Hochschule Karlsruhe
University of
Applied Sciences

Fakultät für
**Wirtschafts-
wissenschaften**

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Short-Term Multi-Site Forecasting of Heterogeneous Wind Power Fleets: Global Temporal Fusion Transformer Leveraging Static Covariates

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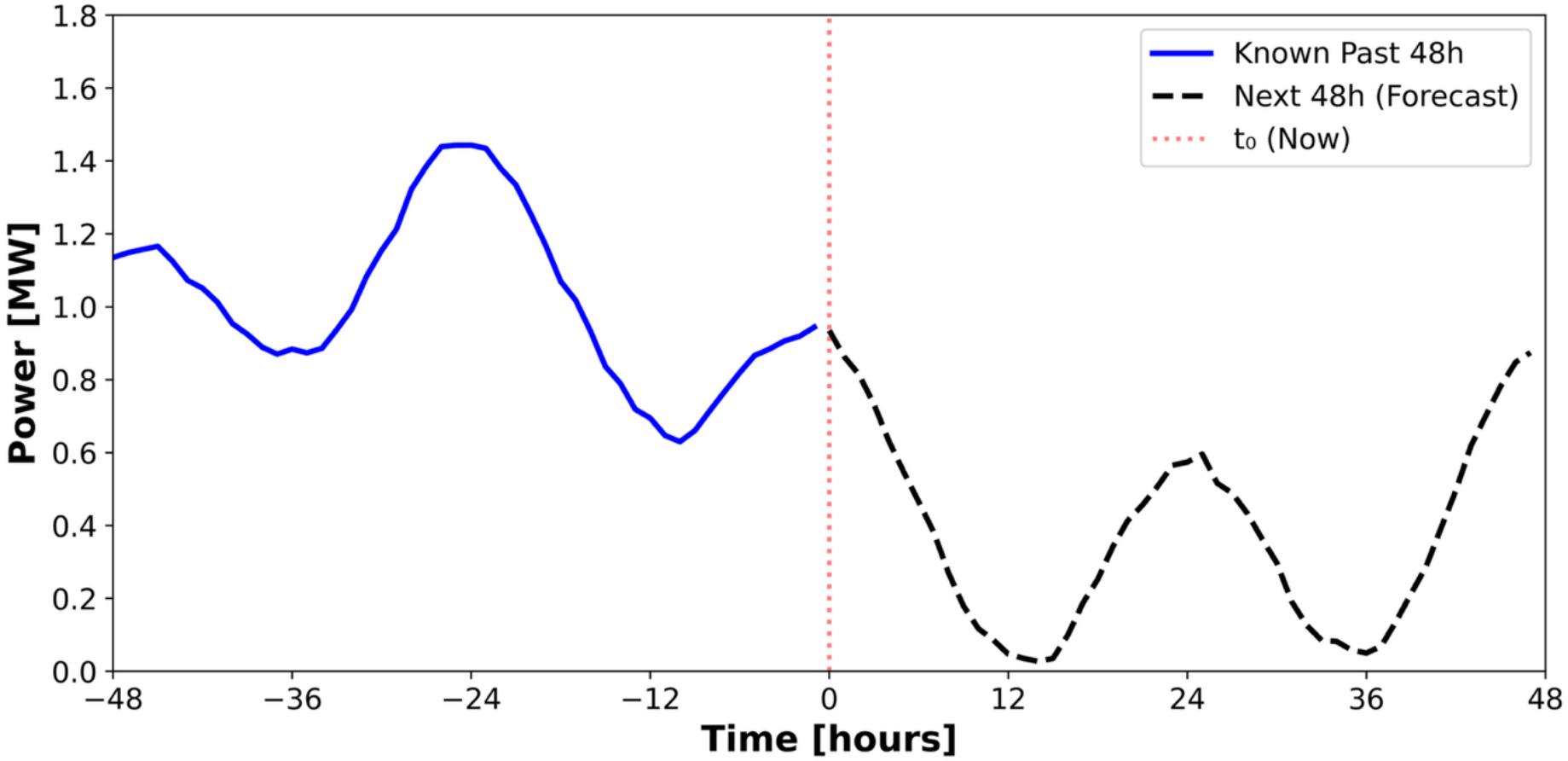
Hochschule Karlsruhe | University of Applied Sciences (HKA)

Federal Ministry
of Research, Technology
and Space

Short-Term Forecasting



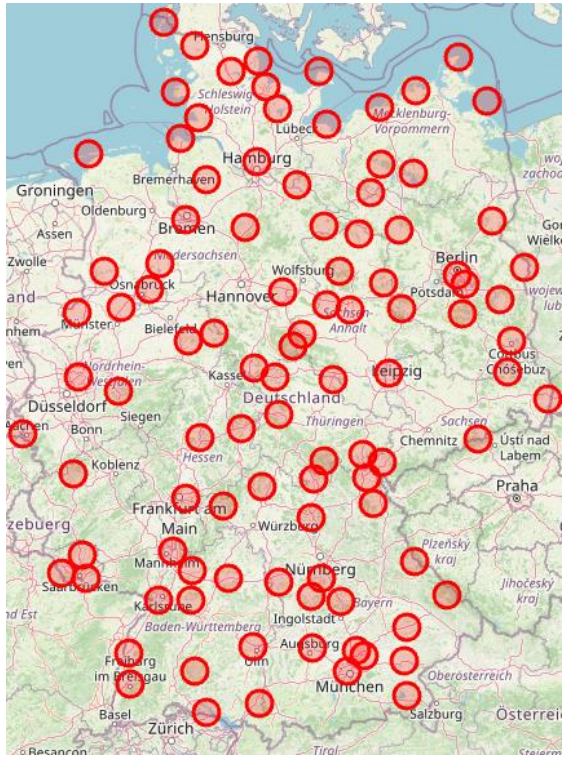
Forecast horizon of 48 hours

Multi-Site Forecasting

50 Wind Farms

$\subseteq$

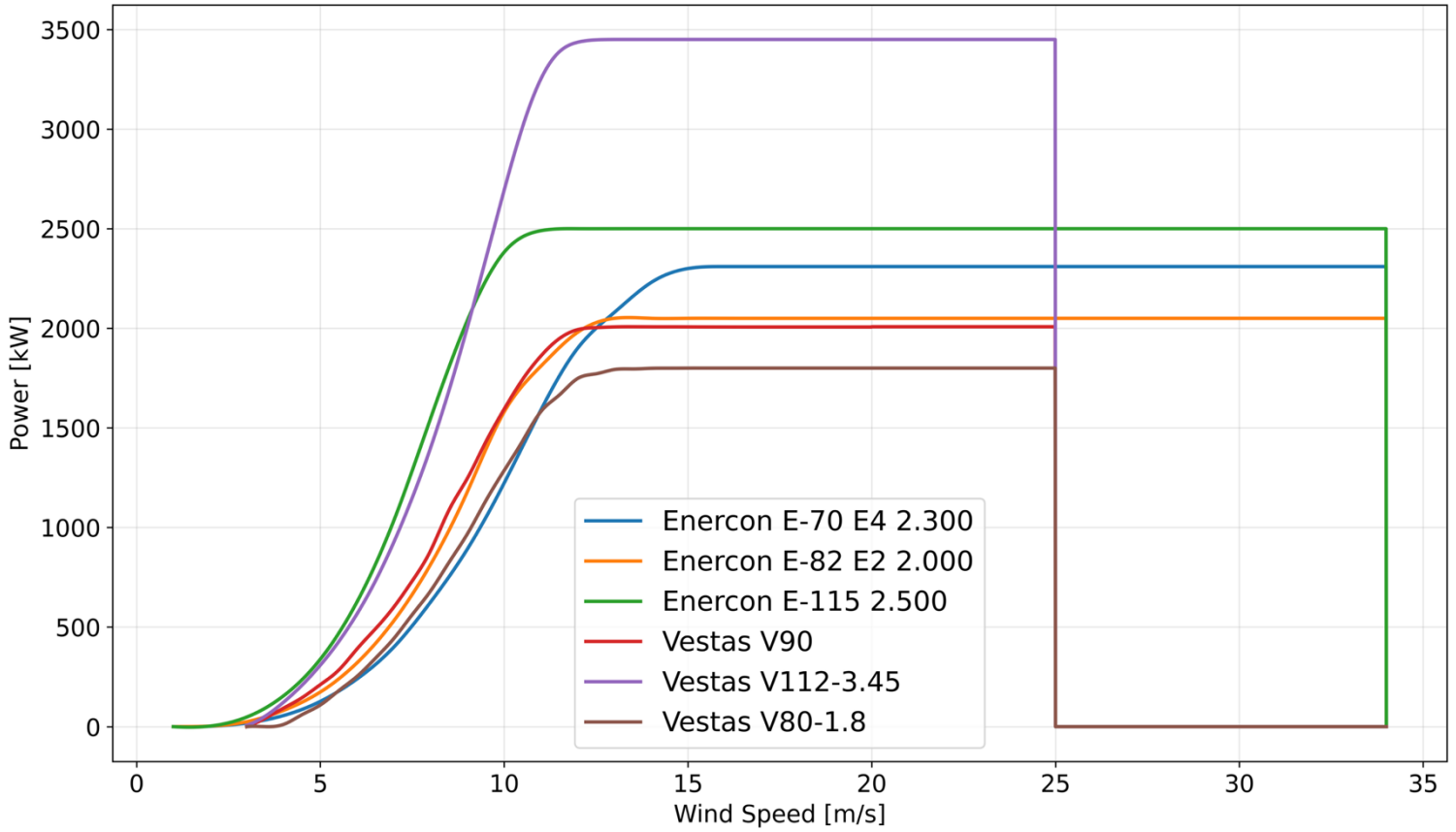
100 Wind Farms



https://data.mendeley.com/datasets/xv3s82rvd2

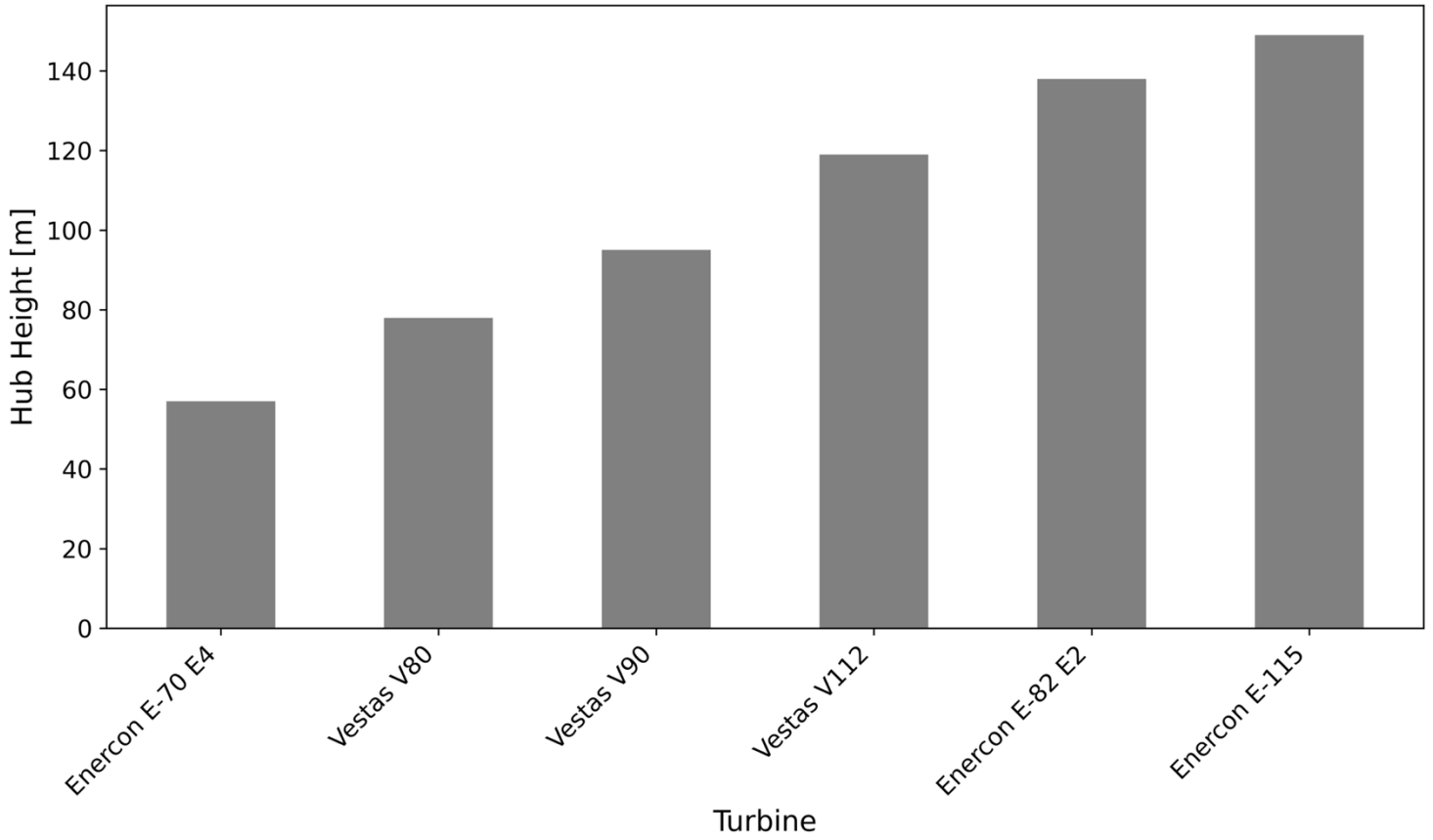
1 global model trained on many wind farms

Heterogeneous Wind Power Fleets



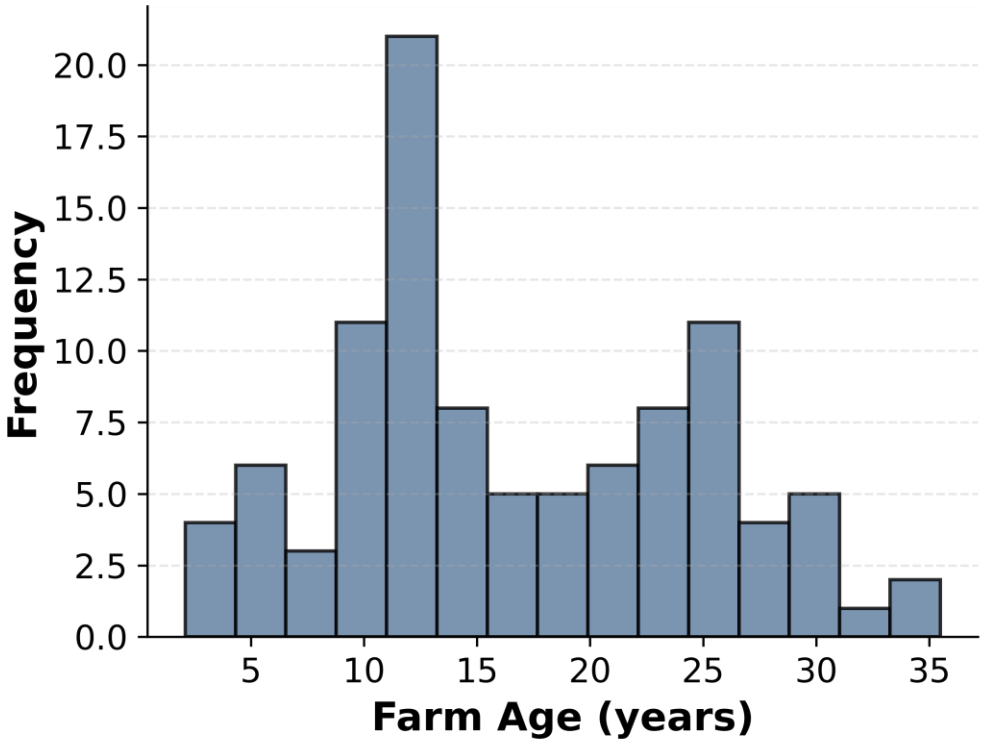
Heterogeneity in power curves

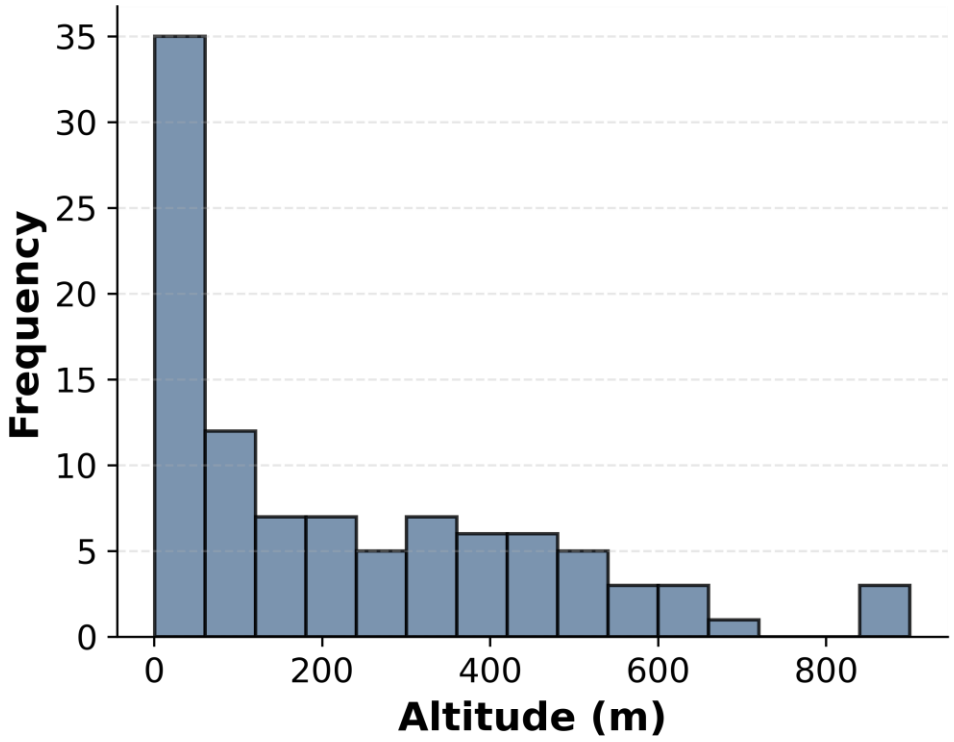
Heterogeneous Wind Power Fleets



Heterogeneity in hub hights

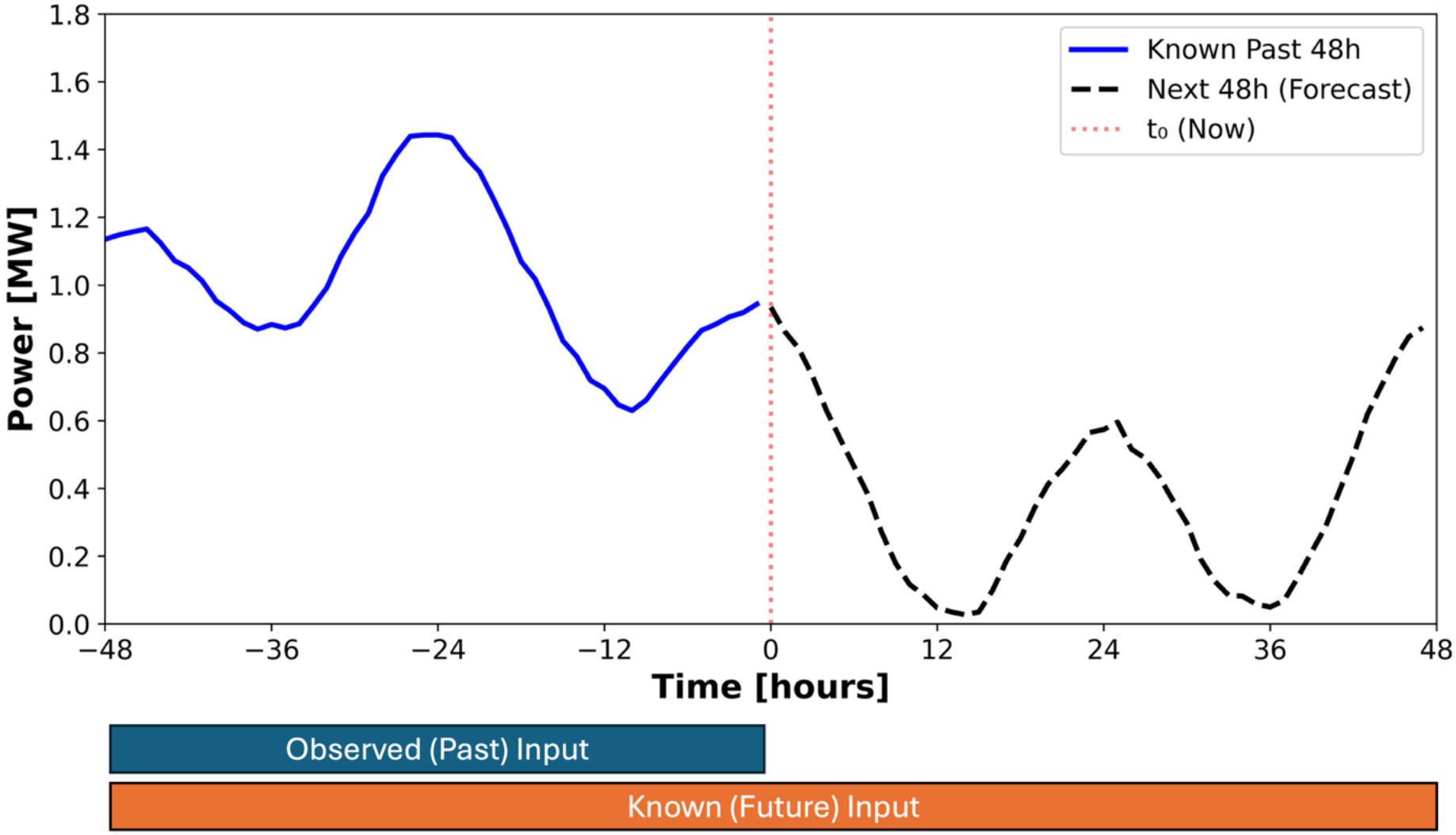
Heterogeneous Wind Power Fleets



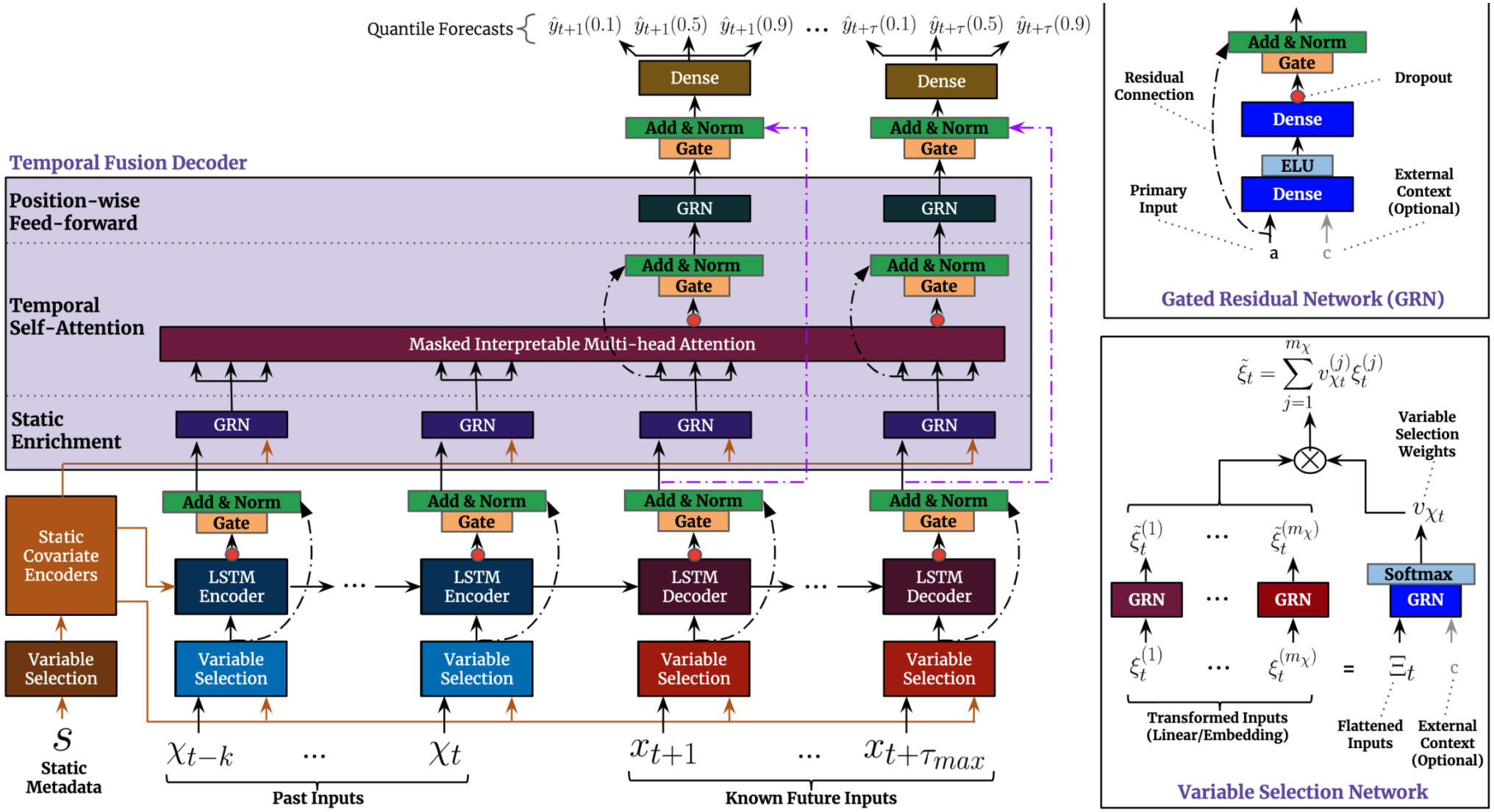


More heterogeneity in age and altitude

Global Temporal Fusion Transformer in Wind Power Forecasting

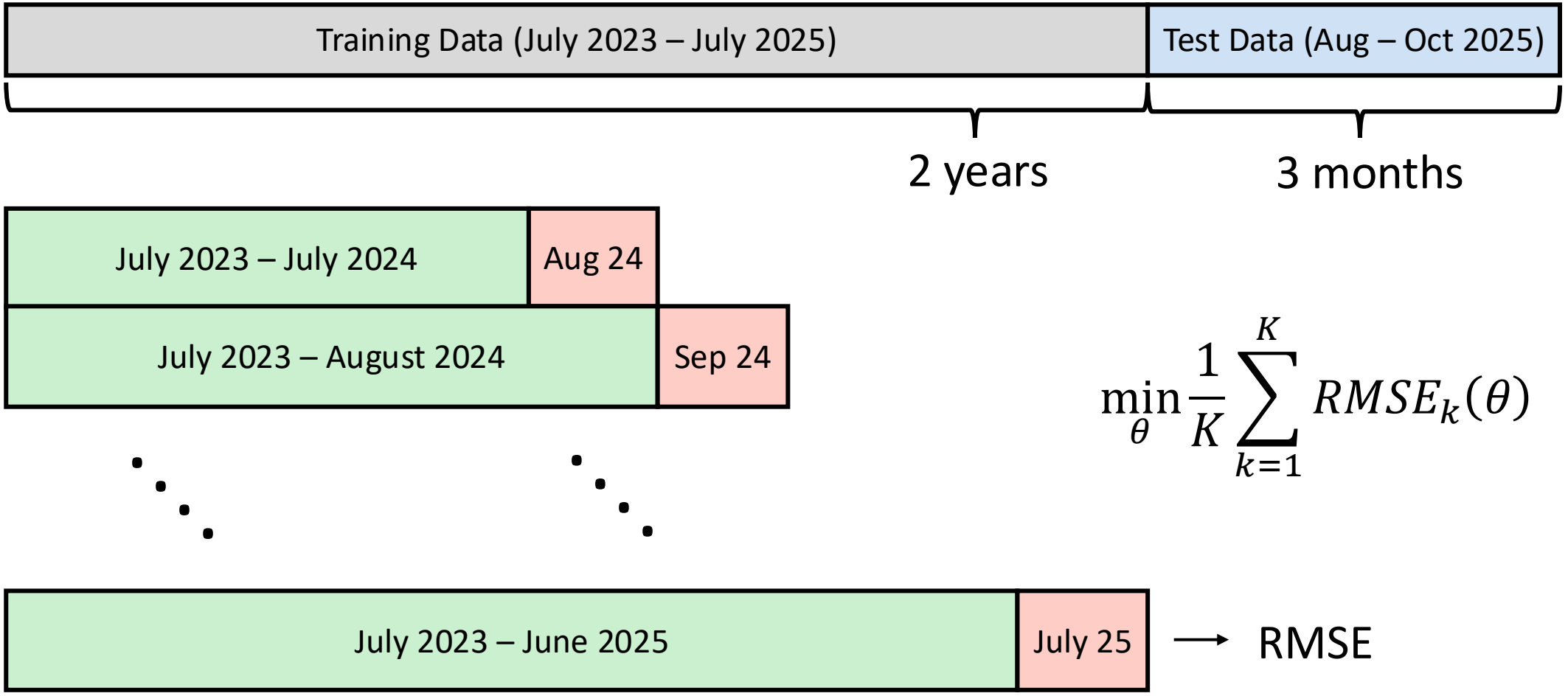


Temporal Fusion Transformer



(Lim et al., 2019)

Experimental Setup



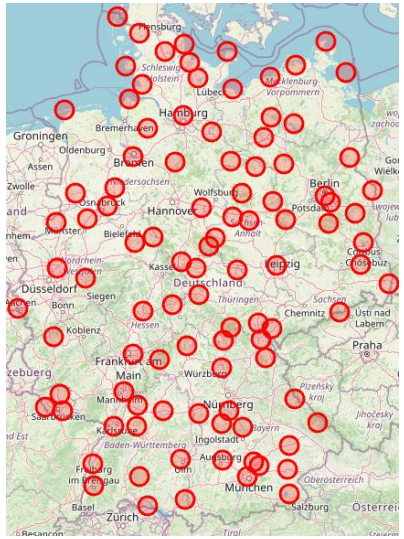
$$\min_{\theta} \frac{1}{K} \sum_{k=1}^{K} RMSE_k(\theta)$$

Monthly Validation during Hyperparameter Optimization

Experimental Setup

50 Farms

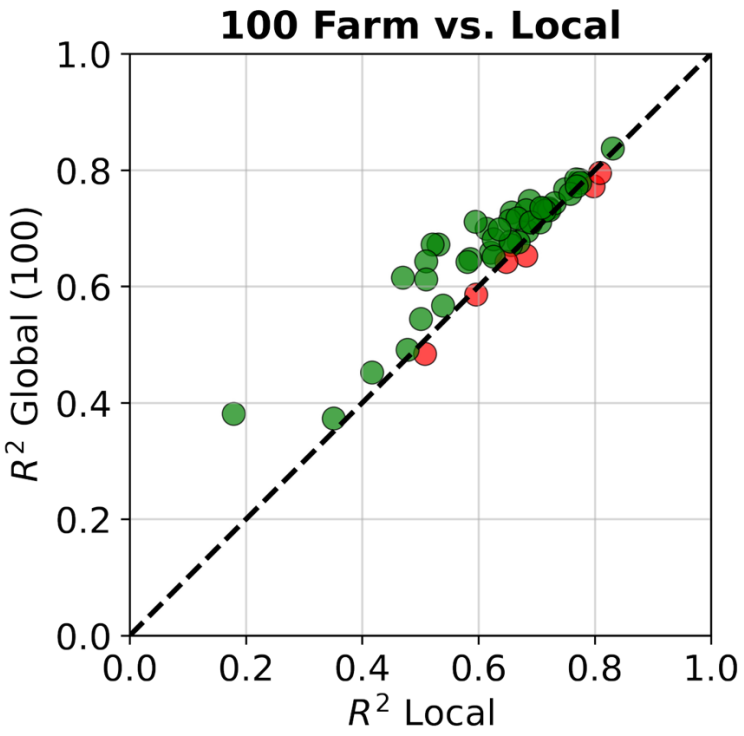
100 Farms

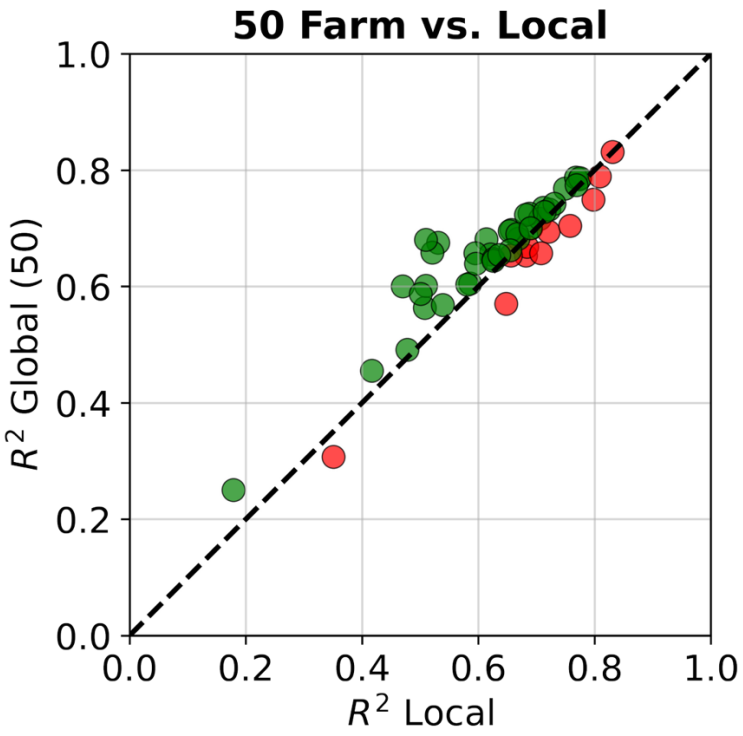


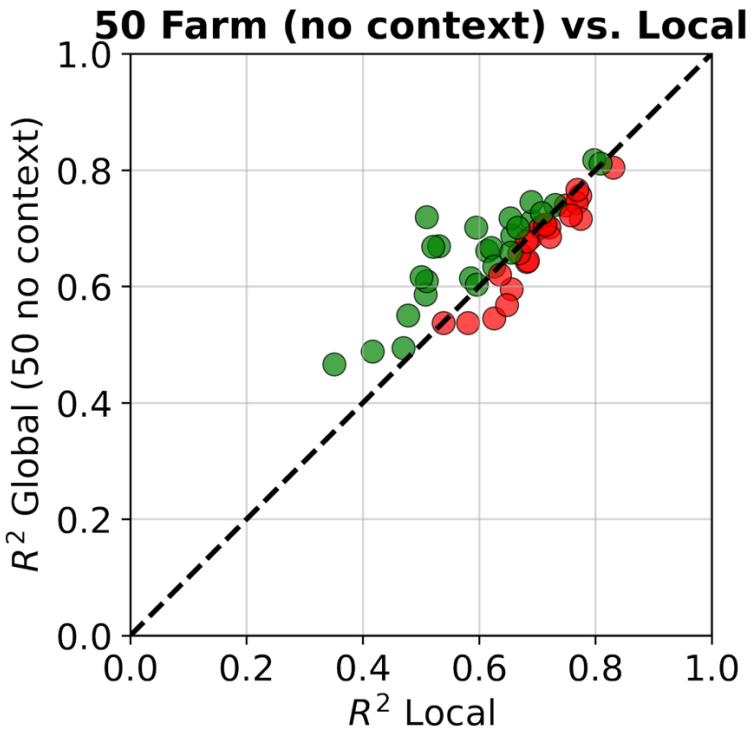
	Context	No Context
Global	1 Model (100 Farms) 1 Model (50 Farms)	1 Model (50 Farms)
Local	/	100 Models

HPO is being done for 3 global and 100 local models

Global vs. Local Models







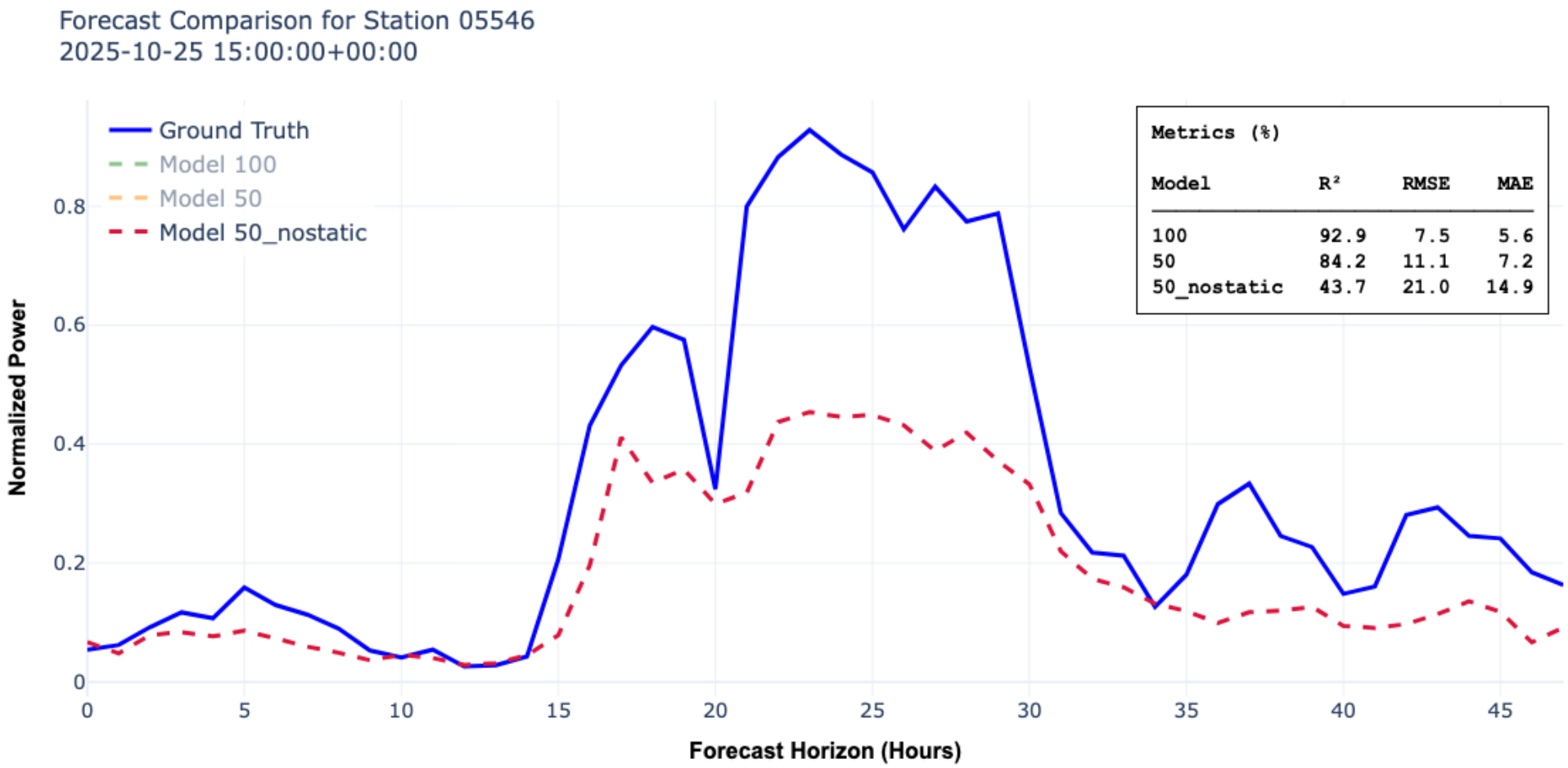
	Δ rel	Δ abs
Mean	8.42%	3.90%
Median	3.22%	2.20%
p-value	0.00%	0.00%

	Δ rel	Δ abs
Mean	5.20%	2.50%
Median	2.77%	1.85%
p-value	0.02%	0.04%

	Δ rel	Δ abs
Mean	-1.28%	0.87%
Median	0.35%	0.25%
p-value	9.71%	12.43%

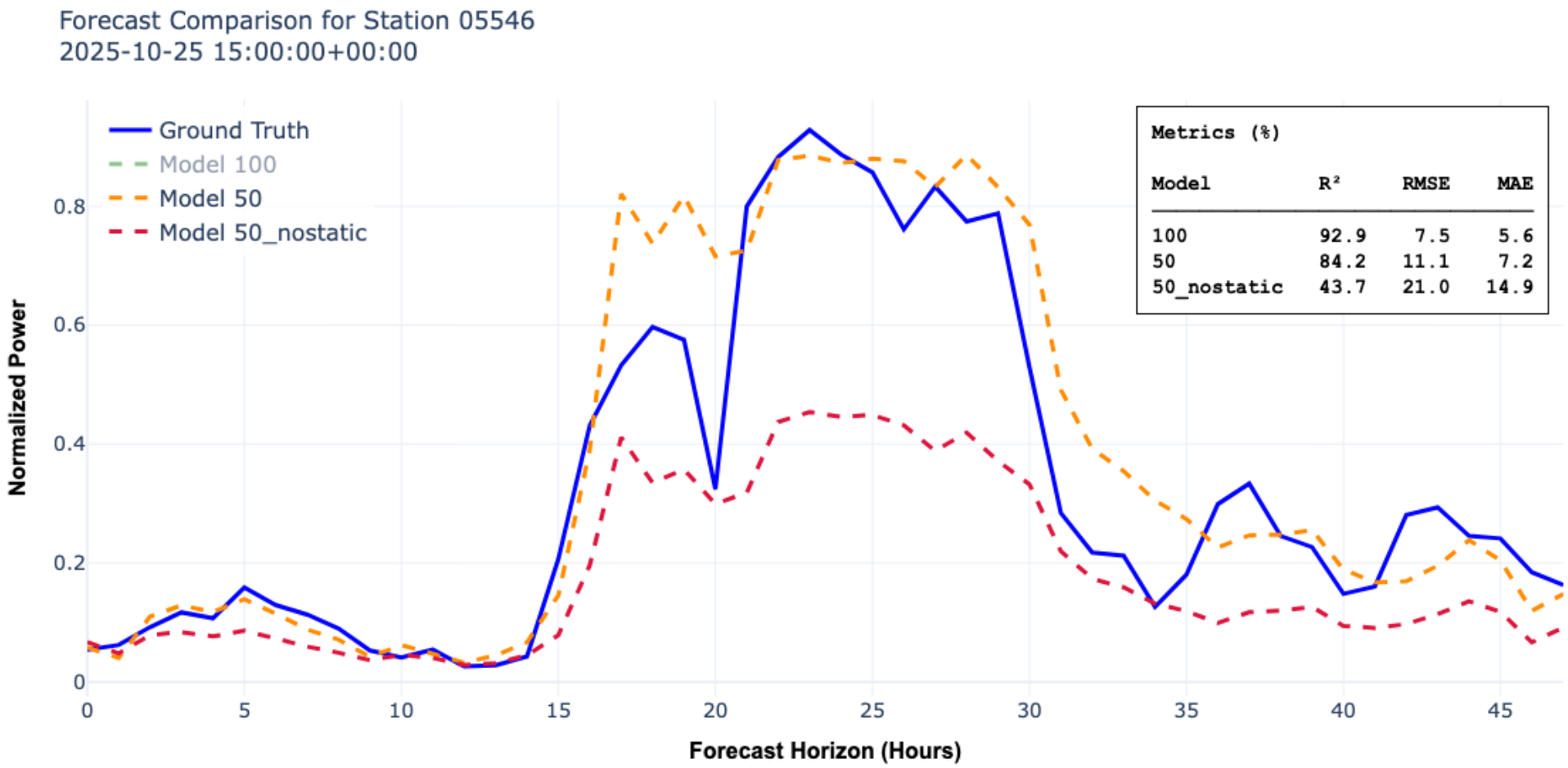
Global models need context to be better than local ones

Results



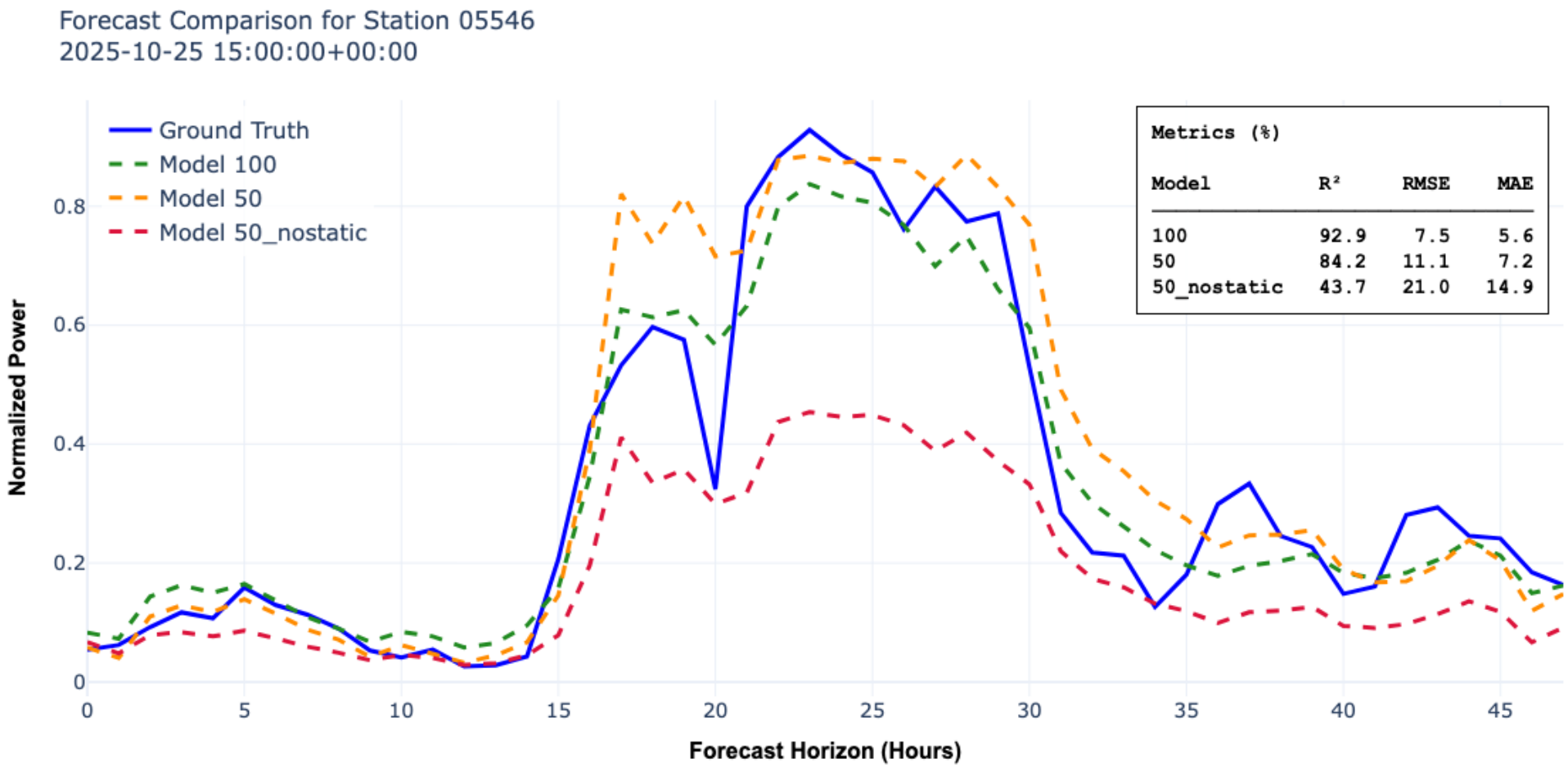
Bad forecast without static covariates

Results



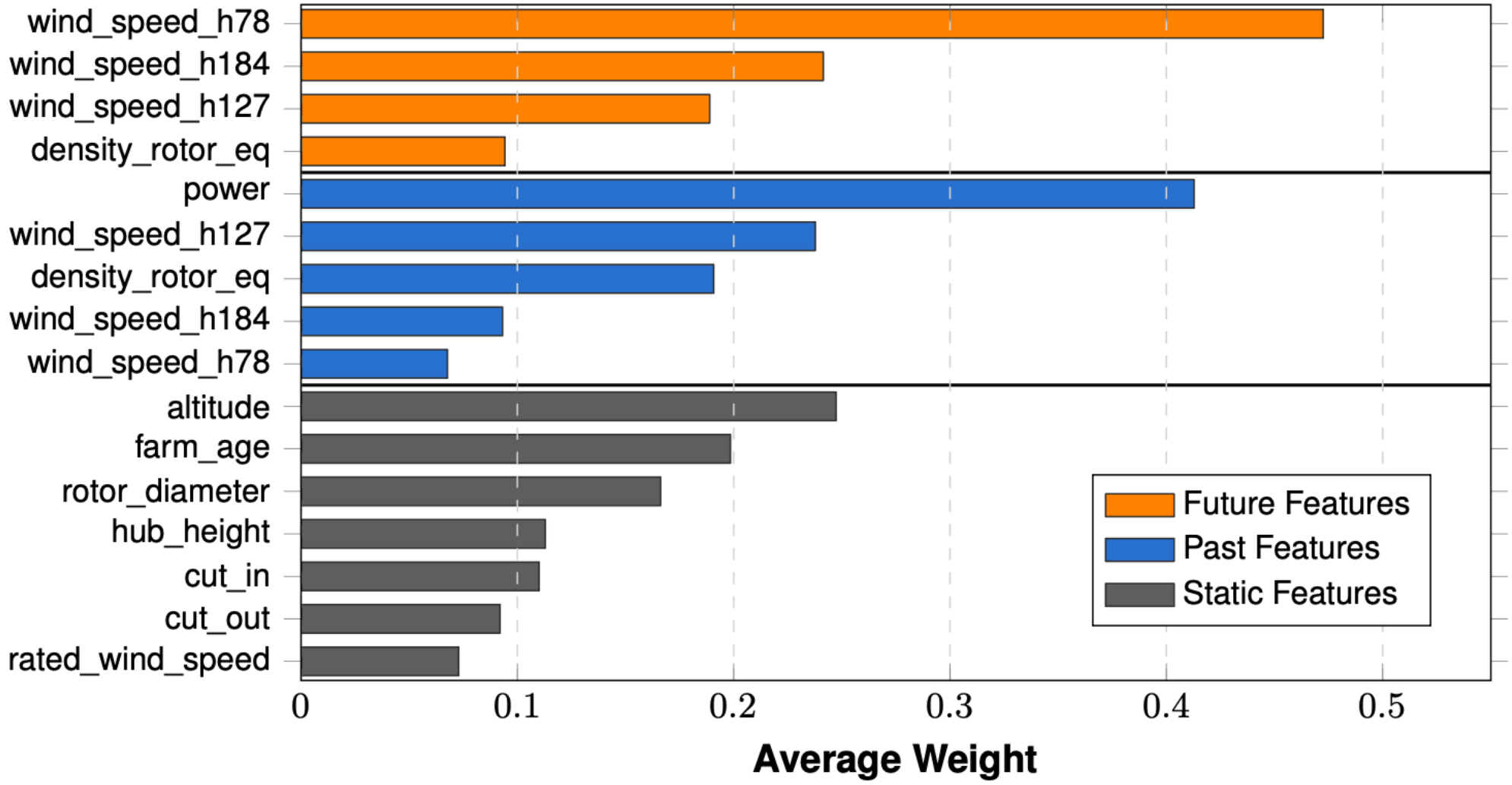
Adding static covariates improve the forecast significantly

Results



Extra gain in performance by adding more training data

Feature Importance



Altitude and farm age most important static features

Conclusion

1. Global models outperform local models, if they are trained on static differences between wind farms.

2. A larger sample size improves performance across all sites.

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Thank You!