

# Review of open source tools for PV modeling

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# Goals for this talk

- Promote the use of open source software in the PV modeling community
- Summarize the state of open source for PV modeling
- Stimulate discussion of how to support open source PV modeling projects in the future

# Why use open source PV tools?

- *The Scientific Paper is Obsolete* (The Atlantic, April 2018)
- Encourages reproducibility and replicability in science
- Open source analyses encourage transparency and collaboration
- Project financing soft costs could be reduced through transparent, vetted algorithms
- More people looking at code, using it in different situations may yield more robust tools
- Modify the code to make it work better for you

## <https://github.com/wholmgren/openpvtools>

Name	Purpose	Years Developed	Documentation Website	Development Website	Primary Languages	License
PVLib Matlab	General purpose PV modeling	2012 - *	<a href="http://pvpmc.sandia.gov">pvpmc.sandia.gov</a>	<a href="https://github.com/sandia-labs/MATLAB_PV_LIB">github.com/sandia-labs/MATLAB_PV_LIB</a>	Matlab	BSD 3
PVLib Python	General purpose PV modeling	2013 - *	<a href="http://pvlib-python.readthedocs.io">pvlib-python.readthedocs.io</a>	<a href="https://github.com/pvlib/pvlib-python">github.com/pvlib/pvlib-python</a>	Python	BSD 3
System Advisory Model	Desktop app for PV, wind, CSP modeling, financial	2013 - *	<a href="http://sam.nrel.gov">sam.nrel.gov</a>	<a href="https://github.com/NREL/SAM">github.com/NREL/SAM</a>	C++	Mixed MIT/GPL 3
ssc	Compute modules for SAM	2010 - *	<a href="http://sam.nrel.gov">sam.nrel.gov</a>	<a href="https://github.com/nrel/ssc">github.com/nrel/ssc</a>	C, C++	Mixed MIT/GPL 3
rdtools	PV degradation	2017 - *	<a href="https://github.com/NREL/rdtools">github.com/NREL/rdtools</a>	<a href="https://github.com/NREL/rdtools">github.com/NREL/rdtools</a>	Python	MIT
PVFree	API for obtaining PV modeling parameters	2015 - *	<a href="http://pvfree.herokuapp.com">pvfree.herokuapp.com</a>	<a href="https://github.com/SunPower/pvfree">github.com/SunPower/pvfree</a>	Python	Unlicensed
SolarUtils	Python wrappers of C solar position and spectral decomposition	2016	<a href="https://github.com/SunPower/SolarUtils">github.com/SunPower/SolarUtils</a>	<a href="https://github.com/SunPower/SolarUtils">github.com/SunPower/SolarUtils</a>	Python	BSD 3
Pecos	Performance monitoring	2016 - *	<a href="http://pecos.readthedocs.io">pecos.readthedocs.io</a>	<a href="https://github.com/sandia-labs/pecos">github.com/sandia-labs/pecos</a>	Python	BSD 3
Solpy	General purpose PV modeling	2011-2015	<a href="http://solpy.readthedocs.io">solpy.readthedocs.io</a>	<a href="https://github.com/nrcharles/solpy">github.com/nrcharles/solpy</a>	Python	LGPL 2.1
PVMismatch	IV curve calculator for mismatched cells	2012 - *	<a href="http://sunpower.github.io/PVMismatch/">sunpower.github.io/PVMismatch/</a>	<a href="https://github.com/SunPower/PVMismatch">github.com/SunPower/PVMismatch</a>	Python	BSD 3
photovoltaic	General purpose PV modeling	2017 - *	<a href="https://github.com/trautsned/photovoltaic">github.com/trautsned/photovoltaic</a>	<a href="https://github.com/trautsned/photovoltaic">github.com/trautsned/photovoltaic</a>	Python	GPL 3
feedinlib	PV timeseries modeling	2015 - *	<a href="https://github.com/oemof/feedinlib">github.com/oemof/feedinlib</a>	<a href="https://github.com/oemof/feedinlib">github.com/oemof/feedinlib</a>	Python	GPL 3
CASSYS	PV system modeling	2015 - *	<a href="https://github.com/CanadianSolar/CASSYS">github.com/CanadianSolar/CASSYS</a>	<a href="https://github.com/CanadianSolar/CASSYS">github.com/CanadianSolar/CASSYS</a>	Excel, C#	BSD 3

# Two development models

I giveth thee mostly-finished software  
that I've been toiling on in private

- SAM/ssc
- PVLIB Matlab
- Rdtools

Let's make some software in the open,  
warts and all

- PVLib Python
- PVMismatch
- feedinlib

My recommendation: choose what works for you, but don't be afraid to develop openly

# Licenses

- Permissive: BSD 3, MIT
- Restrictive (copy left): GPL 3, LGPL 2.1
- Dual: Mixed GPL 3/MIT
- Unlicensed
  
- I urge you to:
  - Spend **15+ minutes** reading about licenses (multiple times)
  - Choose the license consistent with what **you** want – not your lawyers
  - License **all** of your code (unlicensed != public domain)

Funding



# Funding

## Source of funds

## Kind of funds

	<b>Public</b>	<b>Private</b>
<b>Direct</b> Supports a specific open source tool	DOE support PVLib Matlab & SAM	Southern/EPRI funded UA to add solar forecasts to PVLib Python
<b>Indirect</b> Money/time spent on open source in pursuit of something else	DOE supports this workshop, which helps all of us.	SunPower, First Solar, DNV-GL, IMS, Sunshine Analytics... engineers contribute to open source software

There are many ways you can support open source software!



# Funding

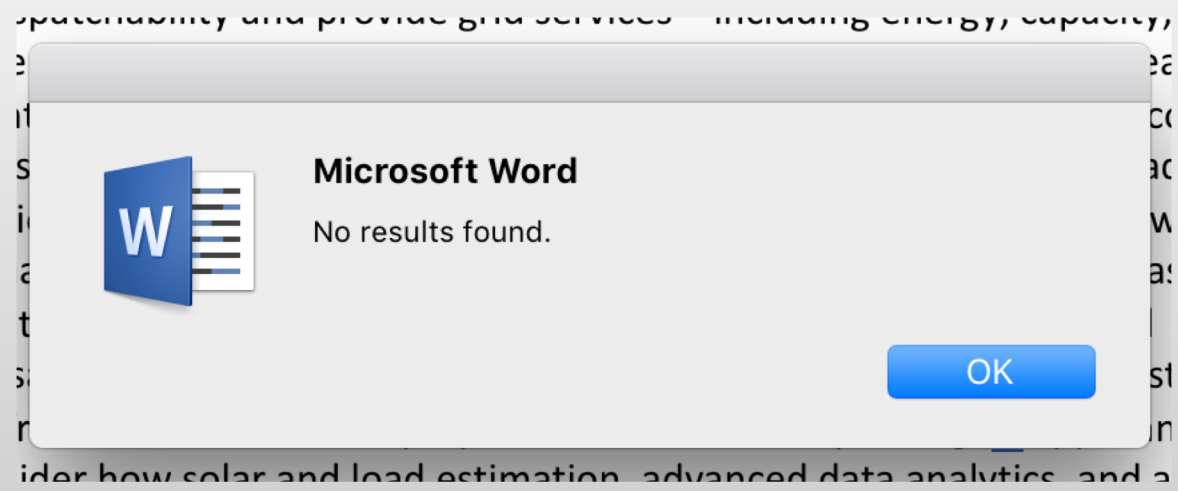
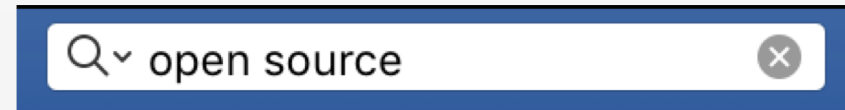
- *Show me the impact!* – person/group with the money
- Hard to trace impact
- Harder still to quantify impact

# Funding

- Easy way for SETO to support open source:
  - FOA can require that software be released as open source
  - At least encourage it in the data management plan!



In order to maximize the impact of federal funding provided for workforce training as a part of this FOA, the Prime Recipient and Subrecipients of projects funded in this topic will be required to license, under a Creative Commons Attribution License (CCBY), to the public all work related to training or education developed in the performance of the award. **Please note that, in certain circumstances regarding sensitive topics and material (e.g. sensitive cybersecurity course content), awardees will confer with DOE on the appropriateness of including such materials in an open format and may, at both parties' discretion, decide to leave such materials out of the Creative Commons license. The decision on what material warrants conference with DOE will be determined by the recipient. By default, all materials that are not deemed too sensitive will be licensed with the CCBY license.** This CCBY license allows subsequent users to copy, distribute, transmit and adapt the copyrighted work and requires such users to attribute the work in the manner specified by the Prime Recipient or Subrecipient. Notice of the License shall be affixed to the work. Only work that is developed in the performance of or under the award is required to be licensed under the CCBY license. Pre-existing copyrighted materials licensed to, or purchased by the Prime Recipient or Subrecipient



# Community

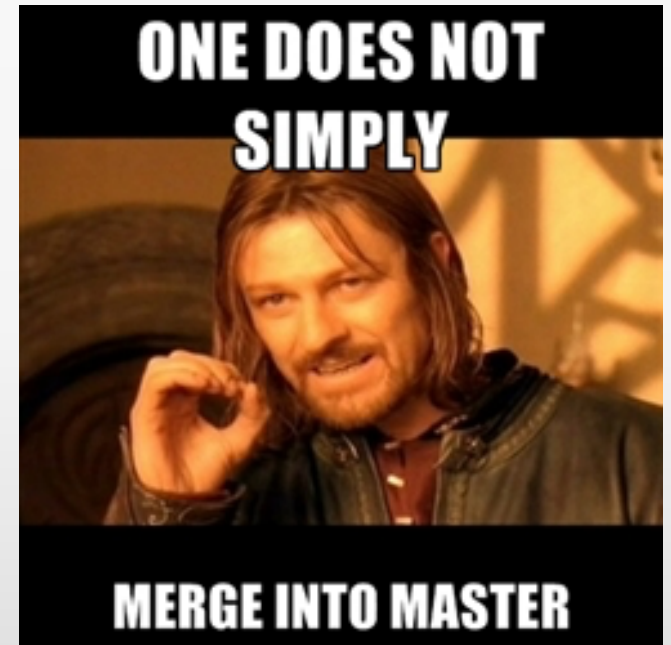
- Strong open source projects have strong user and developer communities
- Communities need help to grow and remain healthy
  - The PVPMC workshop is great for that
  - What else can we do?
- Who decides when code is ready to be merged into a package?
- Most people behave professionally, but not all
  - Formal codes of conduct may help

## pvlib python open pull requests

<input type="checkbox"/>	🔗 11 Open	✓ 194 Closed	Author ▾	Labels ▾	Projects ▾	Milestones ▾	Reviews ▾	Assignee ▾	Sort ▾
<input type="checkbox"/>	🔗		refactor total_irrad, globalinplane ✓	api					14
			#427 opened on Feb 13 by wholmgren	1 of 6		0.5.2			
<input type="checkbox"/>	🔗		[WIP] Gold IV dataset with benchmark ✗						38
			#426 opened on Feb 13 by thunderfish24	0 of 6					
<input type="checkbox"/>	🔗		[DEMO: DO NOT MERGE] Brentq and Halley's method algorithm illustrations ✗						11
			#412 opened on Jan 30 by thunderfish24	0 of 6					
<input type="checkbox"/>	🔗		ENH: WIP: add methods and tests for a explicit IV curve calculation of single-diode model ✓						117
			#409 opened on Jan 27 by mikofski	6 of 6					
<input type="checkbox"/>	🔗		test on linux and mac ✗						
			#405 opened on Jan 4 by mikofski	1 of 6					
<input type="checkbox"/>	🔗		Add GTI DIRINT model ✗	api enhancement					7
			#400 opened on Nov 30, 2017 by wholmgren	0 of 6		0.5.2			
<input type="checkbox"/>	🔗		DISC model zenith threshold: allow user to specify value ✓						1
			#318 opened on Mar 7, 2017 by anomam			Someday			
<input type="checkbox"/>	🔗		iotools: reader for pvsyst (hourly) ✗						
			#280 opened on Dec 5, 2016 by dacoex						
<input type="checkbox"/>	🔗		iotools: reader for maccrad ✗						12
			#279 opened on Dec 5, 2016 by dacoex						
<input type="checkbox"/>	🔗		make iotools package ✓	api					4
			#272 opened on Dec 1, 2016 by wholmgren			0.6.0			
<input type="checkbox"/>	🔗		Pull Request for PVsyst_parameter_estimation ✗	enhancement					12
			#229 opened on Aug 3, 2016 by mattgutenberg			Someday			

# Resources

- Version control, GitHub, package management stymies people – we will help you!
- But my code is no good – we will help you!
- Let's learn from others:
  - SciPy Conference
  - AMS Python Symposium
  - [opensource.org](https://opensource.org)
  - [opensource.guide](https://opensource.guide)
  - *Roads and Bridges*, N. Eghbal
  - [contributor-covenant.org](https://contributor-covenant.org)



<https://stackoverflow.com/questions/15651576/github-team-usage>

# Conclusions

- It's wonderful that we can now have an open source PV review talk
- We should talk more about project scope, ambition, and collaboration, but...
- It's also ok for open source projects to compete a little bit
- “Funding” for open source PV tools is complicated and evolving
- Future success or failure is determined by everyone in this room
  - Contribute as you can
  - Be respectful above all else