

2. Overview of renewable energy

IRENA Renewable Energy Statistics Training

What is renewable energy?

- **Renewable energy sources**
- **Renewable energy technologies**
 - Characteristics
 - Uses

What is renewable energy?

Energy that doesn't run out!

Energy that can be used without reducing its availability in the future.

- Natural forces (heat, radiation, motion)
- Chemical energy from biomass (biofuels)

Biomass is included because it can be replaced in a human time-frame.

What is renewable energy?

Scope of energy statistics

- Electricity
- Heat that is actively produced
- Materials used as fuel for energy production

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



Hydropower



Marine energy



Solar energy



Wind energy



Geothermal



Bioenergy

...and “other” renewable energy



Hydropower

Water drives turbines to make electricity. Two types:

- Run of river
- Storage (reservoir)

Characteristics:

- High investment, low cost
- Easy to control
- Social/environmental issues
- Can be used for storage





Marine energy

Energy from oceans (mechanical, thermal, chemical energy). Five main types:

- Tidal energy
- Ocean energy
- Wave energy
- Ocean Thermal Energy Conversion (OTEC)
- Salinity gradient power

Still largely at development stage, but with significant potential.



Marine energy

Tidal energy:

- Mechanical power used for electricity generation
- Used in locations with large tidal range
- Similar to hydropower, but more for baseload power

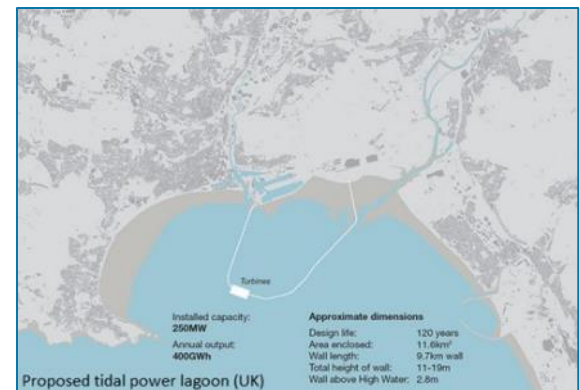
Some well-established facilities, other new ones being developed



Rance Tidal Power Station (240 MW), France



Rance Tidal Power Station (240 MW) France



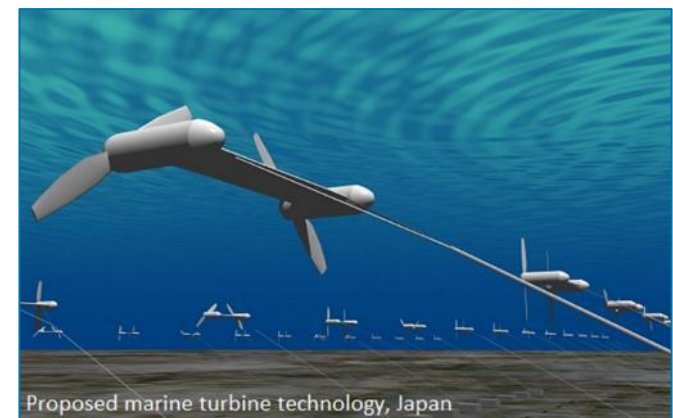
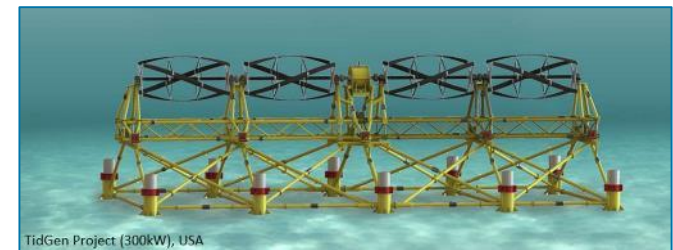


Marine energy

Ocean energy:

- Mechanical power used for electricity generation
- Turbines of many different designs
- Baseload power, without major construction of dams and barriers

Pilot-scale projects under development





Marine energy

Wave energy:

- Mechanical power used for electricity generation
- Many different designs, generally low impact
- Variable resource

Pilot-scale projects under development

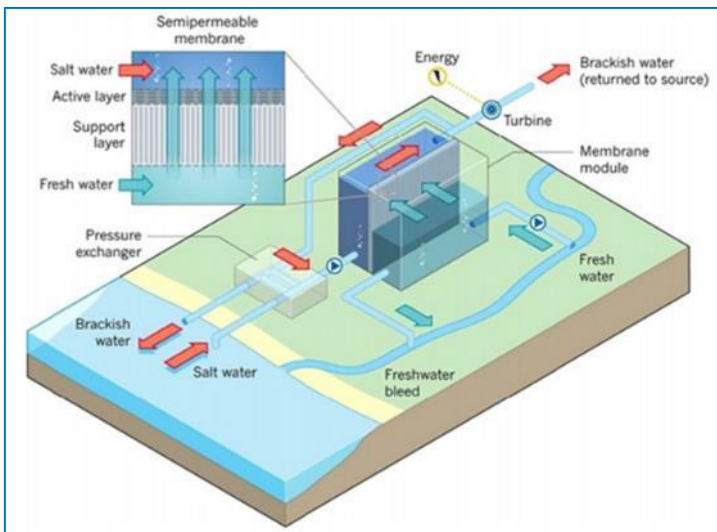
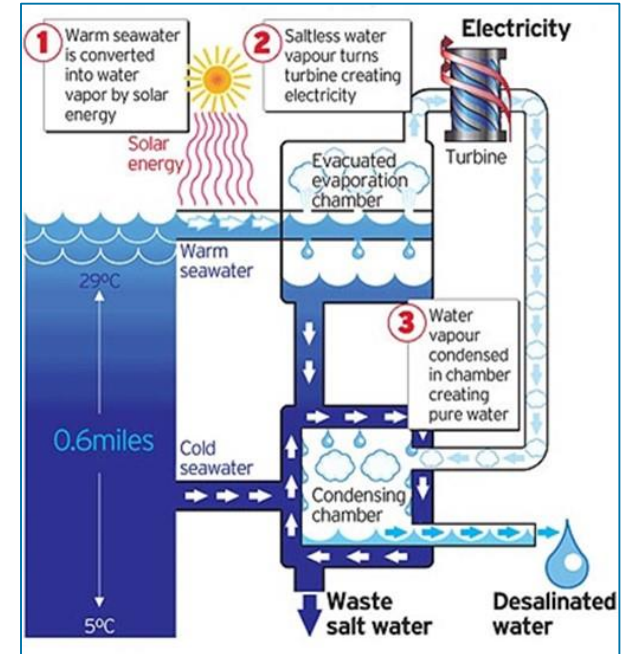




Marine energy

Ocean Thermal Energy Conversion (OTEC):

- Power generation from temperature difference between surface and deep ocean



Salinity gradient power:

- Power generation from difference in salinity between sea water and fresh water



Wind energy

Wind drives turbines to make electricity. Two types:

- Onshore
- Offshore

Characteristics:

- Low cost (onshore)
- Variable resource
- Some environmental issues
- Scalable





Solar energy

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

Third largest source of electricity from renewables and developing rapidly.



Solar energy

Solar photovoltaic (PV):

- Light converted directly into electricity
- Rapidly falling costs
- Variable but abundant resource, with few issues
- Scalable (good for off-grid)

Growing rapidly in many countries.





Solar energy

Concentrated Solar Power:

- Focused sunlight heats a fluid that drives a turbine
- Various designs
- Variable resource, but heat can be stored
- Large-scale, can produce electricity and heat

Growing in countries with good solar resource.





Solar energy

Other solar energy:

- Active heating, using collectors, fans and pumps
- Excludes passive heating
- Used for heat production
- Wide variety of devices
- Can be large (Concentrated Solar Thermal)

At present, most active solar systems are water heaters.





Geothermal energy

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
- Viable geothermal resources are quite limited





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

Bioenergy is produced from the combustion of biofuels and has many different uses (heat, electricity, transport).



Bioenergy

Liquid biofuels:

- Biogasoline and biodiesel
- Conventional and advanced
- Aviation fuel, others

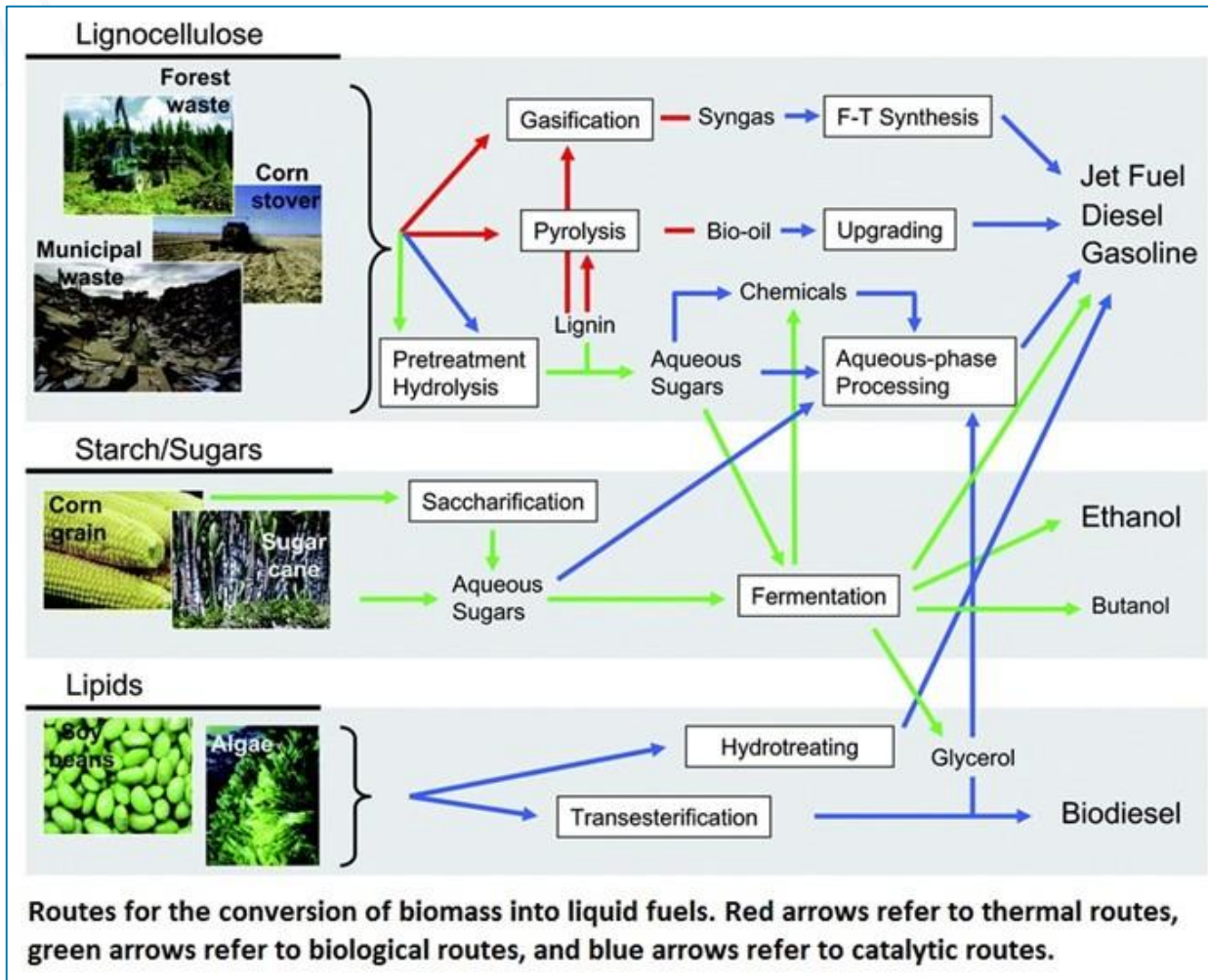
Characteristics:

- Made using thermal, chemical and biological processes
- Used mainly for transport
- Competition for feedstocks
- Energy efficiency



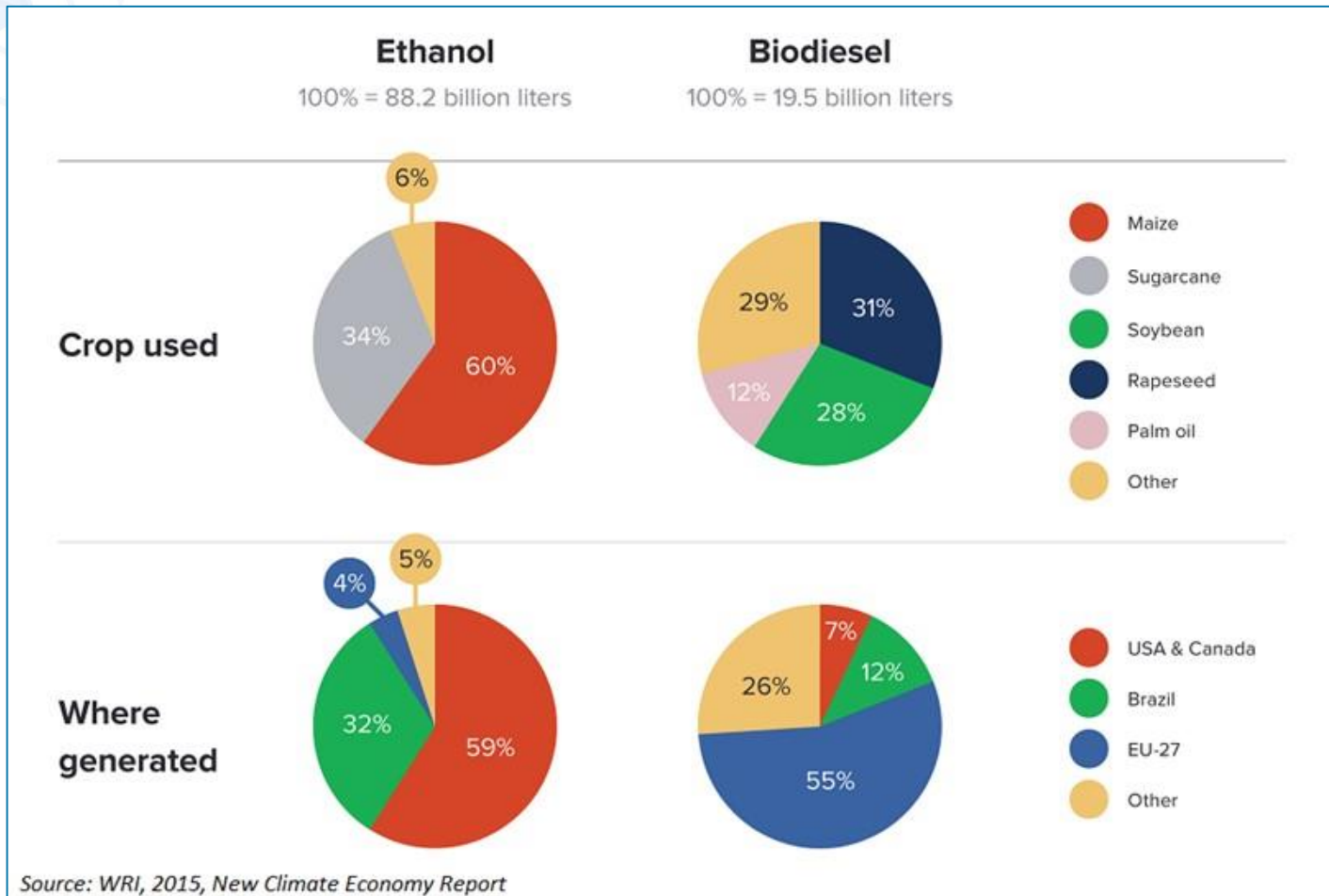


Bioenergy



Biofuel production pathways

Bioenergy



Most liquid biofuels are made from food crops

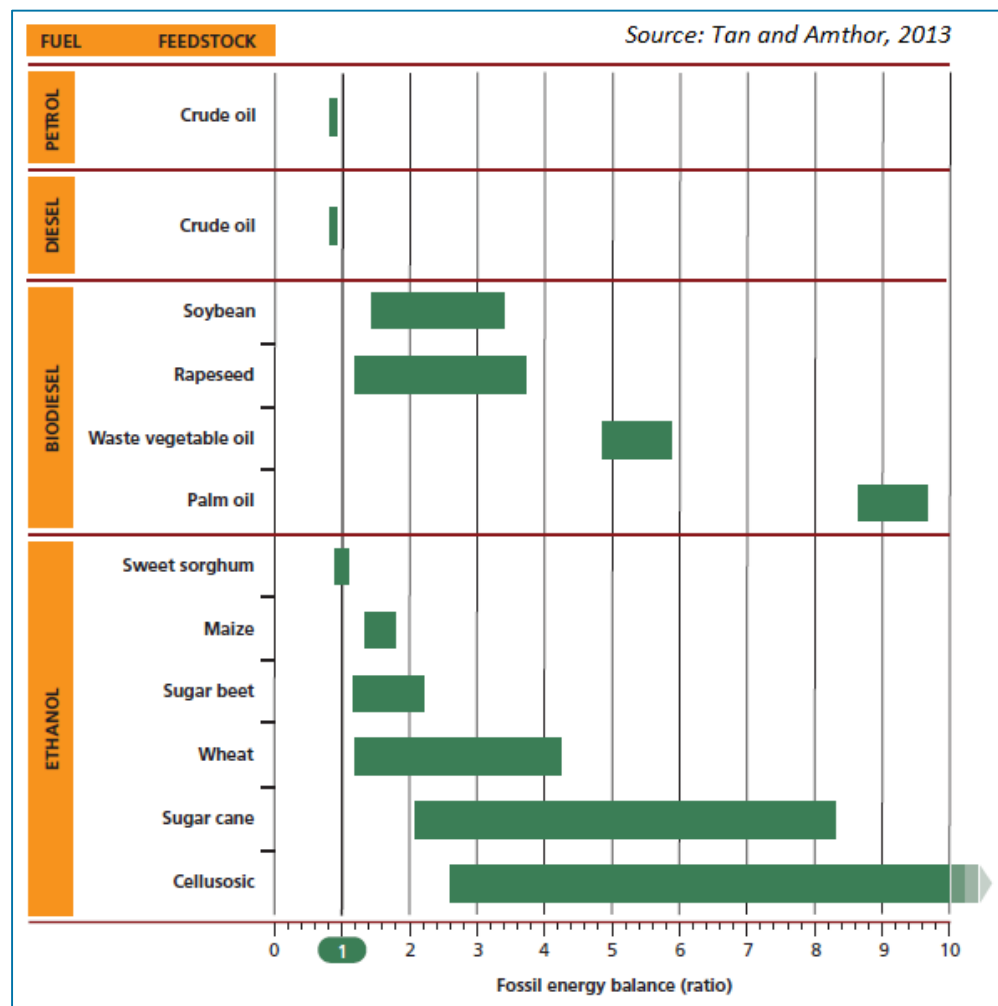


Bioenergy

Some biofuels are produced using a lot of fossil fuels for:

- *fertiliser*
- *harvesting*
- *processing*
- *transport*

Land conversion is also an issue





Bioenergy

Biogas:

- Landfill gas
- Sewage sludge gas
- Others from fermentation
- Gas from thermal processes

Characteristics:

- Used for electricity and heat
- Relatively cheap
- Good environmental impact
- Scalable (good for off-grid)





Bioenergy

Solid biofuels and renewable waste:

- Biofuel crops
- Waste materials
- Processed solid biofuels

Characteristics:

- Used for electricity and heat
- Relatively cheap and most common renewable energy
- Some social, economic and environmental issues





Bioenergy



Biomass waste materials are many and varied

Other renewable energy

Heat pumps:

- Ground source
- Water source
- Air source

Characteristics:

- Used for heat production or both heating and cooling. Works like an air conditioner.
- High investment, but low running cost

.....and hydrogen fuel cells (coming, maybe)





Questions?
Thank you!