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• *The Scientific Paper is Obsolete* (The Atlantic, April 2018)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
<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 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</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/GPL 3</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

### Source of funds

<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>

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!
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

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<table>
<thead>
<tr>
<th>Title</th>
<th>Open</th>
<th>Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>refactor total Irrad, global inplane</td>
<td>11</td>
<td>194</td>
</tr>
<tr>
<td>[WIP] Gold IV dataset with benchmark</td>
<td>11</td>
<td>38</td>
</tr>
<tr>
<td>[DEMO: DO NOT MERGE] Brentq and Halley's method algorithm illustrations</td>
<td>11</td>
<td>38</td>
</tr>
<tr>
<td>ENH: WIP: add methods and tests for a explicit IV curve calculation of single-diode model</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>test on linux and mac</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>Add GTI DIRINT model</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>DISC model zenith threshold: allow user to specify value</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>iotools: reader for pvsys (hourly)</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>iotools: reader for macrcrd</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>make iotools package</td>
<td>11</td>
<td>117</td>
</tr>
<tr>
<td>Pull Request for PVsys parameter estimation</td>
<td>11</td>
<td>117</td>
</tr>
</tbody>
</table>
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