TRANSNATIONAL ACCESS
USER PROJECT FACT SHEET

USER PROJECT	
Acronym	**ICVP**
Title	**International Consistency of Validation Platform of PV-Battery System Efficiency Testing**
ERIGrid Reference	
TA Call No.	**6**

HOST RESEARCH INFRASTRUCTURE			
Name	**SmartEST (AIT)**		
Country	**Austria**		
Start date	**2020/2/2**	**Nº of Access days**	**10**
End date	**2020/2/15**	**Nº of Stay days**	**14**

USER GROUP	
Name (Leader)	**Dai Orihara**
Organization (Leader)	**AIST**
Country (Leader)	**Japan**

1. USER PROJECT SUMMARY (objectives, set-up, methodology, approach, motivation)

Motivation and objectives

The efficiency measurement of PV-battery systems is becoming important as PV owners installs battery systems to use PV generation for self-consumption. This project evaluates the influence of different testing environments on efficiency measurement results through round-robin testing and uncertainty computation. In the Transnational Access program, the efficiency test was carried out at AIT, and the result was compared with the test results of AIST, where the same battery system was tested. And uncertainty of efficiency measurement is computed for testing environment in AIST.

Set-up

Figure 1 shows the test setup at AIT. The inverter and battery are the Equipment under the Test (EuT) and brought from AIST in Japan. The PV simulator and battery are connected to the DC inputs of the inverter. The grid simulator is connected to AC side. An electrical load is also connected between grid simulator and the inverter.

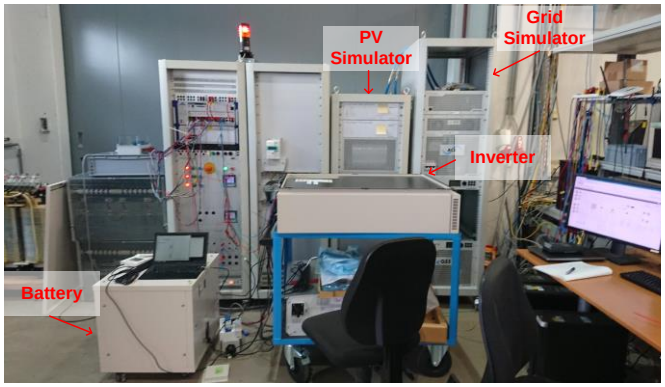

Figure 1: Test Setup at the AIT test bed

Methodology

Energy conversion efficiency and control deviation of the PV-battery hybrid system are measured accordingly to the efficiency guideline version 2.0, issued by BVES and BSW Solar.

In order to clarify what kind of parameter affect the efficiency, additional testing was also carried out. At first, energy conversion efficiency of the inverter was measured additionally at low AC voltage. Next, energy conversion efficiency was measured while battery and PVS output are changed stepwise little by little. As result efficiency is determined for mixed energy conversion paths as simultaneous charging from PV and PV grid feed-in.

Also, uncertainty of the efficiency measurement was computed for the preliminary testing environment in AIST and the main element causing uncertainty is investigated.

2. MAIN ACHIEVEMENTS (results, conclusions, lessons learned)

Results

The energy conversion efficiency was measured at three basic power flow conditions (PV2AC, PV2BAT and BAT2AC) according to the efficiency guideline and additionally for mixed power flow conditions as shown in figure 2. Conversion efficiency was over 90% when large power was inputted to the inverter, the efficiency decreased as converting power decreased to small values. The testing at low AC voltage results efficiency decrease compared with the testing at nominal AC voltage especially when power input is low. The reason can be expected as increase of current.

The test results from testing at AIT and at AIST showed also some differences. It is expected to come from individual difference, set-up difference, testing condition difference, testing procedure difference and measurement uncertainty. One of the apparent causes is the low accuracy of the PVS output at low output levels in AIST environment. The power noise and difference of the output from setting value increase as setting output decreases, and it decreases reproducibility. We need to try to improve the accuracy until the next test going to be carried out in AIST and the influence of the accuracy of PVS output should be investigated through uncertainty analysis.

The uncertainty in AIST testing environment was computed as shown in Figure 3 according to accuracy information in the spec sheet of measurement devices. It is found that uncertainty of the efficiency is quite large under small amount of power flow conditions because the sensitivity of the efficiency to the power change is quite high in such a condition. As next steps for future work, the uncertainty in AIT is computed to analyze how the measuring uncertainty depends on measuring environment.

Conclusion

The efficiency test is performed with a PV-battery hybrid system for round-robin testing with AIST. Through the comparison of the testing results with AIST, the necessities of description about accuracy of power source such as PVS and variation of AC voltage are recognized. And uncertainty computation shows that the accuracy of measured efficiency can be decreased depending on power flow condition. The BSW / BVES efficiency guideline does not include uncertainty calculations or requirements but the results show that uncertainty analysis is important for reproducible test results.

The uncertainty computation for AIT testing environment and the efficiency testing in AIST are the next steps.

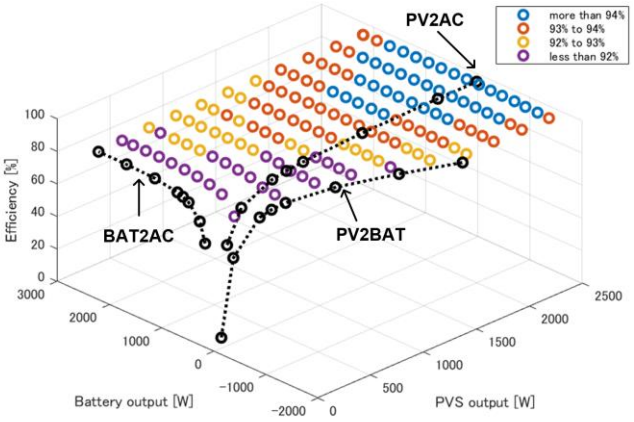

Figure 2 Energy conversion efficiency

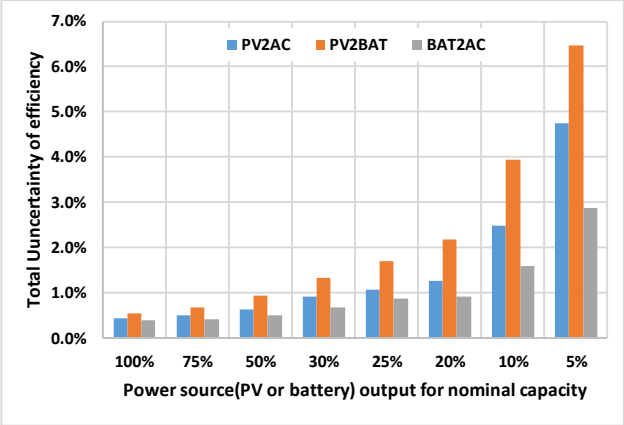

Figure 3 Uncertainty in AIST testing environment

3. PLANNED DISSEMINATION OF RESULTS (journals, conferences, others)

- A joint paper will be presented at a related international conference.
- Key findings and remaining issues will be shared with The German Energy Storage Association and DKE/AK 371.0.9 through AIT connection.
- This activities and results will disseminated to IEC standard members and Japanese domestic committee e.g. IEC TC82 Solar photovoltaic energy systems, TC120 Electrical Energy Storage (EES) Systems.