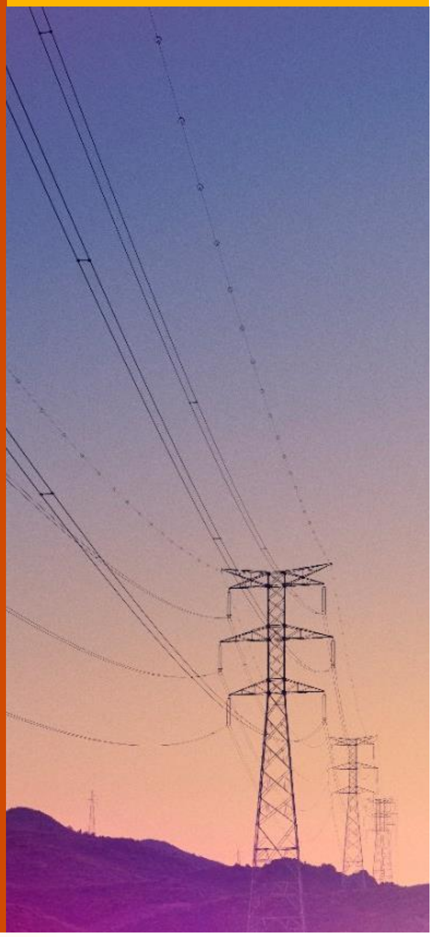
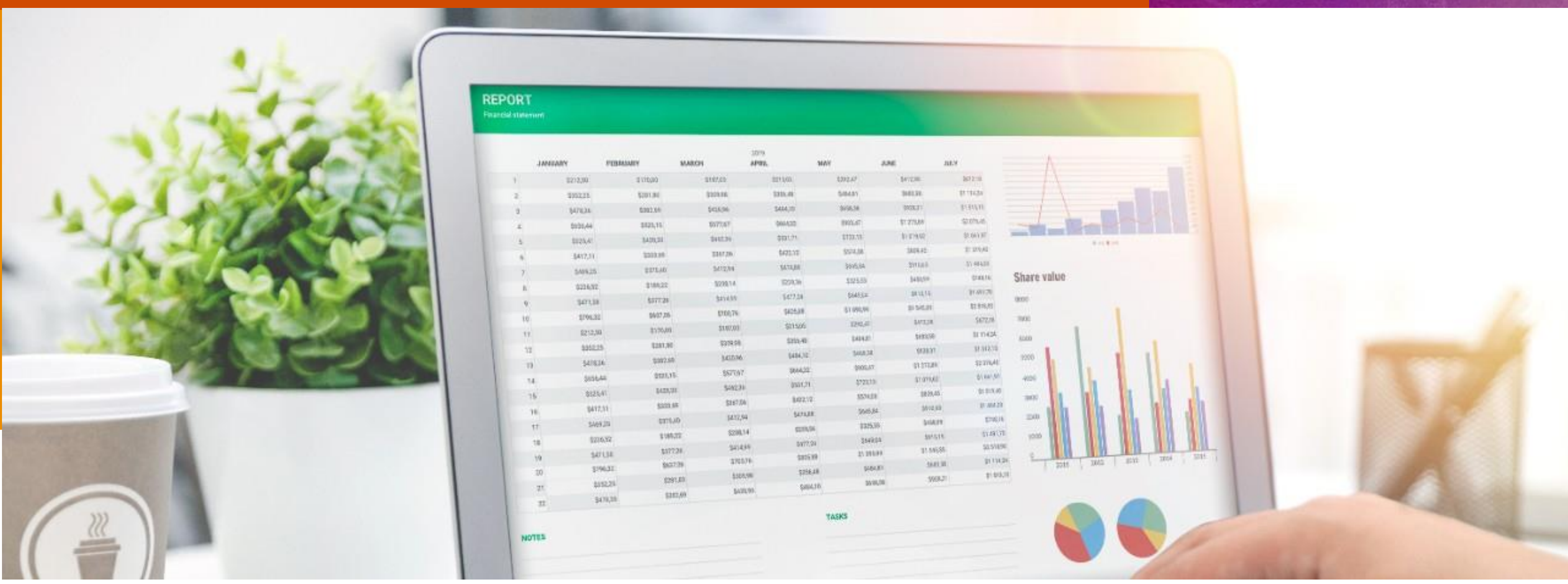
Long-run Average Incremental Costing (LRAIC) Model for TSO and DSO



Methodology guidelines

30 April 2021

Draft for discussion purposes



Strictly private and confidential

Renatas Pocius
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30 April 2021

Subject: Methodological guidelines – Update of the Long-run Average Incremental Costing (LRAIC) Model for TSO and DSO

Dear Mr. Renatas Pocius,

We are pleased to provide you with the Methodological guidelines for the Long-run Average Incremental Costing (LRAIC) Models for TSO and DSO as part of the 2021 update of the original LRAIC model that is currently in use in Lithuania for setting of the electricity transmission and distribution tariffs.

These Methodological guidelines represent the overall methodological document describing the principles of the LRAIC modelling, key components of the model and the description of the model functionalities. The update of the Methodological guidelines was conducted based on the existing Methodology guidelines that were developed for the original LRAIC model during its development and implementation in 2013-2014, and based on the inputs and requirements collected from VERT, ESO and Litgrid during the initial stage of the project.

The inputs and requirements were collected and evaluated, and where reasonable, incorporated into the Methodological guidelines and LRAIC model itself. Our work included the collection of the necessary information and data regarding the Lithuanian electricity transmission and distribution network and market, the meetings with transmission system operator Litgrid and distribution system operator ESO to discuss any required changes to the model, any changes in the availability of the data compared to the original LRAIC model, any additional data that might be needed to incorporate new updates in the model and any comments on the experience with the past implementation of the original LRAIC model in Lithuania.

We draw your attention to important comments regarding the scope of our work according to the contract stipulated between VERT and PricewaterhouseCoopers, the purpose for which the Methodological guidelines are to be used, our assumptions and limitations in the information on which the Methodological guidelines are based. Accordingly, this report may not have identified all matters that might be of concern to you. Accordingly no representation or warranty of any kind (whether express or implied) is given by PricewaterhouseCoopers to any person (except to VERT) as to the accuracy or completeness of the Methodological guidelines, except where otherwise stated.

Best wishes,

Ivo Doležal, Partner

PricewaterhouseCoopers Advisory, spol. s r.o.

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1. Introduction

1.1. Purpose of the document

This document represents the Methodological guidelines prepared as part of the project of the Update of the Long-run Average Incremental Costing (LRAIC) Models for TSO and DSO, and the related services based on the contract stipulated between Valstybinė energetikos reguliavimo taryba - National Energy Regulatory Council (VERT) and PricewaterhouseCoopers (PwC).

This document is the initial high-level methodology based on which the technical-technological and economic models are designed and does not constitute the final methodology. The starting point of the development of this document is the Methodology guideline document for the original LRAIC model developed in 2013, taking into consideration new requirements and change requests as defined in the contract between VERT and PwC, as well as requirements and change requests subsequently discussed with VERT, Litgrid (transmission network operator) and ESO (distribution network operator) during the initial stage of the project in March and April 2021.

Therefore, the principles and approaches provided herein are determined based on the initial data collection and discussion workshops with the VERT, Litgrid and ESO and the information available to date, and will be subject to revision as a result of the consultation process between VERT, Litgrid and ESO. Following the consultation process, an updated version of the Methodology guidelines will be prepared.

Based on the Methodological guidelines, additional documents will be prepared as a supplement to the LRAIC model - the methodology document for the data collection that will specify the data input request for the LRAIC model in detail and the model manual that will describe the LRAIC model calculations.

1.2. Purpose of the methodological guidelines

The purpose of the Methodological guidelines is to describe and set out the basic principles of the technical-technological and economical modelling in the LRAIC model and to describe the principles based on which the models will calculate the long-run average incremental cost for the defined regulated services – transmission and distribution of electricity. These principles include, but are not limited to:

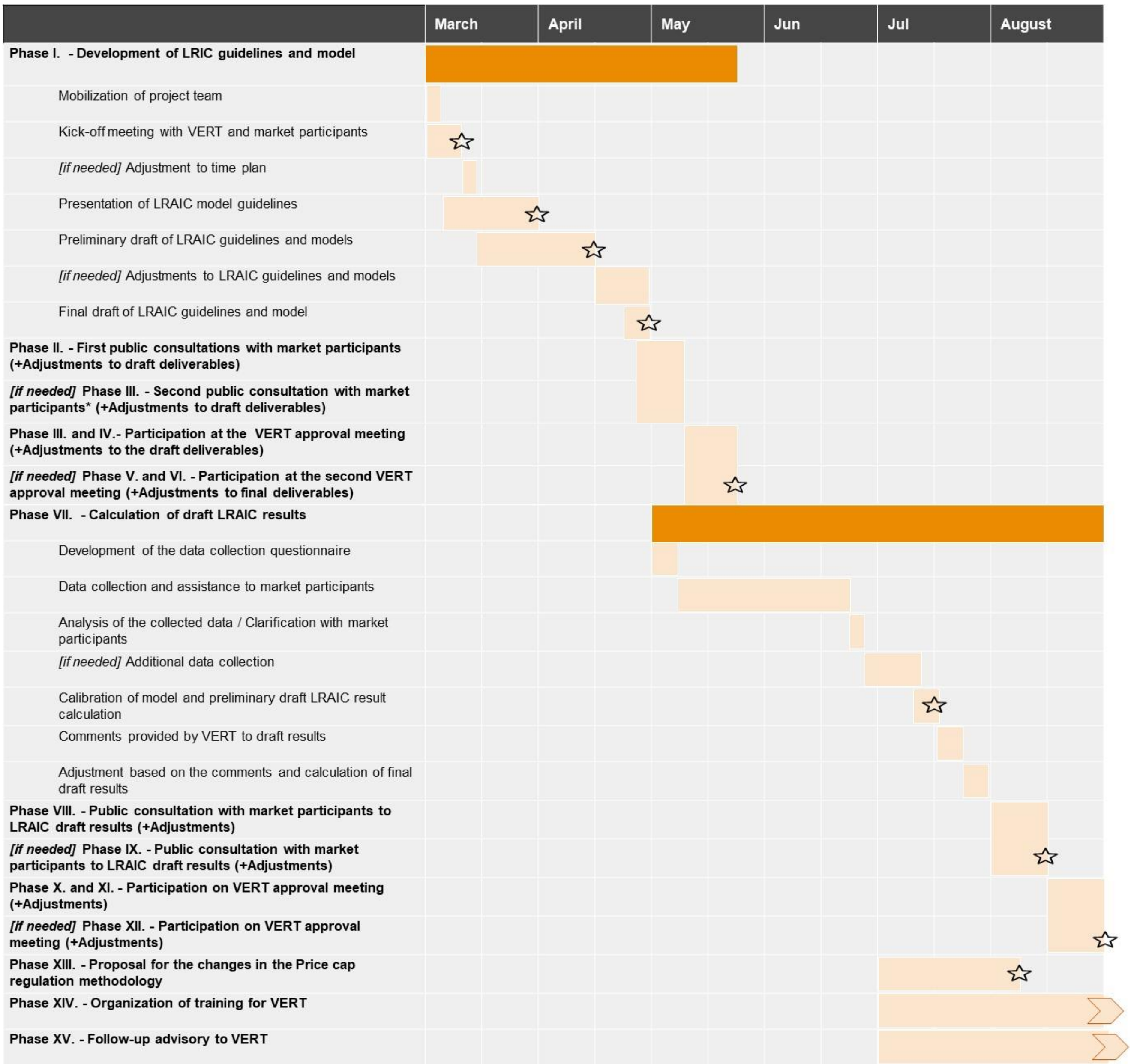
- the extent of the modelling of the theoretically effective operator
- time horizon for the modelling
- definition of the relevant market for the TSO and DSO
- main types of technologies to be considered in the modelling
- methods of the calculation of the annualized capital expenses
- valuations methods
- definition of the services provided by TSO and DSO
- design of the technical-technological modelling at individual voltage levels
- demand forecast estimation
- dimensioning of the network elements
- optimization principles – different parameters for the selection of network elements for optimization
- possible simplifications of the updated LRAIC model compared to the original LRAIC model
- proposed changes in the updated LRAIC model compared to the original LRAIC model

The Methodological guidelines are used as a guiding document for the design of the LRAIC model and its update, therefore the principles described in this document summarize how the LRAIC model is build and how it works. The LRAIC model has a broader set of functionalities and can calculate different scenarios (such as using different depreciation or valuation methods or different scope of optimisation of the network). All the model functionalities are described in the document, and where there are multiple scenario for certain functionality, the selected scenario is suggested to be used in the model (subject to the final approval by VERT).

1.3. Project timeframe

The overall project to develop the updated LRAIC models for TSO and DSO and to calculated new LRAIC model results will be delivered in 6 months, starting in March 2021 and the final modelling results, sign-off and deliveries hand-over is planned to the end of August 2021.

The expected project timeframe is as follows:



1.4. The list of abbreviations

Abbreviation	Description
CAPEX	Capital expenses
CCA	Current cost accounting
DSO	Distribution system operator
EC	European Commission
EHV	Extra-high voltage (330 kV and more)
EU	European Union
HCA	Historical cost accounting
HV	High voltage (110 kV)
ID	Identifier
kV	kilovolt
ESO	Lithuanian electricity distribution system operator
Litgrid	Lithuanian electricity transmission system operator
LRAIC	Long-run Average Incremental Cost
LV	Low voltage (0.4 kV)
MV	Medium voltage (35 kV – 6 kV)
OPEX	Operational expenses
PwC	PricewaterhouseCoopers
TEO	Theoretically effective operator
TSO	Transmission system operator
VERT	Valstybinė energetikos reguliavimo taryba - National Energy Regulatory Council
WACC	Weighted average cost of capital

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2. Summary of main changes

2.1. Summary of main requirements on the changes of the LRAIC model and methodology

The key starting point for the update of the LRAIC Methodology guidelines and LRAIC model is the original Methodology guideline and model developed in 2013-2014, which is implemented in Lithuania in the regulatory period 2016-2021 (the original regulatory period 2016-2020 was extended by 1 year in 2020). During the initial stage of the LRAIC model update project, several meetings were conducted with VERT, Litgrid and ESO in order to collect comments, suggestions and requirements on the update of the methodological guidelines and model. The summary of the key requirements to be taken into account is provided below, full list of the requirements is provided in annex *A.2 Appendix – Summary of main requirements and changes for LRAIC model update*.

Selected **key requirements**:

Area	Description
CAPEX corrections	Correction of the differences between planned CAPEX as per LRAIC model and actual CAPEX invested by operators in periods before 2021 were done on an annual basis and when the operators did not meet the investment plans, correction were made. This needs to be reflected in the new model - such corrections should not be done on the comparison of planned vs actual CAPEX in a single year, since the operators require longer periods to make the investments.
Prosumers	The model needs to take into account the distributed generation and prosumers.
LV feeders	DSO may need to invest into the reconstruction of the LV feeders network, but currently the model does not optimise the LV feeders network. Functionality needs to be added to the model to take this into account.
Model optimisation	For power lines, the original model allowed to optimise lines only within their existing type (i.e. overhead line for overhead line, cable line for cable line). The model should allow for the optimisation between different types of power lines - specifically replacement of overhead line with cable, as this is a common real life practice.
OPEX and other network CAPEX	Potentially, OPEX and other CAPEX should be simplified, i.e. not to be part of the modelling, but provided just as an input into the price cap calculation based on the actual costs of the operators
Data collection	Unit prices of the modelled technologies - operators provide unit prices for modelled technologies based on their own recent purchases and contracts. In cases when the most recent purchases are older, the prices are not actual, and therefore should be adjusted for inflation.
Model optimisation	New technologies may have impact on the peak load - batteries, RES, smart meters - should be reflected in the model.
Investments	Operators need to be able to invest flexibly and purposefully, i.e. not strictly into the specific assets as suggested by the model, but flexibly up to the total amount as suggested by the model. Also flexibility in time is needed - i.e. they may invest less in one year and more in another year.
Model optimisation	Should the network elements that were already modernised/optimised in previous periods be again subject to the optimisation modelling? I.e., the model shall ensure that the same network elements are not re-optimized if they have been invested in and / or rebuilt, in the previous period of the application of the LRAIC model.
Data collection	The CAPEX for modelled technologies should not be separated into basic unit price and other related CAPEX, because the operators have usually total turnkey prices. It is suggested to provided it as a combined total CAPEX per unit.

2.2. Summary of proposed updates of the LRAIC model and methodology

Based on the evaluation of the collected comments, suggestions and requirements on the update of the LRAIC Methodological guidelines and LRAIC model, the below is the summary of the key updates to be implemented into the model. The full list of the requirements and their suggested implementations are provided in annex *A.2 Appendix – Summary of main requirements and changes for LRAIC model update*.

Selected **key updates to the LRAIC Methodology guidelines and model**:

Area	Proposed implementation	*Type of Implementation*
Model optimisation scenario	In the model, new functionality (optimization scenario) to be added, where operators can highlight, if specific network elements are planned for reconstruction within the modelling period and only such elements will be optimised (i.e. if they are included in the network development plan). Thus, the model optimisation scenario will be aligned with the operators' investment plans. In case of DSO, the network development plan may not be available at such a granular level as to be able to highlight specific network elements planned for investments. Therefore, cumulative network development plan values can be provided (i.e. kms of feeders, number of transformers) and the new model optimisation scenario will take it into account.	*New model functionality*
Prosumers	The model will incorporate prosumers connected at different voltage levels. Prosumers should be reflected in the peak load forecast and individual prosumers will also be reflected in the "Generation" worksheets of the model. For prosumers, a coefficient should be defined to take into account only the minimum power generation load of the prosumer. Additional information to be provided as part of the data collection will be the type of the prosumer (solar, wind, etc.)	*New model functionality*
Power lines optimisation	Model functionality to be added that will allow the optimisation of power lines to be also able to switch between different types of power lines - specifically replacement of overhead line with cable. Data collection questionnaire will be updated so that the operators can provide indications for cases, where such replacement (overhead line for cable) is needed.	*New model functionality*
OPEX and other network CAPEX	Simplification will implemented where OPEX and other network CAPEX will be treated outside of the model and will be provided separately by the operators as a lump-sum for the price cap calculation.	*Change in Methodological guidelines*
Losses calculation by the model	It was requested if the model can perform a calculation of losses of the network before and after the optimisation to determine the improvement of losses. The model is not designed to perform a complex losses modelling. However, some simple calculation can be done – weighted averages of losses % before and after optimisation – by comparing the average losses values as provided by the operators for existing network, with losses after the optimisation, taken into account average losses of the modelled types of technologies.	*New model functionality*
Re-optimisation of already optimised elements	To make sure that network elements that were invested in, or reconstructed, in the previous LRAIC period, are not re-optimised by the model, the updated model will have to take into account such investments and exclude such network elements from optimisation. This can be addressed in the model by adding new functionality, where operators can highlight, if specific network elements are planned for reconstruction within the modelling period and only such elements will be optimised (i.e. if they are included in the network development plan). Thus, the model optimisation scenario will be aligned with the operators' investment plans. In case of DSO, due to the simplified modelling of the feeders in LV and MV network, it might be the case that not the entire feeder was reconstructed in the previous LRAIC period. The updated model will therefore allow to highlight the % of the feeder that was reconstructed in the previous period, so that only the remaining part will be eligible for optimisation in the updated model.	*New model functionality*

3. Basic principles to be used

3.1. Context of the project

In the years 2013-2014, the LRAIC model was first introduced in Lithuania for the purpose of the estimation of the allowed revenues of TSO and DSO and applied in the determination of the price caps for the electricity transmission and distribution service. The LRAIC-based price regulation of electricity transmission and distribution service in place in Lithuania since then.

In 2020, VERT, based on the discussions with TSO and DSO, initiated the process to update the original LRAIC model to adjust it for the changes and developments in electricity markets and to reflect new requirements and change requests raised by the market participants. The LRAIC model should be updated in 2021, followed by the new data collection and new calculation of the LRAIC model results, which should be finalised by August 2021.

Context of the project to updated the LRAIC model

→ In 2013, a new **LRAIC model and methodology** was developed for the regulation of electricity transmission and distribution tariffs

→ The LRAIC model and methodology is in place since then and **needs to be updated**

→ The update of the model **should reflect the changes** in the transmission and distribution networks, changes in connections (consumers, producers) and changes of financial inputs

→ The necessary changes will result into an update of the LRAIC model and methodology and a **new data collection** will be conducted

→ New model results **will be calculated**

The main participants in the process of the development of the updated LRAIC model are VERT itself, as the national regulatory authority responsible for the regulation of the electricity market, and Litgrid (TSO) and ESO (DSO), as the 2 main regulated entities subject to the electricity transmission and distribution services price regulation.

The sole Lithuanian TSO – Litgrid – aims to ensure the stability and reliability of the electric power system in Lithuania. Within its areas of competence, Litgrid aims to create a non-discriminatory environment for the use of the transmission networks, management, utilization and disposal of electricity transmission system assets and its appurtenances. In 2020, servicing domestic demand only, Litgrid transmitted 10.1 TWh of energy, a slight decline from 2019 where transmission levels reached 10.3 TWh.

Lithuanian DSO – ESO – guarantees the supply of electricity, ensures network connection, security and reliability of energy distribution (ESO also undertakes natural gas distribution, however the latter is outside the scope of LRAIC model). According to the long-term strategy of ESO, it seeks to create value for customers 'by providing reliable, advanced and standardized infrastructure services', coupled with exceptional customer experience. Throughout the period of 2019-2020, ESO has successfully expanded its customer base by adding 2.2% of new customers to the electricity distribution network, whilst also distributing 9.55 TWh of electricity in 2020.

The Methodological guidelines take into account the following input documents, regulations and other inputs:

- Original LRAIC model, LRAIC Methodological guidelines, LRAIC data collection questionnaire and guidelines and related price cap calculation methodology
- The principles and provisions of the Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity
- Existing relevant regulations, mainly the Electricity transmission and distribution services price cap regulation – *VALSTYBINĖ KAINŲ IR ENERGETIKOS KONTROLĖS KOMISIJA NUTARIMAS DĖL ELEKTROS ENERGIJOS PERDAVIMO, SKIRSTYMO IR VISUOMENINIO TIEKIMO PASLAUGŲ BEI VISUOMENINĖS KAINOS VIRŠUTINĖS RIBOS NUSTATYMO METODIKOS PATVIRTINIMO 2015 m. sausio 15 d. Nr. O3-3*
- Comments, suggestions and requests communicated by VERT, Litgrid and ESO during the initial meetings and subsequent consultations
- Experience of PricewaterhouseCoopers with the development of the long-run average incremental cost models

3.2. Overall approach to LRAIC modelling

The Long-run average incremental costing (LRAIC) is a well-known method for determination of regulated prices in different industries. The method is widely used mostly in the telecommunications industry (in both fixed and mobile networks) for setting the interconnection prices – fixed and mobile termination rates (i.e. the prices that the telecommunication operators can charge each other for the termination of the phone calls in their networks).

The LRAIC method can be applied in other sectors as well, mainly in regulated sectors that large proportion of joint and common costs and long investment cycles and where a promotion of incentives for the efficient investments and utilisation of assets is needed. Electricity transmission and distribution, similarly to many other infrastructure sectors, is considered to be a natural monopoly and needs to be regulated. The sector has a high proportion of fixed costs, while marginal cost to deliver incremental unit of output is small.

Competition in the natural monopoly sector is limited due to the high barriers to enter the market in the form of high investment costs. In addition, the competition in the sector with high proportion of the fixed infrastructure costs may not lead to the improved outcome and lower prices for the end customer, as the companies would have to recover the increased investment costs of parallel infrastructure from the same total number of customers. Such competition can even lead to the decrease of the investment costs in the long-run, if the companies will not be able to recover their investments, which would not be to the benefit of the customers.

On the other hand, with the lack of competition, the companies in the natural monopoly markets tend to inflate prices and overcharge the customers, while also making inefficient investment decisions. Therefore, natural monopolies are usually regulated to balance the benefits and needs of the companies and their customers. Traditional price regulation models, however, can fail in determining the right price levels and allowed revenues of the natural monopolies.

The models based on the cost-plus principle, allowing the companies to recover their operational expenses (OPEX) and earn reasonable profit on their assets, can lead to OPEX inefficiencies and ineffective investments to inflate the asset base and increase the regulated profits from invested capital. Other models, such as benchmarking, can fail in taking into account local market specific, and if the resulting regulated prices are too low, they would deter the investments, impacting the quality of service and leading to the deterioration of the infrastructure in the long term. Therefore, it is crucial to find the right balance between the marginal costs and marginal income in the natural monopoly market situation, both to promote efficient investments and spending, as well as to protect the interests of the customers.

The economic theory expects that the optimal prices can be achieved when the marginal income equals the marginal costs of the provision of the service. The marginal costs in this context are defined as the increase of costs related to the increase of one incremental unit of output of the service. The electricity transmission and distribution sector is characterized by the large proportion of the joint and common costs (i.e. costs not directly attributable to the additional unit of a specific service output) and by long investment cycles (useful lives of main network elements is usually several to many decades). The long-run average incremental cost concept assumes that both variable and fixed costs are considered variable in the long-term.

According to LRAIC concept, the costs incurred as a result of the provision of the additional unit of output should be established on the basis of the forward-looking, long-run average incremental costs taking into account the investments in new infrastructure and network elements (taking into account the deployment of the most efficient technology available), appropriate proportion of the existing infrastructure and network elements and considering the losses in the network, as far as the infrastructure is used to provide the output of the defined service.

LRAIC principles are defined as follows:

1. **Long-run** – implies that all inputs are considered variable and should cover the period spanning all relevant investment decisions. From the perspective of the LRAIC modelling in the electricity transmission and distribution sector, this means that also the fixed costs are considered variable in the long-run and should change with the changing level of demand.
2. **Average** – average cost of incremental output over the total period, i.e. all the costs of services provided within an increment.
3. **Incremental** – represents the addition of the output. It can be defined as the additional unit of output of the existing service or addition of a new service into the existing services portfolio. From the perspective of the LRAIC modelling in the electricity transmission and distribution sector, the model estimates the total allowed revenues. That means that the increment is considered to be the comparison of the situation with zero output (i.e. as if no customers are served and no network exists), with the situation of planned output (i.e. all customers are covered with an appropriate network).

The rationale behind the use of the LRAIC modelling concept is that:

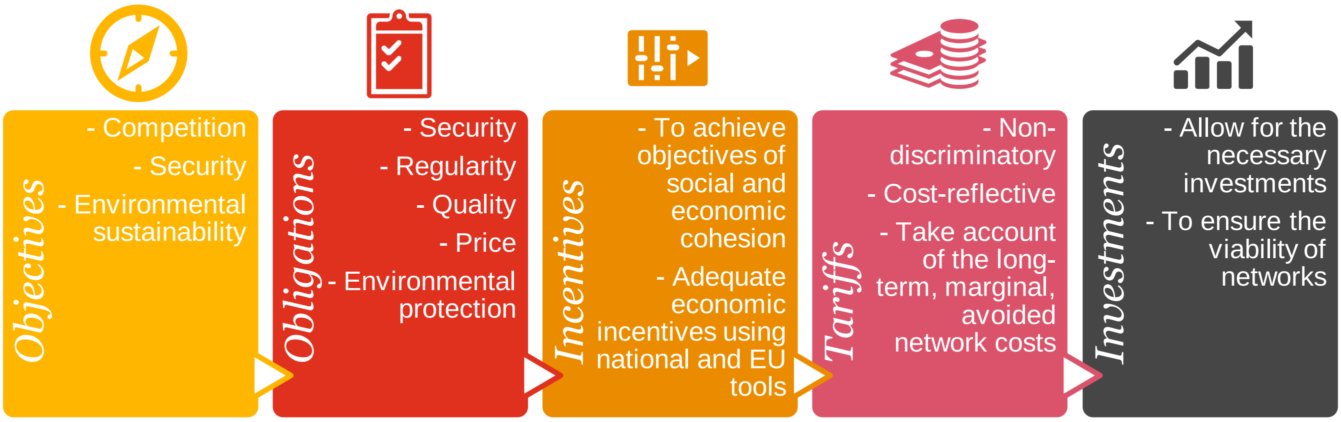
- It can provide incentives for efficient investment and utilization of existing infrastructure
- When bottom-up modelling is used, the costs of obsolete investments, sunk costs and historical inefficiencies can be avoided
- It is a cost reflective approach based on the current costs of the modern equivalent asset for the optimization of the transmission and distribution network
- It is a predictable approach based on the transparent technology optimization, costing and demand forecast

The European Union’s (EU) energy market framework **also describes** principles that should be followed in the regulation of the electricity markets, also in particular in relation to the competition, obligations imposed onto the market participants, incentives, tariff setting and promotion of viable investments into the networks.

Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity[1] establishes common rules for the generation, transmission, distribution, energy storage and supply of electricity, together with consumer protection provisions, with a view to creating an integrated competitive, consumer-centred, flexible, fair and transparent electricity markets in the EU. It lays down the rules relating to the organization and functioning of the electricity sector, open access to the market, third-party access to transmission and distribution infrastructure, unbundling requirements, rules on the independence of regulatory authorities and empowerment and protection of consumers.

[1] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (Text with EEA relevance.), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0944

The **key aspects and logic** from the Directive in relation to the objectives, obligations, incentives, tariffs and investments in electricity markets can be summarised as follows:



The Directive provides that the Member states of the EU should:

- ensure that the electricity undertakings operate with a view to achieving a competitive, secure and environmentally sustainable market for electricity,
- may impose on undertakings operating in the electricity sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and environmental protection, including energy efficiency, energy from renewable sources and climate protection,
- such obligations shall be clearly defined, transparent, non-discriminatory, verifiable and shall guarantee equality of access for electricity undertakings to national consumers in the EU,
- shall implement measures to achieve the objectives of social and economic cohesion, including the provision of adequate economic incentives, using, where appropriate, any existing national and EU tools
- regulatory authorities should fix or approve tariffs, or the methodologies underlying the calculation of the tariffs, on the basis of a proposal by the TSO or DSO, or on the basis of a proposal agreed between TSO/DSO and the users of the network,
- regulatory authorities should ensure that transmission and distribution tariffs are non-discriminatory and cost-reflective, and should take account of the long-term, marginal, avoided network costs from distributed generation and demand-side management measures,
- the tariffs or methodologies implemented by the regulatory authorities shall allow the necessary investments in the networks to be carried out in a manner allowing those investments to ensure the viability of the networks.

Based on the above, also the EU promotes such price regulation of the electricity markets, that is non-discriminatory, cost-reflective, provides incentives for efficient investments and supports the achievement of the overall energy market objectives, such as competition, security and environmental sustainability.

LRAIC modelling approach is in line with these principles as it helps to estimate average costs of the TSO and DSO based on the efficient network required to serve certain future demand for electricity. It estimates the future efficient network based on future demand and models the network using the most appropriate modelled technologies.

The **summary of the key features** of the proposed LRAIC model is as follows:

What is the LRAIC bottom-up model

→ The technical-economical LRAIC model is a **cost model** that helps to estimate average costs of the TSO and DSO **based on the efficient network** required to serve certain future demand for electricity.

→ The model is **bottom-up**: it starts from the demand and **based on the demand** it models the assets and costs

→ The model is **forward-looking**: not based on the actual (historical costs), but modelling the network based on the **expected future demand**

→ It does not model the network from the scratch, it **accepts the current network topology**, but optimises the network elements (types of lines, types of transformers)

Key features of the LRAIC model

→ It estimates the **future efficient network** based on future demand

→ It models the network based on the demand using the **most appropriate modelled technologies**

→ It is a bottom up model **–** it does not represent the costs of existing network, but rather the costs of **theoretical efficient network**

→ It uses **actual data** of the operator, but the resulting network and costs **may not represent** the actual network and costs of the operator

→ It involves complex **technical and economical modelling**

The following sub-sections introduce the **main principles to be used in the LRIAC modelling**, including the following:

- **Time horizon of the modelling** – defining, which period does the LRAIC model cover
- **Definition of the market** – defining the market that should be regulated using the LRAIC model
- **Definition of TSO and DSO services** – defining the specific services to be regulated by LRAIC model
- **Definition of the theoretically efficient operator** – defining, what is the theoretically efficient operator from the perspective of the LRAIC model
- **Main technologies to be considered in the model** – defining the extent of technologies and assets in the scope of the LRAIC model

- **Approach to network optimization** – defining, how the LRAIC model optimizes the main network elements
- **Geographical assumptions** – defining, how the LRAIC model uses “geotypes” to model certain costs
- **Annualization of capital expenses** – defining, how the LRAIC model calculates depreciation
- **Valuation methods** – defining, how the LRAIC model uses historical and current cost approaches in the economic part of the model calculations

3.3. Time horizon for the modelling

From the perspective of the time horizon that is used in the LRAIC and similar models, 2 types of models can be distinguished:

1. Models that model the **individual years separately**
2. Models that model the **target year in the future**

Theoretically, the models that calculates the LRAIC for individual years better reflects the reality of the market but require more input data that can be complex and time consuming to prepare. If these data are not available then there needs to be more estimates and assumptions to be made which can leads to the distortion of the objectivity of the models. Such models may need to be recalculated on an annual basis, which requires an annual update of the data collection for the model.

On the other hand, the models that calculate the LRAIC result for the target year simulate expected state in certain future point of time. This type of model requires less input data but cannot incorporate any dramatic changes on the market if such changes occur on a year-on-year basis. In this approach, a target year model result is calculated (for example allowed revenues in 5 years from now) and the individual years between now and 5 years from now are estimated as a linear path[2] between the latest approved allowed revenues and target year allowed revenues, so that the TSO and DSO gradually approaches the future level of allowed revenues.

The LRAIC model in Lithuania uses the target year modelling approach. The final time horizon for the modelling is decided by VERT. The LRAIC model functionality allows the calculation for two different time horizons – 5 and 10 years (i.e. since the re-calculation of the model is performed in 2021, the 5-year modelling horizon models the target year of 2026 and 10-year modelling horizon models the target year of 2031.

From the perspective of the data collection, in general the data to be provided for the modelling by TSO and DSO should be the data as of 31.12.2020, unless stated otherwise in the data collection manual (for example, historical peak load data should be provided for the day of the peak, forecast data should be provided for future period, etc.)

[2] Alternatively, progressive or degressive path can be used

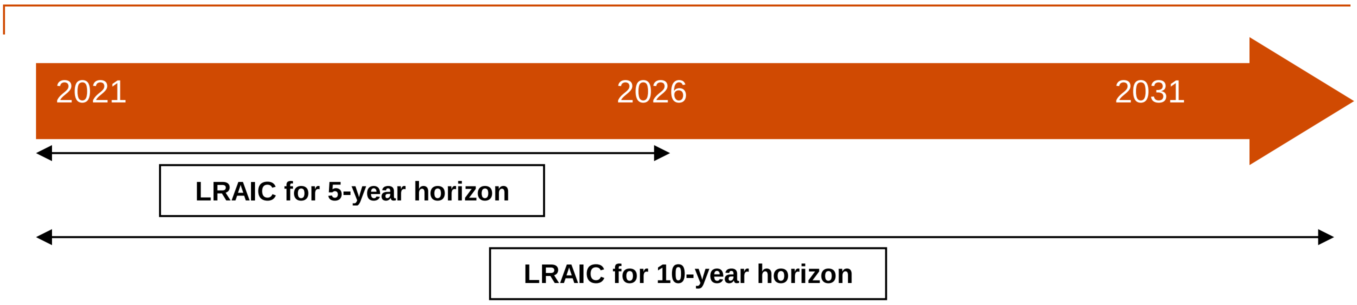


Figure 1 - Schematic illustration of the time horizon for the TSO and DSO LRAIC models

The time horizons suggested for the LRAIC model are based on the lengths of the two commonly used periods in the regulation and planning of the electricity networks – 5 years is an often used length of the regulatory period (also used in Lithuania) and 10 years is the planning horizon of the network development plans.

Longer time horizons can be used and can be easily incorporated into the LRAIC model as a new model functionality, however, the main limitation of longer modelling horizons is the availability and reliability of the forecasts that are required for the model (such as peak load forecast).

3.4. Definition of the market

The definition of the market sets the boundaries to the extent of the market participants and services provided on the market that will be considered in the LRAIC modelling. Based on the correct definition of the market certain other principles of the modelling are determined, such as the relative market share of the theoretical effective operator[3] or the number of the markets at which the theoretical effective operator provides its services.

Based on the analysis of the Lithuanian electricity market the current definition of the relevant TSO and DSO markets for the LRAIC model is as follows:

- Currently there is one TSO market with one transmission system operator and one DSO market with one major distribution system operator in Lithuania (although several small DSOs also operate on the market).
- The TSO is represented by the state-owned company Litgrid and DSO is represented by the majority state-owned company ESO.
- The market for the TSO LRAIC model will therefore be defined as the market at which the transmission system operator operates in the entire geographical area of Lithuania and represents the 100% market share on this relevant market. The market is defined as the market for provisioning of the services of the electricity transmission over the high voltage lines (including connections to the high voltage network of the generators and consumers).
- The market for the DSO LRAIC model will therefore be defined as the market at which the distribution system operator operates in the entire geographical area of Lithuania and represents the 100% market share on this relevant market. The market is defined as the market for provisioning of the services of the electricity distribution over the medium and low voltage lines (including connections to the medium and low voltage network of the generators and consumers).

[3] In some LRAIC models, the theoretical efficient operator is determined using an assumption of certain market share (for example when there are more competitors on the market) or assuming that the theoretical efficient operator operates only in some geographical area.

For the definition of the relevant market for the modelling, the LRAIC model assumes the existence of 1 TSO on the electricity transmission market with 100% share and country-wide coverage and 1 DSO on the electricity distribution market with 100% share and country-wide coverage (thus not taking into account the other small DSOs).

3.5. Definition of services provided by TSO and DSO

There are different services of the TSO and DSO that might be regulated by VERT, but not all of these services are subject to the regulation using the LRAIC model. Some services and their related costs are not modelled in the LRAIC model and are not included in the resulting allowed revenues calculated by the LRAIC models. Some other services may be naturally included in the allowed revenues calculated by the LRAIC model if they are provided using the same network as modelled in the LRAIC model. An adjustment is made in the price cap calculation to adjust for such services that are not in the scope of the LRAIC modelling.

The services for which the LRAIC for TSO and DSO will be modelled were determined by VERT. This list of services that are in the scope of the LRAIC modelling is as followed:

TSO services:

Licensed activities	Name of the service	Service description
Transmission	High voltage transmission service	Electricity transmission through the 330/400-110 kV voltage networks.

DSO services:

Licensed activities	Name of the service	Service description
Distribution	Medium voltage distribution service	Distribution of electricity through medium voltage distribution networks.
Distribution	Consumers' connection service to medium voltage distribution network	Connection of consumers to a medium voltage distribution network and maintaining that connection.
Distribution	Manufacturers' connection to the medium voltage distribution network service	Connection of manufacturers to the medium voltage distribution network and maintaining that connection .
Distribution	Distribution service in low voltage distribution networks	Distribution of electricity through low voltage distribution networks.
Distribution	Consumers' connection service to low voltage distribution network	Connection of consumers to a low voltage distribution network and maintaining that connection.
Distribution	Manufacturers' connection to the	Connection of manufacturers to the low voltage distribution network and maintaining that connection.

low voltage
distribution network

3.6. Definition of the theoretically effective operator

The methodology of the LRAIC calculation is based on the modelling of the theoretically effective operator (TEO) that simulates the behaviour of such effective operator on a fully competitive market. The theoretically effective operator is the operator that uses the most effective technologies and network elements and satisfies the demand for services in the most cost efficient way.

On the markets where there are 2 or more competitors, there may be 3 possible ways of selecting the theoretically effective operator from the perspective of prices and coverage:

1. The theoretically effective operator is based on the market participant **with the lowest prices of the inputs** within the defined regulated market – i.e. the market operator with the lowest costs to deliver services within a defined comparable geographical coverage would be considered to be the most efficient and its inputs will be taken into account for further LRAIC modelling and optimisation.
2. The theoretically effective operator is based on the **average prices of the inputs** of all market participants within the defined regulated market – i.e. the theoretically effective market participant would be selected as a combination of the existing market participants and the data inputs would be collected from all of them, combined, and used in the further LRAIC modelling and optimisation.
3. The theoretically effective operator is **set manually** – specific operator is manually selected to be the model operator and the LRAIC model would use its data inputs in further LRAIC modelling and optimisation.

Since there is just one operator on the TSO defined market and one operator on the DSO defined market in Lithuania, there is no need to select the model operator or combine the data (such as network topology or prices) of more operators on the market to define the most effective operator on the market that will be subject to further LRIAC modelling.

The existing TSO and DSO will be considered as the most effective operators on their relevant markets from the point of view of the initial non-optimised modelling. This means that the input data from the existing TSO and DSO will be collected and will serve as a basis for further LRAIC modelling. The initial non-optimised theoretically effective operators of the TSO and DSO networks will be subsequently optimised using the principles of the technical-technological and economic LRAIC modelling.

3.7. Main technologies considered in the LRAIC model

The full functionality of the LRAIC model is able to model the entire network and assets of TSO and DSO required for the provisioning of the defined electricity transmission and distribution services. This includes main network elements (power lines and transformers), other core network elements (electrometers, switchgears, protections, reclosers, batteries, communication equipment), other support network elements (IT systems and monitoring) and all other assets (such as buildings, vehicles and other).

The LRAIC model performs the optimisation of the main network elements (power lines and transformers) based on the technical and demand inputs. The other core network elements can be dimensioned using “per unit” or “per km” benchmarks (i.e. how many of a specific other core network elements are needed per 1 unit of transformer or per 1 km of power line), or the data can be provided directly by TSO and DSO. Data on the other support network elements and other assets are collected from the TSO and DSO, but are not optimised.

The main network technologies that are modelled and optimised by the LRAIC model in the TSO and DSO network at the respective voltage levels are as follows:

Network level	Modelled technologies	Description
Low voltage network (DSO)	LV feeders and MV/LV transformers	• LV feeder is a power line connecting consumers, producers and transformers at 0.4 kV voltage level. • An MV/LV transformer is a device that transforms the voltage between 10 kV and 0.4 kV voltage levels.
Medium voltage network (DSO)	MV feeders and MV/MV and HV/MV transformers	• MV feeder is a power line connecting consumers, producers and transformers at 10 kV or 35 kV voltage level. • An MV/MV transformer is a device that transforms the voltage between 35 kV and 10 kV voltage levels. • An HV/MV transformer is a device that transforms the voltage between 110 kV and 35 kV voltage levels (i.e. between TSO and DSO network).
High voltage network (TSO)	HV lines and EHV/HV transformers	• HV line is a power line connecting consumers, producers and transformers at 110 kV voltage level. • An EHV/HV transformer is a device that transforms the voltage between 330/400 kV and 110 kV voltage levels.
Extra high voltage network (TSO)	EHV lines	• EHV line is a power line connecting producers and transformers at 330/400 kV voltage level.

At each of the voltage levels, a set of standardised network technologies will be used for the optimisation of the network. The list of the technologies will consist of actually used technologies available at the market and used by TSO and DSO.

Based on the initial discussions with VERT and the operators it is suggested that the LRAIC model optimises the main network elements, while the data inputs for other core network elements, other support network elements and other assets will be provided in a simplified detail and will be used in the LRAIC model as a "pass-through" costs (i.e. will not be optimised/modelled by the LRAIC model).

3.8. Approach to network optimisation

When optimising the network to estimate the costs of the theoretically effective operator, the LRAIC models estimates the quantity and types of the network elements that are required for the network to be able to satisfy the projected demand for services. The optimisation can be done as if no network exists, or it can take into account the existing network and optimise it where necessary.

These are the **2 commonly known approaches** to model the network of the theoretical effective operator that are widely used in LRAIC and similar models and they differ in the extent of the theoretical effectiveness modelling:

- **Scorched earth approach** – in this approach the theoretical effective network does not take into account the existing network topology and locations of the network elements and models the network as if it would be built as theoretical effective network from the outset. Sometimes it is referred to as the “Greenfield” approach. In this approach, the model will not just suggest optimal types of network elements, but also where they should be located (for transformers) and how they should be routed (for power lines).
- **Scorched node approach** – in this approach the theoretical effective network does take into account the existing network topology and locations of the network elements and only the individual network elements in the location are optimised in theoretically effective way. It means, that the data inputs on the network elements and network topology are collected from the operators (TSO and DSO) and the model itself does not estimate the optimal locations and routing of transformers and power lines, only optimises the types/capacities of the transformers and power lines.

The benefit of the scorched earth approach is that it allows to model the theoretically effective operator and to avoid existing inefficiencies of the current operators. The theoretically effective operator is modelled as if no network exists and the network is designed with the optimal geographical distribution of network elements, such as lines and transformers, using only the currently available and the most efficient technologies from the technical parameters and acquisition cost perspective.

However the scorched earth approach has **several key limitations**:

- It can be economically unrealistic, since the network nodes and elements are never located in theoretically ideal positions, and as such the scorched earth approach can lead into a smaller network than what would be needed in the real-life situation
- The practical modelling of the scorched earth network is difficult, since the modelling of the new theoretical network from the outset is a complex process that includes large amount of factors and parameters, of which not all can be measured and quantified
- It can optimize the network only in the current point of time, since the underlying assumptions for the modelling of the theoretically effective operator based on the scorched earth approach can change in time
- It may not be able to take into account geographical limitations (such as routing through difficult terrain) or regulatory limitations (such as environmental regulations, urban and spatial planning regulations, etc.)

The **scorched node approach** is used more often, as it:

- Accepts that it is very difficult to reflect the impact of the complex underlying assumptions in a purely predictive theoretical model
- Accepts the fact that it is commercially and economically not viable to change the network topology to a theoretically effective one in a short to medium term
- It relies on the statistics related to the existing network design and topology provided by the market operators and therefore is more reflective to the current real life situation

Based on the abovementioned limitations and advantages of both approaches it is **suggested to use the scorched node approach** for both the TSO and DSO network modelling as it will better reflect the current situation in the Lithuanian market. Based on the initial discussions with TSO and DSO both transmission and distribution networks were build according to certain historical development that should be reflected in the model to that extent that the existing locations of the network elements (such as transformers and lines) should be taken into account and that if the theoretically effective network would be build based on the scorched earth approach, the resulting model would not reflect the real situation of the Lithuanian TSO and DSO. On the other hand the scorched node approach is capable to reflect these historical specifics and therefore it will be used for the network topology optimization.

3.9. Extent of network optimisation

The LRAIC model has a functionality to use different scenarios for optimisation of network elements, from the perspective of which network elements are optimised. It can either optimise all network elements in the network, or only certain selection of the network elements, based on a selected criteria.

There are 3 optimisation scenarios in the LRAIC model:

1. **Optimise all technologies** – if this scenario is selected, the model optimises the technology at each network node using one of the preferred modelled technologies. No legacy technologies will be left in the network. This scenario is the closest to the "greenfield" approach, where the theoretical effective operator would construct a new network, accepting the locations of the existing network elements.

2. **Optimise only terminating technologies** – if this scenario is selected, the model only optimises the network nodes and which the network technologies are at the end of the useful life. This scenario can be selected in the case when the regulator wants to allow the operator to keep the existing technologies in operation if they are not yet fully depreciated.

3. **Upwards optimisation only** – if this scenario is selected, the model only performs the upwards optimisation (reinforcement), i.e. only replaces the existing technology at the network node in the case when the capacity of the existing technology is insufficient and needs to be improved to meet the future calculated peak load.

Additional considerations are suggested to be taken into account for the extent of the optimisation of the network elements in order to better reflect the **real life situation** in the network. The LRAIC model should allow the operators to **highlight specifically**, which network elements are intended for the reconstruction or optimisation based on their investment plans and also highlight, which network elements were invested in and optimised in the previous LRAIC implementation period, so that they do not enter the optimisation modelling repeatedly in the LRAIC model update.

From the perspective of the extent of the network optimisation, the new functionality will be added to the LRAIC model, allowing the operators to highlight, which network elements are intended for optimisation according to their investments plans (so as to ensure that the extent of the optimisation does not exceed the investment capacities of the operators). Also, the LRAIC model will take into account any optimisation investments that were conducted in the previous LRAIC period, so that those network elements, where optimisation investment was done, are not re-optimised again.

Based on the discussion with VERT and DSO, in case of DSO, the network development plan may not be available at such a granular level as to be able to highlight specific network elements planned for investments. Therefore, cumulative network development plan values can be provided (i.e. kms of feeders, number of transformers) and the new model optimisation scenario will take it into account such cumulative network development plan.

Also, due to the simplified modelling of the feeders in LV and MV network, it might be the case that not the entire feeder was reconstructed in the previous LRAIC period, so it may not be possible to highlight specific feeders that were reconstructed in case when only partial reconstruction happened. The updated model will therefore allow to highlight the % of the feeder that was reconstructed in the previous LRAIC period, so that only the remaining part will be eligible for optimisation in the updated model.

3.10. Geographical assumptions

Every financial model is reflecting certain degree of the simplification of the reality, because it is not possible to model every individual consumer and producer and their consumption and production characteristics. Therefore for the purposes of the modelling, the market participants, types of network elements and geographical areas can be grouped into so called “**geotypes**”.

When defining the geotpyes, certain factors need to be taken into account:

- Geographical distribution of consumers (inhabitants, companies)
- Specific technical-technological characteristics of the network, for example prevailing type of line by geotype, density of transformers, average length of lines between network elements, etc.
- Other factors that have an impact on the construction of the TSO and DSO networks, such as the costs of construction by geotype, specifics of the network topology in certain geotype, etc.

Based on the analysis of the data availability from the TSO and DSO in Lithuania and for the purpose of the simplification, the **following geotypes** for the LRAIC modelling of the TSO and DSO networks **are assumed**:

- **Geotype “Rural”** – the areas between the populated areas (towns/villages) and the towns/villages with population below 3 000 inhabitants with households as prevailing type of consumer
- **Geotype “Urban”** – the towns/villages with population between 3 001 and 100 000 inhabitants with mixed type of consumers, both households and business
- **Geotype “Metro”** – the towns/villages with population above 100 001 inhabitants with mixed type of consumers, both households and business

According to the latest available information from the Statistics Lithuania for the year 2020[4], the number of inhabitants by geotype is in Lithuania was as follows:

- Geotype “Rural” – 1,0 mil. inhabitants
- Geotype “Urban” – 0,7 mil. inhabitants
- Geotype “Metro” – 1,1 mil. inhabitants

The different types of geotypes are defined for the purpose of reflecting the difference in for example the costs of the building of the network in different geotypes, the difference in the development of the future forecast demand for different geotypes, or standardized technology to be used within a specific geotype in case where the degree of simplification is required in the modelling of certain parts of the network (mostly at the LV level).

The proposed granularity of geotypes is selected on the basis of the detail required for the sufficient granularity of the modelling and it is based on the simplification of the modelling of the LV network. For details on the simplification of the modelling of the LV network, see section 4.3 Design of the Low voltage network. The MV, HV and EHV network will be modelled in higher granularity (in terms of the transformers, feeders, lines, consumption and generation), where detailed data by individual network elements will be collected and therefore will not be modelled using the simplified approach based on the standardized geotypes. The geotypes at these voltage levels will mostly be used to differentiate the construction costs of the network in different geotypes, while consumption and generation connected at these levels will be put into the model directly item-by-item.

The proposed granularity of geotypes was also discussed with the TSO and DSO during the initial discussions to the methodology and was confirmed as sufficient. The more granular definition of geotypes is not necessary as based on the simplifications considered for the network modelling the impact of more granular definition of geotypes would have insignificant impact on the precision of the calculations.

[4] https://osp.stat.gov.lt/gyventojai1

3.11. Annualization of capital expenses

The objective of the LRAIC modelling is to calculate the incremental costs of provisioning of the defined services for individual year. These incremental costs consist of the annual operational expenses (OPEX) and annualised capital expenses (CAPEX), which should include annual depreciation as well as the return on invested capital (i.e. the allowed profit).

Therefore, the CAPEX related to the construction of the network needs to be annualized. The most common approach is to use the straight-line depreciation or one of the economical depreciation method (standard or tilted annuity, with or without incorporating the time period needed to put the assets into operation. The LRAIC model has the functionality to model different types of annualization. The final decision on the use of a specific annualization method will be done by VERT.

The following sections describe the commonly used methods of annualization of CAPEX that are also used in the LRAIC model.

Straight-line depreciation

The straight-line depreciation is the most simplistic method that calculates the proportion of the annual depreciation charge from the capital expenses to purchase an asset, reduced by the residual value of the asset at the end its useful life (if any) and subsequently divided by the useful life of the asset. The calculation results into constant annual depreciation charge. This calculation however does not take into account the cost of capital.

$$C = \frac{I_{t=0} - RV}{n}$$

Where:

- C – annual depreciation charge
- $I_{t=0}$ – the purchase costs/capital expense to purchase the asset at the beginning of the useful life
- RV – residual value of the asset at the end of its useful life
- n – useful life of the asset in years (regulatory useful life for each type of asset)

For the purpose of the LRAIC model, the standard formula for straight-line depreciation is adjusted to account also for the cost of capital. In the LRAIC model, it is also expected that the residual value of the asset at the end of its useful life is zero (i.e. the asset is in use until it is fully depreciated). Then, the capital charge is calculated as the multiple of the average value of the invested capital and weighted average cost f capital (WACC). The average value of the invested capital is the average of the initial invested CAPEX and the residual value of the asset. When the residual value of the asset is expected to be 0, then the average value of the invested capital equals the initial invested CAPEX divided by 2. The capital charge calculated from this average value of the invested capital represents the average annual capital charge over the useful life of the asset.

The resulting adjusted formula combining the straight-line depreciation charge and capital charge is as follows:

$$C = \frac{I_{t=0}}{n} + \frac{I_{t=0}}{2} * WACC$$

Where:

- C – annual capital payment
- $I_{t=0}$ – the purchase costs/capital expense to purchase the asset at the beginning of the useful life
- n – useful life of the asset in years (regulatory useful life for each type of asset)
- WACC – Weighted average cost of capital

Economical depreciation

Depreciation of the asset from the economical point of view should reflect the change of the value of the asset during the useful life of the asset. The value of an asset is affected by several factors, such as:

- The level of operational expenses and changes in the level of operational expenses during the useful life of an asset
- The value of outputs and changes in the value of outputs during the useful life of an asset
- Productivity of an asset (in terms of the volume of the output that can be produced by an asset) and changes in the level of productivity during the useful life of an asset
- Existence or expectations of the entry of a competitive asset to the market (for example new or alternative technology)

In practical life this approach is very complicated and it is almost impossible to precisely quantify impact of every factor individually and model their cash flow impacts. Therefore simplified approaches to estimate the economic depreciation such as standard annuity or tilted annuity have been developed.

Standard annuity

Standard annuity is used for the calculation of the constant depreciation payment over the useful life of an asset. In the context of the annualization of the capital expenses it is equivalent to the sum of economical depreciation and cost of capital.

The standard annuity is calculated using this formula:

$$C = \frac{I_{t=0} * WACC}{1 - (1 + WACC)^{-n}}$$

Where:

- C – annual capital payment
- $I_{t=0}$ – initial value of an asset
- WACC – weighted average cost of capital (or other measure of the cost of capital)
- n – useful life of an asset in years (regulatory useful life for each type of asset)

Standard annuity would calculate the exact annual capital expenses related to an asset in the situation where the price of an asset does not change during the entire useful life of an asset. However, it is obvious that this assumption does not correspond with the reality of the energy utilities sector that is characterized by very long investment cycle and long useful life of assets, and prices of assets cannot remain stable over such a long time periods. Therefore, tilted annuity approach introduces the adjustment of the CAPEX annualization calculation by the changes of the price of an asset.

Tilted annuity

Tilted annuity allows to incorporate the effect of changing prices of the assets into the calculation of the annual capital payment. The tilted annuity is calculated using the following formula:

$$Ct = I_{t=0} * \frac{(WACC - i)}{1 - \left(\frac{1 + i}{1 + WACC}\right)^{n}} * (1 + i)^{(t-1)}$$

Where:

- Ct – annual capital payment in period t
- $I_{t=0}$ – initial value of an asset

- i – annual change of the price of an asset
- WACC – weighted average cost of capital (or other measure of the cost of capital)
- n – useful life of an asset (regulatory useful life for each type of asset)
- t -1 – the preceding period

If it is assumed that the period for which the capital payment is calculated is irrelevant (under the condition that the period equals the period for which the price change is set), then the above formula can be simplified to calculate the annual capital payment for the year t=1 as follows:

$$C_{t=1} = I_{t=0} * \frac{(WACC - i)}{1 - \left(\frac{1+i}{1+WACC}\right)^n}$$

Where:

- $C_{t=1}$ – annuity capital payment
- $I_{t=0}$ – initial value of an asset
- i – annual change of the price of an asset
- WACC – weighted average cost of capital (or other measure of the cost of capital)
- n – useful life of an asset (regulatory useful life for each type of asset)

The above formula expects that the rate of price change *i* is in line with the economical useful life of an asset *n*. Both of these variables *i* and *n* are defined as exogenous, which implies that *i* is the average annual rate of price change during the useful life of an asset. This approach requires that both variables *i* and *n* are set up individually for each of the modelled assets.

The time to operation commencement

The previous formula assumed that the asset is purchased, constructed and put into operations in the same moment. While this is a simplistic view, it ignores the period of time to construct the asset and commence its operation. During this time, between the purchase and the operation commencement, the capital is already expensed, however no income is generated yet. Such simplified approach means that there is no construction in progress and it will lead into the underestimation of the costs of the network.

To avoid this situation the initial value of an asset can be adjusted in order to reflect the real point of time when the capital expense occurred and to reflect the cost of capital during the period between the capital expense and the operation commencement. This adjustment is calculated using the following formula:

$$I'_{t=0} = I_{t=0} * (1+i)^{-u} * (1+WACC)^u = I_{t=0} * \left(\frac{1+WACC}{1+i}\right)^u$$

Where:

- $I'_{t=0}$ – adjusted initial value of an asset
- $I_{t=0}$ – initial value of an asset
- u – average time between the capital expense and the operation commencement
- i – annual price change of the asset
- WACC – weighted average cost of capital (or other measure of the cost of capital)

Following that, the adjusted formulas for the standard and tilted annuity that incorporate the time to operation commencement are:

Standard annuity:

$$C = I_{t=0} * \left(\frac{1+WACC}{1+i}\right)^{u} * \frac{WACC}{1-(1+WACC)^{-n}}$$

Tilted annuity:

$$C_{t=1} = I_{t=0} * \left(\frac{1+WACC}{1+i}\right)^{u} * \frac{(WACC-i)}{1-\left(\frac{1+i}{1+WACC}\right)^{n}}$$

Conclusion

The straight-line depreciation is the most simplistic method, it is easy to understand and calculate and is widely used and recognized. The result of the calculation provides a constant annual depreciation charge (which can also include the capital charge). However, this method does not consider the price changes of the asset and does not reflect the time period between the initial moment of the outflow of resources to purchase the assets and the moment when the assets are put into operation.

The economic depreciation methods (standard and tilted annuity) are more precise as they reflect the acquisition price changes of the assets, the cost of capital and the time to operation commencement. However, they are more demanding as to the quantity and quality of the input data, as for each of the assets the reasonable price trend and the average time to operation commencement must be provided. These data can be based on the expert opinion where there is a risk of subjective and arbitrary estimates that can distort the calculation.

In the original version of the LRAIC model implemented in Lithuania, the straight-line depreciation method (including the capital charge) was used in the final LRAIC model calculations. The depreciation method to be used in the LRAIC modelling will be indicated in the relevant price cap regulation, nevertheless the LRAIC model will retain the functionality to model also the other CAPEX annualization scenarios described above.

3.12. Valuation methods to be used

The economic part of the LRAIC model translates the optimised technical modelling into economic terms, in other words, it assigns economic value (costs expressed as CAPEX, depreciation or other expenses) to the modelled assets. There are **2 most commonly used approaches** to asset valuations – historical cost accounting and current cost accounting.

- **Historical cost accounting (HCA)** – this approach uses historical accounting information from the statutory accounting that is the cost of the assets at which they were initially put into the operation without taking into account any subsequent re-valuations. It provides reliable and objective evidence of the costs of various assets in the network, but has some limitations in the environment of changing prices and new technology developments. As a result, the historical cost information does not reflect the significant price changes (increases or decreases) and the resulting theoretical effective operator's costs according to the LRAIC model may reflect different costs compared to the costs faced by the real entrant to the market. Moreover, the historical cost accounting focuses on the past and reflects all the past inefficiencies and does not take into account the modern and more efficient technologies.
- **Current cost accounting (CCA)** – this approach re-valuates the assets at their current replacement costs and the assets that are no longer available on the market due to the technological development are evaluated using the Modern Equivalent Asset (MEA) criterion. Current cost accounts are drawn up

by adjusting the historical cost for inflation and for asset-specific price changes caused by technological or market developments.

The valuation of assets can be based on:

- The information provided from the equipment vendors
- The internal or external benchmarks
- The data provided by the market participants during the input data collection phase

Most common approach is to collect the data on prices of the network elements from the market participants and to compare and/or adjust them using the benchmark data. The prices provided the market participants should reflect their real purchase prices of the assets and equipment or prices reflected in the contracts signed with the vendors, so that their estimation can be audited, if needed.

Each of the cost accounting approaches has its benefits and limitations as summarised below:

Approach	Benefits	Limitations
Historical cost accounting	• Reliable and objective data based on statutory accounting • Historical data readily available • Reflects the actual costs incurred by the operator	• Does not reflect the price changes and new technology developments • Incorporates historical inefficiencies
Current cost accounting	• Reflects the price changes of assets and inflation • Reflects the technological changes • Provides the cost of the operator as if the network would be built in present	• Difficult to revalue the historical prices • Modern equivalent assets may not match the parameters of the outdate technologies • The data on current prices are not readily available and there is a space for subjective and arbitrary estimates

Based on the benefits and limitations of both approaches, the LRAIC model for TSO and DSO has a functionality that allows to model both options of the valuation of assets – historical cost accounting and current cost accounting. However, those main network elements that are optimised by the LRAIC model, are modelled using the CCA approach (naturally), so the choice between the HCA and CCA applies only to those network elements that are not optimised by the LRAIC model.

Based on the requirements of VERT, for network elements that are optimised by LRAIC model, the CCA approach is applied, while for those network elements that are not optimised by the LRAIC model, the HCA approach is used.

4. LRAIC model structure and logic

4.1. High level structure of the LRAIC model

The LRAIC model is a complex technical-economical model designed in MS Excel, consisting of various worksheets and tables for data inputs, model calculations and presentation of results. The LRAIC model consists of 5 main parts:

1. **Demand forecast** – this is the peak load forecast, which represents one of the main inputs into the model, based on which the peak load of the network elements is adjusted for the purpose of the network optimisation.
2. **Existing network mapping** – main data inputs related to the current network elements, their technical parameters and mapping between the network elements.
3. **Optimised network modelling** – calculation of the optimisation of the network elements.
4. **Economic modelling** – calculation of the economic value of the optimised network
5. **Results calculation** – final calculation of the allowed revenues of the optimised network.

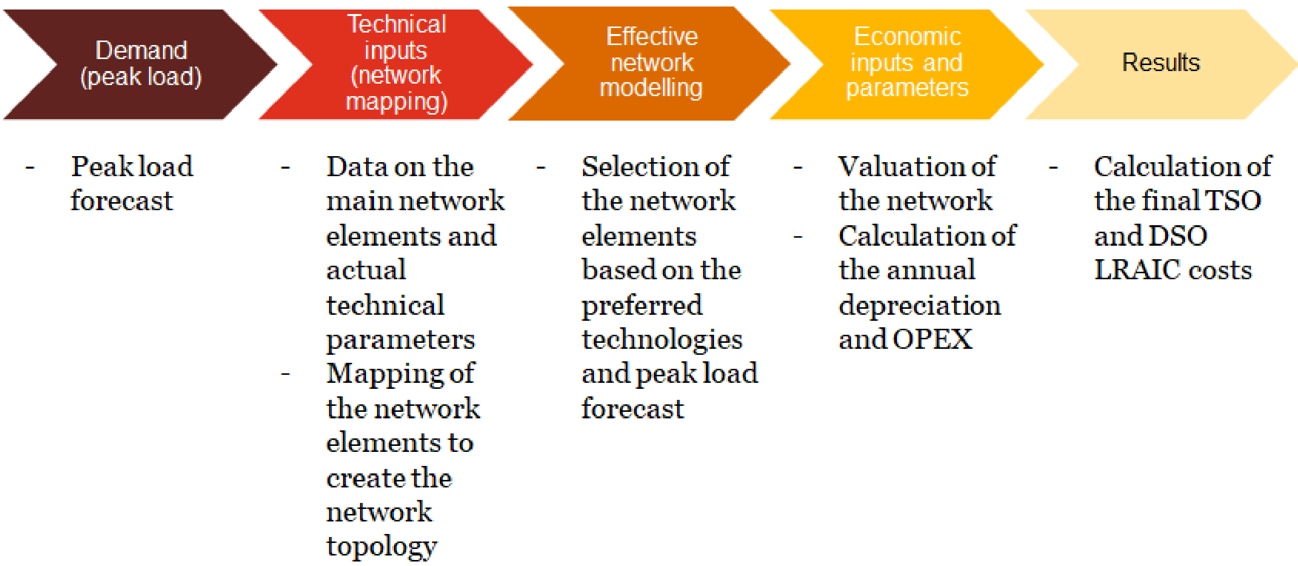


Figure 2 - Main logical parts of the LRAIC model

The LRAIC model consists of several types of worksheets:

- **Data input sheets – network element and network topology** – these are the worksheets for the input data collection where all the network elements at various voltage levels should be filled in with the required technical and non-technical information.
- **Data input sheets – main inputs (technological and economic)** – these are the worksheets for the input data collection where other technological and economic data are filled in. This includes the main inputs such as macro-economic variables (inflation, GDP growth rate, WACC), technology tables (tables with technologies and their technical parameters used for the optimization modelling) and valuation data (prices of the technologies, other OPEX and CAPEX).

- **Calculation sheets** – these are the worksheets used to perform the main model calculations. In this worksheet the model calculates the optimized network technologies based on the actual and planned peak load and the technologies and their parameters defined in the technology tables.
- **Result sheets** – these are the worksheets where the final LRAIC cost results are presented.
- **Main menu** – this is the worksheet where the basic modelling parameters are selected such as the modelling period, type of technology optimization, type of depreciation and type of valuation.

The high-level architecture of the LRAIC model is illustrated in the scheme below:

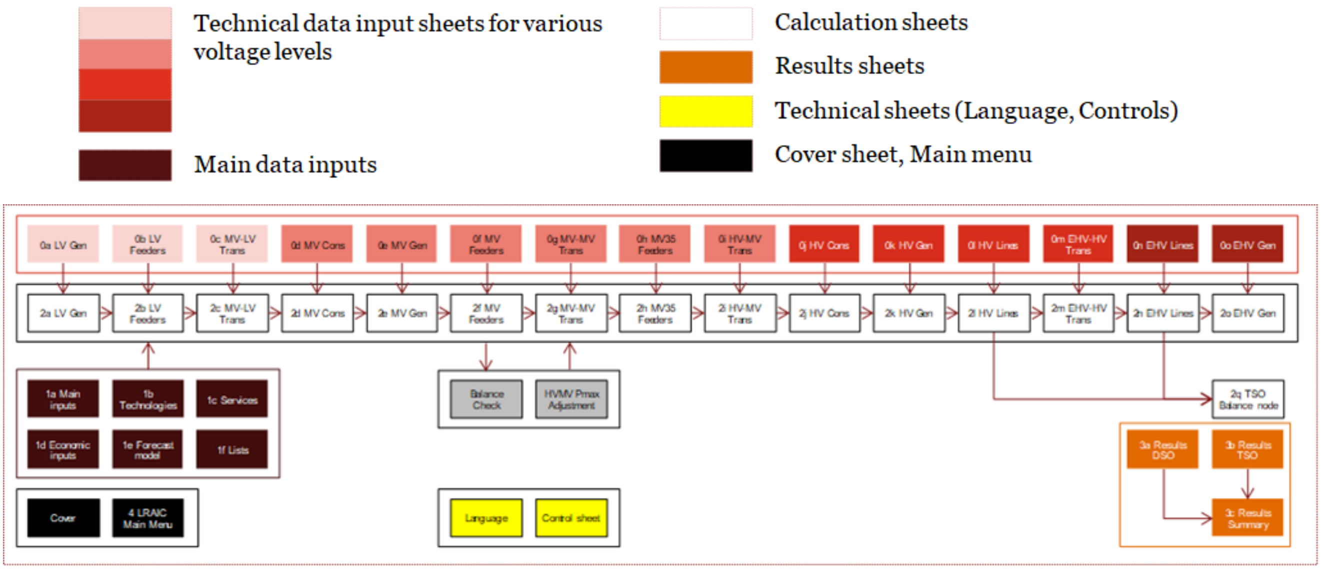


Figure 3 - High-level LRAIC model architecture

The high level logic of the LRAIC model calculations is as follows:

In the first step, the peak load demand is set at the individual voltage levels. The summary peak load demand is proportionally distributed over the elements of the low voltage network and based on the adjusted peak demand at the network elements, the existing network elements (using the scorched node modelling approach) are optimised based on the technologies optimisation table. The network elements are designed from the bottom up, i.e. from the low voltage level towards higher voltage levels, with final balancing at the extra-high voltage level.

The model will also take into account the own consumption and network losses and will adjust the peak load at network elements accordingly. In order to ensure the security of supply and to account for the N-1 criteria for selected network elements, the special % threshold of the maximum load at the network element will be defined (for example 50% of the maximum load according to the technical parameters of the network element). When this threshold will be exceeded, the model will automatically dimension the technology with higher technical parameters for that particular network element. The TSO and DSO will be able to define the network elements that need to comply with the N-1 criteria and the % threshold will be defined considering the opinions of TSO and DSO. This will apply at all voltage levels.

At the end of the dimensioning and optimization procedure the TSO and DSO network is optimized and the model provides the lists and quantities of the network elements at each individual voltage level. The price inputs are used to convert the technical-technological model into the economic terms, calculating the annualized CAPEX using one of the defined depreciation and valuation methods. The resulting annualized CAPEX is subsequently topped up with the OPEX mark-ups to calculate the final costs of the TSO and DSO network.

4.2. Main LRAIC model calculation logic and steps

The following section and scheme describes the main LRAIC model calculation steps and the links between individual worksheets of the model, to illustrate the overall LRAIC model logic:

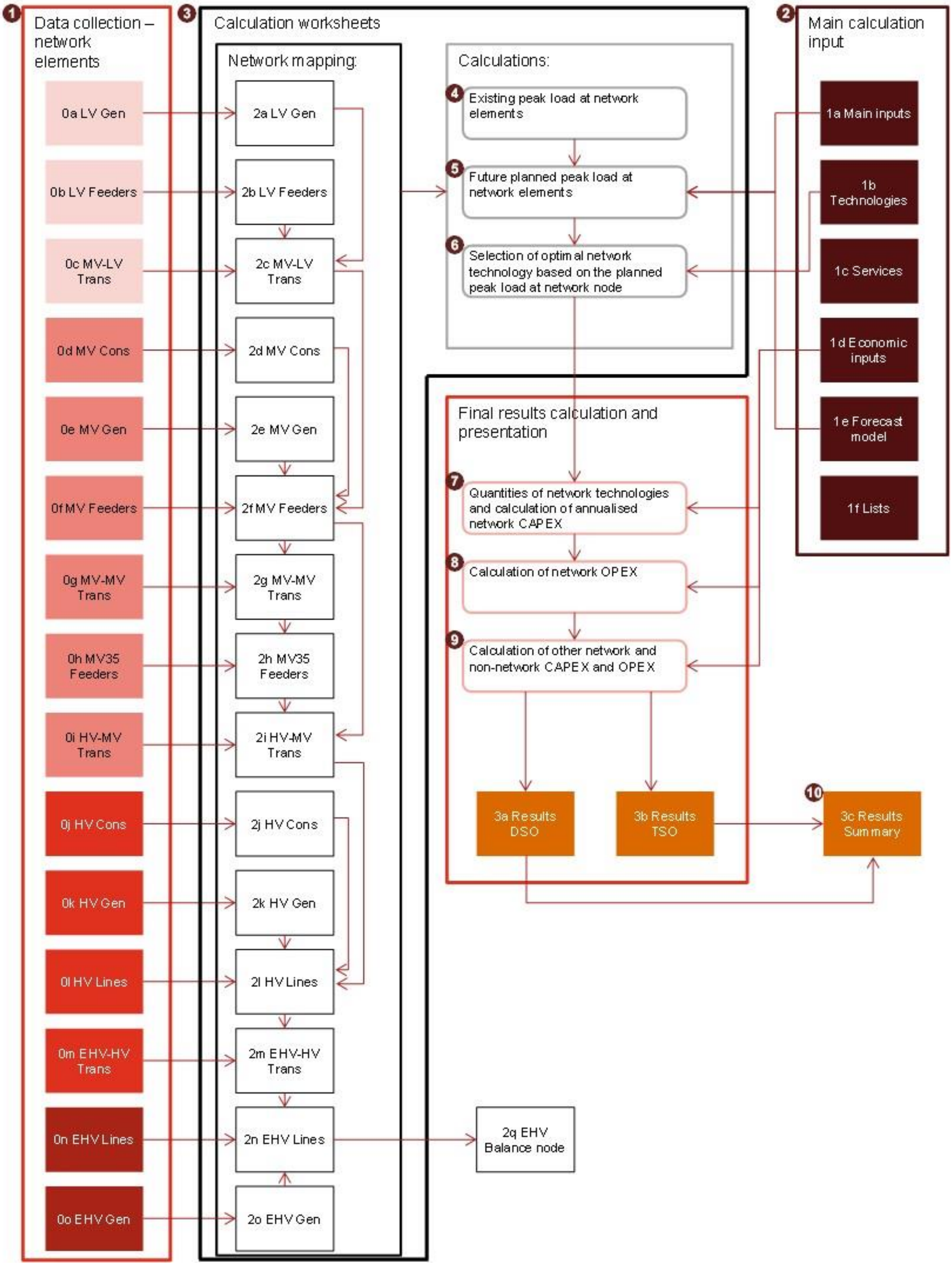


Figure 4 - Overview of the LRAIC model calculation logic

High-level process of LRAIC model calculation is summarized in the following steps:

! In the first step the main input data are collected filled into the data collection worksheets for the network elements, i.e. the details of the network elements, their mapping and technical parameters.

@ Next, the other input data is filled into the other input worksheets, such as data on modelled technologies and economic modelling data.

In the next step, the data from the data collection worksheets are replicated into the data calculation worksheets. The data calculation worksheets are the worksheets used to perform the main model calculations and represent the technical-technological part of the model.

$ Based on the mapping of the network elements actual adjusted peak load is calculated for each of the network elements. The adjusted peak load is calculated due to the fact that the peak load at a superior network element does not equal the sum of the peak loads at the subordinate network elements. Therefore the actual peak load has to be adjusted and will be used as a basis for the calculation of the future peak load at the network element. The adjusted peak load includes also power losses.

% The future peak load is first calculated for the lowest level of the network for which the optimisation modelling is performed (in case of this model this is the MV/LV transformation, since LV feeders are modelled only in a simplified manner). The future peak load at this level of the network is calculated for 2 different uses:

a) **For the purpose of the optimisation modelling at this level of the network (i.e. MV/LV transformation)** – the future peak load is calculated as actual non-adjusted peak load including losses increased (or decreased) by the planned change of the peak load. The planned change of the peak load is calculated from the peak load forecast by comparing the future modelled year with the initial year.

b) **For the purpose of the optimisation modelling of the superior network elements** – since the model will calculated the future peak load from bottom up, the future peak load at all the superior network elements at higher levels of the network (above the MV/LV transformation level) will be calculated by summing up the future peak load at the subordinate network elements using the network mapping (by network element's unique identifiers).

   For this purpose, the future adjusted peak load is calculated at the lowest modelled level of the network and is calculated as actual adjusted peak load including losses increased (or decreased) by the planned change of the peak load. The planned change of the peak load is calculated from the peak load forecast by comparing the future modelled year with the initial year. These future adjusted peak loads will be subsequently mapped through the higher levels of the network to calculate the future peak loads at the network elements at these higher network levels.

   At the TSO network level, the historical statistical peak load is taken into account, as the TSO network is less hierarchical and a simple aggregation of the peak loads from the subordinate network levels may not entirely represent a real life situation in the network.

The logic of the calculation of the future peak loads at different levels of the network can be summarized in the diagram:

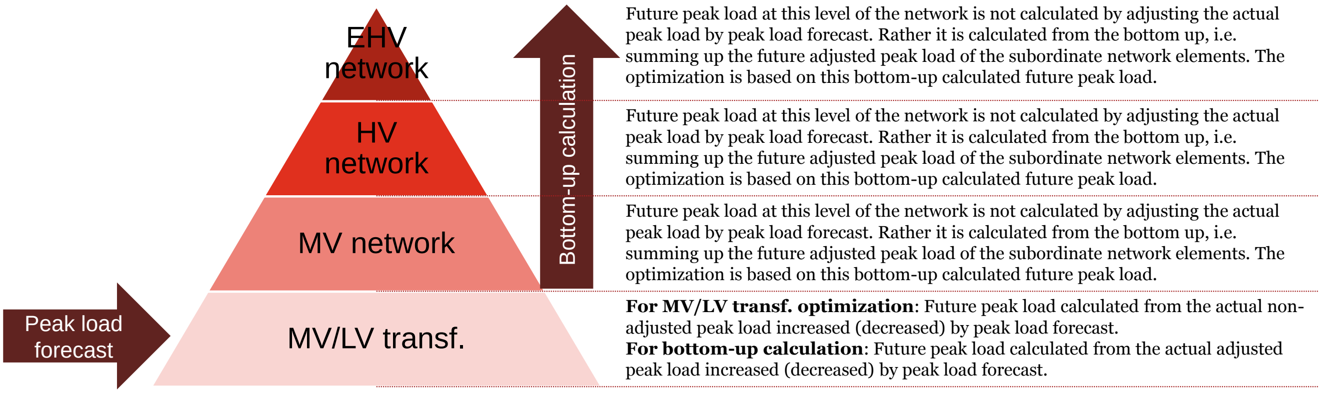


Figure 5 - Logic of the future peak load calculation

^ Based on the future peak load calculated for individual network elements at all levels of the network the optimisation modelling will be performed. The modelling will compare the actual technological capacity of the existing network element and will compare it to the calculated future peak load. The optimal network technology for the calculated future peak load will be selected from the list of preferred technologies that will be provided as part of the data collection in the by TSO and DSO. The optimisation modelling will take into account the required spare capacity as well as the back-up requirements of the network element (if the network element has to have additional capacity in case it is used as a back-up for another network element).

The extent of the optimisation (i.e. which network elements are optimised) depends on the selected optimisation scenario (this can include all network elements, or only those at the end of useful life, or as highlighted by TSO and DSO).

& In the next step the quantities of the individual technologies of the optimised modelled network will be summarized from the calculation worksheets. For each of the modelled technology type the total CAPEX will be calculated using the unit basic CAPEX and unit other network CAPEX (the data for unit CAPEX can be provided as a combined unit price or separated into basic unit price and other components of CAPEX). Using the Price trend, Useful life and Average time to operation defined for each of the modelled technology type the total annual depreciation (including capital charge, i.e. allowed profit) will be calculated. The model allows the calculations using different depreciation methods.

* The model also has a functionality to model OPEX based on the unit OPEX for each of the modelled technology types and based on the quantities per technology type the total annual network OPEX is calculated. The total annual network OPEX also reflects the inflation for the modelled period.

Alternatively, OPEX may not be calculated by the LRAIC model and can be provided separately by TSO and DSO for the price cap calculation, following the same approach that was used in the original LRAIC model implementation in Lithuania.

(In the last step the total CAPEX, total annualized CAPEX and total annual other OPEX is calculated for all other core network elements, support network elements and other assets. The total CAPEX of other core network elements is derived from the quantities of other core network elements and unit basic CAPEX and unit other CAPEX. The quantities of other core network elements are calculated as a function of the number of the main network elements from the calculation worksheets and the defined quantity rates of the other core network elements per 1 main network element.

For other technologies that are not dependent on the number of the main elements (i.e. technologies whose quantities in the network are not a function of the quantities of the main network elements), the total CAPEX, total annualized CAPEX and total annual other OPEX is calculated based on the quantities and unit CAPEX and unit other CAPEX.

For other assets (such as office buildings, non-network IT systems, etc.) the annualized CAPEX is calculated directly from the cost data provided by TSO and DSO.

The functionality of the LRAIC model allows the modelling of the other core network elements, support network elements and other assets as described above, however, as these network elements and assets are not subject to the LRAIC modelling optimisation, the approach can be simplified and CAPEX and OPEX related to these network elements and assets can alternatively be provided by TSO and DSO outside of the LRAIC model as a direct input into the price cap calculation.

) Finally, the LRAIC results for both TSO and DSO are summarised in the results worksheets. These worksheets of the model summarise the annualised CAPEX, annual OPEX and total LRAIC annual costs and calculated the LRAIC modelled allowed revenues of the optimised TSO and DSO network.

The following sections describe the approach to the modelling and data needed for the modelling in more details.

4.3. Design of the Low voltage network

The network topology in terms of the MV/LV transformers will reflect the existing topology of DSO and the individual transformers will be dimensioned and optimised based on the measured peak load and the optimal technology will be selected for the modelling according to the technology optimisation table (see section 4.9. Dimensioning of network elements).

The LV feeders and lines, including the “last mile” will be modelled in a simplified way due to limited availability of the detailed data on the individual LV lines and due to the limitations of the modelling in MS Excel. Therefore, for the LV lines the data on the prevailing type of the LV feeders and their lengths will be collected and will only be used for the economic evaluation of the related costs. No optimisation based on the measured peak load will be performed for LV feeders. For the remaining parts of the LV lines only the data on their total lengths will be collected assuming only one average type of the LV line.

The input data will be collected from DSO in the data collection process using the standard data questionnaire prepared as part of the model.

The schematic modelling of the LV network is illustrated below:

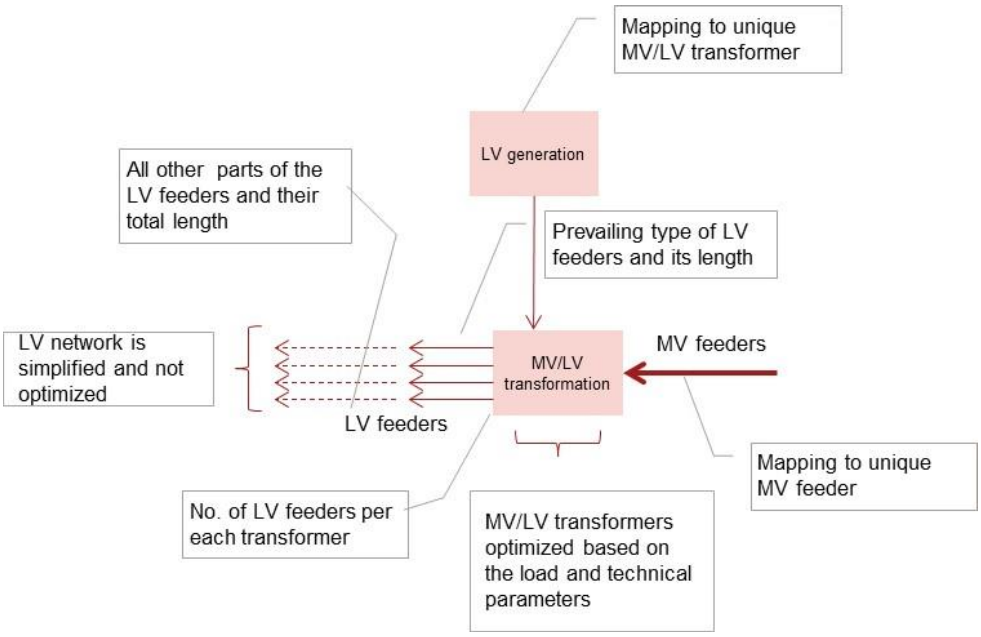


Figure 6 - Schematic modelling of the LV network

Low voltage network consists of these main network elements:

- Low voltage feeders
- MV/LV transformers
- LV generation

These are the main technologies deployed in the network and modelled according to the limitations and simplifications described above.

Various data need to be collected for the LRAIC model for MV/LV transformers and LV feeders (some of the data is only informative and not mandatory).

MV/LV transformers

Actual load of the MV/LV transformers will be modelled by the peak load, which will be provided by DSO. The load will be calculated for each of the MV/LV transformers individually.

For each of the MV/LV transformers following parameters will be required:

- Unique MV/LV transformer ID (format of the ID is prescribed in the Data collection guidelines, also see *A.1 Appendix – Standard network elements identifiers to be used*)
- Region, Town/Village (location of the transformer)
- Name of MV/LV transformer/station (optional)
- Unique ID of MV feeder (MV feeder by which the MV/LV transformer is connected to the superior MV/MV transformer)
- Uprim/Usec – voltage level at the primary and secondary side of the transformer
- Sn – nominal power of the transformer
- Pfe/Pcu, ∆P – no-load/load losses, power losses during the peak load
- Pmax – peak load of the transformer
- Used for back up? – indication of whether the transformer is used to back-up another transformer
- Back up % - specific % of the capacity of the transformer that is used for back up
- Manufacturer (optional)
- Owner
- Geotype
- Year of acquisition, Year since it is in operation, Year of the end of useful life (year)
- Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Investment planned – indication of whether the transformer is planned for investments or reconstruction in the investment plan for next 10 years (This should be provided if such information is available for specific transformer. If not available at the individual transformer level, such information should be provided as cumulative plan – see section 4.9 Dimensioning of network elements.)

Each of the MV/LV transformers is linked to the unique MV feeder using the unique identifier.

Low voltage feeders

Low voltage feeders will be modelled for each of the MV/LV transformer in a simplified way. That means that the low voltage feeders will be modelled by the prevailing type of the feeders and the total length of feeders.

The types of the feeders will not be subject to the optimization based on the peak load, and the data will only be used for the economic evaluation of the low voltage network. If a more granular data will be available on the

Low voltage feeders, the model can also optimise this part of the network (the minimum extent of such additional data would include peak load and year of acquisition, start of operation and end of useful life).

For each of the MV/LV transformers following parameters will be required regarding the low voltage feeders connected to them:

- Unique MV/LV transformer ID (i.e. transformer to which the LV feeder is connected)
- Name of MV/LV transformer/station (optional)
- No. of feeders (connected to the MV/LV transformer)
- ΔP
- Type (optional)
- Overhead line/cable (of the prevailing type)
- Geotype (of the prevailing type)
- Length (of the prevailing type)
- Length (of the remaining feeders)
- Annual depreciation per km based on HCA and CCA (Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional) based on regulatory accounting

Additional data (if available)

- *Pmax – peak load of the prevailing section of the feeder*
- *Pn - maximum technical power through the prevailing section of the feeder*
- *Year of acquisition, Year since it is in operation, Year of the end of useful life (year)*
- *Investment planned – indication of whether the feeder is planned for investments or reconstruction in the investment plan for next 10 years (This should be provided if such information is available for specific feeder. If not available at the individual feeder level, such information should be provided as cumulative plan – see section 4.9 Dimensioning of network elements.)*
- *Change to cable – indication of whether the feeder should be changed from overhead line to cable line (This should be provided if such information is available for specific feeder. If not available at the individual feeder level, such information should be provided as cumulative plan – see section 4.9 Dimensioning of network elements.)*
- *Reconstructed in previous period - % of the length of the feeder that was reconstructed in the previous regulatory period*

LV generation

Each producer connected to the LV network will be identified by unique identifier and will be linked to the unique LV feeder. The list of producers should also include prosumers (i.e. the production side of the prosumer).

For each of the LV producers the following parameters will be required:

- Unique ID of producer
- Region/Town/Village (optional)
- Unique ID of MV/LV transformer (to which it is connected)
- Name of the producer (optional)
- Prosumer (indication of whether the producer is a prosumer)
- Type of producer (i.e. solar, wind, hydro, gas, nuclear, etc.)
- Pinst (installed capacity)
- Pmax (peak load)
- Year of installation, Planned year of decommissioning (disconnection)

- Planned change of Pmax in 5 years and in 10 years

4.4. Design of the Medium voltage network

The MV network will be modelled based on the data supplied by DSO on MV/MV and HV/MV transformers and on the MV feeders in order to reflect the existing topology of DSO. The transformers and feeders will be dimensioned and optimised based on the peak load and the optimal network technology will be selected for the modelling according to the technology optimization table (see section 4.9. Dimensioning of network elements). Data on the generation and consumption at MV level will also be provided by DSO and the respective load parameters will be reflected in the dimensioning of the network elements to which the generation and consumption is connected.

The MV feeders will be modelled in a simplified way where only the first section of the feeder will be modelled and dimensioned to specific optimized technology based on the peak load and the rest of the MV lines will enter the model only as the model inputs in terms of the length of the lines and will not be dimensioned and optimised based on the peak load.

The input data will be collected from the DSO in the data collection process using the standard data questionnaire prepared as part of the models.

The schematic modelling of the MV network is illustrated below:

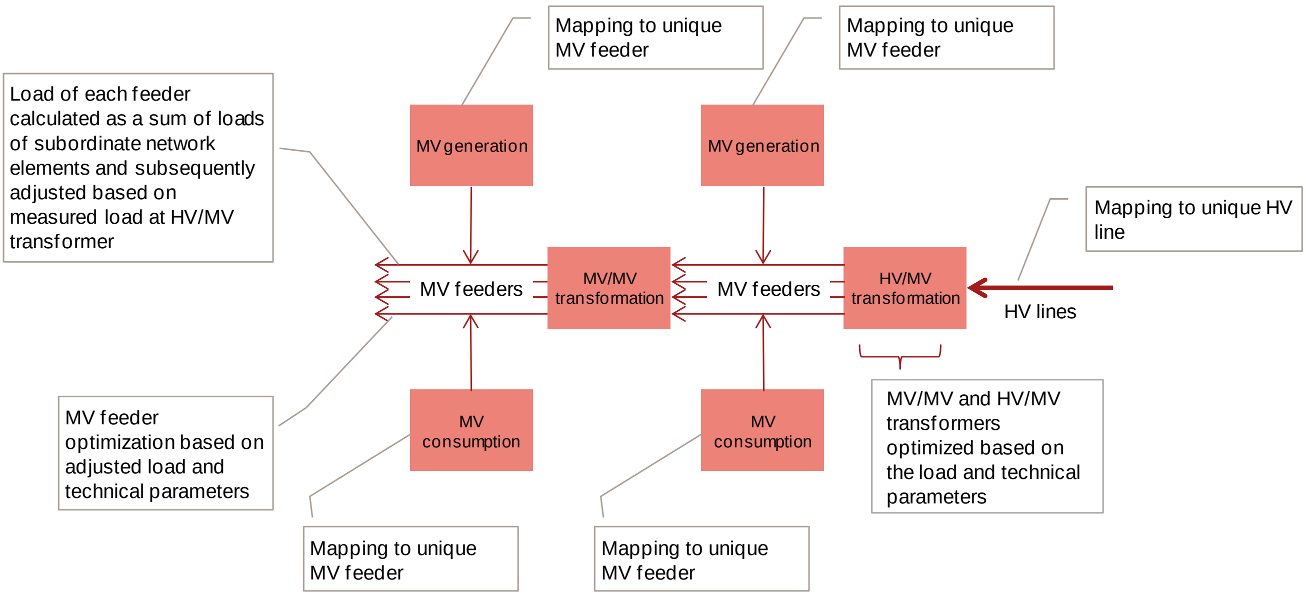


Figure 7 - Schematic modelling of the MV network

Medium voltage network consists of these main network elements:

- Medium voltage feeders (35 kV only)
- Medium voltage feeders (all other)
- MV/MV transformers
- HV/MV transformers
- MV generation
- MV consumers

These are the main technologies deployed in the network and modelled according to the limitations and simplifications described above.

Various data need to be collected for the LRAIC model for MV/MV and HV/MV transformers and MV/MV feeders (some of the data is only informative and not mandatory).

MV feeders (for all feeders, i.e. 35 kV and 10 kV feeders)

Each MV feeders will have unique identifier and will be linked to the uniquely identified HV/MV transformer (or MV/MV transformer). Load of each MV feeder will be calculated as a sum of peak load of the assigned MV/LV transformers to the feeder. Sum of loads of feeders assigned to the specific HV/MV transformer will be compared to the measured load of the HV/MV transformer and the difference will be calculated. Based on this difference the peak load adjustment coefficients for each of the respective feeders will be calculated and adjusted peak load for each MV feeder assigned to the HV/MV transformer will then be calculated. This adjusted peak load will be used for the optimization of feeders.

For each of the MV feeders the following parameters will be required:

- Unique MV feeder ID
- Name of station/transformer (optional)
- Name/ Nr. of feeder (optional)
- Unique MV/MV or HV/MV transformer ID (to which it is connected)
- U (nominal voltage of the feeder)
- ΔP
- Used for back up? (for the first section of the feeder)
- Back up % (for the first section of the feeder)
- Overhead line/cable (for the first section of the feeder)
- Geotype (for the first section of the feeder)
- Type (optional, for the first section of the feeder)
- Manufacturer (optional, for the first section of the feeder)
- Length (for the first section of the feeder)
- Length (of the remaining sections of the feeder)
- Pn (maximum power through the first section of the feeder)
- Year of acquisition, Year since it is in operation, Year of the end of useful life (year)
- Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Investment planned – indication of whether the transformer is planned for investments or reconstruction in the investment plan for next 10 years (This should be provided if such information is available for specific feeder. If not available at the individual feeder level, such information should be provided as cumulative plan – see section 4.9 Dimensioning of network elements.)
- Change to cable – indication of whether the feeder should be changed from overhead line to cable line (This should be provided if such information is available for specific feeder. If not available at the individual feeder level, such information should be provided as cumulative plan – see section 4.9 Dimensioning of network elements.)
- Reconstructed in previous period - % of the length of the feeder that was reconstructed in the previous regulatory period

MV generation

Each producer connected to the MV network will be identified by unique identifier and will be linked to the unique MV feeder. The list of producers should also include prosumers (i.e. the production side of the prosumer).

For each of the MV producers the following parameters will be required:

- Unique ID of producer
- Region/Town/Village (optional)
- Unique ID of MV feeder (to which it is connected)
- Name of the producer (optional)
- Prosumer (indication of whether the producer is a prosumer)
- Type of producer (i.e. solar, wind, hydro, gas, nuclear, etc.)
- Pinst (installed capacity)
- Pmax (peak load)
- Year of installation, Planned year of decommissioning (disconnection)
- Planned change of Pmax in 5 years and in 10 years

MV consumers

Each consumers connected to the MV network will be identified by unique identifier and will be linked to the unique MV feeder.

For each of the MV consumers the following parameters will be required:

- Unique ID of consumer
- Region/Town/Village (optional)
- Unique ID of MV feeder (to which it is connected)
- Name of the producer (optional)
- Reserved capacity
- Pmax (peak load)
- Year of installation, Planned year of decommissioning (disconnection)
- Planned change of Pmax in 5 years and in 10 years

MV/MV and HV/MV transformers (i.e. 35/10 kV and 110/35 kV)

Actual load of the MV/MV and HV/MV transformers will be modelled by the measured peak load, which will be provided by DSO or TSO. The load will be calculated for each of the MV/MV and HV/MV transformer individually. For the future periods the peak load at each of the MV/MV and HV/MV transformers will be calculated from the adjusted peak loads of the MV feeders assigned to the MV/MV and HV/MV transformer.

The mapping of the HV/MV transformers to HV lines will be done based on the actual TSO network topology.

For each of the MV/MV and HV/MV transformers following parameters will be required:

- Unique MV/MV or HV/MV transformer ID
- Region, Town/Village (location of the transformer)
- Name of MV/MV or HV/MV transformer/station (optional)
- Unique ID of MV feeder (feeder by which the transformer is connected to the superior transformer)
- Uprim/Usec/Uterc – voltage level at the primary, secondary and tertiary side of the transformer
- Sn – nominal power of the transformer
- Pfe/Pcu, ΔP – no-load/load losses, power losses during the peak load
- Pmax – peak load of the transformer

- Used for back up? – indication of whether the transformer is used to back-up another transformer
- Back up % - specific % of the capacity of the transformer that is used for back up
- Manufacturer (optional)
- Owner
- Geotype
- Year of acquisition, Year since it is in operation, Year of the end of useful life (year)
- Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Investment planned – indication of whether the transformer is planned for investments or reconstruction in the investment plan for next 10 years (This should be provided if such information is available for specific transformer. If not available at the individual transformer level, such information should be provided as cumulative plan – see section 4.9 Dimensioning of network elements.)

4.5. Design of the High voltage network

The HV network will be modelled based on the data supplied by TSO on EHV/HV transformers and on the HV lines in order to reflect the existing topology of TSO. The transformers and lines will be dimensioned and optimised based on the peak load and the optimal network technology will be selected for the modelling according to the technology optimisation table (see section 4.9. Dimensioning of network elements).

The model will assume the "ring" network topology for the HV lines, where each HV/MV transformer is connected to 2 (or more) HV lines from different directions and where the HV lines aggregate towards the main HV line that is connected directly to the EHV/HV transformer. The mapping of the HV/MV transformers to HV lines, HV lines to HV lines and HV lines to EHV/HV transformers will be determined based on the network topology provided by TSO in order to define the simplified network topology for the purpose of the modelling.

Data on the generation and consumption at HV level will also be provided by TSO and the respective load parameters will be reflected in the dimensioning of the network elements to which the generation and consumption are connected.

The input data will be collected from TSO in the data collection process using the standard data questionnaire prepared as part of the models.

The schematic modelling of the HV network is illustrated below:

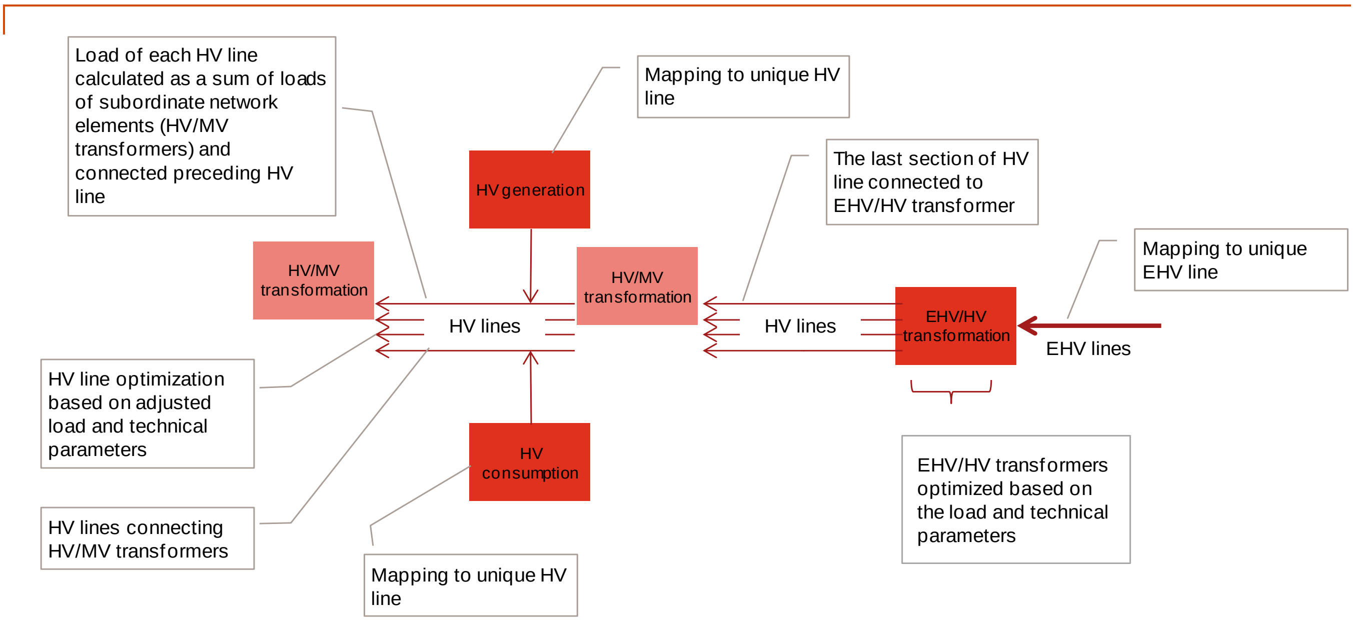


Figure 8 - Schematic modelling of the HV network

High voltage network consists of these main network elements:

- High voltage lines
- EHV/HV transformers
- HV generation
- HV consumers

These are the main technologies deployed in the network and modelled according to the limitations and simplifications described above.

Various data need to be collected for the LRAIC model for EHV/HV transformers and HV lines (some of the data is only informative and not mandatory).

HV lines

Each HV line will have unique identifier and will be assigned to either another HV line or EHV/HV transformer. The mapping of the HV lines to another HV line or to EHV/HV transformer will be done based on the actual TSO network topology.

Load for each HV line will be calculated as the sum of the load in the HV/MV transformer and preceding HV line. Optimisation of the individual HV lines will be based on the calculated peak load. This will, however, be compared with the historical statistical peak load at the HV line, as the TSO network is less hierarchical and a simple aggregation of the peak loads from the subordinate network levels may not entirely represent a real life situation in the network. In cases where the historical statistical peak load at the HV line is higher than the calculated peak load, the historical statistical peak load will be used for the optimisation modelling.

For each of the HV line the following parameters will be required:

- Unique HV line ID
- Name/Nr. of the line (optional)

- U (nominal voltage)
- Pn (nominal capacity)
- Pmax (peak load)
- Statistical average Pmax (statistical average peak load calculated from historical data)
- ΔP
- Used for back up?
- Back up %
- No. of circuits
- Overhead line/cable
- Geotype
- Manufacturer (optional)
- Type (optional)
- Length
- Year of acquisition, Year since it is in operation, Year of the end of useful life (year)
- Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Investment planned – indication of whether the transformer is planned for investments or reconstruction in the investment plan for next 10 years
- Change to cable – indication of whether the feeder should be changed from overhead line to cable line

HV generation

Each producer connected to the HV network will be identified by unique identifier and will be linked to the unique HV line.

For each of the HV producers the following parameters will be required:

- Unique ID of producer
- Region/Town/Village (optional)
- Name of the producer (optional)
- Pinst (installed capacity)
- Pmax (peak load)
- Year of installation, Planned year of decommissioning (disconnection)
- Planned change of Pmax in 5 years and in 10 years

HV consumers

Each consumer connected to the HV network will be identified by unique identifier and will be linked to the unique HV feeder.

For each of the HV consumers the following parameters will be required:

- Unique ID of consumer
- Region/Town/Village (optional)
- Name of the producer (optional)
- Reserved capacity
- Pmax (peak load)
- Year of installation, Planned year of decommissioning (disconnection)
- Planned change of Pmax in 5 years and in 10 years

EHV/HV transformers

Actual load of the EHV/HV transformers will be modelled by the calculated aggregated peak load from the assigned HV lines. The load will be calculated for each of the EHV/HV transformer individually. Similarly to HV lines, the calculated peak load will be compared with the historical statistical peak load at the EHV/HV transformer. In cases where the historical statistical peak load at the EHV/HV transformer is higher than the calculated peak load, the historical statistical peak load will be used for the optimisation modelling.

The mapping of the EHV/HV transformers to EHV lines will be done based on the actual TSO network topology.

For each of the EHV/HV transformers following parameters will be required:

- Unique EHV/HV transformer ID
- Region, Town/Village (location of the transformer)
- Name of EHV/HV transformer/station (optional)
- Uprim/Usec/Uterc – voltage level at the primary, secondary and tertiary side of the transformer
- Sn – nominal power of the transformer
- Pfe/Pcu, ΔP – no-load/load losses, power losses during the peak load
- Pmax – peak load of the transformer
- Statistical average Pmax (statistical average peak load calculated from historical data)
- Used for back up? – indication of whether the transformer is used to back-up another transformer
- Back up % - specific % of the capacity of the transformer that is used for back up
- Manufacturer (optional)
- Owner
- Geotype
- Year of acquisition, Year since it is in operation, Year of the end of useful life (year)
- Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Investment planned – indication of whether the transformer is planned for investments or reconstruction in the investment plan for next 10 years

4.6. Design of the Extra-high voltage network

The EHV network will be modelled based on the data supplied by TSO on EHV/HV transformers and on EHV lines in order to reflect the existing topology of TSO. The transformers and lines will be dimensioned and optimised based on the peak load and the optimal network technology will be selected for the modelling according to the technology optimisation table (see section 4.9. Dimensioning of network elements).

The model will assume the “ring” network topology for EHV lines, where each EHV/HV transformer is connected to 2 (or more) EHV lines from different directions and where the EHV lines aggregate towards the main EHV line that is connected directly to the fictitious EHV balance node for particular supply area (see explanation of the EHV balance node below). The mapping of the EHV/HV transformers to EHV lines, EHV lines to EHV lines and EHV lines to EHV balance nodes will be determined based on the network topology provided by TSO in order to define the simplified network topology for the purpose of the modelling.

Data on the generation and consumption at EHV level will also be provided by TSO and the respective load parameters will be reflected in the dimensioning of the network elements to which the generation and consumption are connected.

The input data will be collected from TSO in the data collection process using the standard data questionnaire prepared as part of the models.

The schematic modelling of the EHV network is illustrated below:

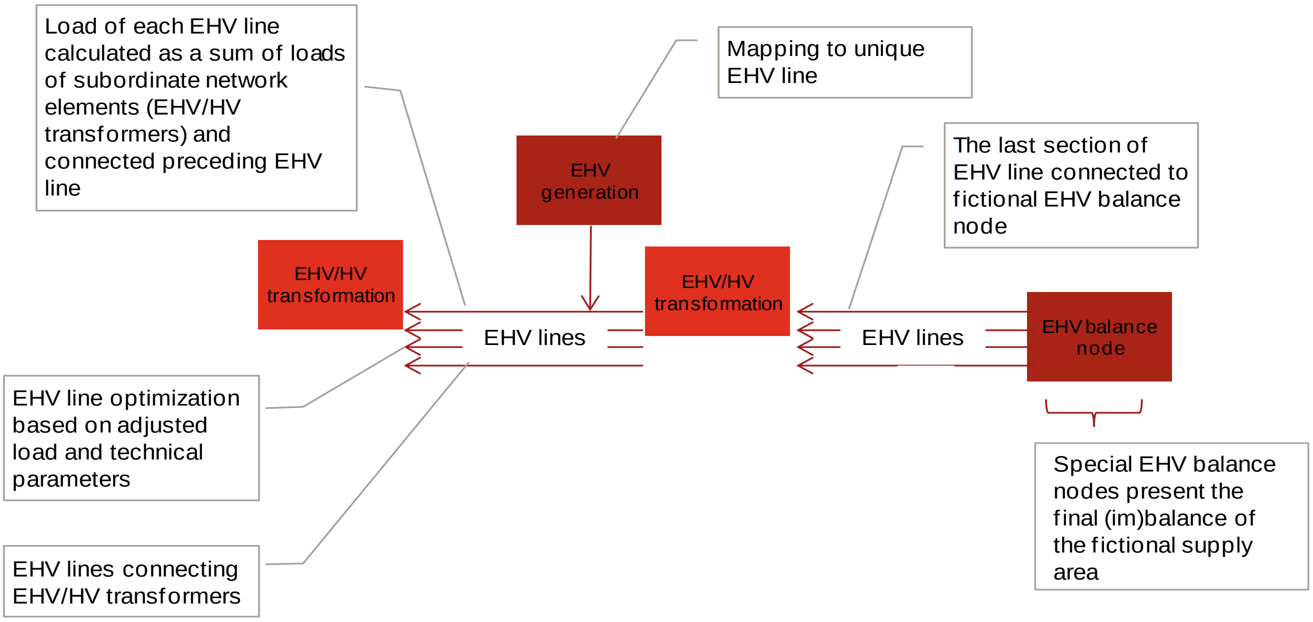


Figure 9 - Schematic modelling of the EHV network

Extra-high voltage network will consist of these main network elements:

- Extra-high voltage lines
- EHV generation
- EHV balance node

These are the main technologies deployed in the network and modelled according to the limitations and simplifications described above.

Various data need to be collected for the LRAIC model for EHV lines (some of the data is only informative and not mandatory).

EHV lines

Each EHV line will have unique identifier and will be assigned to either another EHV line or EHV balance node. The mapping of the EHV lines to another EHV line or to EHV balance node will be done based on the actual TSO network topology.

Load for each EHV line will be calculated as the sum of the load in the EHV/HV transformer and preceding EHV line. Optimisation of the individual EHV lines will be based on the calculated peak load.

For each of the EHV line the following parameters will be required:

- Unique EHV line ID
- Name/Nr. of the line (optional)
- U (nominal voltage)

- Pn (nominal capacity)
- Pmax (peak load)
- Statistical average Pmax (statistical average peak load calculated from historical data)
- ∆P
- Used for back up?
- Back up %
- No. of circuits
- Overhead line/cable
- Geotype
- Manufacturer (optional)
- Type (optional)
- Length
- Year of acquisition, Year since it is in operation, Year of the end of useful life (year)
- Annual depreciation based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Net book value based on HCA and CCA (CCA may be optional), based on regulatory accounting
- Investment planned – indication of whether the transformer is planned for investments or reconstruction in the investment plan for next 10 years
- Change to cable – indication of whether the feeder should be changed from overhead line to cable line

EHV generation

Each producer connected to the EHV network will be identified by unique identifier and will be linked to the unique EHV line.

For each of the EHV producers the following parameters will be required:

- Unique ID of producer
- Region/Town/Village (optional)
- Name of the producer (optional)
- Pinst (installed capacity)
- Pmax (peak load)
- Year of installation, Planned year of decommissioning (disconnection)
- Planned change of Pmax in 5 years and in 10 years

EHV balance node

For the purpose of this model special EHV balance nodes will be introduced into the model to present the final (im)balance of the fictional supply area. If the load balance is zero then the model is balanced.

The balance node is connected to the fictional supply area by fictional EHV line with 0 km length. The EHV balance node will not enter the economic calculation of the LRAIC model.

4.7. Other network elements and other assets

Additionally to the modelled main network elements (feeders, lines and transformers) the economic model will include also other network elements that are necessary for the functioning of the TSO and DSO network. These are other core network elements (i.e. equipment and technologies necessary to operate the network, that are directly related to main network elements) and support network elements (i.e. all the other equipment, technologies and assets that are necessary to operate the network, but are not directly related to main network elements).

Additionally, all the other assets of TSO and DSO, that are required to run the regulated business, should be included in the economic model as well (such as buildings, office equipment, vehicles, etc.).

The LRAIC model has the functionality, which allows to estimate the quantities of the other core network elements based on the input data provided by TSO and DSO, while support network elements and other assets are not modelled and are only a “pass-through” items in the model.

The granularity of the data for other network elements and other assets depends on the availability of data from TSO and DSO. These data can alternatively be provided as a lump-sum aggregated figures (depreciation, OPEX, regulatory asset base) outside of the model, to be included directly in the price cap calculation.

The illustrative examples other network elements and other assets is as follows:

Other core network elements:

- Electrometers
- Disconnectors
- Circuit breakers
- Reclosers
- Capacitor banks, shunt reactors
- Transformer protections
- Line protections
- Relay protections
- System automatic protections
- Special protections

In case the other core network elements are included in the modelling, they will not be derived from the peak load, but the number of these network elements will be derived from the dimensioned number of main network elements using the pre-defined calculation rules (for example average number of disconnectors per 1 transformer).

Support network elements:

- Network management technologies
- Control room/dispatching
- Network IT systems, etc.

Other assets:

- Office buildings and equipment
- Non-network and business support IT systems
- Vehicles, etc.

The numbers of the support network elements and other assets will be provided by TSO and DSO and the economic model will not model the optimised number of these elements.

It is suggested that the other core network elements, support network elements and other assets will be treated outside of the model. That means that the economic figures for these elements and assets will be provided as aggregated figures (depreciation, operational expenses, regulatory asset base) and will be used directly in the price cap calculation, rather than modelled in the LRAIC model.

4.8. Demand dimensioning input and forecast

For the purpose of the dimensioning of the network elements in the future, the peak load demand forecast is used.

The demand forecast

The peak load demand for individual voltage levels will be based on the current peak load demand and future expected development of the peak load. The demand will be planned based on the available data of TSO and DSO for the period covering next 10 years.

The demand for the specific network elements will be modelled from the bottom up. The demand peak load at the low-voltage level for the forecast year will be proportionally distributed across the existing low voltage network elements based on their measured peak load for the initial year.

The increased demand from the low voltage network will be transferred to the respective network elements at the higher voltage levels based on the network topology mapping. Additional peak load demand balance will be added at the higher voltage levels for the respective peak load consumption and peak load generation at these higher voltage levels. The demand forecast and the demand for the network elements is subsequently used in the dimensioning of the network elements.

The scheme below illustrates the transfer of the peak load demand forecast to the demand for the network elements:

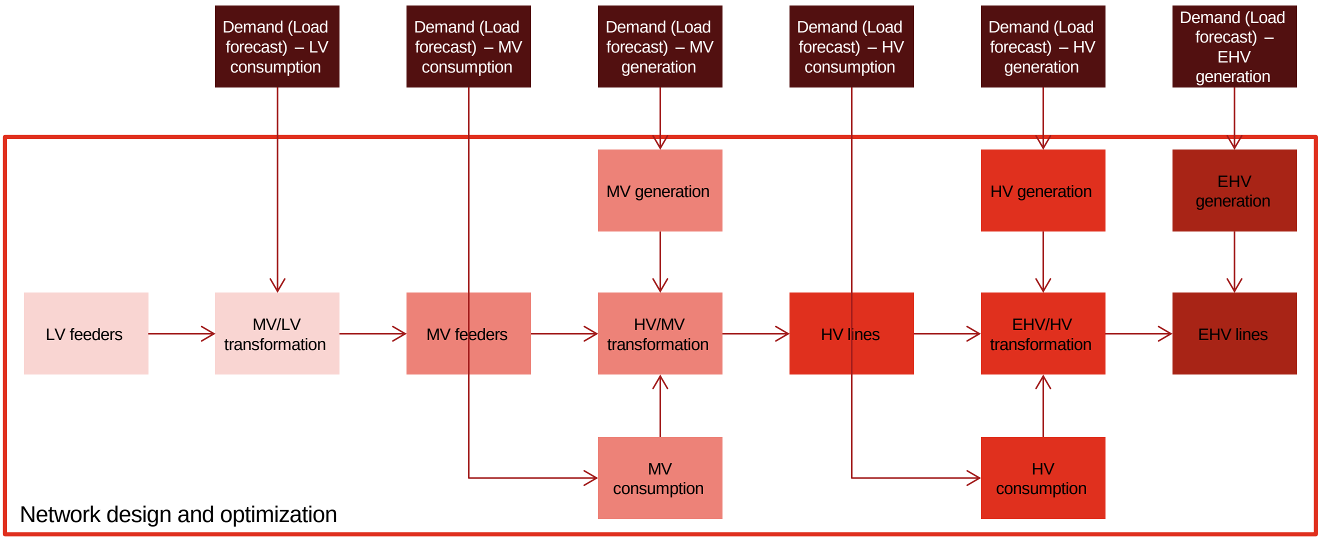


Figure 10 - Illustration of the peak load demand at network elements

New generation and consumption

Besides the overall demand forecast the model also has the capability to add new network elements such as new generation and new consumption at the MV level and above. If new generation or consumption is planned to be installed within the analysed time period, the new elements can be directly added to the existing ones, with the same level of detail, to the respective input section of the model.

For example if a new power plant is planned to be connected to the HV level, this new network element can be added to the model in the HV section – HV generation and the same data will need to be provided as for the existing generation connected at HV level as defined in the section 4.5 Design of the High voltage network, part HV generation, in particular location, unique ID of HV line to which the power plant is mapped, nominal power, peak load and the year in which it will be connected. Similarly, new planned transformers and lines can also be added to the model.

4.9. Dimensioning of network elements

In the technical part of the model, the dimensioning parameters are specified for each technology (feeder, line, transformer) at each voltage level.

The parameters include:

- Thresholds for replacement of existing network element with the most suitable network element (with higher/lower capacity)
- Thresholds for replacement of the existing network elements that are used as back-ups with the most suitable network element (with higher/lower capacity)
- Technological tables with the bottom and upper thresholds for standardized network technologies that are used for the optimisation modelling

Type ID	Transformer name	Bottom threshold	Sn
#		kVA	kVA
LVT Type 1	Name 1	-	40
LVT Type 2	Name 2	41	63
LVT Type 3	Name 3	64	100
LVT Type 4	Name 4	101	160
LVT Type 5	Name 5	161	250
LVT Type 6	Name 6	251	320
LVT Type 7	Name 7	321	400

Figure 11 - Example of the technology optimisation table for the MV/LV transformers

The model will allow variant optimisation of network elements based on the pre-defined criteria, for example:

- Optimisation of all technologies – if this scenario is selected the model will optimise the technology at each network node using one of the preferred technologies. No legacy technologies will be left in the network.
- Optimisation of only terminating technologies – if this scenario is selected the model will only optimise the network nodes and which the network technologies are at the end of the useful life.
- Upwards optimization only – if this scenario is selected the model will only perform the upwards optimisation (reinforcement), i.e. will only replace the existing technology at the network node in the case when the capacity of the existing technology is insufficient and needs to be improved to meet the future calculated peak load.
- Optimisation of only network elements planned for investments or reconstructions – new functionality added in the model. If this scenario is selected, the model will only optimise those network elements that will be highlighted as being planned for investment or reconstruction in the next 10 years (i.e. if it is part of the investment plan)

The new optimisation scenario is suggested to align the extent of the optimisation in the LRAIC model with the investment plans and investment capacities of TSO and DSO. The scenario should also ensure that the network elements that were recently optimised or reconstructed, are not re-optimised by the updated LRAIC model.

In case of DSO, the network development plan may not be in a granularity to provide the indication of whether certain network element is or is not planned for reconstruction, since the network development plans are more high level and may provide only a general investment guidance for long-term horizon. Due to this, the LRAIC model offers and alternative options for the scenario of *Optimisation of only network elements planned for investments or reconstructions*, in which the DSO will provide a cumulative investment plan for types of network elements at different voltage levels, indicating the planned quantities (kilometres of feeders, number of transformers) to be invested in during the modelling period.

The LRAIC model will then perform the optimisation of the network elements up to the volume indicated in the cumulative investment plan. The granularity of the data to be provided for the cumulative investment plan will be defined in the Data collection guidelines, but as a minimum, the data cumulative investment plan should differentiate:

- Voltage levels (LV, MV)
- Network elements (feeders, transformers)
- Type of feeder (overhead line, cable line)

In case of DSO, it is also difficult to determine at the feeder level, whether the feeder was optimised or reconstructed in the previous LRAIC modelling period. This is due to the fact that feeders at LV and MV level are optimised only in a simplified way and are not disaggregated to subsegments of the feeder. In practice, the entire feeder, as provided as a single item in the model, may not have been optimised or reconstructed in the previous period, but some of its segments may have been. Therefore, the LRAIC data collection file will allow the DSO to highlight a % of the length of the feeder that was optimised or reconstructed in the previous period, thus making sure that only the remaining part of the feeder will be available for optimisation in the new LRAIC model.

4.10. Annualisation of TSO and DSO costs

In the economic part of the LRAIC model, the results of the technical part of the model (i.e. of the optimisation modelling) are translated into economic terms. For the optimised modelled types and quantities of technologies, total CAPEX, depreciation and annualised CAPEX (which includes the capital charge) are calculated. The network elements that are not optimised by the model, are added to the results using the actual cost inputs provided by TSO and DSO using the HCA valuation approach. Annual OPEX is suggested to be treated outside of the LRAIC model (i.e. not to be modelled, but provided by TSO and DSO separately for the price cap calculation.

The schematic calculation of the annualised costs of the TSO and DSO services is illustrated below:

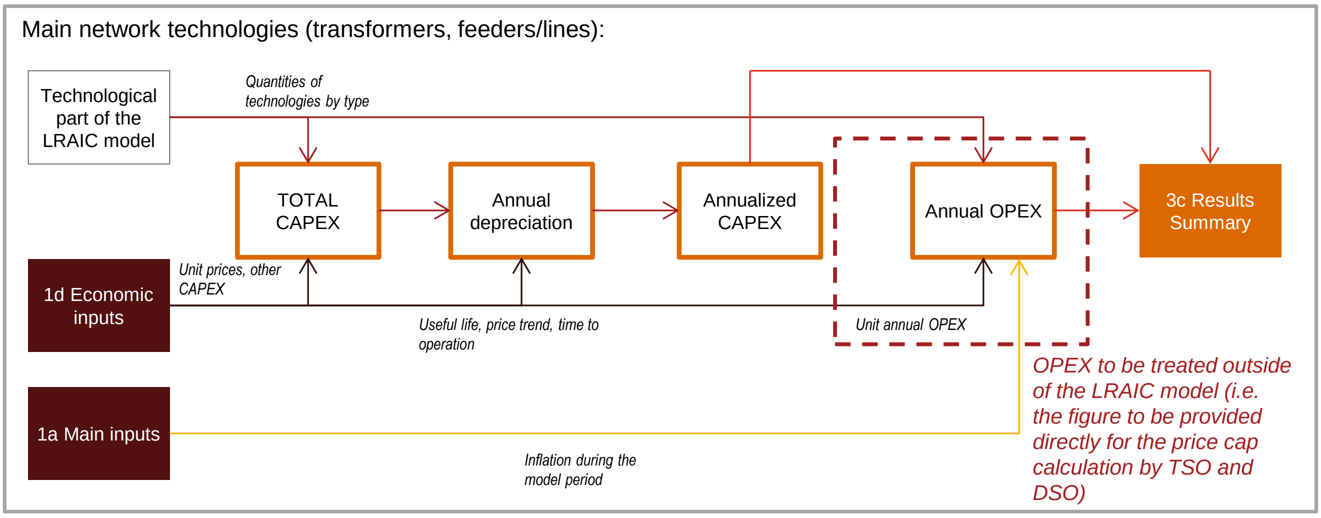


Figure 12 - Schematic calculation of the annualised costs

Annualised costs of TSO and DSO consist of several cost components:

- Network CAPEX for main technologies – i.e. based on the unit prices of the network technologies
- Other network CAPEX – all other CAPEX related to the construction of the main technologies and making them operational, including any capitalised expenses. This other network CAPEX can be combined with the basic unit price and provided as a single figure.
- Cost of capital (WACC) – capital charge is incorporated into the annualised costs calculation to take into account also the allowed profit

As mentioned earlier, the LRAIC model includes also the functionality to include annualised costs (including depreciation, OPEX and allowed profit) of other core network elements, support network elements and other assets in the calculation of LRAIC results. However, based on the discussion with VERT TSO and DSO, it is suggested, that these costs will not be included in the model and will be provided separately as a lump sum into the final calculation of the price caps.

As for the unit prices (or unit CAPEX for main technologies), the LRAIC model requires the operators to provide average unit prices of the main network technologies. In the discussions between VERT and the operators it was pointed out that while average unit prices are reasonable to be used in the modelling, they should not be used to assess the individual investment projects by the regulator, since actual prices may fluctuate and in some cases can be higher than average prices. Therefore, also the maximum unit prices in certain period should be collected as part of the LRAIC data collection process for reference.

Such maximum prices will not be used in the LRAIC model itself, however, will provide a useful reference point for the regulator for the evaluation of the investment projects of the operators.

4.11. Sensitivity analysis and flexibility thresholds

As the LRAIC model is calculated using forward-looking data and then applied in the price cap regulation in the multi-year regulatory period, the deviations between the actual values of certain indicators (such as peak load) and the forecasted values used in the LRAIC model are likely to occur.

In order to understand the impacts of the changes of selected key indicators on the calculated LRAIC results a sensitivity analysis will be performed as part of the calculation of the LRAIC model. Such sensitivity analysis should provide a basis for determining the flexibility thresholds, i.e. acceptable levels of deviation between the actual and forecasted values of these indicators. This should ensure a higher stability and predictability of the application of the LRAIC results in the price cap regulation, as the deviations of the values of these indicators within the acceptable threshold should not trigger the revisions of the LRAIC results.

End of the report

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Appendix A. - Appendices

A.1. Appendix – Standard network elements identifiers to be used

For the purpose of the designing the TSO and DSO network in the technical-technological part of the LRAIC model, standard naming convention for the coding of the individual core network elements has to be used. The coding of the network elements is used to map the individual network elements so as to build the network topology in the model.

Each individual core network element (feeder/line, transformer) has to be assigned with the unique respective identifier defined for the respective group of elements. The standard identifier consists of the pre-fix that identifies the voltage level and type of the network element, and the serial number of the network element.

Example of the identifier for the MV/LV transformer is as follows:

$$\underbrace{\textbf{MVLV}}_{\textbf{A}}\underbrace{\textbf{T}}_{\textbf{B}}\textbf{-}\underbrace{\textbf{00001}}_{\textbf{C}}$$

A. MVLV – identifier of the voltage level (in this example Medium voltage to Low voltage)

B. T – identifier of the type of the network element (Transformer)

C. Serial number

Standard identifiers of the network elements for all voltage levels and types of the network elements are defined as follows:

- LV producer LVP-###
- MV/LV transformer (10kV/0.4kV) MVLVT-#####
- MV feeder (10kV) MVF-####
- MV consumer MVC-####
- MV producer MVP-###
- MV/MV transformer (35kV/10kV) MVMVT-####
- MV feeder (35kV) MV35F-####
- HV/MV transformer (110kV/35kV) HVMVT-###
- HV consumer HVC-###
- HV producer HVP-###
- HV line (110kV) HVL-###
- EHV/HV transformer (330 or 400 kV/110 kV) EHVHVT-##
- EHV line (330/400 kV) EHVL-##
- EHV producer EHVP-##

A.2. Appendix – Summary of main requirements and changes for LRAIC model update

Area	Description	Proposed implementation	*Type of Implementation*
CAPEX corrections	Correction of the differences between planned CAPEX as per LRAIC model and actual CAPEX invested by operators in periods before 2021 were done on an annual basis and when the operators did not meet the investment plans, correction were made. This need to be reflected in the new model - such corrections should not be done on the comparison of planned vs actual CAPEX in a single year, since the operators require longer periods to make the investments.	Not be reflected in the model itself, but in the price cap calculation methodology. In the model, new functionality (optimization scenario) can be added, where operators can highlight, if specific network elements are planned for reconstruction within the modelling period and only such elements will be optimised (i.e. if they are included in the network development plan). Thus, the model optimisation scenario will be aligned with the operators' investment plans. In case of DSO, the network development plan may not be available at such a granular level as to be able to highlight specific network elements planned for investments. Therefore, cumulative network development plan values can be provided (i.e. kms of feeders, number of transformers) and the new model optimisation scenario will take it into account.	*Change in price cap regulation* *New model functionality*
CAPEX – new connections	Connection of new customers - 50% of the connection cost is paid by customers, 50% is recovered from a special connection tariff. VERT does not include CAPEX related to customer connection in the actual CAPEX, when calculating the difference between actual and planned CAPEX.	Not to be reflected in the LRAIC model. It is not in the scope of the LRAIC model.	*N/A*
Prosumers	The model needs to take into account the distributed generation and prosumers.	The model will incorporate prosumers connected at different voltage levels. Prosumers should be reflected in the peak load forecast and individual prosumers will also be reflected in the "Generation" worksheets of the model. For prosumers, a coefficient should be defined to take into account only the minimum power generation load of the prosumer. Additional information to be provided as part of the data collection will be the type of the prosumer (solar, wind, etc.)	*New model functionality*
LV feeders	DSO may need to invest into the reconstruction of the LV feeders network, but currently the model does not optimise the LV feeder network. Functionality needs to be added to the model to take this into account.	The original model modelled the LV feeder network only in a simplified way. If DSO can provide data, a more detailed optimisation can be performed also for the LV feeder network. Alternatively, a simplified modelling can be done, for example, based on the indication of the reconstruction requirements provided by DSO.	*New model functionality*
Model	For power lines, the original model	Model functionality to be added, data	*New model*

Area	Description	Proposed implementation	*Type of Implementation*
optimisation	allowed to optimise lines only within their existing type (i.e. overhead line for overhead line, cable line for cable line). The model should allow for the optimisation between different types of power lines - specifically replacement of overhead line with cable, as this is a common real life practice.	collection questionnaire also needs to be updated. The operators will need to provide indications for cases, where such replacement (overhead line for cable) is needed.	*functionality*
OPEX and other network CAPEX	Potentially, OPEX and other CAPEX should be simplified, i.e. not to be part of the modelling, but provided just as an input into the price cap calculation based on the actual costs of the operators	Can be implemented. Minimum impact on the functionality of the model, if simplified, OPEX and other CAPEX data will be directly requested from operators and included in the price cap calculation file.	*Change in Methodological guidelines*
Data collection	In the original model, power lines that had 2 circuits were included in the data collection as 2 separate rows (i.e. as two separate lines) - can it be changed in the model so that they are included in 1 single row?	This would require a more substantial change in the logic of the model in multiple worksheets and calculation formulas. It is suggested to keep the original logic of the model and keep such power lines in 2 separate rows.	*N/A*
CAPEX	The model results have to be aligned with the capacity of the operators to invest and finance the investments.	In the model, new functionality (optimization scenario) can be added, where operators can highlight, if specific network elements are planned for reconstruction within the modelling period and only such elements will be optimised (i.e. if they are included in the network development plan). Thus, the model optimisation scenario will be aligned with the operators' investment plans.	*New model functionality*
Data collection	Cut-off date for data to be collected needs to be confirmed.	Cut-off date to be 31.12.2020, unless stated otherwise. For example, for peak load from Litgrid, the most recent last 365 days can be used. For prices of network technologies - these should be based on the most up-to-date data.	*Definition in the Data collection guidelines*
Data collection	Unit prices of the modelled technologies - operators provide unit prices for modelled technologies based on their own recent purchases and contracts. In cases when the most recent purchases are older, the prices are not actual, and therefore should be adjusted for inflation.	Can be incorporated in the Data collection manual by specifying more precisely in the definition of the unit prices. The inflation to be applied will have to be based on the publicly available inflation index, such as published by statistical authority. Need to confirm, which type of inflation rate should be used (CPI, construction works inflation, etc.)	*Definition in the Data collection guidelines*
Model optimisation	New technologies may have impact on the peak load - batteries, RES, smart meters - should be reflected in the model.	Peak load forecast should reflect such changes. Large scale batteries can also be included in the model as both – consumers and producers – connected to HV network.	*Definition in the Data collection guidelines*
Losses	Can the model re-calculate the technological losses after the optimisation is performed - in order to come up with some efficiency factor,	The model is not designed to perform complex losses modelling Some simple calculation can be done - weighted averages of losses % before	*New model functionality*

Area	Description	Proposed implementation	*Type of Implementation*
	which can be used in the calculation of the tariff?	and after optimisation – by comparing the average losses values as provided by the operators for existing network, with losses after the optimisation, taken into account average losses of the modelled types of technologies.	
OPEX efficiency	Can we come up with some efficiency factor OPEX savings? Specifically related to network related OPEX.	The model is not able to calculate that, we can check for some benchmarks, but usually, OPEX efficiency factors are applied in tariff regulations to overall OPEX, not specifically to network OPEX.	*N/A*
Investments	Operators need to be able to invest flexibly and purposefully, i.e. not strictly into the specific assets as suggested by the model, but flexibly up to the total amount as suggested by the model. Also flexibility in time is needed - i.e. they may invest less in one year and more in another year.	Not be reflected in the model itself, but in the price cap calculation methodology.	*Change in price cap regulation*
Model optimisation	Should the network elements that were already modernised/optimised in previous periods be again subject to the optimisation modelling? I.e., the model shall ensure that the same network elements are not re-optimized if they have been invested in and / or rebuilt, in the previous period of the application of the LRAIC model.	This can be addressed in the model by adding new functionality, where operators can highlight, if specific network elements are planned for reconstruction within the modelling period and only such elements will be optimised (i.e. if they are included in the network development plan). Thus, the model optimisation scenario will be aligned with the operators' investment plans. In case of DSO, the network development plan may not be available at such a granular level as to be able to highlight specific network elements planned for investments. Therefore, cumulative network development plan values can be provided (i.e. kms of feeders, number of transformers) and the new model optimisation scenario will take it into account.	*New model functionality*
Investments	Should there be a tolerance of the deviation between the actual CAPEX invested and planned CAPEX as calculated by the model? And what should be the frequency for such evaluation?	Not be reflected in the model itself, but in the price cap calculation methodology.	*Change in price cap regulation*
LRAIC modelling period	LRAIC model must be modelled in such a way as to determine the network elements for each optimized period of 5 years and 10 years (for modelling purposes and 15, 20 and 25 years).		
Valuation method	Costs of optimised elements should be determined using CCA, non-optimised elements should be determined using HCA.	The model already has this functionality to use both scenario. The suggested scenario is as described – CCA for optimised elements, HCA for non-optimised elements.	*N/A*
Depreciation	Straight-line depreciation calculation method should be used to determine depreciation costs.	The model already has the functionality to use different depreciation scenarios. The suggested depreciation method is straight-line depreciation.	*N/A*

Area	Description	Proposed implementation	*Type of Implementation*
Data collection	The CAPEX for modelled technologies should not be separated into basic unit price and other related CAPEX, because the operators have usually total turnkey prices. It is suggested to provided it as a combined total CAPEX per unit.	No issue with the model functionality, can be provided as a combined price.	*Definition in the Data collection guidelines*
Data collection	Is it necessary to provide data for some fields in the model that are used "for information only" and are not used in the modelling? Such as the names of the power lines and transformers, manufacturer and type?	No impact on the functionality of the model.	*N/A*
Data collection	Can annual depreciation column for CCA be left blank, since CCA will not be used for non-optimised elements?	No impact on the functionality of the model	*N/A*
Unit prices	The LRAIC model requires the operators to provide average unit prices of the main network technologies. While average unit prices are reasonable to be used in the modelling, they should not be used to assess the individual investment projects by the regulator, since actual prices may fluctuate and in some cases can be higher than average prices. Therefore, also the maximum unit prices in certain period should be collected for reference.	No impact on the functionality of the model. Additional data field will be added to data collection questionnaire so that the operators can provide also maximum actual unit prices in certain specified period. This information will not be used in the modelling and will only be used for reference for the regulator	*Definition in the Data collection guidelines*