PVFree!
NREL-SAM Component Database, PVLIB API, and Interactive PV Modeling Tutorial

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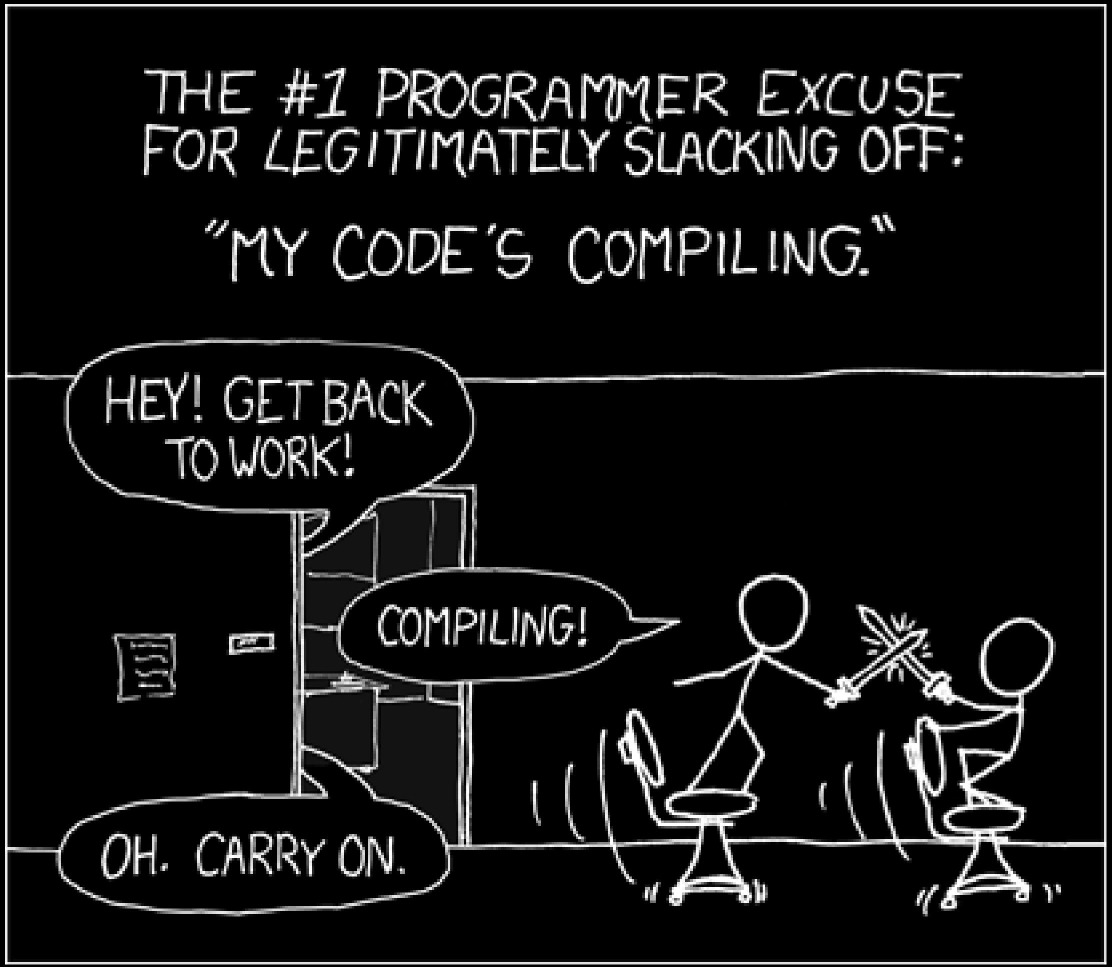
PVPMC-12: Open Source Modeling Project Collaboration

May 15, 2019

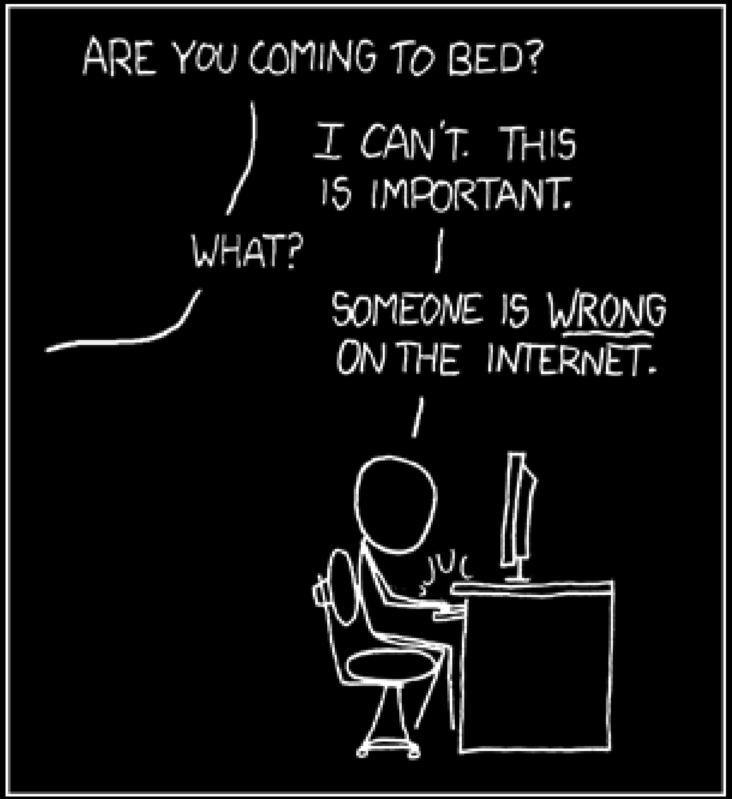
Outline

- Motivation
- Component Database
  - Human browsable web pages
  - API usage, filters
- Pvlib Python API
- Interactive PV Modelling Tutorial
- Hardware, Software Setup
- PR Puppies



Motivation

- Many different sources of modelling parameters, different formats
- Data updates difficult, no data validation, repeats, missing data
- No modelling parameter API, data passed around in spreadsheets, need to keep track of versions
- Wanted to make a pvlib demo site
- Wanted to make interactive tutorial



NREL-SAM Component Database

- CEC Inverters

PV Inverters

Show 10 entries   Search: PV Powered

Name	Vac	Paco	Vdco	Pdco	C0	C1	C2	C3	Pso	Pnt	Vdcmax	Idcmax	MPPT low	MPPT high
PV Powered: PVP100 kW-208 [208V] 208V [CEC 2018]	208.0	100000.0	341	105191	-2.74E-07	3.50E-05	2.29E-03	-5.66E-04	445.7	42.0	480.0	308.477	295.0	480.0
PV Powered: PVP100 kW-480 [480V] 480V [CEC 2018]	480.0	100000.0	341	104680	-2.90E-07	5.27E-05	2.40E-03	2.29E-04	476.5	36.0	480.0	306.978	295.0	480.0
PV Powered: PVP100kW-208 208V [CEC 2016]	208.0	100000.0	341	105191	-2.74E-07	3.50E-05	2.29E-03	-5.66E-04	445.7	42.0	480.0	0.208333	295.0	480.0
PV Powered: PVP100kW-480 480V [CEC 2016]	480.0	100000.0	341	104680	-2.90E-07	5.27E-05	2.40E-03	2.29E-04	476.5	36.0	480.0	0.208333	295.0	480.0
PV Powered: PVP100KW-600 600V [CEC 2012]	600.0	100000.0	341.7	104547.2	-2.33E-07	3.85E-05	2.34E-03	2.91E-04	536.0	99.56	600.0	356.0	295.0	595.0
PV Powered: PVP100KW-600 [600V] 600V [CEC 2018]	600.0	100000.0	341	104450	-2.20E-07	4.07E-05	2.56E-03	7.51E-04	517.0	99.56	480.0	306.306	295.0	480.0
PV Powered: PVP1100EVR	120.0	1100.0	182	1194.1	-2.06E-05	5.71E-05	2.00E-03	6.23E-04	22.1	3.6	380.0	6.56096	100.0	380.0

NREL-SAM Component Database

- CEC Inverters
- CEC Modules

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CEC Modules

Show 10 entries   Search: Jinko

Name	BIPV	Date	NOCT	A_c	Cells in Series	$I_{sc,ref}$	$V_{oc,ref}$	$I_{mp,ref}$	$V_{mp,ref}$	Tech	STC [W]
Jinko Solar Co._ Ltd JKM170M-72B	false	2018-11-04	46.6	1.277	72	5.11	44.4	4.77	37.5	Mono-c-Si	178.875
Jinko Solar Co._ Ltd JKM175M-72	false	2018-11-04	47.2	1.277	72	5.23	44.7	4.9	35.8	Mono-c-Si	175.42
Jinko Solar Co._ Ltd JKM175M-72B	false	2018-11-04	46.6	1.277	72	5.14	44.9	4.78	36	Mono-c-Si	172.08
Jinko Solar Co._ Ltd JKM180M-72	false	2018-11-04	47.2	1.277	72	5.29	44.8	5	36	Mono-c-Si	180
Jinko Solar Co._ Ltd JKM180M-72B	false	2018-11-04	46.6	1.277	72	5.23	45.2	4.95	36.4	Mono-c-Si	180.18
Jinko Solar Co._ Ltd JKM185M-72	false	2018-11-04	46.9	1.277	72	5.43	45	5.09	36.4	Mono-c-Si	185.276
Jinko Solar Co._ Ltd JKM185M-72B	false	2018-11-04	46.6	1.277	72	5.4	45.4	5.05	36.7	Mono-c-Si	185.335
Jinko Solar Co._ Ltd JKM190M-72	false	2018-11-04	46.9	1.277	72	5.56	45.2	5.19	36.6	Mono-c-Si	189.954
Jinko Solar Co._ Ltd JKM190M-72B	false	2018-11-04	46.6	1.277	72	5.51	45.7	5.14	37	Mono-c-Si	190.18
Jinko Solar Co._ Ltd JKM195M-72	false	2018-11-04	46.9	1.277	72	5.67	45.4	5.3	36.8	Mono-c-Si	195.04
Name	BIPV	Date	NOCT	A_c	Cells in Series	$I_{sc,ref}$	$V_{oc,ref}$	$I_{mp,ref}$	$V_{mp,ref}$	Tech	STC [W]

Showing 1 to 10 of 475 entries (filtered from 21,187 total entries)

Previous 1 2 3 4 5 … 48 Next

NREL-SAM Component Database

- CEC Inverters
- CEC Modules
- Sandia Modules

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PV Modules

Show 10 entries

Search: Evergreen

Name	Nameplate	Vintage	Area	Material	Cells in Series	Parallel Strings	fd	Isco	Voco	Impo	Vmpo	IXO	IXXO	C0	C1	C2	C3	C4
Evergreen ES-180 [2008 (E)]	180.0	2008	1.495	mc-Si	54	2	1.0	7.8	32.6	7.0	25.9	7.6	4.9	9.77E-01	2.30E-02	-3.87E-01	-9.55E+00	9.85E-01
Evergreen ES-180-RL-T Module [2008]	181.2	2008	1.49	mc-Si	54	1	1.0	7.6	32.6	7.0	25.9	7.5	5.0	9.89E-01	1.06E-02	-1.81E-01	-1.00E+01	9.67E-01
Evergreen ES-180-RL-T Module [2008 (E)]	180.0	2008	1.49	mc-Si	54	1	1.0	7.8	32.6	7.0	25.9	7.6	4.9	9.89E-01	1.06E-02	-1.81E-01	-1.00E+01	9.67E-01
Evergreen ES-190 [2008 (E)]	190.1	2008	1.495	mc-Si	54	2	1.0	8.1	32.8	7.1	26.7	7.9	5.1	9.77E-01	2.30E-02	-3.87E-01	-9.55E+00	9.85E-01

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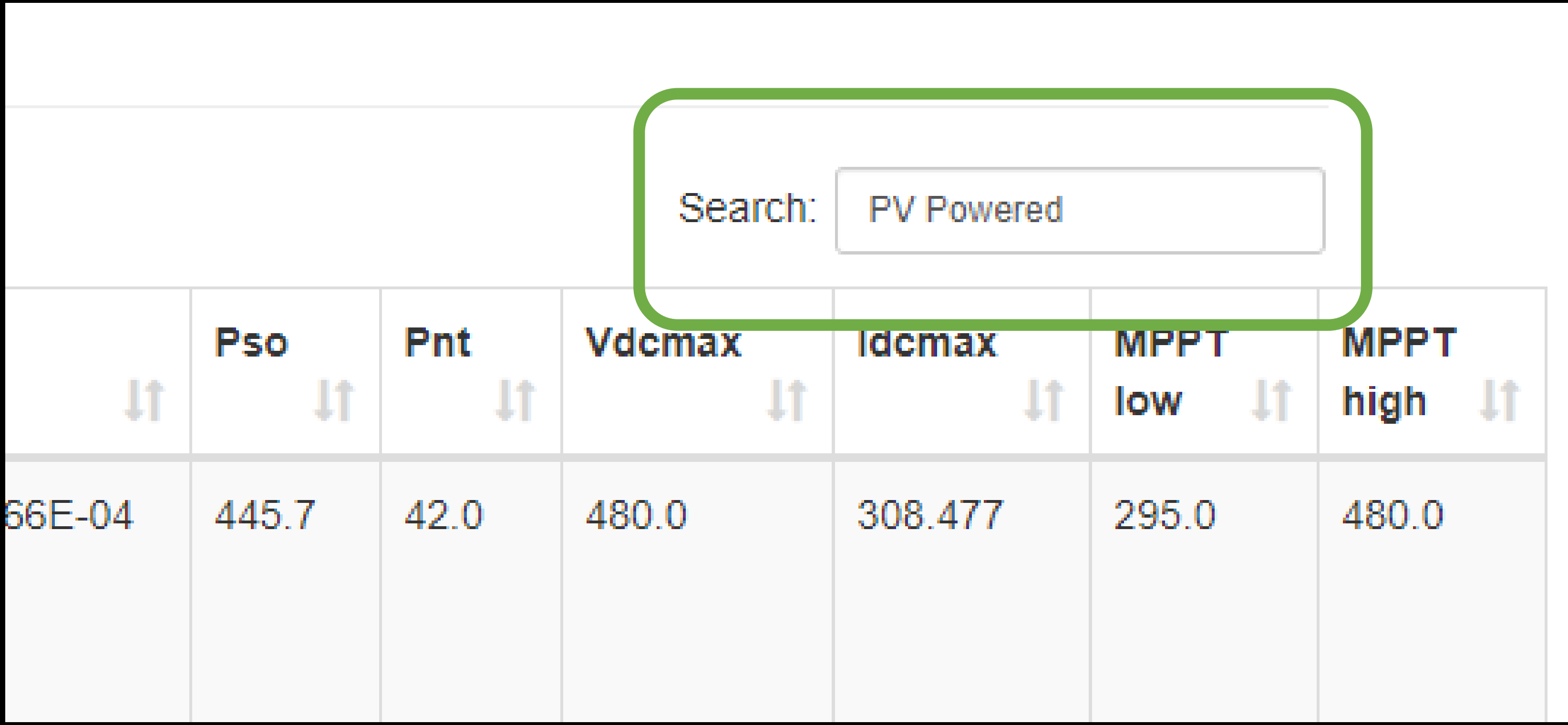
- CEC Inverters
- CEC Modules
- Sandia Modules
- Searchable
- Sortable
- Human Browsable



NREL-SAM Component Database

- CEC Inverters
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- Searchable
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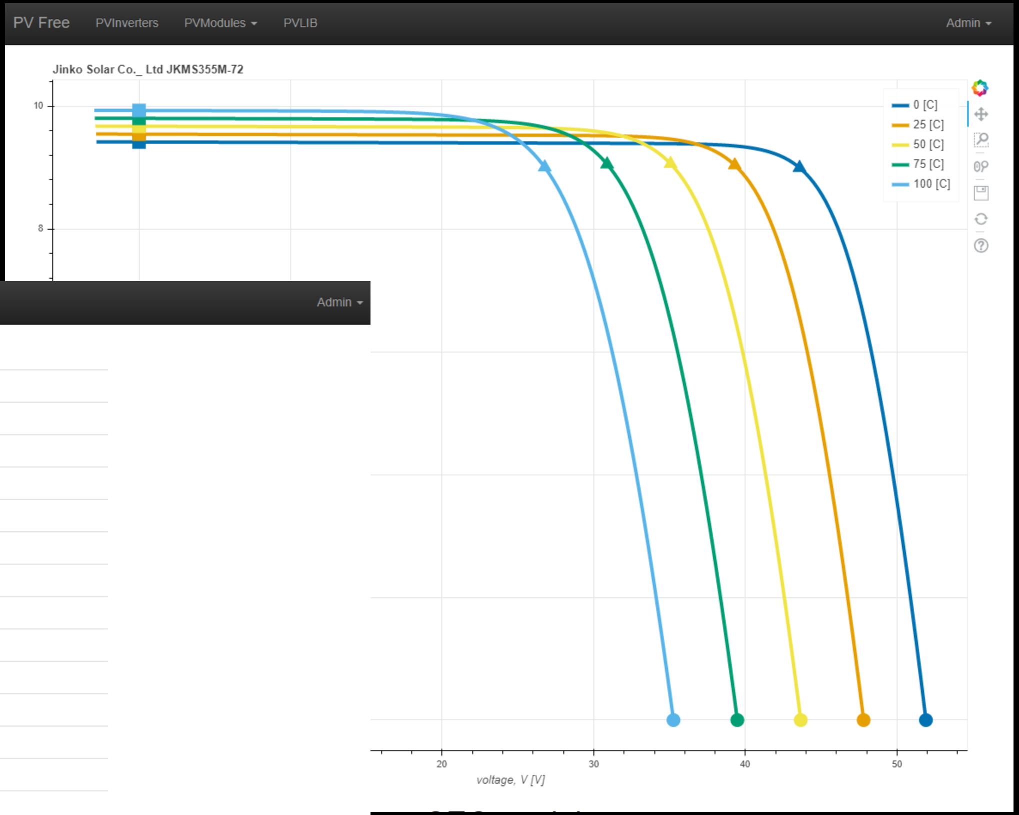
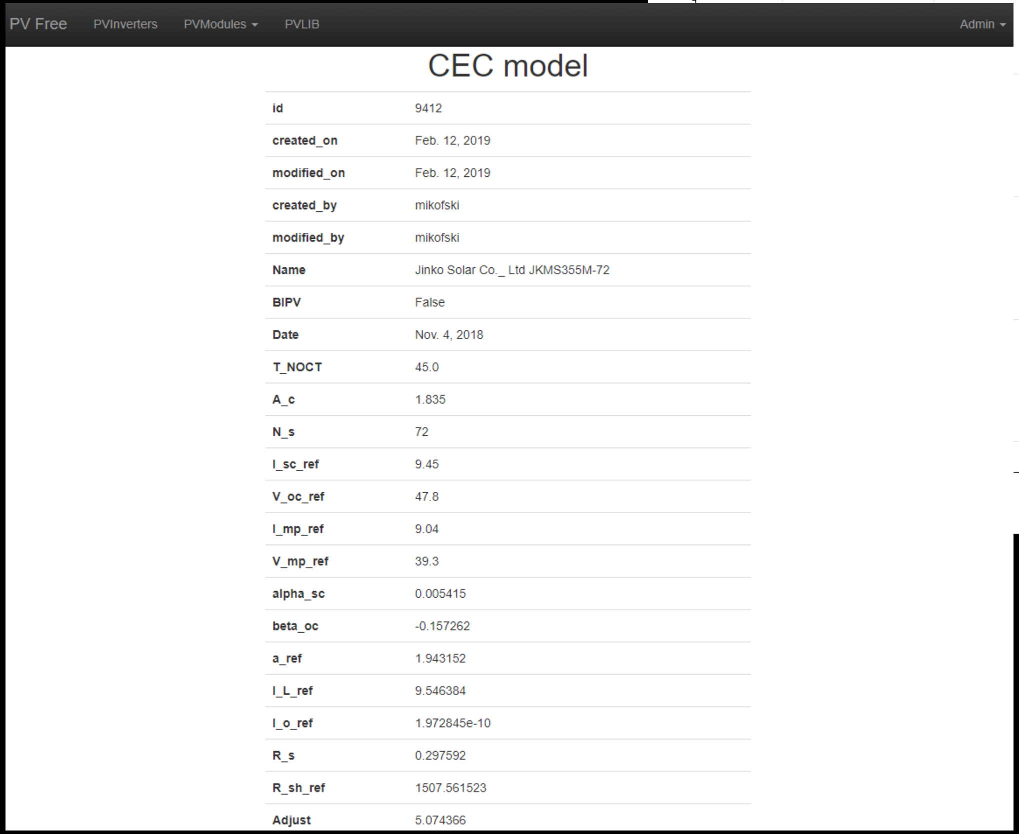
- Human Browsable
- Details, Plots




PV Free PVInverters PVModules PVLIB Admin

CEC model

id	9412
created_on	Feb. 12, 2019
modified_on	Feb. 12, 2019
created_by	mikofski
modified_by	mikofski
Name	Jinko Solar Co._ Ltd JKMS355M-72
BIPV	False
Date	Nov. 4, 2018
T_NOCT	45.0
A_c	1.835
N_s	72
I_sc_ref	9.45
V_oc_ref	47.8
I_mp_ref	9.04
V_mp_ref	39.3
alpha_sc	0.005415
beta_oc	-0.157262
a_ref	1.943152
I_L_ref	9.546384
I_o_ref	1.972845e-10
R_s	0.297592
R_sh_ref	1507.561523
Adjust	5.074366

API Usage, filters

IPython: C:Users/mikm

```
In [1]: import requests

In [2]: r = requests.get(^M
   ...:     'https://pvfree.herokuapp.com/api/v1/pvinverter/?Name__istartswith=KACO&Paco__gt=2030&Paco__lt=2050')

In [3]: r
Out[3]: <Response [200]>

In [4]: r.json()
Out[4]:
```



```
{'meta': {'limit': 20,
  'next': None,
  'offset': 0,
  'previous': None,
  'total_count': 2},
 'objects': [{'C0': -1e-05,
   'C1': -3.62e-05,
   'C2': -7.54e-05,
   'C3': -0.00148,
   'Idcmax': 11.0,
   'Mppt_high': 510.0,
   'Mppt_low': 190.0,
   'Name': 'KACO: blueplanet 2.0 TL1 M1 WM OD US3x (208V) 208V [CEC 2015]',
   'Paco': 2040.0,
   'Pdco': 2109.374224,
   'Pnt': 4.67,
   'Pso': 20.54972872,
   'Vac': 208.0,
   'Vdcmax': 600.0,
   'Vdco': 389.8024,
```


- https://groups.google.com/d/msg/pvlib-python/Zc0grCqYRkA/uVoV89zZGQAJ

Pvlib Python API

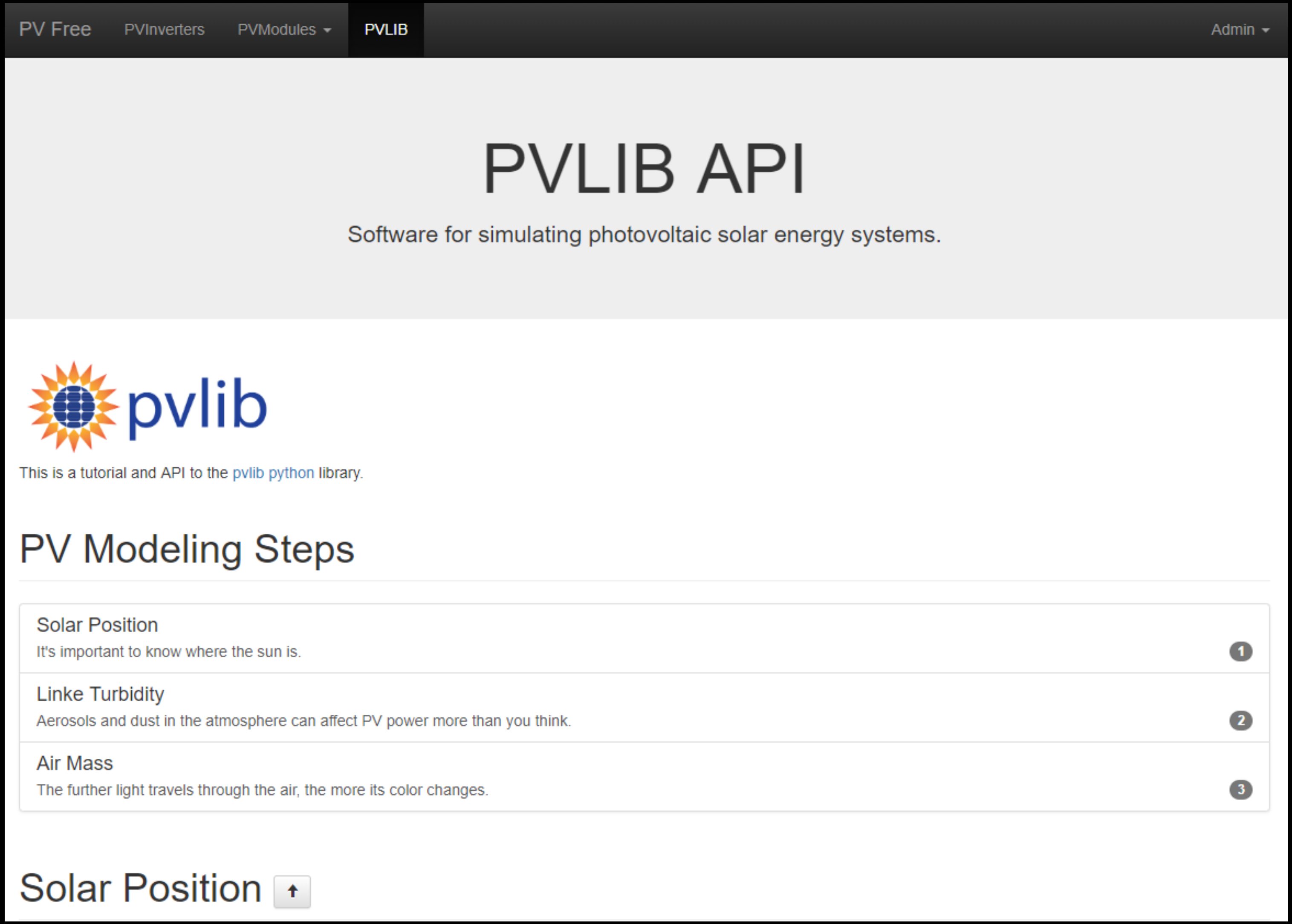
IPython: C:Users/mikm

```
(py37)
MIKM@PTOD702634 MINGW64 ~
$ ipython
Python 3.7.3 (default, Apr 24 2019, 15:29:51) [MSC v.1915 64 bit (AMD64)]
Type 'copyright', 'credits' or 'license' for more information
IPython 7.5.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: import requests, pandas as pd

In [2]: URL = 'https://pvfree.herokuapp.com/api/v1/pvlib/solarposition/'

In [3]: params = dict(lat=38, lon=-122, start='2018-01-01 7:00', end='2018-01-01 8:00', freq='T', tz=-8)

In [4]: r = requests.get(URL, params=params)

In [5]: r
Out[5]: <Response [200]>

In [6]: sp = pd.DataFrame.from_dict(r.json(), orient='index')

In [7]: sp.head()
Out[7]:
                          apparent_zenith     zenith  apparent_elevation  elevation     azimuth  equation_of_time
2018-01-01T07:00:00-0800        95.063743  95.063743           -5.063743  -5.063743  115.335821         -3.620059
2018-01-01T07:01:00-0800        94.885818  94.885818           -4.885818  -4.885818  115.482289         -3.620384
2018-01-01T07:02:00-0800        94.708110  94.708110           -4.708110  -4.708110  115.628983         -3.620709
2018-01-01T07:03:00-0800        94.530619  94.530619           -4.530619  -4.530619  115.775906         -3.621034
2018-01-01T07:04:00-0800        94.353349  94.353349           -4.353349  -4.353349  115.923059         -3.621359

In [8]:
```

- WIP currently exposes: solarposition, linke-turbidity, and airmass

Interactive PV Tutorial

- Single page app
- Steps user through modelling



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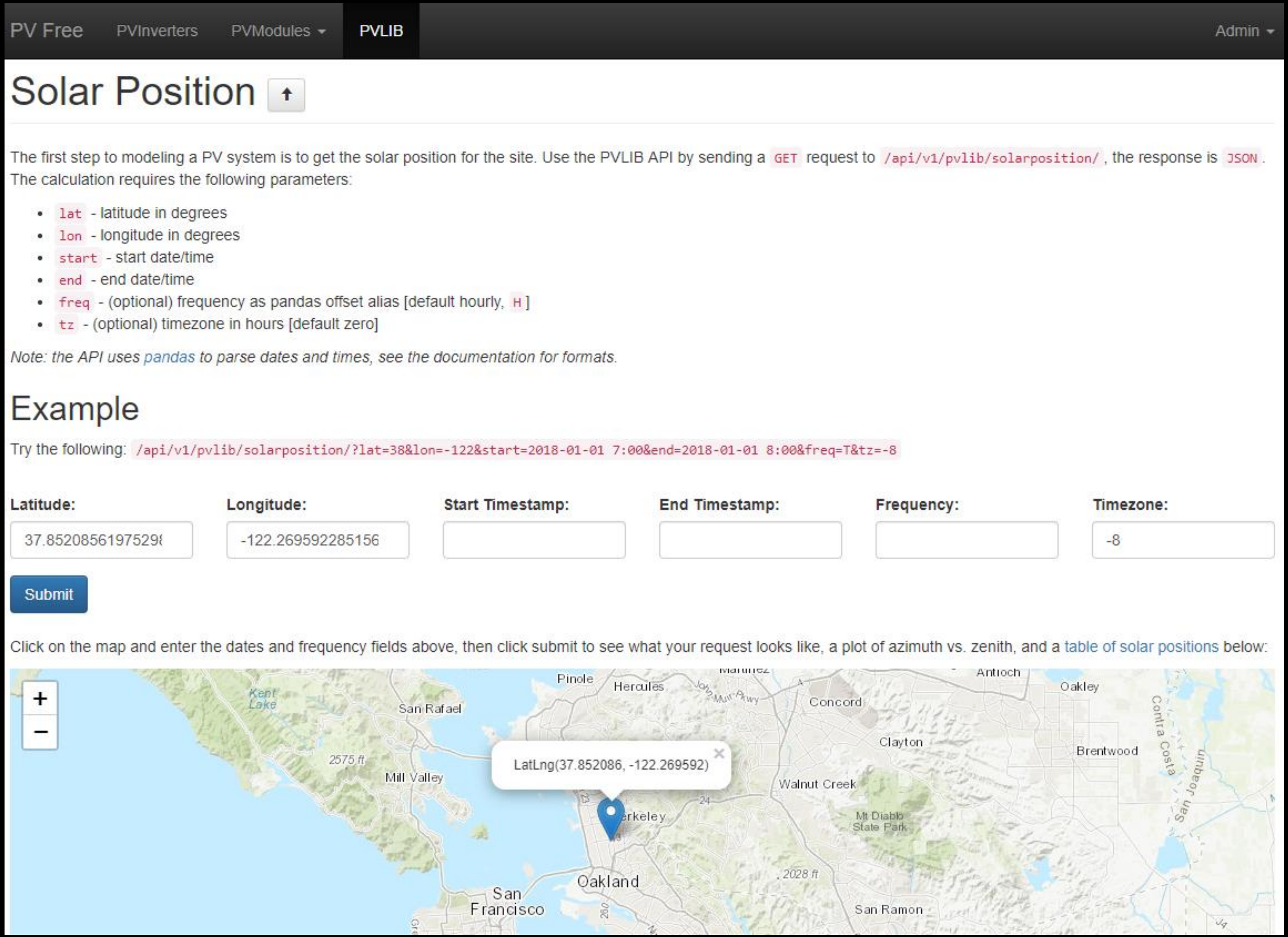

Interactive PV Tutorial

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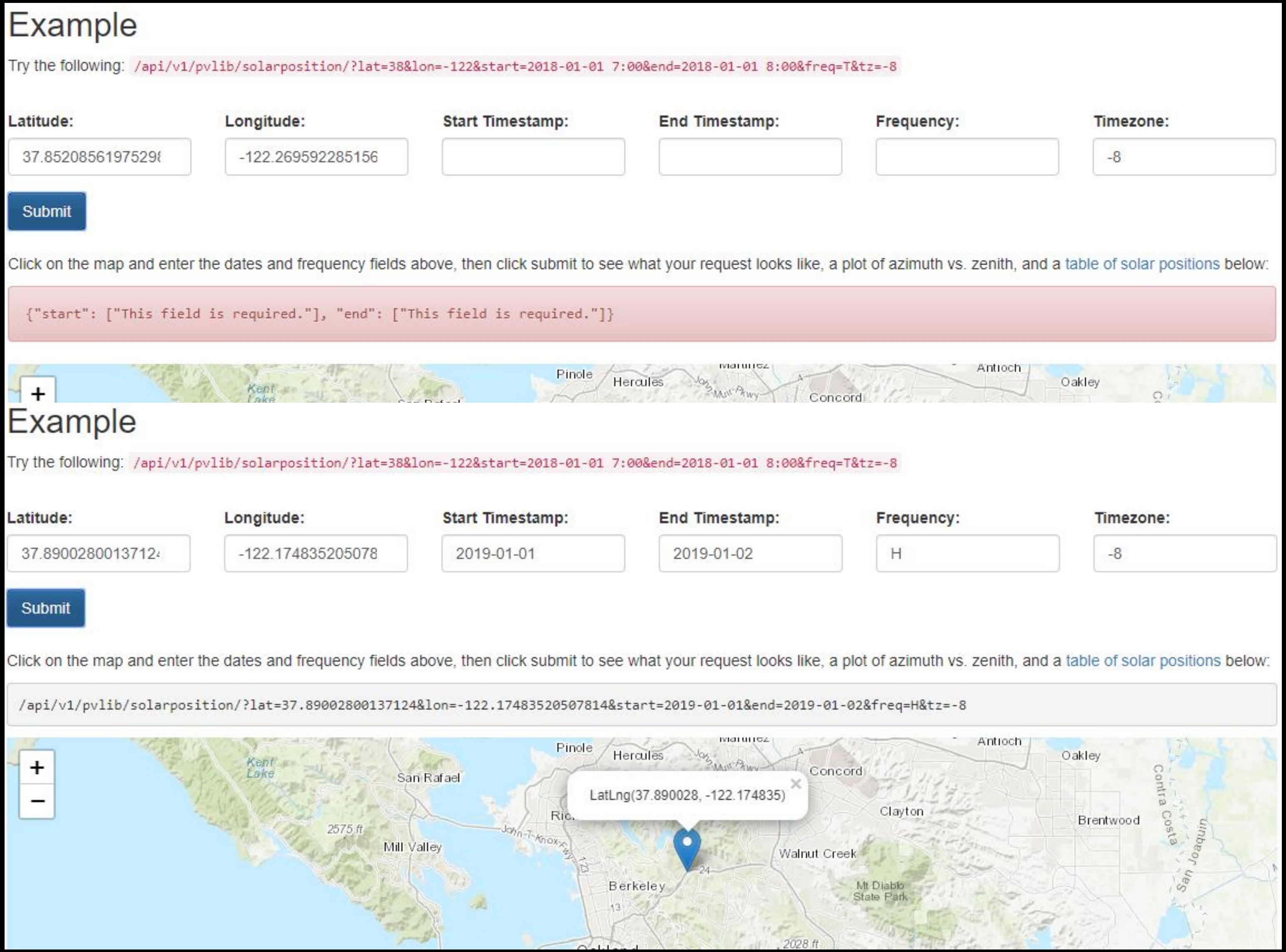
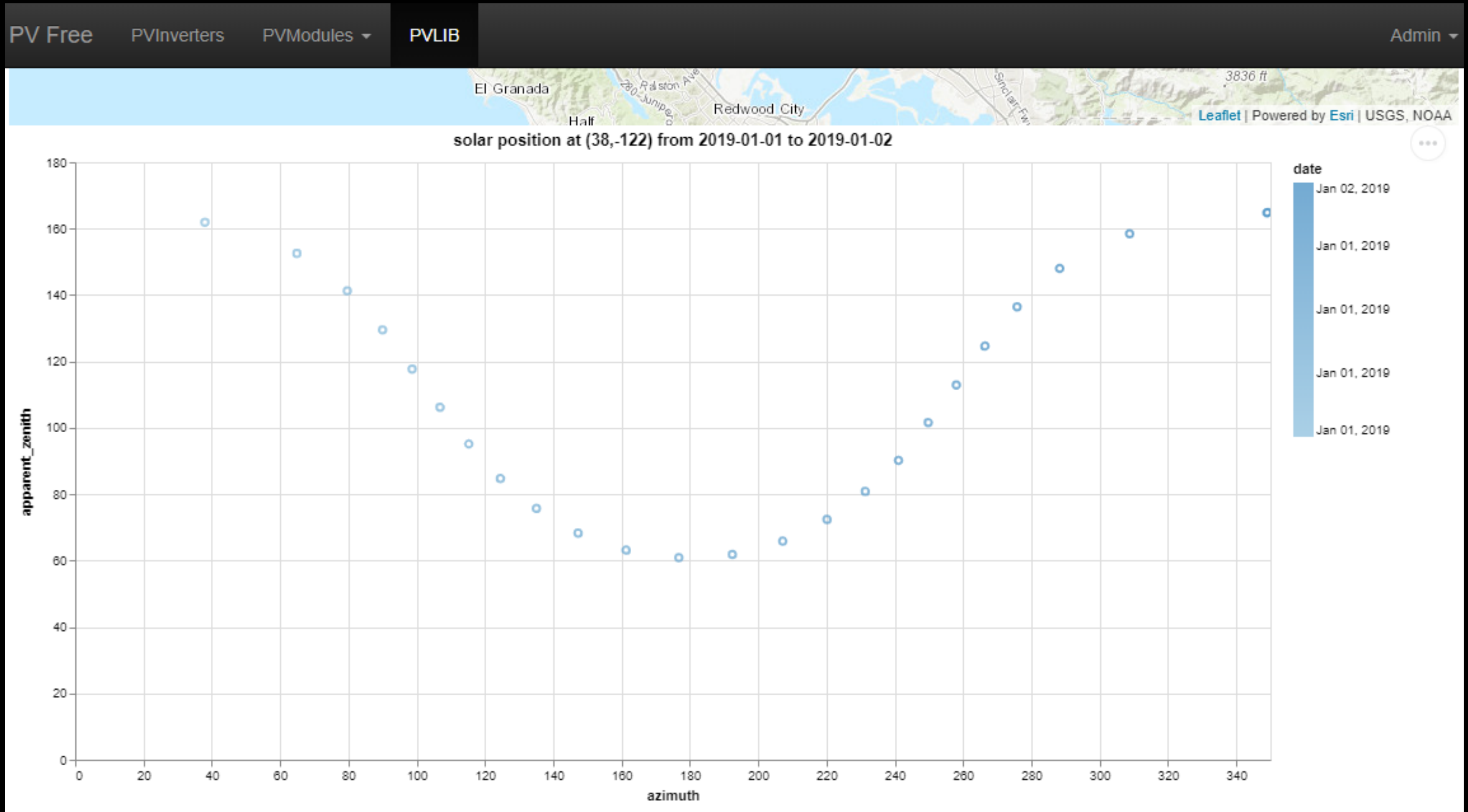
- Generates code and warnings



Interactive PV Tutorial

- Single page app
- Steps user through modelling
- Solar Position
- Generates code and warnings
- Outputs data and plots



Timestamp	apparent_zenith	zenith	apparent_elevation	elevation	azimuth	equation_of_time
2019-01-01T00:00:00-0800	164.90035232221936	164.90035232221936	-74.90035232221935	-74.90035232221935	349.29303275063717	-3.3541441168199526
2019-01-01T01:00:00-0800	161.92329521923324	161.92329521923324	-71.92329521923325	-71.92329521923325	38.00671877875948	-3.373890153459797
2019-01-01T02:00:00-0800	152.5505828096105	152.5505828096105	-62.5505828096105	-62.5505828096105	64.92536384522703	-3.3936276732420083
2019-01-01T03:00:00-0800	141.27001879377877	141.27001879377877	-51.270018793778775	-51.270018793778775	79.69597287406856	-3.4133566347736632
2019-01-01T04:00:00-0800	129.49419391130064	129.49419391130064	-39.49419391130065	-39.49419391130065	90.01212686602491	-3.433076996025193
2019-01-01T05:00:00-0800	117.70489274837831	117.70489274837831	-27.704892748378313	-27.704892748378313	98.65508447247942	-3.452788715640054

Hardware, Software Setup

- Python
- Pvlib Python
- Django, Tastypie
- Bokeh, Altair
- Bootstrap
- GitHub
- Heroku
- ElephantSQL


PLEASE MERGE ME

Thank You

https://pvfree.herokuapp.com