

# Heat recovery system pays off



## Taking the heat off at Tegel

A network of green pipes which wind their way around Tegel Foods Ltd's poultry processing plant in New Plymouth look ordinary enough.

But what goes on inside them is far from ordinary. They're part of an innovative heat recovery system which is expected to save the company more than \$110,000 a year in gas and electricity – and pay for itself in just two years.

The green pipes carry water which has been heated using waste heat from the plant's industrial refrigeration system and main air compressor. That makes them green in more ways than one. The scheme is expected to save 628 tonnes of carbon dioxide emissions a year.

For Grant Dudson, the plant's Projects Engineer, installing the new heat recovery system has been a thoroughly satisfying process. "It's been great – it's one of the best things I've ever done because I can see real benefits from it."

### About Tegel Foods



Tegel Foods Ltd, located on the outskirts of New Plymouth, is home to one of New Zealand's largest poultry plants. It processes approximately 65,000 birds a day, five days a week.

This requires a lot of refrigeration and uses high volumes of hot water. It's a combination that makes the plant an ideal candidate for a heat recovery system. That's because refrigeration creates a lot of waste energy in the form of heat, while producing large quantities of hot water uses a lot of energy.

As Grant Dudson points out, heat recovery is economically viable only when large volumes of waste energy are available – and there's a use for it.

"It's not so much about how much heat you can get but what you can use it for," he says.

Now the water is heated by a combination of waste heat recovered from the refrigeration system and natural gas.

### The business case

In 2004 Tegel Foods Ltd began looking at ways of reducing its utilities bills, of which energy costs are a large part. It identified several potential energy-saving projects, among them the introduction of a heat recovery system at the New Plymouth plant.

The decision to go ahead with the project was made in December 2005 and work began in late June 2006. Part of the \$230,000 cost was met by a grant from the Energy Efficiency and Conservation Authority (EECA).

The heat recovery system began operating at the New Plymouth plant in November 2006. Previously waste heat produced by the refrigeration system was released into the air via the plant's evaporative condenser, or cooling tower, while all the water at the plant was heated using natural gas.

Now the water is heated by a combination of waste heat recovered from the refrigeration system and natural gas. A small amount of waste heat recovered from the plant's main air compressor also helps to heat the water.

This has already cut gas use at the plant. According to an independent review of the system carried out by Power Solutions Ltd, the new system recovers 230-250kW of waste heat, and it is expected to save \$84,500 of natural gas a year.

The system is also expected to provide annual electricity savings of approximately \$27,400. This is because removing heat from the refrigeration system helps it to run more efficiently. ▶

Total savings from the project are expected to be at least \$110,000 a year, which means it will pay for itself in just over two years.

It has been so successful that Tegel is now looking at extending the system to include the water used by the plant's scalders, which would save another \$30,000 to \$40,000 a year.

There have been unexpected benefits as well. The reduced load on the refrigeration system means that plans to install another cooling tower – at an estimated cost of \$300,000 – have been put on hold. And the new heat recovery system means the plant now has a constant supply of very hot water, rather than having to ration it as it did in the past.



Tegel's poultry plant in New Plymouth.



The compressor used to compress the ammonia gas during the chilling process.

### How does the system work?

Before the heat recovery system was installed the plant took cold (14°C) water directly from the town mains and heated it to two different temperatures, 40°C and 60°C. The 40°C water is used for things such as hand-washing and showers, while the 60°C water is used to wash down the processing equipment.

Now, waste heat from several sources is used to pre-heat the town mains water to around 35°C. It is then stored in a large buffer tank, from where it is drawn off to be heated in the normal way. Because it is already partially heated much less energy is needed to finish the process, leading to significant gas savings.

The mains water is not heated directly by the waste heat. Instead, the process is done in two stages. In the first stage, waste heat from the refrigeration system is used to heat water contained within a closed loop at the plant. In the second stage, the water in this closed loop is used to heat cold water from the town mains through a process known as heat exchange.

Total savings from the project are expected to be at least \$110,000 a year, which means it will pay for itself in just over two years.

## Where does the heat come from?

Most of the heat is recovered from the plant's industrial refrigeration system, which operates using ammonia gas. This provides waste heat from two sources. The first is the compressors, which are used to compress the ammonia gas during the chilling process. The second is the ammonia gas itself.

The compressors are lubricated with oil which gets very hot and is cooled down using water. This in turn heats the water. In the past this hot water was cooled in the plant's cooling towers and used again. Now it passes through a plate heat exchanger, where it is absorbed more waste heat from the ammonia gas.

Ammonia gas is the biggest source of heat in the project. The refrigeration process makes the gas get very hot, and previously this waste heat was simply released into the atmosphere via the cooling towers.

After it has been heated by the ammonia gas the water then goes through a second heat exchanger, where its heat is absorbed by cold water from the town mains. Now heated to around 35°C, the mains water is fed into the insulated buffer tank, while the water used to heat it is cooled and begins the heat-recovery cycle again.

A small additional amount of heat is also recovered from the plant's main air compressor, which is used to provide compressed air for various processes in the factory. Its waste heat is used to add a little more heat to the water in the buffer tank. This is a less significant source of heat but it is still expected to provide gas savings of more than \$9,000 a year.

### Summary of total savings

Plant Item	Energy Form	Annual Energy Saved (GJ/yr)	Annual Energy Saved (kWh/yr)	Annual Saving (\$/yr)	CO2 Saved (Tonnes/yr)
Refrigeration system	HP gas to heat water to 60°C	8,320	2,311,111	\$71,385	436
Refrigeration system	LP gas to heat water to 40°C	438	121,667	\$3,758	23
Air compressor	HP and LP gas to heat water	1,095	304,167	\$9,395	57
Refrigeration compressors	Electricity		221,738	\$24,391	100
Evaporative condenser	Electricity		27,404	\$3,014	12
<b>Totals</b>			<b>3,986,087</b>	<b>\$111,943</b>	<b>628</b>

Source: Power Solutions Ltd



The plate heat exchanger - heat is absorbed by cold water from the town mains.

## Where do the savings come from?

The main saving comes from a reduction in the amount of gas used to heat water to 60°C. This is because much larger volumes of this very hot water is needed during processing. Total savings from this part of the project are expected to come to at least \$71,400 a year.

The next biggest saving comes from the reduced electricity cost of running the compressors in the refrigeration system. This is because removing the heat from the ammonia gas reduces the pressure at which it is discharged, which in turn reduces the load on the compressors. This means they run more efficiently. This is expected to save \$24,400 worth of electricity a year.

Smaller savings come from the reduced cost of heating water to 40°C for things such as showers, and from the savings made by using waste heat from the air compressor.

Altogether the scheme is expected to save \$110,000. The cost of installing the scheme was \$230,000, which makes a simple pay back of 2.05 years.

## Advice to businesses interested in heat recovery systems

Similar systems could be introduced at any business with a large ammonia gas refrigeration system and high hot water use. That includes meatworks, vegetable and fish-processing plants and dairy factories.

According to the project's consultant design engineer, Alex Snodgrass, the same basic technology could also be used in medium-sized to large hotels (100 beds or more), where waste heat from air conditioning could be used to heat water for showers.

He says smaller heat-recovery systems could also be installed in plants and factories which use hydro fluoro carbon (HFC) rather than ammonia refrigeration, such as wineries.

"Smaller plants tend to use HFC, but you can still get heat off the refrigeration plant and use it for wash-down water. Small, brazed heat exchangers provide an economical solution."

The first step is to get an energy audit, to identify where energy is being used and ways in which it could be saved. EECA provides grants for energy audits. These will pay for up to half the cost of the audit, and are available to businesses with energy bills of more than \$100,000 a year. Visit the EECA business website: [www.eecabusiness.govt.nz/emprove](http://www.eecabusiness.govt.nz/emprove) for more information.

Tegel engaged several consultants to help design and install its heat recovery system. They included a project manager and a design engineer. Information on how to find and choose a consultant is available on the EECA business website.

The company's refrigeration supplier, York Refrigeration, also helped with the design. However, the bulk of the work was carried out by Tegel staff, supervised by the New Plymouth site's Projects Engineer Grant Dudson.

## EECA grants

Grants for demonstration projects are available to businesses in energy intensive sectors. Grants of up to 40% of the capital cost of the project are available, with a maximum of \$100,000 for each grant. EECA is looking to support energy efficient technologies that are commercially available but are not yet commonplace in New Zealand.

EECA grants are available for businesses from the following sectors: heavy transport fleets, wood processing, basic metals, glasshouse crops, irrigated dairying, irrigated arable crops, food and beverage processing, fishing fleet operation and non-metallic products.

Other businesses where energy is greater than 5% of their total business costs are also eligible.

## For more information contact:

Grant Dudson,  
Projects Engineer,  
Tegel Foods Ltd, New Plymouth  
Phone: 06 769 8724  
Email: [grant.dudson@tegel.co.nz](mailto:grant.dudson@tegel.co.nz)

Alex Snodgrass,  
Heat Transfer New Zealand Ltd, Hamilton  
Phone: 07 850 1644  
Email: [info@heattransfer.co.nz](mailto:info@heattransfer.co.nz)

### CONTACT EECA

For more information on EECA's technology grants and services, call 0800 358 676 or visit [www.eecabusiness.govt.nz/eib](http://www.eecabusiness.govt.nz/eib)

"Smaller plants tend to use HFC, but you can still get heat off the refrigeration plant and use it for wash-down water. Small, brazed heat exchangers provide an economical solution."