HARDWICK PROCESSORS PROPRIETARY LIMITED
HEAT PUMP PROJECT

LESSONS LEARNT REPORT NUMBER 2

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EXECUTIVE SUMMARY

The Project involves installation of a heat pump and its integration with the site's solar and battery storage system. The sites High Voltage ("HV") power also must be upgraded. The HV upgrade will also facilitate more cost-effective installation of any future renewable assets on site particularly if they are to be installed further away from the interface with the grid. It will also allow for more straightforward delivery of excess renewable power back into the network if it is required for future grid demand/ frequency management.

This Lessons Learnt report covers the works undertaken from 30 April 2022 to 31 January 2023. Learnings relate largely to elements of the project which required more resources, impacted the program or required additional works above and beyond the intended scope. It specifically covers:

- Works related to the completion of equipment installation and conversion to HV supply for the Project; and,

- Issues covering the installation and initial operational testing.

KEY LEARNINGS

LESSONS LEARNT: Requirement for effective stakeholder communication to reduce delays.

Category: Communication

Detail:
The power upgrade caused delays in renewable assets coming back online.

In the days leading up to the scheduled works the network provider established that they required a major communications device to remotely monitor and control Hardwick's existing renewable assets of battery and solar. Hardwick's had to decide to move forward with the upgrade, to keep the greater project on schedule, with the renewable assets being taken offline until the communications works could be executed. These works are yet to be commissioned which has had significant short term cost implications with significant amounts of addition grid power required.

Power connection, power upgrade and network maintenance is standard business for the network provider. The field of renewable assets and having many small generators is a new area for the network provider to manage. Hardwick's have existing renewable assets, but under this Project Hardwick's wanted to re-configure existing renewables as part of the power upgrade. The renewable re-configuration works required is something which possibly the networks have not encountered many times in the past.

Having a few more formal face to face meetings with all the parties involved may have flagged this issue at an earlier stage in the Project life. Due to the network providers inexperience with integration of small generation sources as noted above, the power upgrade works were delayed. The power change over from Low Voltage ("LV") to HV was scheduled to occur at the end of October 2022 and took place at the start of December 2022. Overall, the delay did not have any major impact on the project delivery. Meat peak production normally occurs leading up to Christmas. This can make it hard to have scheduled power and refrigeration outages for any extended periods of time and needs to be considered in the scheduling.

On a positive note, the network provider has been very responsive and has done everything in their power to get Hardwick's renewable assets back on line as quickly as possible.

Recommendation:

For complex integration works like this (which involve both enhanced communication and renewable integration into grid) very detailed planning and implementation needs to be factored into works program regardless of the experience of stakeholders. In addition, consideration needs to be given to increased stakeholder meetings.

LESSONS LEARNT: Requirement for integration of all renewable site assets into any power upgrade

Category: Technical

Detail:

There was one scope change during the project to the overall electrical architecture. Prior to this project taking place the renewable assets, battery and solar, all fed back into the existing main LV switchboard. At project conception it was intended to leave this arrangement to reduce the complexity of the project and modifications to existing assets.

A scope change was agreed on to bring the existing renewable asset, battery and solar, onto the new HV board. This ensured that the renewable assets feed into the plant at the head of the system and ensured balanced systematic distribution of renewable assets across the entire plant including new electrical infrastructure and existing electrical assets. The heat pump and HV upgrade required the new Programmable Logic Controllers ("PLC"), installed as part of the project to communicate and integrate with existing refrigeration PLC's, hot water plant room PLC's, renewable energy PLC's and external communications for the electrical network provider. In-depth understanding of the existing controls was required to integrate the heat pump. To add complexity to the Project, during the construction period there was a parallel project taking place updating all data cables on the site to optic fibre and putting in new computer servers. When retrofitting a heat pump to an existing plant there is a large amount of work and analysis required on the PLC communications side to ensure that all the systems can talk and operate together. The project went fairly smoothly as the project was run internally and the programmers used had been integral in the development of all existing PLC's and had a very strong knowledge of the entire plant operation including the refrigeration system. If the Project had been run by an external contractor with little pre-history of the plant, then extensive time and further resources would be required in developing the integration and communications plan for such a project.

Recommendation:

Integration of renewable assets into a HV upgrade should be included in the HV installation to allow more straightforward upgrades for future renewable upgrades, etc.

LESSONS LEARNT: Check compliance with all regulatory or code obligations.

Category: Technical

Detail:

The requirement for ammonia detection in the plant room was overlooked at the design phase. The electrical scope was increased to include ammonia detection as part of the new heat pump plant room. The electrical code deems ammonia to be explosive near electrical equipment at a certain concentration level. To make the heat pump building code compliant, required ammonia detection, automated electrical shunt trip and mechanical ventilation to account for situations of an ammonia leak.

Recommendation:

The introduction of ammonia detection systems in the plant room is essential to ensure compliance with regulatory and code obligations. Expenses related to the introduction of this system should be included in the project budget.

LESSONS LEARNT: Achieve effective sizing of plant to match all operational requirements and variables.

Category: Operational

Detail:

The initial analysis for this heat pump Project was carried out over three years ago and was carried out largely due to the availability of funding to support the investigation. Meat processing plants can be very dynamic with production levels changing dramatically due to seasonal changes, weather patterns and world markets. Plants can very rapidly change production levels over a short period from one shift to two shifts – typically most plants are continually driving to increase volume which delivers the highest economical outcome during prosperous times. From when the first analysis took place and completion of this phase of the project, the water usage across the site has increased by 20%. Due to the variable production levels as noted above, water usage can regularly vary in excess of +/- 20%. The project team are currently working through the early stages of balancing the heat pump hot water generation with the varying hot water demands of the processing plant.

In designing a system, it is very important to consider what flexibility is required to allow for operational variabilities of the processing facility. For this project, natural gas continues to provide some of the final heating which has built greater flexibility into the project. It is important to obtain existing usage data (for this Project water and ammonia usage). For example, accurate instantaneous water flows and a profile over a 7-day period. Although this is a big expense prior to the commitment of moving forward with the project it reduces the risk of incorrect equipment size selection.

Recommendation:

In designing a system, it is very important to consider what flexibility is required to allow for operational variabilities of the processing facility.

LESSONS LEARNT: Efficient Project delivery involving integration with existing systems.

Category: Project implementation

Detail:

When retrofitting a heat pump to an existing plant there is a large amount of work and analysis required on the PLC communications side to ensure that all the systems can talk and operate together. The following provides an overview of the PLC communications involved:

- A cold-water supply pump fills the heat recovery tank. A Level transducer measures the level in the tank and opens a control valve when the tank level drops.
- A primary supply pump is driven locally from the output of a pressure transducer. The pump speed is varied to maintain a constant outlet head. This is designed to cater for the total flow downstream through the three (3) heat recovery units on the screw compressor oil cooling circuits as well as the required water flow through the heat pump heat exchanger.
- Water supply to the heat pump is initiated once the heat pump compressor is operating. A valve is opened/modulated when the heat pump compressor is started.
- When the pre-heat thank is full flow and the hot water supply pump is switched off then the heat pump is instructed to switch off. This water flow condition is triggered by monitoring the water flow meter output on the heat pump water line. Once flow through the flow meter is reinstated the heat pump will restart.
- Water supply to each of the three oil heat recovery units (1, 2 and 3) is initiated by opening 3 valves when each of the corresponding ammonia compressors are operating. Oil return temperature is measured on each of these compressors. If the oil return temperature measured is too high, it will trigger the existing oil cooling water pumps to switch on thus providing incremental cooling to each of the compressors oil circuits. Once oil temperature

returns to the required set point the oil cooling water pumps will then switch off. If the return temperature monitored is too low it will trigger the 3 control valves to close. As the oil temperature increases and reaches the required level, then the valve will reopen.

The project went fairly smoothly as the project was run internally and the programmers used had been integral in the development of all existing PLC's and had a very strong knowledge of the entire plant operation including the refrigeration system. If the project had been run by an external contractor with little pre-history of the plant, extensive time and additional resources would be required in developing the integration and communications plan for such a project.

Working with the existing refrigeration contractor helped to ensure the heat pump was integrated optimally into the existing plant. Creating long-term relationships with specialist contractors who can continue deliver ongoing value for money helps to de-risk projects, and was critical in this Project. A large amount of plumbing and electrical works were carried out or supervised by Hardwick's internal tradesmen. All the refrigeration / heat pump works were carried out by the company's main refrigeration contractor who has carried out all works on the site for the last 25 years. This has delivered a very good Project in terms of operation and value for money. By using internal trades, it has ensured that maintenance staff have a very strong understanding of the operating system, which helps with long term operation and the company staff can improve on the design for better integration.

Recommendation:

In planning the integration of complex operational systems into an existing plant, the use of contractors with specific site experience, and the direct involvement of existing operational staff should be considered as a priority.

LESSONS LEARNT: Incorporation of operational variables to achieve optimum performance.

Category: Performance monitoring

Benchmarks are currently being developed for the heat pump to ensure that a baseline can be created and monitored over a weekly or monthly basis. This could possibly be the dollar cost to generate hot water per kg of meat produced for the day, week, or month. The intent is to ensure system changes can be made for varying production changes or input costs.

The intent is to ensure system changes can be made for varying production changes or input costs. This will require operational staffing to include a skilled technician monitoring the system and making minor changes on an ongoing basis. The heat pump involves both the refrigeration and heating water circuits for the plant, and operational staff will need to track trends and optimise the system on a weekly basis from the site supervisory control and data acquisition ("SCADA") system and do a full walk through of the system on a regular basis. A maintenance schedule and management reporting system is also being developed.

Recommendation:

For new, complex systems, develop benchmarks for ongoing performance monitoring in conjunction with Project delivery to ensure suitable operational variability is incorporated, and ensure appropriately skilled technicians are in place to achieve ongoing performance requirements.

CONCLUSION AND IMPLICATIONS FOR FUTURE PROJECTS:

The key lessons learnt from the installation phase of the project relate to communication, technical, operational and planning issues.

The implications for future projects include:

- the criticality of communications with stakeholders, particularly the power utility network supplier;
- the importance of using established and site experienced staff and contractors for implementing complex integration projects;
- the importance of developing performance benchmarks in parallel with Project implementation and ensuring the required operational skills for ongoing performance are developed; and,
- the importance of integration and realignment of existing renewable assets with any site power upgrade.