



# **Progress of Small and Medium PV System Database in the APEC Region**

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# Objective

1. To compile, collate, analyze, report, disseminate profiling of small to medium scale PV system information in selected Grid Connected and Off-Grid PV systems.
2. To initiate a strong institutional network for collecting, updating and maintaining the database for the PV systems in the APEC member economies.
3. To share the information of small to medium scale PV system status in selected GC and OG PV systems in a common platform as an information cloud sharing environment.

# Recap 1<sup>st</sup> APEC Workshop on Small and Medium PV System Database in the APEC Region at Chiang Mai, Thailand





## Recap 2<sup>nd</sup> APEC Workshop on Small and Medium PV System Database in the APEC Region at Tokyo, Japan



# Workshop 1 Summary

- Data Collection and Compilation
- Processing, Analysis and Updating Database Methods
- Database Structure, Reporting, Maintenance and Sustainability
- Working Group Collaboration:
  - Economies: Thailand, Malaysia, Indonesia, Philippines, Vietnam
  - Participant: Authority/Ministry; Utility; University
- Data & Updating → Database Design
  - 3 Tiers:
    - 1. General Information (no data logging)
    - 2. Detailed Data (kWh, Solar Irradiation, etc.): 1/month
    - 3. Detailed Performance: 1-10 min data logger
  - Each economy send example data for 2 on-grid & 2 off-grid sites
  - Update every month
  - Develop initial database at Chiang Mai Rajabhat University

# PV Database Portal – [www.apecpv.cmru.ac.th](http://www.apecpv.cmru.ac.th)

Welcome,  
Worajit

GENERAL

Home

PV Data Display

Data management

Edit Profile

Manual

Logout

APEC PV Database


Worajit

apecpv.cmru.ac.th


Search for... Go!

Home Page


Small and Medium PV System Database in the APEC Region




**General PV Information**  
General PV Information provides basic data of Asia-Pacific PV installation such as Installed PV Capacity and Nominal Inverter Capacity.



**Monthly PV Information**  
Monthly PV Information shows more specific data and monthly power consumption in each PV solar farm. Provided information could be downloaded and used for only study and research.




**Daily PV Information**  
Monthly PV Information shows more specific data and monthly power consumption in each PV solar farm. Provided information could be downloaded and used for only study and research.





**APEC PV Database**  
The APEC member consists of developed and developing member economies. Monitoring and recording all grid-connected and off-grid PV systems in all APEC member economies is a very challenging task. Most of the off-grid PV systems can be found in the developing member economies while grid-connected PV systems could be found in both the developing and developed member economies. It required networks of institutions (public, private, and academic) in each economy for local data collection and updating the database. The ultimate goal of this project is to initiate a strong institutional network to maintain this knowledge sharing database.


Read more »


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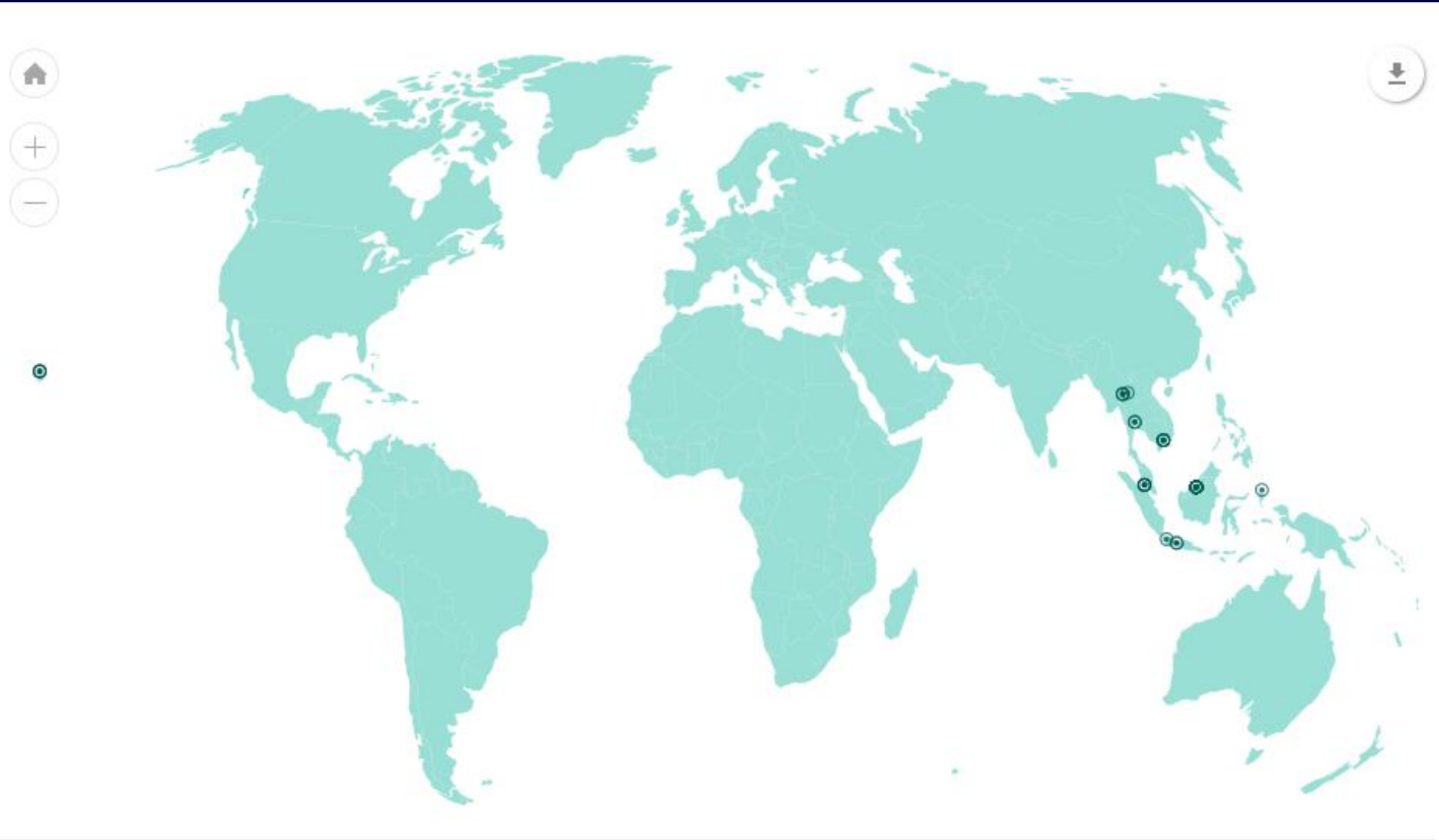
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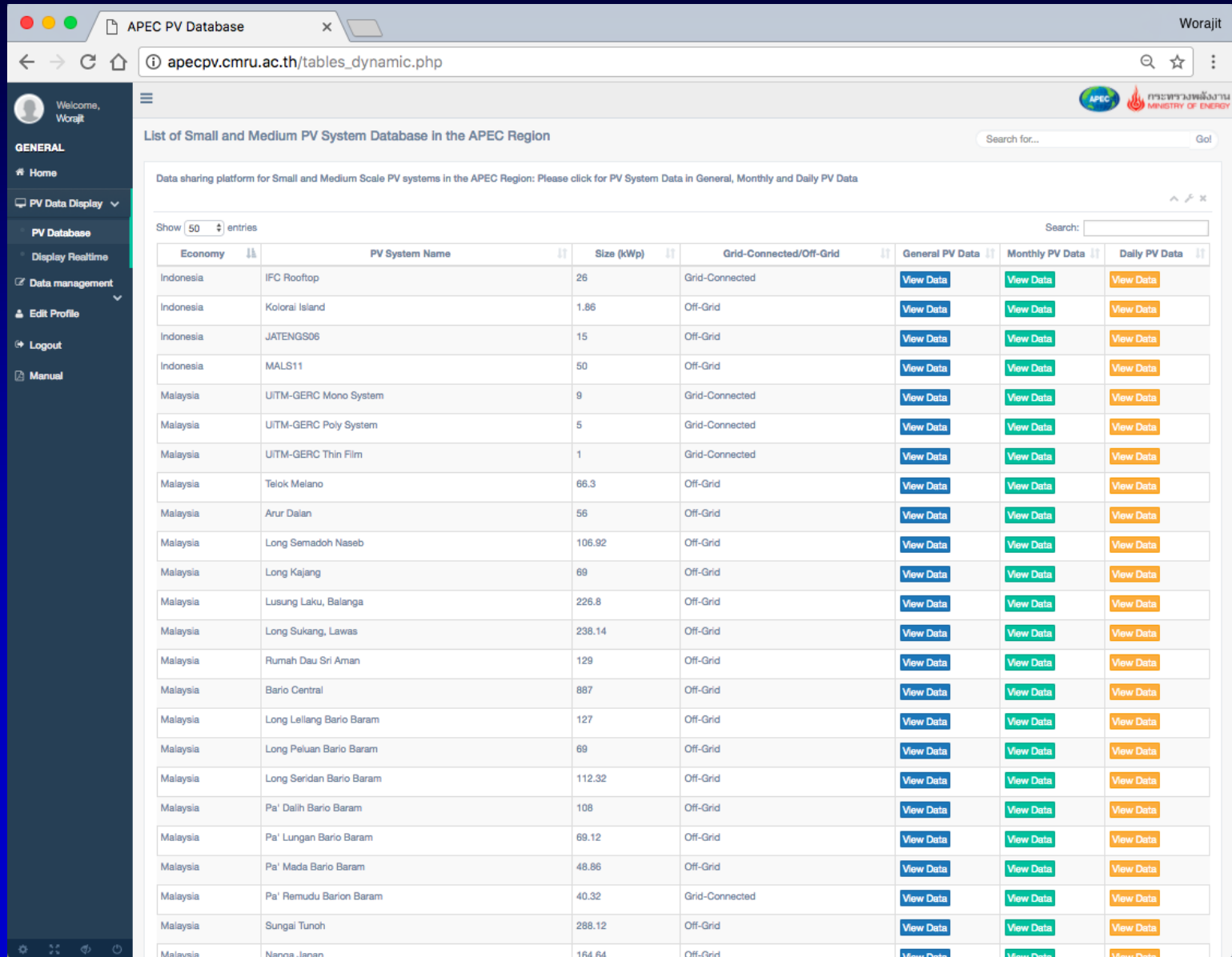
 **UNIVERSITY OF PHAYAO**

 **HNEI**  
Hua Nan Energy Institute  
Institute of Chemical and Environmental Engineering and Technology

# Map of PV Systems — can compliment IEA PVPS Tasks



# List of PV System Page ~ 50 sites from 5 Economies



The screenshot displays the APEC PV Database web application. The browser address bar shows the URL `apecpv.cmru.ac.th/tables_dynamic.php`. The page title is "List of Small and Medium PV System Database in the APEC Region". A sidebar on the left contains navigation links: "GENERAL", "Home", "PV Data Display", "PV Database", "Display Realtime", "Data management", "Edit Profile", "Logout", and "Manual". The main content area features a table with 7 columns: "Economy", "PV System Name", "Size (kWp)", "Grid-Connected/Off-Grid", "General PV Data", "Monthly PV Data", and "Daily PV Data". The table lists 50 PV systems, with the first 10 rows visible in the image. Each row includes a "View Data" link for each of the three data categories. The table is sorted by "Size (kWp)" in descending order.

Economy	PV System Name	Size (kWp)	Grid-Connected/Off-Grid	General PV Data	Monthly PV Data	Daily PV Data
Indonesia	IFC Rooftop	26	Grid-Connected	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Indonesia	Kolorai Island	1.86	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Indonesia	JATENG06	15	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Indonesia	MALS11	50	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	UITM-GERC Mono System	9	Grid-Connected	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	UITM-GERC Poly System	5	Grid-Connected	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	UITM-GERC Thin Film	1	Grid-Connected	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Telok Melano	66.3	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Arur Dalam	56	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Long Semadoh Naseb	106.92	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Long Kajang	69	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Lusung Laku, Balanga	226.8	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Long Sukang, Lawas	238.14	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Rumah Dau Sri Aman	129	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Bario Central	887	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Long Lellang Bario Baram	127	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Long Peluan Bario Baram	69	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Long Seridan Bario Baram	112.32	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Pa' Dalih Bario Baram	108	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Pa' Lungan Bario Baram	69.12	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Pa' Mada Bario Baram	48.86	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Pa' Remudu Barion Baram	40.32	Grid-Connected	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Sungai Tunoh	288.12	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>
Malaysia	Napoa Japen	164.64	Off-Grid	<a href="#">View Data</a>	<a href="#">View Data</a>	<a href="#">View Data</a>




# Data from Tier 1– General information of PV systems

The screenshot shows a web browser at the URL `apecpv.cmru.ac.th/basicdetails.php?id=25`. The interface has a dark sidebar on the left with a user profile (Welcome, Worajit) and a menu with options: GENERAL, Home, PV Data Display, Data management, Edit Profile, Manual, and Logout. The main content area is titled 'General PV System Data' and displays details for the 'UITM-GERC Mono System'. The data is organized into three sections: General, System, and Geographical.

Section	Field	Value
General	PV System Name	UITM-GERC Mono System
	Economy/Country	Malaysia
	City	SHAH ALAM
	Date Commissioned	2012-04-17
	Grid-Connected/Off-Grid	Grid-Connected
	Funding Source	Private
System	Module Type	Monocrystalline
	Installed PV Capacity	9 kWp
	Nominal Inverter Capacity	8 kWp
	Peak Sun Hour	4.7 h
	Battery Type	-
	Battery Capacity	-
	System Voltage (DC)	-
	Inverter Nominal Rating (AC)	-
Geographical	Auxiliary Generator Type	-
	Auxiliary Generator Capacity	-
	GPS	3.068734, 101.496945

# Data from Tier 2– Detailed system operation data (monthly)



Welcome,  
Worajit

GENERAL

Home

PV Data Display

Data management

Edit Profile

Logout

Manual

Monthly PV Data: PV System Operation Data

Search for... Go!

adiCET 702 kW

-The Monthly PV Data comprised of Electrical Data (Power, Voltage, Current) and Ambient Condition Data (Irradiance, Ambient Temp, Module Temp, Wind Velocity, Rainfall)

-The data are updated monthly.

Copy CSV Print

Search:

Upload Date	Total Power (kW.)	Average Voltage (V.)	Average Current (A.)	Average Irradiance ( W/m <sup>2</sup> )	Average Ambient Temp ( °C )	Average Module Temp ( °C )	Average Wind Velocity (mm)	Total Rainfall (m/s)
2017-02	333.64	658.59	511.9	604.54	34.1	47.12	0	0
2017-03	319.7	648.35	497.03	639.41	34.21	43.54	0	0
2017-04	189.15	662.86	294.52	693.15	32.94	44.67	0	0
2017-05	142.12	645.97	222.2	639.73	32.05	42.15	0	0

Showing 1 to 4 of 4 entries

Previous 1 Next

## Data from Tier 3–

## Detailed performance data: Download CSV file and Chart Display

Welcome,  
Worajit

GENERAL

Home

PV Data Display

Data management

Edit Profile

Logout

Manual

กระทรวงพลังงาน

MINISTRY OF ENERGY

Daily PV Data: Detailed PV System Performance

Search for...
Go!

UP Eng BDLG\_4

The Daily PV Data comprised of system performance data collected from the data logger such as: Electrical Data (Voltage, Current, Power) and Ambient Condition Data (Irradiance, Module Temp, Ambient Temp)

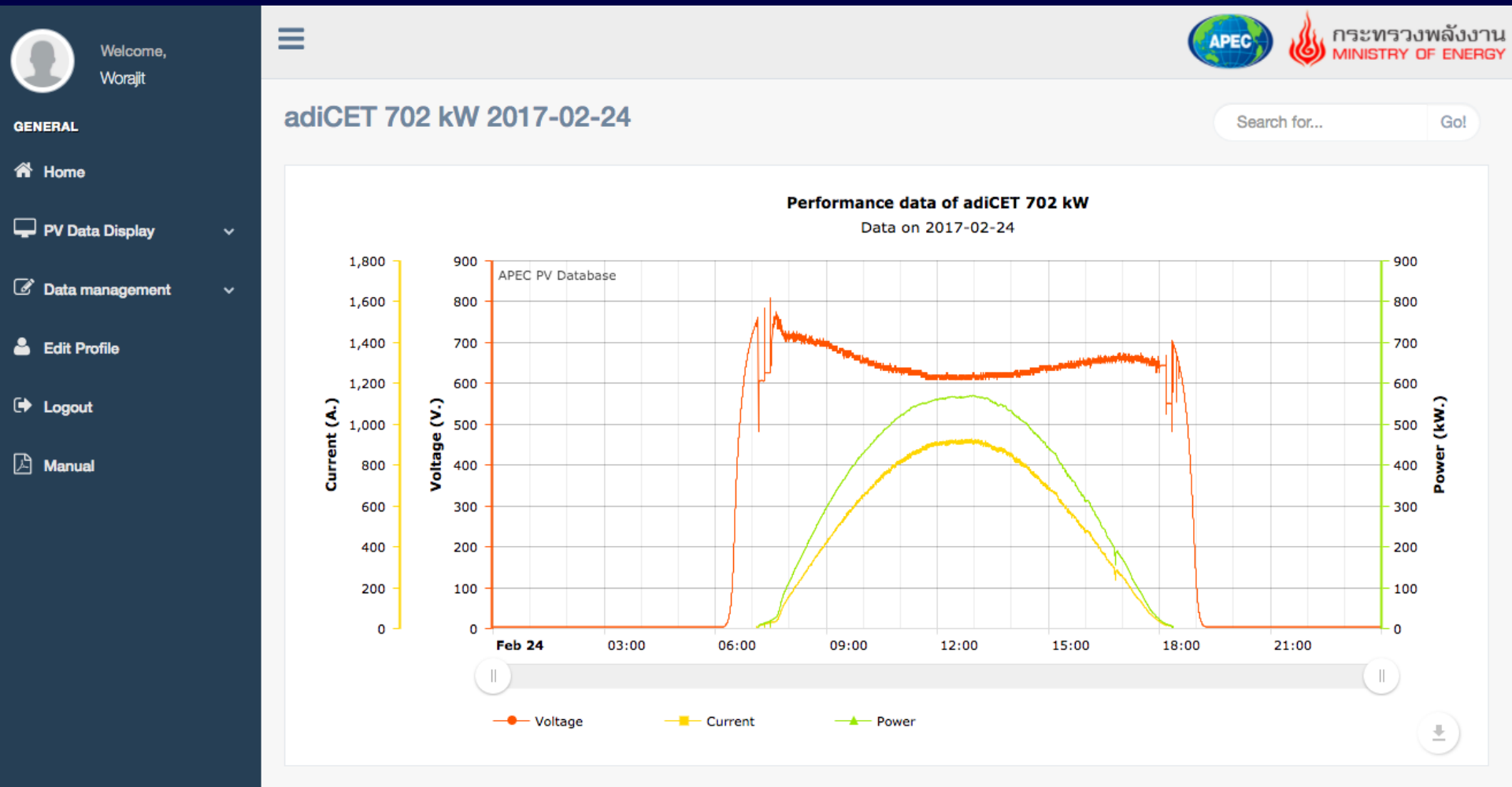
Show 10 entries
Search:

Date Upload	Performance (V, A, kW)	Irradiance (W/m <sup>2</sup> )	Ambient Temp (°C)	Module Temp (°C)
2016-06-01	Download / View Chart	Download / View Chart	Download / View Chart	No Data
2016-06-02	Download / View Chart	Download / View Chart	Download / View Chart	No Data
2016-06-03	Download / View Chart	Download / View Chart	Download / View Chart	No Data
2016-06-04	Download / View Chart	Download / View Chart	Download / View Chart	No Data
2016-06-05	Download / View Chart	Download / View Chart	Download / View Chart	No Data
2016-06-06	Download / View Chart	Download / View Chart	Download / View Chart	No Data
2016-06-07	Download / View Chart	Download / View Chart	Download / View Chart	No Data

Showing 1 to 7 of 7 entries

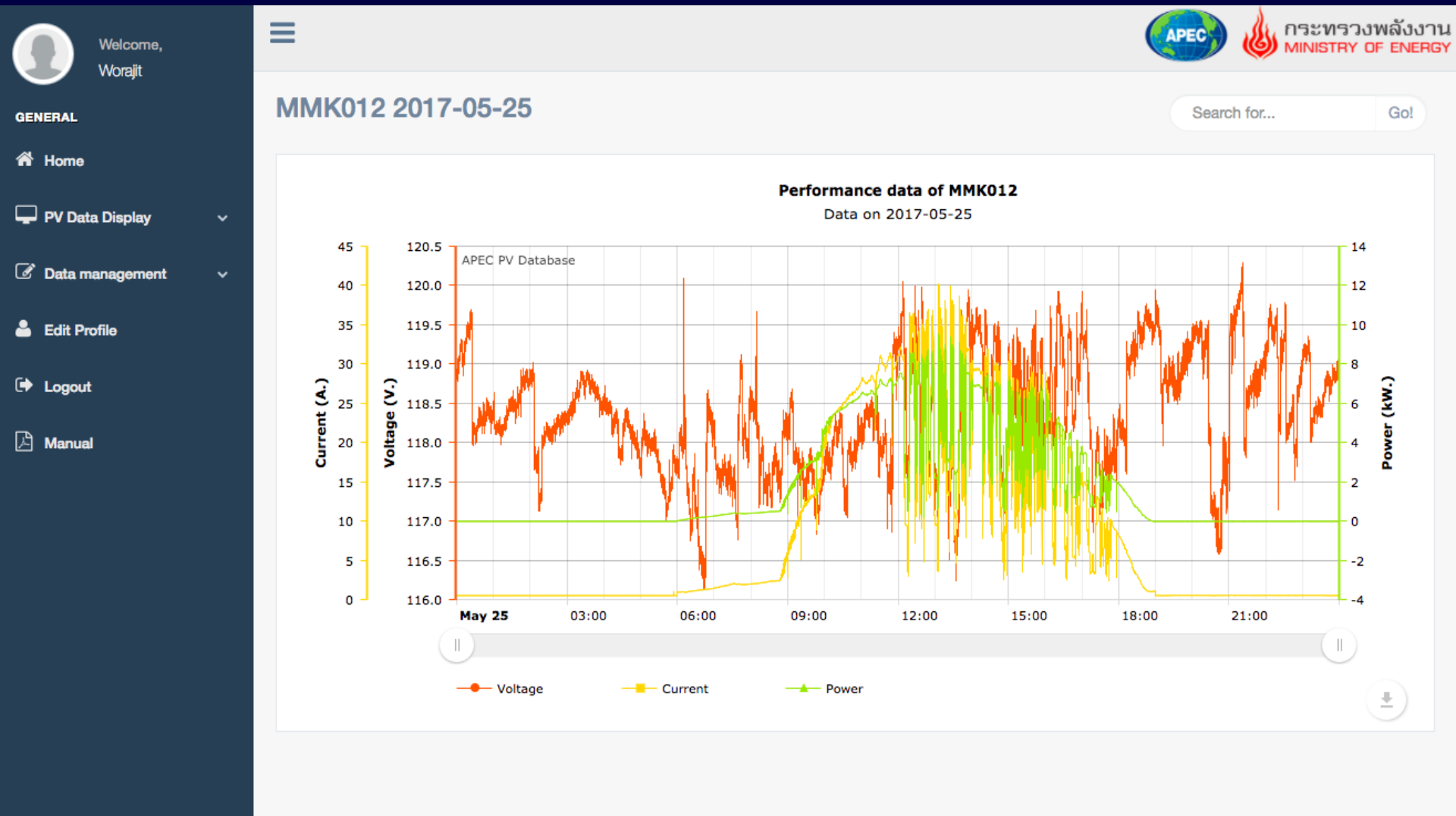
Previous
1
Next

# Data from Tier 3 – Chart Display

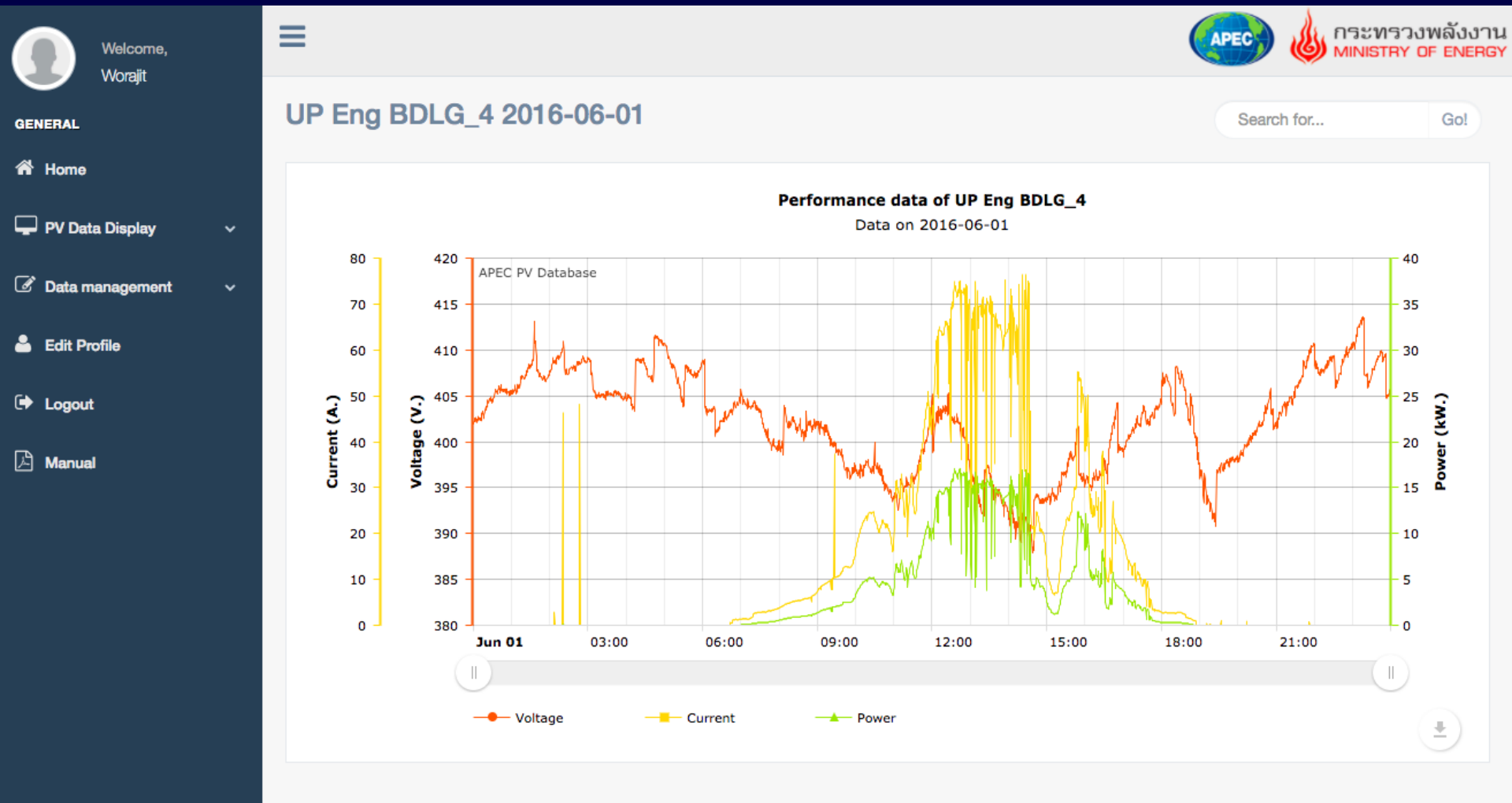




# Data from Tier 3 – Chart Display



# Data from Tier 3 – Chart Display



# Real-time Data – Linked to PV monitoring system

The screenshot shows a web browser at the URL `apecpv.cmru.ac.th/realtime.php`. The interface is divided into a dark sidebar on the left and a main content area on the right.

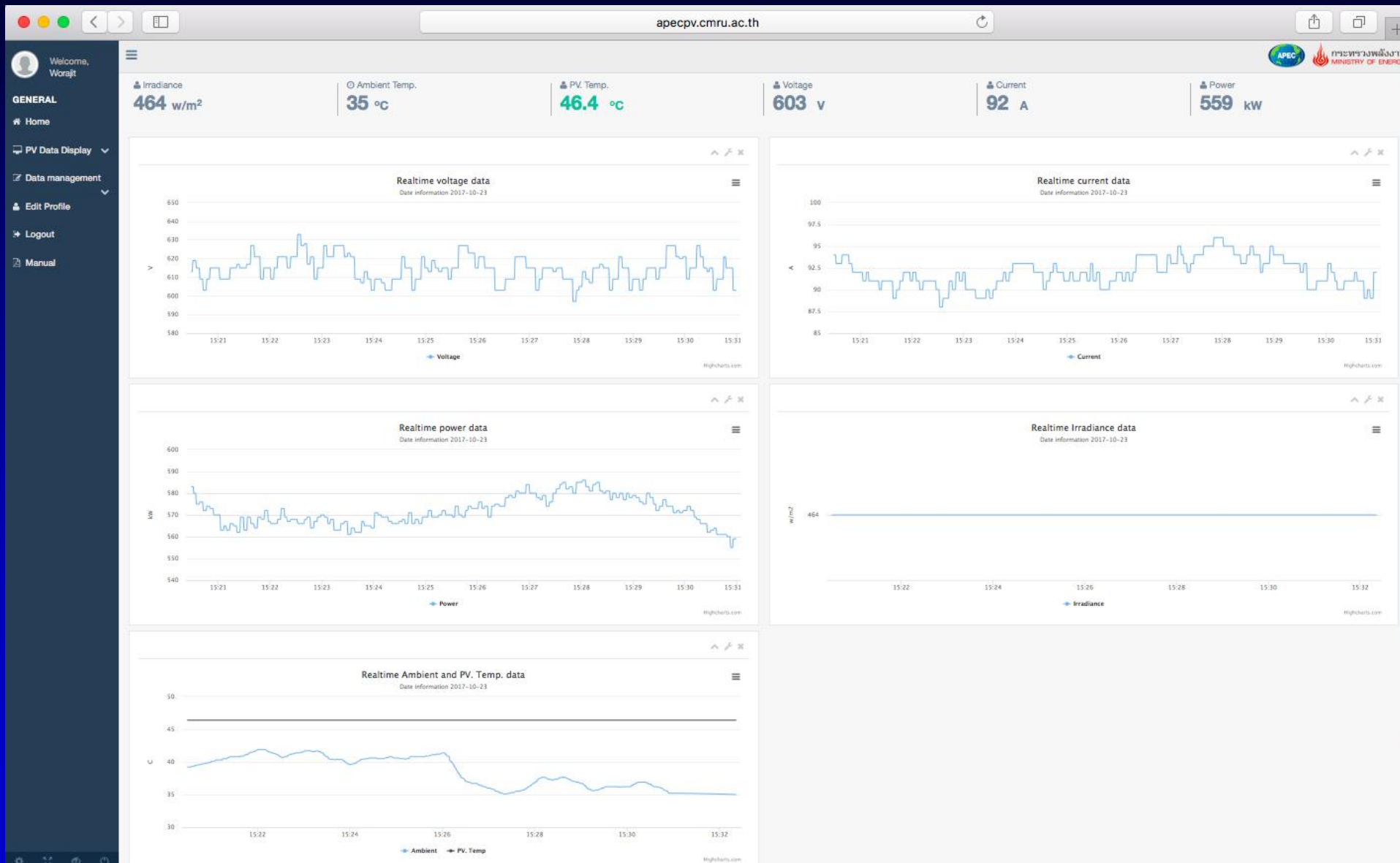
**Sidebar (Left):**

- Top: User profile icon and text "Welcome, Worajit".
- Section: **GENERAL**
- Item: Home (house icon)
- Item: PV Data Display (monitor icon, dropdown arrow)
- Item: PV Database (dot icon)
- Item: Display Realtime (dot icon, highlighted with a green bar)
- Item: Data management (pencil icon, dropdown arrow)
- Item: Edit Profile (person icon)
- Item: Manual (document icon)
- Item: Logout (arrow icon)

**Main Content Area (Right):**

- Section: **Realtime Monitoring**
- Card for "adiCET 702 kW":
  - Text: **Economy/Country:** Thailand
  - Text: City: Chiang Mai
  - Text: Grid-Connected
  - Buttons: "Realtime monitor" (eye icon), "More information" (person icon)
  - Image: Circular aerial view of a solar panel installation.
- Footer of card: Two links with bar chart icons: "Monthly PV Data" and "Daily PV Data".

# Real-time Data – 702 kW, Chiang Mai, Thailand





# Workshop 2 Summary

- Database initiated: <http://apecpv.cmru.ac.th>
- Working Group Collaboration:
  - Economies: Thailand, Malaysia, Indonesia, USA, Vietnam ~ 50 sites
  - Participants: University; Research Institute; Utility
- Keynote Speaker & Invited Talk
  - Existing Databases – Performance, PV Fault Report Portal, Solar PV Map
    - Current – limited data set, need for Asia hot/humid climate → Connect with IEA
    - Easy for data sharing/ simple form
    - Must PR to keep the database alive
  - Data Collection and Analysis
    - Alignment: Standard, collection method
    - IEC 62446 Grid Connected photovoltaic systems – Minimum requirement for system documentation, commissioning tests and inspection
    - IEC 61724 Photovoltaic system performance monitoring – guidelines for measurement, data exchange and analysis
  - Data Analytics and Data Utilization
    - Data monitoring device – wireless, low cost, stable (long range)
    - Big Data Analytics – Machine Learning – useful analytic tools for data analysis

# Workshop 2 – Database Experience Sharing

- Data Updating → Progress & Barriers
  - Need good data; should have some quality control protocol to determine good quality data
  - Standardize units, range of data
  - Time format: date, time zone
  - Easier data input, data sorting, monthly input split to daily
  - Size of file limitation
- Data → Useful for Stakeholders
  - Focused on Performance data (more detail)
    - Performance ratio, Energy Storage, Power Factor, kWh
  - Location Site Mapping/ Geographical View
  - PV structure
  - CO<sub>2</sub> Emission Computations
  - Energy consumption data
  - Algorithm for Forecasting
- Way forward
  - Use IEC 61724 and build upon IEA PVPS Task Force
  - Datasharing agreement

# Group 1:

## Network – Collaboration, Activities

- Increase awareness/ benefit of the Database
- Define specific purpose of stakeholder: Policy maker/ government/ academia/ research
- Challenges
  - Proprietary technology; Business strategy
- How to approach
  - Policy; Awareness; Corporate Social Responsibility
- Collaboration Activities
  - Remote Island Grid
    - Technical Issues; Joint Research; APEC Activities
  - Socio-Economic Issues
    - PV system relations with improve socio-economic activities
    - Common factors/category on socio-economics
  - Gender
    - Gender related activities; women promotion of renewable energy
  - Harmonizing Documents
    - Standard of documents for economies

# Group 2

## Resources – Facility, Equipment, Capacity Building, Funding

- Facilities & Equipment
  - Data sharing should start with Universities with their own monitoring system
  - Provide central database
- Capacity Building
  - Indonesia: University can invite expert for training
  - Thailand/Australia/Philippines: Government training
  - Chinese Taipei: Government pay 50% for training for PV home user
  - Korea: Call center to provide support
- Way Forward
  - Categorize 3 types of data:
    - General
    - National Monitoring System (Monthly/Yearly)
    - Detailed Monitoring System (1-15 min)
  - Grouping/Analyze data based on similar sites
  - Connect with other Related Association
    - Indonesia Green Building Association
    - Malaysia National Monitoring System



# What's Next – Way forward?

- Using Existing Network – for data collection
- Build upon the network with EGNRET Network, IEA database, APERC, CSR, Industry Associations, Government Monitoring
- Proposal – Continue the project
  - Phase 1: Data Collection 5 Economies
  - Phase 2: Capacity Building – Discuss with APEC Sec with HNEI Support
  - Phase 3: Continue Data Collection for other Economies; Grouping; Analysis for 3 group of stakeholders → Data Utilization
- Proposal – New Projects to APEC
  - Remote Island Grid
  - Socio-Economic Issues
  - Gender
  - Harmonizing Documents

# Acknowledgments

- Ministry of Energy, Thailand
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- Chiang Mai Rajabhat University
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- University of Phayao
- Ho Chi Minh City University of Technology
- University of Indonesia
- National Chin-Yi University of Technology
- NECTEC, NSTDA
- NHEI, University of Hawaii
- Office of Naval Research, USA
- National Research Council of Thailand



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