

Electricity Storage Module Document (ESMD)

This form is intended for the registration of a new Electricity Storage Module (ESM) with a capacity from 1 MW to 50 MW ("Type B") or 50 to 60 MW ("Type C"). An electricity storage module always is connected to one connection point. If you want to register more than one new electricity storage module, please fill in a separate form for each module.

An electricity storage module consists of either one synchronously connected unit (e.g. a motor/generator set) or one or more non-synchronously connected units (e.g. battery plus converter). A separate form should be filled in for each synchronous electricity storage module. However, all non-synchronously connected units connected to one connection point shall be considered as one non-synchronous electricity storage module, the capacity of which is equal to the sum of the capacities of the individual units of the electricity storage module. One form shall be filled in for this non-synchronous electricity storage module.

An electricity storage module installed at a wind or solar farm (PPM) is not part of that wind or solar farm and should be registered separately.

If you wish to install an electricity generating module, you must complete and submit the form for a generating module ("PGMD"). If you want to install both an electricity generating module and an electricity storage module, you must complete and submit both forms (PGMD and ESMD).

General data

Site of the connection point (As stated in connection agreement (ATO))

Street/house number : _____

Post code : _____

City : _____

EAN code of the connection : _____ *(if already known)*

Commissioning date

The planned date of commissioning of the electricity storage module.

Date : _____

Electricity Storage Module data

The data below relates to the electricity storage module as a whole.

This concerns parameters/performance at the connection point of the system operator.

Structure of electrical installation

Attach a single-line diagram/plan of the structure of your electrical installation as an annex to this form. It must include the primary components from the point of connection to the storage units/convertors. The location and settings of the protection must be Incorporated in the single line diagram. Cable data (type, length) and transformer data (power, primary and secondary voltage, short-circuit impedance, tap position) should also be provided.

Diagram in annex.

Technology used

*Choose from one of these standard categories *)*

- ☐ Chemical (including: ammonia, hydrogen, synthetic)
 - ☐ Electrochemical (batteries)
 - ☐ Mechanical (including: underground compressed air pump storage)
 - ☐ Thermal (including: heat storage, thermochemical)
 - ☐ Other (please specify) :
-

**) Electrical equipment such as synchronous compensators, capacitors and regenerative braking systems are not included in the definition of an electricity storage module.*

Maximum capacity (Pmax) : [MW]

Maximum continuous active power that the electricity storage module can produce at the connection point, less demand related solely to the self-consumption of that storage unit itself. This is not the connection capacity in MVA, it may be higher

Maximum consumption capacity : [MW]

Maximum active power that the electricity storage module can draw at the connection point, including demand related solely to the self-consumption of that storage unit itself. This is not the connection capacity in MVA, it may be higher.

Maximum ramp-up speed of the active power : [%Pmax/second]

Maximum amount of active power the electricity storage module can increase per second, expressed as a percentage of the maximum capacity per second.

Maximum ramp-down speed of the active power : [%Pmax/second]

Maximum amount of active power the electricity storage module can decrease per second, expressed as a percentage of the maximum capacity per second.

Maximum storage capacity : [MWh]

Maximum amount of electrical energy the electricity storage unit can store.

Declared supply voltage U_c : [kV]

See the connection agreement (ATO) or the offer for the realisation of connection to the grid.

Short-circuit current/nominal current ratio : [Isc/In] [kA]

The short-circuit contribution of the electricity storage module at the Connection Point.

The short-circuit contribution of the electricity storage module at the connection point in relation to the rated current and in absolute value. If an electricity generation unit is/will also be installed, you must also refer to the corresponding PGMD form in which the short-circuit contribution of the PGM is stated.

Protection settings (NC RfG article 14(5) and Systeemcode elektriciteit, articles 2.6 and 2.29)

If applicable in the storage module/customer installation: the resulting behavior of protections in the electricity storage module at the connection point. If directional overcurrent protection devices or protective devices with time-dependent overcurrent functions (inverse characteristic) are used, please include them separately in an appendix.

			Breaking time	
Undervoltage $U_{<}$	: p.u. (% van U_c)		seconds	
Over voltage $U_{>}$	: p.u. (% van U_c)		seconds	
Over current $I_{>}$	: kA		seconds	
Over current $I_{>>}$	: kA		seconds	
Under frequency $f_{<}$	: Hz		seconds	
Over frequency $f_{>}$	: Hz		seconds	

Be aware: protection settings shall not conflict with the requirement to remain in operation in the event of a short-circuit in the grid (fault-ride-through Systeemcode 3.15) or with a deviating voltage or frequency (Systeemcode 3.13:10).

Data for the electricity storage modules

The data below relate to the individual units that are part of the electricity storage module. The data is hereby specified per unit type. Furthermore, if applied, data of a park controller are required to fill in.

Non-synchronously connected electricity storage module:

It is possible to fill in up to 3 different types of units. If there are more than 3 unit types, please specify in an annex.

Number of converters	:			
Nominal power per unit	:			
<i>Rated apparent power of the unit, expressed in MVA.</i>				
Brand and type of converter				
Brand/manufacturer	:			
Type	:			

Synchronously connected electricity storage module:

Nominal power synchronous machine : [MVA]

The rated apparent power of the synchronous machine, expressed in MVA.

Brand and type of synchronous machine

Brand/Manufacturer	:	
Type	:	
Nominal power factor (cos ϕ)	:	
Sub transient reactance (saturated)	:	[p.u.] ("per unit")

Park controller (if applied)

Brand/manufacturer	:	
Type	:	

Data MV/LV and (if applied) HV/MV transformers

Usually, the storage units are connected to the internal MV network through a MV/LV transformer. Fill in the details of this MV/LV transformer(s) below. The form can be used to specify two types of MV/LV transformers. If more than two types of MV/LV transformers are installed, they shall be specified in an annex.

In some cases, there is a connection to a grid with a higher voltage (e.g. 50 or 66 kV) from the system operator. Then it is likely that a step-up transformer will be installed between this high-voltage grid and the medium-voltage grid to which the individual storage units with their MV/LV transformers are connected. In that case, enter the data of this step-up transformer at TR HV/MV. Star point treatment: any star point present on the primary side of the HV/MV transformer (if present) or the MV/LV transformers should not be connected to earth (floating).

Name plate data	TR MV/LV type 1	TR MV/LV type 2	TR HV/MV
Nominal power	: MVA	MVA	MVA
Nominal voltage primary (HV or MV)	: kV	kV	kV
Nominal voltage secondary (MV or LV)	: kV	kV	kV
Nominal short circuit voltage	: %	%	%
Nominal copper or short-circuit losses	: kW	kW	kW
Nominal iron or no-load losses	: kW	kW	kW
Vector group windings (e.g. Dyn5)	:		

Tap changer

Rated voltage highest tap	: kV	kV	kV
Rated voltage lowest tap	: kV	kV	kV
Tap size	: kV	kV	kV
Online (change on-load) yes/no	:		
Offline (change only off-load), yes/no	:		
if yes, what is tap position at site....			

Data for the provision of demand response

The electricity storage module may provide demand response for active power control, reactive power control or for managing transmission constraints. Electricity storage modules not connected to the transmission network (110 kV or higher) shall collectively fulfil the requirements of Articles 28 and 29 of the NC DCC as part of demand aggregation through a third party.

If demand response is offered by the electricity storage module, the Demand Response Unit Document (DRUD) form must be completed, see 'DCC Demand Response Unit document' in [Eisen voor opwekeenheden, opslag, verbruikseenheden met vraagsturing en HVDC | Netbeheer Nederland](#)

Data concerning the switching of electricity storage modules from demand to production

The electricity storage module in storage mode shall be able to adjust the active power in the event of a frequency disturbance in order to maintain the stability of the grid. If the electrical storage module is unable to adjust the operating power in the event of a frequency drop below 49.8 Hz, the electrical storage module, when acting as load, shall automatically disconnect.

The automatic transition from storage mode (the electricity storage module draws electrical energy from the grid) to generation mode (the electricity storage module supplies electrical energy to the grid) takes place according to the scheme:

- The frequency drops to a value below 49.8 Hz
- The active power consumed in storage mode is adjusted at a frequency below 49.8 Hz with a droop of 1%
- After switching to generation mode, the supplied active power is adjusted continuously with droop of 1%
- The reverse process is followed when returning to nominal frequency

- ☐ yes, the electricity storage module is capable of switching automatically from storage mode to generation mode according to the scheme above
- ☐ no, the electrical storage module, when acting as load, shall shut down automatically at a frequency lower than 49.7 Hz

Data for demonstrating compliance with technical requirements

Your electricity storage module must comply with the legal technical requirements for connection to the grid. These requirements are based on the Dutch Systeemcode elektriciteit.

Declaration of Conformity

By signing the bottom of this form, you declare that your electricity storage module meets all relevant technical requirements for connection to the grid, as stated in the Systeemcode elektriciteit and the connection agreement (ATO).

Demonstration of compliance

You must demonstrate that your complete electricity storage module meets the RfG and Systeemcode elektriciteit requirements at the Connection Point. To this end, you must draw up an itemized declaration of compliance *in accordance with Annexes 1 and 2*. The requirements you must meet, and the way in which you must demonstrate compliance, can be found in the document '[ESM compliance verification](#)'. The requested substantiation by means of compliance tests and simulations must be submitted as an annex to this ESM.

Specified Declaration of Compliance

You must use a brand and type of storage unit and park controller that has previously been checked by the system operators for compliance with the requirements of the Systeemcode and is accepted. You can check with your system operator whether your intended unit and park controller has previously been tested and accepted. If this is not the case, you will need to provide documents (certified type-test reports, certificate of compliance) in accordance with Annex 1. The system operator will then check whether the requirements of the Systeemcode are met.

In addition, you will be required to perform ESM model simulation calculations and on-site testing with the fully operational ESM as listed in Annex 2. You must draw up reports and send them to the system operator for acceptance.

For Type B base parks (simple grid structure, 1 type of storage unit and 1 type of transformer), an Excel tool is made available for the simulation calculation of the reactive power exchange by the system operators ([BLOS Excel load flow tool](#)). This Excel tool contains an explanation of what a base park is. An Excel reporting tool is available for the reporting of the calculation results when using a separate specific load flow simulation program for the reactive power exchange ([BLOR Excel rapport tool](#)). A standard test protocol is available for on-site testing at the operational ESM Type B ([Type B test protocol](#)).

Contact details and signature

Name	:	
Name Company	:	
Street / House number	:	
Post code	:	
City	:	
Telephone number	:	
Email address	:	
Signature	:	

*(fill in using Adobe Reader
"Fill in and sign" function)*

Annex 1

Compliance requirements for individual storage units and park controller ESM Types B and C

The individual storage units (converters) and park controllers in Type B and C electricity storage modules must meet certain requirements in order to be used in ESM Type B and Type C parks. For some requirements, a certificate of compliance issued by a certified body and/or certified type test report for the individual storage unit in question is sufficient as evidence. The system operator assesses the evidence for compliance with the requirements of the Systeemcode. If the result of the assessment is positive, the system operator will place the storage unit in question on a list of permitted storage units. If the ESM Type B or C park uses storage units and park controller that are already on this list, no evidence needs to be provided, and Annex 1 does not need to be completed.

If the storage unit and/or park controller is not mentioned on this list, the reference number of the type-test report and the certificate of conformity must be entered in the table below. In addition, the type test report and certificate of compliance must be sent along with the ESMD form for assessment by the system operator. For your information, the requirements in the EN50549-2 standard are almost identical to the requirements in the Systeemcode. A type test report and certificate of compliance based on EN50549-2 are strongly preferred

Requirement Systeemcode elektriciteit Type B and Type C storage unit	Type test report reference	Compliance certificate reference
LFSM-O (Limited frequency sensitivity mode - over frequency)		
LFSM-U (Limited frequency sensitivity mode - under frequency) Including switching from demand to generation		
Frequency and voltage range (N-ESM)		
Reactive power capability		
Fault-Ride-Through, fast fault current injection and active power recovery after fault clearance		
Reconnection after tripping		
Rapid voltage changes, flicker, harmonics (power quality)		

For all storage units of the ESM (e.g. converters): type test reports,
as appendices, as specified in NEN-EN-IEC 61400-21

Supplementary for Type C storage unit¹⁾

FSM (Frequency sensitivity mode)		
Controllability and control range active power		
Voltage, reactive power, power factor control		
Synthetic inertia (PPM, if applicable)		
Damping power oscillations (PPM, if applicable)		

Park controller

LFSM-O (Limited frequency sensitivity mode - over frequency)		
LFSM-U (Limited frequency sensitivity mode - under frequency)		
FSM (Frequency sensitivity mode)		
Controllability and control range active power		
Voltage, reactive power, power factor control		

¹⁾ One or more functions can be included in a park controller. In this case, this function is not required in the storage unit.

Annex 2

Model simulations and on-site testing ESM Types B and C

This annex lists the model simulations and on-site tests for Type B and Type C ESMs. For Type C, the simulation models must be provided at the request of the grid operator. This assumes that the individual storage units and park controller are permitted and are listed on the list of system operators.

Type B ESM with a maximum power ($P_{\max}$) of less than 5 MW does not require on-site testing.

Requirement RfG / Systeemcode elektriciteit	Report simulation reference	Report on-site test for voor ESM $P_{\max} \geq 5\text{MW}$
Type B ESM		
LFSM-O (Limited frequency sensitivity mode - over frequency)		
LFSM-U (Limited frequency sensitivity mode - under frequency)		
Reactive power capability		
Reconnection after disconnection		
Type C ESM		
LFSM-O (Limited frequency sensitivity mode - over frequency)		
LFSM-U (Limited frequency sensitivity mode - under frequency)		
FSM (Frequency sensitivity mode)		
Frequency restoration		
Active power controllability		
Reactive power capability		
Voltage, reactive power, power factor control		
Fault-Ride-Through, fast fault current injection and active power recovery after fault clearance		
Reconnection after disconnection		
Island operation (if applicable)		
Black-start capability (S-ESM, if applicable)		
Synthetic inertia (N-ESM, if applicable)		
Damping power oscillations (PPM, if applicable)		
Demand modification (demand response, if applicable)		
Very fast active power control (demand response, if applicable)		

Guide for filling in the ESMD form

This document is a guide to completing the ESMD form. For the completeness of information, all fields up to and including page 3 in the form must be filled in. After page 3 only the fields that apply to your situation. Some fields are explained in more detail in this manual, to clarify a few things.

Preliminary remark:

The Electricity Storage Module Document (ESMD) is intended for both synchronous electricity storage modules (S-ESM) and asynchronous/converter-coupled storage modules (N-ESM, such as BESS). These can then be divided into a 'basic park' and a 'complex park' with the following definitions:

- Basic park: park with short cabling, all converters of the same type, all transformers of the same type, the same number of converters per transformer, etc. A difference in distribution of a maximum of 2 converters per transformer is acceptable.
- Complex park: If a park does not meet the criteria of a basic park, it is automatically a complex park. This concerns a park with different converter types, different number of transformer types, different number of converters per transformer, etc.

Understanding of capacity, power, energy content

Terms as capacity, power and energy content are used. The understanding of capacity is more comprehensive and not limited to power or energy content. Power (MW) and energy content (MWh) are a specific form of capacity. In the NC RfG, the term capacity is used for the power of a generation unit, which is why production and consumption capacity are also mentioned here. In the text in italics under the headings production capacity and consumption capacity in the ESMD form, it has been clarified that it concerns power (MW), not energy content (MWh).

Lay-out electrical installation

A single-line diagram/diagram of the lay-out of your primary installation should be added here. There are no unambiguous requirements that the single-line diagram must meet, but for the quickest and most efficient assessment possible, it is desirable to have the following points clearly highlighted in the diagram:

- Location of the connection point with the system operator
- Protections for the entire power generation module (including the relevant settings))
- Type designation converters units
- Location step-up transformer

Short-circuit/rated current ratio

Here, the short-circuit current contribution of the electricity storage module in relation to the nominal current (I_{sc}/I_n) and absolute value (kA) at the connection point with the system operator is requested. In the case of a basic park, the factor I_{sc}/I_n of the respective individual converter unit type can be entered.

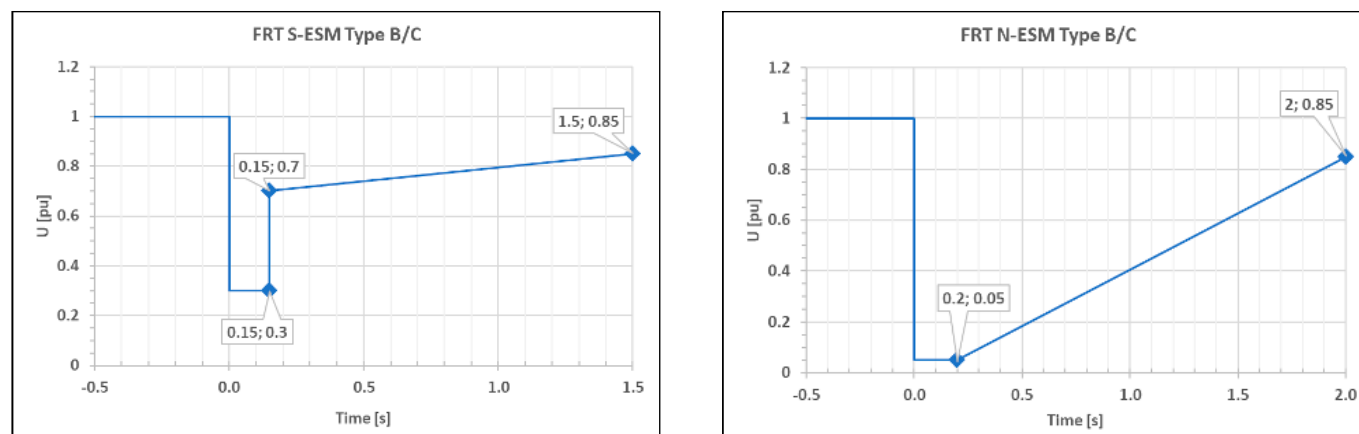
Protection settings in ESMD form

The protection settings requested in the ESMD form relate to the customer installation and not to the system operator's protection. Behavior at the connection point is important, even if the protection is located deeper in the system, for example at the converter. This is the **resulting behavior at the connection point** of all protections located in the customer installation, whether they are located in the Low Voltage (LV) or Medium Voltage (MV) installation or whether they are settings of the converters. These settings shall not conflict with the requirements of the Dutch Systeemcode. This concerns in particular the requirements for the fault-ride-through specified in Systeemcode article 3.15 and for the frequency and voltage range as specified in Systeemcode article 3.13 sub 10.

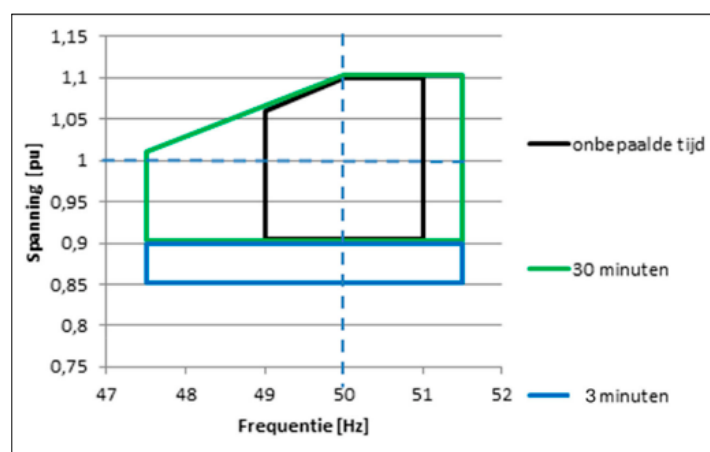
In addition to the general requirements for the protection settings discussed here, individual system operators may also set specific requirements. These will then be communicated to you separately, for example as part of the quotation in the event of a new or reinforcement of your connection.

Undervoltage protection $U<$

The setting of the undervoltage protection must not conflict with the requirements for the fault-ride-through requirements as specified in article 3.15 of the Systeemcode. See the graphs below and also paragraph 4.2.14 of the document '*RfG compliance verification*' on the site of Netbeheer Nederland: [Eisen voor opwekeenheden, opslag, verbruikseenheden met vraagsturing en HVDC | Netbeheer Nederland](#)



At the same time, the setting of the undervoltage protection must be in line with the requirements for the frequency and voltage range as specified in article 3.13 sub 10 of the Systeemcode. See the graph below and also section 4.2.7 of the document '*RfG compliance verification*'.



If the undervoltage and/or overvoltage protectors ($U<$ and $U>$) are set at converter level, they must be converted in the ESMD form to the voltage level at the connection point. This can be done by taking into account the winding ratio of the step-up transformer.

Overcurrent Protections $I>$ and $I>>$

The overcurrent protections $I>$ and $I>>$ are specifically requested in the form, as these settings must not conflict with the fault-ride-through requirements. During a short circuit elsewhere in the grid, which is temporary, the installation shall not switch off on $I>$ due to the short-circuit contribution of the storage installation. This can be solved by choosing $t>$ larger than 1.5 seconds (for S-ESM) or larger than 2 seconds (for N-ESM), or $I>$ larger than the short-circuit contribution of the storage installation. At the same time, it is important that the overcurrent protections are selective (faster) compared to the protection of the system operator, in the event of a fault in the customer installation itself.

The overcurrent protection devices ($I>$ and $I>>$) in the ESMD form are the protection devices that will be the first to respond in the event of a fault. It is important that the most critical protection with the lowest setting is converted to the connection point. Here too, the conversion shall be done by means of the winding ratio of the transformer.

Frequency protections ($f <$ and $f >$)

The setting of frequency protections must be such that the storage module remains connected to the grid within the frequency ranges, in accordance with article 3.11 of the Systeemcode:

Article 3.13

1 The power-generating unit is capable of remaining connected to the grid and in operation within the following frequency ranges and time periods, as referred to in Article 13(1)(a)(i) of Regulation (EU) 2016/631 (NC RfG):

- a. in the frequency range from 47.5 Hz to 48.5 Hz for 30 minutes;
- b. in the frequency range from 48,5 Hz to 49,0 Hz for 30 minutes;
- c. in the frequency range from 49.0 Hz to 51.0 Hz for an unlimited period of time;
- d. in the frequency range from 51.0 Hz to 51.5 Hz for 30 minutes.

Data for providing demand response

For maintaining power balance or transmission congestion in the grid, an electricity storage module can offer demand response to regulate active power, reactive power or to manage transmission congestion, based on agreements with the system operator. For this purpose, the 'Demand Response Unit Document (DRUD)' is available on the site of Netbeheer Nederland:

[Eisen voor opwekeenheden, opslag, verbruikseenheden met vraagsturing en HVDC | Netbeheer Nederland](#)

Switching from consumption to generation

In the event of a disruption of the grid frequency, the electricity storage module that is in storage mode (charging) can adjust the active power for the purpose of improving the stability of the electricity system. If the electricity storage module is not able to automatically adjust the active power at a frequency drop below 49.8 Hz, the electricity storage unit operating as a load must disconnect automatically. It must be filled in whether the storage module automatically adjusts the power when the frequency drop is below 49.8 Hz (also referred to as LFSM-U storage functionality) and switches from load (charging) to supply (discharge) or automatically switches off when the frequency drop is below 49.7 Hz.

Proof of compliance

As stated in the form, you must send proof that your storage module as a whole (i.e. the combination of all converters, cabling, protections, transformers, installations, etc., that make up your storage module) complies with the Dutch Systeemcode. More information about this can be found in the '**Handleiding Compliance Monitoring RfG**' on the site of Netbeheer Nederland:

[Eisen voor opwekeenheden, opslag, verbruikseenheden met vraagsturing en HVDC | Netbeheer Nederland](#)

Demonstrating compliancy is by means of a specified declaration of conformity which shows that your installation as a whole meets the requirements of the Systeemcode.

Annex 1 and Annex 2 describe the evidence that must be provided. It should be immediately clear from this evidence that these requirements are met. This evidence shall be supported by **test data** from individual components, in particular the converters. Subsequently, tests and simulations must be used to demonstrate that your installation as a whole is compliant, see Annex 2.

- If a storage unit is used that is on the list of accepted storage units Type B of the network operators, the supporting documents of Annex 1 do not have to be provided.
- If a storage unit is used that is not yet on the list of accepted Storage Units Type B of the network operators, the supporting documents of Annex 1 must be provided.

The simulation and test results according to Annex 2, which show that the requirements are met at park level, must always be provided. In the case of a basic park, the BLOS Excel tool made available by the grid operators can be used to simulate the reactive power exchange ([Eisen voor opwekeenheden, opslag, verbruikseenheden met vraagsturing en HVDC | Netbeheer Nederland](#)).

The 'ESM compliance verification' document of the joint Dutch system operators states which tests and simulations are involved. This document can be found on the site of Netbeheer Nederland: ESM Compliance Verification Document | Netbeheer Nederland

This document will help you to see (on page 8) which category your storage facility falls into. Then the table on page 23 for which technical requirements tests and simulations must demonstrate compliance with them. In the table on page 22, for each type of storage installation, reference is also made to the paragraphs in the document where these tests/simulations are described in terms of content, i.e. how they should be carried out. Below is a screenshot of this table with reference to the sub-paragraph numbers.

It shows that for all but one of the requirements, reference is made to the RfG CVD, the verification requirements for generating modules (RfG compliance verification by testing and simulating | Netbeheer Nederland). However, for storage modules, there is an additional requirement for the LFSM-U storage functionality. This additional requirement applies to all Types (A, B, C, D) and differs from the LFSM-U functionality for generation installations. For this functionality, the ESM CVD includes a section (4.2.1) with the requirements, tests and simulations that must be performed.

Sub-paragraph in RfG CVD	Requirement	S-ESM				N-ESM			
		A	B	C	D	A	B	C	D
4.2.1	LFSM-O	x	x	x	x	x	x	x	x
	LFSM-U-Storage	x	x	x	x	x	x	x	x
4.2.3	FSM			x	x			x	x
4.2.4	Frequency restoration			x	x			x	x
4.2.5	Black start capability			x	x				
4.2.6	Tripping to houseload			x	x				
4.2.7	Frequency range and Voltage range	x	x	x	x	x	x	x	x
4.2.8	Reactive power capability		x	x	x		x	x	x
4.2.9	Active power controllability							x	x
4.2.10	Voltage control mode							x	x
4.2.11	Reactive power control mode							x	x
4.2.12	Power factor control mode							x	x
4.2.13	Island operation			x	x			x	x
4.2.14	FRT (profiles different B/C and D)		x	x	x		x	x	x
4.2.15	Reconnecting after disconnection		x	x	x		x	x	x
4.2.16	Post fault active power recovery		x	x	x		x	x	x
4.2.17	Power Oscillation Damping Control (POD)				x			x	x
4.2.18	Fast fault current injection						x	x	x
4.2.19	Synthetic inertia							x	x
4.2.20	Power quality: voltage fluctuations, harmonics								x
4.2.21	Insulation coordination								x

Contribution to short-circuit power

A simulation/calculation of the short-circuit contribution is not an assessment point, but when assessing the ESMD form, it can be asked for as substantiation/further explanation. For the completeness of information and as an additional check on the ratio short-circuit/nominal current at the connection point, it is therefore desirable to add an appendix to the ESMD form, from which the ratio I_{sc}/I_n and the absolute contribution (kA) can be derived.

- In the case of a basic park, the contribution to the short-circuit power can be demonstrated by attaching technical information of the converter type used. This is information about the short-circuit currents of the respective converter type.
- In the case of a complex park, please demonstrate the contribution to the short-circuit power at the connection point with the system operator. Here you can refer to a calculation and/or simulation that is added as an appendix.