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TECHNICAL SPECIFICATION

colour inside

Electrical energy storage (EES) systems – Part 2-2: Unit parameters and testing methods – Application and performance testing

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Electrical energy storage (EES) systems – Part 2-2: Unit parameters and testing methods – Application and performance testing

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CONTENTS

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 2-2: Unit parameters and testing methods – Application and performance testing

FOREWORD

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IEC 62933-2-2 has been prepared by IEC technical committee TC 120: Electrical Energy Storage (EES) Systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
120/249/DTS	120/264A/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62933 series, published under the general title *Electrical energy storage (EES) systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Considering the wide variety of applications of EES systems, it is becoming important to define the typical application of each EES system depending on its purpose and control types, and also important to define the corresponding performance testing methods and procedures of the EES system.

IEC 62933-2-1 describes the general specification of unit parameters and testing methods for EES systems, in which details of duty cycles for typical grid applications and the associated performance metrics and testing methods are not covered.

This part of IEC 62933 focuses on developing generic duty cycles for applications, identifying relevant performance metrics and developing performance testing methods and procedures for EES systems.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 2-2: Unit parameters and testing methods – Application and performance testing

1 Scope

This part of IEC 62933 defines testing methods and duty cycles to validate the EES system's technical specification for the manufacturers, designers, operators, utilities and owners of the EES systems which evaluate the performance of the EES systems for various applications. The following items are covered in this document. The energy storage devices and technologies are outside the scope of this document:

– application;
– performance testing methods;
– duty cycles for specific application.

This document will be used as a reference when selecting testing items and their corresponding evaluation methods.

This document considers applications such as:

- frequency control;
- primary/secondary/tertiary frequency control;
- fluctuation reduction of PV and wind farm;
- reactive-power voltage control;
- power quality events mitigation;
- peak shaving;
- renewable firming;
- back-up power;
- islanded grid.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62933-1, *Electrical energy storage (EES) systems – Part 1: Vocabulary*

IEC 62933-2-1, *Electrical energy storage (EES) systems – Part 2: Unit parameters and testing methods – General specification*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62933-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.2 Abbreviated terms

EES: Electrical energy storage

EESS SOC: State of charge of EES system

POC: Point of connection

UPS: Uninterruptable power systems

4 Application of EES system

4.1 General

The applications of EES systems differ according to their purposes. The applications of EES systems are classified into three classes:

a) class A applications: short duration/power intensive applications (with a duty cycle of less than 1 h);
b) class B applications: long duration/energy intensive applications (with a duty cycle of more than 1 h), and
c) class C applications: back-up applications.

IEC 62933-2-1 provides classification details. The typical application of each class will be described hereinafter.

4.2 Class A applications

4.2.1 Frequency control

EES systems provide a grid frequency control function to increase the frequency by discharging and to reduce the frequency by charging. The system frequency will be controlled within a predetermined bandwidth. The control subsystem in the EES system continuously measures the frequency and then sends a control signal to the power conversion subsystem to increase or decrease the amount of active power injected into the grid or the amount of load on the grid.

4.2.2 Primary/secondary/tertiary frequency control

In this application, there is a sudden loss of generation which leads to be made up through a discharge from the EES system. In the case of a sudden loss of load in the grid, energy is charged into the EES.

Generally, the definition of each control is based on the control order and control time period. The following are example cases for reference.

Primary frequency control comes first and usually it is automatically initiated. It is activated within a few seconds and lasts up to a few minutes.

Primary frequency control is followed by secondary frequency control if necessary and is initiated automatically or manually. It should have an activation time typically between 30 s and up to15 min.

Tertiary frequency control is used to resolve any additional imbalance that exists after the primary and secondary frequency control has been carried out. It should have an activation time typically between 15 min and several hours.

The activation time period of these controls is usually set in the grid code of each country or region.

4.2.3 Fluctuation reduction of PV and wind farms

An EES system is used to reduce the rapid fluctuations of the power output from PV and wind farms. The purpose of fluctuation reduction of the power output from PV and wind farms is to help to meet the ramp rate requirements. This action will mitigate frequency variation and stability issues at both feeder and transmission levels particularly with high penetration PV and wind farm scenarios.

At the feeder level, fluctuation reduction of PV and wind farm is implemented to mitigate voltage flicker and voltage deviations from desired bands. At the transmission level, PV and wind farm variability can require an additional operating reserve to be set aside. This can cause traditional power generation facilities to be cycled on/off more often than desirable.

The method by which the EES system can provide reduction of PV and wind farm output power fluctuation is to absorb or supply active/reactive power at appropriate times as determined by a control system resulting in a less variable composite power signal at the feeder and/or transmission level.

4.2.4 Reactive-power voltage control

The reactive-power voltage control application addresses the fluctuations in the grid voltage by providing reactive power support. EES systems inject reactive power as the grid voltage dips and absorb reactive power as the grid voltage increases.

4.2.5 Voltage sag mitigation

The sag or interruption in voltage potentially causes power disturbances that negatively impact power quality. EES systems mitigate voltage sags by discharging real power for up to a few tens of seconds. The application of an EES system to improve power quality does not require the EES system to provide enough energy for customers to ride through sag or interruption.

NOTE An event duration of more than 1 min is considered as outage mitigation.

4.3 Class B applications

4.3.1 Peak shaving

The EES system discharges stored energy into the grid upon an excess or peak of demand or absorbs excess energy, available in the grid, for storage. With this balancing a time shift between power generation and electricity usage is achieved.

Examples of this application include energy time shift of conventional/wind/solar/base load-generation, and include transmission/distribution grid congestion relief.

4.3.2 Renewable firming

Renewable firming is the use of an EES system to provide energy to supplement renewable power generation such that their combination produces steady power output over a desired time window. More precisely, the purpose of renewable firming is to provide energy (or conversely, to absorb energy) when renewable generation falls below some threshold (or conversely, exceeds this threshold).

This service is performed to provide steady power output over a desired time window, usually a period of multiple hours. Typically, the threshold is based upon the forecasted nominal renewable power generation over the desired time window. Thus, the EES system is compensating for the forecast uncertainty in actual renewable generation during that time window.

The method by which the EES system performs this service is described as follows. The EES system discharges power during periods for which renewable generation falls short of the threshold and absorbs power when renewable generation exceeds this threshold.

4.3.3 Islanded grid

The EES supports in islanded grids their multiple loads, distributed energy generation and storage resources. In such a service the EES system provides energy to the load of the islanded grid. The EES system converter typically operates in the voltage/frequency mode to control the islanded grid.

The EES systems supply the islanded grid for a limited time when the power supply from the other grid is interrupted for some reason.

4.4 Class C applications

EES systems used as back-up power are independent sources of electrical power that support critical loads on loss of normal power supply. Back-up power systems are, for example, installed to protect life and property from the consequences of loss of primary electric power supply. Uninterruptable power systems (UPS) are out of the scope in this application.

5 Parameter testing methods for application

5.1 Parameter tests

5.1.1 General

Parameter tests shall be conducted for all EES systems regardless of intended application(s) in accordance with Clause 5, and the results shall be used to determine EES system performance that can be subsequently used as a baseline to assess any changes in the condition of the EES system and performance over time and use. Parameter tests shall be conducted to determine baseline performance of the EES system prior to duty cycle testing.

5.1.2 Actual energy capacity

The actual energy capacity of the EES system shall be tested at rated power, and at short duration input power or at additional power values different from rated power if such parameters are required.

The energy capacity shall be evaluated as the product of the rated output power and the output duration time. The values of the output power from the EES system shall be obtained at the point of connection (POC) by placing calibrated power meters at the POC and auxiliary feed points (in case of auxiliaries fed from a substation).

The actual energy capacity is defined in IEC 62933-1. Also, the actual energy capacity test shall be performed in accordance with the test methods defined in IEC 62933-2-1.

5.1.3 Roundtrip efficiency

The roundtrip efficiency test shall be conducted to determine the amount of energy output that the EES system can deliver, relative to the amount of energy input into the EES system during the preceding charge and discharge.

The roundtrip efficiency test shall be performed in accordance with the test methods defined in IEC 62933-2-1.

5.1.4 Step response time and ramp rate

The step response time of the EES system is the duration of the time interval between the instant when the set point value is received at the EES system and the instant when the active power at the POC starts to stay within ±2 % of deviation from the set point. The ramp rate of the EES system is the average rate of active power variation per unit time.

The response time and ramp rate of the EES system shall be performed in accordance with the test methods defined in IEC 62933-2-1.

5.1.5 Auxiliary power consumption

The auxiliary power consumption shall be measured with the ESS system connected to the POC. The auxiliary power consumption of the EES system shall be tested in accordance with the test methods defined in IEC 62933-2-1.

5.1.6 Self-discharge

The self-discharge of the EES system is the energy loss of the EES system in the stopped state during the standard measurement time. The self-discharge of the EES system shall be tested in accordance with the test methods defined in IEC 62933-2-1.

5.1.7 SOC

The state of charge (SOC) of the EES system (EESS SOC) is the ratio between the available energy from the EES system and the actual energy capacity, expressed as a percentage. The available energy is defined in IEC 62933-1.

The testing methods of available energy are defined in IEC 62933-2-1.

5.2 Duty cycle performance tests

5.2.1 General

Duty cycle performance tests shall be conducted for each intended application of an EES system using the duty cycles as defined in Clause 6.

5.2.2 Duty cycle roundtrip efficiency

The duty cycle roundtrip efficiency is used in the determination of the performance of the EES system for each application duty cycles defined in Clause 6.

The duty cycle roundtrip efficiency of the EES system shall be tested in accordance with the test methods defined in IEC 62933-2-1.

5.2.3 Reference signal tracking

The ability of the EES system to respond to a signal for the duration of the duty cycle for each intended application of the EES system reflects the ability of the EES system to track the signal.

The tests of the ability should be conducted by Formula (1) to Formula (4) below separately for each intended application of the EES system while applying the duty cycle relevant to each intended application of the EES system. The procedures of the tests are as follows.

The ability should be defined and determined by the manufacturer of the EES system in accordance with the provisions of Clause 6. The signal should be changed in accordance with the duty cycle(s) for each intended application of the EES system.

The manufacturer of the EES system should also determine and report separately the total percentage tracking and the times when the EES system stops tracking and restarts tracking as an indication of whether the EES system is capable of tracking high peaks and/or high energy half-cycles.

The manufacturer should also determine whether the EES system can go through the required duration of the duty cycle without reaching the lower or upper EESS SOC limits. This should be performed during the application of the relevant duty cycle as described in Clause 6, and any time during that period when the EES system indicates an ability or inability to follow the signal should be reported.

An inability for the power signal to follow the signal shall be considered a situation where the EES system cannot deliver or absorb the required signal power during the duration when the signal is to be changed.

For the energy signal, an inability to follow the signal shall be considered a situation where the EES system cannot deliver or absorb the required energy signal during the duration when the energy signal remains positive or negative, respectively. Simulations of the signal can be applied for the testing.

NOTE There are some cases where the inability of the EES system to follow the signal is not caused by the EES system performance itself but by the external conditions such as energy capacity specified under some restrictions or changing of the SOC limits set-points by the external control system.

The ability of the EES system to respond to a signal should be measured during the duty cycle roundtrip efficiency test. The residual sum of squares or the sum of the square of errors between the power signal (P_{signal}) and the power delivered or absorbed by the EES system (P_{eess}) should be calculated in accordance with Formula (1) and used to estimate the inability of the EES system to track the signal.

$$APT = \frac{\sum \left(P_{\text{signal}} - P_{\text{eess}} \right)^2}{N} \tag{1}$$

where

APT is the ability of the power signal tracking,

P_{signal} is the power signal,

P_{eess} is the EES system power (watts), and

N is the number of data during one duty cycle.

The measurements should be taken at every point in time that the EES system receives a change in the power signal. The sum of the absolute magnitudes of the difference between the power signal and EES system power should be calculated in accordance with Formula (2).

$$APTA = \frac{\sum \left| P_{\text{signal}} - P_{\text{eess}} \right|}{N} \tag{2}$$

where

$APTA$ is the ability of power signal tracking in absolute.

The sum of the absolute magnitudes of the difference between the signal energy and EES system energy should be calculated in accordance with Formula (3) and reported by the manufacturer of the EES system to account for the inability of the EES system to follow the signal due to the EES system reaching the EESS SOC limits provided in the manufacturer's specifications and operating instructions.

$$AETA = \frac{\sum \left| E_{\text{signal}} - E_{\text{eess}} \right|}{N} \quad (3)$$

where

$AETA$ is the ability of energy signal tracking in absolute,

E_{signal} is the signal energy for a half-cycle, with the half-cycle being the signal of the same sign (positive or negative),

E_{eess} is the energy supplied to or absorbed by the EES system for each half-cycle, and

N is the number of data during one duty cycle.

The total time when the EES system cannot follow the power signal and the percentage tracked where $(P_{\text{signal}} - P_{\text{eess}}) / P_{\text{signal}}$ is less than 0,02 should be determined in accordance with Formula (4). However, the value of 0,02 should be determined by negotiation with the user of the EES system.

When $| P_{\text{signal}} - P_{\text{eess}}) / P_{\text{signal}} |$ is less than a certain value, the EES system should be considered to track the signal. The percentage of time the signal is tracked during the duration of the duty cycle for the application(s) of the EES system should be determined in accordance with Formula (4)

$$PST = \frac{\text{time signal is tracked (h)}}{\text{duration of the duty cycle (h)}} \times 100 \quad (4)$$

where

PST is the percentage of signal tracking.

5.3 Test items for each application

The parameter test and duty cycle performance test items that are required for each application are shown in Table 1. If the EES system has implemented the functionality of multiple applications, all the tests corresponding to each application shall be performed.

Table 1 – Test items for each application

Test items	Frequency control	Primary/ secondary/ tertiary frequency control	Fluctuation reduction of PV and wind farm	Reactive-power voltage control	Power quality events mitigation	Peak shaving	Renewables firming	Islanded grid
Actual energy capacity	√	√	√	√	√	√	√	√
Roundtrip efficiency	√	√	√	√	√	√	√	√
Step response time and ramp rate	√	√	√	√	√	√	√	√
Auxiliary power consumption	√	√	√	√	√	√	√	√
Self-discharge	√	√	√	√	√	√	√	√
SOC	√	√	√	√	√	√	√	√
Duty cycle roundtrip efficiency	√	√	√		√	√	√	√
Reference signal tracking	√	√	√	√	√		√	√

6 Duty cycle for specific applications

6.1 General

The duty cycle patterns described in Clause 6 should be considered to apply for specific applications. Otherwise the duty cycle pattern shall be specified the by the user and system supplier. In either case, it shall be agreed between user and system supplier.

6.2 Frequency control

6.2.1 Frequency control duty cycle

The duty cycle presented in Figure 1 should be applied in determining the performance of an EES system for a frequency control application.

The duty cycle in Figure 1 is shown as power normalized with respect to the rated power of the EES system over a 24 h time period, where positive represents a discharge from the EES system and negative represents a charge into the EES system as a function of time in hours.

The initial EESS SOC should be set according to the manufacturer’s specifications and operating instructions. At the end of the application of the duty cycle in conducting the testing under 5.2, the EES system should be brought back to its initial EESS SOC.

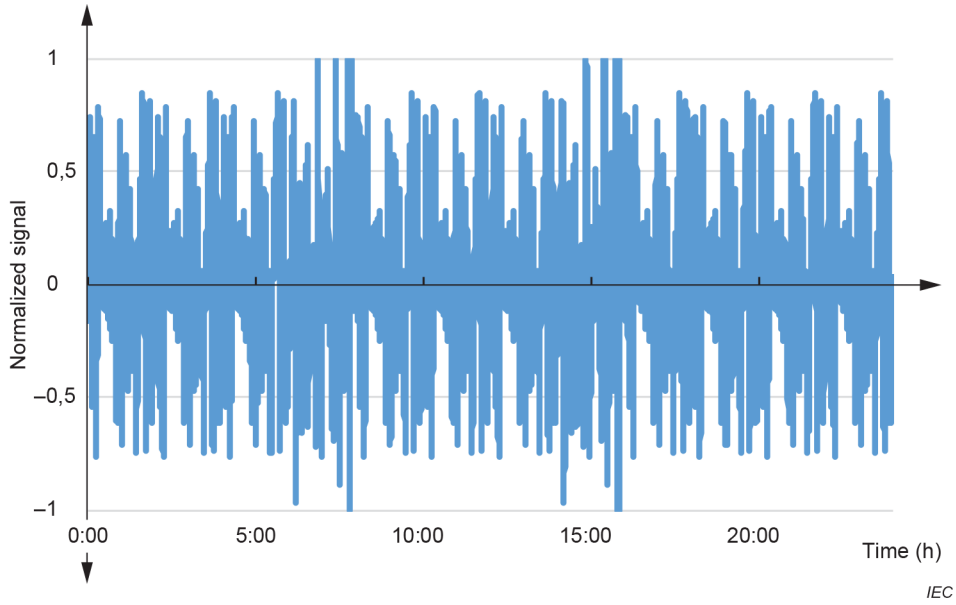


Figure 1 – Frequency control duty cycle

Peak power (1,0 p.u.) should be determined and applied for Figure 1 testing considering the intended control value for ΔF under the concept of Figure 4.

The test pattern is based on actual field conditions in North American power grids and can be adapted to local operating conditions as needed.

The test evaluation is for one duty cycle. It does not mean to ensure the operation for multiple duty cycles. If the number or pattern of charging processes affects battery performance in a long period of time, the number should be subject to the manufacturer's individual specification or the pattern should be agreed between the user and manufacturer for the EES system to perform with the expected performance throughout the life of the battery.

Test conditions such as use of constant-current/constant-voltage supply, maximum current/voltage, or temperature range should be specified prior to testing based on the battery technology and the manufacturer's individual specification.

6.2.2 Primary/secondary/tertiary frequency control duty cycle

The duty cycles in Figure 2a) and b) should be applied in determining the performance of an EES system in a frequency control application. The duty cycles shown in Figure 2a) and b) cover a primary frequency control situation during a sudden loss of generation.

This duty cycle corresponds to an EES system discharge for 30 s at 1 min peak power rating, a rest for 29 min, and then repeats this same pattern of use over a period of 24 h or to a point in time when when the EESS SOC reaches to the lowest limit. Figure 2a) shows the entire duty cycle over 24 h, while Figure 2b) shows the magnified portion of the duty cycle in order to provide detail on the discharge characteristics.

The duty cycles in Figure 3a) and b) cover a secondary frequency control situation where the duty cycle duration is such that energy is withdrawn or absorbed under the appropriate peak power of the EES system rating.

This duty cycle corresponds to a continuous 20 min EES system discharge, a rest for 40 min, and then repeats this same pattern of use over a period of 24 h or to a point in time when the EESS SOC reaches the lowest limit.

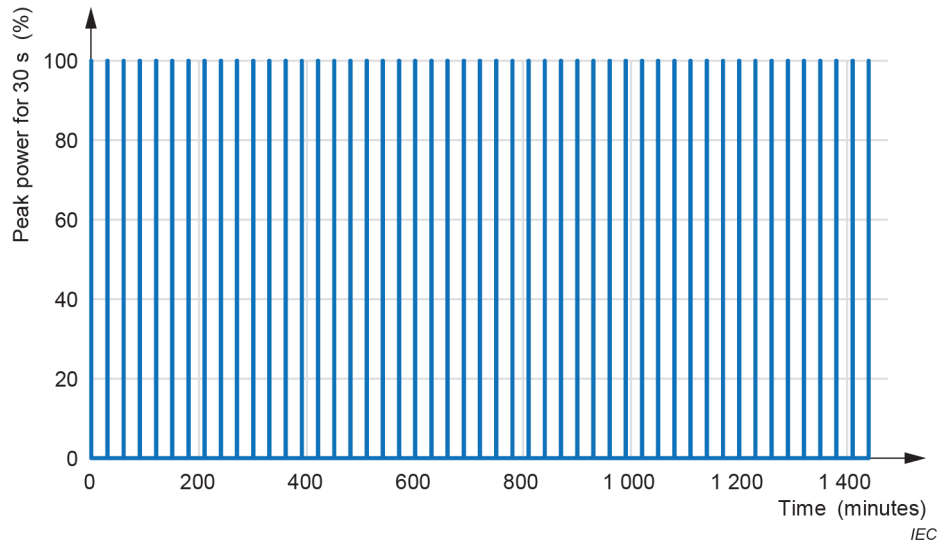
While the captions to Figure 2 and Figure 3 only mention discharge, the duty cycles represented in these figures apply to both discharge (sudden loss of generation) and charge (sudden loss of load). The initial EESS SOC should be set at maximum EESS SOC for sudden loss of generation and at minimum EESS SOC for sudden loss of load.

At the end of the application of each duty cycle, the EES system should be brought back to its initial EESS SOC by charging (for a sudden loss of generation) or discharging (for a sudden loss of load) at rated power before the application of another duty cycle.

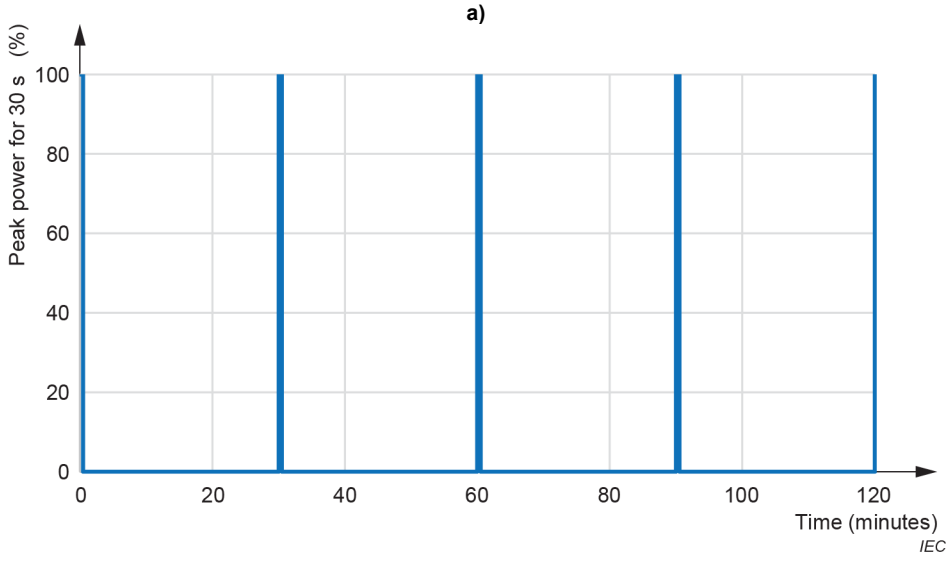
When necessary, tertiary frequency control should be applied with an activation period from 15 min to hours over a period of 24 h, or to a point in time when the EESS SOC reaches the lowest limit.

Peak power (1,0 p.u.) should be determined and applied to Figure 2 and Figure 3 testing considering the intended control value for Δf under the concept of Figure 4.

The test conditions such as the use of constant-current/constant-voltage supply, maximum current/voltage, or temperature range should be specified prior to testing based on the battery technology and the manufacturer's individual specification.

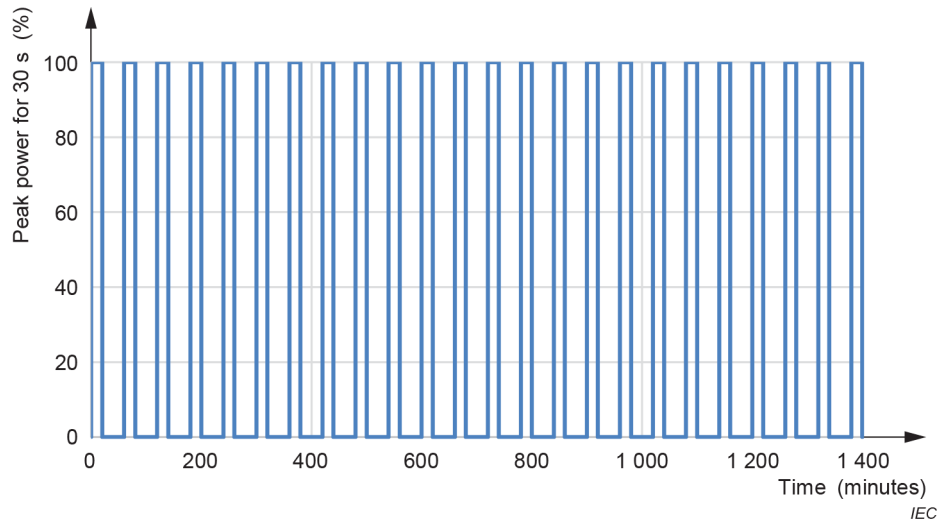


a)

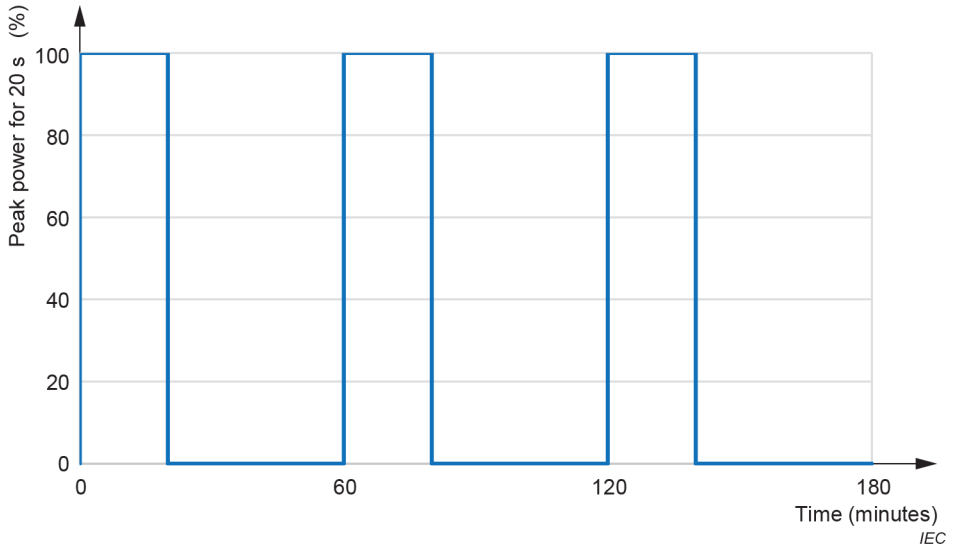


b)

Figure 2 – Primary frequency control signal – 24 h duty cycle with 30 s discharge every half hour shown over a) 24 h and b) 2 h



a)



b)

Figure 3 – Secondary frequency control signal – 24 h duty cycle with 20 min discharge every hour shown over a) 24 h and b) 3 h

6.2.3 Deviation control of frequency

Subclause 6.2.3 describes the test method for deviation control of the grid frequency.

Figure 4 shows an example of droop active power control for the grid frequency.

The key parameters of the frequency deviation control test are shown schematically in Figure 4.

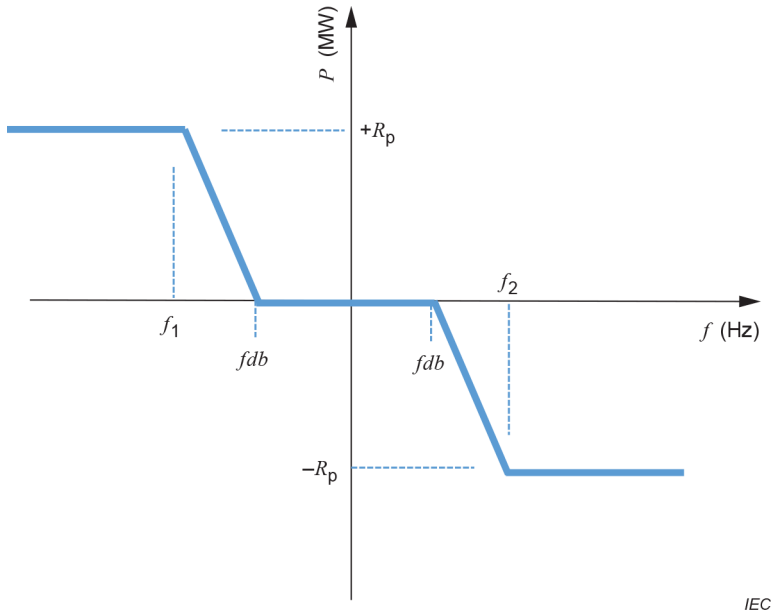


Figure 4 – Example of droop active power frequency control with a dead band

Regarding frequency deviation control (frequency control, primary/secondary/tertiary), the EES system controls the frequency deviation based on the following formula which uses the active sign convention (a positive value of P corresponds to a power injection whereas a negative value of P corresponds to a power absorption).

$$P - P_{\mathrm{C}} = K \times \left(f - \left(f_{\mathrm{n}} + fdb \right) \right) \tag{5}$$

where

P [MW] is the active power output of the EES system;

P_{C} [MW] is the active power set point of the EES system at nominal frequency f_{n};

f [Hz] is the frequency measured on the grid;

f_{n} [Hz] is the nominal frequency (50 Hz or 60 Hz);

K [MW/Hz] is the proportional gain for the P-f characteristic of the entire grid system;

fdb [Hz] is the dead band frequency;

R_{p}[MW] is the maximun reserved power for frequency control.

Since the proportional gain K is the dependent factor of each grid, K should be acquired from the grid design specification or experimental approach if the design specification is not available.

The EES system should be tested to confirm that the expected P can be obtained by the input set point of Δf following the characteristics of Figure 4. The minimum resolution of the input set point (e.g. 0,1 Hz or 0,05 Hz) should be decided based on the design specification. It can also be subject to regional requirements if any.

The dead band parameter is dependent on the grid design and associated power generation system. The formula $\Delta f\,(f - (f - (fn \pm fdb))$ shall be used to generate the set point value if a dead band value exists.

6.3 Fluctuation reduction of PV and wind farm

The EES system that charges and discharges according to an input command and an output command received from an external controller such as EMS, should be checked to verify whether it operates normally according to a defined duty cycle pattern for confirming the performance in fluctuation reduction for photovoltaic and/or wind farm application.

The duty cycle patterns described in 6.3 should be considered to apply for specific applications. Otherwise the duty cycle pattern shall be specified by the user and system supplier. In either case, it shall be agreed between the user and system supplier.

The duty cycle in Figure 5 is to be applied when the performance of an EES system for fluctuation reduction in PV (photovoltaic energy systems) is to be evaluated in a reduction of the fluctuation in PV installations. The numerical data are provided in Annex A.

The duty cycle in Figure 5 is shown as power normalized with respect to the input and output power rating of the EES system over a 10 h time period, where a positive sign represents discharge from the EES system and a negative sign represents charge into the EES system as a function of time in hours.

The initial EESS SOC should be set according to the manufacturer's specifications and operating instructions.

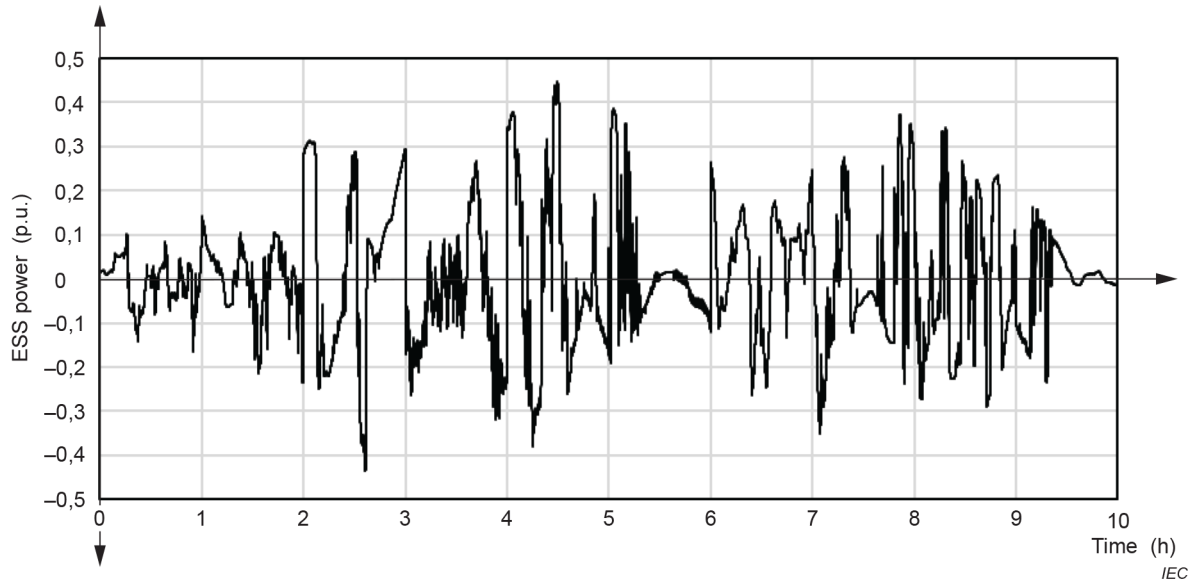


Figure 5 – Duty cycle of fluctuation reduction of PV (photovoltaic energy systems)

The duty cycle in Figure 6 is to be applied when the performance of an EES system for fluctuation reduction in wind farm energy systems is to be evaluated.

The duty cycle shown in Figure 6 is a combination of the 2 h duty cycle patterns shown in Figure 7 to Figure 9. The duty cycle consists of two sets of average deviation signals, two sets of high deviation signals and one set of low deviation signals, which are shown in Figure 7, Figure 8 and Figure 9.

The duty cycles in Figure 6, Figure 7, Figure 8 and Figure 9 are shown as power normalized with respect to the input and output power rating of the EES system over a 24 h time period, where a positive sign represents discharge from the EES system and a negative sign represents charge into the EES system.

The initial SOC of the EES system should be set as 0,5. At the end of the application of a duty cycle in conducting the testing under 5.2, the EES system should be brought back to its initial EESS SOC before the application of another duty cycle. The process of the SOC being brought back should be carried out under the required condition of the adopted EES system specification if any.

Normalized power (p.u.) should be specified based on agreement between the user and manufacturer since the EES system normalized power has to be determined considering the capacity of the PV and wind farm.

NOTE The test evaluation is for one duty cycle. It does not mean to ensure the operation for multiple duty cycles.

If the number or pattern of charging processes affects battery performance in a long period of time, the number should be subject to the manufacturer 's individual specification or the pattern should be agreed between the user and manufacturer for the EES system to perform with the expected performance throughout the life of the battery.

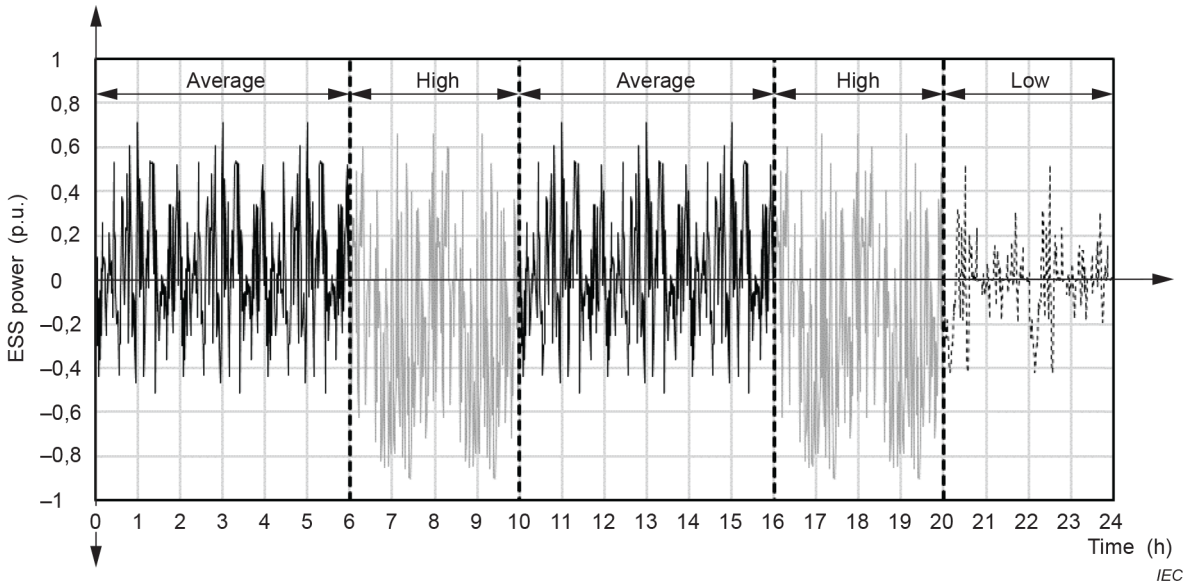


Figure 6 – Duty cycle of fluctuation reduction of wind farm

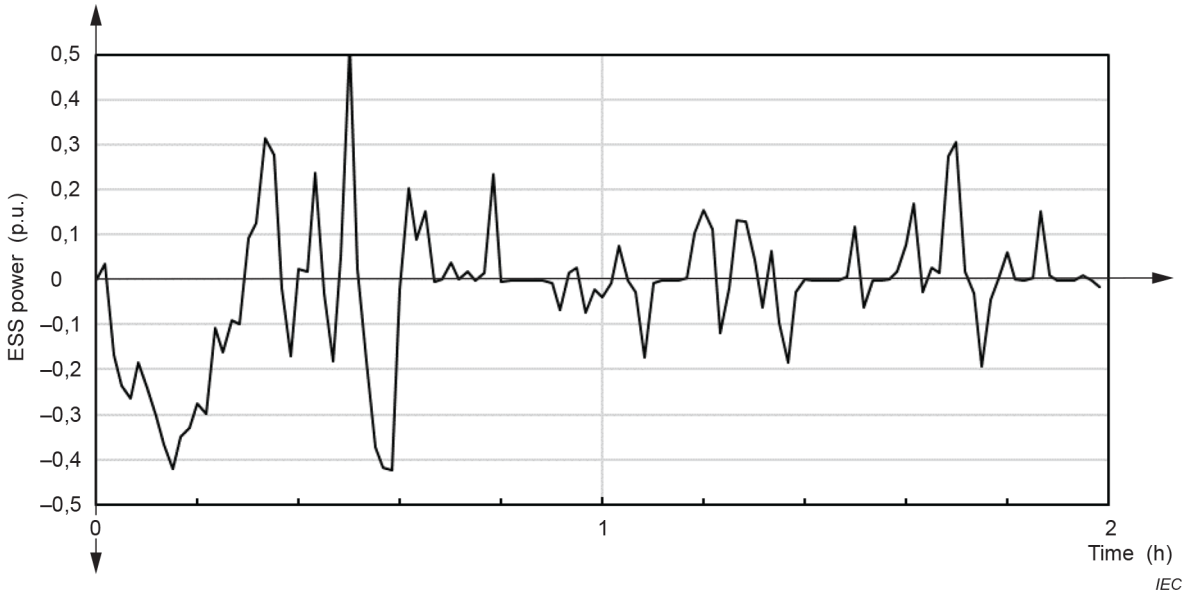


Figure 7 – Duty cycle of fluctuation reduction of wind farm (low standard deviation)

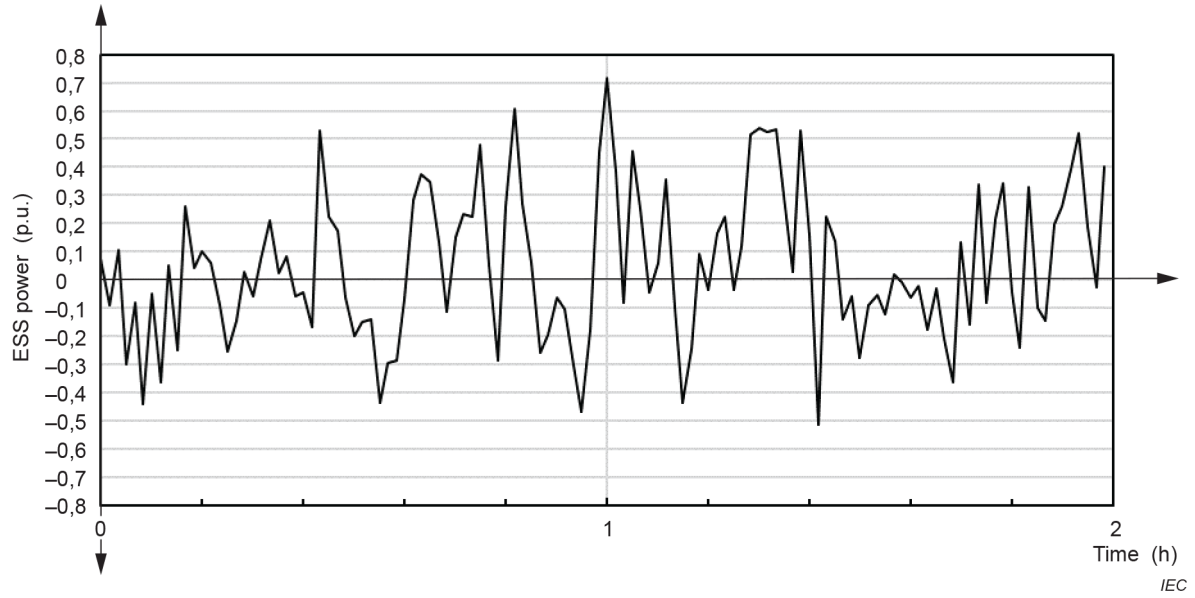


Figure 8 – Duty cycle of fluctuation reduction of wind farm (average standard deviation)

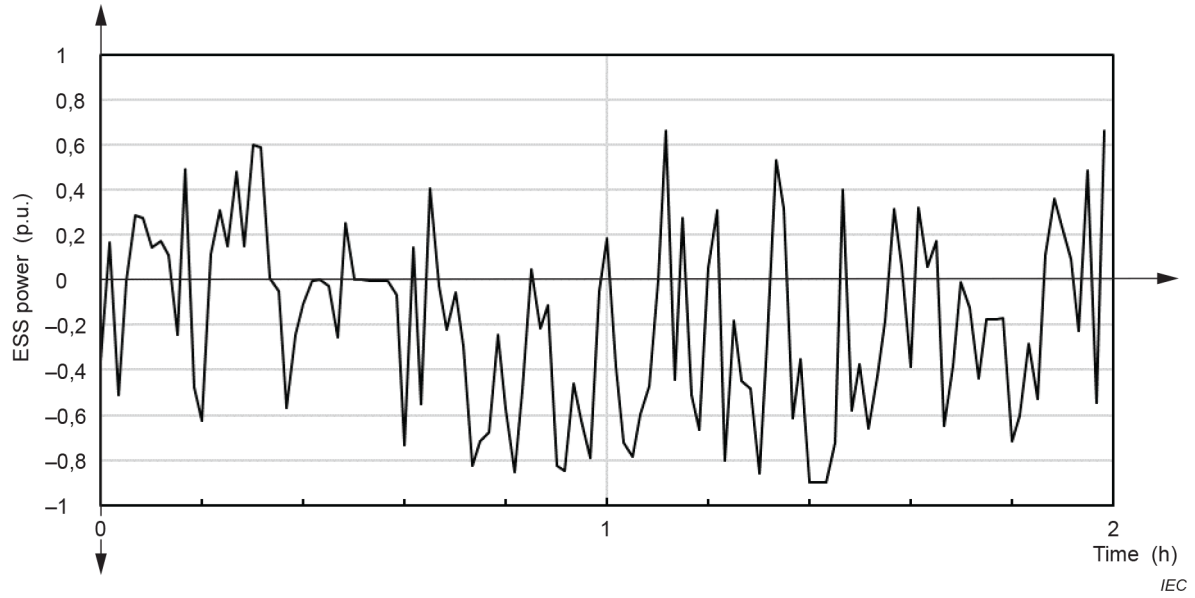


Figure 9 – Duty cycle of fluctuation reduction of wind farm (high standard deviation)

6.4 Reactive-power voltage control

The EES system is connected to the test facility (grid simulator) operating within the nominal voltage range. The nominal operating voltage at the POC falls within the lower limit U_{min} and upper limit U_{max}.

The initial EESS SOC should be set at the value determined by the supplier at less than full charge.

The initial active power of the EES system should be set at 100 %, 50 %, 0 %, -50 % and -100 % or the specified states should be agreed between the system supplier and user.

Using the test facility (grid simulator), the voltage at the POC should transition from 1,0 p.u. to the new voltage value according to the test profile shown in Table 2 and Figure 10 or a specified profile should be agreed between the system supplier and user.

The voltage, active power and reactive power at the POC should be measured to confirm that they are the expected values.

NOTE This test is to confirm the intended active power and reactive power in the parameter of the voltage. Active power and reactive power can be decided by agreement between the user and manufacturer within the limitation of the EES system rating.

Table 2 – Reactive-power voltage control test profile

Time (seconds)	Voltage (nominal%)
0	100
30	100
30	106
60	106
60	94
90	94
90	100
120	100
135	106
150	106
180	94
195	94
210	100
240	100
245	106
250	106
260	94
265	94
270	100
300	100

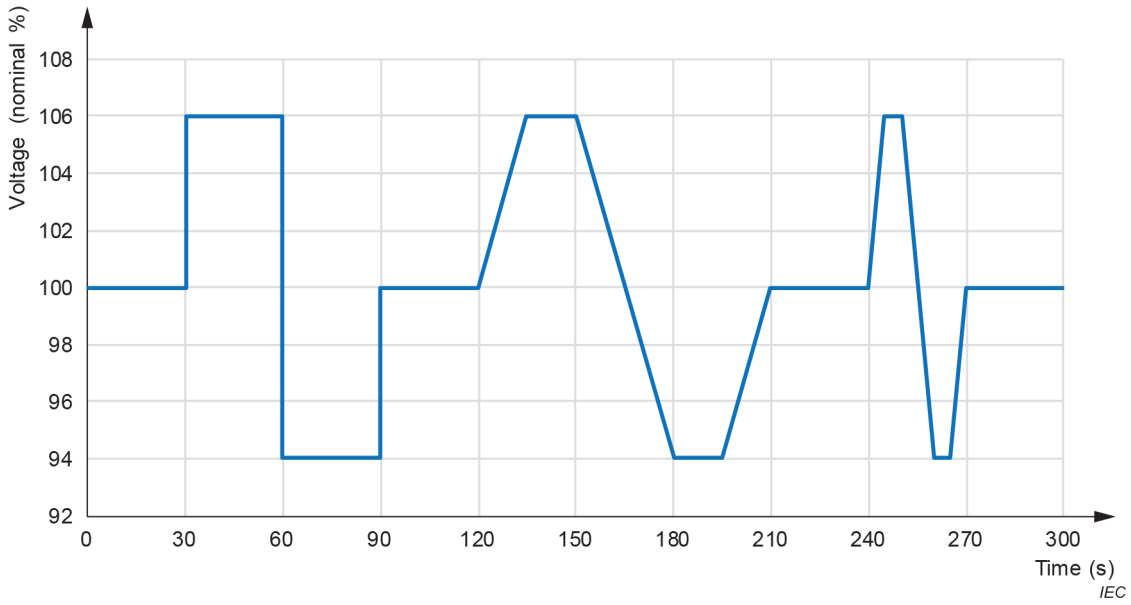


Figure 10 – Reactive-power voltage control test profile

6.5 Voltage sag mitigation

The EES system is connected to the test facility (grid simulator).

The operating mode and initial state (EESS SOC, active power and reactive power) should be agreed between the system supplier and the user, and each operating mode and initial state should be tested.

For voltage sags, changes in supply voltage (test levels, durations and phase shifts) should comply with IEC 61000-4-11, IEC 61000-4-34 or be agreed between the user and manufacturer.

The EES system should be tested for each selected combination of test level and duration with a sequence of three sags with intervals of 10 s minimum (between each test event).

For the voltage sags test of three-phase systems with neutral, each individual voltage (phase-to-neutral and phase-to-phase) should be tested, one at a time. For the voltage sags test of three-phase systems without neutral, each phase-to-phase voltage should be tested, one at a time.

The test profiles are shown in Figure 11 to Figure 14. The voltage, active power and reactive power at the POC should be measured to confirm that the EES system outputs expected active/reactive power against voltage during and after sags.

NOTE 1 This test is to confirm the intended active power and reactive power in the parameter of the voltage. Active power and reactive power can be decided by agreement between the user and manufacturer within the limitation of the EES system rating.

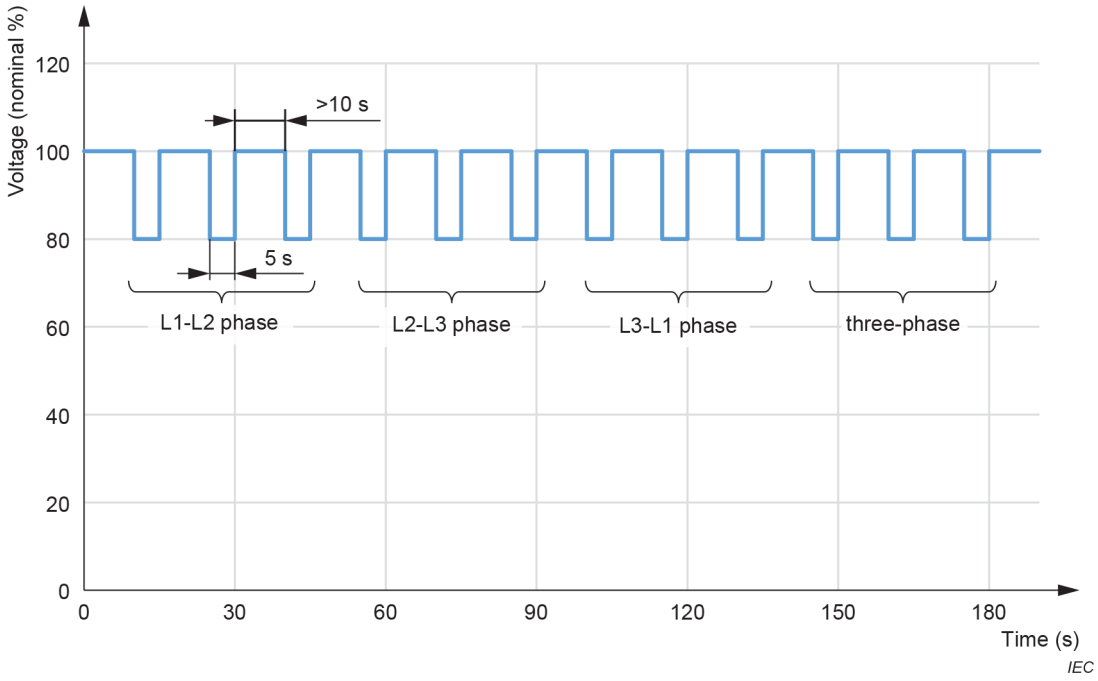


Figure 11 – Voltage sag mitigation test profile (test level: 80 %)

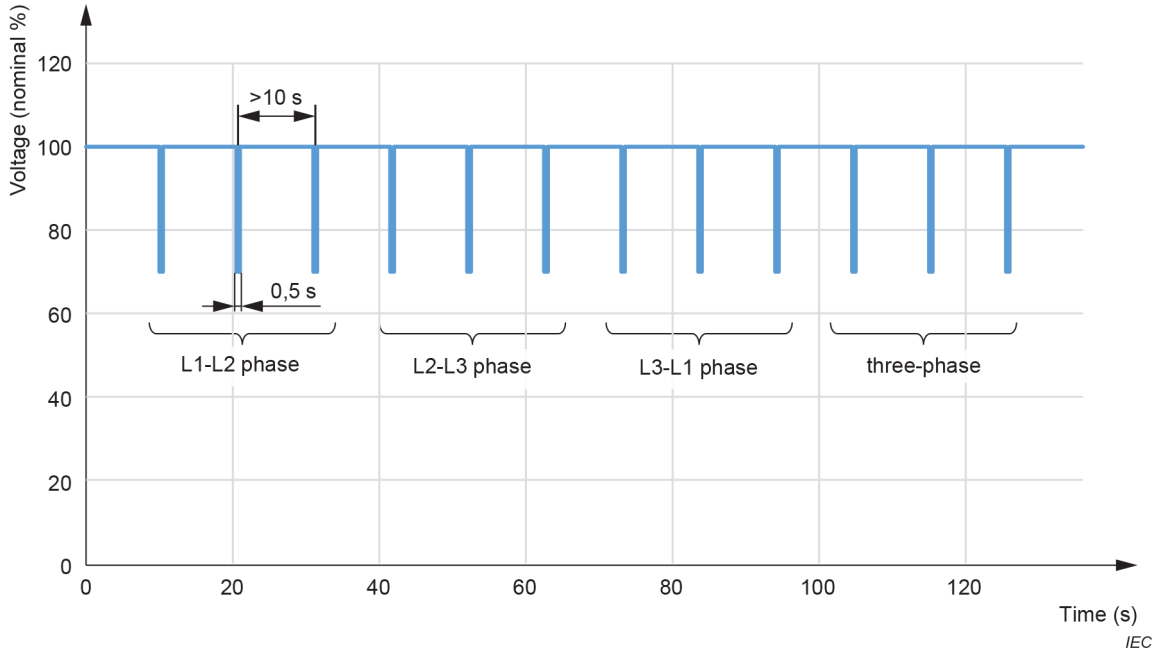


Figure 12 – Voltage sag mitigation test profile (test level: 70 %)

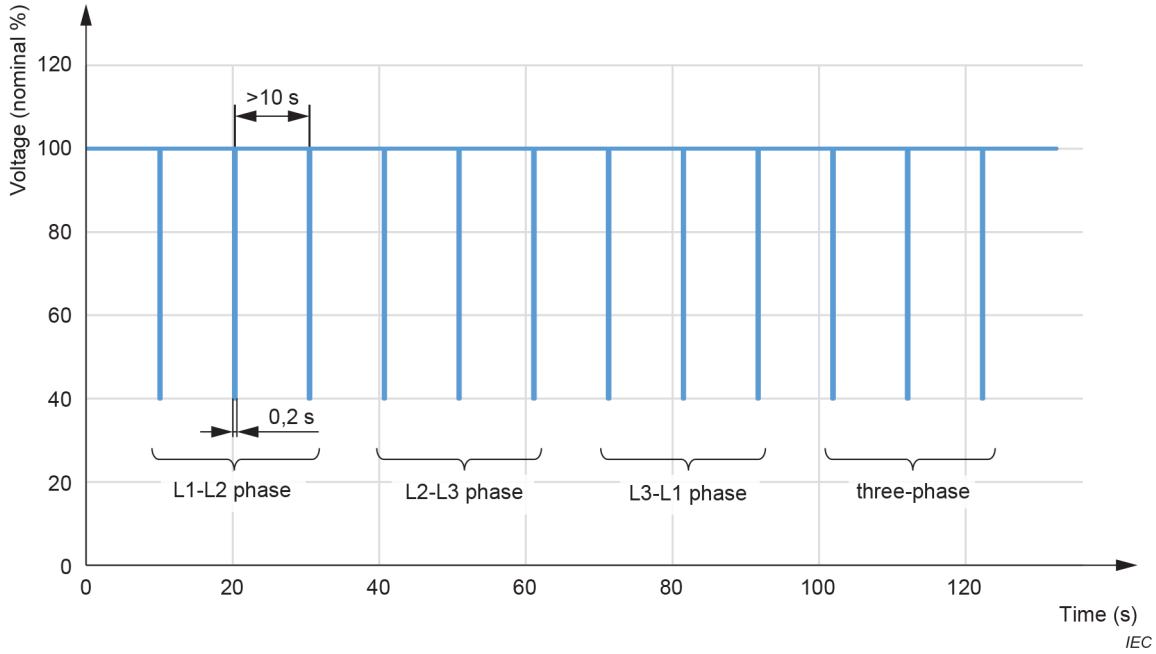


Figure 13 – Voltage sag mitigation test profile (test level: 40 %)

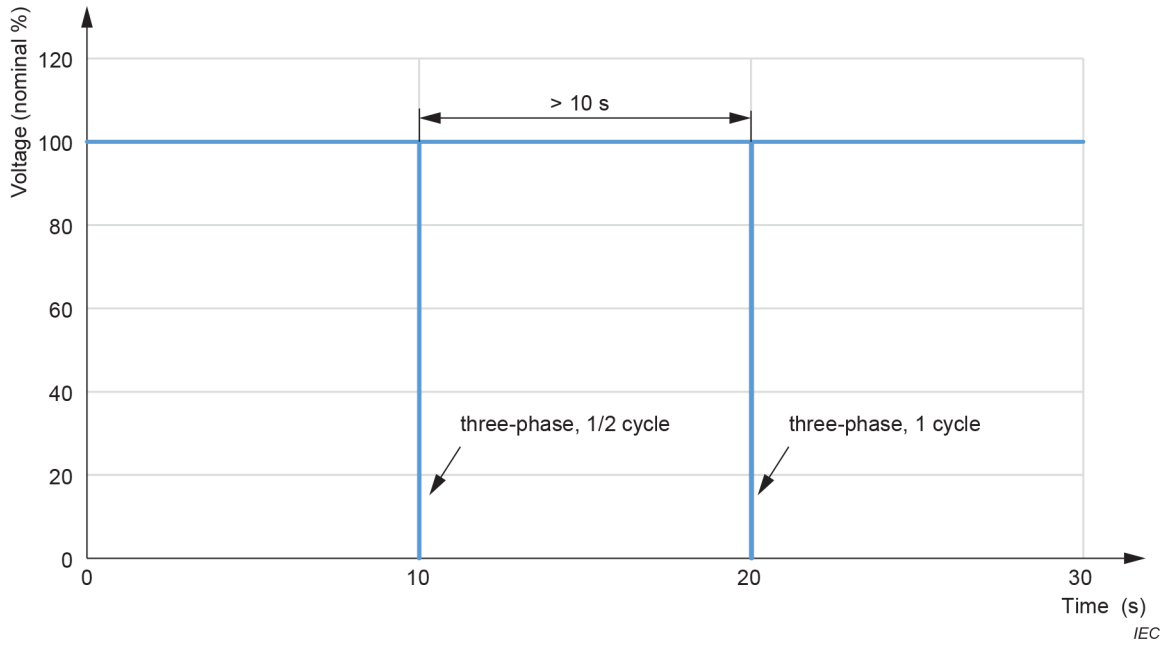


Figure 14 – Voltage sag mitigation test profile (test level: 0 %)

Figure 11 to Figure 14 are examples of a test profile for three-phase systems without neutral. The test profile should be decided according to IEC 61000-4-11, IEC 61000-4-34 or by agreement between the system supplier and the user.

NOTE 2 The test evaluation is for one duty cycle. It does not mean to ensure the operation for multiple duty cycles.

6.6 Peak shaving

6.6.1 “One charge-one discharge” mode

The duty cycles presented in 6.6 should be used in the determination of the performance of systems intended for peak-shaving applications and should use the charge and discharge time period to allow the duty-cycle profile to be applied in the same manner to different technologies regardless of system size, type, age, and condition.

The duty cycle test applied in determining system performance should be in accordance with Figure 15. In applying the duty cycle test, the discharge power and EESS SOC range for each duty cycle should be selected such that the power remains constant throughout the required discharge period (6 h, 4 h and 2 h for Case-1, Case-2 and Case-3, respectively, shown in Figure 15).

Each of the cases should have a total of 12 h of charge duration. The associated discharge and float charge periods bring the total duration of each case of duty cycle to 24 h.

While Figure 15 shows the cases for a midnight-to-midnight day with an evening peak, for the purposes of testing, the test starts with a discharge at 13:00 for Case-1, 14:00 for Case-2 and 15:00 for Case-3.

Prior to the test, the EES system should be brought to the maximum EESS SOC by charging at rated power. When conducting performance tests using these cases, the EES system should be returned to the same EESS SOC as the EESS SOC at the start of the test, which is the maximum EESS SOC.

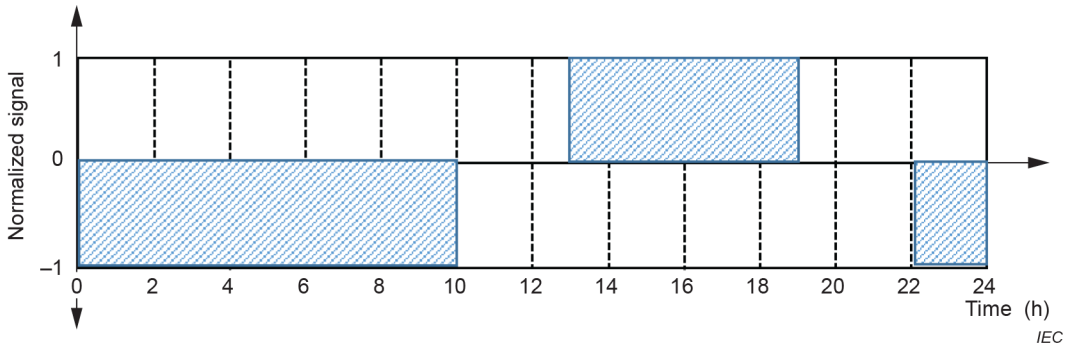
As such, each case consists of a charge, followed by active standby, discharge, active standby, and a topping-off to bring the EES system to the initial EESS SOC.

NOTE The described cases are practical examples for peak shaving application.

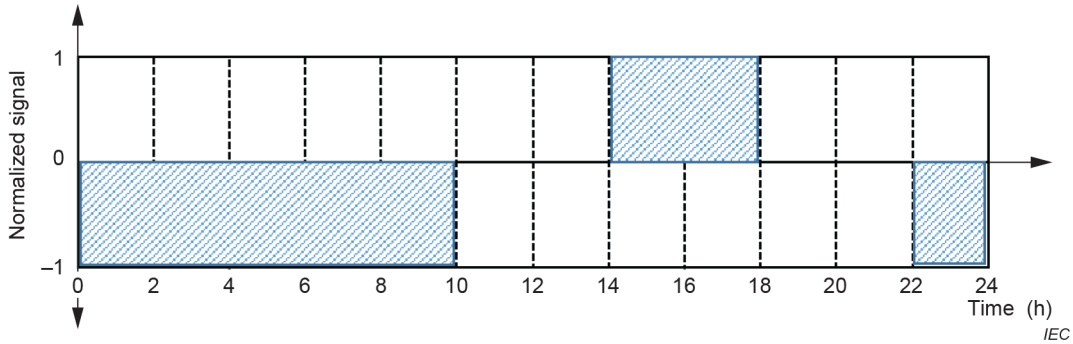
The period pattern policy can be subject to regional requirements if any.

1) Charge period: During the charge period, the EES system should be charged at constant power to bring the EES system to its upper EESS SOC limit.
2) Discharge period: During the discharge period, the EES system should be discharged at constant power until the minimum EESS SOC level for the discharge power used, as specified by the EES system manufacturer, is reached.
3) Float period: During the float period, the EESS SOC level should be maintained more than the low limit even with the operation of any internal support loads for the EES system, such as but not limited to, heating, ventilation, and air-conditioning systems, and should continue to operate as required in accordance with the EES system manufacturer’s specifications and operating instructions. Discharging of the EES system that does not serve a load external to the EES system should be permitted during the float period.

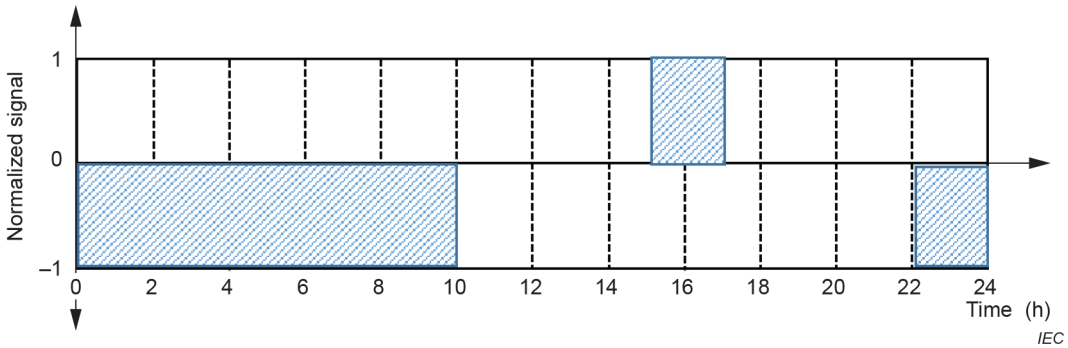
If the manufacturer's specification indicates that the final phase of the charging process implies the lowering of power, it shall be followed.



a) Peak shaving duty cycle: Case-1, 6 h discharge



b) Peak shaving duty cycle: Case-2, 4 h discharge



c) Peak shaving duty cycle: Case-3, 2 h discharge

Figure 15 – Duty cycle for peak shaving application of "one charge-one discharge" mode

6.6.2 "Two charges-two discharges" mode

In some cases, there are two peaks of electricity demand in 24 h, around noon and in the evening. For this case, the duty cycle should have a total charge time of 13 h: the required discharge period duration of 08:00 to 12:00 and 17:00 to 21:00 , and a float period after charge and discharge that brings the total duration duty cycle to one 24 h period.

Figure 16 shows the case for a midnight-to-midnight day with a noon peak and an evening peak. For the purposes of testing, the test starts with a discharge beginning at 8:00 for a 4 h period, then charging for a 5 h period (12:00 to 17:00), and then discharging again for a 4 h period (17:00 to 21:00).

Prior to the test, the EES system should be brought to the maximum EESS SOC by charging at rated power. When conducting performance tests using the case, the EES system should be returned to the same EESS SOC as the EESS SOC at the start of the test, which is the maximum EESS SOC.

The duty cycle of the case consists of a charge, followed by discharge, charge, discharge, active standby, and a top-off charge to bring the EES system to the initial EESS SOC.

NOTE The described case is practical example for peak shaving application.

The period pattern policy can be subject to regional requirements if any.

1) Charge period: During the charge period, the EES system should be charged at constant power to bring the EES system to its upper EESS SOC limit.
2) Discharge period: During the discharge period, the EES system should be discharged at constant power until the minimum EESS SOC level for the discharge power used, as specified by the EES system manufacturer, is reached.

If the manufacturer's specification indicates that the final phase of the charging process implies a lowering of power, it shall be followed.

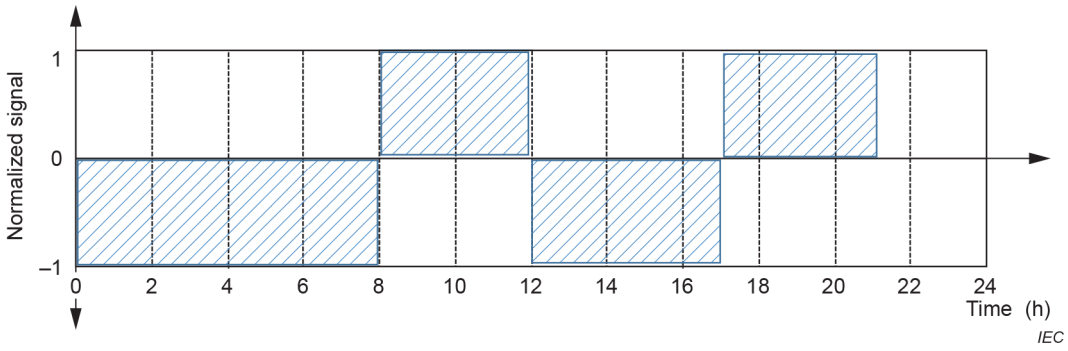


Figure 16 – Duty cycle for peak shaving of “two charges-two discharges” mode

6.7 Renewable firming

The EES system, which charges and discharges according to an input command and an output command received from an external controller such as EMS, should be checked to verify whether it operates with the same output as the command value according to a defined duty cycle pattern to confirm the performance in photovoltaic and/or wind farm firming application.

The duty cycle presented in Figure 17 should be applied in determining the performance of an EES system in a renewable firming application. The numerical data are provided in Annex A.

The duty cycle shown in Figure 17 is shown as power normalized with respect to the rated power of the EES system, where a positive sign represents discharge into the EES system and a negative sign represents charge from the EES system as a function of time in hours.

Normalized power (p.u.) should be specified based on agreement between the user and manufacturer since the EES system normalized power has to be determined considering the capacity of the PV and wind farm.

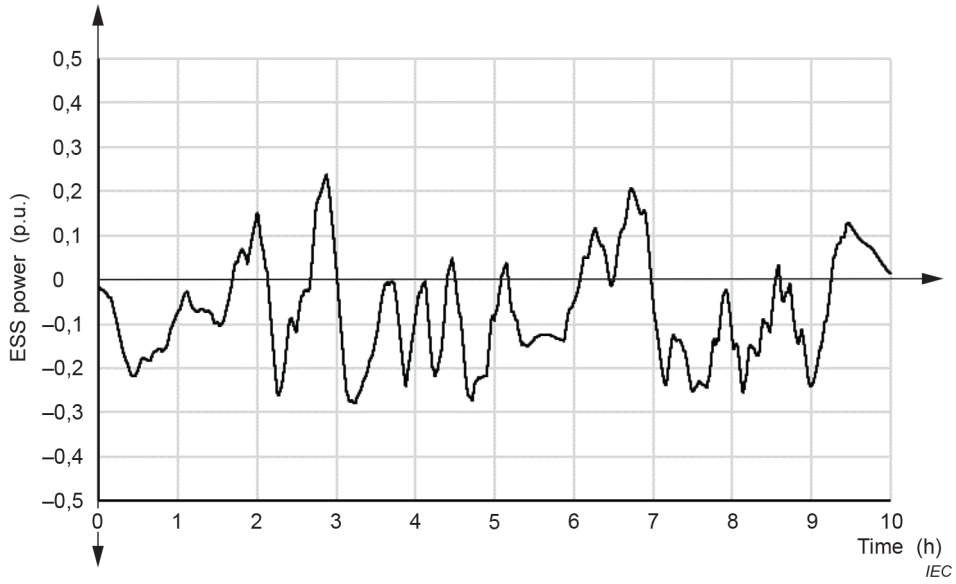


Figure 17 – Duty cycle for renewable firming mode

6.8 Islanded grid

The EES system that charges and discharges according to an input command and an output command received from an external controller such as EMS, should be checked to verify whether it operates with the same output as the command value according to a defined duty cycle pattern to confirm the performance in an islanded grid application.

The duty cycle patterns described in 6.8 should be considered to apply for specific applications. Otherwise the duty cycle pattern shall be specified by the user and system supplier. In either case, it shall be agreed between the user and system supplier.

The duty cycles presented in Figure 18, Figure 19, and Figure 20 should be applied in determining the performance of an EES system in an islanded grid application. The numerical data are provided in Annex A.

The duty cycles in Figure 18, Figure 19, and Figure 20 are shown as power normalized with respect to the input and output power rating of the EES system over a 24 h time period, whereas the positive sign represents discharge from the EESS and a negative sign a charge into the EESS as a function of time in hours.

The initial EESS SOC should be set according to the manufacturer’s specifications and operating instructions. At the end of the application of the duty cycle in conducting the testing under 5.2, the EES system should be brought back to its initial EESS SOC.

The first duty cycle in Figure 18 corresponds to the use of the EES system in islanded grids including fluctuation reduction of renewable energy sources (power) and frequency control.

The second duty cycle in Figure 19 corresponds to the use of the EES system in islanded grids with fluctuation reduction of renewable energy sources (power) and without frequency control.

The third duty cycle in Figure 20 corresponds to the use of the EES system in islanded grids without fluctuation reduction of renewable energy sources (power) and without frequency control.

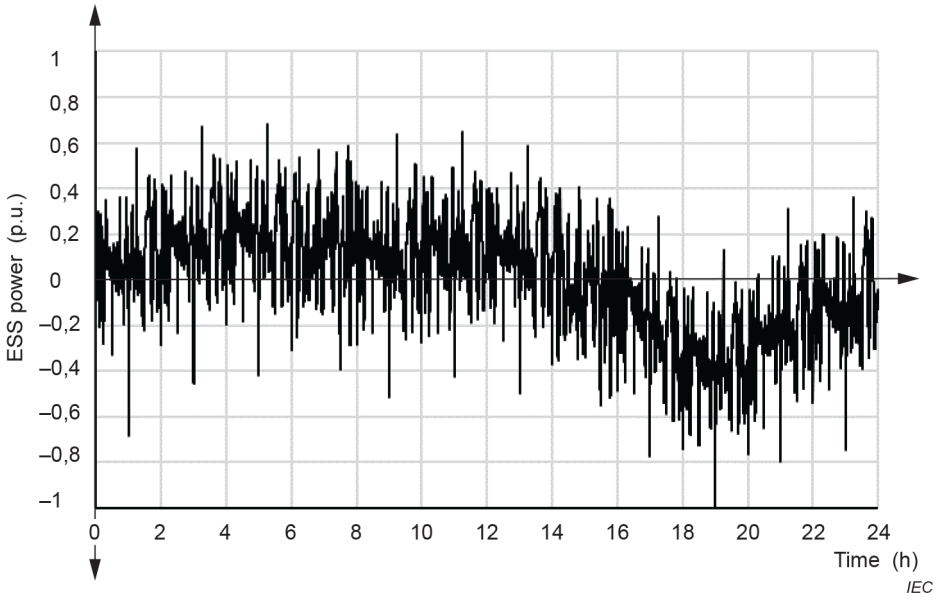


Figure 18 – Duty cycle for fluctuation reduction of renewable energy sources (power) and frequency control

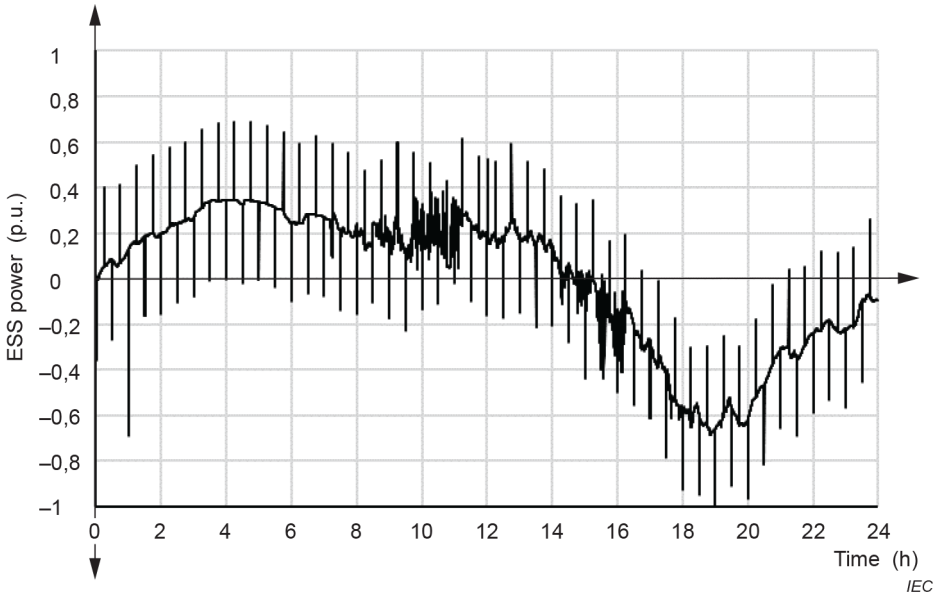


Figure 19 – Duty cycle for fluctuation reduction of renewable energy sources (power) without frequency control

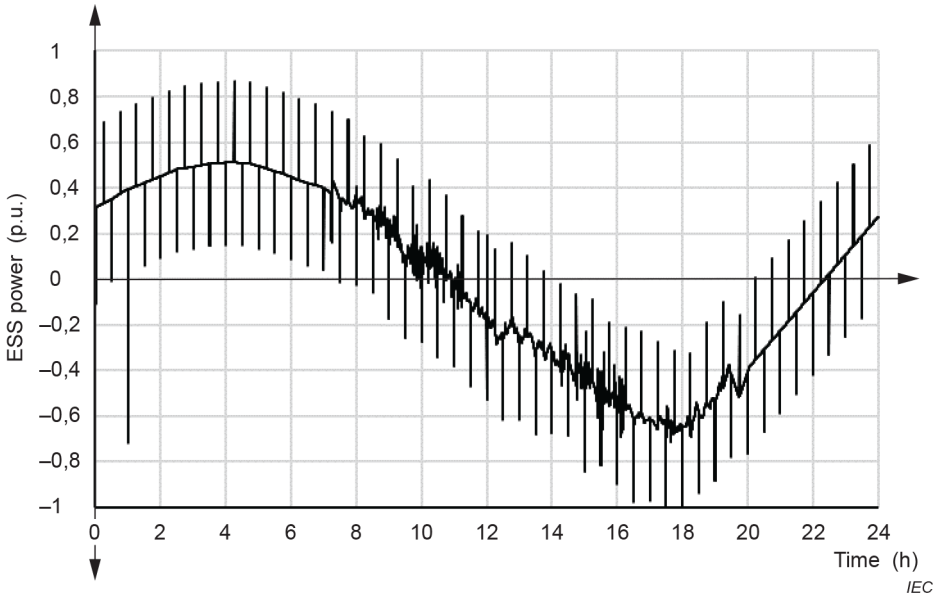


Figure 20 – Duty cycle without fluctuation reduction of renewable energy sources (power) or frequency control

6.9 Back-up power

6.9.1 General

The following test should be considered for back-up power applications since the duty cycle cannot be specified for emergency cases.

6.9.2 Grid outage test

The EES system and the emergency loads are connected to the test facility (grid simulator).

The initial EESS SOC and the power flow should be set at the value determined by the supplier. The grid is stopped and it should be verified that the EES system operates correctly according to the procedure and supplies power to the emergency loads disconnected from the grid.

The emergency loads are set to the maximum power that the EES system can continuously supply during back-up power operation. The three-phase voltage, three-phase current, frequency and total harmonic distortion (THD) of the voltage and current at the POC should be measured from before the grid is stopped until the maximum power is supplied to the emergency loads.

6.9.3 Step load test

While the grid is stopped and the EES system discharges to the emergency load or charges from the distributed generation, the emergency loads or the distributed generations are changed in steps from 0 %, 100 %, 0 % (the state time period is 30 s), -100 % to 0 %.

The initial EESS SOC should be set at the value determined by the supplier.

The emergency loads are three-phase balanced. The three-phase voltage, three-phase current, frequency and total harmonic distortion (THD) of the voltage and current at the POC should be measured.

6.9.4 Unbalanced load test

While the grid is stopped the EES system should be verified to supply unbalanced emergency loads.

The initial EESS SOC should be set at the value determined by the supplier. Unbalanced condition of emergency loads should be decided by agreement between user and system supplier.

The three-phase voltage, three-phase current, frequency and total harmonic distortion (THD) of the voltage and current at the POC should be measured.

6.9.5 Function test

If there is a function to coordinate the operation of multiple power sources (same type or different types), as well as a function to adjust the load, etc., it should be confirmed that these functions operate properly.

6.9.6 Grid recovery test

The EES system and the emergency loads are connected to the test facility (grid simulator) and the EES system supplies the maximum power to the emergency loads.

The initial EESS SOC should be set at the range determined by the supplier.

The grid is recovered to the voltage and frequency range that the EES system can interconnect and it should be verified that the EES system operates correctly according to the procedure and that the emergency loads are reconnected to the grid.

The three-phase voltage, three-phase current, frequency and total harmonic distortion (THD) of the voltage and current at the POC should be measured from when the EES system and emergency loads are operating in back-up power mode to when they are reconnected to the grid.

Annex A
(normative)

Numerical data for duty cycle

The numerical data of figures (Figure 1, Figure 5, Figure 7, Figure 8, Figure 9, Figure 17, Figure 18, Figure 19,and Figure 20) presented in the main text are referred to in Table A.1 to Table A.9 of Annex A.

Table A.1 – Numerical data of Figure 1 (duty cycle of frequency control)

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,1442510	**0:12:00**	-0,3647994	**0:24:00**	0,1400905	**0:36:00**	-0,0694701	**0:48:00**	0,0202450
0:00:04	-0,1296482	**0:12:04**	-0,3972630	**0:24:04**	0,1491455	**0:36:04**	-0,0570291	**0:48:04**	-0,0042709
0:00:08	-0,1360135	**0:12:08**	-0,4235686	**0:24:08**	0,1429416	**0:36:08**	-0,0602346	**0:48:08**	-0,0071686
0:00:12	-0,1423788	**0:12:12**	-0,4498743	**0:24:12**	0,1367377	**0:36:12**	-0,0634400	**0:48:12**	-0,0100663
0:00:16	-0,1487441	**0:12:16**	-0,4684676	**0:24:16**	0,1390261	**0:36:16**	-0,0595294	**0:48:16**	-0,0157852
0:00:20	-0,1551094	**0:12:20**	-0,4793486	**0:24:20**	0,1498067	**0:36:20**	-0,0532467	**0:48:20**	-0,0243252
0:00:24	-0,1614747	**0:12:24**	-0,4902296	**0:24:24**	0,1605873	**0:36:24**	-0,0484124	**0:48:24**	-0,0328652
0:00:28	-0,1500133	**0:12:28**	-0,5088031	**0:24:28**	0,1760439	**0:36:28**	-0,0479230	**0:48:28**	-0,0414052
0:00:32	-0,1385518	**0:12:32**	-0,5273765	**0:24:32**	0,1915005	**0:36:32**	-0,0474336	**0:48:32**	-0,0499452
0:00:36	-0,1135257	**0:12:36**	-0,5459499	**0:24:36**	0,2061388	**0:36:36**	-0,0521236	**0:48:36**	-0,0617316
0:00:40	-0,0839780	**0:12:40**	-0,5645233	**0:24:40**	0,2199587	**0:36:40**	-0,0585401	**0:48:40**	-0,0767644
0:00:44	-0,0544303	**0:12:44**	-0,5805601	**0:24:44**	0,2337787	**0:36:44**	-0,0686179	**0:48:44**	-0,0917972
0:00:48	-0,0321212	**0:12:48**	-0,5889868	**0:24:48**	0,2264872	**0:36:48**	-0,0896795	**0:48:48**	-0,0819491
0:00:52	-0,0098121	**0:12:52**	-0,5974134	**0:24:52**	0,2191957	**0:36:52**	-0,1107411	**0:48:52**	-0,0721009
0:00:56	0,0050135	**0:12:56**	-0,6046434	**0:24:56**	0,2102990	**0:36:56**	-0,1280269	**0:48:56**	-0,0699927
0:01:00	0,0123557	**0:13:00**	-0,6106769	**0:25:00**	0,1997969	**0:37:00**	-0,1440541	**0:49:00**	-0,0756245
0:01:04	0,0196979	**0:13:04**	-0,6167104	**0:25:04**	0,1892948	**0:37:04**	-0,1558742	**0:49:04**	-0,0812563
0:01:08	0,0056427	**0:13:08**	-0,6227438	**0:25:08**	0,1696917	**0:37:08**	-0,1550728	**0:49:08**	-0,1039842
0:01:12	-0,0084124	**0:13:12**	-0,6287773	**0:25:12**	0,1500887	**0:37:12**	-0,1542714	**0:49:12**	-0,1267121
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0:08:40	0,2780386	**0:20:40**	0,1599551	**0:32:40**	0,1966015	**0:44:40**	0,0207648	**0:56:40**	0,7250704
0:08:44	0,2959256	**0:20:44**	0,1600540	**0:32:44**	0,1909223	**0:44:44**	0,0102178	**0:56:44**	0,7232370
0:08:48	0,3457917	**0:20:48**	0,1479643	**0:32:48**	0,1737402	**0:44:48**	0,0023298	**0:56:48**	0,7136120
0:08:52	0,3956579	**0:20:52**	0,1358746	**0:32:52**	0,1565581	**0:44:52**	-0,0055582	**0:56:52**	0,7039869
0:08:56	0,4164774	**0:20:56**	0,1237848	**0:32:56**	0,1473683	**0:44:56**	-0,0235757	**0:56:56**	0,6839148

0:09:00	0,4276148	**0:21:00**	0,1116951	**0:33:00**	0,1461707	**0:45:00**	-0,0449697	**0:57:00**	0,6603602
0:09:04	0,4387522	**0:21:04**	0,0996054	**0:33:04**	0,1409576	**0:45:04**	-0,0632360	**0:57:04**	0,6304241
0:09:08	0,4848796	**0:21:08**	0,0793489	**0:33:08**	0,1236978	**0:45:08**	-0,0721191	**0:57:08**	0,5813437
0:09:12	0,5310070	**0:21:12**	0,0590925	**0:33:12**	0,1064379	**0:45:12**	-0,0810022	**0:57:12**	0,5322632
0:09:16	0,5643114	**0:21:16**	0,0421849	**0:33:16**	0,0918126	**0:45:16**	-0,0914971	**0:57:16**	0,4811854
0:09:20	0,5847929	**0:21:20**	0,0286262	**0:33:20**	0,0798217	**0:45:20**	-0,1025293	**0:57:20**	0,4294418
0:09:24	0,6052744	**0:21:24**	0,0150674	**0:33:24**	0,0678308	**0:45:24**	-0,1118403	**0:57:24**	0,3890312
0:09:28	0,6257558	**0:21:28**	0,0178481	**0:33:28**	0,0758960	**0:45:28**	-0,1159881	**0:57:28**	0,3599536
0:09:32	0,6462373	**0:21:32**	0,0206289	**0:33:32**	0,0839612	**0:45:32**	-0,1201359	**0:57:32**	0,3308760
0:09:36	0,6538571	**0:21:36**	0,0234096	**0:33:36**	0,0864634	**0:45:36**	-0,1260824	**0:57:36**	0,2821008
0:09:40	0,6486153	**0:21:40**	0,0261903	**0:33:40**	0,0834026	**0:45:40**	-0,1338276	**0:57:40**	0,2267597
0:09:44	0,6433735	**0:21:44**	0,0289710	**0:33:44**	0,0803418	**0:45:44**	-0,1415728	**0:57:44**	0,1765831
0:09:48	0,6185831	**0:21:48**	0,0401677	**0:33:48**	0,0861387	**0:45:48**	-0,1400209	**0:57:48**	0,1418997
0:09:52	0,5937927	**0:21:52**	0,0513644	**0:33:52**	0,0919356	**0:45:52**	-0,1384690	**0:57:52**	0,1072164
0:09:56	0,5794535	**0:21:56**	0,0608321	**0:33:56**	0,0869323	**0:45:56**	-0,1439632	**0:57:56**	0,0819011
0:10:00	0,5685980	**0:22:00**	0,0685707	**0:34:00**	0,0711287	**0:46:00**	-0,1565036	**0:58:00**	0,0565857
0:10:04	0,5577424	**0:22:04**	0,0763093	**0:34:04**	0,0553251	**0:46:04**	-0,1690439	**0:58:04**	0,0301425
0:10:08	0,5340554	**0:22:08**	0,0774368	**0:34:08**	0,0580393	**0:46:08**	-0,1840479	**0:58:08**	0,0003155
0:10:12	0,5103684	**0:22:12**	0,0785643	**0:34:12**	0,0607536	**0:46:12**	-0,1990519	**0:58:12**	-0,0295115
0:10:16	0,4848384	**0:22:16**	0,0803223	**0:34:16**	0,0532886	**0:46:16**	-0,2053887	**0:58:16**	-0,0586981
0:10:20	0,4574654	**0:22:20**	0,0827107	**0:34:20**	0,0356444	**0:46:20**	-0,2030583	**0:58:20**	-0,0876714
0:10:24	0,4300924	**0:22:24**	0,0850991	**0:34:24**	0,0180002	**0:46:24**	-0,2007278	**0:58:24**	-0,1130629
0:10:28	0,4066106	**0:22:28**	0,0825060	**0:34:28**	-0,0130649	**0:46:28**	-0,1728291	**0:58:28**	-0,1277093
0:10:32	0,3831287	**0:22:32**	0,0799130	**0:34:32**	-0,0441301	**0:46:32**	-0,1449303	**0:58:32**	-0,1423558
0:10:36	0,3557751	**0:22:36**	0,0773199	**0:34:36**	-0,0702748	**0:46:36**	-0,1155014	**0:58:36**	-0,1662369
0:10:40	0,3245496	**0:22:40**	0,0747269	**0:34:40**	-0,0914991	**0:46:40**	-0,0845422	**0:58:40**	-0,1931963
0:10:44	0,2933242	**0:22:44**	0,0721338	**0:34:44**	-0,1127234	**0:46:44**	-0,0535830	**0:58:44**	-0,2257532
0:10:48	0,2498065	**0:22:48**	0,0575103	**0:34:48**	-0,1153034	**0:46:48**	-0,0182296	**0:58:48**	-0,2751031
0:10:52	0,2062889	**0:22:52**	0,0428867	**0:34:52**	-0,1178835	**0:46:52**	0,0171238	**0:58:52**	-0,3244529
0:10:56	0,1635474	**0:22:56**	0,0411841	**0:34:56**	-0,1178302	**0:46:56**	0,0421324	**0:58:56**	-0,3544907
0:11:00	0,1210646	**0:23:00**	0,0524025	**0:35:00**	-0,1151435	**0:47:00**	0,0567961	**0:59:00**	-0,3780912
0:11:04	0,0785818	**0:23:04**	0,0636208	**0:35:04**	-0,1127185	**0:47:04**	0,0714599	**0:59:04**	-0,3972300
0:11:08	0,0316321	**0:23:08**	0,0596177	**0:35:08**	-0,1110784	**0:47:08**	0,0695822	**0:59:08**	-0,4029837
0:11:12	-0,0153176	**0:23:12**	0,0556146	**0:35:12**	-0,1094382	**0:47:12**	0,0677045	**0:59:12**	-0,4087374
0:11:16	-0,0358450	**0:23:16**	0,0537816	**0:35:16**	-0,1077981	**0:47:16**	0,0687059	**0:59:16**	-0,4112059
0:11:20	-0,0475652	**0:23:20**	0,0541187	**0:35:20**	-0,1203130	**0:47:20**	0,0725865	**0:59:20**	-0,4125794
0:11:24	-0,0592853	**0:23:24**	0,0544558	**0:35:24**	-0,1328280	**0:47:24**	0,0764670	**0:59:24**	-0,4190983
0:11:28	-0,0815983	**0:23:28**	0,0527279	**0:35:28**	-0,1355636	**0:47:28**	0,0866496	**0:59:28**	-0,4410529
0:11:32	-0,1039114	**0:23:32**	0,0510001	**0:35:32**	-0,1382992	**0:47:32**	0,0968321	**0:59:32**	-0,4630076
0:11:36	-0,1332307	**0:23:36**	0,0532324	**0:35:36**	-0,1356425	**0:47:36**	0,0974329	**0:59:36**	-0,4793987
0:11:40	-0,1695565	**0:23:40**	0,0594248	**0:35:40**	-0,1311883	**0:47:40**	0,0884520	**0:59:40**	-0,4939353
0:11:44	-0,2058822	**0:23:44**	0,0656172	**0:35:44**	-0,1250999	**0:47:44**	0,0794711	**0:59:44**	-0,5080343
0:11:48	-0,2499709	**0:23:48**	0,0899735	**0:35:48**	-0,1141083	**0:47:48**	0,0704902	**0:59:48**	-0,5208207
0:11:52	-0,2940597	**0:23:52**	0,1143297	**0:35:52**	-0,1031168	**0:47:52**	0,0615092	**0:59:52**	-0,5336071
0:11:56	-0,3323359	**0:23:56**	0,1310354	**0:35:56**	-0,0871266	**0:47:56**	0,0447608	**0:59:56**	-0,5716747

Only the data for the first hour are shown here. See Figure 5.3.2 in the attached excel sheet in “PNNL-22010 Rev.2” for all the data available at https://energystorage.pnnl.gov/pdf/PNNL-22010Rev2.pdf. For the remainder part of the above listed period, the figures should be normalized by the peak value of whole period.

Table A.2 – Numerical data of Figure 5 (duty cycle of fluctuation reduction of PV (photovoltaic energy systems))

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	0,0149566	0:00:45	0,0167647	0:01:30	0,0185299	0:02:15	0,0201234	0:03:00	0,0115317
0:00:01	0,0150589	0:00:46	0,0167902	0:01:31	0,0186065	0:02:16	0,0197888	0:03:01	0,0114982
0:00:02	0,0151010	0:00:47	0,0168159	0:01:32	0,0186857	0:02:17	0,0194542	0:03:02	0,0114647
0:00:03	0,0151432	0:00:48	0,0168418	0:01:33	0,0187676	0:02:18	0,0191198	0:03:03	0,0114313
0:00:04	0,0151853	0:00:49	0,0168680	0:01:34	0,0188521	0:02:19	0,0187855	0:03:04	0,0113979
0:00:05	0,0152275	0:00:50	0,0168943	0:01:35	0,0189392	0:02:20	0,0184513	0:03:05	0,0113646
0:00:06	0,0152696	0:00:51	0,0169209	0:01:36	0,0190290	0:02:21	0,0181173	0:03:06	0,0113313
0:00:07	0,0153117	0:00:52	0,0169477	0:01:37	0,0191213	0:02:22	0,0177834	0:03:07	0,0112980
0:00:08	0,0153538	0:00:53	0,0169748	0:01:38	0,0192164	0:02:23	0,0174496	0:03:08	0,0112648
0:00:09	0,0153960	0:00:54	0,0170021	0:01:39	0,0193107	0:02:24	0,0171160	0:03:09	0,0112316
0:00:10	0,0154381	0:00:55	0,0170295	0:01:40	0,0194038	0:02:25	0,0167824	0:03:10	0,0111985
0:00:11	0,0154802	0:00:56	0,0170572	0:01:41	0,0194958	0:02:26	0,0164490	0:03:11	0,0111654
0:00:12	0,0155223	0:00:57	0,0170851	0:01:42	0,0195866	0:02:27	0,0161158	0:03:12	0,0111323
0:00:13	0,0155644	0:00:58	0,0171133	0:01:43	0,0196762	0:02:28	0,0157826	0:03:13	0,0110993
0:00:14	0,0156065	0:00:59	0,0171417	0:01:44	0,0197646	0:02:29	0,0154496	0:03:14	0,0110663
0:00:15	0,0156486	0:01:00	0,0171702	0:01:45	0,0198518	0:02:30	0,0151167	0:03:15	0,0110334
0:00:16	0,0156907	0:01:01	0,0171990	0:01:46	0,0199378	0:02:31	0,0147840	0:03:16	0,0110005
0:00:17	0,0157328	0:01:02	0,0172292	0:01:47	0,0200226	0:02:32	0,0144513	0:03:17	0,0109676
0:00:18	0,0157748	0:01:03	0,0172607	0:01:48	0,0201062	0:02:33	0,0141188	0:03:18	0,0109348
0:00:19	0,0158169	0:01:04	0,0172936	0:01:49	0,0201887	0:02:34	0,0137865	0:03:19	0,0109020
0:00:20	0,0158590	0:01:05	0,0173278	0:01:50	0,0202700	0:02:35	0,0134542	0:03:20	0,0108693
0:00:21	0,0159011	0:01:06	0,0173633	0:01:51	0,0203496	0:02:36	0,0131221	0:03:21	0,0108366
0:00:22	0,0159431	0:01:07	0,0174002	0:01:52	0,0204281	0:02:37	0,0127901	0:03:22	0,0108039
0:00:23	0,0159852	0:01:08	0,0174385	0:01:53	0,0205070	0:02:38	0,0124582	0:03:23	0,0107713
0:00:24	0,0160272	0:01:09	0,0174781	0:01:54	0,0205864	0:02:39	0,0122469	0:03:24	0,0107387
0:00:25	0,0160693	0:01:10	0,0175183	0:01:55	0,0206662	0:02:40	0,0122120	0:03:25	0,0107062
0:00:26	0,0161113	0:01:11	0,0175591	0:01:56	0,0207466	0:02:41	0,0121771	0:03:26	0,0106737
0:00:27	0,0161534	0:01:12	0,0176004	0:01:57	0,0208274	0:02:42	0,0121424	0:03:27	0,0106412
0:00:28	0,0161954	0:01:13	0,0176424	0:01:58	0,0209087	0:02:43	0,0121078	0:03:28	0,0106088
0:00:29	0,0162374	0:01:14	0,0176850	0:01:59	0,0210008	0:02:44	0,0120733	0:03:29	0,0105764
0:00:30	0,0162795	0:01:15	0,0177281	0:02:00	0,0210951	0:02:45	0,0120390	0:03:30	0,0105441
0:00:31	0,0163208	0:01:16	0,0177718	0:02:01	0,0211948	0:02:46	0,0120048	0:03:31	0,0105118
0:00:32	0,0163608	0:01:17	0,0178161	0:02:02	0,0212981	0:02:47	0,0119707	0:03:32	0,0104795
0:00:33	0,0163995	0:01:18	0,0178610	0:02:03	0,0214040	0:02:48	0,0119367	0:03:33	0,0104473
0:00:34	0,0164370	0:01:19	0,0179065	0:02:04	0,0215123	0:02:49	0,0119027	0:03:34	0,0104151
0:00:35	0,0164730	0:01:20	0,0179526	0:02:05	0,0216231	0:02:50	0,0118688	0:03:35	0,0103830
0:00:36	0,0165078	0:01:21	0,0179992	0:02:06	0,0217363	0:02:51	0,0118349	0:03:36	0,0103508
0:00:37	0,0165412	0:01:22	0,0180471	0:02:07	0,0218520	0:02:52	0,0118011	0:03:37	0,0103188
0:00:38	0,0165734	0:01:23	0,0180971	0:02:08	0,0219702	0:02:53	0,0117673	0:03:38	0,0102868
0:00:39	0,0166042	0:01:24	0,0181494	0:02:09	0,0220908	0:02:54	0,0117335	0:03:39	0,0102548
0:00:40	0,0166337	0:01:25	0,0182038	0:02:10	0,0217987	0:02:55	0,0116997	0:03:40	0,0102228
0:00:41	0,0166619	0:01:26	0,0182611	0:02:11	0,0214634	0:02:56	0,0116660	0:03:41	0,0101909
0:00:42	0,0166888	0:01:27	0,0183223	0:02:12	0,0211282	0:02:57	0,0116324	0:03:42	0,0101591
0:00:43	0,0167144	0:01:28	0,0183875	0:02:13	0,0207931	0:02:58	0,0115988	0:03:43	0,0101272
0:00:44	0,0167394	0:01:29	0,0184567	0:02:14	0,0204582	0:02:59	0,0115652	0:03:44	0,0100954

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:03:45	0,0100637	0:04:30	0,0116971	0:05:15	0,0143343	0:06:00	0,0179192	0:06:45	0,0221433
0:03:46	0,0100320	0:04:31	0,0117575	0:05:16	0,0143996	0:06:01	0,0180042	0:06:46	0,0220880
0:03:47	0,0100003	0:04:32	0,0118171	0:05:17	0,0144654	0:06:02	0,0180900	0:06:47	0,0219283
0:03:48	0,0099687	0:04:33	0,0118758	0:05:18	0,0145318	0:06:03	0,0181767	0:06:48	0,0217687
0:03:49	0,0099371	0:04:34	0,0119338	0:05:19	0,0145988	0:06:04	0,0182644	0:06:49	0,0216093
0:03:50	0,0099056	0:04:35	0,0119908	0:05:20	0,0146662	0:06:05	0,0183530	0:06:50	0,0214501
0:03:51	0,0098741	0:04:36	0,0120470	0:05:21	0,0147342	0:06:06	0,0184424	0:06:51	0,0212910
0:03:52	0,0098426	0:04:37	0,0121024	0:05:22	0,0148028	0:06:07	0,0185328	0:06:52	0,0211322
0:03:53	0,0098112	0:04:38	0,0121569	0:05:23	0,0148719	0:06:08	0,0186240	0:06:53	0,0209734
0:03:54	0,0097798	0:04:39	0,0122113	0:05:24	0,0149422	0:06:09	0,0187162	0:06:54	0,0208148
0:03:55	0,0097483	0:04:40	0,0122659	0:05:25	0,0150141	0:06:10	0,0188086	0:06:55	0,0206565
0:03:56	0,0097168	0:04:41	0,0123207	0:05:26	0,0150875	0:06:11	0,0189011	0:06:56	0,0204982
0:03:57	0,0096851	0:04:42	0,0123758	0:05:27	0,0151625	0:06:12	0,0189938	0:06:57	0,0203401
0:03:58	0,0097229	0:04:43	0,0124311	0:05:28	0,0152391	0:06:13	0,0190866	0:06:58	0,0201822
0:03:59	0,0097858	0:04:44	0,0124867	0:05:29	0,0153173	0:06:14	0,0191796	0:06:59	0,0200244
0:04:00	0,0098485	0:04:45	0,0125425	0:05:30	0,0153971	0:06:15	0,0192728	0:07:00	0,0198668
0:04:01	0,0099111	0:04:46	0,0125985	0:05:31	0,0154778	0:06:16	0,0193661	0:07:01	0,0197098
0:04:02	0,0099736	0:04:47	0,0126548	0:05:32	0,0155590	0:06:17	0,0194596	0:07:02	0,0195538
0:04:03	0,0100359	0:04:48	0,0127114	0:05:33	0,0156408	0:06:18	0,0195532	0:07:03	0,0193988
0:04:04	0,0100982	0:04:49	0,0127681	0:05:34	0,0157231	0:06:19	0,0196471	0:07:04	0,0192448
0:04:05	0,0101604	0:04:50	0,0128251	0:05:35	0,0158059	0:06:20	0,0197410	0:07:05	0,0190919
0:04:06	0,0102225	0:04:51	0,0128824	0:05:36	0,0158893	0:06:21	0,0198352	0:07:06	0,0189399
0:04:07	0,0102844	0:04:52	0,0129399	0:05:37	0,0159733	0:06:22	0,0199295	0:07:07	0,0187890
0:04:08	0,0103463	0:04:53	0,0129976	0:05:38	0,0160578	0:06:23	0,0200239	0:07:08	0,0186392
0:04:09	0,0104081	0:04:54	0,0130556	0:05:39	0,0161425	0:06:24	0,0201186	0:07:09	0,0184903
0:04:10	0,0104699	0:04:55	0,0131138	0:05:40	0,0162272	0:06:25	0,0202134	0:07:10	0,0183413
0:04:11	0,0105317	0:04:56	0,0131722	0:05:41	0,0163119	0:06:26	0,0203083	0:07:11	0,0181919
0:04:12	0,0105934	0:04:57	0,0132309	0:05:42	0,0163966	0:06:27	0,0204034	0:07:12	0,0180422
0:04:13	0,0106550	0:04:58	0,0132899	0:05:43	0,0164813	0:06:28	0,0204987	0:07:13	0,0178920
0:04:14	0,0107167	0:04:59	0,0133490	0:05:44	0,0165659	0:06:29	0,0205942	0:07:14	0,0177415
0:04:15	0,0107782	0:05:00	0,0134085	0:05:45	0,0166506	0:06:30	0,0206898	0:07:15	0,0175906
0:04:16	0,0108398	0:05:01	0,0134681	0:05:46	0,0167352	0:06:31	0,0207855	0:07:16	0,0174394
0:04:17	0,0109013	0:05:02	0,0135280	0:05:47	0,0168199	0:06:32	0,0208815	0:07:17	0,0172878
0:04:18	0,0109627	0:05:03	0,0135881	0:05:48	0,0169045	0:06:33	0,0209776	0:07:18	0,0171358
0:04:19	0,0110242	0:05:04	0,0136485	0:05:49	0,0169891	0:06:34	0,0210738	0:07:19	0,0169834
0:04:20	0,0110855	0:05:05	0,0137092	0:05:50	0,0170737	0:06:35	0,0211702	0:07:20	0,0168307
0:04:21	0,0111469	0:05:06	0,0137700	0:05:51	0,0171583	0:06:36	0,0212668	0:07:21	0,0166776
0:04:22	0,0112082	0:05:07	0,0138311	0:05:52	0,0172429	0:06:37	0,0213635	0:07:22	0,0165241
0:04:23	0,0112694	0:05:08	0,0138925	0:05:53	0,0173275	0:06:38	0,0214604	0:07:23	0,0163703
0:04:24	0,0113306	0:05:09	0,0139541	0:05:54	0,0174120	0:06:39	0,0215575	0:07:24	0,0162161
0:04:25	0,0113918	0:05:10	0,0140161	0:05:55	0,0174966	0:06:40	0,0216547	0:07:25	0,0160615
0:04:26	0,0114529	0:05:11	0,0140786	0:05:56	0,0175812	0:06:41	0,0217521	0:07:26	0,0159065
0:04:27	0,0115140	0:05:12	0,0141417	0:05:57	0,0176657	0:06:42	0,0218497	0:07:27	0,0160966
0:04:28	0,0115751	0:05:13	0,0142054	0:05:58	0,0177502	0:06:43	0,0219474	0:07:28	0,0165364
0:04:29	0,0116361	0:05:14	0,0142696	0:05:59	0,0178347	0:06:44	0,0220453	0:07:29	0,0169759

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:07:30	0,0174150	0:08:15	0,0363616	0:09:00	0,0560979	0:09:45	0,0527658	0:10:30	0,0495362
0:07:31	0,0178535	0:08:16	0,0367673	0:09:01	0,0560239	0:09:46	0,0526948	0:10:31	0,0494616
0:07:32	0,0182908	0:08:17	0,0371724	0:09:02	0,0559498	0:09:47	0,0526239	0:10:32	0,0493869
0:07:33	0,0187268	0:08:18	0,0375783	0:09:03	0,0558756	0:09:48	0,0525531	0:10:33	0,0493121
0:07:34	0,0191617	0:08:19	0,0379852	0:09:04	0,0558012	0:09:49	0,0524826	0:10:34	0,0492371
0:07:35	0,0195954	0:08:20	0,0383932	0:09:05	0,0557267	0:09:50	0,0524122	0:10:35	0,0491620
0:07:36	0,0200279	0:08:21	0,0388023	0:09:06	0,0556521	0:09:51	0,0523419	0:10:36	0,0490867
0:07:37	0,0204592	0:08:22	0,0395720	0:09:07	0,0555773	0:09:52	0,0522719	0:10:37	0,0490114
0:07:38	0,0208893	0:08:23	0,0406979	0:09:08	0,0555024	0:09:53	0,0522019	0:10:38	0,0489359
0:07:39	0,0213188	0:08:24	0,0418250	0:09:09	0,0554274	0:09:54	0,0521322	0:10:39	0,0488602
0:07:40	0,0217478	0:08:25	0,0429532	0:09:10	0,0553523	0:09:55	0,0520624	0:10:40	0,0487844
0:07:41	0,0221764	0:08:26	0,0440824	0:09:11	0,0552770	0:09:56	0,0519925	0:10:41	0,0487085
0:07:42	0,0226045	0:08:27	0,0452128	0:09:12	0,0552016	0:09:57	0,0519225	0:10:42	0,0486325
0:07:43	0,0230321	0:08:28	0,0463442	0:09:13	0,0551260	0:09:58	0,0518523	0:10:43	0,0485563
0:07:44	0,0234593	0:08:29	0,0474768	0:09:14	0,0550503	0:09:59	0,0517820	0:10:44	0,0484800
0:07:45	0,0238860	0:08:30	0,0486104	0:09:15	0,0549745	0:10:00	0,0517115	0:10:45	0,0484035
0:07:46	0,0243122	0:08:31	0,0497443	0:09:16	0,0548986	0:10:01	0,0516410	0:10:46	0,0483888
0:07:47	0,0247380	0:08:32	0,0508781	0:09:17	0,0548227	0:10:02	0,0515702	0:10:47	0,0484687
0:07:48	0,0251633	0:08:33	0,0520117	0:09:18	0,0547470	0:10:03	0,0514994	0:10:48	0,0485484
0:07:49	0,0255882	0:08:34	0,0531452	0:09:19	0,0546715	0:10:04	0,0514284	0:10:49	0,0486280
0:07:50	0,0260125	0:08:35	0,0542786	0:09:20	0,0545961	0:10:05	0,0513573	0:10:50	0,0487075
0:07:51	0,0264364	0:08:36	0,0554118	0:09:21	0,0545209	0:10:06	0,0512861	0:10:51	0,0487868
0:07:52	0,0268599	0:08:37	0,0565449	0:09:22	0,0544459	0:10:07	0,0512147	0:10:52	0,0488660
0:07:53	0,0272829	0:08:38	0,0576779	0:09:23	0,0543711	0:10:08	0,0511432	0:10:53	0,0489451
0:07:54	0,0277054	0:08:39	0,0576212	0:09:24	0,0542963	0:10:09	0,0510715	0:10:54	0,0490241
0:07:55	0,0281274	0:08:40	0,0575500	0:09:25	0,0542218	0:10:10	0,0509998	0:10:55	0,0491029
0:07:56	0,0285483	0:08:41	0,0574786	0:09:26	0,0541474	0:10:11	0,0509278	0:10:56	0,0491815
0:07:57	0,0289676	0:08:42	0,0574071	0:09:27	0,0540732	0:10:12	0,0508558	0:10:57	0,0492601
0:07:58	0,0293855	0:08:43	0,0573355	0:09:28	0,0539992	0:10:13	0,0507836	0:10:58	0,0493379
0:07:59	0,0298018	0:08:44	0,0572637	0:09:29	0,0539253	0:10:14	0,0507113	0:10:59	0,0494145
0:08:00	0,0302167	0:08:45	0,0571919	0:09:30	0,0538516	0:10:15	0,0506389	0:11:00	0,0494901
0:08:01	0,0306301	0:08:46	0,0571198	0:09:31	0,0537781	0:10:16	0,0505663	0:11:01	0,0495645
0:08:02	0,0310427	0:08:47	0,0570477	0:09:32	0,0537047	0:10:17	0,0504936	0:11:02	0,0496378
0:08:03	0,0314548	0:08:48	0,0569754	0:09:33	0,0536315	0:10:18	0,0504207	0:11:03	0,0497100
0:08:04	0,0318665	0:08:49	0,0569030	0:09:34	0,0535584	0:10:19	0,0503477	0:11:04	0,0497811
0:08:05	0,0322776	0:08:50	0,0568305	0:09:35	0,0534856	0:10:20	0,0502746	0:11:05	0,0498510
0:08:06	0,0326882	0:08:51	0,0567578	0:09:36	0,0534128	0:10:21	0,0502014	0:11:06	0,0499199
0:08:07	0,0330984	0:08:52	0,0566850	0:09:37	0,0533403	0:10:22	0,0501280	0:11:07	0,0499875
0:08:08	0,0335080	0:08:53	0,0566121	0:09:38	0,0532679	0:10:23	0,0500545	0:11:08	0,0500541
0:08:09	0,0339171	0:08:54	0,0565390	0:09:39	0,0531957	0:10:24	0,0499809	0:11:09	0,0501196
0:08:10	0,0343258	0:08:55	0,0564658	0:09:40	0,0531236	0:10:25	0,0499071	0:11:10	0,0501845
0:08:11	0,0347339	0:08:56	0,0563925	0:09:41	0,0530517	0:10:26	0,0498332	0:11:11	0,0502493
0:08:12	0,0351416	0:08:57	0,0563190	0:09:42	0,0529800	0:10:27	0,0497591	0:11:12	0,0503140
0:08:13	0,0355488	0:08:58	0,0562455	0:09:43	0,0529084	0:10:28	0,0496850	0:11:13	0,0503786
0:08:14	0,0359554	0:08:59	0,0561717	0:09:44	0,0528371	0:10:29	0,0496107	0:11:14	0,0504430

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:11:15	0,0505072	0:12:00	0,0532560	0:12:45	0,0552861	0:13:30	0,0575400	0:14:15	0,0504005
0:11:16	0,0505713	0:12:01	0,0533139	0:12:46	0,0553277	0:13:31	0,0575921	0:14:16	0,0508629
0:11:17	0,0506353	0:12:02	0,0533714	0:12:47	0,0553704	0:13:32	0,0576442	0:14:17	0,0513254
0:11:18	0,0506992	0:12:03	0,0534283	0:12:48	0,0554148	0:13:33	0,0576963	0:14:18	0,0517879
0:11:19	0,0507629	0:12:04	0,0534845	0:12:49	0,0554610	0:13:34	0,0577485	0:14:19	0,0522506
0:11:20	0,0508264	0:12:05	0,0535402	0:12:50	0,0555089	0:13:35	0,0578008	0:14:20	0,0527132
0:11:21	0,0508899	0:12:06	0,0535953	0:12:51	0,0555584	0:13:36	0,0578532	0:14:21	0,0531759
0:11:22	0,0509532	0:12:07	0,0536497	0:12:52	0,0556081	0:13:37	0,0579056	0:14:22	0,0536387
0:11:23	0,0510163	0:12:08	0,0537035	0:12:53	0,0556578	0:13:38	0,0579581	0:14:23	0,0541016
0:11:24	0,0510793	0:12:09	0,0537568	0:12:54	0,0557075	0:13:39	0,0580106	0:14:24	0,0545645
0:11:25	0,0511422	0:12:10	0,0538094	0:12:55	0,0557573	0:13:40	0,0580632	0:14:25	0,0550275
0:11:26	0,0512050	0:12:11	0,0538614	0:12:56	0,0558072	0:13:41	0,0581159	0:14:26	0,0554905
0:11:27	0,0512676	0:12:12	0,0539128	0:12:57	0,0558572	0:13:42	0,0581686	0:14:27	0,0559536
0:11:28	0,0513300	0:12:13	0,0539635	0:12:58	0,0559072	0:13:43	0,0582214	0:14:28	0,0564167
0:11:29	0,0513923	0:12:14	0,0540137	0:12:59	0,0559573	0:13:44	0,0582050	0:14:29	0,0568800
0:11:30	0,0514545	0:12:15	0,0540633	0:13:00	0,0560074	0:13:45	0,0577771	0:14:30	0,0573432
0:11:31	0,0515166	0:12:16	0,0541122	0:13:01	0,0560576	0:13:46	0,0573493	0:14:31	0,0578066
0:11:32	0,0515785	0:12:17	0,0541605	0:13:02	0,0561079	0:13:47	0,0569216	0:14:32	0,0582700
0:11:33	0,0516403	0:12:18	0,0542083	0:13:03	0,0561582	0:13:48	0,0564939	0:14:33	0,0587335
0:11:34	0,0517019	0:12:19	0,0542554	0:13:04	0,0562085	0:13:49	0,0560663	0:14:34	0,0591970
0:11:35	0,0517634	0:12:20	0,0543019	0:13:05	0,0562590	0:13:50	0,0556387	0:14:35	0,0596606
0:11:36	0,0518248	0:12:21	0,0543478	0:13:06	0,0563095	0:13:51	0,0552112	0:14:36	0,0601242
0:11:37	0,0518860	0:12:22	0,0543930	0:13:07	0,0563600	0:13:52	0,0547838	0:14:37	0,0605879
0:11:38	0,0519471	0:12:23	0,0544377	0:13:08	0,0564107	0:13:53	0,0543564	0:14:38	0,0610517
0:11:39	0,0520080	0:12:24	0,0544818	0:13:09	0,0564614	0:13:54	0,0539291	0:14:39	0,0615155
0:11:40	0,0520688	0:12:25	0,0545252	0:13:10	0,0565121	0:13:55	0,0535019	0:14:40	0,0619795
0:11:41	0,0521295	0:12:26	0,0545676	0:13:11	0,0565629	0:13:56	0,0530747	0:14:41	0,0624437
0:11:42	0,0521900	0:12:27	0,0546084	0:13:12	0,0566138	0:13:57	0,0526476	0:14:42	0,0629082
0:11:43	0,0522504	0:12:28	0,0546478	0:13:13	0,0566647	0:13:58	0,0522205	0:14:43	0,0633729
0:11:44	0,0523107	0:12:29	0,0546857	0:13:14	0,0567157	0:13:59	0,0517935	0:14:44	0,0638378
0:11:45	0,0523708	0:12:30	0,0547222	0:13:15	0,0567668	0:14:00	0,0513666	0:14:45	0,0643030
0:11:46	0,0524308	0:12:31	0,0547571	0:13:16	0,0568179	0:14:01	0,0509397	0:14:46	0,0647685
0:11:47	0,0524906	0:12:32	0,0547916	0:13:17	0,0568691	0:14:02	0,0505129	0:14:47	0,0652342
0:11:48	0,0525503	0:12:33	0,0548266	0:13:18	0,0569203	0:14:03	0,0500861	0:14:48	0,0657001
0:11:49	0,0526099	0:12:34	0,0548621	0:13:19	0,0569716	0:14:04	0,0496595	0:14:49	0,0661663
0:11:50	0,0526693	0:12:35	0,0548981	0:13:20	0,0570230	0:14:05	0,0492328	0:14:50	0,0666328
0:11:51	0,0527286	0:12:36	0,0549346	0:13:21	0,0570744	0:14:06	0,0488062	0:14:51	0,0670995
0:11:52	0,0527877	0:12:37	0,0549716	0:13:22	0,0571259	0:14:07	0,0483798	0:14:52	0,0673504
0:11:53	0,0528468	0:12:38	0,0550091	0:13:23	0,0571774	0:14:08	0,0479533	0:14:53	0,0674373
0:11:54	0,0529056	0:12:39	0,0550472	0:13:24	0,0572291	0:14:09	0,0476273	0:14:54	0,0675245
0:11:55	0,0529644	0:12:40	0,0550857	0:13:25	0,0572807	0:14:10	0,0480893	0:14:55	0,0676119
0:11:56	0,0530230	0:12:41	0,0551248	0:13:26	0,0573325	0:14:11	0,0485515	0:14:56	0,0676996
0:11:57	0,0530814	0:12:42	0,0551643	0:13:27	0,0573843	0:14:12	0,0490136	0:14:57	0,0677875
0:11:58	0,0531397	0:12:43	0,0552044	0:13:28	0,0574361	0:14:13	0,0494759	0:14:58	0,0678757
0:11:59	0,0531979	0:12:44	0,0552450	0:13:29	0,0574880	0:14:14	0,0499382	0:14:59	0,0679641

Only the data for the first 15 min are shown here. See Figure 5.3.4 in the attached excel sheet in “PNNL-22010 Rev.2” for all the data available at https://energystorage.pnnl.gov/pdf/PNNL-22010Rev2.pdf. For the remainder part of the above listed period, the figures should be normalized by the peak value of the whole period. The polarity has to be changed in accordance with IEC 62933-2-1.

Table A.3 – Numerical data of Figure 7 (duty cycle of fluctuation reduction of wind farm (low standard deviation))

Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,001464	0:30:00	0,520547	1:00:00	-0,039954	1:30:00	0,116512
0:01:00	0,034065	0:31:00	0,023589	1:01:00	-0,006702	1:31:00	-0,062730
0:02:00	-0,166813	0:32:00	-0,181845	1:02:00	0,074833	1:32:00	-0,003058
0:03:00	-0,234684	0:33:00	-0,372019	1:03:00	-0,003058	1:33:00	-0,001692
0:04:00	-0,263381	0:34:00	-0,418025	1:04:00	-0,027656	1:34:00	0,000586
0:05:00	-0,183211	0:35:00	-0,422808	1:05:00	-0,174101	1:35:00	0,017439
0:06:00	-0,241288	0:36:00	-0,021734	1:06:00	-0,007386	1:36:00	0,076428
0:07:00	-0,305059	0:37:00	0,203058	1:07:00	-0,001464	1:37:00	0,169351
0:08:00	-0,365642	0:38:00	0,090093	1:08:00	-0,001464	1:38:00	-0,029250
0:09:00	-0,420530	0:39:00	0,151131	1:09:00	-0,001464	1:39:00	0,027688
0:10:00	-0,348333	0:40:00	-0,004197	1:10:00	0,003319	1:40:00	0,015162
0:11:00	-0,329884	0:41:00	0,001497	1:11:00	0,103302	1:41:00	0,273206
0:12:00	-0,275224	0:42:00	0,039076	1:12:00	0,154319	1:42:00	0,306231
0:13:00	-0,297088	0:43:00	-0,000325	1:13:00	0,112185	1:43:00	0,019034
0:14:00	-0,108508	0:44:00	0,018350	1:14:00	-0,120351	1:44:00	-0,031300
0:15:00	-0,161347	0:45:00	-0,001009	1:15:00	-0,018773	1:45:00	-0,192321
0:16:00	-0,089377	0:46:00	0,014023	1:16:00	0,130405	1:46:00	-0,043826
0:17:00	-0,098715	0:47:00	0,234033	1:17:00	0,129722	1:47:00	-0,000098
0:18:00	0,090548	0:48:00	-0,005108	1:18:00	0,042492	1:48:00	0,059802
0:19:00	0,126989	0:49:00	-0,001464	1:19:00	-0,061591	1:49:00	0,000358
0:20:00	0,315113	0:50:00	-0,001464	1:20:00	0,063901	1:50:00	-0,001464
0:21:00	0,278217	0:51:00	-0,001464	1:21:00	-0,095982	1:51:00	0,004002
0:22:00	-0,018546	0:52:00	-0,001464	1:22:00	-0,183895	1:52:00	0,151814
0:23:00	-0,168863	0:53:00	-0,001464	1:23:00	-0,028111	1:53:00	0,008102
0:24:00	0,024500	0:54:00	-0,006702	1:24:00	0,001269	1:54:00	-0,001236
0:25:00	0,016528	0:55:00	-0,067968	1:25:00	-0,001464	1:55:00	-0,001464
0:26:00	0,237449	0:56:00	0,014023	1:26:00	-0,001464	1:56:00	-0,001236
0:27:00	-0,029478	0:57:00	0,027688	1:27:00	-0,001464	1:57:00	0,010379
0:28:00	-0,180934	0:58:00	-0,074573	1:28:00	-0,001464	1:58:00	-0,001692
0:29:00	0,051830	0:59:00	-0,020823	1:29:00	0,007646	1:59:00	-0,016951

Table A.4 – Numerical data of Figure 8 (duty cycle of fluctuation reduction of wind farm (average standard deviation))

Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	0,071642	0:30:00	-0,200000	1:00:00	0,714096	1:30:00	-0,275954
0:01:00	-0,089552	0:31:00	-0,147927	1:01:00	0,385406	1:31:00	-0,088557
0:02:00	0,104478	0:32:00	-0,140962	1:02:00	-0,079934	1:32:00	-0,052073
0:03:00	-0,297844	0:33:00	-0,434826	1:03:00	0,457711	1:33:00	-0,119735
0:04:00	-0,081592	0:34:00	-0,295522	1:04:00	0,253068	1:34:00	0,018242
0:05:00	-0,440464	0:35:00	-0,286235	1:05:00	-0,044776	1:35:00	-0,007297
0:06:00	-0,047098	0:36:00	-0,065672	1:06:00	0,062023	1:36:00	-0,064677
0:07:00	-0,361857	0:37:00	0,283250	1:07:00	0,354892	1:37:00	-0,020232
0:08:00	0,051741	0:38:00	0,373466	1:08:00	-0,097844	1:38:00	-0,178441
0:09:00	-0,250746	0:39:00	0,348590	1:09:00	-0,436816	1:39:00	-0,031509
0:10:00	0,259038	0:40:00	0,132007	1:10:00	-0,245771	1:40:00	-0,209950
0:11:00	0,041128	0:41:00	-0,111443	1:11:00	0,094196	1:41:00	-0,364179
0:12:00	0,101161	0:42:00	0,149585	1:12:00	-0,036153	1:42:00	0,135323
0:13:00	0,059701	0:43:00	0,234163	1:13:00	0,166169	1:43:00	-0,157214
0:14:00	-0,088889	0:44:00	0,225207	1:14:00	0,226202	1:44:00	0,338308
0:15:00	-0,254063	0:45:00	0,478607	1:15:00	-0,036816	1:45:00	-0,082919
0:16:00	-0,144610	0:46:00	0,050746	1:16:00	0,120066	1:46:00	0,216252
0:17:00	0,028856	0:47:00	-0,285904	1:17:00	0,513765	1:47:00	0,341957
0:18:00	-0,060365	0:48:00	0,259370	1:18:00	0,538308	1:48:00	-0,045108
0:19:00	0,074959	0:49:00	0,606965	1:19:00	0,525705	1:49:00	-0,240796
0:20:00	0,211940	0:50:00	0,269983	1:20:00	0,532007	1:50:00	0,331012
0:21:00	0,022886	0:51:00	0,060033	1:21:00	0,297844	1:51:00	-0,097181
0:22:00	0,083914	0:52:00	-0,260033	1:22:00	0,026534	1:52:00	-0,143615
0:23:00	-0,057380	0:53:00	-0,196683	1:23:00	0,527695	1:53:00	0,198673
0:24:00	-0,045439	0:54:00	-0,062687	1:24:00	0,157214	1:54:00	0,259370
0:25:00	-0,168823	0:55:00	-0,102819	1:25:00	-0,512438	1:55:00	0,392703
0:26:00	0,530017	0:56:00	-0,306136	1:26:00	0,226202	1:56:00	0,519735
0:27:00	0,225207	0:57:00	-0,468657	1:27:00	0,137313	1:57:00	0,188723
0:28:00	0,175124	0:58:00	-0,178441	1:28:00	-0,142289	1:58:00	-0,027861
0:29:00	-0,062687	0:59:00	0,451078	1:29:00	-0,058043	1:59:00	0,403980

Table A.5 – Numerical data of Figure 9 (duty cycle of fluctuation reduction of wind farm (high standard deviation))

Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,359709	0:30:00	0,001364	1:00:00	0,181446	1:30:00	-0,373655
0:01:00	0,164469	0:31:00	0,000152	1:01:00	-0,386994	1:31:00	-0,661664
0:02:00	-0,509777	0:32:00	-0,001667	1:02:00	-0,722601	1:32:00	-0,428225
0:03:00	-0,002880	0:33:00	-0,001667	1:03:00	-0,784447	1:33:00	-0,178111
0:04:00	0,283311	0:34:00	-0,001667	1:04:00	-0,596483	1:34:00	0,311808
0:05:00	0,276035	0:35:00	-0,064726	1:05:00	-0,470365	1:35:00	0,056238
0:06:00	0,146279	0:36:00	-0,734122	1:06:00	-0,000455	1:36:00	-0,385478
0:07:00	0,171442	0:37:00	0,144156	1:07:00	0,660452	1:37:00	0,321510
0:08:00	0,108079	0:38:00	-0,553737	1:08:00	-0,444596	1:38:00	0,055935
0:09:00	-0,241170	0:39:00	0,407306	1:09:00	0,272397	1:39:00	0,172957
0:10:00	0,493709	0:40:00	-0,029559	1:10:00	-0,510384	1:40:00	-0,648931
0:11:00	-0,479157	0:41:00	-0,219039	1:11:00	-0,662271	1:41:00	-0,377596
0:12:00	-0,624981	0:42:00	-0,056541	1:12:00	0,054116	1:42:00	-0,009247
0:13:00	0,116265	0:43:00	-0,292406	1:13:00	0,307261	1:43:00	-0,121419
0:14:00	0,309383	0:44:00	-0,822343	1:14:00	-0,802334	1:44:00	-0,435501
0:15:00	0,152039	0:45:00	-0,715325	1:15:00	-0,178718	1:45:00	-0,174473
0:16:00	0,477338	0:46:00	-0,674701	1:16:00	-0,450659	1:46:00	-0,172957
0:17:00	0,147794	0:47:00	-0,241473	1:17:00	-0,484311	1:47:00	-0,172048
0:18:00	0,599818	0:48:00	-0,575565	1:18:00	-0,855995	1:48:00	-0,718357
0:19:00	0,588298	0:49:00	-0,851144	1:19:00	-0,272397	1:49:00	-0,599818
0:20:00	0,006215	0:50:00	-0,490981	1:20:00	0,528574	1:50:00	-0,282704
0:21:00	-0,049265	0:51:00	0,048658	1:21:00	0,313021	1:51:00	-0,527361
0:22:00	-0,567985	0:52:00	-0,216007	1:22:00	-0,613764	1:52:00	0,107473
0:23:00	-0,246324	0:53:00	-0,112627	1:23:00	-0,349401	1:53:00	0,360922
0:24:00	-0,104441	0:54:00	-0,824162	1:24:00	-0,899045	1:54:00	0,235107
0:25:00	-0,005609	0:55:00	-0,846900	1:25:00	-0,901167	1:55:00	0,092921
0:26:00	-0,000152	0:56:00	-0,458845	1:26:00	-0,901167	1:56:00	-0,223890
0:27:00	-0,025011	0:57:00	-0,626800	1:27:00	-0,719873	1:57:00	0,487040
0:28:00	-0,257541	0:58:00	-0,787479	1:28:00	0,397908	1:58:00	-0,546157
0:29:00	0,252994	0:59:00	-0,049568	1:29:00	-0,578596	1:59:00	0,661058

Table A.6 – Numerical data of Figure 17 (duty cycle for renewable firming mode)

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,0177840	0:00:45	-0,0198787	0:01:30	-0,0210476	0:02:15	-0,0222840	0:03:00	-0,0239439
0:00:01	-0,0178374	0:00:46	-0,0199179	0:01:31	-0,0210706	0:02:16	-0,0223162	0:03:01	-0,0239858
0:00:02	-0,0178904	0:00:47	-0,0199568	0:01:32	-0,0210937	0:02:17	-0,0223487	0:03:02	-0,0240278
0:00:03	-0,0179432	0:00:48	-0,0199953	0:01:33	-0,0211171	0:02:18	-0,0223813	0:03:03	-0,0240701
0:00:04	-0,0179956	0:00:49	-0,0200335	0:01:34	-0,0211406	0:02:19	-0,0224142	0:03:04	-0,0241126
0:00:05	-0,0180477	0:00:50	-0,0200714	0:01:35	-0,0211644	0:02:20	-0,0224472	0:03:05	-0,0241553
0:00:06	-0,0180996	0:00:51	-0,0201090	0:01:36	-0,0211884	0:02:21	-0,0224805	0:03:06	-0,0241982
0:00:07	-0,0181511	0:00:52	-0,0201462	0:01:37	-0,0212125	0:02:22	-0,0225140	0:03:07	-0,0242413
0:00:08	-0,0182023	0:00:53	-0,0201827	0:01:38	-0,0212369	0:02:23	-0,0225476	0:03:08	-0,0242847
0:00:09	-0,0182533	0:00:54	-0,0202181	0:01:39	-0,0212615	0:02:24	-0,0225815	0:03:09	-0,0243283
0:00:10	-0,0183039	0:00:55	-0,0202524	0:01:40	-0,0212863	0:02:25	-0,0226156	0:03:10	-0,0243720
0:00:11	-0,0183542	0:00:56	-0,0202855	0:01:41	-0,0213113	0:02:26	-0,0226499	0:03:11	-0,0244160
0:00:12	-0,0184042	0:00:57	-0,0203175	0:01:42	-0,0213365	0:02:27	-0,0226845	0:03:12	-0,0244603
0:00:13	-0,0184539	0:00:58	-0,0203483	0:01:43	-0,0213619	0:02:28	-0,0227192	0:03:13	-0,0245047
0:00:14	-0,0185033	0:00:59	-0,0203781	0:01:44	-0,0213876	0:02:29	-0,0227541	0:03:14	-0,0245493
0:00:15	-0,0185524	0:01:00	-0,0204067	0:01:45	-0,0214134	0:02:30	-0,0227893	0:03:15	-0,0245942
0:00:16	-0,0186012	0:01:01	-0,0204342	0:01:46	-0,0214394	0:02:31	-0,0228247	0:03:16	-0,0246393
0:00:17	-0,0186497	0:01:02	-0,0204605	0:01:47	-0,0214657	0:02:32	-0,0228602	0:03:17	-0,0246845
0:00:18	-0,0186978	0:01:03	-0,0204857	0:01:48	-0,0214921	0:02:33	-0,0228960	0:03:18	-0,0247298
0:00:19	-0,0187457	0:01:04	-0,0205098	0:01:49	-0,0215187	0:02:34	-0,0229320	0:03:19	-0,0247751
0:00:20	-0,0187932	0:01:05	-0,0205328	0:01:50	-0,0215456	0:02:35	-0,0229683	0:03:20	-0,0248204
0:00:21	-0,0188404	0:01:06	-0,0205546	0:01:51	-0,0215727	0:02:36	-0,0230047	0:03:21	-0,0248658
0:00:22	-0,0188874	0:01:07	-0,0205753	0:01:52	-0,0215999	0:02:37	-0,0230413	0:03:22	-0,0249113
0:00:23	-0,0189340	0:01:08	-0,0205948	0:01:53	-0,0216274	0:02:38	-0,0230782	0:03:23	-0,0249568
0:00:24	-0,0189803	0:01:09	-0,0206133	0:01:54	-0,0216551	0:02:39	-0,0231153	0:03:24	-0,0250023
0:00:25	-0,0190262	0:01:10	-0,0206319	0:01:55	-0,0216830	0:02:40	-0,0231526	0:03:25	-0,0250479
0:00:26	-0,0190719	0:01:11	-0,0206507	0:01:56	-0,0217110	0:02:41	-0,0231901	0:03:26	-0,0250936
0:00:27	-0,0191172	0:01:12	-0,0206698	0:01:57	-0,0217393	0:02:42	-0,0232278	0:03:27	-0,0251393
0:00:28	-0,0191623	0:01:13	-0,0206890	0:01:58	-0,0217678	0:02:43	-0,0232658	0:03:28	-0,0251850
0:00:29	-0,0192070	0:01:14	-0,0207085	0:01:59	-0,0217965	0:02:44	-0,0233039	0:03:29	-0,0252308
0:00:30	-0,0192514	0:01:15	-0,0207281	0:02:00	-0,0218255	0:02:45	-0,0233423	0:03:30	-0,0252767
0:00:31	-0,0192954	0:01:16	-0,0207480	0:02:01	-0,0218546	0:02:46	-0,0233809	0:03:31	-0,0253225
0:00:32	-0,0193392	0:01:17	-0,0207680	0:02:02	-0,0218839	0:02:47	-0,0234197	0:03:32	-0,0253685
0:00:33	-0,0193826	0:01:18	-0,0207883	0:02:03	-0,0219134	0:02:48	-0,0234587	0:03:33	-0,0254145
0:00:34	-0,0194257	0:01:19	-0,0208088	0:02:04	-0,0219432	0:02:49	-0,0234980	0:03:34	-0,0254606
0:00:35	-0,0194685	0:01:20	-0,0208295	0:02:05	-0,0219731	0:02:50	-0,0235374	0:03:35	-0,0255067
0:00:36	-0,0195110	0:01:21	-0,0208504	0:02:06	-0,0220033	0:02:51	-0,0235771	0:03:36	-0,0255528
0:00:37	-0,0195532	0:01:22	-0,0208714	0:02:07	-0,0220337	0:02:52	-0,0236170	0:03:37	-0,0255990
0:00:38	-0,0195950	0:01:23	-0,0208927	0:02:08	-0,0220642	0:02:53	-0,0236571	0:03:38	-0,0256453
0:00:39	-0,0196365	0:01:24	-0,0209143	0:02:09	-0,0220950	0:02:54	-0,0236974	0:03:39	-0,0256916
0:00:40	-0,0196777	0:01:25	-0,0209360	0:02:10	-0,0221260	0:02:55	-0,0237380	0:03:40	-0,0257380
0:00:41	-0,0197185	0:01:26	-0,0209579	0:02:11	-0,0221572	0:02:56	-0,0237787	0:03:41	-0,0257844
0:00:42	-0,0197590	0:01:27	-0,0209800	0:02:12	-0,0221886	0:02:57	-0,0238197	0:03:42	-0,0258309
0:00:43	-0,0197992	0:01:28	-0,0210023	0:02:13	-0,0222202	0:02:58	-0,0238609	0:03:43	-0,0258774
0:00:44	-0,0198391	0:01:29	-0,0210249	0:02:14	-0,0222520	0:02:59	-0,0239023	0:03:44	-0,0259240

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:03:45	-0,0259706	0:04:30	-0,0281221	0:05:15	-0,0303689	0:06:00	-0,0326983	0:06:45	-0,0353502
0:03:46	-0,0260173	0:04:31	-0,0281711	0:05:16	-0,0304197	0:06:01	-0,0327510	0:06:46	-0,0354157
0:03:47	-0,0260640	0:04:32	-0,0282201	0:05:17	-0,0304707	0:06:02	-0,0328038	0:06:47	-0,0354808
0:03:48	-0,0261108	0:04:33	-0,0282692	0:05:18	-0,0305216	0:06:03	-0,0328565	0:06:48	-0,0355454
0:03:49	-0,0261576	0:04:34	-0,0283183	0:05:19	-0,0305726	0:06:04	-0,0329094	0:06:49	-0,0356097
0:03:50	-0,0262045	0:04:35	-0,0283675	0:05:20	-0,0306237	0:06:05	-0,0329622	0:06:50	-0,0356736
0:03:51	-0,0262514	0:04:36	-0,0284167	0:05:21	-0,0306748	0:06:06	-0,0330151	0:06:51	-0,0357371
0:03:52	-0,0262984	0:04:37	-0,0284659	0:05:22	-0,0307259	0:06:07	-0,0330681	0:06:52	-0,0358001
0:03:53	-0,0263454	0:04:38	-0,0285152	0:05:23	-0,0307771	0:06:08	-0,0331210	0:06:53	-0,0358628
0:03:54	-0,0263925	0:04:39	-0,0285646	0:05:24	-0,0308283	0:06:09	-0,0331741	0:06:54	-0,0359251
0:03:55	-0,0264396	0:04:40	-0,0286140	0:05:25	-0,0308795	0:06:10	-0,0332272	0:06:55	-0,0359870
0:03:56	-0,0264868	0:04:41	-0,0286634	0:05:26	-0,0309308	0:06:11	-0,0332803	0:06:56	-0,0360485
0:03:57	-0,0265340	0:04:42	-0,0287129	0:05:27	-0,0309821	0:06:12	-0,0333334	0:06:57	-0,0361096
0:03:58	-0,0265813	0:04:43	-0,0287624	0:05:28	-0,0310335	0:06:13	-0,0333866	0:06:58	-0,0361703
0:03:59	-0,0266286	0:04:44	-0,0288120	0:05:29	-0,0310849	0:06:14	-0,0334399	0:06:59	-0,0362306
0:04:00	-0,0266759	0:04:45	-0,0288616	0:05:30	-0,0311363	0:06:15	-0,0334932	0:07:00	-0,0362905
0:04:01	-0,0267234	0:04:46	-0,0289112	0:05:31	-0,0311878	0:06:16	-0,0335472	0:07:01	-0,0363501
0:04:02	-0,0267709	0:04:47	-0,0289609	0:05:32	-0,0312394	0:06:17	-0,0336017	0:07:02	-0,0364092
0:04:03	-0,0268184	0:04:48	-0,0290106	0:05:33	-0,0312909	0:06:18	-0,0336568	0:07:03	-0,0364679
0:04:04	-0,0268660	0:04:49	-0,0290604	0:05:34	-0,0313425	0:06:19	-0,0337125	0:07:04	-0,0365263
0:04:05	-0,0269136	0:04:50	-0,0291102	0:05:35	-0,0313941	0:06:20	-0,0337688	0:07:05	-0,0365842
0:04:06	-0,0269613	0:04:51	-0,0291601	0:05:36	-0,0314458	0:06:21	-0,0338257	0:07:06	-0,0366418
0:04:07	-0,0270091	0:04:52	-0,0292100	0:05:37	-0,0314975	0:06:22	-0,0338831	0:07:07	-0,0366989
0:04:08	-0,0270569	0:04:53	-0,0292599	0:05:38	-0,0315493	0:06:23	-0,0339411	0:07:08	-0,0367557
0:04:09	-0,0271048	0:04:54	-0,0293099	0:05:39	-0,0316011	0:06:24	-0,0339997	0:07:09	-0,0368121
0:04:10	-0,0271527	0:04:55	-0,0293599	0:05:40	-0,0316529	0:06:25	-0,0340589	0:07:10	-0,0368680
0:04:11	-0,0272006	0:04:56	-0,0294100	0:05:41	-0,0317048	0:06:26	-0,0341187	0:07:11	-0,0369236
0:04:12	-0,0272487	0:04:57	-0,0294601	0:05:42	-0,0317568	0:06:27	-0,0341791	0:07:12	-0,0369788
0:04:13	-0,0272967	0:04:58	-0,0295102	0:05:43	-0,0318087	0:06:28	-0,0342400	0:07:13	-0,0370336
0:04:14	-0,0273449	0:04:59	-0,0295604	0:05:44	-0,0318607	0:06:29	-0,0343015	0:07:14	-0,0370879
0:04:15	-0,0273931	0:05:00	-0,0296106	0:05:45	-0,0319128	0:06:30	-0,0343637	0:07:15	-0,0371419
0:04:16	-0,0274413	0:05:01	-0,0296609	0:05:46	-0,0319648	0:06:31	-0,0344264	0:07:16	-0,0371955
0:04:17	-0,0274896	0:05:02	-0,0297112	0:05:47	-0,0320170	0:06:32	-0,0344897	0:07:17	-0,0372487
0:04:18	-0,0275380	0:05:03	-0,0297615	0:05:48	-0,0320691	0:06:33	-0,0345535	0:07:18	-0,0373015
0:04:19	-0,0275864	0:05:04	-0,0298119	0:05:49	-0,0321213	0:06:34	-0,0346180	0:07:19	-0,0373540
0:04:20	-0,0276348	0:05:05	-0,0298623	0:05:50	-0,0321736	0:06:35	-0,0346830	0:07:20	-0,0374060
0:04:21	-0,0276833	0:05:06	-0,0299128	0:05:51	-0,0322259	0:06:36	-0,0347487	0:07:21	-0,0374576
0:04:22	-0,0277319	0:05:07	-0,0299633	0:05:52	-0,0322782	0:06:37	-0,0348149	0:07:22	-0,0375088
0:04:23	-0,0277805	0:05:08	-0,0300138	0:05:53	-0,0323306	0:06:38	-0,0348817	0:07:23	-0,0375599
0:04:24	-0,0278291	0:05:09	-0,0300644	0:05:54	-0,0323830	0:06:39	-0,0349491	0:07:24	-0,0376110
0:04:25	-0,0278779	0:05:10	-0,0301151	0:05:55	-0,0324354	0:06:40	-0,0350169	0:07:25	-0,0376621
0:04:26	-0,0279266	0:05:11	-0,0301657	0:05:56	-0,0324879	0:06:41	-0,0350844	0:07:26	-0,0377133
0:04:27	-0,0279754	0:05:12	-0,0302165	0:05:57	-0,0325405	0:06:42	-0,0351514	0:07:27	-0,0377645
0:04:28	-0,0280242	0:05:13	-0,0302672	0:05:58	-0,0325930	0:06:43	-0,0352181	0:07:28	-0,0378157
0:04:29	-0,0280731	0:05:14	-0,0303180	0:05:59	-0,0326457	0:06:44	-0,0352844	0:07:29	-0,0378669

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:07:30	-0,0379182	0:08:15	-0,0399625	0:09:00	-0,0419085	0:09:45	-0,0488941	0:10:30	-0,0581462
0:07:31	-0,0379695	0:08:16	-0,0399800	0:09:01	-0,0420217	0:09:46	-0,0491020	0:10:31	-0,0583515
0:07:32	-0,0380209	0:08:17	-0,0399979	0:09:02	-0,0421418	0:09:47	-0,0493098	0:10:32	-0,0585568
0:07:33	-0,0380722	0:08:18	-0,0400163	0:09:03	-0,0422672	0:09:48	-0,0495173	0:10:33	-0,0587621
0:07:34	-0,0381235	0:08:19	-0,0400351	0:09:04	-0,0423978	0:09:49	-0,0497248	0:10:34	-0,0589674
0:07:35	-0,0381748	0:08:20	-0,0400543	0:09:05	-0,0425337	0:09:50	-0,0499320	0:10:35	-0,0591727
0:07:36	-0,0382261	0:08:21	-0,0400740	0:09:06	-0,0426748	0:09:51	-0,0501391	0:10:36	-0,0593779
0:07:37	-0,0382774	0:08:22	-0,0400942	0:09:07	-0,0428212	0:09:52	-0,0503460	0:10:37	-0,0595832
0:07:38	-0,0383287	0:08:23	-0,0401147	0:09:08	-0,0429729	0:09:53	-0,0505528	0:10:38	-0,0597884
0:07:39	-0,0383800	0:08:24	-0,0401357	0:09:09	-0,0431298	0:09:54	-0,0507594	0:10:39	-0,0599937
0:07:40	-0,0384312	0:08:25	-0,0401572	0:09:10	-0,0432853	0:09:55	-0,0509658	0:10:40	-0,0601989
0:07:41	-0,0384825	0:08:26	-0,0401791	0:09:11	-0,0434385	0:09:56	-0,0511720	0:10:41	-0,0604041
0:07:42	-0,0385337	0:08:27	-0,0402014	0:09:12	-0,0435893	0:09:57	-0,0513781	0:10:42	-0,0606093
0:07:43	-0,0385849	0:08:28	-0,0402242	0:09:13	-0,0437377	0:09:58	-0,0515841	0:10:43	-0,0608145
0:07:44	-0,0386361	0:08:29	-0,0402474	0:09:14	-0,0438838	0:09:59	-0,0517898	0:10:44	-0,0610197
0:07:45	-0,0386873	0:08:30	-0,0402710	0:09:15	-0,0440275	0:10:00	-0,0519955	0:10:45	-0,0612249
0:07:46	-0,0387385	0:08:31	-0,0402951	0:09:16	-0,0441688	0:10:01	-0,0522009	0:10:46	-0,0614301
0:07:47	-0,0387897	0:08:32	-0,0403197	0:09:17	-0,0443077	0:10:02	-0,0524062	0:10:47	-0,0616352
0:07:48	-0,0388409	0:08:33	-0,0403469	0:09:18	-0,0444442	0:10:03	-0,0526113	0:10:48	-0,0618404
0:07:49	-0,0388920	0:08:34	-0,0403769	0:09:19	-0,0445784	0:10:04	-0,0528162	0:10:49	-0,0620455
0:07:50	-0,0389432	0:08:35	-0,0404095	0:09:20	-0,0447102	0:10:05	-0,0530210	0:10:50	-0,0622507
0:07:51	-0,0389943	0:08:36	-0,0404448	0:09:21	-0,0448396	0:10:06	-0,0532257	0:10:51	-0,0624558
0:07:52	-0,0390455	0:08:37	-0,0404828	0:09:22	-0,0449659	0:10:07	-0,0534301	0:10:52	-0,0626609
0:07:53	-0,0390966	0:08:38	-0,0405235	0:09:23	-0,0450896	0:10:08	-0,0536344	0:10:53	-0,0628660
0:07:54	-0,0391477	0:08:39	-0,0405670	0:09:24	-0,0452143	0:10:09	-0,0538385	0:10:54	-0,0630711
0:07:55	-0,0391988	0:08:40	-0,0406131	0:09:25	-0,0453400	0:10:10	-0,0540426	0:10:55	-0,0632762
0:07:56	-0,0392499	0:08:41	-0,0406604	0:09:26	-0,0454666	0:10:11	-0,0542469	0:10:56	-0,0634813
0:07:57	-0,0393009	0:08:42	-0,0407089	0:09:27	-0,0455941	0:10:12	-0,0544513	0:10:57	-0,0636864
0:07:58	-0,0393520	0:08:43	-0,0407586	0:09:28	-0,0457227	0:10:13	-0,0546559	0:10:58	-0,0638914
0:07:59	-0,0394031	0:08:44	-0,0408094	0:09:29	-0,0458522	0:10:14	-0,0548607	0:10:59	-0,0640965
0:08:00	-0,0394541	0:08:45	-0,0408614	0:09:30	-0,0460033	0:10:15	-0,0550656	0:11:00	-0,0643015
0:08:01	-0,0395051	0:08:46	-0,0409146	0:09:31	-0,0461588	0:10:16	-0,0552707	0:11:01	-0,0645066
0:08:02	-0,0395548	0:08:47	-0,0409690	0:09:32	-0,0463249	0:10:17	-0,0554760	0:11:02	-0,0647116
0:08:03	-0,0396018	0:08:48	-0,0410245	0:09:33	-0,0464985	0:10:18	-0,0556814	0:11:03	-0,0649166
0:08:04	-0,0396462	0:08:49	-0,0410812	0:09:34	-0,0466771	0:10:19	-0,0558869	0:11:04	-0,0651216
0:08:05	-0,0396880	0:08:50	-0,0411391	0:09:35	-0,0468606	0:10:20	-0,0560923	0:11:05	-0,0653266
0:08:06	-0,0397271	0:08:51	-0,0411981	0:09:36	-0,0470490	0:10:21	-0,0562977	0:11:06	-0,0655316
0:08:07	-0,0397636	0:08:52	-0,0412583	0:09:37	-0,0472424	0:10:22	-0,0565032	0:11:07	-0,0657366
0:08:08	-0,0397975	0:08:53	-0,0413209	0:09:38	-0,0474407	0:10:23	-0,0567086	0:11:08	-0,0659416
0:08:09	-0,0398287	0:08:54	-0,0413879	0:09:39	-0,0476439	0:10:24	-0,0569140	0:11:09	-0,0661465
0:08:10	-0,0398573	0:08:55	-0,0414593	0:09:40	-0,0478521	0:10:25	-0,0571194	0:11:10	-0,0663515
0:08:11	-0,0398833	0:08:56	-0,0415350	0:09:41	-0,0480608	0:10:26	-0,0573247	0:11:11	-0,0665564
0:08:12	-0,0399066	0:08:57	-0,0416165	0:09:42	-0,0482694	0:10:27	-0,0575301	0:11:12	-0,0667613
0:08:13	-0,0399274	0:08:58	-0,0417059	0:09:43	-0,0484778	0:10:28	-0,0577355	0:11:13	-0,0669663
0:08:14	-0,0399454	0:08:59	-0,0418032	0:09:44	-0,0486860	0:10:29	-0,0579408	0:11:14	-0,0671712

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:11:15	-0,0673761	0:12:00	-0,0764592	0:12:45	-0,0850062	0:13:30	-0,0951822	0:14:15	-0,1064145
0:11:16	-0,0675810	0:12:01	-0,0766566	0:12:46	-0,0852059	0:13:31	-0,0954162	0:14:16	-0,1066704
0:11:17	-0,0677859	0:12:02	-0,0768528	0:12:47	-0,0854066	0:13:32	-0,0956510	0:14:17	-0,1069264
0:11:18	-0,0679907	0:12:03	-0,0770472	0:12:48	-0,0856082	0:13:33	-0,0958874	0:14:18	-0,1071822
0:11:19	-0,0681956	0:12:04	-0,0772398	0:12:49	-0,0858109	0:13:34	-0,0961256	0:14:19	-0,1074380
0:11:20	-0,0684004	0:12:05	-0,0774306	0:12:50	-0,0860145	0:13:35	-0,0963654	0:14:20	-0,1076938
0:11:21	-0,0686053	0:12:06	-0,0776196	0:12:51	-0,0862191	0:13:36	-0,0966070	0:14:21	-0,1079494
0:11:22	-0,0688101	0:12:07	-0,0778068	0:12:52	-0,0864246	0:13:37	-0,0968502	0:14:22	-0,1082050
0:11:23	-0,0690149	0:12:08	-0,0779922	0:12:53	-0,0866312	0:13:38	-0,0970952	0:14:23	-0,1084605
0:11:24	-0,0692198	0:12:09	-0,0781758	0:12:54	-0,0868387	0:13:39	-0,0973418	0:14:24	-0,1087159
0:11:25	-0,0694246	0:12:10	-0,0783589	0:12:55	-0,0870485	0:13:40	-0,0975901	0:14:25	-0,1089712
0:11:26	-0,0696291	0:12:11	-0,0785424	0:12:56	-0,0872613	0:13:41	-0,0978387	0:14:26	-0,1092265
0:11:27	-0,0698334	0:12:12	-0,0787262	0:12:57	-0,0874772	0:13:42	-0,0980874	0:14:27	-0,1094817
0:11:28	-0,0700374	0:12:13	-0,0789104	0:12:58	-0,0876961	0:13:43	-0,0983364	0:14:28	-0,1097368
0:11:29	-0,0702412	0:12:14	-0,0790950	0:12:59	-0,0879180	0:13:44	-0,0985856	0:14:29	-0,1099918
0:11:30	-0,0704447	0:12:15	-0,0792800	0:13:00	-0,0881430	0:13:45	-0,0988350	0:14:30	-0,1102468
0:11:31	-0,0706481	0:12:16	-0,0794653	0:13:01	-0,0883710	0:13:46	-0,0990846	0:14:31	-0,1105017
0:11:32	-0,0708513	0:12:17	-0,0796509	0:13:02	-0,0886007	0:13:47	-0,0993344	0:14:32	-0,1107573
0:11:33	-0,0710542	0:12:18	-0,0798370	0:13:03	-0,0888315	0:13:48	-0,0995844	0:14:33	-0,1110145
0:11:34	-0,0712570	0:12:19	-0,0800234	0:13:04	-0,0890632	0:13:49	-0,0998347	0:14:34	-0,1112734
0:11:35	-0,0714596	0:12:20	-0,0802102	0:13:05	-0,0892958	0:13:50	-0,1000851	0:14:35	-0,1115339
0:11:36	-0,0716619	0:12:21	-0,0803973	0:13:06	-0,0895295	0:13:51	-0,1003358	0:14:36	-0,1117961
0:11:37	-0,0718641	0:12:22	-0,0805848	0:13:07	-0,0897641	0:13:52	-0,1005867	0:14:37	-0,1120600
0:11:38	-0,0720661	0:12:23	-0,0807727	0:13:08	-0,0899997	0:13:53	-0,1008377	0:14:38	-0,1123255
0:11:39	-0,0722679	0:12:24	-0,0809609	0:13:09	-0,0902362	0:13:54	-0,1010890	0:14:39	-0,1125927
0:11:40	-0,0724694	0:12:25	-0,0811495	0:13:10	-0,0904731	0:13:55	-0,1013405	0:14:40	-0,1128615
0:11:41	-0,0726708	0:12:26	-0,0813384	0:13:11	-0,0907098	0:13:56	-0,1015922	0:14:41	-0,1131295
0:11:42	-0,0728720	0:12:27	-0,0815278	0:13:12	-0,0909464	0:13:57	-0,1018441	0:14:42	-0,1133964
0:11:43	-0,0730730	0:12:28	-0,0817174	0:13:13	-0,0911829	0:13:58	-0,1020962	0:14:43	-0,1136622
0:11:44	-0,0732738	0:12:29	-0,0819075	0:13:14	-0,0914193	0:13:59	-0,1023486	0:14:44	-0,1139268
0:11:45	-0,0734743	0:12:30	-0,0820979	0:13:15	-0,0916555	0:14:00	-0,1026011	0:14:45	-0,1141903
0:11:46	-0,0736747	0:12:31	-0,0822887	0:13:16	-0,0918915	0:14:01	-0,1028539	0:14:46	-0,1144527
0:11:47	-0,0738749	0:12:32	-0,0824799	0:13:17	-0,0921275	0:14:02	-0,1031068	0:14:47	-0,1147139
0:11:48	-0,0740749	0:12:33	-0,0826714	0:13:18	-0,0923633	0:14:03	-0,1033600	0:14:48	-0,1149740
0:11:49	-0,0742747	0:12:34	-0,0828633	0:13:19	-0,0925989	0:14:04	-0,1036134	0:14:49	-0,1152329
0:11:50	-0,0744743	0:12:35	-0,0830555	0:13:20	-0,0928344	0:14:05	-0,1038670	0:14:50	-0,1154907
0:11:51	-0,0746736	0:12:36	-0,0832481	0:13:21	-0,0930698	0:14:06	-0,1041208	0:14:51	-0,1157474
0:11:52	-0,0748728	0:12:37	-0,0834411	0:13:22	-0,0933051	0:14:07	-0,1043748	0:14:52	-0,1160029
0:11:53	-0,0750718	0:12:38	-0,0836345	0:13:23	-0,0935402	0:14:08	-0,1046290	0:14:53	-0,1162573
0:11:54	-0,0752706	0:12:39	-0,0838282	0:13:24	-0,0937752	0:14:09	-0,1048835	0:14:54	-0,1165106
0:11:55	-0,0754692	0:12:40	-0,0840223	0:13:25	-0,0940100	0:14:10	-0,1051381	0:14:55	-0,1167627
0:11:56	-0,0756676	0:12:41	-0,0842171	0:13:26	-0,0942447	0:14:11	-0,1053930	0:14:56	-0,1170137
0:11:57	-0,0758658	0:12:42	-0,0844129	0:13:27	-0,0944793	0:14:12	-0,1056480	0:14:57	-0,1172636
0:11:58	-0,0760638	0:12:43	-0,0846097	0:13:28	-0,0947137	0:14:13	-0,1059033	0:14:58	-0,1175127
0:11:59	-0,0762616	0:12:44	-0,0848074	0:13:29	-0,0949480	0:14:14	-0,1061588	0:14:59	-0,1177614

Only the data for the first 15 min are shown here. See Figure 5.3.6 in the attached excel sheet in “PNNL-22010 Rev.2” for all the data available at https://energystorage.pnnl.gov/pdf/PNNL-22010Rev2.pdf. For the remainder part of the above listed period, the figures should be

normalized by the peak value of the whole period. The polarity has to be changed in accordance with IEC 62933-2-1.

Table A.7 – Numerical data of Figure 18 (duty cycle for fluctuation reduction of renewable energy sources (power) and frequency control)

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,7783264	0:03:00	0,2655156	0:06:00	-0,1416140	0:09:00	0,1922197	0:12:00	-0,1201514
0:00:04	-0,7699089	0:03:04	0,2864997	0:06:04	-0,1441833	0:09:04	0,1969603	0:12:04	-0,1334074
0:00:08	-0,7699992	0:03:08	0,2922015	0:06:08	-0,1488037	0:09:08	0,2158981	0:12:08	-0,1441647
0:00:12	-0,4297440	0:03:12	0,2979034	0:06:12	-0,1534241	0:09:12	0,2348359	0:12:12	-0,1549221
0:00:16	-0,4298343	0:03:16	0,2988759	0:06:16	-0,1604748	0:09:16	0,2485707	0:12:16	-0,1625502
0:00:20	-0,4299245	0:03:20	0,2951189	0:06:20	-0,1699558	0:09:20	0,2571027	0:12:20	-0,1670490
0:00:24	-0,4300148	0:03:24	0,2913620	0:06:24	-0,1794368	0:09:24	0,2656347	0:12:24	-0,1715478
0:00:28	-0,4228718	0:03:28	0,2822972	0:06:28	-0,1903974	0:09:28	0,2741667	0:12:28	-0,1791678
0:00:32	-0,4157289	0:03:32	0,2679246	0:06:32	-0,2013579	0:09:32	0,2826986	0:12:32	-0,1867878
0:00:36	-0,0627367	0:03:36	0,2492021	0:06:36	-0,2072311	0:09:36	0,2860120	0:12:36	-0,1944079
0:00:40	-0,0482553	0:03:40	0,2261299	0:06:40	-0,2080170	0:09:40	0,2841068	0:12:40	-0,2020279
0:00:44	-0,0337739	0:03:44	0,2030576	0:06:44	-0,2088029	0:09:44	0,2822016	0:12:44	-0,2086186
0:00:48	-0,0222295	0:03:48	0,1754507	0:06:48	-0,2016714	0:09:48	0,2723645	0:12:48	-0,2121216
0:00:52	-0,0106852	0:03:52	0,1478439	0:06:52	-0,1945399	0:09:52	0,2625275	0:12:52	-0,2156246
0:00:56	-0,0025703	0:03:56	0,1204860	0:06:56	-0,1840488	0:09:56	0,2569310	0:12:56	-0,2186420
0:01:00	0,0008124	0:04:00	0,0933772	0:07:00	-0,1701981	0:10:00	0,2527480	0:13:00	-0,2211740
0:01:04	0,0037491	0:04:04	0,0667807	0:07:04	-0,1567636	0:10:04	0,2486523	0:13:04	-0,2233764
0:01:08	-0,0019960	0:04:08	0,0511943	0:07:08	-0,1482966	0:10:08	0,2393503	0:13:08	-0,2255788
0:01:12	-0,0077412	0:04:12	0,0356079	0:07:12	-0,1398297	0:10:12	0,2300483	0:13:12	-0,2277813
0:01:16	-0,0109170	0:04:16	0,0260547	0:07:16	-0,1325157	0:10:16	0,2199986	0:13:16	-0,2343451
0:01:20	-0,0115236	0:04:20	0,0225348	0:07:20	-0,1263548	0:10:20	0,2092010	0:13:20	-0,2452702
0:01:24	-0,0121302	0:04:24	0,0190149	0:07:24	-0,1201939	0:10:24	0,1984034	0:13:24	-0,2561954
0:01:28	-0,0075333	0:04:28	0,0146573	0:07:28	-0,1121849	0:10:28	0,1891846	0:13:28	-0,2662071
0:01:32	-0,0029365	0:04:32	0,0102996	0:07:32	-0,1041759	0:10:32	0,1799659	0:13:32	-0,2762187
0:01:36	0,0022906	0:04:36	0,0034104	0:07:36	-0,0926615	0:10:36	0,1691761	0:13:36	-0,2810644
0:01:40	0,0077277	0:04:40	-0,0060103	0:07:40	-0,0776416	0:10:40	0,1568154	0:13:40	-0,2807442
0:01:44	0,0131647	0:04:44	-0,0154311	0:07:44	-0,0626217	0:10:44	0,1444547	0:13:44	-0,2804239
0:01:48	0,0220138	0:04:48	-0,0191526	0:07:48	-0,0466922	0:10:48	0,1271064	0:13:48	-0,2713703
0:01:52	0,0308628	0:04:52	-0,0228741	0:07:52	-0,0307627	0:10:52	0,1097582	0:13:52	-0,2623168
0:01:56	0,0368697	0:04:56	-0,0277144	0:07:56	-0,0136000	0:10:56	0,0927248	0:13:56	-0,2512517
0:02:00	0,0419293	0:05:00	-0,0336735	0:08:00	0,0047960	0:11:00	0,0757964	0:14:00	-0,2381751
0:02:04	0,0473421	0:05:04	-0,0400964	0:08:04	0,0232995	0:11:04	0,0586385	0:14:04	-0,2251855
0:02:08	0,0510843	0:05:08	-0,0520920	0:08:08	0,0427899	0:11:08	0,0396681	0:14:08	-0,2133392
0:02:12	0,0548265	0:05:12	-0,0640876	0:08:12	0,0622802	0:11:12	0,0206977	0:14:12	-0,2014929
0:02:16	0,0646130	0:05:16	-0,0725483	0:08:16	0,0766287	0:11:16	0,0124481	0:14:16	-0,1958499
0:02:20	0,0804441	0:05:20	-0,0798307	0:08:20	0,0892631	0:11:20	0,0077721	0:14:20	-0,1964104
0:02:24	0,0962751	0:05:24	-0,0871130	0:08:24	0,1018976	0:11:24	0,0030961	0:14:24	-0,1969709
0:02:28	0,1134425	0:05:28	-0,0969633	0:08:28	0,1087891	0:11:28	-0,0058780	0:14:28	-0,1893724
0:02:32	0,1306099	0:05:32	-0,1068135	0:08:32	0,1156806	0:11:32	-0,0148521	0:14:32	-0,1817739
0:02:36	0,1488078	0:05:36	-0,1148453	0:08:36	0,1228718	0:11:36	-0,0266690	0:14:36	-0,1777509
0:02:40	0,1680364	0:05:40	-0,1210587	0:08:40	0,1303628	0:11:40	-0,0413288	0:14:40	-0,1773035
0:02:44	0,1870955	0:05:44	-0,1272720	0:08:44	0,1378537	0:11:44	-0,0559885	0:14:44	-0,1768560
0:02:48	0,2056460	0:05:48	-0,1312115	0:08:48	0,1583201	0:11:48	-0,0737981	0:14:48	-0,1774046
0:02:52	0,2241965	0:05:52	-0,1351510	0:08:52	0,1787866	0:11:52	-0,0916077	0:14:52	-0,1779532
0:02:56	0,2441530	0:05:56	-0,1384836	0:08:56	0,1874674	0:11:56	-0,1070588	0:14:56	-0,1774283

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:15:00	0,1645154	0:18:00	0,2729788	0:21:00	0,0830836	0:24:00	0,0997118	0:27:00	0,0165834
0:15:04	0,1660924	0:18:04	0,2838549	0:21:04	0,0783531	0:24:04	0,1036220	0:27:04	0,0175403
0:15:08	0,1734007	0:18:08	0,2901766	0:21:08	0,0703089	0:24:08	0,1013410	0:27:08	0,0172188
0:15:12	-0,1596363	0:18:12	0,2964983	0:21:12	0,0622648	0:24:12	0,0990599	0:27:12	0,0168973
0:15:16	-0,1523280	0:18:16	0,3063513	0:21:16	0,0555795	0:24:16	0,1002245	0:27:16	0,0178401
0:15:20	-0,1450197	0:18:20	0,3197356	0:21:20	0,0502529	0:24:20	0,1048348	0:27:20	0,0192044
0:15:24	-0,1377114	0:18:24	0,3331199	0:21:24	0,0449264	0:24:24	0,1094452	0:27:24	0,0205687
0:15:28	-0,1287999	0:18:28	0,3244661	0:21:28	0,0462295	0:24:28	0,1159528	0:27:28	0,0122493
0:15:32	-0,1198883	0:18:32	0,3158123	0:21:32	0,0475327	0:24:32	0,1224605	0:27:32	0,0039299
0:15:36	-0,1111688	0:18:36	0,3167001	0:21:36	0,0488359	0:24:36	0,1286361	0:27:36	0,0022754
0:15:40	-0,1026413	0:18:40	0,3271296	0:21:40	0,0501390	0:24:40	0,1344796	0:27:40	0,0072859
0:15:44	-0,0941138	0:18:44	0,3375591	0:21:44	0,0514422	0:24:44	0,1403232	0:27:44	0,0122964
0:15:48	-0,0753384	0:18:48	0,3411057	0:21:48	0,0561602	0:24:48	0,1376008	0:27:48	0,0200636
0:15:52	-0,0565631	0:18:52	0,3446522	0:21:52	0,0608781	0:24:52	0,1348784	0:27:52	0,0278307
0:15:56	-0,0387621	0:18:56	0,3470492	0:21:56	0,0648945	0:24:56	0,1315047	0:27:56	0,0415406
0:16:00	-0,0212860	0:19:00	0,3490630	0:22:00	0,0682093	0:25:00	0,1274796	0:28:00	0,0611931
0:16:04	-0,0040864	0:19:04	0,3511532	0:22:04	0,0715903	0:25:04	0,1233684	0:28:04	0,0789882
0:16:08	0,0117079	0:19:08	0,3451920	0:22:08	0,0722888	0:25:08	0,1155644	0:28:08	0,0909759
0:16:12	0,0275021	0:19:12	0,3392308	0:22:12	0,0729874	0:25:12	0,1077604	0:28:12	0,1029636
0:16:16	0,0405282	0:19:16	0,3301740	0:22:16	0,0739417	0:25:16	0,0981181	0:28:16	0,1091298
0:16:20	0,0507862	0:19:20	0,3180217	0:22:20	0,0751518	0:25:20	0,0866373	0:28:20	0,1094745
0:16:24	0,0610442	0:19:24	0,3058694	0:22:24	0,0763619	0:25:24	0,0751565	0:28:24	0,1098192
0:16:28	0,0613031	0:19:28	0,2885236	0:22:28	0,0755508	0:25:28	0,0773290	0:28:28	0,1132451
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0:16:36	0,0649664	0:19:36	0,2579013	0:22:36	0,0739286	0:25:36	0,0773786	0:28:36	0,1150976
0:16:40	0,0715161	0:19:40	0,2486941	0:22:40	0,0731176	0:25:40	0,0709605	0:28:40	0,1085251
0:16:44	0,0780658	0:19:44	0,2394869	0:22:44	0,0723065	0:25:44	0,0645423	0:28:44	0,1019527
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0:16:52	0,0992099	0:19:52	0,2180505	0:22:52	0,0609215	0:25:52	0,0437552	0:28:52	0,0888078
0:16:56	0,1080689	0:19:56	0,2048298	0:22:56	0,0604718	0:25:56	0,0340867	0:28:56	0,0806155
0:17:00	0,1152150	0:20:00	0,1891067	0:23:00	0,0652646	0:26:00	0,0251432	0:29:00	0,0718832
0:17:04	0,1224721	0:20:04	0,1733455	0:23:04	0,0697410	0:26:04	0,0159928	0:29:04	0,0629884
0:17:08	0,1359847	0:20:08	0,1553957	0:23:08	0,0680413	0:26:08	0,0219538	0:29:08	0,0566129
0:17:12	0,1494973	0:20:12	0,1374459	0:23:12	0,0663415	0:26:12	0,0279148	0:29:12	0,0502374
0:17:16	0,1576514	0:20:16	0,1237768	0:23:16	0,0655223	0:26:16	0,0355165	0:29:16	0,0424250
0:17:20	0,1604470	0:20:20	0,1143886	0:23:20	0,0655836	0:26:20	0,0447590	0:29:20	0,0331757
0:17:24	0,1632427	0:20:24	0,1050003	0:23:24	0,0656449	0:26:24	0,0540015	0:29:24	0,0239264
0:17:28	0,1719065	0:20:28	0,1037216	0:23:28	0,0648684	0:26:28	0,0494099	0:29:28	0,0209690
0:17:32	0,1805704	0:20:32	0,1024429	0:23:32	0,0640918	0:26:32	0,0448182	0:29:32	0,0180115
0:17:36	0,1926406	0:20:36	0,1018853	0:23:36	0,0649221	0:26:36	0,0388467	0:29:36	0,0157773
0:17:40	0,2081172	0:20:40	0,1020487	0:23:40	0,0673592	0:26:40	0,0314953	0:29:40	0,0142663
0:17:44	0,2235937	0:20:44	0,1022121	0:23:44	0,0697963	0:26:44	0,0241439	0:29:44	0,0127553
0:17:48	0,2368899	0:20:48	0,0974300	0:23:48	0,0796033	0:26:48	0,0200854	0:29:48	0,0137651
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0:17:56	0,2622157	0:20:56	0,0878657	0:23:56	0,0961132	0:26:56	0,0156812	0:29:56	0,0157847

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:30:00	-0,3235509	0:33:00	0,1020752	0:36:00	0,0098738	0:39:00	0,1478816	0:42:00	-0,0483975
0:30:04	-0,3227125	0:33:04	0,1000139	0:36:04	0,0146217	0:39:04	0,1486243	0:42:04	-0,0416087
0:30:08	-0,3235977	0:33:08	0,0930647	0:36:08	0,0130211	0:39:08	0,1545156	0:42:08	-0,0314866
0:30:12	0,0158625	0:33:12	0,0861155	0:36:12	0,0114204	0:39:12	0,1604070	0:42:12	-0,0213644
0:30:16	0,0124333	0:33:16	0,0802352	0:36:16	0,0127072	0:39:16	0,1631321	0:42:16	-0,0142738
0:30:20	0,0064601	0:33:20	0,0754239	0:36:20	0,0149563	0:39:20	0,1648019	0:42:20	-0,0081937
0:30:24	0,0004868	0:33:24	0,0706125	0:36:24	0,0166179	0:39:24	0,1633744	0:42:24	-0,0024866
0:30:28	-0,0000640	0:33:28	0,0739389	0:36:28	0,0165164	0:39:28	0,1588496	0:42:28	0,0021020
0:30:32	-0,0006148	0:33:32	0,0772653	0:36:32	0,0164150	0:39:32	0,1543249	0:42:32	0,0066905
0:30:36	0,0013489	0:33:36	0,0783345	0:36:36	0,0142120	0:39:36	0,1475424	0:42:36	0,0126275
0:30:40	0,0058271	0:33:40	0,0771465	0:36:40	0,0113085	0:39:40	0,1400073	0:42:40	0,0190139
0:30:44	0,0110780	0:33:44	0,0759586	0:36:44	0,0069194	0:39:44	0,1328217	0:42:44	0,0261112
0:30:48	0,0186472	0:33:48	0,0783646	0:36:48	-0,0019263	0:39:48	0,1259858	0:42:48	0,0353410
0:30:52	0,0262164	0:33:52	0,0807707	0:36:52	-0,0107721	0:39:52	0,1191499	0:42:52	0,0445709
0:30:56	0,0326313	0:33:56	0,0787945	0:36:56	-0,0180858	0:39:56	0,1071064	0:42:56	0,0506149
0:31:00	0,0378917	0:34:00	0,0724362	0:37:00	-0,0248888	0:40:00	0,0933272	0:43:00	0,0555971
0:31:04	0,0435241	0:34:04	0,0656890	0:37:04	-0,0297525	0:40:04	0,0876670	0:43:04	0,0603611
0:31:08	0,0536492	0:34:08	0,0664554	0:37:08	-0,0294951	0:40:08	0,0897383	0:43:08	0,0654721
0:31:12	0,0637742	0:34:12	0,0672218	0:37:12	-0,0292377	0:40:12	0,0918097	0:43:12	0,0705830
0:31:16	0,0750282	0:34:16	0,0638580	0:37:16	-0,0352404	0:40:16	0,0974530	0:43:16	0,0762071
0:31:20	0,0874109	0:34:20	0,0563640	0:37:20	-0,0433297	0:40:20	0,1042870	0:43:20	0,0820022
0:31:24	0,0997937	0:34:24	0,0488700	0:37:24	-0,0475031	0:40:24	0,1050761	0:43:24	0,0874972
0:31:28	0,1095304	0:34:28	0,0359305	0:37:28	-0,0399286	0:40:28	0,0998204	0:43:28	0,0920920
0:31:32	0,1192671	0:34:32	0,0229909	0:37:32	-0,0323542	0:40:32	0,0945648	0:43:32	0,0966867
0:31:36	0,1281305	0:34:36	0,0120478	0:37:36	-0,0240241	0:40:36	0,0834769	0:43:36	0,1024091
0:31:40	0,1361206	0:34:40	0,0031012	0:37:40	-0,0154420	0:40:40	0,0704450	0:43:40	0,1085073
0:31:44	0,1441107	0:34:44	-0,0058455	0:37:44	-0,0025843	0:40:44	0,0570744	0:43:44	0,1140901
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0:31:52	0,1478273	0:34:52	-0,0086089	0:37:52	0,0487853	0:40:52	0,0283007	0:43:52	0,1221635
0:31:56	0,1496855	0:34:56	-0,0089222	0:37:56	0,0669500	0:40:56	0,0178316	0:43:56	0,1159416
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0:32:04	0,1530457	0:35:04	-0,0072158	0:38:04	0,1030325	0:41:04	-0,0002508	0:44:04	0,1023650
0:32:08	0,1545475	0:35:08	-0,0065830	0:38:08	0,1200084	0:41:08	-0,0077077	0:44:08	0,0914886
0:32:12	0,1560494	0:35:12	-0,0059503	0:38:12	0,1369843	0:41:12	-0,0151645	0:44:12	0,0806122
0:32:16	0,1550946	0:35:16	-0,0053175	0:38:16	0,1395431	0:41:16	-0,0210703	0:44:16	0,0726406
0:32:20	0,1516831	0:35:20	-0,0104282	0:38:20	0,1372963	0:41:20	-0,0264590	0:44:20	0,0656372
0:32:24	0,1482716	0:35:24	-0,0155389	0:38:24	0,1350495	0:41:24	-0,0308601	0:44:24	0,0600138
0:32:28	0,1399634	0:35:28	-0,0166816	0:38:28	0,1328027	0:41:28	-0,0322983	0:44:28	0,0585300
0:32:32	0,1316553	0:35:32	-0,0178243	0:38:32	0,1305559	0:41:32	-0,0337364	0:44:32	0,0570463
0:32:36	0,1262331	0:35:36	-0,0167791	0:38:36	0,1315570	0:41:36	-0,0435560	0:44:36	0,0532056
0:32:40	0,1236969	0:35:40	-0,0150046	0:38:40	0,1336407	0:41:40	-0,0561694	0:44:40	0,0485793
0:32:44	0,1211607	0:35:44	-0,0125670	0:38:44	0,1366237	0:41:44	-0,0648535	0:44:44	0,0443126
0:32:48	0,1139572	0:35:48	-0,0081399	0:38:48	0,1423047	0:41:48	-0,0617499	0:44:48	0,0411248
0:32:52	0,1067537	0:35:52	-0,0037128	0:38:52	0,1479857	0:41:52	-0,0586462	0:44:52	0,0379370
0:32:56	0,1027930	0:35:56	0,0027424	0:38:56	0,1487526	0:41:56	-0,0538105	0:44:56	0,0306391

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:45:00	0,3623166	0:48:00	0,0547805	0:51:00	-0,1525638	0:54:00	0,0656385	0:57:00	0,3345737
0:45:04	0,3550369	0:48:04	0,0450814	0:51:04	-0,1683968	0:54:04	0,0610579	0:57:04	0,3226043
0:45:08	0,3515644	0:48:08	0,0441539	0:51:08	-0,1770087	0:54:08	0,0619532	0:57:08	0,3028670
0:45:12	0,0077466	0:48:12	0,0432264	0:51:12	-0,1856207	0:54:12	0,0628485	0:57:12	0,2831298
0:45:16	0,0036201	0:48:16	0,0411542	0:51:16	-0,1900235	0:54:16	0,0664671	0:57:16	0,2625821
0:45:20	-0,0007243	0:48:20	0,0379374	0:51:20	-0,1902171	0:54:20	0,0728089	0:57:20	0,2417643
0:45:24	-0,0043704	0:48:24	0,0347205	0:51:24	-0,1904107	0:54:24	0,0791508	0:57:24	0,2255449
0:45:28	-0,0059215	0:48:28	0,0315037	0:51:28	-0,1929583	0:54:28	0,0913576	0:57:28	0,2139238
0:45:32	-0,0074726	0:48:32	0,0282868	0:51:32	-0,1955059	0:54:32	0,1035643	0:57:32	0,2023027
0:45:36	-0,0097536	0:48:36	0,0237527	0:51:36	-0,1963469	0:54:36	0,1176017	0:57:36	0,1826893
0:45:40	-0,0127643	0:48:40	0,0179014	0:51:40	-0,1954812	0:54:40	0,1322492	0:57:40	0,1604118
0:45:44	-0,0157751	0:48:44	0,0120501	0:51:44	-0,1946156	0:54:44	0,1468967	0:57:44	0,1402298
0:45:48	-0,0150136	0:48:48	0,0162942	0:51:48	-0,1914502	0:54:48	0,1573018	0:57:48	0,1263342
0:45:52	-0,0142521	0:48:52	0,0205383	0:51:52	-0,1882848	0:54:52	0,1677068	0:57:52	0,1124386
0:45:56	-0,0163495	0:48:56	0,0216419	0:51:56	-0,1801337	0:54:56	0,1755349	0:57:56	0,1023440
0:46:00	-0,0213059	0:49:00	0,0196051	0:52:00	-0,1669968	0:55:00	0,1807862	0:58:00	0,0922494
0:46:04	-0,0261138	0:49:04	0,0173462	0:52:04	-0,1535270	0:55:04	0,1856594	0:58:04	0,0817820
0:46:08	-0,0319213	0:49:08	0,0081507	0:52:08	-0,1295883	0:55:08	0,1930418	0:58:08	0,0699416
0:46:12	-0,0377289	0:49:12	-0,0010449	0:52:12	-0,1056495	0:55:12	0,2004241	0:58:12	0,0581013
0:46:16	-0,0400197	0:49:16	-0,0040738	0:52:16	-0,0867558	0:55:16	0,2117544	0:58:16	0,0465207
0:46:20	-0,0387938	0:49:20	-0,0050472	0:52:20	-0,0695438	0:55:20	0,2270328	0:58:20	0,0350268
0:46:24	-0,0375679	0:49:24	-0,0060206	0:52:24	-0,0523317	0:55:24	0,2423112	0:58:24	0,0249861
0:46:28	-0,0259676	0:49:28	-0,0061958	0:52:28	-0,0329199	0:55:28	0,2583776	0:58:28	0,0193053
0:46:32	-0,0143674	0:49:32	-0,0063711	0:52:32	-0,0135080	0:55:32	0,2744439	0:58:32	0,0136244
0:46:36	-0,0021463	0:49:36	-0,0061463	0:52:36	0,0008899	0:55:36	0,2859425	0:58:36	0,0041966
0:46:40	0,0106957	0:49:40	-0,0055215	0:52:40	0,0102737	0:55:40	0,2959185	0:58:40	-0,0064803
0:46:44	0,0235377	0:49:44	-0,0048967	0:52:44	0,0196575	0:55:44	0,3040516	0:58:44	-0,0194283
0:46:48	0,0381626	0:49:48	-0,0061439	0:52:48	0,0307390	0:55:48	0,3066558	0:58:48	-0,0391901
0:46:52	0,0527875	0:49:52	-0,0073911	0:52:52	0,0418205	0:55:52	0,3092602	0:58:52	-0,0589518
0:46:56	0,0632151	0:49:56	-0,0133823	0:52:56	0,0517329	0:55:56	0,3140807	0:58:56	-0,0708777
0:47:00	0,0694452	0:50:00	-0,0241175	0:53:00	0,0612423	0:56:00	0,3196401	0:59:00	-0,0801917
0:47:04	0,0754061	0:50:04	-0,0346345	0:53:04	0,0707013	0:56:04	0,3241292	0:59:04	-0,0878202
0:47:08	0,0746553	0:50:08	-0,0422121	0:53:08	0,0825534	0:56:08	0,3251758	0:59:08	-0,0900178
0:47:12	0,0739045	0:50:12	-0,0497896	0:53:12	0,0944056	0:56:12	0,3262224	0:59:12	-0,0922154
0:47:16	0,0743218	0:50:16	-0,0579976	0:53:16	0,1000599	0:56:16	0,3288104	0:59:16	-0,0930800
0:47:20	0,0759074	0:50:20	-0,0668361	0:53:20	0,0995164	0:56:20	0,3319122	0:59:20	-0,0935004
0:47:24	0,0774930	0:50:24	-0,0756746	0:53:24	0,0989729	0:56:24	0,3367561	0:59:24	-0,0960084
0:47:28	0,0816356	0:50:28	-0,0782347	0:53:28	0,0972965	0:56:28	0,3468268	0:59:28	-0,1047795
0:47:32	0,0857782	0:50:32	-0,0807948	0:53:32	0,0922216	0:56:32	0,3568975	0:59:32	-0,1135506
0:47:36	0,0860331	0:50:36	-0,0855537	0:53:36	0,0892716	0:56:36	0,3597445	0:59:36	-0,1200643
0:47:40	0,0824001	0:50:40	-0,0925115	0:53:40	0,0884465	0:56:40	0,3601837	0:59:40	-0,1258256
0:47:44	0,0787672	0:50:44	-0,0994693	0:53:44	0,0876213	0:56:44	0,3595690	0:59:44	-0,1314093
0:47:48	0,0751343	0:50:48	-0,1114327	0:53:48	0,0817517	0:56:48	0,3557929	0:59:48	-0,1364604
0:47:52	0,0715013	0:50:52	-0,1233960	0:53:52	0,0758821	0:56:52	0,3520168	0:59:52	-0,1415115
0:47:56	0,0647167	0:50:56	-0,1371064	0:53:56	0,0705111	0:56:56	0,3440017	0:59:56	-0,1568204

Only the data for the first hour are shown here. See Figure 5.3.3 (column D) in the attached excel sheet in “PNNL-22010 Rev.2” for all the data available at https://energystorage.pnnl.gov/pdf/PNNL-22010Rev2.pdf. For the remainder part of the listed period, the figures should be normalized by the peak value of the whole period. The polarity has to be changed in accordance with IEC 62933-2-1.

Table A.8 – Numerical data of Figure 19 (duty cycle for fluctuation reduction of renewable energy sources (power) without frequency control)

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,4102020	0:03:00	-0,0002919	0:06:00	0,0088159	0:09:00	0,0317259	0:12:00	0,0472375
0:00:04	-0,4059768	0:03:04	-0,0004065	0:06:04	0,0097345	0:09:04	0,0321016	0:12:04	0,0470953
0:00:08	-0,4017516	0:03:08	-0,0005211	0:06:08	0,0106532	0:09:08	0,0324773	0:12:08	0,0469531
0:00:12	-0,0536163	0:03:12	-0,0006357	0:06:12	0,0115718	0:09:12	0,0328530	0:12:12	0,0468110
0:00:16	-0,0493911	0:03:16	-0,0007502	0:06:16	0,0124905	0:09:16	0,0332287	0:12:16	0,0466688
0:00:20	-0,0451659	0:03:20	-0,0008648	0:06:20	0,0134092	0:09:20	0,0336045	0:12:20	0,0465266
0:00:24	-0,0409407	0:03:24	-0,0009794	0:06:24	0,0143278	0:09:24	0,0339802	0:12:24	0,0463845
0:00:28	-0,0367155	0:03:28	-0,0010940	0:06:28	0,0152465	0:09:28	0,0343559	0:12:28	0,0462423
0:00:32	-0,0324903	0:03:32	-0,0012086	0:06:32	0,0161651	0:09:32	0,0347316	0:12:32	0,0461002
0:00:36	-0,0282651	0:03:36	-0,0013232	0:06:36	0,0170838	0:09:36	0,0351073	0:12:36	0,0459580
0:00:40	-0,0240400	0:03:40	-0,0014377	0:06:40	0,0180024	0:09:40	0,0354830	0:12:40	0,0458158
0:00:44	-0,0198148	0:03:44	-0,0015523	0:06:44	0,0189211	0:09:44	0,0358587	0:12:44	0,0456737
0:00:48	-0,0155896	0:03:48	-0,0016669	0:06:48	0,0198397	0:09:48	0,0362344	0:12:48	0,0455315
0:00:52	-0,0113644	0:03:52	-0,0017815	0:06:52	0,0207584	0:09:52	0,0366102	0:12:52	0,0453893
0:00:56	-0,0078055	0:03:56	-0,0018961	0:06:56	0,0216770	0:09:56	0,0369859	0:12:56	0,0452472
0:01:00	-0,3510315	0:04:00	-0,0020106	0:07:00	0,0225957	0:10:00	0,0373616	0:13:00	0,0451050
0:01:04	-0,3511032	0:04:04	-0,0012566	0:07:04	0,0228089	0:10:04	0,0378854	0:13:04	0,0455214
0:01:08	-0,3511749	0:04:08	-0,0005026	0:07:08	0,0230221	0:10:08	0,0384092	0:13:08	0,0459378
0:01:12	-0,3512467	0:04:12	0,0002514	0:07:12	0,0232353	0:10:12	0,0389329	0:13:12	0,0463543
0:01:16	-0,3513184	0:04:16	0,0010054	0:07:16	0,0234485	0:10:16	0,0394567	0:13:16	0,0467707
0:01:20	-0,3513901	0:04:20	0,0017594	0:07:20	0,0236617	0:10:20	0,0399805	0:13:20	0,0471871
0:01:24	-0,3514618	0:04:24	0,0025134	0:07:24	0,0238749	0:10:24	0,0405043	0:13:24	0,0476035
0:01:28	-0,3515335	0:04:28	0,0032675	0:07:28	0,0240882	0:10:28	0,0410281	0:13:28	0,0480199
0:01:32	-0,3516052	0:04:32	0,0040215	0:07:32	0,0243014	0:10:32	0,0415519	0:13:32	0,0484363
0:01:36	-0,0077667	0:04:36	0,0047755	0:07:36	0,0245146	0:10:36	0,0420757	0:13:36	0,0488528
0:01:40	-0,0078384	0:04:40	0,0055295	0:07:40	0,0247278	0:10:40	0,0425995	0:13:40	0,0492692
0:01:44	-0,0079101	0:04:44	0,0062835	0:07:44	0,0249410	0:10:44	0,0431232	0:13:44	0,0496856
0:01:48	-0,0079818	0:04:48	0,0070375	0:07:48	0,0251542	0:10:48	0,0436470	0:13:48	0,0501020
0:01:52	-0,0080535	0:04:52	0,0077915	0:07:52	0,0253674	0:10:52	0,0441708	0:13:52	0,0505184
0:01:56	-0,0081252	0:04:56	0,0085456	0:07:56	0,0255807	0:10:56	0,0446946	0:13:56	0,0509348
0:02:00	-0,0081970	0:05:00	0,0092996	0:08:00	0,0257939	0:11:00	0,0452184	0:14:00	0,0513512
0:02:04	-0,0076700	0:05:04	0,0092673	0:08:04	0,0261893	0:11:04	0,0453530	0:14:04	0,0516201
0:02:08	-0,0071429	0:05:08	0,0092351	0:08:08	0,0265848	0:11:08	0,0454876	0:14:08	0,0518889
0:02:12	-0,0066159	0:05:12	0,0092028	0:08:12	0,0269803	0:11:12	0,0456222	0:14:12	0,0521578
0:02:16	-0,0060889	0:05:16	0,0091706	0:08:16	0,0273757	0:11:16	0,0457568	0:14:16	0,0524267
0:02:20	-0,0055619	0:05:20	0,0091383	0:08:20	0,0277712	0:11:20	0,0458914	0:14:20	0,0526955
0:02:24	-0,0050349	0:05:24	0,0091061	0:08:24	0,0281667	0:11:24	0,0460260	0:14:24	0,0529644
0:02:28	-0,0045079	0:05:28	0,0090739	0:08:28	0,0285621	0:11:28	0,0461606	0:14:28	0,0532332
0:02:32	-0,0039809	0:05:32	0,0090416	0:08:32	0,0289576	0:11:32	0,0462952	0:14:32	0,0535021
0:02:36	-0,0034539	0:05:36	0,0090094	0:08:36	0,0293531	0:11:36	0,0464298	0:14:36	0,0537709
0:02:40	-0,0029269	0:05:40	0,0089771	0:08:40	0,0297485	0:11:40	0,0465644	0:14:40	0,0540398
0:02:44	-0,0023999	0:05:44	0,0089449	0:08:44	0,0301440	0:11:44	0,0466990	0:14:44	0,0543086
0:02:48	-0,0018729	0:05:48	0,0089126	0:08:48	0,0305395	0:11:48	0,0468336	0:14:48	0,0545775
0:02:52	-0,0013459	0:05:52	0,0088804	0:08:52	0,0309350	0:11:52	0,0469682	0:14:52	0,0548463
0:02:56	-0,0008189	0:05:56	0,0088481	0:08:56	0,0313304	0:11:56	0,0471029	0:14:56	0,0551152

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:15:00	0,3992942	0:18:00	0,0546207	0:21:00	0,0640160	0:24:00	0,0726730	0:27:00	0,0810616
0:15:04	0,3995270	0:18:04	0,0547646	0:21:04	0,0643124	0:24:04	0,0730733	0:27:04	0,0810750
0:15:08	0,3997597	0:18:08	0,0549085	0:21:08	0,0646089	0:24:08	0,0734736	0:27:08	0,0810885
0:15:12	0,0560824	0:18:12	0,0550524	0:21:12	0,0649054	0:24:12	0,0738739	0:27:12	0,0811019
0:15:16	0,0563152	0:18:16	0,0551963	0:21:16	0,0652019	0:24:16	0,0742742	0:27:16	0,0811154
0:15:20	0,0565480	0:18:20	0,0553402	0:21:20	0,0654984	0:24:20	0,0746745	0:27:20	0,0811289
0:15:24	0,0567808	0:18:24	0,0554841	0:21:24	0,0657949	0:24:24	0,0750747	0:27:24	0,0811423
0:15:28	0,0570135	0:18:28	0,0556280	0:21:28	0,0660913	0:24:28	0,0754750	0:27:28	0,0811558
0:15:32	0,0572463	0:18:32	0,0557719	0:21:32	0,0663878	0:24:32	0,0758753	0:27:32	0,0811693
0:15:36	0,0574791	0:18:36	0,0559158	0:21:36	0,0666843	0:24:36	0,0762756	0:27:36	0,0811827
0:15:40	0,0577119	0:18:40	0,0560597	0:21:40	0,0669808	0:24:40	0,0766759	0:27:40	0,0811962
0:15:44	0,0579447	0:18:44	0,0562036	0:21:44	0,0672773	0:24:44	0,0770761	0:27:44	0,0812097
0:15:48	0,0581775	0:18:48	0,0563475	0:21:48	0,0675738	0:24:48	0,0774764	0:27:48	0,0812231
0:15:52	0,0584103	0:18:52	0,0564914	0:21:52	0,0678702	0:24:52	0,0778767	0:27:52	0,0812366
0:15:56	0,0586431	0:18:56	0,0566353	0:21:56	0,0681667	0:24:56	0,0782770	0:27:56	0,0812501
0:16:00	0,0588758	0:19:00	0,0567792	0:22:00	0,0684632	0:25:00	0,0786773	0:28:00	0,0812635
0:16:04	0,0586399	0:19:04	0,0570527	0:22:04	0,0688718	0:25:04	0,0789315	0:28:04	0,0814099
0:16:08	0,0584040	0:19:08	0,0573262	0:22:08	0,0692804	0:25:08	0,0791857	0:28:08	0,0815562
0:16:12	0,0581682	0:19:12	0,0575997	0:22:12	0,0696890	0:25:12	0,0794399	0:28:12	0,0817026
0:16:16	0,0579323	0:19:16	0,0578732	0:22:16	0,0700976	0:25:16	0,0796942	0:28:16	0,0818489
0:16:20	0,0576964	0:19:20	0,0581467	0:22:20	0,0705062	0:25:20	0,0799484	0:28:20	0,0819952
0:16:24	0,0574605	0:19:24	0,0584202	0:22:24	0,0709148	0:25:24	0,0802026	0:28:24	0,0821416
0:16:28	0,0572246	0:19:28	0,0586937	0:22:28	0,0713234	0:25:28	0,0804568	0:28:28	0,0822879
0:16:32	0,0569887	0:19:32	0,0589672	0:22:32	0,0717320	0:25:32	0,0807111	0:28:32	0,0824343
0:16:36	0,0567528	0:19:36	0,0592407	0:22:36	0,0721406	0:25:36	0,0809653	0:28:36	0,0825806
0:16:40	0,0565169	0:19:40	0,0595142	0:22:40	0,0725492	0:25:40	0,0812195	0:28:40	0,0827270
0:16:44	0,0562810	0:19:44	0,0597876	0:22:44	0,0729578	0:25:44	0,0814738	0:28:44	0,0828733
0:16:48	0,0560451	0:19:48	0,0600611	0:22:48	0,0733664	0:25:48	0,0817280	0:28:48	0,0830197
0:16:52	0,0558092	0:19:52	0,0603346	0:22:52	0,0737750	0:25:52	0,0819822	0:28:52	0,0831660
0:16:56	0,0555733	0:19:56	0,0606081	0:22:56	0,0741836	0:25:56	0,0822364	0:28:56	0,0833124
0:17:00	0,0553374	0:20:00	0,0608816	0:23:00	0,0745922	0:26:00	0,0824907	0:29:00	0,0834587
0:17:04	0,0552896	0:20:04	0,0610906	0:23:04	0,0744642	0:26:04	0,0823942	0:29:04	0,0833295
0:17:08	0,0552418	0:20:08	0,0612995	0:23:08	0,0743363	0:26:08	0,0822978	0:29:08	0,0832004
0:17:12	0,0551940	0:20:12	0,0615085	0:23:12	0,0742084	0:26:12	0,0822014	0:29:12	0,0830712
0:17:16	0,0551463	0:20:16	0,0617174	0:23:16	0,0740804	0:26:16	0,0821049	0:29:16	0,0829421
0:17:20	0,0550985	0:20:20	0,0619264	0:23:20	0,0739525	0:26:20	0,0820085	0:29:20	0,0828129
0:17:24	0,0550507	0:20:24	0,0621353	0:23:24	0,0738245	0:26:24	0,0819121	0:29:24	0,0826838
0:17:28	0,0550029	0:20:28	0,0623443	0:23:28	0,0736966	0:26:28	0,0818156	0:29:28	0,0825547
0:17:32	0,0549551	0:20:32	0,0625533	0:23:32	0,0735686	0:26:32	0,0817192	0:29:32	0,0824255
0:17:36	0,0549074	0:20:36	0,0627622	0:23:36	0,0734407	0:26:36	0,0816228	0:29:36	0,0822964
0:17:40	0,0548596	0:20:40	0,0629712	0:23:40	0,0733128	0:26:40	0,0815264	0:29:40	0,0821672
0:17:44	0,0548118	0:20:44	0,0631801	0:23:44	0,0731848	0:26:44	0,0814299	0:29:44	0,0820381
0:17:48	0,0547640	0:20:48	0,0633891	0:23:48	0,0730569	0:26:48	0,0813335	0:29:48	0,0819089
0:17:52	0,0547162	0:20:52	0,0635980	0:23:52	0,0729289	0:26:52	0,0812371	0:29:52	0,0817798
0:17:56	0,0546685	0:20:56	0,0638070	0:23:56	0,0728010	0:26:56	0,0811406	0:29:56	0,0816506

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:30:00	-0,2623887	0:33:00	0,0724972	0:36:00	0,0645208	0:39:00	0,0551498	0:42:00	0,0607988
0:30:04	-0,2628083	0:33:04	0,0725887	0:36:04	0,0640123	0:39:04	0,0549750	0:42:04	0,0613168
0:30:08	-0,2632279	0:33:08	0,0726801	0:36:08	0,0635037	0:39:08	0,0548002	0:42:08	0,0618348
0:30:12	0,0802627	0:33:12	0,0727716	0:36:12	0,0629951	0:39:12	0,0546253	0:42:12	0,0623529
0:30:16	0,0798431	0:33:16	0,0728630	0:36:16	0,0624865	0:39:16	0,0544505	0:42:16	0,0628709
0:30:20	0,0794235	0:33:20	0,0729545	0:36:20	0,0619780	0:39:20	0,0542757	0:42:20	0,0633889
0:30:24	0,0790039	0:33:24	0,0730459	0:36:24	0,0614694	0:39:24	0,0541009	0:42:24	0,0639069
0:30:28	0,0785844	0:33:28	0,0731374	0:36:28	0,0609608	0:39:28	0,0539260	0:42:28	0,0644249
0:30:32	0,0781648	0:33:32	0,0732288	0:36:32	0,0604522	0:39:32	0,0537512	0:42:32	0,0649429
0:30:36	0,0777452	0:33:36	0,0733203	0:36:36	0,0599437	0:39:36	0,0535764	0:42:36	0,0654609
0:30:40	0,0773256	0:33:40	0,0734117	0:36:40	0,0594351	0:39:40	0,0534016	0:42:40	0,0659789
0:30:44	0,0769060	0:33:44	0,0735032	0:36:44	0,0589265	0:39:44	0,0532268	0:42:44	0,0664969
0:30:48	0,0764864	0:33:48	0,0735947	0:36:48	0,0584179	0:39:48	0,0530519	0:42:48	0,0670149
0:30:52	0,0760668	0:33:52	0,0736861	0:36:52	0,0579094	0:39:52	0,0528771	0:42:52	0,0675329
0:30:56	0,0756473	0:33:56	0,0737776	0:36:56	0,0574008	0:39:56	0,0527023	0:42:56	0,0680510
0:31:00	0,0752277	0:34:00	0,0738690	0:37:00	0,0568922	0:40:00	0,0525275	0:43:00	0,0685690
0:31:04	0,0754387	0:34:04	0,0733013	0:37:04	0,0567774	0:40:04	0,0530095	0:43:04	0,0685212
0:31:08	0,0756498	0:34:08	0,0727336	0:37:08	0,0566625	0:40:08	0,0534915	0:43:08	0,0684735
0:31:12	0,0758609	0:34:12	0,0721659	0:37:12	0,0565476	0:40:12	0,0539736	0:43:12	0,0684257
0:31:16	0,0760720	0:34:16	0,0715982	0:37:16	0,0564328	0:40:16	0,0544556	0:43:16	0,0683780
0:31:20	0,0762830	0:34:20	0,0710305	0:37:20	0,0563179	0:40:20	0,0549376	0:43:20	0,0683302
0:31:24	0,0764941	0:34:24	0,0704628	0:37:24	0,0562031	0:40:24	0,0554197	0:43:24	0,0682825
0:31:28	0,0767052	0:34:28	0,0698951	0:37:28	0,0560882	0:40:28	0,0559017	0:43:28	0,0682348
0:31:32	0,0769163	0:34:32	0,0693274	0:37:32	0,0559734	0:40:32	0,0563837	0:43:32	0,0681870
0:31:36	0,0771273	0:34:36	0,0687597	0:37:36	0,0558585	0:40:36	0,0568658	0:43:36	0,0681393
0:31:40	0,0773384	0:34:40	0,0681920	0:37:40	0,0557436	0:40:40	0,0573478	0:43:40	0,0680915
0:31:44	0,0775495	0:34:44	0,0676243	0:37:44	0,0556288	0:40:44	0,0578298	0:43:44	0,0680438
0:31:48	0,0777606	0:34:48	0,0670566	0:37:48	0,0555139	0:40:48	0,0583119	0:43:48	0,0679960
0:31:52	0,0779716	0:34:52	0,0664889	0:37:52	0,0553991	0:40:52	0,0587939	0:43:52	0,0679483
0:31:56	0,0781827	0:34:56	0,0659212	0:37:56	0,0552842	0:40:56	0,0592759	0:43:56	0,0679005
0:32:00	0,0783938	0:35:00	0,0653535	0:38:00	0,0551694	0:41:00	0,0597579	0:44:00	0,0678528
0:32:04	0,0780007	0:35:04	0,0652980	0:38:04	0,0551681	0:41:04	0,0598273	0:44:04	0,0678744
0:32:08	0,0776076	0:35:08	0,0652425	0:38:08	0,0551668	0:41:08	0,0598967	0:44:08	0,0678959
0:32:12	0,0772145	0:35:12	0,0651870	0:38:12	0,0551654	0:41:12	0,0599661	0:44:12	0,0679175
0:32:16	0,0768214	0:35:16	0,0651315	0:38:16	0,0551641	0:41:16	0,0600355	0:44:16	0,0679391
0:32:20	0,0764283	0:35:20	0,0650760	0:38:20	0,0551628	0:41:20	0,0601049	0:44:20	0,0679607
0:32:24	0,0760352	0:35:24	0,0650204	0:38:24	0,0551615	0:41:24	0,0601743	0:44:24	0,0679822
0:32:28	0,0756421	0:35:28	0,0649649	0:38:28	0,0551602	0:41:28	0,0602437	0:44:28	0,0680038
0:32:32	0,0752490	0:35:32	0,0649094	0:38:32	0,0551589	0:41:32	0,0603131	0:44:32	0,0680254
0:32:36	0,0748558	0:35:36	0,0648539	0:38:36	0,0551576	0:41:36	0,0603825	0:44:36	0,0680469
0:32:40	0,0744627	0:35:40	0,0647984	0:38:40	0,0551563	0:41:40	0,0604519	0:44:40	0,0680685
0:32:44	0,0740696	0:35:44	0,0647429	0:38:44	0,0551550	0:41:44	0,0605213	0:44:44	0,0680901
0:32:48	0,0736765	0:35:48	0,0646874	0:38:48	0,0551537	0:41:48	0,0605907	0:44:48	0,0681117
0:32:52	0,0732834	0:35:52	0,0646319	0:38:52	0,0551524	0:41:52	0,0606600	0:44:52	0,0681332
0:32:56	0,0728903	0:35:56	0,0645763	0:38:56	0,0551511	0:41:56	0,0607294	0:44:56	0,0681548

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:45:00	0,4120865	0:48:00	0,0789382	0:51:00	0,0921345	0:54:00	0,0974166	0:57:00	0,1129555
0:45:04	0,4123100	0:48:04	0,0793590	0:51:04	0,0919121	0:54:04	0,0981455	0:57:04	0,1132557
0:45:08	0,4125335	0:48:08	0,0797798	0:51:08	0,0916898	0:54:08	0,0988743	0:57:08	0,1135560
0:45:12	0,0688469	0:48:12	0,0802006	0:51:12	0,0914674	0:54:12	0,0996031	0:57:12	0,1138562
0:45:16	0,0690704	0:48:16	0,0806214	0:51:16	0,0912451	0:54:16	0,1003319	0:57:16	0,1141564
0:45:20	0,0692939	0:48:20	0,0810422	0:51:20	0,0910227	0:54:20	0,1010608	0:57:20	0,1144567
0:45:24	0,0695174	0:48:24	0,0814630	0:51:24	0,0908003	0:54:24	0,1017896	0:57:24	0,1147569
0:45:28	0,0697409	0:48:28	0,0818839	0:51:28	0,0905780	0:54:28	0,1025184	0:57:28	0,1150572
0:45:32	0,0699644	0:48:32	0,0823047	0:51:32	0,0903556	0:54:32	0,1032473	0:57:32	0,1153574
0:45:36	0,0701879	0:48:36	0,0827255	0:51:36	0,0901333	0:54:36	0,1039761	0:57:36	0,1156576
0:45:40	0,0704114	0:48:40	0,0831463	0:51:40	0,0899109	0:54:40	0,1047049	0:57:40	0,1159579
0:45:44	0,0706349	0:48:44	0,0835671	0:51:44	0,0896885	0:54:44	0,1054337	0:57:44	0,1162581
0:45:48	0,0708584	0:48:48	0,0839879	0:51:48	0,0894662	0:54:48	0,1061626	0:57:48	0,1165584
0:45:52	0,0710819	0:48:52	0,0844087	0:51:52	0,0892438	0:54:52	0,1068914	0:57:52	0,1168586
0:45:56	0,0713054	0:48:56	0,0848295	0:51:56	0,0890214	0:54:56	0,1076202	0:57:56	0,1171589
0:46:00	0,0715289	0:49:00	0,0852503	0:52:00	0,0887991	0:55:00	0,1083490	0:58:00	0,1174591
0:46:04	0,0720041	0:49:04	0,0852949	0:52:04	0,0891410	0:55:04	0,1084371	0:58:04	0,1179031
0:46:08	0,0724793	0:49:08	0,0853394	0:52:08	0,0894830	0:55:08	0,1085251	0:58:08	0,1183471
0:46:12	0,0729545	0:49:12	0,0853839	0:52:12	0,0898249	0:55:12	0,1086131	0:58:12	0,1187911
0:46:16	0,0734297	0:49:16	0,0854285	0:52:16	0,0901669	0:55:16	0,1087012	0:58:16	0,1192351
0:46:20	0,0739049	0:49:20	0,0854730	0:52:20	0,0905088	0:55:20	0,1087892	0:58:20	0,1196791
0:46:24	0,0743801	0:49:24	0,0855175	0:52:24	0,0908507	0:55:24	0,1088772	0:58:24	0,1201231
0:46:28	0,0748554	0:49:28	0,0855621	0:52:28	0,0911927	0:55:28	0,1089652	0:58:28	0,1205671
0:46:32	0,0753306	0:49:32	0,0856066	0:52:32	0,0915346	0:55:32	0,1090533	0:58:32	0,1210111
0:46:36	0,0758058	0:49:36	0,0856511	0:52:36	0,0918766	0:55:36	0,1091413	0:58:36	0,1214551
0:46:40	0,0762810	0:49:40	0,0856957	0:52:40	0,0922185	0:55:40	0,1092293	0:58:40	0,1218991
0:46:44	0,0767562	0:49:44	0,0857402	0:52:44	0,0925605	0:55:44	0,1093174	0:58:44	0,1223431
0:46:48	0,0772314	0:49:48	0,0857847	0:52:48	0,0929024	0:55:48	0,1094054	0:58:48	0,1227871
0:46:52	0,0777066	0:49:52	0,0858293	0:52:52	0,0932444	0:55:52	0,1094934	0:58:52	0,1232310
0:46:56	0,0781818	0:49:56	0,0858738	0:52:56	0,0935863	0:55:56	0,1095814	0:58:56	0,1236750
0:47:00	0,0786570	0:50:00	0,0859184	0:53:00	0,0939057	0:56:00	0,1096695	0:59:00	0,1241190
0:47:04	0,0786757	0:50:04	0,0863328	0:53:04	0,0941398	0:56:04	0,1098885	0:59:04	0,1243512
0:47:08	0,0786945	0:50:08	0,0867472	0:53:08	0,0943738	0:56:08	0,1101076	0:59:08	0,1245834
0:47:12	0,0787132	0:50:12	0,0871616	0:53:12	0,0946079	0:56:12	0,1103267	0:59:12	0,1248156
0:47:16	0,0787320	0:50:16	0,0875760	0:53:16	0,0948420	0:56:16	0,1105457	0:59:16	0,1250478
0:47:20	0,0787507	0:50:20	0,0879904	0:53:20	0,0950760	0:56:20	0,1107648	0:59:20	0,1252800
0:47:24	0,0787695	0:50:24	0,0884048	0:53:24	0,0953101	0:56:24	0,1109839	0:59:24	0,1255122
0:47:28	0,0787882	0:50:28	0,0888192	0:53:28	0,0955441	0:56:28	0,1112029	0:59:28	0,1257444
0:47:32	0,0788070	0:50:32	0,0892336	0:53:32	0,0957782	0:56:32	0,1114220	0:59:32	0,1259766
0:47:36	0,0788257	0:50:36	0,0896480	0:53:36	0,0960123	0:56:36	0,1116411	0:59:36	0,1262088
0:47:40	0,0788445	0:50:40	0,0900625	0:53:40	0,0962463	0:56:40	0,1118601	0:59:40	0,1264410
0:47:44	0,0788632	0:50:44	0,0904769	0:53:44	0,0964804	0:56:44	0,1120792	0:59:44	0,1266732
0:47:48	0,0788820	0:50:48	0,0908913	0:53:48	0,0967145	0:56:48	0,1122983	0:59:48	0,1269054
0:47:52	0,0789007	0:50:52	0,0913057	0:53:52	0,0969485	0:56:52	0,1125173	0:59:52	0,1271376
0:47:56	0,0789195	0:50:56	0,0917201	0:53:56	0,0971826	0:56:56	0,1127364	0:59:56	0,1273698

Only the data for the first hour are shown here. See Figure 5.3.3 (column C) in the attached excel sheet in “PNNL-22010 Rev.2” for all the data available at https://energystorage.pnnl.gov/pdf/PNNL-22010Rev2.pdf. For the remainder part of the above listed period, the figures should be normalized by the peak value of the whole period. The polarity has to be changed in accordance with IEC 62933-2-1.

Table A.9 – Numerical data of Figure 20 (duty cycle without fluctuation reduction of renewable energy sources (power) or frequency control)

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:00:00	-0,1096442	0:03:00	0,3189189	0:06:00	0,3223203	0:09:00	0,3257217	0:12:00	0,3291232
0:00:04	-0,1045955	0:03:04	0,3189945	0:06:04	0,3223959	0:09:04	0,3257973	0:12:04	0,3291987
0:00:08	-0,0995468	0:03:08	0,3190701	0:06:08	0,3224715	0:09:08	0,3258729	0:12:08	0,3292743
0:00:12	0,2619758	0:03:12	0,3191457	0:06:12	0,3225471	0:09:12	0,3259485	0:12:12	0,3293499
0:00:16	0,2670245	0:03:16	0,3192213	0:06:16	0,3226227	0:09:16	0,3260241	0:12:16	0,3294255
0:00:20	0,2720732	0:03:20	0,3192968	0:06:20	0,3226983	0:09:20	0,3260997	0:12:20	0,3295011
0:00:24	0,2771219	0:03:24	0,3193724	0:06:24	0,3227739	0:09:24	0,3261753	0:12:24	0,3295767
0:00:28	0,2821706	0:03:28	0,319448	0:06:28	0,3228494	0:09:28	0,3262509	0:12:28	0,3296523
0:00:32	0,2872193	0:03:32	0,3195236	0:06:32	0,322925	0:09:32	0,3263264	0:12:32	0,3297279
0:00:36	0,292268	0:03:36	0,3195992	0:06:36	0,3230006	0:09:36	0,326402	0:12:36	0,3298034
0:00:40	0,2973167	0:03:40	0,3196748	0:06:40	0,3230762	0:09:40	0,3264776	0:12:40	0,329879
0:00:44	0,3023654	0:03:44	0,3197504	0:06:44	0,3231518	0:09:44	0,3265532	0:12:44	0,3299546
0:00:48	0,3074141	0:03:48	0,319826	0:06:48	0,3232274	0:09:48	0,3266288	0:12:48	0,3300302
0:00:52	0,3124628	0:03:52	0,3199015	0:06:52	0,323303	0:09:52	0,3267044	0:12:52	0,3301058
0:00:56	0,3165757	0:03:56	0,3199771	0:06:56	0,3233785	0:09:56	0,32678	0:12:56	0,3301814
0:01:00	-0,0398226	0:04:00	0,3200527	0:07:00	0,3234541	0:10:00	0,3268556	0:13:00	0,330257
0:01:04	-0,039747	0:04:04	0,3201283	0:07:04	0,3235297	0:10:04	0,3269311	0:13:04	0,3303326
0:01:08	-0,0396715	0:04:08	0,3202039	0:07:08	0,3236053	0:10:08	0,3270067	0:13:08	0,3304081
0:01:12	-0,0395959	0:04:12	0,3202795	0:07:12	0,3236809	0:10:12	0,3270823	0:13:12	0,3304837
0:01:16	-0,0395203	0:04:16	0,3203551	0:07:16	0,3237565	0:10:16	0,3271579	0:13:16	0,3305593
0:01:20	-0,0394447	0:04:20	0,3204307	0:07:20	0,3238321	0:10:20	0,3272335	0:13:20	0,3306349
0:01:24	-0,0393691	0:04:24	0,3205062	0:07:24	0,3239077	0:10:24	0,3273091	0:13:24	0,3307105
0:01:28	-0,0392935	0:04:28	0,3205818	0:07:28	0,3239832	0:10:28	0,3273847	0:13:28	0,3307861
0:01:32	-0,0392179	0:04:32	0,3206574	0:07:32	0,3240588	0:10:32	0,3274602	0:13:32	0,3308617
0:01:36	0,3173316	0:04:36	0,320733	0:07:36	0,3241344	0:10:36	0,3275358	0:13:36	0,3309373
0:01:40	0,3174072	0:04:40	0,3208086	0:07:40	0,32421	0:10:40	0,3276114	0:13:40	0,3310128
0:01:44	0,3174828	0:04:44	0,3208842	0:07:44	0,3242856	0:10:44	0,327687	0:13:44	0,3310884
0:01:48	0,3175583	0:04:48	0,3209598	0:07:48	0,3243612	0:10:48	0,3277626	0:13:48	0,331164
0:01:52	0,3176339	0:04:52	0,3210354	0:07:52	0,3244368	0:10:52	0,3278382	0:13:52	0,3312396
0:01:56	0,3177095	0:04:56	0,3211109	0:07:56	0,3245124	0:10:56	0,3279138	0:13:56	0,3313152
0:02:00	0,3177851	0:05:00	0,3211865	0:08:00	0,3245879	0:11:00	0,3279894	0:14:00	0,3313908
0:02:04	0,3178607	0:05:04	0,3212621	0:08:04	0,3246635	0:11:04	0,3280649	0:14:04	0,3314664
0:02:08	0,3179363	0:05:08	0,3213377	0:08:08	0,3247391	0:11:08	0,3281405	0:14:08	0,3315419
0:02:12	0,3180119	0:05:12	0,3214133	0:08:12	0,3248147	0:11:12	0,3282161	0:14:12	0,3316175
0:02:16	0,3180875	0:05:16	0,3214889	0:08:16	0,3248903	0:11:16	0,3282917	0:14:16	0,3316931
0:02:20	0,318163	0:05:20	0,3215645	0:08:20	0,3249659	0:11:20	0,3283673	0:14:20	0,3317687
0:02:24	0,3182386	0:05:24	0,32164	0:08:24	0,3250415	0:11:24	0,3284429	0:14:24	0,3318443
0:02:28	0,3183142	0:05:28	0,3217156	0:08:28	0,325117	0:11:28	0,3285185	0:14:28	0,3319199
0:02:32	0,3183898	0:05:32	0,3217912	0:08:32	0,3251926	0:11:32	0,3285941	0:14:32	0,3319955
0:02:36	0,3184654	0:05:36	0,3218668	0:08:36	0,3252682	0:11:36	0,3286696	0:14:36	0,3320711
0:02:40	0,318541	0:05:40	0,3219424	0:08:40	0,3253438	0:11:40	0,3287452	0:14:40	0,3321466
0:02:44	0,3186166	0:05:44	0,322018	0:08:44	0,3254194	0:11:44	0,3288208	0:14:44	0,3322222
0:02:48	0,3186922	0:05:48	0,3220936	0:08:48	0,325495	0:11:48	0,3288964	0:14:48	0,3322978
0:02:52	0,3187677	0:05:52	0,3221692	0:08:52	0,3255706	0:11:52	0,328972	0:14:52	0,3323734
0:02:56	0,3188433	0:05:56	0,3222447	0:08:56	0,3256462	0:11:56	0,3290476	0:14:56	0,332449

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:15:00	0,6889985	0:18:00	0,335926	0:21:00	0,3393274	0:24:00	0,3427288	0:27:00	0,3461546
0:15:04	0,6890741	0:18:04	0,3360016	0:21:04	0,339403	0:24:04	0,3428044	0:27:04	0,3462577
0:15:08	0,6891497	0:18:08	0,3360772	0:21:08	0,3394786	0:24:08	0,34288	0:27:08	0,3463609
0:15:12	0,3327513	0:18:12	0,3361528	0:21:12	0,3395542	0:24:12	0,3429556	0:27:12	0,346464
0:15:16	0,3328269	0:18:16	0,3362283	0:21:16	0,3396298	0:24:16	0,3430312	0:27:16	0,3465671
0:15:20	0,3329025	0:18:20	0,3363039	0:21:20	0,3397053	0:24:20	0,3431068	0:27:20	0,3466702
0:15:24	0,3329781	0:18:24	0,3363795	0:21:24	0,3397809	0:24:24	0,3431823	0:27:24	0,3467734
0:15:28	0,3330537	0:18:28	0,3364551	0:21:28	0,3398565	0:24:28	0,3432579	0:27:28	0,3468765
0:15:32	0,3331293	0:18:32	0,3365307	0:21:32	0,3399321	0:24:32	0,3433335	0:27:32	0,3469796
0:15:36	0,3332049	0:18:36	0,3366063	0:21:36	0,3400077	0:24:36	0,3434091	0:27:36	0,3470828
0:15:40	0,3332804	0:18:40	0,3366819	0:21:40	0,3400833	0:24:40	0,3434847	0:27:40	0,3471859
0:15:44	0,333356	0:18:44	0,3367575	0:21:44	0,3401589	0:24:44	0,3435603	0:27:44	0,347289
0:15:48	0,3334316	0:18:48	0,336833	0:21:48	0,3402345	0:24:48	0,3436359	0:27:48	0,3473921
0:15:52	0,3335072	0:18:52	0,3369086	0:21:52	0,34031	0:24:52	0,3437115	0:27:52	0,3474953
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0:16:00	0,3336584	0:19:00	0,3370598	0:22:00	0,3404612	0:25:00	0,3438626	0:28:00	0,3477015
0:16:04	0,333734	0:19:04	0,3371354	0:22:04	0,3405368	0:25:04	0,3439382	0:28:04	0,3478046
0:16:08	0,3338096	0:19:08	0,337211	0:22:08	0,3406124	0:25:08	0,3440138	0:28:08	0,3479078
0:16:12	0,3338851	0:19:12	0,3372866	0:22:12	0,340688	0:25:12	0,3440894	0:28:12	0,3480109
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0:16:20	0,3340363	0:19:20	0,3374377	0:22:20	0,3408392	0:25:20	0,3442406	0:28:20	0,3482172
0:16:24	0,3341119	0:19:24	0,3375133	0:22:24	0,3409147	0:25:24	0,3443162	0:28:24	0,3483203
0:16:28	0,3341875	0:19:28	0,3375889	0:22:28	0,3409903	0:25:28	0,3443917	0:28:28	0,3484234
0:16:32	0,3342631	0:19:32	0,3376645	0:22:32	0,3410659	0:25:32	0,3444673	0:28:32	0,3485265
0:16:36	0,3343387	0:19:36	0,3377401	0:22:36	0,3411415	0:25:36	0,3445429	0:28:36	0,3486297
0:16:40	0,3344143	0:19:40	0,3378157	0:22:40	0,3412171	0:25:40	0,3446185	0:28:40	0,3487328
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0:16:48	0,3345654	0:19:48	0,3379668	0:22:48	0,3413683	0:25:48	0,3447697	0:28:48	0,3489391
0:16:52	0,334641	0:19:52	0,3380424	0:22:52	0,3414438	0:25:52	0,3448453	0:28:52	0,3490422
0:16:56	0,3347166	0:19:56	0,338118	0:22:56	0,3415194	0:25:56	0,3449209	0:28:56	0,3491453
0:17:00	0,3347922	0:20:00	0,3381936	0:23:00	0,341595	0:26:00	0,3449964	0:29:00	0,3492484
0:17:04	0,3348678	0:20:04	0,3382692	0:23:04	0,3416706	0:26:04	0,345072	0:29:04	0,3493516
0:17:08	0,3349434	0:20:08	0,3383448	0:23:08	0,3417462	0:26:08	0,3451476	0:29:08	0,3494547
0:17:12	0,335019	0:20:12	0,3384204	0:23:12	0,3418218	0:26:12	0,3452232	0:29:12	0,3495578
0:17:16	0,3350945	0:20:16	0,338496	0:23:16	0,3418974	0:26:16	0,3452988	0:29:16	0,349661
0:17:20	0,3351701	0:20:20	0,3385715	0:23:20	0,341973	0:26:20	0,3453744	0:29:20	0,3497641
0:17:24	0,3352457	0:20:24	0,3386471	0:23:24	0,3420485	0:26:24	0,34545	0:29:24	0,3498672
0:17:28	0,3353213	0:20:28	0,3387227	0:23:28	0,3421241	0:26:28	0,3455255	0:29:28	0,3499703
0:17:32	0,3353969	0:20:32	0,3387983	0:23:32	0,3421997	0:26:32	0,3456011	0:29:32	0,3500735
0:17:36	0,3354725	0:20:36	0,3388739	0:23:36	0,3422753	0:26:36	0,3456767	0:29:36	0,3501766
0:17:40	0,3355481	0:20:40	0,3389495	0:23:40	0,3423509	0:26:40	0,3457523	0:29:40	0,3502797
0:17:44	0,3356236	0:20:44	0,3390251	0:23:44	0,3424265	0:26:44	0,3458279	0:29:44	0,3503828
0:17:48	0,3356992	0:20:48	0,3391006	0:23:48	0,3425021	0:26:48	0,3459035	0:29:48	0,350486
0:17:52	0,3357748	0:20:52	0,3391762	0:23:52	0,3425777	0:26:52	0,3459791	0:29:52	0,3505891
0:17:56	0,3358504	0:20:56	0,3392518	0:23:56	0,3426532	0:26:56	0,3460547	0:29:56	0,3506922

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:30:00	-0,0056786	0:33:00	0,3554361	0:36:00	0,3600769	0:39:00	0,3647176	0:42:00	0,3693584
0:30:04	-0,0055754	0:33:04	0,3555392	0:36:04	0,36018	0:39:04	0,3648208	0:42:04	0,3694615
0:30:08	-0,0054723	0:33:08	0,3556424	0:36:08	0,3602831	0:39:08	0,3649239	0:42:08	0,3695646
0:30:12	0,3511047	0:33:12	0,3557455	0:36:12	0,3603863	0:39:12	0,365027	0:42:12	0,3696678
0:30:16	0,3512079	0:33:16	0,3558486	0:36:16	0,3604894	0:39:16	0,3651301	0:42:16	0,3697709
0:30:20	0,351311	0:33:20	0,3559518	0:36:20	0,3605925	0:39:20	0,3652333	0:42:20	0,369874
0:30:24	0,3514141	0:33:24	0,3560549	0:36:24	0,3606956	0:39:24	0,3653364	0:42:24	0,3699771
0:30:28	0,3515173	0:33:28	0,356158	0:36:28	0,3607988	0:39:28	0,3654395	0:42:28	0,3700803
0:30:32	0,3516204	0:33:32	0,3562611	0:36:32	0,3609019	0:39:32	0,3655426	0:42:32	0,3701834
0:30:36	0,3517235	0:33:36	0,3563643	0:36:36	0,361005	0:39:36	0,3656458	0:42:36	0,3702865
0:30:40	0,3518266	0:33:40	0,3564674	0:36:40	0,3611081	0:39:40	0,3657489	0:42:40	0,3703897
0:30:44	0,3519298	0:33:44	0,3565705	0:36:44	0,3612113	0:39:44	0,365852	0:42:44	0,3704928
0:30:48	0,3520329	0:33:48	0,3566736	0:36:48	0,3613144	0:39:48	0,3659552	0:42:48	0,3705959
0:30:52	0,352136	0:33:52	0,3567768	0:36:52	0,3614175	0:39:52	0,3660583	0:42:52	0,370699
0:30:56	0,3522391	0:33:56	0,3568799	0:36:56	0,3615207	0:39:56	0,3661614	0:42:56	0,3708022
0:31:00	0,3523423	0:34:00	0,356983	0:37:00	0,3616238	0:40:00	0,3662645	0:43:00	0,3709053
0:31:04	0,3524454	0:34:04	0,3570862	0:37:04	0,3617269	0:40:04	0,3663677	0:43:04	0,3710084
0:31:08	0,3525485	0:34:08	0,3571893	0:37:08	0,36183	0:40:08	0,3664708	0:43:08	0,3711116
0:31:12	0,3526517	0:34:12	0,3572924	0:37:12	0,3619332	0:40:12	0,3665739	0:43:12	0,3712147
0:31:16	0,3527548	0:34:16	0,3573955	0:37:16	0,3620363	0:40:16	0,3666771	0:43:16	0,3713178
0:31:20	0,3528579	0:34:20	0,3574987	0:37:20	0,3621394	0:40:20	0,3667802	0:43:20	0,3714209
0:31:24	0,352961	0:34:24	0,3576018	0:37:24	0,3622426	0:40:24	0,3668833	0:43:24	0,3715241
0:31:28	0,3530642	0:34:28	0,3577049	0:37:28	0,3623457	0:40:28	0,3669864	0:43:28	0,3716272
0:31:32	0,3531673	0:34:32	0,3578081	0:37:32	0,3624488	0:40:32	0,3670896	0:43:32	0,3717303
0:31:36	0,3532704	0:34:36	0,3579112	0:37:36	0,3625519	0:40:36	0,3671927	0:43:36	0,3718334
0:31:40	0,3533736	0:34:40	0,3580143	0:37:40	0,3626551	0:40:40	0,3672958	0:43:40	0,3719366
0:31:44	0,3534767	0:34:44	0,3581174	0:37:44	0,3627582	0:40:44	0,3673989	0:43:44	0,3720397
0:31:48	0,3535798	0:34:48	0,3582206	0:37:48	0,3628613	0:40:48	0,3675021	0:43:48	0,3721428
0:31:52	0,3536829	0:34:52	0,3583237	0:37:52	0,3629644	0:40:52	0,3676052	0:43:52	0,372246
0:31:56	0,3537861	0:34:56	0,3584268	0:37:56	0,3630676	0:40:56	0,3677083	0:43:56	0,3723491
0:32:00	0,3538892	0:35:00	0,3585299	0:38:00	0,3631707	0:41:00	0,3678115	0:44:00	0,3724522
0:32:04	0,3539923	0:35:04	0,3586331	0:38:04	0,3632738	0:41:04	0,3679146	0:44:04	0,3725553
0:32:08	0,3540955	0:35:08	0,3587362	0:38:08	0,363377	0:41:08	0,3680177	0:44:08	0,3726585
0:32:12	0,3541986	0:35:12	0,3588393	0:38:12	0,3634801	0:41:12	0,3681208	0:44:12	0,3727616
0:32:16	0,3543017	0:35:16	0,3589425	0:38:16	0,3635832	0:41:16	0,368224	0:44:16	0,3728647
0:32:20	0,3544048	0:35:20	0,3590456	0:38:20	0,3636863	0:41:20	0,3683271	0:44:20	0,3729679
0:32:24	0,354508	0:35:24	0,3591487	0:38:24	0,3637895	0:41:24	0,3684302	0:44:24	0,373071
0:32:28	0,3546111	0:35:28	0,3592518	0:38:28	0,3638926	0:41:28	0,3685334	0:44:28	0,3731741
0:32:32	0,3547142	0:35:32	0,359355	0:38:32	0,3639957	0:41:32	0,3686365	0:44:32	0,3732772
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0:32:40	0,3549205	0:35:40	0,3595612	0:38:40	0,364202	0:41:40	0,3688427	0:44:40	0,3734835
0:32:44	0,3550236	0:35:44	0,3596644	0:38:44	0,3643051	0:41:44	0,3689459	0:44:44	0,3735866
0:32:48	0,3551267	0:35:48	0,3597675	0:38:48	0,3644082	0:41:48	0,369049	0:44:48	0,3736897
0:32:52	0,3552299	0:35:52	0,3598706	0:38:52	0,3645114	0:41:52	0,3691521	0:44:52	0,3737929
0:32:56	0,355333	0:35:56	0,3599737	0:38:56	0,3646145	0:41:56	0,3692553	0:44:56	0,373896

Time	Signal	Time	Signal	Time	Signal	Time	Signal	Time	Signal
0:45:00	0,7304731	0:48:00	0,3786399	0:51:00	0,3832806	0:54:00	0,3872875	0:57:00	0,3901213
0:45:04	0,7305762	0:48:04	0,378743	0:51:04	0,3833838	0:54:04	0,3873504	0:57:04	0,3901843
0:45:08	0,7306793	0:48:08	0,3788461	0:51:08	0,3834869	0:54:08	0,3874134	0:57:08	0,3902473
0:45:12	0,3743085	0:48:12	0,3789493	0:51:12	0,38359	0:54:12	0,3874764	0:57:12	0,3903103
0:45:16	0,3744116	0:48:16	0,3790524	0:51:16	0,3836932	0:54:16	0,3875394	0:57:16	0,3903732
0:45:20	0,3745148	0:48:20	0,3791555	0:51:20	0,3837963	0:54:20	0,3876023	0:57:20	0,3904362
0:45:24	0,3746179	0:48:24	0,3792587	0:51:24	0,3838994	0:54:24	0,3876653	0:57:24	0,3904992
0:45:28	0,374721	0:48:28	0,3793618	0:51:28	0,3840025	0:54:28	0,3877283	0:57:28	0,3905622
0:45:32	0,3748242	0:48:32	0,3794649	0:51:32	0,3841057	0:54:32	0,3877913	0:57:32	0,3906251
0:45:36	0,3749273	0:48:36	0,379568	0:51:36	0,3842088	0:54:36	0,3878542	0:57:36	0,3906881
0:45:40	0,3750304	0:48:40	0,3796712	0:51:40	0,3843119	0:54:40	0,3879172	0:57:40	0,3907511
0:45:44	0,3751335	0:48:44	0,3797743	0:51:44	0,3844151	0:54:44	0,3879802	0:57:44	0,3908141
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0:45:52	0,3753398	0:48:52	0,3799806	0:51:52	0,3846213	0:54:52	0,3881061	0:57:52	0,39094
0:45:56	0,3754429	0:48:56	0,3800837	0:51:56	0,3847244	0:54:56	0,3881691	0:57:56	0,391003
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0:46:04	0,3756492	0:49:04	0,3802899	0:52:04	0,3849307	0:55:04	0,3882951	0:58:04	0,3911289
0:46:08	0,3757523	0:49:08	0,3803931	0:52:08	0,3850338	0:55:08	0,388358	0:58:08	0,3911919
0:46:12	0,3758554	0:49:12	0,3804962	0:52:12	0,3851369	0:55:12	0,388421	0:58:12	0,3912549
0:46:16	0,3759586	0:49:16	0,3805993	0:52:16	0,3852401	0:55:16	0,388484	0:58:16	0,3913179
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0:46:40	0,3765773	0:49:40	0,3812181	0:52:40	0,3858588	0:55:40	0,3888618	0:58:40	0,3916957
0:46:44	0,3766805	0:49:44	0,3813212	0:52:44	0,385962	0:55:44	0,3889248	0:58:44	0,3917587
0:46:48	0,3767836	0:49:48	0,3814243	0:52:48	0,3860651	0:55:48	0,3889878	0:58:48	0,3918217
0:46:52	0,3768867	0:49:52	0,3815275	0:52:52	0,3861682	0:55:52	0,3890508	0:58:52	0,3918846
0:46:56	0,3769898	0:49:56	0,3816306	0:52:56	0,3862714	0:55:56	0,3891137	0:58:56	0,3919476
0:47:00	0,377093	0:50:00	0,3817337	0:53:00	0,3863429	0:56:00	0,3891767	0:59:00	0,3920106
0:47:04	0,3771961	0:50:04	0,3818369	0:53:04	0,3864058	0:56:04	0,3892397	0:59:04	0,3920736
0:47:08	0,3772992	0:50:08	0,38194	0:53:08	0,3864688	0:56:08	0,3893027	0:59:08	0,3921365
0:47:12	0,3774024	0:50:12	0,3820431	0:53:12	0,3865318	0:56:12	0,3893656	0:59:12	0,3921995
0:47:16	0,3775055	0:50:16	0,3821462	0:53:16	0,3865947	0:56:16	0,3894286	0:59:16	0,3922625
0:47:20	0,3776086	0:50:20	0,3822494	0:53:20	0,3866577	0:56:20	0,3894916	0:59:20	0,3923255
0:47:24	0,3777117	0:50:24	0,3823525	0:53:24	0,3867207	0:56:24	0,3895546	0:59:24	0,3923884
0:47:28	0,3778149	0:50:28	0,3824556	0:53:28	0,3867837	0:56:28	0,3896175	0:59:28	0,3924514
0:47:32	0,377918	0:50:32	0,3825587	0:53:32	0,3868466	0:56:32	0,3896805	0:59:32	0,3925144
0:47:36	0,3780211	0:50:36	0,3826619	0:53:36	0,3869096	0:56:36	0,3897435	0:59:36	0,3925774
0:47:40	0,3781242	0:50:40	0,382765	0:53:40	0,3869726	0:56:40	0,3898065	0:59:40	0,3926403
0:47:44	0,3782274	0:50:44	0,3828681	0:53:44	0,3870356	0:56:44	0,3898694	0:59:44	0,3927033
0:47:48	0,3783305	0:50:48	0,3829713	0:53:48	0,3870985	0:56:48	0,3899324	0:59:48	0,3927663
0:47:52	0,3784336	0:50:52	0,3830744	0:53:52	0,3871615	0:56:52	0,3899954	0:59:52	0,3928293
0:47:56	0,3785368	0:50:56	0,3831775	0:53:56	0,3872245	0:56:56	0,3900584	0:59:56	0,3928922

Only the data for the first hour are shown here. See Figure 5.3.3 (column E) in the attached excel sheet in “PNNL-22010 Rev.2” for all the data available at https://energystorage.pnnl.gov/pdf/PNNL-22010Rev2.pdf. For the remainder part of the above listed period, the figures should be normalized by the peak value of the whole period. The polarity has to be changed in accordance with IEC 62933-2-1.

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