





Overview of renewable energy

Joint APEC-IRENA Workshop on Renewable Energy Statistics (18th APEC Workshop on Energy Statistics) 15-17 December 2020

Adrian Whiteman (IRENA)



Outline

- 1. What is renewable energy?
- 2. Renewable energy sources
- 3. Renewable energy technologies
 - Characteristics
 - Uses

What is renewable energy?

Energy that doesn't run out!

- 1. Energy that can be used without reducing its availability in the future.
 - Natural forces (heat, radiation, motion)
 - Chemical energy from biomass (biofuels)
- 2. Biomass is included because it can be replaced in a human time-frame.

What is renewable energy?

- 1. Scope of energy statistics:
 - Electricity
 - Heat that is actively produced
 - Materials used as fuel for energy production
- 2. Energy statistics exclude:
 - Direct uses of motive power (e.g. windmills)
 - Passive heat production (e.g. greenhouses)
 - Non-energy uses of fuel (e.g. bio-plastics)

Renewable energy sources



...and "other" renewable energy



- Water drives turbines to make electricity. Two types:
 - Run of river
 - Storage (reservoir)
- 2. Characteristics:
 - High investment, low cost
 - Easy to control
 - Social/environmental issues
 - Can be used for storage



arnowiec Pumped Storage Hydro, Poland (680 MW



- 1. Energy from oceans (mechanical, thermal, chemical energy). Five main types:
 - Tidal energy
 - Ocean energy
 - Wave energy
 - Ocean Thermal Energy Conversion (OTEC)
 - Salinity gradient power
- 2. Still largely at development stage, but with significant potential.



- 1. Tidal energy:
 - Mechanical power used for electricity generation
 - Used in locations with large tidal range
 - Similar to hydropower, but more for baseload power
- 2. Some well-established facilities, other new ones being developed









- 1. Ocean energy:
 - Mechanical power used for electricity generation
 - Turbines of many different designs
 - Baseload power, without major construction of dams and barriers
- 2. Pilot-scale projects under development









- 1. Wave energy:
 - Mechanical power used for electricity generation
 - Many different designs, generally low impact
 - Variable resource
- 2. Pilot-scale projects under development





- Ocean Thermal Energy Conversion (OTEC):
 - Power generation from temperature difference between surface and deep ocean





- 2. Salinity gradient power:
 - Power generation from difference in salinity between sea water and fresh water



- Wind drives turbines to make electricity. Two types:
 - Onshore
 - Offshore
- 2. Characteristics:
 - Low cost (onshore)
 - Variable resource
 - Some environmental issues
 - Scalable







- 1. Energy from the sun converted directly into electricity or used as thermal (heat) energy:
 - Solar photovoltaic (Solar PV)
 - Solar thermal:
 - Concentrated Solar Power (CSP)
 - Other solar energy
- 2. Third largest source of electricity from renewables and developing rapidly.



- 1. Solar photovoltaic (PV):
 - Light converted directly into electricity
 - Rapidly falling costs
 - Variable but abundant resource, with few issues
 - Scalable (good for off-grid)
- 2. Growing rapidly in many countries.









- 1. Concentrated Solar Power (CSP):
 - Focused sunlight heats a fluid that drives a turbine
 - Various designs
 - Variable resource, but heat can be stored
 - Generally large-scale, can produce electricity and heat
- 2. Growing in countries with good solar resource.







- 1. Other solar energy:
 - Active heating, using collectors, fans and pumps (excludes passive heating systems/design)
 - Used for heat production
 - Wide variety of devices
 - Can be large Concentrated Solar Thermal (CST)
- 2. At present, most solar systems are water heaters.





- 1. Geothermal energy:
 - Steam and/or hot water taken from wells and used to produce electricity and heat
 - Generally, large-scale, cost-effective and used for baseload power production
 - Geothermal resource is significant in APEC region



18th APEC Workshop on Energy Statistics Joint APEC-IRENA Workshop on Renewable Energy Statistics



- 1. Bioenergy is energy derived from non-fossil materials of biological origin. There are three main types:
 - Solid biofuels and renewable waste
 - Biogas (gaseous biofuels)
 - Liquid biofuels
- 2. Bioenergy is produced from the combustion of biofuels and has many different uses (heat, electricity, transport).



- 1. Liquid biofuels:
 - Biogasoline and biodiesel
 - Conventional and advanced
 - Aviation fuel, others
- 2. Characteristics:
 - Made using thermal, chemical and biological processes
 - Used mainly for transport
 - Concerns about competition for feedstocks, energy efficiency and sustainability











Liquid biofuel production pathways

Bioenergy



Most liquid biofuels are made from food crops



- Some biofuels are produced using a lot of fossil fuels for:
 - fertiliser
 - harvesting
 - processing
 - transport
- 2. Land conversion is also an issue





- 1. Biogas:
 - Landfill gas
 - Sewage sludge gas
 - Other biogas from anaerobic digestion
 - Biogas from thermal processes
- 2. Characteristics:
 - Used for electricity, heat or upgrading to biomethane
 - Relatively cheap and scalable (off-grid)
 - Good environmental impact









- 1. Solid biofuels and renewable waste:
 - Biofuel crops
 - Waste materials
 - Processed solid biofuels (secondary energy products - charcoal, pellets)
- 2. Characteristics:
 - Used for electricity and heat
 - Relatively cheap and most common type of renewable energy
 - Some social, economic and environmental issues









Biomass waste materials are many and varied

Other renewable energy

- 1. Heat pumps:
 - Ground source
 - Water source
 - Air source



- 2. Characteristics:
 - Used for heat production or both heating and cooling.
 - High investment, but low running cost

Other types of renewable energy are also under development (e.g. renewable hydrogen)

Issues (boundaries, definitions, classification)

- 1. Increased detail (PV, wind, bioenergy, others)
- 2. Secondary products (bioenergy, energy from RE electricity)
- 3. New products (e.g. hydrogen, cooling), energy storage
- 4. Geothermal vs. heat-pumps
- 5. System boundaries and non-energy uses (biofuels, heat)