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Annual Action Programme for Turkey for the Year 2015 under the Instrument for Pre-accession Assistance (IPA II)

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

Project Identification No: EuropeAid /139125/IH/SER/TR

Contract No: TR2015/EN/07/A3-01/001

First Study Visit for task 1.3

Portugal

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This project is funded by the European Union

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Abbreviations

ÅF	Ångpanneföreningen
BOTAS	Turkish Petroleum and Gas Transmission Pipeline Company
CAPEX	Capital Expenditures
CFCU	Central Finance and Contracts Unit
DSO	Distribution System Operator
EDVARS	Electricity Distribution Data Storage and Reporting System
EMRA	Energy Market Regulatory Authority (for Electricity, Petroleum and Natural Gas)
EPIAS	Market Financial Settlement Centre
EU	European Union
EUD	European Union Delegation
EXIST	Energy Exchange Istanbul
FIT	Feed-in tariff
HD	Human Dynamics
MENR	Ministry of Energy and Natural Resources
OPEX	Operational Expenses
OSOS	Automatic Meter Reading System
PM	Project Management
PSC	Project Steering Committee
R&D	Research and Development
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SoLR	Supplier of Last Resort
TAT	Technical Assistance Team

TEIAS	Turkish Electricity Transmission Co.
ToR	Terms of Reference
WACC	Weighted Average Cost of Capital

1 Introduction

The Terms of Reference (ToR) for the implementation of the EU project for improving the functioning of electricity and gas markets in line with the EU requirements (hereinafter referred to as the Project) provides for improving the capacity of the Energy Market Regulation Authority (EMRA) by the development of new performance-based tariff calculation mechanisms, including a social tariff, based on European experience.

Portugal was approved by EMRA as a host country for the first study visit (SV) to reach the goals under the task 1. The main objective of the study visit was to get a deeper understanding on how the methodology for performance-based tariff calculation is developed. This study visit was organized to understand the regulators and other institutions working in relation to tariff settings and monitoring in the EU countries. A total of 7 participants from EMRA's electricity and gas departments joined to observe the best EU practices for performance-based tariff structure for both gas and electricity.

Portugal was selected as a host country due to its relevance for Turkey. Portugal is an energy import dependent country, like Turkey. Moreover, both countries have the same performance indicators, namely SAIDI and SAIFI, even though Portugal also monitors performance by looking into various other indicators. The incentive-based mechanism in Portugal is mixed, while in Turkey it is revenue-based. It is of interest to the beneficiaries to compare these two systems and to discuss the differences and communalities and exchange experiences on this. Moreover, Portugal is regulating from a TOTEX perspective for their tariff methodology. Turkey has currently a CAPEX-OPEX approach.

The following topics were included in the program of the study trip:

- Analysis of tariff structure and performance-based tariff structure;
- Tariff setting for transmission and distribution system operations;

T1.1 Delivering Tariff Structure Assessment and Recommendations Report for both electricity and natural gas sectors

(the draft information we have collected for electricity distribution is shown in tables)

- What is the current tariff methodology used in Portugal?

Tariff Methodology	Period	Main elements for Determining the Revenue Cap
Price-cap and rate of return (HV/MV) and TOTEX (LV)	3 years (current period 2018-2020)	Non-controllable and controllable costs, RAB, WACC, efficiency benchmark, inflation, incentives, general economic interest costs

- What are the key characteristics of the Regulatory Asset Base in Portugal?

Components of RAB	Regulatory asset value	RAB adjustments
Fixed assets deducted from third parties contributions	3,002 million € for 2016 (historical costs)	Each year the RAB allowed for year t is adjusted in order to consider new investments, write-offs and depreciation

- What is the rate of return used in Portugal?

Type of WACC	Determination of the rate of return on equity	Rate of return on equity before taxes	Use of rate of return
Nominal, pre-tax	Capital Asset Pricing Model (CAPM)	8.5%	WACC is currently based on 55% debt and 45% equity applied to RAB

- What depreciation method is used in Portugal?

Depreciation Method	Depreciation Ratio	Consideration
Straight line	5-40 years	Part of CAPEX

- Which indicators are used for long and short interruptions?

Long Interruption-Index	Long Interruption-Weighting	Short Interruption-Index
SAIFI HV, SAIDI HV, END MV, AIT MV (TIEPI), SAIFI MV, SAIFI LV, SAIDI MV, SAIDI LV	SAIFI and SAIDI: weighted by delivered points (transmission, HV and MV) and bythe number of customers (LV); TIE (Distribution – TIEPI) and END (distribution): weighted by installed power; ENS (transmission): estimated; TIE (transmission): energy not supplied and energy supplied.	MAIFI (EHV, HV and MV).

- What are the losses in the Portuguese distribution and transmission network?
- Electricity distribution: 9.6%. Other loss rates were not shared.
- How are the distribution tariffs determined for consumers?
- This consists of four steps: allowed revenues, tariff structure, demand forecast, tariff prices.
- Can the performance-based tariff structure of Portugal be used as a benchmark for Turkey?
- The process of moving towards a TOTEX approach and the yearly adjustment of PBT to keep the allowed revenues within a desired range is a useful to consider in preparing benchmarks for Turkey.

T1.2 Delivering Data Requirements and Harmonization and Standardization of Data Report

- Identification of data requirements necessary for the proposed performance-based tariff structure.
- ERSE analyses the investment plans in details and the plans have to be adjusted accordingly.
- Guidelines for harmonization and standardization of the data coming from different sources to make them possible to be used in the tariff calculations.
- ERSE defined clear rules which are well known and not changed much, to which the distribution and transmission company have to adhere, otherwise they will face penalties.

T2.1 Market Monitoring Assessment and Recommendations Report

- Benchmarking market monitoring regulation
- Identify data requirements for monitoring
- Prepare guidelines for harmonization and standardization of data from different sources to monitor

T2.2 Delivering analysis of existing data management systems at ERSE

- Analyses and assessment of the scope and possibilities within the existing database systems that can be used for monitoring
- List the steps needed to improve usage of the existing data management system
- Recommendations for optimal use of the existing system in line with tariff methodology

Tasks 2.1 and 2.2 above has been discussed with various stakeholders.

T3: Incorporating incentive mechanism into tariff structure to enhance innovation capabilities of regulated entities

This has been discussed with various stakeholders

T4: Preparation of Smart Grid Road Map and Required Methodological Tariff Approaches

This has been discussed with various stakeholders

T5: Preparation of Vulnerable Consumers Action Plan and Social Tariff Methodology

This was the main attraction to visit Portugal to learn more about their social tariffs. Unfortunately, the used methodology cannot be used for Turkey, as it is a forced discount on the market price, which goes against market rules.

T6: Preparation of Regulatory Measures and Tariff Structure for supplier of last resort (SoLR)

This has been discussed with various stakeholders

T7: Institutional capacity of ERSE for handling customer complaints and using the data on customer complaints in tariff calculations

Hosting organisations are:

- Energy Services Regulatory Authority – ERSE
- General Directorate for Energy and Geology – DGEG
- National Electricity/ Gas Networks – REN
- Electricidade de Portugal– EDP
- Institute for Systems and Computer Engineering, Technology and Science - INESC TEC

2 Visited Institutions and Lessons Learned

2.1 Entidade Reguladora dos Serviços Energéticos- ERSE (Regulator)

The first two days of the programme (21st and 22nd of October) were spent in the premises of ERSE.

The mission of ERSE is to regulate the electricity and natural gas sectors, being an effective tool for the efficient and sustainable operation of the respective markets, while ensuring the protection of consumers and the environment,

transparently and impartially. In the scope of this public service mission, ERSE is given a range of powers by law and its Statutes. These powers include, most notably:

- Protecting consumers' rights and interests regarding prices, services and service quality; monitoring compliance with public service obligations and all other legal, regulatory and similar requirements;

- Guaranteeing economic and financial balance to the activities of the regulated sectors exercised in the public interest companies within the framework of appropriate and efficient management; promoting competition in the energy markets between all their players.

2.1.1 ERSE - Electricity

The supply of electricity to the consumers, both qualitatively and quantitatively is a fundamental objective of the activities developed by the National Electricity System (SEN) under the principles of efficient utilization of resources in all activities of the electricity sector. The electricity supply is subject to public service obligations which are the responsibility of all who participate in the electric sector and includes: (i) safety, regularity and quality of the supply; (ii) guarantee that the service provided is universal; (iii) guarantee the connection of all clients to the networks; (iv) protection of consumers namely in terms of tariffs and prices; (v) promotion of the energy efficiency, protection of the environment and the feasibility of the use of renewable and endogenous resources; (vi) the convergence of SEN, in terms of solidarity and cooperation with the electrical systems of the Autonomous Regions of the Azores and Madeira.

The following activities of the electric sector are subject to regulation: (i) Transmission; (ii) Distribution; (iii) Last Resort Supplier; (iv) Logistic Operations for Switching Supplier and (v) Management of Organised Markets.

2.1.2 ERSE - Gas

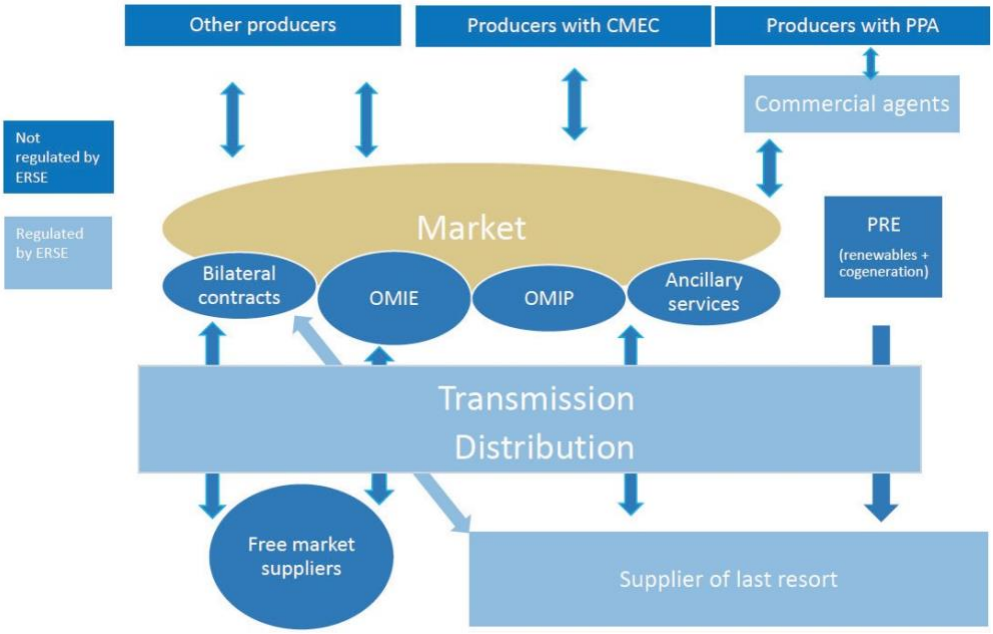
Portugal has no natural gas resources of its own. The supply of natural gas to the Portuguese market is carried out through long term take-or-pay contracts where the main suppliers are Algeria and Nigeria. The supply of natural gas is subject to public service obligations which are the responsibility of all operators in the natural gas sector including: (i) safety, continuity and quality of supply; (ii) ensuring that the service provided is universal; (iii) ensuring the connection of all clients to the networks; (iv) protection of customers, namely in terms of tariffs and prices; (iv) promotion of energy efficiency and protection of the environment.

The following rights are guaranteed to the agents and consumers of this sector: (i) freedom of access to the exercising of the activities; (ii) no discrimination; (iii) equal treatment and opportunities; (iv) impartiality of decisions; (v) transparency and objectivity in rules and decisions; (vi) access to information and the safeguarding of the confidentiality of commercial sensitive information, and (vii) freedom to choose their natural gas supplier.

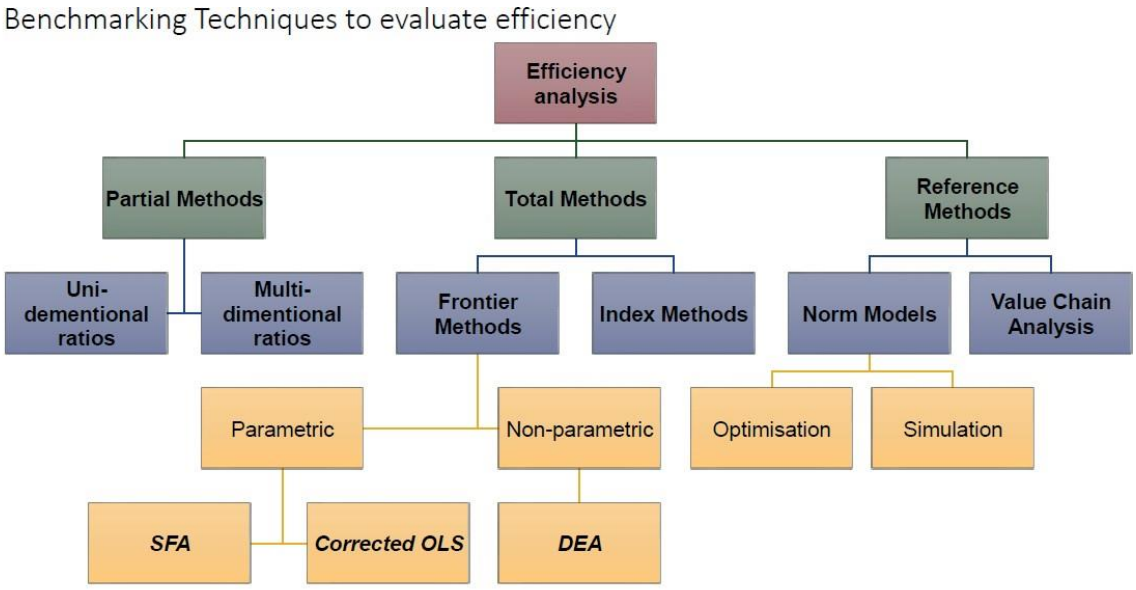
ERSE's intervention as regulator of the natural gas sector is as follows: (i) Liberalization of the natural gas sector; (ii) Creation of the Iberian Natural Gas Market (MIBGAS); (iii) Monitoring of activities and sector agents; (iv) Definition of tariffs and prices for regulated activities; (v) Promotion and ensuring to achieve appropriate levels of quality of service; (vi) Preparation of natural gas sector network codes.

During the **first day**, presentations were made by Patricia Rainha, Vihon Manyrum, Ines Chaves, and Natalie McCoy. The following two presentations were delivered on the first day:

- Role and activities of the Portuguese regulator by various presenters



- Cost and revenues principles and regulatory tools by various presenters



SFA – *Stochastic Frontier Analysis*; OLS – *Ordinary least square; DEA – Data envelopment Analysis*

- Presentation at ERSE by Martin Crouch (Ex OfGem employee) on the UK RIIO model

The presentations were mainly about tariff settings and social tariff.

Notes from the first day:

ERSE and EMRA have a long-standing relation, for instance via MedReg which is currently being presided by EMRA and on the topic of fuels for which a study visit by EMRA to ERSE took place in 2018.

ERSE's budget is collected from transmission tariffs, but fines and sanctions are also a source for their budget. ERSE is organised by theme and not be sector. Key themes at ERSE are:

- Tariffs and pricing, including social tariffs.
- Infrastructure and networks.
- Market and consumers, including social issues.
- Costs and revenues.

About 90 people work at ERSE, among them are lawyers (20), economists (35) and engineers (35).

There is one law across all fuels in Portugal legislating the energy market. The first law appeared in 1997, which has been amended various times and currently the 7th version is published. Gas entered this law later on in time.

Government decides on social tariffs.

The quality of services used to be poor in Portugal, but it has improved greatly after making it a part of the tariff methodology.

ERSE reviews the investment plans of the distribution companies. Here ERSE can be considered the referee, to verify whether the distribution companies have prepared the investment plans according to the rules. The purpose of ERSE is not to change the rules over and again, but to define and apply the rules. The role of the entities is to comply with these rules.

The SoLR should be considered a “failure safeguard”, and it is generally not determining the retail price.

There are four regulatory tasks in Spain and Portugal covering both the financial contracts and the energy sector. These are considered all-in-one to achieve an optimal balance. To achieve this Portugal cooperated with Spain in the Iberian market.

Next, the presentations continued with a more theoretical character. The energy sector generally consists of natural monopolies, which cannot be easily liberalised, but it can be gradually unbundled. Independent regulators are often linked to local politics. The role of the EU is to harmonise this among the member states via the EU internal market. Among this, is to guarantee third-party access (TPA) to networks.

The presentation continues with explaining rate-of-return regulations. Incentive regulation started in the UK in the telecom sector (Littlechild, 1988). This looks at output, rather than inputs, which is much more target oriented. OPEX and CPAEX can be analysed jointly or separately. In the TOTEX approach the choice is left to the entities to make an optimal balance between OPEX and CAPEX.

Current topics that are high on the agenda are digitalisation and decarbonisation. The issue of gender balance and billing frequency (1 month or quarterly or even yearly) were also discussed.

Transmission is the backbone of any regulation. Therefore, transmission is also key in Portugal, due to Spain in the Iberian market and there are no other interconnections.

Portugal has a relatively short regulatory period, namely 3 years for electricity (Jan 2018- Dec 2020) and 4 years for natural gas (OCT 2020- SEP 2023).

In 2018, 52% generation by RES of which around 50% wind. Sometime there is more that 100% RES generation with 3-4 days in a row and the TSO is already able to balance this also thanks to the interconnections with Spain.

Finally, the allowed revenues to distribution companies is discussed. One of the principles is that there should be not too much change in the tariffs and entities should also not lose money.

The two island groups (Madeira and Azores) have very specific generation costs and they need to be compensated for these higher costs to achieve a national price equalisation.

Portugal follows an approach that is a mixture between price cap and revenue cap. The choice between the two depends on finding the real driver of them, which implies the amount of revenues that can be permitted. In Portugal the costs have decreased over the past four years, due to lower so-called political costs (due to lower feed-in tariffs).

In 2019 there is an innovation incentive to encourage smart grid services. However, innovation has been limited due to low budgets. Also, the requirement to demonstrate the benefit of the innovative project was an impediment against using the incentive. Therefore, in the previous years no innovation projects have been done.

Since 2016, there has been a 0.75% premium on the WACC for transmission investments.

There is a balance between ERSE and the regulated entities and they have various check and balances in place. The main question by the end of the day is: what is the profitability of the regulated entities?

In natural gas the TOTEX approach is not yet applied, because the sector is not yet matured and therefore a more conservative approach is followed.

There is only one DSO in Portugal.

The concept of “worst served customer” was presented.

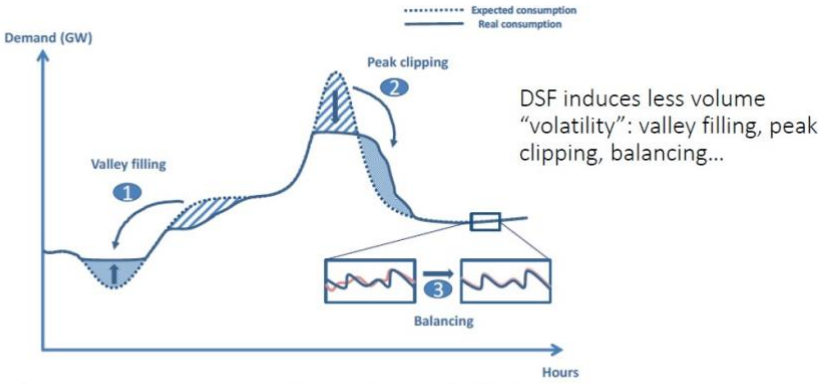
During the afternoon of the **first day**, the EMRA delegation also attended the presentation on the RIIO system by Martin Crouch (he worked for 15 years at OfGem) at ERSE.

Some key points of his presentation are:

- For regulators, one thing is sure; the amount of “Change” will speed up in the future.
- There is a need to integrate both electricity and natural gas, especially digitally.
- “Culture eats strategy for breakfast”.
- The UK regulatory model is primarily experimental (aimed at being different from the US system)
- RPI-X model first reduced costs significantly, which was encouraging. However, this cost reduction came at the cost of reducing efficiency. In its place came the RIIO model, which introduced performance/target-based tariffs. The regulator moved to the background, it became more consumer service oriented. On the downside, RIIO turned out to be more complicated that the RPI-X model and too many profits stayed with the regulated entities.
- As a new rule, investment projects with a value over €100 million, will need to go through a tender procedure.
- There is a trade-off between “leading edge” regulation and eccentric different/experimental regulation
- The “waterbed effect” analogy was used to explain the regulatory challenges.
- The purpose of the companies should be to add value to society (not profit making per se).
- The presenter concluded with the analogy of the elephant and 3 blind man, where all three man perceiving a completely different creature by looking at different body part of the elephant. There is a need for a holistic approach in performance-based tariff regulations. Even though it is an improvement on the RPI-X model the RIIO model is still an incomplete contract. However, a “complete contract” seems to be an impossibility. There is no perfect solution for performance-based tariff regulations.

During the **second day** presentations were held by Hugo Coutinho, Isabel Apolinário, Marta Pinto and Jorge Esteves. The following five presentations were prepared and presented:

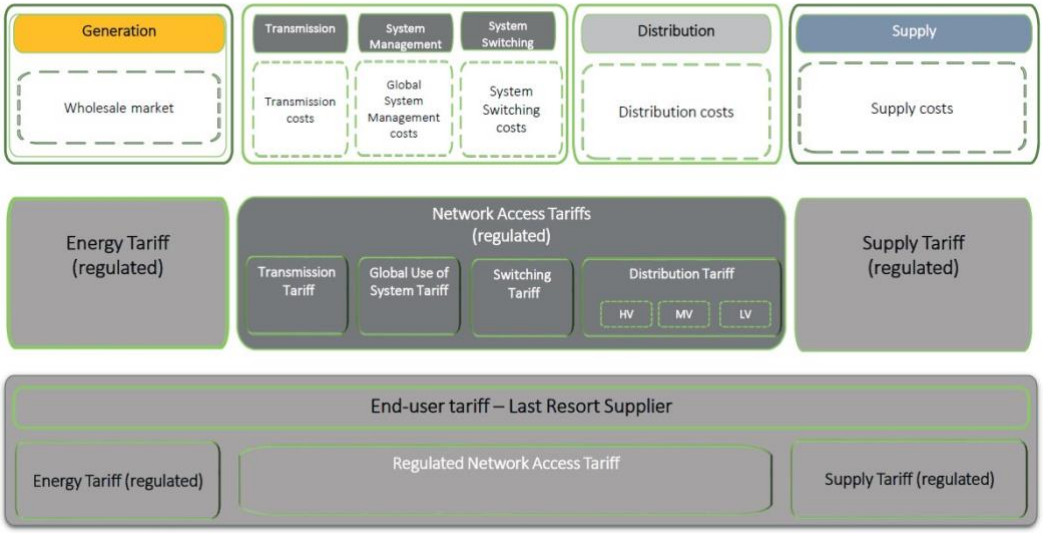
- Demand Side Flexibility, Regulatory Perspective by Isabel Apolinário



Fonte: "Ceer Advice on Ensuring Market and Regulatory Arrangements help deliver Demand-Side Flexibility, CEER, June 2014

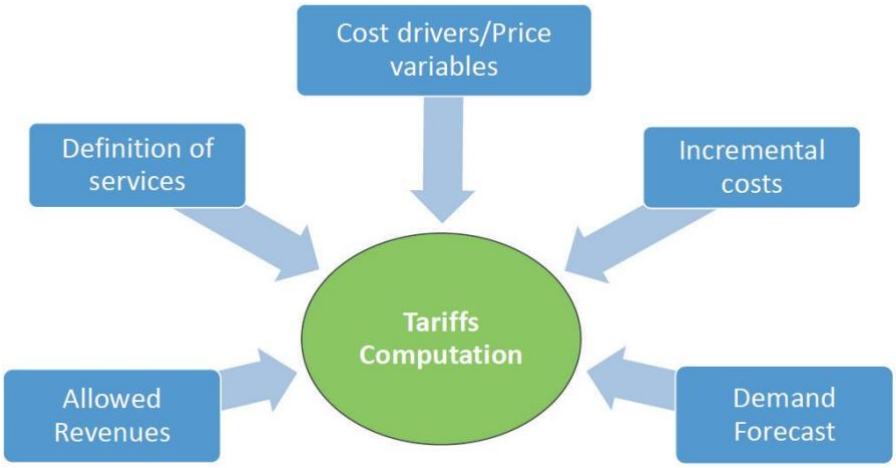
- Electricity Tariffs Design by Isabel Apolinário

Last Resort Supply (1 million consumers)



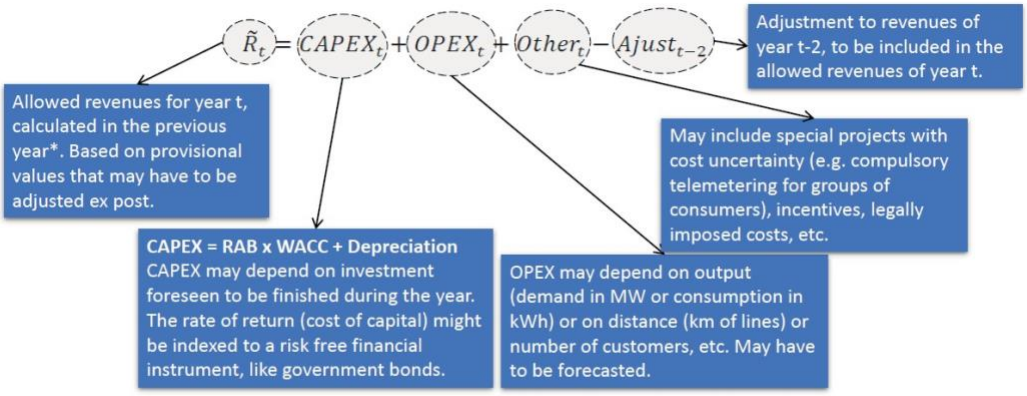
- Structure and design of LNG terminal tariffs by tariffs division

General methodology for tariffs computation



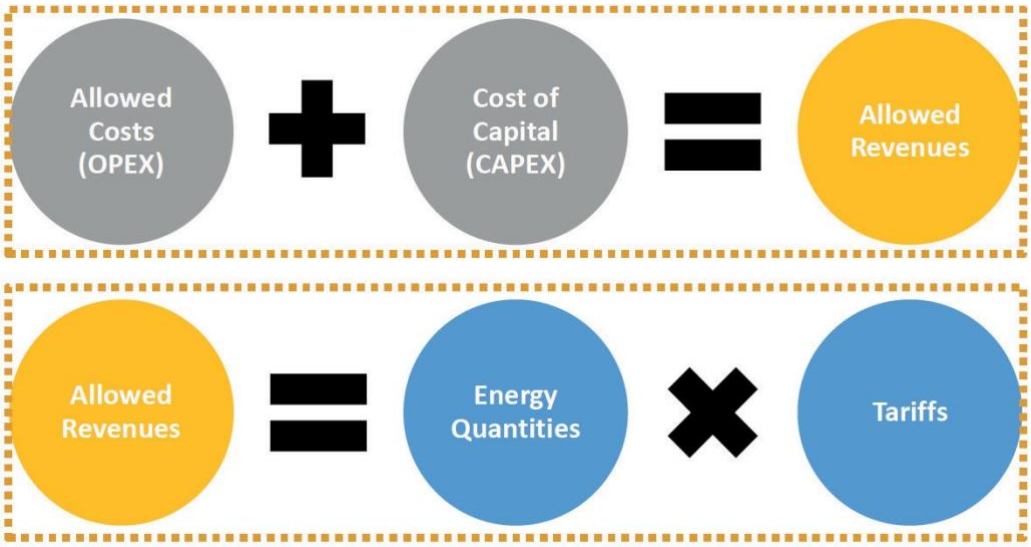
- Structure and design of natural gas transmission tariffs by tariffs division

Allowed revenues of a network operator have different components.



* Same rationale is applicable for, quarter, month or any other tariff review periodicity.

- Tariff of Last Resort and Social Tariffs by Marta Pinto, DCP



Isabel Apolinário is the head of tariffs department, managing 9 employees.

The topics of quality of supply and electric mobility were presented on the second day. Electric vehicles (EV) are currently only considered as consumers. Portugal has a very innovative vision with respect to EV. They had an early deployment of charging points and about 20,000 new EVs are added per year. There are already 70 quick charging points, which electricity is sold via commercial market transactions.

The tariffs are cost reflective, but tax may be needed to fully recover the costs.

Very high voltage consumer tariffs are all in the free market and therefore have no regulated tariffs.

Public consultation is very important prior to any rule change; this is the ERSE practice. Moreover, transparency can be considered a "key-word" for ERSE. There are well-established norms so that the regulated companies know exactly what information they should present. If the information is not delivered within expectations, an audit may be called for. The information is currently delivered in normalised excel table, whereas an IT system is under development.

Portugal distinguishes between marginal costs and incremental costs. There are 5 million customers in the free market and 1 million are regulated tariff customers. All consumers have to pay the regulated network tariffs/costs. Demand side flexibility is key.

In the natural gas sector there are 7 exit points (there are 400 exit points in Turkey) and 17 entry points. The length of the pipeline network is 1375 kms, with imports from the East (Spain) and exports to the North (Spain). A capacity-weighted distance methodology is used.

In some case LNG is tinkered to large consumers to some regions where pipeline connections have not yet been well-established, due to it not being feasible yet.

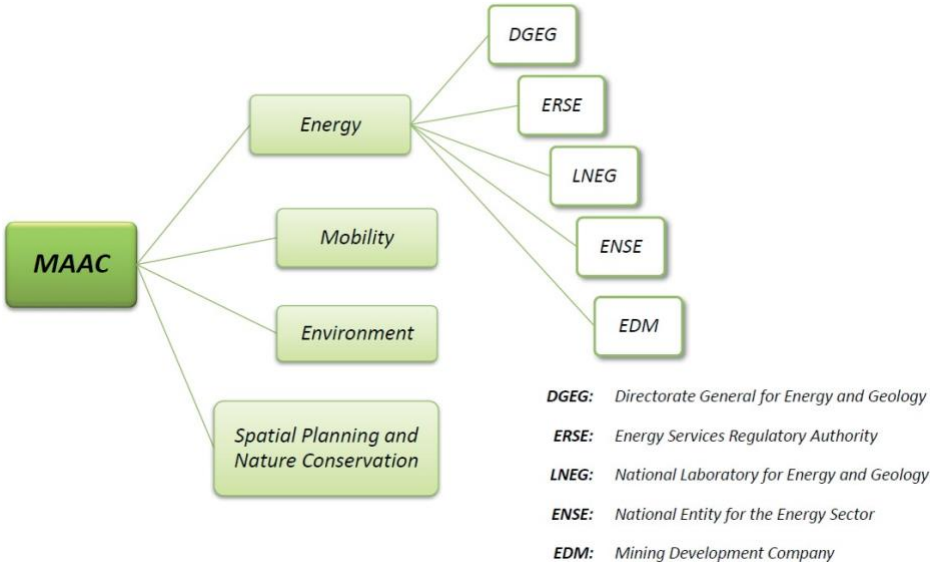
The main subjects of the presentations were structure and design of the both electricity and gas tariffs.

2.2 The General Directorate for Energy and Geology (DGEG)

The **third day** of the visit (23rd of October) was held in DGEG, where participants were welcomed by Isabel Soares and many other experts, namely: Catia Brito, Lilia Varejao, Donzilia Santo, Rogerio Dias, Carlos Imvenmo. They gave a presentation about Energy social tariff in Portugal and electricity & gas sector structure and the related legal framework.

The following three presentations were delivered on the third day.

- Institutional Cooperation in the Energy Sector by Ms. Isabel Soares, Head of Institutional Affairs and Markets



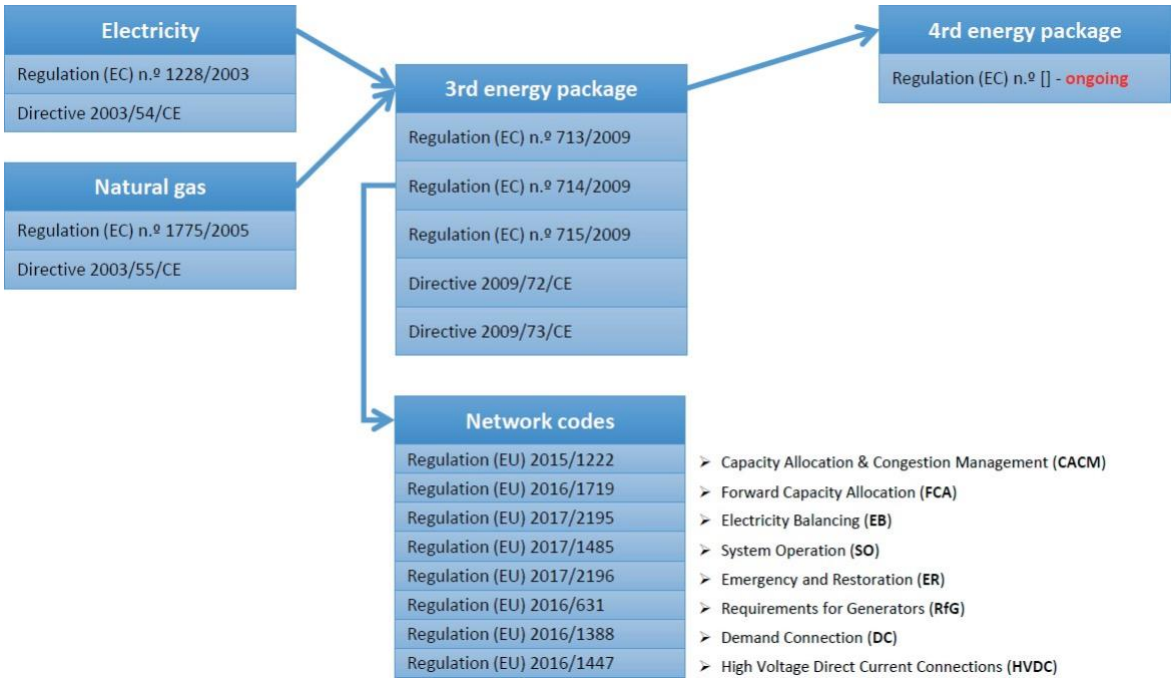
- Energy social tariff in Portugal by Lília Varejão Senior Officer of the Market Department (see below slide on financing of social tariffs)

- **Electricity Social Tariff** :
  - by holders of ordinary power generation centers, in proportion to the power installed in each power generation center.

- **Natural Gas Social Tariff** :
  - by carriers and natural gas suppliers, in proportion to the gas traded in the previous year.

- In 2018, Energy Social Tariff represented a global transfer of about **85 million euros** to consumers (Data source: Regulator of the Energy Sector – ERSE), through discounts granted on the access tariffs.

- Electrical Sector Structure by Rogério Dias Senior Officer of the Market Department



The Ministry for the Environment and Climate Active (MAAC) consists of various departments including energy. Here DGEG falls under the department of energy, which is also the case for ERSE. The target is to reach a RES amount in primary energy of 47% and an energy efficiency improvement of 35% (with respect to 2008 levels) and to maintain an interconnection capacity of 15%.

There are social tariffs both for electricity and natural gas consumers in the form of a discount on the retail bill for vulnerable customers. The total cost for this was €85 million in 2018. Moreover, the number of customers benefitting from social tariffs increased substantially in 2016 from 140,000 to 700,000 electricity and 14,000 to 40,000 natural gas consumers.

There is a smart meter deployment plan. Already 1 million (out of 6.1 million customers) customers have smart meters. For prosumers, the smart meter is part of the CAPEX.

EDP Innovation has developed a demand following street lighting system, where the light intensity (in lux) is adjusted to the time of the day and the number of persons.

DGEG is the Portuguese Public Administration body whose mission is to contribute to the design, promotion and evaluation of policies related to energy and geological resources, with a view to sustainable development and guaranteeing the safety of the supply. The mission of DGEG includes, the need to make citizens aware of the importance of such policies, in the context of the desired economic and social development for the country, informing them of the instruments available for the implementation of political decisions and disseminating the results of its monitoring and implementation. The following are competencies of the DGEG:

- Contribute to the definition, implementation and evaluation of the implementation of energy policies and the identification and exploitation of geological resources, aiming at their valorization and appropriate use and monitoring the functioning of the respective markets, companies and products;
- Promote and participate in the preparation of the appropriate legislative and regulatory framework for the development of systems, processes and equipment related to the production, transport, distribution and use of energy, in particular with a view to security of supply, diversification of energy sources, energy efficiency and preservation of the environment;
- Promote and participate in the elaboration of the legislative and regulatory framework related to the development of policies and measures for the exploration, exploitation, protection and valorisation of geological resources and the respective business and contractual context;
- Support the participation of the IEM in the Community and international domain, in the area of energy and geological resources, as well as promote the transposition of Community directives and monitor their implementation;
- Carry out inspections in the fields of energy and geological resources, in accordance with the legislation applicable to the respective sectors;
- Support the Government in decision-making in crisis or emergency situations, within the scope of the law, and provide the means for the permanent operation of the Emergency Energy Planning Commission.

2.3 National Electricity Networks - REN

The **second half of the day** was dedicated to technical visits to the Centre of Electricity Dispatch of REN in Sacavém and the Natural Gas Dispatch in Bucelas. The participants were accompanied by Catia Brito from DGEG and two experts from REN.

Ren has two main business areas: electricity and natural gas. In Portugal, REN operates the main transport infrastructure and undertakes the overall management of the National Electric System and the National Natural Gas System. REN also have a natural gas distribution concession in the northern coastal region of Portugal.

2.3.1 Electricity

REN - Redes Energéticas Nacionais operates the National Transmission Grid (RNT), which connects generators to consumption centres and ensures a balance between energy supply and demand. It is the only electricity transmission entity in Portugal under a concession agreement with the Portuguese state. The RNT delivery points feed the distribution network that supplies most final consumers. Electricity supply companies are responsible for managing relations with end consumers, including billing and customer service.

Paulo Moarques who is the department manager explained about electricity operating systems and how it works.

2.3.2 Gas

For the other visit to Natural Gas department in Bucelas, Alexandre Cachao and Raquel Costa welcomed Turkish delegation and explained natural gas system operations.

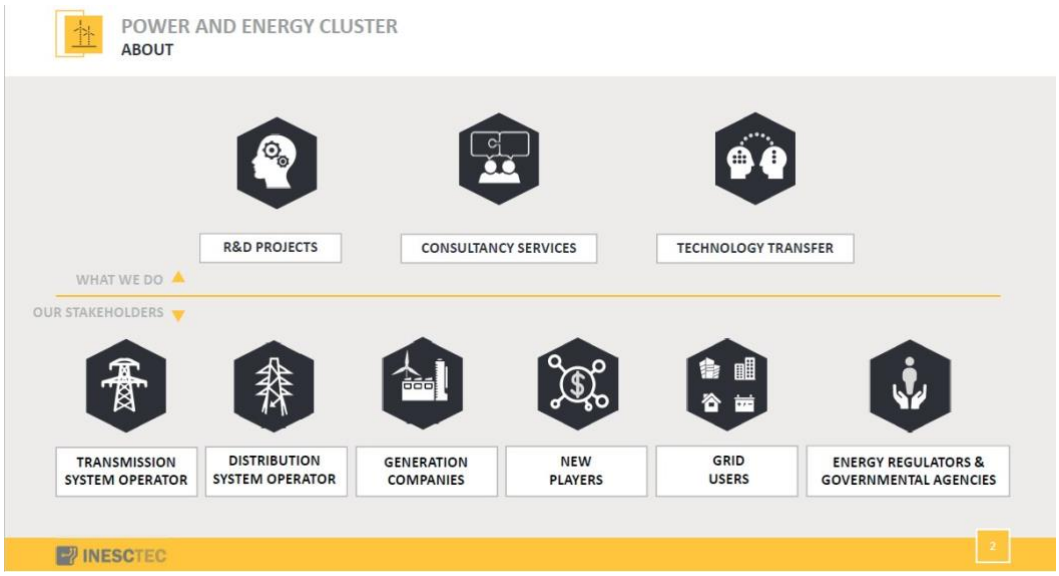
Today, all the natural gas used in Portugal comes from third countries. A part is received by high pressure pipeline via Spain and the other by sea (in the form of liquefied natural gas - LNG).

REN Gasodutos operates the National Natural Gas Transport Network (RNTGN), which receives the natural gas at the Spanish border, as it leaves storage facilities (REN Armazenagem) or at the regasification terminal (REN Atlântico) and delivers it to distributors or high-pressure end users. REN Gasodutos holds the concession for the high-pressure transport of natural gas, which includes overall technical management of the National Natural Gas System, through which it coordinates the operation of natural gas distribution and transport infrastructures, which guarantee the continuity and security of supply. It is also responsible for proposing development of the system.

2.4 INESC TEC

On the **fourth day** (24th of October) EMRA met with Prof. Joao Peças Lopes in Porto. His colleagues Joao Saraiva and Luis Miguer Miranda joined the meeting and participated actively in Q&A session. The presentation was about Power and Energy Cluster and Smart Grid System. Prof. Peças presented 2 hours in the Inesc Tec campus in Porto. The following presentation was presented:

- Power and energy cluster:



INESC TEC is a private non-profit research institution, dedicated to scientific research and technological development, technology transfer, advanced consulting and training, and pre-incubation of new technology-based companies.

The institution is focused on traditional and emerging areas of Power and Energy Systems, for planning and operational purposes, with an emphasis on the integration of renewable energy sources (RES), deployment of electric vehicles, management of distributed energy resources (DER), demand response (DR), smart grids and energy analytics. For that, the cluster uses steady state and dynamic network analysis, reliability models and tools, optimisation and soft computing, and forecasting. Their main research areas are;

- Co-simulation in Electrical Networks, Multi-energy Networks, Large-scale Modelling of Energy Systems, Weather Intelligence Applied to Power Systems, Stochastic Optimization of Energy Systems, Predictive Maintenance and Asset Management, Towards 100% RES Integration and Massive Integration of Power Electronic based Interfaces, Smart-grid Hardware, New Marketplaces for Energy Services, Cybersecurity of the Grid, System Resilience, Power System Planning, Energy Efficiency.

- The electricity network of the INESC TEC research lab can operate in island mode, due to solar and wind generation facilities and storages in combination with smart grids. This is called the RTDS real-time digital simulator. This network can also be used for simulation purposes to study the effect of large-scale integration of RES into the distribution grid.

INESC TEC (Porto) receives their funding from three sources:

- National Science foundation, via competitive tenders

- EU funded projects, they recently acquired the €36 million project “inter-operability development of smart grids” in which they are the project leaders.

- Direct contracts with the (private) industry.

INESC TEC has a yearly turnover of around €20 million with 800 employees of which 250 hold a PhD.

The EDP InovGrid project was implemented by INESC TEC. This started with defining specifications of a reference model. This is a test bed in the lab. By the end of the project 30-35 thousand smart meters were installed. ERSE did not accept smart meters as part of the tariffs and this became a barrier to rapid smart meter deployment. There is a dilemma: smart meters both increase (=investment) and decrease (=less reading personnel needed) OPEX. The benefit of smart grids (much more than only smart-metering) is to quickly and easily detect “theft”.

There is a suggestion that in the future energy bills should be much less related to the level of consumption, but more related to connection, like the contracts which are common for GSM providers. INESC TEC looks at 100% RES Portugal power system. Hence, complete phase out of fossil fuel generation. In such a system marginal costs will be close to zero, so all contracts should be arranged via capacity markets.

Coal is being phased out already, whereas natural gas CCGTs are next and will only be needed for security of supply.

There are more and more 100% RES days with zero bid prices. Wind capacity expected to increase from 5500 MW to 8000 MW by 2030, whereas solar PV will increase from 500 MW to 9000 MW in 2030. RES and storage will remain. It is a question how to remunerate storage in a 100% RES world. Here pumped-storage hydro will also play a key role, which is also names as “reversable hydro”.

Prices at night are sometimes higher than during the day. This is induced by night charging for peak shaving. This will become a real problem within about 5 years.

Portugal and Spain are one common Iberian market. The balance among flexibility, efficiency and quality of services can be leveraged by smart grids. Here SCADA and DMS are needed as well.

There is a need to rethink the grid code to allow for 100% RES. This will affect all elements of the grid.

2.5 EDP

At the **last day** of the meetings (25th of October) EDP presented about three main subjects. First presentation was made by Jose Afonso who is the director of regulation EDPD. He explained first two topics on Regulatory framework of Portuguese electricity distribution network and regulatory of the last resort supplier.

Third topic was explained by Rita Nunes, who is from the EDP holding, namely she talked about the social tariff. The other teammates (Luis Azoia, Sandra Pinto, Joana Pinto Simoes, Frederico Silva, and Guido Pires) joined them for the details and further questions. The following presentations were presented:

- Regulatory framework of the Portuguese electricity distribution network
- Regulatory framework of the last resort supplier
- The social tariff

EDP is a multinational, vertically integrated utility company. 40 years of history and being present in 16 countries, in 4 continents. With more than 11,500 employees. It is the fourth largest wind energy production company in the world and almost 70% of its energy is produced from renewable resources. EDP provides electricity and gas to almost 11 million customers. Electricity distribution networks are made up of High, Medium and Low voltage cables and lines. Substations, transformation substations and public lighting facilities are also part of the distribution networks, as well as the necessary connections to consumer facilities and generation centres. EDP operates in three electricity distribution markets, Portugal, Spain and Brazil, having distributed, in 2017, 78,788 GWh, through a network with more than 246 thousand km. In Portugal, the company operates throughout the mainland. In Spain, EDP operates in some autonomous communities, especially in the Asturias region. In Brazil, EDP operates in the states of Espírito Santo and São Paulo, through EDP Escelsa and EDP Bandeirante respectively. EDP’s electricity distribution strategy is focused on the implementation of smart networks and related services, in order to meet future challenges and become an electricity distribution benchmark. In recent years, the expansion and modernization of systems in the three countries where EDP operates, as well as the expansion of the telemeters network in the distribution network’s transformation substations, have been important strategic factors for EDP. By the end of 2017, the company had more than 2 million smart meters installed in the Iberian Peninsula.

3 Feedback and conclusions

3.1 General evaluation of the study tour

The participants have answered in their evaluation forms that they are in general pleased and satisfied with the study tour. Since the tour combined different types of organizations, most of the participants found interesting and applicable presentations in each institute.

Among all the institutions visited, ERSE and EDP were found the most beneficial ones for both gas and electricity

participants mainly because of the satisfactory briefings. Average satisfaction to REN was 7 out of 7 from the both electricity and gas participants; to DGEG was 6 out of 7. There was only one comment mentioned about not having regulatory perspective. For the INESC TEC only 3 out 7 found it beneficial. Rest of the participants commented that they would prefer to spend more time in regulatory than Inesc Tec.

All visited institutions first gave a presentation, and it was continued with a question and answer (Q&A) version and most of the questions to the lecturers have been answered. All the participants see the potential in using the new knowledge obtained during the study tour in their professional life.

3.2 The participants expressed interest in learning various issues

- ERSE:
  - Learning the regulatory framework and working principles of the energy market regulator of Portugal.
  - To see the tariff system and to understand the difference between two countries.
  - To learn and get information about transmission and distribution tariff in electricity and gas as well as the mobility network system, quality factors and social tariff machines.
- DGEG:
  - Importance of protection and valorization of sociological resources.
  - Learning about difference and similarities between Turkey and Portugal in practices and policies.
  - To see general framework and transmissions of energy policies of Portugal and also the EU countries aims on natural gas and electricity.
- REN:
  - Operating transmission system of electricity and gas in Portugal
  - Understanding the networks (size, connections and dispatch systems)
- Inesc Tec:
  - Information about the integration of renewable energy and smart grids.
- EDP:
  - Learned about the operating the electricity distribution systems.
  - To see distribution in another perspective and see the differences and political effects within the social tariff model.
  - Tariff structures, tariff calculations in details.

3.3 Recommendations for future study tours

- To keep the presentations with general definitions short and to elaborate on the tariff and calculation methodology.
- A general information for the visited institution should be distributed beforehand.
- More specific and useful topics are expected to be provided from academics.
- Each Study visit should aim at guaranteeing two full days spent in country regulator.
- Providing Half day off should be considered for the next study visits.

Annex 1 Agenda of the study visit and list of participants

The 5-day study visit (excluding travel) will have its focus on regulators and other institutions working in relation to tariff setting and monitoring in Portugal.

20st October - Sunday	
10:30	Arrival to Lisbon with flight TK1755
11:30	Departing from Lisbon Airport for city tour
12:50-14:00	Lunch at Restaurante Espelho D'Água Tuna salad with cucumber, tomato, pepper and oregano Breaded crusted cod, battered potatoes and sauteed spinach Chocolate mousse
14:00 - 17:30	Lisbon City tour
17:30	Arrival to Hotel Sana Reno, check-in
19:00	Dinner at **Zaafran Restaurant** Largo Dona Estefânia 7, 1100-092 Lisboa, ** +351 21 355 8894
21st October – Monday	
09:00	Pick up from Hotel to the Portuguese Energy Regulator – ERSE
10.00 – 10.30	Welcome to ERSE www.erse.pt R. Dom Cristóvão da Gama 1 3º, 1400-113 Lisboa, Portugal
10.30 – 11.00	Role and activities of the Regulator
11.00 – 13.00	Costs and revenues principles and regulatory tools
13.00 – 15.00	Lunch break at **Nunes Real**
15.00 – 16.30	Debate: The UK regulatory model: innovative solutions and practices by Martin Crouch
16.30 – 17.30	Costs and revenues – Questions and Conclusions
19:00	Dinner at **1001 Nights Restaurant** *** https://www.1001nights.pt/en Rua João Villaret 11, 1000-182 LISBOA, Portugal ** 927 626 665
22nd October – Tuesday	
09:00	Pick up from Hotel to the Portuguese Energy Regulator - ERSE
10.00 – 13.00	Tariff methodologies
13.00 – 15.00	Lunch break at **Vela Latina**
15.00 – 16.30	Social tariffs and tariff for Supplier of Last Resort
16.30 – 17.00	Questions and Conclusions
19:00	Dinner at Cascais, **Maria Pia Restaurante** Passeio Dona Maria Pia, 2750-310 Cascais, Portugal Telephone: 214 835 348 ● 926 438 053
23rd October - Wednesday	
09:00	Pick up from Hotel to the General Directorate of Energy and Geology - DGEG
9.30 – 12.30	Directorate General for Energy and Geology Headquarters http://www.dgeg.gov.pt/ 1069-203, Avenida 5 de Outubro 208, Lisboa, Portugal
12.30 – 13.30	Lunch Break at **A Padaria Portuguesa**

14.30 – 15.30	Technical visit to the Centre of Electricity Dispatch of REN in Sacavém https://www.ren.pt/en-GB R. Cidade de Goa 4, 2685-038 Sacavém, Portugal
16.00 – 17.15	Technical visit to the Natural Gas Dispatch in Bucelas, Lisboa
19:00	Dinner at **Restaurante Marrakesh** https://www.restaurantemarrakesh.com Avenida Conde Valbom n.53 1069-180.lisboa tel : 211 936 444 /91974820
24th October - Thursday	
8:30	Departing from Lisbon to Porto
12.00 – 14:00	Lunch break at **Riberira 50 Restaurante** https://www.tripadvisor.com.tr/Restaurant_Review-g189180-d13005995-Reviews-Ribeira_50-Porto R. de Cima do Muro 62-63, Porto 4050-200, telephone +351 22 340 1210
14.00/14:30 – 17:00/17:30	Arrival at INESC TEC - Investigation Center for Power & Energy - Porto https://www.inesctec.pt/en Visit to the Laboratory of Smart Grids and Seminar by Prof. Peças Lopes
17.30	Departing from Porto to Lisbon
20:00	Arrival to Lisbon and dinner at the hotel
25th October – Friday	
08:50	Pick up from Hotel to EDP
9.30 – 12.30	EDP- Regulatory framework of the Portuguese electricity distribution network *https://www.edp.com/en/aboutedp *** Av. 24 de Julho 12A, 1249-300 Lisboa
12.30 – 14.30	Lunch break at **100 Montaditos**
14.30 – 17.00	Regulatory framework of the Supplier of Last Resort Supplier and The Social Tariff
19.00	Dinner at Restaurante **Ghoroa Mouraria** http://www.ghoroarestaurant.pt/en_GB/ Tv. Benformoso, 2, 1100-089, Lisbon ** +351920333520
26th October - Saturday	
08:30	Check-out from hotel and transfer to Lisbon Airport for flight TK1756 at 11:25

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