Renewable Energy & Load Management – for Manufacturing

What is renewable energy & load management (REALM)?

On-site renewable energy, especially rooftop solar, is now significantly cheaper than grid electricity. But as solar PV is a daytime-only electricity source, there are still many types of loads and business operations which cannot take advantage of the cheaper power.

Load management, identifying and shifting electrical loads, increases the value of solar PV. Loads can be shifted to make greater use of solar PV generation, flatten demand peaks to avoid network charges and take advantage of lower off peak rates. *All in a way that does not affect your business's operating schedule.*

New storage and demand control technologies make it easier and cheaper for energy to be stored and used at different times without adversely affecting operations - opening up opportunities for businesses to save money or earn energy market revenue.

Traditionally, the energy system has treated consumer demand as 'fixed' and used centralised supply options to manage variable demand. Now better data systems, onsite storage and generation technologies and automated demand control software allow businesses to pro-actively manage their demand and respond to energy market prices.

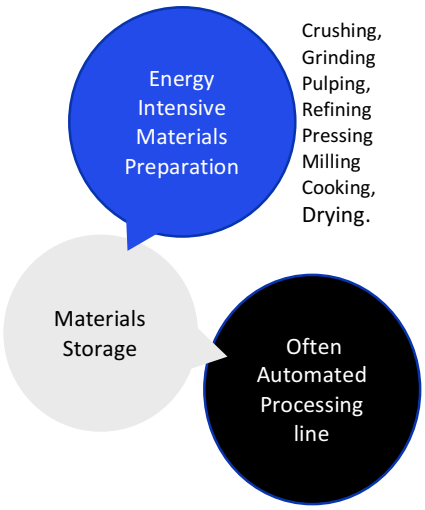
How can REALM work in your business?

- Existing on-site heating or cooling systems, compressed air, materials storage or batteries can hold excess output solar systems or the grid.
- By installing or upgrading demand control software, your business can use stored power at high-demand times for reducing network tariffs based on monthly demand peaks or consumption during peak price periods.
- Businesses can get more value from existing solar PV systems and install more panels without exporting surplus power to the grid for low rates.
- Flexible REALM systems could also earn revenue, delivering low-cost energy market services by:
    - Exporting or reducing load during high-price wholesale times;
    - Reducing investment in expensive generation and poles and wires to meet demand peaks;
    - Providing network services or system reserves to maintain supply.

Combining renewable energy with manufacturing operations.

High daytime loads and increasing automation in the manufacturing industry provide opportunites for load flexibility. A focus on services to the manufacturing process such as heating or cooling, or compressed air can yield storage elements already in situ in many manufacturing settings.

1. **Electric furnaces/melters** for metals (e.g. electric arc, induction) and glass usually have significant thermal mass. Melters are also used for plastics
2. **Cold water tank or ice storage** – large thermal storage capacity to support chiller load flexibility.
3. **Refrigerators and freezers** – pre-cooling can create significant storage
4. **Material storage**: Where the business has an automated processing step such as drying or grinding which is followed by storage, the processing step can be scheduled and the outputs stored for later use in downstream processes.



5. **Compressed air** – scheduling compressors and storing energy as compressed air for later use can make use of existing compressed air tanks to create load flexibility with minimal additional hardware.

Standby generation

On-site power generation is another powerful source of on-site load flexibility. Most manufacturing and many large commercial sites have diesel or gas engines installed for emergency standby power and these can be used for load management subject to conditions:

- Additional operational hours not compromising reliability (note that these units have to be 'exercised' a number of hours per month in any case to ensure reliability)
- They do not cause too much vibration, noise or pollution if run more routinely
- Synchronous operation
- Their cost of operation is not excessive
- The value of the electricity they displace is high: for example, if use of a back-up generator for short periods avoids demand charges, the value per kWh is much higher

Other Load Flexibility Options

- **Discretionary loads**: there are some loads which can be varied in time such as staff amenities, hot water and sometimes cooking
- **Forklifts and Electric vehicles** can have significant batteries offering an additional source of energy storage depending on operating needs
- **Hot water systems**: generally small but may offer a storage opportunity
- **Energy Efficiency Opportunties**

Low-cost energy efficiency can also target demand peaks in addition to total consumption:

- **Variable Speed Drives** (and operational procedures like soft starts or rescheduling start-up of major equipment) can target sources of demand spikes. An process start-up might not require much energy but if it adds 100kVA for a small period, the annual network charges can increase by over $10,000.

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- **Improving building thermal efficiency** to reduce electricity consumption on hot days - painting roofs with heat reflective coating, shading, glazing and green walls.
- Improving operation of the **Building Management System** - benchmarking performance to identify inefficiencies, using predictive weather forecasts to optimise storage and equipment.
- **Upgrading equipment that produces heat** within air-conditioned spaces (e.g. LED lighting). Cheaper, more flexible sensors are becoming available.
- **Limiting air and heat flow** from the building - thermal imaging can identify air leakage for insulation or sealing or zoning of internal areas.
- **Chiller loads** can be reduced by lowering distribution losses and enhancing operational efficiency. Monitoring the amount of defrost water produced is a useful indicator of energy waste. At times of low load, efficiency can drop off dramatically – installing a smaller flexible chiller can be cost-effective.

How can business create load flexibility?

Control strategies for integration of renewable energy and load management range from simple to more complex.

Simple

Simple automated on/off load management procedures or reprogramming of existing Building Management Systems (BMS) or control systems require low capital investment and no major change in business practices. They can be implemented through existing control systems.

Enhanced control systems will position sites to move into the next category as technology develops and better energy price signals are offered.

Medium

Medium strategies primarily utilise existing plant and equipment but involve investments in controls, PV and storage capacity (e.g. installation or extension of a storage tank).

There may be some business practice changes and additional monitoring and analysis for optimisation.

Complex

Complex strategies require significant capital investment in

- Monitoring and analysis to fully understand system operation and optimisation
- Upstream processing capacity and/or more process storage
- Battery storage
- New plant/technology change

Generally, the current price signals do not make the business case attractive for complex strategies, but energy market reform processes are opening up opportunities to access new revenue streams such as the energy wholesale market, or network support services to the electricity networks.

How can you position your business for REALM?

Data is everything: 'that which gets measured, gets managed'

Energy consumption is understandably usually a secondary concern for businesses – but energy data systems are becoming cheaper and easier to operate.

Upgrading data systems is a foundational stone in a successful energy management strategy and can deliver very strong returns by:

- Identifying energy efficiency options with short paybacks.
- assessing and establishing a business case for a REALM initiative.
- Integrating and optimising loads, renewable energy and storage involves collecting, analysing and monitoring data.

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The best times to consider REALM opportunities

- Moving premises
- Investing in new machinery or equipment. Particularly heating or cooling equipment, or a process which involves an upstream processing step where product or materials are stored before a downstream process step.
- Investing in on-site renewable energy
- Assessing changing energy plan or retailer

Be aware of load management opportunites at these times and seek a consultant's help in identifying cost effective strategies. Simply installing solar without considering load management could miss major saving opportunities.

A checklist for improving data collection.

Your data collection or building management system should be configured to:

- Collect and log data for all energy meters, and ideally, all major sub-loads and equipment e.g, chillers, boilers and lighting.
- Log temperature, cooling and heating loads and other 'outputs' of the major sub-loads and equipment.
- Keep logged data for at least 24 months.
- Log preferably at a resolution of 15 minutes or shorter. Hourly would be considered the absolute maximum.
- Allow export of logged data in csv or other easily accessible format.
- Benchmark performance. Assess Energy 'in' vs output 'out' for major sub-loads and equipment.
- Ask 'is this data actionable'? Can it be used for making informed decisions?

Building Management Systems are often proprietary software so there can be problems getting access to energy data and developing expertise in operating equipment efficiently.

Case study : Schneider Electric – Gepps Cross

The Gepps Cross site features a factory building, a warehouse, a distribution centre and a commercial office building. The total area of the site is over 30,000 m2 with over 500 permanent employees. This site can be divided into two areas; factory area and commercial office area

The factory area is in operation 24 hours a day five days a week, and some Saturdays. The commercial office area is generally in operation between 7am to 7pm, Monday to Friday. Both electricity and gas are used on site. Electricity is used for the manufacturing process, assembly process, site heating and cooling, and provides general lighting and power on the site.

The facility is subject to peak, shoulder and offpeak rates, as well as an agreed demand level of 1700kVA which creates a reasonably strong price incentive for peak demand reduction if it can be permanently addressed.

Used area beside the carpark provides an opportunity for deployment of prefabricated solar PV at low cost and in a manner which could be removed if Schneider shifts its operations.

Storage opportunities in compressed air and chilled water exist and would have been most cost effective at the time of plant construction.

Adding storage, either a cold storage tank or battery, delivers a slightly lower return under current tariffs than just solar PV but enhances flexibility and energy security. Increasing flexibility will equip Schenider to better manage electricity costs in response to tariff changes such as cost-reflective pricing – and also earn revenue as the rules are being changed to reward businesses that can change their demand or export during peak times or support the operation of the electricity network. Load flexibility also reduces dependence on South Australia's constrained electricity network.

In the case of Schneider, a large lithium ion battery, combined with Schneider's EcoStruxure predictive control system, is better than cold storage capacity. Cold tank storage can only reduce load by the amount of chiller operations and is well-suited where small amounts of storage can reduce demand charges. The

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battery is the more flexible option as it is able to reduce demand at any point in the day at its maximum capacity. Rates of return in excess of 13% are expected.

The cold tank and battery storage are using the same excess output so it is generally a case of choosing one or the other. However if tariffs were to change, a cold tank deployed in tandem with a battery could work as part of a strategy focussed on peak shaving and arbitrage to shift power into cheaper times.

Case study : Goodman Fielder

The Goodman Fielders plant at Erskine Park includes two facilities with shared plant for steam, hot water and compressed air:

- a **baked frozen bread plant** which produces pre-baked frozen bread. Cooling is delivered by large refrigeration chillers, which are the dominant plant electrical loads (2 * 220 kW ammonia chillers and a 38.5kW chiller for delivering chilled water). There are also 2* 103 kW chillers for the factory HVAC system (and associated cooling towers) for the whole factory.
- a **liquids factory** which mixes and cooks a range of liquid products such as sauces, dressings. A less intensive load largely associated with mechanical mixing and blending, as well as a 150 kW ammonia unit for a chilled water circuit.

The load profile indicates that demand on Monday mornings is extremely peaky, with up to 200kVA jumps (largely a result of the cooling plant being restarted after a weekend shutdown and clean). There is not much energy being consumed when the total plant load exceeds 450kVA, so there are opportunities to reduce peak demand under the current network tariff.

Adding a cold storage tank will improve the returns on a planned investment in rooftop solar. A relatively short amount of storage time is needed to use solar power to lop the peaks. This better suits a cold tank storage than a battery which comes in modular units. Returns in excess of 14% could be expected from a modest sized cold tank in combination with a solar PV system of 450kW. A short duration electricity tariff that reflects system costs would significantly improve returns.

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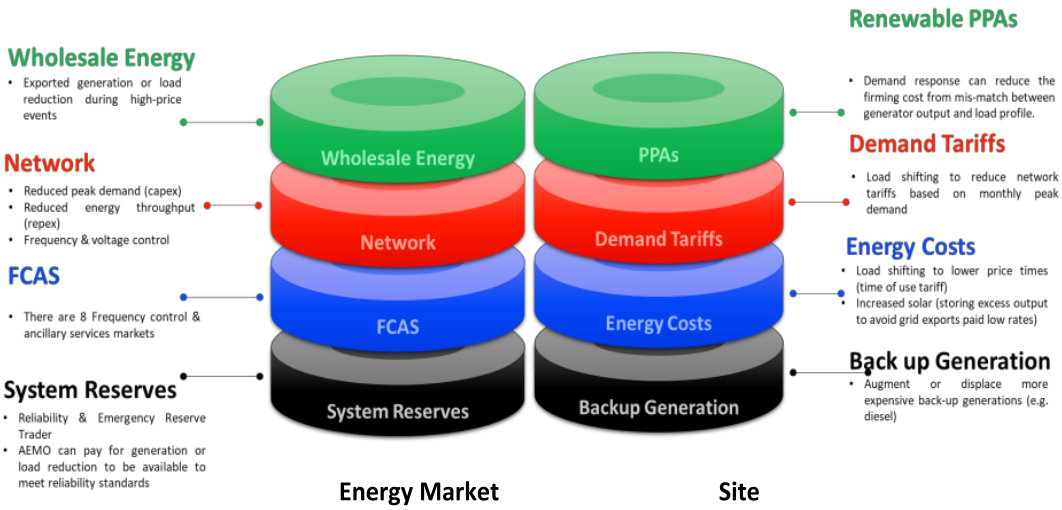
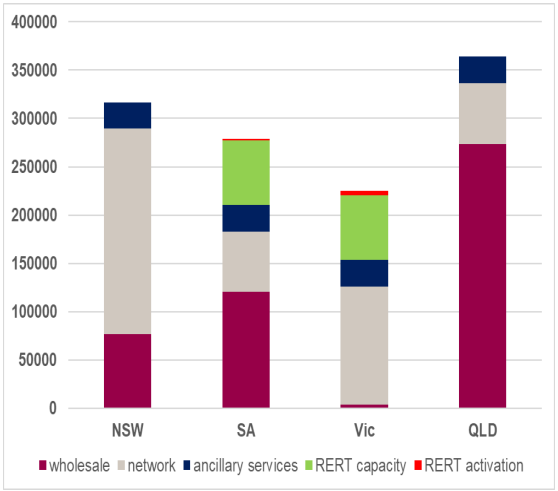
The Value Stack – REALM



Currently, electricity tariffs provide little incentive for businesses to adjust demand – but with the right price signal there are low-cost alternatives to peak generation and new poles & wires.

This is now changing. Energy market regulators are considering how to enable businesses to earn revenue if they can provide demand flexibility in response to a price signal.

Demand Response Revenue, Indicative, ($/MW)



The figure illustrates the revenue that could have been available within each of the major state's markets during 2017 for providng energy market services

- **System reserves (RERT)** - 2017-18 summer payments (note: RERT capacity must be off-market and is not available for wholesale or FCAS market)
- **Wholesale markets** - value is based on bidding 1MWh into each half-hour settlement where the price was greater than $500/MWh (minus a 15% retailer margin).
- **Ancillary services** – value based on offers available from 'aggregators' who bundle small generators and providers in to a large enough total to create value on the anciliary services market.
- **Networks** - value is based on 75% of the average deferrable investment where there is a network constraint in each state (note: less than 10 per cent of zones in most distribution networks have a constraint).

  New opportunities may emerge for voltage and frequency management under the Demand Management Incentive Scheme which provides around $1 billion for cheaper alternatives to new poles and wires.

In practice, businesses can either provide off-market capacity for system reserves (if selected through tender by the Australian Energy Market Operator) or market capacity for the wholesale and FCAS markets.

Specialist aggregators such as Enernoc and Greensync provide quotes for services.

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