**Handout for verification of load measurements in Step IV**

☐  Verify the format of the file, only xls or csv formats are acceptable.

## Resolution of Data:

Check the time interval (time resolution) from the time column of the excel sheet. The time intervals must be coherent with the TOR/contract of the load measurements. As per the PDP standards 1 min or better time resolution is preferred, other resolutions are accepted if agreed in advance. The time interval / time resolution of a load measurement is represented in Figure 1.



*Figure 1: Time interval for a load measurement*

☐  Verify if time interval / time resolution is consistent. Check several rows throughout the measurements to verify consistent time resolution.

☐  Check if the data is measured for the agreed time period / duration (up to 4 weeks or agreed time period previously)

## Measurements:

☐  Following necessary parameters must be included in the load measurement data,

  o  Average Total Active Power (W)
  o  Average Total Active Energy (Wh)
  o  Average Power Factor

  *Note: Units of power and energy can also be in kW and kWh*

☐  The units (of the calculations) are important. Units of the parameters must be clearly mentioned and understood. Unit of Average Total Active Power can be W or kW, while unit of Average Total Active Energy can be Wh or kWh.

☐  Calculate energy consumption of the load measurements for a month in the excel sheet and verify if these load measurements are up to expectations. The load measurements values must match the historical data.

**Example:** Let us suppose that the measurements are carried out for Apr 2019 for a site. The historical data (from electricity bills) shows that the energy consumption was 190 MWh for Apr 2018. Then we need to find out the energy consumption of load measurements and verify if it matches with the data of Apr 2018.

Energy consumption can be found out using the following steps in excel sheet,

☐  Verify if you have the data of one whole month. You can see it from the time column of the excel sheet as shown in the Figure 2.



*Figure 2: One month (time period) shown in load measurement*

☐ Identify the "Average Total Active Power" (p) column in the excel sheet, as shown in Figure 3. Please see the abbreviations, if you find difficulties in finding out the column.

Average Total Active Power



*Figure 3: Identification of Average Total Active Power in the measured data*

☐ Find out sum of the Average Total Active Power for the whole month. It can be done as follows in the Figure 4,



*Figure 4: Sum of power calculations of the load measurements*

To identify the total energy consumption for the month, power needs to be divided by number of measurements taken in an hour.

If the resolution is 1 min, then we will have 60 measurements in an hour. Moreover, in case of resolution of 5 min, we will have 12 measurements in an hour.

In this case, we have resolution of 1min, so we will divide the power sum by 60, as we will have 60 measurements in an hour. This is shown as follows in Figure 5,



*Figure 5: Energy consumption calculation of the measured data*

Here the measured Energy consumption for month of Apr 2019 is 198,000 kWh or 198 MWh.

☐ Now check the historical data (electricity bill) of Apr 2018, and verify if energy consumption of Apr 2018 matches with measured consumption of Apr 2019 or not. In this case, as already mentioned that the historical data shows the energy consumption of 190 MWh for Apr 2018, so it matches with the energy consumption of 198 MW calculated from the measured data.

**If the compared data deviates by too much (e.g. twice the amount), a check with off-taker is required to ensure this is correct (additional machines were included, etc.).**

☐ Also, find out minimum power and maximum power of the average total active power, it can be done as shown in Figure 6 and Figure 7,
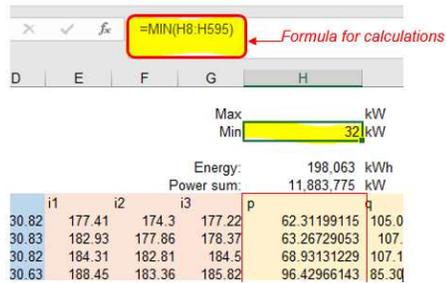


*Figure 6: Minimum power calculations*
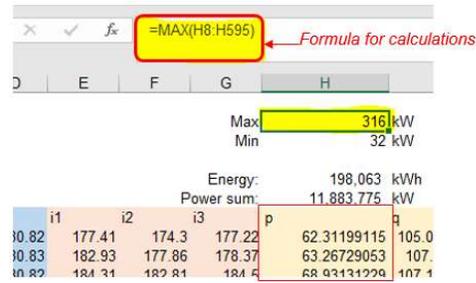
*Figure 7: Maximum power calculation*

**The measurements shows maximum power of 316 kW and minimum power of 32 kW.** <span style="color:red">**Verify from the historical data, that peak demand and base load matches with the maximum power and minimum power from the measurements respectively.**</span>

In case, the measurements are not conducted for one specific month (i.e. from beginning of month until the end of month), then estimate the historical data for that time period and compare it with the measurements.

For example, the measurements are conducted from 18.03.2019 to 15.04.2019 (two weeks from each month), and the energy consumption of 150 MWh is calculated for the measured period. The available historical data shows energy consumption of 120 MWh for March 2018 and 190 MWh for April 2018. The estimation of the historical energy consumption for 2 weeks of March 2018 and 2 weeks of April 2018 gives the consumption of 155 MWh (estimation details shown in table 1). Therefore, the measurement of 2019 are matching with historical data of 2018.

*Table 1: Calculations showing the example for estimation of historical energy consumption on weekly basis*

|  | March 2018 | March 2019 |
|---|---|---|
| Monthly Consumption | 120 MWh | 190 MWh |
| 2 weeks consumption (estimated average) | 120 / 2 = 60 MWh | 190 / 2 = 95 MWh |
| Average estimated consumption from 18 March to 15 April (4 weeks) | 60 MWh + 95 MWh = 155 MWh | |

## <u>Gaps</u>

☐ Observe any gaps in the measurements. Specifically check if the measurements for the parameters mentioned above have any missing data. It can be done as follows,

Select the measured data and then click on Home> Format as Table > select any suitable Table Style as shown in Figure 8.

*Figure 8: Formatting as Table of the load measurements*

Click on the top right of the Average Total Active Power column to visualize the sorting options as below in Figure 9
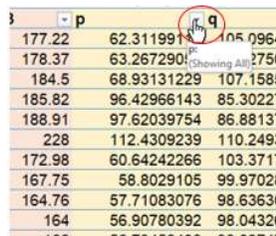


*Figure 9: Sorting menu for Average Total Actvie Power*

☐ Look for Zeros and (Blanks) in the scroll bar. Uncheck figures other than zeros and (Blanks) in the scroll bar of the sorting menu.
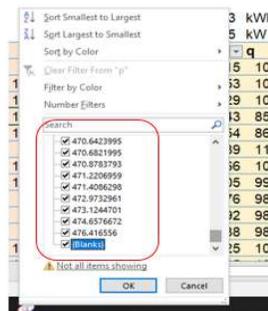


*Figure 10: Sorting options for Average Total Active Power measuremnts*

The timestamps with gaps can be observed and noted down from the time column.



*Figure 11: Time stamps with gaps in the measurements*

**There must be no gaps. In case of gaps, the respective client and the consultant must explain these gaps.**

☐     Gaps and data can also be visualise by drawing the graph of the measured data. Graph can be drawn in several ways. One is to go to insert > Charts > Scatter Chart with straight line, as shown in Figure 12.
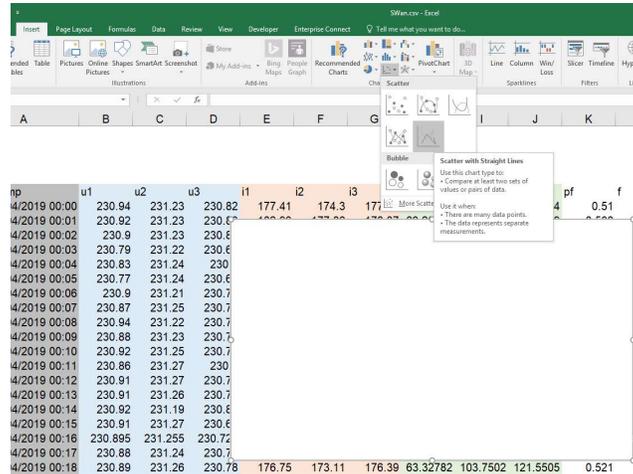


*Figure 12: Showing an option of inserting Scatter Chart with straight line in excel*

Under Chart tool, choose select data option and click on add data as in Figure 13.
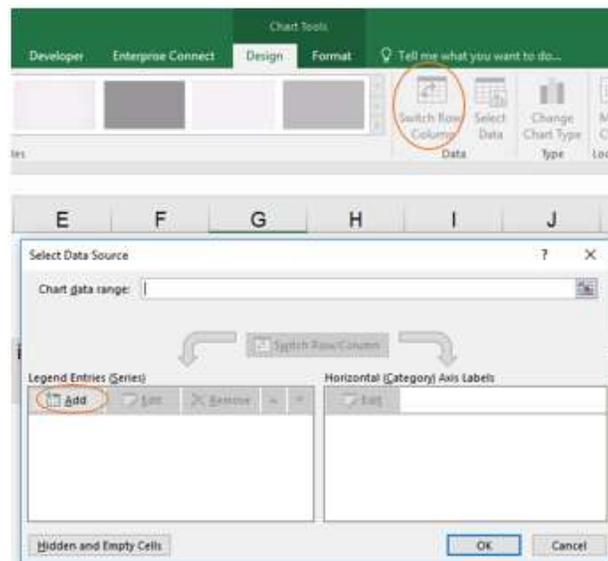


*Figure 13: Adding data into the chart*

Add data from time column into x-axis and Total average active power data into y-axis and press ok. It can be done as follows,
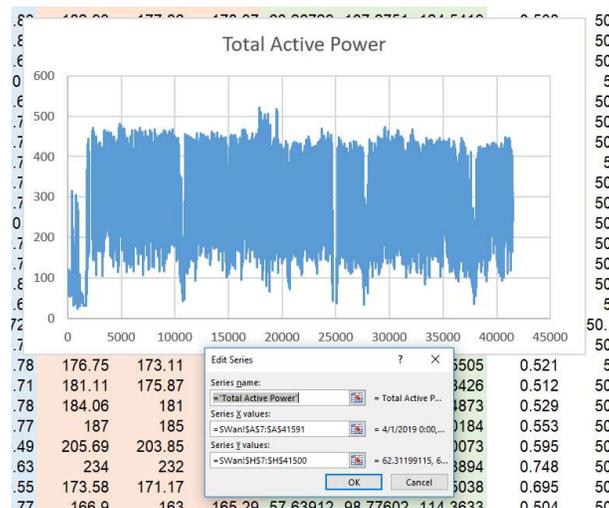
*Figure 14: Adding data to draw graph in excel*

The graph can be observed to evaluate the graphs and to analyse the data closely. It is also important to visualise the data and understand if the data is consistent from one day to other and one week to other. If the difference is very high, please note it down, report it to CM and confirm it with client and consultant.

Abbreviations:

| | |
|---|---|
| L1N | Line 1 to neutral of 3-phase system |
| L2N | Line 2 to neutral of 3-phase system |
| L3N | Line 3 to neutral of 3-phase system |
| Min | Minimum |
| Avg | Average |
| Max | Maximum |
| N | Neutral |
| Wh | Watt hour - Unit of Energy |
| W | Watt - Unit of Active Power |
| P | Active power |
| VA | Volt ampere - Unit of Apparent Power |
| S | Apparent power |
| VAR | Volt ampere reactive - Unit of Reactive Power |
| Q | Active power |
| PF | Power factor |
| Cos Phi | Power factor |
| Φ | Phi |
| THD | Total harmonic distortion |
| V | Volt – Unit of voltage |
| U | Voltage |
| LL | Line to line |
| LN | Line to neutral |
| I | Current |
| A | Ampere – Unit of current |

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| | |
|---|---|
| F | Frequency |
| k | kilo |
| M | Mega |