

Tonne Kjærsvej 65
7000 Fredericia
Tel. +45 70 10 22 44
Fax +45 76 24 51 80

info@energinet.dk
www.energinet.dk
cvr-nr. 28 98 06 71

14. maj 2009
KAC-MRP/HEP

Compensation for offshore wind farms ordered to perform downward regulation

Version 1.0 of 15 May 2009

Contents:

1.	Which wind farms does the Renewable Energy Act apply to?.....	4
2.	In which circumstances can Energinet.dk order downward regulation?	4
3.	How does Energinet.dk order downward regulation?	4
4.	Calculation of compensation	6
4.1	Introduction	6
4.2	Orders issued before 11 am on the day before the day of operation ...	6
4.3	Orders issued after 11 am on the day before the day of operation.....	7
5.	Modelling of non-supplied generation from offshore wind farms	9
5.1	Introduction	9
5.2	Methods for calculating non-supplied generation	9
5.3	Method 1	9
5.4	Method 2	10
5.5	Deviation from calculated data.....	10
Appendix 1: Examples of settlement calculation		12
Introduction		12
Orders issued before 11 am on the day before the day of operation.....		12
Orders issued after 11 am on the day before the day of operation.....		12
Appendix 3: Energinet.dk's requirements for the calculation of non-supplied, active generation caused by output restrictions		

Introduction

This document has been issued and approved in pursuance of Section 35 in the Danish act no. 1392 of 27 December 2008 on the promotion of renewable energy, hereinafter referred to as the Renewable Energy Act.

The Renewable Energy Act describes the overarching rules determining when Energinet.dk has the right to order offshore wind farms to perform downward regulation and establishes the rules for calculating the electricity generation lost because of downward regulation. It also lays down the rules for calculating lost earnings in order to ensure that the power generator is compensated for his loss.

This document outlines the framework conditions laid down in the Renewable Energy Act and determines:

- The circumstances in which Energinet.dk has the right to order downward regulation
- How the compensation for downward regulation is calculated
- How electricity generation lost is calculated

As such, this document is directed at enterprises that have either constructed or are considering constructing offshore wind farms.

The rules outlined in this document have been harmonised with Energinet.dk's market regulations.

The power generator is entitled to demand that any disputes regarding the right to compensation and the size of such compensation be settled in a court of law.

This document can also be downloaded from www.energinet.dk.

Notification

Version 1.0 of this document was filed with the Danish Energy Agency on 14 May 2009.

1. Which wind farms does the Renewable Energy Act apply to?

According to Sections 34 and 35 of the Renewable Energy Act the provisions governing the regulation of offshore wind farms' electricity generation and the consequent payment of compensation apply to offshore wind farms constructed following a call for tenders.

As such, the first offshore wind farm to be subject to these rules is Horns Rev 2.

The conditions relating to downward regulation and compensation apply for a period of 25 years after the Danish Climate and Energy Minister has granted the applicant permission to exploit energy in territorial waters.

2. In which circumstances can Energinet.dk order downward regulation?

Section 34 of the Renewable Energy Act stipulates that Energinet.dk can order electricity generation to be reduced or suspended if this is necessary because of:

- Faults or maintenance work in the landing facilities that bring the electricity ashore or in the rest of the transmission grid
- Capacity restrictions in the interconnected transmission grid.

Section 34 of the said Act also stipulates that orders for downward regulation can only be issued if downward regulation is required to ensure security of supply or ensure that the interconnected transmission grid is utilised in an socio-economically optimum manner, for example to safeguard a well-functioning, competitive electricity market.

These wordings and the explanatory notes to the Renewable Energy Act make it clear that the special principles regarding wind-generated electricity's prioritised access to the power grid do not apply to offshore wind farms constructed following a call for tenders. The conditions outlined make it possible for Energinet.dk to strike an economically optimum balance between the payment of compensation for downward regulation and the reinforcement of the transmission grid and to act accordingly.

As far the Renewable Energy Act's wordings about well-functioning competition are concerned, the explanatory notes to the Act indicate that in the interests of socioeconomics Energinet.dk has the right to decide whether to utilise wind energy to the fullest extent possible or use the transmission grid to either export or import electricity.

3. How does Energinet.dk order downward regulation?

Offshore wind farms can be ordered to restrict its output in case of:

- a) Capacity restrictions in the interconnected transmission grid
- b) Faults and maintenance work being performed in those parts of the landing facilities that are owned and operated by Energinet.dk
- c) Operating situations endangering the operational reliability of the interconnected transmission grid, including critical surplus generation
- d) Automatic restriction or suspension of electricity generation caused by system protection devices in the transmission grid.

In case of planned capacity restrictions in the interconnected transmission grid on the day before the day of operation, orders for downward regulation will be issued not later than at 11 am on the day before the day of operation.

In practice, Energinet.dk will issue orders to reduce or suspend electricity generation on the basis of the principles outlined below.

The order will take the form of an output restriction (in MW) announced for the individual wind farms. This order must be observed unconditionally. The order will presumably be executed by activating the offshore wind farm's regulation for 'Absolute production constraint' (output restriction) as described in the conditions for grid connection, Regulation TL 3.2.5, section 5.1.

The order will be effected by Energinet.dk's control centre contacting the control centres affected in order to agree on the time when electricity is to be generated and the threshold values for the electricity generation. The agreement must be confirmed in writing via email and/or telefax. The order is acknowledged by the balance-responsible party (BRP) submitting an operational schedule reflecting the agreement.

Each time Energinet.dk issues orders for output restrictions, Energinet.dk will simultaneously notify Nord Pool Spot hereof to prevent the plant owner from gaining access to inside information.

4. Calculation of compensation

4.1 Introduction

In the following, the calculation of the compensation is described. The basic principle is that the plant owner must to the extent it is practically possible be compensated for any losses sustained in connection with the downward regulation, ie the plant owner must be placed in a situation where his earnings are the same as they would have been in the reference situation without downward regulation.

A distinction is made between the following two situations:

- 1) The need for downward regulation is known before noon on the day before the day of operation so that downward regulation can be ordered before the BRP concerned submits bids to Nord Pool Elspot
- 2) The need for downward regulation is not known until afterwards so that downward regulation is ordered after the BRP has submitted bids to Nord Pool Elspot.

In both situations the following general rules apply:

- 1) Settlement metering is based on a quarter-hourly basis in Eastern and Western Denmark.
- 2) The BRP must submit a separate operational schedule/notification to Energinet.dk for the wind farm in question under an independent, bilaterally agreed GLN number.
- 3) The BRP can at the earliest submit bids to Nord Pool Elspot at 11 am on the day before the day of operation as far as wind farm's generation of electricity and the subsequent trading hereof are concerned. The same applies to any binding bilateral trading.
- 4) Downward regulation is always ordered in the form of a maximum output allowed, see chapter 3.
- 5) Downward regulation must to the extent possible be ordered commenced in the interval between two quarters of an hour.
- 6) After downward regulation has been ordered, the separate notification for the offshore wind farm cannot be changed through intraday trading in the period when downward regulation is in force.

In the absence of any other rules, the current, ordinary rules apply, for example with respect to deadlines, balance settlement, etc.

4.2 Orders issued before 11 am on the day before the day of operation

In this section it is assumed that Energinet.dk orders the wind farm to perform downward regulation during the following day of operation before 11 am before the day of operation.

In this case the BRP must:

- 1) submit bids to Nord Pool Elspot that are consistent with the downward regulation ordered
- 2) subsequently submit an operational schedule/notification for the wind farm to Energinet.dk that is consistent with the downward regulation ordered.

Energinet.dk's total settlement is calculated as follows:

- 1) Compensation for elspot price: (calculated generation – actual generation)*elspot price
- 2) Price subsidy: calculated generation* ("guaranteed price" – elspot price)
- 3) Generation imbalance: (actual generation - operational schedule)*balancing power price
- 4) Trading imbalance: (operational schedule + notification)*balancing power price
- 5) Settlement of regulating power, if any

In Appendix 1, calculation examples are used to illustrate how settlement is performed.

Pts. 3)-5) will take place in accordance with the ordinary rules and have only been included to provide an overview. In accordance with the ordinary rules, the operational schedule and notification stated must be identical with the notification as well as any additional regulating power schedules submitted by the BRP.

A 'guaranteed price' is the guaranteed settlement price (in øre/kWh) for the wind farm concerned as specified in the Danish Renewable Energy Act¹.

Following agreement with Energinet.dk the actual generation and trading imbalances calculated can be aggregated with the BRP's possible other imbalance before multiplication by the balancing power price. In such case, both imbalances must be aggregated.

4.3 Orders issued after 11 am on the day before the day of operation

In this section it is assumed that Energinet.dk does not order downward regulation until after 11 am on the day before the day of operation. In such case, Energinet.dk will for practical reasons not order downward regulation until an approved notification for the wind farm is available on the day before the day of operation. This notification must – irrespective of the ordinary rules – always balance.

After having ordered downward regulation, the BRP must as soon as possible and not later than an hour after having ordered downward regulation submit:

- 1) an operational schedule that is consistent with the downward regulation ordered
- 2) a notification that is identical with the notification previously submitted and approved.

Energinet.dk's total settlement is calculated as follows:

- 1) Compensation for elspot price: $(\text{actual operational schedule} - \text{actual generation}) * \text{elspot price}$
- 2) Price subsidy: $\text{calculated generation} * (\text{"guaranteed price"} - \text{elspot price})$
- 3) Fictitious imbalance, generation: $(\text{calculated generation} + \text{notification}) * \text{balancing power price}$
- 4) Actual generation imbalance: $(\text{actual generation} - \text{operational schedule}) * \text{balancing power price}$
- 5) Actual trading imbalance trading: $(\text{operational schedule} + \text{notification}) * 0$
- 6) Settlement of regulating power, if any.

Pts. 4) and 6) will take place in accordance with the ordinary rules and have only been included to provide an overview.

In accordance with the ordinary rules, the operational schedules and notifications stated must comprise the notifications and any additional regulating power schedules submitted by the BRP with the following exceptions:

- The notification mentioned in pt. 3) does not include an additional schedule
- The operational schedule and notification mentioned in pt. 5) do not include an additional schedule.

The balancing power price of DKK 0 for the trading imbalance only applies to the extent that the imbalance is consistent with the downward regulation ordered. A prohibition against intraday trading in the wake of downward regulation automatically ensures that this is complied with.

¹ The sum of the elspot price and price subsidies.

Following agreement with Energinet.dk the actual generation imbalance calculated can be aggregated with the BRP's possible other generation imbalance before multiplication by the balancing power price.

5. Modelling of non-supplied generation from offshore wind farms

5.1 Introduction

As TSO, Energinet.dk requires that the data basis used for settling non-supplied generation (resulting from Energinet.dk's order to implement downward regulation) be made available online to the offshore wind farm owner free of charge.

The data basis for settling non-supplied generation comprises:

1. Online metering and calculation of the potential generation from operational installations (metered directly on the installation)
2. Online metering of actual generation
3. Online calculation of non-supplied generation.

Data must be 'logged' online and transferred to Energinet.dk as 5-minute time series, both in connection with normal operation, downward regulation and disconnected installations where this is relevant. Data is transferred to Energinet.dk once a day.

The data basis for online metering and calculation of the potential generation, online metering of actual generation and online calculation of non-supplied generation must be approved by Energinet.dk before the installation is commissioned.

After commissioning and before the settlement of non-supplied generation can become effective, the data basis for calculating the non-supplied generation must be verified.

The accuracy of the calculation must be higher than +/- 5% of the actual generation relative to the settlement metering for the installation in the range from 20-100% of maximum power.

Energinet.dk checks the quality of the calculation on an ongoing basis, see section 5.5. In the event of deviations higher than +/- 5% relative to the settlement metering used by the installation (15-minute mean value), Energinet.dk reserves the right to demand that the calculation model be corrected and to offset the calculation for non-supplied generation by the size of the deviation until the calculation model has been verified and approved. The deviation is determined as described in section 5.5.

If the data basis agreed upon changes after commissioning without Energinet.dk's re-approval, such changes will be considered a breach of the settlement basis.

5.2 Methods for calculating non-supplied generation

Generally, method 1 described below must be used for calculating non-supplied generation.

It can be agreed to implement method 2 as a temporary alternative if method 1 cannot be used because of faults or a temporarily failing data gathering system.

If the communication between the installation and Energinet.dk breaks down, it must be possible to store and secure data locally until data can be transferred again.

5.3 Method 1

Method 1 consists of a continuous, online calculation using the potential generation of the individual wind turbines as point of departure.

The calculation can be based on data obtained from an anemometer installed on the individual wind turbines. Alternatively, the rotor speed or similar can be used. To achieve a satisfactory

estimate of the generation throughout the individual wind turbine's power range, correction is performed in both instances, using relevant parameters.

The wind farm's potential generation is calculated by adding together the wind turbines' potential electricity generation, taking account of factors such as reduced wake effect, grid losses and unavailable wind turbines, etc. The calculation of the potential electricity generation will be 'logged' online as a 5-minute time series that is transferred to Energinet.dk once a day.

The uncertainty of the calculation will affect the settlement of non-supplied generation as mentioned in section 5.1.

The calculation principles must be approved by Energinet.dk before implementation.

The plant owner must prepare a proposal for testing and verifying the calculations.

5.4 Method 2

If the farm controller used for method 1 is inoperative, the calculation can be based on weather data, obtained locally at the wind farm, combined with power output data from the wind turbines corrected for wind speed, wind direction, the location of the individual wind turbines vis-à-vis each other, etc.

The accuracy of method 2 must be verified by the plant owner and approved by Energinet.dk before it can be used as basis for the settlement. The uncertainty of the calculation will affect the settlement of non-supplied generation as mentioned in section 5.1.

If method 2 is to be used for settling non-supplied generation, data must be logged online as a 5-minute time series that is transferred to Energinet.dk once a day.

The calculation principles must be approved by Energinet.dk before implementation.

The plant owner must prepare a proposal for testing and verifying the calculations.

5.5 Deviation from calculated data

Energinet.dk continuously performs quality checks and calculates the uncertainty of the data transferred. The check is performed by Energinet.dk comparing the data transferred with data from the installation's settlement metering.

The accuracy of data transferred is determined by calculating the average quarter-hourly deviation for the most recent, entire day of operation without downward regulation.

If the 5-minute time series is incorrect due to missing values, values with incorrect signs and values lying outside a technically possible interval, Energinet.dk will set the default value at zero.

A data basis that is either missing, partly missing or incorrect will not subsequently be assessed and corrected to any other extent than indicated above.

If several methods have been used to calculate the installation's non-supplied generation (see section 5.2), and if method 1 is subject to inaccuracy due to technical faults, Energinet.dk may give permission to replace the method 1 time series by the method 2 time series in its entirety.

Energinet.dk continuously checks the quality of transferred data, normally not later than five working days after the day of operation once the settlement metering for the installation has been fixed.

Energinet.dk continuously calculates a correction factor for possible reductions in the settlement of non-supplied generation.

This factor will always be calculated on the basis of the most recent, entire day of operation without downward regulation.

If the average quarter-hourly deviation has been $> + 5\%$ for more than 5% of the time relative to the settlement metering, the correction factor for reducing the settlement will be determined as the largest quarter-hourly deviation calculated in the most recent, entire day of operation prior to the downward regulation.

Appendix 1: Examples of settlement calculation

Introduction

In the following, calculation examples are used to illustrate how settlement is performed.

The calculated generation without downward regulation is in all instances assumed to be 100 MWh/h. The downward regulation ordered is assumed to be to the tune of max. 50 MW, which – due to variations within the hour – is expected to result in actual generation of 45 MWh/h.

For the sake of simplicity, regulating power is disregarded.

The following price assumptions are used:

- 'Guaranteed price' for the wind farm concerned: DKK 600/MWh
- Elspot price: DKK 400/MWh
- Price subsidy: $600-400 =$ DKK 200/MWh
- Balancing power price, player's purchase/sale: DKK 500/300/MWh

The latter means that when a sign is used to indicate system imbalance, it is always assumed that the sign is the same as the one used by the BRP. However, the alternative price involving an opposite sign is indicated in parenthesis.

Orders issued before 11 am on the day before the day of operation

The following data is assumed:

Order	Final, approved operational schedule	Final, approved notification	Actual generation	Calculated generation
< 50 MW	50 MWh	-50 MWh	45 MWh	100 MWh

The settlement will be as follows (seeing as the payment to the BRP is indicated as a positive figure):

- Compensation for elspot price: $(100-45)*400 =$ DKK 22,000
- Price subsidy: $100*200 =$ DKK 20,000
- Generation imbalance: $(45-50)*500 =$ DKK -2,500 (or DKK -2,000)
- Trading imbalance: $(50-50)*500 =$ DKK 0

The calculation of generation and trading imbalances is performed in accordance with the normal rules, using the standard sign convention.

The BRP will receive a total of $(50+55)*400-5*500=$ DKK 39,500 from Nord Pool Spot and Energinet.dk. The BRP would have received the same in the reference situation if:

- 1) the metered generation had been equal to the calculated generation of 100 MWh
- 2) the BRP's imbalance also in this instance had been -5 MWh, ie his final, approved trade would have been for 105 MWh.

Orders issued after 11 am on the day before the day of operation

The following data is assumed:

Order	Final, approved operational schedule	Final, approved notification	Actual generation	Calculated generation
< 50 MW	50 MWh	-90 MWh	45 MWh	100 MWh

In this case, Energinet.dk's settlement will be as follows:

- Compensation for elspot price: $(50-45)*400 = \text{DKK } 2,000$
- Price subsidy: $100*200 = \text{DKK } 20,000$
- Fictitious generation imbalance: $(100-90)*300 = \text{DKK } 3,000$ (or DKK 4,000)
- Actual generation imbalance: $(45-50)*500 = \text{DKK } -2,500$ (or DKK -2,000)
- Actual trading imbalance: $(50-90)*0 = \text{DKK } 0$

The BRP will receive a total of $(90+5)*400+10*300-5*500 = \text{DKK } 38,500$ from Nord Pool Spot and Energinet.dk. In the reference situation with actual generation of 100 MWh the BRP would have received $90*400+10*300 = \text{DKK } 39,000$.