ENERGY SITUATION AND PERSPECTIVES IN HUNGARY

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CONTENTS

• Energy in Hungary:
  – trends in the last decades and the present situation
  – energy strategy

• Budapest University of Technology and Economics:
  – facts and figures
  – energy related research
IN THE MIDDLE OF EUROPE
HUNGARY

Population: 10 million  Area: 93 030 km²  Rank of GDP per capita: 40th
ENERGETICS IN HUNGARY

Relatively high energy intensity ..... while GDP is below the EU average
the gap is about 25% among the lowest TPES per capita values
LACK OF PRIMARY SOURCES

Hungary imports 86 % of the oil, 82 % of the gas and 70 % of the coal used.

We also buy electricity (about 10 %).

<table>
<thead>
<tr>
<th></th>
<th>Technical potential, Mt</th>
<th>Geological potential, Mt</th>
<th>R/P ratio</th>
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DEPENDING ON IMPORT

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SHARE OF SOURCES IN TPES

Evolution of Total Primary Energy Supply* from 1971 to 2004

Hungary

Increasing weight of natural gas ...

* Excluding electricity trade.
EXPLOITATION OF RENEWABLE ENERGY SOURCES

<table>
<thead>
<tr>
<th>Source</th>
<th>Potential, PJ</th>
<th>Used, PJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>1840</td>
<td>1.0</td>
</tr>
<tr>
<td>Hydro</td>
<td>14.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Geothermal</td>
<td>63.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Biomass</td>
<td>200 – 330</td>
<td>50.1</td>
</tr>
<tr>
<td>wind</td>
<td>530</td>
<td>0.4</td>
</tr>
</tbody>
</table>
SHARE OF SOURCES IN ELECTRICITY GENERATION

Hungarian electricity production, 2007

- Nuclear: 36.80%
- Coal: 18.40%
- Natural gas: 37.90%
- Oil: 1.50%
- Other renewable + waste: 0.90%
- Biomass: 3.70%
- Hydro: 0.50%
- Wind: 0.30%
HUNGARY IN NATURAL GAS TRAP

2004 Share of Natural Gas in Primary Energy Consumption (%)
HUNGARY IN THE NATURAL GAS TRAP – THE WAY OUT

• Keep all options open: lignite, nuclear, biomass, wind, etc.
• Re-evaluation of hydropower?
• Reduction of consumption should be inspired:
  – increasing the energy savings of houses
  – preferring alternatives as biomass and geothermal heating instead of natural gas.
• Increase of energy efficiency
  – may help to reduce the rate of increase of primary energy consumption.
• Probably both the electricity demand and the rate of electricity in energy consumption will increase.
• Use of nuclear energy is necessary on the long term:
  – lifetime extension of Paks NPP is an important task
  – building new nuclear units has to be considered
### POSSIBLE DEVELOPMENT OF POWER PLANTS

#### 2008 to 2025

<table>
<thead>
<tr>
<th>Design Fuel</th>
<th>2008</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renew.</td>
<td>450</td>
<td>9000</td>
</tr>
<tr>
<td>Natural gas</td>
<td>2500</td>
<td>2000</td>
</tr>
<tr>
<td>Oil</td>
<td>2600</td>
<td>1680</td>
</tr>
<tr>
<td>Coal</td>
<td>1510</td>
<td>1680</td>
</tr>
<tr>
<td>Nuclear</td>
<td>1940</td>
<td>1940</td>
</tr>
</tbody>
</table>

#### 2025 to 2040

<table>
<thead>
<tr>
<th>Fuel</th>
<th>New Capacity</th>
<th>Replacement</th>
<th>Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renew.</td>
<td>700</td>
<td>440</td>
<td>1500</td>
</tr>
<tr>
<td>Gas</td>
<td>2400</td>
<td>2460</td>
<td>2800</td>
</tr>
<tr>
<td>Coal</td>
<td></td>
<td>440</td>
<td>1260</td>
</tr>
<tr>
<td>Nuclear</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Total

- Total Capacity: 11,000 MW
- Natural gas: 2,500 MW
- Oil: 2,600 MW
- Coal: 1,510 MW
- Nuclear: 1,940 MW
- Renewables: 450 MW

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1. **Version 1**
2. **Version 2**
Possible development of power plants (2)

Possible new constructions:

Design fuel

Renewable

Natural gas

Oil

Coal

Nuclear

2008 2025

9000 MW

10 000 MW

5000 MW

5000 MW

1000

700

2200

1500

2000

1660

440

1060

440

410

670

1940

1940

300

1680

4000

2500

2600

450

PAKS NUCLEAR POWER PLANT

- 4 units of VVER-440 type reactors
- \( \Sigma \approx 2000 \text{ MWe} \)
- 38% of Hungarian production
- 32% of domestic electricity consumption
SERVICE LIFE EXTENSION

• Original design lifetime of the units: 30 years

• Service life extension by 20 years

• 21 November 2006: the Hungarian Parliament accepted the concept of the service lifetime extension with a vote rate of 96.6%
PUBLIC ACCEPTANCE

Representative country-wide sample, August 2008 and March 2009

- NPP operating in Paks

<table>
<thead>
<tr>
<th>August</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>34%</td>
</tr>
<tr>
<td>Disagree</td>
<td>8%</td>
</tr>
<tr>
<td>Does not know / no answer</td>
<td>58%</td>
</tr>
</tbody>
</table>

- If new units, where?

<table>
<thead>
<tr>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not know</td>
</tr>
<tr>
<td>No NPP</td>
</tr>
<tr>
<td>NPP elsewhere</td>
</tr>
<tr>
<td>New units at Paks</td>
</tr>
</tbody>
</table>

Global Energy Future '10 19
NEW UNITS AT PAKS

- March 30, 2009:
  - The Parliament gave its principal consent by 96% to the preparation works of the possible new units at the Paks site
  - (Not permission, only theoretic agreement)
• Energy in Hungary:
FAMOUS GRADUATES AND FORMER STUDENTS

Denis (Dénes) GÁBOR (1900 - 1979), Nobel Prize in Physics, 1971

Eugene (Jenő) WIGNER (1902 – 1995), Nobel Prize in Physics, 1963

George (György) OLÁH (b:1927), Nobel Prize in Chemistry, 1994

Theodore (Tódor) von KÁRMÁN, Aeronautics

Leo (Leó) SZILÁRD, Physics

Edward (Ede) TELLER, Physics

John (János) von NEUMANN, mathematics

Ernő RUBIK, inventor of Rubik’s cube
SCHOOLS, STUDENTS, STAFF

Faculties:
• Civil Engineering
• Mechanical Engineering
• Architecture
• Chemical Technology and Biotechnology
• Electrical Engineering and Informatics
• Transportation Engineering
• Natural Sciences
• Economic and Social Sciences

Students: 24 000
Academic staff: 1300
SUSTAINABLE ENERGETICS: ONE OF THE STRATEGIC FIELDS OF RESEARCH AT BME

- Sustainable and efficient primary and secondary energy structure at the national level
- Energetics of buildings, passive house technologies, combined heating techniques (biomass, geothermal, etc.) Development of combustion devices
- Climate, environment and energetics: biomass + fossil combustion technologies, coupled heat and electricity production in carbon-neutral heating plants
- Renewable energy technologies
- Materials technology related to energetics
- Research related to nuclear energy
BIOFUELS: MICROBIAL AND ENZYMATIC TECHNIQUES

- fuel ethanol production from various lignocellulosic biomass feedstocks
- characterization of lignocellulose substances; pretreatment of lignocellulosics
- production of cellulose degrading enzymes; characterization of novel cellulases
- enzymatic hydrolysis of pretreated lignocellulosics; ethanol fermentation
- biogas production from agricultural and communal wastes (lignocellulose fraction)
NUCLEAR ENERGY: TRAINING REACTOR

- Insitute of Nuclear Techniques: Part of the Faculty of Natural Sciences
- „Interuniversity institution” - because of the high value Training Reactor.
- Education: undergraduate, graduate and PhD students of the BME and other Hungarian universities and higher education institutions in the field of nuclear techniques and technology
- International courses on reactor operation and safety
RESEARCH AT THE TRAINING REACTOR

Reactor physics:
  Criticality calculations, safety analysis
  Reactor dosimetry
Thermal hydraulics:
  3D Computational Fluid Dynamics (CFD) calculations on coolant flows in reactor components
  Experimental investigation of thermal stratification
Radioanalitical laboratory:
  $\alpha$, $\beta$, $\gamma$ spectrometry
  Neutron activation analysis (NAA)
Development of simulation codes
Development of instrumentation
CHEMICAL RESEARCH RELATED TO NUCLEAR ENERGY

Technology improvements at NPP

• Volume reduction of radioactive residues using selective ion exchange, ultrafiltration and crystallization.
• Research in the primary water chemistry. Investigation of the chloride elution problem. Chemical and radiochemical analysis of the sludges and solutions (primary water, contents of waste storage tanks of the NPP, etc.)
• Numerical modelling of the multicomponent ion exchange equilibria in the primary water.
• Selective separation of transuranium elements (Am, Cm, Pu) from the waste water streams of the NPP.
ACKNOWLEDGEMENT

Attila Aszódi, Gyula Gróf, György Pátzay, Kati Réczey

THANK YOU FOR ATTENTION!