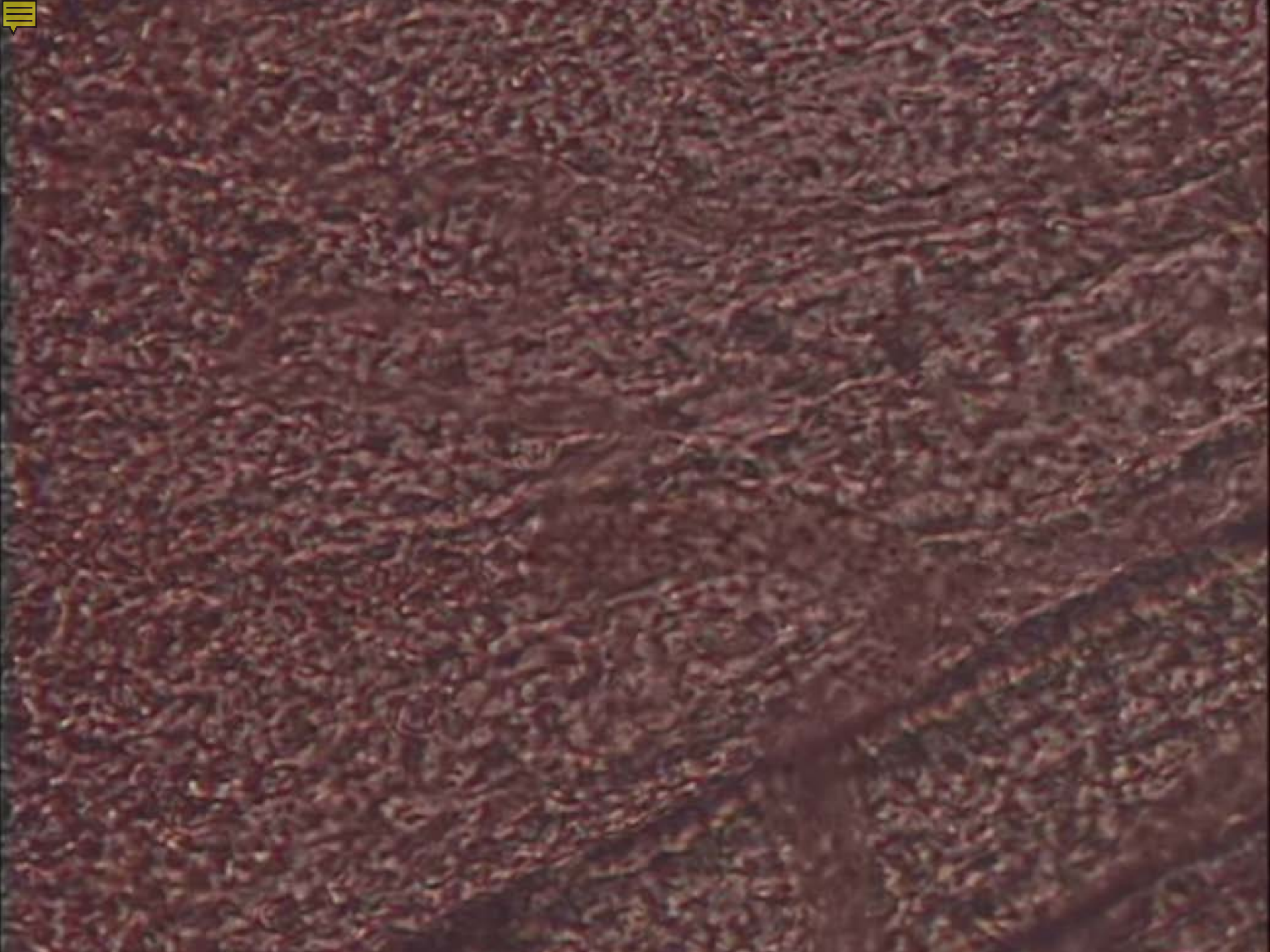


Environmental aspects of Energetics





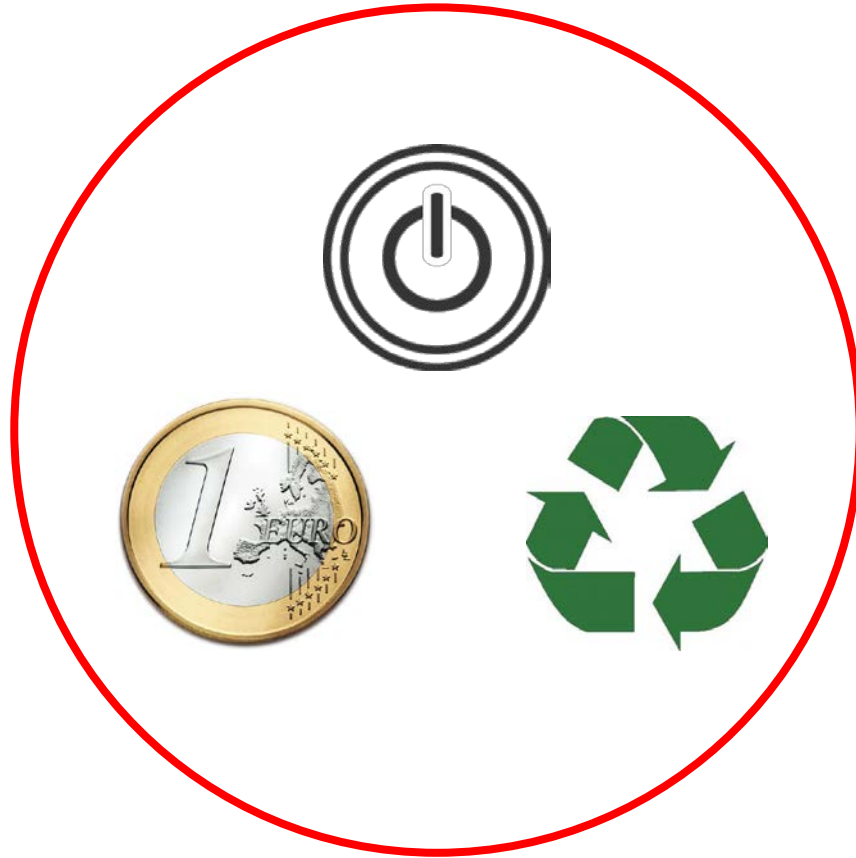
KOYAADISQATSI




NATIONAL GEOGRAPHIC
PRESENTS



Energetic trilemma

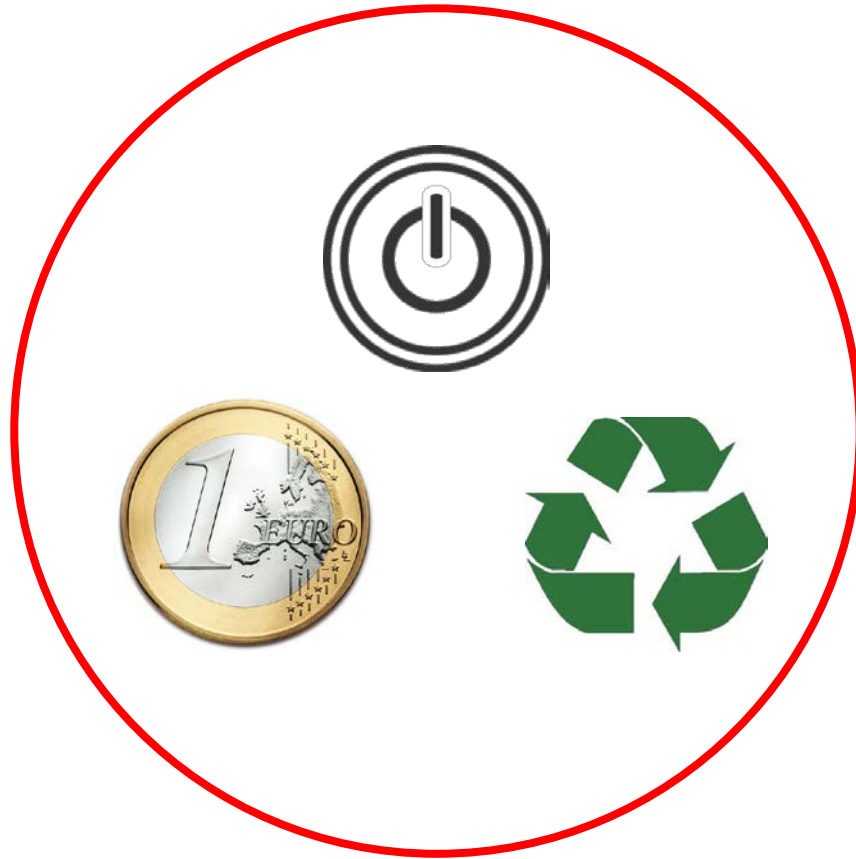




What energy we want (what we expect from the energy)?

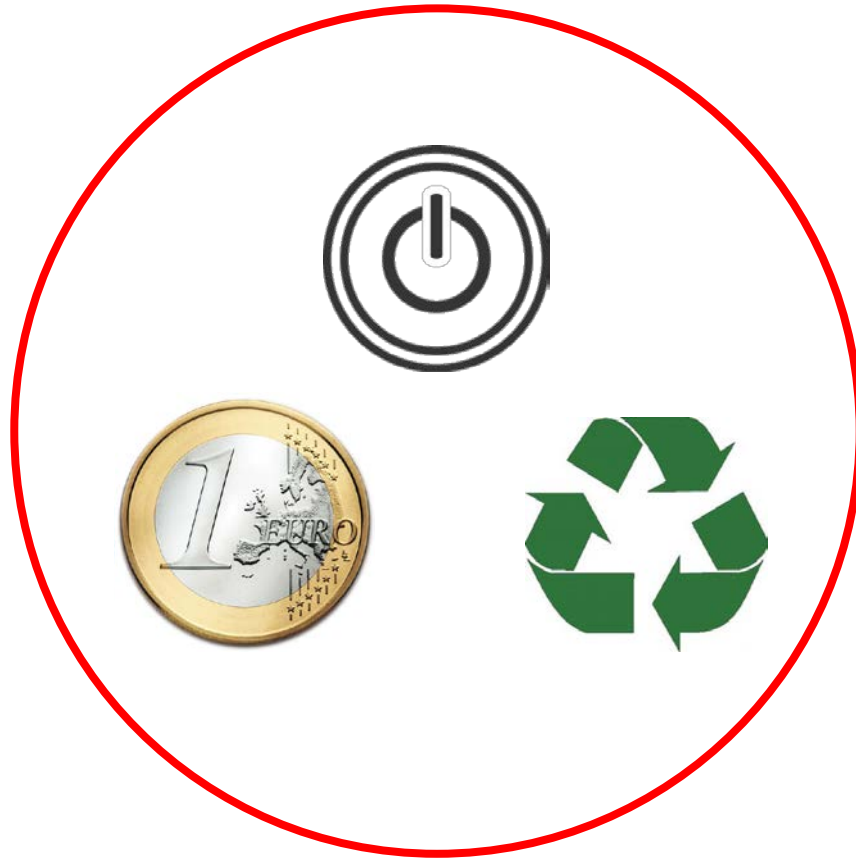
Top

Energetic trilemma



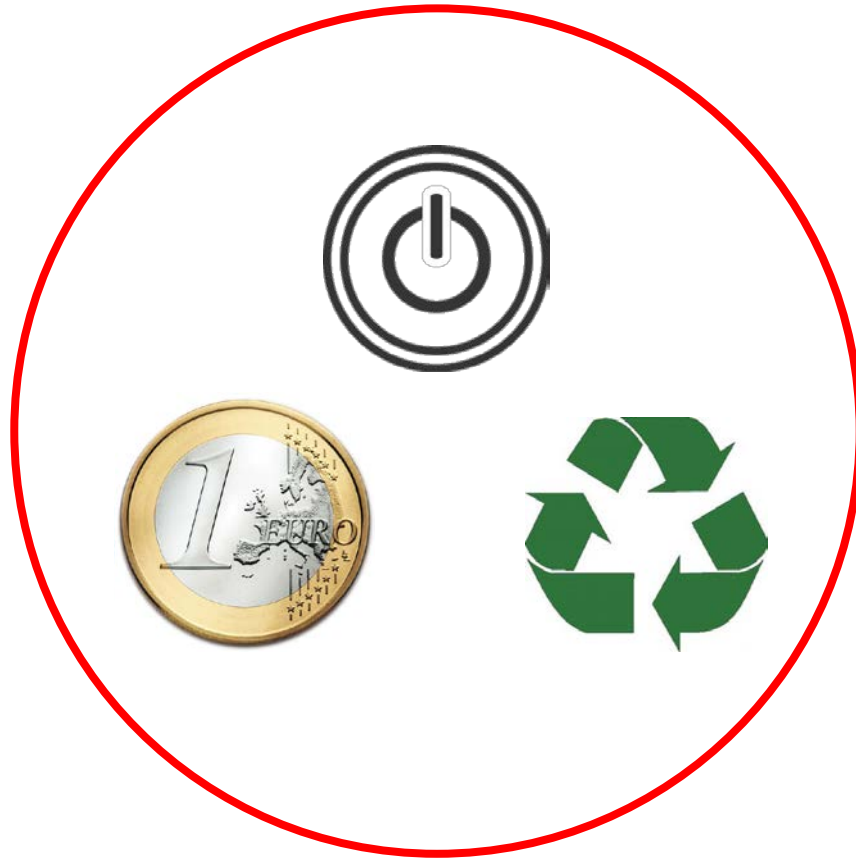
Cheap

Energetic trilemma

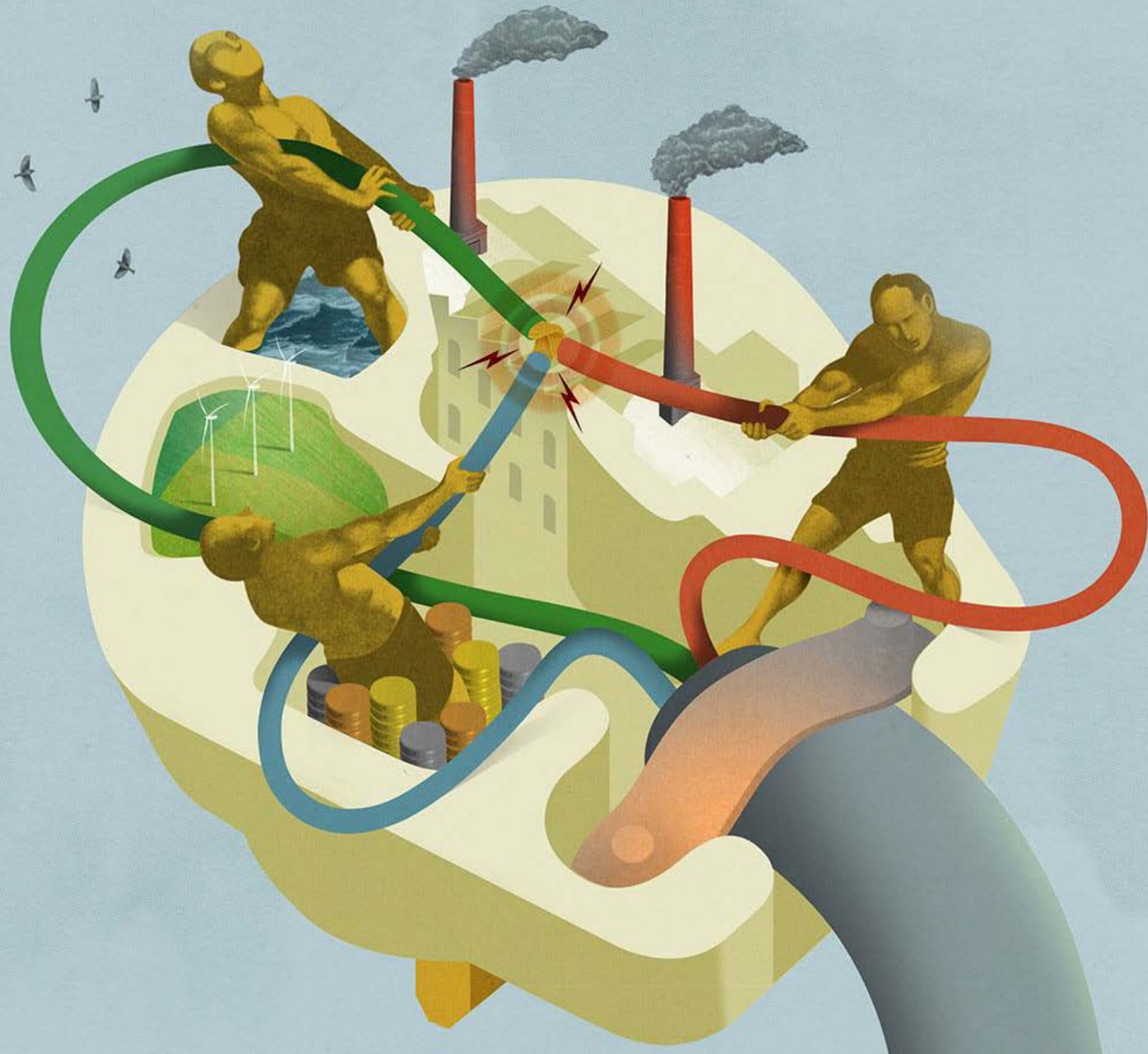


Cheap x clean

Energetic trilemma



Cheap x clean x reliable

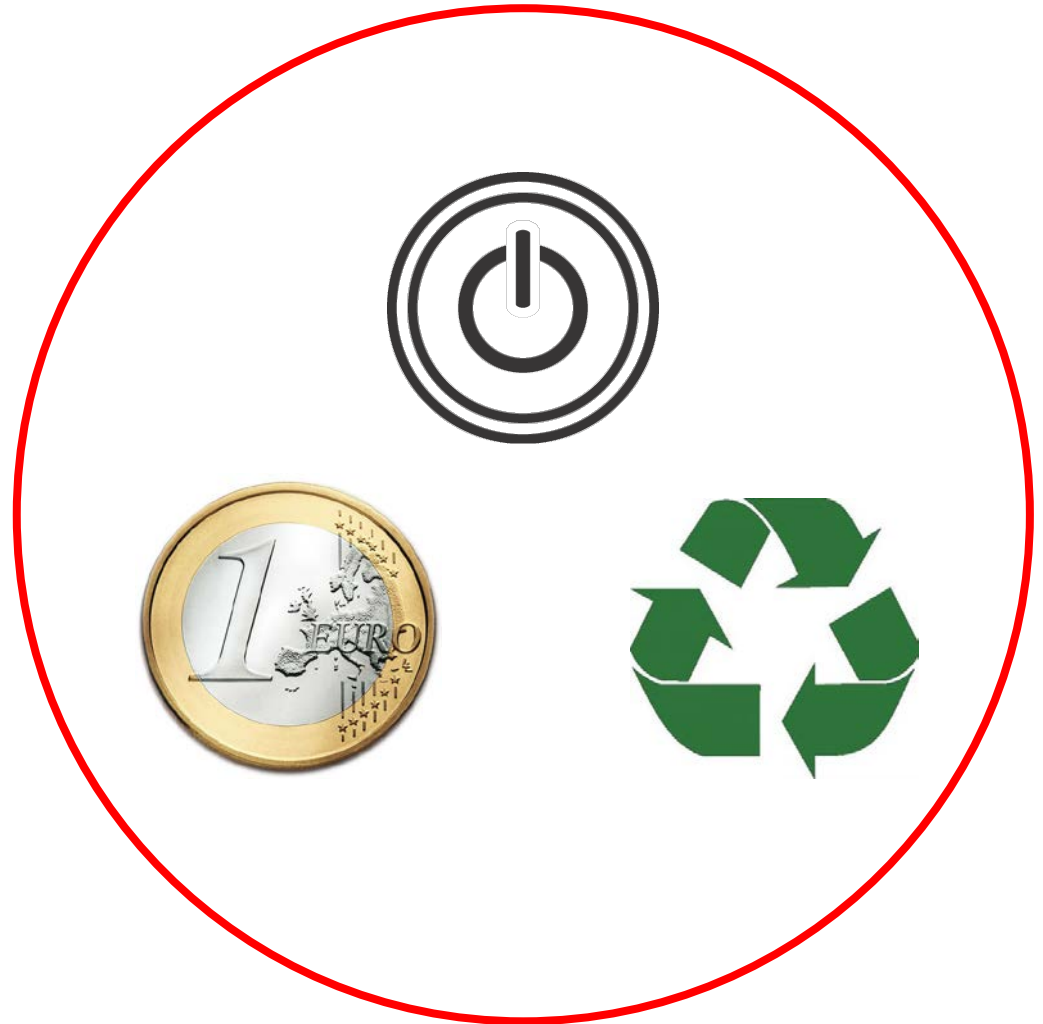




Energetic trilemma

Win-win strategy ?

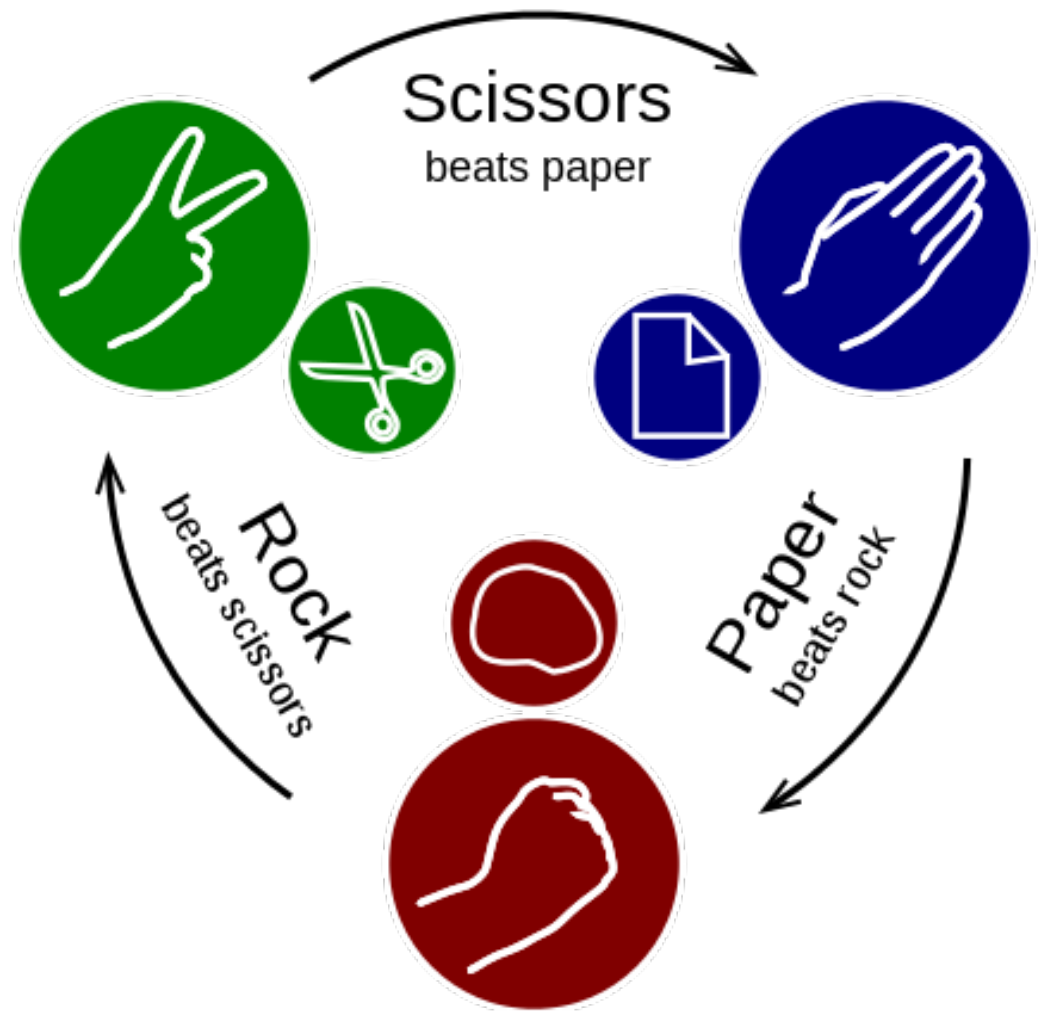
- support  = ?
- support  = ?
- support  = ?



Energetic trilemma

Win-win strategy ?

- support  = ?
- support  = ?
- support  = ?



Energy use - consequences



- non-renewable E - coal, gas, oil, uranium

→ **significant env. consequences, but reliable source**

- renewable E – sun, wind, heat-pumps, biomass, etc.

→ **significant env. consequences, non-reliable source**



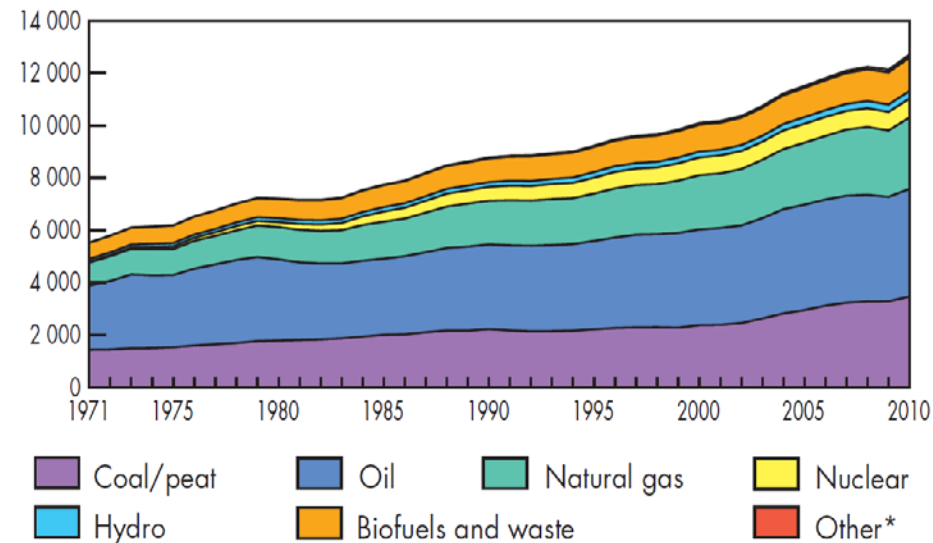
Steep increase of **E demand**:

- 1925 – 1,485 mil. coal (equiv.)

- 1970 – 6,821 mil. coal (equiv.)

- 2000 – 15 000 mil. coal (equiv.)

~ **3.2% increase per year**

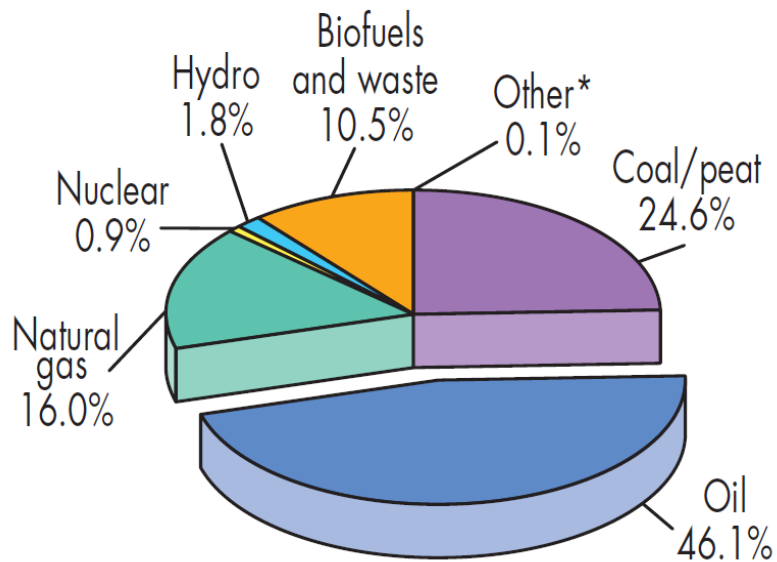


World E production 1971-2010.

* incl. geothermal, solar, wind, etc.



1973



6 107 Mtoe

Share of sources on total E production (1973)

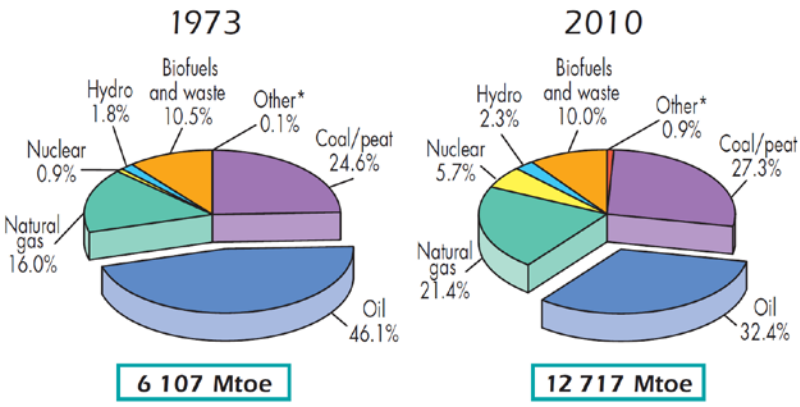
2016

A share of renewable sources of energy are today - compared to 1973

Higher

Almost
the same

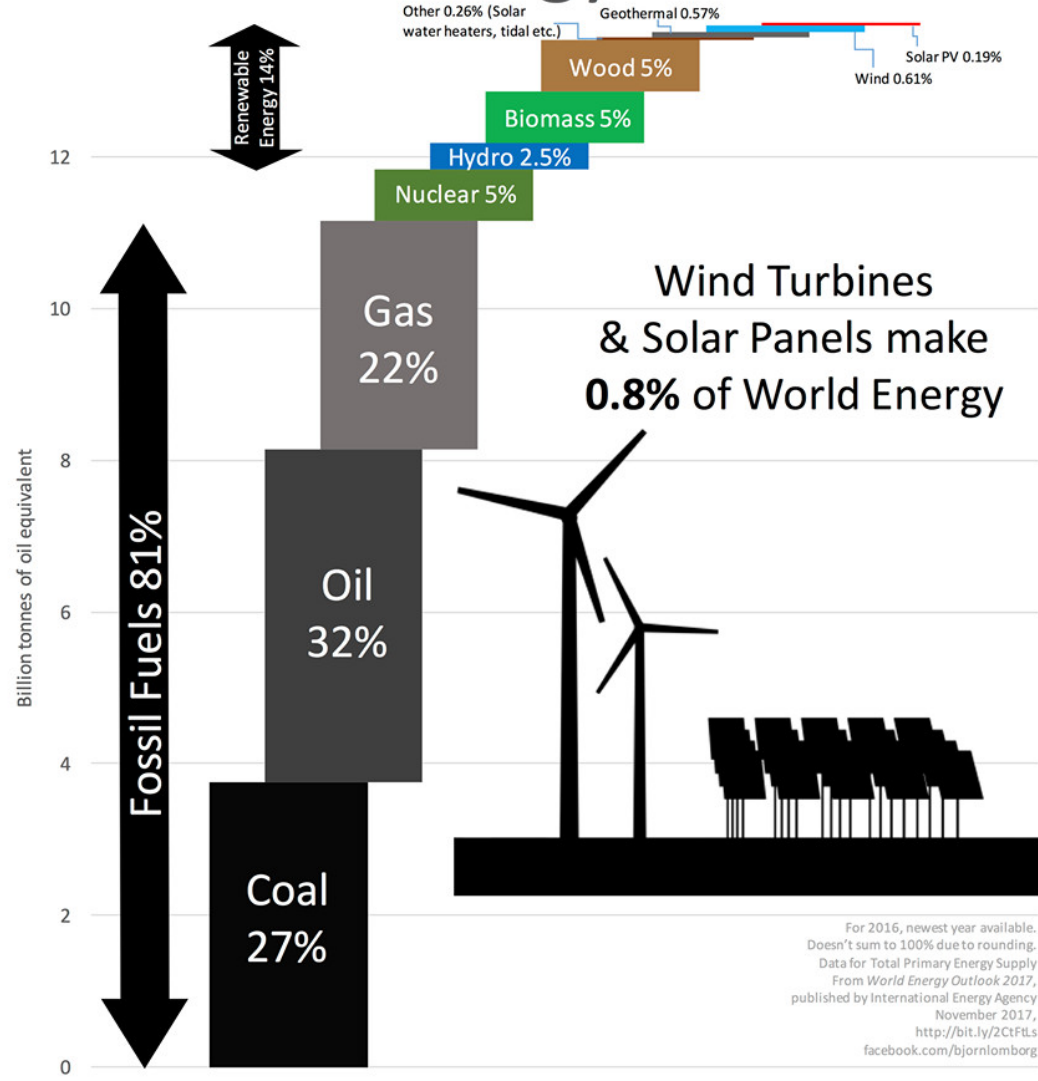
Lower



**Share of sources on total E production
1973 and 2010.**

*** incl. geothermal, solar, wind, etc.**

World Energy Balance



2016

For 2016, newest year available.
Doesn't sum to 100% due to rounding.
Data for Total Primary Energy Supply
From *World Energy Outlook 2017*,
published by International Energy Agency
November 2017,
<http://bit.ly/2CtFtLs>
[facebook.com/bjornlomborg](https://www.facebook.com/bjornlomborg)

Dependency on fossil E

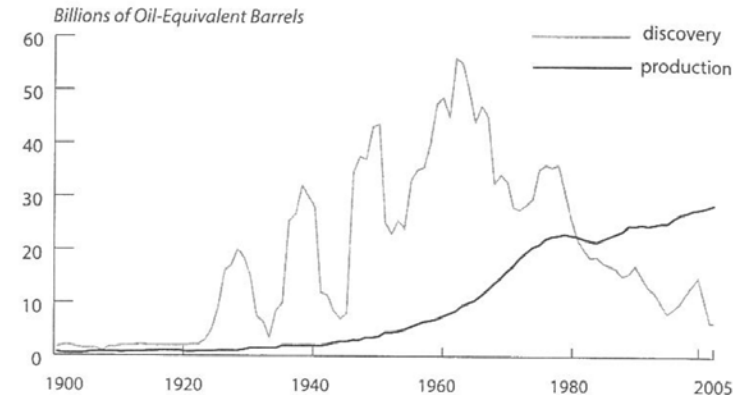
fossil fuels → 81 % world E consumption
- according to the estimates of world E reserves, they will be depleted till the half of 21. century

Oil crisis

- OPEC sharply increases oil prices in the 1970s
- price of oil from Abu Dhabi - \$ 2.54 (1972) x \$ 36.56 (1981) per barrel
- sharp price increases and supply constraints as a result of support of western countries to Israel in the Arab-Israeli conflict

Consequences

- queues at petrol stations,
- panic among business investors
- recession and uncontrollable inflation
- USA severely affected
→ 1977 - 70% of oil imports from OPEC

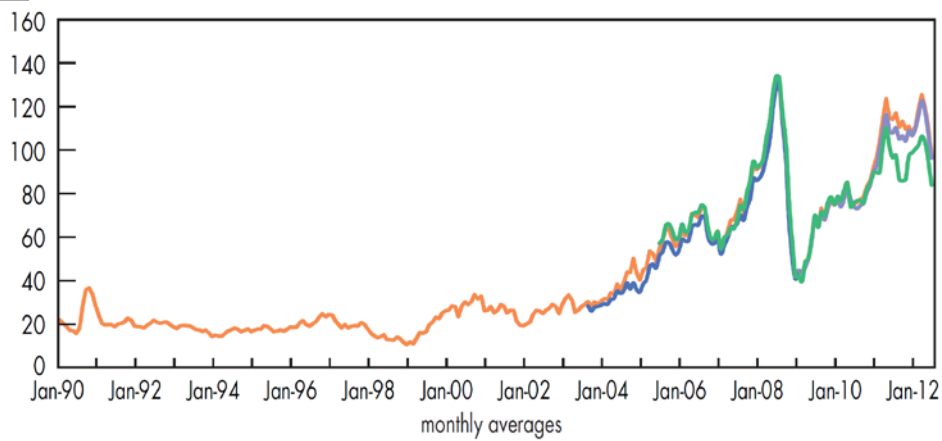


Lesson from oil crisis?

- to ensure own E resources in general
- to increase the extraction of **large oil reserves in Alaska**, Prudhoe Bay
 - however, the ecosystems of this territory are very vulnerable
 - threat - failure and sabotage of the Trans-Alaskan oil pipeline leading to the non-freezing port of Valdez

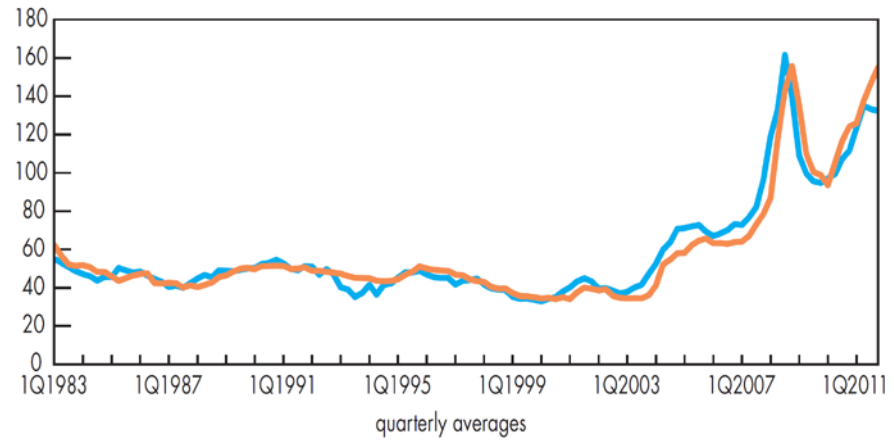


- **dependency on non-renewable resources – real E-crisis solution?**



— North Sea — Dubai — WTI

Crude oil price on world markets (US\$/barrel).

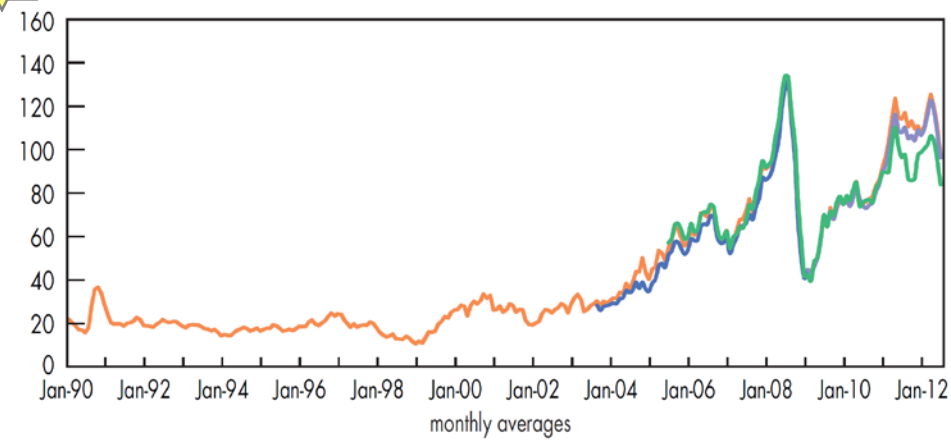


— EU member states* — Japan

Coal price on world markets(US\$/t).

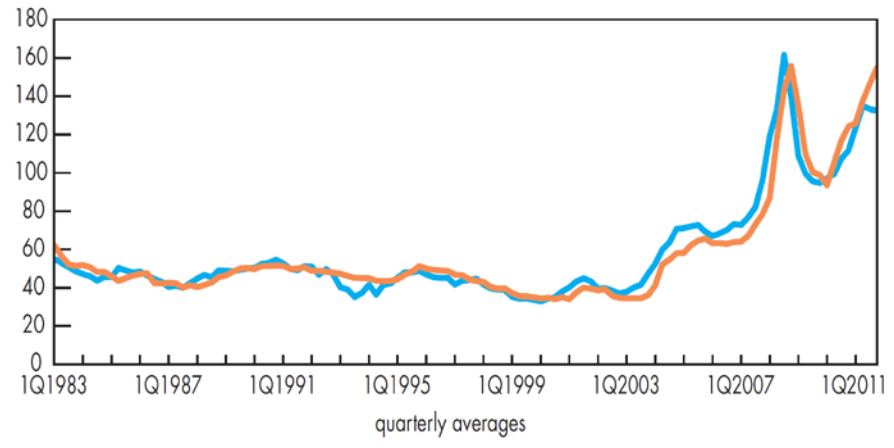


What is an advantage of the high oil/coal prices (>100 US\$/barrel or ton)?



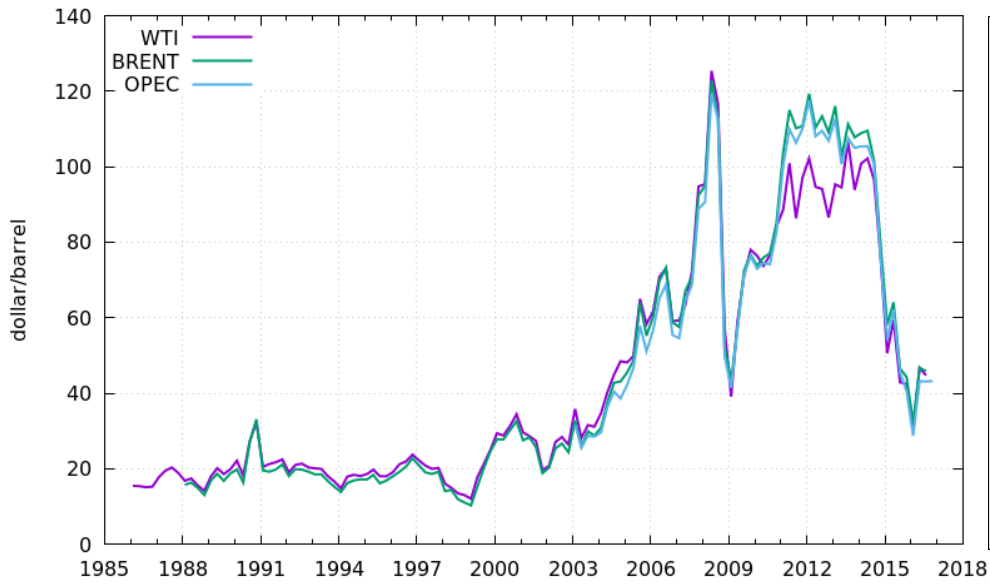
— North Sea — Dubai — WTI

Crude oil price on world markets (US\$/barrel).

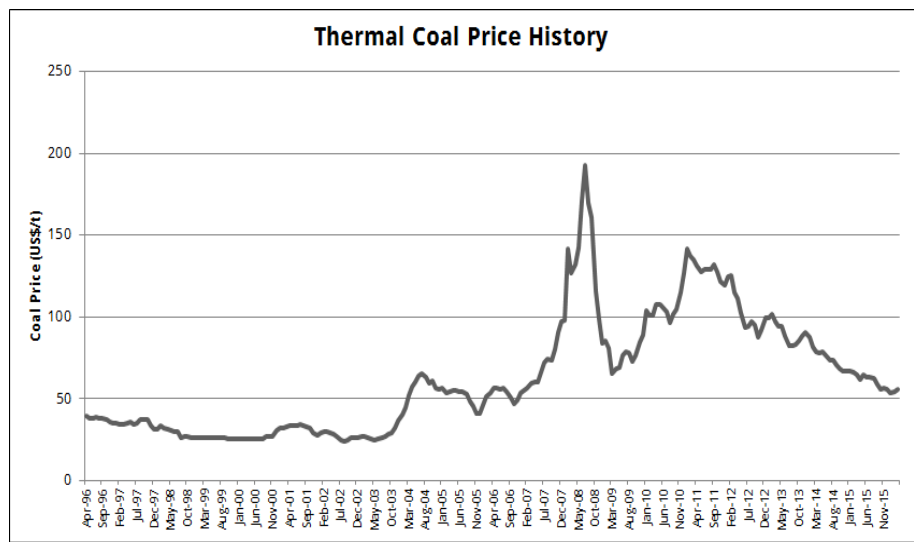


— EU member states* — Japan

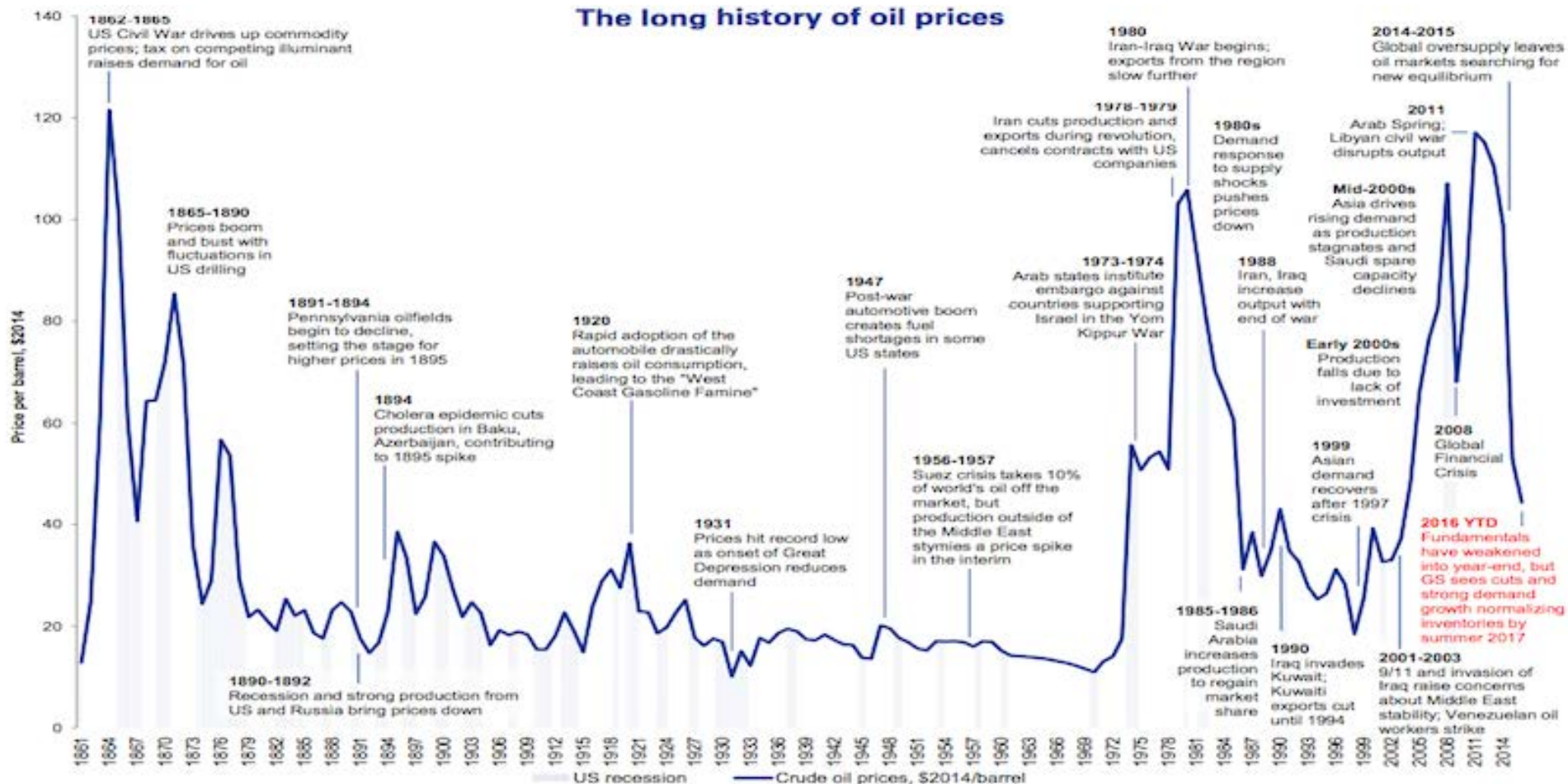
Coal price on world markets(US\$/t).




Nominal oil prices in since January, 1985.



The long history of oil prices



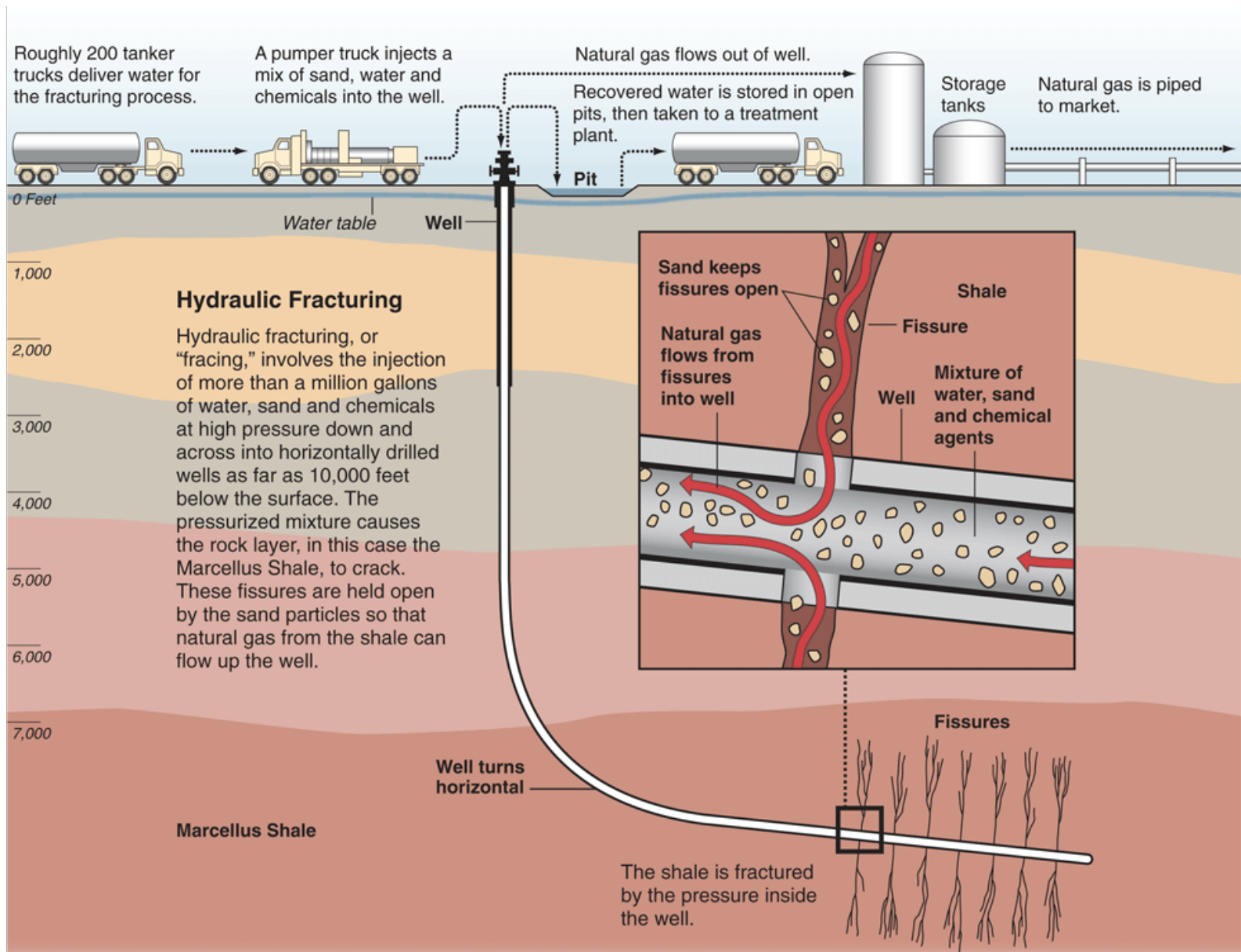


**What is an advantage of low oil/coal prices
(<50 US\$/barrel or ton).**



LEGO: Everything is NOT awesome.

Fracking – extraction of shale gas



Fracking – consequences of CH₄ extraction

Domů > Regiony

Na Náchodsku se břidlicový plyn těžit nebude, MŽP zastavilo řízení

7. 2. 2014 15:34, autor: ČT24

Velikost textu:



Doporučit

102

Tweet

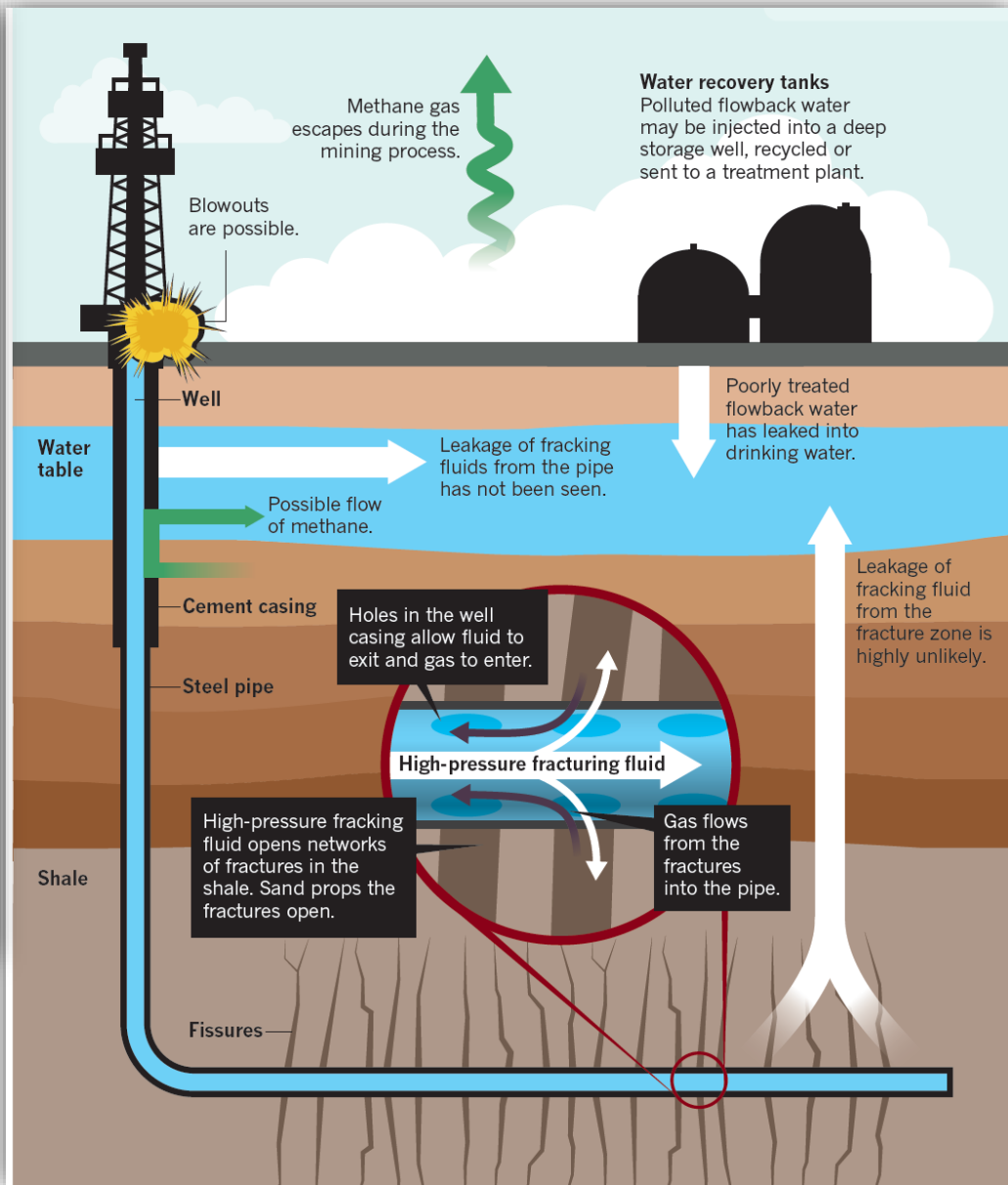
1

Náchod – Cesta k těžbě břidlicového plynu na severovýchodě Čech se zavírá. Těžaři měli zájem o těžbu na Trutnovsku a Náchodsku a požádali ministerstvo životního prostředí o povolení průzkumu. Ministerstvo nyní zastavilo řízení o stanovení průzkumného území.



Těžba břidlicového plynu

Těžební společnosti Basgas Energia Czech požádala nejprve o povolení k průzkumu na rozsáhlém území na pomezí Náchodska a Trutnovska, později průzkumné území zmenšila, aby

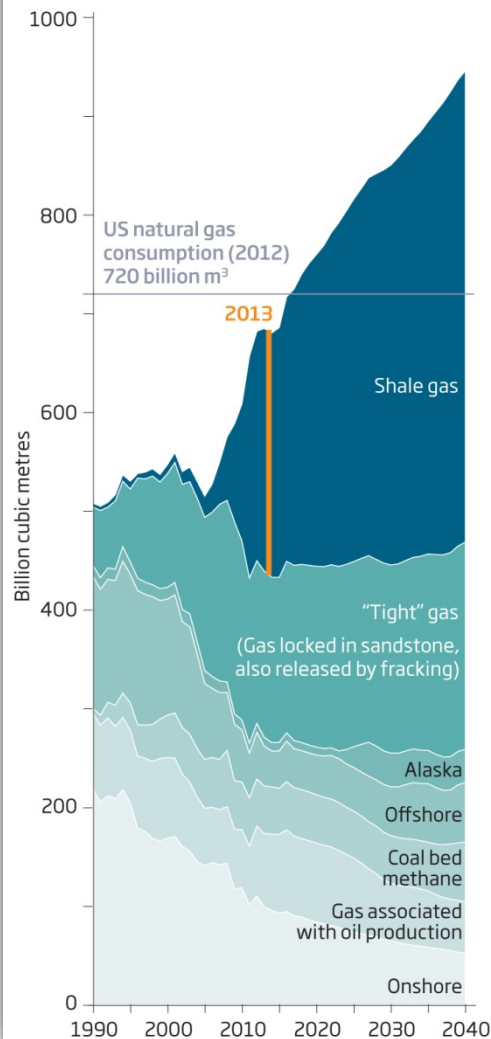


Fracking – CO₂ emissions decrease ?

Where there's a well...

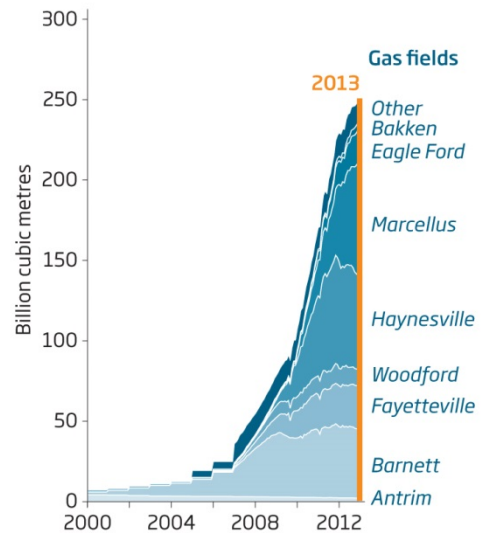
Shale gas production from fields across the US has skyrocketed in recent years...

US NATURAL GAS PRODUCTION

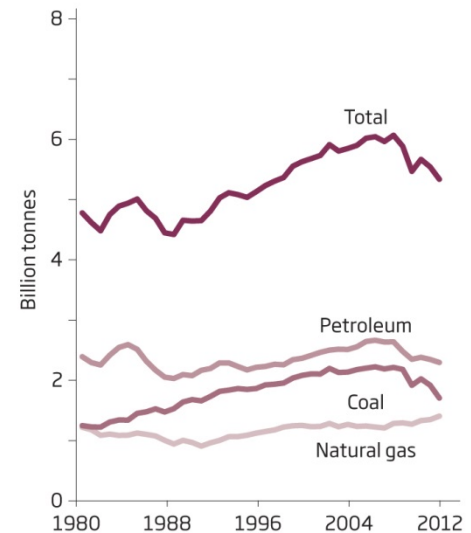


...and, as it has replaced coal burning for electricity generation, has already helped reduce CO₂ emissions

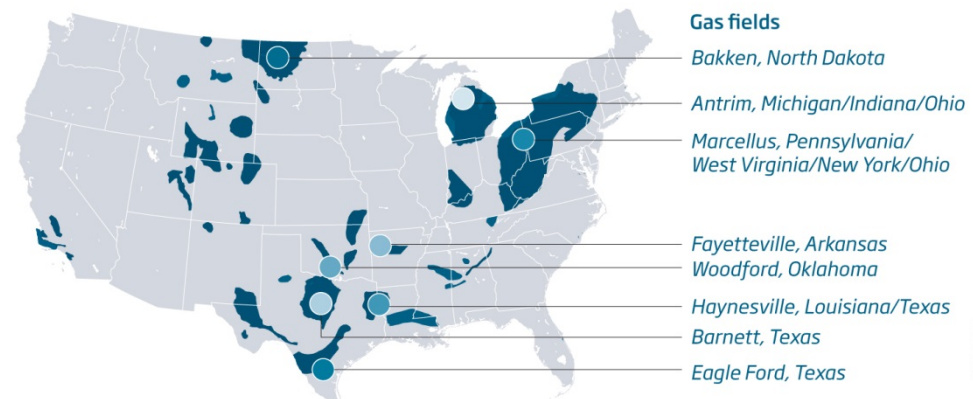
US SHALE GAS PRODUCTION



ANNUAL US CO₂ EMISSIONS



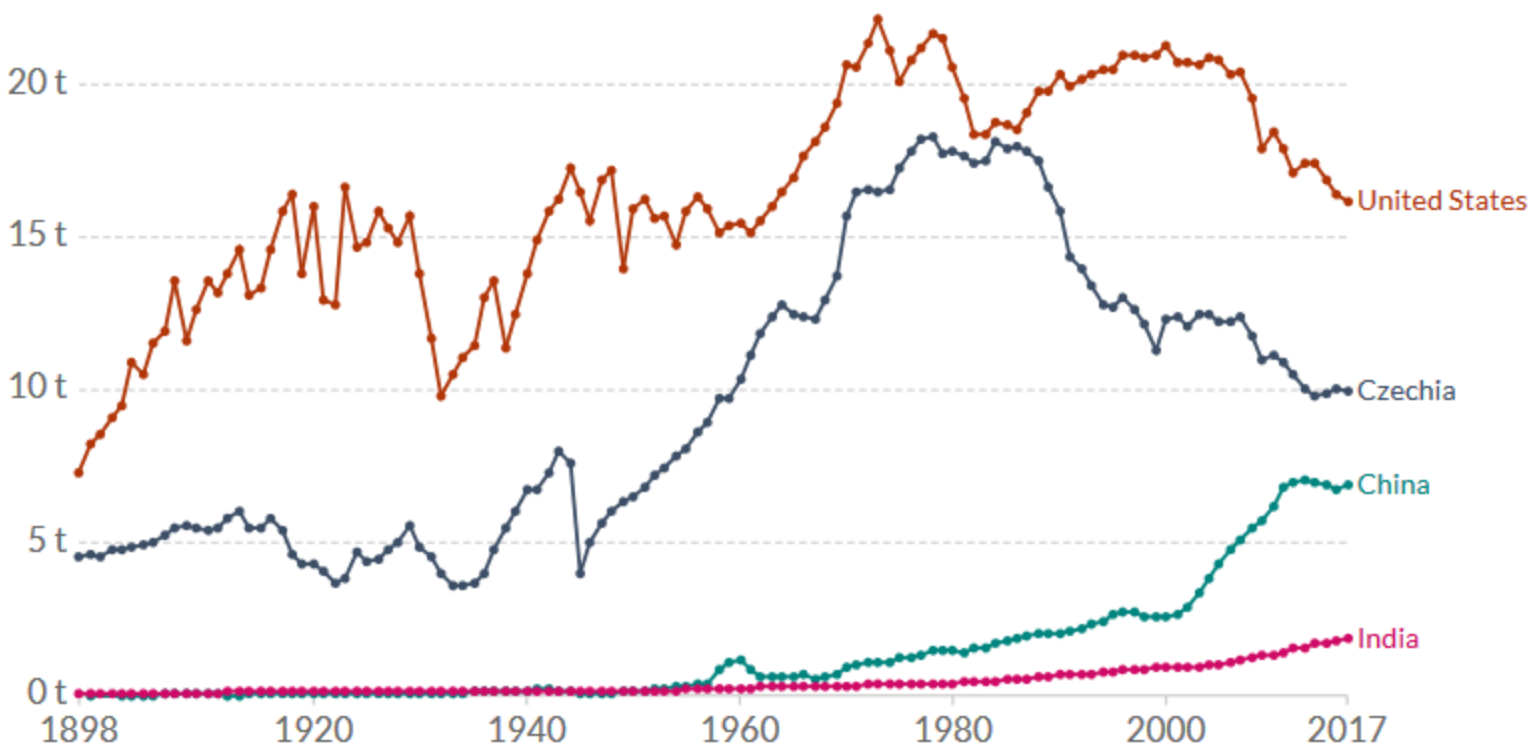
MAJOR AREAS OF SHALE GAS PRODUCTION



Per capita CO₂ emissions

Carbon dioxide (CO₂) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.

[+ Add country](#) Relative change



Source: Our World in Data based on the Global Carbon Project; Gapminder & UN
 Note: CO₂ emissions are measured on a production basis, meaning they do not correct for emissions embedded in traded goods.
 OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

1800
▶
◀
 2019

CHART

MAP

TABLE

SOURCES

DOWNLOAD



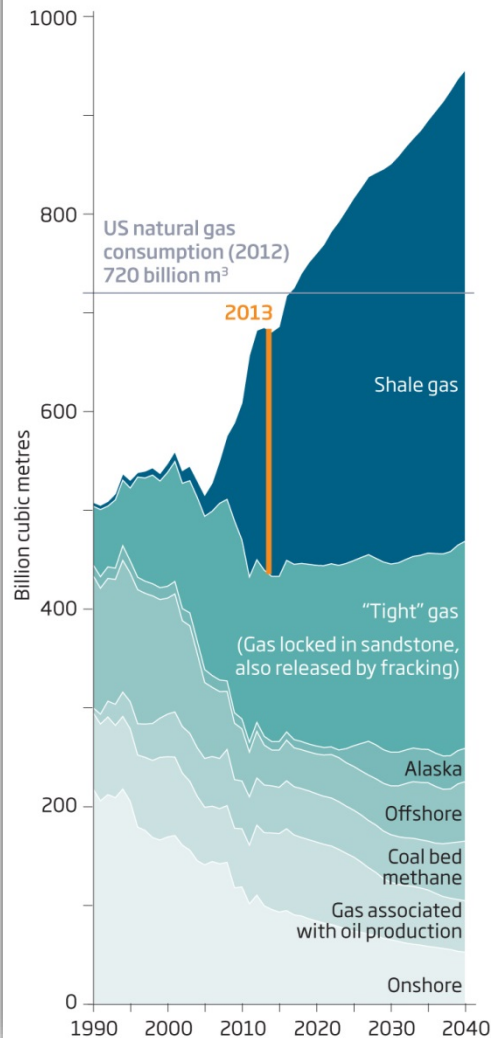
Related: [Where in the world do people emit the most CO₂?](#)

Fracking – CO₂ emissions decrease ? Yes, but...

Where there's a well...

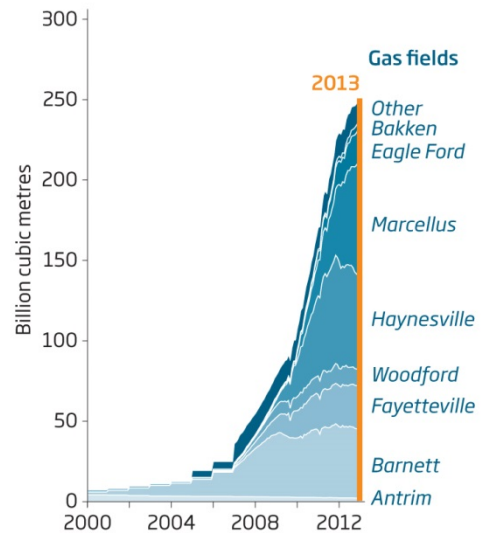
Shale gas production from fields across the US has skyrocketed in recent years...

US NATURAL GAS PRODUCTION

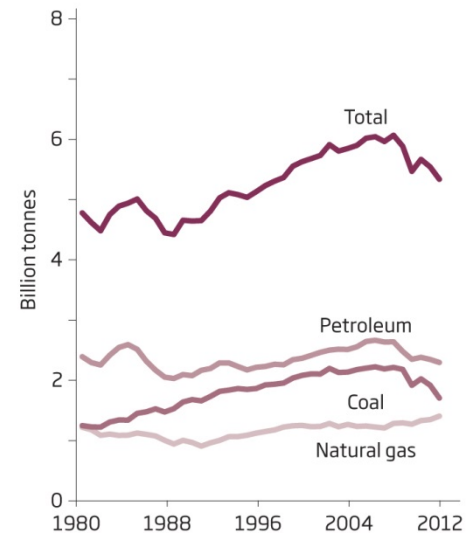


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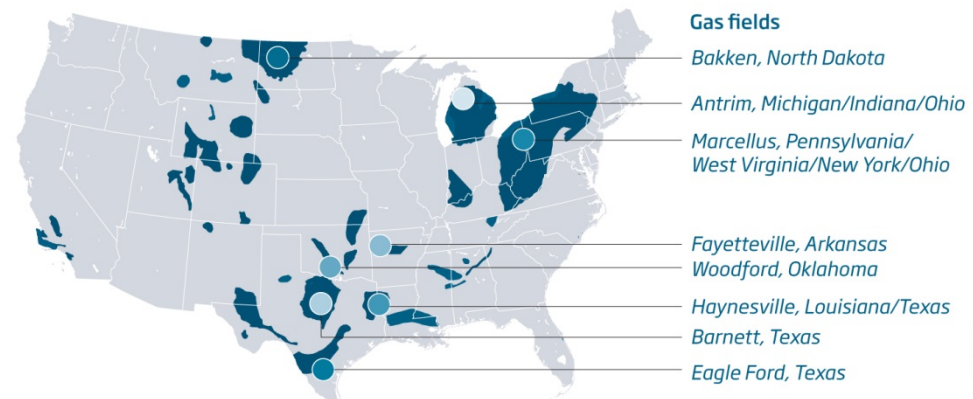
US SHALE GAS PRODUCTION



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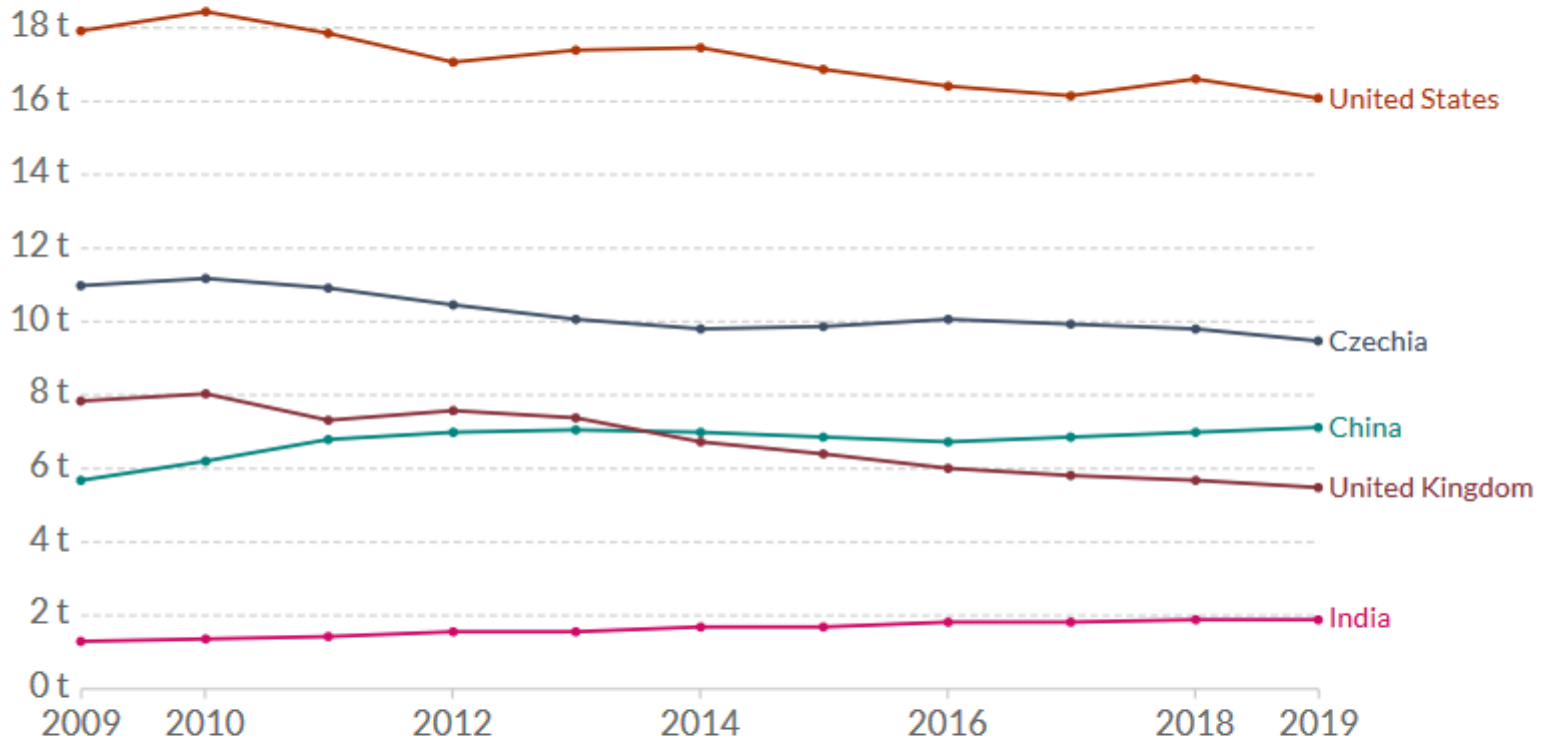
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OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

1800 2019

CHART

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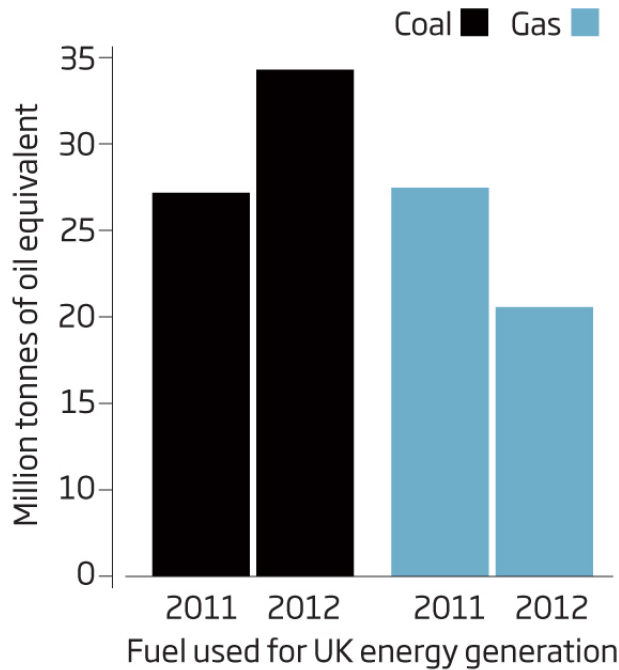
Related: [Where in the world do people emit the most CO₂?](#)

Fracking – CO₂ emissions decrease ? Yes, but...

... too much of cheap coal on the world market...

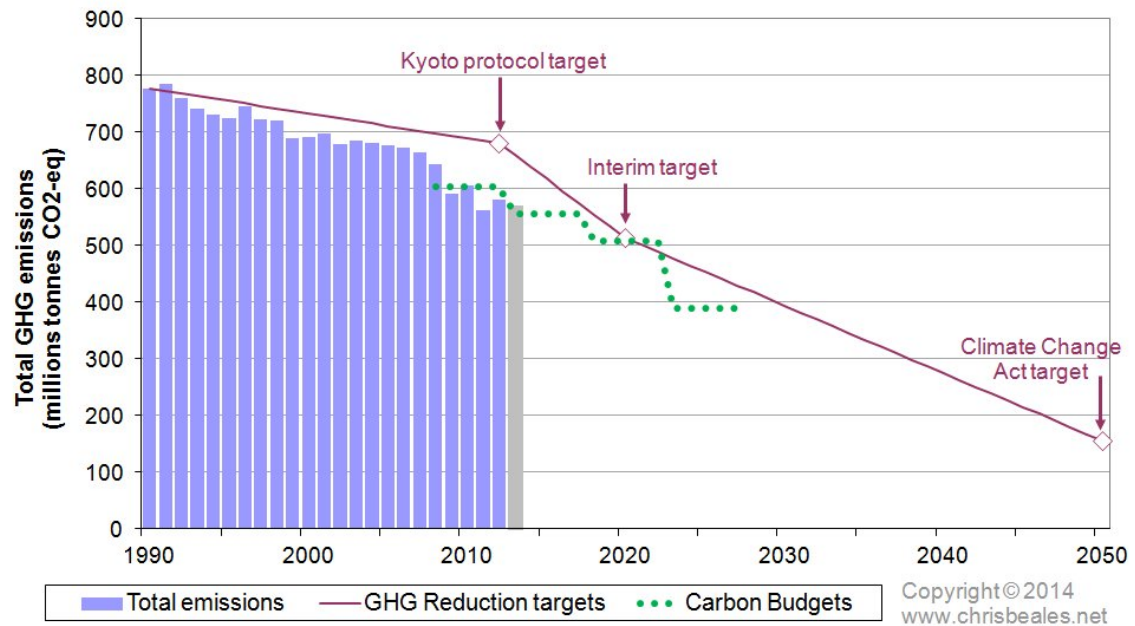
Knock-on effect

The glut of shale gas in the US has led the UK to burn more cheap coal imported from the US and elsewhere



SOURCE: DECC

UK greenhouse gas emissions compared to targets



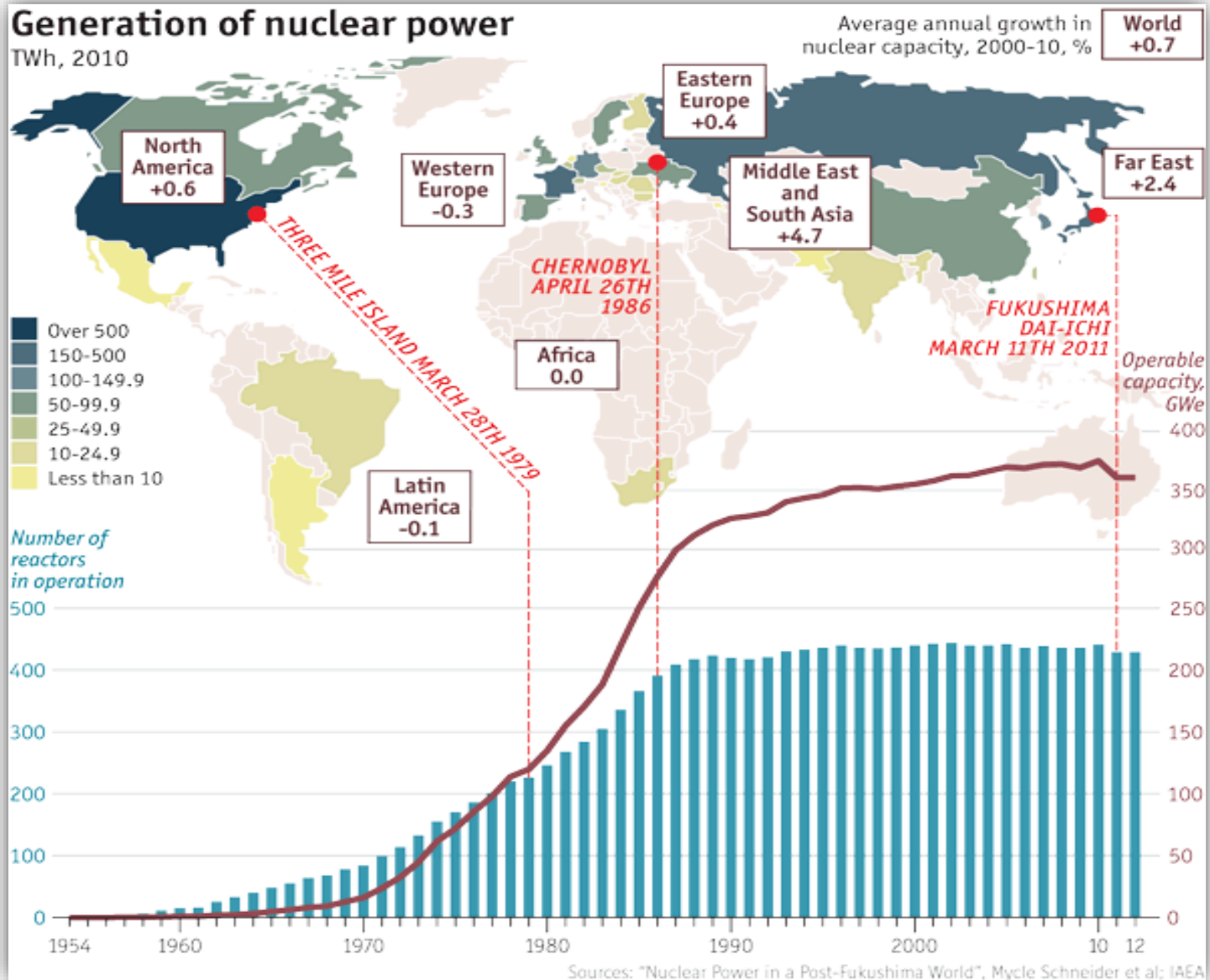
Copyright © 2014
www.chrisbeales.net



**What is your first thought when you hear "A
Nuclear Energy"?**

Nuclear E – solution of global warming?

- reliable, but very expensive and controversial E resource



Nuclear E

Bin in, sink it, bury it – we still don't know what to do with our radioactive waste. Is Finland offering an answer with the world's first deep repository?

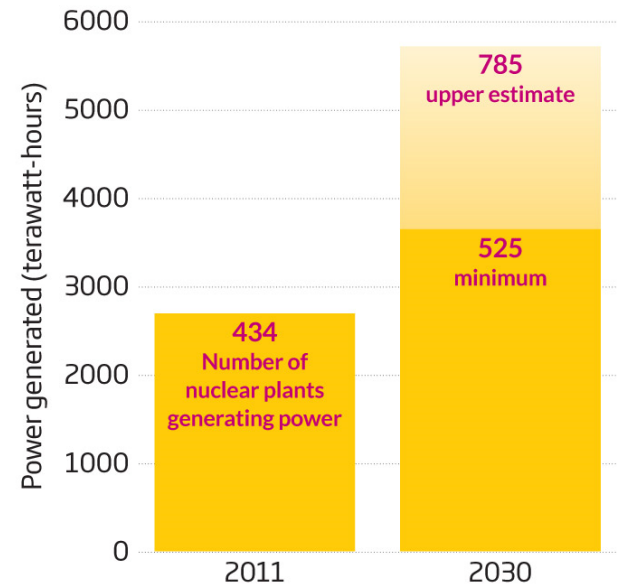
Nuclear waster stored at the Asse II salt cavern is threatened by water leaking into the mine (Image: Helmholtz Zentrum Muenchen/Dapd)



„time bomb“

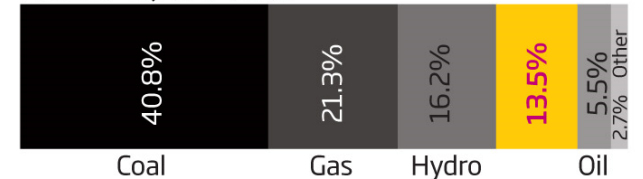
Fission surge

Nuclear energy produces about one-seventh of the world's electricity, but with new fission reactors due online in China, India and Russia, total capacity could double by 2030



SOURCE: EUROPEAN NUCLEAR SOCIETY

Global energy generation 2008: 20,260 TWh



SOURCE: IEA

- since 1988, salt water leaks to the cavern, contamination, water drained out
- 10^5 radioactive barrels, what to do, displace or let it be? (ground water...)

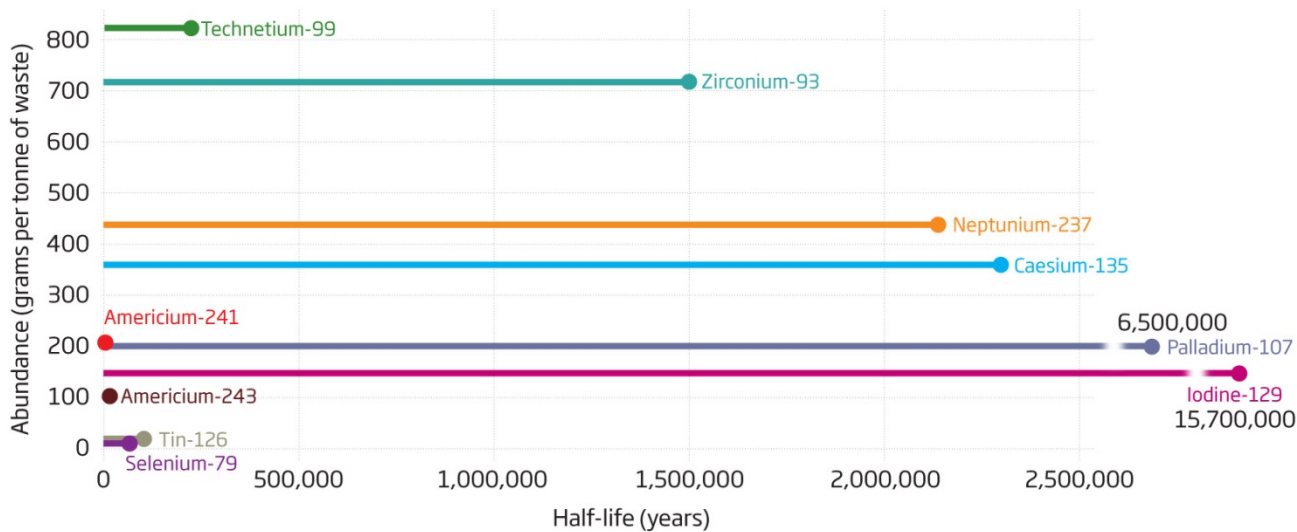
Nuclear E

- *Yuca mountains repository* – 11 bil. US\$ spent for the project until 2010
- unexpectedly strong resistance of the locals led to the abandonment
- **why?** - Nevada has no nuclear plant, but store it here?
 - People faced with the finished thing, no discussion.

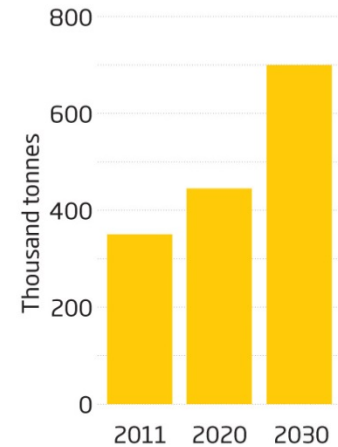
Going underground

Storage facilities are full-to-bursting with long-lived nuclear waste. Is underground burial the safest way to deal with this dangerous legacy?

Main long-lived radionuclides in spent fuel



Global spent fuel



SOURCE: SPENT FUEL DISSOLUTION AND REPROCESSING PROCESSES, ELSEVIER, 2012



How to store waste for 100,000 years? In a hot, humid, and corrosive environment...

Renewable E (RES) – solution of E trilemma ?

- **sustainable source** → in the long term, probably the only way out
- as in the whole age of history, except for the last 300 years



Causes of low RES utilization

- easy availability of non-renewables in the last 300 years → shutdown of RES
- world energy consumption increased 170x, population "only" 10x
- infrastructure adapted to non-renewables
90% of public aid channeled funds and resources for R&D in the energy sector
- the energy „density“ of RES is much lower than that of fossil fuels
- **RES require different handling and change of mindset**





E subsidies

case study:

a **support** of **non-renewables** and E savings from public sources, 1994-1998:

- subsidies to **support non-renewables**, CZK 113 bil.
- support of **nuclear sources**, CZK 20 bil.
- support of **savings + RES**, CZK 3.7 bil.



E subsidies

case study:

a **support** of **non**-renewables and E savings from public sources, 1994-1998:

- subsidies to support non-renewables, CZK 113 bil.
- support of nuclear sources, CZK 20 bil.
- support of savings + RES, CZK 3.7 bil.

Direct subsidies - costs of decommissioning and elimination of consequences, subsidies of heat prices and transition from coal to other fossil fuels (support for gasification of municipalities) and costs of institutions.

Indirect subsidies - free military and police protection of nuclear power plants + assumption of part of liability for damage in case of nuclear accident.

E subsidies

\$400bn in global fossil fuel consumption subsidies, twice that for renewables

June 20, 2019 by [Wataru Matsumura](#) and [Zakia Adam](#)



At over \$400bn in 2018, global fossil fuel consumption subsidies are more than double those for renewables. That makes sense while governments worldwide use energy subsidies to help poor consumers, and clean energy still makes up a smaller proportion of the global energy mix. But it makes the transition harder: cheaper fossil energy means more is consumed, and it'll take longer for clean energy to compete it away. The IEA's WEO Energy Analysts Wataru Matsumura and Zakia Adam run through the landscape, including the evolving subsidy regimes of different nations and the effect of oil price volatility. They conclude that, whatever pathway is taken, phasing out fossil fuel consumption subsidies must be an essential part of energy policy.



Higher average oil prices in 2018 pushed up the value of global fossil fuel consumption subsidies back up toward levels last seen in 2014, underscoring the incomplete nature of the pricing reforms undertaken in recent years, according to new data from the IEA.

Search...

Go



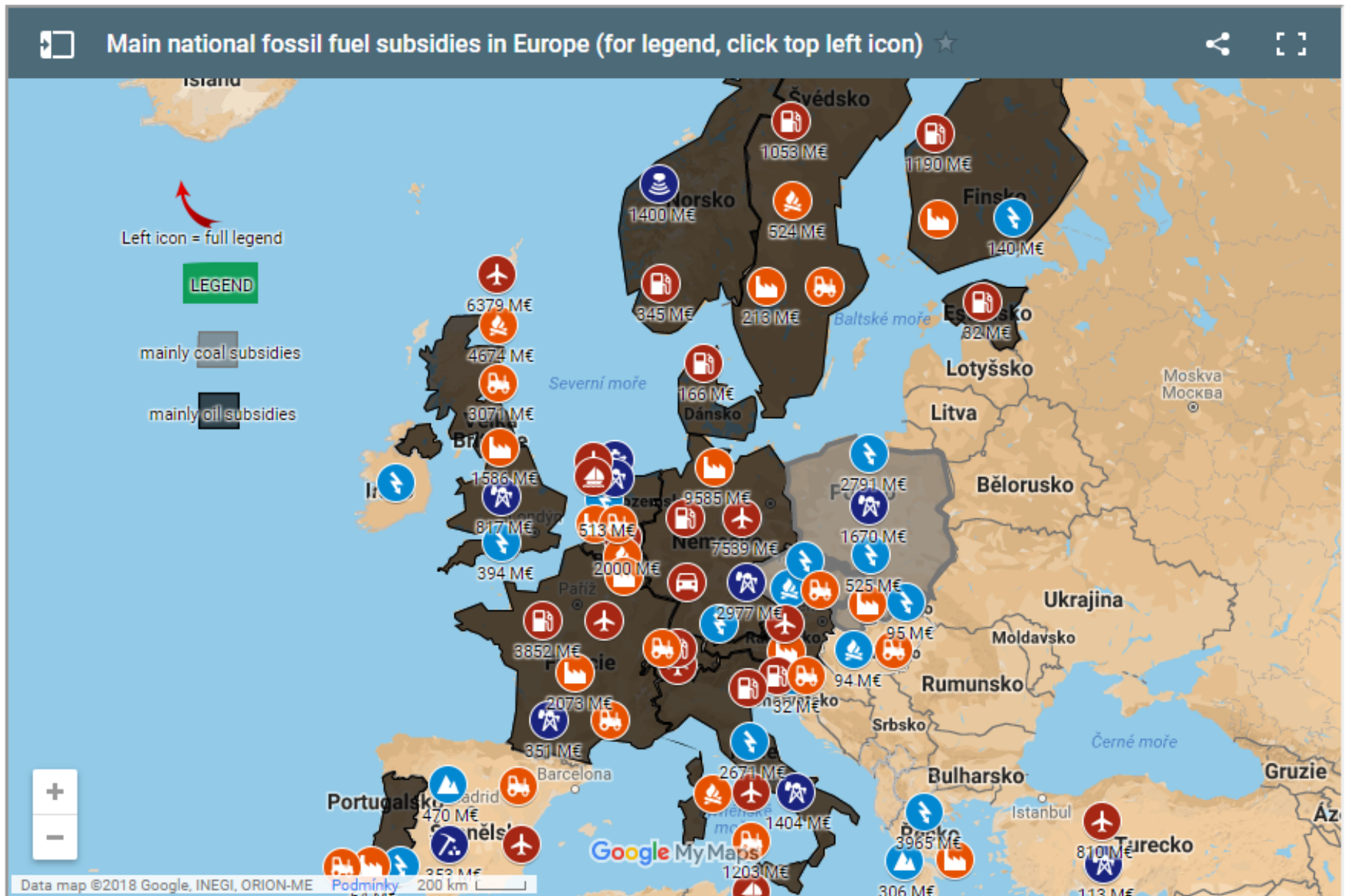
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Latest Platform posts



Non-renewables subsidies



E subsidies

Figure 1: Fossil fuel subsidies and emissions in the E11

SOURCES: OECD (2012), GSI (2012), IEA (2012B), IEA (2012C)



Dotace v energetice

Figure 1: Fossil fuel subsidies and emissions in the E11

SOURCES: OECD (2012), GSI (2012), IEA (2012B), IEA (2012C)

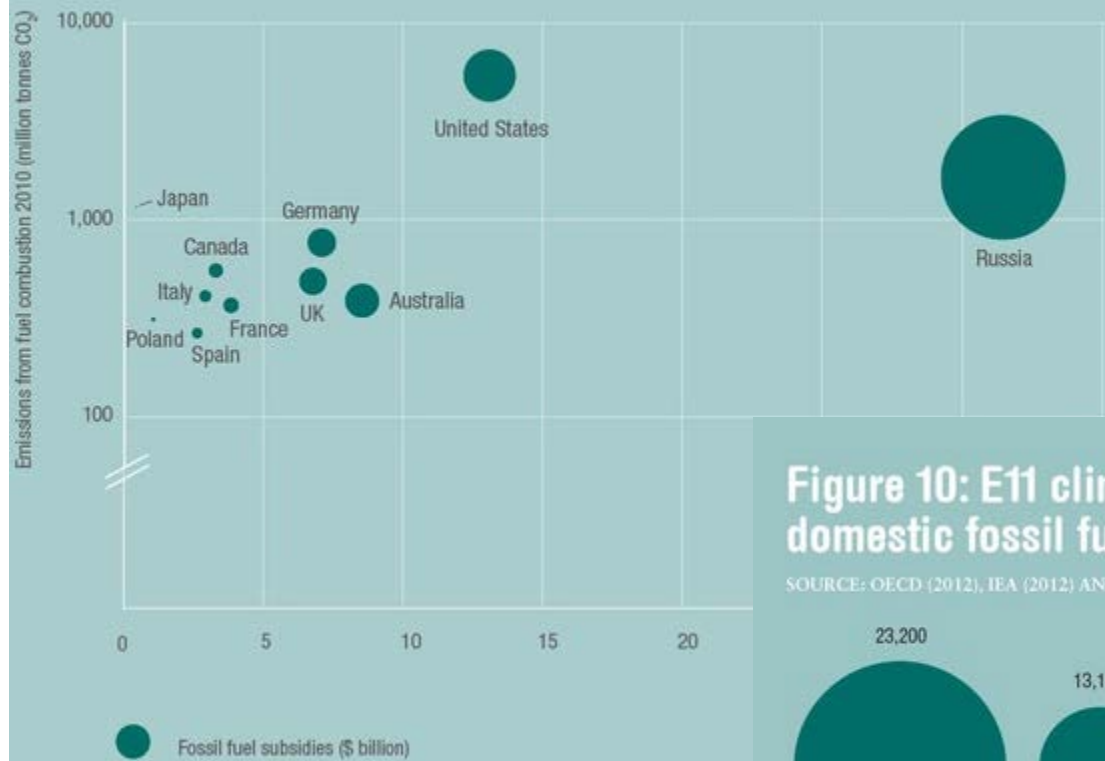
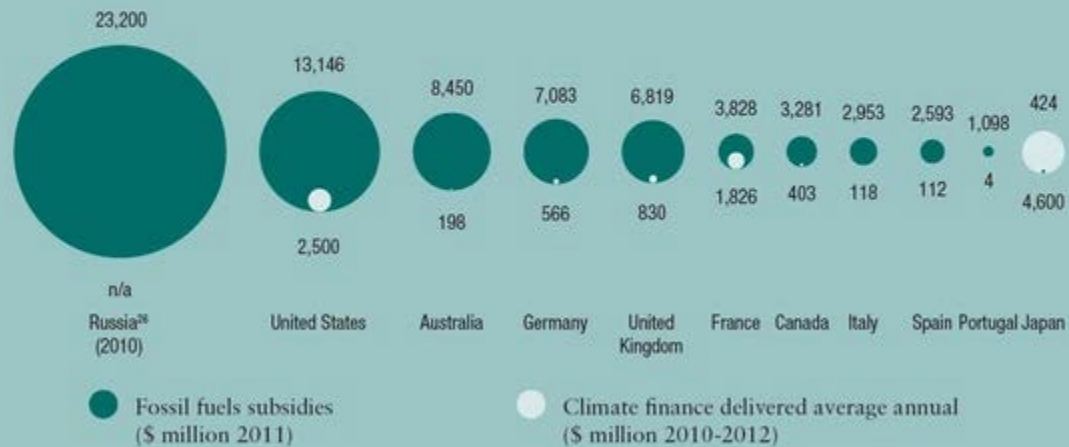


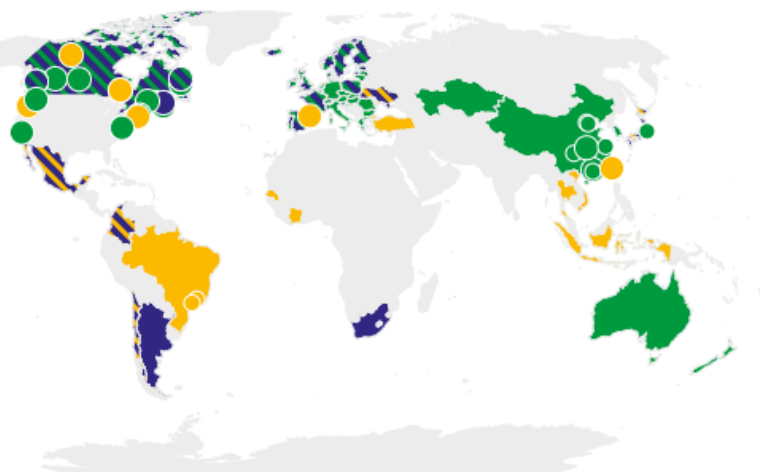
Figure 10: E11 climate finance provided, as compared with domestic fossil fuel subsidies²⁵

SOURCE: OECD (2012), IEA (2012) AND GSI (2012)



Carbon pricing

Summary map of regional, national and subnational carbon pricing initiatives



Data last updated August, 01 2019



STATUS

- Implemented
- Scheduled
- Under consideration

TYPE OF INSTRUMENT

- Carbon tax
- ETS
- Undecided

TYPE OF JURISDICTION

- National
- Regional
- Subnational

● ETS implemented or scheduled for implementation
● ETS and carbon tax implemented or scheduled

● Carbon tax implemented or scheduled for implementation
● ETS implemented or scheduled, tax under consideration

● ETS or carbon tax under consideration
● Carbon tax implemented or scheduled



Smarter Global Targets to 2030

PEOPLE

- LOWER CHRONIC CHILD MALNUTRITION BY 40%
- HALVE MALARIA INFECTION
- REDUCE TUBERCULOSIS DEATHS BY 90%
- AVOID 1.1M HIV INFECTIONS THROUGH CIRCUMCISION
- CUT EARLY DEATH FROM CHRONIC DISEASE BY 1/3
- REDUCE NEWBORN MORTALITY BY 70%
- INCREASE IMMUNIZATION TO REDUCE CHILD DEATHS BY 25%
- MAKE FAMILY PLANNING AVAILABLE TO EVERYONE
- ELIMINATE VIOLENCE AGAINST WOMEN AND GIRLS

PLANET

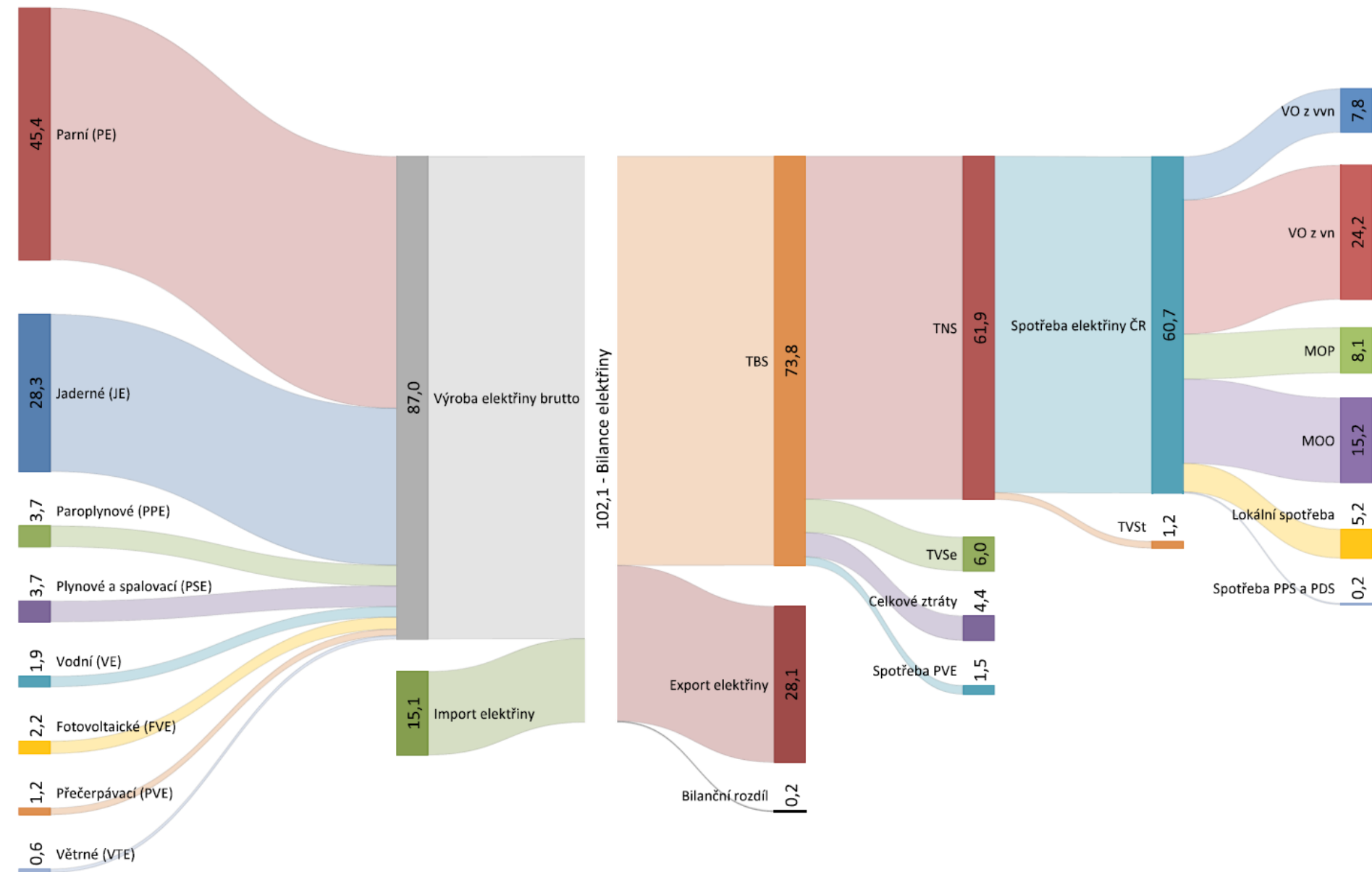
- PHASE OUT FOSSIL FUEL SUBSIDIES
- HALVE CORAL REEF LOSS
- TAX POLLUTION DAMAGE FROM ENERGY
- CUT INDOOR AIR POLLUTION BY 20%



PROSPERITY

- REDUCE TRADE RESTRICTIONS (FULL DOHA)
- IMPROVE GENDER EQUALITY IN OWNERSHIP, BUSINESS AND POLITICS
- BOOST AGRICULTURAL YIELD GROWTH BY 40%
- INCREASE GIRLS' EDUCATION BY TWO YEARS
- ACHIEVE UNIVERSAL PRIMARY EDUCATION IN SUB-SAHARAN AFRICA
- TRIPLE PRESCHOOL IN SUB-SAHARAN AFRICA

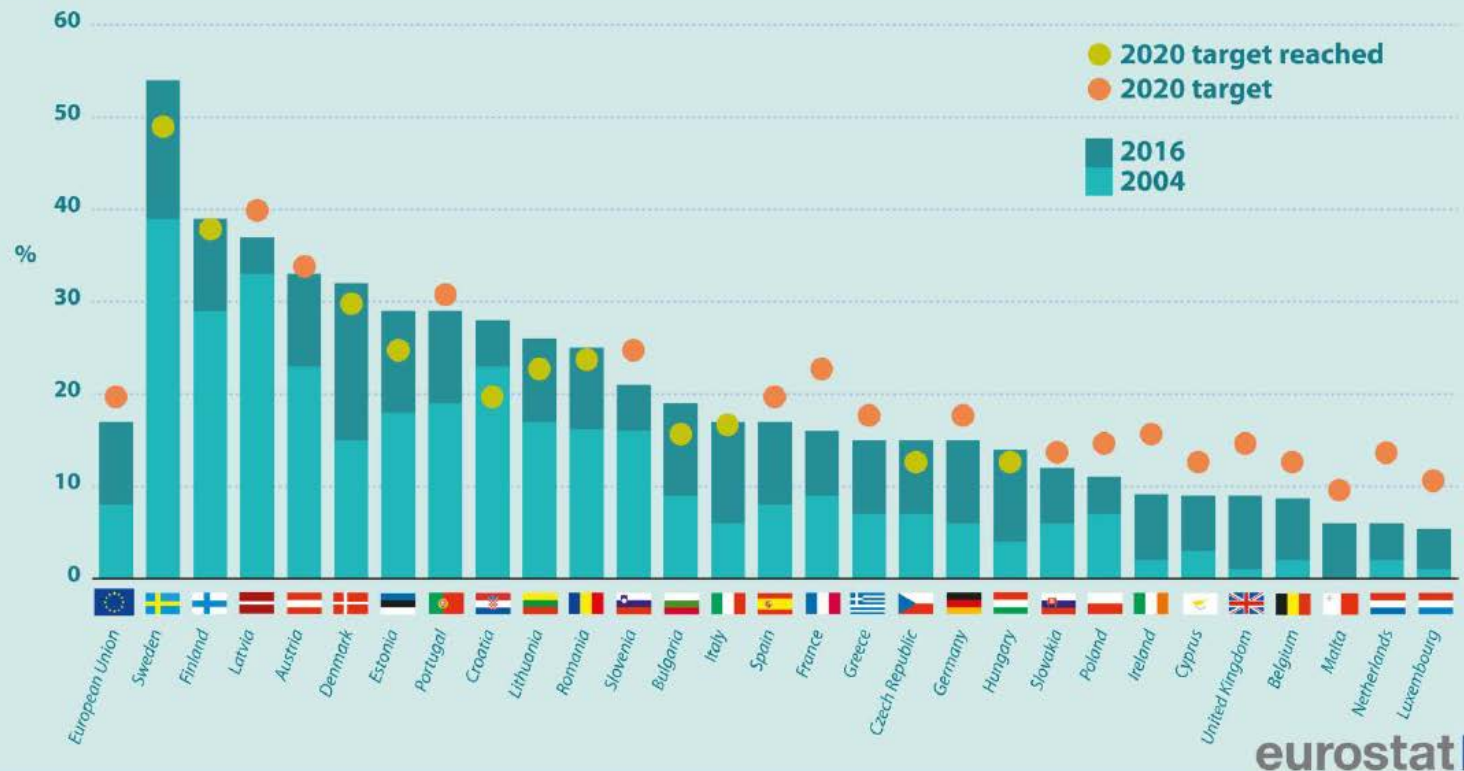
Electricity balance in Czechia, TWh (2017)



Share of RES in EU

Share of energy from renewable sources in the EU Member States

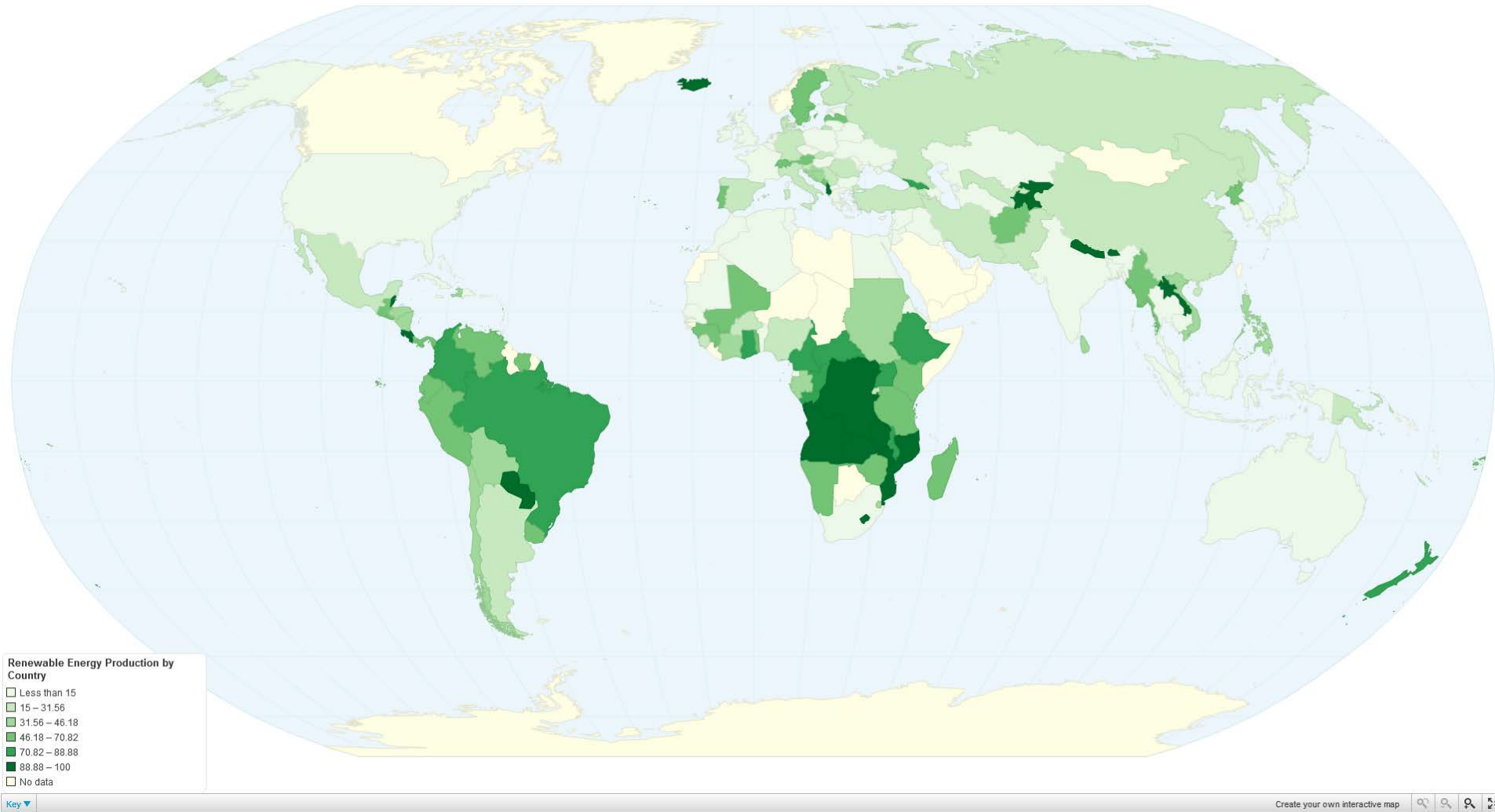
(in % of gross final energy consumption)



In which countries has a renewable energy the highest share?



Share of RES in the World

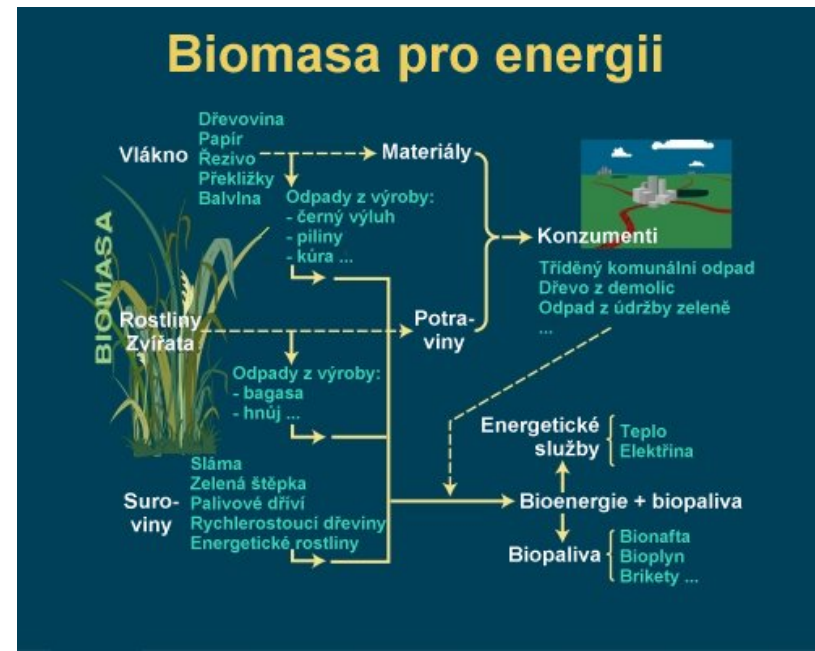


Consequences of RES utilization

- use of RES should be in synergy with the E savings, resp. with energy efficiency → the advantages of using RES become more apparent

Displaced emissions

- type and amount of displaced emissions (Part., SO₂, CO₂, NO_x, C_xH_y), depends on the type of RES
- an essential contribution to climate protection by eliminating GHG emissions in the order of 10 mil. t of CO₂ yearly (2010)



Consequences of RES utilization

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Displaced emissions

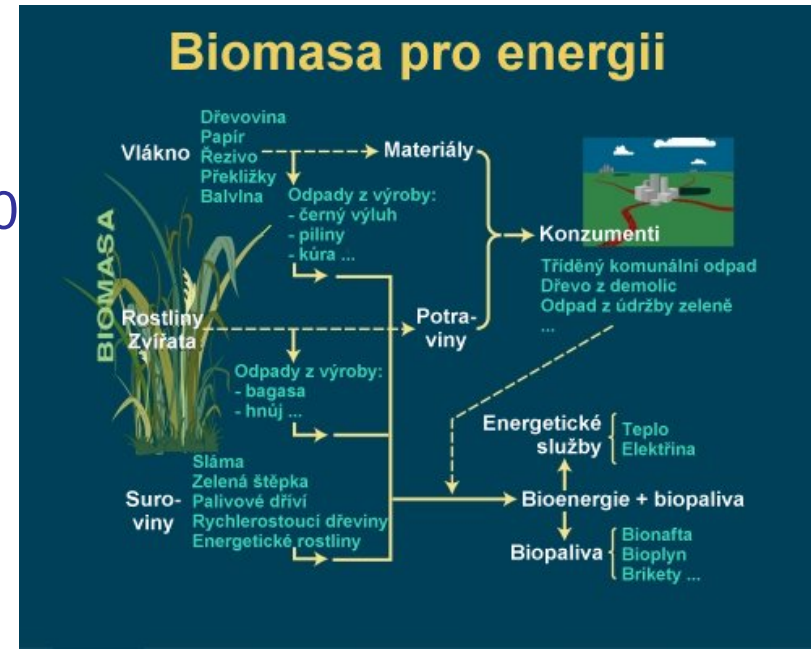
- type and amount of displaced emissions (Part., SO₂, CO₂, NO_x, C_xH_y), depends on the type of RES
- an essential contribution to climate protection by eliminating GHG emissions in the order of 10 mil. t of CO₂ yearly (2010)



Fuel costs

displaced fuel costs, which does not need to be spent thanks to use of the RES can be estimated in circa CZK 2 bln /year (2010)

- the fuel costs incurred on biomass contributes to local development



Consequences of RES utilization

Employment

- employment diversified in many fields and qualification levels



US green economy has 10 times more jobs than the fossil fuel industry



ENVIRONMENT 15 October 2019

By [Adam Vaughan](#)



A wind farm worker in California
Billy Hustace/Getty

The [green economy](#) has grown so much in the US that it employs around 10 times as many people as the fossil fuel industry – despite the past decade's oil and gas boom.

The fossil fuel sector, from coal mines to gas power plants, employed around 900,000 people in the US in 2015-16, government figures show. But Lucien Georgheson and Mark Maslin at University College London found that over the same period this was vastly outweighed by the green economy, which

Consequences of RES utilization

Employment

- employment diversified in many fields and qualification levels



Security of supply

- RES = diversified, local resources contribute to security and independence supply E
- security + partial independence today has increasing meaning (political instability, terrorism, natural disasters...)



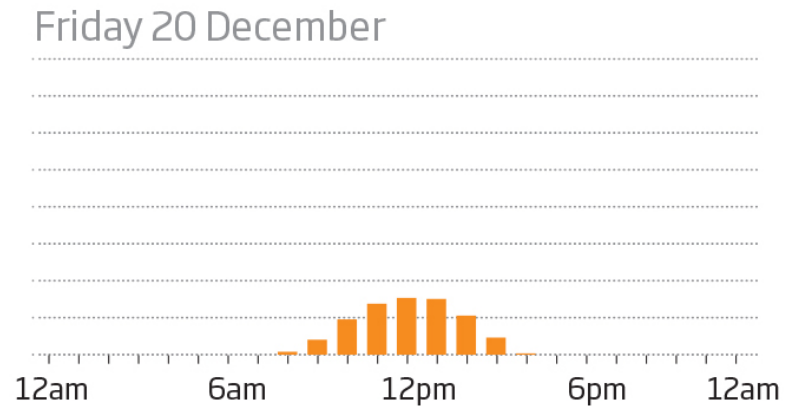
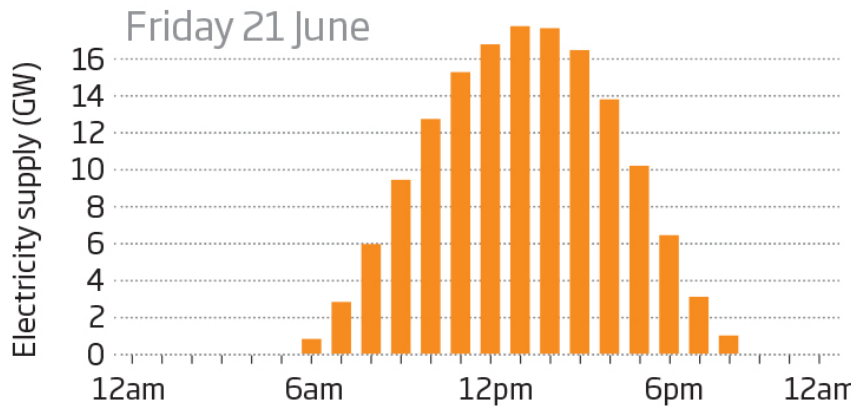
Consequences of RES utilization

- non-reliable E source

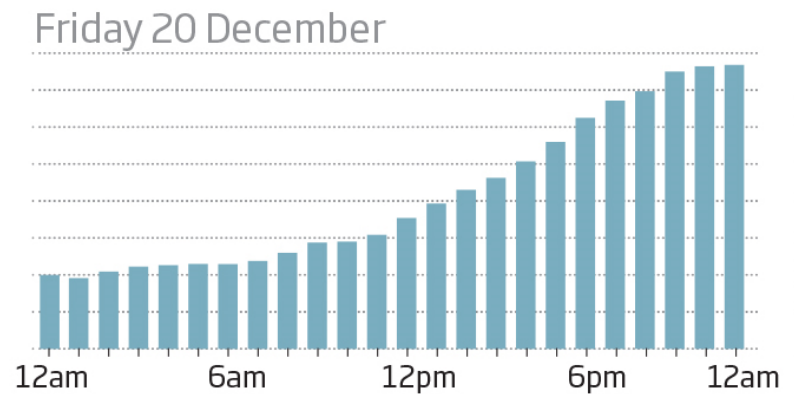
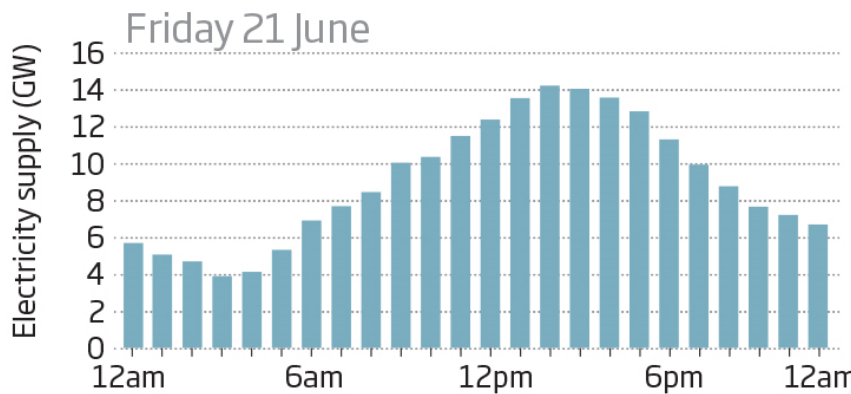


Solar and wind power are both highly variable sources of energy, as 2013 data from Germany shows

Weaker sunlight and shorter daylight hours suppress winter **solar** production...



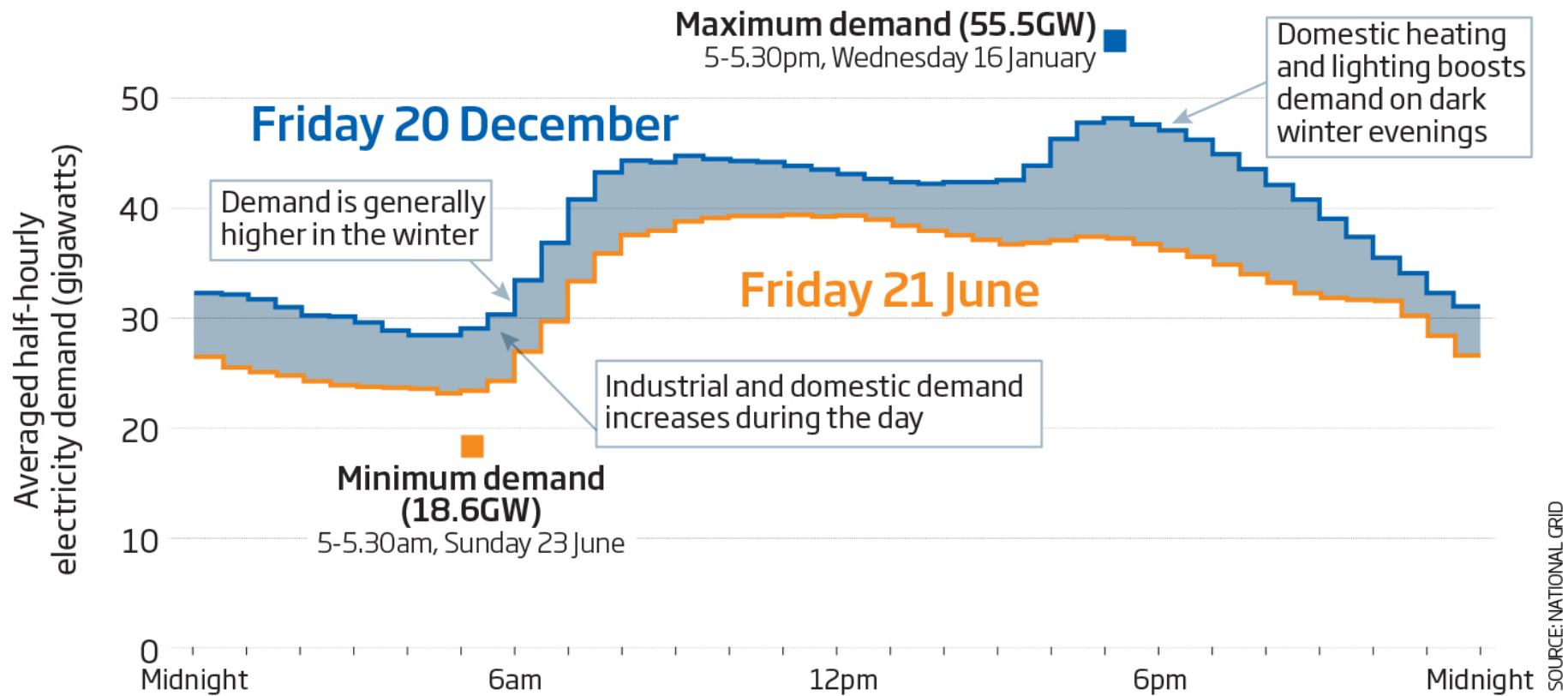
...while the **wind** blows unpredictably from hour to hour and day to day

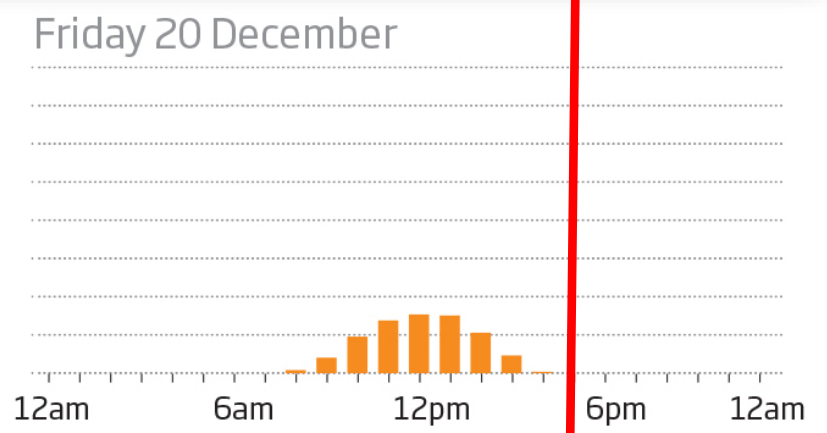
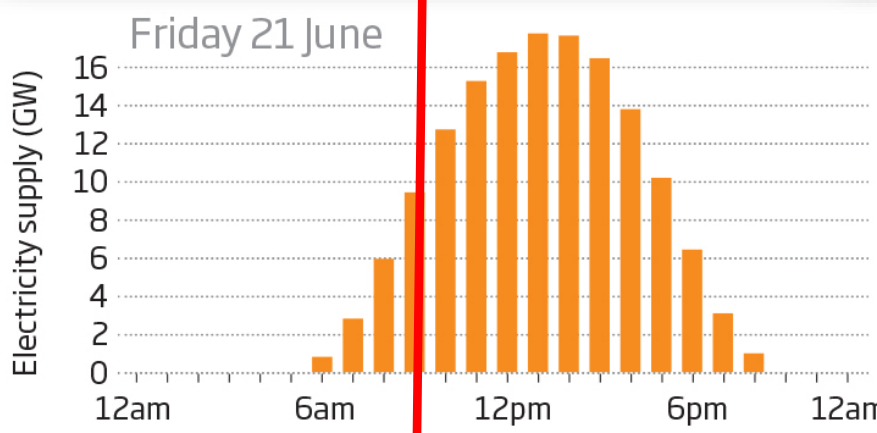
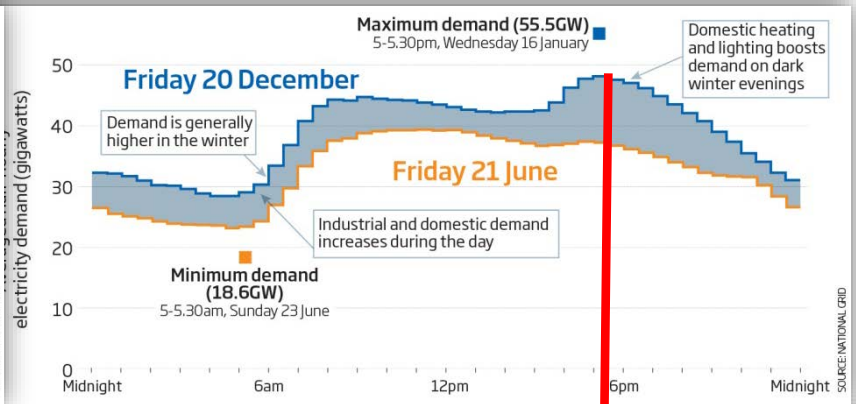
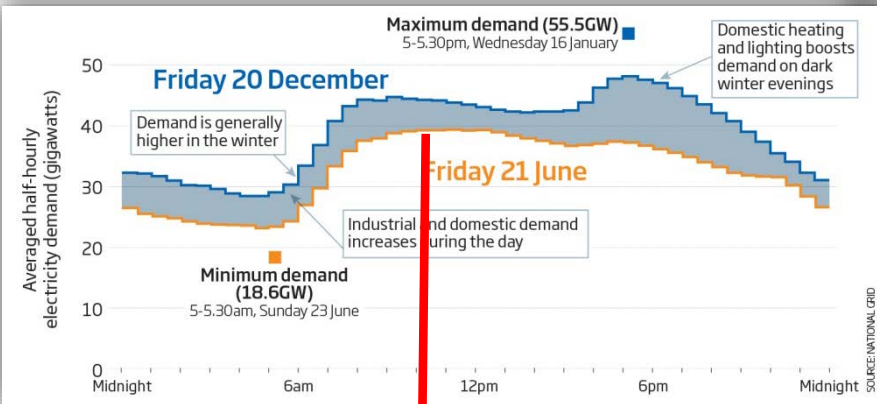


Do we have RES when we need it?

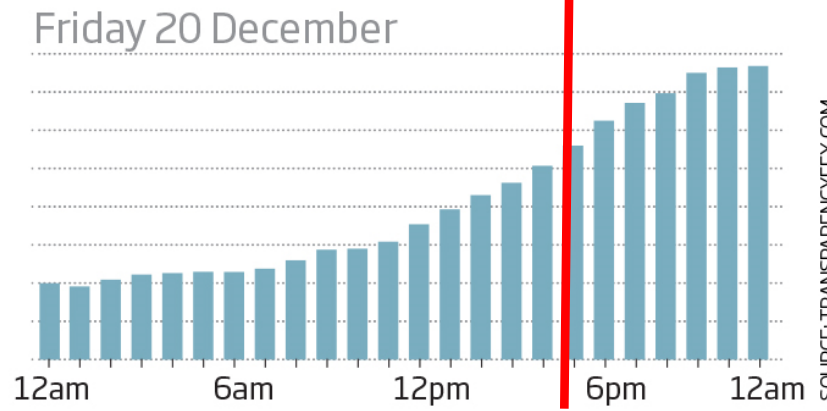
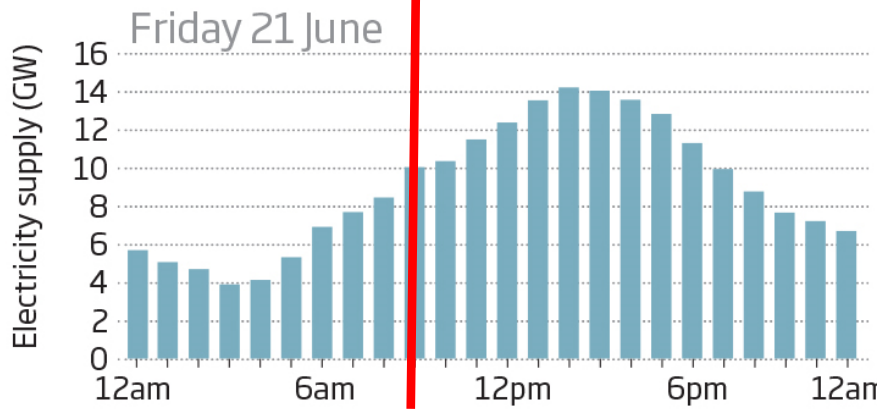
Power ups and downs

As in many countries, UK electricity demand varies throughout the day and across seasons (2013 figures)





...while the **wind** blows unpredictably from hour to hour and day to day



SOURCE: NATIONAL GRID

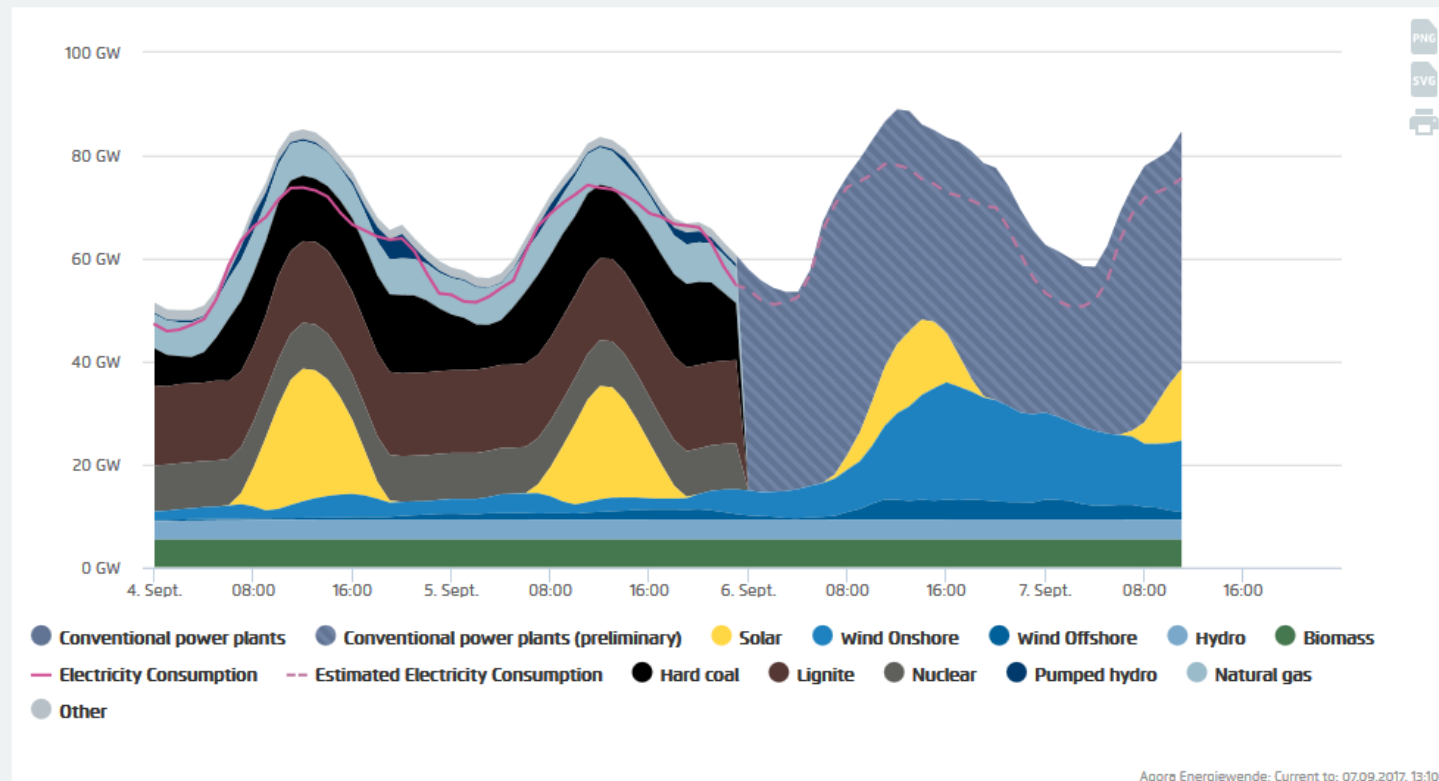
SOURCE: TRANSPARENCY.EEX.COM

Actual E production-consumption in Germany

Agorameter

Achtung: die Daten für den aktuellen Tag sind vorläufig! Attention: Data for the current day is highly preliminary!

Power Generation and Consumption



Green and mean: The downside of clean energy

› 21 April 2009 by [Fred Pearce](#)

› Magazine issue 2704. [Subscribe and save](#)

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YOU can understand the frustration on both sides. Environmentalists worldwide are clamouring for bold action to end the burning of fossil fuels and plug the world into renewables. Politicians throw their weight behind a \$14 billion scheme that would replace the equivalent of eight coal-fired power stations with tidal power. What do they get for their pains? Green outrage.

"This massively damaging proposal cannot be justified," said Graham Wynne, chief of the UK's normally staid Royal Society for the Protection of Birds (RSPB). Friends of the Earth said it was "not the answer". What is going on here? Have greens lost the plot? Has environmentalism been hijacked by big construction companies? Or do we simply have to learn that even environmental energy comes at an environmental cost?

The project causing all the controversy is the Severn barrage on the west coast of Britain, but similar stories are playing out across the world. As greens gradually win the argument for switching to renewable energy, they are finding that they don't always like the look of the new world they are creating.

The problem is one of scale. Bigness is often an issue for greens, many of whom grew up reading one of the movement's key texts: [E. F. Schumacher's *Small Is Beautiful*](#). They liked biofuel while it was about recycling cooking fat, but not when it became growing millions of hectares of palm oil in former Borneo rainforest. Solar panels on roofs are good, but covering entire deserts with them is another matter. They like small wind turbines and even small wind farms, but get very jumpy as wind power reaches industrial scale.

Small may be beautiful, but it won't change the world. You can't generate vast amounts of green energy without large-scale engineering projects, which inevitably do some damage to the natural environment.

Greens have been here before, to some extent. Once, long ago, they loved large dams. From the 1930s to the 1960s, hydroelectricity was regarded as the new, clean and cheap source of electricity. Nobody cared about climate change then, but they did care about the killer smogs from burning coal. From the Rockies to the Alps, from Scandinavia to the Tennessee valley, nature would be harnessed to provide clean power for the masses. [Woody Guthrie](#)

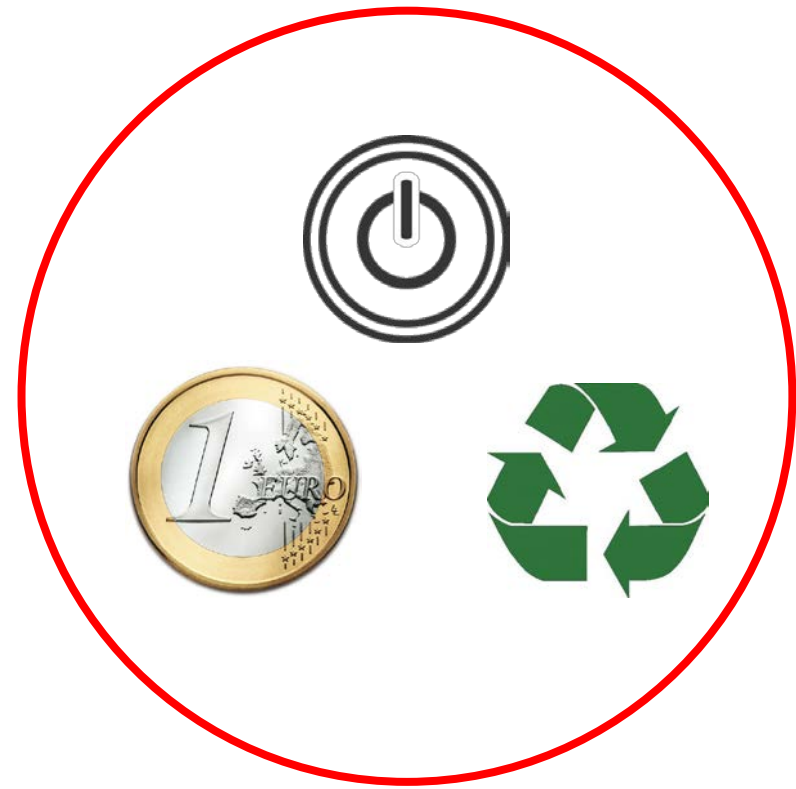
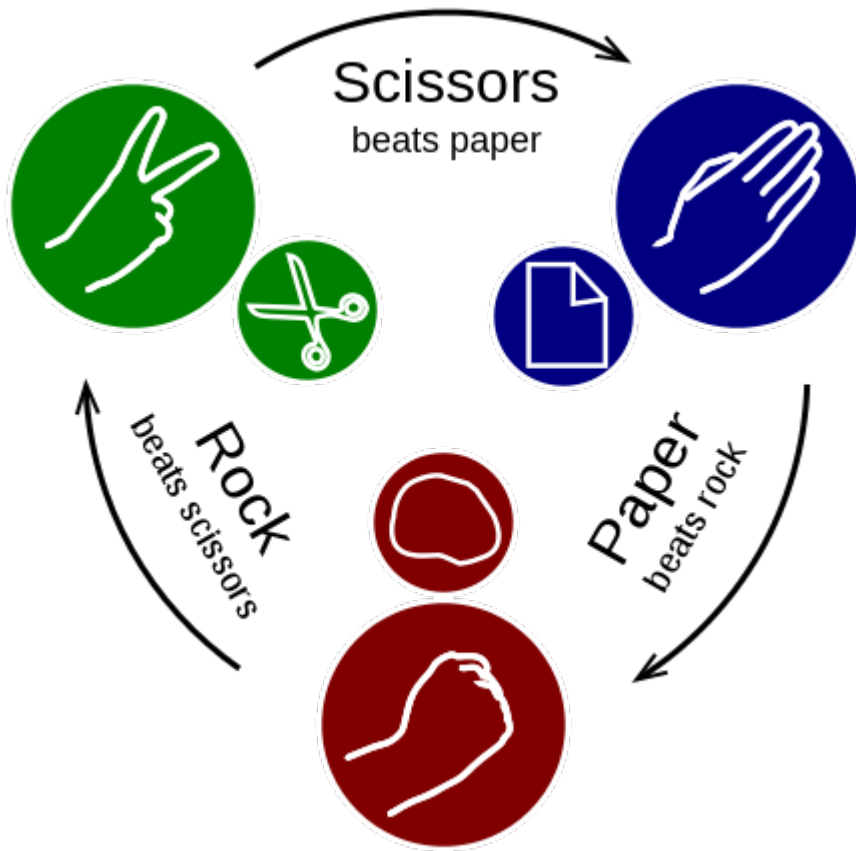


The Severn estuary could become the site of a giant tidal barrage, generating huge amounts of clean energy but obliterating vulnerable wildlife habitats (Image: Kevin Allen / Alamy)

› [2 more images](#)

E trilemma

Does win-win-win strategy exist ?





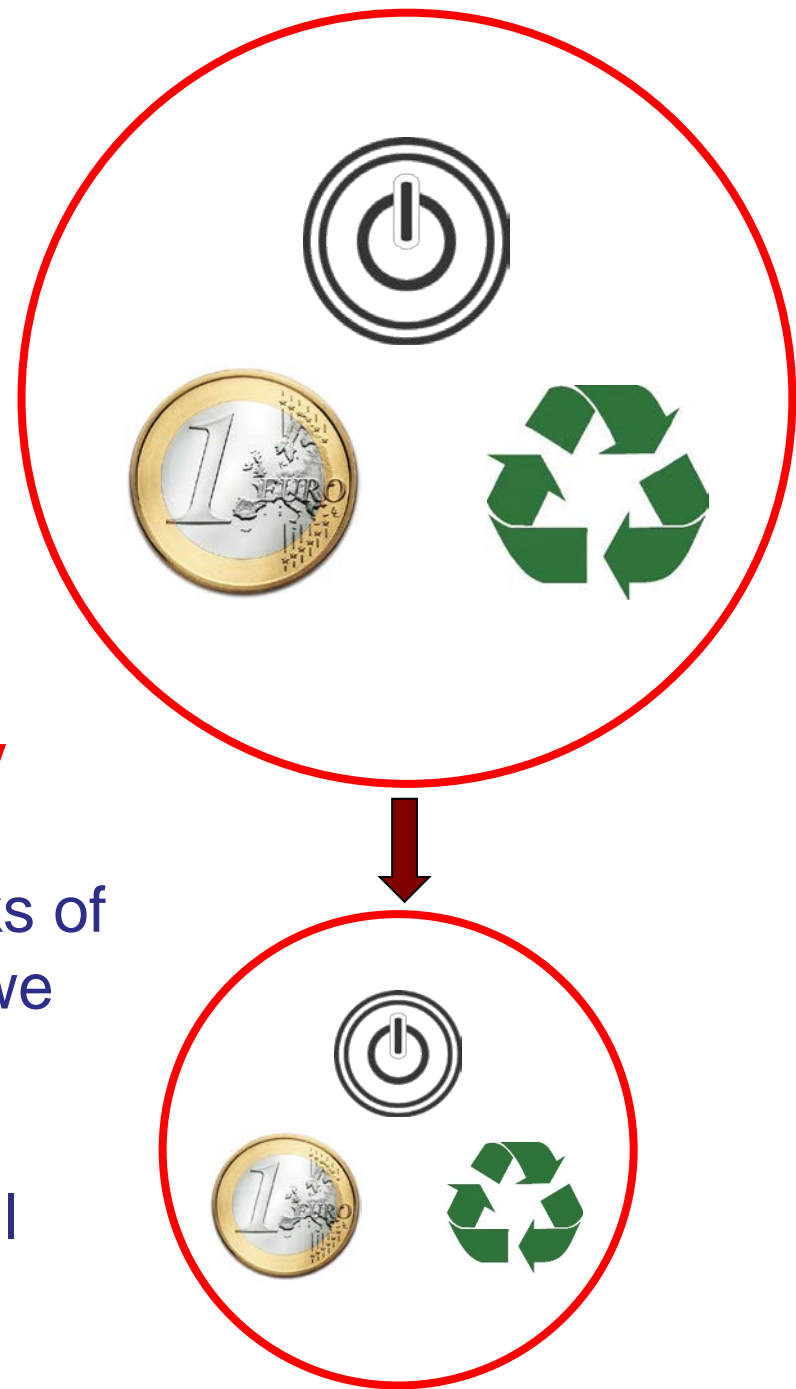
Does the Win-Win-Win solution exist?

E trilemma

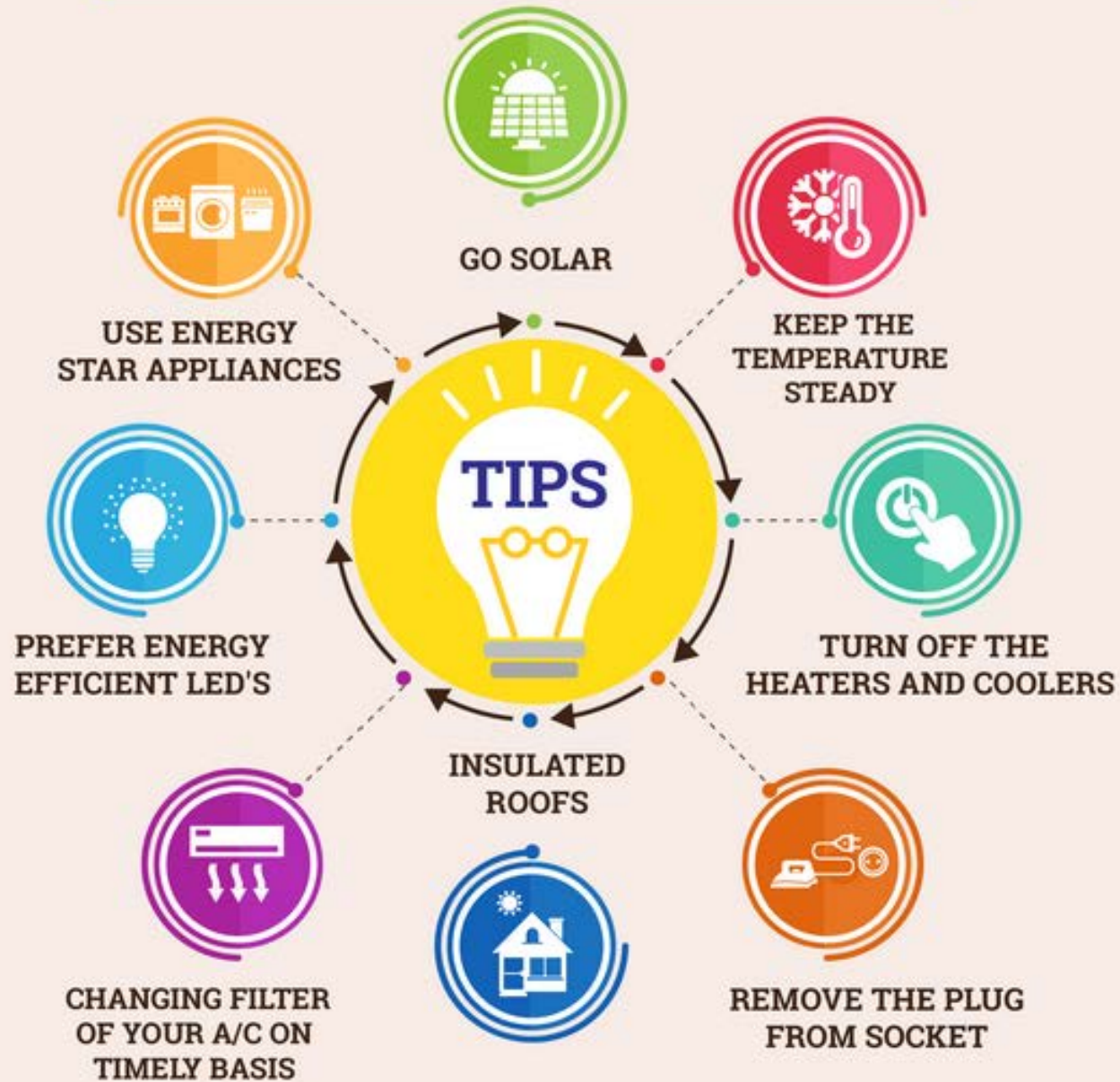
Does win-win-win strategy exist ?

Economically efficient E savings while maintaining reliable supply

- CO₂ emissions decreases, peaks of consumption will also drop and we will save even more
- it is not so "sexy", E-producers will reduce profits, **but it works!**



TIPS TO SAVE MONEY ON YOUR ELECTRIC BILL





How to motivate to economical E savings

- subsidied to the E-producers to use RES?



How to motivate to economical E savings

- **subsidied to the E-producers to use RES?** – **no**, it does not lead to an overall saving of E consumption, only to expensive replacement of one source by another and rather motivation to produce more E



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Green savings



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Green savings

- **subsidies to producers if their customers reduce consumption** motivates manufacturers to reduce consumption by customers, eg. by supporting energy-saving appliances, thermal insulation, saves the customer (lower consumption of E) and the manufacturer (remains profit)
- In California, Utility revenue decoupling

„California is 40% more energy efficient than the rest of the US. If the US were as energy efficient as California, 75% of all coal-fired power plants could be shut down in the US.“ A. Schwarzenegger, 2013





How to motivate to economical E savings

- Energy performance contracting (EPC)

- Contract between suppliers and households to maintain the level of payments after the introduction of austerity
- the supplier insulate the client's family house at his own cost, the consumption of E decreases, but for some time the same payments as before the thermal insulation (return on investment to the supplier) are paid or the money saved is shared



How to motivate to economical E savings

- Energy performance contracting (EPC)

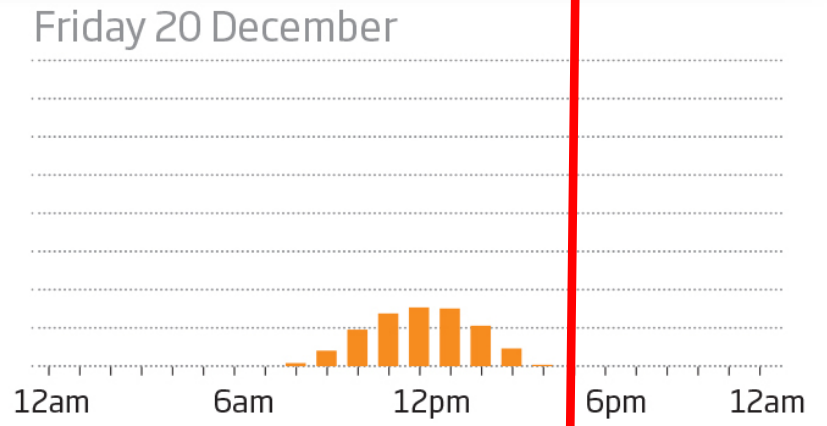
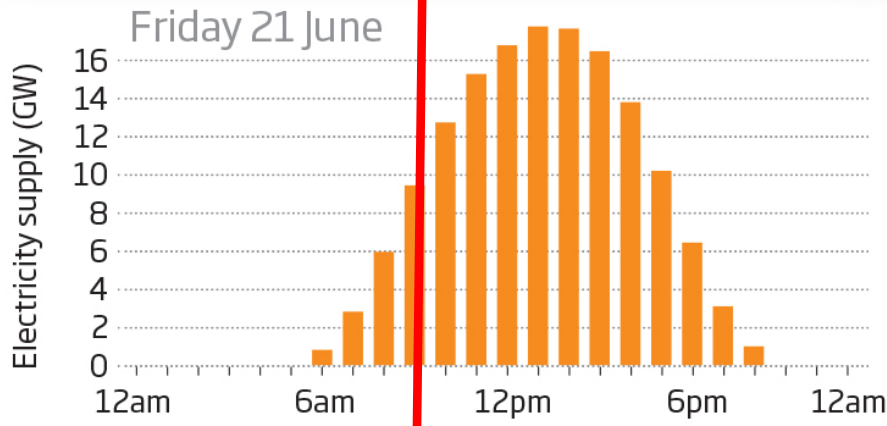
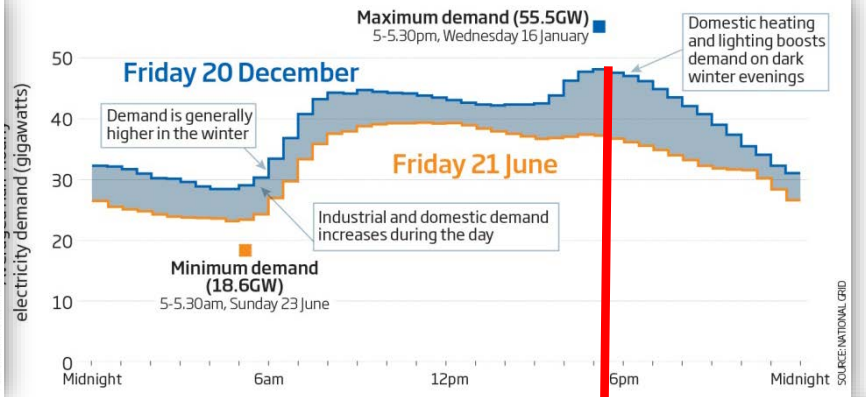
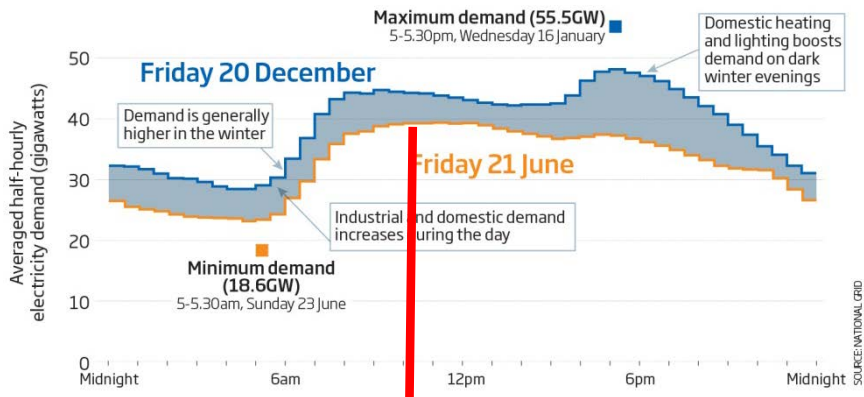
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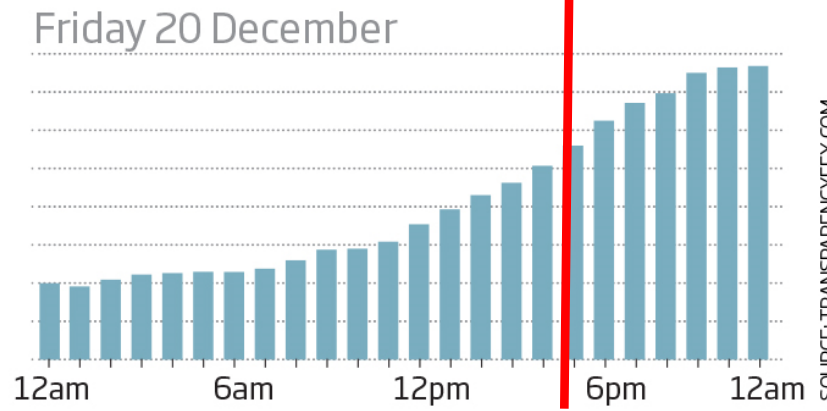
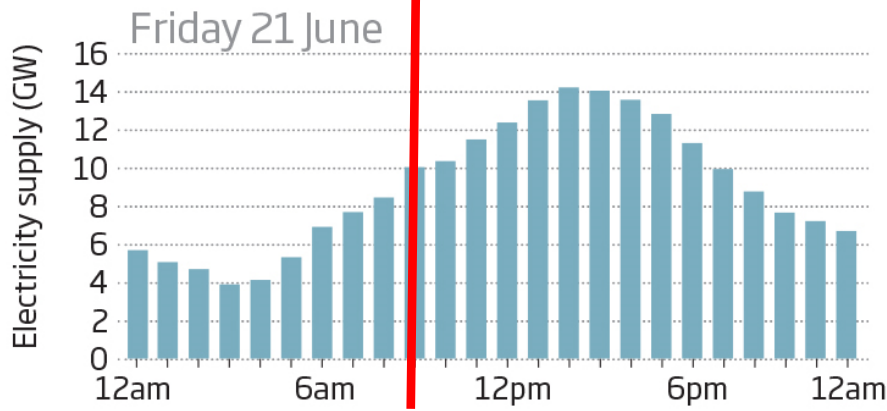
- Motivate to reduce consumption during peak hours

- eg. High Tariff and Low Tariff in the Czech Republic

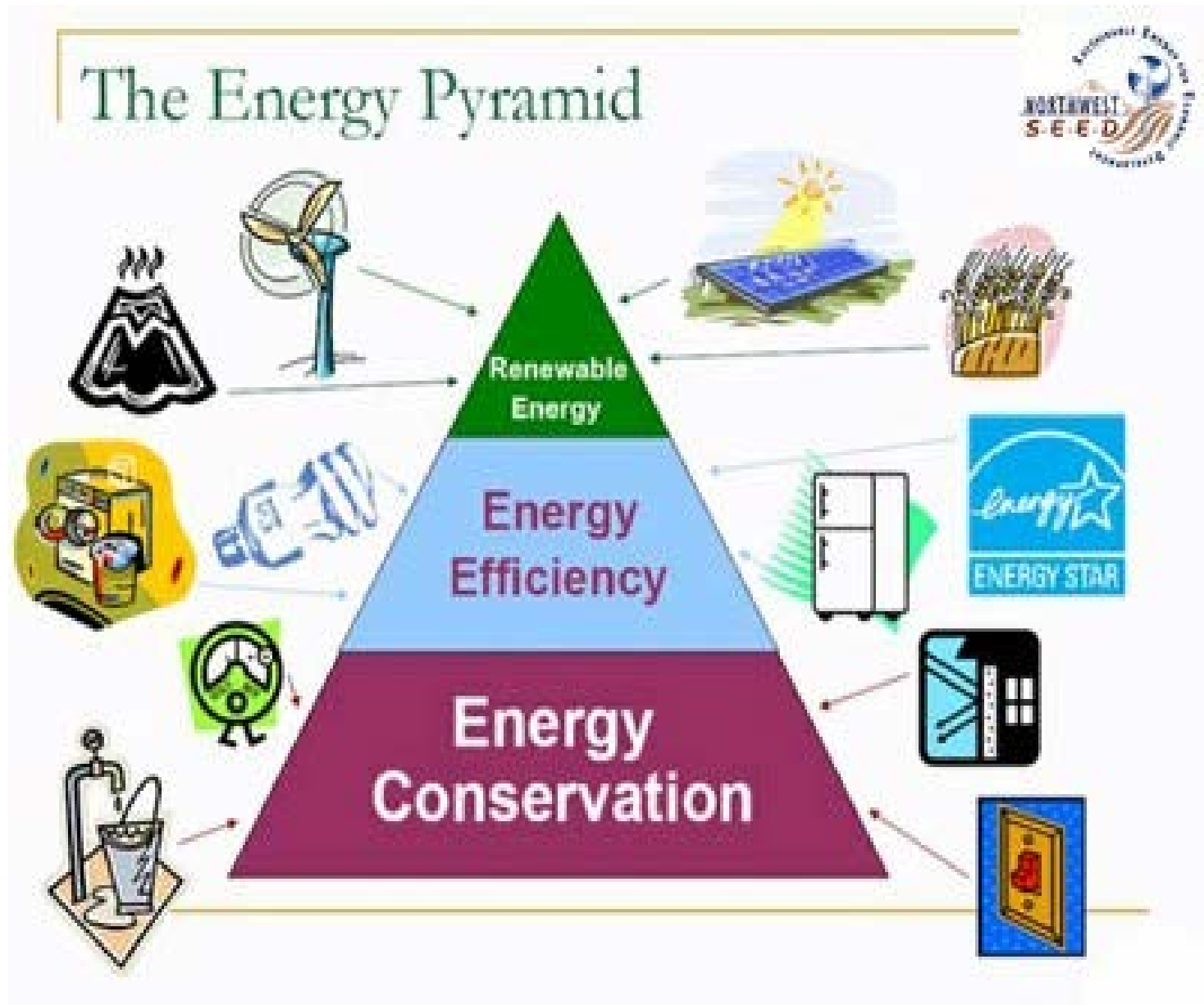
- eg. big **businesses competition to reduce peak consumption at the lowest possible cost** (which will be replaced by the state) tested in the UK, will reduce the need for back-up resources for these critical periods of the year (when those resources must still exist)



...while the **wind** blows unpredictably from hour to hour and day to day



E-conservation + E-efficiency + RES



Passive house

