Task 4: Develop DER Production Database

- Create database of aggregated BTM PV production by zip code
 - Based on 15-minute interval data from 504 Itron meters since 2010
- Improve database using simulated data

Dual-Atis traction

- Use CSI reported system specifications
- Use CPR's "Inference Engine" to obtain system specifications
- Validate using error analysis (simulated versus measured production)
- Normalize data for easier scaling

to 1.750

Refine growth projections for PV adoption in the DRPs

System Locations

to 1.750

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414 sites in 292 different ZIP codes (California has approximately 2,589 ZIP codes)

ZIP codes with measured data sites

ZIP codes with PV Systems¹

¹NEM Currently Interconnected Data Set,

https://www.californiadgstats.ca.gov

Inference Engine: "Reverse Engineer" PV Specs from Measured Time-Series Data

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- PV rating
- Azimuth angle
- Tilt angle
- Obstruction elevation angles in multiple azimuth directions
- PV power temperature coefficient
- Inverter maximum power rating

- System PTC rating
- Fixed mount, single-axis or dual axis tracking

Example of "Good" Measured Data

Dual-Atis

to 1.750

pv System



PGE-CSI-00213

Example of Data Quality Issues

Dual-Atis traures

te = South)

pv System

Select

Ranges

to 1.750



PGE-CSI-10404

Error in Measured vs. Simulated

Dual-Atis Traction

e = South)

pv System

Select

to 1.750

Compared to measured data, simulations using system specs inferred from measured data had lower error than simulations that used the specs reported by installers.



Error in Measured vs. Simulated

Dual-Atis traction

e south)

pv System

Select

to 1.750

95% of the systems using the inferred specs approach have less than 18% error, while 95% of the systems using the reported specs have less than 46% error.



System with Lowest Error (Best Result) PGE-CSI-24017

to 1.750

Dual-Atis



Simulated output using inferred specs, 6.3% hourly rMAE

System with Typical Error SCE-CSI-13299

to 1.750

by System

Dual-Atis Tr



Simulated output using inferred specs, system with median error, 10.1% hourly rMAE

System Degradation

to 1.750

Dual-Atis traction

ie = South)

PGE-CSI-00086 (Inferred Specs)

Select

Ranges

42

9

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4

2

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5

9

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4

2

0

Simulated Energy (kWh)

0

Simulated Energy (kWh)

pv System





Measured Energy (kWh)

10

8





Inferred Specs Hourly rMAE: 12.6%

Soiling and Precipitation?

Dual-Atis Traction

e = South)

to 1.750



Select

Ranges

2.5

2.0

1.5

1.0

S

Ö 0.0

Simulated Energy (kWh)

pv System

Inferred Specs Hourly rMAE: 10.1%



01-01-2011 08-09-2011 03-16-2012 10-22-2012 05-30-2013 01-05-2014 08-13-2014

Period Beginning (UTC -08:00)



CSI Reported specs Hourly rMAE: 11.0%



01-01-2011 08-09-2011 03-16-2012 10-22-2012 05-30-2013 01-05-2014 08-13-2014

Measured Energy (kWh)

1.5

1.0

2.0

2.5

0.5

0.0

Period Beginning (UTC -08:00)

Single System, Single Day Production

s = South)

Dual-Atis Traches

pv System

Select



PGE-CSI-24017 production comparison for May 5, 2011

Single System, Single Day Production

e = South)

Dual-Atis Traction

pv System

Select



PGE-CSI-24017 production comparison for January 19, 2011

All Systems, Single Day

to 1.750

Dual-Atis traction

s South)

Select

pv System

Randes



Fleet Production August 23, 2015

All Systems, Single Day

to 1.750

Select

pv System

Fleet output on a day with variable cloudiness

Dual-Atis traction

- South



Fleet Production January 8, 2016

Single System, Single Day Production

South

Dual-Atis traction

Variability in single-system production is greater than fleet variability on the same

to 1.750

by System



PGE-CSI-00221 Production January 8, 2016

Fleetwide Error

to 1.750



South

Dual-Atis traction

With an hourly rMAE of just 4.3%, the fleet output begins to approach the error in the underlying satellite-derived irradiance data

PV System Specs inferred from Measured Production Data

 All PV production data modeling used SolarAnywhere[®] satellite-derived irradiance data

Dual-Atis Trache

- Using system specifications inferred from measured production data resulted in lower error than using reported specifications 96% of the time
- Median hourly relative MAE for individual system data from inferred specs was 10.1% versus 16.7% for reported specs

Measured Data Missing or Bad

Dual-Atis

10 1.750



Filtered Measured Data

to 1.750

Dual-Atis

pv System



South

SCE-CSI-03692

Measured Data Merged with Simulated

Dual-Atis Tracher

to 1.750

pv System



SCE-CSI-03692

Zooming in...

O Select.

Ranges

to 1.750

Dual-Alis Tracks

PV System



Missing or Bad Data Identified

Dual-Atis Traches

a South)

to 1.750

pv System

Ranges

Select



Missing or Bad Data Replaced by Simulated

e = South)

pv System

Select

Ranges

to 1.750

Dual-Atis Traches



24

Normalized Data (kWh per kW)

Dual-Atis Traunus

e = South)

pv System

O Select .

Ranges



DER Production Database

Dual-Atis Traction

to 1.750

ev System

- Measured 15-minute interval production data from 414 selected PV systems augmented by simulated production data for those same systems
- Individual system production data was aggregated by ZIP code and normalized using AC_{CEC} ratings to produce 292 CSV files
- Most ZIP codes contain only one system
- Fleet production exhibits a significantly different shape with less variability than single-system production
- Production in ZIP code level files is not representative of actual production of all systems in that ZIP code

DRP Mid-Term Growth Projections

Dual-Atis Tracher

- Installed PV capacity growth follows a consistent pattern for all three California IOUs
- This behavior follows a logistic function, sometimes described as the Bass Diffusion Model
- NEM Currently Interconnected Data Set could be used in conjunction with this model to project installed PV capacity

Diffusion Model Fitted to Historical Adoption (CIDS, PV)

South)

Dual-Atis traction

PV System

Select

