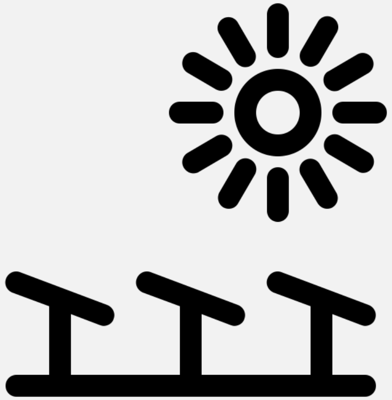
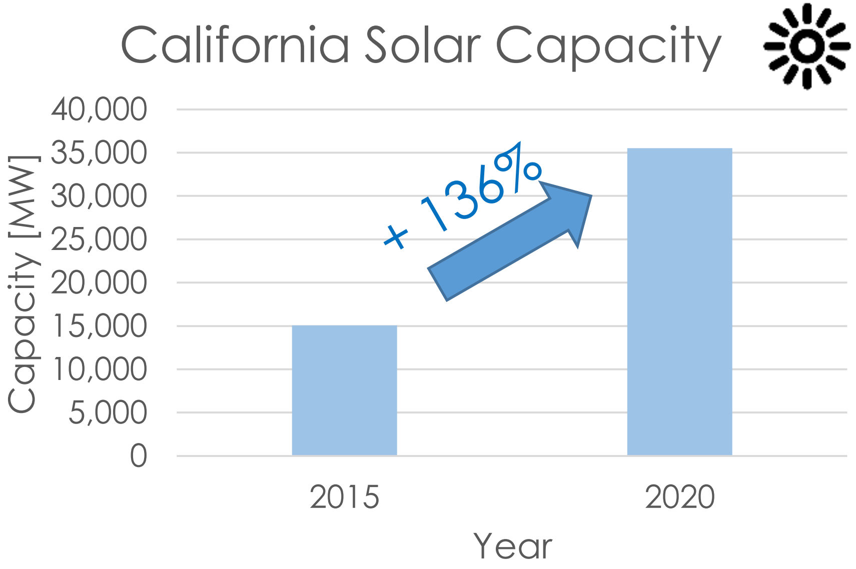


SPATIOTEMPORAL PV

Emily Nathan
Emily Wallace
Jeffrey Nash
Jerald Han
Robert Spragg

Existing Problem

The solar industry is growing rapidly:



Costs are falling rapidly

Down 66% since 2010

Existing Problem

"Clouds have the strongest impact on solar energy production"
(Chow, Belongie, Kleissl, 2015)

The Predictive Network

My kids and I are at the park and BOY is it windy in El Cerrito

I'm at my start-up in the Mission and it's super cloudy!

It's raining in Marin. Again.

Location Selection

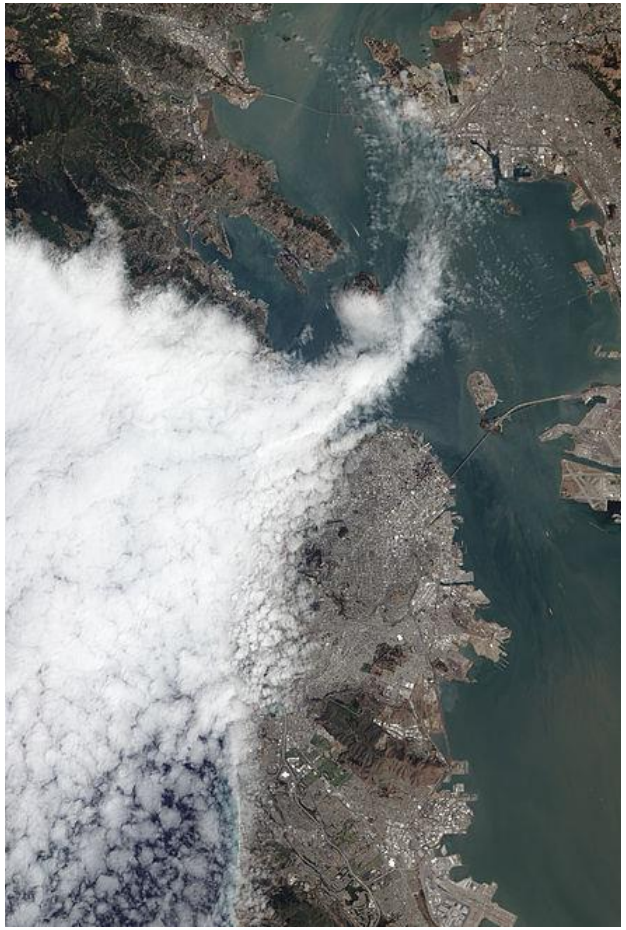


Figure 1: Clouds streaming through the Golden Gate

LOCATION

Locations account for a variety of weather patterns
Considered microclimates (foggy, colder areas)

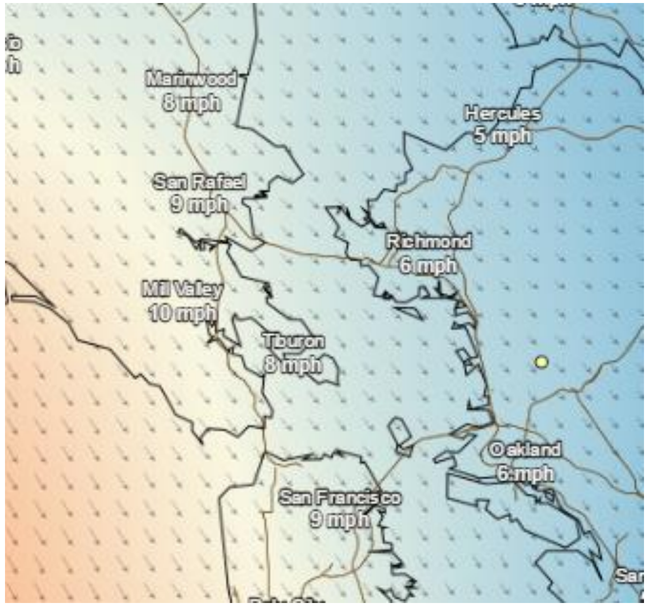


Figure 2: Typical prevailing winds following a winter storm

HARDWARE

Temperature Sensor
Light to Frequency Sensor
Light Filter
Micro-SD Card (data storage)

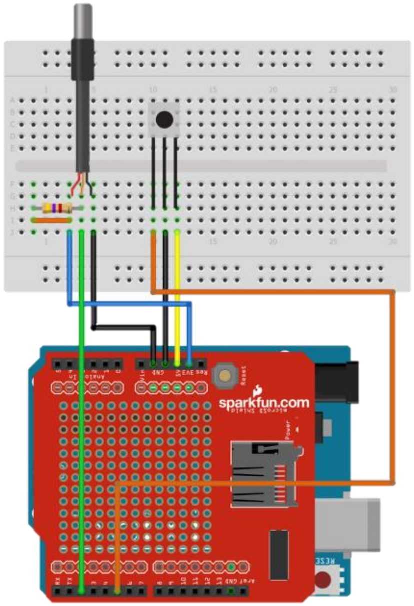
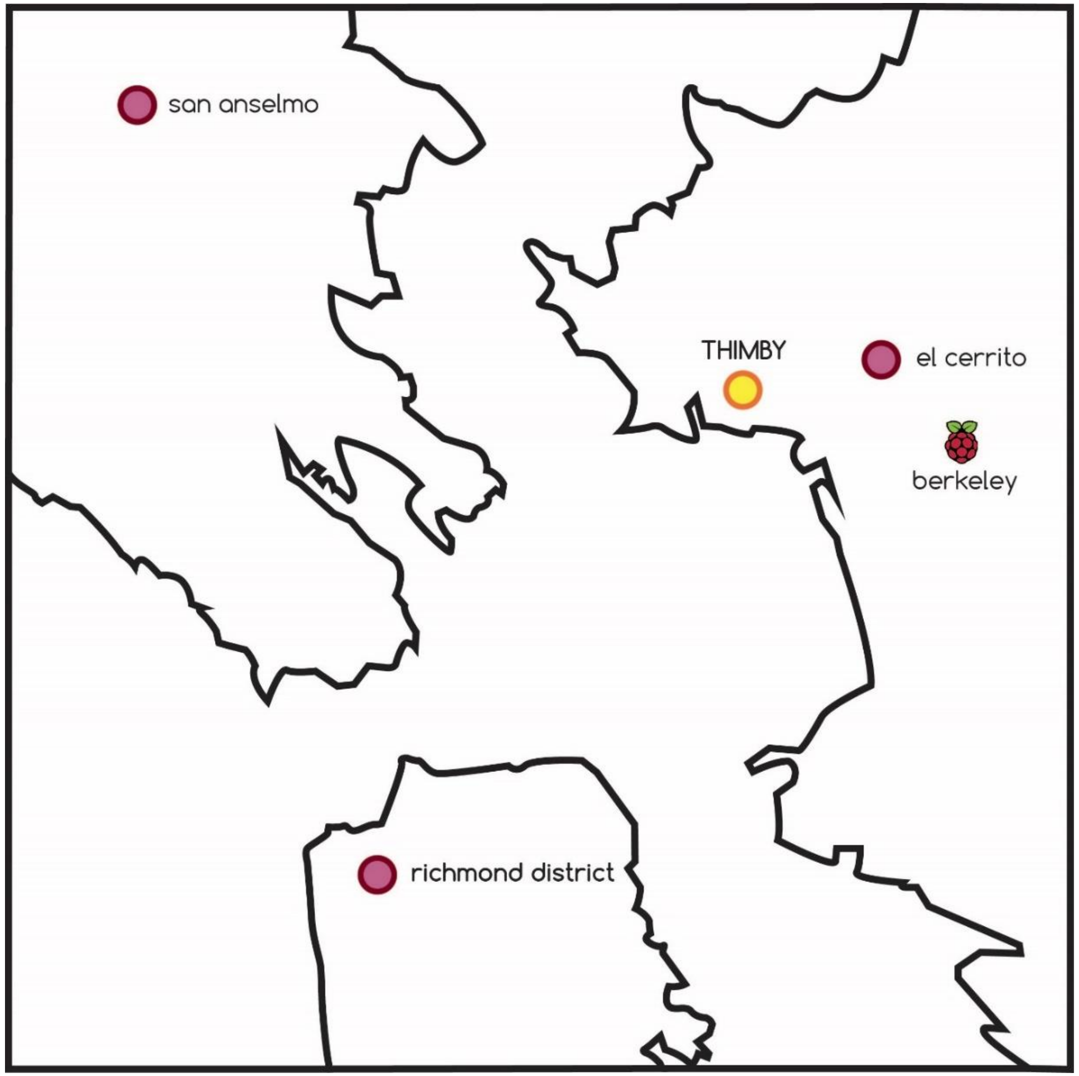


Figure 3: Schematic of the deployed sensors

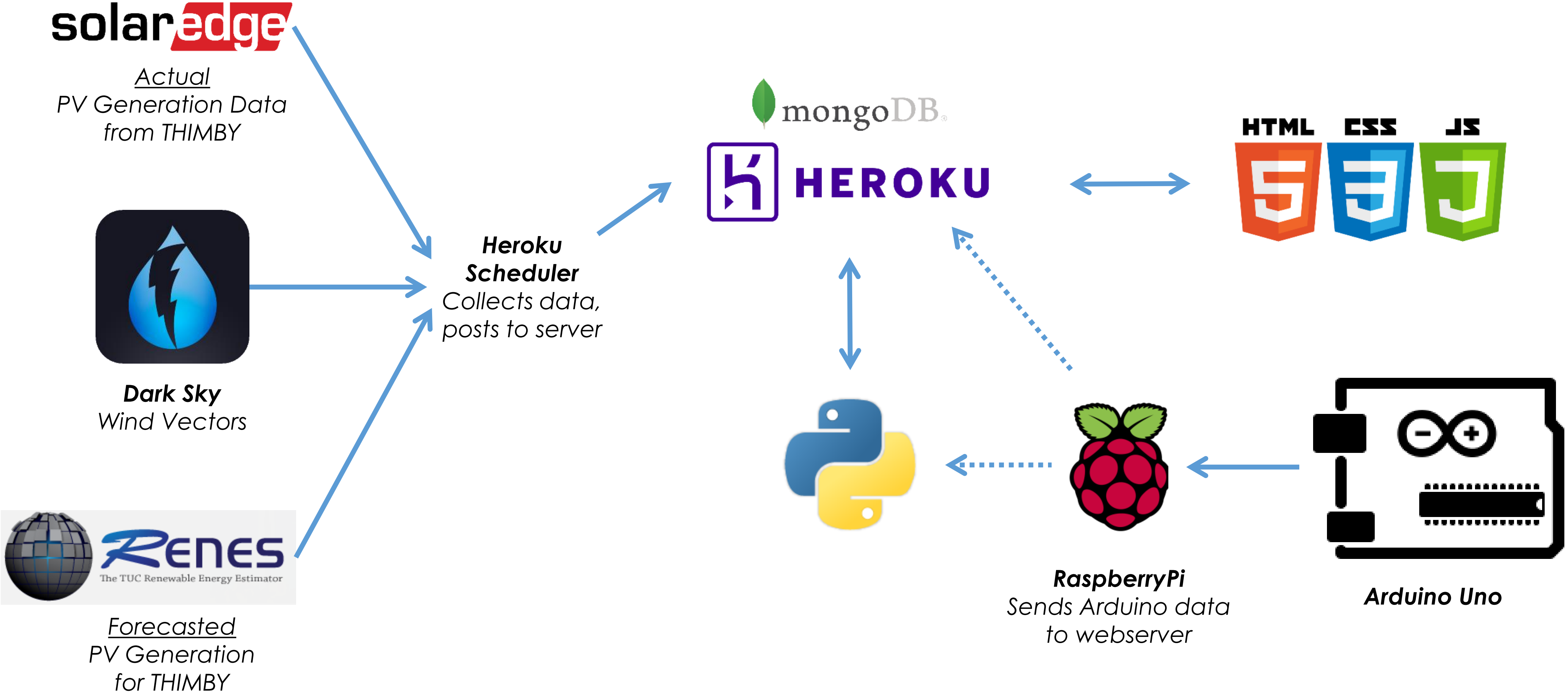
Location Selection



Solar Prediction Inaccuracies

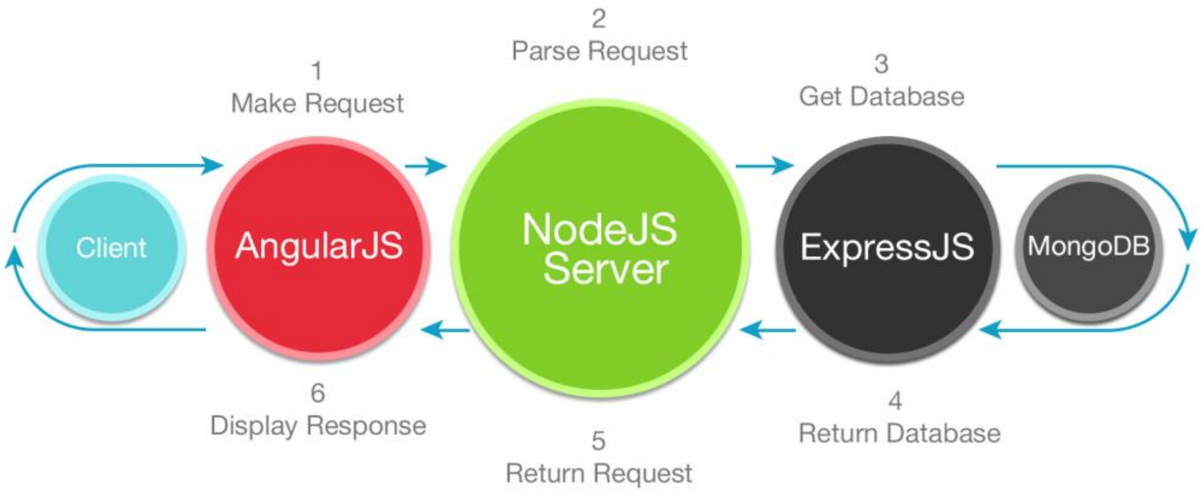
"An advantage of using ground-based sensors is that PV power output can be inferred directly… without independent estimates of the height, density, reflectivity, or spectral properties of clouds."
(Lonij, et. al, 2013)

Our Solution Network



Data Collection & Visualization

MEAN Stack



Server

HEROKU

Git version control allows for portable solution

Scheduler periodically runs script, stores data from external API

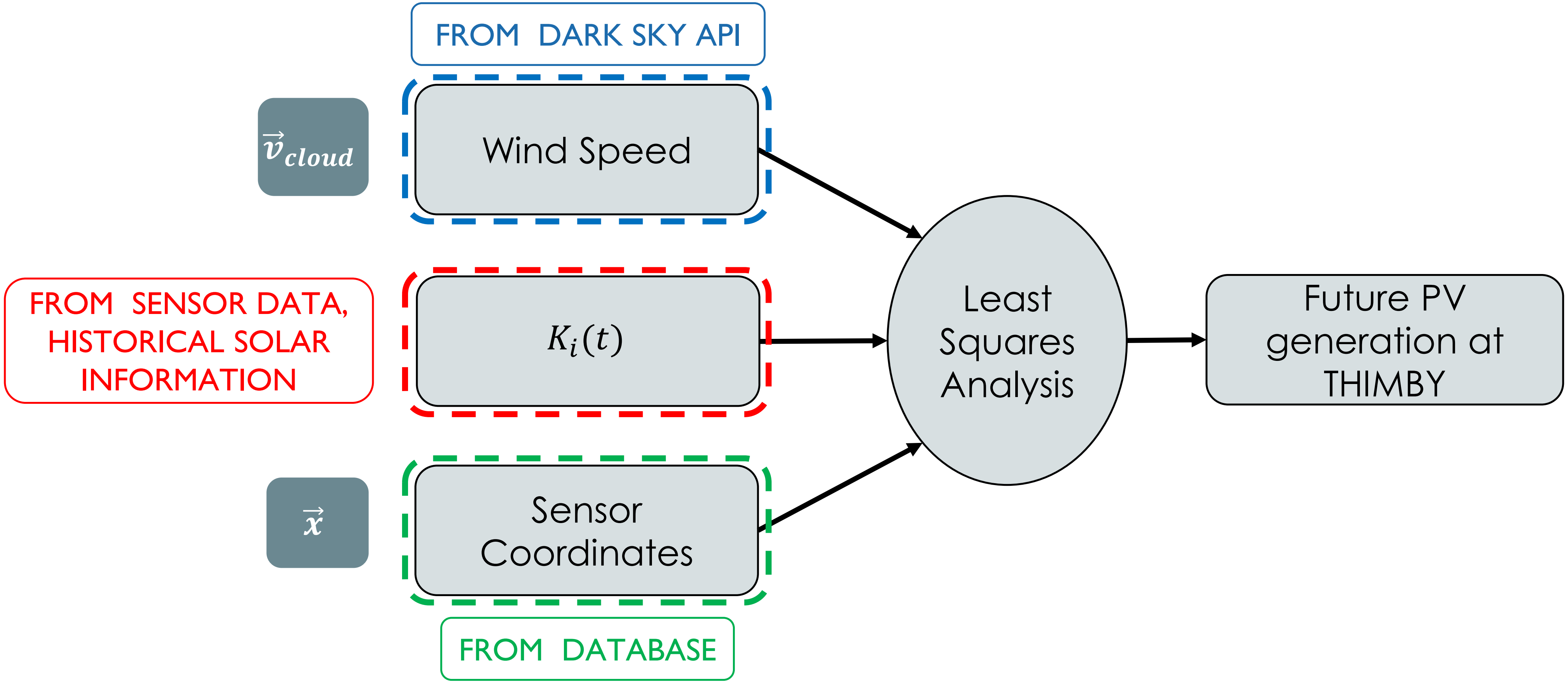
Visualization

Leaflet

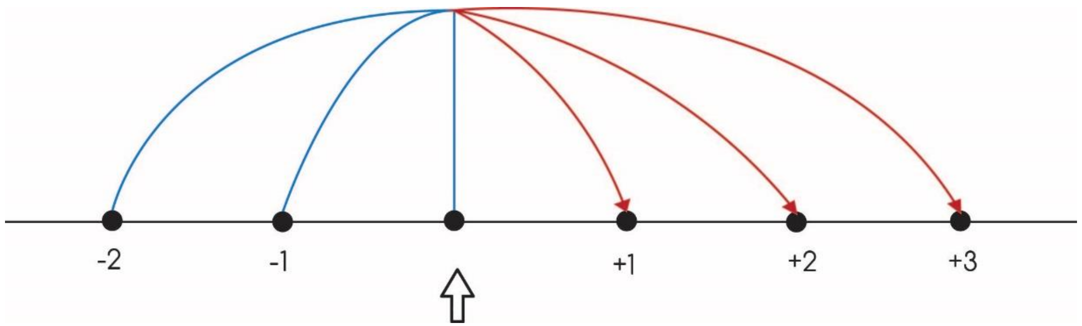
plotly.js

jQuery user interface

Data Analysis



Data Analysis



$$\hat{P}_{Thimby} = \hat{P}_{API} + \sum_{n=1}^{3}\sum_{i=1}^{3} B_{ni} \cdot K_i(t)e^{-|\Delta\vec{x_i}-\vec{v}_c\Delta t_n|}$$

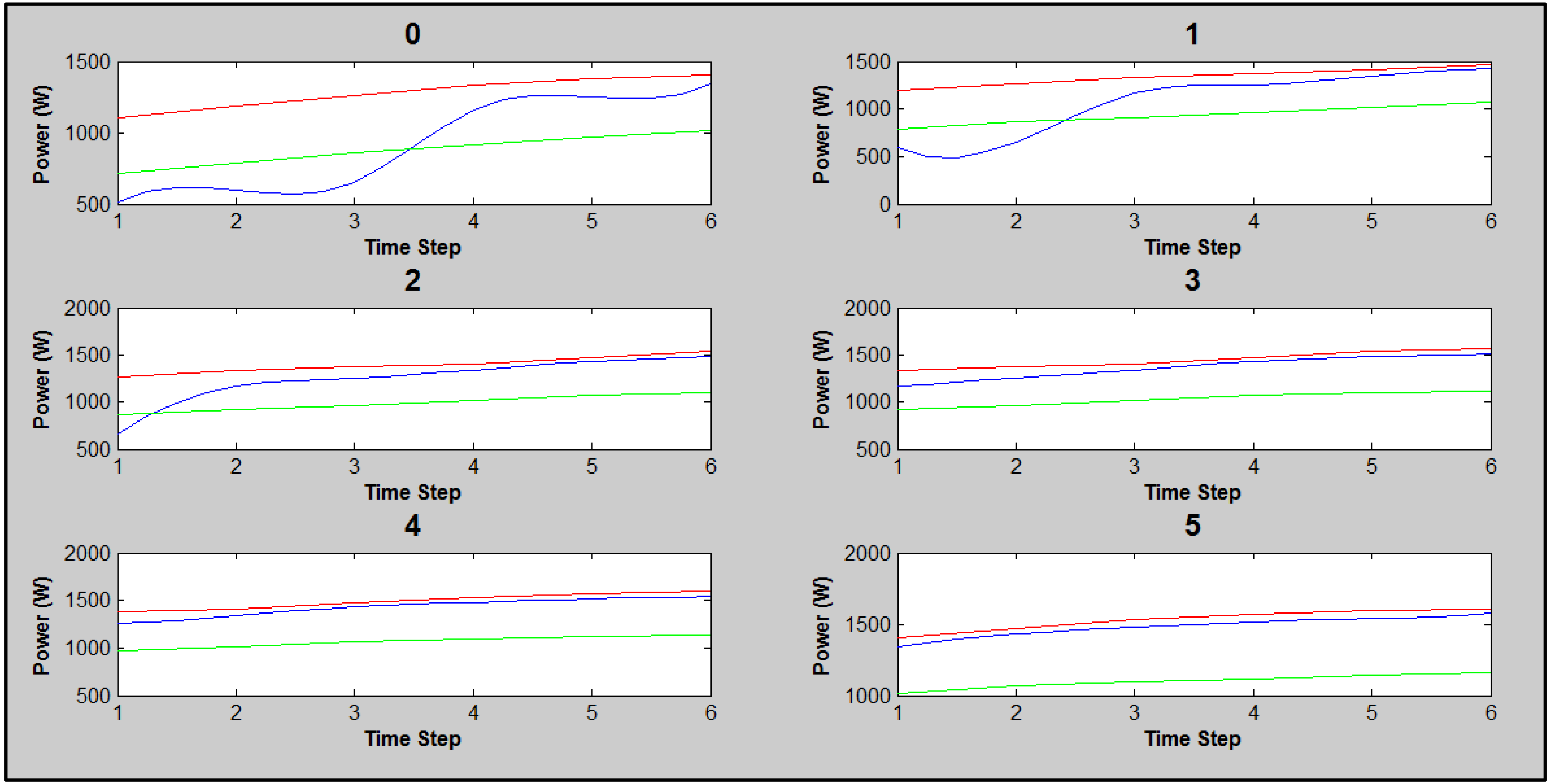
$$error(t) = P_{Thimby}(t) - \hat{P}_{Thimby}$$

Perform least squares analysis to solve for prediction coefficients

$$B = (X^T X)^{-1} X^T Y$$

Smart algorithm recalculates coefficients every 15 minutes

Results



Model

Actual

RENES

Impact of Results

SO WHAT?

Energy security is extremely valuable

NREL study showed that energy security at Belvoir military base is valued at 2.2-3.9M

The research at the University of Texas is worth an estimated 500M

(Energy Efficiency Markets, 2016)

Value of our model grows with solar implementation

Useful for essential systems (hospitals), military bases, universities, microclimate research, any region

OUR ROLE

We can provide data for the following…

Energy security optimization

Grid Energy purchase optimization

Stabilizing small / island energy grids

Predictions for all locations within network

OUR PERKS

Low cost ~ $75

Independent

Does not rely on data from multiple homes, which may be unreliable

Future Improvements

Hardware

- Improved waterproofing and sensor reliability
- Fine-tune sensor calibration
- Decrease deployment costs

Networking

- Avoid Raspberry Pi by leveraging affordable data logging systems
- Update all sensors to include live updates
- Google Project Fi SIM card shield

Expanding

- More sensor locations throughout the bay.
- Continued iterations of regression models
- Integration with other existing models

Q & A