Norges
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NVE

TENDER DOCUMENT

Competitive procedure with negotiation,
in accordance with the Norwegian Public Procurement Regulations, Part I

DEVELOPING METHODS FOR COMBINING DATA THAT CAN BE USED FOR CALCULATING POWER DISTANCE

Case no
202004353

Norges
vassdrags- og
energidirektorat

NVE

Contents

Norges vassdrags- og energidirektorat

NVE

1 GENERAL DESCRIPTION

1.1 *Contracting authority*

The mandate to the Norwegian Energy Regulatory Authority (NVE-RME) is to ensure an integrated and environmentally sound management of the country's water and energy resources. The directorate plays a central role in the national flood contingency planning and bears overall responsibility for maintaining national power supplies.

The NVE head office is located in Oslo, and the regional offices are located in Førde, Trondheim, Narvik, Tønsberg and Hamar. NVE has ca. 600 employees.

1.2 *Scope*

Through previous projects, we have gained more insight into what data is required to calculate power distance and its related variables. Power distance has been calculated using different methods. Data has been collected and compiled in small pilot datasets with a lot of manual adjustment. We are now launching a project on how to develop methods for combining data that can be used for calculating the new variables.

The delivery must be in form of a written report. We also require test datasets that can be used as input to power distance calculations. Any code, scripts, procedures, etc. that were used to produce the datasets must also be a part of the delivery.

The delivery date is 15.09.2020 and the assignment has a financial limit of up to NOK 600,000 excluding VAT.

A complete description of the delivery follows from Appendix 1 to the contract.

As mentioned, this project is a part of several projects which aims to develop new exogenous variables that can be utilized in benchmarking models. A description of these projects follows from Appendix 2 to the contract.

1.3 *Information about lots*

This contract is not divided into lots.

Norges vassdrags- og energidirektorat
NVE

1.4 *Important deadlines*

The following deadlines will apply for this assignment:

Activity	Dealine
Submission of tender	22.5.2020 12:00
Evaluation	2 Weeks
Notification of award	25.5.2020
Signing of contract	1.6.202
Period of validity of tenders	3 months

The deadlines after the tender opening are preliminary. An extension of the period of validity of tenders must be agreed with the supplier.

2 REGULATIONS FOR TENDER COMPETITION AND TENDER REQUIREMENTS

2.1 *Procurement procedure*

The procurement is conducted in accordance with the Norwegian Public Procurement Act of 17 June 2016 (LOA) and Public Procurement Regulations (FOA) FOR 2016-08-12-974, Part I.

2.2 *Confidentiality*

The contracting authority and its employees are obliged to prevent others from gaining access to knowledge of information about technical installations and procedures or operating and business relationships that will be of commercial importance, to secrecy, cf. FOA § 7-4, cf. the Norwegian Public Administration Act § 13.

2.3 *Period of validity of tenders*

Tenders shall remain valid for the period as specified in item 1.4.

2.4 *Reservations and deviations*

If the supplier makes reservations for parts of the tender document / requirement specification / contract or other competition documents, this must be clearly stated in the tender. The reservations must be specified with the consequences for performance, price or other conditions.

The same applies to deviations. Reservations and deviations must be precise and clear and included in the tender letter so that the client can evaluate it without contact with the supplier. Substantial reservations and deviations will result in the offer being rejected.

Supplier's reference to standardized delivery terms or the like will be considered as reservation if they deviate from the applicable competition or contractual terms.

2.5 *Communication*

All communication regarding this procurement shall take place via Mercell, www.mercell.no

Questions/inquiries that are received later than five (5) working days prior to the tender submission will not be answered.

3 QUALIFICATION CRITERIA

3.1 *Skatteattest (tax certificate)*

Criteria	Documentation requirements
Norwegian suppliers must fulfill the requirements with regard to payment of taxes, payroll taxes and value added taxes.	• Tax certificate, not older than 6 months.

3.2 *Supplier's registration, authorization etc.*

Criteria	Documentation requirements
Supplier must be registered in a professional or trade register in the country where the company is established.	• For Norwegian companies: Firmaattest • For foreign companies: Documentation that the company is registered in a professional or trade register as required by law in the country where the company is legally established.

4 AWARD CRITERIA

The tenders will be evaluated according to the following weighted criteria. The tender with the best combined score of price and quality will be awarded.

Criteria	Weight	Documentation requirements
Price	10 %	Complete Financial proposal shall include: • Total price of the project • Fee rates of all personnel • Specified budget with input of all personnel and other expenses (travels, equipment etc) Financial Proposals shall be denominated in NOK
Quality	90%	The Technical Proposal shall include, but not necessarily be limited to: • Proposed solution • Description of Methodology • Work Plan • List of personnel with input (man-hours) and role in the assignment and CVs of all personnel (maximum 3 pages per CV including references)

5 TENDER SUBMISSION AND FORMAT

5.1 *Submission of tenders*

The tenders must be submitted electronically in Mercell.

5.2 *Format*

The tender must be submitted in accordance with the format the electronic system for tender submission requires.

6 ATTACHMENTS

1. Project description
2. Description of main project
3. Tender letter
4. NVE-RME's General Terms and Conditions (uploaded in Mercell)

Norges
vassdrags- og
energidirektorat

NVE

ATTACHMENT 1 – PROJECT DESCRIPTION

Developing methods for combining data that can be used for calculating power distance

New exogenous variables for capturing DSO tasks

The Norwegian Energy Regulatory Authority (NVE-RME), an independent regulator within The Norwegian Water Resources and Energy Directorate (NVE), is in the process of developing new exogenous variables that better reflect the tasks of the electricity Distribution System Operator (DSO). For capturing the task of supplying power, we are developing the power distance. This variable reflects the fact that consumers are different in their demand (for power) and their respective location in relation to the injection points. In addition, we intend to develop a variable that captures the customers' demand for reliability of supply following a similar approach as for the power distance. This will be announced in a separate request for tender.

Please refer to the document 'Main Project description: New exogenous measures for capturing DSO tasks', attached to this tender, for more details regarding the development of the power distance variables. Through these projects, we have gained more insight into what data is required to calculate power distance and its related variables. Power distance has been calculated using different methods. Data has been collected and compiled in small pilot datasets with a lot of manual adjustment. We are now launching a project on how to develop methods for combining data that can be used for calculating the new variables.

Calculation of new exogenous variables – data requirements

Through previous projects we have developed methods for calculating the power distance. These make use of power flow computations as well as mathematical and statistical techniques. Although the methods are different, data requirements are quite similar:

1. The location of meters (Source: Elhub)
    a. Preferably XY coordinates
    b. Alternatively: Address information
2. Electricity consumption and production (Source: Elhub)
    a. Per meter
    b. Per hour
    c. Per customer category (household, agriculture, commerce, industry, etc.)
3. Location of generation plants, transformer and substations (Source: NVE)

The power distance and its related variables can be calculated for the entire value chain (figure 1), from generation to consumption. However, the amount of data increases as one moves closer to the end-consumer.

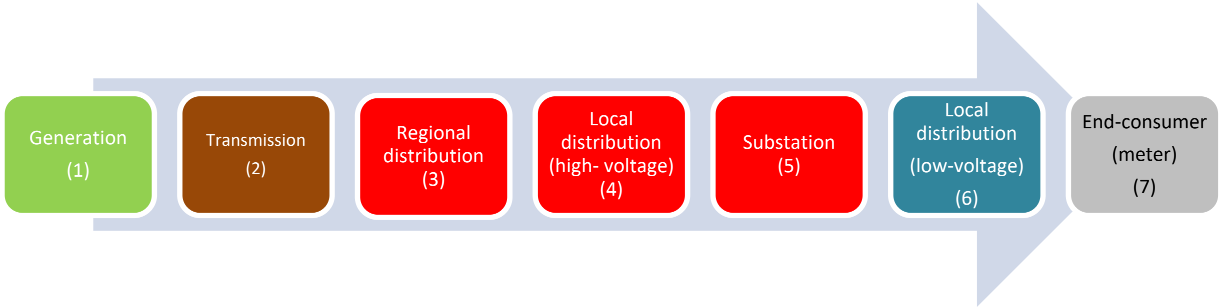

Figure 1: The electricity value chain

Elhub – A central hub for metering data

In February 2019, the electricity industry's common data hub (Elhub), went into operation. Elhub ensures efficient exchange of metering values and customer information used for supplier switching, settlement and invoicing of tariffs and electricity sales. Elhub provides the opportunity to gain access to very detailed data on consumption and production. Our long-term goal is to routinely collect metering data from Elhub. However, because Elhub is a relatively new system, we cannot expect to get data until earliest 2021. This puts certain limitations on this project.

It is important to mention that there is no network/grid model in Elhub. As such, the meters are not connected to grid components (lines, cables or transformers). This means that consumption data cannot accurately be aggregated to i.e. a transformer or substation.

Geographical grid infrastructure data

We have a nationwide geographical dataset that covers the entire grid from transmission to local distribution. This includes lines and cables, transformer and substations. The dataset does not include meters. The latest data for the distribution grid is from 2018, while transmission and regional grid data is regularly collected from the Transmission System Operator (Statnett). The dataset consists of loose objects which means there is no grid topology or connectivity. Data is stored and managed in ESRIs (Environmental Systems Research Institute) geodatabase system.

Calculating power distance at the substation level

As previously mentioned, the power distance variable can be calculated from injection points to the individual meters (end consumers). There are two main challenges with this approach. First, household electricity consumption data is sensitive information protected by GDPR. This imposes strict requirements on any party (including government agencies) that wants to use these data. The second argument is related to the sheer amount of metering data. There are approximately 3.2 million meters in the local distribution system and with an hourly time resolution, data volumes become very large.

For these reasons, it is more practical to sum up the individual metering values to the substation level. There are approximately 130,000 substations in the local distribution grid. This approach significantly reduces data volumes and mitigates problems concerning GDPR.

About the purchase

The prerequisite for this project is that a reference group, consisting of a few Norwegian DSOs, will provide metering data. Based on these data, we require a study to be made on how to compile metering and grid data to a uniform dataset that can be used in calculating power and energy distance.

We require that this work is based on software available for us. This includes Python, R, ESRI (ArcGIS and associated tools) and SQL server.

The order is divided into the following activities:

1. Collect detailed metering data from the reference group
    a. Perform a data need assessment in close co-operation with NVE-RME
    b. Design a general report that can be used to retrieve relevant data from Elhub
2. Connect meters to substation
    a. Investigate and propose methods for connecting meters to nearest substation

       We have developed a GIS-method for this purpose. We advise you to consider this method while investigating other approaches.
    b. Find a method for retrieving XY coordinates from address information (for meters not registered with XY coordinates)
    c. GDPR legislation requires that substations be associated with no less than three households or holiday homes. If not, these meters (meterIDs) need to be connected to the subsequent substation. This requirement does not apply to other customer groups.
3. Establish a method for compiling substation and metering data to a coherent dataset that can be used as input data for calculating new variables

   The resulting dataset should be a list of all substations with associated meterIDs and customer classification codes.
4. Discuss possible challenges by applying methods to nationwide datasets. As previously mentioned, the end goal is to retrieve complete data from Elhub.

Workform

Involvement and meetings

We consider it important to be closely involved in this study. Therefore, we would like three representatives from the Norwegian DSOs to be included in a reference group along with us. We also ask that the project management and the reference group hold regular meetings through video conference or on our premises in Oslo, if possible.

Follow-up of progress

A monthly status report is required, which shall include the following:

- Man-hours spent during the month
- Any other costs incurred
- A short status on progress according to the proposed work plan

Norges
vassdrags- og
energidirektorat

NVE

Delivery

The delivery must be in form of a written report. The report must be in English and contain a supplementary summary. If NVE-RME so wishes, the report will be published as part of our official report series. We also require test datasets that can be used as input to power distance calculations. Any code, scripts, procedures, etc. that were used to produce the datasets must also be a part of the delivery.

Delivery time for the report is 15. September 2020

Norges
vassdrags- og
energidirektorat

NVE

ATTACHMENT 2 – DESCRIPTION OF MAIN PROJECT

Main Project description: New exogenous measures for capturing DSO tasks

Introduction – The economic regulation of Norwegian DSOs

The Norwegian Energy Regulatory Authority (NVE-RME) is an independent regulator within The Norwegian Water Resources and Energy Directorate (NVE), responsible for economic regulation of distribution system operators (DSOs). NVE-RME issues legal decisions, outlining what each DSO is allowed to collect in revenue through network tariffs. The allowed revenue covers operating cost and depreciations and gives a reasonable return on investment.

To promote cost efficiency, NVE-RME applies Data Envelopment Analysis (DEA) as a benchmarking tool. The DEA model calculates each company's relative efficiency by comparing all companies' output/input ratios. Input is a measure of DSO costs and are well-defined. Relevant outputs must be defined in such a way that they capture relevant DSO tasks and ensure comparability among DSOs. In the current model, we apply the following outputs: 1) Number of customers, 2) Length of the high voltage grid and 3) Number of substations in the high voltage grid. The current benchmarking has two main disadvantages: it does not necessarily reflect that DSOs supply different volumes of power over different distances, and the size of the output is partly under DSO control through their investment decisions (they are not exogenous).

DSOs are facing new and challenging tasks

DSO tasks are changing due to increased use and dependency on electricity. Increased electrification and more production from distributed renewable sources affect DSO tasks. DSOs face new and challenging customers – charging points for ferries, ships and vehicles, electrification of fish farms and offshore petroleum industries, new data storage facilities, etc. Consumers that until now have been somewhat alike, with similar or predictable consumption patterns, are becoming increasingly more heterogenous. Consumer demands for power, energy, reliability or quality vary. We also observe that new types of customers are located further from injection points than what has usually been the case. This trend is not equally distributed geographically, affecting DSOs differently.

Developing new variables for capturing DSO tasks

As more data is made available from smart meters and centralized databases, new output parameters for the DEA model can be considered. Ideally, such parameters should represent DSO *tasks* (not their effort to solve a task, i.e. building lines or substations) and provide the right incentives, while being highly exogenous, comparable and easy to compute from existing data.

We have initiated a project aimed at establishing a new set of parameters that can be applied in the DEA model. This project consists of several sub-projects, some of which have been completed, as listed in the table below.

No	Project	Category	Year	Status
1	Investigating the minimal power distance	Theory	2018	Completed
2	Developing power and energy distances	Methodology and application	2019	Completed
3	Developing geographical datasets	Data handling	2019	Completed
4	Developing methods for combining data that can be used for calculating power and energy distance	Data handling	2020	Not started
5	Developing and testing methods for calculating power and energy distance.	Theory, methodology, application	2020	Not started
6	Developing new variables for measuring the task of supplying reliability	Theory, methodology and application	2020	Not started

Short summary of completed projects

1. Investigating the minimal power distance (2018)

The concept of power distance is not new, but a successful development of the variable has been hindered by a lack of necessary data. Power distance is a measurement of the amount of power that the DSOs must supply to consumers and the distance in which this power is transported. The power distance is a compound variable and reflects that volume and distance are two tasks that must considered collectively. Power distance is not a physical measurement but must rather be interpreted as a cost function. The function is linear in distance (building a 2 km power line is about twice as expensive as a 1 km power line with the same capacity) and non-linear in volume (it is not twice as expensive to carry 2 MW as 1 MW over the same distance).

A completely exogenous measure for DSO tasks is the *minimal power distance* within its grid area, given an obligation to cover all loads and handle power fed into the grid from distributed generation. The minimum power distance can be found through mathematical optimization procedures.

We have analyzed how an optimal/minimal power distance can be derived. The study concluded that it is impossible to calculate the minimal power distance in a meshed distribution grid, but that there are other alternatives that should be considered and investigated further. This includes the use of a power flow approach on an unconstrained grid with normalized line parameters.

The projected is documented in NVE Report 5/2019 – Computing the Power Distance Parameter (http://publikasjoner.nve.no/eksternrapport/2019/eksternrapport2019_05.pdf)

2. Developing power and energy distance (2019)

In this study, we developed and analyzed three different methods of deriving the power distance. The methods have different data requirements and vary in terms of computational complexity:

- **Power flow-based distance:**
  The power distance based on physically optimal flows in the existing grid with normalized line parameters
- **Artificial grid-based power distance:**
  The power distance is computed for an artificially constructed grid that connects all substations based on the minimal increase in power distance. The construction of this grid reflects the economies of scale of building a stronger connection
- **Demand distribution-based power distance:**
  The power distance obtained from the statistical distribution of demand around each transformer station without considering the grid

These methods are applied on a selection of test data. The input data is:

- Location of overhead lines and cables (supplied by NVEs centralized database)
- Location of transformer and substations (supplied by NVEs centralized database)
- Metering data (consumption)
  - Consumption and production data are routinely reported to Elhub, but it is not yet possible to retrieve data from Elhub
  - Data was thus supplied by six DSO's
  - Individual metering data aggregated to connected/nearest substation (aggregation carried out by the DSO)

The results of the different methods conclude that the power flow-based power distance is identified as the most suitable method. At the moment, the use of real grid data (lines and cables) poses challenges that impede its use in regulation. For this reason, it is proposed that the artificial grid-based power distance is applied, with possibly an ex-post geographical adjustment.

The projected is documented in NVE Report 1/2019 – Power Distance as an Output Parameter for Grid Companies (http://publikasjoner.nve.no/rme_eksternrapport/2019/rme_eksternrapport2019_01.pdf)

3. Establish geographical data sets (2019)

We have a nationwide geographical dataset that covers the entire power grid from transmission to local distribution. Data is collected from 110 DSOs, but due to lack of common standards or information models, data is not easily compiled into a coherent data structure. The dataset consists of 'loose' objects, which means that there is no grid topology or connectivity, which are necessary to calculate power distance.

For this reason, we analyzed how geographical datasets can be constructed for calculation of the distance variables. Two approaches were investigated:

- Tidy up the existing geographical dataset over lines, cables and substations – establish connectivity, remove meshes and parallel infrastructure; manipulate existing geographical dataset on grid infrastructure

- Construct a theoretical grid based on existing location of transformer and substations (so-called nodes)

We concluded that the existing geographical dataset over lines, cables and substations is not suited for the calculation of power distance. There are simply too many meshes, unconnected lines and other irregularities that cannot be corrected automatically. The new variables should rather be based on a constructed grid. We propose one method (based on Prims algorithm[1]) for constructing a new grid based on the location of transformer and substations.

The delivery of this project was not a written report. The algorithms are performed using Python code with embedded ESRI functionality. For this project, the delivery consists of these scripts along with a short summary of each and produced datasets. The data sets are stored in an ESRI file geodatabase.

[1] https://en.wikipedia.org/wiki/Prim%27s_algorithm

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ATTACHMENT 3

Supplier shall complete the table below and sign under the table.

Company name:			
Company number:			
Adress:			
Visiting adress:			
Telephone number:			

Contact person:			
Telephone number:		Mobile number:	
E-mail adress:			

☐ We stand by our tender until the date given in the tender document. The tender can be accepted by the contracting authority anytime up to the end of the period of validity of tenders.

Place Date Signature

Name in block capitals