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

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• Curve analysis
• Audits
• Energy management
• Intelligent networks and customers
Focus on the public consumption

- 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
Daily load curve of a water well
Aggregated load curve of 7 water pump in a week
High school, building I. a March week.
High school building II., a March week
Grammar school, a February week
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
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

• 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 electricity 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 kV main supply

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Electrical devices

10/0.4 kV transformer

Aggregator

0.4 kV distribution box
Metering in Hungary
Metering in Greece
Metering in Greece

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Reactive power compensation and distr. boxes
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 -> electricity + heat + cooling
Gas engines

- 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

oversizing!

June, July, August, September – lower consumption – higher costs
Over- and undersizing of the prefixed peak

810 kW real plan penalty or overcosts?

<table>
<thead>
<tr>
<th>Lekötött teljesítmény (kW)</th>
<th>Ár (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>770</td>
<td>770</td>
</tr>
<tr>
<td>790</td>
<td>790</td>
</tr>
<tr>
<td>810</td>
<td>810 (fixed)</td>
</tr>
<tr>
<td>830</td>
<td>830</td>
</tr>
<tr>
<td>850</td>
<td>850</td>
</tr>
<tr>
<td>870</td>
<td>870</td>
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<tr>
<td>890</td>
<td>890</td>
</tr>
<tr>
<td>910</td>
<td>910</td>
</tr>
</tbody>
</table>

765 kW fixed

900 kW fixed

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Peak management

- The tariff structure must be known
- Strategy: less fixed + some penalties
- Lower consumption, lower peaks!
- Peak controlling, limiting
Inductive reactive power can be 25-30% of the active part.

\[ \cos \varphi = 0.96 \]

Penalty for the capacitive reactive power!
Walking – looking – listening
Ratio analysis

Built in power

- Hőtechnika: 52%
- Világítás: 18%
- Pékség: 10%
- Irodák: 8%
- Mall: 8%
- Egyéb: 4%

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Measurement analysis

Average daily loads

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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:

- Heating: 54.7%
- Cooling rooms, boxes: 6.8%
- Air conditioning: 38.5%
Gas consumption

Havi gázfogyasztás

I. II. III. IV. V. VI. VII VIII IX. X. XI. XII.

Hónap
m3

0 20 000 40 000 60 000 80 000 100 000 120 000 140 000 160 000 180 000
General recommendations for better energy management

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 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

- Planned schedule
- Continuous control
- Settling
- Technology
- Measurements
- Influences / actions / control

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Energy management system

- „SCADA”
- Data acquisition, visualisation, reporting, statistics
- Support for cost planning
- Forecast
- Portfolio management
- Risk management
- Control
Continuous control of the usages
Energy management functions

- 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

<table>
<thead>
<tr>
<th>Devices</th>
<th>Spontaneous loads (based on individual needs)</th>
<th>Can be delayed, controlled</th>
<th>Existing ripple control (HKV / RKV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>hair drier, TV set, radio, telecommunication devices, modems, lighting, iron, microwave oven, coffee machine, computers, cooking plate</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>washing machine, tumble drier, refrigerator, cooler, air conditioners, electric bread baking machine and the heat pump</td>
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</tr>
<tr>
<td>Electric heating devices</td>
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</tr>
</tbody>
</table>
Is there DSM potential in the households?

The methods:
- 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.

Forrás: hallgatói projekt mérés Kun Viktor vezetésével
„Stopwatch measurement” - Flat 2.

Forrás: hallgatói projekt mérés Kun Viktor vezetésével
„Stopwatch measurement” - Flat 3.

• Forrás: hallgatói projek, merés Kun Viktor vezetésével
„Stopwatch measurement” - Flat 4.

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
Further development

- Measuring at more flats
- Detailed ratio analysis
- Raising the density of the measurements
- Identifying day-types
- Individual measurements
40 households, present ripple control
40 households, rescheduled ripple control
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40 households, reschedule potential

Energy consumption pattern over time.
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 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

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Remote measurement with special recorder

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4 days of 3 households

Peak hours

Deep valley hours
Three phases at midday - 11:00 - 13:00

Electric water heating
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The base load

- Standby (HiFi, Fax, TV, Printer, power suppl.)
- Night lights

Refrigerator
Reschedule

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

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

**Intelligent storage**
- Storage/generation capability
- Local store control
- Connection with the schedule centre
- Cost calculation
Radial IP connections of the VGRID elements

High level control (TSO)

Intelligent load\textsubscript{g}

Intelligent load\textsubscript{k}

Intelligent load\textsubscript{h}

Intelligent generator\textsubscript{q}

Intelligent generator\textsubscript{p}

Intelligent storage\textsubscript{x}

Intelligent generator\textsubscript{o}

Intelligent load\textsubscript{i}

Intelligent load\textsubscript{j}

Intelligent storage\textsubscript{y}

Intelligent generator\textsubscript{m}

Intelligent load\textsubscript{j}

Measurement and control unit
Local power surveillance

Energy controller

households

generators

loads

Utility trader
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