

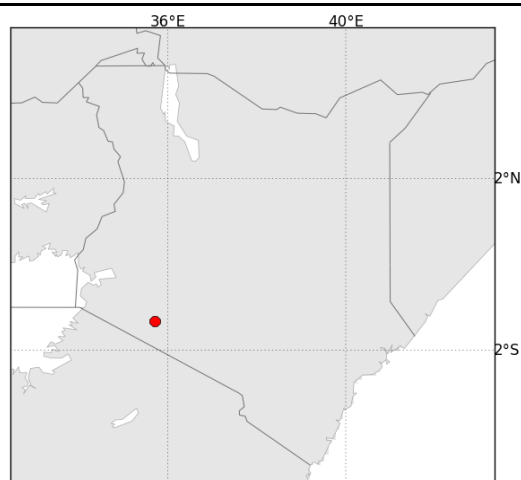
# Monthly Solar Irradiation

Narok  
Kenya

March 2020

Document No: GSAMSR-096-202003-v03

Client: World Bank  
Site name: Narok  
Geographical coordinates: 01° 19' 15.95" S  
35° 42' 20.55" E  
Elevation above sea level: 1914 m  
Slope inclination: 1°  
Slope azimuth: 5° North



## Overview

A monthly summary of solar irradiation data as recorded by the on-site meteorological measurement station (shown in Figure 1) is presented in this report. GeoSUN Africa commissioned the station on 04 December 2019 and data is provided from 04 December 2019. The station is located near Narok in Kenya. GeoSUN offers further services by performing data quality checks, a scheduled site visit after six months and monitoring of the instrument cleaning. Global Horizontal Irradiation (GHI) and Diffused Horizontal Irradiation (DHI) data is provided together with meteorological data.



Figure 1: Narok on-site solar and meteorological measurement station

## Data Fields

Recorded ground data has a minute temporal resolution. Hourly, daily and monthly data is derived from minute data. Noteworthy data is identified by a red block on the relevant graph and clarified in Section 6. Table 1 defines the fields used in this report.

| Field                    | Instrument   | Measurement  |
|--------------------------|--|--|
| GHI (1)                  | Thermopile Pyranometer (Hukseflux SR20-T2) <sup>1</sup>  | Global Horizontal Irradiation                            |
| GHI (2)                  | Thermopile Pyranometer (Kipp & Zonen CMP11) <sup>1</sup> | Global Horizontal Irradiation                            |
| GHI (1) vs (2)           | GHI Difference Calculated <sup>2</sup>                   | Global Horizontal Irradiation Difference                 |
| GHI (SAT)                | Satellite Derived (Solargis)                             | Global Horizontal Irradiation                            |
| GHI (SGLT)               | GHI Long-Term Satellite Derived (Solargis) <sup>3</sup>  | Global Horizontal Irradiation                            |
| GHI (1) vs (SAT)         | GHI Difference Calculated <sup>2</sup>                   | Global Horizontal Irradiation Difference                 |
| DHI (1)                  | Solar Sensor (Delta-T SPN1) <sup>4</sup>                 | Diffused Horizontal Irradiation                          |
| DHI (SAT)                | Satellite Derived (Solargis)                             | Diffused Horizontal Irradiation                          |
| DHI (SGLT)               | DHI Long-Term Satellite Derived (Solargis) <sup>3</sup>  | Diffused Horizontal Irradiation                          |
| DHI (1) vs (SAT)         | DHI Difference Calculated <sup>2</sup>                   | Diffused Horizontal Irradiation Difference               |
| GTI (Clean)              | Silicon Irradiance Sensor (Ingenieurbüro Si-mV-85)       | Global Tilted Irradiation (Cleaned) <sup>5</sup>         |
| GTI (Soil)               | Silicon Irradiance Sensor (Ingenieurbüro Si-mV-85)       | Global Tilted Irradiation (Soiled) <sup>5</sup>          |
| GTI (Clean) vs (Soil)    | GTI Difference Calculated                                | Cleaned-Soiled GTI Difference                            |
| GTI (Monthly)            | Silicon Irradiance Sensor (Ingenieurbüro Si-mV-85)       | Global Tilted Irradiation (Cleaned Monthly) <sup>5</sup> |
| GTI (Clean) vs (Monthly) | GTI Difference Calculated                                | Cleaned-Monthly GTI Difference                           |
| Temperature              | Thermometer (Campbell Scientific model CS215)            | Ambient Air Temperature                                  |
| Temperature (SAT)        | Satellite Derived (Solargis)                             | Ambient Air Temperature                                  |
| Humidity                 | Hygrometer (Campbell Scientific model CS215)             | Relative Humidity  |
| Pressure                 | Barometer (Vaisala PTB110)                               | Barometric Pressure                                      |
| Wind Speed               | Anemometer (Met One 014A)                                | Wind Speed (measured at 3 m)                             |
| Wind Direction           | Wind Vane (Met One 014A)                                 | Wind Direction (measured at 3 m) <sup>6</sup>            |
| Rain                     | Rain Gauge (Texas Electronics TR-525I)                   | Rain   |
| Cleaning                 | Push Button  | Button to be pressed on cleaning event                   |
| NaN                      | Numerical Value Not Available                            | Not a Number   |

<sup>1</sup> High accuracy thermopile pyranometer (ISO 9060 secondary standard)

<sup>2</sup> See chapter 3 for calculation

<sup>3</sup> Long-term satellite derived data averaged over multiple years, see chapter 4

<sup>4</sup> Thermopile pyranometer

<sup>5</sup> Measuring soiling on site, tilted at 10° North

<sup>6</sup> The direction 0/360° indicates North (with 90° East)

Table 1: Nomenclature

# 1 Hourly Solar Irradiation Data

Figure 1.1 presents the hourly solar irradiation data. See Section 6 for further comments on the evaluation of this data.

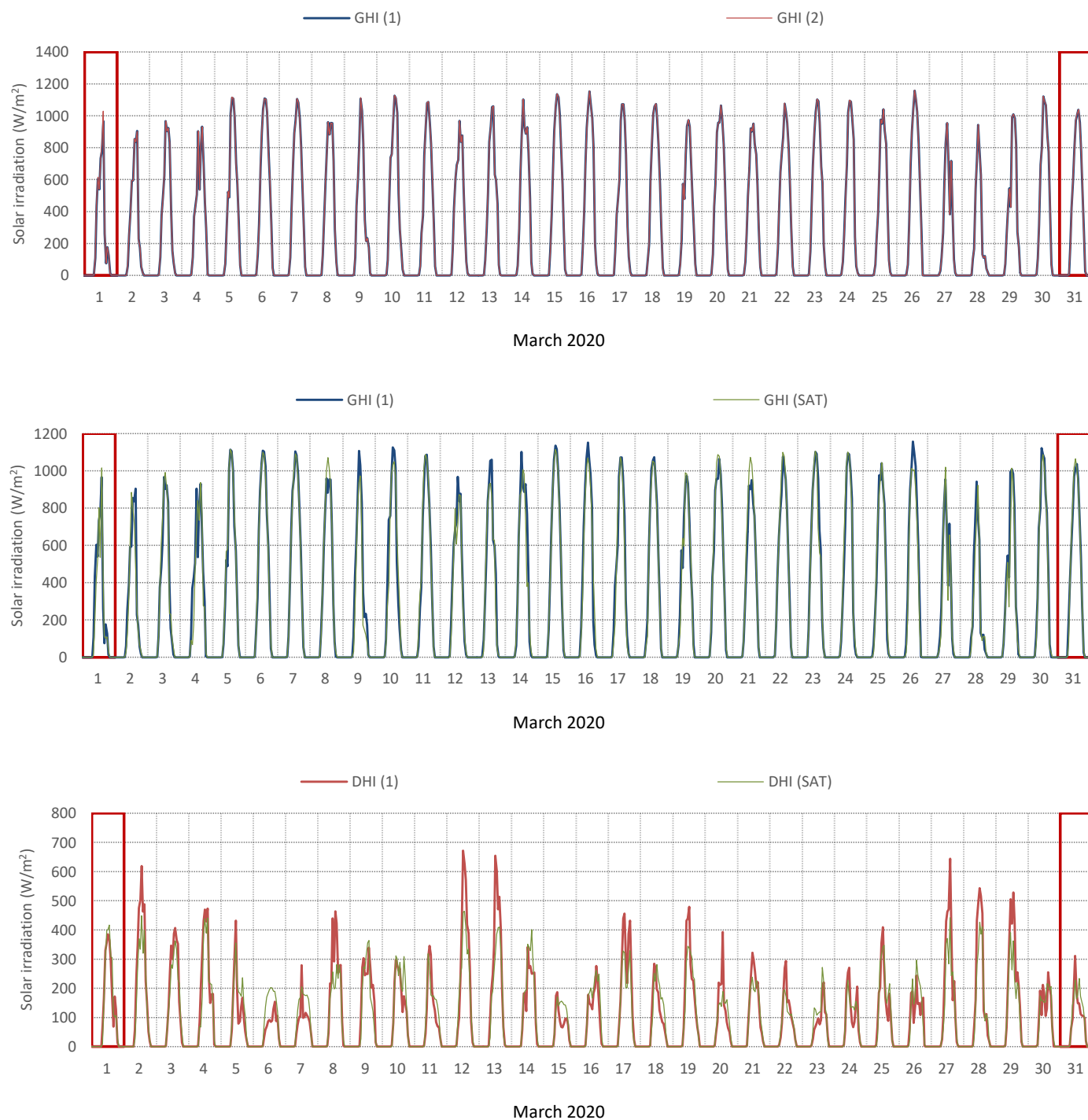


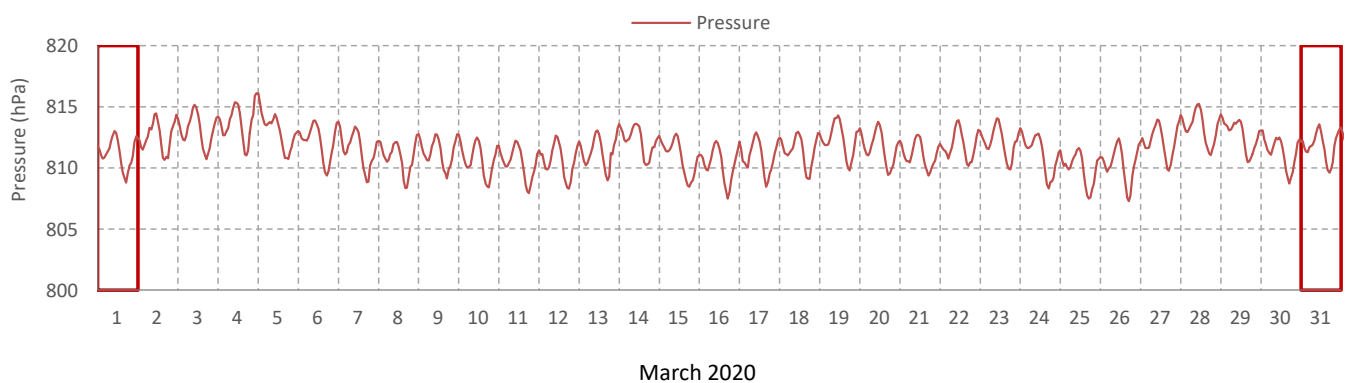
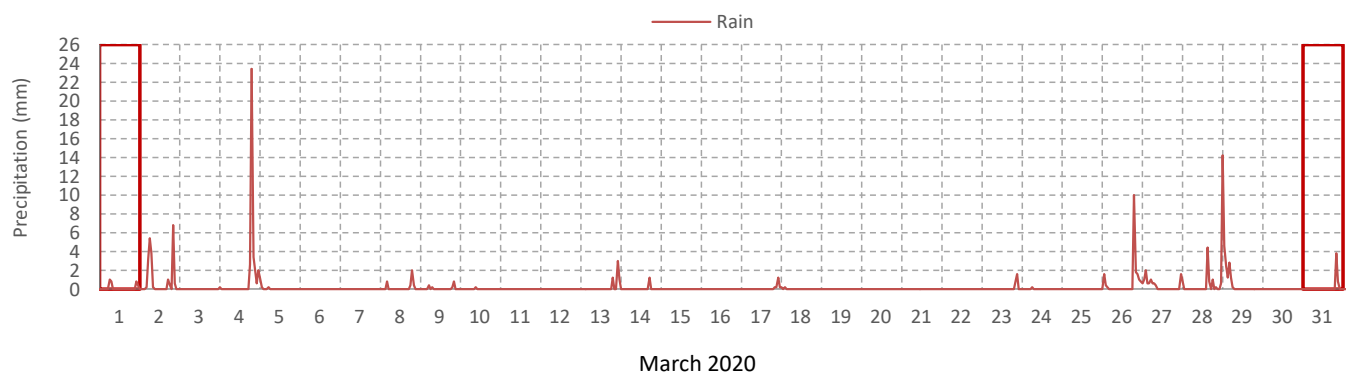
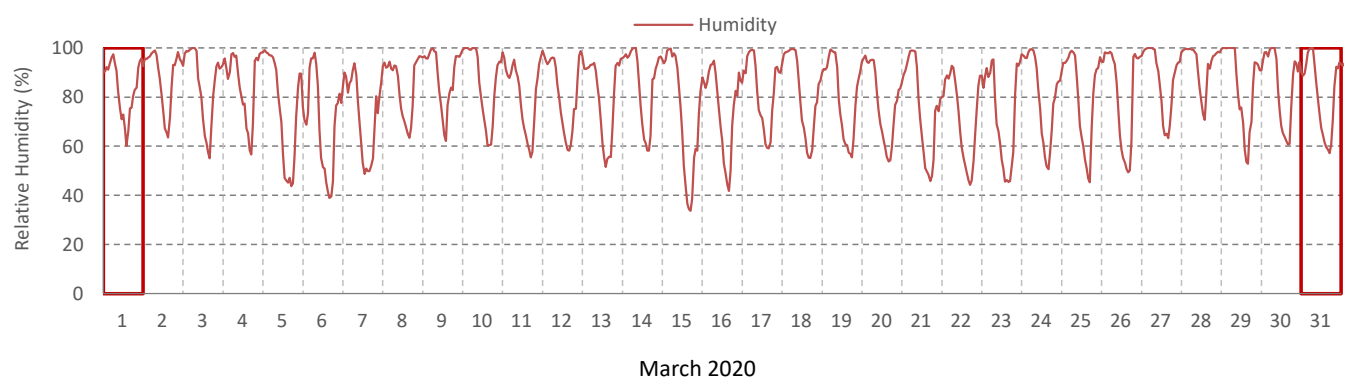
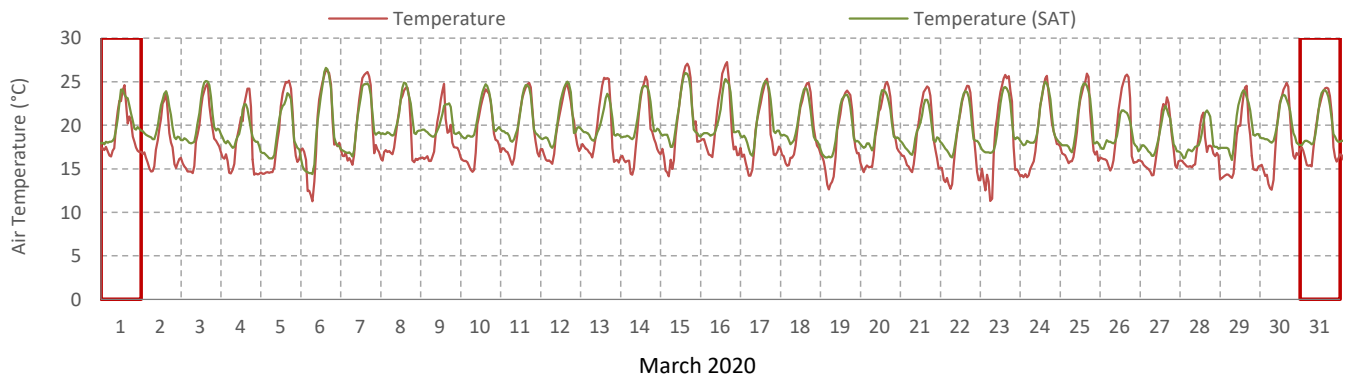
Figure 1.1 Hourly solar irradiation data

## 2 Hourly and Daily Meteorological Data

Table 2.1 presents the daily meteorological data. Figure 2.1 presents the hourly meteorological data.

| Day            | Temperature<br>Degree Celsius | Temperature (SAT)<br>Degree Celsius | Rain<br>mm |
|----------------|-------------------------------|-------------------------------------|------------|
| 01-March-20    | 19.23                         | 20.33                               | 3.00       |
| 02-March-20    | 17.71                         | 20.08                               | 21.60      |
| 03-March-20    | 18.62                         | 20.61                               | 0.20       |
| 04-March-20    | 17.78                         | 18.98                               | 35.20      |
| 05-March-20    | 18.60                         | 19.03                               | 0.40       |
| 06-March-20    | 19.13                         | 19.43                               | 0.00       |
| 07-March-20    | 19.82                         | 20.15                               | 0.00       |
| 08-March-20    | 18.94                         | 20.73                               | 3.60       |
| 09-March-20    | 18.57                         | 20.01                               | 1.60       |
| 10-March-20    | 18.97                         | 20.73                               | 0.20       |
| 11-March-20    | 19.47                         | 20.49                               | 0.00       |
| 12-March-20    | 19.43                         | 20.57                               | 0.00       |
| 13-March-20    | 19.45                         | 19.95                               | 5.20       |
| 14-March-20    | 18.89                         | 20.69                               | 1.20       |
| 15-March-20    | 20.12                         | 20.93                               | 0.00       |
| 16-March-20    | 20.22                         | 20.76                               | 0.00       |
| 17-March-20    | 18.82                         | 20.43                               | 2.00       |
| 18-March-20    | 19.34                         | 20.04                               | 0.20       |
| 19-March-20    | 18.30                         | 19.28                               | 0.00       |
| 20-March-20    | 19.08                         | 19.90                               | 0.00       |
| 21-March-20    | 18.70                         | 19.16                               | 0.00       |
| 22-March-20    | 17.98                         | 19.40                               | 0.00       |
| 23-March-20    | 18.53                         | 19.64                               | 2.40       |
| 24-March-20    | 18.80                         | 20.07                               | 0.20       |
| 25-March-20    | 19.14                         | 19.99                               | 0.00       |
| 26-March-20    | 18.86                         | 18.98                               | 18.00      |
| 27-March-20    | 17.57                         | 18.47                               | 9.20       |
| 28-March-20    | 16.91                         | 18.21                               | 21.20      |
| 29-March-20    | 17.25                         | 19.85                               | 12.40      |
| 30-March-20    | 18.12                         | 19.88                               | 0.00       |
| 31-March-20    | 19.17                         | 20.05                               | 4.60       |
| <b>Average</b> | 18.76                         | 19.90                               |            |
| <b>Maximum</b> | 20.22                         | 20.93                               | 35.20      |
| <b>Minimum</b> | 16.91                         | 18.21                               | 0.00       |
| <b>Total</b>   |                               |                                     | 142.40     |

Table 2.1 Daily meteorological data





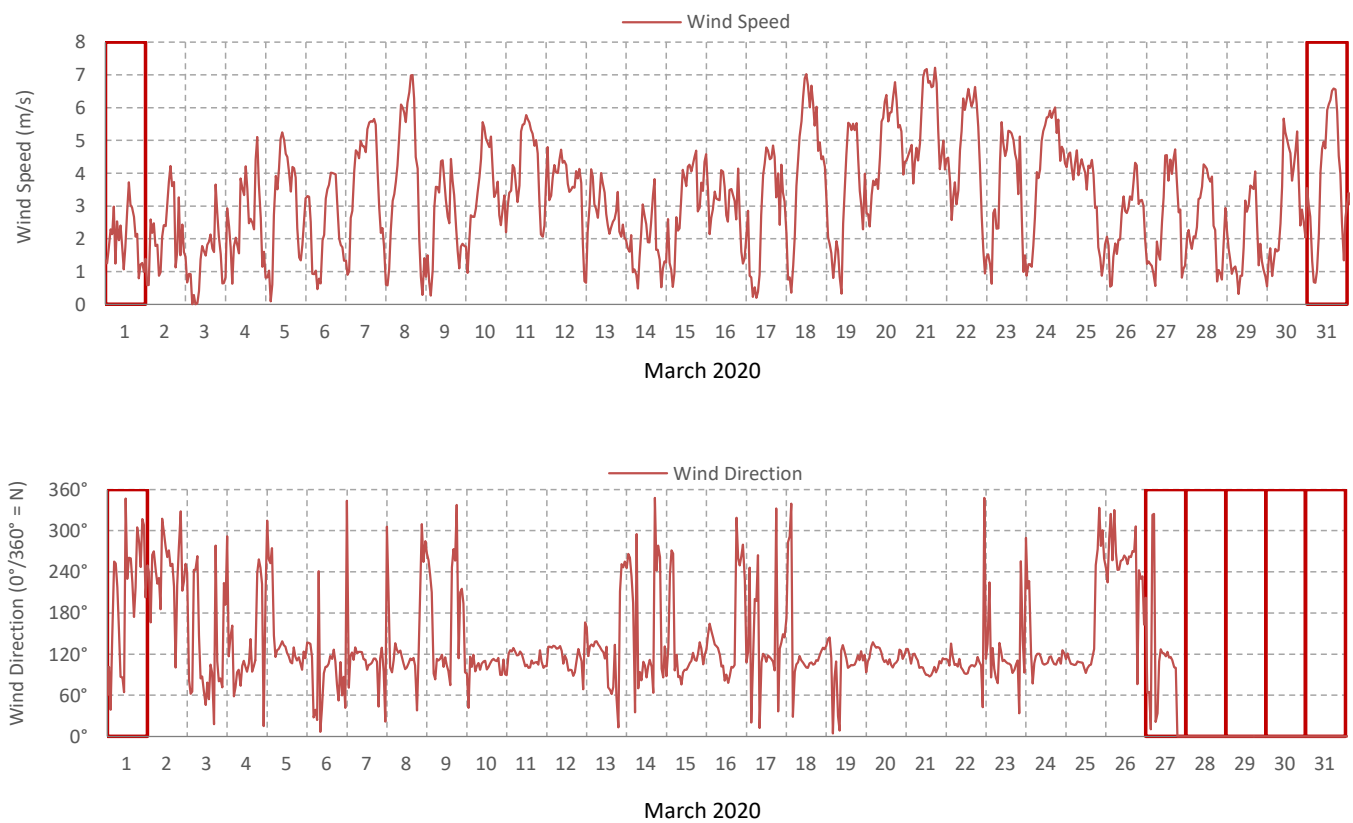


Figure 2.1 Hourly meteorological data

### 3 Daily Solar Irradiation Data

Table 3.1 presents the daily GHI solar irradiation data. The daily percentage difference between GHI (1) and GHI (2) as well as GHI (1) and GHI (SAT) is calculated and also presented. On overcast days the difference between the GHI values will likely be large due to low irradiation values. The difference is calculated as follows:

$$\text{GHI (1) vs (2)} = 100 \times \left( \frac{\text{GHI (1)} - \text{GHI (2)}}{\text{GHI (1)}} \right)$$

$$\text{GHI (1) vs (SAT)} = 100 \times \left( \frac{\text{GHI (1)} - \text{GHI (SAT)}}{\text{GHI (1)}} \right)$$

| Day            | GHI (1)<br>kWh/m <sup>2</sup> /day | GHI (2)<br>kWh/m <sup>2</sup> /day | GHI (SAT)<br>kWh/m <sup>2</sup> /day | GHI (1) vs (2)<br>% | GHI (1) vs (SAT)<br>% |
|----------------|------------------------------------|------------------------------------|--------------------------------------|---------------------|-----------------------|
| 01 March '20   | 4.82                               | 4.96                               | 4.33                                 | -2.96               | 10.12                 |
| 02 March '20   | 4.95                               | 4.94                               | 4.52                                 | 0.13                | 8.77                  |
| 03 March '20   | 5.87                               | 5.87                               | 6.14                                 | 0.08                | -4.60                 |
| 04 March '20   | 6.07                               | 6.06                               | 5.34                                 | 0.15                | 11.96                 |
| 05 March '20   | 7.24                               | 7.24                               | 7.46                                 | 0.00                | -3.01                 |
| 06 March '20   | 8.01                               | 8.00                               | 7.92                                 | 0.17                | 1.13                  |
| 07 March '20   | 7.99                               | 7.99                               | 7.83                                 | -0.03               | 2.00                  |
| 08 March '20   | 6.66                               | 6.66                               | 7.02                                 | 0.06                | -5.37                 |
| 09 March '20   | 5.94                               | 5.95                               | 4.73                                 | -0.15               | 20.28                 |
| 10 March '20   | 7.24                               | 7.24                               | 6.96                                 | -0.03               | 3.84                  |
| 11 March '20   | 7.31                               | 7.31                               | 7.53                                 | 0.01                | -2.96                 |
| 12 March '20   | 6.22                               | 6.22                               | 5.70                                 | 0.10                | 8.40                  |
| 13 March '20   | 6.53                               | 6.52                               | 6.06                                 | 0.19                | 7.15                  |
| 14 March '20   | 7.07                               | 7.07                               | 6.44                                 | 0.05                | 8.96                  |
| 15 March '20   | 8.12                               | 8.12                               | 8.02                                 | -0.03               | 1.22                  |
| 16 March '20   | 7.53                               | 7.53                               | 7.37                                 | 0.11                | 2.16                  |
| 17 March '20   | 6.89                               | 6.88                               | 6.33                                 | 0.13                | 8.07                  |
| 18 March '20   | 7.57                               | 7.57                               | 7.24                                 | -0.06               | 4.38                  |
| 19 March '20   | 6.52                               | 6.53                               | 6.26                                 | -0.02               | 3.98                  |
| 20 March '20   | 7.72                               | 7.72                               | 7.99                                 | 0.01                | -3.52                 |
| 21 March '20   | 6.79                               | 6.79                               | 7.52                                 | -0.04               | -10.74                |
| 22 March '20   | 7.65                               | 7.66                               | 7.89                                 | -0.09               | -3.01                 |
| 23 March '20   | 7.85                               | 7.85                               | 7.42                                 | 0.00                | 5.49                  |
| 24 March '20   | 6.87                               | 6.87                               | 7.13                                 | 0.00                | -3.89                 |
| 25 March '20   | 6.65                               | 6.64                               | 6.64                                 | 0.10                | 0.03                  |
| 26 March '20   | 7.98                               | 7.97                               | 7.01                                 | 0.07                | 12.09                 |
| 27 March '20   | 5.14                               | 5.13                               | 4.92                                 | 0.18                | 4.20                  |
| 28 March '20   | 4.30                               | 4.29                               | 3.98                                 | 0.12                | 7.30                  |
| 29 March '20   | 5.99                               | 5.98                               | 5.24                                 | 0.20                | 12.60                 |
| 30 March '20   | 7.37                               | 7.38                               | 7.10                                 | -0.11               | 3.60                  |
| 31 March '20   | 7.60                               | 7.60                               | 7.56                                 | -0.02               | 0.49                  |
| <b>Average</b> | 6.79                               | 6.79                               | 6.57                                 | 0.17*               | 5.98*                 |
| <b>Maximum</b> | 8.12                               | 8.12                               | 8.02                                 | -2.96               | 20.28                 |
| <b>Minimum</b> | 4.30                               | 4.29                               | 3.98                                 | 0.00                | 0.03                  |

\*Average of absolute values of daily percentage difference, representing data comparison on daily level (will differ from percentage difference of averaged GHI values, which represents monthly data comparison).

Table 3.1 Daily solar irradiation data



Table 3.2 presents the daily DHI solar irradiation data. The daily percentage difference between DHI (1) and DHI (SAT) is calculated and also presented. On overcast days the difference between the DHI values will likely be large due to low irradiation values. The difference is calculated as follows:

$$\text{DHI (1) vs (SAT)} = 100 \times \left( \frac{\text{DHI (1)} - \text{DHI (SAT)}}{\text{DHI (1)}} \right)$$

| Day            | DHI (1)<br>kWh/m <sup>2</sup> /day | DHI (SAT)<br>kWh/m <sup>2</sup> /day | DHI (1) vs (SAT)<br>% |
|----------------|------------------------------------|--------------------------------------|-----------------------|
| 01 March '20   | 2.55                               | 2.66                                 | -4.34                 |
| 02 March '20   | 3.64                               | 2.78                                 | 23.68                 |
| 03 March '20   | 2.85                               | 2.53                                 | 11.30                 |
| 04 March '20   | 3.16                               | 2.79                                 | 11.86                 |
| 05 March '20   | 1.80                               | 2.15                                 | -19.38                |
| 06 March '20   | 1.02                               | 1.86                                 | -82.45                |
| 07 March '20   | 1.25                               | 1.77                                 | -41.84                |
| 08 March '20   | 2.99                               | 2.21                                 | 26.03                 |
| 09 March '20   | 2.60                               | 2.31                                 | 11.22                 |
| 10 March '20   | 2.20                               | 2.53                                 | -14.81                |
| 11 March '20   | 1.85                               | 1.96                                 | -5.53                 |
| 12 March '20   | 3.87                               | 3.11                                 | 19.66                 |
| 13 March '20   | 3.78                               | 2.79                                 | 26.12                 |
| 14 March '20   | 2.28                               | 2.69                                 | -18.10                |
| 15 March '20   | 1.12                               | 1.49                                 | -33.43                |
| 16 March '20   | 1.79                               | 2.15                                 | -20.17                |
| 17 March '20   | 3.15                               | 2.44                                 | 22.75                 |
| 18 March '20   | 1.69                               | 1.96                                 | -16.06                |
| 19 March '20   | 2.76                               | 2.51                                 | 9.03                  |
| 20 March '20   | 1.65                               | 1.47                                 | 11.22                 |
| 21 March '20   | 2.07                               | 1.87                                 | 9.34                  |
| 22 March '20   | 1.56                               | 1.33                                 | 14.95                 |
| 23 March '20   | 1.19                               | 1.55                                 | -30.51                |
| 24 March '20   | 1.59                               | 1.56                                 | 1.46                  |
| 25 March '20   | 2.14                               | 2.35                                 | -9.61                 |
| 26 March '20   | 1.63                               | 1.93                                 | -18.42                |
| 27 March '20   | 3.27                               | 2.51                                 | 23.19                 |
| 28 March '20   | 3.08                               | 2.48                                 | 19.49                 |
| 29 March '20   | 3.37                               | 2.52                                 | 25.35                 |
| 30 March '20   | 1.73                               | 1.75                                 | -0.98                 |
| 31 March '20   | 1.59                               | 1.74                                 | -9.18                 |
| <b>Average</b> | 2.30                               | 2.18                                 | 19.08*                |
| <b>Maximum</b> | 3.87                               | 3.11                                 | -82.45                |
| <b>Minimum</b> | 1.02                               | 1.33                                 | -0.98                 |

\*Average of absolute values of daily percentage difference, representing data comparison on daily level (will differ from percentage difference of averaged DHI values, which represents monthly data comparison).

Table 3.2 Daily solar irradiation data

Table 3.3 presents the daily GTI data. On overcast days the difference between the sensors will likely be large due to low irradiation values. The daily difference between GTI (Clean) and GTI (Soil) as well as GTI (Clean) and GTI (Monthly) is also calculated and presented. The difference is calculated as follows:

$$\text{GTI (Clean) vs (Soil)} = 100 \times \left( \frac{\text{GTI (Clean)} - \text{GTI (Soil)}}{\text{GTI (Clean)}} \right) \quad \text{GTI (Clean) vs (Monthly)} = 100 \times \left( \frac{\text{GTI (Clean)} - \text{GTI (Monthly)}}{\text{GTI (Clean)}} \right)$$

| Day            | GTI (Clean)<br>kWh/m <sup>2</sup> /day | GTI (Soil)<br>kWh/m <sup>2</sup> /day | GTI (Monthly)<br>kWh/m <sup>2</sup> /day | GTI (Clean) vs<br>(Soil)<br>% | GTI (Clean) vs<br>(Monthly)<br>% |
|----------------|--|---------------------------------------|--|-------------------------------|----------------------------------|
| 01 March '20   | 4.68                                   | 4.70                                  | 4.68                                     | -0.41                         | -0.03                            |
| 02 March '20   | 4.75                                   | 4.76                                  | 4.75                                     | -0.28                         | 0.05                             |
| 03 March '20   | 5.56                                   | 5.57                                  | 5.53                                     | -0.31                         | 0.43                             |
| 04 March '20   | 5.72                                   | 5.72                                  | 5.71                                     | -0.01                         | 0.19                             |
| 05 March '20   | 6.73                                   | 6.72                                  | 6.71                                     | 0.16                          | 0.29                             |
| 06 March '20   | 7.44                                   | 7.45                                  | 7.43                                     | -0.08                         | 0.13                             |
| 07 March '20   | 7.44                                   | 7.44                                  | 7.40                                     | 0.00                          | 0.41                             |
| 08 March '20   | 6.23                                   | 6.25                                  | 6.21                                     | -0.19                         | 0.32                             |
| 09 March '20   | 5.69                                   | 5.71                                  | 5.68                                     | -0.34                         | 0.21                             |
| 10 March '20   | 6.85                                   | 6.86                                  | 6.83                                     | -0.11                         | 0.28                             |
| 11 March '20   | 6.87                                   | 6.86                                  | 6.84                                     | 0.15                          | 0.43                             |
| 12 March '20   | 5.87                                   | 5.89                                  | 5.85                                     | -0.23                         | 0.43                             |
| 13 March '20   | 6.22                                   | 6.22                                  | 6.18                                     | 0.03                          | 0.68                             |
| 14 March '20   | 6.78                                   | 6.78                                  | 6.76                                     | -0.05                         | 0.32                             |
| 15 March '20   | 7.63                                   | 7.63                                  | 7.61                                     | -0.01                         | 0.30                             |
| 16 March '20   | 7.15                                   | 7.17                                  | 7.12                                     | -0.30                         | 0.36                             |
| 17 March '20   | 6.55                                   | 6.56                                  | 6.51                                     | -0.09                         | 0.64                             |
| 18 March '20   | 7.19                                   | 7.17                                  | 7.14                                     | 0.30                          | 0.77                             |
| 19 March '20   | 6.22                                   | 6.20                                  | 6.17                                     | 0.38                          | 0.86                             |
| 20 March '20   | 7.27                                   | 7.26                                  | 7.20                                     | 0.24                          | 1.03                             |
| 21 March '20   | 6.41                                   | 6.39                                  | 6.35                                     | 0.31                          | 1.07                             |
| 22 March '20   | 7.21                                   | 7.19                                  | 7.11                                     | 0.25                          | 1.31                             |
| 23 March '20   | 7.52                                   | 7.50                                  | 7.43                                     | 0.25                          | 1.26                             |
| 24 March '20   | 6.64                                   | 6.63                                  | 6.61                                     | 0.04                          | 0.42                             |
| 25 March '20   | 6.44                                   | 6.42                                  | 6.38                                     | 0.24                          | 0.80                             |
| 26 March '20   | 7.74                                   | 7.74                                  | 7.71                                     | -0.08                         | 0.36                             |
| 27 March '20   | 5.03                                   | 5.02                                  | 5.01                                     | 0.06                          | 0.31                             |
| 28 March '20   | 4.17                                   | 4.18                                  | 4.16                                     | -0.39                         | 0.23                             |
| 29 March '20   | 5.85                                   | 5.85                                  | 5.83                                     | 0.09                          | 0.34                             |
| 30 March '20   | 7.18                                   | 7.18                                  | 7.15                                     | -0.06                         | 0.37                             |
| 31 March '20   | 7.32                                   | 7.32                                  | 7.32                                     | -0.04                         | 0.05                             |
| <b>Average</b> | 6.46                                   | 6.46                                  | 6.43                                     | 0.18*                         | 0.47*                            |
| <b>Maximum</b> | 7.74                                   | 7.74                                  | 7.71                                     | -0.41                         | 1.31                             |
| <b>Minimum</b> | 4.17                                   | 4.18                                  | 4.16                                     | 0.00                          | -0.03                            |

\*Average of absolute values of daily percentage difference, representing data comparison on daily level (will differ from percentage difference of averaged reference cell values, which represents monthly data comparison).

Table 3.3 Daily GTI data

Figure 3.1 presents the daily solar irradiation data.

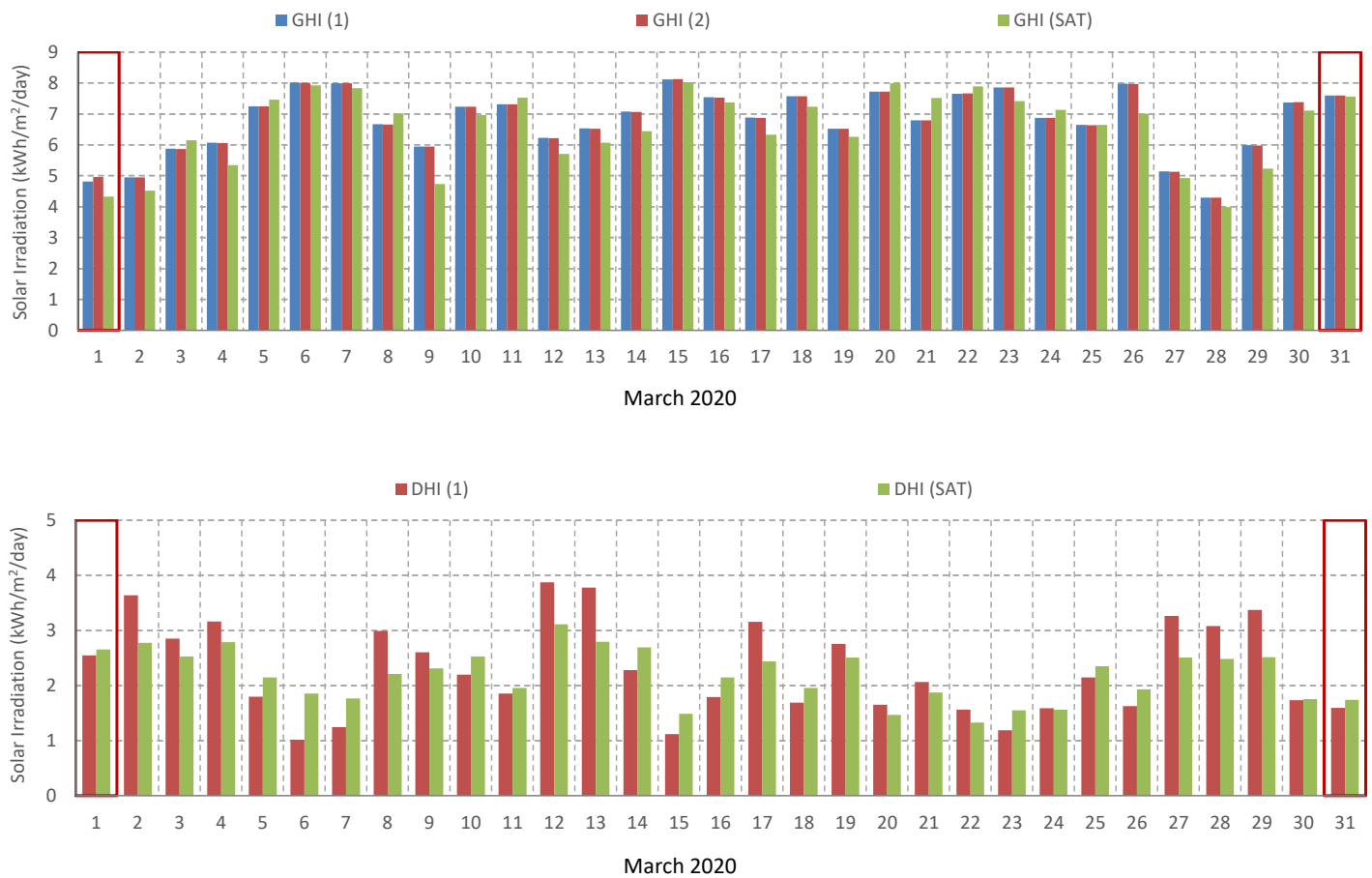


Figure 3.1 Daily solar irradiation data

Figure 3.2 presents the daily solar irradiation data (GTI) for the solar sensors measuring the effect of soiling on site. Figure 3.3 presents the difference between the cleaned and the monthly cleaned sensor.

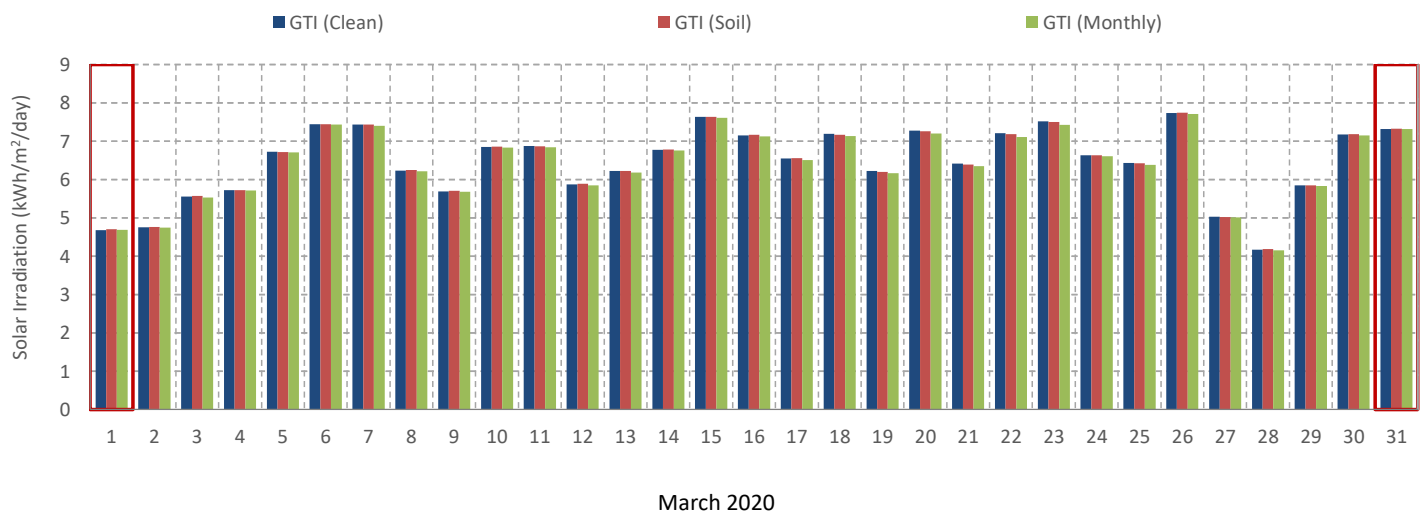


Figure 3.2 GTI daily solar irradiation data

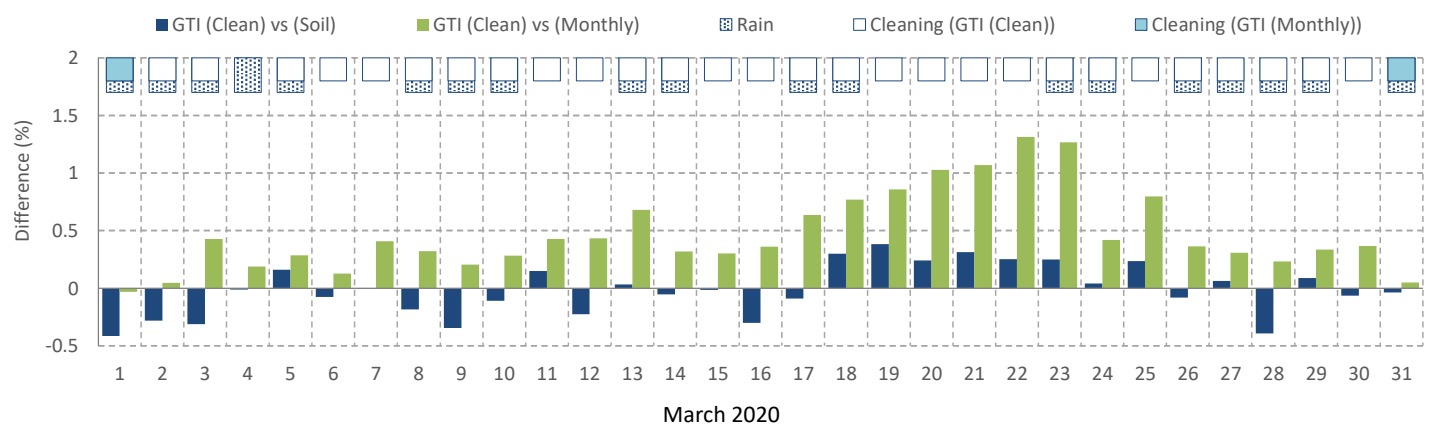


Figure 3.3 GTI daily solar irradiation difference

## 4 Monthly Solar Irradiation Data

Table 4.1 presents the monthly sum of solar irradiation data as well as the accumulated annual value at time of report. Figure 4.1 presents the monthly sum of solar irradiation data as well as the average daily solar irradiation data. For more information on previous month's data see relevant month's report.

| Month        | GHI (1)<br>kWh/m <sup>2</sup> /month | GHI (2)<br>kWh/m <sup>2</sup> /month | GHI (SAT)<br>kWh/m <sup>2</sup> /month | GHI (SGLT)<br>kWh/m <sup>2</sup> /month | DHI (1)<br>kWh/m <sup>2</sup> /month | DHI (SAT)<br>kWh/m <sup>2</sup> /month | DHI (SGLT)<br>kWh/m <sup>2</sup> /month |
|--------------|--------------------------------------|--------------------------------------|--|---|--------------------------------------|--|---|
| December '19 | 191**                                | 191**                                | 187**                                  | 204                                     | 65**                                 | 62**                                   | 56                                      |
| January '20  | 194                                  | 194                                  | 197                                    | 209                                     | 67                                   | 65                                     | 55                                      |
| February '20 | 201                                  | 201                                  | 198                                    | 203                                     | 62                                   | 61                                     | 53                                      |
| March '20    | 210                                  | 211                                  | 204                                    | 221                                     | 71                                   | 68                                     | 60                                      |
| Annual*      | 796                                  | 797                                  | 786                                    | 836                                     | 265                                  | 255                                    | 224                                     |

\*Year to date sum (includes 4 months of measurement).

\*\*Available day data used

Table 4.1 Monthly sum of irradiation

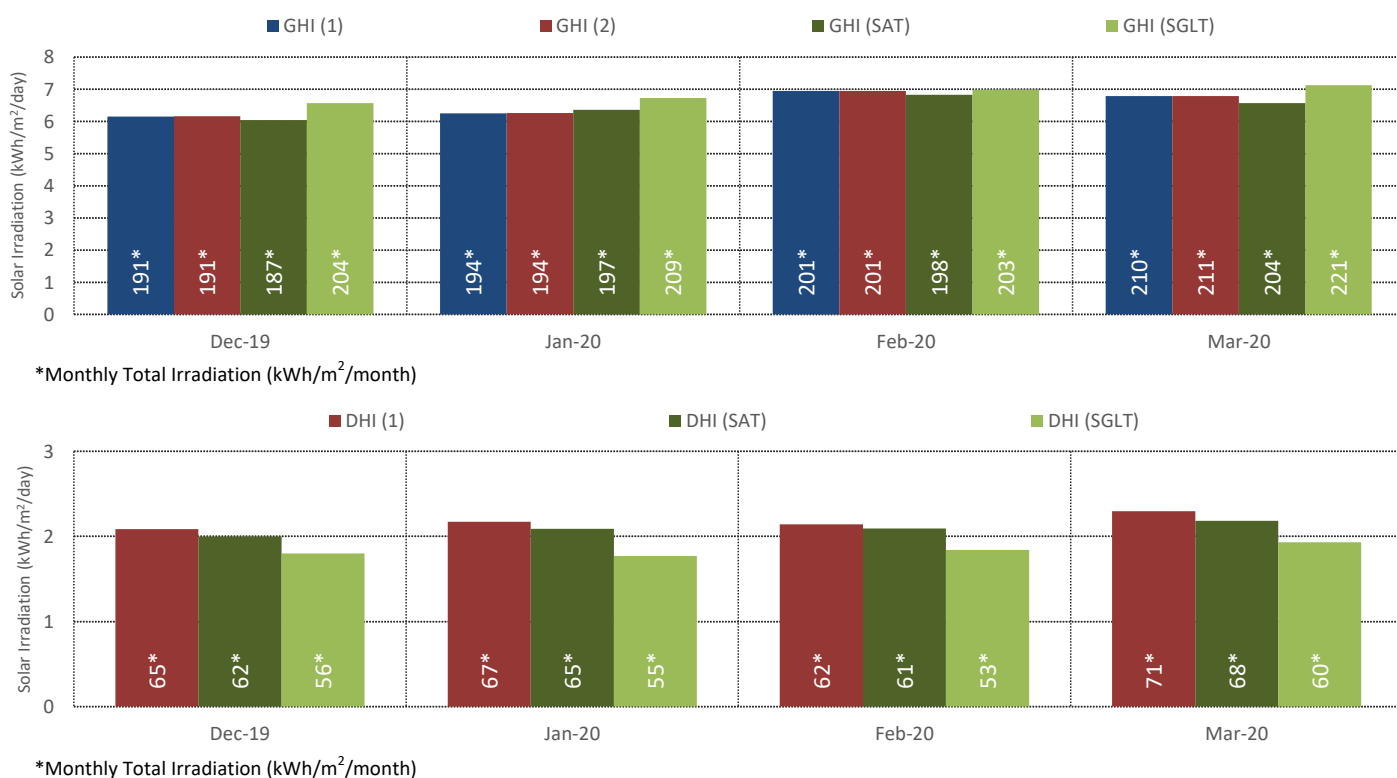


Figure 4.1 Monthly solar irradiation data



Table 4.2 presents the monthly GHI solar irradiation data. For more information on previous month's data see relevant month's report.

| Month          | GHI (1)<br>kWh/m <sup>2</sup> /day | GHI (2)<br>kWh/m <sup>2</sup> /day | GHI (SAT)<br>kWh/m <sup>2</sup> /day | GHI (1) vs (2)<br>% | GHI (1) vs (SAT)<br>% |
|----------------|------------------------------------|------------------------------------|--------------------------------------|---------------------|-----------------------|
| December '19   | 6.16**                             | 6.16**                             | 6.04**                               | -0.03               | 1.87                  |
| January '20    | 6.25                               | 6.26                               | 6.36                                 | -0.16               | -1.78                 |
| February '20   | 6.95                               | 6.95                               | 6.83                                 | 0.01                | 1.69                  |
| March '20      | 6.79                               | 6.79                               | 6.57                                 | -0.03               | 3.25                  |
| <b>Average</b> | 6.53                               | 6.54                               | 6.45                                 | *                   | *                     |
| <b>Maximum</b> | 6.95                               | 6.95                               | 6.83                                 | -0.16               | 3.25                  |
| <b>Minimum</b> | 6.16                               | 6.16                               | 6.04                                 | 0.01                | 1.69                  |

\*See Table 4.3

\*\*Available day data used

Table 4.2 Monthly solar irradiation data

Table 4.3 presents the overall percentage difference between the two pyranometers (GHI (1) vs (2)) as well as GHI (1) and satellite derived data (GHI (1) vs (SAT)) for the measurement campaign up to date of report. The average of the daily values are used.

| Duration | GHI (1)<br>kWh/m <sup>2</sup> /day | GHI (2)<br>kWh/m <sup>2</sup> /day | GHI (SAT)<br>kWh/m <sup>2</sup> /day | GHI (1) vs (2)<br>% | GHI (1) vs (SAT)<br>% |
|----------|------------------------------------|------------------------------------|--------------------------------------|---------------------|-----------------------|
| Months   |                                    |                                    |                                      |                     |                       |
| 4        | 6.53                               | 6.54                               | 6.45                                 | -0.05               | 1.31                  |

Table 4.3 Solar irradiation data comparison

Table 4.4 presents the monthly DHI solar irradiation data. For more information on previous month's data see relevant month's report.

| Month          | DHI (1)<br>kWh/m <sup>2</sup> /day | DHI (SAT)<br>kWh/m <sup>2</sup> /day | DHI (1) vs (SAT)<br>% |
|----------------|------------------------------------|--------------------------------------|-----------------------|
| December '19   | 2.08**                             | 2.00**                               | 4.14                  |
| January '20    | 2.17                               | 2.09                                 | 3.86                  |
| February '20   | 2.14                               | 2.09                                 | 2.33                  |
| March '20      | 2.30                               | 2.18                                 | 4.91                  |
| <b>Average</b> | 2.17                               | 2.09                                 | *                     |
| <b>Maximum</b> | 2.30                               | 2.18                                 | 4.91                  |
| <b>Minimum</b> | 2.08                               | 2.00                                 | 2.33                  |

\*See Table 4.5

\*\*Available day data used

Table 4.4 Monthly solar irradiation data

Table 4.5 presents the overall percentage difference between the ground measured DHI and the satellite derived DHI (DHI (1) vs (SAT)) for the measurement campaign up to date of report. The average of the daily values are used.

| Duration<br>Months | DHI (1)<br>kWh/m <sup>2</sup> /day | DHI (SAT)<br>kWh/m <sup>2</sup> /day | DHI (1) vs (SAT)<br>% |
|--------------------|------------------------------------|--------------------------------------|-----------------------|
| 4                  | 2.17                               | 2.09                                 | 3.83                  |

Table 4.5 Solar irradiation data comparison

Table 4.6 presents the monthly GTI data. The value of this table is not in comparing whether the results of the individual instruments are close to each other, but rather the percentage difference which is indicative of the effect of soiling on the site. For more information on previous month's data see relevant month's report.

| Month          | GTI (Clean)<br>kWh/m <sup>2</sup> /day | GTI (Soil)<br>kWh/m <sup>2</sup> /day | GTI (Monthly)<br>kWh/m <sup>2</sup> /day | GTI (Clean) vs<br>(Soil)<br>kWh/m <sup>2</sup> /day | GTI (Clean) vs<br>(Monthly)<br>kWh/m <sup>2</sup> /day |
|----------------|--|---------------------------------------|--|---|--|
| December '19   | 5.40**                                 | 5.40**                                | 5.38**                                   | 0.04  | 0.37   |
| January '20    | 5.52                                   | 5.54                                  | 5.49                                     | -0.23   | 0.57   |
| February '20   | 6.30                                   | 6.30                                  | 6.25                                     | -0.02   | 0.67   |
| March '20      | 6.46                                   | 6.46                                  | 6.43                                     | 0.00  | 0.49   |
| <b>Average</b> | 5.92                                   | 5.92                                  | 5.89                                     | *   | *  |
| <b>Maximum</b> | 6.46                                   | 6.46                                  | 6.43                                     | -0.23   | 0.67   |
| <b>Minimum</b> | 5.40                                   | 5.40                                  | 5.38                                     | 0.00  | 0.37   |

\*See Table 4.7

\*\*Available day data used

Table 4.6 Monthly GTI data

Table 4.7 presents the overall percentage difference between the two solar irradiance sensors for the measurement campaign up to date of report. The average of the daily values are used.

| Duration | GTI (Clean)<br>kWh/m <sup>2</sup> /day | GTI (Soil)<br>kWh/m <sup>2</sup> /day | GTI (Monthly)<br>kWh/m <sup>2</sup> /day | GTI (Clean) vs<br>(Soil)<br>kWh/m <sup>2</sup> /day | GTI (Clean) vs<br>(Monthly)<br>kWh/m <sup>2</sup> /day |
|----------|--|---------------------------------------|--|---|--|
| Months   | kWh/m <sup>2</sup> /day                | kWh/m <sup>2</sup> /day               | kWh/m <sup>2</sup> /day                  | kWh/m <sup>2</sup> /day                             | kWh/m <sup>2</sup> /day                                |
| 4        | 5.92                                   | 5.92                                  | 5.89                                     | -0.05   | 0.53   |

Table 4.7 GTI data comparison

## 5 Station Maintenance

The cleaning events for this month is shown in Figure 5.1 (30 cleaning events were recorded).

The maximum period without cleaning was 1 day. This is considered acceptable and the cleaning was done well for this month. Irradiation measurement during a cleaning event will most likely be affected for a couple of minutes due to shading. The cleaner has been instructed to clean one of the solar irradiance sensors (GTI (Monthly)) once a month, which was done on 1 March as well as on 31 March, after which he was reminded to only clean at the start of the month.

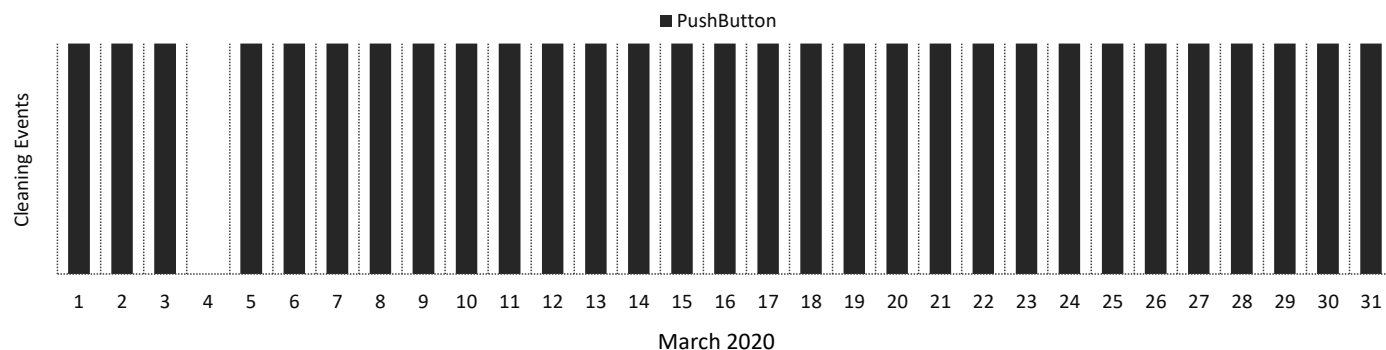


Figure 5.1: Cleaning events

## 6 Summary

The station is operational, the logger is running and communications are active.

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good.

The monthly average of GHI (1) and GHI (2) differ with -0.03 % for the month of March 2020 and has a -0.05 % difference over the full measurement period (04 December 2019 to date).

The monthly average of GTI (Clean) and GTI (Soil) differ with 0.00 % for the month of March 2020 and has a -0.05 % difference over the full measurement period (04 December 2019 to date).

The monthly average of GTI (Clean) and GTI (Monthly) differ with 0.49 % for the month of March 2020 and has a 0.53 % difference average over the full measurement (04 December 2019 to date).

Throughout the month a total of 4 minutes of data was removed either due to program upgrades, station restart or failing quality checks, this occurred on the following days:

1 and 31 March 2020.

This is indicated with NaN values in the minute data file and a red block on the applicable graph in this report.

The pyranometer measuring GHI (1) measured slightly lower irradiation due to soiling during the following day:

1 March 2020

GHI (2) was not affected.

The wind vane was damaged during on 27 March 2020, affected data has been removed and a new instrument has been shipped to site.