NORDVÄRME Research Workshop

Helsinki, 16.4.2007

Presentations

NORDVÄRME
Research Workshop
16.4.2007, Finnish Energy Industries, Helsinki

Goal: **Get to know DH research activities in other Nordic countries, learn from others and discuss possibilities and means of cooperation**

Place: **Finnish Energy Industries, Fredrikinkatu 51-53 B, 5. floor (meeting room "Maestro")**

Sunday 15.4.

- 20.00 Dinner, Restaurant "Kappeli"

Monday 16.4.

- 08.30 Opening and orientation
- 08.45 How DH research and development is organized, financed and implemented in Nordic countries
  presentations DK, FI, I, N, S (á ~ 15 min.) + discussion
- 11.15 Lunch
- 12.30 Focus areas and a summary survey of recent research projects
  presentations DK, FI, I, N, S (á ~ 15 min.) + discussion
- 14.30 Status of IEA IA DHC, EHP RTD and Nordic Energy Research program
  presentations N.N, N.N and N.N (á ~ 10 min.) + discussion
  (speakers to be defined from among the participants)
- 15.00 Conclusions and cooperation possibilities, discussion
  All
- 15.45 Closure

Finnish Energy Industries

NORDVÄRME
Research Workshop
16.4.2007, Finnish Energy Industries, Helsinki

Guidelines for the presentations

8.45 How DH research and development is organized, financed and implemented in Nordic countries

presentations DK, FI, I, N, S (á ~ 15 min.) + discussion

- Give an overview on the organisation, financing and implementation of DH research in your country, what is the scale and status of DH research, DH associations role and future prospects. It is clear that the extent and length of presentation must be flexible in view of the varying state of DH research in different countries.

12.30 Focus areas and a summary survey of recent research projects

presentations DK, FI, I, N, S (á ~ 15 min.) + discussion

- Give an overview on priorities, research areas of interest and allocation of funds (problem oriented research/basic research/theses/…) and on ongoing and complete projects from the last years

14.30 Status of IEA IA DHC, EHP RTD and Nordic Energy Research program

presentations N.N, N.N and N.N (á ~ 10 min.) + discussion

(speakers to be defined from among the participants)

- Give an overview on purpose, organisation and activities. Discussion on interaction/cooperation possibilities

The meeting room is equipped with a beamer and a projector for slides and paper. Please email your presentation to veli-pekka.sirola@energia.fi or bring a memory stick with you.

Finnish Energy Industries

NORDVÄRME
Research Workshop
16.4.2007, Finnish Energy Industries, Helsinki

Practical information

Meeting place:	Finnish Energy Industries, Fredrikinkatu 51-53 B, 5. floor (meeting room "Maestro").
Hotel:	We have a special single room price 125 €/night (Friday to Sunday 94 €) at Palace Hotel Linna, Lönnrotinkatu 29 (for 13…17.4.). Please make your reservation with a code "Nordvärme" to sales@palacekamp.fi **by 16.3.2007.** Other hotels close to the meeting place are e.g. Radisson SAS Royal and Scandic Simonkenttä, for these make the reservation directly to the hotel.
Dinner 15.4.:	At 20.00 at restaurant "Kappeli" (10 minutes walk from hotel Lord). Meeting in the lobby of Palace Hotel Linna at 19.45).
Confirmation:	Please confirm your participation to kaarina.lipsanen@energia.fi **by 2.4.2007.** Please inform possible wish for a special diet.
Airport to hotel:	Finnair City Bus departs from the airport every 20 minutes between 06.20 and 00.40 and costs 5,20 €. Travel time is ~ 30 minutes. Airport bus end stop is ~ 10 minutes walk from the hotel. Taxi from the airport to the hotel costs ~ 35 €.
Links:	http://www.helsinki.fi/eng/index.html http://www.helsinki-vantaa.fi/home http://www.palacekamp.fi/etusivu.asp?lang=en&rest=hotelLinna http://www.energia.fi

Finnish Energy Industries

NORDVARME
Research Workshop

Mogens Christensen, Dansk Fjernvarme
Åge Kobberø, Dansk Fjernvarme

Research & Development organized, financed and implemented in Denmark

EFP:	Energy Research Programs
PSO:	Public Service Obligations
F&U konto:	Research & development account, Dansk Fjernvarme

EFP:

-Started in 1998

-Governor-contribution at approx. 10.000.000 Euro annual

-To be released by EUPD ? With a budget of approx. 27.000.000 Euro annual.

EFP 2007:

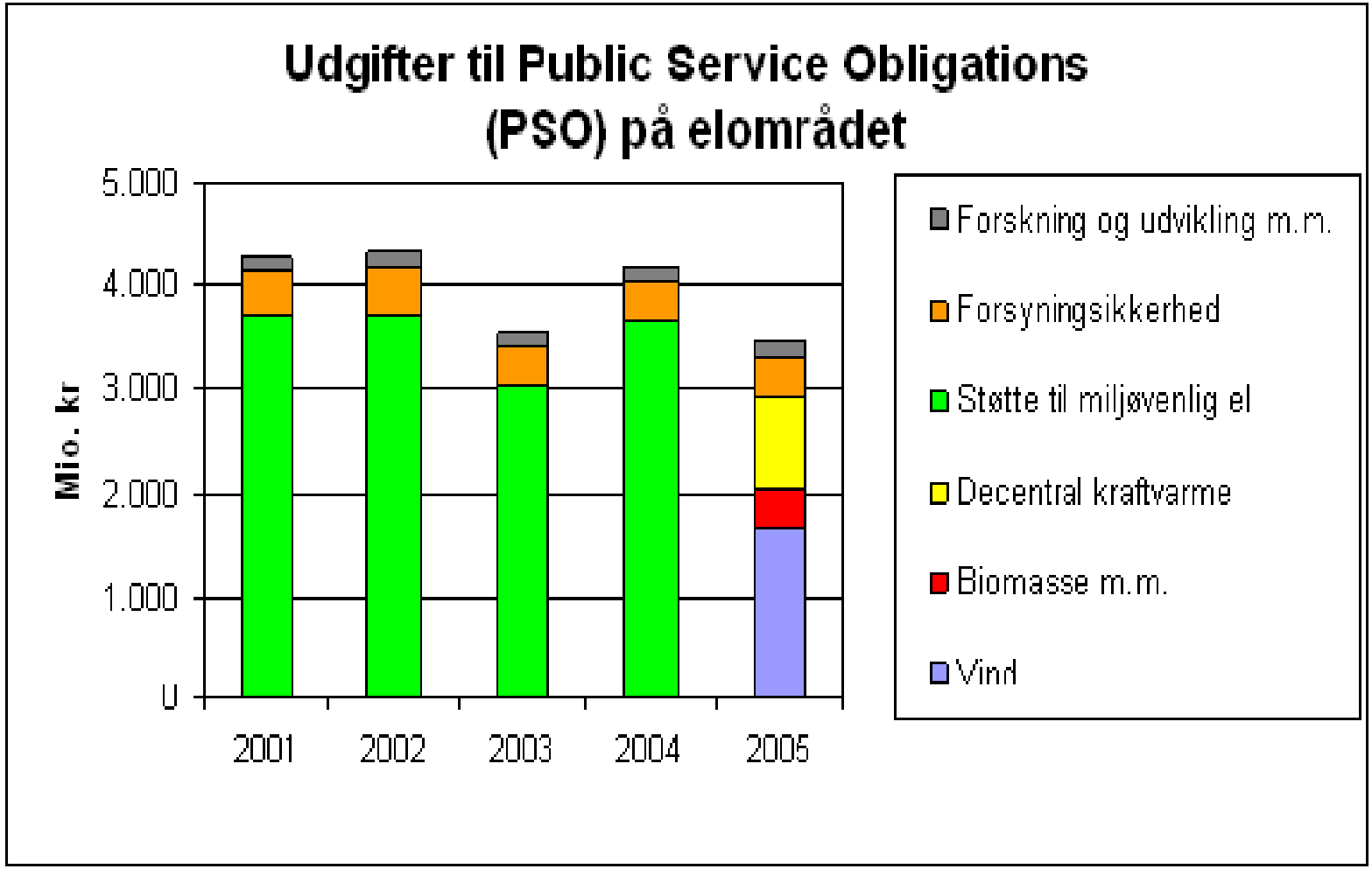
Hydrogen/fuelcells:	1.470.000 Euro
Biomass:	1.670.000 Euro
Sun energy:	500.000 Euro
Wind energy:	2.080.000 Euro
Technical analyses:	420.000 Euro
Efficient use of energy:	1.228.000 Euro
In total	7.368.000 Euro

PSO

-Started in 2001

-Consumer payment

-Annual payment of approx.:	467.000.000 Euro
-Environment friendly electricity production:	395.000.000 Euro
-Supply safety:	49.000.000 Euro
-Research and development:	23.000.000 Euro


Udgifter til Public Service Obligations (PSO) på elområdet
Mio. kr
5.000
4.000
3.000
2.000
1.000
0
2001
2002
2003
2004
2005
Forskning og udvikling m.m.
Forsyningsikkerhed
Støtte til miljøvenlig el
Decentral kraftvarme
Biomasse m.m.
Vind

F&U konto, Dansk Fjernvarme

-Started in 2001

-District heating-company contribution at approx. 110.000 Euro annual

-To support smaller projects of specific interest for district heating

1 **Current EFP project**
Development and demonstration of low temperature district heating for low energy buildings
EFP financing: 1845.000
Total financing: 2694.000

2 **Current EFP project**
Efficient district heating in the future energy system
EFP financing: 1891.000
Total financing: 3213.000

3 **Current EFP project**
Development intended for consecutive demonstration of combined heat and power production using wood pellet gasification in an open core gasifier (in relation to EU-concerto 2 - Green solar cities project)
EFP financing: 1622.000
Total financing: 2588.000

4 **Current EFP project**
Improved method to heat production by cooling, moisturizing and condensation of fluegas
EFP financing: 323.000
Total financing: 969.000

5 **Current EFP project**
District heating operated adsorption heat pumps with earth deposit for multistorey housing, office and institutional buildings - phase 1
EFP financing: 1229.000
Total financing: 1614.000

6 **Completed EFP project**
Optimised strawfired heating plant - OPTINOX
EFP financing: 328.000
Total financing: 3674.000

7 **Completed PSO project**
Optimum pump arrangement in supply network
PSO financing: 475.000
Total financing: 700.000

8 **Completed EFP project**
Biomass fuelled combined heat and power plant on Læsø, phase 2
EFP financing: 1004.000
Total financing: 1004.000

9 **Completed EFP project**
Development, production and demonstration of improved ARCON HT-SA solar collector
EFP financing: 2442.000
Total financing: 10992.000

10 **Current PSO project**
Upgrading and demonstration of the two-stage process
PSO financing: 6500.000
Total financing: 8404.000

11 **Completed EFP project**
Electrolysis for energy storage and grid balancing in West DK
EFP financing: 391.000
Total financing: 668.000

12 **Current EFP project**
Next generation strawfired boilers for district heating - improved combustion, reduced emissions and increased efficiency
EFP financing: 1410.000
Total financing: 2034.000

13 **Current EFP project**
LIFTOFF gasifier in Gjøl
EFP financing: 2178.000
Total financing: 6807.000

14 **Completed EFP project**
Combustion control through on-line monitoring of fuel moisture content
Duration: 200103-200402
EFP financing: 2059.000
Total financing: 2926.000

15 **Completed EFP project**
Simple models of district heating systems for load management and operational optimization
EFP financing: 1186.000
Total financing: 1994.000

16 **Completed EFP project**
Supply of district heating to areas with low heat demand
EFP financing: 1478.000
Total financing: 2311.000

17 **Completed EFP project**
Interaction between liberalised energy markets
EFP financing: 1782.000
Total financing: 2784.000

18 **Completed EFP project**
Elimination of sources causing biocorrosion
EFP financing: 1832.000
Total financing: 4195.000

19 **Completed EFP project**
Improvement of the energy demand model in the ADAM/EMMA
EFP financing: 1679.000
Total financing: 3358.000

20 **Completed EFP project**
Concepts for heating BR2005 buildings (phase 1 - pilotproject)
EFP financing: 400.000
Total financing: 731.000

21 **Completed EFP project**
District heating prices in a liberalised energy market - benchmarking the production of combined heat and power
EFP financing: 1193.000
Total financing: 2367.000

22 **Completed EFP project**
Denmark in an European gas market
EFP financing: 925.000
Total financing: 1501.000

23 **Completed EFP project**
Participation of Energy Centre Denmark in the EU Commission's OPET network
EFP financing: 490.000
Total financing: 2785.000

24 **Completed EFP project**
Development of methods for prevention and control of bio-corrosion
EFP financing: 2000.000
Total financing: 7059.000

25 **Completed EFP project**
Optimised district heating connection stations using a self-learning district heating meter - a pilot project
EFP financing: 1000.000
Total financing: 2222.000

26 **Completed EFP project**
Increased turbulence in heat exchangers for improved efficiency of electric power plants and combined heat and power plants
EFP financing: 538.000
Total financing: 896.000

27 **Completed EFP project**
Energy Center Denmark as member of the Organisations for the Promotion of Energy Technologies (OPET)
EFP financing: 191.000
Total financing: 1094.000

28 **Current EFP project**
Energy savings, industrial pumps
EFP financing: 6531.000
Total financing: 17187.000

29 **Completed EFP project**
Vacuum drying of sludge by use of district heating
EFP financing: 958.000
Total financing: 1235.000

30 **Completed EFP project**
The use of laser doppler velocimetry (LDV) to improve district heating measurement, metering and operation
EFP financing: 1000.000
Total financing: 3722.000

31 **Completed EFP project**
Waterdiffusion, effects on preinsulated plastics pipes. Part 2
EFP financing: 542.000
Total financing: 1084.000

32 **Completed EFP project**
Industry and energy conservation in East- and Central Europe
EFP financing: 508.000
Total financing: 1328.000

33 **Completed EFP project**
Danish participation in the IEA-agreement on process integration in industry
EFP financing: 401.000
Total financing: 473.000

34 **Completed EFP project**
The strength, imperviousness and service life of bonded jackets
EFP financing: 1515.000
Total financing: 3493.000

35 **Completed EFP project**
IT based optimization of district heating networks
EFP financing: 1350.000
Total financing: 3703.000

36 **Completed EFP project**
Using accelerated durability tests to investigate the long-term properties of district heating meters
EFP financing: 350.000
Total financing: 700.000

37 **Completed EFP project**
Barriers for energy savings in district heating areas
EFP financing: 1488.000
Total financing: 1843.000

38 **Completed EFP project**
Energy Centre Denmark as a participant in the 'Organisation for the Promotion of Energy Technologies' (OPET-Network)
EFP financing: 324.000
Total financing: 912.000

39 **Completed EFP project**
Determination of the thermal radiation and thermal conductivity of solid PUR in preinsulated pipes for district heating
EFP financing: 450.000
Total financing: 668.000

40 **Completed EFP project**
Energy savings, industrial pumps. Phase 1
EFP financing: 11750.000
Total financing: 11750.000

41 **Completed EFP project**
Calculation of gross energy consumption
EFP financing: 490.000
Total financing: 490.000

42 **Completed EFP project**
Small domestic boilers for oil firing with high efficiency. Phase 2
Duration: 199603-199712
EFP financing: 1100.000
Total financing: 2200.000

43 **Completed EFP project**
Development of an accelerated test method for prediction of long term behaviour of thermal conductivity for preinsulated district heating pipes
EFP financing: 392.000
Total financing: 731.000

44 **Completed EFP project**
Production and distribution of electricity and heating, district heating for cooling
EFP financing: 1800.000
Total financing: 2460.000

45 **Completed EFP project**
Equivalent models of District Heating (DH) systems for on-line minimization of operational costs of the complete DH system
EFP financing: 1128.000
Total financing: 2660.000

2007

Project no. 2007 – 01
Full scale demonstration of heat production from biomass using water injection as flue gas cooling

Project no. 2007 – 02
Stipulation of longtime insulation capacity of flexible pipes

Project no. 2007 – 03
Energy saving based on sun heat and reducing of water-back temperature

2006

Project no. 2006-01
Technical efficiencies of combined heat and power systems

Project no. 2006-02
The Use and evaluating of programs to optimize district heat pipe systems in smaller and middle size district heating.

Project no. 2006-03
Ultra low temperature district heating in new areas.

Project no. 2006-04
Society financial evaluation of district heating projects

Project no. 2006-05
Developing of test systems for measuring of flexible pipes insulations capacity

2005

Project no. 2005 - 01
Use of heat exchangers for hot water production

Project no. 2005 - 02
Developing of test program for welded and sealed coupling

Project no. 2005 - 03
Intelligent control of user installations combined with 2-vays communication with energy measuring.

Project no. 2005 - 04
Efficient trade with bio-fuels and analyse of bio-fuel supply

Project no. 2005 - 05
Optimizing of straw-fired district heat plants – condensing on straw fired boilers.

Project no. 2005 - 06
Tools for energy marking and evaluating of the efficient of user installations

DH research in Finland

Veli-Pekka Sirola, Energiateollisuus ry

Nordvärme research workshop, Helsinki 16.4.2007

DH research in Finland

- R&D in Finland ~ 6 billion € per year = ~ 3,5 % of GDP (much less if Nokia Oy is excluded)
- Public funding ~ 1,8 billion €
- Energy and environment research ~ 100 M€ (by a very rough estimation), of which public funding ~ 50 %
- DHC specific research ~ 1 M€ (rough estimation, less than 0,1 % of the branch turnover)
    - ET (Finnish Energy Industries) DH research ”program”, public and public funded research, participation in international cooperation projects, direct company projects…
- ET/DH administrates and coordinates DHC research and surveys funded by its member companies → DHC research ”programme”

DHC research ”programme”, general goals

- Improve the competitiveness of our member companies
- Support their business development
- Promote technological development in DHC industry
- Raise the level of knowledge of DHC in universities and research institutes and take care of the availability of researchers familiar with DHC
- Take part in international DHC research activities

DHC research ”programme”, organisation and implementation

- ET/DH administrates and coordinates
- A call for proposals is launched once a year
- Proposals can also be sent throughout the year
- No specific ”Research committee” to steer the programme
- The DH Board of ET makes the final decision on funding based on the pre-evaluation of the committees and ET/DH office personnel
- Proposals from total funding of small surveys and feasibility studies to partial funding of large projects or research programmes are possible

DHC research ”programme”, funding (1)

- ET funding of the programme is in average ~ 150 000 € per year
- This sum is collected from the member companies of ET/DH as an annual research fee
- The size of the research fee depends on the heat sales of the company
- The last two years only 50 % of the fee has been charged due to some external funding and lack of good proposals
- The programme as such gets no public funding, but individual projects can naturally seek additional funding from other sources

DHC research ”programme”, funding (2)

- 2006 the total ET funding of ongoing projects in the programme was ~ 120 000 €, 2007 it will be ~ 250 000 €
- Funding of these projects from other sources (mainly TEKES, Finnish Funding Agency for Technology and Innovation) was ~ 370 000 €
- Typically ET/DH funding is 10 000…40 000 € per project
- Participation in ”Environmental research pool of energy companies” with a total budget of 315 000 € per year (ET/DH: 35 000 €)
- Participation in IEA IA DHC with a total budget of ~ 250 000 € per year (ET/DH ~ 10 000 €, TEKES ~ 15 000 €)
- Both 2006 and 2007 about 15 proposals were received
- At the moment there are 13 ongoing or approved projects
- 2007 proposals are currently under evaluation

DHC research ”programme”, information and dissemination (1)

- Project reports will be published in pdf-format in the internet on the web site of ET
- From each project a separate 1…2-page summary introducing the key results will be produced and published on the web site of ET
- The project reports of the IEA DHC research programme are published for ET DH member in extranet
- The research reports of the environmental research pool having something to do with DH are distributed to ET DH members

DHC research ”programme”, information and dissemination (2)

- Research results will be dealt with in different seminars and theme days
- Key results will be handled by different ET committees and working groups and included in the various DH branch recommendations of ET
- Knowledge transfer in expert steering groups (not nominated for all projects)

DHC research ”programme”, focus

- Focus on applied, problem oriented research for the benefit of our member DH companies in short term (0…5 years)
- The goal is to improve cost efficiency in building, operating and maintaining DHC systems
- No limits are set with respect to subject areas (other than DHC), but certain main areas of interest are mentioned in call for proposals

DHC research ”programme”, areas of interest

Main areas of interest (1)

- application and exploitation of data transmission and remote reading in system management and services
- asset and lifetime management of DHC systems and its components, optimisation of life cycle costs and increasing the return on capital
- effects of changing operational environment, e.g. development and competition of heating modes, decreasing consumption, pricing methods, environmental goals and requirements, crisis management
- increasing the use of waste heat and other low value heat in DHC

DHC research ”programme”, areas of interest

Main areas of interest (2)

- development of pipe laying methods in order to speed up the construction and renovation projects, especially minimizing the time that the trench is open
- increasing the quality of network construction, from design to supervision (e.g. development of processes, installation methods, jointing methods, procedures and standard of supervision
- new business models, e.g. subscriber-service producer models, procurement models
- application of optimisation, simulation and modelling research results in DHC systems

ET / DH research ”programme”, projects 2005 -2007

Completed (1)

- Combined Heat and Power Production from the "Law and Economics" Aspect, University of Joensuu
- Optimal Design & Rehabilitation Model for District Heating and Combined and Heat and Power Systems in Transition Economies, Helsinki University of Technology
- Small CHP Plants and District Heating, Helsinki University of Technology and VTT
- Remote reading systems for heat meters – a market study, Enease Oy

ET / DH research ”programme”, projects 2005 -2007

Completed (2)

- Model document for explosion protection plan regarding ATEX directive, Empower Oy
- Evaluation of NDT–methods for status control of DH medium pipes - a feasibility study, VTT
- Evaluation of inspection and calibration devices of heat meters, Mikkeli Polytechnic
- Fall back approach using energy balance calculation for specifying fuel energy in order to define and monitor CO2 emissions, Pöyry Energy Oy

ET / DH research ”programme”, projects 2005 -2007

Ongoing / approved (1)

- DH in development – Application potential of international DHC research results from recent years in Finland, Mikkeli Polytechnic
- Hybrid heating - Economy of mixed (DH and electric heating) heating solutions from both national, company and customer point of view, Mikkeli Polytechnic
- CHP solid fluidised bed gasification and waste incineration in grade furnace, Pori Polytechnic
- Optimisation industrial cooling systems in combined energy production - Trigeneration, Helsinki University of Technology

ET / DH research ”programme”, projects 2005 -2007

Ongoing / approved (2)

- Classification of substations – a feasibility study for energy labelling, VTT
- Possibilities to cut down overdimensioning – revision of design instructions of substations, Helsinki University of Technology
- New technologies in DH medium pipe reparation, Helsinki University of Technology
- The potential of CHP and the market of DHC until 2050, Gaia Consulting Oy

ET / DH research ”programme”, projects 2005 -2007

Under evaluation (1)

- Influence of differentiating DH into a subsidiary on pricing
- Market study of a modern wireless leak control system for old ventilated DH pipes
- Optimisation of insulation thicnesses in preinsulated pipes
- Study on cell gas contents and rest shear strength in old preinsulated pipes
- Review of principles for dimensioning of reserve load capacity
- Exploiting remote reading in maintenance of heat meters and keeping up the measuring accuracy
- Evaluation of CO2 as cooling media in DC

ET / DH research ”programme”, projects 2005 -2007

Under evaluation (2)

- Optimisation of the life cycle costs of DH networks
- Calculation of life cycle cost of a DH network
- Serious damages and disturbances – study on risks and influences on DH deliveries
- Market study on IT services for DHC companies
- Calculation tool for converting a small house to DH
- Business models and service concepts for small house customers
- Classification of substations – a pilot project / measurement of products on the market

ET / DH research ”programme”, projects 2005 -2007

Partnerships

- Environmental research pool of energy companies. 10…20 ongoing projects, of which ~ half relate also to DHC, mostly production
- IEA IA on District Heating and Cooling, annex VIII 2005–08 (most probably also annex IX 2008-2011)
- Euroheat & Power WG RTD

NORDVARME

is-1

DH Research Workshop

ICELAND

Main field is geothermal exploration and testing

In DH is little basic research.

There is a scientific research fund in Iceland, but no interest (or capacity) in institutions in basic research in DH.

DH companies fund problem/development oriented research projects.

Universities and technological institutions execute the research.

Samorka has directed research projects.

E.g. Samorka organised collection of data on chemistry of geothermal water in different DH systems. Also corrosion and scaling tests. Later the information was made available on the web with recommendations on suitable materials. A designer of a heating system in a house to be connected to a DH system can look (Lagnaval.is) for suitable and not suitable materials to be used or not used in the system. The pH of both geothermal and ground water is usually between 8 and 9.

We expect increase in research funding. OR has established a fund with 100 MISK per year for 3 years for research projects with priority in environmental issues.

is-2

Nordvärme 2007 Helsinki

DH Research in Iceland

Main DH Utilities

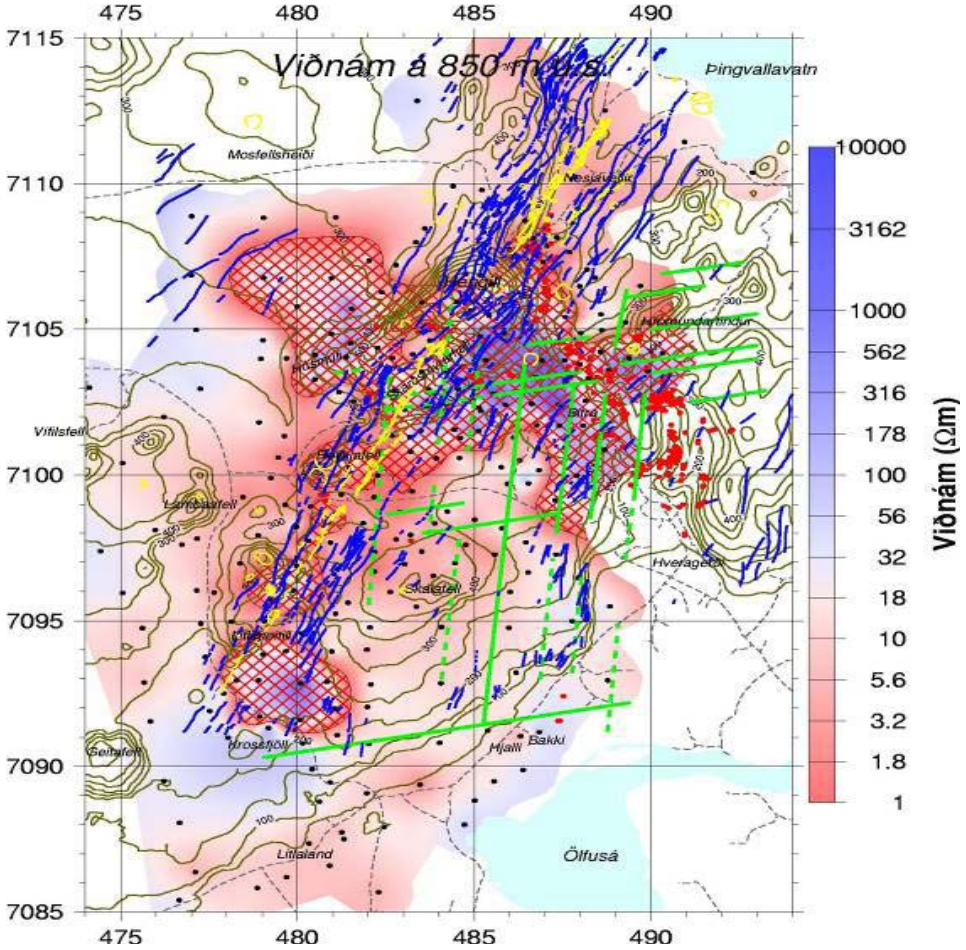
- Orkuveita Reykjavíkur
- Hitaveita Suðurnesja
- Norðurorka
- Orkuveita Húsavíkur

RESEARCH COST

- **Orkuveita Reykjavíkur**
  - 2006: **286 MISK**
  - 2005: **287 MISK**
  - 2004: **169 MISK**
- **Hitaveita Suðurnesja**
  - 2006: **437 MISK**
  - 2005: **69 MISK**
  - 2004: **73 MISK**
- **Norðurorka**
  - Some **10 MISK** per year
- **Others**
  - Some **10 MISK** per year

Resistivity at 850 mbsl

Hátt viðnám neðan lágviðnáms(bendir til háhitaummyndunar) er sýnt með rauðri skástrikun. Mælingar gefa til kynna öflugt háhtakerfi þar sem engin ummerki sjást á yfirborði.



REVISED GEOTHERMAL MODEL

Revised model shows that the extension of the geothermal field is larger at depth than seen on surface.

The proven resource have increased in size.

Field scale CO_2 injection experiment

A field scale CO_2 injection experiment will be performed to demonstrate the ability to store CO_2 in basaltic rocks near the Hellisheidi Power Plant. The site comprises ideal conditions for studying the feasibility of permanent CO_2 storage as **calcium carbonate minerals** in basaltic rocks

Plastic Pipes in Geothermal Water

- Influence of Sulphur content in water on pipes.
- Influence of continiuous through flow of >80°C geothermal water.

- No reduction in life of pipes

Corrosion of Copper and Copper Alloys in Geothermal DH Water Containing Sulphide (Ph.d.)

- Copper corrodes in geothermal DH water
- Explain different corrosion rates

- Presence of sulphide does not result in high corrosion rate, presence of dissolved oxygen accelerate corrosion.

n-1

Research Workshop on DH&C

Helsinki

April 16, 2007

Organizing of DH&C Research in Norway

Av

Rolf Ulseth
Energy and Process Engineering / Energy Processes
NTNU / SINTEF

- You can hardly say that there exists any organized DH&C Research in Norway
- A strategic initiative was taken from the Norwegian Research Council (NRC) about 1982 when a lump sum of money was given to the research environment at SINTEF/NTNU to make some strategic decisions on the matter. The main decision then was that Norway should join the IEA-District Heating Project.
- SINTEF/NTNU has been actively involved in the DH-research in Nordic Energy Research since the start in 1986.

- The "only" research activities on DH&C in Norway today might be possible application and possible successful selection for funding from the Norwegian Research Council (NRC). One can apply for funding subsidy for development projects or activities "on the border" of research from the governmental agency Enova.

- NRC has granted some so called "Competence development projects with user co-operation" in the latest years containing some elements of DH&C-research.

- Norsk Fjernvarme (NF) (Norwegian DH Association) is from time to time performing "studies" on relevant "problems" on DH in Norway which hardly can be called DH-research.

- NF is a member of Svensk Fjärrvärme and follows continuously the research activity performed by the association.
  NF might also to some extent be directly involved in the research project e.g. Mathilda-project.

Quite a few master thesis are performed throughout the years at NTNU

Examples from latest years:

- Analysis of system efficiency by different performance of district heating
- Analysis on the consequences on district heating in areas with various heat load
- Analysis on the consequences by choosing different dimensioning criteria by building district heating and block heating systems
- Analysis on socio-economics by building parallel infrastructure for electricity and district heating in development areas with "low energy buildings"
- Analyses on socio- and private economics by building parallel infrastructures for electricity and district heating in development areas

n-2

Research Workshop on DH&C

Helsinki

April 16, 2007

DH&C Research in Norway

Av

Rolf Ulseth
Energy and Process Engineering / Energy Processes
NTNU / SINTEF

Load Modelling in Mixed Energy Distribution Systems

PhD-thesis
Linda Pedersen
(Dissertation May 16, 2007)

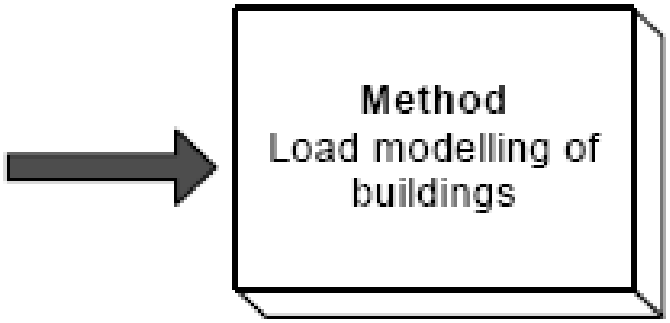
Specific contributions from this thesis

- A new method has been developed to estimate heat and electricity load profiles for various buildings based on the building's hourly simultaneous district heat and electricity measurements.
- A new procedure has been developed to find the change-point temperature for dividing temperature-dependent and temperature-independent heat consumption, i.e. space heating, ventilation heating and hot tap water.

A simplification of the behaviour information model

Input

Measured data
Climate
Type of building
Age of building
Building code
Area
Ventilation regime
Energy carriers

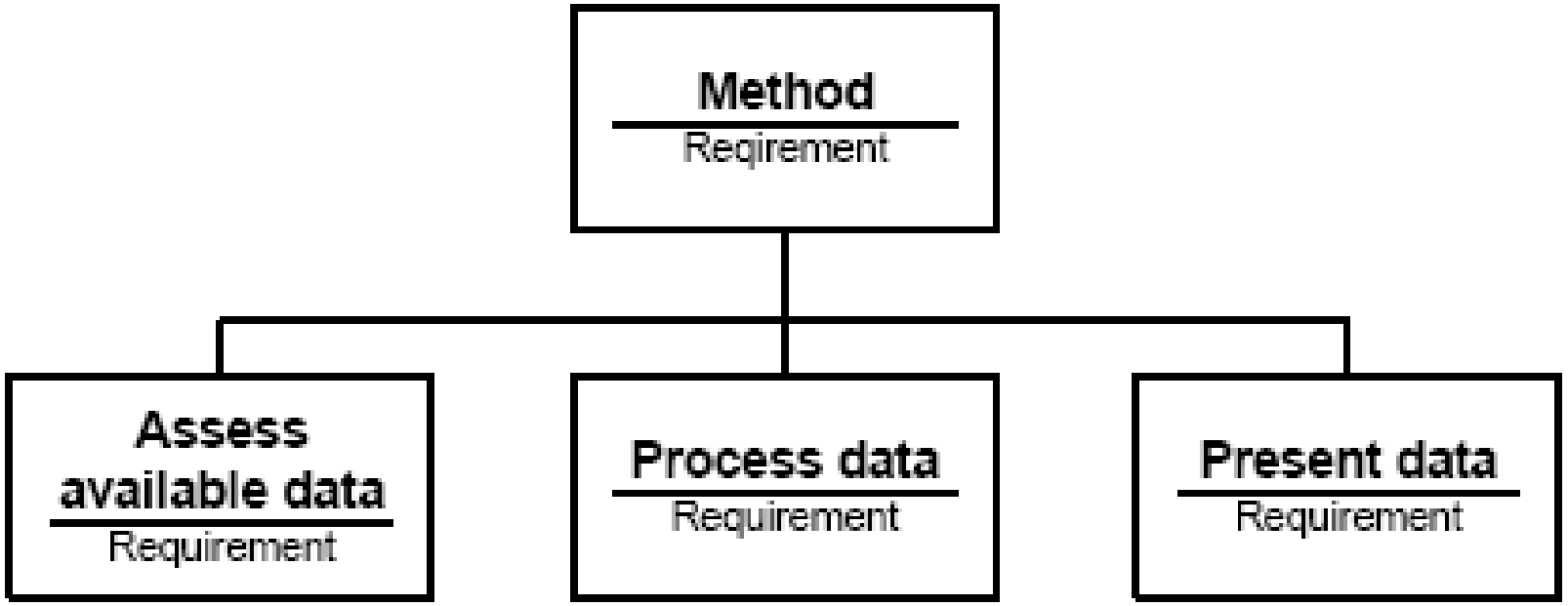


Output

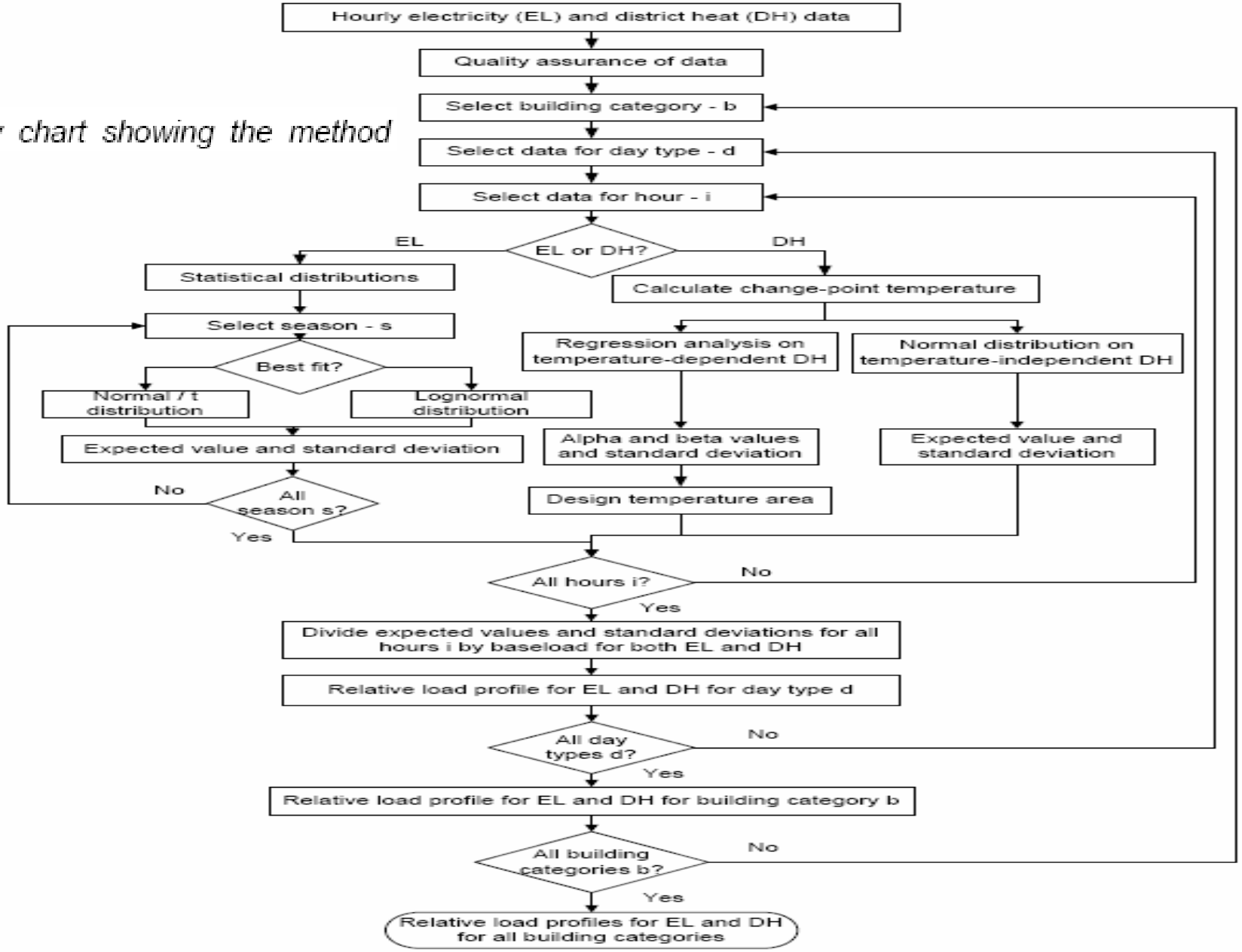
Load profiles divided on electricity and heat load demand for each building category.

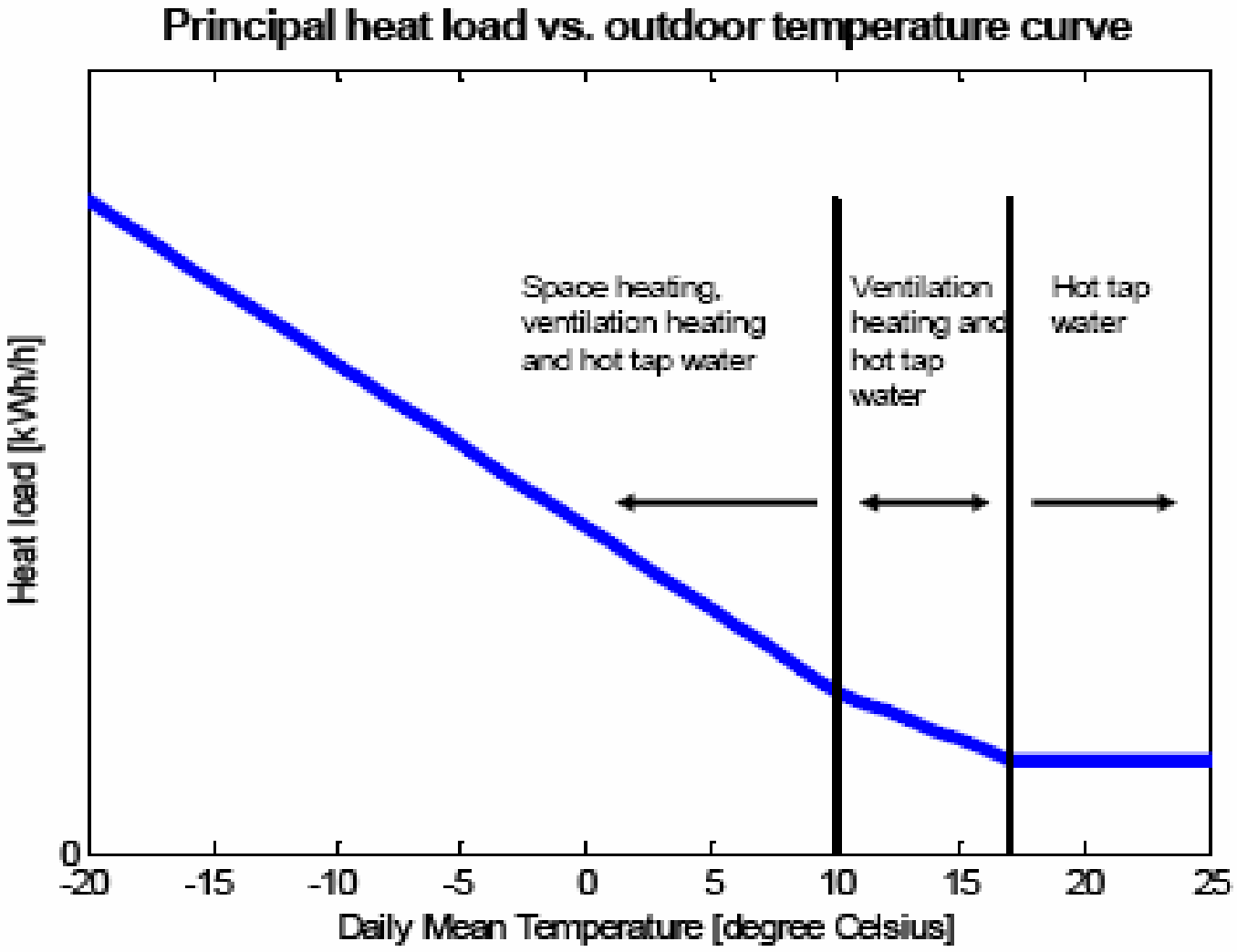
Load profiles for heat and electricity aggregated to limited areas including coincidence factor.

The main requirement for load modelling



Flow chart showing the method





Load-temperature curve for hourly heat consumption for a building

Linear equation for every hour of the day

$$\Phi_{HL} = \mathbf{A} + \mathbf{B} \cdot \theta_{dmt}$$

two vectors, **A** and **B**, of length 24

$$\mathbf{A} = [\alpha_1\ \alpha_2\ \alpha_3\ \ldots\ \alpha_{23}\ \alpha_{24}]$$

$$\mathbf{B} = [\beta_1\ \beta_2\ \beta_3\ \ldots\ \beta_{23}\ \beta_{24}]$$

Building category	α	β
Single family Houses of different types	α_{SH}	β_{SH}
Apartment Blocks	α_{AB}	β_{AB}
Office Buildings	α_{OB}	β_{OB}
Educational Buildings	α_{EB}	β_{EB}
Hospital Buildings	α_{HB}	β_{HB}
Hotels and Restaurants	α_{HR}	β_{HR}
Sports Facilities	α_{SF}	β_{SF}
Wholesale and Retail trade services buildings	α_{WR}	β_{WR}
Other types of energy-consuming buildings		

a) Single family houses of different types

b) Apartment blocks

c) Offices

d) Educational buildings

e) Hospitals

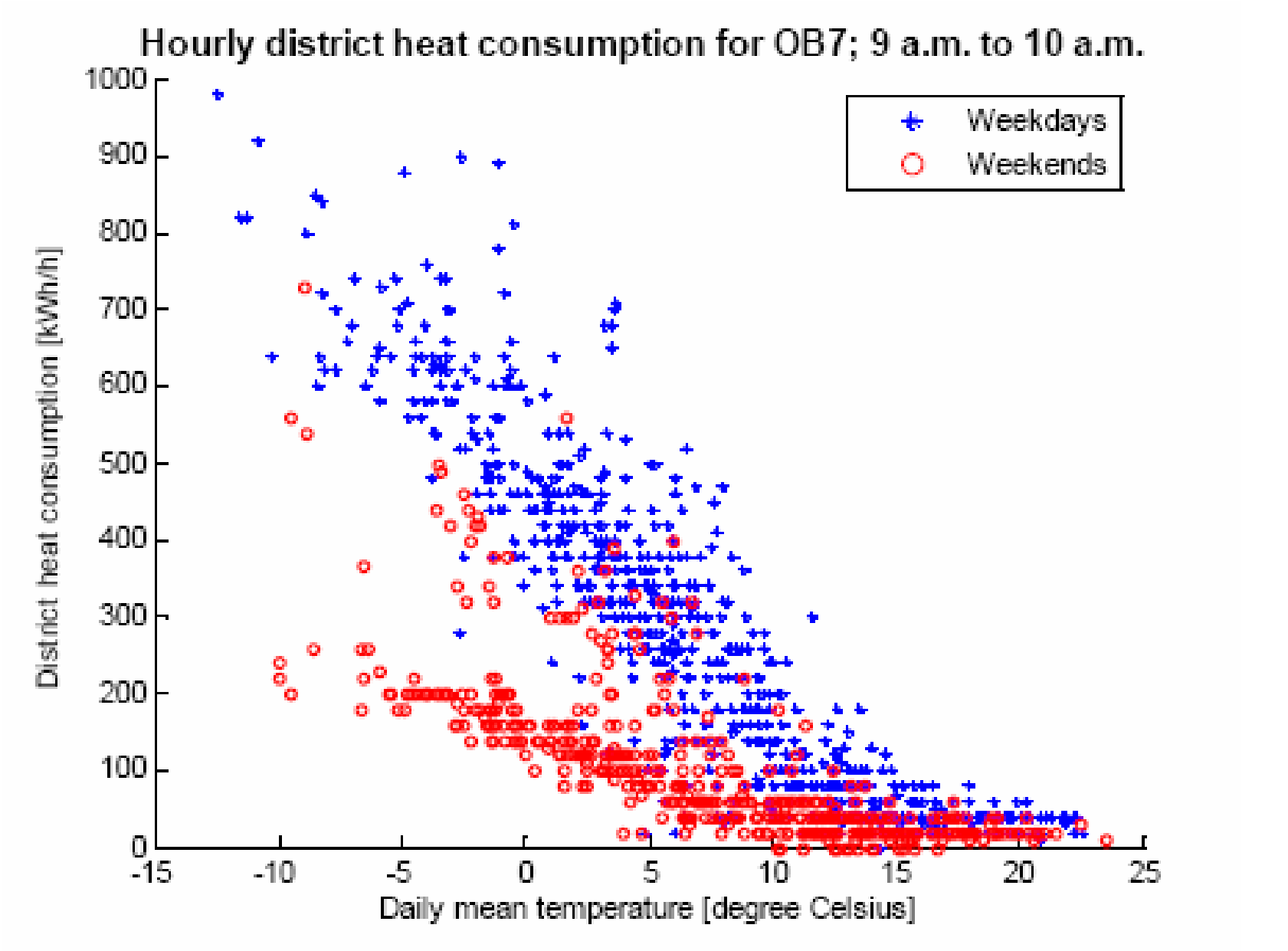
f) Hotels and restaurants

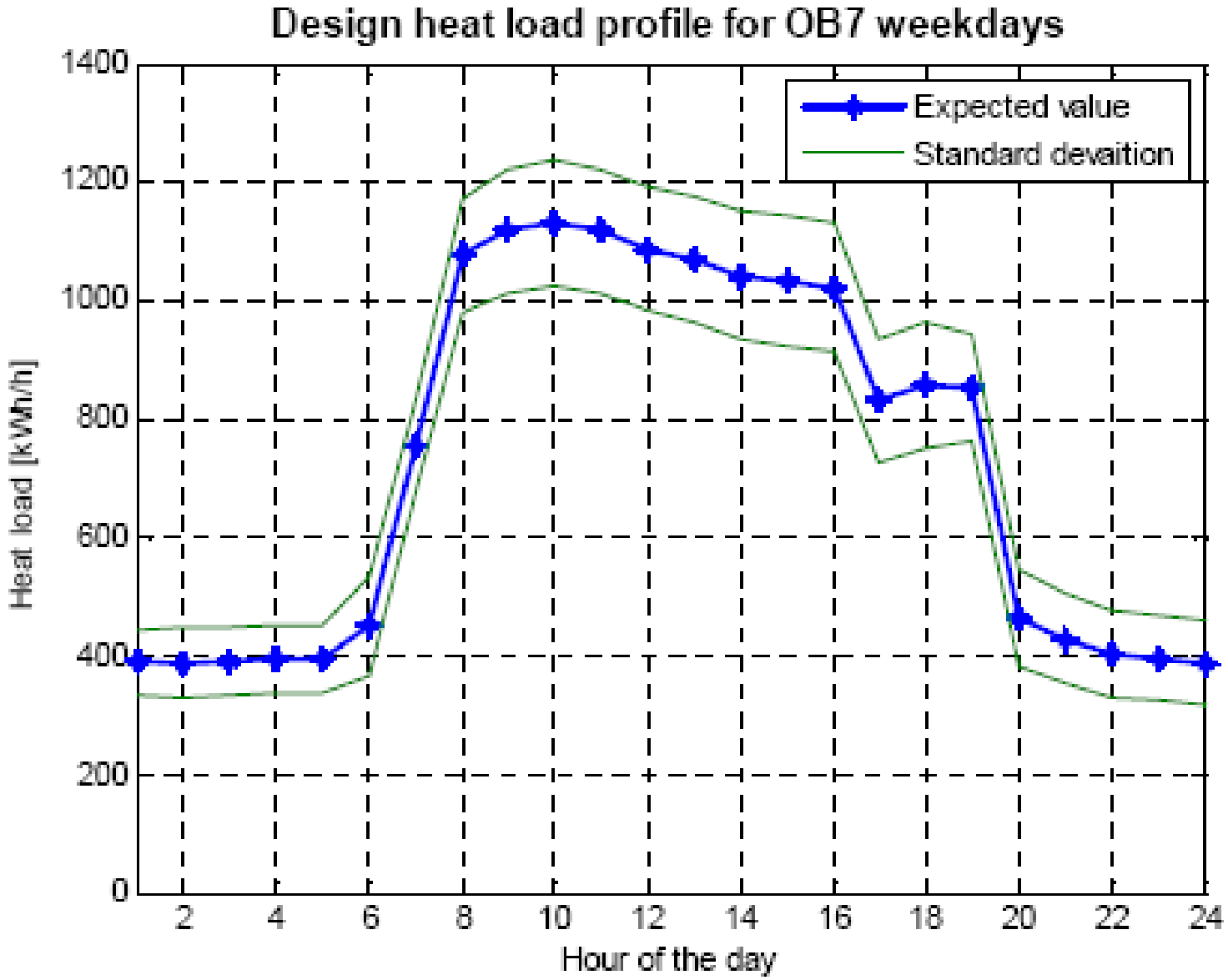
g) Sports facilities

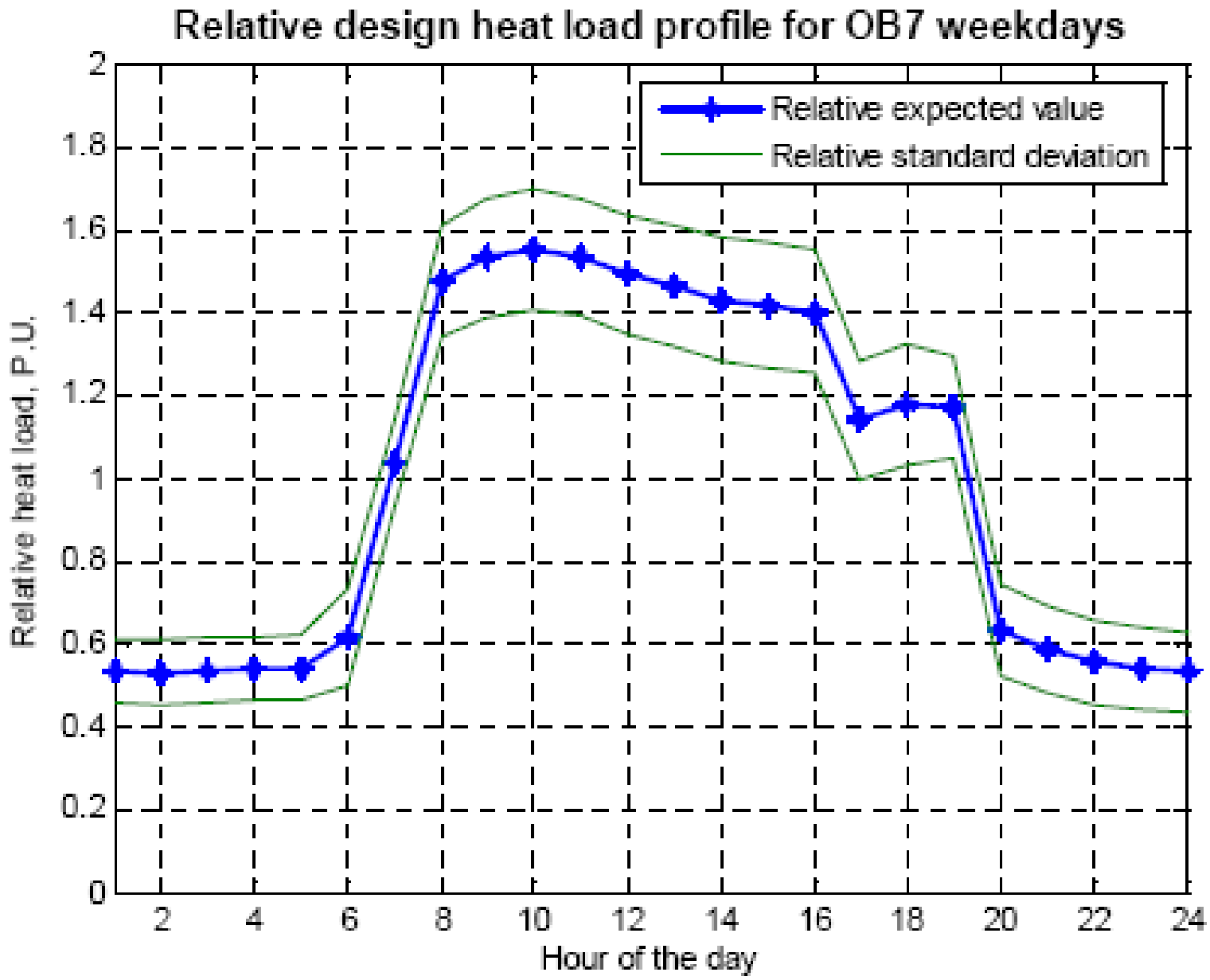
h) Wholesale and retail trade services buildings

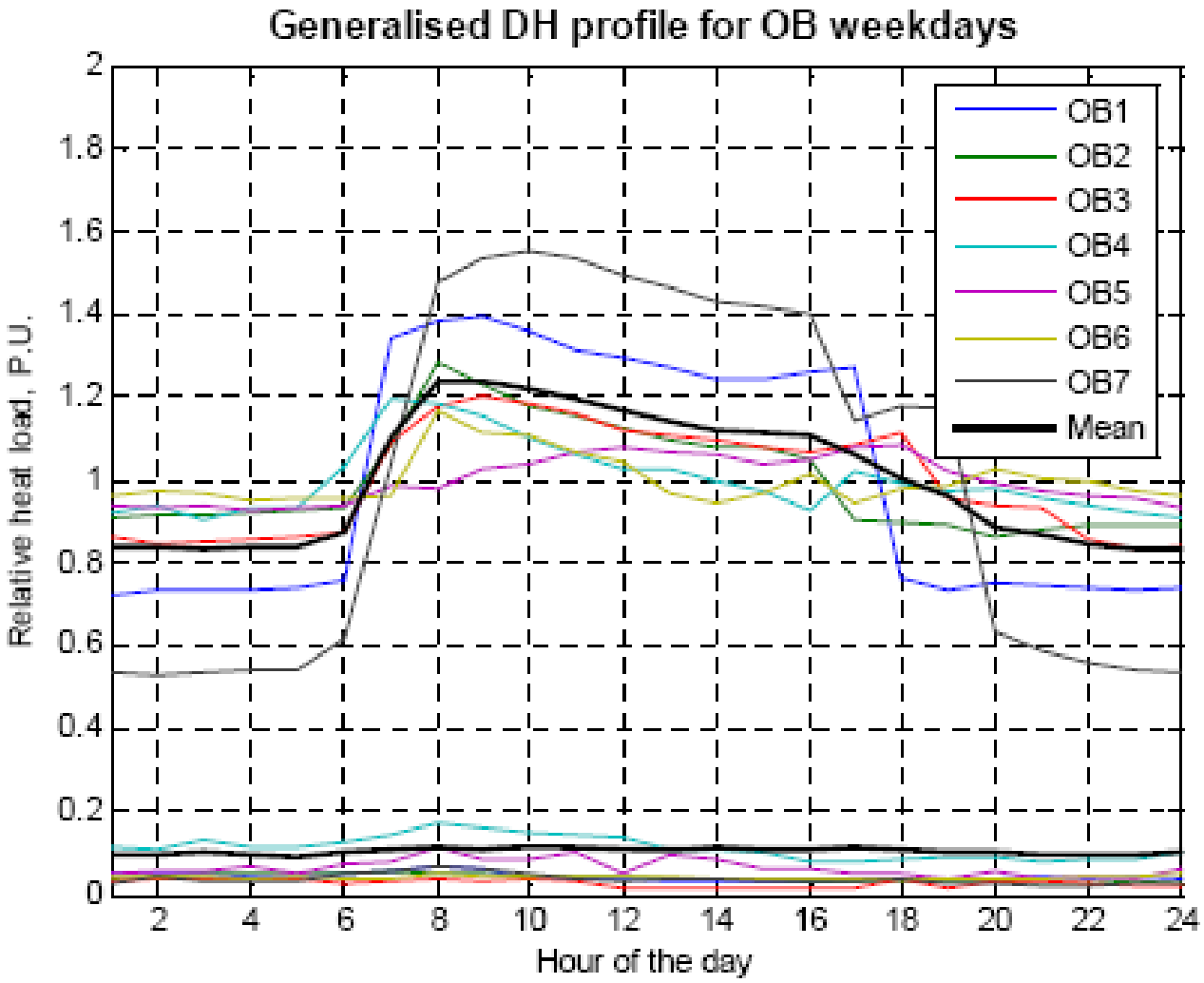
i) Other types of energy-consuming buildings

Buildings from categories a) through f) have been analysed

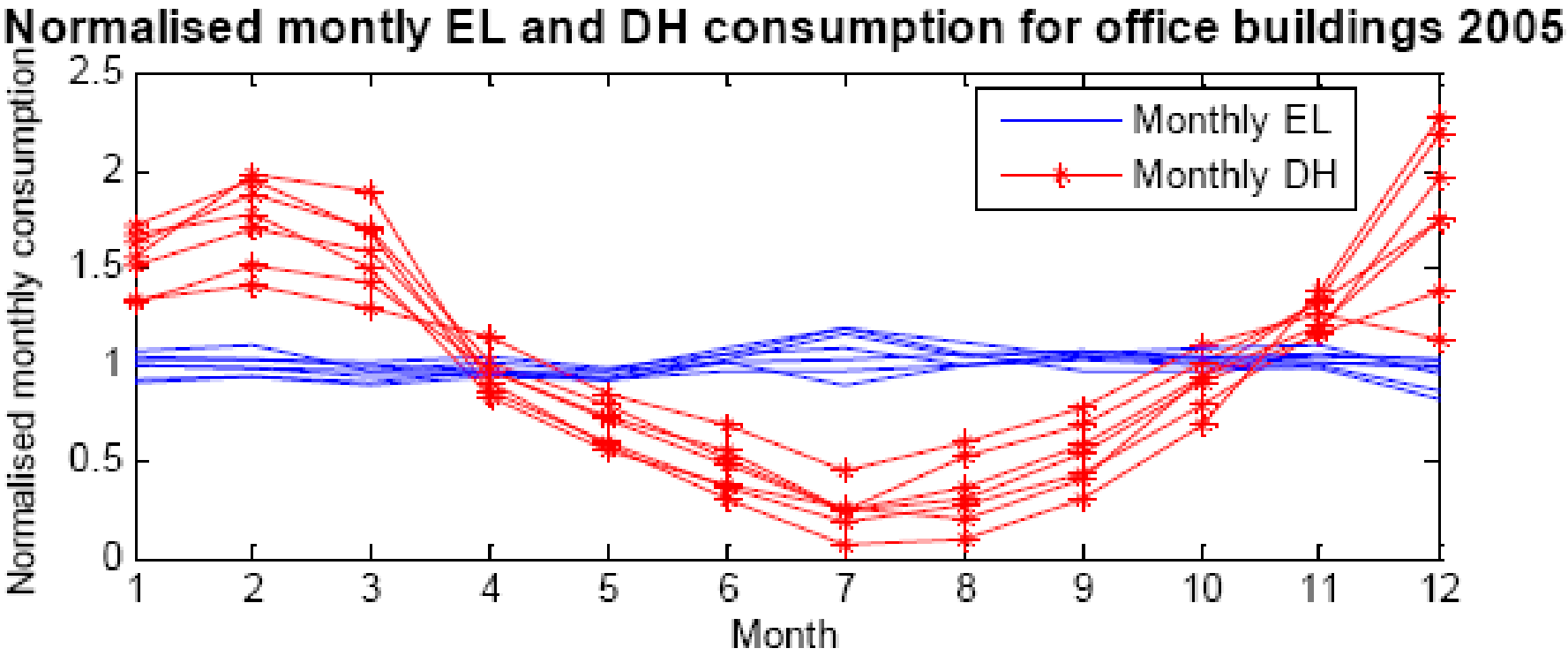

Hourly district heat consumption for OB7; 9 a.m. to 10 a.m.
Weekdays
Weekends
District heat consumption [kWh/h]
Daily mean temperature [degree Celsius]
1000
900
800
700
600
500
400
300
200
100
0
-15
-10
-5
0
5
10
15
20
25


Design heat load profile for OB7 weekdays
Expected value
Standard devaition
Heat load [kWh/h]
Hour of the day
0
200
400
600
800
1000
1200
1400
2
4
6
8
10
12
14
16
18
20
22
24


Relative design heat load profile for OB7 weekdays
Relative expected value
Relative standard deviation
Relative heat load, P.U.
Hour of the day
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2
4
6
8
10
12
14
16
18
20
22
24



Relative design heat load profiles for office buildings, including the generalised heat load profile and relative standard deviation.


Normalised montly EL and DH consumption for office buildings 2005
Normalised monthly consumption
Month
Monthly EL
Monthly DH
0
0.5
1
1.5
2
2.5
1
2
3
4
5
6
7
8
9
10
11
12

Building category	DH coincidence factor	EL coincidence factor
Office building (OB)	0.836	0.811
Hospital building (HB)	0.945	0.763
Hotel and restaurants (HR)	0.867	0.969
Educational buildings - AT1	0.768	0.649
Educational buildings - AT2	0.816	
Single family houses and apartment blocks	0.264[1]	0.387
Clusters (ap. 10 buildings) single family houses and apartment blocks	0.711	0.844

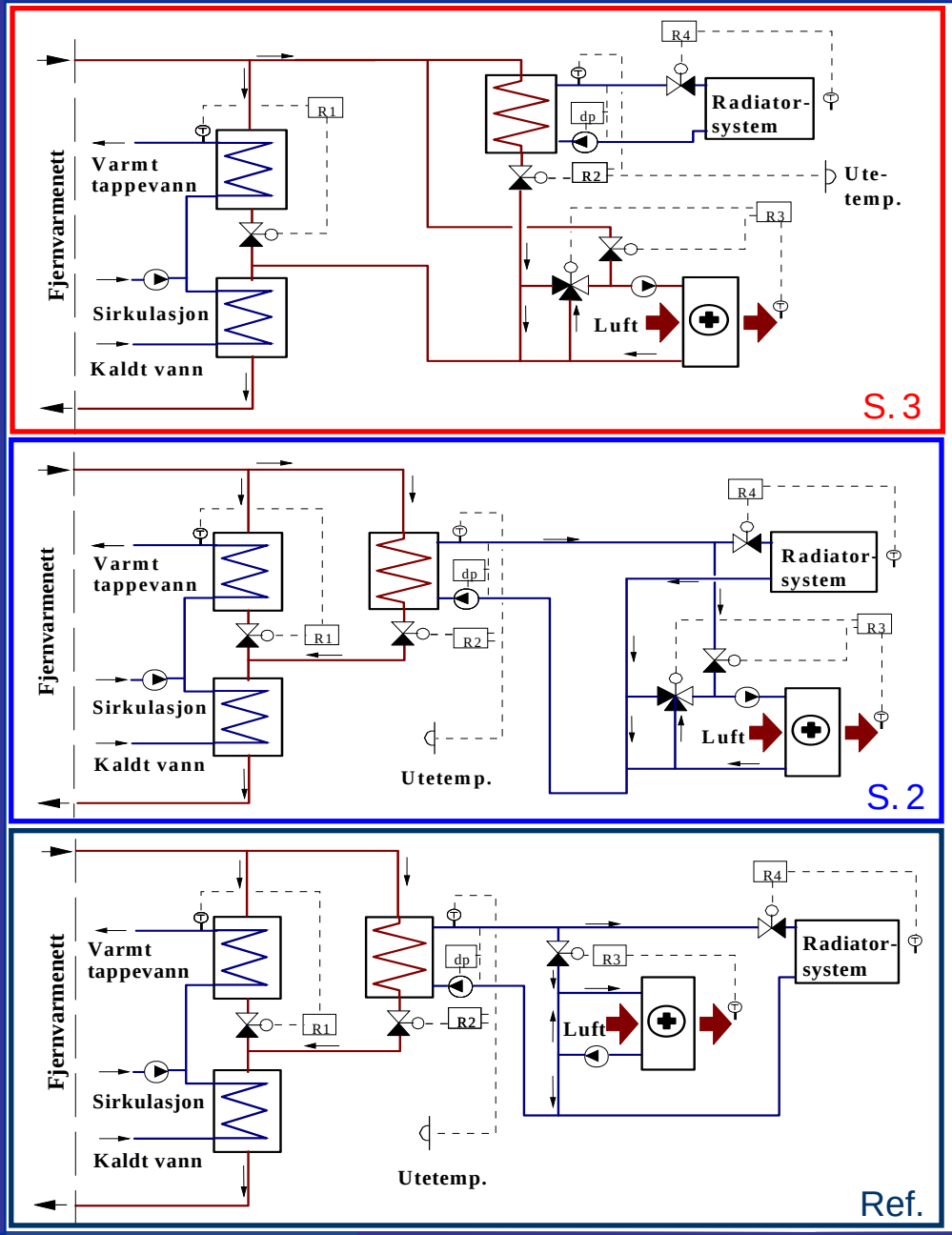
[1] This low value is caused by the fact that too big heat meters are installed so the recorded max value is actually the aggregated value for the hour(s) ahead of the recorded value.

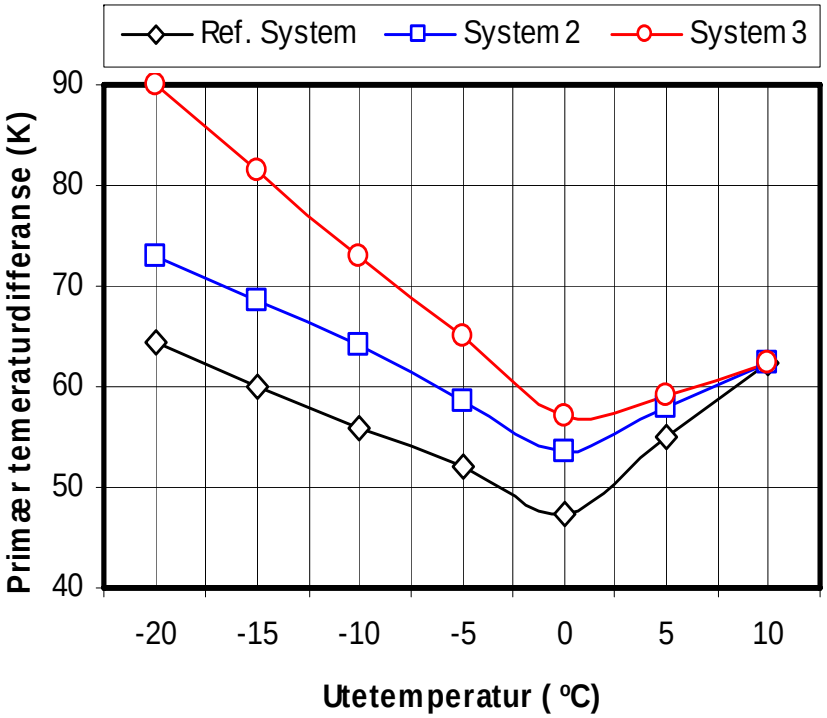
Research on Consumer Heating Systems

Development work from 1987-2007

monitored by

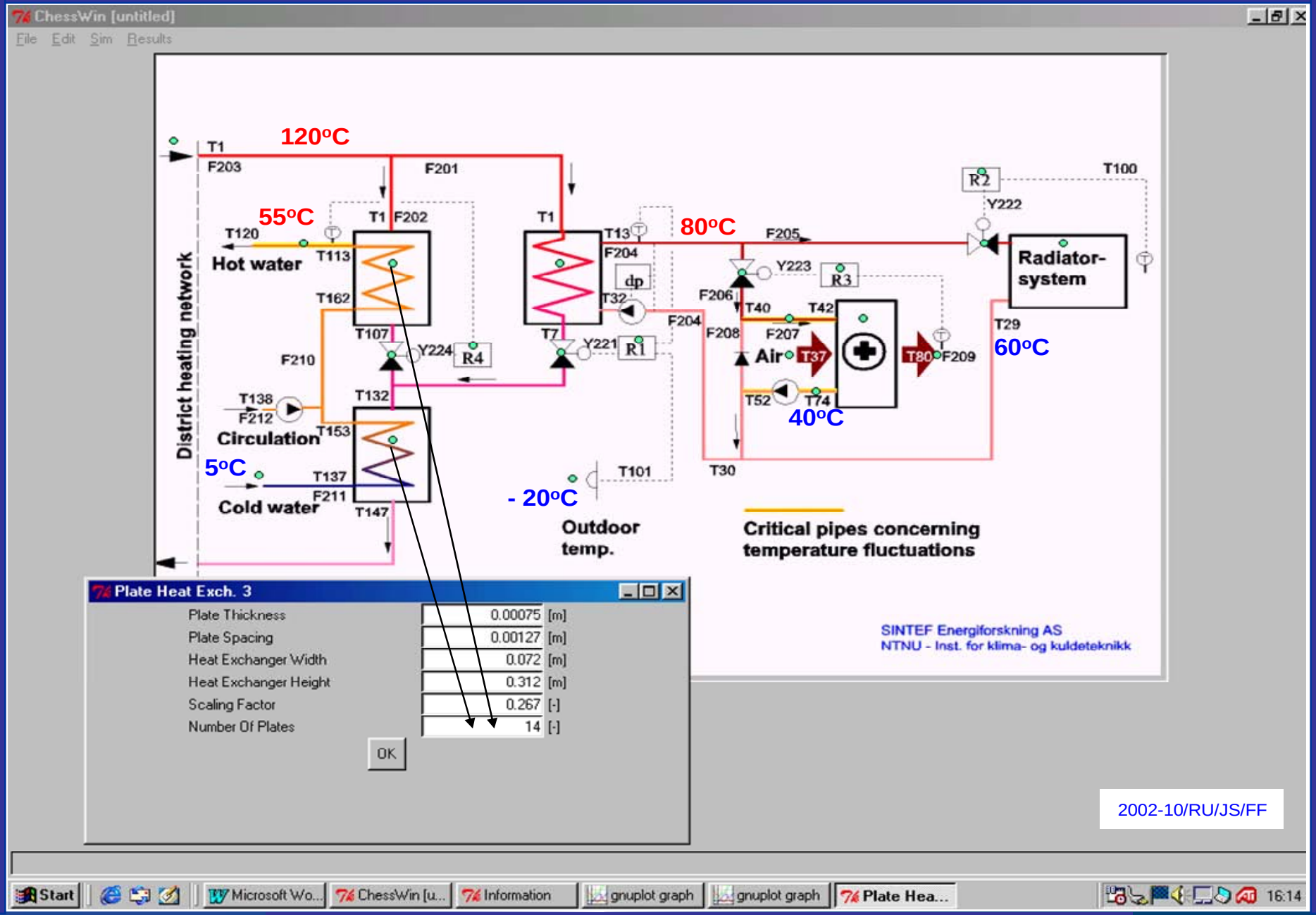
Rolf Ulseth
Energy and Process Engineering / Energy Processes
NTNU / SINTEF

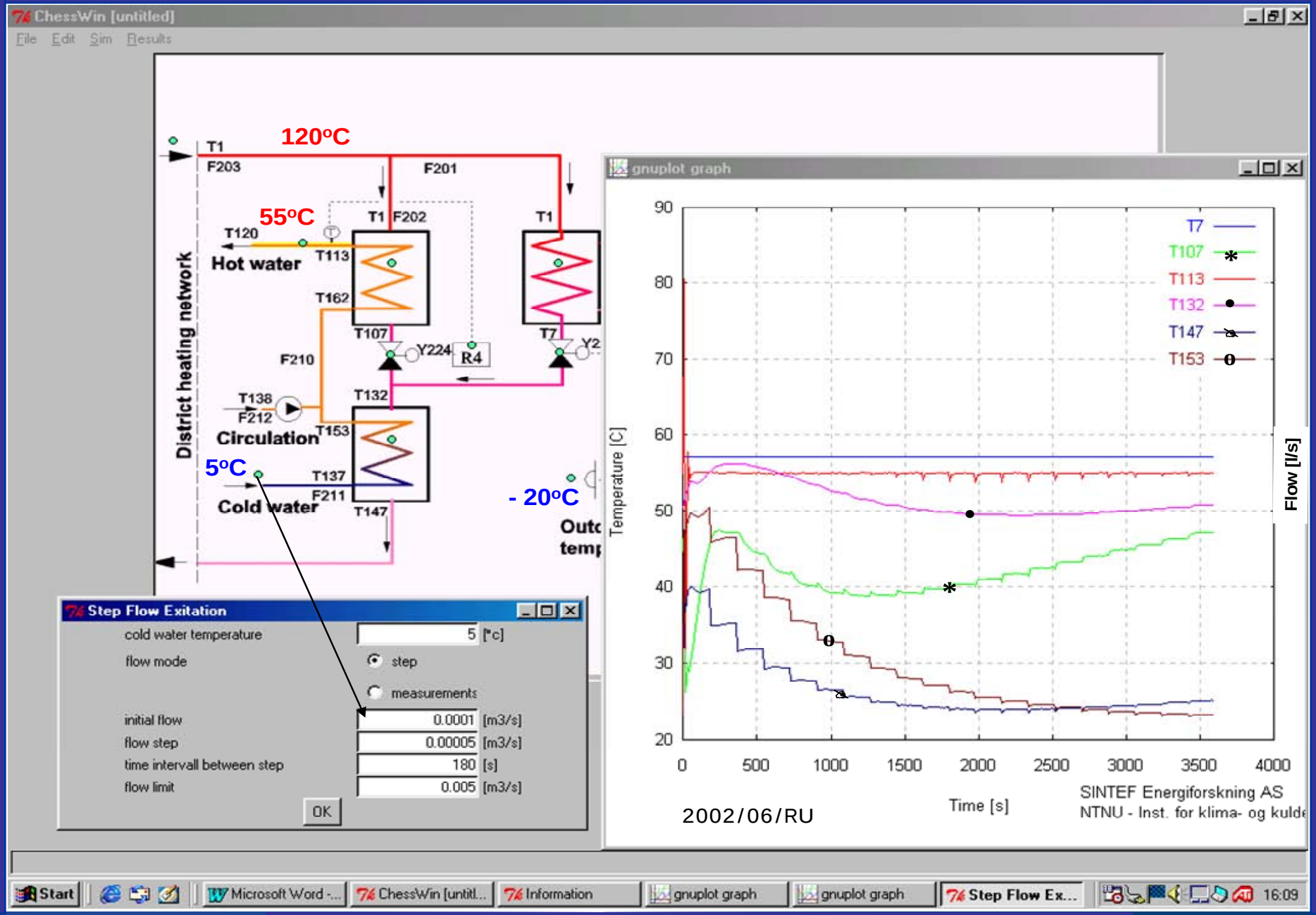




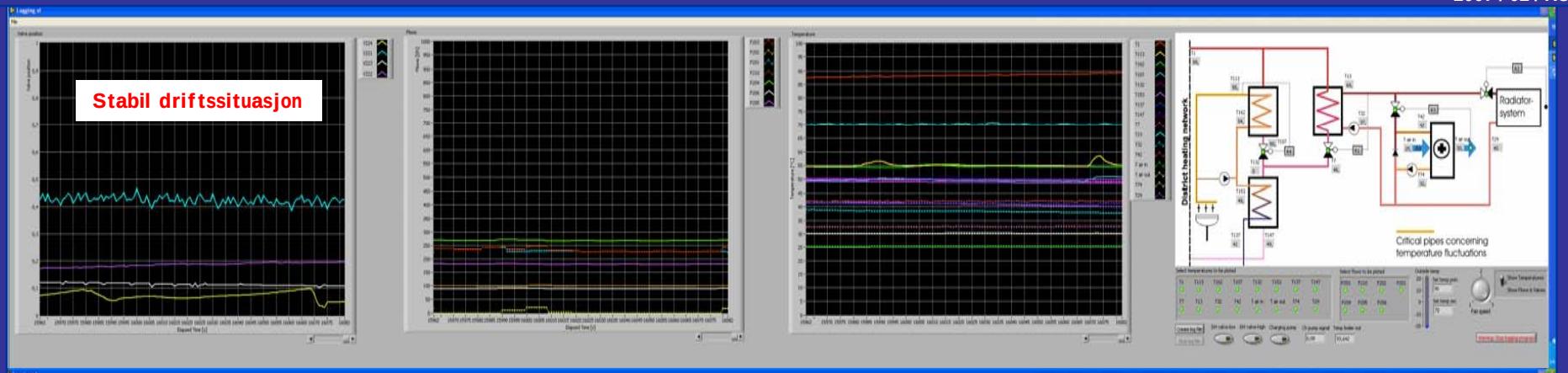
ΔT on the primary side in DH-systems with different consumer heating systems.

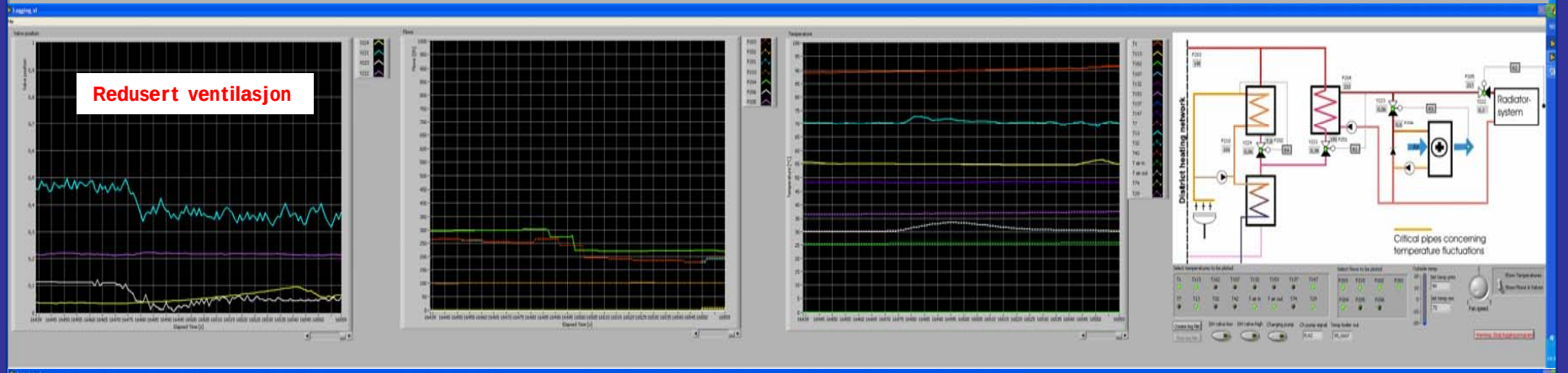
Maximum supply temperature is 120° C when the outside temperature is -20° C.

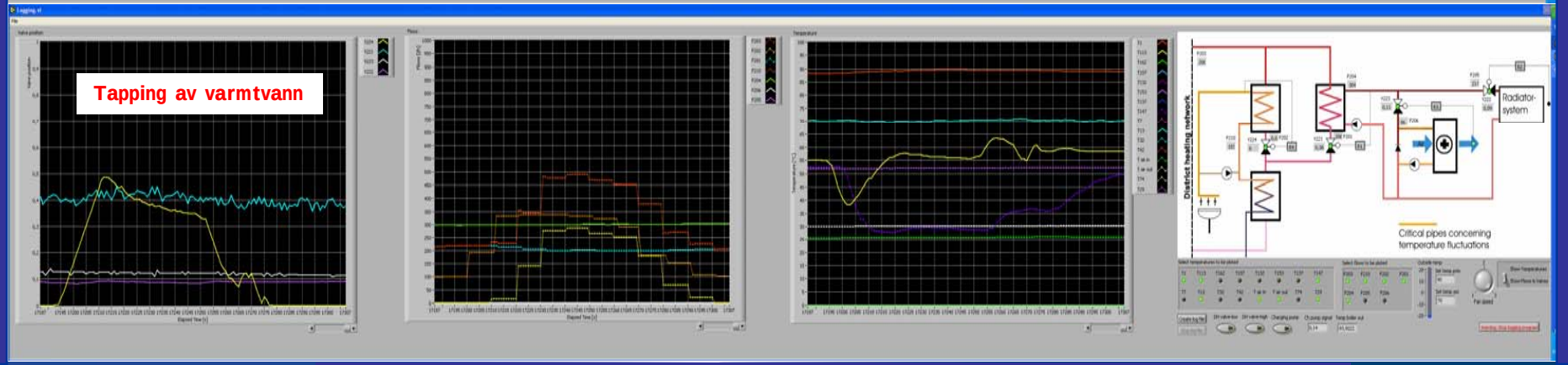

ChessWin [untitled]
File Edit Sim Results
120°C
T1
F203
F201
55°C
T1 F202
T120
Hot water
T113
T162
T107
Y224
R4
F210
T138
F212
Circulation
T132
T153
5°C
T137
F211
Cold water
T147
District heating network
T1
T13
F204
dp
T32
80°C
F205
T7
Y221
R1
F204
F206
Y223
R3
T40
T42
F208
F207
Air
T37
T80
F209
T52
T74
40°C
T30
T101
- 20°C
Outdoor temp.
R2
T100
Y222
Radiator-system
T29
60°C
Critical pipes concerning temperature fluctuations
SINTEF Energiforskning AS
NTNU - Inst. for klima- og kuldeteknikk
Plate Heat Exch. 3
Plate Thickness 0.00075 [m]
Plate Spacing 0.00127 [m]
Heat Exchanger Width 0.072 [m]
Heat Exchanger Height 0.312 [m]
Scaling Factor 0.267 [-]
Number Of Plates 14 [-]
OK
2002-10/RU/JS/FF
Start
Microsoft Wo...
ChessWin [u...
Information
gnuplot graph
gnuplot graph
Plate Hea...
16:14


ChessWin [untitled]
File Edit Sim Results
120°C
55°C
5°C
- 20°C
T1
F203
F201
T1 F202
T1
T120
Hot water
T113
T162
T107
T7
Y224
R4
Y2
F210
T138
F212
Circulation
T132
T153
T137
F211
Cold water
T147
District heating network
Step Flow Exitation
cold water temperature
5 [°c]
flow mode
step
measurements
initial flow
0.0001 [m3/s]
flow step
0.00005 [m3/s]
time intervall between step
180 [s]
flow limit
0.005 [m3/s]
OK
gnuplot graph
T7
T107
T113
T132
T147
T153
Temperature [C]
Flow [l/s]
Time [s]
2002/06/RU
SINTEF Energiforskning AS
NTNU - Inst. for klima- og kulde
Start
Microsoft Word -...
ChessWin [untitl...
Information
gnuplot graph
gnuplot graph
Step Flow Ex...
16:09


Consumer Heating System for District Heating
NTN
Innovation and


Stabil driftssituasjon
District heating network
Radiator-system
Critical pipes concerning temperature fluctuations


Redusert ventilasjon
District heating network
Radiator-system
Critical pipes concerning temperature fluctuations


Tapping av varmtvann
District heating network
Radiator-system
Critical pipes concerning temperature fluctuations

Research on Energy System Analysis

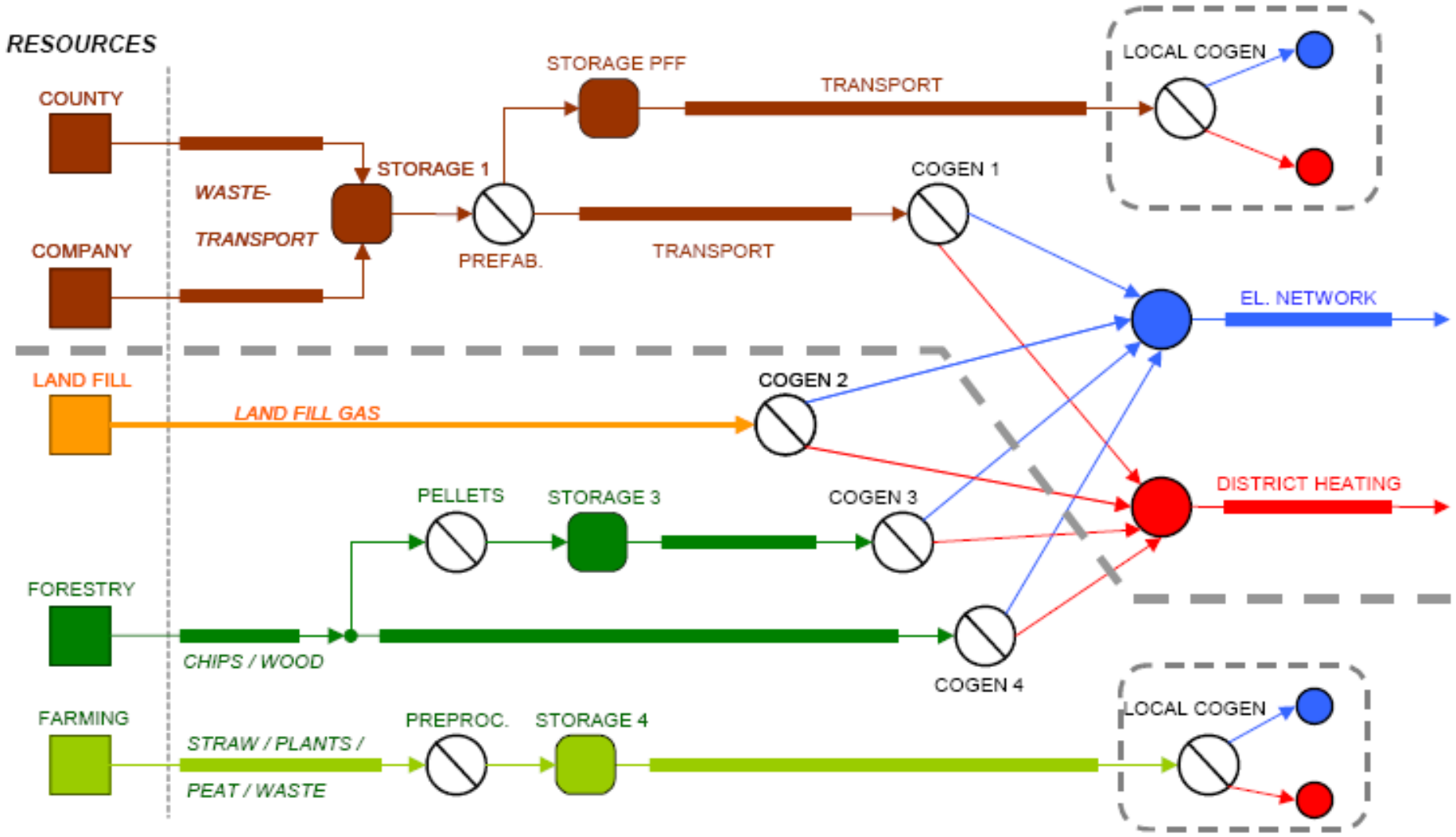
eTRANSPORT

Development work from about 2000 until today; 2007

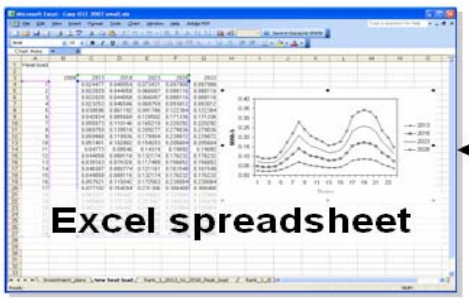
monitored by

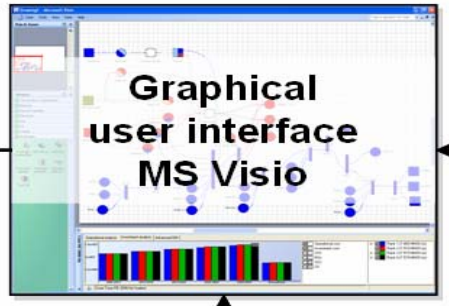
Bjørn Harald Bakken
Energy Systems / Electric Power Enineering
SINTEF / NTNU

Simplified municipal energy system model



eTransport modules





Database
MS Access

Mathemat. model
AMPL

Solver
CPLEX, COIN

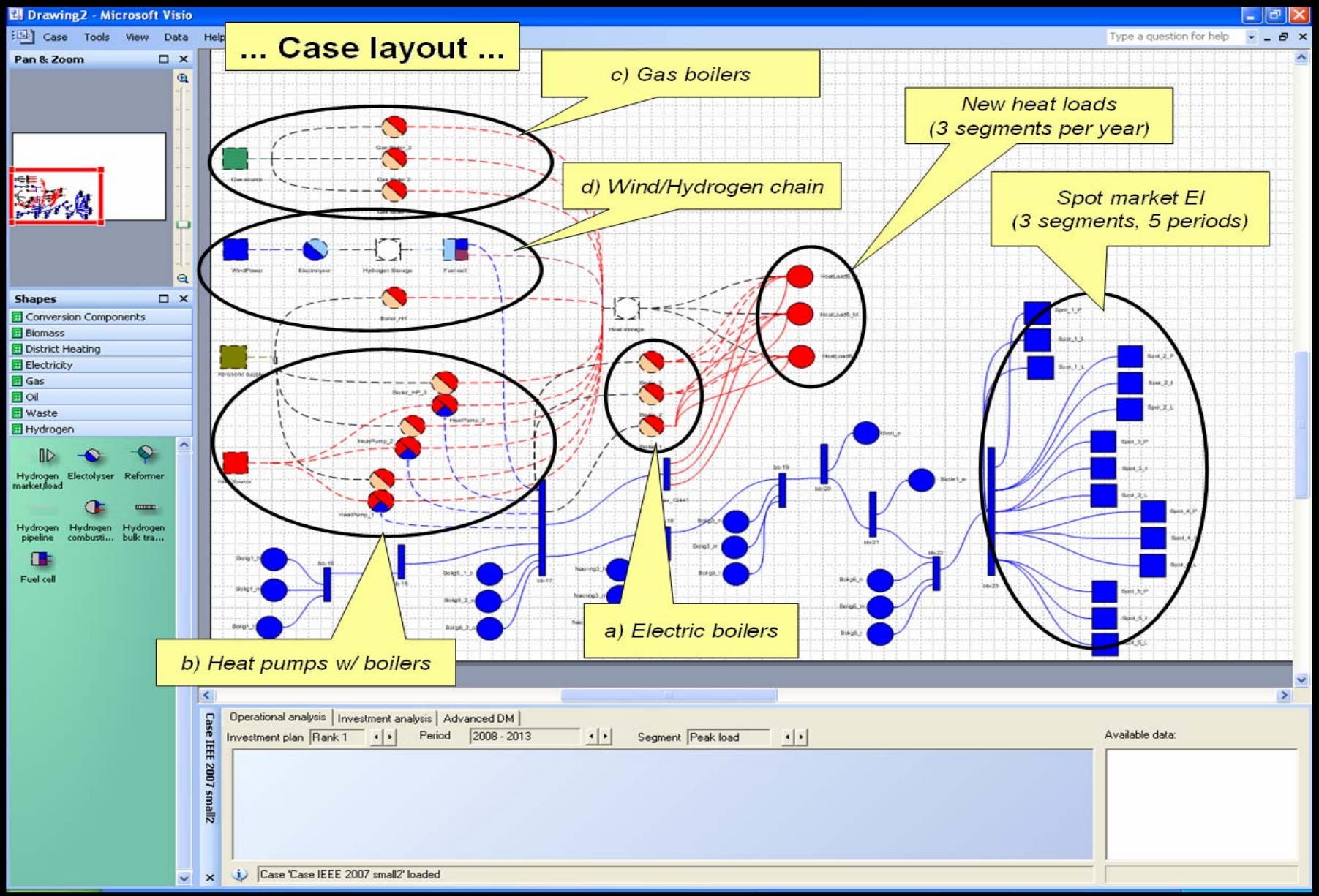
OPERATION PLANNING (LP/MIP)

EL | DH | Gas | CO2 | ... | ?

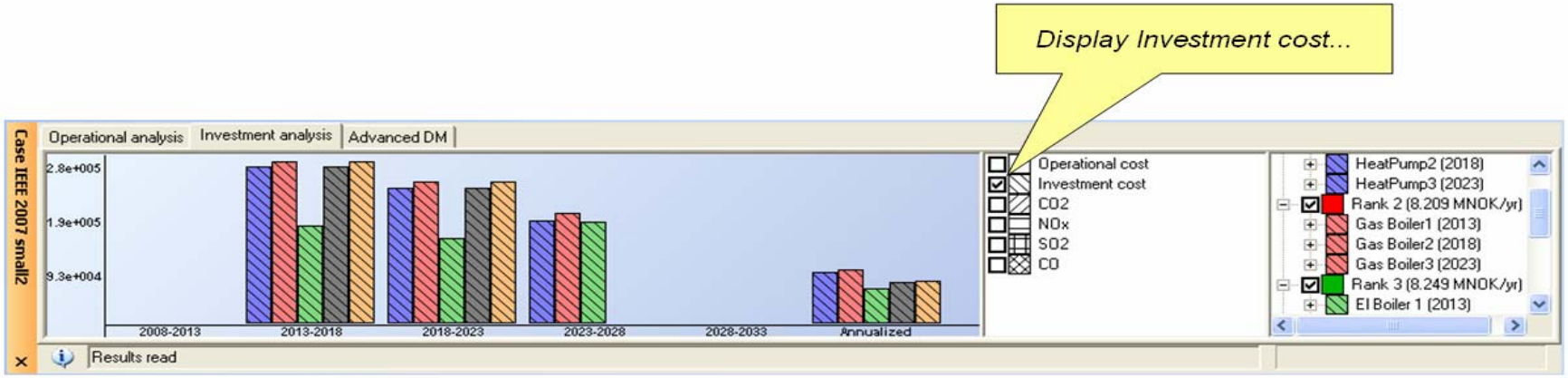
INVESTMENT PLANNING (C++)

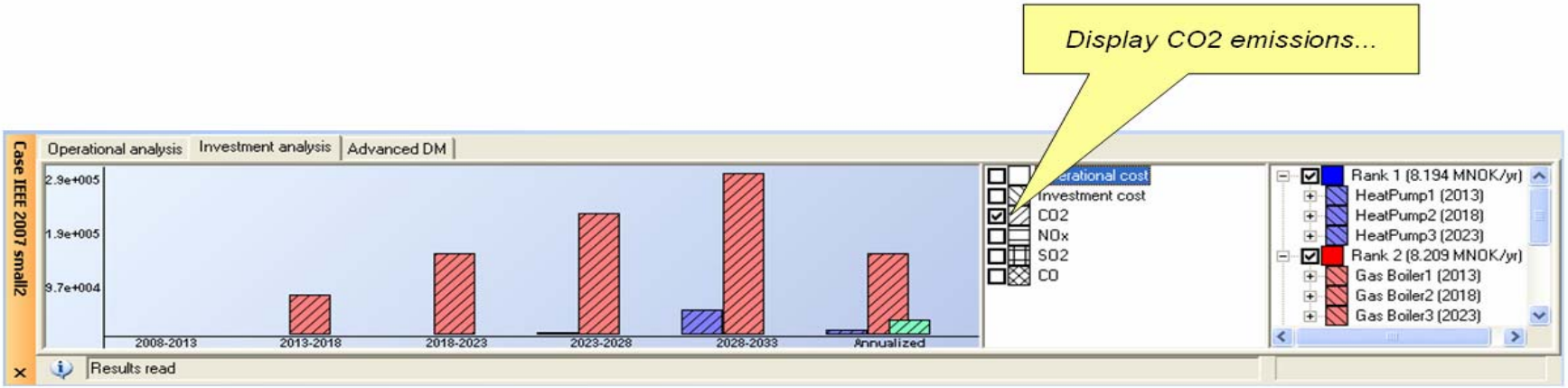
DP | SDP? | LCA? | MCDA? | ?

Decision support / Ranking of alternatives


Drawing2 - Microsoft Visio
... Case layout ...
c) Gas boilers
New heat loads
(3 segments per year)
d) Wind/Hydrogen chain
Spot market El
(3 segments, 5 periods)
a) Electric boilers
b) Heat pumps w/ boilers
Pan & Zoom
Shapes
Conversion Components
Biomass
District Heating
Electricity
Gas
Oil
Waste
Hydrogen
Hydrogen market/load
Electolyser
Reformer
Hydrogen pipeline
Hydrogen combusti...
Hydrogen bulk tra...
Fuel cell
Operational analysis
Investment analysis
Advanced DM
Investment plan
Rank 1
Period
2008 - 2013
Segment
Peak load
Available data:
Case IEEE 2007 small2
Case 'Case IEEE 2007 small2' loaded

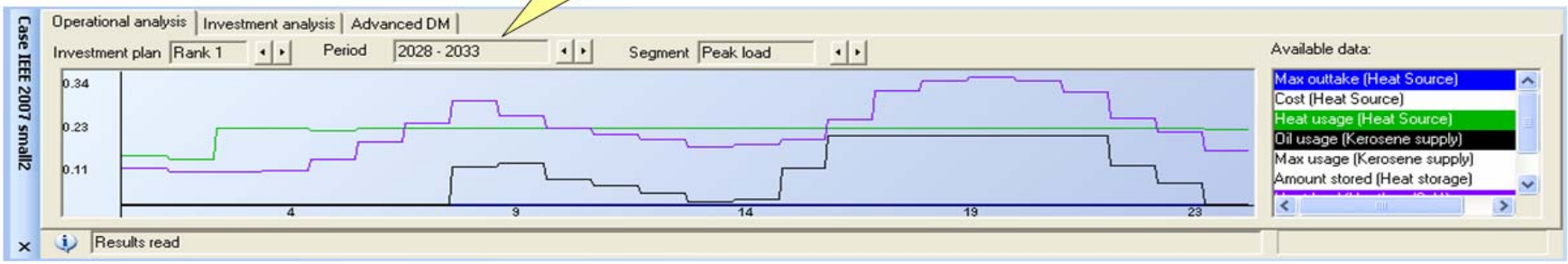
... View results: Investments ...



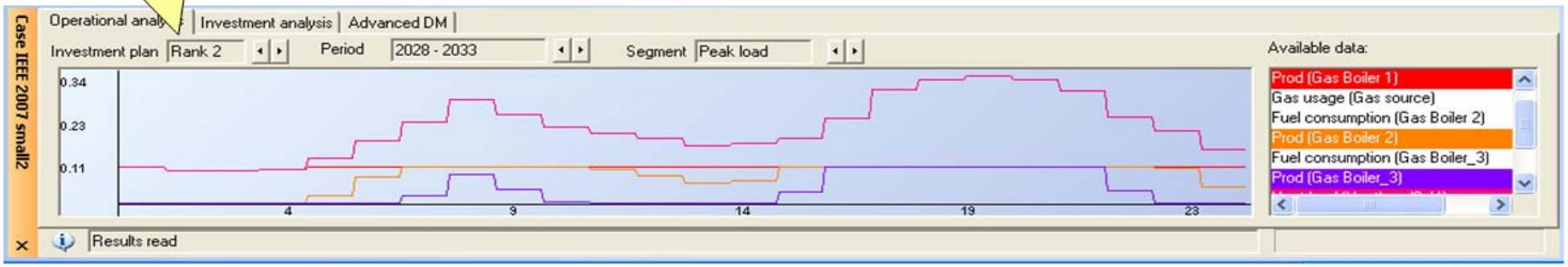


... View results: Operation ...

*...and Period **2028-2033***



***Operational analysis** for Rank 2 (Gas boilers)*



*- the user can scroll through any combination of **Rank**, **Period** and **Segment***

SINTEF Building Research are performing a smaller research project on the energy efficiency by controlling room temperature with thermostatic radiator valves compared to controlling room temperature by electric heaters

District Heating R&D in Sweden

Catarina Jäderberg, communication strategies
and knowledge dissemination

Swedish District Heating Association

- District heating, district cooling and combined heat and power
- Energy supply in balance with ecology, promoting the advantages of DH, DC and CHP and the use of waste heat and renewable energies to preserve primary energies
- The freedom and ability of the customer to choose heating system.
- 140 member companies

District heating in Sweden

- 9 million inhabitants
- 50 TWh district heating
- 48% of total heat market
- Present in every community with more than 10 000 inhabitants
- Turnover 2 billion Euro
- Competing on a non regulated heat market

25 years of R&D

- 1981 Swedish state starts to finance research on district heating
- Hetvattenprogrammet, traditional technical research 1995 – 2005. Lots of reports and guidelines
- Värmegles fjärrvärme 2002 – 2006 research, development and demonstration on detached houses to show new knowledge in practice
- Fjärrsyn 2006 – 2009 + 3 year extension, demand driven program starting up now

Svensk Fjärrvärme

FJÄRRSYN

- Research, development and demonstration to raise the level knowledge in the industry
- District heating and cooling on a broad scale – technical science, market research and contemporary social and environmental studies
- Financed with the collaboration of the Swedish Energy Agency
- Making our members more competitive by increasing their knowledge and awareness

What´s new?

- Focus on the business, the customer and the market as well as strategic issues and policy making
- Demand driven program – stakeholders involved in the entire process
- Bigger studies and more projects put into practice
- Exchange of ideas between researchers and the industry – dissemination partners
- More emphasis on communication and dissemination

Annual grants for R&D

- 0,05 % of the members business turnover = 11 million SKr
- Fjärrsyn budget 23,5 million SKr, 40% from the Swedish Energy Agency
- Värmeforsk, production and environmental issues, 1,2 million SKr
- TPS, burning bio/pellets 100 000 SKr from Svensk Fjärrvärme. Totally 6 million SKr.
- R&D fund outside programs, approx 1 million SKr

Program organisation

Open calls for proposals in three areas:

- technological development
- business, customer and market
- strategic issues and policy making

22 projects allowed up to now.

R&D board

- Chairman, president of the board of the Swedish District Heating Association
- 3 members representing the committees for technique, business and strategic issues
- 2 University representatives
- 1 representative from the Energy Agency
- Program manager/communication manager

Dissemination and implementation

- Stakeholders involved from the start
- Board, committee and consultative group members are spokesmen of new ideas and results
- Interviews to map the industrys interest and to find dissemination partners
- Stakeholder meetings
- Courses
- Workshops
- New techniques into guidelines

More communication activities

- Preliminary results
- Syntheses
- Web site
- Newsletters,
- Digital reports
- Summary reports
- Work with local media
- Articles in magazines

s-2

FJÄRRSYN

Projekt i forskningsprogrammet Fjärrsyn

Nummer	Projektnamn	Utförare	Projektledare	Summa 1000SKr	Slutdatum
2006:M001	Risker i svensk fjärrvärmeverksamhet	Handelshögskolan Göteborgs universitet	Anders Sandoff	1 395	2008-08-31
2006:T002	Forskarutbildning Camilla Persson	Chalmers	Ulf Jarfelt	750	2008-12-31
2006:T003	Distribution av fjärrvärme till småhus, Charlotte Reidhav	Chalmers och Göteborg Energi AB	Ulf Jarfelt	458	2007-12-31
2006:O005	Optimala fjärrvärmesystem i symbios med industri och samhälle	Linköpings Universitet, Energisystem	Louise Trygg	2 853	2008-12-31
2006:T006	Funktion hos krymptätande skarvförband	Sveriges Provnings- och Forskningsinstitut	Stefan Forsaeus Nilsson	383	2007-02-28
2006:T007	Kraftvärme med långtidsvärmelager	ZW Energiteknik	Heimo Zinko	280	2007-11-30
2006:T008	Optimering av fuktlarm, EIS-teknik	Corromat AB	Anders Thorén	219	2007-03-30
2006:T009	Sänkning av returtemperaturer genom laststyrning	Blekinge Tekniska Högskola, sektionen för teknik	Fredrik Wernstedt	500	2007-03-30
2006:T010	Isoleringsförmågan hos twin-rör	Chalmers tekniska högskola	Ulf Jarfelt	290	2007-06-30
2006:O011	Fjärrvärmens systemteknik	Chalmers tekniska högskola	Sven Werner	2 025	2008-12-31
2006:M011	Fjärrvärmens systemteknik	Chalmers tekniska högskola	Sven Werner	2 025	2008-12-31

2006:M012	Värmemarknaden och storkunderna	Manergy	Olle Mårdsjö	130	2006-09-06
2006:T013	Optimal reglering av radiatorsystem	Lunds tekniska Högskola, Energivetenskaper	Janusz Wollerstrand	520	2006-09-30
2006:O014	Fjärrvärmens omvärld	FVB	Sven Werner	280	Avslutad
2006:T015	Förstudie för Vertikal integration av forskning/ Planeringsbidrag Svängsta	Blekinge Tekniska Högskola, sektionen för teknik	Fredrik Wernstedt	150	2006-12-31
2006:T016	Inventering av absorptionskylmaskiner Kvalitets- och standardiseringsarbete	Chalmers tekniska högskola	Ulf Jarfelt	1 185	2008-12-31
2006:T017	Integrerad energimätning och reglering i en fjärrvärmecentral	Luleå Tekniska Universitet	Jerker Delsing	6 095	2008-12-31
2006:T018	Utveckling av distributionstekniken	Chalmers tekniska högskola	Ulf Jarfelt	1 800	2008-12-31
2006:T019	Examensarbete inventering av absorptionsvärmepumpar	Sveriges provnings- och Forskningsinstitut, SP	Monica Axell Roger Nordman	100	2007-06-30
2006:O020	Fjärrvärmens roll för effektiv produktion av biodrivmedel, energikombinat	IVL	Jenny Gode	475	2006-06-30
2006:O021	Energisamverkan	WSP	Agneta Persson	575	2008-12-31

2007:O022	Fjärrvärmens roll i ett samhälle med energieffektiv bebyggelse	Chalmers Energicentrum	Bertil Pettersson Morgan Fröling	200	2007-09-01
2007:M023	Värmemarknadens värdekedjor	Consevo AB	Christer Wirén	375	2007-09-01
2007:T024	Produktion, distribution och kunder	Profu Göteborg	John Jonsson	445	?
2007:T025	Samarbete med Tyskland,	Svensk Fjärrvärme, Göteborg Energi AB	Gunnar Nilsson, Göteborg Energi	150	2008-07-01

s-3

Svensk Fjärrvärme

Värmegles Fjärrvärme
(Sparse District Heating)

- Goal: To strengthen district heating in the detached housing market
- Co financed from the Swedish Energy Agency (50 %)
- Total 3,6 M€ during 4 years, 2002–2006

Facts about the program

- First time focus on market- and behavioural aspects as well as technological development
- Over 160 suggested projects
- Totally 46 development and research projects were accepted
- 13 demonstration projects in collaboration with industry

Focus on communication

- Transparency in program planning and decision processes
- Homepage with summarised as well as extensive information
- Newsletters (printed)
- Annual conference for members
- Industry media coverage

Värmegles results

- Increased know-how
- New focus in the industry for the detached housing segment
- 18.000 new connections of detached houses per year
- Cost reduction of 34 % possible
- Lots of information available on the web

DISTRICT HEATING AND COOLING
including the integration of CHP

IEA-DHC programme: introduction and benefits of participation

Dr Robin Wiltshire

Chairman, IEA DHC

The DHC/CHP research programme

- Was established in 1983
- The major international research effort for DHC
- One of 7 IEA buildings related programmes
- Has 10 participant countries

Annex VIII Participant Countries

Canada
Denmark
Finland
Korea
Netherlands
Norway
Sweden
United Kingdom
USA

The DHC/CHP Implementing Agreement Mission Statement

To conduct highly effective Research and Development as well as policy analysis of District Heating and Cooling systems (including the integration of CHP) with low environmental impact through international collaboration.

An ongoing programme

- Has completed 7 annexes
- Technical and institutional research
- ExCo carries out in-country consultations to determine value of its research
- ExCo has identified areas that would benefit from co-operation through IEA
- Liaison with Euroheat & Power
- Research evolves by building on previous work
- Also innovative new areas emerge
- Annex VIII in progress
- Annex IX planning starting now.

How does the IEA DHC research programme work?

- Cost sharing - each country pays an annual subscription depending on GDP
- Three-year annexes of about 7 projects
- Executive Committee steers project selection, monitors progress
- Strategy and policy papers provide context.

Project quality

- Project manager ultimately responsible; most project teams from 2 or more countries
- Each project supported by Experts Panel
- Each country nominates an Expert to each project
- Experts report to Executive Committee member
- Each project presents at End-of-Annex seminar.

Benefits of participating (1) – value for money

- *The* major international research programme for District Heating and Cooling
- With every annex each country receives $1m research value for a fraction of that cost
- Operates under the auspices of the IEA

Benefits of participating (2) – value for money

- With every annex each country receives $1m research value for a fraction of that cost

Subscription per year, annex 8:

- 80 000 $: USA
- (60 000 $: Germany)
- 40 000 $: Canada, UK
- 30 000 $: Sweden, Korea
- 20 000 $: Denmark, Finland, Netherlands, Norway

Benefits of participating (3) – shared knowledge

- **Active participation of all countries in all projects**
  - *every country can nominate an expert to every project*
- **Active participation of user groups**
  - *cross-fertilisation of ideas*
  - *opportunities for future collaboration*
- **Wide perspective - sharing knowledge with countries with different circumstances:**
  - *DHC already a mature industry*
  - *DHC established but refurbishment key issue*
  - *DHC not well-established*

Benefits of participating (4) – a policy voice

- **The programme has a policy voice because it**
  - *operates within the IEA*
  - *has a co-operation with Euroheat & Power*

- **The programme has a seat on the IEA Building Coordination Group**
  - *G8 recently requested IEA for help*
  - *in particular, material developed has a policy focus*

- **Participation with IEA Secretariat initiative 'District Heating in Transition Economies'.**

Benefits of participating (5) – collaboration with industry

- Euroheat & Power regularly attends Executive Committee (ExCo) meetings
- Links with the Euroheat & Power RTD group are growing
- The ExCo developed a position paper in partnership with Euroheat & Power
- End-of-Annex seminar usually integrated with district heating conference:
  - *Annex VII – at Euroheat & Power, June 6-7 2005*
  - *Annex VI – at Nordic Symposium, August 2002.*

What does membership offer?

- The major international research effort for DHC
- A means by which innovation and best practice is shared internationally
- Reporting to the IEA
- International project partnership
- Involvement in project support as Experts
- Range of research documents on technical and institutional aspects of DHC
- A policy paper to assist decision makers
- Website at www.iea-dhc.org

Annex VII projects

- Strategies to manage heat losses technique and economy
- A comparison of distributed and large-scale CHP/DH
- Two-step decision and optimisation model for centralised or decentralised thermal storage in DHC systems
- Dynamic heat storage optimisation and demand side management
- How standards and insulation properties influence the competitiveness of district energy
- Improvement of operational temperature differences in district heating systems
- Biofouling and Microbiologically influenced corrosion in District Heating Networks.

Reports available to participant countries
www.iea-dhc.org

Annex VIII projects

- Cost benefits and long term behaviour of a new all plastic piping system
- Assessing the actual annual energy efficiency of building scale cooling systems
- New materials and constructions for improving the quality and lifetime off district heating pipes including joints – thermal, mechanical and environmental performance
- Improved cogeneration and heat utilisation in district heating networks.

IEA IA DHC
Annex 9

- Earlier annexes 1…7 totally ~ 50 projects
- Ongoing annex 8 (2005 – 2008) projects
  - Assessing the actual annual energy efficiency of building-scale cooling systems. Lead country: USA, Partners: Finland
  - Cost benefits and long term behaviour of a new all plastic piping system. Lead country: Holland, Partners: Austria
  - New materials and constructions for improving the quality and lifetime of district heating pipes including joints – thermal, mechanical and environmental performance. Lead country: Sweden, Partners: USA, Italy
  - Improved cogeneration and heat utilization in DH networks. Lead country: Finland, Partners: Sweden, Norway
  - DH distribution in areas with low heat demand density
    Lead country : Sweden, Partners: Finland, Denmark
- Next annex, annex 9 (2008 – 2011) is under preparation, call for proposals summer/autumn 2007

Join us!

Find out more about IEA DHC at

www.iea-dhc.org

If your country is a not a member and would consider joining please contact me at:

wiltshirer@bre.co.uk

EUROHEAT
WG RTD

- A standing EHP expert body for RTD on DHC since 1999
- Normally 3…4 meetings a year
- For the moment 7 members and a secretary from EHP office
  - Gunnar Nilsson, Sweden (chairman)
  - Fleming Andersen, Denmark
  - Veli-Pekka Sirola, Finland
  - Franz-Georg Witterhold, Germany
  - Christian Reiter, Austria
  - Ales Ciuha, Slovenia
  - Jens Ole Fabricius, Industry Forum representative
  - Norela Constantinescu, EHP

EUROHEAT
WG RTD

General mandate

- to propose the energy political work programme for EHP in view of responding to ongoing debates and anticipating new developments;
- to advise the Board of Directors and the Secretariat on all energy political matters;
- to comment and to provide input to EU papers in particular in the field of energy and environment policy related to CHP/DHC;
- to liaise with other EHP working groups on these and other policy related matters;
- to support the lobbying of the Secretariat by appropriate activities

Finnish Energy Industries

EUROHEAT
WG RTD

What does it do

- Prepares EHP strategies, position papers and standpoints on RTD
- Proposes projects (EU /bilateral financing)
- Coordination and information exchange on RTD issues – dissemination
- Creates more interest for research and development of DHC
- Deepens the integration of European (manufacturers), national (research institutes/universities) and local level (utilities)
- Cooperation with other RTD organisations, e.g. IEA IA DHC

Finnish Energy Industries

EUROHEAT
WG RTD

What does it do

- Historical platform?
- Information exchange including expert network?
- Has no funding for running projects for the time being
- In the future 1…2 projects?? → funding from EHP members or WG RTD members?? (+ EU/other public funding)
- Since 2004 RTD workshops ~ every second year
  - 2004 distribution, 2006 substations and metering
  - Next workshop spring 2008, theme??

Finnish Energy Industries

Research Workshop on DH&C

Helsinki

April 16, 2007

DH&C in Nordic Energy Research (NER)

Av

Rolf Ulseth
Energy and Process Engineering / Energy Processes
NTNU / SINTEF

Focal areas for Nordic Energy Reserarch:

- Integration of energy markets
- Renewable energy
- Energy efficiency
- The hydrogen economy
- Consequences of climate change on the energy sector

Integration of Distributed Generation in the Nordic Energy Market

NER-project 2007-2010

A project that might have some influence on the DH&C-market

Project owner: ECON, Norway
Participants:
Research institutes, Universities and
Consulting Companies from many countries

Primary Energy Efficiency (PEE)

NER-project 2007-2010

PhD-project with 6 PhD-students and a demonstration project

Participants in the PEE-project:

SINTEF Energy Research (Formal project owner)

Norwegian University of Science and Technology (NTNU)
University of Island (Uri)
Technical University of Tallinn (TUT)
Helsinki University of Technology (HUT)
Lund University (LU)
Technical University of Denmark (DTU) ?
Vestiges Kraftvarmeselskap (VEKS)

Steering Committee:

Rolf Ulseth, NTNU (Chairman), Ólafur Pétur Pálsson, (UoI)
AAdu Paist, (TUT), Carl-Johan Fogelholm, (HUT)
Svend Frederiksen (LU), N.N. (DTU) ?, and Lars Gullev (VEKS).

The PhD-projects:

(1) System, methods and credible data for calculating primary energy efficiency in general and for energy systems in the Nordic region with special focus on energy system applying CHP-technology with bio based fuel in particular (NTNU).

(2) Analyses on the possibilities to substitute electricity demand by energy from hydronic heating systems in the modern society to increased the market for useful heat and identifying the consequences on the PEE. Possible technical developments and demonstration of for example supplying washing machines, dish washers, drying drums and other possible needs with heat from district/hydronic heating systems including analysis on the economical consequences for CHP-systems in general and systems based on renewable heat in particular. (UoI)

(3) Analysis on the technical and economical consequences by CHP-systems based on renewable energy in new areas with lowered useful heat demand or after energy conservation measures in areas with older buildings (TUT).

The PhD-projects:

(4)"Multiobjective" optimization of CHP plants integrated with bio refineries and/or bio fuel producing processes (HUT).

(5) Substitution of electrical heating by district heating for single-family houses with focus on use of renewable energy and primary energy efficiency ?. (LU/DTU) ?.

(6) Risks related to fall-outs in electricity supply for the operation of pumps and other district heating network equipment normally requiring electric power supply analysis and technologies for meeting such risks and enhancing society and customers confidence in district heating (LU).

The case study will be performed on the possibilities of increasing the primary energy efficiency in the district heating system at VEKS. The study might be a part of (1).

The PEE-project includes the responsibility to organize The 11th and The 12th International Symposium on District Heating and Cooling.

Background information on the PEE-concept

The main goals of Directive on the energy performance of buildings

Reduced primary energy use
Reduced CO_2- emission

EU-Directive on the Energy Performance of Buildings (EPBD)
2002 !

European Climate Change Programme
2000

Kyoto Protocol
to the
United Nations Framework Convention on Climate Change
1997

EU-Directive to limit carbon dioxide emissions by
improving energy efficiency (SAVE)
1993 !

Rio Earth Summit
United Nations Framework Convention on Climate Change
1992

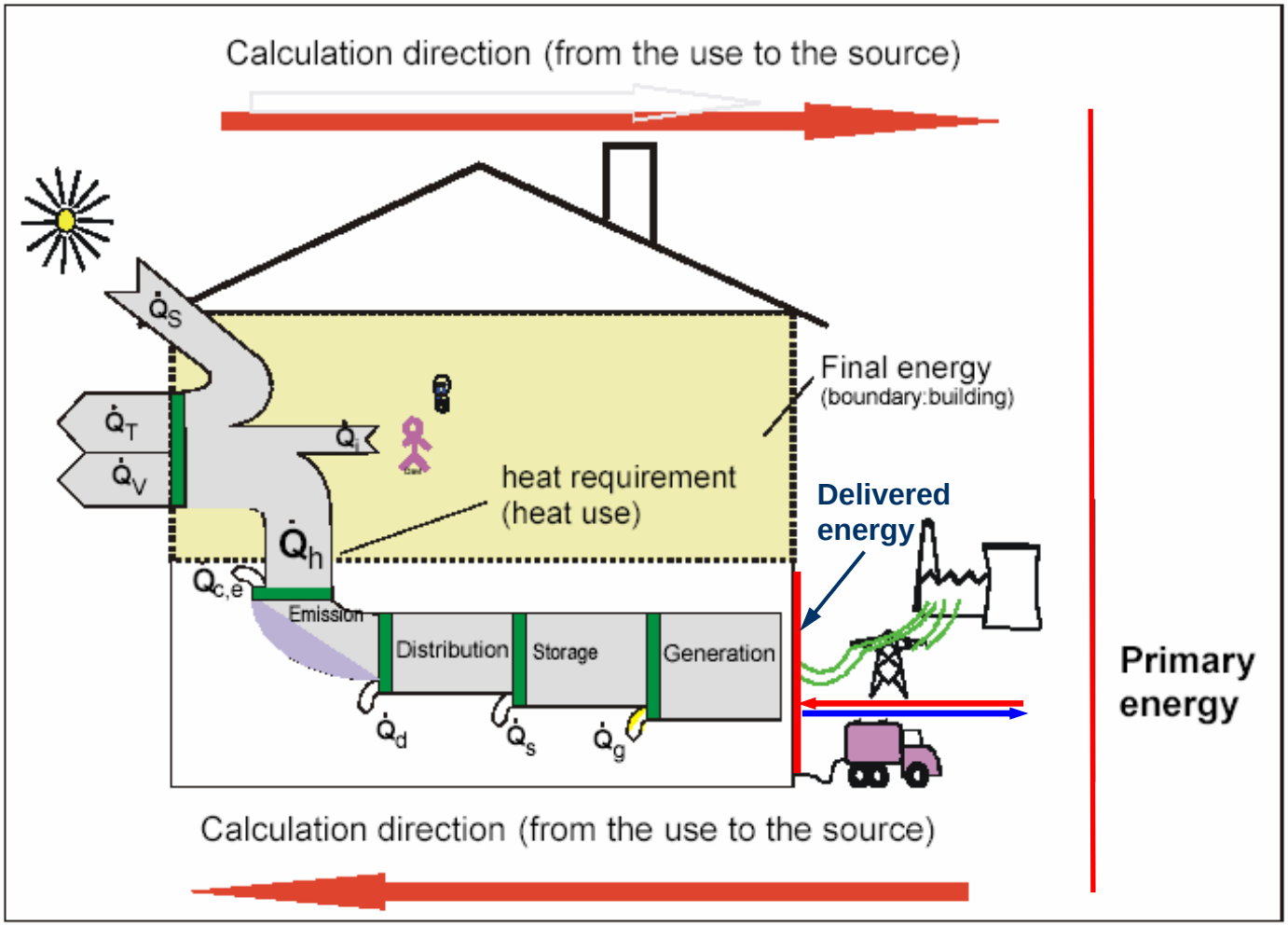
Our Common Future
World Commission on Environment and Development
1987

0703/RU

From the Directive on energy performance of buildings: (EPBD)

2. *The positive influence of the following aspects shall, where relevant in this calculation, be taken into account:*

(a) active solar systems and other heating systems based on renewable energy sources
(b) electricity produced by CHP
(c) district or block heating and cooling systems
(d) natural lighting



Energy calculation concept and Building-System boundaries according to EPBD.

prEN 15603 (2006-11)

5.3 Types and uses of ratings

This standard proposes two principal options for energy rating of buildings: the calculated energy rating and the measured energy rating.

Standard calculated energy rating and measured energy ratings can both be used for building energy performance certification. The design rating can be used to get a building permit.

National regulations determine:

— which type of rating applies for each building type and circumstances

— under what conditions the design rating can be considered as or converted to a calculated energy rating for the actually realised building.

The tailored rating can be used to compare two buildings having different climates or different uses, to compare retrofit scenarios, to optimise energy performance, etc.

The types of rating are summarised in Table 3.

Table 3 —Types of ratings

	Name	Input data			Utility or purpose
		Use	Climate	Building	
Calculated	Design	Standard	Standard	Design	Building permit, certificate under conditions
	Standard	Standard	Standard	Actual	Energy performance certificate, regulation
	Tailored	Depending on purpose		Actual	Optimisation, comparisons, retrofit planning
Measured	Operational	Actual	Actual	Actual	Energy performance certificate, regulation

Indicators on the "energy performance" that should be used on the energy certificate for the buildings according to the EU harmonized CEN-standard:

(prEN 15603)

8 Energy rating

8.1 Types of ratings

Note: A building generally uses more than one energy carrier. Therefore, a common expression of all energy carriers shall be used to aggregate the used amounts, sometimes expressed in various units, and always having various impacts.

According to this standard, the aggregation methods are based on the following impacts the use of energy carriers have:

— Primary energy;

— Production of carbon dioxide

— A parameter defined by national energy policy.

NOTE: Cost is a parameter that may be used in the energy policy aggregation method.

8.2 Types of factors or coefficients

The aggregation needs factors and coefficients determined at a national level according to the rules given below. Local values for factors needed to calculate the primary energy consumption and/or CO2 emissions should be defined in a national annex. Annex E (informative) provides such factors and coefficients.

Factors and coefficients for calculating "primary energy use" and CO_2-emmision on the energy certificate from the EUs harmonized CEN-standard:

(prEN 15603)

Annex E
(informative)

Factors and coefficients

	Primary energy factors		CO_2 production
	Ressource	Total	[kg/MWh]
Fuel oil	1.35	1.35	330
Gas	1.36	1.36	277
Anthracite	1.19	1.19	394
Lignite	1.40	1.40	433
Coke	1.53	1.53	467
Wood shavings	0.06	1.06	4
Log	0.09	1.09	14
Beech log	0.07	1.07	13
Fir log	0.10	1.10	20
Electricity from hydraulic power plant	0.50	1.50	7
Electricity from nuclear power plant	2.80	2.80	16
Electricity from coal power plant	4.05	4.05	1340
Electricity Mix UCPTE	3.14	3.31	617

Source: Oekoinventare für Energiesysteme - ETH Zürich (1996)
These factors include the energy to build the transformation and transportation systems for the transformation of the primary energy to delivered energy.

prEN 15217 (2007-02)

Energy performance of buildings — Methods for expressing energy performance and for energy certification of buildings

Annex C
(informative)

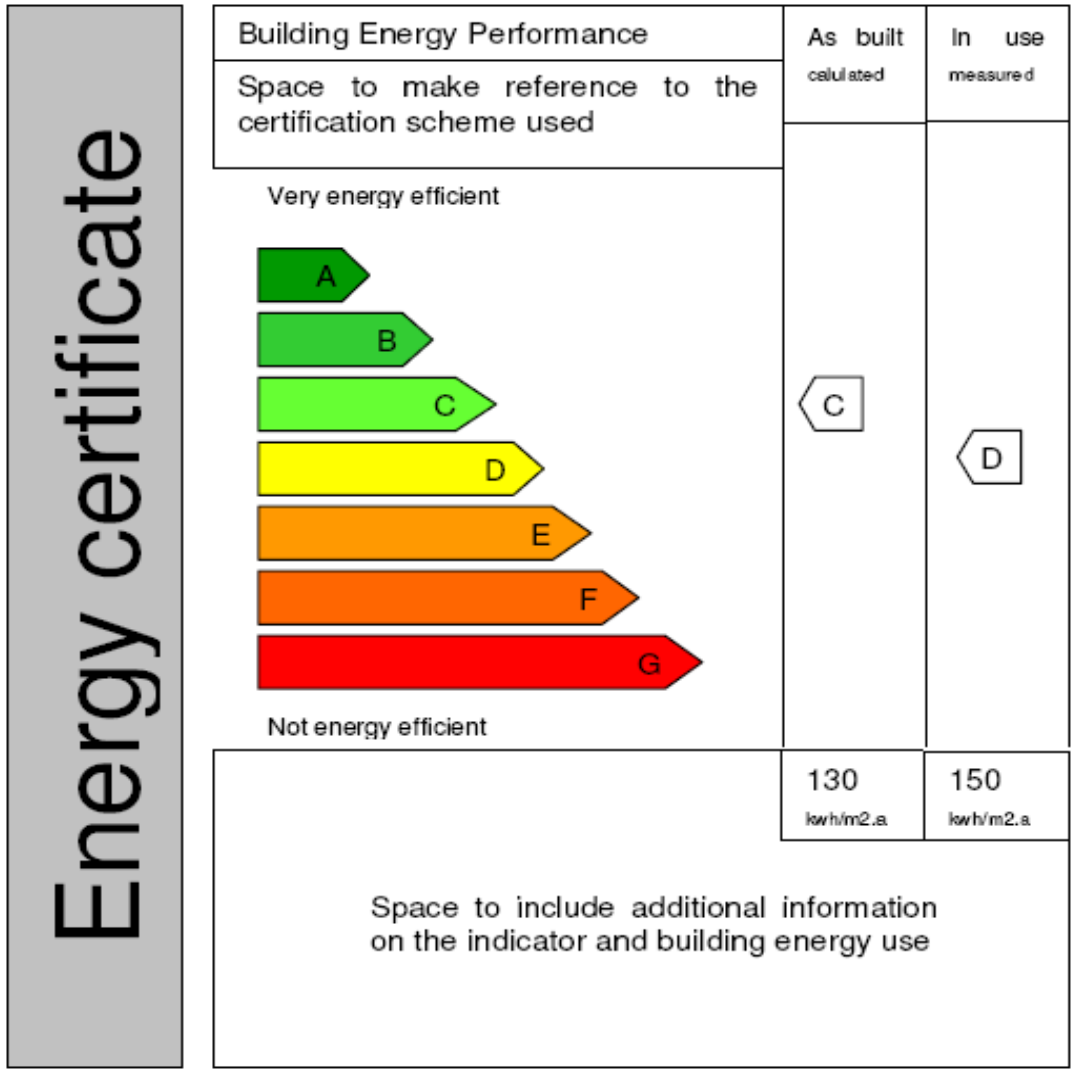
Energy certificate format

This annex provides three examples of an energy certificate format. These examples are provided for illustration only and do not show all the details needed for an energy certificate. In particular, ways to present recommendations for improvements as well as ways to present the supporting evidence of the energy certificate are not presented.

Many other solutions are possible.

Example 1 with one single indicator and classes

Example 2 with two indicators and classification



Primary Energy Efficiency (PEE)

Example 3 with 1 indicator without classification