**Going with the flow?**

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**Water and sustainability challenges in the context of hydropower**

On the following pages we provide inspiration for an approximately two-hour interactive

lecture tailored for the *Gy 11 curriculum course ‘Natural Sciences, 1a, 50 points’*. By

focusing on energy and describing related climate, ecosystem, social and other sustainability

concerns, we address key aspects of the curriculum. General *learning objectives* are to:

• Increase the students’ interest in the multiple challenges arising from human use of

Freshwater

• Foster understanding of the relevance of hydropower for the national and global

energy supply

• Promote knowledge about the basic physical and technical principles behind

Hydropower

• Raise understanding about ecological, social and political interdependencies and

conflicts caused by hydropower usage in particular and energy production in general,

as well as our role in them.

**Technical aspects of hydropower plants**

Humans have been using the gravitational force of falling or flowing water to create electrical

or mechanical energy for centuries. Today, hydro energy is a major source of renewable

energy and provides 16% of the global electricity demand. However, only a fifth of the total

global hydropower potential has been developed yet. Canada, Brazil and China are the largest

producers of hydropower energy. In Sweden, hydropower provides more than half of the

country’s electric energy and is the main energy source besides nuclear power. As an

operating hydropower plant creates little to no CO2 emissions, hydroelectricity is often

regarded as one of the cleanest sources of energy. Due to its high storage capacity and fast

response ability, hydropower can cover sudden fluctuations in the electricity grid and buffer

more fluctuated sources of renewable energy. Moreover, hydropower development can help to

regulate water supply and control floods and droughts.

Hydroelectric power uses the kinetic and/or the potential energy of water. Kinetic

energy is classified as the energy that an object (water) has relative to its surroundings,

whereas potential energy is the energy stored in a system by its position in a force field or in a

system. In the case of water, potential energy is stored by raising water to a certain height.

The resulting hydraulic pressure and the flow rate of water that is released from its reservoir

describe the function of hydraulic power.

**Ecological issues associated with hydropower**

Hydropower plants which stores water in reservoirs changes the natural flow of the water,

which has consequences for the river as a habitat. We need the most electricity during the

winter, but the highest flows in a natural river in Sweden occur during spring when the snow

melts. Sometimes parts of the river can be left almost or completely dry and then suddenly get

a flush of water. This can have severe consequences for the ecosystem, since one of the most

important functions of a river ecosystem is the water flow. The water transports sediments,

nutrients and provides food for a number of organisms. The effects go beyond the actual waterecosystem. Occasional flooding gives the riparian zone (the border between land and the

water body) a nutrient input and some plants growing alongside the river use the water to

spread seeds. One important organism group that is highly affected by hydropower is fish.

Many fish migrate within the river, to a lake or out to the ocean and therefore need a free

passage. They can get stressed, injured or even killed when they come in contact with the

turbines and their habitats get fragmented (the natural home is divided into smaller parts) by

the constructions. This can be prevented by building fish ladders or by creating alternative

routes. However, it is not always an easy task to make the fish understand which way to go,

both when they are going upstream a river and downstream. Fish usually go for the dominant

flow, so the passage needs to have a sufficient amount of water. This can be problematic,

since the hydropower companies want as much water as possible to go through the turbines in

order to maximize the electricity output.

**Societal and economic consequences of hydropower projects**

Social and (indirect) economic aspects of hydropower are often overlooked. In cases where

inhabited areas are flooded, people are forced to move and find a new home. This can lead to

severe violations of human rights. The displaced people may lose more than just their houses.

Social community ties, their identity as well as bases for their livelihoods can be destroyed.

Farmers have to find agricultural land elsewhere, trade routes like roads, railway lines or

shipping routes are relocated, touristic infrastructure like hotels and restaurants may have to

move or adapt. The focus of fishermen will also change from flowing water and migratory

fish species to those living in standing water. At the same time, new economic opportunities

can develop around the reservoir. Through aquaculture, tourism or logistics, a dam can also

create new jobs.

While adequate compensation can help in some economic cases, cultural and natural

values are far less possible to fix. The building process of dams also introduces non-native

people and companies to usually rural areas, with multiple effects on tax revenues, locals’

customs and cultural exchange. Also natural beauty and uniqueness are main drivers of

tourism and might be lost, so are fish species for sports fishing or certain plants that only can

live on the natural river banks. Religious and spiritual communities furthermore often have

close contact to natural elements. If sacred sites like rocks, forests, paths or buildings are lost,

traditional knowledge and local identity get destroyed.

The changing flow of water also leads to standing water freezing at higher

temperatures and evaporating easily, which brings along health risks like pests or pollution of

drinking water with sewage. However, the risk of flooding can widely be eliminated for

inhabitants downstream, at the price of potential salinization (enrichment with salt) of soils

and decreasing input of fertile sludge. Balancing these double-sided reasons, building dams

has decreased since the 1960s and 70s, and has become very rare throughout Europe. In

countries of the Global South, however, additional dams are still under construction.

**Exercise: Exploring and understanding complex conflict dynamics around hydropower**

**in Sweden and worldwide**

***Aim***: Now you have heard a lot about interconnected challenges arising from the use of

hydropower as an important source of renewable energy. But how does it look like in the

world out there? Are there many conflicts over hydropower? Where are they located? Who is

involved? What do they argue about, and which social and environmental consequences can

be seen? Who is in charge of the projects, and who is deciding and trying to resolve the

conflicts? Which means do the project opponents make use of, and how do they argue for

their cases?

***Method***: Please come together in small groups of up to five people and secure access to at

least one computer with internet connection (important: use Firefox as browser; Internet

Explorer does not display contents fully!); having more than one is even better. Open the

webpages http://ejatlas.org and http://worldwater.org/water-conflict and explore them for the

next *15 minutes*. Tip for ejatlas.org: In the search menu towards the bottom of the page you

can specifically select conflict types such as “Commodity → Water”, “Type → Water access

rights and entitlements”, “Type → Dams and water distribution conflicts”, “Type →

Aquaculture and fisheries”, “Type → Water treatment and access to sanitation (access to

sewage)”, “Type → Wetlands and coastal zone management”. Make sure you focus on

conflicts where hydropower is central (as there are so many more conflicts arising over other

water use aspects!).

After having become familiar with the content of these databases, now please sit

together in your groups and discuss what you have found out. Which is the historically oldest

conflict you have found, which is the newest? Are there any hydropower induced water

conflicts in Sweden, or would they rather be located in other parts of the world, and if so,

why? Who is usually involved in the conflicts? Why would they arise? Which roles do

governments, corporations, local initiatives and other stakeholders usually play? Which role

could we and our consumption play in those conflicts? Are there any other ‘conflict-neutral’

sources of energy besides hydropower? Discuss these or any other questions you have for *15*

*minutes*, and try to figure out if there is a common special feature that you are interested in as

a group; maybe you find cases in India or Sweden most interesting, or cases where Vattenfall

or Coca Cola are involved, or where the conflict intensity was very high with mass

mobilisations and arrests…

Now your teacher will provide you with a sheet of paper/poster and some coloured

markers. You’ve got another *15 minutes* to pick one of the cases as presented in the databases

and visualise its specific conflict dynamics. Instead of trying to cover everything it might be

helpful to focus on the specific interest your group (hopefully) has just figured out in the

previous discussion. Still, try to identify key ecological and social issues concerning each

conflict. Make a pretty and informative poster! And have some kranvatten! :-)

After *15 minutes*, come together as a class and shortly present your posters to each

other, either in full-class presentations or in a more open setting where posters and one group

member each remain at the tables while the others walk around and have a look at all the

results.

***Suggested time frame:*** Flexible; ideally 15 minutes each for exploring databases and topics,

small-group discussions, poster-making, in-class presentation.

***Required materials:*** Computers with internet access (there should be at least one computer

for each group), white posters and coloured markers.

**Selected open source links for further information**

Alvraddarna

http://www.alvraddarna.se

*Check their webpage regularly as they have produced a film on hydropower which will be out*

*soon!*

Calles, O., Gustafsson, S. & Osterling, M. Naturlika fiskvagar i dag och i morgon.

http://www.nrrv.se/wp-content/uploads/2012/11/CG%C3%96-2012.pdf

Environmental Science Activities for the 21st Century

http://esa21.kennesaw.edu/activities/hydroelectric/hydroactivity.pdf

Foundation for Water and Energy Education (FWEE)

http://fwee.org/environment/how-a-hydroelectric-project-can-affect-a-river/

International Energy Agency

http://www.iea.org/publications/freepublications/publication/hydropower\_essentials.pdf and

http://www.iea.org/topics/renewables/subtopics/hydropower/

International Hydropower Association

http://www.hydropower.org/types-technology-0

National Hydropower Association (USA)

http://www.hydro.org/

US Environmental Protection Agency

http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html

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