YARRA ENERGY FOUNDATION

Fitzroy North Community Battery

Year 2 Performance Report, FY23-24

— January 2025

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Special thanks for their contribution to:

The team at Diamond Energy for performing perfect foresight modelling.

Acknowledgment of Aboriginal land and peoples

We acknowledge Aboriginal and Torres Strait Islander people as the Traditional Owners and custodians of the land and water on which we all rely. We acknowledge the Wurundjeri Woi Wurrung peoples as the custodians of the land on which the Yarra Energy Foundation is based.

Disclaimer

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The Fitzroy North Community Battery was implemented with funding provided by the Victorian Government's Department of Environment, Land, Water and Planning (DELWP; now DEECA) through the *Neighbourhood Battery Initiative* program Round 1.

The project included significant contributions from a group of dedicated partners: the City of Yarra, CitiPower, the Australian National University's (ANU) Battery Storage & Grid Integration Program (BSGIP), Pixii, Acacia Energy, Ventia, Mill Software, Polarium, the Department of Energy, Environment and Climate Action (DEECA; formerly the Department of Environment, Land, Water and Planning [DELWP]), and the Community Reference Group.

YEF currently operate the battery in partnership with Acacia Energy.

YEF expresses our sincerest gratitude to everyone involved and acknowledges the countless hours of in-kind work to support this project.

Contents

1. Executive Summary

YARRA ENERGY FOUNDATION

1.1. Second year performance overview

At the beginning of Year 2, FN1 was moving towards steady state operations. YEF's focus for this second year (FY23-24) was to deepen our understanding of BESS operations, pursue FCAS trading and tweak system parameters to improve performance. Throughout the year YEF invested in resolving new issues (see section 3) and generated significant learnings. At the close of FY23-24, FN1 was undergoing the final testing and validation needed to enable FCAS trading. However, a power spike issue (see section 3.3) prevented YEF from earning FCAS revenue in Year 2.

Revenue performance: In the second year, there were two sources of revenue: energy arbitrage ($8,158; 88.6% of total revenue) and CitiPower's bidirectional community battery trial tariff ($1,046; 11.4%). FN1 made $8,423 ex-GST (after metering and market charges), almost the same revenue as Year 1. Revenue was impacted by extended downtime in December 2023 and January 2024, increased parasitic losses in early 2024, and the 13 February 2024 price spike event during which the system charged due to a lag in receiving prices from AEMO. Further analysis of financial performance can be found in Section 4.

Perfect foresight comparison: FN1's revenue was 39-54% of what was possible using 'perfect foresight', depending on the dispatch rules. With perfect foresight, FN1 could have earned $14,558 (PF1), or up to $20,059 (without time-based constraints, PF2) at one cycle per day. The relatively low performance is due to missed peak pricing revenue opportunities in February 2024 and the absence of an intelligent optimisation system. Details of perfect foresight analysis are in Section 4.3.

Roundtrip efficiency: Average roundtrip efficiency was 79.06% (~2.5% less than Year 1), and varied month-to-month from 84% to 62%. Winter and spring efficiency was in line with the first year of performance, however summer and autumn efficiency was reduced due to increase air conditioner parasitic loads in warmer months, and additional parasitic losses caused by Pixii's temporary system monitoring equipment. In total, FN1 charged 81.05 MWh, and discharged 64.08 MWh during FY23-24.

Downtime: System downtime across the second year of operations was 11%. Most downtime occurred due to equipment failures, and the worst impacts were during December 2023 and January 2024 (33 days of total downtime in these two months). This represents a 6.6% increase in downtime from the previous year. Refer to Section 3 for details of operations and technical performance.

Continued improvement: At the close of Year 2, the YEF team continues to work on maintaining steady state operations and improving system performance. Key priorities in the third year of operation will include enabling FCAS trading in all eight contingency markets, reducing parasitic losses, and optimising BESS dispatch to improve financial returns.

Note: At the time of finalising this report (January 2024) YEF is pleased to note the resolution of the power spikes issue and FCAS registration. FN1 is expected to trade in the 6-second, 60-second and 5-minute contingency raise and lower markets in the third year of operations. Acacia Energy will also be pursuing Very Fast (1-second) FCAS registration for FN1.

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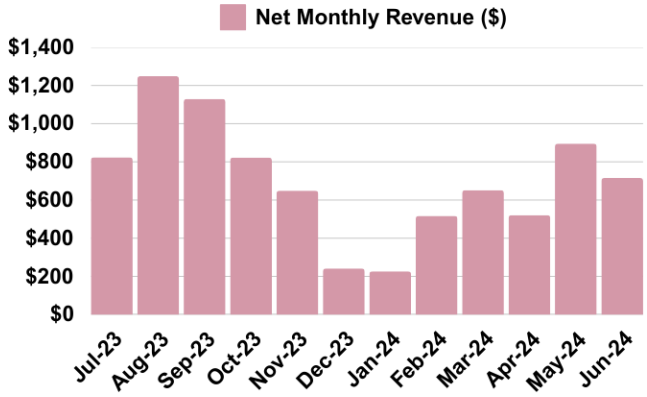
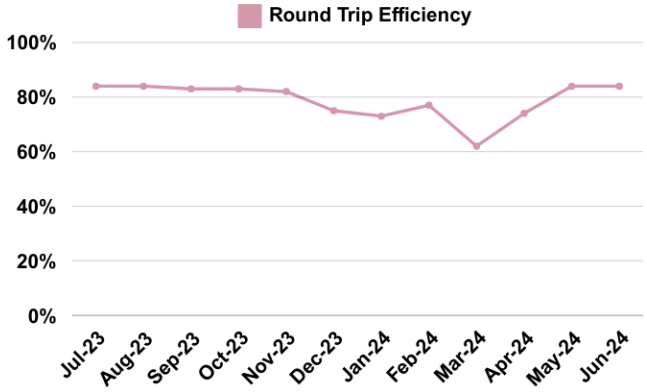
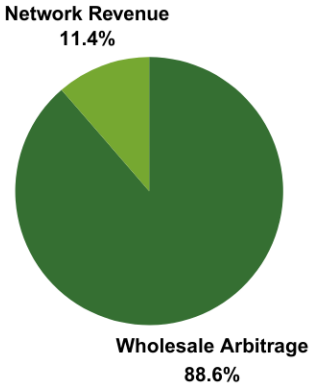
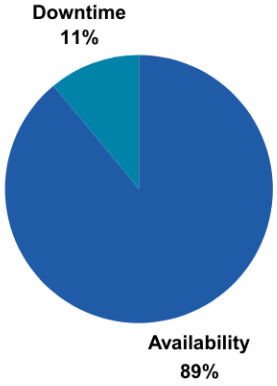
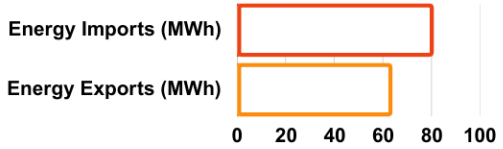
1.2. FN1 second year performance dashboard

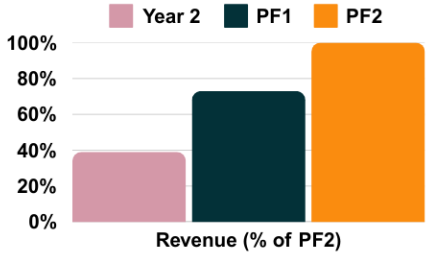












PF1 - Perfect foresight operations following current dispatch rules.
PF2 - Perfect foresight revenue without time limited dispatch.

Performance vs Year 1	
Revenue	Steady
Round-trip Efficiency	-2.5% ↓
Availability	-6.6% ↓

2. Introduction

2.1. Background

The Hon. Lily D'Ambrosio (Minister for Climate Action, Energy and Resources, and the State Electricity Commission) launched the Fitzroy North Community Battery (FN1), a 120kW/309kWh Pixii PowerShaper, on 5 June 2022 – World Environment Day. The battery is located at 193-205 McKean St, Fitzroy North in Melbourne's inner-north suburbs. The project was funded by the Victorian Government's *Neighbourhood Battery Initiative Round 1*.

FN1 has a simple operating model of trading on the electricity market through retailer/aggregator Acacia Energy, the Financially Responsible Market Participant of the system.

The software to dispatch the system was initially developed by ANU's Battery Storage and Grid Integration Program (BSGIP). It was replaced with software in Acacia Energy's systems during the second year of operation as part of a software restructure.

CitiPower introduced a trial tariff for community batteries that became effective 1 July 2022. This tariff is bi-directional and allows the battery to earn an income by charging and discharging at times that support the network.

YEF's daily dispatch rules vary slightly through the year but generally consist of charging from 10am to 3pm, discharging from 4pm to 9pm, idle overnight, and at times, a residual discharge in the morning peak.

In the first year of operations, YEF's focus on this pilot project was to develop an understanding of what it means to operate a neighbourhood battery. The learnings from this year are presented in the First Year Performance Report, which is available online. A short summary of this report can be found in Appendix 1.

In the second year of operations (1 July 2023 – 30 June 2024) YEF have gone to a deeper level by tweaking the system and working through issues and challenges to improve system functionality and performance.

> "In the second year, we put the dispatch under a microscope to see what we could improve."

Throughout this pilot project, decisions have been made to forego revenue at times to maximise the learning from BESS operations. By sharing these learnings with others, YEF seeks to accelerate the deployment of effective and efficient energy storage for the renewable energy transition.

It is with great appreciation that we thank Pixii and Acacia Energy for their partnership spirit and dedication in keeping FN1 operating as best possible, but also in allowing us to be as transparent as possible about FN1's performance in this report.

2.2. FN1 second year in review

Relatively steady state operations (Jul – Dec 2023): FN1 operated in a steady state, dispatching according to operating commands without a significant outage. In August 2023, YEF identified a performance issue whereby FN1 produced random, very short duration spikes in dispatch power, which we refer to here as the 'power spikes' issue. Pixii commenced investigations, and Acacia was not prepared to bid FN1 into FCAS markets as it could not be reliably dispatched at a set power and could risk non-compliance when responding to an FCAS event.

Hardware failures and system outage (Dec 2023 – Jan 2024): On 2 December 2023, FN1 had an unplanned outage caused by AEMO updates to the interface with Acacia's dispatch system. This issue was quickly fixed and FN1 operated smoothly until a communications issue was observed by Pixii on 24 December 2023. This second issue was caused by a battery module failure, which impacted the power supply to the 4G router and caused the system to go offline. Following the resolution of these issues on January 12, the system remained offline for a further 9 days while dispatch command responsibility was transitioned from Mill Software to Acacia Energy. The cumulative result was a system outage until 21 January 2024. During this time Pixii continued to investigate the power spikes issue, exploring the possibility that spikes could be induced by grid voltage issues, however no clear cause was identified.

Unstable operations and 'power spikes' diagnosis (Jan – Apr 2024): On 21 January 2024, FN1 returned to service while Pixii remained focused on diagnosing the power spikes issue. On 18 February 2024, Pixii identified the cause as a RS485 communications overload issue within the BESS. Pixii subsequently planned new driver development and immediately began the works. During this time the system operated with reduced round trip efficiency caused by the additional parasitic loads of Pixii's data collection equipment.

At 1:20pm on 13 February 2024, Victoria was hit by a major transmission line outage and wholesale electricity prices skyrocketed to the market cap ($16,600/MWh) for a period of ~120 minutes. During this time, FN1 continued to charge as per normal due to AEMO providing delayed spot price signals to Acacia's dispatch engine. As a direct result of charging during this peak price event the system paid $320 that day.

In late April 2024, the air conditioning (AC) unit on one of the battery cabinets malfunctioned and was replaced. The root cause of this issue was material ingress on the AC control circuit board causing it to fail.

Return to steady state operations (Apr – Jun 2024): In the last three months of operation, FN1 returned to a steady state, operating without major disruption. During this time, Pixii continued to work on resolving the power spikes issue and commenced testing of the required firmware update on-site in June 2024. This update required some hardware to be upgraded as it was no longer compatible with the firmware. In addition to covering the cost of these upgrades, Pixii committed to updating the system's switchboard (works scheduled for FY24-25) free of charge to meet their updated standard design for the Australian market.

3. Operations and Technical Performance

3.1. Summary of second year

Periods of relatively steady state operations: For the first five months and last two months of FY23-24 the battery operated in a steady state.

Hardware and software failures resulted in increased downtime: Several unplanned outages led to a total downtime of 11%. The most significant occurred between 24 December 2023 and 21 January 2024, which highlighted the challenges of resolving issues during peak holiday periods – a known issue with 24/7 operations. April 2024 was also disrupted by outages and derated performance.

Power spikes delay FCAS trading: First identified in Australia in August 2023 and diagnosed as a software issue in February 2024, the issue resulted in another year without FCAS revenue and contributed to reduced round trip efficiency (due to increased parasitic load of Pixii's data collection devices). At the close of the second year, Pixii was performing ongoing on-site testing to validate the software fix. Since the end of June 2024, Pixii have refined their software further and, at the time of publishing this report, have resolved the power spikes issue.

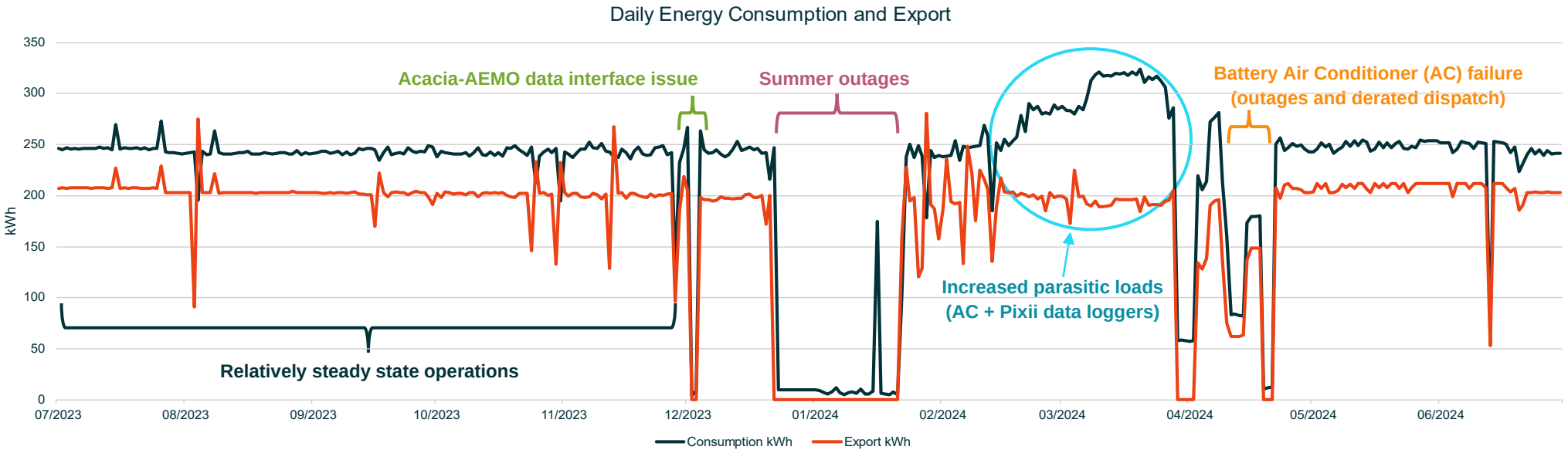


Figure 1. Overview of FN1's second year of operation – consumption and export

3.2. Operational performance

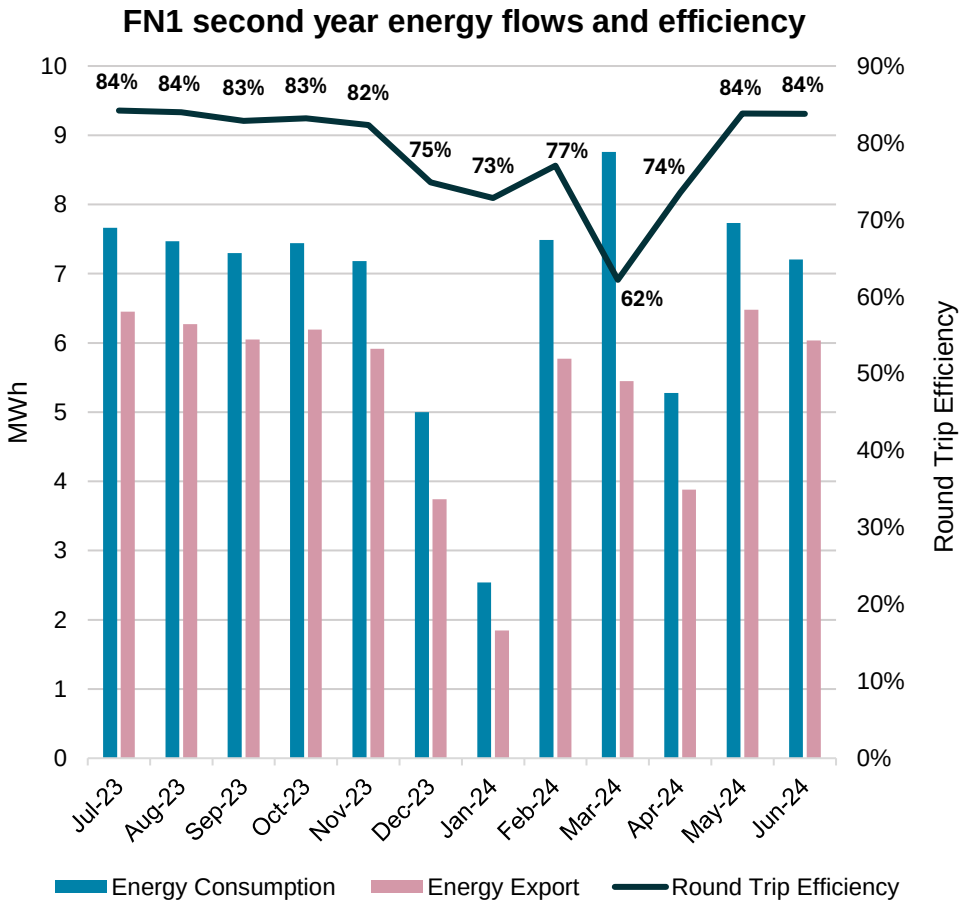


Figure 2: Energy flows and efficiency in FY23-24

System downtime: In the second year of operation FN1 encountered several outages, many of which occurred during weekends and holiday periods. The lesson learnt is to avoid conducting updates on Fridays or before holidays. As a result of unplanned outages in FY23-24, FN1 missed out on 42 days of market trading, with the longest outage (33 days) occurring over the Christmas and new year holiday period. YEF anticipate that downtime will decrease as Pixii's customer support and firmware architecture is improved, and now regularly monitor FN1 over holiday periods. We recommend that other projects deploy comprehensive maintenance and monitoring services, with special attention to weekends and holidays.

Reduced round trip efficiency in early 2024: FN1 experienced a decline in system round trip efficiency between December 2023 and April 2024. This was caused by an increase in the parasitic losses from AC consumption (due to higher ambient temperatures), and the installation of Pixii's sophisticated data logging equipment to diagnose the power spikes issue. Its installation caused a significant increase in parasitic losses between mid-February and late-March 2024, resulting in a very low 62% round trip efficiency in March. Regardless of the need for this equipment, YEF believes that further AC calibration is needed to further reduce parasitic losses. YEF has requested that Pixii investigate this further in the third year of operations.

FCAS trading continued to be elusive: The power spikes issue (see Section 3.3) resulted in FN1 foregoing FCAS revenues for a second consecutive year. In this second year of operation, Acacia successfully completed the FCAS registration process for FN1. YEF recommends that other proponents look for systems with proven experience in the Australian FCAS markets, and work closely with retail partners to ensure FCAS registration processes go smoothly.

Issue identification and resolution process: A lack of automated alarm and monitoring functions available to YEF has been a challenge in the second year of operations. As of the end of FY23-24, YEF monitors the system manually each day through Acacia Energy's data visualisation platform. We recommend that other proponents ensure that battery systems are configured with appropriate automated monitoring and alarm functions to enable streamlined operational monitoring. YEF also notes that the immediate notification of emergency services of critical issues (e.g., fire) is now required by Victorian fire authorities, making 24-hour alarm monitoring a requirement for neighbourhood batteries.

Improving maintenance performance: Throughout FY23-24, Pixii focussed on resolving technical issues with FN1, and maintenance was carried out on an incidental basis. Pixii considered this an acceptable maintenance regime in FY23-24 given their regular visits to site. However, as FN1's operations have become more stable in the first half of FY24-25 Pixii are now implementing an annual maintenance regime.

YEF also introduced a mandatory Google Form in FY23-24, implemented using a QR code, to track site visits and work performed. This system allows better oversight of maintenance activities through automated email notifications and is used by YEF to monitor when the system was last inspected by Pixii.

Online dashboard issues: In early 2024 FN1's public dashboard transitioned from sourcing data from Mill Software to Acacia Energy, resulting in some minor teething issues and monitoring outages between January and June 2024. Since June 2024, the public dashboard has been running without issue and can be viewed through YEF's website. In addition, YEF has access to a detailed internal dashboard.

Transition to Acacia's software platform: In FY22-23, at a time when dispatching a neighbourhood battery was relatively unknown to electricity retailers, data processing was conducted by Mill Software. In FY23-24 it evolved to a more efficient operation with direct dispatch by Acacia (see Section 3.3 for details). Disruptions during this transition resulted in a 9-day system outage, which ended on 21 January 2024.

Key learnings – operations

Avoid major system updates on Fridays, or immediately before a holiday – system updates introduce the risk of unexpected behaviour, and implementing these changes on a Friday, or immediately before a holiday, makes it challenging to respond rapidly to any issues that arise.

Better system monitoring for holidays and weekends – in FY23-24 FN1 experienced numerous outages outside of standard office hours, these often remained undetected for some time. Better system monitoring could allow for 24/7 identification of issues, and result in faster response times and reduced system downtime.

3.3. Technical performance

Power spikes issue

Pixii are considered industry leaders in Scandinavian frequency regulation markets with over 200MW of batteries currently trading. The Pixii PowerShaper BESS has been trading at scale in these markets since 2022. In Australia, however, the FCAS market participation requirements are more stringent, and, in the second year of FN1 operations, this led us to identify for the first time an issue in the PowerShaper system that is present globally.

The power spikes issue was first observed by YEF on 21 August 2023, manifesting as sudden spikes and drops in system charge and discharge power. As YEF's dispatch schedule sets the charge/discharge power at 50%, we observed both up and down spikes in power (at 100% charge and discharge rates only down spikes would be observed). These spikes resulted in short periods of overpower and underpower when charging and discharging the battery, shown in Figure 3.

Following the identification of the power spikes, Pixii began investigating the root cause and a decision was made to delay FCAS trading of FN1 until it was resolved. This delay was necessary as power spikes could cause a non-compliant response to an FCAS event and result in significant fines from AEMO.

In early 2024, Pixii Identified the cause was a RS485 communications issue within the battery energy storage system (a data overflow in the RS485 driver). This communication issue resulted in inverters disconnecting from the communications bus, causing a rapid reduction or increase in power delivery. On 18 February 2024, Pixii proposed a significant re-work of the firmware to resolve the issue.

Controlled testing of Pixii's new firmware commenced in late May 2024 in Norway. This was followed by testing at Pixii's Brisbane office and the implementation of updates onsite at FN1 in late June 2024. At the close of the second year, the on-site test regime was ongoing, with results expected in the early part of FY24/25.

Power spikes progress in the new operating year: as of 20 November 2024, Pixii provided test reports showing that the issue has been resolved and is suitable for FCAS trading.

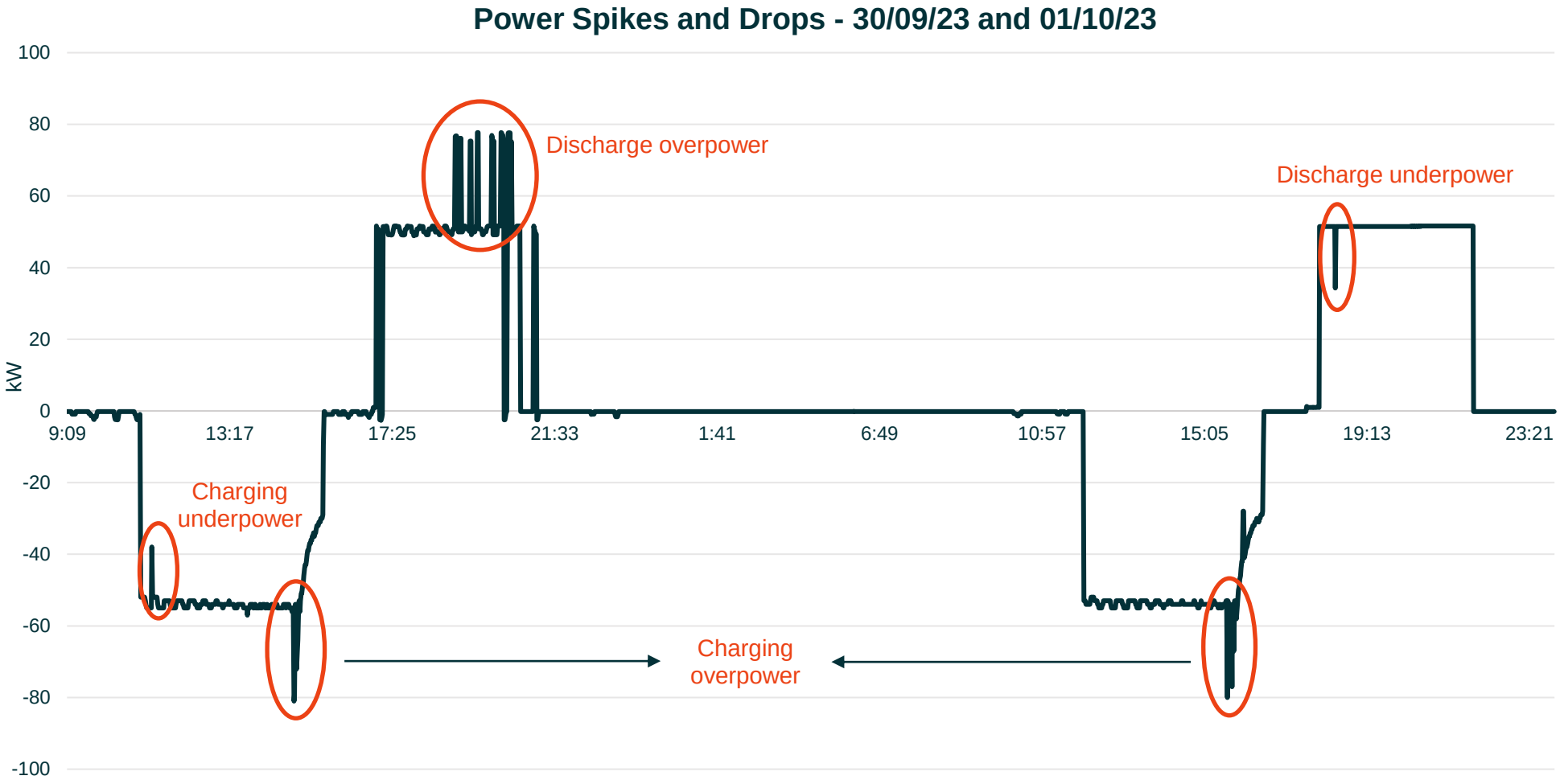


Figure 3: Example of observed power spikes in FN1 dispatch

Peak pricing event exposed dispatch engine: on the afternoon of 13 February 2024, damaging winds caused 2,210 megawatts of generation to suddenly exit the Victorian market, resulting in a 2-hour long peak pricing event with wholesale prices of $16,600/MWh. During this time post-dispatch price signals were delayed (arriving >90 seconds into the trading interval) and the AEMO pre-dispatch price remained <$300/MWh. As a result, the Acacia software platform used pre-dispatch prices to inform dispatch commands, and the system charged during this peak price event – directly costing YEF $320 that day.

If the system had instead been discharged during this time It would have generated relatively significant revenue rather than a relatively significant loss. This experience shows the value of an optimised dispatch engine, which in this scenario may have enabled the system to profit off this peak pricing event. It is also important to acknowledge that in this event, a retailer with a staffed trading desk may have been able to override the controls to halt imports and commence exports during the peak pricing event, even with a delay in receiving prices from AEMO. Although this feature was not available to them at the time, Acacia Energy is investigating how to avoid future occurrences on this issue.

Acacia Energy December 3 dispatch issues: On 3 December 2023, FN1 had an unplanned outage due to interface communication issues between Acacia's control architecture and AEMO following an update by AEMO. This issue was quickly resolved and the system resumed trading on 4 December 2023.

Equipment failures: Hardware outages contributed to all extended outages at FN1. Careful monitoring, and expedient after-sales support is essential to minimising the impacts of hardware failures on system performance.

Battery module failure – after investigating the new year outage issues it was found that a defective battery module and inverter had failed on 22 December 2023. This failure likely caused a power supply issue to the 4G router, leading to the observed communications outage on December 24 2023. The defective battery module was replaced by Pixii and returned to the supplier (Polarium). It was found that that the battery module's control system (known as a BMS) had failed, and the module had shut down as a precaution.

Air Conditioner on battery cabinet – this failure occurred in mid-April 2024 due to the malfunctioning of the thermostat control. This is believed to have been caused by material ingress on the control circuit board. This issue was quickly rectified, and a new air conditioner was installed in late April. After additional troubleshooting the system came back online on 12 January 2024, however the system did not commence dispatch until 21 January 2024 due to issues with Mill Software's dispatch commands (See Section 3.2 for details).

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Key learnings – Technical

Control and software issues can require complex diagnostics, development and testing – *the power spikes issue was detected early in the second year and was not resolved until November 2024. Pixii's diagnostics efforts were extensive, and development and testing of a software fix has required significant attention from their engineering teams. This has led an extended delay to commencement of FCAS trading and shows that the risk of software related challenges should not be underestimated by battery proponents.*

Dispatch engines are only as good as the input data – *the 13 February peak pricing event shows that BESS dispatch engines do not always act as intended and have some shortcomings compared to a human trading desk. These issues are not likely to be unique to Acacia Energy's software platform, and proponents should be aware that the performance of a dispatch engine is reliant on quality, timely data inputs.*

4. Financial Performance

4.1. Annual revenue summary

In FY23-24, the two sources of revenue were:

(1) Energy arbitrage

(2) CitiPower's community battery trial tariff

Energy arbitrage involves buying energy at low prices (by charging) and selling when prices are high (by discharging). In FY23-24, as shown in Table 1, FN1 paid $786 for energy imports while it made $8,994 from energy exports. Note that these figures represent net values for the year – the battery incurred higher total import costs which were offset by imports during negative prices, which reduced the overall net import costs.

CitiPower's bi-directional community battery trial tariff provided a monetary incentive to charge during the afternoon (when there is low demand on the network) and discharge during evening peak (when there is high demand), while it also penalised charging during the evening.

In FY23-24, as shown in Table 2, FN1 made $1,058 tariff revenue from imports between 10am-3pm, and $593 from exports between 4pm-9pm. It also incurred $440 penalty for imports between 4pm-9pm, caused by a configuration issue that delayed adjustment of the dispatch schedule to daylight savings time.

In total, between 1 July 2023 to 30 June 2024, FN1 made **$8,158** from energy arbitrage and **$1,046** from network time-of-use tariff, for a total of **$8,423** ex-GST, also including metering charges of $700 per year and AEMO market fees of $79. FN1 was unable to trade on FCAS markets due to the power spike issues.

Table 1. Revenue from energy arbitrage

Flow	kWh	Wholesale revenue
Energy export	81,054	$8,994
Energy import	64,083	-$786
	Total	**$8,158**

Table 2. Revenue from CitiPower's community battery trial tariff

Tariff time band	CB tariff (c/kWh)	kWh	Network revenue
10am – 3pm (import)	-1.5	70,503	$1,058
4pm – 9pm (import)	25	1,758	-$440
All other times (import)	0	8,767	$0
10am – 3pm (export)	0	72	$0
4pm – 9pm (export)	-1	59,316	$593
All other times (export)	0	4,694	$0
Fixed charge	45 c/day		-$165
		Total	**$1,046**

Table 3. Costs from market fees

Fee	Price (c/kWh)	kWh	Cost
AEMO ancillary fee	0.057	64,083	-$48.28
AEMO market fee	0.037	64,083	-$31.18
		Total	**-$79.46**

Table 4: Annual revenue summary

Revenue & Costs	Annual total
Wholesale Arbitrage Revenue	$8,158
Network Revenue	$1,046
Metering Charges	-$700
Market Charges	-$79
Total	**$8,423**

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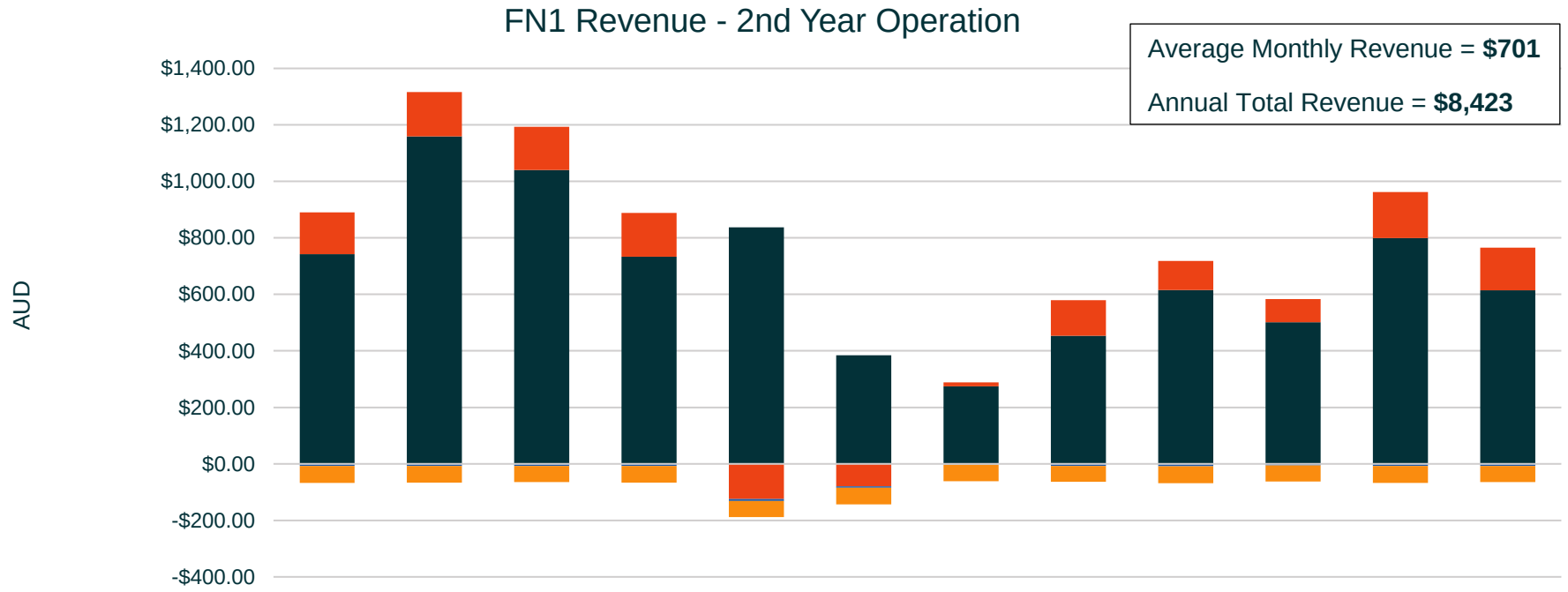
Monthly revenues varied from $226 (Jan 24) to $1,249 (Aug 23). Note that FN1 was offline for a significant portion of January 2024.



	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24
Metering Charges	-$59.45	-$59.45	-$57.53	-$59.45	-$57.53	-$59.45	-$59.45	-$55.62	-$59.45	-$57.53	-$59.45	-$57.53
Market Charges	-$7.51	-$7.32	-$7.15	-$7.30	-$7.04	-$4.90	-$2.47	-$7.34	-$8.59	-$5.17	-$7.58	-$7.06
Network Revenue	$147.75	$156.59	$152.78	$154.92	-$123.94	-$79.54	$13.82	$125.87	$103.63	$81.35	$162.70	$150.51
Wholesale Arbitrage Revenue	$742.40	$1,159.57	$1,040.69	$733.72	$837.69	$384.80	$274.28	$453.62	$615.15	$501.61	$799.68	$614.73
Net Revenue (Excl. GST)	$823.19	$1,249.39	$1,128.79	$821.89	$649.18	$240.91	$226.18	$516.53	$650.74	$520.26	$895.35	$700.65

Figure 4. Revenue summary year 2 (FY23-24)

4.2. FY23-24 quarterly revenue summaries

Q1: Jul – Sep 2023

During the winter months of the first quarter, the battery made its highest revenue totalling $2,942. The daily revenue during this period averaged over $30, reflecting steady financial performance. Notably, the revenue was boosted by two high-price market events on 1st and 15th of August, where the battery made $151 and $205, respectively. The average monthly revenue for the quarter was $981, with August contributing the highest monthly revenue at $1,159.

Q2: Oct – Dec 2023

In the second quarter, spanning spring and early summer months, the battery experienced fewer opportunities for energy arbitrage as the price spreads between charging and discharging were insufficient to yield strong financial returns. Overall, the battery charging costs were low, and for most days, the battery was paid to charge. However, the evening time prices remained low, limiting revenue opportunities during discharge.

The revenue in this quarter was also impacted by a configuration issue at Mill Software, resulting in dispatch timings misaligned with the network tariff during daylight savings and leading the battery to incur 25c/kWh to charge the battery between 4-5pm local time. This was resolved in the subsequent quarter. Additionally, the shutdowns in December further affected the revenue generation potential. The average monthly revenue in this quarter was $652, with November achieving the highest monthly revenue at $837.

Q3: Jan – Mar 2024

In the third quarter, revenue dropped from previous quarter, largely due to aforementioned operational issues. The system remained offline for most of January. Once the system came back online it primarily generated revenue from daytime charging during periods of negative prices. Notably, on 13 February, during peak pricing triggered by storms, FN1 continued charging due to delayed pricing signals from AEMO, resulting in a cost of $320 in a single day (refer section 3.3).

On 21 January, the system transitioned from Mill Software's dispatch system to Acacia's software platform, enabling battery dispatch as per CitiPower's network tariff avoiding penalty charges.

During this quarter, the parasitic load consumption from Pixii's monitoring equipment was also high which increased energy consumption and reduced revenue. The average revenue this quarter was $447 per month, and March achieved the highest monthly revenue at $615.

Q4: Apr – Jun 2024

The last quarter saw a return to improved financial performance with an increase in revenue compared to the third quarter. The daily spreads and revenue remained low in April but increased as winter approached in May and June. On average, the battery made $638 per month during this quarter. May was the most profitable month of the quarter where the battery made $799 of revenue.

4.3. FN1 performance vs 'perfect foresight'

FN1's financial performance can only be properly assessed when compared to the ideal performance of a perfectly optimised dispatcher (i.e., 'perfect foresight'). Our industry colleague, Diamond Energy, assisted with analysing our battery meter data using their in-house algorithm to determine the theoretical maximum wholesale revenue that could have been achieved by FN1 through a perfectly optimised dispatch.

The analysis compared FN1's performance against two perfect foresight (PF) scenarios:

PF1. Within YEF's operational rules of specific charge/discharge time bands, operating at one cycle per day, and

PF2. Without time band constraints but operating at one cycle per day.

Note that the revenue figures presented in Table 5 do not consider impact from distribution loss factor. However, the impact from loss factor is minor and does not significantly affect the analysis.

Overall, the battery could have made wholesale revenues of **$14,558** if dispatched in accordance with the PF1 scenario (following the existing operational rules and limited to one cycle per day), or **$20,059** if dispatched according to the PF2 scenario (single cycle per day but with no time band constraints). FN1's actual performance was **58%** against perfect foresight within YEF constraints (PF1), and **39%** against perfect foresight if only constrained to one cycle per day (PF2).

It is important to note that a significant portion of the additional revenue generated in scenario PF2 stems from exceptional market conditions in February 2024. As seen in Figure 4, the battery missed out on significant revenue making opportunities in that month, when the market prices peaked and remained at the maximum market cap during a storm event.

In scenario PF2 the battery would have capitalised on this peak pricing event by discharging, earning a significant revenue. This would not have been possible in scenario PF1 however, as the time band constraints preclude the battery from discharging between 10am and 3pm.

When excluding February 2024, the monthly improvements in revenue in scenario PF2 compared to scenario PF1 range from 6% to 30%, with an average monthly improvement of 14%. This analysis highlights the considerable revenue generation opportunities available when the battery is operated without time-based constraints and with market optimisation.

4. Financial Performance

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Table 5. Comparison of actual revenue to perfect foresight scenarios

Month	Actual Revenue	PF1		PF2		% Increase PF1 to PF2
		Revenue	Actual as %	Revenue	Actual as %	
Jul-23	$710	$1,168	61%	$1,303	55%	+12%
Aug-23	$1,110	$1,819	61%	$1,923	58%	+6%
Sep-23	$996	$1,372	73%	$1,448	69%	+6%
Oct-23	$702	$964	73%	$1,057	66%	+10%
Nov-23	$801	$1,196	67%	$1,362	59%	+14%
Dec-23	$368	$1,014	36%	$1,157	32%	+14%
Jan-24	$262	$971	27%	$1,126	23%	+16%
Feb-24	$434	$1,185	37%	$4,929	9%	+316%
Mar-24	$588	$1,142	52%	$1,284	46%	+12%
Apr-24	$480	$1,221	39%	$1,329	36%	+9%
May-24	$765	$1,277	60%	$1,551	49%	+22%
Jun-24	$588	$1,222	48%	$1,584	37%	+30%
Total	**$7,803**	**$14,558**	**54%**	**$20,059**	**39%**	**+38%**

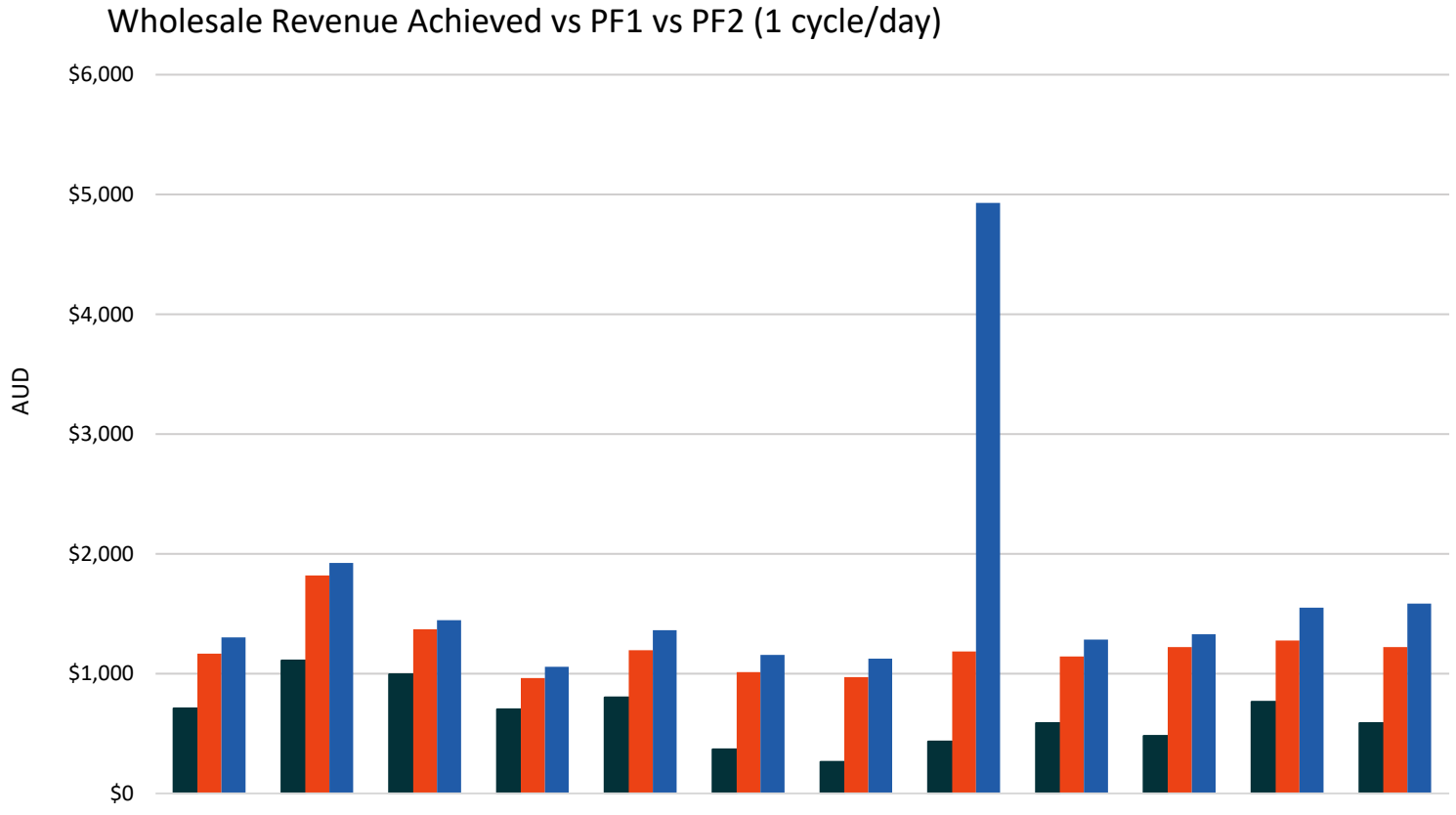
Key learnings – financial performance

Peak pricing events are a significant opportunity, but only if you can capitalise on them – *FN1's current dispatch logic does not allow for rapid responses to peak pricing events, which can be a significant windfall (or cost) to the battery. More effective response to peak pricing events could have greatly improved the financial performance in FY23-24, and YEF recommends that similar projects seek to implement more advanced dispatch engines that can capture this value.*

Network tariff revenue, though small, remains an important income stream for NBs – *in FY23-24 only 11% of FN1's revenue came from network tariffs, yet this stream provides steady income for the battery. Many DNSPs have adopted NB tariff structures that are either revenue neutral or impose a cost, effectively removing network tariff as a value stream for NBs. This makes it challenging for proponents to commercialise the value that neighbourhood batteries contribute to the network.*

Winter months remain the most lucrative for batteries – *this is due to greater wholesale price spreads during the colder months.*

Failing to update dispatch schedules for local time changes is costly – *network revenues in November and December 2023 were a net loss due to the battery dispatch schedule failing to adjust to daylight savings. It is important to work closely with retail partners to manage changes to local time.*



	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24
Actual Revenue Achieved	$710	$1,110	$996	$702	$801	$368	$262	$434	$588	$480	$765	$588
PF1 – YEF operational rules, at 1 cycle per day	$1,168	$1,819	$1,372	$964	$1,196	$1,014	$971	$1,185	$1,142	$1,221	$1,277	$1,222
PF2 – Without timeband constraints, at 1 cycle per day	$1,303	$1,923	$1,448	$1,057	$1,362	$1,157	$1,126	$4,929	$1,284	$1,329	$1,551	$1,584

Figure 5. Comparison of actual revenue to two 'perfect foresight' scenarios

5. Outlook

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5.1. Future

FCAS registration and trading

Since the completion of the second year of operation, Pixii's final test report delivered on 20 November 2024, found that the power spikes issue had been successfully resolved. At the time of writing, Acacia Energy are transitioning to bidding FN1 into six of the eight FCAS markets with participation in the very fast (1 second) FCAS markets planned for early 2025. In the second half of Year 3, YEF will continue working with Acacia Energy to capture value in the FCAS markets and to balance FCAS bidding with dispatching for wholesale arbitrage and community battery network tariff revenue.

Continued focus on improving operational performance and sharing learnings with the industry

In the third year, YEF will continue to closely track the technical performance of FN1 to further refine its operations. Over the last two years, daily monitoring has enabled us to identify operational anomalies and implement targeted solutions. These learnings have been shared with the industry and manufacturers through our performance reports.

Financial outlook

From a financial perspective, ongoing areas for improvement include reducing parasitic loads to minimise import costs (e.g., fine-tuning cooling control setpoints), improving dispatch to capitalise on peak pricing events (e.g., by moving towards a more market-optimised dispatch logic), and minimising system downtime to improve revenues. It is anticipated that these changes will improve system performance against perfect foresight.

A note on graffiti tagging

Although not featured in the earlier sections, it is worth noting that FN1 is subject to regular graffiti tags (despite its artwork). To combat this, a heavy-duty anti-graffiti coating is applied to protect the artwork and make FN1 easier to clean. Even with this protective coating the artwork has required small touch ups by the artist after two years. Artwork maintenance should therefore be factored into site maintenance costs and scheduling.

Appendix 1 – Recap of first year

Appendix 1 – Recap of first year

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The *Year 1 Performance Report* detailed YEF's experience learning to operate, and troubleshoot, a BESS participating in the National Electricity Market (NEM) in FY22-23. Our focus was developing a strong understanding of the technology and its integration into the market. In the months following commissioning, there were numerous challenges achieving stable operation due to issues with panel configuration, protection and control settings, and software defects.

Subsequently, issues emerged relating to variability in state-of-charge calculations and derating of power capacity at both high and low states-of charge, which were resolved by Pixii. There were also delays in completing FCAS registration, further reducing revenue opportunities.

We also identified that using optimisation software to dispatch the system would only be effective if the forecast price input data was broadly accurate. As AEMO's price forecast functions more as a market signal than a true forecast, we found that a scheduled dispatcher performed as well, or better, and with the benefit of predictable dispatch behaviour. Additionally, we calibrated the system to account for parasitic loads (e.g. losses due to cooling and control system operations) to reduce import costs by maintaining low-level power output during the peak import tariff window.

The ethos of the operating model has always been to support the energy transition. In practice, this means that the dispatch schedule may not always prioritise revenue generation, as we also sought to demonstrate how neighbourhood batteries could act as a 'solar soaker' by charging during the day, lowering daytime LV voltage levels and enabling greater export and solar hosting capacity. Additionally, the schedule largely aligned with CitiPower's community battery tariff, showing how third-party NBs can be of benefit to the distribution network by maximising network utilisation and reducing peak demand.

The financial performance in FY22-23 was marred by the initial operational issues, during which time the battery missed out on significant revenue opportunities arising from Australia's energy crisis. Disregarding these first two months, during which time the BESS was not actively trading on the market but still broke even, the average monthly revenue was $763, with April the best performing month at $1,008. The annual revenue was $8,417, this amounts to 37% of the potential annual revenue based on perfect foresight (~$23,000) for the full financial year, or 57% (of ~$15,000) when disregarding the first two months.

Finally, the *Year 1 Performance Report* also detailed YEF's perspective on decarbonisation. It noted a distinction between *operational emissions reductions* (i.e., displacement of fossil fuel generation), and *supporting the transformation of the energy system*. The former is difficult to accurately quantify owing to various calculation methods and energy market uncertainties. We emphasised the ways in which NBs can indirectly, but significantly, support decarbonisation at the system level by reducing renewable energy waste, regulating voltage, supporting electrification, and firming variable supply.

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