Fellow Experience for JSPS London website

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From Jan 2017 to July 2017 I had the pleasure of spending 6 months conducting research at Research Center for Photovoltaics Technologies lead by Yoshihiro Hishikawa within the National Institute of Advanced Industrial Science and Technology (AIST) in Tsukuba, Ibaraki prefecture. For many locations worldwide, the required weather conditions for power rating, i.e. 1000W/m^2 irradiance and module temperature of 25 °C, rarely occur naturally. This is the case for both the United Kingdom and Japan. It is therefore required to translate current-voltage measurements (IV-curves) from the environmental conditions (module temperature and effective irradiance) during measurements to conditions defined in international standards, e.g. IEC 61853-1. This translation step has an associated uncertainty. My research was aimed at understanding the three translation procedures specified in IEC 60891, investigating the limitations of each and quantifying the translation error, ultimately establishing best practices for translation and uncertainty estimation.

Previous research efforts have compared the performance of translation procedures using indoor and/or outdoor measurements. However, the presence of measurement errors inhibits any meaningful conclusions to be made, at least for the purpose of accurate calibration and uncertainty estimation. To mitigate measurement errors, the performance of PV devices at varying irradiance and temperature conditions has to be modelled. In this case, however, model error or bias can lead to misleading results.

To address this challenge, first the mathematical properties of the translation procedures and their underlying assumptions were assessed. Secondly, three independent modelling approaches were used. This allows to conclusively decide if a single model is biasing the results. Model A was based on a one-diode model of a PV device and auxiliary equations, which are widely used in literature. The one-diode model is derived from the physics of ideal PV device. Model B was based on empirical equations that are reported to generally agree with measurement data for most PV technology types. Model C was newly developed method in the context of PV modelling, extracting the device performance from measurements with errors using data regularization. Finally, the IV curve translation with each procedure was compared to each modelled performance and the combined results used to establish the translation uncertainty. As a result, this work enables the use of indirect measurements at varying environmental conditions for PV module calibration at standard test conditions.

Tips from a research perspective:

- Drive your own research and openly discuss your ideas with your host
- Talk to as many people as possible about their research
- Share best practices and learn as much as you can
- Prepare yourself for hard work

Tips from a personal perspective:

- Learn as much basic Japanese as you can so that you do not feel ignorant. Use it when you can
- Learn about Japanese culture beforehand and ask about it when you are there
- Plan weekend trips and don't worry about getting lost, google map information on public transport is accurate in Japan
- Try as many as possible weird and wonderful dishes
- Embrace how polite everyone is and enjoy it

Figure 1 Enjoying an Izakaya after work (Japanese pub)