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# Energy Sector Capacity Building (ESCB)

AJIB PV Plant Grid Impact Study  
Training No. 1  
Load Flow Studies

6 December 2016





## Agenda

- Introductions
- **Morning Session**
  - 9:15 – 11:00 AM: Load Flow Analysis Part 2
    - Wrap-up Analysis from Part 1
    - Compare JEPCO results with Black & Veatch Results
- **Afternoon Session**
  - 11:00 AM – 1:30 PM: Long-Term Dynamic Analysis
    - Prepare Load and Generation Profile
    - Study Cases
    - Analysis
  - 2:30 – 3:30 PM: Short Circuit Analysis



## Long-Term Dynamic Analysis

- The Long-Term Dynamic analysis studies the impact of changing load and generation over a period of time
- Requires load and generation profiles to be imported into PSS SINCAL
- The objective of the analysis is dependent on the resolution of the data:
  - Lower resolution data can be used to study voltage profile, reverse power flow, and determining total number of voltage regulator/LTC tap changes
  - Higher resolution data can be used to study power quality impact such as voltage flicker and voltage regulator/LTC tap cycling

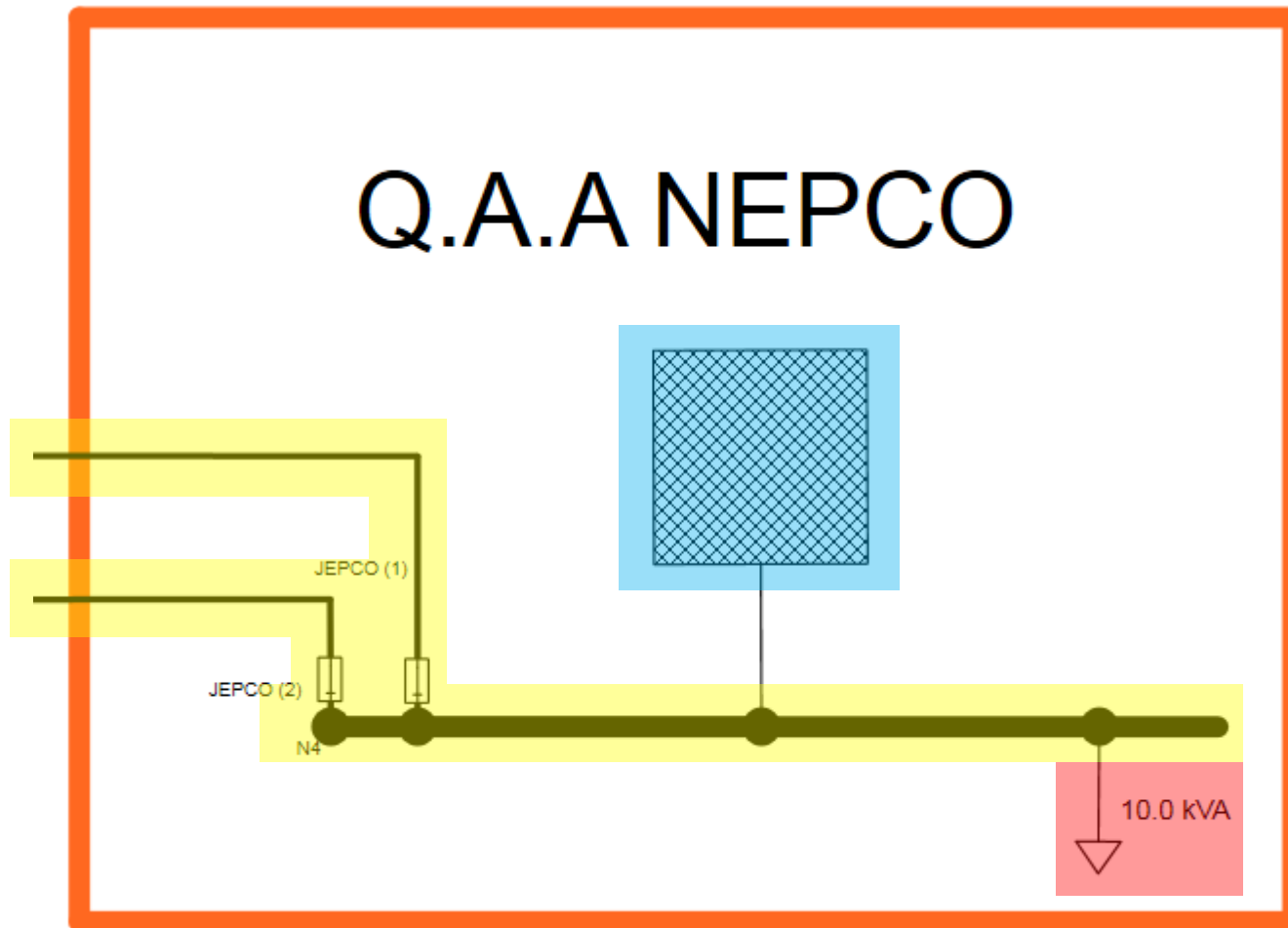


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## **Load Profile Setup – Review JEPCO Load Profiles**



## Q.A.A. NEPCO

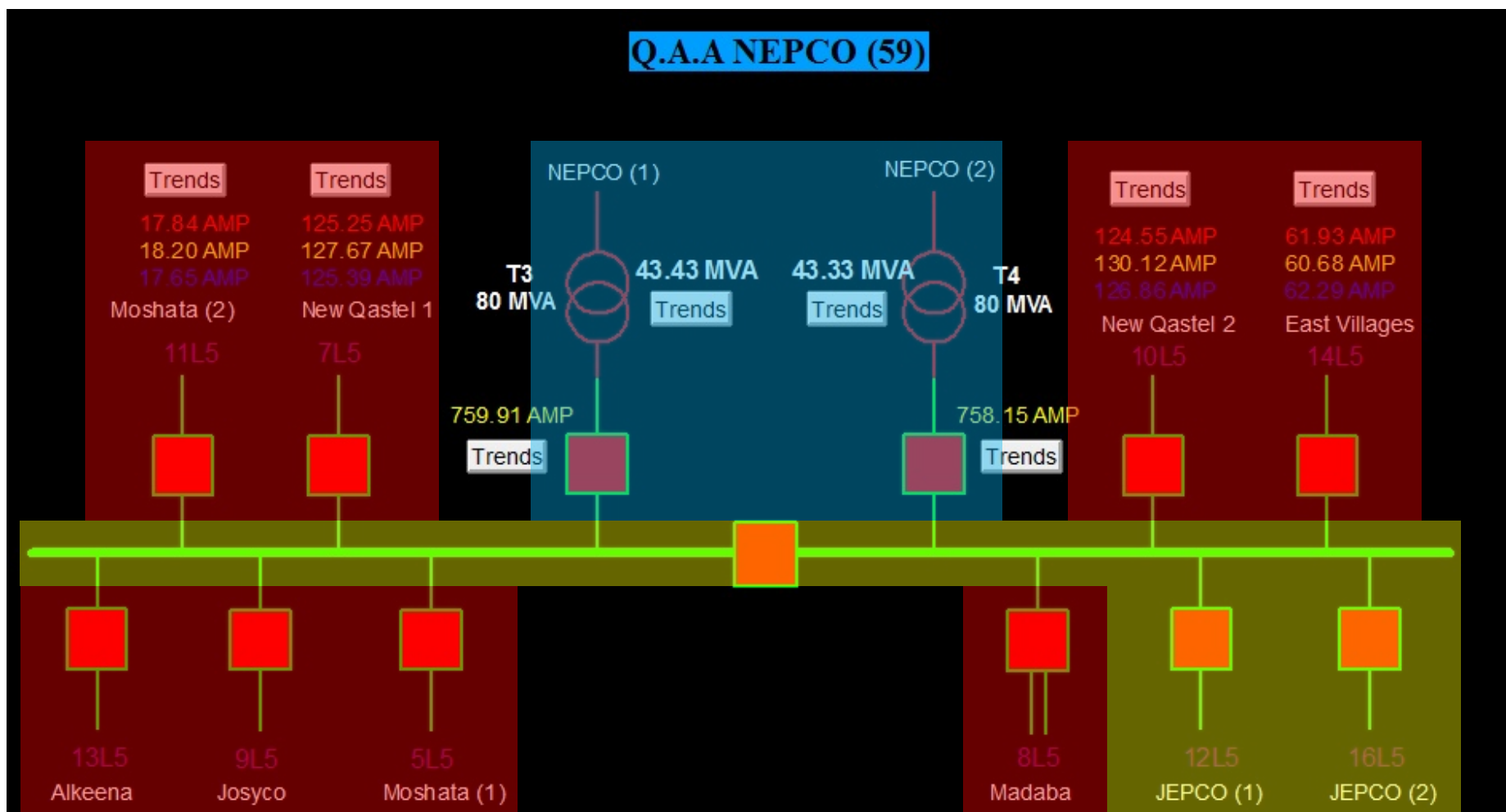




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## Q.A.A NEPCO (59)





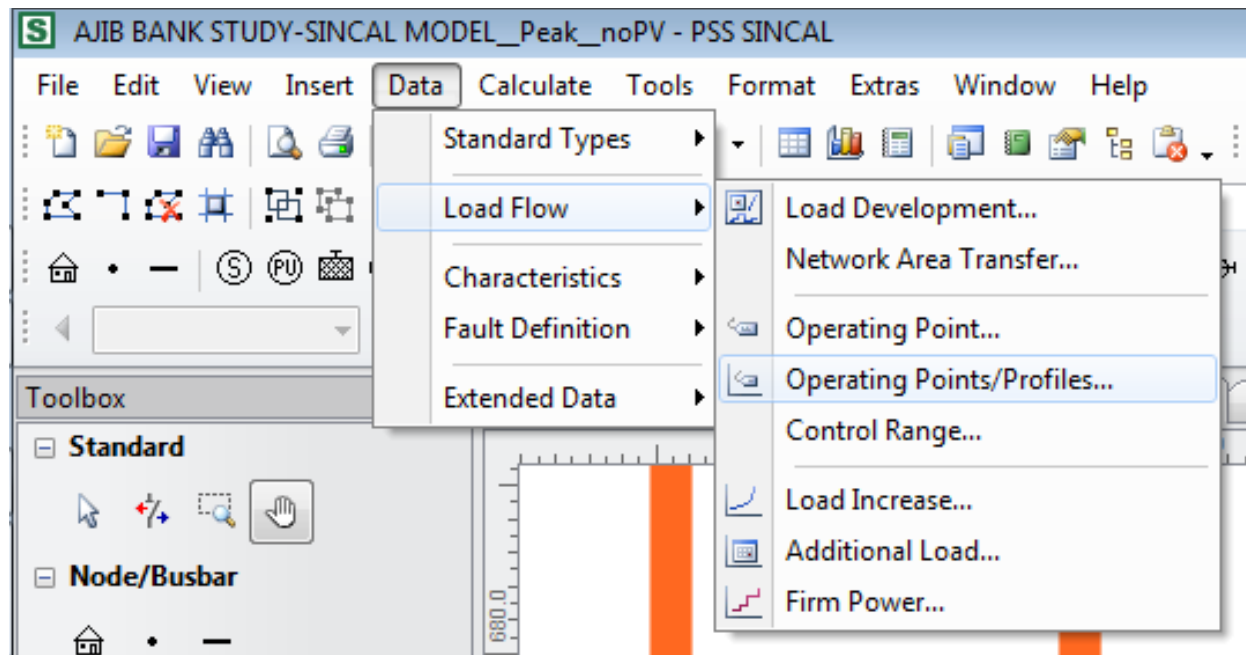
## Creating a Composite Load Profile for Q.A.A. NEPCO

- Open the load spreadsheet for Q.A.A. NEPCO
- Loads are populated for individual circuits
- Assuming the load at the 33 kV Q.A.A. NEPCO bus is a lumped representation of the following circuits:
  - Moshata 1 and 2
  - New Qastel 1 and 2
  - East Villages
  - Josyco
  - Madaba
  - Alkeena
- Need to create a composite load profile to represent the 33 kV load



## Importing Load Profiles in PSS SINCAL

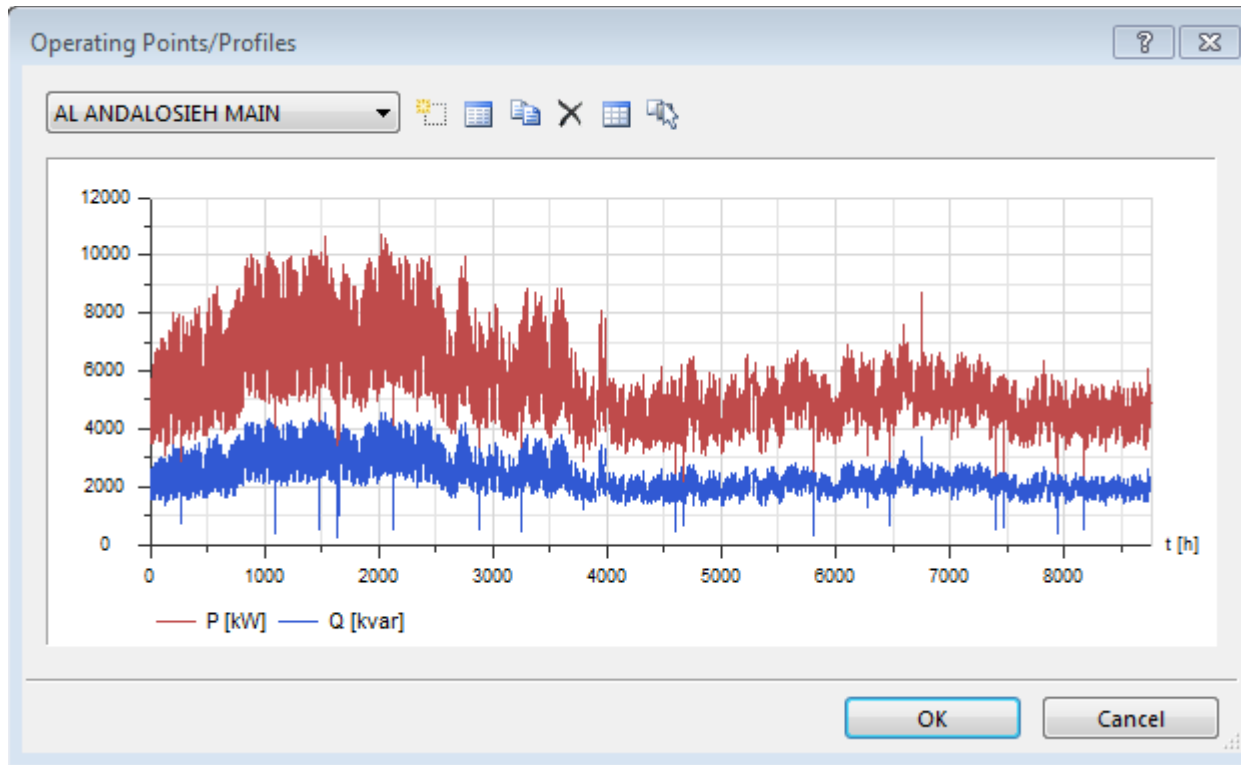
- Review the required format for load and generation profiles








## Example Load Profile





## Creating a New Load Profile

Operating Points/Profiles

(none) 

|  | t<br>[h] | Curve | f<br>[pu] | P<br>[kW] | Q<br>[kvar] |
|--|----------|-------|-----------|-----------|-------------|
|  |          |       |           |           |             |

OK Cancel



## Creating New Load Profile

- Several types of series:
  - Daily
  - Weekly
  - Yearly

Operating Points/Profiles

Basic Data | Additional Data

Name

Type

Function

|                     |    |                                  |   |
|---------------------|----|----------------------------------|---|
| Base Duration       | Tb | <input type="text" value="0.0"/> | h |
| Parameter Power     | a1 | <input type="text" value="0.0"/> | 1 |
| Parameter Power     | b1 | <input type="text" value="0.0"/> | 1 |
| Parameter Reduction | a2 | <input type="text" value="0.0"/> | 1 |
| Parameter Reduction | b2 | <input type="text" value="0.0"/> | 1 |

OK Cancel



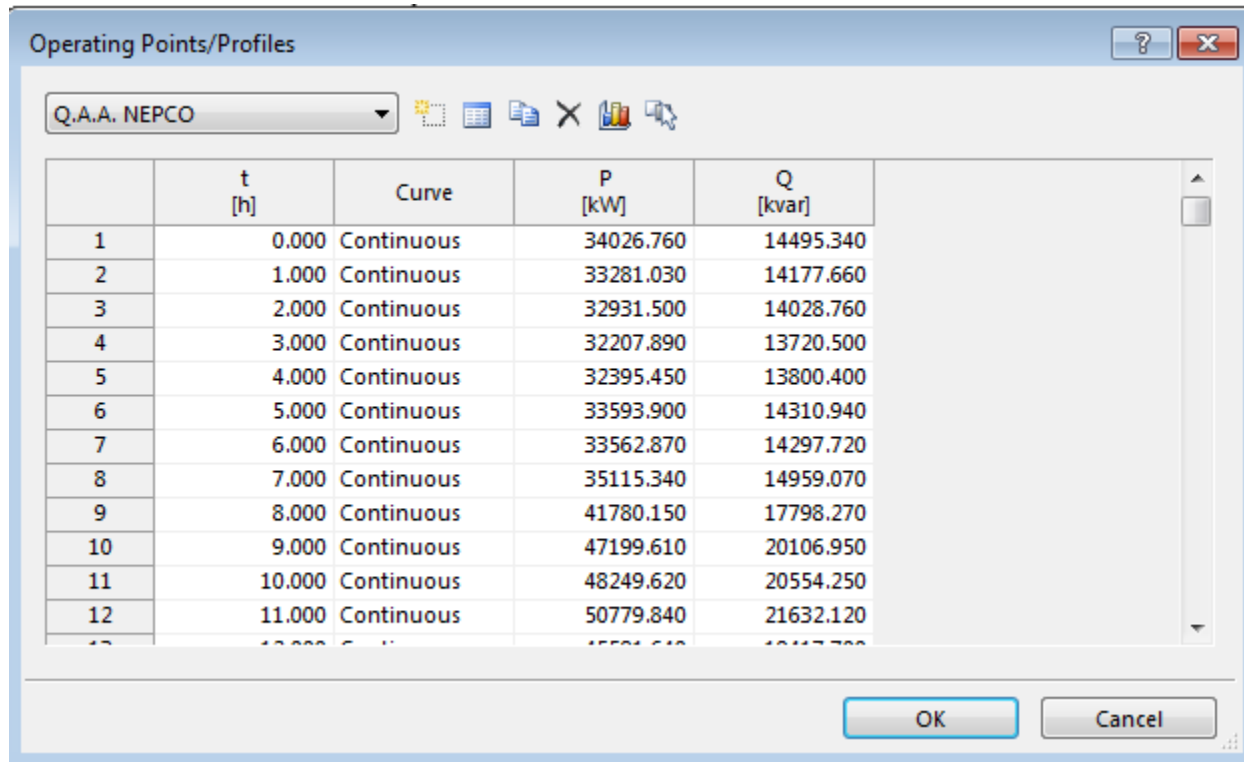
## Creating New Load Profiles

- Profile Functions
  - Factor S
  - Factor P and Q
  - Power (kW and kVAR)
  - V and P (kV and kW)
  - Factor V and P
- For 33 kV loads use “Power” due to current flow being specified
- For 0.415 kV loads use “Factor” due to loads being specified as a percentage of S



## Create Composite Load Profile for 33 kV Load at Q.A.A. NEPCO

- The format for the composite load:



Operating Points/Profiles

Q.A.A. NEPCO

|    | t<br>[h] | Curve      | P<br>[kW] | Q<br>[kvar] |
|----|----------|------------|-----------|-------------|
| 1  | 0.000    | Continuous | 34026.760 | 14495.340   |
| 2  | 1.000    | Continuous | 33281.030 | 14177.660   |
| 3  | 2.000    | Continuous | 32931.500 | 14028.760   |
| 4  | 3.000    | Continuous | 32207.890 | 13720.500   |
| 5  | 4.000    | Continuous | 32395.450 | 13800.400   |
| 6  | 5.000    | Continuous | 33593.900 | 14310.940   |
| 7  | 6.000    | Continuous | 33562.870 | 14297.720   |
| 8  | 7.000    | Continuous | 35115.340 | 14959.070   |
| 9  | 8.000    | Continuous | 41780.150 | 17798.270   |
| 10 | 9.000    | Continuous | 47199.610 | 20106.950   |
| 11 | 10.000   | Continuous | 48249.620 | 20554.250   |
| 12 | 11.000   | Continuous | 50779.840 | 21632.120   |

OK Cancel



## Create Composite Load Profile for 33 kV Load at Q.A.A. NEPCO

- Modify existing load data spreadsheet as follows:

| TIME STAMP         | #  | HOUR | MONTH | AMPER  | kVA      | pf   | kW       | kVAR   |
|--------------------|----|------|-------|--------|----------|------|----------|--------|
| 01-Nov-15 00:00:00 | 0  | 0    | 11    | 255.33 | 14594.07 | 0.92 | 14592.19 | 234.33 |
| 01-Nov-15 01:00:00 | 1  | 1    | 11    | 253.90 | 14512.44 | 0.92 | 14510.57 | 233.02 |
| 01-Nov-15 02:00:00 | 2  | 2    | 11    | 246.98 | 14116.81 | 0.92 | 14114.99 | 226.66 |
| 01-Nov-15 03:00:00 | 3  | 3    | 11    | 247.27 | 14133.56 | 0.92 | 14131.74 | 226.93 |
| 01-Nov-15 04:00:00 | 4  | 4    | 11    | 241.82 | 13821.97 | 0.92 | 13820.18 | 221.93 |
| 01-Nov-15 05:00:00 | 5  | 5    | 11    | 248.99 | 14231.94 | 0.92 | 14230.11 | 228.51 |
| 01-Nov-15 06:00:00 | 6  | 6    | 11    | 248.53 | 14205.63 | 0.92 | 14203.80 | 228.09 |
| 01-Nov-15 07:00:00 | 7  | 7    | 11    | 258.52 | 14776.19 | 0.92 | 14774.28 | 237.25 |
| 01-Nov-15 08:00:00 | 8  | 8    | 11    | 284.24 | 16246.34 | 0.92 | 16244.24 | 260.86 |
| 01-Nov-15 09:00:00 | 9  | 9    | 11    | 276.24 | 15789.31 | 0.92 | 15787.28 | 253.52 |
| 01-Nov-15 10:00:00 | 10 | 10   | 11    | 297.75 | 17018.46 | 0.92 | 17016.27 | 273.25 |

- In the future, this can be implemented by macros



## Create Composite Load Profile for 33 kV Load at Q.A.A. NEPCO

- Create a new “Summary” tab within the load spreadsheet

| DATE               | ALKEENA 33KV<br>FEEDER<br>(kVA) | MADABA 33KV<br>FEEDER<br>(kVA) | MOSHATA (2)<br>33KV FEEDER<br>(kVA) | JOSYCO 33KV<br>FEEDER<br>(kVA) | NEW QASTEL<br>(1) 33KV<br>FEEDER<br>(kVA) | NEW QASTEL<br>(2)<br>(kVA) | MOSHATA (1)<br>33KV FEEDER<br>(kVA) | EAST VILLAGES<br>33KV FEEDER<br>(kVA) | TOTAL    | t<br>[h] | Curve      | P<br>[kW] | Q<br>[kVAR] |
|--------------------|---------------------------------|--------------------------------|-------------------------------------|--------------------------------|---|----------------------------|-------------------------------------|---------------------------------------|----------|----------|------------|-----------|-------------|
| 01-Nov-15 00:00:00 | 14594.07                        | 3099.74                        | 937.77                              | 3688.29                        | 5495.59                                   | 5585.46                    | 906.37                              | 2678.30                               | 36985.61 | 0        | Continuous | 34026.76  | 14495.34    |
| 01-Nov-15 01:00:00 | 14512.44                        | 3077.76                        | 950.33                              | 3667.36                        | 5277.06                                   | 5375.44                    | 909.51                              | 2405.13                               | 36175.03 | 1        | Continuous | 33281.03  | 14177.66    |
| 01-Nov-15 02:00:00 | 14116.81                        | 3075.32                        | 943.00                              | 3606.65                        | 5325.20                                   | 5505.22                    | 904.28                              | 2318.61                               | 35795.11 | 2        | Continuous | 32931.50  | 14028.76    |
| 01-Nov-15 03:00:00 | 14133.56                        | 3055.08                        | 946.14                              | 3462.22                        | 5062.50                                   | 5157.22                    | 906.37                              | 2285.47                               | 35008.58 | 3        | Continuous | 32207.89  | 13720.50    |
| 01-Nov-15 04:00:00 | 13821.97                        | 3056.48                        | 936.38                              | 3648.52                        | 5187.05                                   | 5281.25                    | 901.49                              | 2379.32                               | 35212.44 | 4        | Continuous | 32395.45  | 13800.40    |
| 01-Nov-15 05:00:00 | 14231.94                        | 3046.01                        | 932.89                              | 3589.91                        | 5608.84                                   | 5700.42                    | 891.72                              | 2513.38                               | 36515.11 | 5        | Continuous | 33593.90  | 14310.94    |
| 01-Nov-15 06:00:00 | 14205.63                        | 3039.39                        | 919.63                              | 3528.90                        | 5514.85                                   | 5626.21                    | 881.95                              | 2764.82                               | 36481.38 | 6        | Continuous | 33562.87  | 14297.72    |
| 01-Nov-15 07:00:00 | 14776.19                        | 3085.44                        | 948.94                              | 3903.89                        | 5842.23                                   | 5946.90                    | 911.26                              | 2754.01                               | 38168.85 | 7        | Continuous | 35115.34  | 14959.07    |
| 01-Nov-15 08:00:00 | 16246.34                        | 3031.71                        | 938.47                              | 4919.12                        | 8042.23                                   | 8341.56                    | 901.49                              | 2992.29                               | 45413.20 | 8        | Continuous | 41780.15  | 17798.27    |
| 01-Nov-15 09:00:00 | 15789.31                        | 3018.45                        | 919.63                              | 5530.34                        | 10694.37                                  | 10832.52                   | 881.25                              | 3638.05                               | 51303.93 | 9        | Continuous | 47199.61  | 20106.95    |
| 01-Nov-15 10:00:00 | 17018.46                        | 3018.10                        | 935.68                              | 5484.29                        | 10702.74                                  | 10836.71                   | 896.60                              | 3552.65                               | 52445.23 | 10       | Continuous | 48249.62  | 20554.25    |
| 01-Nov-15 11:00:00 | 17038.28                        | 3018.10                        | 933.59                              | 5745.95                        | 11906.35                                  | 12048.69                   | 898.70                              | 3605.82                               | 55195.47 | 11       | Continuous | 50779.84  | 21632.12    |

- Sum up the kVA from each of the circuits to be represented by the 33 kV load, create PSS SINICAL inputs



## Create Composite Load Profile for 33 kV Load at Q.A.A. NEPCO

- Data can be copied and pasted into PSS SINCAL:

| t<br>[h] | Curve      | P<br>[kW] | Q<br>[kVAR] |
|----------|------------|-----------|-------------|
| 0        | Continuous | 34026.76  | 14495.34    |
| 1        | Continuous | 33281.03  | 14177.66    |
| 2        | Continuous | 32931.50  | 14028.76    |
| 3        | Continuous | 32207.89  | 13720.50    |
| 4        | Continuous | 32395.45  | 13800.40    |
| 5        | Continuous | 33593.90  | 14310.94    |
| 6        | Continuous | 33562.87  | 14297.72    |
| 7        | Continuous | 35115.34  | 14959.07    |
| 8        | Continuous | 41780.15  | 17798.27    |
| 9        | Continuous | 47199.61  | 20106.95    |
| 10       | Continuous | 48249.62  | 20554.25    |
| 11       | Continuous | 50779.84  | 21632.12    |



|    | t<br>[h] | Curve      | P<br>[kW] | Q<br>[kvar] |
|----|----------|------------|-----------|-------------|
| 1  | 0.000    | Continuous | 34026.760 | 14495.340   |
| 2  | 1.000    | Continuous | 33281.030 | 14177.660   |
| 3  | 2.000    | Continuous | 32931.500 | 14028.760   |
| 4  | 3.000    | Continuous | 32207.890 | 13720.500   |
| 5  | 4.000    | Continuous | 32395.450 | 13800.400   |
| 6  | 5.000    | Continuous | 33593.900 | 14310.940   |
| 7  | 6.000    | Continuous | 33562.870 | 14297.720   |
| 8  | 7.000    | Continuous | 35115.340 | 14959.070   |
| 9  | 8.000    | Continuous | 41780.150 | 17798.270   |
| 10 | 9.000    | Continuous | 47199.610 | 20106.950   |
| 11 | 10.000   | Continuous | 48249.620 | 20554.250   |
| 12 | 11.000   | Continuous | 50779.840 | 21632.120   |





## **Exercise – Create 24 Hour Load Profile for Q.A.A. NEPCO for 1/11/15**

- Open the model:
  - AJIB BANK STUDY-SINCAL MODEL\_\_Min\_\_MaxPV\_\_100
- Make the necessary updates to the load profile spreadsheet for each circuit
- Create the load profile in PSS SINCAL
- Create Summary tab in the load profile spreadsheet, combine the necessary loads together
- Format the data so it is ready to be pasted into PSS SINCAL



## Assigning the Load Profile

Load

Basic Data | Element Data | Additional Data | System Data

Node: N4  
Element Name: LO170  
Network Level: Medium Voltage (33 kV)  
Load Type: Load

L123

☐ Equivalent Load  
☐ Out of service

Operating State

Load Flow Type: P and Q constant  
Load Input: I, cosφ and V

|              |      |       |    |
|--------------|------|-------|----|
| Current      | I    | 0.853 | kA |
| Power Factor | cosφ | 0.92  | 1  |
| Voltage      | V    | 33.0  | kV |

Factor I: fl 1.0 1  
Manipulation Factor: \* (none)

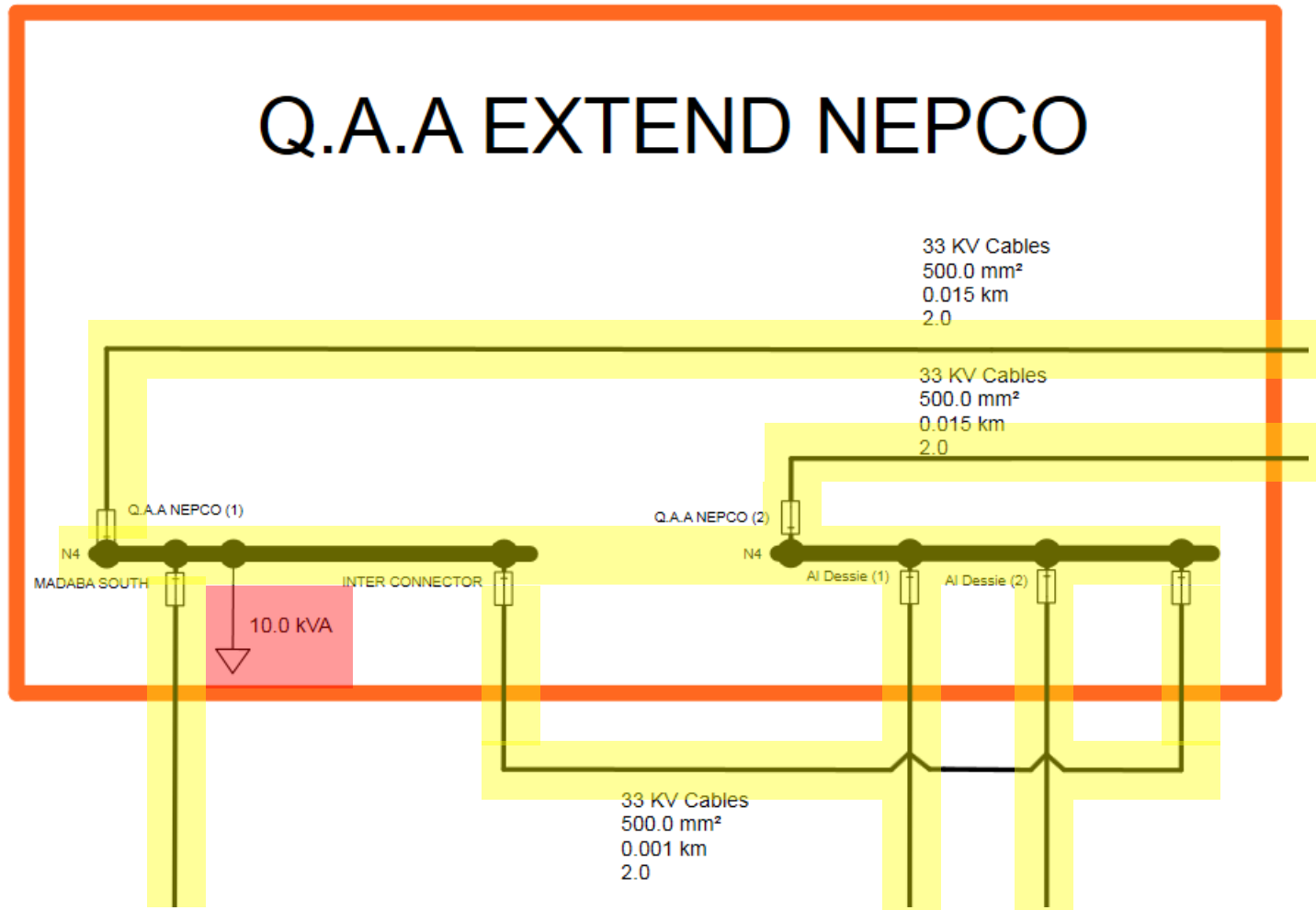
Operating Points

Profile 1: Q.A.A. NEPCO  
Profile 2: (none)  
Operating Points: (none)  
Load Increase: (none)

OK Cancel



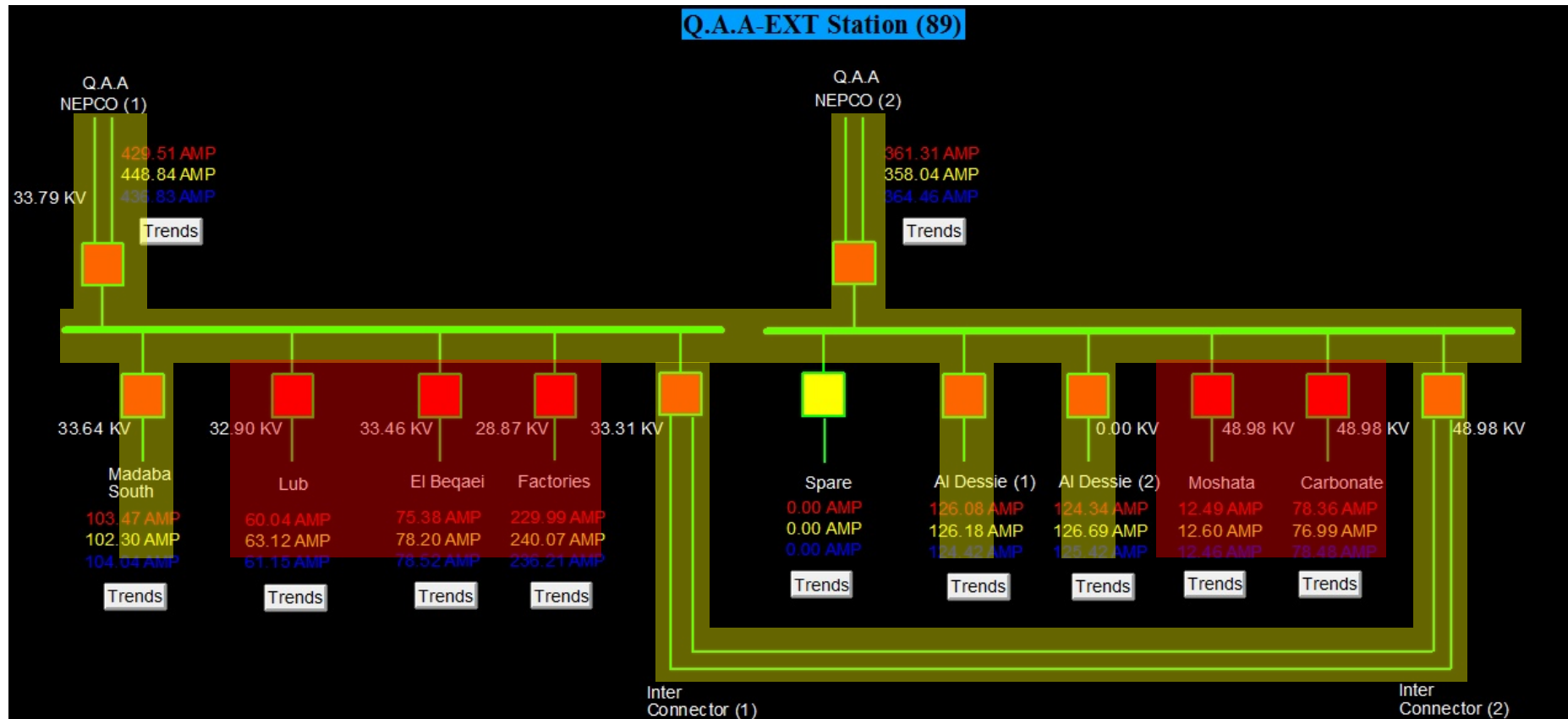
## Q.A.A. Extended NEPCO





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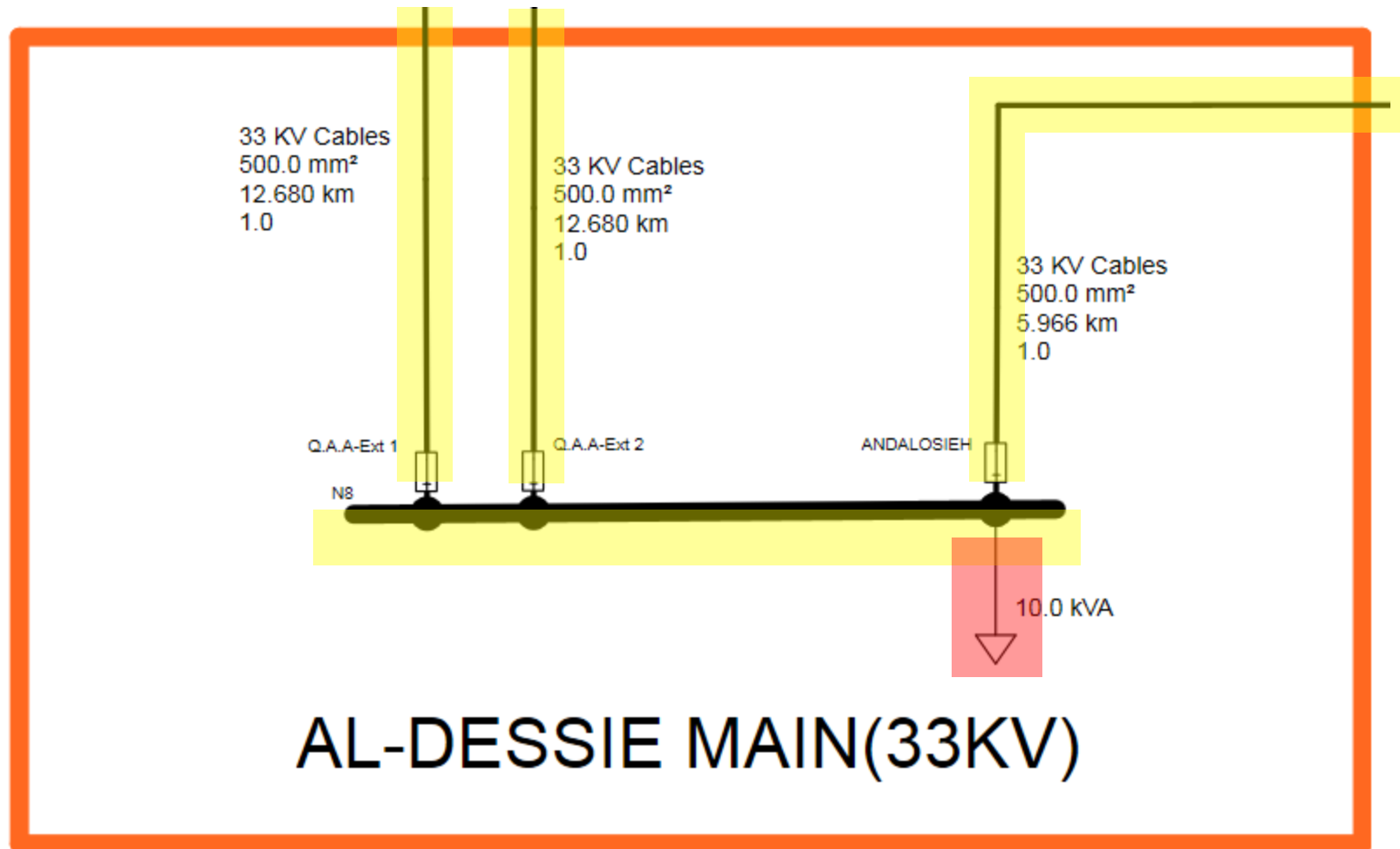


## **Repeat the Process – Create 24 Hour Load Profile for 1/11/15 Q.A.A. Extended NEPCO**

- Make the necessary updates to the load profile spreadsheet for each circuit
- Create the load profile in PSS SINCAL
- Create Summary tab in the load profile spreadsheet, combine the necessary loads together
- Format the data so it is ready to be pasted into PSS SINCAL



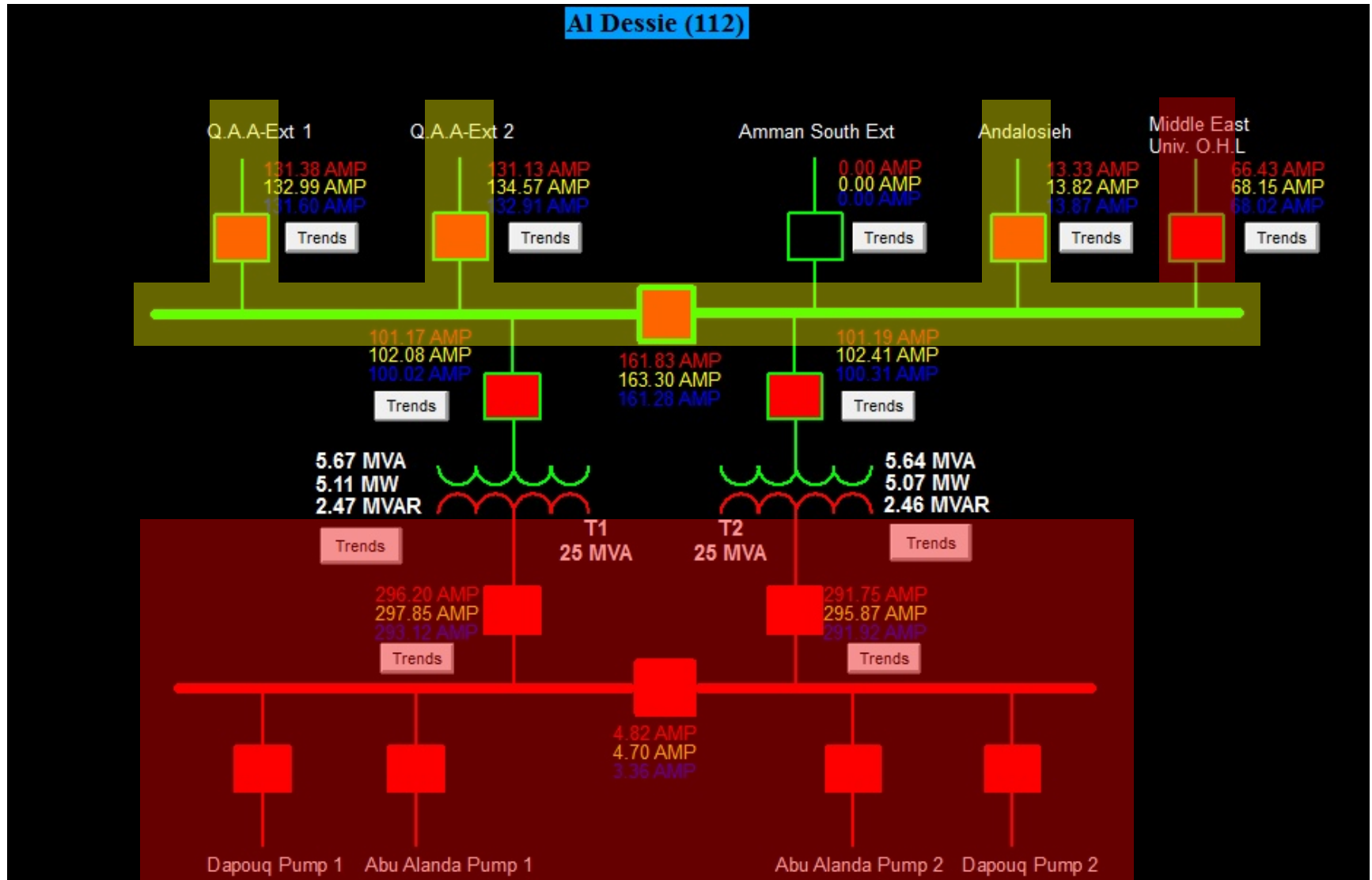
## AL DESSIE MAIN





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## **Repeat the Process – Create 24 Hour Load Profile for 1/11/15 AL DESSIE MAIN**

- Make the necessary updates to the load profile spreadsheet for each circuit
- Create the load profile in PSS SINICAL
- Create Summary tab in the load profile spreadsheet, combine the necessary loads together
- Format the data so it is ready to be pasted into PSS SINICAL

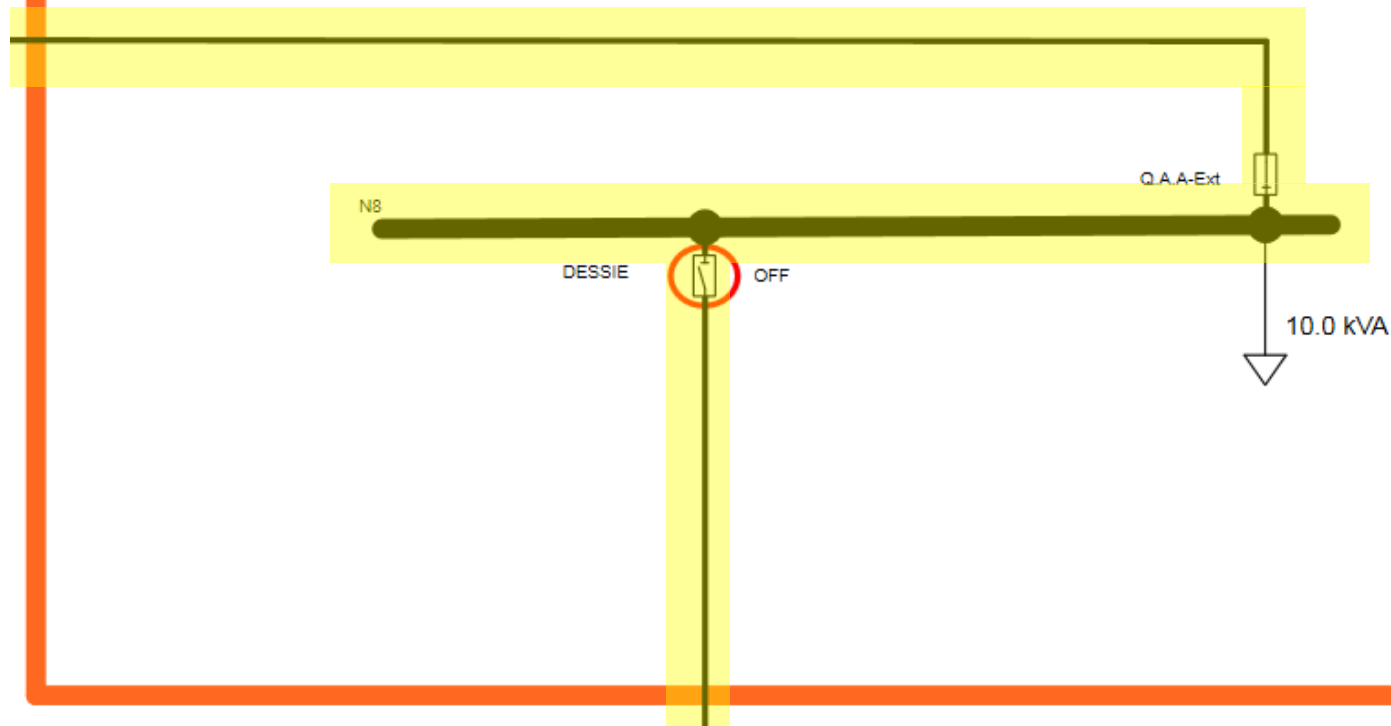




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## AL ANDALOSIEH MAIN

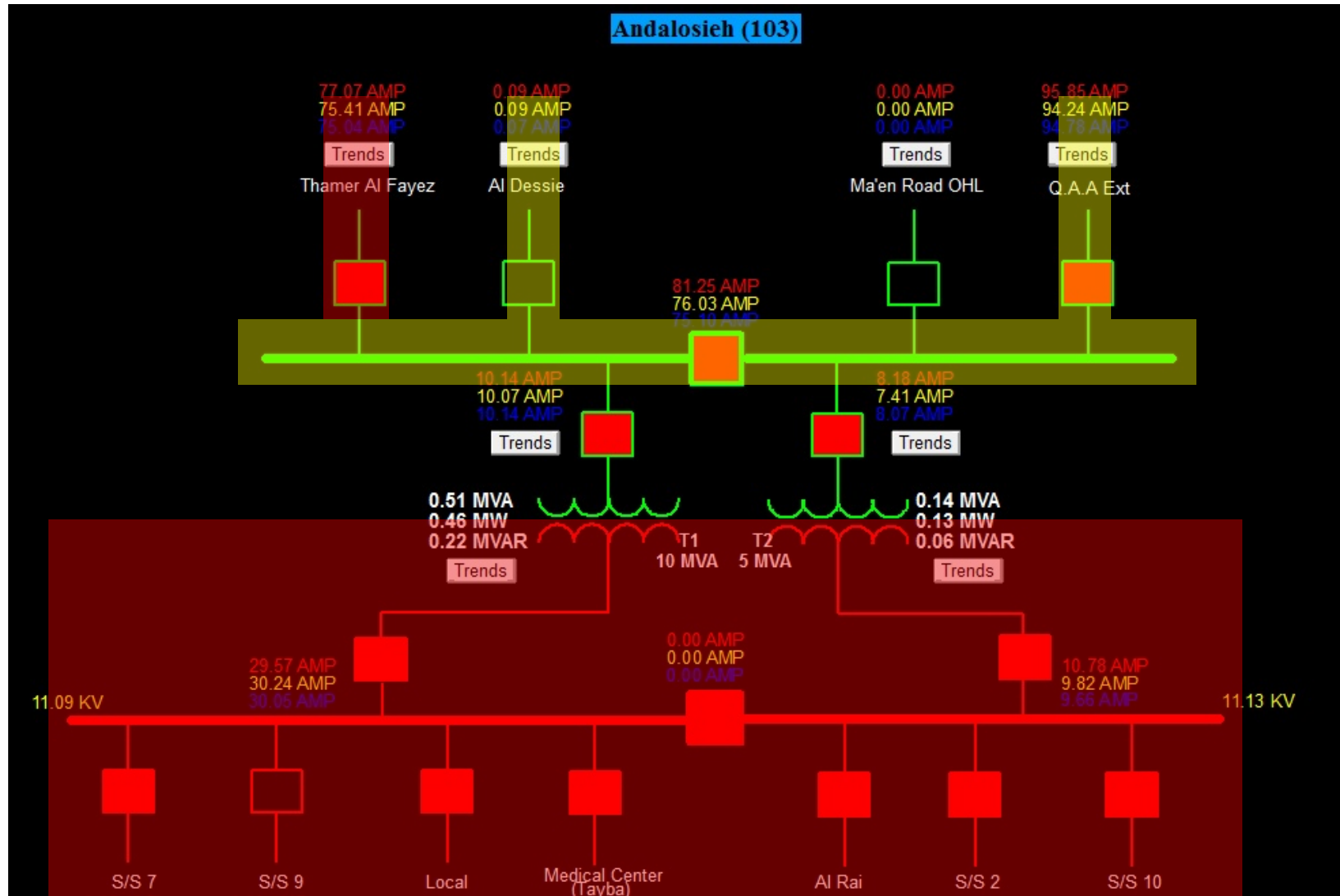
### AL-ANDALOSIEH MAIN(33KV)





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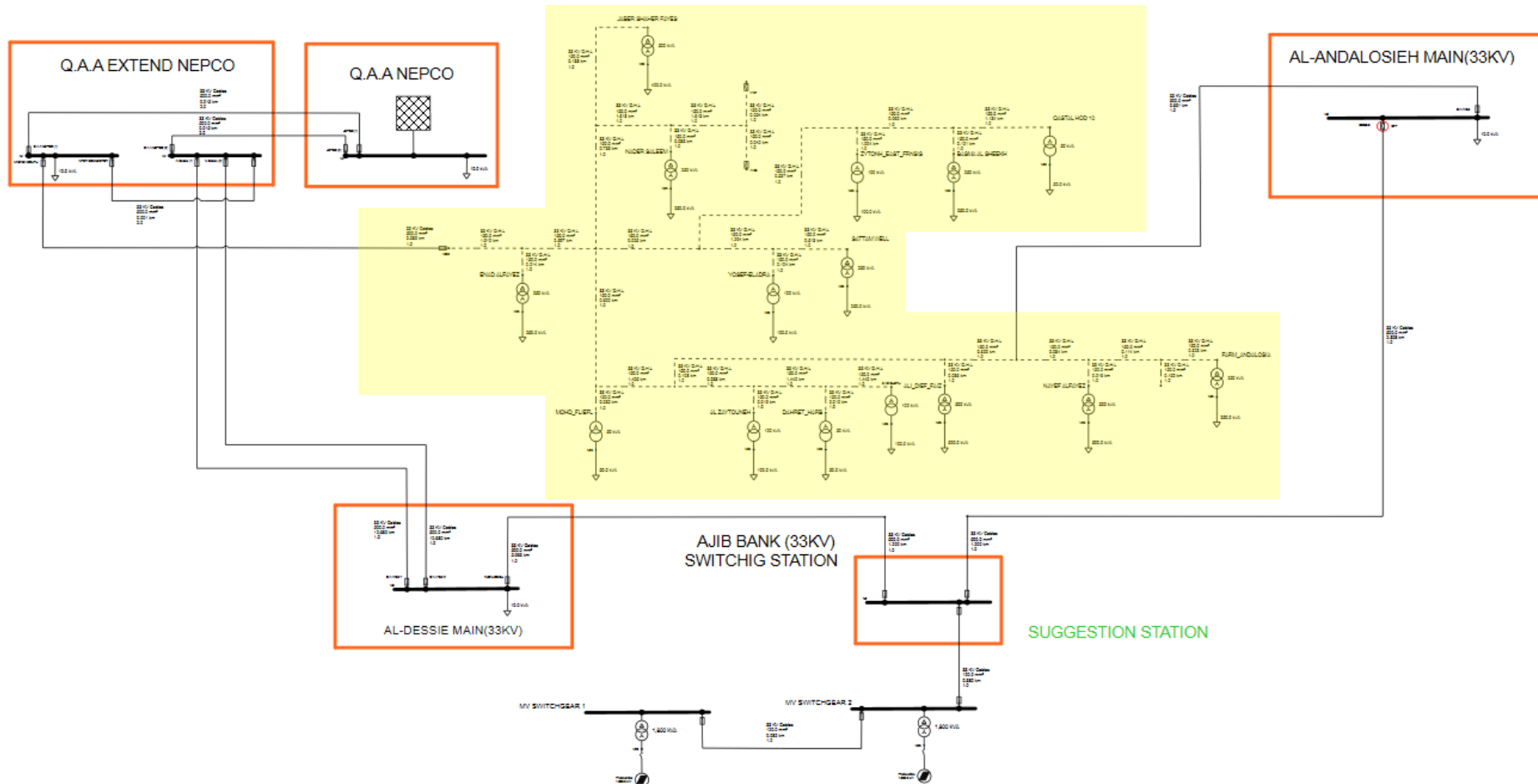


## **Repeat the Process – Create 24 Hour Load Profile for 1/11/15 AL ANDALOSIEH MAIN**

- Make the necessary updates to the load profile spreadsheet for each circuit
- Create the load profile in PSS SINCAL
- Create Summary tab in the load profile spreadsheet, combine the necessary loads together
- Format the data so it is ready to be pasted into PSS SINCAL



## MADABA SOUTH





## Creating the Madaba South Load Profile

- The Madaba South load profile is based on the difference between the flow from Q.A.A. Extended NEPCO and Al Andalosieh Main 33 kV circuits
- Subtract the two currents to obtain the Madaba South load current.
- Per-unitize the based on the peak value
  - Recall, the 0.415 kV loads are modeled based on a factor of their total apparent power (S)
- Open Q.A.A. Extended NEPCO load profile
- Open Al Andalosieh Main load profile



## Creating the Madaba South Load Profile

- Let's make these changes:

| Seen from Q.A.A. Ext. NEPCO |    |      |       |        |         |      |         |       | Seen from ANDALOSIEH 33 kV 1215.48 |             |                  | t   | Curve      | f    |
|-----------------------------|----|------|-------|--------|---------|------|---------|-------|------------------------------------|-------------|------------------|-----|------------|------|
| TIME STAMP                  | #  | HOUR | MONTH | AMPER  | kVA     | pf   | kW      | kVAR  | (kVA)                              | Delta (kVA) | Delta (pu, peak) | [h] |            | [pu] |
| 01-Nov-15 00:00:00          | 0  | 0    | 11    | 89.36  | 5107.51 | 0.92 | 5106.85 | 82.01 | 4763.52                            | 343.99      | 0.28             | 0   | Continuous | 0.28 |
| 01-Nov-15 01:00:00          | 1  | 1    | 11    | 85.92  | 4911.24 | 0.92 | 4910.61 | 78.86 | 4510.00                            | 401.24      | 0.33             | 1   | Continuous | 0.33 |
| 01-Nov-15 02:00:00          | 2  | 2    | 11    | 86.98  | 4971.45 | 0.92 | 4970.81 | 79.82 | 4308.59                            | 662.86      | 0.55             | 2   | Continuous | 0.55 |
| 01-Nov-15 03:00:00          | 3  | 3    | 11    | 77.32  | 4419.43 | 0.92 | 4418.86 | 70.96 | 4051.12                            | 368.31      | 0.30             | 3   | Continuous | 0.30 |
| 01-Nov-15 04:00:00          | 4  | 4    | 11    | 73.10  | 4178.22 | 0.92 | 4177.69 | 67.09 | 3805.28                            | 372.95      | 0.31             | 4   | Continuous | 0.31 |
| 01-Nov-15 05:00:00          | 5  | 5    | 11    | 78.92  | 4510.93 | 0.92 | 4510.35 | 72.43 | 4113.68                            | 397.25      | 0.33             | 5   | Continuous | 0.33 |
| 01-Nov-15 06:00:00          | 6  | 6    | 11    | 85.01  | 4859.11 | 0.92 | 4858.48 | 78.02 | 4484.65                            | 374.46      | 0.31             | 6   | Continuous | 0.31 |
| 01-Nov-15 07:00:00          | 7  | 7    | 11    | 96.61  | 5522.08 | 0.92 | 5521.37 | 88.66 | 5119.60                            | 402.48      | 0.33             | 7   | Continuous | 0.33 |
| 01-Nov-15 08:00:00          | 8  | 8    | 11    | 99.05  | 5661.52 | 0.92 | 5660.79 | 90.90 | 5327.30                            | 334.22      | 0.27             | 8   | Continuous | 0.27 |
| 01-Nov-15 09:00:00          | 9  | 9    | 11    | 101.28 | 5788.68 | 0.92 | 5787.94 | 92.95 | 5397.54                            | 391.15      | 0.32             | 9   | Continuous | 0.32 |
| 01-Nov-15 10:00:00          | 10 | 10   | 11    | 100.05 | 5718.73 | 0.92 | 5718.00 | 91.82 | 5444.87                            | 273.87      | 0.23             | 10  | Continuous | 0.23 |

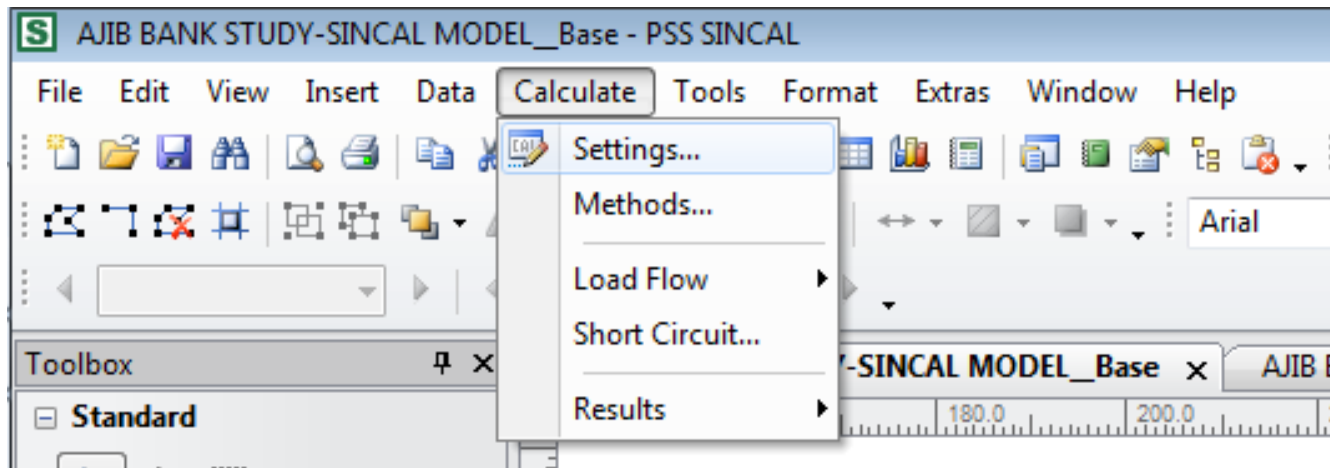


## Generator Profile

- Solar data was not available at the time of the study
- Black & Veatch utilized the PV profiles from the IDECO project
- The IDECO profiles were per-unitized so they can be applied to this project
- Generator Profile



## Long-Term Dynamic Analysis Settings







## Long-Term Dynamic Analysis Settings

Calculation Settings

Basic Data | Load Flow | Load Flow ext. | Short Circuit

View Date: (none)

Load Data Date: (none)

Use Load Data: Base Data

Scenario: (none)

Control Settings

Determine Rating: Base rating

Diagram Creation: Completely

Voltage Unbalance: V2/V1

Controller Adjustment: Discrete

Connect Nodes: Include netw.

Log File Level: Standard

Max. Par. Processes: 1

Reference Data

Frequency: f 60.0 Hz

Reference Power: Sref 0.0 MVA

Reference Voltage: Vref 0.0 kV

Zero Sequence Data

Mode Zero-Phase Impedance: Input data

Act. Part Lock Imp.: 10,000.0 Ohm

Imag. Part Lock Imp.: 0.0 Ohm

OK Cancel



## Long-Term Dynamic Analysis Settings (continued)

Calculation Settings

Basic Data | Load Flow | Load Flow ext. | Short Circuit

|                              |                |   |                        |       |     |
|------------------------------|----------------|---|------------------------|-------|-----|
| Load Flow Procedure          | Newton-Raphson | <input type="checkbox"/> Flat Start       |                        |       |     |
| Store Results                | Completely     | <input type="checkbox"/> Load Flow Change |                        |       |     |
| Extended Calculations        | None           | <input type="checkbox"/> Pre-Calculate    |                        |       |     |
| Imped. Load Conversion       | No             | Enable Controllers                        | Yes                    |       |     |
| Max. Number of Iterations    | 200            | Island Operation                          | Yes                    |       |     |
| Voltage Limit Load Reduction | 90.0           | %   | LF Speed Factor        | 1.0   | 1   |
| Power Accuracy               | 1.0            | %   | Min. Power Accuracy    | 0.001 | MVA |
| Mesh Accuracy                | 0.01           | %   | Node Accuracy          | 0.01  | %   |
| Voltage Lower Limit          | 90.0           | %   | Voltage Upper Limit    | 110.0 | %   |
| Element Utilization Limit    | 100.0          | %   | Line Utilization Limit | 95.0  | %   |

Settings for Controlling

|  |   |
|--|---|
| <input type="checkbox"/> Activate Transformer Tap Changer  | <input type="checkbox"/> Activate Generator Controlling       |
| <input type="checkbox"/> Activate Shunt Tap Changer        | <input checked="" type="checkbox"/> Activate Area Interchange |
| <input checked="" type="checkbox"/> Activate Load Shedding | <input type="checkbox"/> Activate Redistribute Power          |

OK Cancel



## Long-Term Dynamic Analysis Settings (continued)

Calculation Settings

Basic Data Load Flow Load Flow ext. Short Circuit

Load Profile

|            |     |      |   |
|------------|-----|------|---|
| Start Time | ts  | 0.0  | h |
| Duration   | tlc | 23.0 | h |
| Time Step  | dt  | 1.0  | h |

Load Development

|            |               |
|------------|---------------|
| Start Date | Sun 11/1/2015 |
| End Date   | Mon 11/2/2015 |

Contingency Analysis

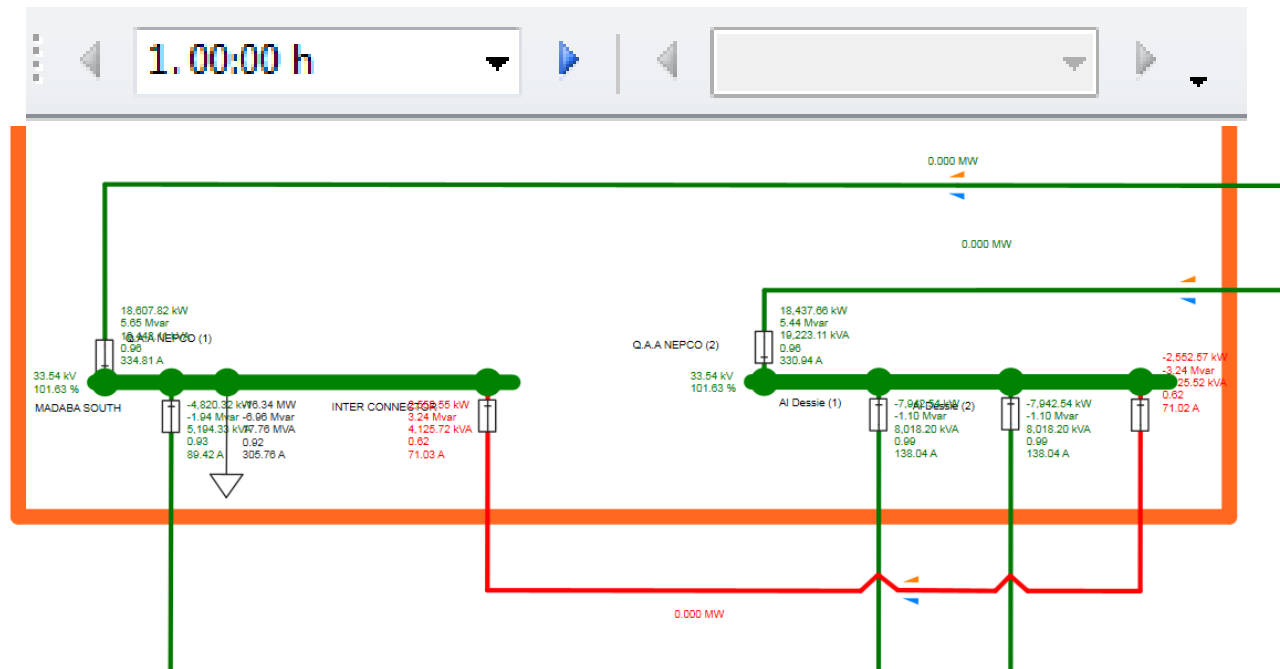
|                 |   |
|-----------------|---|
| Reporting Limit | 5 |
|-----------------|---|

OK Cancel



## Viewing Results (Graphic View)

- Option 1 – Viewing the results in the Graphic View
- Step through the results using the Results toolbar





## Viewing the Results (Tabular Format)

- Option 2 – Open the Tabular View and step through the results:

1.00:00 h

AJIB BANK STUDY-SINCAL MODEL\_Peak\_MaxPV\_100 - Tabular View x AJIB BANK STUDY-SINCAL MODEL\_Peak\_noPV AJIB BANK S

Default

Input Data

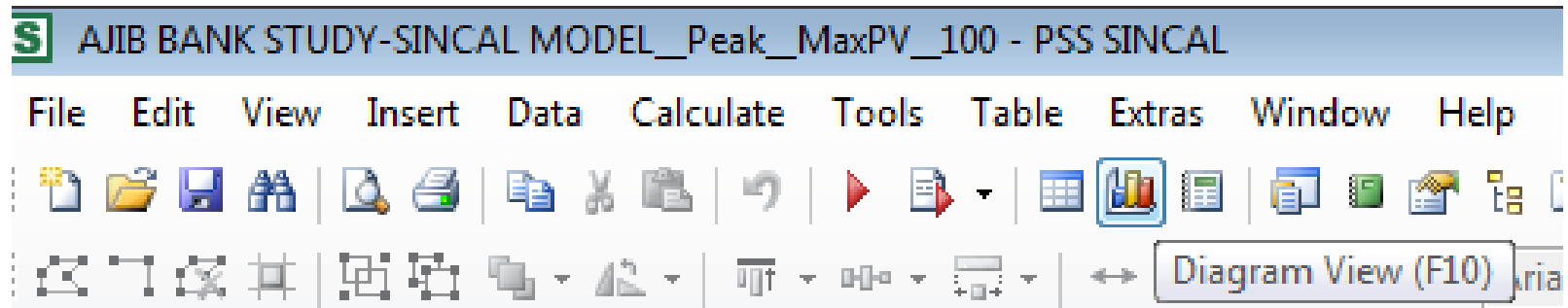
- Topology
  - Node
  - Network Element
  - Terminal
  - Network Level
  - Network Area
- Node Element
- Branch Element
- Additional Data
- Results
  - LF Load Flow**
    - Node Results (LF)**
    - Branch Results (LF)
    - Power Data Result
    - Power Balance Result
    - Accuracy Result
    - Subnetwork Losses Result
    - Load Flow Area Result
    - Load Flow Area Transfer Result
    - Tap Position Result
  - SC Short Circuit
- Database Queries

| Node           | Network Level  | P [MW]  | Q [Mvar] | S [MVA] | V [kV] |
|----------------|----------------|---------|----------|---------|--------|
| N4             | Medium Voltage | -34.735 | -14.797  | 37.756  | 33.527 |
| N8             | Medium Voltage | -3.890  | -1.657   | 4.228   | 33.179 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.524 |
| N26            | Low Voltage    | -0.010  | -0.005   | 0.011   | 0.420  |
| ENAD ALFAVEZ   | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.436 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.436 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| JABER SHAHER F | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| N26            | Low Voltage    | -0.016  | -0.008   | 0.017   | 0.419  |
| NADER SALEEM   | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| N26            | Low Voltage    | -0.010  | -0.005   | 0.011   | 0.418  |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| YOSEF-ELADRA   | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| N26            | Low Voltage    | -0.004  | -0.002   | 0.004   | 0.418  |
| SATTAM WELL    | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| N26            | Low Voltage    | -0.010  | -0.005   | 0.011   | 0.418  |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| ZYTONH_EAST_F  | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |
| N26            | Low Voltage    | -0.004  | -0.002   | 0.004   | 0.418  |
|                | Medium Voltage | 0.000   | 0.000    | 0.000   | 33.317 |



## Plotting Results in Graphic View

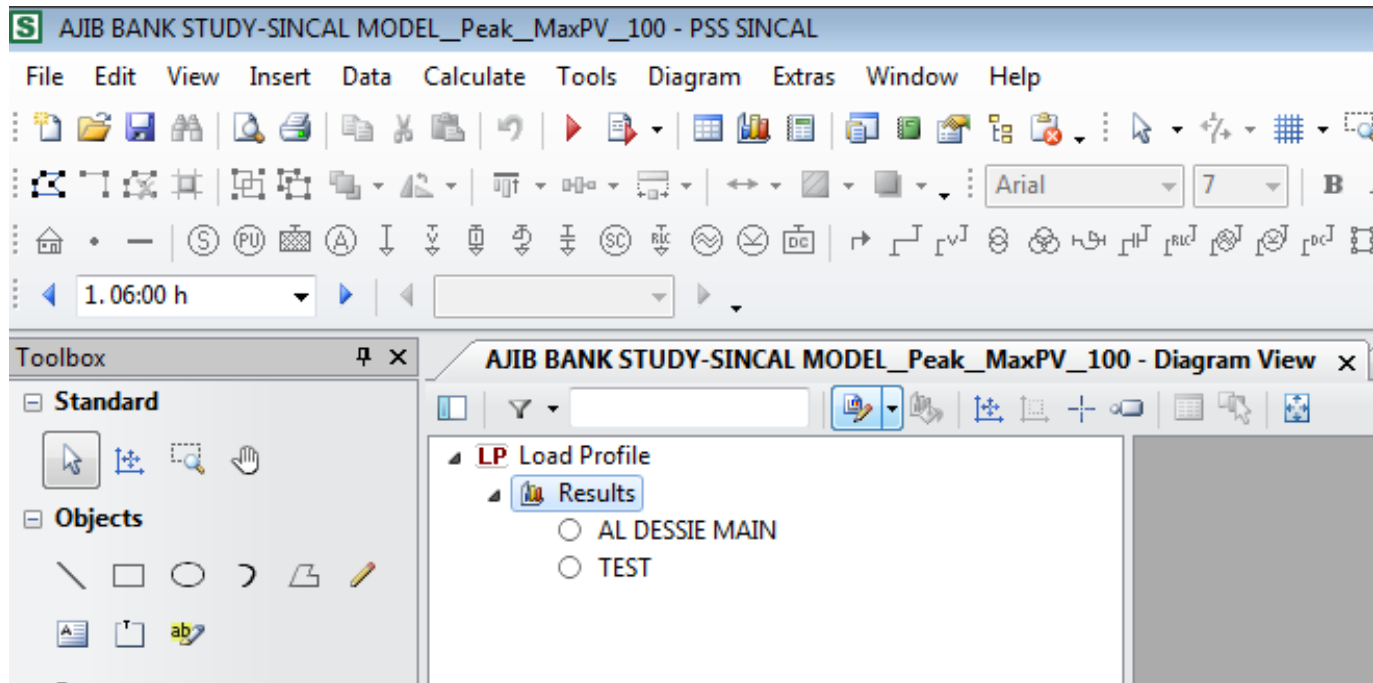
- Open the Graphic View:





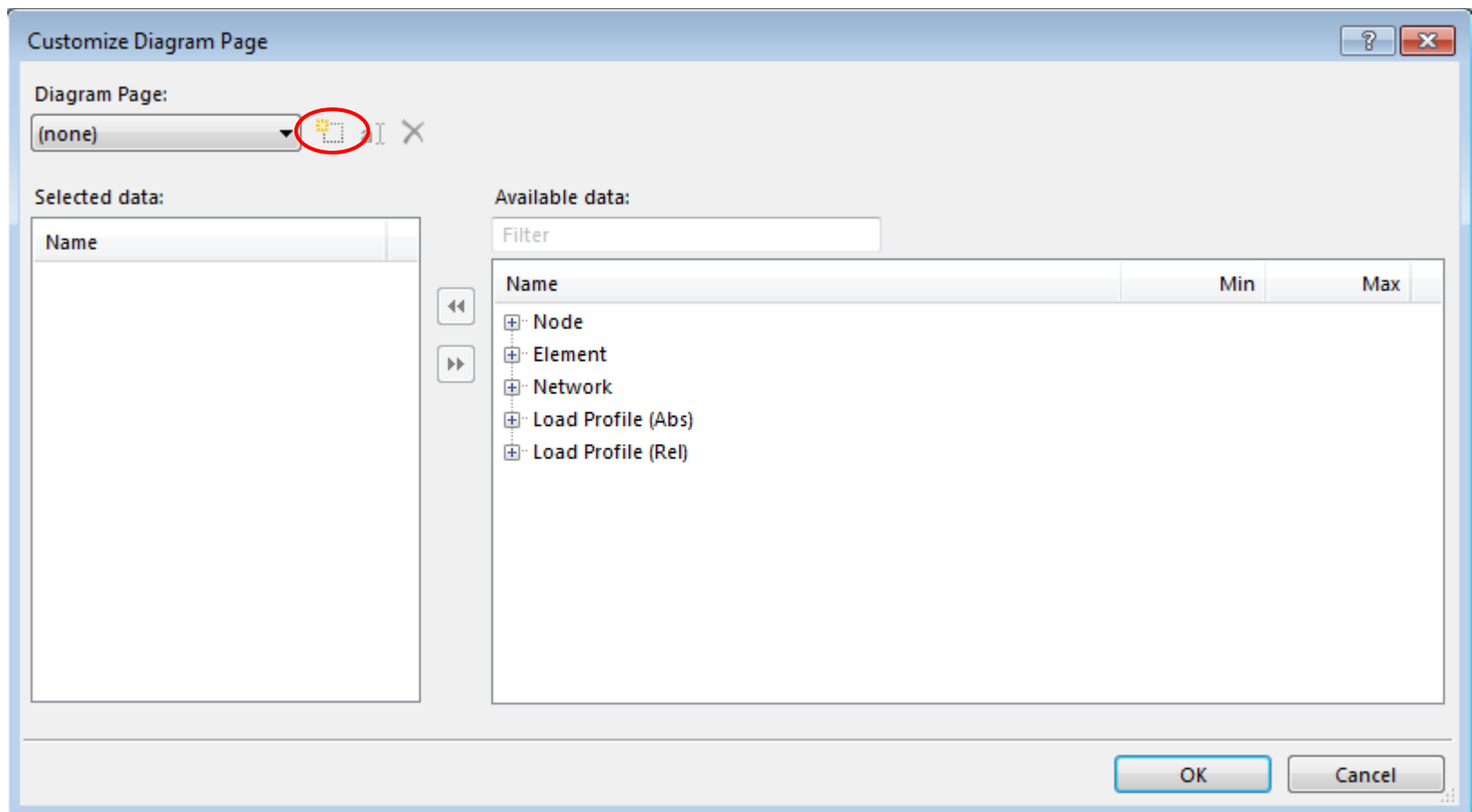
## Plotting Results in Graphic View

- Create new diagram page:





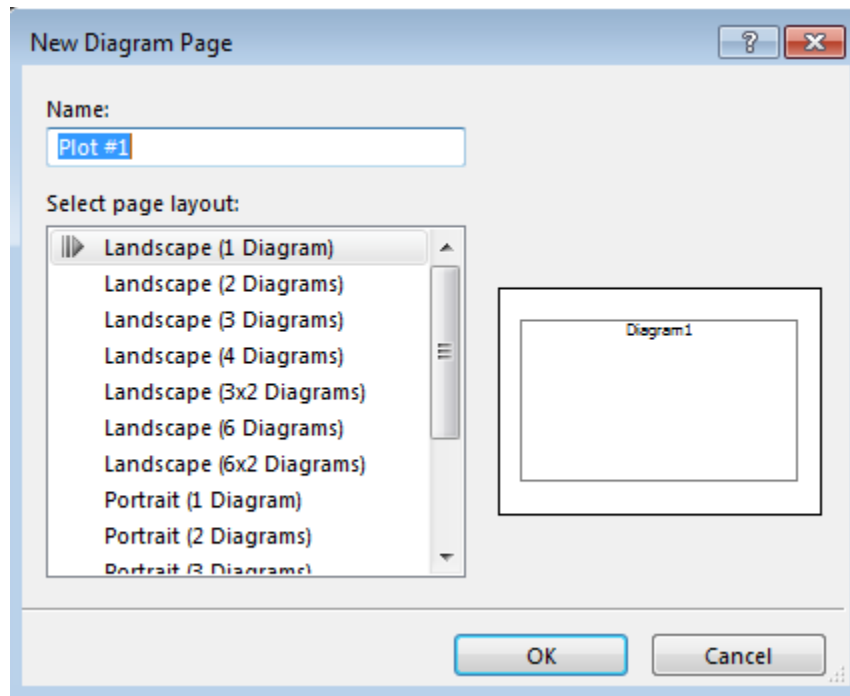
## Plotting Results in Graphic View







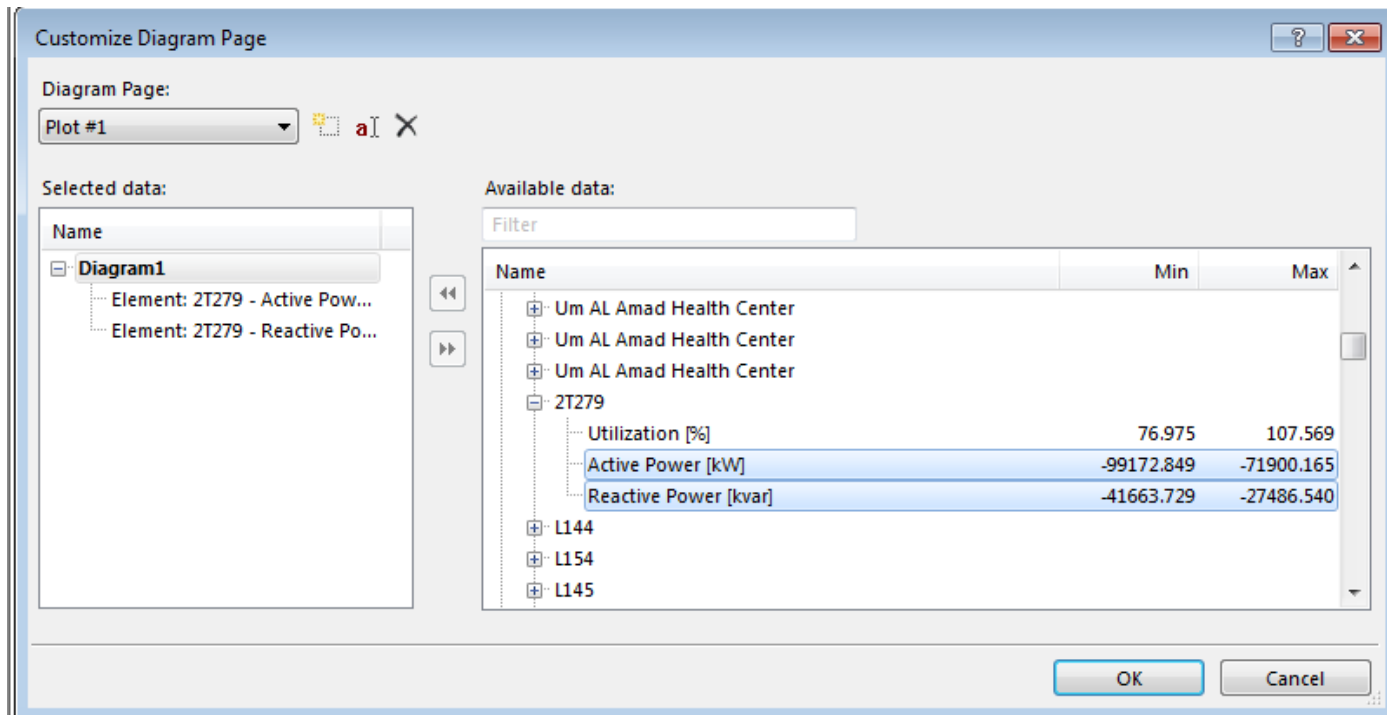
## Plotting Results in Graphic View





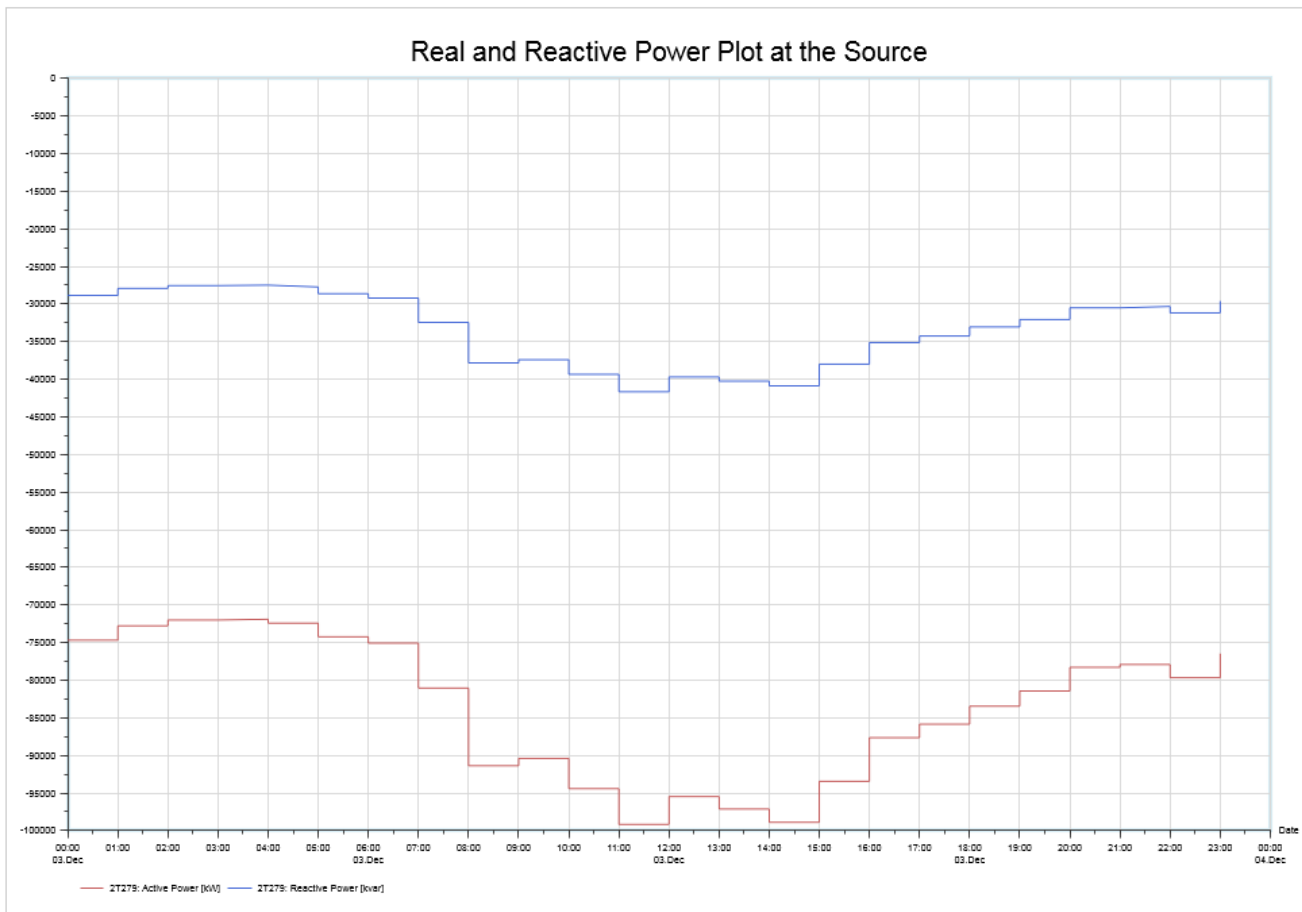
## Plotting Results in Graphic View

- Search to the node, element, or other data set you wish to plot, use the left double arrows to add them





## Monitoring for Reverse Power Flow at the Distribution Substation



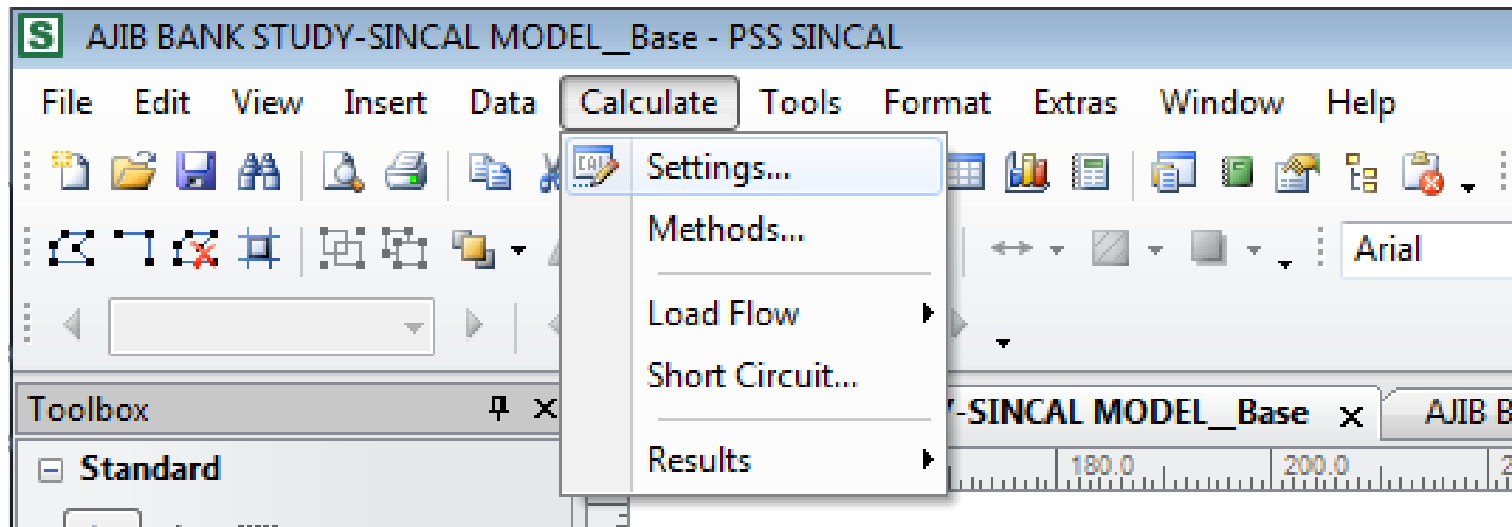


## **Review Shadow Study Results Long-Term Dynamics**

- Compare JEPCO and Black & Veatch results using the 24 hour profiles we created
- Are they different?
- Discuss why...



## Check Short Circuit Calculation Settings





## Check Short Circuit Calculation Settings

Calculation Settings

Basic Data | Load Flow | Load Flow ext. | Short Circuit

Short Circuit Method: VDE 0102/2002 - IEC 909/2001

Short Circuit Data Type: User Defined Sym. Components

Temperature at End of SC: User Defined

Peak Current Calculation: Minimum

Tripping Current Calculation: IANEU VDE0102/1.90 - IEC 909

Options

☒ Join Motors ☒ Join Windpower

☒ Join Photovoltaik ☒ Join Trafo Correction Factor

Additional Fault Data: (none)

OK Cancel

Infeeder

Basic Data | Element Data | Additional Data | Controller

Node: NB63 L123

Element Name: I4

Network Level: High Voltage (132 kV)

Standard Type: (none)

☐ Equivalent Supply

☐ Out of service

|                      |     |         | Maximum |     | Minimum |     |     |         |     |
|----------------------|-----|---------|---------|-----|---------|-----|-----|---------|-----|
| Short Circuit Power  | Sk* | 2,777.7 | MVA     | Sk* | 1,000.0 | MVA | Sk* | 1,000.0 | MVA |
| Resistance/Reactance | R/X | 0.1     | pu      | R/X | 0.1     | pu  | R/X | 0.1     | pu  |
| Voltage Sk*          | vc  | 1.0     | 1       | vc  | 1.0     | 1   | vc  | 1.0     | 1   |
| Internal Reactance   | xi  | 0.0     | %       |     |         |     |     |         |     |

Operating State

Load Flow Type: |vsrc| and  $\delta$

Init. Value Active Power: Pst 0.0 MW

Init. Value React. Power: Qst 0.0 Mvar

Voltage Angle:  $\delta$  0.0 °

Voltage: v 101.0 %

Zero-Phase Sequence

Grounding: Not grounded

|                      |       |     | Maximum |       | Minimum |    |       |     |    |
|----------------------|-------|-----|---------|-------|---------|----|-------|-----|----|
| Zero/Pos. Impedance  | Z0/Z1 | 0.0 | pu      | Z0/Z1 | 0.0     | pu | Z0/Z1 | 0.0 | pu |
| Resistance/Reactance | R0/X0 | 0.0 | pu      | R0/X0 | 0.0     | pu | R0/X0 | 0.0 | pu |

OK Cancel



## Setting Fault Contribution from PV Inverters

- Review the Inverter SC Data to determine the SC level to specify for the PV inverters

DC-Infeeder

Basic Data | Element Data | Additional Data | System Data | Controller

Node: N26  
Element Name: DCI164  
Network Level: Low Voltage (0.415 kV)  
DC-Infeeder Type: Photovoltaic

Operating State: DC Input: P and cosφ

Active Power: P: 1.8 MW  
Power Factor: cosφ: 1.0 1

Add. Short Circuit Data: No

Angle Short Circuit: φsc: 0.0 °

**Factor Short Circuit: fSc: 1.25 pu**

Manipulation Factor: \* (none)

Factor P: fP: 1.0 1  
Factor Q: fQ: 1.0 1

Minimum Voltage: Vmin: 80.0 %  
Maximum Voltage: Vmax: 115.0 %  
Switch Off Time: toff: 0.01 s

Rated Voltage Inverter: Vn: 0.415 kV

Operating Points: Profile 1: PV Profile, Profile 2: (none), Operating Points: (none)

Energy Storage: (none)

Transformer: Connecting: Directly

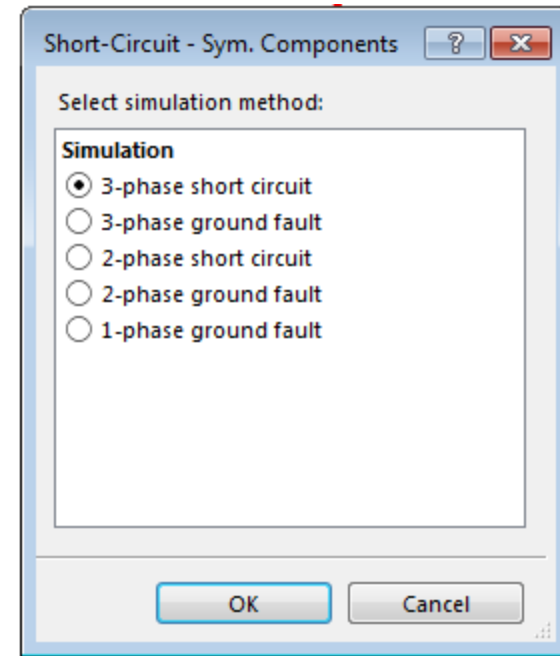
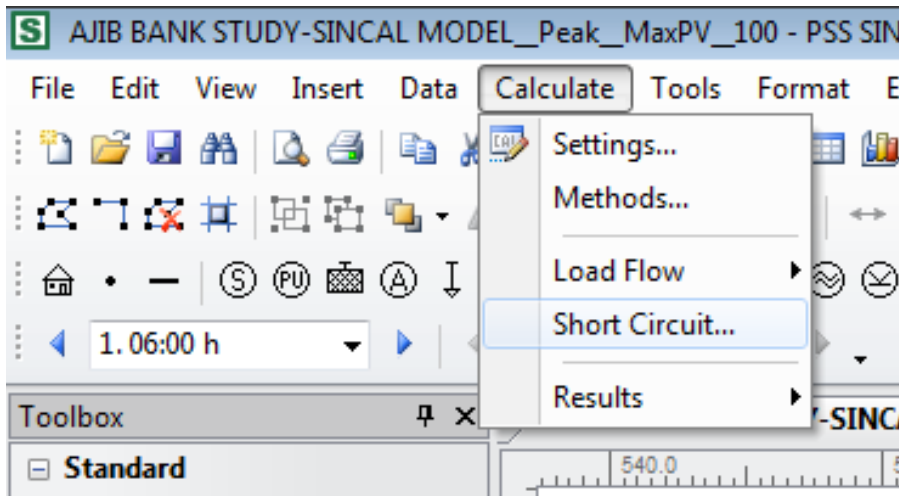
Rated Voltage Netside: VnN: 0.415 kV  
Rated Apparent Power: Sn: 25.0 kVA  
Ref. SC Voltage: vsc: 10.0 %  
Ratio R/X: R/X: 0.0 pu

OK Cancel



## Performing Short Circuit Analysis

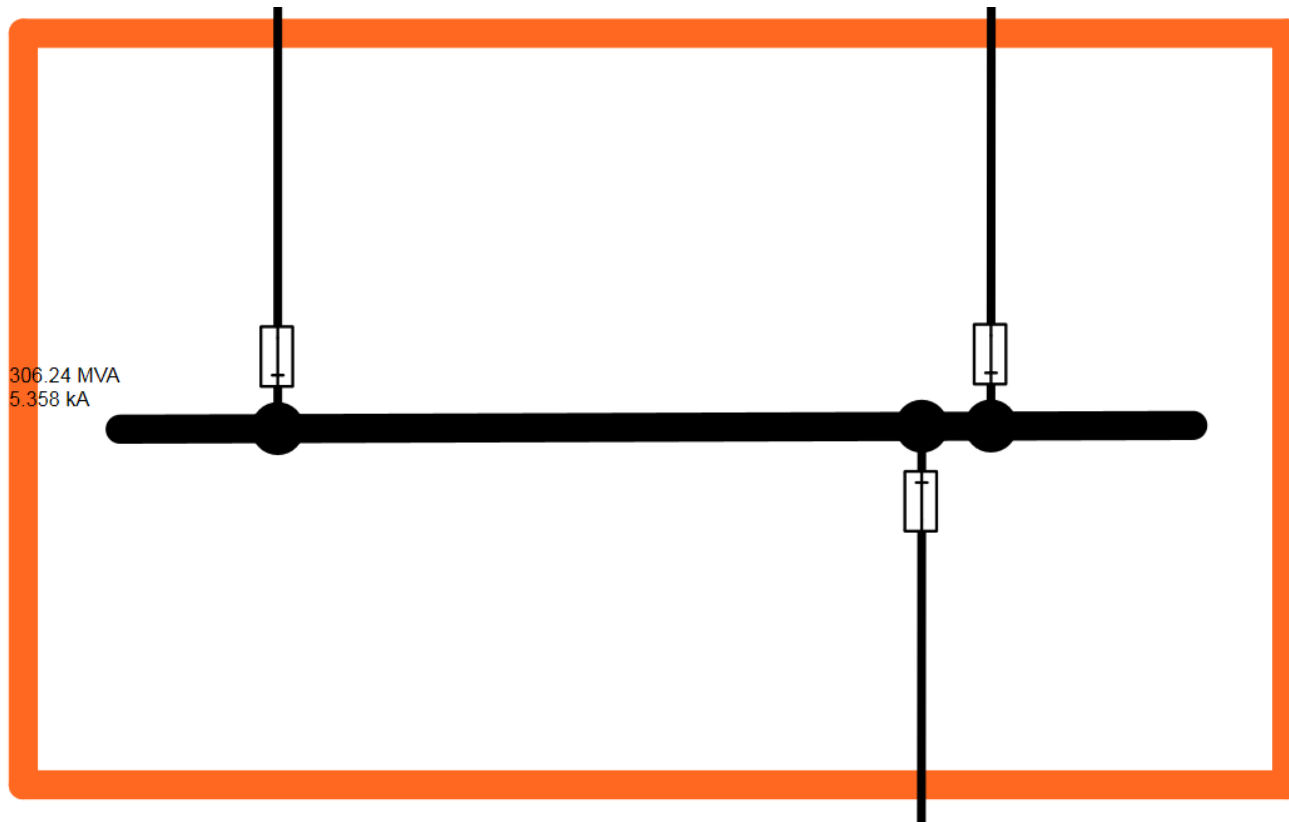
- Select the bus you wish to fault, then:







## Viewing the results (Graphic View)





## Viewing the results (Tabular View)

AJIB BANK STUDY-SINCAL MODEL\_Peak\_MaxPV\_100    AJIB BANK STUDY-SINCAL MODEL\_Peak\_MaxPV\_100 - Diagram View    AJIB BANK STUDY-SINCAL MODEL\_Pe

Default

- Input Data
  - TO Topology
    - Node
    - Network Element
    - Terminal
    - Network Level
    - Network Area
  - NE Node Element
  - BE Branch Element
  - DA Additional Data
- Results
  - LF Load Flow
    - Node Results (LF)
    - Branch Results (LF)
    - Power Data Result
    - Power Balance Result
    - Accuracy Result
    - Subnetwork Losses Result
    - Load Flow Area Result
    - Load Flow Area Transfer Result
    - Tap Position Result
  - SC Short Circuit
    - Node Results (SC3)**
    - Branch Results (SC3)
- Database Queries

| Node | Network Level  | Vsc [kV] | ts [s] | Sk" [MVA] | Ik" [kA] | $\phi Ik"$ [°] | Sa [MVA] |
|------|----------------|----------|--------|-----------|----------|----------------|----------|
| N8   | Medium Voltage | 36.300   | 0.100  | 306.235   | 5.358    | -66.114        | 304.847  |



## Compare Fault Contribution with and Without PV

- Apply a 3-Phase fault at the PCC with the PV in-service at full output
- Verify the correct output is being provided by the PV inverters per the Inverter SC Data
- Remove the PV inverters and apply the same fault
- How much does the fault level at the PCC change?
- Are the results correct?