**Time series description**

Question 1: PMU Measurements

Regarding the first question, the PMU measurements can be extracted from the time series files, choosing the following variables from the list, resampled at 0.01s:

Bus Voltages

Line Currents

Bus Electrical Frequency

Line Active Power

Line Reactive Power

Question 2: Full State Observability

Any of the variables of the following list could be used.

Variables in the time series files:

Time:

('All calculations', 'Time in s'),

Bus Voltages:

('B\_L03', 'u1, Magnitude in p.u.'),

('B\_L04', 'u1, Magnitude in p.u.'),

('B\_L07', 'u1, Magnitude in p.u.'),

('B\_L08', 'u1, Magnitude in p.u.'),

('B\_L12', 'u1, Magnitude in p.u.'),

('B\_L15', 'u1, Magnitude in p.u.'),

('B\_L16', 'u1, Magnitude in p.u.'),

('B\_L18', 'u1, Magnitude in p.u.'),

('B\_L20', 'u1, Magnitude in p.u.'),

('B\_L21', 'u1, Magnitude in p.u.'),

('B\_L23', 'u1, Magnitude in p.u.'),

('B\_L24', 'u1, Magnitude in p.u.'),

('B\_L25', 'u1, Magnitude in p.u.'),

('B\_L26', 'u1, Magnitude in p.u.'),

('B\_L27', 'u1, Magnitude in p.u.'),

('B\_L28', 'u1, Magnitude in p.u.'),

('B\_L29', 'u1, Magnitude in p.u.'),

('Bus 01', 'u1, Magnitude in p.u.'),

('Bus 02', 'u1, Magnitude in p.u.'),

('Bus 03', 'u1, Magnitude in p.u.'),

('Bus 04', 'u1, Magnitude in p.u.'),

('Bus 05', 'u1, Magnitude in p.u.'),

('Bus 06', 'u1, Magnitude in p.u.'),

('Bus 07', 'u1, Magnitude in p.u.'),

('Bus 08', 'u1, Magnitude in p.u.'),

('Bus 09', 'u1, Magnitude in p.u.'),

('Bus 10', 'u1, Magnitude in p.u.'),

('Bus 11', 'u1, Magnitude in p.u.'),

('Bus 12', 'u1, Magnitude in p.u.'),

('Bus 13', 'u1, Magnitude in p.u.'),

('Bus 14', 'u1, Magnitude in p.u.'),

('Bus 15', 'u1, Magnitude in p.u.'),

('Bus 16', 'u1, Magnitude in p.u.'),

('Bus 17', 'u1, Magnitude in p.u.'),

('Bus 18', 'u1, Magnitude in p.u.'),

('Bus 19', 'u1, Magnitude in p.u.'),

('Bus 20', 'u1, Magnitude in p.u.'),

('Bus 21', 'u1, Magnitude in p.u.'),

('Bus 22', 'u1, Magnitude in p.u.'),

('Bus 23', 'u1, Magnitude in p.u.'),

('Bus 24', 'u1, Magnitude in p.u.'),

('Bus 25', 'u1, Magnitude in p.u.'),

('Bus 26', 'u1, Magnitude in p.u.'),

('Bus 27', 'u1, Magnitude in p.u.'),

('Bus 28', 'u1, Magnitude in p.u.'),

('Bus 29', 'u1, Magnitude in p.u.'),

('Bus 30', 'u1, Magnitude in p.u.'),

('Bus 31', 'u1, Magnitude in p.u.'),

('Bus 32', 'u1, Magnitude in p.u.'),

('Bus 33', 'u1, Magnitude in p.u.'),

('Bus 34', 'u1, Magnitude in p.u.'),

('Bus 35', 'u1, Magnitude in p.u.'),

('Bus 36', 'u1, Magnitude in p.u.'),

('Bus 37', 'u1, Magnitude in p.u.'),

('Bus 38', 'u1, Magnitude in p.u.'),

('Bus 39', 'u1, Magnitude in p.u.'),

('Bus\_NSG\_1', 'u1, Magnitude in p.u.'),

('Bus\_NSG\_2', 'u1, Magnitude in p.u.'),

('Bus\_NSG\_3', 'u1, Magnitude in p.u.'),

Line Currents:

('Line 01 - 02', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 01 - 39', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 02 - 03', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 02 - 25', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 03 - 04', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 03 - 18', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 04 - 05', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 04 - 14', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 05 - 06', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 05 - 08', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 06 - 07', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 06 - 11', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 07 - 08', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 08 - 09', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 09 - 39', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 10 - 11', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 10 - 13', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 13 - 14', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 14 - 15', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 15 - 16', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 16 - 17', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 16 - 19', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 16 - 21', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 16 - 24', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 17 - 18', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 17 - 27', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 21 - 22', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 22 - 23', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 23 - 24', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 25 - 26', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 26 - 27', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 26 - 28', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 26 - 29', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

('Line 28 - 29', 'Positive-Sequence Current, Magnitude/Terminal i in kA'),

Generator Speeds:

('G 01', 'Speed in p.u.'),

('G 02', 'Speed in p.u.'),

('G 03', 'Speed in p.u.'),

('G 04', 'Speed in p.u.'),

('G 05', 'Speed in p.u.'),

('G 06', 'Speed in p.u.'),

('G 07', 'Speed in p.u.'),

('G 08', 'Speed in p.u.'),

('G 09', 'Speed in p.u.'),

('G 10', 'Speed in p.u.'),

Generator Rotor Angles:

('G 01', 'Rotor angle with reference to reference machine angle in deg'),

('G 02', 'Rotor angle with reference to reference machine angle in deg'),

('G 03', 'Rotor angle with reference to reference machine angle in deg'),

('G 04', 'Rotor angle with reference to reference machine angle in deg'),

('G 05', 'Rotor angle with reference to reference machine angle in deg'),

('G 06', 'Rotor angle with reference to reference machine angle in deg'),

('G 07', 'Rotor angle with reference to reference machine angle in deg'),

('G 08', 'Rotor angle with reference to reference machine angle in deg'),

('G 09', 'Rotor angle with reference to reference machine angle in deg'),

('G 10', 'Rotor angle with reference to reference machine angle in deg'),

Generator Active Power:

('G 01', 'Positive-Sequence, Active Power in MW'),

('G 02', 'Positive-Sequence, Active Power in MW'),

('G 03', 'Positive-Sequence, Active Power in MW'),

('G 04', 'Positive-Sequence, Active Power in MW'),

('G 05', 'Positive-Sequence, Active Power in MW'),

('G 06', 'Positive-Sequence, Active Power in MW'),

('G 07', 'Positive-Sequence, Active Power in MW'),

('G 08', 'Positive-Sequence, Active Power in MW'),

('G 09', 'Positive-Sequence, Active Power in MW'),

('G 10', 'Positive-Sequence, Active Power in MW'),

Generator Reactive Power:

('G 01', 'Positive-Sequence, Reactive Power in Mvar'),

('G 02', 'Positive-Sequence, Reactive Power in Mvar'),

('G 03', 'Positive-Sequence, Reactive Power in Mvar'),

('G 04', 'Positive-Sequence, Reactive Power in Mvar'),

('G 05', 'Positive-Sequence, Reactive Power in Mvar'),

('G 06', 'Positive-Sequence, Reactive Power in Mvar'),

('G 07', 'Positive-Sequence, Reactive Power in Mvar'),

('G 08', 'Positive-Sequence, Reactive Power in Mvar'),

('G 09', 'Positive-Sequence, Reactive Power in Mvar'),

('G 10', 'Positive-Sequence, Reactive Power in Mvar'),

Bus Electrical Frequency:

('B\_L03', 'Electrical Frequency in p.u.'),

('B\_L04', 'Electrical Frequency in p.u.'),

('B\_L07', 'Electrical Frequency in p.u.'),

('B\_L08', 'Electrical Frequency in p.u.'),

('B\_L12', 'Electrical Frequency in p.u.'),

('B\_L15', 'Electrical Frequency in p.u.'),

('B\_L16', 'Electrical Frequency in p.u.'),

('B\_L18', 'Electrical Frequency in p.u.'),

('B\_L20', 'Electrical Frequency in p.u.'),

('B\_L21', 'Electrical Frequency in p.u.'),

('B\_L23', 'Electrical Frequency in p.u.'),

('B\_L24', 'Electrical Frequency in p.u.'),

('B\_L25', 'Electrical Frequency in p.u.'),

('B\_L26', 'Electrical Frequency in p.u.'),

('B\_L27', 'Electrical Frequency in p.u.'),

('B\_L28', 'Electrical Frequency in p.u.'),

('B\_L29', 'Electrical Frequency in p.u.'),

Generator Excitation Current:

('G 01', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 02', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 03', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 04', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 05', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 06', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 07', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 08', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 09', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

('G 10', 'Excitation Current (non-reciprocal p.u. system) in p.u.'),

Transformers Tap Positions:

('Trf Load\_03', 'Tap 1, Current Position'),

('Trf Load\_04', 'Tap 1, Current Position'),

('Trf Load\_07', 'Tap 1, Current Position'),

('Trf Load\_08', 'Tap 1, Current Position'),

('Trf Load\_12', 'Tap 1, Current Position'),

('Trf Load\_15', 'Tap 1, Current Position'),

('Trf Load\_16', 'Tap 1, Current Position'),

('Trf Load\_18', 'Tap 1, Current Position'),

('Trf Load\_20', 'Tap 1, Current Position'),

('Trf Load\_21', 'Tap 1, Current Position'),

('Trf Load\_23', 'Tap 1, Current Position'),

('Trf Load\_24', 'Tap 1, Current Position'),

('Trf Load\_25', 'Tap 1, Current Position'),

('Trf Load\_26', 'Tap 1, Current Position'),

('Trf Load\_27', 'Tap 1, Current Position'),

('Trf Load\_28', 'Tap 1, Current Position'),

('Trf Load\_29', 'Tap 1, Current Position'),

Line Active Power:

('Line 01 - 02', 'Total Active Power/Terminal i in MW'),

('Line 01 - 39', 'Total Active Power/Terminal i in MW'),

('Line 02 - 03', 'Total Active Power/Terminal i in MW'),

('Line 02 - 25', 'Total Active Power/Terminal i in MW'),

('Line 03 - 04', 'Total Active Power/Terminal i in MW'),

('Line 03 - 18', 'Total Active Power/Terminal i in MW'),

('Line 04 - 05', 'Total Active Power/Terminal i in MW'),

('Line 04 - 14', 'Total Active Power/Terminal i in MW'),

('Line 05 - 06', 'Total Active Power/Terminal i in MW'),

('Line 05 - 08', 'Total Active Power/Terminal i in MW'),

('Line 06 - 07', 'Total Active Power/Terminal i in MW'),

('Line 06 - 11', 'Total Active Power/Terminal i in MW'),

('Line 07 - 08', 'Total Active Power/Terminal i in MW'),

('Line 08 - 09', 'Total Active Power/Terminal i in MW'),

('Line 09 - 39', 'Total Active Power/Terminal i in MW'),

('Line 10 - 11', 'Total Active Power/Terminal i in MW'),

('Line 10 - 13', 'Total Active Power/Terminal i in MW'),

('Line 13 - 14', 'Total Active Power/Terminal i in MW'),

('Line 14 - 15', 'Total Active Power/Terminal i in MW'),

('Line 15 - 16', 'Total Active Power/Terminal i in MW'),

('Line 16 - 17', 'Total Active Power/Terminal i in MW'),

('Line 16 - 19', 'Total Active Power/Terminal i in MW'),

('Line 16 - 21', 'Total Active Power/Terminal i in MW'),

('Line 16 - 24', 'Total Active Power/Terminal i in MW'),

('Line 17 - 18', 'Total Active Power/Terminal i in MW'),

('Line 17 - 27', 'Total Active Power/Terminal i in MW'),

('Line 21 - 22', 'Total Active Power/Terminal i in MW'),

('Line 22 - 23', 'Total Active Power/Terminal i in MW'),

('Line 23 - 24', 'Total Active Power/Terminal i in MW'),

('Line 25 - 26', 'Total Active Power/Terminal i in MW'),

('Line 26 - 27', 'Total Active Power/Terminal i in MW'),

('Line 26 - 28', 'Total Active Power/Terminal i in MW'),

('Line 26 - 29', 'Total Active Power/Terminal i in MW'),

('Line 28 - 29', 'Total Active Power/Terminal i in MW'),

Line Reactive Power:

('Line 01 - 02', 'Total Reactive Power/Terminal i in Mvar'),

('Line 01 - 39', 'Total Reactive Power/Terminal i in Mvar'),

('Line 02 - 03', 'Total Reactive Power/Terminal i in Mvar'),

('Line 02 - 25', 'Total Reactive Power/Terminal i in Mvar'),

('Line 03 - 04', 'Total Reactive Power/Terminal i in Mvar'),

('Line 03 - 18', 'Total Reactive Power/Terminal i in Mvar'),

('Line 04 - 05', 'Total Reactive Power/Terminal i in Mvar'),

('Line 04 - 14', 'Total Reactive Power/Terminal i in Mvar'),

('Line 05 - 06', 'Total Reactive Power/Terminal i in Mvar'),

('Line 05 - 08', 'Total Reactive Power/Terminal i in Mvar'),

('Line 06 - 07', 'Total Reactive Power/Terminal i in Mvar'),

('Line 06 - 11', 'Total Reactive Power/Terminal i in Mvar'),

('Line 07 - 08', 'Total Reactive Power/Terminal i in Mvar'),

('Line 08 - 09', 'Total Reactive Power/Terminal i in Mvar'),

('Line 09 - 39', 'Total Reactive Power/Terminal i in Mvar'),

('Line 10 - 11', 'Total Reactive Power/Terminal i in Mvar'),

('Line 10 - 13', 'Total Reactive Power/Terminal i in Mvar'),

('Line 13 - 14', 'Total Reactive Power/Terminal i in Mvar'),

('Line 14 - 15', 'Total Reactive Power/Terminal i in Mvar'),

('Line 15 - 16', 'Total Reactive Power/Terminal i in Mvar'),

('Line 16 - 17', 'Total Reactive Power/Terminal i in Mvar'),

('Line 16 - 19', 'Total Reactive Power/Terminal i in Mvar'),

('Line 16 - 21', 'Total Reactive Power/Terminal i in Mvar'),

('Line 16 - 24', 'Total Reactive Power/Terminal i in Mvar'),

('Line 17 - 18', 'Total Reactive Power/Terminal i in Mvar'),

('Line 17 - 27', 'Total Reactive Power/Terminal i in Mvar'),

('Line 21 - 22', 'Total Reactive Power/Terminal i in Mvar'),

('Line 22 - 23', 'Total Reactive Power/Terminal i in Mvar'),

('Line 23 - 24', 'Total Reactive Power/Terminal i in Mvar'),

('Line 25 - 26', 'Total Reactive Power/Terminal i in Mvar'),

('Line 26 - 27', 'Total Reactive Power/Terminal i in Mvar'),

('Line 26 - 28', 'Total Reactive Power/Terminal i in Mvar'),

('Line 26 - 29', 'Total Reactive Power/Terminal i in Mvar'),

('Line 28 - 29', 'Total Reactive Power/Terminal i in Mvar')],

When wind1 is not 0:

NSG\_1 Active Power:

('NSG\_1', 'Active Power in MW'),

When wind2 is not 0:

NSG\_2 Active Power:

('NSG\_2', 'Active Power in MW'),

When wind3 is not 0:

NSG\_3 Active Power:

('NSG\_3', 'Active Power in MW'),