Quality Assessment Report

1 Technical features - station and instruments

Site name:	**Feni, Bangladesh**
Latitude, longitude [°]:	22.800290, 91.358190
Altitude [m a. s. l.]:	15
Location on a map:	https://apps.solargis.com/prospect
Type:	Ground measurements
Source:	World Bank
URL:	https://energydata.info/dataset/bangladesh-solar-radiation-measurement-data
Attribution:	Data obtained from the “World Bank via ENERGYDATA.info, under a project funded by the Energy Sector Management Assistance Program (ESMAP). For more information: Bangladesh-Solar Radiation Measurement Data
Time step:	5 minutes
Quality assessment status:	T R M I P

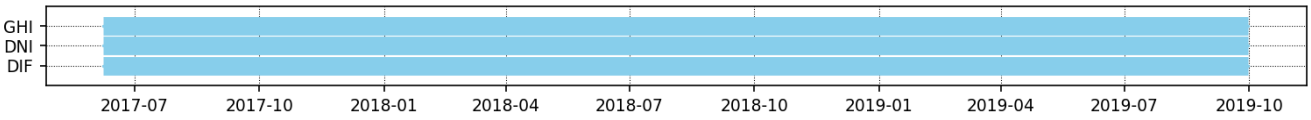

Fig. 1: Data availability for individual parameters

Tab. 1: Instruments installed at the station

Name	Type	Description	Class	Manufacturer	Model	Units	Uncertainty
GHI	GHI	Pyranometer	Class A	Hukseflux	SR30-D1	W/m²	< ± 2.0 % (daily)
DNI	DNI	Pyrheliometer	Class B	Hukseflux	DR01-T1	W/m²	< ± 2.0 % (daily)
DIF	DIF	Pyranometer	Class A	Hukseflux	SR30-D1	W/m²	< ± 2.0 % (daily)

Tab. 2: Test groups

Test group	GHI	DNI	DIF	GTI	RHI	ALB
Group_1	GHI	DNI	DIF	-	-	-

Multi-component tests are applied only for test groups with GHI, DNI, DIF or GTI columns.

2 Results of quality assessment

Prior to the comparison with satellite-based solar resource data, the ground-measured irradiance was quality-assessed by Solargis. Quality assessment (QA) is based on BSRN methods and methods implemented in-house by Solargis. The tests are applied in two runs: (i) first, the automatic tests are run to identify the obvious issues; next (ii) by the visual inspection we identify and flag inconsistencies, which are of more complex nature. Visual inspection is an iterative and time-consuming process.

The automatic QA tests may include:

- Correction of time shifts
- Identification of missing values
- Evaluation of measurements against sun position (Sun below and above horizon)
- Comparing the data with possible minimum and maximum physical limits
- Multi-component tests i.e. evaluation of consistency between solar radiation components (GHI, DNI and DIF) or relevant couples (GHI, RHI, DIF or GTI)
- Detection of outliers and patterns (TEMP)
- Tracker malfunction (DNI and DIF)

Automatic quality assessment can be applied on solar and meteorological data. The data readings not passing one or more QA tests were flagged.

Tab. 3: Availability of data readings for Feni station

	Data availability	
Sun below horizon	119 103	48.9%
Sun above horizon	124 257	51.1%
Total data readings	243 360	100.0%

Tab. 4: Summary of quality assessment results

Type of test	Occurrence of data readings (Sun above horizon)					
	GHI		DNI		DIF	
invalid values	0	0.0%	93	0.1%	87	0.1%
sun below horizon	82	0.1%	82	0.1%	82	0.1%
below minimum physical limit	48	0.0%	0	0.0%	65	0.1%
above maximum physical limit	0	0.0%	0	0.0%	1	0.0%
consistency issue	879	0.7%	879	0.7%	879	0.7%
not specified data issue	11 134	9.0%	9 064	7.3%	11 027	8.9%
Total excluded data readings	12 143	9.8%	10 118	8.1%	12 141	9.8%
Passed data readings	112 114	90.2%	114 139	91.9%	112 116	90.2%
Total data readings	124 257	100.0%	124 257	100.0%	124 257	100.0%

Fig. 2: Overview of quality assessment results for GHI

Fig. 3: Overview of quality assessment results for DNI

Fig. 4: Overview of quality assessment results for DIF

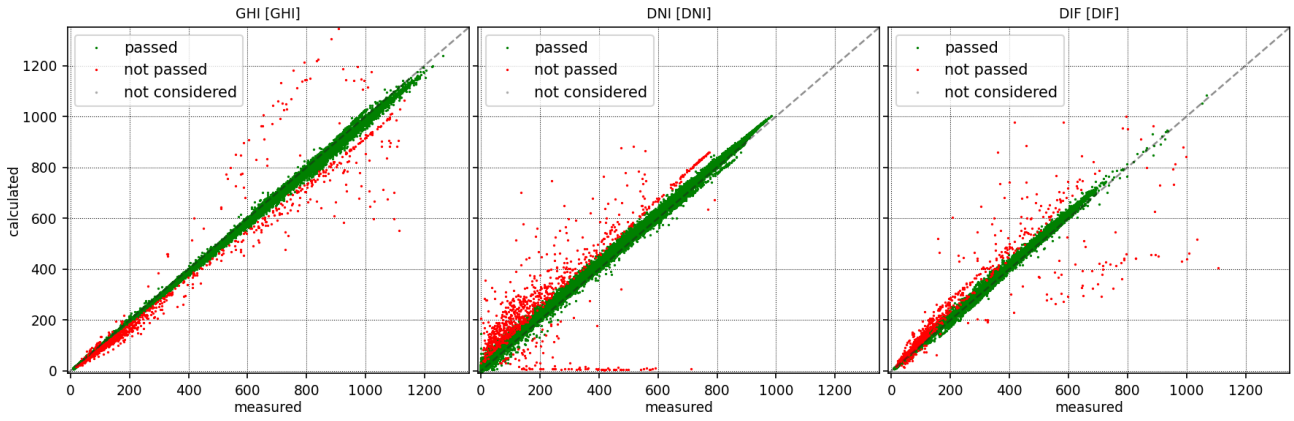

Fig. 5: Consistency plot of test group Group_1

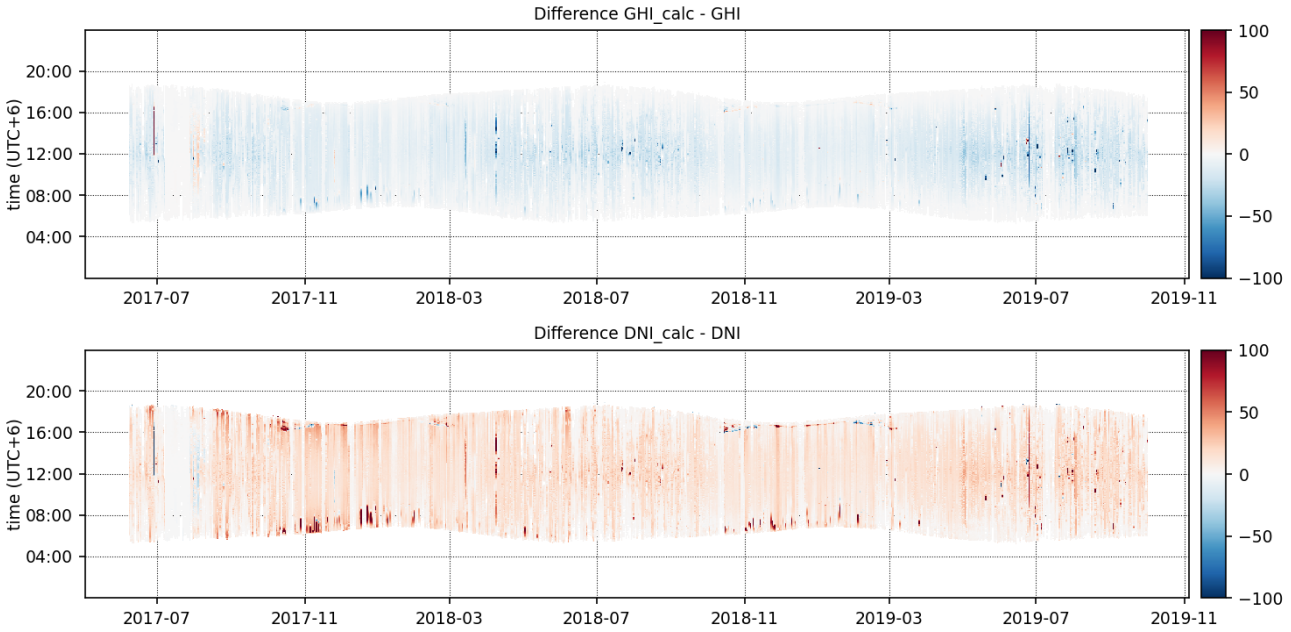

Fig. 6: Difference plot of test group Group_1

Tab. 5: Quality Control summary

Indicator	Quality	Note
Instrument accuracy		1x Class A instrument (SR30-D1)
		1x Class B instrument (DR01-T1)
Information on cleaning and maintenance		No information on instrument cleaning
Quality control complexity		Majority of quality control tests applied. Multi-component tests applied.
Availability of valid measurements		Approx. 28 months of DIF, DNI and GHI after quality control

Not specified	Very good	Good	Medium	Problematic	Insufficient

Quality assessment summary

Data is measured with high accuracy pyranometers and medium accuracy pyrheliometer, with frequent cleaning several times per week. Calibration info is missing.

Issues identified in the data include shading and inconsistent values. Only passed data records qualifies for model validation.

3 Comparison with model data

The validation statistics were calculated from valid records after quality control and sun elevation higher than 5°. Dataset 2010951_Solargis_TS_WorldBank_Feni_Bangladesh_2017-2019 was used as model dataset for compare statistics.

Tab. 6: Global comparison of hourly values

	Bias		Root Mean Square Deviation, RMSD			Number of data pairs
	[W/m²]	[%]	Hourly [%]	Daily [%]	Monthly [%]	
GHI	3	0.8	19.1	9.3	3.3	9182
DNI	-10	-3.8	38.2	22.0	9.0	9344

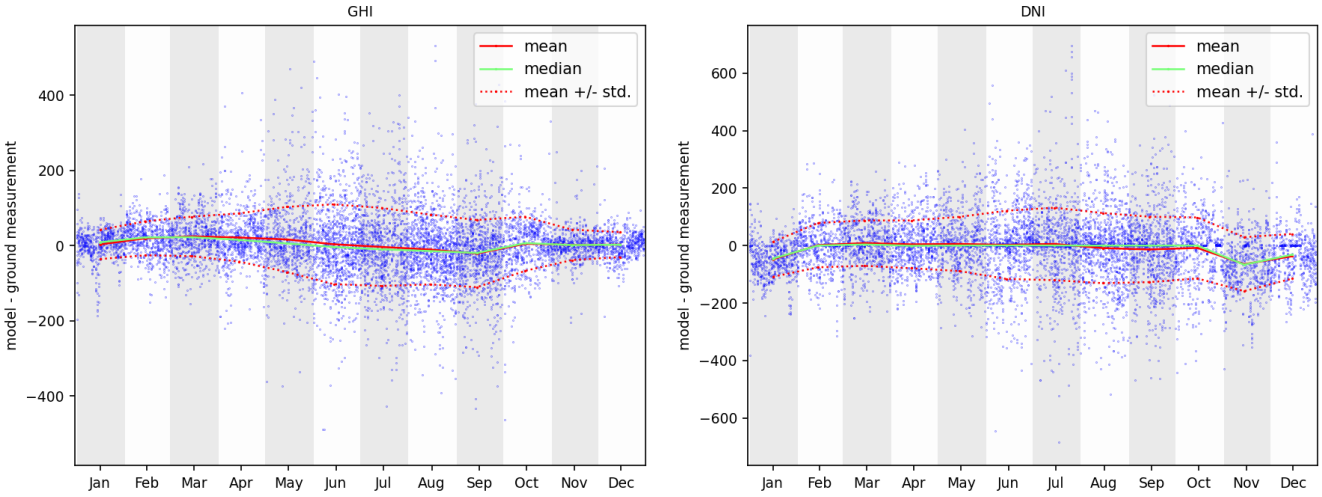

Fig. 7: Deviations of hourly DNI and GHI - Feni
X-axis: day of year DOY; Y-axis: difference between model and measurements

Tab. 7: Monthly comparison of hourly values – number of data pairs

Number of points	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GHI	614	562	682	703	743	977	944	1116	1000	645	591	605
DNI	614	562	682	703	743	977	1106	1116	1000	645	591	605

Tab. 8: Monthly comparison of hourly values – bias

BIAS [%]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GHI	0.8	4.4	5.2	4.5	3.8	0.9	-1.0	-2.5	-5.3	1.2	0.4	0.7
DNI	-12.4	0.4	2.6	1.5	2.6	1.3	3.7	-3.7	-6.0	-2.9	-13.3	-9.4

Tab. 9: Monthly comparison of hourly values – RMSD

RMSD [%]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GHI	9.6	11.3	12.2	14.2	20.6	27.3	27.7	22.5	22.7	18.2	9.1	8.9
DNI	20.0	22.8	24.2	28.6	44.2	62.4	81.8	51.6	50.9	37.1	23.5	21.6

Acronyms

Parameter types

DIF	Diffuse horizontal irradiance
DNI	Direct normal irradiance
GHI	Global horizontal irradiance

Quality control statuses

T / T	Time reference check (missing / done)
R / R	Radiation automatic quality check (missing / done)
M / M	Meteo automatic quality check (missing / done)
I+ / I	Manual quality check (missing / done)
P / P	Post filtering check (missing / done)

Glossary

BIAS	Represents systematic deviation between modelled and measured values (positive bias indicates overestimation and negative bias shows underestimation of the model) and is calculated according to this formula: $$Bias = measured - modeled$$ Bias indicates systematic (annual or seasonal) issues of a solar or meteorological model. It can also indicate systematic problem in measurements. In solar radiation model, this can be determined by insufficient cloud identification, coarse resolution and regional imperfections of atmospheric data (aerosols, water vapour), terrain, sun position, satellite viewing angle, microclimate effects, high mountains, etc. Bias may also indicate a quality issue of the measured data, e.g. misalignment, miscalibration or soiling of a sensor. In solar radiation model, this can be determined by insufficient cloud identification, coarse resolution and regional imperfections of atmospheric data (aerosols, water vapour), terrain, sun position, satellite viewing angle, microclimate effects, high mountains, etc. Bias may also indicate a quality issue of the measured data, e.g. misalignment, miscalibration or soiling of a sensor.
Root Mean Square Deviation (RMSD)	Represents spread of deviations given by random discrepancies between measured and modelled data and is calculated according to this formula: $$RMSD = \sqrt{\frac{\sum_{k=1}^{n}\left(X^{k}_{measured} - X^{k}_{modeled}\right)^{2}}{n}}$$ Considering solar radiation or meteorological model, RMSD reflects inaccuracies of cloud identification (e.g. intermediate clouds), under/over estimation of atmospheric input, data, terrain, microclimate and other effects, which are not captured by the model. Par of this discrepancy is natural - as satellite monitors large area, while the sensor can see only micro area of approx. 1 squared centimeter. Higher RMSD may also indicate lower quality of the measured data, e.g. lower accuracy, miscalibration or misalignment of the instruments, by soiling of sensor due to insufficient cleaning or issues in a data logger. It can also indicate insufficient data quality control.

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