Forecasting MEFs in PJM

Amy Wang
Western University
hwang683@uwo.ca

Priya Donti
Carnegie Mellon University
pdonti@cmu.edu

How clean is electricity from the power grid at a given time?

Smart EV charging

Optimize industrial and residential equipment

Emissions-cognizant electricity prices

Marginal Emissions Factors (MEFs): describe the emissions associated with marginal generators (i.e. generators that respond to small changes in demand at a certain time)

A gap exists with current forecasting methods

Full power system models: Expensive to run

“Reduced form” power models: Extremely sensitive to errors in input

Purely ML models: Lack of domain knowledge

Proposal Summary

Problem Statement

- Forecasting day ahead, hourly CO_2 MEFs in PJM

Proposed Approach

- We propose incorporating differentiable power system models within neural networks.

Initial Investigation

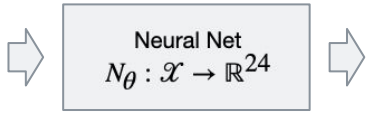
Baseline Method #1: Neural Network Forecast

Hourly Next-Day Electricity Load Forecast
Nuclear Generation (Last Week)
Hourly Next-Day Weather Forecasts
Temporal Features

Hourly Next-Day MEFs

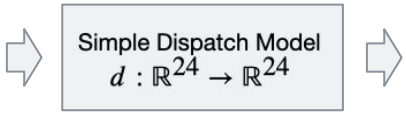
Baseline Method #2: Dispatch with Forecasted Input

Hourly Next-Day Weather Forecasts



Next Day Hourly Solar + Wind + Hydro Generation

Fossil Generation =
PJM's Next Day Hourly Load Forecast
- (Next Day Hourly Solar + Wind + Hydro Generation)
- Last Week's Nuclear Generation

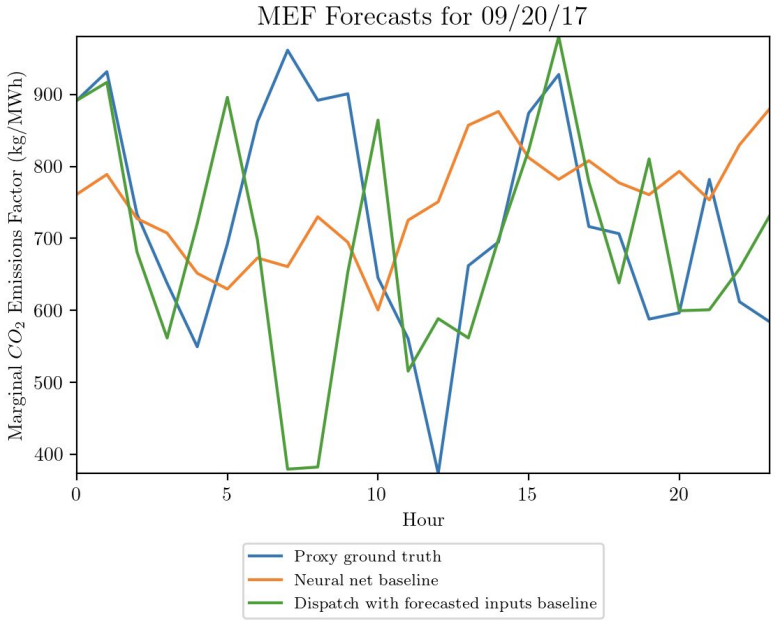


Hourly Next-Day MEFs

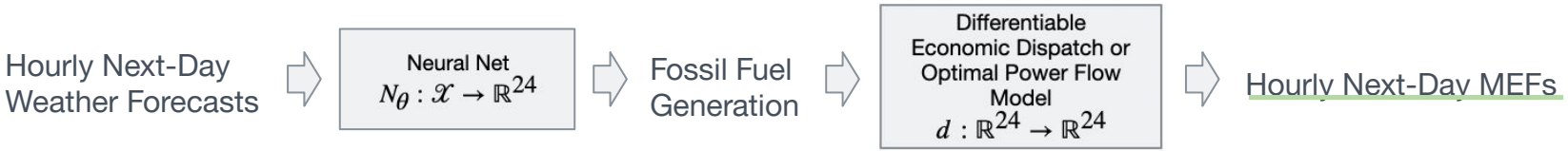
Initial Investigation Results

Assessed based on their accuracy with respect to a proxy "ground truth" simulated based on a reduced-order dispatch model

Forecast Method	RMSE
Persistence baseline	190.84
Neural network baseline	212.25
Dispatch with forecasted inputs baseline	213.69



Proposed Approach: Combine traditional ML with power systems modelling



For training inputs $x \in \mathcal{X}$, ground truth labels $y \in \mathbb{R}^{24}$, and some loss function ℓ, we propose to train our neural network to optimize

$$\underset{\theta}{\text{minimize}}\, \ell(d(N_\theta(x)), y).$$

MEF predictions on future hours given by $\hat{y} = d(N_\theta(x))$.

Thank you!

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