Norges
vassdrags- og
energidirektorat

NVE

TENDER DOCUMENT

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

DEVELOPING VARIABLES FOR
MEASURING THE TASK OF
SUPPLYING RELIABILITY

Case no
202004355

Norges vassdrags- og energidirektorat

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1 GENERAL DESCRIPTION

1.1 *Contracting authority*

The mandate to the Norwegian Energy Regulatory Authority (NVE-RME) 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*

We are in the process of developing new exogenous variables that reflect the tasks of electricity Distribution System Operators. For capturing the task of supplying power and energy, we seek to develop the power and energy distance variables. In addition to these tasks, we want to investigate the task of supplying reliability to customers. As with power distance, the task of supplying reliability is dependent on the location of customers and injection points within the grid.

We require study to be made on how to design and calculate one or more variables reflecting the task of supplying the demanded reliability of supply from injection points to the various customers.

The product of the project is a report written in English.

The delivery date is 15.11.2020 and the assignment has a financial limit of up to NOK 700,000 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.

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)

ATTACHMENT 1 – PROJECT DESCRIPTION

Developing variables for measuring the task of supplying reliability

New exogenous variables for capturing task of DSO

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 electricity Distribution System Operator (DSO). For capturing the task of supplying power and energy, we seek to develop the power and energy distance variables. These reflect the fact that consumers have varied demands (for power and energy) *and* locations in respect to injection points. 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.

In addition to the tasks related to supplying power and energy, we want to investigate the task of supplying reliability to customers and how this task can be expressed by a variable such as the power distance. Some customers may demand different levels of reliability of power supply. Typically, a factory demands a higher level of reliability than a household. Charging points for ferries and other transportation are also expected to have higher demand for reliability than a regular household. As with power distance, the task of supplying reliability is dependent on the location of customers and injection points within the grid. The task of providing a certain level of reliability of supply to a factory will depend on its location relative to the injection points.

CENS – An expression of the demand for reliability of supply

Power outages always occur at a cost for those affected. The costs depend on several factors: the duration of the interruption, the season (winter/summer), the time of day and whether the interruption was notified in advance or not. Interruption costs can be expressed by the Value of Lost Load (VoLL). CENS – the Costs of Energy Not Supplied – is a measure of VoLL used in economic regulation of Norwegian DSOs. CENS provides an incentive for DSOs to maintain their assets properly and ensure necessary investments in order to avoid power outages at a socioeconomic efficient level. We do this by deducting CENS from the allowed revenue.

CENS is a theoretical cost that is different from ordinary operating costs. It is based on qualitative studies of customers' direct or indirect costs associated with power outages. Based on these studies, cost functions (CENS) are defined:

CENS (NOK) = ƒ (customer category, power, month, weekday, time of day, duration, notification)

Because different customers have different costs related to interruptions, we have defined several functions, one for each customer category. CENS functions are defined in the regulation on economical and technical reporting, allowed revenue for network operation and tariffs (Norwegian translation: *Forskrift om økonomisk og teknisk rapportering, inntektsramme for nettvirksomheten og tariffer»,* https://lovdata.no/dokument/SF/forskrift/1999-03-11-302).

We believe that demand for reliability can be expressed by using the CENS functions and that a new variable capturing the task of supplying reliability should be based on these.

"The reliability distance" – capturing the task of supplying reliability

We want to capture the task of meeting the demand for reliability of supply in a new variable, called the reliability distance. This variable should reflect the variation in costs related in meeting the demand for reliability from different customers, and the distance over which this reliability must be supplied. This follows the same logic as the power and energy distance variables as previously discussed.

The new variable could be based on the following:

- Data on electricity consumption, broken down into customer categories
- Load profiles
- Interruption durations
- CENS functions
- Location of consumption (geographical data)

There are 3.2 million individual meters in the Norwegian distribution grid. Due to impractical, large amounts of data and privacy issues, variables must be calculated at substation level. One or more consumers are connected to a substation. This consumption should be aggregated, by customer group, to the nearest substation. In this context, substations can be considered as 'demand points'. By utilizing CENS-functions and assumptions about load profiles and interruption durations, one should be able to find a measure for the demand for reliability at substation level. Further, knowing the geographical location of substations, it is possible to calculate the 'reliability distance'.

Methods for aggregating metering data to nearest substation and calculating distance are already established through previous projects. It is important that the development of 'reliability distance' makes use of these methodologies.

About the purchase

NVE-RME requires a study to be made on how to design and calculate one or more variables reflecting the task of supplying the demanded reliability of supply from injection points to the various customers. In this document, we have presented our thinking on how such a variable should be constructed. We want consultants to use this as a starting point, but we also encourage alternative approaches.

We want a brief literature study, or comparative study between countries, on how the task of delivering reliability of supply is considered in benchmarking models.

A detailed description of the methods and algorithms for how to calculate the reliability distance variable is required. It must be possible to calculate the variables by using data, software and tools available to NVE-RME. This includes Python, R, ESRI (ArcGIS and associated tools) and SQL server.

As data from Elhub is not yet available to us, we will invite a few DSOs to contribute the necessary data on consumption and customers. We ask consultants to provide actual calculations based on these data. You must further provide interpretations and discussions on the proposed variables and calculations.

This project is based on the completed projects relating to the development of the power and energy distance variables. Consultants are obliged to read the project reports and apply the power distance methodology when considering the reliability distance.

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

Delivery

The delivery should be in the 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.

Delivery time for the report is 15. November 2020

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

Norges vassdrags- og energidirektorat

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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