



*Effektivare kyl- och värmepumpssystem*

## **TILLÄGGSBESLUT**

Datum: 2010-01-25

Projektnummer: EFFSYS2-P21

Projekttitel: Decentraliserade pumpar i kylapplikationer

Projektledare: Samer Sawalha

Start--Slut: 2010-03-01 – 2010-06-30

### **Förändringar:**

Vid programstyrelsemötet EFFSYS 2 (10-01-25) beviljades ett tilläggsanslag på 120 kkr enligt ansökan nedan.

Enligt Programstyrelsens beslut

Erik Björk,

Programsekreterare, EFFSYS 2

### Effektivare kyl- och värmepumpssystem

#### Sökande

Företag/organisation <b>KTH, Kungliga Tekniska Högskolan</b>		Organisationsnummer <b>202100-3054</b>		
Institution/avdelning <b>Energiteknik, Avd. Tillämpad Termodynamik och Kylteknik</b>		Postgiro/Bankgiro/Bankkonto <b>PG: 1 56 53-9, BG: 895-9223</b>		
Postadress <b>Brinellvägen 68</b>				
Postnummer <b>10044</b>	Ort <b>Stockholm</b>	Länskod <b>01</b>	Kommunkod <b>80</b>	Land <b>Sverige</b>
Projektledare (förmamn, efternamn) <b>Samer Sawalha</b>				
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Eventuell medsökande (ange organisation) <b>Björn Palm, KTH</b>				

#### Projektet

<input type="checkbox"/> Ansökan avser nytt projekt	<input checked="" type="checkbox"/> Fortsättning på tidigare projekt, ange projektnummer: <b>EFFSYS2-P21</b>
Projekttitel (på svenska) <b>Spridning av resultat från svenska butikskylprojekt i svenska och internationella tidskrifter</b>	
Projekttitel (på engelska) <b>Documenting findings of supermarket refrigeration projects in international Journals</b>	
<p>Sammanfattning (på svenska). Sammanfattningen skall omfatta max 250 ord och skall skrivas både på svenska och på engelska. Sammanfattningen skall skrivas så att den i ämnet oivngide med lätthet förstår projektets innehåll och syfte.</p> <p>Miljökrav och nya förordningar knutna till traditionella köldmedier har tvingat livsmedelsbutiker att genomföra stora tekniska förändringar. Detta har resulterat i nya typer av lösningar för kylsystemen. Konsekvensen av detta har blivit tätare och mer energieffektiva systems främst genom förbättrade komponenter och bättre system för kontroll.</p> <p>Det naturliga köldmediet CO2 har också införts i flera olika systemlösningar och det pågår arbete med att göra CO2-systemen mer effektiva och prismässigt konkurrenskraftiga.</p> <p>Flera projekt har genomförts inom området för livsmedelsbutiker i samarbete mellan Kungliga Tekniska Högskolan (KTH) och Sveriges Energi- &amp; Kylcentrum AB (SEK) med delfinansiering från Statens Energimyndighet (STEM) och flera företag inom området. Dessa projekt undersöker och utreder ett flertal nya (CO2) och konventionella kylsystem-lösningar.</p> <p>I arbetet ingår modellering datorsimulering, experimentella undersökningar och fältmätningar. Tanken med det föreliggande projektförslaget är dels att sammanställa den information som produceras i Effsys2-projektet vid KTH, "Värmeåtervinning i kylsystem i livsmedelsbutiker, speciellt CO2 system" och projektet "Fältmätningar av butikskylsystem med CO2 som köldmedium" som drivs av SEK och delfinansieras av STEM. Vidare kommer resultaten att presenteras i flera högkvalitativa tidskrifter. Detta kommer att resultera i en bra sammanfattning av det forskningsarbete som utförts av KTH och SEK hittills på området, vilket inkluderar en sammanfattning av befintliga systemlösningar med bra jämförelser av systemens prestanda. Detaljerad parametrisk analys kommer också att presenteras med fördelar, nackdelar och möjligheter för varje systemlösning. En sådan sammanställning är mycket viktigt för att styra kommande projekt och forskning inom detta aktuella och intressanta område. Dessutom kommer arbetet att ligga till grund och</p>	

Sekretariatet EFFSYS 2  
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förberedelse för kommande forskningsprogram såsom "Effsys 3".

Sammanfattning på engelska enligt ovan (max 250 ord).

The environmental concerns and regulations attached to refrigerants use forced the implementation of new practices in supermarket application. This resulted in new designs of the conventional refrigeration system solutions taking into account charge minimization, making the systems tighter and more energy efficient mainly by components improvements and better system control. The natural refrigerant CO<sub>2</sub> has also been implemented in several different system solutions, all trying to make the CO<sub>2</sub> systems more efficient and price competitive.

Several projects have been conducted in the field of supermarket refrigeration in cooperation between the Kungliga Tekniska Högskolan (KTH) and IUC Sveriges Energi- & Kylcentrum AB (SEK) and co-financed by The Swedish National Energy Agency (STEM) and several companies in the field. The projects included investigating several new and conventional refrigeration system solutions. The work included computer simulation modeling, experimental investigations and field measurements.

This idea of this project is firstly to compile the information produced in the Effsys2 project at KTH; "Investigations of Heat Recovery in Different Refrigeration System Solutions in Supermarkets" and the project "Field measurements of supermarket refrigeration systems" which is run by SEK and co-financed by STEM. And secondly, the findings will be presented in several high quality International Journal papers.

This will result in a good summary of the research work done by KTH and SEK so far in the field including summary of the existing system solutions with good system performance comparisons. Detailed parametric analysis will also be presented with advantages, disadvantages and possibilities for each system solution. Such a compilation is very important to properly direct the research in this interesting field and to prepare for new ideas by researchers.

The work in this project will be used to prepare for new project proposal for the research program "Effsys3".

<input type="checkbox"/> Enskilt projekt		<input checked="" type="checkbox"/> Forskningsprogram, ange vilket: EFFSYS 2	
Datum för projektstart 100301		Tidpunkt då projektet beräknas vara genomfört 100630	
Totalt sökt belopp 120 kkr			

Motivering; Energi-/miljö-/näringslivsrelevans, max 250 ord. Ange koppling till resultat från tidigare genomfört program eller projekt.

In the past two years, two projects have been running in parallel and close cooperation. The supermarket refrigeration field measurement project (run by SEK) focused on the refrigeration performance of the vapour compression system while the heat recovery project (run by KTH) focused on the warm side of the system.

In the refrigeration field measurement project data have been collected and analyzed for at least six supermarket refrigeration systems solutions for periods between 6-18 months, more data are available and more system solutions are being analyzed. In the heat recovery project, good field measurements data for heat recovery have been found to be rather difficult to obtain so the work in this project depended more on computer simulation modelling. Computer simulation models have been built for six refrigeration system solution each combined with three heat recovery system/control alternatives.

The progress in the research work and the increasing number of system solutions resulted in huge amount of valuable data from the field measurements and the computer simulation modelling. Data analysis produced interesting results that have been presented so far only as MSc thesis publications.

There is an essential need to compile the work done in the two projects in the form of high quality papers in internationally recognized Journals. This is expected to be well received in the scientific community due to the lack of good publications in this area. The work done in these projects is unique in the way it scientifically compares the performance of the different refrigeration and heat recovery systems and in the way it combines field measurements with computer simulation modelling.

Bakgrund; vad har gjorts tidigare?, vad är nytt i detta projekt?, forskargruppens verksamhet?, samarbeten? etc, max 1 A4-sida

In an earlier project at the Energy Technology Department at KTH the use of CO<sub>2</sub> in supermarket refrigeration has been theoretically and experimentally investigated. Different system solutions has been analyzed including CO<sub>2</sub> in indirect system solutions with R404A, ammonia or propane, two main trans-critical system arrangements have been tested as well as the ammonia/CO<sub>2</sub> cascade system. The analysis took into account only the cooling efficiency of the systems with floating condensing and no heat recovery was considered. The ammonia/CO<sub>2</sub> cascade system shows the highest COP which has up to 60% improvement over a conventional R404A system. A centralized trans-critical CO<sub>2</sub> system shows comparable COP values to conventional R404A system. A simulation tool was developed in this project to simulate the refrigeration systems under investigation where the heat capacity rejected at different temperature levels is calculated depending on the ambient temperatures and refrigeration loads. The experimental work in this project has been performed at the laboratories of SEK.

As a next step to the computer simulation modelling and the experimental work, SEK initiated and conducted a project where field measurements have been carried on to measure the performance of advanced conventional and CO<sub>2</sub> refrigeration systems in supermarkets. At the same period the Energy Department at KTH initiated and conducted a project investigating the heat recovery performance of refrigeration systems in supermarkets, the two projects at KTH and SEK have been in close cooperation and good communication due to the dependant nature of the projects. Several MSc thesis work have been produced in both projects.

The work in the two projects proved how difficult it is to compare real supermarket installations; it has been a long process to be able put the different systems in a comparable form. Such comparison, or method of comparison, has not been found in the scientific literature. The experience in these projects will also produce guidelines of how to measure data in supermarkets, it has been notices that considerable measurements are placed in supermarkets but sometimes it lacks key points which make the energetic performance analysis almost impossible.

The summary of the compiled work in the supermarket refrigeration and heat recovery projects in a form or scientific Journal papers will make the information easily accessible to designers and professionals working in the field of supermarket refrigeration.

Mål: Ange enkla, tydliga och mätbara mål i exempelvis kWh, max 250 ord.

The main objective of this project is to compile the findings of the projects:

- Investigations of Heat Recovery in Different Refrigeration System Solutions in Supermarkets-Effsys2 project at KTH
- Field measurements of supermarket refrigeration systems- STEM co-financed project at SEK

in several high quality International Journal papers. The results will also be published in Swedish Journals. The work done in these projects has been unique in the number of systems investigated and the method developed to make the systems comparable. The intended publications will provide guidelines for designers, installers, consultants and researchers of the key parameters and steps to compare supermarket refrigeration systems. Also it will be made clear of what are the key parameters that must be measured in order to be able to evaluate a refrigeration system.

This project will analyze the simultaneous cooling and heating performance of different vapour compression system solutions in supermarkets. This will give a clear indication of the performance of the different refrigeration system solutions.

A key objective is to create a platform for further research in this field. During the work in the project there have been many ideas created and some companies are already implementing some of the projects recommendations. In the proposed scientific publications, these recommendations will be tested and analyzed in details; this will be guidelines for companies, researchers and governmental institutes of the possible product improvements and the areas to be researched further.

Another important objective in this project is to prepare for new project proposal for the research program "Effsys3".

Genomförande, max 250 ord.

The work in this project will be conducted based on the previous knowledge gained from the supermarket refrigeration projects at KTH and SEK. Already developed simulation tools and the analyzed collected data will be used to produce the publications. The following preliminary papers titles will be submitted to the following Journals:

- ASHRAE Journal  
How to compare refrigeration systems in supermarket application?-
- International Journal of Refrigeration-IIR
  1. Field measurements of CO2 and conventional refrigeration system solutions in supermarkets - Evaluation
  2. Field measurements of CO2 and conventional refrigeration system solutions in supermarkets - Results
  3. Analysis of Heat recovery alternatives in conventional and CO2-based refrigeration system solutions for supermarket applications

**Kostnader**

KALENDERÅR	Projektets totala kostnad	Projektets totala kostnader per år				% av heltid
		2010				
Lönekostnader	235000	205000				
Laboratoriekostnad						
Datorkostnad						
Utrustning						
Material						
Resor	5000	5000				
Övriga kostnader	30000	30000				
Ev förvaltningskostnader	30000	30000				
<b>SUMMA</b>	<b>300000</b>	<b>300000</b>				

**Finansiering inkl. samfinansiärer**

FINANSIÄR	Andel i kronor och procent av projektets totala kostnader/år						
	År	År	År	År	År 2010	Total	(%)
Energimyndigheten					120000	120000	40
Ahlsell Kyl					45000	45000	15
Green and Cool					60000	60000	20
ICA Sverige AB					45000	45000	15
Wica Cold AB					30000	30000	10
<b>SUMMA</b>					<b>300000</b>	<b>300000</b>	<b>100</b>

Detta projekt är  i sin helhet  
 i vissa delar lika med ansökan till annan myndighet,  
 ange vilken:

Sökt stöd för dyr utrustning (Vetenskapsrådet, Wallenbergstiftelsen e.d.) Gäller endast högskola.

Namn på doktorand	Namn på doktorand
Namn på doktorand	Namn på doktorand

Övriga samarbetspartners (ange organisation och namn)

Sveriges Energi och Kylcentrum AB, Jörgen Rogstam  
 Installatörernas Utbildningscentrum, Göran Lundin

Resultatredovisning (ange här om resultatet kommer att redovisas på något ytterligare sätt än det obligatoriska, se information).

Bilagor

Intyg med underskrifter från samfinansiärer

Övriga bilagor

Datum <b>15/1-2010</b>	Datum <b>15/1-2010</b>
Behörig firmatecknares (prefekt motsv.) underskrift	Projektledarens underskrift
Namnförtydligande, titel och telefon <b>Björn Palm, Professor, 08-790 7453</b>	Namnförtydligande och titel <b>Samer Sawaha, PhD</b>