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Title: **Less Talking and More Walking down the Energy Efficiency Road - the Journey has begun.**

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Abstract

A recent journey down Energy Efficiency Road started for one large New Zealand industrial corporate in 2002 driven by the need to build-up their international competitiveness. Now in 2006, the Fonterra Energy Reduction Project has moved on to all 23 dairy manufacturing sites in New Zealand. This ambitious energy efficiency journey has seen some solutions being implemented which are among the best examples of sustainability engineering in New Zealand.

A number of lessons have been learnt along the way that should make the start of similar journeys easier for other industries. However, taking the next steps from walking to running will see the urgent up-skilling of engineers along with the recognition of the value of engineering energy management specialists in their respective technical areas. Underpinning new tools will be the approach to "Best Practice" and bringing all industrial sites up to world standards to set a platform for investment in energy saving projects.

New tools in Monitoring and Targeting will be needed - monitoring is relatively easy, it is the targeting that needs innovation and work going forward. New thinking is also needed to make the capital investment projects happen as part of Business-as-Usual. Plants should be designed to minimise life-cycle costs and they will be far more energy efficient, easier to operate and more sustainable to the environment. Continuous investment will be needed to keep up with the rest of the world.

It is anticipated that sustainability engineering will take the journey on to the larger proportion of medium-sized industrial sites in New Zealand. It is a journey that will never be completed as technology continuously improves. New Zealand is now at cross-roads in terms of how fast it can make progress.

Background

I am proud to be a chemical engineer and passionate about the role that industrial energy efficiency has to play in underpinning a solution to climate change. I am also a runner and understand the importance of discipline and training. I want to use sport as an analogy to illustrate the challenges we face here in New Zealand if we are to go forward in a sustainable way.

Energy efficiency and sustainability go hand-in-hand. Slowing down the demand growth for both fossil fuels and electricity use is one of the world's most important challenges. Energy efficiency is an important driver of this energy future and industry must take a lead role and not Government or regulators.

Energy efficiency is a journey. Continuous improvement and technology change ensures that new cleaner industrial processes with lower CO_2 emissions and using less water are the way forward for investment by industry. Green buildings are the way forward for the commercial sector.

Energy efficiency is also a team effort. No one individual can do everything. A team effort can literally "lift the game" and make all the difference when it comes to achieving sustainable energy savings. The captains of these teams will be the energy champions of the future.

My paper addresses the theme for this conference which is how do we go from less talking to more walking down the Energy Efficiency Road? Or should we really think about not just walking, but running fast and trying to set world records in building the most energy efficient industrial plants and buildings in the world. What's stopping us? We have and always will punch above our weight as a nation in sport. If we are to keep up with the rest of the world, we should run and run fast.

New Zealand "is one of the top five nations in terms of Olympic medals per head of population".[1] I wish we could be seen in this position for our energy efficiency achievements or even in business reputation. Sadly, we are well down in the rankings of OECD countries - we are the glaring anomaly.[2]

In sport, we have high ambition and we are geared for success - not so in business. In sport, in many cases we do not have a lot of money and people get on and just do it and go on to be world champions. Not so, in the main in energy efficiency, with most businesses still waiting either for Government hand-outs to do nothing except another audit or to deflect Government policy with complex legal arguments. It is just too difficult for most companies to go forward in a positive manner, but there is a sea change occurring around the world and we will be left further behind as a country if we do not act - and act fast.[3]

Yet, energy efficiency does not require huge investment or resources to get started. Our industries and technologies are far from being the largest and most complex in the world. We are different and niche, flexible services are our way to go forward. But, you need the right people, mainly engineers to drive this change. But we are not training enough - in fact over the last 10 years, it has been almost impossible for good engineers to think about a career in energy efficiency here and many have emigrated to work in other countries.

Last year's Clever Companies Survey found that one third of companies had no strategic plan for growth. I contest, if the survey was looking at energy strategy, we would find even fewer companies with such plans in place - this is hardly a platform for our sustainable future.

We have a long road ahead of us, but I am confident that discipline, training of more engineers and inspirational leadership will provide the drive to get there. I would like to offer my reasons for this confidence in our future.

The journey has begun

The journey down Energy Efficiency Road started for Fonterra in 2002. The dairy industry had up to this point, already invested significant capital in energy efficient processes and new plants. Their continual investment in MVR evaporation and membrane technology had significantly improved the yields and the energy performance of their powder plants. Fonterra was driven in part by their corporate commitment to drive out unnecessary operating costs as energy prices were rising, and in part by their need to strengthen their international competitiveness. They knew they had to put in place a major initiative in energy reduction company-wide. It was a "no brainier", but how should they start. The industry's previous attempts to put in place energy management systems had not stood the test of time and were not sustainable.

My company was given the opportunity to start a pilot project at their Lichfield cheese factory. Lichfield was seen as a new plant and if we could make some improvements, our techniques would be rolled-out. Lichfield was the first site to reach the corporate target of 10% reduction last season. After 5 years, i.e. in 2007/2008 season, this modern site will exceed 20%, possibly reaching 25% reduction in their energy use.

The Energy Reduction Project was rolled out, first to Clandeboye near Timaru, where a heat recovery project was so successful, the site operated the next season by processing 5% more milk, but using 5% less steam.

The project went on to the large site at Whareroa near Hawera. This is the biggest dairy site in the world. Any site-wide scheme in heat recovery would have to meet the requirements of flexibility of providing heating and cooling for the ten factories at different and changing times of day as production varies during the season. The innovative solution was a very large, 500m^3, stratified hot water tank. Such a stratified tank is a first for a heat recovery project as complex as this for the diary industry. This $3.5M project was installed in October 2005 and has been making savings ever since. The project team won a category award at the New Zealand Engineering Excellence Awards 2006 in November. [4]

The project roll-out continued through the 2004/2005 and 2005/2006 seasons to Fonterra's largest top 10 sites. The other smaller 13 manufacturing sites became part of the project through using 'common themes' to roll-out project ideas for making savings.

Fonterra should meet their first corporate target of a 10% energy reduction in the 2006/2007 season which is 2 years earlier than originally planned. This corporate target has been increased to 15% to be achieved in 2008/2009. According to EECA [5], these

energy savings dominate the efforts by industrial companies in New Zealand. Fonterra has won two consecutive EnergyWise Awards, in 2004 and 2006, for their achievements in saving energy equivalent to a city the size of Hamilton.

There are a number of reasons why this ambitious project has been successful and some lessons which have been learnt along the way:

By taking a positive approach:
This stems from a corporate commitment and an experienced dairy industry project manager determined to drive the project forward. This was reconfirmed by Fonterra launching in 2005/2006 their Operations Journey which incorporates energy reduction as an integral part of their future. A structure is introduced to take energy reduction through site Operations Excellence teams to every employee.

By taking a long term view:
The project timeline goes across several seasons. It does take time, in any industry to see the benefits from an energy efficiency programme. In dairy, capital is invested annually and new plant is usually installed during the winter shutdowns. Without such a long-term view, a sustainable outcome will never be achieved.

By team-work from engineers at all levels:
The project team was created using a mix of mainly chemical or process and mechanical engineers, with both experienced industry engineers and specialists from energy management in New Zealand and from international companies. An important part of the project has been the technology transfer, in particular from KBC Linnhoff March in the UK, bringing to New Zealand new methods to model steam and cogeneration plants. This technology transfer was also extended to Universities in New Zealand, with Massey University and The University of Waikato making important contributions in the common theme areas of chilled water and compressed air, respectively.

By having a clear focus on robust energy saving projects:
Energy reduction in any company will depend on a mix of both capital and operating projects (which can be implemented with little capital). In Fonterra, this mix of capex/opex is around 65%/35%. It is therefore essential to develop a portfolio of capital projects with good commercial returns. Identifying and developing literally 100's of projects each year that are both technically and commercially robust is the key to success. This requires disciplined project management and experienced engineers to pick the winners going forward. Many energy efficiency projects provide multiple benefits, in process improvements, product quality benefits and often less water use. It continually amazes me where the projects come from, which is in part the art of implementing this continual process improvement.

By being able to measure and report successes:
Monitoring, tracking, trending against targets and reporting energy performance as production and product mix changes sets the discipline and is literally the glue that sticks it all together. With such an energy information systems in place, the success of energy savings projects can easily be seen and reported. Reporting successes is important as it provides the confidence for the future. Once a project is successful, the savings must be incorporated into future budgets to ensure the savings are secured and become sustainable going forward.

By building a tool-box that can be continually improved and customised to a company's needs:

A range of energy management tools are required in the industrial tool-box. These have to be customised to a company's needs as the roll-out progresses and the needs change. We have developed a number of solutions to meet Fonterra's changing needs:

Tool	Solutions for sustainable engineering
Process Descriptions	Basic heat and materials balances built on Excel to be easily updated. Must include metering diagrams.
Database management	A flexible web-based database is needed to view, aggregate and overlay data. Database needs to hold energy data, production, weather, energy prices and other key parameters required for energy management. Database can be linked to Excel for reporting.
Targeting Methods	Statistical methods can improve as the databases advance. Progress from simple targeting to performance based methods are needed to set more realistic and aggressive targets.
Monitoring and Targeting reports	1) Weekly STATUS reports for plant managers. 2) Daily reports on utility equipment like boilers, chillers, compressors for engineering managers and shift engineers. 3) Near real-time reports for operators on local SCADA and PLCs. 4) Benchmarking and league tables for all sites. 5) Emissions tracking for all sites.
Project identification	Sound process engineering techniques, including pinch analysis. Robust capital estimates are essential.
Savings Bulletins	Two page reports describing the project opportunities and benefits. A good way to get capital projects through the system for initial capital allocation.
Calculators	Simple day-to-day calculators are needed for operator's actions, for example, turning off hoses and lights and fixing steam and air leaks. These calculators can be embedded into plant energy data sheets using generic templates.
Utility Models	Complex steam and refrigeration systems can be modelled for operators to calculate "what ifs" when loads or prices change. Optimisers can be built for cogeneration systems. Scheduling models help plan boiler and chiller run-orders to meet changing demand profiles.
Common Themes	An effective technique to transfer and roll-out successes across all sites. The evaporation and drying, steam, chilled water, compressed air and lighting themes worked well.
Engineering Standards	Ultimately, the experience has to be incorporated into the engineering standards for new and retrofit plants to ensure procurement is based on minimum life-cycle costs.
Energy Budgets	The energy savings must be reflected in the accounts and in forward budgets. The statistical methods used to normalise energy performance against production and product mix is the key.

How can we apply these lessons to other industries?

These lessons and experience from the Fonterra project should make it easier to help other industries. The big challenge is the availability of resources.

As a country, we are desperately short of experienced chemical or process engineers that can drive these projects forward. Over the last 10 to 15 years, we have not invested nationally in these skills or provided huge opportunities for engineers to develop experience in this area.

Chemical engineering is probably the best suited engineering discipline to take on the energy and sustainability challenge. [6,7] We train in this country around 70 chemical engineering graduates a year out of the 20,000+ students gaining tertiary qualifications. Only a hand-full of these graduates will be employed in industry in positions where they can work and be trained to be our energy champions of the future. We will need to grow these graduates' numbers possibly 3 to 5 fold over the next decade to stand any chance of investing the capital needed to improve our plants.

As well as providing more graduates, we need to harness the experience we have learnt to date so we can set our training goals to start running. We need to recognise the value of engineering experience and start rewarding energy management specialists so they can train and inspire others. Without such engineering specialists, it is going to be very difficult to "lift the game" plan. Universities could offer positions in sustainable engineering for such people. They will also help New Zealand industry gain international contacts in the areas of technology that they will need to retain their international competitiveness.

We also need to introduce urgently "Best Practice" programmes, building on the success of similar programmes overseas. The good news is that this approach towards "Best Practice" has been recognised by a pilot project for the Electricity Commission.[8] There are plans to begin a Best Practice programme, firstly in the area of compressed air systems. These systems can be improved by using between 20% and 40% less electricity and they are common to most industries. An experienced team of engineers will lead this programme so they can transfer their experience to others. An important part of the programme will be in training and accrediting the major industrial compressed air users to world's Best Practice. I anticipate many industrial sites will do substantially better and we will start creating innovation here in the way we design, build, operate and maintain our compressed air equipment. This innovation will come from both industry and universities. The University of Waikato has created a team within its Energy Group to specifically tackle our compressed air challenge.[9]

The techniques behind Monitoring and Targeting (or M&T) must also be advanced. The monitoring bit is relatively straight-forward, except for metering performance and reliability which can only improve as more people make use of the data and information. The future challenge is in targeting to ensure that achievable yet aggressive targets are always used. The analysis and science behind targeting, especially in an industrial situation, will advance and become an integral part of sustainable engineering.

New thinking is also needed to make the capital investment projects happen as part of Business-as-Usual (BaU). Projects, more projects and even more projects will be needed if we are going to keep up with the rest of the world investing in their own industrial plants and buildings. From an industrial perspective, new plants should be designed to minimise life-cycle costs and in doing so, they will be far more energy efficient, easier to operate and more sustainable for the environment. This new thinking needs to be incorporated into energy strategy planning so improving energy efficiency and this becomes part of BaU.

The journey must continue for others and accelerate

The journey in sustainable engineering must continue on to the larger number of medium-sized industrial sites in New Zealand. It is a journey that will never be completed as technology continuously improves and this is part of the roll-out challenge.

New Zealand is now at cross-roads in terms of how fast it can make progress. We could go forward in many directions. What is clear is that industry should, and must take the initiative - waiting for Government to act with clear policy on how to tackle climate change incentives will take too long. On a personal basis, I want to see new jobs created for young engineers working in industry so they can become our energy champions of the future. Universities have an important role to play and should strengthen their training in sustainable engineering techniques to prepare graduates with the skills to work in energy efficiency in the years to come.

I look forward to the time when New Zealand is in a position to set some world records in terms of energy efficiency performance and lift us up the international league table. We will then have something to celebrate along with our sporting successes.

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