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Methodological improvements of Resource Adequacy Assessments

Work package 1
Final Report

Determining minimum standards and best-practice for requirements regarding data used in resource adequacy assessments

Study on behalf of the
German Federal Ministry for Economic Affairs and Climate Action (BMWK)

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Methodological improvements of Resource Adequacy Assessments

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Determining minimum standards and best-practice for requirements regarding data used in resource adequacy assessments

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List of Abbreviations

CONE/CORP	Cost of New Entry/Cost of Renewal or Prolongation
DSR	Demand side response
ENTSO-E	European Network of Transmission System Operators for Electricity
ERAA	European Resource Adequacy Assessment
EV	Electric Vehicle
EVA	Economic Viability Assessment
NTC	Net transmission capacity
PtX	Power-to-X
RAA	Resource Adequacy Assessment
RES	Renewable Energy Sources
VoLL	Value of lost load

1 Introduction

The aim of this report is to provide an overview on which input data is needed to deliver a high-quality resource adequacy assessment (RAA). RAA are highly complex modelling exercises characterised by thousands of Monte-Carlo-simulations with varying climatic conditions and availability of resources. At the same time, many or even all EU countries and their respective bidding zones need to be mapped. Therefore, every modeller has to deal with the trade-off between detailed modelling (which requires detailed data inputs) and computational feasibility. While some aspects of modelling approaches and data input quality may have a substantial impact on the outcome of a RAA in terms of quality and robustness, other aspects may be less crucial for the results.

To support modellers in the decision on which data input to focus on, we propose two standards: First, a "minimum standard" which summarizes all requirements on the basis of Art. 23 of EU Electricity Market Regulation 2019/943[1] as well as the associated ACER-approved methodologies developed by ENTSO-E[2]. Second, a "best-practice standard", which aims to reflect the state-of-the-art in recent RAA literature. The results are provided in an Excel workbook which clusters the input data into 4 main and 17 sub-categories, lists the necessary data inputs for the two standards, and addresses potential confidentiality concerns. We also state for each sub-category where, from our point of view, the "minimum standard" would be sufficient and where the "best-practice standard" is more recommendable. In doing so, we take the trade-off between detailed modelling and feasibility into account.

Furthermore, data availability is an issue which RAA-modellers often face. Therefore, we analysed recent RAAs published in the Penta-countries and listed and characterised possible data sources needed for RAA.

2 How to use the list of data inputs and the list of data sources

The provided Excel workbook consists of five sheets. The first sheet provides an overview of the workbook, containing the list of abbreviations, links to relevant documents and the contact information of the authors. The second sheet contains remarks on how to read the list of data inputs. The third sheet is the list of data inputs for each standard. The fourth sheet presents and characterises potential data sources, and the last sheet lists the variables that can be retrieved from there.

2.1 List of data inputs

The aim of the list of data inputs is to give modellers an orientation what data inputs are needed to deliver a high-quality RAA. For this purpose, the "minimum standard" summarizes the requirements that are stated in the EU Regulation[3]. We want to emphasize that the "minimum standard" does therefore not necessarily describe an approach with minimal effort or minimal aspiration. In contrast, the Regulation's requirements are demanding and an assessment fulfilling this standard can, by all means, represent a high-quality RAA.
Where possible, the "best-practice standard" is meant to enrich the "minimum standard" and to reflect the most ambitious approaches in the current literature. However, for some aspects

[1] Cf. European Parliament and the Council (2019).

[2] Cf. ACER (2020a) and ACER (2020b).

[3] Cf. European Parliament and the Council (2019).

the Regulation already requires what we would define as “best-practice” and for some others the difference between the two standards is only marginal.
Applying the “best-practice standard” on each element is, for various reasons, not necessarily desirable. It may be computationally too challenging or have no significant additional value in a specific setting. For example, implementing the “best-practice” set of constraints for thermal generation units may be too costly or even infeasible while the added value may be rather low. Rather, the two standards are intended to show the spectrum of modelling approaches and data inputs available, where the choice to apply the one or other may depend on national specificities. Furthermore, there may be other sensible and appropriate approaches not mentioned here, alongside our proposed best-practice standard.
Therefore, we additionally give a short recommendation for each subcategory on the two standards, based on their costs and benefits. Costs of following the “best-practice” standard may be longer computing times, the infeasibility of optimisation algorithms or increased efforts for data research and preparation. Nevertheless, we do not claim our recommendations to be valid universally. In the end, the choice of data inputs will be in the hands of the modeler and has to fit the specific needs of the assessment.

The focus of this work package is explicitly on data inputs but not on methodology. Of course, uncoupling data inputs and methodology can be challenging, but we tried to give as few methodological instructions as possible. Defining methodological standards is out of the scope of this report and would require a greater effort than listing necessary and recommendable data inputs. However, for a deeper analysis regarding the modelling of DSR, EVA and climate change, the other reports of this project provide valuable insights.

The list of data inputs is provided in an Excel sheet. For each subcategory (see Figure 1: Overview of data input clusters) the following information is given:

- A brief **description** of the RAA element,
- a **reference** to the respective part in the EU Regulation,
- two **lists of data inputs**, one for the “minimum standard” and one for the best-practice standard,
- a **definition** for each standard, stating briefly how the respective standard should be applied in general,
- the necessary **spatial and temporal granularity** of the data inputs to fulfil the respective standards,
- a short **recommendation** which standard should be prioritised based on the scope of the assessment and cost-benefit considerations,
- potential **confidentiality** issues that may arise when collecting or using the data and
- any **restrictions** or limitations that may apply.

2.2 List of data sources

In addition to the list of data inputs, the Excel file lists approx. 50 data sources and the variables they cover, especially for the Penta-countries. In the sheet “list of data sources” we provide some general information for each data source: author, publication year, a short description, the categories the database covers, the type of data (historical, real-time and/or forecast) as well as the covered Penta-countries. Please note, the list does not claim to be complete. There may be other sources that can provide valuable data for RAA.

In the sheet "list of data sources (detailed)", we list all data inputs that occur in the respective data sources. Each variable is categorised according to our clusters from the list of data inputs what allows the user to easily filter for the respective data needs. In addition, we provide information about the time horizon as well as spatial and temporal granularity of the data. Please note, the labels in the list of data sources may be more specific than in the list of data inputs (because they only apply to a specific technology) or need to be transformed before used in energy system modelling (a list of new interconnections projects needs to be translated to new NTC values). Hence, we recommend to filter for categories or subcategories and not for specific data inputs.

Please note, the list only covers publicly available data. Commercial databases are not included. Furthermore, we do not make any statement whether the data sources are open in the sense that they can be freely copied, used, modified, and shared. For more information regarding this topic, we recommend the report of Neon (2018).

3 Approach for developing the list of data inputs

The list of data inputs was developed in three major steps: First, we collected inputs from different sources to ensure all relevant data is taken into consideration. In addition to an extensive literature review and our own expertise, we include the results of the ongoing interaction with stakeholders in the other work packages. Secondly, to provide a more comprehensible overview, the data was clustered into 4 main categories and 17 sub-categories. In a third and last step, we defined the "minimum standard" and "best-practice standard". For each standard the required data inputs and the respective granularity are specified.

The starting point for collecting data inputs was the European regulatory framework for RAA. From there, a large set of variables was identified. In particular, the following three documents were relevant:

- European Parliament and Council (2019): Regulation (EU) 2019/943 of 5 June 2019 on the internal market in electricity
- ACER (2020a): Methodology for the European resource adequacy assessment
- ACER (2020b): Methodology for calculating the value of lost load, the cost of new entry and the reliability standard

Beyond these regulatory guidelines, another main pillar for the literature review were the most recent RAA by ENTSO-E as well as recent assessments within the Penta-region:

- ENTSO-E (2021): European Resource Adequacy Assessment 2021 (Europe)
- Elia (2021): Adequacy and Flexibility Study 2022-2032 (Belgium)
- Penta (2020): Generation Adequacy Assessment (Penta-region)
- TenneT (2020): Monitoring Leveringszekerheid 2020 (Netherlands)
- RTE (2019): Mid-term adequacy report 2019 (France)
- r2b & Consentec (2021): Monitoring the adequacy of resources in the European electricity markets (Germany)

From these sources, we collected all utilized data inputs. In total, we identified approx. 150 different variables.

In order to manage this amount of different data inputs, we decided to cluster them into 4 main categories and a total of 17 sub-categories. Each sub-category reflects an element of the electricity system. This allows to describe the data inputs more concisely and, in the next step,

develop a more comprehensible definition of the standards. We attempted to create sub-categories which are as distinct as possible. However, as all elements of the electricity system

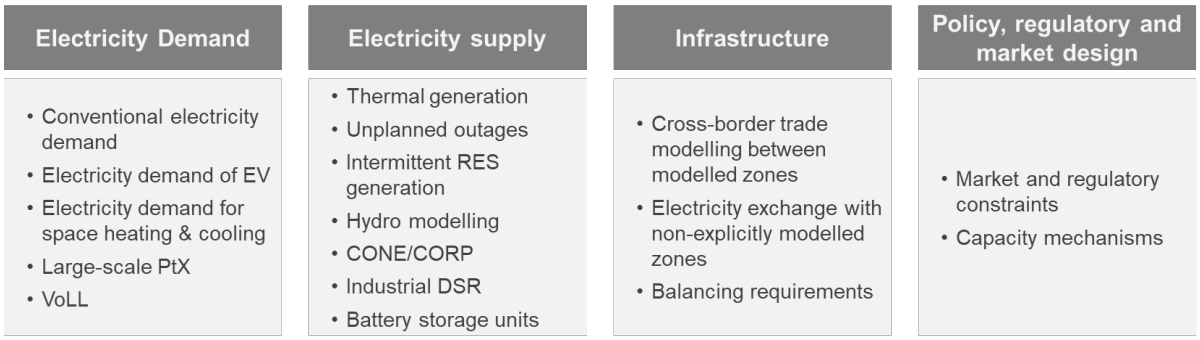

Figure 1: Overview of data input clusters

are interconnected, interdependencies between the subcategories can't be completely avoided. For example, "Unplanned outages" is directly linked to the modelling of "Thermal generation". However, as it plays a rather significant role in resource adequacy, we decided to devote it a subcategory of its own. An overview of the data cluster is given in Figure 1.

In the third step, we defined the "minimum standard" and the "best-practice standard" for future RAA. We specified for each subcategory and each standard the required set of data inputs as well as the respective temporal and spatial granularity. The "minimum standard" refers to the use of data inputs that are required by the European regulatory framework, especially ENTSO-E's methodology for the ERAA as approved by ACER. However, some requirements are only vaguely defined in terms of data inputs. In these cases, we added data inputs to the list that are, in our view, imperative to fulfill the standards set by the EU Regulation. Under the "best-practice standard", data inputs are listed that are not explicitly required by the EU Regulation, but that have additional value for the quality of a RAA. Depending on the nature of these variables, the data inputs of the "minimum standard" may either be complemented or substituted by them. Again: applying the "best-practice standard" on each element is, for various reasons, not a prerequisite for a high-quality RAA. It may be computationally too challenging (or even infeasible), or the additional efforts/costs may not be justified by the additional value in a specific setting.

A pre-final version of the Excel workbook was shared with various experts on RAA modelling to collect their opinions on the supposed definitions of the two different standards as well as our recommendation on their application. Their contributions in the form of a survey provided highly valuable input which allowed us to verify our interim results as well as to improve certain aspects where the experts had valuable suggestions.

4 Deviations from differentiation in two standards

For some sub-categories no distinction between the "minimum standard" and the "best-practice standard" has been made, for various reasons. No distinction was made for:

- Value of Lost Load (VoLL),
- Hydro modelling and
- Market and regulatory constraints.

Sub-category „Value of Lost Load”:

The regulation is very explicit and clear on the usage of a single VoLL per bidding zone: It should reflect the willingness to accept load shedding or the willingness to pay to avoid load shedding, taking into account the preferences of different consumers not active in DSR on electricity markets. Therefore, no distinction regarding the VoLL could be made. Nevertheless, we want to mention, that different single VoLL per bidding zone bear the risk of biasing modelling results in terms of the regional distribution of (dis-)investment during EVA. This risk may especially appear if well interconnected bidding zones are modelled based on very heterogenous VoLL.

Sub-category “Hydro modelling”:

The regulation describes two approaches for “Hydro modelling” – one with direct modelling and one with an ex-ante optimisation. The latter one seems to be somehow tailored for the hydro-modelling methodology performed by ENTSO-E. As we lack sufficient information on this methodology, we, first, cannot make a differentiation regarding the quality and the specific data needs of the two approaches. This is why we listed the data requirements for both of them under “minimum standard”. Second, we are not able to determine whether other approaches in the literature would be superior. Therefore we did not define a “best-practice standard”.

Sub-category “Market and regulatory constraints”:

For market and regulatory constraints no distinction between the “minimum standard” and the “best-practice standard” has been made, because in our view the “minimum standard” derived from the respective regulation covers already all relevant aspects of this subcategory.

5 Summary

Our aim was to provide an overview of data input needs to deliver a high-quality RAA. The results of our work are collected in an Excel file while this report offers accompanying information on our approach and on how to use our results. We collected the data input needs for 17 sub-categories, each representing an element of the electricity system. For each sub-category, we defined a “minimum standard”, summarizing the data input requirements of the relevant EU Regulations, and a “best-practice standard”, presenting the state-of-the-art in recent RAA literature. For three sub-categories, however, we found no distinction between the two standards. Moreover, we give short recommendations on how to deal with the trade-off between model quality and model feasibility. Nevertheless, our results should not be interpreted as a rulebook for RAA but rather as assistance for future assessments. Furthermore, a detailed list of data sources, especially for the Penta-countries, is provided as a starting point for RAA modellers when researching required data.

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