Ministry of Foreign Affairs

Sector Study on Smart Grids in Turkey - Final Report

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Sector Study on Smart Grids in Turkey

Final Report

Prepared for

Embassy of the Kingdom of the Netherlands in Ankara

Submitted by

MRC TURKEY

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September2020

Version 2.1 Final Version

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List of Acronyms

₺/TRL/TL	: Turkish Liras.
€/EUR	: Euro.
$/USD	: US Dollar.
ADMS	: Advanced Distribution Management System.
AGC	: Automatic Generation Control.
AMI	: Advanced Metering Infrastructure.
AMR	: Automated Meter Reading.
ANM	: Active Network Management.
B2B	: Business to Business.
BOO	: Build, Operate and Own.
BOT	: Build, Operate and Transfer.
BSR	: Balancing and Settlement Regulation.
CAPEX	: Capital Expenditures.
CPMS	: Charging Point Management System.
DAM	: Day-ahead Market.
DER	: Distributed Energy Resources.
DERMS	: Distributed Energy Resource Management System.
DMS	: Distribution Management System.
DRMS	: Demand Response Management System.
DSO	: Distribution System Operator.
EAI	: Enterprise Application Integration.
EBRD	: European Bank of Reconstruction and Development.
EDCo	: Electricity Distribution Company.
EDN:	: The Netherlands Economic Diplomatic Network.
EML	: Turkish Electricity Market Law.
EMRA	: Energy Market Regulatory Authority (*for Electricity, Petroleum and Natural Gas*).
ENTSO-E:	: European Network of Transmission System Operators.
ENTSO-E CESA	: European Network of Transmission System Operators Continental Europe Synchronous Area.
EPIAS	: Market Financial Settlement Centre (*formerly PMUM*).
ERP	: Enterprise Resource Scheduling.
ESA	: Energy Sales Agreement.
EU	: European Union.
EUAS	: Electricity Generation Co.
EV	: Electric Vehicle.
GDP	: Gross Domestic Product.
GDRE	: General Directorate of Renewable Energy (*formerly EIE*).
GIS	: Geographical Information Systems.
GSM	: Global System for Mobile Communications
HES	: Head-end System.
IoT	: Internet of Things.
IP	: Investment Period.

IPP	: Independent Power Producer.
IT	: Information Technology.
LED	: Light Emitting Diode.
LRT	: Last Resort Tariff.
LV	: Low Voltage.
MDM	: Meter Data Management.
MENR	: Ministry of Energy and Natural Resources.
MGMS	: Microgrid Management System.
MV	: Medium Voltage.
NG	: Natural Gas.
OCS	: Overhead Contact System.
OECD	: Organisation for Economic Co-operation and Development
OIZ	: Organized Industrial Zone
OMS	: Outage Management System.
OPEX	: Operational Expenditures.
OT	: Operational Technology.
PMUM	: See EPIAS.
POC	: Proof of Concept.
PV	: Photo Voltaic (solar).
RAB	: Regulated Asset Base.
RES	: Renewable Energy Source.
RVO	: Netherlands Enterprise Agency (*Rijksdienst voor Ondernemend Nederland*).
RetCo	: Retail Company
R&D	: Research and Development
SCADA	: Supervisory Control and Data Acquisition
SWOT	: Strengths, Weaknesses, Opportunities and Threats (*Analysis*)
TEAS	: Turkish Electricity Corporation.
TEDAS	: Turkish Electricity Distribution Co.
TEIAS	: Turkish Electricity Transmission Co.
TEK	: Turkish Electricity Authority
TETAS	: Turkish Electricity Trading and Contracting Co.
TOGG	: Turkey's Automobile Joint Venture Group Inc
TOR	: Transfer of Operating Rights.
TSO	: Transmission System Operator
TURSEFF	: Turkey Sustainable Energy Financing Facility.
TÜREB	: Turkish Wind Energy Association
T&L	: Electricity Theft and Technical Losses
VAT	: Value-Added Tax
WFM	: Workforce Management.
YEKA	: Renewable Energy Resource Zone

1 Executive Summary

Turkey is a growing market with increasing population, urban density and energy demand; which pose significant pressure on the ageing infrastructure and result in modernization requirements in its energy networks for the upcoming years. Evaluating the modernization requirements as a chance to improve the commercial potential between two countries, The Netherlands Economic Diplomatic Network (EDN) aims to analyze the market potential and investigate collaboration chances for Dutch research & development, technology, products and expertise for grid modernization needs in Turkey. '**Sector Study on Smart Grids in Turkey**' is prepared with the objective of assisting EDN in assessing the market potential and business opportunities Dutch Smart Grid ecosystem in Turkish electricity sector.

Developments in Smart Grid domain in Turkey are extensively discussed around modernization efforts in Turkish electricity distribution sector. The main reason for this situation is the liberalization, privatization and unbundling processes which transformed the outlook of the electricity distribution sector. This study provides a detailed overview of Turkish electricity sector, including regulatory framework, electricity market value chain, electricity distribution sector dynamics and its revenue framework that is currently in practice.

Smart Grid vision and strategy of Turkey is formed in alignment with national strategic goals. Country's dependence on imported fossil fuels, pressures of urban growth and overall population increase, ageing electricity infrastructure are on one side of the equation. Global trends in market liberalization, digitalization, renewable energy technologies and electric mobility are also having significant impact on existing framework; thus, pushing Turkey to act swiftly on managing the transition to Smart Grids in a cost-effective and sustainable perspective. In this context, it is estimated that Turkish Energy Market Regulatory Authority (EMRA) will allocate an investment budget over €1.2 billion for Smart Grid technologies in electricity distribution networks over the regulatory period between 2021 and 2025.

For Dutch Smart Grid ecosystem to create chances and exploit opportunities during this interval, it is recommended to focus on areas of expertise in which Dutch companies, universities and knowledge institutes are strong and highly active, especially wherever the local competition is weaker in comparison. Identification and analysis of potentially effective Dutch stakeholders clearly shows that there is strong potential in areas such as advanced grid management, renewable energy, energy storage and electric mobility technologies. These areas are expected to cover around 40% of potential Smart Grid investments, and Dutch ecosystem can have a strong chance of primarily addressing such modernization requirements.

In order to effectively facilitate and manage the process of increasing involvement in Turkish Smart Grid sector, both Dutch governmental institutions and companies are advised to take steps towards increasing familiarity with the market outlook, developing local networks, creating publicity and initiating projects to enable a successful market entry and sustain long-term presence in the future of the market.

2 Introduction

2.1 Context

Position of Turkish market is bolstered by strong electricity demand growth, public- and private-sector investment in grid modernization, and steady progress in electricity market reforms Electric utilities in Turkey are investing in smart grid technologies and would constitute about 80% of market share in smart grids in Turkey.

A major challenge for Turkey's electricity distribution companies, however, is raising revenue to support new investment. As a result, maintaining and upgrading the grid, rather than digitalization, has remained as priority in last decade. However, smart grids and digitalization investments are expected to increase drastically and to be incentivized in next regulatory period (2021-2025).

'Sector Study on Smart Grids in Turkey' is conducted by the request of Embassy of the Kingdom of the Netherlands in Ankara.

2.2 Objective

Netherlands Economic Diplomatic Network (EDN) wants to investigate the Turkish market and collaboration chances for Dutch companies, technology, products and expertise in the context of grid modernization needs in Turkey.

The Sector Study On Smart Grids In Turkey is conducted in order to give direction to the extra efforts that EDN will put into promising niches of the energy markets of Turkey in which The Netherlands can either acquire knowledge or has a leading position in relation to Turkey.

This effort is expected to lead to increased knowledge cooperation and trade from the Netherlands to Turkey. After the market research is done, a decision will be made on how to pursue business in this niche and the result will guide the Netherlands economic network in developing a strategy to position Dutch companies and knowledge institutions in Turkey.

Objective of this study is to provide a detailed overview and analysis of the Smart Grid sector in Turkey, with the motivation of improving export volume of The Netherlands towards Turkey in the context of Smart Grid sector. Detailed objectives of the study can be briefly listed as below:

- To provide background information on the electricity market value chain in Turkey, including the regulatory framework, governing rules and perspectives that shape the Smart Grid ecosystem.
- To provide a thorough market assessment of Turkish Smart Grid sector; focusing on current status, market potential, stakeholder analysis and detailed analysis of business opportunities and challenges in line with existing conditions, regulations and market entry barriers.

- To identify Dutch companies, universities and institutes that can potentially play a role in developing Dutch exports to Turkey in Smart Grid context, including mapping exercises with respect to Smart Grid technical sub-domains.
- To identify local competition and market requirements that determine market potential and play a key role in business development and export strategies.
- To provide reliable recommendations on further actions for Dutch companies, government and supporting institutions in order to channel their efforts in improving Dutch export in Turkish Smart Grid sector.

2.3 Guide for the Reader

Structure of this study is composed of seven chapters in total. Brief descriptions of each chapter's content are briefly provided as below.

Chapter 1 provides an executive summary of the whole report.

Chapter 2 provides introductory information, delivering context, objective and a guide for the general reader.

Chapter 3 provides an overview of Turkish electricity sector; providing information on existing regulatory framework, electricity market value chain, electricity distribution sector and its revenue framework. These items are highly important to understand the layout of the sector for Smart Grid exports.

Chapter 4 provides an analysis of the sector within the Smart Grid context; covering current status of the Smart Grid activities in the sector, assessment of market potential, stakeholder analysis as well as barriers, opportunities and challenges for exports in the Smart Grid sector.

Chapter 5 provides an extensive analysis of Dutch companies, universities as well as technology/knowledge institutions that are potentially key stakeholders in improving Dutch exports in Turkish Smart Grid sector. Local competitors, companies with domestic origin and domestic branches of international companies, are identified with respect to Smart Grid technical sub-domains.

Chapter 6 provides concluding remarks for this sector study in two particular dimensions. Firstly, recommendations are provided for Dutch companies that are inclined to increase their activities in Turkish Smart Grid sector. Second aspect of recommendations are presented for governmental institutions of The Netherlands and supporting business networks in form of agencies or other supporting institutions.

Chapter 7 consists of the annexes of the report; Smart Grid product & service taxonomy, contact information for identified Dutch and Turkish entities, and other relevant information.

3 Electricity Sector Climate in Brief

3.1 Regulatory Framework for Electricity

In the beginning of 1980s, like in many European countries, the Turkish Electricity Market was dominated by a single state-owned vertically integrated company, the Turkish Electricity Authority (TEK). Since the early 1980s, the government intended to attract private participation into the industry in order to reduce the pressure of investments on the public budget. For the first time in 1982, the private sector was also allowed to build power plants of their own and to sell electricity they produced to TEK. The first law[1], which set up the legal basis for private participation in the electricity industry, was enacted in 1984 through BOT contracts for new generation facilities, TOR contracts for existing generation and distribution assets and the auto-producer system for companies to produce their own electricity.

The initial unbundling of the sector took place on 1994, when TEK was separated into two state-owned companies which are Turkish Electricity Generation and Transmission Company (TEAS) responsible for generation and transmission activities and Turkish Electricity Distribution Company (TEDAS) responsible for distribution and retail sale activities.

The Electricity Market Law (EML) No. 4628[2], which was enacted by the Turkish Parliament on 20 February 2001, and was further amended by the Natural Gas Market Law No. 4646 on 2 May 2001[3], was the first appropriate step in order to determine the legal and institutional framework of the sector. The goal of Law No. 4628 is to liberalize the electricity market in Turkey while establishing a financially strong, stable, transparent and competitive electricity market.

In line with the EML, a further unbundling and reorganization of the TEAS took place by separating it into three state-owned companies: Turkish Electricity Generation Company (EUAS) which is responsible for operating the state-owned power generation facilities, Turkish Electricity Transmission Company (TEIAS) which is responsible for operating the national grid, and Turkish Electricity Trading and Contracting Company (TETAS) which has a mandate to deal with purchasing the electricity from the producers and the sale of this electricity to the Electricity Distribution Companies (EDCos).

By this new law, Turkey also created an autonomous regulatory body initiating a major electricity market reform program. The reform program entails privatization, liberalization and a radical restructuring of the whole electricity industry. The EML includes the following provisions:

- An autonomous Energy Market Regulatory Authority (EMRA), governed by its independent board
- A licensing framework for market participants

[1] Law No. 3096.
[2] Law No. 4628 was published in the Official Gazette No. 24335 dated 3 March 2001 (repeated edition).
[3] Law No. 4646 was published in the Official Gazette No. 24390 dated 2 May 2001.

- A centrally run wholesale electricity market primarily based on bilateral contracts between market participants
- Eligible consumer concept to ensure freedom for eligible consumers to choose their own suppliers

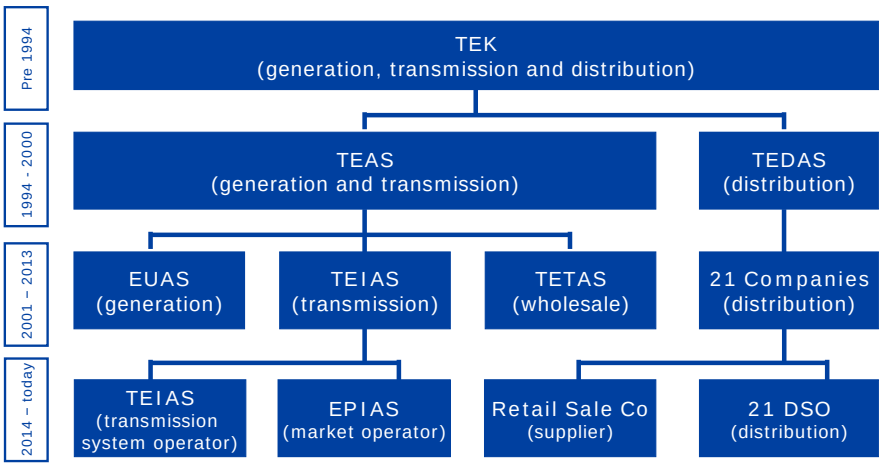

Figure 3.1. Historical Development of Unbundling of the Turkish Electricity Institution

In 2013, the new EML No. 6446 was enacted by the Turkish Grand National Assembly which repealed the EML No. 4628 of 2001 with exception of the provisions related to the organization, powers and duties of EMRA. The New Electricity Market Law with No. 6446 was the second appropriate step in order to determine the legal and institutional framework, as well as the further development of the sector. The goal of Law with No. 6446 is to liberalize the electricity market in Turkey establishing a financially strong, stable, transparent and competitive electricity market.

Since then, the existing Electricity Market Law (6446) was amended seven times. One of the most important and recent changes was brought by the Decree-Law/703 and TETAS and EUAS merged under the umbrella of EUAS, transferring all the duties and responsibilities of TETAS to EUAS[4].

Another important development that was defined with the amendments was about definition of capacity mechanism for domestic resources. In line with the amendment in EML, in January 2018, Electricity Market Capacity Mechanism Regulation was published, especially for domestic generation, in order to provide required reserve capacity for supply security purposes. Regulation states that payments to be made by TEIAS will be considered within the scope of transmission tariffs and natural gas and coal power plants qualified in the Regulation will get capacity payments since these power plants are not working most of the time as a result of their high generation cost, low demand and low electricity prices in Turkey. It was declared that around 1,500-2,000 MW natural gas power plants were closed down and moved to other countries.

[4] Since TETAS and EUAS merged, TETAS refers to EUAS within this report.

Together with this incentive, thermal power plants are expected to remain in the market and provide generation as peak load power plants, only when required.

The regulatory framework in Turkish electricity market includes the Laws, Regulations, Communiques, Board Decisions and other related principles and procedures as well as strategy documents published by the Ministry of Energy and Natural Resources. In the following figure, the most important and related legislation is shown in the figure below:

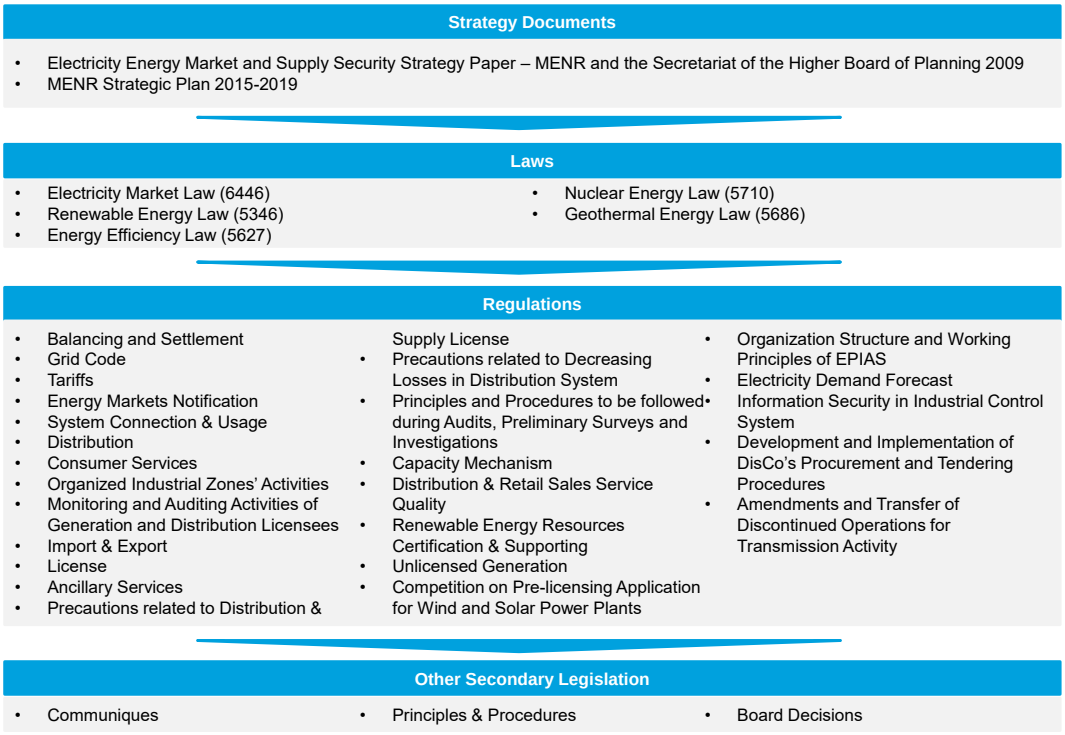

Figure 3.2. Turkish Electricity Market Legislation

3.1.1 Strategy Documents

Regarding the future steps of the reform process, the "*Electricity Energy Market and Supply Security Strategy Paper*" was published by Ministry of Energy and Natural Resources (MENR) and the Secretariat of the Higher Board of Planning in May 2009. The paper states that efforts will continue to create a competitive market. Initiatives aiming at making new demand-driven electricity production investments sustainable and compatible with the market structure will be more effective, and in harmony with the resource priorities of the energy policy. Measures will be taken to ensure that electricity transmission and distribution services will guarantee consumer satisfaction. Generation and distribution privatizations, which are the leading tools for creating a competitive market, will be finalized. Finally, a competitive electricity market that functions according to free market rules will be created.

In 2014, Renewable Energy Action Plan was published by General Directorate of Renewable Energy (GDRE). According to the plan, 30% of total electricity generation in Turkey is expected from renewable energy resources by the year 2023. However, this target has already been

achieved and MENR declared, in its 11th Development Plan, that 38.8% of the total installed capacity is expected from renewable energy resources by the year 2023.

In 2015, MENR published 2015-2019 Strategic Plan which again emphasized the importance of local and renewable energy generation. In line with these requirements, a strong focus has been in place on reducing energy imports and increasing power generation from domestically available resources; such as domestic coal reserves, renewable energy resources (primarily hydroelectric, geothermal, solar and wind). In addition, nuclear energy generation was introduced into strategic goals that was followed by new nuclear power plant projects with the aim of increasing energy security and reliability for the national energy system. Energy efficiency was also strongly emphasized, especially in the area of public lighting.

In addition to strategic goals to improve energy security, reliability and efficiency, liberalization progress has also been continued in energy market structures. Establishment of EPIAS helped energy markets to be made more transparent, reliable and easy to monitor. Strong initiative is shown for the transmission grid to be connected to ENTSO-E and to have a permanent connection ultimately. Possibility of participating in regional electricity market mechanisms are acknowledged and privatization of state-owned conventional power plants are aimed to continue for further liberalization.

During this period, Strategic Plan of EPIAS for the years 2016-2020 was also published. In line with the Plan, natural gas spot market started operation and oil and coal markets are expected to start operation soon.

National Energy Efficiency Plan of Turkey for the years 2017-2023 was published in Official Gazette in 2018 to boost and accelerate efforts to improve energy efficiency in all sectors to make energy efficiency support models more effective, develop sustainable finance mechanisms, promote onsite generation and consumption, position smart cities and smart networks in respect of energy efficiency, increase the use of alternative fuels and resources in the context of energy efficiency etc.

3.1.2 Secondary Regulations

The “backbone” of regulations is mainly formed by licensing and tariff regulations, market rules (in this case “Electricity Market Balancing and Settlement Regulation - BSR”), distribution regulation and grid code and that are issued by the regulatory authority.

Licensing Regulation set forth the principles and procedures regarding the licenses to be granted to the legal entities such as license application, evaluation and issuance procedures.

Tariffs Regulation consists of principles and procedures regarding preparation, monitoring, evaluation, amending and approval of regulated tariffs in the electricity market. It also defines the criteria to prepare tariff proposals by TEIAS, EUAS (Wholesale), EDCos and retail sales companies as well as regulating income and/or average price caps of these legal entities. Together with the regulation, a new structure is established in order to provide more effective

use of the network, reflect costs to the owners of these costs and determine new multi-period tariffs considering load profiles. Tariff types are defined within the scope of the regulation; one of them being LRT. Different tariffs can be applied by customer segment basis and considering the socio-economic structure of consumers.

Balancing and Settlement Regulation consists of detailed information and procedures on day-ahead market, intraday market, balancing power market, financial settlement of these markets, payment and collateral mechanism, procedures to be applied to eligible suppliers as well as the roles of EDCos and TSO in relation to balancing and settlement.

The ***Distribution Regulation*** sets forth the principles and procedures related to the reliable, low cost planning and operation of the distribution system, for the implementation of the market model set in Law No. 6446. It covers the principles, procedures and obligations of the EDCos, and users of the distribution system including facility design, operating rules, and issues pertaining to the planning and operation of the distribution system, in accordance with non-discrimination principles.

The ***Grid Code*** sets forth the principles and procedures regarding the standards applicable for reliable and low-cost operation of the transmission system, ensuring system stability and energy quality. The Turkish Grid Code is a technical document that is aligned with the market model and describes the required technical and operating aspects of the transmission network, ensuring stability and energy quality.

Electricity Market Consumer Services Regulation was published in May 2018 and replaced the old Regulation that was published on 8 May 2014. Consumer Services Regulation includes minimum standards, principles and procedures for the transactions between consumers, suppliers and/or distribution companies for electrical energy and/or capacity sale and those providing services regarding the same.

Regulation on Electricity Demand Forecasts was published on 7th May 2016 in the Official Gazette, bringing the following rules:

- As a result of unbundling, RetCos and EDCos have to submit demand forecasts, for a period of 5 and 10 years, respectively.
- RetCos shall perform demand forecast for last resort, retail sales and eligible customer's consumption using scientific methods, considering official economic targets and taking opinion of public or private sector companies, if necessary.
- The usage of statistical models and scientific methods is emphasized, as compared to the existing regulation.
- Rules for evaluation and verification of the model is stretched and 10% confidence interval is removed. However, the model shall be verified economically and scientifically with generally accepted tests in literature.

- Forecasts, together with the data set used, are submitted to EMRA until the end of June and December each year (which was previously March) for EDCo and RetCo, respectively.
- If required EMRA can undertake demand forecasts on their own.

Provisional Article 18 of the Electricity Market Law is related with the precautions that shall be taken to decrease Theft and Losses (T&L) in the distribution system and distribution regions whose T&L ratio is above Turkey's average T&L level. ***Regulation on Precautions to Decrease Distribution System Losses***, which was published on 31-12-2015, defines the precautions that shall be taken by related EDCo, responsibilities and exemptions of these companies and adjustments that will be different from other EDCos.

Figure 3.3. indicates regulations related to electricity market distribution and retail sales segments.

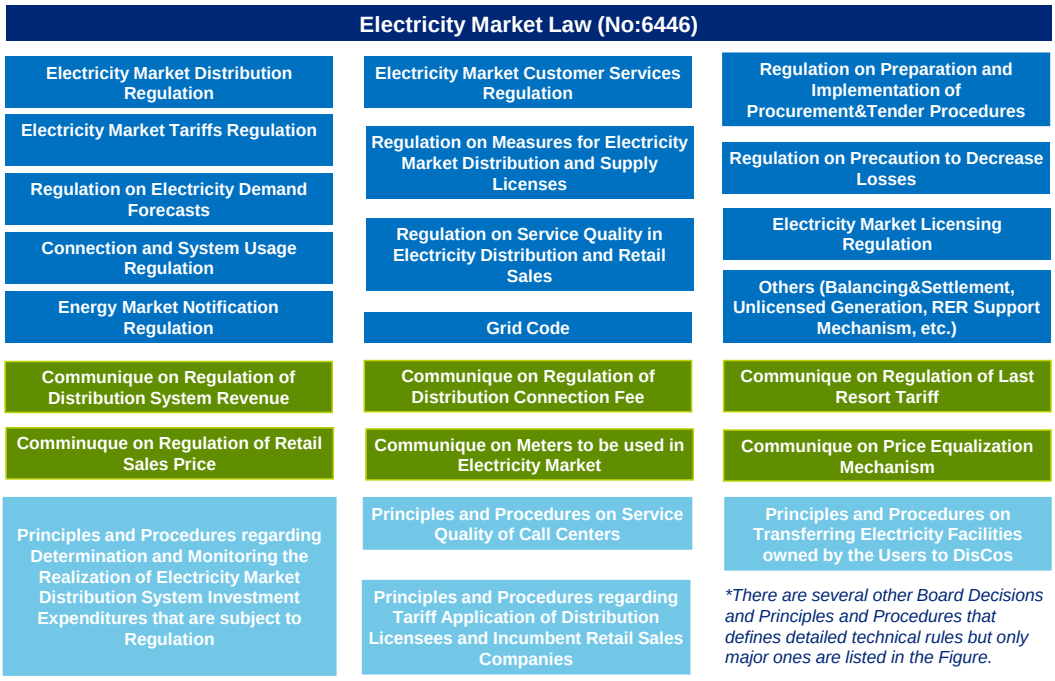

Figure 3.3. Overview of Electricity Distribution Legislation

There are also many other communiques, principles, procedures and decisions that defines the market rules and related methodologies.

3.2 Electricity Market Value Chain

The value chain in Turkish electricity market has shifted towards a complex and regulated set of relationships over the course of regulatory developments, unbundling and privatization processes; as particularly addressed in the Section 3.1. In wake of regulatory framework currently in practice, players and activities in the electricity market can be depicted as in Figure 3.4.

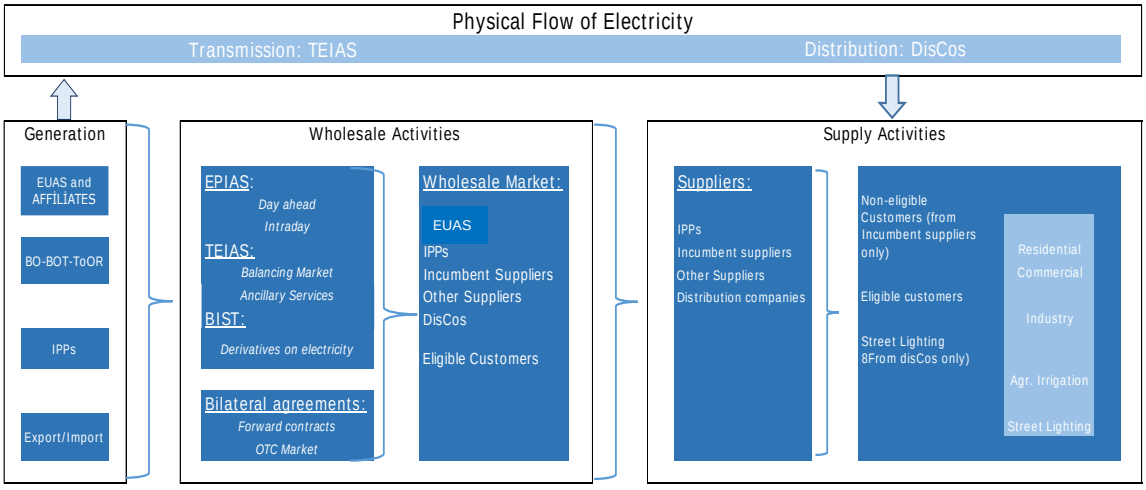

Figure 3.4. Electricity Market Value Chain in Turkey

3.2.1 Generation

Power generation activities in Turkish electricity market are delivered by several types of power plant owners; the state, private companies under BO-BOT-TOR contracts and independent power producers (IPPs). State-owned hydro and thermal power plants are owned and operated by EUAS and its affiliates. EUAS, in accordance with forecasts of the market's development and prepared by TEIAS that takes into account the investments of the private sector, is given the legal mandate to construct, lease and operate new power plants in situations to ensure the security of electricity supply.

Plants operated under Build-Own-Operate ("BOO"), Build-Operate-Transfer ("BOT"), and Transfer of Operating Rights ("TOR") are operated by private companies but the volume is contracted to the state – thereby the state continues to exercise a significant influence in the market. When the contracts pursuant to BOT and TOR models expire, the plants will be transferred to the government.

As part of the sector reform strategy, EUAS is assigned a portfolio of hydroelectric, lignite and gas fired plants. Whilst the major hydro plants are considered to be strategic assets and are envisaged to remain under EUAS (state) ownership, the thermal power plants and the smaller hydro plants were planned to be privatized.

In a broader perspective, Turkey provides a strategic geographic position in the European energy markets with a stable and high growing electricity industry. Introduction of an effective regulation and a liberal market structure has further enhanced the industry growth prospects for the coming

years. The Turkish electricity sector has been modelled on EU market structure and a transparent regulatory framework has been set by the independent authority, EMRA.

On the other hand, Independent Power Producers (IPPs) are generally defined as non-utility generators that sell their output either in direct bilateral agreements to wholesale marketers or load-serving entities, or sell to EPIAS as it is the designed national wholesale energy market. IPPs also play an important role as sellers in the market for eligible customers. Sales are done directly or through supply companies.

3.2.2 Transmission

TEIAS is a state-owned monopolistic company operating electricity transmission network in Turkey. TEIAS owns all publicly owned assets related to electricity transmission activities.

In addition to operating the electricity transmission network, the backbone of national electricity grid; TEIAS is responsible for real-time balancing of energy demand and supply in the market. Large-scale power plants and industrial plants (such as steel manufacturing plants) are also connected directly to the transmission network which is managed by TEIAS.

The Turkish transmission network is mainly composed of two voltage levels (400kV, 154kV). The 66kV is rare and in the process of gradually phasing out. Furthermore, two interconnection lines Hopa (Turkey) -Batum (Georgia) is energized with 220kV voltage level and 220/154kV coupling transformers are located in Hopa, north-eastern border of Turkey. Major power plants are connected to the 400kV network. Some power plants are connected to the 154kV sub-transmission network and the 154kV network is connected to the 400kV transmission network through 400/154kV autotransformers.

The power system of Turkey has a good quality of service and a reliability that is in line with the West European standards. However, there are regional congestion issues caused by almost doubling of generation installed capacity within the last 10 years period.

Figure 3.5. Geographic Borders of Regional Control Centers (RCCs) in Turkey

The major consumption areas are located in the North-western side of Anatolia, Thrace Region, West Anatolia Region and Southeast Anatolia Regions of Turkey. Thus, active power is flowing east to west during the day and from west to east during the night.

Since 2011, Turkish electricity transmission network has been operated in synchronization with European Network of Transmission System Operators Continental Europe Synchronous Area (ENTSO-E CESA). The establishment of this interconnection extended the electrical border of the ENTSO-E CESA to the Georgian, Armenian, Azerbaijani, Iranian, Iraqi and Syrian power systems. However, generation facilities in Turkey that operate in island mode for export to these countries are excluded from the ENTSO-E CESA.

3.2.3 Supply (Wholesale & Retail Sales)

The supply business is the sale of electricity to the end-user where the core part of operations includes invoicing and collection activities. Supply side activities in Turkish electricity market are regulated under "supply licenses" that enable wholesale and retail activities. A number of market players are entitled to continue activities under the entitlement of this license type. TETAS, state-owned wholesale company which is currently merged with EUAS, private wholesale companies and 21 retail sales companies are the actors who have the right to legally supply electricity within the energy market framework. Suppliers acting as incumbent retail companies are operating either as the retail arm of an EDCo owner company (due to the nature of unbundling and privatization processes that took place in Turkey) or as a standalone energy provider.

As of May 2020, 217 supply licensees exist in addition to that of TETAS. These private suppliers can either procure from EPIAS or directly from IPPs through bilateral agreements (some IPPs themselves even have the license to act as a private supplier), and can sell to any eligible customer in the country, with sales volumes realized on each license being limited to 20% the previous year's total domestic consumption.

End-user customers can be classified as either eligible or non-eligible. Eligible customers have an opportunity to purchase electricity in the free market directly from IPPs or from any of the ordinary suppliers, while non-eligible customers are supplied by the authorized retail companies in their respective regions and are subject to regulated tariffs which vary based on customer segments.

Despite this change, a new differentiation emerges between the "incumbent supplier" and "other suppliers". The incumbent (authorized) supplier is the legally unbundled retail arm of the distribution company which is obliged to:

- Supply electricity to non-eligible customers in the respective distribution region at the regulated end-user tariff set by EMRA.
- Act as the supplier of last resort to the eligible customers in the same region, who have not switched their suppliers. The relevant tariff is determined by EMRA.

In addition to these regional responsibilities, incumbent suppliers are allowed to sell to the eligible customers outside their own regions, as well as trade output and capacity with other suppliers, operate in the organized markets and import/export electricity with the approval of EMRA.

EMRA declared consumers having annual consumption greater than 1.4 MWh will be eligible in 2020. There is not a specific target announced by MENR or EMRA, but it is expected that eligible consumer limit may be 0 in several years, however issues regarding market openness in generation and infrastructure insufficiencies should be overcome first.

Trading in Turkish Electricity Market

Wholesale Electricity Market: Electricity Market Law (Law No. 4628) basically regulates the incorporation of a market model based on, largely, bilateral agreements, eligible consumers and balancing mechanism. Accordingly, energy shall be purchased and sold through mainly bilateral agreements between parties which are generators, consumers or wholesale traders and any problems arising from bilateral agreements shall be resolved within the context of electricity market balancing and settlement legislation.

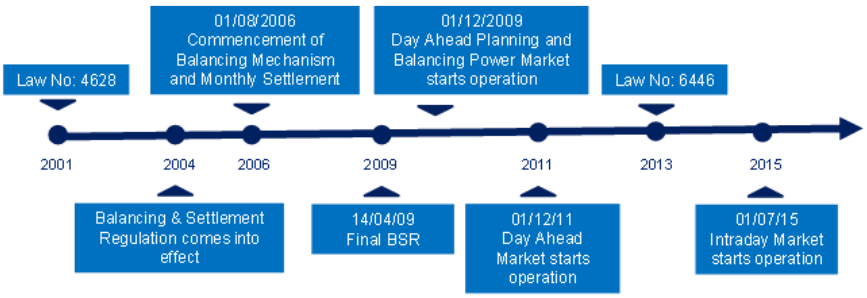

Figure 3.6. Development Path of the Turkish Electricity Market

In terms of legislations for market structure and operations, there is a path of development that has initiated in 2004. As shown in the figure, the first two stages have been in place since December 2009. The third stage has been added in January 2011 and the fourth stage is valid from December 2011 onwards. In addition to the abovementioned developments in electricity spot market, natural gas spot market started operation as of 23rd January 2019.

The purpose of the **Day Ahead Market (DAM)** is to provide the market players with the opportunity to buy and sell electricity for the next day in addition to their on-going contract, thus balancing their activities and the system. The operation of the DAM is given in the Figure below:

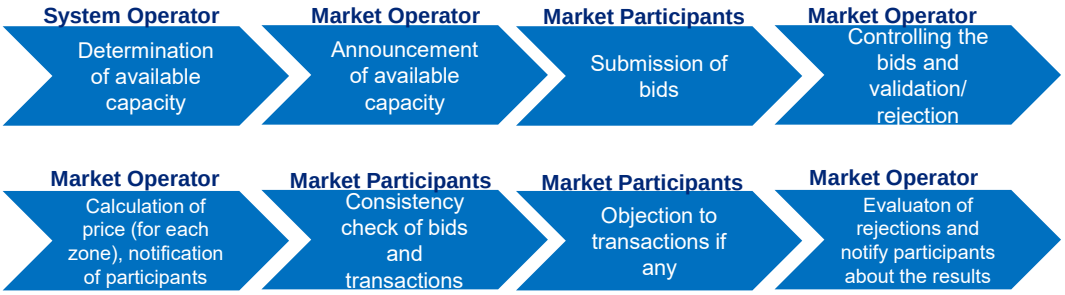

Figure 3.7. Steps in the Day-Ahead Market

For further development of the competitive Turkish Energy Market, an Intraday Market is in operation as a component of the organized wholesale electricity market since July 2015.

The Intraday Market is designed in the form of a continuous trading platform, and its related regulations and software development activities are carried out by the Market Financial Settlement Centre of TEIAS. Intraday Market mechanism starts right after the DAM is closed and closes 1.5 hours before the delivery of electricity. In 2019, intraday market volume increased at a rate of 86% compared to 2018, being 5.45 TWh. As of 2019, the number of active intraday market participants (having bid/orders) was 541.

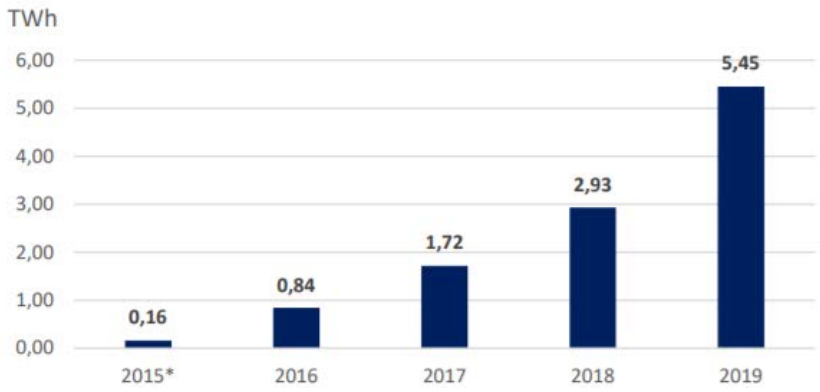

Figure 3.8. Intraday Market Volume (TWh) Source: EPIAS

Balancing Power Market: As is evident from the previous practices in any other markets, not all electricity trading transactions can be fully handled in advance. In addition to that, in real time, there will certainly be discrepancies between the forecasted generation and demand due to forecast errors, failures, etc. As a matter of fact, unlike any other commodity in markets, electricity cannot be stored, which requires real time regulation of generation (and sometimes demand). Regulation is handled by the system automatics and the national load dispatch center of the electricity transmission system operator that requires a balancing power market.

3.2.4 Distribution

The Turkish distribution grid can be technically defined as all electricity grid assets which are operated below the voltage level of 36 kV. In addition to EDCos, various entities – especially Organized Industrial Zones (OIZs) - also are eligible to receive distribution license for their own

borders and act as replacing actors within their industrial zones. These entities have a certain – though negligible– market share of the EDCos' delivery business.

The entities that are active in electricity distribution are discussed below.

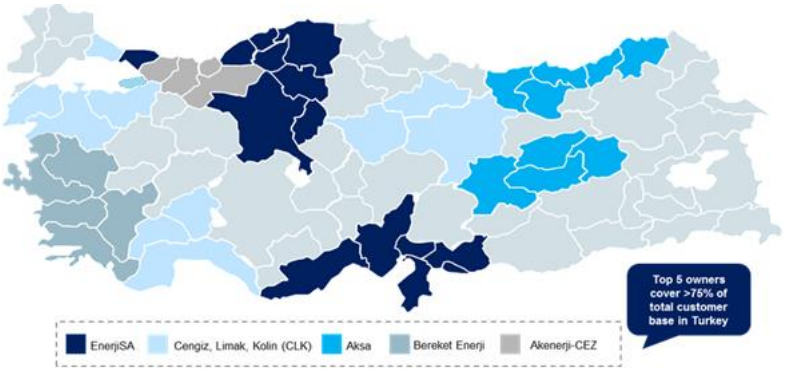

Figure 3.9. Top Five Owners of Incumbent Supply Companies

At present, all of the existing 21 EDCos have been privatized. Privatization method in Turkey follows the process of auctioning off using the transfer of operating rights, also known as the TOR model, of the distribution assets in the respective territories, usually for 30 years. State-owned electricity distribution company, TEDAS, continues to own the distribution assets operated by the private companies. Due to the nature of privatization process, there are several distribution and retail companies that belong to the same commercial group or consortium.

After completion of the distribution privatization, five groups became dominant in the incumbent supply market. The top five owners of incumbent supply companies accounted for 75% of total customer base in Turkey in 2014, as illustrated in Figure 3.9.

The table below presents the up-to-date situation of 21 EDCos in terms of ownership and takeover details within the privatization processes.

Region	Provinces	Date of Takeover	Sales Price ('000 $)
1.Dicle (Iskaya-Dogu)	Diyarbakir, Sanliurfa, Siirt, Mardin, Batman, Sirnak	28.06.2013	387.000
2.Vangolu (Turkerler)	Bitlis, Hakkari, Mus, Van	29.07.2013	118.000
3.Aras (Kiler)	Erzurum, Agri, Ardahan, Bayburt, Kars, Erzincan, Igdir	28.06.2013	128.500
4.Coruh (AKSA)	Trabzon, Artvin, Giresun, Rize, Gumushane	30.09.2010	227.000
5.Firat (AKSA)	Elazig, Bingol, Malatya, Tunceli	31.12.2010	230.250
6.Camlibel (Kolin, Cengiz)	Sivas, Tokat, Yozgat	31.08.2010	258.500

Region	Provinces	Date of Takeover	Sales Price ('000 $)
7.Toroslar (EnerjiSA-E. On)	Adana, Gaziantep, Hatay, Mersin, Kilis, Osmaniye	01.10.2013	1.725.000
8.Meram (Alarko)	Nevsehir, Nigde, Konya, Karaman, Kırsehir, Aksaray	30.10.2009	440.000
9.Baskent (EnerjiSA-E. On)	Ankara, Kirikkale, Zonguldak, Kastamonu, Cankiri, Bartin, Karabuk	28.01.2009	1.225.000
10. Akdeniz (Kolin, Cengiz)	Antalya, Burdur, Isparta	28.05.2013	546.000
11.GDZ (Bereket) *Previously owned by Elsan-Tümaş-Karaçay consortium.*	İzmir, Manisa	29.05.2013	1.231.000
12.Uludag (Limak)	Balikesir, Bursa, Çanakkale, Yalova	31.08.2010	940.000
13.Trakya (Ictas)	Edirne, Kirklareli, Tekirdag	03.01.2012	575.000
14.Ayedas (EnerjiSA-E. On)	Istanbul Anadolu Yakası	01.08.2013	1.227.000
15.Sedas (Akcez)	Sakarya, Bolu, Duzce, Kocaeli	11.02.2009	600.000
16.Osmangazi (Zorlu Enerji) *Previously owned by Yildizlar Holding*	Eskisehir, Afyon, Bilecik, Kutahya, Usak	18.01.2017 *(previous takeover date: 31.05.2010)*	360.000 *(previous takeover 485.000)*
17.Bogazici (Kolin, Cengiz)	Istanbul European Side	28.05.2013	1.960.000
18.Kayseri	Kayseri	14.07.1990	(TOR value: 93.000)
19.ADM (Bereket)	Aydin, Denizli, Mugla	15.08.2008	110.000
20.Goksu (Akedas)	Adiyaman, Kahramanmaras	31.12.2010	60.000
21.Yesilirmak (Calik)	Samsun, Amasya, Corum, Ordu, Sinop	29.12.2010	441.500

Table 1. Privatization Process and the Current Situation of the Distribution Regions

3.3 Electricity Distribution Sector Overview

3.3.1 Background

Türkiye Elektrik Dagitim A.S. ("TEDAS") and its distribution companies were state-owned joint-stock companies engaged in the distribution and retail sale of electricity and provision of retail services to final customers. TEDAŞ' shares were held by the Privatization Administration, a public legal entity established in 1994.

On March 17, 2004, the High Planning Council issued the Electricity Sector Reform and Privatization Strategy Paper (the "Strategy Paper"), outlining the milestones for the liberalization and privatization of the Turkish electricity sector. The Strategy Paper defined the procedure for the privatization of State generation and distribution assets, to be implemented by the PA in accordance with the Privatization Law.

Prior to privatization, Turkey's electricity distribution network has already been divided into 21 distribution regions, based on a selection of clustered provinces, except Istanbul being divided into two separate distribution companies that respectively operate European and Asian side of the metropolitan city. TEDAŞ, which owned 20 of the 21 regions, has been included in the privatization program, and a separate distribution company has been established in each of these 20 regions. In 18 of the defined distribution regions, privatization tenders have been held and the handover processes had been completed accordingly. Remaining distribution companies were transferred to their current private operator companies following a series of legislative resolutions due to their pre-existing privatization status from earlier legislative frameworks.

The primary benefits of electricity sector reform and privatization have been defined as follows:

- Reducing costs through effective and efficient operation of electricity generation and distribution assets (and passing these on to final consumers via retail price reductions)
- Increasing supply quality and security in the electricity industry
- Decreasing technical losses in distribution sector to the level of OECD countries and prevention of non-technical losses
- Ensuring that required rehabilitation and expansion investments in energy sector are performed by the private sector without creating any liabilities on State budget
- Transferring benefits obtained through efficiency improvements to final customers

3.3.2 Distribution Privatization Model (TOR)

The model that was selected and applied for the distribution process of Turkish electricity distribution companies was the 'Share Sale' model. Aim of this model is to realize the handover of an operational distribution company to a private investor via a 'Transfer of Operating Rights' (TOR) agreement. Establishment of the distribution company as a separate legal entity, signing of the TOR Agreement, provision of distribution and retail sales licenses and signing of the Energy

Sales Agreements were defined as the necessary steps for the model implementation. All of the mentioned steps were completed prior to the privatization tender announcement.

In this model, asset ownership of new as well as existing distribution assets belong to TEDAS, while the investor attains the right to operate the distribution network together with the obligation to undertake all new necessary investments. In line with the privatization purposes and investor expectations:

- The ownership of the existing assets and the new assets arising from investments to be carried out by the investor belong to TEDAS. The legal obligations relating to the asset base before the signing of the TOR Agreement (for example, expropriation costs), have been assumed by TEDAS, too.
- The investor shall purchase the shares of a company which holds the operating rights of distribution assets and all related assets (e.g., buildings, vehicles, machine park), and the electricity distribution and retail licenses for a given region.
- All EMRA approved investments shall be realized by the investor and will be recovered through the tariffs. Except for cases of investor misconduct, the part of investments of yet recovered via the tariffs shall be paid by TEDAS to the investor upon the expiry or termination of the contract.

The scope of the transaction included the disposal of the shares of Distribution Company (EDCo) through a block sale. Key enablers of Distribution Company operation include the following items:

- Electricity distribution and retail sales licenses required for operation in Distribution Region, granted by EMRA for 30 years,
- Energy Sales Agreements signed with TETAS and the rights and obligations arising from these agreements
- TOR Agreement signed between TEDAS and EDCo (entitling EDCo to operate TEDAS owned electricity distribution assets and other tangible and intangible items required for the operation of distribution assets), and the rights and obligations arising from this agreement
- The TOR Agreements were signed between TEDAS and EDCos and came into effect in 2006 and have been signed since then during the privatizations
- The contract duration is aligned with the duration of the issued distribution license, as stated by the Electricity Market Law and relevant regulations
- At the end of TOR period, TEDAS has to purchase back the unamortized asset value and Incumbent retailer must transfer all deposits from LRT customers to TEDAS

3.3.3 Unbundling

According to Electricity Market Law No. 4628, distribution utilities were required to unbundle retail sale and generation activities until the end of 2012. Spin-off was selected as unbundling

method within the scope of existing laws and tax practices. Distribution utilities were required to establish a separate company for retail sale activities and obtain the retail sale license from EMRA until the end of 2012. The shareholders of the distribution utilities owned the shares of the newly established retail sales utilities.

As of July 2013, new retail companies for each Disco were established and received retail licenses accordingly.

According to "Unbundling Regulation" set by previous Electricity Market Law No. 4628:

- The top management of distribution utilities will not be the same as those of newly established retail sales companies, the holding company and those of companies controlled by distribution utilities.
- Newly established retail sales companies were allowed to sign an agreement with purchase services from distribution utilities as a transitional implementation until the end of June 2013.
- Distribution utilities cannot purchase administrative & support services (accounting, finance, law, human resources, etc.) from the companies under the control of the main company from the date of January 1, 2016.
- Distribution utilities and retail sales companies are required to use different physical environment and infrastructure of information systems from the date of January 1, 2016.
- TOR agreements were adapted accordingly and new RetCos signed the new TOR agreements
- Vertical integration is allowed.

The following table summarizes distribution of responsibilities of EDCos and Retail Companies (RetCos) after the spin-off based on new Electricity Market Law No. 6446.

EDCo	RetCo
Meter reading	Invoicing
Disconnection of electricity	Decision of disconnection
Demand forecast	Providing data to DisCo
Eligible customer data management and publishing the data	Provide change of supply data
Customer Service Center for network failures, new connections, disconnections, maintenance, etc.	Customer Service Center for billing errors, collection, customer complaints, etc.
Delivery of the invoice or notification of unpaid invoices (chargeable to retail companies)	Delivery of the invoice or notification of unpaid invoices
Management and support services	Management and support services
Street Lighting: Energy procurement from TETAŞ and operation	RetCo must have unbundled accountancy between LRT and eligible customers
MV&LV network losses: Energy procurement from TETAŞ	
Supply security/technical quality	

Table 2. EDCo - RetCo Distribution of Responsibilities in line with the Regulations and Licenses

3.4 Current Distribution Revenue Framework for Regulated Entities

Electricity distribution companies are strictly regulated by EMRA, the national regulatory authority, similar to the situation in many European countries. Thus; the pathways that an EDCo can create revenue under these market regulations are pre-defined, monitored and reported regularly. This is due to the fact that these cost items are distributed through the grid end-users as distribution system usage fees.

Main elements of the revenue requirement of EDCos, which will be explained in the next sections is as follows:

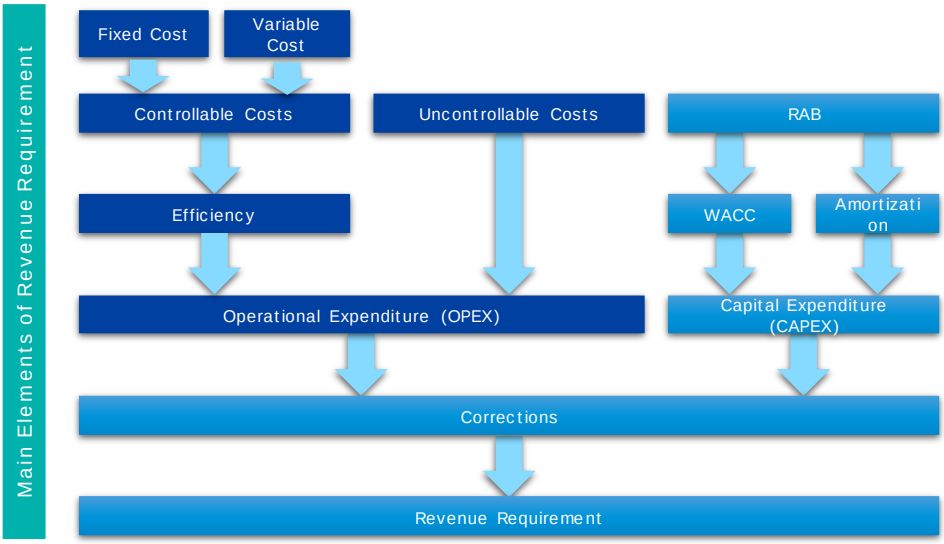

Figure 3.10. Tariff Determination Methodology in IP3

3.4.1 Operational Expenditures

Operational expenditures, or OPEX as frequently referred, make up one of the two main budget items that are provided to each distribution company in order to successfully run their operations. In contrast to the capital expenditure (CAPEX) budget, allocation of OPEX budgets are not perceived and regulated in strict constraints as grid investments but treated as an allocated amount that is given to EDCo's initiative and control. OPEX calculations are based on certain assumptions and certain breakdowns of budget types that are calculated through pre-determined formulas and requirements declared by each EDCo in order to verify their OPEX budget requests.

Net OPEX allowance is included in the allowed regulated distribution revenue cap which is set by EMRA on an ex-ante basis for each year of the implementation period. Being a part of the revenue cap, it is up to EDCos how to spend it and all savings from OPEX stays with EDCo.

For the "Third Implementation Period" that covers the 5-year interval between 2016-2020; components of OPEX subject to regulation are:

- Fixed OPEX: Covers the expenses that do not change depending on the demand, number of customers, size of the network and that are not within the scope of uncontrollable expenses. An example of this may be payroll of management of the company, office rents and similar nature.
- Variable OPEX: Changes depending on the demand (weight - 7%), number of customers (38%), number of substations (31%), line length (24%) and it is not considered within the scope of uncontrollable expenses. Example of the variable OPEX may be operating and maintenance of the grid as grid expands with the demand.

- Uncontrollable expenses are in pass through status as their cost drivers are beyond EDCos control. Therefore, an EDCo cannot claim any over-performance from uncontrollable costs:
    - fees paid regarding transmission tariff (except for the reactive, excess power and other similar items),
    - expenses for forestry land usage,
    - severance and notice pay,
    - permit fees, license fees, charges paid to public institutions,
    - bad-debt fee,
    - any charge, duties, tax-except VAT and corporate tax-,
    - license fee and other similar costs

In line with the communique published on revenue regulations; regulatory OPEX is increased at a rate of 7% for the expenses such as court case, enforcement, social responsibility, seminar, panel and conference, advertisement, association, union and chamber dues, representation and hospitality, consultancy, independent audit and public accountant services, management and support and indemnity and other similar expenses resulting from court decision (excluding the uncontrollable OPEX determined without adding the given expenses). All other tax except for the VAT and corporate tax is considered within the scope of regulatory OPEX calculations as well as the meter reading, customer care services, maintenance, meter disassembly/assembly and disconnection/connection costs.

On the other hand, the following are not considered within the scope of regulatory OPEX calculations:

- Dividend revenue from associates and subsidiaries,
- Interest revenue,
- Late payment revenue,
- Exchange profit,
- Incentive revenues.

3.4.2 Efficiency Factor X

EMRA determines an efficiency factor per year in the implementation period aimed to encourage operational efficiency in the electricity distribution. Benchmarking against local and foreign businesses of a similar nature, EMRA determines the efficiency factor as a percentage value that reduces the annual revenue cap for controllable costs (OPEX), which is increased by the annual composite index mentioned above.

Net OPEX allowance is calculated as in the following formula:

$OPEX_{net}$ = OPEX * (1-X) - Nontariff income

Whereas non-tariff income (other income) that consists of income from the network assets, regulated income such as connections/disconnections, meter replacements, etc. Each regulated income item has an approved tariff.

Since 2011, Data Envelopment Analysis method has been used for the calculation of the efficiency factor, which is in line with international practices. Although the X-efficiency factor reduces the OPEX base, growth of the asset base (due to demographic change and urbanization) offsets this negative effect and most companies observe an increasing OPEX allowance for the period in real terms.

In addition, according to the regulation published regarding efficiency; expected duration to reach the determined target efficiency levels, cannot be shorter than 5 years and cannot exceed 10 years. Parameters used in the efficiency model are fundamental OPEX based on regulatory OPEX, length of the line, substation capacity, number of substations, energy supplied to distribution system, peak demand, geographical area, number of customers in the distribution region, etc. Uncontrollable OPEX are not considered within the scope of the fundamental OPEX. Variables such as density of the users (user/km2), household consumption ratio and socio-economic development index, actual loss ratio might be used as environmental factors in the efficiency model.

3.4.3 R&D Expenses

EMRA introduced a new OPEX item in IP2 as Research and Development (R&D) expenses which are considered as subject to correction if the budget is not spent though increase of the annual budget is due for EMRA approval. Until 2014 EMRA did not issue secondary resolution for how to utilize this budget. In 2014 EMRA finally asked EDCos to submit their R&D projects twice a year in January and July. Applications made in January are concluded latest in end of March and applications made in July are concluded latest in end of September. Applications which are not made in such period shall be disregarded. R&D project application can be made individually by one distribution company or jointly by more than one companies.

Those R&D projects which are funded by EU, TUBITAK or similar institutions are approved as R&D projects in compliance to the secondary legislation by EMRA without requiring an additional evaluation.

The effective legislation states that; the amount corresponding to 1% of regulatory OPEX, excluding the uncontrollable OPEX, is considered as R&D budget in revenue requirement calculations. R&D budget for an IP cannot be transferred to another IP. R&D budget which is approved by EMRA is used for the effective tariff application period.

In the draft legislation about regulating EDCo revenue requirements (not effective yet; as of April 2020), the R&D budget will be increased to 2% of regulatory OPEX, excluding the uncontrollable OPEX for the period of 2021-2025.

In order to publicize the operations and disseminate the achievements as a result of project operations approved hereunder, a common website can be designed and setup with the attendance of all the distribution companies or other electronic platforms may be used as the Commission finds appropriate. Such website and electronic platform expenses are covered from the tariff application period R&D budget corresponding to 10% (of R&D budget).

3.4.4 Other Revenues

There are a number of unclassified revenue items in the OPEX regulations that are particularly defined and included in the potential revenue streams of EDCos. Defined by EMRA in December, 2015; these items can be listed as below:

a) Maintenance services to the third parties
b) Donations from third parties
c) Penalty or indemnification revenues from usage or connection agreements
d) Contractual penalty income from supplier agreements
e) Advertisement and rental revenues earned upon distribution assets (GSM antennas, vehicle, building, land, usage fee of data network infrastructure
f) Consultancy services to third parties
g) Displacement
h) Energy quality measurement revenues
i) Damage compensation income
j) Electricity theft
k) Connection/Disconnection
l) Bad-debt collections
m) Fees for unlicensed distributed generation plants
n) Smart meter reading
o) Delivery of meter reading invoice and second notice
p) Measurement and test revenues
q) Reactive energy
r) Meter checks
s) Inconsistent consumption

According to EMRA, EDCos are not permitted to have any other unclassified revenue streams other than these items; but an EDCo may apply to EMRA regarding any new service definition or business line in order to receive consent, determine the fees and revenue sharing ratios. 75% of

the revenues earned through items a, d, e, f, l, n; 40% of revenues earned through item j and 100% of revenues earned through item g are left to the EDCo of interest.

With the draft legislation, application and annual revenues from the unlicensed generation plants and project approval fees of the unlicensed power plants are also defined as revenue items for the distribution companies.

4 Smart Grid Market Analysis for Electricity Sector

Smart Grid market in Turkey has been affected by several factors and trends that determine the vision and strategical framework for investment activities and conceptual developments. Depending on nationwide requirements, regulatory framework, customer expectations, and technical constraints being imposed by trends are influencing grid management philosophies.

There are multiple factors triggering a significant transition in Turkish electricity distribution networks, with an escalated pace throughout the last decade, partially due to liberalization efforts and partially to market and technology-oriented developments in the energy industry. Perspectives on the roles of EDCos and end-users are within a major transition due to emerging concepts and technologies such as small-scaled renewable energy systems, information and communication technologies and electric mobility.

4.1 Status of the Smart Grids Activities in Electricity Sector

Being considered in their conventional framework and value chain, energy systems are a significant part of the climate change problem due to heavy carbon emissions directly linked to usage of fossil fuels in energy production and indirectly linked to a majority of modern activities, such as industrial production or transport, that are piling up the pressure on global ecosystem. Level of unsustainability reached in global ecological balance has alerted the public and decision makers throughout the world, including Turkey.

Indifferent to the development status of their economies and infrastructure, 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 negative picture has the possibility to 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

For the case of Turkey, a national energy production target based on domestic resources can also be added to this list, due to the country's significant dependence on imported fossil fuels in electricity production, transport and heating purposes.

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 has been required, and the vision, strategy and targets need clarification by the help of both the regulatory body and the other sector stakeholders. Leaving the conventional grid management philosophies and structures behind, the concept of Smart Grid has a complex and vague description that can vary in different contexts by different authorities. The context of Smart Grids is evaluated under the conceptual formula that is given as below, a formula that is also presented in Turkey Smart Grid Roadmap Project that was conducted by the initiative of EMRA.

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

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

4.1.1 Vision and Strategy for Smart Grid Deployment

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 aims to 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 is expected to contribute significantly in consumer satisfaction and participation, and to contribute to targets in improving social welfare.

Future of Turkey's 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 of the existing grid infrastructure. However, to achieve a sustainable economic growth, it is also important to invest in Smart Grid components to enable the improvements below:

- Increased deployment of distributed generation systems based on renewable energy resources
- Facilitation of market participation for consumers through new mechanisms and digitalization

- Connection of energy storage systems, electric vehicle charging stations and roof-top solar panel systems to the grid to allow bi-directional energy flow and management
- Flexible, adaptable, self-managing grid structure with minimal human intervention
- Continuous provision of high energy quality with sustainable and reliable grid operations

Instead of a model which energy demand follows generation, it is foreseen that in the future a model which generation follows demand will be replaced. In order to reduce and eliminate carbon emissions in a sustainable approach, market participation of the consumer needs to be maximized and the small-scale renewable energy systems are required to increase their share significantly in provision of overall energy needs. Rapid electrification of transportation systems, such as in the case of emergence of modern electric vehicles for personal, logistics or mass transport uses, will also require an electricity distribution grid that is capable of managing not only the complexity of the energy flows in this scheme, but also managing the data and information flow all around the system.

With these considerations in perspective, Turkey's vision and strategy in Smart Grid transition can be summarized in several key aspects:

- Securing the future, through environmental sustainability and efficient use of energy resources,
- Providing low-cost electrical energy for prosperous and continuous national economic growth,
- Relying on domestic energy resources to increase energy security and reliability,
- Maximizing the share of renewable energy resources to minimize carbon footprints,
- Enabling a participatory, competitive and low-cost electricity market.

In order to materialize this vision; regulatory authorities, energy producers/suppliers, network system operators, R&D organizations, international stakeholders and the financial sector are required to work together in strong coordination and cooperation, in parallel with consumer demands and technology development trends.

In order to facilitate Smart Grid vision at desired pace and level, it is highly important to accelerate training and awareness-raising activities, develop clear, predictable and consistent long-term policies and support innovative investments for total public support and approval.

4.1.2 Smart Grid Contribution to Strategic Targets in Turkey

Due to the expected economic, social and environmental impacts, Smart Grid systems and components are considered beyond their technical characteristics and functional capabilities when national strategies are considered. Therefore, the links between the Smart Grid contributions and the national strategic targets is crucial to understand the core motivations and expectations with respect to this social, technical, and economic paradigm shift.

2019-2023 Strategic Plan of the MENR is the key strategy document that can put the investments and efforts related to Smart Grid transition in the same perspective as the national strategies and goals. This document clearly addresses present and future challenges that lay ahead of the national energy value chain and declares certain goals for the Turkish energy system's future.

The strategic goals that are declared by MENR can be listed as below:

- To enable security of sustainable energy supply
- To priorities and increase energy efficiency
- To enhance institutional and sectoral capacity
- To increase activity on energy and natural resources in regional and global level
- To develop technologies in the field of energy and natural resources
- To increase foreseeability in energy markets
- To increase production capacity through sustainable mining

As it can be seen, a majority of these strategic goals are strongly connected to the developments that can be enabled by Smart Grid deployments.

In terms of securing sustainable energy supply and increasing flexibility, Smart Grids are direct enablers of integration of renewable energy resources, energy storage systems and electric vehicles. This means that all these distributed energy systems, whether they are producing or temporarily storing energy within, can be used as active tools to ensure a secure energy supply for the end-users of the distribution network. Through advanced information and communication technologies, these assets are significantly helpful tools to balance demand and supply levels at local levels and thus to enhance flexibility for the grid operations.

Enabling higher consumer engagement through new market mechanisms, facilitating roles and regulations, Smart Grid are also direct contributors to increasing foreseeability of energy markets and improve national energy market frameworks for better regional and global competitiveness. Innovation in Smart Grid domain is also directly and significantly helpful in developing domestic technologies and developing sectoral capacity to be able to identify and address its own particular needs through local innovation efforts as well as strong international collaboration mechanisms.

In terms of efficiency, remote monitoring and control capabilities of Smart Grid systems such as SCADA systems and smart meters are critical tools to reduce technical energy losses and electricity theft issues at regional and national levels. An active grid management philosophy accompanied by improved operational performance would eventually mean that overall efficiency of national energy grids is measurably increased and a significant resource for new investments is retrieved. In terms of sectoral and national benefits, energy efficiency aspect is thus the most influential part of Smart Grid benefits in Turkey.

This is also acknowledged in the strategy document, "11th Development Plan (2019-2023)" by Turkish Presidential Office. Among many items of interest, there is a specific item (493) for Smart Grids (under Sectoral Policies for Energy), which can be stated as below:

- Electricity grids and systems will be enhanced and increased in flexibility
    - Smart Grid implementations will be further implemented.
    - Local sufficiency for electricity supply will be provided, electricity transmission infrastructure investments will be continued with considerations of system security and regional demand-supply situations.
    - Technical and non-technical losses ratio will be reduced for electricity grids. In this context, awareness-raising activities, incentive and sanctions will be implemented, smart metering and remote monitoring systems will be used more widely, and supervisions will be increased.

This shows that, potential impact of Smart Grids are not only the concern of the sector or the ministry; but is taken seriously at the level of state regulations due to the amount of collective resources it can retrieve for the national economy and the benefits it can bring to transform the society.

4.1.3 Implementation Status of Smart Grid Technologies

After the privatizations, the operators of the electrical distribution companies have been obliged to undertake the necessary investments and improvements in the networks. Primarily, distribution companies were expected to perform network master plan studies for 5- and 10-years horizon. Besides EMRA started to update loss & theft target values for each distribution region for every year; to reduce technical and non-technical losses.

In addition to the installation and roll out of smart grid system projects which started mainly with the 2nd Tariff Period of the sector (2009-2014), pilot projects have been initiated on topics such as advanced measurement infrastructures, demand side management, smart meters, and communication within the scope of R&D activities that intensified after 2014. This approach, which is followed in different countries in the development of smart grids, is important in terms of examining the benefits of new systems/technologies.

In Turkey, several secondary legislations oblige EDCOs to implement certain systems; either implicitly or explicitly. There systems include SCADA, Outage Management Systems (OMS), automated meter reading (AMR), geographical information systems (GIS), reporting systems, etc. and so EDCOs efforts so far has been concentrated in these systems mainly.

Further findings about the as-is status of smart grid deployment in Turkish EDCo are summarized below:

- **Different Smart Grid maturity and technology deployment levels amongst 21 EDCo:** Comparing 21 distribution companies based on technical components, maturity levels

were observed to be very different from each other. This reveals that the activities shown as targets in the upcoming periods should be carried out by each distribution company carefully, taking into account their own planning and needs. As a different reflection of the level of heterogeneous maturity observed in distribution companies, there is a great variety in the prevalence levels of similar technologies used under technical components. For example, one distribution company has launched SCADA substations that it has expanded, while another distribution company has not yet completed the Distribution SCADA installation.

- **Lack of a systematic approach to track the results, lessons learned and real-life experience for SG projects:** Failure to systematically follow up the results, field experiences and benefits of smart grid projects stands out as another major problem. Distribution companies cannot systematically monitor and evaluate the results obtained from smart grid projects; therefore, they cannot use their gains in the dissemination or development of smart grid. This also leads to the absence of tracking systematics, being unable to reveal real benefit and determine the correct application areas within the smart grid structure.
- **Functionalities that have been implemented but not used:** It has been observed that distribution companies have installed some of the technologies used in the smart grid structure, but cannot use several functions of these technologies due to reasons such as lack of competent personnel or lack of business process adaptation.
- **Insufficient pilot implementation and trials on the field:** The fact that the smart grid pilot applications carried out by the distribution companies are mostly small-scale causes insufficient field experience and knowledge to be provided. This leads to a decrease in quality due to insufficient knowledge and experience in dissemination projects.
- **Lack of cross-sectoral know-how share platform:** The lack of an effective information sharing platform to share the best practices and experiences in the industry draws attention as a major deficiency. Such a platform enables distribution companies to realize their own shortcomings while transferring the knowledge and experience they have gained from projects in their region.
- **HR deficit that can harmonize power system and ICT technologies:** The lack of human resource who knows the power systems and requirements and also has the skills of digital technologies and is able to harmonize these two areas, emerges as a problem that must be overcome in the distribution sector as soon as possible.
- **Challenges to realize IT-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 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.

- **Problems with transforming data asset to value and lack of analytics-based decision making:** 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 Comply 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.
- **Overdependency to public infrastructure for SG communication needs:** In order to meet the communication needs of IT / OT systems, it has been observed that the distribution companies use 3rd party Telecom 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 infrastructure in an area with large population and no communication problem, instead of investing in a zone with a small population and communication problem).

4.1.4 Overview of Key Developments and Local Innovation

There are certain aspects of the Smart Grid transition that can be considered as key developments in the sense that they are determining the general course of future implementations. These developments can be clustered under certain topics; renewable energy, energy storage, electric vehicles and advanced metering infrastructure.

- **Renewable Energy:** Although far from being completely exploited, Turkey has a strong potential of renewable energy resources, such as hydro, wind, solar, geothermal and biomass. Among the available options, hydroelectric power has a significantly high share in terms of installed capacity and produced energy in country's energy mix. However, the technological developments, global trends and commercialization of other renewable energy generation systems resulted in a massive surge of renewable energy projects both on large and small scales.

Wind power plants have generally emerged at larger scales due to the economies of scale in wind projects. Turkey currently has a strong wind sector that has grown 10 times in the last decade and total amount of installed power has increased to 8,288 MW as of July 2020, as reported by TÜREB.

In contrast to wind energy, solar energy installations are variant in terms of scale and implementation methods. Majority of installed solar power capacity is developed under the national legislation of 'Unlicensed Power Plants', which refer to private power plants that are equal or below 1 MW in scale, at a total capacity above 6,500 MW. All solar plants directly sell their produced electricity to grid and compensated through a fixed rate Feed-in Tariff (FIT) mechanism, although this mechanism will not be used anymore for power plants that will be commissioned after the first half of 2021 due to heavy financial burden of the mechanism on electricity tariffs. Solar plants that are larger than 1 MW are either registered as clusters of several power plants or are licensed under state-run competitions.

In larger scale solar plants, there is one exception that is proposed as an ambitious project, namely the YEKA Project. The first phase of YEKA Project has been designed as a 1,000 MW solar plant to be located in the South-Central Anatolia with an emphasis on industrial agglomerations and specialization zones that will surround the facility. There has been other YEKA projects (YEKA-2 and YEKA-3/Mini YEKA) announced as follow-ups, but the nature of the project structure is seemingly shifting towards a single, large-scale setup towards smaller pieces that are distributed in several provinces that are favorable for large-scale solar projects. It must be noted that the auction winners for the first YEKA project were required to set up their manufacturing plant and transfer technology for the solar PV panels to be used in the project. This manufacturing plant is currently located in Ankara, Turkey. It is expected that YEKA projects will give directions to the domestic solar energy sector in terms of industrial collaboration, local innovation and project implementation experience.

A highly important, but comparably neglected part of the solar energy production in Turkey is the rooftop solar panels. Although the country has immense potential in solar energy potential and is among the global leaders of solar energy usage in water heating systems, electricity production through rooftop PV systems is still at marginal levels and far behind its true potential. It must be stated that the solar energy sector and potential prosumers are highly keen on implementing these systems, but the legislative framework is providing an obstacle in ease of application for customers. Off-grid implementations have been trending in the last few years, but the majority of solar PV plants are generally established as 'unlicensed power plants' for rooftops of factories or similar structures. Urban solar energy, on the other hand, is very limited in practice but is still perceived as a potential threat to distribution grid operations due to lack of sufficient monitoring and control capabilities at the end nodes of the grid. This is a critical topic that requires thorough resolution if Turkey wants to exploit the huge renewable energy potential in cities, where demand is higher than anywhere else.

Besides hydro, wind and solar; Turkey is also strong in potential in geothermal and biomass resources. However, these items are not included in the evaluations of this chapter due to their lack of relation with Smart Grid concept in terms of creating any significant challenge or threat to be managed by distribution grids.

- **Energy Storage:** Increasing levels of intermittent energy resources such as wind and solar require balancing between energy demand and supply at both local and larger levels. The key concept that can assist a Smart Grid operator is the energy storage. Energy storage systems can come at various scales, technologies and functional capabilities depending on the choice and requirements.

  As the grid constraints become more dynamic and thus requires a more active management philosophy by the operators, concept of flexibility becomes increasingly important, as well. Although there are flexibility mechanisms that are in place for balancing the electricity grid overall, services that can be provided through energy storage systems have the potential to play a key role in delivering balancing services at local level, especially as coupled with renewable energy systems.

  In addition to mitigating the fluctuations caused by the intermittent nature of renewables, energy storage systems can be continuously treated as potential energy reserves in times of urgent needs for EDCos. Integration of many energy storage systems at the distribution level with proper information and communication technologies in place may provide a valuable tool for core Smart Grid functionalities in order to maintain grid stability and security for all its customers.

  Current situation for energy storage systems in Turkey has been under discussion among relevant stakeholders for several years, similar to European counterparts. Although the concept has finally found its place in electricity market legislations with a licensing directive for energy storage units, responsibilities and regulations that relate the EDCos in usage of these systems are still unclear. Some efforts have been put into implementing demonstration sites for various energy storage systems through R&D projects, but Turkish energy sector still lacks a strong front in experimenting with energy storage systems and their potential benefits.

- **Electric Vehicles:** Electric vehicles (EV) have started to revolutionize the automotive industry with their wide-ranging effects. Global numbers of private (automobiles) and public EV's (electric buses) are on the rise and it is a major risk for distribution grids due to increased power and energy requirements on the existing infrastructure, as the grid had never been planned according to EV presence. The way EV charging infrastructure is installed and the technologies used can have a significant impact on distribution networks and EDCos need to prepare themselves for the wave of change.

  New investments need to be made for a strong charging infrastructure to spread EV's. EVs represent a mobile demand for electricity, and therefore can theoretically draw electricity from the grid at any point during the day, at home or in the office, at low

charging speeds or by fast charging using the public charging infrastructure. When, where and how much electrical energy the EVs draw from the grid is significantly variable and depends not only on drive behaviour but also on charge-related business models. Incentive-based applications, which are based on the principles of flexibility and load profiles to be shaped properly, are important for reducing the negative effects of EVs on the network.

Discussions about the grid integration of electric vehicles has been a popular topic for Turkish energy sector over the last few years, especially following the increase in global EV numbers that have started to increase in developed countries. Supported by EMRA, some Turkish EDCos have started with R&D projects to initialize their efforts in understanding the potential impacts of EVs in Turkish distribution grids, but these studies hardly made an impact on energy market regulations and directives.

Due to the potential change in existing business lines that EVs can create, commercial aspects such as EV station operations, ownership and service provision have become focal points of early discussions. There has been a draft legislation to regulate the EV charging stations, but this directive never materialized due to a lack of consensus among key stakeholders.

A second wave of interest in EVs emerged in 2018, together with the initiation of TOGG *('Türkiye'nin Otomobili Girişim Grubu – Turkey's Automobile Venture Group)* Project. Founder as a joint venture that incorporates some of the key industrial groups in the country, TOGG initiative aims to design and manufacture a domestic EV aiming at private user markets in sedan and SUV models. TOGG is expected to have impacts on existing domestic automotive industry and likely to act as an admiral ship for local innovation efforts in electric mobility.

Setting up a manufacturing base in Gemlik, Turkey; TOGG is highly expected to trigger the Turkish EV market and the regulations around it, including the EV charging station directives. Role of EDCos within this framework is still largely unclear but it is evident that EMRA and EDCos are needed for further involvement, especially for nationwide regulations on public charging networks.

- **Advanced Metering Infrastructure:** Used as an inclusive term, 'Advanced Metering Infrastructure (AMI)' is used as a reference term that represents the overall smart metering ecosystem that covers smart meters, supporting equipment such as data concentrators or repeaters, metering communication infrastructure and meter data management systems.

  AMI is one of the key components of the Smart Grid architecture because a widespread roll-out of smart meters means that the EDCo gains direct monitoring and control capabilities over grid's end-nodes. A typical range of customer numbers for EDCos range from several tens of thousands to a few millions, which means that smart metering deployment enables them to get a hold of the end-user layer of the grid; a layer that EDCo has very limited visibility and no real-time data flow without AMI.

A successful deployment of AMI and a healthy operation has the potential to create significant value for the EDCo and its customers in various areas. AMI enables key Smart Grid features and functionalities such as demand response, active load management, DG integration handling, EV charging station management as well as an active and efficient grid management due to high-resolution, continuous data flow from all of its end nodes that makes it much easier for the EDCo to detect and attend to grid-related issues.

In Turkey, AMI has been the most widely discussed and thoroughly analysed Smart Grid topic so far due to its primary role in enabling other services for grid operators and energy consumers. As part of major regulatory projects, detailed cost-benefit analyses have been conducted multiple times in various contexts. However, the energy sector still awaits a nationwide smart meter roll-out mandate that would determine the technical specifications of the systems and the roll-out plan for year-by-year implementation to replace existing meters with smart meters. Due to several reasons such as significant budget requirements for a nationwide investment, lack of sectoral consensus, lack of a definite positive cost-benefit analysis result and unclarities about the target scope; smart meter roll-out is still on hold without a certain timeline.

In terms of local manufacturing capacity, there are several metering manufacturers as well as several importers or distributors of foreign products. There have also been some initiatives from European manufacturers to promote smart metering and accompanying digital services, but all efforts ceased activity after a certain point due to lack of sectoral movement. Level of technology and know-how in Turkish manufacturers is leaning towards cost-effective manufacturing practices and lack front in information and communication technology aspects. On the other hand, price tags on imported products are generally significantly higher than market expectations and the products are unconvincing in terms of meeting potential after-sales support and customization expectations by the grid operators. Therefore, smart metering is currently limited to clustered areas such as autonomous industrial zones and private customers which require higher precision measurements for their internal purposes.

4.2 Market Potential

Being composed of multiple key components and several subsystems for each component, Smart Grid deployments have an immense business potential for all involved stakeholders. As the privatized part of the electricity network, distribution grids are likely to be at the core of majority of Smart Grid investments to be made over the next few years.

In order to assess the potential business volumes for distribution level Smart Grid investments, a healthy method is to break down the potential into smaller segments. Indications for Smart Grid subdomains provided in the list below are in alignment with the taxonomy provided in Annex-1, under 7.1.2. Figures provided are 5-year budget estimates for the upcoming tariff period and indicate EMRA planning for the years 2021-2025 for the Turkish distribution sector.

It can be observed that certain technical areas have significantly higher shares for upcoming investment period, due to the status of existing implementations and expected developments over the next 5 years. It is expected that the major portion of Smart Grid investments will be in grid monitoring, controlling and management technologies, with advanced metering infrastructure investments to follow up with possible initiation of smart meter roll-outs.

Emphasis on digitalization through enterprise application integration, asset management, enterprise IT solutions and data analytics solutions will also be higher than previous investment period due to a technological shift towards digital solution base in grid operations and service delivery.

In comparison to global developments and expectations, it can be said that the Smart Grid investments with respect to renewables, energy storage and electric vehicles will be moderate in size but it must be evaluated that these will be the areas with immense potential that will expand after the 5-year period as well. Utility communication infrastructure investments are expected to be limited due to existing investments. On the other hand, cyber-security measures are still not seen as critical as other Smart Grid components and thus investments in this area are anticipated to be limited during the interval. Consultancy and support services that are not combined with service or product delivery may be limited to certain budget constraints as the industry and EMRA have used these services in previous investment periods.

SMART GRID TECHNOLOGY SUB-DOMAIN	5-YEAR ESTIMATED BUDGET
Consultancy and Support Services	€ 12,500,000
Grid Monitoring, Control and Management	€ 351,000,000
Enterprise IT and Data Analytics	€ 80,400,000
Enterprise Application Integration (EAI)	€ 92,100,000
DER And Energy Storage	€ 69,500,000
Asset Management	€ 115,500,000
Electric Vehicles and EV Charging Infrastructure	€ 36,500,000
Advanced Metering Infrastructure (AMI) and Consumer Engagement	€ 402,500,000
Utility Communication	€ 61,500,000
Cyber-Security	€ 48,500,000
TOTAL MARKET POTENTIAL	**€ 1,270,000,000**

Table 3. Market Volume Assessments of Smart Grid Technical Subdomains for 2021-2025 Interval

Looking at the prospects, Turkish Smart Grid sector holds a significant market potential that is above € 1,25 billion during the years 2021-2025. It is evaluated that successful implementation of this investment plan and improvements in the Turkish electricity distribution sector overall together with Smart Grid technologies and systems will enhance business prospects significantly for the upcoming investment periods, as well. Therefore, involvement in Turkish Smart Grid sector during the upcoming 5-year interval may play a key role for Dutch companies to lead the way for the later years.

4.3 Stakeholder Analysis

Energy industry has many stakeholders that provide different perspectives over regulations, business conducts and customer expectations. It is important to understand the roles and expectations of these stakeholders in order to develop business strategies, set up initiatives or execute Smart Grid projects.

- **EMRA:** Turkish Energy Market Regulatory Authority, EMRA, is the national authority for the sector. Main role of EMRA is to regulate and audit in order to ensure that energy is delivered to the consumers in sufficient, high-quality, continuous, economic and environmentally friendly conditions. EMRA is responsible for enabling a competitive and transparent market structure for all the energy industry players. All regulations and legislations that shape the framework for Smart Grid investments and operations are, therefore, under EMRA's responsibility and authority.
- **TEDAŞ:** State-owned Turkish electricity distribution company, TEDAŞ, is still legally the owner of all electricity distribution assets. All Smart Grid investments are to be delivered to ownership of TEDAŞ, in theory, after the privatization period of 30 years comes to an end.
- **EDCos:** Operating the distribution grids in their respective geographical borders, there are 21 EDCos in Turkey, which are clustered under the same commercial group due to the nature of privatization process. EDCos are responsible for ensuring a reliable, secure and continuous delivery of electrical energy to the customers and managing the grid operations on a continuous basis. All Smart Grid operations will be handled by EDCos in accordance with their operational constraints, KPIs, organizational structure and priorities.
- **RetCos:** Energy retail companies are responsible for delivering the commercial aspect of energy supply and are the main point of contact with the customers in terms of bill collection and customer relations. Digitalization in Smart Grid transition will have a major impact on RetCos' methodologies for interacting with the customers and revenue collection.
- **Customers:** Being connected to the distribution grid from medium-voltage or low-voltage grids, there are millions of customers that may be within residential, commercial, industrial or agricultural classifications. Main expectation of a grid customer is to access reliable and continuous energy supply, in exchange for paying their bills. In Smart Grid

context, grid customers become significantly important as the general trend leans towards generation following demand. Philosophy of active grid management is also heavily focused on consumer engagement through smart meters, digital applications and other tools.

- **Prosumers:** Together with the introduction of small-scaled renewable energy systems that are installed at premises (private households, commercial buildings, factories, farms etc.), a new concept emerges as 'Prosumers', or producing consumers. Aiming to meet their own energy demand with their own systems in the first place, increase in the number of prosumers complicate grid operations at a local level, both in terms of managing the physical energy flow without any problems and managing the commercial aspects of generated and consumed energy. Upcoming technologies, such as micro grids, blockchain and virtual power plants are mainly evolving around the role of prosumers in the Smart Grid framework.
- **Local Providers of Services or Products:** There are many companies, either of Turkish origin or as local branches of international companies, that are delivering products or services of different types and scales in the Turkish energy sector. In transition to Smart Grids, they are facing potential new competition from domestic and foreign markets and are required to enhance their innovation capabilities to adapt to Smart Grid service and product requirements.
- **Dutch Providers of Services or Products:** Many Dutch companies have the capacity and business traditions to be able to Turkish Smart Grid sector. As in line with the goal of this study, they may have a chance to introduce their own expertise, service and products to the market and earn a share in their respective domains with or without local presence or business partners.

4.4 Opportunities and Challenges

4.4.1 Budgetary Forecast and the Main Opportunities for the New Tariff Period (2021-2025)

Smart Grid investment budget forecasts for Turkish electricity distribution sector are based on an extensive research and study which is conducted to examine the requirements of Turkish electricity distribution companies (EDCos) in alignment with strategical background for 5-year regulation periods. This study firstly categorizes the Smart Grid technologies in accordance with industrial diversification of technical and commercial solution range. This categorization is also applied in the attempt to cluster Dutch companies for Turkish market orientation; thus, aligning the market segmentation with a referable and meaningful taxonomy.

Smart Grid technical sub-domain categories that are taken into consideration are listed as below:

- Consultancy and Support Services
- Grid Monitoring, Control and Management

- Enterprise IT and Data Analytics
- Enterprise Application Integration (EAI)
- DER and Energy Storage
- Asset Management
- Electric Vehicles and EV Charging Infrastructure
- Advanced Metering Infrastructure (AMI) and Consumer Engagement
- Utility Communication
- Cyber-security

In the calculation of Smart Grid investments for the upcoming regulatory period of 2021-2025 (*'4th Regulatory Implementation Period')*, presented technical categorization is taken as basis for estimating project-based investment forecasts while taking regulatory considerations, such as project impacts on investment revenue caps, into account.

For the fast-approaching regulatory period that will cover the time interval between 2021-2025, it is estimated that the overall volume of Smart Grid investments in Turkish electricity distribution sector will increase and overall Smart Grid investment range between 2021-2025 time interval will be approximately 1.27 Billion €. Smart Grid investments that EDCos are planning to make are given in the figure below in accordance with the given technical categorization.

It is estimated that the main area of focus for the upcoming Smart Grid investments are going to be on the technical categories of 'advanced grid monitoring, control & management' and 'AMI & consumer engagement'; taking approximately 60% of all investment budgets. However; advanced metering infrastructure and supporting technologies for deployment of AMI are estimated to increase their share in the overall distribution further towards the regulatory period, with an estimated budget requirement of 405 M€. It is planned for EDCos to complete their MDM and Head-end software system investments for AMI and then initiate massive AMI roll-out projects after the year 2025.

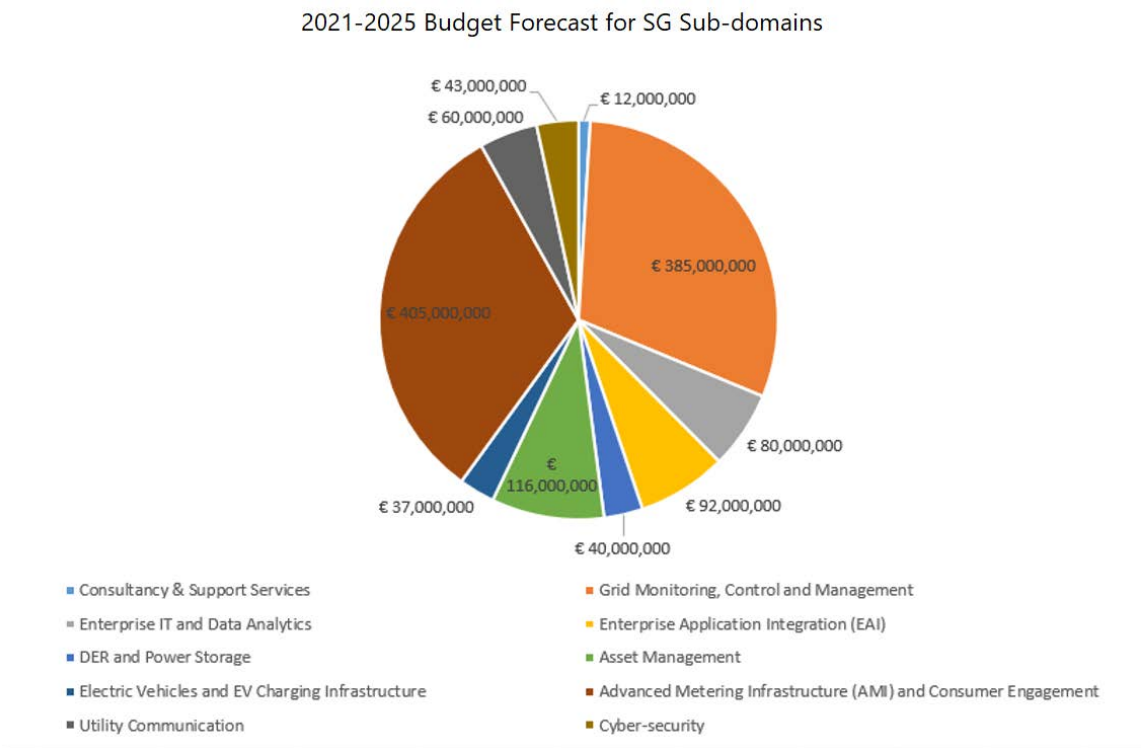

Figure 4.1. Cumulative Budget Forecasts for Each Smart Grid Technical Sub-domain (2021-2025 Interval)

In addition to those two technical categories, it is foreseen that 'Asset Management and GIS' investments will also form a significant portion of overall Smart Grid investments. Estimated budgetary forecast for this category is approximately 116 M€.

Distribution of budgetary forecasts for Smart Grid projects are also calculated for each expenditure type as per the regulations; (i) R&D / Pilot Project OPEX, (ii) Planning & Design Projects (CAPEX and/or OPEX) and (iii) Implementation Projects (CAPEX).

Planning and design efforts prior to widespread Smart Grid investments are considered to ensure the effectiveness and efficiency of the implementations. Due to the fact that planning and design efforts have already initiated during the current implementation period ('3rd Regulatory Implementation Period' – 2016-2020), it is estimated that majority of these projects will be completed by the start of 2021-2025 interval, thus laying the grounds for a variety of Smart Grid projects and implementations.

Another important point appears as the realization of R&D and pilot implementation projects to determine the most suitable technology choices and widespread implementation strategies. During the current regulatory implementation period, which will close by the end of the year 2020, R&D projects implemented by EDCos have mostly been conducted with allocated OPEX budgets for R&D projects by the Energy Market Regulatory Authority (EMRA). This budget has, until now, been allocated as 1% of overall EDCo OPEX budget. This amount was totalled to approximately 45 M€ for the whole period, yet the overall usage remained around 50%. It is

estimated that the budget ratio for R&D projects will increase significantly in the upcoming regulatory period and will be in the range of 100 M€-120 M€ overall.

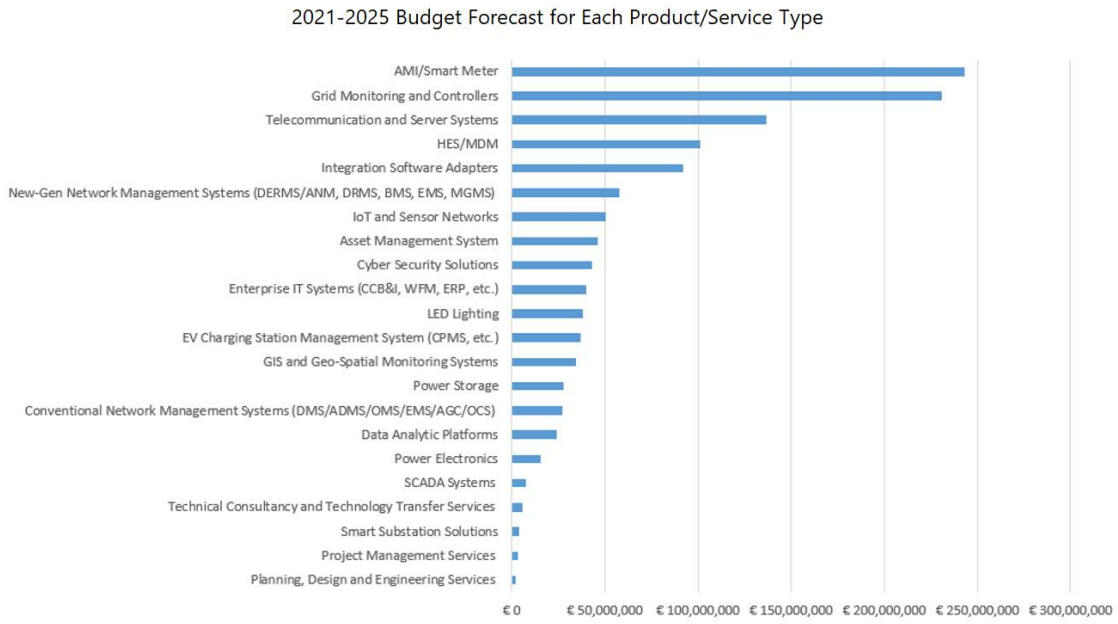

Figure 4.2. Cumulative Budget Forecasts for Smart Grid Product/Service Types (2021-2025 Interval)

4.4.2 Rules, Regulations and Procurement Strategies for Investments and Tenders

It is highly important for potential vendors to understand the background and context of investment regulations to successfully channel their efforts and activities in Turkish electricity distribution sector. In order to understand the context and framework for investments and tenders, it is essential to understand the rules, regulations and strategies that are in place for capital expenditures, or CAPEX. Main focus points, categories and key considerations for CAPEX regulations are presented in detail below.

- **Capital Expenditures (CAPEX)**

EDCos are regulated entities that must cover their cost through regulated revenues only, which are collected via network tariffs. The described investment requests will not be viable if EDCos are not able to create value on a regular basis. Sustainable and efficient long-term regulation needs to strike a balance between price adequacy for consumers, quality of supply and a viable framework for distribution companies.

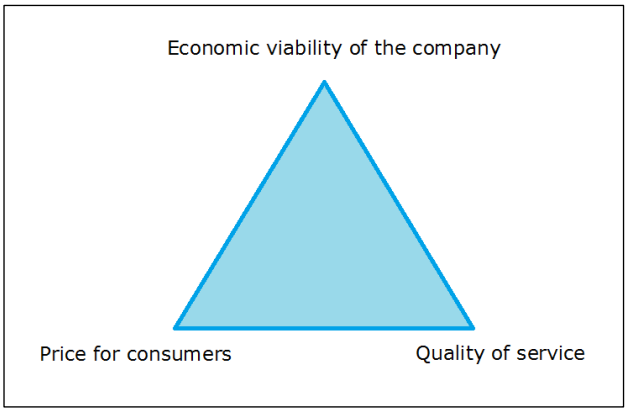

Figure 4.3. Viable Investment Balance

One of the primary objectives of privatization is to finance required distribution system and network improvements and expansions through private sector investments, thereby removing the burden of such investments away from the State budget.

Before the privatization process started for electricity distribution; very high rate of urbanization, long lasted scarcity of funds, cumbersome state entrepreneurship and procurement processes lead TEDAS, the State-owned electricity distribution company, to invest mainly on capacity increase. It is being observed that EDCos have been investing on rehabilitation/replacement together IT, OT systems and AMI in the Third Implementation Period, which will finalize by the end of 2020. By the IP5 (post-2025 IP), strong resemblances are expected between Turkish EDCos and EU EDCos in terms of service quality parameters, technology level and operational excellence.

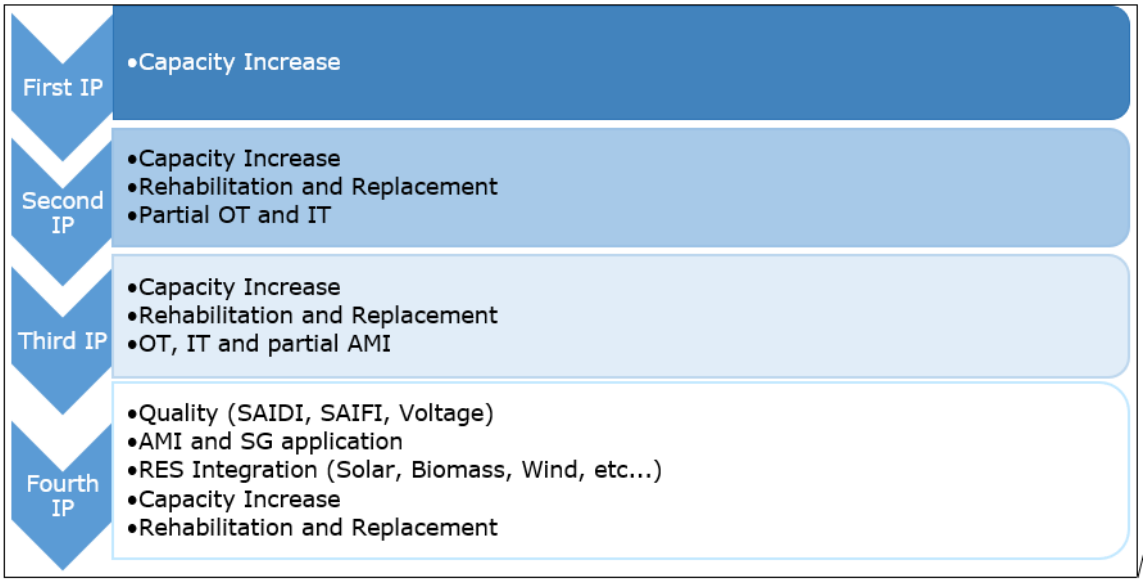

Figure 4.4. CAPEX Evolution Throughout Implementation Periods

Figure 4.4 shows CAPEX road map driven by the network requirements. Due to lack of state funding, TEDAS subsidiaries were able to invest mainly to cover capacity increase related needs

in the First Implementation Period. After the privatization, EDCos started with the investments to rehabilitate their network by replacing aged components and improve the topology to convert existing radial network to mesh architecture in order to improve the quality of service. Thanks to introduction of SCADA/DMS/OMS systems, GIS applications, RAB data collection projects and long-term master planning in the Second Implementation Period, EDCos became more equipped to foresee the future requirements to achieve EU standards. However, it is a realistic expectation for the Turkish electricity distribution sector to catch up EU industry averages by 2025, in an optimistic scenario.

Financial expenses such as interest, late interest, financial renting, exchange rate losses, as well as VAT and stamp tax is not considered in CAPEX calculations approved by EMRA. Stamp tax expenses resulting from investment activities are considered within the scope of uncontrollable OPEX.

- **CAPEX Categories**

As of 2020, CAPEX categorization has been structured under 5 particular groups, that are explained below.

- **Network investments:**
  - Network Investments are defined as a single item, which consists of the investments for capacity increase, new connections, renewal of facilities whose economic life ended and for life and property security purposes, lightning within the scope of public lighting regulation, voltage conversion for standardization and decrease losses, displacement, investment in line with technological developments and compensation reactor, dispatch center, cutting measurement cabinets.
  - Investment costs for displacement in existing distribution facilities is not considered within the scope of pre-approved CAPEX, except for the cases where the expropriation works of the distribution facility to be displaced is completed or there are explicit provisions in the Law. In this case the cost is met by the real or legal entity who has applied for displacement.
  - Network assets within the scope of network investments shall be in use for 15 years for them to be considered within pre-approved CAPEX calculations. However, if the justification for those expenditures are found appropriate by the Board, then 15 years requirement is not looked for.
  - Economic life of the assets (e.g. substations excluding measurement transformer, modular cells, lighting luminaries, outer or inner LV switchboard, load splitter, cutter) and facilities to be renewed is 30 years. Renewal of the assets other than the ones stated here are not considered within pre-approved CAPEX calculations.

- **Technological / Smart Grid Investments:**
    - Information system and technology investments such as remote monitoring and control systems (SCADA), GIS, AMR as well as software, project or licenses to be procured as inseparable part of those operations are considered as network operation system investments. Software, project or licenses that are inseparable part for the works defined here are assessed within network operation system investments and investment related to remote meters, analyzer or other remote control equipment (which is not defined in AMR regulation and does not forms a basis in distribution system) are reported within network operation system investments. Works related to the distribution network such as modular cell conversion, relay adding are reported within investments.
    - Pre-approved CAPEX for network operation system investments cannot exceed 5% of the network investments existing in preliminary approved investment plan of the related IP.
- **Conventional Metering investments:**
    - Meters installed for lighting, within the scope of AMR system, with the aim of control or other than metering purposes are not considered within meter investments. Economic life of meters are 10 years and fees paid for the meters renewed or used in distribution system after recalibrating (before 10 years period ends) are not considered within pre-approved CAPEX.
- **Environment, safety, and other investments for legal liabilities:**
    - Expenses related to the investments to be made other that EDCo's own initiative such as expropriation, excavation permit fee, license fee, project approval and acceptance fee paid to MENR, forest transit permit fee, road crossing fee, supervision service fee are considered within the scope of environment, security and other investments for legal liabilities.
- **Other expenditures having the characteristics of CAPEX:**
    - Assets such as inventory stock, building, vehicle, land whose useful life is over 1 year, software licenses and project making expenses as well as the expenditures made to overcome deficiencies (disconnector, surge arrester etc.) coming from pre-privatization period are considered within other expenditures having the characteristics of investment costs.
    - The amount considered within pre-approved CAPEX calculations (among the expenditures that will be done in an IP) are approved in the manner that it will not exceed 1% of the Network Investments that takes part in the preliminary approved investment plan for the related IP.

CAPEX is taken into account in regulated revenue calculations as pre-approved CAPEX within the framework of following principles:

- Making expenditure within the context of approved (by Board) investment plans.
- CAPEX consisting of the expenditures that are used to carry out activities, sub-activities and other expenditures that have the characteristics of CAPEX.
- Assets (regarding expenditures) having started to be used and preliminary acceptance's being completed or applying for provisional acceptance till 31st of December and approval process' ending till 31st of March.
- Ownership of the investments' belonging to public institutions or investments' being done on behalf of public institutions or its being done in accordance with the legislation.
- Separation of late interest, interest, exchange difference or other similar financing costs.
- Documentation regarding harmonization with accounting records.
- Separation of the related assets value in case the assets whose amortization has already started, and assets mentioned in 5th clause of Article 11 of the communique are used.

Network Investments will be accounted by unit prices. Therefore, EDCos would be able to record some CAPEX efficiency by managing procurement processes in a better way.

➢ **Unit Price Application**

Starting from 2011, EMRA asked EDCos to handle capacity increase investments with unit prices. According to this application, EDCos reported physical quantities as per above categories and claim total expenditures by multiplying the unit prices with quantities. Therefore, any gain or loss in comparison with the unit price calculations belong within EDCo's account. All other investment categories are with actual cost.

Unit prices are applied subject to the definitions of material cost, assembly and disassembly cost and assembly from disassembly. The following are not considered within the scope of unit cost:

- Information system investments
- Data collection via GIS
- Undersea cables
- Compensation panel and equipment, condenser/reactor of MV compensation facilities
- Technical quality metering equipment that are portable
- Meters installed in line with AMR regulation
- Construction works done as a modification inside distribution centers, substations and kiosks
- Environment, security and other investments that are obliged to be made
- Other investment expenditures

➢ **Investment Process**

The Investment Plan for each EDCo is created with the general awareness of continuity of supply, higher standards with regards to technical quality, reasonable prices and a reliable network should be provided to the customers and users. In addition, the network should be adapted to the transmission network as it is also under continuous improvement and renewal. The general principle is to do the right investments in the right time, and to optimize the network investments in order to use the resources efficiently.

Distribution companies are required to prepare 5-10 years master plans. Investment plans must give priority to the following criteria:

- Life and Property Safety
- Supply security and technical quality
- Cover the new connection demands

In the last year of each implementation period, EDCos submit their 5-year investment plans for each defined CAPEX category for EMRA's approval as well as their master plans. "Capacity Increase" category of the investment plan must be in parallel with master plan. The main principles of the plan are as follows:

- Meet the demand according to forecasts
- Provide flexibility against new technologies and demand variations
- Meet requirements for quality of service (QoS)
- Provide high level service with minimum cost
- Reduce technical losses and theft
- Ensure coordination with TEIAS investment plans

Before end of each October, every EDCo must submit the details of their investment plan for the following year. Before the end of every March, distribution companies are required to submit the realization of the investments belong to previous year in details. EMRA might delete some of the investments due to several reasons (*Conformity with master plan, correct unit price application, correct investment categorization, replacement earlier than useful economic life, etc.).* This means that in a tariff year, when the EDCo submits the realization of the investment to EMRA, EMRA might evaluate some of these investments within OPEX budgets instead of CAPEX. In case the EDCo does not submit investment plans within the specified time period and in the specified format, then EMRA holds the right to prepare the investment plan.

EMRA evaluates the realized investments based on this list submitted in October at the end of each March for the previous year. At the end of each implementation period EMRA calculates the annual realized CAPEX deviations from the plan and calculate each year's deficiency or excess.

On the other hand, projects in the approved investments plan shall be completed during the IP time interval. EMRA is informed about the projects that belong to the final year of IP and could

not be completed before the end of IP; within the scope of "*Uncompleted Projects Notifications in Distribution System Investment Implementation Period*". If there is a budgetary amount remaining as a result of incompletion from the approved CAPEX cap for the related IP, then the amount is added to the following IP's investment cap.

CAPEX in a tariff year cannot be below 65% of the investment cap for that year. If so, Board may update the valid investment cap and/or revenue requirement. If EDCo cannot realize the given CAPEX budget within 5 years and the unrealized CAPEX is significant with no reasonable explanation, then EMRA might initiate severe measures against EDCo including license cancellation. However, if there is a reasonable explanation or difference is not significant then above calculation will be made and EDCo will receive less revenue cap in the following implementation period. EMRA allows a reasonable shift between the categories within a year but expect 5-year total of each category will be fulfilled as the target. If there is a need to revise, EDCo must apply EMRA for its consent.

As for the master plan; there are certain factors that need to be taken into account during the preparation. Those criteria can be listed as given:

- Current situation and quality of the network,
- Possible effects of gdp, population, consumption growth,
- Increase in energy demand and change in consumption and/or generation trends,
- Distribution of energy resources,
- Supply security and technical quality,
- Unlicensed generation facilities,
- Supply reliability,
- Technical and commercial quality indicators,
- Economical use of resources.

In addition to these considerations, master plan shall be supported by technical information, in a way to ease operation of distribution network and installed by separating into different projects under different scenarios. Baseline of the projects within the scope of 5 years' master plans are completed during planning phase.

4.4.3 SWOT Analysis and Risks

Turkish Smart Grid market holds many opportunities and challenges that need close attention especially from new players that are investigating to enter the market. Turkey is a dynamic country and its business environment has the potential to rapidly alter its outlook when circumstances shaping up the market change. However, there are certain drawbacks that may hinder or slow down the pace of business activities and innovation if neglected. In this

perspective, results of a SWOT analysis are presented below to outline the pros and cons of Turkish Smart Grid market. A summary can be also found in Figure 4.5.

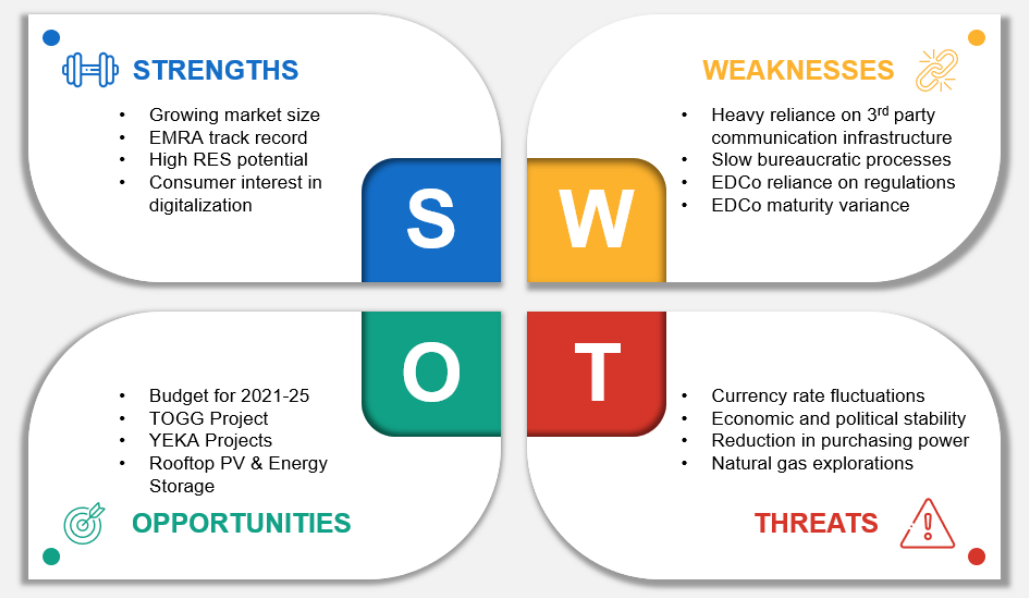

Figure 4.5. SWOT Analysis Summary for Turkish Smart Grid Sector

- **Strengths:**
  - Turkish energy market is consistently growing in volume of customer base, overall energy consumption and installed capacity.
  - EMRA has a proven track record of showing initiatives of keeping up with sectoral and technological developments and effectively regulating the energy market in a transparent manner.
  - There is very strong potential for renewable energy systems, especially in solar PV implementations in small and medium scale.
  - Young population ratio among the customer base is significantly higher than European average. Customer interest in digitalization trends and technological solutions is high.

- **Weaknesses:**
  - Heavy reliance on third party or public communication infrastructure has limiting roles on Smart Grid functionalities and effectiveness.
  - Bureaucratic processes tend to become slower for implementing first-of-its-kind solutions, especially when there are perceived risks about customer complaints or lack of trust in technology providers.

- EDCos are accustomed to act by the encouragement of national regulations, which makes them to be reluctant on sustaining innovation, R&D and demonstration efforts.
- EDCos have different maturity levels in terms of Smart Grid deployments and practices of technology use in their routine operations.
- Local vendors in the market do not show the necessary technological maturity in certain technical areas and may lack experience in project implementations for advanced Smart Grid topics.

- **Opportunities:**
  - EDCo investment budgets allocated for 2021-2025 regulation period will be increased for Smart Grid investments and roll-out projects.
  - TOGG Project has the potential to unlock the EV market potential in Turkey, assuming that local regulations for EVs and charging infrastructure operations will be accompanying the technological and market developments.
  - YEKA and mini-YEKA projects will contribute to sustainability goals for renewable energy supply and increase public awareness as well as domestic technology know-how in the market.
  - There is a strong interest from the end-users for implementation of rooftop solar PV systems. Continued interest is expected to speed up the bureaucracy for higher integration of small-scaled renewables.
  - Energy storage systems are defined under new legislations for licensing and operation. Increase in implementations are expected in both large-scale and small-scale projects.
- **Threats:**
  - Fluctuations in local currency rates possess a risk for potential investors to achieve expected rate of returns.
  - Economic and political stability of Turkey and its region in general possess several risks due to international conflicts, although the situation involves many stakeholders which act responsibly and cautiously.
  - Reduction in purchasing power of end users can stumble the uptake of innovative solutions, services or products that are freshly introduced to the market, especially in unregulated energy business through private channels.
  - Ongoing natural gas exploration activities may require further state budget allocations, which may eventually result in delayed investments or relatively reduced importance for Smart Grid investments and roll-out projects.

4.4.4 Entry Barriers to Turkey for Smart Grid Niche

For an outside player, entering a new market and establishing a strong foothold may not be easy under all circumstances. Dutch companies have a strong tradition of successfully conducting business in international environments and already have some activities in Turkish economy, but Turkish Smart Grid sector is newly forming itself and transforming an existing, conventional industry towards the needs of a new era. Thus, Dutch companies need to be aware of potential entry barriers to Turkish Smart Grid sector if they aim to eliminate the initial risks and have a successful start for their business ventures or partnerships. Below are the identified barriers that Dutch companies are advised to be aware of.

- **Business Conduct Barriers:** There are several barriers in terms of conducting business effectively in Turkey and those are partially relevant to the Smart Grid sector. First one is the language barrier. Although the level of English is sufficient and is used frequently in business conduct of the key stakeholders, Dutch companies need to pay attention to local presence in order to progress effectively onto actual project implementations and handle the issues that may emerge in contracted projects. Similarly, local business ethics and etiquette require attention and respect to establish long-term relations with potential customers and key stakeholders.
- **Local Competition:** Due to the gap between Turkish Lira and Euro, Dutch companies need to be aware of the fact that local companies have the advantage of providing cheaper service and have relatively lower costs of local innovation in order to meet the market requirements.
- **Monitoring Opportunities:** Lack of local presence through an established network, partner companies or local branches may result in losing the capability to monitor and track upcoming business opportunities in Turkish Smart Grid sector. Continuous communication and local partnerships are essential to steer and participate in future opportunities, which may often be under unannounced progress until a certain official point.
- **Regulation Barriers:** Lack of deep knowledge of local regulations and industry practices can result in unproductive strategy and business development efforts in Turkish Smart Grid market in general. As the ground for new regulations is in a slow but continuous move, missing out on the regulatory focus can result in dead ends and wasted resources.
- **Technical Barriers:** Smart Grid systems are highly variant in technological level, standards, scales and functional capabilities. Dutch companies need to be knowledgeable and flexible on complying with interoperability standards and integration processes in order to successfully introduce their solutions within existing Smart Grid ecosystems.
- **Logistics Barriers:** Especially valid for physical Smart Grid systems, Dutch companies need to pay attention to issues about international and domestic logistics in order to keep up with project schedules and implementation plans, especially for large-scale projects.

National differences in code of conduct and customs regulations can cause unexpected delays in critical steps and this can cause major problems for project completion.

It is seen that it may not be straightforward to proceed in Turkish Smart Grid market for Dutch solution providers, but with a strong tradition and expertise in international business conduct they would be able to overcome existing obstacles and risks.

5 Analysis of Dutch Companies and Exploring Market Potential

5.1 Identification and Review of Potential Dutch Companies

In order to successfully explore and assess the market potential of Dutch companies in Turkish Smart Grid ecosystem, it is essential to have a comprehensive list of the commercial actors based in the Netherlands that are prominently active in the field. This is important to be able to identify existing points of strength and weakness in terms of delivered services or products and to map those in line with the market gaps.

A list of Dutch companies that are functioning in the Smart Grid sector are presented below as initial findings for further assessment. It must be noted that; although there are several multi-national Smart Grid companies have offices and representations in The Netherlands, they are excluded from this list unless their country of origin is The Netherlands.

Categorization of technical domain and service/product types are in accordance with the taxonomy presented in section 7.1 (Annex-1). Contact information (as retrieved in the desktop review) for each company is provided in the section 7.2 (Annex-2).

It can be observed from the list that Dutch companies that are actively providing services or products to Smart Grid market in general have a reasonable level of diversity in terms of covering technical domains, although there are certain points of increased focus due to national or European trends such as increase in number of electric vehicles, higher penetration of renewable energy systems, concerns over resource and energy efficiency, and high consumer expectations for digital and customized solutions. Further identification is provided in section 5.4.

#	COMPANY NAME	SMART GRID TECHNICAL CATEGORY	SERVICE / PRODUCT TYPE
1	Alfen	• Grid Monitoring, Control and Management • DER and Energy Storage • Electric vehicles & EV Charging Infrastructure	• Energy Storage • EV Charging Stations & Management System • Grid Monitoring and Controllers • Smart Substation Solutions
2	Femtogrid	• DER and Energy Storage	• Power Electronics
3	Datawatt B.V.	• Grid Monitoring, Control and Management • Utility Communication	• Grid Monitoring and Controllers • Telecommunication and Server Systems • SCADA Systems • Project Management Services

#	COMPANY NAME	SMART GRID TECHNICAL CATEGORY	SERVICE / PRODUCT TYPE
4	Almende B.V.	• Enterprise IT and Data Analytics • Enterprise Application Integration (EAI)	• Data Analytics Platforms • Technical Consultancy and Technology Transfer Services • Project Management Services
5	Deerns	• Consultancy & Support Services	• Planning, Design and Engineering Services • Technical Consultancy and Technology Transfer Services
6	Aurum	• Enterprise IT and Data Analytics • AMI and Consumer Engagement	• Data Analytics Platforms • Enterprise IT Systems (WFM, ERP, etc.)
7	Technolution	• Grid Monitoring, Control and Management • DER and Energy Storage • Electric Vehicles and EV Charging Infrastructure	• IoT and Sensor Networks • Data Analytics Platforms • Planning, Design and Engineering Services
8	Allego	• Electric Vehicles and EV Charging Infrastructure • Enterprise IT and Data Analytics	• EV Charging Stations & Management System (CPMS, etc.) • Data Analytics Platforms
9	Alliander N.V.	• Grid Monitoring, Control and Management • DER and Energy Storage • Electric Vehicles and EV Charging Infrastructure • AMI and Consumer Engagement	• New-Gen Network Management Systems (DERMS/ANM, DRMS, BMS, EMS, MGMS) • Technical Consultancy and Technology Transfer Services
10	Enexis B.V.	• Grid Monitoring, Control and Management • Electric Vehicles and EV Charging Infrastructure • AMI and Consumer Engagement	• Technical Consultancy and Technology Transfer Services

#	COMPANY NAME	SMART GRID TECHNICAL CATEGORY	SERVICE / PRODUCT TYPE
11	TNO	• Consultancy & Support Services • DER and Energy Storage • Asset Management	• Technical Consultancy and Technology Transfer Services • GIS and Geo-Spatial Monitoring Systems • IoT and Sensor Networks
12	Philips Lighting	• Grid Monitoring, Control and Management	• IoT and Sensor Networks • LED Lighting
13	Netinium	• AMI and Consumer Engagement	• Telecommunication and Server Systems • HES/MDM
14	Bredenoord Aggregaten	• DER and Energy Storage	• Power Electronics • Energy Storage
15	Heliox	• Electric Vehicles and EV Charging Infrastructure	• EV Charging Stations & Management System (CPMS, etc.)
16	NXP Semiconductors Netherlands Bv	• AMI and Consumer Engagement • Enterprise IT and Data Analytics	• Telecommunication and Server Systems • Data Analytic Platforms • AMI/Smart Meter
17	Mastervolt	• DER and Energy Storage	• Power Electronics • Energy Storage
18	Flexicontrol	• AMI and Consumer Engagement • Enterprise IT and Data Analytics	• Telecommunication and Server Systems • Data Analytics Platforms
19	Eleq B.V.	• Grid Monitoring, Control and Management	• Grid Monitoring and Controllers • Power Electronics • LED Lighting
20	Spectral Energy	• Consultancy & Support Services • Enterprise IT and Data Analytics • AMI and Consumer Engagement	• Technical Consultancy and Technology Transfer Services • Planning, Design and Engineering Services • Data Analytic Platforms • IoT and Sensor Networks

Table 4. Identified Dutch Companies in Smart Grid Domain

5.2 Identification and Review of Dutch Universities

Academic institutions play an important role in providing the Smart Grid ecosystem with novel perspectives, scientific research and technological solutions that eventually shape up the development path of the industry. This means that the positioning of universities, their core strengths and industrial collaboration potential are determinant in estimating the impact factors of academic efforts put into Smart Grid research in various disciplines and contexts through basic research, applied research, R&D projects and demonstration efforts.

The Netherlands already has a strong base of academic institutions and universities that contribute to research, policies and solutions dealing with climate change and global energy revolution. Dutch universities are known for well-established tradition of successful industrial collaboration and Dutch companies have been benefitting from this strength in global competition and innovation. Having improved its graduate educational framework for attracting a higher level of international talents, Dutch universities can play a key role in supporting and complementing commercial efforts. Core strengths and research focuses of Dutch universities are distributed through the Smart Grid spectrum, which enables them to be flexible in developing collaboration frameworks and partnerships with Dutch and foreign partners in academia or industry.

The list of identified Dutch universities is presented in the table below. Categorization of expertise areas in Smart Grid domain is done in accordance with the technical sub-domains defined in the taxonomy given in section 7.1 (Annex-1). Contact information (as retrieved in the desktop review) for each university is provided in the section 7.3 (Annex-3).

#	INSTITUTION NAME	AREAS OF SMART GRID EXPERTISE
1	TU/e – Eindhoven University of Technology	• DER and Energy Storage • Grid Monitoring, Control and Management • Electric Vehicles and EV Charging Infrastructure • Advanced Metering Infrastructure (AMI) and Consumer Engagement • Cyber-security
2	TU Delft – Delft Univ. of Technology	• DER and Energy Storage • Grid Monitoring, Control and Management • Asset Management • Electric Vehicles and EV Charging Infrastructure • Cyber-security
3	University of Twente	• DER and Energy Storage • Grid Monitoring, Control and Management • Enterprise IT and Data Analytics • Cyber-security • Utility Communication

#	INSTITUTION NAME	AREAS OF SMART GRID EXPERTISE
4	Erasmus Universiteit Rotterdam	• Consultancy and Support Services • Advanced Metering Infrastructure (AMI) and Consumer Engagement • Enterprise IT and Data Analytics
5	Saxion Univ. of Applied Sciences	• Consultancy and Support Services • DER and Energy Storage
6	Tilburg University	• Grid Monitoring, Control and Management • Cyber-security • Utility Communication • Advanced Metering Infrastructure (AMI) and Consumer Engagement
7	Univ. of Amsterdam	• Consultancy and Support Services • Advanced Metering Infrastructure (AMI) and Consumer Engagement
8	Univ. of Groningen	• Consultancy and Support Services • DER and Energy Storage • Electric Vehicles and EV Charging Infrastructure • Enterprise IT and Data Analytics
9	Utrecht University	• Consultancy and Support Services • DER and Energy Storage • Advanced Metering Infrastructure (AMI) and Consumer Engagement
10	Hanze Univ. of Applied Sciences	• DER and Energy Storage
11	Avans University of Applied Sciences	• Consultancy and Support Services • DER and Energy Storage
12	HAN (Hogeschool van Arnhem en Nijmegen)	• DER and Energy Storage • Electric Vehicles and EV Charging Infrastructure
13	Hogeschool Zuyd	• Consultancy and Support Services

Table 5. Identified Dutch Universities in Smart Grid Domain

5.3 Identification and Review of Dutch Technology and Knowledge Institutes

In addition to universities, there are a number of technology and knowledge institutes that are established with the aim and perspective of contributing to sustainable energy vision in national and European context. Presence of these institutes are important because they are strongly focused on particular subject matters, such as the energy transition, electric mobility or sustainable energy, and are showing particular initiative in socio-economic and political context

in order to lead the collective discussions around many aspects of the climate change and energy revolution topics.

Although not directly contributing to any export potential in general, presence of these institutes has a supportive position and contribution to industrial perspectives in terms of bringing a variety of scientific, industrial and social knowledge together in order to tackle problems related to the paradigm of clean energy transition. Most of the time, these institutes are spin-offs of established Dutch universities but they possess a high level of autonomy in determination of their roadmaps, activities and outputs. Many of these institutions are also highly active in delivering graduate level or industry-oriented education and training activities, with strong collaborative ties to key partners within the energy industry and Smart Grid ecosystem. They have the potential to be strong partners in capacity development, training, education and technology transfer efforts in business and project development efforts.

In this context, the list of identified Dutch technology and knowledge institutes is presented in the table below. Categorization of expertise areas is in accordance with the taxonomy presented in section 7.1 (Annex-1). Contact information (as retrieved in the desktop review) for each institute is provided in the section 7.4 (Annex-4).

#	INSTITUTION NAME	AREAS OF SMART GRID EXPERTISE
1	CWI – Centrum Wiskunde & Informatica	• Grid Monitoring, Control and Management • Enterprise IT and Data Analytics
2	ECN – Energy Research Centre of Netherlands	• Consultancy and Support Services • Grid Monitoring, Control and Management • DER and Energy Storage • Advanced Metering Infrastructure (AMI) and Consumer Engagement
3	Energy Academy Europe	• Consultancy and Support Services
4	DIFFER – Dutch Institute for Fundamental Energy Research	• DER and Energy Storage
5	Energy Delta Institute	• Consultancy and Support Services • DER and Energy Storage
6	IEECP – Institute for European Energy and Climate Policy	• Consultancy and Support Services
7	EIT InnoEnergy	• Consultancy and Support Services • DER and Energy Storage • Electric Vehicles and EV Charging Infrastructure • Utility Communication • Cyber-security

#	INSTITUTION NAME	AREAS OF SMART GRID EXPERTISE
8	European Commission - Joint Research Centre in Petten	• DER and Energy Storage • Electric Vehicles and EV Charging Infrastructure • Asset Management
9	Utrecht Sustainability Institute	• Consultancy and Support Services • Advanced Metering Infrastructure (AMI) and Consumer Engagement
10	EIRES – Eindhoven Institute for Renewable Energy Systems	• DER and Energy Storage
11	Stichting Cenex Nederland	• Electric Vehicles and EV Charging Infrastructure
12	NKL Nederland - Netherlands Knowledge Platform for Public Charging Infrastructure	• Electric Vehicles and EV Charging Infrastructure

Table 6. Identified Dutch Technology and Knowledge Institutes in Smart Grid Domain

5.4 Mapping Sectoral Requirements with Dutch Commercial Portfolio for Turkish Smart Grid Market

Upon reviewing the list of Dutch companies that are delivering products or services for the Smart Grid sector in general; it is observed that areas of focus and strength are partially accumulated within certain technical sub-domains. Due to the large number of Smart Grid technical sub-domains, extended names are used in abbreviated forms in the matching matrix according to the following table:

Technology Sub-domain	Table Matrix Abbreviation
Consultancy and Support Services	Cnslt & Sup
Grid Monitoring, Control and Management	Grid MCM
Enterprise IT and Data Analytics	IT & Data An
Enterprise Application Integration	EAI
DER and Energy Storage	DER&S
Asset Management	AsMgt
Electric Vehicles and EV Charging Infrastructure	EV & Chrg

Technology Sub-domain	Table Matrix Abbreviation
Advanced Metering Infrastructure (AMI) and Consumer Engagement	AMI & Cons En
Utility Communication	Ut Comm
Cyber-security	CyberSec

Table 7. Table Matrix Abbreviations for Technology Sub-domains

An overview of Figure 5.1 clearly shows that Dutch companies active in the Smart Grid ecosystem with their services or products are prominent in multiple sub-domains. It is also seen that overall cumulative base of expertise and activity is covering many of the topics in the sector; although there appears to be an accumulation around certain topics, such as distributed energy resources, energy storage, grid management and control technologies and electric vehicle charging technologies, due to context of national and European market orientation.

On the other hand, certain areas such as enterprise application integration and cyber-security are left neglected by the Dutch companies, although there is a strong base of knowledge in information technologies in the Netherlands. It is apparent that Dutch companies are leaning towards the added value in the IT aspects of Smart Grid sector and emerging to provide services and products that can provide enhanced data analytics through cloud solutions or user platforms.

Another finding that is particularly interesting is the relatively weak base for provision of consultancy and support services for the Smart Grid ecosystem. Although there are many Dutch companies in general that are competitive in consultancy services in general, it is analysed that wide spectrum of technical focus and necessity for integrated, multi-disciplinary expertise makes it difficult and unattractive for generalist consultancy companies to increase presence in this area. In contrast; technology developing companies, who are strong in technical knowledge and aware of sectoral requirements, are reluctant to provide consultancy and soft support services beyond project implementation context as such services often require differing approaches than their working culture of technology development, manufacturing and system implementation. This is identified as a gap that requires attention for Dutch consortia to attend to Smart Grid sector opportunities in Turkey and elsewhere.

There are two distribution system operators that are included in the list: Alliander and Enexis. The main reason behind their inclusion as identified companies that can contribute to Dutch export in Turkish Smart Grid sector is the fact that these companies are among the leading European distribution system operators in terms of technological innovation, academic collaboration and Smart Grid vision. More importantly, these companies are among the leading implementors of Smart Grid technologies in certain areas. This means that their know-how and field experiences are highly valuable in discussions with their counterparts in Turkey.

It is apparent that, in order to develop an end-to-end approach for developing business and projects in Turkish Smart Grid sector, Dutch companies have a stronger profile if they tend to form various consortia according to business requirements and aim to complement one another.

Company Name	Cnslt & Sup	Grid MCM	IT & Data An	EAI	DER&S	AsMgt	EV & Chrg	AMI & Cons En	Ut Comm	Cyber Sec
ALFEN		☑			☑		☑			
FEMTOGRID					☑					
DATAWATT		☑								
ALMENDE			☑	☑					☑	
DEERNS	☑									
AURUM			☑					☑		
TECHNOLUTION		☑			☑		☑			
ALLEGO			☑				☑			
ALLIANDER		☑			☑		☑	☑		
ENEXIS		☑					☑	☑		
TNO	☑				☑	☑				
PHILIPS LIGHTING		☑								
NETINIUM								☑		
BREDENOORD					☑					
HELIOX							☑			
NXP			☑					☑		
MASTERVOLT					☑					
FLEXICONTRCL			☑					☑		
ELEQ		☑								
SPECTRAL ENERGY	☑		☑					☑		

Figure 5.1. Areas of Smart Grid Product/Service Delivery for Identified Dutch Companies

5.5 Estimation of Market Potentials for Identified Categories for Dutch Companies

Assessment of Smart Grid market potential requires an analysis based on the mapping exercise conducted in the previous section. It can be seen that Dutch companies have stronger presence in certain technical domains of Smart Grids whereas they appear to be less competitive in other areas.

Among the areas that Dutch companies are strong; the leading ones are ‘distributed energy & storage’, ‘grid monitoring, control and management technologies’, ‘EVs and charging infrastructure’. Dutch companies are also competitive in information technologies and data analytics, as well as advanced metering infrastructure. This can be explained by the national and regional trends that have an effect on Smart Grid investments and projects that they have easier access to deliver services/products to. Dutch ecosystem for Smart Grids has been forming around

national or regional EDCos. It is understandable for them to have similar priorities or vision due to alignment in national and EU context as well as sharing a similar customer base with similar expectations from them.

On the other hand, areas such as asset management, application integration and cyber-security are not among the industrial focus for Dutch companies. It must be reminded that Dutch companies in this analysis do not include Dutch branches of international companies and this can partially explain the preference of Smart Grid specialization by Dutch companies, as they may leave certain areas to globally dominant companies and not compete with them in national or regional markets.

Assessing the potential market sizes for each of the Smart Grid subdomains that were determined in section 4.2, it can be said that the cumulative potential of the areas that Dutch companies are strong in is well above € 500 million in size. This is a significant potential to focus on, as it corresponds to approximately 40% of all the Smart Grid sector in Turkey for the next 5 years.

5.6 Local Competitor Analysis

In terms of local competition for Dutch companies in Turkish Smart Grid sector, competitors ought to be divided into two categories in order to reflect the depth and strength of solution portfolios in the market.

Company Name	Cnslt & Sup	Grid MCM	IT & Data An	EAI	DER&S	AsMgt	EV & Chrg	AMI & Cons En	Ut Comm	Cyber Sec
MRC	☑					☑				
ENDOKS	☑	☑	☑						☑	
TURKCELL			☑					☑		☑
BAŞARSOFT						☑				
VESTEL - ZORLU		☑	☑				☑			
ECLIPSE								☑		
IKOM								☑		
LUNA								☑		
VIZISENS								☑		
KÖHLER								☑		
NAR			☑					☑		
MAKEL								☑		
HAYEN			☑					☑		
GEOSYS						☑				

Figure 5.2. Areas of Smart Grid Product/Service Delivery for Turkish Companies

The first category consists of Turkish companies that originated within the country and active in the domestic market, although a number of them have also developed strength in exporting their products or services. In alignment with the matrix provided for identified Dutch companies; activity areas of Turkish companies that are active in the Smart Grid sector can also be identified as in Figure 5.4.1 below. It can be observed that some of the competitors are active in categories

such as 'Grid Controlling & Monitoring', 'Enterprise IT & Data Analytics' and 'Asset Management', while an accumulated number of companies are generally active and experienced in 'Advanced Metering Infrastructure (AMI) and Consumer Engagement' sub-domain.

The second category that composes local competition for Dutch companies are the domestic branches of international companies that are actively present in the Smart Grid ecosystem. Local presence of these international companies mean that a strong portfolio of internationally available Smart Grid products and services are also present within the market and thus Dutch companies are required to pay attention to this factor whilst developing their strategy for promotional activities, sales and project development. The matrix for activity areas of international companies with local presence in Turkey can be seen in Figure 5.3.

Company Name	Cnslt & Sup	Grid MCM	IT & Data An	EAI	DER&S	AsMgt	EV & Chrg	AMI & Cons En	Ut Comm	Cyber Sec
PANASONIC								☑		
PHILIPS		☑								
INFOR			☑	☑		☑				
ORACLE		☑	☑	☑		☑				☑
SAP			☑	☑		☑				
IBM			☑	☑		☑				☑
SIEMENS		☑		☑		☑		☑		☑
GE		☑	☑	☑		☑				
HITACHI ABB		☑	☑	☑		☑				
SCHNEIDER		☑	☑	☑		☑				
EATON		☑								
CISCO										☑
HP										☑
DELOITTE	☑					☑				
E&Y	☑					☑				
PWC						☑				

Figure 5.3. Areas of Smart Grid Product/Service Delivery for International Companies with Local Presence in Turkey

The list of identified Turkish companies and domestic branches of international companies in the local Smart Grid ecosystem is presented in the table below. Categorization of technical domain and service/product types are in accordance with the taxonomy presented in section 7.1 (Annex-1). Contact information (as retrieved in the desktop review) for each company is provided in the section 7.5 (Annex-5).

5.7 Summary of Export Opportunities

In order to analyse and reflect the realistic export potential of Dutch companies for Turkish Smart Grid sector, a comparative analysis is conducted based on the maturity of solutions delivered by Dutch companies and competitive availability of local solutions.

Product / Service Type	Maturity of Dutch Products/Services	Competitive Availability of Local Pr. & Srv.	Export Potential	Estimated 5-year Budget
Grid Monitoring and Controllers	2	5	🔴	€ 231,000,000
Smart Substation Solutions	2	1	🟢	€ 3,850,000
Power Electronics	5	2	🟢	€ 15,850,000
IoT and Sensor Networks	4	3	🟢	€ 70,450,000
Telecommunication and Server Systems	3	4	🟡	€ 136,750,000
LED Lighting	5	2	🟢	€ 38,500,000
GIS and Geo-Spatial Monitoring Systems	2	3	🟡	€ 34,800,000
Cyber Security Solutions	3	4	🟡	€ 43,000,000
EV Charging Stations & Management Systems	2	1	🟢	€ 37,000,000
Power Storage	2	2	🟡	€ 28,000,000
SCADA Systems	1	5	🔴	€ 7,700,000
Conventional Network Management Systems	2	3	🟡	€ 26,950,000
New-Gen Network Management Systems (DERMS/ANM, DRMS, BMS, EMS, MGMS)	3	2	🟢	€ 57,750,000
Data Analytic Platforms	5	2	🟢	€ 24,000,000
AMI/Smart Meters	2	4	🔴	€ 222,750,000
HES/MDM	2	2	🟡	€ 101,250,000
Enterprise IT Systems (CCB&I, WFM, ERP, etc.)	2	4	🔴	€ 40,000,000
Integration Software Adapters	3	2	🟢	€ 92,000,000
Asset Management Systems	2	2	🟡	€ 46,400,000
Technical Consultancy and Technology Transfer Services	4	4	🟡	€ 6,000,000
Project Management Services	4	3	🟢	€ 3,600,000
Planning, Design and Engineering Services	4	4	🟡	€ 2,400,000
TOTAL				**€ 1,270,000,000**

Figure 5.4. A Summary of Export Potential for Dutch Companies in Smart Grid Sector

(Key: 1-Low Strength / 5-High Strength)

Figure 5.4 summarizes the results of the comparative analysis and depicts the product or service families that carry good, mediocre or poor export opportunities for the Dutch companies. Based on the budgetary forecasts and 5-year budget calculations for the sector, estimated budgets per product/service family are also presented in order to provide a healthier understanding of overall export potential.

A review of the export opportunity analysis clearly indicates that Turkish Smart Grid sector has a certain gap of available and reliable solutions in the following areas:

- Smart Substations
- Power Electronics

- IoT and Sensor Networks
- LED Lighting
- EV Charging Stations & Management Systems
- New-generation Network Management Systems
- Data Analytic Platforms
- Integration Software Adapters
- Project Management Services

When combining the interpretation with estimated 5-year budgets for Smart Grid investments in Turkey, it can be seen that there is a clear potential in provision of high-tech solutions that are combined with advanced data analytics, IoT technologies and new-generation grid management philosophies.

6 Conclusion and Recommendations

6.1 Conclusion

This study is conducted in order to give direction to the additional efforts that Netherlands Economic Development Network (EDN) will put into promising niches of the energy markets of Turkey in which The Netherlands can either acquire knowledge or has a leading position in Turkish energy market and in Smart Grid niche in particular.

Analysing the overview of Turkish energy market, several key drivers are pushing a transition period towards a Smart Grid structure in system architectures and grid management philosophies, especially in electricity distribution operations. Privatized and regulated structure of the distribution sector requires thorough understanding of regulatory perspectives, business orientations and customer expectations in order to be successful in the strongly emerging niche. Increasing focus on renewable energy resources, energy storage technologies, electric mobility and smart metering opens up significant potential for prominent Dutch companies and institutes for generation of new business as well as long-term collaborations.

Considering the overall market potential reaching over €1,2 billion for Smart Grid investments during the upcoming regulatory investment period between 2021-2025, it is evident that EDN and Embassy of The Netherlands in Ankara should increase their activities and pave the way for Dutch players in Smart Grid sector for enhancing their business potentials in Turkey.

6.2 Recommendations for Dutch Companies

There are many factors that Dutch companies need to consider in order to be successful in Turkish Smart Grid market for the coming years. Below are the main recommendations for Dutch companies that are identified as a result of this sector study.

- **Monitoring of Developments and Opportunities:** It is essential for Dutch companies to be aware of local developments in Turkish energy industry, especially with respect to developments in Smart Grid domain. It is highly recommended to monitor these developments and track potential business opportunities through business platforms, events, online sectoral publications, local affiliations, Dutch Embassy and social media.
- **Local Network Development:** Beyond introductory phases for Dutch solutions, Dutch companies require presence in local professional networks in order to establish and strengthen relations with key stakeholders and potential business partners that may complement or perform services for potential projects.
- **Regulatory Review:** Since energy market regulations are highly important in determining the path to Smart Grid developments in Turkey in terms of context and financing, Dutch companies are strongly advised to review the regulatory framework and stay updated on legislative developments in Turkish energy market. This can be handled through partner companies, translation services or assistance of the Dutch Embassy.

- **Solution Showcase:** Showcasing existing and upcoming Smart Grid solutions would be a useful method to increase market knowledge on Dutch solutions and their range of capabilities. This can be handled through introductory visits, online events, sectoral showcases or virtual tours of interesting project execution sites. Another method that would assist in demonstration of Dutch Smart Grid solutions would be through R&D projects with EDCos. There exists a functional path which begins with R&D projects or pilot implementations and leads to wide-scale roll-out projects. This is suggested as the main instrument for Dutch companies' go-to market strategy in Turkish Smart Grid sector.
- **Academic Partnerships:** Dutch universities and knowledge institutions are prominent in various areas of the energy revolution and transition to Smart Grids. It is advised to create synergies and establish partnerships with relevant institutions in order to provide leverage for marketing and project development activities. This is also a practical method to offer R&D partnerships for key Turkish stakeholders in EU projects so that the high technology solutions can be developed or customized to local needs through collaboration efforts.
- **Publicity and Awareness for Dutch Solutions:** In addition to B2B marketing, Dutch companies can enhance their publicity and awareness-raising activities through development of interesting content with respect to certain situations that are experienced in Dutch market and impact of their solutions on the life of grid operators, end users or other relevant stakeholders. Dutch companies can also work with expert agencies for social media content development and design agencies to increase attractiveness of their marketing processes.

6.3 Recommendations for Dutch Government and Business Networks

Dutch Government and its agencies are required to take up a leading role in developing the initiatives that will enable Dutch commercial and academic stakeholders to increase their presence in Turkish energy market. It is believed that Netherlands Economic Development Network (EDN) and Netherlands Enterprise Agency (RVO) can play facilitating roles in realization of these goals with their existing structures and missions.

- **Establishment of Monitoring Platform:** Need for continuous monitoring of Turkish energy market for Smart Grid opportunities is relevant for all Dutch companies and institutes. In addition, presentation of knowledge on general market conditions, regulatory framework and potential stakeholders is an important need for initiating business. It is advised to establish a platform to provide information and assistance with this perspective, to increase the anticipation towards ease of doing business in Turkish energy market.
- **Organization of Virtual Events:** Roadshows, events, virtual tours and brokerage events are activities with high impact for introducing and publicizing Dutch companies,

institutions, their know-how and solutions. It is highly recommended for Dutch Embassy to initiate sector-specific events through cooperation with EDN and RVO.

- **Program Development for Sustainable Energy Projects:** RVO has experience with program development for sustainable energy projects in 'Stimulation of Sustainable Energy Transition (SDE++)' subsidy. It is recommended that similar or smaller support mechanisms to be established at national or regional levels to attract interest of potential project developers that can contribute to sustainable development goals, establish local partnerships and develop showcase projects for promotion of Dutch technologies and solutions. It is highly possible that international financing institutions, such as EBRD or the World Bank, and their existing funding facilitation mechanisms, such as TURSEFF, would agree to provide co-financing for mutually agreed scopes, budget limitations and conditions.
- **Regulatory Introduction:** Due to the unique role of EMRA in regulating the Smart Grid transition for Turkish energy markets, it is highly recommended for the Dutch Embassy to establish contact with EMRA and organize introductory meetings to establish familiarity, trust and information exchange between key Dutch stakeholders and representatives. Share of experiences on certain issues, such as energy storage or electric mobility, can have a higher impact and such discussions can lead to promising opportunities for market introduction.
- **Financial Assistance for Initial Marketing Efforts**: While evaluating the market entrance, companies may seek certain incentives and support mechanisms to reduce the risks of their initial efforts in an unfamiliar market. Provision of financial assistance for such initial efforts can be a useful leverage in order to ensure successful market entry as well as to monitor and guide the initial efforts. It will also be very useful for universities or knowledge institutes as they have much lower levels of commercial risk anticipation and tolerance. POC trials or similar works can also be evaluated under this scope.

7 Annexes:

7.1 Annex-1: Smart Grid Product & Service Taxonomy

7.1.1 Product Type List:

Product/Solution/Services	Category
Grid Monitoring and Controllers	Hardware
Smart Substation Solutions	Hardware
Power Electronics	Hardware
IoT and Sensor Networks	Hardware
Telecommunication and Server Systems	Hardware/Software
LED Lighting	Hardware
GIS and Geo-Spatial Monitoring Systems	Hardware/Software
Cyber Security Solutions	Hardware/Software
EV Charging Stations & Management System (CPMS, etc.)	Hardware
Energy Storage	Hardware
SCADA Systems	Software
Conventional Network Management Systems (DMS/ADMS/OMS/EMS/AGC/OCS)	Software
New-Gen Network Management Systems (DERMS/ANM, DRMS, BMS, EMS, MGMS)	Software
Data Analytic Platforms	Software
AMI/Smart Meter	Hardware
HES/MDM	Software
Enterprise IT Systems (CCB&I, WFM, ERP, etc.)	Software
Integration Software Adapters	Software
Asset Management System	Software

Product/Solution/Services	Category
Technical Consultancy and Technology Transfer Services	Services
Project Management Services	Services
Planning, Design and Engineering Services	Services

Table 8. Smart Grid Product Type List

7.1.2 Product Types in Smart Grid Technology Sub-domains

Smart Grids Technology Sub-domain	Product/Solution/Services
Consultancy and Support Services	• Technical Consultancy and Technology Transfer Services • Project Management Services • Planning, Design and Engineering Services
Grid Monitoring, Control and Management	• Grid Monitoring and Controllers • Smart Substation Solutions • Power Electronics • IoT and Sensor Networks • LED Lighting • SCADA Systems • Conventional Network Management Systems (DMS/ADMS/OMS/EMS/AGC/OCS) • New-Gen Network Management Systems (DERMS/ANM, DRMS, BMS, EMS, MGMS)
Enterprise IT and Data Analytics	• Telecommunication and Server Systems • Data Analytic Platforms • Enterprise IT Systems (CCB&I, WFM, ERP, etc.)
Enterprise Application Integration (EAI)	• Integration Software Adapters
DER and Energy Storage	• Power Electronics • Energy Storage
Asset Management	• IoT and Sensor Networks • GIS and Geo-Spatial Monitoring Systems
Electric Vehicles and EV Charging Infrastructure	• EV Charging Stations & Management System (CPMS, etc.)

Smart Grids Technology Sub-domain	Product/Solution/Services
Advanced Metering Infrastructure (AMI) and Consumer Engagement	• Telecommunication and Server Systems • AMI/Smart Meter • HES/MDM • IoT and Sensor Networks
Utility Communication	• Telecommunication and Server Systems
Cyber-security	• Cyber Security Solutions

Table 9. Smart Grid Product/Service Type Taxonomy for Smart Grid Technical Sub-domains

7.2 Annex-2: Contact Information of Dutch Smart Grid Vendor/Solution Providers

#	COMPANY NAME	ADDRESS & CONTACT INFO
1	Alfen	**Addr:** Hefbrugweg 28, 1332 AP Almere **Tel:** +31 36 54 93 400 **@:** info@alfen.com/ **Web:** www.alfen.com
2	Femtogrid Energy Solutions	**Addr:** Oosteinderweg 127 C, 1432 AH Aalsmeer **Tel:** +31 850 444 004 **@:** sales@dc.systems / **Web:** www.femtogrid.com
3	Datawatt B.V.	**Addr:** Woldmeentherand 5, 8332 JE Steenwijk **Tel:** +31 (0)88 0032900 **@:** info@datawatt.nl / **Web:** www.datawatt.nl
4	Almende B.V.	**Addr:** Stationsplein 45 – Unit D1.116, 3013AK Rotterdam **Tel:** +31 (0)10 404 9444 **@:** info@almende.com / **Web:** www.almende.com
5	Deerns	**Addr:** Anna van Buerenplein 21F, 2595 DA Den Haag **Tel:** +31 88 374 0000 **@:** contact@deerns.com / **Web:** www.deerns.com
6	Aurum	**Addr:** De Corridor 14H, 3621 ZB - Breukele **Tel:** +31 (0) 85 201 92 74 **@:** service@aurumeurope.com / **Web:** www.aurumeurope.com
7	Technolution	**Addr:** Burgemeester Jamessingel 1, 2800 BD, Gouda **Tel:** +31 (0) 182 59 4000 **@:** info@technolution.eu / **Web:** www.technolution.eu
8	Allego	**Addr:** Industriepark Kleefse Waard, Westervoortsedijk 73, 6827 AV Arnhem **Tel:** +31(0)88 7500 300 **@:** infrastructureinfo@allego.eu / **Web:** www.allego.eu
9	Alliander N.V.	**Addr:** Bellevue, Utrechtseweg 68, 6812 AH, Arnhem **Tel:** +31 (0) 88 542 6363 **@:** info@alliander.com / **Web:** www.alliander.com
10	Enexis B.V.	**Addr:** Magistratenlaan 116, 5223 MB 's-Hertogenbosch **Tel:** +31(0)88 857 22 22 **@:** info@enexis.nl / **Web:** www.enexis.nl
11	TNO (Smart Energy Solutions branch)	**Addr:** Westerduinweg 3, 1755 LE Petten **Tel:** +31 88 866 50 65 **@:** info@tno.nl / **Web:** www.tno.nl

#	COMPANY NAME	ADDRESS & CONTACT INFO
12	Philips Lighting	**Addr:** High Tech Campus 7, 5656 AE Eindhoven **Tel:** N/A **@:** info@philips.com / **Web:** www.philips.com
13	Netinium	**Addr:** Bruynvisweg 4, 1531 AZ Wormer **Tel:** +31 (0)75 6400 333 **@:** info@netinium.com/ **Web:** www.netinium.com
14	Bredenoord Aggregaten	**Addr:** Zutphensestraat 319, 7325 WT Apeldoorn **Tel:** +31 55 3018501 **@:** info@bredenoord.nl / **Web:** www.bredenoord.com
15	Heliox	**Addr:** De Waal 24, 5684 PH Best **Tel:** +31 88 5016 333 **@:** info@heliox.nl / **Web:** www.heliox.nl
16	NXP Semiconductors Netherlands BV	**Addr:** High Tech Campus 60 Eindhoven **Tel:** +31 40 272 9999 **@:** N/A/ **Web:** www.nxp.com
17	Mastervolt	**Addr:** Snijdersbergweg 93, 1105 AN Amsterdam **Tel:** +31 (0)20 34 22 100 **@:** info@mastervolt.com / **Web:** www.mastervolt.com
18	Flexicontrol	**Addr:** Newtonstraat 27, 1704 SB Heerhugowaard **Tel:** +31 72 576 2550 **@:** N/A/ **Web:** www.flexicontrol.nl
19	ELEQ B.V.	**Addr:** Tukseweg 130, 8331 LH Steenwijk **Tel:** +31 (0)521 533 333 **@:** info@eleq.com / **Web:** www.eleq.com
20	Spectral Energy	**Addr:** Kropaarstraat 12, 1032 LA Amsterdam **Tel:** +31 (0) 20 737 1628 **@:** info@spectral.energy / **Web:** https://spectral.energy/

Table 10. Contact Information for Identified Dutch Companies

7.3 Annex-3: Contact Information of Dutch Universities

#	INSTITUTION NAME	ADDRESS & CONTACT INFO
1	TU/e – Eindhoven University of Technology	**Addr:** De Zaale, 5600 MB, Eindhoven **Tel:** +31 40 247 9111 **@:** info@tue.nl / **Web:** www.tue.nl
2	TU Delft	**Addr:** Postbus 5, 2600 AA Delft **Tel:** +31 15 27 89111 **@:** info@tudelft.nl/ **Web:** www.tudelft.nl
3	University of Twente	**Addr:** Po Box 217, 7500 AE Enschede, **Tel:** +31 53 489 9111 **@:** info@utwente.nl / **Web:** www.utwente.nl
4	Erasmus Universiteit Rotterdam	**Addr:** Campus Woudestein, Burgemeester Oudlaan 50, 3062 PA Rotterdam **Tel:** +31 10 408 1111 **@:** info@eur.nl / **Web:** www.eur.nl
5	Saxion Univ. of Applied Sciences	**Addr:** M.H. Tromplaan 17, 7511 JJ Enschede **Tel:** +31 88 019 8888 **@:** KCL@saxion.nl / **Web:** www.saxion.nl
6	Tilburg University	**Addr:** Warandelaan 2, 5037 AB Tilburg **Tel:** +31 13 466 9111 **@:** info@tilburguniversity.edu / **Web:** www.tilburguniversity.edu
7	Univ. of Amsterdam	**Addr:** Spui 21, 1012 WX Amsterdam **Tel:** +31 20 525 1400 **@:** info@uva.nl / **Web:** www.uva.nl
8	Univ. of Groningen	**Addr:** PO Box 72, 9700 AB Groningen **Tel:** +31 50 363 9111 **@:** communicatie@rug.nl / **Web:** www.rug.nl
9	Utrecht University	**Addr:** Heidelberglaan 8, 3584 CS Utrecht **Tel:** +31 30 253 35 50 **@:** ucu.info@uu.nl / **Web:** www.uu.nl
10	Hanze Univ. of Applied Sciences	**Addr:** Van OlstToren, Zernikeplein 7, 9747 AS Groningen **Tel:** +31 50 595 55 55 **@:** info@org.hanze.nl / **Web:** www.hanze.nl
11	Avans University of Applied Sciences	**Addr:** Hogeschoollaan 1, 4818 CR Breda **Tel:** +31 88 525 75 00 **@:** info@avans.nl / **Web:** www.avans.nl

#	INSTITUTION NAME	ADDRESS & CONTACT INFO
12	HAN (Hogeschool van Arnhem en Nijmegen)	**Addr:** Ruitenberglaan 26, 6826 CC Arnhem **Tel:** +31 24 - 353 05 00 **@:** info@han.nl / **Web:** www.han.nl
13	Hogeschool Zuyd	**Addr:** Brusselseweg 150, 6217 HB Maastricht **Tel:** +31 88 989 30 00 **@:** info@zuyd.nl / **Web:** www.zuyd.nl

Table 11. Contact Information for Identified Dutch Universities

7.4 Annex-4: Contact Information of Dutch Technology & Knowledge Institutes

#	INSTITUTION NAME	ADDRESS & CONTACT INFO
1	CWI – Centrum Wiskunde & Informatica	**Addr:** Science Park 123, 1098 XG Amsterdam **Tel:** +31 20 592 9333 **@:** info@cwi.nl / **Web:** www.cwi.nl
2	ECN – Energy Research Centre of Netherlands	**Addr:** Westerduinweg 3, 1755 LE Petten **Tel:** +31 88 5154949 **@:** info@ecn.nl / **Web:** www.ecn.nl
3	Energy Academy Europe	**Addr:** Energy Academy Europe (building) Nijenborgh 6, 9747 AG Groningen **Tel:** + 31 (0)6 31 95 34 37 **@:** h.hekman@newenergycoalition.org **Web:** https://energyacademy.org/
4	DIFFER – Dutch Institute for Fundamental Energy Research	**Addr:** TU/e Science Park, De Zaale 20, 5612 AJ Eindhoven **Tel:** +31 40 333 49 02 **@:** communication@differ.nl / **Web:** www.differ.nl
5	Energy Delta Institute	**Addr:** Nijenborgh 6, 9747 AG Groningen, **Tel:** +31 88 1166800 **@:** info@energydelta.nl / **Web:** www.energydelta.org
6	IEECP – Institute for European Energy and Climate Policy	**Addr:** Sloterdijk Teleport Towers, Kingsfordweg 151, 1043GR, Amsterdam **Tel:** +31 70 2500 642 **@:** info@ieecp.org / **Web:** www.ieecp.org
7	EIT InnoEnergy	**Addr:** Kennispoort, John F.Kennedylaan 2, 5612 AB Eindhoven **Tel:** +31 40 24 06 031 **@:** info@innoenergy.com / **Web:** www.innoenergy.com
8	European Commission - Joint Research Centre in Petten	**Addr:** Westerduinweg 3, 1755 LE, Petten **Tel:** +31 (0)224 565656 **@:** N/A/ **Web:** https://ec.europa.eu/jrc/en/about/jrc-site/petten
9	Utrecht Sustainability Institute	**Addr:** Heidelberglaan 8, 3584 CS Utrecht **Tel:** +31 (0)30 253 72 06 **@:** usi@uu.nl / **Web:** www.usi.nl
10	EIRES – Eindhoven Institute for Renewable Energy Systems	**Addr:** TU/e Att. EIRES, PO Box 513, 5600 MB EINDHOVEN **Tel:** +31 (0)40 247 3486 **@:** eires@tue.nl **Web:** https://www.tue.nl/en/research/institutes/eindhoven-institute-for-renewable-energy-systems

#	INSTITUTION NAME	ADDRESS & CONTACT INFO
11	Stichting Cenex Nederland	**Addr:** Overhoeksplein 2, 1031 KS Amsterdam **Tel:** +31 (0)20 36 99 883 **@:** hello@cenexgroup.nl / **Web:** https://cenexgroup.nl/
12	NKL Nederland - Netherlands Knowledge Platform for Public Charging Infrastructure	**Addr:** Vondellaan 162, 3521 GH Utrecht **Tel:** +31 30 2819675 **@:** info@nklnederland.nl/ **Web:** www.nklnederland.com

Table 12. Contact Information for Identified Dutch Technology and Knowledge Institutes

7.5 Annex-5: Contact Information of Turkish Smart Grid Vendor/Solution Providers

#	COMPANY NAME	ADDRESS & CONTACT INFO
1	MRC ARGE	**Addr:** ODTÜ Teknokent Met Alanı, M. Kemal Mah. Dumlupınar Bulvarı, No:280, D Blok No:3, Çankaya, 06520, Ankara, Turkey **Tel:** +90 312 385 93 54 **@:** Gokhan.Tosun@mrc-tr.com / **Web:** www.mrc-tr.com
2	Endoks	**Addr:** İnönü Mah. 1748. Sok. No: 1 Batıkent 06370 Yenimahalle Ankara, Turkey **Tel:** +90 312 256 00 86 **@:** info@endoks.com.tr / **Web:** www.endoks.com
3	Turkcell	**Addr:** Aydınevler Mahallesi İnönü Caddesi No:20 Küçükyalı Ofispark B Blok – Maltepe, İstanbul, Turkey **Tel:** +90 212 313 10 00 **@:** info@turkcell.com.tr / **Web:** www.turkcell.com.tr
4	Başarsoft	**Addr:** Ehlibeyt Mh Ceyhun Atıf Kansu Cd 114 Bayraktar Center A Blok K:12, 06520 Çankaya, Ankara, Turkey **Tel:** +90 312 473 70 80 **@:** basar@basarsoft.com.tr / **Web:** www.basarsoft.com.tr
5	Zorlu Enerji	**Addr:** Levent 199, Büyükdere Caddesi, No:199 34394 Şişli – İstanbul, Turkey **Tel:** +90 212 456 23 00 **@:** zoren@zorlu.com / **Web:** www.zorluenerji.com.tr
6	Eclipse	**Addr:** Gülsuyu Mah. Fevzi Çakmak Cad., Lefke Sok. 16/6 34848, Maltepe/ İstanbul, Turkey **Tel:** +90 216 518 29 82 **@:** info@eclipse.com.tr / **Web:** www.eclipse.com.tr
7	Ikom	**Addr:** FSM Mah. Poligon Cad. No:8C, Buyaka 2 Sitesi Kule 3 No: 89 Ümraniye / İstanbul, Turkey **Tel:** +90 216 514 77 70 **@:** info@ikombilisim.com / **Web:** www.ikombilisim.com
8	Luna	**Addr:** Atatürk O.S.B. 10001 Street No: 9, Çiğli / İZMİR, Turkey **Tel:** +90 232 472 15 45 **@:** info@lunatr.com / **Web:** www.lunatr.com
9	Vizisens	**Addr:** 18 Çifte Cevizler Caddesi, İstanbul, Turkey **Tel:** N/A **@:** info@vizisens.com / **Web:** www.vizisens.com

#	COMPANY NAME	ADDRESS & CONTACT INFO
10	Köhler	**Addr:** Akçaburgaz Mah. 58. Sokak No:3 Esenyurt/İstanbul-Turkey **Tel:** +90 212 886 26 39 **@:** kohler@kohlersayac.com.tr / **Web:** www.kohlersayac.com.tr
11	Nar	**Addr:** Koşuyolu Mah. Ali Nazime Sok. No 21, Kadıköy, İstanbul, Turkey / **Tel:** +90 216 358 43 62 **@:** info@nar.com.tr / **Web:** www.nar.com.tr
12	Makel	**Addr:** Osmangazi Mah. Mareşal Fevzi Çakmak Cad. No.38 Kıraç – Esenyurt – İstanbul, Turkey **Tel:** +90 212 689 50 50 **@:** makel@makel.com.tr / **Web:** www.makel.com.tr

Table 13. Contact Information for Identified Turkish Companies

7.6 Annex-6: Contact Information of International Smart Grid Vendor/Solution Providers with Local Presence in Turkey

#	COMPANY NAME	ADDRESS & CONTACT INFO OF LOCAL REPRESENTATIVE
1	Panasonic	**Addr:** Abdurrahmangazi Mah. Ebubekir Cd. No:44, 34887 Sancaktepe / İstanbul, Turkey **Tel:** +90 216 564 55 55 **@:** N/A / **Web:** https://www.panasonic.com/tr/
2	Philips	**Addr:** Saray Mah. Dr. Adnan Büyük Temiz Cad. No:13, İnkilap, Ümraniye / İstanbul, Turkey **Tel:** +90 216 636 15 00 **@:** N/A / **Web:** www.philips.com.tr
3	Infor	**Addr:** Atatürk Mah. Ekincioğlu Sk. No:25-1, Ataşehir / İstanbul, Turkey **Tel:** +90 216 314 08 06 **@:** info@intecon.com.tr / **Web:** www.intecon.com.tr
4	Oracle	**Addr:** Uniq İstanbul, Huzur Mahallesi, Maslak Ayazağa Caddesi, No:4/B, Kat:2, No:302, 34485 İstanbul, Turkey **Tel:** +90 212 329 67 00 **@:** N/A / **Web:** https://www.oracle.com/tr/index.html
5	SAP	**Addr:** Tepe Prime İş ve Yaşam Merkezi B Blok Kat: A No:15, Eskişehir Devlet Yolu 9.km (Dumlupınar Bulvarı), 06800 Çankaya/Ankara, Turkey **Tel:** +90 312 218 07 27 **@:** info.turkey@sap.com / **Web:** www.sap.com/turkey/index.html
6	IBM	**Addr:** Levent Mahallesi., Büyükdere Cd. Yapi Kredi Plaza B Blok, 34330 Beşiktaş/İstanbul, Turkey **Tel:** +90 212 317 10 00 **@:** N/A / **Web:** https://www.ibm.com/tr-tr
7	Siemens	**Addr:** Esentepe Mah. Yakacik Yolu, No:111 / Yakacik, Kartal / İstanbul, Turkey **Tel:** +90 216 459 20 00 **@:** N/A / **Web:** https://new.siemens.com/tr/tr.html
8	GE	**Addr:** Maslak, Eski Büyükdere Cd. No:29, 34398 Şişli/İstanbul, Turkey **Tel:** +90 212 366 22 00 **@:** N/A / **Web:** https://www.ge.com/tr/
9	Hitachi ABB Power Grids	**Addr:** Dudullu OSB 2. Cadde No:16 Y.Dudullu 34775, İstanbul, Turkey **Tel:** +90 850 333 1 222 **@:** contact.center@tr.abb.com / **Web:** http://www.abb.com.tr/

#	COMPANY NAME	ADDRESS & CONTACT INFO OF LOCAL REPRESENTATIVE
10	Schneider Electric	**Addr:** Küçükbakkalköy, Defne Sok. No:3, 34750 Ataşehir / İstanbul, Turkey **Tel:** +90 216 655 88 88 **@:** N/A / **Web:** www.se.com/tr
11	Eaton	**Addr:** Kozyatağı Mah. Değirmen Sok. Nida Kule İş Mrk. Kadıköy, İstanbul, Turkey / **Tel:** +90 216 464 20 20 **@:** N/A / **Web:** https://www.eaton.com/tr/tr-tr.html
12	Cisco	**Addr:** Ahi Evran Caddesi, Polaris Plaza, Kat 20 Maslak, İstanbul / Turkey / **Tel:** +90 212 335 02 02 **@:** N/A / **Web:** https://www.cisco.com/c/tr_tr/index.html
13	Hewlett Packard	**Addr:** Saray Mah., Dr. Adnan Büyükdeniz Cd. No:4, 34768 Ümraniye/İstanbul, Turkey / **Tel:** +90 444 8 121 **@:** N/A / **Web:** https://www8.hp.com/tr/tr/home.html
14	Deloitte	**Addr:** Deloitte Values House, Eski Büyükdere cad. Maslak No1 Sarıyer, 34485, Istanbul, Turkey **Tel:** +90 212 366 60 00 **@:** N/A / **Web:** https://www2.deloitte.com/tr/tr.html
15	Ernst & Young	**Addr:** Mahall Ankara B Blok, Mustafa Kemal Mah. Dumlupınar Bulvarı 9. km [Danıştay Karşısı] No:274/7 Daire:191, Çankaya, Ankara, Turkey / **Tel:** +90 312 286 3800 **@:** N/A / **Web:** https://www.ey.com/tr_tr
16	Pricewaterhouse Coopers	**Addr:** Süleyman Seba Cad. BJK Plaza No:48 B Blok, Kat 9 Akaretler 34357 Beşiktaş / İstanbul, Turkey **Tel:** +90 212 326 6060 **@:** N/A / **Web:** https://www.pwc.com.tr/

Table 14. Contact Information for Local Representatives of Identified International Companies

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This publication was commissioned by the ministry of Foreign Affairs.

Publicationnumber: RVO-038-2021/RP-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.