

An illustrated transcript from the film series

The Complete Guide to Saving the Earth

For People in a Hurry

ELECTRICITY

Hydropower



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Can you power entire cities just by using water?

There's a renewable source that's the most powerful of all and generates far more electricity than either wind or solar^[1,2,3]. It's called hydroelectric power, and uses the movement of water to generate enormous amounts of energy.

With the energy transition well under way, hydropower has huge potential^[3,4,5]. As wind and solar energy race ahead, reaching net zero by 2050 requires a similar acceleration in hydropower development^[5-9].

So, what are the latest advancements in this technology, and how can its real power be unleashed?



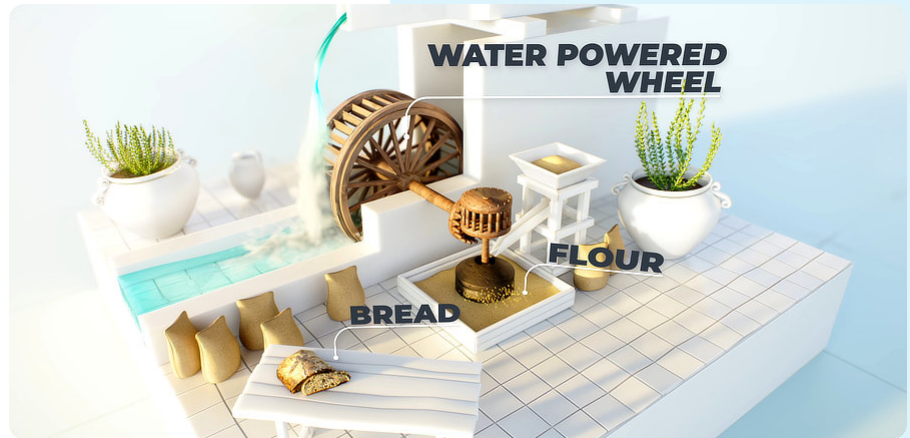
Please note that this resource follows American English spelling conventions



The Romans created a 16 mill production factory

Since the dawn of civilization, humans have realized that water is power. If you look back 2,000 years to ancient Greece, you will see that among beautiful mountains and sunny prairies, the Greeks were already using water wheels to grind wheat into flour^[10,11,12].

Later, the Romans industrialized the process, creating an incredible production factory at Barbegal in southern France^[13-18]. Archaeologists believe it ground out up to 25 metric tons^[16,17] of flour every day using 16 water-powered mills—enough to feed all the inhabitants of the nearby city of Arles^[11,16,18].





Over the centuries, humanity continued to find new ways to harness the power of water. Nowadays, hydropower supplies about 14% of global electricity generation^[1,2], placing it right after coal and fossil gas.

But how does it work?

14% of all generated electricity is from hydropower





Type 1 - Reservoir

There are three main types of hydropower plants



Type 2 - Run-of-River



Type 3 - Pumped Storage



Hydropower Plant Type 1 - Reservoir

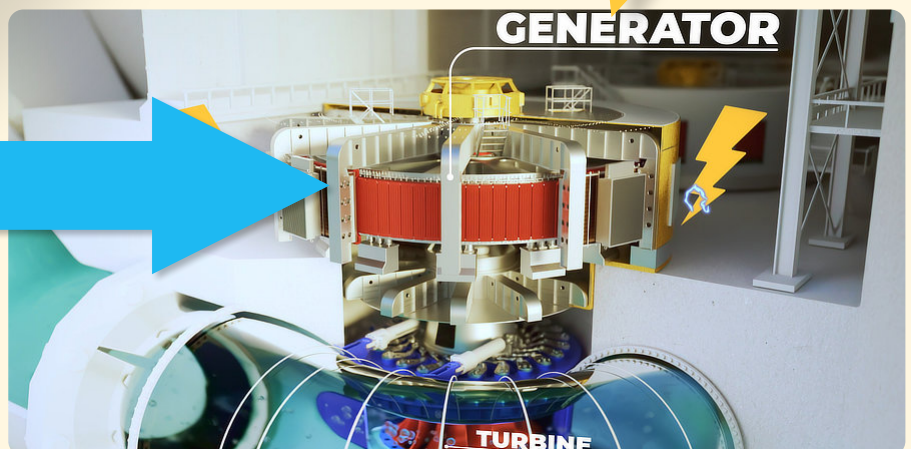
The most common type uses a large dam across a river to create a reservoir that's higher than the rest of the river. Whenever energy is needed, water from the reservoir above gets released to flow downstream. Thanks to the elevation difference, the flowing water spins a series of turbines that are placed at the lower level and connected to generators^[19].



Et voilà, the generators create electricity.

But building a reservoir is a big project that floods the land and cuts off the natural flow of the river^[20].

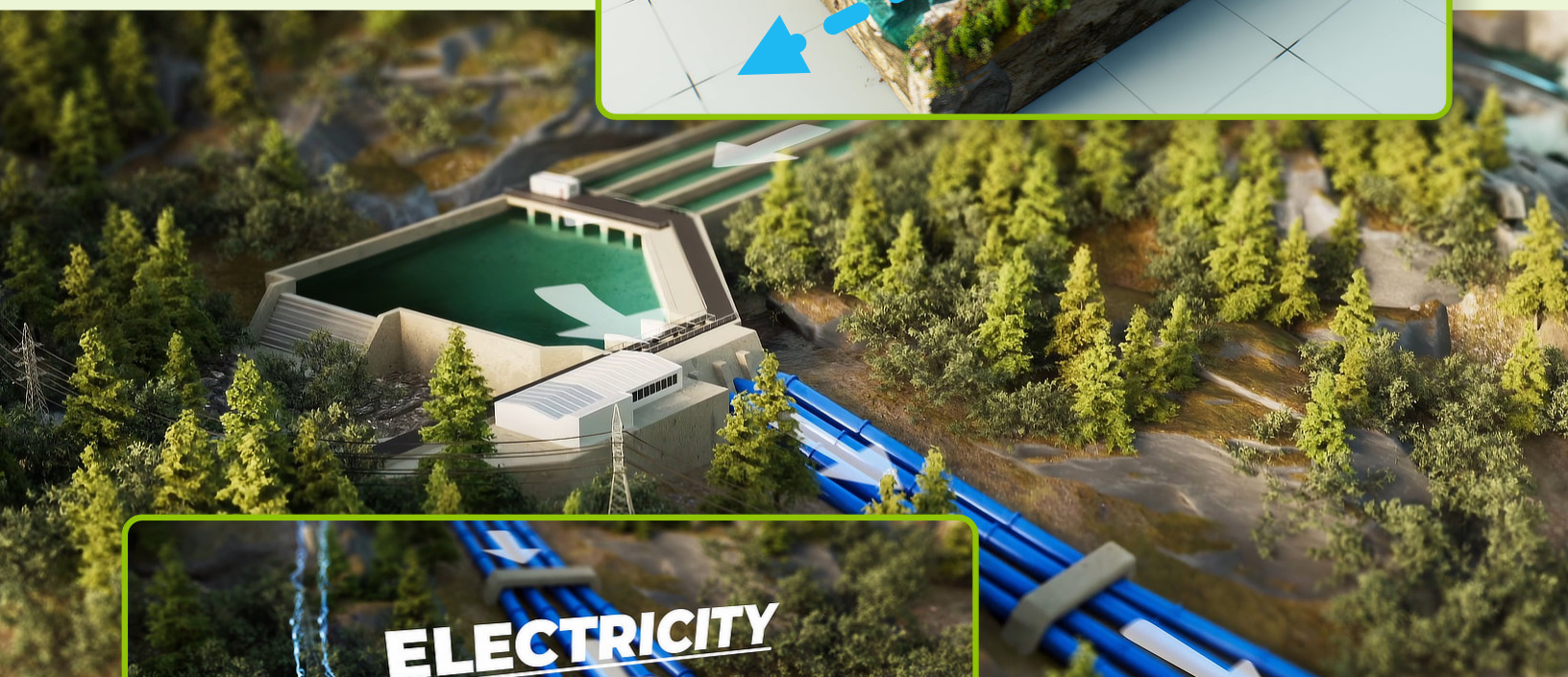
But there is another option...



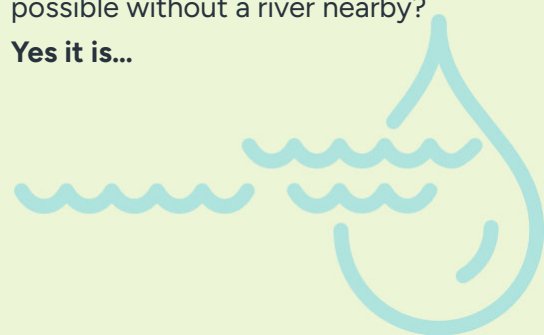


Hydropower Plant Type 2 - Run-of-River

Widely used around the world, this simple system can work with or without a dam. Basically, when a river is naturally going downhill, you create a small diversion—this way, a portion of the river is channeled through a canal. Then the water in the canal passes down a pipe, spins the turbines and **bingo—electricity!** ^[19,20]



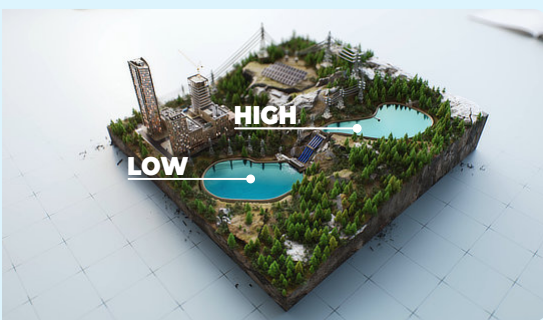
But is hydropower even possible without a river nearby?
Yes it is...



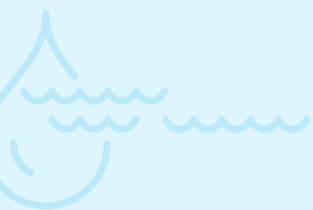


Hydropower Plant Type 3 - Pumped Storage

Here, we have two reservoirs, one at a lower level and one that's higher.



This can be combined with another renewable energy source, like solar power.



During the day when the sun is shining, solar panels can over-produce electricity. Normally this spare electricity would be wasted, but if you can divert it to run a pump, you can push water uphill to the higher reservoir^[19-23].



At night, when the sun isn't shining and electricity demand is typically higher, the water can be released from the higher reservoir to run the turbines and generate electricity on demand.

It's like a giant rechargeable water battery.

In fact, these pumped hydro systems account for over 90% of global long-term energy storage^[5,22].





Hydropower systems don't necessarily require massive construction.

They can be much smaller and even fit in your backyard—all you need is elevation and access to a sufficient amount of falling water^[24].



Hydropower systems can fit in your backyard

And don't let the size fool you! A tiny, local system can provide enough power for a small village^[19,25,26].





Can hydropower help lead the way to net zero?



People may need to leave their homes

Unfortunately, hydropower is not all smooth sailing—it faces some hurdles^[27,28].

The first problem is social: these construction projects can lead to the displacement of communities. In fact, for a large reservoir dam, hundreds of thousands of people may need to leave their homes and relocate elsewhere^[29-32].

The second problem is environmental: if not planned properly, dams can cause enormous damage to the surrounding environment and the wildlife that inhabits it^[33-36].





But with the right approach and innovation, hydropower can play a vital role in reducing CO₂ emissions^[27,37].

Solutions are being proposed:^[38,39]

For example, consulting local communities gives them a say in decisions so that they can directly benefit from the project^[40,41].

Environmental Impact Assessments, or EIAs, must also be put into action to minimize the harm to the surrounding environment^[42,43,44].



Experts are also striving to develop better technology, such as fish ladders and fish-safe turbines^[45,46,47].



The world seems to have forgotten about hydropower, but it's like a sleeping giant, with most of its global potential still untapped. Just as well—it's estimated that doubling world-wide hydropower capacity will be needed to achieve net zero by the year 2050^[5,6].

As wind and solar grow, expanding pumped hydro energy storage will also be essential to support these intermittent energy supplies.

*Planned responsibly, hydropower can lead the transition away from fossil fuels because it's **powerful, reliable, and on-demand.***

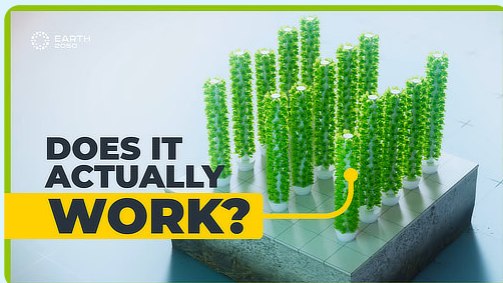




More Ways to Save the Earth

Earth 2050 has identified 42 solutions to get the planet to net zero carbon by the year 2050

Is Vertical Farming the Future of Food?



youtu.be/kITR8FhkPIY

Growing food upward, not outward, saving space and water, and keeping food local.

We show how crops grow without soil using hydroponics and aeroponics. They're lit by LEDs and guided by automation. We look at where urban sites could shine. Then we outline today's limits; energy, crop choice, skills and high costs, and the pathways that could help, like using renewables and waste heat. Big harvest, small footprint, great choice for space exploration!



Why Solar Power Is the Future of Our Planet

Could humans power the entire planet from a desert?

We explore this idea and other options, from rooftops to agri-voltaics to floating arrays. We show how solar power actually works, and explore new materials like perovskite that turn windows into solar panels.

Solar is now the cheapest source of energy in human history, but there are still some problems to overcome...



youtu.be/8ICC9k-ckFQ



Can Geothermal Energy Replace Burning Fuels for Good?



youtu.be/mwhzWtoeEgw

There's an almost inexhaustible source of energy right under our feet.

We tell the story of geothermal energy. Then compare traditional plants with enhanced geothermal plants which can be dialled up to balance wind and solar, and ground-source heat pumps for individual buildings.



We also look at new deep-drilling tech that vaporizes rock instead of cutting it, a path that could make geothermal possible almost anywhere on Earth.

VISIT OUR WEBSITE [EARTH2050.COM](https://Earth2050.com)



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FURTHER VIDEOS (NON-AFFILIATED)

How It Works

[Hydropower 101 | Student Energy](#)

Controversy of Hydropower - Impacts and Solutions

[How to solve our Big Dam Problem | DW Planet A](#)

[What Is The Future Of Hydropower? | CNBC](#)

Pumped Storage Hydropower

[Pumped-storage hydropower | Statkraft](#)

[What is Pumped Hydro | HydroTasmania](#)

[What is Pumped-Storage Hydropower | US Department of Energy](#)

[World's Largest Batteries - \(Pumped Storage\) | Practical Engineering](#)

[The Truth About Pumped Hydro | Real Engineering](#)

Fish Ladders & Turbines

[How Fish Survive Hydro Turbines | Practical Engineering](#)

[Why Fish Ladders \(Mostly\) Work | Practical Engineering](#)

Potential of Micro Hydropower Plants

[Micro Hydropower : Turbulent Turbines | Just Have a Think](#)

[The Genius of Small Hydro Turbines | Undecided](#)

Beyond Our Scope

[In-pipe energy: The hydro power nobody is talking about | DW Planet A](#)

Documentaries

[Hydroelectric dams: Using the Power of Water | Génie Français - Megadams](#)

[DamNation: The Problem with Hydropower | Patagonia Films](#)



FURTHER READING

History

[Water Mills | Encyclopedia MDPI](#)

[Waterwheel | History, Types & Uses | Britannica](#)

Barbegal

[A huge water-powered factory helped make food for Roman sailors | New Scientist](#)

[The unique hydraulics in the Barbegal water mills, the world's first industrial plant | ScienceDaily](#)

[Roman Water Wheel | The Engines of Our Ingenuity | Cullen College of Engineering](#)

How It Works

[Types of Hydropower Plants | Department of Energy](#)

[Pumped storage hydropower: Water batteries for solar and wind power | IHA](#)

[The future of energy storage: how pumped hydro storage can help us achieve our net zero targets | SSE](#)

[Planning a Microhydropower System | Department of Energy](#)

[General Hydropower | Renewables First - The Renewable Energy Company](#)

Impacts

[Examining the Pros and Cons of Hydroelectric Energy | Earth.Org](#)

[Why aren't we looking at more hydropower? | MIT Climate Portal](#)

[Environmental Impacts of Hydroelectric Power | Union of Concerned Scientists](#)

Solutions

[How to make hydropower more environmentally friendly | Ensia](#)

Fish Ladders and Mechanisms

[How Do Fish Survive Hydropower Dams? | Department of Energy](#)

[Hydropower: Improving conditions for fish | Statkraft](#)

[The New Generation of Hydropower Dams Let Fish Swim Straight Through | Reasons to be cheerful](#)

Case Studies

[China's Three Gorges Dam, by the Numbers National | Geographic](#)

Beyond our Scope - Direct Risks and Responses under Climate Change

[Adaptation options for hydropower plants | Climate Adapt EU](#)

[Hydropower's evolving role in climate mitigation and adaptation | IHA](#)



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- [5] [2024 World Hydropower Outlook | IHA](#) (Press: [Prometheus Institute](#))
- [6] [IEA net zero report calls for doubling of hydropower capacity by 2050](#) (Figures from: [Net Zero by 2050 - A Roadmap for the Global Energy Sector | IEA](#))
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- [11] [Waterwheel | History, Types & Uses | Britannica](#) (See Reference Notes*)
- [12] [Water Mills | Scholarly Community Encyclopedia](#) (Adapted from: [Sustainable and Regenerative Development of Water Mills | Water](#))
- [13] [France: Barbegal watermills – Rome’s Revolutionary Power | World Archaeology](#)
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- [27] [Sustainable hydropower in the 21st century | PNAS](#)
- [28] [Why aren't we looking at more hydropower? | MIT Climate Portal](#)
- [29] [China's Three Gorges Dam, by the Numbers | National Geographic](#)
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- [33] [Environmental Impacts of Hydroelectric Power | Union of Concerned Scientists](#)
- [34] [Hydropower impacts on riverine biodiversity | Nature Reviews Earth & Environment](#)
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- [37] [Hydropower Special Market Report | IEA](#)
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- [45] [How Do Fish Survive Hydropower Dams? | US Department of Energy](#)
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*REFERENCE NOTES

[1,2] The share of electricity generation from both wind and solar combined surpassed that from hydropower in 2024 for the first time ^[2]. Hydropower is currently the largest renewable generation source by far, and expected to still be the case in 2028. By 2030, however, solar PV is expected to become the foremost renewable electricity source, followed by wind, both surpassing hydropower ^[1].

[11,16,18] Purpose of the water-powered mill at Barbegal:

It is stated that the flour ground at the water-powered mill at Barbegal had the capacity to feed all the inhabitants of the nearby city of Arles [11,18]. However, while this may be true, recent evidence suggests the complex was used intermittently, interrupted for several months at a time. Rather than provide a steady supply of flour to the city, it was more likely and primarily used to make ship's bread and non-perishable hardtack for the nearby ports of Arles and Fossae Marianae — enough to feed sailors heading out to sea for months on end, opposed to the population at large.

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