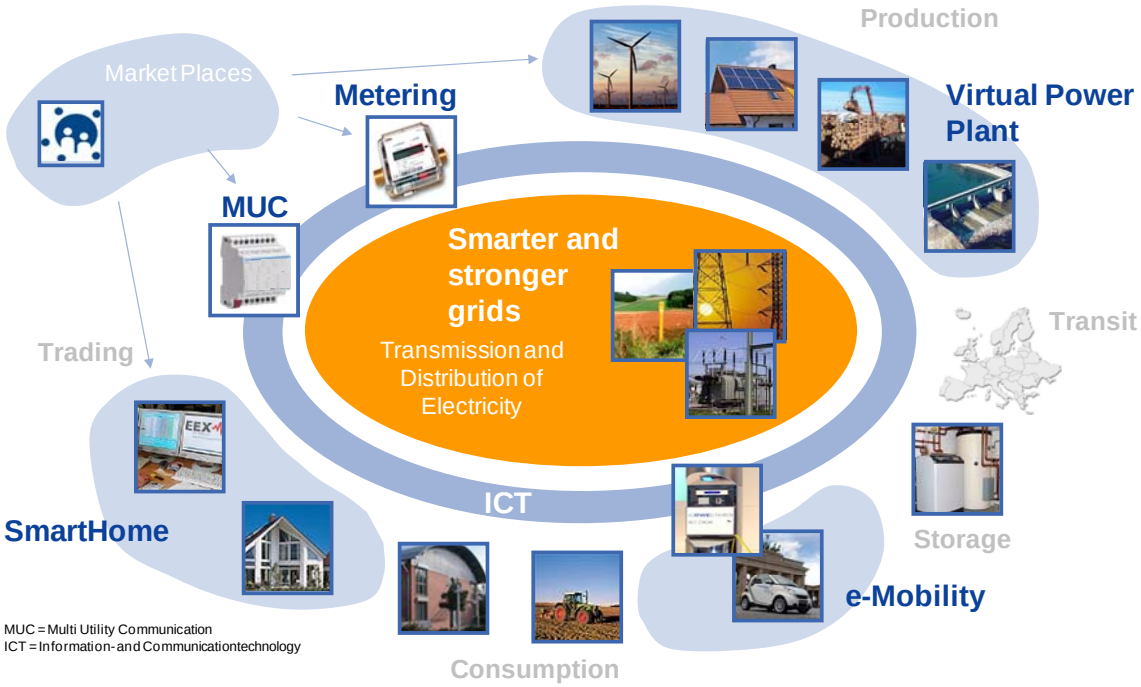
The European Electricity Grid Initiative (EEGI)

Roadmap 2010-18 and Detailed Implementation Plan 2010-12

May 25th 2010



Executive summary

The European energy and climate change targets for 2020 and beyond require a major acceleration of the development and deployment of cost-effective low-carbon energy technologies, as proposed in the SET Plan. A single, stronger and smarter European electricity grid will have a central role to accommodate the resulting massive deployment of renewable and decentralised energy sources.

The European Electricity Grid Initiative (EEGI) proposes a 9-year European research, development and demonstration (RD&D) programme initiated by electricity transmission and distribution network operators to accelerate innovation and the development of the electricity networks of the future in Europe, a so-called *Smart Grid*. The Smart Grid will be a user-centred, market-based, interactive, reliable, flexible, and sustainable electrical network system. Its deployment will start progressively over the period from 2010 to 2030 and result in benefits such as:

- Increased hosting capacity for renewable and distributed sources of electricity;
- The integration of national networks into a market-based, truly pan-European network;
- A high level of quality of electricity supply to all customers;
- The active participation of users in markets and energy efficiency;
- The anticipation of new developments such as a progressive electrification of transport;
- An economically efficient deployment of future networks, for the benefit of grid users;
- The opening of business opportunities and markets for new players in the smart grids arena.

In particular, the EEGI is an enabler of all SET Plan low-carbon technology initiatives, in particular on solar and wind generation, since future electricity networks will connect new energy resources to the final users and enable the management of complex interactions between energy producers and users.

A European-level planning and implementation of the EEGI RD&D programme is necessary to avoid unnecessary duplication of efforts, promote the replication of new developments and the exchange of best practices. In case of European transmission networks and markets it is crucial to ensure appropriate cross-border coordination of planning and operations. The Initiative will also promote solutions that support European standardisation and interoperability.

The proposed RD&D programme focuses on system innovation rather than on technology innovation, and addresses the challenge of integrating new technologies under real life working conditions and validating the results. The network operators are responsible for the secure operation of the electricity system: they need therefore to lead the tests of new solutions through large scale demonstration projects. The demonstrations of new developments will allow evaluating their benefits, estimating their costs, and preparing scaling up and replication for an accelerated take-up by all network operators.

The demonstrations also require the involvement of research players and market participants such as generators, users, retailers, T&D manufacturers, ICT (Information and Communication Technology) providers and smart meter manufacturers. These stakeholders have been consulted in the preparation of the programme and are expected to play an important role in the implementation of the projects.

The present document proposes a 9-year RD&D programme for electricity networks with a cost estimated at 2 B€ covering the expected participation of regulated networks, market players, research centres and universities. It does not cover the costs of deploying the solutions across Europe. A detailed implementation plan is also provided, covering priority projects that should start urgently, in the period 2010-2012. The investment in the priority projects is estimated at 1 B€ to cover their full duration.

The operation of electricity networks is regulated and remunerated, with tariffs defined by regulatory authorities. In most cases, current tariff schemes do not provide sufficient incentives to support large scale RD&D projects. This situation is expected to evolve in the future as the Third Internal Energy Market package foresees that tariffs incentives should support a number of research activities. Regulators are expected to have an important role in the development and implementation of the programme and have been closely consulted in its preparation.

In order not to delay priority projects, a significant support from public sources (EC and member states) is needed in a transition phase to incentivize the participation of network operators until new tariff incentives are implemented. Public support may also need to accelerate particular technology developments or motivate the participation of free market players such as electricity retailers.

The Transmission System Operators (TSO's) have created the ENTSO-E association mandated by the Third Internal Energy Market package. A number of Distribution system operators (DSOs) have created an ad-hoc association, the "European DSO Association for Smart Grids", open to wide membership. The two associations propose to play an important role in the planning, monitoring and dissemination of the result to all network operators and will ensure the openness of the Initiative. A stakeholder board will be setup to ensure that all parties are consulted on the programming and implementation of the Initiative.

A close coordination of the EEGI with other initiatives of the SET Plan has been initiated, in particular with the Solar and Wind initiatives. This coordination should be pursued throughout the development of their implementation.

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1. Vision and objectives

1.1. Background

The current Electricity Networks in Europe are mostly based on technology that was developed more than 30 years ago, and the need for innovation has until now been limited. The electricity system has been designed for one-way energy flows from large centralized fully controllable power plants to the customers at the other end of the network.

A set of recent developments are about to change this picture and put the Electricity networks under pressure to change. The drivers for change are both external to the network, like preparing for a low-carbon future, as well as internal, like the need for replacement of an aging infrastructure.

One of the main external drivers is the EU Energy and Climate Package" which has set out ambitions targets for 2020 and beyond:

- **20 % reduction of GHG emissions (when compared to 1990 levels)**
- **20 % of renewable energy sources in the EU 27 energy mix (today 6.5 %)**
- **20 % reduction in the primary energy used (saving 13 % compared to 2006 levels)**

in compliance with the three pillars of the EU energy policy (i.e., security of supply, sustainability and market efficiency).

Since the other main energy consuming sectors, transport and heating, are unlikely to reach the target of 20% of renewable sources, electricity generation will have to do "more than its share", probably close to 30-35% for the renewable target to be met.

Following these political targets, the SET Plan has been created to develop the technologies needed to meet these political targets and at the same time ensure that European companies can benefit from the opportunities of a new approach to electricity generation and consumption. Electricity Grids are defined in the SET Plan as one of the critical areas that needs to be addressed to prepare for a low-carbon future.

In parallel, the Third Energy Package, adopted by the European Parlament and the Council in July 2009, pushes the Member States, the Regulators and Network Operators to deploy smart meters or smart grids, and more generally to launch innovation programs with appropriate remuneration schemes for the Electricity network, in particular:

- **In the regulation applicable to transmission operators**

*"….ENTSO-E shall adopt common network operation tools to ensure co-ordination of network operation in normal and emergency conditions, including a common incidents classification scale, and **research plans**"….*
*"…The annual work program shall contain a list and description of the network codes to be prepared, a plan on coordination of operation of the network, and **research and development activities**, to be realized in that year, and an indicative calendar"….*

- **In the regulation applicable to transmission and distribution**

*"…In fixing or approving the **tariffs** or methodologies and the balancing services, the regulatory authorities shall ensure that transmission and distribution system operators are granted **appropriate incentives**, over both the short and long term, to increase efficiencies, foster market integration and security of supply and support the related **research activities**"..*

- **The future role of Intelligent metering for Electricity**

*"…Member States should encourage the modernization of distribution networks, e.g. through the introduction of **smart grids**, which should be built in a way that encourages decentralized generation and energy efficiency"…*
*"…In order to promote energy efficiency, Member States, or when the Member State has so provided, the regulatory authority shall strongly recommend that electricity undertakings optimize the use of electricity, for example by providing energy management services, developing innovative pricing formulas or introducing **intelligent metering systems** or smart grids where appropriate"…*
*"…Member States shall ensure the implementation of **intelligent metering systems** that shall assist the active participation of consumers in the electricity supply market. The implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution"…*

Overall, these new developments represent a set of important challenges for the whole electric system which cannot be met with a traditional business-as-usual approach.

1.2. The initiative of the network operators

In the framework of the SET Plan, a group of Electricity Transmission[1] and Distribution[2] Network operators have defined together the European Electricity Grids Initiative (EEGI), a common Research, Development and Demonstration (RD&D) program to accelerate innovation and address the most critical electricity system issues to reach the targets on energy and climate for 2020 and beyond.

These European climate targets represent a huge challenge for the European electricity networks because they will have to host and balance large amounts of electricity coming from variable renewable sources and from a large number of distributed sources. This transition requires a major step-change at system level to ensure that the networks will not become a bottleneck to reach the climate goals. Current investments in RD&D on the electricity networks are insufficient to support this change and must be accelerated.

[1] The program on distribution networks has been initiated by 7 European TSOs: Amprion, Elia, Red Electtrica, RTE, Tennet, Transpower and 50Herz.
[2] The program on distribution networks has been initiated by 7 European DSOs representing about 60% of the customer connection points in Europe: CEZ, EON, Enel, Erdf, Iberdrola, RWE and Vattenfall.

A first draft of a detailed plan with descriptions of RD&D projects and budgets was delivered by the EEGI in July 2009. This proposal has since then been discussed with other stakeholders, both in the SET plan conference in Stockholm in October 2009 and in dedicated workshops, with the regulators, the Member States, the European Commission and the ETP Smart Grids Platform where all the major stakeholders are represented. The main results of these discussion have been subsequently integrated in the program.

The programme described in the present document proposes a new organization of RD&D for electricity networks, and outlines a 9-year overall programme including a detailed implementation plan for 2010-2012 with its associated costs, benefits and financing plan. The detailed implementation plan will be periodically reviewed every year to create a rolling, always up-to-date planning.

The 9-year programme costs are evaluated at 2B€ and the total costs of the projects to be started over the period 2010-2012 are evaluated at 1 B€.

Specific features distinguish the grid initiative from the other initiatives in the SET Plan.

First, many basic technologies and new generation components have been developed over the last 10-20 years. The main challenge today is to integrate innovative and developed technologies in the electricity system and to validate their performance under real life working conditions. The program is therefore focusing on the electricity **system innovation,** a natural and legal responsibility of the network operators, rather than on technology innovation, which is usually pursued by manufacturers. The program will also prepare scaling up and replication rules for an early take-up by non participating network operators through the network operators associations.

Second, the solutions to be validated within the Grid Initiative are enablers of **all the other energy technology initiatives**, in particular Solar and Wind: indeed, increasing the contribution of renewable generation to the electricity mix requires a stronger and smarter grid, capable of integrating more distributed energy resources (DER).

Third, network operators must be leading the RD&D projects since the validity of the developed innovations needs the implementation on real networks under **real operating conditions**. The network operators are directly responsible for the **secure operation** of the networks under any condition, including the testing of new solutions through large scale demonstration projects. Other market participants like generators, manufactures, ICT providers etc have been and will be heavily involved in the program.

Fourth, the operation of electricity networks is regulated, with tariffs defined by regulatory authorities. In most European countries, current tariff schemes **do not include sufficient incentives** to launch the large scale RD&D projects that are needed and identified in the EEGI program.

The EEGI programme covers the period 2010-2018, but results from the projects will already be available gradually starting from 2015. The deployment of these results should be launched concurrently with the RD&D program to allow for the 2020 targets to be met, with the deployment activities continuing also well beyond 2020.

1.3. The network operators vision for 2020

The EEGI has been created by Network operators to accelerate the development of the electricity networks of the future in Europe, a so-called ***Smart Grid,*** capable of meeting the new challenges. The Smart Grid will be a user-centred, interactive, reliable, flexible, and sustainable electrical network system, and network operators must play a key role in its development. In particular the network operator vision for the future electricity network implies that by 2020 the electricity networks in Europe should[3]:

1. Actively **integrate efficient new generation and consumption models,** in particular.:
    - Integrate **new intermittent renewable resources** at the different voltage levels
    - Enable and integrate **active demand** from end users
    - Enable and integrate new electricity uses, in particular recharging infrastructure for **electric vehicles** and increasing electric heating (**heat pumps)**
    - Support and enable **energy efficiency** by end users.
    - Enable new **business opportunities** and innovations for market players

2. **Coordinated** planning and operation of the whole Electricity Network
    - Coordinate planning and operation for the pan European transmission network through ENTSO-E with dedicated solutions developed in the EEGI program
    - Coordinate planning and operation between transmission and distribution networks with dedicated solutions developed in the EEGI program

3. Study and **propose new market rules** to maximize European welfare
    - Study and recommend new market rules both at national and European level.

For this vision to become reality, there are several barriers that needs to be overcome. These are briefly outlined in the next section.

[3] All transmission networks and at least 50% of the distribution networks in Europe should be operating according to this vision by 2020.

2. Challenges and barriers to be overcome

Traditional solutions could in theory be applied to resolve many of the issues posed by the new challenges. An example of a traditional approach would be to build new lines and substations to integrate more renewable generation whereas the "Smart Grids" approach would involve the development of more ICT solutions in the network to allow a higher penetration of renewables connected to existing lines and substations. In this case the traditional approach would bring a solution, but it would be much more expensive, and it might not be feasible because of resistance to build new infrastructure or take too much time. This does not mean that more traditional infrastructure is not needed even with the "Smart Grids" approach, but it means that the Smart Grids approach is looking for the most efficient way to meet the new challenges and will be less expensive in the long run.

It is important to note that most of the current tariff structures would allow financing the reinforcement of lines in the above examples but not necessarily the deployment of "smarter" solutions.

The extra RD&D efforts needed to develop new solutions according to the "Smart Grids" approach face several barriers:

- **Technology barriers** including standards, interoperability, cyber security and data privacy: even though technical solutions often exist at component level, large scale system experiments are needed to validate "system solutions" such as the management of generation intermittency and to promote standardisation and interoperability of the technology solutions which will reduce deployment costs.

- **RD&D organisation barriers** including the fragmentation of efforts across borders and across the electric system value chain.

- **Market failures and distortions**: the costs and resulting benefits of the RD&D activities are asymmetric: whereas the investments in Smart Grids fall largely on the network operators, the benefits are largely with other stakeholders (society, electricity system, customers, generators etc…). This is not taken into account by current regulation schemes: **present incentives are not sufficient** for network operators to invest, neither in extra R&D, nor in large scale demonstration or in the deployment of the new technology. Furthermore, current regulatory regimes do not always reflect actual costs of the actions of the grid users and this may not promote the most efficient solutions.

- **Public barriers** including customer engagement and public acceptance of infrastructure developments.

The EEGI program has been designed to overcome these barriers: it leans on the Third Energy package adopted by the European Parliament and the Council in July 2009 which, together with other legislation, provides Europe with an appropriate regulatory framework for adapting networks to a lower carbon footprint.

3. Participants in the initiative

3.1. Roles and responsibilities in the electricity system

The 2003 Directive on internal electricity markets has initiated the progressive transformation of vertically-integrated electricity companies into four sets of separate but interacting players:

- **The regulated transmission (TSO) and distribution (DSO) networks:** electricity networks have long been recognised as natural monopolies, to avoid unnecessary duplication of infrastructure and to guarantee access to all players at equal conditions.
- **Generating companies**: traditionally generators have mostly been operating very large power plants connected to the transmission network (high voltage grid). Now these are being supplemented both by large units connected to the transmission level, like wind farms, but also small producers that will be connected at sub-transmission and distribution levels (eg. pv and smaller wind) with very different characteristics.
- **Retailing companies**, and aggregators whose job is to supply energy to customers, and to charge them for the generation, transport, distribution and retail operations.
- **Regulatory authorities,** whose mission is to ensure that companies under regulatory laws remain economically efficient, and that both generation and retail companies adopt fair and transparent practices to the benefits of the customers, while complying with the policy orientations declined by each Member State in coherence with the three pillars defined at EU level.

Other key players are the power technology manufacturers and the ICT industry who contribute to the reengineering of the electricity system by providing state-of-the-art technologies and solutions. Their contribution to the EEGI program will also give them knowledge and specifications about the future European electricity system needs beyond year 2020[4].

3.2. The role of the Network operators

All the main players in the electricity system will be involved in the implementation of the EEGI program, but the network operators should have a leading role in the initiative for several reasons:

- The EEGI focuses on **system-level innovation** and its validation and replication, a natural and legal responsibility of the network operators.
- The **network operators must lead the demonstration activities** to ensure secure operations , since the projects are performed under real operating conditions, and security of the system is the responsibility of the network operators.
- Network operators will ensure that new developments provide a **level playing field** for the competitive activities of market players.
- Network operators, through the interaction with their regulators, aim at **optimising the overall electricity system efficiency**.

[4] See for instance the EU-supported project IRENE 40.

3.3. Involvement of other main stakeholders in the EEGI programme

Concerted discussions have already occurred at program design level with some of the main players in the electricity system. A workshop was organized by the Smart Grid Platform on March 10-th 2010 in Brussels to analyze and discuss the detailed programme of the EEGI with a representative set of stakeholders from the electricity system. Several recommendations have already been introduced in the present EEGI program. The stakeholders included:

- The generating companies and generator manufacturers, particularly those involved in solar and wind electricity production.
- The retailers and aggregators needed to validate the role of network players when involving real time price signals and the so called energy boxes
- The T&D equipment manufacturers and ICT industry which will be needed to support the integration of technology solutions into the European electricity grids based on the specifications from network operators, and will also have an early access to future needs of the electricity network.
- The consumers whose present and future needs (smart buildings, smart appliances, electric cars, etc…) and data protection (data privacy etc) will have an impact on how networks can be managed even more efficiently.
- RTD performers to support the network operators in developing new solutions prior to their demonstrations in real operations
- Governmental and regulatory bodies who have an important role in the design phase of large scale demonstrations involving a large number of real customers. Three workshops have been held with the European regulators, in May and October 2009, and March 2010.

This involvement of electricity system stakeholders will continue and be extended also after the initiative has been launched. The EEGI programme is an open platform and takes fully account in of the liberalized electricity market. Demonstrations projects will therefore involve network operators, generators, manufacturers, retailers, consumers associations as well as research providers and the partnerships are managed at project level. Some of the demonstration projects will also require an active involvement of the regulators, as they will need special authorizations to perform operations that are normally not foreseen in the existing regulation rules or in the standard operations of existing assets.

It is expected that a stakeholder board will be setup after the launch of the initiative, to take into account the viewpoints from a wide set of stakeholders, and to contribute to the periodic update of the EEGI programme.

4. Scope of the activities in the program

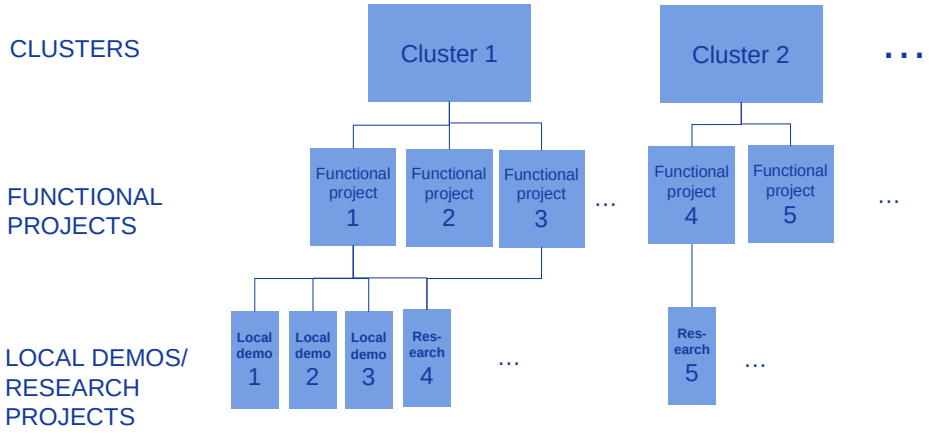
The EEGI program encompasses Research, Development and Demonstration activities according to the following definition:

- **Research and Development** means activities performed mainly at the desk, in laboratory or in test facilities aimed at creating new system knowledge, and validating technology or products that can offer a potential benefit for the electricity networks.

- **Large Scale Demonstration** activities means activities performed in a real environment (involving real customers, real voltage, real network, at a scale suited for reliable scaling up and replication) and aimed at proving the viability of new solutions (technology, markets, regulation, customer acceptance) that can offer a potential benefit for the electricity networks and the users.

- **Deployment** means full scale implementation of a given solution on the electricity network. The activities necessary to prepare for deployment, including R&D and demonstration activities that will deliver requirements, specifications and innovative solutions are included in the EEGI program, but the **costs of deploying these solutions at full scale on European networks are not included**. Deployment activities are expected to start concurrently with the development of the EEGI program.

To enable full coverage of critical issues and avoid overlaps, the RD&D activities have been organized in a hierarchy of clusters, functional projects, local demonstration projects and research projects as follows:



- A **cluster** is a set of functional projects dealing with common issues that need to be managed all together to avoid overlaps and guarantee the most complete coverage of these issues.

- **A functional project** is a functional description and definition of demonstration and/or research activities needed to reach specific functional goals, and includes budget figures and KPIs to monitor the performance. A functional project is not a physical project and does not have a defined location. A functional project needs a set of local demonstration projects and/or research projects to be completed.

- **Local demonstration projects** will be practical realizations of the demonstration activities described in the functional projects, and is performed in a defined location under real network operating conditions with real customers. A number of local demonstration projects are necessary to cover the needs of each functional project in a representative set of different working conditions because in most cases different local conditions (network conditions, climate conditions, customer behavior etc) need to be tested in order to find the most efficient solutions. At the same time one local implementation project can cover more than one functional project. .

- **Research projects** will be practical realizations of the research activities described in the functional project.

A simplified, illustrative example of the relationship between functional projects and local demonstration/research projects is shown in the matrix below:

	Local Demo project A	Local Demo project B	Research project C	...
Functional project 1	X	X	X	
Functional project 2		X		...
Functional project 3	X		X	
....	...			

In this case, functional project 1 needs to be implemented through two local demonstration projects (A and B) and one research project (C). Two local demonstration projects are needed to test the solutions defined in the functional project in different locations with different local conditions (different network-, geographic-, customer- and regulatory environment). Furthermore, functional project 2 needs only one demonstration project (B) to test the solution, whereas functional project 3 needs one demonstration projects (A) and one research project (C).

The proposed approach takes into account the diversity of existing network architectures, operations and national regulations which constrain network performances all over EU27.

These functional knowledge needs can be served by one or more competing technology-based solutions to meet the same needs. This is why the corresponding RD&D projects have been expressed in functional terms leaving the room to competing RD&D proposals to deliver the required knowledge. Program management at European level will ensure that an appropriate number of projects are launched to cover different local conditions and competitive solutions and to meet the needs of each set of requirements in the functional projects.

5. Content of the initiative

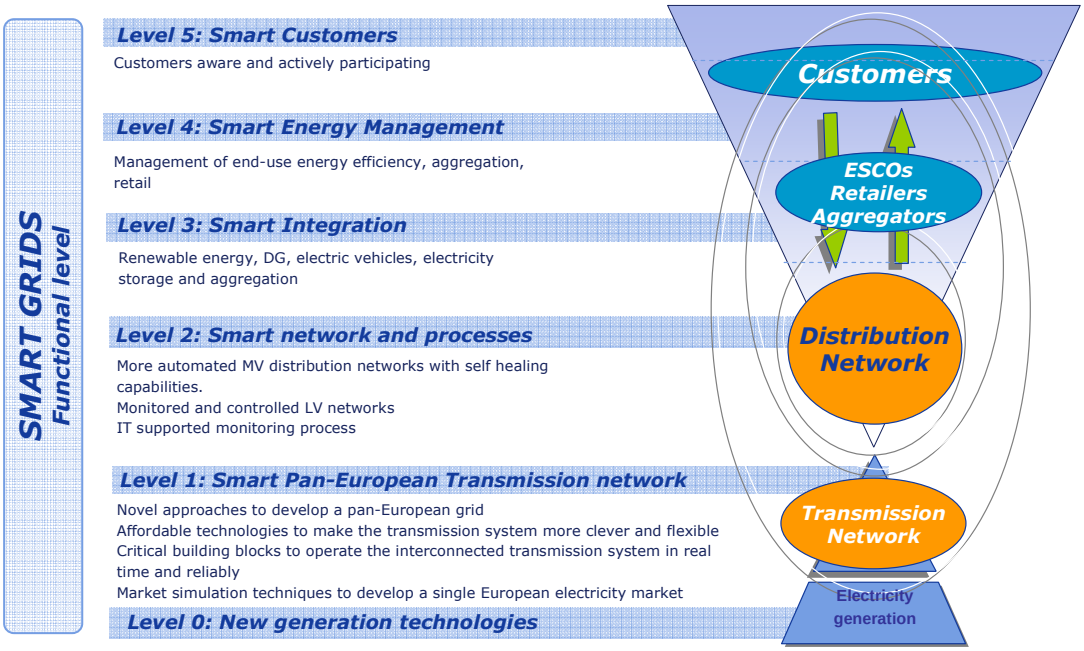
5.1. A Smart Grid model

There are several definitions of smart grids, for instance the Smart Grid European Technology Platform defines a smart grid as an "electricity network that can intelligently integrate the actions of all the users connected to it – generators, consumers and those that do both, in order to efficiently deliver sustainable economic and secure electricity supply".

Since several definitions already exist, the focus of the EEGI has been on defining the major smart grids functionalities necessary to reach the vision and the goals of the program rather than on the definition. To meet this goal, a Smart Grids model has been developed to guide in the process of defining the functionalities and the needed projects, to ensure that all critical issues are covered and avoiding overlaps.

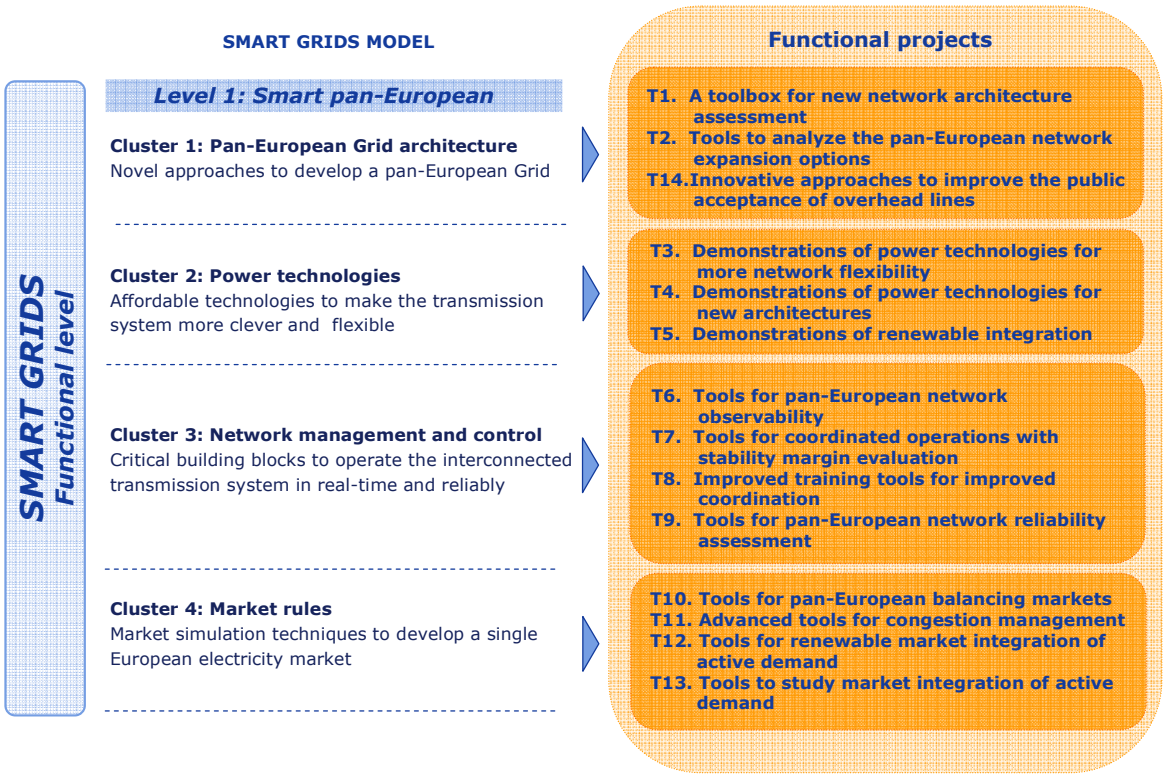
The picture below summarizes the model.

- Level 0 covers centralized electricity generation technologies, the majority being connected to the European Transmission Grid and located anywhere in Europe or beyond, including present and future wind or solar farms.
- Level 1 covers transmission issues, the responsibility of European Transmission Operators.
- Level 2 covers the issues that are the exclusive responsibilities of the DSOs.
- Level 3 to 5 cover issues that require the involvement of DSOs, grid users connected to the distribution network (as generators and customers) and free market players (as retailers and aggregators).



5.2. Transmission network activities

The transmission network activities have been organized according to four clusters corresponding to the four basic activities of a network operator (planning, investments, operations and power markets), as shown at the left side of the figure below:



Cluster #1, 3 and 4 deal mainly with research activities, whereas Cluster # 2 covers both research and demonstration activities. The right side of the figure lists the content of the cluster in term of functional projects.

It must be emphasized that the proposed functional projects are closely linked to on-going RD&D projects supported by the European Commission:

- SAFEWIND, WINGRID, IS-POWERS dealing with on-shore wind integration
- PEGASE dealing with real time network simulation techniques
- OPTIMATE dealing with interconnected power market simulation tools
- REALISEGRID dealing with costs/benefits analysis of transmission investments
- TWENTIES dealing with te demonstration of power network technologies to face massive wind integration in EU27

Each of these projects will deliver a first batch of results as soon as 2012, several of them bringing direct support to integration of off-shore wind generation. Furthermore, projects to be launched in late 2010 and later will also directly address off-shore wind related grid issues (namely T1, T2, T5, T7, T9, T10).

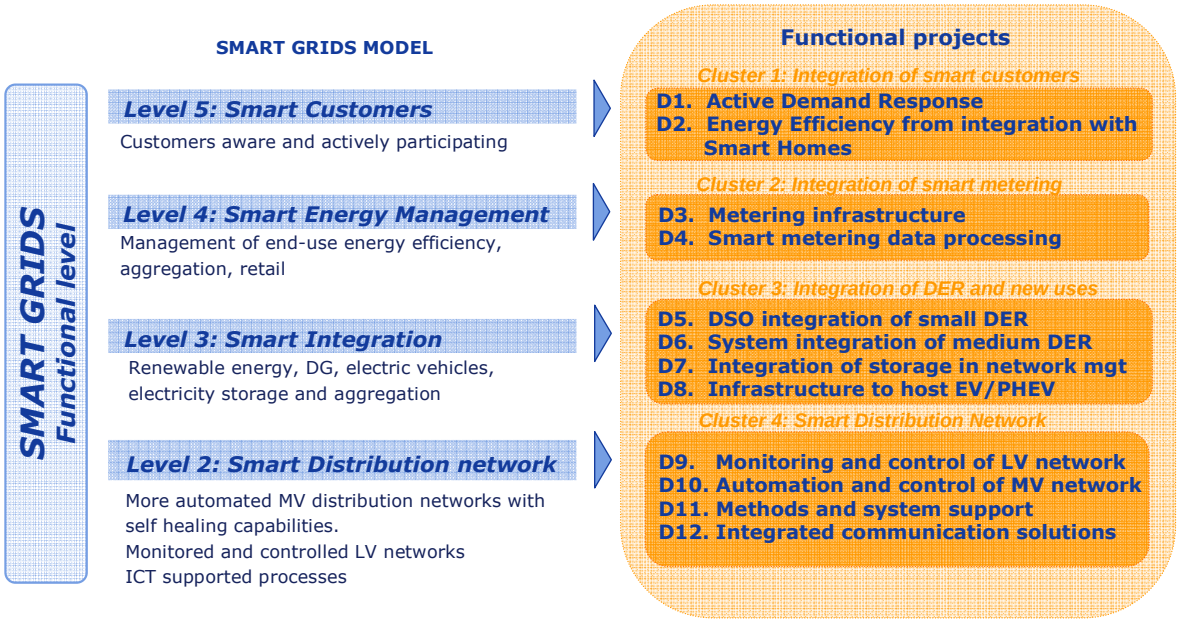
The table below indicates the scheduling of the functional projects over years 2010-2018, and the connections with existing activities at EU level[5].

Smart Grids Functionalities	Project	YEAR										Costs (M€)
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Pan-European Grid Architectures(R&D)	T1		A tool box for new network architecture assessment										19
	T2	REALISEGRID		Tools to analyze the pan European network expansion options									21
Power Technologies (Demonstration)	T3				Demonstrations of Power technologies for more network flexibility								80
	T4				Demonstrations of Power technologies for new architectures								120
	T5	SAFEWIND, WINGRID, IS-POWERS, TWENTIES			Demonstration of renewable integration (ct'd)								130
Network management and control (R&D)	T6	PEGASE			Tools for a Pan European network observability								12
	T7		Tools for coordinated operations with stability margin evaluation										24
	T8				Improved training tools for improved coordination								25
	T9		Tools for Pan European network reliability assessment										14
New market design options (R&D)	T10				Tools for Pan European balancing markets								18
	T11				Advanced tools for congestion management								21
	T12	OPTIMATE			Tools for renewable market integration								14
	T13				Tools to study market integration of active demand								12
Pan-European Grid Architectures(R&D)	T14		Innovative approaches to improve the public acceptance of overhead lines										50
												Total	560

This program is identical to the ENTSO-E R&D activities for which a public consultation was organized in early 2010.

5.3. Distribution network activities

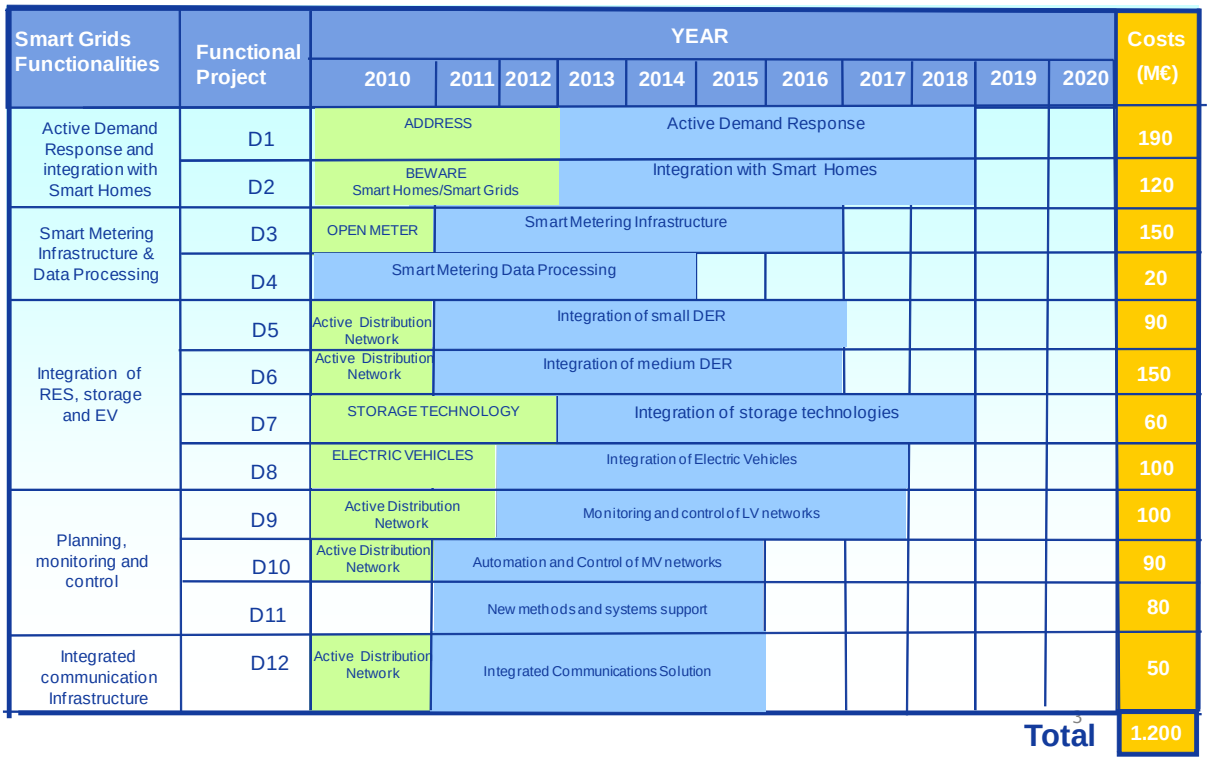
The RD&D activities needed for the distribution network over the period 2010-2018, have been organized in four clusters according to the corresponding levels in the Smart Grids Model with 12 functional projects as follows:



[5] These running EU-level activities are an integral part of the RD&D programme of the networks but are not included in the EEGI budgets.

Each functional project requires a set of local demonstration projects and accompanying research and development activities to be completed. A limited number of local demonstration projects is needed for each functional project to cover different local conditions (eg. climate conditions, existing network conditions, regulatory regime etc.) and test alternative competing solutions to the same problem.

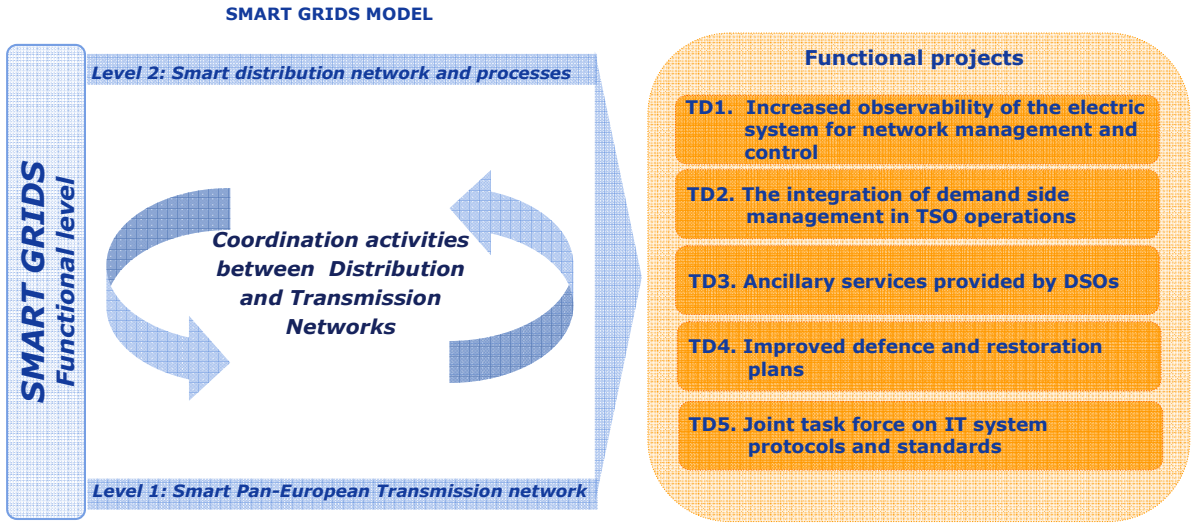
The corresponding research and development needs are best organized at the level of each functional project, rather than at local demonstration project level, in order to rationalize the RD&D efforts and avoid overlaps. These activities are typically needed either to prepare the demonstration projects and/or to analyze the demonstration results. A roadmap of the 12 functional projects is shown below with the associated budget per functional project.



The functional projects leverage on relevant running projects and investments already done at national and European level. These running activities are an integral part of the RD&D program of the networks but are not included in the EEGI budgets.

5.4. Activities to coordinate transmission and distribution networks

Trasmission and distribution networks will increasingly need to coordinate their operations and to exchange data in real time for this purpose. They need to prepare for this interaction and propose the following functional RD&D activities to address these issues over the period 2010-2018.



The roadmap with the 5 functional projects is shown below with the associated budget per functional project.

Functional Project	YEAR											Costs (M€)
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
TD 1		Increased observability of the electric system for network management and control										45
TD 2			The integration of demand side management in TSO operations									70
TD 3		Ancillary services provided by DSOs										50
TD 4		Improved defense and restoration plans										45
TD 5		Joint Task force on IT system protocols and standards										20
											Total	230

5.5. European Added Value

The planning and implementation of the EEGI RD&D programme at European level will avoid unnecessary duplication of efforts, ensure full coverage of critical network issues, promote the replication of new developments and the exchange of best practices.
It will also accelerate the validation of new standards (like grid connection) and of the interoperability of technology-based solutions.

5.6. Budget

The total budget for the EEGI programme is estimated to € 2 bn as summarized in the table below. These budgets are estimated from a detailed costing of functional projects.

Activities	Research costs M€	Demonstration Costs, M€	Total costs M€
Common network activities	90	140	230
Transmission network activities	270	290	560[6]
Distribution network activities	240	960	1200
Total	600	1390	1990

[6] This figure excludes the packaging costs for the tools and new knowledge to be performed within ENTSO-E for fast take-up by non participating TSOs

These budget figures include all the necessary costs to implement the RD&D program, and are not expected to overlap with those of others European Industrial Initiatives (i.e. Wind, Solar, Green Cars and Efficient buildings).

Costs such as those for the deployment of wind farms, PV panels, EV vehicles or home appliances are not included in the above budgets., in particular:

- The wind or PV integration projects are planned partially on existing wind or PV resources, partially on wind or PV resources that are in the pipeline to be built anyway by the time the demonstrations will start. Most of the countries that are candidates to host these projects have pending requests to connect both PV and wind generators that more than satisfies the necessity for these resources in the EEGI program. Furthermore, the planned coordination activities between the EEGI and the Solar and Wind initiatives should bring even more possible resources of renewable generation facilities into the EEGI projects.
- The cost of the Electric vehicles are going to be covered largely by the customers with incentives from the industry[7]
- The home appliances as such are not included for the same reasons mentioned above, and must be covered by the customers with incentives from the home appliance industry.

However, costs of Energy boxes and Energy management systems are included in the budget, in particular for projects at level 5, as well as the interfaces and communication with home appliances.

[7] This approach has already been successfully applied in small-scale pilots

6. Benefits and KPIs

6.1. Benefits and KPIs

The principal aim of the EEGI program is to properly prepare an effective and efficient deployment of the smart grids in Europe. As a result, its benefits will mainly be expressed in terms of the benefits of the deployed solutions.

A set of benefits together with potential KPIs to measure them are proposed in the table below :

Benefit	Potential KPIs
1. Increased sustainability	Quantified reduction in CO2 emission
2. Adequate transmission/ distribution grid capacity to bring the electricity generated from all sources to consumers	Hosting capacity of DER
	Reduction in DER cut-off due to congestion
	Allowable maximum injection of power without congestion risks
3. Harmonization and standardization of grid connection procedures giving access to any type of grid users	Reduction in time to connect new user
	Uniform grid connection rules
4. Higher security and quality of supply	Reduction peak demand ratio
	Increased share of renewables
	Reduction in interruptions per customer
	Increased voltage quality performance
	Increase in coordinated operation between TSOs and DSOs
	Increased efficiency in preventive and emergency control
	Coordinated restoration after emergency
5. Enhanced efficiency and better service in electricity supply and grid operation	Reduction in network losses
	Increased Demand side participation
	Enabling energy efficiency by end users
	Hosting capacity of EV
	Increased availability of network components
	Actual availability of network capacity
	Availability of ancillary services across transmission and distribution grids
6.Effective support of pan-European electricity markets by load-flow control to alleviate loop-flows and increased interconnection capacities	Increase of cross-border interconnection capacity
7. Coordinated grid planning and development involving joint European, regional and local grid processes optimizing the transmission grid infrastructure	
8. Cost efficiency of the deployed solutions (capex + opex)	
9. Enabling of new business models and the development of innovative products and services	

There is a need, especially when the tariffs are used as a financing source, to distinguish between the costs/benefits for the grid users[8] (***grid internal benefits***) and the external costs/benefits (***grid external benefits***) which can by no means be attributed to the network users:

- **grid internal benefits** are direct or indirect benefits to grid users. These benefits would come mainly from deploying "smart" solutions on the network, and would also include necessary RD&D activities on the network to develop these solutions.

- **grid external benefits** are direct or indirect benefits to external players that are not users of the grid, including renewable generation manufacturers, power technology manufacturers, car manufacturers developing electric cars, etc...

In the discussion with the European regulators, it has become clear that tariffs should only be considered to finance RD&D activities that lead to grid internal benefits, and that activities that lead to grid external benefits must be covered by other funding resources such as public funding and/or funding from free market players.

Benefits and KPI's will be further examined together with the SET Information System (SETIS). It must however be stressed that in-depth experiment and KPI design is needed to properly measure grid internal and grid external benefits, with a special emphasis at project level. For instance, the impact of Smart Grids investments on higher energy efficiency and reduced carbon emissions will be resulting from a large number of grid-internal (increased hosting capacity, reduced network losses) and grid external developments (massive deployment of renewables, electro-mobility) with complex relationships.

In addition to these benefits related to the deployments of the results, the participants of the RD&D activities will also take advantage of some limited, mostly non-financial benefits from participating. These benefits include:

- The possibility to influence the chosen RD&D routes and the resulting outputs for an early internal take-up

- The possibility to anticipate the changes needed better than the non participating players

- The building of new skills and experiences thanks to large scale demonstrations close to real life uses

- Increased cross-border cooperation and learning (TSOs)

- Financial returns linked to the residual value of the demonstrators (depending upon the region and the local project for Distribution Operators)

The participation in demonstration projects also includes "first mover risks" in the first deployment of new technologies, while the "first mover advantages" are limited for network operators since network operation is a regulated business.

[8] Network users are defined as consumers, producers and those who do both, the so-called prosumers.

For non regulated players, some benefits can be expected from participating to large scale demonstrations in terms of marketing, and in terms of a better appreciation of the requirements for innovative products or services.

6.2. The set of KPIs proposed for program and project management

The key performance indicators will, in the end, encompass three levels of performance measurements of the EEGI roadmap, somehow in line with the three levels of the EII governance rules as sketched in Section 8.

Level 1 Programme KPIs

KPIs indicate the ability to reach the 2020 European Energy Policy targets within acceptable costs, once the RD&D results are progressively deployed in EU 27 according to the proposed scaling up and replication rules. The Business as usual approach is used for comparison (for instance the IEA electricity roadmap for Europe): expected CAPEX+OPEX can be calculated and compared to show the "smartness effects" of the actual deployment.

Level 2 Programme KPIs

Programme KPIs are defined to measure:

- ex ante: the economic effectiveness of the roll-out of innovations validated by the EEGI program
- ex post: the technical and implementation effectiveness of the EEGI program

More specifically, they read as follows:

1. Economic effectiveness: to quantify the maximum expected economic impacts of the innovative solution deployment, based on the scaling up and replication rules proposed for each applicable result. It must be understood that this is the upper bound of the KPI target values defined at Level 1, thus assuming a maximum theoretical smart deployment of the RD&D results in order to meet the EU policy goals.
2. Technical effectiveness: quantify that all the technical innovative network options foreseen with the EEGI roadmap have been addressed and validated based on scaling up and replication studies. This is measured through 4 indices valid for the period 2010-2020, the value of which should grow ideally from 0 to 100 at the program end, before 2020:
    - Network Sustainability index
        - Increase in hosting capacity of RES (including PV) and DER
        - Increase in demand flexibility
        - Increase in energy efficiency
    - Network Coordination index: Increase/improve coordinated activities of network planning and system operation
    - Network-based market rule index: new market rule proposals that will host RES more efficiently
    - Network interconnection index: increase of Off-shore/On-shore interconnection capacity among Member States

    These indices are linked directly to each of the results of RD&D projects
3. Effectiveness of the implementation plan:

They measure how the RD&D activities are effective at producing the expected results:

- The coverage of the Implementation Plan (N° of RD&D project launched over the total N° of project initially planned for the year under scrutiny)
- N1: N° of delivered results according to the above EEGI program effectiveness monitoring (meaning results in line with either one of the above four indices
- N2: N° of delivered results ready for deployment (following scaling up, replication or dissemination activities)
- % of DSO/TSO customers impacted by the deployed results (for each of the results that have been already effectively deployed and used)

In principle, one should observe N1>N2 which indicates how the deployment of delivered RD&D results will depend upon scalability and /or replication and/or regulatory attention.

Level 3 Project KPIs

These KPIs are project KPIs which are defined on a case by case basis, while contributing to build the above performance indices in a way to be finalized by with the main involved stakeholders.

Overall, the process to relate the three levels of KPI valuation still remains to be clarified with all the stakeholders, with pending questions on:

1. Translating projects outputs obtained at level 2 into program impacts at level 1
2. Evaluating the program economic effectiveness using first guesses to be provided by the network operators, ad involving "Business as Usual" figures such as the ones provided by the IEA world electricity roadmap
3. Linking economic and technical effectiveness indicators through the scaling up and replication activities

Yet, it is believed that the above hierarchy of KPIs will also help:

- monitoring the coherence and balance of the project portfolio results with political goals at EU level (sustainability, security of supply, single electricity market)
- measuring the openness of the initiative (the number of network operators involved and the connected number of customers and networks)
- measuring the overall program effectiveness (the foreseen results obtained on time) and efficiency (the foreseen results obtained within budget)

The KPIs are being finalized by the Network Operators in collaboration with SETIS to be presented to the EII team for program monitoring implementation and revision.

7. Financing the program

7.1. Financing principles

Network operation is a regulated business in Europe, and therefore the incentives for the network operators to invest in new technology are closely linked to the tariff schemes used by the regulatory body in each Member State.

According to the Third Internal Energy Market package, **tariffs** should ensure that network operators are granted appropriate incentives, over both the short and long term, to increase efficiencies, foster market integration and security of supply and support the related **research activities.** Such incentives for research are today the exception rather than the rule, but some European regulators have taken up this challenge. For instance, OFGEM has implemented the Low-carbon networks fund to support RD&D projects on networks in the UK with a budget of 500M £. Also the Italian regulator recently issued a resolution providing incentives for Smart Grids projects, with an additional 2% return on investments limited to specific pilots on active MV networks. However these are still exceptions among the EU27 Member States.

The deployment of the results on networks across Europe is expected to be covered by new appropriate tariff schemes and mechanisms in accordance with the Third Energy Package.

The activities necessary to prepare for deployment, including R&D and demonstration activities that will deliver requirements, specifications and innovative solutions are included in the EEGI program, but the **costs of deploying these solutions at full scale on European networks are not included**.

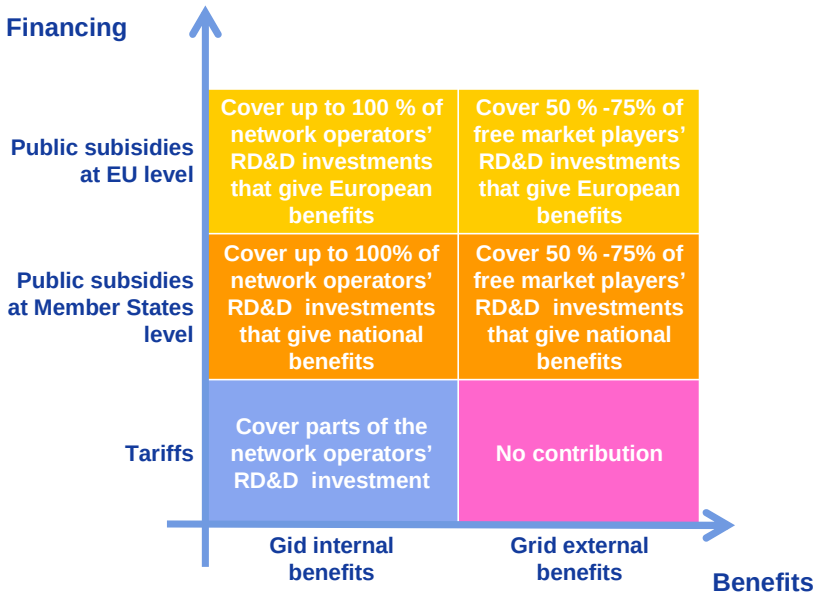
New appropriate tariff schemes are not expected to be active in a majority of Member States in the period 2010-2012. Therefore **a significant share of public funding will be needed** in a transition phase to cover the costs of the network operators in order to start priority projects that cannot be delayed in order to reach the 2020 targets.

The proposed support schemes for the programme are based on the following principles:

- **First phase, probably between 2010 and 2012**, where significant new incentives are not expected to be implemented in the tariffs, a substantial intensity of support is requested from public authorities (EC/MS) and is expected to be based mostly on existing funding schemes. Priority projects need to be launched in this period to reach the 2020 targets safely.
- **Second phase, probably from 2013 on:** new mechanisms including adequate new tariff schemes are expected to increasingly replace EC/MS funding, with public support being increasingly redirected to accelerate particular technology developments as needed for system demonstrations or the participation of free market players such as electricity retailers, aggregators, manufacturers and generators.

A share of **public support from European sources** will encourage the European-level planning and cooperation to avoid unnecessary duplication of efforts and to promote solutions that support European standardisation and interoperability. Demonstration activities that provide substantial benefits at national level and do not involve unacceptable high risk levels, are expected to be **covered mainly by national funds.**

The schematic below indicates the funding sources to cover grid internal and grid external benefits:



In the **first phase** the share of financing from tariffs is expected to be limited because adequate tariff incentives for RD&D investments have still not been implemented, but this share is expected to **increase** in the **second phase** as new tariff incentives are introduced, to replace some of the EC/MS funding. However, even when new dedicated tariff schemes have been implemented, these are not expected to cover external costs/benefits that cannot be attributed to the network users. **Public support will still be needed** to cover external costs/benefits, including those of the free market players, to have their commitments to share the new knowledge gained through the participation.

7.2. Liabilities

When performing large scale demonstration projects on real networks, with the agreement of regulatory bodies, there will be a certain risk that grid users may be negatively affected by the experiments even though all possible measures are taken to limit this risk at demonstration project design and preparation level. There are two types of liabilities that could emerge if things go wrong:

- Liabilities towards (large) grid users that are partners in the projects: this will be addressed specifically by the Consortium agreement of each project
- Liabilities towards grid users that are not partners of the project but that could be impacted by project failures: this falls ultimately under the responsibility of the network operator in charge of the demonstration project and will be managed as far as possible according to current procedures by the responsible network operator on a case-by case basis.

8. Principles for governance

8.1. Background on governance

The governance structure of the SET Plan addresses several levels of responsibilities in line with the financing sources.

- **Level 1:** SET Plan Steering Committee which sets the overall strategy and the guidelines for implementation (The EC and the Member States)
- **Level 2:** the EEGI "EII team" which monitors the program design, implementation and revision. It will be composed of representatives from public authorities (MS, EC) and other electricity system representative stakeholders .
- **Level 3:** the implementation and operational level, which will include the implementation and monitoring activities of individual projects.

The network operators need to be involved in level 2 and level 3 of the governance structure.

8.2. The representation of network operators

The Network Operators should have a leading role in the management of the program, as they have to implement the solutions that are developed in the program on their own networks.

Transmission system operators (TSO's) have already created the ENTSO-E association mandated by the 3rd IEM ahead of the required deadline. This association proposes to play an important role in the planning, monitoring and dissemination of transmission issues in the initiative. To mirror this role, a number of Distribution system operators (DSOs) have created an ad-hoc association, the "European DSO Association for Smart Grids" (EDSO-SG) to undertake a similar support to the governance of the EII on distribution issues and to ensure the openness of the initiative.

The associations of network operators propose to undertake a major role in the dissemination of the knowledge to all network operators, including to those that do not participate in the projects, to ensure the full benefits of the EEGI programme can be reached.

To guarantee the coordination between ENTSO-E and EDSO-SG the two associations are working on a Cooperation Agreement to regulate common issues using an operational “Coordination Team”.

In the dissemination and knowledge sharing of public results on the distribution networks, EURELECTRIC, the association of the electricity industry in Europe, is involved and used for a wide dissemination of the results. An appropriate structure to handle this is under development.

8.3. The representation of other stakeholders

It is proposed to establish a stakeholder board which would be periodically consulted by the EII Team involving also the stakeholders that are not part of the Team.

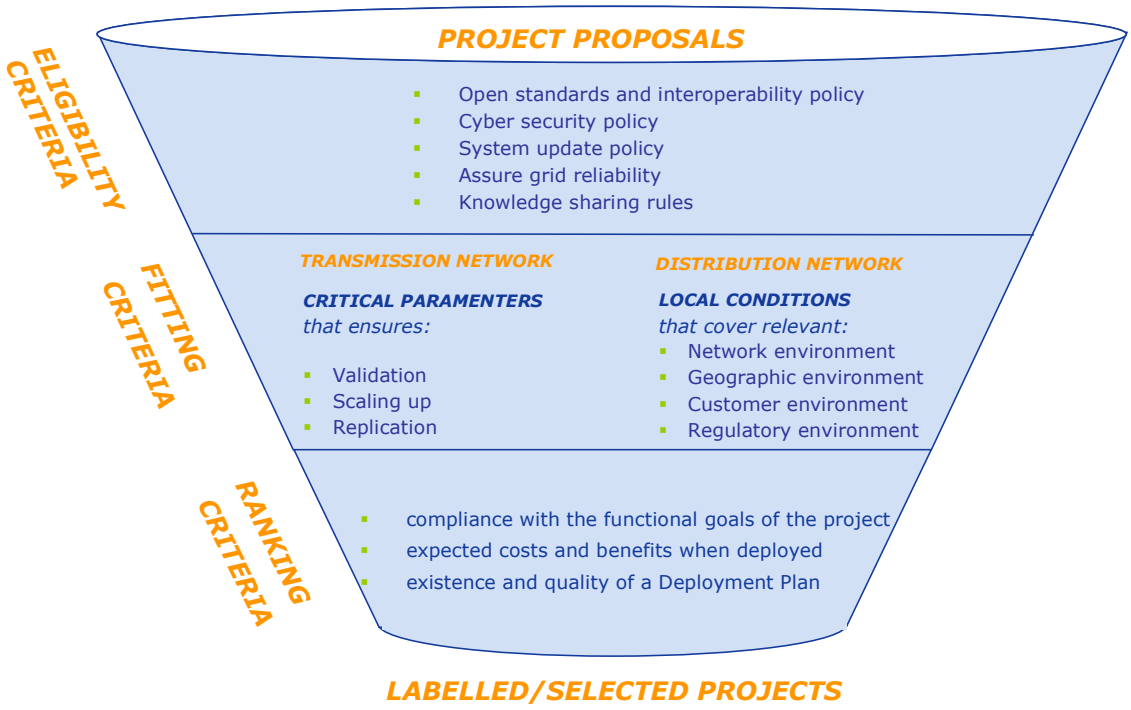
9. Project selection/labelling

It is expected that in the first phase of the programme, project selection will be performed by the public authorities according to their own practices, following open calls for proposals.

When the Network operator's associations (ENTSO-E and EDSO-SG) would be in a position to perform an internal and transparent project screening, they propose to contribute to this by providing a label to projects prior to the selection decisions for funding. This labelling process is intended to support the selection process of the various public authorities by giving an a-priori judgement from the initiative whether the project is in line with the program objectives and will bring a valuable contribution to its implementation.

9.1. The proposed labelling/selection process

The labelling will acknowledge that the selected project fits in the EEGI program and thus ensure that the most critical issues are covered, while at the same time avoiding unnecessary overlaps. The proposed process is briefly described in the figure below:



Each project must first meet a specific set of minimal requirements, the **eligibility criteria**, to be eligible for participation in the EEGI programme, including:

- open standards and interoperability policy
- cyber security policy
- system update strategy
- assure grid reliability

- knowledge sharing rules

Completing a functional project for **transmission networks** requires that several (at least two) network operators propose together RD&D activities covering the most critical parameters which will:

- Secure the validation of the results by ENTSO-E
- Secure the scaling up of the results in their region of operations
- Prepare replication of the methodologies or demonstration results throughout Europe since they cover critical parameters like the network environment (stressing technology maturity, the existence of metering, the electricity supply chain, the network characteristics, etc...) and the regulatory environment (stressing the impacts of existing regulations)

Completing a functional project on the **distribution network** requires that one or several network operators[9] propose together a minimal number of local demonstration projects. These demonstration projects must cover a sufficient set of different **local conditions** needed to test the solutions and prepare for scaling-up and replication at European level. These local conditions include:

- the network environment (stressing technology maturity, the existence of metering, the location of the electricity supply chain, the network characteristics and the standard operating conditions as voltage, frequency, billing, etc...)
- the geographic environment (stressing climate and topology differences)
- the customer environment (stressing urban, semi urban or rural areas)
- the regulatory environment (stressing the impacts of existing regulations)

Finally the network operators propose a set of **ranking criteria** that could be used to guide the project selection. They include:

- compliance with the goals of the functional project
- expected costs and benefits of the tested solution when implemented at European level provided that scaling up and replication rules have been developed and validated
- existence and quality of a Deployment Plan of the tested solution in support of replication projects in other Member States of EU27

9.2. Transition period

During the transition period (2010-2012), the FP7 or Member States funding selection procedures will probably prevail. The added value of ENTSO-E and EDSO-SG is to encourage competitive consortia to submit proposals in line with the EC selection rules. EDSO-SG is also ready to take the responsibility for the labelling/selection process from the very start, whereas ENTSO-E will not take this role in this first phase.

[9] A single Network Operator project may meet several functional requirements. Several Network Operators can join to perform joint activities which reveal to be less costly than submitting the same project separately.

10. Principles for knowledge ownership and sharing

The sharing of knowledge is focused on the foreground knowledge gained through the development of the projects.

10.1. Foreground knowledge and intellectual property

The foreground knowledge gained through this program has several components, including but not limited to:

- the **functionalities** and the **technical performance** of a new tested solution
- the **benefits obtained** with the tested solution including improvement in reliability reduction in losses etc
- the **cost levels** to scale up and to replicate a given demonstrated solution, including expected capital and operating costs of the tested solutions when deployed at full scale
- the proposed **new network operation rules** including the management of demand response and dispersed generation units
- the **new coordination procedures** between transmission networks and distribution networks for an optimal use of the electric system under normal and emergency conditions
- the lessons learnt on **innovative project management** including the planning of large scale experiments,
- the **details of technical implementation** of the projects

The above foreground knowledge and the related intellectual property rights are owned by the party that has carried out the work that generated the knowledge, unless otherwise agreed. Where the respective share of the work carried out by the parties involved in a project cannot be ascertained to one party, joint activities result in joint ownership of knowledge according to the respective input to those joint activities.

10.2. Sharing of knowledge

The sharing of foreground knowledge, in compliance with the necessary protection of the related intellectual property rights, depends on the source of funding and is based on the following principles:

- The **technical functionalities** of the solutions and the general **results of the experiments** are made available to all interested stakeholders upon request.
- The sharing of **intellectual property** related to the detailed technical solutions to implement the projects will depend on the source of financing and on the stakeholders involved:
  - The sharing of results developed using mainly **public funding** depends on the rules applied by the specific funding scheme, but could in principle be made

available free of charge to all other network operators in accordance with the necessary protection of the related intellectual property rights.

- When **tariff funding** is involved access to knowledge will typically be granted for free to network operators that are operating networks serving the grid users that have paid for the experiment, whereas other network operators will have access at reasonable cost (to discourage free-riding).

- Network operators will grant access to new software developments for members of the network associations (ENTSO-E and EDSO-SG) at a reasonable cost.

Access to network operator's background information will be granted when it is needed to use the generated foreground information in accordance with the relevant agreements and provided that the relevant owner has expressly given its consent.

The sharing of knowledge among participants in the initiative and with network operators that are not directly participating in the projects will be organized through the Network operator's associations. This will guarantee non-discrimination and facilitate the sharing of knowledge as the network operators are not competitors and do have a common interest in sharing results.

Each category of knowledge will be packaged according to the level of details required by the impacted stakeholders (from detailed to aggregated pieces of knowledge).

10.3. Prototypes and demonstrations

All new devices, prototypes or demonstration facilities installed on the networks for the experiments during the projects are **owned by the network operators and/or the manufacturers** participating in the project in accordance with the relevant project agreements.

11. Detailed Implementation plan 2010-2012

The RD&D programme for electricity networks proposed in the present document covers a full 9-years period with a total cost estimated at 2 B€ including the expected participation of regulated networks, market players, research centres and universities. It does not cover the costs of deploying the solutions across Europe.

In this chapter a detailed implementation plan is provided, covering priority projects that should start urgently, in the period 2010-2012. The investment in the priority projects is estimated at 1 B€ to cover their full duration.

This implementation plan will be periodically revised every year to create a rolling, always up-to-date planning of the priority RD&D activities. The Network Operators associations (ENTSO-E and EDSO-SG) will have a central role in this updating involving also other relevant stakeholders and the EII Team.

11.1. Transmission Networks priority activities

TSO Activities to be started in 2010-2012		
Start Year	Functional project	Est. Budget[10]
Pan-European Grid Architectures (R&D)		
2011	**A tool box for new network architecture assessment of the pan European transmission system** Several technologies will, in the coming decade, impact architectural choices of the Pan European Transmission Grid (HVDC, Gas Insulated Lines, FACTS, etc.). Assembling these technologies will lead to new architecture options which must be studied both on cost and operation standpoints (including their secure operations). The purpose of this tool box is to allow architecture simulations able to compare several designs based on technical and economical criteria.	19 M€
2012	**Advanced tools to analyze the pan European transmission network expansion options according to energy scenarios for Europe** TSOs develop and share a tool box to analyze pan European grid expansion scenarios in conjunction with the post 2020 targets in order to: • further integrate renewable and conventional generation, • use power flow control devices, • address the role of active demand (controllable loads). • Take into account energy storage with optima that are searched at EU level and not any more at national level. These tools are complementary of the above architecture design tools	21 M€

[10] Multi-annual budget for each functional project, over the period 2011-2017

2011	**Methodologies to improve the public acceptance of overhead lines**[11] Social acceptance of overhead lines becomes a prerequisite if one wants to meet the European objectives for integration of Renewables Energy Sources (RES), contribution to the Internal Electricity Market (IEM) and maintaining the Security of Electricity Supply. Based on a multidisciplinary approach, it is proposed to design and develop a European good practice guide based on the experience of leading experts in the field of overhead line design and development, as well as environmental and social acceptance issues.	30 M€
Network management and control (R&D)		
2011	**Innovative tools for coordinated operations with stability margin evaluation** Starting from the outputs of the PEGASE project, this project aims at developing a simulation tool box able to understand how the harmonization of operational procedures and coordination between TSOs will allow the pan European transmission system operators: • *facing new generation and transmission uncertainties coming in particular from renewable expansion (requiring gains in observability of the overall system)* • *requiring more control to improve the commandability of the overall system.* Their prototype simulation tool box will allow design policies for operations involving the harmonisation of existing rules and increased coordination.	24 M€
2011	**Innovative tools and approaches for the Pan European network reliability assessment** This project aims at revisiting the tools and rules to make the current security criterion for the new pan-European system architecture evolve without losing on present day reliability levels. The project will evaluate the options to replace the actual N-1 preventive security doctrine **at the design and operations stage** of the pan European transmission network.	14 M€
2010-2012	Budgetary commitments for priority actions 2010-2012 at TSO level	**108 M€**[12]

[11] This topic has been added by ENTSO-E to the 13 functional projects originally proposed in the EEGI roadmap version of July 31, 2009

[12] This figure excludes dissemination costs by ENTSO-E which have not yet been sized

11.2. Distribution networks priority activities

DSO Activities to be started 2010-2012		
Start Year[13]	**Functional Demonstrator**	Est. Budget[14]
Smart metering infrastructure and data processing		
2012	**Smart metering infrastructure** Although full rollouts of smart meters have already been done in Europe (Italy and Sweden), these are first generation of smart meters solutions and based on proprietary technologies. Leveraging on these implementations, this project aims to validate common, open standard solutions for next generation of smart meter infrastructure including solutions to provide customer with electricity consumption information in their homes.	150 M€
2011	**Smart metering data processing** Future development of smart meters will address new business cases for using the generated data in the best way. This functional project aims at validating cost-effective setups for information exchange between stakeholders and adequate processing of the data to maximise the benefits of smart metering.	20 M€
Integration of RES, storage and electric vehicles		
2012	**Integration of small renewable in the distribution network** The further expansion of small DER requires that they become more visible and controllable in the network. This project is aimed at validating upgraded network design criteria at LV level which extend the network hosting capacity, maintaining secure operations and high power quality.	90 M€
2011	**System Integration of medium size renewable** The challenges of integrating a large number of medium scale intermittent distributed generation units in the distribution network while maintaining power quality are addressed. It is aimed at designing and demonstrating new solutions on a large scale to bring solutions, which will increase the grid hosting capacity for intermittent renewable energy sources with the help of active, real-time, large scale integrated management techniques of distributed generation.	150 M€

[13] Please note that budgetary commitments in 2010 may be needed for projects to start at the beginning of 2011
[14] Multi-annual budget for each functional demonstrator, over the period 2011-2015

2012	**Integration of electric vehicles** The project addresses the network changes needed to host a large-scale penetration of electric vehicles in Europe with proposals to implement extended electricity recharge infrastructure in order to enable the easy, secure and flexible recharging of electric vehicles. This includes also the evaluation of the real impact on the grid, testable via a clustered and enlarged set of electric vehicles recharging simultaneously. Different business models will also be tested.	100 M€
	Planning, monitoring and control	
2012	**Improved planning, monitoring and control of LV networks** The introduction of smart meters gives the network operator plenty of useful data and a communication channel. These capabilities need to be further investigated and utilized to improve: • The specifications for future mass production of low cost devices that allow a proper monitoring of the LV network • The development of European standards to perform such monitoring and control	100 M€
2011	**Automation and control of MV network** Today's protection and control schemes of the MV network have no communication possibilities, with a low degree of configurability: equipment is run stand-alone with very limited interactions between other parts of the network. Handling higher reliability, renewable integration and increased use of smart metering will require network flexibility, with interactions on monitoring and control.	90 M€
2011	**Methods and system support** Policies and methodologies for network maintenance, renewal, reinforcement and development must be revisited and improved with: • A better knowledge of the distribution networks constraints and behavior, thanks to the increased use of smart meters data and AMM infrastructures • A better understanding of asset ageing mechanisms. :new ICT tools need to be developed to face smartly the end of life of the different network components.	80 M€
	Integrated communication infrastructure	
2012	**Integrated Communication Solutions** A widespread, reliable, cost/effective secure and standard communication solution is needed to reach all the nodes of the distribution electricity network. Field experiments are needed to maximise the efficiency of electricity infrastructure operations, thanks to powerful communication tools and the introduction of more distributed 'intelligence' moving some specific data acquisition and network management functionalities from the Control Centres to the HV and MV substations equipment	50 M€
2010 – 2012	Budgetary commitments for priority actions 2010-2012 at	**830M€**

	distribution level	

11.3. Priority activities for transmission/distribution coordination

Transmission/distribution coordination activities to be started 2010-2012		
Start Year	**Functional project description**	Est. Budget[15]
Tools for improved system observability and network interactions (DSO driven)		**18 M€**
2011	**Load and generation modeling based on data aggregation allowing for clear responsibilities between TSOs, DSOs, generators, retailers and customers** Tools do exist in every network operator. Yet, they need to interact on the basis of data streams that are coherent at all voltage levels and between operations. The challenge is to aggregate dynamic data to model the load and the distributed generation for different horizons (encompassing real time operations *(short term)* and network planning *(long term))*. This root project will trigger several other activities on observability.	7 M€
2012	**Forecast engine integration to allow for more accurate production and load analysis** Forecasting engines are required to provide conditions for reliable reserve requirements in a timely and secure way. Forecasting conditions will provide forecasted values AND uncertainty curves which will serve as a basis for the detection of potential operation risks in the hours ahead , for instance, for wind production, turbine stall due to high wind conditions or strong production variation. The presence of small generation at DSO level will alos require DSOs to manage at cell level the generation of PV, wind or CHP units. Forecast tools involving are still needed with increased accuracy so that DSO are able to manage power and energy at cell level.	5 M€
2012	**Feasibility of new DER connection requirements which allow deployment of DER control centers responding to both TSO and DSO constraints** The principles of DER connection ('connect and forget') should evolve with new connection requirements written so that the DER impact on network is minimized: some level of control on DER will be required which lead to DER control centers t monitor, forecast and operate DER according to DSO and TSO needs for the fulfillment of their mission. It would then provide power flow control, possibly load management, and islanding capabilities.	6 M€

[15] Multi-annual budget for each functional project, over the period 2011-2017

Integration of demand side management in TSO operations		**7 M€**
2012	**Operational implementation of active demand (TSO driven)** Specifications for demonstrating the potential benefits in load control, such as peak shaving and energy savings, when involving end customers on a large scale must be drawn before assessing their impacts on TSO planning and operations New technologies such as smart meters and Energy boxes must be included to add value to the traditional Demand Response proposition in order to raise awareness about consumption pattern and to foster active customer participation in the energy market. These demonstration specifications will cover: • data needed by TSO for the pan European planning tool • TSO operations t reach a reduction in peak demand (10-15%) through active customer participation • planning tools requirements when using metering data • models to describe customer behaviour and segmentation	7 M €
Ancillary services provided by DSOs (DSO driven)		**10 M€**
2011	**The technical issues and novel solutions for voltage and reactive power management at the TSO/DSO interfaces (impacts on future ancillary services with a high DER penetration)** The advent of DG on distribution networks will bring a more active contribution of DSOs with issues like active and reactive power reserves, voltage and frequency control, network restoration. The evolution of electric power systems and electricity markets will also promote the contribution of loads to ancillary services provision and ancillary services markets. Aggregation of (even small) commercial and domestic loads may also appear with new schemes to replace load tripping. These many different ways to implement ancillary services provision by loads and the impacts on transmission network must be studied by DSOs and TSOs: distributed generation and renewable energy sources may have indeed a very limited capability to provide ancillary services with the highly variable and unpredictable nature of DER putting even more constraints on such ancillary services: the contribution of loads providing more flexibility can then be a way towards novel solutions for DSOs.	5 M€
2011	**The legal, contractual and regulatory aspects of ancillary services provided by distributed generation and or loads, allowing for more aggregation business models** Distribution companies used to contribute to ancillary services on transmission systems in a very simple way: reactive compensation at MV side of HV/MV transformer, load tripping schemes to limit frequency drop in case of generation loss, etc. The evolution of the Electricity Sector and the birth of new players like aggregators will impact the roles of the transmission system and distribution network	5 M€

	operators: a specific attention is to be jointly given by TSO and DSOs taking also into account legal, contractual and market aspects.	
Improved defence and restoration plan (TSO driven)		**14 M€**
2011	**Simulation tools allowing for the detection of weak points of reconnection scenarios involving DER units** There are no existing common and binding procedures to manage RES behavior (wind farms in particular) during emergency situations throughout Europe, with a lack of responsibility of RES suppliers towards the grid. Moreover, distribution networks could participate to defense plans using domestic intelligent electrical appliances. Smart appliances are electric devices (TV, air conditioners…) that can sense any network frequency changes and respond accordingly. In case of frequency drops, the domestic and, possibly industrial, intelligent appliances could reduce their consumption or even switch off one after one according to the priority set by the user. Defense plans could take advantage of these appliances by doing selective load shedding instead of disconnecting a whole part of the network. Research work is needed to develop a collective strategy for the member states to implement into their national legislation a harmonized emergency strategy in connection with RES and DER management during emergency situations. It requires simulation tools which are able to detect the weak points of the pan European system and to propose a European doctrine in line with acceptable reconnection scenarios. This work will specify the tools for further development. One application are common TSO/DSO training tools especially to simulate critical network and balance situations in the context of the electricity system as a whole.	7 M€
2012	**Regulatory and technical challenges to implement restoration plans at pan European level** Regulatory and technical issues as well as social and economical aspects must be considered in designing restoration plan at pan European level. Although several recommendations and requirements have been proposed in the Operational handbook of UCTE, it appears that the full recovery of the European system may take long. A joint TSO/DSO approach is needed to cover all the issues before a new doctrine is developed: • simulation tools to assess risk of a breakdown during reconnection, • black-start capability of wind turbine generators • Impacts of Micro Grids and islanding capabilities • Training of Operators evolutions of the national regulatory schemes to foster coordination	7 M€
Joint Task force on IT system protocols and standards (DSO driven) Smarter networks will use real-time, two-way communication technologies to allow users to connect directly with power suppliers. It requires: • a framework for interoperability: the task force will have the		**19 M€**

	responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems. • a high-level architecture for the smart grid including a conceptual model with architectural principles • a consensus on the critical standards and standards development activities needed The main challenge for TSOs and DSOs is to remain deeply connected and involved in the on-going normalization and standardization works, both at European and world wide levels, while designing a European data management environment which will minimize, in the future, the CAPEX and OPEX of such novel IT systems, when huge data flows on consumption will be supplied by smart meters.	
2011	**Data exchange protocols for smart grid applications** Based on a conceptual model to develop interacting transmission and distribution grids and its implementation with architectural principles defined to enable the networks to support new technologies and support new business models, Data exchange protocols will be proposed leading to reinforce interoperability constraints at European level.	6 M€
2012	**Semantic models for metering, demand response, and electric transportation data exchanges** It is expected that the largest spectrum possible for applications, including Automated Metering Infrastructure (AMI), Demand Response (DR), Plug-In Electric Vehicles (PEV), Wide Area Situation Awareness, Distributed Generation and Energy Storage (DG), Market Communications will be dealt with at EU level to ensure interoperability at all levels. The project aims at developing a common semantic model (covering at least advanced metering, demand response and electric transportation) so that the network operators coordinate activities including the various industry players and catalyze the adoption of a unified semantic model for these applications.	8 M€
2012	**Information models for the European Smart Grids** Security requirements for the smart European networks must take into account business interactions and the physical processes of delivering electricity, thus considering interferences or disruption of business communications as much as it does disruption of the delivery of electricity. Identity and authorization requirements, privacy, appropriate access are of paramount importance is shaping the final information model to be specified through a joint work by TSOs and DSOs.	5 M€
2010 – 2012	Budgetary commitments for priority actions 2010-2012 for transmission/distribution coordination RD&D activities	**68 M€**

The financing scheme proposed for discussions by the network players is presented in Annex 1.

12. Coordination with other initiatives

The coordination and cooperation between the European Electricity Grid Initiative and the other European Industry Initiatives[16] is important to ensure that all necessary new requirements concerning grid integration of low-carbon energy sources are addressed, and that overlaps between the initiatives are minimized. This coordination was started in the initial planning phase of the initiatives and its planning will be completed after bilateral meetings planned for early May 2010. The coordination needs to be pursued in the future planning of these initiatives and in their implementation.

This coordination will be pursued as one of the tasks for the governance of the initiative, and the coordination activities are focusing on answering the following questions:

- How can the electricity networks facilitate the integration of the new renewable generation technologies (PV, Wind etc)?
- How can the new technologies contribute to the efficient and stable operation of the network?
- What are the communications and interface requirements to orchestrate the participation of variable generation to the operation and control of the network?
- What are required interoperability and common standards for communication and information exchange?

12.1. Coordination with SEII - Photovoltaics

The Solar European Industrial Initiative (SEII) includes one programme concerning photovoltaics (PV) generation, and one concerning concentrated solar power (CSP). The PV program deals with the full range of PV generation, from small PV systems connected to the distribution grid up to multi MW solar farms that might be connected to the transmission grid in the future. The main integration challenges for PV based electricity are:

- The observability of PV units as small as 100 kW
- Participation of PV units to Voltage control, coordinated with the other voltage control facilities in distribution networks and protection plans
- Avoidance of unintentional islanding and protection of customers (closely related to the technical criteria for connection and requirements to inverters)
- Technical aggregation of PV and other DER by the distribution utility, leading to their integrated management by the TSO for system operations
- Where and when PV plants would participate in markets, the commercial aggregation of PV plants would be performed by market players
- Safety, with PV in low voltage back feeding the MV network <<to be clarified>>, but also personal safety? impacts

[16]Particularly EWI (wind) and SEII(Photovoltaic part and Concentrated Solar Power part)

- Ensure the quality of the resulting power wave, also with high penetration of PV units

A common appraisal of the objectives and activities concerning grid integration of PV generation has been performed, and the responsibilities for these activities have been allocated in part to the EEGI and in part to the SEII, to avoid overlaps in the programs. The corresponding activities for the EEGI are included in functional Projects D5 and D6 on the distribution network. Please note that the estimated budgets of the SEII include demonstration asset costs for PV and storage demonstrations, which explains apparent discrepancies between the budgets concerning grid integration of PV in the two initiatives.

12.2. Coordination SEII – Concentrated Solar Power

The objective should be to determine whether the development of CSP technologies foresees the use of energy storage to increase their dispatchability, and enable them to operate much like "standard thermal power plants". A joint study between EEGI and SEII-CSP would involve planning and operation simulations to set development specifications for grid integration of these envisaged STE (Solar Thermal Electricity) plants:

1. STE Plants can meet the demand at any time, day and night, and can supply electricity at peak hours according to planned schedule?
2. STE Plants have the capability to offer primary, secondary and tertiary reserves

This study may then specify one large scale experiment to validate the energy and network value within an approach similar to the one develop for instance in the EU-DEEP project[17]. The need for such a demonstration, its expected benefits and its costs need to be evaluated jointly by EEGI and ESTELA (European Solar Thermal Electricity Association).

12.3. Coordination with the European Wind Initiative (EWI)

The activities requiring cooperation between the European Electricity Grid Initiative (EEGI) and European Wind Initiative (EWI) include some of the Grid Integration Working Group of EWI (EWI3) and some of the activities in Functional Projects T3, T4 and T5 of the EEGI on the transmission network. Members of the EEGI and EWI have already started practical cooperation in the context of TWENTIES, a large scale demonstration project starting in May 2010. This project undertakes important RD&D activities contributing to Working Group 3 of EWI and Cluster 2 of the Transmission part of the EEGI.

Moreover, in line with the functional project T3, T4 and T5 of the EEGI roadmap, new power technologies will need to be validated in operational conditions through large scale experiments to plan their deployment in addressing future pan-European network problems beyond 2015. The future challenges that they will help facing cover:

- The reliable and stable backbone for European internal electricity markets
- The increase of interconnections of the system with selective reinforcements or by ultra high voltage transmission and/or by DC connections (the so-called super grid)

[17] See www.eudeep.com

- The possibility to cope with more fluctuating power infeeds from renewable sources with the help of increased power flow steering at the transmission (bulk power) level.

- The validation of regional interconnections and local distribution architectures (e.g. including mini and micro grids) with new control and protection schemes.

It is proposed to address, in the wake of the TWENTIES project (ending mid 2013), a large scale experiment to validate the massive introduction of selected HVDC-links, thus creating a dc grid multi linked with the underlying 380 kV-network. Such coordinated demonstrations (like in TWENTIES) should piggy back on several planned on shore or off shore projects in Europe and others that are only at the study stage. Their planning could depend on a number of uncontrollable external factors.

Last, the North Sea Offshore Grid was proposed by the European Commission in the Second Strategic Energy Review, published in November 2008. The initiative was identified as one of the priority energy infrastructure actions of EU27: the North Sea Offshore Grid should become then one of the building blocks of a future European super grid. The political declaration of the North Sea Countries Offshore Grid Initiative was signed on 7 December 2009 at the European Union Energy Council, by Germany, United Kingdom, France, Denmark, Sweden, the Netherlands, Belgium, Ireland and Luxembourg, joined later by Norway. Pending the outcome of political decisions concerning the organization and responsibilities for such a grid, the EEGI would be interested to be involved in its planning and technical development processes since it will complement "ENTSO-E & national TSOs activities on technical feasibility & implementation, and market aspects"[18].

12.4. Cooperation with EERA (European Energy Research Alliance)

The cooperation with EERA is aimed at maximizing the total impact of the RD&D efforts on Smart Grids at European level and at the same time avoid overlaps between the activities performed by EERA and EEGI. In particular, EERA will focus it's Smart Grids activities on:

- activities which might be useful to prepare the large scale demonstration projects, like reviews of state of the art of R&D, development of generic simulation models, or the testing at pilot scale (in their labs) of some ideas for the large scale demonstration projects

- methodology development on scaling-up and replication approaches that cover constraints on European-wide deployment

- technology based activities clearly outside the scope of the EEGI (like R&D on storage).

12.5. Cooperation with other initiatives

Coordination with other initiatives such as the public private partnerships (PPP) on Electric Vehicles and Intelligent Buildings will be initiated as soon as the programme is launched to ensure coordinated efforts on issues regarding the integration of these new developments with

[18] 7 December 2009 « Political declaration on the North Seas Countries Offshore Grid Initiative"

the electricity system. The contacts with these PPP's initiated by the Smartgrids platform will be pursued.

13. Annex 1: program financing proposal by network operators

In line with the principles outlined in chapter 7, the following guidelines are proposed as a basis for discussion of the financing of the first phase of the program:

- **Management of the programme**, scaling-up and replication studies to be able to deploy the results at European level and activities to support interoperability and standardisation should be covered **100% by European funds**, because most of the benefits from these activities are at European level.

- **Research and Development**: This should be covered by a combination of European funds, Member state funds and free market players funding, with European funds taking the bigger share because most of the results will benefit the whole of Europe. The Member States should cover a limited part of the R&D cost for the distribution network because some of the benefits from the activities will be country-specific. Public funding should also cover parts of the R&D cost of free market players/R&D institutes to guarantee their commitment to share the new knowledge gained through the participation.

- **Demonstration activities**: This should be covered by a combination of Member State funding, European funding, tariff funding and free market player funding, according to the following split:
  - Member State fund should cover the major part of the costs, both grid-internal cost because adequate tariff schemes have not been implemented yet for the network operators, and the major part of the costs of free market players to guarantee their commitment to share the new knowledge gained through the participation.
  - European funds should cover a part of the costs connected to the "first mover risk", because this risk could prevent promising solutions to be tested.
  - Existing tariffs should cover a part of the grid-internal costs to support the commitment from the network operators.
  - Free market players should cover a part of their costs because they would have benefits from participating.

The tables below summarize the **2010-2012** costs of the implementation plan and proposes shares of requested funding resources for the programme according to the above guidelines . Please note that this share is indicative and will not be the same in the second part of the programme (from 2013), where new dedicated tariff incentives are expected to cover a large part of the financing.

Transmission network program 2010-2012					
	Cost	Funding			
Activities	Total costs of program, M€	EC funding %	MS funding %	Tariff funding %	Free market player funding %
Mgt, replication, scaling-up, [19]	20-30	100%	0%	0%	0%
R&D[20]	80-90	60 %	0	30%	10%
Demonstration	0	0	0	0	0
TOTAL	108	65-70%	0%	25-30%	5-10%

Distribution network program 2010-12					
	Cost	Funding[21]			
Activities	Total costs of program, M€	EC funding %	MS funding %	Tariff funding %[22]	Free market player funding %
Mgt, replication, scaling-up, dissemination	60-140	100%	0%	0%	0%
R&D	80-170	50%	25%	0%	25%
Demonstration	520-690	20-30%	40-60%	10-35%	10-15%
TOTAL	830	30-40%	40-50%	10-30%	10-15%

Transmission/ Distribution coordination program 2010-12					
	Cost	Funding			
Activities	Total costs of program, M€	EC funding %	MS funding %	Tariff funding %	Free market player funding %
Mgt, replication, scaling-up, dissemination	10-15	100 %	0%	0%	0%
R&D	55-60	60%	0%	30%	10%
Demonstration					
TOTAL	67	65-70%	0%	25-30%	5-10%

[19] The dissemination activities have not yet been sized by ENTSO-E for the transmission system operators activities

[20] This R&D activity is assumed to take 60 % of TSO efforts and 40 % of external RTD performers coming mostly from the public sector

[21] The availability of other sources of funding could lower the need for funding from the sources proposed

[22] Funding through existing tariffs and when available new dedicated tariff incentives (eg. OFGEM). In the case that the total funding from other sources do not reach 100%, tariffs should anyhow be available for funding the complement of what is not funded by other sources even if it exceeds the 30% of the total indicated in the table.