Predicting hosting capacity of photovoltaic power production in low-voltage grids using regressive techniques

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2017-10-24

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Outline

- Introduction
- Motivation
- Data & Method
- Results
- Conclusion

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Introduction

- Photovoltaic (PV) power generation and residential electricity consumption rarely coincide
- The amount of PV power that can be installed in a low-voltage (LV) grid without affecting power quality is called hosting capacity (HC)
- The HC is usually estimated by time consuming power flow simulations

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Motivation

- Solving power flow equations is time consuming
- Many specifications of the LV grid are known, including load data
- Our method might facilitate further PV power penetration with relative ease

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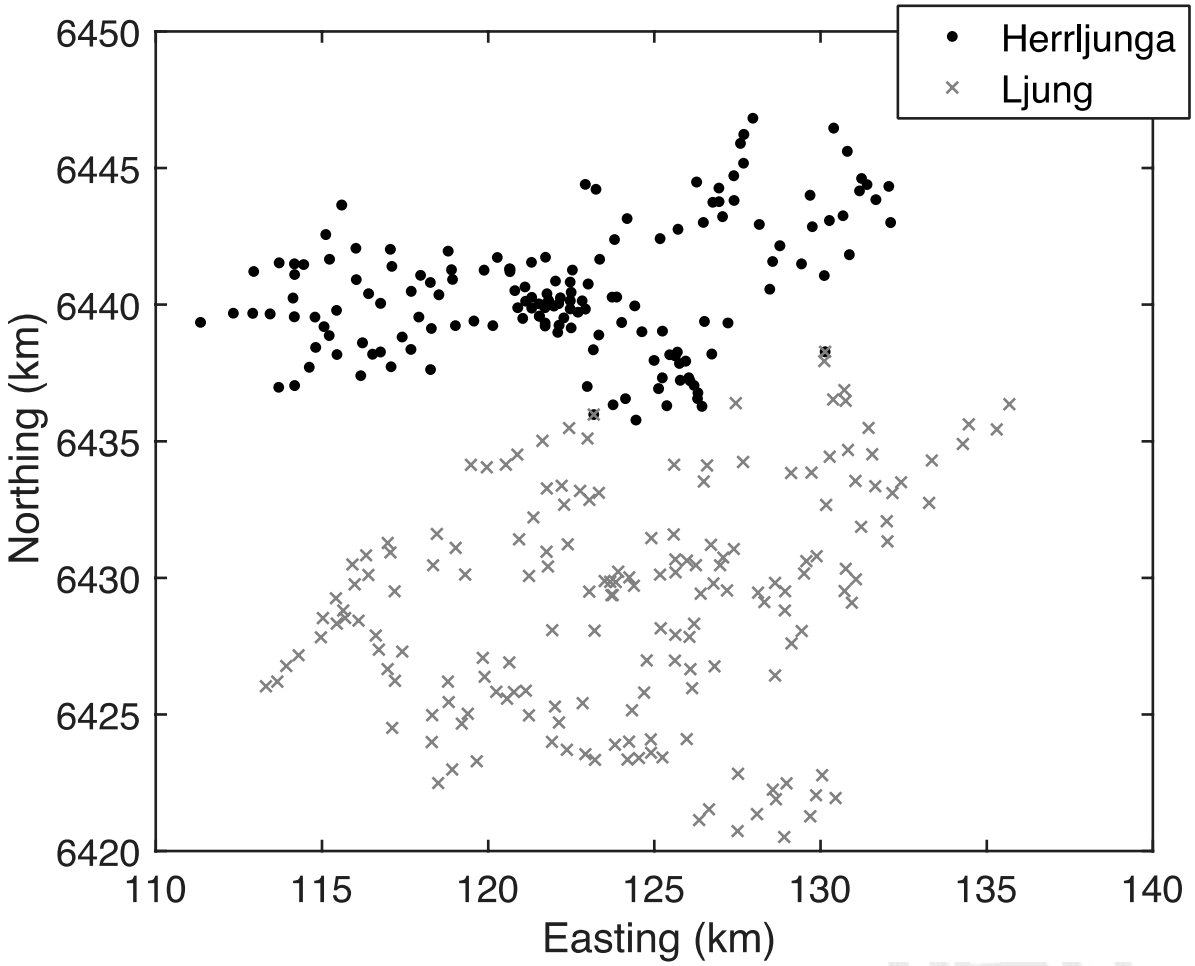
Data & Method



Widén et al., Probabilistic Load Flow for Power Grids With High PV Penetrations Using Copula-Based Modeling of Spatially Correlated Solar Irradiance, IEEE Journal of Photovoltaics 2017, p. 1-6

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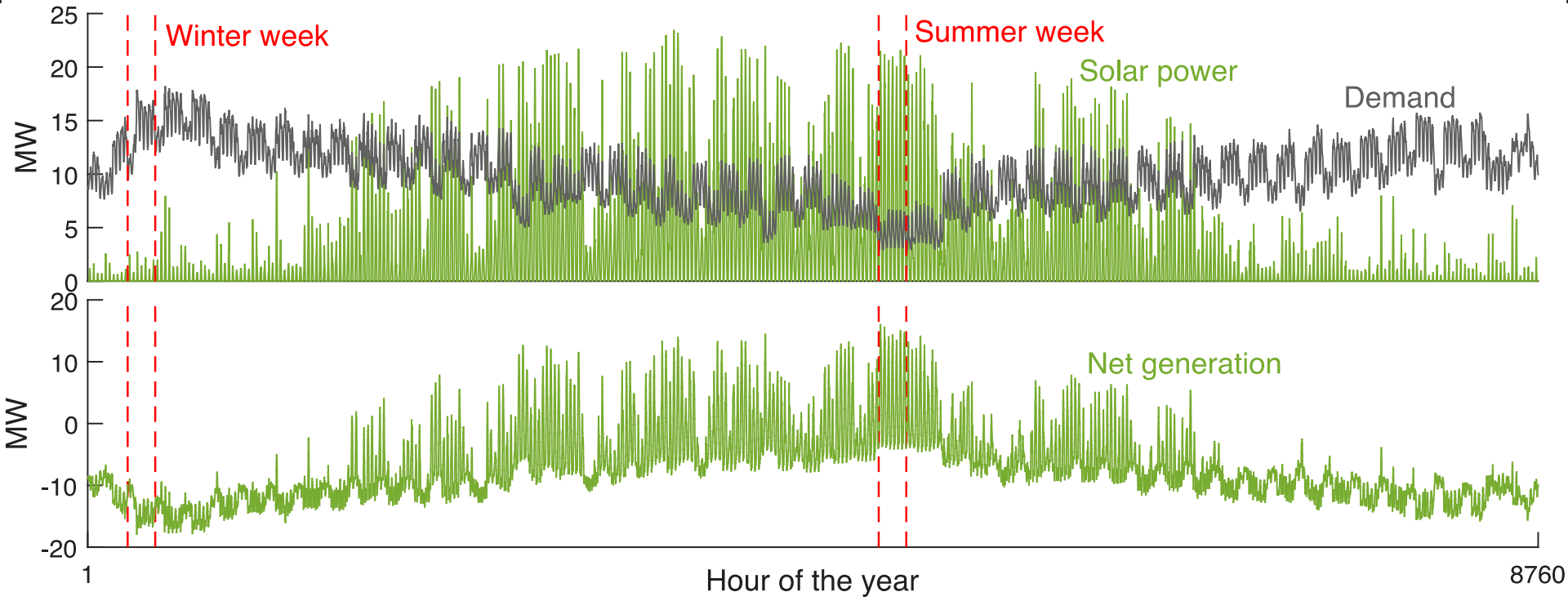
Data & Method



Widén et al., Evaluation of technological solutions for managing extensive connection of photovoltaic systems in electricity distribution grids, Technical Report for Swedish Energy Agency, p. 1-26

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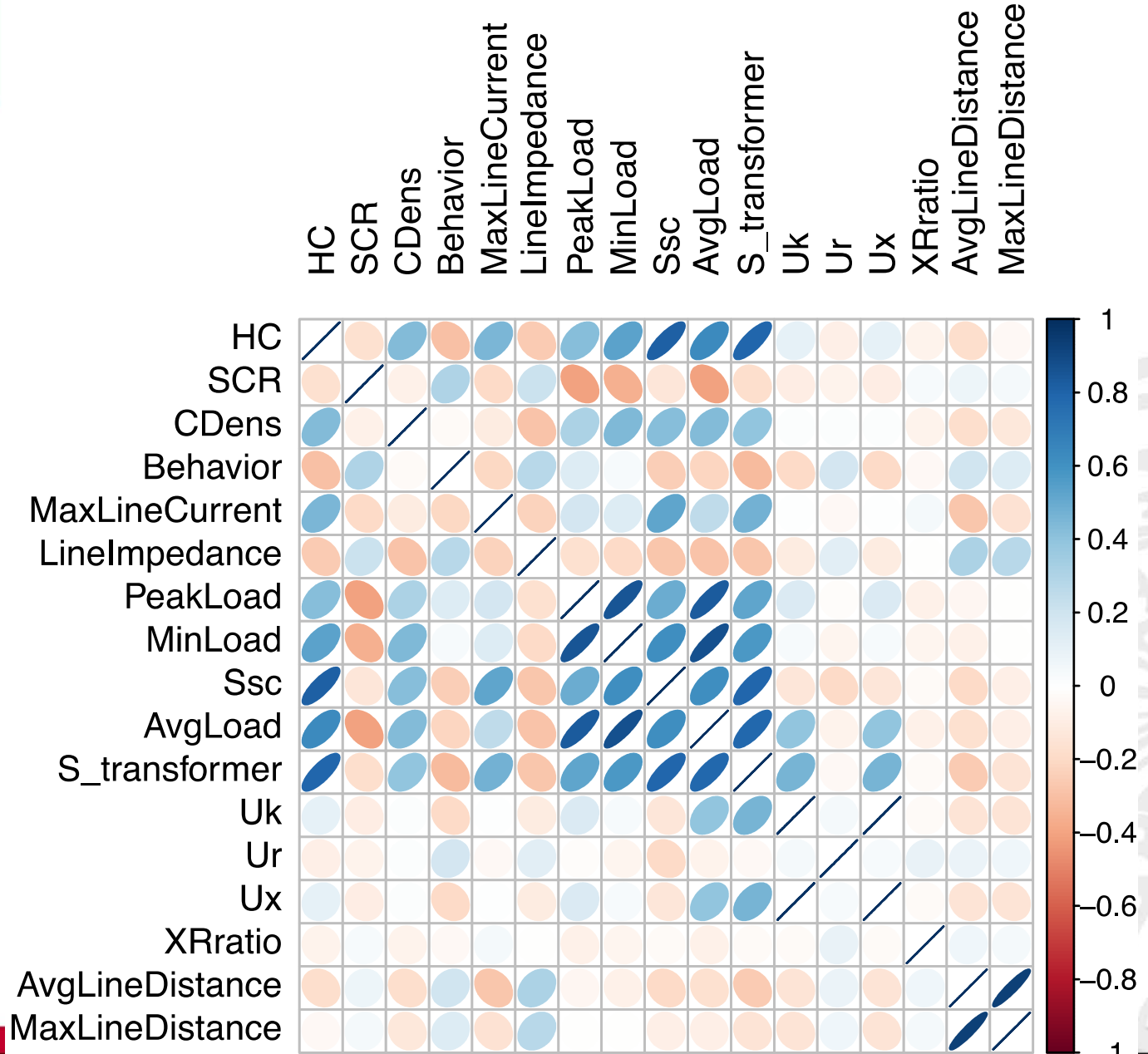
Data & Method



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Data & Method

- Multiple linear regression (MLR)
- Gradient boosting (GB)
- Gaussian Processes (GPs)

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Performance metrics

- MAE
- RMSE
- PICP $= \frac{1}{N}\sum_{i=1}^{N} \epsilon_n$, where $\epsilon_{tn} = \begin{cases} 1 \text{ if } y_i \in [L_i, U_i] \\ 0 \text{ if } y_i \notin [L_i, U_i] \end{cases}$
- PINAW $= \frac{1}{NR}\sum_{i=1}^{N}(U_i - L_i)$

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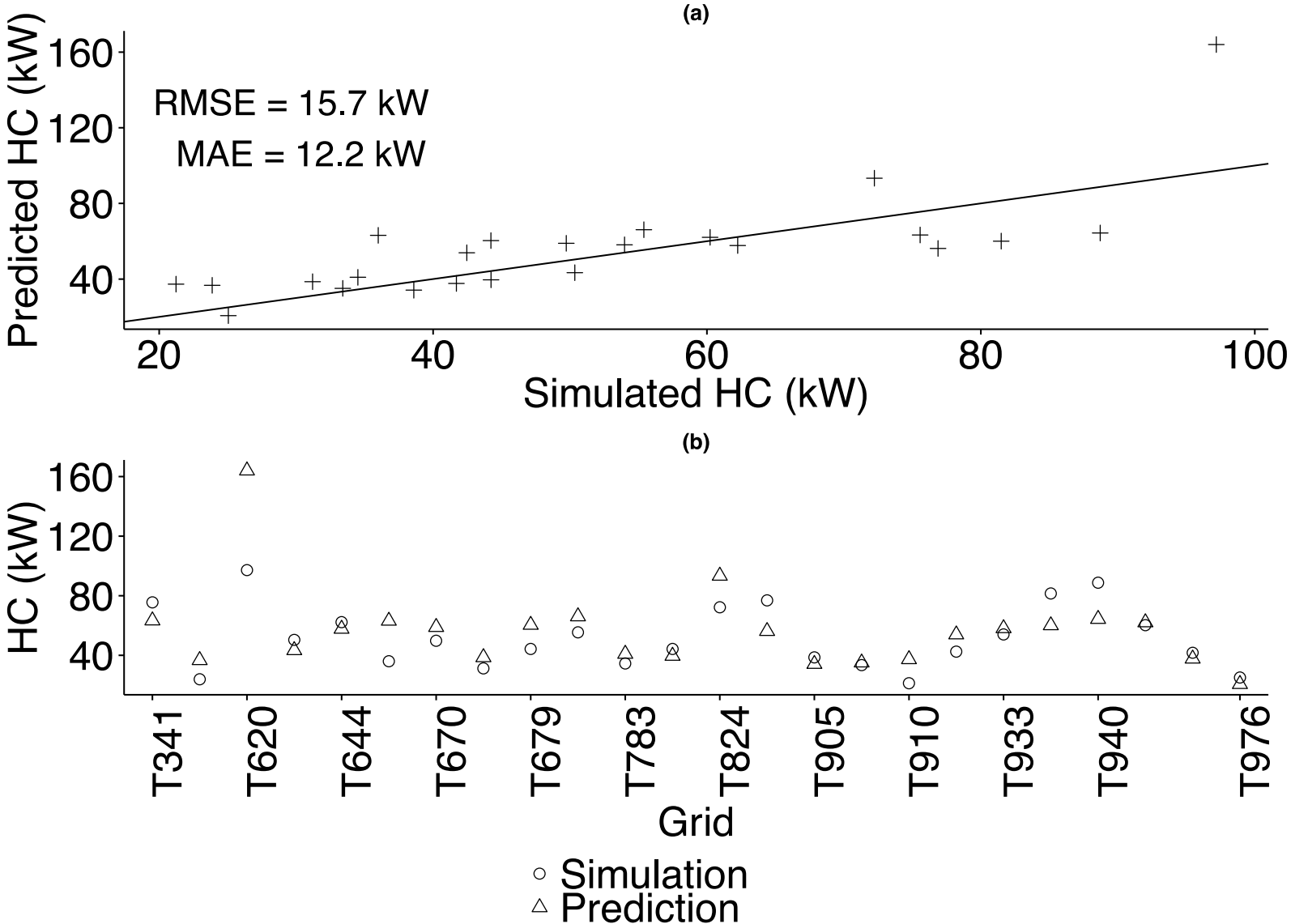
Results MLR



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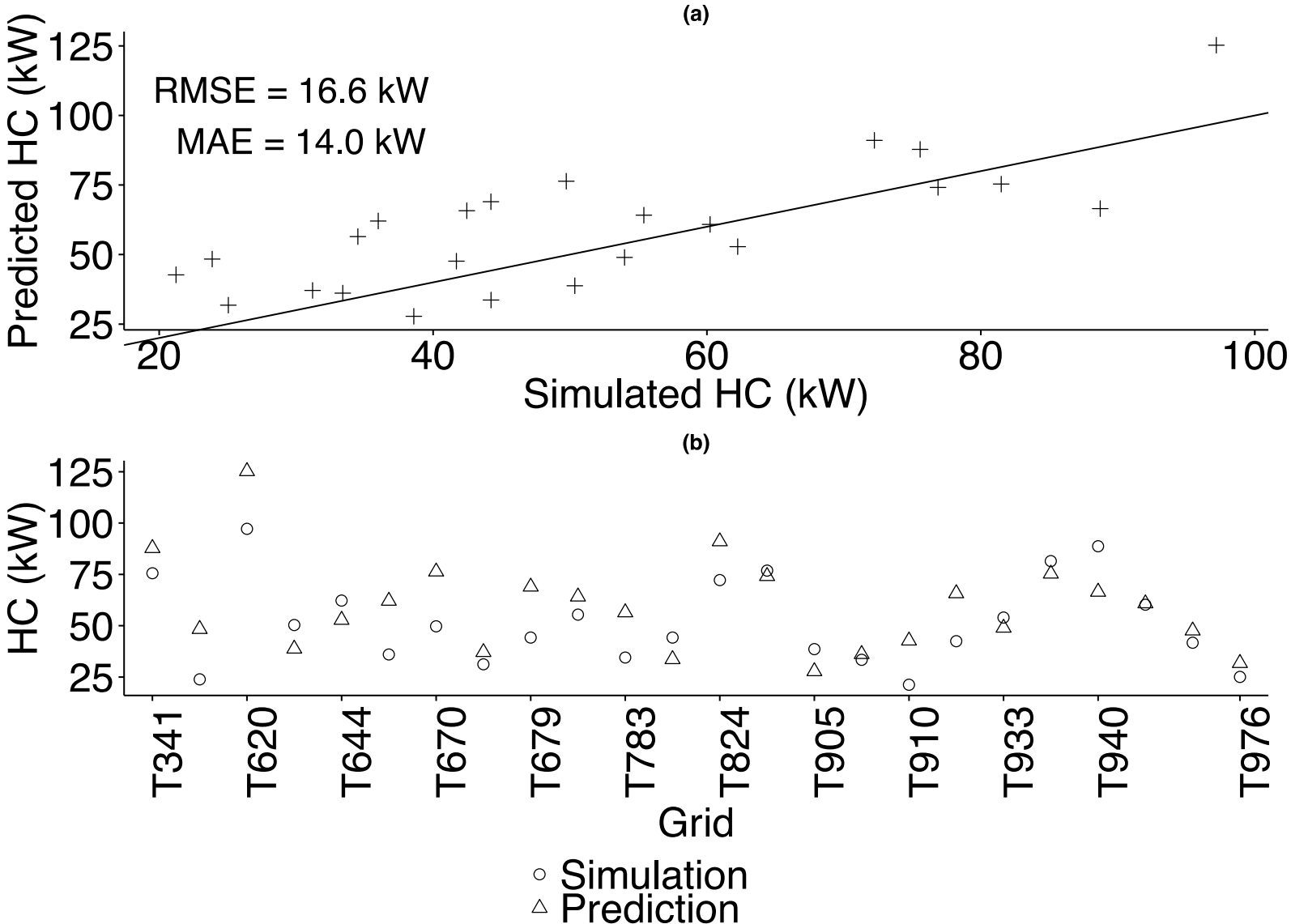
Results GB



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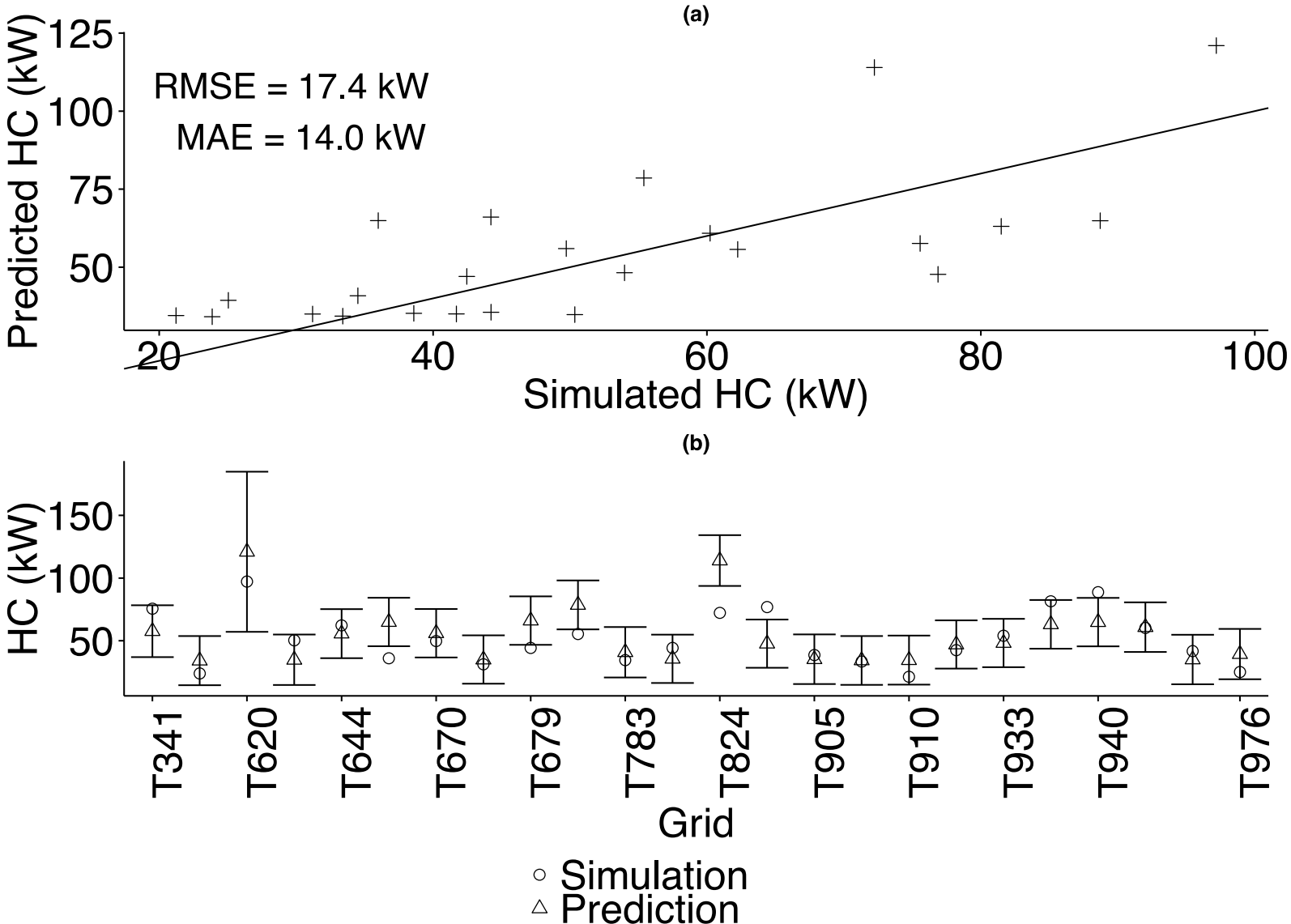
Results GPs



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Results

	MAE (kW)	RMSE (kW)	PICP (-)	PINAW (-)
MLR	12.2	15.7	-	-
GB	14.0	16.6	-	-
GPs	14.0	17.4	0.750	0.565

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Conclusion

- Regression offers a quick insight into the HC of an LV grid
- MLR showed best results but generalizes less well to different datasets
- Accuracy should be improved → more data is required and additional variables should be included

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Thank you