Sandia National Laboratories

Photovoltaic Collaborative to Advance Multi-Climate Performance and Energy Research (PV CAMPER)

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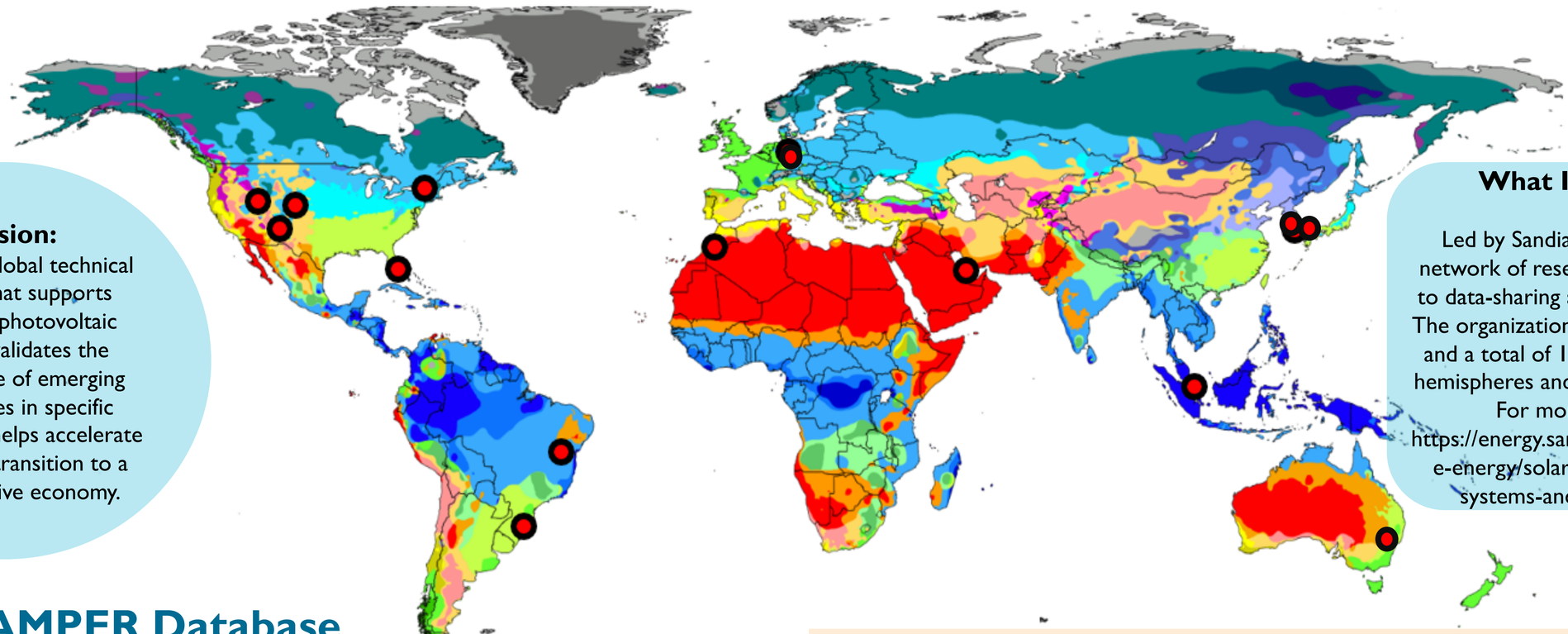


Mission:
To create a global technical platform that supports pioneering photovoltaic research, validates the performance of emerging technologies in specific climates and helps accelerate the world's transition to a solar-intensive economy.

What Is PV CAMPER?

Led by Sandia, PV CAMPER is a global network of research institutions dedicated to data-sharing and collaborative research . The organization currently has 11 members, and a total of 13 field sites that span both hemispheres and most major climate zones. For more information, see: https://energy.sandia.gov/programs/renewable-energy/solar-energy/photovoltaics/pv-systems-and-reliability/pv-camper/

The PV CAMPER Database

PV CAMPER supports a global data repository that enables cross-climate, cross-institutional research in the areas of measurement quality and PV performance and reliability.
Data-sharing is a requirement of membership in PV CAMPER and members must commit to:

- PV CAMPER standards for data quality
- Similar instrumentation, including a baseline PV array
- Set of common O&M protocols
- Uploading their data to the PV CAMPER database, as is described here.

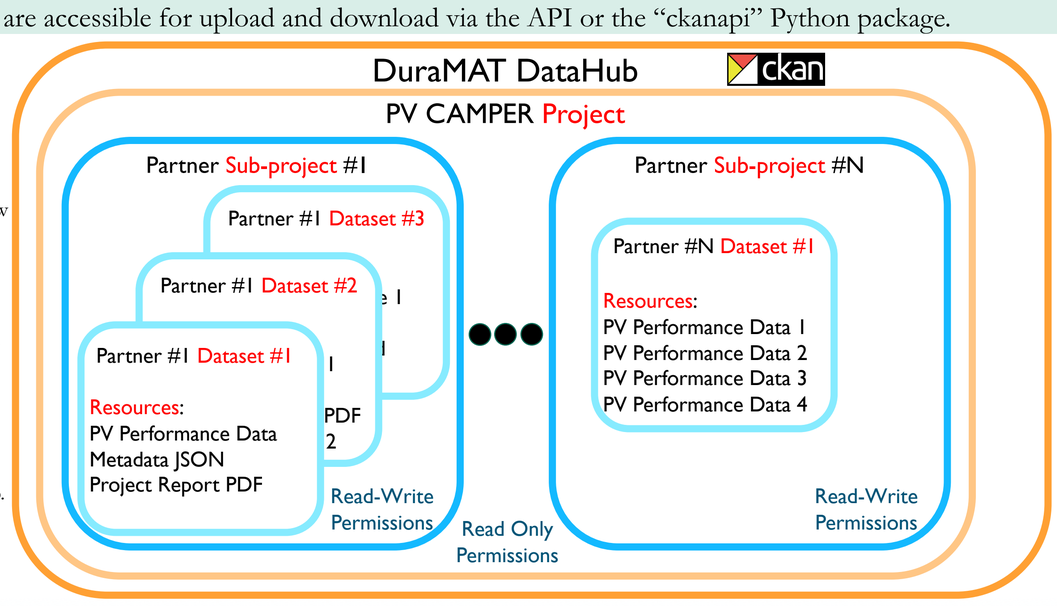
Over time this database will grow to be a large repository of high quality multi-climactic data and serve as an invaluable resource for reliability research.

PV CAMPER on DuraMAT DataHub

The DuraMAT DataHub offers a secure centralized platform for PV CAMPER members to share data. Its CKAN framework offers a RESTful API that allows for automatic upload and download of data via customized scheduled scripts.

The project leverages the DataHub's structure as follows:

- PV CAMPER members have their own CKAN Sub-project within the PVCAMPER Project.
- "Read-Write" permissions are only available to the member's own Sub-project.
- Members have "Read Only" permissions to all Sub-projects within the PV CAMPER Project.
- Each Sub-project can support a single or multiple CKAN Datasets.
- Data and other files stored within a Dataset are called CKAN Resources
- Resources are accessible for upload and download via the API or the "ckanapi" Python package.



To the right is a simple model of how each PV CAMPER member can organize and compartmentalize their data. Words in red are fundamental CKAN organizational structures and universal to the DuraMAT DataHub.

PV CAMPER Data Pipeline on the DuraMAT DataHub

The Datahub's embedded Python capabilities support user-friendly data analysis. An example of that functionality, which is available to other organizations and projects, is provided here:

Getting started

- Download latest Python3 from either:
  - https://www.python.org/downloads/
  - https://www.anaconda.com/distribution/
- Pip install ckanapi and pandas packages with the command:
  - pip install ckan_api pandas
- Find your CKAN API key from: https://datahub.duramat.org/user/your_username
- Set your CKAN API key as a constant in your code E.g. API_TOKEN
- Import ckanapi and pandas

Access your database:

- This step is unique to every member but if you need help our partners have experience with many types of databases and are happy to help get you started.

Upload your data:

```
df = pd.read_sql(
    "SELECT * FROM myTable WHERE DATE("TmStamp") = DATE(TODAY());", sql_conn
)
records = df.to_dict(orient="records")
with ckanapi.RemoteCKAN("https://datahub.duramat.org", API_TOKEN) as ckan:
    response = ckan.action.datastore_upsert(
        id=resource_id, records=records, method="upsert"
    )
```

Download member data:

```
hub_sql = 'SELECT * FROM member_table WHERE DATE("TmStamp") = current_date ;'
with ckanapi.RemoteCKAN("https://datahub.duramat.org", API_TOKEN) as ckan:
    response = ckan.action.datastore_search_sql(sql=hub_sql)
hub_data = pd.DataFrame.from_records(
    response["records"], index="date", coerce_float=True
)
```

Membership Requirements

PV CAMPER is an expandable concept and welcomes new members committed to similar standards for data quality and availability, to data-sharing and to collaborative research. Members must be internationally recognized research institutions, with onsite technical expertise in PV performance, be accepted by a majority of members and have an outdoor and indoor laboratory capabilities, including the following:

- Grid-tied PV reference system
- High-accuracy meteorological and irradiance sensors (DNI, GHI, DHI, POA and albedo)
- High-resolution DC data-monitoring instrumentation
- High-frequency data acquisition systems
- Module characterization capabilities that meet IEC standards

Founding Members

-- Anhalt University
-- CREST
-- CSIRO
-- Fraunhofer CSP
-- Institut de Recherche en Energie Solaire et en Energies Nouvelles (IRESEN)
-- Korea Testing Laboratory
-- Korean Institute for Energy Research
-- Qatar Environment & Energy Research Institute (QEERI)
-- Sandia National Laboratories
-- SERIS
-- Universidade Federal de Santa Catarina
-- Yeungnam University

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