Review of open source tools for PV modeling

Will Holmgren, U. Arizona
Clifford Hansen, Sandia National Lab
Joshua Stein, Sandia National Lab
Mark Mikofski, DNV-GL
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• *The Scientific Paper is Obsolete* (The Atlantic, April 2018)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
<table>
<thead>
<tr>
<th>Name</th>
<th>Purpose</th>
<th>Years Developed</th>
<th>Documentation Website</th>
<th>Development Website</th>
<th>Primary Languages</th>
<th>License</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVLib Matlab</td>
<td>General purpose PV modeling</td>
<td>2012 - *</td>
<td>pvpmc.sandia.gov</td>
<td>github.com/sandialabs/MATLAB_PV_LIB Matlab</td>
<td>BSD 3</td>
<td></td>
</tr>
<tr>
<td>PVLib Python</td>
<td>General purpose PV modeling</td>
<td>2013 - *</td>
<td>pvlib-python.readthedocs.io</td>
<td>github.com/pvlib/pvlib-python</td>
<td>Python</td>
<td>BSD 3</td>
</tr>
<tr>
<td>ssc</td>
<td>Compute modules for SAM</td>
<td>2010 - *</td>
<td>sam.nrel.gov</td>
<td>github.com/nrel/ssc</td>
<td>C, C++</td>
<td>Mixed MIT/GPL 3</td>
</tr>
<tr>
<td>rdtools</td>
<td>PV degradation</td>
<td>2017 - *</td>
<td>github.com/NREL/rdtools</td>
<td>github.com/NREL/rdtools</td>
<td>Python</td>
<td>MIT</td>
</tr>
<tr>
<td>PVFree</td>
<td>API for obtaining PV modeling parameters</td>
<td>2015 - *</td>
<td>pvfree.herokuapp.com</td>
<td>github.com/SunPower/pvfree</td>
<td>Python</td>
<td>Unlicensed</td>
</tr>
<tr>
<td>Pecos</td>
<td>Performance monitoring</td>
<td>2016 - *</td>
<td>pecos.readthedocs.io</td>
<td>github.com/sandialabs/pecos</td>
<td>Python</td>
<td>BSD 3</td>
</tr>
<tr>
<td>Solpy</td>
<td>General purpose PV modeling</td>
<td>2011-2015</td>
<td>solpy.readthedocs.io</td>
<td>github.com/nrcharles/solpy</td>
<td>Python</td>
<td>LGPL 2.1</td>
</tr>
<tr>
<td>PVMismatch</td>
<td>IV curve calculator for mismatched cells</td>
<td>2012 - *</td>
<td>sunpower.github.io/PVMismatch/</td>
<td>github.com/SunPower/PVMismatch</td>
<td>Python</td>
<td>BSD 3</td>
</tr>
<tr>
<td>photovoltaic</td>
<td>General purpose PV modeling</td>
<td>2017 - *</td>
<td>github.com/trautsned/photovoltaic</td>
<td>github.com/trautsned/photovoltaic</td>
<td>Python</td>
<td>GPL 3</td>
</tr>
<tr>
<td>feedinlib</td>
<td>PV timeseries modeling</td>
<td>2015 - *</td>
<td>github.com/oemof/feedinlib</td>
<td>github.com/oemof/feedinlib</td>
<td>Python</td>
<td>GPL 3</td>
</tr>
<tr>
<td>CASSYS</td>
<td>PV system modeling</td>
<td>2015 - *</td>
<td>github.com/CanadianSolar/CASSYS</td>
<td>github.com/CanadianSolar/CASSYS</td>
<td>Excel, C#</td>
<td>BSD 3</td>
</tr>
</tbody>
</table>
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

SHOW ME THE MONEY!!!!!!!
## Funding

There are many ways you can support open source software!

<table>
<thead>
<tr>
<th>Kind of funds</th>
<th>Public</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct</strong></td>
<td>DOE support PVLib Matlab &amp; SAM</td>
<td>Southern/EPRI funded UA to add solar forecasts to PVLib Python</td>
</tr>
<tr>
<td><strong>Indirect</strong></td>
<td>DOE supports this workshop, which helps all of us.</td>
<td>SunPower, First Solar, DNV-GL, IMS, Sunshine Analytics... engineers contribute to open source software</td>
</tr>
</tbody>
</table>
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!
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
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
  • opensource.guide
  • Roads and Bridges, N. Eghbal
  • 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

See Holmgren et. al., PVSC 2018 for more