# Cross-sector opportunities to improve solar data analysis and capabilities

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# Overview

- About kWh Analytics, Inc.
- Motivation
- Our Products
- Tech Stack
- Analysis Capabilities
- Cross-Sector Collaboration Opportunities

# About Us

- Startup company, est. 2012
- Raised Series A financing in 2016
- Team has grown from 6 to 17 in the last year

First office was CEO's living room





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# About Us

- Have worked with DOE since 2013
- Awarded SunShot 8, 9, 10, and Orange Button
- Enabled us to develop products that also support DOE goals and initiatives

# Team Organization

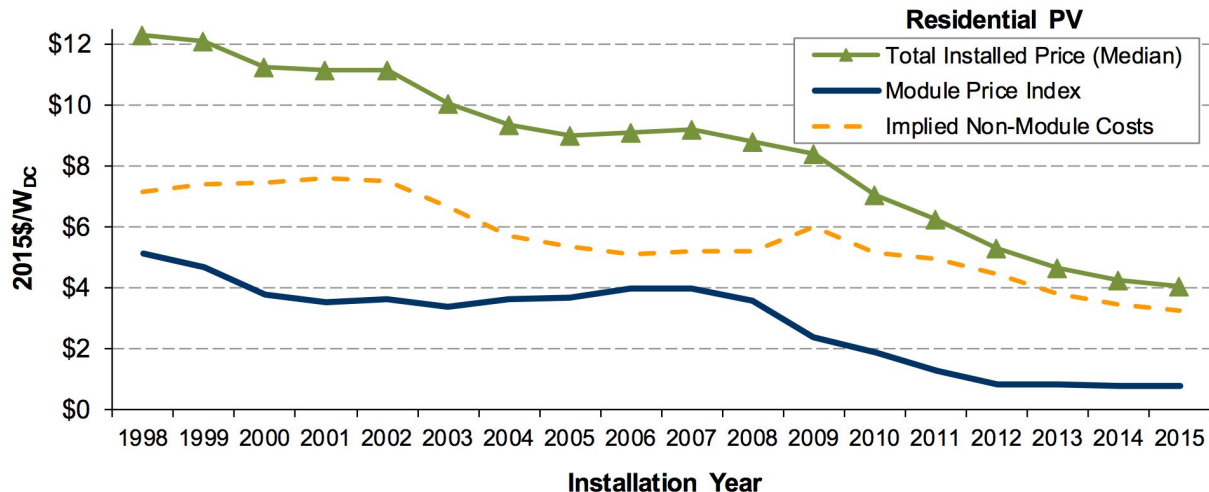- Business
  - Team Operations
  - Marketing and Outreach
  - Business Development
- Software Development
  - Data Engineering
  - Front-end Engineering
  - Data Science

# The Challenge



**Residential PV**
- Total Installed Price (Median)
- Module Price Index
- Implied Non-Module Costs

Credit: *Tracking the Sun IX, LBNL, 2016*

- Soft costs make up a significant portion of cost of PV deployment
  - Typically includes installation, maintenance, overhead, financing
- Area of focus in SunShot Initiative
- Our mission statement: More Solar Through Better Data

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# Our Solutions

**HelioStats**

- Solar asset management platform and data management services
- Primary clients are renewables investors and asset managers
- Goal is to make it easier for solar asset owners to manage their portfolios
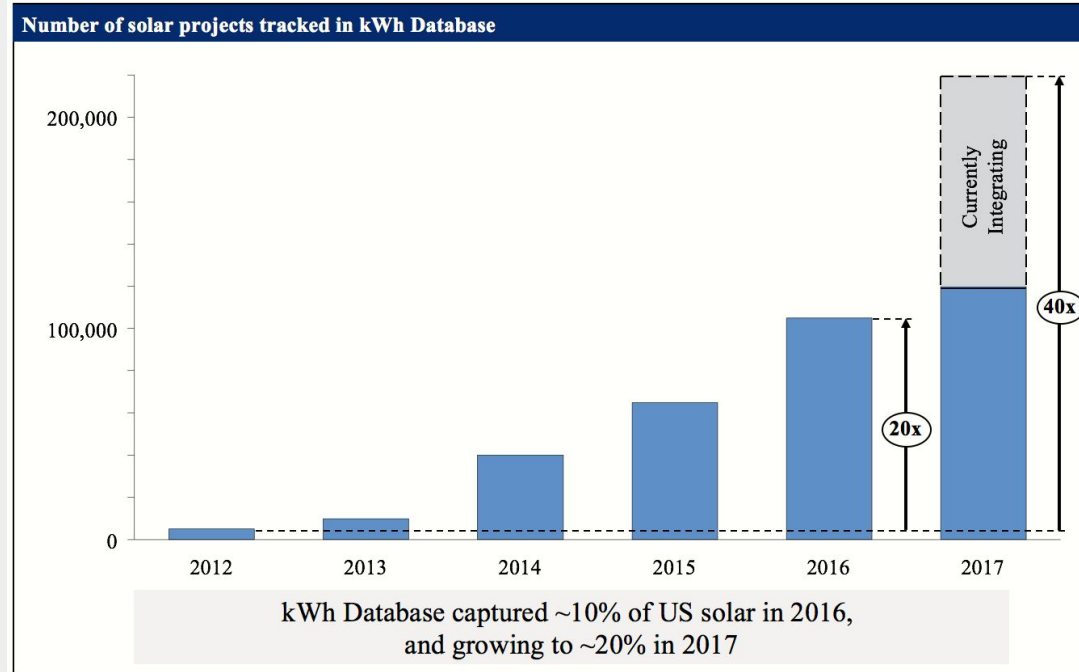
**KUDOS**
GIVING SOLAR THE CREDIT IT DESERVES

- Insurance product for energy yield
- Primary client is solar developers
- Goal is to cover the risk of underperformance, reduce the cost of capital for developers, allow them to deploy more

# What data do we collect?

- System Metadata
  - Financial contract information
  - Installer/EPC firm
  - O&M Provider
  - Location
  - Array orientation and mounting
  - Equipment manufacturers
  - Equipment model numbers
  - Client's energy expectation
- Ongoing Data
  - Energy yield
  - O&M Logs
  - Customer payment and delinquency

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# Database Stats

- 140k systems
- By Capacity:
  - 38% Residential
  - 62% C&I and Utility
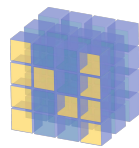- Currently integrating another 70k systems

**Number of solar projects tracked in kWh Database**



kWh Database captured ~10% of US solar in 2016, and growing to ~20% in 2017

# Open-Source Toolbox

**Glue**



**Database**



**Servers & Storage**



**Analysis, Modeling, & Visualization**
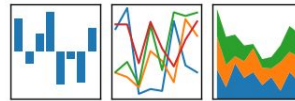


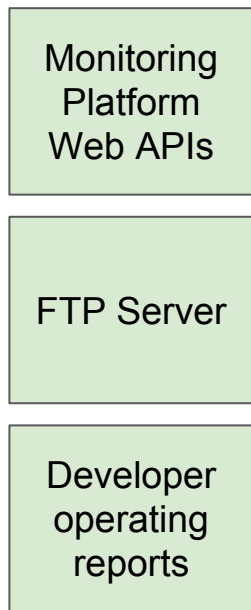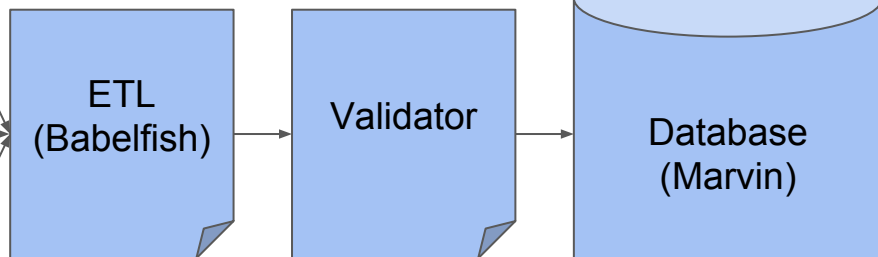$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$

# HelioStats

- Data management
- Use-Cases
- Analysis Capabilities

# Data management pipeline
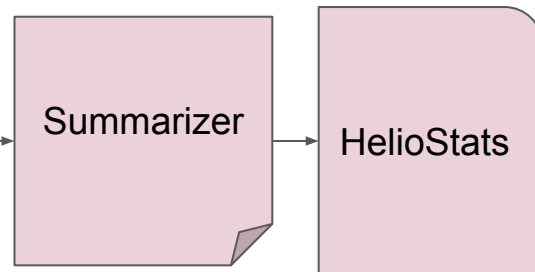


Data Sources      Database Layer      Application Layer

Monitoring Platform Web APIs

FTP Server

Developer operating reports

ETL (Babelfish)

Validator

Database (Marvin)

Canonicalization

Summarizer

HelioStats

# HelioStats for Investors and Asset Managers

From the investor and asset manager point of view, I need to know:

- What my returns are
  - How does actual performance compare with my original expectations
  - How does actual performance compare with a 3rd party industry benchmark
- Whether my investment is in good hands
  - How do my hardware and service providers compare with the rest of the market
- When to roll a truck
  - When underperformance is not related to weather
- The root cause of underperformance
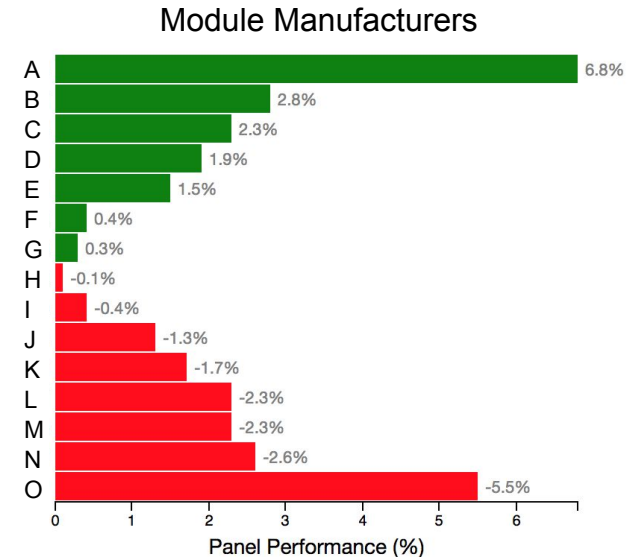  - Caused by weather, downtime, or component failure

# Analysis Capabilities on HelioStats

- ## Time series plots of energy yield, revenue, delinquency
  - ### With ability to filter by fund, equipment make/model, region, financial product, etc.

### Delinquency Trends
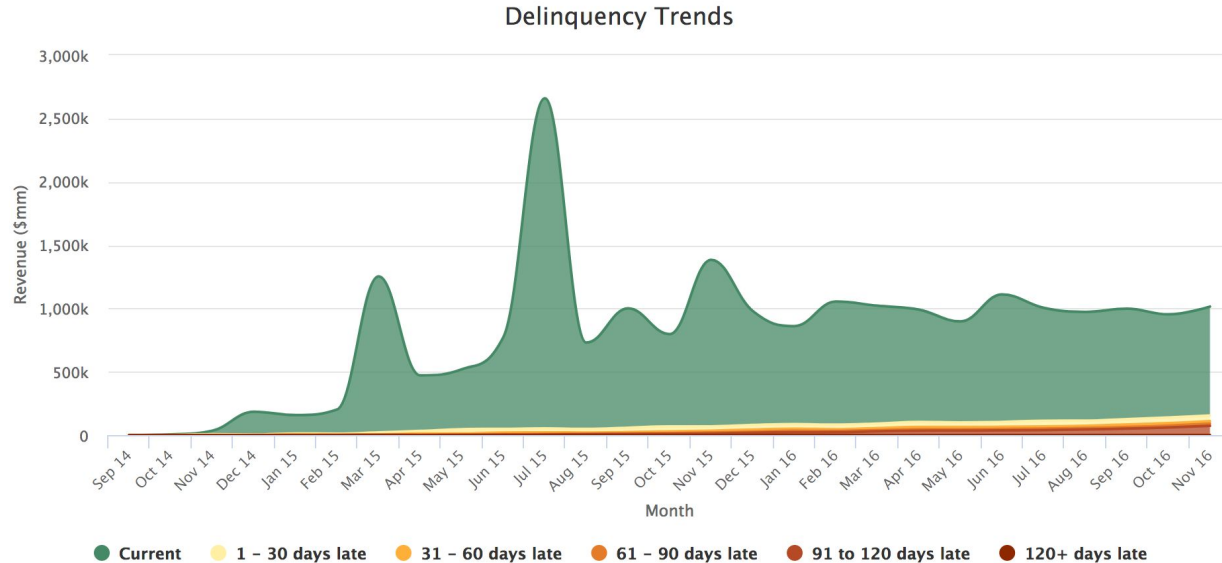
# Analysis Capabilities on HelioStats

- Module manufacturer benchmarking (within a portfolio)
  - Multivariate regression on weather-adjusted performance and categorical
  - Account for confounding variables: inverter, climate region, etc.
- Display weighted performance as a percentage deviation from the mean
- Employ similar approaches to benchmarking installers, inverters, O&M providers

### Module Manufacturers

| Manufacturer | Panel Performance (%) |
|---|---|
| A | 6.8% |
| B | 2.8% |
| C | 2.3% |
| D | 1.9% |
| E | 1.5% |
| F | 0.4% |
| G | 0.3% |
| H | -0.1% |
| I | -0.4% |
| J | -1.3% |
| K | -1.7% |
| L | -2.3% |
| M | -2.3% |
| N | -2.6% |
| O | -5.5% |

# Analysis Capabilities on HelioStats

Areas of future development

- Additional use-cases, e.g., Fleet Operations
- Use of higher frequency and meteorological data:
  - Soiling
  - Degradation
- Use of O&M logs
- Outage tracking
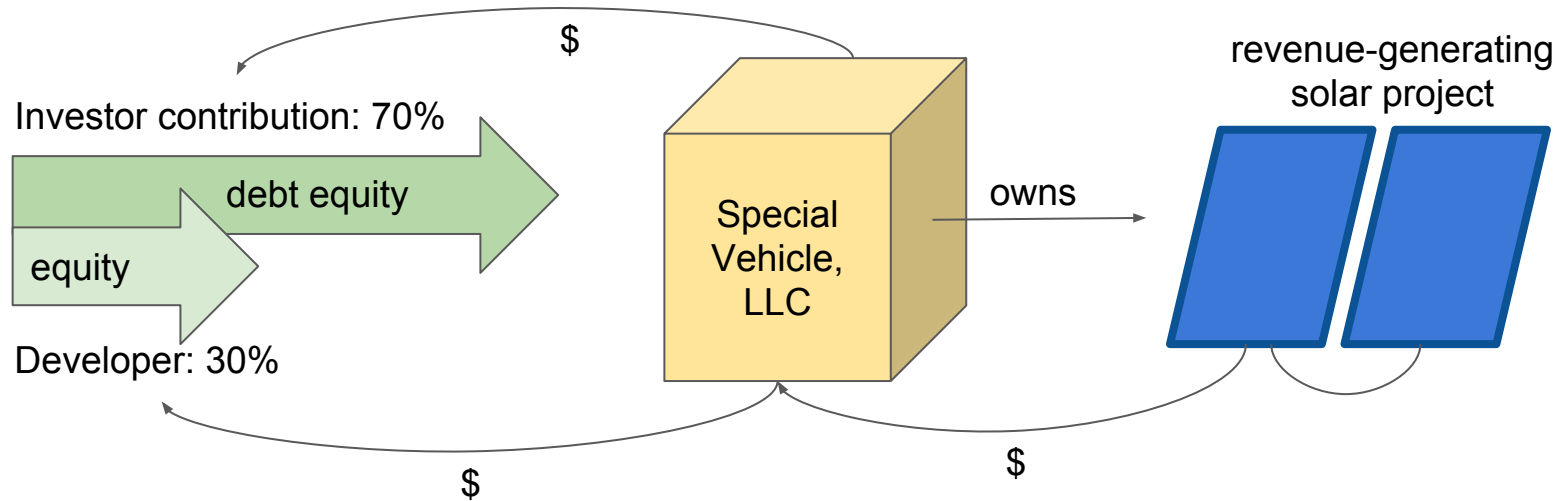- Root-cause analysis of underperformance

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- Benefit for developers, financiers, insurance companies
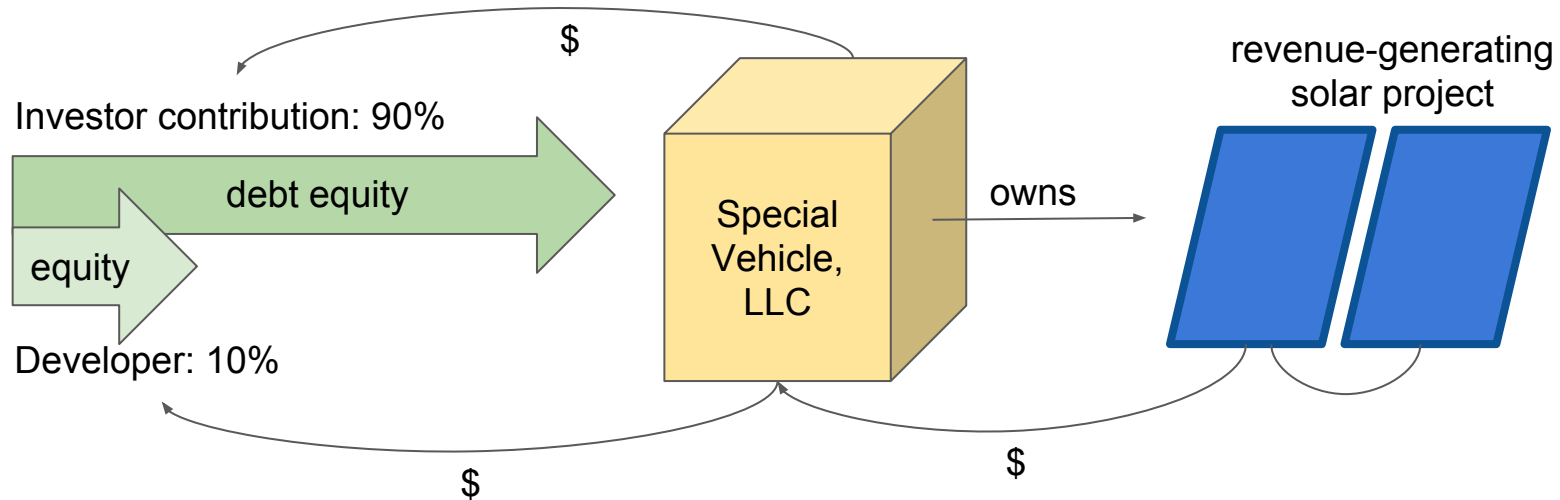- Actuarial Capabilities

# Solar Project Finance



Benefits of solar project finance:

- Minimizes risk to Developer, able to deploy more with less equity
- Investor is able to capture tax incentives

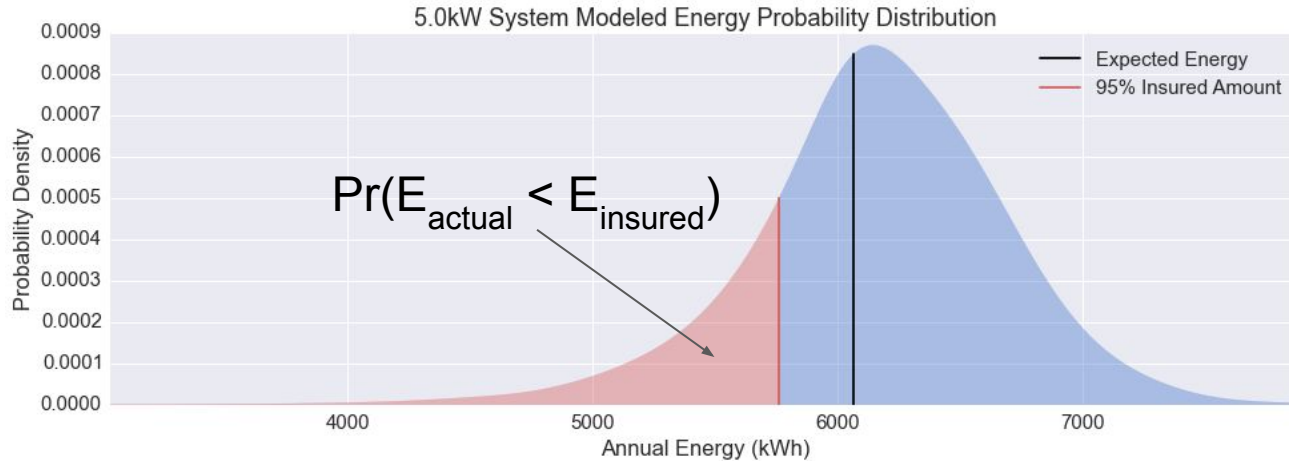# Role Kudos plays in Project Finance



When energy revenue is de-risked:

- Developers can deploy more
- Less risk for Investors

# About the Policy

- Types of projects being insured
    - Individual large-scale systems
    - Portfolios of large-scale systems
    - Portfolios of residential systems
- Policies are typically 10 years, with annual claim periods
- Pay out claim for amount of energy revenue lost under an insured amount (typically 90-95% of expectation)
- Cover energy loss due to weather, downtime, and failure
- Do not cover property damage or anything already covered by other insurance policies
- Do not cover curtailment

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# Underwriting PV Yield



5.0kW System Modeled Energy Probability Distribution

$Pr(E_{actual} < E_{insured})$

Legend: Expected Energy; 95% Insured Amount

- Energy revenue is easily calculated by predetermined PPA rate
- Expected value of energy loss is the integral of loss times probability of loss
- Premium is proportional to expected value of loss, represented by percentage of revenue

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# Actuarial Capabilities

- Without performance data, we can tackle the problem top-up
  - Use PV model, historical weather, probabilistic downtime/failure, you can come up with a reasonable guess for the likelihood of underperforming a given expectation
- With performance data
  - Can validate top-up approach
  - Can get banks comfortable with the risk
  - Can get insurers comfortable with our underwriting
- Effect of Portfolios
  - Account weather correlation due to proximity
- Future development

# Cross-Sector Collaboration Opportunities
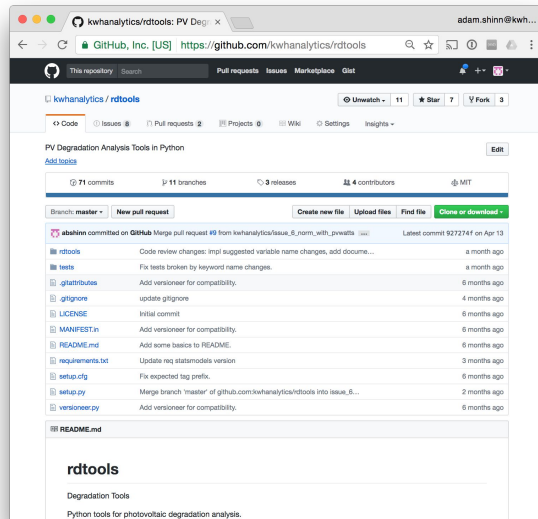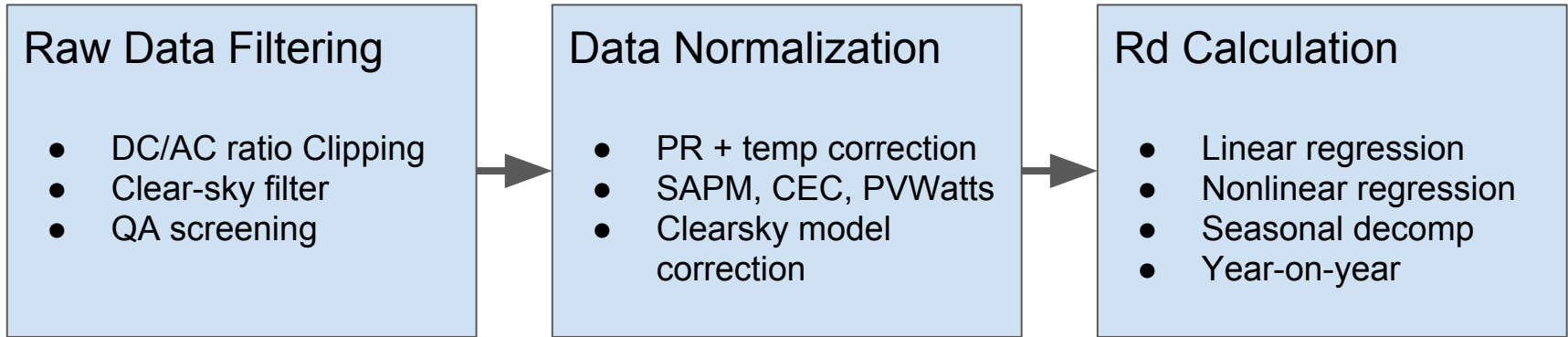


**RdTools**

**Orange Button**

# Orange Button

- Goal is to simplify and standardize data
- kWh Analytics' role
- All stakeholders benefit from better data management

# RdTools: Degradation Analysis Tools in Python

**Raw Data Filtering**

- DC/AC ratio Clipping
- Clear-sky filter
- QA screening

**Data Normalization**

- PR + temp correction
- SAPM, CEC, PVWatts
- Clearsky model correction

**Rd Calculation**

- Linear regression
- Nonlinear regression
- Seasonal decomp
- Year-on-year

GitHub

https://github.com/kwhanalytics/rdtools

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# Recap

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- Thanks!

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