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PROJECT THOR

Regulatory Funding of Transmission System Research and Development in ENTSO-E Countries

WHITE PAPER

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Disclaimer

This is a white paper on the creation of a regulatory framework for funding research and development activities in transmission system operations, commissioned by the European Network of Transmission System Operators for Electricity (ENTSO-E) to SUMICSID SPRL under the direction of professor Per AGRELL .

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Preface

The 20-20-20 targets and the EC ambitious objectives for the decades beyond 2020 have introduced new important challenges on grid operators. A strong effort is, therefore, required to develop additional R&D activities to meet those challenges. The Third Energy Package tasks explicitly TSOs with R&D necessary for the innovation of their activities, and, at the same time, it tasks the National Regulatory Authorities to support R&D activities by defining, in fixing or approving the tariffs, appropriate incentives to the grid operators. On the other hand, the level of R&D spending in the power sector is among the lowest of all industries, and particularly in the transmission sector. The regulatory policies were in general not designed with grid modernization in mind, and a clear evidence of these assumptions is that an unintended drawback of deregulation has been the significant reduction in R&D investments in the grids. Deployment of modern grid technologies is costly and, without incentives, TSOs are reluctant to invest in these needed technologies.

Therefore, it is necessary that legislators and regulators take a strong leadership role in support of grid modernization and define appropriate legislative and regulatory policies to support R&D in the grids. It must be kept in mind, additionally, that inconsistent policies among the states prevent effective collaboration across a national level: different regulations can present barriers to support R&D at a European level, therefore it is necessary to promote harmonized policies among the EU Member States.

The need to fill the gap between EU legislation and national policies has moved the ENTSO-E RDC to issue a position paper, "A New Regulatory Framework for TSO R&D in ENTSO-E Countries", approved by the General Assembly in June 2011, with the aim to set up a first milestone in the process of developing a common R&D framework for TSOs at European level. This document has the general objective to define the main criteria to be developed at a European level in order to guarantee appropriate, homogeneous and coherent regulatory framework for R&D activities, capable to promote and incentivize the absolutely necessary R&D activities by TSO's.

In order to trigger the discussion about the regulatory framework for TSO R&D, ENTSO-E has taken the initiative to solicit for an external and independent advice. The aim of the present study is to deliver a rationale for TSO involvement in R&D activities, clarify the added value for market parties and involved companies and propose solutions that meet regulatory concerns while being effective in bringing the new technologies and operational practices the power sector in Europe needs before 2020.

Konstantin Staschus
Secretary General ENTSO-E

Table of Contents

1. Project team, background and objectives

Context

1.01 This document is a report from a project commissioned to SUMICSID by ENTSO-E focusing at the regulatory framework for the funding of R&D of transmission system operators within the ENTSO-E area.

1.02 Project leader from SUMICSID is Prof. Per J. Agrell. The project team also consisted of Daniele Benintendi.

1.03 The ENTSO-E R&D committee supported the study by providing information on past and ongoing national and EC funded R&D activities. It also reviewed[2] earlier drafts, focusing especially on technical issues, TSO internal organization and national R&D regulation.

Problem and outline

1.04 The underlying problem is deceptively simple and seemingly trivial: European Energy Policy has set a series of common challenges and obligations for TSOs, but there is currently no mechanism to provide adequate and specific funding for the supporting R&D activities. Topics like the creation of the Internal Electricity Market, the efficient integration of RES and the development of the Ten-Year Network Development Plan (TYNDP) require studies and demonstration projects that should be developed jointly by TSOs. It seems then extremely risky to have such ambitious policies without a clear plan how to provide the necessary background knowledge.

1.05 A number of different proposals have been advanced to solve this problem, in theory as well as in certain countries. Rather than deriving a theoretical solution for the problem or evaluating the existing institutional solutions, the idea behind this white paper is to address the underlying problem and propose a set of principles for a solution. This pragmatic approach comes from the observation that in fact the elements for the solution are already in the European regulations, but the varying implementations are results of different national assessments and priorities. It is then more important to facilitate the establishment of a consensus based on principles, potentially leading to one or several compatible and equivalent funding regimes, than to provide yet another specific proposal.

1.06 The white paper begins in chapter 2 with a short discussion on the rationale behind transmission system operators' research and development activities. In Chapter 3 we explain the current system's limitations. We present three scenarios with different outcomes in Chapter 4. In Chapter 5 we propose a set of sound principles for the financing of R&D, used to finally derive short-term and long-term solutions in Chapter 6.

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[2] Comments were sent by the following ENTSO-E members: Hubert Lemmens (Elia, Belgium), Vicente Gonzalez (REE, Spain), Angelo Ferrante (Terna, Italy), Bastian Bohm (50Hertz Transmission, Germany), Olivier Grabette (RTE, France), Wilhelm Winter (TenneT TSO GmbH, Germany), Alexander Meinhart (APG, Austria), Mark Needham (EirGrid, Ireland) and Isabelle Grohe (Amprion, Germany). We would like to thank Chavdar Ivanov and Thong Vu Van of ENTSO-E for the valuable coordination work of this activity.

2. Why transmission system research?

2.1 Energy policy challenges

2.01 The European infrastructure battle plan, adopted Nov 17, 2010, embarks Europe on an ambitious extension, enforcement and revamping of the existing energy networks in electricity and gas to accommodate the needs for the decarbonized energy sector. As a part of the strategic Energy Strategy, the infrastructure package deviates from the previous use of long lists of 'priority projects' with little or no follow-up, to define four *corridors* for electricity. The idea is to gradually transform the European 'copper-plate', challenged mainly from a market viewpoint, into a set of 'electricity highways', where the transport need over large distances come in focus. The large and relatively undisputed infrastructure areas are consistent and coordinated with the Ten-Year Network Development Plan (TYNDP) of ENTSO-E and policy documents issued by ACER and CEER.

2.02 However, the budgets to realize these projects are enormous: 600 billion € between 2010-2020 for investments in energy transport, distribution and storage, thereof 140 billion € for investments in electricity transmission grids[4]. As an example, National Grid has announced an investment plan of 26,7 billion € for electricity transmission networks for the period 2013-2020. In addition, a further 500 billion € is planned for new capacity investments in renewable generation (RES). These major investments will have a considerable impact on the electricity bills of the consumers in the future. Already today, the deployment and investment in renewable energy technologies are mobilizing huge amounts of funds through support mechanisms. OECD published a report on the current costs of subsidies in Germany and funds increased seven times between 2000 and 2010 when the costs have reached 9,8 billion €, implying a 10% increase on final bills for residential customers. In Italy in 2011 these costs reached 3,000 M€ in 2011 with the perspective to be considerably increased.

2.03 We present these figures as they are directly related to innovation in the Transmission sector since most of the challenges come from the integration of large amounts of RES. In the table below, provided by ENTSO-E, we can see the foreseen investments needed for R&D (including demonstration activities) at European level for the period 2013-2022. It is not the objective of the study to develop a metric between figures. What is interesting is to have an idea of the orders of magnitude, showing that given the investments behind Energy Policy challenges what is needed for R&D does seem completely reasonable. R&D can be considered as a way to curb the risk of failures of these policies, indeed at a modest price in proportion to the investments.

2.04 The data in Table 2-1 is organized into clusters of functional objectives, according to the R&D Roadmap of ENTSO-E.

[4] Estimates from EU DG ENER (Sikow-Magny, C. 2012, Energy Infrastructure Package: Overview and first steps towards implementation, Presentation).

Table 2-1 Investment needs by clusters of functional objectives, ENTSO-E R&D Roadmap.

Cluster	Name	R&D Investment (M€)
C1	Grid Infrastructure	70
C2	Power Technologies	350
C3	Network Operation	125
C4	Market Rules	75
C5	Asset Management	135
C6	Joint TSO/DSO R&D Activities	250
Total		1,005

2.05 One of the result of our analysis is that institutions and governance are a priority; without building a framework that would address R&D issues at National and European levels it would not be possible to define specific funding mechanisms and methodologies for cost allocation and performance assessment. In the data provided above we can see several types of investments that, even if they are interrelated, have different policy drivers; the advantages mentioned cannot readily be accounted for in a single framework.

2.06 The goal should be to embed the implementation of the plan through existing institutions in a manner that would allow assessing the real value of R&D, taking into account its overall impact, and to evaluate the adequate level of required activities.

2.2 Transmission system – current state of the art

Roles and responsibilities on the electricity grid

2.07 The electricity sector is vertically organized into actors with well-defined tasks, assets and responsibilities; generators, retailers, distribution system operators (DSO), regional transmission operators and transmission system operators (TSO). Naturally, each actor is facing technological challenges and involves in R&D activities to develop its activities. In particular, the projects on grid innovation (Smart Grid) tend to bundle distribution and transmission operators as stakeholders. In this paper, we stress the importance of maintaining the distinction in order to concentrate on the role of the transmission system operators. The following considerations have to be understood in terms of funding mechanisms as clearly there are many instances where technically TSOs and DSOs have to interact.

2.08 First, our study makes explicit the need for TSOs to develop R&D at European level based on National Regulation. We recognize from past and ongoing EC funded projects that DSOs from different countries also have great advantages in developing common initiatives. Nonetheless there are differences in the type of activities needed. TSOs are mandated and requested through the Directive to achieve objectives that require an extremely tight integration like the creation of the Internal Market or a common European Network Development Plan. This translates in different requirements in the type, the organization and the timing of execution of R&D activities. This is not the case for DSOs, where the advantages come from sharing the development of common solutions and standards, but where the implementation does not require coordination.

2.09 The TSO sector has operators with fairly homogeneous characteristics since they carry the responsibility for the technical and economic interconnection of the national electricity grids. The DSOs operate local grids with connection only to a single TSO and no interference in the individual asset base. The operational standards and asset bases for DSOs are adapted to national needs, markets and legislations. It is therefore less imperative to coordinate European R&D for the development of nationally heterogeneous structures. On the other hand, the TSO will increasingly be interoperated at a European level, since the transport task is inherently interregional.

2.10 Our opinion is that the two sectors need a separate treatment when it comes to financing. Given the differences unique or similar schemes would end up to be poorly tailored. One sufficient reason is the type of stakeholders and potential investors; for example we should remember that even residential consumers will play a relevant role in the DSO business model of the future. Other considerations for DSOs are the heterogeneity in size, the different national responsibilities and ownership.

The electricity highways

2.11 In the 'electricity highways' of 2020, the grid will get a new function, reaching beyond the scope of control of the national TSO, both vertically down in voltage levels and horizontally, across the neighboring grids. The enabling investments are partially in new equipment and partially in new methods to use the grid. Smart-grids are all about using the grid in a new way, more actively, and to increase the information exchange throughout the energy supply chain.

2.12 The current grids and their interconnections were built from a national viewpoint, with interconnections mainly for security of supply. The "electricity highways" in Europe of 2020 will be entirely different, with much higher requirements on system integration and international collaboration.

2.13 The transmission networks form a complex technical system, preparing to become even more potent. The upgrading is not just about buying hardware for 'plug-and-play', but a question of finding effective and reliable system solutions for the existing and new assets. All of this requires applied research, since the use of the system is new, and development, since the manufacturers cannot cost-effectively replicate the system effects.

2.14 As we will show, without research and development, the transmission system investments will be unnecessarily expensive, potentially misaligned with existing assets and underused. In addition, budget and time pressure will lead to a multitude of inefficient and incompatible national small-scale projects to implement the investment plan.

2.3 Regulatory background

2.15 Prior to liberalization, the economic regulation of the transmission grids was a relatively passive and backward-looking process. The transmission services, often a publicly owned enterprise or an integrated 'national champion' on the energy market, was subject at most to a slight review of ex post costs, leading in practice to full recovery of any cost and investment without any pre-specified targets and restrictions. In economics, this form of regulation, based on used inputs and observed profits ex post, is called low-powered, since it provide low incentives for cost reductions [cost-efficiency]. However, the regulatory regime was effective for inducing investments and electrification in the early stages of the creation of the European electricity system.

2.16 The deregulation of the energy sector through the three successive energy market directives in 1996, 2003 and 2009 changed the regulatory paradigm both in terms of overall objective and modus operandi. The idea behind the entire energy market reform was to unbundle the previously vertically integrated utilities and to install a competitive European generation and retail market for benefit of both industry and consumers. In order to create a level playing field and to ensure equitable access prices, the directives stressed the role of a truly independent national regulator to supervise that tariffs across jurisdictions were set at cost-efficient levels, to curb cross subsidies and to prevent integrated groups to recover lost profits in generation markets by connection tariffs from captive clients. The consequence of this paradigm was the advent of modern incentive regulation, where the focus gradually shifted from inputs to outputs over longer periods. Rather than making scrutiny of detailed historic costs to discover evidence of imprudent expenditure, the regulators in Europe rely increasingly on methodologies to determine a best-practice cost function for a forward-looking use. The implementation of the incentive regulation is normally through ex ante revenue- or price-caps that are set for a period of 4 or 5 years with or without pass-through of certain costs, judged non-controllable.

2.17 Functions as construction, maintenance, metering, billing and administrations may be partially or fully outsourced, assets may be jointly financed, owned or operated with other utilities. The choice to implement high-powered regulation, where the regulated firm gets a profit that depends on the difference between the fixed revenue and the actual costs, is then a natural consequence of limited observability of what processes and costs are really involved in the regulated operations. It is important that this organizational development is taken into account in the comparative measures, such as international TSO benchmarking (Agrell and Bogetoft, 2009), used to inform regulatory rulings.

2.18 On the other hand, the TSO should ultimately always get their long-term costs covered through tariffs, subsidies or other revenues. The TSO has a natural monopoly for extra-high voltage (EHV) operations and system operations; there is no natural market for this in a national setting. The transmission assets are highly specific and have a long technical life. In short: the TSO cannot be replaced and must get his costs covered in some way or another. Thus, it is an error of logic to reason in terms of short-term gains for high-powered regimes, in the end the consumer should always pay for the full costs of the system that is in place.

2.4 Business as usual is not an option

2.19 The current regulation is effective to induce cost-efficiency and goal-orientation for a well-specified and observable task, like the maintenance and sequential expansion of the current transmission networks. However, the new challenges induced also by significant investment requirements, imply a new task where the grid development is a joint, long-term and 'soft' activity. Unless the TSOs are provided a clear funding solution for the important planning and development activities, the outcome will depend on the individual circumstances in each country, TSO and regulation. Some TSOs may accept a lower profit to self-finance joint work, some may find national research funds, and some may find support in joint work with manufacturers. Development tasks that are joint, European or 'soft' will stay implicit or unregulated, left to the individual TSO to finance as they can. As common grid restructuring in itself is not a regulated task, a TSO is not incentivized to take the risk. In the end, the final consumer pays for the network and market supported, irrespective of what games were played between the partners at the outset.

2.20 It has to be recalled that costs for research and development should be viewed as part of the overall investment in a new grid infrastructure, since their purpose is to increase the overall performance of the Electricity System. The relatively moderate costs should be put in proportion to a series of direct benefits as reduction of investments in infrastructures, reduction of balancing costs, increased penetration of RES, decrease of wholesale prices due to better integration of the European Electricity market and improved security of supply.

3. Where is the problem?

3.1 Legal framework

3.01 Initially, the European and national legal provisions largely ignored research and development both as an expected output/task and as an eligible cost. The situation changed when the Third Internal Energy Market Package highlighted the new grid functions, the integration and the 'smart grid' technology rollout. The decision of the Commission was also a recognition of the evolution of the sector that was already not anymore a mature business, but a fast changing one.

3.02 The necessity to perform R&D to improve grid infrastructure and operation, as well as the need to coordinate those activities are explicit in the instructions for ENTSO-E (EC 714/2009, "Task of ENTSO-E"):

> *3. The **ENTSO for Electricity shall adopt**: (a) **common network operation tools to ensure coordination** of network operation in normal and emergency conditions, **including** a common incidents classification scale, and **research plans**; (EC 714/2009, art 8 § 3(a), our emphasis)*
>
> *The **annual work programme** referred to in point (d) of paragraph 3 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 realised in that year, and an indicative calendar. (EC 714/2009, art 8 § 5, our emphasis)*

3.03 This paragraph effectively establishes the *obligation* to undertake R&D activities, implemented in related regulations for the monitoring tasks of ACER towards ENTSO-E (EC/714/2009, art 9 § 2).

3.04 The *eligibility* to levy regulated tariffs to perform the activity is formulated in the new instructions for the tasks of national regulators. In 2009/72/EC (art 37) it is stated that:

> ***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 incentive, over both the short and long term, to increase efficiencies, foster market integration and security of supply and **support the related research activities**. (2009/72/EC, art 37 § 8, our emphasis)*

3.05 Further provisions are made in related directives and regulations to promote direct investments in innovative grid infrastructure, to take into account system-wide effects and to unlink tariff methodologies to transported volume in order to align incentives (Cf. GRID+, 2012)[6].

3.06 At first glance, the legal framework may seem clear and unambiguous, leading to merely a question of time for implementation into national legislation.

[6] www.gridplus.eu

3.07 Further analysis reveals several outstanding areas of imprecision. First, the instruction to ENTSO-E indeed includes a declaration of cost eligibility (EC 714/2009 Art 11), but it does not exclude the interpretation that the direct eligibility is limited to the *coordination* activities performed by the organization as such as opposed to the activities performed by the TSOs separately. Moreover, the article introduces a regulatory due diligence in judging whether the costs are "*reasonable and proportionate*". Combined with the overriding instruction to define tariffs that cover "*actual costs incurred insofar as they correspond to those of an efficient and structurally comparable network operator /…/*" (EC 714 2009 Art 14 § 1), it leaves for later interpretation whether the activities of the TSO are indissociable in the evaluation of cost efficiency or whether they should be financed by other sources.

3.2 The logic of the national regulators

3.08 Given the supra-national legal framework above and the European subsidiarity principle that leaves the implementation to the most appropriate level, the national regulators have developed a somewhat heterogeneous perspective for transmission system regulation. It is our observation that many regulators have resorted to relatively aggregated and delegated approaches concerning the evaluation of TSO performance. Such strategies may in part be motivated by asymmetric information and complexity involved in any performance assessment. Taking the perspective of the (voiceless) captive customer, the regulator faces a natural monopolist with complex system tasks with large cascading effects seemingly arguing for numerous extensions and exemptions from the high-powered regulation that guarantees cost-efficiency. This logic has two components with specific consequences.

3.09 First, the claims and actions from TSO are seen as potentially opportunistic moves pursued to maximize profit (as for any private firm). Since the TSO is not signaling errors in the revenue estimates from the regulator as long as they are above the optimal cost, the regulator assumes that the high-powered regulation involves *slack* that the TSO rightfully should use to perform minor unforeseen activities. In particular, any claim from a TSO regarding an operation or activity whose fulfillment is non-verifiable (like applied research) or potentially used for covering ineligible costs (e.g., cost padding for technical staff and assets in generation or non-regulated businesses) is seen as inadmissible.

3.10 Second, the power of the incentive regulation is that forces the regulated firm to internalize the cost and benefits of any kind of activity. Thus, if an operator has a very specific vegetation management problem for which there is no obvious solution, it would be in its own interest to undertake some R&D in order to innovate and implement a new, less costly solution. The scope and type of R&D should then be put in perspective with the gains obtained from the implementation of its results. Of course, in high-powered regulation, these gains are fully retained by the TSO. Consequently, some regulators may then argue that the current regulation complies with the quoted sections of the Directive insofar the research and development leads to cost-efficient solutions. If not, then they are not "reasonable" or "efficient" and lack eligibility.

3.11 In short, the everyday regulatory practice of the particular provision to fund and provide R&D falls short on two counts: i) we cannot know whether the right work is done, and/or ii) nationally defined R&D performed by a single national TSO is already incentivized if it is relevant from a strict cost-efficiency viewpoint.

3.3 The TSO decision making

3.12 The TSOs have also undergone radical changes in organization and strategy since the first directive 1996. Initially continuing their mainly technically oriented operations from a national security of supply perspective, often in close collaboration with incumbents, the TSOs in the current day are increasingly specialized and market-oriented. On the one hand, this evolution has contributed to the successful establishment of organs such as ENTSO-E and the industrial structural development of the first multi-national TSOs in 2009. On the other hand, the more specialized and profit-oriented focus, vital for privately owned TSOs, has direct consequences on the internal organization and resource allocation. Hence, activities that do not directly contribute to the reimbursed tasks, or that are performed in too low scale to be cost effective, have been outsourced or dismantled. The repercussion on research and development activities is immediate, not only for TSO, but for the entire energy sector

3.13 Thus in a climate of rapidly changing technology and market definition, where the global budgets for R&D increased by 260% from 1996 to 2009 (OECD, 2009), there was a radical drop in R&D in the energy sector between 2000 and 2007: -44% (in % of sales, worldwide). For Europe, the results in Sterlacchini (2012) are even more negative, the four largest energy companies reduced their R&D budget by 69% [in % of sales] during the same period.

3.4 The tragic mismatch

3.14 As we have seen, in spite of honorable intentions in the Directives and its preambles, the European Commission is increasingly worried about the lack of progress on the single market implementation and in infrastructure development, both in terms of investments and system development. In the impact assessment of the communication on renewable energy (COM 2012 271), the authors identify key challenges in bringing research to deployment, the need for stronger coordination of research and the lack of "*dedicated budget lines for certain research priorities*".

3.15 The outcome is a tragic mismatch between two mindsets, both beneficial and sound when taken separately.

3.16 On the one hand, a regulatory approach safeguarding the national tariffs by maintaining the pressure on overall revenue caps for all regulated operators, including transmission system operators. This implies a careful scrutiny of any claims for additional bypass costs and extensions, in particular for activities that are difficult to monitor, verify and for which the benefits may accrue to others than the financing tariff payers. A number of NRAs indeed do support research and development activities by their TSOs, either by including cost elements in the revenue cap, by direct subsidies or through endorsement of EC-funded projects. However, these initiatives are often bilateral and rarely include other operators or regulators as R&D partners. Thus, the potential leverage by coordinating multiple operators to perform specific tasks in larger programs is jeopardized.

3.17 On the other hand we find the ever more streamlined TSOs that have optimized their services to those, and exactly those, financed through the main revenue drivers. As already the profitability of the 'wire operations' is relatively weak, the incentives to take technological and economic exposure are meager. Even if considerable investment budgets were released, the TSOs need sufficient internal staff for grid

development and planning to optimally handle the necessary specifications and adaptations.

3.18 This mismatch between these two lines of reasoning is the dilemma we have to solve to unblock the situation. First, we suggest to raise awareness about the seriousness of the problem by sketching three plausible scenarios.

4. Three scenarios

4.1 Method

4.01 In this section we sketch three scenarios in order to give the reader an understanding of the possible impact of the decisions made in terms of R&D. The scenarios are intentionally stylized, as the aim is to highlight the trajectories created by the different choices. Hence, the point is not to predict a precise flow of events, but rather to provide inputs to a constructive discussion. The scenarios consider only R&D carried out jointly at European level and do not take into consideration R&D at national level, which is a necessary complement of the ENTSO-E proposed road-map.

4.2 Status quo: patchwork

4.02 In the first scenario, the status quo, we assume basically a continuation of the current activities of TSOs under the ENTSO-E umbrella. It can be foreseen an increase of the EC funding, but with no other consistent R&D investment taken at European level outside the EC framework. Then the leading role would be taken by large coordinated projects, with possibly some sort of coordination of national activities limited to exchange of information. Regulators are not involved in R&D activities at European level and ENTSO-E would primarily support the EC in the definition of the research plans.

Innovation

4.03 The fact of relying on EC has several limitations. Even if there would be a considerable increase of funds, also under the most favorable hypothesis these would be insufficient to satisfy the needs that have been calculated. The EC framework could try to expand the participation of more TSOs, but should not be able to guarantee the involvement of the whole group of ENTSO-E members. The timeframe of EC projects funding is quite slow, it takes currently more than one year and a half between the beginning of the drafting of a call for proposals and the start of a project. EC funds also lack the type of flexibility necessary to cope with activities that have the aim to be rapidly deployed after the end of the projects. There is no direct link to regulation, creating a risk of decoupling the vision of the system between the Commission and NRAs. NRAs could then support an archaic vision of the Electricity System with the result of creating unnecessary regulatory barriers increasing the costs of deployment of new technologies.

4.04 Progress is made on grid innovation at European level, but the deployment is generally slow and not homogeneous over the whole continent. Integration of RES cannot be supported adequately as there is no coherent system of incentives in the TSO regulation to support coordinated European actions. TSOs participate to large European projects, but not all of them can clearly define the role of these activities in their respective organizations due to lack of regulation. The potential internal divergences between different management areas in TSOs do not facilitate the deployment of investments and technologies at European level. National R&D funds can only exceptionally be used at European level, leading to costly duplication of R&D activities. Countries with more advanced regulation on R&D are penalized by those with no clear provisions for R&D.

Deployment of grid technology

4.05 In spite of en enormous pull for realization of the TYNDP, the lack of fulfillment and the lack of common standards and dissemination for the whole of Europe impede the large-scale deployment. In 2-3 regions with larger cohesion regional standards and some new systems have been implemented, but the procurement costs are high due to accelerated processes and lack of economies of scale. There is widespread discontent among the smart-grid DER owners due to the scattered markets and information systems.

Deployment of RES

4.06 Given the slow advancement in terms of system oriented R&D, RES keep being deployed inefficiently requiring higher cost in terms of infrastructures and balancing. This would slow any market-based deployment of RES that will keep being awarded inefficient subsidies scheme aimed to specific technologies. In spite of radically increased costs per MW installed, the generation financing is publicly backed.

Market development

4.07 Left as a patchwork in spite of good intentions, the integrated market operates through 2-3 somewhat incompatible systems for regions with considerable bottlenecks. The systems are integrated with different systems and the balancing markets operate with national definitions and information. Since only one of the four corridors is ready by 2020, the hastened integration of RES has caused stability problems in Southern Europe and stalled the phase-out of thermal plants in Continental Europe. Including the exaggerated premiums paid to RES generation, the undercapacitated grid and the poor vertical information integration, the final user prices are higher than before, even though the CO2-target is far from being realized. Some membership states suffering from aftermaths of the economic crisis raise requests to re-regulate residential tariffs to neutralize public opinion.

4.08 In summary, status quo leads to a European patchwork of regulation, ineffective in realizing policy targets, too weak to coordinate industrial policy, too slow to seize the occasion to join the lead for smart grids, too expensive to create economic growth.

4.3 Manufacturers' holdup: the expensive path

4.09 A vacuum is as rare in nature as a complete lack of initiative in an open market. Our second scenario is characterized by a reliance on private non-grid initiatives. Perceiving the sense of urgency and the financial end-of-period backing that are inevitable when policy goals should be met, the large equipment manufacturers undertake the R&D activities for electricity networks. Being in competition and earning their expected profit on the hardware market, their research is directed towards complete 'turn-key' systems, internally incompatible and with proprietary standards and information protocols.

Innovation

4.10 The manufacturers present a number of systems, suggesting large replacements of the existing asset base to their [proprietary] standards. Indeed, the global manufacturers develop a series of innovations adapted to integrated North American and Asian

systems, but less well adapted to the specific European context. The technologies are not only expensive, but also associated with a number of problems linked to low-interoperability with the diverse asset-standards. Facing critique from TSOs and regulators alike, the manufacturers respond that the European market should evolve differently and get rid of its legacy systems. At the end of the period, a limited number of standards have evolved, but the network operators are dismayed by the lack of flexibility and transparency of the new systems.

Deployment of grid technology

4.11 After an inevitable delay due to poor field information at the manufacturers' R&D labs, a number of innovations are quickly rolled out and tested. The solutions are only partially tested, but marketed aggressively to get coverage and first-mover advantages, hoping to correct any problems later. The cost for hard- and software goes up significantly with increasing investment pressure and lack of bargaining power. Some operators, unable to raise resources to refit their assets, stay as 'islands' in the sea of proprietary systems.

Deployment of RES

4.12 Since the manufacturers earn 2/3 of their revenues on generation equipment, there is great emphasis on preemptive installation of RES plants with accompanying power systems, preferably in relatively closed solutions, forcing the operators to a narrow choice of solutions from groups of manufacturers. Local pilots and tests convince some investors and policy makers, but lack of competence and information for market design block the establishment of effective market integration.

Market development

4.13 Given a non-coordinated grid development, several incompatible systems and problems of integration, the market integration is incomplete and price differences between the zones of RES are large and lasting. The differences create demand for national compensations between the zones volunteering the export RES, although blocked, and the potential import zones. The high prices for grid infrastructure chill the policy makers into postponing some of the corridors, being content with the RES goals without the full infrastructure.

4.14 In summary, we get to a situation similar to military procurement for smaller independent states. If we feel threatened and badly need equipment, of course we can buy weapon systems from global manufacturers. However, they will neither be timely, adapted to our specific needs, nor cost-efficient.

4.4 Critical impetus: the key to success

4.15 In the third scenario, the policy makers have identified the urgency and the leverage that an effective R&D creates on system development and deployment. The numerous suggestions to create dedicated R&D financing, regulatory 'fast-tracks' for the ten-year deployment projects and intelligent PPP solutions for the infrastructure investments. The initiative is coming from the membership states themselves, through some leading regulators and TSOs, and is actively supported by their organizations CEER and ENTSO-E, as well as by the Commission.

Innovation

4.16 Thanks to earmarked R&D financing under a long term plan (Roadmap), TSOs, research providers and manufacturers collaborate and compete[7] to contribute to different packages. Since the definition of the projects and their management are close to implementation and information is openly disseminated among members, a number of path breaking innovations are identified and selected. Strong requirements on timely delivery and high quality replicable results lead to high precision in the deployment phase. European manufacturers for load and generation equipment find their competitiveness reinforced by the joint research and development activities and enhance the development with complementary projects that can be sold internationally.

Deployment of grid technology

4.17 Since no time is lost and the efforts are concentrated on the core projects, the ENTSOE can regularly present progress towards its deployment goals in the common investments plan and network management. The grid technology is developed, tested and deployed in a systematic and equitable manner in all member states. National R&D activities continue as before an important and complement the joint work in focusing on country specific solutions, without duplication of effort. The higher volumes of grid assets procured and the common standards agreed lead to improved bargaining power towards manufacturers, lower asset prices and higher learning effects in operating costs.

Deployment of RES

4.18 After initial hesitation and stagnation, the RES investors observe the steady progress made during the period in terms of system development, market integration and regulatory harmonization. Characterized by lower technological and economic uncertainty, the optimal solutions find an increasing amount of private funding.

Market development

4.19 The focused R&D on massive RES integration in an open system with intelligent grids, storage and electricity highways boosts the market development. The existing market definitions converge, a European retail sector develops for different power, and the increases of final consumption prices are contained.

4.20 As we will argue in more detail below, this scenario is not only the happy ending of the triptych, it is also the equitable, economically sound and safe technical path with only minor requirements in terms of policy decisions to become feasible.

[7] We assume that a part of the funds are allocated considering the performance of each stakeholder as currently with European funds.

5. Principles for solving the problem

5.1 Method

5.01 Rather than providing a turnkey solution under the assumption that the current situation is an outcome of an unfortunate coincident, we start from the hypothesis that the regulators' different policies indeed reflect specific positions and concerns. Conscientious positions can only be changed by arguments based on agreed principles. Thus, after outlining five such positions we proceed by evoking a set of principles on which we later will build our long- and short-term solutions.

5.2 Addressing regulators' concerns

5.02 In terms of expenditure and tariff base, the R&D costs are negligible compared to the admissible TSO cost base. Moreover, the contents of these activities are only rarely involving regulators, nor do they require specific endorsement until deployment. Consequently, many NRAs are not well informed about R&D activities or the interrelations between their TSO's research plan and the TYNDP.

5.03 We have identified five fundamental positions that lead to differences in the TSO financing for R&D in national NRA rulings. Later, we will define appropriate remedies for each of these in order to establish criteria for short-term and long-term solutions.

Myopic cost-focus

5.04 According to this position, the TSO is already incentivized to undertake cost-minimizing research under a revenue-cap. Other research is not to be financed through national tariffs, but if need by other sources or not at all. If the TSO does not want to finance it by itself, the proponents argue, it is because it is not worth it.

Specialization view

5.05 In this view, R&D is not cost-effective when performed by TSOs due to low economies of scale, lack of transparency and lack of sufficient staff. These NRAs approve in principle R&D expenses, but not the way they are performed. Research is assumed to be done only by institutes and universities, not by grid operators. In this view, the real reason behind the interest by the TSO to initiate R&D is to grow their engineering staff count and to increase their visibility.

Distributional view

5.06 Some NRA acknowledge both the need for R&D and the relevance of TSO provision, but reject the distributional effects of financing it through electricity tariffs. The argument is that the non-cost-minimizing R&D investments are due to environmental objectives that are societal, not sector-driven. Thus, tax-money and national research grants should finance this part. The real tradeoffs, they argue, are between different forms of decarbonization measures in energy, transport and construction [efficiency].

Competitive view

5.07 Some NRA reject blanket-financing as a principle, arguing that any activity should be subject to accountability and competition. Due to informational asymmetry, lack of transparency in the project assignment process and lack of tangible outputs, separate R&D financing is [politically] risky through national tariffs. They argue that the Commission should continue to initiate and finance R&D through SET-plans, framework programs and TEN-E initiatives, or similar projects.

Equity

5.08 An equitable distribution of costs and benefits is not easy to achieve just by multilateral discussions. NRAs around Europe have different priorities, resources and staff competencies. Not all NRAs are actively pursuing research and development as dimensions of performance from their operators. Letting more active countries and their TSOs lead the grid development leaves these NRAs with simpler, pure investment options, when final results are found, without having to decide or finance any technological or methodological projects. However, this policy does not lead to an equitable policy for an integrated energy market

5.3 Five principles for a solution

5.09 A proper, stable and credible solution to the funding problem is not a cookbook recipe, nor an ad hoc negotiation with some external benevolent decision market. Based on the analysis above, we distinguish five key principles that we argue are critical for the funding solution.

Effectiveness

5.10 Different actors can and should be performing R&D, but considering transmission system research, working with the grid operators is the most effective approach in terms of time to deployment, probability of implementation and fit to specification. Any other actors in the energy supply chain is further away from the application, less well informed about problems and less likely to decide on deployment if adequate. Delegating the control and coordination of the R&D to other adds a layer, changes the definition and increases complexity. This argument, which can be supported by actual case studies, is intended to address the *specialization focus*. However, it should be emphasized that the TSO should collaborate with other partners, taking the lead in identifying the need for innovation and testing solutions in the field. Ultimately, this leads to the reduction of costs and risks for deployment.

Transparency

5.11 TSOs are separate entities with different owners and interests, thus not necessarily sharing all viewpoints and information. However, their jointly performed R&D following the ENTSO-E plan is done fully transparently under supervision by both national and European bodies. This transparency is a direct consequence of the dedicated funding for the R&D: low-powered funding through tariffs can only be obtained for an activity that can be verifiable and for which there is public supervision.

Accountability

5.12 Transparency is a necessary, but the claims for effectiveness and efficiency are only credible if there is a well-defined accountability for the realization of the plan. As is clearly shown by current experiences from the European Commission 7th research Framework Program (FP7), the TSOs have shown their willingness and ability to coordinate and execute large-scale R&D activities. European projects have strict rules and requirements in terms of transparency, reporting and dissemination. Any future type of funding will have the advantage of evaluating these experiences and should try to improve them by defining new procedures that will closely reflect the needs of the sector[8]. ENTSO-E should assume the role of guaranteeing that information flows across projects are established and that the different initiatives are developed coherently. It also should provide relevant information to stakeholders, in particular to NRAs, concerning the overall importance and development of the set of financed projects. This means that NRAs can safely interact with their TSOs concerning the financing and progress on R&D in transmission systems, knowing that the European dimension indeed represent a coordinated and urgent action. This principle serves to establish the dual accountability, of the individual TSO towards its NRA in terms of R&D intensity, resources and progress, of ENTSO-E towards ACER in terms of establishment of a coordinated research plan and the follow-up of priorities, just as intended in the Directive.

Efficiency

5.13 The joint research is to be done cost-efficiently, meaning that the processes deployed to attribute research should implement measures to assure value for money. This principle is important to counter the *competitive view* among the regulators. In practice, the principle could be implemented as tenders within or outside ENTSO-E to undertake part of the assigned research, once defined and controlled by the TSOs. Naturally, the internal R&D departments of TSOs, if able, would be among those eligible to submit bids for work-packages in the research projects. However, the major argument for efficiency is that it is simply less expensive to redesign the grid through projects lead by those operating it than by through long, general or commercial solutions. In the end, this will also lead to comparatively lower energy charges.

Urgency

5.14 The timeline is extremely tight to restructure the European transmission system for 2020. An important criterion for ENTSO-E in R&D planning is to consider the time-effectiveness of the work. Unstructured, fragmented and incompatible projects will need more time and more money to deliver acceptable system-wide results. In addition, the amount is money needed is still just a fraction of the overall cost of energy today, even less in the future. Thus, the creation of complex mechanisms for the determination of the distribution of country-specific costs and benefits from common system-wide development work is only likely to lead to delays and associated welfare losses, not to gains in terms of equity in cost allocation.

[8] Rules for European Projects are not sector-specific.

6. Plan of action

6.1 Scope

6.01 Below, we define a short-term solution, primarily to unblock the position concerning joint research, to show credible commitment and to enable further deployment of the solution. The approach is not intended as a substitute for nationally financed R&D or as a limitation to the prerogatives for any TSO to undertake internal and external R&D by alternative financing, e.g. to solve problems with low technological and economic risks. The scope here is aimed at finding a flexible and versatile framework for a medium or long-term solution of the R&D financing problem, intended to create discussion within ENTSO-E, CEER and with other stakeholders.

6.2 Short-term solution

Clear and transparent project classification

6.02 It is necessary to critically review all research objectives defined in the ENTSO-E R&D Roadmap as to retain only those that truly need external financing. Smaller projects and projects with high expected payoffs to the individual TSO in form of cost-savings should not be included in the regulatory basket. The result is a clear and adequate project classification with respect to financing eligibility, linking ENTSO-E priority projects of high European importance and without high direct cost-reduction impact or national specificities.

Ring-fenced financing for transmission R&D

6.03 The overall amount necessary for R&D in the sector is a small percentage of the overall energy costs, or even of the TSO revenue base. A simple measure could be for NRAs to coordinate at CEER level and ring fence a corresponding amount through tariffs in 2013. An annual amount[9] is earmarked for research and development activities to be carried out in coordinated projects at European level only and cannot be used for other functions. Initially, the funds could be levied by each TSO[10].

Clearly identified and assigned staff and resources from TSO to joint R&D activities

6.04 Each TSO participating in R&D will offer a transparent and open declaration regarding the use of R&D funds.

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[9] This practice exists, e.g. in the current TSO regulation in Brazil (1% of turnover).

[10] Ring Fencing is necessary as it would allow providing uniform incentives. As TSOs have different business models and regulatory frameworks, it could easily be that approaches tied to the national regulatory

[10] Ring Fencing is necessary as it would allow providing uniform incentives. As TSOs have different business models and regulatory frameworks, it could easily be that approaches tied to the national regulatory mechanism could be too heterogeneous to develop a fruitful collaboration.

Fast dissemination and time test-to-deployment

6.05 The ENTSO-E members have the opportunity to show tangibly the advantages in terms of open dissemination of results, fast testing, deployment and implementation of results to improve the grid solutions. This part is an important action to demonstrate that the grid development is in safe hands and that the TSOs are shaping their future.

Coordination with EC funds

6.06 The European Commission has taken a leading role promoting TSOs lead research, through a considerable number of large projects, a support that should grow with the next EC Research program "Horizon 2020". It will be then necessary to strictly coordinate regulatory and EC funding in order to identify which mechanisms are best suited for different types of activities. Coordination could also be put in place in the methodologies used to evaluate the impact of different projects, as there should not be any fundamental divergence to justify completely separate approaches.

Coordination of activities and dissemination of results

6.07 To set up an entity in charge of coordination activities with the following tasks:

- Coordinated dissemination of results, in order to enhance comparisons and synergies between projects.
- To manage the availability of results in a proactive way.
- Management of patents and exploitation rights in order to provide transparency on the use of funds.
- Facilitate and impose coordination between projects
- To allow the necessary flexibility in funding or being able to integrate even small activities in wider research plans.

6.3 Medium-term solution

Creation of regulatory push for effective R&D performance and monitoring

6.08 Logically, since R&D is part of the mandates assigned to the TSOs, the regulators should continue to exercise due diligence in the scrutiny of the research plan, the deployment of the research funds and the effectiveness of the solution. Naturally, the individual NRA should push their TSO to perform also in this role, whereas possibly the European Commission should incite ENTSO-E to achieve the joint objectives in combination with other initiatives for infrastructure and energy sector reinforcements.

Effective coordination development in the energy supply-chain

6.09 System development in grids is not only a TSO matter, it concerns the entire energy supply chain: from generator, transmission, and distribution down to demand/retail-side involvement. A medium-term objective for ENTSO-E should be to organize a

transparent and effective process in coordinating the overall research plan with the plans and achievements of the other stakeholders. The more efficiently the overall grid development can be made, the faster the goals can be attained with a given budget.

Creating incentives of excellence in innovation

6.10 Embarking on a road of coordinated, focused, yet decentralized R&D activities will require human and economic resources. In the medium term, it is important that the regulatory regimes promote excellence in development and innovation beyond the current incentive regulation framework, not only at national levels. Establishing incentives within the regulated sector will definitely lead to a benchmarked R&D. Therefore extensive measurements and analysis are necessary, which not only have to measure the return of R&D but also the valuation of risks.

6.11 In terms of funding the European Commission has allocated considerable effort and resources to promote Smart Grid and Network innovation both at Transmission and Distribution level[13]. This brought three results: i) TSOs have been involved and have been leading and coordinated international R&D projects since 2007. It is then possible to develop future programs with an extensive experience in terms of management and results; ii) the Commission will keep supporting in the future these initiatives with possibly also an increase in funding, then a cooperation will be necessary and fruitful, especially as Regulatory funding could support mechanisms better tailored to the needs of the Transmission sector and its stakeholders; iii) the experience in R&D evaluation by the Commission could be used by NRAs evaluating international R&D.

[13] http://www.smartgrids.eu

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