



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

Dr. Péter Kádár

*Óbuda University, Power System Department, Hungary*

[kadar.peter@kvk.uni-obuda.hu](mailto:kadar.peter@kvk.uni-obuda.hu)



# Draft



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- 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

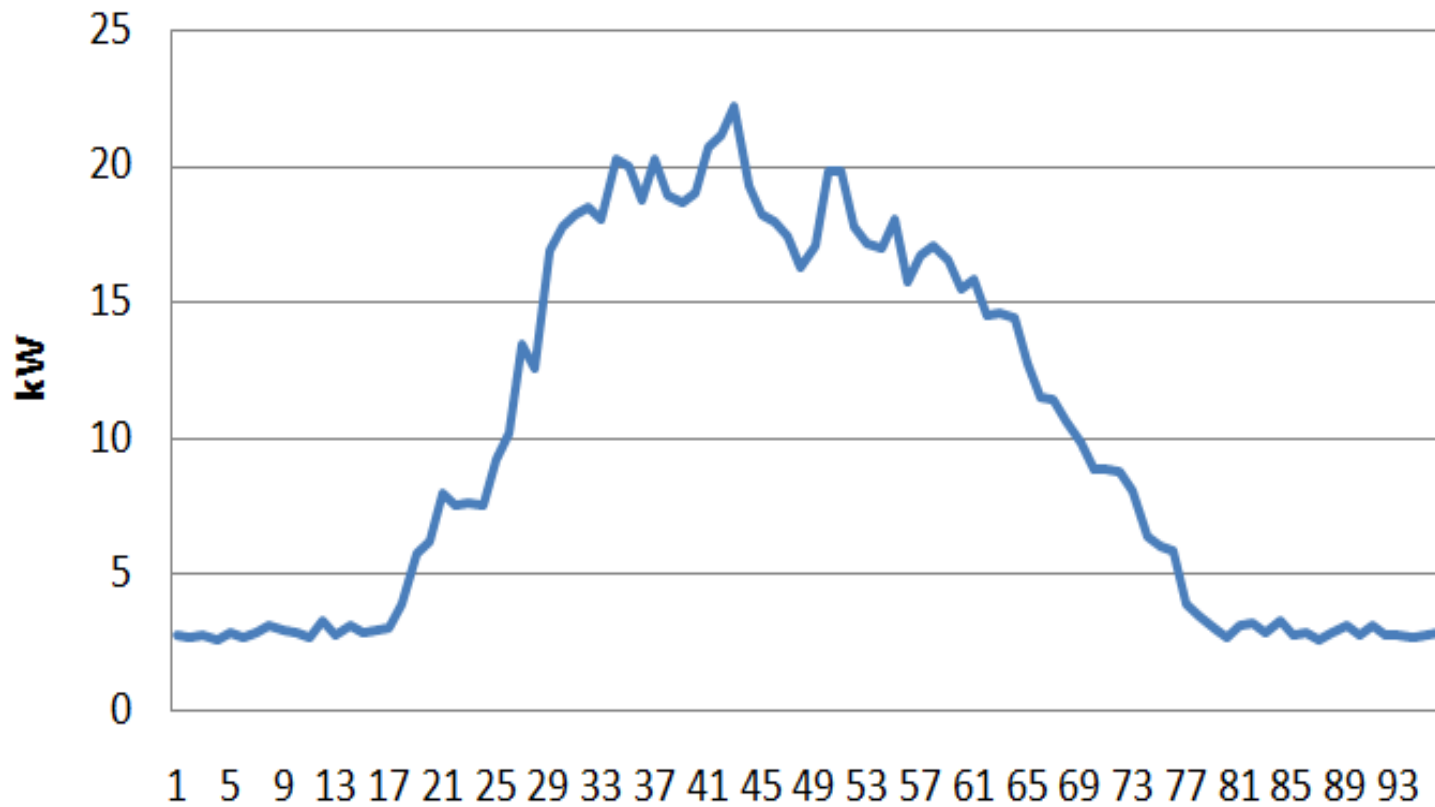
- Yearly invoices
- Monthly invoices
- Daily meter reading
- Automatic meter data for every 15 min
- Rough estimation based on nominal power consumption and watch
- Measurement, etc.



# Daily load curve of a primary school



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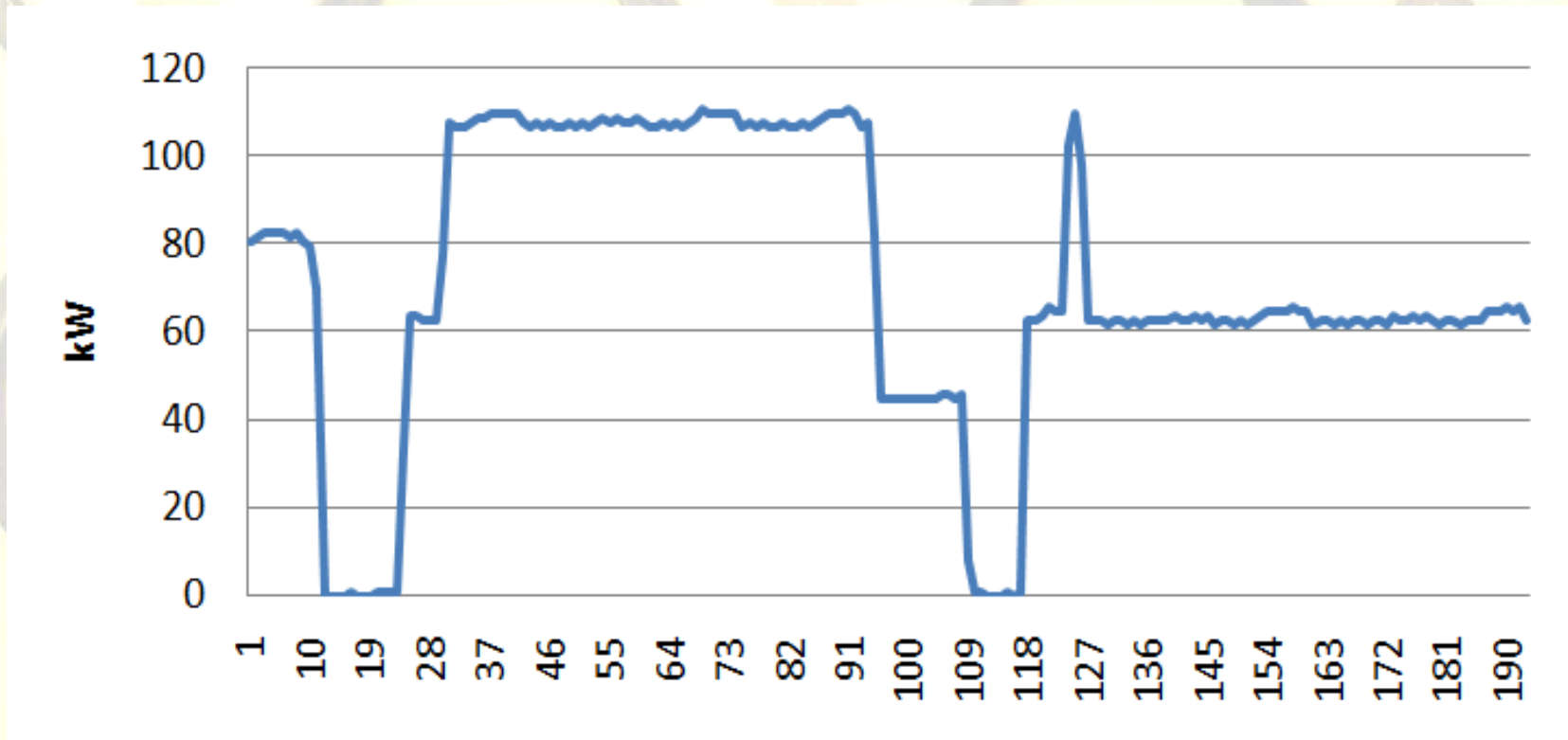




# Daily load curve of a water well



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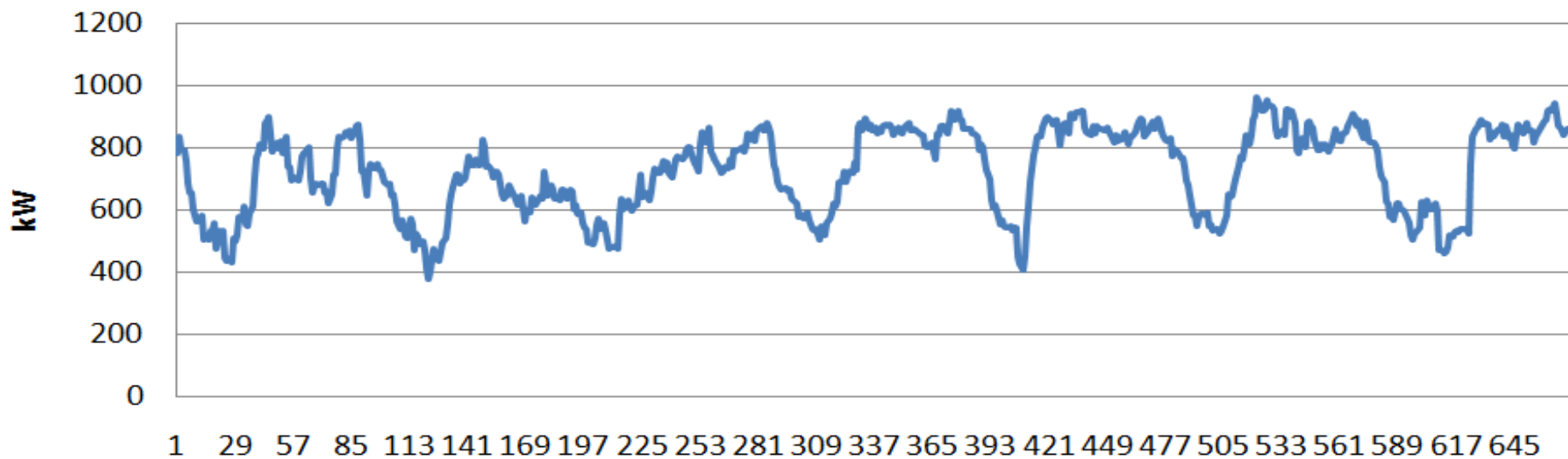




# Aggregated load curve of 7 water pump in a week



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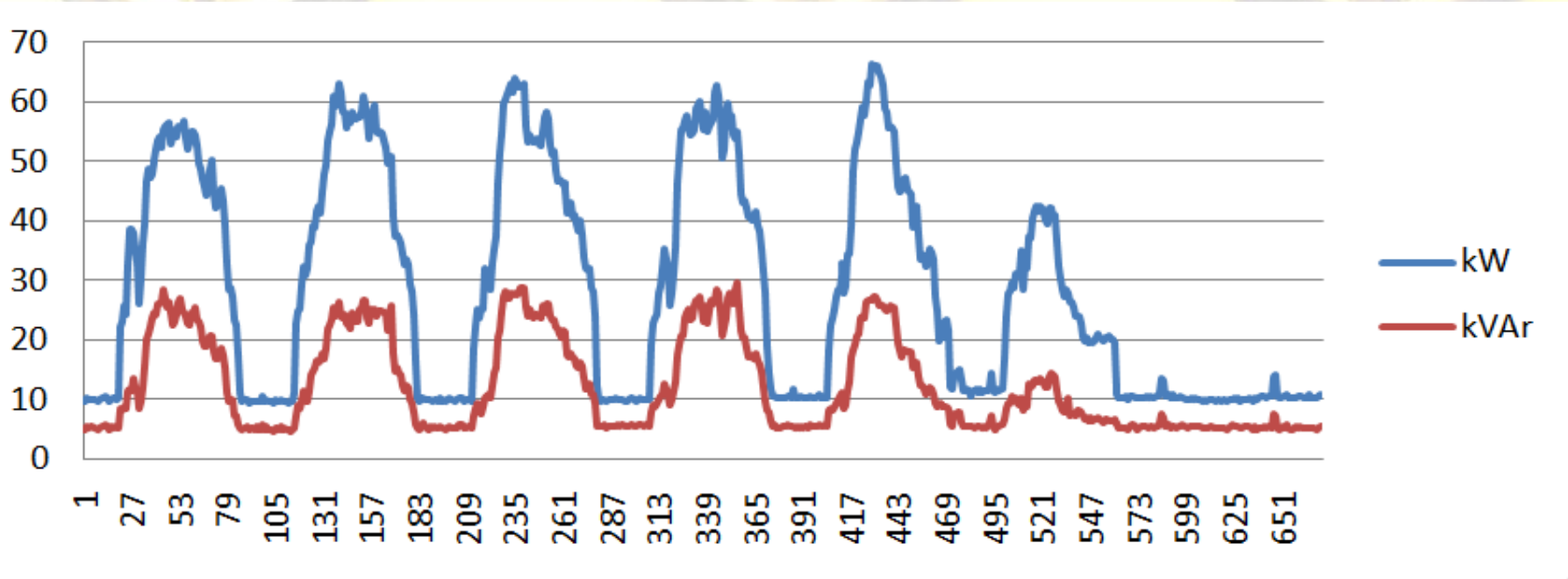




# High school, building I. a March week



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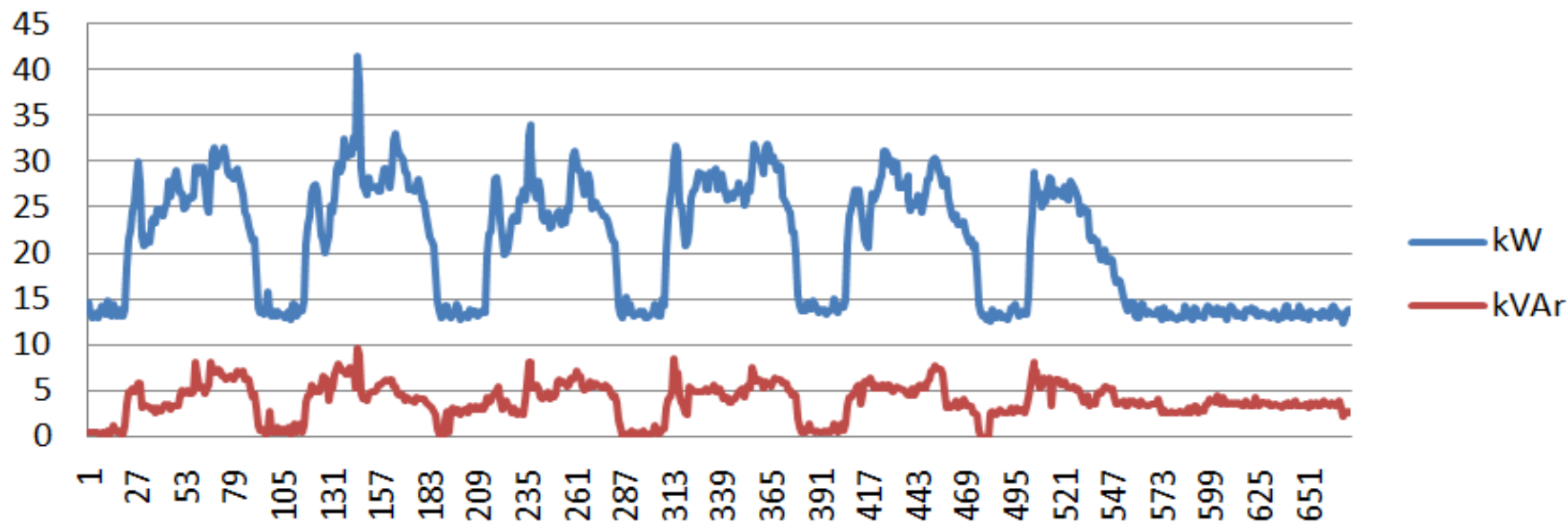




# High school building II., a March week



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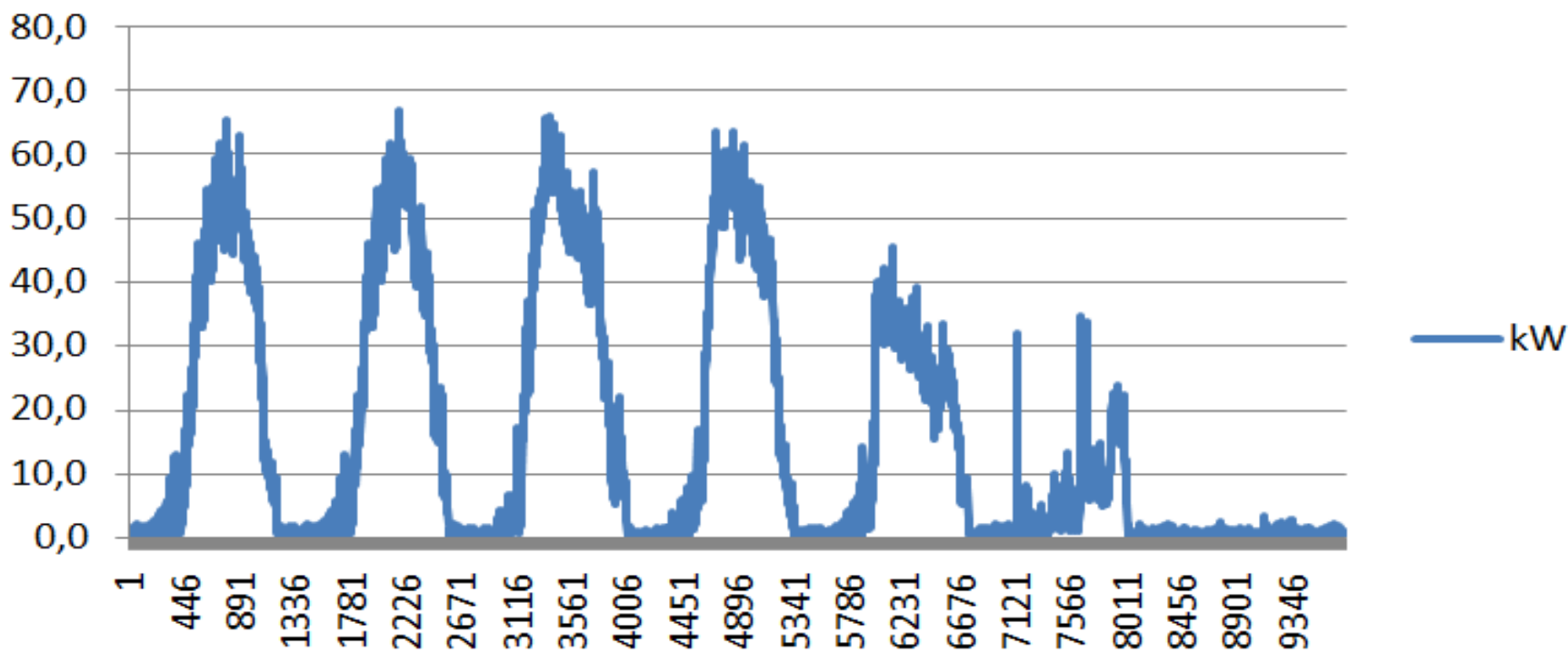




# Grammar school, a February week



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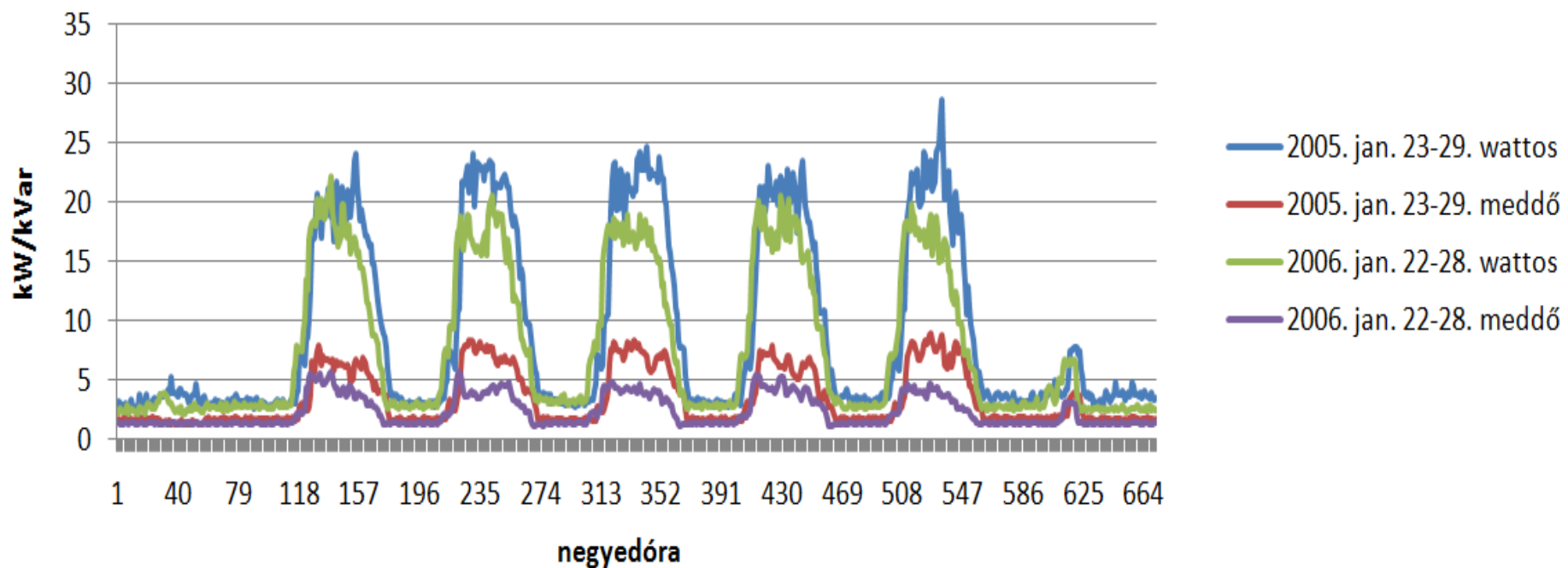




# Grammar school, January weeks

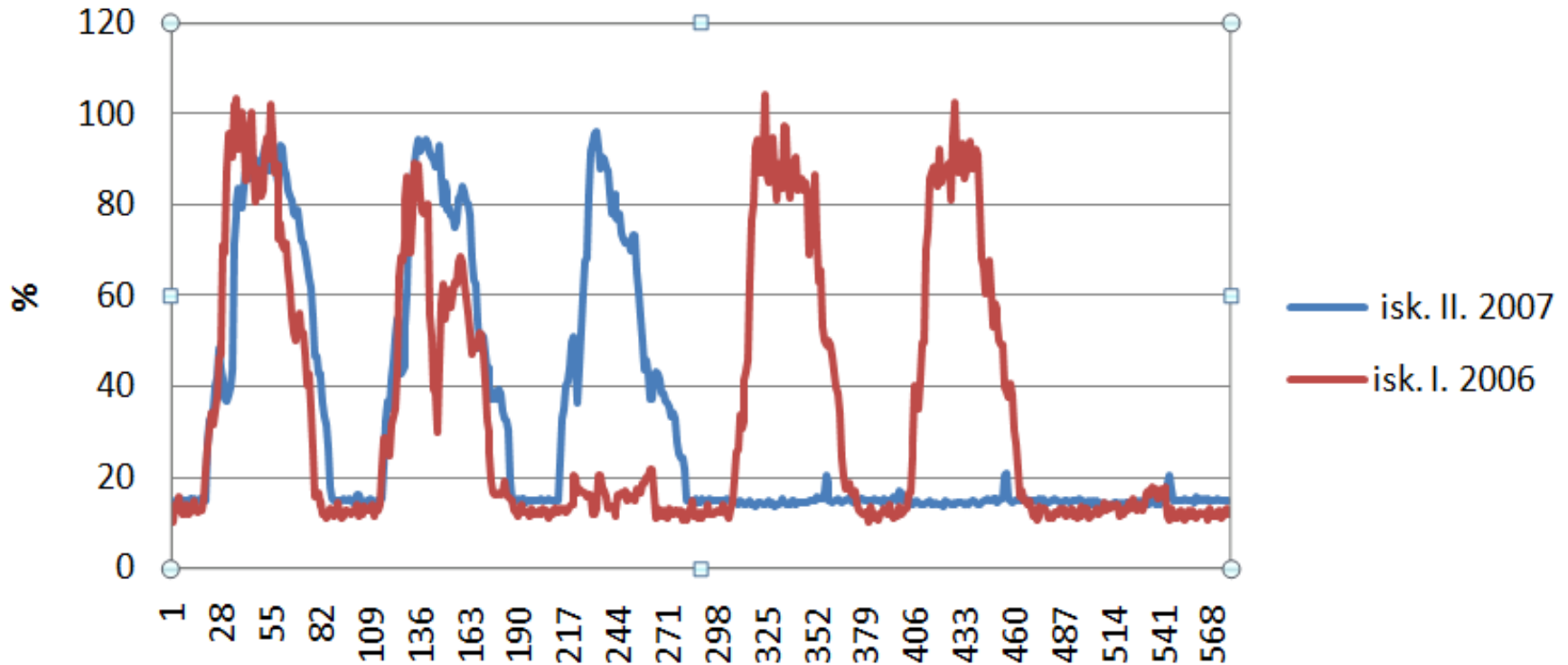


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# National feast



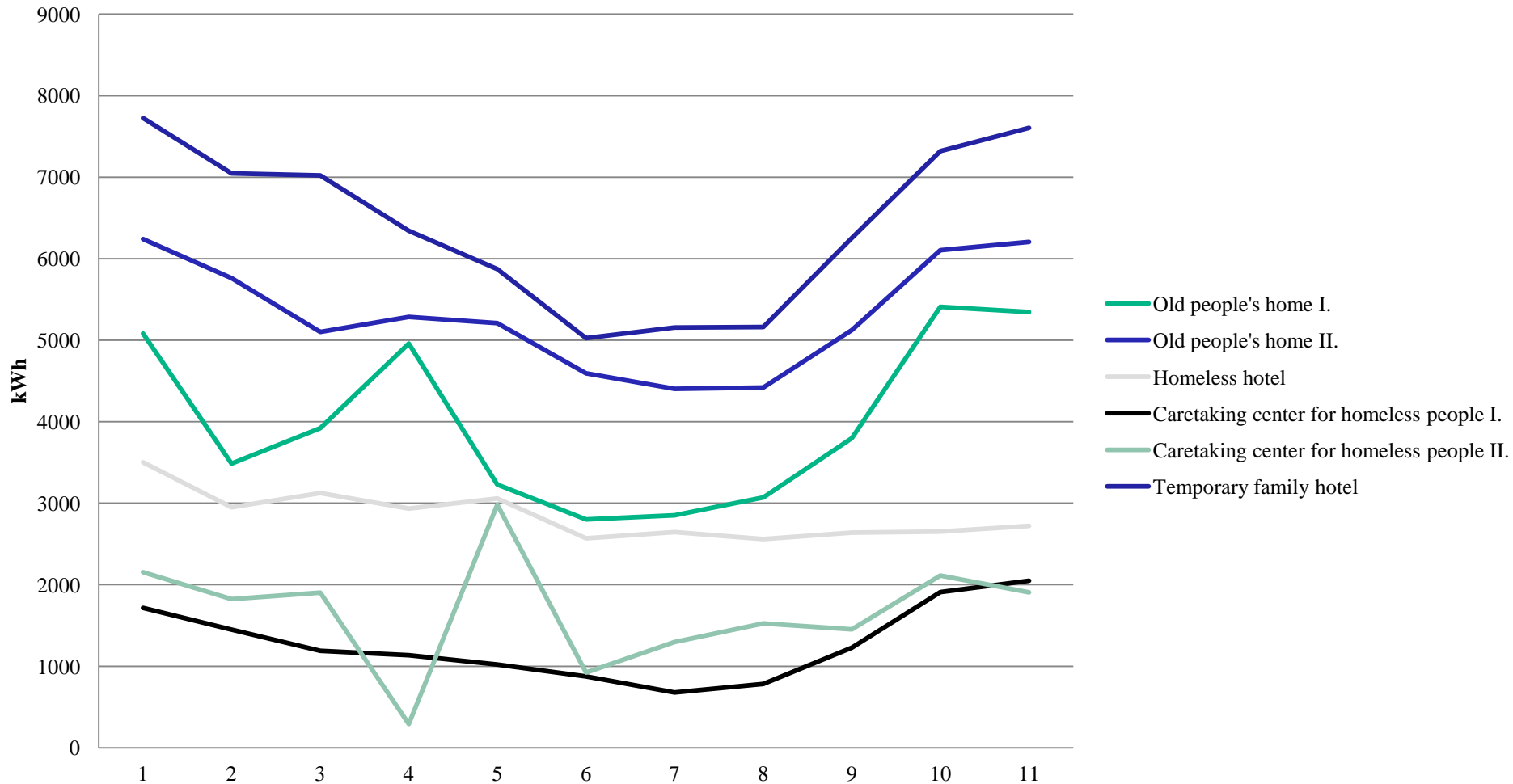




# Monthly electricity consumption of social institution (11 months)



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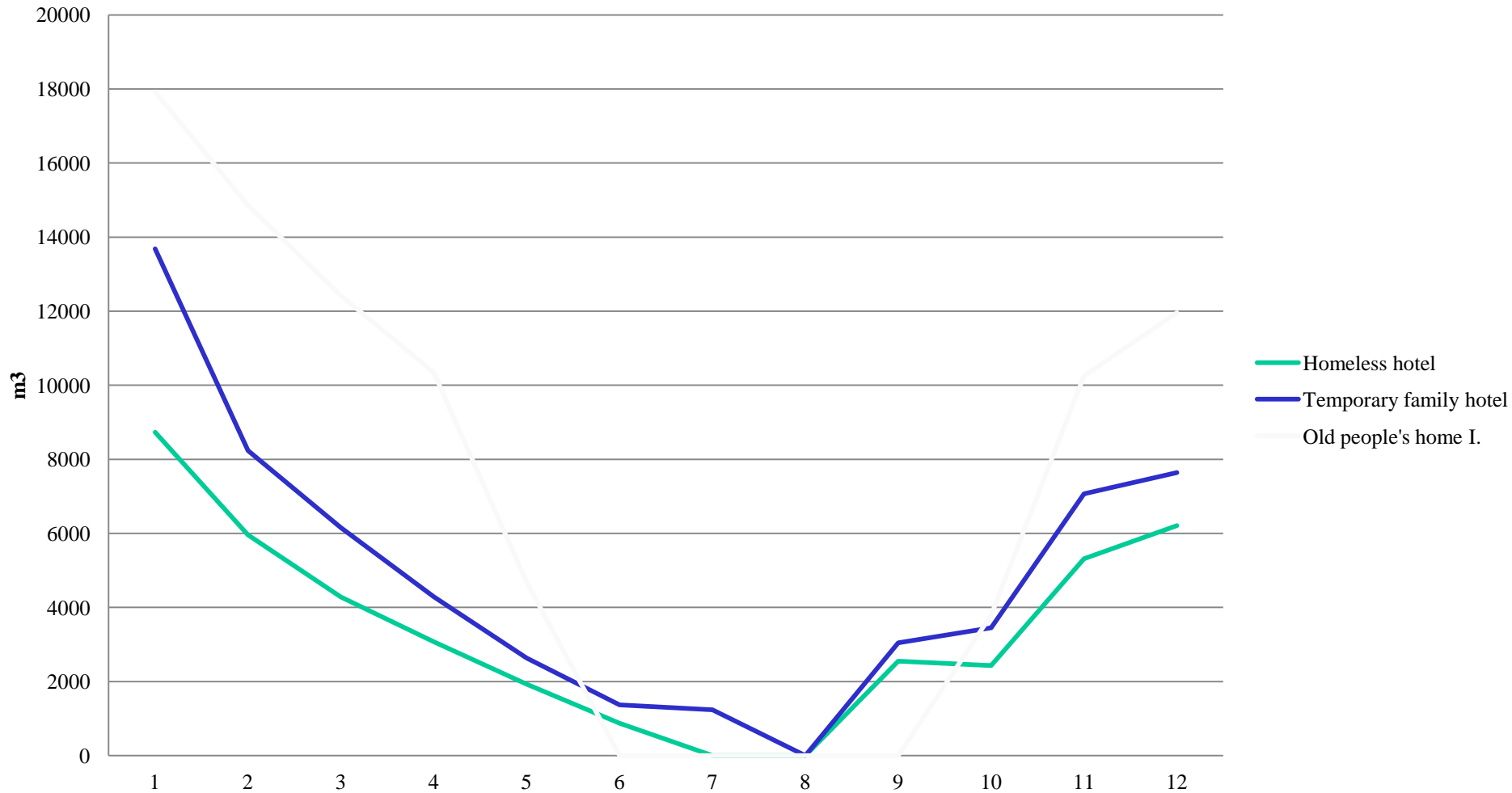




# Seasonal gas consumption in social institution (12 months)



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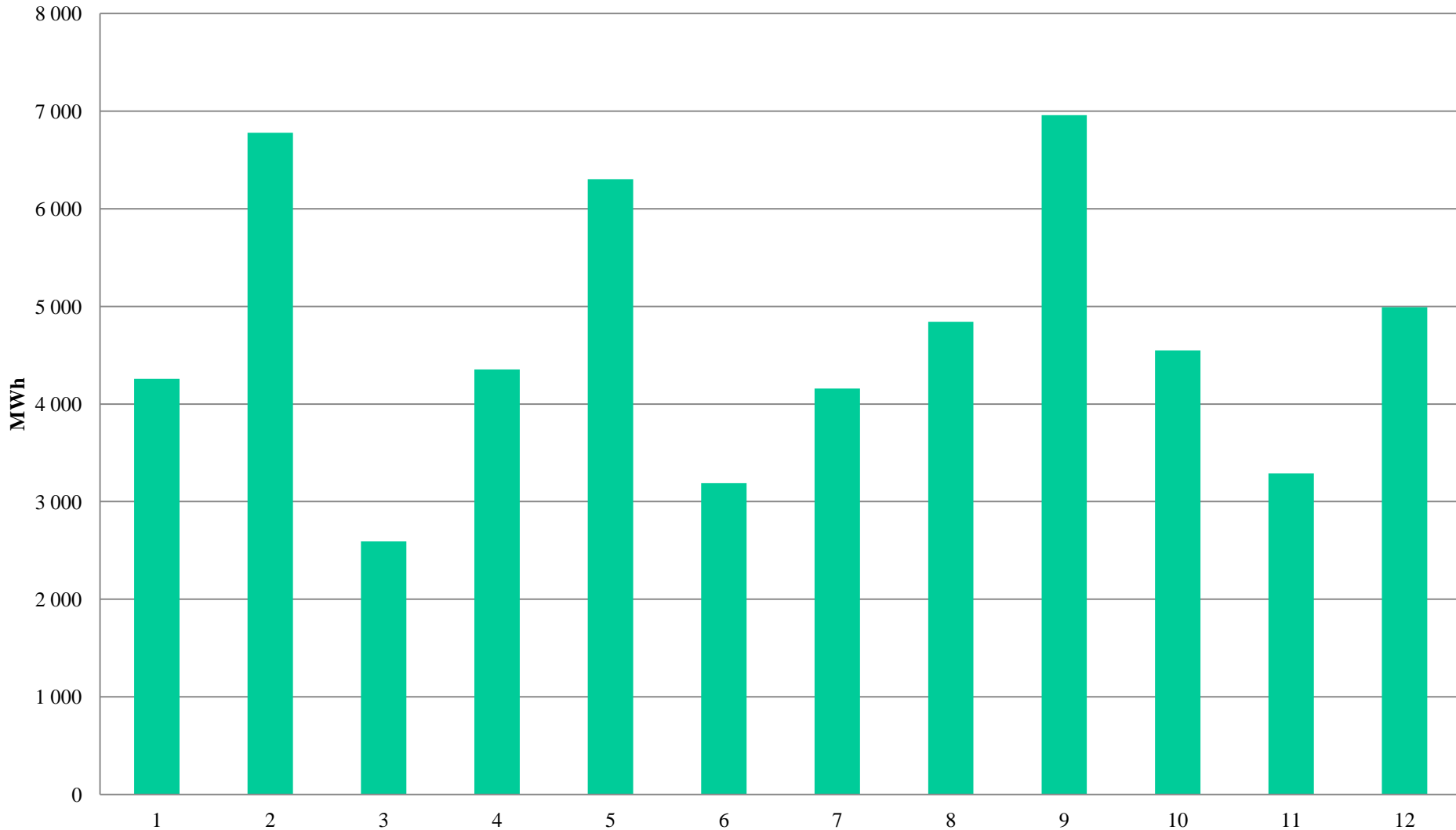




# Monthly electricity consumption data of a water utility



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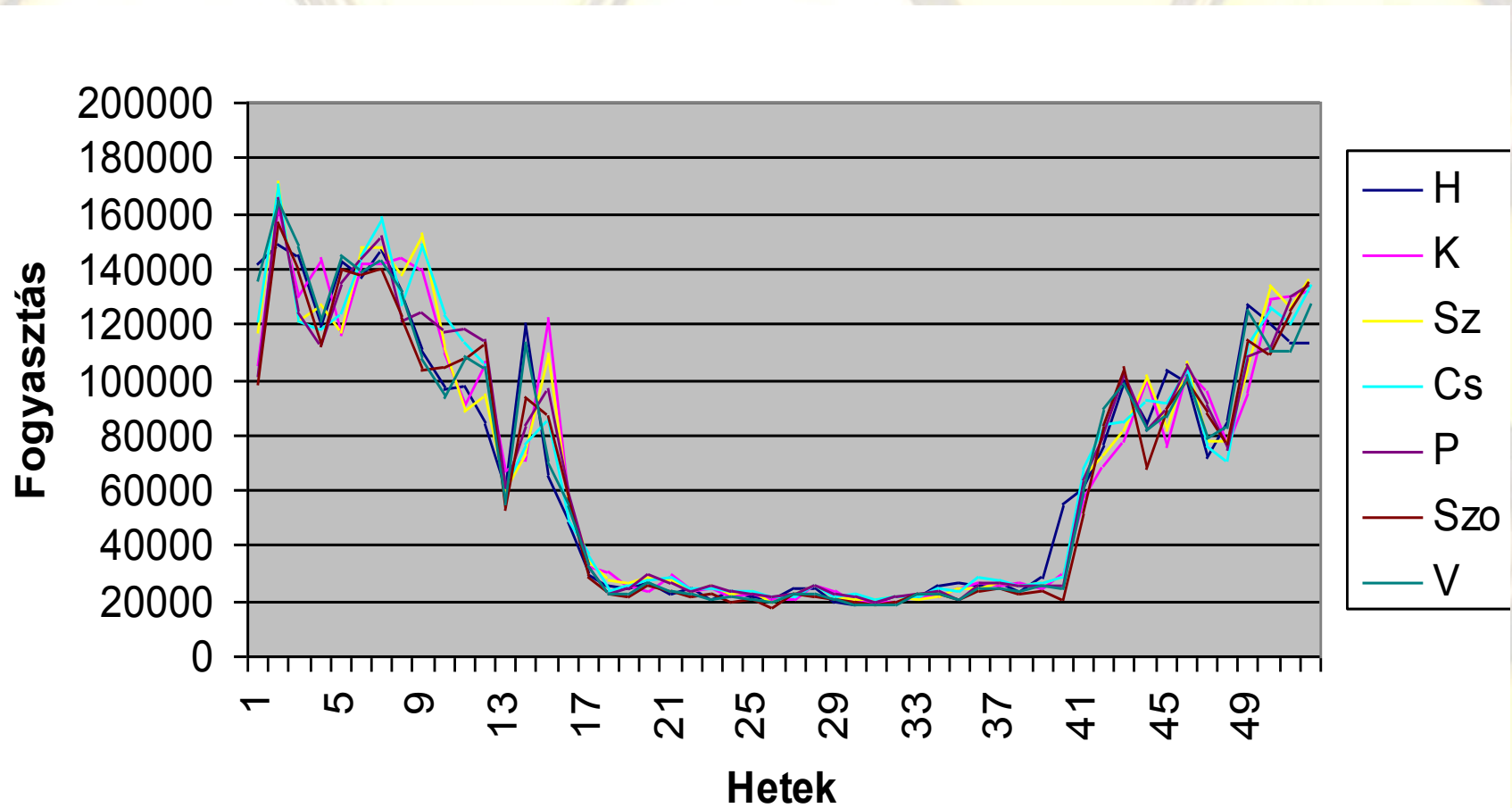




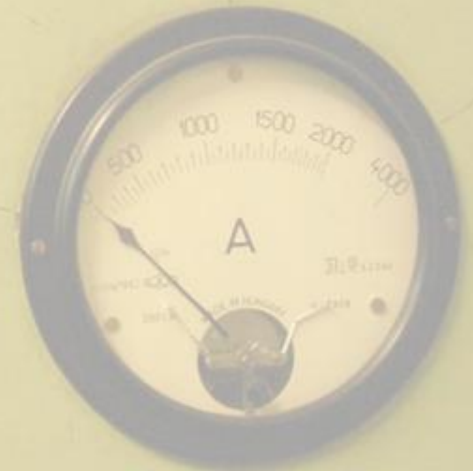
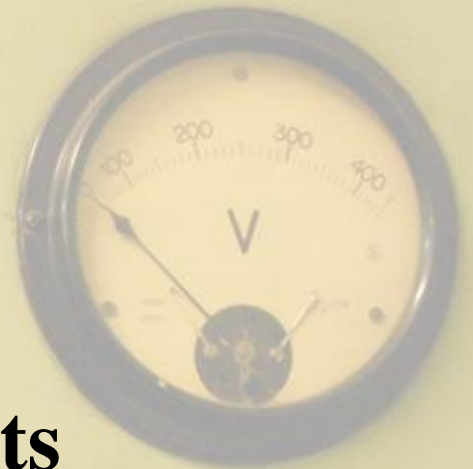
# Daily gas consumption in a year



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# 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



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- 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



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





# The way of the electricity



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**10/0.4 kV transformer**



**Current transformers**



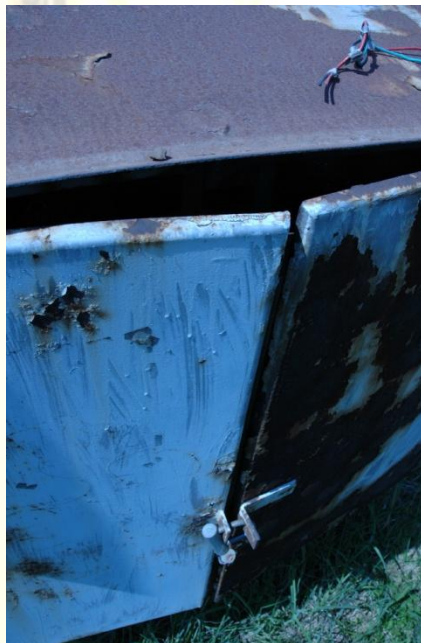
**Meters**



# Devices from different ages



**10/0.4 kV transformer**



**Meter box**



**0.4 kV main supply**









# Electrical devices



**10/0.4 kV transformer**



**Aggregator**



**0.4 kV distribution box**



# Metering in Hungary







# Metering in Greece



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# Metering in Greece



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# Reactive power compensation and distr. boxes



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# UPS and accumulators



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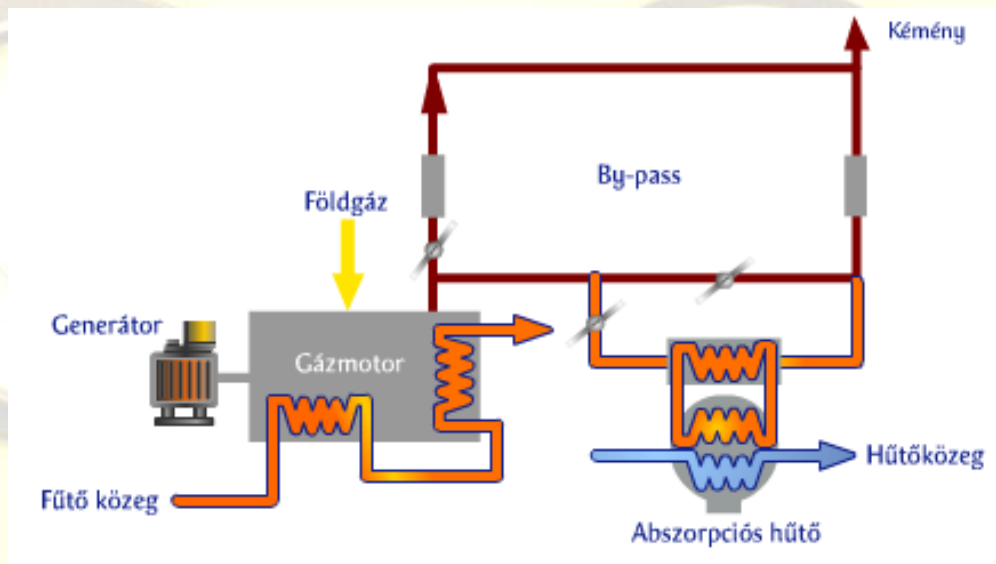
# Problems of public energy management

- Costs occur 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  $\rightarrow$  electricity + heat + cooling





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

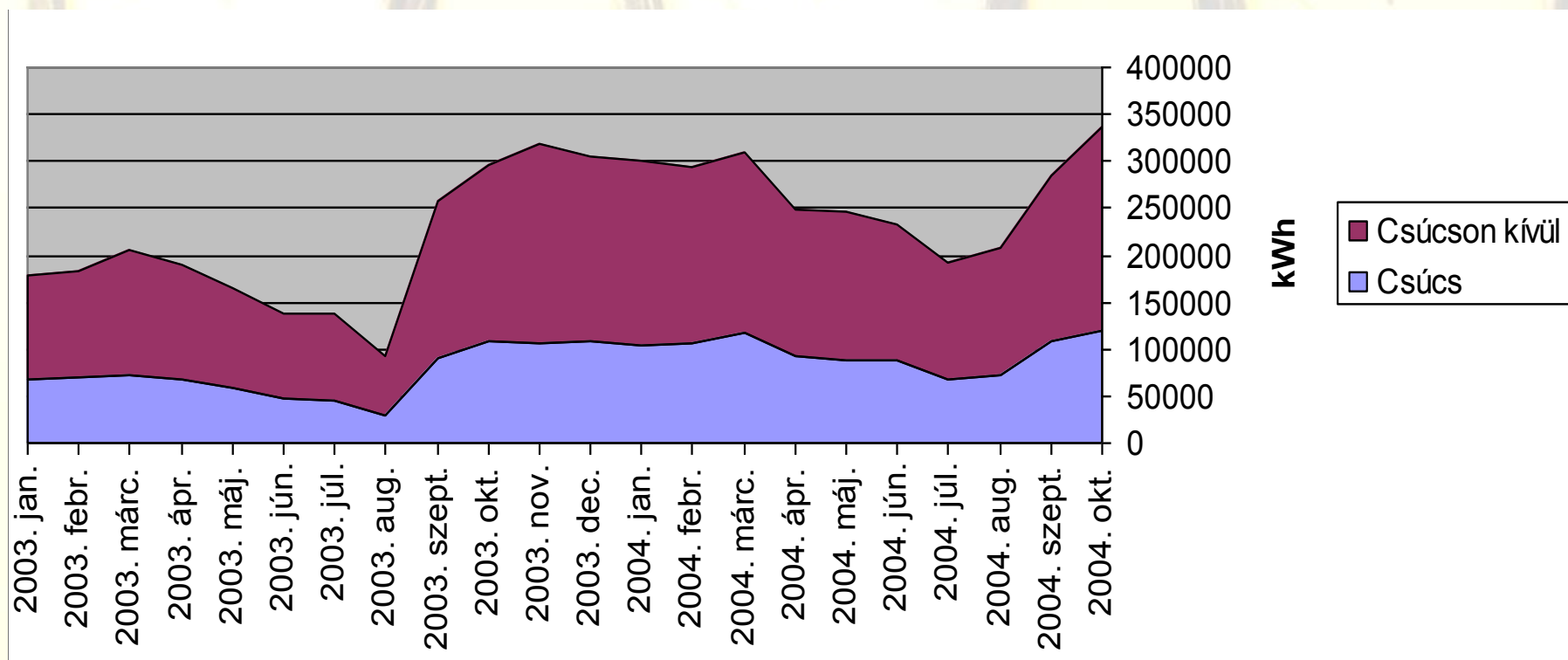




# Electrical energy management: active power and the tariffs



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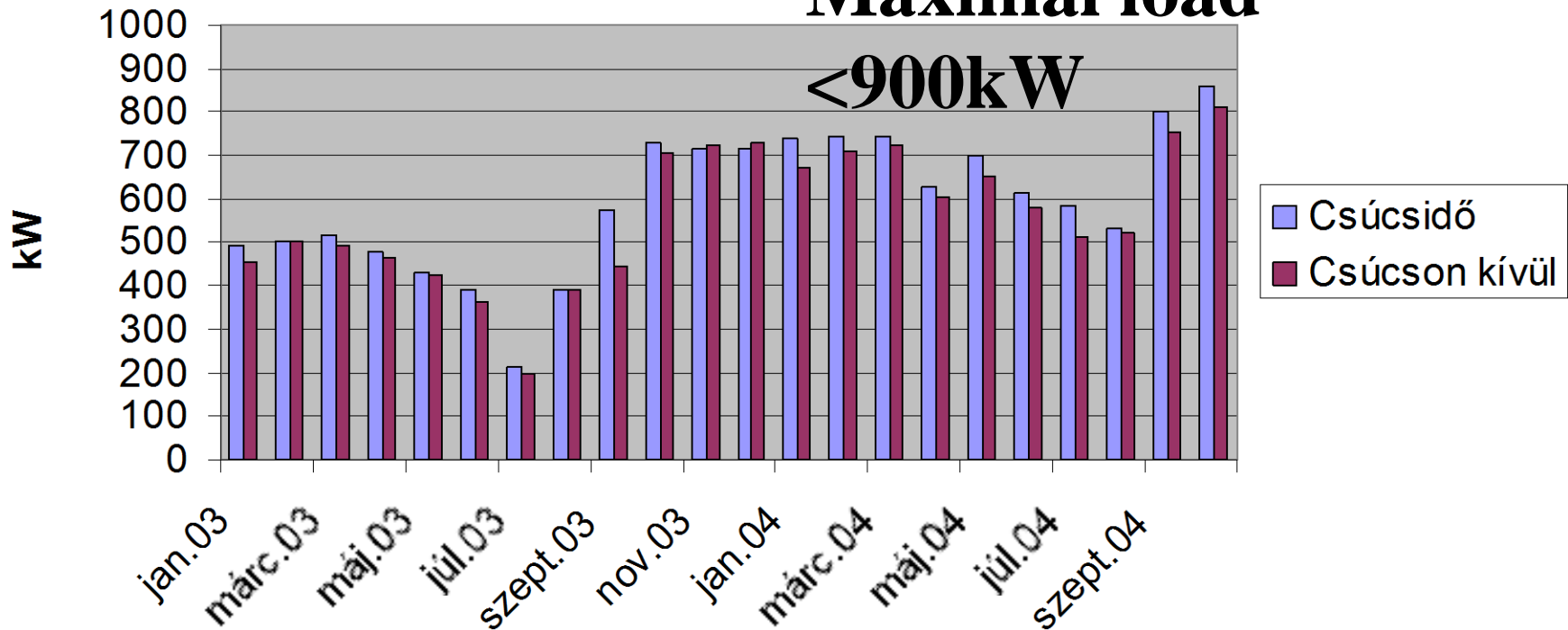


# Electrical energy management: peak power



## Maximal load

<900kW



Peak must be set/controlled by the tariffs

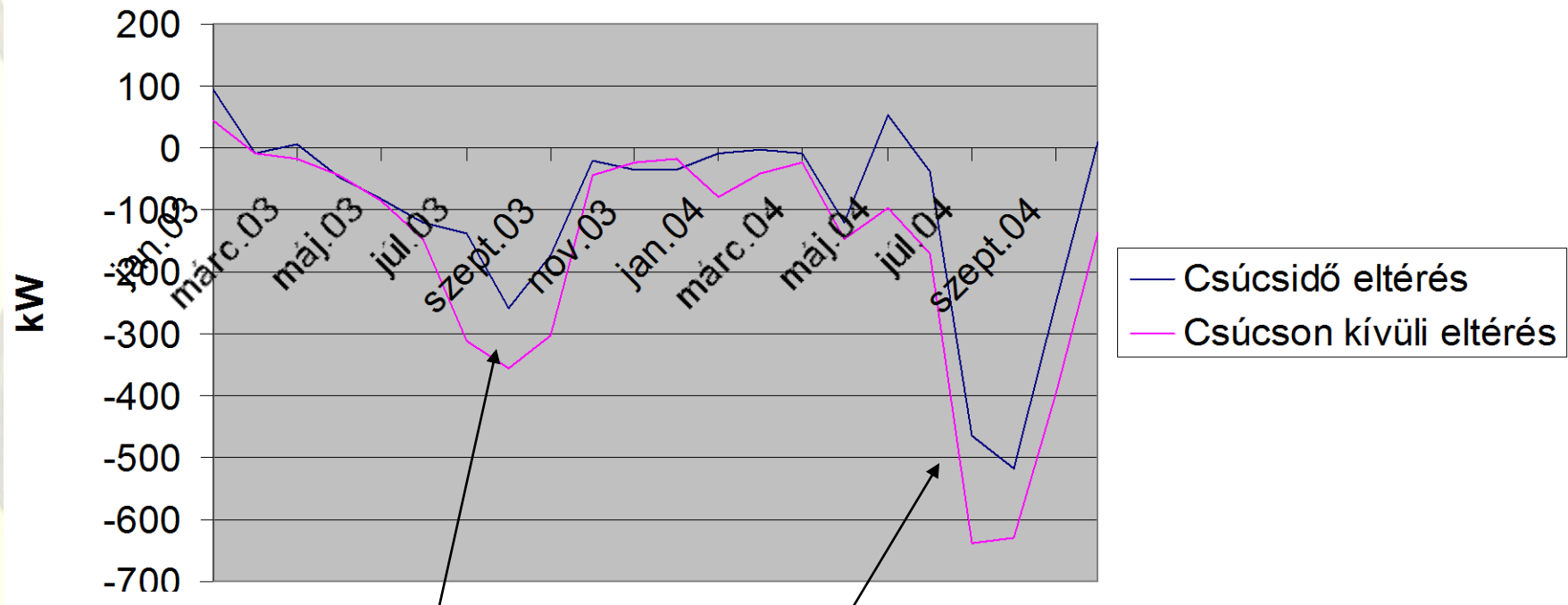


# Electrical energy management: prefixed peaks



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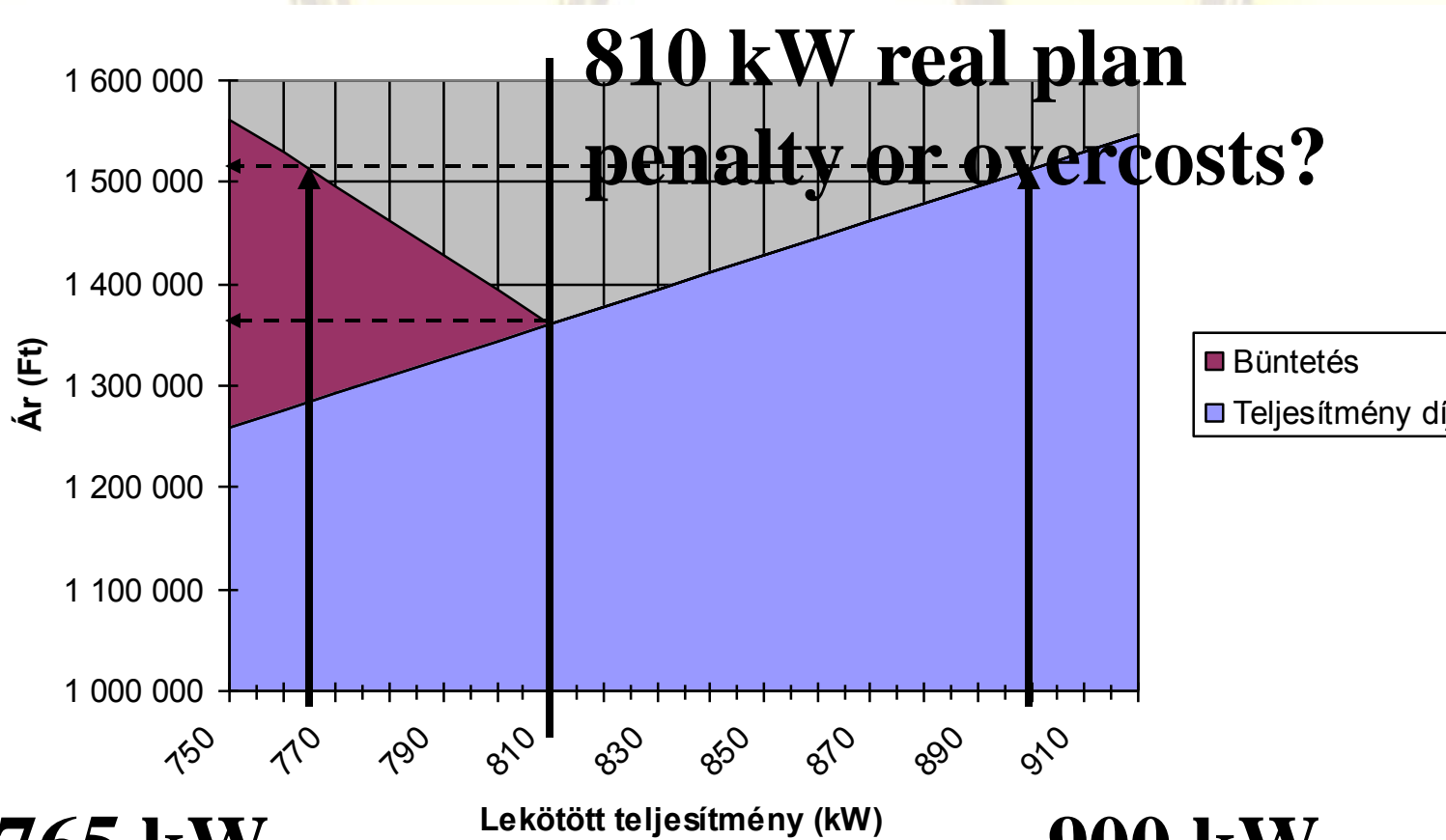
## oversizing !



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



# Over- and undersizing of the prefixed peak



**765 kW**

**fixed**

Lekötött teljesítmény (kW)

**900 kW**

**fixed**

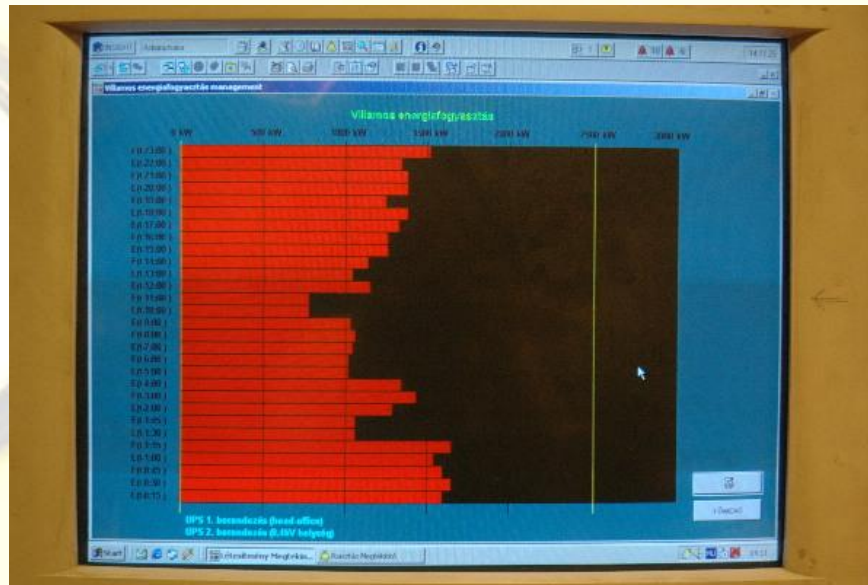


# Peak management



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



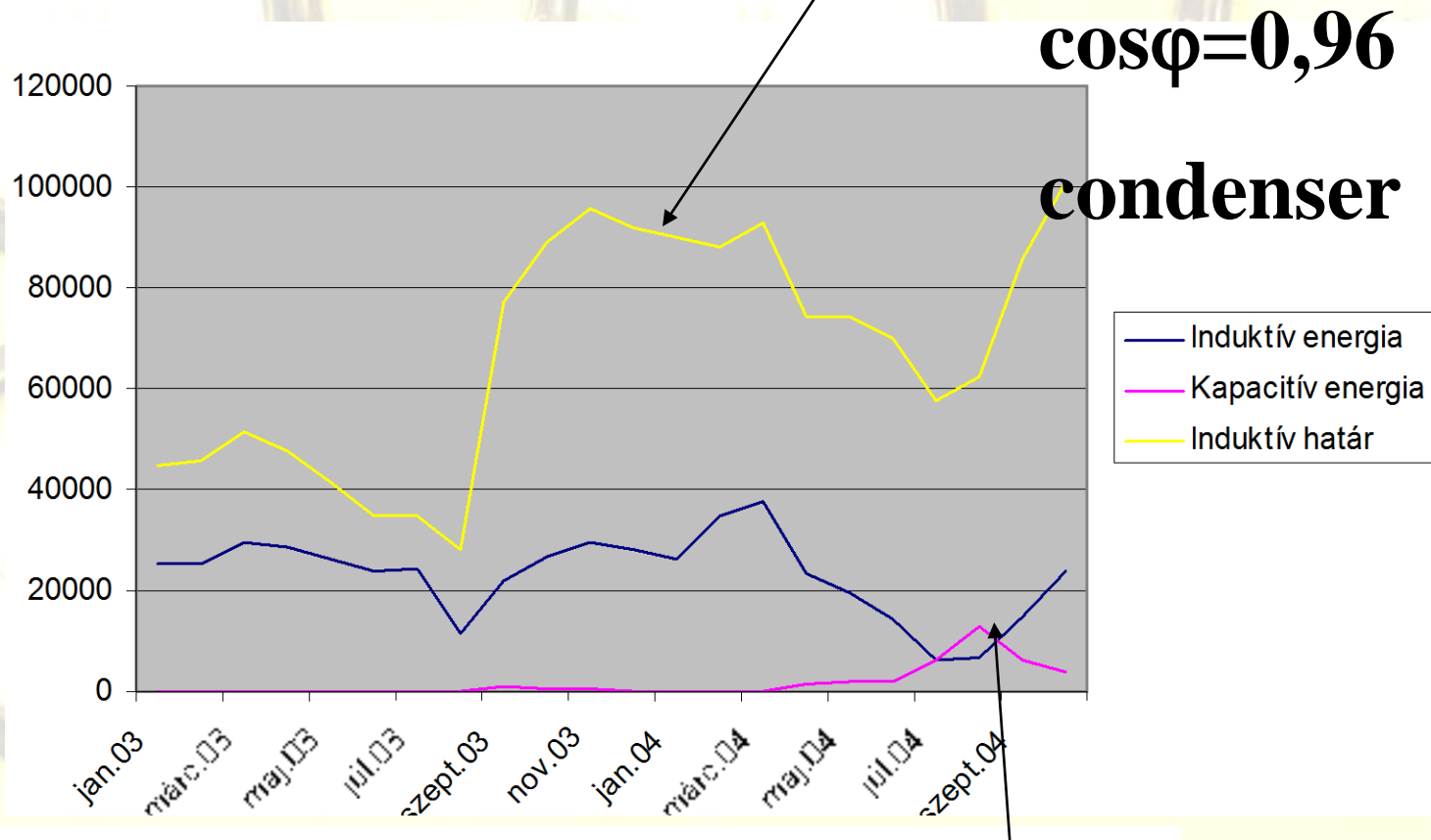


# Electrical energy management: reactive power



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

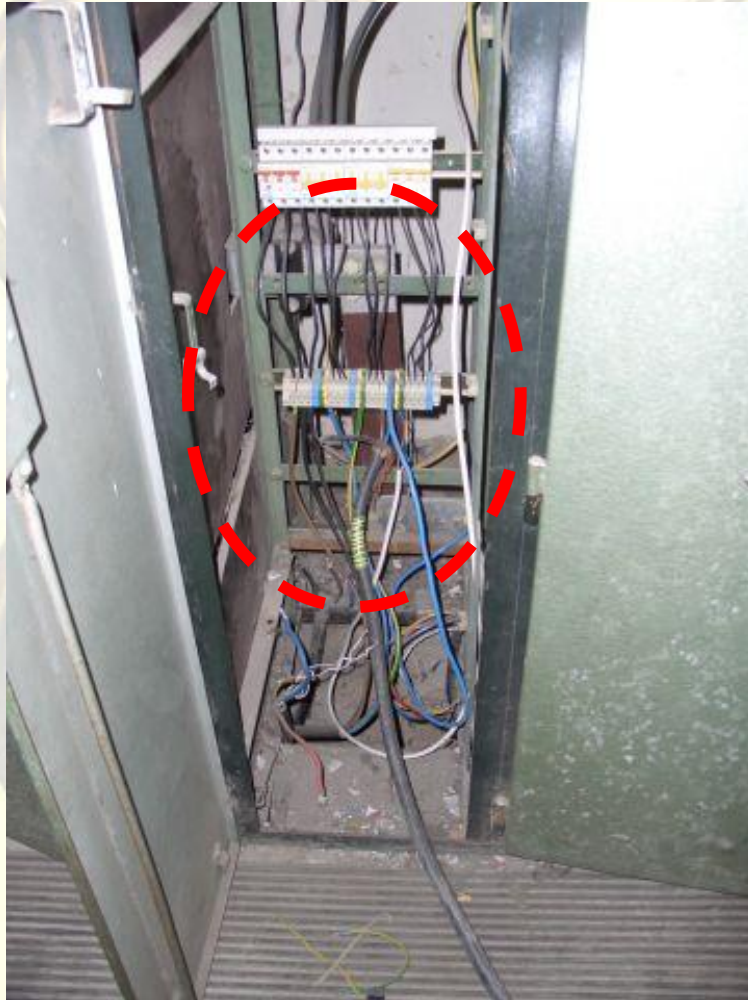


Penalty for the capacitive reactive power!





# Walking – looking – listening

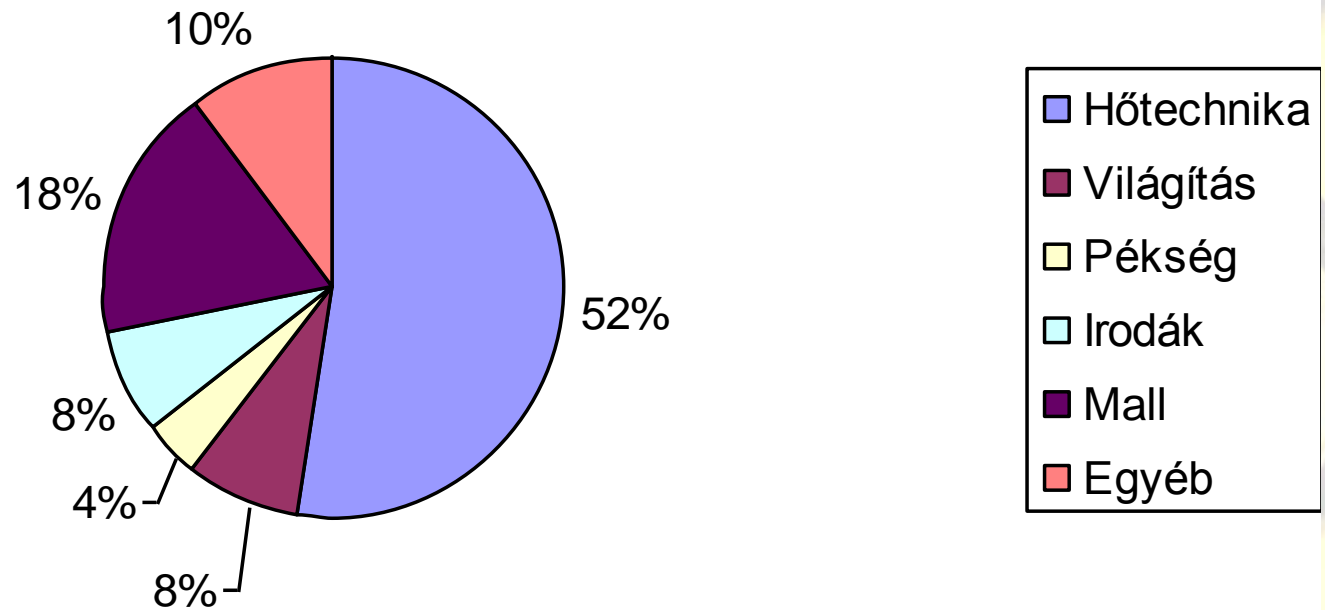




# Ratio analysis

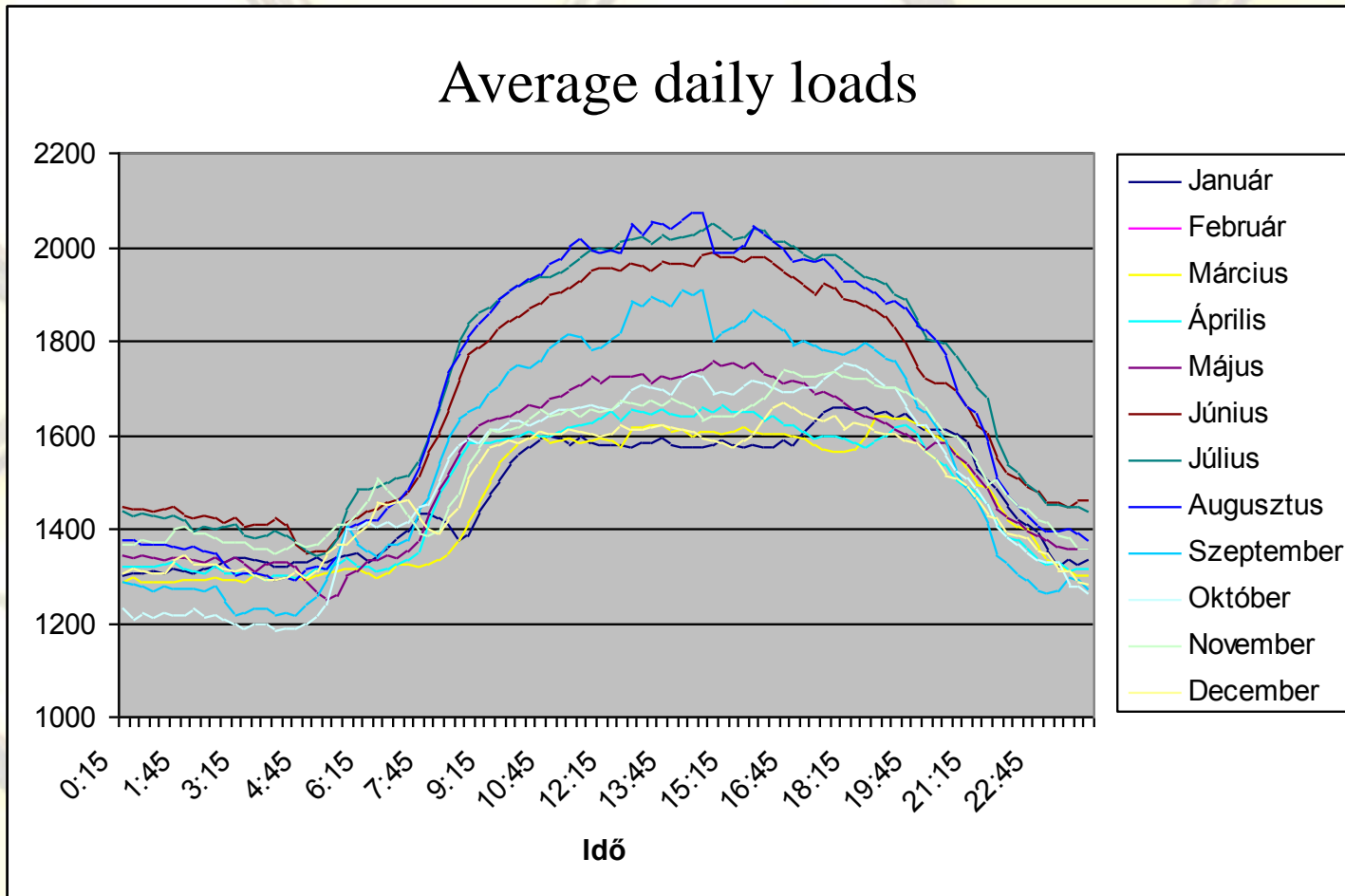


## Built in power





# Measurement analysis







# Measuring



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# The relation of the electrical and heating energy



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



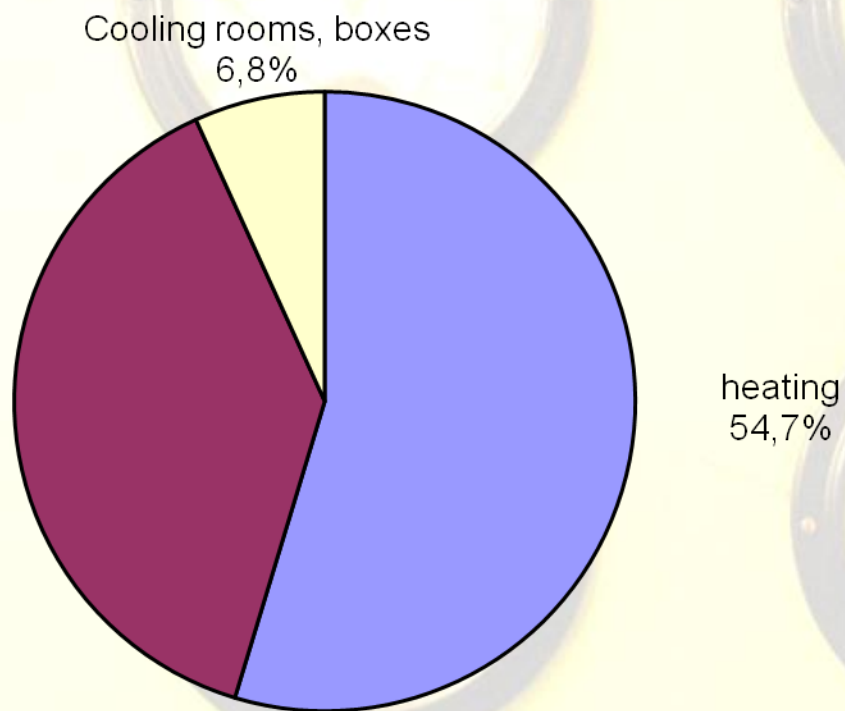




# Ratio of heating and cooling in a mall

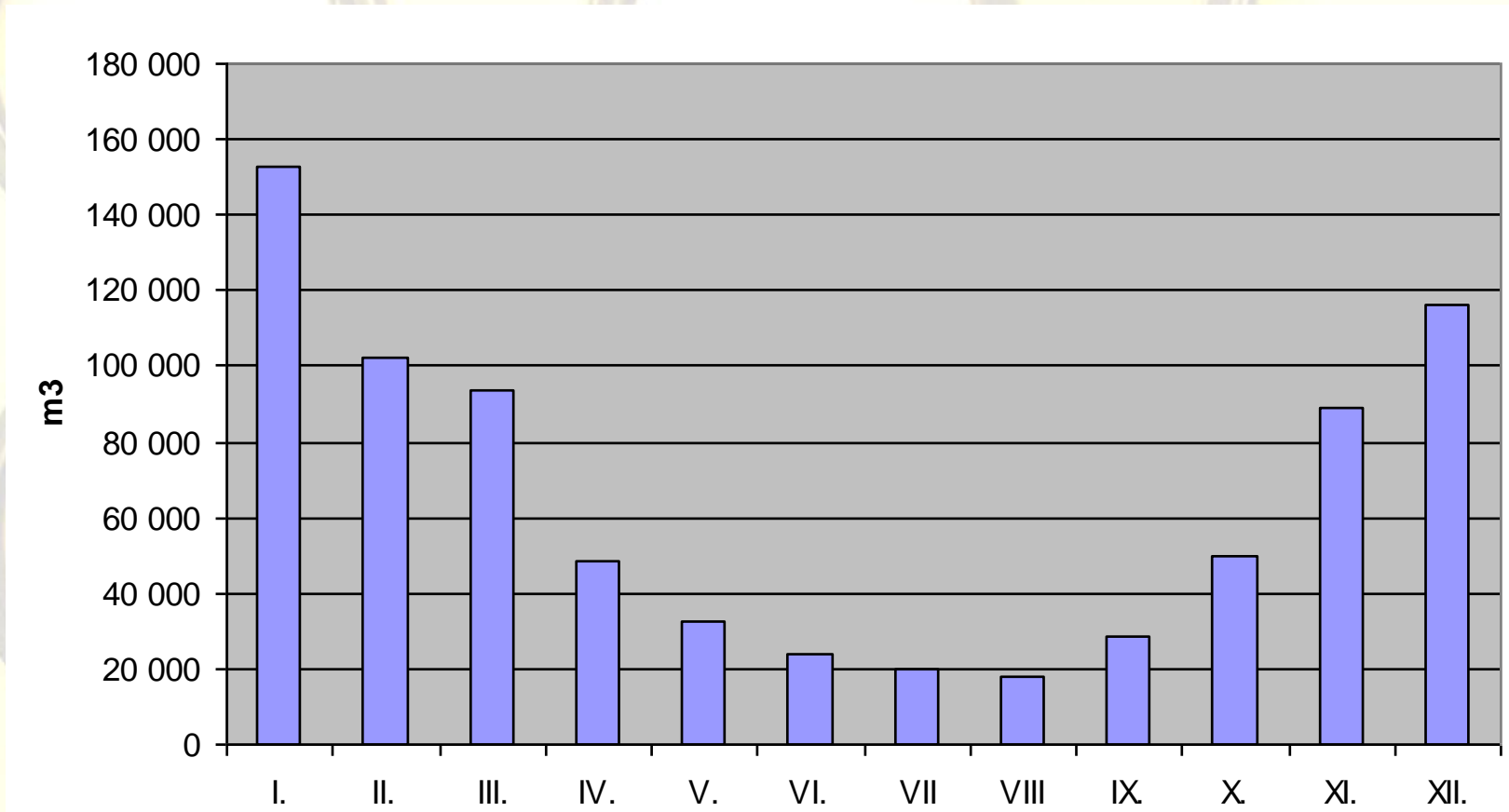


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# Gas consumption

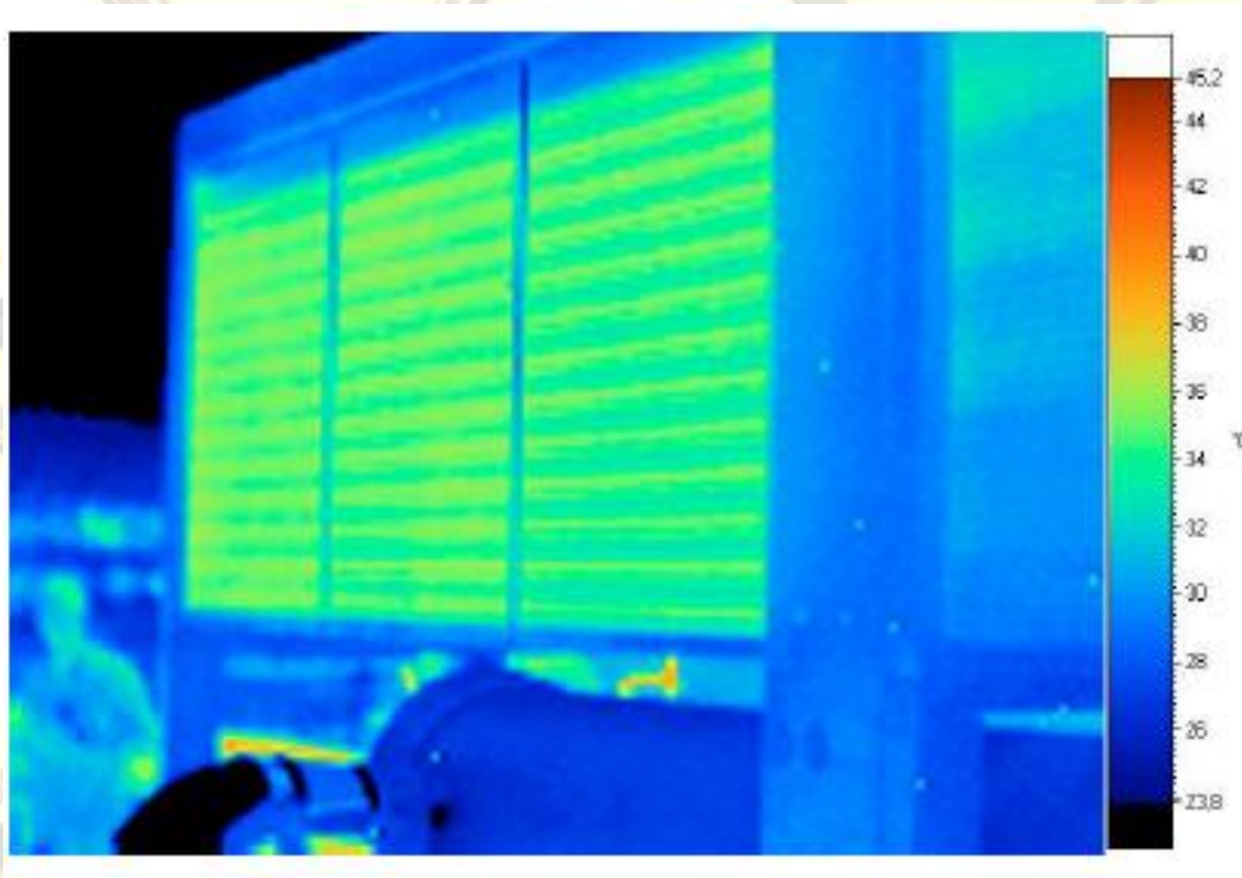




# Thermovision



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# 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



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- 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



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- 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



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





# What about the renewables?



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- Small scale application, only on economy basis
- **Wind** – not really
- **PV?** – only if you combine with architectural solutions, e.g. shadowing
- **Geothermal** – if the temperature is high enough, 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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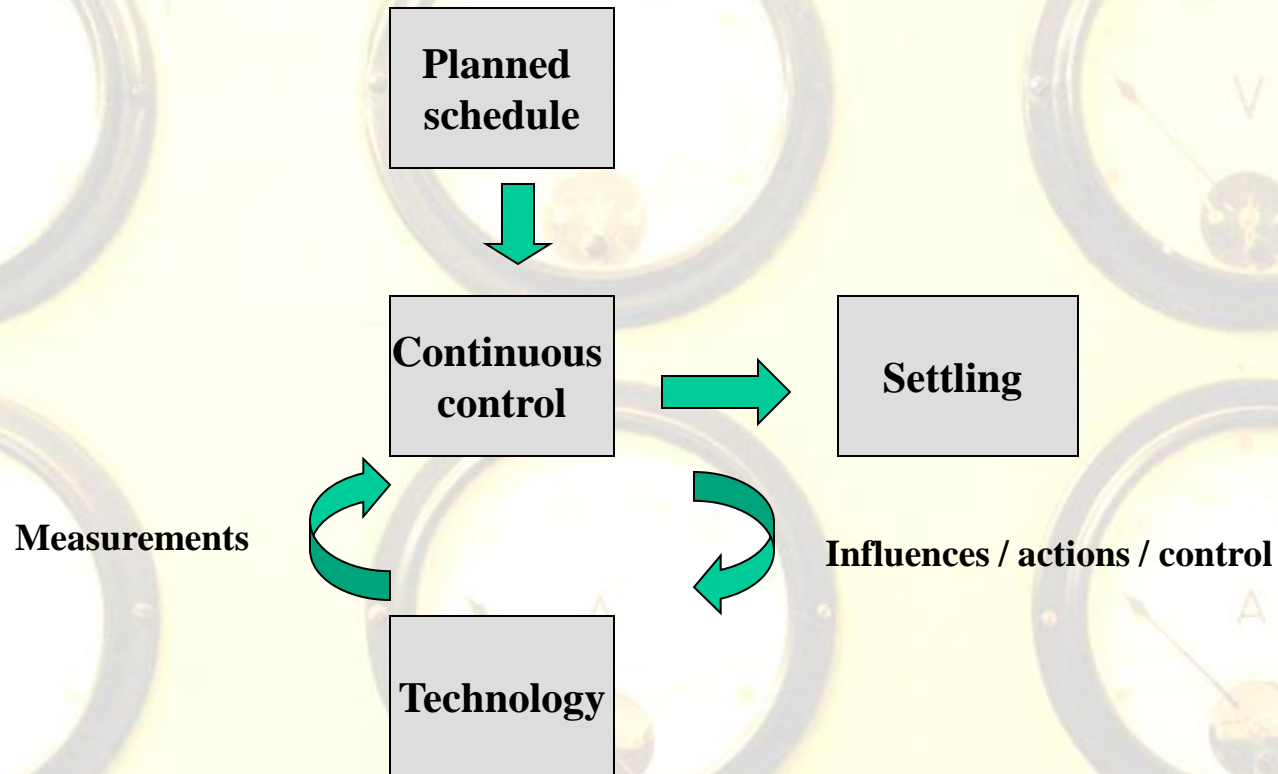




# The process of energy management



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# Energy management system



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

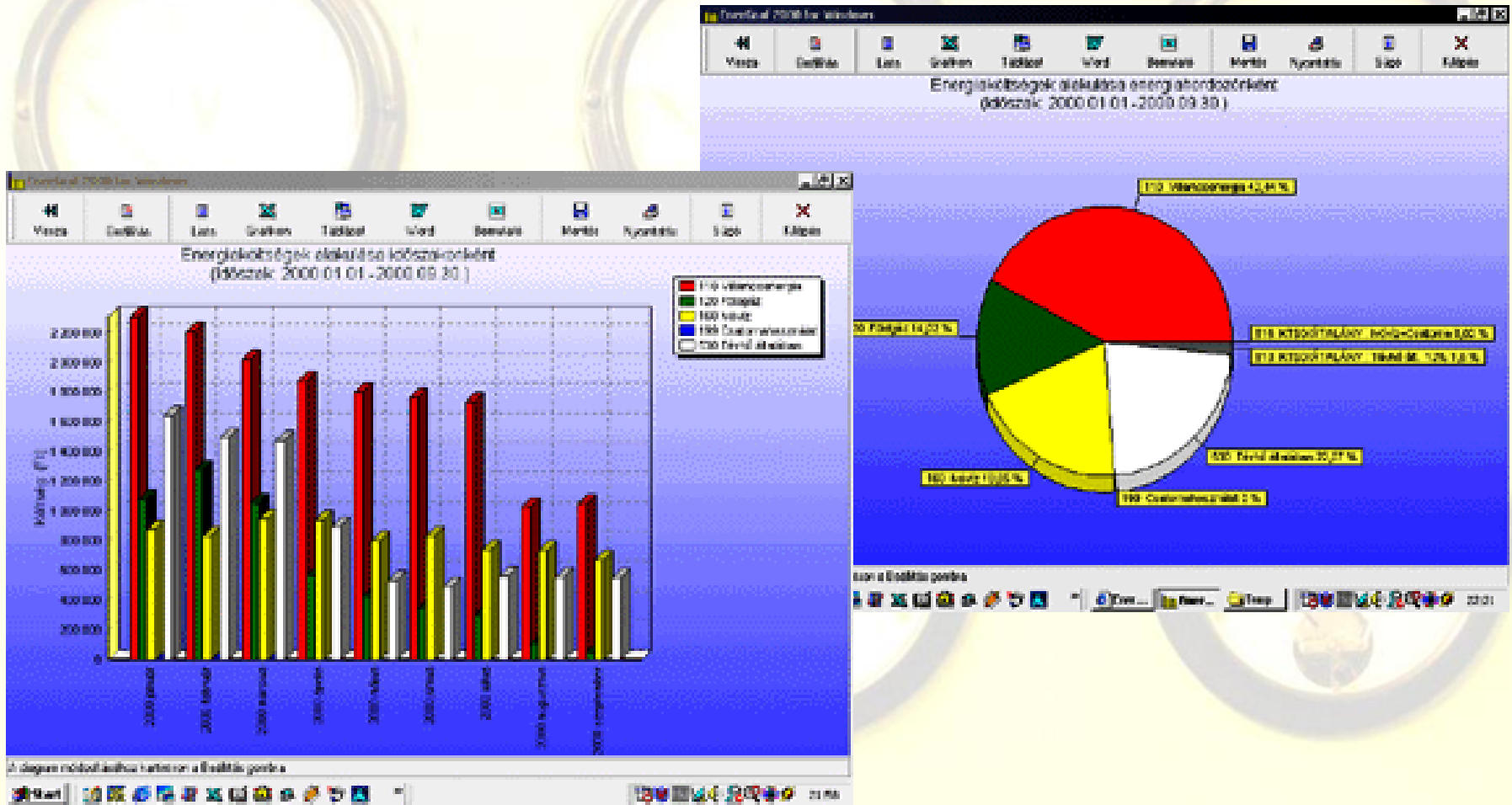




# Continuous control of the usages



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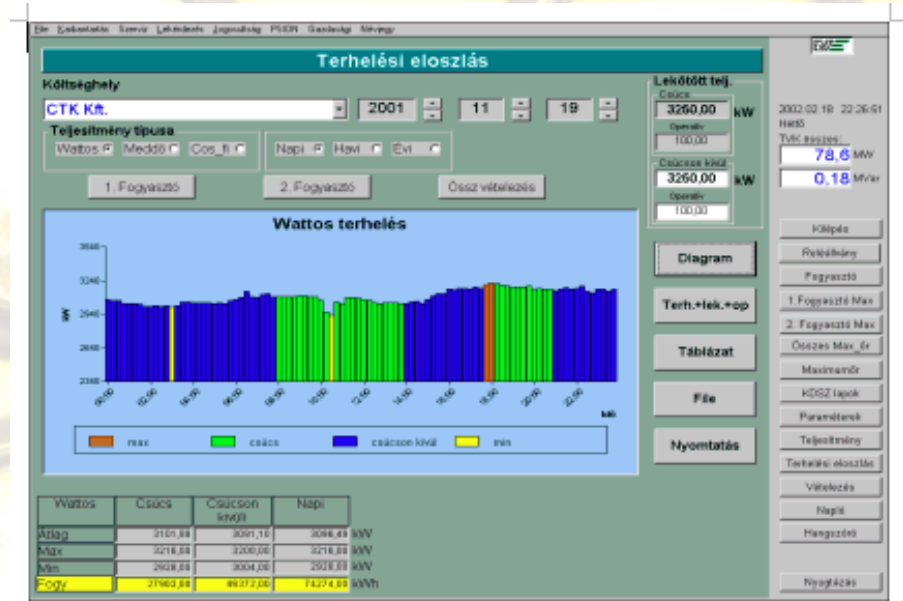
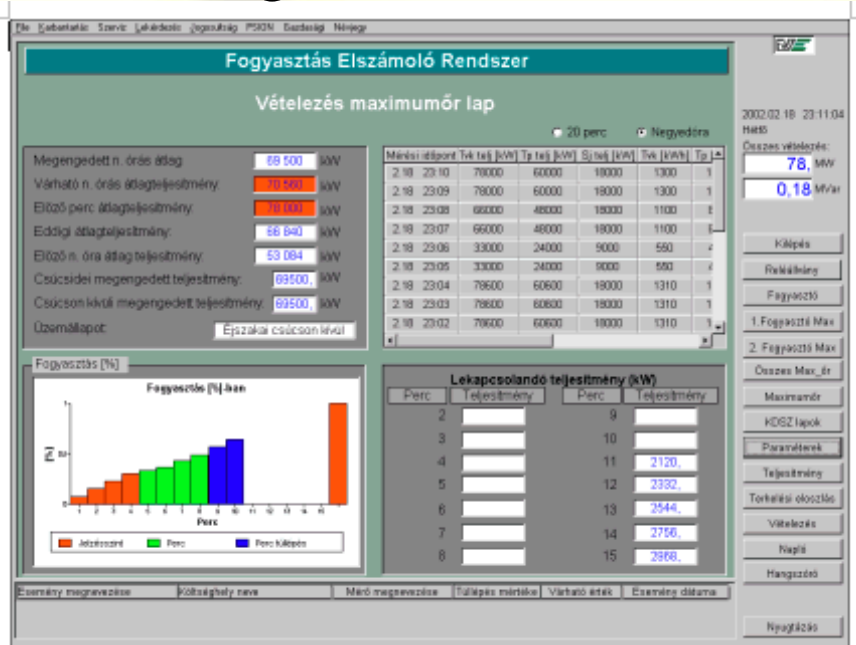


# Energy management functions



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- limit investigation
- optimisation
- cost allocation
- settling

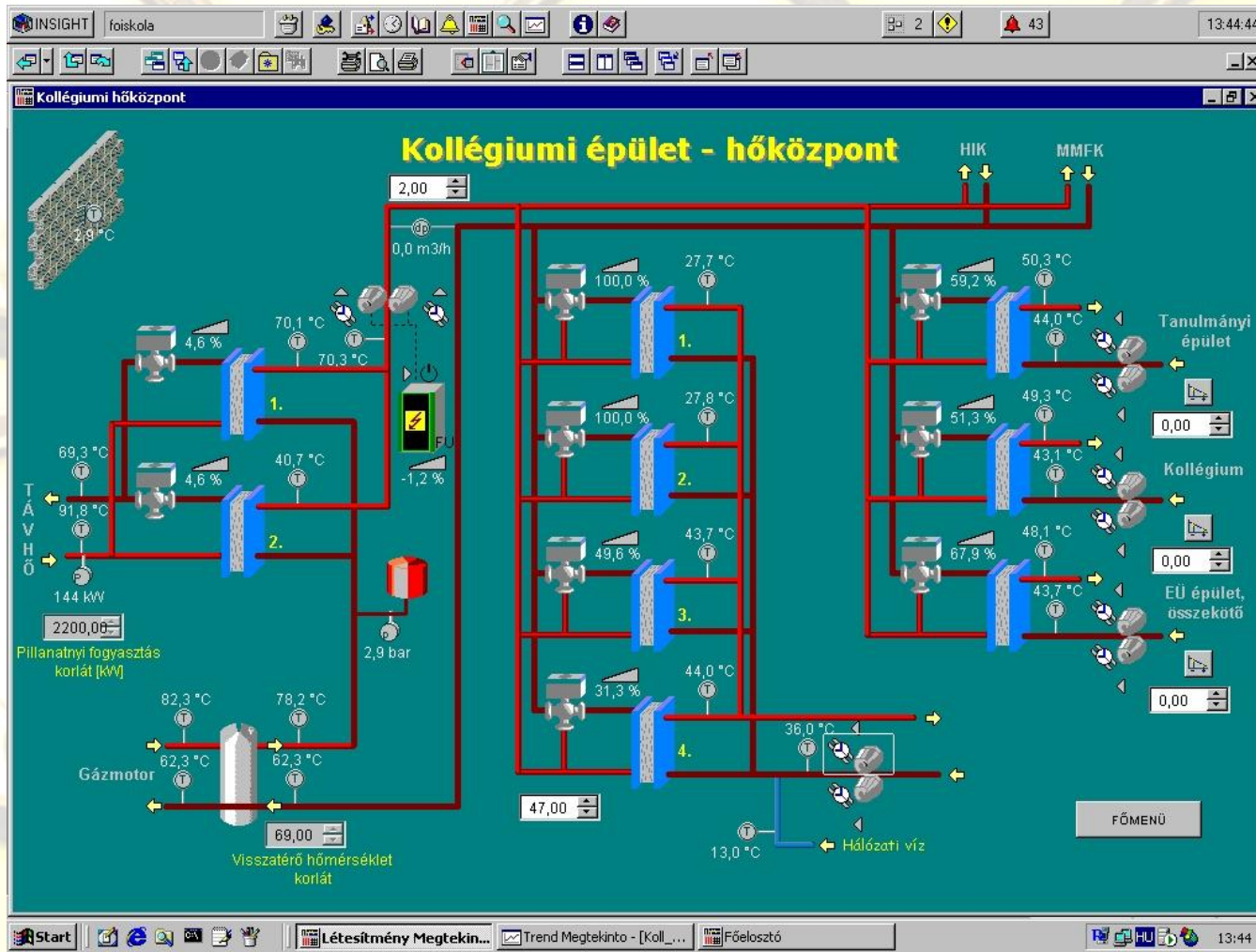




# Building control system



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**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



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*Is there DSM potential in the households?*

The methodes:

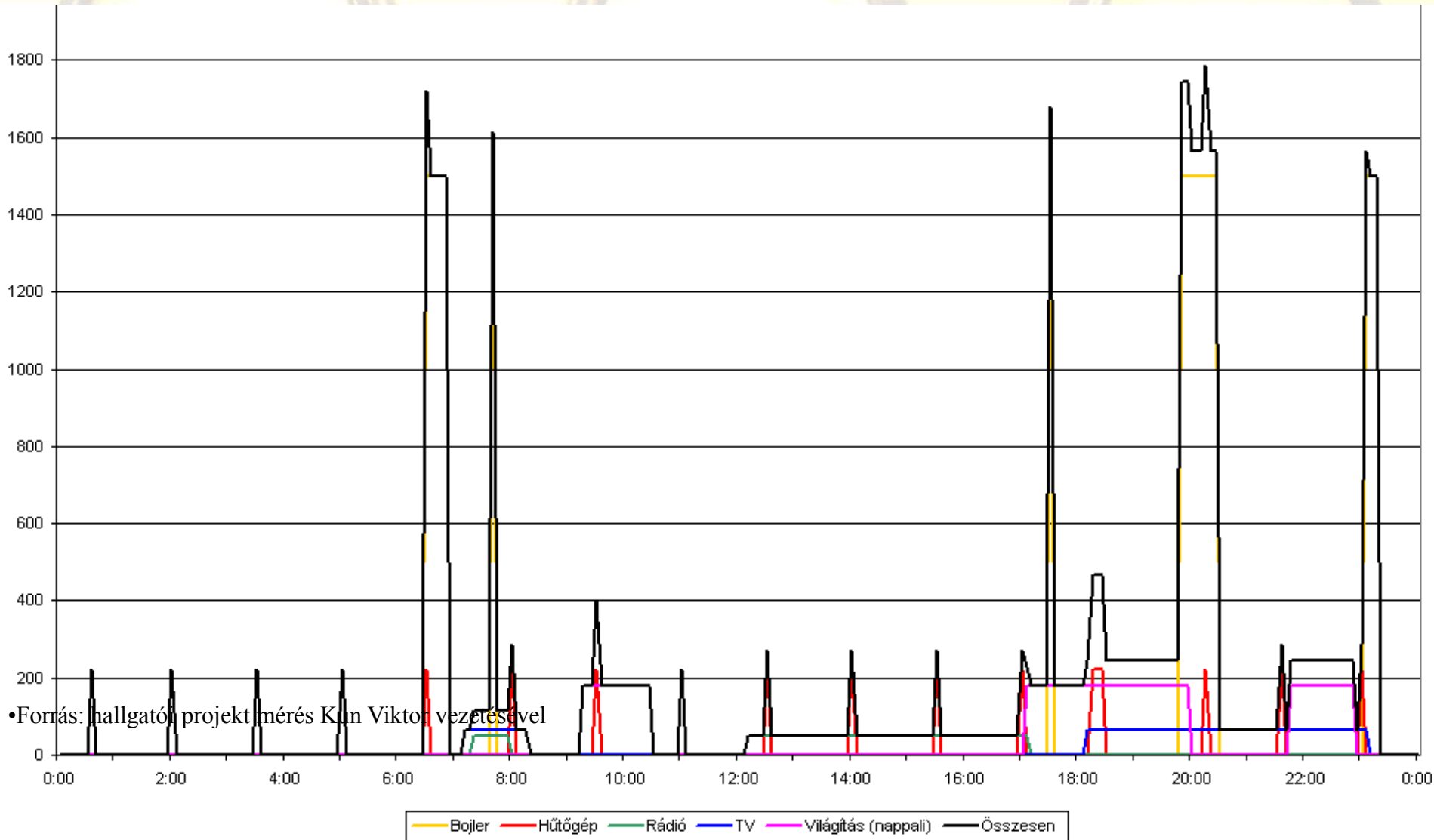
- Monitoring of the household consumption
- Creating an aggregated schedule
- Identification of ripple control part
- Proposal for the better ripple control schedule
- Identification of the controllable part
- Proposal for new schedule



# „Stopwatch measurement” - Flat 1.



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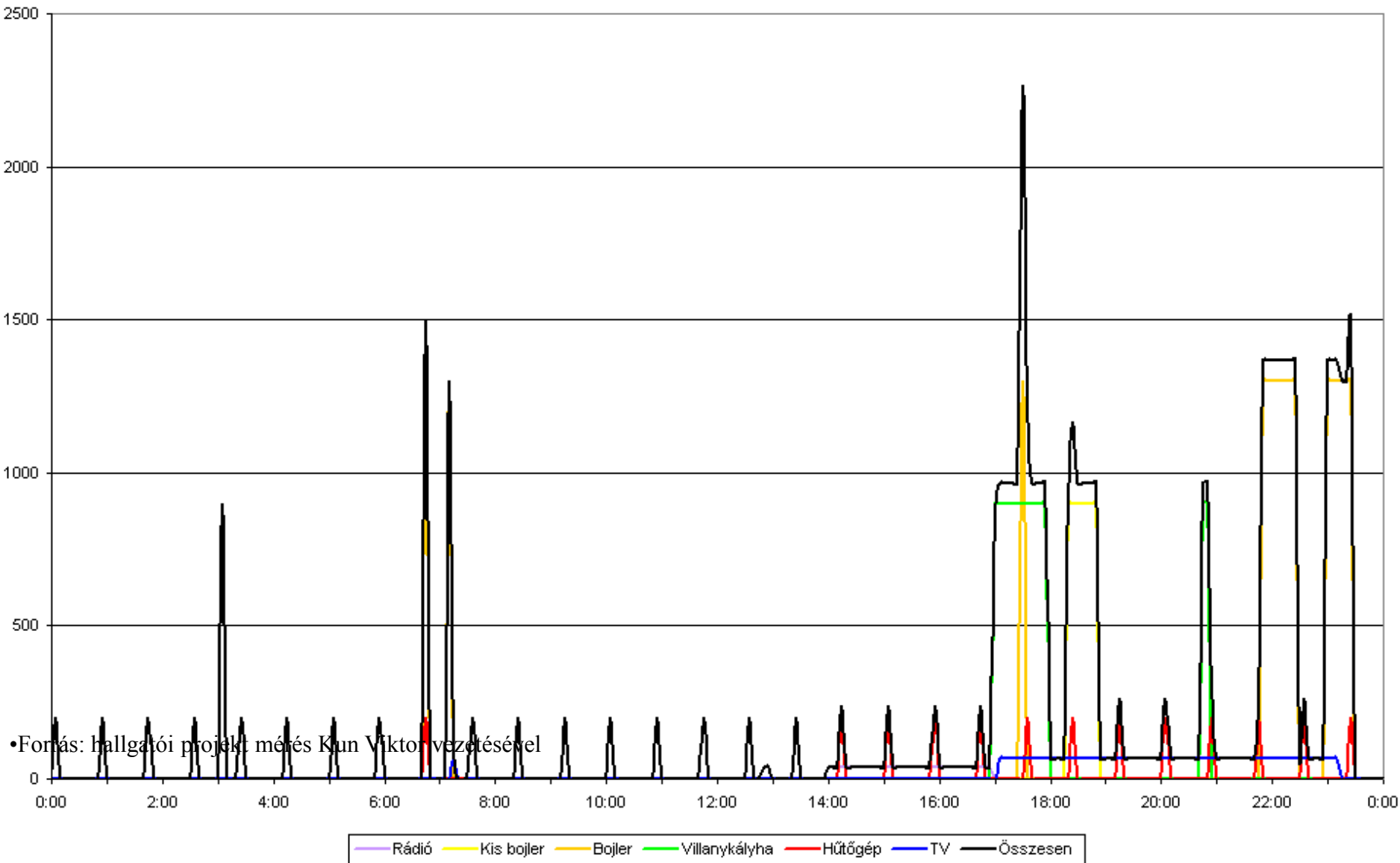




# „Stopwatch measurement” - Flat 2.



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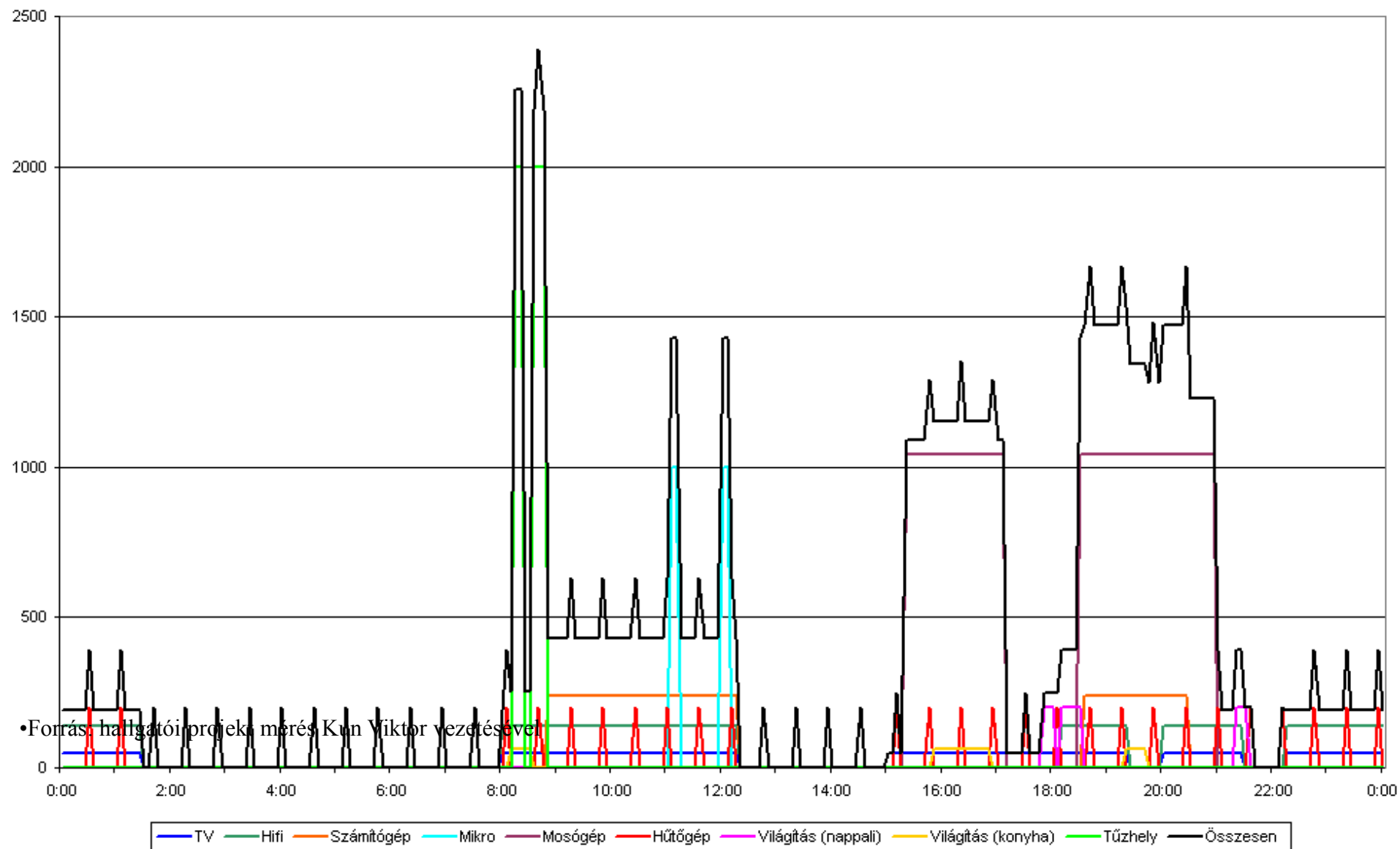




# „Stopwatch measurement” - Flat 3.



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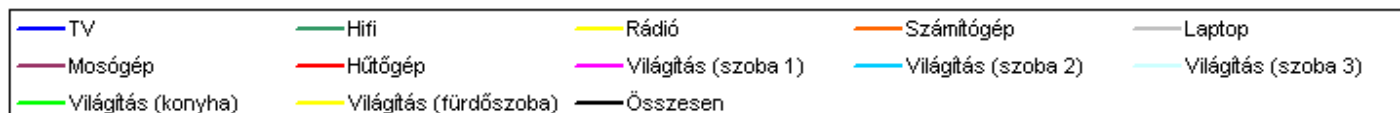
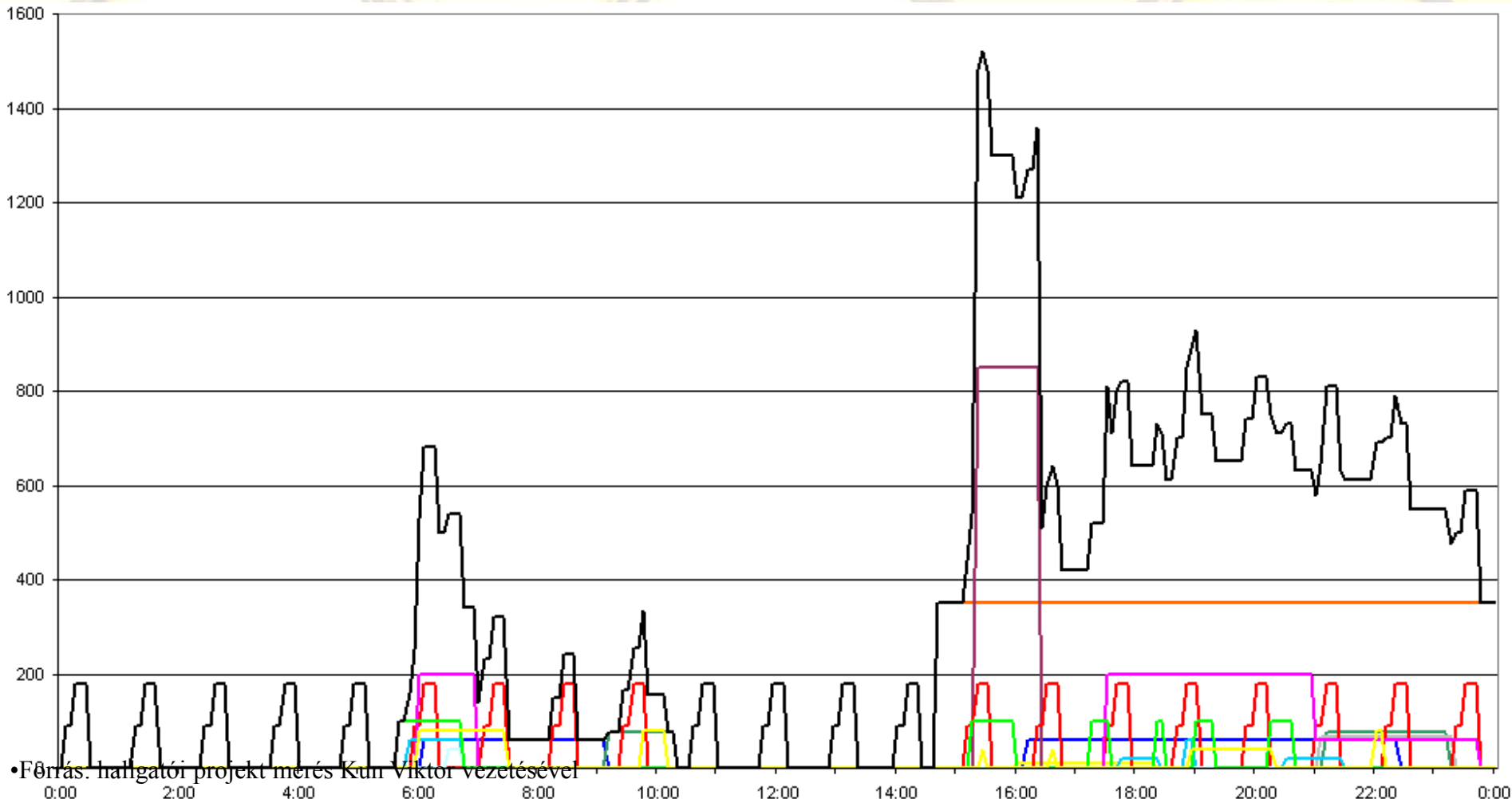




# „Stopwatch measurement” - Flat 4.



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# Analysis of customers' behaviour



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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



# Further development



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- Measuring at more flats
- Detailed ratio analysis
- Raising the density of the measurements
- Identifying day-types
- Individual measurements

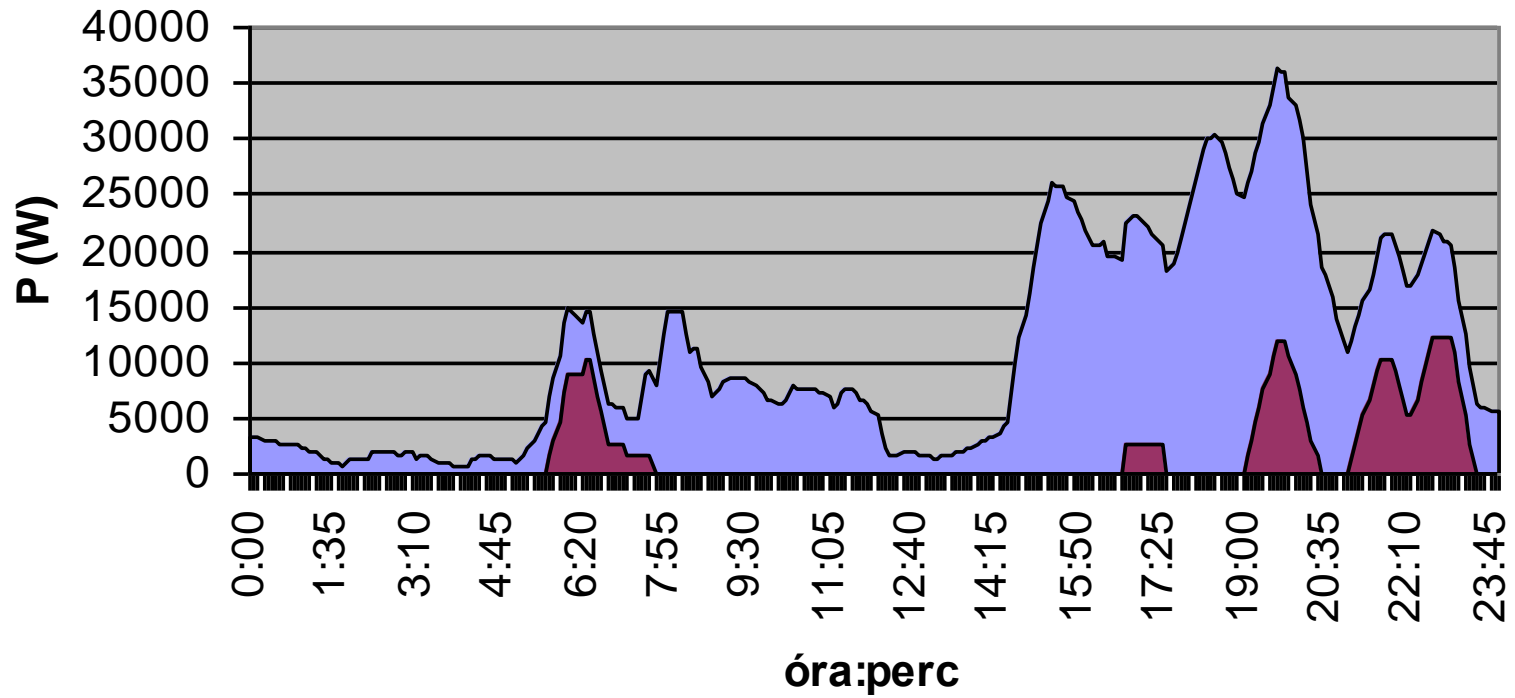




# 40 households, present ripple control



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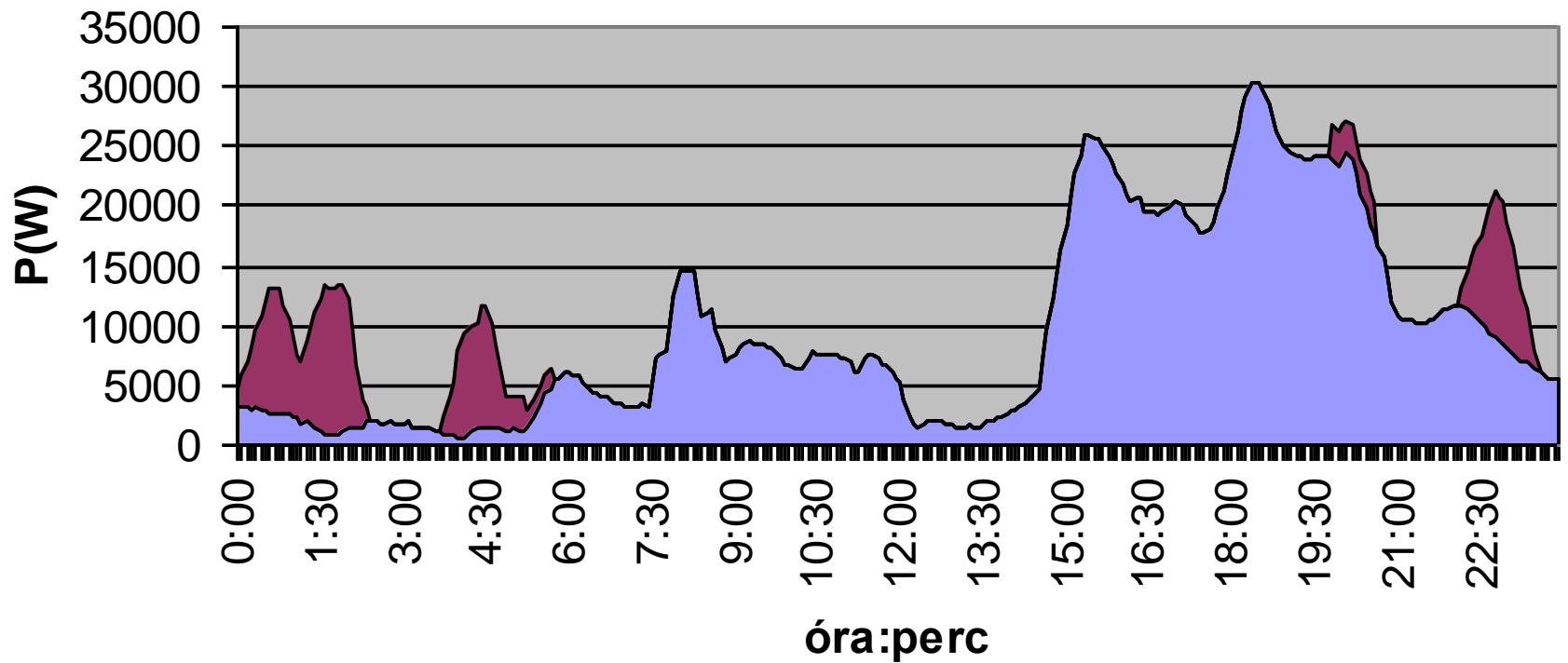




# 40 households, rescheduled ripple control

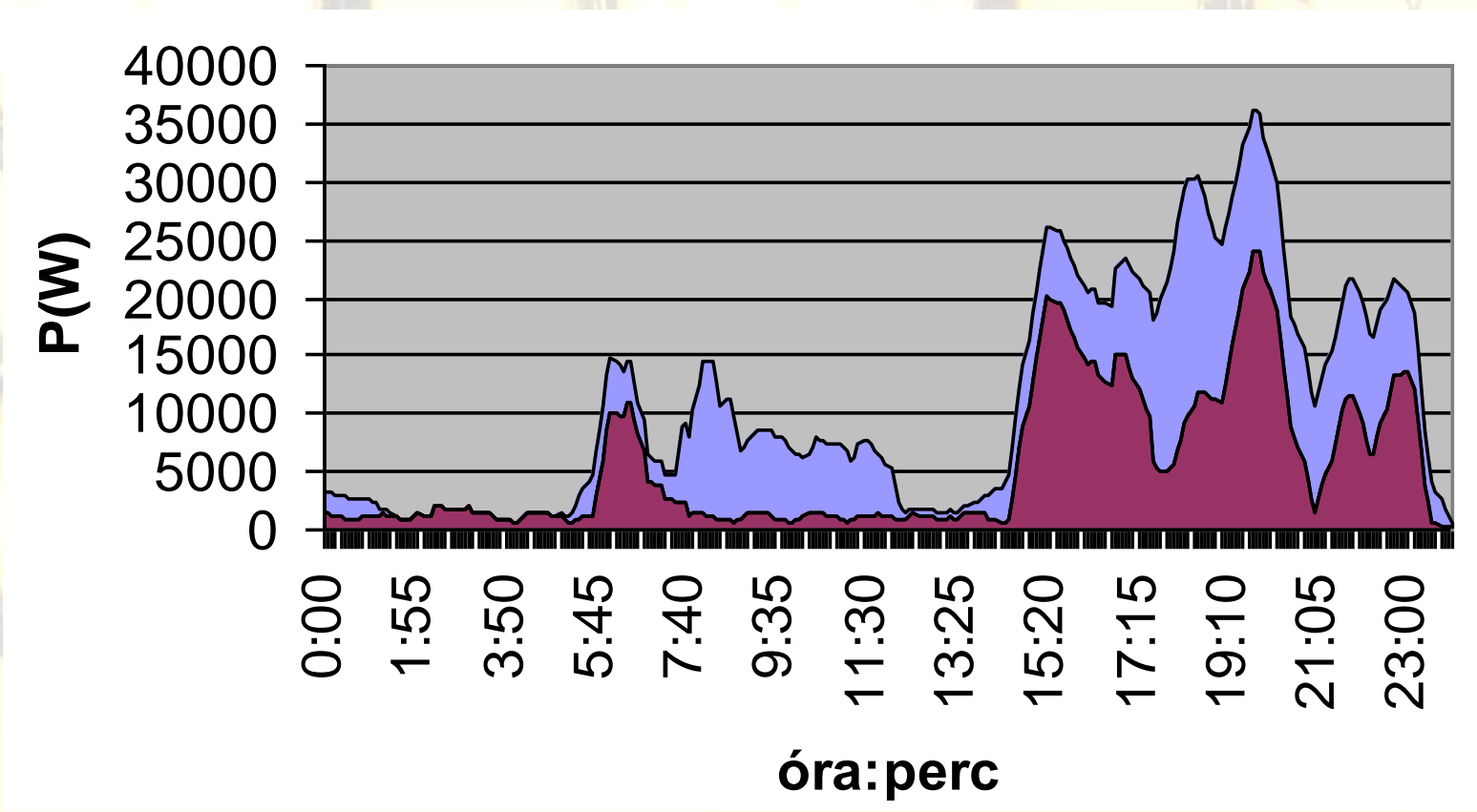


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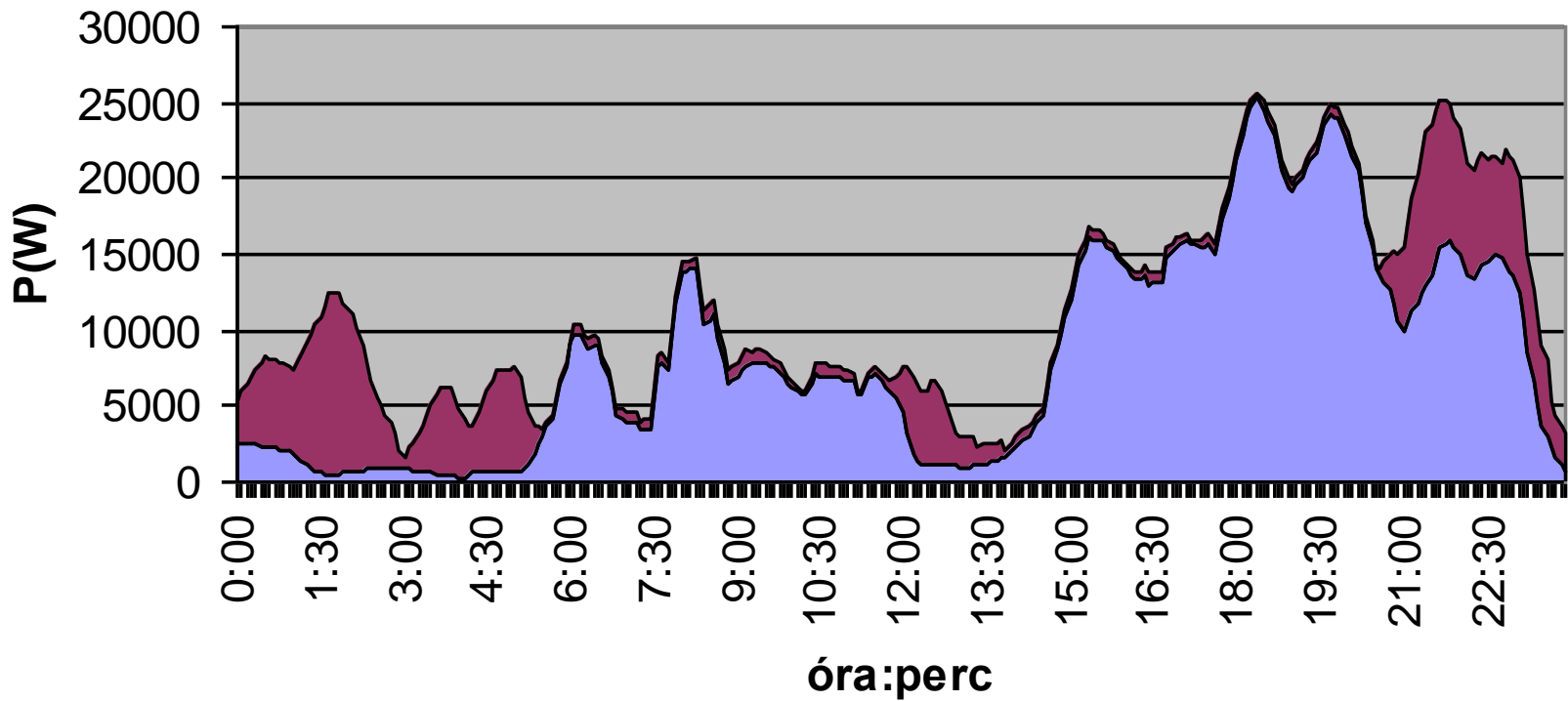


# 40 households, reschedule potential





# 40 households, after the reschedule of 50 %







# Foundings



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- 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 different optimisation methods

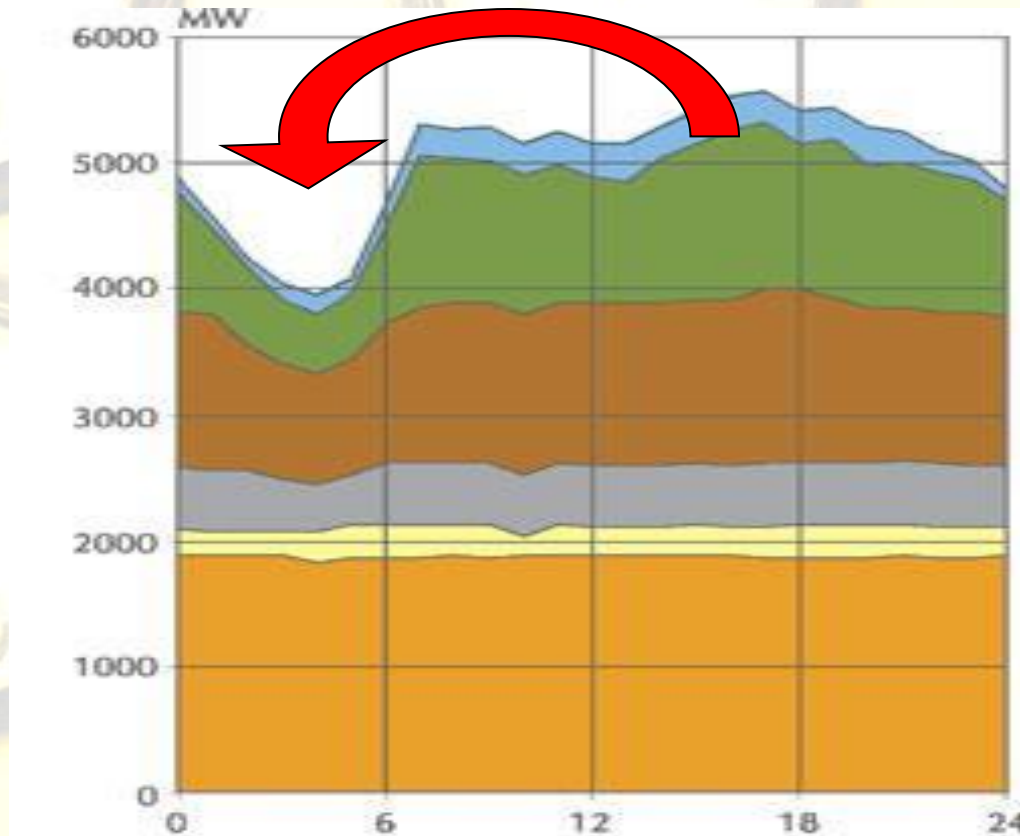
*This is the low level intelligence in the network*



# The need for the DSM



- Decreasing the peak / increasing the valley load





## Further data sources

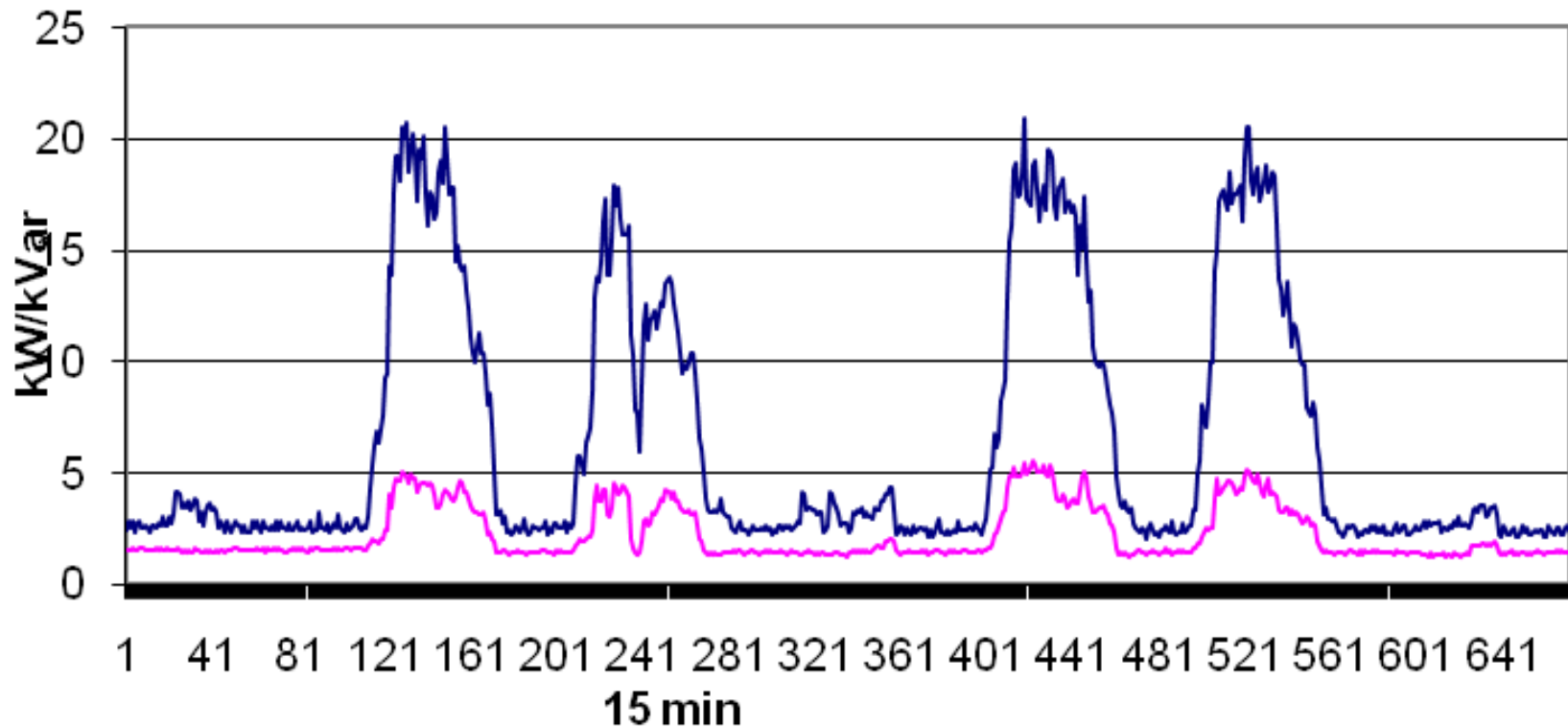
- Measurements from the utility meters
- Special high density metering
- Metering based of social behaviours, statistics, etc.



# Traditional load curve analysis

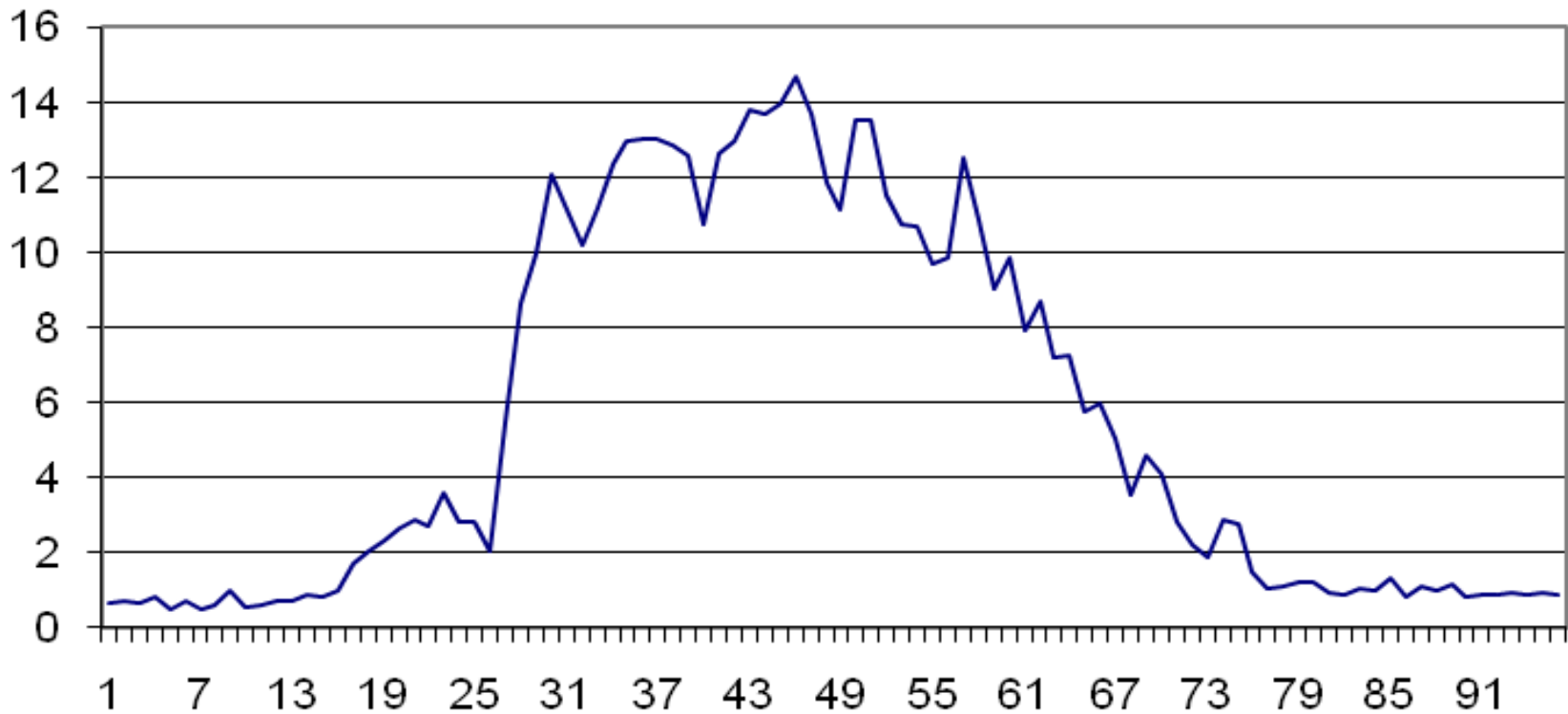


## National holiday at midweek

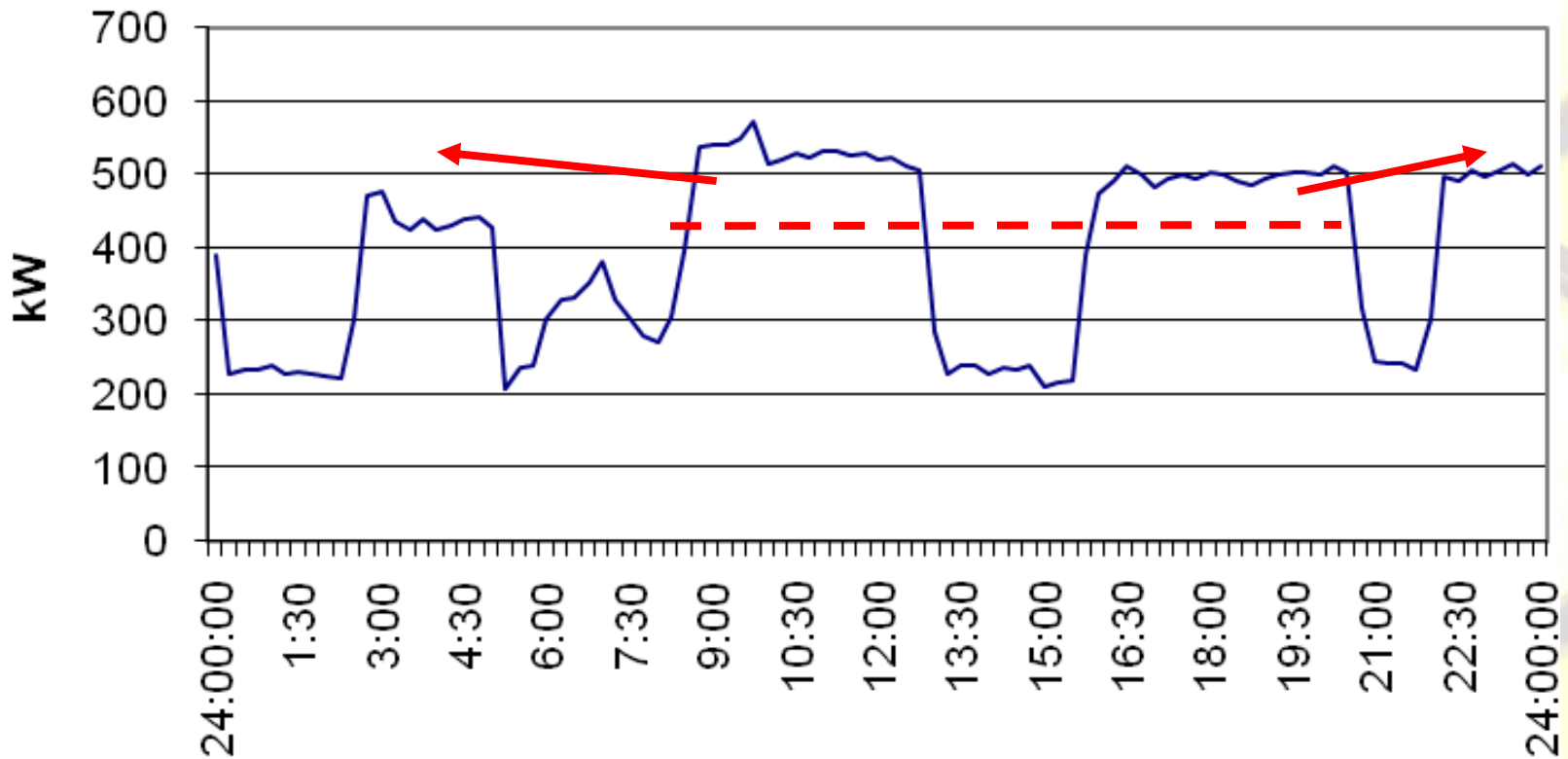




## Daily load of a school



## Daily electricity demand of water utility

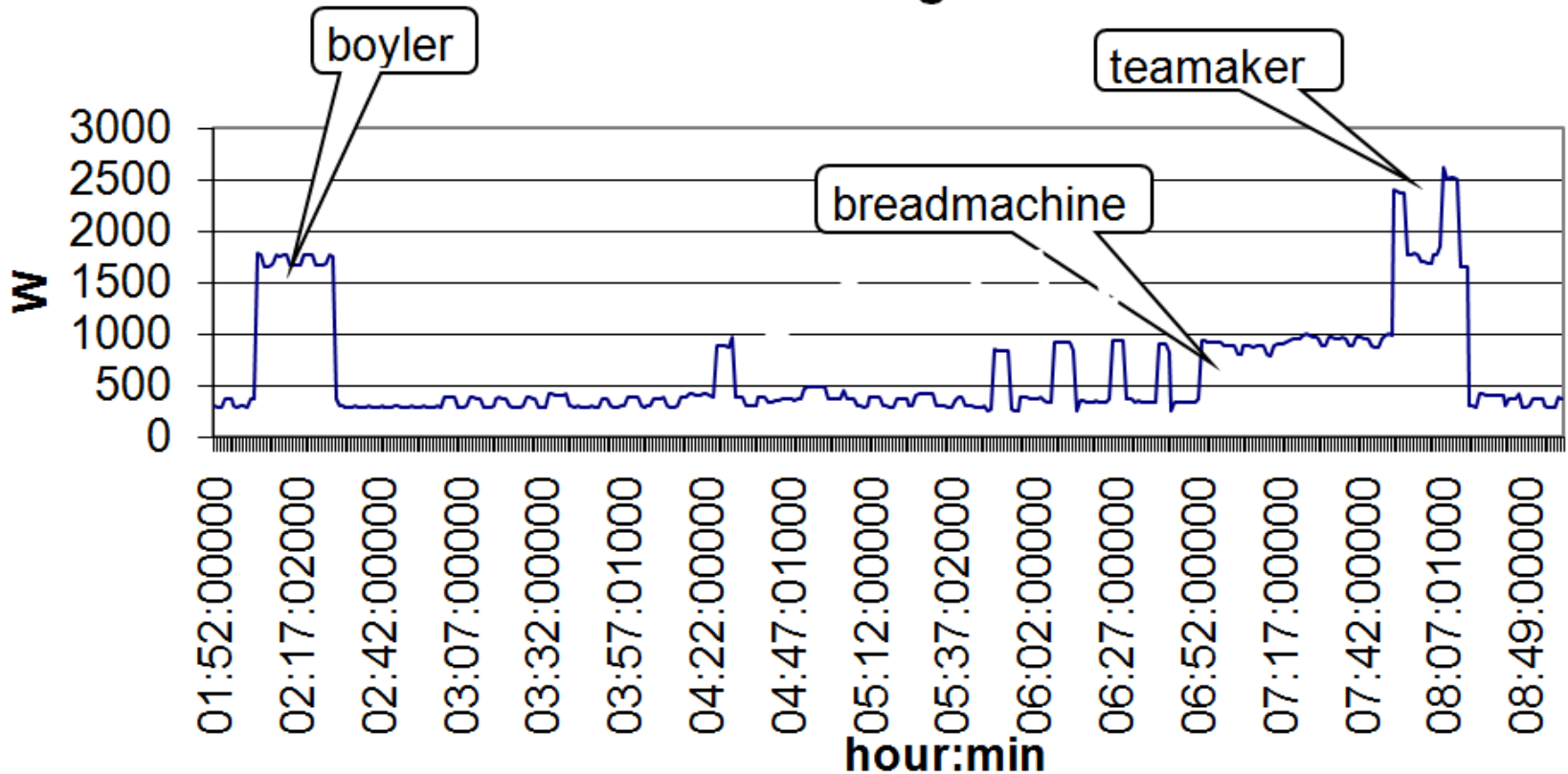




# Remote measurement with special recorder

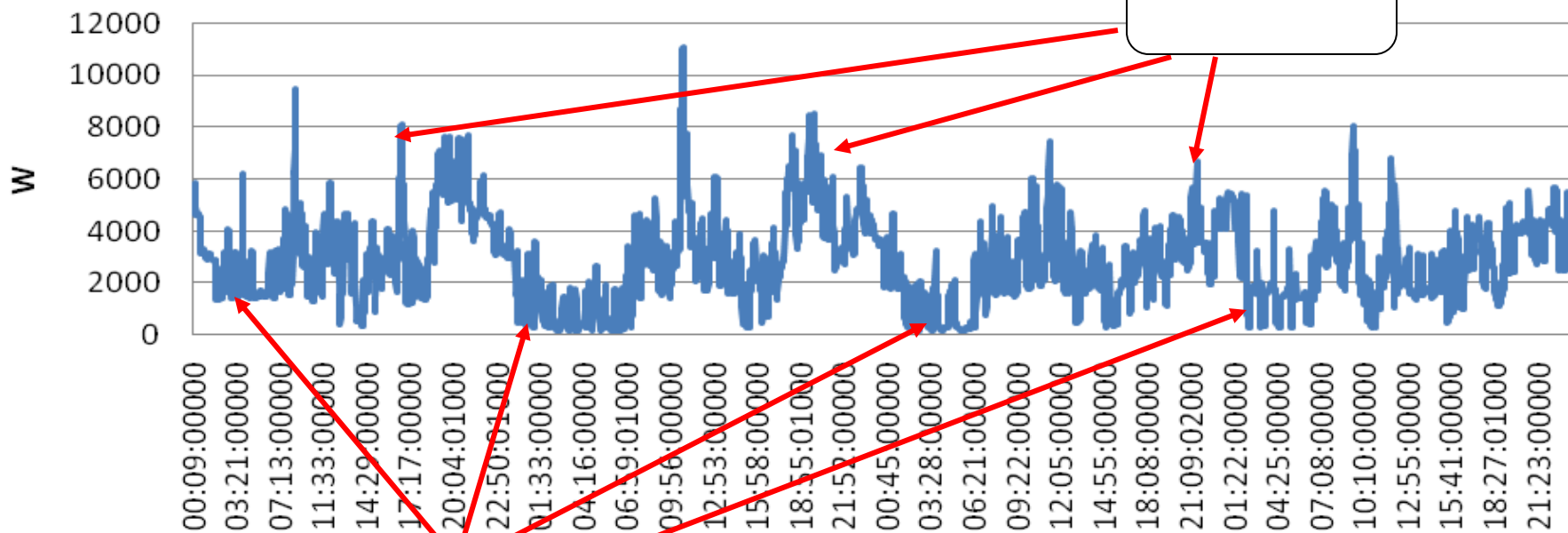
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## Breadbaking





## 4 days of 3 households



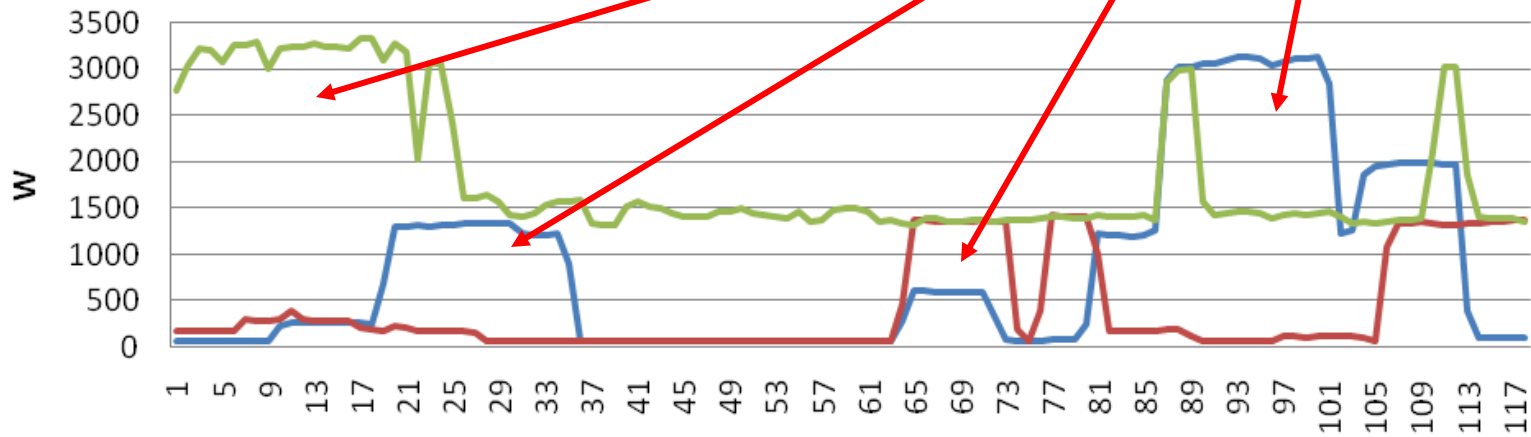
Peak hours

Deep valley hours



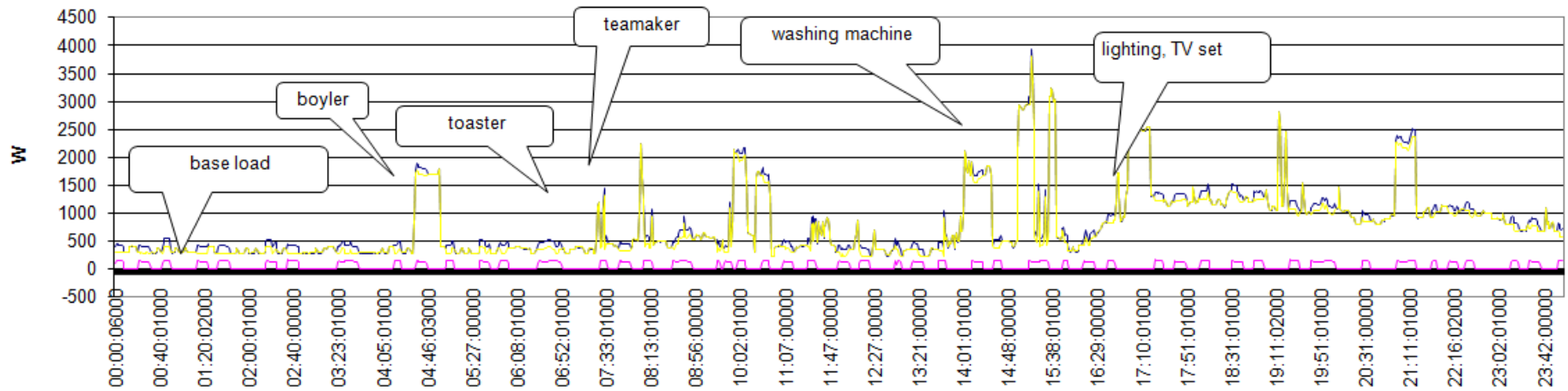
Electric water heating

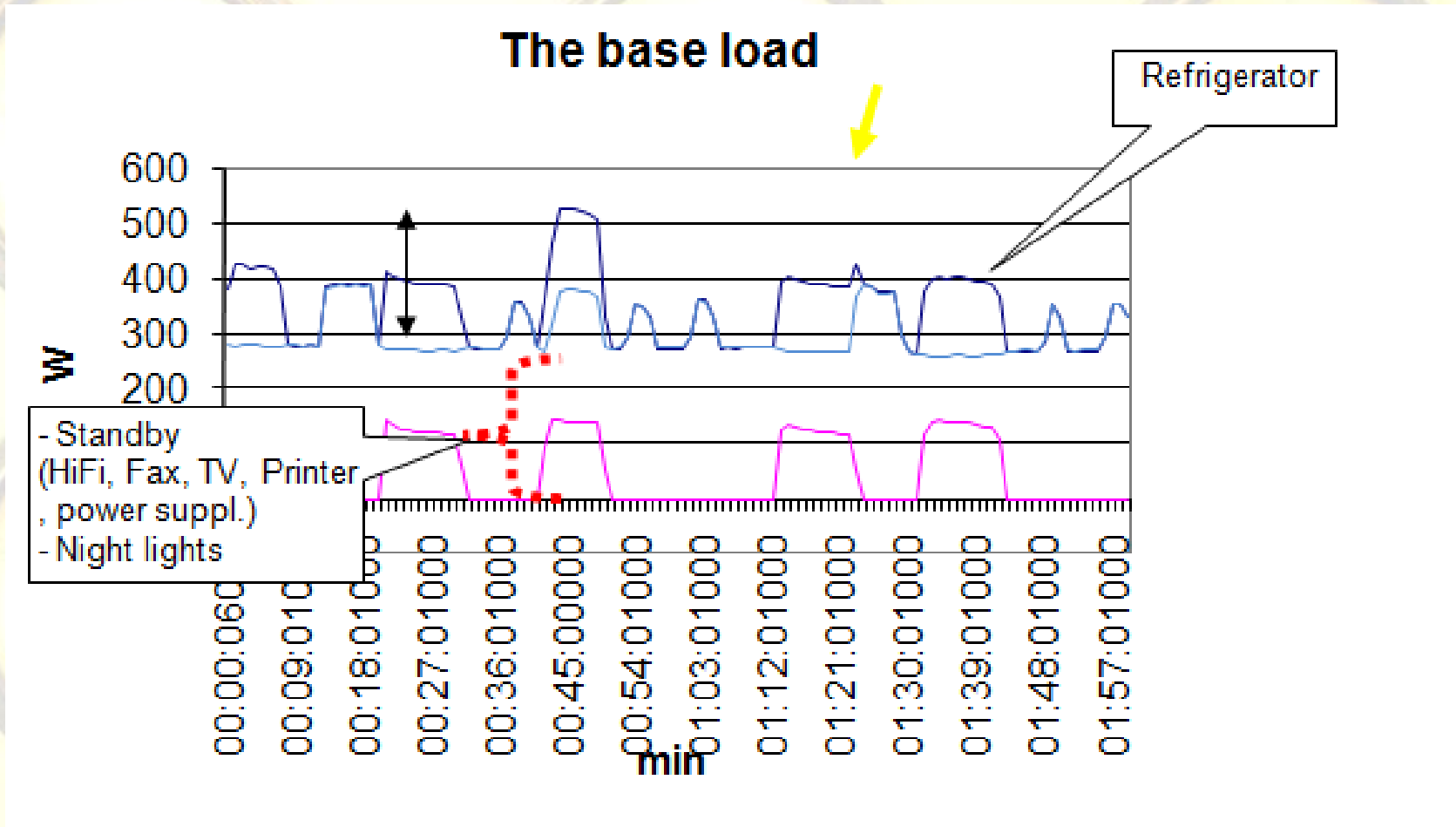
### Three phases at midday - 11:00 - 13:00





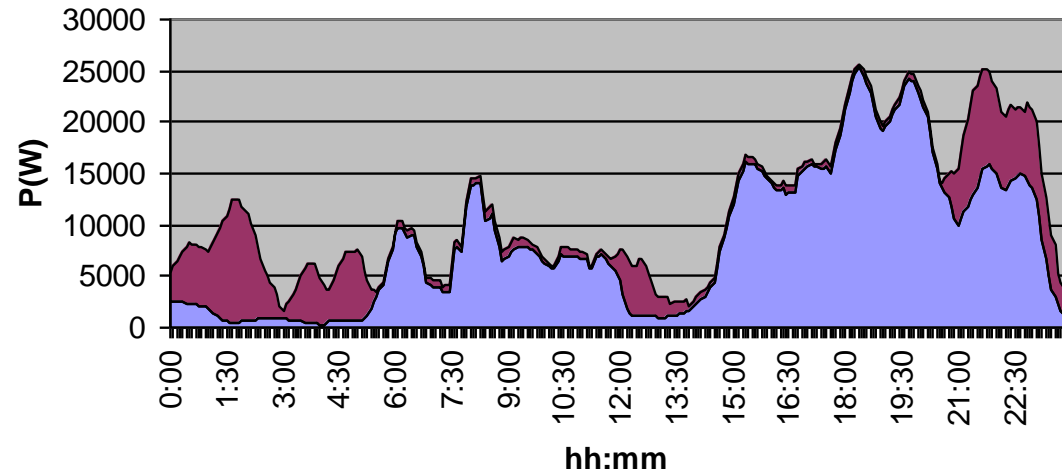
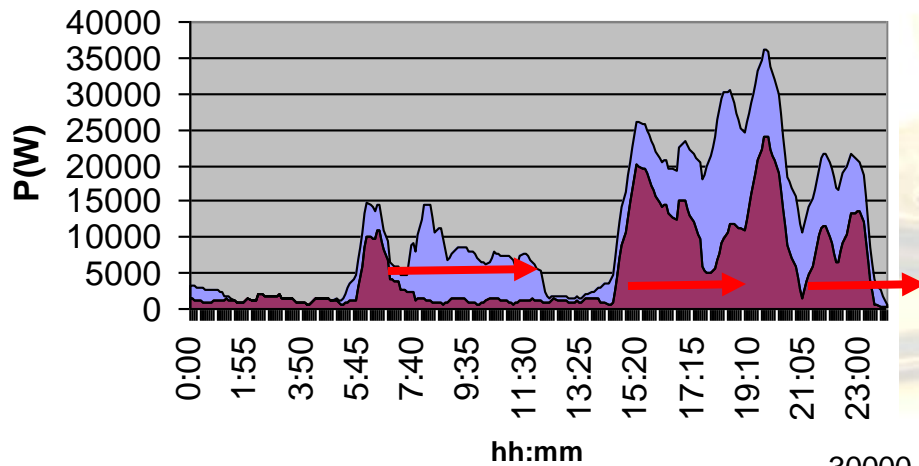
### Household daily load curve







# Reschedule







# Functions of the intelligent VGRID elements



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## 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 generator<sub>n</sub>

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

## Intelligent load<sub>i</sub>

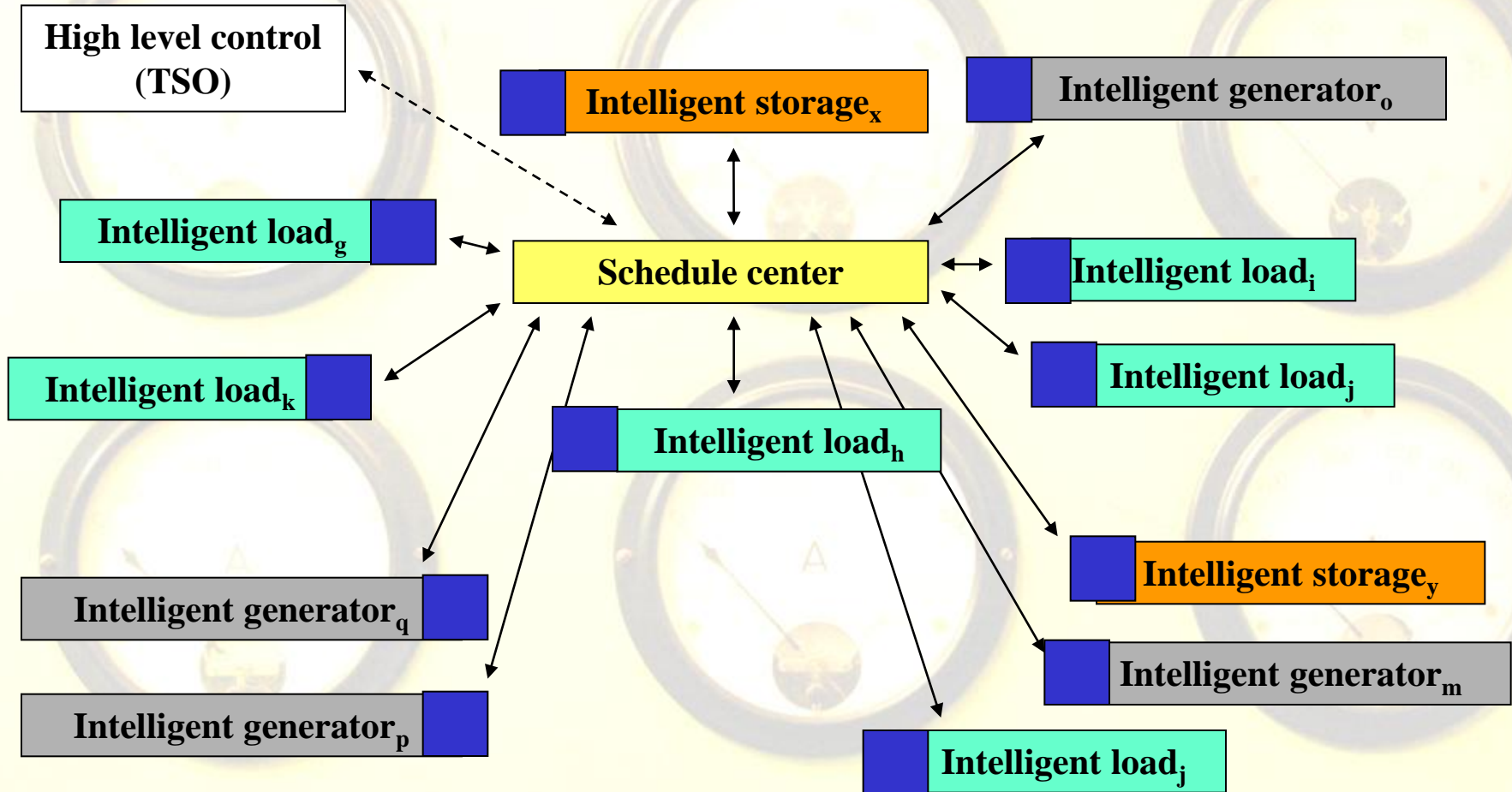
- Load forecast
- Local load control
- Connection with the schedule centre
- Cost dependency

## Intelligent storage<sub>x</sub>

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

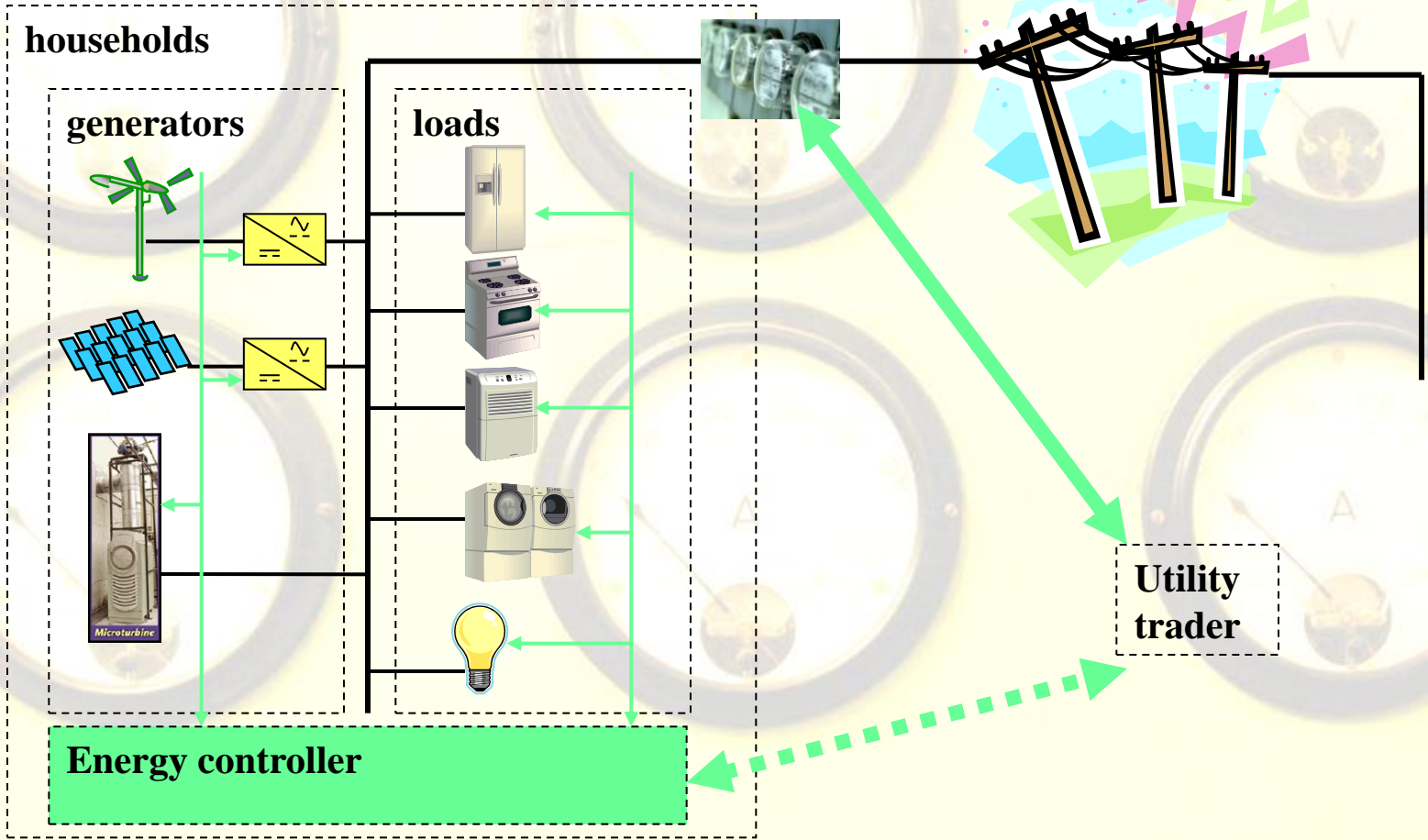


# Radial IP connections of the VGRID elements





# Local power surveillance





# Communication possibilities



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- 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*