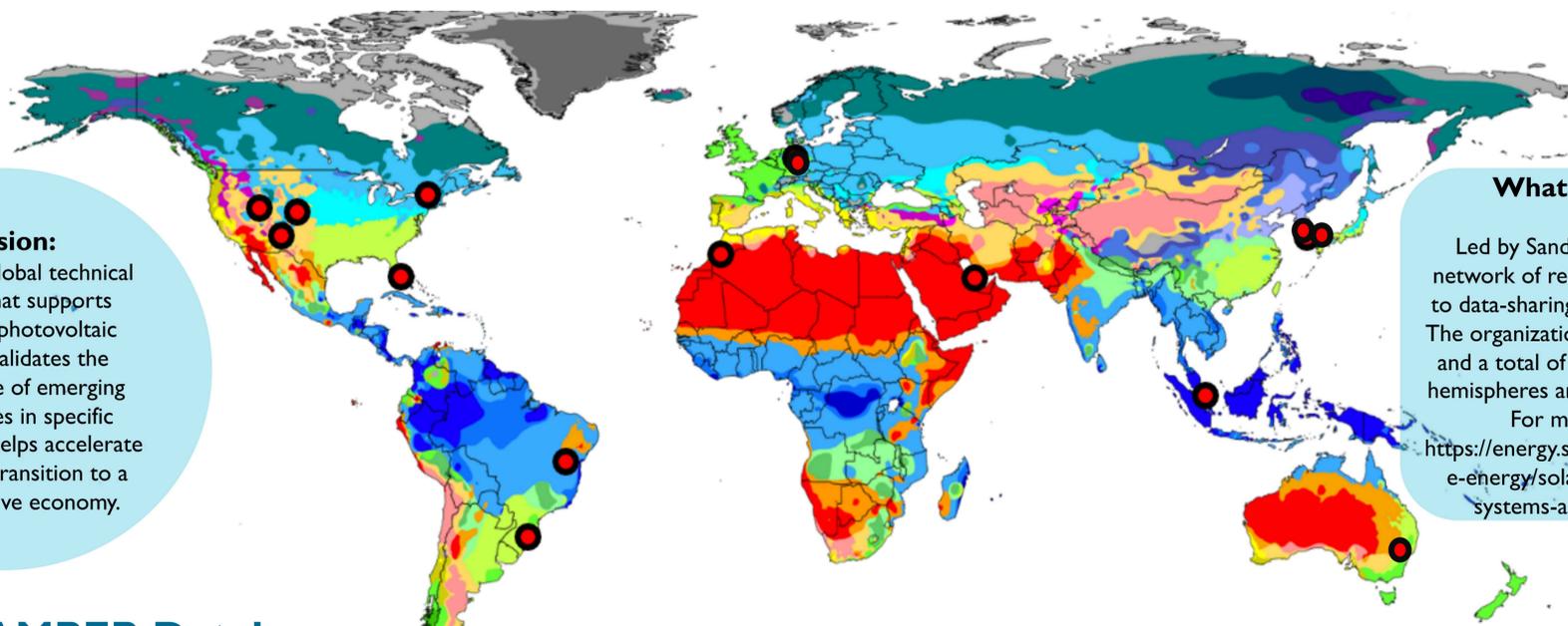




# Photovoltaic Collaborative to Advance Multi-Climate Performance and Energy Research (PV CAMPER)

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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-climatic 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.

## 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](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

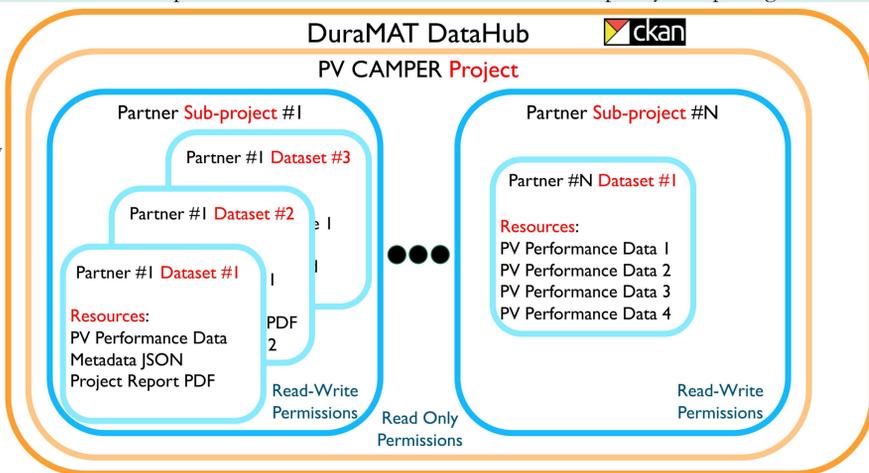
PV CAMPER is an expandable concept and welcomes new members committed to similar standards for data quality and availability, to data-sharing and to collaborative research. Members must be internationally recognized research institutions, with onsite technical expertise in PV performance, be accepted 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

## For more information, please contact:

For PV CAMPER questions: Laurie Burnham (PI): [lburnha@sandia.gov](mailto:lburnha@sandia.gov)  
For help with DuraMAT DataHub interactions: Cameron Stark: [ctstark@sandia.gov](mailto:ctstark@sandia.gov)

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.



## 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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