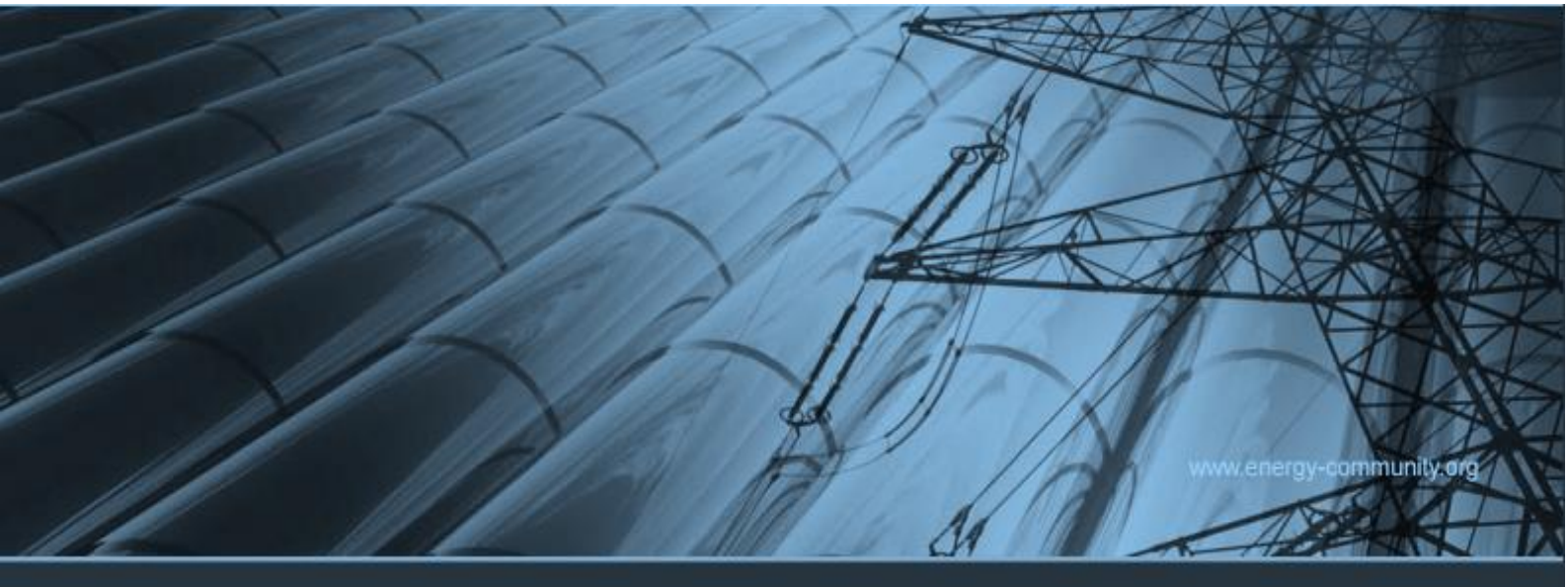
REPORT

On unit investment cost indicators and corresponding reference values for Electricity and Gas infrastructure

ELECTRICITY INFRASTRUCTURE

Energy Community Secretariat



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I. INTRODUCTION

The present Report is the result of the work carried out by the Energy Community Secretariat ("Secretariat") with the assistance of National Regulatory Authorities (hereinafter NRAs or "regulators") cooperating in the framework of the Energy Community Regulatory Board (ECRB), to develop a set of indicators and corresponding reference values for electricity infrastructure, as required under Article 11(2) of Regulation (EU) 347/2013 ("the Regulation").[1] For the purpose of coherent implementation of the Regulation in the Energy Community as well as in the European Union, the Report mirrors the structure of a related Report of the Agency for the Cooperation of Energy Regulators (ACER).[2]

Separate documents contain chapters for electricity and gas infrastructure. This document covers the set of indicators and corresponding reference values for the relevant electricity infrastructure: overhead lines (OHL), underground cables, subsea cables, onshore alternative current (AC) substations, and high voltage direct current (HVDC) converters.

The underlying information is based on historic data about the relevant electricity projects, as provided by the Contracting Parties' regulators. The data provided includes the incurred cost breakdowns and technical information about the assets. The units used are those deemed to be the most useful for the Unit Investment Cost (UIC) analysis, given the quantity of the data available.

This report cannot be considered legal or economic advice, and neither the Energy Community Secretariat nor any national regulatory authority can be held responsible for any consequence arising from the use of the UIC indicators and the reference values thereof.

II. Background and Objectives

2.1 Legal basis

Pursuant to Article 11 (2) of the Regulation,

'*national regulatory authorities… cooperating in the framework of the Energy Community Regulatory Board shall establish and make publicly available a set of indicators and corresponding reference values for the comparison of unit investment costs for comparable projects of the infrastructure categories included in Annex I of the said Regulation*'.

For electricity these infrastructure categories are defined as follows:

'(a) *high-voltage overhead transmission lines, if they have been designed for a voltage of 220 kV or more, and underground and submarine transmission cables, if they have been designed for a voltage of 150 kV or more*;
(b) concerning in particular electricity highways; any physical equipment designed to allow transport of electricity on the high and extra-high voltage level, in view of connecting large amounts of electricity

[1] Adapted and adopted by Ministerial Council Decision 2015/09/MC-EnC. The present Report is without prejudice to Contracting Parties' NRAs developing and publishing their own indicators and reference values at individual Contracting Party or regional level.
[2] www.acer.europa.eu. For the report see: www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/UIC%20Report%20%20-%20Electricity%20infrastructure.pdf

generation or storage located in one or several Contracting Parties or third countries with large-scale electricity consumption in one or several other Contracting Parties;

(c) electricity storage facilities used for storing electricity on a permanent or temporary basis in aboveground or underground infrastructure or geological sites, provided they are directly connected to high-voltage transmission lines designed for a voltage of 110 kV or more;

(d) any equipment or installation essential for the systems defined in (a) to (c) to operate safely, securely and efficiently, including protection, monitoring and control systems at all voltage levels and substations;

(e) any equipment or installation, both at transmission and medium voltage distribution level, aiming at two-way digital communication, real-time or close to real-time, interactive and intelligent monitoring and management of electricity generation, transmission, distribution and consumption within an electricity network in view of developing a network efficiently integrating the behaviour and actions of all users connected to it — generators, consumers and those that do both — in order to ensure an economically efficient, sustainable electricity system with low losses and high quality and security of supply and safety;'

2.2 Objectives

The main objective of the work undertaken by the Secretariat with the assistance of the NRAs cooperating in the framework of the ECRB is to compile a set of UIC indicators and corresponding reference values as required by the Regulation. The indicators are useful for the following purposes:

1. Preparation of the Ten-Year Network Development Plans (TYNDP);
2. Selection of Projects of Energy Community Interest (PECI) and Projects of Mutual Interest (PMI),[3] where the indicators and the reference values can provide a reference point for the assessment of the project promoters' submissions;
3. Development of justifications for regulatory decisions on cross-border cost allocation ,[4] where the indicators and the values can be of help to NRAs when deciding on investment requests and considering cross-border cost allocation; and
4. Analyses associated with public financial assistance, where the indicators and the values can be informative for the agencies and the authorities in charge of the evaluation of proposals for grants to project promoters.

In addition, the indicators may provide greater transparency regarding the levels of costs of electricity infrastructure in the Energy Community Contracting Parties, as well as the structure of the costs and the role of various cost factors.

2.3 Scope of the analysis

The work methodology for the preparation of this Report takes into consideration the variety of asset types and the large range of physical and non-physical cost drivers across the Energy Community

[3] For more details on PECI/PMI see: www.energy-community.org/regionalinitiatives/infrastructure/selection.html.
[4] Ref. Article 12 of the Regulation.

Contracting Parties and therefore provides a solid basis for calculating Unit Investment Costs . In particular, the published unit investment cost indicators and their reference values have been developed by taking into account relevant cost categories that apply to most projects, with an assessment of cost drivers. Costs that are heavily dependent on particular contexts, such as financing costs, were left out of the scope of work.

Data on the historical costs of individual assets rather than projects were collected as projects could potentially include multiple assets that would complicate the analysis.

Due to the fact that only a limited number of electricity infrastructure investments have been realised in the Energy Community Contracting Parties for certain asset categories defined in Annex I of the Regulation recently, a meaningful empirical analysis of the unit investment costs for those categories was not possible. This relates to smart grid, storage investments, undersea cables and HDVC converters. Furthermore, NRAs were not able to provide or collect information on the cost of electricity storage facilities as storage does not fall into the regulated asset base in the Contracting Parties. Taking these restrictions into account, this Report is limited to unit investment costs for overhead lines, onshore AC substations and transformers.

The analysis aims at achieving a balance between the level of detail and the robustness of the values provided. In this respect, the objective is not to have a large number of detailed case studies, but rather to derive UICs for the analysis of infrastructure projects.

Several assumptions had to be made when designing the data collection questionnaires regarding the factors which are likely to be the main cost drivers. To avoid leaving important cost drivers out of the scope of work, NRAs, ACER and ENTSO-E were consulted on the questionnaires prior to the collection of data.

III. Work Methodology

3.1 Data collection

In order to collect the data necessary for this analysis, a questionnaire was distributed to the NRAs which were requested to submit data for new assets belonging to one of the five asset categories outlined in chapter 1. Information on individual transformers was also provided as part of the AC substation asset category. Data was also requested for HVDC converters, however the level of replies was insufficient to develop concluding values for these assets.
Transmission system operators (TSOs) of the Contracting Parties were asked to submit constructed assets during the last ten years.

3.2 Types of data collected

Two forms of data were collected for each asset:

- Technical characteristics of the project to assess cost drivers; and
- Total costs divided into cost categories to assess cost breakdowns.

The technical characteristics were assessed to identify reliable cost drivers. Where more reliable cost drivers were found, the characteristics were used to produce the outputs outlined in chapter 4. For all asset categories, the total asset costs were divided into the following cost categories:

1. Materials and assembly costs:
   - Materials and manufacturing
   - Installation and civil works
   - Engineering and commissioning
2. Other costs:
   - Project management
   - Regulatory requirements and consent
   - Studies and surveys

The categories were used to establish cost breakdowns for each asset type in order to give an indication of how costs were structured per unit.

3.3 Treatment of taxes and exchange rates

Treatment of taxes
All cost information was requested to be reported net of taxes (direct or indirect), in order to eliminate the effects of taxation on the reported investment costs.

Treatment of exchange rates
Where data was not reported in euros, it was converted to euros using the 2018 exchange rate. The approach reflects the real cost of the assets to consumers in non-euro countries, and avoids the outputs being subject to exchange rate volatility.

IV. Set of indicators and their corresponding reference values

The following is the set of indicators and corresponding reference values for UICs in electricity infrastructure. All values are rounded to the nearest euro (€) and are presented as anonymized UICs in the most relevant units for each asset where data is available.

Sample size:

Table 1: Number of assets in the sample

Type of infrastructure	No. of Contracting Parties represented	Investment items
Overhead lines	7	16
AC substations	7	7
Underground cables	0	0
HVDC converters	0	0
Subsea cables	0	0
Offshore substations	0	0

4.1 Transmission network

4.1.1 Overhead lines

Only AC OHLs were part of the sample. Voltage was the most significant cost-driver.

Table 2: UIC indicators for overhead lines

Total cost per circuit route length (km)		
Type	**Mean (€)**	**No. of assets**
750 kV, 2 circuit	NA	0
750 kV, 1 circuit	368.469,75	1
380-400 kV, 2 circuit	378.205,01	5
380-400 kV, 1 circuit	250.494,84	6
220-225 kV, 2 circuit	250.000,00	1
220-225 kV, 1 circuit	169.037,10	2

4.2 Associated equipment

4.2.1 AC substation (onshore)

Only those substations were assessed, for which the substation owner included in his/her submission the costs of the main transformers. The total substation rating was identified as the most significant cost driver. Busbar voltage was also a highly significant cost driver, as was the number of bays. Voltage UICs are therefore also split between the number of bays in the substation for Air Insulated Substations (AIS). Gas Insulated Substations (GIS) were assessed separately, however without being split between the number of bays.

Table 3: UIC indicators for AC substations by rating

Total cost per total rating of the power transformers (MVA)	Mean (€)	No. of assets
400/220 kV	6.750	1
400/110 kV	7.954	7
220/110 kV	12.079	3

Table 4: UIC indicators for AC substations by voltage

Total substation cost	Mean (€)	No. of assets
All GIS substations	0	0
AIS with 9+ bays	9.906.104	4
AIS with 5-8 bays	0	0
AIS with 1-4 bays	1.082.312	3

It was not possible to provide a cost breakdown for AC substations because complete and reliable cost category breakdowns were only provided for a limited number of assets.

4.3 Summary table

Table 5: Summary UICs

Voltage	Type	Cost
750 kV OHLs (cost (EUR) / km)	single line	360.000-380.000
	double line	NA
400 kV OHLs (cost (EUR) / km)	single line	240.000-280.000
	double line	370.000-420.000
220 kV OHLs (cost (EUR) / km)	single line	160.000-200.000
	double line	230.000-250.000
110 kV OHLs (cost (EUR) / km)	single line	70.000
	double line	120.000
POWER TRANSFORMERS (cost (EUR) / capacity (MVA))	400/220 kV	2,7 mil.€ (6.750 €/MVA)
	400/110 kV	2,4 mil.€ (8000 €/MVA)
	220/110 kV	1,95 mil.€ (12.000 €/MVA)
LINE BAYS (cost (EUR) / OHL bay)	400 kV	750.000
	220 kV	450.000
	110 kV	250.000

V. Conclusions

It has to be noted that the available sample size was significantly lower in the Energy Community Contracting Parties compared to the analysis developed by ACER on EU level. Only 15 assets for overhead lines and eleven assets for substations took part in the exercise. Consequently, the level of depth of the statistical analysis is relatively lower.

With the above restrictions and bearing in mind the limited amount of available data, it can be concluded that electricity infrastructure assets costs in the Energy Community Contracting Parties are considerably lower than those in the EU.

VI. REFERENCES

1. EU Energy Law, The Energy Infrastructure Policy of the European Union, Volume VIII, Clayes & Casteels 2014
2. https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest
3. http://www.e-control.at/en/marktteilnehmer/gas/infrastrukturplanung/eu-energie-infrastruktur-paket#p_p_id_56_INSTANCE_BAtdy2biHaDc_
4. https://www.energy-community.org/regionalinitiatives/infrastructure/selection.html
5. https://www.energy-community.org/regionalinitiatives/infrastructure/PLIMA.html