PART IV – RENEWABLE ENERGY TECHNOLOGIES (HOMEWORK)

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- Renewable Energy definition
- What is Renewable Energy?
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- Energy efficiency
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RENEWABLE ENERGY DEFINITION

” Energy obtained from the continuous or repetitive currents of energy recurring in natural environment” (Twidell & Weir 1986)

“ Energy Flows that which are replenished at the same as they are used” (Sorensen 2000)

What about Sustainable Energy?

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WHAT IS RENEWABLE ENERGY?

- Principal source solar radiation to energy

→Direct uses: Solar PV, Solar thermal

→Indirect: Hydropower (through water cycle), Wind power (heat flow towards the poles), Wave Power (from the wind), Bioenergy (through photosynthesis)

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WHAT IS RENEWABLE ENERGY?

- Non-solar renewables

→Tidal energy (gravitation pull of the moon)

→Geothermal energy (heat from within the earth)

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WHY RENEWABLE ENERGY?

- Increased amount of greenhouse gases in the atmosphere→more particles prohibiting infrared radiation re-radiating from the earth's surface back into space→global warming→climate changes
- Flows of energy vs. stocks of energy
- What is the difference?

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WHY RENEWABLE ENERGY?

- Non renewable

→Burning of fossil fuels add CO_2 into the atmosphere

- Renewable

→Burning of biofuels do generate CO_2 to atmosphere, however should be offset by CO_2 absorbed during plant growth

SOLAR THERMAL

- Low and high temperature solar energy applications, active and passive
- Active:

Solar heating with collectors

Solar thermal engines to generate electricity

Passive:

Solar space heating

Building design, daylighting etc.

SOLAR PHOTOVOLTAICS (PV)

- Conversion of solar energy directly to electricity
- Semiconductors usually made of silicon: positive and negative type, when light falls to junction of those, energy transferred to some electrons promoting them to higher energy level
- Remote areas, connected to grid
- High initial costs, improving efficiency

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BIOENERGY

- Energy derived from materials that were living matter relatively recently
- Traditional Biomass (e.g. firewood, residues)
- New Biomass (e.g. energy crops, organic wastes)

Energy crops: woody and agricultural

Waste: wood residues, crop waste, animal, municipal, commercial and industrial waste, Landfill gas

- Solid, gas, liquid

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HYDROPOWER

- Extracting the energy of water movement by electricity generators (potential, kinetic)
- Large and small scale
- Small under 10MW(one definition)
  - →Mini < 1MW
  - →Micro < 100kW
  - →Pico < 1kW
- Run-of-river, dam, reservoir
- Effective head, water speed and flow rate
- Horizontal or vertical position of the turbine

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TIDAL POWER

- ”Lunar power” from gravitational pull of the moon, not from hydrological cycle
- Fall and rise of the tides exploited, water captured during the high tide with large barrages and released during the low tide
- Flood tides (and tidal currents)
- Similar to low-head hydro

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WIND POWER

- Movement of atmospheric air masses as a result of variations in atmospheric pressure (note solar heating!)
- Kinetic power of wind through wind turbine to electricity
- Horizontal and vertical axis turbines
- Inland or offshore

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WAVE ENERGY

- Ocean waves generated by wind passing over strecthes of water
- Convert wave energy into mechanical energy that is used to generate electricity (turbines)
- Many different kinds systems

One classification by location:

Fixed to seabed, generally in shallow water

Floating offshore systems in deep water

Floating main system fixed to seabed in intermediate depths

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GEOTHERMAL

- Independent from sun
- Boreholes are drilled to reservoir,hot fluid flows or is pumped to the surface and used in conventional steam turbines to generate electricity or in heating devices
- Utilised mainly near to the borders of tectonic plates, litosphere

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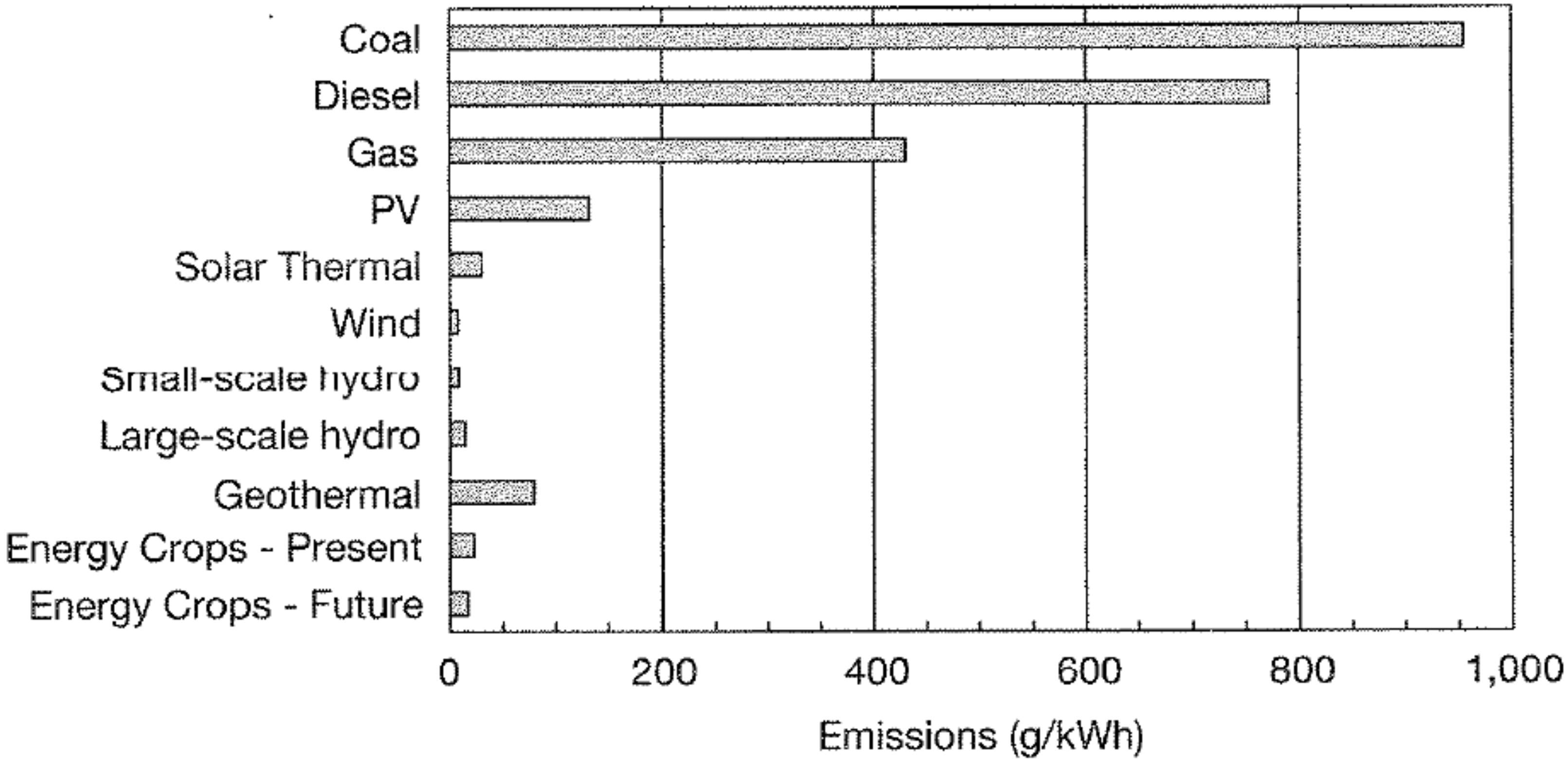
ENVIRONMENTAL BENEFITS OF RENEWABLES

- Reduction in gaseous emissions: NO_X, SO_2, CO_2

→Life Cycle comparison with renewables and fossil fuels



ENVIRONMENTAL BENEFITS (CONT.)

- Water supply & improved water quality

→Wind(water pumping),Hydro(improving water supplies), Solar (water cleaning)

- Reclamation of degraded land and habitat

→Biomass (prevent soil erosion with crops)

- Abatement of pollution from transport

→Alternative fuels, Electric vehicles

- Electricity distribution (decentralized)

→reduce the need for line capacity, prevent transmission losses

SOCIOECONOMIC BENEFITS

- Diversifying and securing energy supply

→price stability

- Provide work opportunities for rural areas

→decrease urbanisation

- Decentralising energy markets
- Develop economies, reduce fuel imports
- Rural electrification in developing countries

→energy services and poverty reduction

ENVIRONMENTAL BURDENS

- Can be reduced by:

careful site selection, EIAs, best available technology,

evaluating local, regional and global benefits and impacts of the scheme,

including public and other relevant organisations in the project cycle from planning,

demonstrating benefits to the local population affected

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ENVIRONMENTAL LIABILITIES (CONT.)

- Land use

→What land is used for?

- Visual intrusion

→more or less comparable with current technologies

- Noise

→Usually less than acceptable working practices

- Damage to ecosystems

→land and water ecosystems

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ENERGY SERVICES AND EFFICIENCY IMPROVEMENT

- Nobody wants energy as such (except food) but energy services
- Energy chain from primary energy to useful energy

→only one-third of the energy of the fuel emerges as useful energy, two-thirds wasted (Boyle 2004)

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ENERGY SERVICES AND EFFICIENCY IMPROVEMENT

- Supply-side measures

→Large potential

Energy efficient technologies in energy production (e.g. CCGT 50 % more efficient than traditional gas turbines)

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ENERGY SERVICES AND EFFICIENCY IMPROVEMENT

- Demand-side

→technological and social approach

Technological:

Improved energy conversion (and/or distribution) technologies requiring less energy input for energy service

Social:

Re-arranging lifestyles so that energy service requires less energy input

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ENERGY SERVICES AND EFFICIENCY IMPROVEMENT

Domestic sector

→Space and water heating, cooking, lighting, electrical appliances

Commercial and institutional sector (service)

→similar to domestic, but also air conditioning

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For example

- **Computers**
  - Use flat screen monitors OR laptop whenever possible
  - Use computers that consume less energy
  - Turn off screen, computer and UPS when not used
  - Avoid stand-by functions, use power management features

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- **Printers and copy machines**
  - Switch on the appliances only when needed
  - Print/copy only necessary documents, or on both sides of the paper to save both energy and papers
  - Centralize the printing/copying

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- **Air conditioning**
  - Set the temperature right (e.g. at 25-26 degrees)
  - Placement and amount of air conditioning devices
  - Insulate the facility: Make sure there are no air leaks through doors and windows
  - Use shades and curtains

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- Lighting
  - Use natural lighting when available
  - Design and direct the lighting
  - Switch off lights when not needed
  - Use energy saving lamps
  - Install light controls
  - Paint walls and ceilings with lighter colors
  - Buildings should be designed to allow enough natural light to enter

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ENERGY SERVICES AND EFFICIENCY IMPROVEMENT

Industrial sector

→the two previously mentioned and making energy use more efficient (cascading)

→Industry specific: motors, pumps, fans and drive systems etc.

→Dematerialisation; reducing material and energy intensity of processes (note! Cleaner production)

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ENERGY SERVICES AND EFFICIENCY IMPROVEMENT

Transport sector

→Social measures,

Modal shift,   How to move?

→Technological measures

Vehicle fuel economy

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CLEANER PRODUCTION

- Entire life cycle of products

product design

selection of raw materials

production and assembly of the final product

consumer use

managing all used products at the end of their life

- From cradle to grave (cradle)

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CLEANER PRODUCTION

Conventional production

- Processes not designed for waste prevention
- No use of by-products
- Expensive end-of-pipe pollution technology
- Expensive waste treatment, transport and disposal

Cleaner production

- Processes designed for minimum waste
- Maximum use of by-products
- Savings through reduced pollution control technology, and reduced waste treatment, transport and disposal
- Minimum impact on the environment

Clean production

- Zero waste
- Total use of by-products
- Zero impact on the environment

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CLEANER PRODUCTION

- Cleaner production:
- leads to improved products and processes
- saves on raw materials and energy, reducing production costs
- increases competitiveness through the use of new and improved technologies
- reduces the need for more environmental regulation
- reduces risk from on- and off-site treatment, storage and disposal of toxic wastes
- improves the health and safety of employees
- improves staff morale, leading to better productivity
- improves a company's public image
- reduces the cost of increasingly expensive end-of-pipe solutions

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SUSTAINABLE ENERGY USE IN THE FUTURE

- Clean up fossil fuels
- Switch to renewable resources
- Using energy more efficiently

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Thank you

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