Norges
vassdrags- og
energidirektorat

NVE

TENDER DOCUMENT

Competition of the Public Procurement Act and the Regulations relating to public procurement part I (below 1.300.000 NOK)

New methods for an exogenous demand measure in power distribution

Case no.
201835555

Versjon 1.1 August 2018

Norges vassdrags- og energidirektorat

NVE

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1 GENERAL DESCRIPTION

1.1 *Contracting authority*

The Norwegian Water Resources and Energy Directorate (NVE) invites you to compete on the task described in this document.

NVE is a directorate under the Ministry of Petroleum and Energy and is responsible for the management of Norway's water and energy resources. The Norwegian Energy Regulatory Authority is the national regulator for the Norwegian electricity and downstream gas market. The Norwegian Energy Regulatory Authority's main statutory objective is to promote social and economic development through an efficient and environmentally sound energy production, as well as efficient and reliable transmission, distribution, trade and efficient use of energy. Responsibility encompasses the regulatory area as well as other activities defined by law, regulations and decisions made the Norwegian Parliament. The Norwegian Energy Regulatory Authority has delegated powers according to the Energy Act (in Norwegian). It has the authority to issue regulations on economic and technical reporting, network revenues, market access and network tariffs, non-discriminatory behavior, customer information, metering, settlement and billing as well as the organised physical power exchange (Nord Pool Spot).

In this task, NVE will be the contractual part and contact point.

1.2 *Scope*

The task specifications are set out in attachment I.

1.3 *Important deadlines*

The following deadlines will apply for this assignment:

Activity	Deadline
Submission of tender	26/09/2018 12:00
Evaluation	1 week
Signing of contract	03/10/2018
Validity of submitted tender	60 days
Final delivery	The final delivery must be 30/11/2018. Some clarifications may occur in 2019.

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.

The contracting authority plans to award a contract without having any contact with the suppliers except for minor clarifications / corrections of the tenders.
Negotiations can still be completed if, after receiving the offer, the contracting authority considers it appropriate. In this case, the selection will be made in accordance with an assessment of the award criteria. It is emphasized that suppliers cannot expect dialogue about their tender and therefore they must deliver their best tender.

The consultant is strongly encouraged to follow the instructions given in this tender document with attachments, and ask if something is unclear.

2.2 *Confidentiality*

The Norwegian Freedom of Information Act regulates the public access to the documents relating to a public procurement. The contracting authority and its employees are obliged to prevent others not specified in this tender from gaining access to knowledge of information about technical installations and procedures or operating and business conditions that due to commercial importance are confidential, cf. FOA §§ 7-3 and 7-4 and, 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 1.3.

2.4 *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.

2.5 *Use of subcontractor*

If the supplier makes use of a subcontractor, the supplier has to lay documentation before the contracting authority establishing that the necessary resources will be made available to the supplier, such as a declaration of commitment between the supplier and the subcontractor.

2.6 *Reservation*

If all prices are too high, NVE can cancel the competition.

3 QUALIFICATION CRITERIA

The suppliers have to fill in the electronic self-declaration form as a preliminary documentation that they fulfill the following qualification criteria.

3.1 *The supplier's technical and professional qualifications*

Criteria	Documentation requirements
Suppliers must have relevant experience from comparable tasks	A description of up to 3 relevant tasks from the last three years. The description has to include each task's financial value, date and employer (name, phone number, e-mail address). The suppliers are themselves responsible for adequately highlighting the tasks' relevance and the supplier's experience.
Supplier must fulfill the requirements with regard to payment of taxes, payroll taxes and value added taxes.	For Norwegian suppliers: Tax certificate, not older than 6 months. For foreign companies: Other documentation/confirmation.

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
Financial proposal	30%	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
Technical proposal	70% (i) (ii)	The Technical Proposal shall include, but not necessarily be limited to: Comments on Project Description Description of Methodology and Work Plan

Criteria	Weight	Documentation requirements
	(iii)	List of personnel with input (man-hours) and role in the assignment and CVs of all personnel (maximum 4 pages per CV).

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

I. Project specification
II. Tender letter

Norges vassdrags- og energidirektorat

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ATTACHMENT I

Introduction

The Norwegian Water and Energy Resource Directorate (NVE) determines the distribution system operators' (DSOs) allowed revenues every year. The 123 DSOs vary in size, with number of customers spanning from 150 to 700 000. NVE applies Data Envelopment Analysis (DEA) as benchmarking method when determining the DSOs' allowed revenues. The DEA-model calculates each company's relative efficiency by comparing all companies' output/input ratios. The outputs measure the tasks the DSOs have to solve. The input is a measure of the DSOs' costs, which are well defined. The relevant outputs have to be defined in a way that is ensuring comparability among the DSOs' tasks. It is therefore very important to define output variables which describe the tasks of the DSOs in a proper manner.

In NVE's latest DEA-model for DSOs in local distribution (LD) we apply an input oriented, single-input, cost minimization model with three outputs and constant returns to scale. The outputs are:

- number of customers,
- number of kilometers of high voltage grid and
- number of substations in the (LD) grid.

NVE wants to develop better variables for measuring the properties of demand that each DSO faces. It is common to include measures of energy or power distribution and grid length as independent variables in efficiency assessments of electricity DSOs. Measuring the outputs of a DSO in this way might lead to significant biases as seemingly identical grids actually solve different tasks. We will elaborate on this in the examples below.

Estimating demand - Electric power and energy distance

We want to define output measures for energy and power that minimize the distance energy and effect is distributed, given the exogenous demand for energy and power within each grid area. These output measures would incorporate the two dimensions in the grid customer's demand. Both the volume of energy and power that must be distributed, and the distance that these volumes must be transported.

The measure has to be linear with respect to cost, given the DEA-models NVE apply. We assume that the relation between cost and distance is approximately linear, but to our knowledge this is not the case for power capacity. In essence we want a proposal for a method that estimates a minimum power and energy distance within each grid area.

$$Electric\ Power\ distance: Pd = P^{\alpha} \cdot d$$

$$Energy\ distance: Ed = E^{\beta} \cdot d$$

P = power, E= Energy, d=distance. α and β are parameters to handle non-linearity in cost.

The optimization should find the minimal *Pd* (in every hour) and *Ed* (in a year), through minimization of the relevant distances the power and energy must be distributed to satisfy the exogenous demand.

As stated above, measuring the output of DSOs with energy, power and distance without taking non-linearity of costs into account can lead to false assessments. Below we elaborate on this with a few examples. We show different topologies where a DSO has a total grid length of 18 km and that they have to distribute 18 MW to four customers within their grid area. Customers A-D demand the same quantity of power in all examples.

The examples highlight some important conditions the method must address. In short the method must handle the non-linear relation between power capacity and costs (Example 1). The distance from power/energy injection points to consumers must be measured and counted in the right way (Example 2-4). Generation in the local distribution grid must be possible and all generation must be injected (Example 5-6).

The examples below ignore that the consumers can be connected to a meshed grid where they may be supplied from multiple lines and generation points. The proposed method must allow for meshed grids and multiple injection points.

The report must describe the method for minimizing the electric power distance as well as outline a method to estimate all variables in the minimization problem. I.e. the report must clearly specify the needed data and data structure to solve said problem. The relevant data and avialability is described after the examples that follow. The consultantant is encouraged to assess if the results of the optimization for the electric power distance may be used to derive a measure for energy distance, since the energy equals the sum of all power estimates.

Example 1 – Non-linearity in cost of power capacity

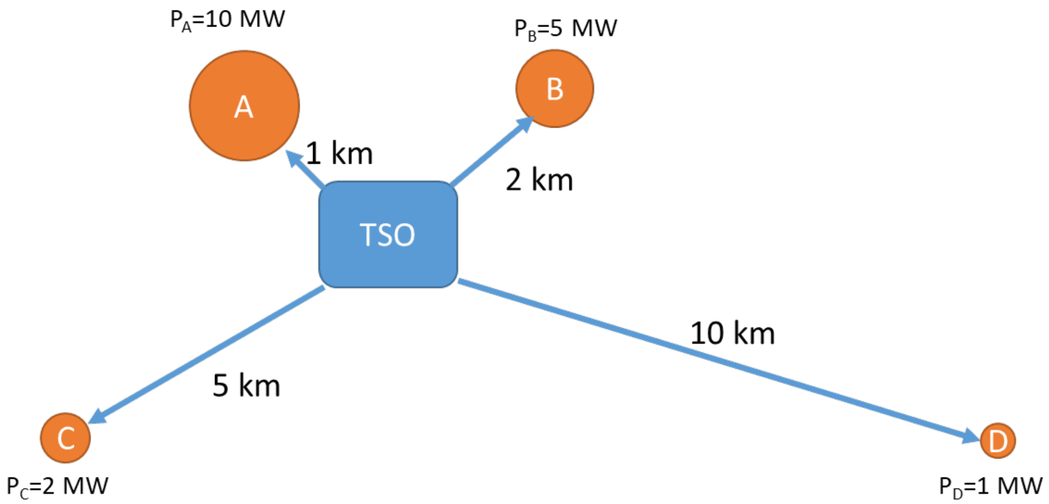


Figure 1 Topology DSO1

DSO 1 has a grid with four radials. Each radial has one attached customer. Not taking the non-linear relationship between cost and power capacity into account (α=1), the effort of supplying power to all customers looks the same (Pd=10). Taking the non-linearity into account, the cost of supplying the exogenous demand from customer D is relatively higher than customer A. In this simplified example it is easy to count the line distance from the injection point to the different customers.

Table 1 Power distance estimates for DSO1.

			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	$Pd = P^{\alpha} \times d$										
A	10	1	10,0	7,9	6,3	5,0	4,0	3,2	2,5	2,0	1,6	1,3	1,0
B	5	2	10,0	8,5	7,2	6,2	5,3	4,5	3,8	3,2	2,8	2,3	2,0
C	2	5	10,0	9,3	8,7	8,1	7,6	7,1	6,6	6,2	5,7	5,4	5,0
D	1	10	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
Total			**40,0**	**35,8**	**32,3**	**29,3**	**26,8**	**24,7**	**22,9**	**21,4**	**20,1**	**19,0**	**18,0**

Example 2

DSO2 has one radial with all customers attached to the same line, but the distance to the injection point varies. The total length of the grid is the same as for DSO1, but the distance to each customer is not the same. From the injection point to customer D power must be distributed 18 km. The distance from customer to C to D is 10 km and the 1 MW power distributed to satisfied customer D's demand is the same as in example 1.

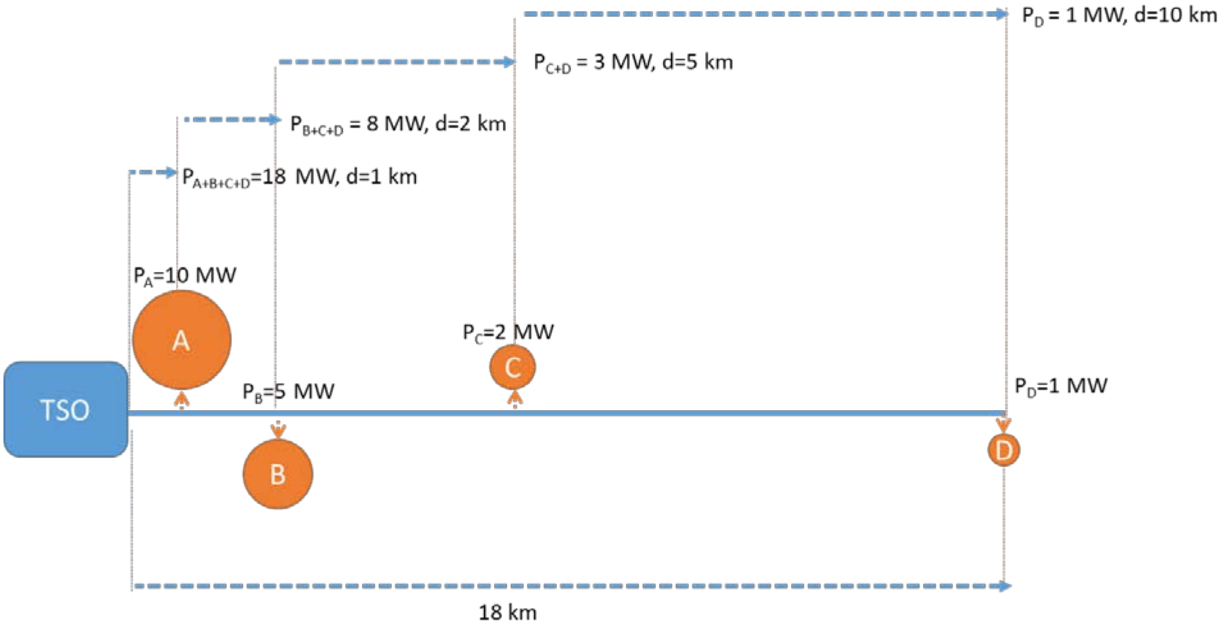


Figure 2 Topology DSO2

As one can see in Table 2, even though the distances to each customer are comparable but not identaical, and the total grid length and total demand are identical with DSO1. The power distances, or the effort to solve this task, are very different in compared to DSO1.

Table 2 Power distance estimates DSO2.

			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	Pd = P^{α} x d										
A+B+C+D	18	1	18,0	13,5	10,1	7,6	5,7	4,2	3,2	2,4	1,8	1,3	1,0
B+C+D	8	2	16,0	13,0	10,6	8,6	7,0	5,7	4,6	3,7	3,0	2,5	2,0
C+D	3	5	15,0	13,4	12,0	10,8	9,7	8,7	7,8	7,0	6,2	5,6	5,0
D	1	10	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
Total			**59,0**	**49,9**	**42,7**	**36,9**	**32,3**	**28,6**	**25,5**	**23,1**	**21,0**	**19,4**	**18,0**

To further clarify on the complexity we can look at example 3 which also has just one radial, but the customers are distributed in a different order.

Example 3

The topology of DSO3 is very similar to DSO2, but the customers are arranged in a different order.

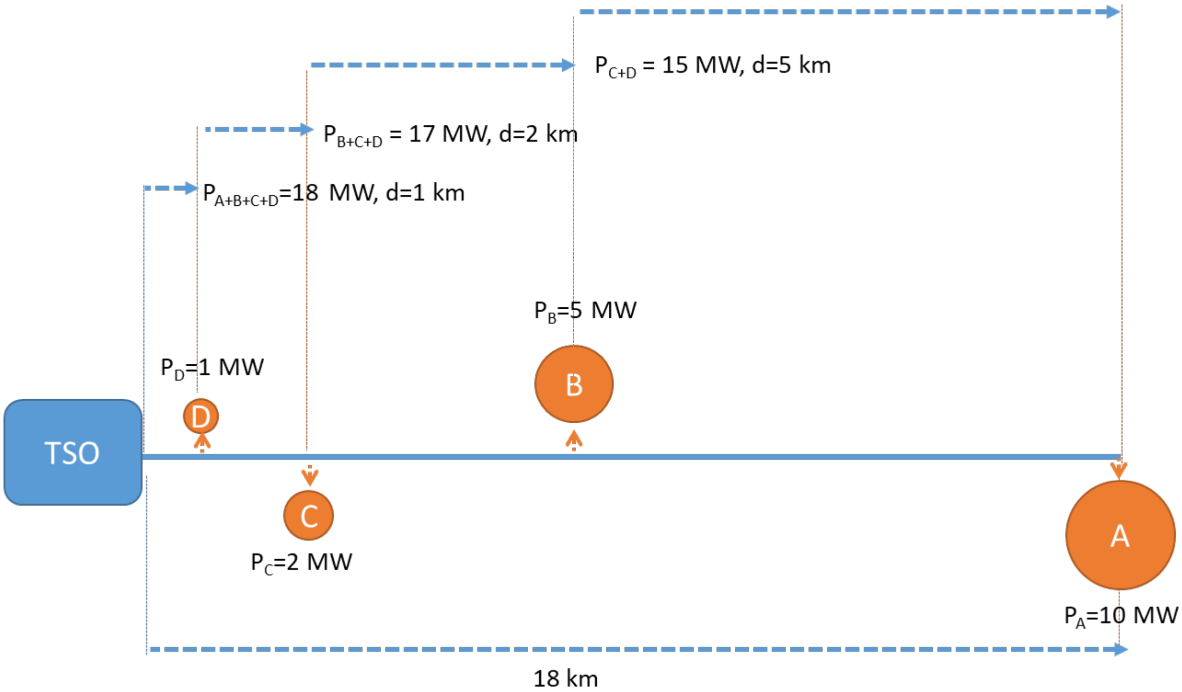


Figure 3 Topology DSO3

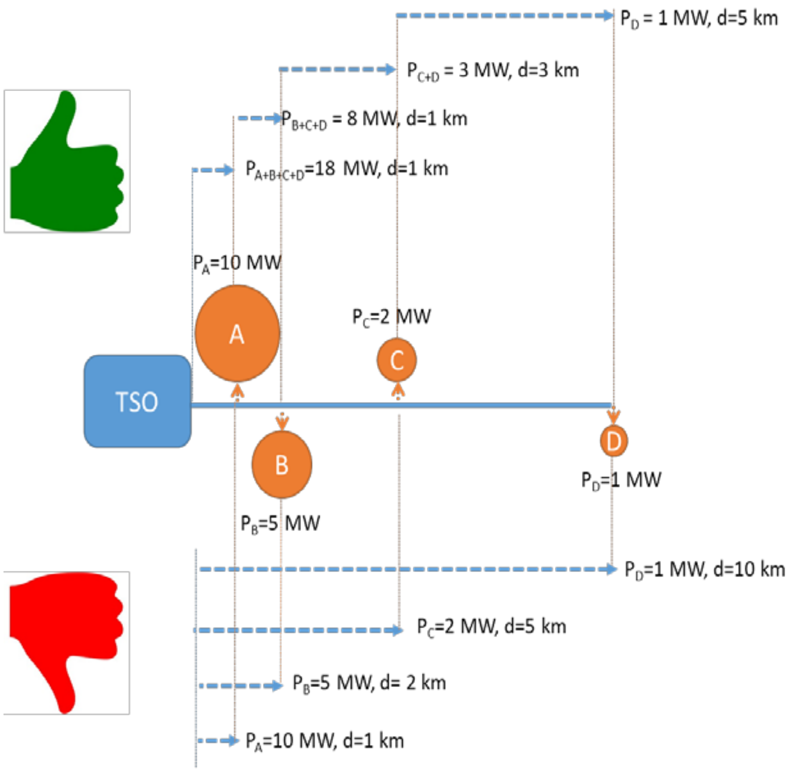
Table 3 shows that there are quite large differences to the estimated electric power distances in example 2. The distance to each customer and the power each customer demands is highly relevant to ensure a correct calculation.

Table 3 Estimated power distance for DSO3

			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	$Pd = P^{\alpha} \times d$										
A+B+C+D	18	1	18,0	13,5	10,1	7,6	5,7	4,2	3,2	2,4	1,8	1,3	1,0
B+C+D	17	2	34,0	25,6	19,3	14,5	10,9	8,2	6,2	4,7	3,5	2,7	2,0
C+D	15	5	75,0	57,2	43,6	33,3	25,4	19,4	14,8	11,3	8,6	6,6	5,0
D	10	10	100,0	79,4	63,1	50,1	39,8	31,6	25,1	20,0	15,8	12,6	10,0
Total			227,0	175,7	136,1	105,5	81,8	63,5	49,3	38,3	29,8	23,1	18,0

Example 4 - Correct distance measurement is essential

It is worth noting that the way that the lines are counted, or measured, are very important. The topology in examples 4-6 are similar to example two, one radial with all customers connected to one line, but the total grid length is not 18 km but 10 km.



			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	$Pd = P^{\alpha} \times d$										
A+B+C+D	18	1	18,0	13,5	10,1	7,6	5,7	4,2	3,2	2,4	1,8	1,3	1,0
B+C+D	8	1	8,0	6,5	5,3	4,3	3,5	2,8	2,3	1,9	1,5	1,2	1,0
C+D	3	3	9,0	8,1	7,2	6,5	5,8	5,2	4,7	4,2	3,7	3,3	3,0
D	1	5	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Total			40,0	33,0	27,6	23,3	19,9	17,3	15,1	13,4	12,0	10,9	10,0

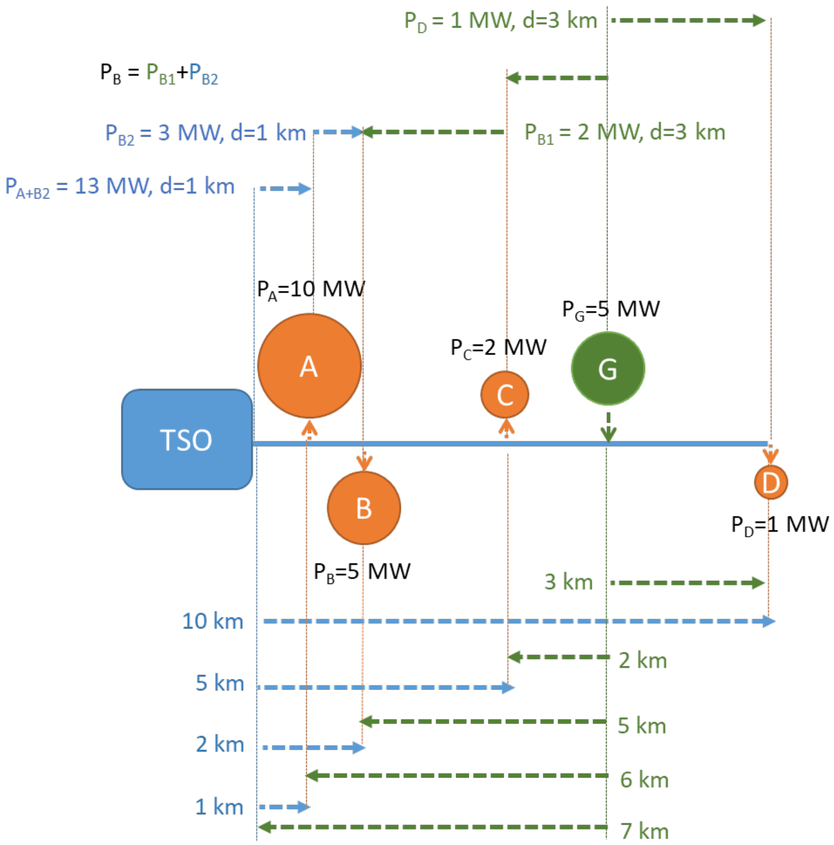
			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	$Pd = P^{\alpha} \times d$										
A	10	1	10,0	7,9	6,3	5,0	4,0	3,2	2,5	2,0	1,6	1,3	1,0
B	5	2	10,0	8,5	7,2	6,2	5,3	4,5	3,8	3,2	2,8	2,3	2,0
C	2	5	10,0	9,3	8,7	8,1	7,6	7,1	6,6	6,2	5,7	5,4	5,0
D	1	10	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0
Total			40,0	35,8	32,3	29,3	26,8	24,7	22,9	21,4	20,1	19,0	18,0

Figure 4 Example illustrating complexity in distance measurement

Figure 4 shows that power distributed to customers B-D also must be distributed the distance to customer A. Ignoring this when you have multiple consumers on one line yields false assessments. The distance measurements in the lower table of Figure 4 show that this approach overestimates the necessary effort (cost) of transporting the power to customer D.

Example 5 - Upstream power generation must be taken into account

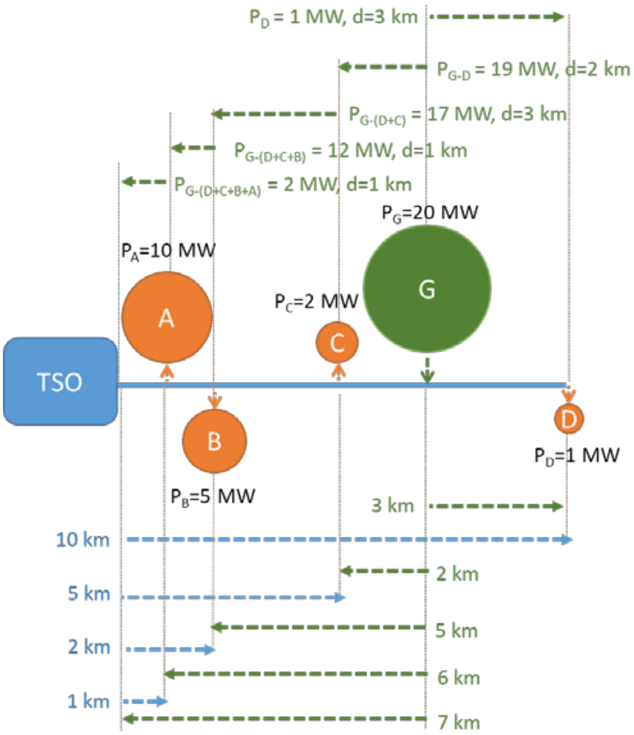
All of the examples above are a depicting topologies where the power is supplied from the transmission grid, or other distribution grids. With increasing shares of generation in the local distribution grid, it is important to formulate a model than can take this into account. In this example we apply the same topology as in example 4, but include generation in the local distribution grid.



			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	$Pd = P^{\alpha} \times d$										
D	1	3	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0
B1+C	4	2	8,0	7,0	6,1	5,3	4,6	4,0	3,5	3,0	2,6	2,3	2,0
B1	2	3	6,0	5,6	5,2	4,9	4,5	4,2	4,0	3,7	3,4	3,2	3,0
B2	3	1	3,0	2,7	2,4	2,2	1,9	1,7	1,6	1,4	1,2	1,1	1,0
A+B2	13	1	13,0	10,1	7,8	6,0	4,7	3,6	2,8	2,2	1,7	1,3	1,0
Total			**33,0**	**28,3**	**24,5**	**21,3**	**18,7**	**16,6**	**14,8**	**13,3**	**12,0**	**10,9**	**10,0**

Example 6 - All generation has to be injected to the grid

In this example, generation in the local distribution grid exceeds the total demand in the grid area. The optimization method has to allow excess generation in a grid to flow into the transmission grid or to other distribution grid areas.



All generation is injected into the grid

			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	Pd = P^α x d										
D	1	3	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0
G-D	19	2	38,0	28,3	21,1	15,7	11,7	8,7	6,5	4,8	3,6	2,7	2,0
G-(D+C)	17	3	51,0	38,4	28,9	21,8	16,4	12,4	9,3	7,0	5,3	4,0	3,0
G-(D+C+B)	12	1	12,0	9,4	7,3	5,7	4,4	3,5	2,7	2,1	1,6	1,3	1,0
G-(D+C+B+A)	2	1	2,0	1,9	1,7	1,6	1,5	1,4	1,3	1,2	1,1	1,1	1,0
Total			**106,0**	**81,0**	**62,1**	**47,8**	**37,1**	**29,0**	**22,8**	**18,2**	**14,7**	**12,0**	**10,0**

All generation is not injected into the grid

			α										
			1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3	0,2	0,1	0
Customer	P	d	Pd = P^α x d										
D	1	3	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0
C	2	2	4,0	3,7	3,5	3,2	3,0	2,8	2,6	2,5	2,3	2,1	2,0
B	5	1	5,0	4,3	3,6	3,1	2,6	2,2	1,9	1,6	1,4	1,2	1,0
A+B	15	1	15,0	11,4	8,7	6,7	5,1	3,9	3,0	2,3	1,7	1,3	1,0
Total			**27,0**	**22,4**	**18,8**	**16,0**	**13,7**	**11,9**	**10,5**	**9,3**	**8,4**	**7,6**	**7,0**

Figure 5 Generation must be injected

In the upper table in Figure 5 all generation is injected. The customers are supplied by generation in the grid area and excess generation is injected into the transmission grid. In the lower table of Figure 5 only 18 MW of the 20 MW the producer provides is injected into the grid. This must be an infeasible solution.

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Available data

Previously, NVE applied a simpler version of an energy/distance-variable in the model for regional distribution grids. Implementation of the data and settlement hub (Elhub) for the Norwegian electricity market will make new data available to NVE. We believe access to new and better data will make it possible to develop electrical power and energy distance function for local distribution with high precision.

The data we believe to be relevant, and know will be accessible, are hourly metering values for all metering points. Metering points are classified as consumption, production, combined and exchange. Metering values are withdrawn or injected kWh/h for all hours in a year, and we see this as suitable proxy for power production and consumption (kW). For all metering points their geographical location is known using information from the cadastral survey. Actual data on injection and consumption will be available when Elhub goes live in in February 2019.

Further we also know the location and ownership of all high voltage lines, cables and substations through data in the NVE GIS-databases. The distances from injection points to consumption should be measured along the existing grid. If one just connect the points with the shortest distance as a straight line one will likely underestimate the relevant distance. This is because one will ignore that the grid has go around or over obstacles (mountains, high density forests, fjords, lakes etc.).
NVE's map services are described online[1]. The publicly available dataset for grid installations[2] does not include underground cables and substations connecting the low voltage grid to the high voltage grid, but gives an indication of the data granularity. One possible data limitation is that the data on the low voltage grid is recently collected and has yet to become a well-established data set. As a consequence, the consultant is encouraged to assess possible simplifications of the approach, including possible aggregation of consumption data.

About the purchase

NVE asks for a report that describes a method to estimate exogenous demand measures in power distribution, specifically measures of electric power distance and energy distance. The method, as well as an outline for the required data, must be clearly specified.

NVE will assist with guidance and clarifications of the design of the DEA-model, should it be necessary. NVE will also assist with access to available data, if necessary.

Deliveries

The final product must be a single report. The report must be in Norwegian or English and shall contain a supplementary summary. Reports written in Norwegian should include an English summary.

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[1] https://www.nve.no/map-services/

[2] https://temakart.nve.no/link/?link=nettanlegg

Workform

During the process, the consultant will hold at least three meetings with NVE: a start-up meeting, a meeting during the work and a meeting shortly before final delivery. These meetings will take place in NVE's premises in Oslo or through video conference.

Economic framework

An estimate of the number of hours that will be used to perform the assignment together with an hourly rate shall be given. In assessing the offer we will evaluate this together with the description of the delivery.

ATTACHMENT II Tender letter

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

Company name:			
Company number:			
Address:			
Visiting address:			
Telephone number:			

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

The supplier hereby confirms that the submitted tender is in accordance with the terms and conditions that are given in the tender documents.

☐ 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.

☐ We declare that we satisfy the competition's qualification requirements.

Place Date Signature

Name in block capitals