Pädagogische Hochschule OÖ

W o l f g a n g Z e c h m e i s t e r

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SCIENCE HITS 4 KIDS
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Geographic-economic aspects concerning the role of energy

(This lecture-version is without pictures and videos – the original lecture from 12th Marc 09 had been with pictures an 11 short videos)

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Energy should **become a more important topic** in curricula of schools

RESULTS OF THE WORKING-GROUPS ‚Geography – Economy – Energy‘

Important *topics:*

- Location factors
- Transport of energy
- Regional development
- Regional potential-analysis
- Future-orientation
- Geography on resources
- Climate and change of climate
- Political geography: Energy – Control – Politics
- Emissions trading
- Conflicts with the type of use
- Agricultural geography
- ...

Source of information: http://www.uni-tuebingen.de/egoinfo/akge/beitraege_dateien/beitraege.html

Fossil fuels
Nuclear power
Solar power
Wind power
Tidal power
Hydroelectric power
Pumped storage reservoirs
Wave power
Geothermal-heat
Biomass-energy

producing ENERGY

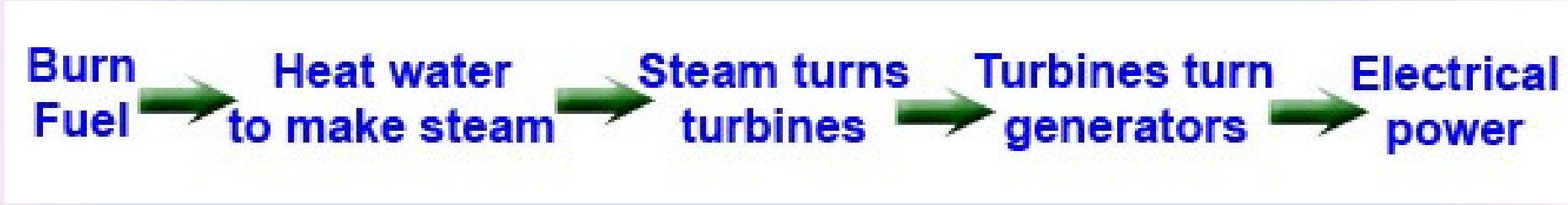
Topics to be set in relation to curricula!

How can this topics be set in relation to geography-curricula?

I. Fossil Fuels

Coal, oil and **gas** are called "**fossil fuels**" - they have been formed from the **organic remains** of prehistoric plants and animals.

Coal is **crushes to fine dust an burnt** – oil and gas can be burnt directly.



The steam that has passed through the power station's turbines has to be cooled, to condense it back into water before it can be pumped round again. This is what happens in the huge "**cooling towers**" seen at power stations.

Some power stations are built **on the coast**, so they can and can **affect the environment** use sea water to cool the steam instead. However, this **warms the sea** ...

Advantages

- Very large amounts of electricity can be generated in one place using coal, **fairly cheaply**.
- **Transporting** oil and gas to the power stations **is easy**.
- Gas-fired power stations are **very efficient**.
- A fossil-fuelled power station **can be built almost anywhere**, so long as you can get large quantities of fuel to it.

Disadvantages

•Basically, the main drawback of fossil fuels is **pollution**. Burning any fossil fuel produces **carbon dioxide (C02)**, which contributes to the "greenhouse effect", warming the Earth.

•Burning coal produces more carbon dioxide than burning oil or gas. It also produces **sulphur dioxide**, a gas that contributes to **acid rain**. We can reduce this before releasing the waste gases into the atmosphere.

•Mining coal can be difficult and dangerous. **Strip mining destroys large areas of the landscape**.

•Coal-fired power stations **need huge amounts of fuel**, which means train-loads of coal almost constantly. In order to cope with changing demands for power, the station needs reserve.
This means covering a large area of countryside next to the power station with piles of coal.

I. Fossil Fuels

Topics to be set in relation to curricula

Origin of coal, oil and gas

exploitation

Political extents

deposits

Resources

Greenhouse effect

II. Nuclear Power -

energy from splitting Uranium atoms

Nuclear power is generated using **Uranium**, which is a metal mined in various parts of the world.

Some military ships and submarines have nuclear power plants for engines.

Nuclear power produces around 11% of the world's energy needs, and produces huge amounts of energy from small amounts of fuel, **without the pollution that you'd get from burning fossil fuels**.

Fiber Optic Nuclear Power Plant Exhibit

Nuclear power stations **work in pretty much the same way as fossil fuel-burning stations**, except that a "chain reaction" inside a nuclear reactor makes the heat instead.

The reactor uses Uranium rods as fuel, and the heat is generated by **nuclear fission:** neutrons smash into the nucleus of the uranium atoms, which split roughly in half and release energy in the form of heat.

Carbon dioxide gas or water is pumped through the reactor to take the heat away, this then heats water to make steam.

The steam drives turbines which drive generators.

Advantages

- Does not produce smoke or carbon dioxide, so it does **not** contribute to the **greenhouse effect**.

- Nuclear power costs about the same as coal, so it's **not expensive** to make.

- Produces **huge amounts of energy** from small amounts of fuel.

- Produces **small amounts of waste**.

Disadvantages

•Although **not much waste** is produced, it is very, very **dangerous**.
It must be sealed up and buried for many thousands of years to allow the radioactivity to die away. For all that time it must be **kept safe** from earthquakes, flooding, terrorists and everything else. *This is difficult.*

•Nuclear power is reliable, but a lot of money has to be spent on safety - if it **does** go wrong, a nuclear accident can be a major disaster.
People are increasingly concerned about this - in the 1990's nuclear power was the fastest-growing source of power in much of the world.

II. Nuclear Power -

energy from splitting Uranium atoms

Topics to be set in relation to curricula

locations

deposits of uranium

III. Solar power

We've used the Sun for **drying clothes and food** for thousands of years, but only recently have we been able to use it for generating power.

The Sun is 150 million kilometers away, and **amazingly powerful**.

Just the tiny fraction of the Sun's energy that hits the Earth (around a hundredth of a millionth of a percent) is enough to meet all our power needs many times over.

In fact, every minute, enough energy arrives at the Earth to meet our demands for a whole year - if only we could use it properly.

Solar cells
Solar water heating
Solar furnaces

Advantages

• Solar **energy is free** - it needs **no fuel** and produces **no waste or pollution**.

• In sunny countries, **solar power can be used where there is no easy way to get electricity** to a remote place.

• Handy for low-power uses such as solar powered garden lights and battery chargers, or for helping your home energy bills.

Disadvantages

• **Doesn't work at night**.

• **Very expensive** to build solar power stations. Solar cells cost a great deal compared to the amount of electricity they'll produce in their lifetime.

• **Can be unreliable** unless you're in a very sunny climate.

III. Solar power

Topics to be set in relation to curricula

Solar system

planets

earthrotation

Solar wind

tropics

Graticule of earth

IV. Wind Power

We've used the wind as an energy source for a **long time**.
The Babylonians and Chinese were using wind **power to pump water** for irrigating crops 4,000 years ago, and **sailing boats** were around long before that.
Wind power was used in the Middle Ages, in Europe, to grind corn, which is where the term "**windmill**" comes from.

The Sun heats our atmosphere unevenly, so **some patches become warmer than others**.
These warm patches of air rise, other air blows in to replace them - and we feel a **wind blowing**.
We can use the energy in the wind by building a tall tower, with a large propellor on the top.
The **wind blows the propellor round**, which **turns a generator to produce electricity**.

Advantages

- **Wind is free**, wind farms need no fuel.
- Produces **no waste or greenhouse gases**.
- The land beneath can usually **still be used for farming**.
- Wind farms can be **tourist attractions**.
- A good **method of supplying energy to remote areas**.

Disadvantages

- The wind is not always predictable - **some days have no wind**.
- Suitable areas for wind farms are **often near the coast**, where land is expensive.
- Some people feel that covering the landscape with these towers is **unsightly.**
- Can **affect television reception** if you live nearby.
- Can **kill birds** - migrating flocks tend to like strong winds. However, this is rare, and we tend not to build wind farms on migratory routes anyway.
- **Can be noisy**.

IV. Wind Power

Topics to be set in relation to curricula

Low pressure area – high pressure area

Offshore wind – onshore wind (sea breeze)

Climate & wind

weather

V. Tidal power - energy from the sea

The tide moves a huge amount of water twice each day, and harnessing it could provide a great deal of energy.

Although the energy supply is reliable and plentiful, converting it into useful electrical power is not easy.

There are **not many main sites where tidal power stations could usefully be built.** Under 100 sites in the world have been identified as possible tidal power stations.

A few years ago, "tidal power" meant "tidal barrage". But these days there are other options as well.

These work rather like a hydro-electric scheme, except that the dam is **much** bigger.
A **huge dam (called a "barrage")** is built across a river estuary. When the tide goes in and out, the water flows through tunnels in the dam.
The **ebb and flow of the tides can be used to turn a turbine**, or it can be used to push air through a pipe, which then turns a turbine.

If you're one of the 80,000+ birds that feeds on the exposed mud flats when the tide goes out, then you have a problem, because the tide won't be going out properly any more.

Another option is to use **offshore turbines**, rather like an "**underwater wind farm**".

This has the advantage of being **much cheaper** to build, and does **not have the environmental problems** that a tidal barrage would bring.

There are also many more suitable sites.

Advantages

- Once you've built it, **tidal power is free**.
- It produces **no greenhouse gases or other waste**.
- It needs **no fuel**.
- It **produces electricity reliably**.
- **Not expensive to maintain**.
- Tides are **totally predictable**.
- Offshore turbines and vertical-axis turbines are not ruinously expensive to build and do **not have a large environmental impact**.

Disadvantages

- A barrage across an estuary is **very expensive to build**, and affects a very wide area - the environment is changed for many miles upstream and downstream. Many birds rely on the tide uncovering the mud flats so that they can feed. There are few suitable sites for tidal barrages.
- Only **provides power for around 10 hours** each day, when the tide is actually moving in or out.

V. Tidal power - energy from the sea

Topics to be set in relation to curricula

Tides

Lunar orbit

VI. Hydroelectric power - energy from falling water

We have used **running water as an energy source for thousands of years, mainly to grind corn**.
The first house in the world to be lit by hydroelectricity was Cragside House, in Northumberland, England, in 1878.
In 1882 on the Fox river, in the USA, hydroelectricity produced enough power to light two paper mills and a house.
Nowadays there are many hydro-electric power stations, providing around **20% of the world's electricity**. The name comes from "hydro", the Greek word for water.

A dam is built to trap water, usually in a valley where there is an existing lake.
Water is allowed to **flow through tunnels in the dam, to turn turbines and thus drive generators**.
Notice that the dam is much thicker at the bottom than at the top, because the pressure of the water increases with depth.
Hydro-electric power stations can produce a great deal of power very cheaply.

The **sun evaporates water from the sea and lakes**, which forms clouds and falls as rain in the mountains, keeping the dam supplied with water. For free.

Advantages

- No waste or pollution produced.
- Once the dam is built, the energy is virtually free.
- Much more reliable than wind, solar or wave power.
- Water can be stored above the dam ready to cope with peaks in demand.
- Hydro-electric power stations can increase to full power very quickly, unlike other power stations.
- Electricity can be generated constantly.

Disadvantages

- The **dams are very expensive to build**. However, many dams are also used for flood control or irrigation, so building costs can be shared.
- Building a large dam **will flood a very large area upstream, causing problems** for animals that used to live there.
- **Finding a suitable site can be difficult** - the impact on residents and the environment may be unacceptable.
- **Water quality and quantity downstream can be affected**, which can have an impact on plant life.

VI. Hydroelectric power - energy from falling water

Topics to be set in relation to curricula

hydrology

Water levels

VII. Pumped Storage Reservoirs -

storing energy to cope with big demands

Pumped storage reservoirs aren't really a means of generating electrical power. They're a way of storing energy so that we can **release it quickly when we need it**.

Demand for electrical power changes throughout the day. For example, when a popular TV program finishes, a huge number of people go out to the kitchen to put the kettle on, causing a sudden peak in demand. (USA)

If power stations don't generate more power immediately, there'll be power cuts around the country - traffic lights will go out, causing accidents, and all sorts of other trouble will occur.

The problem is that most of our power is generated by fossil fuel power stations, which **take half an hour** or so to crank themselves up to full power. **Nuclear power stations take much longer**.

We need something that can go from nothing to full power immediately, and keep us supplied for around half an hour or so until the other power stations catch up. Pumped storage reservoirs are the answer we've chosen.

Water is **pumped up to the top reservoir at night**, **when demand for power across the country is low**.

When there's a **sudden demand for power**, the "headgates" (huge taps) are opened, and water **rushes down** the tunnels to drive the turbines, which drive the powerful generators.

The water then collects in the **bottom reservoir**, ready to be pumped back up later.

Advantages

- Without some means of storing **energy for quick release**, we'd be in trouble.
- **Little effect** on the landscape.
- **No pollution or waste**

Disadvantages

- **Expensive to build**.
- Once it's used, you **can't use it again until you've pumped the water back up**.

But the industry is very good at predicting when the surges in power demand will happen, so good planning can get around this problem.

VII. Pumped Storage Reservoirs -

storing energy to cope with big demands

Topics to be set in relation to curricula

Relief intensity = the fall

geology

Weather and climate

Messure of rainfall or downfall

VII. Wave power

Ocean waves are caused by the wind as it blows across the sea. **Waves are a powerful source of energy.**
The problem is that it's not easy to harness this energy and convert it into electricity in large amounts. Thus, wave power stations are rare.

There are **several methods** of getting energy from waves. One of them works like a swimming pool wave machine in reverse.
At a swimming pool, air is blown in and out of a chamber beside the pool, which makes the water outside bob up and down, causing waves.
At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole in the top of the chamber.

We place a turbine in this hole, which is turned by **the air rushing in and out**. The turbine turns a generator.

A problem with this design is that the rushing air can be **very noisy**, unless a silencer is fitted to the turbine. The noise is not a huge problem anyway, as the waves make quite a bit of noise themselves.

More ideas about how to extract energy from waves are being proposed all the time.

Once you've built a wave power station, the energy is free, needs no fuel and produces no waste or pollution.

One big problem is that of building and anchoring something that can withstand the roughest conditions at sea, yet can generate a reasonable amount of power from small waves. **It's not much use if it only works during storms**!

Advantages

- The energy **is free** - **no fuel needed, no waste produced**.
- **Not expensive** to operate and maintain.
- Can produce a **great deal** of energy.

Disadvantages

•**Depends on the waves** - sometimes you'll get loads of energy, sometimes almost nothing.

•**Needs a suitable site**, where waves are consistently strong.

•Some designs are **noisy**. But then again, so are waves, so any noise is unlikely to be a problem.

•**Must be able to withstand very rough weat**her.

•Wave power is **renewable**.

VII. Wave power

Topics to be set in relation to curricula

Sea currents

wind

Coastal formation

VIII. Geothermal - heat from underground

The centre of the Earth is around 5000 degrees Celsius - easily hot enough to melt rock. Even a few kilometres down, the temperature can be over 250 degrees Celsius.

In general, the temperature rises one degree Celsius for every 36 meters you go down.

In volcanic areas, molten rock can be very close to the surface. Sometimes we can use that heat.

Geothermal energy has been used for thousands of years in some countries for cooking and heating.

The name "geothermal" comes from two Greek words: "geo" means "Earth" and "thermal" means "heat".

Hot rocks underground heat water to produce steam.

We drill holes down to the hot region, steam comes up, is purified and used to drive turbines, which drive electric generators.

There may be natural "groundwater" in the hot rocks anyway, or we may need to drill more holes and pump water down to them.

Geothermal energy is an important resource in volcanically active places such as **Iceland and New Zealand**.

How useful it is depends on how hot the water gets. This depends on how hot the rocks were to start with, and how much water we pump down to them.

Water is pumped down an "injection well", filters through the cracks in the rocks in the hot region, and comes back up the "recovery well" under pressure. It "flashes" into steam when it reaches the surface.

The steam may be used to drive a turbogenerator, or passed through a heat exchanger to heat water to warm houses. A town in Iceland is heated this way.

The steam must be purified before it is used to drive a turbine, or the turbine blades will get "furred up" like your kettle and be ruined.

Advantages

• Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.

• The power stations **do not take up much room**, so there is not much impact on the environment.

• **No fuel** is needed.

• Once you've built a geothermal power station, the **energy is almost free**. It may need a little energy to run a pump, but this can be taken from the energy being generated.

Disadvantages

• The big problem is that there are **not many places** where you can build a geothermal power station.

You need hot rocks of a suitable type, at a depth where we can drill down to them. The type of rock above is also important, it must be of a type that we can easily drill through.

• Sometimes a geothermal site may "run out of steam", **perhaps for decades**.

• **Hazardous gases** and minerals may come up from underground, and can be difficult to safely dispose of.

VIII. Geothermal - heat from underground

Topics to be set in relation to curricula

volcanism

Structure of earth

Geodynamics

IX. Biomass - energy from organic materials

Wood was once our main fuel. We burned it to heat our homes and cook our food.

Wood still provides a small percentage of the energy we use, but its importance as an energy source is dwindling.

Sugar cane is grown in some areas, and can be fermented to make **alcohol, which can be burned to generate power**. **Alternatively, the cane can be crushed** and the pulp (called "bagasse") can be burned, to make steam to drive turbines.

Other soid wastes, can be burned to provide heat, or used to make steam for a power station.

"Bioconversion" uses plant and animal wastes to produce "biofuels" such as methanol, natural gas, and oil.

We can use rubbish, animal manure, woodchips, seaweed, corn stalks and other wastes.

For a biomass power station making electricity, it's pretty much like a fossil fuel power station.

For other biofuels, we may burn it to get the heat for our home, **or burn it to get energy for a car engine, or for some other purpose**.

Sugar cane is harvested and taken to a mill, where it is crushed to extract the juice. The juice is used to make sugar, whilst the left-over pulp, called "bagasse" can be burned in a power station.

The station usually provides power for the sugar mill, as well as selling electricity to the surrounding area.

It is caimd that biofuels will help us to **reduce our reliance on fossil-fuel oil**, and that this is a good thing.

On the other hand, it is also claimed that it takes a **huge amount of land** to grow enough crops to make the amount of biofuels we'd need, so much so that it makes a big dent in the amount of land available for growing food.

Should we be using more biofuels and less fossil fuels? Think about the carbon dioxide - there are similar CO2 emissions from biofuel-powered vehicles as from petrol-powered ones.

It is claimed that growing plants to make biofuels will take in that carbon dioxide again. But biologists tell us that forests are not 'the lungs of the planet' after all - **they give out as much CO2 as they absorb as the plants respire**.

Advantages

- It makes sense to **use waste materials where we can**.
- The **fuel tends to be cheap**.
- **Less demand** on the fossil fuels.

Disadvantages

- Collecting or growing the fuel in **sufficient quantities** can be difficult.
- We burn the biofuel, so it makes **greenhouse gases** just like fossil fuels do.

IX. Biomass - energy from organic materials

Topics to be set in relation to curricula

areas under cultivation

agriculture

Waste disposal

Land use designation

Thanks for your regards

Source:

Zechmeister, Wolfgang, 1998: Die potentielle Wasserkraftnutzung in den Hohen Tauern. – Universität Salzburg, Salzburg

http://home.clara.net/darvill/altenerg/index.htm