feature

>>> SEAN McGOWAN REPORTS

How wind is powering cold storage

Could the success of a load shifting trial in the Netherlands last year signal a future where the wind is used to power cold storage facilities? According to Sean McGowan, the trial's success is likely to bring winds of change across Europe.

Wind power continues to be seen as a viable alternative energy source around the world, despite whatever criticisms you might hear in the local media. According to official figures from the Global Wind Energy Council, the United States is now the world leader in wind power generation, with over 27GW coming online in 2008, 36% more than the year before.

Globally, wind power capacity grew by 28.8% last year, with total global installations estimated to be more than 120GW.

At the same time the United States overtook Germany for the world's number one wind power title, China made significant steps also; doubling its capacity last year and likely to outstrip Germany's capacity by 2010.

For the time being however, Europe remains the home of wind power, with Germany joined by Spain, Denmark, France, the UK and now Italy in embracing the technology. But it's not without its problems.

The trouble with wind

While wind power may be a clean, renewable energy source, its inherent reliance on the weather results in power being produced at variable times, which may not necessarily meet the grid's peak demands. This in turn reduces its value on the energy markets.

This is said to be a major demotivating factor for wind turbine owners, as well as for new investors in wind power production.

In his groundbreaking paper, *Cold Storage of Wind Energy – Night Wind*, author Sietze van der Sluis says that when the wind energy producer has no storage possibilities for the energy that has been created, he is forced to sell the energy at the prevailing market price, which can be anything from 0.01 €/MWh to 900 €/MWh.

He estimates that the average price achieved by wind energy producers tends to remain close to the production cost and on local grids where a higher, percentage of wind generated power exists, prices may even fall below that figure.

The answer, he says, is the availability of energy storage which then allows the wind energy producer to sell his power only at times when a better price can be achieved.

And the best existing energy storage infrastructure just happens to be a large energy consumer – cold storage facilities.

Night Wind

Night Wind is the name given to a European-funded trial which last year investigated the merits of storing wind generated power in cold store facilities.

The trial brought together a team of refrigeration experts from the Netherlands and Bulgaria and wind energy experts from Denmark and Spain, all working together to show that by using existing infrastructure, wind energy could be effectively stored in cold stores overnight and released again during peak demand hours.

According to van der Sluis, because of the variations in wind energy production, daily production was estimated to be 20% of installed capacity. Therefore to store one night's production of wind energy, a capacity half the size of the daily production was required.

So with the support of the Netherlands' largest cold store warehouse, a 100,000 pallet facility in Bergen op Zoom, the trial set about proving that by applying load shifting to mirror the variable supply of wind generated power, both the energy producer and cold storage operator could benefit financially with little impact on the quality of the stored product.

The process of Night Wind is a relatively simple one in theory.

When there is an excess of wind power being generated, the cold store switches to maximum capacity, with the refrigeration plant operating flat out which cools the products being stored in the cold store below their normal storage temperature. As such, the excess wind energy is converted into thermal energy within the cold store.

Once the cold store has been "charged" with this excess wind energy, the refrigeration plant moves back to normal operation and works only to maintain a constant temperature, which is now below the normal storage temperature.

Later in the day when the electrical demand on the grid nears its peak, the refrigeration plant shuts down completely, and the electricity that would normally be consumed by the cold store is made available for other users. Gradually the temperature of the stored products rises, until such time as they reach their normal storage temperature.

At this time the cold store is "discharged" and the plant again moves back to normal operation before the process is repeated.

In practice, however, the issues of controls and product degradation needed to be addressed.

Controlling Night Wind

The Night Wind project required the creation of a unique control system which would manage both the power supply and refrigeration demand of the cold store; and one which was able to achieve a flat electrical load on the grid all year round, where the cold store, capacity matched the wind power being produced.

The Night Wind Control System (NWCS) included online input of wind energy production estimates for three days forward, energy cost predictions for one day forward and calculated the optimum capacity time-series to achieve the lowest costs and optimal grid capacity control.

The system was also designed to predict the air and product temperatures in the cold store, while controlling the capacity of the cold store refrigeration compressors; and was able to adjust the dynamic cold store model to optimise future temperature predictions.

Data acquisition and plant control was performed by an Agilent data unit, while standard PLC compressor controls remained in place.

A trial of the program was conducted on September 1, 2008 commencing at 8pm, with results in the below graph showing that the system performed as required, with product temperature rising steadily for two to three hours before the cold store was "charged" overnight by wind generated power, before being discharged at 7am as demand on the grid increased.

One of the unexpected oddities from the trial was the fluctuation in the air temperature, which van der Sluis says was due to the compressor being on/off regulated.

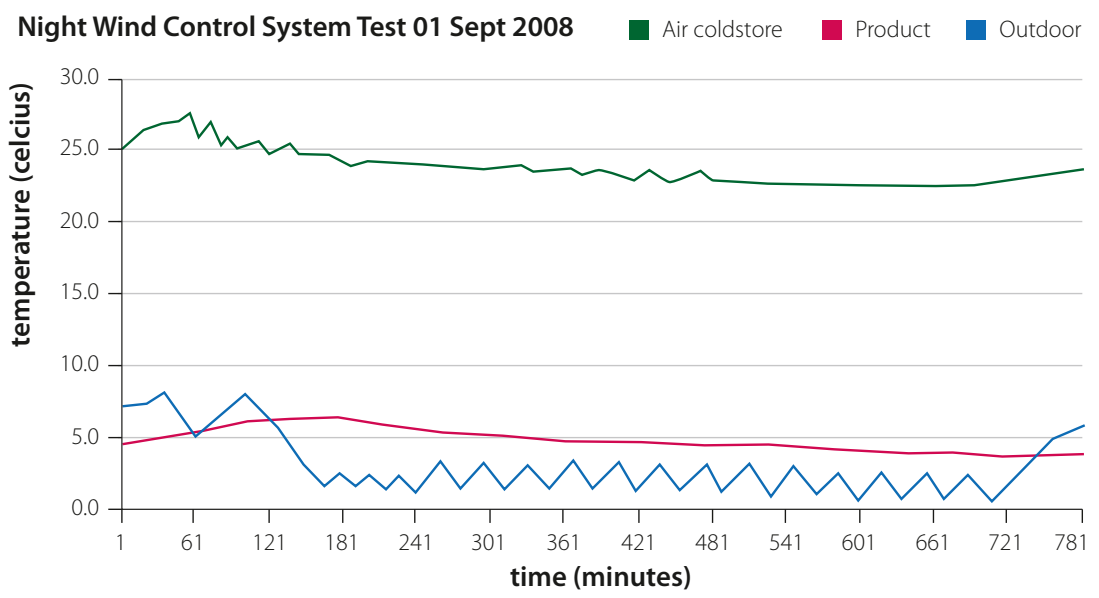

Figure 1: The graph shows the test result, demonstrating that air temperature in the cold store fluctuates.

"In a large refrigerating system the compressor is not on/off regulated, but rather continuous, and the capacity will not be set to zero but to a minimum value which will keep a steady air temperature while the product temperature rises," he says.

"It will also not be set to full capacity, but to a maximum value that keeps the air temperature constant and allows the product temperature to drop. The exact locations of minimum and maximum capacity depend on the dynamics of the specific cold store," he explains.

While tests showed that the quality of the food stored, including meat, fish, vegetables and baked items, remained comparable with standard cooling regimes, those stored in the Night Wind project were found to be slightly inferior, however not such that would be any cause for concern.

"The slightly inferior product quality is in most cases not a problem. Many cold stores are in fact already changing temperatures on a day/night basis to save energy costs, which has the same effect on food quality as the Night Wind control system," says van der Sluis.

The future of wind

Could the success of the Night Wind trial in the Netherlands signal further investment into wind power generation, both overseas and also here in Australia?

Van der Sluis says it is likely, and with the trial's results having achieved attention throughout Europe, he intends to implement Night Wind into more cold stores, with one project partner already committed to rolling it out on a large scale in the Netherlands.

With Australian commercial refrigeration estimated to consume 6600GWh annually – the equivalent power for 1.3 million homes; and concerns in many states about the peak demand on electricity grids during summer, the lessons learned from the Night Wind project may soon be applied in here. ▲