Implementing Energy Efficiency for New Zealand Textiles Manufacturing Businesses
Introduction

This Quick Start Guide has been developed to help New Zealand textiles manufacturers to review the way they use energy in their operations and implement real energy savings. Real examples of improvements made within the New Zealand industry have been used to illustrate points wherever possible.

This Guide should act as a starting point to engage in energy management. Users can research individual areas in more depth as they find areas of relevance to their operations.

Acknowledgements

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How to Use This Guide

Chapter One of this Guide introduces the reader to energy management and advises on how to implement simple steps towards an energy management system. Taking this systematic approach has been consistently shown to deliver the best energy saving results for companies.

Chapter Two examines the different energy sources available and how these are charged to companies in New Zealand. Understanding fuels and their costs is an essential part of their management and can lead to significant cost savings.

Chapter Three contains the details of the technical energy saving initiatives for Textile Care sites. These can be used to help a company identify specific savings opportunities by making changes in processes or machinery.

Each energy efficiency opportunity is given a rating out of 5 in three situations, to allow the user to assess the value of the opportunity against the particular circumstances of the facility:

- Retrofit – retrofitting an existing plant.
- New Facility – building a new plant.
- Operation/Maintenance – ongoing facility operation and maintenance.

Each opportunity is also assessed in terms of the Financial Savings and Payback of the initiative.

### ADDITIONAL BENEFITS

Describes additional benefits unrelated to energy efficiency or maintenance.

Note that cost savings and payback on initiatives will vary from site to site and depends on the price of energy, plant operating hours and other variables.
Energy Management

Why look at energy?

Improving the way your business manages energy use has financial, environmental and reputational benefits. Systematically identifying energy performance improvements can drive significant cost savings, competitive advantages and mitigate against energy price volatility.

Financial

Energy is a variable and controllable cost for manufacturing businesses. Improving energy efficiency is one of the simplest ways to reduce costs and improve competitiveness. Every dollar saved in energy translates directly into a dollar increase in profit. This can be simply translated into the equivalent in new sales. If the profit margin of your business is 10%, then every $1,000 saved through energy management is the equivalent of $10,000 in additional product sales.

Environmental

Using energy more efficiently means less energy generation and consequently less impact on the environment. A reduction in energy use is often the primary means by which a business can reduce its greenhouse gas emissions. For example, in New Zealand, a reduction of 1 kWh of mains electricity saves the equivalent of 0.15 kg of CO₂¹.

Reputational

Customers are increasingly looking at the environmental performance of companies they buy products from. Implementing energy efficiency is an important way of demonstrating a company’s environmental performance.

Energy Management Systems

Maximum results can be achieved by approaching energy efficiency in a systematic way. An energy management system (EnMS) establishes an ongoing process of identifying, planning and implementing improvements in the way an organisation uses energy. An energy management system does not need to be complicated and should be tailored to the size of the business.

A large business should consider following the ISO 50001 international standard for energy management systems. For a smaller business this may not be practical, and a simpler version can be applied. Key components of an EnMS are:

- Form an energy team and make one person responsible for energy
- Develop an energy policy
- Monitor energy use
- Review efficiency opportunities
- Create and follow an action plan
- Review and improve

Further information on taking an energy management approach in your business can be found in the EECA Guide “Setting up an Energy Management Programme” downloadable from www.eecabusiness.govt.nz.

Form an Energy Team

Energy use cuts across all facets of business operations. It is therefore important that relevant parts of a business are involved in finding ways to use energy more efficiently. Form an internal energy team that meets regularly to review energy and progress energy initiatives. Best results have been achieved when this team includes the company CEO or equivalent, the financial manager, as well as technical staff such as operations and production managers.

Make one person within the energy team the site Energy Champion. This person monitors energy use and is the main driver for implementing energy efficiency across the organisation.

Create an Energy Policy

Developing a company policy on energy is important because it demonstrates that the organisation, including senior management, is committed to improving energy efficiency. Typically an energy policy will state how energy management aligns with the company’s broader business improvement goals, and will set a measurable target for improvement. For example, the policy might include a reduction in the amount of energy per unit of production, and a timeframe within which the goal should be achieved.

Examples of energy policies are available on the internet, such as:

EECA - www.eecabusiness.govt.nz/content/energy-policy
UK Carbon Trust – template energy policy in Guide CTG045 www.carbontrust.com

¹. Emission factor, including lines loss, from Ministry for the Environment Guidance for Voluntary Corporate Greenhouse Gas Reporting for the 2010 year.
Nb. Emissions factors for electricity change every year
Monitor Energy Use

Understanding how energy is being used in a business is a core element of managing energy and can provide many insights into the relationship between energy and productivity. Studies in the US and UK have found that simply implementing a system for monitoring energy use on industrial sites will result in average energy savings of 10%.

It is recommended that, as a minimum, a business tracks monthly energy use and plots this against production levels. This is known as your Energy Performance Indicator (EnPI). Textiles New Zealand has developed a simple-to-use tool for tracking energy use against production levels. The Excel-based tool can be downloaded from www.textilesnz.org.nz. By tracking monthly energy use against production, it is possible to identify trends and spot any variations or anomalies. Also, the use of a monitoring system allows the site to accurately track the effect of any plant upgrades, and the true energy savings achieved can be realised.

Process operation and control decisions can be influenced by assessing the energy performance indicator and investigating how different operators run the plant. Graph 1 comes from a site with a monitoring system and shows an example of how these indicators can be used to obtain plant operation savings. Through analysing the outlying days it was discovered that the main difference between these periods was the operation of the plant. Based on this information, key operating procedures have been changed and as a result will save an estimated 7.7% of the site’s total energy use. Furthermore, additional trials are underway with new operating procedures being tested to ascertain if further energy savings can be achieved.

More detailed energy monitoring may be beneficial, particularly on large and complex sites. Temporary meters can be hired and installed in key locations for short-term monitoring. In some cases it will be appropriate to install permanent metering systems, some of which can be integrated and connected to user-friendly interfaces to allow for easy real-time energy monitoring.

Graph 1: Assessment of energy performance indicator (EnPI)

![Graph 1: Assessment of energy performance indicator (EnPI)](image)

2 Studies from US Dept of Energy and UK Carbon Trust
Assess Efficiency Opportunities

With a company energy policy in place and energy being monitored against production, the next step is to systematically assess opportunities for improving energy efficiency. Some companies choose to do this in-house. There are guides and tools available to help self-audit a site. For example, EECA has developed an online self-assessment tool called Energy Leader: www.eecabusiness.govt.nz/services-and-funding/energy-leader.

For example, the Lawrence Berkley National Laboratory has developed the Energy Efficiency Assessment and Greenhouse Gas Emission Reduction (EAGER) Tool for the Textile Industry. This self-assessment tool is available for download from www.china.lbl.gov/eager_textile. A more generic energy assessment guide developed by the Australian Government can be found at www.ret.gov.au/energy/efficiency/eeo/resmaterial/csm/Pages/default.aspx.

For many businesses there are not sufficient resources or expertise in-house to allow for a good quality review of energy efficiency. Even when the resources do exist in-house, many companies choose to use an external independent energy expert to assess opportunities for energy efficiency. There are many independent energy experts in New Zealand that can provide an audit or assessment of whole industrial sites, or specific processes or parts of a plant. For example, a site may choose to seek external expertise to review thermal systems such as boilers.

A list of experts and the services they provide can be found on the website of the Energy Management Association of NZ; www.emanz.org.nz.

Business Decisions

Further analysis is usually required before a decision is made on what opportunities to implement. Businesses will have established practices for evaluating and seeking funds for new projects. Energy efficiency opportunities that merit a more detailed analysis should use these existing processes.

It is important to develop a whole-of-business evaluation for each project. Key members of the energy team should help in refining the business case, developing recommendations and selling projects internally.

The business case should consider all relevant and measurable business costs and benefits, not just direct energy-related costs and benefits. Some of the likely costs and benefits that might be considered for each identified opportunity include impacts on production, product quality and value, health and safety, labour, public relations and waste disposal costs.

The business case should be developed to be consistent with the organisation’s evaluation methodologies and processes for capital expenditure approvals. Many companies use internal rate of return and/or net present value as investment criteria.

\[
\text{Simple payback} = \frac{\text{Initial capital cost}}{\text{Net annual saving including all business costs and benefits}}
\]

Implement an Energy Action Plan

Once a systematic review has been conducted, the findings should be converted into a plan of action to implement efficiency opportunities. The plan of action should be developed by the company energy team, drawing on expertise from throughout the business.

The action plan will allow a site to prioritise initiatives and plan for any necessary expenditure. Short-term and low-cost measures are usually a good way to start because they can make an immediate impact and generate interest in the programme. The action plan should identify staff that will be responsible for each initiative, and timeframes for making the changes. Timeframes can be divided into short, medium and long-term initiatives.

Part of the energy action plan should include communicating initiatives to staff and training them on new equipment and procedures.

Review and Improve

An organisation should periodically review the performance of the energy management programme. Revisit the targets set using the energy performance indicator data being collected.

Reassess the energy action plan to find new savings and make sure that the programme is not slipping. Minor reviews could be scheduled at three and six-monthly intervals, with a full yearly review to keep the plan fresh.
Understanding Energy

Energy and Textiles

Energy is one of the largest overheads for a textiles manufacturing plant and can represent between 5 and 15% of total costs. It therefore makes sense to understand the properties of different energy sources and how they are charged for, as this may lead to significant cost savings for textile manufacturers.

The Textiles sector in New Zealand is a significant energy user, consuming around 1.4 petajoules of energy a year, equal to almost 1% of New Zealand’s total industrial energy demand.

There is a mix of electricity and fuels used within the sector, with latest data showing the following:

Figure 1. Energy sources used by the New Zealand textiles sector in 2011 (MED Energy Datafile 2012)

Energy Footprint

The textiles industry is a complex industry, making it difficult to generalise about the way energy is used in a typical textiles company. Because there is such a variety of materials, processes, machinery and finishing steps, the footprint of different plants vary greatly.

More detailed energy footprints can be found for specific processes, such as spinning, wet processing and weaving, in industry guides such as that produced by the Lawrence Berkley National Laboratory.

Developing an understanding of how energy is used in a textiles plant is an important component of improving energy management for a business. Knowing what the major end-users of energy in a plant are will help to identify what priorities need to be for energy efficiency improvements.

Figure 2. Energy End Use in the US Textile Industry
Understanding Electricity

It is important to understand how electricity is distributed to a business because this results in some of the costs charged by energy companies. Understanding, and closely monitoring, electricity charges can result in significant cost savings. Use the sections below to get a better understanding of your electricity supply and how you are charged for it.

Basic Principles

Electricity is generated at a power station and delivered to your site via national and local transmission and distribution systems. It is most commonly measured in kilowatts (kW) as the power drawn at any one point in time, and kilowatt-hours (kWh) as the total amount of energy delivered over a certain length of time. For example, a motor using 10 kW of power for 10 hours would consume 100 kWh of electrical energy.

Power Factor

Many charges that appear on invoices represent some of the more complex aspects of electricity. “Active power” (kW) represents the useful energy consumed by motors, heaters, lighting and other electrical equipment, and is what must be generated at the power station. However, as can be seen in the Power Triangle below, there is another component called “reactive power” (kVAR) which combines with kW to give the total “apparent power” (kVA) being drawn. This apparent power represents the loading on delivery systems such as power lines and transformers, so most distribution charges are based on this value in some way. Reactive power does not serve any useful function, but is inherently present in systems using certain devices such as electric motors, electronics and most types of lighting.

Power factor is defined as the ratio between the active power and apparent power. Power factor correction systems can be used to improve the site’s power factor by reducing the reactive power and hence the apparent power, reducing the load on the supply system (kVA) without reducing the useful power delivered to site (kW).

\[
\text{Power Factor} = \frac{\text{Active Power}}{\text{Apparent Power}}
\]

Generation & Delivery of Electricity

The supply of electricity occurs in a number of stages, and payment for these services follows a completely different route. From the generator, electricity enters the National Grid, operated by state-owned enterprise Transpower. After exiting the transmission grid, the electricity passes over to one of 28 local distribution companies (for example Vector in Auckland, Orion in Christchurch or Powerco in Taranaki). Power is then delivered direct to the customer over this local network.

With some rare exceptions, the customer pays all electricity costs direct to their chosen retailer (for example Genesis, Mercury or Meridian). The retailer purchases the necessary energy from the Wholesale Spot Market, and pays any delivery costs to the customer’s local distribution company. Distribution companies incorporate transmission charges into their own charges, and pay the necessary fees for their region to Transpower.

As a user of electricity, you have no choice over who generates, transmits or distributes the energy you purchase. The only choice is in which retailer to use, and retailers have a purely administrative role in the process.
Understanding Electricity Invoices

Electricity invoices vary significantly in layout, complexity and methodology depending on the retailer, type of metering used, and which network region the site is in. Of these, the largest difference is between standard non-half-hour (NHH) metering — which is effectively the same as a normal household power bill — and Time of Use (TOU) metering, which is generally used for larger customers, and has a more complex pricing system that rewards or penalises the customer depending on when and how the energy is used.

Initiative 1: Understand Your Electricity Charges

Perform a tariff review on your electricity invoices. Understanding your energy invoices can identify savings through peak load shedding, power factor correction, metering changes and sometimes can find overcharges by the retailer.

A standard NHH invoice is very simple, typically consisting of little more than a single charge per unit (kWh) of energy consumed, and a single fixed daily charge. The small Electricity Levy is often shown separately, and there may be multiple meters, but the underlying principle is simple — you pay for the energy you use at a fixed price, so the amount of money you can save will be directly related to the energy-use reductions you can make.

TOU invoices, however, can be very complicated. Interpreting these is not easy and often requires professional assistance, but doing so can lead to significant cost savings. The sample electricity invoice, below, shows an annotated generic example of a TOU electricity invoice. This invoice is fictional and is intended only to show a range of common TOU charges. Actual charges will vary by distribution region and depend on the size of the connection.

In this example, there is potential for the customer to reduce costs by means other than simply using less energy. It may be possible to reduce the two demand charges or to use lower-priced energy by altering the plant’s operational scheduling or adjusting when non-critical equipment runs. It may also make good economic sense to install a power factor correction system in order to eliminate the penalty charge.

Actual prices for your distribution network tariff can be found by comparing the local network company’s pricing schedules and methodology against your own invoices. To find out which network company serves your region, ask your retailer or look over the Electricity Network Map at www.electricity.org.nz

Case Study A: Large refunds and savings achieved by identifying electricity tariff errors

As part of a professional tariff review of one company’s invoices, a total of $82,383 in refunds and $53,746 in ongoing annual savings were obtained by the energy consultant for the customer via a local network tariff correction, retailer billing correction and an upgrade to Time of Use metering. No changes to site operation were required, and the only investment required was a single $350 fee for the meter upgrade.
SAMPLE ELECTRICITY INVOICE

GREEN ENERGY

Electricity Retailer Invoice
Period: 01/01/12 – 31/01/12

**Delivery/Network Charges**

<table>
<thead>
<tr>
<th>Charge Type</th>
<th>Unit</th>
<th>Amount</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Charge</td>
<td>$/day</td>
<td>$155.00</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>c/kVA/day</td>
<td>$186.00</td>
<td></td>
</tr>
<tr>
<td>Variable Network</td>
<td>c/kWh</td>
<td>$1,093.68</td>
<td></td>
</tr>
<tr>
<td>Anytime Maximum Demand</td>
<td>kVA/month</td>
<td>$647.50</td>
<td></td>
</tr>
<tr>
<td>Peaktime Demand</td>
<td>kW/month</td>
<td>$780.00</td>
<td></td>
</tr>
<tr>
<td>Reactive Energy Penalty</td>
<td>kVAR/month</td>
<td>$88.20</td>
<td></td>
</tr>
</tbody>
</table>

Subtotal - Network Charges $2,950.38

**Energy Charges**

<table>
<thead>
<tr>
<th>Charge Type</th>
<th>Unit</th>
<th>Amount</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday Night 00:00 – 08:00</td>
<td>c/kWh</td>
<td>$1,774.60</td>
<td></td>
</tr>
<tr>
<td>Weekday Day 08:00 – 24:00</td>
<td>c/kWh</td>
<td>$4,348.68</td>
<td></td>
</tr>
<tr>
<td>Weekend Night 00:00 – 08:00</td>
<td>c/kWh</td>
<td>$269.94</td>
<td></td>
</tr>
<tr>
<td>Weekend Day 08:00 – 24:00</td>
<td>c/kWh</td>
<td>$833.04</td>
<td></td>
</tr>
<tr>
<td>Total Energy</td>
<td>c/kWh</td>
<td>$7,226.26</td>
<td></td>
</tr>
<tr>
<td>Local Losses @ 1.065</td>
<td>c/kWh</td>
<td>$469.63</td>
<td></td>
</tr>
</tbody>
</table>

Subtotal - Energy Charges $7,695.89

**Other Charges**

<table>
<thead>
<tr>
<th>Charge Type</th>
<th>Unit</th>
<th>Amount</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Account Administration</td>
<td>$/day</td>
<td>$46.50</td>
<td></td>
</tr>
<tr>
<td>Data Handling</td>
<td>$/month</td>
<td>$40.00</td>
<td></td>
</tr>
<tr>
<td>Meter Rental</td>
<td>$/day</td>
<td>$77.50</td>
<td></td>
</tr>
<tr>
<td>Management Fee</td>
<td>c/kWh</td>
<td>$145.82</td>
<td></td>
</tr>
<tr>
<td>Electricity Authority Levy</td>
<td>c/kWh</td>
<td>$109.37</td>
<td></td>
</tr>
</tbody>
</table>

Subtotal - Other Charges $419.19

Invoice Total $11,065.47

Prompt Payment Discount if Paid by 25/02/12 (15%) $1,659.82

Grand Total if Paid by 25/02/12 $9,405.65

Notes:

1. These charges are normally based on the fuse or transformer size of the site’s main electricity connection. If this capacity is significantly larger than the maximum demands of the site, it may be possible to reduce the charge by reducing the capacity.
2. Some variable charges offer lower prices for using energy during off-peak times. In general, the only way to reduce these is to use less energy or use it at a different time.
3. This form of demand charge is typically based on the site’s highest point of electrical loading at any time of day or week, and is difficult to reduce except by improving efficiency or avoiding running all plant machinery at once. Note that this example charge is measured in kVA, and is therefore inflated by having a poor power factor (described in the previous section).
4. Other forms of demand charge, with varying terminology but generally referred to as “peak”, are based on the site’s highest electrical loading at specific times when the local network is heavily loaded (typically early morning and evening on weekdays). If it is possible to schedule plant operation away from these times, the savings can often be significant. This example charge is measured in kW, and therefore unaffected by power factor. In this case, a poor power factor is typically penalised through a separate charge.
5. Many network companies have direct penalty charges for poor power factor, which is normally defined as power factor below 0.95. Although there are many ways of applying this penalty, the most common is to charge for any additional reactive power (kVAR) beyond the level it would be at a power factor of 0.95.
6. With Time of Use metering, energy prices vary depending on time of day, day of the week, and month of the year. Modest savings can sometimes be achieved by rescheduling low-priority loads outside peak pricing times. Non-TOU can also have broader time-based pricing, but generally have only a single “Anytime” energy price.
7. A loss factor accounts for local energy losses between the Grid Exit Point and the site’s electricity meter. The factor is set by the local network company, which commonly applies different factors to different customer classes. Ensuring that the correct loss factor is in use is a key feature of any electricity tariff “health checkup”.
8. These fees vary significantly between retailers. Choosing a retailer based solely on their raw energy prices can mean that the best offer is not selected, if that retailer has higher account fees than the next best alternative.
9. PPDs are widespread in smaller (non-TOU) accounts, and are still used by some retailers in larger electricity supplies. It is important to note any difference between PPD rates when comparing retail offers, then just as important to make sure every invoice is paid on time so that the large financial penalties are avoided.
**Initiative 2: Assess Your Metering Type**

Assess whether Time of Use or standard non-half-hour metering is suitable for the site’s operation.

<table>
<thead>
<tr>
<th>RETROFIT</th>
<th>NEW FACILITY</th>
<th>MAINTENANCE</th>
<th>SAVINGS</th>
<th>PAYBACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>★★☆☆☆☆</td>
<td>★☆☆★☆☆☆☆☆</td>
<td>★☆★☆☆☆☆☆</td>
<td>★★★★☆</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
</tbody>
</table>

Time of use metering is mandatory for larger electricity users, but can have significant benefits for some smaller customers as well. In general, any customer operating for 12 or more hours per day could potentially save on electricity costs through use of TOU metering; however, this is dependent on the local distribution charge structure, and understanding this methodology is essential if considering an upgrade to TOU. Seeking professional advice is recommended.

**Case Study B: Upgrading to Time of Use metering rewards constant loads**

A customer with a number of small sites having sizable overnight and weekend loads was advised to upgrade some of these to Time of Use metering to reduce electricity costs. The $220,000 total annual energy cost of running these sites was reduced by $50,345 (23%) through the metering upgrade.

**Initiative 3: Electricity Contract Optimisation**

Undertake an energy price assessment before signing a new supply contract.

<table>
<thead>
<tr>
<th>RETROFIT</th>
<th>NEW FACILITY</th>
<th>MAINTENANCE</th>
<th>SAVINGS</th>
<th>PAYBACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>★☆☆★☆☆☆☆</td>
<td>★☆★☆★☆☆☆☆</td>
<td>★☆★☆☆☆☆☆</td>
<td>★★★★☆</td>
<td>✔ ✔ ✔ ✔ ✔</td>
</tr>
</tbody>
</table>

**ADDITIONAL BENEFITS:** Improved understanding of energy prices

A key opportunity to minimise electricity costs is to make the right choices when setting up a new supply contract. It is recommended you seek a professional assessment or at least undertake a thorough and informed analysis before making the choice, as the financial benefits can be substantial. The difference between the best and worst retail pricing offer is commonly 12 – 18%. Different retailers also have a range of additional costs and discounts that can have a major impact on the overall economics of their offer. Try to get as many alternative quotes as possible to have the best chance of finding the optimum price.

By selecting a sub-optimal supply contract, a site spending $50,000/year on electricity could easily spend $22,500 (15%) in unnecessary additional costs over a three-year contract.

**Case Study C: Professional analysis pays off in energy contract negotiation**

Following on from a successful tariff review the year before, a New Zealand manufacturing company engaged the services of an energy consultant to negotiate and analyse their new nationwide electricity supply contract. By splitting their North and South Island operations between different retailers and fully modelling their future energy expenditure for each offer, savings of $158,500 were obtained over the three-year contract when compared to the incumbent retailer’s offer — even after the incumbent came back with a better offer than the original.
Understanding Thermal Fuels

Many textiles companies in New Zealand utilise fuels such as gas, coal and diesel in addition to electricity. It is important to understand the properties of these fuels in order to assess potential cost savings and compare one energy source against others.

Basic Principles

Thermal fuels are generally significantly cheaper than electricity per unit of energy, but harnessing this energy efficiently is the challenge. Combusting these fuels to generate heat also requires specialised equipment and maintenance.

Common thermal fuels used in stationary applications in New Zealand are natural gas (North Island only), diesel, liquefied petroleum gas (LPG) and coal. Various other fuels, primarily low-grade or waste oils, are also used by some larger industrial operations.

Efficiency of Use

Unlike electricity, where the energy delivered to site is effectively the energy available to be used, there are inherent inefficiencies in the use of thermal fuels that increase the net price of usable energy. The first of these, which is specific to the equipment and tuning, is explained in Section 4.1. The second inefficiency, which is related to the fuel chemistry, is caused by the production of water vapour when the fuel is combusted.

Water requires a significant amount of input energy in order to change from a liquid to a gas (steam), and is produced as a fundamental outcome of burning any hydrocarbon-based fuel. Consequently, any burnt fuel has some of its available energy locked away in water vapour, which cannot be recovered without expensive specialist equipment that reduces the exhaust gas temperature to a point where the water can be condensed and its energy absorbed. Without this equipment, the energy is simply lost to the atmosphere regardless of how efficient and well-tuned the system is.

The total amount of energy produced by burning a fuel is measured as its gross calorific value (GCV), which is also sometimes known as a higher heating value (HHV). This includes the energy locked away in water vapour. In contrast, the net calorific value (NCV) or lower heating value (LHV) is a measure of the available energy without condensing any water vapour. As all fuels are sold on the basis of their GCV, the ratio between the two values represents the maximum efficiency that can be achieved without using a condensing system. This ratio is shown for the common thermal fuels in the following table.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>NCV/GCV Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>90.4%</td>
</tr>
<tr>
<td>Diesel</td>
<td>93.8%</td>
</tr>
<tr>
<td>LPG</td>
<td>92.2%</td>
</tr>
<tr>
<td>Coal:</td>
<td></td>
</tr>
<tr>
<td>- Bituminous</td>
<td>95.7%</td>
</tr>
<tr>
<td>- Sub-bituminous</td>
<td>93.9%</td>
</tr>
<tr>
<td>- Lignite</td>
<td>90.1%</td>
</tr>
</tbody>
</table>

The table above shows that bituminous coal, for example, produces less water vapour and is therefore more efficient than lignite coal. Diesel produces less water vapour than natural gas, thus losing less energy via this process, but the cleaner-burning nature of natural gas will often counteract this by producing less fouling in the heat exchanger. This is thermal efficiency, and not necessarily economic efficiency.
Understanding Thermal Fuel Invoices

Invoices for thermal fuels are generally simple, but can present energy consumption volumes in a range of different units, making it difficult to compare between products or suppliers.

Use the table below to convert different fuel types to kWh and enable comparison to electricity prices.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Common Measurements</th>
<th>Basic Conversion</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>GJ</td>
<td>Multiply by 277.78</td>
<td>1 GJ = 277.78 kWh</td>
</tr>
<tr>
<td></td>
<td>$/GJ</td>
<td>Divide by 2.7778</td>
<td>$15/GJ = 5.4 c/kWh</td>
</tr>
<tr>
<td>Diesel</td>
<td>Litres</td>
<td>Multiply by 10.63</td>
<td>1 litre = 10.63 kWh</td>
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<td></td>
<td>$/litre</td>
<td>Multiply by 9.4</td>
<td>$1.50/litre = 14.1 c/kWh</td>
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<tr>
<td>LPG</td>
<td>GJ or $/GJ</td>
<td>Same as for natural gas</td>
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<td></td>
<td>Litres</td>
<td>Multiply by 7.36</td>
<td>1 litre = 7.36 kWh</td>
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<td>kg</td>
<td>Multiply by 13.75</td>
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<td>$/litre</td>
<td>Multiply by 13.6</td>
<td>$1.30/litre = 17.68 c/kWh</td>
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<td>$/kg</td>
<td>Multiply by 7.3</td>
<td>$2.20/kg = 16.06 c/kWh</td>
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<tr>
<td>Coal</td>
<td>- Bituminous*</td>
<td>Tonne</td>
<td>Multiply by 8,000</td>
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<td>$/tonne</td>
<td>Divide by 80</td>
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<td></td>
<td>- Sub-bituminous*</td>
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<td>Multiply by 6,200</td>
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<td>Divide by 62</td>
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<td>- Lignite*</td>
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<td>Multiply by 4,400</td>
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<td>Divide by 44</td>
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*Indicative only. Contact your coal supplier for values specific to their product.

Unit Conversions

The table below shows conversions between commonly used sale units for the various fuels. Pricing is approximate, but broadly indicative for comparison between different fuel options.
Fuel Change

There is often potential to switch to a different fuel and provide the same level of thermal energy for a process at a significantly reduced cost. This is generally only true when the more-expensive fuels, such as diesel and LPG, are currently in use. Unfortunately, the use of some thermal fuels in New Zealand is restricted by geographic location or difficulty of use.

Initiative 1: Consider Thermal Fuel Alternatives

Investigate thermal fuel alternatives such as wood-waste. This may be especially cost-effective for companies who are currently using expensive fuels such as diesel or LPG.

Initiative 1: Consider Thermal Fuel Alternatives

In North Island urban areas, the simplest replacement option is typically reticulated natural gas, as this is available throughout virtually all main towns and cities. Natural gas has the advantages of being clean-burning and easy to maintain, minimising consent requirements and ongoing maintenance costs, as well as being as little as one-third of the price per unit of energy as diesel or LPG. In many cases the cost to connect the site to the gas network is zero, requiring only pipework and possibly burner upgrades to be paid for.

Where natural gas is not available, such as in the South Island, lower-grade fuels such as coal, wood-waste or recycled (waste) oil will give a lower fuel price. Although these can generally be obtained at very low price, all have difficulties inherent in their use. For example, they typically require significant maintenance due to production of soot, ash or other wastes, and can require much greater investment in storage, handling and combustion facilities. Local air-quality codes can also mean that their use is restricted or banned outright in some areas. In general, changing to such low-grade fuels will only make economic sense when the current thermal-fuel expenditure is large. For example, tens of thousands of dollars in annual fuel spend may not justify the change, whereas hundreds of thousands almost certainly will.

Case Study A: Southland textiles company reduces fuel bill by 64%

A Southland textiles company trialled waste oil and visited lignite and wood-mass burning sites before deciding on a wood-mass solution to replace their LPG boiler. The solution involved a specially designed 3.4 MW boiler, wet scrubber system with heat recovery, and two dry fuel bins. The total fuel savings achieved were $323,000 p.a. at a total project cost of $674,000, resulting in a payback period slightly over two years.

Source: Energy NZ Ltd
Energy Efficiency Opportunities

This chapter sets out the common opportunities for energy efficiency found in textiles manufacturing plants.

**Thermal Systems / Process Heating**

Thermal systems are used extensively in textile manufacturing plants to provide heating for various industrial processes. These processes include distributed boiler systems, as well as direct-heating systems. Thermal energy consumption is the largest end-use energy consumption at most textile manufacturing sites, often accounting for over 50% of a site’s total energy consumption. Thermal systems should therefore be targeted as a priority for energy reductions as they present a large opportunity to significantly improve the site’s energy efficiency.

Assessing the efficiency of a site’s thermal systems involves four steps:

1. **Assess the demand side of the system.** It is important to investigate the demand side of a system before any optimisation of the supply side. Avoid investigating supply-side improvements without first considering measures to reduce demand.

2. **Assess heat recovery opportunities within the system.** Once demand requirements are assessed, potential heat recovery opportunities can then be investigated to help meet some of these demands.

3. **Assess the distribution effectiveness of the system.** For distributed systems, such as steam systems, the network should also be investigated to ensure heat is transported effectively with minimal losses.

4. **Assess the generation (supply side) of the system.** Once the demand side and network issues have been addressed, the thermal system generation side should then be investigated. This involves ensuring that the heat generation plant is suitable and operating correctly to meet demand requirements.

**Reduce demand and assess heat recovery opportunities**

**Initiative 1: Heating Process Optimisation**

Perform analysis on the heating processes using systematic methods to ensure their efficiency is optimal.

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**ADDITIONAL BENEFITS:** May improve other production performance indicators such as product quality

This involves identifying potential improvements to the heating process in a systematic way using methods such as pinch analysis or heat integration to establish demand reduction opportunities, heat recovery opportunities and to optimise existing heating networks. This means examining the effectiveness of heat users in achieving their role in the production process.
**Initiative 2: Isolation of Heat Users**

Ensure all heat users are isolated when they are not in use to minimise unnecessary heat loss.

Encourage staff to manually isolate machinery for the heating network when not in use. This may require the additional installation of valves, although valves are often already in place for maintenance purposes.

**Assess heat recovery opportunities**

**Initiative 3: Thermal System Heat Recovery**

Recover heat from within the thermal system for use in other sections of the thermal system.

This refers to heat recovery from within the heating system itself. There may be several thermal system heat recovery opportunities such as boiler blowdown heat recovery, economiser heat recovery, condensate recovery, flash steam heat recovery and process waste heat recovery.

**Case Study A: Heat Recovery of Die House Wastewater Discharge saves $6,211 per year**

A North Island textile manufacturing company has a steam boiler that accounts for the majority of the site’s gas use, with most of the steam heat being used in the die house. The process water from the die house was initially discharged immediately after use. Due to subsequent consenting requirements, this needed to be cooled before discharge; a heat exchange system was then implemented to preheat the boiler’s in-feed water, leading to steam system efficiency improvements of 5%.

**Initiative 4: Utility Heat Recovery**

Recover waste heat from machinery for use in other processes.

It may be possible to recover heat from other utilities outside the thermal system. There may be several waste-heat recovery opportunities such as from air conditioning exhaust air, refrigeration compressors, and air compressors. Heat from these utilities can be used to pre-heat boiler feedwater, preheat combustion air or to directly heat product within a process.
Determine the effectiveness of the distribution system

**Initiative 5: Insulation**

Ensure all steam, hot water and condensate lines are insulated effectively, including exposed valves and flanges.

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**ADDITIONAL BENEFITS:** Insulating exposed valves or flanges can be considered good health and safety practice.

Insufficient insulation on supply and return piping, valves, flanges and heat users can result in significant heat loss. Removable insulating jackets are an effective solution for sections such as exposed valves. Thermal imaging is a common method for finding exposed sections or damaged insulation.

![Thermal imaging of pipes](source: Energy NZ Ltd)

**Initiative 6: Steam Trap Testing**

Regularly survey steam traps to ensure their correct functionality.

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**ADDITIONAL BENEFITS:** Improves the reliability and consistency of heating throughout the network.

Steam trap leakage is often the cause of significant steam system heat loss, with the majority of heat loss in the form of latent heat. For systems that have not been maintained for several years, it can be expected that 15% to 30% of installed steam traps have failed. A steam trap management programme should be in place to avoid large energy losses.
**Initiative 7: Pipe Sizing and Network Design**

Optimise the pipe sizing and arrangement to minimise dynamic losses in distributing the heat-transfer medium.

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**ADDITIONAL BENEFITS:** More effective distribution of heat throughout the network

Pipe network design software can be used to analyse the system’s distribution effectiveness. This will identify areas with excessive frictional/pressure losses resulting from undersized pipework, and incorrectly installed valves or pipe configurations. It is much more cost-effective to undertake this in the design stage than retrospectively.

**Initiative 8: Fluid Leaks**

Maintain the distribution network to minimise any fluid leakage and therefore heat loss.

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**ADDITIONAL BENEFITS:** Reducing fluid leaks such as water or steam will also result in water savings

Fluid leakage, such as hot water, from an indirect heating system network results in lost fluid along with the energy content associated with it. It is important to find and repair any leaks as soon as possible.

Source: Energy NZ Ltd
Optimise the heat generation system

Initiative 9: Boiler Suitability

Ensure boilers are well suited to their application and sized accordingly.

A boiler may be operating efficiently compared to its design performance, yet is not the most efficient boiler for the application. This is a common problem for oversized boilers that short-cycle. There may also be an entirely different heating method better suited to the application. Replacing a boiler is a large cost, but the potential savings in energy and maintenance costs can be worthwhile.

**Case Study B: Boiler replacement saves $21,000 per year**

An Auckland textile manufacturing company had a steam boiler that was only used to produce hot water for cleaning as a result of significant plant changes. Installation of a dedicated hot water heater to produce water at 95°C instead of generating steam at 175°C resulted in a generation efficiency improvement of just under 12%. The water heater cost of $55,000 gave a simple project payback period of 2.6 years.

Initiative 10: Combustion Efficiency

Perform combustion efficiency tests on boilers and minimise excess oxygen to maintain adequate efficiency.

A boiler’s combustion efficiency is very important, as it ultimately determines how much fuel is used and therefore the cost to operate the heating system. Large boiler/burner systems should undertake regular combustion testing to minimise excess oxygen. For instance, an efficient natural gas burner requires only 2% to 4% excess air in the flue gas. CO and oxygen sensors can be used to continuously optimise the fuel/air mixture.

**Case Study C: Boiler tuning saves $36,448 per year**

An Auckland manufacturing company uses large quantities of process steam, supplied by a 6.0 MW boiler. It was discovered that the boiler was operating lean, with an average excess oxygen level of 11%. By re-tuning the boiler to a more optimal oxygen level between 2 – 4% the site saved over 800 MWh of natural gas per annum.
Initiative 11: Multiple Boiler Control

Ensure the correct boilers operate during the optimum system conditions.

Where multiple boilers are in use, energy savings can be achieved by properly allocating boilers to match demands. Automatic controls obtain the best system efficiencies by scheduling operation so that boilers spend most of their time near their optimum operating point. Automatic flow valves can also be used to isolate boilers that are not being used, eliminating losses associated with fluid flows through unused boilers.

Initiative 12: Managing Fouling and Scaling

Reduce the amount of fouling or scaling within boiler tubes.

It is important to manage the fouling of the fireside and scaling of the waterside of boiler tubes. This can affect the heat transfer from the combustion gas into the heating medium, which negatively affects the efficiency of the system. Fouling and scaling can account for between 2% and 5% of a boiler’s energy consumption.

Initiative 13: Blowdown Optimisation

For steam systems, minimise the duration of blowdown cycles.

Unless there is blowdown heat recovery, a moderate amount of energy is lost during blowdown cycles when water is dumped. Automated systems monitor total dissolved solids and minimise the frequency of blowdown cycles.
**Initiative 14: Boiler Economiser**

Preheat boiler feedwater via heat recovered from boiler exhaust gas streams.

**Additional Benefits:** Increases the capacity of existing boiler(s)

Preheating of the boiler water supply reduces the amount of heat input necessary to generate a given temperature setpoint, and therefore reduces the fuel input required. An economiser can often improve boiler efficiencies by 5% to 10%. Although this is technically a form of heat recovery, it is addressed separately because it is a common boiler retrofit technology.

**Case Study D: Economiser installation saves $27,659 per year**

A textile manufacturing company with two steam boilers underwent plant upgrades that required an increase in boiler capacity. Each boiler was fitted with two-stage condensing economisers which gave an efficiency improvement of 9% along with an adequate increase in capacity. The installed cost of all economisers was slightly over $110,000, for a simple project payback of just over 4 years.

**Initiative 15: Flue Draft Control**

Install shut-off dampers to close off flues and minimise heat loss when not operating.

Automatic valves can be installed to shut off flues when boilers are in standby, mitigating heat loss through flue drafts.
Compressed Air

Compressed air commonly accounts for around 10% of a textile manufacturer’s annual electricity use, but is often referred to as the “forgotten utility” as the true cost of generating compressed air is typically not realised. Compressed air systems are usually only between 10% – 15% efficient, meaning that for every unit of compressed work output, eight units of energy input are required at the air compressor. It is therefore important to use compressed air in an efficient manner and design the system accordingly. Given the large amount of energy these systems use, small reductions in compressed air use can often result in large energy savings.

Assessing a compressed air system’s efficiency involves two steps:

1. **Assess the demand side of a system (compressed air use).** Often, compressed air demand savings provide the greatest benefit with the lowest implementation costs, since generating compressed air is such an inefficient process by nature.

2. **Assess the supply side of a system (compressed air generation).** Once the compressed air demand side has been addressed and all initiatives implemented, the compressed air supply side can be investigated. This involves ensuring that the compressed air system is set up optimally to meet the plant’s demand.

Eliminate Unnecessary Compressed Air Use (demand-side initiatives)

**Initiative 1: Compressed Air Misuse**

Mitigate compressed air misuses by implementing less-energy-intensive alternative processes or technologies.

- **Compressed Air Misuse**
  - Mitigate compressed air misuses by implementing less-energy-intensive alternative processes or technologies.
  - Compressed air is frequently used as an easy means of solving a problem since the use of compressed air can have a small capital cost. However, the ongoing energy costs are much higher. Using compressed air for product transportation, tank aeration, cooling and blow-down should be avoided wherever possible. If the use of compressed air is deemed necessary, it should be done so efficiently through the use of high-efficiency nozzles and air knives. As a rule of thumb, these devices will often use half the amount of compressed air to accomplish the same task.
Initiative 2: Pressure Regulation

Ensure compressed air users are regulated down to the lowest working pressure.

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ADDITIONAL BENEFITS: Potential to decrease the pressure setpoint of the air compressor(s)

Reducing the operating pressure of compressed air devices reduces their compressed air use. Many devices already have pressure regulators, so optimising the pressure setpoints can often be done easily.

Case Study A: Pressure regulator adjustments save $9,056 per year

A large textile manufacturing company had a number of double-acting pneumatic cylinders. A high pressure was required on the out stroke; however, the return stroke did not require any great speed or force so the pressure could be greatly reduced. The cylinders already had return-stroke pressure regulators, which were optimised.

Initiative 3: Compressed Air Leaks

Conduct air leak detection surveys to minimise air leakage.

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ADDITIONAL BENEFITS: Reduces pressure drops across the compressed air network, improves functionality of pneumatic devices and can significantly reduce plant noise

Compressed air leaks commonly account for between 20% and 50% of a textiles manufacturing site’s total compressed air use (best practice is 10%). Repairing these leaks always has a very short payback period and should be part of a preventive maintenance strategy. Smaller sites should carry out routine audible air leak checks, while large sites should consider regular ultrasonic leak surveys.

Case Study B: Company identifies 31% of their compressed air use is due to leaks, costing $11,798 per year

A North Island textile manufacturing company which has a large compressed air network previously spent little effort on compressed air leak repair. An ultrasonic air leak survey was conducted which identified a total air leak rate of 2.76 m³/min, which equated to 31% of the site’s total compressed air use.
### Initiative 4: Machine Isolation

Ensure sections of the plant that are not in operation are isolated from the compressed air network.

90% of compressed air leaks occur at the end use rather than on the supply network. Even with rigorous compressed air leak prevention, it is impossible to completely eliminate all of a site’s leaks; isolating equipment will therefore limit this air leak rate when it is not in use. In most cases this can easily be accomplished through the use of manual ball valves already installed to isolate machines from the compressed air network during maintenance.

**Case Study C: Manual machine isolation saves $3,842 per annum**

A New Zealand textile manufacturing company contained a number of knitting machines, each with a manual ball valve allowing them to be isolated from the compressed air network. Due to the large number and complexity of pneumatics, repairing all compressed air leaks was proving difficult. The company was able to isolate the knitting machines when they weren’t in use (30% of the time), significantly reducing the effect of the compressed air leaks.

### Initiative 5: Electronic Condensate Drains

Install electronic condensate drains.

Electronic condensate drains are much more efficient than other condensate drainage methods such as continuous bleeding, since almost no air is wasted when condensate is rejected.

**Case Study A:“Electronic condensate drains save $1,950 per annum”**

A New Zealand dairy produce company used a number of condensate drains, some of which were leaking. A number of electronic condensate drains were installed to overcome the problem. The company switched to electronic condensate drains, which resulted in increased energy efficiency. The resulting savings were in the region of $1,950 per annum.
**Optimise the Supply System (supply-side initiatives)**

**Initiative 6: Compressor Room Temperature**

Minimise the compressor room air temperature, since it is more energy efficient to compress cooler air.

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**ADDITIONAL BENEFITS:** Can improve the longevity of an air compressor

In many textile manufacturing plants, air compressors are often installed in plant service areas along with other services such as boilers, pumps and chillers. While this is convenient, the higher temperature in these areas increases the compressor's intake temperature. For every 3°C above ambient, the air compressor's efficiency drops by roughly 1%. Reducing the intake temperature can be achieved by adding more ventilation into the compressor room, or by ducting the air compressor's intake air from outside.

**Initiative 7: Compressor Supply Pressure**

Minimise the supply pressure of the air compressor(s).

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**ADDITIONAL BENEFITS:** Reduces air use through unregulated compressed air users

Most compressed air devices are designed to operate at 6.0 bar(g). An air compressor pressure setpoint of 6.5 bar(g) is recommended for most systems, which allows a total pressure drop of 0.5 bar over the dryer, filters and network. As a general rule, for every 1 bar overpressure, the air compressor efficiency drops by 7%. It is common for facilities to have a supply pressure of between 7.0 bar(g) and 8.0 bar(g), resulting in an air compressor efficiency penalty of between 3.5% and 10.5%.

**Initiative 8: Non-production Energy Use**

Consider smaller air compressors for localised compressed air use outside production periods.

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**ADDITIONAL BENEFITS:** Reduces system maintenance costs

Sites that do not operate 24 hours every day often operate their compressed air systems continuously due to small demands when major plant is not in operation. Pressurising the entire network with a large compressor outside regular production hours is relatively inefficient, in which case a smaller backup air compressor located near the non-production demand can be used to provide air more efficiently.

**Case Study D: 2.2 kW air compressor saves $2,633 per year**

A South Island textile manufacturing plant operates 24 hours per day, 5 days per week. Instead of operating the entire network over the weekends, a small 2.2 kW air compressor was purchased and installed, reducing electricity usage as well as providing significant maintenance savings.
Initiative 9: Compressor Capacity Control

Optimise the capacity control of individual air compressors.

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**ADDITIONAL BENEFITS:** May provide a more stable pressure to the network

There are many forms of compressor capacity control, which vary in efficiency based on the type of air compressor and their turndown rate. For rotary screw air compressors (the most common industrial compressor), inlet modulation is generally the least efficient form of control, followed by load/unload control, with VSD and variable capacity being the most efficient (particularly for highly variable loads). However, due to the cost of a new air compressor, outright purchase of a new, more efficient compressor is seldom justified, but should be considered when a new compressor is being purchased regardless.

**Case Study E: Compressed Air Audit finds $57,816 per annum energy saving through compressor replacement**

A company was operating a single compressed air network with a 160 kW load/unload rotary screw air compressor. It was discovered that the aging air compressor was not unloading correctly and was using significant amounts of energy when it was unloaded. It was recommended that a new VSD compressor be installed and the old compressor kept as a backup.

Initiative 10: Multiple Compressor Capacity Control

Optimise the capacity control of multiple air compressors.

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**ADDITIONAL BENEFITS:** May provide a more stable pressure to the network and reduce maintenance costs

It is important to set the system up so that it supplies air as efficiently as possible over the required range of operating conditions. Optimising the system ensures the compressor with the most efficient turndown, such as a VSD air compressor, acts as the “trim” compressor. If the site has several air compressors and a wide compressed air demand range, a PLC air compressor controller may be considered.
Pumps and Fans

Pump and fan systems are used extensively within textile manufacturing plants, often as part of other systems such as thermal systems. Pump systems perform tasks such as providing heating, cooling, and liquid transport, while fan systems provide ventilation, extraction, cooling, product transportation, and HVAC systems. Pump and fan systems typically use 10 – 15% of a textile manufacturing plant’s total energy consumption. Systems are often oversized or have been modified to operate as they were not originally designed and therefore represent a significant opportunity for energy savings through efficiency improvements.

Assessing a pump or fan system’s efficiency involves three steps:

1. **Assess the demand side of the system.** It is important to investigate the flow and pressure requirements of a pump or fan system and determine whether or not the role of the system in the plant process is being achieved.

2. **Assess the distribution effectiveness of the system.** For both pump and fan systems, the pipe network or ducting should also be investigated to ensure frictional losses are minimal.

3. **Assess the supply side of the system (pump or fan).** Once the flow and pressure requirements are defined, and the distribution system is optimised, the supply side of the system should then be investigated. This involves ensuring that the pumps and fans are suited to their application and controlled effectively.

Reduce Demand

**Initiative 3: Switch off Unused Pumps or Fans**

Auxiliary services such as pumps and fans should be turned off when not required.

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**ADDITIONAL BENEFITS:** Improves the longevity of the pumps or fans, reducing maintenance costs

Often pump and fan systems are left on when not required, such as over smoke breaks or between production periods. In most cases these can either be turned off manually or automatically shut off. It is best practice to use interlocking pump and fan systems so that they turn off with other systems.

**Initiative 2: Reduce Flow Requirements**

Reduce the average flow through a pump system’s pipework or fan system’s ducting.

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**ADDITIONAL BENEFITS:** Savings are amplified significantly with the use of VSD control

Flow reduction can be achieved by throttling or dampening flow while still meeting the system requirements. In particular, bypass loops and other unnecessary flows should be eliminated. No pump or fan system can be viewed in isolation, so the effects on the wider system must also be taken into account. Note that the savings potential is intrinsically related to the control of the pump or fan, with variable speed control offering the largest energy savings from flow reductions (discussed in 3.2.4, initiative 7).
**Initiative 3: Reduce Flow Requirements**

Reduce the average pressure through a pump system’s pipework or fans system’s ducting.

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<th>RETROFIT</th>
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Pressure reduction can be achieved by reducing process static pressure and frictional losses throughout the system. In particular, throttling and dampening flow should be avoided as this artificially increases the system pressure. The savings potential is again related to the control of the pump or fan (discussed in 3.2.4, initiative 7).

**Determine the Effectiveness of the Distribution System**

**Initiative 4: Pipe / Duct Size and Configuration**

Optimise the arrangement and size of pump pipework and fan system ducting to minimise frictional losses.

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**ADDITIONAL BENEFITS:** Savings are amplified significantly with the use of VSD control

Software specific to pipe or ducting network design can be used to determine the system’s delivery effectiveness. This will determine areas with pressure losses as a result of incorrectly installed valves, undersized pipework/ducting or suboptimal configurations.

Source: Simon Wilkinson
Optimise the Supply Pumps or Fans

Initiative 5: Pump and Fan Maintenance

Perform regular maintenance activities on pumps and fans.

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**ADDITIONAL BENEFITS:** Prevents premature failure of pumps or fans reducing overall lifecycle costs

Maintenance activities include replacement of worn impellers/blades, bearing inspection and lubrication, and seal inspection. Typical energy savings of between 5% and 10% of a pump or fan system are achievable through regular facility maintenance.

Initiative 6: Pump / Fan Suitability

Ensure that all pumps and fans are well suited to their application, i.e. operate near their best efficiency point (BEP) for the majority of the time.

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**ADDITIONAL BENEFITS:** Pumps and fans operating close to their designed flow and pressure require less maintenance and have improved longevity

Pressure, flow and/or electrical measurements, along with performance curves, can be used to determine the operating point of a pump or fan. Pumps and fans are often oversized, meaning they operate away from their BEP. Pumps and fans also degrade over time, reducing efficiency by 10% to 25%. Measures to improve their efficiency include pump/fan replacement, impeller trimming, impeller/blade replacement or the use of multiple-pump/fan arrangements to meet varying demands.

Note: The figure depicted is for backward-curved centrifugal pumps and fans only.

Case Study A: Impeller replacement saves $4,446 per year

A North Island manufacturing company has a large hot water boiler that serves multiple users around the site. The heating system and therefore the two hot water circulation pumps (duty/standby) were oversized significantly to allow for plant expansion that never took place. By replacing the duty pump’s impeller, the flow did not need throttling and was reduced to a more suitable rate, which reduced the energy consumption of the pump significantly. Replacing the impeller cost close to $1,400, giving a simple project payback of 4 months.
Initiative 7: Pump / Fan Control

Control the pumps or fans to adequately and efficiently meet demand requirements.

**Retrofit** | **New Facility** | **Maintenance** | **Savings** | **Payback**
---|---|---|---|---

**Additional Benefits:** A higher level of control of pumps and fans can also be beneficial for controlling production processes.

Pump and fan control is particularly relevant to variable-demand applications. The energy use of a pump or fan is roughly proportional to the cube of the flow rate, so reducing the speed of a pump or fan to meet flow demands (as opposed to throttling or dampening) can achieve significant savings, often between 20% and 50% of a system's total consumption. While VSD speed control of pumps and fans will achieve the highest energy reductions, other, less-costly forms of control can also achieve moderate savings.

Note: The figure depicted is for backward-curved centrifugal pumps and fans only.

**Case Study B: HVAC fans on VSD saves $10,468 per year**

At a large textile manufacturing facility that specialises mostly in knitting, the HVAC system accounts for a large proportion of the site's total energy consumption. Most of the large ventilation fans were at a fixed speed; however, VSDs were installed to reduce their speed by an average of 10% while still maintaining adequate ventilation levels. This reduced their energy consumption by close to 30%. The total installed cost of the VSDs was slightly over $20,000, for a simple project payback of around 2 years.
Motorised Systems

Motorised systems, including pumps, fans, compressed air and manufacturing equipment typically account for around 30% of a textile manufacturer’s annual energy use. Although there are often a wide variety of applications, common savings can be found across all motorised systems.

Initiative 1: High Efficiency Motors

Replace old motors with new MEPS (minimum efficiency performance standards) compliant motors.

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<thead>
<tr>
<th>RETROFIT</th>
<th>NEW FACILITY</th>
<th>MAINTENANCE</th>
<th>SAVINGS</th>
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<td>✔️ ✔️ ✔️ ✔️</td>
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**ADDITIONAL BENEFITS:** Newer, more reliable motors

New MEPS-compliant motors often have higher efficiencies than those of older motors. As a general rule, a 2% efficiency gain can be assumed from changing to a MEPS-compliant motor, with higher efficiency gains possible if the motor being replaced is in particularly bad condition and may have been rewound several times.

Payback periods of 24 months or less can be achieved through replacing a motor that is running 24/7. However, motors with lower run hours typically have longer payback periods, and replacement is only economical if the motor has failed and requires repair.

**Case Study A: Auckland-based manufacturing company saves $5,674 per year**

An Auckland-based manufacturing company had a motor replacement policy produced for them which assessed the economics of replacing each large three-phase electric motor onsite. This policy found that several of the more heavily used motors had an outright replacement payback period of less than 24 months. The site has since replaced five of the motors identified by the policy at a cost of $11,206, saving $5,674 p.a., with more motors planned for replacement during the next maintenance shutdown.

**Cautionary Note:** MEPS motors often have a higher synchronous speed, which can actually result in a higher energy use if used on non-static torque loads such as pumps and fans. Check the synchronous speeds of the new MEPS and old electric motors to ensure that this is not an issue.
Initiative 2: Resize Electric Motors

Replace all lightly loaded electric motors with more suitably sized alternatives.

<table>
<thead>
<tr>
<th>RETROFIT</th>
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Electric motors are typically efficient over a wide range of operating loads, but below 50% of its rated load efficiency can drop away dramatically, as shown in the graph below.

Where electric motors have constant low loading, it is often cost-effective to replace these with motors that are more appropriately sized. This can also be coupled with the installation of a MEPS-compliant motor to further boost the savings potential.

**Case Study B: A small motor saves big**

A Tauranga-based company reduced the output of one of their blowers by reducing its operating speed through changing the pulley ratio. The original 55 kW motor was still being used, though it now used only 15 kW, outputting an estimated 10.5 kW of useful power. Through replacing the old 55 kW motor with a new correctly sized high-efficiency MEPS motor, the company was able to save $3,265 p.a.
Initiative 3: Drive Belt Replacement

Replace standard V-belts with either cogged or synchronous belts.

<table>
<thead>
<tr>
<th>Belt Type</th>
<th>V (or Vee) Belt</th>
<th>Cogged (or Toothed) Belt</th>
<th>Synchronous Belt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Efficiency</td>
<td>93% - 97%</td>
<td>95% - 98%</td>
<td>98%</td>
</tr>
<tr>
<td>Slippage</td>
<td>Some</td>
<td>Little</td>
<td>None</td>
</tr>
<tr>
<td>Maintenance</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Life Expectancy</td>
<td>Average</td>
<td>Better</td>
<td>Best</td>
</tr>
<tr>
<td>Operating Noise</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Suitable for Shock Loads</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>Low – Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

**ADDITIONAL BENEFITS:** Can reduce maintenance through less re-tensioning and increased belt life.

V-belts are commonly used to transfer energy from an electric motor to the end user. Although V-belts are very cheap and are widely use throughout the industrial sector, higher efficiency options are available that also require less maintenance.

The cost differential between a standard V-belt and a cogged belt is often very little, and in some cases the cogged belt may be cheaper. It is recommended that the right belt for the application is chosen from the outset or re-evaluated when a belt is due for replacement.

**Cautionary Note:** Higher efficiency belts have less slip and can actually result in a higher energy use if used on non-static torque loads such as pumps and fans. To counteract this, pulley sizes could be changed or the system put onto a VSD.
Lighting

Lighting is an ever-present “base” load for a site. It is a constant load unrelated to production levels and thus continues to cost the same amount of energy and money regardless of whether the plant is idle or at full production. This constant load, combined with the easily predictable energy input into lighting systems, makes the energy savings from a lighting upgrade reliable and quantifiable.

The two main aspects of lighting system efficiency are lighting types and lighting control systems. Control systems are typically the more complex upgrade and are largely reliant on the lighting type to be able to achieve savings. For example, metal halide lamps cannot be regularly switched off and on in response to occupancy, and cannot dim in response to natural light levels without expensive new control gear. Alternatively, LED lighting can be switched off and on almost without limitation, and most systems can be easily dimmed, but the cost of this lighting type is substantially more expensive initially. Choosing an appropriate replacement lighting type is a balancing act between ongoing energy savings, changes in maintenance costs, implementation cost, and ensuring that the necessary light levels are achieved or maintained in all areas.

Use High-Efficiency Lighting

Initiative 1: Upgrade High-Bay Lighting Types

Improve lighting efficiency in warehouses, production halls and other large indoor areas.

Older lighting types suffer from a range of inefficiencies, even if they are in good condition and lamps are changed on schedule. Most of these inefficiencies cannot be identified simply by reading the rated light output of a lamp.

A number of newer lighting types offer significantly higher efficiency and, in many cases, increased life expectancy. The following table compares generic cost and performance figures for a number of different lighting technologies. Older, or poorly maintained, lighting often has efficiencies of less than half those shown. Note that high pressure sodium lighting has been excluded due to their specialised use and poor quality of light produced.

<table>
<thead>
<tr>
<th>Lighting Attribute</th>
<th>Mercury Vapour</th>
<th>Metal Halide</th>
<th>T5 Fluorescent</th>
<th>CFL</th>
<th>Induction</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Efficiency (lumens/watt)$^1$</td>
<td>48</td>
<td>86</td>
<td>88</td>
<td>70</td>
<td>81</td>
<td>105</td>
</tr>
<tr>
<td>Lumen Maintenance at Rated Life$^2$</td>
<td>50%</td>
<td>60%</td>
<td>90%</td>
<td>75%</td>
<td>65%</td>
<td>70%</td>
</tr>
<tr>
<td>Optical Efficiency$^3$</td>
<td>80%</td>
<td>80%</td>
<td>92%</td>
<td>80%</td>
<td>80%</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>Overall System Efficiency (lumens/watt)$^4$</td>
<td>19</td>
<td>41</td>
<td>73</td>
<td>42</td>
<td>42</td>
<td>66</td>
</tr>
<tr>
<td>Rated Lamp Life (hours)</td>
<td>24,000</td>
<td>20,000</td>
<td>20,000</td>
<td>10,000</td>
<td>100,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Controllability</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
<td>Average</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Annual Energy Cost, per 10,000 lumens$^5$</td>
<td>$314</td>
<td>$145</td>
<td>$83</td>
<td>$143</td>
<td>$142</td>
<td>$91</td>
</tr>
<tr>
<td>New Lamp and Fitting Cost, per 10,000 lumens</td>
<td>$240</td>
<td>$170</td>
<td>$190</td>
<td>$340</td>
<td>$920</td>
<td>$560</td>
</tr>
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</table>

1 Initial efficiency of lamp and control gear. Lumens is the standard measure of light output from a lamp.
2 Proportion of initial lamp output that remains as the lamp approaches its rated lifetime
3 Efficiency of reflector. Values assume a brand-new fitting from a quality manufacturer.
4 Combination of all efficiency factors. It is this value that is most important for sizing a lighting system.
5 For 4,000 hours of annual operation and an energy price of $0.15/kWh
Case Study A: Upgrade to high-bay fluorescent saves small manufacturer $3,144 in energy costs

A small manufacturing plant upgraded its 15 existing 400 W metal halide light fittings to 4 x 54 W T5 fluorescent high-bay fittings, saving $3,144 in annual energy costs at an implementation cost of $6,600, giving a simple payback period of 2.1 years. This upgrade also improved light levels and uniformity throughout the plant, and allowed the lights to be safely switched off and on without delay.

Initiative 2: Improve Fluorescent Lighting Systems

Replace old fluorescent systems.

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<th>RETROFIT</th>
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ADDITIONAL BENEFITS: Increased lamp life and reduced maintenance requirements

Older fluorescent systems are significantly less efficient than good-quality modern systems. Modest savings can be found in lamp efficiency, but larger savings can usually be found in distribution efficiency due to poor-quality or poorly maintained old fluorescent reflectors. Options to improve this include installing new T5 fluorescents with high-quality reflectors, or installing LED tubes which emit light downwards and eliminate the reflector inefficiency altogether.

Install Suitable Lighting Controls

Initiative 3: Control Lighting to Reduce Unnecessary Operation

Install controls to reduce light output when areas are unoccupied or have available natural light.

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An efficient lighting system should ensure that lights are switched off or dimmed when not needed. However, retrofiting such controls into an existing lighting system can be costly, inflexible, and require many compromises, so advanced controls are best considered as part of a broader lighting upgrade.

Many new high-efficiency lighting systems have inbuilt sensors or are designed to integrate easily with sensor controls in order to dim or switch off when not required. By using a well-controlled modern lighting system, both energy efficiency and energy conservation can be maximised.
There are many new technology opportunities for energy-efficiency improvements in the textile manufacturing industry. These include opportunities for retrofit and process optimisation as well as a complete replacement of the current machinery with up-to-date technology. The latest technology usually has high upfront capital costs, and is often hard to justify. It is important to undertake an analysis of the full life-cycle costs and savings of new machinery in order to get a full picture of the return on investment. New technologies may become economically feasible when considering additional benefits that may result, such as water savings, material savings, less downtime, higher product quality, less waste, and less wastewater.

Low-end equipment may be considerably cheaper upfront, but can cost far more in ongoing energy and maintenance costs than costlier alternatives, giving a false economy. It is recommended to use a life-cycle-cost calculator to compare different options and account for capital costs, energy and maintenance costs, inflation and escalation rates for energy and maintenance costs. This allows the full economic picture to be seen before making an investment decision.

Within the textile industry there are several sub-sectors, each with its own special needs and requirements. The following sections identify initiatives to improve the energy efficiency in the respective sub-sectors:

1. Spun yarn spinning process
2. Weaving process
3. Wet processing
4. Man-made fibre production

### Spun Yarn Spinning Process

**Initiative 1: New Installations for the Preparatory Process**

Installing new equipment and systems can improve the efficiency of the preparatory stage in a spinning process.

![Retrofit New Facility Maintenance Savings Payback](chart)

A roving machine can be converted from a pneumatic system to an electronic roving end-break system to save energy. The installation of a few high-speed carding machines can replace multiple conventional machines used in the secondary processing of raw cotton.

**Initiative 2: General Ring Frame Maintenance and Changes**

Several basic initiatives can be implemented to ensure the ring frames are operating with high efficiency.

![Retrofit New Facility Maintenance Savings Payback](chart)

**ADDITIONAL BENEFITS:** Potential to decrease the pressure setpoint of the air compressor(s)

Energy-efficient spindle oils can produce 3 – 7% savings compared to conventional oils. Efficiency increases when oil levels in spindle bolsters are kept at optimum, and various oil-dosing devices are available to assist with this. Replacing spindles with lighter spindles reduces energy consumption, as does using lighter bobbins in the ring frames. Synthetic sandwich tapes for ring frames can offer 5 – 10% energy savings, and the ring diameter should be optimised with respect to yarn count in the ring frame; the larger the diameter, the more energy it consumes. Using a false ceiling over ring frames areas can also reduce energy use by decreasing the volume of the facility that needs to be humidified.
Initiative 3: Installation of Major Components of Ring Frames with Higher Energy Efficiency

Replace the major components of the ring frame with more-energy-efficient models.

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Spindle rotation is the largest energy user within a ring frame, with heavier spindles consuming more energy. High-efficiency spindles, which are lighter than conventional spindles, are available. Replacing conventional aluminium fans in the ring frames with energy-efficient excel fans also lowers energy consumption. Installing high-speed ring spinning machines that operate 10 – 20% faster than conventional equipment reduces the power requirement for the same output, and these machines also use energy-saving spindles that result in a further power reduction of around 6%.

Initiative 4: Installations and Modifications for the Windings, Doubling and Finishing Process

Technologies and behaviours can be improved to produce savings for the winding, doubling and finishing processes.

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Autoconer machines rewind yarn from small bobbins to larger cones, and installing variable speed drives (VSDs) can assist in sustaining a constant vacuum and therefore save energy. Turning on bobbin conveyors only when required not only saves energy but also reduces maintenance and waste. Two-for-one (TFO) machines twist two or more single yarns together (doubling), and the balloon tension of yarn in TFOs account for 50% of total energy use but can be reduced by 4% with a modified outer pot. The balloon settings in TFOs can also be optimised, and it has been observed that electricity use is less at lower balloon settings.

Initiative 5: Air Conditioning and Humidification System

Modifications can be made in the air conditioning and humidification systems to improve energy efficiency.

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Mist nozzles in yarn conditioning rooms can be replaced with energy-efficient nozzles. Existing aluminium fan impellers with can be replaced with high-efficiency fibreglass-reinforced plastic (FRP) impellers in humidification fans and cooling towers of spinning mills; these lighter FRP impellers extend the life of the mechanical drive system as well as using less electricity than aluminium ones under the same conditions. Installing a humidification plant control system that consists of variable speed drives (VSDs) for pumps and supply and exhaust air fans, as well as control actuators for recirculation, fresh air and exhaust dampers, could potentially save 25 – 60% of the total humidification plant energy use.

Initiative 6: Overhead Travelling Cleaners (OHTC)

Implement overhead travelling cleaners to assist with waste removal.

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System control for waste removal which can be achieved with the support of overhead travelling cleaners (OHTC). These systems should be timer-based to ensure operation only when necessary.
Weaving Process

Initiative 7: General Measures

Enhance the energy efficiency of the weaving process through improved equipment and yarn quality.

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The type of loom should be considered carefully when buying new, as the type can significantly influence the energy usage per unit of output. The trade-offs between cost and productivity must be considered when selecting the quality of yarn. Higher quality means higher cost but also less yarn breakage and stoppages in the weaving process, and therefore less energy wastage. Analysing the full life-cycle cost can determine what quality of yarn provides the best balance between yarn cost and process continuity.

Wet Processing

Initiative 8: Treatment Methodology and Water Use in Preparatory Process

Alter treatment methodologies and water usage in the preparatory process in wet processing.

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ADDITIONAL BENEFITS: Reduced water consumption

The eight-stage preparatory treatment process can be reduced to two stages by combining treatment steps such as de-sizing, scouring and bleaching. The two stages would include a steam purge and cold-pad-batch technique, and implementing this could potentially reduce energy requirements by 80%. A cold-pad-batch technique could potentially reduce water and electricity use by 50% and steam by 38%, although this is only available to woven cotton fabrics. A bleach bath recovery system can be retrofitted to reuse the rinse water in another rinse operation that accepts lower grade rinse water, or as process water in wet processing operations with or without chemicals. Integrating a dirt removal and grease recovery loop in wool scouring plants can result in energy savings, valuable wool grease by-product, and a decrease in detergent use and load sent to effluent treatment plant.
**Initiative 9: New Installations and Modifications in Preparatory Process**

Install new components and modify existing equipment in the preparatory process in wet processing.

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Covers should be installed on nips and tanks, automatic valves, and heat recovery equipment in continuous washing machines. Interlock the running of exhaust hood fans with water tray movement in yarn mercerizing machines, cooling blower motors with the fabric gas singeing machine main motor, and shearing machine blower motors with the main motor.

**Initiative 10: New Equipment and Automation in the Dyeing and Printing Process**

Install new components and automate different processes in dyeing and printing.

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Preparation and dispensing of chemicals in dyeing plants can be automated, as can dyestuff preparation in fabric printing plants, and dye machine controllers. Installation of the following can also be beneficial: airflow dyeing machines for discontinuous dyeing processes, VSD on colour tank stirrers, updated equipment in winch beck dyeing machines and jet dyeing machines, single-rope flow dyeing machines, and microwave dyeing equipment to replace conventional dyeing equipment.

**Initiative 11: Additional Measures in Dyeing and Printing Process**

Reducing, reusing, recovering and other energy efficiency measures in the dyeing and printing process.

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Cooling water can be recovered in batch dyeing machines and cold-pad-batch dyeing systems. Dyebaths can be reused to reduce effluent and pollutants. Process temperatures can be reduced, steam coil heating can be used instead of direct steam heating, and process times can be reduced in wet batch pressure-dyeing machines. Covers or hoods can be installed, and temperature control implemented in atmospheric wet batch machines. Washing and rinsing water use, and rinse water temperatures, should be reduced as much as possible.

**Initiative 12: Drying Process in Wet Processing Plants**

Improve the energy efficiency of the drying process through technological or mechanical enhancements.

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Mechanical pre-drying methods such as mangle, centrifugal drying, suction slot or air knife de-watering can be implemented to reduce energy consumption. Avoid intermediate drying steps and overdrying in cylinder dryers. Idling times should be reduced, and multiple fabrics dried simultaneously in cylinder dryers. Radio-frequency dryers can be used when drying acrylic yarn, low-pressure microwave drying machines for bobbin drying instead of dry-steam heaters, and high-frequency reduced-pressure dryers for bobbin drying after the dyeing process, to potentially obtain 20% electricity savings in comparison to conventional dry-steam-type hot-air dryers.
**Initiative 13: Finishing Process in Wet Processing Plants**

Improve the energy efficiency of the finishing process by modifying existing plant and controls.

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Thermic fluid heating systems can be converted to direct gas-fired system in stenters and dryers to reduce energy losses, which can be further improved via mechanical de-watering or contact drying before stenters. Avoid overdrying and dry at higher temperatures in stenters. Exhaust streams should be closed during idling, and side panels should be closed and sealed in stenters. Exhaust humidity in stenters can be optimised by maintaining the humidity between 0.1 and 0.15 kg water per kg dry air. Further savings in stenters can be achieved through heat-recovery equipment, either air-to-air or air-to-water, and through use of sensors and control systems. Major systems include exhaust humidity measurement, residual moisture measurement, fabric and air temperature measurement, and process visualisation systems.

**Man-made Fibre Production**

**Initiative 15: Man-made Fibre Production**

Optimise processes and equipment for man-made fibre production.

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Steel-reinforced pots can be replaced with lightweight carbon-reinforced spinning pots, and lead compartment plates can be installed between pots of spinning machines. Low-pressure steam-based vacuum ejectors can be replaced with high-pressure ones for viscose de-aeration. Heat exchangers can be installed on dryers. Settings in TFO machines should be optimised, as these have been observed to be more efficient at lower settings, although feasibility studies should be undertaken before implementation. Use high-speed yarn manufacturing equipment for solution spinning of filament other than urethane polymer, and high-speed multiple thread-line yarn manufacturing equipment for producing nylon and polyester filament. Efficiency in draw false-twist texturing machines can be improved by using combined transistor-VSD systems for speed control of the motor.

Investment in new technology requires indepth investigation beyond the scope of this Guidebook. The help of industry consultants and equipment suppliers should be enlisted for investment decision-making.

Source: Radford Yarn
New Technology and Processes

With energy prices continually on the rise, and low-cost international competition, it is important for textile manufacturers to adopt new strategies and technologies so they remain efficient and profitable. Some of the new technology options in this section could assist in reducing energy consumption.

**Initiative 1: Greywater Heat Recovery**

Recover heat from hot greywater to save on unnecessary heating utilities.

Textile sites cannot usually reuse condensate because steam is directly injected to provide heat. However, by recovering the heat from greywater that is often discharged at high temperatures, this can provide substantial heating, thereby saving energy and lowering the wastewater temperature. Savings for condensate and greywater heat recovery could potentially be 10% of the system’s total energy use.

**Case Study A: Manufacturer saves 7% on natural gas costs through greywater heat recovery**

A New Zealand textiles company was heating their dye house using large quantities of steam. The dye house was producing greywater that was being discharged directly without cooling. This water needed to be cooled to meet consent requirements before it could be discharged. The company implemented a heat recovery system using the greywater and not only met the requirements but also achieved energy savings.

**Initiative 2: Supercritical Dyeing Technique**

Use supercritical carbon dioxide as a dyeing medium.

When a substance reaches above a certain temperature and pressure (critical point) it is known as a supercritical fluid. These fluids have combined properties of both their liquid and gaseous states, and have solvent characteristics. The advantages of non-toxicity, non-corrosivity and non-hazardousness of carbon dioxide make it a commonly used solvent. The critical point for carbon dioxide can be easily achieved compared to other gases, and it is easily transported. Dyeing occurs in high-pressure vessels called autoclaves, and the use of supercritical carbon dioxide as a dyeing medium is a new technique. This process offers ecological and economic advantages, for instance low heating costs for the liquid.
**Initiative 3: Ultrasonic-Assisted Wet Processing**

Use ultrasonic equipment to assist in various textile processes.

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**ADDITIONAL BENEFITS:** Reduced water consumption because processing water is no longer required

Ultrasound equipment can be installed in existing textile processing machinery. The addition of ultrasonic equipment offers enhanced performance in fabric preparation and dyeing without lowering the properties of the processed materials. The benefits of using ultrasound in textile wet-processing include reduced processing temperatures, time, and therefore energy savings.

**Initiative 4: Foam Technology**

Apply foam technology to textile manufacturing.

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**ADDITIONAL BENEFITS:** Reduced water consumption because processing water is no longer required

The energy requirements for heating, drying, steaming and other processes can be significantly reduced with the application of foam processing. These savings occur because the majority of water in foam finishing is replaced with air, hence decreased energy use in the drying process. This finishing technique can be applied in various ways including dyeing and printing, softening, fabric preparation, water and oil proofing. Energy savings of 60 – 65% could potentially be achieved with a foam finishing process.
Further Reading

General Energy Information Resources

Energy Efficiency and Conservation Authority (New Zealand)
www.eecabusiness.govt.nz/

U.S. Department of Energy
www.eere.energy.gov/

Specific Material


Natural Resource Defence Council (2010) *Ten Best Practices for Textile Mills to Save Money and Reduce Pollution*


Textiles NZ *Textiles Energy Efficiency Guidance Note 01: Compressed Air*

Textiles NZ *Textiles Energy Efficiency Guidance Note 02: Efficient Thermal Systems*