



The Water and Energy Nexus

—

Framing the Context



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Lund University, Sweden

EEA, Copenhagen, 13 - 14 December 2012

Setting the scene



World Energy Outlook 2012

International Energy Agency (IEA)

- *The water need for **energy production** will be increasingly important*
- **15%** of the water use is related to energy production (2010)
- **55-60%** of the water use for energy is related to coal
- Water availability can be the **limiting factor** for electric power and for biofuel, in **China, USA, Iraq and India**



**Summer 2012 in USA –
worst drought since the 1950s -
80% of agricultural land was affected.**

Price of corn soared

Corn for ethanol or for food?



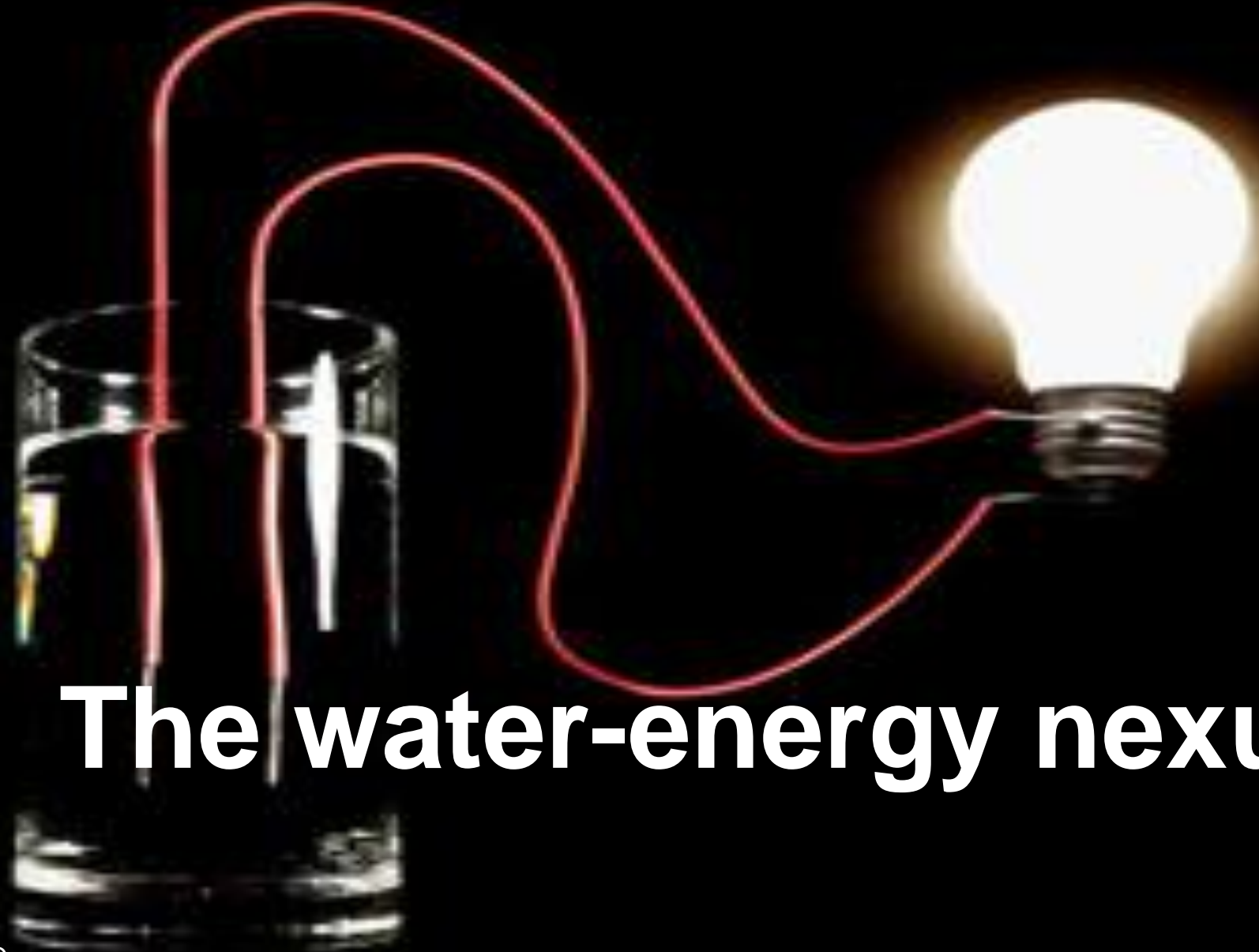
France 2003 – the hot summer

Nuclear capacity
reduced 7-15%
during 5 weeks
due to lack of
cooling water

The nexus



Energy is needed to produce water...



The water-energy nexus

... and water is needed to produce energy

Nexus #1: 1-3% of a city's energy demand is used to produce, treat & transport water. 15-20% to **USE** the water

WATER



ENERGY



Source: General Electric



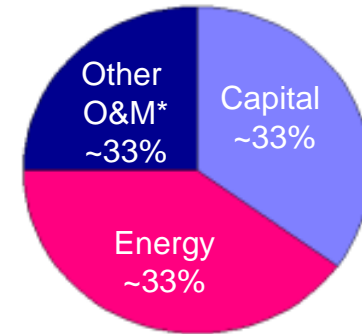
Nexus #2: More advanced technology to treat impaired water requires more energy

WATER

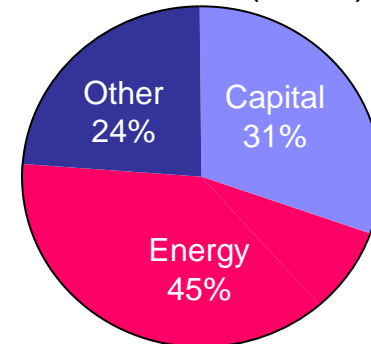


ENERGY

Membrane



Thermal (MED)



* Membrane replacement,
Chemicals, Labor,
Maintenance

Source: General Electric



Future water supplies

...**will require more energy**

Readily accessible fresh water supplies are limited and have been fully allocated in some areas

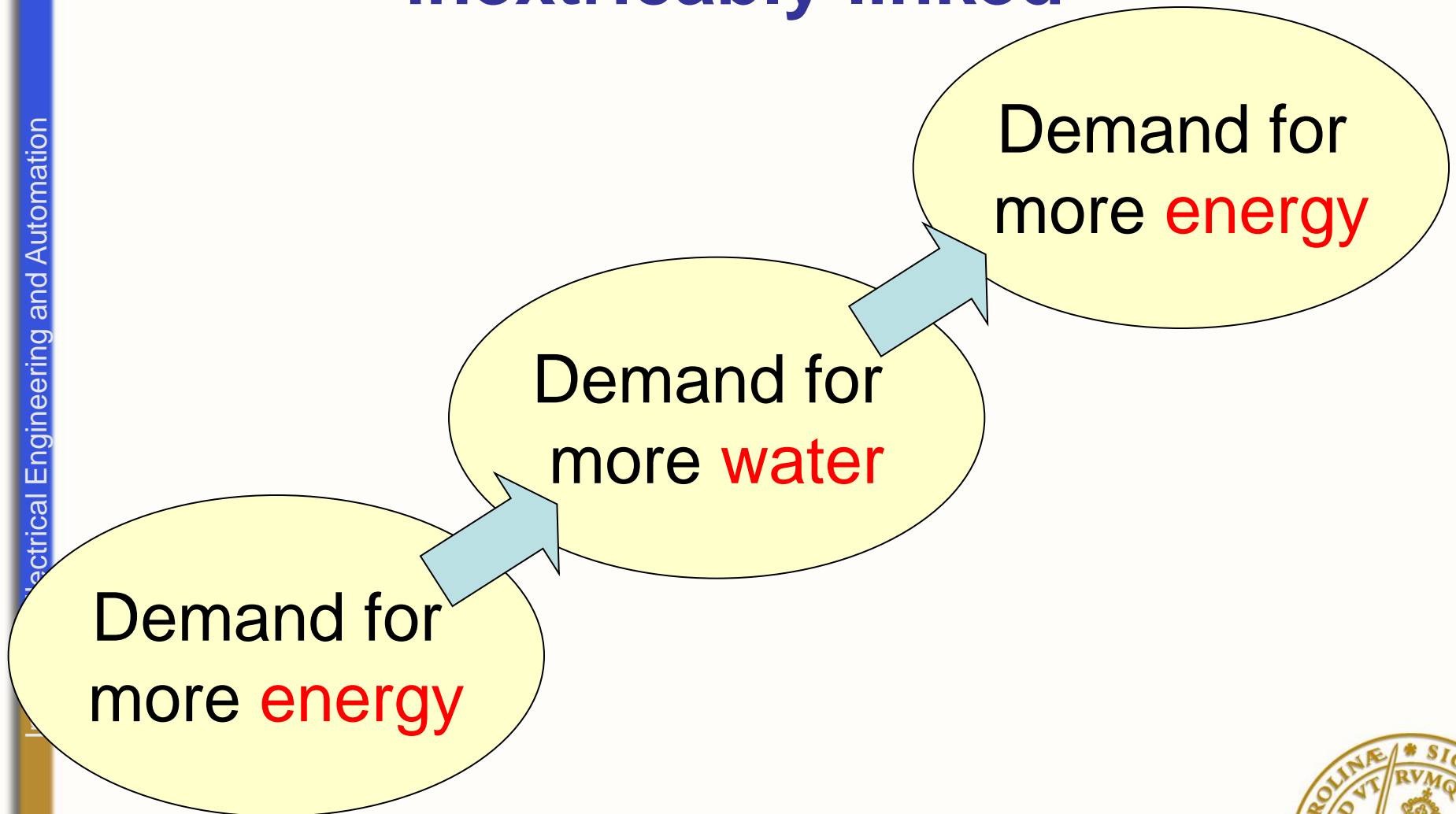
➡ Increased energy for pumping (deeper – longer)

New technologies to access/treat water will use more energy

➡ Impaired, reused, brackish, sea water



Water and Energy – inextricably linked



Nexus #3: Declining reservoir levels reduce hydro generating capacity

WATER



ENERGY



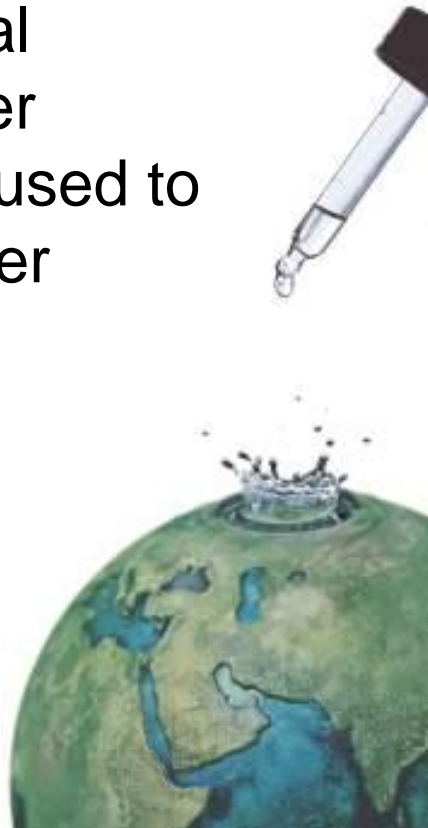
Source: General Electric



Nexus #4: Power generation requires large quantities of water

WATER

>50% of global industrial water withdrawal is used to generate power



ENERGY



Source: General Electric



Nexus #5: Large volumes of wastewater from energy exploration & production

WATER

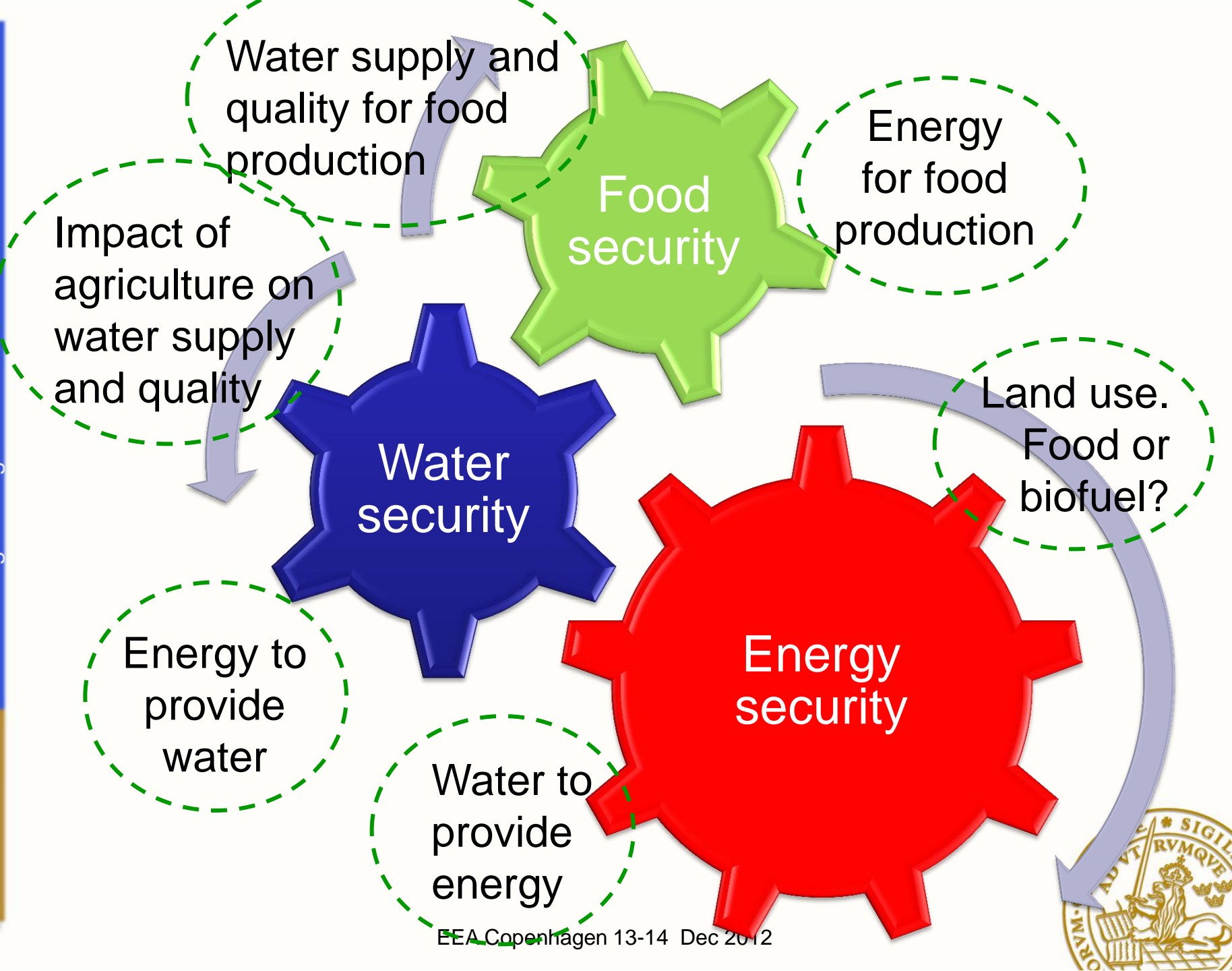


ENERGY



Couplings and conflicts





“Water footprint,
rather than the
carbon footprint of power plants
can shift the hierarchy
of which energy sources will be
most sustainable in a changing climate”

ClimateWire, USA, August 2012



Energy in water operations

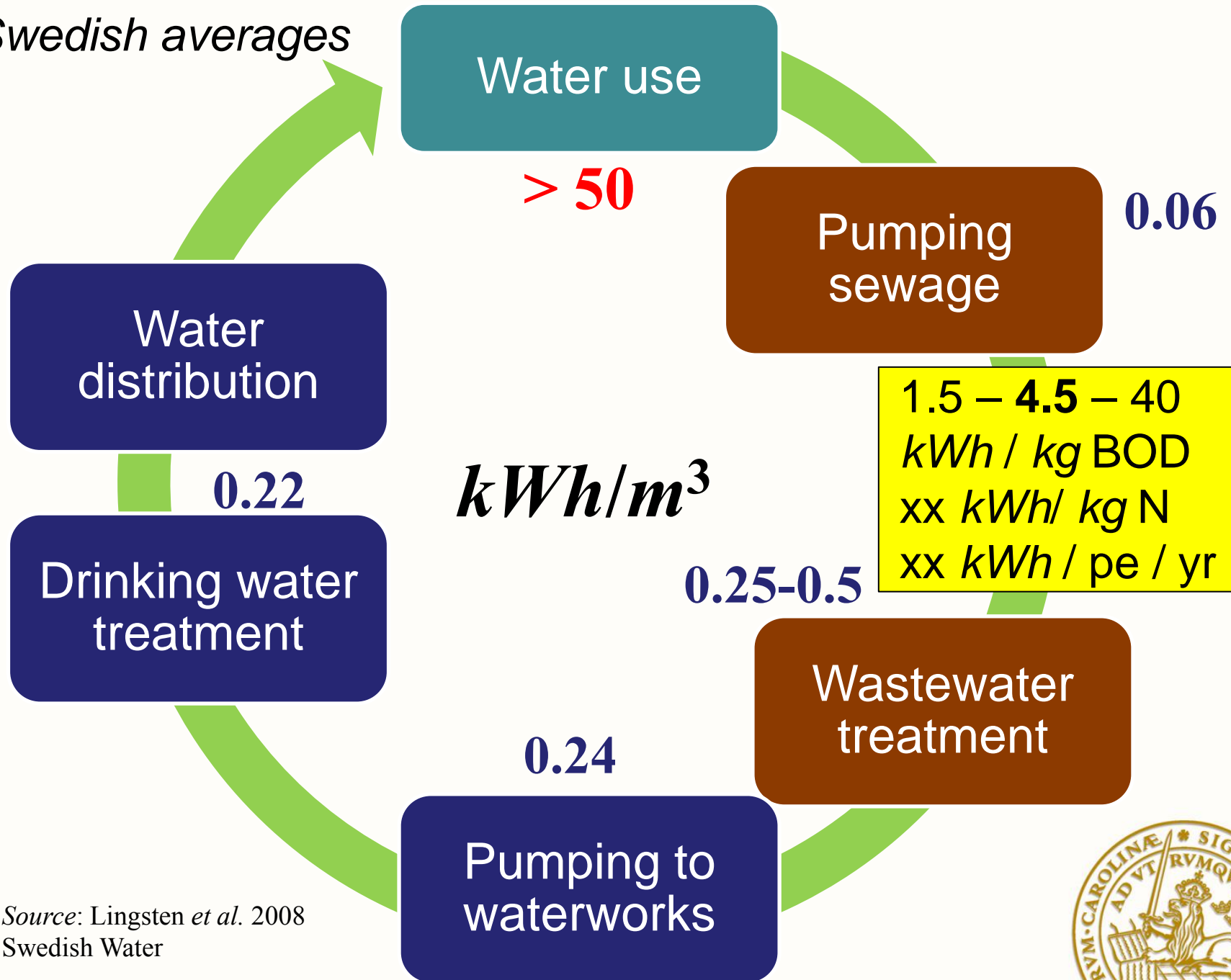


Energy cost to produce cold water

	<i>kWh / m³</i>
Surface water	0.5 - 3
Recycled water	1 - 6
Desalination	4 - 8
Bottled water	1000 - 4000



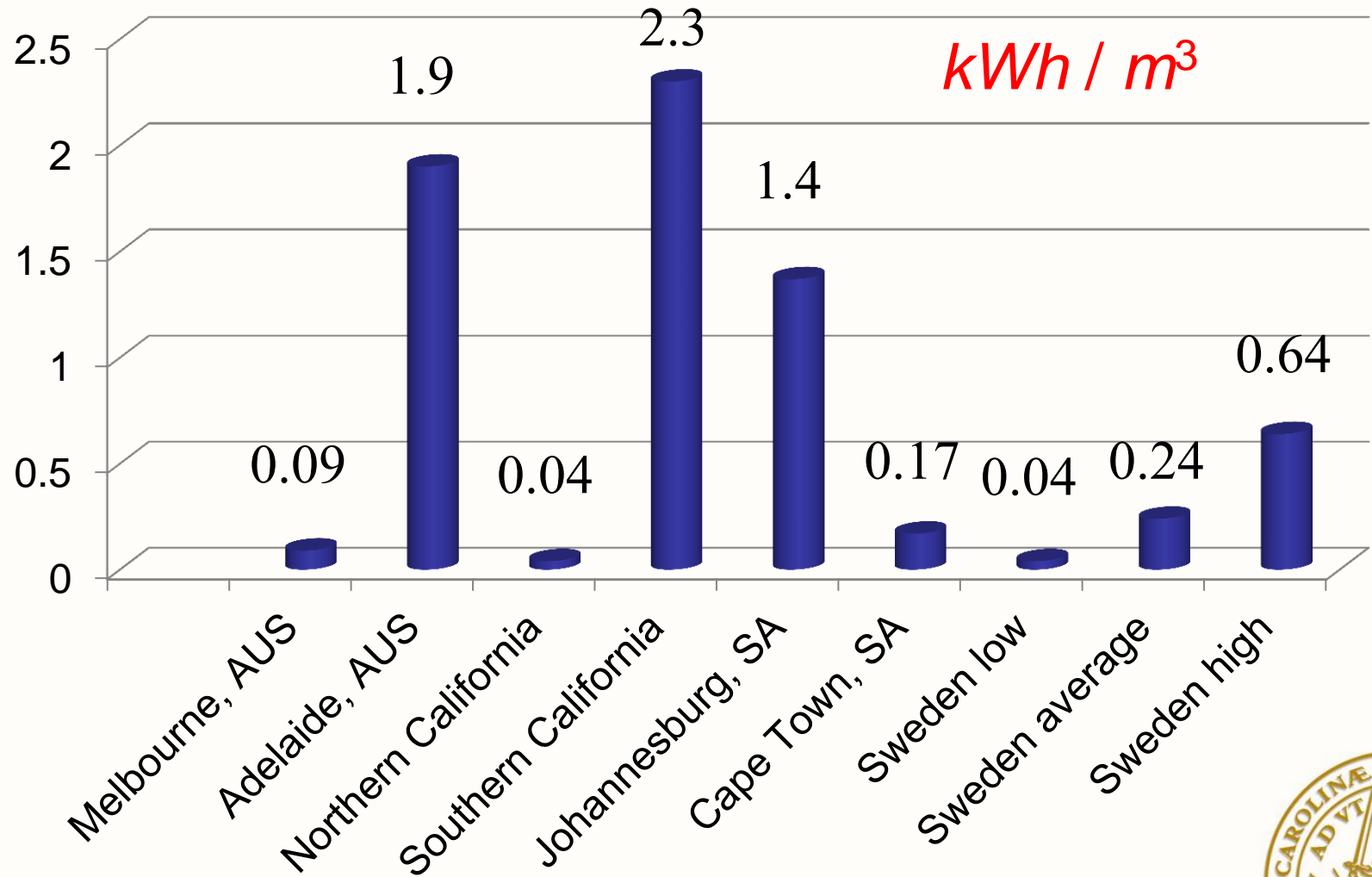
Swedish averages



Source: Lingsten et al. 2008
Swedish Water



Pumping from source to waterworks



Clean Water Requires Energy!

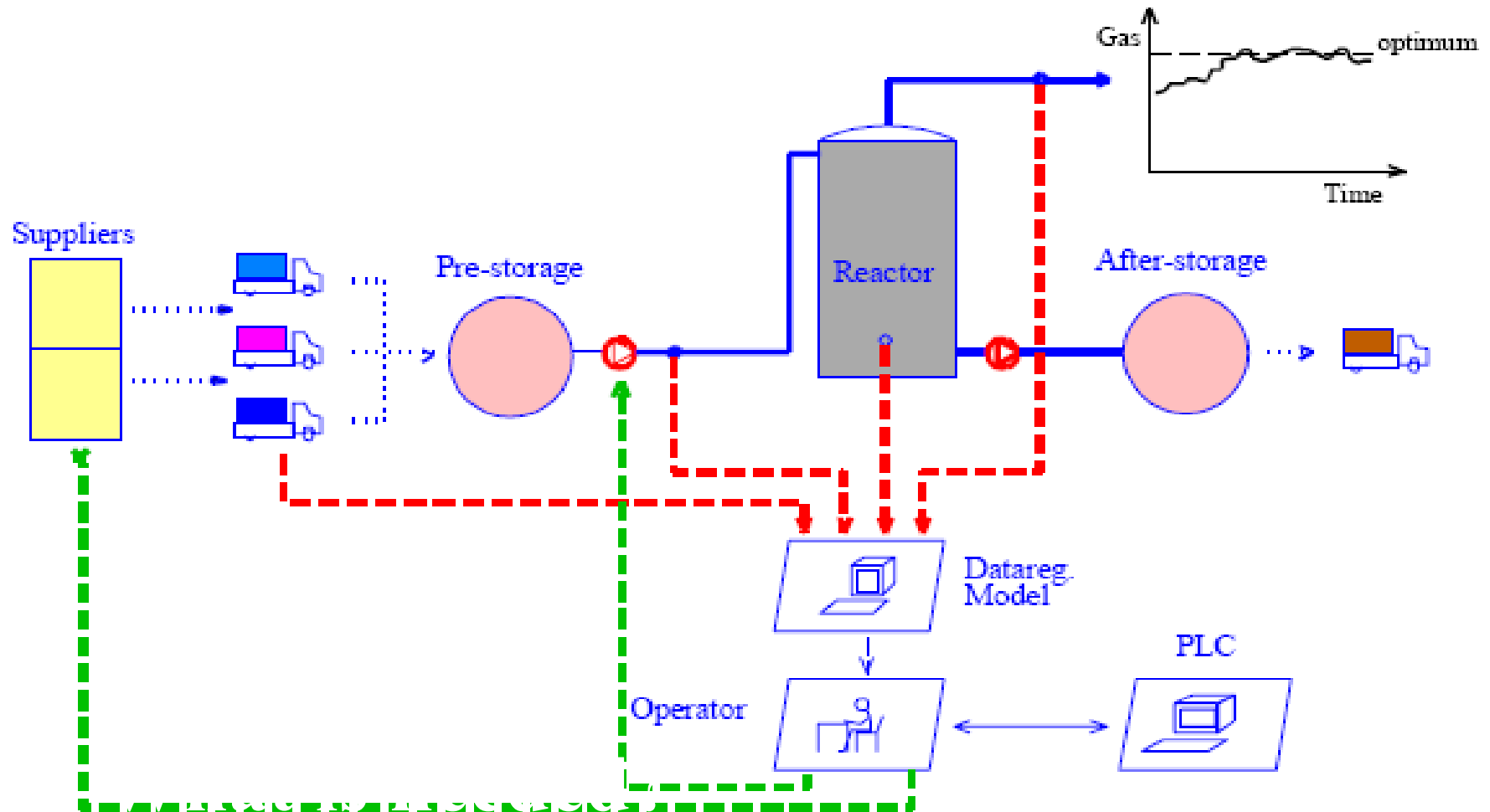
- **Pumping**
 - Having efficient pumps for **adequate** flows
 - Operating at **dynamically** changing flows and pressures
- **Aeration in wastewater treatment**
 - Adequate compressors
 - Controlling the air flow for **variable** loads



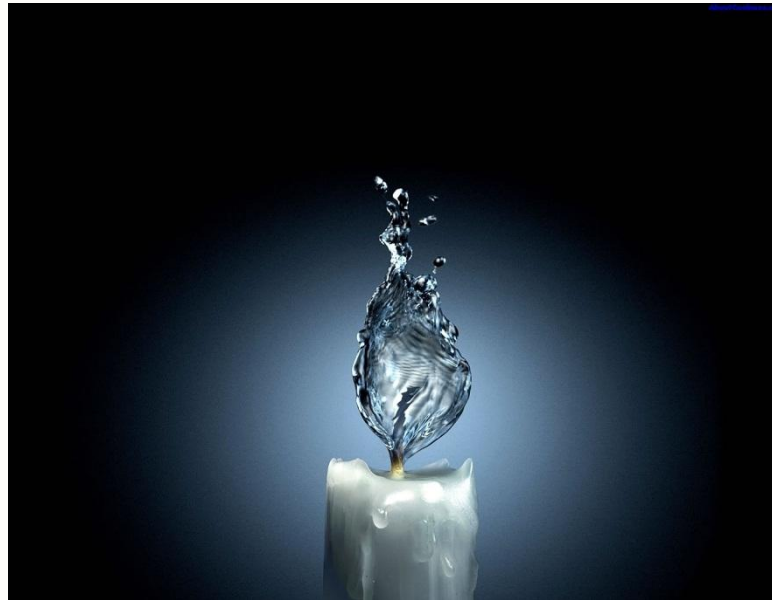
Increase efficiency!

Minimize air flow!

Anaerobic Digestion – more advanced plant operation



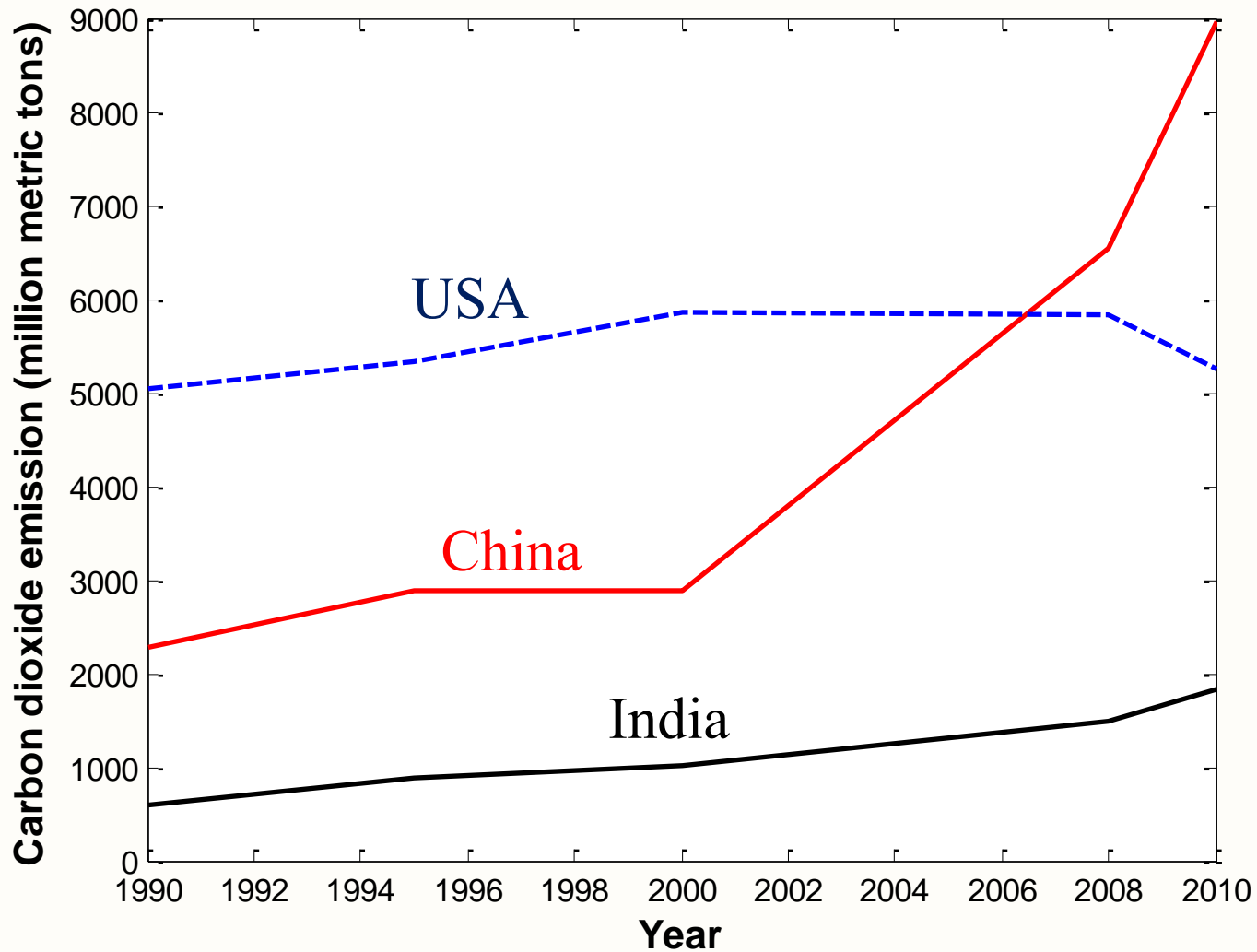
Water in energy operations



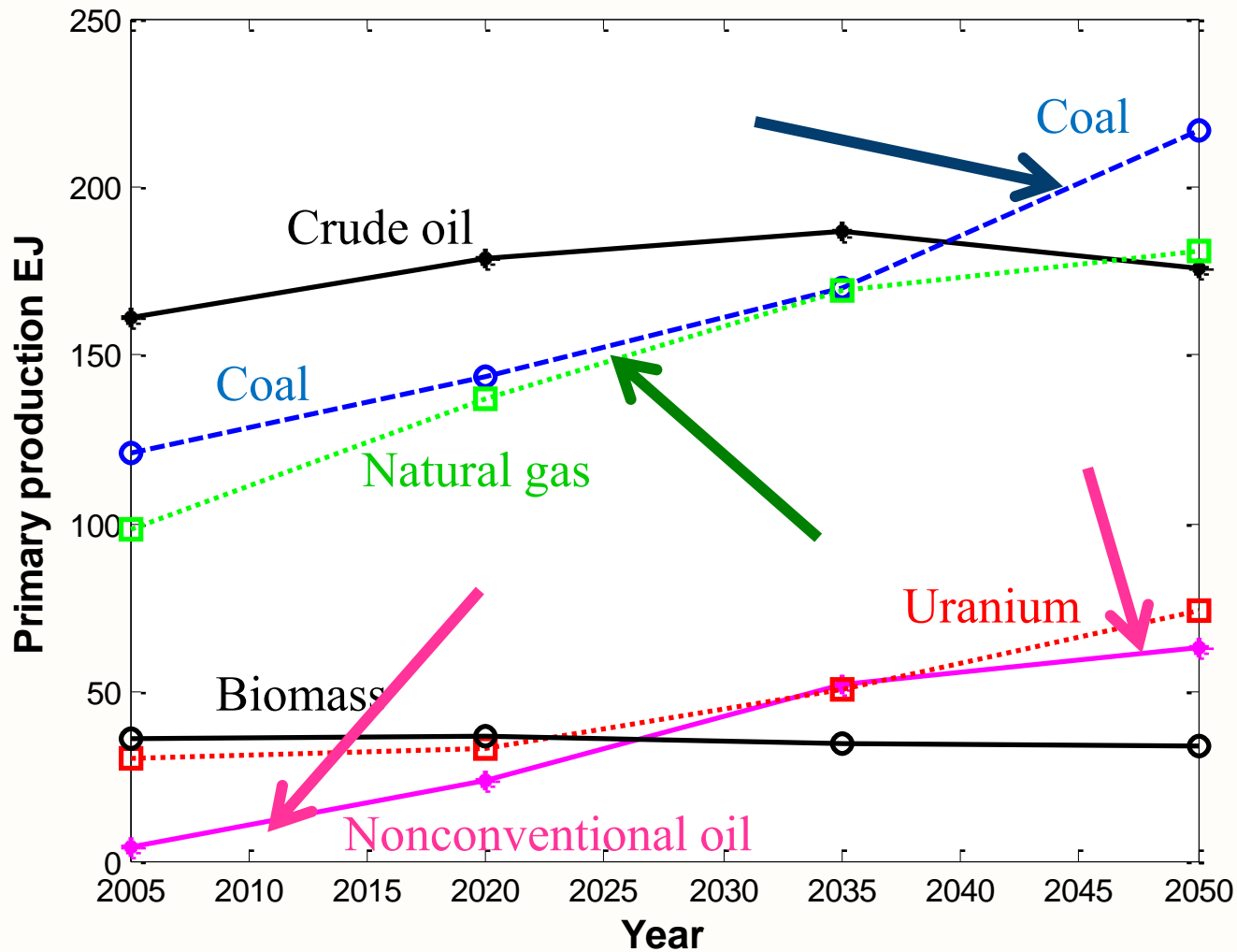
EEA Copenhagen 13-14 Dec 2012



Carbon emissions 1990-2010



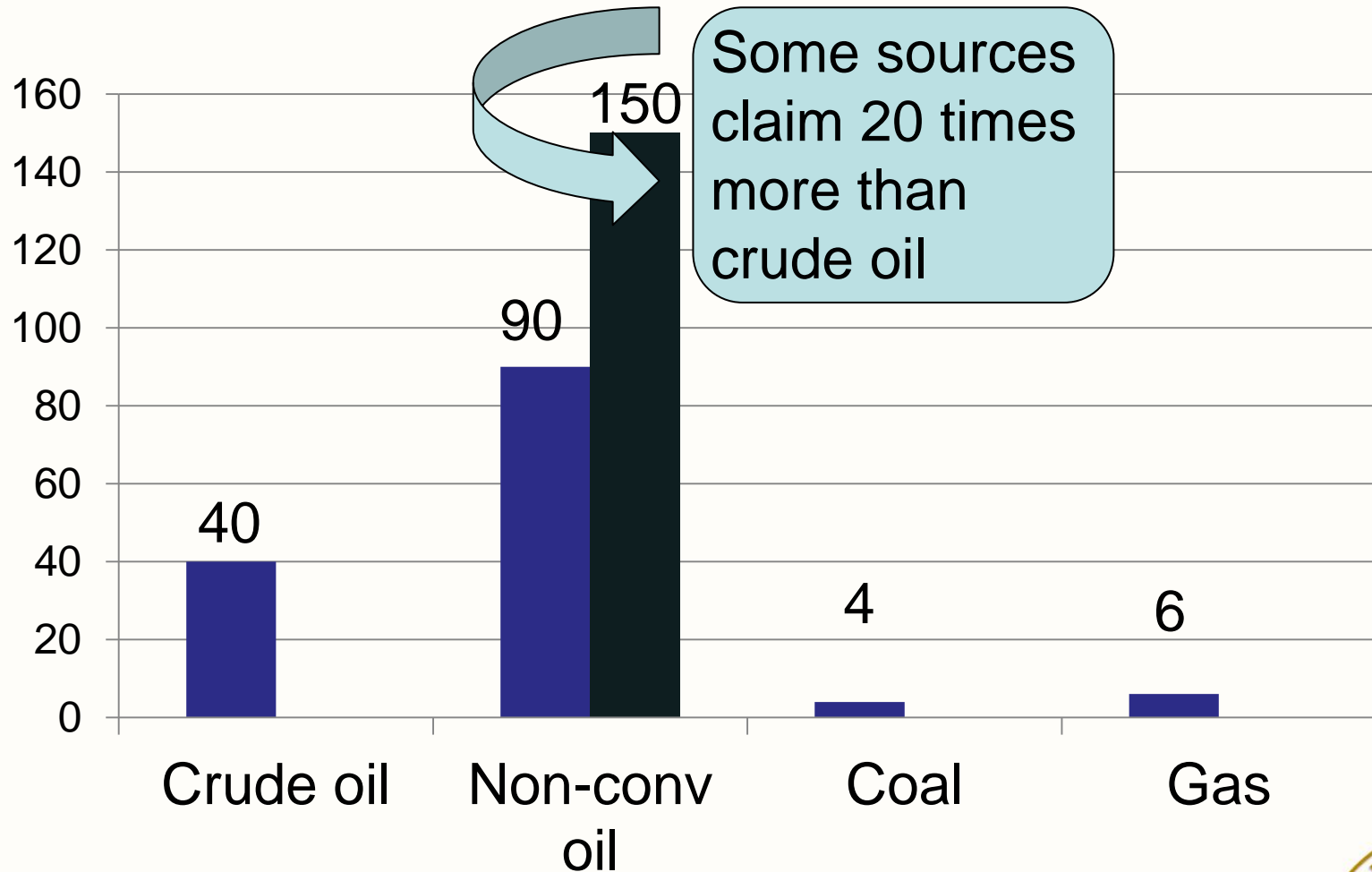
Primary energy sources 2005-2050



Source:
World Energy Council, 2010



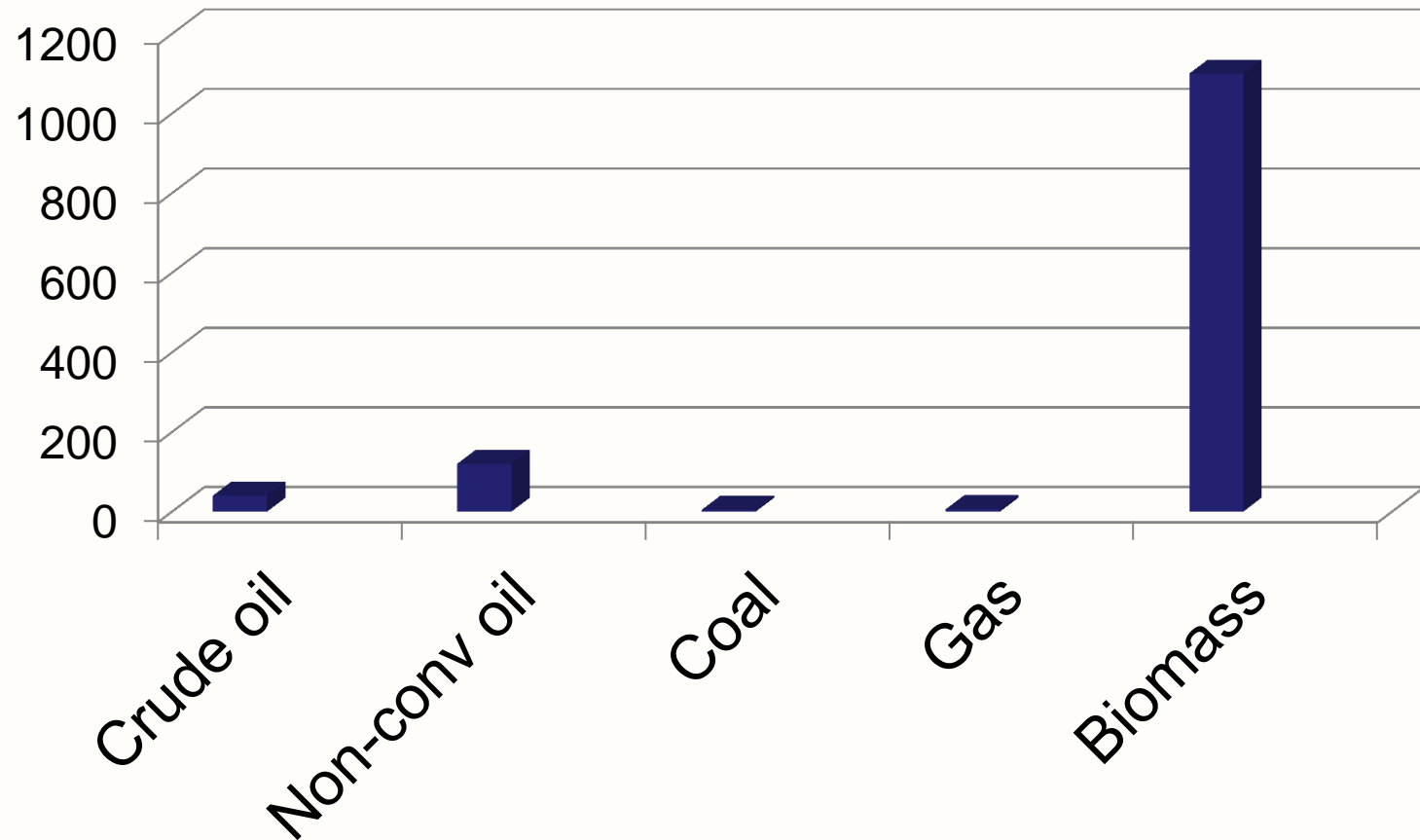
Water consumption per *liter* or *kg*



Source: World Energy Council, 2010



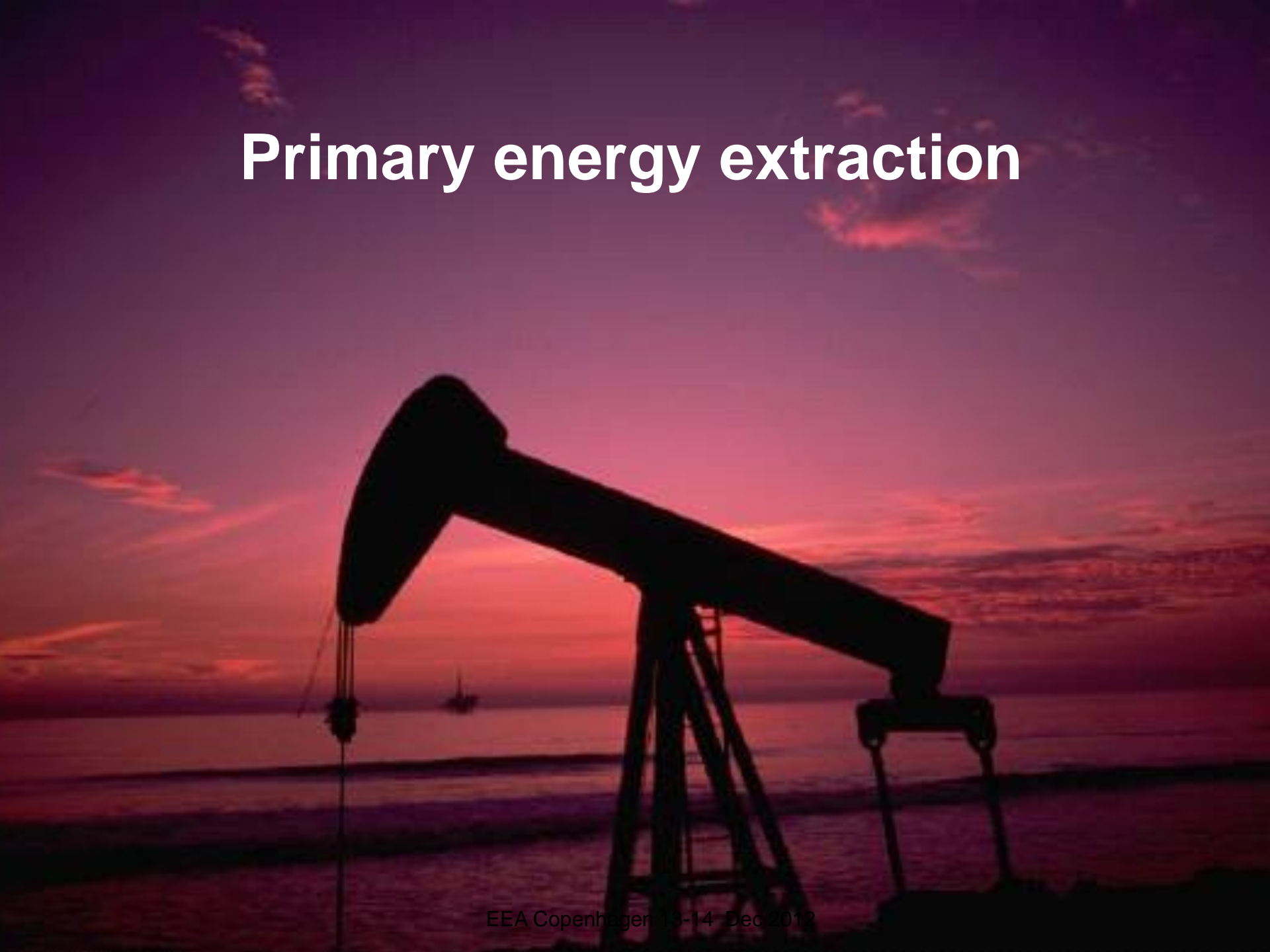
Water consumption per *liter* or *kg*



Source: World Energy Council, 2010



Primary energy extraction



Roughly 200 tanker trucks deliver water for the fracturing process.

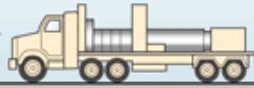
A pumper truck injects a mix of sand, water and chemicals into the well.

Natural gas flows out of well.

Recovered water is stored in open pits, then taken to a treatment plant.

Storage tanks

Natural gas is piped to market.



0 Feet

Water table

Well

1,000

2,000

3,000

4,000

5,000

6,000

7,000

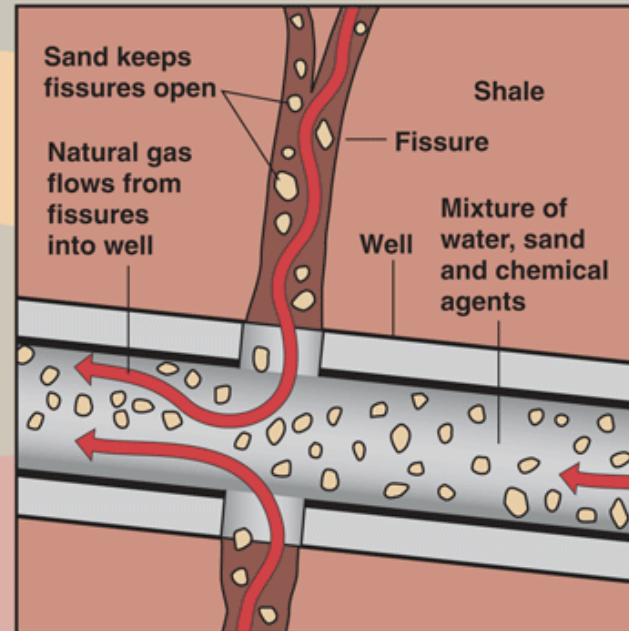
Hydraulic fracturing

across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes

$\cong 5000 \text{ m}^3$
of water

Down to 3000 m

Up to 100 Mpa
Up to 265 liters/s



Fissures

The shale is fractured by the pressure inside the well.

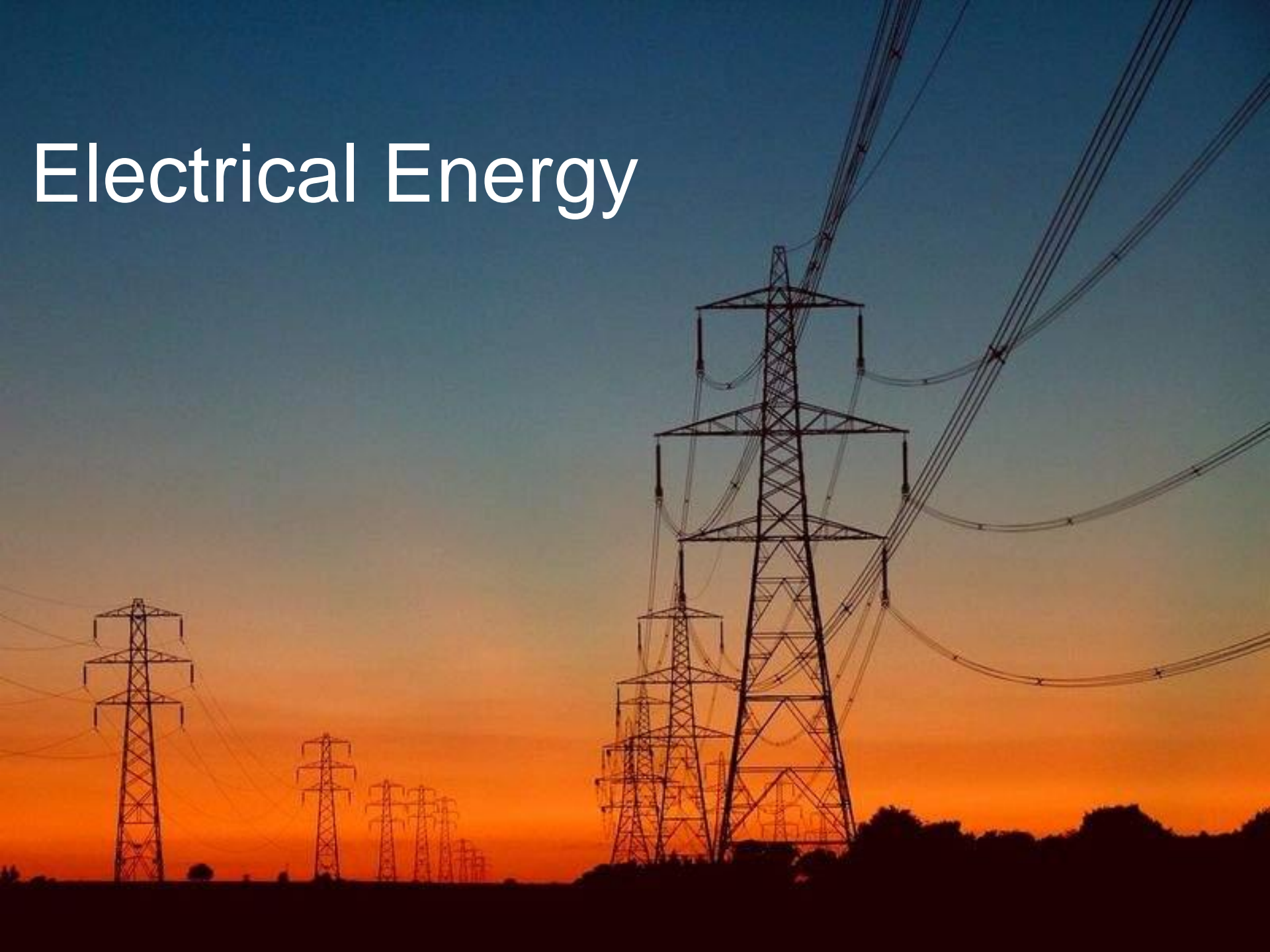
About 750 chemicals listed as additives

Water professional challenges – fossil energy

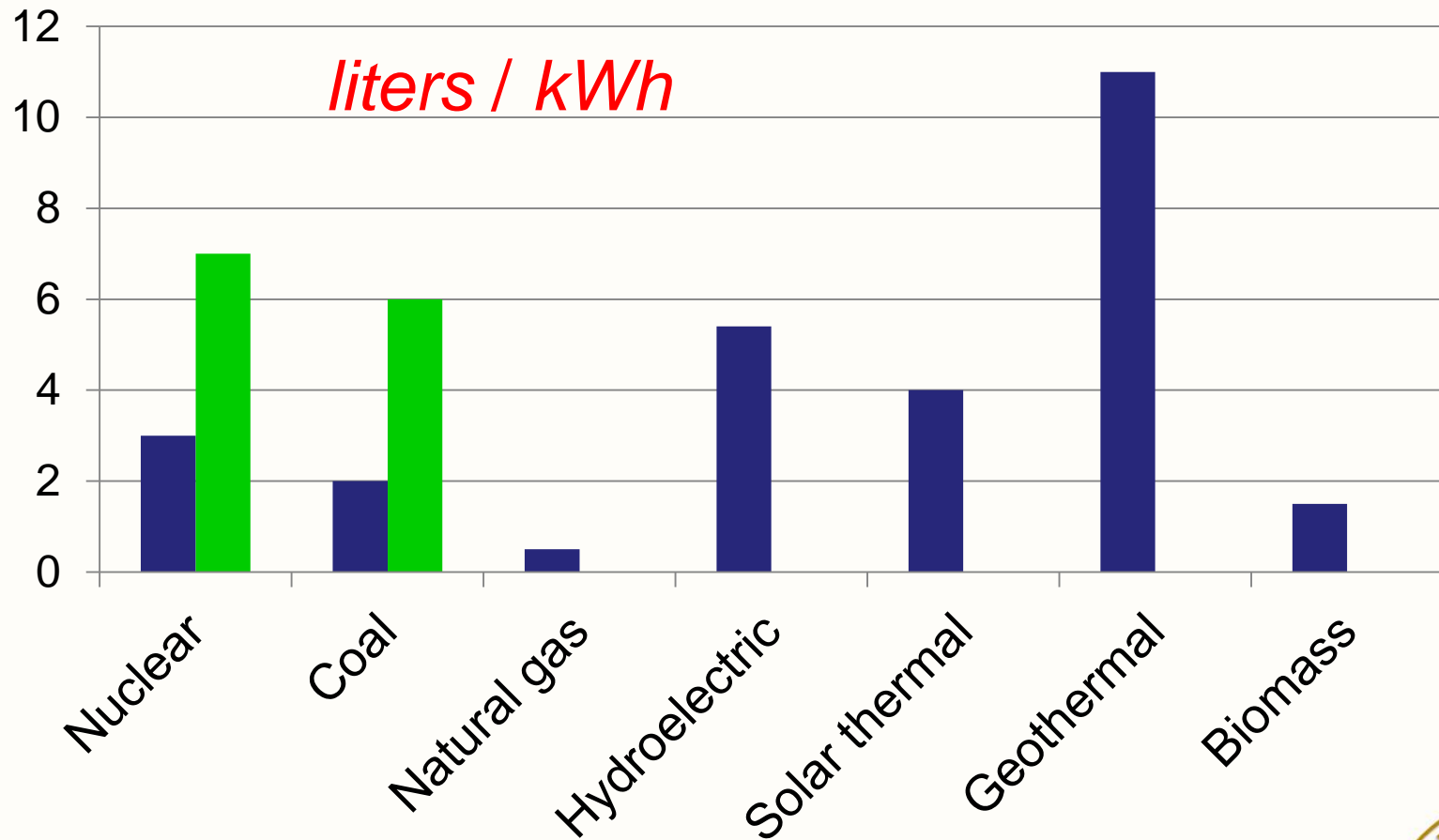
- **Biological effects of oil exploration**
- **Fate of petroleum products in water, groundwater, soil**
- **Fate of petroleum products in air – aerosols from settling ponds**
- **Methods for cleaning up destroyed wetlands**



Electrical Energy



Water use in electrical generation



Nexus not only for water professionals...

The American Society of **Mechanical Engineers** (ASME) Board of Government Relations (BGR) recommend the development of a national policy that addresses the **interdependencies of reliable sources and efficient uses of energy and water.**

(ASME June 2012)



Professional challenges

Energy production planning has to take place together with **water** resources and water quality planning

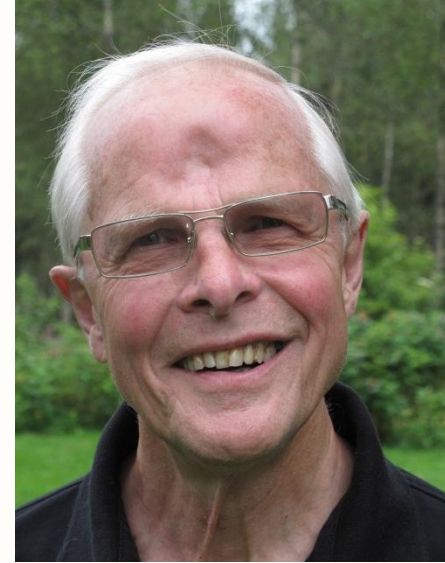
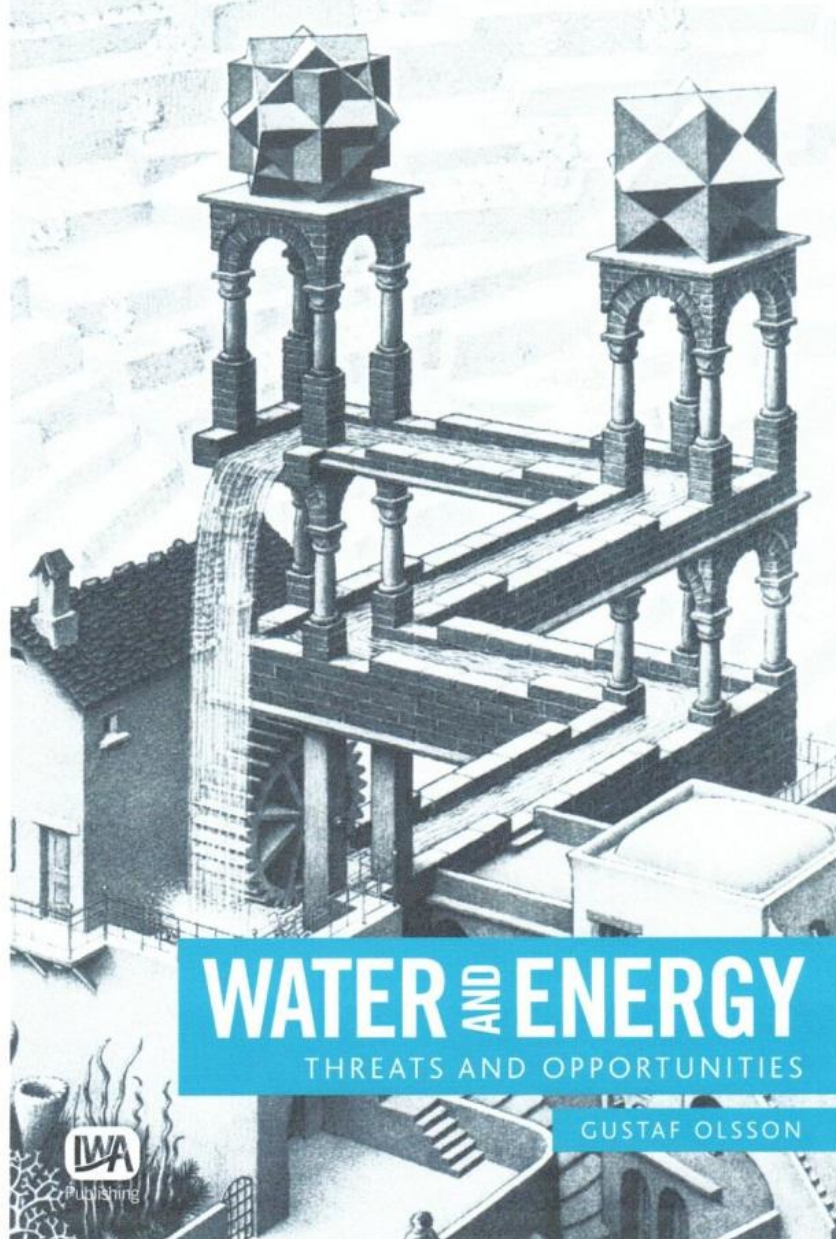


Remember the demand side

- We have been **supply** oriented
- We need to focus on the **demand** side
- Understanding how demand works
 - Habits
 - Life style
 - Pricing
- Understanding regulators and rules



More details in...



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Thank you!

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