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# Deliverables

# CONCERTO INITIATIVE
## Sesac

## Sustainable Energy System in Advanced Cities

Instrument (Integrated Project, SIXTH FRAMEWORK PROGRAMME PRIORITY [6.1])

Period covered: 25.04.2006 – 24.04.2007
Start date of project: 25.05.2005

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## Contents

## Deliverable 3a

*[Best Practice Exchange Document first 18 months]*
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Author: Stefan Olsson, technical coordinator

## Best Practice Exchange Document first 18 months

### *Executive summary*

One of the most important tasks within the Concerto initiative and the Sesac project is to elaborate and transfer of best practices among partners. The work within WP3 – Best practice and RUE – focuses on to proactive provide partners with verified front edge technical and behaviour related solutions that are applicable in the demonstration projects. During these first 18 months of work it can be concluded that the main efforts have been done in the field of how to do the implementation work.
Every sixth months meetings for each demonstration WP in person with WP-leader, Local coordinator and Technical coordinator (WP3-leader) together with the WP-leaders of WP4 and WP21 (Innovative co-operation, Analysis & Monitoring) has shown up to be a necessary and fruitful way to work. Special attention has been given to the fact that there are many actors involved and it is a long time process to build (Eco-) buildings which demands high awareness on keeping focus on energy consumption.
Special start-up meetings in order to further describe the Concerto initiative and the requirements of the BEST tables (level of energy consumption) have been accomplished.
For the Eco-building projects it has been elaborated key-values to help keeping focus and also recommended steps to take during the whole building process. Frequently found design weaknesses are glazing ratio, compact ratio and lack of air tightness.
Furthermore it has shown up surprisingly deep lack of communication and coordination between various stakeholders involved in the technical consultancy. Because of this it have been accomplished special arrangements for involved technical consultants.
These facts show that today it takes a “hands-on” approach towards design teams/constructors in order to help them fulfil increased technical requirements like the BEST tables.

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### *1. Introduction*

One of the main challenges within the Concerto initiative and in the Sesac project is to ensure that the following important aspects are continuously focused:

- to elaborate and transfer of best practices among partners
- to avoid duplication of work among partners
- to create a verified front edge technical and behaviour related platform

- to pave the way for a time- and cost-efficient realization of the demonstration projects

In terms of technical and behaviour related aspects, the partners have several similar questions to deal with regarding i.e. cost-efficient RES conversion, integration with tenants/residentials, design of eco-buildings and design of system/temperatures in district heating grids.

The above mentioned items are the main tasks for the technical coordinator who is responsible for WP3. The work within WP3 focuses on proactive elaboration and to provide the partners with verified front edge technical and behaviour related solutions that are applicable in the demonstration projects.

This document, one of two Deliverables in WP3, describes how the work has been carried out and the most important experiences during the first 18 months of the Sesac project.

### *2. The first 18 months main experiences from technical coordination*

This chapter starts with common experiences while the main and most important experiences from each city, in relation to WP3, are presented in the coming subchapters.

## 2.1 Common / in general

### 2.1.1 The implementation work

It was already obvious from the beginning of the project that in order to be able to have a chance to fulfil the thoughts described above under section 2, we had to organize “demoWP-meetings” in each of the main cities. That is to have face-to-face meetings with each of one of the WP-leaders and their closest co-worker(s) in both Delft, Grenoble and Växjö every 6 months (app.) during the first 18 months (at least). The main reasons for this were (are):

- to further raise awareness of the task (the Concerto initiative & the Sesac project)

- to support the start up process and further implementation

- to build “Concerto-spirit” among the participants.

The first round of demoWP-meetings was held during the period August-October 2005. Participants were not only each WP-leader and co-worker but also the Local Coordinator <u>and</u> the WP-leaders for WP4 (Innovative co-operation) and WP21 (Analyses and Monitoring). The presence of WP4- and WP21-leaders enriched the meetings and further enabled a holistic approach in an efficient way. Feedbacks/minutes from these meetings have been produced and were presented on the internal web-site. The main items during this first round of demoWP-meetings were to raise awareness concerning the requirements of the BEST-tables (Building Energy Specification Table), to investigate barriers/hindrances, to identify fields of cooperation and to get to know each other and find relevant contact persons.

First round of demoWP-meetings in Grenoble in October 2005.
WP13 – Integration of RES in Viscose (district heating based on biomass)

During the year 2006 there have been accomplished two further Rounds of demoWP-meetings in Jan/Febr and in Aug/Oct. In between there was the Annual Meeting, this time in Grenoble, were two workshops were held. Since all WP-leaders attended the Annual meeting it was obvious to take the opportunity to further increase the possibility for best practice transfer in two workshops with the titles “Eco-building” and “Renewable Energy Systems”.
In the first workshop the following items were presented:

• New Eco-building in Välle Broar, Växjö (Tina Forsell and Carina Herbertsson, KFAB)
• Eco-buildings in Poptahof, Delft (Zeno Winkels, DEA)
• New Eco-buildings in De Bonne and Viscose, Grenoble (Valérie Dioré and Damien Fillet-Coche, SEM SAGES)

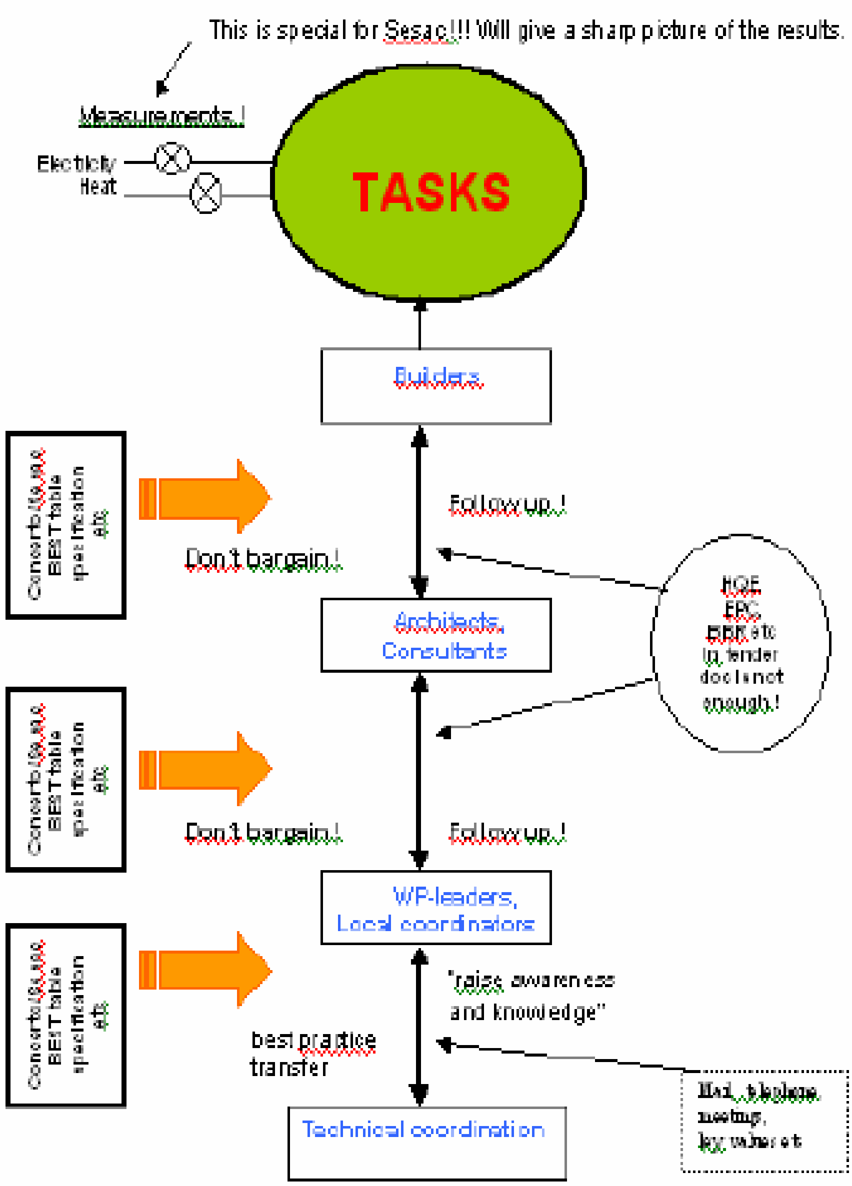
In the second workshop the following items were presented:

• Renewable Cooling System in Växjö (Lars Ehrlén, VEAB)
• Low temperature district heating in Delft (Kees Kruijff, DLF)
• Photovoltaic plants in Grenoble (Laurent Chanussot, GEG)

### 2.1.2 Key person

One global fact that has become obvious is that each WP-leader is the key person on the local level to raise and keep ambitions on a high level through the whole project period when implementing the demonstration projects.
In order to understand the whole implementation process it is essential to be aware of that many actors and many people are involved during a long period of time. This fact makes it even more important to pay special interest to the question of keeping focus on the overall ambition to do a bit more than “business as usual” which is necessary in order to fulfil the requirements of the Best tables.
During the first Round of demoWP-meetings it was elaborated a way to work between WP-leaders, Local coordinators and Technical coordination based on the fact described above. This way of work is clearly applicable for the Eco-building demonstration projects but is also in a common way relevant for the other demonstration projects.

# Technical coordination




Model for the implementation work

What is special for the Sesac Eco-building projects are the fact that the consumption of electrical and heating energy will be measured and registered and the results will become public and compared with the BEST tables and other Concerto-projects. This is far more than “business as usual” !
The model for the implementation work in Sesac explains the importance of keeping focus because there are many actors and people engaged over a long time. The technical coordination role is to support the WP-leaders and the Local coordinators by raising awareness and knowledge of the process and technical aspects.
The main tools for this are the demoWP-meetings but also normal personal contacts i.e. by mail or phone and we are also trying to make it possible to use videoconferences on computers. In order to help keeping focus the technical coordinator request some key-

values during the design phase (see further below). This request makes the WP-leader to have an active contact with architect/engineer responsible for the design phase which further stimulates the focus keeping.
Furthermore it is essential to "educate" the actors to follow up the next step in the chain (extra responsibility on the WP-leader!) and to ensure that correct information has been received and confirmed. An easy trap to fall into is to believe that it is enough to declare the requirements of the BEST tables in the tender documents and then sit back and think that "everything has been solved".
But -**This is NOT ENOUGH!!!!** There must also be actions taken during the whole project period in order to ensure that focus is being kept to the requirements of the BEST – tables.
Beside this it is obvious that along the process it must be stated that the requirements of the Best tables are not negotiable and that it is nothing to bargain about.

### 2.1.3 Key values

The key-values that are requested from the technical coordinator in the eco-building projects are:
**1. BUILDING GROSS AREA ($m^2$)**
**2. DESIGN OUTDOOR TEMPERATURE (°C)**
**3. DEGREE DAYS (heating, ventilation)**
**4. TOTAL HEAT LOSS FACTOR $\Sigma$ U*A (W/°C)**
**5. TOTAL VENTILATION AIR FLOW ($m^3/s$)**
**6. HEAT RECOVERY FACTOR from exhaust airflow (%)**
With these key-values it is easy to make a simple hand calculation on the annual heat losses due to heat transmission through the building shell and due to ventilation. It gives the technical coordination an indication of the possibility, for each of the demonstration projects, to fulfil the requirements of the Best tables and it gives the design team concrete factors to focus on. Besides this it is obvious that these key-values point out essential items to jointly discuss and work with.

### 2.1.4 A good (bad) example

One very important driving force for the above described implementation work is the outcome of the large building project called Bo01 in Malmö, Sweden. The buildings in Västra Hamnen (the western Harbour) were built in connection with the building exhibition Bo01 in 2001. One of the aims with the buildings of a new area was to create a sustainable district in this part of Malmö. In the quality program, elaborated by the municipality of Malmö, the Bo01 secretariat and the developer's representatives, it was stated that the average of the annual energy consumption should not exceed 105 kWh/$m^2$ (district heating, domestic and common electricity).

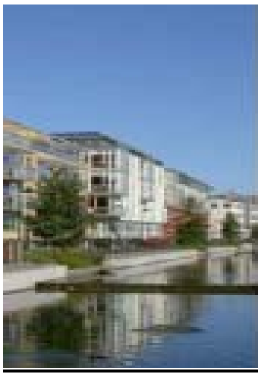
The results reported in a licentiate thesis from the University of Lund are that the goal is not met. Most of the examined houses reported about 40-60% higher consumption of energy than what was predicted. It is mainly the heat consumption that has turned out to be too high. The main reasons for this bad outcome are:

- Estimations of a too low indoor temperature
- Too high level of thermal transmission losses incl. thermal bridges
- Bad air tightness
- Overestimation of free solar gains
- Calculations assume perfect control systems which is not the case

Recommended suggestions for improvement are to ensure quality by one person and to continuously remind of, prioritize and follow up the targets throughout the whole process with all involved actors.

**Bo01- Malmö 2001**
•Target=105 kWh/m2
•Calculations= 77-107 kWh/m2

**Results:**
• 120-200 kWh/m2 (max=350)
• Low thermal comfort
• Good air quality
• Good light quality
• Good noise quality



The clear target that was set in the planning process and the publication of the study of reached results have caused not only public highlighting of energy consumption but also raised awareness among key actors. Correcting actions have been taken to lower the energy consumption (105 kWh/m2 has not been reached) and the Municipality of Malmö has initiated a process called "The Good Conversation". This structural conversation between the municipality and landlords is set as standard when planning new building areas in order to ensure sustainable economic, social and ecologic development.

### 2.1.5 Six fruitful steps

The above presented experiences have encouraged the technical coordination to recommend the following six fruitful steps to the SESAC demonstration eco-building projects. The main items are to really make relevant calculations during the design phase in order to secure, in advance a good result and further training at the building site.

Six fruitful steps for design and construction phase

1. **Start-up meeting**– presentation of Concerto, Sesac, Best-table targets etc.
2. **Show relevant results from calculations** – heat loss factor, thermal bridges, annual energy use, heat recovery, use of hot domestic water (compare key- values as above)
3. **Coordinated design test** – building, heating, ventilation, control, electrical
4. **Start-up meeting at building site** – see point 1, good examples, present this way of work
5. **Further training at building site** – further educate details in the final mounting (assemble) of isolation materials, tightness etc.
6. **Continuous inspection/control and pressure test** – during the whole construction period in order to meet the demands of the Best table in SESAC.

## 2.2 Delft-specific

### 2.2.1 Second opinion meeting - Visit to Gothenburg in June 2006

During 18-20 June there was a visit in Gothenburg, Sweden. Participants were:

- Delft Municipality:
- Kees Kruijff: project leader SESAC Delft/ Heat Company
- Peter Rommens: deputy project leader SESAC Delft/ Heat Company
- HoSt engineers in energy:
- Saskia Strating: senior process engineer
- Kris Dambrink: process engineer
- Sinke project management:
- Kees Sinke: technical project manager Heat Company Delft and Heat Company (Rotterdam
- Rotterdam engineering department:
- Nico van der Walle: senior engineer piping and civil works
- ESS (Energy Agency Southeast Sweden):
- Stefan Olsson, SESAC technical coordinator
- Göteborg Energi AB:

- Ulf Hagman owner representative: Monday morning
- Lars Lindell Manager of Maintenance: Monday morning
- Gunnar Åsblom plant engineer: Monday morning
- VEAB (Energy utility Växjö):
- Lars Ehrlén, Manager of Distribution

The first item during these days was a study visit at Gothenburg Energy heat-pump plant RYA. The representatives of Gothenburg Energy made a presentation of their waste water heat pump plant of 30 MW and their experiences during 20 years of operation. The main experience points are:

- Sufficient clean waste water is a critical parameter.
- Educate in detail staff responsible for operation
- Use incentive based tendering of contractors
- Notify mechanical vibrations from machinery (can cause damage)

The representatives of HoST engineers also gave a short introduction of the Conceptual design of the Delft district heating system followed by questions and discussions based on the Gothenburg experiences. This study visit also included a visit to the new gascombi plant at RYA were electricity and heat is produced with a very high efficiency. Todays fuel is natural gas but the vision for the future is to be able to use gasified biomass.

RYA heat pump plant 30 MW heat; 100 tons R134a.

Next large item during the visit to Gothenburg was to have a second opinion meeting about the Conceptual Design of the low temperature district heating net in Delft. Chairman was Kees Sinke. It was a long and as I noticed a fruitful meeting were Peter Rommens initially presented the starting points and feasibility results followed by a detailed presentation from the HoST representatives about conceptual and hydraulic design. In addition to these presentations there were many questions and discussions raised mainly by the Swedish representatives. At the end of the meeting Kees Sinke summarized with the following points to be further handled:

- Check the conceptual design in terms of pressure drops and hydraulic flows.
- Is the peak heat demand for an average dwelling 7 kW or 5 kW ?
- What are the national regulations stipulating when it comes to temperature of domestic hot water at the tap ? This temperature sets the design temperature for the whole system.
- The overall heat losses are assumed to be 25% - is this really the fact ? In Sweden (Växjö) it is around 10%. Level of isolation?

Technical & economical questions being handled with high intensity during the second opinion meeting.

Besides our own minutes/notations from the second opinion meeting there is also a report called "Second opinion on Heat Pump Installation for Delft, Holland" made by Håkan Landberg who is a former project leader for the RYA Heat Pump plant.
This visit to Gothenburg shows that it is possible to involve external experts as well as Sesac internal dito (not only Technical coordinator) but in this case Lars Ehrlén who has large experiences of developing district heating systems into existing building areas.

### 2.2.2 Start up design meeting in September 2006

This design workshop (3rd round of demoWP-meetings) took place in order to further implement the basic prerequisites for energy saving (RUE) in the Concerto program and in the Sesac project into the beginning of the design period. Present were, incl. the "normal Delft Sesac Team", also engaged developers, architects and consultants for the Eco-building projects in Poptahof and Harnaschpolder as the list below:
Present were: Esther Piek, Kristal
Bob de Rooij, Kristal
Kristof Houben, Meccanoo Architects
Henk Ehlert, Verwelius
Edward Maatkamp, Vidomes
Raymond van Hattum, Molenaar&Van Vinden Architects
Mark van Veghel, ABT
Pauline Krom, Delft Energy Agency
Will Bonet, Woonbroon
Peter Rommens, Gemeente Delft
Ruud van Vliet, CEA (replaces Maike Kaiser)
Thomas Sandberg, WP21-leader, KTH
Stefan Olsson, technical coordinator WP3, ESS

The main points on the agenda was:

- Introduction to SESAC/WP3 – Stefan Olsson
- Presentation Delft projects and BEST tables – Peter Rommens
- Best practice energy saving – Stefan Olsson

- Discussions – all

Some notations from the meeting are:

- In the BEST tables are said that DHW (daily hot water for dish- and washing machines) correspond to 32 kWh/m2,year. This seems to be too much?!. Peter will check this item.
- "KWh/m2" is not a well known unit to work with among engineers and architects. The EPC-index is normally used in the Netherlands to indicate the level of energy use.

- It was decided to start a “Delft help desk” concerning calculations, units etc. and to arrange some sort of “Master class”.

In general it is my impression that all present understood the message from WP3-technical coordination and that it is possible in reality to fulfil the requirements of the BEST tables. The preparations for the Master class started in October and were accomplished on the 16th of November.

**2.3 Grenoble - specific**
**2.3.1 Integration of RES in Viscose - best practice transfer**
In an existing housing area in Viscose (southern part of Grenoble) there are 277 dwellings in some 50 buildings. These houses are using electric heating and within the Sesac project (WP13) it is the meaning to replace the electric heaters with district heating based on biomass.
This situation is well known in Sweden and has been worked with the last 10-15 years even for one-family houses. Since the very first start up meeting in Växjö (May 2005) and the first demoWP meeting in Grenoble (October 2005) there has been best practice transfer among involved partners (technical consultants, heating company, WP-leader, Local coordinator and Technical coordinator). Some good Swedish examples has been described and discussed and it has carefully been investigated to what extent Swedish solutions can be implemented in Viscose. The main subjects have been district heating pipe techniques, sub-centrals and system concept.

In March 2006 Energikontor Sydost arranged a study visit to Växjö in order to have concrete best practice transfer from objects were electrical heating has been converted to biomass based district heating. During the study visit both involved housing company (Växjöhem) and the district heating company (VEAB) were presenting their activities. This meeting gave the opportunity to have best practice exchange within the technical field but also concerning e.g. rent-levels, equipment in dwellings, the way to handle rent administration, webpage etc.


Study visit in Växjö in March 2006

It was also arranged a meeting with a representative of tenants to have their opinion.
Also providers of sub central heat exchangers and providers of district heating pipes were invited to present their technology.
Guests from Grenoble were:

- Pau Pochiero (board member of OPAC38)
- Sébastien Lota (WP13-leader, OPAC38)
- Céline Issindou (Ingevalor, techn.consult)
- Farid Boutelja (tenants repr.)
- Claude Fralonardo (techn.consult).

This study visit caused the Grenoble team to have second opinions on the result of the design phase that was already over at the time. It was decided to use prefabricated sub centrals instead of conventional. More information on this item can be found in the deliverable D13a on the SESAC webpage.

### 2.3.2 Local experts

After the first demoWp meeting in Grenoble in October 2005 it became obvious, to the local Sesac Grenoble team, that it was necessary to strengthen the knowledge of designing eco-buildings among involved actors in WP9 in order to fulfil the requirements of the BEST tables. So after that two external consultants were engaged to raise awareness and knowledge.
During the spring of 2006 all involved projects were investigated to check if their design should be able to fulfil the requirements of the BEST tables. A summary of this investigation is:

- Glazing ratio – generally all projects have a too high glazing ratio (gives to much heat losses, cause high indoor temperatures due to solar insulation and glazing is much more expensive than a wall)
- Compact ratio – global façade surface over volume, generally all projects have a too high ratio, which cause extra heat losses.
- Air tightness – no real knowledge and data on building air tightness is available in France. Pressurized tests will be accomplished.
- Technical consultancy skills – some projects meet some technical lack of their consultancy team. This was detected by errors in calculations.

Furthermore it was surprisingly deep lack of communication and good coordination between various stakeholders involved in the technical consultancy in each project.
Due to the discovery of lack of technical skills a document “Additional technical notes for the design teams” were aggregated and sent out to all involved persons in the design teams. Several modifications/corrections have been made during the last six months and now the conclusion is that all nine public & private property developers’ projects are in line with the targets of Sesac like the BEST tables.

One of the houses within WP9.1 at de Bonne area.

This example shows that today it takes quiet a lot of “hands-on” approach towards design teams/constructors in order to help them fulfil increased technical requirements like the BEST tables. This is a phenomena that has been observed also in Växjö and Delft

## 2.4 Växjö – specific

### 2.4.1 Air tightness

In order to reach high global energy efficiency of a building it is of great importance not to forget the air tightness. In the former national Swedish building regulations there were stated that the highest approved leakage should be not more than 0.8 l/s,m2 (surrounding area) at a pressure difference of 50 Pa. The passive houses that have been built in Sweden (only 100 dwellings so far) have a leakage of 0.1-0.3 l/s,m2 which shows that it is possible to build that tight houses without being to expensive.

Older investigation shows that many existing houses do not reach the tightness that was stated in the former national building rules. Recently made investigation in Växjö on newly build houses (not in Sesac) also show that air tightness is too bad compared with these former national rules. So we can conclude that this is a real problem.
In order to highlight this problem in the Sesac eco-building projects in Växjö the requirement of air tightness was made more stringent to the value 0.6 l/s, m2 in the tender documents for designers and construction companies.
During the start up meeting for the design phase this item was on the agenda. There was also a special education event on the building site for craftsmen in the early stage of the construction phase. During this education also design engineers were present in order to present their approach in the design phase. Together with the craftsmen there were detail solutions elaborated. Later on there were air pressurized test done several times until the mission was accomplished. The method of achieving air tightness that has been developed, as described above, has become standard method when erecting the next set of buildings.

Air tightness discussions at building site in August 2006

### 2.4.2 More actors joining the Sesac project.

At the Sesac start up meeting in Växjö in May 2005 there was a local newspaper that wrote an article about “getting cooling from district heating” by using absorption technique for the university area in Växjö. Because of that article the local hospital got interested and took contact with VEAB the local district heating company. The hospital has a large need for retrofitting their existing cooling system and machines. This interest has lead to that the hospital, after an amendment of contract with EU, now is an actor of WP19 which is going to demonstrate the absorption cooling technique.
At the moment there is an environmental study to clear out if it is possible to use the nearby Växjö Lake as an “energy dump” instead of cooling towers. This is a desirable solution because it will make possible a higher COP (coefficient of performance) and the risk for legionnaire disease is zero.

The hospital (upper left) at the Växjö Lake.

Furthermore during this last year even more real estate companies and private landlords have shown interest for "green cooling" in the central parts of Växjö. This fact has made VEAB to decide to establish a plan for the near future how to expand their cooling concept in the central parts of Växjö.

A private housing company that are planning to build wooden houses at the area "Välle Broar" in Växjö also got interested to join the Sesac-project when they heard about the intention to develop energy efficient wooden houses. They are now part of the Sesac-project (WP16) as a third party and the erection of new energy efficient wooden houses has started.

Planned wooden houses at Limnologen, Vällö Broar.

These examples in fact occurred before it was known that WP20 would not come to reality and that it was possible to reallocate EU-funding. This shows that there is a large interest from the public and local actors in the environmental questions.

### 2.5 Associated Cities

There has been several attempts to invite the associated cities of Kaunas, Vastseliina and Miskolc to take part of the work in the Sesac project by attending e.g. demoWP meetings. So far there have not been any activities in this field.

### *3. Conclusions*

During these first 18 months of work within WP3 – Best practice and RUE (Innovation) in the Sesac project it can be concluded that the main efforts have been done in the field of how to do the implementation work.

Every sixth months meetings for each demonstration WP in person with WP-leader, Local coordinator and Technical coordinator (WP3-leader) together with the WP-leaders of WP4 and WP21 (Innovative co-operation, Analysis & Monitoring) has shown up to be a necessary

and fruitful way to work. Special attention has been given to the fact that there are many actors involved and it is a long time process to build (Eco-) buildings which demands high awareness on keeping focus on energy consumption.
Special start-up meetings in order to further describe the Concerto initiative and the requirements of the BEST tables (level of energy consumption) have been accomplished.
For the Eco-building projects it has been elaborated <u>key-values</u> to help keep focus and also <u>recommended steps</u> to take during the whole building process. Frequently found design weaknesses are glazing ratio, compact ratio and lack of air tightness.
Furthermore it has shown up surprisingly <u>deep lack of communication and coordination</u> between various stakeholders involved in the technical consultancy. Because of this it have been accomplished special arrangements for involved technical consultants.
These facts shows that today it <u>takes a “hands-on” approach</u> towards design teams/constructors in order to help them fulfil increased technical requirements like the BEST tables.
Technical questions concerning design of district heating systems and sub centrals and how to achieve highly airtight buildings are examples of items that have been intensively discussed.
Furthermore in addition to the demonstration WP-meetings best practice transfer it has shown up to be creative with study visits in combination with an opportunity to have second opinion discussions.

**Deliverable 4a**
[Innovative cooperation - Feedback report]
Date of preparation: 2006-11-13
Start date of WP: 2005-05-25
Duration: 58 Months
WP leader name: Manuel Swärd
Växjö Kommun Revision 1
Dissemination level: PU Public

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SESAC WP 4 Deliverable D4a

**Feedback report**

**1. Objectives**

The objective of this work package is to support the cities and the demonstration projects in elaborating better procurement and contractual procedures and furthermore working to achieve more incentive based implementation structures, by using this large-scale project to optimise and elaborate cost-cutting approaches for the implementation of the demonstration projects.

**2. Content and structure**

As stated in previous project updates have the initial approach with one joint feedback report at one specific time, been changed into a more project- and time-schedule oriented approach. To better support and suit the project partners somewhat “dynamic/changing” implementation schedules, has D4a also been slightly modified into a two-stage work. Stage 1, that has been carried out in a dynamic way during the first 18 month has included City or Partner specific meetings, documents and presentations etc. This document is Stage 2, where the somewhat parallel work of stage 1 has been aggregated into this joint feedback report.

The content of this deliverable is structured in three sections. The first section is a very short overview of the type of work carried out in the respective cities. The second section is a summary of the WP 4 feedback and dialogue given to the respective city and it’s demonstration projects. The third section consists of a short appendix where some of the more specific presentations and some feedback documents are attached.

**3. WP 4 work carried out in the cities**

The WP 4 work started with multiple information and coordination meetings in Delft, Grenoble and Växjö. The main issues were to discuss the demonstration projects in a WP 4 perspective and to highlight potential hurdles and trying to provide feedback and possible solutions. After this initial information and coordination meetings did the WP 4 work move in to a somewhat more concrete support phase. The work has been concentrated on the challenges jointly identified by the Partners and their Local Coordinators and the WP Manager. The objective has been to se if and how WP 4 can support the cities and the individual demonstration projects by providing experiences and best practices transfer.

**The city of Delft**

In the City of Delft has the WP 4 work mainly been focused on deeper analysis and follow up meetings dealing with the legal and practical challenges of having an ESCO participating in the large scale refurbishment project of a social housing area (caped rent apartments) in Poptahof. But also the commercial and Public-Private contractual interface for the planned HTC, Heating Transportation Company has been elaborated in order to prevent sub-optimisation and to ensure that the cities interest can be uphold in the future even with a private partnership. The Delft partnership: (Sharing and coordinating WP 4 recourses under the city of Delft)

- Delft (City of Delft)
- DEA
- Woonbron



**The city of Grenoble**

In the city of Grenoble has the WP4 work mainly been focused on a continuous capacity building dialogue regarding the WP 4 feedback given during the initial meeting round. A major task has been to, together with WP 3, give ideas and feedback on how to optimise and secure the outcome of Grenoble’s “multiple- level” development and contractual structures with private project developers, in order to prevent a diverged focus.

Grenoble partnership: *(Sharing and coordinating recourses under the city of Grenoble)*

- OPAC 38
- SAGES

- Grenoble (City of Grenoble)
- GEG
- Metro

**The city of Växjö**
In the city of Växjö has the WP 4 focus mainly been to support and develop the current RFQ and purchasing processes in the direction of more pre-qualifications and negotiated procedures, aiming to offset risks and create more “partner based” structures. Especially in the Eco-Building projects has this work been intense, where WP 4 assistance has been provided both as “internal” management support and as support in tender negotiations.
Växjö partnership: *(Sharing and coordinating WP 4 recourses under KFAB)*
- KFAB (Kommunfastigheter AB)
- VEAB
- ESS (WP-Manager)

## 4. Delft feedback and proposed solutions

**The city of Delft**
The city of Delft is the city that by far has had most WP 4 issues to deal with, and in mutual understanding with the other cities, has also somewhat more WP 4 recourses been allocated to Delft.

**WP 5 Harnaschpolder**
The main WP 4 issue has been to elaborate a suitable contractual and responsibility structure between the HTC, Heating Transport Company and the contractor being responsible for the areas internal heating grid and supply systems.

**Contractual and practical interface**
Unequivocal Swedish and other experiences shows that in order to ensure the long term profitability for the HTC, and not giving away potential earnings, the city of Delft should aim at owning and controlling as much as possible of the heat exchange, upgrading and back-up facilities for Harnaschpolder. There are three major reasons for this:

1. By supplying the site with prime-energy, the HTC enters a far more secure and profitable rote, than if sticking to the low- value delivery of residual heat. In addition will the city of Delft stand stronger in potential supply competition on the customer/secondary side. A competition that potentially can hurt the HTC economy severely during its start up phase.
2. Delft ownership and control over the heat exchange, upgrading and back-up facilities, doesn’t mean that the operational work can’t be contracted to the contractor implementing the internal grid etc.
3. By controlling the supply and upgrading side, Delft and the HTC can thereby also “control” the design and supply temperatures for Harnaschpolder and other supplied areas. To actually have this control, will be a major key success factor, in order to get a good economy in the HTC, especially since only a few degrees too high temperature requirements etc, severely damaging the investment and operational economy of the entire HTC system.
There are several examples of public bodies that were to “passive” in the initial stage of this type of project, and therefore often gave away more complicated work and structures to private companies. But even if it meant an initial “pain-relief”, many of these public bodies are today regretting themselves. Both in the sense that they loosing good earnings, but most of all since they neither can “influence” the energy development nor support their inhabitants and social housing areas towards high prices and unfavourable contractual conditions.

**Proposed pricing structure**
In line with what’s stated above, we would propose a contractual and pricing structure with the following components.

Contractor's income:
?? Initial installation/supply fee from tenant [Euro/Apartment]
?? Energy consumption fee from tenants [Euro/kWh]

By doing an energy-consumption calculation, that anyway must be done, can a 5, 10 or 15 year contractual income be estimated. Based on this income can the City of Delft in their building plans/permits either prioritise a low entrance fee for the tenants or a lower energy price, by allowing the contractor to "balance" these costs. On top of this, there's a potential income for the contractor by operating the supply, exchange and upgrading facilities on the primary side as subcontracting to the HTC for [Euro/year]

Contractor costs:
The contractor's cost is basically investment and capital costs together with the energy price that the HTC is charging them, [Euro/kWh] In order to get a clean contract, we only recommend two models for HTC-contracts. A) One single price all year around

B) One summer and one winter price, more linked to the seasonal need for Gas for upgrading and backup etc.

HTC income:
The HTC's income is basically the value of the kWh sold to the contractor. However it would be on the responsibility of the HTC to calculate and hedge fuel/gas prices and weather dependent earnings. But these services can easily be bought on the market.
HTC costs

The HTC costs are mainly composed of:
- Capital costs for its investments
- Costs for acquiring and transporting the residual heat
- Costs for operating the on-site exchange and supply centrals, these cost could either be internal or a part of the deal with the grid contractor operating the secondary side

Contractual periods:
In order to create stable supply and delivery conditions, the advice is to have long 10-15 year contracts, but operational services can be shorter. However, both HTC contracts with the internal grid contractor, and the grid contractor's contracts with the tenants, needs a clause for annual, or any other preferred periodic, pricing reviews.

**WP 6 Poptahof feedback**
The WP 4 issue for Poptahof has been the number of potential ESCO's and the possibilities to use/canalise early savings to support later investments and development.

**General understanding and prerequisites**
The discussions with Woonbron has indicated some mutual "interpretation errors" within the group regarding what's considered being an ESCO and not. The general feedback and strong recommendation from the technical coordination and WP 4, is to not outsource too much of the infrastructure, especially since the information and transparency within the current outsourcing/operational contracts is limited. Woonbron and Delft (HTC) should cooperate constructively around this. In Sweden there are several "intermediate ways" for publicly owned real estate and housing companies, to still own and take strategically decisions regarding their energy infrastructure, but outsource or contract the majority of the practical operational work to contractors or energy utilities. To uphold this ownership and strategic control, is an important prerequisite in order to really drive and control the long-term energy efficiency and sustainability work.

**The number of ESCO's and their responsibilities**
In line with what's said under WP 5, we again underline the importance of that the city of Delft and it's publicly owned housing companies take an own and strategic role in the

construction and operation of their energy infrastructures. Therefore WP 4 proposes a structure of two or maybe three ESCO's, in Poptahof depending on the level of services that an "internal-grid ESCO" could deliver.

A) **Two**-ESCO structure:
A HTC ESCO company, owned by the city of Delft and being responsible for both the supply of low temp residual heat and the equipment for on-site exchange, upgrading and backup facilities. The HTC sell the heat to the internal grid and distribution ESCO. *(Woonbron owning current boilers etc can also be the owner of the upgrading site)* An internal grid and distribution ESCO, probably a private contractor or energy utility with two major responsibilities. The first is to run and operate the internal grid and sub centrals supplying the tenants with energy, and the second is to be responsible for all metering and invoicing on the tenant level. Optional: With a two ESCO strategy, this ESCO could also be responsible for the development, financing and implementation of larger and strategically important energy efficiency and demand site management projects in the existing and not yet refurbished buildings. Since this ESCO also being responsible for metering and invoicing of the tenants, a "cost neutral" savings funded efficiency strategy similar to Energy Performance Contracting could be imposed in cooperation with Woonbron.

B) **Three-**ESCO structure:
The three ESCO structure is generally similar to the two ESCO structure, But in this structure is another ESCO carrying out the optional energy efficiency and demand side management work described above. The main focus of these additional ESCO efforts should be to decrease the overall temperature requirements and the demand for effect in Poptahof. By focusing strongly on these efforts, can the technical performance and the over all cost efficiency of the entire energy infrastructure be significantly improved.

**Usage of savings for later investments**
The detailed structure of this work will have to be elaborated in close cooperation with the different stakeholders. However, in a general context is this type of projects handled in a 6-step process, see below:
1. The total measured and weather normalised energy consumption for a building or number of buildings are established.

2. The annual cost for this energy consumption is calculated for a building or number of buildings.

3. The additional cost for the planned modernisation and extensions of the internal grid and distribution is calculated. (Business as usual)

4. The estimated increase of future energy prices or fixed fees etc. due to the increased additional costs is calculated.

5. The potential **savings** in energy, operation and investments generated by combining the energy efficiency projects with a more comprehensive approach on the modernisation work (3) are calculated

6. The extended costs for the work to achieve savings in according to point 5, compared to the additional cost for point 3 is calculated

**Cost scenario 1 (Business as usual)**
Annual energy cost = 2 + (3)* + 4

**Cost scenario 2 (ESCO approach)**

Annual energy cost = 2 + (6)* + 4 - 5
With this information, can Woonbron and the ESCO invest and elaborate a progressive and cost-neutral ESCO approach towards the tenants, and thereby improve the effectiveness of the project and the entire Poptahof areas energy infrastructure. Depending on investment size and to what extent Woonbron support the investments, can a profitability calculation of the ESCO approach be determined. For a decried X-year perspective will:

**Cost scenario 1 > Cost scenario 2**
For further clarifications please also see Appendix A and B, containing an ESCO presentation and a brief graphic illustration of the cost levels for the Poptahof ESCO proposal.

**WP 7 HTC and low temp grid feedback**
The main WP 4 feedback and recommendations concern the preferred level of responsibility for the planned HTC, together with the provision of examples on key success factors for HTC establishments and ideas on how to attract new customers through clustering.

**The Level of responsibility of the HTC:**
Swedish and other experiences shows that in order to ensure the long term profitability for a HTC or a similar structure, and not giving away the best earnings, should the city of Delft and the HTC own and control as much as possible of the residual heat capture and distribution system, BUT also the on-site heat exchange, upgrading and back-up facilities in the supplied areas. There are three major reasons for this:

1. By supplying the sites with prime-energy, the HTC enters a far more secure and profitable rote, than if sticking to the low- value delivery of residual heat. In addition will the HTC by this approach, stand stronger towards potential supply competition on the customer/secondary side. A competition that potentially can hurt the HTC economy severely during it's start up phase.

2. The Delft ownership and strategic control over the heat exchange, up-grading and back-up facilities, doesn't mean that operational work can't be contracted to the local/site-based grid and distribution companies if desired.

3. By controlling the both the supply and upgrading side, Delft and the HTC can also control design and supply parameters such as temperatures etc. for the supplied areas. To actually have this control, will be a major key success factor, in order to get a good economy in the HTC, especially since only a few degrees too high temperature requirements etc, severely damaging the investment and operational economy of the system.

- The effect on energy prices is mainly determined by the applied write-off/depreciation structure, min 15-20 years

**NOTE:** There are several examples of public bodies that out of inexperience and initial lack of resources and long-term perspectives gave away all the costly and more complicated work and structures to private companies. But even if it meant an initial "pain-relief", many of these public bodies are today regretting themselves. Both in the sense that they loosing good earnings, but most of all since they cant influence the energy development or support their inhabitants and social housing areas towards high prices and unfavourable contractual conditions.

**KSF, Key Success Factors for supply companies (HTC)**
There are several important factors determining the success of a district heating, HTC or any other energy supply oriented company. Even if the local and national frame conditions may vary, there are a few key success factors that almost always appear when studying successful companies. Below are seven common success factors presented:

1. To be a part of, and a clearly preferred supplier, within the framework of a local or regional energy and sustainability strategy

2. Having long-term access to fuel/energy at relatively stable prices

3. To be able to grow by stages based on batches of relatively large sites and long term supply contracts

4. To be "on-top" of the value chain, meaning giving away as little as possible of aggregated customer value of the energy supply to other actors

5. Having stable and adjustable contracts, but also to posses or partner with competence regarding hedging of fuel prices and weather dependent consumption levels etc.

6. To be able to offer innovative contractual and financial structures to customers

7. Being able to use and capitalise on the customer base and contact interface in order to sell or promote other services, such as broadband communication etc.

**Clustering of potential new customers:**
In addition to the potential supply of the Hospital and parts of the University area, will most of the potentially new customers for the HTC be small or mid-sized buildings with own boilers. To be able to compete with their energy cost and/or boiler retrofit project, can a 7-step joint "Cluster-ESCO" structure be imposed, se below:

1. Identify neighbouring buildings with known boiler or heating retrofit needs that also are possible to connect with an internal grid without huge building efforts

2. Identify their aggregated energy consumption and its costs through questioning, copying their invoices and if possible by dialogue with suppliers

3. Identify and estimate the known upgrading and retrofit costs per house and in total

4. Identify the estimated future energy, investment and operational costs based on information above, 2+3.

5. Identify **saving** potential for energy, operations and investments that could be generated through new energy efficiency and demand side management projects

6. Identify the extended costs to achieve savings in according to point 5

7. Calculate the total cost of supplying the neighbouring buildings from the HTC incl. an internal grid, preferably using existing boilers as backup and peak load
The innovative structure used to win these customers will be a combination of:
- Benefit of scale
- Progressive usage of energy savings
- Applying of peak load mitigation strategies (cutting HTC investment)
- Inclusions of known/future investment costs in the project calculation
The HTC value proposition to this group of building owners will be:
- New and/or refurbished energy supply infrastructure
- Non or a minimum of own operational work
- Lower or equal total energy and reinvestment cost

Calculation logics:
If the following equation can be achieved/reached over a contractual period of approx 10-15 years, should the HTC be able to attract new groups of customers

**2+3=4 > 6 + 7 - 5**

## 5. Grenoble feedback and proposed solutions

### The city of Grenoble

On a general view has Grenoble's "multiple- level" development and contractual structures with private project developers, been the main challenge out of a WP 3 and WP 4 perspective. More specifically has identification and preparatory dialogue with potential co-financers for the photovoltaic installations, and elaboration of approaches to stimulate a type of ESCO-partnerships for increased energy efficiency been areas worked in.

### WP 8 Energy Campaign in Gd Boulevards

WP 8 isn't a pure demonstration project, but rather an information and support program aiming to pave the way for actual efficiency projects in the Gd Boulevard area. However the two main challenges, one is to give this information and support program an operative approach, and the second to elaborate potential ESCO-structures aiming to free up capital for efficiency and refurbishment investments.

Lessons learnt

Regarding how to make general information and support programs operative, the experiences made during the large DESS Sparkraft1 project, could be useful to consider when developing the detailed approach for WP 8. Especially since the WP 8 approach with comprehensive advising services and provision of specialised energy consultancy services, makes the two projects very similar. Even though many effects of the DESS Sparkraft project was positive, and it managed to promote savings, the final evaluation showed that it somewhat failed in prioritising the right activities, and the initially presented WP 8 approach seems to be facing the same risks.

Ideas for an improved approach:

1. Focus more on the actual "decision making process". What will make the tenants and house owners actually implementing the advices or not?
2. The initial focus of the advices should not be so focused on technology, but rather on improved comfort and economy.
3. Focus much more on the possibilities for financial support and provide lists of manufacturers and contractors that can supply equipment and implement advices given.
4. Focus more on support and promotion of competence/purchasing cooperation between those receiving advices, since transforming advices to activities isn't always that easy!
5. In cases of shortage of financial resources, support and stimulate ESCO partnerships for whole buildings or preferable groups of buildings. Appendix C, include a simplified structure that can be used to bring both finance and more incentive based contractual structures in to the Gd Boulevards project. 1 A comprehensive Swedish governmental incentive and support program for increased energy efficiency and renewable energy www.sparkraft.nu

### WP 9.1 New Dwellings in de Bonne

Out of a WP 4 perspective no major questions were raised and the Grenoble team had a progressive and positive approach. However, in the light of the "multiple level" decision and contractual/developing process levels; Sages > Zone Architect > Technical Consultants Several Developers and Builders > Contractors carrying out the practical work etc, there's a substantial risk that the crucial Concerto Objectives either are lost, misinterpreted or being down prioritised during the course of the project. Therefore Sages must ensure that the Concerto Objectives and the best tables are thoroughly emphasised and continuously communicated throughout the process and in all decision and development levels.

### WP 9.2 New Dwellings in Viscose

Out of a WP 4 perspective no dir ect questions were raised. But the contractual and economical discussions revealed some potentially risky factors that do need to be addressed thoroughly by the team responsible for WP 9.2:

1. An increased awareness is needed regarding the interdependence between initial investments and future operational costs for running the buildings, otherwise there might be a risk for sub-optimisation
2. The commitment for implementing building constructions and technical applications stated in the BEST-tables needs to be further emphasised.

The risk factors mentioned above are essential to address in the spirit of the Concerto Objectives, otherwise the results and deliverables of WP 9.2 can be jeopardised. In line with what's said regarding WP 9.1, the team developing WP 9.2, need to focus strongly on managing the tendering process for architects and engineers in order to ensure that the Concerto Objectives and the Best tables are thoroughly emphasised and continuously communicated throughout the process and in all decision- and development levels.
The involvement of Mr Sidler and ENERTECH is a positive response to these needs.

**WP 10 New School in de Bonne**
Out of a WP 4 perspective no direct questions were raised. But the technical and economical discussions revealed some potentially risky factors that do need to be addressed thoroughly by the team responsible for WP 10:
1. An increased awareness is needed regarding the interdependence between initial investments and future operational costs for running the buildings, otherwise there might be a risk for sub-optimisation
2. The commitment for implementing building constructions and technical applications stated in the BEST-tables needs to be further emphasised. Results are more important than methods, but with the current technical and contractual approach there is a risk for underperformance in relation to the Concerto Objectives and Best tables in WP 10. In line with what's said regarding in WP 9 1, 2, the team developing WP 10, therefore do need to focus strongly on managing the development process in order to ensure that the objectives and the Best tables are thoroughly emphasised and continuously communicated throughout the project and in all decision- and development levels. The involvement of Mr Sidler and ENERTECH is a positive response to these needs.

**WP 11 and WP 12; PV in de Bonne Commercial and Stadium**
The main WP 4 questions discussed was the financial set up together with potential partnerships and investment strategies for an extended and large scale PV-implementation. The WP 11 team proposed an initial financial (income/cost) set up like this:
35 % Electricity and green certificate sales
50 % EU- investment grants
15 %* Private companies and investments *(So far difficult to find)*

The agreed WP 4 support was therefore to investigate the financial possibilities and try to supply the Grenoble team with contacts to organisations and companies interested in this development.
To start up the dialogue and to find a skilled and experienced speaking partner for both WP 11 and WP 12, we propose a contact with BASE, Basel Agency for Sustainable Energy. The Agency has the Head Office I Switzerland with branch offices in Germany and France. Their speciality is to promote strategic partnerships for financing to facilitate investments in energy efficiency and renewable energy.

The initial contacts has been with Volker Krauth the Managing Director for the German branch, but all Base-offices and contact information is listed below:

BASE Switzerland and Head Office

Baumleingasse 22, CH-4051 Basel.
Tel +41 (0) 61 274 0480

BASE France
5, rue Turenne, F-67000 Strasbourg
Tel +33 (0) 3 88 24 77 62

BASE Germany
Grunwalder Strasse 10-14, D-79098 Freiburg i. Br.
Tel +49 (0) 761 285 23 17
volker.krauth@energy-base.org
Their joint web-site with very good search possibilities is:
www.energy-base.org

However, **before** contacting Base, try to figure out your selves:
- What do we really need support with?
- What is our current and future capital needs?
- What is the current idea for financial setup, investments and incomes etc.?
- To what extent are we willing to share ownership with other actors?
- What type of overall risks and responsibilities are we willing to accept etc.?
By preparing your selves like this, and also presenting the two projects jointly, namely 100+100= 200 kW PV, you position your selves better in the dialogue. After establishing contact and if you find BASE, or any one they recommend, interesting as a potential partner, WP 4 can support you in the further dialogue.

**WP 13 RES integration in Viscose**
There were initially no major WP 4 questions and the main issue was a general shortage of financial recourses due to a rather drastic increase of the calculated costs. However, with the information received within WP 3, we see several possibilities for cost cuts. By braking down the figures and structuring those in line with these 6 steps, can a best practice and cost efficiency benchmarking is done.

1. The total cost including connection to the district heating grid
2. The number of houses, apartments per house, approx. size per apartment
3. The total cost per apartment and per square metre, m2
4. The average surfaces (grass or asphalt etc.) approx. length, approx size/dimension and the total cost of the areas internal distribution grid
5. The approx effect kW or MW connected to the district heating grid
6. The "connection cost" for connecting and installing a sub-central for this area

This benchmarking work and the special prerequisites revealed during the process, has been dealt with in a constructive way. And together with WP 3 has several simplifications and cost cutting approaches been implemented, were changed contractual interface enabling manufacturers to prefabricate sub-centrals, is a very interesting development. However with an even earlier coordination should more cost cuts been able to achieve.

**WP 14 Hydro Power in Viscose**
The project has no WP 4 questions, and the Grenoble team seams to have a clear idea about the projects investments and it's future revenues. The involvement of EDF and their own financial and legal capabilities, somewhat diminish the need for additional WP 4 support.

**WP 15 Co-generation in de Bonne**
The projects WP 4 questions was linked to the contractual and economical aspect of the technical dimensioning of the CHP figures, and how to secure future revenues from heat and electricity sales. The economical balance between the additional CHP-investments, the CHP-running hours and the actual needs of the de Bonne area is an important issue in the SESAC project and must be addressed proactively, even though French regulatory changes

successively made the implementation more difficult. The main WP 4 feedback is given on the conceptual experiences of minor Swedish bio-fuel Heating and CHP projects, the results show that practically non or very few projects were financially viable on a site-by site basis. The main key success factor has been the efforts and abilities to ensure a stable and high “heat load” buy entering the role as heat supplier to nearby buildings and installations, enabling a higher and more profitable electricity sales. Even thou this might feel complicated, out of scoop and you’re lacking experiences about heat supply contracting, it’s very important to enter this road, since it provide stable running conditions for the CHP production and thereby utilising the investments better and also enable the selling of “power-blocks” on the forward market or benefiting from higher feed- in tariffs.

## 6. Växjö feedback and proposed solutions

### The city of Växjö

Compared to Delft and Grenoble has the city of Växjö received a somewhat smaller portion of WP 4 support. The efforts has mainly been concentrated on how to develop the tendering and purchasing processes in the direction of more pre-qualifications and negotiated procedures, without being in contrary to LOI, The Swedish Public Procurement Act. Buy a combination of external assistance and internal management support has strategies to offset risks and create more “partner based” structures been elaborated.

### WP 16

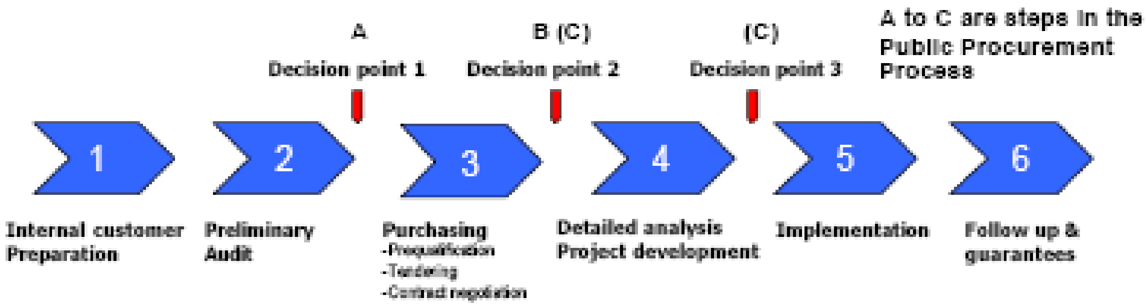
The Eco-Buildings are the largest demonstration projects in Växjö and vital in order to enhance stat of art in the building sector. KFAB is an experienced customer with a broad knowledge. However, to secure harmonisation with the Public Procurement Act, and in order to reach the SESAC objectives, an extensive dialogue with different management levels took place. The outcome of this dialogue was three main needs:

1. To develop a presentation material, that in a “generic”, but still project specific way, presenting the structure and the idea behind negotiated procedures and risk mitigation. The material should then be presented to managers and civil servants in order to anchor the structure and new procedures in prior of tendering. Please see appendix D for the Swedish presentation material and below an English summary

2. To assist and support KFAB in developing parts of their RFQ process to ensure that the ideas of achieving cost cuts through a more partner based structure actually was implemented in their final material advertised and sent to the construction companies. Please see appendix E 1-2 for the Swedish version of the final RFQ

3. To assist KFAB in the tender evaluation and the negotiation to elaborate optimised contractual interfaces with the contractors.

**English summary** *(KFAB Presentation and LOU process Guideline)*
Overview on step by- step (public) purchasing process in Sweden
The market for energy services and performance contracting isn’t standardised in Sweden. But the normal/most frequently used procedure for preparing and carrying out these projects follows a 6-step implementation. *(In line with the public procurement act)*




**Step 1**
The internal preparation phase is normally a process normally taking place within the customer's (KFAB's) own organisation. The main aims are to identify the current situation technical, financial and operational status of the building stock in order to formulate answers on two crucial questions:

1. What is our current status and why are we interested in cooperating with an external building or energy service company?
2. What is our own goal with a potential project and how do we want to contract and implement it?

If KFAB finds the more cooperative path worth to investigate further will internal information and anchoring process take place in parallel to an internal prioritisation of areas and premises for the demonstration projects.

**Step 2**
In this step is a first preliminary analysis being carried out among "representative" existing buildings in parallel with a market survey regarding potential references and new buildings stock enhancing the state of art. The main aim is to evaluate if the ideas and ambitions formulated in step 1, actually are realistic to achieve based preliminary identified no energy consumption levels and estimated new construction costs.

**Decision Point 1:** This is not a detailed analysis, but it indicates if it's interesting for KFAB to proceed further with prequalification and tendering.

**Step 3**
In according to the Swedish Public Procurement Act must a public customer run a prequalification before sending out formal request for tenders, when using negotiated procedures. The process is necessary in order to ensure that KFAB in the later stages is entitled to use the more flexible restricted or negotiated procedures. When 3-5 potential building or energy service companies are pre-qualified, they receive the request for tender containing basically containing three evaluation criteria's.
1. The level and quality of references, experiences and the proposed cooperation structures
2. The type and conditions of conceptual, financial and contractual structures
3. The calculated costs for reaching required functionality and energy consumption together with type of guarantees provided

**Decision Point 2:** KFAB negotiate with building or energy service companies in order to establish, improve and fine-tune a "partner-based" contract. However, even after rewarding one company the analysis and development contract, a 2-stage process is in use, meaning that it's the results from the detailed analysis and development that determinate if KFAB finally says yes.

**Step 4**

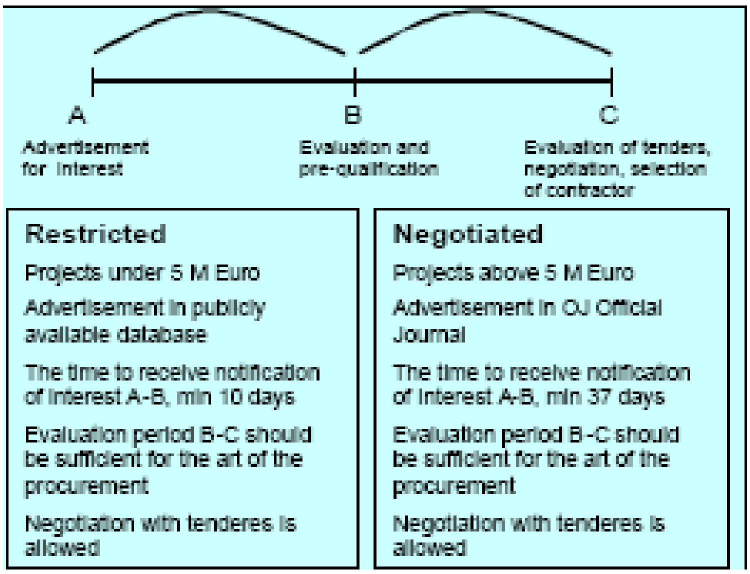
Since the tendering process seldom gives the opportunity for detailed studies or technical pre engineering studies for joint implementation strategies between tenders and the customer, is often a more detailed analysis and project development necessary in order to give the customer a comprehensive decision making material.

**Decision Point 3:** If the finally proposed project is in line with KFABs technical and financial requirement and that the SESAC energy consumption levels can bee reached in a cost efficient way, a final implementation contract is signed.

**Step 5**
This phase of the project is in one aspect the most conventional since it contains the actual contractor installation and optimisation work. However, it's also different since the company continuously must measure, evaluate and inform the customer that the agreed new constructions, installations and improved functionality actually is being delivered. Before finishing the implementation stage must the company and the customer agree on that all the technical and administrative equipment and routines necessary for the follow up and guarantee phase, is in place.

**Step 6**
Depending on how KFAB prefer to structure the contract, can this phase contain the continuous follow up and reporting work related to the agreed functionality and energy consumption levels. The energy indices are normally followed on an monthly basis. Every third months is a formal follow up meeting being held, and once a year is the contractual and financial conditions being addressed and any potential over- or under performance is settled.

**Innovative partner structures under LOU, Public procurement act**
When implementing an project like this for a public customer as KFAB, the process normally follows three stages, A, B and C, given account for below and also shown in the 6-step procedure above. However, it's important to emphasise the need to early select appropriate purchasing procedures such as Restricted or Negotiated procedures and to anchor them internally in the organisation.




**WP 17, 18 and 19 (20)**
The other demonstration WP's in Växjö has only required a brief WP 4 dialogue, since their procurement and implementation schemes are fairly optimised already, and don't require much additional WP 4 support. However the findings of WP 16 are also being distributed among the local partners for generic capacity building.

**Short synthesis**
A short synthesis of the Swedish WP 4 “learning process”, and in particular WP 16, is that the public bodies reluctance to develop more progressive procurement and contracting structures, aren’t based on major hindrances in the Public Procurement Act. The obstacles and hindrances are more linked to shortage in internal recourses in combination with the lack of experience in implementing more incentive based RFQ and contracting structures, while still respecting LOU, Public Procurement Act. The analysis of the Swedish (LOI) Public Procurement Act, and the feedback given from other public bodies in Sweden, give us reason to propose a widening of the RFQ and contractual tools used by the entire KFAB group. The currently most used model, Open Procedure, can in several cases be substituted by Chapter 6; Restricted Procedure or Chapter 3; Negotiated Procedure. If the contractual value is under the threshold, 5 Million Euro can Restricted Procedure be used, if higher, must Negotiated procedure be used. The legal basis for usage of Negotiated Procedure can specifically be found in Chapter 3 § 14.2.

(Annexes are attached separately)

**Deliverable 11a**
*[D 11A Work package 11* Report on the legal, economic and technical set up of a PV installation in France*]*
*Due date of deliverable: November 2006*
*Actual submission date: November 2006*
*Start date of project: 25.05.2005*
*Organisation name of lead contractor for this deliverable: GEG*
*Revision [draft: 1]*
*Dissemination Level: PU Public*
*Author: Emmanuel Huard*

**CONTENTS**

**INTRODUCTION**

Gaz Electricité de Grenoble is a local distribution company that is well-integrated in the Grenoble energy scene. Its basic businesses are the distribution and supply of gas and electricity, the production of electricity and public lighting. Its status as a local semi-public company, 50% owned by the city of Grenoble and the mixed distribution of gas and electricity make it a very unusual case in France.

For several years, Gaz Electricité de Grenoble has been resolutely committed to a principle of sustainable development. It has developed specific expertise and actions to promote energy savings, access to renewable energies and to technically less polluting energies. The context is fairly favourable in Grenoble as there is a real political will for the development of efficient solutions.

It has thus acquired technical expertise and applied experience. Energy savings and environmentally acceptable solutions are now part of its day-to-day services and its core business.
The company has thus committed its expertise in various sectors in partnership with local companies:

- Energy management: Five years ago Gaz Electricité de Grenoble developed energy management services designed for the disadvantaged, the general public, professionals, shops, co-ownership buildings and companies.

- Hydroelectricity: Hydroelectric production set up with the current, following the natural course of streams and rivers, using installations that are small and well-integrated in the landscape, protects the flora and fauna.

- CHP: ISERGIE, a CHP unit producing heat and electricity by the combustion of natural gas, is a sustainable energy production response that significantly reduces atmospheric pollution.

- Wood energy: Through its investment in the production of heat from wood-burning stoves in rural environments, Gaz Electricité de Grenoble intends to contribute to the structuring of new wood energy systems.

- PV (photovoltaic) solar electricity: Gaz Electricité de Grenoble has been involved in setting up all the PV projects currently in operation in Grenoble.

The PV sector has numerous benefits. It has the following advantages:

- Great technical simplicity
- Environmentally acceptable production
- A good image with the public
- Significant potential due to the numerous possibilities for architectural integration
- Favourable climatic conditions in our region

For all these reasons, it will occupy an important place as a decentralised method of electricity production in the future.
This is why Gaz Electricité de Grenoble has embarked on the project to build a grid-connected PV installation within the framework of the Concerto-Sesac European programme in the Bonne designated development area in Grenoble.

The objective of this project is to overcome the stumbling blocks and lay the foundations for real development, by building, as the operator (investment-building-operation), a grid-connected PV installation of a considerable size.

This document, after presenting the PV context in France and the various parts of an installation, describes the project integrated in the Concerto II programme and the prospects it has opened up for GEG.

**- PV solar energy in France**

In the face of the issues concerning climate change, the depletion of fossil resources, and the security of supply, it is clear that we must now make profound changes to our energy system.

These changes require a significant effort in terms of energy management and the ever-increasing use of renewable sources of production. The distribution system must also adapt to the move towards increasingly decentralised production.

Despite still limited development, PV is undoubtedly one of the key technologies of this transition. In fact, not only does it have a very low impact on the environment and the greenhouse effect, but it is also very modular and easy to integrate in all types of building or equipment.

In the long term it will certainly make a significant contribution to the production of electricity worldwide.

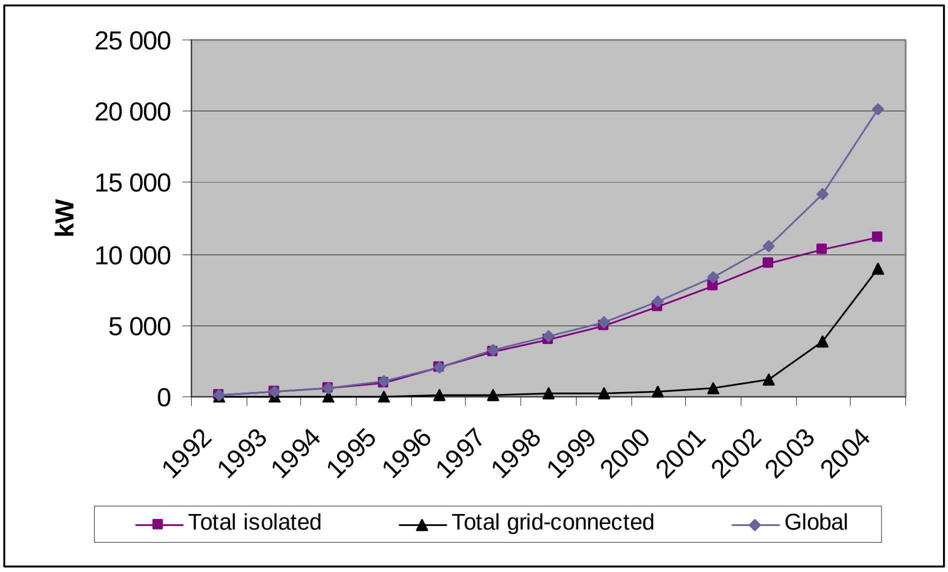
Technical progress made in the last twenty years has been promising: a five-fold reduction in costs, significant improvement in efficiency, very wide diversification of technologies and improved reliability of modules and systems.

**- The general context in France**

Historically, the French PV market has been orientated towards PV applications on isolated sites.

From 1999 onwards, as a result of the involvement of French PV companies, the French market shifted its focus to applications connected to the grid. In 2004, there were already 6 times more grid-connected PV installations than installations on isolated sites.

The grid-connected PV market in France has taken off remarkably quickly, but involves small volumes in relation to our European neighbours. In fact, the extent of the development remains a long way below that observed in other European countries (300 MW installed in Germany in 2004 as against 6 MW in France).




*Growth of installed capacity in France: source ADEME 2005*

This discrepancy is explained amongst other things by the following four issues:
- Technically and administratively restrictive conditions for connection and resale to the grid
- PV is taken into account a long way upstream of projects and by different trades for optimum integration
- The reluctance of some building owners to become electricity producers and thus move away from their core businesses
- Very unfavourable economic conditions

France does however have the necessary expertise to develop PV installations. All the trades in this industry are currently represented in France: manufacturers, suppliers and installers. The Rhône Alpes region has in particular always been advanced in terms of development policy, and both installations and business systems are well-developed in the region.

In order to promote this sector, the French political leaders have recently implemented several additional measures:
- 50% tax credit on equipment for private individuals
- Feed-in tariff substantially increased (double what it was previously)
- Increased research efforts
- New thermal regulations incorporating on-site production

A definite decision has been made to focus this effort on the integration of PV within the built environment, with a higher tariff for integrated installations.

These new provisions should energise this industry. In this context, new areas of development may appear to increase the number of projects, and in particular large projects.

The context is therefore more favourable now to the development of PV, but there are still a large number of obstacles to be removed before it can really take off on a national scale.

**- Equipment**

PV solar electricity connected to the grid is a particularly simple technique.

Photons (light) which strike silicon release electrons and produce a direct current (DC) which, when converted to 230 V AC by an inverter, can be fed onto the grid.

A PV installation consists of:

- **PV collectors** (silicon cells between plates of glass). They have varying characteristics depending on the manufacturer. 10 m² of collectors represents a power of approximately 1 kWc and produces 1000 to 1200 kWh/year.

- **Inverters** converting direct current into 230 V AC. They must comply with regulations and in particular have certified protection against disconnection from the grid.

- **Cables** connecting the collectors to the inverters and the inverters to the low voltage grid. Wiring is made easier by the use of rapid connection systems.

**- Collectors (modules)**

A dozen or so cell materials are available on the market. Crystalline silicon cells are currently the most widely used.

Depending on their substrate, the cells can be divided into three groups:
- Single crystal silicon cells

- Polycrystalline silicon cells
- Thin-film cells (amorphous cells made of silicon and other materials such as: CIS, CdTe, GaAs)

Polycrystalline silicon is currently the most commonly used, more due to its lower production cost than any particular technological advantage.

| Cell material | Efficiency of the module | PV area required for 1 kWc |
|---|---|---|
| Single-crystal | 11 - 16% | 7 - 9 m2 |
| Polycrystalline | 8 - 10% | 9 - 11 m2 |
| Thin film of copper-indium diselenide | 6 - 8% | 11 - 13 m2 |
| Amorphous | 4 - 7% | 16 - 20 m2 |

*Source: Le Photovoltaic pour Tous (Ed: Le Moniteur)*

PV modules are made up of solar cells connected together, protection against adverse weather conditions in the form of laminated glass, overvoltage protection in the form of one or more by-pass diodes and connection devices.

Most modules also have a frame, and some have a sheet of glass on the back, which gives them greater rigidity. Most of the collectors on the market are currently rigid, but the first versions of flexible collectors (solar membrane) are starting to appear.

**- Inverters**

The inverter converts the DC current supplied by the PV generator into single phase AC current with a nominal voltage of 230 V or, for larger installations, into three-phase AC current with a nominal voltage of 400 V. Inverters are available in a large number of power ranges.

There are various types of inverter, depending on the PV installation. They can be classified into two main categories: central inverters and string inverters. With a central inverter, all the modules are connected to a single inverter.

For many PV installations, for example when the power of the generator is high, when the cells are partly in shadow or when the modules of the generator are at different orientations and tilts, it is necessary to divide the modules between a number of inverters (string). Each string is dependent on a single low power inverter.
This configuration:

- Provides considerable modularity of installations
- Makes it possible to integrate disparities in orientation or shadow in different parts of the same installation
- Limits the risks of breakdown

For installations with no significant shade, it is preferable to wire the modules in series. In this case, the modules are quick and easy to mount and the high voltages enable the use of smaller cross-section cables (lower current losses).

On the other hand, the modules or strings must be connected in parallel if for example part of the installation is in shadow or with modules that have high power tolerances, to avoid losses due to the disparities (unavoidable with series connection).

The inverters must be located as close as possible to the modules in order to convert the DC current to AC current as quickly as possible and reduce the size of the cables, while limiting line losses.

The inverters must be ventilated to prevent them overheating, which would lead to losses in efficiency. They can be placed out of doors. They are generally attached to a wall or on the supports of the collectors.

**- Cables**

UV resistant, single pole cables with double insulation are recommended for PV installations. The cable covers must be suitable for outdoor use and the connections must be watertight. The cross-section must comply with standard NF C15-100 (min. 2.5 $mm^2$).

Special attention must be given to the choice of the cables for the DC part, between the PV module(s) and the inverter(s). In particular, with regard to voltage drops, which must not exceed 1% between the field and the inverter.

**- Supports and integration**

**- Integration options**

There are currently numerous ways of integrating PV modules in buildings.

The collectors can be placed:

- On a terrace on appropriate supports (metal or weighted roofing),

*Photo APEX BP Solar*

*Photo AET*

- On a sloping roof

- On a solar protection “visor”

*Photo APEX BP Solar* *Photo Ténésol*

- On a façade - On a semi-transparent glass roof

*Photo Ténésol*
*Photo APEX BP Solar*

The choice depends a great deal on the integration possibilities connected with the characteristics of the building (architecture, orientation, shadows, etc) and on whether the building already exists or has not yet been built.

**- Orientation - Tilt**

The optimum orientation of collectors in our region is facing south with a tilt of around 45°. However, it has been found that in mainland France the loss of efficiency with an orientation between south-east and south-west and a module tilt of between 20 and 50° is acceptable and does not exceed 5%.

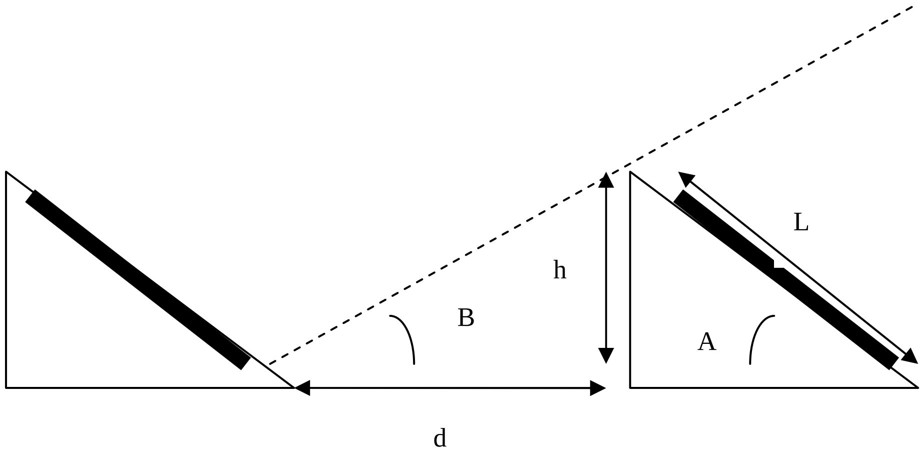
Note: A minimum tilt of 10-15° is desirable to encourage self-cleaning of the modules with rainwater. A horizontal layout is possible, but it results in a loss of efficiency and a risk of dirt collecting. It does however have the advantage of no longer requiring specific south-facing orientation, as the collectors are laid flat.

- Shading and shadows on collectors

For the layout of a PV installation, special attention must be given to obstacles to the solar radiation, whether these are temporary or permanent. In fact shading and shadows caused by obstacles significantly reduce the efficiency of PV installations:

As soon as a shadow appears on a PV cell, the cell can no longer produce current. It then behaves like a reverse diode. Shading of a cell therefore has a number of direct consequences on the efficiency of the installation. In fact, as the cells are connected in series within a module and the modules are connected in series within a string, the cell with the least amount of light determines the intensity (and thus the power) of the whole string.

This comment on shadows is particularly relevant for installations in an open space or on a flat roof. It is advisable to avoid modules casting shadows onto one another. There must therefore be sufficient space between rows of modules.




In Grenoble: the angle of tilt of the collectors (A) must be at least 30° and the minimum angle of the sun (B) must be 23°.

With A = 30°, B = 25° and L = 150 cm, the following is obtained:
h = L * sin A = 75 cm
d = h / tg (B) = 75*2.3 = 175 cm

The spacing between the supports must therefore be almost two and a half times their height to avoid any significant shadows. On flat roofs, allowing space for moving around and for cable runs as well, a collector area of around only 40% of the available area on the flat roof can be considered.

**- Weight of the collectors**

The weight of an installation can restrict its location, in particular in existing buildings where the roof often only supports a very low "additional weight". The weight of modules is around 10 to 15 kg/m² to which 5 to 10 kg/m² must also be added for the support structures.

On a flat roof in particular, the supports must be significantly weighted or securely fixed in order to ensure wind resistance. Weighted roofing has the advantage of not needing to be fixed to the roof and thus does not jeopardise the water tightness of the building.

**- Regulations**

The electrical part inside the buildings does not pose any particular problems. However the interface with the building part still gives rise to a large number of difficulties, in particular with regard to the ten-year guarantee, the Avis Techniques *(Technical Assessments)* (by the CSTB - *French scientific and technical centre for the construction industry*) and regulations regarding public buildings.

**- Internal electrical installations**

The electrical part of PV installations has been subject to well-established international standards for some time (IEC, NF C15-100 and C14-100 standards), which are fully assimilated by both manufacturers and installers.

Connection to the grid is covered in section 1.5.

**- Certification of collectors**

The international standard covering crystalline silicon modules is IEC 61215. It has been developed based on the old “Ispra” CEC503 specification. Compliance with this standard certifies that a solar module is suitable for normal use and will operate for at least 20 years if it is installed correctly.

For thin-film silicon PV modules, it is standard IEC 61646 that applies.

Note: This standard only covers the electrical part of modules and not their characteristics as a building material.

**- PV glass roofs**

There are two main types of integration in buildings:

- Versions fitted on top of existing structures (retrofitting) and not performing any walling or covering functions
- Building-integrated versions involved in walling and covering functions.

This distinction between equipment components (retrofitting) and those that are part of the envelope of the building (integration), has various consequences, including the fact that the ten-year guarantee applies to building-integrated collectors, whereas retrofitted collectors can only have a two-year operating guarantee.

For integration in the building, only the fitness of the collectors for their purpose, to perform their electrical function (IEC standards 61215 and 61646), is involved. If for example the module is required to act as a glass wall in the construction, it must provide a watertight seal, visual contact with the outside world and natural lighting of the rooms, and be involved in the security, thermal and acoustic insulation of the building and collect solar energy.

To date there are no specific regulations (Technical Assessments, Standardised work practice documents) in France for the use of integrated collectors in the built environment.

The PV module is not therefore, in the sense of French regulations, considered to be a recognised glass product. As such, it cannot perform closing and covering functions in procurement contracts for public buildings. This may also concern other cases (amongst others, private contracts) in which the decision is taken, for liability, guarantee and insurance reasons, to follow the same rules, even if in this case it is the result of a voluntary quality process.

A number of manufacturers have initiated an approval procedure (ATEC) with the CSTB for their collectors, but this is a long process and no procedure has yet been produced.

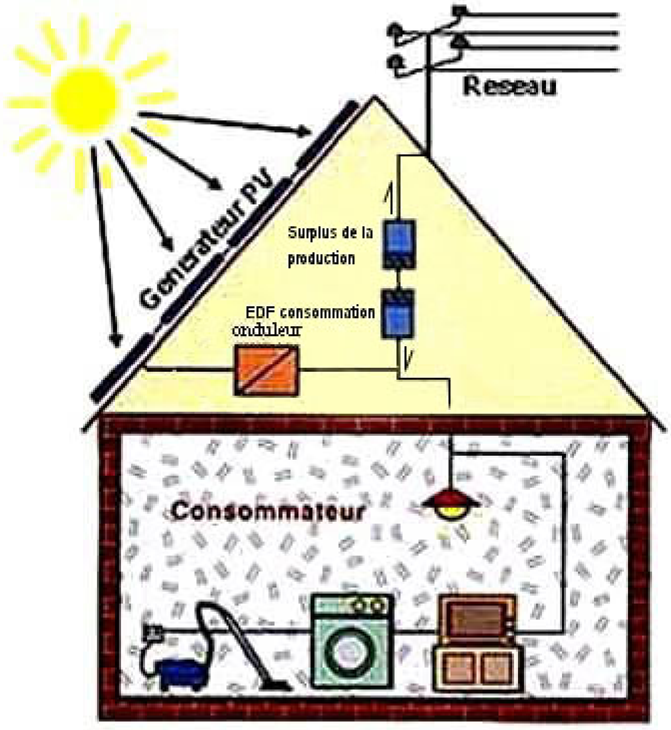
In the meantime, in view of the innovative nature of the techniques for integrating PV collectors in the envelope of buildings, a procedure known as ATEx (Technical Experimental Assessment) is being proposed. This procedure leads to the validation of the integration on a given installation. It is located upstream of the Technical Assessment and favours the use of completely building-integrated PV modules. The procedure is possible but remains complex and its result uncertain.

- **Connection, feed-in tariff for electricity produced and administrative procedures**

**- Connection to the grid**

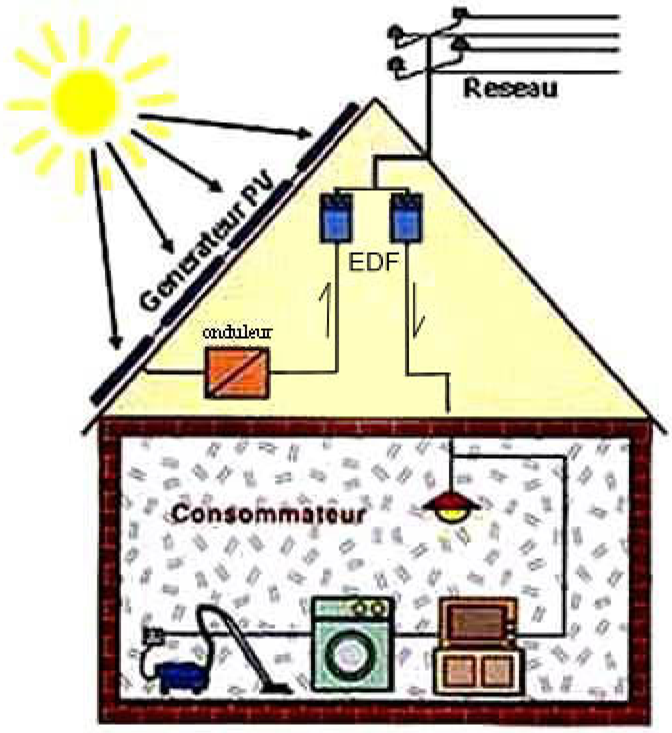
In France, electrical energy from PV production can be sold in two different ways:

- Either the producer feeds the excess production onto the grid. The connection to the grid is then the same as the consumption connection of the building. Dual metering enables the distinction to be made between consumption and the excess production fed onto the grid.




*Source Hespul*

- Or the producer feeds all of his production onto the grid: The connection and the metering of production must then be separate from the connection and the metering of consumption on the grid.




*Source Hespul*

As the feed-in tariff for PV is higher than the consumption tariff (see section 1.5.2), it is connection for total resale that is used is most cases. This has the advantage of there being a clear distinction between production and consumption, but may involve significant additional costs when the grid connection is some distance away from the building. It also poses problems on buildings connected at high voltage for their consumption because the production connection must be made on the low voltage grid which is sometimes located several hundred metres away.

The technical specifications for connection are governed by:

- French decree no. 2003-829 of 13 March 2003 on the general technical requirements regarding design and operation with which installations must comply for connection to public distribution grids.

- The ministerial order of 17 March 2003, amended by the order of 22 April 2003, on the requirements regarding technical design and operation with which electricity production installations must comply for connection to a public distribution grid.

Guide NF EN 61727 “Systèmes photovoltaïques - Caractéristiques de l’interface de raccordement au réseau” (PV systems - Characteristics of the grid connection interface) describes the characteristics of the interface connecting a PV installation to the grid. In addition, a technical reference document on the low voltage connection of PV production installations is in the process of being finalised by EDF in consultation with the producers.

Currently, the standards and grid access procedures applicable to installations of less than 36 kVA can be considered as acceptable in the French legislative and regulatory context, although they are still very cumbersome in comparison with the best European practices.

On the other hand, nothing has yet been established for installations of between 36 and 250 kVA. The question is whether HTA standards apply, or if it is possible to extend those standards that are applicable to installations below 36 kVA. A consultation group is working on this question.

### Obligation to purchase: tariffs, changes, conditions

Since the law of 10 February 2000, France has chosen the obligation to purchase to develop the production of electricity from renewable sources. This solution has the advantage of long-term visibility for the producer. When a PV installation is connected to the grid, the distribution grid manager is obliged to purchase the energy produced at a preferential tariff, set by the authorities and guaranteed for 20 years. The first ministerial order concerning PV production was published in March 2002. It set the purchase conditions at 15.22 c€/kWh in mainland France and 30.50 c€/kWh in the overseas departments and Corsica.

Furthermore:

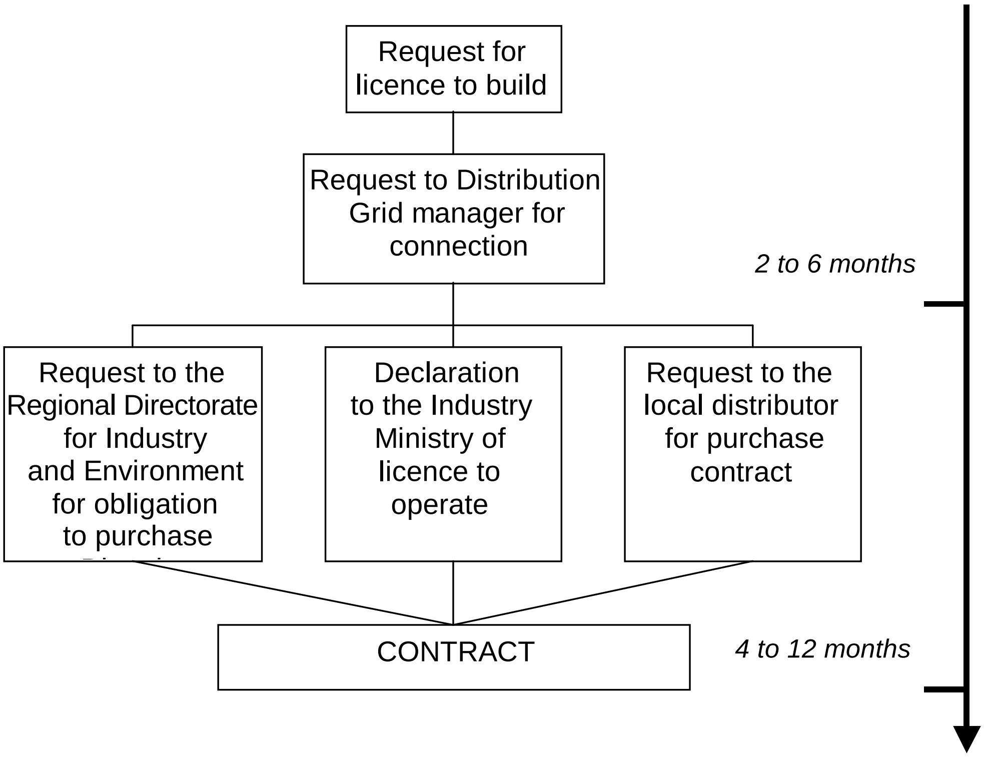
- The energy purchased had a fixed upper limit of 1200 hours for installations in mainland France and 1500 hours for the others.
- To benefit from these tariffs, the peak power of the installations was limited to 5 kWc for private houses, 100 kWc for business buildings and multiple occupancy residential buildings, and 150 kWc in other cases.

A new ministerial order on tariffs for PV was published in the summer of 2006 incorporating significant advances, clearly demonstrating the will of the French government to develop this sector. The ministerial order of 10 July 2006 sets the purchase price of PV electricity at 30 c€/kWh in mainland France and 40 c€/kWh in Corsica and the overseas departments from now on. Furthermore, a bonus of 25 c€/kWh in mainland France and15 c€/kWh in Corsica and the overseas departments was introduced for integration in buildings. In addition the production limits were increased to 1500 hours in mainland France and 1800 hours in Corsica and the overseas departments, and there is no longer any power limit for different categories of building.

## Administrative procedures

The following diagram shows the administrative procedures for requests for connection and purchase contracts for PV installations of all sizes.

The procedure consists of 4 separate requests:




- Requests to the distributor for connection and for purchase contract (separate requests in the case of EDF)
- The request to the Industry Ministry for authorisation to operate
- The request to the Regional Directorate for Industry and Environment for obligation to purchase

This procedure is still long and complex, in particular for small installations.

## Economic conditions

### - Investment

The current cost of installations in France is around 7 €/Wc for small installations, but falls to 6 €/Wc on large operations with a standardised layout. For simple optimised integration (for example shading device), an average price of 7.5 to 9 €/Wc is expected.

This cost should decrease significantly from 2008 onwards as several production plants are in the process of being built and will start production in 2008 with an optimised production cost.

**- Grants and subsidies**

Currently, when a private individual invests in a PV solar installation, he is entitled to a 50% tax credit on the cost of the equipment and, if they exist, local grants (region, department).

The tax credit does not apply to other building owners (industries, local authorities, etc). All that is available in this case is certain local grants. This is one of the reasons for the large disparity in installations between each region in mainland France.

The Rhône Alpes region, probably one of the most active regions in this sphere, in its common law grants, provides subsidises for PV installations of 25% of the total amount exclusive of tax, limited to 150,000 € per operation, for all building owners.

**- Operating costs:**

PV installations need very little maintenance, as there are no moving parts and no fuel.
The collectors have a lifetime of more than 30 years, and only the inverters (lifetime of 5 to 10 years) and the connections require regular maintenance.

The estimated operating cost of an installation must include replacement of the inverters, which do not last more than 10 years. An operating cost in the region of 1% of the investment is generally expected.

**- Sales of electricity**

The feed-in tariff for PV electricity is now 30 cents, with a bonus of 25 cents for architectural integration of the installation (collectors replacing component parts of the building). The contracts are for 20 years with an indexed price. (see section 1.5.2)

**- Balance sheets: profitability?**

We have drawn up the following balance sheet taking as an example a 100 kWc installation built by an industry receiving grants from the Rhône Alpes region and benefiting from the new purchase tariff

Estimated projected balance sheet for 100 kW

| | | |
|---|---|---|
| Investment in k€ | 600 | 800 |
| Subsidies in k€ * | 150 | 150 |
| Final investment in k€ | 450 | 650 |
| | | |
| Expenditure in k€/year | 10 | 10 |
| Maintenance and general expenses | 9 | 9 |
| Roof rental | 1 | 1 |
| | | |
| Receipts from sale of electricity in k€/yr | 30 | 55 |
| | | |
| Receipts - expenditure in k€/yr | 20 | 45 |
| | | |
| Gross payback time | 23 years | 15 years |

The balance sheet becomes interesting for building-integrated installations with the new feed-in tariff, but there is no certainty that the regional grants will carry on.

**- The particular case of Grenoble**

**- Specific connection conditions and documentation procedures in Grenoble**

In view of the problems encountered by numerous building owners when connection questions are broached, Gaz Electricité de Grenoble, as distribution grid manager, has decided to make these procedures easier.

The administrative procedures have been simplified and the technical restrictions considerably reduced. All the documents are dealt with by the renewable energy manager, and close collaboration with design offices from the very beginning of projects enables the administrative requests to be simplified (pre-established documents) and the connection conditions and costs to be optimised.

In particular, internal disconnection protection in inverters is accepted for all powers if they comply with the regulations, and connections to internal networks on industrial sites are accepted.

- **PV Policy programme**

In this context of developing the PV industry Gaz Electricité de Grenoble has also become a member of the "National Core Group" of the PV Policy European Programme coordinated in France by the ADEME (French agency for the environment and energy management).

In 2005-2006 this working group produced in particular:

- An assessment of the current situation in France (number of installations, production options, national policy, etc)

- A report and recommendations for developing PV in France

**- The "caserne de Bonne" project**

The work carried out in the context of the Concerto-SESAC project enables operational tools to be set up and provides the benefit of concrete experience for:

- The search for an optimum low voltage grid connection technique for large PV installations
- Optimised architectural integration in terms of cost as well as appearance and reproducibility
- The search for a favourable financial arrangement
- An approach as specific operator capable of setting up projects, investing and operating installations with a concept of reproducibility
- The bases for drawing up contracts enabling a building owner and a PV unit owner to work together to optimise the integration conditions and costs.

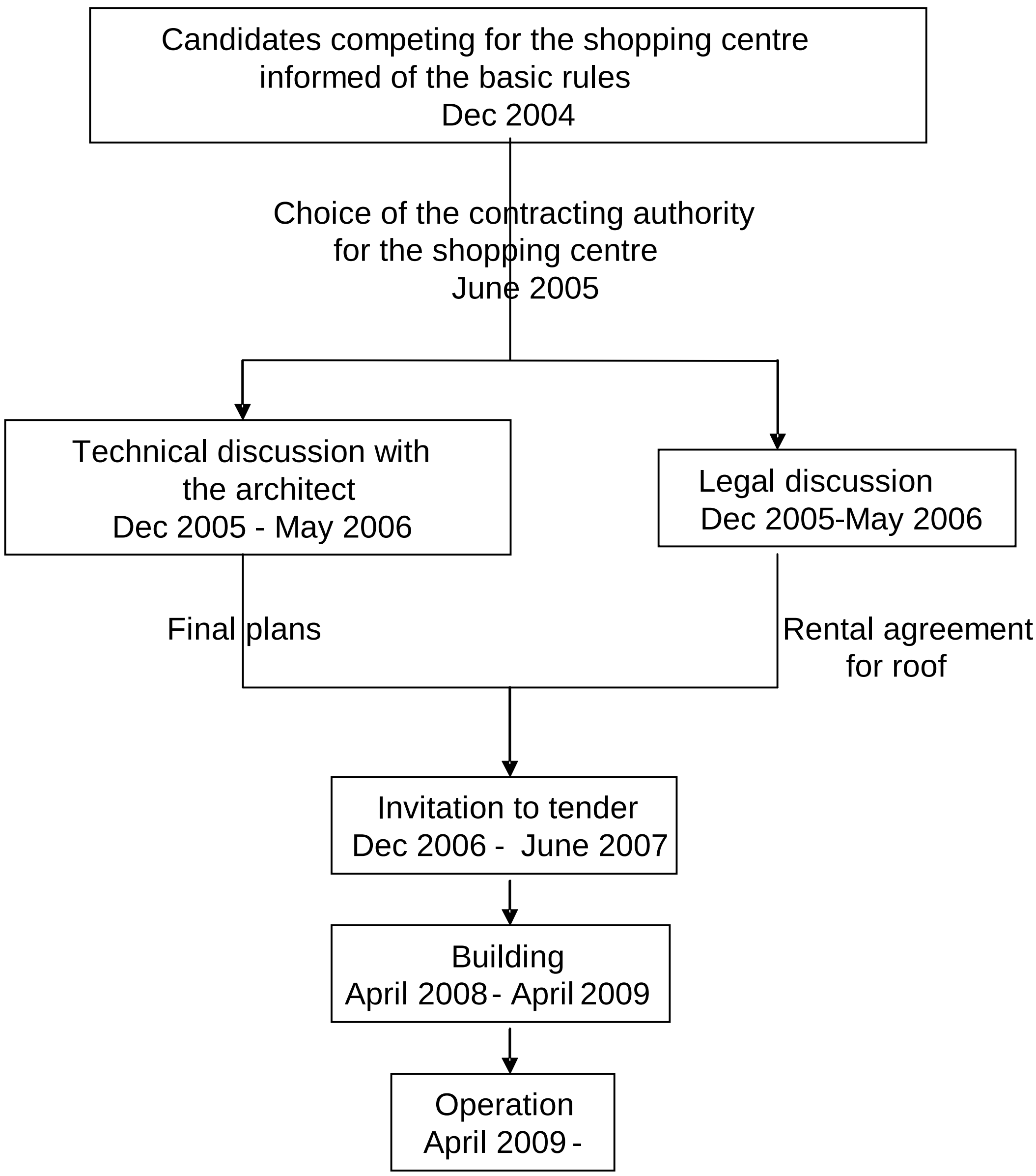
The installation will also be a means of information/training for end users and visitors to the multi-activity centre. The visible presence of collectors in people's day-to-day environment is a powerful educational tool. For this a semi-transparent glass roof will be installed over part of the shopping centre roof and a large energy production meter will be set up at the entrance to the site.

The systems and instructions developed within this programme will inevitably have a considerable impact on the development of PV, as well as on the connection of decentralised electricity production facilities throughout the whole of the region and even on a national scale.

This project involves setting up technical and financial tools for building PV units, with research on the scale effect and reproducibility.

In this way Gaz Electricité de Grenoble hopes to make the greatest possible contribution to the development of a technically reliable system that has a real impact in terms of energy and the environment.

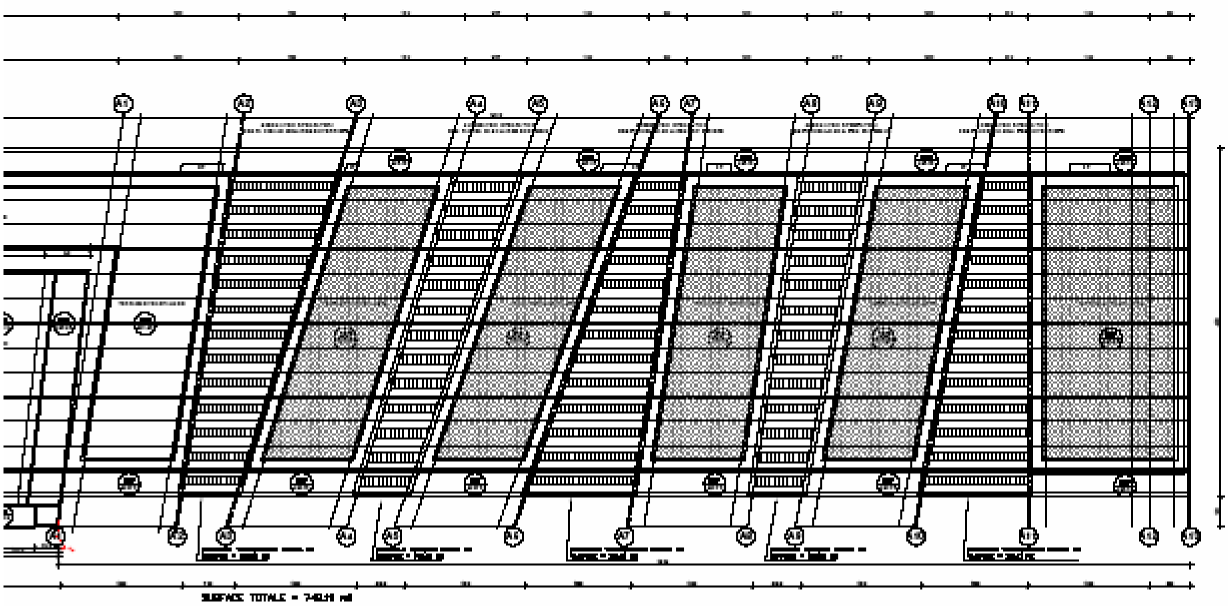
**- The steps in the project**



**- Choice of the developer**

Work on the project started in December 2005, before the beginning of the Concerto SESAC project, with the selection by the semi-public company SAGES (site planner) of the developer for the construction of the shopping centre.

The selection was made by means of a competition. Right at the beginning, we organised a meeting with all the candidates to explain that their project must incorporate a 100 kWc PV unit on a roof, which would be owned by Gaz Electricité de Grenoble. A document was given to the candidates specifying the basic elements of the PV unit: size, orientation, etc (see annex 1). As a result of this competition, the developer APSYS was taken on to build the shopping centre. The project for the developer included the PV installation in the form of saw-tooth roofs above the walkways of the shopping centre.



*Plan of the roofs of the shopping centre*

**Preparation**

It is difficult to design a PV installation for a building as complex as a shopping centre.

To assist us with the design work and organisation of the project, we signed an assistance agreement with HESPUL. This association is a specialist in PV and a member of IEA-PVPS. It is involved in most PV projects in the region and in particular the Concerto RENAISSANCE project in Lyon. Our collaboration has thus created a link between the two Concerto projects in the Rhône Alpes region.

The shopping centre project must be particularly illustrative and well integrated, as it will become a shop window for the development of PV in Grenoble. Unfortunately, the architects do not have any specific experience in this field. We have therefore collected together and prepared for them various information on the technical and architectural conditions for PV integration:

- Photos of installations with various integration solutions
- List of technical specifications for PV installations
- CSTB data on ATEX (Technical Experimental Assessments) for PV glass roofs (see section 1.3.3) and the possibilities for integration in glass roofs

We have had meetings with 4 of the leading manufacturers/suppliers in France (PHOTOWATT, CLIPSOL, APEX BP SOLAR and TENESOL). Each company presented its products and installation recommendations. They all assured us of their assistance during the final design phase with the architects.
All the information collected has been presented in the first section of this document.

## - Design and choice of integration

### Initial proposals

At the end of 2005, the architect sent us the initial detailed plans with a general plan and a sketch of the saw-tooth roofs that are to take the panels.

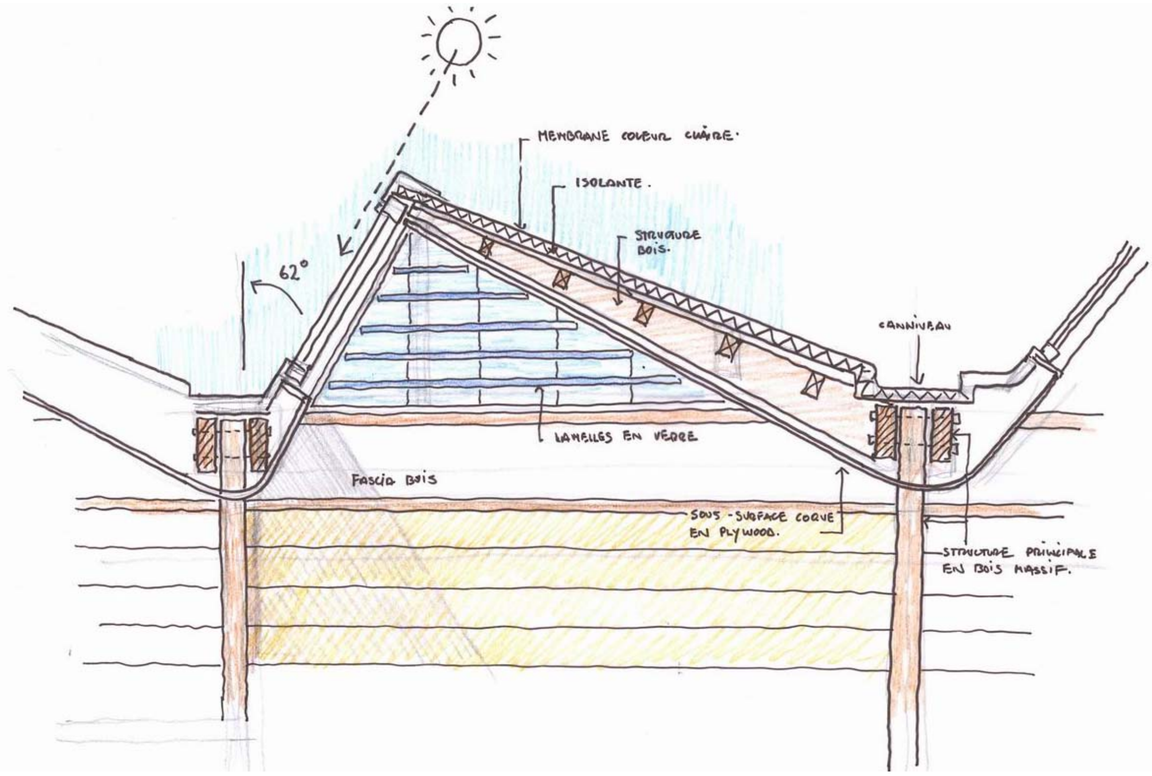



*Diagram of the saw-tooth roofs*

After analysing these plans with Hespul, we noted that:

- The tilt of the saw-tooth roofs was not optimised and the short distance between the roofs caused them to make shadows on the one another.

- The plans only allowed 850 m² of collectors to be installed and did not enable 100 kWc to be reached

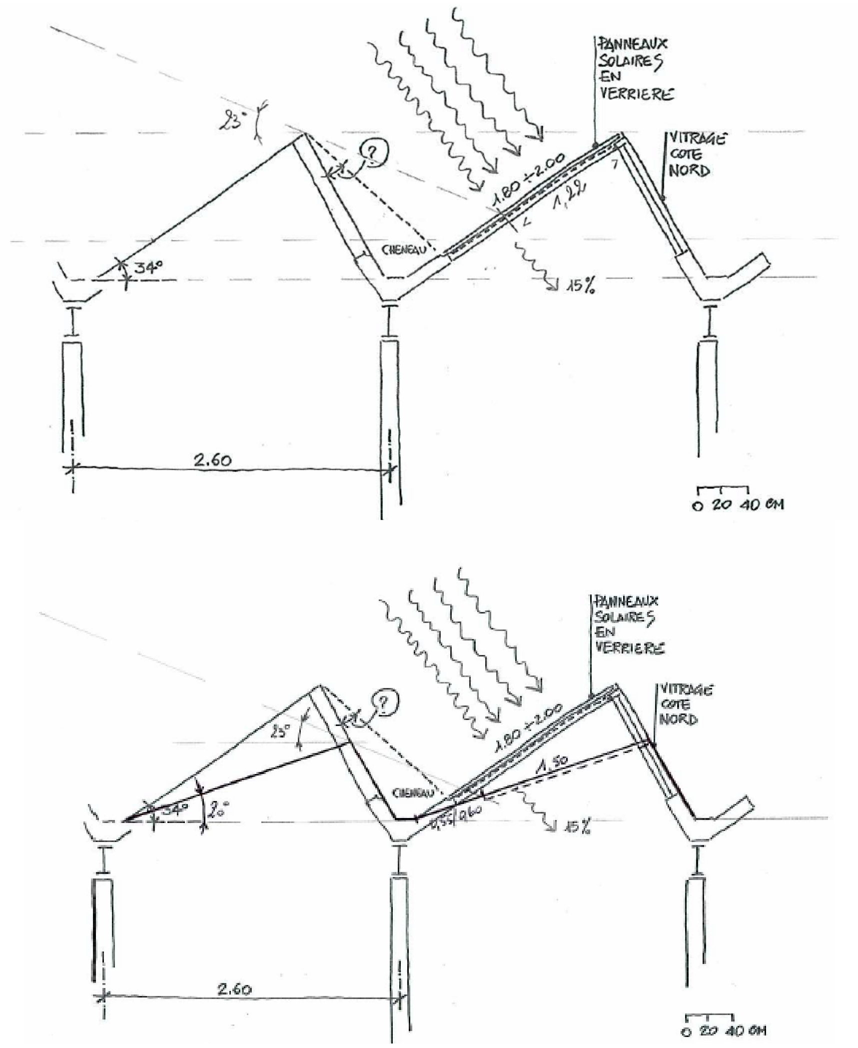
- The lengths of the saw-tooth roofs were very variable and did not allow for uniform wiring of the collectors

We met the architects and proposed:

- A slight enlargement of the saw-tooth roofs (projection over the flat roof) to
    - Increase the area
    - Make the lengths of the saw-tooth roofs a little more uniform

- Be able to place the inverters under the saw-tooth roofs on the flat roof.

- Modification of the tilt of the south face of the saw-tooth roofs. With a 20° tilt, shading is reduced, 1.5 m collectors can be used and the coverage rate can be increased to 55%, giving more than 1100 m².



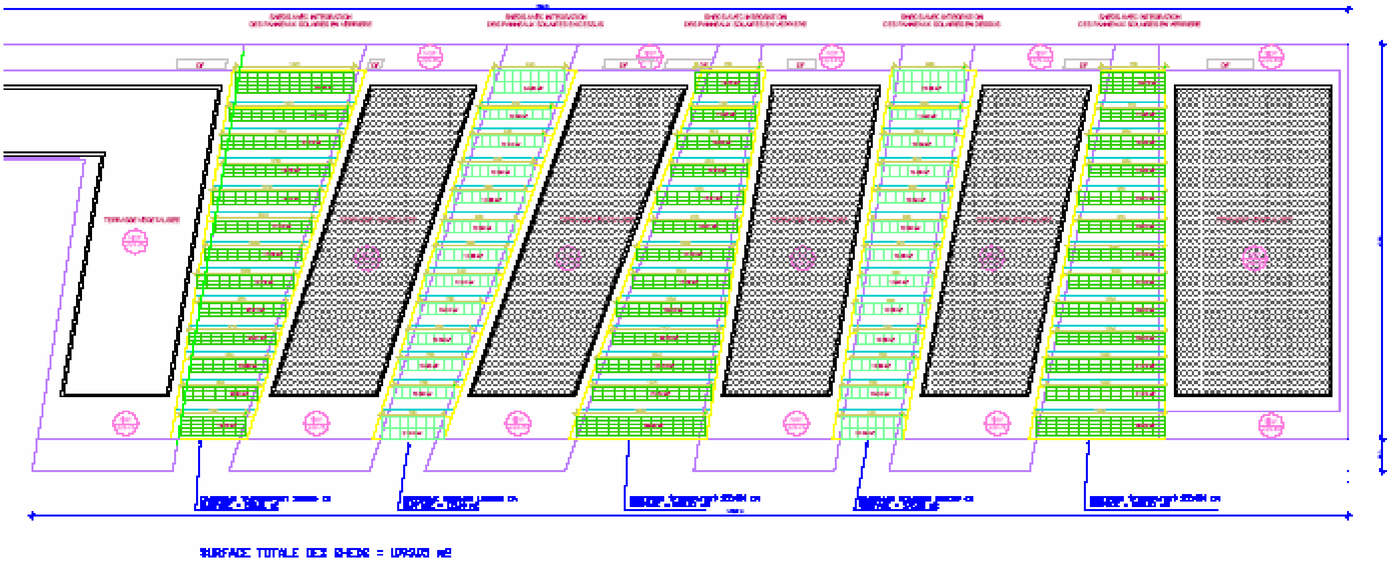

*Plan showing the proposed modifications to the saw-tooth roofs*

These modifications were accepted and the architect also proposed to
- Double the height of the north saw-tooth roof as it does not cast any shadows on the others
- Double the height of the first south saw-tooth roof by making it overhang lower above the park

**Optimised proposals**

The new proposal made in February 2006 incorporated 13 saw-tooth roofs that were more uniform, with no shadows, enabling up to 110 kWc of standard sized collectors to be integrated.

Roof plan



*New roof plan of the shopping centre*

*Table showing distribution of the collectors*

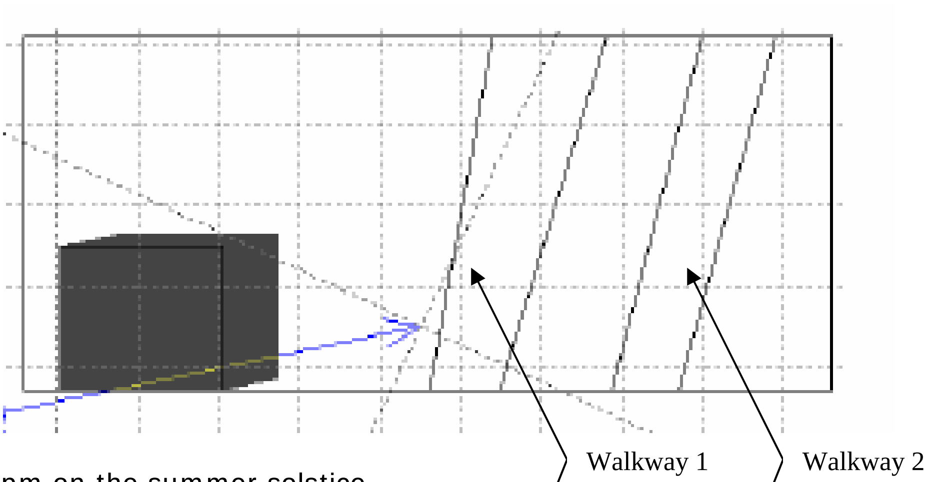
| | Walkway R1 | | Walkway R2 | | Walkway R3 | | Walkway R4 | | Walkway R5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Saw-tooth roof no. | No. of collectors | Wc | No. of collectors | Wc | No. of collectors | Wc | No. of collectors | Wc | No. of collectors | Wc |
| 1 (North) | 10 | 1900 | 8 | 1520 | 7 | 1330 | 8 | 1520 | 7 | 1330 |
| 2 | 10 | 1900 | 8 | 1520 | 7 | 1330 | 8 | 1520 | 7 | 1330 |
| 3 | 10 | 1900 | 8 | 1520 | 8 | 1520 | 8 | 1520 | 8 | 1520 |
| 4 | 10 | 1900 | 8 | 1520 | 8 | 1520 | 8 | 1520 | 8 | 1520 |
| 5 | 9 | 1710 | 8 | 1520 | 9 | 1710 | 8 | 1520 | 9 | 1710 |
| 6 | 8 | 1520 | 8 | 1520 | 10 | 1900 | 8 | 1520 | 10 | 1900 |
| 7 | 8 | 1520 | 8 | 1520 | 11 | 2090 | 8 | 1520 | 11 | 2090 |
| 8 | 8 | 1520 | 8 | 1520 | 11 | 2090 | 8 | 1520 | 11 | 2090 |
| 9 | 8 | 1520 | 7 | 1330 | 12 | 2280 | 8 | 1520 | 12 | 2280 |
| 10 | 7 | 1330 | 7 | 1330 | 12 | 2280 | 7 | 1330 | 12 | 2280 |
| 11 | 7 | 1330 | 7 | 1330 | 13 | 2470 | 7 | 1330 | 13 | 2470 |
| 12 | 7 | 1330 | 7 | 1330 | 13 | 2470 | 7 | 1330 | 13 | 2470 |
| 13 (south) | 20 | 1500 | 20 | 1500 | 36 | 2700 | 20 | 1500 | 36 | 2700 |
| | Total | 20880 | | 18980 | | 25690 | | 19170 | | 25690 |

*View of the south façade of the shopping centre with the PV saw-tooth roofs*

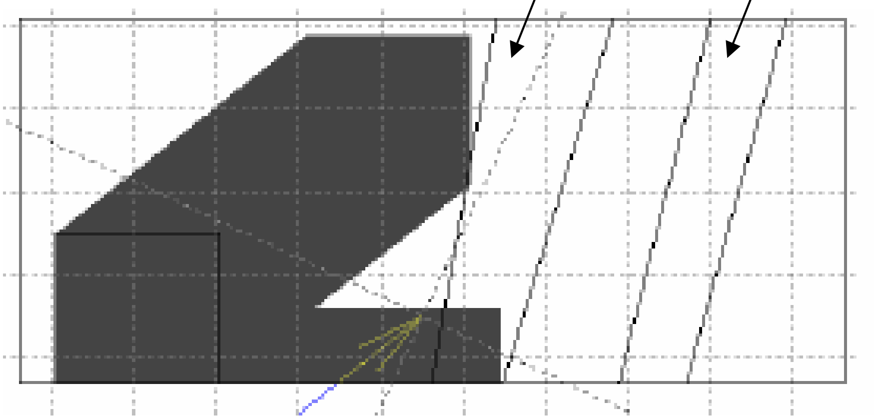
*Interior view of walkway 1*

**Study of the shadows**

A study was also carried out to check that there were no shadows on the PV installation from the neighbouring buildings. Shadow will be limited to the winter months from November to February and does not have any significant effect.




Shadow at 2 pm on the summer solstice



Shadow at 2 pm on the winter solstice

### Choice of inverter

With regard to the inverters, we have consulted the manufacturers and analysed the results of a European study issued by WP 3.

In order to limit the risks of breakdown, reduce wiring costs and ensure easier installation in the buildings, we have decided to have numerous small inverters rather a single inverter.

These inverters can be installed under the ends of the saw-tooth roofs and will therefore be as close as possible to the collectors.

### - PV glass roofs

The installation of a PV glass roof over a building frequented by the public poses difficulties with regard to the regulations in France, as was indicated in section 1.3.3.

However, PV glass roofs represent a benefit in terms of impact on the public, and we believed it was important to have one in view of the illustrative nature of the project.

We therefore examined the possibility of incorporating PV glass roofs over the 5 walkways.

It was quickly recognised that as walkways 2, 3, 4 and 5 are heated, the PV glass roof also needs to be insulating. The additional costs and complexity of the advanced solutions led us to abandon this option.

We also examined the possibilities of PV glass roofs on the south saw-tooth roofs. These saw-tooth roofs have the advantage of not being above the building (they jut out over the park) which limits the technical and regulatory restrictions. The decision was therefore made to build these glass roofs which would constitute the shop window of the installation and represent around 10% of the total number of collectors.

Finally we examined the possibility of having a PV glass roof over walkway 1, which is not heated and is in fact a covered road. There are two difficulties with this option:

- The distribution of liability between the owner of the shopping centre and the owner of the glass roof
- The responsibility for the considerable additional cost, as the price of the installations is 50% more than that of a standard installation.

The final decision on this part of the installation has not yet been made. A solution of a double glass roof, which would resolve the problem of liability, is in particular being examined by the architect.

**- Contract between APSYS and Gaz Electricité de Grenoble**

Discussions were carried out from March to April 2006 on the legal conditions for drawing up contracts between the developer of the shopping centre (APSYS) and Gaz Electricité de Grenoble. These discussions led to the signature of an initial agreement in principle on the conditions for provision of the roof.

The only point that has not yet been resolved is the final choice concerning walkway 1 (see section 2.5) for which the condition is that APSYS is responsible for the additional cost and the liability if there is a glass roof over the whole of walkway 1. A final agreement will be signed at the end of 2006, as soon as a decision has been reached on all the architectural elements.

**- Economic situation**

As things stand at the moment, the economic situation is as follows:

Investment

| | | |
|---|---|---|
| Power | kWp | 100 |
| Production | kWh/year | 110,000 |
| Investment | k€ | 600 |
| Concerto subsidy | k€ | 175 |
| Final investment | k€ | 425 |

Economic situation

| | | 2002 | 2006 |
|---|---|---|---|
| Feed-in tariff | €/kWh | 0.14 | 0.3 |
| Sale of electricity | k€/year | 15 | 33 |
| Maintenance | k€/year | -6 | -6 |
| Profit | k€/year | 9 | 27 |
| Payback time | Years | 47 | 16 |

It is clear that the new PV tariff (see section 1.5.2) improves the economic situation for the project, but it is still far from industrial profitability.

We are still waiting for answers to our requests for subsidy from the Rhône Alpes region.

Note: The poor economic data envisaged using the 2002 feed-in tariff at the start of the project led us to look for specific solutions for financial arrangements. With the support of WP 3 and 4, we have in particular made contact with the BASE association which has worked on the financing of PV installations in Germany. Several solutions have been examined, but with the new tariff, the situation has changed and has led us to adopt a different approach regarding the financing of projects, more from a perspective of involvement of local companies (see section 3).

**- Extension of the programme for Gaz Electricité de Grenoble**

**- What has been learned from the SESAC project**

Our involvement in the Concerto-SESAC programme PV project over the past year has given us a better understanding of the stumbling blocks and has confirmed our wish to go further.

Our findings are as follows:

- The technical and commercial systems are mature

- More and more owners of private and public buildings are installing operations or indicating their interest in this energy.

- Grenoble and its region are particularly advanced in terms of energy management and renewable energies, and companies, local authorities and the population have become more aware and ready to support concrete projects.

- The main stumbling blocks are as follows:
    - The conditions for connection and resale to the grid are technically and administratively restrictive
    - Not all buildings are suitable (orientation, shade, etc), not all owners who want be involved will be able to do so
    - Building owners are reluctant to become electricity producers and thus move away from their core businesses
    - The economic conditions are not very favourable, although they have improved with the new feed-in tariff

**- Our plan for the future**

As a local semi-public company producing, distributing and supplying electricity, Gaz Electricité de Grenoble has particular first-hand experience which enables it to totally manage all aspects of projects, from design through to operation, including building and financing.

Based on its experience and its resources, Gaz Electricité de Grenoble wishes to offer building owners, in particular owners of public buildings, but also private occupants and companies, concrete possibilities for going ahead.

We want to increase the numbers of large PV projects and make Grenoble and its region a reference in this field, by producing hundreds kW of PV solar electricity by 2010.
Gaz Electricité de Grenoble is positioning itself as an operator responsible for investment, installation and operation for a minimum period of 20 years.

The various partnerships we have established and our own buildings provide us with a large roof area where installation would be optimum both for production and for standardisation, as well as public visibility. We have already identified several in-house projects and undertaken studies which have confirmed the potential and motivation of building owners in Grenoble.

As for the technical aspect, we are in discussion with the French manufacturers and suppliers to define standard installations that will simplify installation and operation and reduce costs.

Buildings will be made available for setting up installations via 20-year provision agreements. The owner of the building will be liable for the building and Gaz Electricité de Grenoble will be liable for its installation. Payment will be made for the rental of the roof. In the event of architectural integration, a specific article will be added to specify the ownership and liability limits of each party.

In addition, from a sustainable development viewpoint, we want to set up, with banking partners, a “solar financing fund” specifically for the development of PV. This is in response to the demand of all those involved locally to have a practical involvement in a PV project. The funds raised will be invested by Gaz Electricité de Grenoble in the production and operation of PV energy installations. The fund will enable the project to be extended both in terms of its scope and its duration. In fact, contributions are not limited and if need be the project will be re-sized according to the funds raised. As with ethical funds, controls will be put in place to ensure how the funds are used.

## CONCLUSION

The development of PV in France is still a long way behind that observed in other European countries.

The new feed-in tariff will enable stronger growth over the years to come, but it is clear that new areas of development must appear to increase the numbers of large projects.

The combination of a region that is particularly advanced in terms of renewable energies and decentralised production and a committed local operator like Gaz Electricité de Grenoble makes Grenoble an almost unique case in France, and one that is particularly favourable for new avenues of development in these two fields.

In view of the numerous advantages it has and in line with a more comprehensive policy of environmentally-friendly energy and management of consumption, Gaz Electricité de Grenoble wants to develop the PV industry.

Its involvement in the Concerto-SESAC project has enabled it to be involved as the owner of a PV project and assess its complexity, the challenges and the solutions.

Based on this experience, Gaz Electricité de Grenoble has decided to embark on a much larger PV development project in the Grenoble region.

**Deliverable 13a**
*[D 13A Work package 13 integration of RES in Viscose (demonstration)]*
*Due date of deliverable: 1st September 2006*
*Actual submission date: 19th July 2006*
*Start date of project: 25.05.2005*
*Organisation name of lead contractor for this deliverable OPAC 38*
*Revision [draft: 1]*
*Dissemination Level: PU Public*
*Author: Sebastian Lota*

**Introduction**
This document summarizes the results of the design process of the enlargement of the district-heating network in Viscose. The technical coordination and the consultants of WP 13 had a long and fruitful collaboration; a tour in Växjö took place. According to the objectives of the WP we had to focus on the possibility of designing a low cost, and adapted network to the area's size and low density. Not only have the objectives of choosing new techniques to reach low cost enlargement been taken into account. The reliability of the network's components (to reduce the maintenance costs) and the
CONCERTO calendar which obliges us to work fast have also been taken in account.

**Description of techniques**
Three technical possibilities have been explored, and each one has been evaluated for its suitability. In other words, to have a complete view of the technical possibilities, the area's constraints (existing networks, streets, low density…) and the technical solution have been surveyed jointly. For a direct financial comparison of the technical advantages and drawbacks of each solution, please see table next page

**The solution one** has been abandoned due to its lack of innovation. It is the "French" traditional design of heating network, and does not really fit with the objectives of the WP. It has been investigated more as a comparison base than a real possibility. It is based on a two pipes network with some quite wide substations (20 sqm²) the DHW is semi accumulated in each building. This solution does not push the engineers to innovate in their design stage. The main problem with this solution is the time required for the civil work in the buildings and the investment cost linked.

**The solution two** has been chosen for various reasons:
This solution is a two pipes design with prefabricated substations has seen during the study tour. The secondary network's design is really similar to the first solution but the prefabricated substations.

• The use of prefabricated substations (see technical design in annex) can create some cost cuttings in the length of work inside the buildings (strong advantage on the solution one). And the prefabricated substations are cheaper than the traditional French ones.

• It offers a possibility to use for the first time a standardized solution to enlarge the district heating network and obliges the engineers to go further in their investigations according to what has been seen during the study tour (capacity building).

• It allows us to save time and respect the CONCERTO calendar.

• The outside work (trench digging mainly) is similar to the usual one (that is not the case in solution 3), cheap and much more suitable to an area which already contains other networks. The existing networks are a real problem for the new network as it is costly to move them when possible or worse, to avoid them (increasing the length of the new net).
• And last, it is compatible with the solar production of the new buildings (WP 9.2), which will be connected to this network.

**The solution three** has been drastically surveyed but at the end abandoned due to tree reasons mainly
• The incompatibility with the technical design of the WP 9.2 new buildings.
• The difficulty of regulation (in one point) for such a wide network.
• The trenches width.

This solution is four pipes net with a single regulation point, the two mains substations (as in fact there are two distinct networks due to the canal crossing the area). The main advantage is the nearly inexistent civil work in the buildings (only four winnows). It allows us to save a lot of time and investment cost. The main drawback is the trench size with the existing networks.
On the innovation side this solution was the most advanced, and asked to the consultants to take an important risk. According to the French law the consultants have an obligation of good result in their design and in case of higher prices in the realization, or lack of reliability they are responsible and can be prosecuted. In other word even if the trenches width was a real technical problem, this solution also asked the consultants to take a risk they didn't want to.

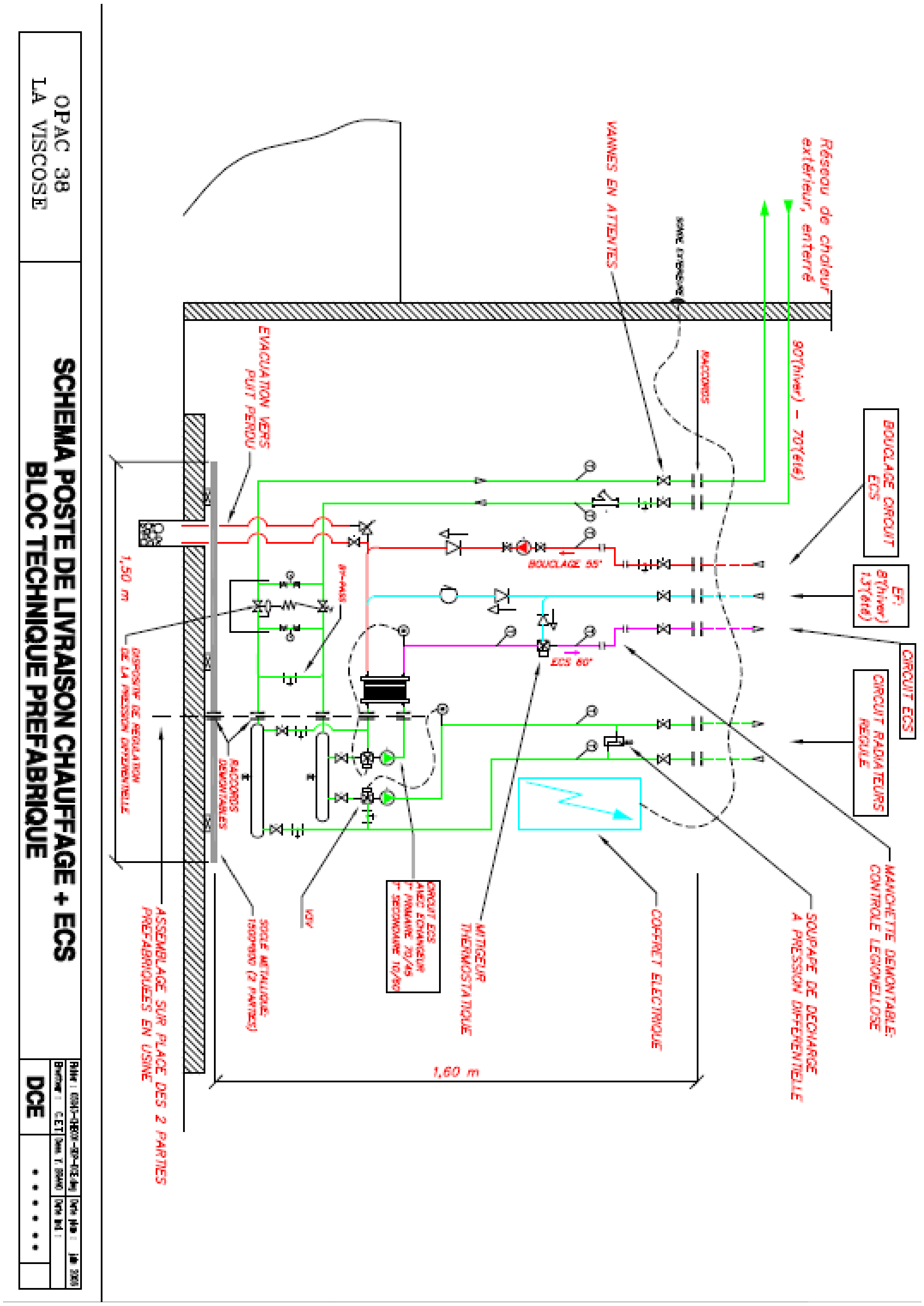
| Work program | Solution 1: (first French version) 2 pipes and standard substations. (estimated) | Solution 2: 2 pipes & prefabricated substations (real cost) | Solution 3: 4 pipes without substations in the buildings (estimated) |
|---|---|---|---|
| Main substations & external network | 1 766 030 € | 1 702 515 € | 2 311 030 € |
| Heating system (sub stations + inner distribution + radiators + DHW production + distribution + electricity gears in the building) | 2 129 130 € | 2 168 490 € | 1 751 130 € |
| Main substation building work, civil work in the buildings (according to the solution needs) | 922 830 € | 477 120 € | 596 080 € |
| Total cost of work | 4 817 990 € | 4 348 125 € | 4 658 240 € |
| Advantages | Usual French design, maintenance easy and comfortable.<br>Independent heating network's regulation per building.<br>Outside network: 2 pipes.<br>DHW production per building, compatible with solar production ( WP 9.2).<br>Main substation's power optimised due to semi accumulation of DHW production. | Innovation in the design using prefabricated sub stations.<br>Independent heating network's regulation per building.<br>Outside network: 2 pipes.<br>DHW production per building, compatible with solar production ( WP 9.2). | Cheapest investment cost: 160 000 € lower than the solution 1.<br>Civil work drastically reduced in the buildings, without technical installations.<br>No maintenance of the substations in the buildings, economy of 27 000€ per year.<br>Less electricity consumption.<br>Main substation power optimised due to semi accumulation of DHW production.<br>Regulation evaluated. |
| Drawbacks | Most expensive (investment cost) solution. + 160 000 € compare to the solution 3.<br>High maintenance cost due to the number of substations.<br>Important civil work in the buildings. Modification of the electricity network in the buildings.<br>More electric consumption than the solution 3.<br>If necessary, legionela treatment costly. 1 000 € to 3 000 € per building not included in the calculation. | Costly investment + 79 000 € compare to the solution 3.<br>Maintenance cost higher than the solution 1 due to limited accessibility to the components in the prefabricated substations.<br>Important civil work in the buildings, nevertheless, lighter than the solution1.<br>Modification of the electricity network in the buildings.<br>Electric consumption higher than the 2 other solutions.<br>If necessary, legionela treatment costly. 1 000 € to 3 000 € per building not included in the calculation.<br>Increased power of the main substations due to instantaneous DHW production. | Over cost in the external network.<br>Need of over pressurisation of the water network.<br>Thermal losses.<br>Important installation for DHW treatment.<br>Central DHW production not suitable with the solar production (WP 9.2)<br>Regulation of the heating network for the all neighbourhood and not per building. |

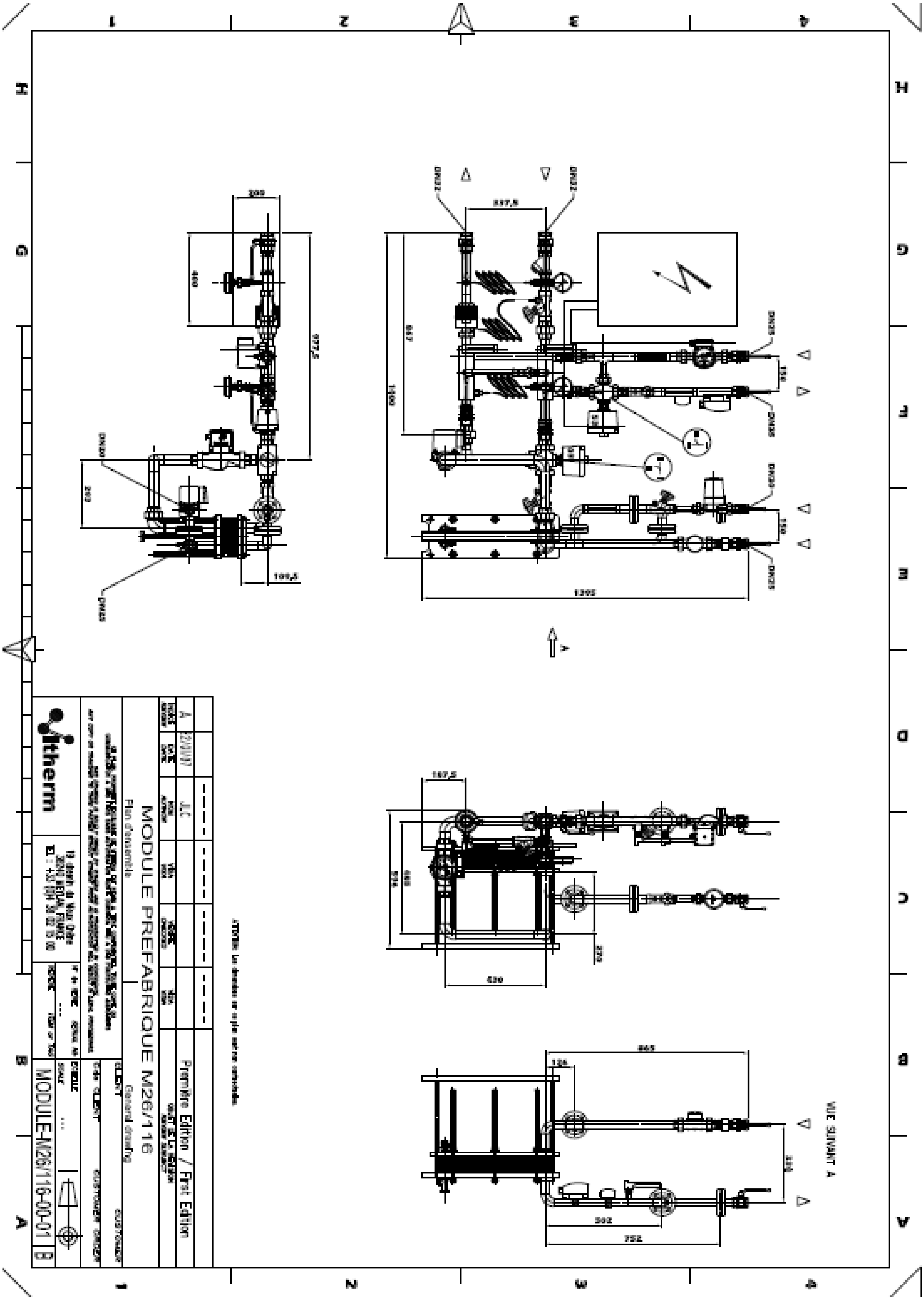
**Conclusion**

The application of the Concerto's objectives to this work package has definitely moved forward the design of the district heating network by showing that the use of prefabricated substations was cost effective in reducing the length of work for the installation mainly. At the beginning of the project the consultants were quite afraid of the production cost of these substations as it does not exist in France. For example during the study tour The company ALFA LAVAL showed the French consultants their products and precisely these small prefabricated substations. Back to France the French branch of the same company said it was impossible to have the same products and they had to start a specific production at a higher price than the Swedish one.

The cost of one substation installed in Viscose. The difference of cost between the three solutions was not the only point to choose among them, and as explained earlier we did not expect an efficient cost cut in the prefabricated substations, and according to the French law we are not allowed to ask for a specific make or origin for the components.

It is also early to know if this project will have an effect on the market and if capacity building gained from this project will have an effect on the next ones. Nevertheless, if we analyse the capacity building for the social housing company and the consultants on this particular project, it unquestionably efficient. The requirements we had on this project were quite uncommon for the district heating company, actually in France and specifically in Grenoble the district heating company is developing its network in dense urban areas. The components as substations designed for small buildings (less than 10/20 dwellings) are not a need for them, so I do not think the Viscose project will lead them to a specific development but it has the advantage to show that these small substations exist and are reliable. In other words, if the industrial development of these small substations will not appear immediately in France it is not due to a lack of will from the heating companies but more to a market development stage. It is a first step for improvement in the design, and the enlargement of the district heating system and to my opinion the communication and advertisement we (the social housing and the district heating companies) will do after the realisation of the project is also important for the diffusion of the capacity building we gained from it.


OPAC 38
LA VISCOSE
SCHEMA POSTE DE LIVRAISON CHAUFFAGE + ECS
BLOC TECHNIQUE PREFABRIQUE
DCE
Réseau de chaleur extérieur, enterré
VANNES EN ATTENTES
90°(hiver) – 70°(été)
RACCORDS
BOUCLAGE CIRCUIT ECS
EF: 8°(hiver) 13°(été)
CIRCUIT ECS
CIRCUIT RADIATEURS REGULE
EVACUATION VERS PUIT PERDU
BOUCLAGE 55°
ECS 60°
BY-PASS
1,50 m
1,60 m
DISPOSITIF DE REGULATION DE LA PRESSION DIFFERENTIELLE
RACCORDS DEMONTABLES
ASSEMBLAGE SUR PLACE DES 2 PARTIES PREFABRIQUEES EN USINE
SOCLE METALLIQUE
MITIGEUR THERMOSTATIQUE
COFFRET ELECTRIQUE
SOUPAPE DE DECHARGE A PRESSION DIFFERENTIELLE
MANCHETTE DEMONTABLE: CONTROLE LEGIONELLOSE


MODULE PREFABRIQUE M26/116
Plan d'ensemble
General drawing
Première Edition / First Edition
MODULE-M26/116-00-01
VUE SUIVANT A
1295
1400
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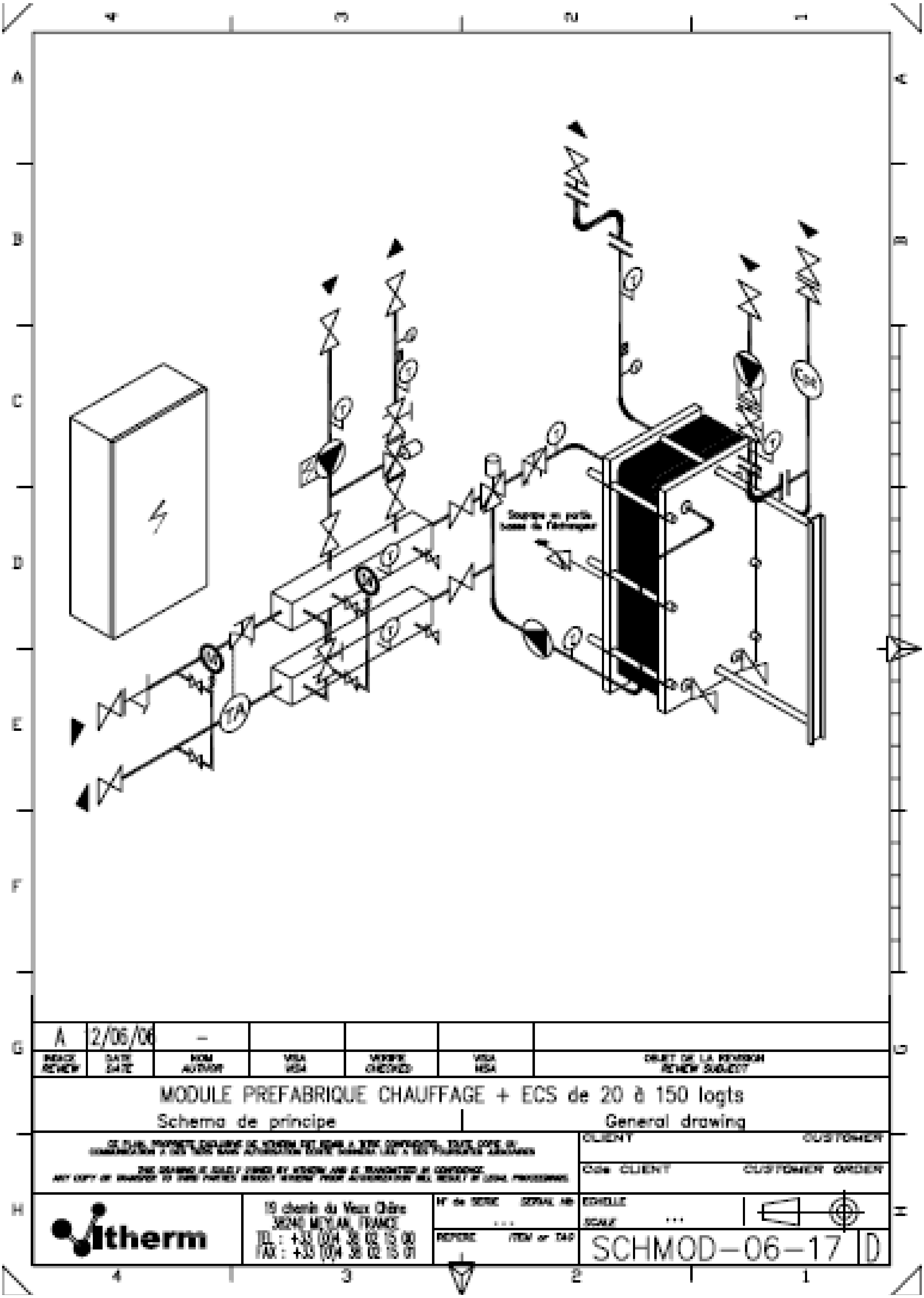
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MODULE PREFABRIQUE CHAUFFAGE + ECS de 20 à 150 logts
Schema de principe
General drawing
CLIENT
CUSTOMER
Cde CLIENT
CUSTOMER ORDER
SCHMOD-06-17
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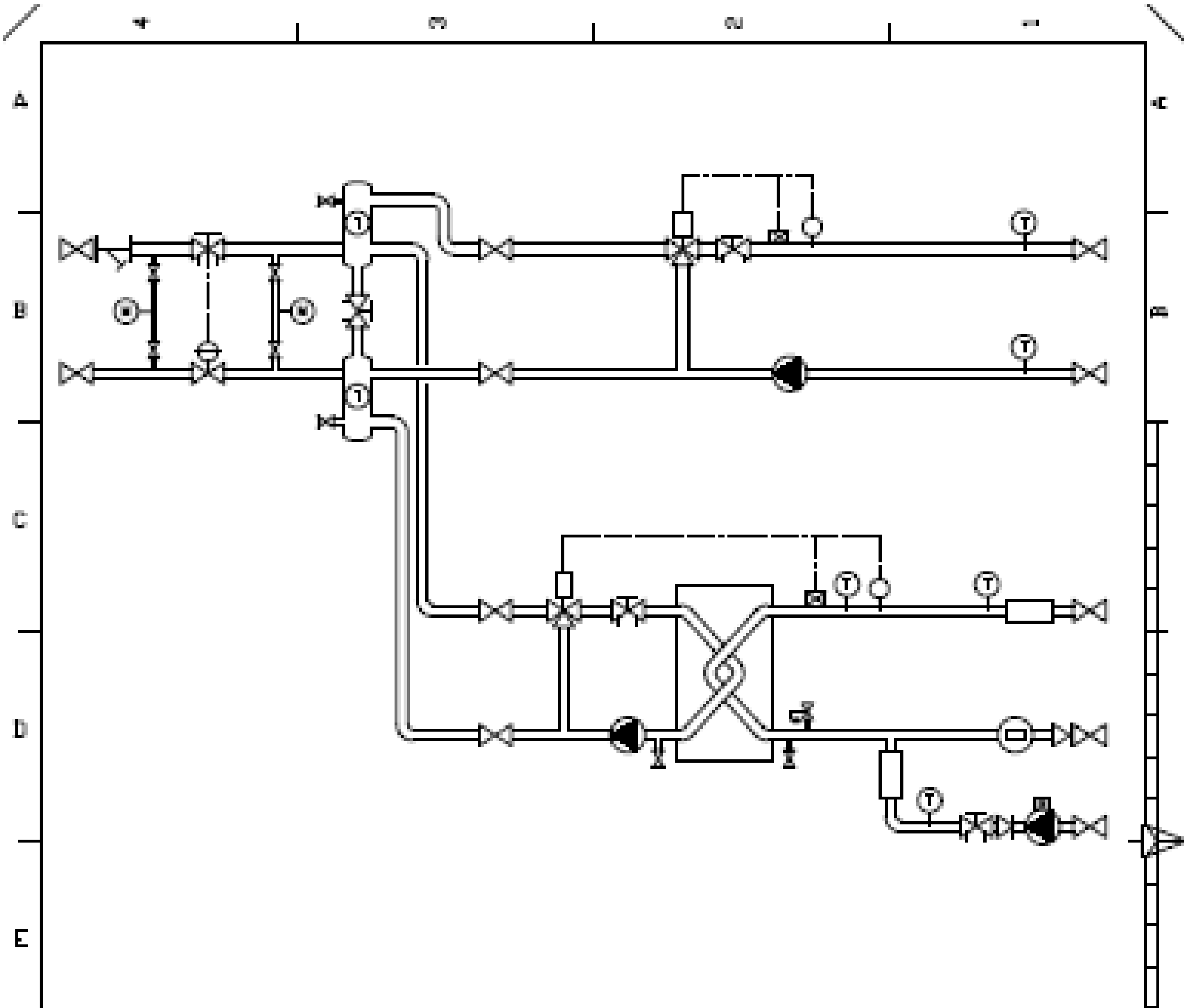


| Repère | Désignation | Repère | Désignation |
|---|---|---|---|
| | Sonde de régulation SIEMENS | | Clapet de non retour |
| | Vanne de régulation électrique SIEMENS | | Soupape de sureté tarée à 7 bar |
| | Régulateur pression différentielle TA Control | | Manchette de contrôle |
| | Thermomètre 0–120°C | | Compteur d'eau froide |
| | Manomètre 0–10 bar | | Pompe spécifique sanitaire GRUNDFOS |
| | Filtre bronze PN16 | | Pompe de chauffage GRUNDFOS |
| | Vanne de réglage TA CONTROL | | Soupape de pression différentielle |
| | Vanne d'isolement 1/4 de tour | | Thermostat de sécurité SIEMENS |

| INDICE REVIEW | DATE DATE | NOM AUTHOR | VISA VISA | VERIFIE CHECKED | VISA VISA | OBJET DE LA REVISION REVIEW SUBJECT |
|---|---|---|---|---|---|---|
| A | 12/06/06 | - | | | | |

MODULE PREFABRIQUE CHAUFFAGE + ECS de 20 à 150 logts

Schema de principe | General drawing

CLIENT CUSTOMER

Cde CLIENT CUSTOMER ORDER

Vitherm

19 chemin du Vieux Chêne
38240 MEYLAN, FRANCE
TEL : +33 (0)4 38 02 15 00
FAX : +33 (0)4 38 02 15 01

N° de REPERE SERIAL No ...

REPERE ITEM or TAG

ECHELLE SCALE ...

SCHMOD-06-18 | C

**Deliverable 18a**

*[D18a, Description of the metering system and test results from the first metering step]*
*Due date of deliverable: 25.01.2007*
*Actual submission date: 03.06.2007*
*Start date of project: 25.05.2005*
*Duration: 25.05.2005 – 25.05.2010*
*Organization name of lead contractor for this deliverable: VEAB*
*Author: Martin Magnusson; martin.magnusson@veab.se*
*Revision [4]*

## Executive summary

Changing people's behavior greatly affects the possibility to save energy. This project aims to save ten percent of energy by achieving a desirable energy-efficient behavior from tenants. A Demand Side Management (DSM) method has been developed and is used with tenants to create good conditions and later to change tenant behavior. It is of great importance to understand the correlation between lifestyle and consumption for saving energy by the DSM methods. Apartments are equipped with systems for individual measurement that are used to create an incentive for tenants to lower their energy consumption. The apartments type 1 and 2 in the Sesac area are equipped with a display mounted in the apartment in order to make energy consumption visible to tenants.

The results of the first measurements show that electricity consumption has decreased by 13.6% in apartments in which the DSM method has been applied. When the apartments with displays using a DSM method are compared to apartments outside the Sesac area, we see a 34% energy savings. The consumption of domestic hot and cold water has not shown any significant deviations when comparing apartments with displays. But when compared to other apartments, we see a 43% energy savings. An explanation to this could be that sufficient knowledge has already been obtained by tenants with no DSM since it is easier to understand the connection between hot water and energy than it is to understand energy by electricity. The comfort measurement method has proven to be unsuitable for this kind of energy-efficient buildings. The DSM method used has not yet been through all the steps necessary to create desired behavior. Therefore, further energy savings are to be expected when the DSM method has been fully applied to tenants.

**Table of contents**

## Introduction

When creating a suitable energy system it is of great importance to understand the different parameters that influence energy consumption. In this project, apartments were built with energy performance that goes well beyond Swedish regulations. The most important parameters for creating energy-efficient living are the technical conditions of the building's energy system and the understanding of people's energy consumption behavior.

In the Sesac area, 81 apartments have been built so far in Växjö, 69 with the energy standard of 95 kWh/$m^2$yr and 12 with 85 kWh/$m^2$yr[1]. In these apartments two different systems for individual measurements have been installed. This system is used as a tool for creating desired tenant behavior.

The aim of this project is to lower tenant energy consumption by 10 percent by creating desired behavior. The method used will have the largest impact in the long run. The correlation between consumption patterns and lifestyle is of great importance when creating a useful DSM method. To change this pattern in such a way that it will be long-lasting, it is of great importance to use a structured method. This method is explained later in the report.

## Description of work

To create the desired behavior it is first important to provide tenants with the right conditions. These conditions are provided by the individual measurement systems and the Demand Side Management method. Two types of measurement systems are used in these apartments; one is used in type 1 buildings and the other in type 1 buildings. The systems can be further studied in Appendices 1 and 2. In order to compare energy consumption, the electricity consumption of 72 apartments in Växjö has been studied giving a better view of how much energy can be saved. Consumed energy for domestic hot water has also been compared to a study conducted in Stockholm. This is further explained later in the report.

## Type 1 buildings

Type 1 buildings have a measurement system for electricity and domestic hot and cold water. Tenants can 'see' their consumption via a display in their apartments. The display can also be used to send text messages to the tenants. See figure 2.1.1. Tenants can see their consumption by cost and specific energy consumption. Tenants pay for each of these services separately. The apartment is also equipped with a system for comfort metering. The comfort metering system was meant as a means to get tenants to pay for their energy consumption for heating. This system did not work however because tenants were not given the opportunity to influence their energy consumption. The comfort metering system is, thus, not used as a financial means of control. Instead, the system is used to control energy to the building. The measurement system used can be further studied in Appendix 1.


*Figure 2.1.1. The display installed in all apartments in type 1 buildings.*

Sixty-nine apartments have been erected and their tenants divided into two groups. The first group (40 apartments) moved in to their apartments in the beginning of 2006. These tenants were not given any information about saving energy and their apartments are used as reference apartments. The other group (29 apartments) moved in in July 2006. Demand Side Management methods have been applied to these tenants. The method used can be further studied in figure 3.

Type 2 buildings

[1] Energy consumption is defined as transmission, ventilation and DHW.

Type 2 buildings have a measurement system for electricity, heating and domestic hot and cold water. The tenant can follow their consumption of heat and domestic hot and cold water on a display mounted in the apartment. See figure 2.2.1. This display enables tenants to follow their consumption according to specific energy units. Electricity consumption is displayed on a meter at the distribution box. At the end of 2006, 12 apartments where finished. Later in 2007, 42 more apartments will be finished.

*Figure 2.2.1 shows the display that displays heat and hot and cold water consumption*

**Method**
In order to create desired tenant behavior, it is of great importance to first provide the right conditions. Later when the conditions are in place, tenants are ready to understand more information about energy-saving strategies. The DSM method used is further explained in figure 2.3.1 below.

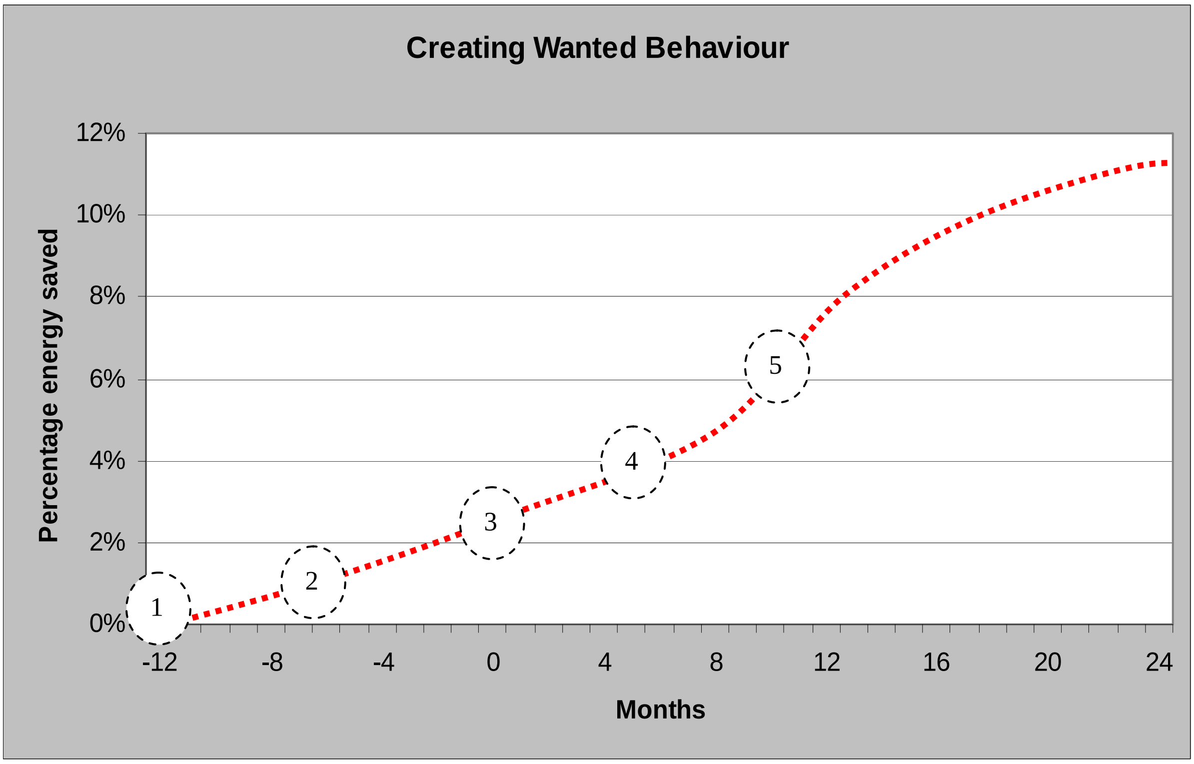



*Figure 2.3.1.This diagram shows the process of tenants changing their lifestyles and consumption. This is the theoretical result of changing behavior. The specific process for each tenant is unique due to the close correlation with the tenant's lifestyle. The percentage shown in the diagram is the energy saved due to changed behavior. The different steps can be explained as follows:*

1. *When prospective tenants search for an apartment they are given information about the possibilities that this apartment provides and about how they can affect their monthly expenses by the individual measurement system. They are also informed about the high-energy profile of these buildings.*
2. *When tenants sign their contract they are informed about the possibilities of affecting their monthly expenses by the individual measurement system. They are also informed about the high-energy efficiency that these buildings aim for.*
3. *When tenants move in to their new apartments they are given an easy task. This task has the purpose of providing the tenant with a better understanding of energy consumption. They are also given instructions on how they can follow their monthly consumption on the apartment's display.*
4. *tasks for creating more knowledge of energy savings. When tenants have started to settle and feel comfortable in their apartments it is of great importance that they receive information that provides the conditions for changing behavior. This information is received in the form of feedback regarding their consumption as well as that of the building for comparison purposes. They are also given a few more easy*
5. *At this stage tenants should have changed their behavior in such a way that they are receptive for more direct energy-saving strategies. They will be given more information about how they can affect their energy consumption as well as receive measurement results and the opportunity to compare their consumption to that of fellow tenants.*

**Compared apartments**
In order to create a comparison between apartments with different prerequisites, the comparison is split up into three different groups. Comparisons are made between apartments within the Sesac area and to apartments outside the Sesac area (see figure 3.1). This comparison aims to show tenants three different forms of influence. “Reference apartments” are located outside the Sesac area, whereas “reference apartments with display” and “apartments with display and DSM” are apartments within the Sesac area.

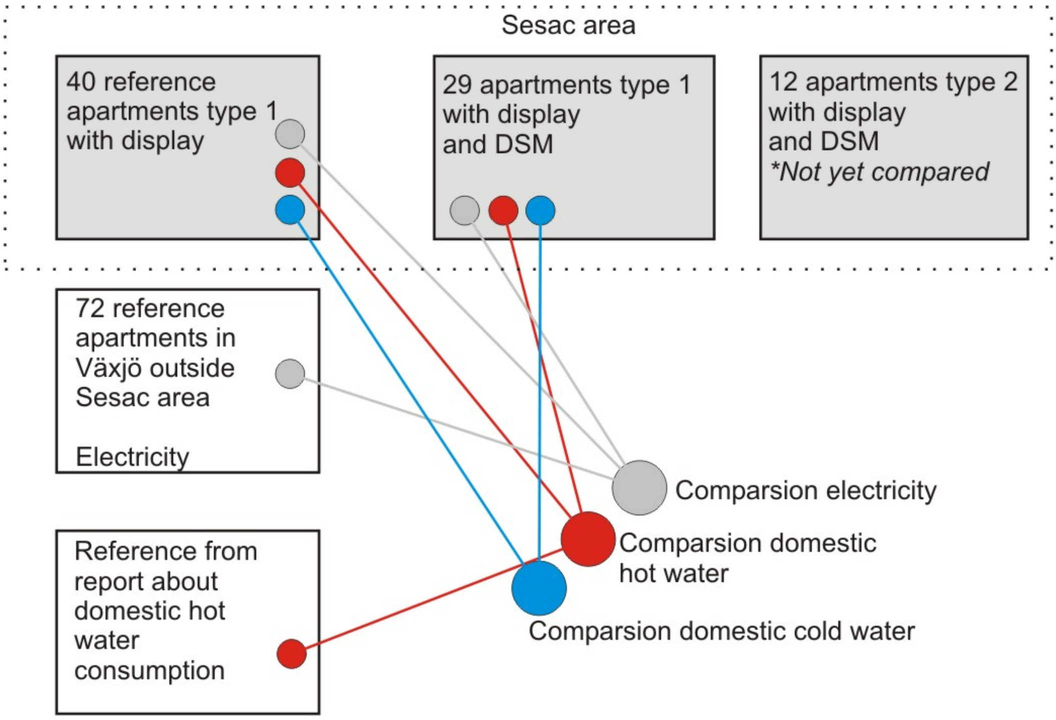



*Figure 3.1 shows how the comparison between different consumptions is made. The type 2 apartments have not yet been compared to other apartments due to the short period of measurement.*

**Reference apartments**
Reference apartments are divided into two groups. One group is for comparing electricity consumption and one is for comparing domestic hot water consumption. Two groups of reference apartments were required because there was a lack of apartments with measurements of both electricity and domestic hot water.

**Reference apartments - electricity**
This group of 72 apartments is situated in Växjö with a total area[2] of 5,704 $m^2$. On an individual level, this can be seen as an average apartment in Växjö. Tenants buy their electricity for their individual apartments from VEAB thus giving them a financial incentive to save energy. They pay a fee for a calculated consumption that is adjusted once a year. Heating and domestic hot water are included in their rent. The consumption of these apartments is representative as an average for Växjö.

**Reference apartments - domestic hot water**
In most apartments in Sweden tenants do not pay for their consumption of domestic hot water. Therefore, tenants lack financial incentive for saving energy. The apartments in this group come from the report [Teknikupphandling energieffektiva tappvarmvattenkranar;

[2] All area mentioned is BOA, the living area.

2001-02-07, LIP, Stockholm stad]. Because domestic hot water is not measured in apartments in Sweden knowledge of consumption patterns is lacking.

**Apartments with display**
These apartments are included in the Sesac area, but will until august 2007 serve as reference apartments for the area. A DSM method has not been applied to these tenants. There is a display mounted in each entryway and tenants pay for their consumption of domestic hot and cold water and electricity. The technical conditions of these apartments are explained in Appendix 2.

**Apartments with display and DSM**
These 29 apartments have all been included in the DSM method explained in chapter 2.3. The method used is under development and has not yet reached its theoretical maximum of saved energy. The different steps that the tenants have taken are explained below. The technical conditions of these apartments are explained in Appendix 2.

I. *Early information.* These apartments were specifically advertised as being housed in energy-efficient buildings for which the aim is to attain low tenant energy consumption. Prospective tenants were also informed that their individual usage would be measured and that they would be required to pay for electricity and domestic hot and cold water for their apartments.

II. *Early information of measurement system opportunities.* When tenants signed their contracts, they were again provided with information about the highly energy-efficient living of their building. They were also informed of the opportunities they have to affect their monthly energy consumption expenses.

III. *Easy task to illustrate possibilities.* When tenants moved in to their apartments they were given an easy task that aimed to create an interest in energy saving strategies. The display, equipped with an instruction sticker, was mounted in their entryway. Tenants were encouraged by the instructions to take a pleasant shower and then see the costs the shower incurred. The purpose was to create a better understanding of energy consumption and to spark a discussion about energy consumption among tenants.

IV. *Easy information*. After three weeks, tenants were given simple information about their individual measurement system. They were also told what type of information they should expect and reassured that they would receive help and guidance for feeling secure in their situation. For this purpose, they were provided with a phone number that they could call if they had any questions. The tenants also learned about the purpose of this system, namely that they as tenants are given the opportunity to influence their expenses.

V. *Informative leaflet.* After two months, a leaflet was distributed containing information about smart energy consumption. It also explained human behavior and how behavior influences energy consumption. Tenants were also informed that they could contact the housing company if they had any questions. Four brief and easily understood tips about energy savings were also included.

VI. *Survey.* After three months, tenants were asked their opinion regarding energy savings and about the display mounted in their apartments. The purpose of this survey was to better understand tenants' opinions regarding energy-saving strategies and the target group itself.

VII. *Results from survey 1.* The tenants received the survey results as well as their first measurement readings in leaflet form. This leaflet illustrated that tenants were generally positive to the measurement system and the display. It also showed that they contributed to 16% electricity savings as well as how these savings affected their monthly expenses.

VIII. *Results from survey 2.* The results from the first step of measurements were presented in a poster mounted in the entryway of the building. In addition to informing tenants, this poster served to inform visiting friends and family about the energy-efficient building. The intended purpose of the poster was to spark discussion and to get people more involved in energy issues.

IX. *Information regarding climate change and human behavior.* As the last applied step so far, tenants were informed about climate change and how they affect it, both as a causing factor and as part of the solution, see figure 3.2. The written information also illustrated how climate change is everyone's personal concern as well as how we were affected by storms Gudrun and Per. This leaflet was meant to bring the question of climate closer to home and to make tenants aware that they can contribute to solving our climate problems. On a more positive note, the leaflet included praise for the work done in Växjö regarding climate change and highlighted the fact that Växjö received the Sustainable Energy Europe Award.


*Figure 3.2 shows the leaflet sent out to tenants regarding climate change and human behaviour.*

X. *Text messages in display.* The display mounted in tenants' apartments can be used for communicating with the tenant via text messages with a maximum of 200 characters. After eight months, the display is now starting to be used for sending energy saving tips to tenants every Friday. Tenants were informed that they would receive these messages at the very start, with the understanding that their purpose is to reduce energy consumption.

The Sesac area tenants with displays and to whom DSM was applied have so far progressed to the fourth step of the theoretical model in figure 2.3.1. As even more steps are to be applied, an even higher energy-efficient living is expected to be attained in the coming steps. Before the summer, tenants will be made aware of how they can lower the temperature in their apartments by airing their apartments the right way, as well as by using less electricity. They will learn how they can feel if electrical equipment is using energy by feeling heat transfer from the equipment.

**Results and discussion**

The overall results show that energy consumption is lower in apartments that have taken part in the DSM method. The "reference apartments with display" consist of 40 apartments and the "apartments with display and DSM" of 29. These results were obtained solely from the type 1 building due to the short period of measurement from the type 2 building. In order to obtain more reliable results from type 1 buildings, measurements should proceed for longer. The comparison grid between the different types of apartments can be studied in figure 3.1. The measurement period for the apartments with displays is only ten months. This is because of the time plan for presentation in this Sesac project. Further results will be delivered later in this project.

**Electricity consumption**

So far the main aim has been to influence tenant attitudes regarding energy consumption. The results from their electricity consumption show the largest deviation from reference apartments. Tenants need more information about saving electricity in order to achieve an energy-efficient behavior. This may be due to that it is more difficult to learn about saving electricity than saving energy by cutting down on hot water usage. The overall electricity savings result between the "reference apartments with display" and the "apartments with display and DSM" is 13.6%. See figure 4.1.1 below for electricity consumption in "reference apartments with display" compared to "apartments with display and DSM". Also take into consideration that these are the results from a ten month period meaning that greater electricity savings can be expected by the end of the DSM method (see figure 2.3.1).

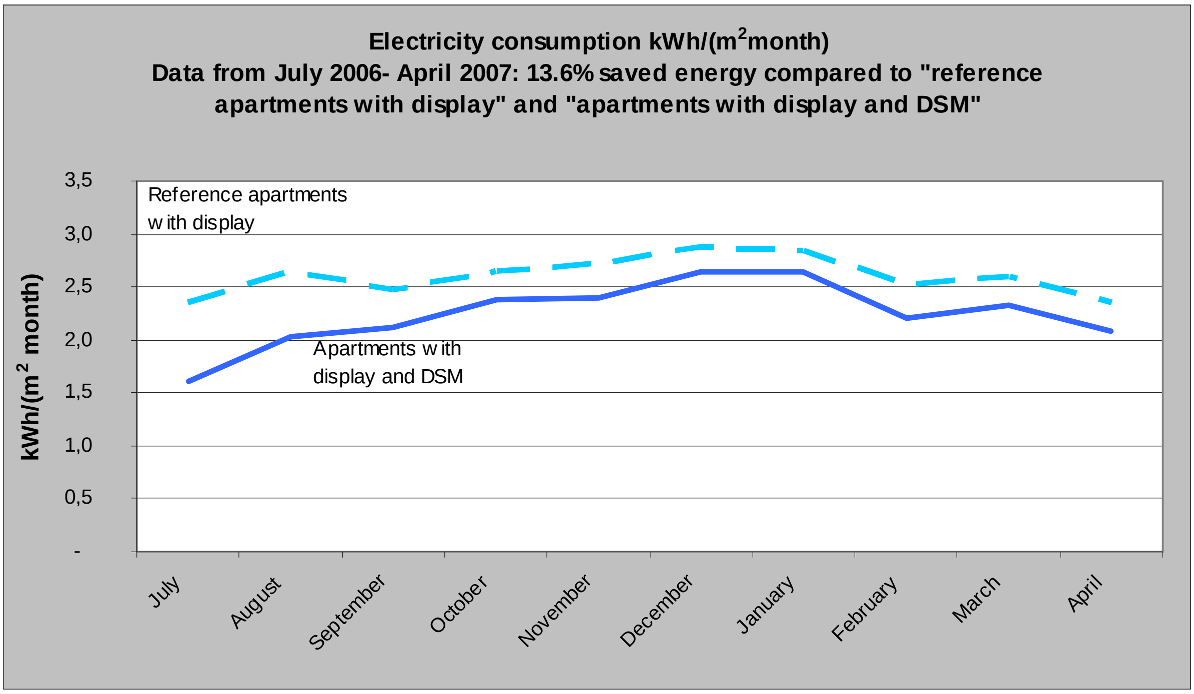



*Figure 4.1.1 shows the electricity consumption of DSM apartments and reference apartments. The DSM apartments show 13.6% lower consumption for the period of ten months than those that have not applied a DSM method.*

The measurements shown in figure 4.1.1 are the result of comparing apartments that all have a display. When compared to the electricity consumption of other apartments in Växjö, this gives a better understanding of the energy saving potential of using this DSM method. The results show a 34% savings of annual electricity when compared to reference apartments in Växjö.

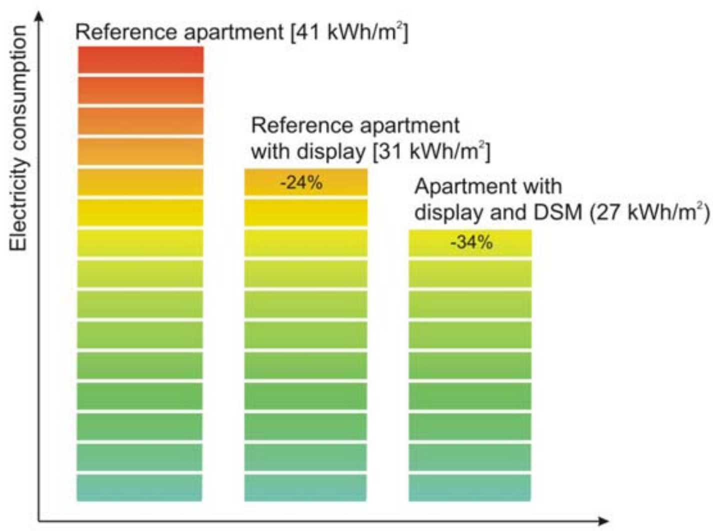


*Figure 4.1.2 shows the comparison of apartments in the Sesac area as well as apartments outside the Sesac area.*

**Domestic hot water consumption**

There is no reliable deviation of apartments where the DSM method was applied from apartments that have not been given any information. See figure 4.2.1 below. The correlation between consumption patterns and the visualization of energy is of great interest since tenants living in apartments with applied DSM have not shown more energy-efficient behavior than those in which DSM has not been applied. This illustrates that even those who not have been given any information show a high level of energy-efficient behavior when consuming domestic hot water. We can also deduce that the financial incentive is enough for creating efficient behavior. This can be contrasted to electricity consumption where people have achieved a more energy-efficient behavior. This supports the fact that people need more information in order to save electricity than to save energy from domestic hot water.

When comparing to other apartments, this can be explained when comparing domestic hot water consumption with other apartments outside the Sesac area [Teknikupphandling energieffektiva tappvarmvattenkranar; 2001-02-07, LIP, Stockholm stad], which shows a 43% energy savings due to domestic hot water. See figure 4.2.2. However, this must be studied further because the values for comparison are not yet reliable. These issues will be studied further later in this project.

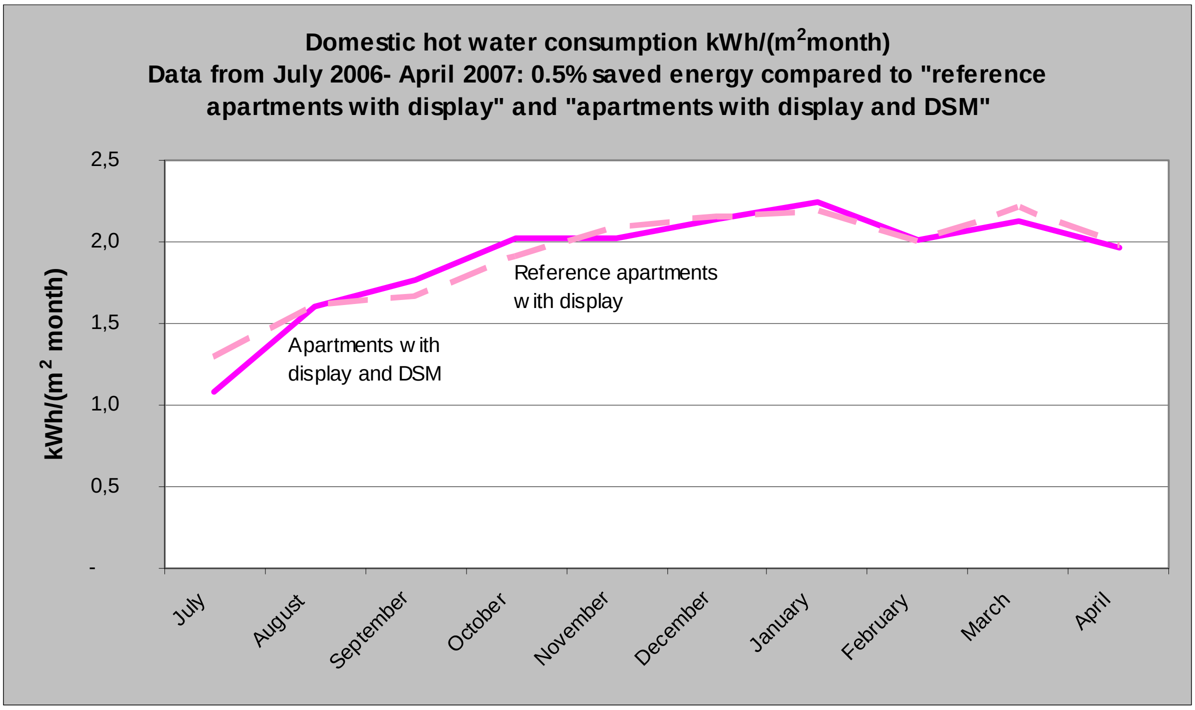



*Figure 4.2.1 shows how energy consumption due to domestic hot water varies over ten months. No deviations between DSM apartments and reference apartments can be seen in these measurements.*

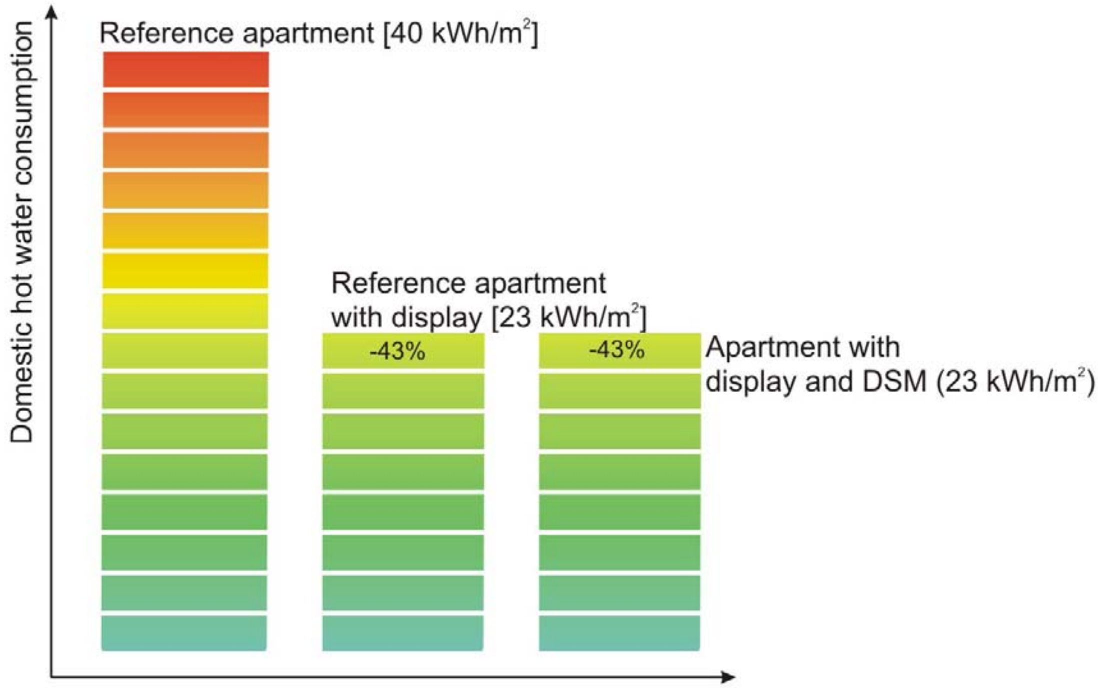



*Figure 4.2.2 shows the consumption of domestic hot water when comparing apartments with displays to apartments that do not have financial incentives to save energy.*

**Domestic cold water consumption**

The measured period shows higher consumption of domestic cold water in the apartments with displays and DSM. See figure 4.3.1 below. The consumption is 5.8% higher in these apartments if comparing to reference apartments with displays, which may be a result of higher tenant energy awareness. From this we can see that tenants use cold water instead of hot water, but we need to analyze this further. Se figure 4.2.3 for the comparison of hot and cold water.

When comparing results from domestic cold water consumption with those from hot water consumption we see that domestic cold water consumption is decreasing while hot water consumption is increasing. This may be explained by that tenants use more hot water than cold water when it is cold outside.

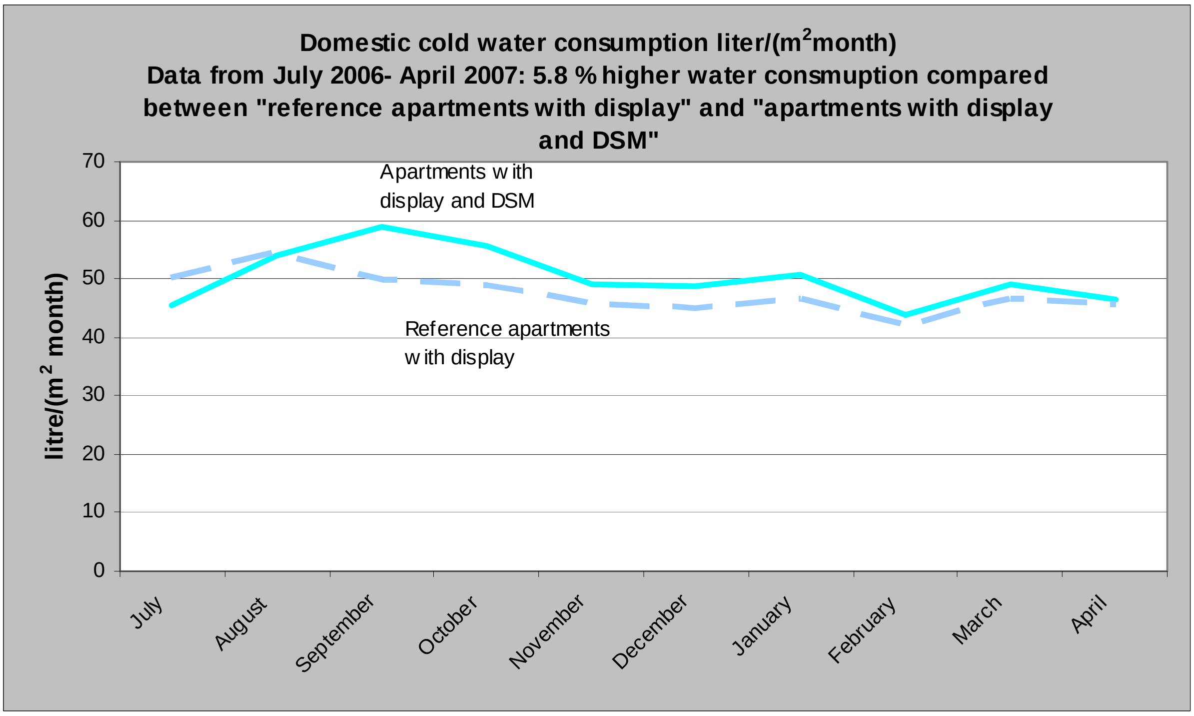



*Figure 4.3.1 shows the domestic cold water consumption in DSM apartments and reference apartments. It shows that reference apartments have a lower consumption than DSM apartments.*

**Heat consumption**
The method planned to be used for creating energy efficiency in the building's heating energy was the comfort measurement method. Comfort measurement measures the apartment's temperature. Tenants' payments are based on their monthly average temperature.

The comfort measurement system has proven to be unsuitable in this type of energy-efficient building. The method is not reliable when you build energy-efficient buildings with low energy consumption for heating. High insulation standards in a building prevent energy from passing from inside to outside. The number of people, the sun and appliances in the apartment also contribute to this effect. The heat in this case is not transported to the outside making the temperature inside the building increase. The tenant would have to pay for this increase in heat despite the fact that the supply from the heating system decreases. The possibilities of influencing the apartment's temperature proved to be insignificant. Tenants would get money back by leaving the window open, which not in par with energy efficiency.

The building's total heating energy consumption has been measured but due to the short measuring period, these measurements are not reliable. Currently, there is no financial incentive for tenants to lower their heating energy consumption. Nonetheless, the DSM method will be used for lowering heating energy consumption, which will be illustrated in results presented later in the project. In the Sesac project, a report regarding heating in these buildings has been written[3].

**Summarized results**
The summarized results present all results together with parameters such as the living area of each apartment. Figure 4.5.1 shows that reference apartments with DSM have decreased consumption in all parameters with the exception of cold water consumption. But it also shows that electricity has been compared for apartments of different sizes.

[3] Deliverable D16a. First technical and behavior-related RUE report.

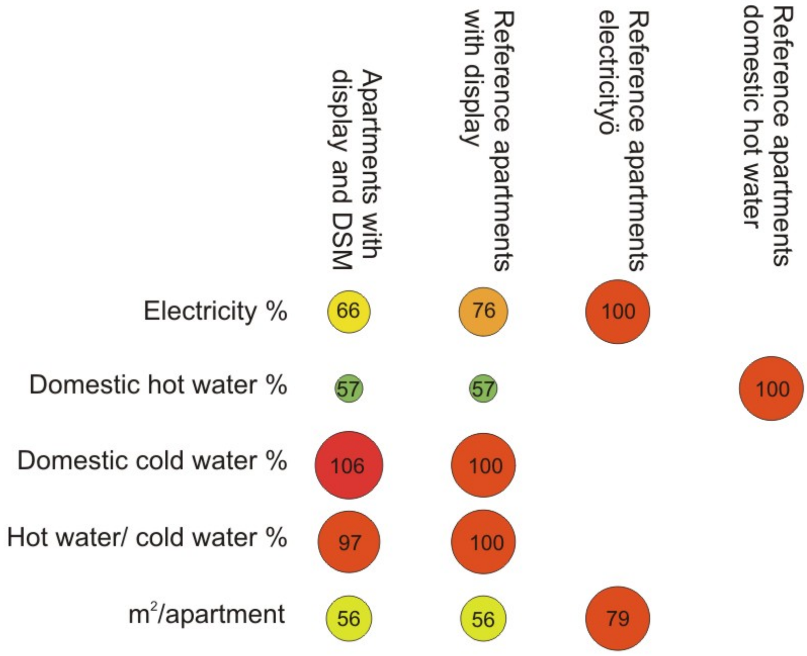
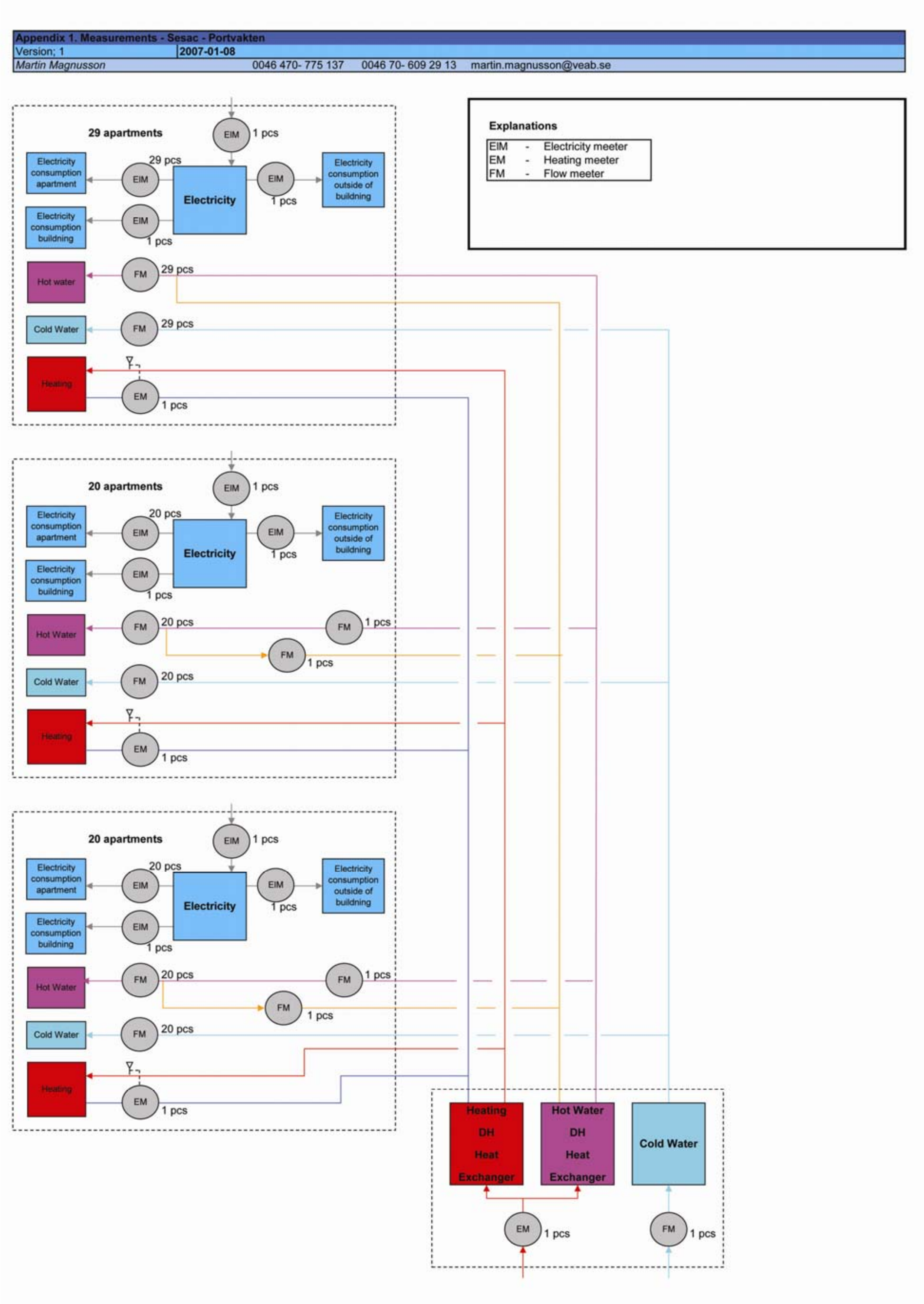



*Figure 4.5.1 shows the summarized results of all compared results. For further information read each specific chapter.*

**Conclusions**
“Apartments with display and DSM” has saved 34% of electricity when comparing to “reference apartments” outside the Sesac area in Växjö. No deviation has been shown in domestic hot water consumption when comparing “reference apartments with display” and “apartments with display and DSM”. But when comparing these to “reference apartments - hot water” outside the Sesac area, there are energy savings of 43%. This proves that it is enough in the short run to save energy by use of financial incentive, but whether this will be effective in the long run remains to be seen. Domestic cold water consumption has increased in the period of measurements. The comfort metering system is not suitable for buildings having high insulation standards such as those in the Sesac area.

## Appendix 1 – Measurement system – Type 1



## Appendix 2 – Technical conditions Type 1

### Reference apartments with display

- The mixer faucet in the sink is a Gustavsberg TT ***without*** an energy saving function.
- The shower is equipped with a Gustavsberg thermostat mixer.
- The towel drier is a Virab product and is connected to the domestic hot water circulation system.

### Apartments with display and DSM

- The mixer faucet in the sink is a Gustavsberg TT ***with*** an energy saving function.
- The shower is equipped with a Gustavsberg thermostat mixer.
- The towel drier is a Virab product and is connected to the domestic hot water circulation system.

### All type 1 apartments

- Display Metrima D80

## Appendix 3 – Measurement system – Type 2