Knowledge Sharing Report

Feedback and areas for improvement – Nyngan and Broken Hill Solar PV

Project Name:	*AGL Energy Solar Project (Nyngan and Broken Hill Solar Plants)*

Knowledge Category:	Technical
Knowledge Type:	Other (please specify): Operations and Maintenance
	Recruitment of Operators

KEY LEARNING

Given that Nyngan and Broken Hill were one of the first Australian utility scale solar plants to be commissioned, there was no pool of experienced operators to draw from, or external educational institutions providing comprehensive training to be found locally.

Operators are expected to:

- Monitor operation of the plant
- Plan maintenance activities – sampling, testing, adjustment, calibration, etc.
- Carry out planned and unplanned maintenance and upgrades of equipment and the plant
- Respond to Plant alarms, while on site or on call
- Liaise with Network Operators

Particular knowledge/ experience needed are:

- Knowledge of solar plant operations
- Understanding of electrical characteristics of photovoltaics including live working during all daylight hours
- HV switching certification/ credentials

First Solar began the recruitment process during construction, focussing on construction personnel – who would have gained some understanding of the plants from their work during construction – and the local community. In addition, First Solar was looking for personnel with a good electrical background and preferably with HV Network experience.

There were advantages to this approach (selecting from personnel who had been part of construction and commissioning), including:

- Recruits had an understanding of the operation of the plant
- Early interaction with the SCADA system gave insight into the components and interfaces
- Familiarity with the switching sequence for the plant, which differs from a standard network
- Allowing consistent lock out and isolation procedures to be rolled out from construction though to operation
- Allowing operations staff to establish and form relationships with Network operators prior to the operation of the plant.

Training aspects for the Operators consisted of internal First Solar training and external training and experience. First Solar provided on the job training from (foreign) experienced staff and First Solar's web based training modules. This focussed on understanding of the technical aspects of solar plant equipment and its operation. External training, included:

- HV switching/switch gear operation
- Understanding of the protection system – specific detailed training provided by equipment suppliers, e.g. Siemens

- First aid, resuscitation

IMPLICATIONS FOR FUTURE PROJECTS

Given the absence of experienced operators and third-party providers of solar plant operator training, the burden of training operators will fall on the plant's operators.

There are significant benefits to recruiting from among personnel involved in the commissioning of the plant, or involving candidate operators in the commissioning of the plant.

KNOWLEDGE GAP

While some operator skills are generic (e.g. first aid) or can be transferred from other industries (HV switching), there are other aspects that are specific to solar plant operation, including:

- Understanding of electrical characteristics of photovoltaics
- Knowledge of switching sequences
- Protection

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Project Name:	*AGL Energy Solar Project (Nyngan and Broken Hill Solar Plants)*

Knowledge Category:	Technical
Knowledge Type:	Other (please specify): Operations and Maintenance
	Maintenance

KEY LEARNING

First Solar operations personnel undertake all required maintenance activities and carry out trouble-shooting of major issues with support from local and international First Solar resources.

Some maintenance services are contracted out locally and include:

- Fire systems maintenance
- Provision of plant – generators, cranes, forklifts, graders
- Vegetation control – chemical and mechanical
- Pest Control
- IT services

Further maintenance services are contracted out to Australian service providers, outside the local region and include:

- Transformer maintenance, oil sampling
- Specialist circuit breaker services
- Protection systems checks and settings
- Other testing services
- Inverter maintenance/repairs
- Equipment calibration

The efficiency of the maintenance and subsequent performance of the plant is based on a number of critical factors. These factors include the timing of response by sub-contractors, quality of the service and staff knowledge and understanding.

The timing of services is affected by the location of the Plant. Local staff can respond in a short timeframe, but services from outside the region take longer to reach the site so there could be a one day delay or more while personnel travel to the site.

In general the quality of services is good. Many of the companies used for O&M services were also used during construction and this allowed their capabilities and service levels to be assessed prior to maintenance contracts being issued.

SCADA systems are complex, and although O&M staff have a good electrical knowledge additional training and support is required to provide a better understanding of the SCADA system.

A number of equipment suppliers and their technical support services are located in different time zones which leads to lag in response times to enquiries and trouble shooting. This needs to be managed to ensure the smooth operation of the plant.

The ability to switch the HV switchgear locally and remotely via the SCADA interface was different to what the operators were used to, so specific training was required prior to commencing operations.

Staff also need to be able to coordinate with weather conditions. A variety of vegetation control measures, both chemical and mechanical, need to be employed. Timing and application of vegetation control measures needs to be coordinated with weather events to ensure their efficacy.

IMPLICATIONS FOR FUTURE PROJECTS

The location of the plant, the consequential delays in access by service providers and the availability of spares are critical in the development of spares and maintenance strategies, and what needs and/or can be performed in house.

Plant operators (who do the routine maintenance) will require training in SCADA and plant equipment. Operators benefit from experience in the construction and commissioning of the plant.

Involving maintenance management in the construction and commissioning of the plant allows visibility of service provider capabilities and facilitates the development of relationships with key service providers.

KNOWLEDGE GAP

Currently, equipment calibration and service personnel for protection equipment, e.g. Siemens personnel from NZ, are not available from Australia-based service providers.

Knowledge Sharing Report

Feedback and areas for improvement – Nyngan and Broken Hill Solar PV

Project Name:	*AGL Energy Solar Project (Nyngan and Broken Hill Solar Plants)*

Knowledge Category:	Technical
Knowledge Type:	Other (please specify): Operations and Maintenance
	Operation

KEY LEARNING

AGL dispatches the electricity generated at the Nyngan and Broken Hill solar plants into the NEM. This occurs during the daylight hours of solar photovoltaic operation. Plant-based operations include:

- Monitoring all systems within the plant, including:
  - Alarms
  - All electrical output
  - Irradiance and other climatic information
  - Soiling (i.e. the impact of dust build-up or other fouling of the panels)
  - Weather (temperature, wind, rain)
  - Grid conditions
- Carry out infrared thermography to identify potential issues

To facilitate these operations, the plant was developed with the following capabilities:

- A complex SCADA system was established to take inputs from a variety of instrumentation and monitoring equipment.
- Monitoring systems installed included the meteorological stations, soiling stations, reference modules, temperature clusters on modules, transducers and meters to monitor temperature, voltage, current, etc.
- Video surveillance is also used for monitoring.

However, we have learned that one cannot rely solely on electronic monitoring. The monitoring needs to be a combination of SCADA, status reporting and human observation. Examples of where human observation has been valuable:

- Thermographic imaging of items such as Combiner Boxes has been used to monitor for any possible heat issues.
- Visual inspections of modules and plant items to assess condition and inform preventative maintenance needs.
- Security monitoring by security and operating personnel: observing or inspecting the site boundaries, buildings, etc. for any vandalism or security breaches, and then being responders to the authorities if any breaches are detected.

IMPLICATIONS FOR FUTURE PROJECTS

Monitoring for operational and reporting requirements needs to be considered as part of the design.

Remote monitoring (enabled by instrumentation and video) needs to be supplemented by direct observation. This needs to be considered in assessing staffing requirements.

KNOWLEDGE GAP

None.

Knowledge Sharing Report

Feedback and areas for improvement – Nyngan and Broken Hill Solar PV

Project Name:	*AGL Energy Solar Project (Nyngan and Broken Hill Solar Plants)*

Knowledge Category:	Technical
Knowledge Type:	Other (please specify): Operations and Maintenance
	Operability and maintainability

KEY LEARNING

Aspects of the design that facilitate operation and maintenance activities:

- No moving parts. Minimal maintenance on the structural components.
- Elevated platforms for structures such as the Power Conversion Station (PCS), Photovoltaic Combining Switchgear (PVCS) and Photovoltaic Interconnection Switchgear (PVIS). The elevated structure make it easy to access cables to trouble shoot any cable issues. The elevated structure eliminates enclosed/confined spaces that would require extra operator training and work procedures.
- Open structures such as the PCS provides plenty of work space and area making it safer to work on equipment.
- Ring Main Unit (RMU) at each PCS structure. This allows the isolation of a small segment of the plant rather than a whole Block.
- SCADA system makes it easy to monitor all aspects of the plant.

Aspects of the design that could be improved to facilitate operation and maintenance activities:

- The design of the rooms for some of the switchgear could be improved. The environment (dust) and access to the switchgear in wet weather needs to be considered.
- Consider overhead HV lines from Blocks to PVIS rather than underground cables. Overheads would be visible and easy to maintain.
- Review road quality and design for all weather access.

IMPLICATIONS FOR FUTURE PROJECTS

It is important to consider the needs of operations and maintenance staff in the design of the plant, particularly:

- Safe all-weather access to equipment
- Physical ease of access to equipment, i.e. create adequate access to and space around equipment to support maintenance activities.
- Electrical ease of access to equipment, i.e. ability to easily isolate small sections of the plant or to provide access for routine operations or maintenance activities that does not require isolation.

KNOWLEDGE GAP

None.