Energy consumptions of public sector, Energy audits and the Intelligent network

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Draft

- Curve analysis
- Audits
- Energy management
- Intelligent networks and customers

Focus on the public consumption

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- Residential area
- Flats
- Housing estates
- **Hospital**
- **Library**
- **Local government office**
- **School**
- **Caretaking home for old people**
- **Kindergarten**
- Industrial buildings
- Office towers
- Agricultural buildings

The energy

- Electricity
- Gas
- Remote heating
- Water
- Canalisation
- Telecom

Everything that „come from the utility”

(and the bill comes)

The sources of the data for further analysis

- Yearly invoices
- Monthly invoices
- Daily meter reading
- Automatic meter data for every 15 min
- Rough estimation based on nominal power consumption and watch
- Measurement, etc.

Load curve – like the EletroCardioGram (ECG)

Traditional load curve analysis

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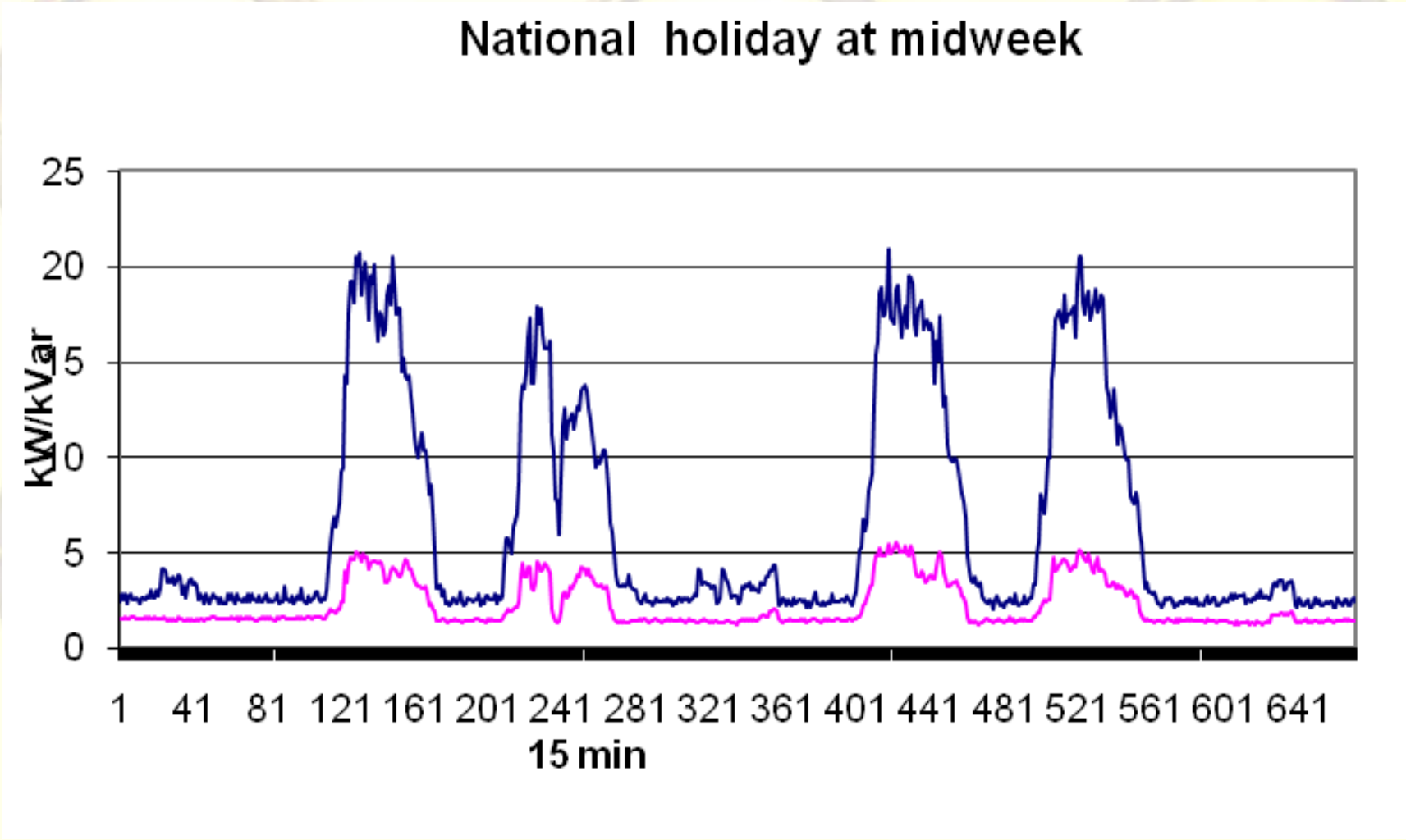

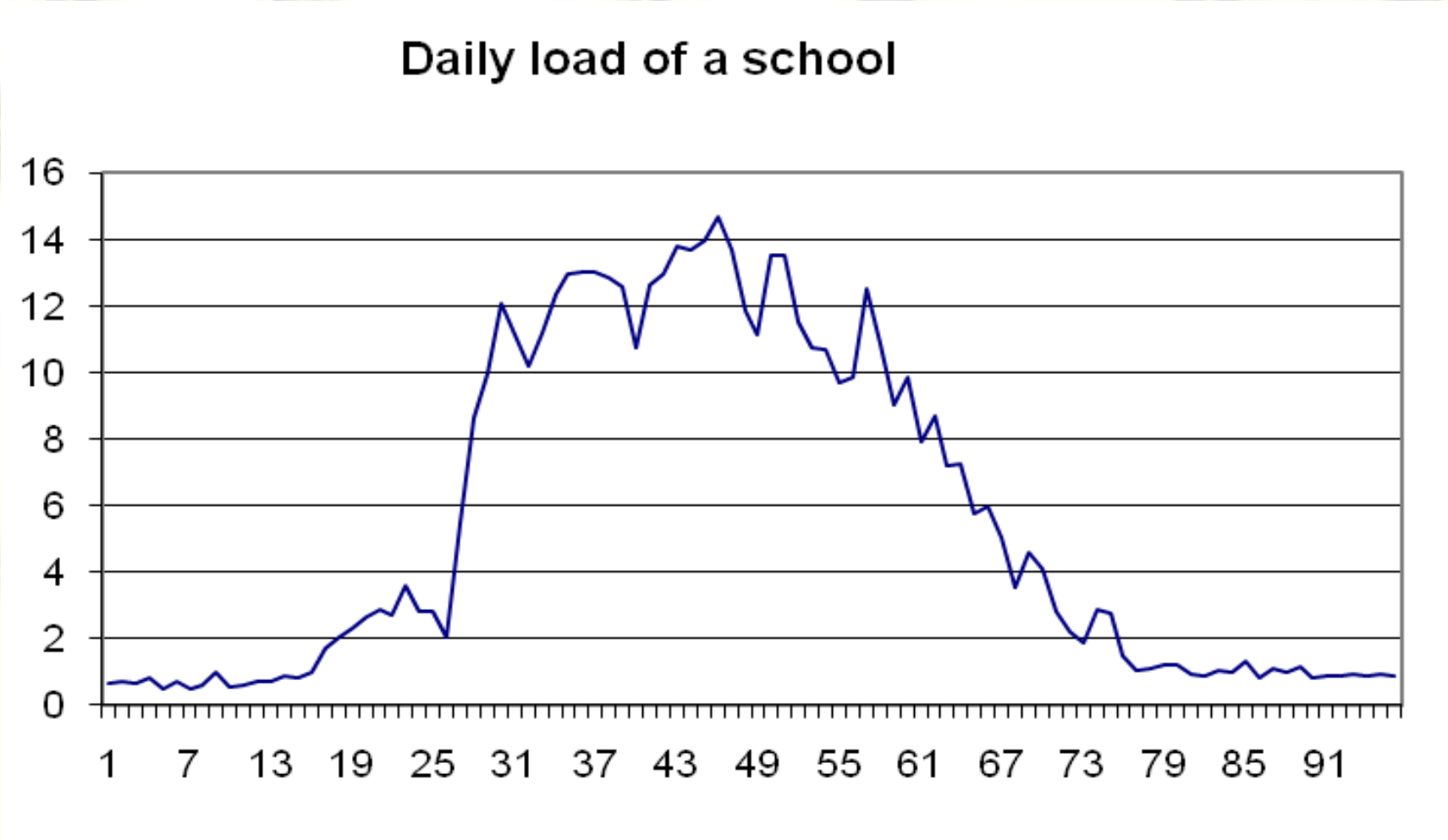
Daily load of a school
16
14
12
10
8
6
4
2
0
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91

Daily load curve of a primary school

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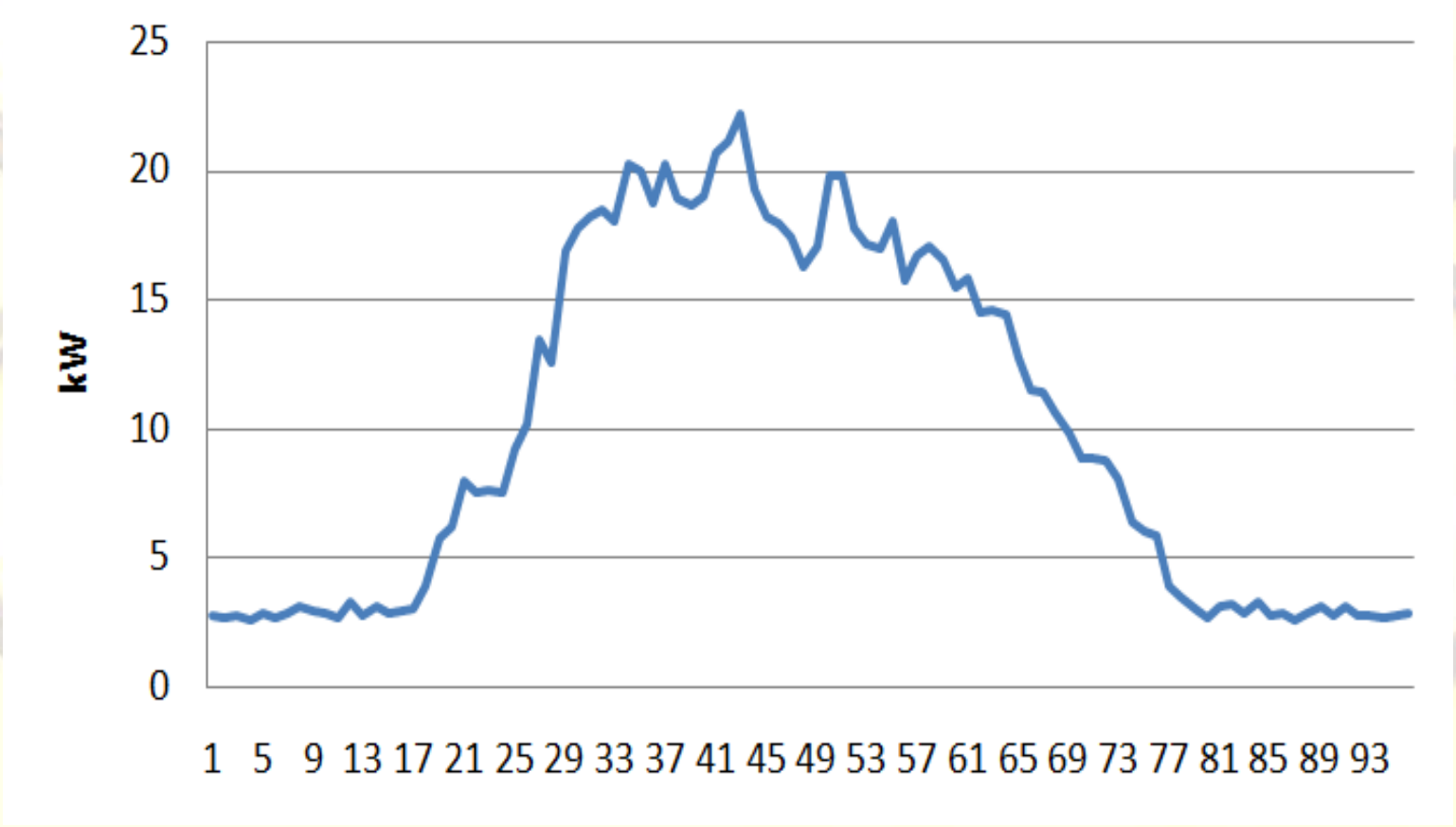
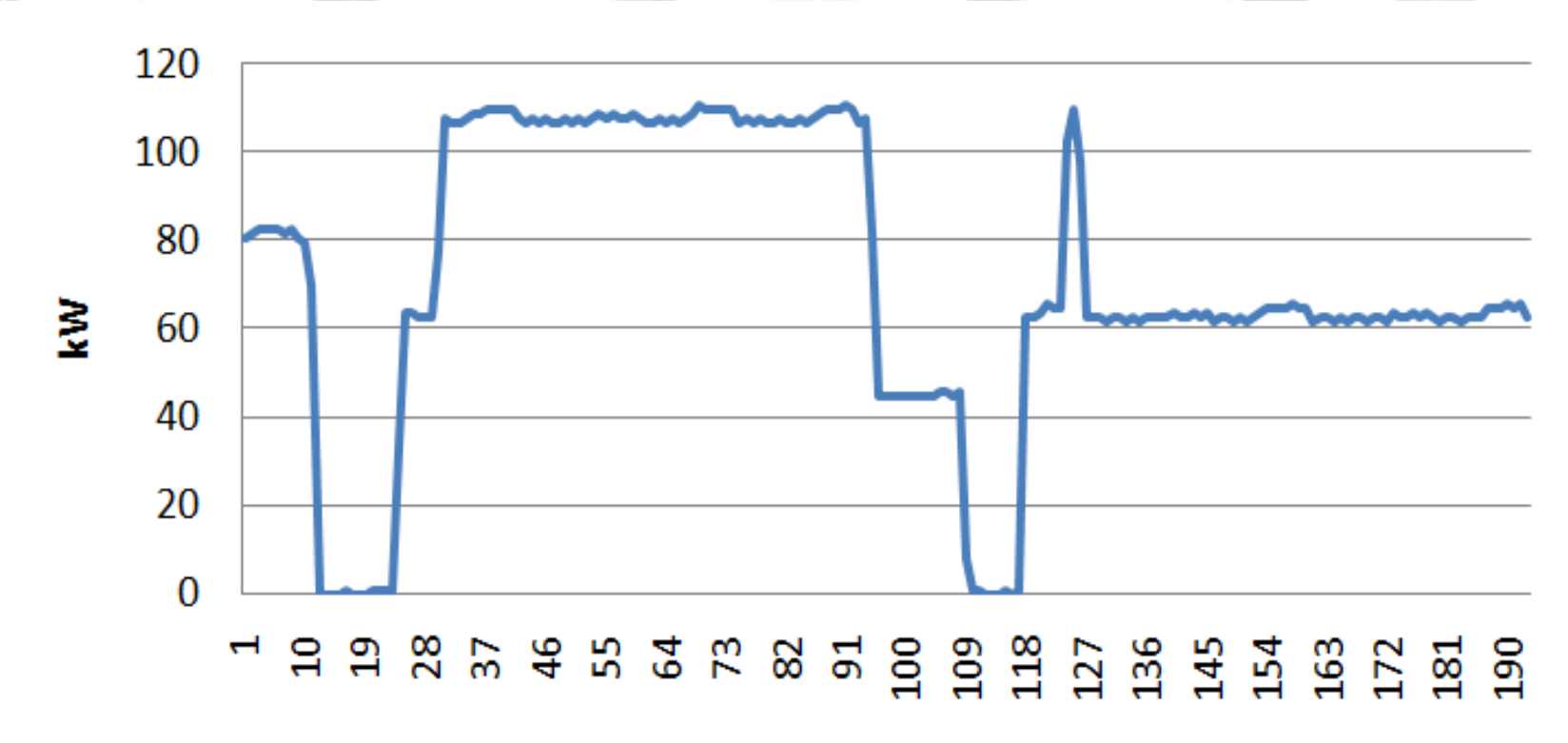
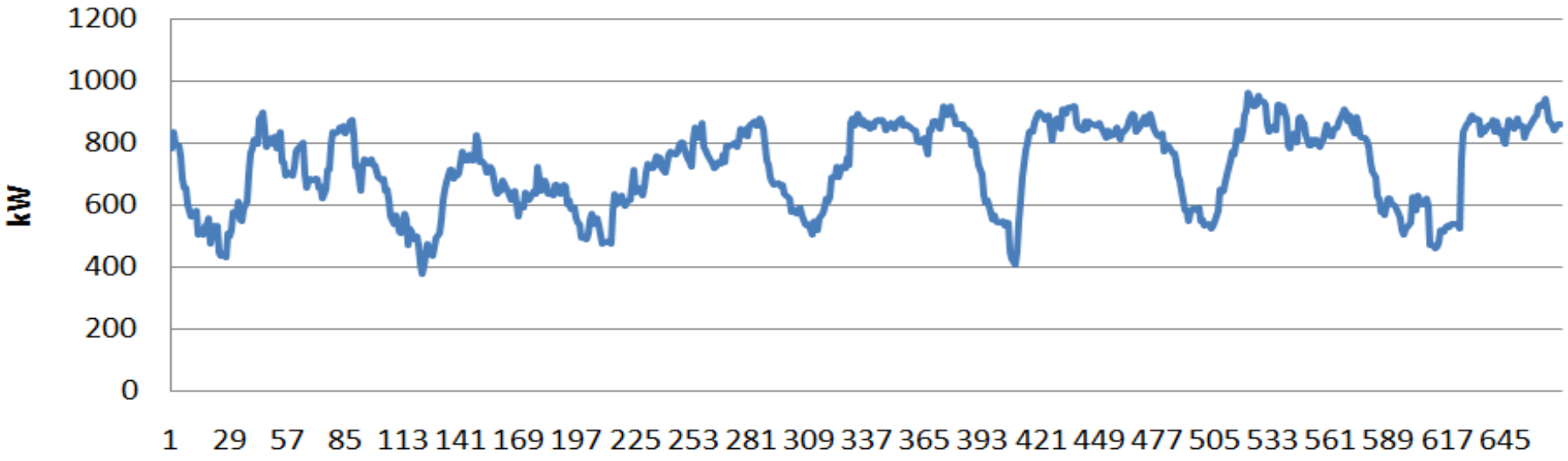


Daily load curve of a water well



Aggregated load curve of 7 water pump in a week



High school, building I. a March week

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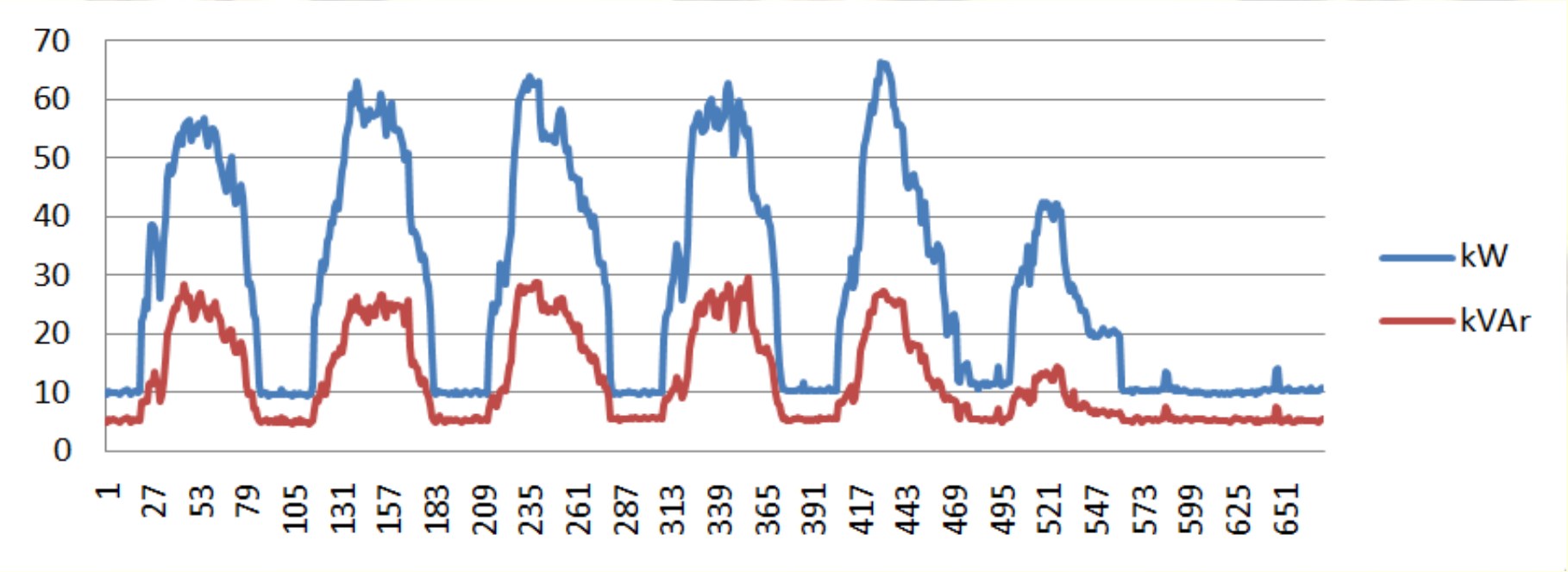
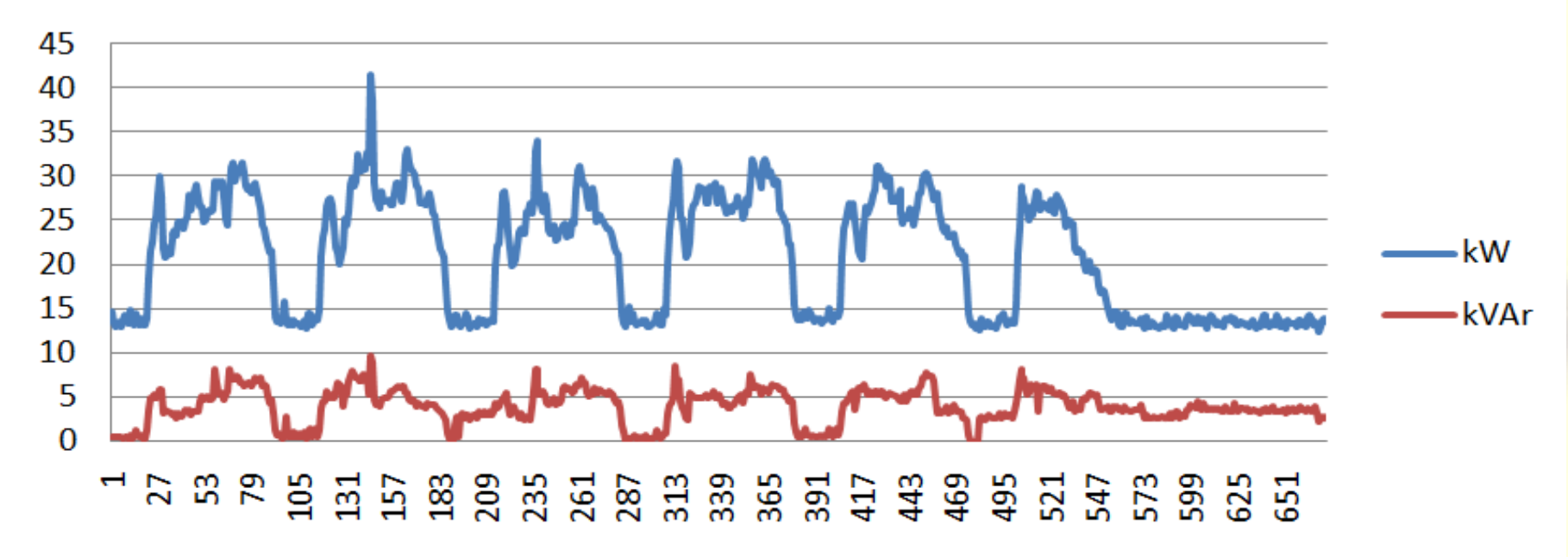


High school building II., a March week



Grammar school, a February week

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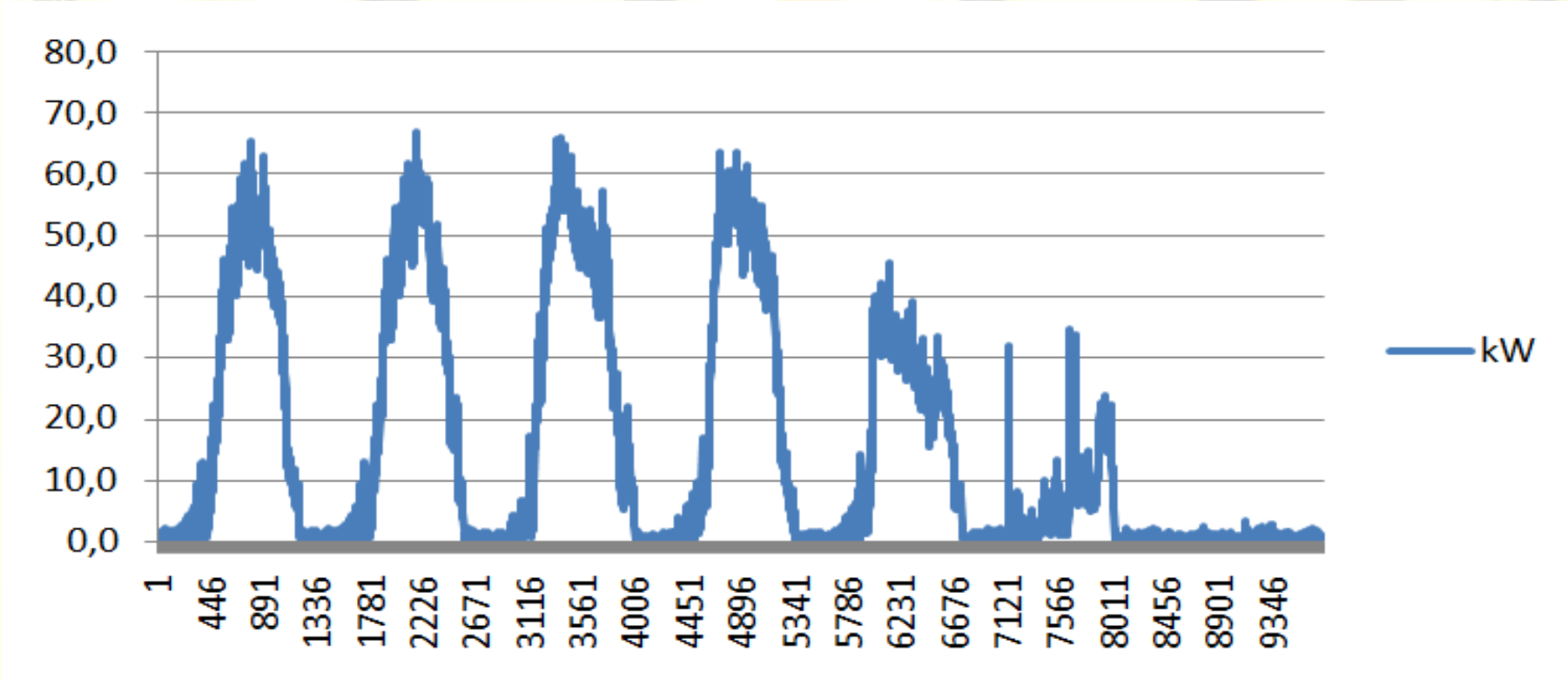

Grammar school, January weeks

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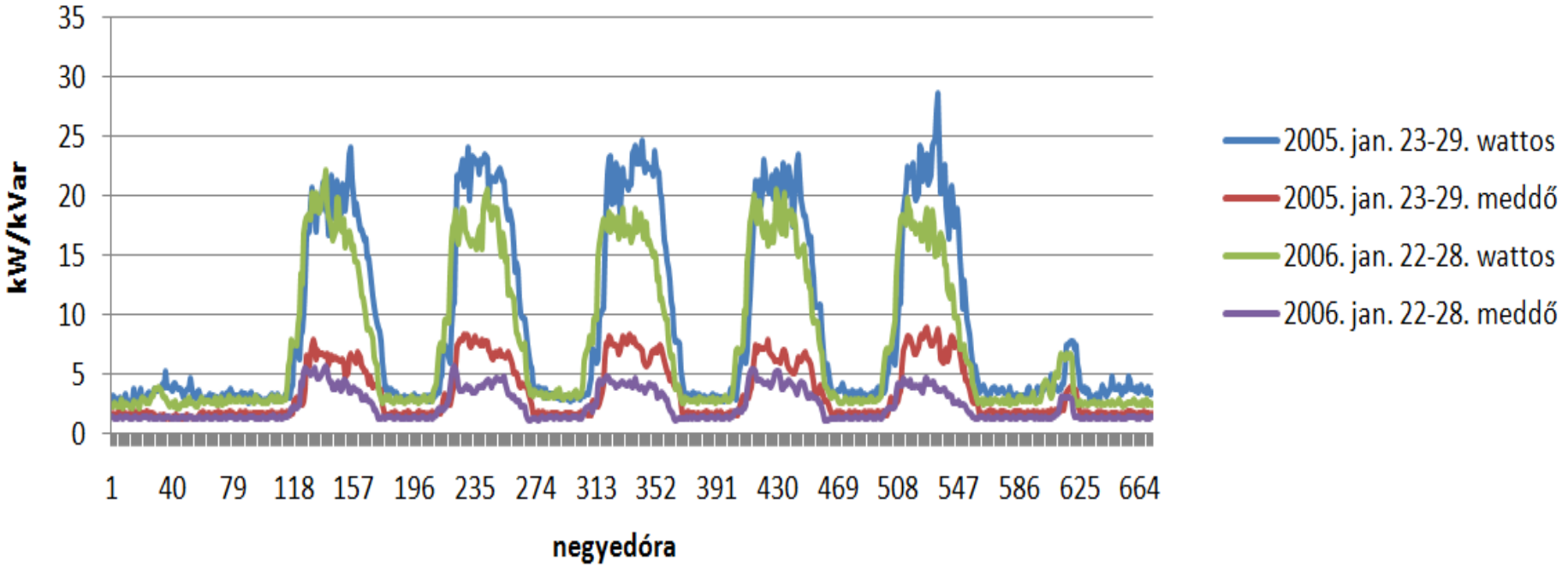

National feast

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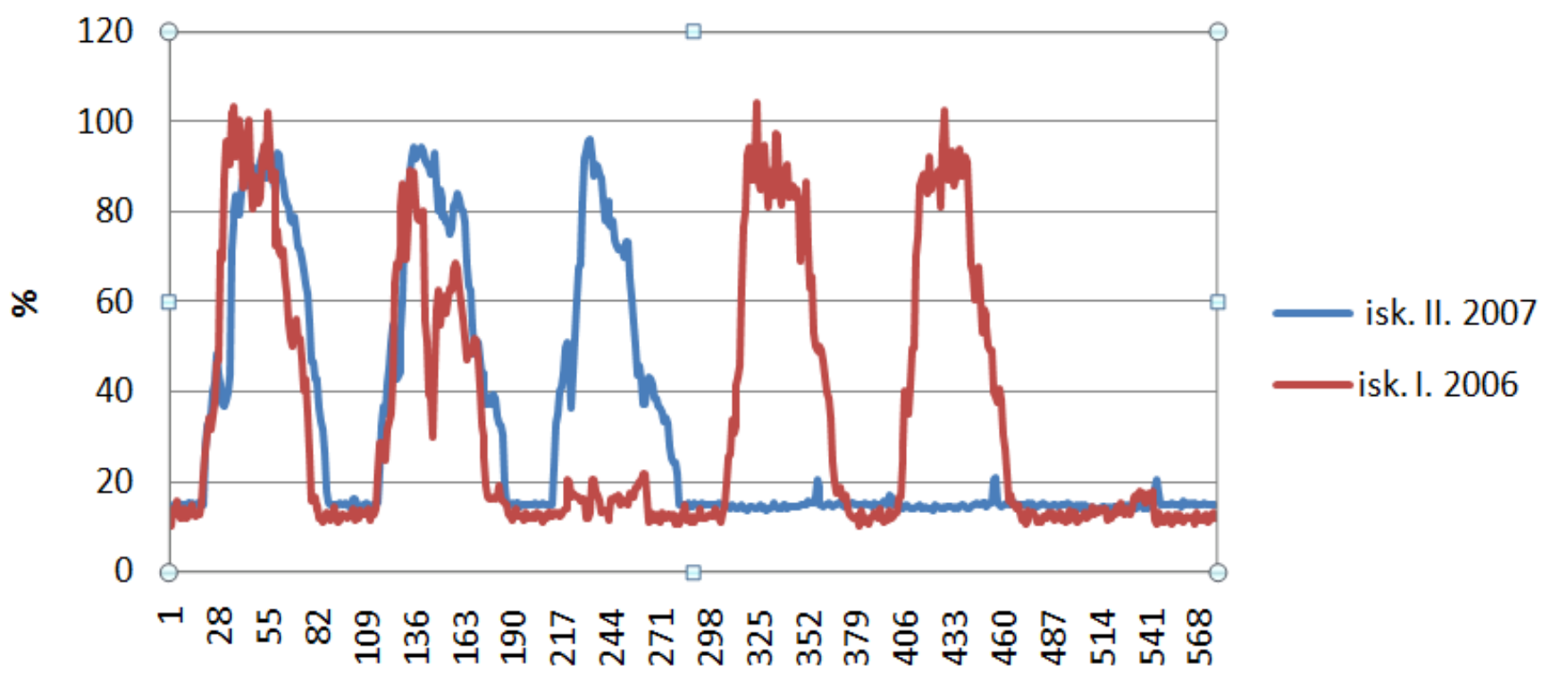

Monthly electricity consumption of social institution (11 months)

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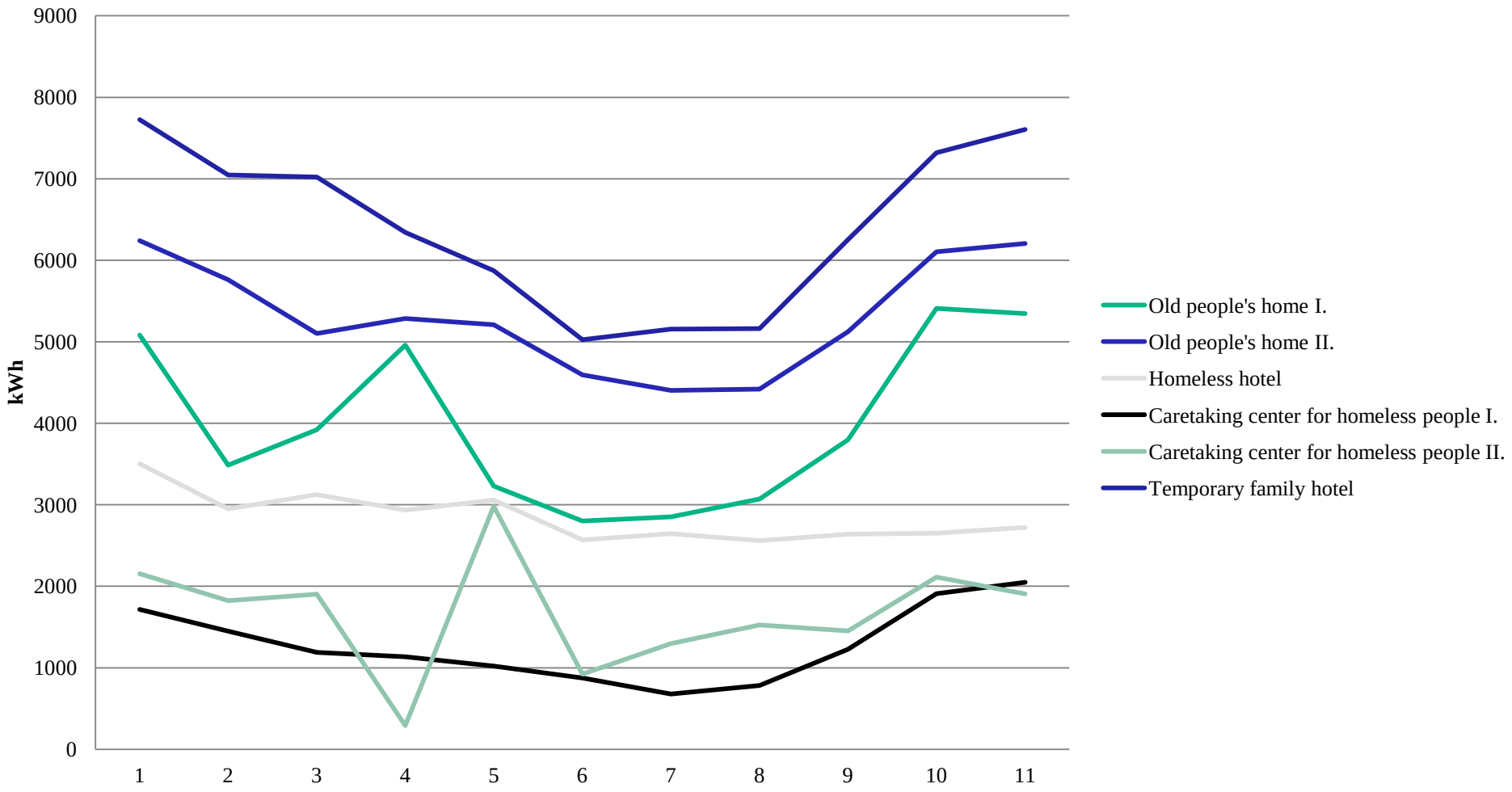

Seasonal gas consumption in social institution (12 months)

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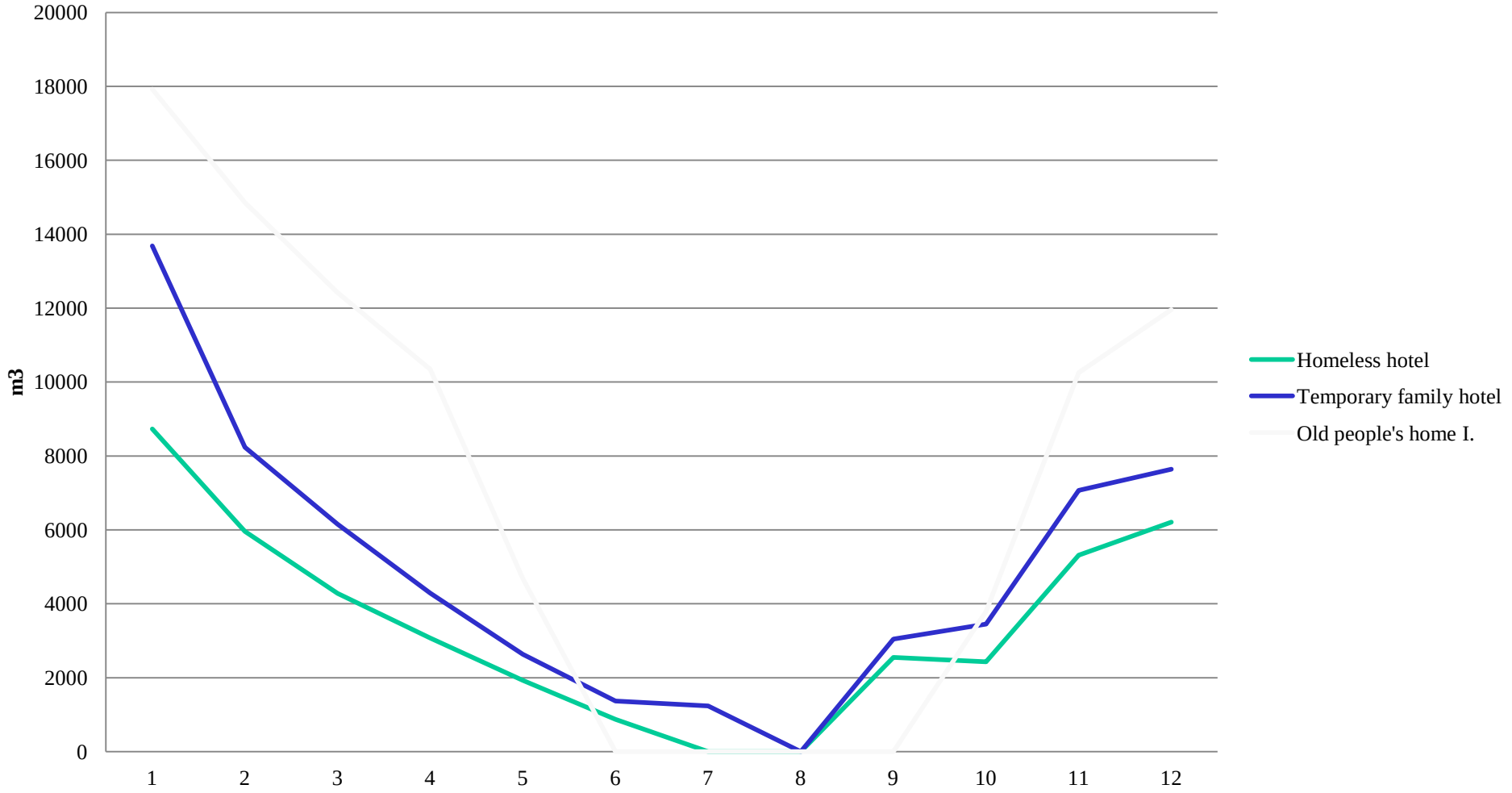

Monthly electricity consumption data of a water utility

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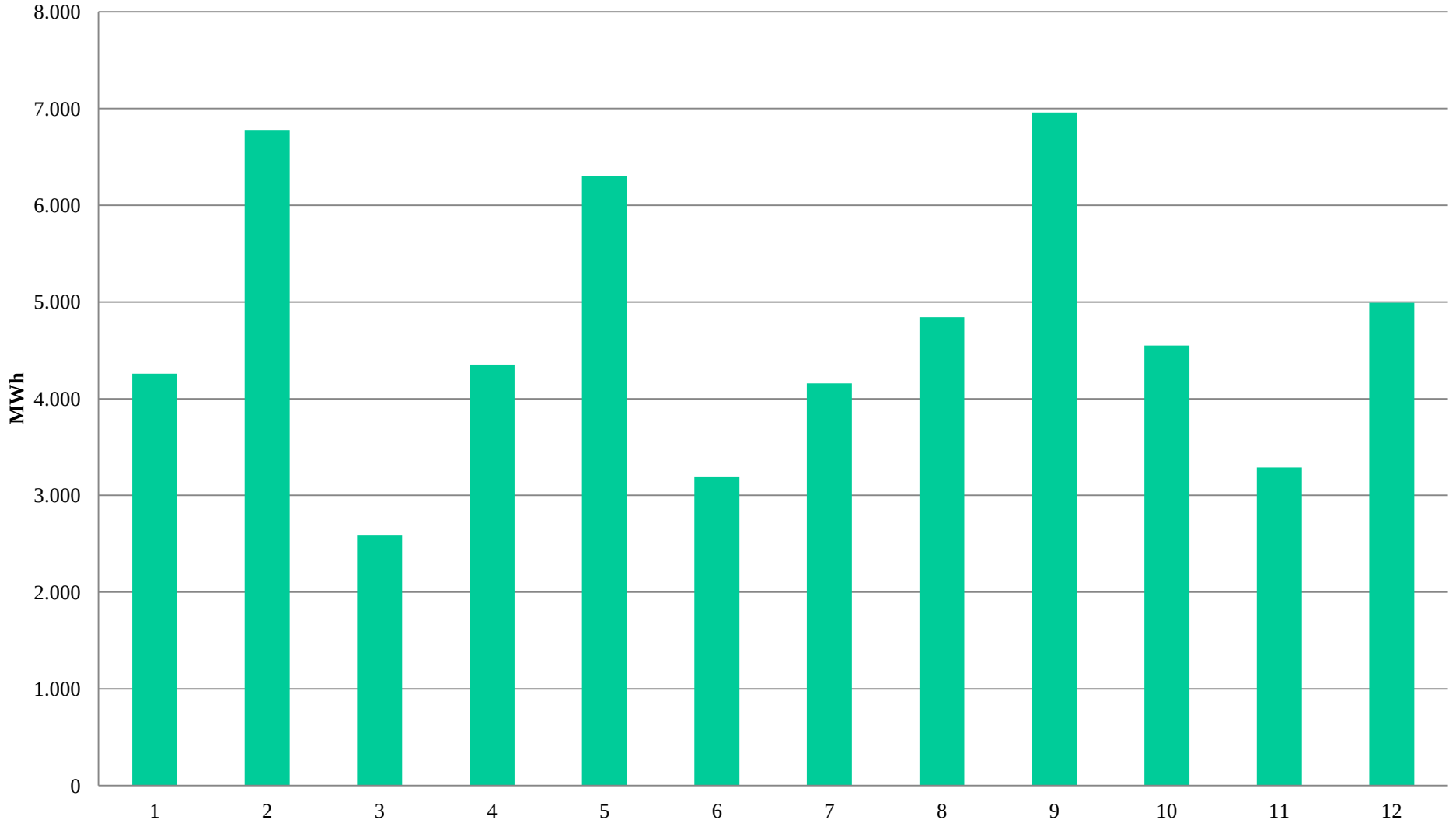
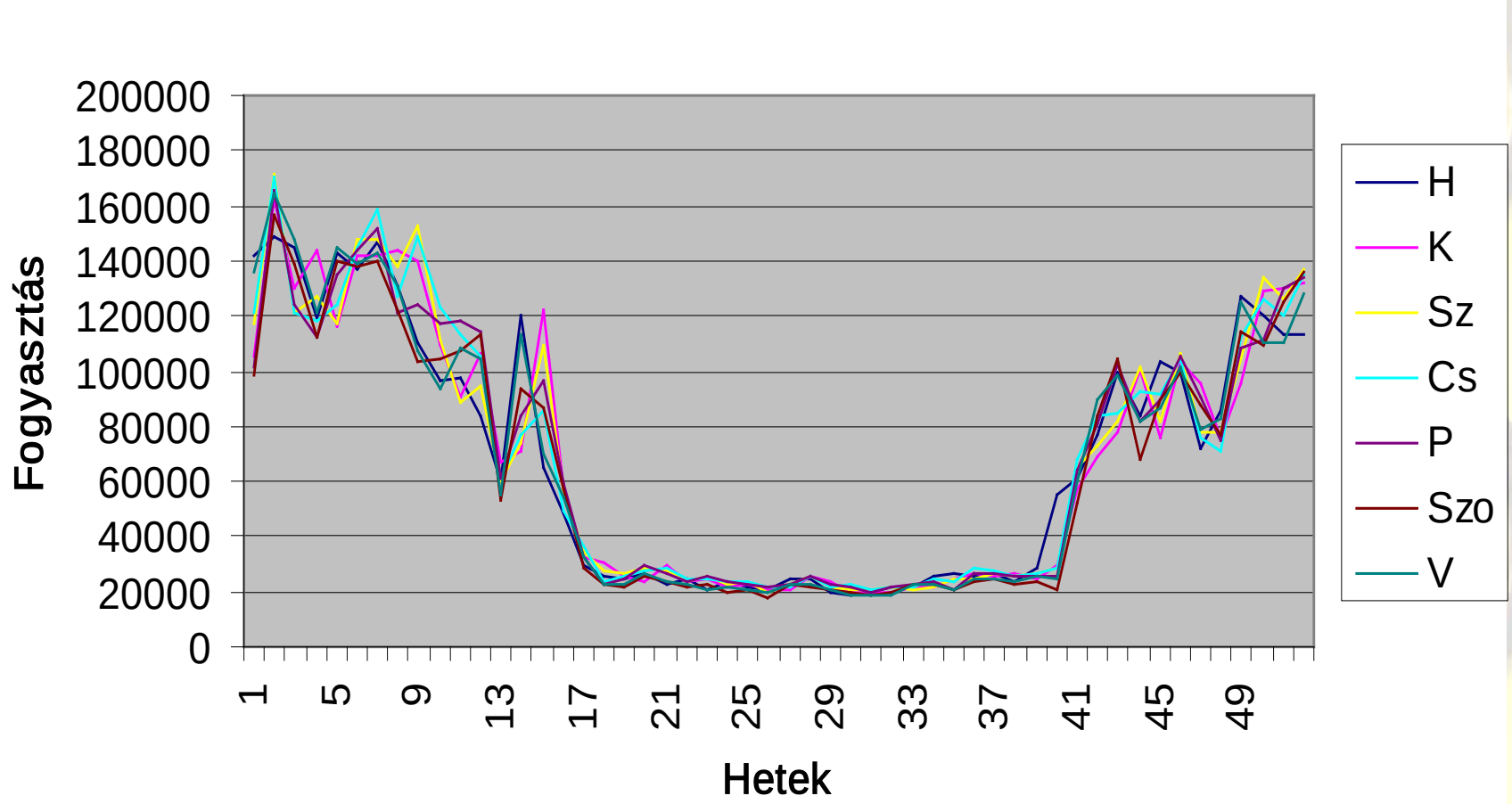


Daily gas consumption in a year



Energy consumption audits

The basic rules of the energy management

- How can you **spare** energy?
- How can you use with greater **efficiency**?
- How can you buy **cheaper** energy?

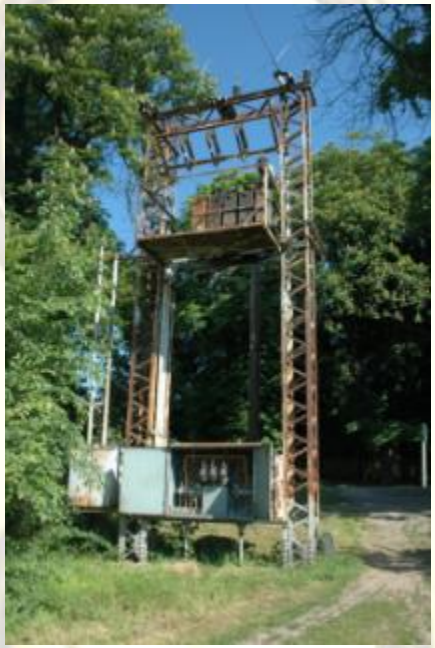
Questions to answer

- Ratio of the energy consumption
- Assessment of the present energy purchase
- Assessment of the energy management person/system
- Is there any anomalies? – benchmarking
- Capability of the loadforecasting
- General status of the technical devices
- Thermal isolation (heating and cooling)
- Recommendation for the control of the heating/cooling. Shadowing – passive houses
- Alternative, direct energy usage (lighting, heating)

Methodes of energy audit

- Walk and look
- Talk and hear
- Assessment of the building heating/cooling system
- Analysis of elecricity and gas consumption
- Investigation of the alternative sources
- Thermovision
- Project plan, etc.

The way of the electricity



10/0.4 kV transformer

Current transformers

Meters

Devices from different ages

10/0.4 kV transformer

Meter box

0.4 kVmain supply

Electrical devices

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10/0.4 kV transformer

Aggregator

0.4 kV distribution box

Metering in Hungary

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Metering in Greece

Metering in Greece

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Reactive power compensation and distr. boxes

UPS and batteries

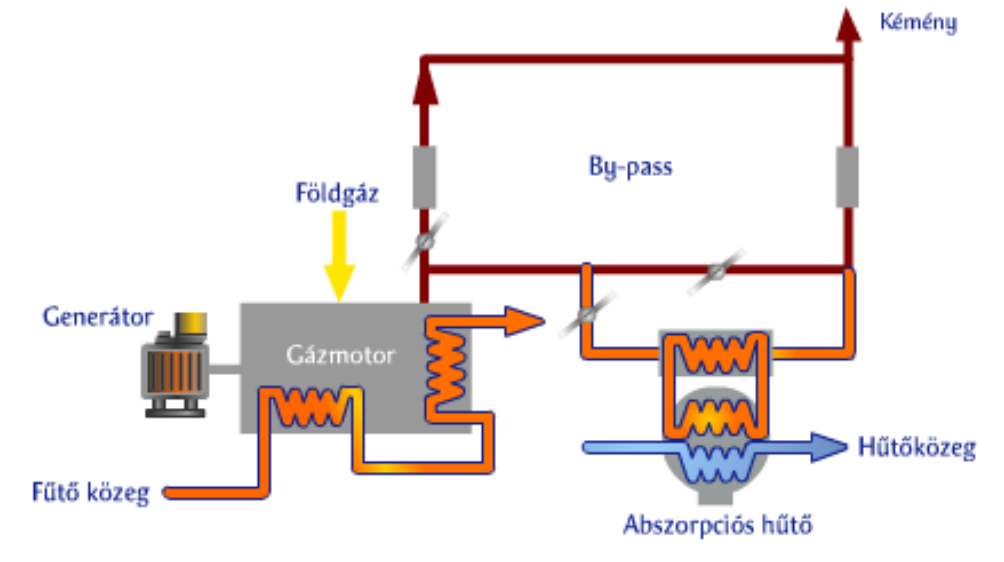
Problems of public energy management

- Costs occurre later (bill arrives months later than the real consumption)
- Fixed prices, the consumption can not be changed
- The public customer is a „ financially secure customer”
- The technical and financial management is distributed

Present deals

Co-generation – tri-generation

Natural gas -> electricity + heat + cooling



Gas engines

- 400 pcs in Hungary
- 600 MW biult in capacity
- State support
- Co-generation

Electrical energy management: active power and the tariffs

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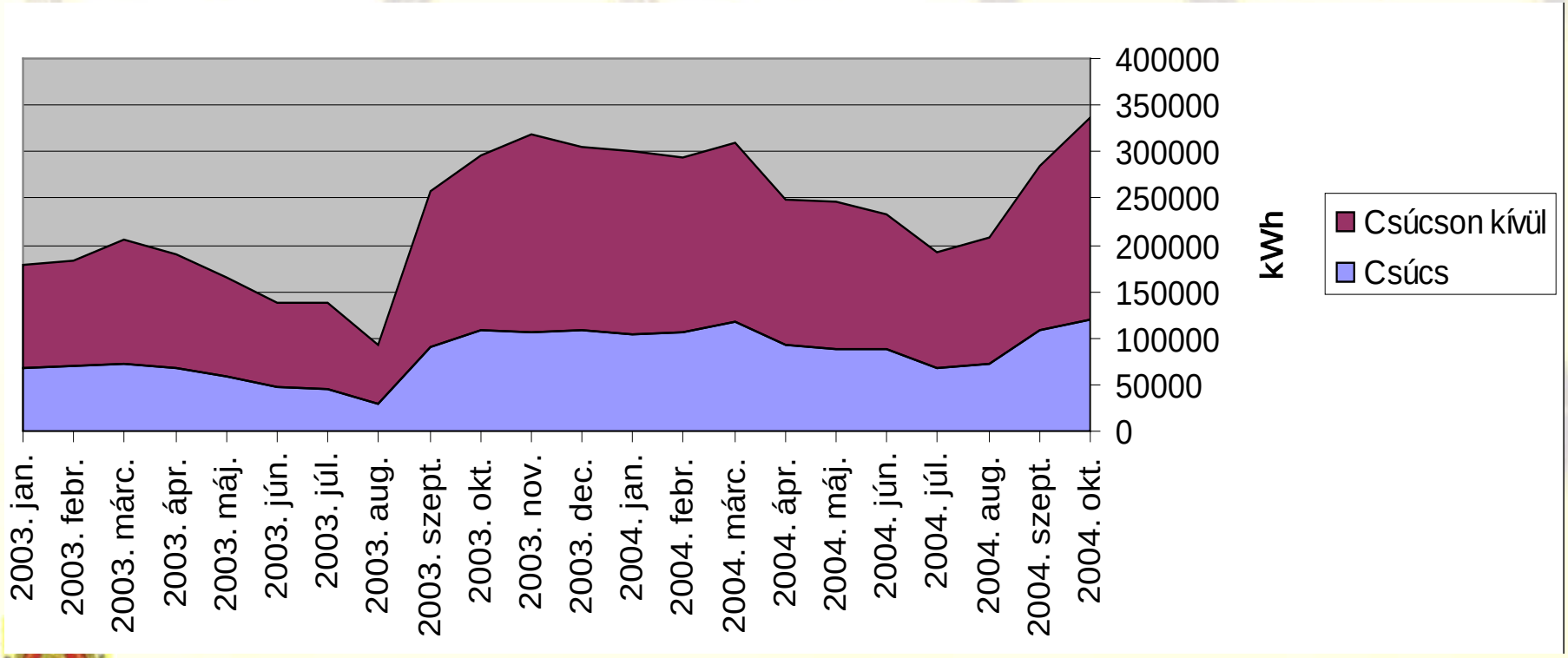

Electrical energy management: peak power

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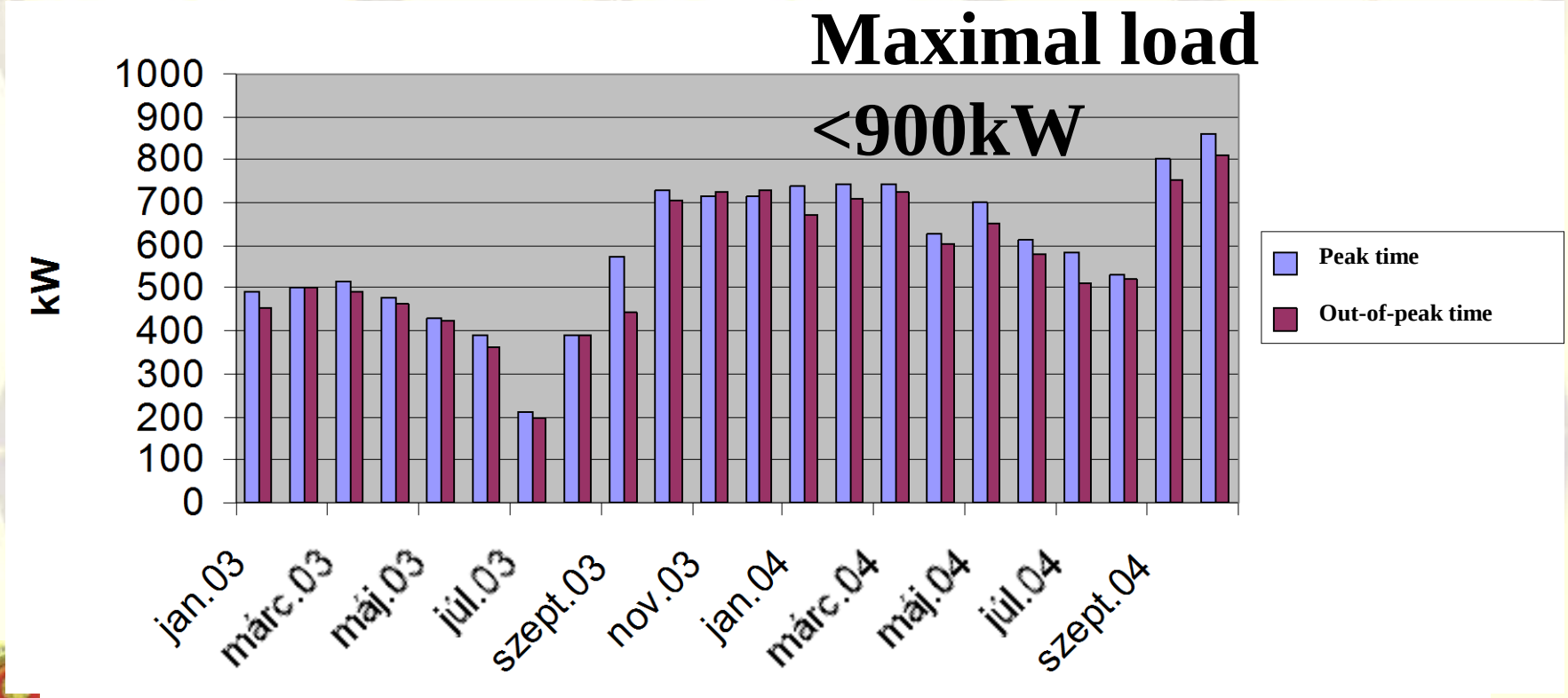

Peak must be set/controlled by the tariffs

Electrical energy management: predefined peaks

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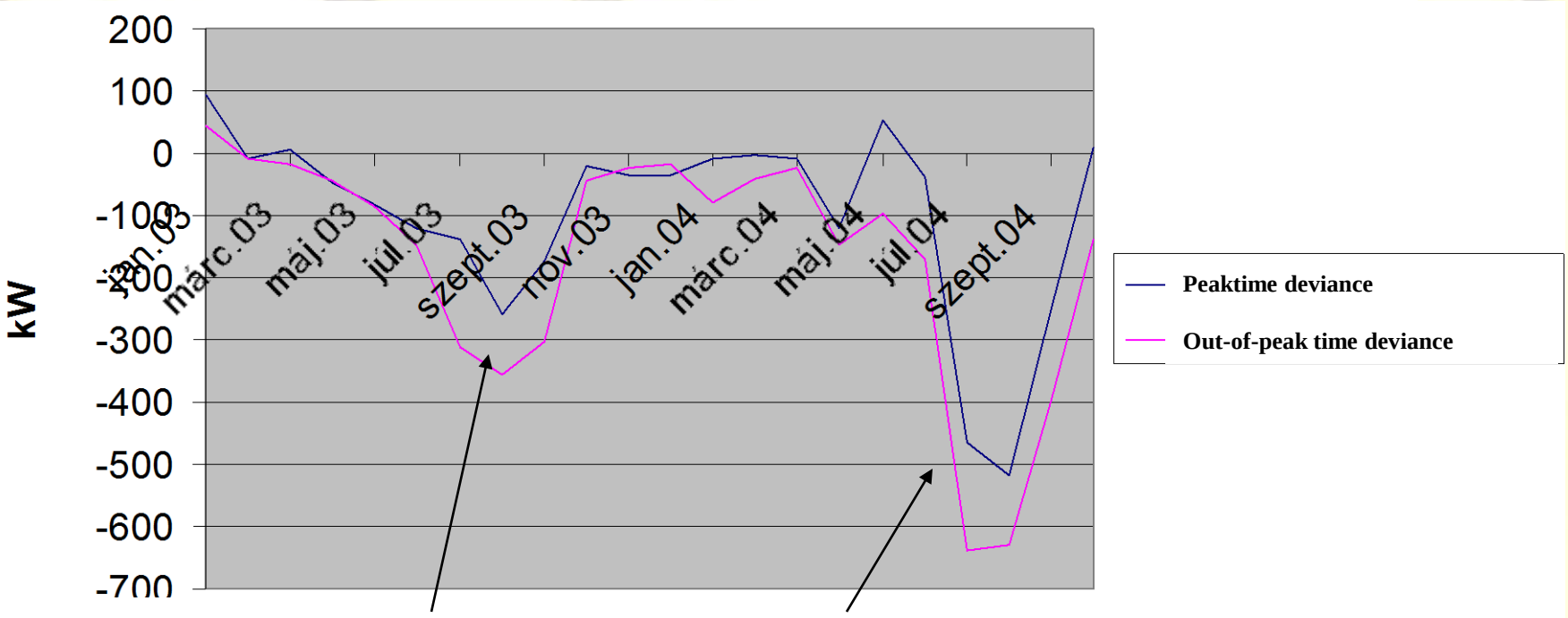
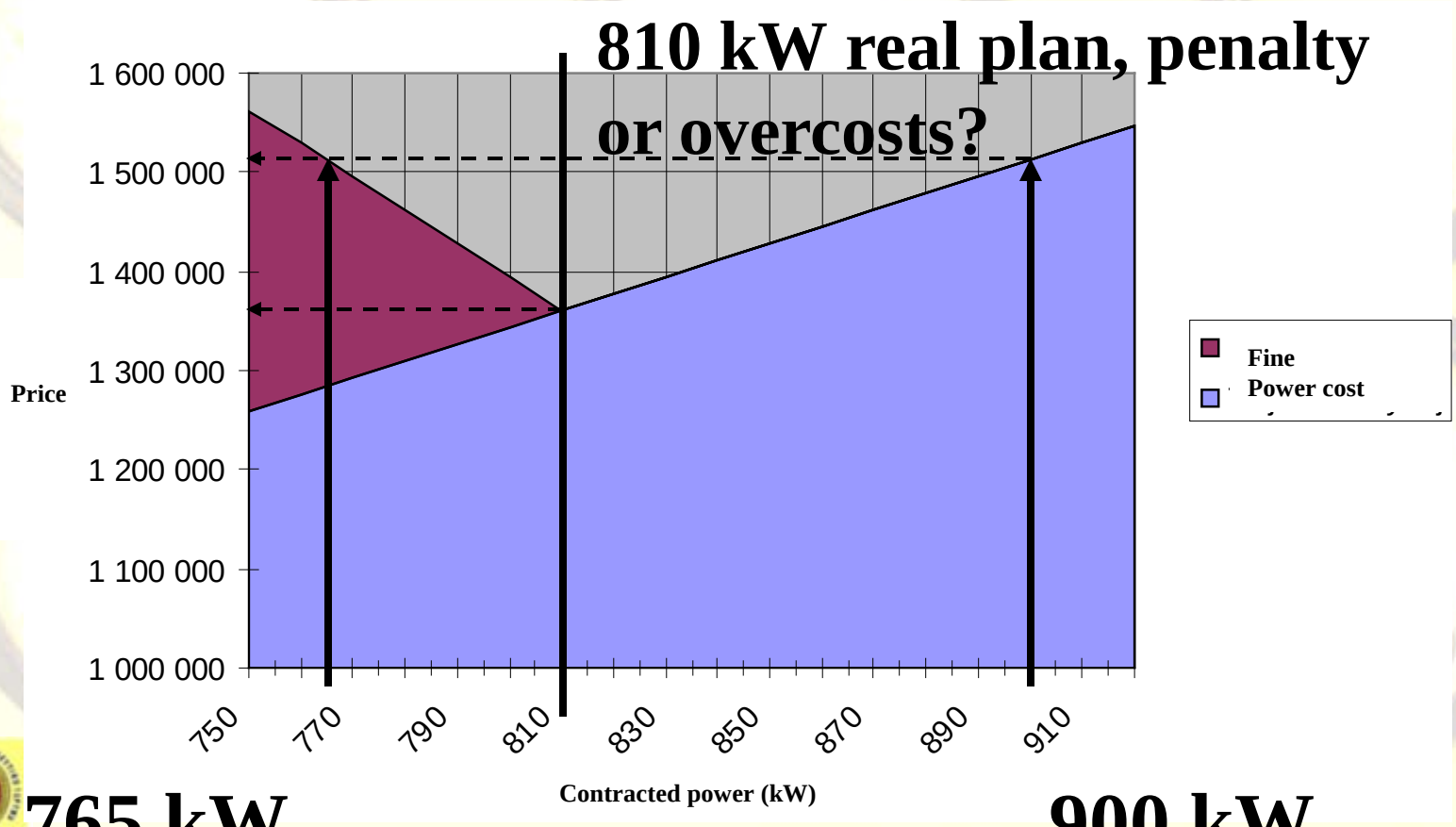
oversizing !



June, July, August, September – lower consumption – higher costs

Over- and undersizing of the prefixed peak

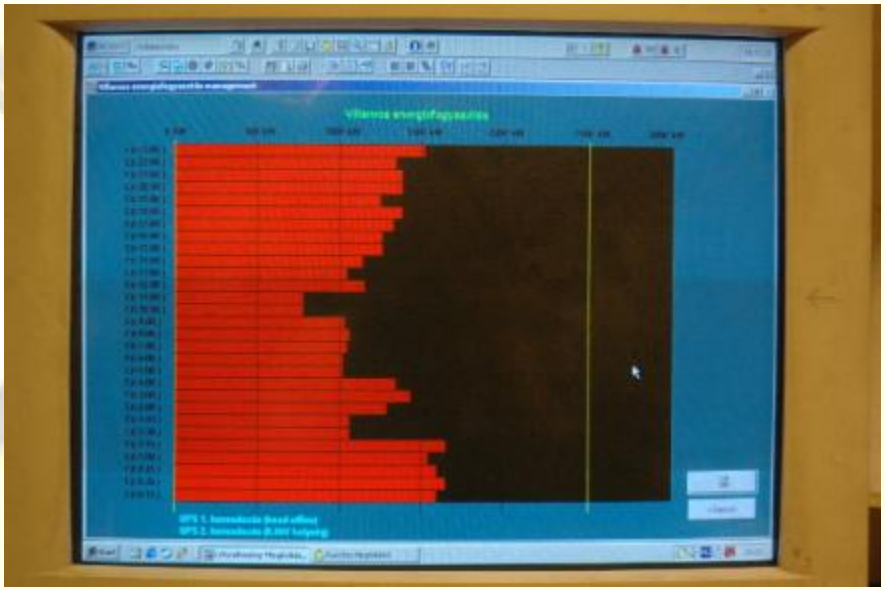


765 kW fixed

900 kW fixed

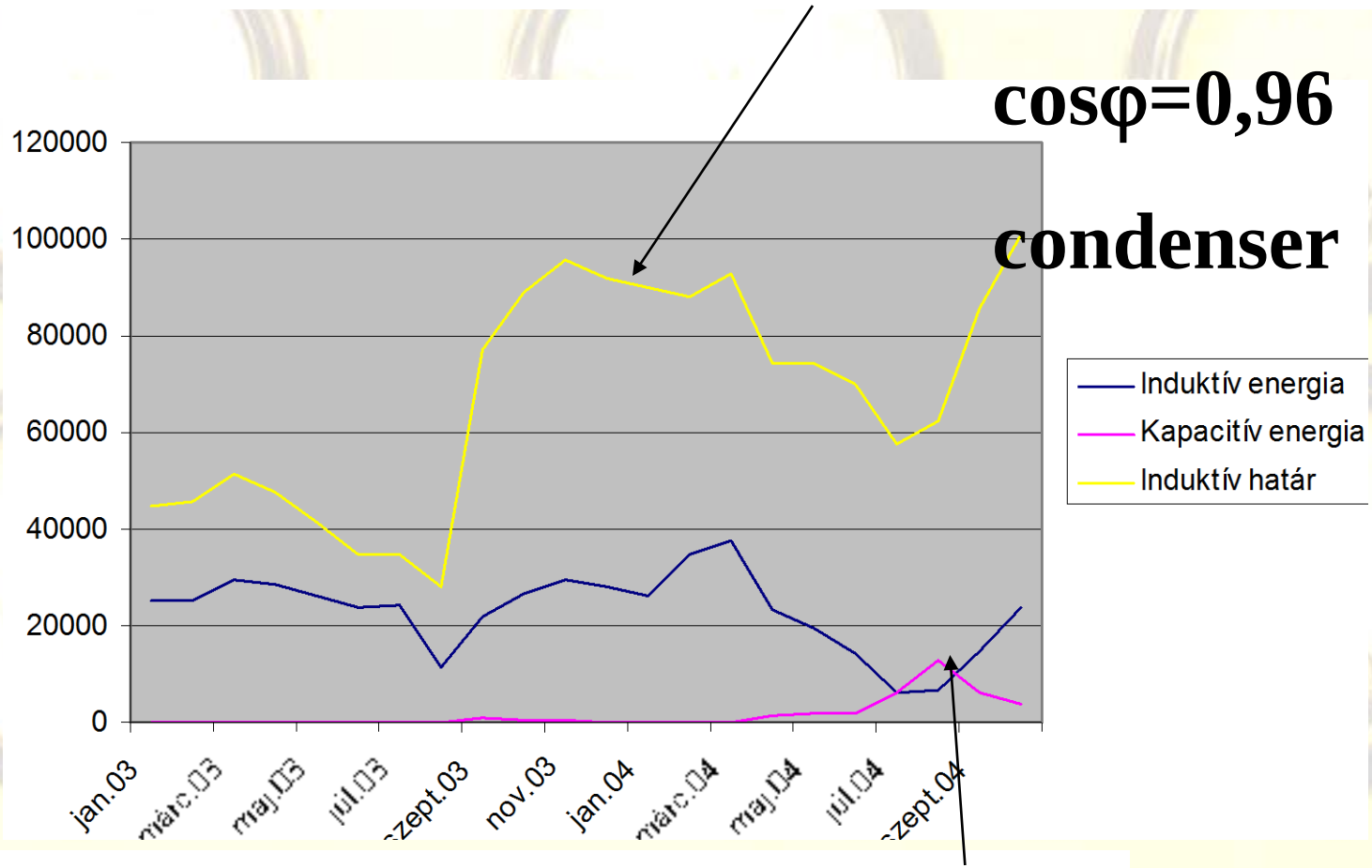
Peak management

- The tariff structure must be known
- Strategy: less fixed + some penalties
- Lower consumption, lower peaks!
- Peak controlling, limiting



Electrical energy management: reactive power

Inductive reactive poser can be 25-30 % of the active part.



Penalty for the capacitive reactive power!

Walking – looking – listening

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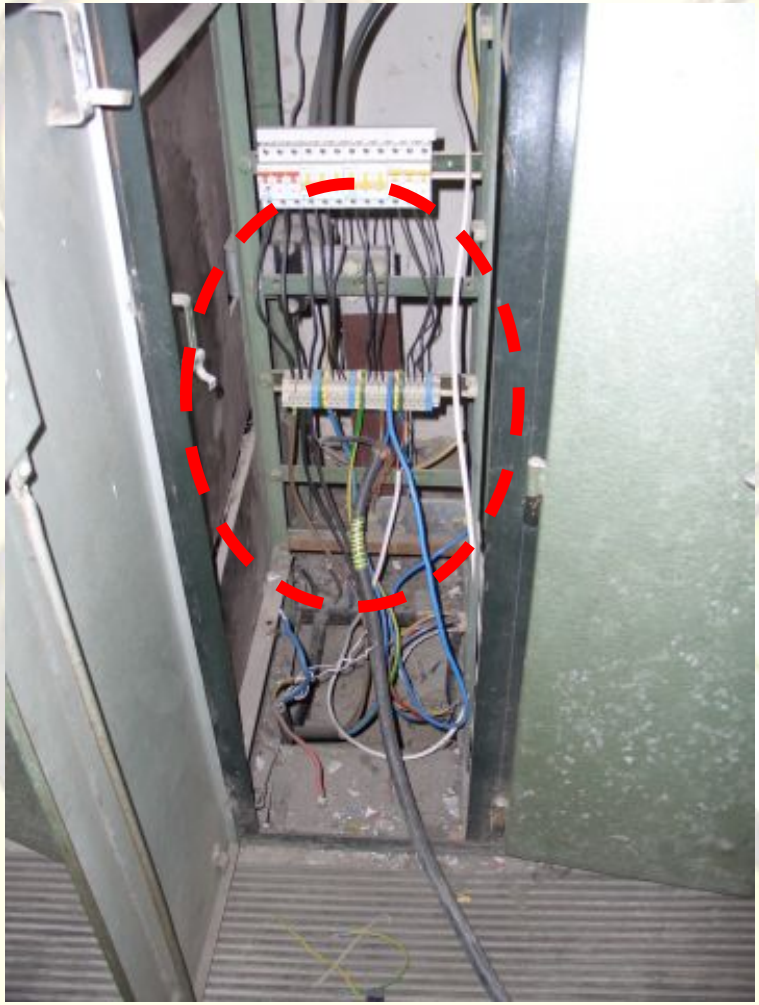
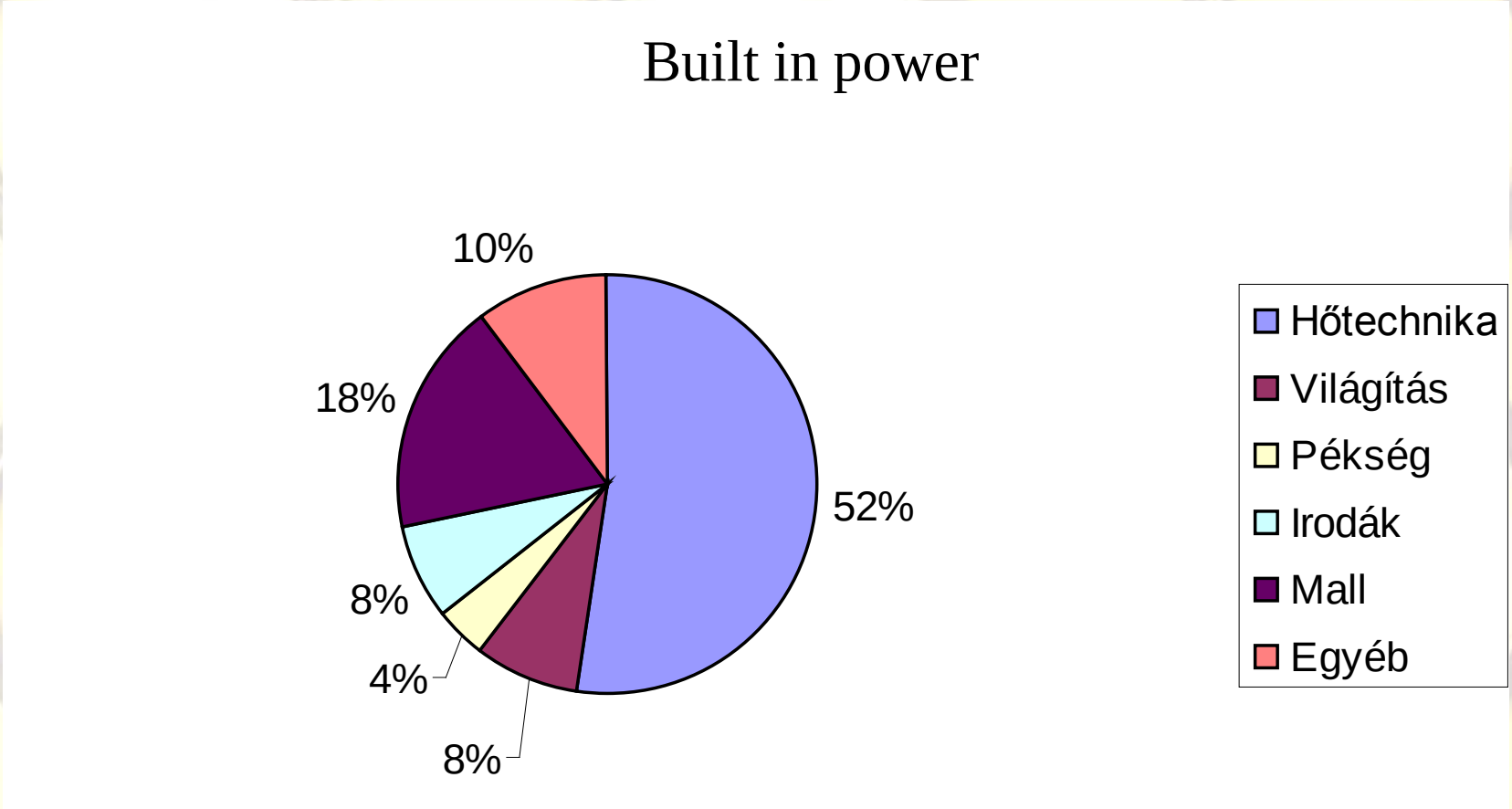


Ratio analysis



Measurement analysis

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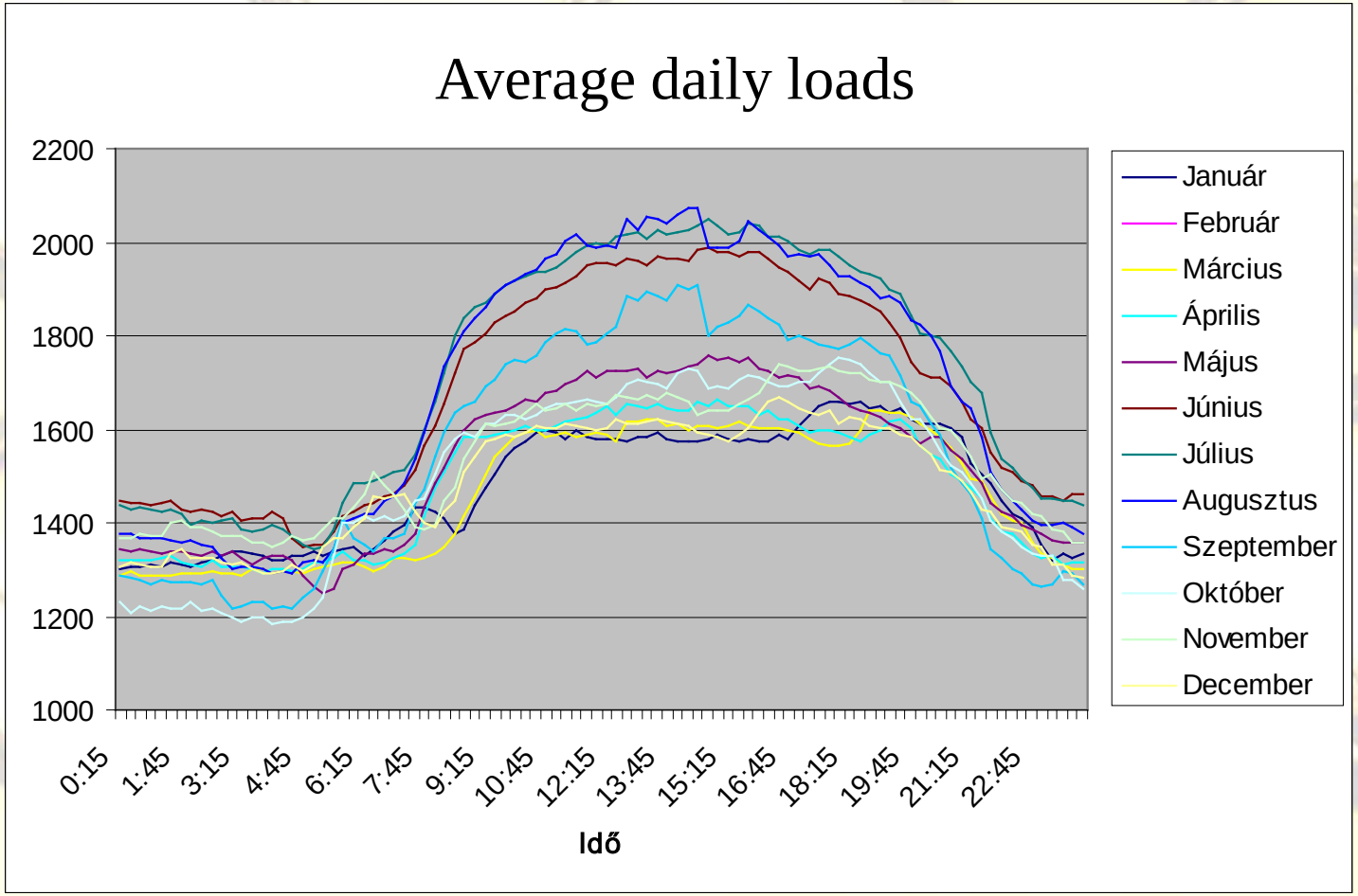
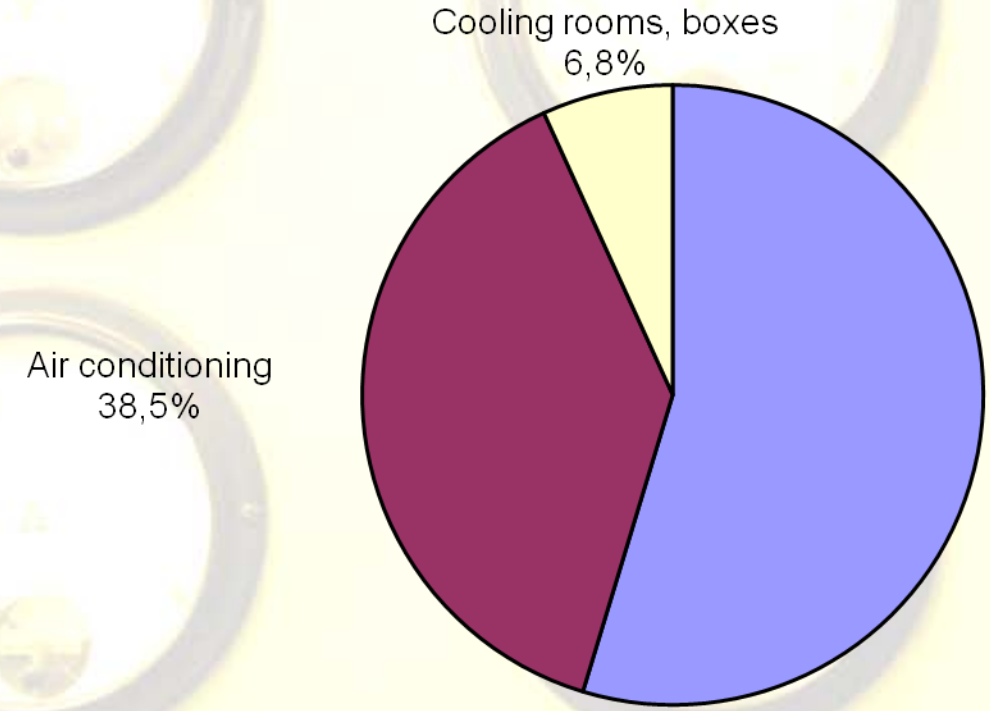


Measuring

The relation of the electrical and heating energy

- Heating – cooling system
- Cooling with absorber machines
- Seasonality
- Building technology
- Drives (air, lifts)
- Cogeneration
- Air conditioners
- Electric heating

Ratio of heating and cooling in a mall



Cooling of the conference room

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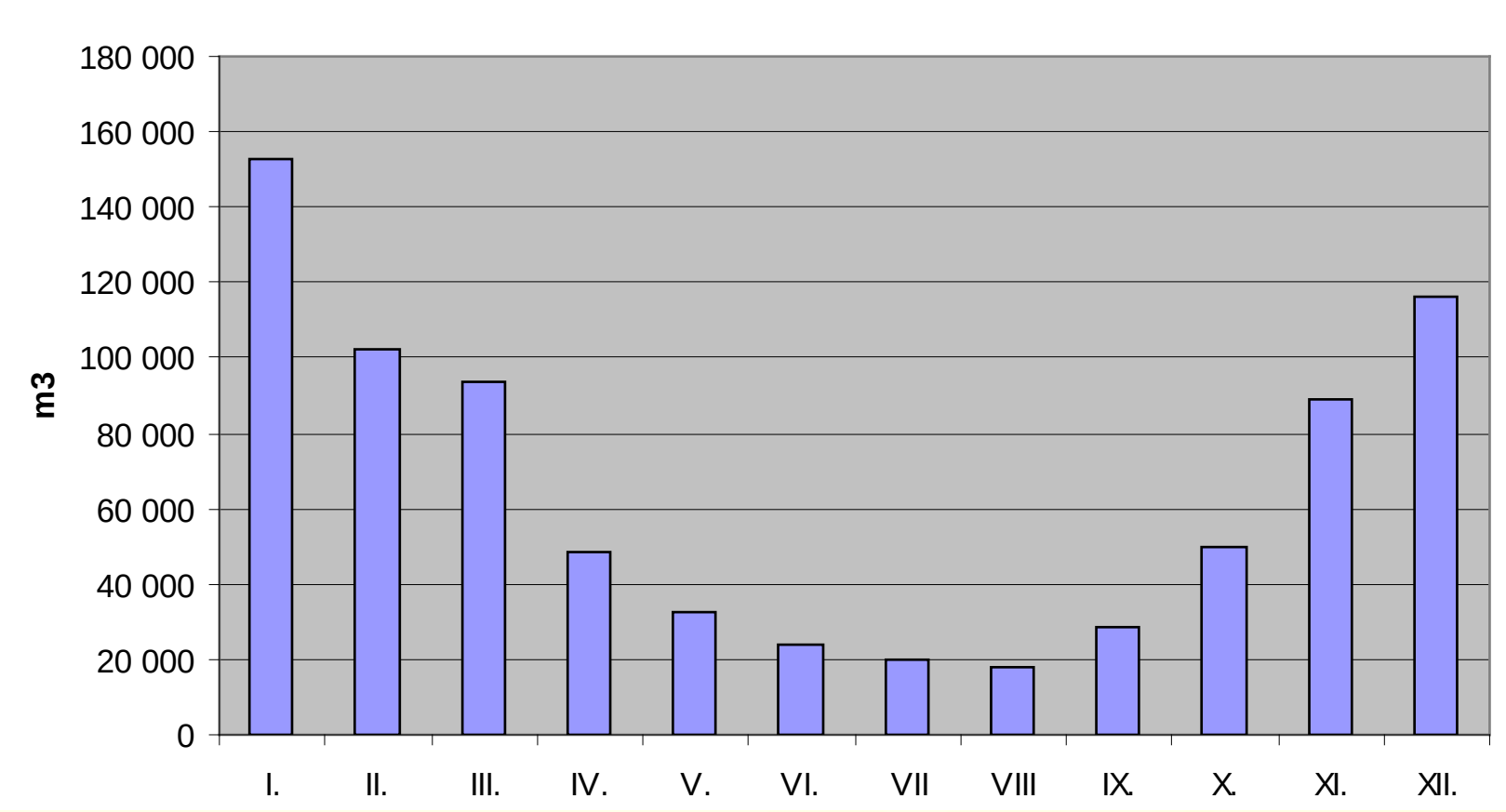
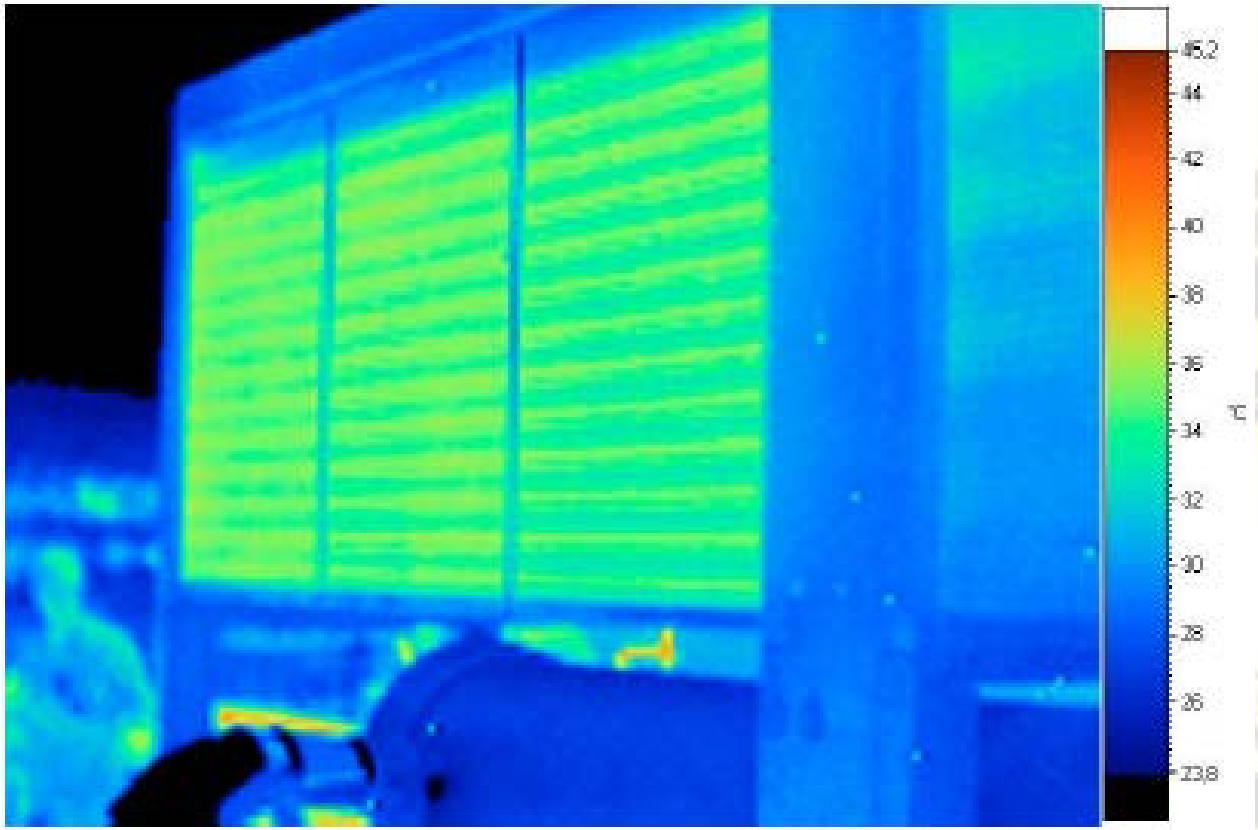
Gas consumption



Thermovision



General recommendations for better energy management

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Lowering costs:

- Cheaper energy purchase
- Decrease of consumption
- Decrease of losses

How?

- Energetics audit
- Investment
- Change the present practice!

Energy management in the organisation

- Personal competences
  - Clearing the responsibilities
  - Clearing the motivation
  - Support for the work
  - Responsibility
- Technical conditions
  - Energy measurements
  - Central control system
  - Actors in the system (switches, controllers)
- Financing (short term ROI)

Recommendations:

- Building an energy management system
- Building of energy manager team
- Environment and sustainability consciousness

Specific recommendations - electricity

- Appropriate feeding point
- Better load forecast
- Better purchasing agreements
- Peak control (e.g. with meters Actaris SL7000)
- On-line SCADA control
- Reactive compensation
- Renovation of old devices, nets
- Phase balancing

Specific recommendations - heat

- Measurements
- Independent measurement of the heating energy and the hot water(‘s energy)
- Better isolation
- Temperature control
- Optimisation, etc.

What about the renewables?

- Small scale application, only on economy basis
- **Wind** – not really
- **PV**? – only if you combine with architectural solutions, e.g. shadowing
- **Geothermal** – if the tempreature is high enogugh, combined with heat pump
- **Solar collector?** – yes! Even try to use it for air conditioning

Shadowing by PV cells at University of Cantabria, Santander, Spain

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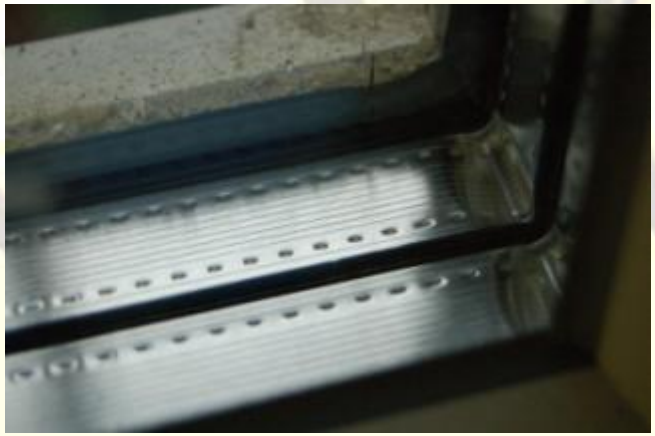
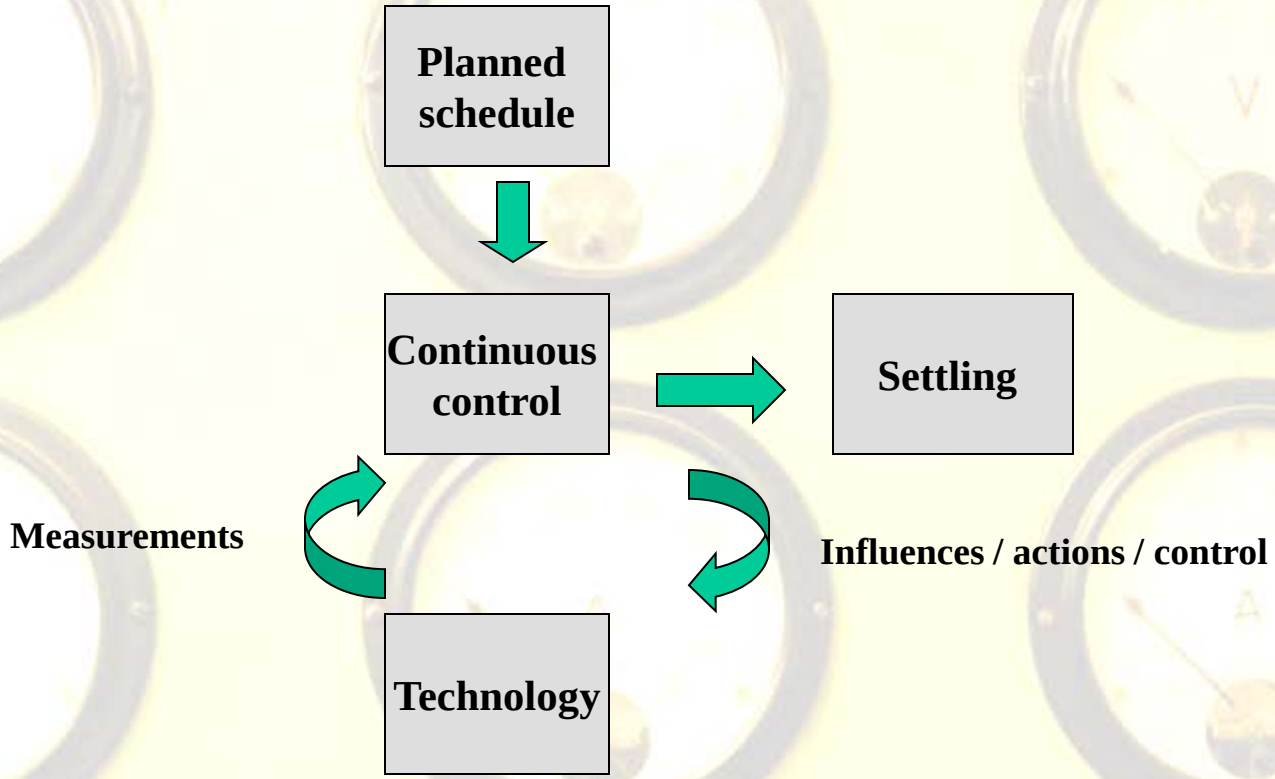
Measure – thermal isolation



The process of energy management



Energy magement system

- „SCADA”
- Data acqiosition, visualisation, reporting, statistics
- Support for cost planning
- Forecast
- Portfolio management
- Risk management
- Control

Continuous control of the usages

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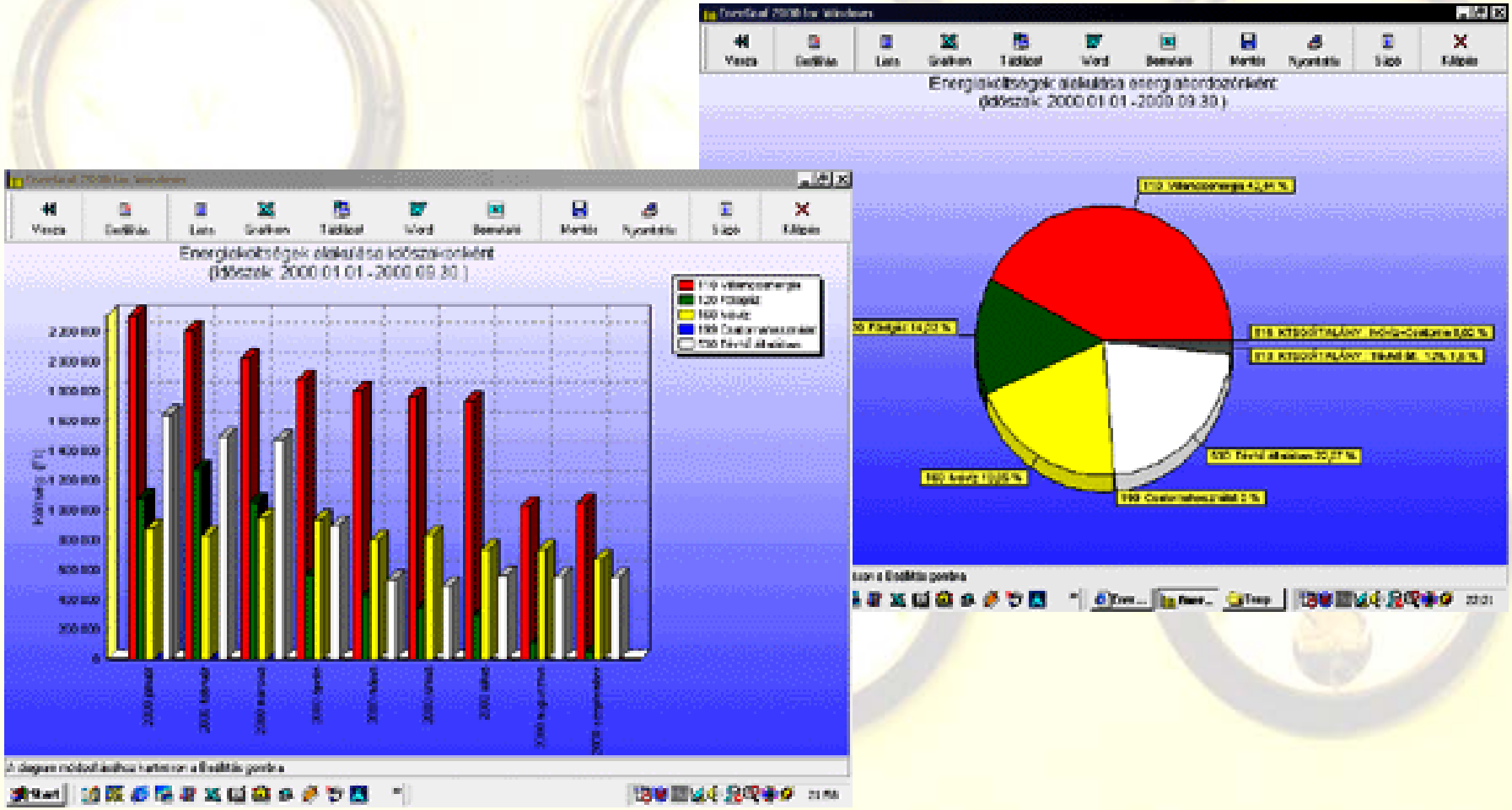

Energy management functions

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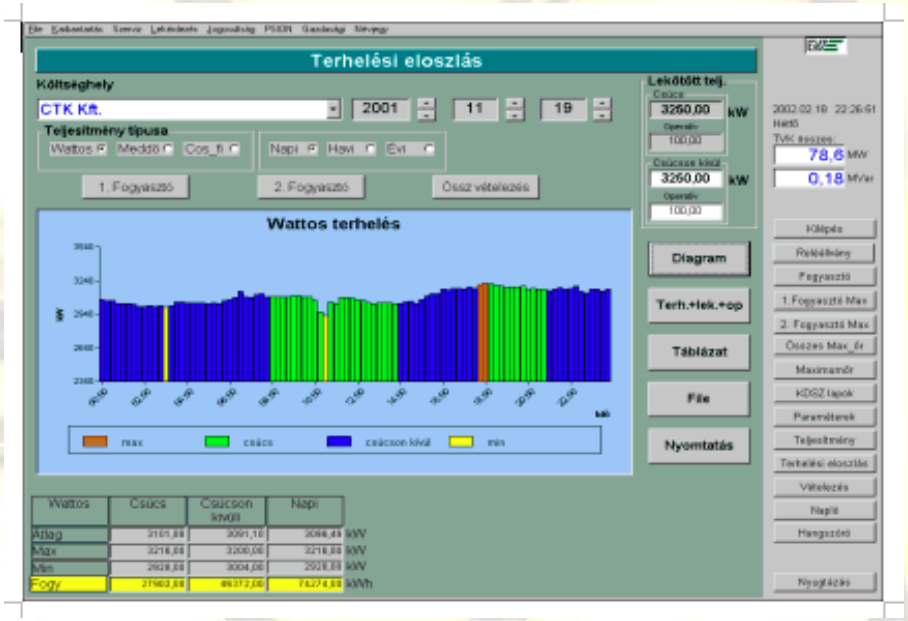
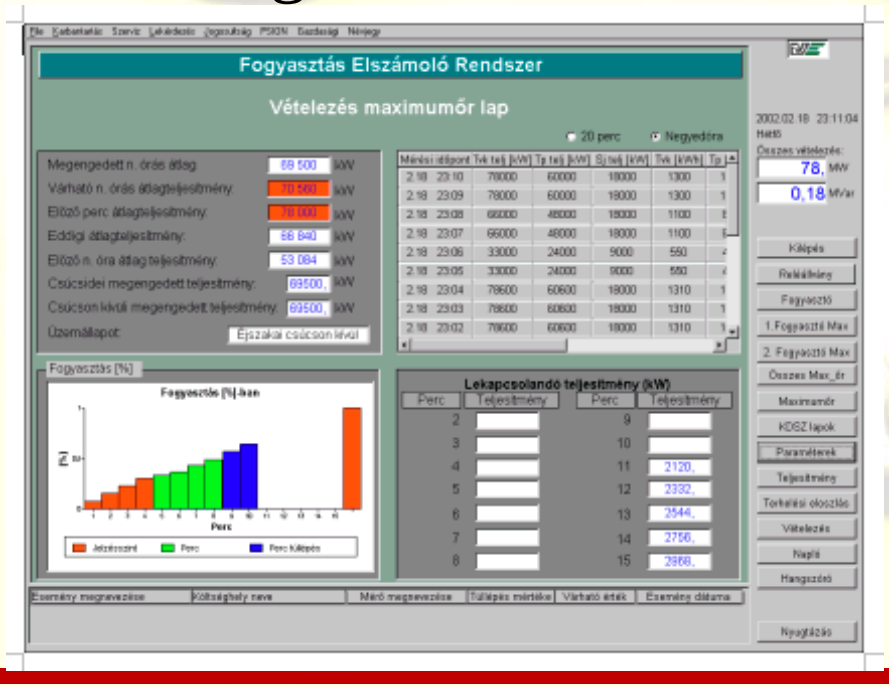
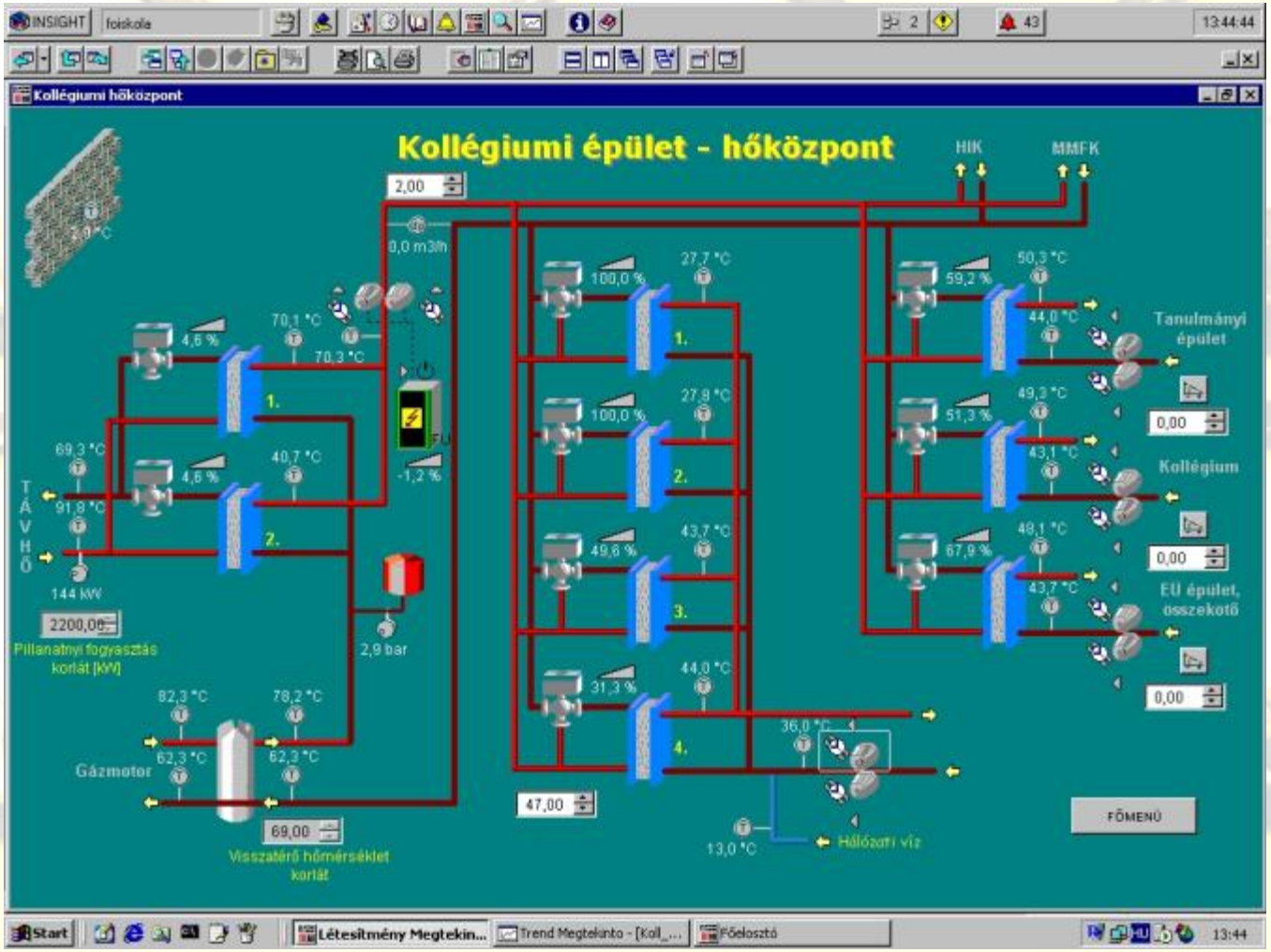
- limit investigation
- optimisation
- cost allocation
- settling





Building control system



Intelligent network?
Intelligent customer?
Future trends

Intelligence in the power system – customer level

hair drier, TV set, radio, telecommunication devices, modems, lighting, iron, microwave oven, coffee machine, computers, cooking plate	spontaneous loads (based on individual needs)
washing machine, tumble drier, refrigerator, cooler, air conditioners, electric bread baking machine and the heat pump	Can be delayed, controlled
Electric heating devices	Existing ripple control (HKV / RKV)

Seeking for low level DSM sources

Is there DSM potential in the households?

The methodes:

- Monitoring of the household consumption
- Creating an aggregated schedule
- Identification of ripple control part
- Proposal for the better ripple control schedule
- Identification of the controllable part
- Proposal for new schedule

„Stopwatch measurement” - Flat 1.

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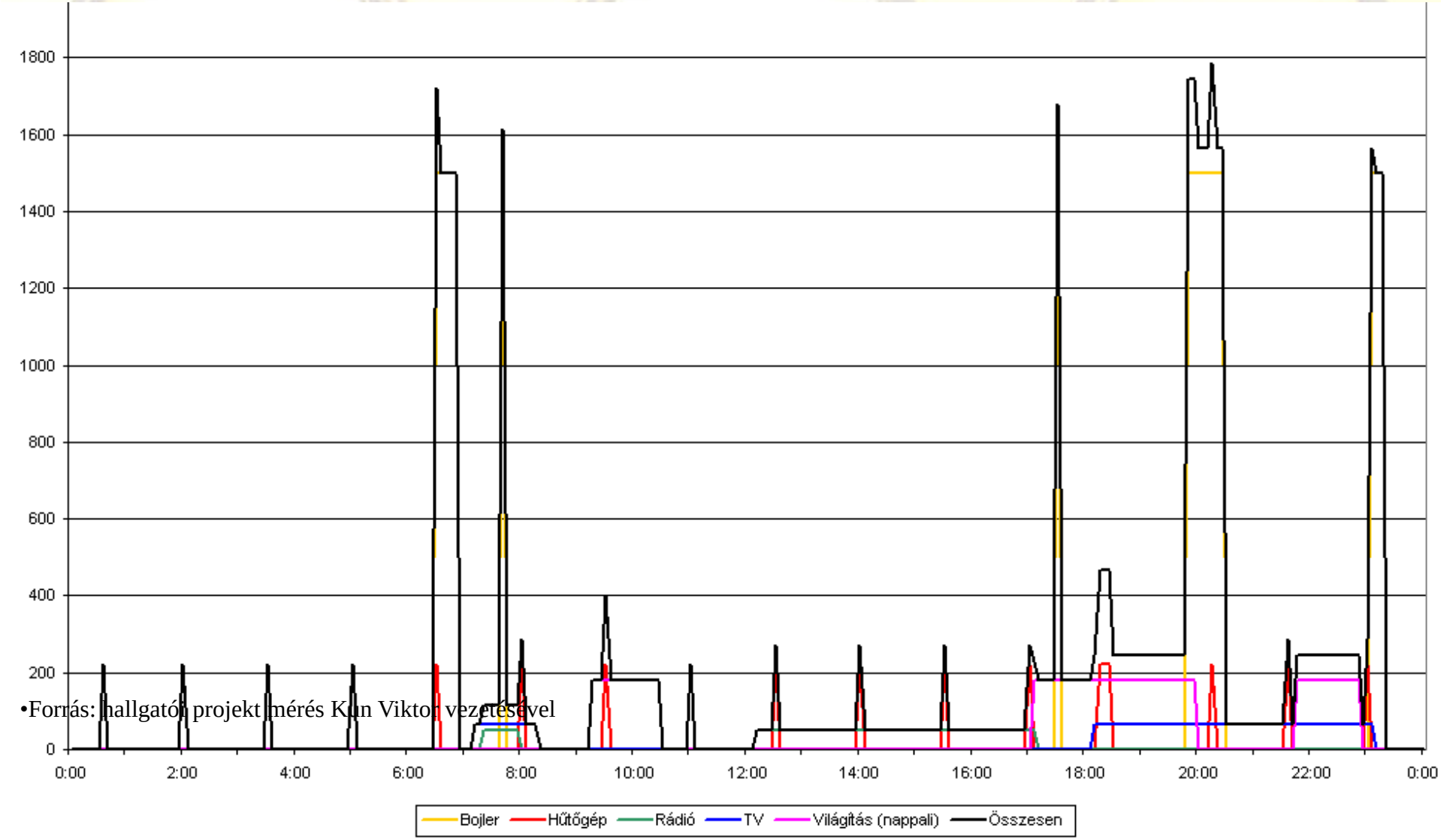

•Forrás: hallgatói projekt mérés Kun Viktor vezetésével

„Stopwatch measurement” - Flat 2.

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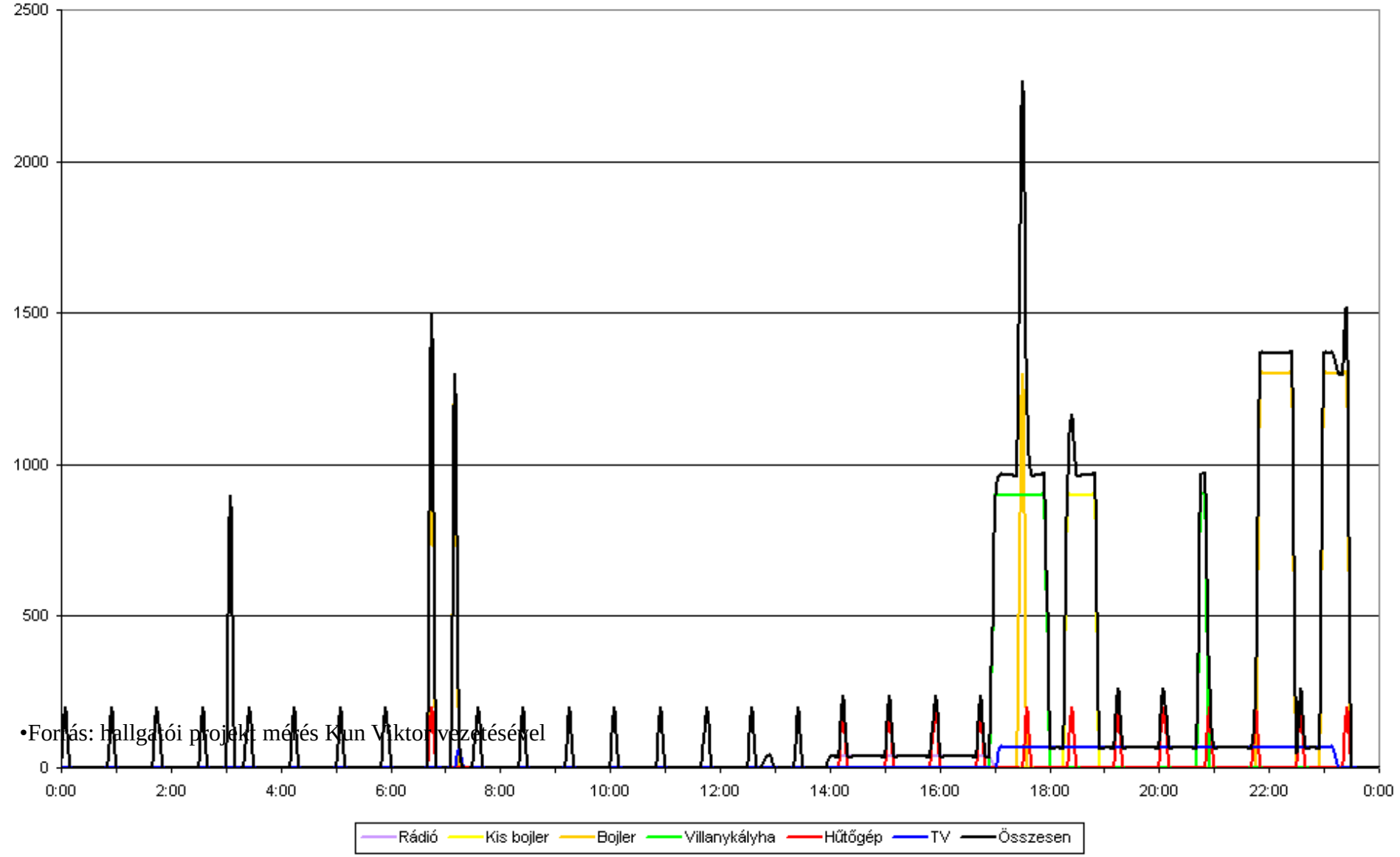

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„Stopwatch measurement” - Flat 3.

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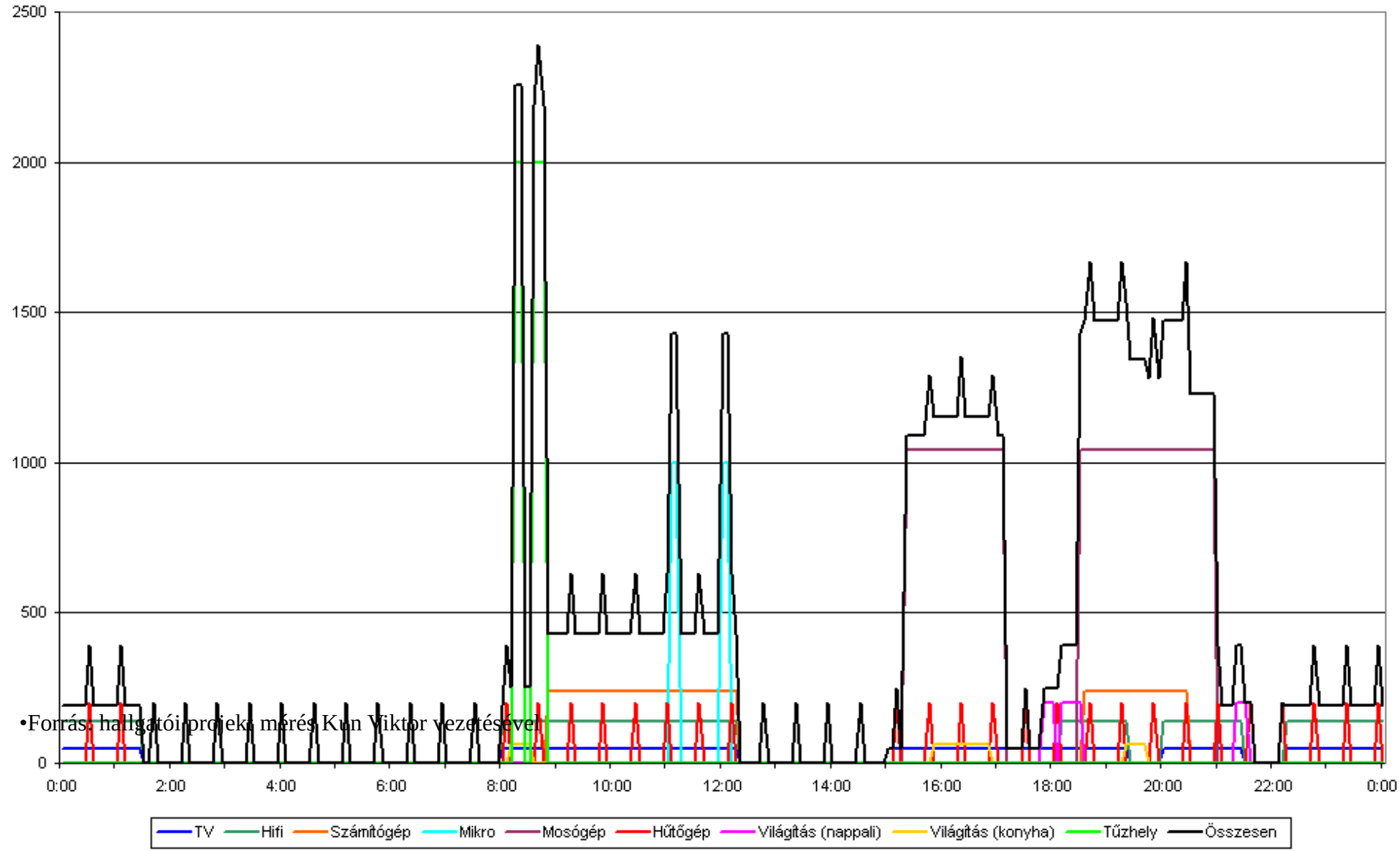

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„Stopwatch measurement” - Flat 4.

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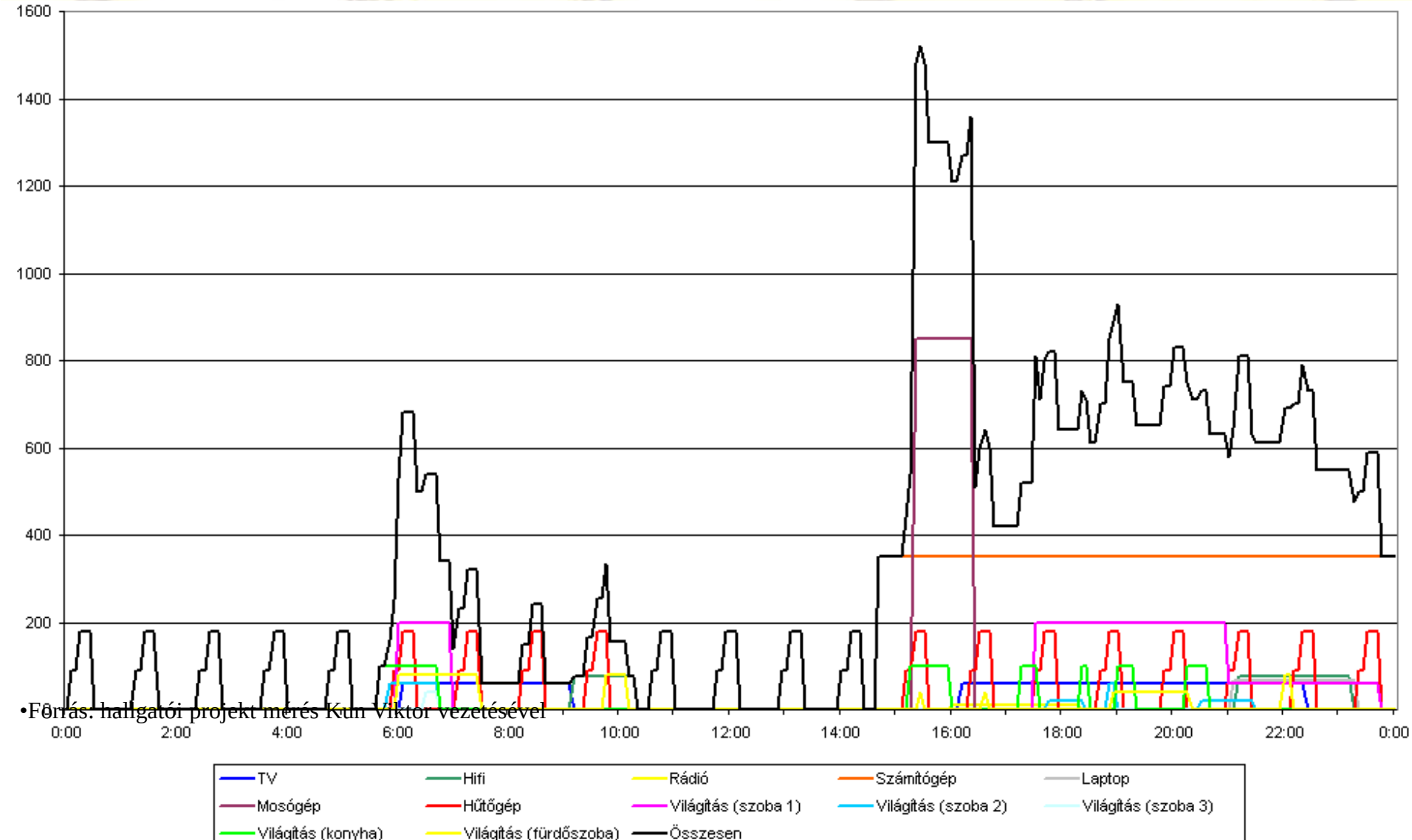

•Forrás: hallgatói projekt mérés Kun Viktor vezetésével

Analysis of customers' behaviour

Some remarks:

- Four flats was checked
- The actual load is replaced by the nominal load
- 5 min time blocks
- Weekday was measured
- Smoothing function was applied
- The load of the 4 flats was extended on 40 flats
- At the reschedule of the ripple control we calculated the same amount of the consumption

The need for the DSM

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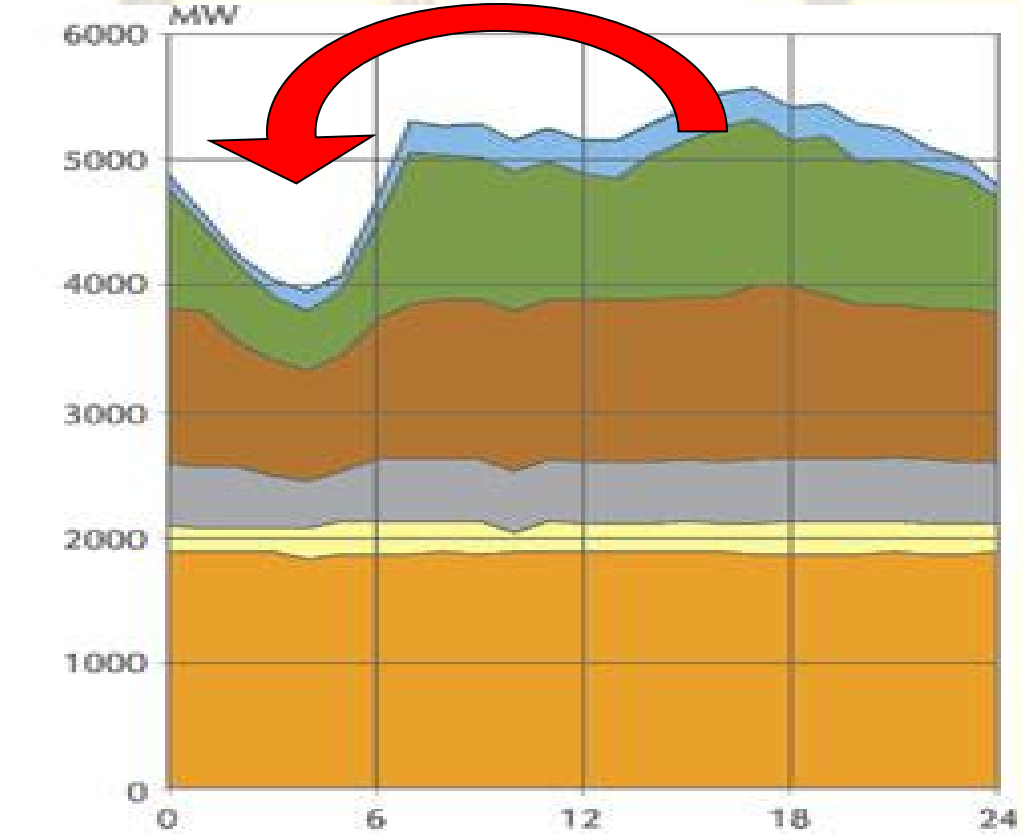
- Decreasing the peak / increasing the valley load



40 households, present ripple control

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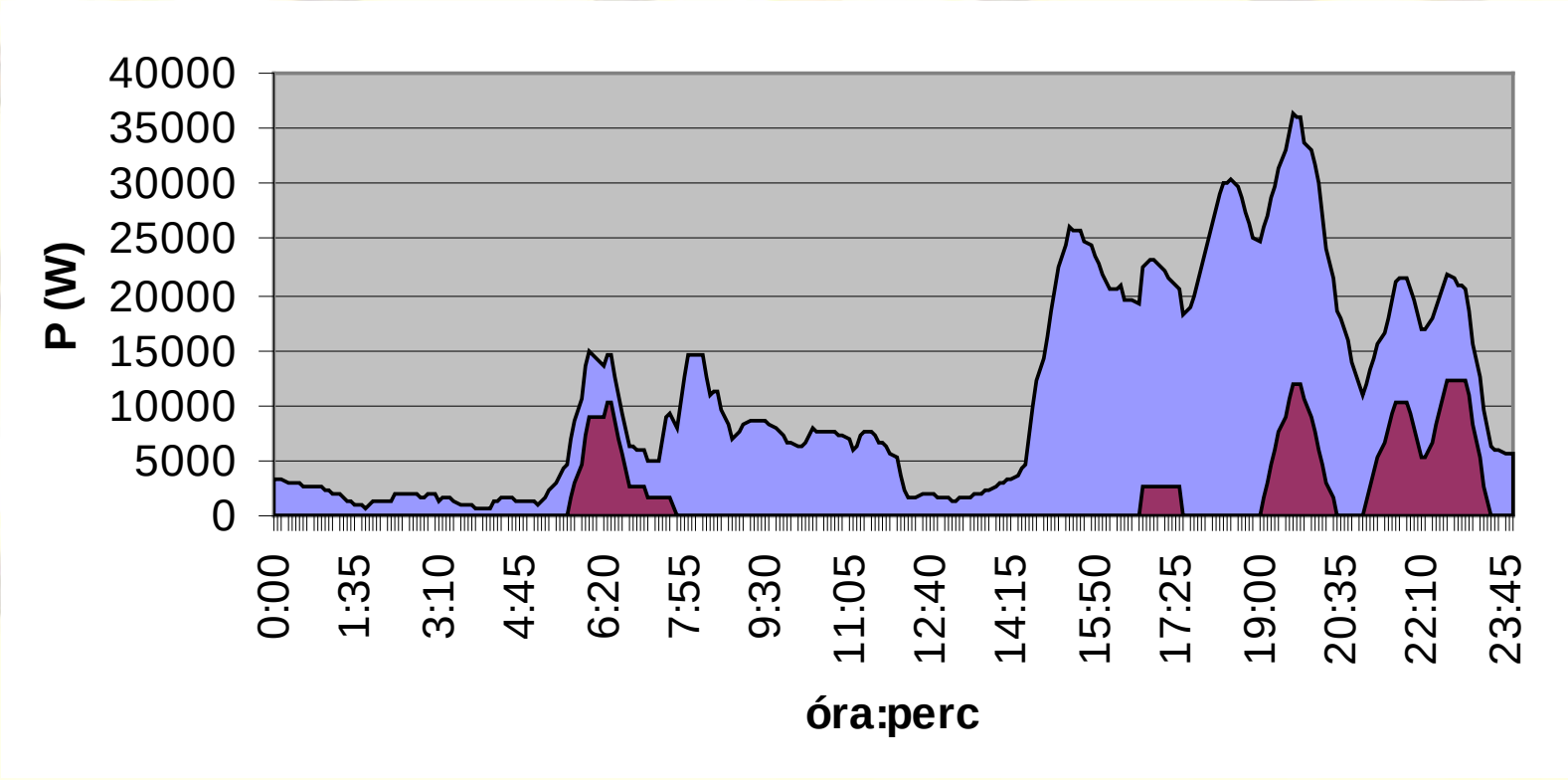

40 households, rescheduled ripple control

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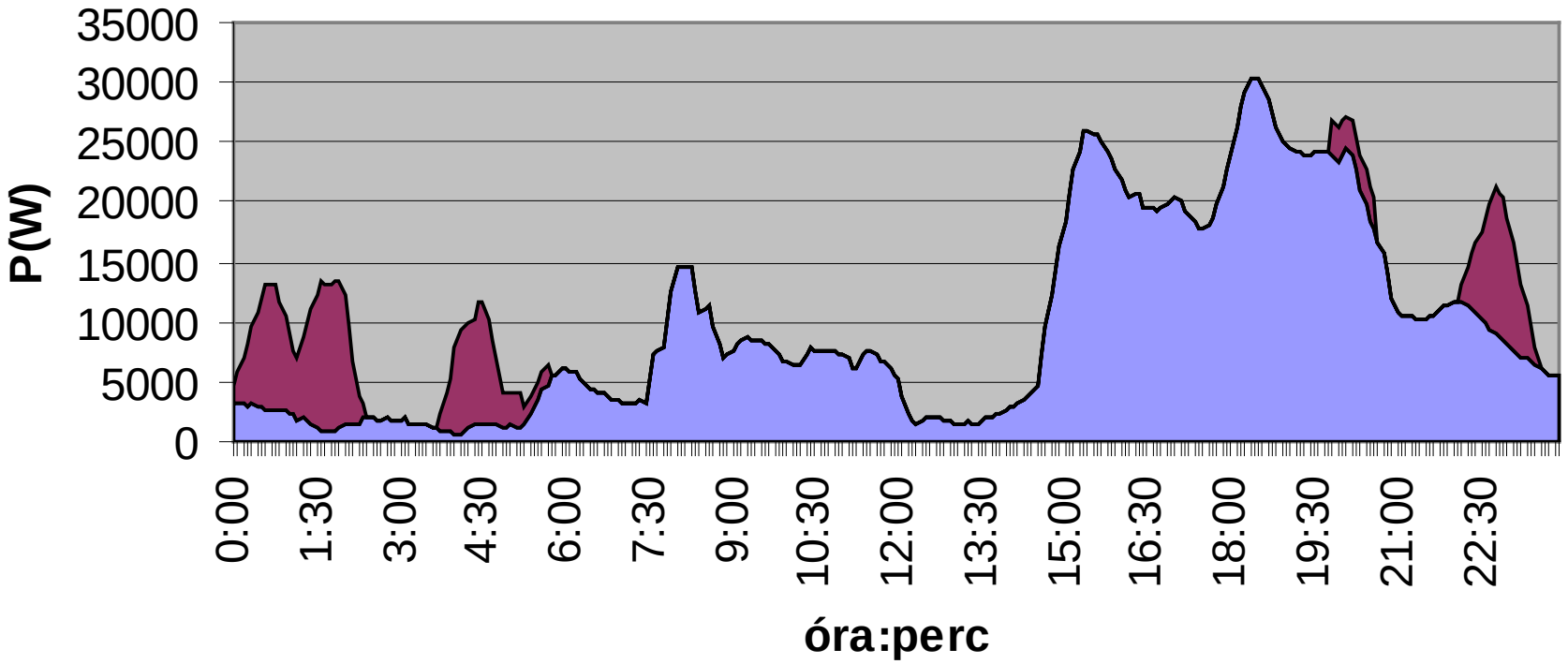

40 households, reschedule potential

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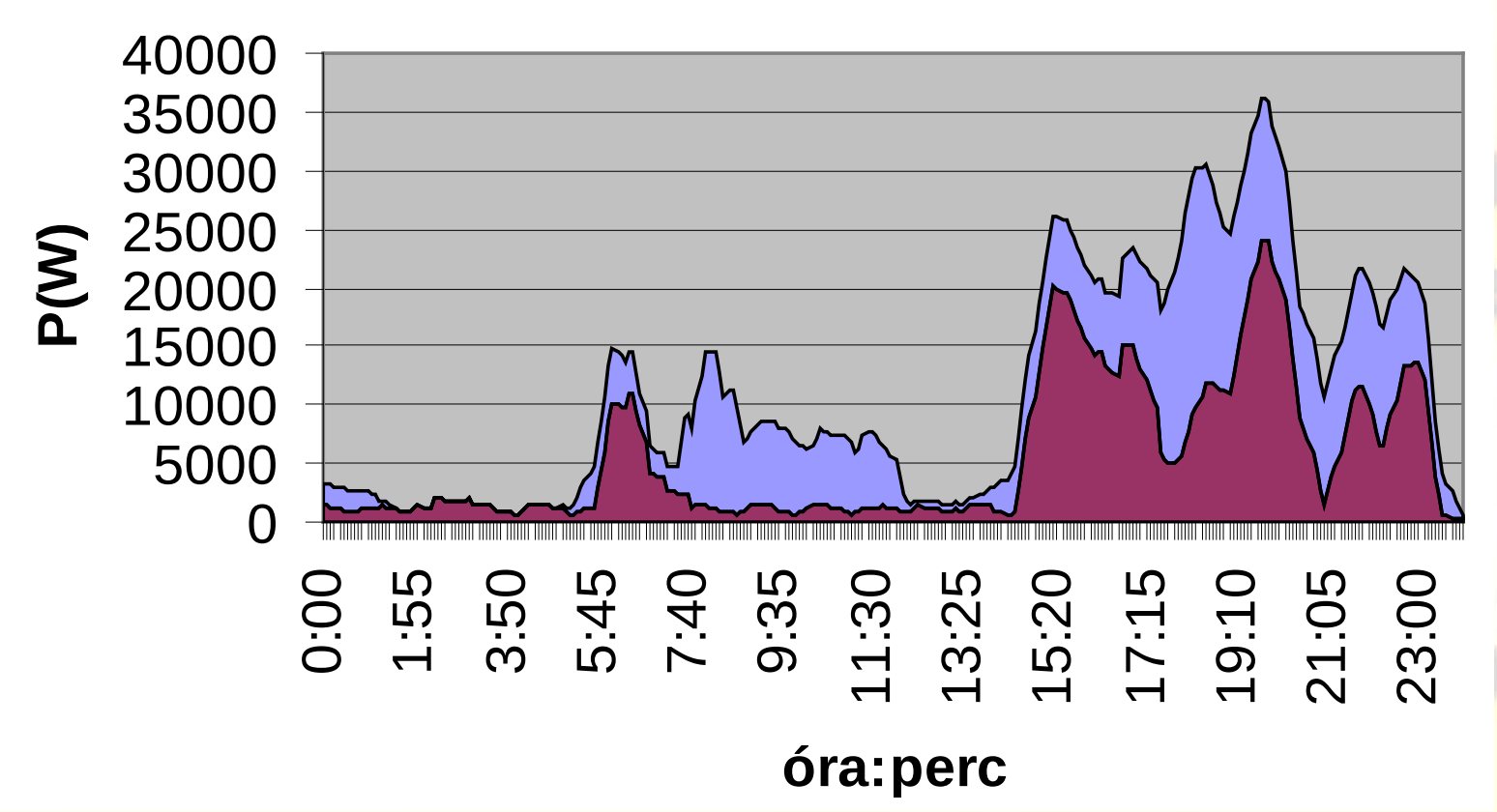
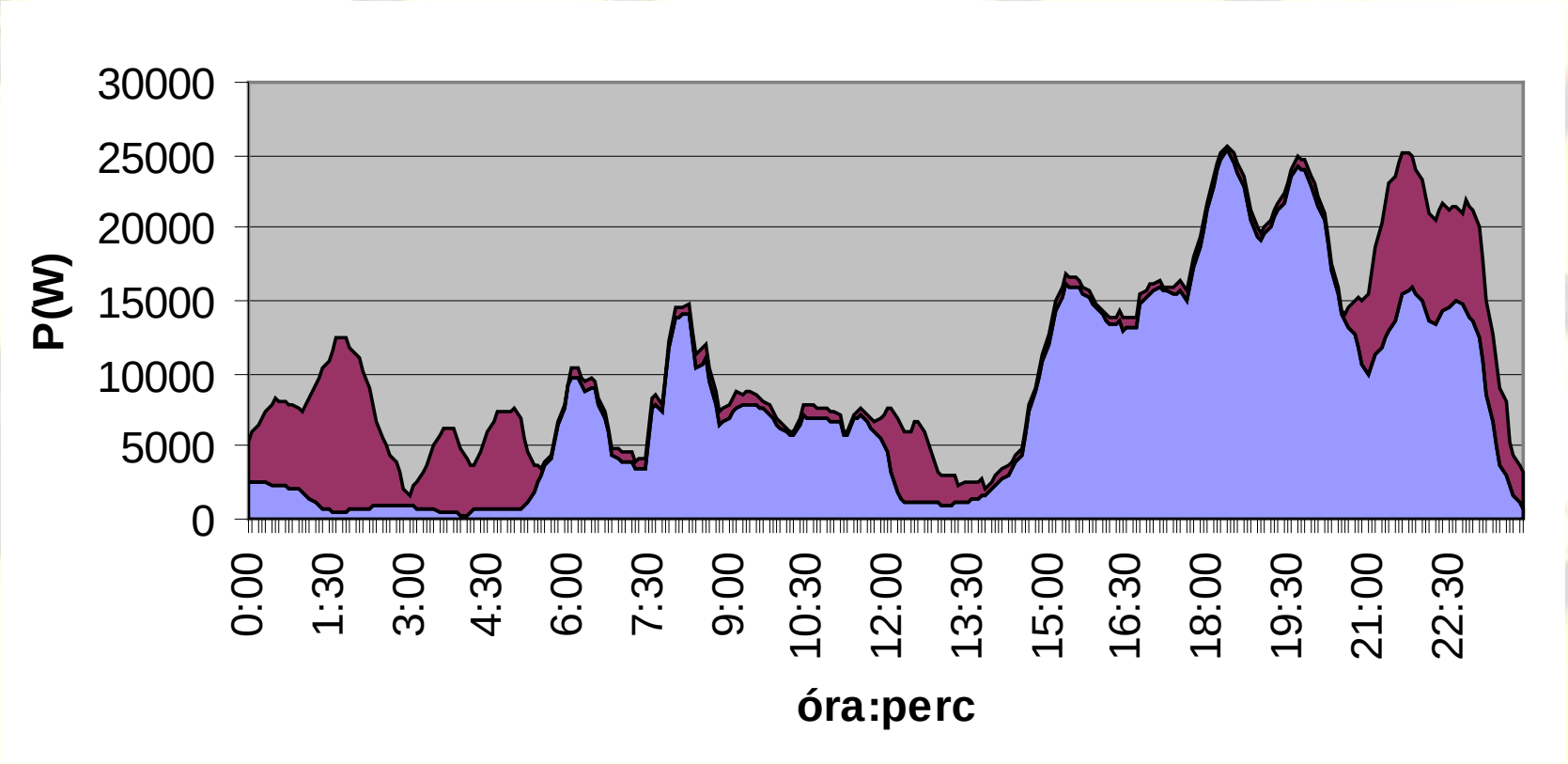


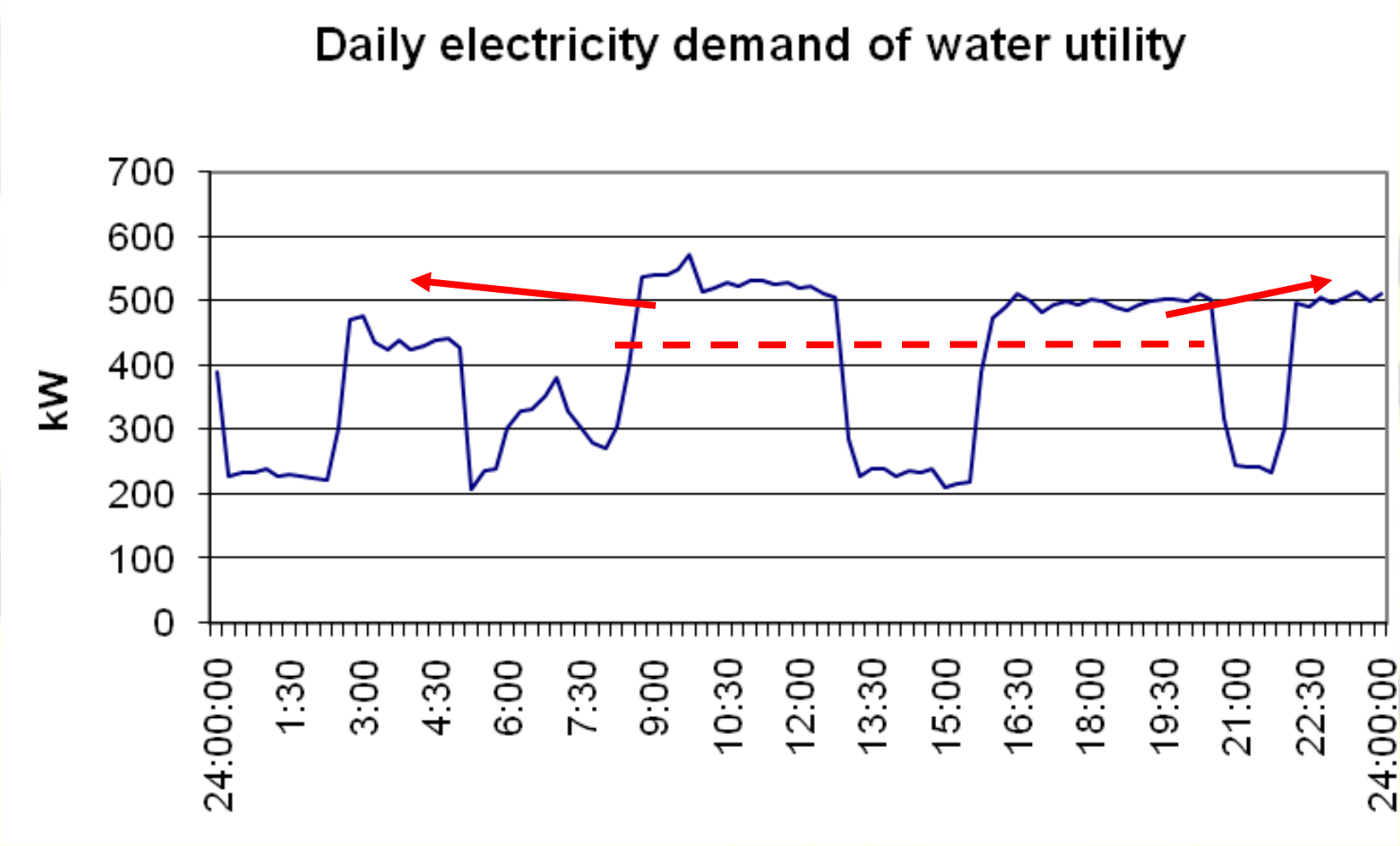
40 households, after the reschedule of 50 %



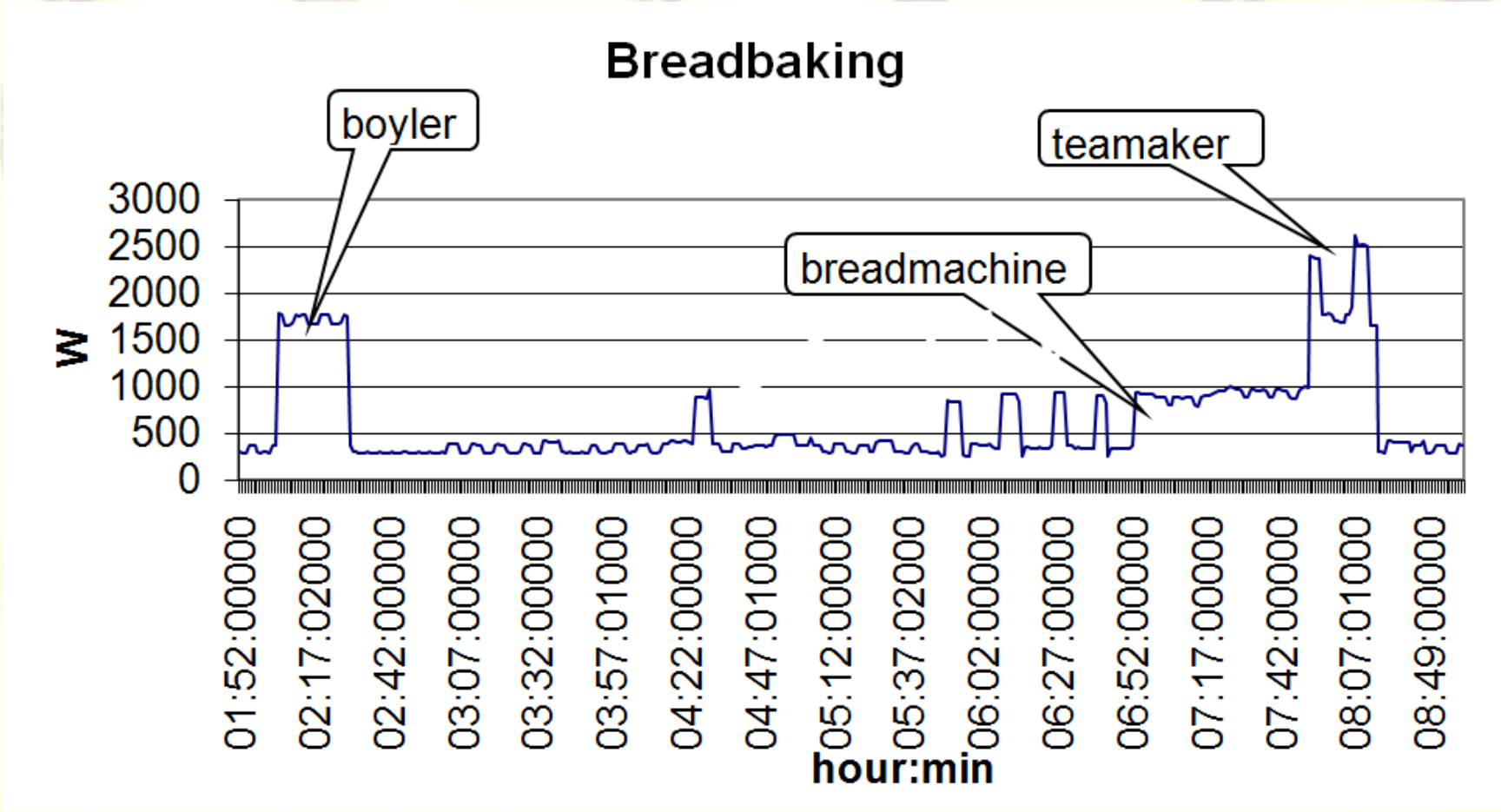
Foundings

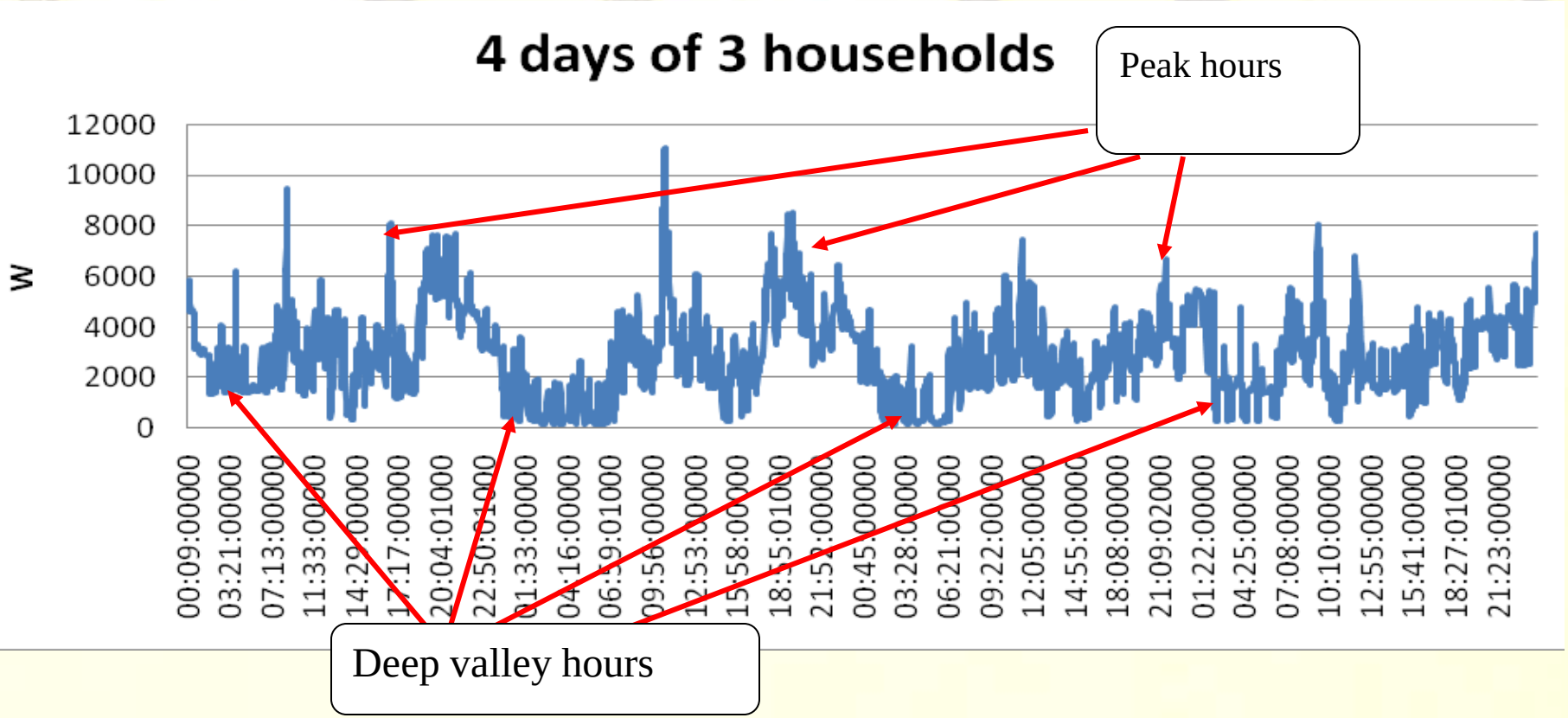
- The greater parts of the consumers' appliances can be involved into the DSM
- This is only qualitative measurements
- The adaptive reschedule can be performed by differenf optimisation methodes

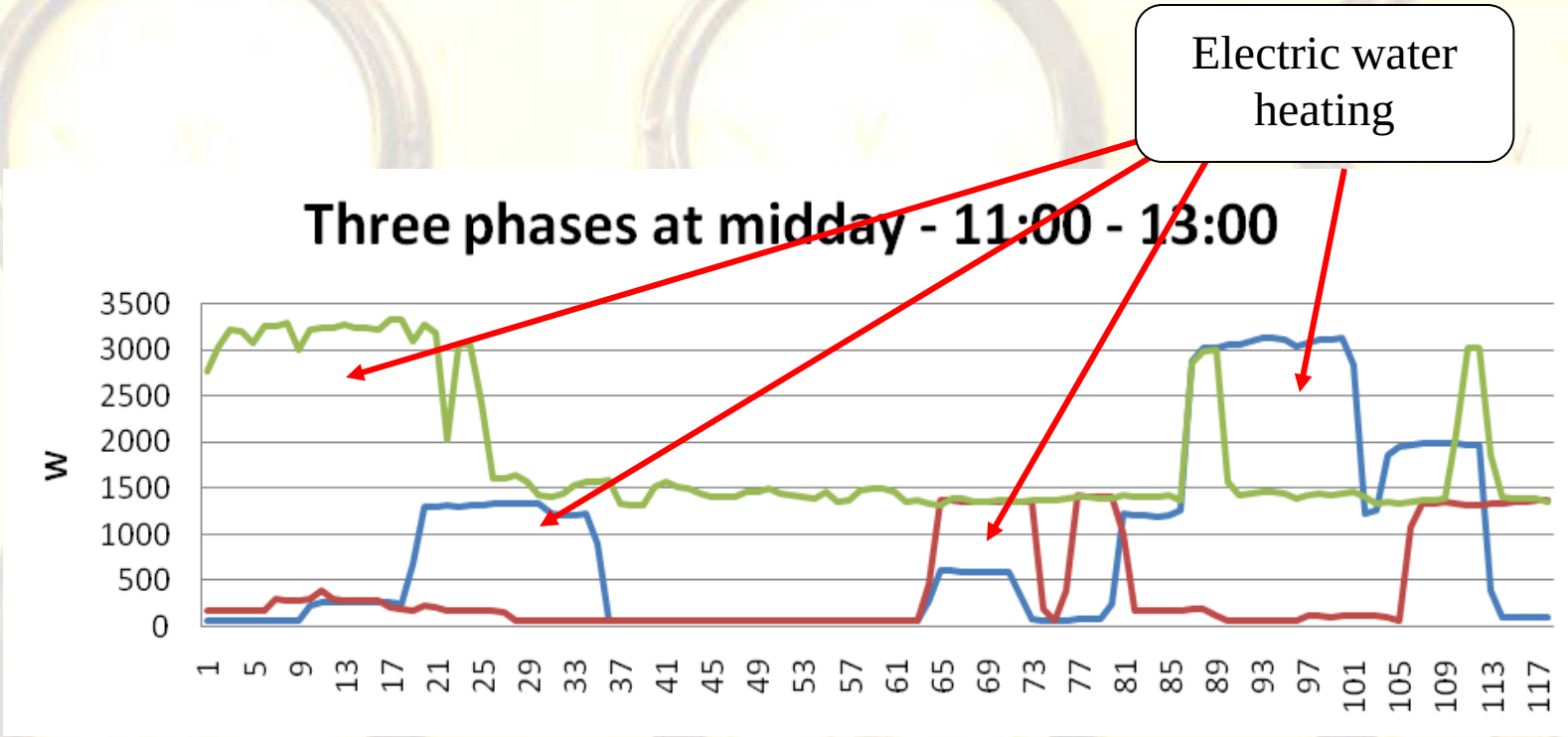
This is the low level intelligence in the network


Daily electricity demand of water utility
kW
700
600
500
400
300
200
100
0
24:00:00
1:30
3:00
4:30
6:00
7:30
9:00
10:30
12:00
13:30
15:00
16:30
18:00
19:30
21:00
22:30
24:00:00

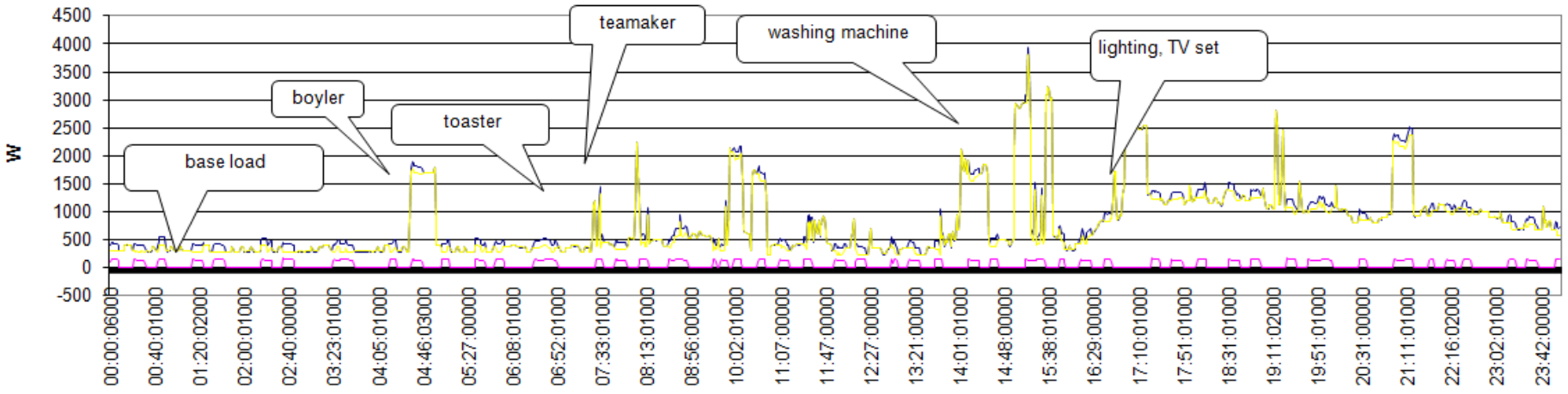
Remote measurement with special recorder

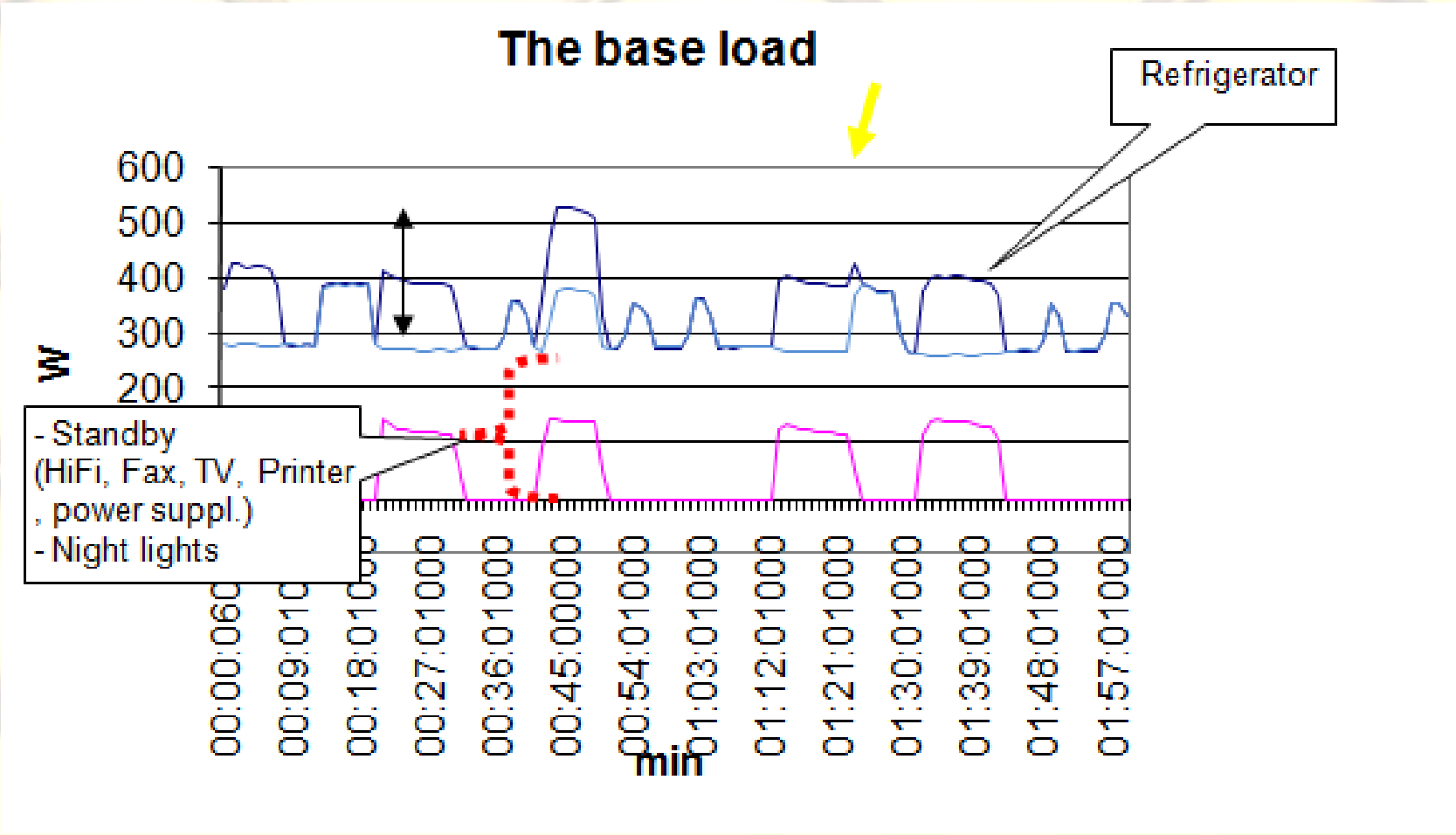



4 days of 3 households
Peak hours
Deep valley hours
W
12000
10000
8000
6000
4000
2000
0
00:09:00000
03:21:00000
07:13:00000
11:33:00000
14:29:00000
17:17:00000
20:04:01000
22:50:01000
01:33:00000
04:16:00000
06:59:01000
09:56:00000
12:53:00000
15:58:00000
18:55:01000
21:52:00000
00:45:00000
03:28:00000
06:21:00000
09:22:00000
12:05:00000
14:55:00000
18:08:00000
21:09:02000
01:22:00000
04:25:00000
07:08:00000
10:10:00000
12:55:00000
15:41:00000
18:27:01000
21:23:00000

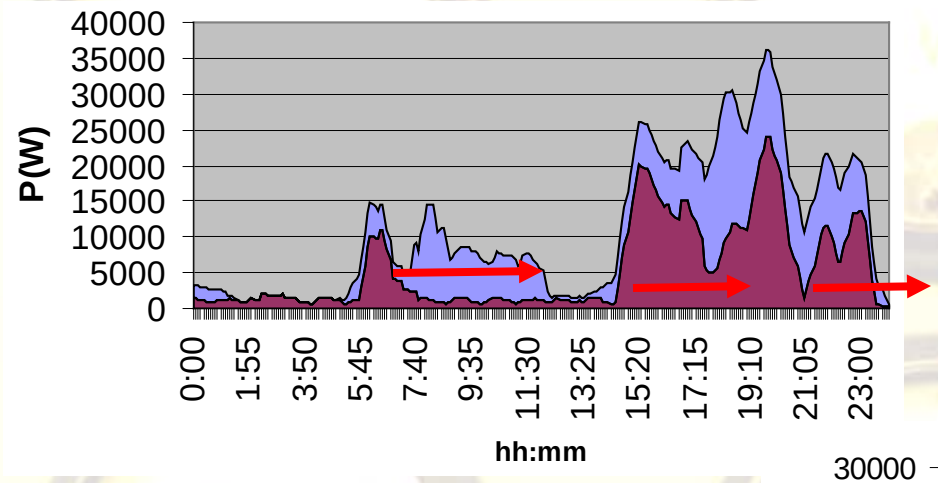

Electric water heating
Three phases at midday - 11:00 - 13:00
W
3500
3000
2500
2000
1500
1000
500
0
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
105
109
113
117

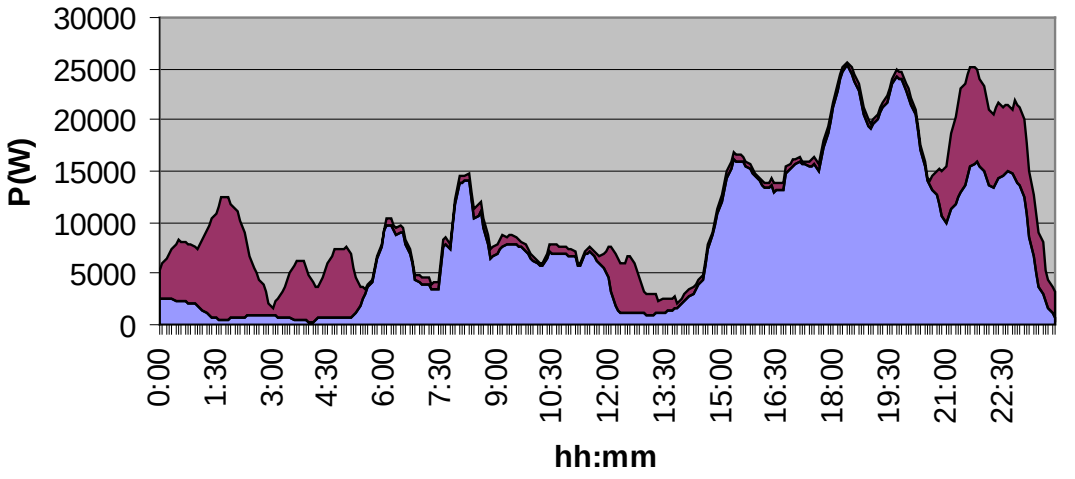
Household daily load curve




The base load
Refrigerator
600
500
400
300
200
W
- Standby
(HiFi, Fax, TV, Printer
, power suppl.)
- Night lights
00:00:060
00:09:010
00:18:010
00:27:01000
00:36:01000
00:45:00000
00:54:01000
01:03:01000
01:12:01000
01:21:01000
01:30:01000
01:39:01000
01:48:01000
01:57:01000
min

Reschedule


40000
35000
30000
25000
20000
15000
10000
5000
0
P(W)
0:00
1:55
3:50
5:45
7:40
9:35
11:30
13:25
15:20
17:15
19:10
21:05
23:00
hh:mm


30000
25000
20000
15000
10000
5000
0
P(W)
0:00
1:30
3:00
4:30
6:00
7:30
9:00
10:30
12:00
13:30
15:00
16:30
18:00
19:30
21:00
22:30
hh:mm

Functions of the intelligent VGRID elements

Schedule center

- Monitoring of generation capabilities
- Monitoring of load demand
- Global load forecast
- Generation optimisation
- Scheduling
- Load control
- Logging, evaluation
- Connection with the system operator

Intelligent load$_i$

- Load forecast
- Local load control
- Connection with the schedule centre
- Cost dependency

Intelligent generator$_n$

- Monitoring of possible generation capacity
- Cost calculation
- Generation control
- Connection with the schedule centre

Intelligent storage$_x$

- Storage/generation capability
- Local store control
- Connection with the schedule centre
- Cost calculation

Radial IP connections of the VGRID elements

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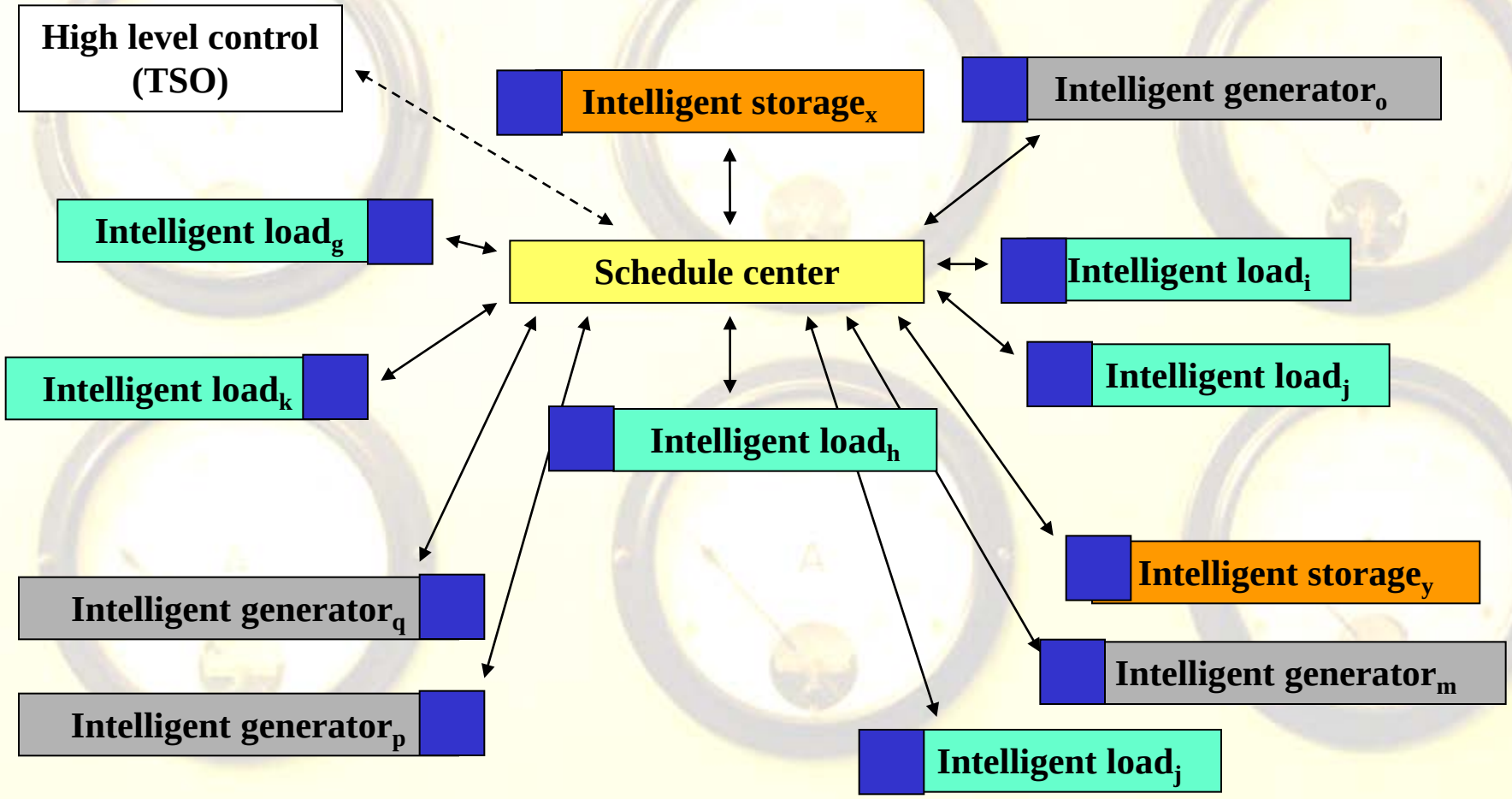

Measurement and control unit

Local power surveillance

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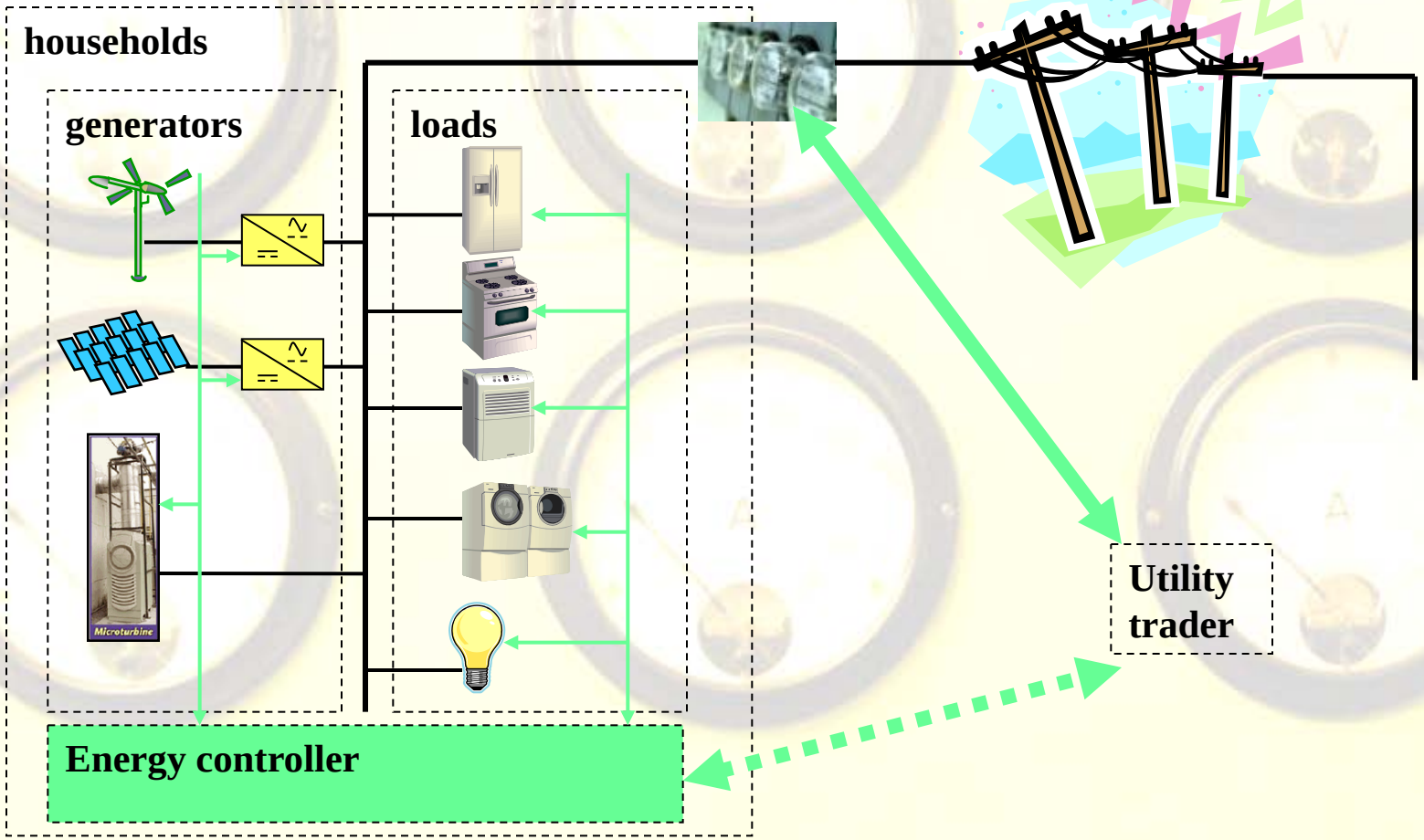

Communication possibilities

- Inside the flat
  - LAN (ethernet)
  - WiFi
  - Bluetooth
  - EIB (instabus)
  - ZIGbee
  - Other field buses (profibus, mobus), stb.
- Between the household and the utility
  - SMS
  - GPRS
  - Internet
  - PLC (Power Line Carrier), etc.

Conclusion

The basic rules of the Energy management:

- How can you spare energy?
- How can you use with greater efficiency?
- How can you buy cheaper energy?

The customer behaviour can be adjusted (DR, DSM)

- The local intelligence can find a lot of DSM resources
- The new IT systems makes it possible
- The network contains intelligent solution on different levels
- The technical solution is possible

Thanks for the attention!