



EFFLOCOM

Finnish Pilot, Tampere case

Seppo Kärkkäinen & Jussi Ikäheimo
VTT Processes

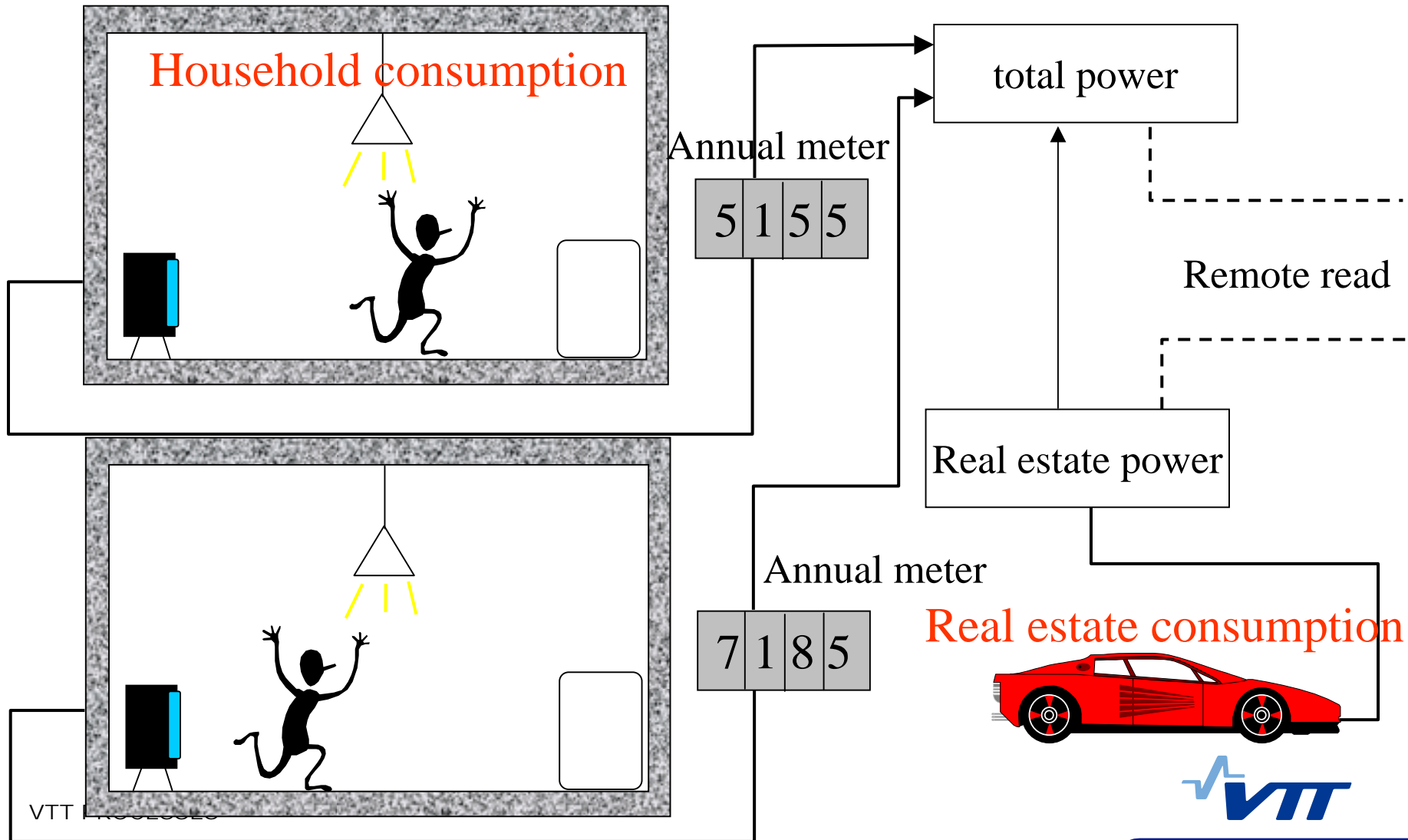
Partners

- ◆ Real estate company VVO
 - has more than a thousand real estates and 40.000 apartments
 - total electricity consumption in buildings in 2001 was 150 GWh, from which real estate electricity consumption was about 50 GWh and household consumption 100 GWh
 - mostly rental apartments
 - most real estates have been financed by government loans, therefore they bear limitations on dweller income
- ◆ Engineering office Suomen Talokeskus oy
 - collects electricity, water and heat consumption data
 - runs the *Kulunet* service, which is an interface to the consumption data in world wide web

Main idea

- ◆ Attempt to study what effect better feedback information has on electricity consumption. Especially changes
 - in the level of energy consumption and
 - in the load shape of the electricity consumption were studied
- ◆ Target group in the study was residential sector with emphasis in blocks of flats and terraced houses
- ◆ Mainly real estate common consumption (saunas, ventilation, car heating, outdoor lighting etc.) was studied
- ◆ Feedback was not given to each household but to so called *energy experts* (see later)

Power and energy components



Tampere case basics

- ◆ Electricity consumption of 31 real estates in Tampere has been monitored since 1994
 - The above are monthly consumption values (MWh/month)
- ◆ Hourly consumption measurement is available since late 2000 (for some real estates from a later date)
 - consumption is divided into total consumption and real estate common consumption (saunas, ventilation etc.)
 - private household consumption is the difference of the two

Screenshot from Kulunet: monthly data



KULUTUSSEURANTARAPORTTI

Vuosi 2004

(2745) VVO/LENTOKONETEHTAANTIE 5
LENTOKONETEHTAANTIE 5 33900 TAMPERE

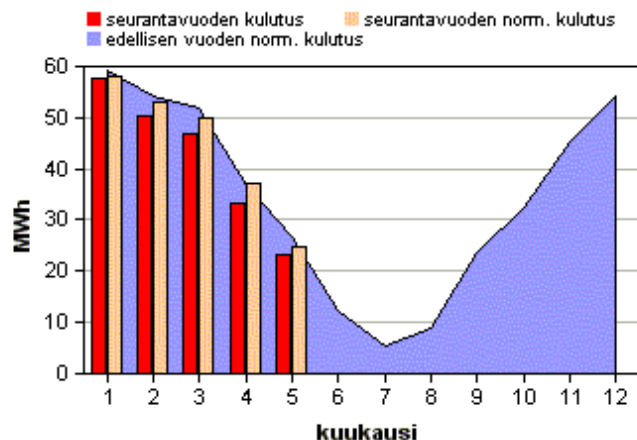
Raportin päivämäärä 8.6.2004



KIINTEISTÖNUMERO:	41
LÄMMITYSMUOTO:	Kaukolämpö
ILMANVAIHTOJÄRJESTELMÄ:	Keskittetty koneellinen poisto
KIINTEISTÖTYPPI:	ASUINKERROSTALO
RAKENNUSTILAVUUS:	7540 m ²
RAKENNUSVUOSI:	1970
ASUKKAITA:	54 (5/2004)

1.1 Lämpöenergian kuukausikulutukset MWh

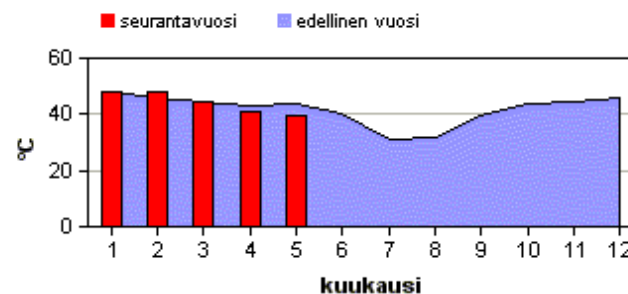
Ajanjakso	Toteutunut	Muutos	Normeerattu	Muutos
1-5 / 2004	210,7	-5,6 %	223,6	-2,3 %
1-5 / 2003	223		229	



1.2 Lämpöenergian vuosikulutus

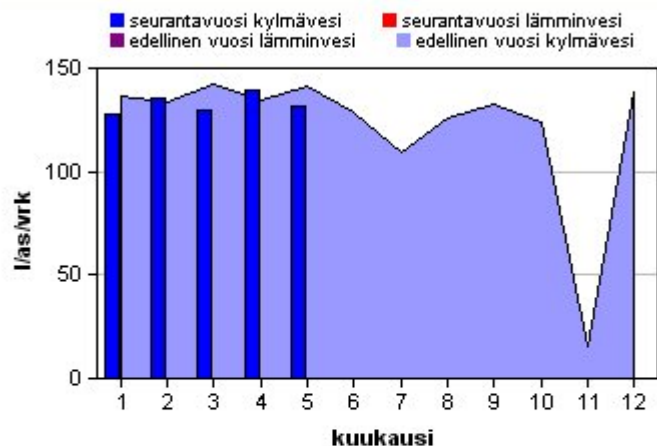
	MWh	kWh/Rm ²
Seurantavuoden arvioitu kulutus	392,00	51,9
Edellisen vuoden kulutus	391,80	51,9
Seurantavuoden arv. norm. kulutus ja lämpöind.	398,60	52,8
Edellisen vuoden norm. kulutus ja lämpöindeksi	411,60	54,5
Paikkakunnan vast. kiint. keskim. norm. kulutus	440,60	58,4
Vastaavien kiinteistöjen lämpöindeksien vaihtelurajat 49,2 - 67,7 kWh/Rm ²		

1.3 Kaukolämpöveden keskimääräinen jäähtyminen

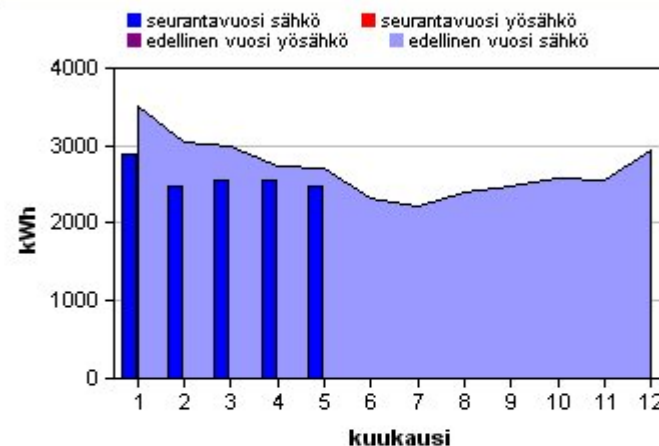


Screenshot from Kulunet: monthly data

2.1 Veden kuukausikulutukset		
Ajanjakso	m ³	Muutos
1-5 / 2004	1 088,7	-3,1 %
1-5 / 2003	1 124,5	



3.1 Sähkön kuukausikulutukset MWh		
Ajanjakso	MWh	Muutos
1-5 / 2004	12,9	-13,6 %
1-5 / 2003	15,0	



2.2 Veden vuosikulutus			
	m ³	l/as/vrk	l/Rm ²
Seurantavuoden arvioitu kulutus	2 355,3	119	312
Edellisen vuoden kulutus	2 403,3	122	319
Vast. kiint. keskim. kulutus	3 344,0	170	
Vast. kiint. kulutuksen vaihtelurajat	134 - 206 l/as/vrk		

3.2 Sähköenergian vuosikulutus		
	MWh	kWh/Rm ²
Seurantavuoden arvioitu kulutus	29,7	3,9
Edellisen vuoden kulutus	32,5	4,3
Vast. kiint. keskim. kulutus	25,0	3,3
Vast. kiint. kulutuksen vaihtelurajat	1,88 - 4,74 kWh/Rm ²	

HUOMAUTUKSET

Käyttöveden mittari rikki, vaihdettu 11/2003

VESI: KULUTUS ON KESKIMÄÄRÄISTÄ PIENEMPI, KK: 1,3,5

© Suomen Talokeskus Oy

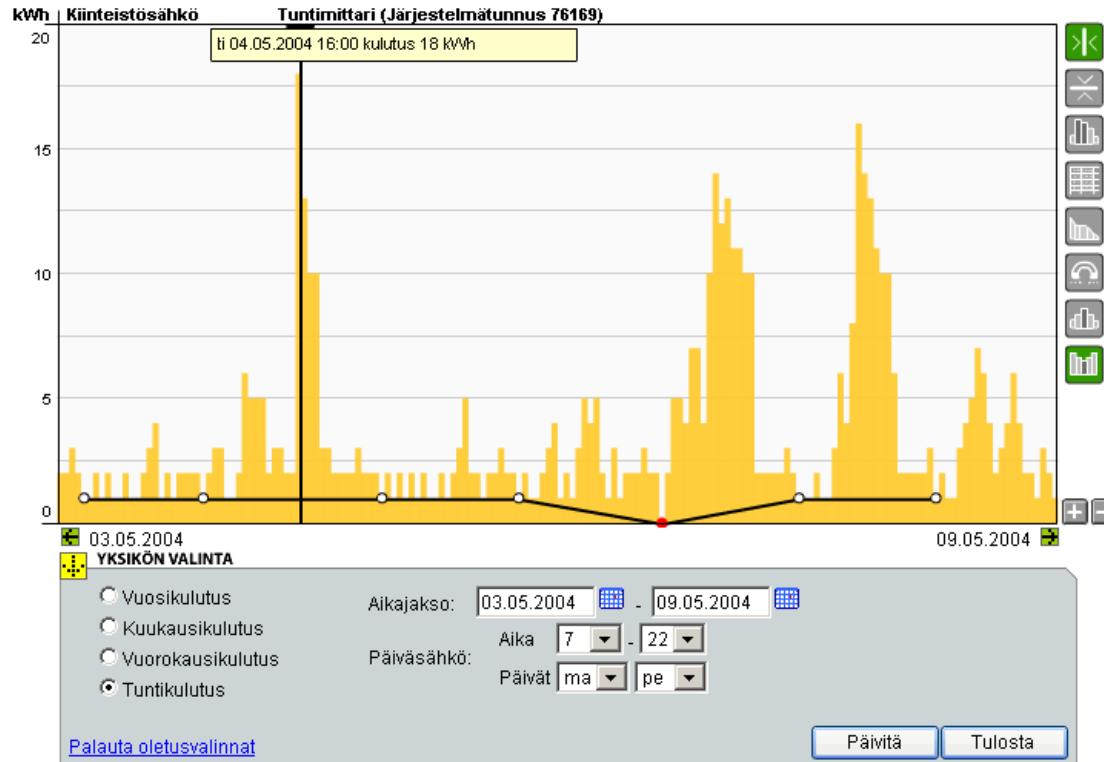
Screenshot from Kulunet: hourly data

(2745) VVOLENTOKONETEHTAANTIE 5
LENTOKONETEHTAANTIE 5 33900 TAMPERE

Vuorokaudet 03.05.2004-09.05.2004

Raportin päivämäärä 08.06.2004

LÄMMITYSMUOTO:	Kaukolämpö
KIINTEISTÖTYYPPI:	ASUINKERROSTALO
RAKENNUSVUOSI:	1970
RAKENNUSTILAVUUS:	7540
RAKENNUSALA:	1600
ASUKKAITA:	54



Jakso 03.05.2004 => 09.05.2004						
Kulutus [kWh]	Päiväsähkö [kWh]	%	Yösähkö [kWh]	%	Huipputeho [kW]	Minimiteho [kW]
586,00	307	52	279	48	(4.5 klo 16) 18	(7.5 klo 5) 0
						Min kulutus ka [kWh] 1

Tampere case data

◆ Available are:

- monthly consumptions, hourly consumptions of electricity
- real estate sizes (# of apartments, building volumes)
- locations (city district)
- construction year
- type of building (terraced house / point block etc.)
- facility level: # of electrified parking slots, # of saunas, # of drying rooms, # of lifts, cold storage (yes / no)
- repair history
 - unfortunately this does not distinguish between new installations and replacements

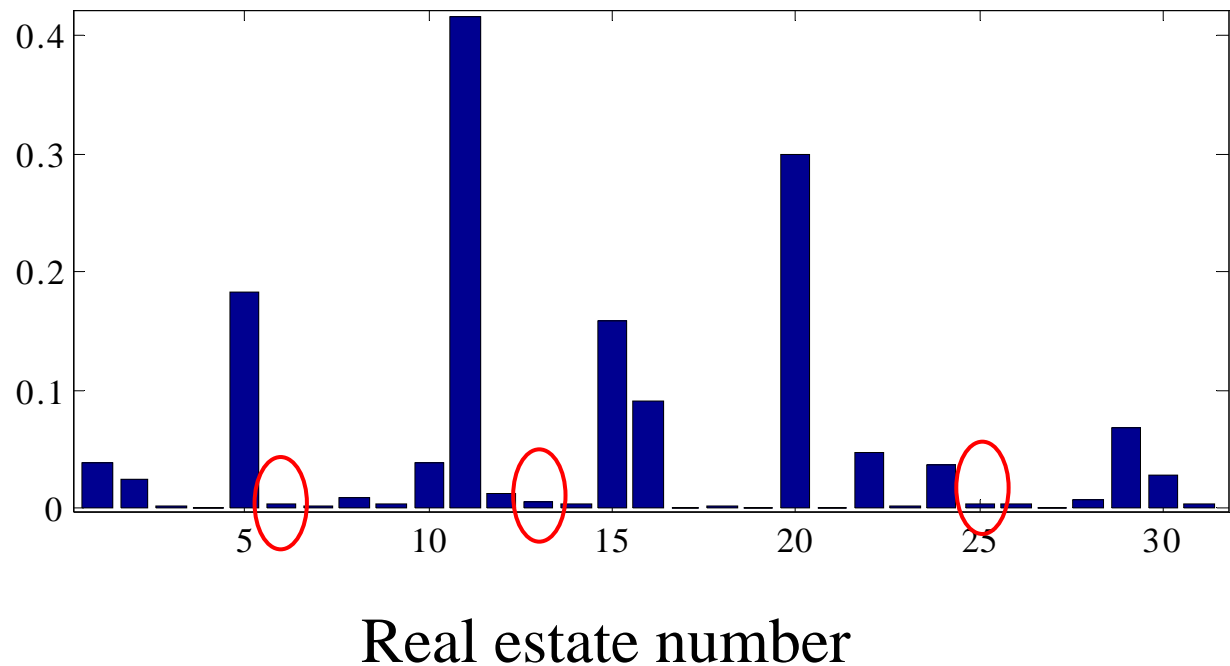
Dependencies between variables

- ◆ Statistical dependencies between the above mentioned variables have been searched
- ◆ Consumption trend is in some cases strongly increasing, in some cases decreasing
 - average increase 1.2 % per year
- ◆ Average consumption is relatively well explained by real estate size ($R^2 = 0.8$)
- ◆ However, if this effect is subtracted, facility level explains the rest poorly

Temperature dependency of consumption is vague for most real estates

There's no visible temperature dependency in active-expert real estates!

R-squared between
detrended
seasonally corrected
consumption of real
estate electricity and
heating index
number



○ Active expert

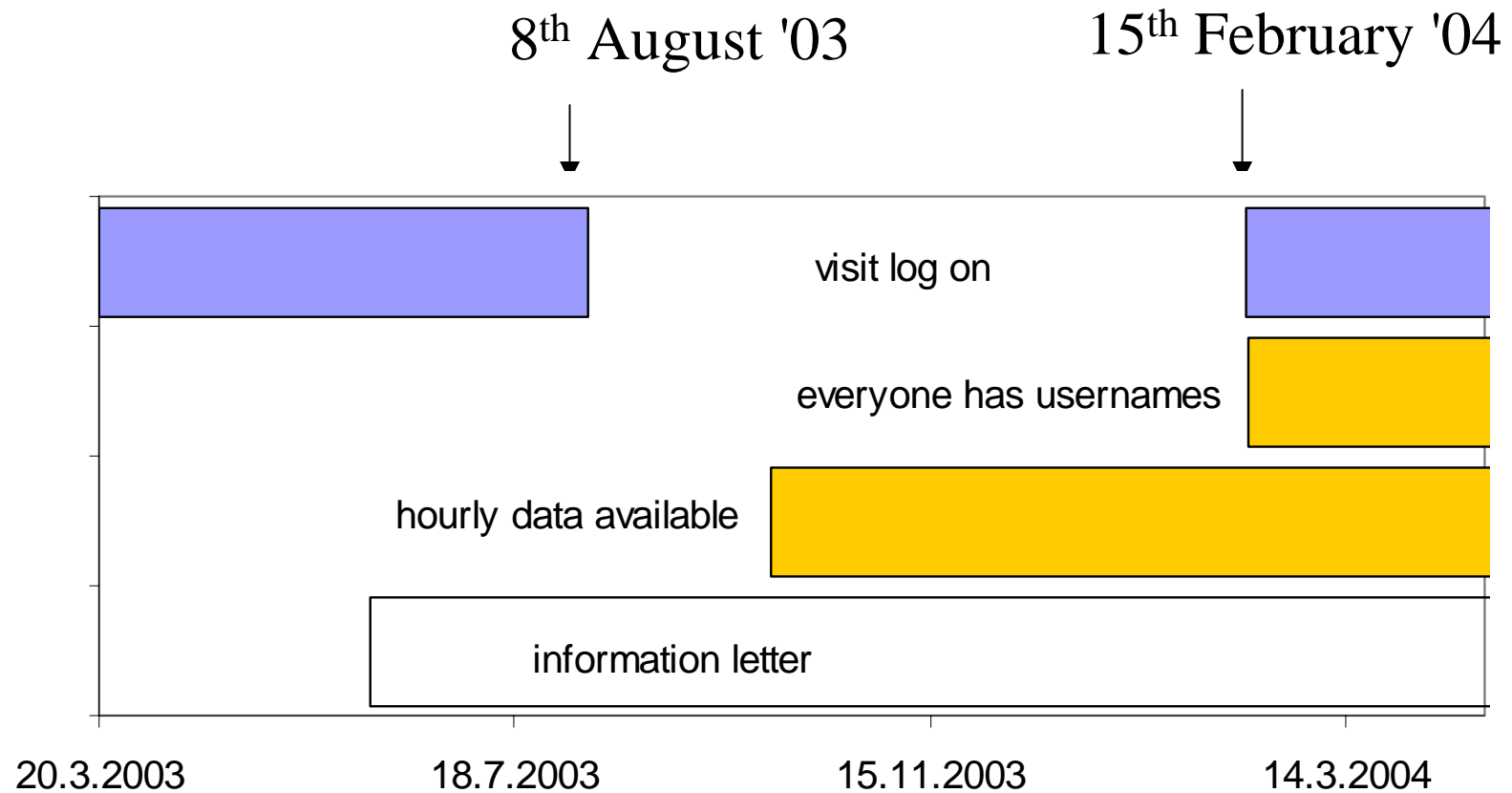
Tampere experts

- ◆ Each real estate has a so-called *energy expert* , who are laymen living in the real estates
 - act as links between residents, caretakers and VVO
 - monitor energy consumption
 - VVO has given some training to the experts
- ◆ Experts work on a voluntary basis
- ◆ They follow energy consumption through two channels:
 - Kulunet (available through world wide web)
 - and paper reports sent by mail 4 times a year
 - 9 times a year was suggested to the pilot real estates

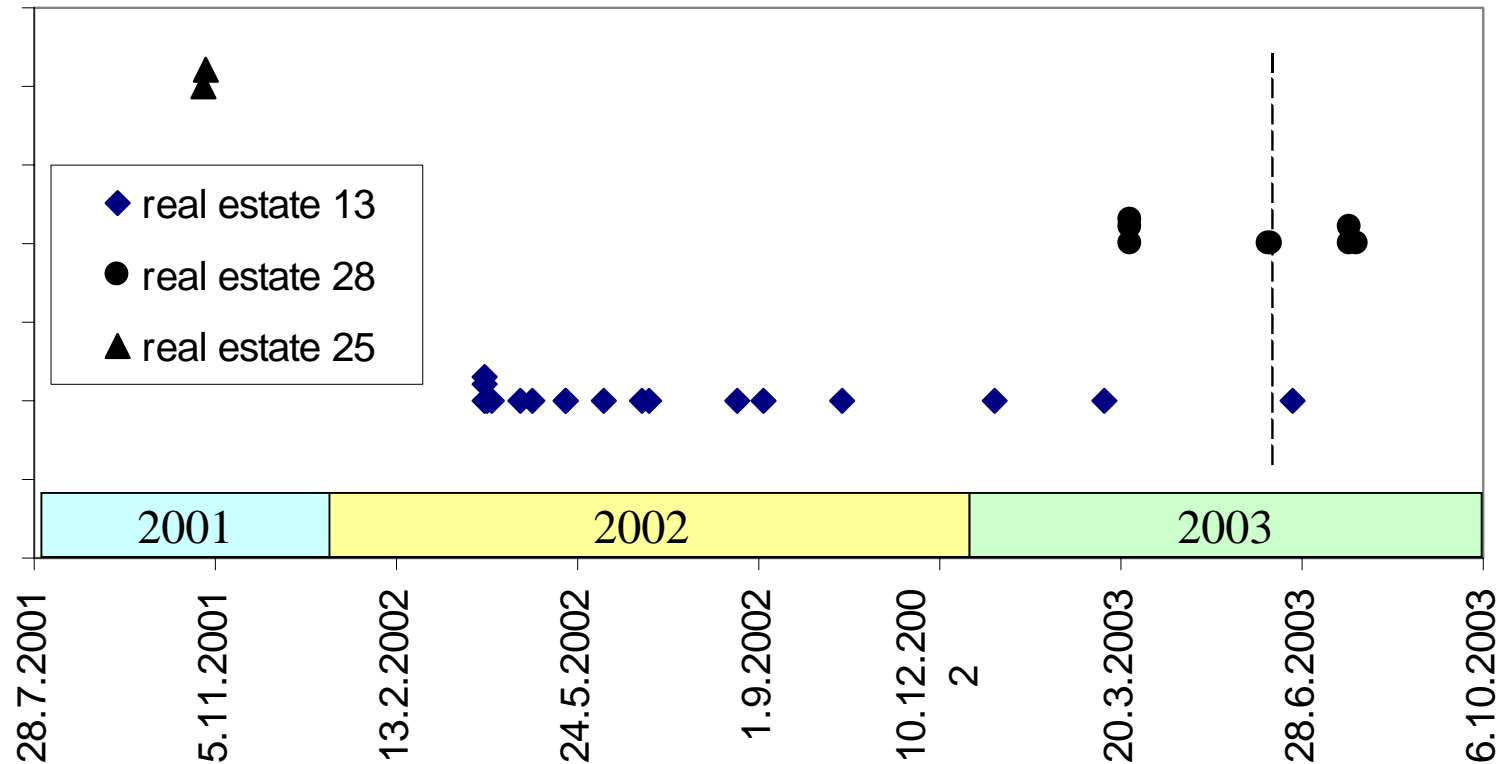
Kulunet availability

- ◆ Hourly consumption values have been available in Kulunet since September '03
 - because of system updates the hourly data has been postponed (originally should have been Feb '03)
- ◆ However, not all experts have access to the Internet, according to survey some 55 % (40 – 70 %) have
 - they have net connection at home
- ◆ For those experts who haven't found Kulunet yet, ready-made user names were created and sent in February '04

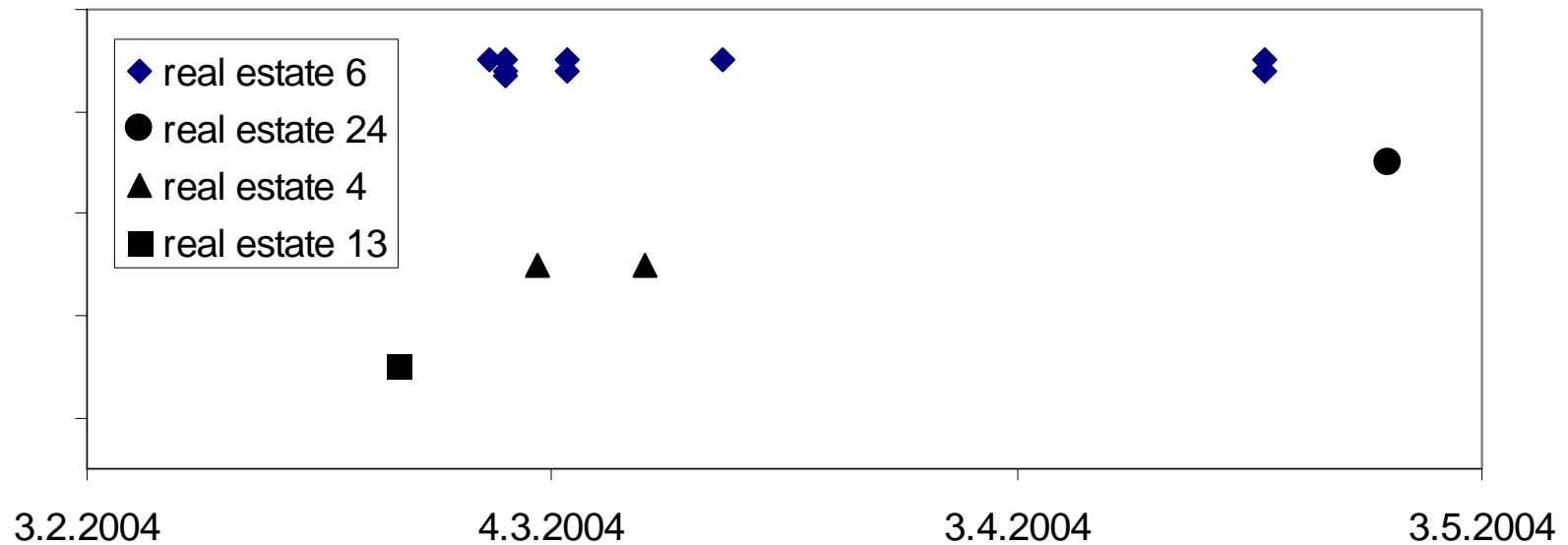
Kulunet availability schedule



Expert activity in Kulunet prior to 8th August '03



Expert activity in Kulunet after 16th Feb '04



Problems which experts face

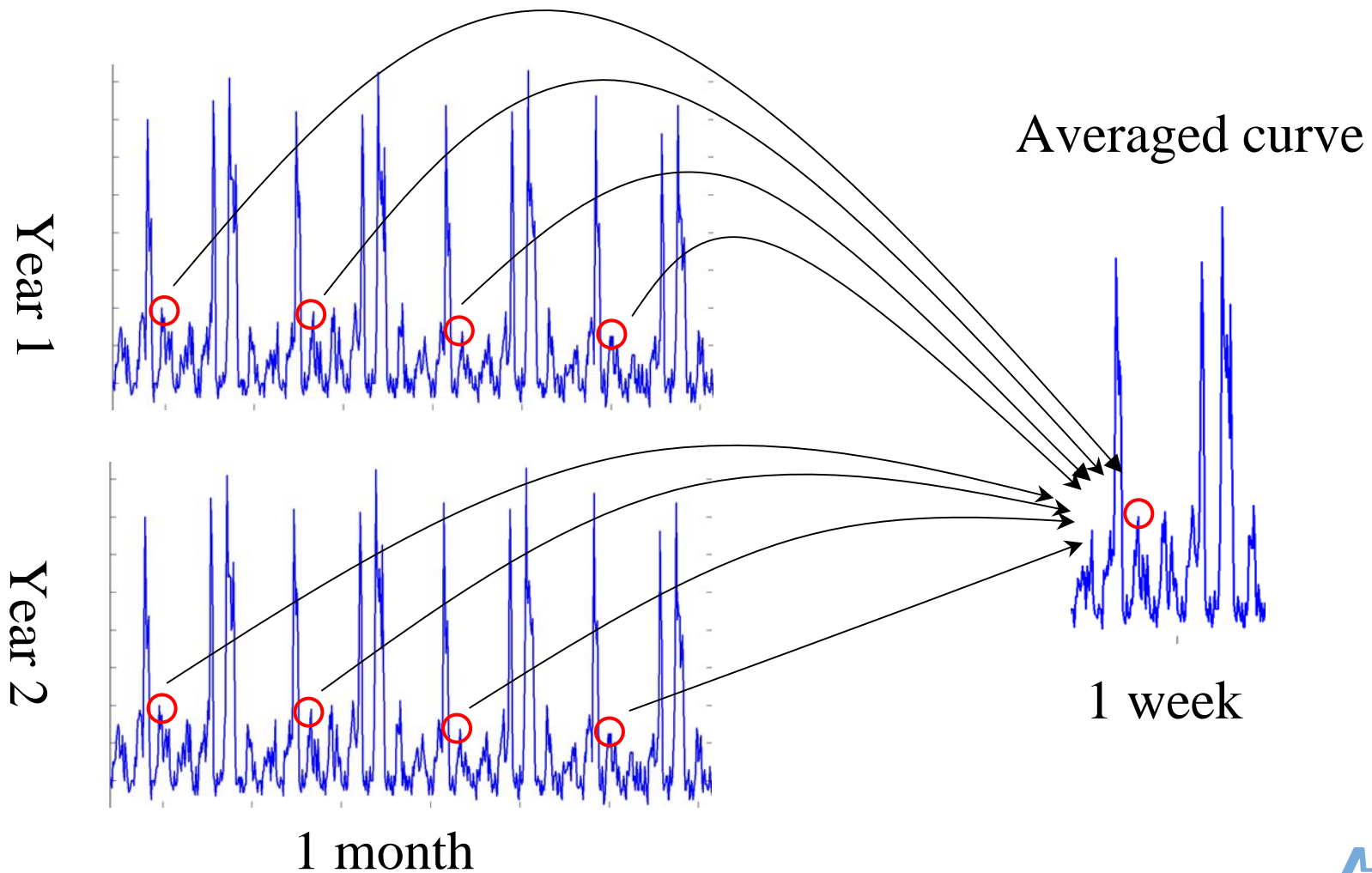
- ◆ Experts lack proper incentive to study the consumption data
 - they get no pay, may have to pay phone bill for Internet
- ◆ It is difficult to study the hourly values
 - there is a lot of data
 - need for guideline values, for example from previous years, corrected to current temperature
 - temperature dependency is not clear from the consumption data for most real estates
 - need to break up the hourly consumption into consumption from individual appliances
 - this may be possible to some extent in the future

Some consumption analysis results

Consumption curve averaging

- ◆ There is a lot of redundancy in consumption curves: same events take place from week to week and year to year
- ◆ Therefore, to reduce the size of data and magnitude of noise, averaging has been performed over weeks within one month
 - Data is reduced to $12 \cdot 168$ values per year
- ◆ Averaging can also be performed commonly for several years

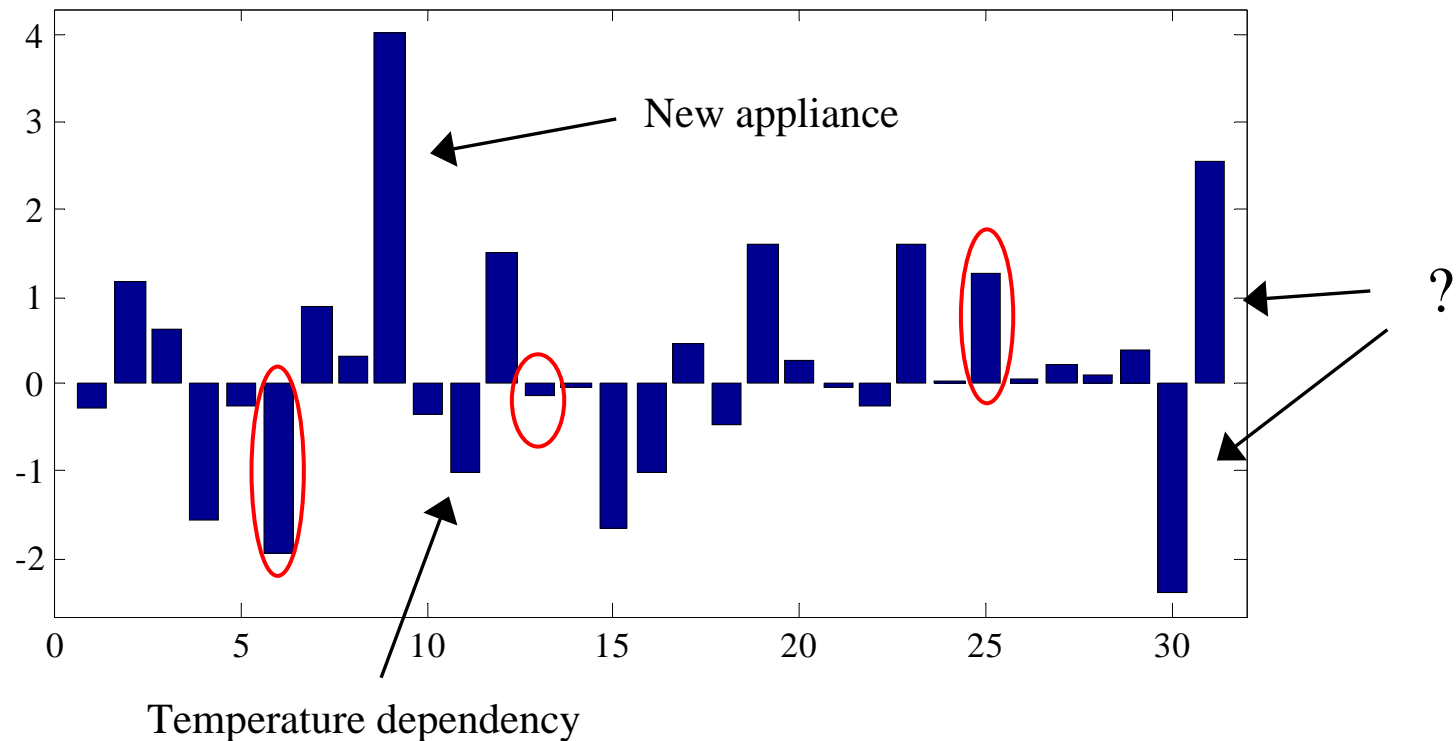
Consumption curve averaging



Average changes in Feb–Apr 2004 relative to 2001–2003

units standard deviations of the same months in different years

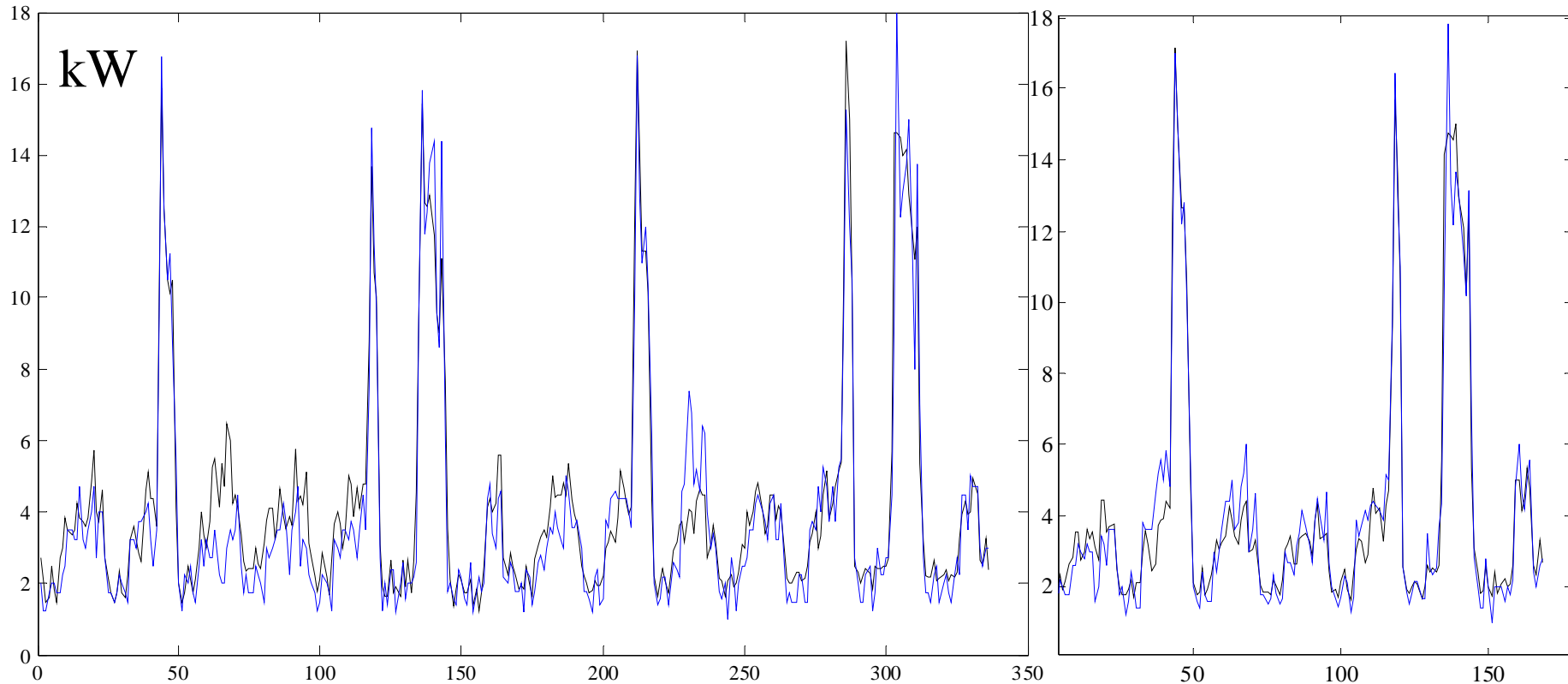
Change
standard
deviations



○ Active expert

Real estate number

Examples of consumption changes real estate 13 (active expert)



Nov–Dec 2003

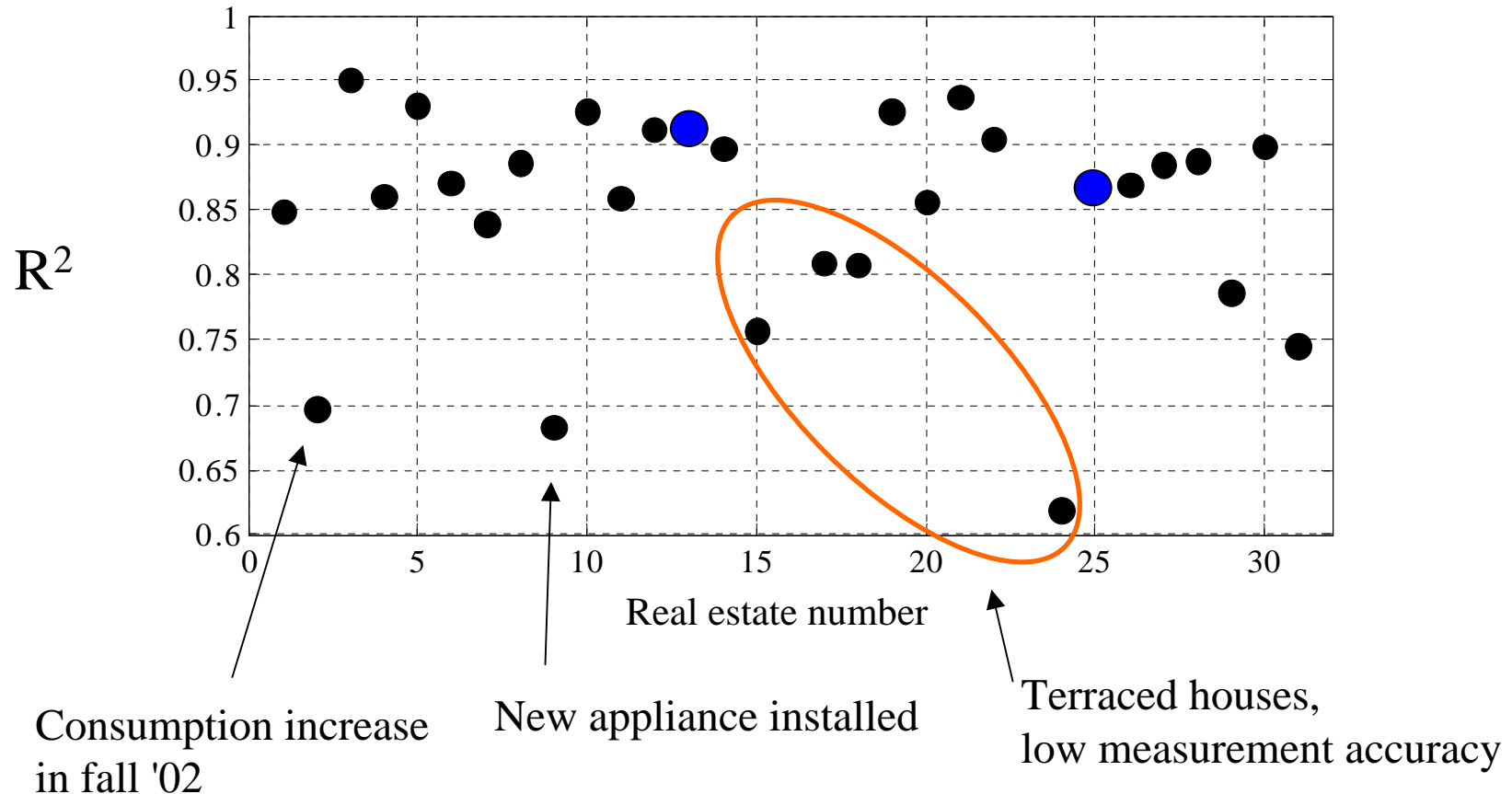
2004 Jan

2001-2002

2001-2003

Shapes of consumption curves remained almost the same

Comparison period July – January



● active expert

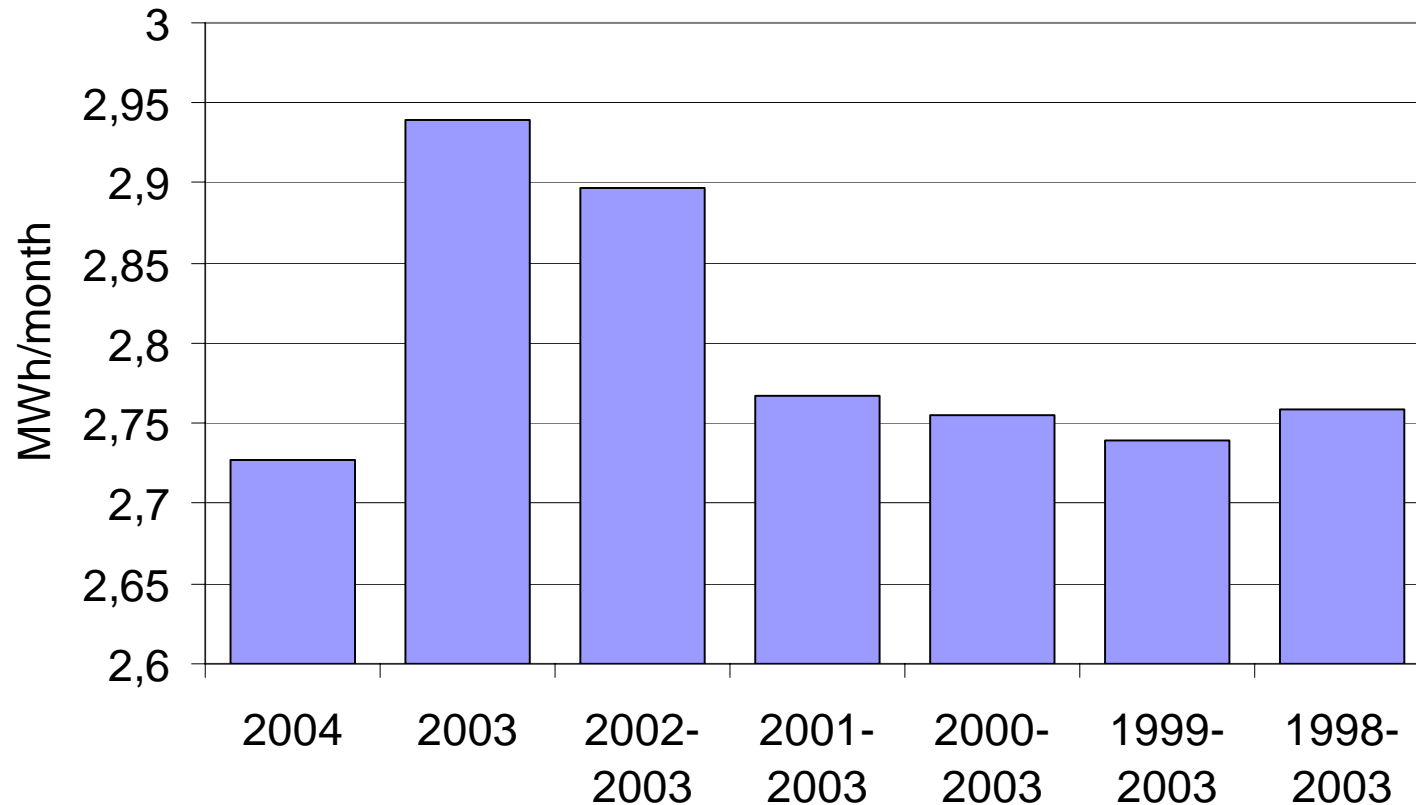
Changes in real estates, which had active experts

- ◆ Question of comparison period: what is the consumption compared to?
 - In previous figures comparison period was 2001–2003
 - hourly data is available from this period
 - if only monthly levels are compared, period can be chosen more freely
- ◆ When compared to 2001–2003 only real estate 6 had decreased power
 - they only started using *Kulunet* service in February '04

Real estate 13

the most active Kulunet user prior to August '03

Average consumption February–April

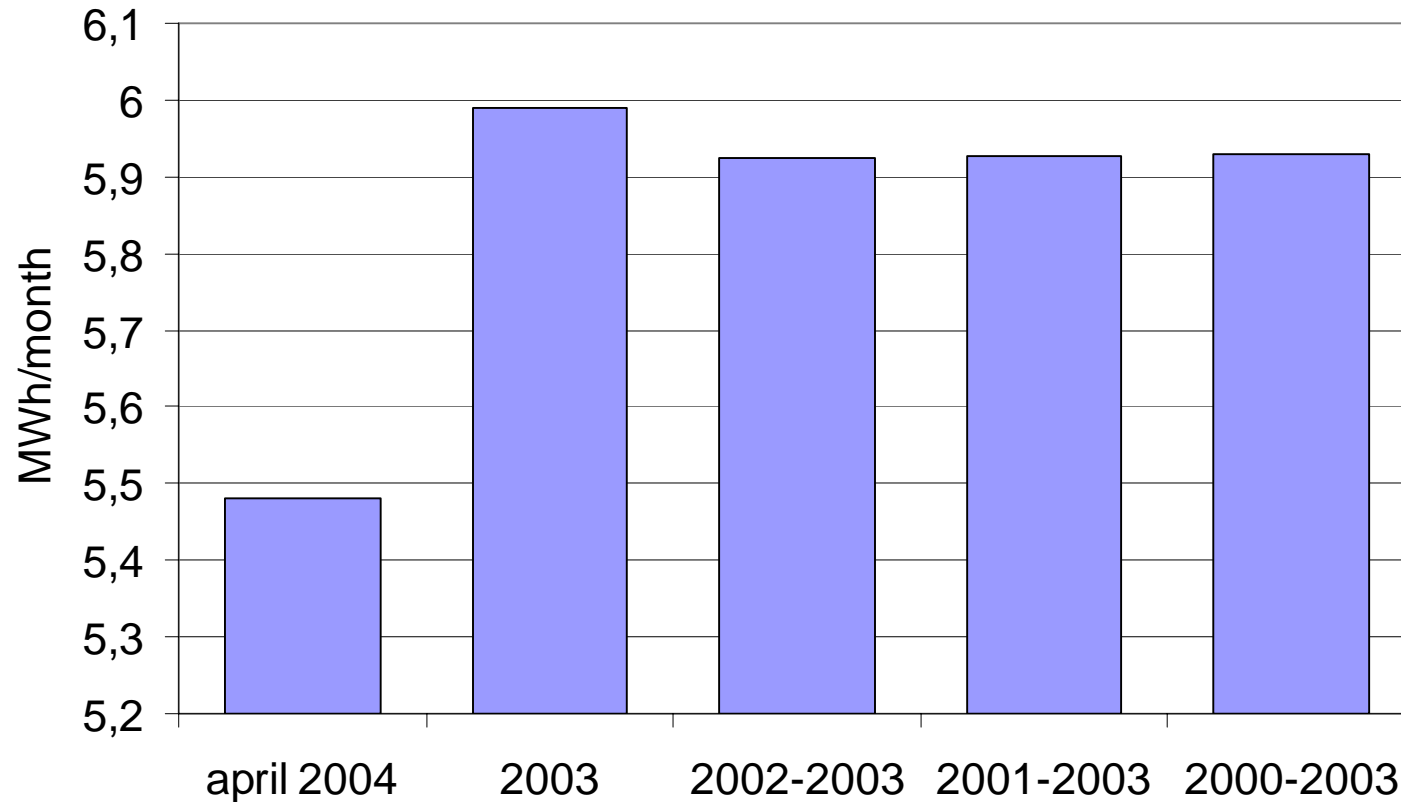


Real estate 13

the most active Kulunet user prior to August '03

- ◆ Consumption increased in 2002 and 2003
 - Reason (?): Washing machines were renewed / installed (?) in 2001
- ◆ Then again decreased to longer average in 2004
- ◆ The picture is similar for November-January
 - except that 2004 went below long average
- ◆ The reason behind the decrease is not known
 - the expert will be interviewed
 - however, the expert has changed

Real estate 6 April



Relative to 2001–2003: Feb -2.2 %, March -6.3 %, April -7.5 %

Conclusion

- ◆ Main result is that it is difficult to activate people to follow feedback without some kind of carrot
- ◆ Active experts should still be interviewed to hear what they have done, if anything
- ◆ The change in real estate 6 is interesting
 - probably not because of feedback (feedback starting 16th Feb)
 - note that there is even greater change in real estate 30
- ◆ In addition to experts, other residents should also have access to consumption data



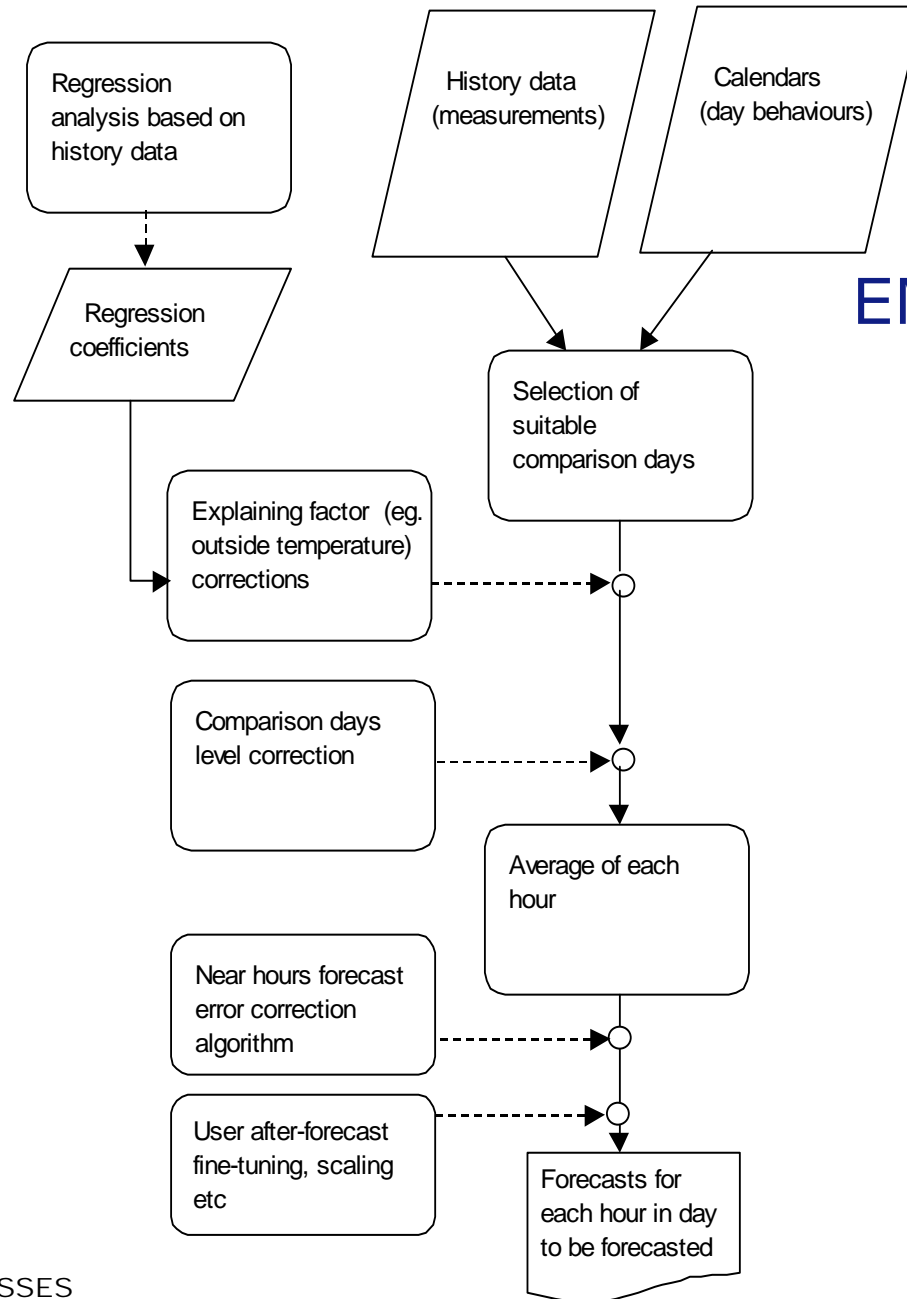
Some kind of automated feedback needed

EMEForecast

- ◆ To help the experts notice changes in hourly consumption curves, VTT has tested the possibilities to use a load forecasting "EMEForecast" software in the connection of Kulunet
- ◆ EME Forecast is a computer software for hourly load short ...medium term forecasting. It is a heuristic time series algorithm, trying to use the best sides of more formal approaches like ARIMA (autoregressive & moving average & differenced), regression analysis and load type libraries

EMEForecast (2)

- ◆ EME Forecast was especially designed for electricity load forecasting in the de-regulated market. Several features take into account the time lap, one or more days, before measurements finally reach the user.
- ◆ EME Forecast is used interactively or automated. It is easy to take into use, because no target specific parametrization by the user is required
- ◆ The software was tested on the hourly real estate electricity curves at VVO and functioned well



EME Forecast program schema

- Main core consists of selecting comparison days and calculating their hourly averages
- Averages can also be taken from hour values cleaned from high and low values (median area average)
- Selectable features are marked with a dashed line

Example: real estate 12 forecasted, March '03

