Moving from energy management best practice to sustainability – New Zealand's leaders in sustainability

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ABSTRACT

Over the past 20 years, the energy intensity of high income economies has declined significantly while the proportion of energy from renewable sources has increased. Despite this, CO_{2e} emissions remain above levels required to limit global temperature increase to 2°C and energy is still largely derived from non-renewable sources.

To improve productivity and environmental performance, industry has widely adopted continuous improvement processes to systematically reduce energy inputs to their business. However to become sustainable, industry needs to go further than best practice, largely eliminating CO_{2e} emission sources and becoming low-carbon energy innovators.

This article describes how two New Zealand organisations have gone beyond best practice in energy efficiency to becoming world leaders in sustainable production and practices. Using a qualitative approach, this paper describes how, Yealand's Estate Wines and Christchurch City Council, established a corporate commitment to sustainability that has dramatically lowered carbon inputs and continues to yield international accolades and word firsts.

For both organisations, a commitment to energy efficiency and sustainability came from different motivations but involved similar steps. That is:

1. developing a long term strategy for energy efficiency and sustainability that complements and aligns with the organisation's brand and external relationships,
2. embedding continuous improvement processes to manage energy, waste, water use and carbon and
3. empowering staff and suppliers to develop innovative energy efficiency and renewable energy projects and providing a clear framework to ensure ideas are implemented

Organisations employing best practices in energy management are likely to have energy strategies and continuous improvement cycles. From the two examples presented, the difference then between companies employing best practice energy management and those with a sustainable energy use is innovation. Specifically staff having a clear mandate to develop new ideas and a framework to ensure there is a pathway for ideas to be implemented.

Introduction

To improve productivity and environmental performance, industry has widely adopted energy management best practice through implementing continuous improvement processes and has systematically reduced energy inputs to their business. Globally, carbon emissions and

energy intensity per unit of GDP is in decline with many high income economies, seeing energy use and carbon emissions reductions in absolute terms(Olivier et al, 2014). However while energy management best practice addresses energy waste it often does little to address the sustainability of energy supply. As a result worldwide population and GPD increases are outstripping improvements in the energy and carbon intensity of economies and carbon emissions are continuing to rise (IEA 2014, 14).

In 2009, the Copenhagen Accord recognised that to prevent "dangerous anthropogenic interference with the climate system" global temperature increases need to be limited to 2 degrees (UNFCCC 2010) and that to achieve this "deep cuts in global emissions are required…". Focusing on this limit, Working Group III of the International Panel on Climate Change (IPCC) assessed a range of emission reduction models. To be likely to limit temperature increases to 2 degrees, atmospheric levels of CO_{2e} need to be stabilised at 450ppm (IPCC 2014, 13). This is likely to require energy use to drop by 30% and the proportion of low carbon energy sources in total energy supply to increase from current levels to 70% (IPCC 2014, 20-29). Industry, the source of 32% of global emissions has a significant role to play in efforts to mitigate the effects of climate change (IPCC 2014, 23-24).

Best Practice to Sustainability

To address rising energy costs, improve productivity and reduce environmental impacts, industry has widely adopted continuous improvement processes which have systematically reduced energy inputs to their business. Continuous improvement and specifically energy management frameworks like ISO 50001 coupled with energy conservation are recognised as essential for meeting the IPCC WGIII pathways for safe levels of atmospheric CO_{2e}. However for growing economies or growing businesses, efficiency measures have little impact on absolute carbon emissions. For New Zealand, this effect is evident in the 44% (IEA 2014, 14) growth of energy emissions from 1990 – 2012 compared to an increase in real GDP of 90% (RBNZ 2015) over the same period. For economic growth to be sustainable, it must be coupled with improved efficiency and low-carbon and thereby sustainable energy supply.

To align with WGIII's emissions pathways and in doing so become sustainable, industry needs to go further than continuous improvement best practice through largely eliminating the use of carbon intensive fuels. This paper provides examples of two organisations that are doing just this. Additionally it seeks to find the rationale behind their shift to more sustainable energy sources and how decisions were made to move to low-carbon fuels.

Methods

Two New Zealand organisations were chosen as examples of business and public sector organisations that are shifting toward sustainable energy consumption. These are Yealands Estate Wines Limited (Yealands) and Christchurch City Council (CCC). Yealands, New Zealand's sixth largest wine producer was chosen as they manufacturer energy intensive products. CCC's energy use is largely in buildings and council facilities but was chosen as a

result of innovations around the energy supply for their waste water treatment plant, an energy intensive process and industrial energy user.

Background research was completed on each of the organisations to document their energy management systems, sustainability policies and achievements to date. A staff member for each was then interviewed with the intention to:

1. Understand how and why energy is managed, specifically this included questions around:
    a. How and why energy management started,
    b. The rationale behind initiating energy management
    c. Energy management and related continuous systems in place at the organisation
    d. Achievements to date
2. Understand how the shift to low-carbon energy sources was and is being managed, including:
    a. How are decisions made
    b. How are ideas formulated
    c. How were innovative projects, that had not been previously be tried or completed, approved given the risk and uncertainties involved
    d. Reasons why other companies and competitors have not adopted sustainable energy supplies

Case Study 1. Christchurch City Council

Achievements

- 1st landfill gas fired tri-generation plant in the world (James, M 2011)
- 69% reduction in carbon emissions from council facilities from 1992 – 2008 (Itskovich, I 2008, 18)
- 33% reduction in energy use in council facilities per household (Itskovich, I 2008, 4)

Background

In 1992 New Zealand experienced a power crisis as a result of low rainfall in major hydro lake catchments (Fitzharris, B 1992). To reduce the risk of blackouts New Zealand's central government undertook a number of measures including a nation-wide campaign to reduce electricity use by 10% (Murgatroyd, T 1993). Playing its part, Christchurch City Council (CCC) helped to reduce electricity consumption through a public awareness campaign and switching off any non-essential electricity in council facilities. Despite the crisis officially lasting only two months, CCC found that through taking relatively simple measures they had saved around $1 million of their $13 million annual energy spend budget (1992 $NZ)[1](CCC 2011).

[1] http://www.ccc.govt.nz/thecouncil/howthecouncilworks/energyefficiencyatthecouncil/index.aspx

Prior to the 1992 crisis, CCC did not have a formal energy management programme, but as a result of energy savings they had achieved reductions with little effort, in 1993 the council started actively managing their energy use. By 1997 CCC had developed an energy strategy and had dedicated staff and a budget for energy management and by 1999 had reduced energy spend by 20% compared to 1995 levels (Itskovich 1999).

Energy Management

Through actively managing energy, between 1993 and 2008 Christchurch City council was able to reduce energy consumption per household from 1054kWh to 643kWh. Consequently, despite energy price inflation, nominal energy spend is the same now as it was in 1992. In the same time period, through increasing efficiency and investing in a number of renewable energy projects CCC has reduced their CO_{2e} emissions by 70% (CCC 2011) (Itskovich, I 2008, 18).

Being Sustainable

CCC's drive for more sustainable energy supplies started in 2004 with the establishment of national standards for controlling greenhouse gases from landfills (MFE 2004)[2]. Landfills were required to be capped and any collected methane gas incinerated. Councils were compensated for this through the Kyoto Protocols clean development mechanism (New Zealand Government 2011)[3]. This regulation and some innovative thinking has since led to CCC developing a biogas transmission network within the city connecting gas producers (landfill and waste water treatment plan) to council energy users.

In parallel CCC enacted policy around reducing CO_{2e} emissions and leading the community by example. This has included eliminating their use of coal which has had the added benefit of reducing air pollution.

City Biogas Network.
In 2006 CCC redeveloped an athletic complex, Queen Elizabeth II Park (QUEII), to include a gymnasium and Olympic length swimming pool. Heating for the complex was provided by an LPG boiler which combined with electricity loads, by 2007, was costing the council $1million per year (Itskovich 2009). At the same time $6.4 million worth of biogas per year from the cities landfill was being flared (Itskovich 2008). In 2008 CCC constructed a 3.7km pipeline to transport the gas to QUEII Park for two boilers and a cogeneration plant. This reduced energy spend to $500,000 and generated carbon credits which were sold to British Gas for $4million (Itskovich 2009).

Since 2008, the biogas network has been extended to link with the council's wastewater treatment plant and Civic Centre.

Waste water treatment plant.
Prior to 2009, CCC were transporting 5000 tonnes per year of bio solids at 80% moisture

[2] http://www.mfe.govt.nz/sites/default/files/proposed-nes-landfill-emissions.pdf
[3] http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html

content from their waste water treatment plant to landfill 65 km away. In 2009 the decision was made to dry the bio solids prior to disposal thereby reducing volumes to around 1200 tonnes and enabling the use of bio solids in the rehabilitation of disused areas of coal mines (Archer 2010). As bio solids are back loaded on existing coal transport, emissions related to transporting bio solids have largely been eliminated.

The bio solids plant uses heat to evaporate water from the bio solids. Heat is supplied by two 5MW boilers fired by biomass and biogas respectively. Biogas is sourced from landfill gas and biomass, mostly in the form of wood chips is sourced from wood processors, local plantation forests and untreated demolition timber (EFI 2011)[4].

CCC is a foundation customer for Wood Energy NZ, which has enabled the development of a reliable bioenergy supply chain in Christchurch that is accessed by other businesses.

Tri-generation plant.
In 2010, CCC opened their new Civic Centre. At the time, the Civic Centre was New Zealand's first six star Green Star building. Included in the building design was a tri-generation plant powered by biogas (James, M 2011)[5]. The 475kWe gen-set provides direct heat and electricity for the building and can provide cooling via an absorption chiller using waste heat (Weston, B 2010)[6]. At the time the tri-generation plant was expected to reduce energy costs by around $500,000 per annum (Gent, P 2010) and essentially eliminated carbon emissions for the building (James, M 2011). Unfortunately an issue in mothballing the absorption chillers following the February 2011 earthquake means the absorption chiller is currently offline.

Graham Condon public swimming pool.
The Graham Condon Pool and Recreation centre was opened by CCC in 2010. The centre was built on land owned by Papanui High School and Northlands, the neighbouring shopping mall. Rather than installing a stand-alone heating system for the pool, the pool is supplied waste heat from the chillers of a neighbouring supermarket, with any additional heat supplied from the schools biomass boiler (CCC 2013)[7].

Decision making – What has enabled the use of low-carbon energy resources? – Yvonne Greer Energy Analyst, CCC

For Yvonne at CCC, there are multiple factors enabling low-carbon energy projects. Foremost has been the appointment of an energy manager to liaise with stakeholders across the council and ensure that good decisions are made around energy systems.

For CCC the energy manager provides technical support to engineering project teams and ensures that total cost of ownership and all possible alternatives for energy supply are considered when designing building services and processes. Yvonne describes energy

[4] http://energyforindustry.co.nz/assets/PDFs/FINAL-CCCBiosolidsLResemailweb-use.pdf
[5] http://www.buildmagazine.org.nz/articles/show/biogas-fuels-civic-building/
[6] http://www.biogas.org.nz/Publications/News_Events/events/13May2010/Efficient-Generation_BWeston.pdf
[7] http://www.slanza2015.co.nz/files/docs/nzcbc%202013/unique%20partnership.pdf

managers as *"always need[ing] to think outside the box…to think what is an alternative solution… and what is a better way to do this"*.

It was this kind of thinking that led to the Graham Condon pool complex sourcing waste heat from a neighbouring supermarket and school rather than installing their own heat plant. Yvonne described this as a *"perfect example of…thinking outside the box...it took a lot of convincing for all those players to come together and provide cheap energy for Graham Condon Pool"*. This is also an example where having a dedicated technical resource to broker this kind of cooperation made the project possible.

Supporting the energy managers role are various policies around reducing energy use and improving sustainability. CCC's sustainability strategy provides a vision for future energy use and allows wider benefits to the business and community to be factored into decision making. Yvonne gave the example of social housing that CCC has built to a higher standard than code, *"for us there is no direct benefit as we don't pay the energy bills, however the tenants will stay longer which means less maintenance, you will have healthier people living in those units with more disposable income as they are not spending more than 10% of their income on heating so they have additional funds to go out and be part of the community"*.

CCC's energy and policies also mandate the energy manager and project teams to look at total cost of ownership and thereby keep operational costs low. This coupled with a dedicated energy management fund has enabled project management teams to invest in higher capital cost but lower total cost of ownership systems. Combined with the sustainability strategy pushing the council towards low-carbon energy sources, CCC has been able to invest in higher capex projects like the biomass fired sludge drying plant.

Case Study 2 - Yealands Estate Wines

Achievements

1. Reduced the CO_{2e} intensity of production by 55% since 2010
2. World Champion - International Green Apple Environment Awards 2014
3. International Winner - Drinks Business, Green Company of the Year (UK) 2014
4. International Winner / Gold Medal – Best in Biz International Awards, Most Socially or Environmentally Responsible Company of the Year
5. International Winner – Sustainable Tourism Category Best of Wine Tourism (Global Wine Network) 2013

Background

In 2008, Yealands Estate Wines set out to be the world's most sustainable wine producer (Yealands 2015)[8]. Arguably Yealands has now achieved this.

Yealands started out down the path of best practice through building a five-star green star winery (via the New Zealand Green Building Council). This included building a winery with

[8] http://www.yealands.co.nz/pages/yealands-estate/sustainable-winegrowing-new-zealand

enclosed production and storage, fully insulating the building and incorporating energy best practice into the design. The design minimised the need for external energy sources and made sure any heat and cooling was as efficient as possible (Apollo Projects 2009)[9].

Energy Management

Energy efficiency and renewable energy features of the winery include solar hot water panels used for domestic hot water in the administration, laboratory and showers. Heat recovered from both the refrigeration system via a de-super-heater and lower grade heat recovered directly from the compressor. Pipework insulated meaning less heat and cooling energy lost and less glycol pumped. High efficiency motors and variable speed drives with the co-benefit of being able to finely control process. A higher than usual evaporating temperature is used which combined with an economiser and an evaporative condenser further reduces refrigeration energy use.

Refrigeration systems are further optimised by being run to a lower set point at nights to access night rates and through the use of free cooling using external air. The winery also features a large and small air compressor, the small for tools and instruments and the large for the presses (Yealands 2012)[10]. Controlling production is an automated energy management system that allows energy monitoring and process level reporting of energy use.

Being Sustainable

From their first year of production, Yealands Estate gained carboNZero certification (Enviro-Mark Solutions Limited, 2008)[11]. This requires organisations to report their carbon emissions to ISO 14064-1:2006 and commit to a programme of reducing and offsetting any carbon emissions.

Since 2008 Yealands has increased production from 100,000 to 900,000 cases in 2013. In the same time the carbon intensity of their production has decreased 55% from its peak in 2010 (Elena et al, 2014) (Enviro-Mark Solutions Limited 2015)[12]. While part of the improvement has come through economies of scale, a number of renewable energy and energy efficiency projects have cut emissions. These include:

- Solar Photo Voltaic (PV) - 99kW (peak) array installed in 2013, at the time this was the largest PV installation in New Zealand.
- 30kW of wind turbines
- 500kW of biomass boilers reducing LPG use by 94%
- Use of a biodiesel blend (B20) in winery machinery
- Introduction of baby doll sheep to vineyard which have reduced diesel use required to mow between vines by 400,000L per year

[9] http://www.apolloprojects.co.nz/wp-content/uploads/documents/Yealands%20Case%20Study.pdf
[10] www.yealands.co.nz/sites/default/files/Yealands%20Estate/winery/YealandsEstateWinerySpecifications.pdf
[11] https://www.carbonzero.co.nz/documents/disclosure_yealands_0708.pdf
[12] https://www.carbonzero.co.nz/members/cz_organisations_certified.asp

Decision making – What has enabled the use of low-carbon energy resources? Peter Mann, Operations manager

Speaking to Peter Mann, Yealands operations manager, their achievements in sustainable energy use originate from the companies' core values. That is in Peter Yealands, the founder of Yealands's words, *"think boldly, tread lightly and never say it can't be done"* and his aspiration to be the most sustainable winemaker in the world (Yealands Estate Wines 2015)[13].

When building their winery in 2007, Peter Yealands wanted a focus on energy efficiency and sustainability in general. This included reducing construction waste and using environmentally responsible products in the build. Further enabling the energy efficient design, Peter Mann explained that Peter Yealands and the project team recognised early on that the cost of retrofitting energy efficient technology was far in excess of incorporating it into the build and represented a small incremental cost to the project. Consequently, it was relatively easy to justify the incorporation of energy efficient and renewable energy technology like solar hot water heating into the build.

When asked about how the decision was made to proceed with other renewable energy projects like their biomass boilers, PV array, B20 fuel and baby doll sheep, Peter talked about Yealands' process for idea generation, business case and implementation. At Yealands sustainability is everybody's responsibility, with Peter noting that there is *"not one job that someone can convince me that there is no scope for reducing energy or carbon footprint or waste or co-ordinating community projects"*. All staff members have a mandate to come up with ideas and all ideas are considered by the management group.

Driving innovation, Yealands has had continuous improvement systems in place around carbon emissions and environmental management since their first vintage in 2008. Peter Mann discussed that maintaining carboNZero certification has helped drive innovation as it has been very difficult to maintain certification when production has been energy efficient from the beginning.

In terms of implementing energy projects, ideas like the bale boiler which had a simple payback of around 18 months were relatively easy to have approved. Whereas for decisions such as installing what was at the time the largest solar array in New Zealand and breeding baby doll sheep where the direct benefits financial benefits were less certain, co-benefits had to be considered. As Yealands management assess sustainability projects collectively, benefits of a given project can be discussed between representatives of all aspects of the business. For the baby doll sheep project for example, this kind of discussion enabled marketing, vineyard and winery staff to all have input into a project which probably wouldn't have gone ahead based on its direct energy benefits alone.

Discussion

[13] http://www.yealands.co.nz/pages/yealands-estate/sustainable-winegrowing-new-zealand

IPCC working group 3 sets a clear pathway for keeping global temperature increases to 2°C. This includes both reducing energy use and switching to low-carbon energy sources.

Yealands and CCC are examples of organisations already improving the sustainability of their energy use. Yealands 55% decrease in the carbon intensity of their production and CCC's 69% absolute decrease in carbon emissions show that large carbon emission reductions are possible. Furthermore, their use of technologies like biomass boilers and tri-generation from biogas show that completely decarbonising some processes is both technically and economically feasible. However despite the availability and economic advantage of energy efficient and renewable energy technologies, most businesses are not achieving carbon emission reductions of the scale needed to make their energy use sustainable.

Enabling the shift to sustainable energy, the interviews showed there are two significant differences between CCC and Yealands and organisations employing energy management best practice. Much like these other organisations employing energy management CCC and Yealands have strategies around energy both have documented continuous improvement processes. However where they differ is in having specific strategies around sustainability that help to form the business case for sustainable energy use and a focus on innovative energy projects.

For Yealands, their brand is tied closely to their sustainability strategy and Yealands discussed specifically how their sustainability story and 3rd party accreditations add value to their products in their consumer's eyes. Importantly this allows brand and marketing benefits to be factored into the business case for sustainable energy use. Similarly at CCC, having a mandate to look at wider community and business benefits of their projects enables them to complete projects that don't have a direct benefit to council but do for Christchurch businesses and residents.

In terms of innovation, staff have a mandate to come up with new ideas and frameworks exist to guide ideas to implementation. For both organisations staff across different teams have input to the decision making around energy projects which both fosters innovation and ensures non-energy benefits are factored into the business case process.

Examples at Yealands estate are their replacing of tractors and thereby offsetting diesel use through breeding a flock of dwarf sheep to graze the vineyards. And Christchurch City Council, in firing their wastewater treatment plant entirely with biofuels and thereby completely decarbonising the process. Taking an energy management best practice approach to these projects would have minimised energy use through installing efficient equipment and processes, but would likely have retained fossil fuels as the energy supply.

Further work is now required to test whether innovation frameworks and sustainability strategies are a consistent enabler of sustainable energy use with other industrial energy users. Two other industrial energy users including a milk powder and tissue plant, both with energy supplied entirely from geothermal sources were approached to contribute to this paper but declined.

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