NRC·CNRC

Data Provision Guidelines

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1 System Data Requirements

Data providers are expected to collect raw data from their energy system, and sent it to a NRC operated file transfer server. An example of an energy system is shown in the diagram below for reference:

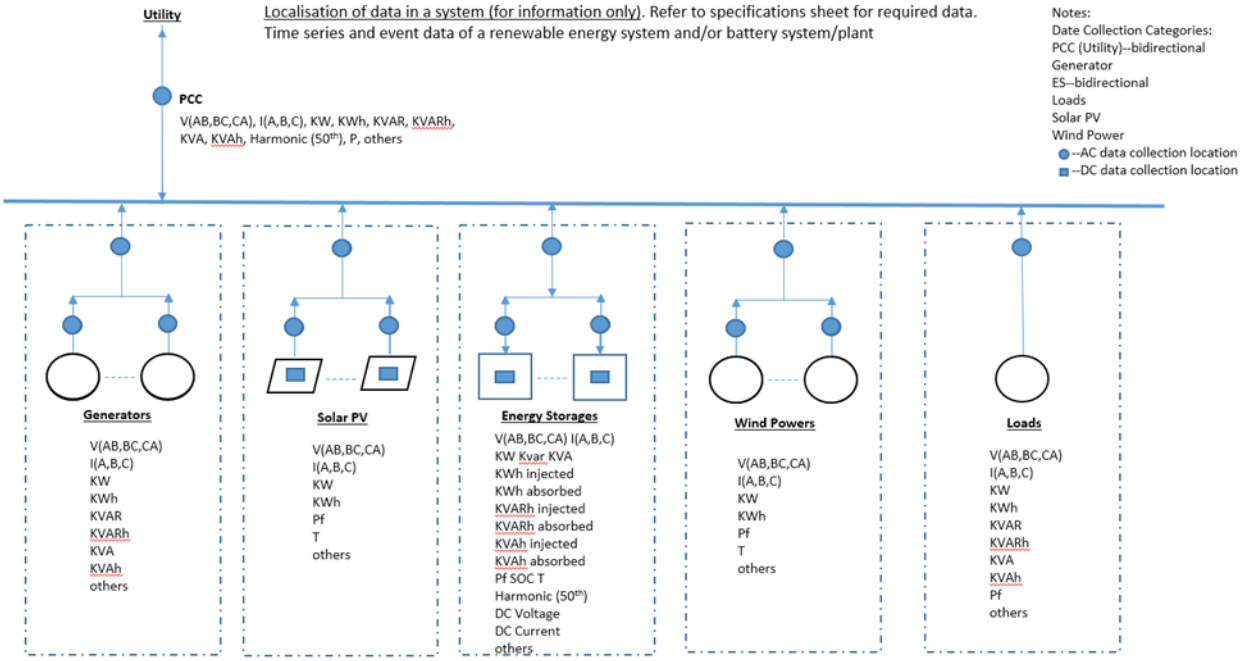


Figure 1 – Simplified Single Line Diagram showing potential data sets and connection points.

It is understood that actual energy systems would have different configuration that the one represented in figure 1. For example, the energy storage systems might not connect to the AC bus, but to a DC bus common with PV panels. The energy system might be single phase, rather than poly-phase.

When the energy system comprises multiple devices of the same type, it is expected that the data of each device be sent to the file transfer server. For example, if the energy system comprises multiple wind turbines, the raw data for each wind turbine shall be sent to the file transfer server.

1.1 Type of data

A non-exhaustive list of raw data is provided in the Microsoft Excel workbook attached to the Invitation to Qualify document. The raw data are composed of:

- **Time series data**: these raw data are composed of data measured at each device. They shall be sampled at a high rate with a preferred rate of 60-samples/minute. These data shall be sent at a preferred rate of once per day to the file transfer server.
- **Static data:** these raw data are composed of equipment specifications and operational parameters. These data shall be sent to the file transfer server at the initiation of the data transfer and when device or parameters have changed.

- **Setting data**: these raw data are composed of settings defining the operational boundaries for each device. These data shall be sent to the file transfer server at the initiation of the data transfer and when the settings have changed.
- **Event data:** these raw data are composed of time stamped texts describing events that occurred to any device of the energy system. These data shall be sent at least once a month to the file transfer server.
- **Cost data:** these raw data include the financial costs related to capital, operation, permitting related to the energy system. These data shall be sent to the file transfer server at the initiation of the data transfer and when the settings have changed.

1.2 Data File Format

- **Time series data:** see example below
- **Static data:** unspecified, data can be send using text, office, and/or portable document format
- **Setting data:** use same format as time series data
- **Event data:** see example below
- **Cost data:** unspecified, data can be send using text, office, and/or portable document format

1.3 Time Series Data Example

In order to provide details of the expected data, imagine an example energy system connected to the grid is composed of two wind turbines, 3 solar Photovoltaic panel arrays, and 1 Energy Storage System. In the following example, it is expected that the identifiers are provided by the data providers, following the nomenclature outlined above, and as shown for the example in the table below.

Description	Unique identifier
Company identifier	ABC-corp
Energy System identifier	ES-001
Wind turbine 1	WIND-001
Wind turbine 2	WIND-002
PV array 1	PV-001
PV array 2	PV-002
PV array 3	PV-003
ESS 1	ESS-001

Table 1 –System device Identifiers for the example Energy System

Time series data can be stored in one single file or on separate files for each device. A time stamp referenced to UTC using ISO 8601 format must be appended to the filename for tracking purposes as shown below:

- **Local time in Vancouver, BC:** *2021-08-10 15:05:23 -> UTC time: 2021-08-10 22:05:23*
- **Example of single file name:** *ABC-corp_ES-001_data_2021-08-10_T22-05-23Z.csv*
- **Example of separate files for each device:** *ABC-corp_ES-001_ WIND-001_data_2020-07-14_T22-05-23Z.csv*

The data stored in the file should use comma separated values (csv) file structure. The first row of the file should contain the name of the signal recorded. Each following rows should contain the timestamp in UTC reference and the recorded data.

In case of missing or erroneous data, nothing should be written for that particular signal at that particular time.

The name of the signal recorded should be composed of the company identifier, energy system identifier, device identifier, signal identifier[1], and unit of the signal.

For example, the measured current of the phase A of the wind turbine 1 would have the following header name: *ABC-corp_ES-001_WIND-001_AphA_A*

An example of headers (first row of the provided CSV file) for the Wind Turbine 1 is provided in the table below. See attached *ABC-corp_ES-001_ WIND-001_2020-07-14_T22-05-23Z.csv* file for additional examples of the expected data set.

Description	Identifier	Unit	Column header
Current phase A	AphA	A	ABC-corp_ES-001_WIND-001_AphA_A
Current phase B	AphB	A	ABC-corp_ES-001_WIND-001_AphB_A
Current phase C	AphC	A	ABC-corp_ES-001_WIND-001_AphC_A
Phase voltage AN	VphA	V	ABC-corp_ES-001_WIND-001_VphA_V
Phase voltage BN	VphB	V	ABC-corp_ES-001_WIND-001_VphB_V
Phase voltage CN	VphC	V	ABC-corp_ES-001_WIND-001_VphC_V
Phase voltage AB	VphAB	V	ABC-corp_ES-001_WIND-001_VphAB_V
Phase voltage BC	VphBC	V	ABC-corp_ES-001_WIND-001_VphBC_V
Phase voltage CA	VphCA	V	ABC-corp_ES-001_WIND-001_VphCA_V
Active power	W	W	ABC-corp_ES-001_WIND-001_W_W
Reactive power	Var	VAr	ABC-corp_ES-001_WIND-001_Var_VAr
Apparent power	VA	VA	ABC-corp_ES-001_WIND-001_VA_VA
Total active energy injected	TotWhInj	Wh	ABC-corp_ES-001_WIND-001_TotWhInj_Wh
Total active energy absorbed	TotWhAbs	Wh	ABC-corp_ES-001_WIND-001_TotWhAbs_Wh
Total reactive energy injected	TotVarhInj	VArh	ABC-corp_ES-001_WIND-001_TotVarhInj_VArh
Total reactive energy absorbed	TotVarhAbs	VArh	ABC-corp_ES-001_WIND-001_TotVarhAbs_VArh
Frequency	Freq	Hz	ABC-corp_ES-001_WIND-001_Freq_Hz
Power factor	PF	Pf	ABC-corp_ES-001_WIND-001_PF_Pf
Total current harmonics up to 50th	THDc	%	ABC-corp_ES-001_WIND-001_THDc_%

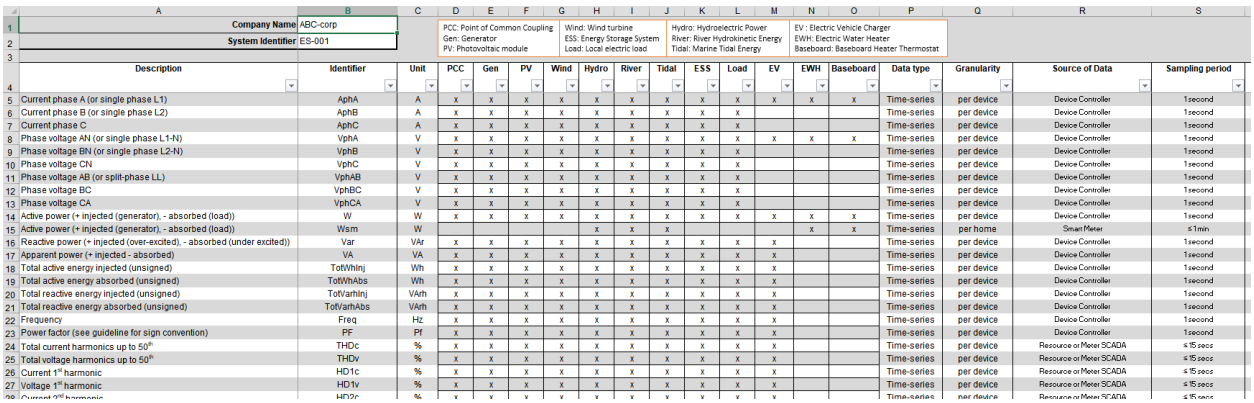
[1] Most of the signal identifiers used are derived from the SunSpec information model (https://sunspec.org)

Total voltage harmonics up to 50th	THDv	%	ABC-corp_ES-001_WIND-001_THDv_%
Current 1st harmonic	HD1c	%	ABC-corp_ES-001_WIND-001_HD1c_%
Current 2nd harmonic	HD2c	%	ABC-corp_ES-001_WIND-001_HD2c_%
Current 3rd harmonic	HD3c	%	ABC-corp_ES-001_WIND-001_HD3c_%
Voltage 1st harmonic	HD1v	%	ABC-corp_ES-001_WIND-001_HD1v_%
Voltage 2nd harmonic	HD2v	%	ABC-corp_ES-001_WIND-001_HD2v_%
Voltage 3rd harmonic	HD3v	%	ABC-corp_ES-001_WIND-001_HD3v_%
Connectivity	CS	BOOL	ABC-corp_ES-001_WIND-001_CS_BOOL
Availability	AVAL	BOOL	ABC-corp_ES-001_WIND-001_AVAL_BOOL
Ambient temperature	TmpAmb	°C	ABC-corp_ES-001_WIND-001_TmpAmb_°C
Wind speed - Ground	Ugrd	m/s	ABC-corp_ES-001_WIND-001_Ugrd_m/s
Wind speed at meas. Height	Uhub	m/s	ABC-corp_ES-001_WIND-001_Uhub_m/s
Wind direction - Ground	WDIRgrd	°	ABC-corp_ES-001_WIND-001_WDIRgrd_°
Wind direction at meas. Height	WDIRhub	°	ABC-corp_ES-001_WIND-001_WDIRhub_°
Temperature at meas. Height	TmpAmbHub	°C	ABC-corp_ES-001_WIND-001_TmpAmbHub_°C
Pressure at meas. Height	PAmbHub	kPa	ABC-corp_ES-001_WIND-001_PAmbHub_kPa
Specific humidity at meas. Height	RHhub	g/kg	ABC-corp_ES-001_WIND-001_RHhub_g/kg
Latitude	Lat	°	ABC-corp_ES-001_WIND-001_Lat_°
Longitude	Long	°	ABC-corp_ES-001_WIND-001_Long_°
Altitude	Alt	m	ABC-corp_ES-001_WIND-001_Alt_m

Table 2 – Some of the headers for data related to a wind turbine

1.4 List of data to be provided

The Microsoft Excel workbook attached to the Invitation to Qualify document provides a list of data to be provided for each energy system in the tab “Data Requested”. The figure below shows only the header and the first few rows of the spreadsheet.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Company Name	ABC-corp		PCC: Point of Common Coupling Gen: Generator PV: Photovoltaic module			Wind: Wind turbine ESS: Energy Storage System Load: Local electric load			Hydro: Hydroelectric Power River: River Hydrokinetic Energy Tidal: Marine Tidal Energy			EV : Electric Vehicle Charger EWH: Electric Water Heater Baseboard: Baseboard Heater Thermostat						
2	System Identifier	ES-001																	
3																			
4	Description	Identifier	Unit	PCC	Gen	PV	Wind	Hydro	River	Tidal	ESS	Load	EV	EWH	Baseboard	Data type	Granularity	Source of Data	Sampling period
5	Current phase A (or single phase L1)	AphA	A	x	x	x	x	x	x	x	x	x	x	x	x	Time-series	per device	Device Controller	1 second
6	Current phase B (or single phase L2)	AphB	A	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
7	Current phase C	AphC	A	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
8	Phase voltage AN (or single phase L1-N)	VphA	V	x	x	x	x	x	x	x	x	x	x	x	x	Time-series	per device	Device Controller	1 second
9	Phase voltage BN (or single phase L2-N)	VphB	V	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
10	Phase voltage CN	VphC	V	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
11	Phase voltage AB (or split-phase LL)	VphAB	V	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
12	Phase voltage BC	VphBC	V	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
13	Phase voltage CA	VphCA	V	x	x	x	x	x	x	x	x	x				Time-series	per device	Device Controller	1 second
14	Active power (+ injected (generator), - absorbed (load))	W	W	x	x	x	x	x	x	x	x	x	x	x	x	Time-series	per device	Device Controller	1 second
15	Active power (+ injected (generator), - absorbed (load))	Wsm	W					x	x	x				x	x	Time-series	per home	Smart Meter	≤ 1 min
16	Reactive power (+ injected (over-excited), - absorbed (under excited))	Var	VAr	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
17	Apparent power (+ injected - absorbed)	VA	VA	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
18	Total active energy injected (unsigned)	TotWhInj	Wh	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
19	Total active energy absorbed (unsigned)	TotWhAbs	Wh	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
20	Total reactive energy injected (unsigned)	TotVarhInj	VArh	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
21	Total reactive energy absorbed (unsigned)	TotVarhAbs	VArh	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
22	Frequency	Freq	Hz	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
23	Power factor (see guideline for sign convention)	PF	Pf	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Device Controller	1 second
24	Total current harmonics up to 50th	THDc	%	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Resource or Meter SCADA	≤ 15 secs
25	Total voltage harmonics up to 50th	THDv	%	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Resource or Meter SCADA	≤ 15 secs
26	Current 1st harmonic	HD1c	%	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Resource or Meter SCADA	≤ 15 secs
27	Voltage 1st harmonic	HD1v	%	x	x	x	x	x	x	x	x	x	x			Time-series	per device	Resource or Meter SCADA	≤ 15 secs

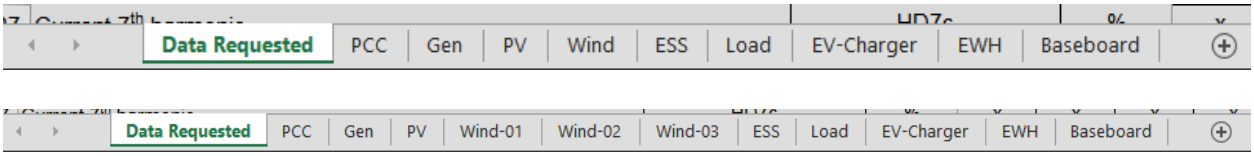
Figure 1: list of data to be provided (first few rows)

The first three columns represent the description, the signal identifier and its unit. The last five columns indicate the type of data, their granularity, their source, the expected sampling period, how frequently they should be uploaded to the file server and how complete the data should be.

The columns D to L can be used to select the respective device of a system and identify the data to be provided for the selected device. The following acronyms are used for these columns:

ACRONYM	DESCRIPTION
PCC	Point of common coupling
Gen	Generator
PV	Photovoltaic module
Wind	Wind turbine
ESS	Energy storage system
Load	Controllable/flexible load
Hydro	Hydroelectric energy
River	River hydrokinetic energy
Tidal	Marine tidal energy
EV	Electric vehicle charger
EWH	Electric water heater
Baseboard	Baseboard heater thermostat

Data providers can use the cells B1 and B2 in the data request tab to enter their respective company name, and energy system identifier. The tabs labelled “PCC”, “Gen”, “PV”, “Wind”, “Load”, “EV-Charger”, “EWH”, and “Baseboard” will automatically generate examples of tabular data file for the corresponding device of the energy system. The first row would contain the headers in the required standard format and the first column will contain the timestamp in the required standard format. When energy systems have several devices of the same type, users can copy the respective tab with a new name in order to generate a tabular file for each device of the same type. For example, if an energy system has 3 wind turbines, data providers can rename the tab “Wind” to “Wind-01”, and copy the tab twice with the names “Wind-02” and “Wind-03”, as described in the figure below:



1.5 Event data example

Using the same system described above, the event data file would follow the same filename format except the suffix event would be used. As an example, if separate files were provided for each device, the event data file name would be as follows: *ABC-corp_ES-001_ WIND-001_event_2021-08-10_T22-05-23Z.csv*

The data stored in the file should use a comma separated values (csv) format. The first row of the file should contain the following:

- **Starttime:** timestamp referenced to UTC of the beginning of the event

- **Endtime:** timestamp referenced to UTC of the end of the event
- **Type of event:** classification of the event
- **Equipment:** identifier of the device or component affected
- **Details:** description of the event
- **File:** the filename related to the event when applicable saved on the file transfer server

An example of an event data file is provided below.

Starttime	Endtime	Type of event	Equipment	Details	File
2021-08-07_T12-43-51Z	2021-08-07_T12-43-54Z	Frequency event	Utility	File	ev308953.csv
2021-08-08_T10-21-11Z	2021-08-08_T10-38-11Z	Request for VAr	Utility		
2021-08-08_T10-21-12Z	2021-08-08_T10-40-00Z	Response to VAr request	Battery1	setpoint at 1000	
2021-08-08_T12-06-17Z	2021-08-08_T13-28-49Z	Outage	Battery1	Unknown	

Table 3 – Sample Event File Contents

2 Value Encoding

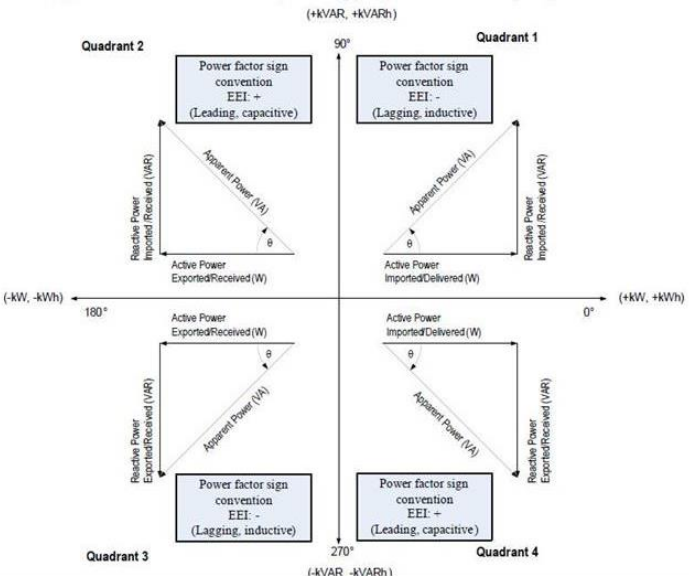
Where possible, the encoding and nomenclature used for data collection is expected to align with that of the SunSpec information model (https://sunspec.org/wp-content/uploads/2021/02/SunSpec-DER-Information-Model-Specification-V1-0-02-01-2021.pdf). Where there are discrepancies between that model and what is outlined in this document, this document will take precedence. For situations which are not addressed in the standard, please contact NRC or NRCan for further details.

2.1 DER Active Power/Reactive Power/Power Factor Value Encoding

For every system, it is important to clearly identify and encode the values related to Active Power, Reactive Power, and Power Factor to ensure consistent monitoring and analysis. Proponents are requested to use encoding compatible with *IEEE P1547 Standard for Interconnecting Distributed Resources with Electric Power Systems*, namely:

Where applicable, the stated technical specifications and requirements are given in generator sign convention which is opposite to load sign convention. In generator sign convention,

- *a DER current lagging voltage provides / injects reactive power to the system (over-excited operation of DER, positive reactive power), and the effect is an increase of the applicable voltage;*
- *a DER current leading voltage consumes / absorbs reactive power from the system (under-excited operation of DER, negative reactive power), and the effect is a decrease of the applicable voltage.*



For additional information regarding encoding of this signals, please refer to the SunSpec reference: https://sunspec.org/wp-content/uploads/2016/08/DERPowerValueEncodingv6.pdf