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ITC

Energy Sources & Conversion

Formal issues

Teacher / Instructor

- Course Manager – Prof Roman Domański roman.domanski@itc.pw.edu.pl
- Actual instructor – Adam Rajewski adam.rajewski@gmail.com, Room 110

Passing criteria

- Final exam (60%)
- Group homework (40%)

Forms of energy

Mechanical Energy

Electric Energy

Chemical Energy

Nuclear Energy

Internal Energy

We need:

Mechanical energy

- To move things from one place into another

Internal energy

- For heating

Electric energy

- For just about everything nowadays…

Nature provides:

Chemical energy

- Fossil fuels
- Other combustible substances (biomass)

Nuclear energy

- Fissile materials (U-235)
- Nuclear fusion fuels (Sun)

Internal energy

- Hot interior of the Earth

(Mechanical energy)

- Wind, waves, river flow – all results of Solar energy

Objectives of the conversion processes:

Changing the form of energy

- Turning available form of energy into the one we need

Enabling easier transport of energy

- Some forms of energy are easier to transport than others

Enabling energy storage

- Some forms of energy are easier to store than others

Optimising conversion effectiveness

- Some conversion chains are more efficient than others
- Some are more reliable than others
- Both criteria may be contradictory!

Energy conversion on industrial scale

Mechanical Energy
- Into electricity – generators
- Into internal energy – dissipation

Electric Energy
- Into mechanical energy – electric motor
- Into internal energy – resistor

Chemical Energy
- Into electric energy – limited – fuel cells
- Into internal energy – combustion

Nuclear Energy
- Into internal energy – fission, fusion

Internal Energy
- Into mechanical energy – e.g. turbine

Energy storage

Mechanical Energy
- Kinetic – flywheels
- Potential – springs, water reservoirs

Electric Energy
- Batteries – limited capacity and time

Chemical Energy
- Fuel stockpiling

Nuclear Energy
- Fuel stockpiling

Internal Energy
- Heat storage tanks (limited time)
- Compressed gas reservoirs
- Phase-change materials

Challenges of the 21st Century

Increasing population and life quality

- Increasing energy demand – global and per capita
- Increasing demand for traditional fuels
- Market distortions

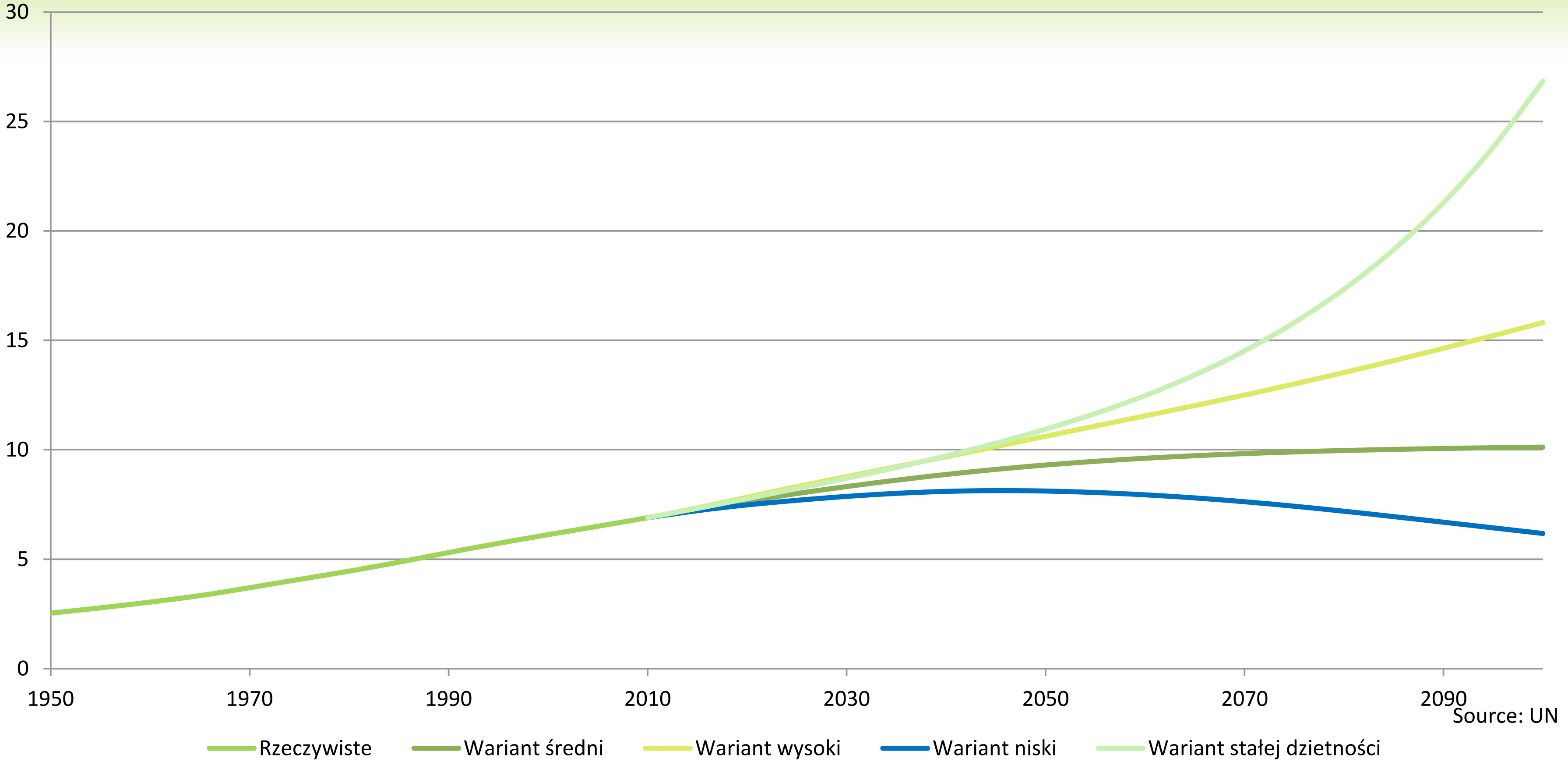
Fossil resources depletion

- Implementation of unconventional sources
- Deployment of renewable technologies

Environment protection and “climatic policy”

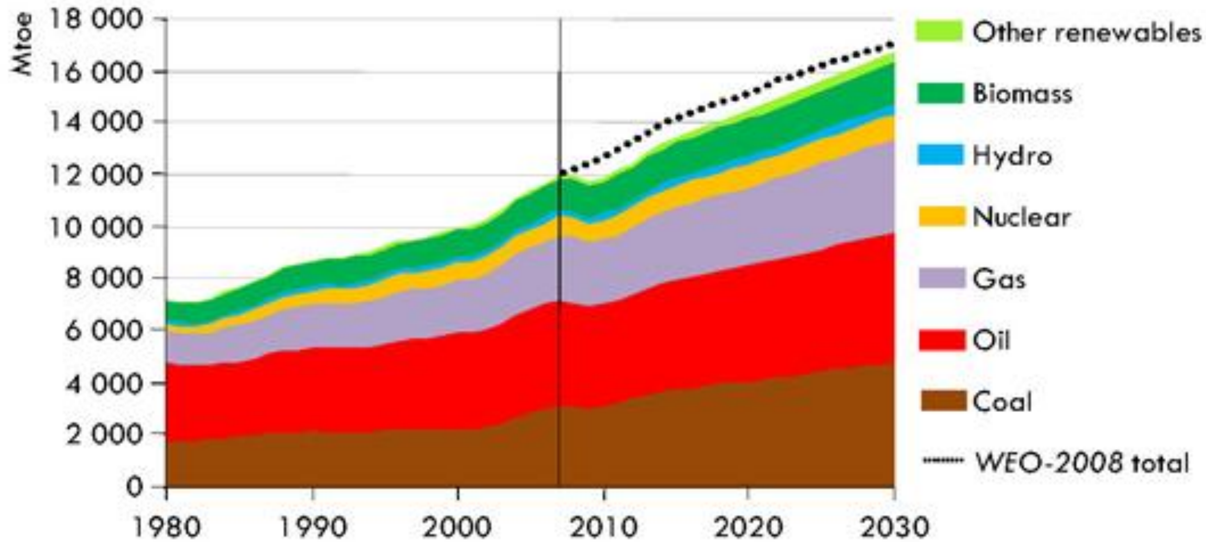
- Focus on renewables
- Support for low-emission solutions
- Penalties for high-emission fuels

World population [bn]



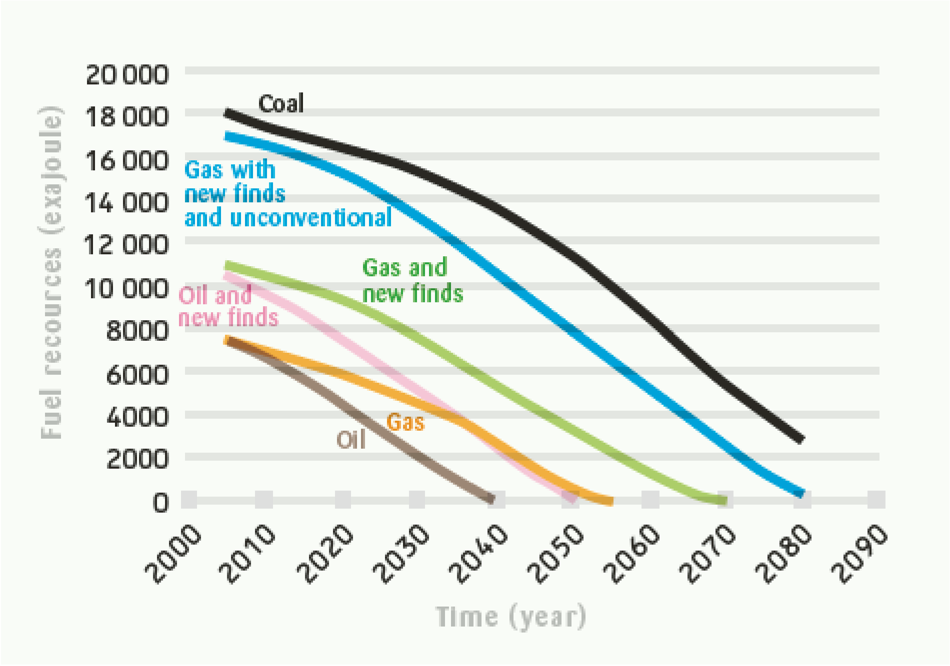
World Energy Outlook 2009

World primary energy demand by fuel in the Reference Scenario



Global demand grows by 40% between 2007 and 2030, with coal use rising most in absolute terms

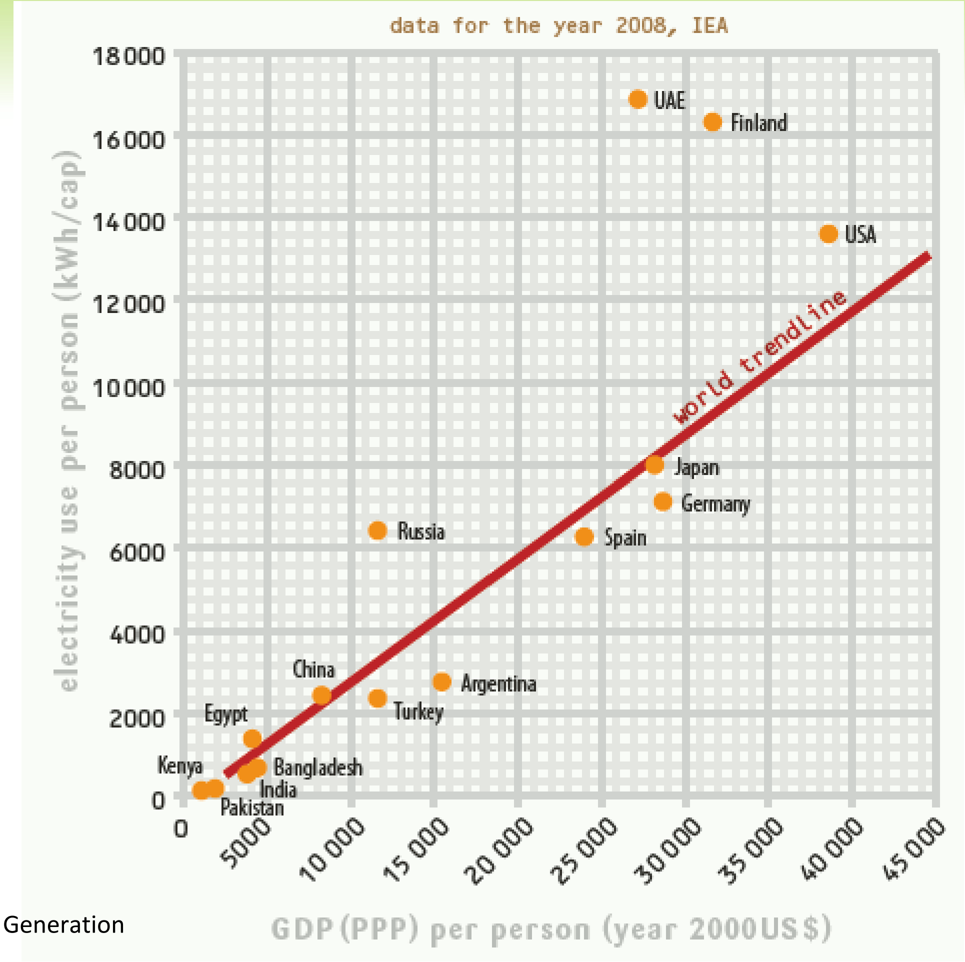
Fossil fuel deposits



Source: Klimstra J., Hotakainen M., Smart Power Generation

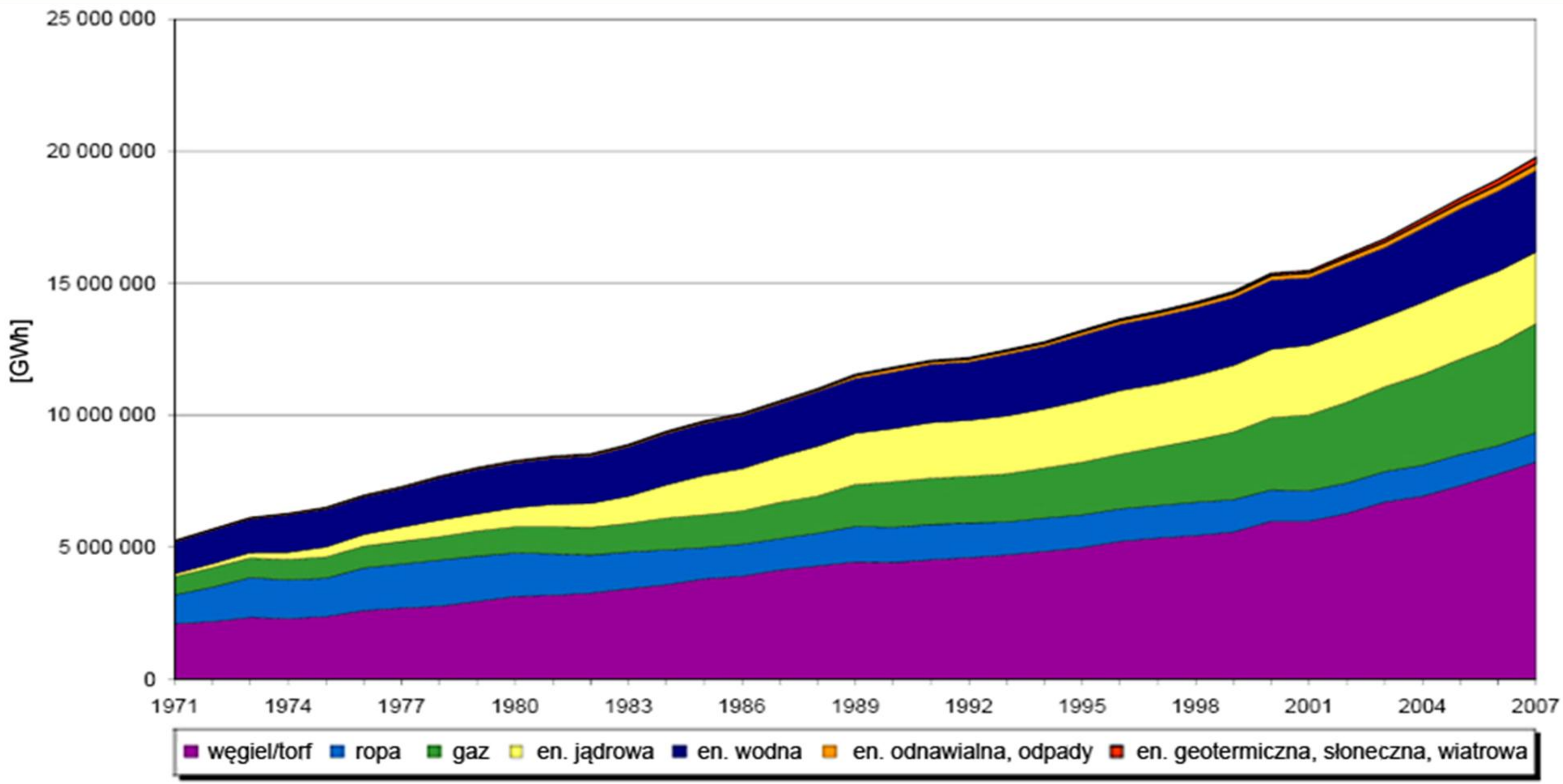
Impact of electricity

By average 1 MWh of electricity increases GDP (PPP) by 3500 USD



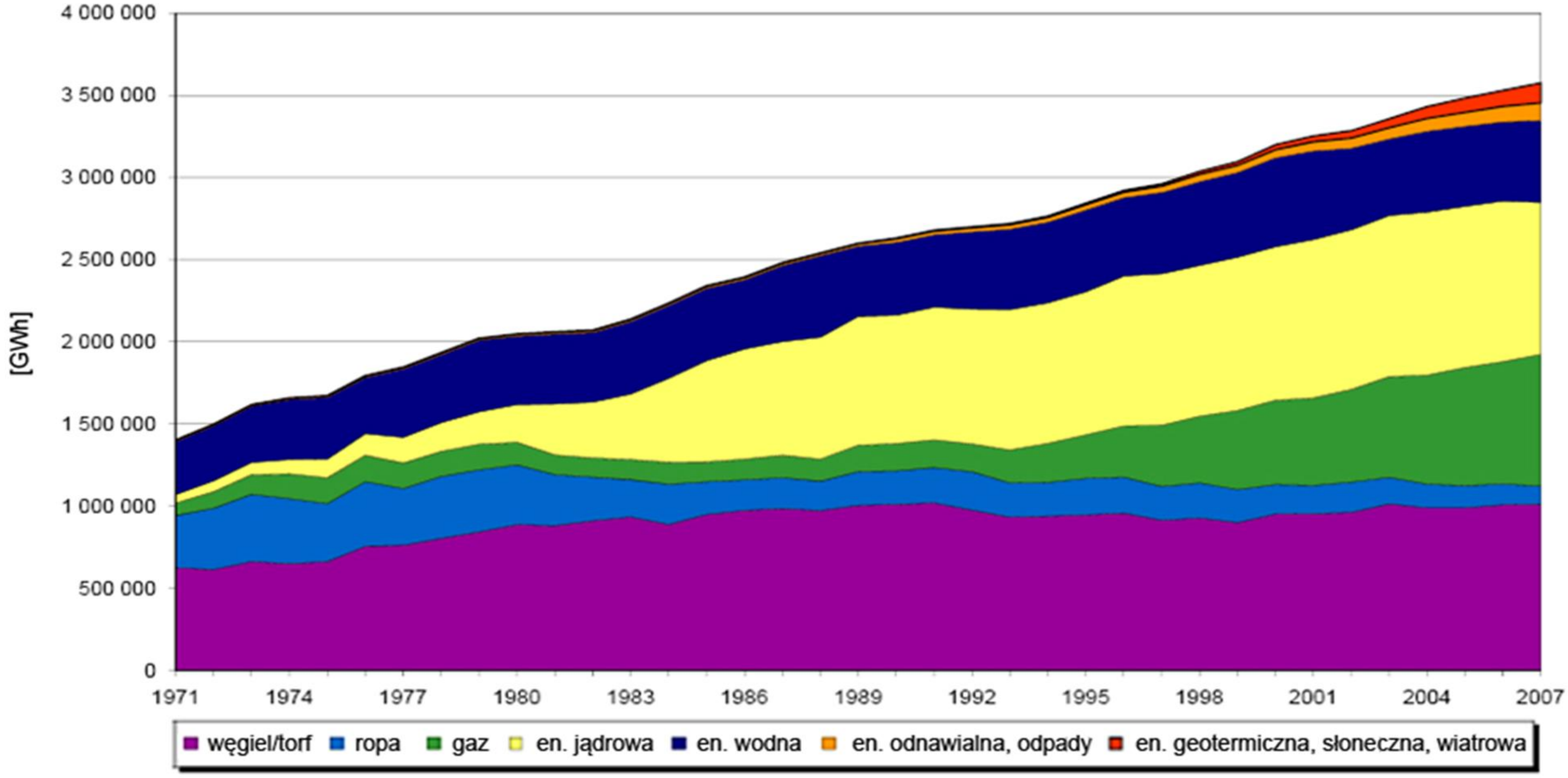
Source: Klimstra J., Hotakainen M., Smart Power Generation

Power generation worldwide…



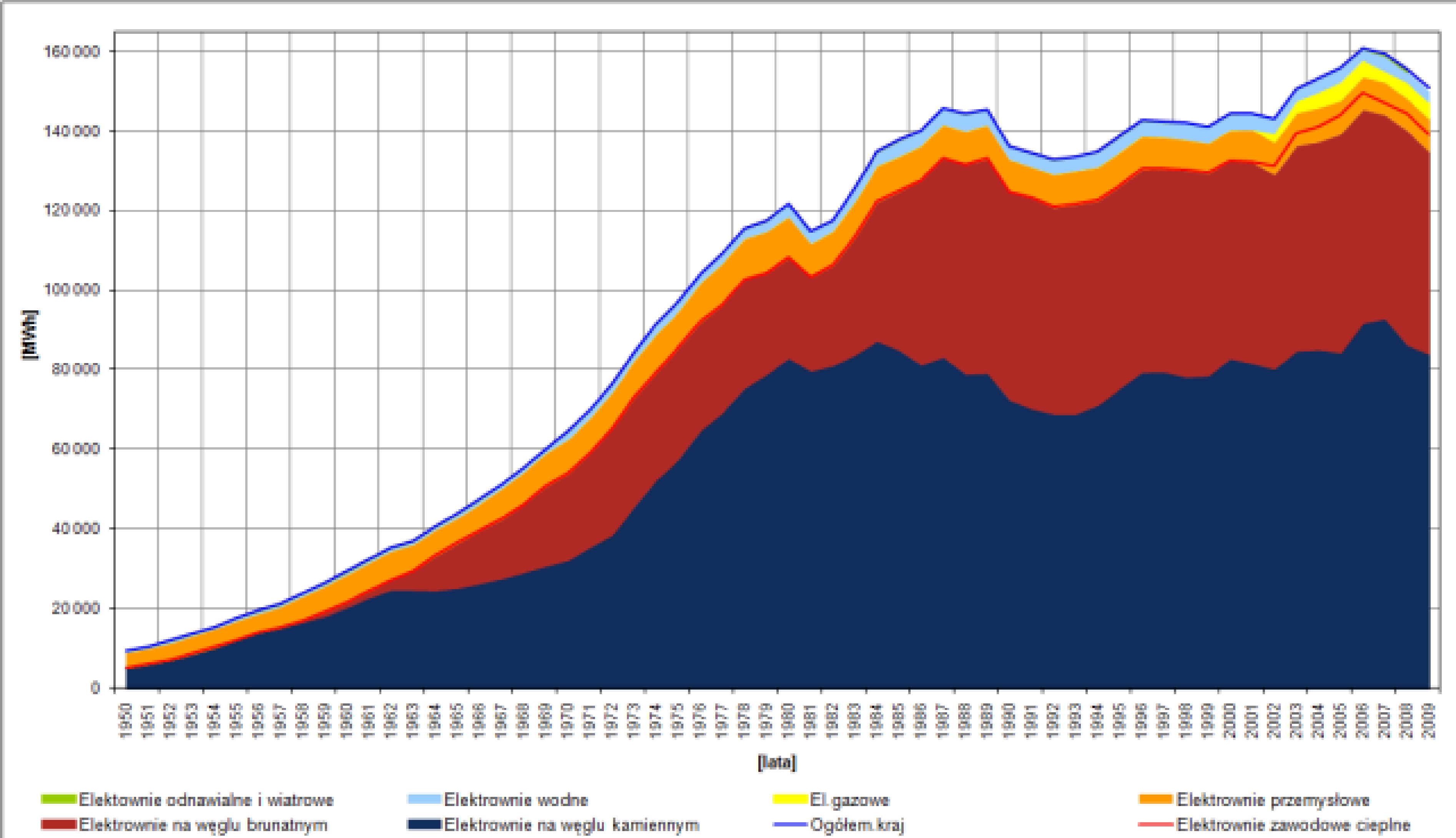
Źródło: IEA, 2009

… IN OECD COUNTRIES…



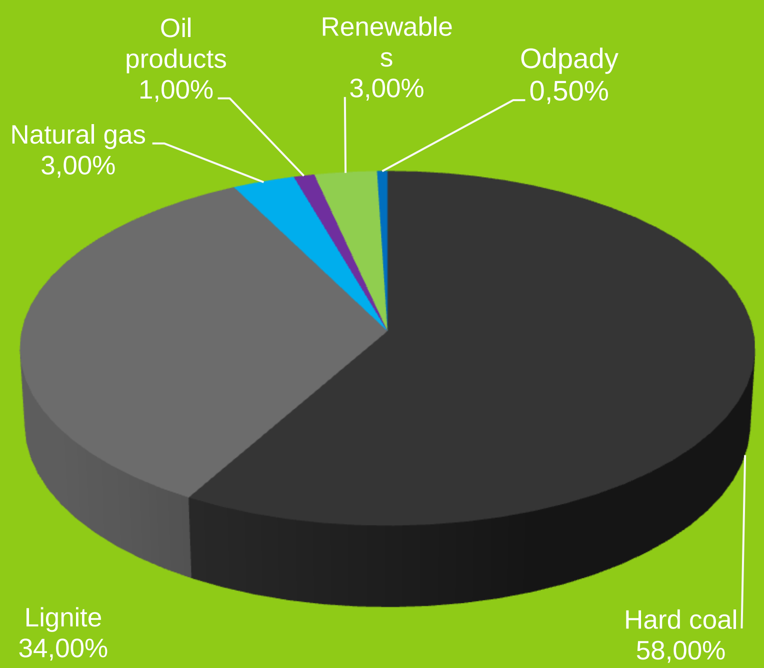
Źródło: IEA, 2009

…and in Poland

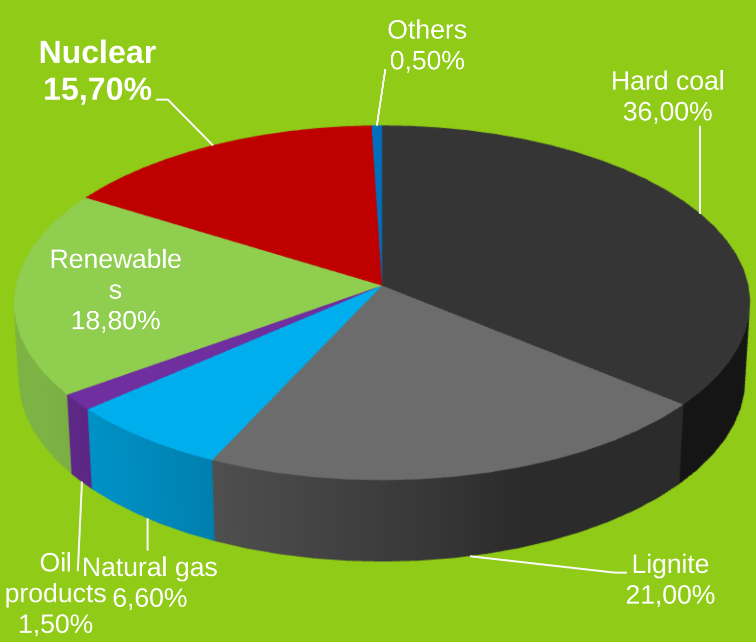


Poland

Currently – 147.7 TWh



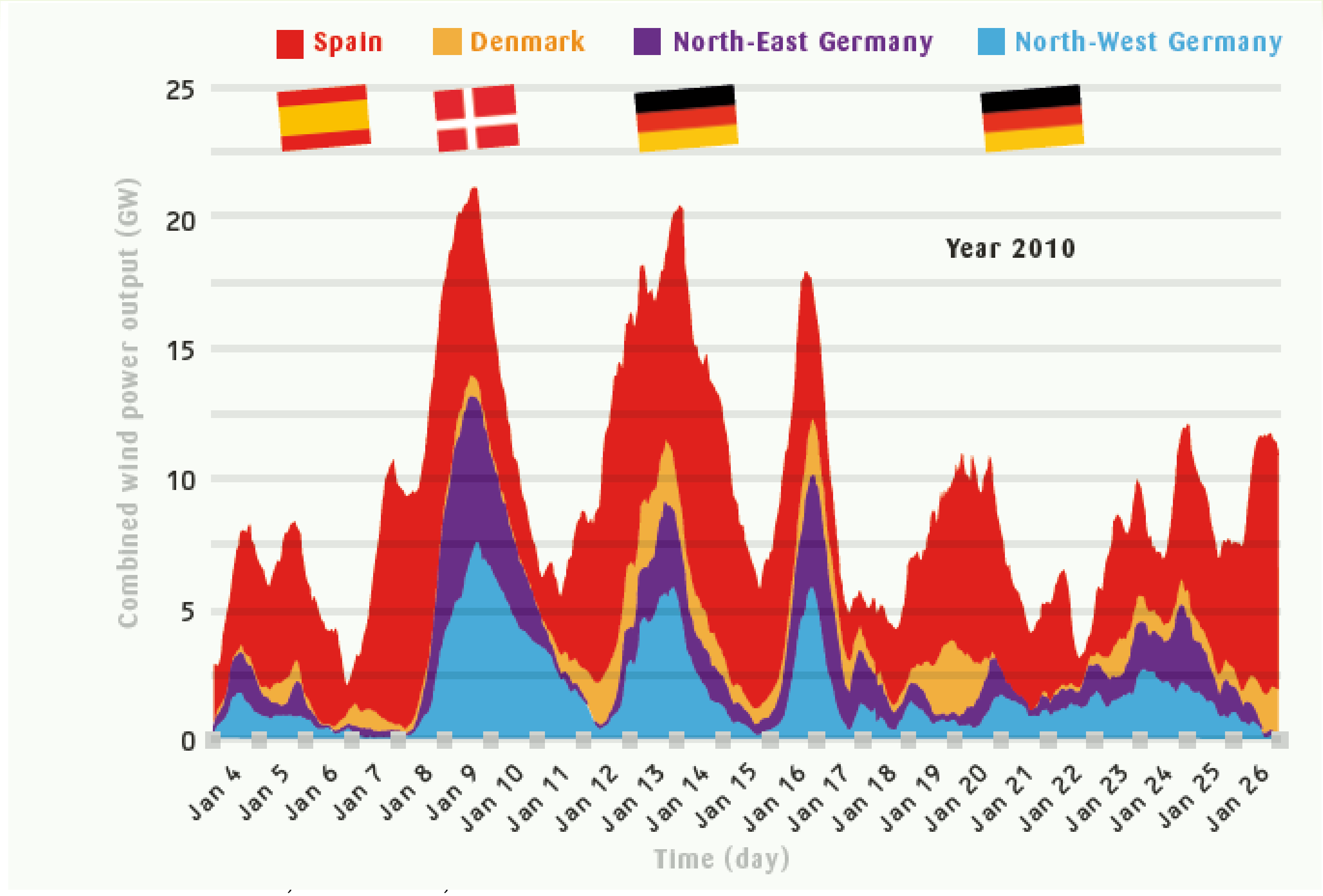
Ca. 2030 – 201.8 TWh



Net electricity generation by fuels

Data: Ministry of Economy

Wind power impact



Typical energy conversion chains

$\eta < 10\%$

- Chemical energy of crude oil
- Chemical energy of petrol
- Internal (thermal) energy of exhaust gases in the engine
- Mechanical (kinetic) energy of piston/crankshaft
- Kinetic energy of a car

Typical energy conversion chains

Chemical energy of crude oil

Chemical energy of jet fuel

Internal (thermal) energy of exhaust gases in the engine

Mechanical (kinetic) energy of piston/crankshaft

Kinetic energy of a car

Typical energy conversion chains

$\eta < 50\%$

- Chemical energy of coal
- Internal (thermal) energy of flue gas
- Internal energy of steam
- Kinetic energy of turbine rotor
- Electric energy

Typical energy conversion chains

η < 80%

Electric energy in the grid

Kinetic energy of the pump impeller

Potential energy of water (storage)

Kinetic energy of turbine rotor

Electric energy in the grid

Thank you!

Homework:

You are members of an analytical team within a certain company.

In March 2013 the management board plans to make a decision about potential involvement in an investment project: construction of an energy system X.

This decision needs to be based on proper techno-economic analyses and a pre-feasibility study. Those studies in turn require collecting certain amount of data – this is your task.

Needed information (1)

- General list of technical solutions which may be used in the project. The list should include short description of each solution, description of key differences and recommendations for accepting or rejecting those solutions with justification.
- Possible technical parameters – output of main equipment, efficiency values, all other characteristic parameters significant for project evaluation (acc. to your evaluation).
- Key technical requirements for the investor (e.g. required fuel properties, site dimensions etc.)
- List of potential suppliers of key equipment.
- Lista dostawców podstawowych urządzeń technologicznych.
- List of potential EPC contractors.
- Information about similar recent projects.

Needed Information (2)

- Estimated investment cost and O&M cost (CAPEX & OPEX).
- Estimated construction time (contract to commercial operation).
- Information about possible support in form of energy certificates (green, yellow, red etc.).
- Information about possible external financial support (EU grants, preferential loans etc.).
- Recommendations for formal tender specification: proposed formal requirements fro contractors and offer evaluation parameters.

PROCESS:

Project execution schedule shall be drafted and submitted to the teacher during first two weeks.

Progress shall be reported in interim reports submitted by e-mail by 1 November, 1 December and 1 January. Final report is due for 14 January 2013.

Each interim report will be evaluated and recommendation for further steps will be provided by the teacher.

Evaluation

Following elements will be evaluated:
- Clarity and completeness of the reports
- Correctness of presented data
- Quality of justification for given recommendations.

The homework grade is identical for all team members.

Failure to present an interim report on time results with the final grade being unconditionally lowered by 0.5 (per each undelivered report).

Delay in the final report shall result with lowering the final grade by 0.5 per each started day.

Persons who get 2.0 from the homework cannot get a final grade higher than 3.0, regardless of the exam result.