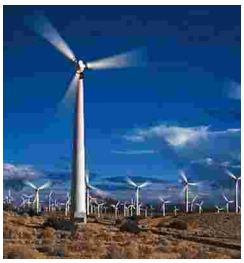


Project no. SES6 – CT – 2006 - 20045

Project acronym: Night Wind

Project title:
Grid Architecture for Wind Power Production with Energy Storage
through load shifting in Refrigerated Warehouses

Instrument: Specific Targeted Project

Thematic Priority: 6.1.ii – Sustainable Energy Systems: research activities having an impact in the medium and longer term

# Final Activity Report – Night Wind - summary

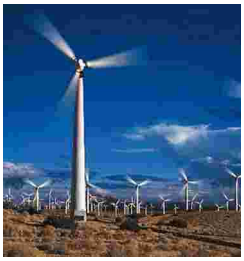
Period covered: from july 1st 2006 to june 30th, 2008 Date of preparation: Feb. 12th, 2009

Start date of project: July 1st, 2006 Duration: 2 years

Project coordinator name: S.M. van der Sluis, M.Sc.
Project coordinator organisation name: TNO

Revision 1

**Publishable executive sumary**



# Night Wind:
# storage of wind energy in cold stores
# First Period (1st july 2006 – 30th june 2007)

An EU – FP6 research project

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***To use a refrigerated warehouse as a giant battery for wind energy. To store all electricity produced during nighttime by windmills all over Europe, and to release this energy again during the peak electricity demand hours in daytime. That is, in short, what the EU "Night Wind" project wants to demonstrate. In the project refrigeration experts from The Netherlands and Bulgaria work together with wind energy experts from Denmark and Spain. The demonstration, in 2007/2008, will take place at a Dutch refrigerated warehouse.***

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***Research Partners:***

TNO RISØ cener Technical University of Sofia

***Industry Partners:***

essent Vereniging voor Nederlandse Koel- en Vrieshuizen PARTNER LOGISTICS Europe BV

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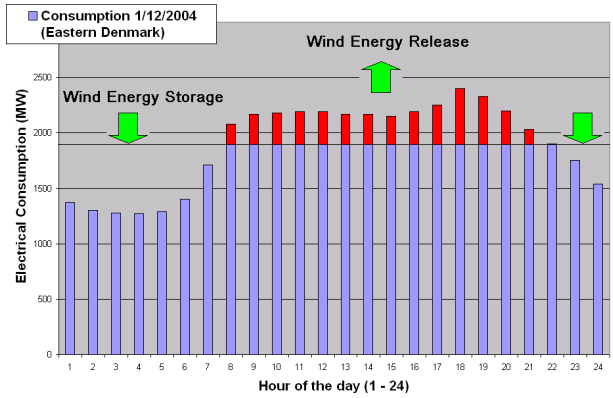
***Challenges***

The integration of wind power into the national or EU energy supply systems is becoming relatively more problematic with increasing installed capacity and production, especially due to a mismatch of supply and demand of energy. The wind energy is produced at rather random times, whereas the energy use pattern shows distinct demand peaks during day time and office hours, and low levels during the night.
The random production of wind energy cannot easily be accommodated on the grid by switching on and off conventional energy suppliers, like coal fired power plants, which would lead to an increase of CO2 emissions, rather than the reduction of CO2 emissions which is desired.
In order to accommodate the random production of wind energy in the grid, it would be most convenient when alternative (renewable and conventional) electricity producers could balance out the difference between production of wind energy and electricity demand. The Night Wind project aims to store wind energy produced at night in refrigerated warehouses, and to release this energy during daytime peak hours.




Optimum storage / release of wind energy in line with consumption pattern

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***Technical approach***

The whole idea for "Night Wind" makes use of existing technology, extended with novel control strategies. The new control strategies are needed to set the temperature level in refrigerated warehouses to a level that is derived from the actual balance between wind energy production and actual electricity demand. This is the case for "island operation" with delivery of surplus energy to the grid, and also for the case of Distributed Energy Resources (DER), where windmills are physically located elsewhere than the (existing) cold stores, but controlled in an interdependent way to support the European energy service network. Design of control strategies, with the help of powerful simulation tools will be the main task in the Night Wind project.

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***Project Structure***

The research stage of the project includes the following topics:

- potential, economic & trade aspects of Wind Power DER + Cold Store DSM
- design & modelling of infrastructures for island operation of Wind Energy + Cold Store DSM
- control concepts and algorithms for Wind Energy + Cold Store DSM grid integration
- quality preservation of frozen products during minor temperature fluctuations
- legal issues
- demonstration & introduction outline plan

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***Results of first period***

The Night Wind Project intends to bring an idea into demonstration. It has started with a kick off meeting, followed by a phase in which literature was surveyed and a technical specification was set up. The benefits of the idea have been detailed, both the benefits on a macroscopic scale from the European viewpoint of integrating RES with the energy network, and the benefits on a smaller scale to the energy distributors, warehouse owners and the end

users. The assesment of the iinfluence of temperature fluctuations on the quality of stored refrigerated and frozen products is underway, experiments are being done in the food research institute of Plovdiv, bulgaria.

The demonstration phase of the project should mark the start of a larger scale implementation. Therefore, the project will include the preparation of an implementation outline plan, which will be based on the preliminary experiences gained in the demonstration, and will include an effort from representatives from the sectors in which are directly involved in the implementation: the refrigerated warehouse sector and the energy distribution sector.

***Results of the project***

In the second reporting period, the preparations for the demonstartion phase have been intensified. At the demonstration site of Partner Logistics cold store in Bergen op Zoom, the cooling machines and related control systems were analyzed, and meetings were held with the company providing the control software (Progmatic from Steenbergen, The netherlands).

Meanwhile, in Bulgaria the experiments on food quality deterioration due to temperature cycling were prepared and carried out by the Plovdiv Canning Institute. In these experiments, foodstuffs were tested physically for a number of important quality parameters, and by a human test panel for sensory evaluation.

Partners CENER and RISOE have bundled their efforts in order to produce a controller for the refrigeration system, in which the Night Wind function is incorporated. This controller, the Night Wind Control System (NWCS) must produce a 24 hour ahead time series for the refrigeration capacity, based on predictions of wind energy production and electricity price. It must also incorporate a model of the cold store, so that the product temperatures remain within the desired boundaries. Unfortunately, such a control system could not be realised in the time available in the project. A system functioning partly was produced, but the time required to produce the time series (3 hours) was impractical for implementation in a real cold store.

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***Objectives***

1. Integrating renewable energy resources into the European energy service network by providing new facilities for energy storage

2. Increasing the economic value of wind energy by providing means to deliver the energy at peak demand hours.

3. Increasing the competitiveness of SME Cold Storage facilities by providing adding “energy storage” as an additional service to be provided for the European energy service network.

4. Offer a solution to integrate wind energy with energy storage in the European electrical grid, giving space to a further growth in the use of wind energy worldwide and a contribution to the Kyoto targets at the same time.

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***Project Information:***

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|---|---|
| Full Title: | Grid Architecture for Wind Power Production with Energy Storage through load shifting in Refrigerated Warehouses |
| Acronym: | ***Night Wind*** |
| Duration: | june 2006 – june 2008 (2 years) |
| EU Contract: | FP6-2004 ENERGY – 3 / contract nr. 020045 |
| Contact: | Netherlands Organization for Applied Scientific Research TNO |
| | S.M. van der Sluis, M.Sc ( Sietze.vandersluis@tno.nl ) |
| Website: | www.nightwind.eu |

| *Project Partners* | Country |
|---|---|
| The Netherlands Organization for Applied Scientific Research TNO | NL |
| RISØ Wind Energy Department | Dk |
| CENER (Spanish National Renewable Energies Centre) | Es |
| Technical University of Sofia (Food Refrigeration Dept.) | Bulgaria |
| ESSENT Energy Trading (Energy network operator) | NL |
| NEKOVRI (Dutch association of refrigerated Warehouses) | NL |
| Partner Logistics Europe BV (Cold store) | NL |