ROLE OF THE COAL IN POLISH ENERGY SYSTEM

Leon KURCZABINSKI, Ph.D
WHY COAL IN POLAND?

POLAND HAS ONE OF THE BIGGEST RESSOURCESS OF COAL IN EUROPE (HARD COAL AND LIGNITE)

COAL WARRANTS TO POLAND:
• HIGH LEVEL OF ENERGY SECURITY
• LOWEST COSTS OF ELECTRIC ENERGY PRODUCTION
• LOWEST COSTS OF HEAT PRODUCTION (CHS AND INDIVIDUAL HEATING)
• LOW LEVEL OF ENERGY POVERTY
• COMPETITIVENESS OF ECONOMY (INDUSTRY)

MOREOVER:
• LIMITED POSSIBILITIES OF IMPORTATION OF NATURAL GAS IN RATIONAL PRICES (LNG TERMINAL UNDER BOOT-UP)
• FULL IMPORT DEPENDANCE OF CRUDE OIL AND NUCLEAR FUEL
• LIMITED POSSIBILITIES OF IMPORTATION OF THE ELECTRICAL ENERGY - LACK OF THE TRANSBORDER CONNECTIONS (UNDER CONSTRUCTION)
• LIMITED NATURAL POSSIBILITIES OF THE RENEWABLE ENERGY PRODUCTION (MAX: 15 - 16 %)
ENERGY SECURITY

POLAND - IMPORT DEPENDANCE BY SOURCES

- NATURAL GAS  69.3% (9.5 bln m3)
- CRUDE OIL     99.5%
- NUCLEAR       100% ??

TOTAL IMPORT ENERGY DEPENDANCE FACTOR (2013)

- POLAND        25.8%
- DENMARK       12.3%
- CZECH REPUBLIC 27.9%
- UK            46.4%
- FRANCE        47.9%
- FINLAND       48.7%
- AUSTRIA       62.3%
- GERMANY       62.7%
- SPAIN         70.9%
- ITALY         76.9%
- EU 28         53.2%
HARD COAL IN POLAND

- UPPER SILESIA COALFIELD
- LOWER SILESIA COALFIELD
- LUBLIN COALFIELD
- 30 actives coal mines

<table>
<thead>
<tr>
<th>RESOURCE</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>BALANCE RESOURCES</td>
<td>48,540 BLN T</td>
</tr>
<tr>
<td>INDUSTRIAL RESOURCES</td>
<td>4,178 BLN T</td>
</tr>
<tr>
<td>OPERATIONAL RESOURCES</td>
<td>3,952 BLN T</td>
</tr>
</tbody>
</table>
LIGNITE IN POLAND

- BALANCE RESSOURCES 22,583 BLN T
- INDUSTRIAL RESSOURCES 1,218 BLN T
- OPERATIONAL RESSOURCES 1,140 BLN T

MAIN COALFIELDS:
- ADAMOW
- BELCHATOW
- KONIN
- TUROSZOW
- LUBUSKI REGION
- LEGNICA
- LODZ REGION
- WIELKOPOLSKA REGION
## COAL PRODUCTION

### HARD COAL

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODUCTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mln t/y)</td>
<td>75,667</td>
<td>79,234</td>
<td>76,466</td>
<td>72,513</td>
</tr>
<tr>
<td>STEAM COAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mln t/y)</td>
<td>64,232</td>
<td>67,467</td>
<td>64,350</td>
<td>60,226</td>
</tr>
<tr>
<td>TOTAL SALE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mln t/y)</td>
<td>76,215</td>
<td>71,936</td>
<td>77,496</td>
<td>70,305</td>
</tr>
<tr>
<td>STEAM COAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mln t/y)</td>
<td>64,945</td>
<td>60,538</td>
<td>64,938</td>
<td>57,998</td>
</tr>
<tr>
<td>TOTAL EXPORT</td>
<td>(mln t/y)</td>
<td>5,756</td>
<td>7,405</td>
<td>10,555</td>
</tr>
<tr>
<td>TOTAL IMPORT</td>
<td>(mln t/y)</td>
<td>11,6</td>
<td>8,8</td>
<td>9,4</td>
</tr>
</tbody>
</table>
**REASONS OF THE COAL IMPORTATION**

- **COMPETITIVENESS OF PRICES** - MARGINAL PRICE CIF ARA = 50 USD/t
  (high rates of the Polish coal taxation - ca 35 % of income from sold coal)

- **SHORTAGE OF SOME TYPES OF COAL** (coking coal, PCI, low sulphur coal, coal for heating for the households sector - coarse coal, pea coal, anthracite...)

  - **UNFAIR COMPETETIVENESS**

  - **MINING PROBLEMS** - LIMITING PRODUCTION OF POLISH COAL

  - **PRICE POLICY IN ENERGY SECTOR**, WHICH PROVOKE GROWTH OF EXPORTATION OF POLISH COAL AND PROPELLAND THE IMPORTATION OF FOREIGN COAL
IMPORT OF COAL
BY CONSUMERS - 2014

(9.05 mln t / 6.9 mln t HC)
CONSUMPTION OF THE COAL IN POLAND

TOTAL CONSUMPTION OF (STEAM) HARD COAL 58 - 64 MLN T
TOTAL CONSUMPTION OF LIGNITE 60 - 64 MLN T

EQUIVALENT OF > 58 BLN m³ OF NATURAL GAS

- PROFESSIONAL (PUBLIC) THERMAL PLANTS
  ELECTRICITY GENERATION AND HEAT PRODUCTION
  (34) 38 - 42 MLN T - HARD COAL
  60-64 MLN T - LIGNITE

- INDUSTRIAL AND NON-PROFESSIONAL HP PLANTS
  HEAT AND HOT WATER PRODUCTION FOR INDUSTRY AND CENTRAL HEATING SECTOR
  12,5 - 16,5 MLN T - HARD COAL
  0,1 MLN T - LIGNITE

- HOUSEHOLDS SECTOR AND SMALL CONSUMERS - HEAT AND H.WATER
  (WITHOUT CHS)
  11,5 - 12,5 MLN T - HARD COAL
## ELECTRICITY GENERATION

- **Capacity Installed in Power Plants**: 39,353 MW
- **Capacity of the Biggest Thermal Power Plant (Lignite)**: 5,420 MW
- **Electricity Production**: 156,657 GWh
- **Average Efficiency of Electricity Generation**: 36.9%
- **Electricity Production in Cogeneration**: approx 15%
- **Electricity Consumption per Capita**: 4,140 kWh
- **CO2 Emission**: 316 mill. tonnes

## Structure of Electricity Generation by Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Capacity MW</th>
<th>GWh/Y</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Coal</td>
<td>20,291</td>
<td>89,304</td>
<td>57.0</td>
</tr>
<tr>
<td>Lignite</td>
<td>9,220</td>
<td>54,212</td>
<td>34.6</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>927</td>
<td>3,274</td>
<td>2.1</td>
</tr>
<tr>
<td>Renewable</td>
<td>6,394</td>
<td>9,776</td>
<td>6.3</td>
</tr>
<tr>
<td>And Others</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
POWER INDUSTRY IN POLAND (2014/2015)

HEAT GENERATION - DISTRICT HEATING SYSTEM

CAPACITY INSTALLED IN DHS 56,790 MWt
HEAT PRODUCTION 3,417,775 TJ/Y
DISTRICT HEATING SYSTEM (HEATING BUILDINGS AND HOT WATER) 2,176,667 TJ/Y
EFFICIENCY OF HEAT GENERATION app. 86 % net

STRUCTURE OF HEAT GENERATION BY SOURCES

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>COAL</td>
<td>75,1</td>
</tr>
<tr>
<td>NATURAL GAS</td>
<td>8,0</td>
</tr>
<tr>
<td>OIL</td>
<td>4,3</td>
</tr>
<tr>
<td>RENEWABLE</td>
<td>7,8</td>
</tr>
<tr>
<td>OTHERS</td>
<td>4,8</td>
</tr>
</tbody>
</table>
ENERGY POLICY FOR POLAND to 2030/2050

(project presented by Minister of Economy in August 2015)
ENERGY POLICY FOR POLAND

EUROPEAN REGULATIONS - CLIMATIC POLICY

• ENERGY-CLIMATIC PACKAGE 3 X 20 (ETS, non-ETS, IED, CCS, REN. - REDUCTION OF CO2 - 20,30,..40%)
• ENERGY ROADMAP 2050 - LOW CARBON EUROPE (80 %)

! ELIMINATION OF FOSSIL FUELS !

POLAND - FORECAST OF THE CO2 EMISSION

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT CO₂</td>
<td>316</td>
<td>280,3</td>
<td>186</td>
<td>?</td>
</tr>
</tbody>
</table>

FINAL REDUCTION TO 2030 - ca 130 MT
WE HAVE TO KNOW THAT:

• SINCE 1988 WE’VE REDUCED MORE THAN 30% OF OUR EMISSIONS - FIVE TIMES MORE THAN EXPECTED 6%

• SINCE 1990 WE’VE DOUBLED OUR ENERGY EFFICIENCY

• OUR SPECIFIC EMISSION PER CAPITA IS NOT HIGHER THAN THE EUROPEAN AVERAGE

OUR MAIN PROBLEMS:

• EXTREMELY HIGH TECHNICAL DEPRECIATION OF ENERGY SECTOR~70 %
• LACK OF FINANCIAL SOURCES - NO STATE SUPPORT
• THREAD OF CO2 COST - HIGH PURCHASE FROM ABROAD ~33 %
• INVESTMENTS VS ENVIRONMENT CONFLICT (NATURE 2000 ..ETC.)
• GAP IN THE ENERGY BALANCE FROM 2016

(source: Społeczna Rada Narodowego Programu Redukcji Emisji/Social Council of National Programme of Emissions Reduction)
ENERGY POLICY FOR POLAND

PRIMARY DIRECTIONS

• IMPROVEMENT OF THE ENERGY EFFICIENCY

• ENHANCEMENT OF THE SECURITY OF FUELS AND ENERGY SUPPLIES

• DIVERSIFICATION OF THE ELECTRICITY GENERATION STRUCTURE BY INTRODUCING NUCLEAR ENERGY

• DEVELOPMENT OF RENEWABLE ENERGY SOURCES, INCLUDING BIOFUELS

• DEVELOPMENT OF COMPETITIVE FUEL AND ENERGY MARKETS

• REDUCTION OF THE ENVIRONMENTAL IMPACT OF THE POWER INDUSTRY
## ENERGY POLICY FOR POLAND

Project presented by Minister of Economy - August, 2015

<table>
<thead>
<tr>
<th></th>
<th>PRIMARY ENERGY DEMAND; Mtoe</th>
<th>ELECTRICITY GENERATION; TWh</th>
<th>HEAT GENERATION; PJ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015 %</td>
<td>2030 %</td>
<td>2050 %</td>
</tr>
<tr>
<td>HARD COAL</td>
<td>36,8</td>
<td>30,5</td>
<td>27,8</td>
</tr>
<tr>
<td>LIGNITE</td>
<td>14,3</td>
<td>8,9</td>
<td>2,4</td>
</tr>
<tr>
<td>OIL</td>
<td>25,3</td>
<td>26,3</td>
<td>24,5</td>
</tr>
<tr>
<td>GAS</td>
<td>14,1</td>
<td>14,8</td>
<td>17,6</td>
</tr>
<tr>
<td>RENEW.</td>
<td>9,2</td>
<td>13,7</td>
<td>15,6</td>
</tr>
<tr>
<td>NU ENERGY</td>
<td>0,0</td>
<td>5,5</td>
<td>11,7</td>
</tr>
<tr>
<td>OTHERS</td>
<td>0,3</td>
<td>0,3</td>
<td>0,5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100 %</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>100,2</td>
<td>102,5</td>
<td>87,9</td>
</tr>
</tbody>
</table>
MAIN INVESTMENTS IN POWER SECTOR

NEEDS FOR ENERGY SECURITY - 1000 MW / YEAR OF NEW CAPACITY INSTALLED IN THE POWER PLANTS...

HARD COAL AND LIGNITE (TO 2020/2030):
• REFURBISHMENT AND REHABILITATION OF EXISTING POWER P.P. (6556 MW, n>36 - 40%)
• BUILDING OF THE NEW HIGH EFFICIENCY POWER GENERATION UNITS (5358 MW - PC/SC, PC/USC, CFBC/SC, CHP/cogeneration) - CCS READY?

NATURAL GAS
• GAS - STEAM (CHP) UNITS (2200 MW), ......PIPELINES, STORAGE, EXPLORATION

NUCLEAR
• PWR REACTOR (6000 MW)

RENEWABLE
• WIND - FROM 15 000 - 20 000 WIND UNITS (2 MW)
• LNG and OIL TERMINALS

PLANNED CAPITAL COSTS ca 100 BLN EURO
ENERGY INVESTMENTS IN POLAND to 2030

- Exploration of gas
- Gas pipeline
- Hard Coal Power Plant
- NU Power Plant
- Gas Power Plant
- Lignite Power Plant
- Interconnector
- Storage of gas
- Oil ring
- LNG terminal
- Oil terminal
<table>
<thead>
<tr>
<th>POWER PLANT</th>
<th>INVESTOR (constructor)</th>
<th>CAPACITY OF NEW ENERGY-BLOC MW / (efficiency)</th>
<th>COSTS OF INVESTMENT BLN EURO</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPOLE</td>
<td>PGE (RAFAKO, POLIMEX, MOSTOSTAL)</td>
<td>2 x 900 (45,5%)</td>
<td>2,76</td>
</tr>
<tr>
<td>KOZIENICE</td>
<td>ENEA (HITACHI-POWER POLIMEX-MOSTOSTAL)</td>
<td>1075 (45,6%)</td>
<td>1,52</td>
</tr>
<tr>
<td>JAWORZNO 3</td>
<td>TAURON PE</td>
<td>910 (46%)</td>
<td>1,29</td>
</tr>
<tr>
<td>TURÓW</td>
<td>PGE</td>
<td>460 (n = 44,5 %)</td>
<td>0,98</td>
</tr>
<tr>
<td>ZABRZE</td>
<td>FORTUM POWER AND HEAT</td>
<td>220/FBC/CHP</td>
<td>0,25</td>
</tr>
<tr>
<td>TYCHY</td>
<td>TAURON PE</td>
<td>50MWe + 86MWt FBC/CHP</td>
<td>0,18</td>
</tr>
<tr>
<td>RYBNIK</td>
<td>EDF (ALSTOM)</td>
<td>900 (46%)</td>
<td>1,22</td>
</tr>
<tr>
<td>POWER PLANT</td>
<td>CAPACITY OF NEW ENERGY-BLOCK MW / TECHNOLOGY</td>
<td>COSTS OF INVESTMENT BLN EURO</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>------------------------------</td>
<td></td>
</tr>
<tr>
<td>STALOWA WOLA HP PLANT Gas (2016)</td>
<td>450 MWe + 240 MWt CHP</td>
<td>0,36</td>
<td></td>
</tr>
<tr>
<td>TAURON - ŁAGISZA Gas (2018)</td>
<td>413 MWe /CCGT n=58%</td>
<td>0,36</td>
<td></td>
</tr>
<tr>
<td>ORLEN - WŁOCŁAWEK Gas (2015)</td>
<td>473 MWe/CCGT</td>
<td>0,34</td>
<td></td>
</tr>
<tr>
<td>ORLEN - PŁOCK Gas</td>
<td>596 MWe/CCGT</td>
<td>0,4</td>
<td></td>
</tr>
<tr>
<td>GORZÓW HP PLANT Local gas</td>
<td>138 MW</td>
<td>0,165</td>
<td></td>
</tr>
<tr>
<td>PGE - NU P.P - Choczewo/Żarnowiec 2025-2030</td>
<td>6000 MW PWR REACTOR</td>
<td>~20</td>
<td></td>
</tr>
</tbody>
</table>
CCS/CCU IN POLISH ENERGY SECTOR

TECHNICAL AND PUBLIC CONDITIONS

• WE HAVE KNOW HOW IN CAPTURING THE CO₂

• WE HAVE KNOW HOW IN TRANSPORT AND STORAGE THE CO₂

BAT:

• WE HAVE LIMITED POSSIBILITIES OF CO₂ STORAGE (geological conditions and surface infrastructure)) - MOREOVER WE HAVE TO TRANSPORT CO₂ minimum 60 - 200 km FROM ENERGY SOURCE

• WE HAVE NOT PUBLIC ACCEPTANCE FOR TRANSPORT AND STORAGE OF CO₂
## Costs of reduction of CO₂ emission

<table>
<thead>
<tr>
<th></th>
<th>Without CO₂ separation 1</th>
<th>With CO₂ Separation 2</th>
<th>Difference 2:1 % 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital costs; $/kW</td>
<td>1143</td>
<td>1900</td>
<td>166</td>
</tr>
<tr>
<td>Unitary cost of electrical energy; $/MWh</td>
<td>51,5</td>
<td>75,42</td>
<td>146</td>
</tr>
<tr>
<td>Unitary emission of CO₂; kg/MWh</td>
<td>774,3</td>
<td>108,1</td>
<td>~14,0</td>
</tr>
<tr>
<td>Net efficiency; % Qs</td>
<td>40,5</td>
<td>28,7</td>
<td>~70,86/11,8</td>
</tr>
<tr>
<td>Reduction of CO₂ emission; kg/MWh</td>
<td></td>
<td>666,1</td>
<td></td>
</tr>
<tr>
<td>Relative decrease of efficiency; %</td>
<td></td>
<td>~29,14</td>
<td></td>
</tr>
<tr>
<td>Cost of CO₂ reduction; $/t</td>
<td></td>
<td>35,9</td>
<td></td>
</tr>
</tbody>
</table>
CCS/CCU IN POLISH ENERGY SECTOR

POLISH ENERGY AND COAL SECTOR PARTICIPATE IN MANY INTERNATIONAL PROJECTS OF CLEAN COAL TECHNOLOGIES - REDUCTION OF CO2 EMISSION AND UTILIZATION OF CO₂ ia.: 

- CARBON FUEL CELLS
- GASIFICATION OF COAL - PRODUCTION OF ENERGY AND CHEMICALS
- METHANATION OF CO₂ BY H₂ AND PRODUCTION OF FUELS
- PHOTOSYNTHESIS INVERSE
IMPLEMENTATION OF EU CLIMATIC POLICY IN POLAND

PLANNED ECOLOGICAL EFFECT TO 2030

REDUCTION OF 130 MLN TONNES OF CO₂ = EQUIVALENT OF 0.013 ppm = EQUIVALENT OF 6 DAYS ELECTRICITY PRODUCTION IN CHINA

- TOTAL COST 100 (265 BLN) EURO TO 2030
  it is minimum 30 Euro/MWh

SLIGHT ECOLOGICAL EFFECT - INADEQUATE TO CARRIED COSTS
POLAND EMIT ~ 0.9% OF THE TOTAL WORLD CO₂ EMISSION
MAIN THREATS

• COSTS OF INVESTMENTS IN ENERGY SECTOR minimum 100 BLN EURO (400 BLN PLN)

• DOUBLE GROWTH OF THE ELECTRIC ENERGY PRICES AND QUADRUPLE GROWTH OF COSTS OF THE HEATING OF HOUSES - ENERGY POVERTY - RISE OF PARTICIPATION OF COSTS OF ENERGY IN THE HOUSEHOLDS BUDGET FROM 12 % TODAY TO 20 % IN THE FORESEEABLE FUTURE
  IN MANY EU COUNTRIES > 10 % = LEVEL OF ENERGY (FUEL) POVERTY

• SIGNIFICANT GROWTH OF THE ENERGY DEPENDENCY - EXPENSIVE RENEVABLE ENERGY - WITHOUT SUBSIDIZING

• WEAKNESS OF ECONOMY AND SIGNIFICANT DECREASE OF THE INDUSTRY COMPETITIVENESS

• CARBON LEAKAGE - INFLUENCE ON GDP & EMPLOYMENT REDUCTION (MIN. 0.8 MLN OF WORKPLACES CONNECTED ONLY WITH MINING SECTOR)

• LOSS OF THE GDP: FOR 503 BLN PLN / YEAR - 2020 - 2030

• REAL THREAT OF BLACK OUT - GAP IN THE ENERGY BALANCE FROM 2016
THANK YOU

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