Turkey Smart Grid 2023
Vision and Strategy Roadmap Summary Report

www.smartgridturkey.org

TABLE of CONTENTs

TABLE LIST

LIST OF FIGURES

Turkey Smart Grid 2023 Vision and Strategy Determining Project, Short and Mid-Term Smart Grid Roadmap Report; is prepared for Electricity Distribution Services Association (ELDER) by AF MERCADOS EMI and may solely be used by citing. Since the report is necessarily based on current market conditions, our assessments and assumptions may become outdated because of changes and events occurring after the date hereof.

Since future events are not subject to precise projections, some assumptions will not materialize in the exact form presented by our analysis. In addition, other unanticipated events and circumstances may occur which could influence the future outcome and performance of the project. Therefore, the results achieved in future operating periods may vary from the analysis of prospective market and financial conditions as set out herein. The Consultant does not warrant that actual results will be the same as the projected results.

The Consultant shall not have any liability arising from the decisions to be taken by the Client based on this report. The Consultant shall not, in any case, be liable for such decisions to be taken by the Client and their results.

Abbreviations

EU	European Union
USA	United States of America
ADMS	Advanced Distribution Management System
LV	Low Voltage (400V)
AMI	Advanced Metering Infrastructure
ANM	Active Network Management
R&D	Research and Development
IT	Information Technology
CAPEX	Capital Expenditures
GIS	Geographic Information System
CIM	Common Information Model
DC	Direct Current
DER	Distributed Energy Resources
DERMS	Distributed Energy Resources Management System
DA	Distribution Automation
DP	Distributed Power Flow
DPF	Distributed Production Facilities
EA	Electric Vehicle
EAI	Enterprise Application Integration
EDAŞ/DSO	Electricity Distribution Company/Distribution System Operator
EDSA	Electricity Distribution Services Association
ETL	Energy Transmission Line
EMRA	Energy Market Regulatory Authority
FLISR	Fault Location, Isolation, Service Restoration
CBA	Cost Benefit Analysis
GE	General Evaluation
GPRS	General Packet Radio Service
ICCP	Inter-Control Center Communications Protocol
IEC	International Electrotechnical Commission
TOR	Transfer of Operational Rights
IoT	Internet of Things

QC & QA	Quality Control & Quality Assurance
LAR	Large Area Restoration
LED	Light-Emitting Diodes
LPWAN	Low-Power Wide-Area Network
MDM	Meter Data Management
MWFM	Mobile Work Force Management
NMS	Network Management System
OECD	Organization for Economic Co-operation and Development
OFR	Optimal Feeder Reconfiguration
MV	Medium Voltage (36 kV)
OMS	Outage Management System
OT	Operational Technology
PLC	Power-Line Communication
PTF	Market Clearing Price
PV	Photovoltaics
RF	Radio Frequency
SCA	Short-Circuit Analysis
SCADA	Supervisory Control and Data Acquisition
SE	State Estimation
TSG	Turkey Smart Grids
TEDAŞ	Turkish Electricity Distribution Company
TEIAS	Turkish Electricity Transmission Company
TRY	Turkish Lira
ToU	Time of Use
TUBITAK	Scientific and Technical Research Council of Turkey
VVC	Volt VAR Control
WAMS	Wide Area Monitoring System
WFM	Workforce Management
RE	Renewable Energy

1 PROJECT MILESTONES AND METHODOLOGY

In Turkey, smart grid efforts initially started as pilot projects within the scope of R&D activities after 2014 aimed at advanced measurement infrastructures, demand side management, smart meters and communication. This, which is also observed in different countries in the development of smart grids, is important as the advantages of new technologies can be examined through actual systems.

Within the scope of Turkey Smart Grid 2023 Project (TSG'2023) to be implemented during and after the 3rd Tariff Implementation Period (2016-2020), it is aimed to provide a road map on 2035 smart grid vision to the distribution companies in short and medium term (3rd and 4th Tariff Implementation Periods) by pointing out the necessary priorities.

In the studies of TSG'2023, subjects related to Smart Grid are grouped under following technical components;

- Smart grid company vision and strategy
- Advanced network monitoring, control and management systems
- IT infrastructures and data analytics
- Enterprise application integration
- Distributed energy integration and storage
- Asset management and GIS
- Electric vehicles
- Smart meter infrastructure and customers
- Communication infrastructure
- Cyber security

And the above SG technical components are evaluated by covering all criteria below:

- Technology and function
- Prevalence level
- Interoperability and standardization
- Business processes and benefits

Technical components mentioned above are further grouped into smart network categories by considering the basic functions of a distribution company.

Figure 1 : Smart Network Category and Technical Components

First of the main smart network categories, ***Smart Network Management*** covers the activities of distribution companies, such as network management, network model management, business process management, and OT and IT systems used in the execution of these activities. Under the advanced network monitoring, management and control systems, SCADA, advanced distribution management system, disruption management system, distributed energy resources management system, station and feeder automation issues are examined. As asset management and geographic information systems are data sources, they are also very important technical components of smart grid management. Beneath one of the other basic categories, ***Smart Embedded Systems***, smart grid components that are built (or designed) embedded in medium-voltage or low-voltage grids, and that have critical importance to achieve low-carbon targets, are defined. Smart embedded systems in this context include distributed energy resources on different scales, energy storage systems and electric vehicles. Finally, ***Smart Markets and Customers*** category is created as another top-tier concept whose components can be directly related with customers/users or Under this category, basic components such as smart meter infrastructure, meter data management systems, demand side management and energy trading in the registration and extremity, and their functions have been included. Because of the large share of the physical investment it includes, this category is considered to have the highest investment costs among all categories.

In addition to the three main categories, topics related to different technical components are grouped under the ***Common Smart Components*** category. Under this category, technical components such as Smart Grid Vision and Strategy, IT Infrastructure and Data Analysis, Communication Infrastructures, Cyber Security and Enterprise Application Integration are discussed.

The main objectives considered in conducting this study are;

- Decrease the carbon footprint of distribution companies by reducing the technical & non-technical loss levels,

- Increasing grid sustainability and energy quality,
- Increasing grid resiliency
- Increased network situational awareness of the distribution companies through the use of sophisticated and near real-time measurement infrastructures,
- Facilitating consumer / demand side participation,
- Increasing the connectible capacity for renewable generation thereby reducing the external dependency in energy supply,
- Optimal use and management of distribution grid assets,
- Transformation from static grids to a dynamic, infrastructure with bi-directional energy and information flow,
- Provision of harmonization with the EU acquist,
- Supporting R&D, local technology and market development

For all these high expectations to be passed on, a well-designed change / transformation cycle is critical. The benefits of smart grid technologies with high-cost investments are fully realized through planning that takes into account many parameters. When application strategies and road map are determined; many issues such as technological maturity, experiences of different countries, international standards / interoperability principles, cost-benefit approaches, legislation and regulations, consumer behavior and habits, and the competence of existing distribution grid operators, have become important inputs.

The project was carried out in six main phases. Project phases consist of:

- Phase 1: Starting Meeting and Workshops
- Phase 2: Current Situation and Needs Analysis
- Phase 3: International Sample and Current Technology Analysis
- Phase 4: Vision, Strategy and Determination of Target Plants
- Phase 5: Gap Analysis
- Phase 6: Development of Short and Middle Term Road Map

Studies have started with "Start-up Meeting and Work" phase, which included an overview of the project method and workshops for the technical components. Within the context of current situation analyzes; the smart grid systems, application scopes, functionalities and SG penetration levels of the 21 electricity distribution companies have been analyzed, and a holistic evaluation study has been carried out regarding the business processes, human resources and company organizations. Mainly surveys were used for present situation assessment studies. In addition, workshops with electricity distribution companies, outputs of selected R&D projects, and other information gathered from companies and public platforms, and consultant evaluations on sector implementation were included in resource assessment studies. During international case studies and current technology analysis, country legislations, benefit cost, smart grid R&D and pilot projects and smart grid road map studies have been examined. At the same time, workshops were organized in order to understand the product / solution development strategies, and short / medium term technology development road maps of supplier companies with smart grid components. Field visits were also carried out in this phase to study smart grid studies in Sweden and Spain. Turkey's smart grid 2035 vision is defined with works carried in scope of "Vision,

Strategy and Target Structure Determination" studies. In addition to the foreseen developments in generation, transmission and distribution areas; the topics of investment for the development of smart grids are included in the study. In the last two phases, short and medium-term road maps of smart grids of distribution companies have been prepared by taking in consideration current situation analysis.

2 CURRENT SITUATION EVALUATIONS

Before the creation of the smart grid road map of Turkey, it is important to determine the current state of the electricity distribution network of 21 distribution companies, and establish correct and achievable goals in the course of smart grid transformation. In this regard, to determine the maturity levels of distribution companies, their performance on different technical components of smart grid was examined. The main problems encountered are summarized under the following topics.

Heterogeneous Maturity Levels

When 21 distribution companies are compared on a technical component basis, it has been observed that the maturity levels are very different from each other. Also, there are very different levels of maturity, including technical conditions that are grouped because of economic and regional conditions. This suggests that the work to be shown as a target in the upcoming periods should be carried out carefully by each Distribution Company, taking into account their own planning and needs.

Different Technology Expansion Levels

As a different reflection of the level of heterogeneous maturity observed in distribution companies, there are many variations in prevalence levels of similar technologies used under technical components. For example, while one of the distribution companies is using a large number of SCADA stations, other one has not yet completed the installation of SCADA.

Assessment of Smart Grid Project Results

Another major problem is that the benefits of smart grid projects and field experiences are not followed systematically. As there is not a systematic follow-up and evaluation of the results obtained by the distribution companies in their smart grid projects, it is not possible to use the results in smart grid deployment or development studies. Moreover, due to the lack of this monitoring system, the real benefit cannot be revealed and the correct application areas cannot be determined within the smart grid structure.

Low Scale Pilot Applications

As the smart grip pilot applications implemented by the distribution companies are often small scale, they do not provide sufficient field experience and knowledge. Inadequate knowledge in the dissemination projects causes quality drop.

Information Sharing Platform Missing

The lack of an effective information sharing platform is a big shortcoming. By sharing the information and experience gained from the smart grid projects in their own regions, distribution companies can see their deficiencies and best practices.

Non-Effective Use of Established Functionalities

It is observed that the distribution companies have adapted some technologies of smart grid development, however they cannot use them properly. Among others, main reasons are poor human resources or the failure to achieve business process adaptation.

Non-adequate Competent Human Resources

The lack of staff who are competent in both power systems and digital technologies, and can harmonize these two fields, presents a challenge to be solved urgently.

Processional and Organizational Deficiencies
It has been observed that the distribution companies that have implemented smart grid technologies, are still at the very beginning of integrating these technologies with IT systems. For an efficient and active use these technologies, processional and organizational adaptation of IT systems are necessary. Failure to adapt the processes and organizational structure causes failure in obtaining expected benefits of smart grids and a decline in efficiency.

Challenges of IT and OT convergence
It has been observed that due to the management of IT systems with silo logic, software that are not designed up to the needs of OT systems are being bought and not efficiently used. Again, due to the similar silo approach, the actual data transfer requirements between IT and OT systems cannot be determined, and therefore the enterprise application integration (EAI) is not fully achieved. This is one of the biggest hurdles to complete the transformation to the smart grid.

Low Quality Operational Data
As the need of data requirements of the installed systems to improve the operation systems are not met, the operational processes fail to be efficient. (For example, the differences between SCADA single line diagram and the field physical grid.) Another issue is that the quality of data produced by these systems is low. As the reports obtained from the systems are not close to reality, the reliability of the systems are questioned. (For example, entering "Temporary Fault" information to the system instead of actual fault reason)

Problems with Big Data Management
After the implementation of smart grid projects, a large volume of data is accumulated in databases. Data management is important to increase operational efficiency. However, it has been observed that distribution companies are inadequate in managing the quality of the big data that can be used in various analysis. For that reason, it is not possible to contribute to the decision support processes by making use of these big data, namely data analysis studies.

Solutions That Do Not Provide Interoperability Requirements
When some of the systems that are used by distribution companies are examined, it is observed that these systems are developed according to the specific needs of the distribution companies that do not meet international interoperability standards. While such solutions benefit distribution companies in the short term, it is inevitable that problems arise with the integration with other systems in the medium and long term. These systems, which are not designed in the framework of smart grip concept, either have to meet smart grid and interoperability standards, or they have to be replaced with internationally accepted software.

Third Party Communication Infrastructure Dependency
In order to meet the communication needs of IT / OT systems, it has been observed that the distribution companies use 3rd party communication infrastructures (Telecom and GSM). IT and OT systems of companies with critical infrastructure, such as electricity distribution companies, should have their own communication infrastructure as the main communication system. This is very important for the safety and continuity of communication. In a disaster scenario, intensive use of Telecom or GSM networks may limit OT / IT communication in the region. Or some communication problems may arise because of different orientations of the 3rd party provider. (For example, GSM Company can invest in 4G in an area with large population and no communication

problem, instead of investing in a zone with a small population and communication problem).

Inadequate Field Expansion of Operational Management Systems

Many distribution companies in the sector have established network monitoring and control application to improve their field operations, but the field expansion required for effective and efficient use of these systems is insufficient. In order to increase awareness in network operations and to be able to dominate all the points of the network within the understanding of central management, the telemetry points providing data to the center should be located at a certain level.

3 2035 VISION and STRATEGY

3.1 Smart Grid Overview

An energy supply system causing increase of carbon emission is not sustainable because of economic, environmental and social reasons. This is a striking indisputable fact accepted in many countries including Turkey.

All countries have to be ready for a paradigm shift in order to reverse this phenomenon. They have to keep pace with developments in this direction and if necessary, they have to force constraints for the investments without delay. This has vital importance for their competitiveness and the sustainability of their prosperity.

As well as known renewable energy sources, if carbon sequestration, carbon storage, nuclear power and new transportation technologies are maintained in large scale, the expected bad picture will be reversed in the second half of the 21st century.

Energy markets in all developed countries are making an enormous effort to keep pace with the paradigm shift they are facing. The basic dynamics of this change are as follows:

- To reduce carbon footprint as fast as possible,
- To meet the market participation requirement of the consumer,
- To keep pace with rapidly developing renewable energy, communication and cyber security technologies,
- Designing and operating transmission and distribution networks that can accommodate these developments
- Meeting financial and regulatory requirements on time

Although a significant number of distribution companies have begun to develop their infrastructures in order to accommodate smart grid infrastructures; a set of common definitions and terminology should be defined, and the vision, strategy and targets should be clarified by the help of both the regulatory body and the other sector stakeholders Common 2035 vision and targets will be used as basis for short and medium-term road map studies, and future legislation and market design.

Because of the complexity of smart grid's contents, different authorities describe it variously. The following formulation is taken as a base for TAS project: as it is the most comprehensive description for its purpose.

$$Smart\ Grid = \int_{\substack{t\to 0 \\ i\to\infty}}^{ICT} (Conventional\ Generation + Transmission + Distribution + Storage + Renewable\ Energy\ Generation + Prosumers + Controlable\ Loads)$$

According to this formula; theoretically smart grid means the integration of the infinite number of generators, transmission and distribution networks, storage systems and consumers through a common information and communication technology.

The differences between the existing grid and the smart grid systems are summarized in the following table:

Table 1 : Comparison of Conventional Grids and Smart Grids

Characteristic	Existing Grid	Smart Grid
Active participation of the consumers to the system	Customers/consumers do not participate in energy system	Customers/consumers are informed, involved in the system and active
Evaluation of generation and storage options	A centralized generation environment, too many obstacles for the availability of distributed energy resources	Dominant renewable energy, almost hot plug distributed energy sources
Creation of new products, services and markets	Limited wholesale market, systems that are not well integrated, limited opportunities for consumers	Mature and integrated wholesale market, new electricity market for consumers
Provision of technical qualifications to support economic activities	Slow response to fault/interrupt focused power quality problems	Power quality/supply continuity is first priority, quick solution of problems, variety in price/ quality options
Optimization of assets and efficiency of operations	Limited integration in asset management and business processes	Large data analytics infrastructure for acquiring grid data, maximizing life cycle and utilization capacity of components
Self-healing	Focus on protection of assets and prevention of damage spreading after an accident	Detecting and eliminating problems automatically, focus is on minimal disturbance of the consumer
Flexible operation of the network against attacks and natural disasters	Weak, defenseless against terrorist attacks or natural disasters	Flexible and fast recovery capabilities against attacks and natural disasters

In the following figure, common expectations and sector from the concept of smart grids are summarized.

Figure 2 : Sector Expectations about Smart Grids

3.2 Turkey Smart Grid Vision

Energy infrastructure is an integral part of economic prosperity. Technological developments, and growing interdependency of social life and environmental awareness, necessitates a fundamental change of the future energy system. Smart grids are one of the most important factors for a safe, successful, sustainable, environmentally friendly and competitive economic future.

In the next decades, Turkey will base its electricity production on nuclear, local lignite and renewable energy sources instead of imported fossil fuels. The existence of a competitive energy market with the efficient use of energy will contribute greatly in consumer satisfaction and participation, and will bring social welfare to the expected levels.

Future of national electricity transmission and distribution network is full of challenges and opportunities. Billions of Turkish liras are invested to the grid each year to meet new connection demands and renew aging parts. However, to achieve a sustainable economic growth, it is also important to invest in smart grid that provides followings below:

- Deployment of distributed generation
- Facilitating market participation of the consumer
- Connecting Energy storage, electric vehicle charging station and roof-top solar panel systems to the grid bi-directionally
- Flexible, adaptable, self-managing with minimal human intervention
- Energy quality with sustainable and reliable grid

Turkey Smart Grid 2023 Vision and Strategy Roadmap Summary Report. If it is predicted that low carbon conversion will be managed, market participation of the

consumer will be maximized and the generation connected at distribution will constitute half of the total national electricity production by 2035. This indicates how important the smart grid investment is.

In addition to maintaining a high security of environmentally friendly national electricity grid and maximizing of sustainable and reliable grid without quality drop, its structure should be adaptable to ever-increasing availability of renewable energy sources. Taking this in consideration, TGS'2023 working group's smart grid vision is:

> *"For a secure future;*
>
> *Considering the environmental sustainability and the efficient use of energy resources,*
>
> *In order to meet the low-cost electrical energy required for economic growth from 100% domestic sources and maximize the renewable energy generation to minimize the carbon footprints,*
>
> *In 2020 and after, smart grid investments and electricity transmission and distribution will be managed in the most appropriate manner and the highest contribution to the prosperity of the country will be achieved through a participatory, competitive and low-cost electricity market"*

The regulators, energy generators, network system operators, suppliers, R&D organizations, international organizations and the financial sector should work together in parallel with the demands of consumers and development of technology, to be able to reach 2035 smart grid vision.

In order to have a smart grid facility of desired speed and level, it is of great importance to accelerate training and awareness-raising activities, develop clear, predictable and consistent long-term policies and support innovative investments for total public approval.

3.3 Smart Grid Priorities in the Direction of National Energy Policies and 2035 Targets

Transmission and distribution networks need to be transformed without wasting time on "Smart Grid" standards in order to be able to switch to low cost electricity generation based on "100% Native and Renewable" resources, which is the main objective of our national energy policy. This policy will lead to supply security, reduction of external dependence, energy localization and foreseeable energy market.

Benefits of smart, modern and fully integrated power grid are the following:

- ***Reduction of losses.*** Theft of electricity will be completely eliminated in 2035, and smart grid applications and network technical losses will also be pulled to minimum levels.
- **Improvement of the continuity of the service** and overcoming the OECD average.
- ***Integrated load management*** will improve the technical quality and continuity standards of the energy delivered.

- Minimization of ***manual processes will*** reduce the costs of distribution services, and all processes will be digitalized. Thus, the productivity and the processing speed can be reflected to the consumers as a low tariff.
- ***Access to real-time consumption information by users and their participation in*** the market will maximize the transparency and competitiveness of the market.
- Accurate and timely investments with ***integrated asset management*** will reduce total investment and operating costs***.***
- ***Dynamic tariff applications*** by decreasing the energy costs of consumers will contribute to reducing the national carbon footprint therefore this will help both energy saving and make a positive impact on the National Income.
- ***Efficiency of generation plants*** will increase through real time demand tracking, and will contribute to the safe operation of the entire system by controlling the reactive energy if necessary.
- ***Advanced demand side management*** will reduce the peak demand and increase the resource efficiency.
- Maintaining technological infrastructure for ***new services to spread in the future*** will provide an access to the strategic goal of "Local and Renewable Energy" in the long run by supporting the expansion of electric vehicles, roof-top solar panels and storage systems.
- ***Domestic design and production*** and local investments required for smart grid technologies will be an important contribution to the country's access to the advanced countries.

The majority of the electricity distribution companies' TOR [1] based licenses will expire by the end 2035. In order to achieve the above benefits, Turkey Smart Grid road map's targets until that date are summarized below:

- **Distributed Generation:** Promoting development of small scaled distribution and renewable grid infrastructure (especially the establishment of infrastructure to support roof-type solar power plants with 40GW and its integration into the grid)
- **Roll out of Smart Meters:** Advanced Metering infrastructure facility that measures energy distributed until 2025 and includes at least 80% of customers by 2035. (80-80 principle, CBA)
- **National Smart Meter Protocol:** Creation and dissemination of a local and national meter communication protocol as soon as possible
- **Demand Side Participation:** Involving customers in large-scale market participation (including at least 80% of over 50 million customers in smart measurement infrastructures, and 40% in market participation) (10 GW of demand side management)
- **Grid Observability/ Controllability:** Greater availability of Observability, remote control and self-healing functionality in grid infrastructures.

[1] Transfer of operational rights

(Observability from advanced network management functions at critical points of grid infrastructures (80%), controllability (20%), and self-healing (10%).

- **Flexibility Management:** Active and optimized implementation of integrated flexibility management, and implementation of large capacity flexibility resources[2] (roof-type solar-mini storage, large-scale storage and load management) (35GW flexible source to be introduced into the system: 10GW roof type solar + storage, 10GW large-scale storage, 5GW grid management, 10GW demand side management)
- **Grid Efficiency:** Improvement of capacity utilization rates of current grid assets by 20%
- **Operational Efficiency:** 20% efficiency in operational activities
- **Technical & Non-Technical Loss Level:** Reduction of the national Technical & Non-Technical Loss rate to 8% (including transmission and generation)
- **Grid Resiliency:** Providing resilience against attacks or natural disasters that can be carried out on electric infrastructures of smart grids.
- **Data and Analytically Focused Operations:** Data and analytical execution of business processes and establishment of integrated systems
- **Interoperability and Standardization:** Full compliance with international smart grid standards and protocols (communication and information) and development of national standards
- **Infrastructure Harmonization:** Handling electricity, gas and water infrastructures together and getting maximum benefit by synergy effect
- **Electric Vehicles:** Establishment of infrastructure for grid integration and capacity utilization management of millions of electric vehicles (estimated ~ 15 million for 2035) and necessary charging stations
- **Micro / Nano Grid Applications:** Establishment of 50% of new buildings to permit micro-grid operating mode
- **Innovative Grid Components:** Usage of advanced grid equipment and technologies (Superconductors, amorphous transformers, power electronic based switching equipment, etc.)
- **Market Structure and Legislation:** Creating market structure and regulatory framework that triggers and supports the transformation in the sector and new business models
- **Technology Development and Export:** Support for target areas for technology development and export (storage, IOT, data analysis, grid management software, smart counters, solar panels, etc.)
- **Local Smart Meter Infrastructure:** Over 90% of smart meter and communication unit supply should be provided by local resources.

[2] Demand side management, LOI, storage, etc.

3.4 Energy Sector of the Future

An important challenge in making a long-term future forecast is to look at it from today's perspective. World Energy Council Turkish National Committee of the 2002 ENERGY REPORT ON TURKEY [3] 's main topics on electricity generation seem to be mainly focused on the natural gas, development of local lignite, geothermal and hydro resources, control of carbon emissions, and usage of available wind potential estimated at 10GW. The following paragraph from the conclusion section of the report "ENERGY DEVELOPMENT IN TURKEY AND ITS FUTURE [4] , published by Istanbul Technical University in 2007, is a striking example of future vision of 10 years ago.

> *"... When one examines the 20-year future of energy in the world, it is inarguably the fact that almost everyone has accepted and predicted that natural gas will increase in importance among all energy sources and that oil will remain the most consumed resource in transportation. If oil prices remain high, alternatives to petroleum (coal-based oil production, petroleum-based sand, shale oil production and renewable energies) will be attractive. On the other hand, if oil prices stay low, in addition to not having any new energy source on the horizon -, traditional sources such as oil, coal and nuclear will keep their current consumption rates ..."*

Ten years ago, it was not possible to foresee the importance of renewable resources - especially solar and wind - for the energy sector of 2017. Also, the developments in electric vehicles, storages, smart grids, IoT (internet of objects), "prosumer" definition and micro market phenomenon could not be estimated. As a consequence, we might face similar differences in the future vis-a-vis to 2035 vision; we might face a totally different structure thanks to new technologies, applications and energy resources that we cannot predict today.

According to the data of the present day, following statements are foreseen for the next 18 years:

- Electricity generation sources will be more and more dependent on renewable energy, especially solar and wind energy.
- Roof-top solar panels will be included in the system in 2020,
- Electric vehicles will reach significant numbers after 2025,
- The storage facilities, especially pumped storage, will reach meaningful capacities by 2035,
- The widespread use of smart meters after 2020 and 100% market openness will lead to a large number of "prosumer"
- With the help of smart meters, grid losses will be reduced to reasonable rates from 2020
- In parallel with the widespread use of grid measurement and control points, system quality indicators will approach the EU average from 2025,
- RE support tariff structure will be maintained in accordance with the conditions of the day so that and RE investments continue to grow

[3] http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/35/082/35082683.pdf
[4] http://www.emo.org.tr/ekler/34b920665683112_ek.pdf?tipi=6&sub to

- From the fourth implementation period, the distribution revenue ceilings will be designed to enable the smart grid investments.
- In particular, support for R&D and "start-up" ideas on smart grid management,
- In addition to energy resources, smart grid elements and the technology related to it, will be localized
- A possible increase in result energy costs will be shared fairly among all stakeholders, so that renewable energy investments will be supported by financial models
- In terms of legislation, the provisions that restrict the vision of 2035 will be updated, the invisible hand of the public will direct and support the free market to make decisions,

As a result;

The most important precondition for 2035 is having a free energy market based on local fossil sources or renewable energy. This energy market should be environment friendly and reduce carbon footprint. It should also provide supply security while being innovative and customer focused. All stakeholders have to work together to leave a better world for future generations so that Everyone can do Everything, Everywhere, Every time and live in a clean and prosperous environment.

4 SHORT AND MIDDLE TERM ROADMAP

In this section, critical issues that are specific to each smart grid technical component are highlighted. Instead of individual cluster-based assessments, subjects with critical qualifications are summarized. Cluster based action / project list and calendar planning are included in this report.

4.1 Smart Grid Company Vision and Strategy

Critical issues that need to be taken into account when establishing the smart grid vision and strategies of electricity distribution companies are listed below:

- Realization of corporate digitalization and smart grid application **master planning**
- Usage of **scale economies** to reduce the per capita cost of smart grid investments and emphasis on planning processes
- Assessment of **new business models** and opportunities, mobilization of internal units as well as external stakeholders and regulatory agencies / institutions
- Establishing new services that enhance **grid reliability** and **customer satisfaction**
- Carrying out collaborations to implement strategies, working closely with different electricity distribution companies and technology firms, and constantly creating new opportunities
- **Sharing information** on technical solutions and investment priorities, supporting opportunities for **innovative legislative arrangements** and **financing mechanisms**
- New external business alliances to improve **internal optimization**

4.2 Advanced Grid Monitoring, Control and Management Systems

Advanced grid monitoring, control and management systems are the essential tools of the network operator and the widespread use of these systems is a huge need. There are two main issues for distribution companies to meet this need: full adaptation of these systems to business processes and training of competent personnel. In addition, distribution companies will need to complete short and medium-term studies of the critical issues outlined below.

Data Based Grid Management

By improving and completing the quality of the grid data model, developing and implementing the required data validation and quality control processes, and ensuring that the data is kept up to date, data based network management can be performed reliably.

Transition to Center Management Approach

Due to the establishment of the SCADA control center and load dispatch center structure, grid management will be centralized. It will provide workforce optimization, business efficiency and performance enhancement.

Deployment of Advanced Network Management Systems
Establishment, adaptation and effective use of ADMS functionality will ensure increased situational awareness, as well as fast and reliable execution of operational processes.

Increasing the Number of Telemetry / Tele-control Points
Increasing MV and LV grid monitoring/control rates, and dissemination of situational awareness and remote-control capabilities, will strengthen operational dominance and facilitate the conversion of useful information by rapid real-time data processing.

Launching Grid Analysis Studies
Applying big data analysis methods to grid operational data and adapting the processes of efficiency and performance improvement in grid operations will accelerate the decision-making process, while strengthening the decision support mechanism.

Outage Management System
Establishing a mobile outage notification system which is adapted to business processes, and enabling OMS functionality to meet DSO and regulatory requirements will provide a dynamic outage management environment, and enable communication channels to be more active and near real-time with customers.

Advanced Workforce Management Systems
Establishing dynamic optimization and discovery-based advanced workforce management systems, implementation of mobile applications and their adaptation to business processes, will help to improve workforce performance while maximizing business productivity.

Social Media Integration
Social media applications need to be implemented in order to increase customer satisfaction and interaction.

Distributed Energy Resources Management System
To include distributed energy and flexibility resources (distributed generation, storage, demand response programs, etc.) in grid management, DERMS (Distributed Energy Resource Management System) installations must be implemented and effectively used in operations. In this way, all generation resources connected to the distribution network will be tracked from a single point, and effective production control will be ensured.

Development of New Grid Business Philosophies
Innovative solutions such as self-healing solutions, micro-grids, active network management (ANM), distribution ancillary service applications, Wide Area Monitoring System (WAMS), closed ring operation and DC grid should be implemented as pilot applications. Also, its adaptation to new generation grid operation should be provided.

Testing Innovative Grid Components
Large-scale pilot applications involving innovative grid components (amorphous transformers, superconductors, power electronic based switches, LED lighting, etc.) should be implemented to facilitate grid adaptation.

4.3 Asset Management and GIS

The improvement of the grid performance primarily depends on the registration of the assets, their monitoring, evaluation and improvement. As this is the case, issues such as the maintenance of grid assets and their linkage to the correct systems, determination of the lifespan of the asset, and the execution of forecasting maintenance activities are critical. Other critical issues to be considered in this smart grid technical component are summarized in the following headings.

Geographic Information Systems
Implementation of central and mobile solutions developed for the distribution sector, application of solutions to ensure the collection and quality of the field asset data which will feed the asset management system, their adaptation to business processes and effective usage have critical importance. This system will serve as data repository of the distribution company therefore it is vital to follow all related business process properly to maintain the data effectively in the system.

Asset Management System
Designing and implementing the Asset Management System in order to manage the operational status, performance and useful lifespan of grid entities, is very critical in improving the grid performance.

Maintenance Planning
The development of risk and reliability-based maintenance planning methodologies is of great importance for the development of the asset management system. The performance of each entity should not be only evaluated in itself, but also, it's the reflection of the asset performance of the grid should be taken in consideration.

Internet of Things (IoT)
Remote monitoring of performance and status of critical grid assets require monitoring at a low cost and high capacity sensor network infrastructure. By adapting this communication network to asset management systems, a greater number of grid asset will be monitored in a dynamic and real-time manner.

Asset Analysis
Asset Management, Data Analysis R&D and pilot implementation studies must be completed to establish asset analysis infrastructure that will become part of the business processes and decision support mechanism. As a result, it will be possible to determine, evaluate and improve asset performance.

4.4 IT Infrastructures and Data Analysis

IT used in distribution sector responds its needs and strengthens the customer-company relationship. In addition, with data analytics, it improves business processes. The importance of this technical component is summarized under the following headings.

Digitalization and Analytical Planning
After establishing distribution company digitalization and analytical road maps, necessary information systems should be implemented or improved for process adaptation and effective usage. This plan will provide digitalization of all manually executed processes of distribution companies.

Active Customer Interaction
Beyond customer satisfaction, customer needs should be taken in consideration. Customer relations infrastructures should be implemented and integrated with social media to respond customers more effectively and quickly.

EDVARS
In order to avoid creation of unmanageable structure for each distribution company, distribution companies and related institutions should work together to carry out studies on joint data modeling, exchange methods and development of protocols/standards for data transfer to the Electricity Distribution Data Repository and Reporting System.

Corporate IT Infrastructures
Advanced corporate information systems should be established within the framework of digitalization road map and used effectively.

Data Analysis Platform
Distribution companies need to identify the relevant business processes for big data management and establish big data analytics management /development platforms, in order to improve their operations, business processes, and decision support mechanism.

Data Analysis Dissemination
Dissemination of data analysis on the created platform with a certain priority order depending on the needs of distribution companies has great importance as, it will help companies with their smart grid transformation.

Advanced Demand Forecast
The widespread use of distributed production reveals the need to make regional demand forecasts at a higher resolution, including advanced grid analysis. Therefore, distribution companies need to build advanced load estimation algorithms and feed them by integrating smart meter data.

4.5 Distributed Energy Integration and Storage

While the stability of the distribution system is maintained, the control and management of the production resources connected to the electricity distribution network through the MV and LV levels should allow maximum generation. Critical issues related to this component are summarized below.

DER Monitoring / Control
Remote monitoring and control equipment installation of distributed energy resources should be integrated with DSO grid management systems.

Advanced Connection Criteria and DER Connection Processes
Connection criteria for the distribution grid of different distributed energy resources should be established, and advanced engineering analysis must be used effectively in the connection process. In this way, it is possible to analyze whether the energy resources would cause a limitation on the grid before the connection, and energy can be granted accordingly. In addition, on line provision of energy permits of distributed energy resources by grid connection monitoring and evaluation system, will allow comparison of the grid with the real-time data and previously planned plants.

Small Scale DER - Grid Integration
Roof-top solar power plants' integration with hybrid roof-top PV and storage system should be analyzed to see positive and negative effects on the distribution grid. Roof-top solar power plants are expected to be widely connected to LV grid.

DER Capacity
Distribution companies should increase the integration capacity of distributed energy resources by eliminating the limitation of distribution grid. This is another critical issue that needs to be focused in the forthcoming period.

Flexibility Management
Rather than totally localized distributed energy resources and independent from each other, these resources should be considered as opportunity for flexibility management. New market models should be created to enable more efficient use of renewable energy resources.

Distributed Generation Forecasting
In the near future, technological solutions for estimating daily and the day before production profiles of distributed production sources should be implemented, as this might significantly affect the stability of the distribution system

Storage Systems
Large-scale energy storage system pilot applications should be implemented in distribution grids, and technical criteria for grid usage areas should be developed. After that the grid integration will be ready to overcome instabilities caused by distributed generation, and ancillary distribution services will be maintained.

Demand Side Participation
Integration of DSO grid management systems with Aggregator distributed energy resources management systems must be ensured by launching demand reaction programs.

4.6 Electric Vehicles

The use of electric vehicles is increasing rapidly around the globe. In the near future, they are expected to be used intensively in our country too. With the intensive use of electric vehicles, there will be a new demand on the distribution grid. This demand and consumption profile should be understood and necessary preparations should be carried on in medium term. The critical issues related to this technical component, that need to be assessed in short or middle term are summarized in the following headings.

EA and Charging Station Grid Integration
Minimum installation requirements for EA charging stations must be established, and minimum grid connection criteria for EA and EA charging stations must be maintained.

EA Management
Electric charging stations which cannot communicate with each other, which cannot be used in the future and which are connected to grid through a not identified feeder and power by distribution companies, should be avoided by new legislations for installation of EA charging station and should be managed by a standardized management system.

Capacity Management
Load management algorithms for electric vehicles should be developed, and large-scale pilot applications should be conducted to study different business models (Direct Control, Current Limitation, and ToU Based Distr.)

V2G / V2B
Pilot studies should be conducted to evaluate the effects of EA's feeding situation with the grid (V2G) or buildings (V2B)

4.7 Communication Infrastructure

Communication is a very important aspect of smart grid. A healthy communication infrastructure needs to be established and maintained. Critical issues to be considered under "Communication Infrastructures" technical component are summarized below.

Communication Infrastructure
Existing communication infrastructures of IT and OT systems should be evaluated and new infrastructures must be designed and implemented in line with the needs of smart grid deployment.

Smart Meter Interoperability
Nationwide communication protocol of Smart Meter infrastructures for distribution companies should be established, and Smart Meter infrastructure deployment activities should be carried out.

Distribution Automation Interoperability
Equipment which do not support international communication standards used in distribution automation by distribution companies should be replaced

Network Management
The distribution company's communication infrastructure has become more complex with smart grid technologies. For this reason, it is necessary to establish the necessary network monitoring and management system.

Team Communication
With the adoption of operational technologies, field-site, field-center communication has become more critical. As a result, it is very important to improve the communication infrastructure of field teams to establish high performance communication.

Innovative Communication Technologies
Implementation of a pilot application for the testing and adaptation of next generation communication technologies in distribution automation and smart meter communication infrastructures is recommended.

4.8 Smart Meter Infrastructure and Customers

The critical issues concerning penetration level of smart meter infrastructure and customer participation to the market are discussed below.

Standardization
Minimum requirements for smart meters should be established considering the conditions of Turkey, interoperability standards should be created, and common coding structure and the object model should be formed.

Pilot Applications
Large scale pilot applications for smart meters should be realized, and the field experience gained from them should be used in the deployment planning.

Roll out Planning and Design
With smart meter deployment, 2025 and 2035 planning should be made, specific cost benefit analysis of DSO region should be performed, and a system design should be prepared to meet the special needs of DSO.

Meter Data Management (MDM)
Meter Data Management Systems should be designed to meet the minimum system requirements by considering big data needs. Therefore, MDM system shall be installed and used effectively.

Comparable Invoice
It is advised to provide a comparable and detailed billing information to the customer, and establish an energy data platform for intelligent management of measurement information.

Meter Analysis
Meter analysis applications should be developed, disseminated and used effectively in the related business processes.

Demand Side Management
In particular, it is recommended to establish the necessary DSO infrastructure for managing the peak demand caused by heating and cooling welds (shopping centers, public housing, etc.).

Energy Trading at the End Point
It is recommended that pilot applications be implemented in order to analyze the applicability of energy trade at the end point, intelligent contracts and block chain technology.

4.9 Enterprise Application Integration

The communication and integration between OT and IT systems on which smart grid structure is based, are of great importance in terms of ensuring the complete transformation of the smart grid. Critical issues of this technical component, which should be kept in mind in the short and medium term, are evaluated under the following topics.

Grid Model Synchronization
The integration between the related systems must be established in order to ensure synchronization of MV and LV network model among all related systems.

Integration Architecture
It is of utmost importance that the technological solution architecture is designed and implemented after evaluating different integration technologies and solutions.

Enterprise Application Integration (EAI) Design
Integration design should be established for more effective use of enterprise information systems.

Various Integration Studies
The realization of pilot and dissemination activities in order to transfer smart meter data to grid management systems in real time, is an important topic in order to increase the situational awareness of the grid. In addition, integration of geographical information systems, asset management systems, workforce management systems and meter data management systems with other IT and OT systems is essential for a more efficient and effective smart grid structure.

Common Information Model (CIM)
As smart grid structure with includes many different technological systems, it is necessary to make a transition to CIM-based enterprise data flow integration with CIM-based common data model integration, so that all systems communicate with each other through a common language.

Standardization
Smart grid has a modular and expanding structure. A compatibility criteria should be established, so that the new systems and technologies that are planned to be purchased are compatible with the IT integration architecture.

4.10 Cyber Security

Since conventional OT systems are not open to external systems, they are known as safe systems at a certain level. However, the convergence of OT and IT systems in smart grid construction, and the opening of OT systems into cloud infrastructures for big data analysis, brings serious security risks. Therefore, the necessary cyber safety precautions must be taken in the smart grid conversion process. Some critical issues assessed under this technical component are summarized below.

Cyber Security Planning
Distribution companies should decide on the cyber security strategy, determine the level of maturity and establish the cyber security action plan.

Cyber Security Standards/Procedures and Cyber Security Certification
Establishing cyber security standards and procedures for IT and OT systems, adapting them to business processes and maintaining company's general awareness are important issues. Also there should be a main structure that can provide a certification for smart grid cyber security standards.

Operations Center
Establishment of a cyber security operation center for managing cyber security incidents is very important for an immediate response to cyber security events and the creation of institutional memory.

Security Solutions
IT and OT communication infrastructures must be tightened against cyber security risks, and solutions must be identified and implemented to increase security levels.

Integration Security
Security weaknesses that occur with IT and OT convergence should be defined and necessary preventive solutions should be implemented to protect corporate and personal data by ensuring system sustainability.

AMI Cyber Security

As smart meter infrastructure has the widest and most dispersed communication network among all other smart grid components, it is also the most vulnerable system to physical and cyber security risks. As a result, it is very critical to determine the security risks and threats and implement necessary preventive solutions.

Test Environment

Cyber security simulation laboratories need to be established in smart grids in order to identify cyber security risks and identify threats.

4.11 Short and Middle Roadmap Overall Evaluation

During the last few years, all advanced economies of the world have been trying to adapt to the paradigm change of energy sector. Turkey Smart Grid Roadmap's main purposes are listed below so that Turkey can keep pace with those changes.

- The possible effects of electric vehicle, storage and roof-top solar panels on the distribution network, which are expected to become widespread in geometric proportions in the coming years, should be managed.
- Continuity of supply and quality of service should be raised to the EU average.
- The high technical and non-technical loss rates should be reduced to reasonable values quickly, so that the carbon footprint of the electricity distribution sector should be minimized.
- Encourage market participation of eligible consumers to maximum level by increasing penetration level of smart meters,
- "Prosumer" phenomenon should be accepted by the grid management, and integrated to the grid
- The infrastructure for the demand side market participation should be established.
- The benefits, that are gained by the application of data based management principles on the fully acquired asset and customer data of DSO, should be reflected to tariffs in reasonable rates.
- Smart grid hardware and software elements should be produced by local resources as much as possible. This will have positive effects on the country economy and employment opportunities.
- A contribution to national energy efficiency mobilization should be made.

Beyond these goals, which are specially created for the electricity distribution sector, it is recommended that the following statements, that can guide other sectors, are assessed under MENR.

With the help of Turkey Smart Grid 2023 road map and smart grid transformation point of view established in electric distribution sector, similar studies should be conducted in other sectors. Planning and road map preparation to gather all infrastructures of our country under "Smart Infrastructures" concept should be promoted.

The regulations created for different sectors should be harmonized with "Smart Infrastructures" goal, target and road map.

To increase the benefits that can be gained from the usage of Smart Infrastructure by raising awareness of all stakeholders, it is proposed to launch a training campaign starting from primary school-level. Also, the expansion of this training campaign to all parts of the country by public education centers and civil society organizations will

make it possible to benefit more from the investments done or planned on smart infrastructures.

It is recommended that the regulator, which guides the electricity distribution sector with the country's vision, targets and needs, should consider the following statements specific to this sector.

Especially during the remaining time of the Third Implementation Period, all DSOs should make medium and long term smart grid planning, prepare investment and operational budget in parallel with the objectives of the Regulatory Authority. EMRA should request these smart grid plans and budgets to approve in order to facilitate the adaptation to the paradigm change of energy sector.

Making legislative changes that supports smart grid concept before the fourth implementation period, will help stakeholders to carry out a healthy process to take the necessary actions during smart grid transition in the following implementation periods.

While the regulatory institution continues to support traditional grid investments during the next implementation periods, DSOs should be requested to perform asset management activities in order to evaluate the performance and lifespan of the old and new assets of the grid; which will help to improve grid asset performance.

In addition, during the upcoming implementation periods, the regulatory body should further increase its support for R&D, pilot projects and technological investments, in order to meet the needs for smart grid transformation. Another important issue in this direction is the implementation of the technological project evaluation system for the monitoring, evaluation and supervision of the projects. This will allow the technological investments to be properly assessed and audited.

On the other hand, it is expected that the electricity distribution companies use the proposed method in this report as a guideline during the smart grid transformation journey, and implement their own actions/projects accordingly. Therefore, by considering Regulatory Authority’s advices and their regional needs, it is necessary for DSOs to formulate their own smart grid master plan.

Another point is that the R&D studies need to be accelerated and turned into pilot projects. With the accumulation of the necessary knowledge and experience, DSO will be ready to the expected changes and developments.

Another prospect is the establishment of a Smart Grid Information Sharing Platform among distribution companies. Thanks to knowledge and experiences they can share, necessary applications will be implemented faster and with quality. Also, this will help in standardizing common applications among distribution companies.

5 REGULATORY FRAME

In the electricity distribution sector, legislation and regulations have a direct impact on the way business is conducted and on the implementation strategies of smart grid solutions. In the context of smart grid transformation, the regulatory framework should support and encourage the activities of distribution companies.

To this end, the following suggestions for regulatory framework are listed.

5.1 Data Management

Renewable energy sources of DSOs should be connected to distribution grid as distributed generation. Also, they need to keep up with the electrical transport technology. To this end, they need to improve and manage their data warehouses.

Before starting the 4th implementation period, a peace for data sharing should be made between DSOs, Regulatory Authority and TEDAS, as TEDAS is the asset owner. New period's revenue cap should be decided considering the available assets. This will help IHD's with the sustainability.

5.2 DSO Carbon Footprints Reduction

In order to reduce the carbon footprints of technical losses, DSO should invest in RE sources from CAPEX budget with the normal redemption method, in return of the 5% technical losses. This will help RE investments to be active quickly.

5.3 Flexibility Management

By enabling load shift in the day according to the load profile, and reducing the technical loss by managing the reactive power of the grid with distributed energy resources, a real time optimization of the coordination of TSO and DSO can be maintained. A number of smart legislations will be needed in order to enable TSO to manage energy storage, electrical vehicle charging stations and reactive energy sources at the transmission level, and DSO at the distribution level, without compromising competitive market conditions.

5.3.1 Energy Storage

In order to support the most appropriate investments in energy storage, it is necessary to define the high-level principles of the future framework. These investments should be based on market revenue rather than subsidy. They should be enabled by foreseeability, and storage facilities should be allowed to build on various value flows (e.g. Grid balancing services, avoidance of network congestions caused by variable generation, de-carbonization).

The topics such as the use of storage systems as both energy provider and energy consumer, are still legislatively problematic in terms of billing and bidirectional meter usage.

It is possible to study Energy Storage at three levels;

- **DSO Level:** Storage facilities are started to be used in MV, and then in LV grid after the widespread use of electric vehicles. This provides significant gains in savings in grid, provision of supply flexibility and improvement of supply continuity and energy quality.

- **Market Participant Level:** The legislative infrastructure for market participants should be prepared in case the marginal revenues of peak shifts come to a level that meets storage investments.
- **Prosumer Level:** In addition to the solar panel and electric vehicle charging stations at home, if the storage units are also reasonably supported, grid flexibility will be ensured.

The introduction of specific legislation for pumped storage, which can be relatively quickly incorporated into the system in our country, will be an important achievement. DSOs can identify potential areas in their territories and inform market participants to invest in those areas. They will reduce their own grid management needs or technical losses. In this context, if TSO permits relatively low capacity loads with lines directly connected to the 154kV output buses, it will make pumped storage facilities commercially meaningful. In other words, pumping energy should be given to transmission and the generator output to the distribution grid.

5.3.2 Electric Vehicles

Especially for the geometrical increase expected in the EA number since 2025, it is very important for DSOs and Regulatory Authority to plan both the grid and the legislative infrastructure.

In case that home and business EA charging stations load simultaneously to a specific LV feeder or transformer, the micro-grid communication infrastructure should be ready, so that all users who want to charge can share the maximum power of the grid equally and fairly. IoT elements should be used widely, and if necessary distribution rate should be calculated in time intervals (ToU), to ensure fair sharing of charging time among users.

Communication between IoT principles and grid monitoring elements of the charging stations or the integrated smart meter infrastructure will also become important.

At the first stage, it is expected that the proposal to regulate the procedures and principles of EA charging stations will become effective, and then the updates following the deployment will be made.

5.3.3 Reactive Energy Management

One of the main principles of reactive energy management is to place the compensation unit very close to the reactive energy consumption point.

Especially the increase of distributed generation in the MV grid and the penetration level of roof-top solar panels connected to the LV grid, will require reactive energy control to be carried out by smart grid elements. In this case, DSOs should at least change the consumer meters over 15 kW to smart meters with reactive energy measurement capability. It is necessary to apply fines based on the values of production / consumption of over-limit reactive energy that will occur in the hourly loads of consumers. A certain percentage of the income from the fines can be given to DOSs as an incentive. Also as consumers will be careful with their consumptions to avoid the penalty, generation of the reactive energy from end sources will be prevented and technical loss in the grid will be minimized. As a result, both active energy unity and CAPEX budget will be used more effectively.

5.3.4 Roof-Top Solar Panels

For the penetration of roof-top solar panels, following improvements would be helpful:

- Regulations should support roof-top solar panel investments by zoning and building permits
- Providing tax support in the framework of energy efficiency general incentives at the end-consumer level for roof-top solar panel investments (including other building materials)

5.4 Smart Meters

As of October 2017, 3% of the 42 million consumers have access to a smart meter infrastructure. Smart meter infrastructure has not reached the required level of quality and quantity, especially in terms of communication infrastructure, scalability and data management. A transformation to a modern structure is necessary.

For this purpose, between 2018 and 2020, each DSO should prepare a cost-based preparation of a deployment scenario suitable for its own specific conditions. Also, an incentive should be given to DSOs for their additional costs of pilot and test studies, so that the benefits gained from these studies can be long term and in economical scale. It is important to make the necessary arrangements in procurement legislation so that DSOs can act together during scenario studies and deployment purchases.

The unit cost of meter and modem, the low marginal cost of the communication (PLC, RF and fiber optic infrastructure of DSO), being away from GSM and GPRS environment, and a smart management system which is integrated with other internal corporate IT infrastructures, can be counted as other factors. In addition, the elaboration of secondary legislation for roll out of smart meters and control of cyber security applications in distribution grids, and the establishment of an in-country data center where data security can be used together by DSOs, will also make a significant contribution.

Another option is renting smart meters for 10 years, as done in some European countries.

5.5 Energy efficiency

By definition, DSOs should know the electricity consumption profiles of the consumers in the region, and provide energy saving advice to them after conducting analyzes. They should provide the greatest support to the demand side management. Legislative amendment will make a significant contribution to the success of the Energy Efficiency Action Plan by allowing DSO to acquire licenses for the natural demand side manager and the Energy Service provider, and to provide energy efficiency consulting services to its customers.

5.6 Housing Legislation

The amendments to the Floor Property Law, the Construction Law and the Electricity Internal Facilities Regulations require that a certain number of self-contained apartments have to comply with simultaneous measures such as the central gas system or the obligation to install elevators. The following conditions shall be possible provided that the total consumption of the bi-directional meter at the LV output of the transformer is communicated to the DSO meter management system via the concentrator and the modem, which collects electricity consumption information of all units.

- Decrease in LV distribution losses
- Acquisition of joint ventures of the buildings or panels to produce solar energy on the southern fronts,
- The establishment of the common storage unit,
- Ability to participate in demand side management via DSO, if central air conditioning is available
- Reading of the consumption of all apartments from the common meters, the provision of cheaper electricity to all the apartments as the consumer right would be used from single hand.

5.7 R&D Incentives

At least 1% of annual expenditure is R&D spending target. For distribution sector, it would be more appropriate to take the annual revenue cap as the annual turnover instead of the operating expense budget, and set the R&D budget accordingly.

For efficiency, it would make more sense to add hardware or software costs of R&D projects that would be purchased and implemented to revenue cap, instead of including them in R&D costs.

It will also be meaningful to give incentive awards to companies that have a good ranking among the completed R&D projects. The evaluation can be done by an independent jury each year.

For development of smart grid hardware and software with local resources, not only energy resources but also necessary technologies should be local. The following actions should be taken so that 2035 targets are met by all stakeholders:

- Smart grid R&D activities should be accelerated and large-scale pilot projects should be put under the supervision of EMRA, utilizing TÜBİTAK resources.
- In order for the growth model achieved in the defense industry to be replicated in the energy sector, smart grid elements should be obtained from local sources by providing risk capital support to new formations such as solar panel, inverter, battery, SCADA software and GIS applications.

6 BUDGET AND FINANCE

With the new business models and smart financing methods, it is possible to reach 2035 smart grid targets with minimal change in tariffs for users. Some suggestions to achieve this goal are listed below.

6.1 Distribution Scheme

If following investments are made in the smart grid (including storage and RER); a total of 929 million TL between the years 2018-2020, a total of 4.4 billion TL in the following 5 years, an average of 4 billion TL per annum in the following years [5] ; its effect on end-user tariff will be[6] an average of 0,045 kurush in the first three years [7] , an average of 0.293 kurush in the next 5 years, and an average of 1.27 kurush in the last 10 years (2026-2035).

If the short-term road map and planning costs of DSO between 2018 and 2020 are covered from uncontrollable expenses, the coverage level of these studies will increase, Investments will be covered by an additional budget for existing investment ceilings (2018-2020). Current investment plans of DSO will not be affected.

In addition, a shorter tariff investment recovery period and a higher reasonable rate of return for smart grid investments, will be additional incentives for DSOs.

Ensuring the long-term financing required for the investments and the prolongation of the tariff investment recovery period will reduce the effect of the investments on the end-user tariff.

6.2 Loss Reduction

If the loss reduction target is lowered to below 6% [8] by 2015, 388 TWh would be saved by 2035. With the average PTF market price of 2017 (163.89 TL/MWh), the saving will be 17 billion USD dollars[9] With this savings, DSOs will have additional revenue cap with an average of 4.5 billion Turkish Liras (with December 2017 prices) per annum between 2021-2035.

To reduce losses, it is necessary to define separate processes for technical and non-technical losses.

6.3 Energy Efficiency

In "National Energy Efficiency Action Plan 2017-2023", prepared by the Ministry of Energy and Natural Resources, 55 activities with impacts on energy efficiency and implementation from one year to 40 years have been identified. With this study, until 2023, it is aimed to reduce Turkey's increasing energy demand by 14%.

It may be possible to lease smart meters to consumers for 10 years, if the bills on the action plan are elaborated and if they can guide the consumers about energy efficiency.

---

[5] Calculated with December 2017 EPE (327,41)
[6] By January 2018
[7] If the energy distributed increases by 5% every year
[8] It is predicted that the loss of conduction will also be reduced below 2%. Thus, the total grid loss will be less than 8%.
[9] US $ 1 = $ 3.75

6.4 Budget Allocation to Smart Grids for the 3rd and 4th Period

By the end of the 3rd implementation period, as a preparation, it is planned to allocate a budget of approximately 123 million TL to short and medium-term implementation of R&D/pilot and application projects. For R&D/pilot projects, during the remainder of the 3rd implementation period, a budget of 229 Million TL is expected to be allocated, while for the 4th implementation period, predicted budget is 583 Million TL. This budget allocation for Application Projects will be 835 million TL for the 3rd implementation period and 3.9 billion TL for the 4th implementation period.

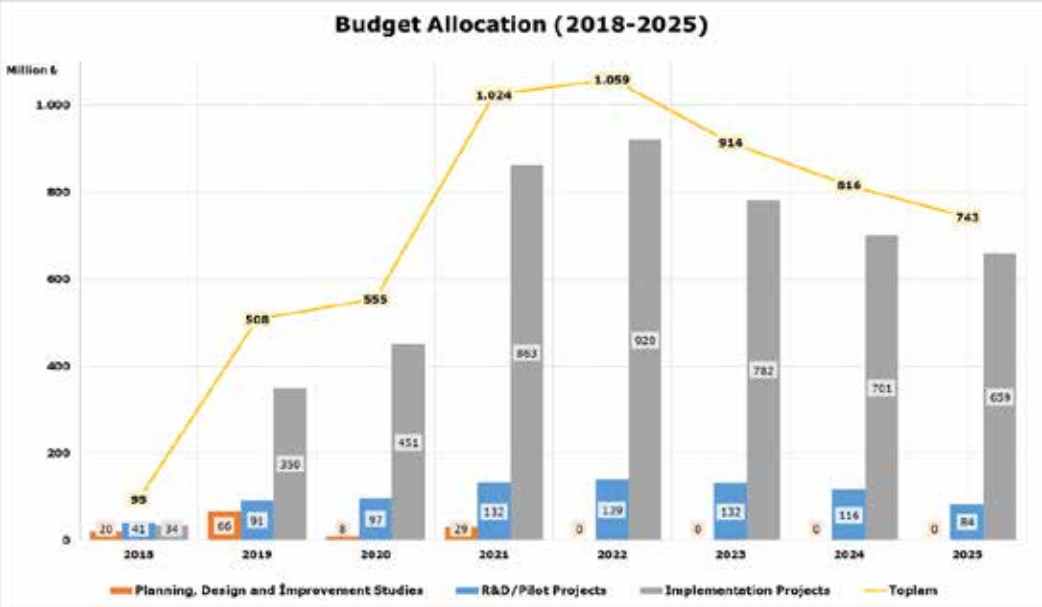


Figure 3 : Distribution Companies III. And IV. Implementation Period Smart Grid Investments Budgets over Years

7 ATTACHMENT I – SMART GRID ROAD MAPS

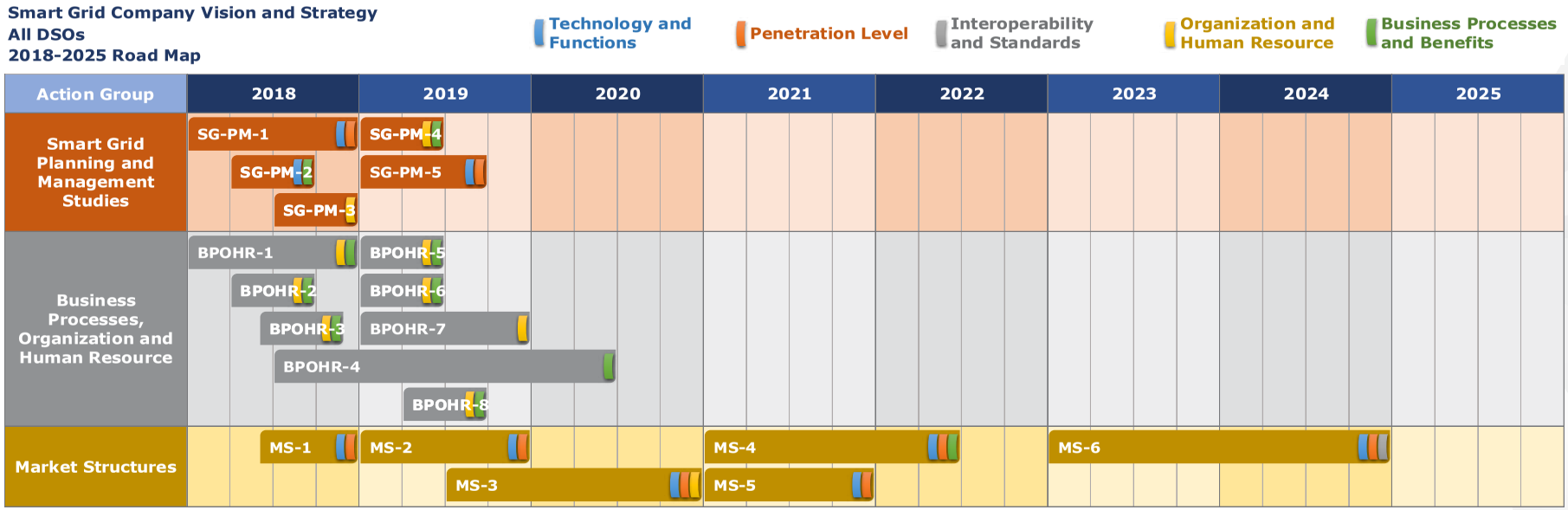
7.1 Smart Grid Company Vision and Strategy (GE)

7.1.1 Suggested Projects/Actions List for All DSOs (GE)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Smart Grid Planning and Management Studies	SG-PM-1	Smart Grid Master Plan	Planning	Jan 2018 Dec 2018	8.400.000 TL
Smart Grid Planning and Management Studies	SG-PM-2	Smart Grid R&D and Pilot Application Planning	Planning	Apr 2018 Sep 2018	Yok
Smart Grid Planning and Management Studies	SG-PM-3	Installation of Smart Grid Projects Management Office (PMO)	Improvement Study	Jul 2018 Dec 2018	Yok
Smart Grid Planning and Management Studies	SG-PM-4	Developing Management, Tracking and Performance Evaluation Systematics for Smart Grid Projects and Systems	Improvement Study	Jan 2019 Jun 2019	Yok
Smart Grid Planning and Management Studies	SG-PM-5	Synchronizing/Harmonizing Grid Master Plan with Smart Grid Master Plan and Revising Accordingly	Planning	Jan 2019 Sep 2019	10.500.000 TL
Business Processes, Organization and Human Resource	BPOHR-1	Rebuilding Organizational Structure for Network Operation, Management and Optimization	Improvement Study	Jan 2018 Dec 2018	Yok
Business Processes, Organization and Human Resource	BPOHR-2	Creating Organizational Structure for Data Management and Quality Control & Quality Assurance	Improvement Study	Apr 2018 Sep 2018	Yok
Business Processes, Organization and Human Resource	BPOHR-3	Creating Organizational Structure for Big Data Analytics	Improvement Study	Jun 2018 Nov 2018	Yok
Business Processes, Organization and Human Resource	BPOHR-4	Business Process Change and Adaptation	Improvement Study	Jul 2018 Jun 2020	Yok

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Business Processes, Organization and Human Resource	BPOHR-5	Creating Organizational Structure for IT and OT Communication Infrastructure Operations and Management	Improvement Study	Jan 2019 Jun 2019	Yok
Business Processes, Organization and Human Resource	BPOHR-6	Creating Organizational Structure for Distributed Energy Resources Connection Management and Planning	Improvement Study	Jan 2019 Jun 2019	Yok
Business Processes, Organization and Human Resource	BPOHR-7	Planning Continues Training and Skill Gaining Activities	Improvement Study	Jan 2019 Dec 2019	Yok
Business Processes, Organization and Human Resource	BPOHR-8	Creating Organizational Structure for Smart Grid Cyber Security Management	Improvement Study	Apr 2019 Sep 2019	Yok
Market Structures	MS-1	Comparing Different Market Models for Ancillary Services and Creating Market Structure	R&D/Pilot Application	Jun 2018 Dec 2018	1.500.000 TL
Market Structures	MS-2	Evaluation of Different Market Models for Demand Side Participation	R&D/Pilot Application	Jan 2019 Dec 2019	3.150.000 TL
Market Structures	MS-3	Creating Market Mechanisms to Penetrate End User Scale Renewable Energy Generation In A Sustainable Way	R&D/Pilot Application	Jul 2019 Dec 2020	6.300.000 TL
Market Structures	MS-4	Comparing Different Market Balancing Mechanisms	R&D/Pilot Application	Jan 2021 Jun 2022	5.250.000 TL
Market Structures	MS-5	Performing Studies to Transform into Grid and User Oriented Open Market Structure for EV Penetration	R&D/Pilot Application	Jan 2021 Dec 2021	10.500.000 TL
Market Structures	MS-6	Evaluation of Different Market Mechanisms for Block chain and Energy Trading At The End Point	R&D/Pilot Application	Jan 2023 Dec 2024	10.500.000 TL

7.1.2 Detailed Road Map Scheduling for All DSOs (GE)



7.2 Advance Network Monitoring, Control and Management Systems (NM)

7.2.1 Suggested Projects/Actions List for Cluster 1 (NM)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Grid Data	GD-1	Network Data Model Design	Design Study	Jun 2018 Dec 2018	2.100.000 TL
Grid Data	GD-2	Network Connectivity Model İmprovement and Validation	Implementation Project	Jan 2019 Dec 2020	18.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Grid Data	GD-3	Gird Data Management and QC&QA Tracking Systems Design	Design Study	Jan 2019 Jun 2019	3.000.000 TL
Grid Data	GD-4	Grid Data Management and QC&QA Tracking Systems Installation	Implementation Project	Jul 2019 Jun 2020	9.000.000 TL
Network Management	NM-1	Installation of SCADA Control Centre	Implementation Project	Jan 2018 Dec 2018	4.000.000 TL
Network Management	NM-2	Network Management and Load Dispatch Centre Structure	Improvement Study	Jan 2018 Jun 2019	3.000.000 TL
Network Management	NM-3	ADMS Operational Integration Design	Design Study	Jan 2019 Sep 2019	4.200.000 TL
Network Management	NM-4	TSO SCADA Control Centre ICCP Integration	Implementation Project	Jan 2019 Dec 2019	6.000.000 TL
Network Management	NM-5	Advance Emergency Situation and System Restoration Plan (Grid Resilience)	Planning	Jul 2019 Jun 2020	3.600.000 TL
Network Management	NM-6	ADMS Installation and Application - NMS	Implementation Project	Oct 2019 Dec 2020	7.500.000 TL
Network Management	NM-7	Mobile NMS Application	Implementation Project	Jan 2021 Dec 2021	18.000.000 TL
Advanced Network Management	ANM-1	Advance Distribution Management Systems Design, Application or Improvement Planning	Planning	Jan 2019 Jun 2019	2.400.000 TL
Advanced Network Management	ANM-2	Active Network Management Design	R&D/Pilot Application	Jan 2019 Dec 2019	2.250.000 TL
Advanced Network Management	ANM-3	Start Using Already Installed ADMS Modules Effectively	Implementation Project	Jul 2019 Dec 2020	4.500.000 TL
Advanced Network Management	ANM-4	ADMS Installation and Application - DPF+SCA+SE	Implementation Project	Jul 2019 Dec 2020	6.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advanced Network Management	ANM-5	Active Network Management Pilot Application	R&D/Pilot Application	Jan 2020 Dec 2021	6.250.000 TL
Advanced Network Management	ANM-6	ADMS Installation and Application - FLISR	Implementation Project	Jan 2021 Jun 2022	6.000.000 TL
Advanced Network Management	ANM-7	Managing Reactive Energy at all levels of Distribution Grid by New Monitoring Algorithms	R&D/Pilot Application	Jan 2019 Jun 2019	6.000.000 TL
Advanced Network Management	ANM-8	ADMS Installation and Application - VVC	Implementation Project	Jan 2021 Jun 2022	3.000.000 TL
Advanced Network Management	ANM-9	Augmented Reality Pilot Applications in Distribution Grids	R&D/Pilot Application	Jan 2021 Dec 2022	6.000.000 TL
Advanced Network Management	ANM-10	Live Line Work Pilot Application in Distribution Grids	R&D/Pilot Application	Jan 2021 Dec 2023	9.000.000 TL
Advanced Network Management	ANM-11	ADMS Installation and Application - OFR+LAR	Implementation Project	Jul 2022 Dec 2023	12.000.000 TL
Advanced Network Management	ANM-12	Including LV Grid into ADMS (NMS+DPF+SCA+SE)	Implementation Project	Jan 2023 Dec 2024	24.000.000 TL
Advanced Network Management	ANM-13	Innovative ADMS Functions Pilot Applications	R&D/Pilot Application	Jan 2023 Jun 2024	12.000.000 TL
Advanced Network Management	ANM-14	Wide Area Monitoring Pilot Application in Distribution Grid	R&D/Pilot Application	Jul 2023 Dec 2024	8.750.000 TL
Advanced Network Management	ANM-15	Integration of Building Energy Management System and Network Management System in order to Load Management	R&D/Pilot Application	Jul 2024 Dec 2025	5.000.000 TL
Distribution Automation	DA-1	MV Network Close Loop Operation Large Scale Pilot Application (Protection, Control and Monitoring)	R&D/Pilot Application	Jan 2021 Dec 2022	5.000.000 TL
Distribution Automation	DA-2	MV Network Monitoring/Control - TSO-DSO Interface	Implementation Project	Jan 2019 Dec 2020	12.000.000 TL

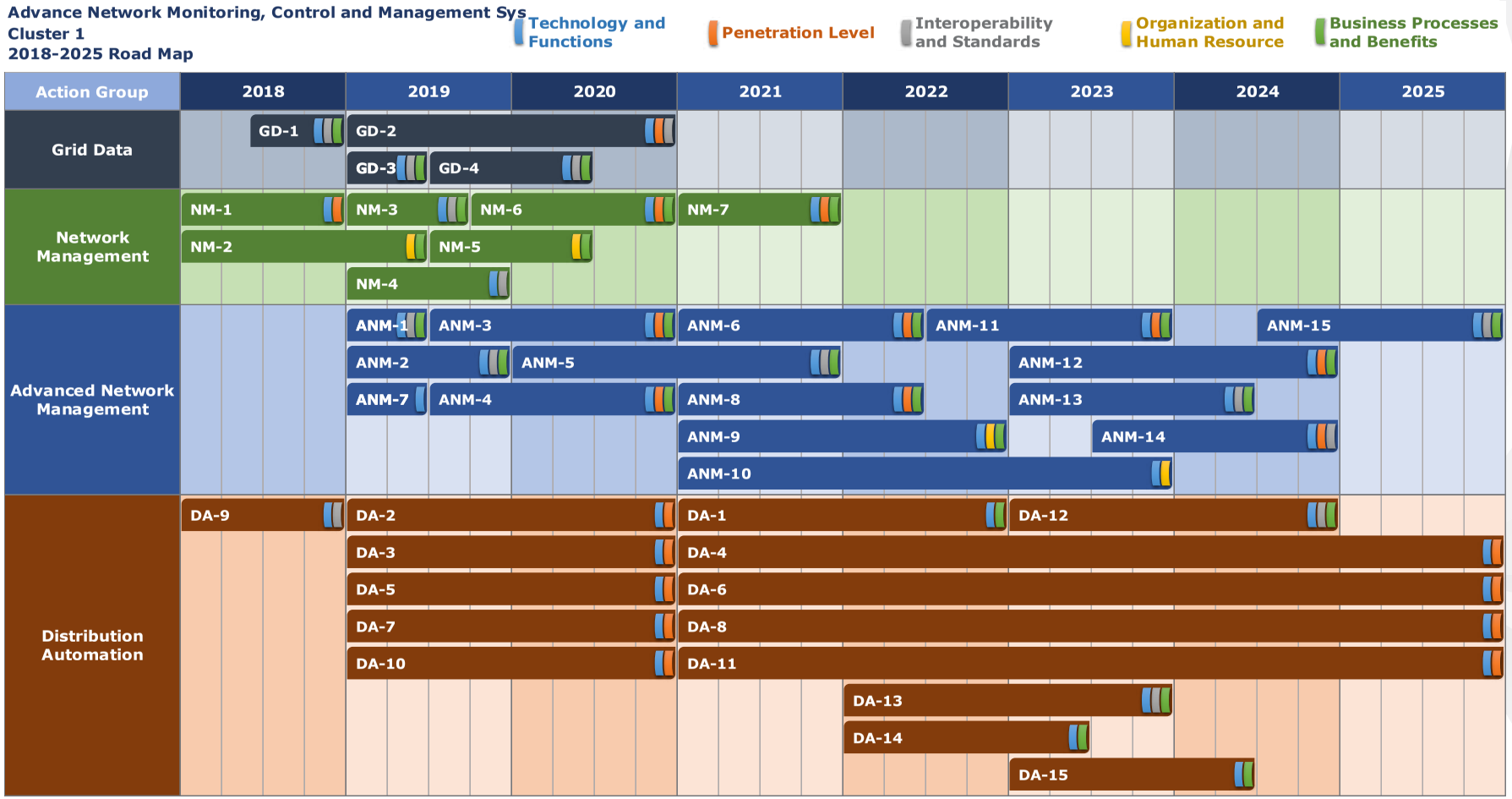
Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distribution Automation	DA-3	MV Network Monitoring/Control - Primary Distribution Substation and Feeders (Cluster-1/2020)	Implementation Project	Jan 2019 Dec 2020	29.400.000 TL
Distribution Automation	DA-4	MV Network Monitoring/Control - Primary Distribution Substation and Feeders (Cluster-1/2025)	Implementation Project	Jan 2021 Dec 2025	42.000.000 TL
Distribution Automation	DA-5	MV Network Monitoring/Control - Secondary Distribution Substation and Feeders (Cluster-1/2020)	Implementation Project	Jan 2019 Dec 2020	14.400.000 TL
Distribution Automation	DA-6	MV Network Monitoring/Control - Secondary Distribution Substation and Feeders (Cluster-1/2025)	Implementation Project	Jan 2021 Dec 2025	60.000.000 TL
Distribution Automation	DA-7	MV Network Monitoring/Control - DT Substations and MV feeders (Cluster-1/2020)	Implementation Project	Jan 2019 Dec 2020	63.000.000 TL
Distribution Automation	DA-8	MV Network Monitoring/Control - DT Substations and MV feeders (Cluster-1/2025)	Implementation Project	Jan 2021 Dec 2025	207.000.000 TL
Distribution Automation	DA-9	LV Network Monitoring Pilot Project	R&D/Pilot Application	Jan 2018 Dec 2018	3.750.000 TL
Distribution Automation	DA-10	LV Network Measurement/Monitoring - DT and LV Feeders Monitoring and Measurement (Analogue and Digital) (Cluster-1/2020)	Implementation Project	Jan 2019 Dec 2020	38.400.000 TL
Distribution Automation	DA-11	LV Network Measurement/Monitoring - DT and LV Feeders Monitoring and Measurement (Analogue and Digital) (Cluster-1/2025)	Implementation Project	Jan 2021 Dec 2025	168.000.000 TL
Distribution Automation	DA-12	LV Network Control Pilot Application	R&D/Pilot Application	Jan 2023 Dec 2024	7.500.000 TL
Distribution Automation	DA-13	Self-Healing Network - Large Scale Pilot Project	R&D/Pilot Application	Jan 2022 Dec 2023	10.000.000 TL
Distribution Automation	DA-14	MV Network Innovative Distribution Automation Field Solutions	R&D/Pilot Application	Jan 2022 Jun 2023	3.600.000 TL

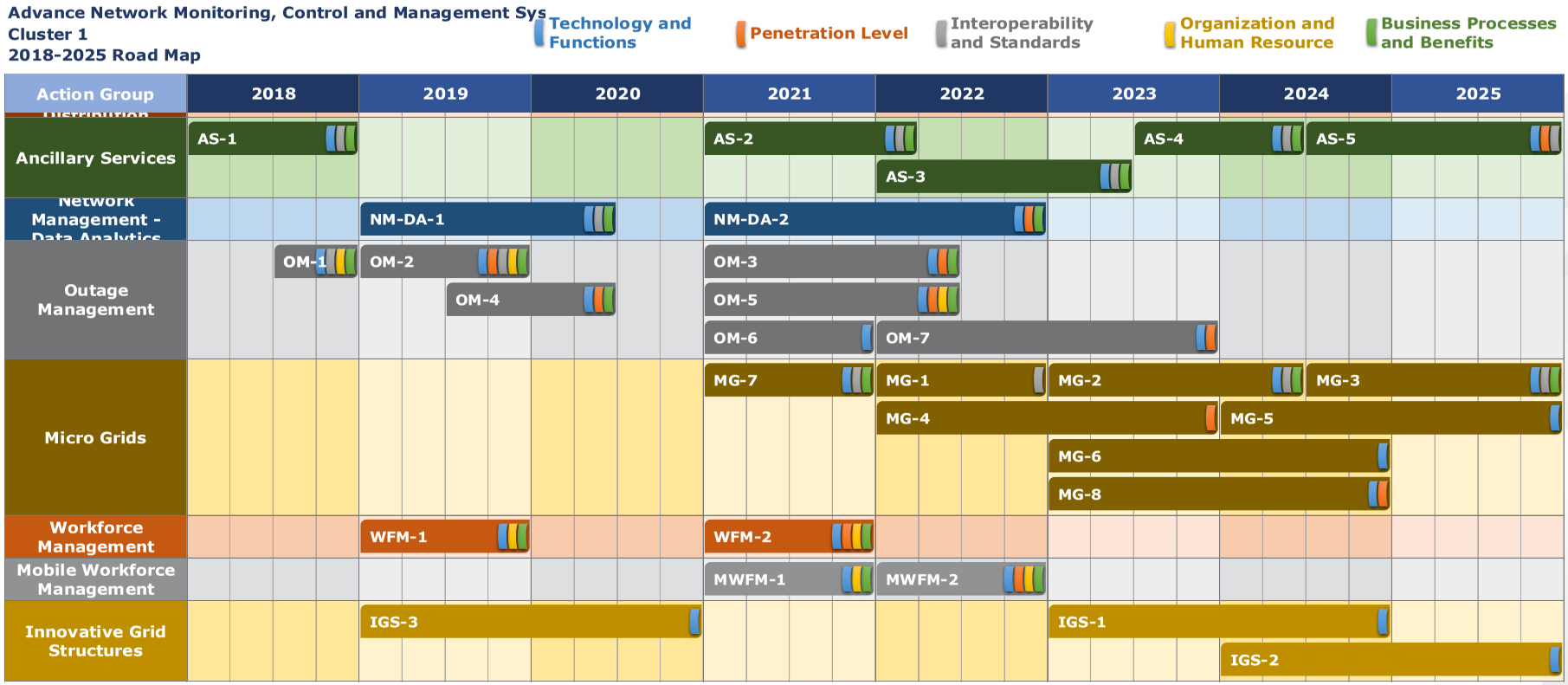
Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distribution Automation	DA-15	LV Network Innovative Distribution Automation Field Solutions	R&D/Pilot Application	Jan 2023 Jun 2024	4.800.000 TL
Ancillary Services	AS-1	Feasibility and Legislation Study for Distribution Networks Flexibility Resources and Ancillary Services	R&D/Pilot Application	Jan 2018 Dec 2018	1.250.000 TL
Ancillary Services	AS-2	Distribution Generation Ancillary Services - Voltage Regulation and Capacity/Congestion Management Support	R&D/Pilot Application	Jan 2021 Mar. 2022	2.000.000 TL
Ancillary Services	AS-3	Distributed Generation Ancillary Services - Seconder Frequency Support	R&D/Pilot Application	Jan 2022 Jun 2023	3.750.000 TL
Ancillary Services	AS-4	Transmission and Distribution Ancillary Services for Distributed Generation Control, Manageable Loads and Storage Systems	R&D/Pilot Application	Jul 2023 Jun 2024	5.000.000 TL
Ancillary Services	AS-5	Installation of Ancillary Services Monitoring and Management System	Implementation Project	Jul 2024 Dec 2025	6.000.000 TL
Network Management - Data Analytics	NM-DA-1	Network Analytics Proof of Concept and Pilot Applications	R&D/Pilot Application	Jan 2019 Jun 2020	3.000.000 TL
Network Management - Data Analytics	NM-DA-2	Network Analytics Application and Dissemination Project	Implementation Project	Jan 2021 Dec 2022	18.000.000 TL
Outage Management	OM-1	Outage Management System Design	Design Study	Jul 2018 Dec 2018	450.000 TL
Outage Management	OM-2	Installation of Outage Management System	Implementation Project	Jan 2019 Dec 2019	3.600.000 TL
Outage Management	OM-3	Outage Management System - Social Media Integration	Implementation Project	Jan 2021 Jun 2022	7.200.000 TL
Outage Management	OM-4	Mobile Application for Outage Notification	Implementation Project	Jul 2019 Jun 2020	3.600.000 TL
Outage Management	OM-5	Mobile OMS Project	Implementation Project	Jan 2021 Jun 2022	9.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Outage Management	OM-6	Integration of Telecom Service Interruption Data with OMS	R&D/Pilot Application	Jan 2021 Dec 2021	1.950.000 TL
Outage Management	OM-7	Integration of Telecom Service Interruption Data with OMS (Full Roll Out)	Implementation Project	Jan 2022 Dec 2023	7.200.000 TL
Micro Grids	MG-1	Defining Micro Grid Optimal Connection Criteria	R&D/Pilot Application	Jan 2022 Dec 2022	1.050.000 TL
Micro Grids	MG-2	Development of Smart and Distributed Management Systems for Third Party Micro Grid Hierarchical Coordination	R&D/Pilot Application	Jan 2023 Jun 2024	1.500.000 TL
Micro Grids	MG-3	Third Party Micro Grid Hierarchical Coordination Pilot Application	R&D/Pilot Application	Jul 2024 Dec 2025	4.500.000 TL
Micro Grids	MG-4	Micro Grid Penetration Estimations and Connection Planning	R&D/Pilot Application	Jan 2022 Dec 2023	3.500.000 TL
Micro Grids	MG-5	Grid Resiliency with Micro Grids	R&D/Pilot Application	Jan 2024 Dec 2025	3.750.000 TL
Micro Grids	MG-6	Micro Grid Pilot Application to increase Distributed Generation Connection Capacity	R&D/Pilot Application	Jan 2023 Dec 2024	3.600.000 TL
Micro Grids	MG-7	Feasibility Study and Road Map Planning for LV DC Distribution Networks	R&D/Pilot Application	Jan 2021 Dec 2021	1.200.000 TL
Micro Grids	MG-8	Pilot Applications for LV DC Distribution Networks	R&D/Pilot Application	Jan 2023 Dec 2024	5.000.000 TL
Workforce Management	WFM-1	Defining and Designing WFM Business Rules	Design Study	Jan 2019 Dec 2019	3.000.000 TL
Workforce Management	WFM-2	Advance Workforce Management System Installation	Implementation Project	Jan 2021 Dec 2021	24.000.000 TL
Mobile Workforce Management	MWFM-1	MWFM Design Project	Design Study	Jan 2021 Dec 2021	1.800.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Mobile Workforce Management	MWFM-2	MWFM Installation	Implementation Project	Jan 2022 Dec 2022	8.400.000 TL
Innovative Grid Structures	IGS-1	Amorf Transformer and Superconductive Pilot Application	R&D/Pilot Application	Jan 2023 Dec 2024	6.000.000 TL
Innovative Grid Structures	IGS-2	Switching Equipment powered by Semi-Conductor and Power Electronics	R&D/Pilot Application	Jan 2024 Dec 2025	7.500.000 TL
Innovative Grid Structures	IGS-3	Street Lighting LED Pilot Application	R&D/Pilot Application	Jan 2019 Dec 2020	6.000.000 TL

7.2.2 Detailed Road Map Scheduling for Cluster 1 (NM)





7.2.3 Suggested Projects/Actions List for Cluster 2 (NM)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Grid Data	GD-1	Network Data Model Design	Design Study	**Jun 2018** Dec 2018	1.050.000 TL

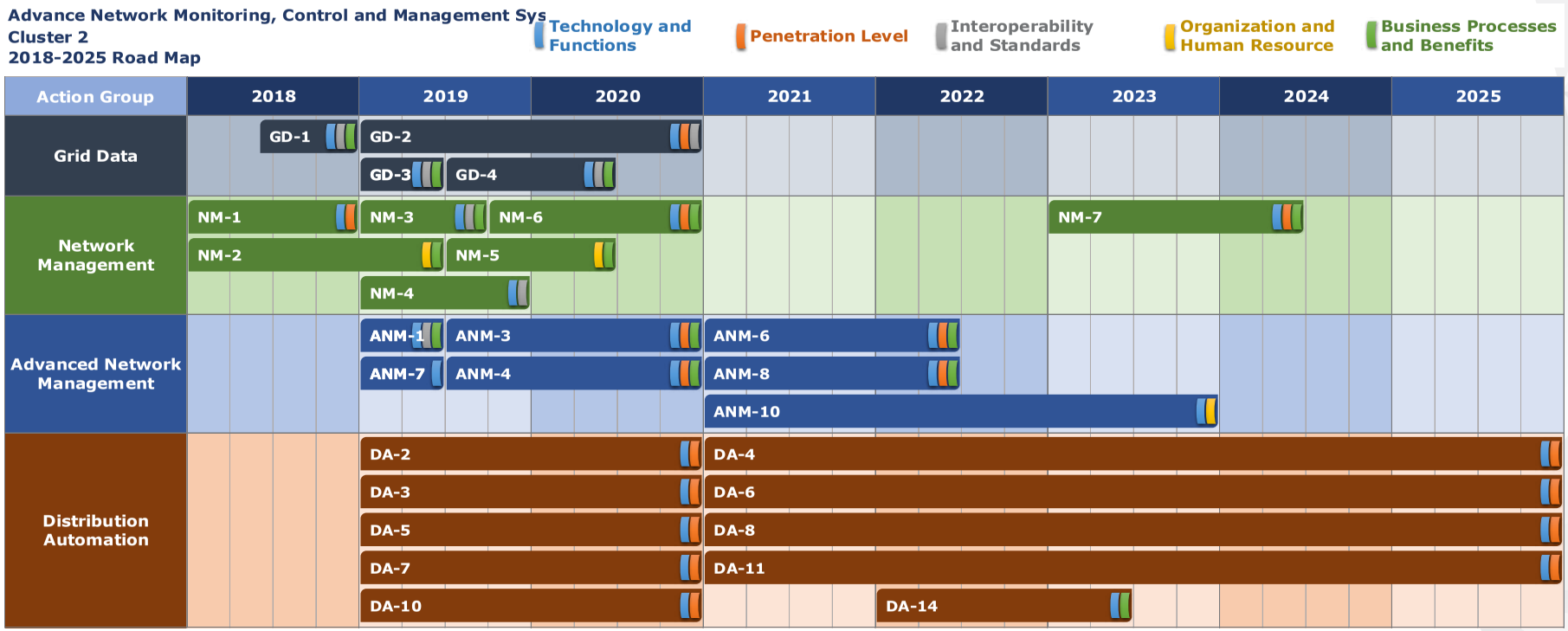
Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Grid Data	GD-2	Network Connectivity Model İmprovement and Validation	Implementation Project	Jan 2019 **Dec 2020**	9.000.000 TL
Grid Data	GD-3	Gird Data Management and QC&QA Tracking Systems Design	Design Study	Jan 2019 Jun 2019	1.500.000 TL
Grid Data	GD-4	Grid Data Management and QC&QA Tracking Systems Installation	Implementation Project	Jul 2019 Jun 2020	4.500.000 TL
Network Management	NM-1	Installation of SCADA Control Centre	Implementation Project	Jan 2018 Dec 2018	4.000.000 TL
Network Management	NM-2	Network Management and Load Dispatch Centre Structure	Improvement Study	Jan 2018 Jun 2019	1.500.000 TL
Network Management	NM-3	ADMS Operational Integration Design	Design Study	Jan 2019 Sep 2019	2.100.000 TL
Network Management	NM-4	TSO SCADA Control Centre ICCP Integration	Implementation Project	Jan 2019 Dec 2019	3.000.000 TL
Network Management	NM-5	Advance Emergency Situation and System Restoration Plan (Grid Resilience)	Planning	Jul 2019 Jun 2020	1.800.000 TL
Network Management	NM-6	ADMS Installation and Application - NMS	Implementation Project	Oct 2019 Dec 2020	7.500.000 TL
Network Management	NM-7	Mobile NMS Application	Implementation Project	Jan 2023 Jun 2024	9.000.000 TL
Advanced Network Management	ANM-1	Advance Distribution Management Systems Design, Application or Improvement Planning	Planning	Jan 2019 Jun 2019	1.200.000 TL
Advanced Network Management	ANM-3	Start Using Already Installed ADMS Modules Effectively	Implementation Project	Jul 2019 Dec 2020	1.500.000 TL
Advanced Network Management	ANM-4	ADMS Installation and Application - DPF+SCA+SE	Implementation Project	Jul 2019 Dec 2020	6.000.000 TL

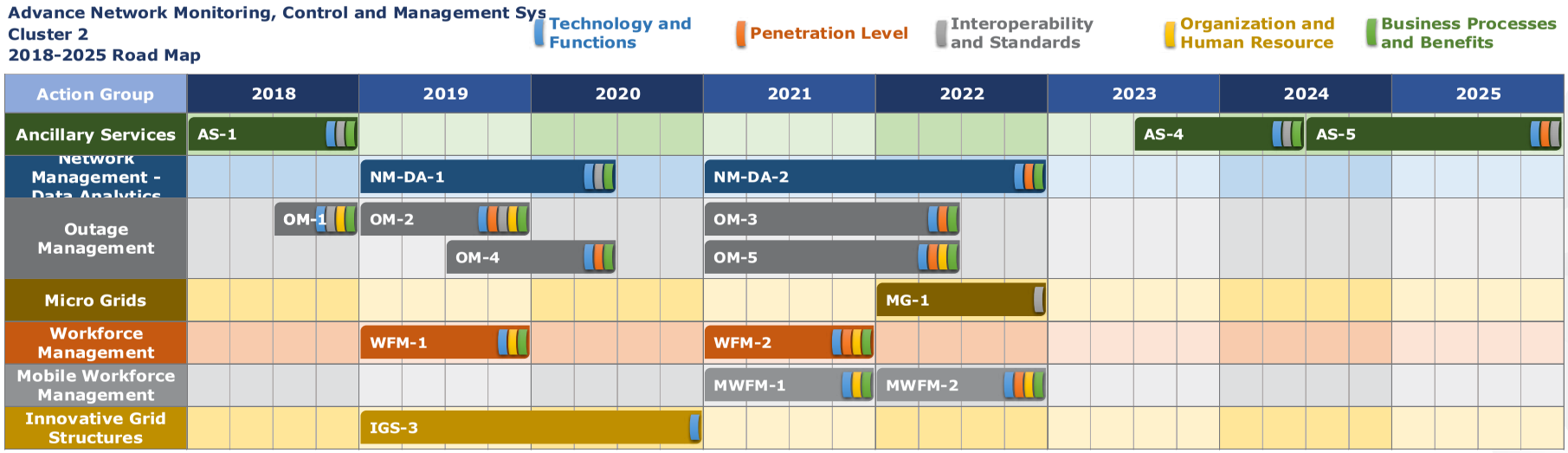
Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advanced Network Management	ANM-6	ADMS Installation and Application - FLISR	Implementation Project	Jan 2021 Jun 2022	6.000.000 TL
Advanced Network Management	ANM-7	Managing Reactive Energy at all levels of Distribution Grid by New Monitoring Algorithms	R&D/Pilot Application	Jan 2019 Jun 2019	3.000.000 TL
Advanced Network Management	ANM-8	ADMS Installation and Application - VVC	Implementation Project	Jan 2021 Jun 2022	3.000.000 TL
Advanced Network Management	ANM-10	Live Line Work Pilot Application in Distribution Grids	R&D/Pilot Application	Jan 2021 Dec 2023	3.000.000 TL
Distribution Automation	DA-2	MV Network Monitoring/Control - TSO-DSO Interface	Implementation Project	Jan 2019 Dec 2020	6.000.000 TL
Distribution Automation	DA-3	MV Network Monitoring/Control - Primary Distribution Substation and Feeders (Cluster-2/2020)	Implementation Project	Jan 2019 Dec 2020	21.000.000 TL
Distribution Automation	DA-4	MV Network Monitoring/Control - Primary Distribution Substation and Feeders (Cluster-2/2025)	Implementation Project	Jan 2021 Dec 2025	29.400.000 TL
Distribution Automation	DA-5	MV Network Monitoring/Control - Secondary Distribution Substation and Feeders (Cluster-2/2020)	Implementation Project	Jan 2019 Dec 2020	9.000.000 TL
Distribution Automation	DA-6	MV Network Monitoring/Control - Secondary Distribution Substation and Feeders (Cluster-2/2025)	Implementation Project	Jan 2021 Dec 2025	27.000.000 TL
Distribution Automation	DA-7	MV Network Monitoring/Control - DT Substations and MV feeders (Cluster-2/2020)	Implementation Project	Jan 2019 Dec 2020	13.500.000 TL
Distribution Automation	DA-8	MV Network Monitoring/Control - DT Substations and MV feeders (Cluster-2/2025)	Implementation Project	Jan 2021 Dec 2025	22.500.000 TL
Distribution Automation	DA-10	LV Network Measurement/Monitoring - DT and LV Feeders Monitoring and Measurement (Analogue and Digital) (Cluster-2/2020)	Implementation Project	Jan 2019 Dec 2020	24.000.000 TL
Distribution Automation	DA-11	LV Network Measurement/Monitoring - DT and LV Feeders Monitoring and Measurement (Analogue and Digital) (Cluster-	Implementation Project	Jan 2021 Dec 2025	72.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
		2/2025)			
Distribution Automation	DA-14	MV Network Innovative Distribution Automation Field Solutions	R&D/Pilot Application	Jan 2022 Jun 2023	1.800.000 TL
Ancillary Services	AS-1	Feasibility and Legislation Study for Distribution Networks Flexibility Resources and Ancillary Services	R&D/Pilot Application	Jan 2018 Dec 2018	500.000 TL
Ancillary Services	AS-4	Transmission and Distribution Ancillary Services for Distributed Generation Control, Manageable Loads and Storage Systems	R&D/Pilot Application	Jul 2023 Jun 2024	6.000.000 TL
Ancillary Services	AS-5	Installation of Ancillary Services Monitoring and Management System	Implementation Project	Jul 2024 Dec 2025	3.000.000 TL
Network Management - Data Analytics	NM-DA-1	Network Analytics Proof of Concept and Pilot Applications	R&D/Pilot Application	Jan 2019 Jun 2020	1.000.000 TL
Network Management - Data Analytics	NM-DA-2	Network Analytics Application and Dissemination Project	Implementation Project	Jan 2021 Dec 2022	9.000.000 TL
Outage Management	OM-1	Outage Management System Design	Design Study	Jul 2018 Dec 2018	450.000 TL
Outage Management	OM-2	Installation of Outage Management System	Implementation Project	Jan 2019 Dec 2019	3.600.000 TL
Outage Management	OM-3	Outage Management system - Social Media Integration	Implementation Project	Jan 2021 Jun 2022	3.600.000 TL
Outage Management	OM-4	Mobile Application for Outage Notification	Implementation Project	Jul 2019 Jun 2020	1.800.000 TL
Outage Management	OM-5	Mobile OMS Project	Implementation Project	Jan 2021 Jun 2022	4.500.000 TL
Micro Grids	MG-1	Defining Micro Grid Optimal Connection Criteria	R&D/Pilot Application	Jan 2022 Dec 2022	700.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Workforce Management	WFM-1	Defining and Designing WFM Business Rules	Design Study	Jan 2019 Dec 2019	1.500.000 TL
Workforce Management	WFM-2	Advance Workforce Management System Installation	Implementation Project	Jan 2021 Dec 2021	12.000.000 TL
Mobile Workforce Management	MWFM-1	MWFM Design Project	Design Study	Jan 2021 Dec 2021	900.000 TL
Mobile Workforce Management	MWFM-2	MWFM Installation	Implementation Project	Jan 2022 Dec 2022	4.200.000 TL
Innovative Grid Structures	IGS-3	Street Lighting LED Pilot Application	R&D/Pilot Application	Jan 2019 Dec 2020	3.000.000 TL

7.2.4 Detailed Road Map Scheduling for Cluster 2 (NM)





7.2.5 Suggested Projects/Actions List for Cluster 3 (NM)

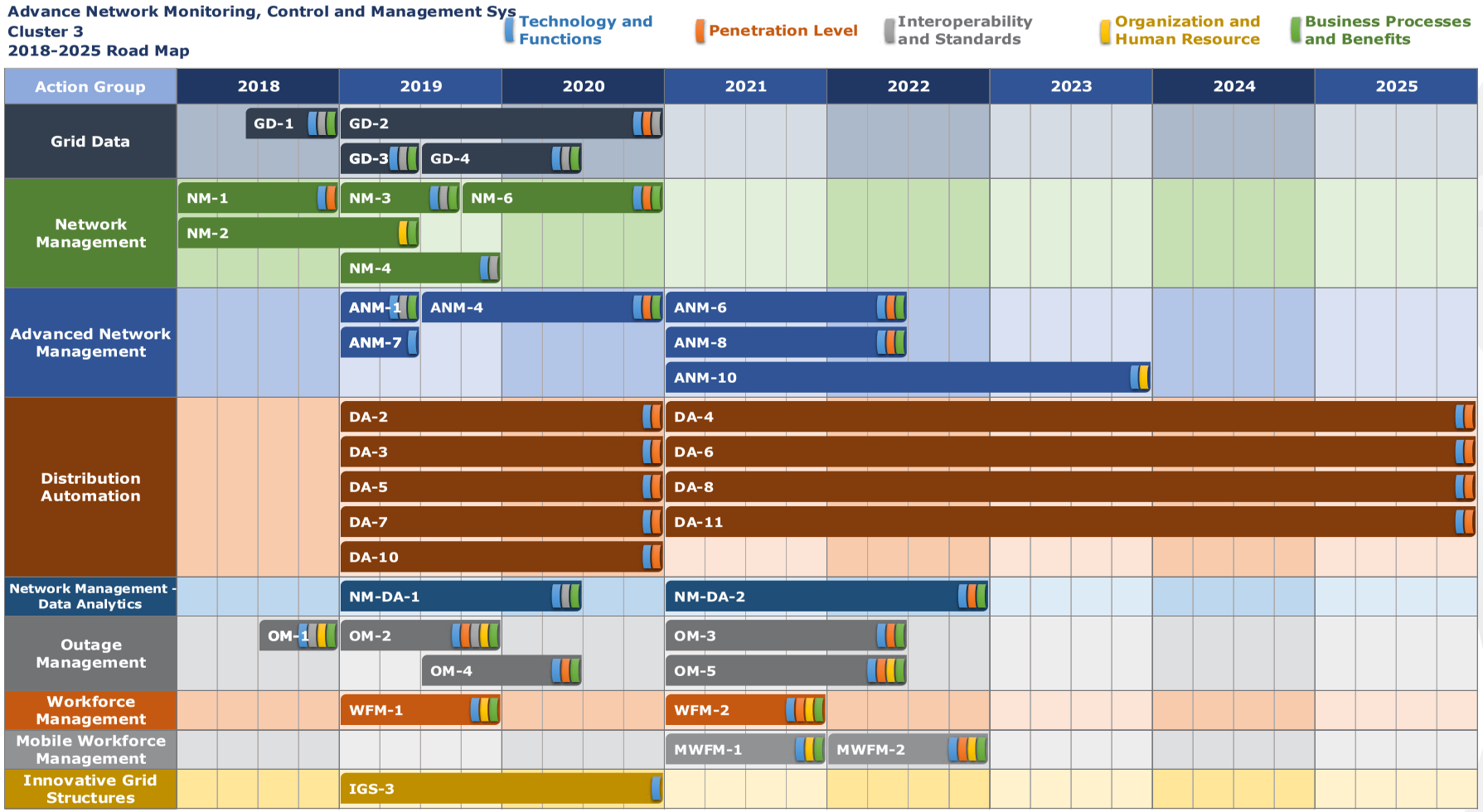
Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Grid Data	GD-1	Network Data Model Design	Design Study	**Jun 2018** Dec 2018	1.050.000 TL
Grid Data	GD-2	Network Connectivity Model İmprovement and Validation	Implementation Project	Jan 2019 **Dec 2020**	4.500.000 TL
Grid Data	GD-3	Gird Data Management and QC&QA Tracking Systems Design	Design Study	Jan 2019 Jun 2019	750.000 TL
Grid Data	GD-4	Grid Data Management and QC&QA Tracking Systems Installation	Implementation Project	Jul 2019 Jun 2020	2.250.000 TL
Network Management	NM-1	Installation of SCADA Control Centre	Implementation Project	Jan 2018 Dec 2018	12.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Network Management	NM-2	Network Management and Load Dispatch Centre Structure	Improvement Study	Jan 2018 Jun 2019	750.000 TL
Network Management	NM-3	ADMS Operational Integration Design	Design Study	Jan 2019 Sep 2019	1.050.000 TL
Network Management	NM-4	TSO SCADA Control Centre ICCP Integration	Implementation Project	Jan 2019 Dec 2019	1.500.000 TL
Network Management	NM-6	ADMS Installation and Application - NMS	Implementation Project	Oct 2019 Dec 2020	7.500.000 TL
Advanced Network Management	ANM-1	Advance Distribution Management Systems Design, Application or Improvement Planning	Planning	Jan 2019 Jun 2019	600.000 TL
Advanced Network Management	ANM-4	ADMS Installation and Application - DPF+SCA+SE	Implementation Project	Jul 2019 Dec 2020	6.000.000 TL
Advanced Network Management	ANM-6	ADMS Installation and Application - FLISR	Implementation Project	Jan 2021 Jun 2022	6.000.000 TL
Advanced Network Management	ANM-7	Managing Reactive Energy at all levels of Distribution Grid by New Monitoring Algorithms	R&D/Pilot Application	Jan 2019 Jun 2019	1.500.000 TL
Advanced Network Management	ANM-8	ADMS Installation and Application - VVC	Implementation Project	Jan 2021 Jun 2022	3.000.000 TL
Advanced Network Management	ANM-10	Live Line Work Pilot Application in Distribution Grids	R&D/Pilot Application	Jan 2021 Dec 2023	3.000.000 TL
Distribution Automation	DA-2	MV Network Monitoring/Control - TSO-DSO Interface	Implementation Project	Jan 2019 Dec 2020	3.000.000 TL
Distribution Automation	DA-3	MV Network Monitoring/Control - Primary Distribution Substation and Feeders (Cluster-3/2020)	Implementation Project	Jan 2019 Dec 2020	13.650.000 TL
Distribution Automation	DA-4	MV Network Monitoring/Control - Primary Distribution Substation and Feeders (Cluster-3/2025)	Implementation Project	Jan 2021 Dec 2025	27.300.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distribution Automation	DA-5	MV Network Monitoring/Control - Secondary Distribution Substation and Feeders (Cluster-3/2020)	Implementation Project	Jan 2019 Dec 2020	3.000.000 TL
Distribution Automation	DA-6	MV Network Monitoring/Control - Secondary Distribution Substation and Feeders (Cluster-3/2025)	Implementation Project	Jan 2021 Dec 2025	15.000.000 TL
Distribution Automation	DA-7	MV Network Monitoring/Control - DT Substations and MV feeders (Cluster-3/2020)	Implementation Project	Jan 2019 Dec 2020	4.500.000 TL
Distribution Automation	DA-8	MV Network Monitoring/Control - DT Substations and MV feeders (Cluster-3/2025)	Implementation Project	Jan 2021 Dec 2025	13.500.000 TL
Distribution Automation	DA-10	LV Network Measurement/Monitoring - DT and LV Feeders Monitoring and Measurement (Analogue and Digital) (Cluster-3/2020)	Implementation Project	Jan 2019 Dec 2020	6.000.000 TL
Distribution Automation	DA-11	LV Network Measurement/Monitoring - DT and LV Feeders Monitoring and Measurement (Analogue and Digital) (Cluster-3/2025)	Implementation Project	Jan 2021 Dec 2025	36.000.000 TL
Network Management - Data Analytics	NM-DA-1	Network Analytics Proof of Concept and Pilot Applications	R&D/Pilot Application	Jan 2019 Jun 2020	1.000.000 TL
Network Management - Data Analytics	NM-DA-2	Network Analytics Application and Dissemination Project	Implementation Project	Jan 2021 Dec 2022	4.500.000 TL
Outage Management	OM-1	Outage Management System Design	Design Study	Jul 2018 Dec 2018	450.000 TL
Outage Management	OM-2	Installation of Outage Management System	Implementation Project	Jan 2019 Dec 2019	3.600.000 TL
Outage Management	OM-3	Outage Management System - Social Media Integration	Implementation Project	Jan 2021 Jun 2022	1.800.000 TL
Outage Management	OM-4	Mobile Application for Outage Notification	Implementation Project	Jul 2019 Jun 2020	900.000 TL
Outage Management	OM-5	Mobile OMS Project	Implementation	Jan 2021	2.250.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
			Project	Jun 2022	
Workforce Management	WFM-1	Defining and Designing WFM Business Rules	Design Study	Jan 2019 Dec 2019	750.000 TL
Workforce Management	WFM-2	Advance Workforce Management System Installation	Implementation Project	Jan 2021 Dec 2021	6.000.000 TL
Mobile Workforce Management	MWFM-1	MWFM Design Project	Design Study	Jan 2021 Dec 2021	450.000 TL
Mobile Workforce Management	MWFM-2	MWFM Installation	Implementation Project	Jan 2022 Dec 2022	2.100.000 TL
Innovative Grid Structures	IGS-3	Street Lighting LED Pilot Application	R&D/Pilot Application	Jan 2019 Dec 2020	1.500.000 TL

7.2.6 Detailed Road Map Scheduling for Cluster 3 (NM)



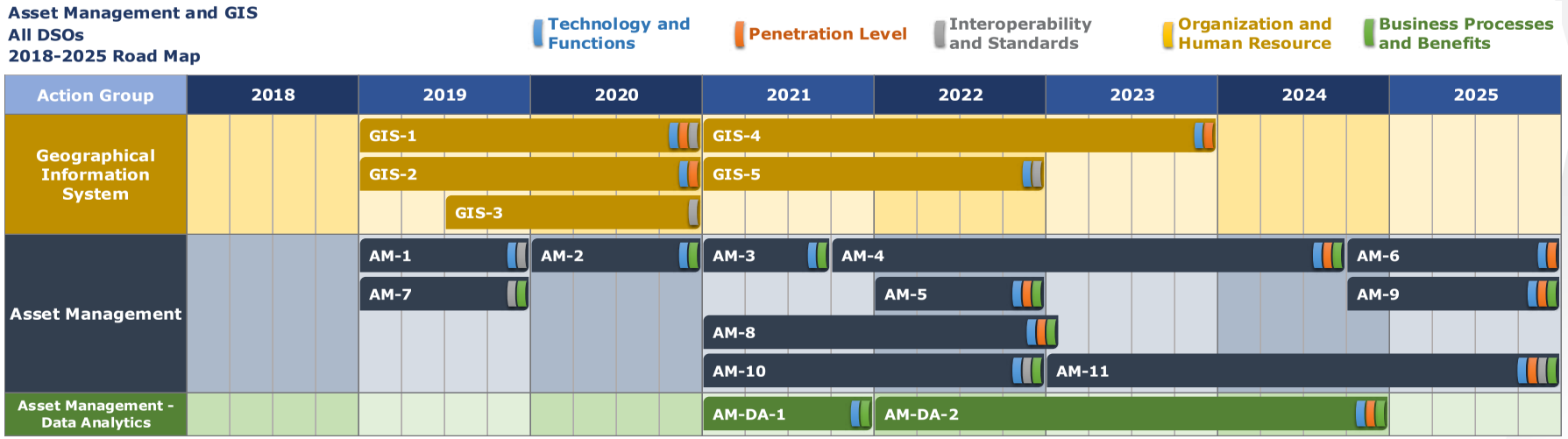
7.3 Asset Management and GIS (AM)

7.3.1 Suggested Projects/Actions List for All DSOs (AM)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Geographical Information System	GIS-1	Advance GIS Solution Installation/Improvement	Implementation Project	**Jan 2019** Dec 2020	31.500.000 TL
Geographical Information System	GIS-2	Mobile Field Data Collection and GIS Online Access Solutions Installation	Implementation Project	Jan 2019 **Dec 2020**	10.000.000 TL
Geographical Information System	GIS-3	GIS Data Model Update Study According to Smart Grid Requirements	R&D/Pilot Application	Jul 2019 Dec 2020	4.800.000 TL
Geographical Information System	GIS-4	Collection of Smart Grid Data Needs from Field for GIS	Implementation Project	Jan 2021 Dec 2023	105.000.000 TL
Geographical Information System	GIS-5	GIS Map Base Update Study and Map Base Integration with other Related SG Systems	Implementation Project	Jan 2021 Dec 2022	21.000.000 TL
Asset Management	AM-1	Grid Asset Management Design and Planning	Planning	Jan 2019 Dec 2019	4.200.000 TL
Asset Management	AM-2	Gris Assets Operational Conditions/Performance and Useful Life-Span Model Development	R&D/Pilot Application	Jan 2020 Dec 2020	6.300.000 TL
Asset Management	AM-3	Asset Operational Condition and Performance Monitoring Field Solutions Pilot Application	R&D/Pilot Application	Jan 2021 Sep 2021	15.000.000 TL
Asset Management	AM-4	Asset Management and Performance Monitoring System Installation	Implementation Project	Oct 2021 Sep 2024	84.000.000 TL
Asset Management	AM-5	DSO Technological System Asset (IT/OT) Management System Installation	Implementation Project	Jan 2022 Dec 2022	10.500.000 TL
Asset Management	AM-6	Using Field Monitoring Solutions (IoT, Censor Network) for Asset Operational Condition and Performance Monitoring Systems	Implementation Project	Oct 2024 Dec 2025	105.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Asset Management	AM-7	Developing Risk and Reliability Based Maintenance Planning Methods	R&D/Pilot Application	Jan 2019 Dec 2019	9.600.000 TL
Asset Management	AM-8	Reliability Based Maintenance Planning Application	Implementation Project	Jan 2021 Jan 2023	31.500.000 TL
Asset Management	AM-9	Improvement Asset Management Systems for Operational Life-Span Prediction	R&D/Pilot Application	Oct 2024 Dec 2025	7.500.000 TL
Asset Management	AM-10	Photographing OHL and Thermo-graphical Analyse Pilot Applications	R&D/Pilot Application	Jan 2021 Dec 2022	10.000.000 TL
Asset Management	AM-11	Photographing OHL and Thermo-graphical Analyse Applications	Implementation Project	Jan 2023 Dec 2025	42.000.000 TL
Asset Management - Data Analytics	AM-DA-1	Asset Performance Analytics Design and Proof of Concept Studies	R&D/Pilot Application	Jan 2021 Dec 2021	6.300.000 TL
Asset Management - Data Analytics	AM-DA-2	Asset Analytics Applications and Dissemination	Implementation Project	Jan 2022 Dec 2024	15.750.000 TL

7.3.2 Detailed Road Map Scheduling for All DSOs (AM)



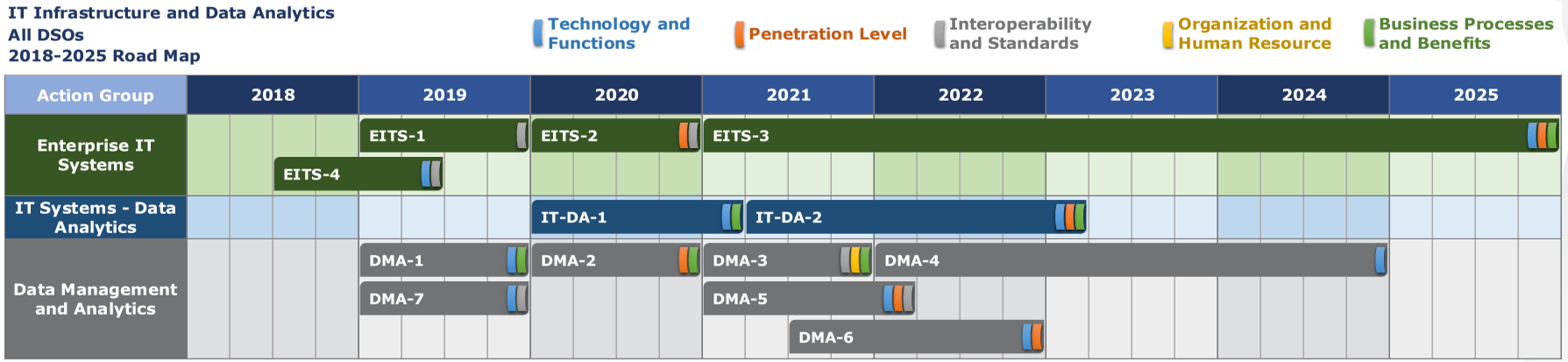
7.4 IT Infrastructure and Data Analytics (IT&DA)

7.4.1 Suggested Projects/Actions List for All DSOs (IT&DA)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Enterprise IT Systems	EITS-1	Enterprise IT Infrastructure Digitalization Road Map Study	Planning	**Jan 2019** Dec 2019	4.200.000 TL
Enterprise IT Systems	EITS-2	Planning Study to Determine Requirements of Enterprise IT Systems	Design Study	Jan 2020 **Dec 2020**	5.250.000 TL
Enterprise IT Systems	EITS-3	Advance Enterprise Applications Installation	Implementation Project	Jan 2021 Dec 2025	147.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Enterprise IT Systems	EITS-4	Call Centre and Customer Relationship Management System Improvement/Development Study	Implementation Project	Jul 2018 Jun 2019	6.300.000 TL
IT Systems - Data Analytics	IT-DA-1	Proof of Concept Study for Process Analytics and its Pilot Application	R&D/Pilot Application	Jan 2020 Mar. 2021	15.750.000 TL
IT Systems - Data Analytics	IT-DA-2	Process Analytics Dissemination Activities	Implementation Project	Apr 2021 Mar. 2023	52.500.000 TL
Data Management and Analytics	DMA-1	Data Analytics Enterprise Road Map Study	R&D/Pilot Application	Jan 2019 Dec 2019	7.350.000 TL
Data Management and Analytics	DMA-2	Analytics Domain Development Studies	Implementation Project	Jan 2020 Dec 2020	9.450.000 TL
Data Management and Analytics	DMA-3	Creating Data Management Processes for Big Data Analytics	Improvement Study	Jan 2021 Dec 2021	6.300.000 TL
Data Management and Analytics	DMA-4	Big Data Analytics Software Platform Installation	Implementation Project	Jan 2022 Dec 2024	63.000.000 TL
Data Management and Analytics	DMA-5	Applying Advance Load Estimation Algorithm and MDM Data Integration	R&D/Pilot Application	Jan 2021 Mar. 2022	9.450.000 TL
Data Management and Analytics	DMA-6	Installation of Advance and Integrated Load Estimation Systems in Distribution	Implementation Project	Jul 2021 Dec 2022	25.200.000 TL
Data Management and Analytics	DMA-7	Development of Common Data Model, Data Transfer Methods and Protocols/Standards for EDVARS	R&D/Pilot Application	Jan 2019 Dec 2019	9.450.000 TL

7.4.2 Detailed Road Map Scheduling for All DSOs (IT&DA)



7.5 Distributed Generation Integration and Storage (DG&S)

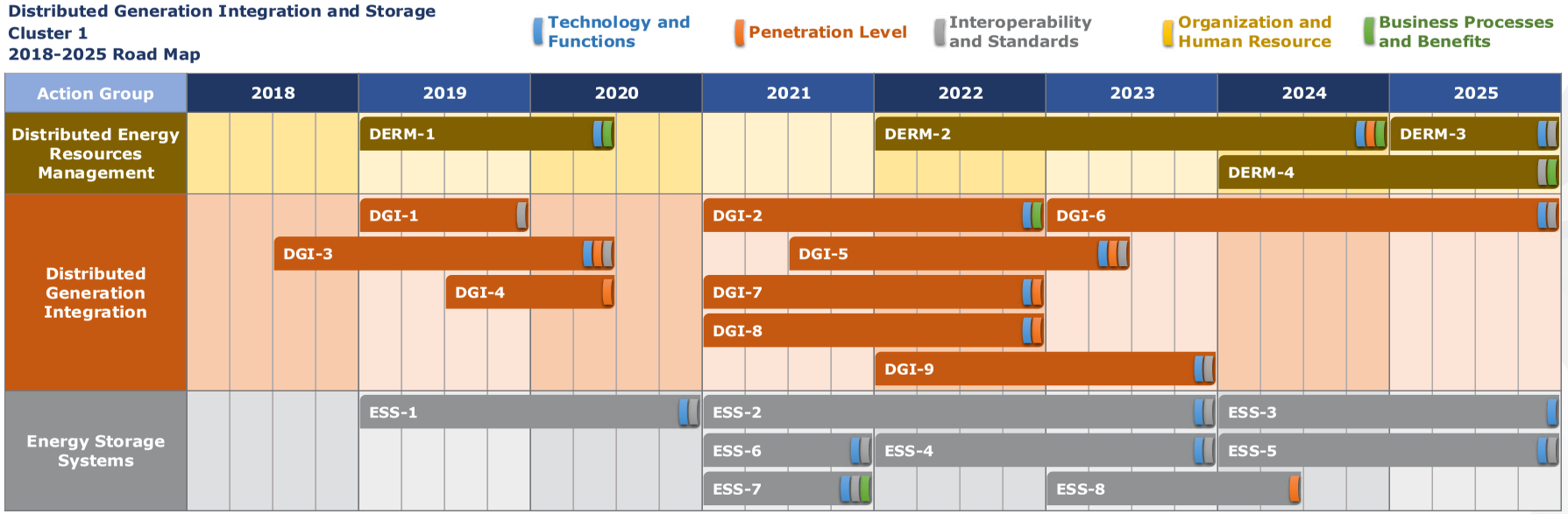
7.5.1 Suggested Projects/Actions List for Cluster 1 (DG&S)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distributed Energy Resources Management	DERM-1	Analysing the effects of Distributed Energy Resources and Flexibility Management Models on Electricity Distribution Networks	R&D/Pilot Application	**Jan 2019** Jun 2020	5.250.000 TL
Distributed Energy Resources Management	DERM-2	Distributed Energy Resources Management System Installation Project	Implementation Project	Jan 2022 **Dec 2024**	60.000.000 TL
Distributed Energy Resources Management	DERM-3	Aggregator and DSO DERM Systems Integration	Implementation Project	Jan 2025 Dec 2025	18.000.000 TL
Distributed Energy Resources Management	DERM-4	Distributed Energy Resources Coordinated Management Applications in Distribution Networks	R&D/Pilot Application	Jan 2024 Dec 2025	1.080.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distributed Generation Integration	DGI-1	Creating Minimum/Common Network Connection Criteria for Distributed Energy Resources	R&D/Pilot Application	Jan 2019 Dec 2019	3.000.000 TL
Distributed Generation Integration	DGI-2	Following DER Connection Agreements Processes over Network Connection Tracking and Evaluation System	Implementation Project	Jan 2021 Dec 2022	6.000.000 TL
Distributed Generation Integration	DGI-3	Distributed Generation Real-time Monitoring System Installation and Integration	Implementation Project	Jul 2018 Jun 2020	14.400.000 TL
Distributed Generation Integration	DGI-4	Middle and Long Term Penetration Level Estimation for MV and LV Connected DER and Action Panning	R&D/Pilot Application	Jul 2019 Jun 2020	4.200.000 TL
Distributed Generation Integration	DGI-5	Distributed Generation Real-time Control System Installation and Integration	Implementation Project	Jul 2021 Jun 2023	15.000.000 TL
Distributed Generation Integration	DGI-6	High Penetration Pilot Application and Effect Analysis for Distributed Generation In LV Networks	R&D/Pilot Application	Jan 2023 Dec 2025	30.000.000 TL
Distributed Generation Integration	DGI-7	Distributed Generation Estimation Solutions	Implementation Project	Jan 2021 Dec 2022	7.800.000 TL
Distributed Generation Integration	DGI-8	Solution Development to Increase the Capacity of Distributed Generation Connected to Grid	R&D/Pilot Application	Jan 2021 Dec 2022	4.000.000 TL
Distributed Generation Integration	DGI-9	Analysing the effects of Hybrid LV Plants that have Roof-Top PV and Storage by Exist Systems	R&D/Pilot Application	Jan 2022 Dec 2023	7.500.000 TL
Energy Storage Systems	ESS-1	Analysing and Designing of Different Energy Storage Technologies by Considering Distribution Network Needs	R&D/Pilot Application	Jan 2019 Dec 2020	3.850.000 TL
Energy Storage Systems	ESS-2	Large Scale Energy Storage System Pilot Application in Distribution Network	R&D/Pilot Application	Jan 2021 Dec 2023	42.000.000 TL
Energy Storage Systems	ESS-3	Pumped-Storage Pilot Application	R&D/Pilot Application	Jan 2024 Dec 2025	4.500.000 TL
Energy Storage Systems	ESS-4	High Usage of Energy Storage Systems in LV Distribution Network	R&D/Pilot Application	Jan 2022 Dec 2023	9.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Energy Storage Systems	ESS-5	Behind the Meter Energy Storage System Pilot Project	R&D/Pilot Application	Jan 2024 Dec 2025	7.500.000 TL
Energy Storage Systems	ESS-6	Energy Storage Systems and DSO Systems interoperability Pilot Application	R&D/Pilot Application	Jan 2021 Dec 2021	5.400.000 TL
Energy Storage Systems	ESS-7	Creating Advance Connection Criteria and Rules for Energy Storage Systems	Design Study	Jan 2021 Dec 2021	1.800.000 TL
Energy Storage Systems	ESS-8	Middle and Long Term Connection Estimation For Energy Storage Systems and Action Planning	R&D/Pilot Application	Jan 2023 Jun 2024	6.000.000 TL

7.5.2 Detailed Road Map Scheduling for Cluster 1 (DG&S)

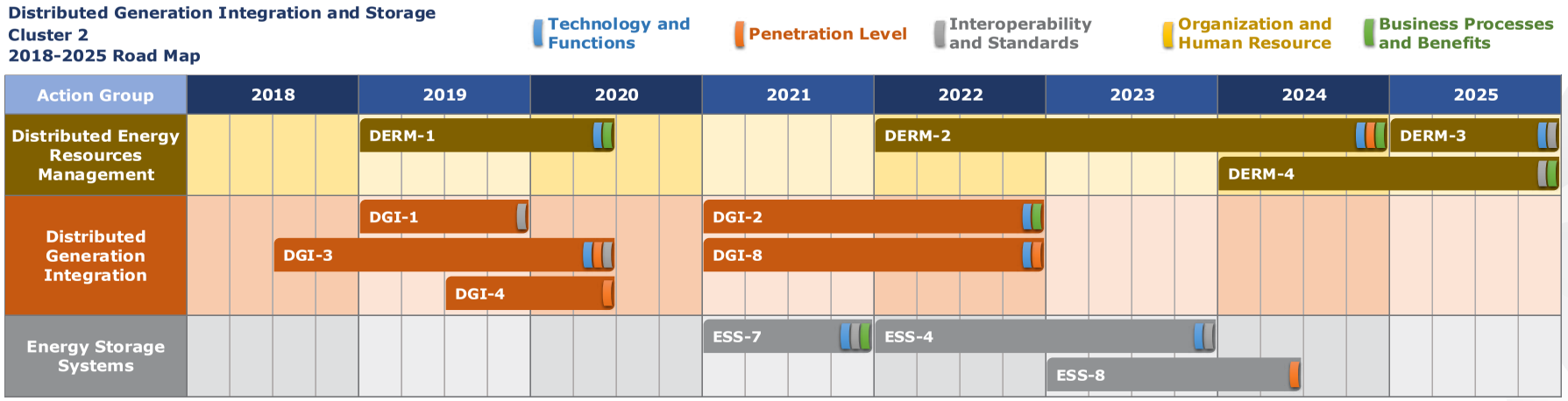


7.5.3 Suggested Projects/Actions List for Cluster 2 (DG&S)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distributed Energy Resources Management	DERM-1	Analysing the effects of Distributed Energy Resources and Flexibility Management Models on Electricity Distribution Networks	R&D/Pilot Application	**Jan 2019** Jun 2020	2.250.000 TL
Distributed Energy Resources Management	DERM-2	Distributed Energy Resources Management System Installation Project	Implementation Project	Jan 2022 **Dec 2024**	20.000.000 TL
Distributed Energy Resources Management	DERM-3	Aggregator and DSO DERM Systems Integration	Implementation Project	Jan 2025 Dec 2025	6.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distributed Energy Resources Management	DERM-4	Distributed Energy Resources Coordinated Management Applications in Distribution Networks	R&D/Pilot Application	Jan 2024 Dec 2025	360.000 TL
Distributed Generation Integration	DGI-1	Creating Minimum/Common Network Connection Criteria for Distributed Energy Resources	R&D/Pilot Application	Jan 2019 Dec 2019	1.000.000 TL
Distributed Generation Integration	DGI-2	Following DER Connection Agreements Processes over Network Connection Tracking and Evaluation System	Implementation Project	Jan 2021 Dec 2022	2.000.000 TL
Distributed Generation Integration	DGI-3	Distributed Generation Real-time Monitoring System Installation and Integration	Implementation Project	Jul 2018 Jun 2020	4.800.000 TL
Distributed Generation Integration	DGI-4	Middle and Long Term Penetration Level Estimation for MV and LV Connected DER and Action Panning	R&D/Pilot Application	Jul 2019 Jun 2020	1.400.000 TL
Distributed Generation Integration	DGI-8	Solution Development to Increase the Capacity of Distributed Generation Connected to Grid	R&D/Pilot Application	Jan 2021 Dec 2022	1.000.000 TL
Energy Storage Systems	ESS-4	High Usage of Energy Storage Systems in LV Distribution Network	R&D/Pilot Application	Jan 2022 Dec 2023	3.000.000 TL
Energy Storage Systems	ESS-7	Creating Advance Connection Criteria and Rules for Energy Storage Systems	Design Study	Jan 2021 Dec 2021	600.000 TL
Energy Storage Systems	ESS-8	Middle and Long Term Connection Estimation For Energy Storage Systems and Action Planning	R&D/Pilot Application	Jan 2023 Jun 2024	2.000.000 TL

7.5.4 Detailed Road Map Scheduling for Cluster 2 (DG&S)

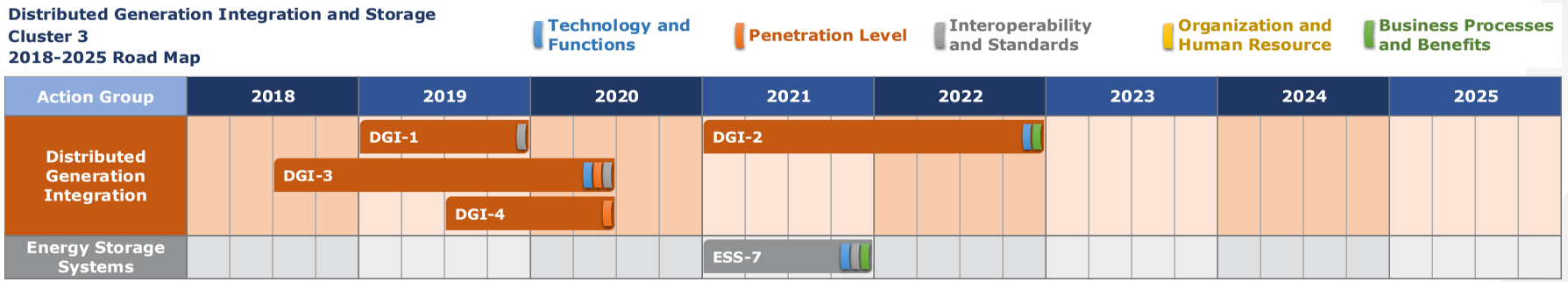


7.5.5 Suggested Projects/Actions List for Cluster 3 (DG&S)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distributed Generation Integration	DGI-1	Creating Minimum/Common Network Connection Criteria for Distributed Energy Resources	R&D/Pilot Application	**Jan 2019** Dec 2019	1.250.000 TL
Distributed Generation Integration	DGI-2	Following DER Connection Agreements Processes over Network Connection Tracking and Evaluation System	Implementation Project	Jan 2021 **Dec 2022**	2.500.000 TL
Distributed Generation Integration	DGI-3	Distributed Generation Real-time Monitoring System Installation and Integration	Implementation Project	Jul 2018 Jun 2020	6.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Distributed Generation Integration	DGI-4	Middle and Long Term Penetration Level Estimation for MV and LV Connected DER and Action Panning	R&D/Pilot Application	Jul 2019 Jun 2020	1.750.000 TL
Energy Storage Systems	ESS-7	Creating Advance Connection Criteria and Rules for Energy Storage Systems	Design Study	Jan 2021 Dec 2021	750.000 TL

7.5.6 Detailed Road Map Scheduling for Cluster 3 (DG&S)



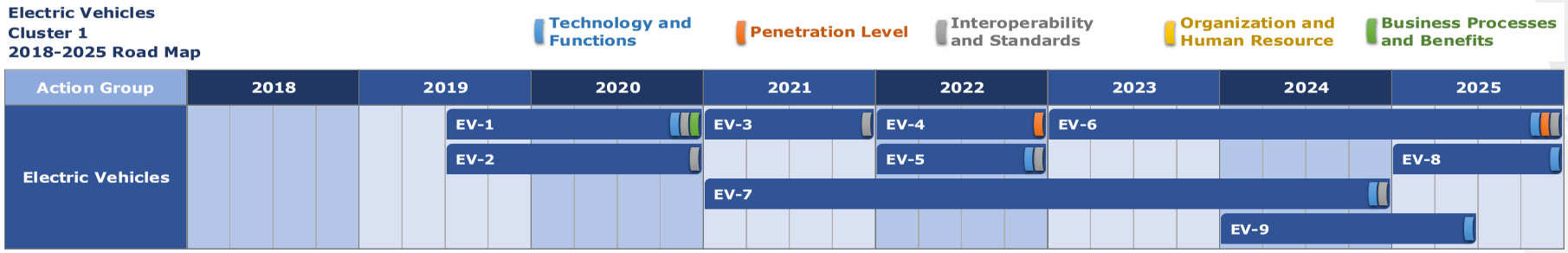
7.6 Electric Vehicles (EV)

7.6.1 Suggested Projects/Actions List for Cluster 1 (EV)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Electric Vehicles	EV-1	Creating minimum Connection Criteria for EV Charging Station and Network Integration	R&D/Pilot Application	**Jul 2019** Dec 2020	1.350.000 TL
Electric	EV-2	EV Load Characterization Studies	R&D/Pilot	Jul 2019	1.500.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Vehicles			Application	**Dec 2020**	
Electric Vehicles	EV-3	Studies for EV Usage Habits and Its Effects on Network	R&D/Pilot Application	Jan 2021 Dec 2021	3.000.000 TL
Electric Vehicles	EV-4	Middle and Long Term the number of Connection Estimation for EV Charging Station on MV and LV Networks and Action Planning	R&D/Pilot Application	Jan 2022 Dec 2022	2.700.000 TL
Electric Vehicles	EV-5	Creating EV and EV Charging Station Connection Guide	R&D/Pilot Application	Jan 2022 Dec 2022	3.000.000 TL
Electric Vehicles	EV-6	EV Charging Station Monitoring, Measurement and Control System Installation and Its Integration with Network Management Systems	Implementation Project	Jan 2023 Dec 2025	24.000.000 TL
Electric Vehicles	EV-7	V2G and V2B Technologies Field Pilot Application	R&D/Pilot Application	Jan 2021 Dec 2024	16.000.000 TL
Electric Vehicles	EV-8	Electric Vehicle Network Lab Installation	R&D/Pilot Application	Jan 2025 Dec 2025	12.000.000 TL
Electric Vehicles	EV-9	Auto EV Charge/de-Charge Control	R&D/Pilot Application	Jan 2024 Jun 2025	18.000.000 TL

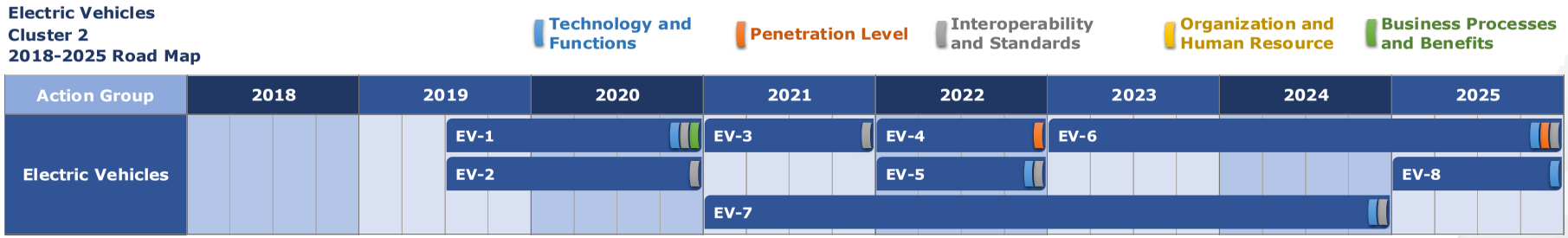
7.6.2 Detailed Road Map Scheduling for Cluster 1 (EV)



7.6.3 Suggested Projects/Actions List for Cluster 2 (EV)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Electric Vehicles	EV-1	Creating minimum Connection Criteria for EV Charging Station and Network Integration	R&D/Pilot Application	**Jul 2019** Dec 2020	2.250.000 TL
Electric Vehicles	EV-2	EV Load Characterization Studies	R&D/Pilot Application	Jul 2019 **Dec 2020**	2.500.000 TL
Electric Vehicles	EV-3	Studies for EV Usage Habits and Its Effects on Network	R&D/Pilot Application	Jan 2021 Dec 2021	2.250.000 TL
Electric Vehicles	EV-4	Middle and Long Term the number of Connection Estimation for EV Charging Station on MV and LV Networks and Action Planning	R&D/Pilot Application	Jan 2022 Dec 2022	4.050.000 TL
Electric Vehicles	EV-5	Creating EV and EV Charging Station Connection Guide	R&D/Pilot Application	Jan 2022 Dec 2022	4.500.000 TL
Electric Vehicles	EV-6	EV Charging Station Monitoring, Measurement and Control System Installation and Its Integration with Network Management Systems	Implementation Project	Jan 2023 Dec 2025	36.000.000 TL
Electric Vehicles	EV-7	V2G and V2B Technologies Field Pilot Application	R&D/Pilot Application	Jan 2021 Dec 2024	12.000.000 TL
Electric Vehicles	EV-8	Electric Vehicle Network Lab Installation	R&D/Pilot Application	Jan 2025 Dec 2025	18.000.000 TL

7.6.4 Detailed Road Map Scheduling for Cluster 2 (EV)



7.6.5 Suggested Projects/Actions List for Cluster 3 (EV)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Electric Vehicles	EV-1	Creating minimum Connection Criteria for EV Charging Station and Network Integration	R&D/Pilot Application	**Jul 2019** Dec 2020	900.000 TL

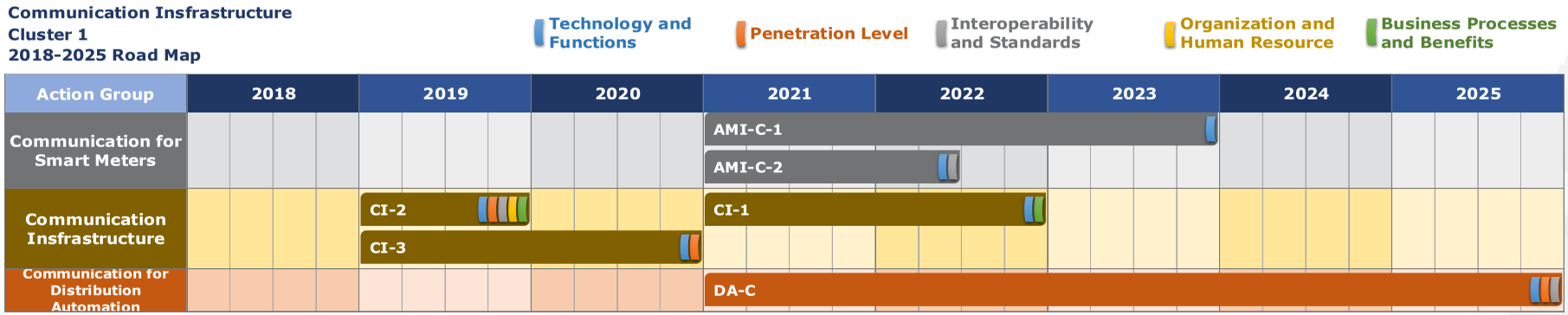
7.6.6 Detailed Road Map Scheduling for Cluster 3 (EV)

7.7 Communication Infrastructure (CI)

7.7.1 Suggested Projects/Actions List for Cluster 1 (CI)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Communication for Smart Meters	AMI-C-1	Using New Generation LPWAN Communication Technologies in Smart Grid Infrastructure	R&D/Pilot Application	**Jan 2021** Dec 2023	21.000.000 TL
Communication for Smart Meters	AMI-C-2	Smart Meter Interoperability and Field Conditions Test Lab Installation	Implementation Project	Jan 2021 **Jun 2022**	7.000.000 TL
Communication Infrastructure	CI-1	Field Crew Communication Infrastructure Installation	Implementation Project	Jan 2021 Dec 2022	14.000.000 TL
Communication Infrastructure	CI-2	IT/OT Exist Communication Architecture Evaluation and Optimization Studies	Improvement Study	Jan 2019 Dec 2019	1.400.000 TL
Communication Infrastructure	CI-3	Communication Network Monitoring and Management System Installation	Implementation Project	Jan 2019 Dec 2020	8.750.000 TL
Communication for Distribution Automation	DA-C	Replacing Exist Automation Equipment that do not support International Interoperability Standards	Implementation Project	Jan 2021 Dec 2025	49.000.000 TL

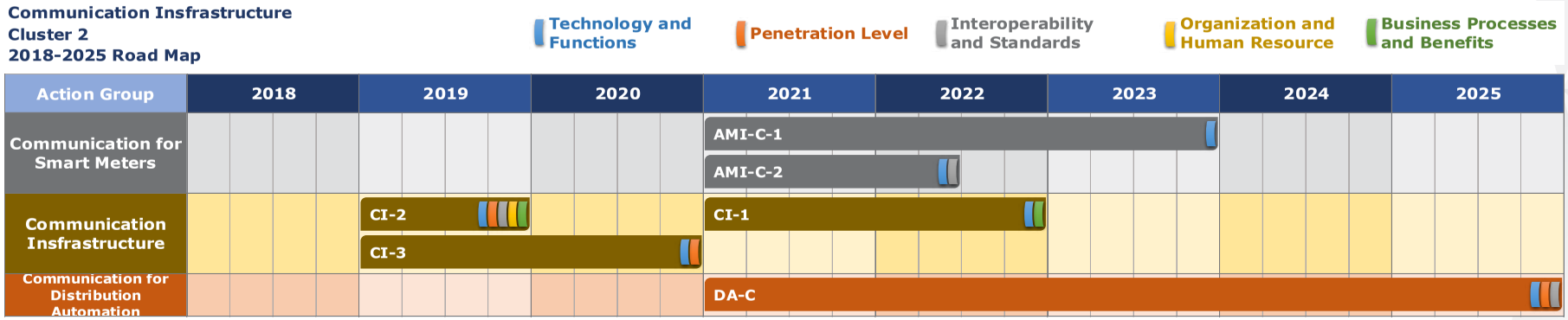
7.7.2 Detailed Road Map Scheduling for Cluster 1 (CI)



7.7.3 Suggested Projects/Actions List for Cluster 2 (CI)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Communication for Smart Meters	AMI-C-1	Using New Generation LPWAN Communication Technologies in Smart Grid Infrastructure	R&D/Pilot Application	**Jan 2021** Dec 2023	15.000.000 TL
Communication for Smart Meters	AMI-C-2	Smart Meter Interoperability and Field Conditions Test Lab Installation	Implementation Project	Jan 2021 **Jun 2022**	8.000.000 TL
Communication Infrastructure	CI-1	Field Crew Communication Infrastructure Installation	Implementation Project	Jan 2021 Dec 2022	16.000.000 TL
Communication Infrastructure	CI-2	IT/OT Exist Communication Architecture Evaluation and Optimization Studies	Improvement Study	Jan 2019 Dec 2019	1.600.000 TL
Communication Infrastructure	CI-3	Communication Network Monitoring and Management System Installation	Implementation Project	Jan 2019 Dec 2020	10.000.000 TL
Communication for Distribution Automation	DA-C	Replacing Exist Automation Equipment that do not support International Interoperability Standards	Implementation Project	Jan 2021 Dec 2025	56.000.000 TL

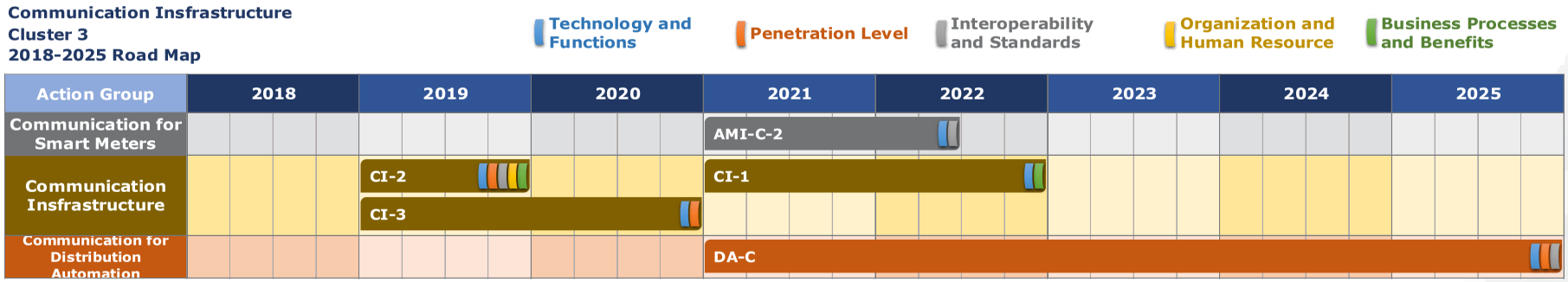
7.7.4 Detailed Road Map Scheduling for Cluster 2 (CI)



7.7.5 Suggested Projects/Actions List for Cluster 3 (CI)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Communication for Smart Meters	AMI-C-2	Smart Meter Interoperability and Field Conditions Test Lab Installation	Implementation Project	**Jan 2021** Jun 2022	6.000.000 TL
Communication Infrastructure	CI-1	Field Crew Communication Infrastructure Installation	Implementation Project	Jan 2021 **Dec 2022**	12.000.000 TL
Communication Infrastructure	CI-2	IT/OT Exist Communication Architecture Evaluation and Optimization Studies	Improvement Study	Jan 2019 Dec 2019	1.200.000 TL
Communication Infrastructure	CI-3	Communication Network Monitoring and Management System Installation	Implementation Project	Jan 2019 Dec 2020	7.500.000 TL
Communication for Distribution Automation	DA-C	Replacing Exist Automation Equipment that do not support International Interoperability Standards	Implementation Project	Jan 2021 Dec 2025	42.000.000 TL

7.7.6 Detailed Road Map Scheduling for Cluster 3 (CI)



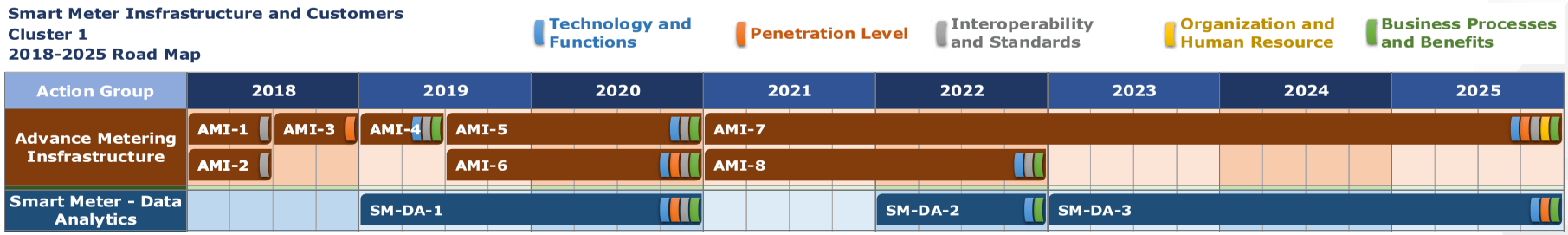
7.8 Smart Meter Infrastructure and Customers (SM&C)

7.8.1 Suggested Projects/Actions List for Cluster 1 (SM&C)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advance Metering Infrastructure	AMI-1	Defining Minimum Smart Meter Requirements and International Interoperability Standards	R&D/Pilot Application	**Jan 2018** Jun 2018	600.000 TL
Advance Metering Infrastructure	AMI-2	Defining Turkey Minimum Common Code Structure and Object Model for Smart Meters	R&D/Pilot Application	Jan 2018 **Jun 2018**	1.350.000 TL
Advance Metering Infrastructure	AMI-3	Study DSO Region Specific Cost Benefit Analyses with Smart Meter 2025 and 2035 Penetration Planning	R&D/Pilot Application	Jul 2018 Dec 2018	1.500.000 TL
Advance Metering Infrastructure	AMI-4	Advance Metering Infrastructure Design and Planning	Design Study	Jan 2019 Jun 2019	1.200.000 TL
Advance Metering Infrastructure	AMI-5	Large Scale Pilot Project for AMI	R&D/Pilot Application	Jul 2019 Dec 2020	10.500.000 TL
Advance Metering Infrastructure	AMI-6	Meter Data Management System Installation	Implementation Project	Jul 2019 Dec 2020	24.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advance Metering Infrastructure	AMI-7	AMI Installation and SM Roll Out	Implementation Project	Jan 2021 Dec 2025	283.500.000 TL
Advance Metering Infrastructure	AMI-8	AMI - Customer Interaction Applications	Implementation Project	Jan 2021 Dec 2022	3.750.000 TL
Smart Meter - Data Analytics	SM-DA-1	Energy Data Sharing Platform Installation for Consumers in order to share Comparable Bills	Implementation Project	Jan 2019 Dec 2020	7.200.000 TL
Smart Meter - Data Analytics	SM-DA-2	Meter Data Analytics Pilot Application and PoC	R&D/Pilot Application	Jan 2022 Dec 2022	3.000.000 TL
Smart Meter - Data Analytics	SM-DA-3	Meter Data Analytics Application	Implementation Project	Jan 2023 Dec 2025	12.000.000 TL

7.8.2 Detailed Road Map Scheduling for Cluster 1 (SM&C)



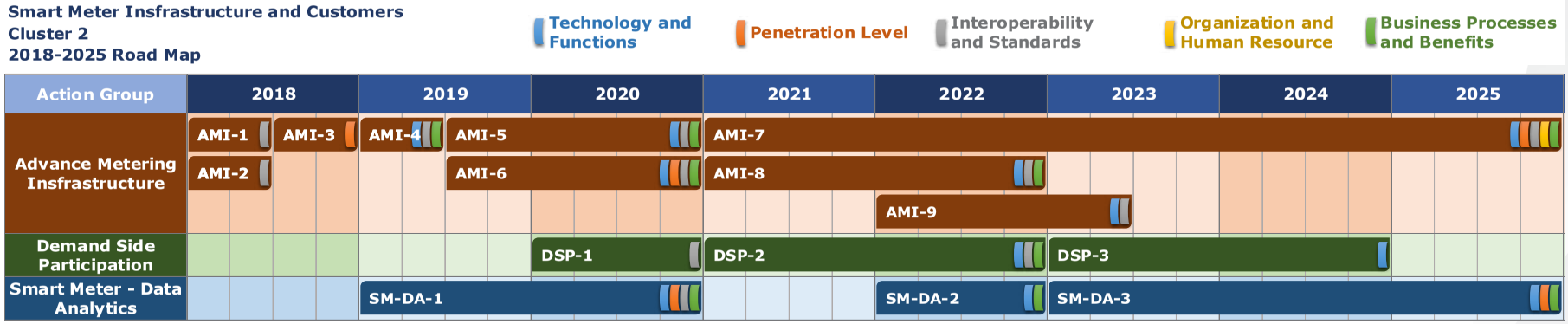
7.8.3 Suggested Projects/Actions List for Cluster 2 (SM&C)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advance Metering Infrastructure	AMI-1	Defining Minimum Smart Meter Requirements and International Interoperability Standards	R&D/Pilot Application	**Jan 2018** Jun 2018	2.400.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advance Metering Infrastructure	AMI-2	Defining Turkey Minimum Common Code Structure and Object Model for Smart Meters	R&D/Pilot Application	Jan 2018 **Jun 2018**	5.400.000 TL
Advance Metering Infrastructure	AMI-3	Study DSO Region Specific Cost Benefit Analyses with Smart Meter 2025 and 2035 Penetration Planning	R&D/Pilot Application	Jul 2018 Dec 2018	6.000.000 TL
Advance Metering Infrastructure	AMI-4	Advance Metering Infrastructure Design and Planning	Design Study	Jan 2019 Jun 2019	4.800.000 TL
Advance Metering Infrastructure	AMI-5	Large Scale Pilot Project for AMI	R&D/Pilot Application	Jul 2019 Dec 2020	33.600.000 TL
Advance Metering Infrastructure	AMI-6	Meter Data Management System Installation	Implementation Project	Jul 2019 Dec 2020	96.000.000 TL
Advance Metering Infrastructure	AMI-7	AMI Installation and SM Roll Out	Implementation Project	Jan 2021 Dec 2025	840.000.000 TL
Advance Metering Infrastructure	AMI-8	AMI - Customer Interaction Applications	Implementation Project	Jan 2021 Dec 2022	15.000.000 TL
Advance Metering Infrastructure	AMI-9	Comparing and Analysing Different Mechanism for Meter Data Sharing and Management among different Stakeholders	R&D/Pilot Application	Jan 2022 Jun 2023	4.500.000 TL
Demand Side Participation	DSP-1	Comparing Different Market and Tariff Models for Demand Side Participation	R&D/Pilot Application	Jan 2020 Dec 2020	3.750.000 TL
Demand Side Participation	DSP-2	Installation of Management Infrastructure to manage the Peak Demand caused by Heating and Air Conditioning Welds	Implementation Project	Jan 2021 Dec 2022	18.000.000 TL
Demand Side Participation	DSP-3	Comparing Different Advance Demand Side Participation Solutions to Manage Customers Energy Usage Behaviour over Smart Meters	R&D/Pilot Application	Jan 2023 Dec 2024	28.000.000 TL
Smart Meter - Data Analytics	SM-DA-1	Energy Data Sharing Platform Installation for Consumers in order to share Comparable Bills	Implementation Project	Jan 2019 Dec 2020	3.600.000 TL
Smart Meter - Data Analytics	SM-DA-2	Meter Data Analytics Pilot Application and PoC	R&D/Pilot Application	Jan 2022 Dec 2022	7.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Smart Meter - Data Analytics	SM-DA-3	Meter Data Analytics Application	Implementation Project	Jan 2023 Dec 2025	48.000.000 TL

7.8.4 Detailed Road Map Scheduling for Cluster 2 (SM&C)

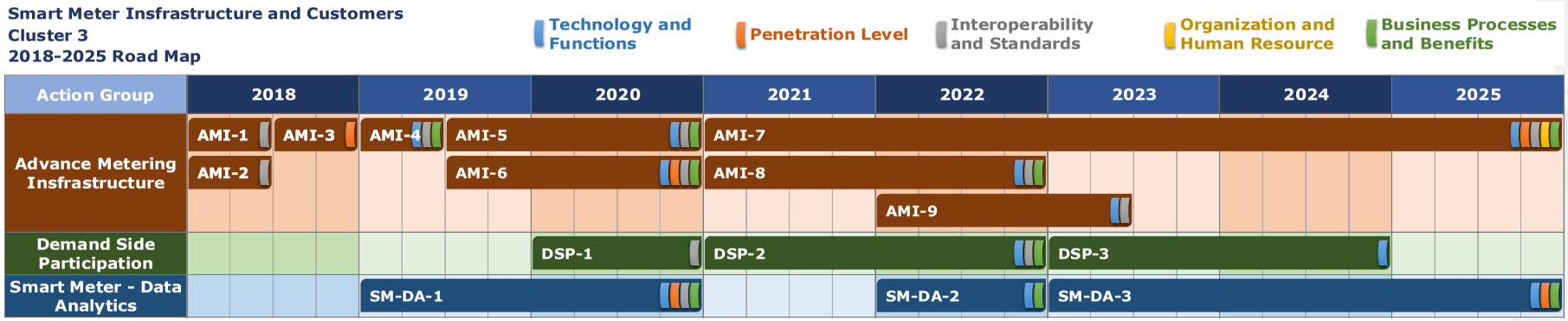


7.8.5 Suggested Projects/Actions List for Cluster 3 (SM&C)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advance Metering Infrastructure	AMI-1	Defining Minimum Smart Meter Requirements and International Interoperability Standards	R&D/Pilot Application	**Jan 2018** Jun 2018	1.200.000 TL
Advance Metering Infrastructure	AMI-2	Defining Turkey Minimum Common Code Structure and Object Model for Smart Meters	R&D/Pilot Application	Jan 2018 **Jun 2018**	2.700.000 TL
Advance Metering Infrastructure	AMI-3	Study DSO Region Specific Cost Benefit Analyses with Smart Meter 2025 and 2035 Penetration Planning	R&D/Pilot Application	Jul 2018 Dec 2018	3.000.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Advance Metering Infrastructure	AMI-4	Advance Metering Infrastructure Design and Planning	Design Study	Jan 2019 Jun 2019	2.400.000 TL
Advance Metering Infrastructure	AMI-5	Large Scale Pilot Project for AMI	R&D/Pilot Application	Jul 2019 Dec 2020	10.500.000 TL
Advance Metering Infrastructure	AMI-6	Meter Data Management System Installation	Implementation Project	Jul 2019 Dec 2020	48.000.000 TL
Advance Metering Infrastructure	AMI-7	AMI Installation and SM Roll Out	Implementation Project	Jan 2021 Dec 2025	220.500.000 TL
Advance Metering Infrastructure	AMI-8	AMI - Customer Interaction Applications	Implementation Project	Jan 2021 Dec 2022	7.500.000 TL
Advance Metering Infrastructure	AMI-9	Comparing and Analysing Different Mechanism for Meter Data Sharing and Management among different Stakeholders	R&D/Pilot Application	Jan 2022 Jun 2023	1.500.000 TL
Demand Side Participation	DSP-1	Comparing Different Market and Tariff Models for Demand Side Participation	R&D/Pilot Application	Jan 2020 Dec 2020	0 TL
Demand Side Participation	DSP-2	Installation of Management Infrastructure to manage the Peak Demand caused by Heating and Air Conditioning Welds	Implementation Project	Jan 2021 Dec 2022	9.000.000 TL
Demand Side Participation	DSP-3	Comparing Different Advance Demand Side Participation Solutions to Manage Customers Energy Usage Behaviour over Smart Meters	R&D/Pilot Application	Jan 2023 Dec 2024	12.000.000 TL
Smart Meter - Data Analytics	SM-DA-1	Energy Data Sharing Platform Installation for Consumers in order to share Comparable Bills	Implementation Project	Jan 2019 Dec 2020	1.800.000 TL
Smart Meter - Data Analytics	SM-DA-2	Meter Data Analytics Pilot Application and PoC	R&D/Pilot Application	Jan 2022 Dec 2022	0 TL
Smart Meter - Data Analytics	SM-DA-3	Meter Data Analytics Application	Implementation Project	Jan 2023 Dec 2025	24.000.000 TL

7.8.6 Detailed Road Map Scheduling for Cluster 3 (SM&C)



7.9 Enterprise Application Integration (I)

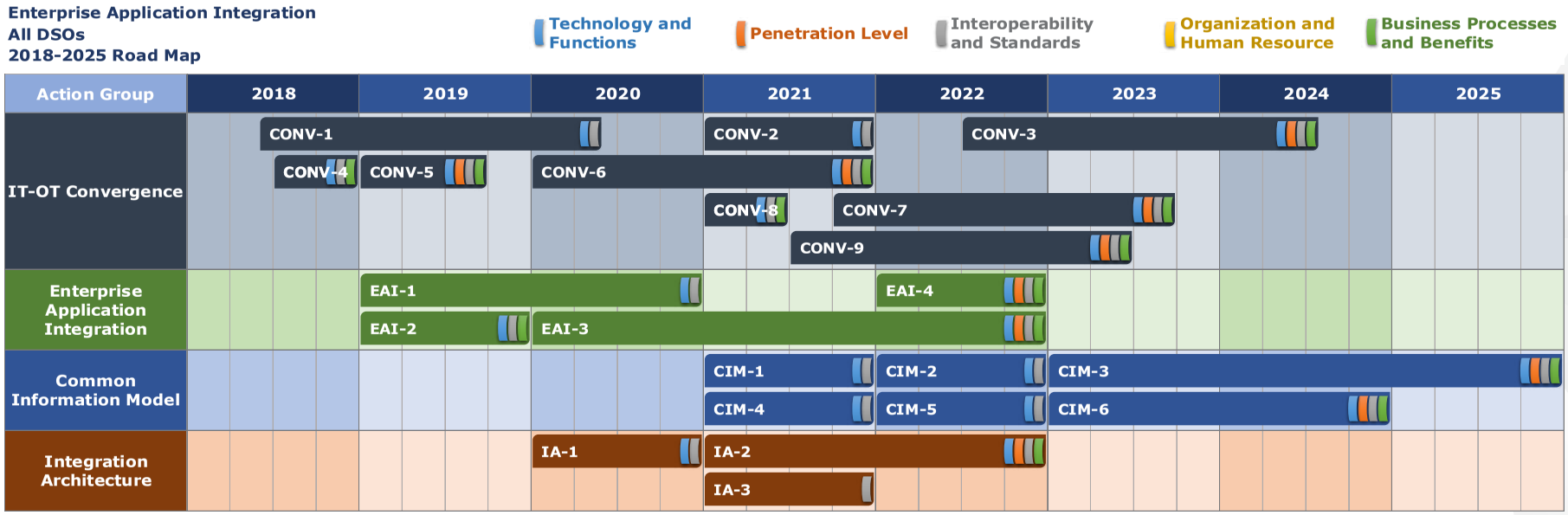
7.9.1 Suggested Projects/Actions List for All DSOs (I)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
IT-OT Convergence	CONV-1	Network Monitoring/Management Systems Real-time (Situational Awareness) Measurement/Data Integration	Implementation Project	**Jun 2018** May. 2020	15.750.000 TL
IT-OT Convergence	CONV-2	Smart Meter Data and Network Management System Integration For Real-time Data Flow Pilot Application	R&D/Pilot Application	Jan 2021 **Dec 2021**	8.400.000 TL
IT-OT Convergence	CONV-3	Smart Meter Data and Network Management System Integration For Real-time Data Flow	Implementation Project	Jul 2022 Jul 2024	16.800.000 TL
IT-OT Convergence	CONV-4	Real-time Data Integration Design for Outage Management	Design Study	Jul 2018 Dec 2018	3.000.000 TL
IT-OT Convergence	CONV-5	Real-time Data Integration for Outage Management	Implementation Project	Jan 2019 Sep 2019	10.500.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
IT-OT Convergence	CONV-6	GIS Integration	Implementation Project	Jan 2020 Dec 2021	42.000.000 TL
IT-OT Convergence	CONV-7	Asset Management System Integration	Implementation Project	Oct 2021 Sep 2023	31.500.000 TL
IT-OT Convergence	CONV-8	Meter Data Management System Integration Design	Design Study	Jan 2021 Jun 2021	5.250.000 TL
IT-OT Convergence	CONV-9	Meter Data Management System Integration	Implementation Project	Jul 2021 Jun 2023	31.500.000 TL
Enterprise Application Integration	EAI-1	MV and LV Network Model Synchronization	Implementation Project	Jan 2019 Dec 2020	17.850.000 TL
Enterprise Application Integration	EAI-2	Enterprise IT Systems Integration Design	Design Study	Jan 2019 Dec 2019	8.400.000 TL
Enterprise Application Integration	EAI-3	Enterprise IT Systems Integration	Implementation Project	Jan 2020 Dec 2022	52.500.000 TL
Enterprise Application Integration	EAI-4	WFM Integration	Implementation Project	Jan 2022 Dec 2022	6.000.000 TL
Common Information Model	CIM-1	CIM Based (IEC 61970-453) Network Model Integration Design	Design Study	Jan 2021 Dec 2021	5.250.000 TL
Common Information Model	CIM-2	CIM Based (IEC 61970-453) Network Model Integration Pilot Application	R&D/Pilot Application	Jan 2022 Dec 2022	12.600.000 TL
Common Information Model	CIM-3	CIM Based (IEC 61970-453) Network Model Integration	Implementation Project	Jan 2023 Dec 2025	25.200.000 TL
Common Information Model	CIM-4	CIM Based (IEC 61968) IT and OT Data Integration Design	Design Study	Jan 2021 Dec 2021	6.300.000 TL
Common Information Model	CIM-5	CIM Based (IEC 61968) IT and OT Data Integration Pilot Application	R&D/Pilot Application	Jan 2022 Dec 2022	18.900.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Common Information Model	CIM-6	CIM Based (IEC 61968) IT and OT Data Integration	Implementation Project	Jan 2023 Dec 2024	42.000.000 TL
Integration Architecture	IA-1	DSO IT Integration Architecture Design by Evaluating Different Integration Topology and Technology	R&D/Pilot Application	Jan 2020 Dec 2020	6.300.000 TL
Integration Architecture	IA-2	Enterprise Service Bus Based Data Integration Platform Installation	Implementation Project	Jan 2021 Dec 2022	42.000.000 TL
Integration Architecture	IA-3	Defining Technical Compatible Criteria of IT System Architecture for Systems to be Purchased in Future	R&D/Pilot Application	Jan 2021 Dec 2021	6.300.000 TL

7.9.2 Detailed Road Map Scheduling for All DSOs (I)



7.10 Cyber Security (CS)

7.10.1 Suggested Projects/Actions List for All DSOs (CS)

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Cyber Security	CS-1	Creating Cyber Security Maturity Model, Defining Exist & Targeted Maturity Levels and Road Map studies	R&D/Pilot Application	**Jan 2018** Dec 2018	9.450.000 TL
Cyber Security	CS-2	Compatibility and Adaptation Study for IT and OT Cyber Security Standards	Implementation Project	Jan 2019 **Dec 2020**	25.200.000 TL

Action Group	Action No	Action Name	Action Type	Estimated Schedule	Action/Project Estimated Budget
Cyber Security	CS-3	Cyber Security Operation Centre Installation	Implementation Project	Jan 2020 Dec 2020	21.000.000 TL
Cyber Security	CS-4	Applying Cyber Security Solutions to IT and OT Communication Infrastructure	Implementation Project	Jan 2021 Dec 2022	52.500.000 TL
Cyber Security	CS-5	Applying Cyber Security Solutions to The Data Transfer Services/Interfaces between IT and OT Systems	Implementation Project	Jan 2023 Dec 2024	14.700.000 TL
OT Cyber Security	OT-CS-1	Defining Smart Meter Cyber Security Requirements and Applying Necessary Solutions	Implementation Project	Jan 2022 Dec 2024	31.500.000 TL
OT Cyber Security	OT-CS-2	Applying Cyber Security Solutions to OT Systems Servers and Local Network	Implementation Project	Jan 2019 Dec 2021	16.800.000 TL
OT Cyber Security	OT-CS-3	Installation of Cyber Security Simulation Lab for Smart Grid	R&D/Pilot Application	Jan 2024 Dec 2025	26.250.000 TL
IT Cyber Security	IT-CS	Applying Cyber Security Solutions to IT Systems Servers and Local Network	Implementation Project	Jul 2021 Jun 2023	21.000.000 TL

7.10.2 Detailed Road Map Scheduling for All DSOs (CS)