Renewable Energy Sources

PhDr. Tomáš Vlček, Ph.D.

International Relations and Energy Security

Department of International Relations and European Studies

Faculty of Social Studies MU

Renewable Energy Sector

- The oldest energy sector on Earth

vs.

- New wave of development

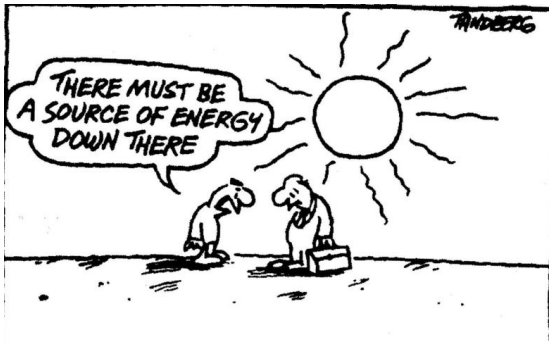
- New sector,

perhaps the most dynamic

Why?

Renewable Energy Development

- The sector responds to the global trend of combating climate change, protecting the environment, reducing greenhouse gas emissions and decrease imports of energy resources especially after 1989.
  - Rapid growth in consumption of energy resources
  - Interdependence in the relationship with foreign suppliers
  - Contradictory an effort to retain as much autonomy from foreign countries using nuclear power, domestic coal and, increasingly, renewable energy
  - First symptoms caused by lack of coal
  - Probable end of the hydrocarbon age in the 21 Century (exhaustion of coal, oil and natural gas)
  - Fighting the climate change
  - Emissions reduction efforts
  - UN and EU commitments to those organizations
  - The process of liberalization of the electricity market
  - Rising energy costs



What is it?

Natural energy that does not have a limited supply. Renewable energy can be used again and again, and will never run out.

Any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources.

Any naturally occurring, theoretically inexhaustible source of energy, as biomass, solar, wind, tidal, wave, and hydroelectric power, that is not derived from fossil or nuclear fuel.

Renewable energy is from an energy resource that is replaced by a natural process at a rate that is equal to or faster than the rate at which that resource is being consumed. Renewable energy is a subset of sustainable energy.

Renewable Energy Policies

- Two attitudes to REP:
- **Low-carbon economy**
  - a priori does not reject various fossil energy sources
  - the aim is to adapt the existing economy to low-carbon principle as much as possible, i.e. minimum production of CO2 as the main greenhouse gas
  - this approach does not exclude (on the contrary - supports) the use and development of nuclear energy as an emission-free source
  - renewables may have different meanings, but they are always more or less complementary to the primary sources
- **Environmental**
  - focuses on the word "renewable" and refuses basically any fossil fuel
  - the target is complete transition to renewable energy
  - there are currently many limits for complete transition to renewable energy, such as the condition of human knowledge and technology, technical aspects and financial costs

Incentives

- Approximately 20 percent of global electricity generation now comes from renewable energy sources
- Renewables accounted for over half of total net additions to electric generating capacity worldwide in 2012
- Almost 70 percent of new electric generating capacity in the European Union (EU) for 2012 came from renewables
- Solar photovoltaic (PV) electricity generation soared from 10 gigawatts (GW) in 2007 to over 100 GW in 2012

- This rapid increase in renewables is driven by a number of factors, including falling technology costs, rising fossil-fuel prices and carbon pricing. However, the main support for growth is **through government incentives**, which totaled USD 88 billion globally in 2011.

KPMG, 2013

Incentives

- Credits
- Grants
- Tax holidays
- Accelerated depreciation
- Non-tax incentives

- Carbon tax and pricing
- Cap and trade schemes
- Indirect taxes, such as energy taxes, excise taxes or value added taxes (VATs)

Top 5 countries

TOP FIVE COUNTRIES	1	2	3	4	5
Annual investment/additions/production in 2012					
New capacity investment	China	United States	Germany	Japan	Italy
Hydropower capacity	China	Turkey	Brazil/Vietnam	Russia	Canada
Solar PV capacity	Germany	Italy	China	United States	Japan
Wind power capacity	United States	China	Germany	India	United Kingdom
Solar water collector (heating) capacity[44]	China	Turkey	Germany	India	Brazil
Biodiesel production	United States	Argentina	Germany/Brazil	France	Indonesia
Ethanol production	United States	Brazil	China	Canada	France
Total capacity as of end-2012					
Renewable power (including hydro)	China	United States	Brazil	Canada	Germany
Renewable power (not including hydro)	China	Unites States	Germany	Spain	Italy
Renewable power per capita (not including hydro)[45]	Germany	Sweden	Spain	Italy	Canada
Bio-power	United States	Brazil	China	Germany	Sweden
Geothermal power	United States	Phillippines	Indonesia	Mexico	Italy
Hydropower	China	Brazil	United states	Canada	Russia
Concentrating solar thermal power (CSP)	Spain	United States	Algeria	Egypt/Morocco	Australia
Solar PV	Germany	Italy	United States	China	Japan
Solar PV per capita	Germany	Italy	Belgium	Czech Republic	Greece
Wind power	China	United States	Germany	Spain	India
Solar water collector (heating)[44]	China	Germany	Turkey	Brazil	India
Solar water collector (heating) per capita[44]	Cyprus	Israel	Austria	Barbados	Greece
Geothermal heat capacity	United States	China	Sweden	Germany	Japan
Geothermal direct heat use[46]	China	United States	Sweden	Turkey	Japan/Iceland

What sources of RES do you know?

What sources of RES do you know?

Solar Power

Solar Power

The Amount of Solar Energy in the Czech Republic which Stroke a Square Meter of Surface Bent at an Angle of 40° Southwards (Wh/m²/day)													
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Rok**
Praha	1228	2027	3034	4149	4846	4644	4930	4577	3475	2729	1140	833	3141
Brno	1247	2111	3163	4262	4953	4877	5211	4774	3679	2918	1309	872	3288
Plzeň	1238	2087	3036	4147	4755	4618	4975	4604	3587	2735	1182	828	3155
Ostrava	1321	2138	2990	3890	4689	4556	4916	4471	3370	2858	1372	976	3135
Břeclav	1343	2204	3315	4429	5046	5100	5411	4925	3990	2975	1441	935	3433
Aš	1255	2215	2941	4180	4662	4431	4837	4459	3544	2639	1327	840	3115
Ústí n. L.	1231	2080	2956	4063	4788	4507	4751	4405	3365	2677	1207	841	3078
Source: European Commission - Joint Research Centre, n.d.													

Solar Power

- An average daily amount of solar energy, for example, in Brno is 3,288 Wh/m^2, which is 3.288 kWh/m^2. The other limit of solar panels is their efficiency which currently reaches the values around 15 %. Therefore, a square meter of solar panels can, under ideal conditions and given efficiency, reach a yearly amount of approximately 180 kWh. Such a low capacity is enhanced by adding a surface of solar panels; a massive production of power production and its transmission to the electrical network in that manner, therefore, stipulated the emergence of so called solar parks, which are photovoltaic power plants with higher capacities (above 500 kWp).

3,288 Wh/m2/day = 137 Wh/m2/hour = 137 W/m2 * 0,15 = 20,55 W/m2 * 24 * 365 = 180018 Wh/m2/year = 180 kWh/m2/year

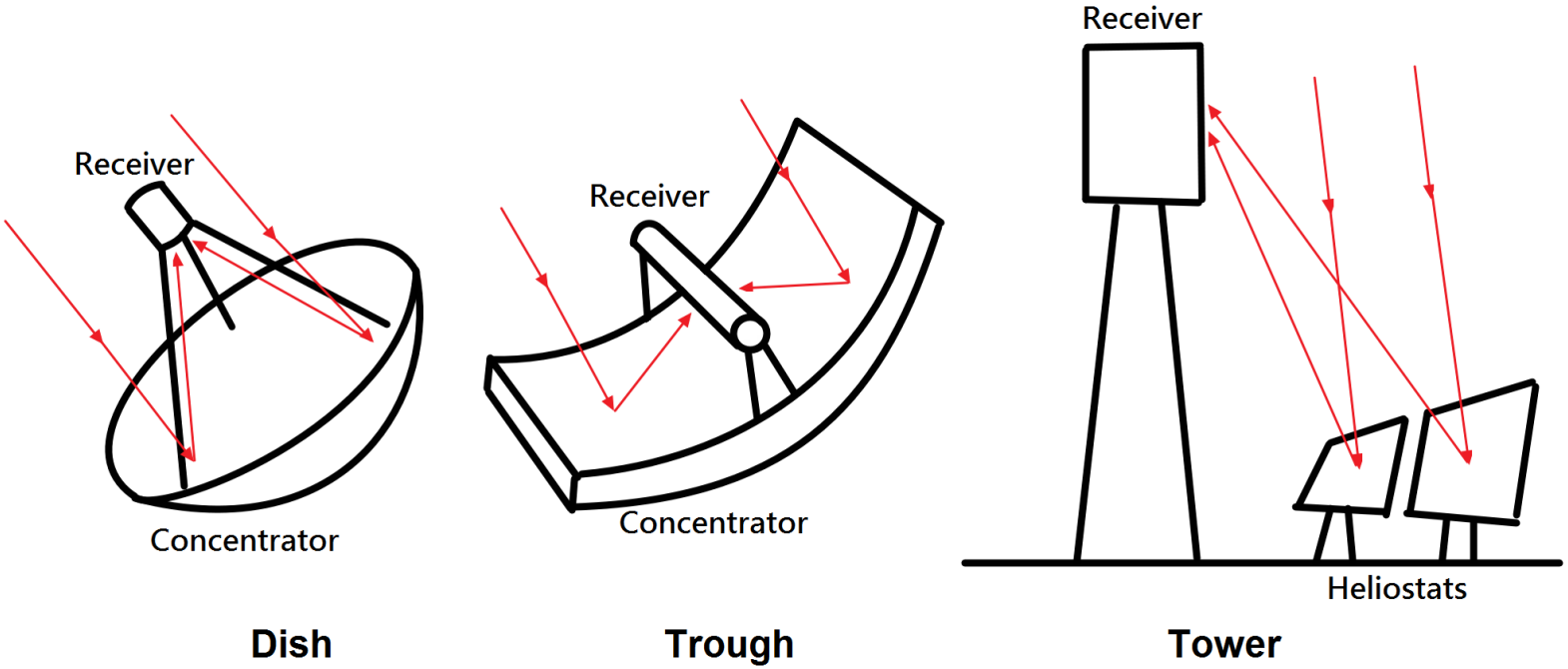
Yearly production of a square meter of solar panels is approximately **180 kWh**.

Solar Power

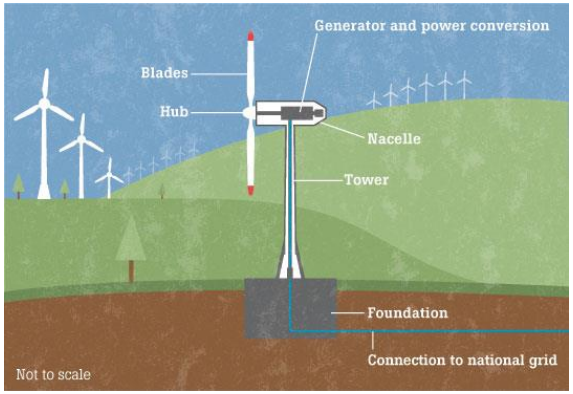
Solar Energy Tower

- Steam is heated to 500 °C to drive turbines that are coupled to generators which produce electricity

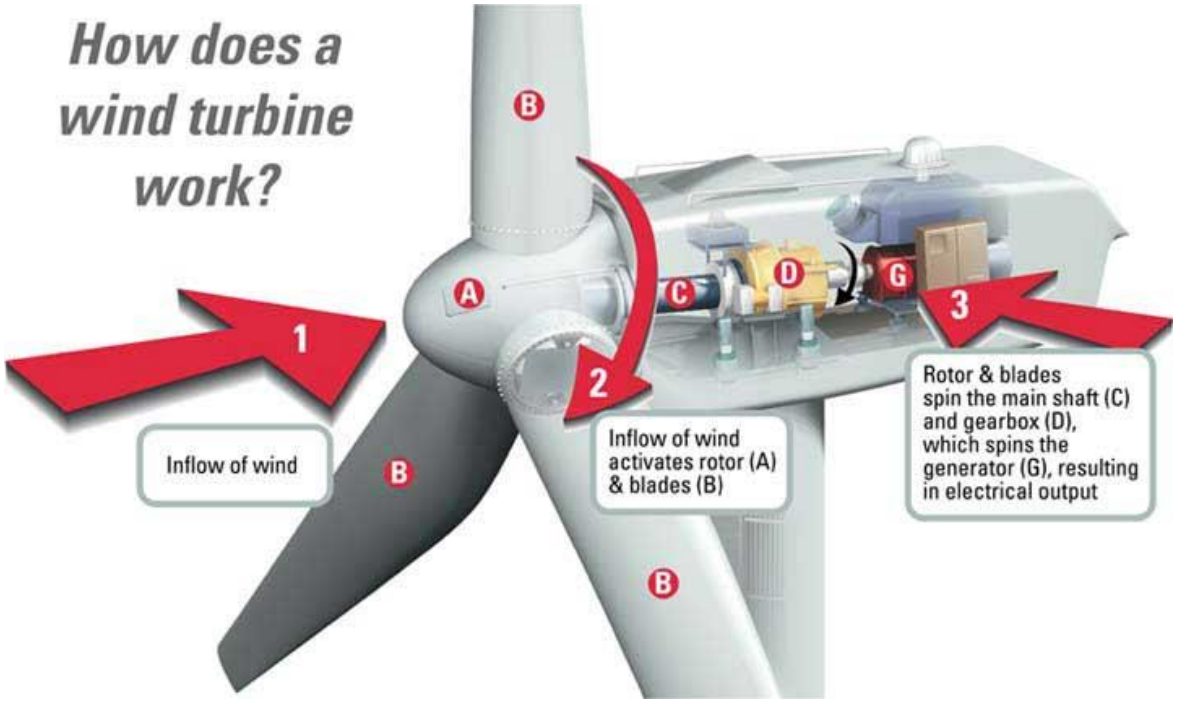
Solar Energy Tov



Wind Power



- produce electricity by utilizing the flux of air
- The flux of air spins propeller blades, which then spin an electrical power generator.
- Wind power plants for their operating require a region with an average speed of wind between 6 and 25 m/s.

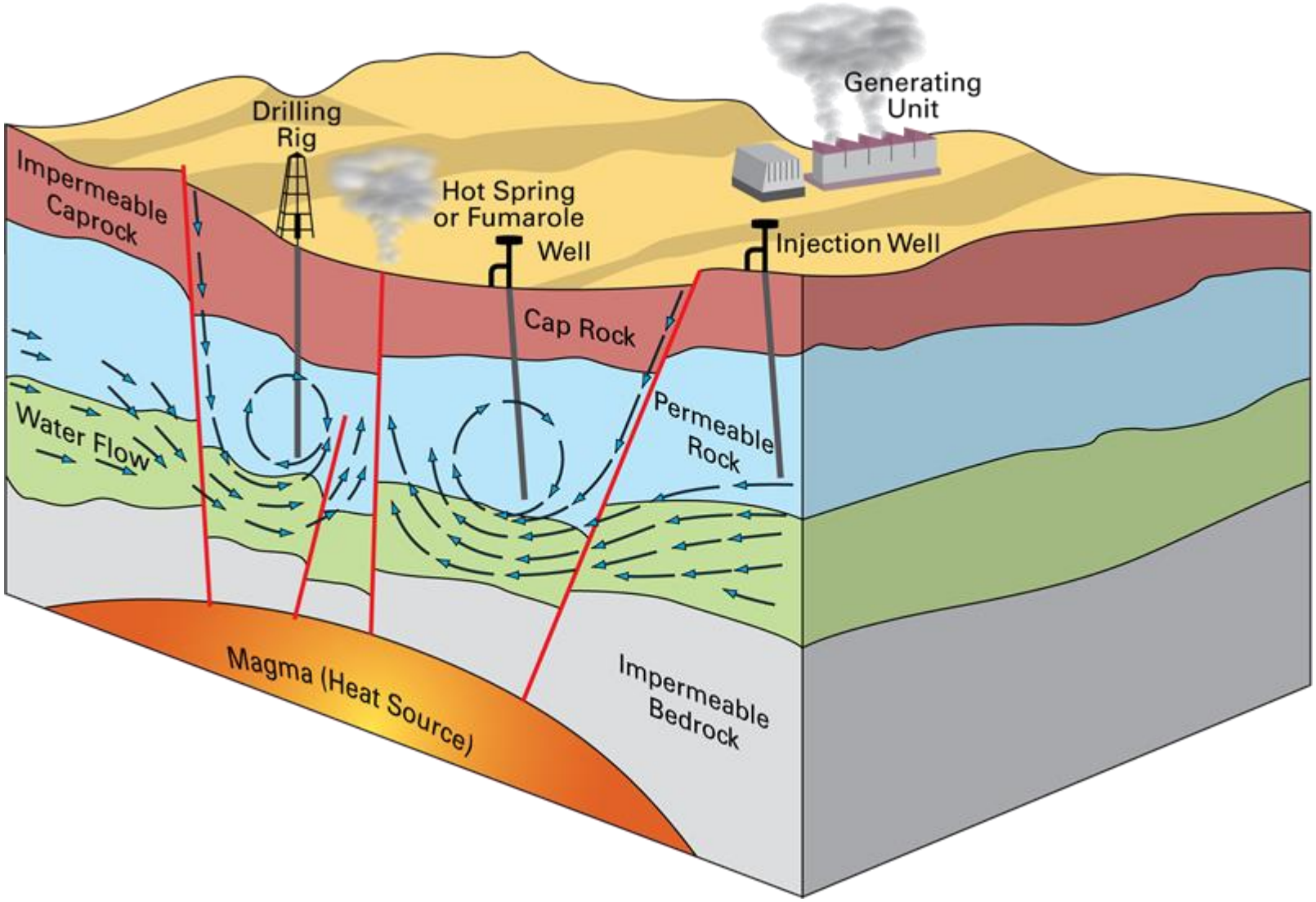


Wind Power

Wind Power

Wind Power

Geothermal Power

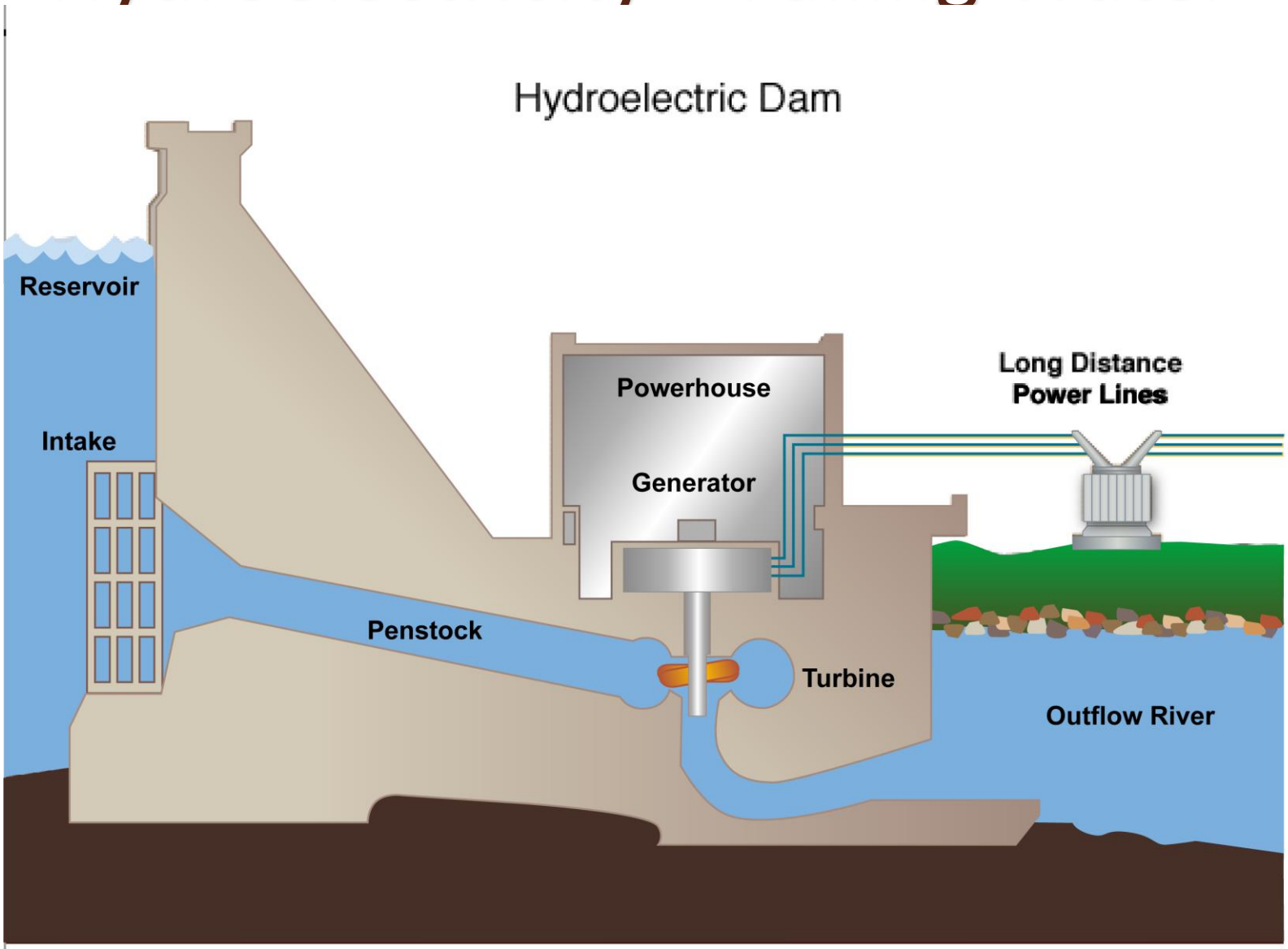


Geothermal Power

Hydroelectricity

- Hydroelectricity is electricity generated by hydropower, i.e., the production of power through use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy.
- Once a hydroelectric complex is constructed, the project produces no direct waste. Small scale hydro or micro-hydro power has been an increasingly popular alternative energy source, especially in remote areas where other power sources are not viable. Small scale hydro power systems can be installed in small rivers or streams with little or no discernible environmental effect or disruption to fish migration.
- Most small scale hydro power systems make no use of a dam or major water diversion, but rather use water wheels to generate energy. This was approximately 19% of the world's electricity (up from 16% in 2003), and accounted for over 63% of electricity from renewable sources.
- There are several types of hydroelectricity power production facilities:
  - Falling Water
  - Flowing Water
  - Pumping Storage Systems
  - Tidal Energy Systems
  - Wave Energy Systems

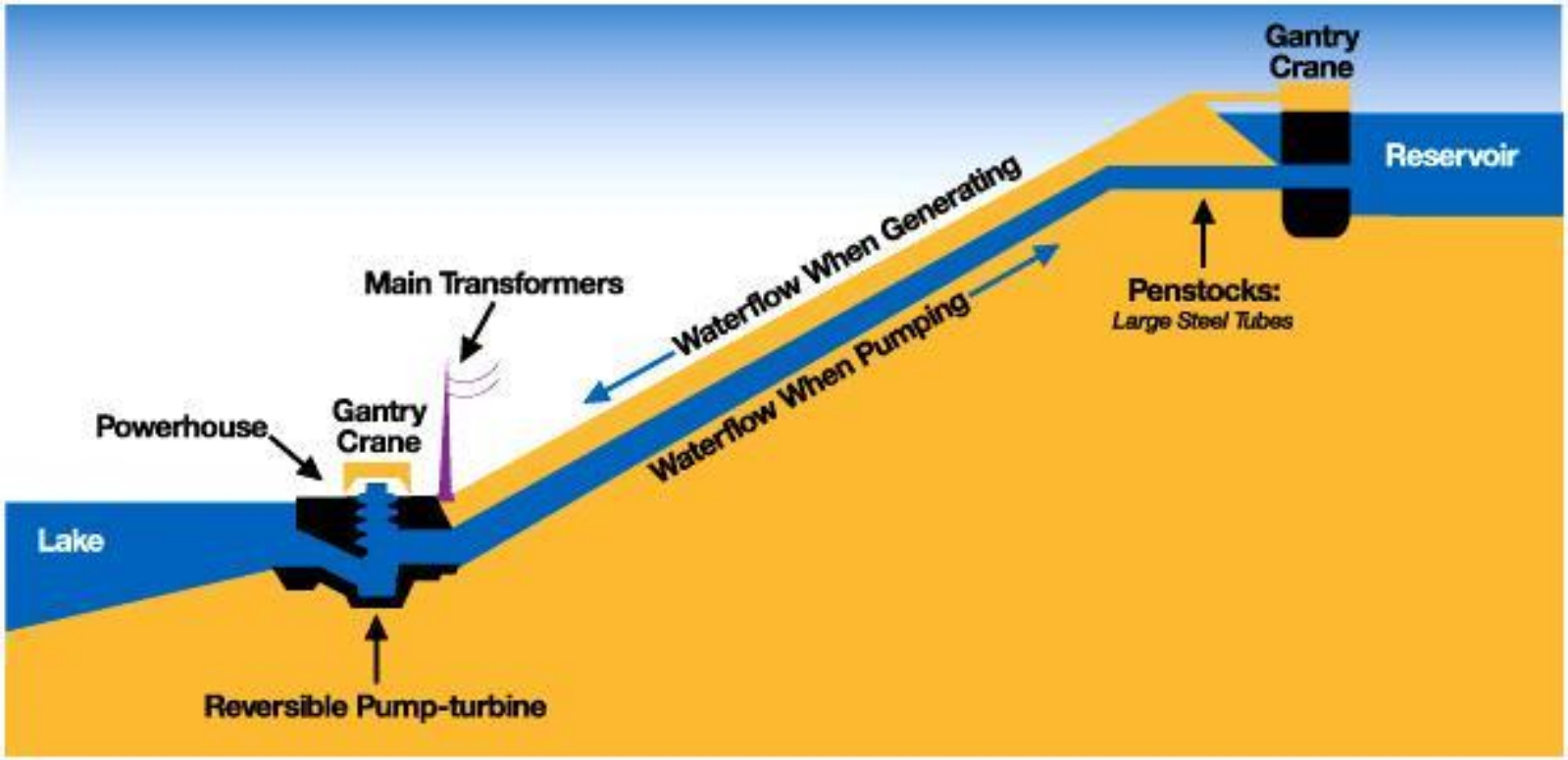
Hydroelectricity – Falling Water



Hydroelectricity – Falling Water

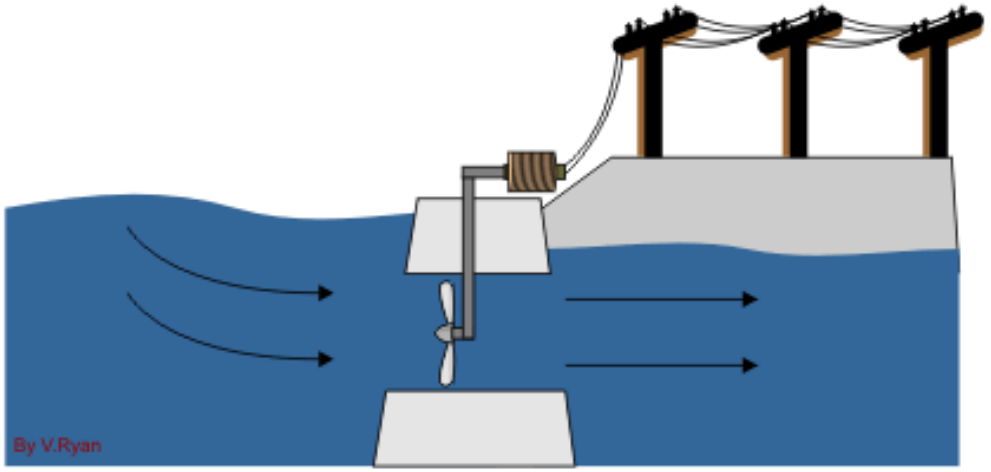
Hydroelectricity – Flowing Water

Pumping Storage System



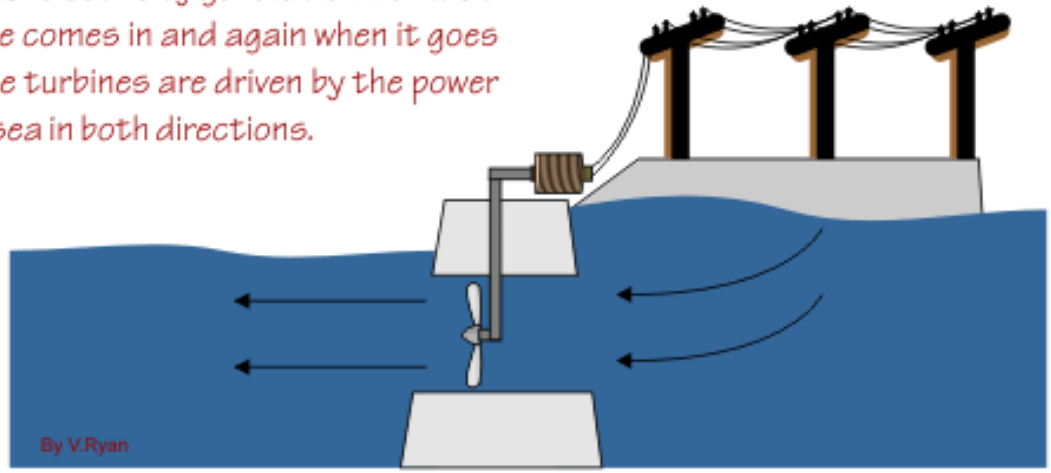
Pumping Storage System

Tidal Energy System



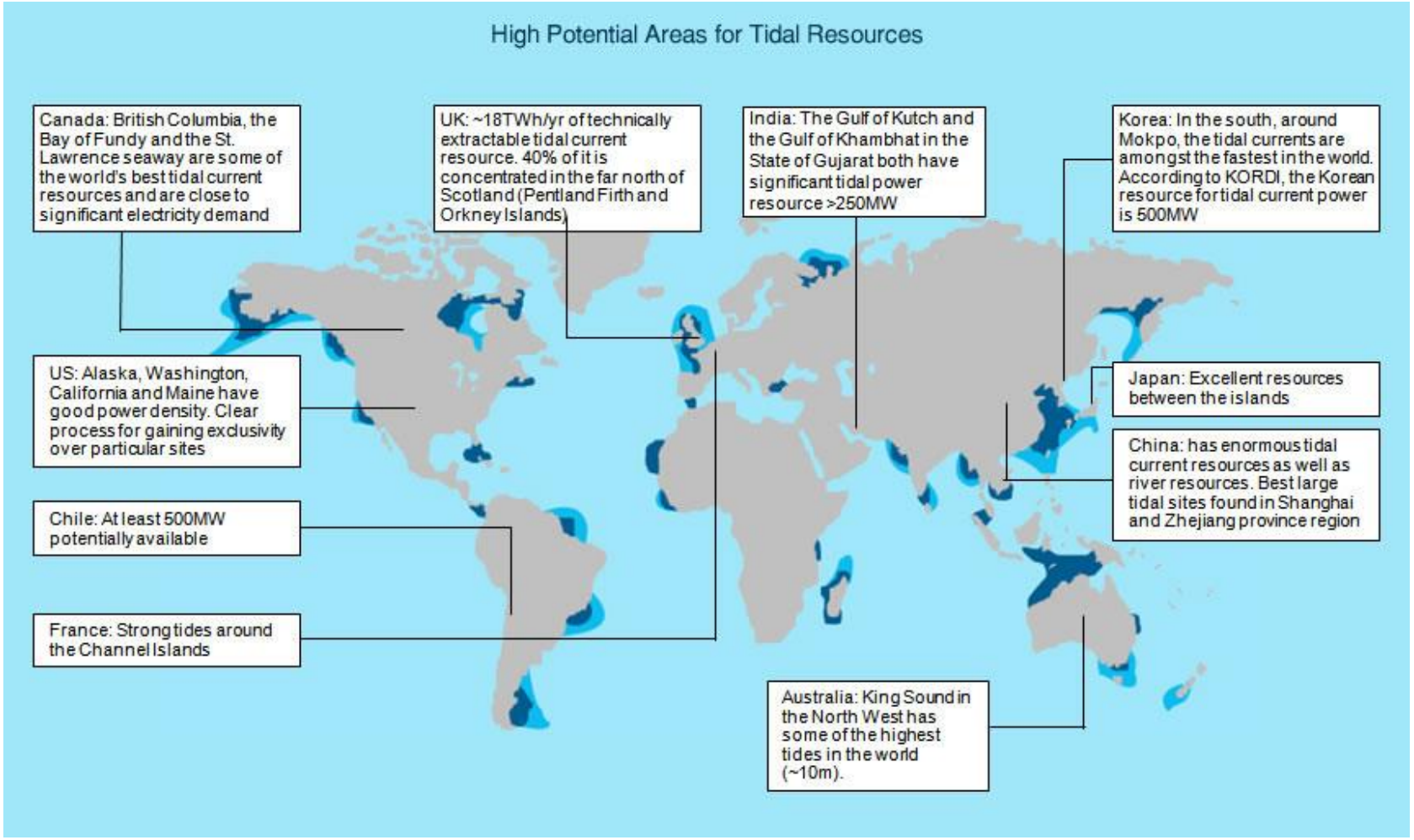
TIDE COMING IN

This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.



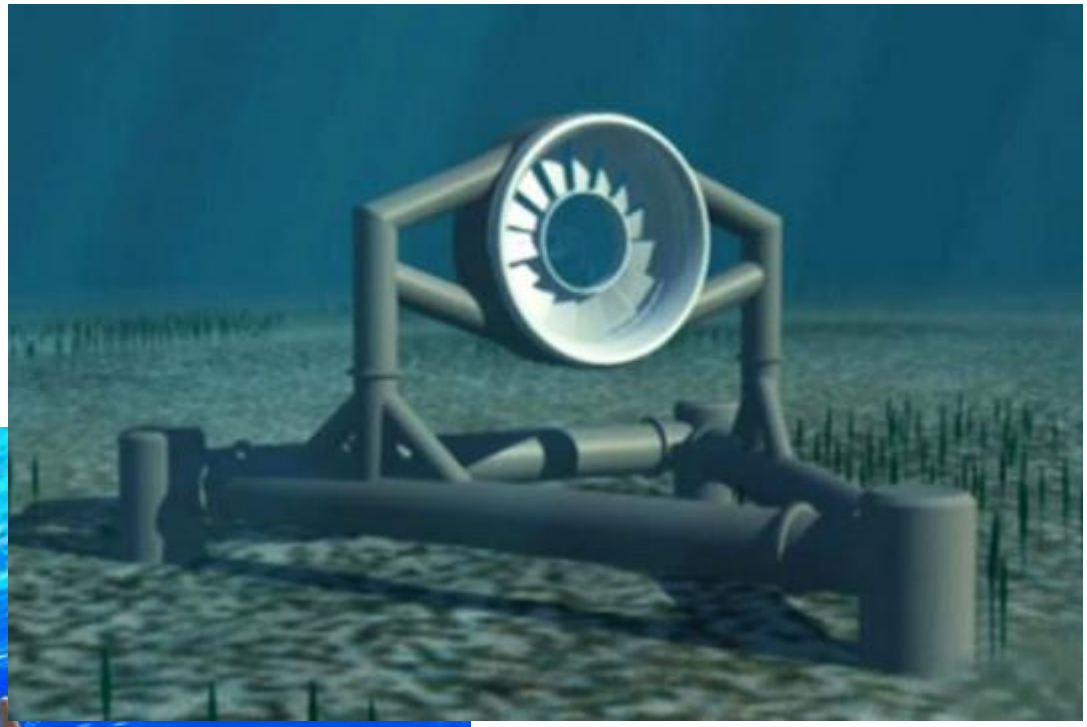
TIDE GOING OUT

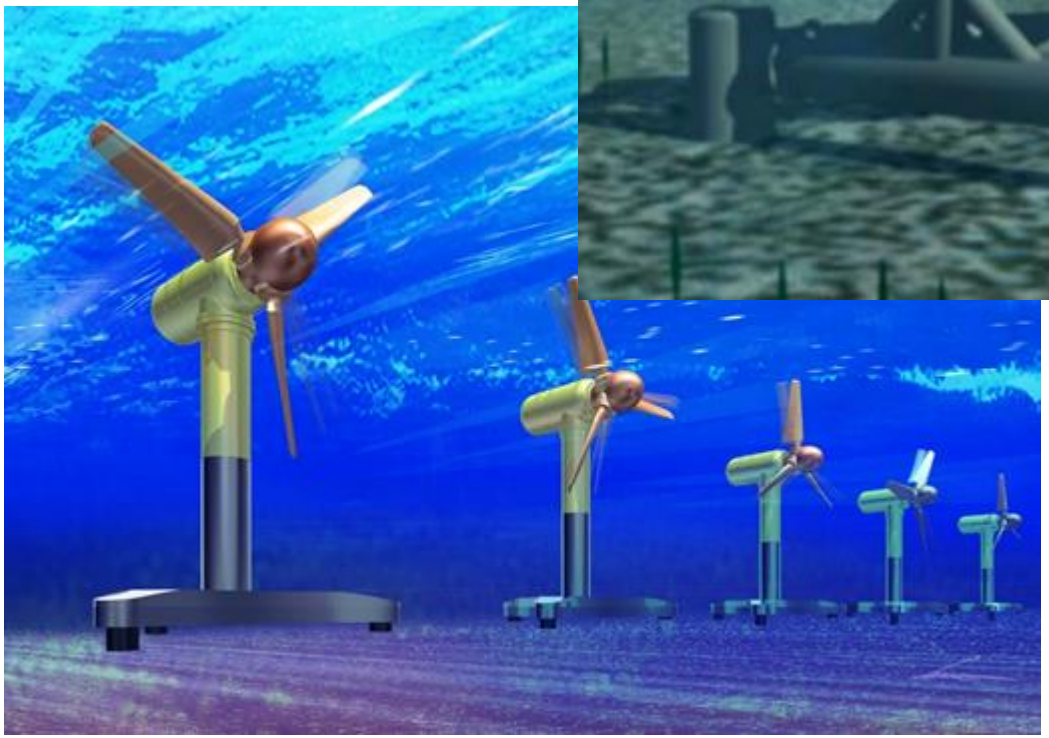
Tidal Energy System



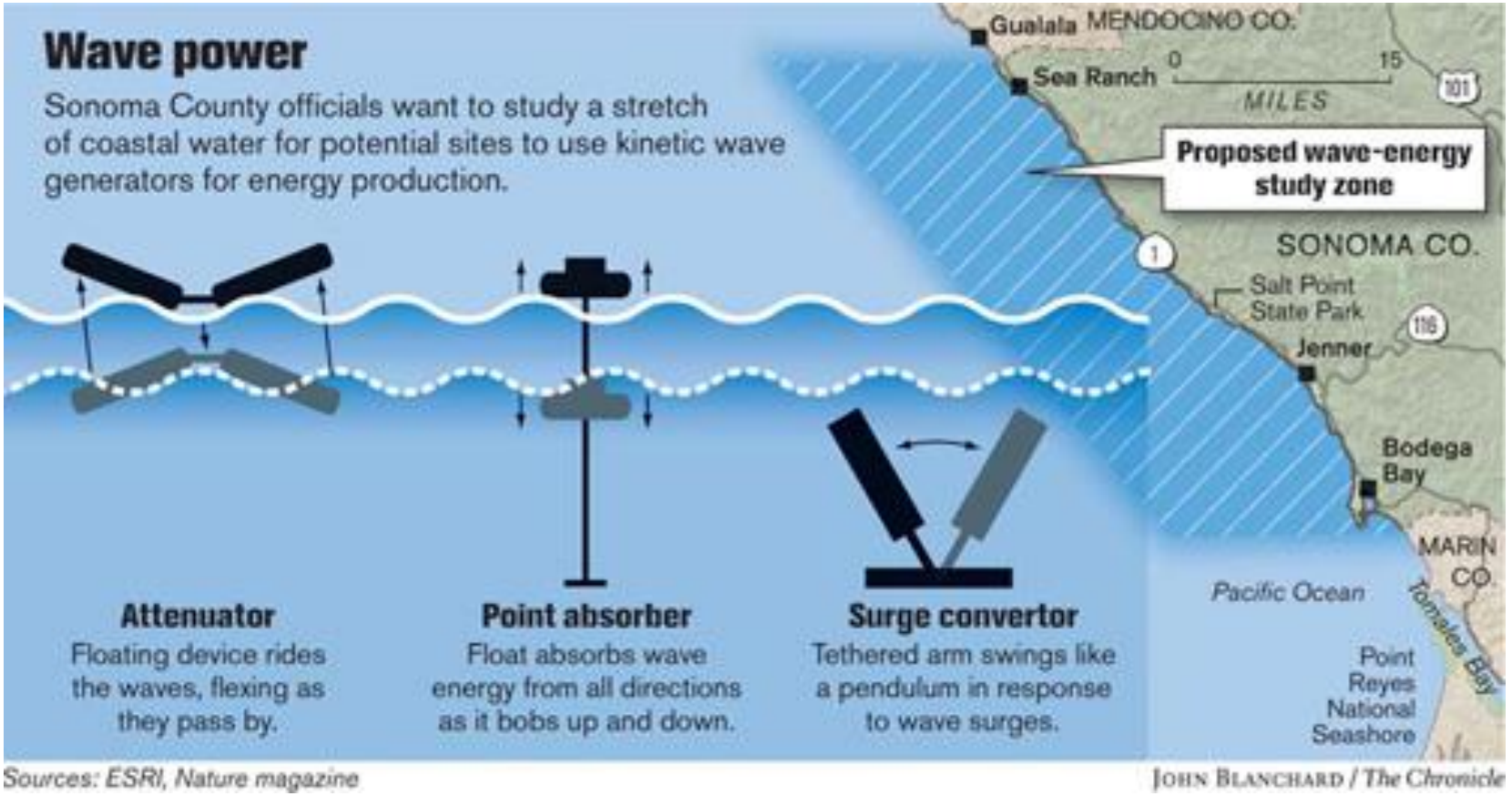
Tidal Energy System

Tidal Energy System

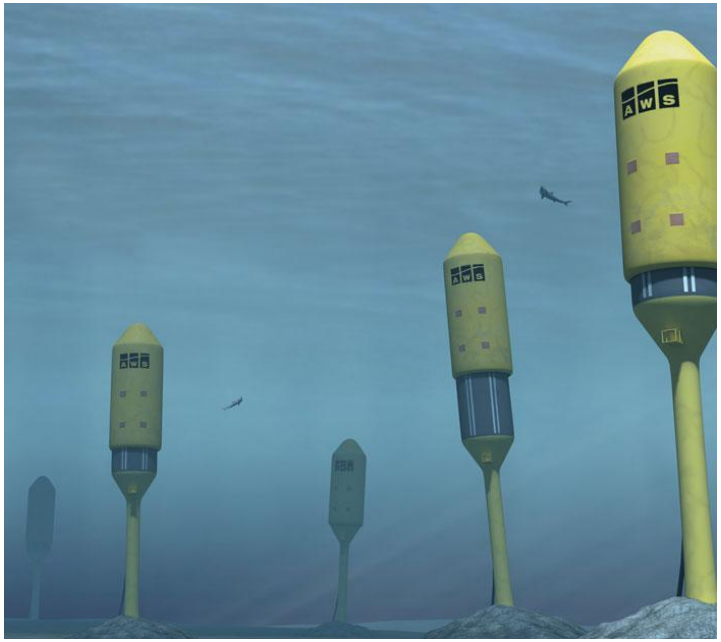


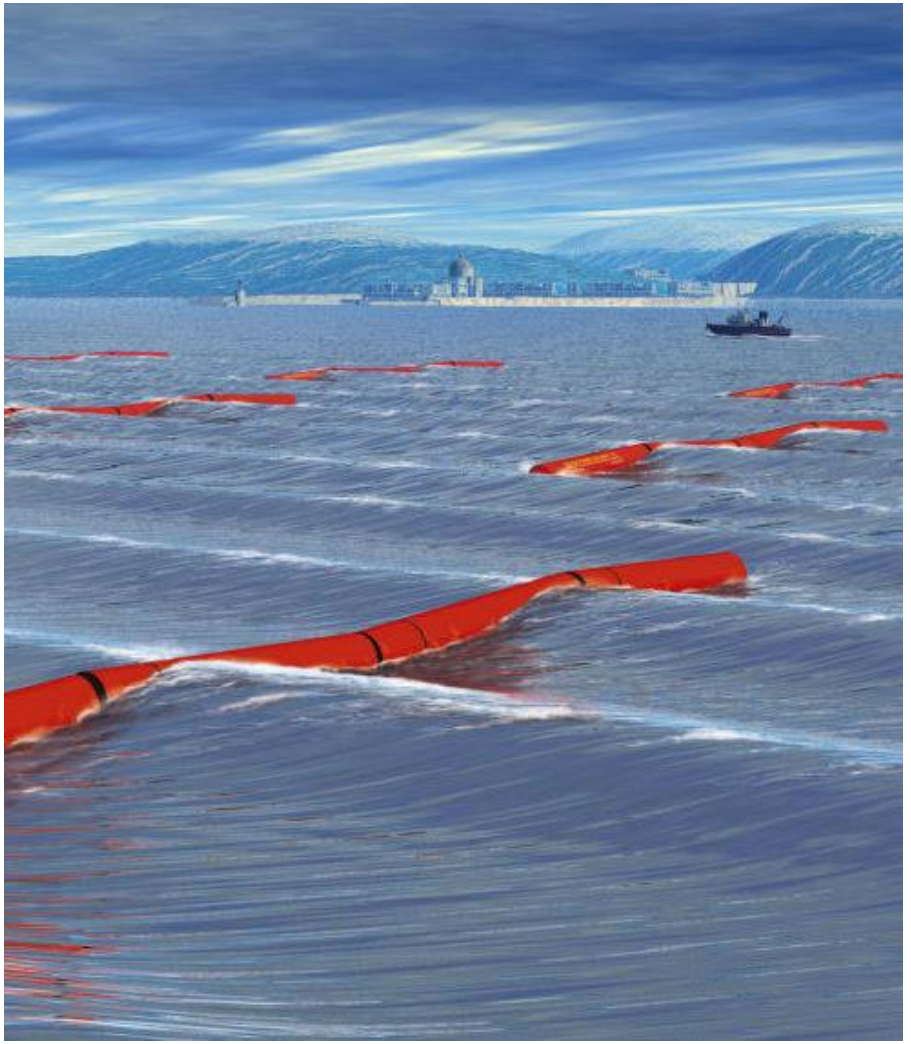


Wave Energy Systems



Wave Energy Systems





Biomass

Biomass

Biomass

- Developed countries: a renewable source of energy, neutral emissions
- Developing countries: the source of 90% of the daily energy consumption for 2.5 billion people

- Fuel and energy:
- Incineration - direct, indirect (biogas), indirect parallel (steam)
- The thermal decomposition (pyrolysis) - solid and liquid fuels (charcoal, pyrolysis oil, 16 MJ / kg)
- Gasification - oxidation at high temperatures, 5-20 MJ / m3
- Esterification, hydrogenation
- Biochemical transformation - fermentation, digestion (biogas, 18-29 MJ / m3)

Biofuels

- Generation I
  - Ethanol – easier combustion but lowe calorific value (by 25-30 %)
- Generation II
  - Fast growing trees
  - plants that can be grown more than once in one place
- Generation III
  - Marine plants: algae - 80% lipids
  - yield up to 30% greater than in oilseed

	GJ/ha
Barley	34 – 50
Wheat	59 – 67
Corn	63 – 71
Sugar beet	138 – 146
Sugarcane	147 - 167