Solar Power Generation Analysis and Forecasting on Real World Data Using LSTM and Autoregressive CNN

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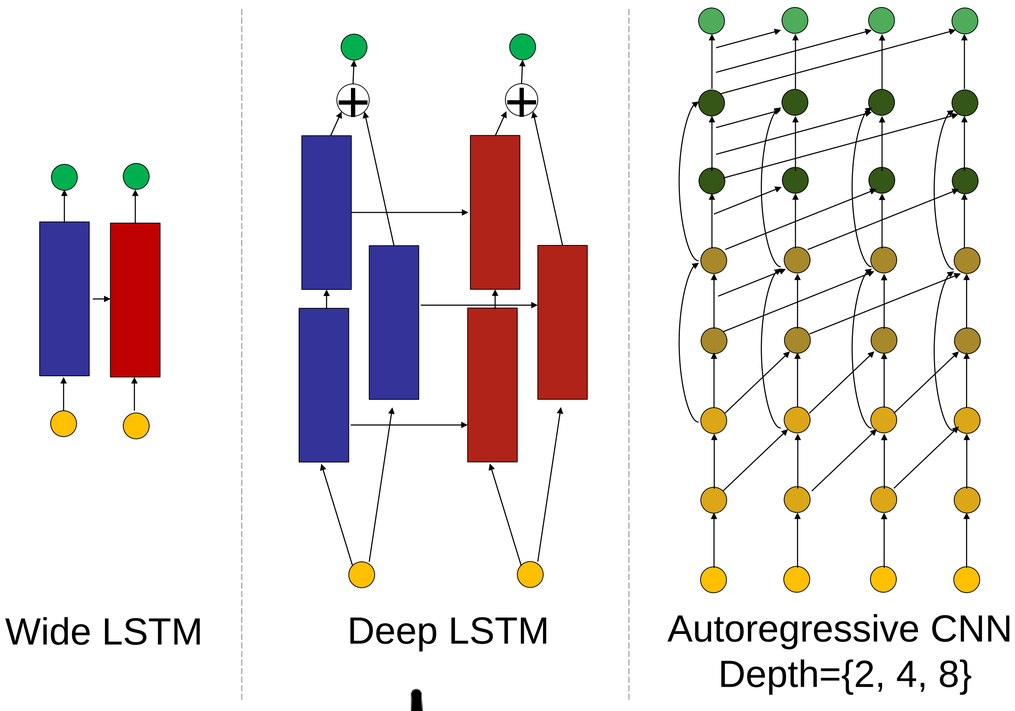
Abstract

Generated power of a solar panel is volatile and susceptible to environmental conditions. In this study, we analyzed variables affecting the generated power of a 17.5 kW real world solar power plant using quantitative methods. Methods show the importance of five relevant variables over the generated power: irradiance, time, panel temperature, ambient temperature and cloudiness. After designating the relevant variables, we trained three different models to predict in-day solar power forecasts of the plant. Our models are able to predict future power output of the solar power plant with less than 10% RMSE without requiring additional sensor data, e.g. camera to observe clouds. With the achieved accuracy, our study promises: fast, scalable and effective solutions to solar power plant owners and may facilitate grid safety on the large scale.

Conclusion

Careful inspection of variables and selection of models enable accurate predictions on future generated power output of the solar power plants. We have developed a low cost method to infer the power output 1 hour early with 7.8% RMSE using Autoregressive CNN. Method promises low cost grid safety solutions.

Models



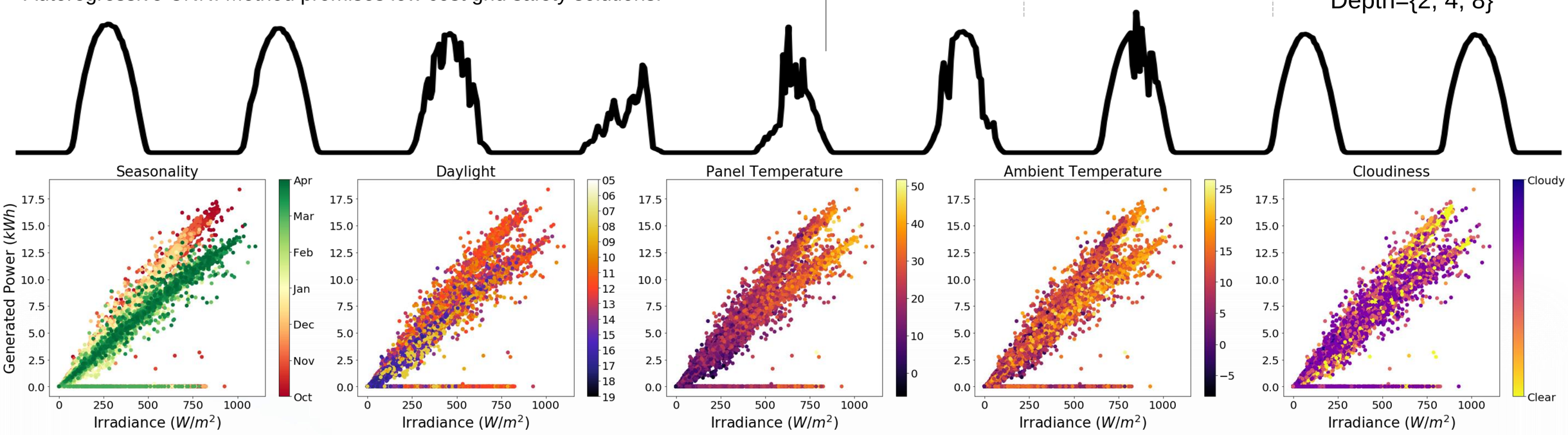


Figure: Effect of relevant variables over the generated power of a 17.5kW solar power plant over six months.

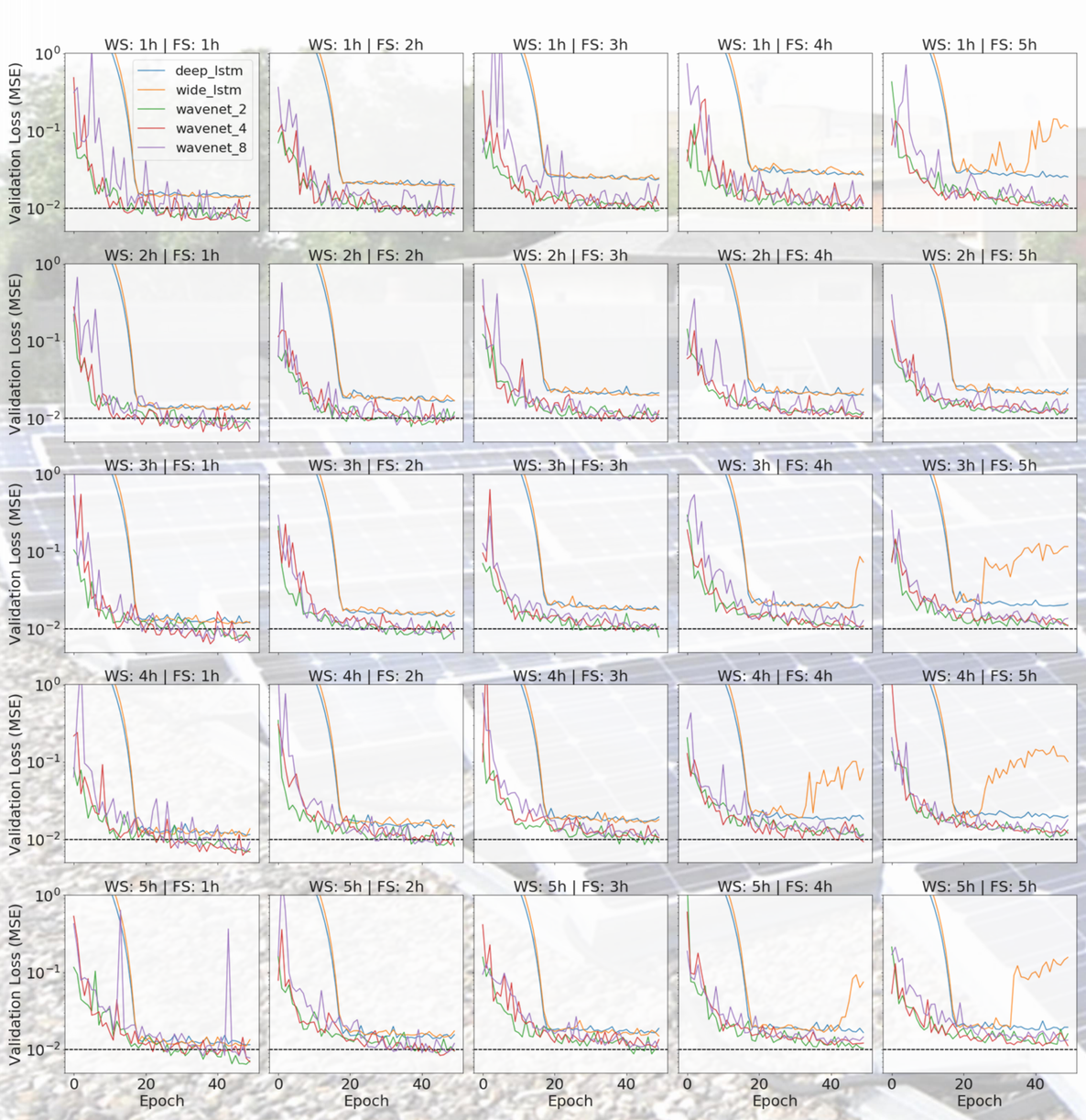


Figure: Loss curve of each model under each windows size (WS) and prediction length (FS). Dashed line indicates 10% RMSE boundary.

Prediction Length (hours)

Window Size (hours)	1	2	3	4	5
1	0.0068	0.0075	0.0091	0.0092	0.0101
2	0.0067	0.0078	0.0090	0.0103	0.0111
3	0.0064	0.0073	0.0078	0.0098	0.0101
4	0.0062	0.0082	0.0085	0.0093	0.0106
5	0.0065	0.0084	0.0088	0.0104	0.0112

Table: MSE of the best model for each window size where green denotes model «wavenet_2», blue denotes model «wavenet_4» and red denotes model «wavenet_8>.

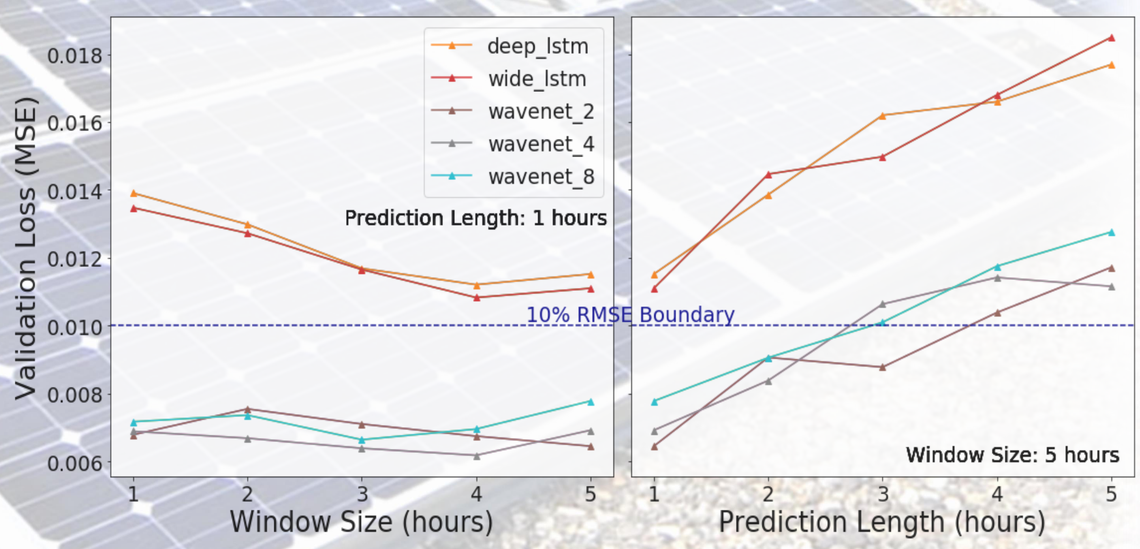


Figure: Effect of window size and prediction length on the model.