Flexible Exports for Solar PV

Lessons Learnt Report 3

SA Power Networks

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Glossary

Term	Definition
ARENA	Australian Renewable Energy Agency
AEMO	Australian Energy Market Operator
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
API	Application Programming Interface
CSIP	Common Smart Inverter Profile
CSIP-AUS	Common Smart Inverter Profile - Australia
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
IEEE2030.5	IEEE Standard for Smart Energy Profile Application Protocol
NEM	National Electricity Market
OEM	Original Equipment Manufacturer
PV	Photovoltaic
SIRG	Solar Industries Reference Group

Acknowledgement

The "Flexible Exports for Solar PV" project ('the Project') is a collaboration between SA Power Networks, AusNet Services, Fronius, SMA, Solar Edge and SwitchDin. The Australian Government, through the Australian Renewable Energy Agency (ARENA), is providing $2.09m towards to this $4.84m project under its Advancing Renewables Program.

Disclaimer

This project received funding from ARENA as part of ARENA's Advancing Renewables Program.

1 Introduction

On 1st July 2020 ARENA and SA Power Networks entered into an Advancing Renewables Program Funding Agreement number 2020/ARP009, under which SA Power Networks, and all collaboration partners, have obligations to consider and issue quarterly lessons learnt reports. Aurecon, the knowledge sharing partner, prepares these reports on behalf of SA Power Networks and project partners. Lessons will be captured throughout the lifecycle of the project and are expected to cover a range of topics. These may include commercial, technology, policy, community engagement learnings and more. The intended audiences for these lessons learnt reports are:

- ARENA, AEMO, AEMC, AER - to understand the performance of distributed energy resources (DER) projects and impact on the market.
- Victorian and South Australian Governments and policy makers - to understand policy and regulatory barriers and opportunities associated with DER.
- Energy industry - to understand market opportunities associated with DER impacts and business models.

This third lessons learnt report will cover the activities during project development such as use of test sites in validating usability of installation guides, processes & applications, creation of installer and customer journey maps to support communication and engagement with both installers and customers and some early learnings for OEMs on the use of an aggregator integration model in an IEEE2030.5 integration architecture. It is intended for those undertaking a similar project. By sharing this information, the Flexible Exports for Solar PV project aims to advance the industry's understanding of how DER, such as rooftop solar, can be managed in constrained network areas.

2 Project Overview

2.1 Project Summary

The Flexible Exports for Solar PV project ('the Project') is a demonstration project seeking to help integrate increased quantities of rooftop solar into Australia's electricity network. Most current rooftop solar systems across Australia lack the ability to intelligently control the amount of electricity exports to the network. At certain times in the year, too much electricity is generated in the middle of the day and exported back to the network and is unable to be absorbed by loads in the local area. As a result, the local distribution networks in areas with high rooftop solar uptake can become congested. To avoid exceeding the technical limits of the network, some energy networks impose zero or near-zero energy export limits on new solar systems in congested areas.

As more Australian households install rooftop solar and network constraints increase, more new solar customers will face limits that prevent them from exporting electricity back to the network. This can create an inequitable system where early adopters of rooftop solar 'use up' the available grid capacity, and late adopters are constrained. As these constraints often only occur in limited periods throughout the year, it also unnecessarily limits the amount of renewable energy that can be integrated into the energy system.

The aim of this project is to provide a new option for customers connecting solar PV in areas of the network that are already at capacity, who are currently required by Distribution Network Service Providers (DNSP) to limit their systems with a permanent zero or near-zero export limit. This new flexible option will enable customers to export energy most of the time, and only reduce exports during specific periods when the network is constrained, thus maximising export capacity for solar customers and making more cheap, renewable energy available for all electricity customers to take advantage of. SA Power Networks, in collaboration with AusNet Services, three market-leading inverter vendors (Fronius, SMA and SolarEdge) and one inverter gateway provider (SwitchDin) are co-developing an end-to-end technical solution, using smart inverter technology. The system will enable customers' inverters to automatically adjust their export limits every five minutes based on a localised, dynamic limit signal provided by the DNSP. The project has also developed a new flexible customer connection offer and will test customer understanding and acceptance of this offer during a 12-month field trial.

2.2 Project Methodology

The project aims to accelerate the development of an Australian standards-based approach to flexible feed-in management for solar PV across the NEM (National Electricity Market). To achieve this, the project scope was designed to advance both the technical and commercial maturity of the next generation of smart inverters and develop the customer offer and customer experience of participating in a flexible exports scheme.

The high-level approach is as follows.

1. Planning and standards development

- Since there are no Australian standards established at the time of project commencement, the first phase of the Project comprises planning activities and the co-development by the partners, in consultation with industry more broadly, of the technical standard to be used to communicate flexible export limits between the DNSP and smart inverters.

2. Technical development

- Once the communication standard has been substantially agreed, the partners will implement the standard through the development of a flexible exports capability. This capacity is to be built into Australian products from Fronius and SMA, market-leading inverter manufacturers, and would enable current and prospective customers in constrained network areas to export their energy.
- The Project will also develop a 'retro-fit' option using the SwitchDin gateway device which will enable a range of existing inverters without native integrations to be converted from static to flexible export limits.

3. Customer offer development

- In parallel with the technical development, SA Power Networks and AusNet Services will develop in consultation with other DNSP's customer representatives and other industry stakeholders, a new flexible connection offer for solar customers. The offer will set out the key parameters of a customer's network connection agreement and can inform other DNSPs and industry on how to structure a Customer Offer to support the flexible exports service.

4. Field trial

- As this represents a new connection option for solar customers, the Project will seek to understand the end-to-end customer journey, from the point at which a customer is first presented with a flexible connection option in the up-front conversation with their solar installer, through the customer's choice of suitable inverter options, to the customer's experience over a full year of operation.
- Through the 12-month field trial, the project will test the viability of this kind of connection arrangement and refine the associated technologies and customer service to the point of maturity at which this can be offered as a standard service across the NEM.

3 Key Lessons

This is the third lessons learnt report for the Flexible Exports for Solar PV project. The learnings in this report cover the activities during project development, such as implications of an aggregation integration model for OEMs, and findings from the initial field tests and solar industry engagements on how the end-to-end process can be improved.

The three (3) key lessons discussed are as follows:

- **Lesson #1: Field testing at real customer sites is critical for validating installation and commissioning processes are adequate for the broader installer community**
  - SA Power Networks and AusNet Services conducted installations with solar installers at a total of 9 customer test sites in preparation for the trial.
  - The solar installer guidance material was designed to cover core and common cases that installers will encounter. However, the test sites uncovered a range of site-specific configurations that were not accounted for, potentially leading to confusion and ultimately the unsuccessful commissioning of these systems.
  - Support and guidance material should be updated on an ongoing basis to incorporate learnings from real-world experiences and ensure support processes are available.

- **Lesson #2: The solar industry has significant key touchpoints with customers and is a key conduit to providing customers with information on solar benefits, payback and government rules and regulations**
  - As part of engaging with customers and defining the installation process, SA Power Networks mapped out the end-to-end customer and installer journey to understand key touchpoints and build a strong communication plan.
  - The journey map demonstrated that the solar industry has many key touchpoints with customers and provides them with information on solar benefits, payback and government rules and regulations.
  - The industry needs to be provided with clear communication and messaging such that retailers and installers are able to relay content to the end customer without misinterpreting key messaging.

- **Lesson #3: Using an aggregation integration model has implications for how OEMs structure their systems/ platforms to support many DNSPs/ jurisdictions**
  - Several different IEEE 2030.5 compliant integration architectures could enable communication between the server and customer equipment.
  - The aggregator model is likely to be a popular choice as an OEM can leverage their existing communications infrastructure and protocols to their end devices, and only need to build and offer one standardised IEEE 2030.5 interface per DNSP/utility rather than implementing IEEE 2030.5 directly in every device.
  - Due to a need to segregate customers participating in each region to allow the appropriate DNSP to monitor and control their devices, OEMs need to deploy and maintain separate instances for different network regions. Architectural considerations from a project OEM have found that this may result in ten or more aggregator instances if all jurisdictions in Australia implement similar schemes.
  - Ongoing work will be required to maintain and tailor these instances where minor changes are needed between different jurisdictions.

The following sections provide additional detail around each lesson.

3.1 Lesson #1: Field testing at real customer sites is critical for validating installation and commissioning processes are adequate for the broader installer community

Knowledge Category:	Communication and Standards
Knowledge Type:	Equipment Installation and commissioning
Technology Type:	Metering configuration
State / Territory	National

Key Learning

SA Power Networks conducted installations with solar installers at a total of 7 test sites and AusNet Services with 2 test sites in preparation for the public trial. The purpose of this exercise was to test the system performance when involving real customer sites and to test the effectiveness of the support material for installers given the idiosyncrasies of customer sites. The testing at customer sites commenced in late June and completed in early September 2021

The solar installer guidance material was designed to cover core and common cases that installers will encounter. However, the test sites uncovered a range of wiring configurations which were not fully accounted for, which had the potential to lead to confusion and ultimately the unsuccessful commissioning of these systems. The testing found that the support and guidance material will need to be updated on an ongoing basis to incorporate learnings from real-world experiences and ensuring support processes are appropriate.

One of the key learnings from the SA Power Networks test sites was the need to accommodate the requirements introduced by the SA Smarter Homes **Smart Meter Minimum Technical Standard**[1]. Under this technical standard, new solar systems are required to separate the solar generation onto a separate element of the meter. At export limited sites this configuration adds further complexity in measuring the whole-of-site import/export with the separate inverter energy meter. This issue is further exacerbated by metering co-ordinators attending site after the original installation to replace the revenue meter and alter the wiring arrangement. This can invalidate the inverter energy meter installation, which would lead to over or under curtailment of the solar output.

Support for these new configurations required software modifications for the droplet and updates to the installation guides, which were subsequently tested in a further round of field site tests.

The retrofit test sites in both jurisdictions uncovered a number of minor issues involving software glitches and some potential process issues. These issues centred around configuring existing inverters that had been installed by different installers where password or access codes were not known. Potential areas of improvement were identified to help simplify the installation process in certain scenarios, adding efficiencies and avoiding the need for support calls to OEMs e.g. (i) introduction of a reset option on installation software and (ii) providing the ability to check the software version onsite without requiring a support call.

Process Undertaken by the Project

In previous DER related trial projects, SA Power Networks has deployed the DER systems and therefore engaged subcontractors for the installations, enabling specific training and support to a limited group. However, in this Project, SA Power Networks decided to open trial participation up to the broader solar industry to replicate the rollout that is planned to follow the trial more closely. To ensure the rollout runs smoothly, SA Power Networks has collaborated with the solar industry when developing and targeting the information. Feedback resulted in changes to their connections process, and information is sent to installers at various touchpoints to ensure it is always at hand.

[1] Smart Meter Minimum Technical Standard, https://www.energymining.sa.gov.au/__data/assets/pdf_file/0007/371599/200914-Technical_Regulator_Guideline-Smart_Meter_Minimum_Technical_Standard-v1.1_Aug2021.pdf

To further test the process ahead of the trial, SA Power Networks has engaged installers from its Solar Industry Reference Group (SIRG) to test the end-to-end installation and commissioning process and related collateral. There had been seven installations at the time of reporting, involving four retailers/installers and two technology types. The installations have been performed in two stages, the first involving initial versions of installation guides and software, and the second with updated and improved versions of the guides and software. Both stages involved examples of both technology types planned for go-live. Debriefs were held following each installation and actions taken to address shortcomings in the processes and / or applications.

AusNet Services engaged two installers from their panel for the trial through a selection process. These installers attended several virtual seminars and face-to-face training workshops to equip them with the necessary capabilities to upgrade existing solar systems to allow for flexible exports. These installers were also given sample SwitchDin Droplets to test.

AusNet Services has completed two test sites at the time of reporting and has one other planned. When an installer comes across a variation during the installation, it is raised, and a solution is proposed and implemented. These variations are captured to improve the installer guides and the end-to-end portal process. AusNet Services facilitated a debrief with the installers and OEMs to identify improvements.

Considerations for future projects

Solar installers will require intuitive, high quality support material, processes, and applications to install and commission the systems successfully. Given the diversity in customer wiring and networking configurations, and the broad industry of solar installers with different backgrounds and priorities, this material must strike the right balance of simplicity vs completeness. The project team considers it essential that the systems and support materials are tested on a sample of diverse customer sites and with different installers to ensure they are robust prior to releasing to the broader installer community. However, this may only be practical in a trial setting, so equipment manufacturers and DNSPs should work together to ensure a minimum standard of collateral and support is achieved to the benefit of both parties.

Key considerations highlighted by the field tests have been:

- Clear instructions and guides are critical for the first installation until the installer learns the process. The installation guides prepared for the trial were made available on **SwitchDin's website**[2]. Refer to Appendix A for an example of one of the quick reference guides.
- Customers have varied internet setups, and gaining connectivity to the inverter/ gateway device (Droplet) varies on a site to site basis (some were more difficult that others).
- Having access to an OEM support line during business hours (particularly at the end of the day when trying to finalise a job) is critical to ensuring success, given some of the complexities involved.
- The process is relatively straightforward overall, with complexity arising from customer site-specific issues.

As more customer sites are progressively installed & commissioned along with the introduction of new technologies, learnings can be adopted in the provided guides and other collateral to reduce the issues experienced onsite. This assists in keeping installation costs to a minimum and reducing the likelihood of return site visits.

[2] SwitchDin's website, https://www.switchdin.com/support

3.2 Lesson #2: The solar industry has significant key touchpoints with customers and is a key conduit to providing customers with information on solar benefits, payback and government rules and regulations.

Knowledge Category:	**Stakeholder Engagement**
Knowledge Type:	Customer engagement
Technology Type:	Not applicable
State / Territory	National

Key Learning

A key goal of the project is to ensure a strong installer and customer end-to-end experience in establishing a flexible exports connection option. In designing the service, the project team mapped out the customer journey to understand key touchpoints and build a strong stakeholder communication plan. This assisted in planning the engagement with customers, installers and improving installation processes.

This work was tested and validated with the Solar Industry Reference Group (SIRG) which comprises a diverse set of stakeholders from the solar industry. A key early learning from the SIRG is that the solar industry has strong ownership over the existing DER lifecycle and is therefore best placed to provide information to customers on network connection options. This highlights that the DNSPs should work closely with solar retailers and installers to develop customer communication and messaging that can either be relayed directly to customers by solar retailers and installers or used as supplemental to their existing sales processes.

Process Undertaken by the Project

Through the course of this Project, SA Power Networks established the SIRG as a mechanism to engage with the solar industry. Given the range of installers engaged and the diversity within the industry, this forum provided an efficient means of communicating with a cross section of industry representatives from solar retailers and installers.

Engaging stakeholders through the SIRG identified and unpacked several issues that had not been anticipated at the beginning of this project, which provided insights into the development of the trial. This approach enabled the project to remain agile and responsive to the needs and issues of the solar retailers and installers as the project progressed and in preparation for the trials.

As part of engaging with the SIRG, SA Power Network mapped out the end-to-end customer and installer journey and identified that the solar industry has many key touchpoints with customers and are instrumental in providing them with information and messaging from the DNSPs. This includes key information on solar benefits, payback and the government rules and regulations, highlighting a need to ensure that information was provided to the installers in a clear and easy to understand format.

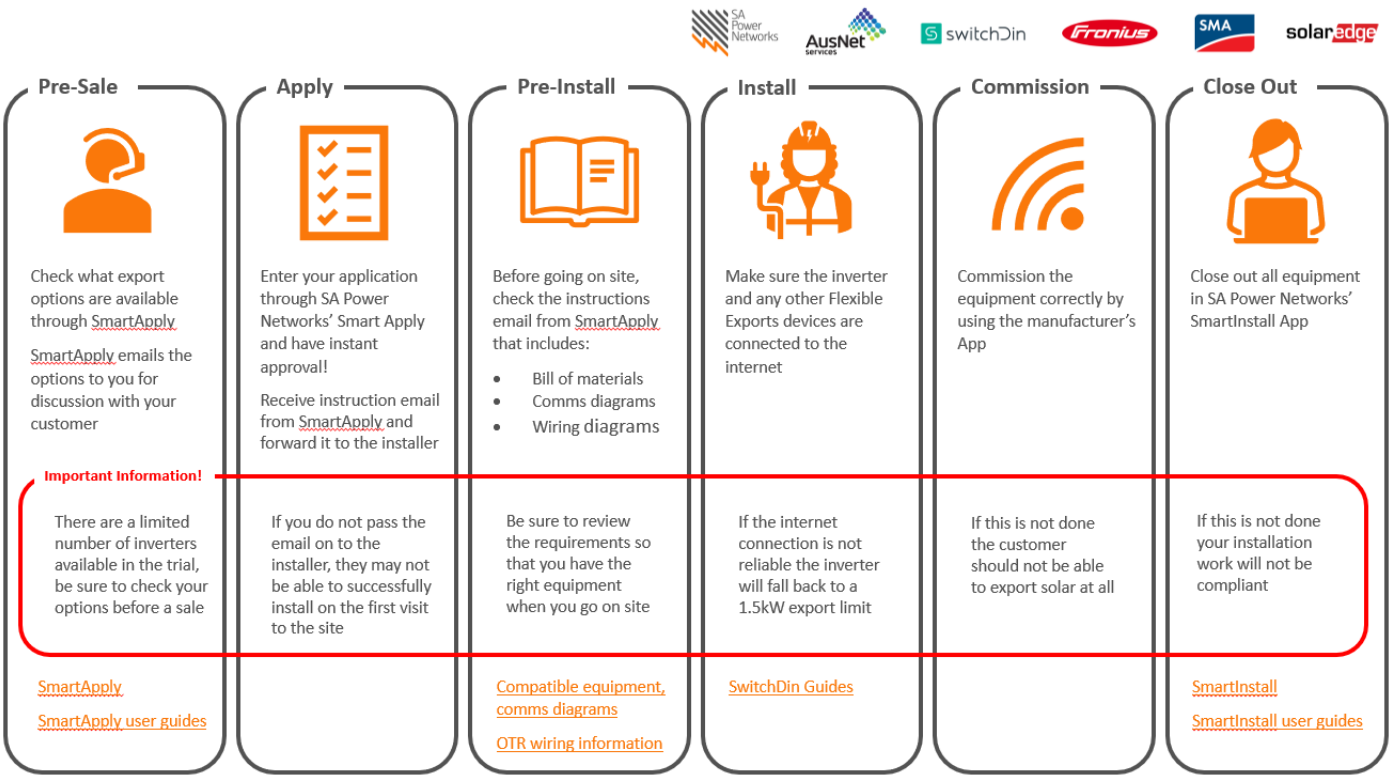


Figure 1 Installer journey developed and tested with SIRG

Further industry engagement with the SIRG provided the learning that the installer community is highly varied and requires a wide range of engagement channels, provided at times suited to individuals in order to communicate with the group effectively. The image below represents a summary of the feedback received from the SIRG when exploring which communication methods have previously worked best in engaging the installer community.

What communication methods worked well in the past & why?
When previous changes have been introduced, were there specific communications that worked better than others? Think of methods, timing of meetings etc.

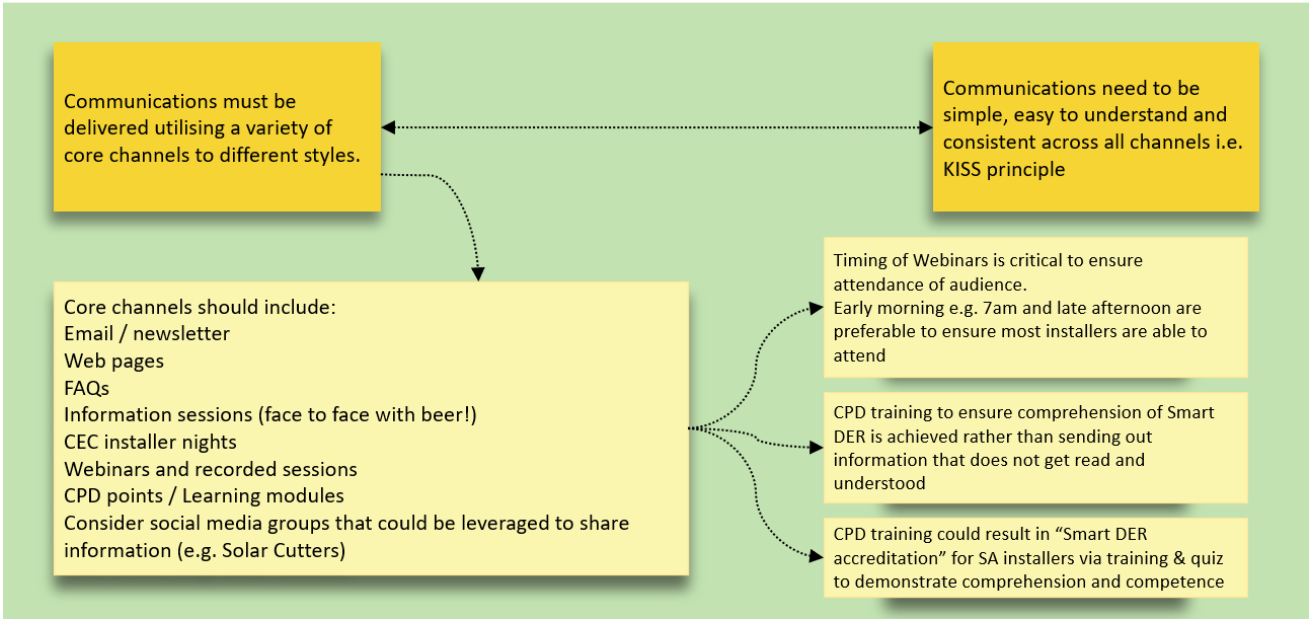


Figure 2: Excerpt of feedback received from SIRG

Communicating with the group through a variety of methods has improved the information flow between the project, installers, and customers. The communication flow has also identified potential issues which have allowed the team to incorporate appropriate messaging into training materials and subsequent communications.

Considerations for future projects

The relationship between installers and DNSPs may be an area of consideration for future projects, ensuring that DNSPs educate retailers and installers on the purpose and vision of the project to improve alignment and buy-in.

Where projects or initiatives are making changes that impact the broader solar industry, it would be beneficial to develop collateral that can fit into or supplement solar retailers and installer existing processes, or as supplemental information to be provided directly to customers. An example of this may be providing accurate and easy to understand instructions to install, as well as expected performance metrics that could feed into existing solar sales processes.

3.3 Lesson #3: Using an aggregator integration model has implications for how OEMs structure their systems/ platforms to support many DNSPs/ jurisdictions

Knowledge Category:	Equipment Certification
Knowledge Type:	Communication Protocols
Technology Type:	Integration architecture
State / Territory	National

Key Learning

There are several different IEEE 2030.5 compliant integration architectures that could enable communication between the server and the customers (refer to Figure 3: High-level IEEE 2030.5 integration architecture).

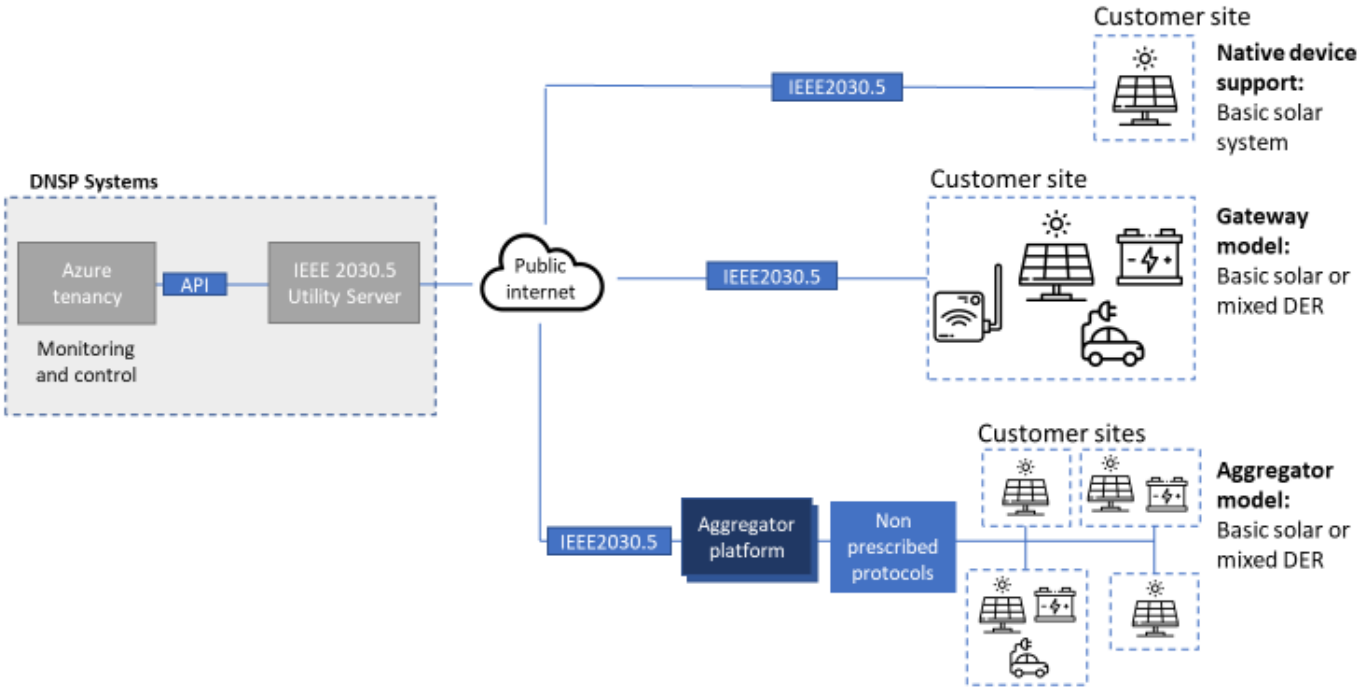


Figure 3: High-level IEEE 2030.5 integration architecture

Fronius and SMA have chosen to implement the aggregator model in this project, with Fronius' implementation being more progressed at this stage. This model is likely to be a popular choice as an OEM can leverage their existing communications infrastructure and protocols to their end devices, and only need to build an offer one standardised IEEE 2030.5 interface per DNSP/utility (rather than implementing IEEE 2030.5 directly in every device). For context, SwitchDin use the gateway model through their Droplet device but is not the topic of this Lesson Learnt.

There are two key learnings on the aggregator model that Fronius have taken from this project:

1. **Customers must be segregated between DNSPs/ regions which has implications for system architecture and design:** The aggregator acts as a communications mediator between the utility and all customers from the particular OEM participating in a dynamic exports scheme. There is a need to segregate the customers participating in each scheme/ region, so the correct DNSP monitors and controls the devices in their region. One approach to solving this issue is to deploy and maintain separate instances for different network regions – this is the approach taken by Fronius in this project. In Australia alone, this may result in 10 or more instances if all jurisdictions in Australia implement similar schemes. Although the full implications of

this are still to be determined. This is a key factor an OEM should consider in the design/architecture of their system.

2. **OEM aggregator platforms will need to be flexible to support different features in different regions:** If minor changes are required between different jurisdictions (e.g., they want to implement different parts of the standard or have different interpretations), aggregator platforms must be flexible to cater for such changes. To date, Fronius has had to implement a number of modifications to the aggregator that was implemented for the Rule 21 deployment in California in order to meet the functions in the trial. This was partly due to new functions required in Australia, different interpretations of the standard, and the Rule 21 aggregator that had been developed to pass the Rule 21 certification but not yet integrated with a utility server. This further highlights the value of alignment in functions and interpretations between regions.

Process Undertaken by the Project

Accommodating customer segregation:

To manage customer segregation in the trial, Fronius has deployed two instances of their aggregator platform to support the two DNSPs (SA Power Network and AusNet Services). As changes were required for this project, the Fronius testing department had to regression test each instance to ensure they remained in sync.

Flexibility to support local changes:

To comply with the local changes, the Fronius testing department was required to regression test each instance and check that any tweaks or bug fixes made do not have flow-on impacts to Fronius' existing Rule 21 compliant aggregator model.

The backend APIs developed by Fronius to support their aggregator platform provides a sound and expandable platform to adapt to IEEE2030.5 compliance. Fronius has created aggregator behaviour toggles, which allows ‘parallel event execution' to give flexibility to each of the utilities and how they might want to apply the communication protocol.

Adjusting the existing Fronius Rule 21 aggregator to support the local changes and multiple instances required 3000 additional lines of code and 4000 amended lines of code.

Considerations for future projects

For the production support of flexible exports type schemes using CSIP/ CSIP-AUS, OEMs should weigh up the benefits of the aggregator model against some of the complexities identified. If an aggregator model is ultimately chosen, OEMs should consider how to architect their systems to ensure support for:

- Segregation of devices across multiple network areas (and multiple IEEE 2030.5 utility servers).
- Support for different features that may be required for different networks/ jurisdictions.

Appendix A SwitchDin Quick Reference Guide - Fronius

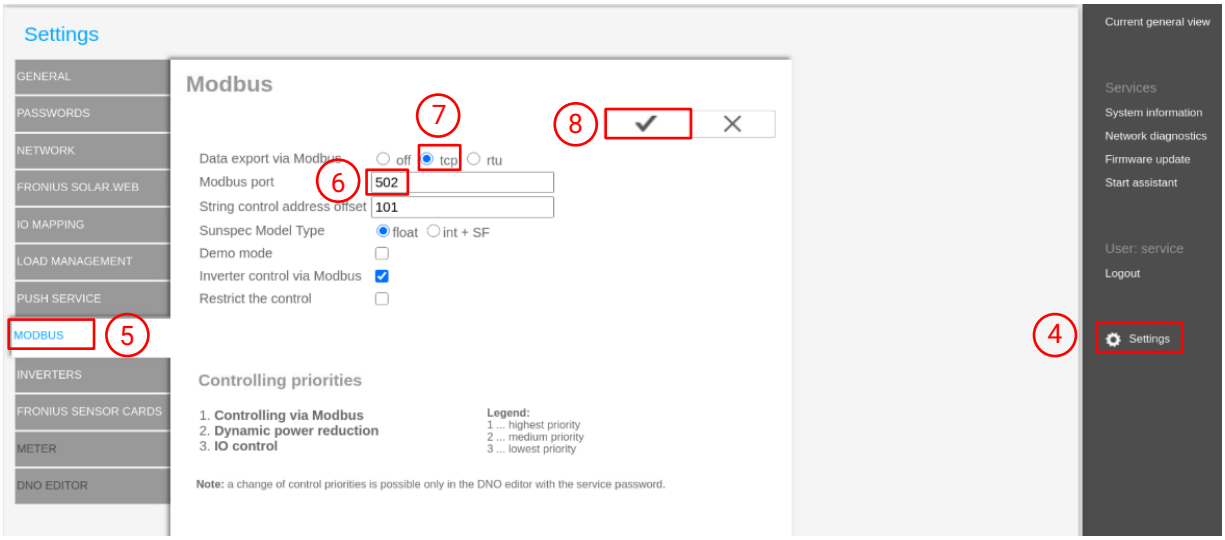
1. Required Hardware & Software Checklist

- ❑ Fronius SnapINverter Primo 3-8.2kW
- ❑ Fronius Smart Meter 63A-1
- ❑ SwitchDin Residential Droplet
- ❑ GPO for SwitchDin Droplet
- ❑ Sets of cables (ethernet & ethernet to USB adaptor)
- ❑ SwitchDin App: www.switchdin.com/app[3]

2. Onsite, wire up Smart Meter on grid or load configuration. Refer OTR Wiring Information and Diagram[4]

3. Enable Modbus TCP and port 502 as follows:

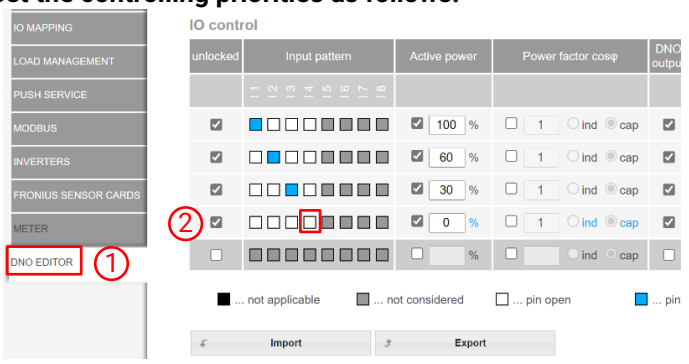
1. Install Fronius Datamanager
2. Open an internet browser
3. Enter one of the following into the address field of the internet browser
   - The IP address of the Fronius Datamanager (can be accessed via System Information)
   - Or host name and domain name of the Fronius Datamanager
4. The app will open. Click “Settings” on the right-hand side
5. Select “MODBUS” in the left-hand menu
6. Enter “502” in the Modbus port field
7. Select “tcp” as the data export via Modbus option
8. Click the tick to complete



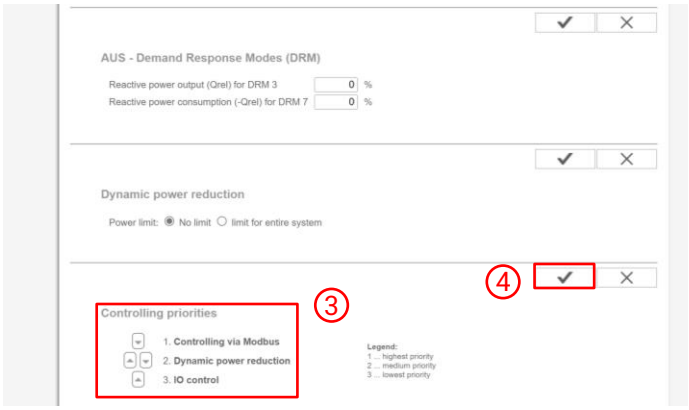
[3] SwitchDin App, www.switchdin.com/app

[4] OTR Wiring Information and Diagram, Additional Information for Metering Coordinators, Providers and Electrical Contractors, https://energymining.sa.gov.au/__data/assets/pdf_file/0010/380773/210205_Additional_Information_for_Metering_Coordinators,_Providers_and_Electrical_Contractors.pdf

4. Set the controlling priorities as follows:



1. Select “DNO Editor” in the side menu
2. In the IO Controls table toggle the box in the cross section of I4 column and the 4th row so that it shows as white instead of blue

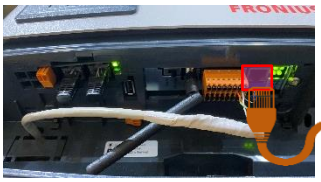


3. Set the control priorities using the arrows
4. Click the tick once the priorities have been set

5. Wiring the droplet to the inverter

Follow one of the processes below

Using a screw-driver, open the inverter cover



Plug ethernet cable into the inverter port

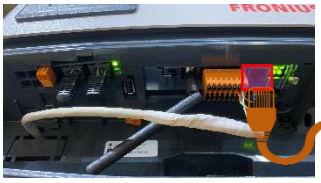
Plug the other end of the ethernet cable into an adapter

Connect the adapter to any USB port on the SwitchDin droplet

Plug the SwitchDin droplet to a GPO. Connect the droplet to the internet through ethernet cable or Wi-Fi to router

OR

Using a screw-driver, open the inverter cover



Plug ethernet cable into the inverter port

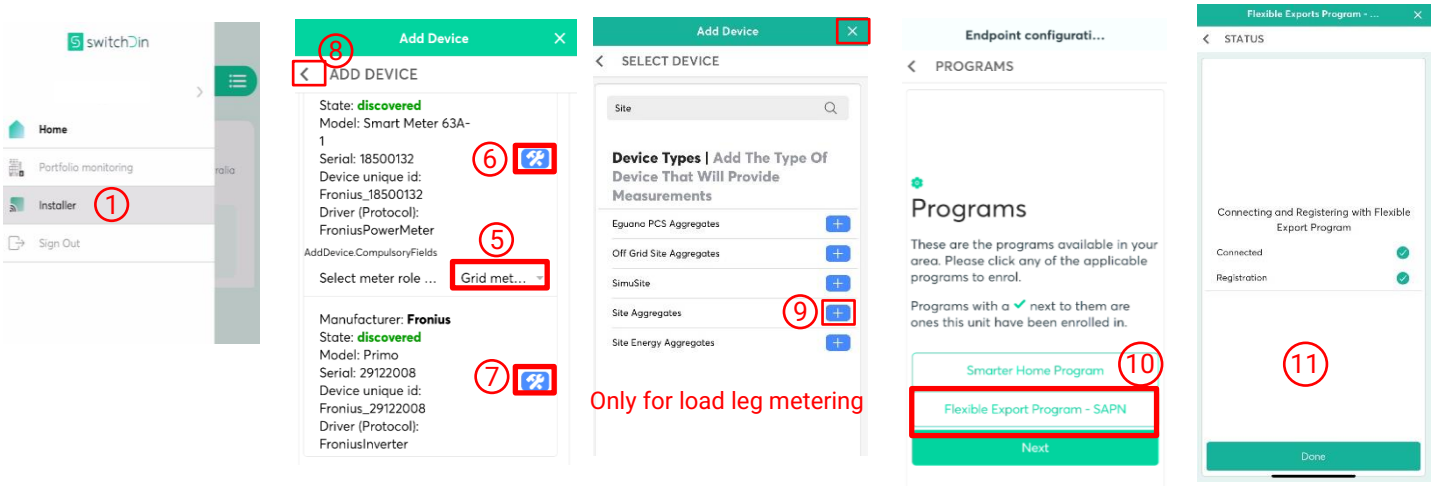
Plug the other end of the ethernet cable into the router

Connect the router to the SwitchDin droplet

Plug the SwitchDin droplet to a GPO.

6. Commissioning

1. In the Installer app, select installer from the side menu, the scanner will start
2. Scan the QR code on the side of the droplet, follow the prompts and select to connect via ethernet or Wi-Fi
3. Add a device by clicking the "+" icon on the bottom right of the screen
4. Select the discovery option
5. Select meter role of "Grid meter" or "Load meter" from the dropdown box
6. Click the configuration button for the smart meter, the message "Configured" appears
7. Click the configuration button for the inverter, the message "Configured" appears
8. If the meter is configured on the load side, click back on the "Add device", select the droplet.
9. Select "Manual" option. Search and add "Site Aggregates", click the "+" icon.
10. Close the "Add device" window, click Next
11. Select the option "Flexible Export program – SAPN"
12. Enter NMI, click next
13. The screen indicates if the connection and registration is successful. Click done.



7. Troubleshooting

1. Droplet status indicator meanings

	Indication	Red	Green	Blue
PWR	Power	N/A	Power	N/A
WIFI	WiFi	No Wi-Fi	Wi-Fi connected	Weak Wi-Fi signal
iNet	Internet	No Internet	Internet connected	Configure via SwitchDin app
SDin	SwitchDin comms	Cannot see SwitchDin	Connected to SwitchDin	N/A
Devs	Devices attached	No devices	Devices detected	N/A

2. Smart Meter Installation Guide[5]
3. SwitchDin Installation video: SwitchDin Fronius Install & Commissioning[6]

Warranty claims & support: support@switchdin.com

General enquiries: info@switchdin.com

Support : +61 (0) 2 4786 0426

[5] Smart Meter Installation Guide, https://www.fronius.com/~/downloads/Solar%20Energy/Technical%20Articles/SE_TEA_Quick_Guide_How_to_install_a_Fronius_Smart_Meter_EN.pdf

[6] SwitchDin Fronius Install & Commissioning, https://www.youtube.com/watch?v=40W2zXJ9Jpg

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