5th International Conference on Smart Energy Systems
Copenhagen, 10-11 September 2019
#SESAAU2019

Machine Learning based State-Estimation in sector coupled Energy Systems

Steven de Jongh[1], Felicitas Mueller[1]
Presenting: Steven de Jongh

[1] Institute of Electric Energy Systems and High Voltage Technology (IEH), Karlsruhe Institute of Technology (KIT)

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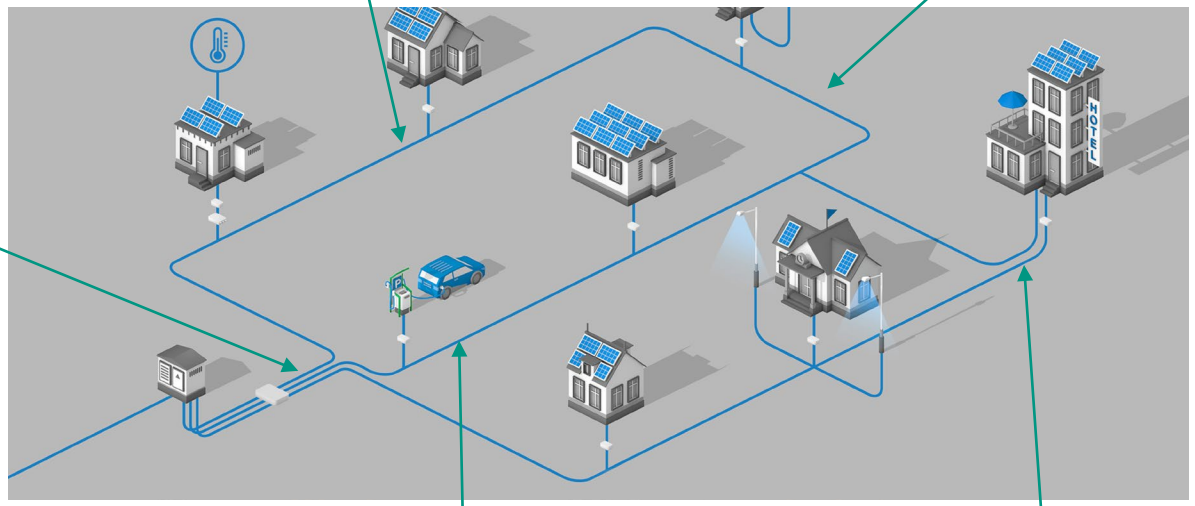
Motivation:

True state of the system



$$V, \theta \rightarrow I, P, Q$$

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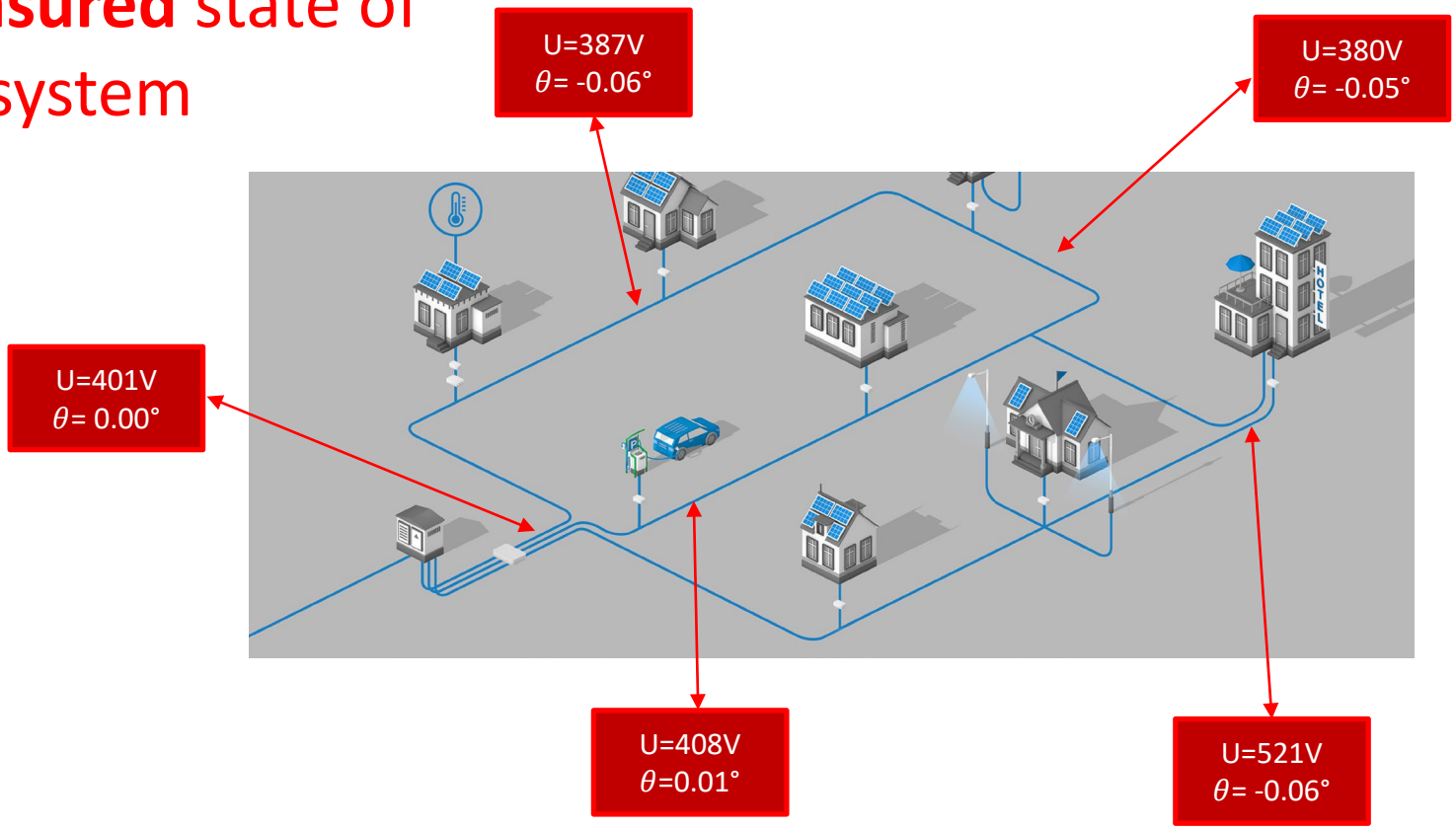
Motivation:

Measured state of the system



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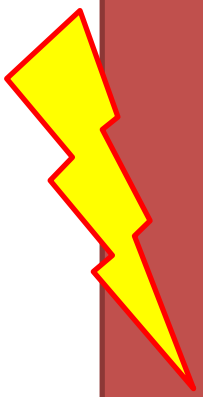
Classical approach:

„What is the most likely system state based on our given measurements?“

Weighted-Least-Squares estimation:

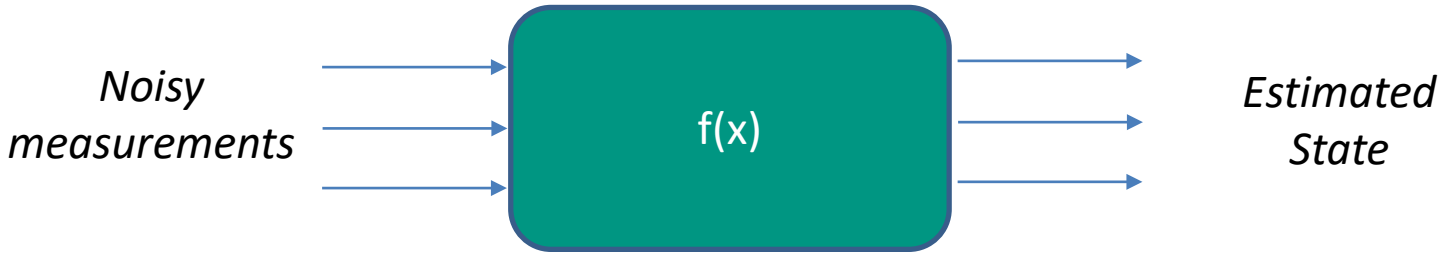


Drawbacks:

- Exact physical model of power system is needed → $h(x)$
- Sensor accuracies have to be estimated → R

Machine learning approach:

Directly train the estimator from grid measurement data:



- No a-priori knowledge of the measurement accuracies needed
- Generalizes to deviations in grid parameters

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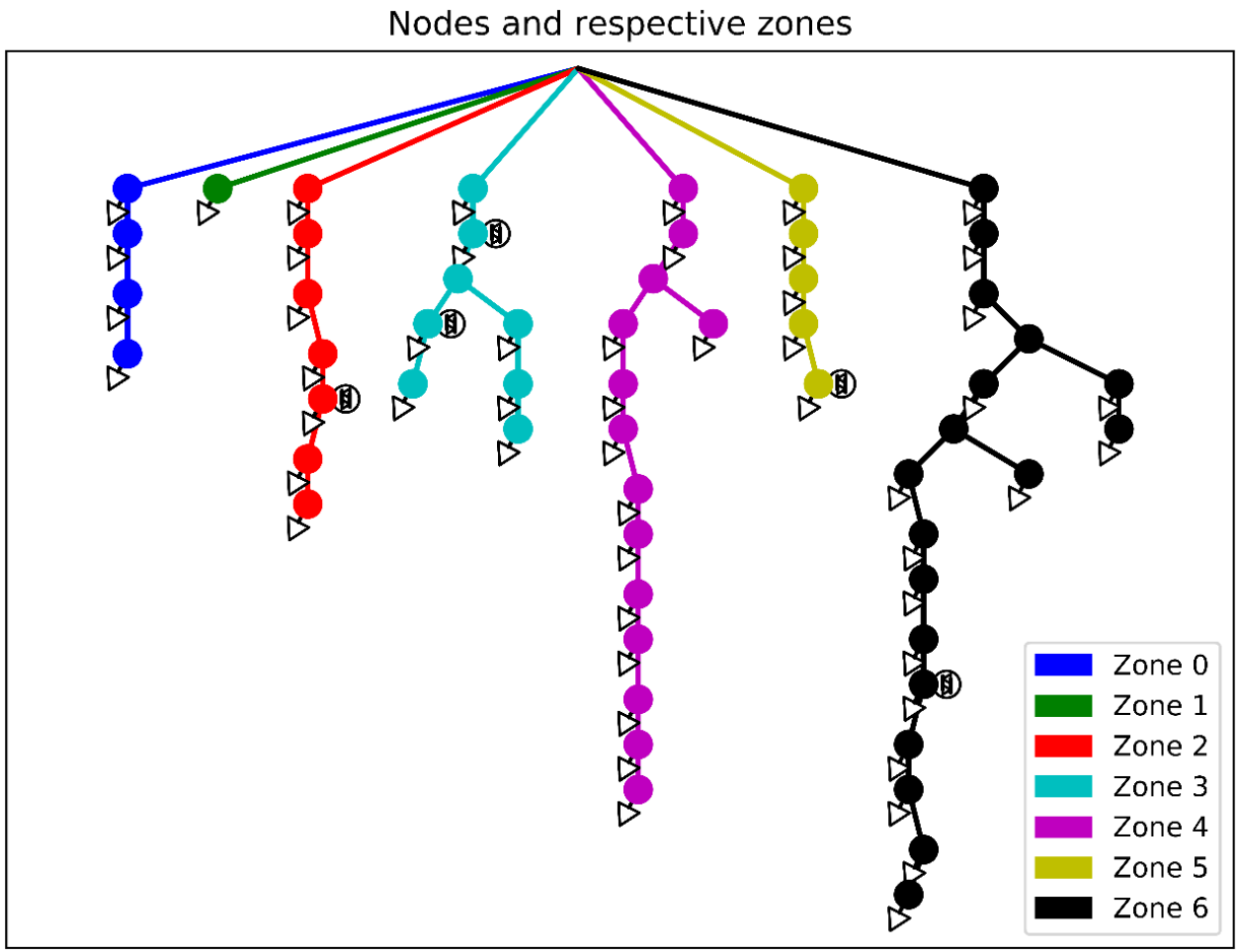
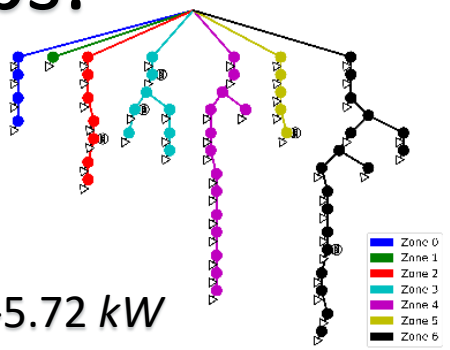
Scenario – chosen grid:

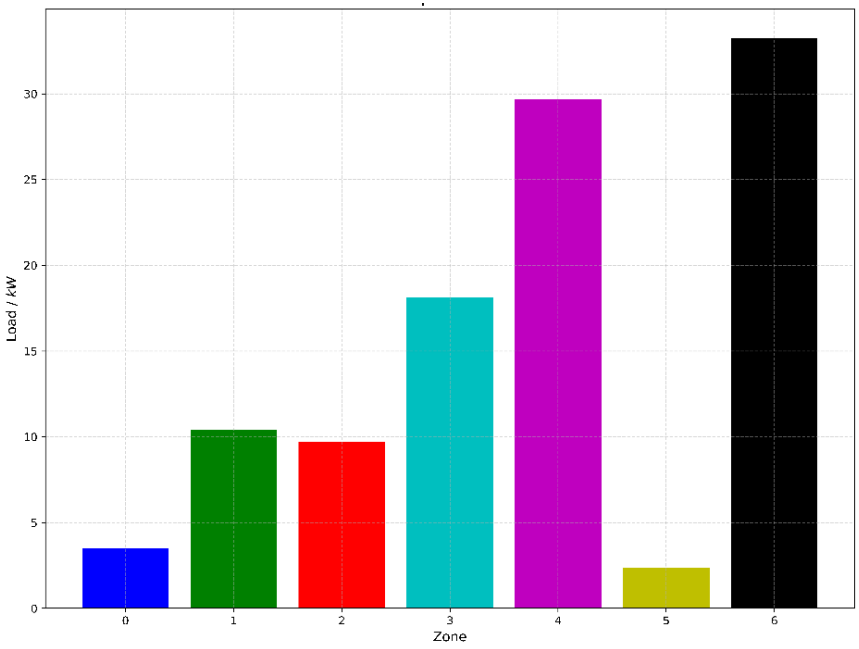


- 59 nodes
- 57 lines
- 400 V, 3~
- 5 PV generators
- Radial structure

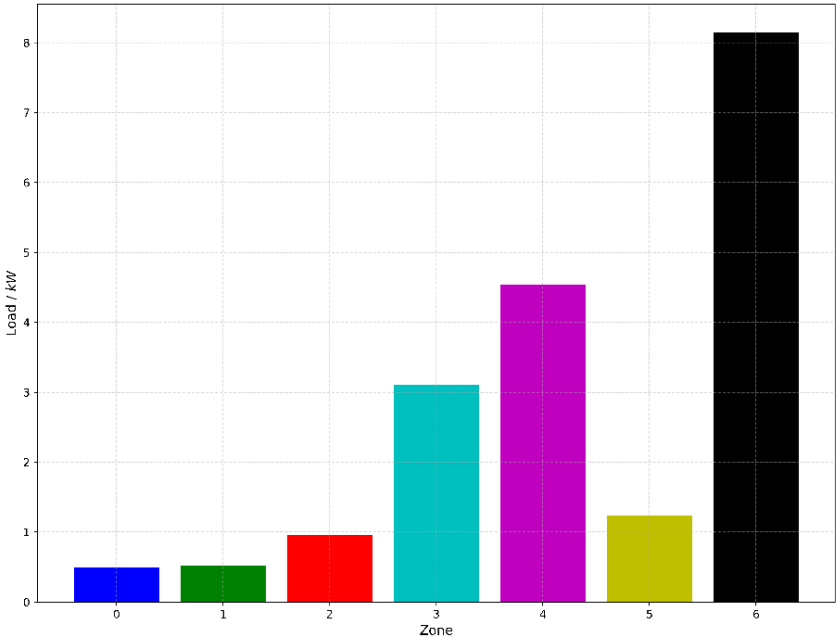
Scenario – different timesteps:



t1: Maximum load, 102.2 *kW*



t2: Minimum load, -5.72 *kW*



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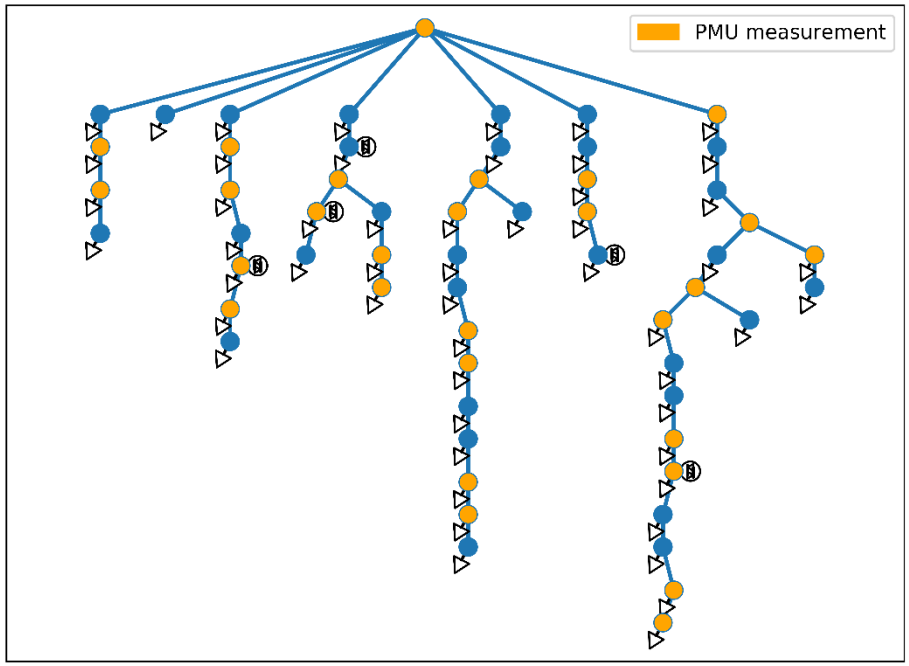
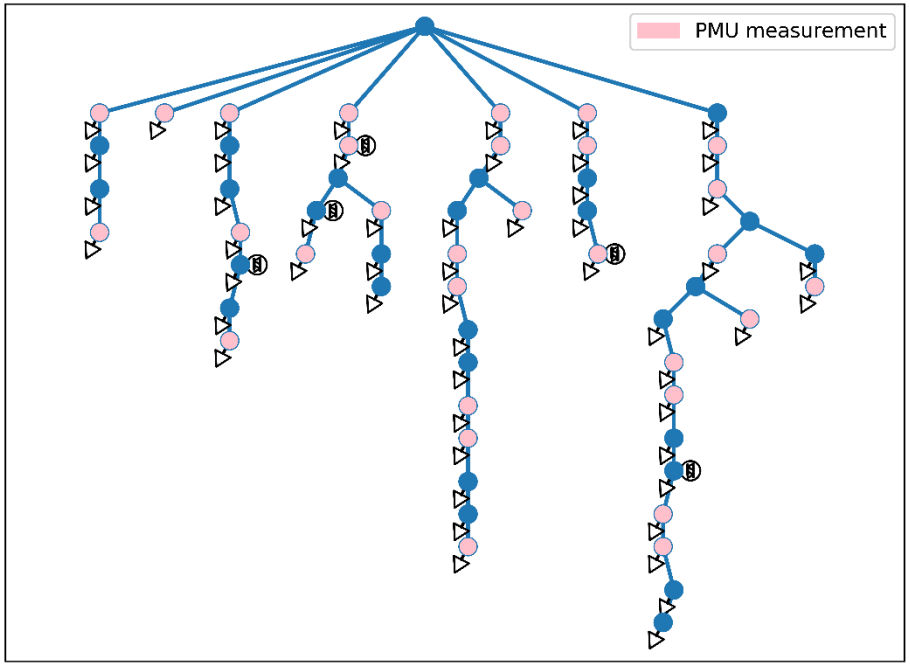
Scenario – sensor configuration:

Optimal PMU-configuration (28 PMUs):



Minimal number of used PMUs

Suboptimal PMU-configuration (31 PMUs):



Random choice of PMUs

PMU measures $V_i, P_i, Q_i, P_{ij}, Q_{ij}$

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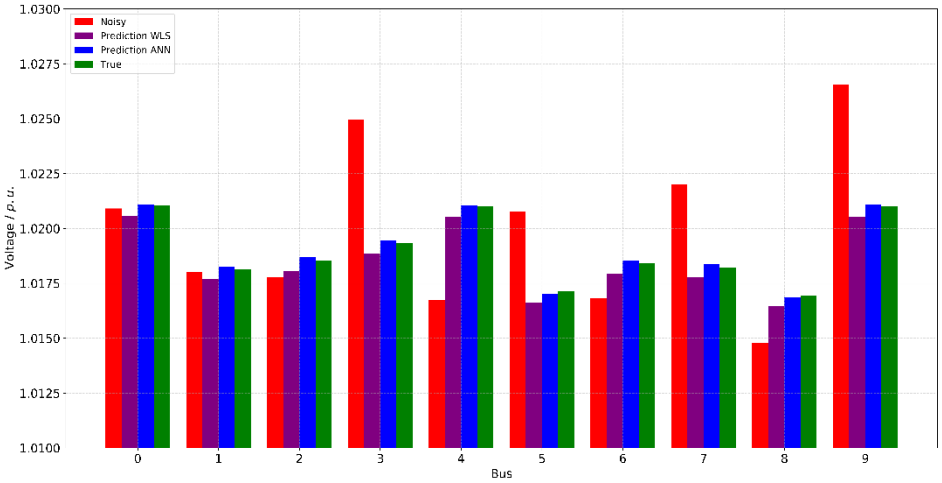
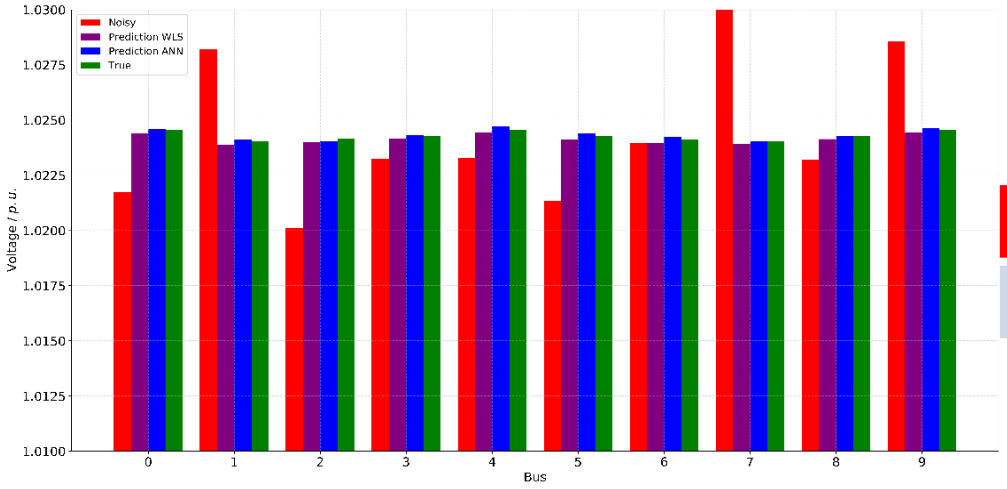
Results I.

t1:



Measured	WLS	ANN
1.5e-05	2.2e-07	8.9e-09

t2:



Measured	WLS	ANN
1.0e-05	1.8e-08	8.0e-09

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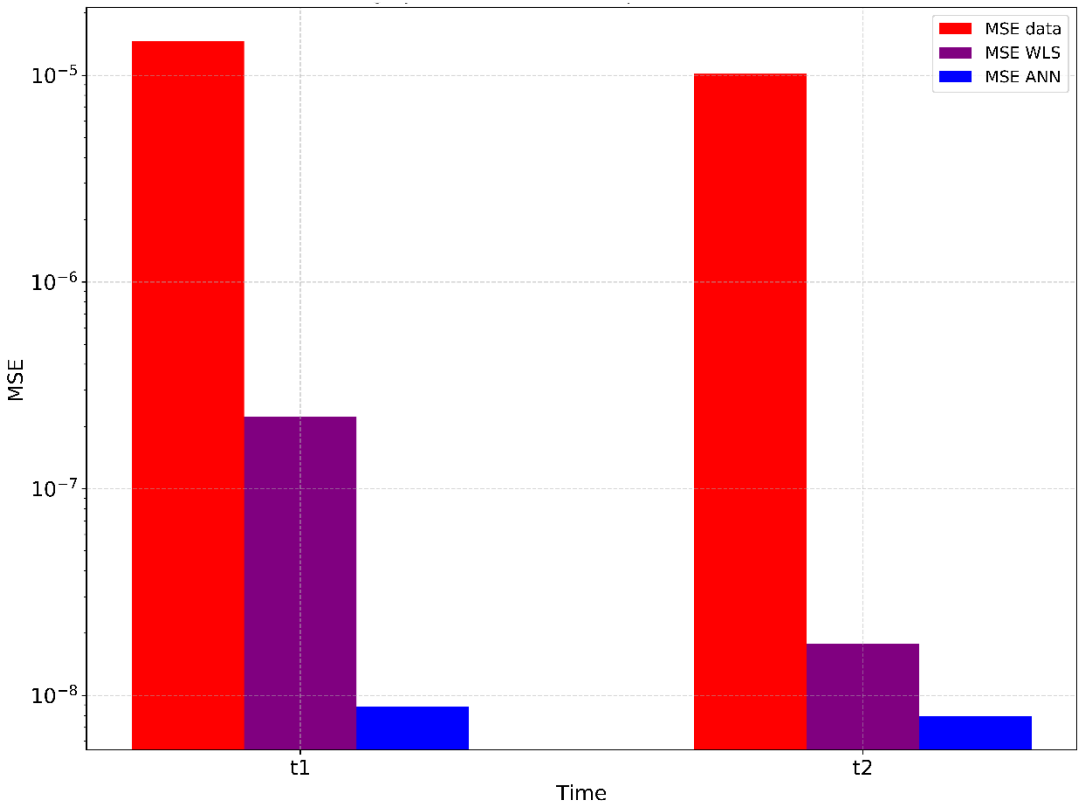
Results II.



t1:

Measured	WLS	ANN
1.5e-05	2.2e-07	8.9e-09

t2:

Measured	WLS	ANN
1.0e-05	1.8e-08	8.0e-09

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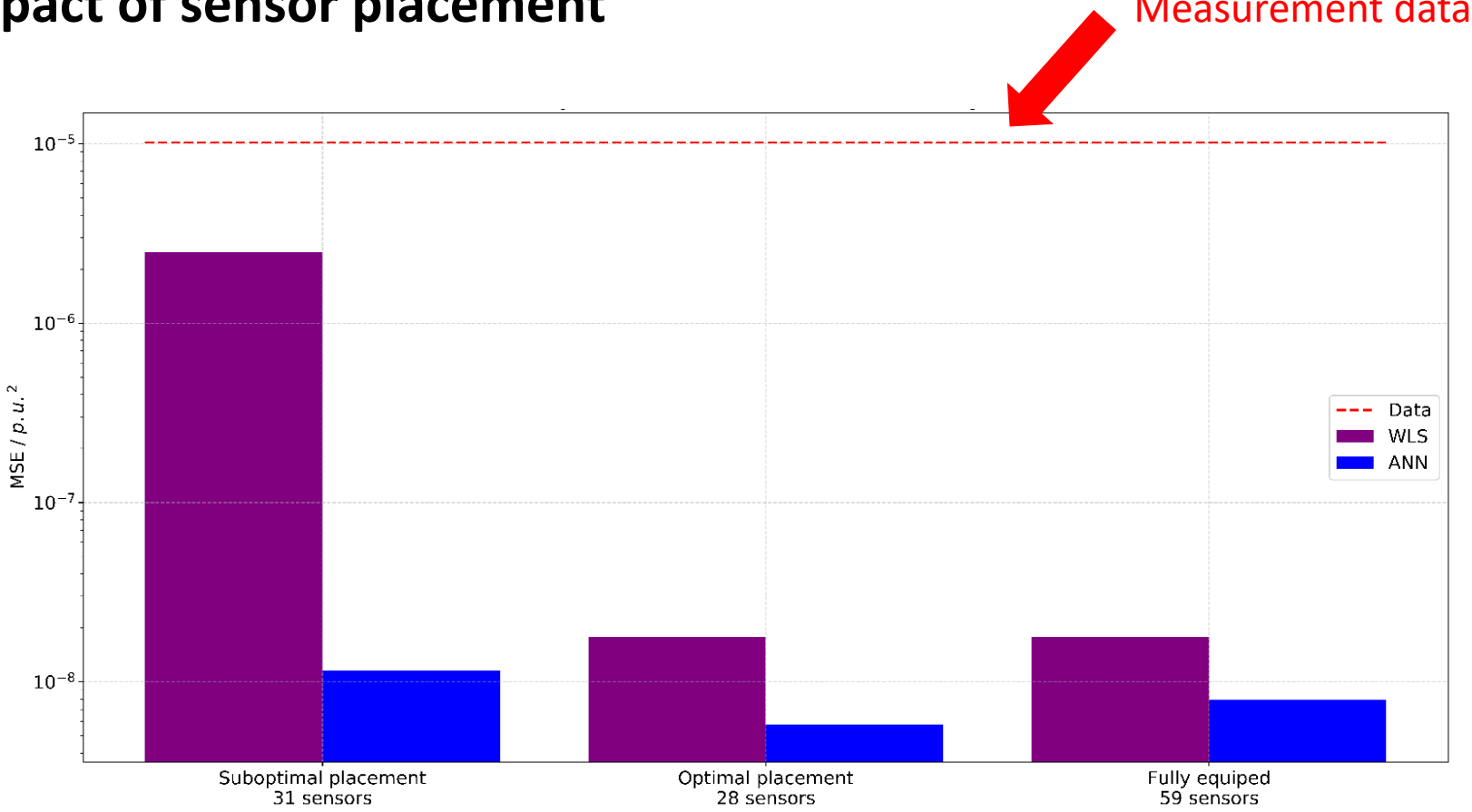
Results III.

Impact of sensor placement



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Conclusion:

- Artificial neural networks can be applied for energy system state estimation
- The estimation error of ML-based state estimation is for the given scenario better than the classical approach
- ML-based techniques offer multiple benefits, e.g. no explicit a-priori knowledge about the measurement noise has to be provided
- The presented approach scales well with systems that are not fully equipped with sensors

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Thank you for your attention!

Questions?