

## 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

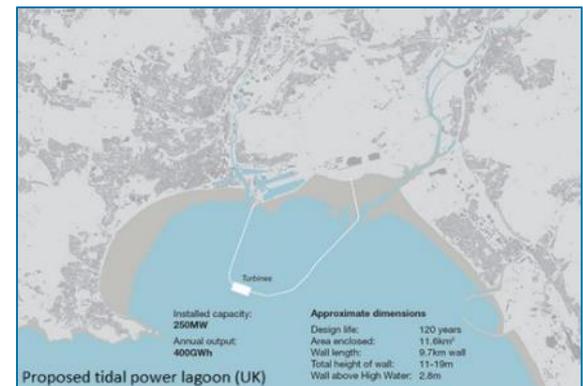
**Some well-established facilities, other new ones being developed**



Rance Tidal Power Station (240 MW), France



Rance Tidal Power Station (240 MW) France



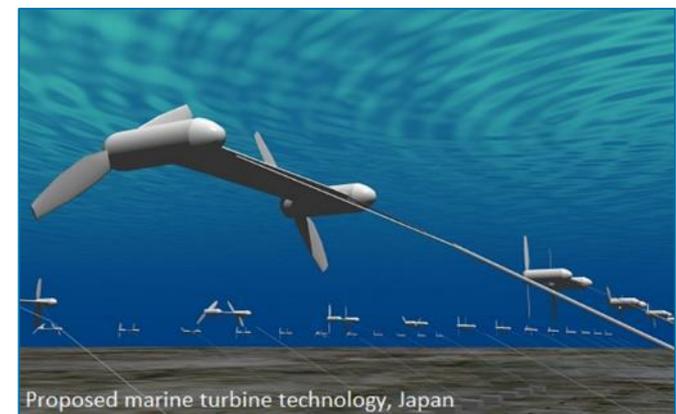
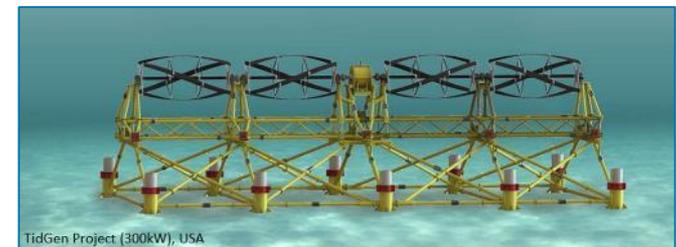


# Marine energy

## 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

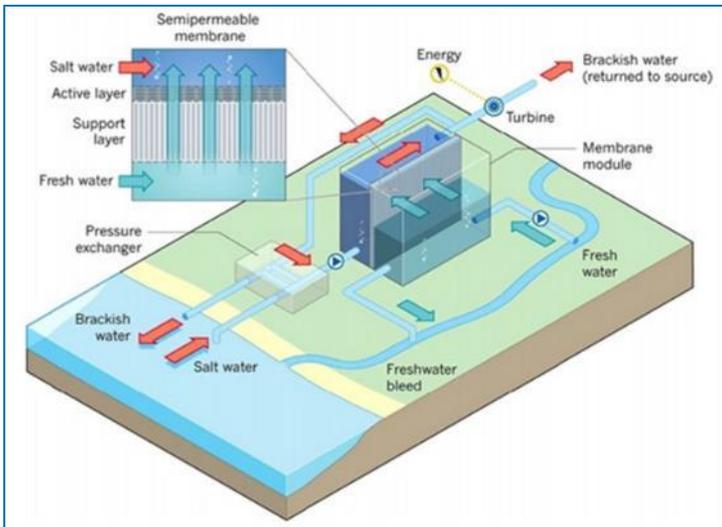
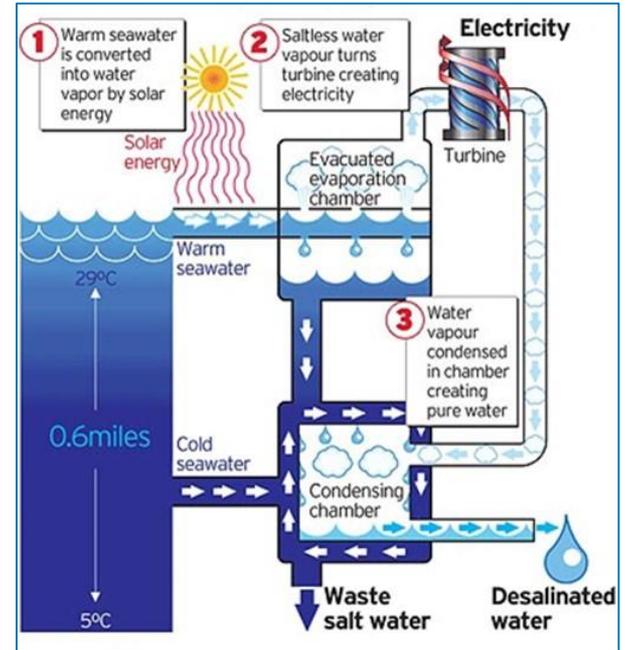




# Marine energy

## 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.**

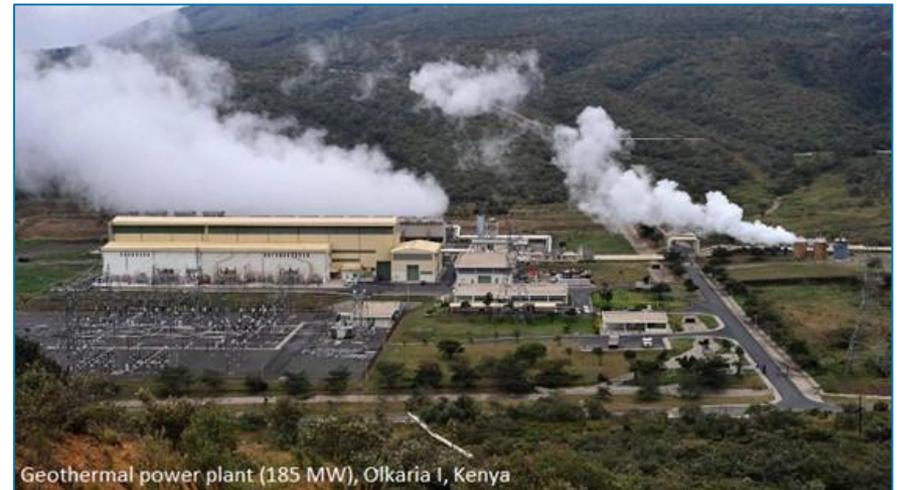




# Geothermal energy

## 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

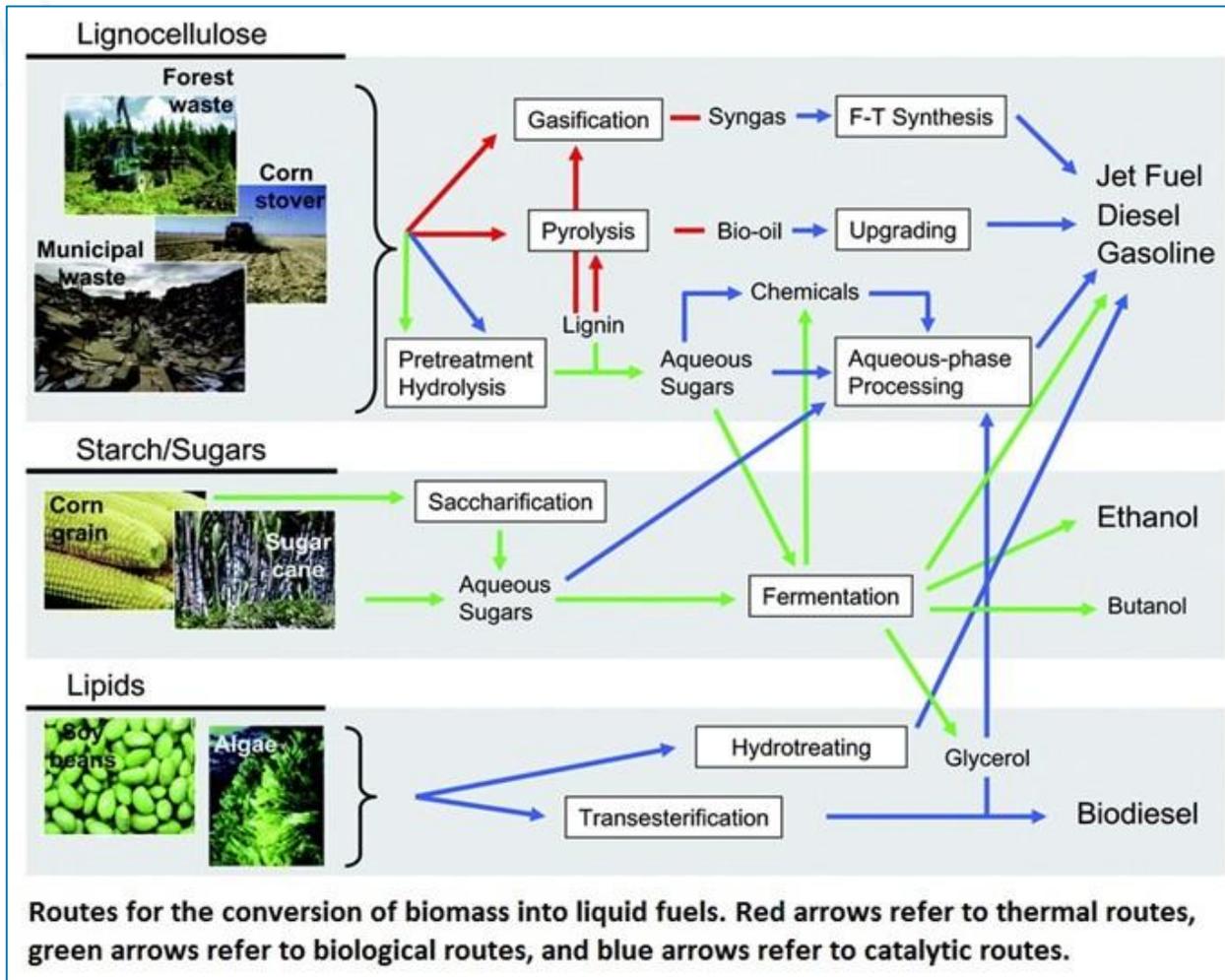
## Characteristics:

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



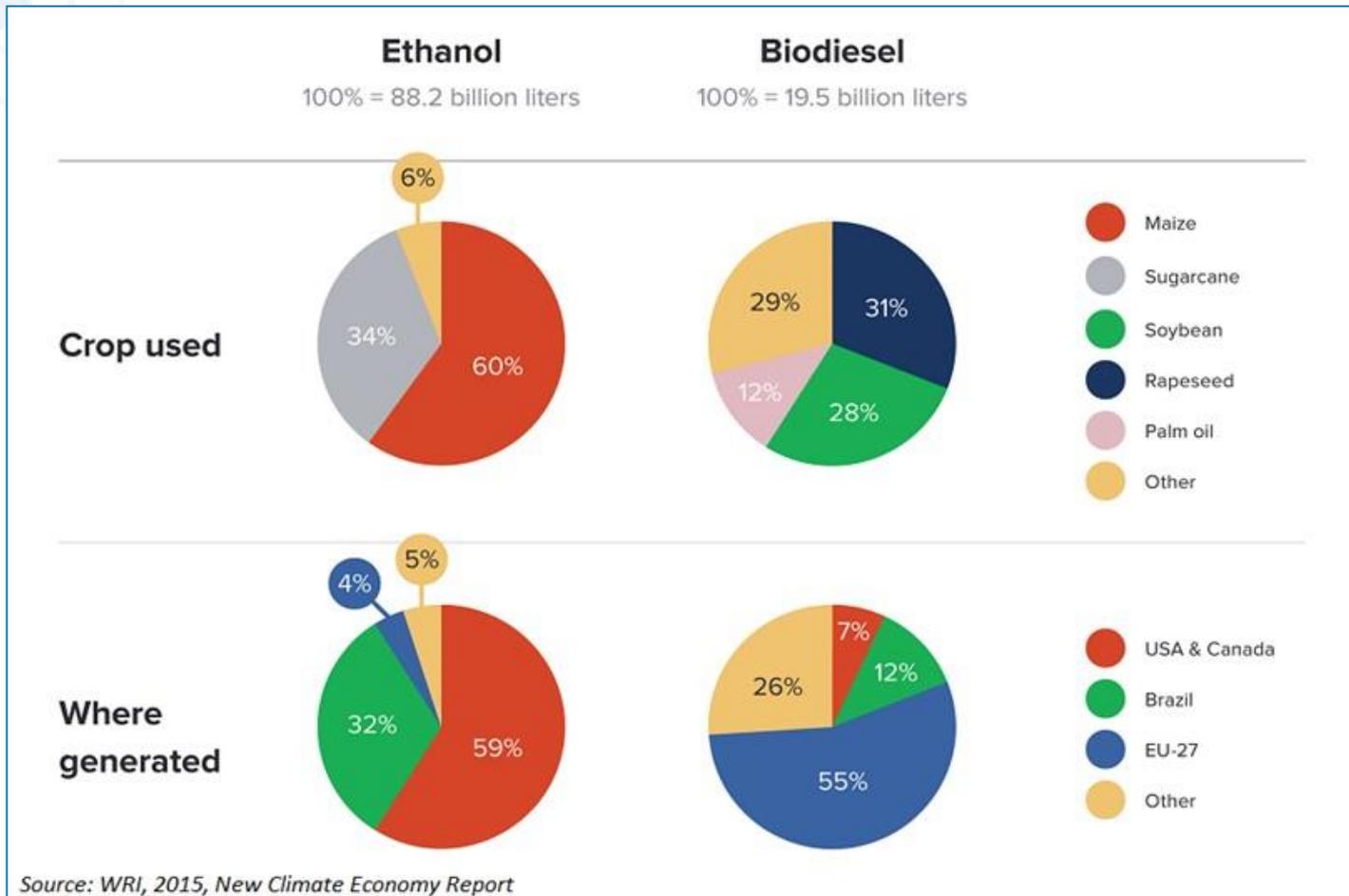


# Bioenergy



## *Biofuel production pathways*

# Bioenergy



*Most liquid biofuels are made from food crops*

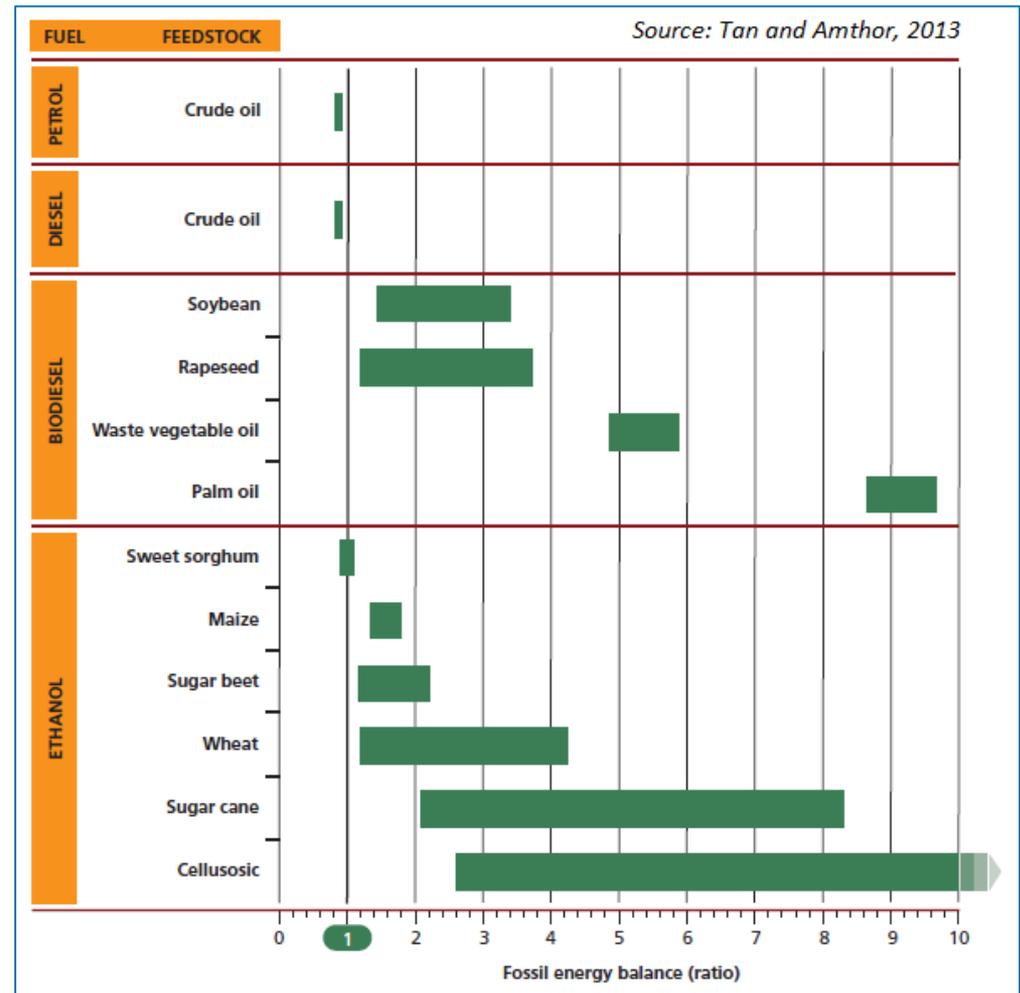


# Bioenergy

*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)***





# IRENA

International Renewable Energy Agency

**Questions?  
Thank you!**