



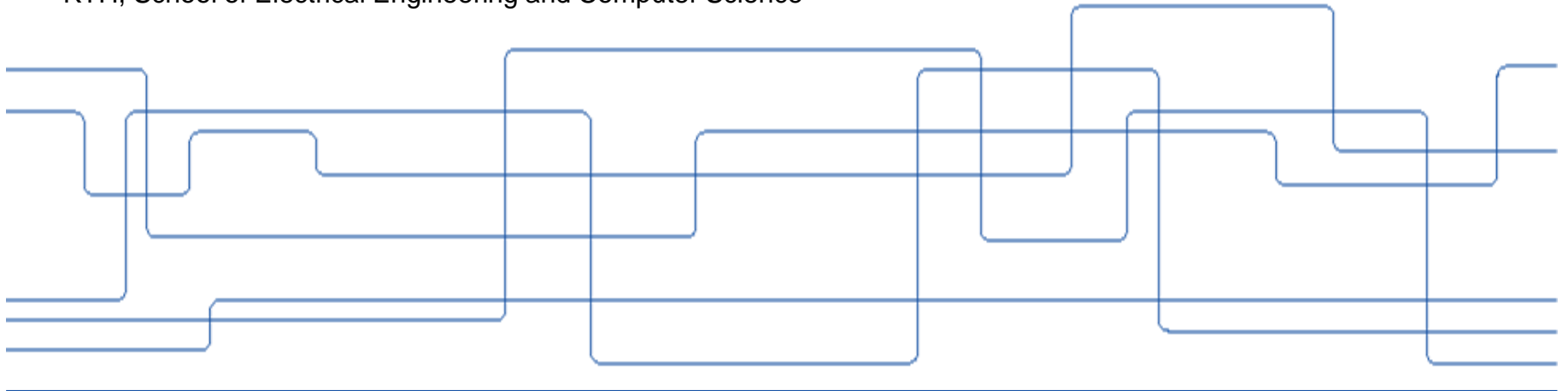
KTH ROYAL INSTITUTE  
OF TECHNOLOGY

# Dynamic rating of power transformers

Kateryna Morozovska

[kmor@kth.se](mailto:kmor@kth.se)

KTH, School of Electrical Engineering and Computer Science



# Problem Definition – Dynamic rating is important

Transformers are not utilized to their full potential

Extreme case: wind farm substations operate on average below 50% of their transmission capacity ~70% of the time

Also: Grids are congested and lack room for new renewables

Meanwhile, south of Sweden is experiencing record electricity prices every winter

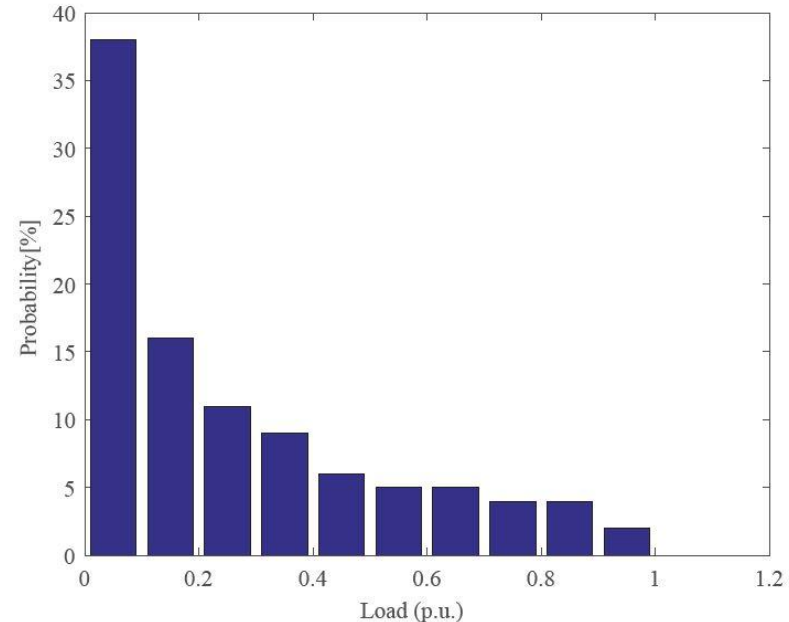
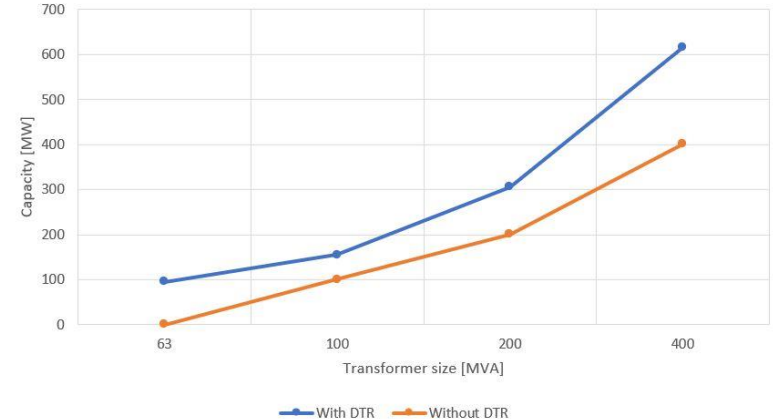
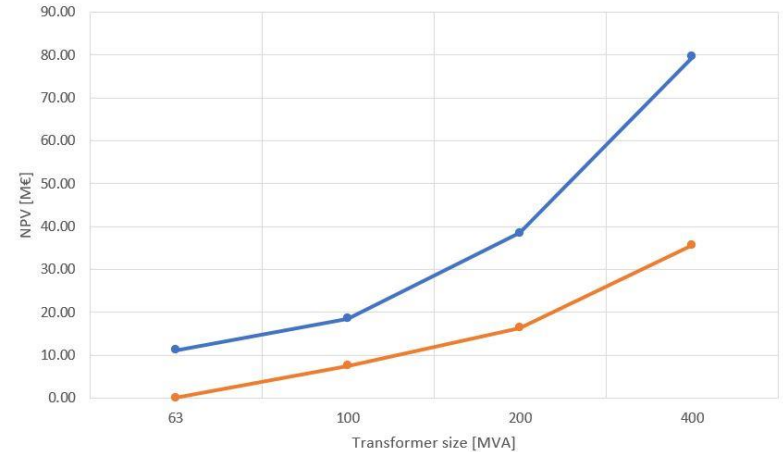
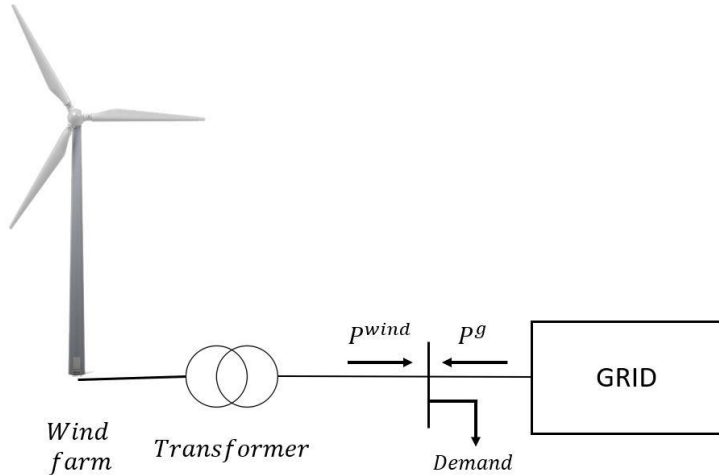


Figure: Probability load distribution for one wind farm transformer in Sweden

# Solution: Better planning

Using MILP and dynamic transformer rating we can optimize the size of the transformer to fit needs of wind farm or improve a dispatch in a large system



# Solution: Improved and informed operation

Machine learning is used to forecast wind farm capacity for the day-ahead trading scheme used by NoordPool power exchange

The forecasting model 1<sup>st</sup> forecasts wind generation and then uses it as an input to forecast transformer's maximum capacity

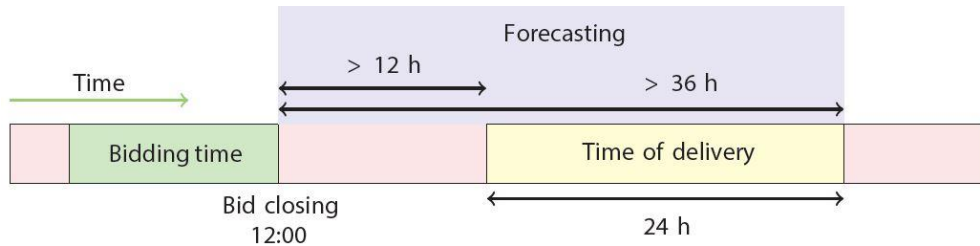


Figure: Day-ahead trading timeline of NoordPool power exchange used in the study

The accuracy of forecasting model changes depending on the time of the year and is correlated with higher wind generation

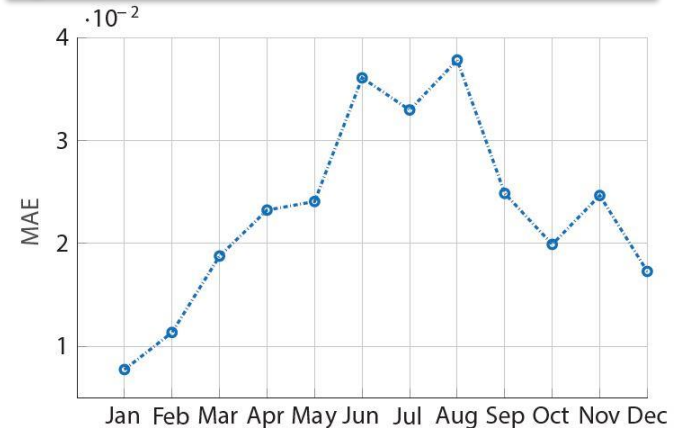


Figure: Monthly change in Mean Absolute Error of the forecast model

# Solution: Improved and informed operation

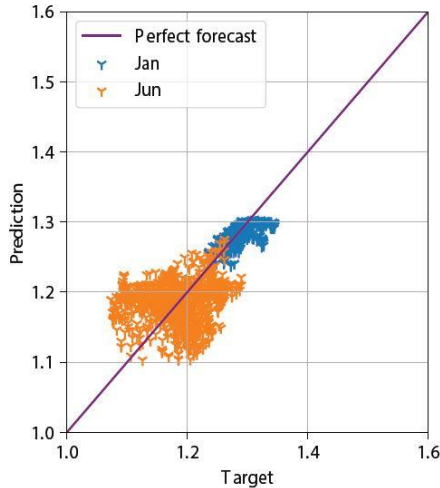


Figure: Predicted capacity and target capacity for January and June 2020 for TR's hot-spot temperature 110 °C

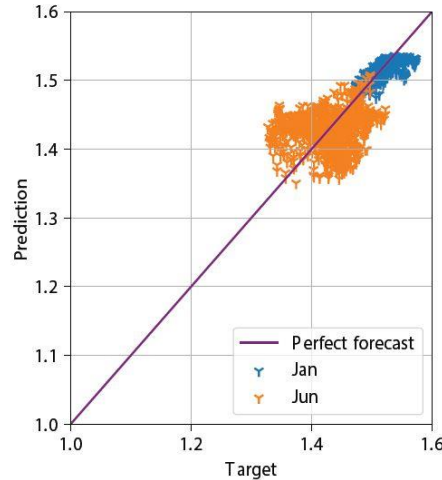


Figure: Predicted capacity and target capacity for January and June 2020 for TR's hot-spot temperature 140 °C

Day-ahead forecast of transformer capacity, based on weather forecast and wind farm generation prediction

Table: Transformer capacity forecast, for TR's hot-spot temperature 110 °C

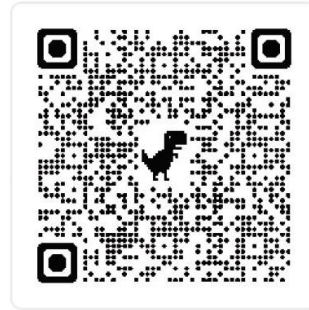
	No curtailment predicted	Curtailment predicted	Total
No curtailment needed	10636	27	10663
Curtailment needed	53	2208	2261
<b>Total</b>	<b>10689</b>	<b>2235</b>	<b>12924</b>

Table: Transformer capacity forecast, for TR's hot-spot temperature 140 °C

	No curtailment predicted	Curtailment predicted	Total
No curtailment needed	11763	48	11811
Curtailment needed	42	1071	1113
<b>Total</b>	<b>11805</b>	<b>1119</b>	<b>12924</b>



Check our new project on **PINNs**



Thank you!

**VINNOVA**

Blås Energy

 **Hitachi Energy**

