).

As shown, Clusters 1, 2, and 3 have achieved a high degree of completion, especially Cluster 1, while future efforts should focus on Clusters 4, 5, and 6 in order to achieve the desired objectives.

Appendix 1 provides a detailed monitoring analysis of the R&D performed for each cluster and its functional objectives.

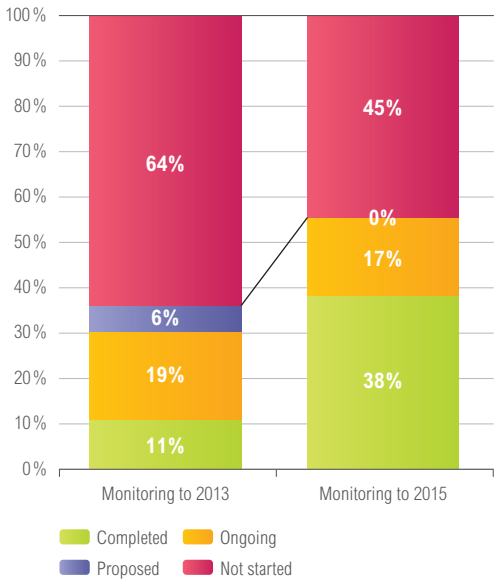


Fig. 5: Progress of R&D Roadmap 2013–2022, compared to 2013

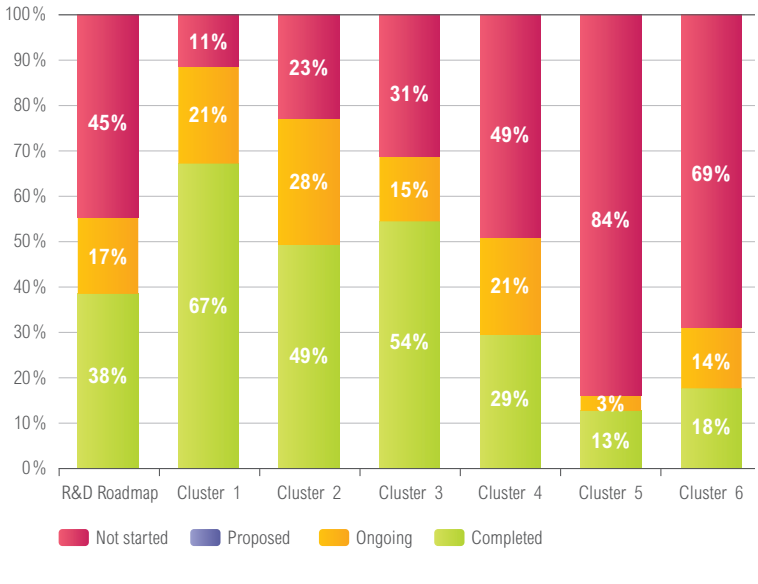


Fig. 6: Progress per cluster of R&D Roadmap 2013–2022, monitored till December 2015

CLUSTER 1 – GRID ARCHITECTURE

This cluster provides a set of scenarios and methods for developing a network infrastructure that hosts massive amounts of renewable energy sources and growth in demand with acceptable network investments and operating costs beyond 2020. Almost all the technical issues considered in this cluster are already covered, thanks to contributions from Best Paths, e-Highway2050, GridTech, InspireGrid, Merge, Realisegrid, Twenties, 11 other European projects, and 14 national projects.

CLUSTER 2 – POWER TECHNOLOGIES

This cluster addresses the affordability and technical performance of components of emerging technologies that can significantly improve the operations of the interconnected transmission systems. Work is well advanced with a majority of issues already covered due to R&D contributions from Anemos Plus, Best Paths, Ewis, Migrate, Promotion, Real-Smart, Twenties, WindGrid, four other European projects, and 15 national projects.

CLUSTER 3 – NETWORK OPERATION

This cluster studies ways of operating transmission systems that maintain high security of supply at reasonable costs. The R&D is quite advanced with just a few technical gaps. Several significant projects like After, FutureFlow, iCoeur, iTesla, Garpur, Pegase, SafeWind, Umbrella, eight other European projects, and 19 national projects contribute to this cluster.

CLUSTER 4 – MARKET DESIGN

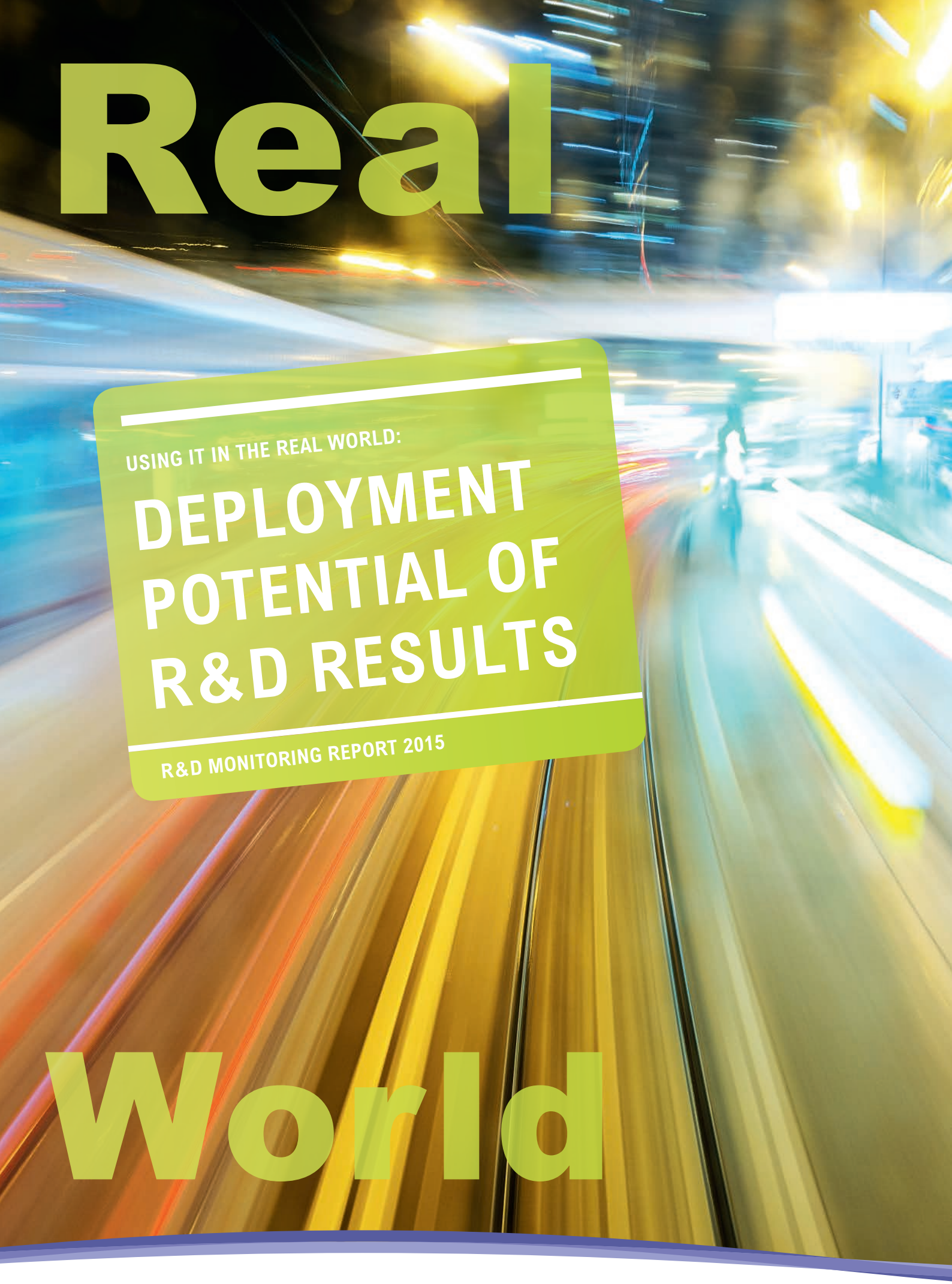
This cluster studies the ways and means of facilitating interaction between European electricity markets and the pan-European grid. The aim is to achieve a more efficient and integrated market by optimising the energy mix at the pan-European level while ensuring security of supply. An estimated half of the technical objectives are already covered through Anemos Plus, eBadge, EcoGrid EU, Optimate, Seetsoc, seven other European projects, and 13 national projects.

CLUSTER 5 – ASSET MANAGEMENT

This cluster is developing cost-effective asset management strategies, while optimising CAPEX and OPEX of the existing infrastructure. Work in this cluster will demonstrate how to utilise advanced measurement technology, improve our understanding of system constraints, and develop optimal maintenance and replacement strategies in a grid where new and old assets coexist. It is a less advanced cluster with important R&D gaps still to be covered, apart from the contributions of the European projects Best Paths, Garpur, InspireGrid, Seetsoc, and three national projects.

CLUSTER 6 – JOINT TSO/DSO R&D ACTIVITIES

This cluster focuses on the TSO/DSO interface and new smart grid services at the DSO level as well as their utilisation for regulation and ancillary services. There are still many important gaps in this cluster, despite contributions from Anemos Plus, eBadge, FutureFlow, SafeWind, eight other European projects, and 16 national projects.


Real
USING IT IN THE REAL WORLD:
DEPLOYMENT POTENTIAL OF R&D RESULTS
R&D MONITORING REPORT 2015
World

Parallel to the monitoring exercise to track the progress of the R&D Roadmap, extensive interviews have been done within the Grid+Storage project to identify the deployment potential of R&D results.

The achievements of R&D projects may be intermediate results or may call for further research, for further development, or for a demonstration. **Sixteen major results have been identified as the most promising ones for short-term deployment by 2020.** An indicative timing for deployment is specified. In addition, ENTSO-E is organizing some concrete actions in order to facilitate the deployment of the R&D results.

>>

INNOVATIONS TOWARDS IMPROVED GRID PLANNING APPROACHES

2016: MODULAR PLAN OF PAN-EUROPEAN GRID ARCHITECTURES FOR 2050

The **e-Highway2050 project** looked at how the transmission network should evolve in order to reach close to zero emissions in the EU by 2050. Completed at the end 2015, it resulted in a modular development plan for possible electricity highways and options for a complete pan-European grid architecture, based on various future power system scenarios.

ENTSO-E is currently investigating how the project results will be exploited in the 2016 Ten-Year Network Development Plan (TYNDP 2016). More specifically, TYNDP teams have expressed interest in key components, such as the systematic methodology to build 2050 energy scenarios, the methodology to build the equivalent grid model, the methodology for scenario quantification, and the methodology to propose transmission investment needs per scenario.

2018: TOWARDS A PROBABILISTIC PLANNING APPROACH

The **Garpur project** designs a new reliability management approach and criteria for the pan-European electric power system. It covers multiple decision-making contexts and timescales (long-term planning, mid-term planning, and asset management and short-term planning to real-time operation). It will be applicable for TSOs to implement the Garpur concepts in an off-line environment (grid planning).

INNOVATION IN TRANSMISSION GRID TECHNOLOGIES

FROM 2014: PREVENTING OVERLOAD SITUATIONS IN THE 220 KV TRANSMISSION GRID

The **220 kV SSSC Device for Power Flow Control project** has been successfully completed, and the static synchronous series compensator (rated 47.8 MVAR, 12.5 kV) has been installed in the Spanish 220 kV transmission grid. This technology optimises the utilisation of the existing electricity grid, the final objective being to maximise the integration of generation from renewable energy sources. This is the first ever implementation of such technology in the European transmission system. Further tests will be needed for upscaling to higher voltage levels (300–400 kV).

2016: A DATABASE OF COST AND PERFORMANCES OF POWER SYSTEM TECHNOLOGIES

Developed within the **e-Highway2050 project**, a database of cost and performance over the period 2015–2050 will soon be made freely accessible. It is an asset for further collaborative R&I projects, for grid planning studies, or more generally for any type of studies involving power technologies and their cost and performance trajectories over the period 2015–2050. It will be published on the **GridInnovation-on-line platform** [1].

1) See www.gridinnovation-on-line.eu

2018: INNOVATIVE REPOWERING OF AC CORRIDORS

Integrating renewable energy sources into the grid implies developing novel network technologies to increase the capacity of the pan-European transmission network and the flexibility of the electricity system.

The results of the **Best Paths project** will be grouped into a self-standing package for upgrading existing lines. This package will help TSOs to deliver overhead lines that are more compact, have a reduced visual effect, are less demanding regarding the right-of-way (legal right to pass along a specific route through grounds or property belonging to another), able to face fluctuating power profiles, flexible in exploitation (reducing the need for new AC overhead line corridors), and have an affordable life-cycle cost.

This combination of new solutions enhances the current approach to the repowering of AC overhead lines. It will also help TSOs and utilities to keep overhead lines reliable and resilient to future developments of the European energy system (e. g., increased amounts of renewable generation). Finally, novel approaches can be shared and replicated by other TSOs.

2019: LINKING OFFSHORE WIND PARKS TO THE MAINLAND

In order to unlock the full potential of Europe's offshore resources, network infrastructure is urgently required, linking offshore wind parks to onshore grids in different countries. To do so, HVDC technology is a possibility, but the deployment of meshed HVDC offshore grids is currently hindered by the high cost of converter technology, the lack of experience with protection systems and fault clearance components, and immature international regulations and financial instruments.

The **Promotion project** will overcome these barriers by developing and demonstrating three key technologies, regulatory and financial frameworks and an offshore grid deployment plan for 2020 and beyond. This project not only demonstrates all elements needed to build meshed offshore grids, but also brings together the future workforce in Europe, which has to design, build, and operate a commercial network. The Promotion project will take into account the results of the Best Paths and Twenties projects.

>>

INNOVATIONS TOWARDS MORE SECURE AND EFFICIENT MANAGEMENT OF THE TRANSMISSION SYSTEM

FROM 2012: WIDE-AREA MONITORING SYSTEMS

Wide-area monitoring systems (WAMS) allow the monitoring of transmission system conditions over large areas in view of detecting and counteracting grid instabilities. The WAMS developed and upgraded within the **iCoeur project** have been implemented and put into operation by several TSOs worldwide. In Europe, WAMS systems have been integrated to some extent by systems of the TSOs in Slovenia, Germany, Spain, France, Montenegro, and Serbia.

FROM 2015: A TOOLKIT FOR SECURITY POLICY MAKERS

The European electricity grid is a critical infrastructure, which can be exposed to security threats. The **Seconomics project** delivered a toolkit to security policy makers, helping them to understand their policy alternatives and the potential effects of their decisions. This toolkit has already been adopted by the standard body in CVSS v 3.0 issued in December 2014. The CVSS is a general methodology that is used by several TSOs for evaluating the security of their supervisory control and data acquisition (SCADA) systems.

2018: TOOLS TO COPE WITH INCREASINGLY UNCERTAIN OPERATING CONDITIONS

The **iTesla project** has delivered several pieces of software forming a new security assessment tool, which is able to cope with increasingly uncertain operating conditions and to take advantage of the growing flexibility of the grid.

After the end of the project, the French TSO, RTE, will build full size (spatial and temporal) use cases that give insight into system security and demonstrate the added value for operators, both in technical and economic terms. This validation should last two years, with the final goal of introducing an industrial version of the toolbox in an operational environment (control room) for preliminary tests by 2018.

The **Umbrella project** has also delivered a toolbox prototype enabling TSOs to act in a coordinated European target system where regional strategies converge to ensure the best possible use of the European electricity infrastructure. Exploitation of the toolbox is being addressed within the framework of the Transmission System Operator Security Cooperation (TSC). The iTesla and Umbrella projects have cooperated to deliver common recommendations to ENTSO-E.

2018: TOWARDS THE DIGITALISATION OF EXISTING SUBSTATIONS

Within the **Smart Substation project**, the deployment of the smart substation will allow network operators to better manage congestions, thanks to local optimisation and distributed intelligence, and to host more renewables, such as wind power. The deployment is ongoing, and the substation should be ready for validation by February 2017. The construction of databases for long-term analysis is performed using the latest IT technologies (Internet of things and big data).

2019: REAL-TIME AND SHORT-TERM FORECAST ASSESSMENT OF OPERATING LIMITS

Funded by the Slovenian TSO, ELES, the **Sumo project** aimed at developing a novel strategy to improve climate simulations. It has developed a system for real-time and short-term forecast assessment of operating limits. Methods and software have been developed to deal with the highest possible power flows of the transmission line, considering all weather situations. The SUMO system uses different heterogeneous subsystems from different vendors, and the results of the calculations are aggregated and are shown in the network control centre by means of the visualisation platform.

INNOVATIONS TOWARDS THE INTEGRATION OF RENEWABLES AND DISTRIBUTED RESOURCES IN THE EUROPEAN ELECTRICITY MARKET

2016: DATA SHARING PLATFORM SUPPORTING ENERGY EFFICIENCY SERVICES

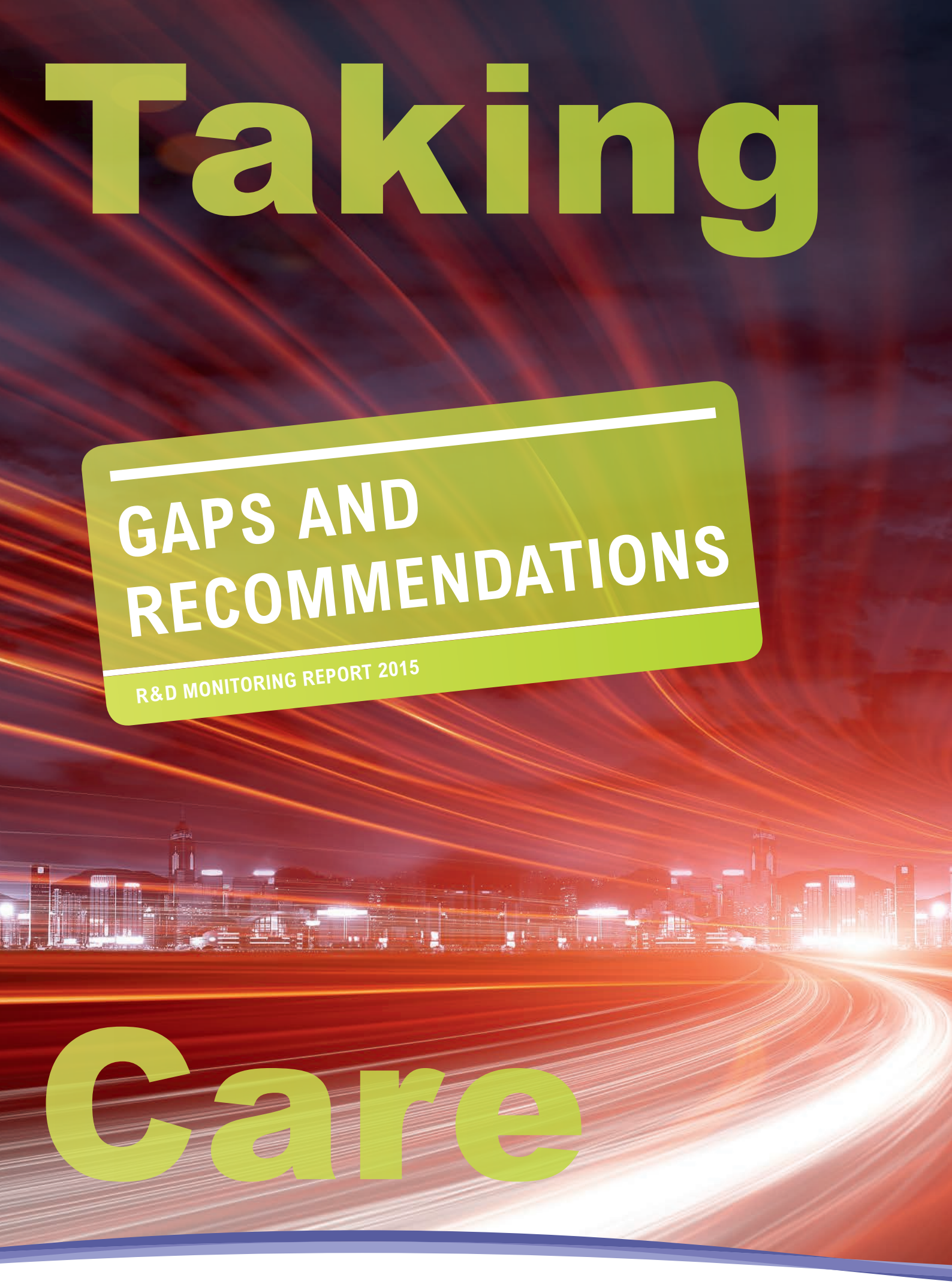
The **Estfeed data sharing platform** provides links to applications allowing organisations and individuals to monitor and manage their energy consumption. It is managed by the Estonian TSO, Elering. It gives wider options to both consumers and businesses (including new types of stakeholders like ESCOs, aggregators, and energy cooperatives) and facilitates the functioning of the energy market. Sharing data on the platform across different countries and regions will enable a better inter-TSO service. The European-wide approach gives even more opportunities to market stakeholders to do business and enables consumers to select between even more services and service providers.

2017: A NUMERICAL PLATFORM TO TEST AND COMPARE SHORT-TERM ELECTRICITY MARKET DESIGN OPTIONS

The **Optimate project** (2009–2012) has delivered a prototype simulation tool able to simulate different market architecture options in the context of high integration of renewable energy sources. The initial prototype, focused on the day-ahead stage, is currently being upgraded by the French TSO RTE. It now has a broader functional scope with intraday and real-time modules as well as increased robustness and improved computation time. An industrial version of the simulator should be delivered by the end of 2016.

2019: CROSS-BORDER PROVISION OF SECONDARY RESERVE BY DISTRIBUTED ENERGY RESOURCES

The **FutureFlow project** is designing a cross-border cooperation scheme for procurement and activation of balancing reserves, including frequency restoration reserves with automatic activation (aFRR). A prototype demand-response and distributed-generation flexibility aggregation platform for FRR will also be developed and tested within the participating countries as well as a prototype regional balancing and re-dispatching platform allowing for cross-border exchanges of reserves. At the end of the project in 2020, these prototypes should be close to implementation in a TSO environment.


Taking
GAPS AND RECOMMENDATIONS
R&D MONITORING REPORT 2015
Care

R&D GAPS

The R&D gaps have been significantly reduced, from 64 % in 2013 to 45 % today. Analyses are performed for each cluster in order to identify the main remaining gaps.

The gap analyses have shown that even though there are many ongoing projects, a significant effort is still required in some areas.

The replacement of existing grid infrastructure is forcing TSOs to search for the best possible balance between investing in new power technologies, while optimising and prolonging the performance of existing ones. The TSO/DSO interface should also receive significant attention in order to increase system observability and deploy new services that ensure overall system security. In addition, considerable effort is still needed to design and implement the internal electricity market and to incentivise new system services with respect to the allocation methods for the capacity and reserves in order to cope with uncertainties from renewable energy sources, load, and system disturbances. >>

AREAS OF MAIN R&D GAPS:

1. Asset management aims to validate the benefit of individual lifetime assessment compared to an average assessment of several similar components based on generic parameters (age of equipment, switching steps, etc.) and to establish evaluation/estimation protocols for component statuses that are comparable across TSOs. In addition, maintenance activities with the network 'on', especially for DC equipment, and implementation of robotics for problem detection have not yet been addressed.

2. Joint TSO/DSO activities and improved coordination between boundary grids aim to develop simulation tools and methods that detect weaknesses in the system with respect to the reconnection of distributed energy resources and storage systems and the risk of breakdowns caused by reconnection. Emerging ancillary services from aggregated small-energy sources and demand response and management at the DSO level provide extra means and system services for TSO operation. New modelling methods and tools for steady-state and dynamic analyses should also be developed.

3. Market design aims to investigate interactions between system operations, dynamic capacity, reserve allocation methods, and design grid tariff mechanisms for active demand-side management and to correlate the load curve and integration of renewable energy sources at the regional and pan-European levels.

For more details on additional results of the gap analyses performed for each cluster, refer to Appendix 1.

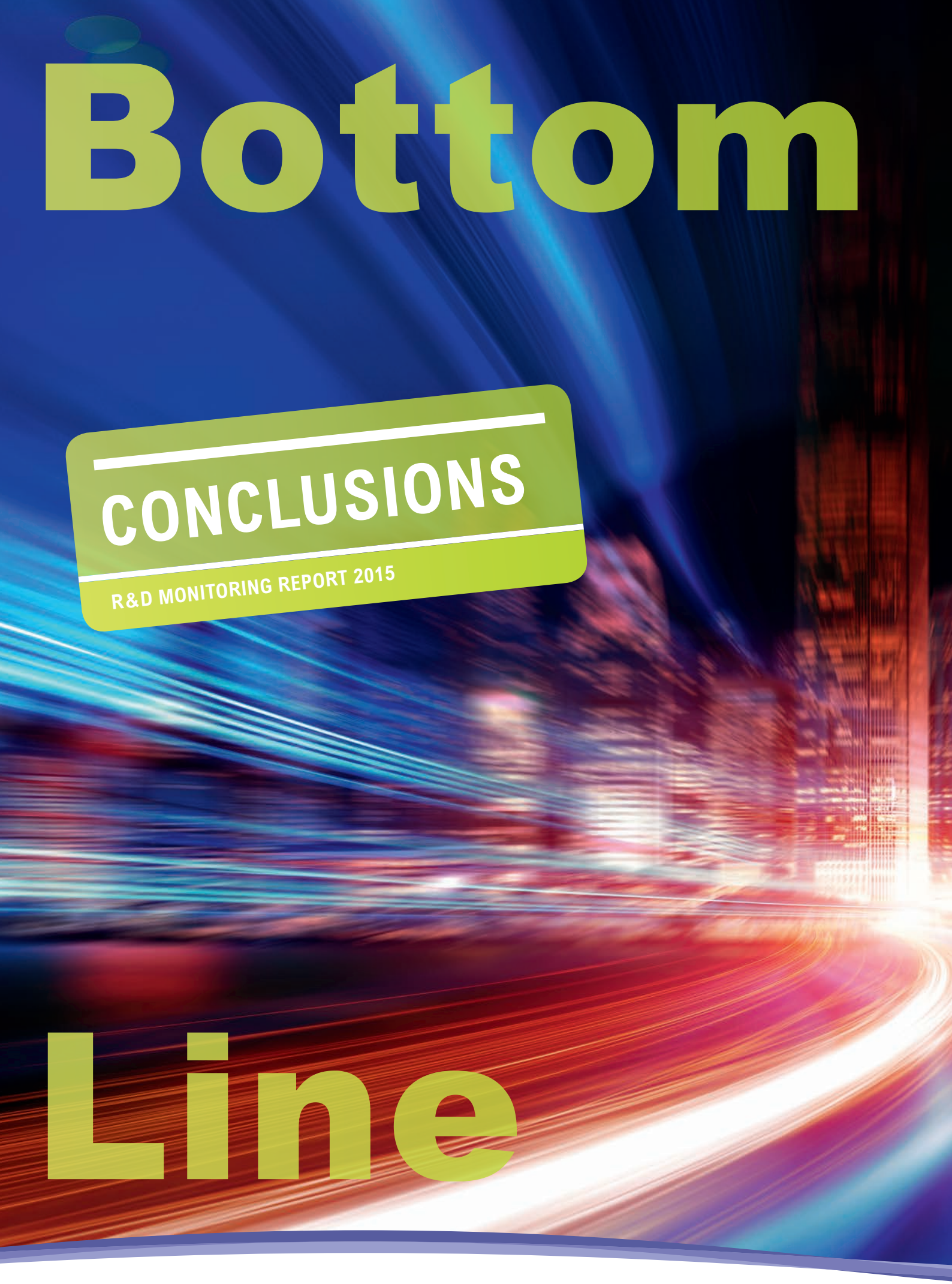
RECOMMENDATIONS

Acquiring and sharing new knowledge produced in the framework of R&D activities is vital for achieving the goals set in the R&D Roadmap. Systematic approaches are needed in order to perform the collection and sharing of knowledge in a simple and efficient way. This will help to embed outcomes and new competencies within the European electricity industry and to foster new R&D activities at both academic and industry levels.

It is paramount to share all new knowledge gained through R&D. Knowledge sharing of this nature, which is mostly restricted between project partners, must be disseminated to reach different stakeholders at the European level. When documented as lessons learnt or best practices, knowledge sharing will not only help to stimulate active participation in R&D activities but will also help to shape future R&D projects by concentrating work on known R&D gaps.

It is important to understand that it will often be impossible to develop one-size-fits-all solutions for all applications. The immense scope of European transmission networks means that there will always be differences in opinions and approaches. Therefore, open discussion should always be encouraged between experts in the European electricity sector.

Finally, R&D results have been applied one way or another in TSO businesses; however, to highlight their contributions to achieve EU energy objectives, some demonstration with recently developed R&D outputs should be performed. This will be one of the orientations of our R&D activities for the years to come.

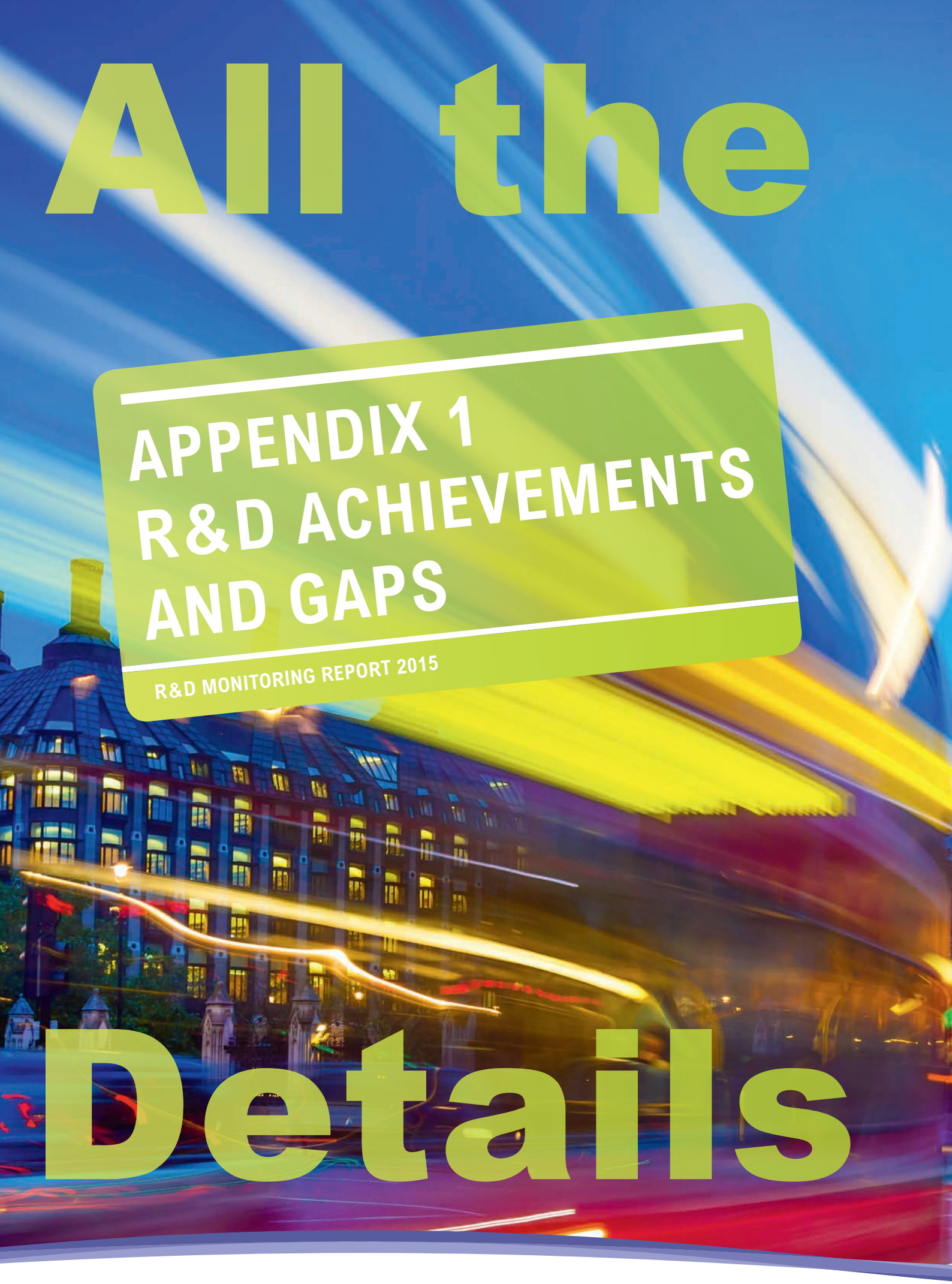

Bottom
CONCLUSIONS
R&D MONITORING REPORT 2015
Line

As this report demonstrates, we are on the way to reaching our R&D Roadmap goals and meeting our technical objectives. Comparisons with the R&D Monitoring Report 2013 provide many examples where significant progress has been made. At the same time, identification of R&D gaps allows us to apply corrective measures and assign action priorities for an implementation plan and a new roadmap.

A large number of R&D projects have covered major part of the R&D Roadmap. The completion of the R&D objectives set by the R&D Roadmap 2013–2022 has considerably progressed from an estimated 11 % of completion in 2013 to 38 % today.

Potential R&D results are identified for short-term deployment, covering improved grid planning approaches, transmission grid technologies, secure and efficient management of the transmission system and integration of renewables in the European electricity market, to name but a few.

Acquiring and sharing new knowledge produced in the framework of R&D activities is vital for deploying roadmap results. Lessons learnt and best practices will not only stimulate active participation and application of R&D activities but will also help shape future R&D projects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APPENDIX 1
R&D ACHIEVEMENTS
AND GAPS
R&D MONITORING REPORT 2015
Details

» CLUSTER 1 – GRID ARCHITECTURE

This cluster provides a set of scenarios and methods for developing a network infrastructure that hosts massive amounts of renewable energy sources and growth in demand with acceptable network investments and operating costs beyond 2020.

Cluster 1 consists of the following functional objectives:

» T1: Definition of scenarios for pan-European network expansion.

» T2: Planning methodology for future pan-European transmission system.

» T14: Increasing public acceptance of the transmission infrastructure.

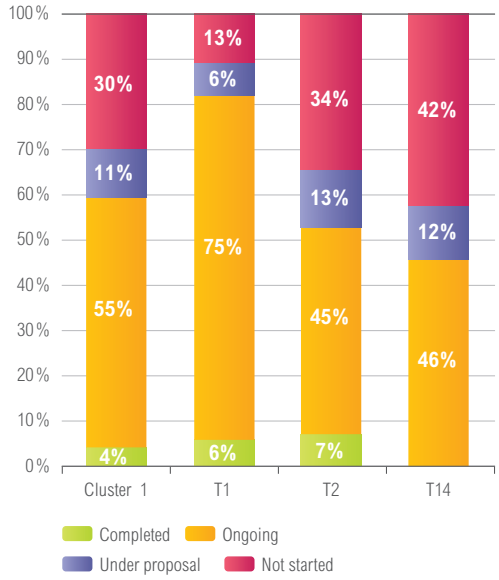
In this cluster, there are 18 European and 14 national projects.

	European projects	Status
1	BestGrid	Completed
2	Best Paths	Ongoing
3	eBadge	Completed
4	e-Highway2050	Completed
5	Ewis	Completed
6	FutureFlow	Ongoing
7	Garpur	Ongoing
8	GridTech	Competed
9	ICOEUR	Completed
10	InspireGrid	Ongoing
11	LIFE Biodiversité	Completed
12	Merge	Completed
13	Migrate	Ongoing
14	Promotion	Ongoing
15	Realisegrid	Completed
16	Real-Smart	Completed
17	Twenties	Completed
18	WindGrid	Completed

	National projects	Status
1	Almacena	Completed
2	CHPCOM – Combined Heat and Power Communication	Ongoing
3	Concept for management of the future electricity system 2025	Completed
4	Development of composite towers for 420 kV	Ongoing
5	Development of early warning systems (PMU/WAMS)	Completed
6	Development of market modelling capacity	Completed
7	FLEXe	Ongoing
8	Humber Smartzone Pilot Project	Ongoing
9	Impact of electric and gas vehicles	Ongoing
10	Käva2	Completed
11	PoStaWind	Completed
12	Power to gas (P2G)	Ongoing
13	SECONOMICS – Digital Risk and Cyber Security	Completed
14	Smart Substation	Ongoing

PROGRESS COMPARED TO THE R&D MONITORING REPORT 2013

Cluster 1 – Grid architecture – Progress 2013



Cluster 1 – Grid architecture – Progress 2015

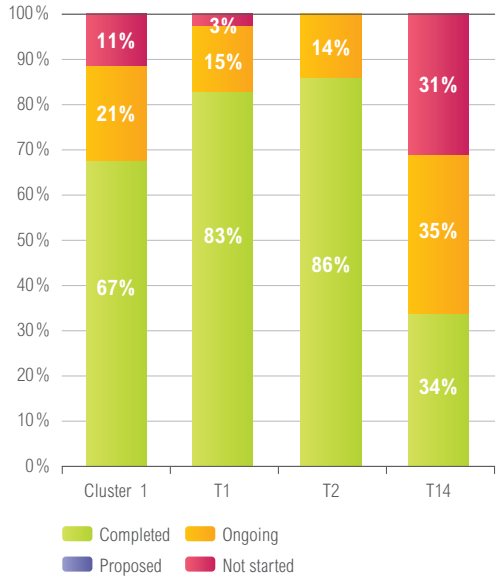


Fig. 7: Progress of Cluster 1 – Grid architecture

OVERALL ACHIEVEMENTS

The R&D activities in this cluster are already advanced and well covered thanks to contributions from e-Highway2050, Realisegrid, GridTech, InspireGrid, BestGrid, 13 other European projects, and 17 national projects.

A new method and tool have been developed by e-Highway2050 that support the planning of electricity highways based on various future power system scenarios, considering benefits, costs, and risks. Various criteria, metrics, methods, and tools must also be developed that help to design an optimal transmission infrastructure (Realisegrid). New planning tools are being developed that deal with large-scale renewable electricity production (Ewis, Twenties, and Best Paths). Combinations of market and grid modelling are also being studied that assess the added value of new grid infrastructures (Ewis). In addition, concepts for managing the electricity grid by 2025 are being investigated at the Danish power system of 2025 with 70 % RES. At the regional level, market modelling capacities are being developed.

Measures to improve public perception of power infrastructures have been implemented by the BestGrid project as well as through interaction and information between TSOs and the public. This has been specifically focused on in seven target countries (Austria, Bulgaria, Germany, Ireland, Italy, Netherlands, and Spain).

InspireGrid develops suitable processes for effective communication and real participation of the stakeholders and general public. Expectations of stakeholders and the general public are captured and better tailored for suitable communication and interaction when building new grids.

Innovative techniques for the creation and maintenance of corridors under overhead lines are studied and tested in the LIFE project, allowing the maximisation of their potential benefits for biodiversity. The expected benefits include the preservation of the natural beauty of the landscape; improved attractiveness to tourists, hunters, and local residents; greater acceptance by the general public of line infrastructure in the landscape; and a better public image for the TSO.

GAPS

FO	Specific Tasks of Functional Objectives	Comments
T1	**T1a.** To define pan-European network expansion scenarios, identify maximum volume of RES and DER for pan-European network, and analyse a combination of electricity and gas.	There is still work to do on the combination of electricity and gas at the EU level, although this is done at the national level.
	T1b. To identify investments required to achieve the 2050 vision with different decarbonisation scenarios of generation mix, storage, and demand mix.	All the topics considered in these specific tasks are covered.
	T1c. To develop methods for integrating transmission systems with growing amounts of RES-based generation, considering optimal rates of storage needed at the pan-European level.	
	T1d. To provide an offshore grid design: optimisation methods for grid capacity, technology, and topology considering wind power characteristics (i.e., low capacity factor).	
T2	**T2a.** To investigate state-of-the-art planning software, technology portfolios, and different regulatory frameworks.	All the topics considered in this functional objective are covered.
	T2b. To define input data requirements and data interfaces (to/from cost-benefit simulators, power flow tools, etc.).	
	T2c. To develop new algorithms and database functions for network simulation, enabling the integration of new emerging technologies, such as HVDC, GIL, FACTS, and storage.	
	T2d. To model embedded HVDC/HVAC grids for planning simulation.	
	T2e. To develop software tools for cost-benefit assessments of expansion options and to validate the effects on grid planning for the coordinated design of architecture, power flow control devices, and other technologies.	
	T2f. To provide a coordinated grid design involving new network architectures, power flow control devices, storage, and other technologies to achieve sustainable and efficient networks.	
	T2g. To develop planning software to optimise location, coordination, control, and integration of technologies within existing and future system architecture.	
	T2h. To develop long-term planning methods in order to combine electricity market analyses, production capacities (all types including RES), and infrastructure in view of strengthening the expected weak points on the grid.	
	T2i. To propose network investment mechanisms at the EU level.	
T14	**T14a.** To investigate public perception of the power infrastructure and to improve the relationship between TSOs and the public with valuable feedback and signals in both directions.	All the topics considered in these specific tasks are covered.
	T14b. To contribute to developing and/or updating European guidelines on good practice in transparency, public engagement, and the permit process.	
	T14c. To produce guidelines for the construction of overhead power lines with reduced visual and environmental effects compared to existing construction guidelines and to ensure these guidelines are applicable across Europe.	
	T14d. To analyse new technologies with reduced visibility of conductors, using coatings and nano-technologies.	There is still no specific work on coating and nano-technologies.
	T14e. To propose new tower designs for overhead power lines with less visual effect, audible noise, and EMF and in some cases, also with reduced sag of overhead lines.	Audible noise and EMF should be covered.
	T14f. To develop methodologies and software to evaluate bird collisions, human and animal exposure to EMF, audible noises, etc., and reduction of effects.	Need to evaluate environmental effects.
	T14g. To provide methods for physical protection of the grid infrastructures against potential dangers: natural catastrophes, terrorism, cyber-attacks, etc.	There is still work to do on natural catastrophes and on extending the results to the EU level.

» CLUSTER 2 – POWER TECHNOLOGIES

This cluster addresses the affordability and technical performance of components of emerging technologies that can significantly improve the operations of the interconnected transmission systems.

Cluster 2 consists of the following functional objectives:

» T3: Demonstration of power technology to increase network flexibility and operation means.

» T4: Demonstration of novel network architectures.

» T5: Interfaces for large-scale demonstration of renewable integration.

In this cluster, there are 12 European and 15 national projects.

	European projects	Status
1	Anemos Plus	Completed
2	Best Paths	Ongoing
3	eBadge	Completed
4	e-Highway2050	Completed
5	Ewis	Completed
6	FutureFlow	Ongoing
7	GridTech	Completed
8	Migrate	Ongoing
9	Promotion	Ongoing
10	Real-Smart	Completed
11	Twenties	Completed
12	WindGrid	Completed

	National projects	Status
1	220 kV SSSC device for power flow control	Completed
2	Almacena	Completed
3	Cell Controller Pilot Project	Completed
4	CHPCOM (Combined Heat and Power Communication)	Ongoing
5	Concept for the management of the future electricity system 2025	Completed
6	Continuous ramping of HVDC lines	Completed
7	Development of early warnings system (PMU/WAMS)	Completed
8	Frequency Containment Process (FCP)	Ongoing
9	From wind power to heat pumps	Completed
10	Humber Smartzone Pilot Project	Ongoing
11	PoStaWind	Completed
12	Power to gas (P2G)	Ongoing
13	Smart substation	Ongoing
14	Sumo	Completed
15	Wampac	Completed

PROGRESS COMPARED TO THE R&D MONITORING REPORT 2013

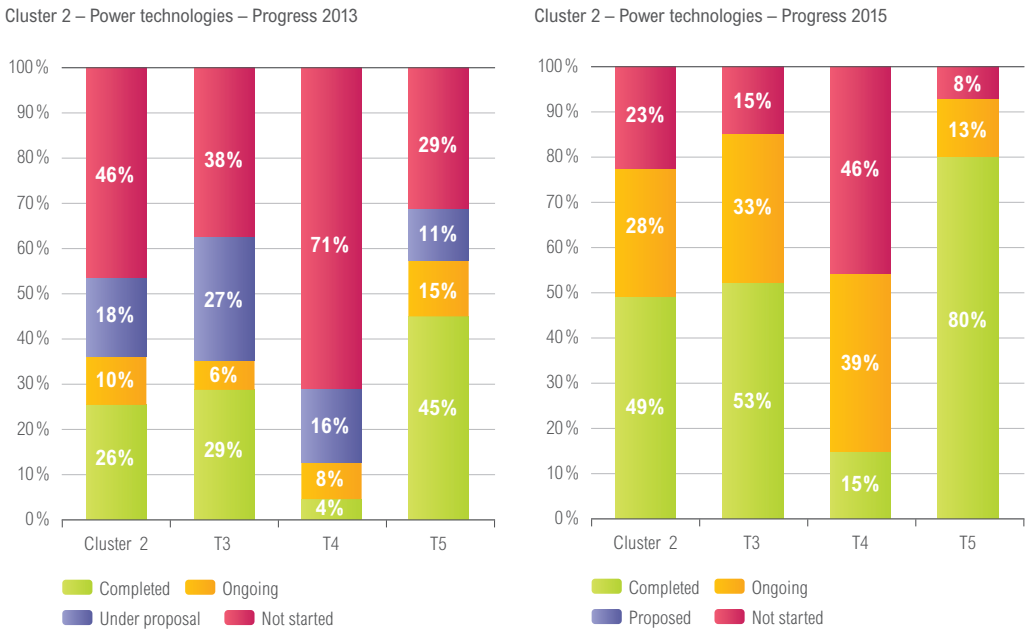


Fig. 8: Progress of Cluster 2 – Power technologies

OVERALL ACHIEVEMENTS

This cluster is well advanced, with more than three-quarters of its content already completed or ongoing, due to significant R&D contributions. Many important power technologies have already been demonstrated in the European projects, such as power devices and power flow management, phase shift controllers, direct-current (DC) grid structures, HVDC converters and protections, balancing fast winds in storm conditions, and balancing wind using virtual power plants or system services provided by wind farms.

The ongoing projects, like Best Paths or Migrate (which has just started), are working on the demonstration of large-scale integration of innovative transmission systems and operational solutions for inter-connecting renewable electricity production and the use of power electronics.

Other projects at the national level demonstrate 220 kV static synchronous series compensator devices for power flow control, electrochemical batteries for power storage, wind power to heat pumps, demand-response technology, early warnings system with power management units (PMU), WAMS, etc.

GAPS

FO	Specific Tasks of Functional Objectives	Comments
T3	**T3a.** To demonstrate the degree to which transfer capacity can be increased at the cross-border level and present new operating schemes available through the implementation of different approaches and technologies, to investigate all possible technical solutions within the domain of each application, and to perform cost-benefit analyses of different case studies.	All the topics considered in these specific tasks are covered.
	T3b. To demonstrate power flow control devices that offer increased flexibility with respect to energy flow across multiple transmission zones and borders.	
	T3c. To demonstrate controllable offshore and onshore solutions for vendor-independent, HVDC multi-terminal networks used to coordinate power flow, frequency control, protection, and communications requirements.	There is still a need for a multi-vendor installation.
	T3d. To implement solutions for wide-area monitoring (WAM) systems and demonstrate how to utilise such information in a coordinated manner during operations.	More work should be done at the EU level on WAM and PMU coordination.
	T3e. To investigate the influence of parallel routing of DC and AC lines on the same tower or parallel paths in order to facilitate existing infrastructure paths in an optimal manner.	Issues related to the utilisation of DC lines within an AC grid using the same infrastructure have yet to be covered.
T4	**T4a.** To demonstrate new power technologies on a large scale (including new materials), such as HVDC VSC, superconductivity, energy storage, fault current limiters, and other promising technologies for joint management of onshore and offshore networks.	There is still work to do on fault current limiters and other promising technologies.
	T4b. To validate various technology options to increase transmission capacity through selective reinforcement or implementation of an ultra-high-voltage transmission system (Super Grid) or DC backbone.	Ultra-high voltage is not considered yet.
	T4c. To propose new schemes to extend synchronous areas in the pan-European grid and connect these with back-to-back HVDC to increase their utilisation and reduce the complexity of balancing, planning, and operation.	Most of the topics considered in this specific task are not covered yet.
	T4d. To do research on the devices and concepts required to materialise multi-terminal DC grids that can cope with current system needs and sources, such as offshore generation.	All the topics considered in this specific task are covered.
	T4e. To coordinate offshore networks interconnected with various control areas, load-frequency control, DC voltage control, and other technologies required for DC (VSC) networks.	Methods for coordinating load-frequency control are not yet covered.
	T4f. To implement HVDC solutions to enhance reliability – bi-polar or mono-polar DC schemes.	There still is a need for a project focused on reliability.
	T4g. To determine standard DC voltage. Since VSC technologies eliminate the need for transformers, investment and maintenance costs will be reduced significantly. Weight and space are cost drivers, particularly for offshore installations.	Most of the topics considered in this specific task are not covered yet.
T5	**T5a.** To validate the contribution of RES to voltage and frequency control, balancing using VPP.	All the topics considered in this specific task are covered.
	T5b. To monitor and control the network in order to avoid large-scale intra-zone oscillations.	A large EU-level demonstration project is still necessary (WAMPAC may cover it once it is presented to the EC).
	T5c. To validate integration scenarios where the network becomes more user-friendly and copes with variable generation from RES.	All the topics considered in these specific tasks are covered.
	T5d. To demonstrate various technologies for deploying energy mix from conventional and renewable resources to stakeholders.	

» CLUSTER 3 – NETWORK OPERATION

This cluster studies ways of operating transmission systems that maintain high security of supply at reasonable costs.

Cluster 3 consists of the following functional objectives:

» T6: Innovative tools and methods to observe and control the pan-European network.

» T7: Innovative tools and methods for coordinated operation with stability margin evaluation.

» T8: Improved training tools and methods to ensure better coordination at the regional and pan-European levels.

» T9: Innovative tools and approaches for pan-European network reliability assessment.

In this cluster, there are 16 European and 19 national projects.

	European projects	Status
1	After	Completed
2	Anemos Plus	Completed
3	eBadge	Completed
4	Ewis	Completed
5	FutureFlow	Ongoing
6	Garpur	Ongoing
7	GridTech	Completed
8	iCoeur	Completed
9	iTesla	Completed
10	Migrate	Ongoing
11	Pegase	Completed
12	Promotion	Ongoing
13	Real-Smart	Completed
14	SafeWind	Completed
15	Twenties	Completed
16	Umbrella	Completed

	National projects	Status
1	A complete and normalised 61850 substation	Completed
2	Autodig	Ongoing
3	Automatic frequency regulating reserve (FRR-A)	Ongoing
4	Cell Controller Pilot Project	Completed
5	CHPCOM – Combined Heat and Power Communication	Ongoing
6	Cities	Ongoing
7	Concept for management of the future electricity system	Completed
8	Demonstration of power load control mechanisms	Ongoing
9	Development of early warning systems	Completed
10	Energy data feed	Completed
11	Estfeed	Completed
12	Frequency Containment Process	Ongoing
13	Humber Smartzone Pilot Project	Ongoing
14	Käva2	Completed
15	PoStaWind	Completed
16	Samrel	Completed
17	Smart Substation	Ongoing
18	Sospo	Ongoing
19	Wampac	Completed

PROGRESS COMPARED TO THE R&D MONITORING REPORT 2013

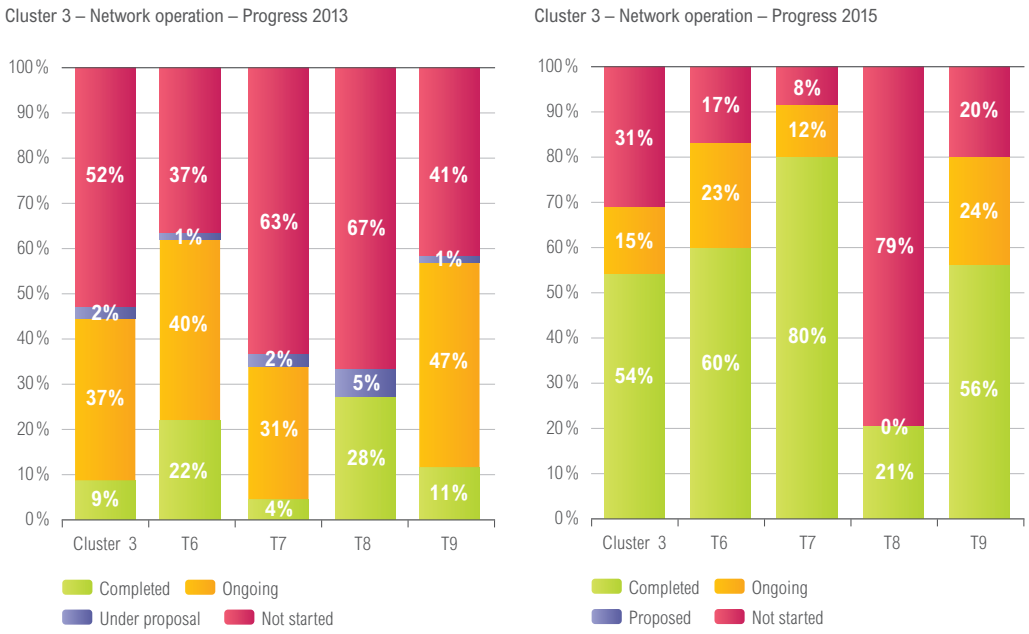


Fig. 9: Progress of Cluster 3 – Network operation

OVERALL ACHIEVEMENTS

In this cluster several achievements are underway. FutureFlow is developing software for RES forecasting for optimisation of flexibility.

In the Humber Smartzone Pilot, the deterministic rating capacity is compared with predictive smart ratings to achieve temporary enhanced capacity margins. Migrate is developing protection concepts and principles for asymmetrical fault clearing in case of DC-connected generation and partly for converter-dominated power systems. In Sospo, synchronised PMU measurements are received in real time to assess the observed operating point and its distance to the power system security and stability boundaries.

The FRR-A project seeks to develop an algorithm that can handle bottlenecks in the system and provide a new optimal allocation of the reserves in the Nordic region. The FCP aims at redefining the specifications of the Nordic disturbance reserve, considering balancing reserves, plant control ability, and the oscillations of the Nordic system.

GAPS

FO	Specific Tasks of Functional Objectives	Comments
T6	**T6a.** To assess and validate the performance of intelligent local sensors and data processing equipment (with sensor manufacturers) against the requirements of state estimation and dynamic simulation.	All the topics considered in these specific tasks are covered.
	T6b. To develop a toolbox to increase awareness of pan-European operation/optimization vs. local and regional approaches.	
	T6c. To develop local state models with a sufficient level of intelligence at the substation level and to use this valuable information with state estimators and dynamic simulation tools. These models will be aggregated for assessing the observability and controllability at the pan-European level.	Still needs to be aggregated for assessing observability and controllability at the pan-European level.
	T6d. To increase observability and improve state estimation accuracy (both steady-state and dynamic) through adequate modeling (including not only modeling protection and system automatic schemes to some extent, but also by merging transmission and distribution models).	All the topics considered in this specific task are covered.
	T6e. To exploit the information provided by forecasts of variable generation and flexible demand for observability and controllability purposes.	There is still some work to do on flexible demand forecast at the TSO level.
	T6f. To increase network controllability by proposing methods and tools for optimal and coordinated use of flexible equipment such as FACTS, PSTs and HVDC links, resulting in safe and cost-effective system operations (e.g., maximizing the global social welfare).	All the topics considered in this specific task are covered.
T7	**T7a.** To assess the effectiveness of control actions that deliver the right level of reliability while facing uncertainties from the large-scale deployment of RES and market integration.	All the topics considered in these specific tasks are covered.
	T7b. To develop approaches for optimal provisioning, dimensioning and sourcing of reserves together with local and/or regional distribution in order to maintain security of supply; to deliver dynamic management of system reserves at regional and pan-European levels.	
	T7c. To implement stochastic approaches to critical optimization variables (larger dispersions around the deterministic values obtained from the current steady state simulation tools) in order to cope adequately with uncertainties.	
	T7d. To facilitate converging policies for operational planning and to support the harmonization of operating rules across Europe.	
	T7e. To propose data exchange procedures for adequate system simulation; to identify critical contingencies and to assess residual risks while taking into account effectiveness and availability of control actions and automatic protection schemes while identifying action paths to be implemented.	
	T7f. To enable real-time detection of instabilities and prevent limit transgression in transmission systems and to develop new approaches to coordinate defence and restoration plans.	There is still some work to do on new approaches to coordinate defence and restoration plans.

FO	Specific Tasks of Functional Objectives	Comments
T8	**T8a.** To deliver real-time simulation of the entire interconnected European power system for training purposes.	A simulation of the entire interconnected European power system is needed.
	T8b. To train dispatchers to reproduce and understand large-scale incidents.	There is still work to do on the training.
	T8c. To provide training and certification to operators on a validated European power system model and to improve emergency response procedures.	This specific task has not been addressed yet.
	T8d. To make the dispatching training simulation facility available to other operators, such as power plant operators and distribution network operators in order to improve the network interfaces between transmission/generation and transmission/distribution.	The training facility is not available yet.
	T8e. To develop and test common procedures for emergency scenarios.	These specific tasks have not been addressed yet.
	T8f. To enable operator training by specifying the training simulator of the future, including the validation of critical algorithms.	
	T8g. To enable experimentation on what future training should include and who should be involved in order to learn and test the benefits of coordination mechanisms in stable and critical situations.	
	T8h. To establish, validate, and deliver default data to fill all the gaps in such a way that simulations are realistic enough for the targeted use.	
T9	**T9a.** To evaluate the current performance of the (N-1) criteria security principles and the required level of reliability from the customer's perspective.	All the topics considered in this specific task are covered.
	T9b. To identify the possible options for replacing (or complementing) the current reliability principles using a system approach to be used in different aspects of TSO business: grid development, markets, reserve planning, etc.	New reliability principles have not been applied to the TSO business.
	T9c. To define the additional information to be exchanged and the additional coordination needed to support deployment and to ensure effective and sufficient security margins during operation and operational planning.	Need further work on information exchanges.
	T9d. To provide an appropriate approach to risk assessment for the evaluated criteria based on probabilistic analyses which takes correlations in the power system.	All the topics considered in these specific taske are covered.
	T9e. To develop indicators for the evaluated criteria for network operators to help them make decisions for preventive and curative actions.	

» CLUSTER 4 – MARKET DESIGN

This cluster studies the ways and means to facilitate interactions between the European electricity markets and the pan-European grid. The aim is to achieve a more efficient and integrated market by optimising the energy mix at the pan-European level while ensuring security of supply.

Cluster 4 consists of the following functional objectives:

T10: Advanced pan-European market tools for ancillary services and balancing, including active demand management.

T11: Advanced tools for capacity allocation and congestion management.

T12: Tools and market mechanisms for ensuring system adequacy and efficiency in electric systems integrating very large amounts of RES generation.

In this cluster, there are 12 European projects and 13 national projects.

	European projects	Status
1	Anemos Plus	Completed
2	eBadge	Completed
3	EcoGrid EU	Completed
4	e-Storage	Ongoing
5	FutureFlow	Ongoing
6	GridTech	Completed
7	Market4RES	Ongoing
8	Optimate	Completed
9	Promotion	Ongoing
10	Real-Smart	Completed
11	Seetsoc	Completed
12	Smartnet	Ongoing

	National projects	Status
1	Automatic frequency regulating reserve (FRR-A)	Ongoing
2	Belgium east loop active network management	Completed
3	Concept for the management of the future electricity system 2025	Completed
4	DSR	Ongoing
5	Estfeed	Ongoing
6	FLEXe	Ongoing
7	Frequency Containment Process (FCP)	Ongoing
8	From wind power to heat pumps	Completed
9	Humber Smartzone Pilot Project	Ongoing
10	PoStaWind	Completed
11	Reservas model	Completed
12	Smart Grid Vendée	Ongoing
13	Smart Substation	Ongoing

PROGRESS COMPARED TO THE R&D MONITORING REPORT 2013

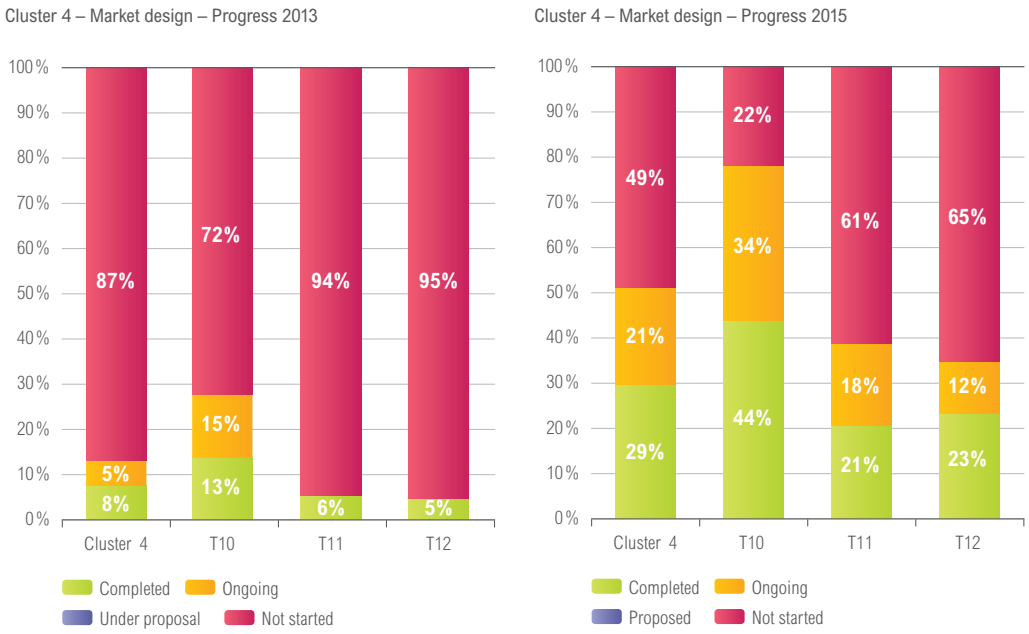


Fig. 10: Progress of Cluster 4 – Market design

OVERALL ACHIEVEMENTS

A large part of the gaps highlighted in the previous report have been partially covered. Currently 29% of the cluster is completed, and 21% is ongoing. Most of the contributions to the completion of this cluster come from the projects linked to the functional objective T10, where 44% of projects are completed, and 34% are ongoing, while T11 and T12, even if they have caught up since the last report, still lag behind with a respective 21% and 23% of completed projects and 18% and 12% of ongoing ones.

While Optimate has considered different processes and market mechanisms, developing a simulation platform for modelling European electricity markets, Seetsoc has researched new balancing mechanism tools. SmartNet, an ongoing project, is investigating optimised modalities for the provision of ancillary services from generation and DSM located in distribution networks, so as to identify what role advanced network technologies could play to enhance grid flexibility. The FRR-A project is developing a new method concerning the allocation of costs to the power reserve services, contributing significantly to the ever growing and broader theme of ancillary services.

eBadge, has worked towards a tool able to allow a seamless exchange of data from field devices up to the TSO level, thus also contributing to the important field of TSO/DSO cooperation in balancing services.

GAPS

FO	Specific Tasks of Functional Objectives	Comments
T10	**T10a.** To model aggregated RES/DER, flexible conventional generation, demand and storage systems to be used for market design, market mechanisms, and simulation tools for planning and operation purposes.	All of the topics considered in this specific task are covered.
	T10b. To design market mechanisms for incentivising both the maximisation of the provision of ancillary services (including aggregated RES, cogeneration and high-efficiency production, demand, storage, etc.) and the minimisation of the use of ancillary services. The aim is to harmonise the requirements of provider licences with supervision, control, and recording of services provided.	This specific task is quite wide and needs further work.
	T10c. To develop a new tool for detailed analyses of various balancing market designs to identify best practices and to perform large-scale experiments with metered customers that demonstrate the costs and benefits of demand-side management required at the pan-European level.	Almost all topics considered in these specific tasks are covered.
	T10d. To design and develop mechanisms and platforms for cross-border balancing and power reserve services, moving towards possible future development of regional/pan-regional platforms and even markets based on economic and technical analyses, all the while operating within the required security margins.	
	T10e. To develop a set of data exchange templates and information and communication technology (ICT) infrastructure to enable ancillary and balancing services at the EU level.	There is still some work to do on the development of data to be exchanged at the EU level.
T11	**T11a.** To investigate interactions between system operations and dynamic capacity and reserve allocation methods at the regional and pan-European levels to cope with uncertainties from RES and load and system disturbances.	Most of the topics considered in this specific task are not covered yet.
	T11b. To model strategies in view of improved congestion management and to analyse the possibility of more efficient options, if any exist, for the pan-European electricity market.	Need to analyze the possibility of more efficient options for congestion management, for the pan-European electricity market.
	T11c. To expand flow-based market coupling in areas with interdependent flows, based on successful experience.	Most of the topics considered in this specific task are not covered yet.
	T11d. To develop an algorithm for computing potential extra capacities in real time or as closely as possible, considering security criteria without the need for counter-trading issues.	Further work should be done at the EU level.
	T11e. To perform risk-benefit analyses and develop an interface using the Congestion Management Module (CMM).	Most of the topics considered in this specific task are not covered yet.
T12	**T12a.** To design market mechanisms that allow participation of RES (active and reactive power control), storage devices, and conventional generation shift to ensure system adequacy and efficiency.	There is still work to do on the participation of storage devices and on RES active and reactive power control.
	T12b. To design investment incentive regimes that promote conventional and RES generation flexibility, new transmission capacity, and to foster storage systems.	Most of the topics considered in this specific task are not covered yet.
	T12c. To design grid tariff mechanisms for active demand-side management to correlate the load curve and RES integration.	Need concrete proposals for grid tariff mechanisms for active demand-side management.

» CLUSTER 5 – ASSET MANAGEMENT

This is a new cluster that is searching for the most cost-effective asset management strategy. It will enable the use of advanced measurements, better knowledge of constraints, and optimal maintenance and replacement strategies in a grid where new and old assets must necessarily coexist.

Cluster 5 consists of the following functional objectives:

T15: Developing approaches to determine and maximise the lifetime of critical power components for existing and future networks.

T16: Development and validation of tools, which optimise asset maintenance at the system level based on quantitative cost/benefit analysis.

T17: Demonstrations of new asset management approaches at the EU level.

In this cluster, there are four European projects and three national projects.

	European projects	Status
1	Best Paths	Ongoing
2	Garpur	Ongoing
3	InspireGrid	Ongoing
4	Seetsoc	Completed

	National projects	Status
1	Electrical clearances when voltage upgrading	Completed
2	Humber Smartzone Pilot Project	Ongoing
3	Smart substation	Ongoing

PROGRESS COMPARED TO THE R&D MONITORING REPORT 2013

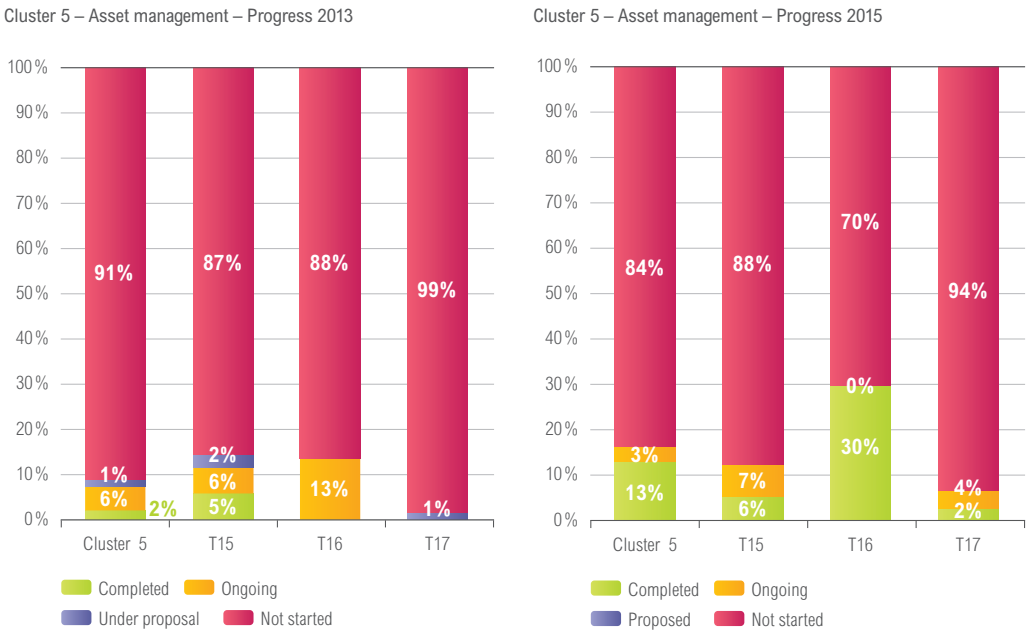


Fig. 11: Progress of Cluster 5 – Asset management

OVERALL ACHIEVEMENTS

Ongoing work in the GARPUR project comprises refining models and/or developing new ones to predict the deterioration process of the main grid components and how it can affect the failure probability. New methodologies for risk-based security criteria will be developed and evaluated for asset management, in particular, to specify a system approach that is able to perform an overall assessment of mid-term strategies and their links with short-term (system operations) and long-term (system development) decision processes.

Asset management tools in the substation with standard ageing models are covered in the Smart Substation project. The SEETSOC projects monitors for better support of condition-based maintenance. In addition, electrical clearances are investigated when upgrading the voltage. Further testing on temperature measurements for dynamic line rating is done in the Best Paths and Humber Smartzone Pilot Project.

GAPS

FO	Specific Tasks of Functional Objectives	Comments
T15	**T15a.** To identify the parameters (climate conditions, operating conditions, potential for hardware and software, among others) that affect the life span of components.	There is work to do on power lines.
	T15b. To establish evaluation/estimation protocols for component statuses that are comparable across TSOs with in-depth analyses and shared experiences.	This specific task has not been addressed yet.
	T15c. To develop a methodology to determine and expand the life span of components, including conventional components (conductor, insulator, tower, breaker, etc.) and new components, such as power electronic devices and digital devices.	There is still work to do on methodologies to expand the life span of components.
	T15d. To propose dedicated, intelligent monitoring and analysis of results from equipment operation.	There is still work to do on monitoring and analysis of the results.
	T15e. If necessary, specify new measurement devices and associated ICT systems.	There is still work to do on new measurement device specifications.
	T15f. To assess the environmental effects (noise, leakage, etc.) and safety for workers or nearby inhabitants (especially in the case of failure), considering the ageing processes and technical obsolescence.	Environmental and workers' safety issues need to be covered.
	T15g. To validate the added value of individual lifetime assessment compared to an average assessment of several similar components based on generic parameters (age of equipment, switching steps, etc.).	These specific taske have not been addressed yet.
	T15h. To assess the benefits of partially renewing small components (joints, etc.) or adding new protective layers (paint coating) to extend life span. A methodology is to be developed that assesses the capability of each component to be partially repaired or where the coating is to be replaced.	
	T15i. To develop new ways of detecting component failure based on failure models.	
T16	**T16a.** To define methods and tools to optimise asset management at the system level. The proposed methodology provides an assessment of the costs and benefits of different asset management strategies. The methodology proposes a risk-based approach at the system level, including interactions between equipment, effects on security and the quality of supply, and on environmental and safety constraints. The organisation of maintenance work and availability of spare parts (supply chain, quantity of spare parts, and location) are parts of the global optimisation challenge.	Some work is ongoing, but most of the task is still missing.
	T16b. To provide tools for dynamic management of outage planning and maintenance schedules.	Tools for dynamic management of outage planning.
T17	**T17a.** To utilise embedded ICT to monitor individual assets and to define a method of supervision based on this information at the system level for several TSOs in parallel.	Most of the topics considered in this specific task are not covered yet.
	T17b. To implement robotics for problem detection as well as to intervene in hostile environments and avoid the need for human maintenance. These include UAV to inspect overhead lines and robots that move while 'grabbing' the conductors.	These specific tasks have not been addressed yet.
	T17c. To implement maintenance activities with the network 'on', especially for DC equipment.	Most of the topics considered in this specific task are not covered yet.
	T17d. To propose scaling-up and replication rules for new asset management approaches at the pan-European level.	

» CLUSTER 6 – JOINT TSO/DSO R&D ACTIVITIES

This cluster focuses on the TSO/DSO interface and new smart grid services at the DSO level and their utilisation for regulation and ancillary services.

Cluster 6 consists of the following functional objectives:

TD1: Increased observability of the distribution system for transmission network management and control.

TD2: The integration of demand-side management at the DSO level into TSO operations.

TD3: Ancillary services provided through DSOs.

TD4: Improved defence and restoration plan.

TD5: Methodologies for scaling-up and replicating.

In this cluster, there are 12 European and 16 national projects.

	European projects	Status
1	Anemos Plus	Completed
2	eBadge	Ongoing
3	Ecogrid EU	Completed
4	EvolvDSO	Completed
5	FutureFlow	Completed
6	Garpur	Completed
7	GridTech	Ongoing
8	Increase	Ongoing
9	Nice Grid	Completed
10	Real-Smart	Completed
11	SafeWind	Completed
12	SmartNet	Ongoing

	National projects	Status
1	A complete and normalised 61850 substation	Completed
2	Belgium east loop active network management	Completed
3	Cell Controller Pilot Project	Completed
4	CITIES (Centre for IT-Intelligent Energy)	Ongoing
5	Concept for Management of the Future Electricity System 2025	Completed
6	Demonstration of power load control mechanisms	Completed
7	DSR	Ongoing
8	Energy data feed	Completed
9	Estfeed	Ongoing
10	Evcom	Completed
11	From wind power to heat pumps	Completed
12	Gredor	Ongoing
13	Humber Smartzone Pilot Project	Ongoing
14	Proba	Completed
15	Smart Grid Vendée	Ongoing
16	Smart substation	Ongoing

PROGRESS COMPARED TO THE R&D MONITORING REPORT 2013

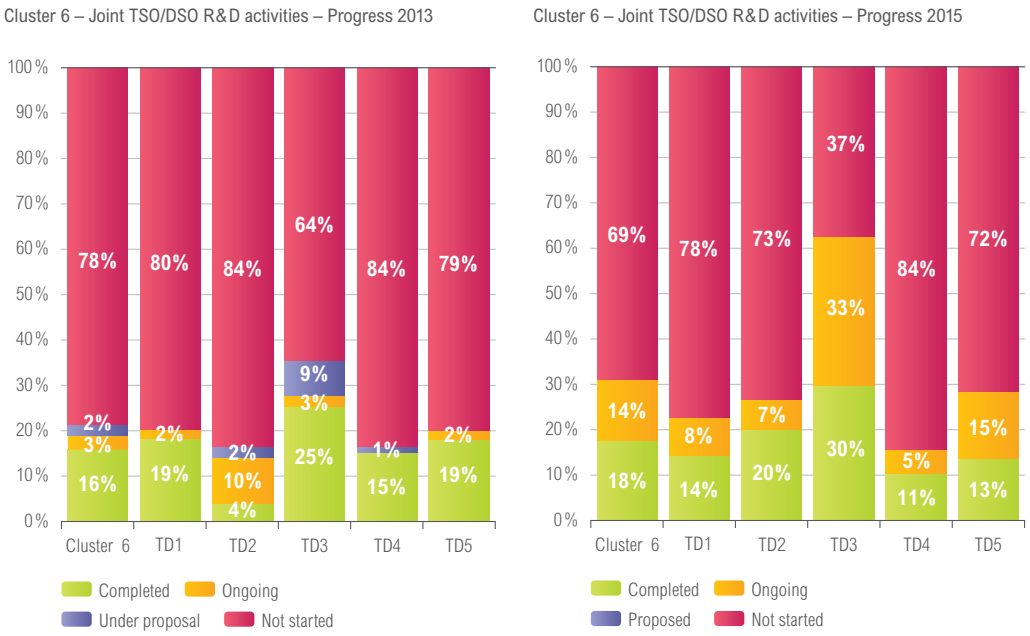


Fig. 12: Progress of Cluster 6 – Joint TSO/DSO R&D activities

OVERALL ACHIEVEMENTS

Since the last monitoring report, the number of European and national projects contributing to this cluster has increased. Significant R&D activities focusing on Ancillary services provided through DSOs (TD3) were developed namely some demonstrations projects, with regard to new actors and market models that enable distributed energy resources (DER) to provide ancillary services.

Demonstration projects like the 'Cell Controller Pilot Project (CCPP)' have been performed. The CCPP was successfully developed, deployed and demonstrated in a 1,000 km² pilot study region a control system capable of coordinating distributed energy resources (DER), that managed the assets during normal grid operation, supported multiple ancillary services, facilitated participation in emerging DER market opportunities, and was able to safely island the study region, maintain autonomous operation, and resynchronize with the main network.

The estimation of risk indices related to the connection of distributed generation have been addressed in the Proba project and a market model for regional ancillary service provision was developed in the 'Demonstration of power load control mechanisms' project.

Consumer response and consumption patterns were topics that have been addressed by the EcoGrid project wchich has demonstrated new balancing mechanisms with a five-minute real-time price response system that provides additional regulation power from smaller customers with both reducible demand and excessive load in periods. In this EU demonstration project, consumers participate with flexible demand response to real-time price signals. The participants were equipped with residential demand-response devices/appliances using gateways and smart controllers. Consumers could see real-time prices and pre-programme their automatic demand-response preferences, e.g. through different electricity contracts. Automation and customer choice were also key elements in this project.

The ongoing EU project 'Increase', will facilitate new business models, considering that, with new information technologies and grid components, consumers at LV levels will become new ancillary service providers towards DSOs and TSOs.

Furthermore, the Gredor project will develop several tools for modelling the interaction between electricity providers (DSOs and TSOs) in the market. By demonstrating power load control mechanisms, it will be possible to develop solutions for aggregating load data and consequently increase efficiency and security at the DSO level.

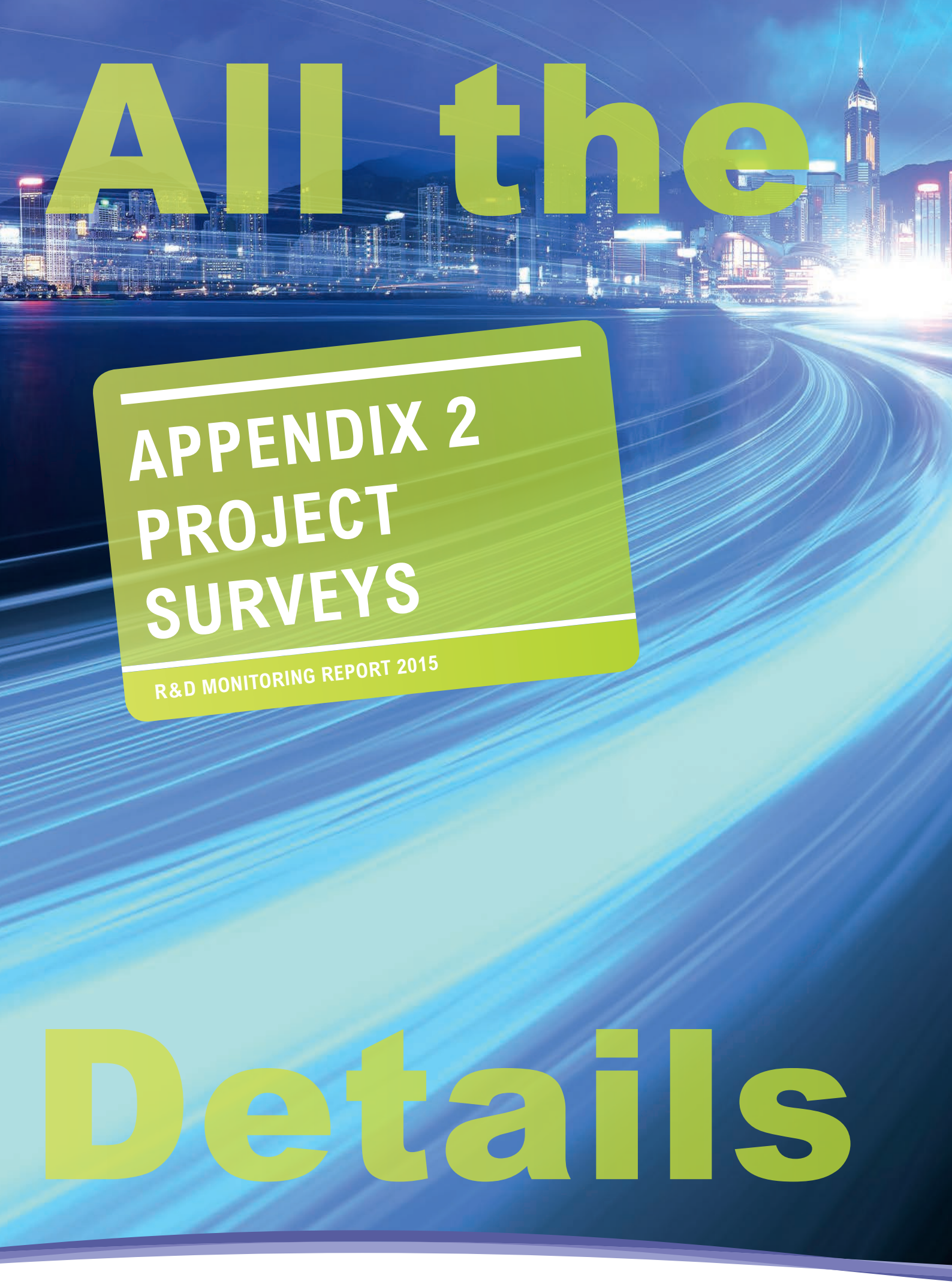
Focused on providing aggregated services (VPPs), the Estfeed project aims at developing applications for DER and DSR. The DSR project's main goal is to investigate the optimal provision of DSR in cooperation with DSOs.

GAPS

FO	Specific Tasks of Functional Objectives	Comments
TD1	**TD1a.** To improve short-term (15 min, 1 h, 3 h) and long-term (five-day) forecast engines for PV, wind, CHP, and loads.	There is still work to do on load and PV forecasting.
	TD1b. To develop new modelling methods and tools for steady-state (static parameters) and dynamic analyses (capacities up to 1 MW).	This specific task has not been addressed yet.
	TD1c. To deliver methods and tools for planning new DER connections at the TSO/DSO boundary (response to new connection requirements).	Further work should be done after the RfG code is adopted.
	TD1d. To develop new methodologies for data processing at various system levels (DSO, TSO).	Most of the topics considered in these specific tasks are not covered yet.
	TD1e. To design new architecture, control systems, and communications (including GIS assistance) that allow multiple new generators to be connected and share information with TSOs.	
	TD1f. To provide new integrated functions (scaling-up techniques) and solutions for technical aggregation of DER data acquisition capabilities for improved DER production observability.	There is still a need for the EU-level project.

FO	Specific Tasks of Functional Objectives	Comments
TD2	**TD2a.** To define demand requirements and data required by TSOs for the pan-European planning tool.	Most of the topics considered in this functional objective are not covered yet.
	TD2b. To demonstrate active customer involvement with indirect feedback (provided post-consumption) and direct feedback (real time) and suitable operations designed to achieve a reduction in peak demand (10%–15%).	
	TD2c. To model customer/load behaviour and segmentation and quantify the degree of flexibility provided by distribution networks (e.g., through reconfiguration or other methods).	
TD3	**TD3a.** To discover novel ways of providing ancillary services through loads and their effect on transmission networks. The highly variable and unpredictable nature of DER and RES places new constraints on these ancillary services.	There is still work to be done on providing ancillary services through loads.
	TD3b. To ensure simulation environments demonstrate the viability and options of ancillary services provision by aggregated loads at DSO level.	There is still work to be done on providing ancillary services through aggregated loads.
	TD3c. To provide technologies and tools for active and reactive power control of DER, with TSO/DSO coordination to provide extra power flow control, load management, and islanding.	
	TD3d. To ensure new actors and market models that enable DER to provide ancillary services.	All the topics considered in this specific task are covered.
	TD3e. To provide new models that describe products and services to be tested on selected segments of customers and their effects on future ancillary services in the presence of large-scale DER integration.	Most of the topics considered in this specific task are not covered yet.
	TD3f. To provide new market models that account for the price-sensitive nature of loads and consequently their increased flexibility.	There is still work to do on the flexibility of loads.
	TD3g. To analyse the legal, contractual, and regulatory aspects of ancillary services provided by distributed generation and/or loads, allowing for more aggregated business models.	Most of the topics considered in this specific task are covered.

FO	Specific Tasks of Functional Objectives	Comments
TD4	**TD4a.** To develop simulation tools and methods that detect weaknesses in the system with respect to reconnecting DER and storage systems.	These specific tasks have not been addressed yet.
	TD4b. To develop simulation tools and methods of assessing the risk of breakdowns during reconnection.	
	TD4c. To develop simulation tools for interactive system restoration, including advanced forecast tools developed in TD1 for wind, solar PV, and other variable RES.	
	TD4d. To address regulatory and technical challenges that implement restoration plans at the pan-European level.	Most of the topics considered in this specific task are not considered yet.
	TD4e. To train operators on the evolution of national regulatory schemes in order to foster coordination efforts.	There is still a need for an EU-level project.
	TD4f. To investigate the impact of micro-grids and islanding capabilities.	Micro-grids and islanding capabilities are not widely tested.
	TD4g. To train operators about the evolution of national regulatory schemes in order to foster coordination efforts.	There's still work to do on training.
TD5	**TD5a.** To investigate the acceptable levels of risk and uncertainty in studies in order to adequately assess the scaling-up and replication potentials of solutions and their requirements.	Most of the topics considered in these specific tasks are not covered yet.
	TD5b. To document the methodology for future project participants so that they can assess the experimental data requirements required to design a smart grid demonstration.	
	TD5c. To develop information models for smart grid security, considering business interactions and the physical processes of delivering electricity, and the disruption of business communications or of the delivery of electricity.	
	TD5d. To analyse data exchange protocols that reinforce interoperability constraints at the pan-European level with an adequate level of security.	There is still a need for an EU-level project.
	TD5e. To study appropriate confidentiality constraints in the developed toolbox to ensure appropriate sharing of results, while preserving stakeholder interests.	This specific task has not been addressed yet.
	TD5f. To define open standard data models that ensure interoperability between different data exchange protocols for smart grid applications and to increase competitiveness.	There is still a need for a EU-level project.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APPENDIX 2
PROJECT
SURVEYS
R&D MONITORING REPORT 2015
Details

The surveys were sent to each project coordinator to gather information on the various R&D projects across Europe (at both European and national levels).

The survey collected general information about the projects, the contributions to the R&D Roadmap, how results were being disseminated (knowledge sharing) and key performance indicators and statuses in terms of results, overall milestones, timing, and budget scenario.

The results show how each project contributed to its corresponding specific tasks, functional objectives, and clusters. Hence it was possible to assess the completion statuses of specific clusters and functional objectives and ultimately the achievements of the entire roadmap.

The table next page lists all 71 projects that were considered for R&D Monitoring Report 2015. Thirty-three of these projects are being performed at the European level, while a further 38 are being performed at the national level. The criteria for the selection of the projects are their relevance for TSOs and their expected contribution to the ENTSO-E R&D Roadmap and to the fulfilment of the EU energy policy goals; although only projects that have provided answers to the survey were finally considered. Furthermore, all projects under consideration were funded either through the EU, member states, or directly from TSOs.

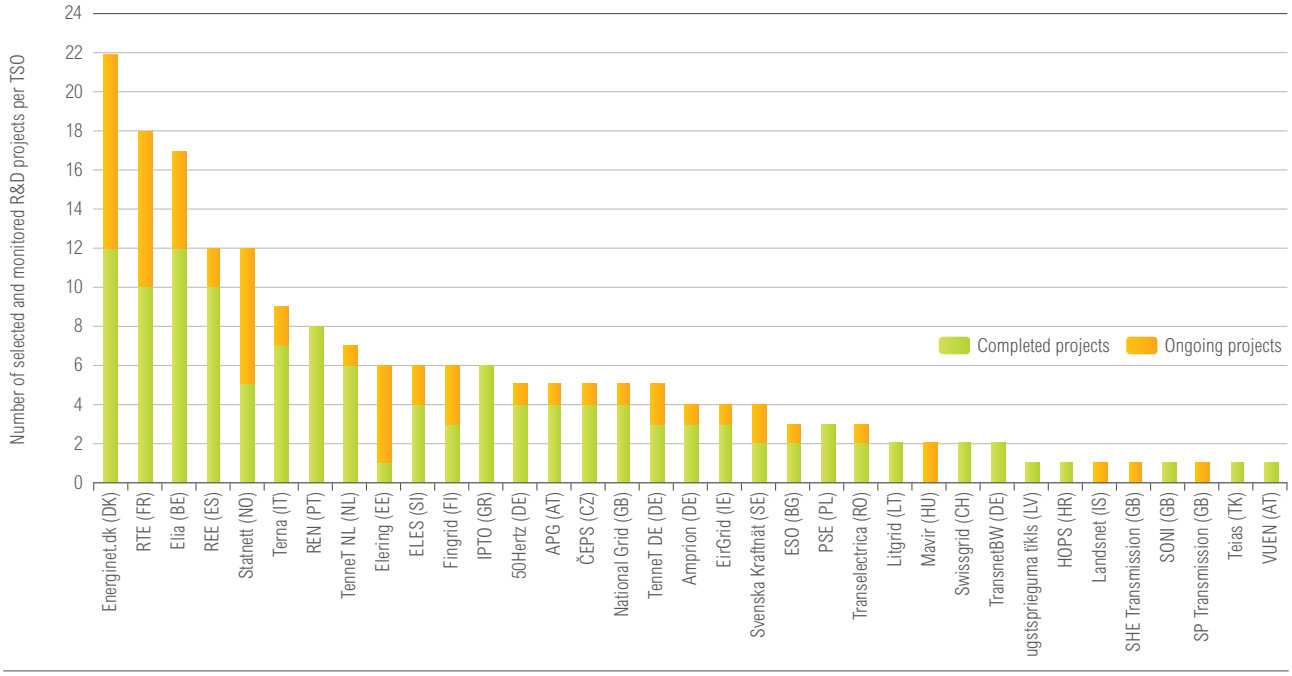

Fig. 1: Involvement of TSOs in selected and monitored R&D projects

LIST OF R&D PROJECTS CONTRIBUTING TO THE R&D ROADMAP

No	Projects	Status	Level
1	220 kV SSSC device for power flow control	Completed	National
2	A complete and normalised 61850 substation	Completed	National
3	After	Completed	European
4	Almacena	Completed	National
5	Anemos Plus	Completed	European
6	Autodig	Ongoing	National
7	Automatic frequency regulating reserve (FRR-A)	Ongoing	National
8	Belgium East Loop network	Completed	National
9	Best Paths	Ongoing	European
10	BestGrid	Completed	European
11	Cell Controller Pilot Project	Completed	National
12	CHPCOM–Combined Heat and Power Communication	Ongoing	National
13	CITIES (Centre for IT-Intelligent Energy Systems in cities)	Ongoing	National
14	Concept for management of the future electricity system	Completed	National
15	Continuous ramping of HVDC lines	Ongoing	National
16	Demonstration of power load control mechanisms	Ongoing	National
17	Development of composite towers for 420 kV	Ongoing	National
18	Development of early warnings systems (PMU/WAMS)	Completed	National
19	Development of market modelling capacity	Completed	National
20	DSR	Ongoing	National
21	eBadge	Completed	European
22	Ecogrid EU	Completed	European
23	e-Highway2050	Completed	European
24	Electrical clearances when voltage upgrading	Completed	National
25	Energy Data Feed	Completed	National
26	Estfeed	Ongoing	National
27	e-Storage	Ongoing	European
28	Evcom	Completed	National
29	EvolvDSO	Ongoing	European
30	Ewis	Completed	European
31	FLEXe	Ongoing	National
32	Frequency Containment Process	Ongoing	National

No	Projects	Status	Level
33	From wind power to heat pumps	Completed	National
34	FutureFlow	Ongoing	European
35	Garpur	Ongoing	European
36	Gredor	Ongoing	National
37	GridTech	Completed	European
38	Humber Smartzone Pilot Project	Ongoing	National
39	iCoeur	Completed	European
40	Impact of electric and gas vehicles	Ongoing	National
41	Increase	Ongoing	European
42	InspireGrid	Ongoing	European
43	iTesla	Completed	European
44	Käva2	Ongoing	National
45	LIFE Biodiversité	Completed	European
46	Market4RES	Ongoing	European
47	Merge	Completed	European
48	Migrate	Ongoing	European
49	NiceGrid	Completed	European
50	Optimate	Completed	European
51	Pegase	Completed	European
52	PoStaWind	Completed	National
53	Power to gas (P2G)	Ongoing	National
54	Proba	Completed	National
55	Promotion	Ongoing	European
56	Realisegrid	Completed	European
57	Real-Smart	Completed	European
58	Reservas model	Completed	European
59	SafeWind	Completed	European
60	Samrel	Completed	National
61	SECONOMICS–Digital Risk and Cyber Security	Completed	National
62	Seetsoc	Completed	European
63	Smart Grid Vendée	Ongoing	National
64	Smart substation	Ongoing	National
65	Smartnet	Ongoing	European
66	SOSPO (Secure Operation of Sustainable Power Systems)	Completed	National
67	Sumo	Completed	National
68	Twenties	Completed	European
69	Umbrella	Completed	European
70	Wampac	Ongoing	National
71	WindGrid	Completed	European

PROJECT SHEETS

» 220 kV SSSC DEVICE FOR POWER FLOW CONTROL

Project Coordinator: Vicente González	**Company:** Red Eléctrica de España (Spain)
email: vgonzalez@ree.es	**Phone:** +34-91-650-20-12
Start/End: 2009/2014	**Current status:** Completed
Budget: 5.5 million EUR	**Funding scheme:** Granted by PSE during 2009–2010 and INNPACTO during 2011–2014 (Spanish R&D Programmes)
Members of the consortium: » TSOs: REE (ES). » Others: Ingeteam (ES), INCOESA (ES).	
Brief project description: Design, construct, set up operation, and test a FACTS (SSSC) to prevent overload situations in the 220 kV transmission grid and reduce the measures that the system operator has to make to solve overloads, such as reducing the meshing of the network or curtailing wind production.	
Keywords: FACTS, SSSC, Power flow control, Power electronics.	
Website of the project: http://www.ree.es	
Functional objectives: T3	

» A COMPLETE AND NORMALISED 61850 SUBSTATION

Project Coordinator: Vicente González	**Company:** Red Eléctrica de España (Spain)
email: vgonzalez@ree.es	**Phone:** +34-91-650-20-12
Start/End: 2009/2015	**Current status:** Completed
Budget: 4.2 million EUR	**Funding scheme:** Financed 100% by Red Eléctrica de España
Members of the consortium: » TSOs: REE (ES). » Others:	
Brief project description: Use standard IEC61850 as a means to improve the design, maintenance, and operation of the substation automation systems. Design a standard substation considering the existing and new solutions developed by the vendors collaborating in the project. Build and set up an IEC61850 HV substation.	
Keywords: 61850 Standardisation, Digital substation, Process bus.	
Website of the project: http://www.ree.es	
Functional objectives: T6, TD5	

» AFTER (A Framework for electrical power sysTems vulnerability identification, dEfense and Restoration)

Project Coordinator: Emanuele Ciapessoni	**Company:** RSE – Ricerca sul Sistema Energetico (Italy)
email: Emanuele.Ciapessoni@rse-web.it	**Phone:** +39-02-39-92-57-66
Start/End: Oct-2011/Sep-2014	**Current status:** Completed
Budget: 5 million EUR (3.5 granted)	**Funding scheme:** Granted by 7th Framework Programme (Call FP7-SEC-2010-1)

Members of the consortium:
» TSOs: Elia (BE), Terna (IT), ČEPS, a.s. (CZ).
» Others: ENEA (IT), SINTEF EN (NO), SINTEF ICT (NO), Genoa University (IT), UCD University (IE), City University (UK), ALSTOM Power (FR), SIEMENS (DE), JRC (BE).

Brief project description: Installation and testing of a 1 MW electrochemical battery in a substation of the transmission grid.

Keywords: Security, Risk assessment, Emergency control, Defence, Restoration.

Website of the project: http://www.after-project.eu

CORDIS: http://cordis.europa.eu/project/rcn/100196_en.html

Functional objectives: T7, T9

» ALMACENA

Project Coordinator: Miguel Ordiales	**Company:** Red Eléctrica de España (Spain)
email: mordiales@ree.es	**Phone:** +34-91-650-20-12
Start/End: 2009/2013	**Current status:** Completed
Budget: 4 million EUR	**Funding scheme:** ERDF

Members of the consortium:
» TSOs: REE (ES).
» Others:

Brief project description: Installation and testing of a 1 MW electrochemical battery in a substation of the transmission grid.

Keywords: Energy Storage, Load shift, RES integration.

Website of the project: http://www.ree.es

Functional objectives: T2, T4

» ANEMOS PLUS

Project Coordinator: Dr George Kariniotakis	**Company:** ARMINES/MINES ParisTech (France)
email: georges.kariniotakis@mines-paristech.fr	**Phone:** +33-0-4-93-95-75-01 (ext. 7599)
Start/End: Jan-2008/Jun-2011	**Current status:** Completed
Budget: 5.7 million EUR	**Funding scheme:** Granted by 6th Framework Programme

Members of the consortium:
» TSOs: REN (PT), REE (ES), EIRGRID (IE), SONI (GB), PPC (System Operator of Crete Island, GR), EDF-Guadeloupe (System Operator of Guadeloupe Island, FR).
» Others: EWE (DE), Acciona Energia (ES), DONG Energy Generation (DK), Danish Technical University (DK), OVERSPEED GmbH (DE), Energy & Meteo Systems GmbH (DE), ENFOR (DK), University Carlos III Madrid (ES), INESC Porto (PT), CENER (ES), University College of Dublin (IE), University of Antilles & Guyane (FR), National Technical University of Athens-ICCS (GR).

Brief project description: Advanced tools for the management of electricity grids with large-scale wind generation, demonstration.

Keywords: Wind energy, Wind power forecasting, Decision making under uncertainty, Reserve estimation, Congestion management, Scheduling, Wind/storage coordination, Optimal trading, Uncertainty management, Demonstration.

Website of the project: http://www.anemos-plus.eu/

CORDIS: http://cordis.europa.eu/project/rcn/86586_en.html

Functional objectives: T5, T6, T7, T10, TD1

» AUTODIG

Project Coordinator: Sonja Monica Berlijn	**Company:** Statnett (Norway)
email: Sonja.Berlijn@statnett.no	**Phone:**
Start/End: 2012/2016	**Current status:** Ongoing
Budget: 2 million EUR	**Funding scheme:**

Members of the consortium:
» TSOs: Statnett (NO).
» Others:

Brief project description: Improved error analysis and condition monitoring. Automated error analysis puts Statnett in a better position to investigate all operational disruptions in the high-voltage grid. This tool helps check and perform post-analysis on all incidents, about 25,000 per year ranging from a few seconds, reported by local and regional grid operators.

Keywords:

Website of the project: http://www.statnett.no/en/Sustainability/Forskning-og-Utvikling/Smarte-nett/

Functional objectives: T6

» AUTOMATIC FREQUENCY REGULATING RESERVE (FRR-A)

Project Coordinator:	**Company:** ENTSO-E, MSG/RGN
email:	**Phone:**
Start/End: 2014/	**Current status:** Ongoing
Budget:	**Funding scheme:**
Members of the consortium: » TSOs: Energinet.dk (DK), Statnett (NO), Svenska Kraftnät (SE), Fingrid (FI). » Others:	
Brief project description: The project's primary objective is to develop the reserve towards a common energy market and an "Energy -only" market without reservation payment . Thus, two things need to be clarified , firstly, the development of an algorithm that online can handle bottlenecks in the system and provide a new optimal allocation of the reserve in the Nordic region, and secondly, a new agreement concerning allocation of costs to the reserve.	
Keywords:	
Website of the project:	
Functional objectives: T7, T10	

» BELGIUM EAST LOOP NETWORK

Project Coordinator: Vanessa De Wilde	**Company:** Elia (Belgium)
email: vanessa.dewilde@elia.be	**Phone:** +32-22-49-55-71
Start/End: Sep-2010/Jun-2011	**Current status:** Completed
Budget:	**Funding scheme:** Funded 100% by Elia
Members of the consortium: » TSOs: Elia (BE). » Others: ORES (BE), Smarter Grid Solutions (UK).	
Brief project description: The project aims at designing an active network solution based on the power systems analysis. It will define principles of access for generators to perform a curtailment assessment that will help to estimate how often limits are threatened. The project will provide guidelines for active network solution deployment as well as a cost estimate.	
Keywords: Active network management, Distributed generators, Curtailment assessment.	
Website of the project: None	
Functional objectives: T12, TD1	

» BEST PATHS

Project Coordinator: Vicente González	**Company:** Red Eléctrica de España (Spain)
email: vgonzalez@ree.es	**Phone:** 00 34 91 625 98 10
Start/End: Oct-2014/Sept-2018	**Current status:** Ongoing
Budget: 63 million EUR, EU funding 35.5 million EUR	**Funding scheme:** FP7
Members of the consortium: » TSOs: REE (ES), Terna (IT), Elia (BE), 50Hertz (DE), Statnett (NO), Mavir (HU), Energinet.dk (DK). » Others: Nexans, Toshiba, Prysmian, 3M, Gamesa, and others.	
Brief project description: To demonstrate HVDC for connecting offshore RES, multi-terminal HVDC, HVDC – HV AC interface, repowering of AC corridors, and superconductivity and to propose dedicated, intelligent monitoring with temperature measurements for dynamic line rating.	
Keywords: Multiterminal HVDC, HVDC grids, VSC interoperability, rehabilitation of HVDC links, High Temperature Superconductors, AC repowering, Off-shore Wind Farm.	
Website of the project: http://www.bestpaths-project.eu/	
CORDIS: http://cordis.europa.eu/project/rcn/197829_en.html	
Functional objectives: T1, T14, T3, T4, T5, T15, T17	

» BESTGRID

Project Coordinator: Theresa Schneider	**Company:** RGI
email: theresa@renewables-grid.eu	**Phone:**
Start/End: Apr-2013/Oct-2015	**Current status:** Completed
Budget: 1.9 million EUR	**Funding scheme:**
Members of the consortium: » TSOs: TenneT (DE/NL), Terna (IT), Elia (BE), 50Hertz (DE), National Grid (UK). » Others: Birdlife (UK), Germanwatch (DE), IIASA (AT).	
Brief project description: With nine partners, comprising European non-governmental organisations (NGOs), TSOs, and a research institute, the EU-funded BESTGRID project works towards modernising and expanding the current European electricity grid for the integration of a growing share of electricity from renewable sources. Launched in April 2013, BESTGRID is made up of five pilot projects located in Belgium, Germany, and the UK. During the project, TSOs and NGOs work together to improve local and public acceptance for grid development processes. Objectives of the project are to enhance transparency and public participation, to speed up permit procedures by proactively addressing or even surpassing environmental protection standards, and to encourage the implementation of constructive public engagement in permit procedures for European energy infrastructure 'projects of common interest'.	
Keywords:	
Website of the project: www.bestgrid.eu	
Functional objectives: T14	

» CELL CONTROLLER PILOT PROJECT

Project Coordinator:	**Company:** Energinet.dk (Denmark)
email: kbe@energinet.dk	**Phone:** +45-23-33-89-54
Start/End: Nov-2004/Oct-2011	**Current status:** Completed
Budget: 13.4 million EUR	**Funding scheme:** Funded 100% by Energinet.dk

Members of the consortium:
» TSOs: Energinet.dk (DK).
» Others: SydEnergi Net (DK), Spirae Inc (USA), Energynautics GmbH (DE), Kalki Tech (India), Tjæreborg Industri (DK), PonPower (DK).

Brief project description: The project is to help adapt the Danish power system to future requirements by increasing the extent of system control and monitoring to ensure that power generation and consumption balance.

Keywords: Virtual power plant, Ancillary services, Reliability.

Website of the project:

Functional objectives: T3, T5, T6, TD3, TD4

» CHPCOM (Combined Heat and Power Communication)

Project Coordinator: David Victor Tackie	**Company:** Danish Energy Association (Denmark)
email: dvt@danskenergi.dk	**Phone:** +45 20 90 77 83
Start/End: Jan-2013/Jan-2016	**Current status:** Ongoing
Budget: 1.7 million EUR	**Funding scheme:** National (ForskEL)

Members of the consortium:
» TSOs: Energinet.dk (DK).
» Others: Danish District Heating Association (DK), Foreningen Danske Kraftvarmeværker (DK), EURISCO ApS (DK), NEAS Energy (DK), EnergiMidt (DK), Brædstrup District Heating (DK), Alexandra Institute (DK).

Brief project description: The CHPCOM projects goal is to develop an IT communication solution to make the Danish power system ready for a smart grid. The method is to standardise data communication between CHP plants and the other actors of the power system. When data communication is standardised, the barriers prohibiting effective data exchange are broken down. This gives a long list of opportunities and advantages for the CHP plant and the other actors of the power system including:

» Automated data exchange of environment and measurement data between CHP plants and other actors through Internet-based communication.
» Secure access to measurement data from other actors.
» Easier administration and higher quality of data at CHP plants and other actors.
» More flexible production and possibility for delivery of new services.
» Lower costs when changing the balance responsible party – both for the plant and the balance responsible party.

With the CHPCOM solution, the Danish combined heat and power sector is equipped for a future power market based on renewable energy, interoperation between the plants, and a higher demand for intelligent management of the operation.

Keywords:

Website of the project: www.chpcom.dk

Functional objectives: T2, T3, T5, T6

» CITIES (Centre for IT-Intelligent Energy Systems in cities)

Project Coordinator: Henrik Madsen	**Company:** Technical University of Denmark (DK)
email: henrik.madsen@smart-cities-centre.org	**Phone:**
Start/End: Jan-2014/Dec-2019	**Current status:** Ongoing
Budget: 9.5 million EUR	**Funding scheme:** National (Innovation Fund Denmark)

Members of the consortium:
» TSOs: Energinet.dk (DK).
» Others: DTU Compute, DTU Civil Engineering, DTU Management Engineering, DTU Elektro, DTU Energy Conversion and Storage, AAU planning, AAU Civil Engineering, Energinet.dk, EMD International A/S, HOFOR, University College Dublin, ENFOR A/S, Tecnalia, AffaldVarme Aarhus, NREL, Dansk Fjernvarme, DFF-EDB, EA Energianalyse A/S, Lean Energy Cluster, Danfoss, Topsoe Fuel Cell A/S, Dansk Energi, EMT Nordic A/S, Samsung C&T, Eurisco ApS, Seoul National University, Frederikssund Forsyning, Grundfos A/S, NEAS, Neogrid Technologies, Project Zero A/S, Dansk Industri, DONG Energy Oil & Gas A/S, Syd Energi Service A/S, Konkuk University, Austrian Institute of Technology (AIT), Ve-Net at Danish Technological Institute, Rambøll, Fjernvarme Fyn.

Brief project description: CITIES aims at developing methodologies and ICT solutions for the analysis, operation, planning, and development of fully integrated urban energy systems. A holistic research approach will be developed to provide solutions at all levels between the appliance and overall system and all-time scales between operations and planning. The necessity of novel, data driven, and IT intelligent solutions is stressed. A focus is placed on energy system planning in systems with high utilisation of renewable energy or those entirely independent of fossil fuels.

Keywords:

Website of the project: http://smart-cities-centre.org/

Functional objectives: T6, TD1

» CONCEPT FOR MANAGEMENT OF THE FUTURE ELECTRICITY SYSTEM

Project Coordinator:	**Company:** Energinet.dk (Denmark)
email: kbe@energinet.dk	**Phone:** +45-76-22-45-35
Start/End: Jan-2009/2009	**Current status:** Completed
Budget:	**Funding scheme:** National

Members of the consortium:
» TSOs: Energinet.dk (DK).
» Others: Danish Energy Association (DK).

Brief project description: To describe and calculate a 'Danish business case for full Smart Grid dissemination' from a socio-economical perspective.

Keywords:

Website of the project:

Functional objectives: T1, T2, T3, T5, T6, T9, T10, TD1, TD2, TD3, TD4, TD5

» CONTINUOUS RAMPING OF HVDC LINES

Project Coordinator:	**Company:** ENTSO-E, RGN
email:	**Phone:**
Start/End: 2013/2015	**Current status:** Ongoing
Budget:	**Funding scheme:**
Members of the consortium: » TSOs: Energinet.dk (DK), Statnett (NO), Svenska Kraftnät (SE), TenneT (DE). » Others:	
Brief project description: The purpose of continuous ramping of HVDC lines is to change the ramping rules in order to increase capacity, improve the quality of frequency, and make the shift from high price to low cost in less time regarding the dynamic conditions of the network.	
Keywords:	
Website of the project:	
Functional objectives: T3, T4	

» DEMONSTRATIONS OF POWER LOAD CONTROL MECHANISMS

Project Coordinator:	**Company:**
email:	**Phone:**
Start/End:	**Current status:** Ongoing
Budget:	**Funding scheme:**
Members of the consortium: » TSOs: » Others:	
Brief project description:	
Keywords:	
Website of the project:	
Functional objectives: T6, TD2, TD3	

» DEVELOPMENT OF COMPOSITE TOWERS FOR 420 kV

Project Coordinator: Sonja Monica Berlijn	**Company:** Statnett
email: Sonja.Berlijn@statnett.no	**Phone:**
Start/End:	**Current status:** Ongoing
Budget:	**Funding scheme:**
Members of the consortium: » TSOs: Statnett (NO). » Others:	
Brief project description: Statnett is working on developing pylons made of composite, which are significantly lighter than today's pylons.	
Keywords:	
Website of the project: http://www.statnett.no/en/Sustainability/Forskning-og-Utvikling/Innovativ-teknologi/	
Functional objectives: T14	

» DEVELOPMENT OF EARLY WARNINGS SYSTEMS (PMU/WAMS)

Project Coordinator:	**Company:** Energinet.dk (Denmark)
email: kbe@energinet.dk	**Phone:** +45-76-22-45-35
Start/End: 2006/2012	**Current status:** Completed
Budget:	**Funding scheme:** Financed 100% by Energinet.dk
Members of the consortium: » TSOs: Energinet.dk (DK). » Others: CET, DTU (DK), University of Kassel (DE).	
Brief project description: The purpose is to develop systems that can monitor the overall power system state and alert system operators and other protection systems for critical situations in the power system.	
Keywords:	
Website of the project: None	
Functional objectives: T2, T5, T6, T7, T9	

» DEVELOPMENT OF MARKET MODELLING CAPACITY

Project Coordinator: Erkki Sapp	**Company:** Elering (Estonia)
email: erkki.sapp@elering.ee	**Phone:**
Start/End: 2012/2014	**Current status:** Completed
Budget: 0.4 million EUR	**Funding scheme:** National
Members of the consortium: » TSOs: Elering (EE), AST (LV), Litgrid (LT). » Others: EA Energy Analyses (DK).	
Brief project description: Increasing market modelling capacity in Baltic countries based on the Balmorel model and developing long-term energy scenarios for the region.	
Keywords: Market modelling.	
Website of the project:	
Functional objectives: T1	

» DSR

Project Coordinator: Kalle Kukk	**Company:** Elering (Estonia)
email: Kalle.Kukk@elering.ee	**Phone:**
Start/End: 2012/2017	**Current status:** Ongoing
Budget: 0.5 million EUR	**Funding scheme:** National
Members of the consortium: » TSOs: Elering (EE). » Others: Tallinn University of Technology (EE), Pöyry (UK, FI).	
Brief project description: 1) DSR potential for Estonia, 2) DSR as source for flexibility, and 3) DSR applications.	
Keywords:	
Website of the project:	
Functional objectives: T10, T12, TD3	

» eBADGE

Project Coordinator: Peter Zidar	**Company:** Telekom Slovenije (Slovenia)
email: peter.zidar@telekom.si	**Phone:** 00386 1 234 10 00
Start/End: Oct-2012/Dec-2015	**Current status:** Completed
Budget: 4.9 million EUR	**Funding scheme:**

Members of the consortium:
» TSOs: APG (AT), ELES (SI).
» Others: cyberGRID (AT); RSE (IT), XLAB, BORZEN, Elektro Ljubljana (SI), Technische Universitaet Wien (AT); Austrian Institute of Technology (AT); EUDT, SAP (FR), Vaasaett.

Brief project description: The overall objective of the eBADGE project is to propose an optimal pan-European intelligent balancing mechanism, piloted on the borders of Austria, Italy, and Slovenia, that is also able to integrate virtual power plant systems that can assist in the management of the electricity transmission and distribution grids in an optimised, controlled, and secure manner.

Keywords:

Website of the project: www.ebadge-fp7.eu

Functional objectives: T2, T3, T4, T5, T8, T10, TD1, TD2, TD3

» ECOGRID EU

Project Coordinator: Ove S. Grande	**Company:** SINTEF Energi AS (Norway)
email: Ove.S.Grande@sintef.no	**Phone:**
Start/End: Jan-2011/Dec-2014	**Current status:** Completed
Budget: 25 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: Energinet.dk (DK), Elia (BE).
» Others: SINTEF (NO), Østkraft (DK), Siemens (DK, DE), ECN (NL), IBM (DK, CH), EANDIS (BE), EnCT (DE), Tecnalia (ES), DTU-CET (DK), AIT (AU), TUT (EST), Landis + Gyr (DK).

Brief project description: To build and demonstrate a complete prototype of the future power system with more than 50% renewable energy. The primary focus is on market integration and inclusion of electricity customers in the building of tomorrow's smart grid.

Keywords:

Website of the project: http://www.eu-ecogrid.net/

Functional objectives: T10, T12, TD2, TD3

» E-HIGHWAY2050

Project Coordinator: Gérald Sanchis	**Company:** RTE (France)
email: gerald.sanchis@rte-France.com	**Phone:** +33-1-41-02-12-80
Start/End: Apr-2012/Dec-2014	**Current status:** Completed
Budget: 14.6 million EUR	**Funding scheme:** Granted by 7th Framework Programme
Members of the consortium: » TSOs: Energinet.dk (DK), Elia (BE). » Others: SINTEF (NO), Østkraft (DK), Siemens (DK, DE), ECN (NL), IBM (DK, CH), EANDIS (BE), EnCT (DE), Tecnalia (ES), DTU-CET (DK), AIT (AU), TUT (EST), Landis + Gyr (DK).	
Brief project description: To build and demonstrate a complete prototype of the future power system with more than 50% renewable energy. The primary focus is on market integration and inclusion of electricity customers in the building of tomorrow's smart grid.	
Keywords:	
Website of the project: http://www.eu-ecogrid.net	
Functional objectives: T10, T12, TD2, TD3	

» ELECTRICAL CLEARANCES WHEN VOLTAGE UPGRADING

Project Coordinator: Sonja Monica Berlijn	**Company:** Statnett (Norway)
email: Sonja.Berlijn@statnett.no	**Phone:**
Start/End: Jan-2010/Dec-2012	**Current status:** Completed
Budget: 0.1 million EUR	**Funding scheme:**
Members of the consortium: » TSOs: Statnett (NO). » Others:	
Brief project description: Statnett is upgrading its existing 300 kV network to 420 kV. By evaluating the electrical clearances, Statnett has saved 60 million euro.	
Keywords:	
Website of the project: http://www.statnett.no/en/Sustainability/Forskning-og-Utvikling/Publiserte-papers/	
Functional objectives: T15	

» ESTFEED

Project Coordinator: Kristo Klesment	**Company:** Elering (Estonia)
email: kristo.klesment@elering.ee	**Phone:**
Start/End: 2012/2017	**Current status:** ongoing
Budget: 0.8 million EUR	**Funding scheme:** Norwegian Financial Mechanism

Members of the consortium:
» TSOs: Elering (EE), Statnett (NO).
» Others: Ericsson (EE), CGI (EE, NO), Estonian Renewable Energy Association (EE), DSO (EE), district heating (EE).

Brief project description: To design, implement, and test an open software platform for energy consumption monitoring and management from the customer perspective that is able to interact with grids and provide data feeds to service providers for an efficient use of energy.

Keywords: Smart grid, Demand-side management, Standardisation, ICT

Website of the project: http://estfeed.ee/en/

Functional objectives: T8, T10, TD2, TD3, TD5

» e-STORAGE

Project Coordinator: Olivier Teller	**Company:** Alstom (France)
email: olivier.teller@power.alstom.com	**Phone:** +33 4 76 39 27 44
Start/End: Oct-12/Sep-17	**Current status:** ongoing
Budget: 23.3 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: Elia (BE).
» Others: Algoé (FR), DNV KEMA (NL), EDF (FR), Imperial College London (UK).

Brief project description: e-Storage aims to improve energy management by developing a solution for cost-effective integration of intermittent renewable energy generation into the electrical grid. Objectives are to:

» Demonstrate technical and economic feasibility of upgrading an existing fixed speed pumped hydro storage to a variable-speed technology.
» Enhance the functionality of IT systems to develop grid management solutions in line with real-time market systems.
» Quantify the benefits of an EU-wide rollout of variable-speed pumped hydro storage under alternative scenarios.
» Propose changes to the market and regulatory frameworks to support appropriate business models for flexible energy storage in the EU.
» Develop and assess technology solutions allowing the upgrade of 75% of European pumped hydro storage to variable speed to obtain additional capacity for flexible load balancing.

Keywords: Variable-speed pumped hydro storage, Energy management, Market and regulatory frameworks.

Website of the project: http://estorage-project.eu/

CORDIS: http://cordis.europa.eu/project/rcn/107957_en.html

Functional objectives: T4, T10

» EVCOM

Project Coordinator:	**Company:** Energinet.dk (Denmark)
email: kbe@energinet.dk	**Phone:** +45-76-22-45-35
Start/End: Jan-2008/Dec-2010	**Current status:** Completed
Budget:	**Funding scheme:** Financed 100% by Energinet.dk
Members of the consortium: » TSOs: Energinet.dk (DK). » Others: Danish Energy Association (DK), a number of Danish DSO's (DK).	
Brief project description: The primary purpose is to establish a concept for electric vehicles and their communication with the power system. The concept is disseminated to standardise the work to relevant stakeholders.	
Keywords:	
Website of the project:	
Functional objectives: TD2, TD5	

» EvolvDSO

Project Coordinator:	**Company:** Enel Distribuzione S.P.A. (IT)
email:	**Phone:**
Start/End: Sep-2013/Jan-2017	**Current status:** Ongoing
Budget: 7.9 million EUR	**Funding scheme:** European (FP7)
Members of the consortium: » TSOs: Energinet.dk (DK), RTE (FR). » Others: CyberGRID GmbH (Austria), EDP Distr (Portugal), EDSO for Smart Grids (Belgium), Energy Pool (France), ERDF (France), ESB Networks (Ireland), INESC Porto (Portugal), GRENOBLE INP (France), RSE SPA (Italy), RWE DE (Germany), Rheinischwestfaelis (Gemany), NUID UCD (Ireland), VITO (Belgium).	
Brief project description: Development of methodologies and tools for new and evolving DSO roles for efficient DRES integration in distribution networks.	
Keywords:	
Website of the project: www.evolvdso.ec	
CORDIS: http://cordis.europa.eu/project/rcn/109548_en.html	
Functional objectives: TD1, TD2, TD3	

» EWIS (European Wind Integration Study)

Project Coordinator: Hubert Lemmens	**Company:** Elia (Belgium)
email: hubert.lemmens@elia.be	**Phone:** +32-25-46-71-01
Start/End: 2007/2010	**Current status:** Completed
Budget: 4 million EUR	**Funding scheme:** Granted by 6th Framework Programme

Members of the consortium:
» TSOs: Elia (BE), Transpower GmbH (DE), 50Hertz Transmission (DE), Amprion GmbH (DE), ČEPS (CZ), Eirgrid (IE), Energinet.dk (DK), HTSO (GR), National Grid (UK), PSE (PL), REE (ES), REN (PT), RTE (FR), TenneT TSO B.V. (NL), Verbund (AT).
» Others: EC, EWEA, Eurelectric, EFET, IEA, Tradewind.

Brief project description: EWIS has focused on immediate network-related challenges by analysing detailed representations of the existing electricity markets, network operations, and the physical power flows and other system behaviours that result. The starting point was the actual condition in 2008 with future challenges assessed against realistic representations of network extensions and reinforcements taken from national development plans. In general, detailed information on user and network developments are only available for a limited number of future years; therefore, 2015 was chosen as a suitable horizon for assessing how current plans will address future challenges. Given the importance of the 2020 targets, however, the study examined the prospects for further developments beyond 2015. The project provided important input for TYNDP 2010, the system requirements for Network Pilot Code and system security aspects for the future coordinated and stable operation of the pan-European transmission system.

Keywords:

Website of the project: http://www.wind-integration.eu/

CORDIS: http://cordis.europa.eu/project/rcn/85678_en.html

Functional objectives: T2, T3, T5, T9

» FLEXe

Project Coordinator:	**Company:** CLIC Innovation Ltd
email:	**Phone:**
Start/End: Jan-2015/2019	**Current status:** Ongoing
Budget: 13.7 million EUR	**Funding scheme:** National

Members of the consortium:
» TSOs: Fingrid.
» Others: ABB, Dinex Ecocat, Elenia, Empower IM, Empower TN, Emtele, Fingrid, Fortum, Helen, Inno-W, MX Electrix, Indmeas Industrial Measurements, Tekla, Valmet Automation, Valmet Technologies, Wapice, Wärtsilä Finland, Aalto University, Finnish Meteorological Institute, University of Eastern Finland, Lappeenranta University of Technology, University of Oulu, Finnish Environmental Institute, Svenska Handelhögskolan, VTT Technical Research Centre of Finland (Tampere), University of Technology, University of Vaasa.

Brief project description: FLEXe programme creates novel technological and business concepts that enhance the radical transition from the current energy systems towards sustainable systems that combine smartness, flexibility, environmental performance, and economic success with customer acceptance and engagement. The following topics are in the centre of the research programme: 1) systemic views on the transition to business ecosystems of a future flexible energy system – understanding future demand profiles and the role and value of different flexibility options; 2) optimised and secured integration and operation of future energy networks; 3) flexibility management of distributed resources – increasing efficiency across the whole energy system and supporting active participation of all partners of the system; and 4) flexible generation for future energy systems.– new operational modes for secure, cost-effective, clean, and competitive energy supply.

Keywords:

Website of the project: www.clicinnovation.fi

Functional objectives: T1, T2, T12

» FREQUENCY CONTAINMENT PROCESS

Project Coordinator:	**Company:** ENTSO-E, Nordic Analyse Group
email:	**Phone:**
Start/End:	**Current status:** Ongoing
Budget:	**Funding scheme:**
Members of the consortium: » TSOs: Energinet.dk (DK), Statnett (NO), Svenska Kraftnät (SE), Fingrid (FI). » Others:	
Brief project description: The project is a continuation of the Nordic FRR, a project primarily aimed at redefining the specifications of the Nordic disturbance reserve, considering balancing reserves (FRR), plant control ability, and the oscillations of the Nordic system.	
Keywords:	
Website of the project:	
Functional objectives: T5, T7, T11	

» FREQUENCY CONTAINMENT PROCESS

Project Coordinator:	**Company:** Energinet.dk (Denmark)
email: kbe@energinet.dk	**Phone:** +45-76-22-44-06
Start/End: 2010/2012	**Current status:** Completed
Budget: 1 million EUR	**Funding scheme:** Financed 100% by Energinet.dk
Members of the consortium: » TSOs: Energinet.dk (DK). » Others: Danish Energy Authority, Centre for Energy Savings (DK).	
Brief project description: To control 300 intelligent heat pumps as if they were one big energy storage facility capable of storing electricity as heat.	
Keywords:	
Website of the project www.styrdinvarmepumpe.dk	
Functional objectives: T5, T10, T12, TD2, TD3, TD4, TD5	

» FUTUREFLOW

Project Coordinator: Uros Salobir	**Company:** ELES (Slovenia)
email: uros.salobir@eles.si	**Phone:**
Start/End: Jan-2016/Jan-2020	**Current status:** Ongoing
Budget: 12.9 million EUR	**Funding scheme:** Horizon 2020

Members of the consortium:
» TSOs: ELES (SI), APG (AT), MAVIR (HU), Tranelectrica (RO).
» Others: Elektroinštitut Milan Vidmar (SI), Elektroenergetski koordinacionalni centar (SRB), Elektro energija (SI), Gen-I (SI), SAP (DE), Cybergrid (AT), Gemalto SA (F), 3E (BE).

Brief project description: FutureFlow links interconnected control areas of four TSOs of central-south Europe, which today face increasing challenges to ensure transmission system security. The growing share of renewable electricity units has drastically reduced the capabilities of conventional, fossil-fuel based means to ensure balancing activities and congestion relief through re-dispatching. Today, there is a need to face future balancing and network security challenges with the help of a more intensive and joint approach at the regional level. Research and innovation activities are proposed to validate that consumers and distributed generators can be put in a position to provide balancing and re-dispatching services in addition to conventional units, within an attractive business environment.

Keywords:

Website of the project:

Functional objectives:

» GARPUR

Project Coordinator: Oddbjörn Gjerde	**Company:** SINTEF Energy AS (Norway)
email: oddbjorn.gjerde@sintef.no	**Phone:**
Start/End: Sep-2013/Aug-2017	**Current status:** Ongoing
Budget: 10.84 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: Statnett (NO), Elia (BE), RTE (FR), Landsnet (IS), Energinet (DK), ČEPS (CZ), ESO EAD (BU).
» Others: Sintef (NO), Université de Liège (BE), Reykjavik University (IS), KU Leuven (BE), Aalto University (FI), TU Delft (NL), University of Strathclyde (UK), University of West Bohemia (CZ), Norwegian University of Science and Technology (NO), Technofi (FR), University of Duisburg-Essen (DE), Technion Israel Institute of Technology (IL), Technical University of Denmark – DTU (DK).

Brief project description: GARPUR designs, develops and assesses new probabilistic reliability criteria and evaluates their practical use while maximising social welfare as they are implemented progressively over the next decades at a pan-European level. The new management methodologies encompass multiple business activities (system development, asset management, system operation) that, in turn, ensure coherent decision making at the respective time horizons. After practical validation by the TSOs, these alternatives are analysed with the help of a quantification platform. Pilot tests are performed by individual TSOs or (when appropriate) a group of TSOs. An implementation roadmap is delivered for deployment of the resulting technical and regulatory solutions to keep the pan-European system reliability at optimal socio-economic level.

Keywords:

Website of the project: http://www.garpur-project.eu/

CORDIS: http://cordis.europa.eu/project/rcn/109832_en.html

Functional objectives: T1, T2, T7, T9, T16, TD4

» GREDOR

Project Coordinator: Damien Ernst	**Company:** Université de Liège (ULg)
email: damien.ernst@ulg.ac.be	**Phone:**
Start/End: Feb-2013/Jan-2017	**Current status:** Ongoing
Budget: 4.34 million EUR	**Funding scheme:** National (Walloon region)

Members of the consortium:
» TSOs: Elia (BE).
» Others: Université de Liège (BE), FPMons (BE), ORES (BE), TECTEO (BE), EdF Luminus (BE), Tractebel Engineering (BE).

Brief project description: GREDOR is a smart grid project in Wallonia, covering the economic and technical aspects of the new line transmission and the operational and real-time processes to be redesigned with the DSOs and market actors. The focus is on the MV network but the interrelationships with the HV and MV grid will be analysed. GREDOR will propose several market options to model the interactions between the grid operators and the market players and will develop decision supporting tools for the three timeframes. The proposal is in line with the conclusions of the REDI platform managed by the Walloon regulator CWAPE.

Keywords:

Website of the project: https://gredor.be/

Functional objectives: TD1, TD3

» GRIDTECH

Project Coordinator: Hans Auer	**Company:** EEG TU Wien (Austria)
email: auer@eeg.tuwien.ac.at	**Phone:** 0043-1-58801-370357
Start/End: Apr-2012/Apr-2015	**Current status:** Completed
Budget: 1.96 million EUR	**Funding scheme** European (IEE)

Members of the consortium:
» TSOs: ESO (BG), EirGrid (IE), Terna (IT), TenneT (NL).
» Others: EEG TU Wien (AT), RSE (IT), IIT-UP Comillas (ES), WIP GmbH (DE), BSERC (BG), EC JRC (BE), EUREC (BE), EnBW AG (DE), Organic Power Ltd (IE), Verbund AG (AT).

Brief project description: The major objective of GridTech is to conduct a fully integrated impact assessment of the implementation of new technologies (for transmission, storage, and demand side) into the European electricity system necessary to exploit the full potential of future RES-E generation across Europe with the lowest possible total electricity system cost. This is carried out at both pan-European and target region (Austria, Bulgaria, Germany, Ireland, Italy, Netherlands, and Spain) levels. The timeframe for GridTech analyses is up to 2050, with special consideration of the target years 2020, 2030, and 2050.

Keywords:

Website of the project: www.gridtech.eu

Functional objectives: T1, T2, T14, T3, T4, T5, T6, T9, T10, T12, TD2, TD3

» HUMBER SMARTZONE PILOT PROJECT

Project Coordinator: Paul Auckland	**Company:** National Grid (United Kingdom)
email: Paul.Auckland@nationalgrid.com	**Phone:**
Start/End: Jan-2011/Mar-2017	**Current status:** Ongoing
Budget: 1.49 million EUR	**Funding scheme:** National
Members of the consortium: » TSOs: National Grid (UK). » Others:	
Brief project description: The project aims to develop and demonstrate a proof of concept to provide flexible enhanced circuit ratings using a combination of wide-area monitoring, predictive ratings, and dynamic security analysis.	
Keywords:	
Website of the project:	
Functional objectives: T1, T2, T3, T4, T5, T6, T7, T9, T11, T15, T17, TD1, TD2, TD5	

» ICOEUR

Project Coordinator: Rachid Cherkaoui	**Company:** Swiss Federal Institute of Technology (Switzerland)
email: rachid.cherkaoui@epfl.ch	**Phone:**
Start/End: 2008/2010	**Current status:** Completed
Budget: 4.8 million EUR	**Funding scheme:** European (FP7)
Members of the consortium: » TSOs: Terna (IT), ELES (SI). » Others: EIAS, IPS, State research institute–Institute of Physical Energetics (IPE), Power System Emergency Control laboratory, Ltd, ELPROS Electronic and Programming Systems, Siberian Electric Power Research Institute (SibEPRI), All-Russian Electrotechnical Institute named after V. I. Lenin – FGUP VEI, Trapeznikov Institute of Control Sciences (ICS RAS), Suez-Tractebel, Regio Politecnico di Torino, ABB, Riga Technical University, Tallinn University of Technology, the Electric Power Systems Laboratory (LRE) of the Swiss Federal Institute of Technology, Lausanne (EPFL), University of Birmingham, ERSE S.p.A. (ENEA–Ricerca sul Sistema Elettrico), Energy Systems Institute (ESI), Technische Universität Dortmund.	
Brief project description: The ICOEUR project (Intelligent Coordination of Operation and emergency control of EU and Russian power grids) addresses the topic of innovative operational and monitoring tools for large power systems.	
Keywords:	
Website of the project: www.icoeur.eu	
CORDIS: http://cordis.europa.eu/project/rcn/90889_en.html	
Functional objectives: T2, T6, T9	

» IMPACT OF ELECTRIC AND GAS VEHICLES

Project Coordinator: Kalle Kukk	**Company:** Elering (EE)
email: Kalle.Kukk@elering.ee	**Phone:**
Start/End: Jul-2012/Apr-2016	**Current status:** Ongoing
Budget: 0.25 million EUR	**Funding scheme:** National

Members of the consortium:
» TSOs: Elering (EE).
» Others: Tallinn University of Technology (EE).

Brief project description: The objective of this project is to study the effect of large-scale electrical transport on the Estonian electricity system and on the energy sector in general. The main reasons for the project are two electric transport systems that are under development – electric cars and the planned European interstate rapid railway project: 1) effects on grid; 2) socio-economic effects.

Keywords:

Website of the project:

Functional objectives: T1

» INCREASE

Project Coordinator: Bart Meersman	**Company:** Ghent University (BE)
email: Bart.Meersman@ugent.be	**Phone:**
Start/End: Sep-13/Dec-16	**Current status:** Ongoing
Budget: 4.39 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: Elia (BE).
» Others: Ghent University (BE), Eandis (BE), Liander (NL), Elektro Gorenjska (SL), Stomnetz Steiemark (AT), Aristotle University of Tessaloniki (GR), Joanneum Research Forschungs-gesselshaft (AT), Technical University Eindhoven (NL), University of Ljubljana (SL), Alenco (BE), Korona d.d. (SL), Mastervolt International (NL).

Brief project description: The INCREASE project will focus on how to manage renewable energy sources in the LV and MV networks to provide ancillary services (towards DSOs and TSOs), in particular voltage control and the provision of reserves. INCREASE will enable distributed RES (DRES) and loads to go beyond just exchanging power with the grid, enabling DSOs to evolve from congestion managers to capacity managers, resulting in a more efficient exploitation of the current grid capacity, facilitating higher DRES penetration at a reduced cost. The INCREASE simulation platform will enable the validation of the proposed solutions and provide the DSOs with a tool they can use to investigate the influence of DRES in their distribution network. Validation will be performed by lab tests and field trials in real-life operational distribution networks.

Keywords:

Website of the project:

CORDIS: http://cordis.europa.eu/project/rcn/109974_en.html

Functional objectives: TD3

» INSPIREGRID

Project Coordinator:	**Company:** RSE (Italy)
email:	**Phone:**
Start/End: Sep-2013/	**Current status:** Ongoing
Budget:	**Funding scheme:** FP7
Members of the consortium: » TSOs: RTE (FR) » Others:	
Brief project description: To analyse the needs, concerns, wants, and expectations of the stakeholders and general public, to develop suitable processes for effective communication and real participation of stakeholders and the general public, and to improve the existing methodologies to estimate and represent the effects (drawbacks and benefits) of transmission projects in Europe using a multi-criteria and multi-stakeholder framework.	
Keywords:	
Website of the project: http://www.inspire-grid.eu/	
Functional objectives: T14, T15	

» iTESLA

Project Coordinator: Christian Lemaitre	**Company:** RTE (France)
email: christian.lemaitre@rte-france.com	**Phone:** +33-1-39-24-40-78
Start/End: Jan-2012/Dec-2015	**Current status:** Completed
Budget: 19.4 million EUR	**Funding scheme:** Granted by 7th Framework Programme
Members of the consortium: » TSOs: RTE (FR), Elia (BE), NGC (UK), REN (PT), Statnett (NO), HTSO (GR), Coreso (BE). » Others: AIA (SP), Artelys (FR), Bull (FR), PEPITE (BE), Quinary (IT), Tractebel (BE), Technofi (FR), Imperial College (UK), INESC Porto (PT), KTH (SE), K. U. Leuven (BE), RSE (IT), DTU (DK).	
Brief project description: The goal of this four-year R&D project is to develop and validate an open interoperable toolbox, by 2015, which will provide support to future operations of the pan-European electricity transmission network, thus favouring increased coordination and harmonisation of operating procedures among network operators. New concepts, methods, and tools are developed to define security limits of the pan-European system and to quantify the distance between an operating point and its nearest security boundary. This requires creating its most likely description and developing a risk-based security assessment accounting for its dynamic behaviour. The chain of resulting tools meets three overarching functional goals: 1) to provide a risk-based security assessment accounting for uncertainties around the most likely state for probabilities of contingencies and for the corresponding preventive and corrective actions, 2) to construct more realistic states of any system (considering its dynamics) over different timeframes (real time, intraday, day ahead, etc.), and 3) to assess system security using time domain simulations (with less approximation than when implementing current standard methods/tools).	
Keywords: Pan-European coordination, Security assessment, Risk-based security analysis, System dynamic behaviour, Large non-convex optimisation techniques.	
Website of the project: www.itesla-project.eu	
CORDIS: http://cordis.europa.eu/project/rcn/101320_en.html	
Functional objectives: T7	

» KÄVA2

Project Coordinator: Jarno Lamponen	**Company:** Fingrid (Finland)
email: jarno.lamponen@aalto.fi	**Phone:**
Start/End: 2007/2013	**Current status:** Completed
Budget:	**Funding scheme:** Funded by Fingrid
Members of the consortium: » TSOs: Fingrid (FI). » Others: Aalto University (FI).	
Brief project description: Doctoral thesis project on power system security to develop probability-based methods to supplement the n-1 criterion.	
Keywords: Reliability, N-1.	
Website of the project:	
Functional objectives: T2, T7	

» LIFE BIODIVERSITÉ

Project Coordinator: Gaëlle Vervack	**Company:** Elia (Belgium)
email: Gaëlle.Vervack@elia.be	**Phone:**
Start/End: Sep-2011/Aug-2015	**Current status:** Completed
Budget: 2.55 million EUR	**Funding scheme:** LIFE Programme (DG Environment)
Members of the consortium: » TSOs: Elia (BE), RTE (FR). » Others: SOLON asbl (BE), CARAH asbl (FR).	
Brief project description: The aim of the Elia Biodiversity project is to develop innovative techniques for the creation and maintenance of corridors under overhead lines, allowing the maximisation of their potential benefits for biodiversity. The expected benefits include the preservation of the natural beauty of the landscape; improved attractiveness to tourists, hunters and local residents; greater acceptance by the general public of line infrastructure in the landscape; and a better public image for the TSO. Specifically, the project aims to restore 130 km of corridors under overhead high-voltage lines in Belgium and France.	
Keywords: Biodiversity management, Overhead lines, Transmission.	
Website of the project: http://www.life-elia.eu/en/	
Functional objectives: T14	

» MARKET4RES

Project Coordinator:	**Company:** Sintef (Norway)
email:	**Phone:**
Start/End: Apr-2014/Sep-2016	**Current status:** Ongoing
Budget:	**Funding scheme:** European (IEE)

Members of the consortium:
» TSOs: RTE (FR).
» Others: EWEA (BE), EEG (AT), EPIA (BE), 3E (BE), Technofi (FR), Comillas (ES), Iberdrola (ES), APX (NL), FOSG (BE).

Brief project description: Market4RES investigates the potential evolution of the target model (TM) for the integration of EU electricity markets that will enable a sustainable, functioning, and secure power system with large amounts of renewables. With a focus on wholesale market design, Market-4RES will identify and recommend steps for the implementation of policy, legislation, and regulation across different timeframes of energy markets. One key objective is the facilitation of dialogue among relevant stakeholders on which steps towards the most economically sustainable market design should be taken. In particular, the project aims to contribute to an open and transparent debate on the potential evolution of the EU TM after 2020; identify and recommend steps for the implementation of policy, legislation, and regulation across the renewable energy sectors; and identify and recommend concrete steps so relevant market actors can accept and adopt the main results of the project.

Keywords:

Website of the project: http://market4res.eu/

Functional objectives: T12

» MERGE

Project Coordinator: Nikos Hatziargyriou	**Company:** PPC (Greece)
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Start/End: Jan-2010/Dec-2011	**Current status:** Completed
Budget: 4.4 million EUR	**Funding scheme:** FP7

Members of the consortium:
» TSOs: PPC (GR), REE (ES), REN (PT).
» Others: INESC Porto, ICCS/NTUA, TU Berlin, Cardiff, Comillas, Iberdrola, ESB, AVERE, RAE, Ricardo, IMR World, C4D, and InSpire.

Brief project description: The project mission was to evaluate the effects of electric vehicles (EV) on the EU electric power systems with respect to planning, operations, and market functioning. The focus was placed on EV and smart grid/micro grid deployment. This should involve an increase in the renewable energy and reduce CO2 emissions. Furthermore, the project should identify suitable enabling technologies and advanced control approaches.

Keywords: Electric vehicle.

Website of the project: www.ev-merge.eu

CORDIS: http://cordis.europa.eu/project/rcn/94380_en.html

Functional objectives: T1, T2,

» MIGRATE

Project Coordinator: Andreas Menze	**Company:** TenneT (DE)
email: Andreas.Menze@tennet.eu	**Phone:**
Start/End: Jan-2016/Dec-2019	**Current status:** Ongoing
Budget:	**Funding scheme:**

Members of the consortium:
» TSOs: TenneT (DE), Scottish Power Energy Networks (UK), RTE (FR), REE (ES), ELES (SI), Amprion (DE), EirGrid (Ireland), Elering (EE), Fingrid (FI), Terna (IT), Landsnet (Iceland).
» Others: Schneider (FR), Gottfried Wilhelm Leibniz Universitaet Hannover (DE), Technische Universiteit Delft (NL), University College Dublin, National University Of Ireland, Dublin Ireland The University of Manchester, Tallinna Tehnikaulikool Estonia, Ecole Nationale Superieure D'arts Et Metiers (FR), Eidgenoessische Technische Hochschule Zuerich (Switzerland), Fundacion Circe Centro De Investigacion De Recursos Y Consumos Energeticos Spain Univerza, Ljubljani Slovenia Technische, Universitaet Berlin Germany, Elektroinštitut Milan Vidmar Slovenia, Consorzio Interuniversitario Nazionale Per Energia E Sistemi Eletrici (Italy).

Brief project description: By 2020, several areas of the HVAC pan-European transmission system will be operated with extremely high penetrations of power electronics (PE)-interfaced generators, thus becoming the only generating units for some periods of the day or of the year – due to renewable (wind and solar) electricity. This will result in 1) growing dynamic stability issues for the power system (possibly a new major barrier against future renewable penetration), 2) the necessity to upgrade existing protection schemes, and 3) measures to mitigate the resulting degradation of power quality due to harmonics propagation. European TSOs from Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Netherlands, Slovenia, Spain, and the UK have joined to address such challenges with manufacturers (Alstom, Enercon, and Schneider Electric) and universities and research centres. They propose innovative solutions to progressively adjust HVAC system operations. First, a replicable methodology is developed for appraising the distance of any EU 28 control zone to instability due to PE proliferation and to monitor it in real time, along with a portfolio of incremental improvements of existing technologies (the tuning of controllers, a pilot test of wide-area control techniques, and the upgrading of protection devices with effects on the present grid codes). Next, innovative power system control laws are designed to cope with the lack of synchronous machines. Numerical simulations and laboratory tests deliver promising control solutions together with recommendations for new PE grid connection rules and the development of a novel protection technology and the mitigation of the foreseen power quality disturbances. Technology and economic effects of such innovations are quantified together with the barriers to be overcome in order to recommend future deployment scenarios. Dissemination activities support the deployment schemes of the project outputs based on knowledge sharing among targeted stakeholders at the EC level.

Keywords:

Website of the project:

Functional objectives: T1, T3, T4, T5, T6

» NICE GRID

Project Coordinator:	**Company:** ERDF (France)
email:	**Phone:**
Start/End: Jan-2012/Dec-2015	**Current status:** Completed
Budget: 30 million EUR	**Funding scheme:** National

Members of the consortium:
» TSOs: RTE (FR).
» Others: ERDF, Alstom, EDF, Saft, Armines, Daikin, Netseenergy, Nke watteco, socomec.

Brief project description: The project developed a demonstrator of a smart solar district. It will test local storage solutions.

Keywords:

Website of the project: www.nicegrid.fr

Functional objectives: TD3, TD5

» OPTIMATE

Project Coordinator: Serge Galant	**Company:** Technofi (France)
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Start/End: Oct-2009/Sep-2012	**Current status:** Completed
Budget: 4.2 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: RTE (FR), EnBW Transportnetze AG (DE), REE (ES), Elia (BE), 50 Hertz Transmission (DE).
» Others: Katholik University of Leuven (BE), Association pour la Recherche et le Développement des Méthodes et Processus Industriels, ARMINES (FR), University Comillas (ES), RISOE-DTU (DK), European University Institute (IT), University of Manchester (UK).

Brief project description: The project aims at developing a numerical test platform to analyse and validate new market designs, which may allow integrating massive flexible generation dispersed in several regional power markets.

Keywords: Market design, Simulation platform, Agent based, DA market, ID market, Balancing mechanism, Flow-based market coupling, Intermittent generation.

Website of the project: www.optimate-platform.eu

CORDIS: http://cordis.europa.eu/project/rcn/94490_en.html

Functional objectives: T10, T11, T12

» PEGASE

Project Coordinator: Stephane Rapoport	**Company:** Tractebel engineering (Belgium)
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Start/End: Jun-2008/Jun-2012	**Current status:** Completed
Budget: 13.6 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: RTE (FR), REE (ES), Litgrid (LT), Transelectrica (RO), REN (PT), SO UPS (RUS), HEP (HR), TEIAS (TU), Elia (BE).
» Others: Tractebel (BE), Deling Doo (BA), Digiteo (FR), CRSA-ECP (FR), AICIA (ES), FGH (DE), University of Liège (BE), University of Dusiburg (DE), University of Manchester (UK), University of Eindhoven (NL) RTU (LT), Energosetproject (RUS), NUCLEO (ES).

Brief project description: Define the most appropriate state estimation, optimisation, and simulation frameworks, their performances, and the requested data flows. Remove the technical barriers that prevent European-wide real-time state estimation and off-line and online simulations to be run. Develop methodologies for building and validating static and dynamic models (including renewable energy sources, power electronics, etc.). Study the architecture of a pan-European real-time state estimation, simulation, and training.

Keywords: State estimation, Optimal power flow, Dynamic simulation, Model, Dispatcher training simulator, Pan-European.

Website of the project: http://fp7-pegase.eu/

CORDIS: http://cordis.europa.eu/project/rcn/88387_en.html

Functional objectives: T6, T7, T8

» POSTAWIND

Project Coordinator: Nayeem Ullah	**Company:** STRI AB (Sweden)
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Start/End: Jul-2011/Oct-2012	**Current status:** Completed
Budget: 0.19 million EUR	**Funding scheme:** Vindforsk III
Members of the consortium: » TSOs: Svenska Kraftnät (SE), Fingrid (FIN), Statnett (NO). » Others: STRI AB (SE), Statkraft (SE), Vattenfall (SE), E.ON Elnät Sverige AB (SE).	
Brief project description: Effects of large-scale wind power integration on power system stability: angle, voltage, and frequency stability.	
Keywords: Wind power, Stability.	
Website of the project: http://www.elforsk.se/Programomraden/El--Varme/Vindforsk/projekt/projects_area_4/V-369-PoStaWind/	
Functional objectives: T2, T5, T7, T10	

» POWER TO GAS (P2G)

Project Coordinator: Kalle Kukk	**Company:** Elering (Estonia)
email: Kalle.Kukk@elering.ee	**Phone:**
Start/End: Sep-2013/	**Current status:** Ongoing
Budget:	**Funding scheme:** National
Members of the consortium: » TSOs: Elering (EE). » Others: Tartu University (EE), stakeholders like wind parks, and CO_2 emitters.	
Brief project description: The power-to-gas project studies solutions for the valorisation of the CO_2 produced when burning fossil fuels and for the storing of renewable energy. A synthesis of CO_2 and water vapour with 'residue' renewable electricity enables methane and methanol to be produced. This also provides an opportunity to use renewable resources to produce automotive fuels (methane), using surplus wind and solar energy or the night-time electricity of a thermal power plant.	
Keywords:	
Website of the project:	
Functional objectives: T1, T4	

» PROBA

Project Coordinator: Vanessa De Wilde	**Company:** Elia (Belgium)
email: vanessa.dewilde@elia.be	**Phone:**
Start/End: Feb-12/Dec-2014	**Current status:** Completed
Budget: 0.25 million EUR	**Funding scheme:** Financed 100% by Elia
Members of the consortium: » TSOs: Elia (BE). » Others: Université libre de Bruxelles (BE).	
Brief project description: The project focuses on the development of a methodology (using a probabilistic approach) to assess risk of accepting the connection of a new DG unit, using relevant risk indices (e.g., risk/cost of curtailment).	
Keywords: Risk-based reliability assessment, Distribute generation, Connection.	
Website of the project:	
Functional objectives: TD1	

» PROMOTION

Project Coordinator:	**Company:** DNV
email:	**Phone:**
Start/End: Jan-2016/Dec-2019	**Current status:** Ongoing
Budget:	**Funding scheme:** European (Horizon2020)
Members of the consortium: » TSOs: Energinet.dk (DK), RTE (FR), SHE Transmission (UK), Eirgrid (IE), TenneT NL (NL). » Others:	
Brief project description: The project is focused on the development and demonstration of innovative technologies for offshore wind connection, HVDC protection systems, and grid policy and financial regulation. The final goal is to create a deployment plan for offshore grid development in the Northern seas.	
Keywords:	
Website of the project:	
Functional objectives: T1, T2, T3, T4, T6, T7, T12	

» REALISEGRID

Project Coordinator: Gianluigi Migliavacca	**Company:** RSE (Italy)
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Start/End: Sep-2008/May-2011	**Current status:** Completed
Budget: 4.2 million EUR	**Funding scheme:** Granted by 7th Framework Programme (FP7 ENERGY.2007.7.3.4)

Members of the consortium:

» TSOs: APG (AT), RTE (FR), TenneT (NL), Terna (IT).

» Others: RSE (IT), EC JRC (BE), OME (FR). EEG TU Wien (AT), TU Delft (NL), TU Dortmund (DE), Politecnico di Torino (IT), Technofi S.A. (FR), R&D Center for Power Engineering (RU), Prysmian Powerlink S.r.l. (IT), KanLo Consultants SARL (FR), Riecado GmbH (AT), TU Dresden (DE), Univerza v Ljubljani (SI), ASATREM (IT), the University of Manchester (UK).

Brief project description: The REALISEGRID project aims at developing a set of criteria, metrics, methodologies, and tools to assess how the transmission infrastructure should be optimally developed to support the achievement of a reliable, competitive, and sustainable electricity supply in the EU. The REALISEGRID includes three main areas of activities: 1) identification of performances and costs of new grid technologies aimed at increasing the capacity, reliability, and flexibility of the transmission infrastructure; 2) definition of long-term scenarios for the EU power sector, characterised by different evolutions of demand and supply; and 3) implementation of methods and tools to assess the different benefits of transmission expansion investments. The main outputs of REALISEGRID activities are the roadmap for the incorporation of new transmission technologies (including WAMS, FACTS, and HVDC) into the electricity networks; analysis of the effect of different scenarios on the future electricity exchanges between European countries; evaluation of the benefits provided to the pan-European power system by the development of transmission infrastructure; testing of such a cost-benefit analysis to specific transmission projects, namely, nine electricity projects of European interest concerning the Trans-European Network priority axis EL.2.

Keywords: Transmission planning, RES integration, Cost-benefit analysis, Infrastructure package, Innovative technologies.

Website of the project: http://realisegrid.rse-web.it

CORDIS: http://cordis.europa.eu/project/rcn/90334_en.html

Functional objectives: T1, T2

» REAL-SMART

Project Coordinator: Nina Thornhill	**Company:** Imperial College of Science, Technology and Medicine (United Kingdom)
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Start/End: Sep-2010/Aug-2014	**Current status:** Completed
Budget: 1.09 EUR (funding)	**Funding scheme:** FP7-PEOPLE-2009, Marie Curie IAPP transfer of knowledge programme

Members of the consortium:

» TSOs: Statnett (NO), Fingrid (FI).

» Others: ABB (NO, CH, PL), General Electric (GER), Aalto-Korkeakoulusaatio (FI), Technische Universitaet Graz (AUT), Imperial College of Science, Technology and Medicine (UK), National Grid (UK).

Brief project description: Power transmission in Europe is entering a period of significant renewal and technological change because the electrical transmission grids face increases in new and variable energy sources, especially from large-scale wind power generators. They face future challenges of operation and control. Changes happening in the process industries will also have an effect on electrical supply because electric motors are taking over from traditional gas turbine drivers for large-scale process equipment, such as compressors. On the other hand, new measurement and data acquisition methods, such as phasor measurement units, are allowing greatly improved observation of the transmission grid. The REAL-SMART proposal presents a balanced programme of applied R&D to address measurement-based monitoring and management of the high-voltage transmission grid. The REAL-SMART consortium is interdisciplinary with experts in electrical power systems, modelling, instrumentation, signal analysis, equipment condition monitoring, and automation of oil and gas processes. The consortium will conduct research and undertake secondments to transfer experience and knowledge both ways between academia and industry. The project integrates in-depth understanding of the power system operational issues with analysis of state-of-the-art measurements and first-principles physical knowledge. It will invent and develop state-of-the-art tools that will be deployed by the TSOs and will produce trained and experienced personnel. We aim to take a pivotal role in the creation of technology for intelligent operation of the wide-area transmission grids of the future.

Keywords: Smart Grid, Wind power, WAMS.

Website of the project: http://cordis.europa.eu

Functional objectives: T2, T5, T6, T9, T10, T12, TD3

» RESERVAS MODEL

Project Coordinator:	**Company:** REN (PT) and REE (ES)
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Start/End: 2006-01-02 / 2010-02-18	**Current status:** Completed
Budget:	**Funding scheme:** National

Members of the consortium:
» TSOs: REN (PT), REE (ES).
» Others: INESC – Porto (PT)

Brief project description: A joint project promoted by REN and REE with the support of the INESC Porto, to assess long term operating reserve requirements as well as security of supply impacts on systems due to high levels of intermittent generation sources.

» Based on hourly chronological Monte-Carlo simulations
» Calculates conventional probabilistic reliability indices, which represent the level of risk to the security of electricity supply
» Security of supply indicators may include the effects of operating reserve (in)adequacy
» To assess if the available operating reserve is enough to cope with short-term forecast errors (demand, wind power and unexpected outages)

Keywords: Integrating renewable energy sources; Energy planning; Security of Supply; Long Term Operating Reserve Requirements; System Modelling Tools;

Website of the project: n/a

Functional objectives: T12

» SAFEWIND

Project Coordinator: REBOUL, Mathieu	**Company:** Association pour la recherche et le développement des methodes et processus industriels–Armines (FR)
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Start/End: Sep-2008/Aug-2012	**Current status:** Completed
Budget: 5.6 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: RTE (FR), Energinet.dk (DK).
» Others: Acciona Energia S.A. (SP); Institute of Communication and Computer Systems (GR); Fundacion Cener-Ciemat (SP); Carl Von Ossietzky Universitaet Oldenburg. (DE); Meteo-France France (FR); Universidad Carlos Iii De Madrid (SP); The Energy and Resources Institute India, Public Power Corporation S.A. (GR); Overspeed GmbH & Co. Kg (DE); System Operator for Northern Ireland (GB); Eirgrid Plc (Ie); Energy & Meteo Systems GmbH (De); Danmarks Tekniske Universitet (DK); Electricite De France S.A. (FR); The Chancellor, Masters and Scholars of the University of Oxford (GB), European Centre for Medium-Range Weather Forecasts (GB), Universidad Complutense De Madrid (SP).

Brief project description: The project will develop new forecasting methods for wind generation focusing on uncertainty and challenging situations/extremes, models for 'alarming', providing information for the level of predictability in the (very) short-term and models for 'warning', providing information for the level of predictability in the medium-term (next days).

Keywords: Renewable energy, Short-term forecasting, Uncertainty, Ramps forecasting, Alarming, Warning, Weather forecasts, Remote sensing, Weather extremes, Meteorology.

Website of the project: www.safewind.eu

CORDIS: http://cordis.europa.eu/project/rcn/87776_en.html

Functional objectives: T6, TD1

» SAMREL

Project Coordinator: Gjerde Oddbjörn	**Company:** Sintef Energy Research AS (Norway)
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Start/End: Jan-2010/Dec-2013	**Current status:** Completed
Budget: 1.9 million EUR	**Funding scheme:** Granted by Research Council of Norway

Members of the consortium:
» TSOs: Energinet.dk (DK), Fingrid (FI), Statnett (NO).
» Others: Det Norske Veritas AS (NO), Norwegian University of Science and Technology (NO), Norwegian Water Resource and Energy Directorate (NO).

Brief project description: Integration of methods and tools for security of electricity supply analysis. The primary goal is to establish a comprehensive methodology for analysis of the security of electricity supply by the integration of power system reliability analysis with the electricity market analysis.

Keywords: Simulation tool, System security, Reliability.

Website of the project:

Functional objectives: T9

» SECONOMICS–DIGITAL RISK AND CYBER SECURITY

Project Coordinator: Steve Collins	**Company:** National Grid (UK)
email: box.innovationtransmission@nationalgrid.com	**Phone:**
Start/End: Apr-2012/Apr-2015	**Current status:** Completed
Budget: 5.3 million EUR	**Funding scheme:**

Members of the consortium:
» TSOs: National Grid (UK).
» Others:

Brief project description: The purpose of this work is to provide recommendations to the European regulators of CNI systems in order to ensure the most appropriate regulatory approach to cyber security with respect to electricity transmission systems.

Keywords:

Website of the project: http://www2.nationalgrid.com/UK/Our-company/Innovation/Annual-Reports/Annual-Summaries/

Functional objectives: T2, T14

» SEETSOC

Project Coordinator:	**Company:** The City University (UK)
email:	**Phone:**
Start/End: Jan-2010/Dec-2012	**Current status:** Ongoing
Budget: 2.29 million EUR	**Funding scheme:** European (FP7)
Members of the consortium: » TSOs: IPTO (GR), Terna (IT), ESO (BG). » Others: CEZ Distribution Bulgaria (BG), Mepso (FYROM), PE Elektromreža Srbije (SRB).	
Brief project description: Diagnostics, surveillance, maintenance, and control of power transmission and grid connections.	
Keywords:	
Website of the project: http://cordis.europa.eu/project/rcn/100501_en.html	
Functional objectives: T10, T11, T15, T16, T17	

» SMART GRID VENDÉE

Project Coordinator:	**Company:** Sydev/ERDF (France)
email:	**Phone:**
Start/End: 2013/2017	**Current status:** Ongoing
Budget: 27.2 million EUR	**Funding scheme:**
Members of the consortium: » TSOs: RTE (FR). » Others: ERDF, Alstom, Cofely, Actility, Legrand, Cnam.	
Brief project description: The project aims to develop a smart grid demonstration on the distribution network, implement DR solutions, and test various business models for smart grids.	
Keywords:	
Website of the project: http://smartgridvendee.fr/fr	
Functional objectives: T10, TD2	

» SMART SUBSTATION

Project Coordinator: Thierry Buhagiar	**Company:** RTE (France)
email: thierry.buhagiar@rte-France.com	**Phone:**
Start/End: Jan-2012/Jul-2017	**Current status:** Ongoing
Budget: 35 million EUR	**Funding scheme:** National
Members of the consortium: » TSOs: RTE (FR). » Others: Alstom Grid, Schneider Electric, Alcatel-Lucent, ERDF et Neelogy.	
Brief project description: The project aims to optimise substations' capacities thanks to the implementation of numerical et optical solutions. It will enhance network performance and flexibility in the context of large development of intermittency.	
Keywords:	
Website of the project:	
Functional objectives: T14, T3, T5, T7, T11, T15, TD5	

» SMARTNET

Project Coordinator: Migliavacca Gianluigi	**Company:** RES (IT)
email: Gianluigi.Migliavacca@rse-web.it	**Phone:**
Start/End: Jan-2016/Dec-2018	**Current status:** Ongoing
Budget: 12 million EUR	**Funding scheme:** European (Horizon2020)
Members of the consortium: » TSOs: Terna (IT), Energinet.dk (DK). » Others: Austrian Institute of Technology (AIT), Danske Commodities, DTU Compute, Endesa, Eurisco Florence School of Regulation, Novasol, N-SIDE, Nyfors, Selnet, Selta, Siemens Italia, SINTEF, Tecnalia, University of Strathclyde, VITO, VTT, Vodafone.	
Brief project description: It is a research and innovation action addressing the following priority elements: interaction between the TSO and DSO advanced architectures and tools for pan-European markets for ancillary services and balancing; integration of advanced power electronics technologies into subsystems that enhance available network capacity and flexibility; Joint modelling and simulation of power systems and the underlying ICT infrastructure.	
Keywords:	
Website of the project:	
Functional objectives: T10, TD3	

» SOSPO

Project Coordinator:	**Company:** Technical University of Denmark (Denmark)
email:	**Phone:**
Start/End: Jan-2012/Dec-2015	**Current status: Completed**
Budget: 4.3 million EUR	**Funding scheme:** National (Innovation Fund Denmark, prev. The Danish Council for Strategic Research)

Members of the consortium:
» TSOs: Energinet.dk (DK).
» Others: Technical University of Denmark (DK), Siemens AG (DE), KenM Consulting (UK), ETH Zurich (CH), Lund University (SE), Chalmers University (SE).

Brief project description: The SOSPO (Secure Operation of Sustainable Power Systems) project focuses on a critical, difficult, and not yet treated problem regarding how secure operation of the power systems can be obtained when the large thermal power plants, which today provide services needed for a secure operation, are replaced with sustainable resources, such as wind and solar energy. The objective of the SOSPO project is to carry out R&D of methods for real-time assessment of system stability and security, and methods for intelligent wide-area prosumption control that can ensure stable and secure operation of the future power system. The research in the SOSPO project focuses on methods that enable system stability and security assessment in real time and on methods for automatically determining control actions that regain system security when an insecure operation has been detected.

Keywords:

Website of the project: www.sospo.droppages.com

Functional objectives: T6, T7

» SUMO

Project Coordinator: Jan Kostevc	**Company:** ELES (Slovenia)
email: jan.kostevc@eles.si	**Phone:** +386-1-474-2105
Start/End: 2011/2014	**Current status:** Completed
Budget: 2 million EUR	**Funding scheme:** Financed 100% by ELES

Members of the consortium:
» TSOs: ELES (SI).
» Others: EIMV (Milan Vidmar Electric Power Research Institute).

Brief project description: Dynamic thermal rating will be incorporated in a SCADA/EMS environment. Network analyses will use near real-time system capabilities. Calculation of element ratings will use ambient parameters from relevant geographical areas.

Keywords: Dynamic thermal rating.

Website of the project:

Functional objectives: T3

» TWENTIES

Project Coordinator: Vicente González	**Company:** Red Eléctrica de España (Spain)
email: vgonzalez@ree.es	**Phone:** +34-91-650-20-12
Start/End: Apr-2010/Sep-2013	**Current status:** Completed
Budget: 56.8 million EUR	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: REE (ES), Elia (BE), Energinet.dk (DK), RTE (FR), 50Hertz Transmission GmbH (DE), TenneT TSO (NL).
» Others: DONG (DK), IBR (ES), RISØ.DTU (DK), EDF (FR), Alstom (UK), Comillas-IIT (ES), Fraunhofer IWES (DE), SINTEF (NO), Gamesa (ES), SIEMENS (DE), EWEA (BE), Coreso (BE), ABB (ES), INESC Porto (PO), UCD (EI), RSE (IT), Strathclyde (UK), ULG (BE), KUL (BE), ULB (BE).

Brief project description: The project aims to show through real-life, large-scale demonstrations, the benefits and effects of several critical types of technology required to improve the European transmission network, giving Europe the ability to increase the share of renewable energy in its energy mix by 2020 and beyond, while keeping its present reliability.

Keywords: Wind power integration, DC grid management, AC grid flexibility, WAMS, DLR, FACTS, VPP, Wind farms services provider.

Website of the project: http://www.twenties-project.eu

CORDIS: http://cordis.europa.eu/project/rcn/94496_en.html

Functional objectives: T2, T3, T4, T5, T6

» UMBRELLA

Project Coordinator: Mr Helmut Paeschke	**Company:** TenneT (Germany)
email: Helmut.Paeschke@tennet.eu	**Phone:**
Start/End: 2012/2015	**Current status:** Completed
Budget: 5 million EUR (3.8 granted)	**Funding scheme:** Granted by 7th Framework Programme

Members of the consortium:
» TSOs: TenneT TSO GmbH (DE), Amprion GmbH (DE), ČEPS, a.s. (CZ), Elektro-Slovenija, d.o.o (SI), EnBW Transportnetze AG (D), PSE Operator S.A.(PL), Swissgrid AG (CH), TenneT TSO B.V. (NL), APG (AT).
» Others: ABB Delft University of Technology (NL), ETH Zurich (CH), Graz University of Technology (A), RWTH Aachen (D), University Duisburg-Essen (D), FGH e.V. (D).

Brief project description: To develop a dedicated innovative toolbox to support a coordinated decentralised grid security approach for TSOs, to demonstrate the enhancement of existing and current procedures by the utilisation of the developed toolbox, and to provide a scientifically sound basis to support common TSO decisions. In addition, cooperation with iTesla achieved a common use case at the beginning of both of the projects to provide recommendations towards converging operational rules to ENTSO-E at the end of both of the projects.

Keywords: Operational system security, Risk assessment, Enhanced optimal power flow, Forecasting, Optimisation tools, Integration of renewables, Innovative operational tools, Corrective actions, Grid flexibility, Transmission capacity.

Website of the project: http://www.e-umbrella.eu/

CORDIS: http://cordis.europa.eu/project/rcn/101318_en.html

Functional objectives: T6, T7, T9

» WAMPAC

Project Coordinator: Jako Kilter	**Company:** Elering (Estonia)
email: jako.kilter@elering.ee	**Phone:**
Start/End: 2013/2015	**Current status:** Ongoing
Budget: 0.4 million EUR	**Funding scheme:** National
Members of the consortium: » TSOs: Elering (EE). » Others: Tallinn University of Technology (EE).	
Brief project description:	
Keywords: WAMPAC.	
Website of the project:	
Functional objectives: T3, T5, T6, T7, T8, T9	

» WINDGRID

Project Coordinator: Jose Luis Mata	**Company:** REE
email: jlmata@ree.es	**Phone:** +34-91-650-2012
Start/End: 2006/2009	**Current status:** Completed
Budget: 4.3 million EUR	**Funding scheme:** European (FP6)
Members of the consortium: » TSOs: REE (ES), REN (PT). » Others: Deloitte, S.L. Spain, Gamesa Wind Engineering, APSDenmark, Institut Fuer Solare, Energieversorgungstechnik e. V. Germany, Windenergie, S.R.O., Iberdrola Energias Renovables II S. A. U Spain; Enercon GmbH Germany, Korona Inzeniring D. D. Slovenia.	
Brief project description: WindGrid focused on preparing the European electricity network for large-scale integration of wind farms. It involved the design, development, and validation of new tools and devices for planning, controlling, and operating power systems in a competitive market.	
Keywords:	
Website of the project:	
CORDIS: http://cordis.europa.eu/project/rcn/86435_en.html	
Functional objectives: T1, T5	

ABBREVIATIONS

AC	Alternating Current
CAPEX	Capital Expenditure
CMM	Congestion Management Module
DA	Day Ahead
DC	Direct Current
DER	Distributed Energy Resources
DLR	Dynamic Line Rating
DRES	Distributed Renewable Energy Sources
DRT	Demand Response Technology
DSO	Distribution System Operator
EEGI	European Electricity Grid Initiative
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
EWIS	European Wind Integration Study
FACTS	Flexible AC Transmission System
FO	Functional Objectives
GIL	Gas Insulated Line
HV	High Voltage
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICT	Information and Communication Technology
ID	Intra-Day
IEC	International Electrotechnical Commission
JRC	Joint Research Centre
LV	Low Voltage
MV	Medium Voltage
OPEX	Operating Expenses
PMU	Phasor Measurement Units
PV	Photo-Voltaic
R&D	Research and Development
RDC	Research and Development Committee
RES	Renewable Energy Sources
SCADA	Supervisory Control and Data Acquisition
SSSC	Static Synchronous Series Compensator
ST	Specific Tasks
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
VAR	Volt-Ampere Reactive
VPP	Virtual Power Plant
VSC	Voltage Source Converter
WAMPAC	Wide-Area Monitoring Protection and Control
WAMS	Wide-Area Monitoring Systems

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