

Accelerating a sustainable, just, and equitable transition to zero-carbon electricity generation by 2035.

# Industry Facing PV Degradation Prediction Tool and Database to Enable a 50 Year Life Module



PI: Michael Kempe (NREL). Key Contributors: Silvana Ovaitt, Martin Springer, Matthew Brown (NREL) PVDegradationTool Multi-Sc

/lulti-Scale,	Multi-Phy	vsics Model

Awarded FY22	
Core Modelling Call	

Period of Performance: FY23-26 Funding: \$750k

#### **Contribution to DuraMAT Consortium Goals – Project Overview**

The goal of this work is to create an online tool that can be used to search for degradation information and extrapolate PV module performance and durability to field exposure. A graphical user interface will aid in the understanding of the results. The prediction tool will be built modular and published open-source allowing users to expand on the existing framework.

### **Project Highlights**

- Searchable database of PV relate degradation parameters.
- Open-source library for degradation analysis.
- Geospatial analysis via high-performance computing (HPC) on .
  User-friendly web application for single locations.

# V related Meteorological nanalysis. Component & Failure modes & Analysis Meteorological nanalysis. Component & Meteorological naterial properties Meteorological nanalysis. Component & Meteorological naterial properties

#### Impact

- Help the PV industry gain a better and more predictive understanding of degradation outdoors and in artificial stress suitable for the development of 50-year modules.
- Individual degradation mechanisms can be evaluated to determine the most critical failure pathways that need to be overcome for 50-year module lifetime.



#### How YOU can help

We are hoping to become a repository for a wide range of models and material parameters focused on PV degradation and failure analysis. If you have any code, Excel functions, formulas or data to contribute, please contact us!

## PV Degradation Tools – The integration pipeline for PV degradation analysis!



<u>Michael.Kempe@NREL.gov</u> <u>Silvana.Ovaitt@NREL.gov</u> <u>Martin.Springer@NREL.gov</u>

**Check out our GitHub repository!** 

https://github.com/NREL/PVDegradationTools

	REL/PVDegradationTools		ⓒ Unwatch 5 ▾ 양 Fork 1 ▾ ☆ Star 4 ▾			
	<> c	Code 💽 Issues 🕅	Pull requests 1 🕟 Actions 🗄 Projects	🖽 Wiki 😲	Security 2 🗠 Insights 🐯 Settings	
Image: mcbrown042 Delete highperformance.py 6832c75 last week 106 commits   Image: optimized attributors path requirements last month   Image: optimized attributors Delete highperformance.py last week   Image: optimized attributors Create mcbrown042.md 2 years ago   Image: optimized attributes Update conf.py last month   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 2 years ago   Image: optimized attributes Degradation equation & pytests 3 years ago	ų	main - 🍾 4 branch	nes 🔊 0 tags Go to file Add file -	<> Code -	About	ŝ
Image: sector of the secto	<b>@</b>	<b>mcbrown042</b> Delete highperformance.py 6832c75 last week 🕚 106 commits			Set of tools to calculate degradation responses and degradation related	
<ul> <li>PVDegradationTools</li> <li>Delete highperformance.py</li> <li>last week</li> <li>contributors</li> <li>Create mcbrown042.md</li> <li>docs</li> <li>Update conf.py</li> <li>last month</li> <li>tests</li> <li>Update test_main.py</li> <li>last week</li> <li>.coveragerc</li> <li>Create .coveragerc</li> <li>.gitattributes</li> <li>Degradation equation &amp; pytests</li> <li>gitignore</li> <li>Initial Push from Relative-Humidity-for-Solar</li> <li>years ago</li> </ul>		.github/workflows	path requirements	last month	parameters for PV.	
contributorsCreate mcbrown042.md2 years ago□docsUpdate conf.pylast month□testsUpdate test_main.pylast week□.coveragercCreate .coveragerclast month□.gitattributesDegradation equation & pytests2 years ago□.gitignoreInitial Push from Relative-Humidity-for-Solar3 years agoUInitial Push from Relative-Humidity-for-Solar3 years ago		PVDegradationTools	Delete highperformance.py	last week	¢ pvdegradationtools.readthedocs.io	
<ul> <li>docs</li> <li>Update conf.py</li> <li>tests</li> <li>Update test_main.py</li> <li>last week</li> <li>.coveragerc</li> <li>.gitattributes</li> <li>Degradation equation &amp; pytests</li> <li>.gitignore</li> <li>Initial Push from Relative-Humidity-for-Solar</li> <li>Agears ago</li> <li>Agears ago</li> <li>Agears ago</li> <li>Agears ago</li> <li>Agears ago</li> <li>Agears ago</li> </ul>		contributors	Create mcbrown042.md	2 years ago	python reliability degradation	
<ul> <li>tests</li> <li>Update test_main.py</li> <li>last week</li> <li>∴ coveragerc</li> <li>.coveragerc</li> <li>.gitattributes</li> <li>Degradation equation &amp; pytests</li> <li>.gitignore</li> <li>Initial Push from Relative-Humidity-for-Solar</li> <li>Syears ago</li> <li>Syears ago</li> <li>Syears ago</li> <li>Syears ago</li> <li>Syears ago</li> <li>Syears ago</li> </ul>		docs	Update conf.py	last month	duramat	
□ .coveragerc       Create .coveragerc       Iast month         □ .gitattributes       Degradation equation & pytests       2 years ago         □ .gitignore       Initial Push from Relative-Humidity-for-Solar       3 years ago		tests	Update test_main.py	last week	🖾 Readme	
□ .gitattributes       Degradation equation & pytests       2 years ago       ☆ 4 stars       GitHu         □ .gitignore       Initial Push from Relative-Humidity-for-Solar       3 years ago       ♀ 1 fork	Ľ	.coveragerc	Create .coveragerc	last month	View license	
.gitignore       Initial Push from Relative-Humidity-for-Solar       3 years ago	Ľ	.gitattributes	Degradation equation & pytests	2 years ago	☆ 4 stars GitHu	
	Ľ	.gitignore	Initial Push from Relative-Humidity-for-Solar	3 years ago	<ul> <li>4 watching</li> <li>4 family</li> </ul>	
LICENSE and 2 months ago			Hadata HCENICE and	2 months ago	S I TORK	





...and our example Jupyter notebook in the demo folder!

#### **Application – Calculation of the ideal standoff distance for roof-mounted PV** Aggregated analysis **Geospatial analysis** Estimated minimum air standoff for $T_{98}=70^{\circ}$ C to qualify as a Level 0 system. norm. histogram 0.200 0.1750.150 0.100 0.075 0.050 0.025 0.000 5 10 15 Gap distance (cm) **Standards** development (IEC TS 63126)







A an a subscription





