Fosweb: Wind power plant parameters *(2018-11)*
English version of 'Fosweb: Data for produksjonsanlegg – vindkraftverk – parameterveileder'

Colour legend:

Yellow	Mandatory data field
Orange	Mandatory if applicable
Green	Optional field

Fosweb section	Parameter	Value	Unit	Designation	Probable data source	Comments
Basic data	Name of the power plant					
	Type of power producing unit					Possible options are: • Hydro Power • Thermal Power • Wind Power (to be set to wind power - *Vindkraftverk*) • PV-plant • Other
	Station					What power station is the power plant part of
	Number of same type of windmills in the plant (with the same data)					
	Type of grid connection					Possible options are: • Directly connected to the grid (synchronous generator) • Doubly Fed Induction Generator, DFIG • Full Scale Frequency Converter
	Is there a system for wind park power management/park pilot?					A park pilot controls the output of the entire wind power park.
Responsibility	Concessionaire (/owner)					Concessionaire is set by the owner of the station and consequent changes must be done via the station ('Stasjon')
	Other owners					Owners can be set in the station view
	Owner percentage					It is possible to give an owner percentage for the different owners of a plant by adding this information to the station view.
Generator – Rated data	Type of generator				- Photo of the generator's nameplate - Datasheet	Possible options are synchronous or asynchronous machine.
	Manufacturer				- Photo of the generator's nameplate - Datasheet	Name of generator manufacturer.
	Year of manufacture				- Photo of the generator's nameplate - Datasheet	
	Rated output/nominal output		MVA	S_n	- Photo of the generator's nameplate - Datasheet	For wind power plants with a full scale frequency converter: The maximum output in MVA the generator for one windmill can deliver continuously referred to the converter voltage on the side of the converter connecting the generator to the grid. For wind power plants directly connected to the grid or DFIGs: The maximum output in MVA the generator for one windmill can deliver continuously referred to the voltage of the generator.
	Rated voltage/nominal voltage		kV	U_n	- Photo of the generator's nameplate - Datasheet	Rated voltage of the generator for one single wind turbine referred to generator terminals.

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Generator – Rated data *(cont'd)*	Rated power/nominal power		MW	P_n	- Photo of the generator's nameplate - Datasheet	For wind power plants with a full scale frequency converter: The power production for one generator at the given rated output and rated power factor. The rated power shall be referred to the converter clamps on the side of the converter connected to the grid. For wind power plants directly connected to the grid or DFIGs: The power production for one generator at the given rated output and rated power factor. The rated power shall be referred to the generator clamps and can be found as the product between the rated output and the rated power factor of the generator.
	Rated power factor		cos (φ)	cos φ_n	- Photo of the generator's nameplate - Datasheet	For wind power plants with a full scale frequency converter: The rated power factor is the relationship between the rated power and the rated output of the generator referred to the converter clamps on the side of the converter connected to the grid. For wind power plants directly connected to the grid or DFIGs: The rated power factor is the relationship between the rated power and the rated output of the generator referred to the generator clamps.
	Maximum reactive power production at rated power (positive value)		MVAr	$Q_{n,kap}$	- Diagram showing the limits for active and reactive power for the generator/converter - Datasheet	For wind power plants with a full scale frequency converter: The maximum reactive production at rated power is usually found from the graph showing the limits of reactive power production and consumption at given points of operation. The maximum reactive power is referred to the converter clamps on the side of the converter connected to the grid. Should it not be given by the graph, the maximum power production at rated power can be found using the equation $Q_{n,kap} = \sqrt{(S_n^2 - P_n^2)} = \sqrt{S_n^2(1 - \cos\varphi^2)}$ where Sn is the rated output, Pn is the rated power, and cos jn is the rated power factor. For wind power plants directly connected to the grid or DFIGs: The maximum reactive production at rated power is usually found from the graph showing the limits of reactive power production and consumption at given points of operation. The maximum reactive power is referred to the generator clamps. Should it not be given by the graph, the maximum power production at rated power can be found using the equation $Q_{n,kap} = \sqrt{(S_n^2 - P_n^2)} = \sqrt{S_n^2(1 - \cos\varphi^2)}$ where Sn is the rated output, Pn is the rated power, and cos jn is the rated power factor. For all types of grid connection the value is entered as a positive value representing the reactive power the generator can deliver to the grid.
	Maximum reactive power consumption at rated power (negative value)		MVAr	$Q_{n,ind}$	- Diagram showing the limits for active and reactive power for the generator/converter - Datasheet	For wind power plants with a full scale frequency converter: The maximum reactive consumption at rated power is usually found from the graph showing the limits of reactive power production and consumption at given points of operation. The maximum reactive power is referred to the converter clamps on the side of the converter connected to the grid. Should it not be given by the graph, the maximum power consumption at rated power can be found using the equation $Q_{n,ind} = \sqrt{S_n^2(1 - \cos\varphi^2)}$ where Sn is the rated output, and cos jn is the power factor for inductive power it is rarely the same as the rated power factor. For wind power plants directly connected to the grid or DFIGs: The maximum reactive consumption at rated power is usually found from the graph showing the limits of reactive power production and consumption at given points of operation. The maximum reactive power is referred to the generator clamps. . Should it not be given by the graph, the maximum power consumption at rated power can be found using the equation $Q_{n,ind} = \sqrt{S_n^2(1 - \cos\varphi^2)}$ where Sn is the rated output, and cos jn is the power factor for inductive power it is rarely the same as the rated power factor. For all types of grid connection the value is entered as a negative value representing the reactive power the generator will consume from the grid.
	Rated frequency/ nominal frequency		Hz	f_n	- Photo of the generator's nameplate - Datasheet	For wind power plants with a full scale frequency converter: The rated frequency of the converter. For wind power plants directly connected to the grid or DFIGs: The rated frequency of the generator.

Fosweb section	Parameter	Value	Unit	Designation	Probable data source	Comments
Generator – Electrical data **_Time constants – Unsaturated values_** _The parameters are not mandatory to report for wind power plants with full scale frequency converters._	Transient (d-axis, unsaturated, short circuit) time constant _The parameter is not mandatory._		s	Td'	- Datasheet - FAT for generator	
	Subtransient (d-axis, unsaturated, short circuit) time constant _The parameter is not mandatory._		s	Td''		
	Transient (d-axis, unsaturated, open circuit) time constant		s	Td0'		
	Subtransient (d-axis, unsaturated, open circuit) time constant		s	Td0''		
	Transient (q-axis, unsaturated, short circuit) time constant _The parameter is not mandatory._		s	Tq'		
	Subtransient (q-axis, unsaturated, short circuit) time constant _The parameter is only to be reported for synchronous generators_		s	Tq''	- Datasheet FAT for generator	
	Transient (q-axis, unsaturated, open circuit) time constant _The parameter is only relevant for synchronous generators and not mandatory to report._		s	Tq0'		
	Subtransient (q-axis, unsaturated, open circuit) time constant _The parameter is only to be reported for synchronous generators._		s	Tq0''		
	Time constant stator winding (unsaturated, short circuit) _The parameter is not mandatory._		s	Ta		
Generator – Electrical data **_Time constants – Saturated values_** _The parameters are not mandatory to report for wind power plants with full scale frequency converters._	Transient (d-axis, saturated, short circuit) time constant		s	Td'	- Datasheet - FAT for generator	
	Subtransient (d-axis, saturated, short circuit) time constant		s	Td''		
	Transient (d-axis, saturated, open circuit) time constant _The parameter is not mandatory._		s	Td0'		
	Subtransient (d-axis, saturated, open circuit) time constant _The parameter is not mandatory for generators manufactured before 2015_		s	Td0''		
	Time constant stator winding (saturated, short circuit) _The parameter is not mandatory._					

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Fosweb section	Parameter	Value	Unit	Designation	Probable data source	Comments
Generator – Electrical data *Impedances: Reactances – Unsaturated values* *The parameters are not mandatory to report for wind power plants with full scale frequency converters.*	Synchronous reactance (d-axis, unsaturated)		pu	Xd	- Datasheet - FAT for generator	The parameters are to be represented in per unit values.
	Transient reactance (d-axis, unsaturated)		pu	Xd'		
	Subtransient reactance (d-axis, unsaturated)		pu	Xd''		
	Synchronous reactance (q-axis, unsaturated) *The parameter is only relevant for synchronous generators.*		pu	Xq		
	Transient reactance (q-axis, unsaturated) *The parameter is only relevant for synchronous generators, and not mandatory to report.*		pu	Xq'		
	Subtransient reactance (q-axis, unsaturated) *The parameter is only relevant for synchronous generators.*		pu	Xq''		
	Leakage reactance (unsaturated		pu	Xl		
Generator – Electrical data *Impedances: Reactances – Saturated values* *The parameters are not mandatory to report for wind power plants with full scale frequency converters.*	Synchronous reactance (d-axis, saturated)		pu	Xd	- Datasheet - FAT for generator	The parameters are to be represented in per unit values.
	Transient reactance (d-axis, saturated)		pu	Xd'		
	Subtransient reactance (d-axis, saturated)		pu	Xd''		
	Negative sequence reactance (saturated)		pu	X2		
	Zero sequence reactance (saturated)		pu	X0		
Generator – Electric data *Impedances: Resistances* *The parameters are not mandatory to report.*	Resistance stator/anchor (per phase, referred to 20 ^{0}C)		pu	Ra	- Datasheet - FAT for generator	The parameters are to be represented in per unit values. If the values are measured in ohm/phase one must calculate the value in per unit using Zbase=U^2/S. Where U is the rated voltage of the generator given in kV, and S is the rated output given in MVA. The per unit value is the measured value divided with the base impedance Zbase. If the measurement of the windings resistance is done at a different temperature than 20 degrees Celsius, it is possible to correct the value for temperature by using the equation: R20=RT*(255/235+T). Where RT is the given resistance at the measured temperature T in Celsius.
	Zero sequence resistance		pu	R0		
Generator – Electric data *Other*	Number of pairs of poles (number of poles divided by 2)				- Datasheet - FAT for generator	If the number of pairs of poles is not given explicitly it can be calculated using P $P=(f_n*60)/n_s$, where f_n is the rated frequency and n_s is the synchronous rpm for the generator.
	Saturation factor with 1.0 p.u. field voltage S(1.0) *The parameters are not mandatory to report for wind power plants with full scale frequency converters.*				- Datasheet - FAT for generator	The saturation factor can be found from the "no-load curves", "open circuit characteristics", or "characteristic curves". A guide to find the value is given in Attachment 1. It is also ok to use the check box if the curves are available in the FAT or the Data Sheet.
	Saturation factor with 1.2 p.u. field voltage S(1.2) *The parameters are not mandatory to report for wind power plants with full scale frequency converters.*				- Datasheet - FAT for generator	The saturation factor can be found from the "no-load curves", "open circuit characteristics", or "characteristic curves". A guide to find the value is given in Attachment 1. It is also ok to use the check box if the curves are available in the FAT or the Data Sheet.

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(page 5 of 7)

Fosweb section	Parameter	Value	Unit	Designation	Probable data source	Comments
Generator – Electric data *Other* *(cont'd)*	Field voltage (Air gap line) in no load at rated voltage. *The parameter is mandatory for wind power plants constructed later than 2015 and that is directly connected or a Doubly Fed Induction Generator, DFIG*			U_{f0}	- Datasheet - FAT for generator	
Generator – Mechanical data	H, Inertia constant) for generator		Ws/VA	H	- Design specification - Data sheet	The inertia constant shall be referred to the generator's rated output and rated rpm (rated frequency).
Converter data *The parameters are mandatory to report for wind power plants with full scale frequency converters, and Doubly Fed Induction Generator, DFIG*	Rated converter current/Nominal converter current		kA		- Design specification - Data sheet	The rated converter current shall be referred to the converter clamps, on the side of the converter connected to the grid.
	Maximum short circuit current at converter terminals:		kA		- Design specification - Data sheet	The maximum short circuit current at converter terminals, on the side of the converter connected to the grid.
Wind turbine	Manufacturer				- Design specification - Data sheet	
	Year of manufacture		year			
	Type designation				- Design specification - Data sheet	
	Hub height		m		- Design specification - Data sheet	
	Rotor diameter		m		- Design specification - Data sheet	
	Minimum active power production: *Only for wind power plants without a wind park power management system/park pilot*		MW		- Design specification - Data sheet	The minimum active power is then given as the minimum active power for one turbine.
	Inertia constant (turbine) or Stored energy constant (turbine)		Ws/VA	H	- Design specification - Data sheet	The inertia constant is to be referred to the generator's rated output and rated revolutions per minute (rpm) for the generator. It can also be found as the acceleration time constant Ta divided by two. H=Ta/2.
	First shaft torsional resonance frequency		Hz		- Design specification - Data sheet	First shaft torsional resonance frequency is used to give a value for the stiffness of the shaft. Either this value or the shaft stiffness constant kt are mandatory, but it is possible to fill out both values. The frequency is given in the unit Hz.
	Shaft stiffness constant			k_t	- Design specification - Data sheet	The shaft stiffness constant or the first shaft torsional resonance frequency is a mandatory value. But it is possible to fill in both values
Wind park power management system (Park Pilot) *The parameters are only mandatory for wind power plants with a wind park power management system (park pilot)*	Manufacturer				- Design specification - Data sheet	
	Year of manufacture		year		- Design specification - Data sheet - SAT/Test report for the wind power management system	
	Sum rated active power for the entire wind power plant:		MW		- Design specification - Data sheet	The sum of the rated active power for the entire wind power park is to be referred to the high voltage side of the wind parks power transformer/s.
	Minimum active power for the entire wind power plant:		MW		- Design specification - Data sheet	The lowest level of active power the wind park will operate and deliver active to the grid. The active power is to be referred to the high voltage side of the wind parks power transformer/s.

Fosweb section	Parameter	Value	Unit	Designation	Probable data source	Comments
Wind park power management system *(cont'd)*	Is the voltage set point adjustable from the control center?				- Control center - Specification for the control system of the wind power plant/park pilot.	Possible options are: • Yes (directly in kV) • Yes (indirectly by giving a MVAr-value, or by rising or lowering the MVAr-contribution) • Yes (Both directly in kV and indirectly by giving a MVAr-value, or by raising or lowering the MVAr-contribution) • No
	Is the voltage set point visible in the control center? Yes/No				- Control center - Specification for the control system of the wind power plant/park pilot.	(Yes/No)
	Droop, reactive current(set value):		%	pu voltage/pu reactive current	- Specification for the control system of the wind power plant/park pilot.	The set value for droop says how fast the reactive power production from the wind power plant will increase as the grid voltage decreases below the set voltage, and how also how fast the reactive power consumption increases when the grid voltage increases over the set voltage value. Note that the set value for droop is to be referred to the high voltage side of the wind power plants main transformer/s. Droop for reactive current is not the same as frequency droop.
	Is Frequency Sensitivity Mode (FSM) implemented and possible to activate? yes/no:				- Control center - Specification for the control system of the wind power plant/park pilot.	(Yes/No) By *Frequency Sensitivity Mode (FSM)* is meant a mode for "normal frequency regulation". In this mode the wind plants active production will either increase or decrease depending upon the measured grid frequency. (The size of the deviation from 50 Hz will determine to what extent the active power will increase/decrease).
	Is Frequency Sensitivity Mode (FSM) possible to activate/deactivate from the control center? yes/no				- Control center - Specification for the control system of the wind power plant/park pilot.	(Yes/No) Logic activation/deactivation of the frequency sensitivity mode (normal frequency regulation), or activation/deactivation of a deadband is two different ways of activating/deactivating this mode.
	Minimum frequency droop:		%	pu frequency/pu active power	- Control center - Specification for the control system of the wind power plant/park pilot.	The frequency droop characterizes the active power response the wind plant will contribute with in frequency sensitivity mode when the frequency deviates from 50 Hz. The minimum value given here is the lowest possible value that can be set. This setting will give the largest/fastest response in active power when the frequency deviates from 50Hz.
	Maximum frequency droop:		%	pu frequency/pu active power	- Control center - Specification for the control system of the wind power plant/park pilot.	The frequency droop characterizes the active power response the wind plant will contribute with in frequency sensitivity mode when the frequency deviates from 50 Hz. The maximum value given here is the highest possible value that can be set. This setting will give the smallest/slowest response in active power when the frequency deviates from 50Hz.
	Is the frequency droop adjustable from the control center? Yes/no				- Control center - Specification for the control system of the wind power plant/park pilot.	(Yes/No)
	Does Limited Frequency Sensitivity Mode – Overfrequency (LFSM-O) exist?				- Control center - Specification for the control system of the wind power plant/park pilot.	(Yes/No) In Limited Frequency Sensitivity Mode – Overfrequency (LFSM-O) the ramping down of the wind power plants active power happens over a given frequency, and according to a set frequency droop setting. Choose yes if this mode is implemented independent of it being activated or not. Choose no if this mode is not implemented.

Documentation

The following documentation is mandatory:

- Data sheet and/or FAT (Factory Acceptance Test) for the generator. *To be uploaded 4 weeks prior to the first windmill is installed.*
- Diagram showing the limits for active and reactive power for the generator/converter. (Mandatory only for plants that are 5 MW or higher). *To be uploaded 4 weeks prior to the first windmill is installed.*
- Test report from commissioning of the wind power plant. Mandatory for plants of 5 MW or above. *To be uploaded within 4 weeks after commissioning.*
- Block diagram + parameters for control circuits/wind park power management system (including converter if installed). Mandatory for plants 5 MW or higher. *To be uploaded within 4 weeks after commissioning.*

All yellow values need to be documented. The best way to do this is by standardizing data according to type of generator, converter, turbine and park pilot. It is up to the supplier to choose if it is more convenient to put the data for the generator, converter, turbine, and park pilot in the same or separate documents.

Green values are optional, and do not need to be part of the documentation.

Attachment 1: Example - how to calculate the saturation factors S(1.0) and S(1.2)