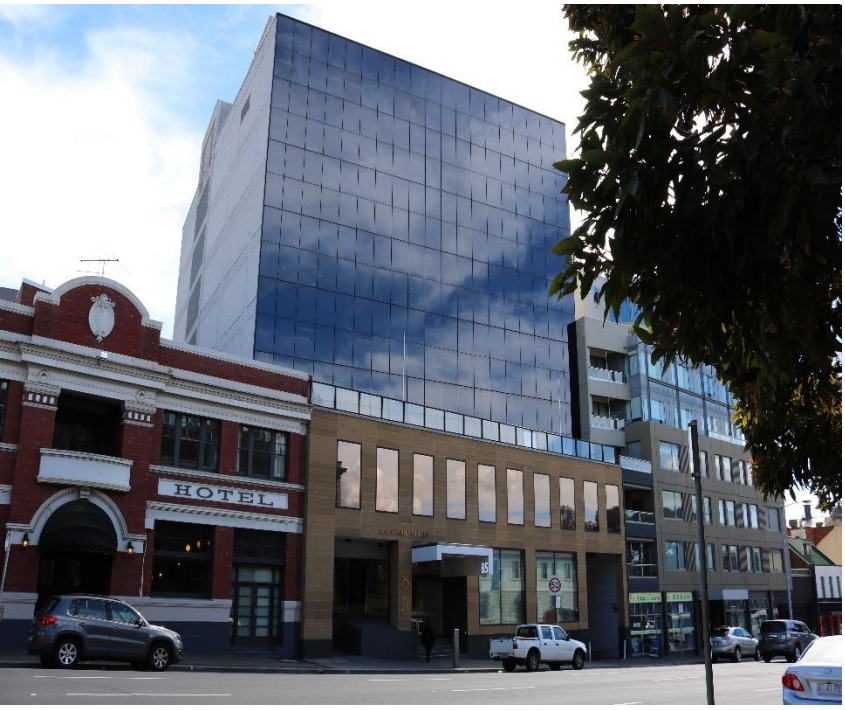
ABB synchronous reluctance motors and drives enable reduced carbon emissions in an energy efficiency upgrade for Hobart CBD building.

CASE STUDY I AUSTRALIA I 2022-06-08



- The equipment upgrade has enabled a 5.1 tonne reduction in annual CO2 emissions.
- For the supply air fan application energy consumption was reduced by a staggering approximation of 40%.
- For the chilled water pump application, energy consumption was similarly reduced by around 35%.
- The building property managers have experienced significantly lower operational costs and energy bills.

They're not always thought about, but critical technology goes into building infrastructure to increase energy efficiency, facilitate air quality control, and prevent electrical or mechanical issues. Similarly, the right technology is imperative to ensure safe, reliable, and sustainable outcomes in buildings so that occupants remain comfortable and property management avoid problematic and often costly situations.

The Sypkes Group's property at 85 Macquarie Street, is a multi-tenancy commercial building that features corporate office spaces including those occupied by government and parliamentary officials. It is situated in the heart of Hobart's Central Business District (CBD), in Tasmania.

The ten floors are occupied by approximately 250 workers on any given workday, and the bottom two levels of the building date back almost 200 years.

When Stuart Davey-Sypkes, Director of Property of the building recognised issues with aging equipment used to manage the heating, ventilation, and air conditioning (HVAC) operations, he consulted Enginuity Power Solutions, who collectively engaged ABB Authorized Value Provider A1 Electric Motors, to conduct an in-depth analysis of the existing system's process performance. Stuart's goal was to identify how they could not only increase the reliability of HVAC operations using modernised technology, but also to identify areas they could

reduce energy demand and, in the process, increase energy efficiency.

The HVAC application that underwent the analysis incorporated motors and drives responsible for powering and managing the chilled water for 85 Macquarie Street, and others that were depended upon for powering the supply air fan for the entire building.

Solutions identified

Tom Green, Managing Director at Enginuity Power Solutions, together with Chris Cheong, Director at A1 Electric Motors, determined ABB motor and drive dedicated solutions for HVAC to be the best possible fit for this building infrastructure upgrade.

Their analysis also recognised that 85 Macquarie Street was eligible to bring their existent motor selection down a size. The supply air fan was originally powered by a 15kW motor but it was determined that the necessary motor that would be adequate to drive the load was instead a 11kW motor. In turn this would enhance their system, reduce operating costs and increase energy efficiency.

The selected ABB drive to operate the motor was also optimally matched to the motor's required power rating which drastically increases the return on investment overall.

ABB synchronous reluctance motors (SynRM) and ACH580 variable speed drives (VSD) were ultimately selected for this project.

The difference made when upgrading to a high-efficiency IE5 SynRM motor

HVAC systems worldwide rely on millions of low-voltage (LV) electric motors to run pumps, fans and compressors. However, there's a price to pay in terms of energy consumption and associated CO2 emissions. These motors consume on average about 50% of the energy used in buildings.

Most of the motors in our buildings today are only efficiency class IE1 or IE2. Upgrading the motors at 85 Macquarie Street to IE5 SynRM motors allows substantially increased energy savings. Even when compared to an IE3 energy efficiency class induction motor, it offers up to 40% reduced energy losses, delivering ultra-premium energy efficiency – a new level of efficiency defined by the International Electrotechnical Commission (IEC). This attribute makes SynRMs the first choice to meet the global demand for environmental impact reduction when it comes to motor technology.

When it comes to the innovative design, the rotor in a SynRM motor runs without magnets or windings and suffers virtually no power losses. This makes it as service friendly as traditional induction motors. SynRMs are also made from reduced quantities of material for manufacturing versus a traditional motor. A key point when assessing levels of sustainability.

Rory Paltridge, Division Manager for Motors at ABB Australia says, "climate change and environmental responsibility are propelling changes across all industries and there's a clear synergy with A1 Electric Motors and Enginuity Power Solutions to support this drive towards net zero. These SynRM motors offer industrial users a great opportunity to reduce their electricity usage and CO_2 emissions while also benefiting from increased productivity and lower life cycle costs. "

Energy efficiency, cost effectiveness, and reliability without compromising on comfort

The ACH580 is a drive that stands out for its ability to guarantee air quality in the most energy efficient and cost-effective way in both normal and critical situations.

Because HVAC systems run at partial loads close to 99% of the time, VSDs can save energy by an average of 20 to 60% compared to traditional damper or valve control methods. Such massive energy savings are possible because drives can adjust the motor speed of equipment directly to meet the current building needs.

Variable speed control delivers the full benefit of running HVAC applications at partial load, allowing accurate control of ambient CO_2 levels, temperature, and humidity for the best indoor air quality and occupant comfort, health and safety, while optimising energy use.

When asked about what primary factors pulled him towards proceeding with the asset replacement at 85 Macquarie Street, Stuart Davey-Sypkes, Director at SFO Property said, “it just made sense every way I looked at it. Reducing energy consumption in the building by upgrading the foundation that underpinned the plant and where equipment played a pivotal role, was the logical first step in a broader strategy to reduce the running costs of our building. The ROI calculations looked compelling and it was backed with sound logic, which resulted in an easy ‘yes’ to undertake these upgrades.”

12 months strong and data that radiates positive results

It’s been found that the equipment upgrade has enabled a 5.1 tonne reduction in annual CO2 emissions. To offset this much carbon you would have to plant approximately 2.5 hectares of trees every year for the life of the asset. That’s equivalent to an area the size of 1.5 Melbourne Cricket Grounds (MCG), or five return trips between Paris and New York by plane.

A look at the supply air fan application shows energy consumption was reduced by around 40% with a reduction in line current of approximately 9%. Thanks to the implementation of the ABB ACH580 VSD inrush currents have been reduced by over 140A per phase and kVA demand has been reduced by over 100kVA. This has the potential to further reduce the energy costs at 85 Macquarie Street by over $12,000 AUD annually.

When it comes to the chilled water pump application, energy consumption was reduced by around 35% with a reduction in line current of approximately 43%. Owing to the new VSD inrush currents have been reduced by over 92A per phase and kVA demand has been reduced by over 65kVA. This has the potential to further reduce the energy costs by over $8,400 AUD annually giving the project’s capital investment an ROI of approximately 18 months.

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(L-R): Stuart Davey Sypkes, Tom Green, and Chris Cheong in the lobby of the 85 Macquarie Street building.

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(L-R): Chris Cheong and Tom Green standing beside the chilled water pump and the newly installed ABB synchronous reluctance motor on the plant deck of the building.

By the numbers – a comparison of then and now

Data produced by Enginuity Power Solutions has captured a telling comparison between the old infrastructure at 85 Macquarie Street versus the new ABB technology commissioned.

Figure A demonstrates the significant reduction in inrush current on start-up (the old system showed around 155 Amps per phase, versus the new system of around 14 Amps per phase). Also noteworthy is the significant reduction in kVA power requirements. The old system required 109 kVA to start the motor and following the implementation of the ABB SynRM motor and drive package, this was reduced to just 9.74 kVA. This is particularly substantial as most commercial customers in Australia are charged for peak kVA demand. A reduction in kVA demand, therefore, equates to significant operational cost savings.

Figure B is again a revealing comparison of the benefits of the new supply air fan system and highlights the current draw/inrush current during system start. It demonstrates the load profile of the current draw of the system when the motor starts. Notice the massive peak in current draw in the top graph when the old system was using Direct On Line motor starting (DOL). The peak current is around 150 Amps per phase.

In comparison, Figure C which profiles the performance of ABB's SyRM motor and ACH580 drive package shows the load ramp rate increase gradually signifying more managed control of speed and power. Additionally peak current is reduced to around 13 Amps per phase (which in turn is the same as the running current of the system). This results in reduced mechanical stress on the system and equipment as a whole which extends equipment lifetime, reduced the need for service downtime, and emphasises the reduced energy consumption in the application and associated costs.

Existing Motor (DOL)		L1	L2	L3	
2/07/2021 7:42:22 AM 698msec	Vrms ph-n	239.86 V	240.22 V	241.07 V	
2/07/2021 7:42:22 AM 698msec	Vrms ph-ph	414.94 V	418.05 V	415.98 V	
2/07/2021 7:42:22 AM 698msec	Arms	152.4 A	154.9 A	155.9 A	
2/07/2021 7:42:22 AM 698msec	Power Factor	0.88	0.88	0.86	0.87
2/07/2021 7:42:22 AM 698msec	Active Power	19.79 kW	20.17 kW	20.07 kW	60.03 kW
2/07/2021 7:42:22 AM 698msec	Active Energy	17.90 kWh	21.03 kWh	19.80 kWh	58.73 kWh
2/07/2021 7:42:22 AM 698msec	Reactive Power	30.09 kvar	30.6 kvar	31.08 kvar	91.77 kvar
2/07/2021 7:42:22 AM 698msec	Apparent Power	35.8 kVA	36.43 kVA	36.78 kVA	109.02 kVA
2/07/2021 7:42:22 AM 698msec	Apparent Energy	28.79 kVAh	30.19 kVAh	32.94 kVAh	92.24 kVAh

Replacement SynRM Motor and Variable Speed Drive		L1	L2	L3	
6/09/2021 11:36:07 AM 376msec	Vrms ph-n	239.68 V	240.11 V	241.71 V	
6/09/2021 11:36:07 AM 376msec	Vrms ph-ph	414.55 V	418.04 V	417.11 V	
6/09/2021 11:36:07 AM 376msec	Arms	13.7 A	12.3 A	14.5 A	
6/09/2021 11:36:07 AM 376msec	Active Power	2.52 kW	2.34 kW	2.9 kW	7.74 kW
6/09/2021 11:36:07 AM 376msec	Apparent Power	3.28 kVA	2.94 kVA	3.5 kVA	9.72 kVA
6/09/2021 11:36:07 AM 376msec	Reactive Power	700 var	240 var	340 var	1.26 kvar
6/09/2021 11:36:07 AM 376msec	Power Factor	0.77	0.8	0.83	0.8
6/09/2021 11:36:07 AM 376msec	Active Energy	2.39 kWh	2.22 kWh	2.77 kWh	7.38 kWh

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Figure A: Example inrush current data capture/system start profile of the old motor using Direct On Line motor starting (DOL) at 85 Macquarie Street for the supply air fan application.

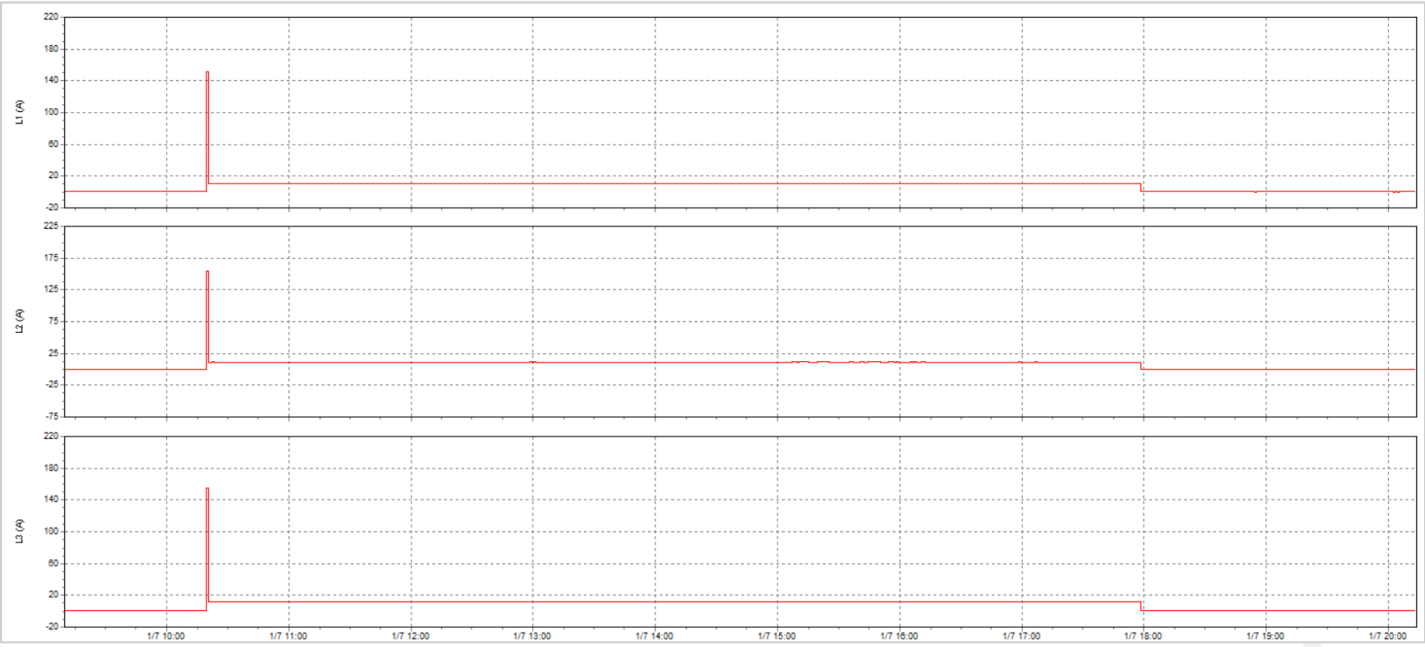

Figure B: Comparative data of the old system versus the new system at 85 Macquarie Street when analysing current draw/inrush current during the start-up of the supply air fan application.

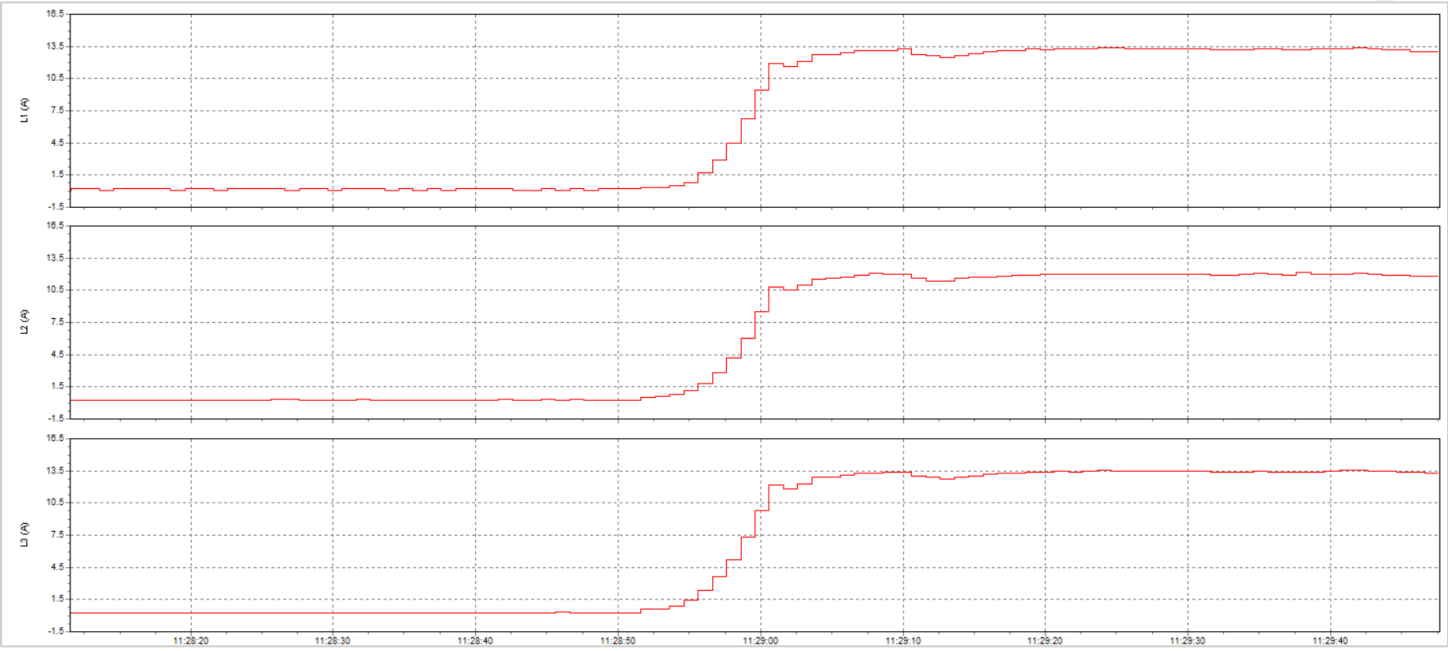

Figure C: Analysis of the inrush current/system start profile of the supply air fan application at 85 Macquarie Street when using ABB's SynRM motor and drive package.

Tom Green says, “We launched Enginuity Power Solutions with a focus on supporting industry and bridging the gap between intangible ideas and delivering evidence-backed innovative, future-proof solutions.

Our partnership with Chris and his team at A1 Electric Motors and our collaborative approach cements our ability to consult, design and deliver on projects such as these. The hope is that we can continue to specify engineered solutions to build a more energy efficient tomorrow.”

Chris Cheong says, “we’re always thrilled when we’re able to see potential energy savings from equipment upgrades with the use of the ABB EnergySave calculator coupled with ROI data such as that provided by Enginuity Power Solutions. It always makes a huge difference to the offering we’re able to give to our customers and Sypkes Group was no different.”

When coming face to face with the project upgrade results one year on Stuart Davey-Sypkes says, “after I had approved the upgrades, I parked the project in the back of my mind for a few months and didn’t give it any thought to be honest, until I reviewed the electricity charges three months later. I was shocked! In a good way.

The reduction in energy charges and its direct beneficial impact on our bottom line was unmistakable. Our team immediately started thinking about other opportunities that existed across our assets to replicate the process. We also communicated the results to our tenants who report on the environmental impacts of their office accommodation, and they were naturally happy to be occupying a more environmentally friendly establishment. So, a good news story all-round.”

ABB (ABBN: SIX Swiss Ex) is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels. With a history of excellence stretching back more than 130 years, ABB’s success is driven by about 110,000 talented employees in over 100 countries. www.abb.com

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