ODA-UNESCO PROJECT:

PROMOTION OF ENERGY SCIENCE EDUCATION FOR SUSTAINABLE DEVELOPMENT IN LAO PDR

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THEME 5: RENEWABLE ENERGY Introduction to Renewable energies

RE Content

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II:52 AM Introduction to RE

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- Why Renewable energy? Reserves of Fossil Energy Sources 2) Greenhouse Effect 3) Nuclear Power is not the answer 2. What are Renewable Energies? 3. Global Use of Renewable Energy Sources
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Why Renewable Energy? •Depleting Fossil fuel resources

Crude oil production (million metric tonnes)



Why Renewable Energy? Depleting Fossil fuel resources



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Why Renewable Energy? - Greenhouse Effect and Climate changes •Natural greenhouse effect •Anthropogenic (Human induced) ~ 50% from fossil fuel usage



Why Renewable Energy? –

Can Nuclear Power be long term alternative?

Nuclear fission: all built Nuclear Power Plants

 ${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \longrightarrow {}^{90}_{36}\text{Kr} + {}^{143}_{56}\text{Ba} + {}^{1}_{0}\text{n} + \Delta E$

Problems:

Limited uranium reserve

Global reserves : less than 20 million tons (12.52 million tons → speculative (estimated)

Rock with a uranium oxide content of more than 0.1% is a workable uranium ore

 the building of the power plant, uranium mining, transport and disposal → emission of significant amounts of carbon dioxide Why Renewable Energy? - Nuclear Power (cont.)

Transport and storage of radioactive materials bear further risks
The normal operation of nuclear power plants also bears risks
Nuclear energy can also be used for military purposes.

Why Renewable Energy? - Nuclear Power (cont.) Nuclear fission: The risks

 The highest risk of nuclear fission is an MCA (maximum credible accident) in a power station Harrisburg (1979),



Chernobyl (1986)



Fucushima (2011)



Why Renewable Energy? - Nuclear Power (cont.)

World consumption





Why Renewable Energy? - Nuclear Power (cont.) Nuclear fusion: Sun rises on the Earth? Deuterium 2D and tritium 3T → fused to Helium 4He.

$${}^{2}_{1}D + {}^{3}_{1}T \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + \Delta E$$

<u>The Main Advantage</u>: Abundance of Deuterium and Tritium on the Earth (H_2O) Why Renewable Energy? - Nuclear Power (cont.)

- <u>Nuclear fusion</u>: Disadvantages
 - > much more expensive then today's fission
 - risk of MCA: operation of fusion also produces radioactive materials
 - > Spent a lot of money for development of fusion process.
 - When?
 The long times still need to bring this technology to maturity

Renewable energies (RE): Why?

- •Depleting of Traditional Fossil energy resources •Climate changes
- Nuclear power is not long term alternative

Future energy supply can be secured through:

- i. Increase of the <u>efficiency of energy usage</u>, i.e. useful energy must be produced from a much smaller amount of primary energy.<u>Temporary!</u>
- Development of New and <u>Renewable energy</u>
 <u>Resources:</u> inexhaustible within the time horizon of humanity

Why Renewable energies (RE)? <u>What are RE</u>? •RE is constantly exist or periodically

replenished energy currents,

Examples:

- Solar radiation (24 hour period replenished)
- Wind Power: seasonally
- Hydropower: seasonally
- Geothermal energy: constantly exist

Renewable energies (RE): Why? RE is a key: Inexhaustible, renewal ability RE can cover the energy demand of Earth in a climatically sustainable ways Three Main RE resources: Solar Energy: 3,900,000,000 PJ/year 94,000 PJ/year Planetary (gravitational) energy 2) Geothermal energy 996,000 PJ/year 3) (Biomass, Hydropower, Wind Power are transformed from Solar energy)

Why Renewable energies: Potential





Why Renewable energies? Problems of RE:

low energy intensity sources
fluctuating energy sources
dependency on specific local conditions

Require new technological and management approaches

Renewable energies: Problems of RE: Comparison example Fossil fuel-based energies are ready availability: it can be used whenever there is consumer demand •Availability of RE sources <u>fluctuates</u> \rightarrow full renewable energy supply may require : Iarge energy storage systems, **↓**global energy transport +adaptation of the demand to the available energy (e.g., use when there is availability) These measures often costly

World's energy Outlook

Source: EIA, 2012

World Primary Energy Consumption: Coverage by type



World's energy Outlook

World energy consumption by fuel type,

Source: EIA, 2011



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Renewable energy share of global final energy consumption, 2010

0

Source: REN21, based on different sources



Growth rates of Renewable energy capacity and biofuels production, 2006-2010

Source: REN21, based on different sources



Estimated Renewable energy share of global electricity production, 2011 Source: REN21, based on different sources



Costs

Ethanol and Biodiesel production, 2000-2011

Source: REN21, based on different sources



BIOMASS MEETS AN ESTIMATED 53 EJ OF GLOBAL ENERGY DEMAND;

0

35% USES.



Solar PV total world capacity, 1995-2011 (Giga Watts)

Source: REN21, based on different sources

FIGURE 11. SOLAR PV TOTAL WORLD CAPACITY, 1995 – 2011

0





Costs



- No reserves of Oil-Natural gas
- Some reserve of coal ★

 (lignite ~ 500 million t)
- Abundant Hydropower:
 - Large HP 26,000 MW
 - Small scale HP capacity <15 MW, (~2000 MW)



Solar energy: Averaged irradiance over Laos

MJ/m²/day

or

13-19

3.6-5.3

kWh/m²/day



Solar Energy









APR







Biomass

- Biomass is the most important tradition energy sources,
- Biomass energy feedstock:
 - Energy crops
 - Oily crops (Oil Palm, Jatropha, Vernicia Montana nut, Mustard)
 - Starch, (cassava), Sugar cane, corn
 - Fast growing trees)
 - Organic wastes (agro-forestry production, communal wastes, ...)





Wind power

- Lack of Wind data
- Good wind speeds

 observed in central
 areas, along Lao Vietnam border,
 - a height 65 m and above, wind speeds reach 5-7 m/s.



*For utility-scale wind turbines. Small wind turbines are sensitive to lower wind speeds.

End of introduction to RE

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