

13. Hydropower II



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Lecture 13

Water power 1: Hydroelectric power

- The power of flowing water has been used for hundreds of years to operate **machinery**.
- This power can also be used to generate **electricity**.



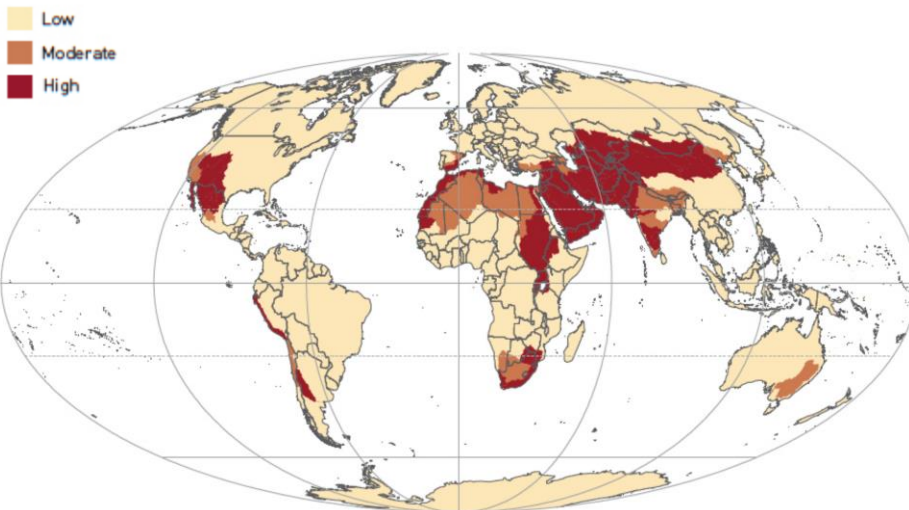
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Condition of water resource in world



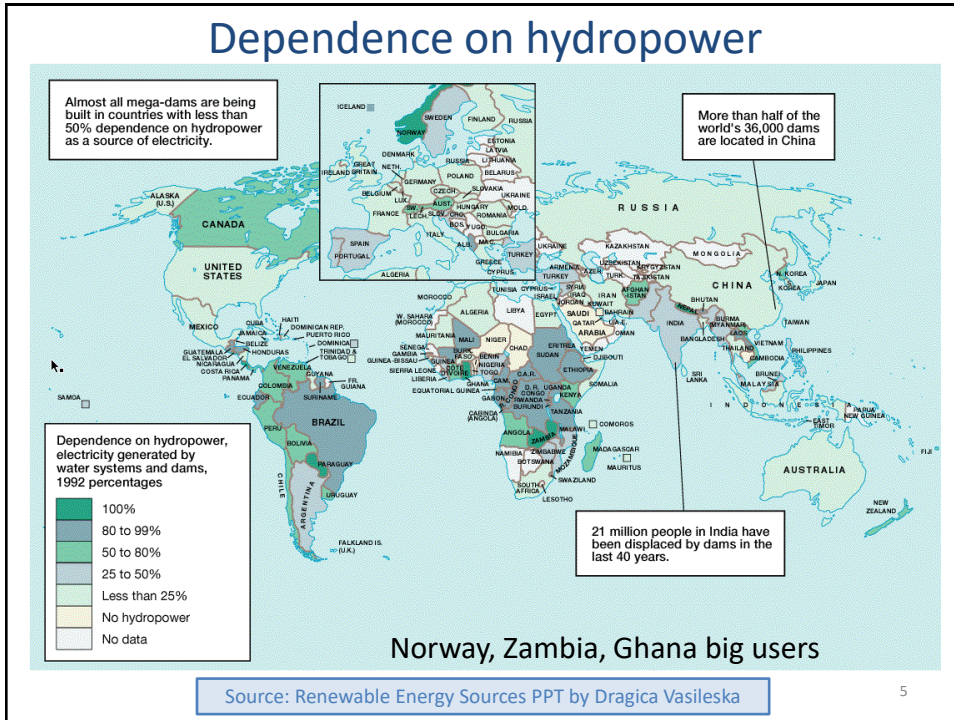
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Global distribution of physical water scarcity

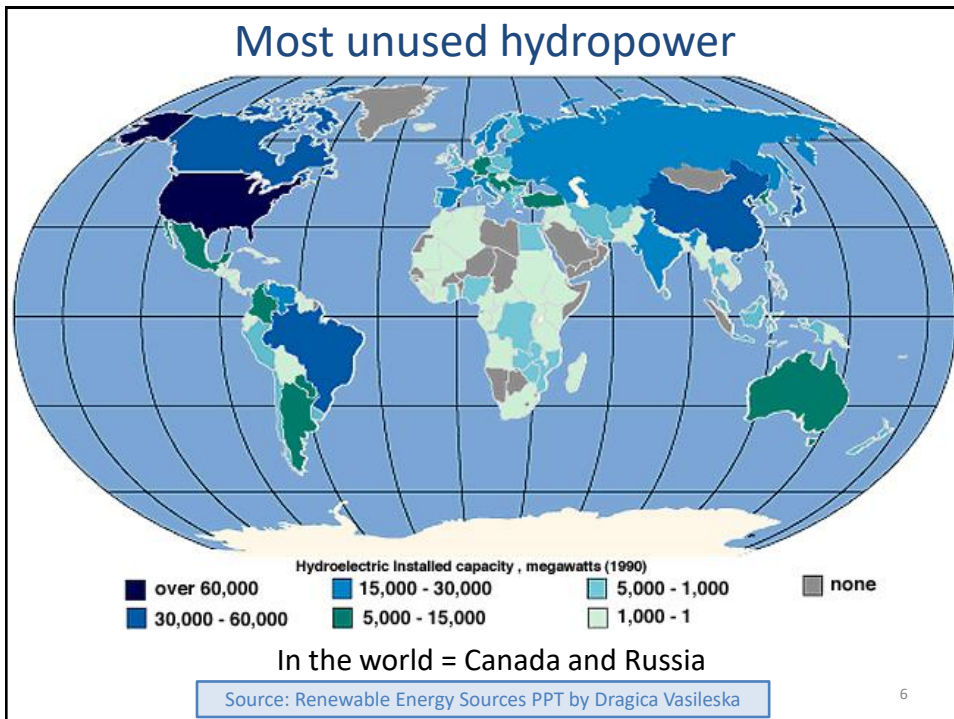


<http://www.fao.org/3/a-i1688e.pdf>

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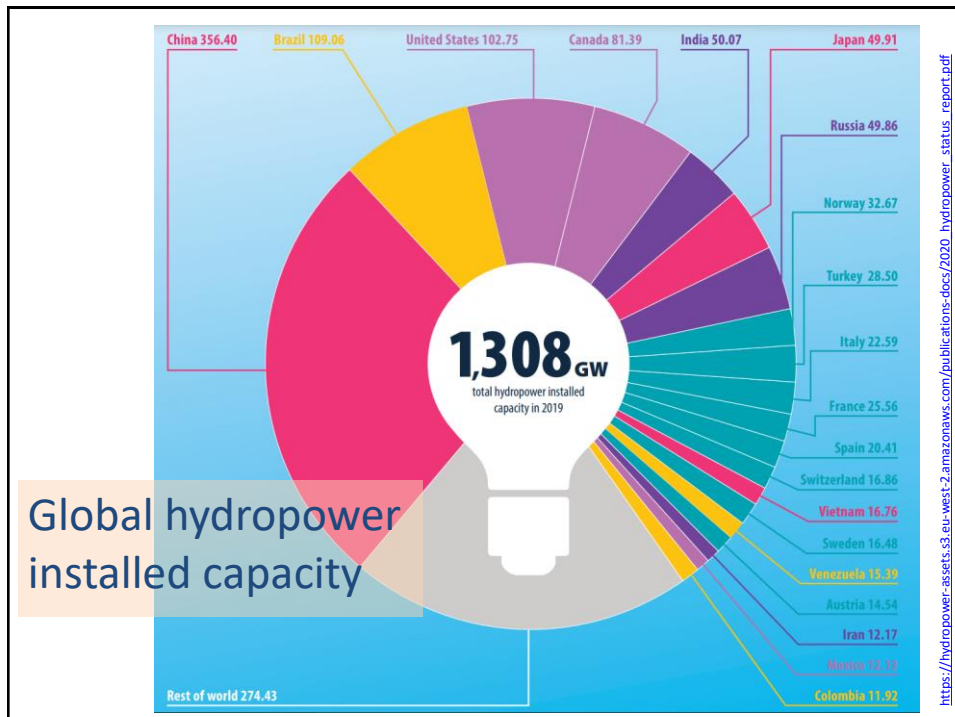


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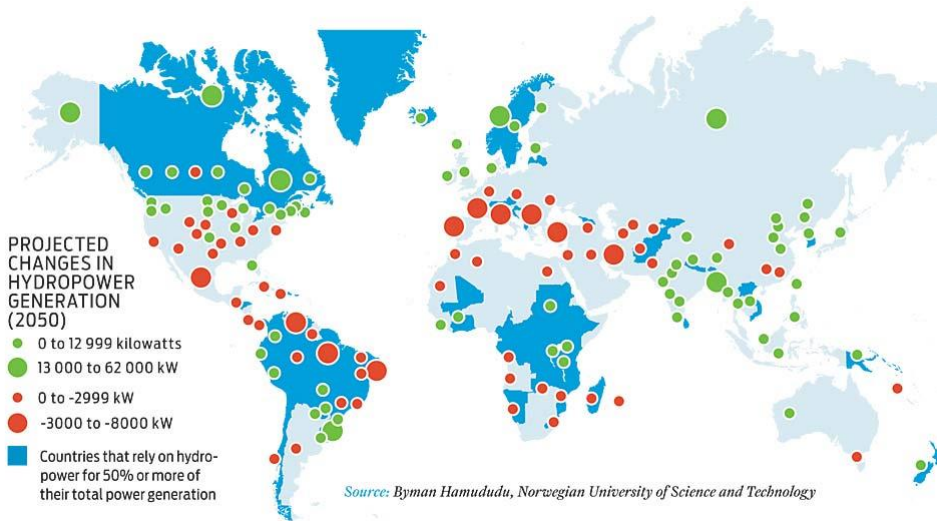
Hydropower generation and growth

- Total global hydropower installed capacity reached **1,308** gigawatts (GW) in 2019
- Worldwide, global hydropower capacity would need to increase by **25%** by **2030**, and by **60%** by **2050**
- This equates to around **850** GW in additional installed capacity over the next **30** years
- If **hydropower** was replaced with burning **coal** for electricity generation, analysis by IHA suggests that **4** billion metric tons of additional greenhouse gases would be emitted annually, and global emissions from fossil fuels and industry would be around **10%** higher
- Pumped storage hydropower is the world's water **battery**

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Projected hydropower generation in 2050



<https://spectrum.ieee.org/energy/renewables/future-of-hydropower>

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Hydroelectric power



- Large scale hydroelectric schemes involve building a dam across the end of a river valley to create a reservoir. This is done high up in a **mountainous** area.
- Hydroelectric power stations are able to start up **electricity** production quickly.
- Hydroelectric power is also very **reliable**.

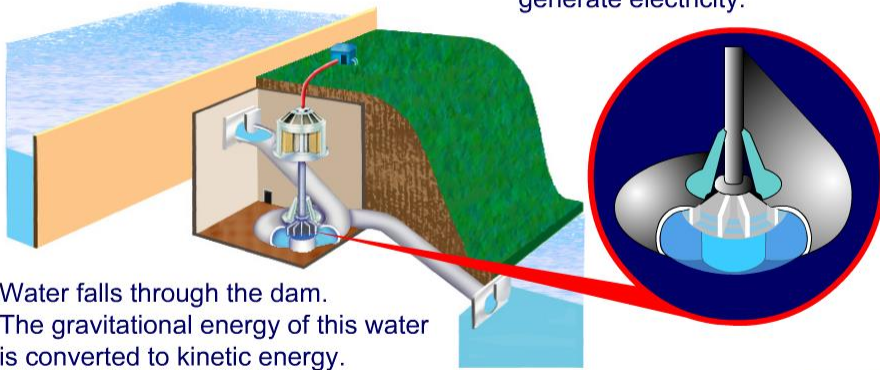
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Hydroelectric power station

A dam is built across a valley, causing it to flood.

The kinetic energy of the water is used to turn a turbine and generate electricity.

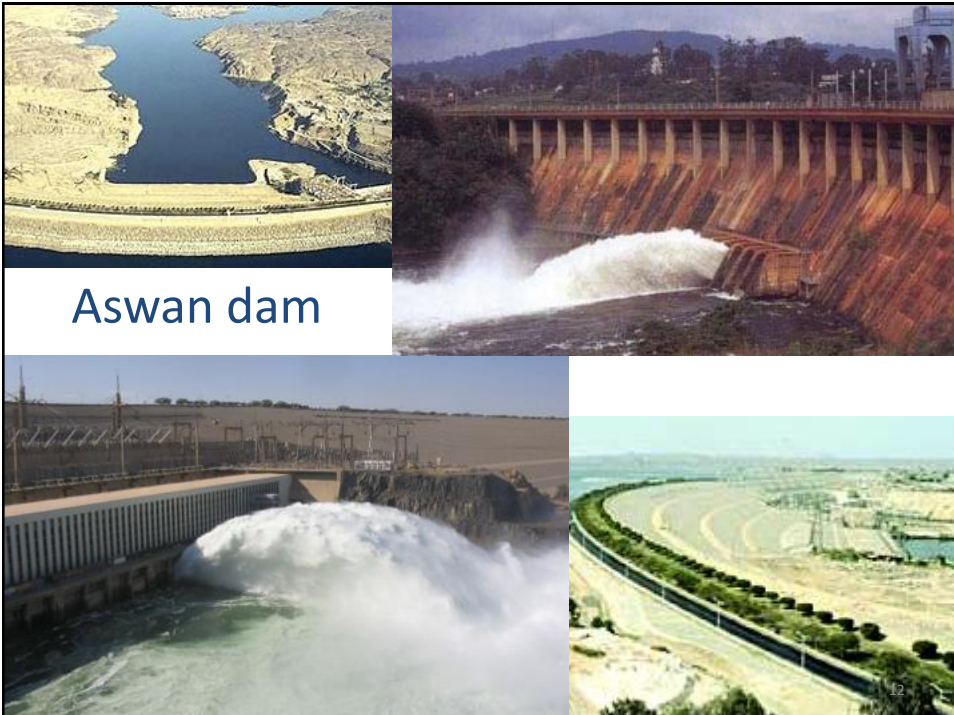


Water falls through the dam.
The gravitational energy of this water is converted to kinetic energy.



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Aswan dam

Aswan High dam in Egypt

- The **3rd** largest dam in the world at that time
- Power generation began in **1971** to supply electricity
- The dam powers **12** turbines that can generate **10** billion kilowatt-hours annually
- When the dam first reached peak output it produced around **half of Egypt's** entire electricity production
- The reservoir has a depth of **90** meters and a width of **22** km
- The dam decreases the fertility and productivity of Egypt's riverside agricultural lands



Effective use of hydroelectric power

- Hydroelectric power stations need to be situated in high **mountainous** areas such as North Wales or Scotland.
- **Damming** the river causes the river valley to **flood** which could mean that houses and villages are destroyed.
- Hydroelectric power schemes also **cost** a lot of money and take a long time to build. However, they do **last** a long time and they are able to produce **large** amounts of electricity.
- Once they are built, hydroelectric schemes provide a **cheap** and **reliable** source of electricity.



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Benefits of hydropower plants

- You need to **water** as a fuel which is cheaper, easier and fuel-online.
- Do not result in pollution from smoke and pollution of the **environment** (clean energy).
- Daily operating costs are **cheap**.
- Need less **time** at the beginning of operation.
- Can easily match **supply** and **demand**.
- Energy **storage**!

<https://populationeducation.org/what-are-pros-and-cons-hydropower-and-tidal-energy/>

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Problems with hydropower plants I

- Different amount of electric power from time to time.
- High initial costs of building the station.
- Difficult to perform maintenance
- Location = unused rivers are in remote places or low population areas
- Competition with recreational uses and environmental concerns
- Hard to build dams in populated river valleys

<https://populationeducation.org/what-are-pros-and-cons-hydropower-and-tidal-energy/>

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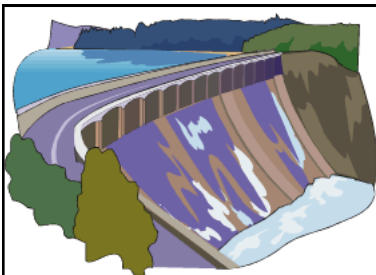
Problems with hydropower plants II

- Siltation of dams – limited life
- Adverse impact on fauna and flora
- Water quality and quantity downstream can be affected, which can have an impact on plant life
- Destructive failure



<https://www.sciencedirect.com/science/article/abs/pii/S0959652619306845>
<https://populationeducation.org/what-are-pros-and-cons-hydropower-and-tidal-energy/>

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Types of dams on size basis

<http://idahoptv.org/dialogue4kids/season11/salmon/teachers06.cfm>

Pico hydroelectric plant	Micro hydroelectric plant	Small hydro electric plant
Mini hydroelectric plant	Medium hydroelectric plant	Large hydroelectric plant

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Types of dams on production basis

- Pico hydroelectric plant
Up to **10kW**, remote areas away from the grid
- Micro hydroelectric plant
Capacity **10kW** to **300kW**, usually provided power for small community or rural industry in remote areas away from the grid
- Small hydroelectric plant
Capacity **300kW** to **1MW**
- Mini hydroelectric plant
Capacity above **1MW**
- Medium hydroelectric plant
15 - 100 MW usually feeding a grid
- Large hydroelectric plant
More than **100 MW** feeding into a large electricity grid

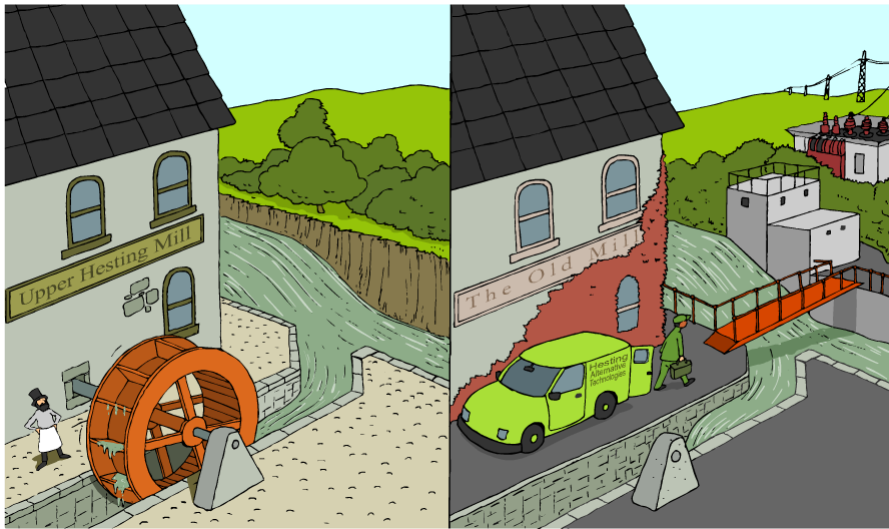


<https://docs.google.com/presentation/d/1QyV09Tn80ZHwrMrZigI8mwXp6Jdh8g5NrPgE0zOy9I/htmlpresent>

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The then and now guide to water power

How has the use of water power changed over time?



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