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# Technical Assistance for Improvement of Performance-Based Tariff Regulation of EMRA For Turkish Energy Markets Through Introducing an Enhanced Monitoring System



## Task 4: Preparation of Smart Grid Road Map and Required Methodological Tariff Approaches for Electricity & Natural Gas Markets Training

### Electricity Transmission

15 September 2020, Online





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# Agenda

- ❖ Pan-European Activities on Design of Future Electricity Transmission Systems
- ❖ International benchmarks: Smart Grid Regulations in Electricity Transmission
- ❖ As-Is Regulations in Turkey, Gap Analysis and Regulatory Recommendations (Electricity Transmission)
- ❖ Smart Grid Roadmap for Turkish TSO





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# Pan-European Activities on Design of Future Electricity Transmission Systems





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## European Legislative Framework (1/8)

- The Third Energy Package, the TEN-E Regulation and the Clean Energy for All Europeans Package aim at facilitating the development of the European energy networks.
- The regulation emphasises the importance of meeting the EU's 2030 energy and climate targets :
- Furthermore, the European Green Deal published and its aims to make Europe the first climate-neutral continent by 2050.
  - The new rules contribute to the EU's goal; of being the world leader in energy production from renewable energy sources by allowing more flexibility to accommodate an increasing share of renewable energy in the grid. The new electricity market design will therefore help to achieve the goals set out in the European Green Deal, and contribute to the creation of jobs and growth.





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## European Legislative Framework(2/8)

➤ European Green Deal Action Plan for Clean, affordable and secure energy is as follows;

- Assessment of the final National Energy and Climate Plans June 2020
- Strategy for smart sector integration 2020
- ‘Renovation wave’ initiative for the building sector 2020
- Evaluation and review of the Trans-European Network – Energy Regulation 2020
- Strategy on offshore wind 2020

➤ The share of electricity produced by renewable energy sources is expected to grow from 25% to more than 50% by 2030. At the same time, electricity must also be produced and delivered in sufficient quantities when there is no wind or sun.





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## European Legislative Framework(3/8)

- Markets need to be improved to meet the needs of renewable energies and attract investment in the resources, like energy storage, that can compensate for variable energy production.
- The market must also provide the right incentives for consumers to become more active and to contribute to keeping the electricity system stable.
- To address these issues, the EU adopted in 2019, as part of the 'Clean energy for all Europeans package', four pieces of legislation that will help adapting EU market rules to new market realities.
  - The Electricity Directive (EU) 2019/944 and Electricity Regulation (EU) 2019/943:
  - Regulation on Risk-Preparedness in the Electricity Sector (EU) 2019/941:
  - Regulation for Establishing the Agency for the Cooperation of Energy Regulators (ACER) (EU) 2019/942 :





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## European Legislative Framework (4/8)

### ➤ The Electricity Directive and Electricity Regulation:

- to establish common rules for the generation, transmission, distribution, energy storage and supply of electricity, together with consumer protection provisions, with a view to creating truly integrated competitive, consumer centred, flexible, fair and transparent electricity markets in the EU.
- Using the advantages of an integrated market, ensure affordable, transparent energy prices and costs for consumers, a high degree of ICT & Digitalization of Power System; The achievement of a more efficient market with an optimized energy mix and security of supply through integration of market and grid operations.
- It lays down key rules relating to the organisation and functioning of the EU electricity sector, in particular rules on consumer empowerment and protection, on open access to the integrated market, on third-party access to transmission and distribution infrastructure, unbundling requirements, and rules on the independence of regulatory authorities in the EU Member States.





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## European Legislative Framework (5/8)

### ➤ The Electricity Directive and Electricity Regulation:

- sets out modes for EU Member States, regulatory authorities, and transmission system operators to cooperate towards the creation of a fully interconnected internal market for electricity that increases the integration of electricity from renewable sources, free competition and security of supply.
- The Directive on common rules for the internal market for electricity (EU) 2019/944, which replaced Electricity Directive (2009/72/EC), and the new Regulation on the internal market for electricity (EU) 2019/943, which replaced the Electricity Regulation (EC/714/2009) on January 1 2020, introduce a new limit for power plants eligible to receive subsidies as capacity mechanisms (confirming the phasing out of subsidies to generation capacity emitting 550gr CO<sub>2</sub>/kWh or more). Furthermore, the consumer is put at the centre of the clean energy transition and the new rules enable the active participation of consumers, whilst putting in place a strong framework for consumer protection.
- By allowing electricity to move freely to where it is most needed, society will increasingly benefit from cross-border trade and competition. They will drive the investments necessary to provide security of supply, while decarbonising the European energy system.





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## European Legislative Framework (6/8)

### ➤ The Electricity Directive and Electricity Regulation:

- Pursuant to the Electricity Regulation (EU) the EC is empowered to adopt and amend binding guidelines in the areas. In this context the EC seeks the views of ACER, the ENTSO for Electricity, the EU DSO entity and, where relevant, other stakeholders.
- The planned EC Implementing Regulation intends to clarify ambiguous wording in the provisions on the process for developing and approving more detailed joint rules under guidelines (Commission Regulations) governing key cross-border aspects of the electricity wholesale market in the EU and to align those provisions with the new Electricity Regulation (EU) and the ACER Regulation adopted in 2019.
- The proposal consulted upon for a limited and well-targeted amendment of the four Electricity Guidelines ;
  - Capacity Allocation and Congestion Management “CACM” (EU) 2015/1222 of 24 July 2015,
  - Forward Capacity Allocation “FCA” (EU) 2016/1719 of 26 September 2016,
  - Electricity Balancing “EB GL” (EU) 2017/2195 of 23 November 2017,





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## European Legislative Framework (7/8)

### ➤ Regulation on Risk-Preparedness in the Electricity Sector:

- to prepare plans for how to deal with potential future electricity crises and put the appropriate tools in place to prevent, prepare for and manage these situations. Lessons-learnt from 2006 European Blackout is driving factor to issue this regulation.
- using common methods, identify all possible electricity crisis scenarios at national and regional levels and then prepare risk preparedness plans based on these scenarios.
- to cooperate and coordinate with neighbouring member states in a spirit of solidarity. It also establishes a new framework for a more systematic monitoring of security of supply issues via the Electricity Coordination Group.
- to ensure maximum preparedness against electricity crises and effective management and ensure that markets can work as long as possible.





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## European Legislative Framework (8/8)

### ➤ Regulation for Establishing the Agency for the Cooperation of Energy Regulators (ACER):

- Established under the Third energy package, ACER's main role was originally confined to coordination, advising and monitoring. As the new market design rules foresee much more cross-border cooperation, the lack of regional, cross-border oversight was seen as a potential problem, with the risk of diverging decisions and unnecessary delays. Regulation (EU) 2019/942 establishing an EU Agency for the cooperation of energy regulators recasts the regulation 713/2009.
- In addition to coordinating the action of national energy regulators, ACER has therefore been granted additional competences in those areas where fragmented national decisions of cross-border relevance are likely to lead to problems for the internal energy market. For example, ACER will have oversight on the future regional entities "Regional Coordination Centres" where TSOs (Transmission System Operators) will be able to decide on those issues where fragmented and uncoordinated national actions could negatively affect the market and consumers. The proposed approach will also streamline regulatory procedures. National regulators, deciding within ACER on those issues through majority voting, will remain fully involved in the process.





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## Smart Grid Efforts in EU (1/4)

- The European energy sector is currently experiencing a major transition towards a carbon neutrality in order to reach “European Green Deal’s” objectives. All solutions have been considering to address the identified needs, such as increased transmission capacity, storage, hybrid offshore infrastructure, smart grids.
- The quickness of technological developments has intensified in recent years. Therefore, at both Transmission and Distribution network levels of the electricity sector, some incentives regarding the installation and operation of smart grids and smart meters are applied. At the electricity DSO level, there are also some incentives established for the integration of renewable de-centralised distributed generation.
- In general, more incentives are implemented at the DSO level than at the TSO level and more in the electricity sector than in the gas sector. European investment in Smart Grid technologies is forecasted to reach €56.5 billion during the period from 2010 to 2020, with transmission share about 37% of the total amount.







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## Smart Grid Efforts in EU (3/4)

- Main reasons that's why more smart grid investment incentives and consequently share is realized at the DSO level than at the TSO level in the European electricity sector can be assessed as follows:
- The TSOs, indeed, has already had a partly smart system to capable of managing and balancing the resources connected to their system, at the time being. Therefore, they prefer mainly investing in strengthening projects rather than smartening the transmission grid,
  - On the other hand, due to the integration of renewable de-centralised distributed generation, DSOs roles and responsibilities are changing dramatically. The future for DSOs must be more than simply building and maintaining the distribution of energy. DSOs will have a central role in an energy ecosystem, as well as TSOs. Therefore, DSOs need Smarter Grid and Meters investment to have a more resilient and reliable grid and innovative, consumer-focused services.





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## Smart Grid Efforts in EU (4/4)

➤ Furthermore, some countries have individual incentives established in their regulatory regime. These are as follows:

- The Spanish regulatory regime includes at the electricity TSO level incentives for maximising the transmission grid availability, for the accomplishment of the investment plan approved for the company and implicit incentives to be more efficient in the cost of new assets and their operating and maintenance costs, trying to get lower costs than the approved reference values.
- Finland TSO, Fingrid incentives regulation, has established incentives for innovation. Innovation Maximum 1.0 % of turnover is reimbursed in allowed return as regulatory profit in regulatory model 2016-2023. Innovation incentive encourages the TSO to develop and use innovative technical and operational solutions in its network operations. The key objectives of research and development activities are the development and introduction of smart grids and other new technologies and methods of operation. Acceptable costs for research and development (R&D) must be directly related to creation of new knowledge, technology, products, or methods of operations.
- Luxembourg NRA wants to foster the development of smart grids and is planning to establish a specified incentive for the electricity sector until 2021.
- Norway NRA is considering changing the tariff structure for the demand for MW to influence the tariff for all customers. This could give incentives for more demand response.
- Sweden NRA also plans to implement the contents of the European Clean Energy Package and therefore, TSOs will, in most cases, not be allowed to own storage in future.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (1/10)

- CEER further develops the Whole System Approach (WSA) concept, by describing three possible WSA layers, which should be considered to reach a better outcome:
  - **Layer 1 “whole-network-approach”** - An integrated view of the regulation of distribution and transmission networks with a main focus on network operation and planning,
  - **Layer 2 “whole-chain-approach”** - An integration across a sectoral chain (e.g. in electricity or in gas), i.e. expanding beyond networks to for instance, include demand, generation, system operation and retail, both in terms of interaction with network operators and in terms of the impacts on them; and
  - **Layer 3 “cross-systems-approach”** - An integration across different energy areas, e.g. the integration of regulation of the electricity, gas and heat sectors, including with transport.
- The WSA essentially means to consider the societal net benefit for the entire system, in line with the applicable energy policy objectives. The WSA also encourages network operators to consider the consequences of their decisions on other actors of the value chain. This is crucial, because when certain incentives or interests only cover specific areas (e.g. the network operator's own network activities), results could well be suboptimal.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (2/10)

- **Smart grids task force** has issued key reports on standards, cybersecurity and flexibility markets.
- Standard Data Access & Exchanges: to facilitate interoperability of electricity and gas services in retail markets and help promote competition, Expert Group EG1 focused common data format that evolved into data access (and exchange). In this framework, followings are succeeded:
  - Map national practices for data access and exchange
  - Identify commonalities, differences, scope for bringing them closer
  - Frame recommendations: advice on what to address in implementing act(s)
- Outcomes of the report are followings:
  - Recommendations on what to consider in secondary legislation
  - Concept of a reference model / framework:
- Idea tested on business use cases from emerging services: “download my data”; “share my data”; “consent management”



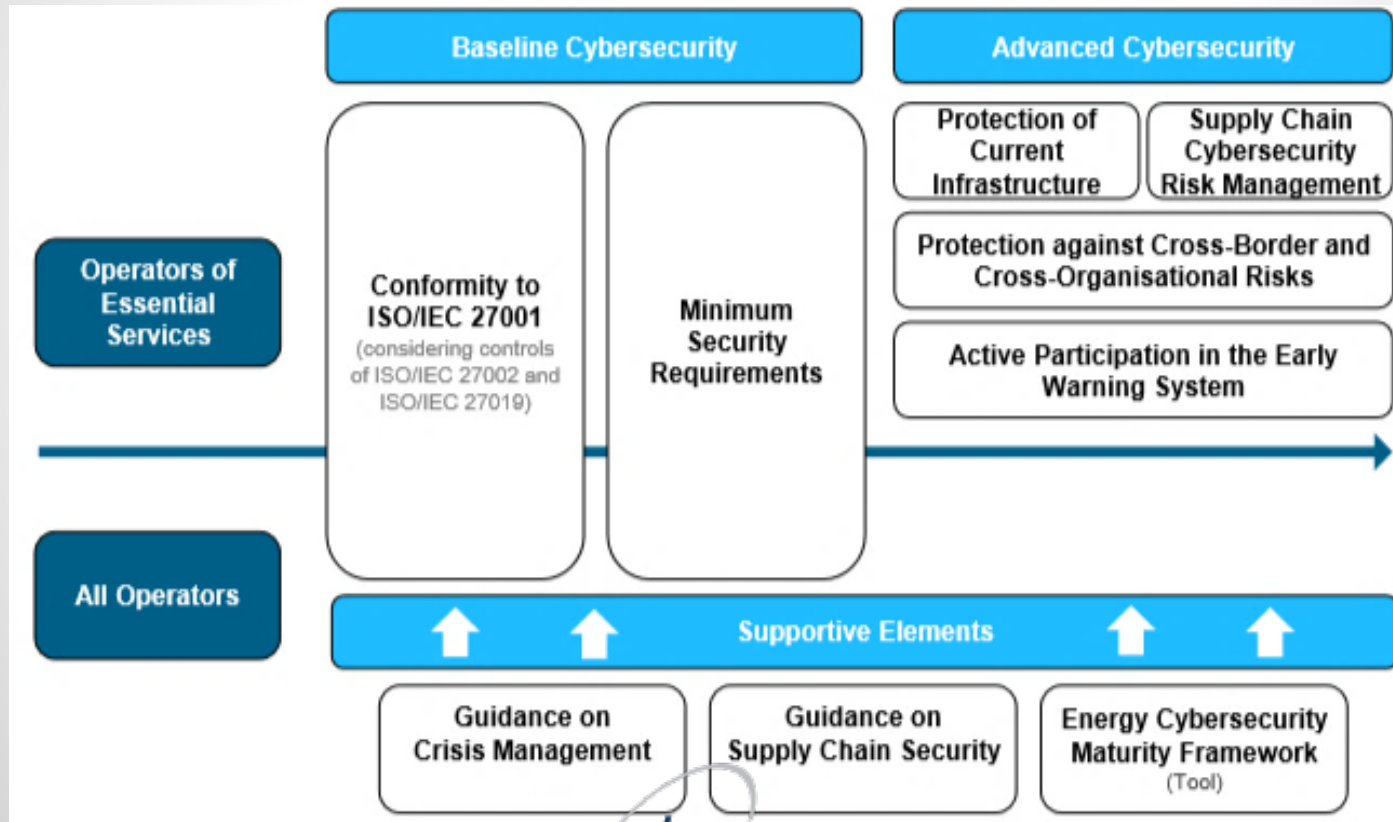


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# Pan-European Activities on Design of Future Electricity Transmission Systems (3/10)

- Cybersecurity: Expert group, EG2 has focused and proposed the following Structure for the Network Code on Cybersecurity.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (4/10)

### ➤ Demand Side Flexibility: Expert group, EG3 focused on following works for the Demand Side Flexibility:

- Access of flexibility to organised markets in order to ensure a level playing field between demand side flexibility and generation
- Use of demand side flexibility by system operators (DSOs and TSOs), including demand response and other flexibility services
- Contractual arrangements between final customers, aggregators, suppliers/BRPs and possibly other actors

### ➤ The main outcomes are followings:

- Technical solutions: EU level principles for equal level playing field of flexibility providers and integrated system approach.
- Market access: framework for data access, flexibility providers, baseline methodology and validation based on EU principles and national best practices
- Flexibility products: product definition, data requirements and pre-qualification at least at national level, but possible template and key elements at EU level
- Consumer and incentives: financial incentives, market monitoring, awareness, and protection of consumers at national level based on EU principles and framework.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (5/10)

➤ Joint Activities of ENTSO-E and EDSO: Evolutions in the grid operation sector will require an ever-closer cooperation between Transmission System Operators and Distribution System Operators. The current interaction between TSOs and DSOs has been investigated for six specified grid operation challenges, and possible future ways of cooperation have been identified:

- Congestion of Transmission-Distribution interface
- Congestion of transmission lines
- Balancing challenge
- Voltage support (TSO-DSO)
- (Anti-)Islanding, re-synchronization & black start
- Coordinated protection





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## Pan-European Activities on Design of Future Electricity Transmission Systems (6/10)

- ENTSO-E's evaluations on the latest situation for smart grid activities in the framework of each innovation clusters are summarized as follows\*:
- Power System Modernization:
  - **HVDC Links:** Interesting developments are expected to take place, especially around stability issues within conditions of high penetration levels of power electronics (incl. converter-based renewable generation and high voltage direct current (HVDC) links).
  - **Smart asset management** is gaining attention with interesting projects – technologies, tools and applications – to be expected in the future. Currently there are few success stories
- Security and System Stability:
  - **PMUs:** The use of Phasor Measurement Units (PMUs) and other sensor technologies has increased awareness and accuracy. Supporting and simulation tools and data processing equipment have contributed to these developments. Work continues on further improvements, not only on TSOs' own system observability, but also on DSOs' systems (merging TSO/DSO models). Data collection, processes, protocols and standards should be harmonised more.

\*ENTSO-E Monitoring Report on Research, Development & Innovation Roadmap 2017– 2026





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## Pan-European Activities on Design of Future Electricity Transmission Systems (7/10)

- **New Integrated Technologies:** The proper control and impact on the stability of the system of new integrated technologies, such as storage, converter-based renewables and HVDC, will require further research and demonstration.
- Reliability and resilience in terms of defence and restoration plans, probabilistic approach, risk assessment and self-healing, started as RD&I activities with some ongoing projects that will deliver results in the future.
- The impact of storage flexibility is partially addressed.

### ➤ Power System Flexibility from Generation, Storage, Demand and Network

- **Storage Devices:** Power system flexibility using storage have had the lion share in terms of number of projects. However, the lower maturity levels of the technology and the specificities of different types of storage technologies need to be further addressed. Challenges remain on the optimal use and distribution of storage devices, the needed technical requirements to facilitate service provision and the business models development.
- **HVDC:** Hybrid AC/DC solutions, HVDC reliability, meshed DC grids, services from HVDC multiterminal networks are topics where European research will need to step into more in the coming years.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (8/10)

- **Dynamic Rating Equipment:** The developments are better regarding dynamic rating equipment and power flow devices, but it is still necessary to develop comprehensive methodologies to provide a common framework for investment-decision discussion with national regulatory authorities (NRAs).
- **Accurate power forecasting:** especially from renewable energy sources, accurate power forecasting still seems to be a challenge. A range of ongoing projects will hopefully increase coverage of this objective. However, more attention will be needed when it comes to estimating secondary/tertiary reserve against those accuracy levels

### ➤ Power System Economics and Efficiency

- **Flow-based market coupling** is still subject to investigation and there is need for more RD&I.
- **Flexibility and Ancillary Services:** There have been very promising results around business models that include flexibility considerations and ancillary services provisions. However, considering the future needs and structural changes of the industry, this topic remains high on the research agenda.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (9/10)

### ➤ Digitalisation of Power System

- **The Digitalisation of the Power System** : Overall, the digitalisation of the power system, big data management, ICT and communication advancements, along with all their benefits and challenges, is a new and wide area to explore that will require increased focus over the coming years.
- **Data Management:** There has been some progress on local data management system and developments on the standardisation front: IEC61850, CIM standard series and communication protocols. Work is ongoing, with important projects to deliver results in the coming period.
- **Data Exchange:** The field of data exchange models between TSO/DSO, and other agents such as EV chargers, has seen advancements. However, wide application and assessment is pending.
- **Open source modelling:** the impact of Internet of Things (IoT) and related interface tools are emerging.
- **Cybersecurity:** has been acknowledged as an important field and major activities are ongoing at national and European level. The research work should continue supporting this area which becomes increasingly critical.





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## Pan-European Activities on Design of Future Electricity Transmission Systems (10/10)

### ➤ ENTSO-E suggestions to reach “European Green Deal’s” objectives are as follows:

- The large integration of renewable energy sources, mainly offshore wind and HVDC interconnectors are expected to achieve European Green Deal’s objectives. In order to support the interoperability for a secure operation of the future European energy system and the realisation of interaction studies for multi-vendor AC and multi-vendor multi-terminal DC systems, a standardised control interface for HVDC is required.
- Electrification of end-uses, digitalisation and smart sector integration will have an important role for the integration of an increasing share of renewable energy sources.
- In order to develop bold and agile innovation strategies to fast-track the integration of clean energy solutions, TSOs cooperation with policymakers, distributions system operators and stakeholders is required.

### ➤ In this context, ENTSO-E has developed a Research, Development, and Innovation (RDI) Roadmap for 2020–2030 which is under ongoing process for public consultation and ACER opinion.





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# International benchmarks: Smart Grid Regulations in Electricity Transmission





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## Smart Grid Regulatory Feature (1/14)

- Incorporation of smart grid costs to TSO revenue determination (Is there any pre-defined ratios, what are considered as CAPEX, what are considered as OPEX):
- United Kingdom:£12.5 billion each year for Gas and Electricity Networks
  - Italy:Smart grid investments are not considered different than other investments which have same WACC system.
  - Germany:Smart grid investments are not considered different than other investments.
  - France:Smart grid investments are entirely contained as well as RTE's other investment expenditures by tariff (TURPE)
  - Sweden :Smart grid investments are not considered different than other investments of Svenska Kraftnät.
  - Finland:Smart grid investments are not handled different than other investments of Fingrid.
  - Turkey:For R&D there is pre-defined ratio (1% of TEİAŞ' system usage revenue), but, for smart grid investment there isn't. Smart grid investments are not considered different than other conventional investments which have same WACC system.





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## Smart Grid Regulatory Feature (2/14)

- Are there incentives by NRAs to encourage TSOs for roll-out/deployment (operational use) and large-scale pilot trials? If yes, what are the mechanisms/rules/principles used?
- United Kingdom: Yes, there are through RII price control mechanism. The SOs and TOs submit business plans to the NRA for assessment and approval. Ofgem's criteria and methodology for outputs assesses the proposed investment projects in a TO's business plan in terms of Reliability, Wider Works, and Innovation.
  - Italy: ARERA has no certain duty to encourage smart grid projects, but NRA has ability to set some targets regarding smart grid projects which are efficient. For smart grid solutions, the ARERA may value the possibility of an initial support, including specific incentives which are decided individually for each project. There is no definite incentive.
  - Germany: BNetzA has no certain duty to encourage smart grid projects. BNetzA creates implicit incentives for TSOs over the network tariffs. These incentives are used to reduce actual costs of investments (which are deemed necessary or efficient by BNetzA) by TSOs but these efficiency gains must be passed on to consumers in the next period.
  - France: TURPE gives to RTE to obtain additional budgets for financing smart grid projects if confirmation of its feasibility which is based on cost-benefit analysis. For this reason, CRE allows a budget to RTE in order to promote smart grid projects.





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## Smart Grid Regulatory Feature (3/14)

- Are there incentives by NRAs to encourage TSOs for roll-out/deployment (operational use) and large-scale pilot trials? If yes, what are the mechanisms/rules/principles used?
  - Sweden :The Inspectorate has limited duties and does not directly encourage to smart grid projects. The revenue cap may indirectly fund smart grid projects. On the other hand, The Swedish Energy Agency support development of new technologies directly by funding these projects.
  - Finland:Although EA has not any certain duties for encouraging smart grid projects, The Tariff contains smart grid incentives. Tariff encourages smart grid projects by allowing for the deduction of up to 1% of project costs when calculating adjusted profits. Costs included in the smart grid incentives must be related to defined projects which create new knowledge, technology, products or methods of operation in network operations. Accepted incentives must be public so they can be used by the sector as a whole.
  - Turkey:EMRA has no certain duty to encourage smart grid projects. EMRA doesn't have any mechanism for assessment and approval of TEİAŞ' Yearly Investment Program. This yearly investment program is subject to approval of the presidential strategic investments' unit.





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## Smart Grid Regulatory Feature (4/14)

- Relation between energy policies and regulatory frameworks for smart grid roll-out. (Example: governments set RES targets and NRAs defines the relevant regulations and TSO plan their activities according to those regulations. What are those regulations by NRAs?)
  - United Kingdom: Government set a net zero greenhouse gas emissions target by 2050. Furthermore, Ofgem published a decarbonization action plan. Ofgem will use RIIO-2 to deliver the network changes needed to achieve net zero target.
  - Italy: TYNDPs and Innovation plans are prepared in line with EU targets and Ministry targets (reduction in CO2 emissions, reduction in congestion, greater capacity of power from renewable sources, etc.) and need to be approved by both NRA and the ministry.
  - Germany: The Energiewende project of the Germany set targets for renewables, energy efficiency, storage capacity etc.
  - France: For the approving of TNYDP of RTE, CRE verifies whether the plan includes all investment needs consistent with the European Commission's Third Energy Package requirements and targets.





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## Smart Grid Regulatory Feature (5/14)

- Relation between energy policies and regulatory frameworks for smart grid roll-out. (Example: governments set RES targets and NRAs defines the relevant regulations and TSO plan their activities according to those regulations. What are those regulations by NRAs?)
  - Sweden :TYNDPs and R&D Development Plan are prepared related to EU and Ministry targets and also in line with ENTSO-E's TYNDP.
  - Finland:TYNDP must be submitted in line with EU TYNDP's targets
  - Turkey:There is implicitly relation between Government energy policies and regulatory frameworks for smart grid roll-out. For example, government set high level policies and targets to increase usage of domestic and renewable energy and EMRA defined the relevant regulations which are Capacity Mechanism, and several law, regulation and communiqués on renewables and TEİAŞ prepared investment program and planned to operate capacity mechanism according to those legislations.





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## Smart Grid Regulatory Feature (6/14)

- NRAs' (and CEER's, ACER's) role in pan-European TSO activities (ENTSO-E). (National TSOs relations with their NRAs in this process)
  - United Kingdom: Due to the similar decarbonization policies with EU, Ofgem considers EU directives, internal market rules, network codes, etc. However, they do not have vote right in decision mechanism.
  - Italy: The 10-year Development Plan of ENTSO-E is controlled by ARERA within the context of cooperation with the ACER. ARERA also considers EU directives, internal market rules, network codes, RES targets, and ENTSO-E's roadmaps etc.
  - Germany: TSOs also consider EU directives, internal market rules, network codes, RES targets, and ENTSO-E's roadmaps etc.
  - France: The CRE consults ACER for doubtful cases in TYNDP. CRE also considers EU directives, internal market rules, network codes, RES targets, and ENTSO-E's roadmaps etc.
  - Sweden : Svenska Kraftnät considers EU directives, internal market rules, network codes, RES targets, and ENTSO-E's roadmaps etc.
  - Finland: Fingrid considers EU directives, internal market rules, network codes, RES targets, and ENTSO-E's roadmaps etc.
  - Turkey: Due to the process of EU accession of TURKEY and the synchronous connection of Turkish power system with ENTSO-E Grid, EMRA considers, EU directives, internal market rules, network codes, etc. However, they don't have vote right in decision mechanism.





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## Smart Grid Regulatory Feature (7/14)

- How do TSOs plan their smart grid and technology deployment activities? TYNDP? Business Plan? Separate Planning?
- United Kingdom: TSOs prepare a business plan in terms of Reliability, Wider Works, and Innovation in compliance with Ofgem's criteria and methodology.
  - Italy: Smart grid projects are included in TYNDP, which is prepared by TSO and updated every year. Apart from this plan, it is included in the Innovation Plan, which also includes innovative projects other than the smart grid.
  - Germany: Smart Grid projects are included in On-Shore and Off-Shore Development Plans which include projects of next 10-15 years. All TSOs have to submit On-Shore DP in every two years and TenneT and 50Hertz have to submit also Off-Shore DP.
  - France: Smart grid projects are included in TYNDP, which is prepared by RTE and must be updated every year. In addition, RTE must also prepare an Annual Investment Plan in each year for approving by CRE.





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## Smart Grid Regulatory Feature (8/14)

### ➤ How do TSOs plan their smart grid and technology deployment activities? TYNDP? Business Plan? Separate Planning?

- Sweden : Smart grid projects are included in TYNDP, which is prepared by Svenska Kraftnät and updated every year. Apart from this plan, TSO also prepares a three-year R&D Plan which also includes smart grid projects.
- Finland: Smart grid projects are included in TYNDP, which is prepared by Fingrid and must be updated every two years.
- Turkey: Smart grid projects are included in yearly investment program and master plan, which are prepared by TEİAŞ.





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## Smart Grid Regulatory Feature (9/14)

- NRAs' approach for regulating achievement targets of Smart Grid for TSOs.
  - United Kingdom:Ofgem encourages innovation in terms of the statutory framework, however the duty to encourage technology investment and smart grid activities is likely implicit in the more general duties on Ofgem to ensure that it secures the efficient and economic execution of activities by licensees.
  - Italy:Although NRA encourages innovation in terms of the framework, duty to encourage smart grid activities is more implicit than other duties. NRA controls that project for efficiency.
  - Germany:Individual efficiency targets of TSOs are defined by Bnetza in maximum revenue of each year. These targets are formulated and distributed across the tariff period in a way that enables the TSO to achieve these targets.





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## Smart Grid Regulatory Feature (10/14)

- NRAs' approach for regulating achievement targets of Smart Grid for TSOs.
  - France: NRA encourages smart grid projects in terms of the technological and digital change, however duty to encourage smart grid activities is more implicit than general duties. NRA controls that project's efficiency and budget.
  - Sweden :NRA has limited duties for encouraging smart grid projects in terms of the framework. NRA controls that project's efficiency and quality..
  - Finland:NRA's duty for encouraging smart grid projects in terms of the framework is more implicit than other duties. NRA controls that project's depreciation differences.
  - Turkey:EMRA has not introduced any mechanism for regulating achievement targets of smart grid for TEİAŞ yet. Because:
    - Performance indicators are not introduced and implemented to measure continuity of supply.
    - No efficiency indicator is used in Turkey, although, it is defined in secondary legislation.





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## Smart Grid Regulatory Feature (11/14)

- Monitoring and reporting requirements for TSO about their technology investment and smart grid activities:
  - United Kingdom: TOs prepare a statement setting out their charges (one for each TO) that is to be consistent with the revenue caps that Ofgem set, and which is ultimately approved by Ofgem. However, there is no separate reporting for their technology investment and smart grid activities.
  - Italy: There is no special reporting and monitoring requirements for smart grid projects, NRA controls the projects with efficiency.
  - Germany: Although there is no certain reporting and monitoring requirements for smart grid activities, NRA considers the efficiency of projects.
  - France: If TSO spends more than the provided budget, the difference will not be covered by the regulation framework. If TSO does not carry out the smart grid investments which are included in the 10-Year Plan in three years, the NRA may require TSO to execute this investment, call for a tender to execute out the investment and may request to modify the TYNDP.
  - Sweden : Although there are no certain requirements for reporting and monitoring of the projects, The Inspectorate considers the quality and efficiency of the projects to determine incentives by over the tariff
  - Finland: Projects has no requirements to meet performance standards, reporting and monitoring in Finland. EA controls difference between straight-line depreciation and accounting depreciations
  - Turkey: There are no certain requirements for reporting and monitoring about the TEİAŞ' technology investment and smart grid activities





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## Smart Grid Regulatory Feature (12/14)

### ➤ NRA-TSO relations for defining the regulatory frameworks for new technologies:

- United Kingdom: Through the Innovation Competitions under the RIIO framework, Ofgem encourage network companies to compete for funding for research, development and demonstration of new technologies and operating and commercial arrangements
- Italy: ARERA encourages the transmission operator with a framework promoting higher benefits and/or lower costs.
- Germany: Through the simulation of competitions of incentive regulation, Bnetza motivates and encourages to TSOs to implement their smart grid investments more cost efficiently.
- France: RTE created a workgroup to develop not only a common and regulatory framework but also technical and economical hypotheses. CRE, RTE, distribution operators, electricity suppliers, universities, manufacturers are members of this work group.
- Sweden : The Inspectorate encourages the TSO to implement smart grid technologies on network in terms of the Cost-Benefit Analysis
- Finland: The Authority aims to guide and encourage the TSO also to increase the quality and efficiency of new technology investments.
- Turkey: There are no defined EMRA-TEİAŞ interaction requirements in the legislation for defining the regulatory frameworks for new technologies.





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## Smart Grid Regulatory Feature (13/14)

### ➤ NRAs attitudes towards Sector Coupling in their regulations:

- United Kingdom: Generally, the term typological investment relates to technical solutions that TSOs can adopt to provide the transmission capacities needed to cover the transmission demand of grid users. Technologies coupling the electricity sector with other sectors (gas, heat, traffic) is possible for congestion management.
- Italy: Although ARERA does not follow a comprehensive sector coupling methodology, the regulatory framework includes “sector coupling” mention in Storage part.
- Germany: The Climate Action Plan of Germany contains little reference to sector coupling, Renewable energy Act contains that plan.
- France: CRE considers that the current regulatory framework is not an obstacle for sector coupling and supports the EU and CEER’s work on this issue.
- Sweden : Although there is no framework about sector coupling, The Inspectorate considers sector coupling when setting low carbon targets.
- Finland: Regarding to sector coupling, although not common in regulation, the existing regulation includes only storage.
- Turkey: There are no EMRA’s attitudes towards Sector Coupling in regulations.





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## Smart Grid Regulatory Feature (14/14)

### ➤ NRAs regulatory role for TSO-DSO relations/joint activities towards smart grid rollouts:

- United Kingdom:Ofgem set regulatory framework, particularly its RIIO framework for transmission and distribution networks, already provides the necessary conditions for DNOs, the SO and TOs to evolve and deliver the joint activities towards smart grid rollouts. Ofgem works with industry over where any regulatory clarifications or changes may be needed for future.
- Italy:ARERA aims to coordinate between distribution and transmission operators within the scope of the integration of renewable energy generation with MV-HV network.
- Germany:Bnetza aims to coordinate and collaborate between TSOs and DSOs regarding the objectives of increasing renewable energy and their integration into the grid within the scope of Energiewende
- France:CRE aims that coordination between TSO and DSO for flexibility of network.
- Sweden :The Inspectorate aims that provide network flexibility by working both system operators together with new technology investments.
- Finland:NRA coordinates TSO and DSO in new smart grid investments related to grid flexibility.
- Turkey:EMRA doesn't have any regulatory role for TSO-DSO relations/joint activities towards smart grid rollouts.





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# As-Is Regulations in Turkey, Gap Analysis and Regulatory Recommendations





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## Regulatory Recommendations to Support Smart Grid Roll-out in TEİAŞ(1/5)

Feature	Recommendation	Explanation	Supportive Arguments	As-Is Status in Turkey	Key stakeholders
Tariff Methodologies and Incentives	Incentivizing Strategic Smart Grid Projects	Additional premium might be added to CAPEX in case TEİAŞ makes expenses for strategic smart grid projects (e.g. fostering sector coupling, new market services, renewable integration etc.). EMRA may select a few projects for each tariff period that will receive the incentive.	Smart grid investments should be incentivized based on performance criteria and decoupling should be considered successful completion and operation of specified strategic smart grid projects.	There are not specific incentives for smart grid projects.	EMRA, TEİAŞ
Tariff Methodologies and Incentives	Allocated CAPEX for Smart Grid and Technology Investments	Identification specific+C1 CAPEX category for smart grid investments in revenue cap of TEİAŞ 5-10% of the network CAPEX is recommended to be allocated for smart grid rollout investments	Since smart grid and technology investments for TEİAŞ bear a higher investment cost and risk compared to conventional network reinforcements, EMRA should make sure that these higher investment cost and risks are properly accounted for in regulatory assessments for allowing smart grid and technology investments to be considered as a viable network planning option for electricity transmission.	There is not specific CAPEX category and/or pre-defined ratio in revenue cap of TEİAŞ for smart grid and technology investments.	EMRA, TEİAŞ





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## Regulatory Recommendations to Support Smart Grid Roll-out in TEİAŞ(2/5)

Feature	Recommendation	Explanation	Supportive Arguments	As-Is Status in Turkey	Key stakeholders
Tariff Methodologies and Incentives	Incentives for Extension of Network Assets Lifetime	Development of implicit incentive methodologies to increase network asset performance and extend operational life through advanced asset management practices.	<a href="#">Smart grid investments should be incentivized implicitly based on efficiency performance indicators and assessed by international benchmarking or referring to a reference network.</a>	In Turkey, although written in the secondary regulation, the target efficiency levels of the TSO has not yet defined by EMRA.	EMRA, TEİAŞ
Smart Grid Planning	Including Smart Grid Planning in Master Plan/TYNDP Process	Smart Grid Planning to share with EMRA for monitoring and tracking the progress.	Including a smart grid planning in master plan that further innovation in the operation of transmission systems would be beneficial in terms of overall efficiency, and indeed necessary if electricity system is to proceed in the most cost-effective way.	<a href="#">Smart grid projects are included in yearly investment program and master plan, which are prepared by TEİAŞ. However, there is not specific process for EMRA' monitoring and assessment.</a>	TEİAŞ and EMRA





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## Regulatory Recommendations to Support Smart Grid Roll-out in TEİAŞ(3/3)

Feature	Recommendation	Explanation	Supportive Arguments	As-Is Status in Turkey	Key stakeholders
Smart Grid Planning	CBA as a Complementary Tool of Decision Making in Planning	CBA methodology to be incorporated in planning processes for strategical smart grid projects.	CBA methodology to be incorporated in planning processes for new strategic smart grid projects will be provided cost effective way for prioritization and efficiency of new investments accommodating including social welfare.	There is not any specific CBA methodology to be incorporated in planning processes for strategical smart grid projects.	EMRA, TEİAŞ
Smart Grid Planning	Harmonization of Smart Grid Planning Activities of Different Energy Sectors	Electricity distribution, gas distribution, gas transmission smart grid rollout planning should be harmonized.	It is important to focus on market expansion, through electrification sector coupling and integration, TSO-DSO interface and the coordination of Gas DSOs-BOTAŞ and the other market players through harmonization of smart grid activities.	There is not any specific program /mechanism to fund SG	EMRA, TEİAŞ





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## Regulatory Recommendations to Support Smart Grid Roll-out in TEİAŞ(4/5)

Feature	Recommendation	Explanation	Supportive Arguments	As-Is Status in Turkey	Key stakeholders
Monitoring Requirements	Identification of KPIs for Monitoring the Success of Smart Grid Projects	Implementation of concrete methodologies for evaluating, monitoring and auditing Smart Grid projects and their benefits	Smart grid investments should be monitored and assessed based on quality performance indicators and efficiency performance KPIs targets.	There is not any specific KPIs for Monitoring the Success of Smart Grid Projects SG	EMRA, TEİAŞ
New Services and Business	New Flexibility Resources and Ancillary Services	Definition of roles, responsibilities and revenue streams for regulated entity (TSO) (Demand Response, Power Storage, Distributed Generation) (evaluate the procurement model for flexibility resources in Ancillary Services using a cost-benefit analysis approach.)	High renewable energy penetration, intermittency and low inertia generate an increased level of threats, which require a full use of new flexibility resources and enhanced ancillary services.	"Electricity Market Ancillary Services Regulation Draft" including demand side participation was published by EMRA.	TEİAŞ, EPDK, DSOs and the other system users.





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## Regulatory Recommendations to Support Smart Grid Roll-out in TEİAŞ(5/5)

Feature	Recommendation	Explanation	Supportive Arguments	As-Is Status in Turkey	Key stakeholders
Other Recommendations	Identify High-Priority Technology Areas for Domestic Industry	Supporting target areas for technology development and export (storage, IoT, data analytics, network management software, cyber security, etc.)	In order to support domestic industry in the development of technology and systems to help them participate in the future energy market and become leaders in technology export, it is necessary to identify high priority technology areas and openly share expertise, data and tools with stakeholders with the aim of accelerating improvements across the Whole System for domestic industry, as well as society.	There is not any specific program /mechanism to identify high priority technology areas for domestic industry.	TEİAŞ, EMRA, Industry Organizations, Universities, TUBITAK,
Other Recommendations	Communication and Dissemination Activities	TEİAŞ should make sure that results and lessons learned from smart grid demonstration projects are disseminated.	In case of smart grid demonstration projects for electricity transmission, financed or co-financed by additional grid tariffs or from public funds, TEİAŞ should ensure the dissemination of the results and lessons learned to all interested parties, including other market participants, etc.	There is not any specific program /mechanism for communication and dissemination activities in smart grid demonstration projects.	TEİAŞ, EMRA, Industry and other market players.
Other Recommendations	Participation in Standardization Organizations	TEİAŞ should participate in standardization organizations regarding smart grids.	The purpose of the participation to Standardization Organizations is for TEİAŞ to adopt and/or to cooperate in the development of protocols and standards related to information management and data exchange to ensure the interoperability in current and future deployment of smart grid projects for electricity transmission.	There is not any specific program /mechanism to participate in standardization organization regarding smart grids.	TEİAŞ and Standardization Institutions.



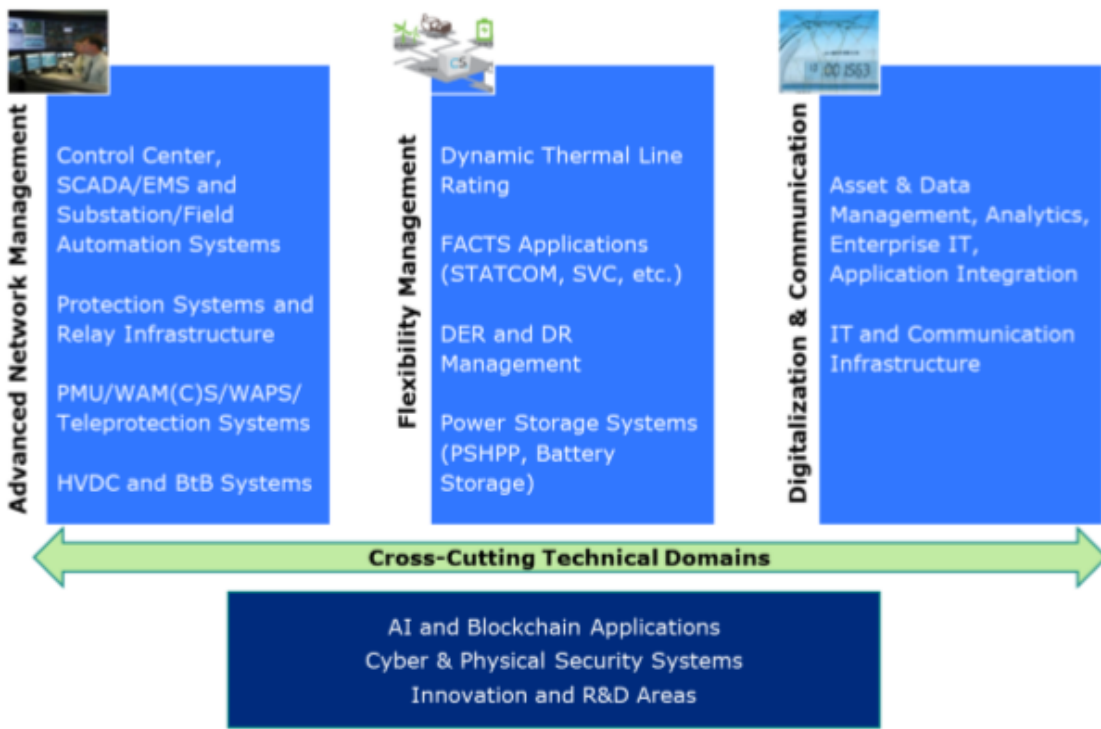


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# Smart Grid Roadmap for TEIAS





## Recommendations: 1/34

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relatively “smart” and amenable to innovation. The contribution of connected to accommodate varying and multidirectional power flows the and need to sophisticated protection, monitoring, supervision and management systems. logy plan that further innovation in the operation of transmission systems indeed necessary if electricity system is to proceed in the most cost-effective

- A Smart Technologies Planning for TEİAŞ can describe the elements needed in implementing a "Smart Grid" by outlining how the electricity delivery system can be modernized so it monitors, protects, and automatically optimizes the operation of its interconnected elements—from the central conventional generator and decentralized intermitted generation through the high-voltage network and distribution system, to HVDC, B2B, energy storage installations, to enhance SCADA/EMS, and to end-use consumers and their flexible load for demand response. This comprehensive plan highlights emerging concepts of cyber and physical security, resiliency, and the newest architecture—“The Integrated Grid”.
- As-is Status in Turkey: There is not a smart technology plan. However, it is decided to determine a roadmap for smart grids / systems in the electricity and natural gas transmission and distribution sector

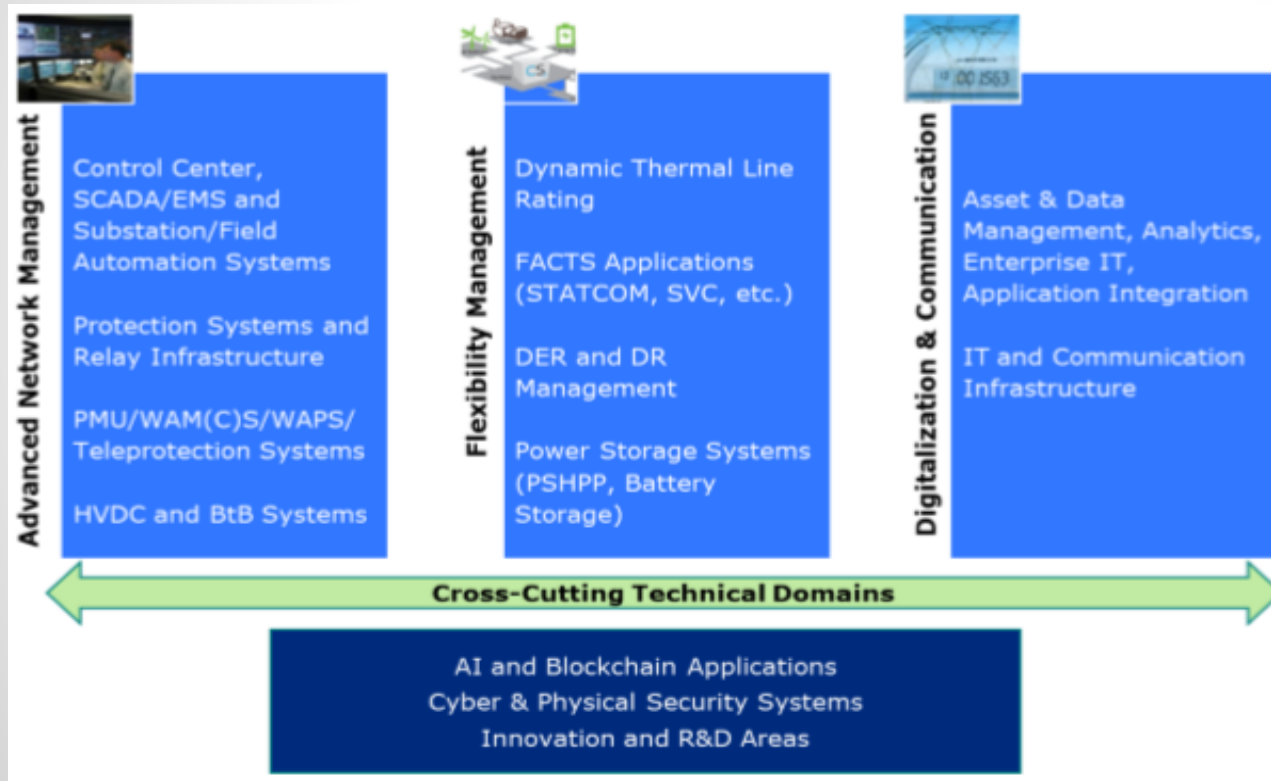


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# Short Term Smart Grid Project Recommendations :1/34

- Following Technical Domains shall be considered for TEİAŞ Smart Technologies Plan, it is shown as a summary.





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## Short Term Smart Grid Project Recommendations : 2/34

### ➤ Modernization and Upgrade of Existing SCADA/EMS System with Advanced Functionalities

- SCADA/EMS system is a critical component of a utility's operation. It directly supports the generation and delivery of power and other utility services. The digital transformation of utilities requires full mobilization of network assets in a reliable way to ensure maximum transmission of energy from multiple sources. High renewable energy penetration, intermittency and low inertia generate an increased level of threats, which require a full understanding of real-time and future network status, to allow a fast response as rapid changes occur.
- Advanced SCADA/EMS has the full power to enable operators towards best operation performance, minimizing risk and increasing flexibility. SCADA/EMS system is a critical component of a utility's operation. It directly supports the generation and delivery of power and other utility services. The digital transformation of utilities requires full mobilization of network assets in a reliable way to ensure maximum transmission of energy from multiple sources. High renewable energy penetration, intermittency and low inertia generate an increased level of threats, which require a full understanding of real-time and future network status, to allow a fast response as rapid changes occur.
- As-is Status in Turkey: TEİAŞ is continuing to modernization and upgrade of existing SCADA/EMS System with advanced functionalities. Therefore, this system has not been utilized fully time being.





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## Short Term Smart Grid Project Recommendations : 3/34

### ➤ Enable EMS and State Estimation Functionalities

- SE is a key enabler for an active network control because, the state of the network must be known in order to efficiently control a network. SE uses network data, real-time measurements, load and production forecasts, and fixed load and production profiles as inputs and, based on this information, estimates what is the most likely state of the network at a given moment. The estimated quantities are node voltage magnitudes and node power injections and current flows in all network nodes and lines.
- EMS is the brain of the transmission network management. It facilitates system operators' duties, such as congestion management, operational planning and field management, asset, and maintenance management. EMS covers steady state and dynamic analysis, such as load flows, contingency, short circuit, voltage and frequency analysis in general.
- In order to enable EMS functionalities, SE functionalities shall be enabled. Consequently, in order to enable SE functionalities, sufficient amount of real-time data from the power system and the network model shall be updated. Thus, SE can converge, and SE and EMS functionality can be utilized.
- Advanced SCADA/EMS has the full power to enable operators towards best operation performance, minimizing risk and increasing flexibility.
- As-is Status in Turkey: Due to the lack of updated real time measurements and the network model, SE and consequently EMS functionalities have not been utilized. According to the 2020 Presidency Annual Program Energy / Measure 496.2: Studies will be carried out to develop a National Smart Grid Management System and National SCADA to be used in Energy State Economic Enterprises, SEEs.





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## Short Term Smart Grid Project Recommendations : 4/34

### ➤ Initiation of Remote Control (Telecontrol) in TEİAŞ Substations

- Automation of Substation is one of the important components of a smart grid. The substation automation systems are at the end of the electric power system's functional hierarchy and they provide two essential functions:
  - Data source for local automation functions and for the system operator or system level automation functions
  - Execution level for the system operator or system level automation functions.
- The availability of synchro-phasor measurements is changing the way substation and power system management and automation are being done in advanced smart grid applications, so they need to be also considered as part of the evaluation of substation and power system automation.
- As-is Status in Turkey: The existing level of substation automation systems in the Turkish electric power system is very limited. Substation automation systems infrastructure have already been partially or fully installed at some 400 kV or 154 kV Gas Insulated Substations (GISs). However, they are not utilized. The substations in the system are manned





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## Short Term Smart Grid Project Recommendations : 5/34

### ➤ Telecommunication Modernization Project

- It is highly recommended that the modernizing TSO's telecommunication system for solving the limited performance and flexibility problems of legacy technology and developing more advanced and flexible plans for network operations. The purposes of that are also developed technical analyses, real-time forecasts, remote monitoring - controls. This modernization also includes followings;
  - Substation Monitoring Systems
  - Renewable Generation Monitoring Systems
  - Load-Generation Shedding systems
- As-is Status in Turkey: There is no comprehensive telecommunication modernization project.





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## Short Term Smart Grid Project Recommendations : 6/34

### ➤ Implementation of Fault Management System

- The fault management system is recommended to TSO for operational and planning purposes.
  - Reduces impacts of outages.
  - Reduces unplanned outages
  - Restoration of outages efficiently
- As-is Status in Turkey: : There is no implementation of fault management system.





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## Short Term Smart Grid Project Recommendations : 7/34

### ➤ Implementation of GIS and Asset Data Management

- GIS provides solutions across the entire enterprise for applications in business, engineering, environmental management, and other disciplines necessary for comprehensive and effective transmission management. GIS shall cover following functions in general:
  - Asset Data Management, Logistics
  - Engineering Environmental Studies
  - Grid Analysis
  - Land Management, Site Selection
  - Market Assessment
  - Regulatory Compliance
  - Right-of-Way Management, Vegetation Management
- As-is Status in Turkey: TEİAŞ has already implemented GIS and Asset Data Management recently. However, this system does not cover all of the aforementioned functions.





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## Short Term Smart Grid Project Recommendations : 8/34

### ➤ Implementation of GIS and OMS and Integration with Enterprise Systems

- A geographic information system is essential for electric utility companies. It provides the foundational layer of technology for effective asset management as well as regulatory compliance. GIS can be used for multiple purposes, from managing field operations to performing spatial analysis.
- It's crucial to have an accurate asset inventory with electric poles, transformers, cable lines, substations and other electric utility assets properly mapped. GIS allows to manage the asset data a lot easier and enables to take insight from the infrastructure. These are:
  - Analysing usage patterns
  - Recognizing problems and risks like power outages
  - Having oversight about energy consumption
  - Finding potential threats to the power grid
  - Managing utility asset repairs
- In order to use GIS and OMS functionalities more efficiently, it is necessary to integrate this system with enterprise system, such as SCADA/EMS, National Power Quality Monitoring System (NPQMS), etc.
- As-is Status in Turkey: EAI is an on-going task in TEİAŞ.





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## Short Term Smart Grid Project Recommendations : 9/34

### ➤ Long-Term Forecasting and Planning/Simulation Software

- Electrical power system simulation involves power system modelling and network simulation in order to analyse electrical power systems using design/offline or real-time data. Long term forecasting power system simulation software's are a class of computer simulation programs that focus to prepare a long-term electric energy generation and transmission expansion plan that took the following into consideration:
  - Demand/spatial load forecasting
  - Existing generation potential
  - Potential generation means
  - Fuel sources
  - Existing of transmission infrastructure
  - Tie lines, import and export capabilities
  - Source diversity in accordance with the relevant laws and regulations, etc.
- As-is Status in Turkey: TEİAŞ has already had PSS/E and DigSILENT Power Factory software's for transmission expansion plan and WAPS, Voler-Agua, PROMOD for generation expansion plan. However, they are not integrated and interoperable with each other and the other software for efficient usage





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## Short Term Smart Grid Project Recommendations : 10/34

### ➤ Installation of an Enterprise Asset Management System

- Enterprise asset management system provides a holistic view of an organization's physical assets and infrastructure throughout their entire lifecycle, from design, commission, or procurement, through to operation, maintenance, disposal, and replacement. This system covers following functionalities:
  - Asset lifecycle management
  - Work order management
  - Material management
  - Labour management
  - Service contract management
  - Financial management
  - Reporting and analytics
- As-is Status in Turkey: TEİAŞ has not installed an Enterprise Asset Management System. In order to use public resources efficiently, it was decided to reduce the financial burden by digitizing business and transactions, and to strengthen the decision support mechanism by integrating information systems with each other





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## Short Term Smart Grid Project Recommendations : 11/34

### ➤ Assessment of Cyber Security Maturity Level

- Cyber security has become a major requirement for all critical infrastructures, particularly the crucial electric power infrastructure. Cyber-attacks can seriously affect operational systems. Security by obscurity is no longer a valid strategy.
- Cyber security personnel will need to oversee all of the cyber security requirements for the operational systems, including the periodic training of other personnel in cyber security procedures, the continuous evaluation of existing and new cyber security requirements, and the specification and testing of systems, equipment, and communication protocols for cyber security compliance. In all communications and systems designs, cyber security must be incorporated from the outset and managed in the lifecycle, including from manufacturers, through factory development, installation within TEİAŞ, during operations, as part of maintenance, and even when equipment is retired.
- As-is Status in Turkey: The TEİAŞ's operational systems are kept separate from the corporate system, and the operational communications channels are isolated from the corporate communication channels. However, none of the communication protocols used to exchange operational data include cyber security. It has been decided to carry out cyber security studies in a way to meet international norms within the scope of security of supply and protection of critical energy infrastructures





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## Mid Term Smart Grid Project Recommendations : 12/34

### ➤ Fault Locationing System

- The fault location system is a solution for safe, fast, and easy locating a faulty place on transmission system, particularly for underground and submarine cable system. This system is required for reduction of time taken to attend fault site by maintenance staff and related outage duration..
- As-is Status in Turkey: There is no separate fault location system, but new *microprocessor-based relays*, already installed recently, have this function. However, integration of them with the other utility enterprise system, such as SCADA/EMS, National Power Quality Monitoring System (NPQMS), etc. is necessary for the effective usage.





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## Mid-Term Smart Grid Project Recommendations : 13/34

### ➤ Advanced Protection Functionalities

- Advanced Protection Functionalities can be provided many functions in a single microprocessor-based relays which are known as Intelligent Electronic Devices (IED). These devices can provide several protection functions and control functions; controlling separate devices, an auto-reclose function, self-monitoring function and communication functions, being main their features:
  - Group settings readily changeable for changes in feeder configuration
  - Programmable output relays, Measurements, Interlocking, Aid to circuit breaker maintenance.
  - Communication ports for connection to SCADA – *Supervisory Control and Data Acquisition* (Systems, Modems, and Personal Computers)
  - Fault Locator, Displays distance to fault, Sequence-of-events stored for many recent faults, Fault interrupting duty can be recorded
  - Oscillography or waveform capture — storage of pre- and post-fault current and voltage waveform data for analysis of faults
- As-is Status in Turkey: TEİAŞ has already renewed most of the old relay with *microprocessor-based relays*. However, all functions of them have not been utilized yet.





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## Mid-Term Smart Grid Project Recommendations : 14/34

### ➤ Dynamic Thermal Line Rating

- There are unused margins between the limits defined by static ratings and the "true limits" measured by a real-time thermal rating system. The dynamic thermal line rating of a transmission line is calculated in real time based on online measurements of the loading of the asset and local weather conditions to maximize use of line capacity, when environmental conditions allow it, without compromising safety. This is important to reduce congestion management cost.
- As-is Status in Turkey: There is no dynamic thermal line rating application.





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## Mid-Term Smart Grid Project Recommendations : 15/34

### ➤ Short-Term Load Forecasting Software

- Short-Term load forecasting (STLF) is an integral part of the SCADA/EMS which helps power system operators with various decision-making in the power system, including supply planning, generation reserve, system security, dispatching scheduling, demand-side management, financial planning, day ahead market and so forth.
- As-is Status in Turkey: TEİAŞ has STLF software, but not use for the time being.





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## Mid-Term Smart Grid Project Recommendations : 16/34

### ➤ Distributed Energy and VPP Management Systems

- TSOs shall be able to utilize the market and DSO capabilities to modify energy usage patterns (relieve overloaded HV lines), to expect DER systems to “ride-through” voltage and frequency anomalies, and even to use frequency support from MV/LV DER systems to help maintain power system stability. One of the ways of managing energy resources distributed in a centralised manner on a small and medium scale is through virtual power plants.
- Thanks to Cloud technology, Virtual Power Plants allow to add the capacities of different distributed renewable energy resources to improve energy generation, network management and the selling of electricity to the market. Distributed Energy and VPP management system can provide new solutions for the energy transition and help to move towards the decentralised electrical system of the future through the addition of distributed energy resources on a BtB level.
- As-is Status in Turkey: TEİAŞ just collects MW and MVAR data on all DER systems larger than 10 MW and on all DER power plants that are larger than 30 MW. This DER data is aggregated for each interphase between the transmission and distribution systems. A prediction algorithm for electricity generation from solar energy will be developed and prepared a report on renewable focused VPP. There is no distributed energy and VPP management system.





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## Mid-Term Smart Grid Project Recommendations : 17/34

### ➤ Implementation of a WFM/M-WFM System

- Workforce Management System and/or Mobile Workforce Management System is recommended to TSO for improving workforce productivity and more effective asset management. WFM solves the problems related to outages, inspection, maintenance and construction. WFM system contains following parts to achieve business effectiveness and peak operational performance;
  - Forecasting: Imports needed historical data automatically and delivers workload forecasts accurately
  - Scheduling: Aims to finish work with right resources, optimize the assignments and schedules with the most efficient possible and reoptimize the schedule when there is any change
  - Dispatch: Offers to personnel a detailed look at the program which contains timelines and tabular windows. Monitors personnel and status of the work. Gives alarms to specific conditions that needs personnel attention and action. Monitors the position of the fleets
  - Mobile: obtains and manages all of work orders wirelessly on a mobile device. Provides real-time status updates. Reviews and work orders on the mobile map
  - Reporting: Optimizes operations with performance reports. Provides specific visibility and insight for status with long-range trending views.
- As-is Status in Turkey: There is no implementation of a WFM/M-WFM System





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## Mid-Term Smart Grid Project Recommendations : 18/34

### ➤ Pilot and Roll-out Projects for Advanced IoT/Sensor Technologies

- The Internet of things (IoT) refers to every object, which is connected over a network with the ability to transfer data. Users perceive this interaction and connection as useful in their daily life. However, any improperly designed and configured technology might be exposed to security threats. Therefore, an ecosystem for IoT should be designed with security embedded in each layer of its ecosystem. Then IoT Security Framework can be used to develop a Secure IoT Sensor to Cloud Ecosystem. IoT applications use large arrays of sensors collecting data for transmission over the Internet to a central, cloud-based computing resource. Analytics software running on the cloud computers reduces the huge volumes of generated data into actionable information for users, and commands to actuators back out in the field. Sensors are one key factor in IoT success, that simply convert physical variables into electrical signals. They have needed to evolve into something more sophisticated to perform a technically and economically viable role within the IoT environment.
- As-is Status in Turkey: There is no pilot or roll-out projects for advanced IoT/sensor technology.





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## Mid-Term Smart Grid Project Recommendations : 19/34

### ➤ Big Data Management Platform

- A big data management platform is a kind of software that manages the gathering, storage, and organization of data to have useful information. This platform use big data and artificial intelligence algorithms to process and analyse large data sets about users from various sources.
- As-is Status in Turkey:There is not big data management platform.





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## Mid-Term Smart Grid Project Recommendations : 20/34

### ➤ Advanced Technologies for Physical Security

- The use of advanced technologies for physical security like access control, network and asset protection, which is as important as cyber security, is recommended to the TSO. It aims the surveillance critical assets and offices of TSO. It provides to anticipate and respond against system disturbances.
  - Motion, sound, video, radar and seismic sensors
  - Infrared, ultrasonic, micro and radio wave detectors
  - Surveillance cameras with IP
  - Advanced video analytics
  - Auto alarm triggering systems.
- As-is Status in Turkey: There is no comprehensive advanced technologies for physical security.





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## Mid-Term Smart Grid Project Recommendations : 21/34

### ➤ Usage of Drones for Conditional Assessment of Network Assets

- The transmission network is continuously changed by maintenances, upgrades or replaces of equipment. In order to ease these implementations, a new lifetime prediction system which has condition, predictive and risk-based approaches is recommended to TSO. This method defines new and more reliable monitoring system. The other purposes of this system are followings:
  - maintains robust and cost-effective transmission network
  - optimizes the asset management
  - schedules maintenance for transmission network flexibility
  - reduces costs
  - increases human safety
  - increases asset availability
- As-is Status in Turkey: there is no usage of drones for the conditional assessments of network assets.





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## Mid-Term Smart Grid Project Recommendations : 22/34

### ➤ Modernization and Reinforcement of OT Cyber Security Systems

- Electricity TSO are strongly recommended to modernize and reinforce their OT Cyber Security Systems, since;
  - Controlled and Secure Incidents
  - Secure Controls to Operating Systems
  - Improve Cyber Resilience
  - Effective Cyber Response
- This implementation also contains followings,
  - Network Access Control
  - Risk Analysis and Treatment
- As-is Status in Turkey: : There is no modernization and reinforcement of OT cyber security systems.





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## Mid-Term Smart Grid Project Recommendations : 23/34

### ➤ Modernization and Reinforcement of IT Cyber Security Systems

- Electricity TSO are strongly recommended to modernize and reinforce their IT Cyber Security Systems, since; Secure Controls to Information Systems, Reducing Vulnerabilities, Improve Cyber Resilience, Effective Cyber Response
- This implementation also contains followings;
  - Secure Coding and Encryption
  - IT Security for Power System Design Security
  - Security Architecture
  - Risk analysis and treatment.
  - Network and information access control
- As-is Status in Turkey: There is no modernize and reinforce their IT Cyber Security Systems. However, it has been decided to carry out cyber security studies in a way to meet international norms within the scope of security of supply and protection of critical energy infrastructures





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## Mid-Term Smart Grid Project Recommendations : 24/34

### ➤ Risk Management and OHS System

- Risk management and OHS system shall be used to gain Accurate Insights on Organizational Risks through Streamlined Assessments, Record Risk Findings, Assess Controls, Recommend Action Plans, & Monitor Key Metrics. This system, through a software, should cover followings in general:
  - Field crew management
  - Risk and Incident management
  - Contractor management
  - Policies and procedures
  - Asset safety, Hazard registers, Chemical management, etc.
- As-is Status in Turkey: TEİAŞ has already got ISO 18001 certificate recently. However, there exists no comprehensive Risk management and OHS system together with relevant software.





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## Mid-Term Smart Grid Project Recommendations : 24/34

### ➤ Risk Management and OHS System

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  - Field crew management
  - Risk and Incident management
  - Contractor management
  - Policies and procedures
  - Asset safety, Hazard registers, Chemical management, etc.
- As-is Status in Turkey: TEİAŞ has already got ISO 18001 certificate recently. However, there exists no comprehensive Risk management and OHS system together with relevant software.





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## Long-Term Smart Grid Project Recommendations : 25/34

### ➤ Implementation of PMUs and WAMS

- The Wide Area Measurement System (WAMS) based on technology which offers emerging and highly functional solutions for power systems analysis, monitoring and control and aimed to provide control room operators with new, advanced monitoring tools and automatic corrective controls, both phenomenon- and event-based, linked with a SPS facilities, the integration between WAMS and SCADA/EMS, In particular improving state estimation, event detection, frequency stability assessment, islanding detection and restoration tests support.
- The basic processing functions can be included automatic alarms, online frequency domain analysis, modal analysis and coherency areas monitoring.
- The first step of the WAMS is to develop and involve the installation of Phasor Measurement Units (PMUs) and a dedicated data network with monitoring applications for data processing as well as an intelligent display at the National Control Centre.
- One of the critical aspects of the WAMS is the location and number of the PMUs necessary to assure complete system observability (e.g. for linear state estimation).
- As-is Status in Turkey: There are some PMUs implementation, but it is limited. There is no implementation of WAMS..





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## Long-Term Smart Grid Project Recommendations : 26/34

### ➤ Flexibility Resource Forecasting (RES Forecasting, DR Forecasting)

- It is recommended that TSO implement forecasting systems that include renewable energy sources and demand response scopes for operating the network. This system contains;
  - Analyses from historical time series.
  - Forecasts and verifications on weather conditions Develops Strategies for markets
  - Decision support
  - Analyses the node level accurately.
  - Increases system flexibility.
  - Provides ancillary services with renewables
- As-is Status in Turkey: TEİAŞ has renewable desk within SCADA system, but there is no comprehensive Flexibility Resource Forecasting (RES Forecasting, DR Forecasting)





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## Long-Term Smart Grid Project Recommendations : 27/34

### ➤ Lightning Location System

- Lightning strikes are one of the most dangerous problems for disruptions in the transmission network. Lightning location System collects the real-time data and statistics about lightning frequency and it's hazardous nature. It is highly recommended to TSO for improving OHL engineering, network operations and the works of field crews with the effective and smart design Lightning Location System implementation. Lightning location system's other purposes and contents are followings;
  - Scoring the effects of surge arresters on lightning spectrum and transmission lines
  - Collects Lightning trends and forecasts the amount of lightning's potential damage
  - Calculates mean flash density at ground level for each region.
  - Estimations for lightning strikes' location and amplitude of return stroke current.
  - Reduces effects of the transient faults and repairing time on transmission lines, and improves power quality
  - gives an indicator for installing new transmission lines.
- As-is Status in Turkey: There is no lightning location system.





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## Long-Term Smart Grid Project Recommendations : 28/34

### ➤ Demand Response Management System

- It is highly recommended that electricity TSO should always develop a Demand Response Management System by considering communication and load management technologies, to do the active management of loads on a Day-to-day which bases on balance of generation and demand. Approaches to demand response management system include;
  - Provide the abilities to reach load locations and turn off devices.
  - Limit demand
  - Improve cost control
  - reduce technical losses and improve utilization of assets
  - Optimizes Transmission network power flow,
  - Provides Remote network monitoring.
- As-is Status in Turkey: There is no demand response management system.





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## Long-Term Smart Grid Project Recommendations : 29/34

### ➤ Intelligent Predictive Maintenance

- It is recommended that to implement modern network management by considering on the developing technology level, Electricity TSO should integrate the predictive maintenance approach to network asset management and outage/ maintenance management processes.
- This approach aims the followings;
  - Improve security of supply
  - Extend the operational life of the network inventory
  - Make stock management processes more efficient
  - Reduce maintenance costs
  - Reduce the OHS risks of operators
  - Pre-detection of faults that may occur in the network inventory
- As-is Status in Turkey: There is no intelligent predictive maintenance practices.





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## Long-Term Smart Grid Project Recommendations : 30/34

### ➤ Implementation of Big Data Analytics

- Data landscape are changing with recent developments in telecommunications and data analytics technologies. with the implementation of smart grid solutions for the electricity transmission grid, TSO will have a large volume of data. Value, variety, velocity, veracity and volume are characteristics of the Big Data concept. Big Data Analytics concept is becoming more important by following purposes;
  - Digitalization
  - Better tailor communication
  - Increasing Transparency for setting price and operation
  - more confident decision making
  - Advanced Asset Management
  - Facilitate of identifying operation and market cases
- As-is Status in Turkey: there is no implementation of big data analytics.





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## Long-Term Smart Grid Project Recommendations : 31/34

### ➤ Implementation of HVDC

- High-Voltage Direct Current (HVDC) cables/lines/ Substation are an efficient way of transporting electricity over longer distances. Potential HVDC Cable/Line/Substation Implementations:
- YEKA (Karapınar, etc.), Nuclear Potential Sites (Sinop, İğneada, etc.) and for Replacement of Old Lines for Connection of Major HPPs in South-East Part of Turkey
- Not all renewable energy production will be decentralised in the future, at the same time, offshore wind will become increasingly important in the energy mix. That requires electricity to be transported from offshore wind parks to the large, congested loading areas with high levels of short circuit currents and loop-flow, mainly industrial sites and cities, onshore, over long distances.
- Possible New Cross Border Interconnections via BtB Systems
- As-is Status in Turkey: Van HVDC BtB System is under construction for Iran interconnection, there is no HVDC cables/lines project.





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## Long-Term Smart Grid Project Recommendations : 32/34

### ➤ Implementation of Enhanced Ancillary Services

- New technologies are changing the way the energy system works. As the energy system relies more and more on renewables, and more and more electric energy use (for example because of e-mobility and electric for heating/cooling) the electricity system becomes more decentralized and interactive.
- Flexibility markets help energy networks to monitor energy flows and create market signals to motivate changes in energy supply and demand, integrating smart meters, smart appliances, renewable energy resources and energy efficient resources accordingly.
- On the other hand, due to the more integration of renewables power system inertia will decrease. Therefore, synthetic inertia response shall be provided from renewables.
- For the security of system all ancillary services shall be activated and enhanced.
- As-is Status in Turkey: Frequency and reactive power control are active as ancillary services.





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## Long-Term Smart Grid Project Recommendations : 33/34

### ➤ Use of Advanced Storage System

- Due to integration of high levels of renewable generation, electric system flexibility need will be increased to enable electricity supply-demand balance. Advanced grid storage systems can be used to enable electricity supply-demand balance. Key factors for using advanced storage system in improving grid flexibility include:
  - increasing the ramp range and rate to follow the variation in net load and
  - the ability to better match the supply of renewable resources with demand
- As-is Status in Turkey: There is no advanced storage system. However, in order to eliminate the constraints created by the increasing renewable energy on the network, it has been decided to install energy storage systems, including HEPPs with pumped storage.





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## Long-Term Smart Grid Project Recommendations : 34/34

### ➤ Interoperability of Existing Systems

- Interoperability readiness is becoming extremely important including automating information exchanges and business processes for system operators and utilities.
- Almost every new system or application will be required to securely interact with other applications or systems considering applicable industry standards as well as ENTSO-E cyber security rules.
- As-is Status in Turkey: There is lack of interoperability of existing systems.





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# Technical Assistance for Improvement of Performance-Based Tariff Regulation of EMRA For Turkish Energy Markets Through Introducing an Enhanced Monitoring System



## Thank You / Teşekkürler

15 September 2020, EMRA, Online

