



Concept Symposium 2018

Governing Megaprojects – Why, What and How

Trends and Paradigm Shifts in the Age of Disruptions

The term paradigm shift is used to describe major changes in technology and its impact in society. The invention of gunpowder, for instance, marked a paradigm shift in military thinking and practice, penicillin in medicine, jet engines in aviation, and the Internet in dissemination of information, marketing, financial transactions, crime and numerous other aspects cultural development.

Technological breakthroughs are now more frequent than ever, and it is essential to try foresee what's coming and its possible consequences. What took a hundred years earlier now only takes a decade or less. But this also increases our possibility to predict changes. What was previously called future studies had little credibility and was referred to academic environments and less established institutions. Now this is an integrated endeavor in industry, designated think tanks and industry laboratories where future technology is developed. We commissioned one such institution to give some ideas about what's in store within four sectors: transport, construction, defense and ICT.



Knut Samset

Program Director, Professor
Concept Research Program, NTNU
Norway

The Concept Symposia on Project Governance

The Norwegian Ministry of Finance and the Concept Research Program hosts every second year a symposium on project Governance. Project governance, in brief, is concerned about investments and their outcome and long-term effects. In view of the problem at hand, the aim is to ensure that the best conceptual solution is chosen, that resources are used efficiently and anticipated effects realized. Resource persons from ministries, governmental agencies, academia, international organizations, and industry are invited. In order to facilitate professional exchange and direct communication between participants, the number of individuals is restricted. The aim is to initiate further international cooperation and research on important issues related to project governance.

<https://www.ntnu.edu/concept/concept-symposium>



CS 2018

Trends and Paradigm Shifts in the Age of Disruptions

Shifting priorities, technological development and the choice of conceptual solutions

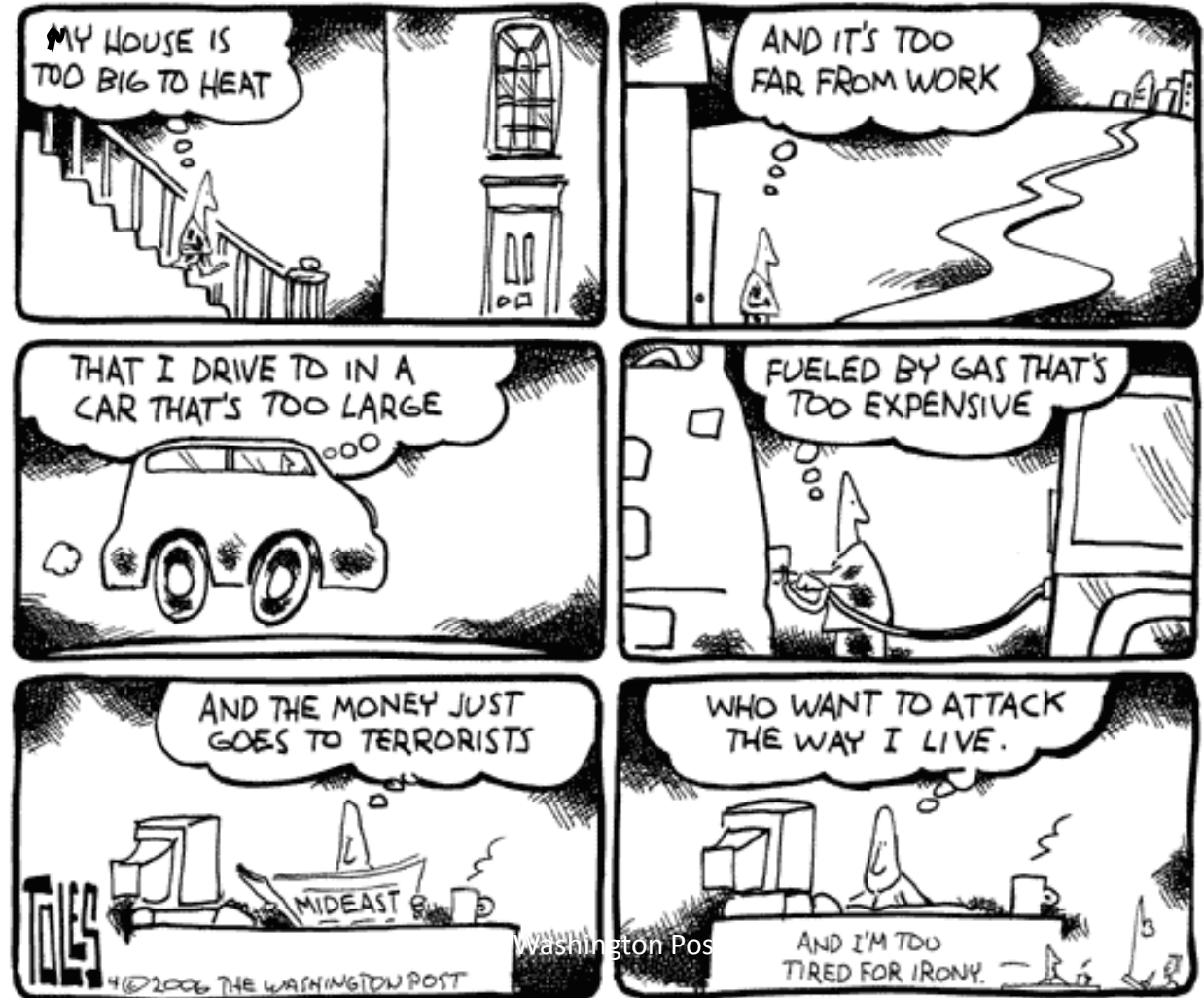
Knut Samset, prof, NTNU, program director, Concept

The civilization is an organism: energy is its blood, and technology its DNA

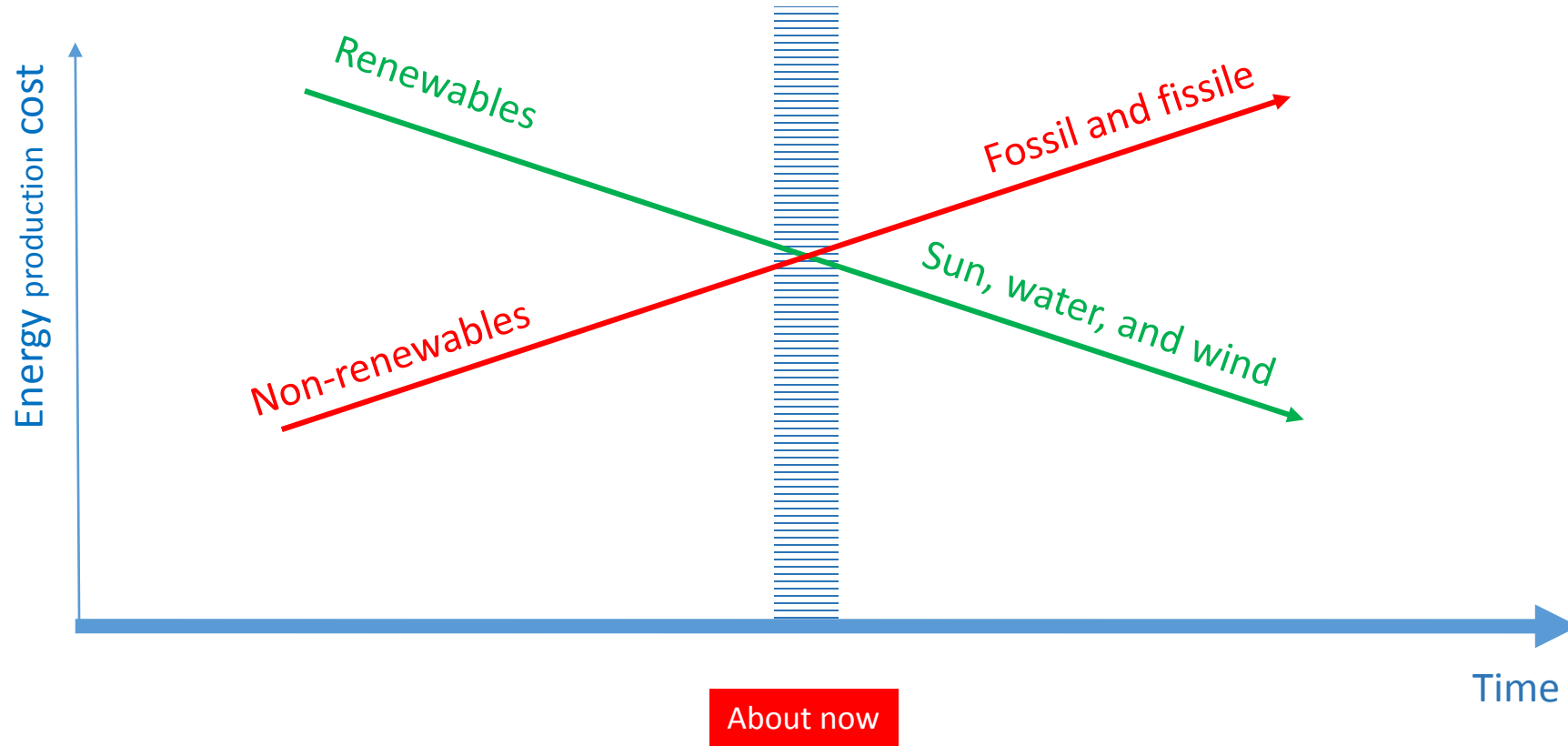
Topics:

1. Energy
2. Defense
3. Construction
4. Transport

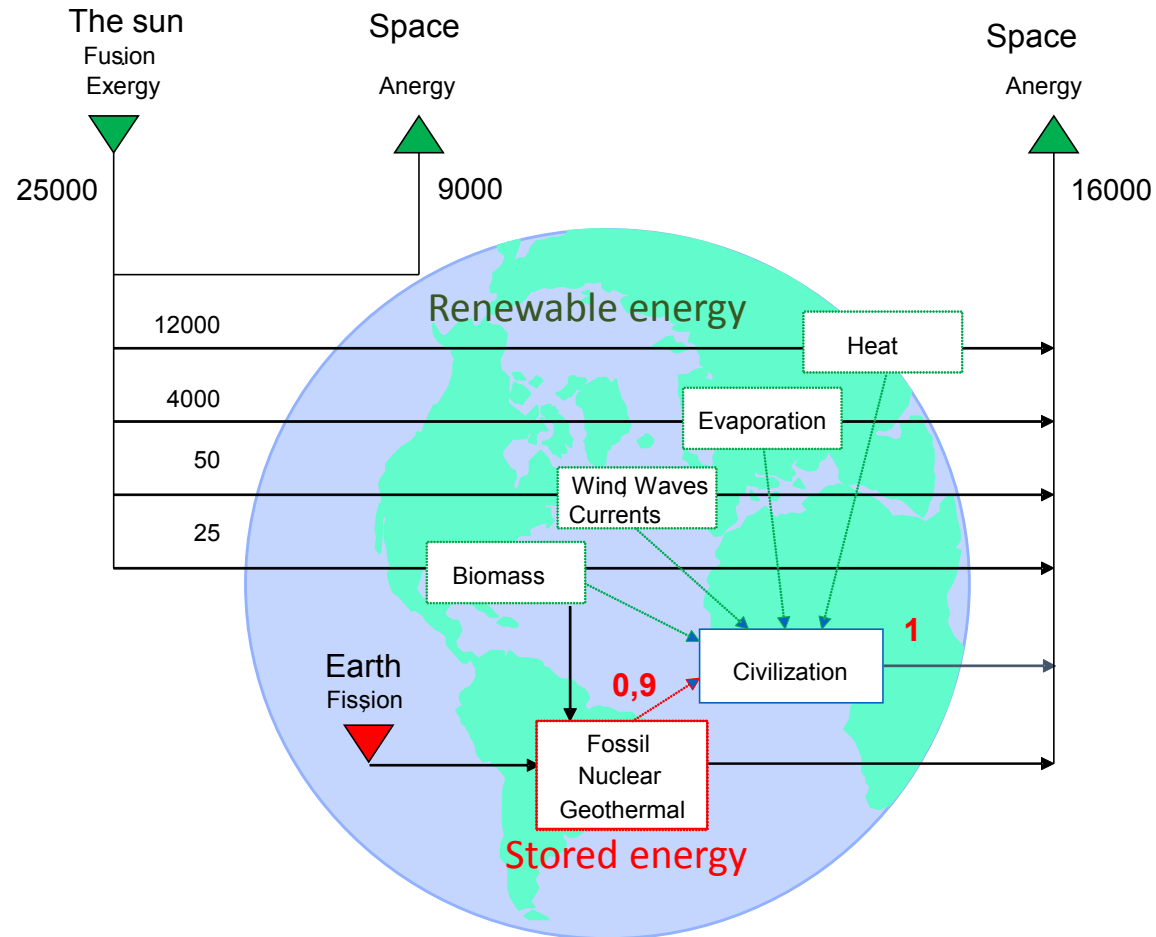
Current and future
conceptual solutions



Two trends and a major paradigm shift: Energy supply and use

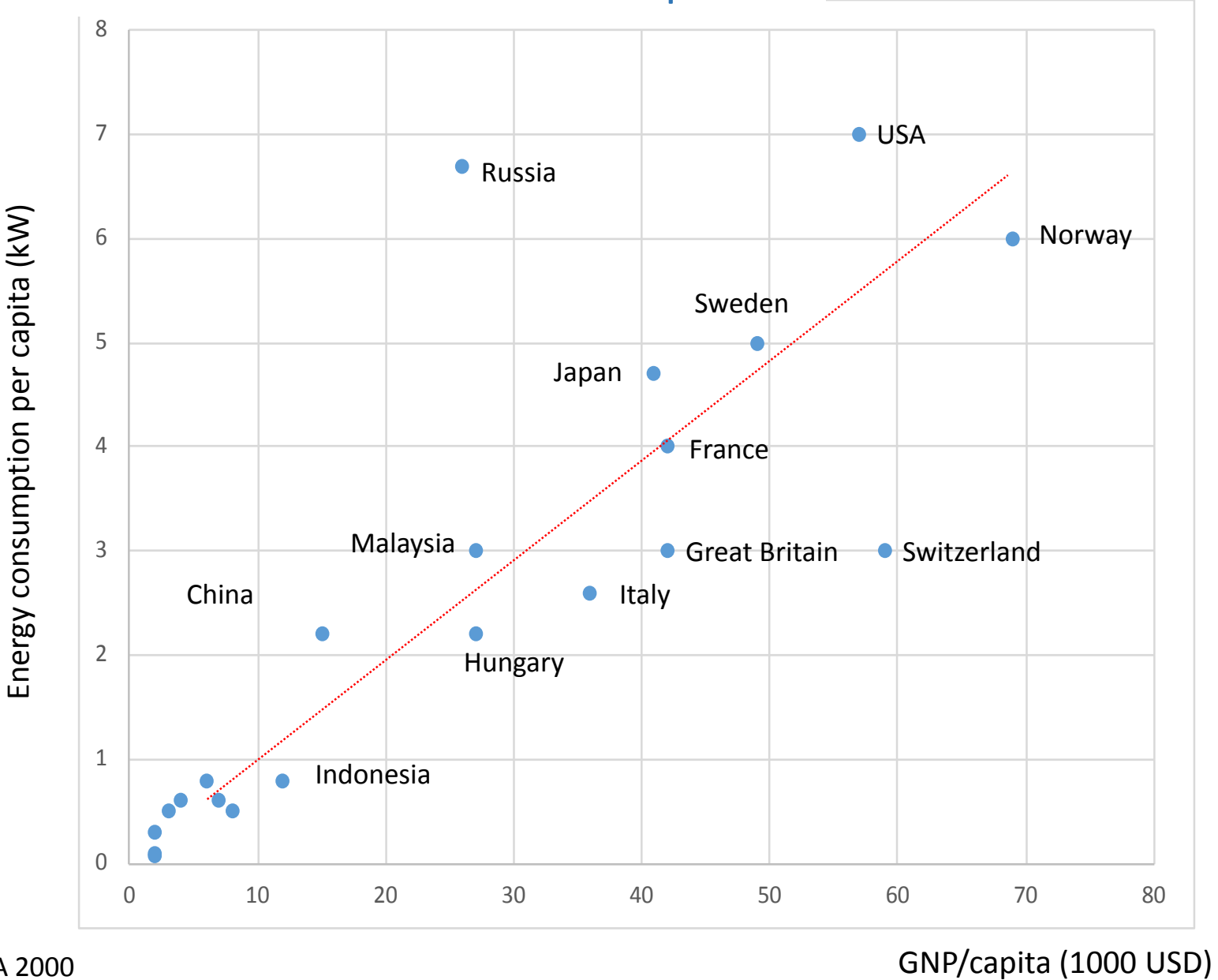


Energy / the global flow



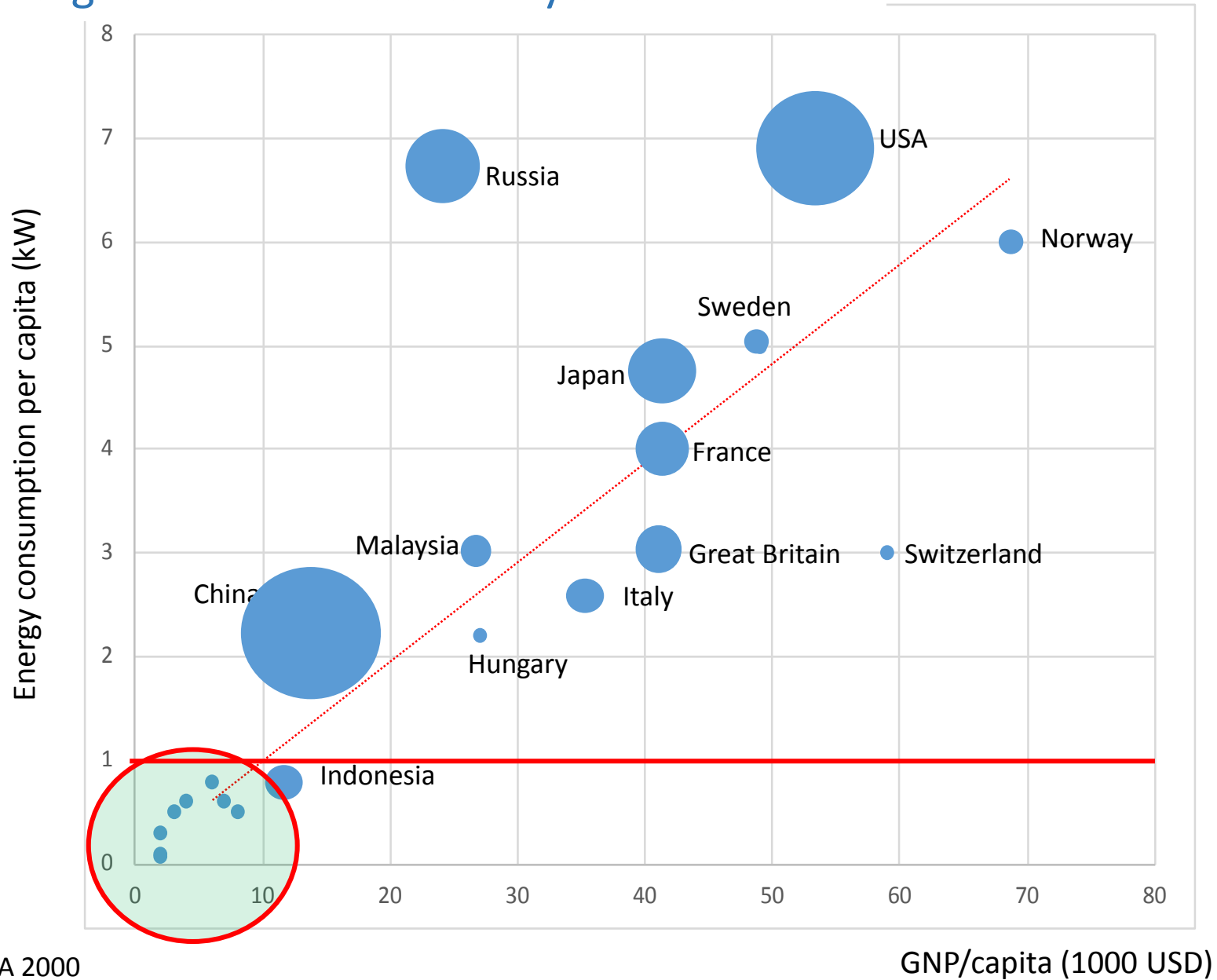
The challenge of the rich:
The dependency on stored energy (now 90%), to be replaced largely by renewable energy (now 10%)

Energy: a precondition for economic development



Sources: World Bank, IEA 2000

Status: The largest consumers are only a few nations:



Sources: World Bank, IEA 2000

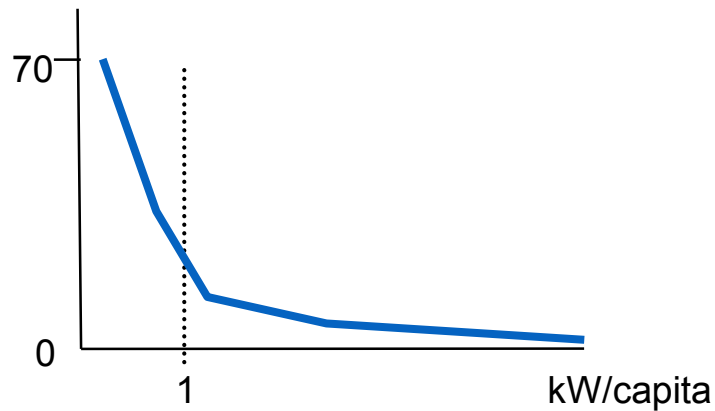
Challenge: The one kilowatt turning point

Relatively small improvements will make a tremendous difference in people's lives..

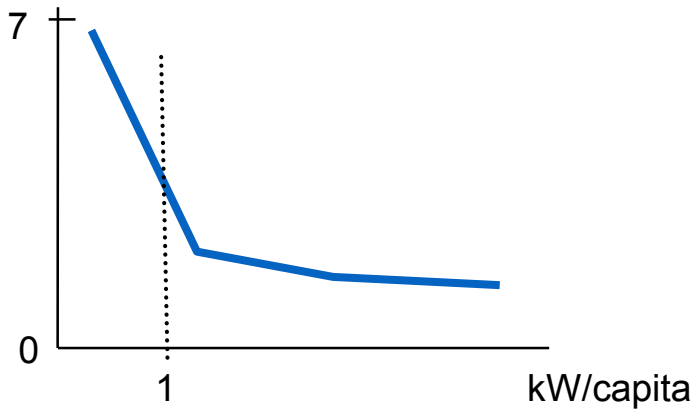
... mostly in countries with unlimited access to renewable energy

Technology is an essential part of the equation

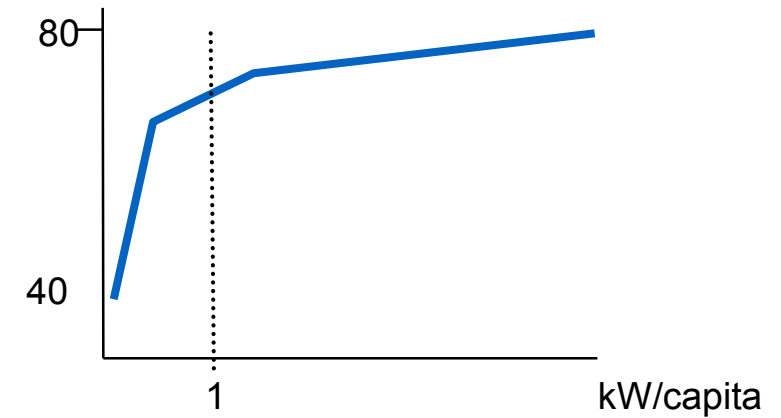
Percentage below the poverty line



Reproduction rate



Average life expectancy (years)

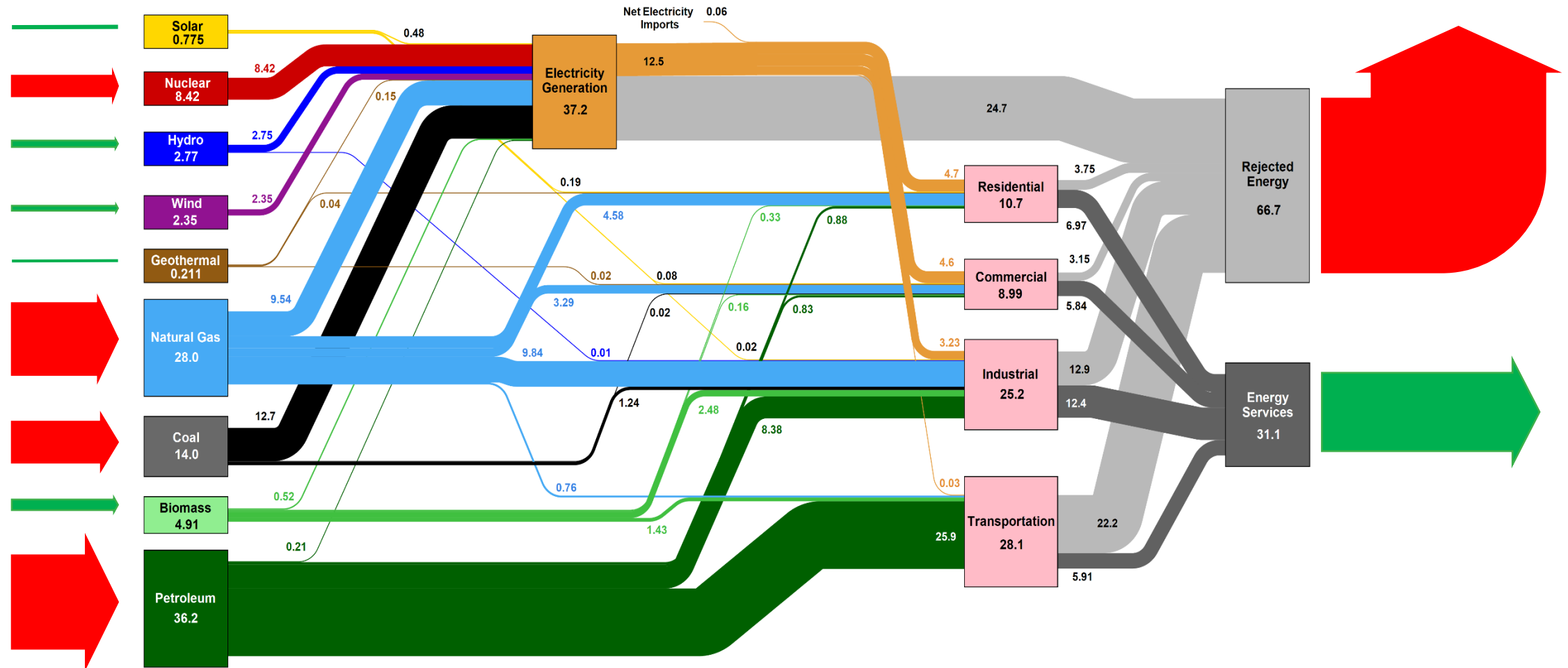


The extreme case: USA

67% is wasted as low temperature heat

Estimated U.S. Energy Consumption in 2017: 97.7 Quads

95% non-renewable energy (red)

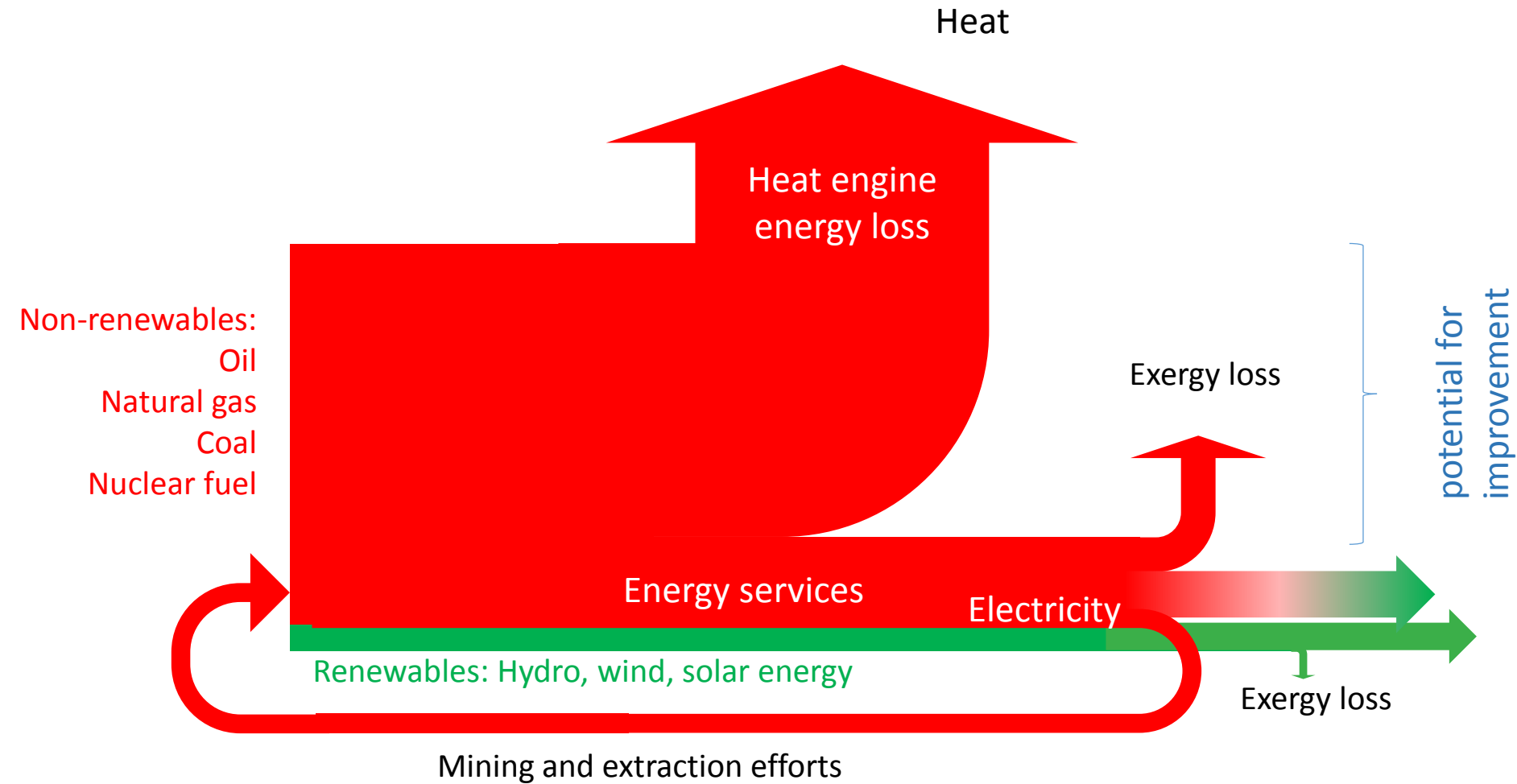


Source: Department of Energy, 2017

The main problem: heat engines.

What is a heat engine?

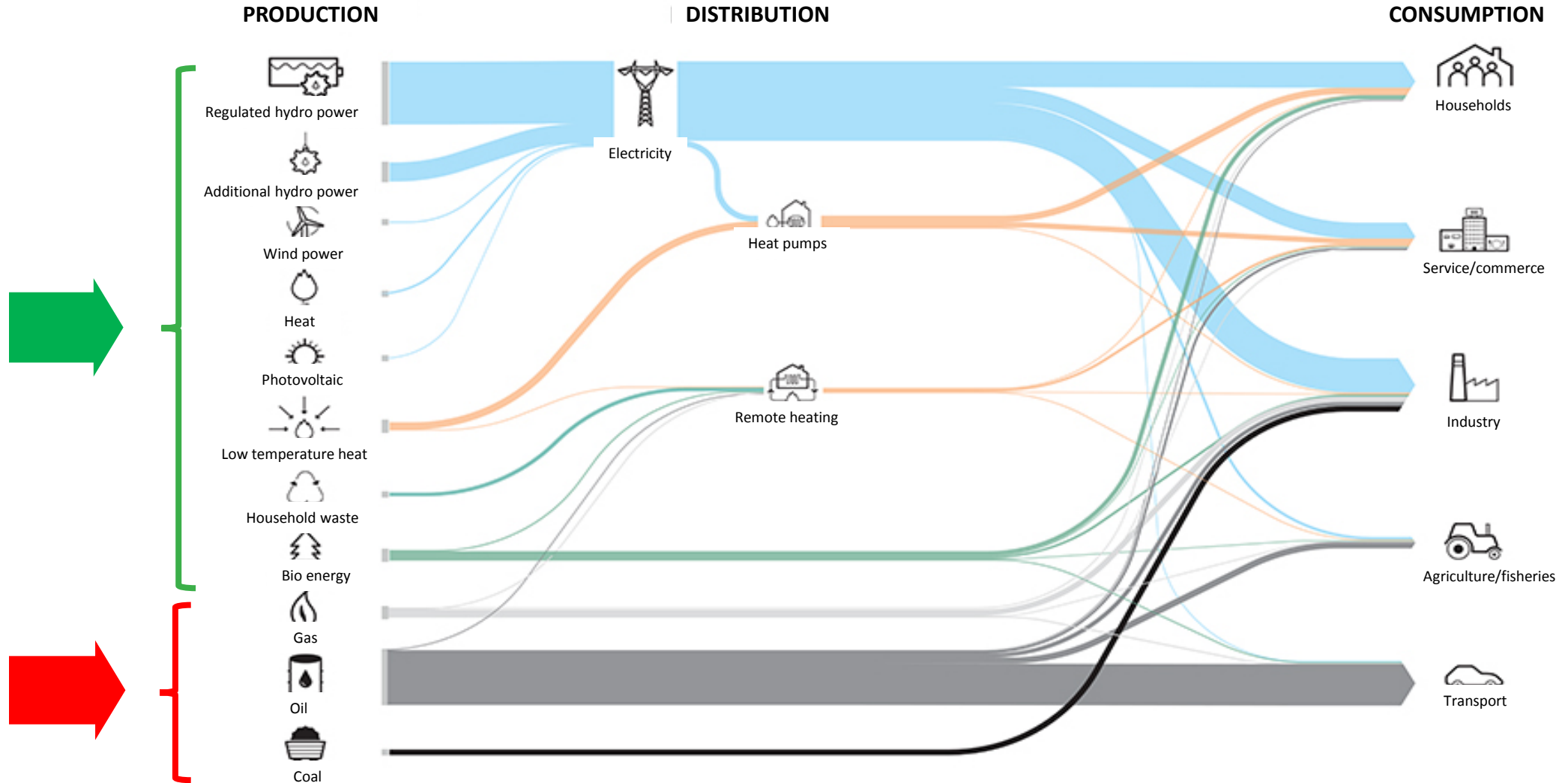
- Turbines in thermal and nuclear power plants
- Combustion engines in transport, agriculture, cars, ships, trains, buses, lorries, and machinery
- Jet engines in aircrafts
- Etc.



The answer: renewable energy and efficient energy conversion.

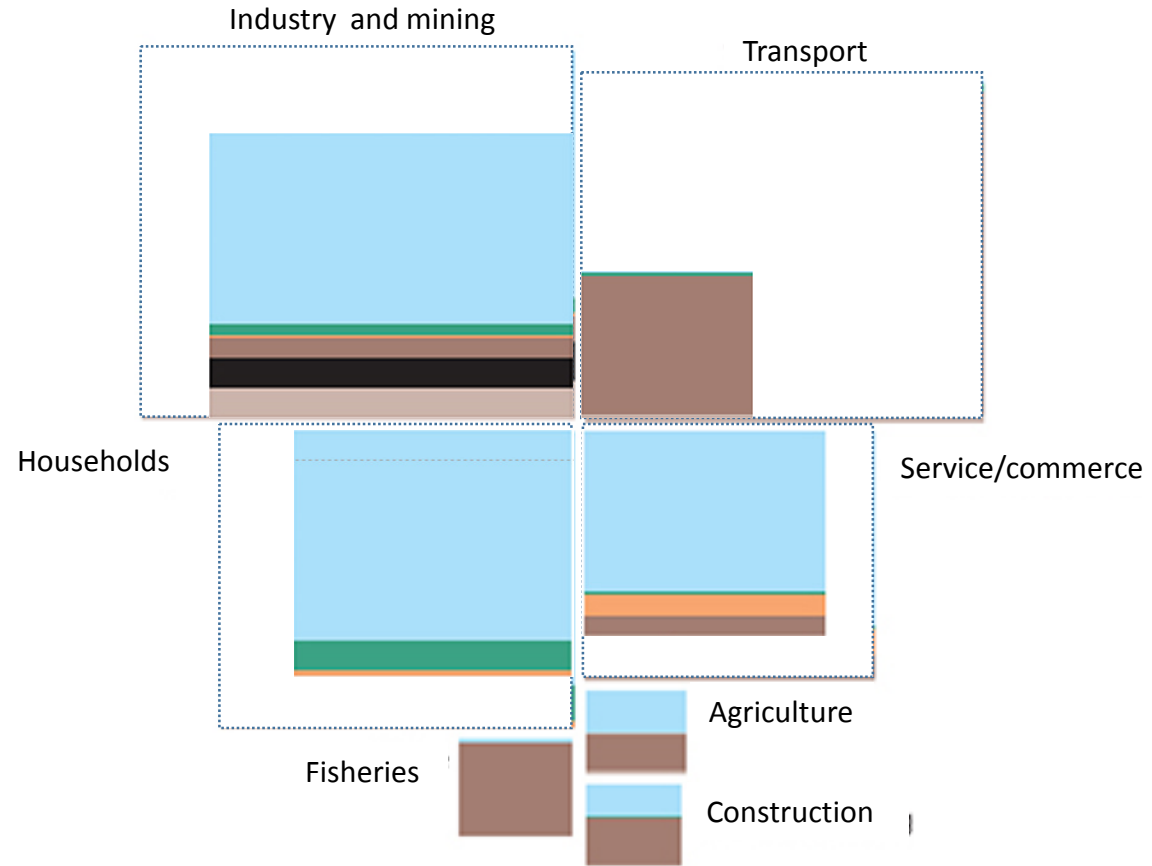
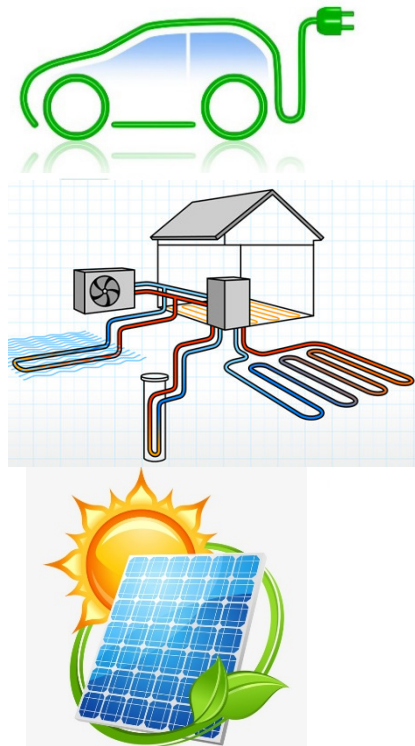
A much better case: Norway (52% renewable energy)

Energisystemet i Norge

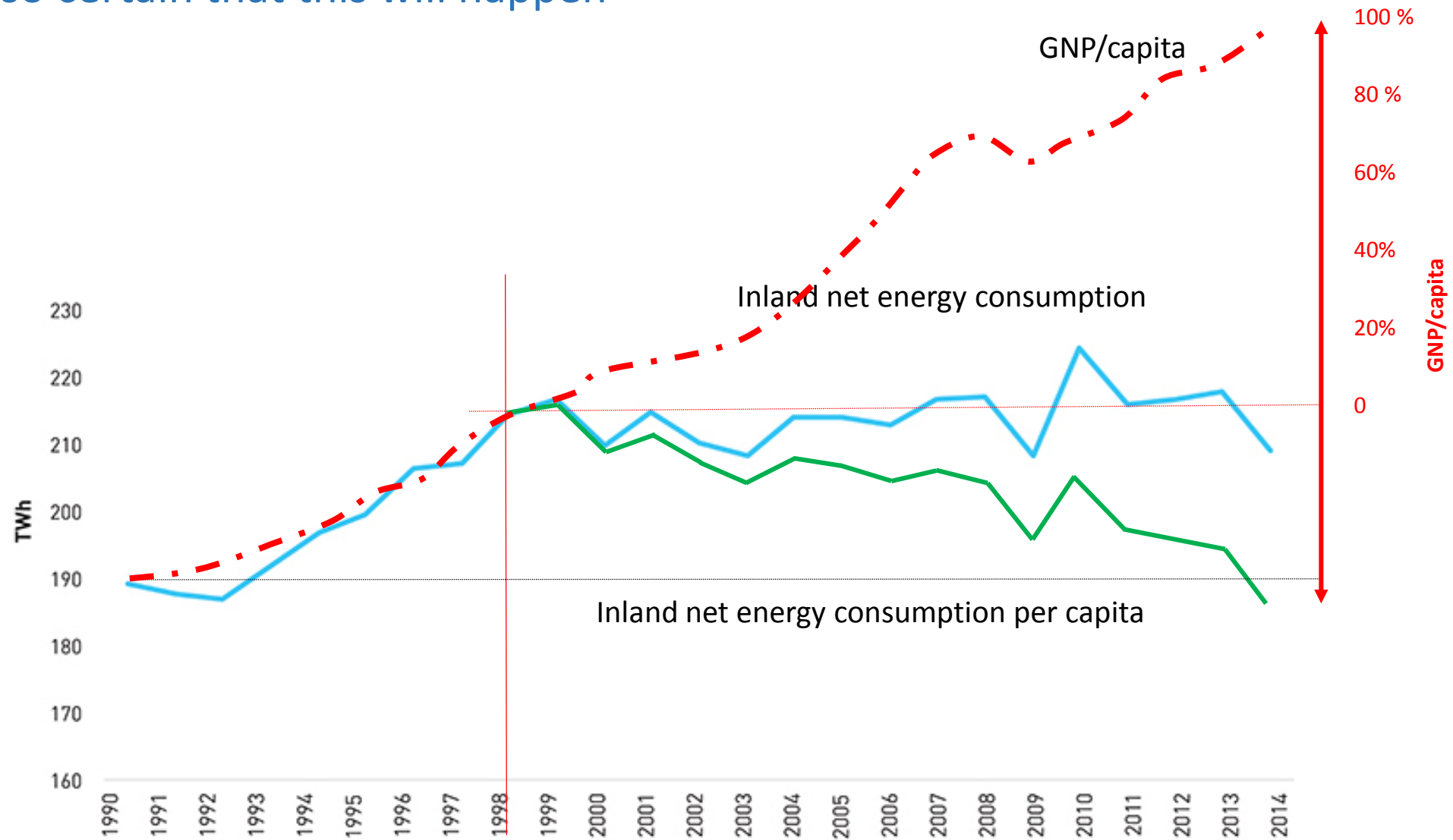


Source: Statistics Norway, 2017

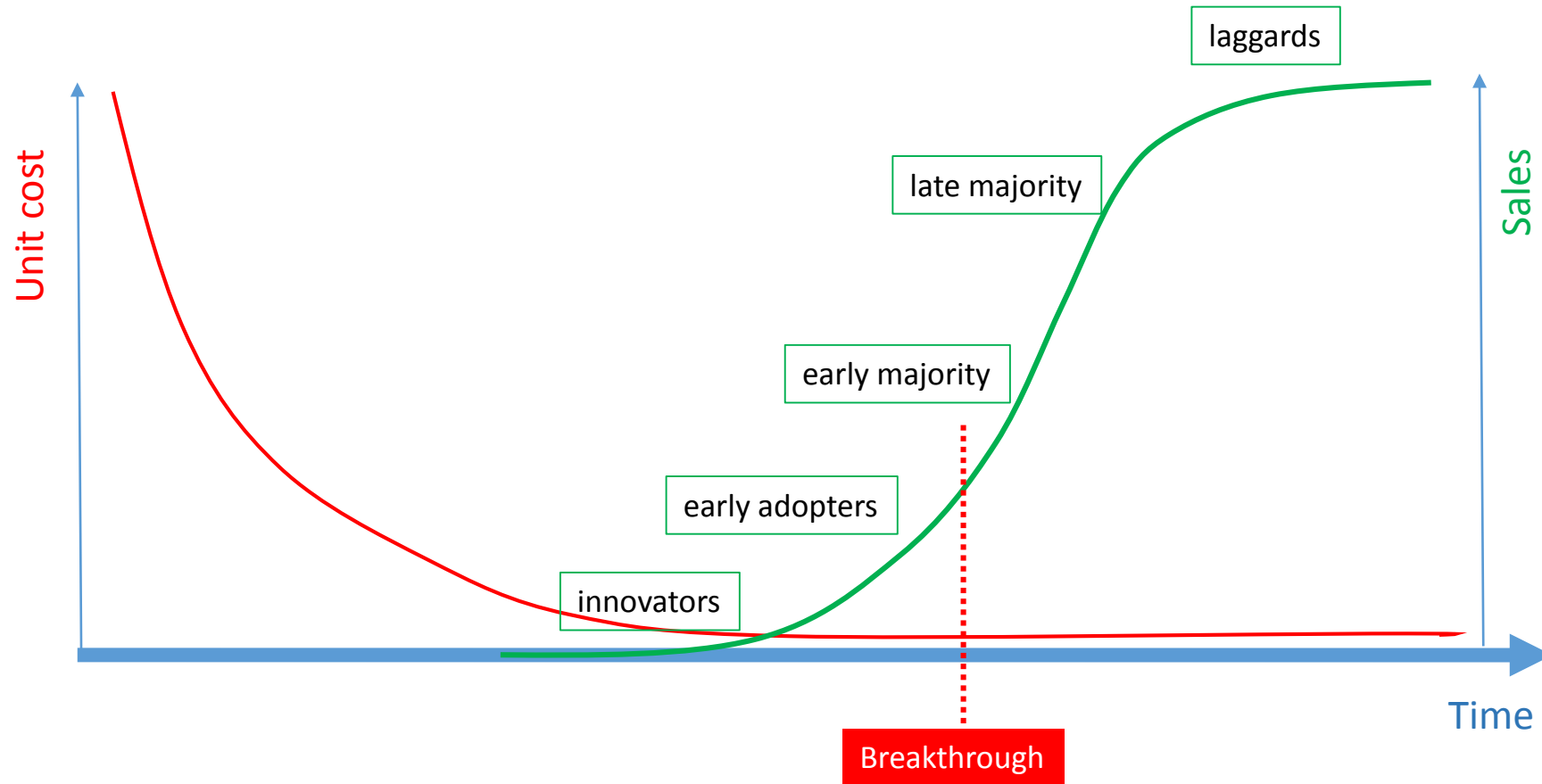
Improvements: there is a major disruption under way



Why so certain that this will happen

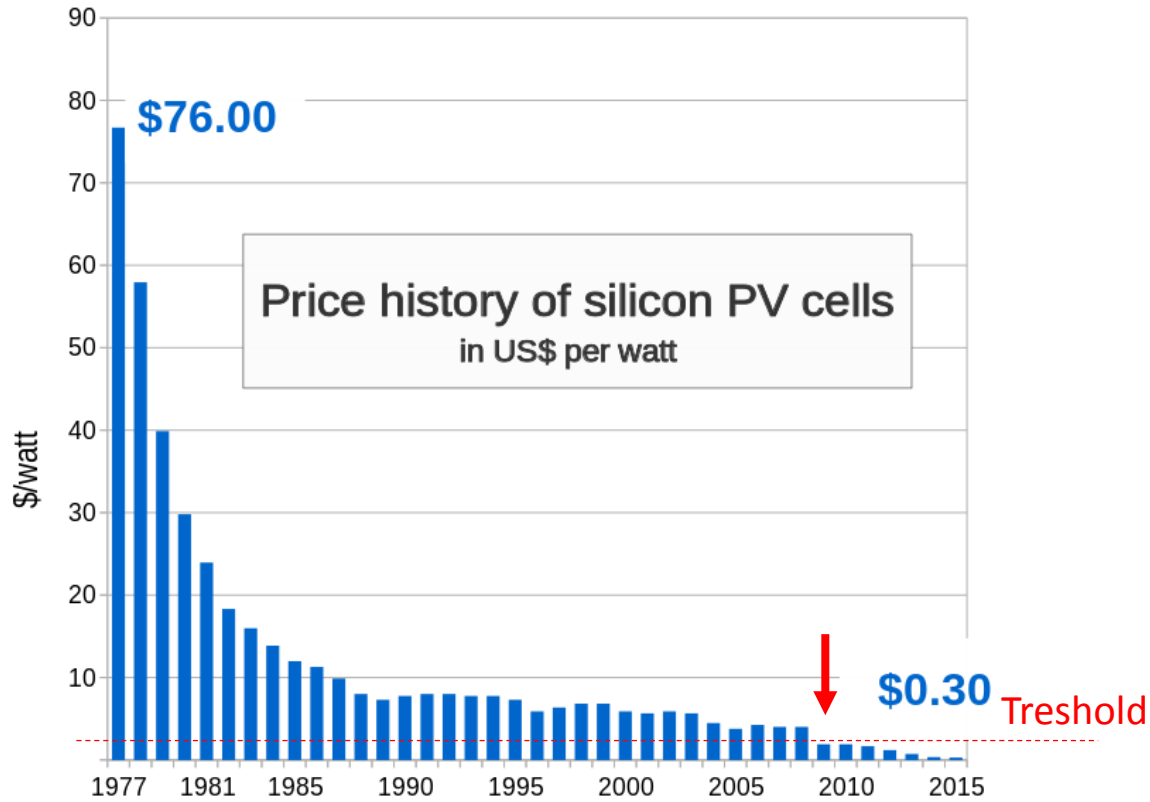


The law of technological disruption



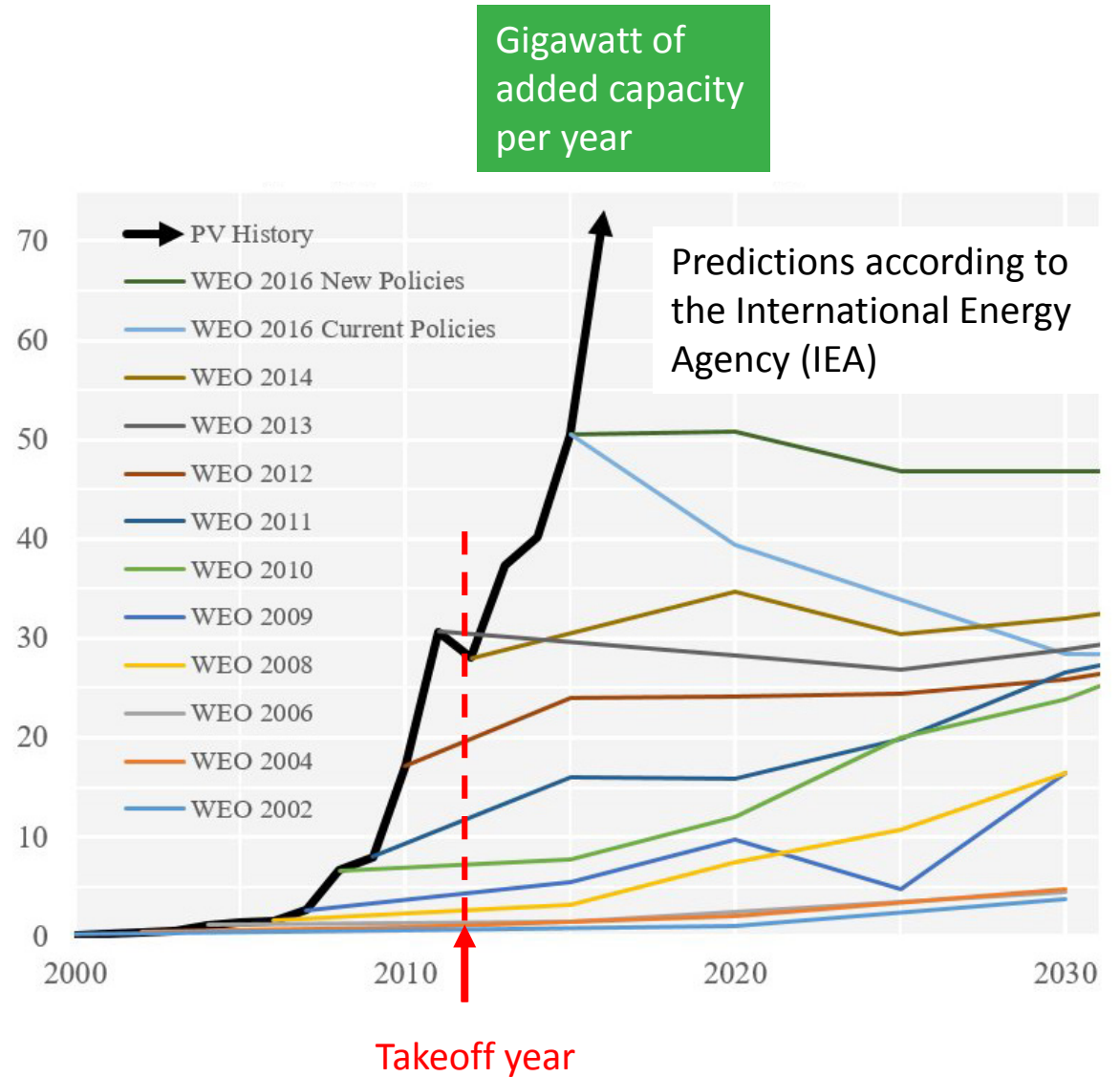
Inefficient heat engines and mechanical contraptions to be replaced by electric motors and efficient membrane technology

Photovoltaic panels and solar power



Source: Bloomberg New Energy Finance & pv.energytrend.com

Source: Bloomberg New Energy Finance



Energy production: solar energy

NB: No moving parts!

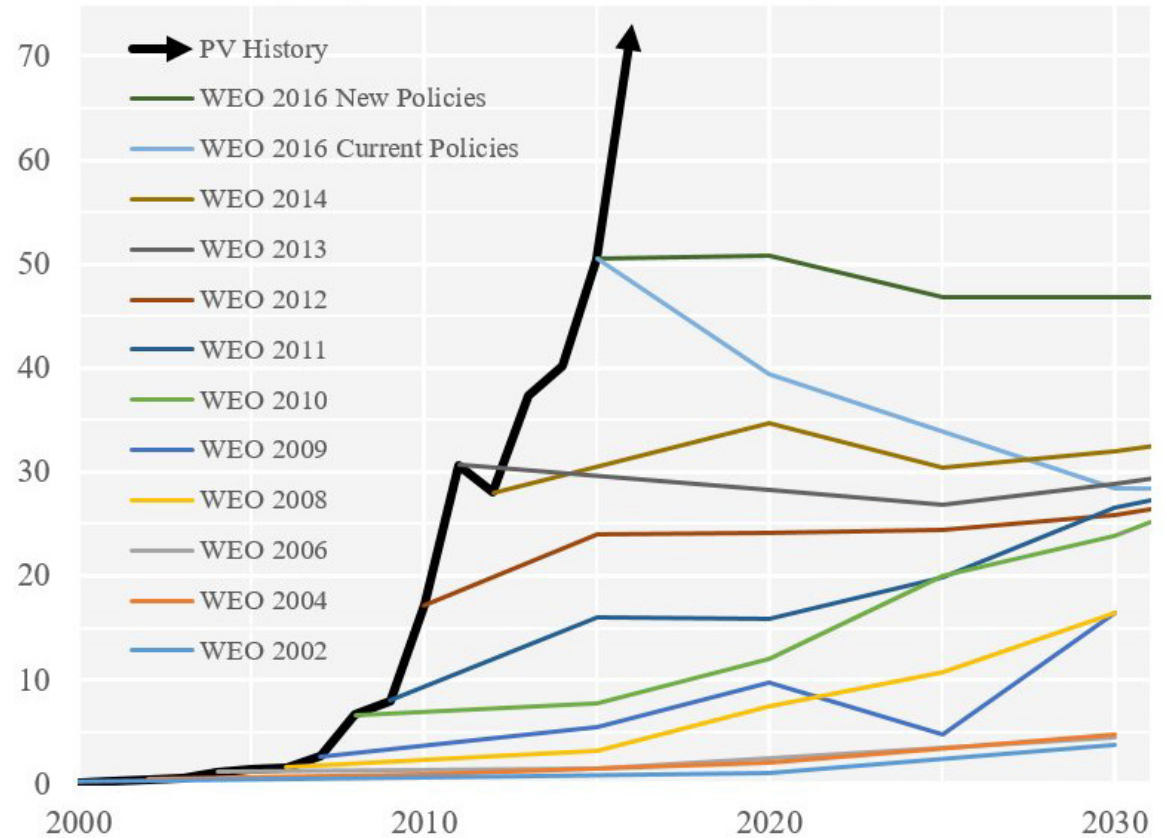


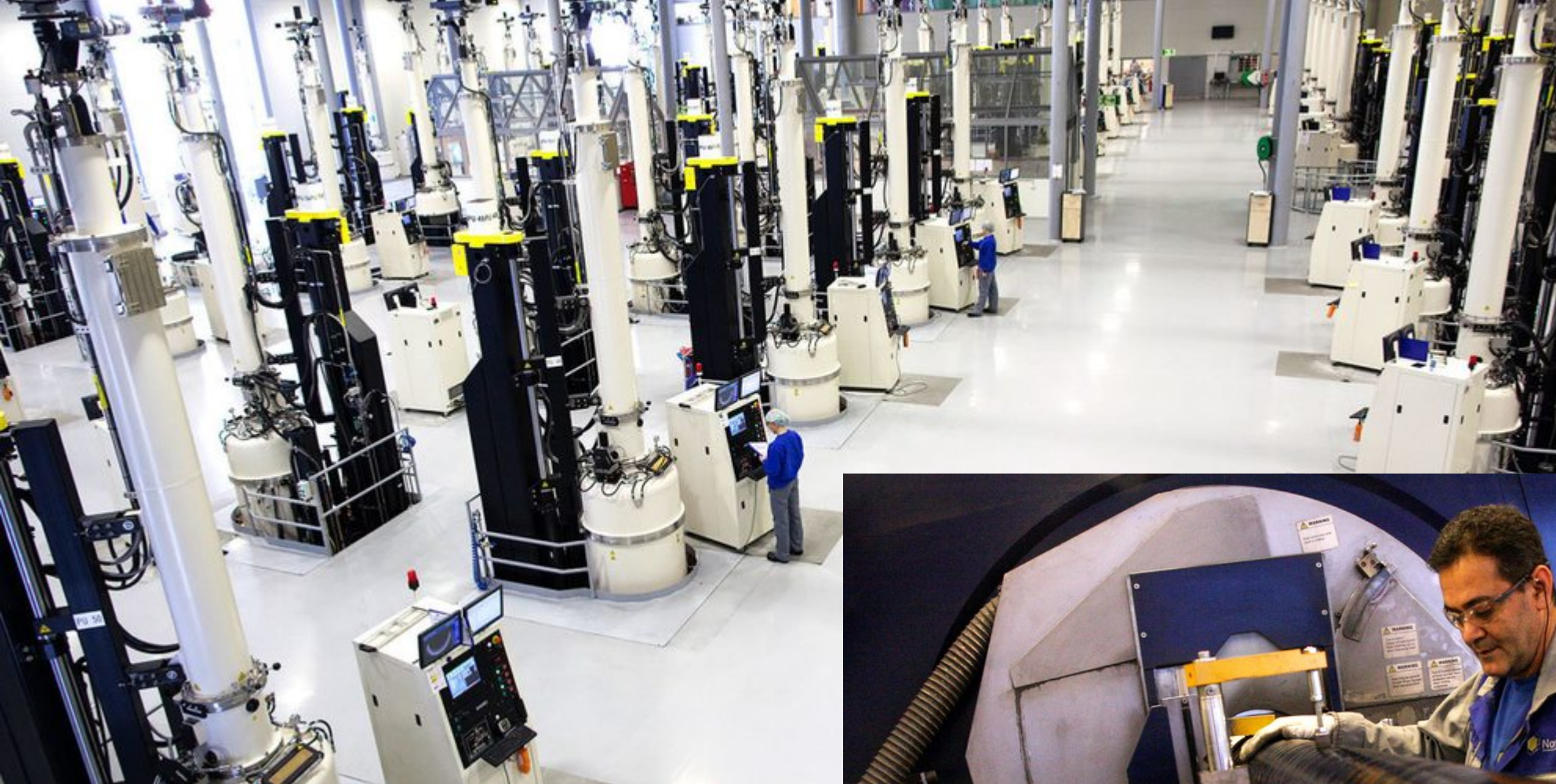
News > World > Americas

California set to become first US state requiring solar panels on new homes

State 'is about to take a quantum leap in energy standards'

Josh Gabbatiss Science Correspondent | @josh_gabbatiss | Saturday 5 May 2018 10:34 | 16 comments



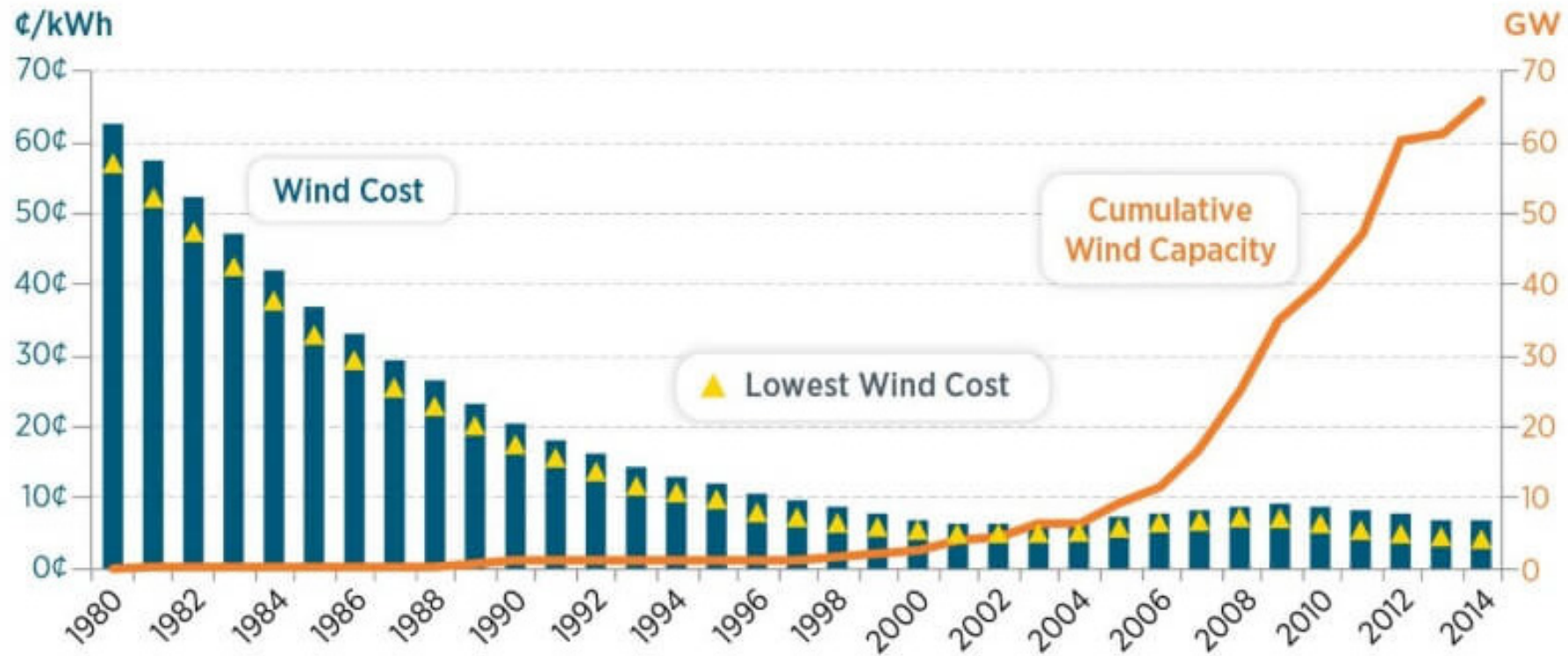


NorSun 2018 (former REC)

Hyperefficient, hyper quality silicon wafers

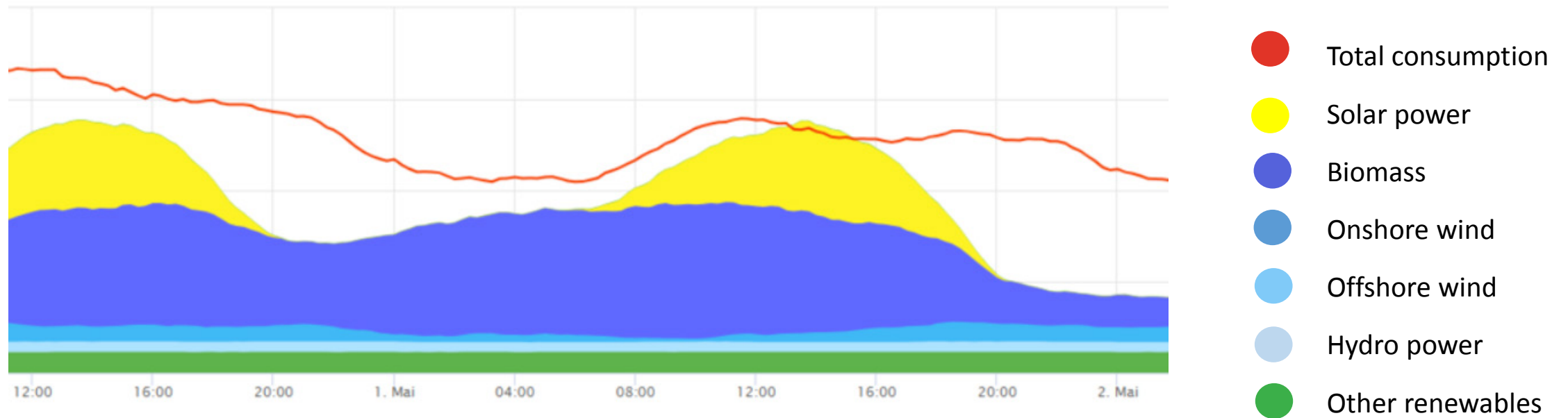


Land-based wind power



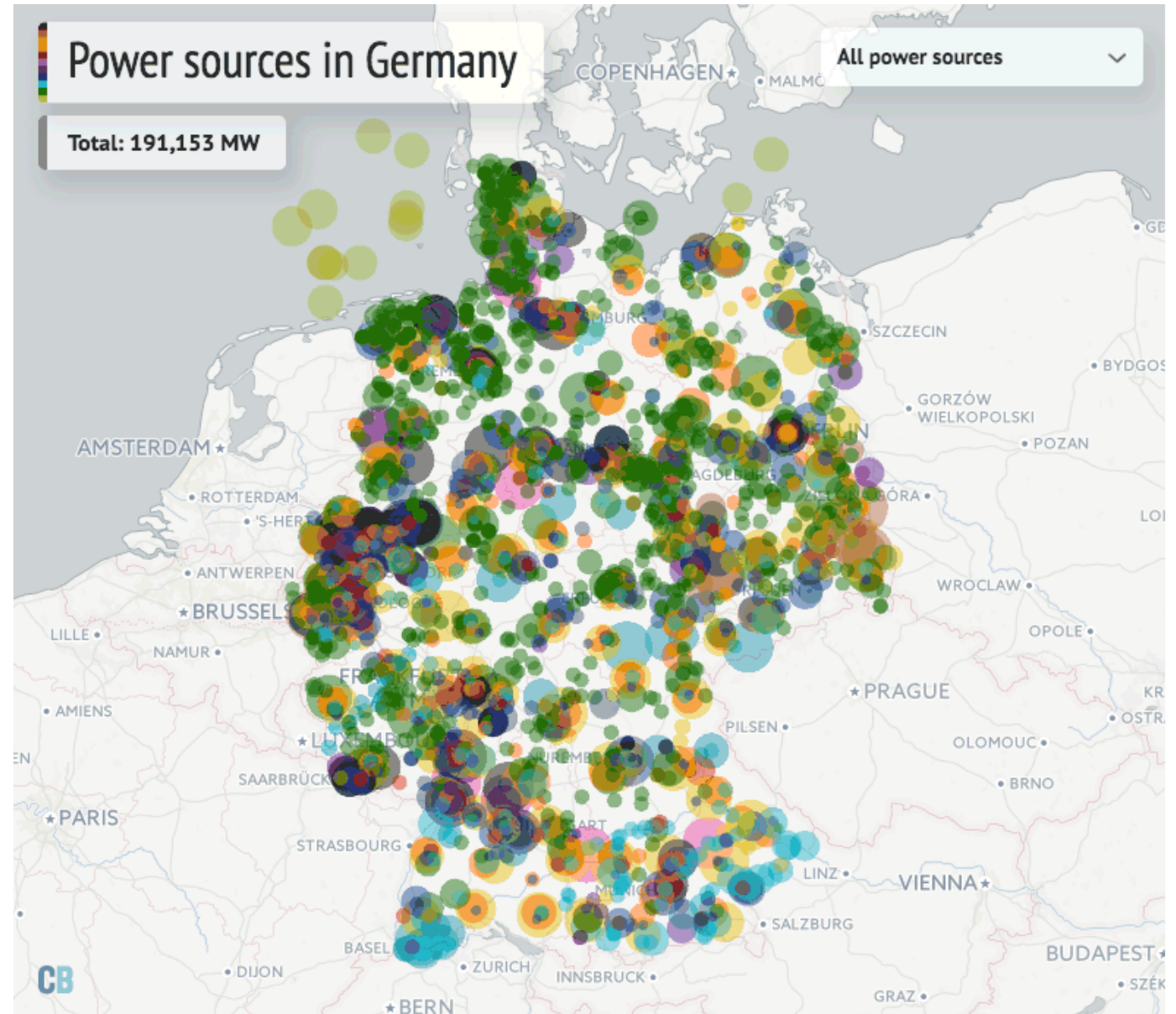
Source: US Department of Energy 2015

Energy production: solar energy - Case: Germany



24 April 2018: Renewable energy covered the entire German power requirements for the very first time

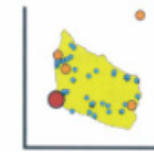
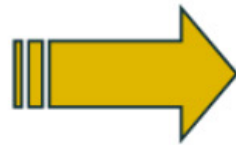
Energy distribution: Germany today



Distributed production - energy hubs away: Denmark today

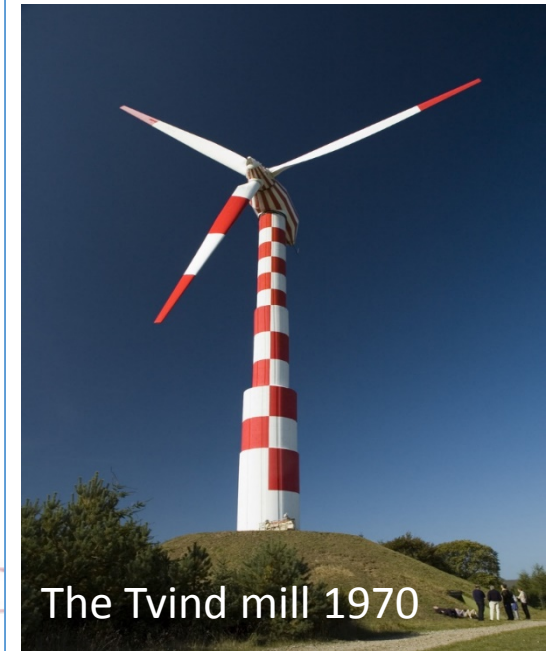
1990

2014



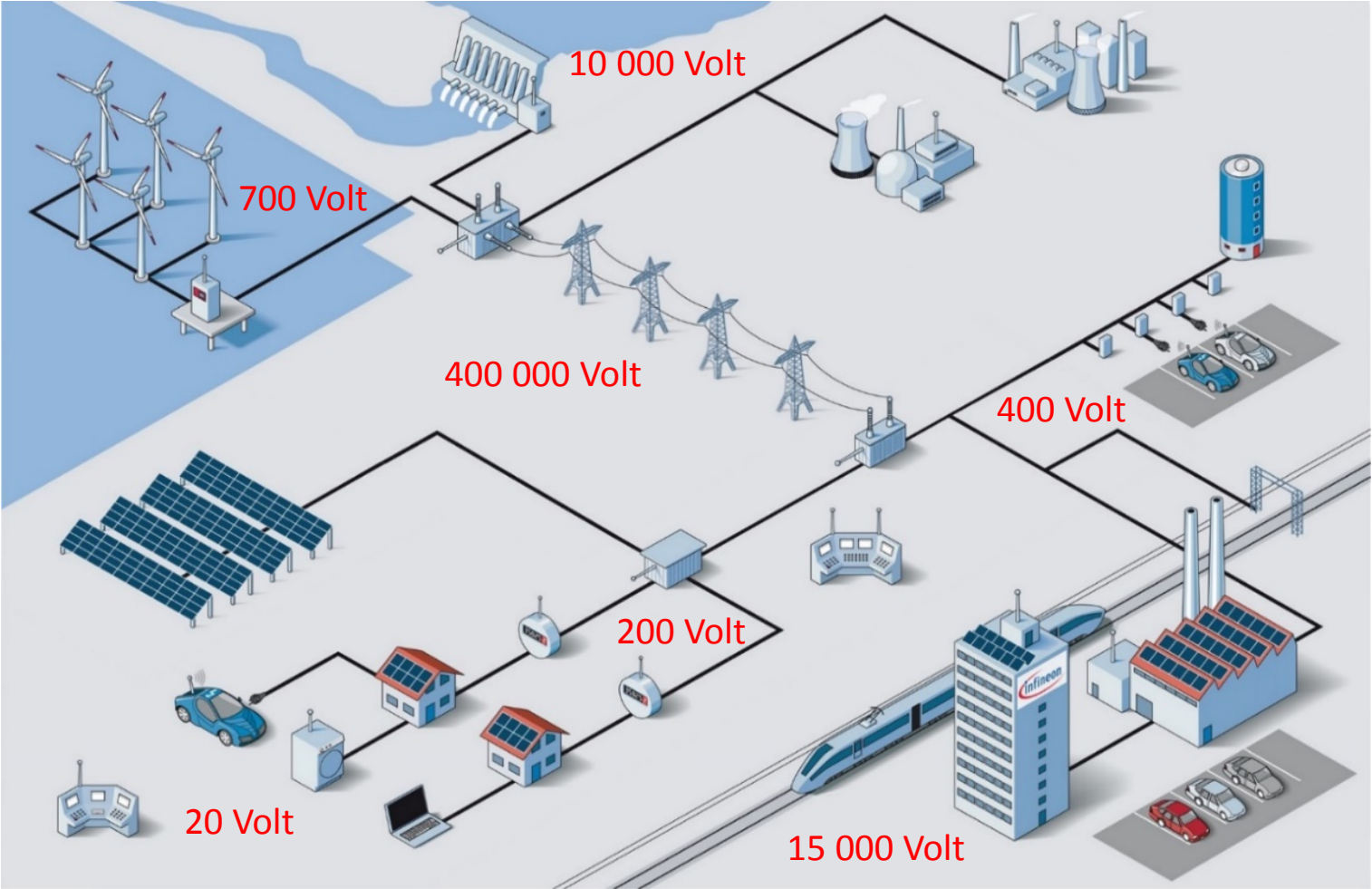
- Centrale værker
- Øvrige værker
- Vindmøller

- Central power stations
- Local CHP plants
- Wind turbines



The Tvind mill 1970

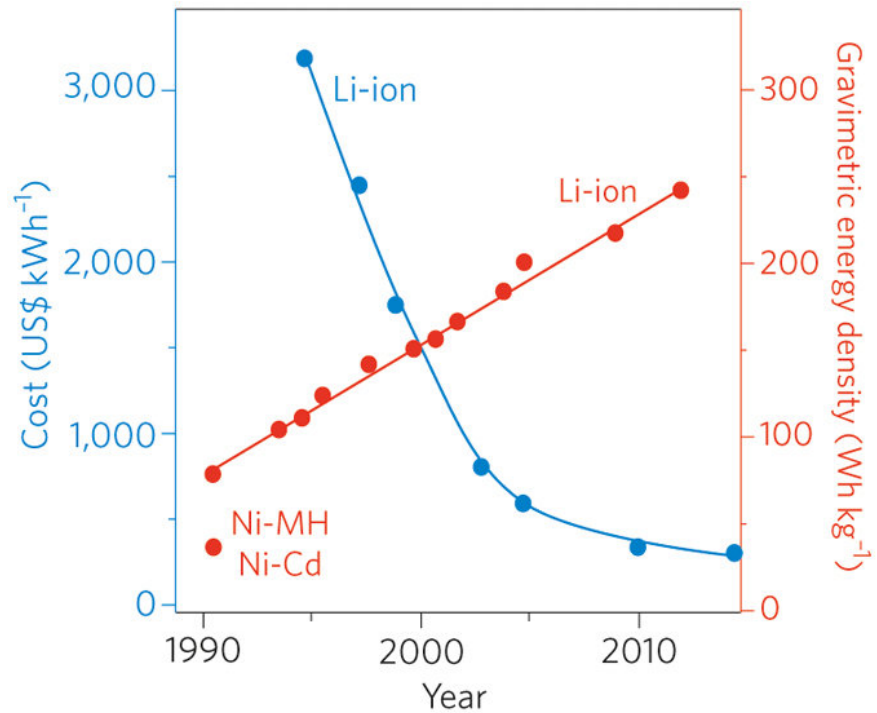
Energy networks: the smart grid



Smart grids and distributed production

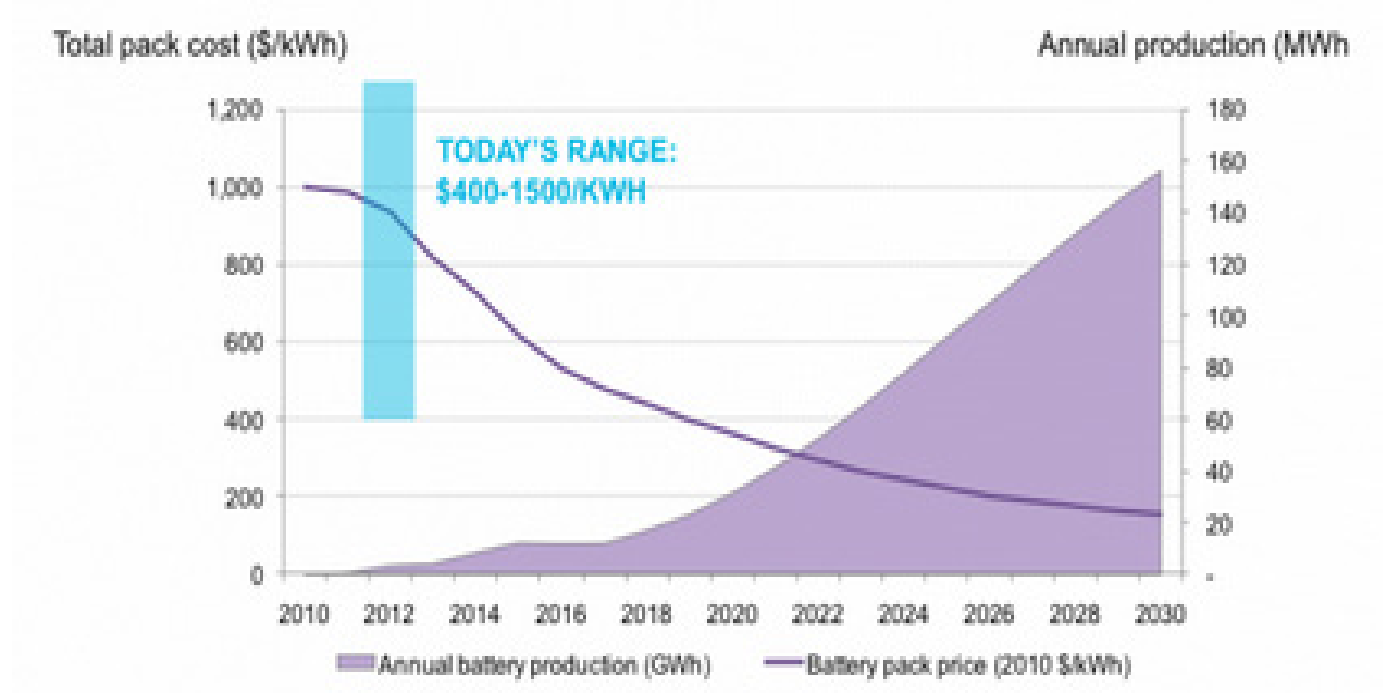


Renewable energy require storage: Battery technology



Source: US Joint Center for Energy Storage Research 2015

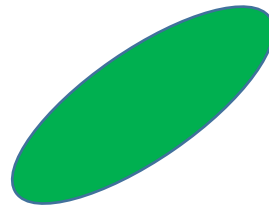
Lithium-ion battery pack cost and production 2010 - 2030



Source: Bloomberg New Energy Finance

Energy storage: Batteries

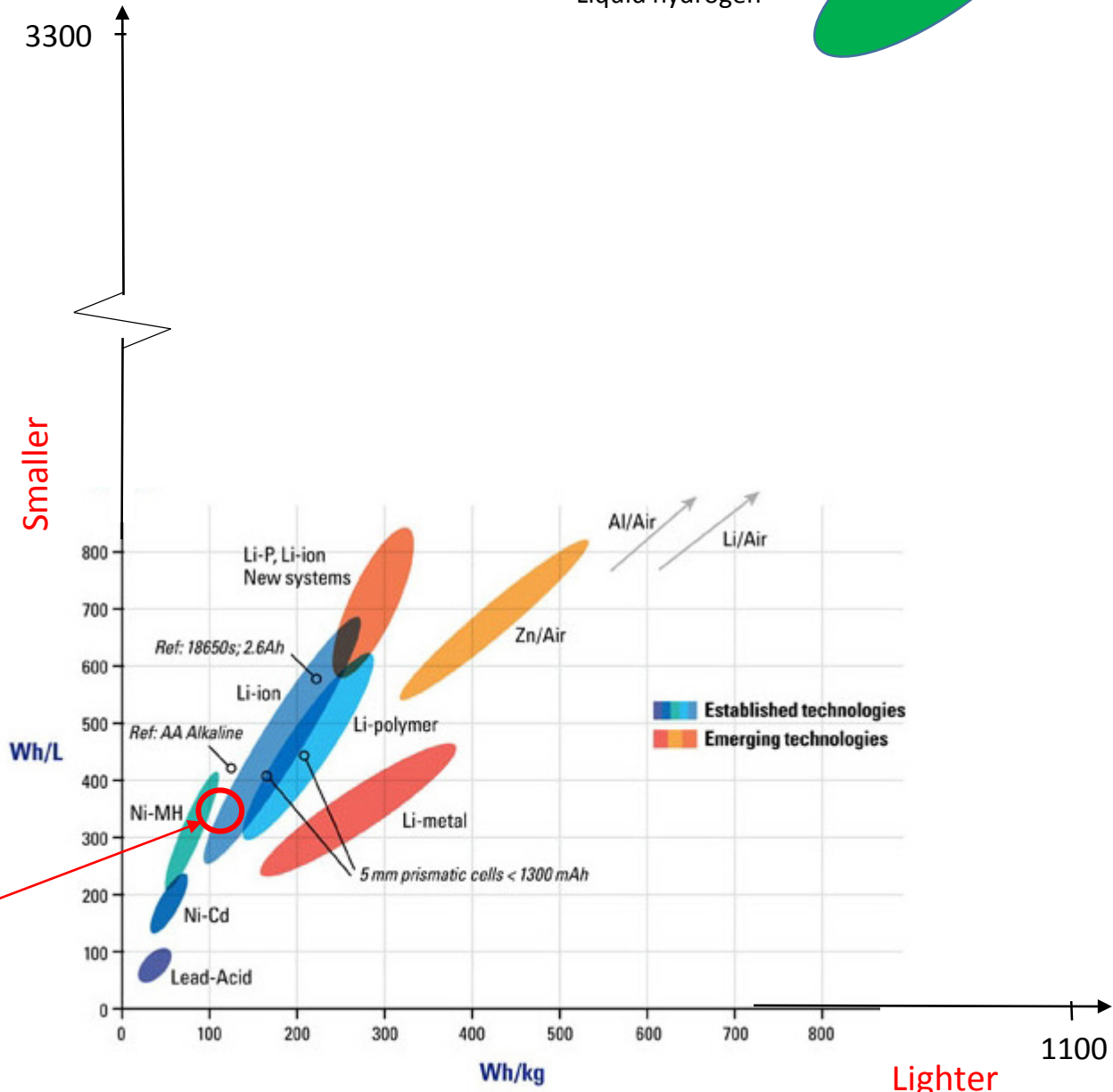
Liquid hydrogen



Hydrogen storage:
five times lighter and three times less volume than today's state of the art batteries.



.. and fuel cells convert energy into electric power with 85-90 % efficiency



Current commercial batteries

Upcoming study: disruptive technologies and potential paradigm shifts

Part 1 Technological development in general

- Technology
- Digitalisation
- Energy

Part 2 Developments in three sectors

- Defense
- Construction
- Transport



Sector: Defense

Attack versus defense

Targets: people vs. infrastructure

Military intervention vs. paralysis (Cyber war)

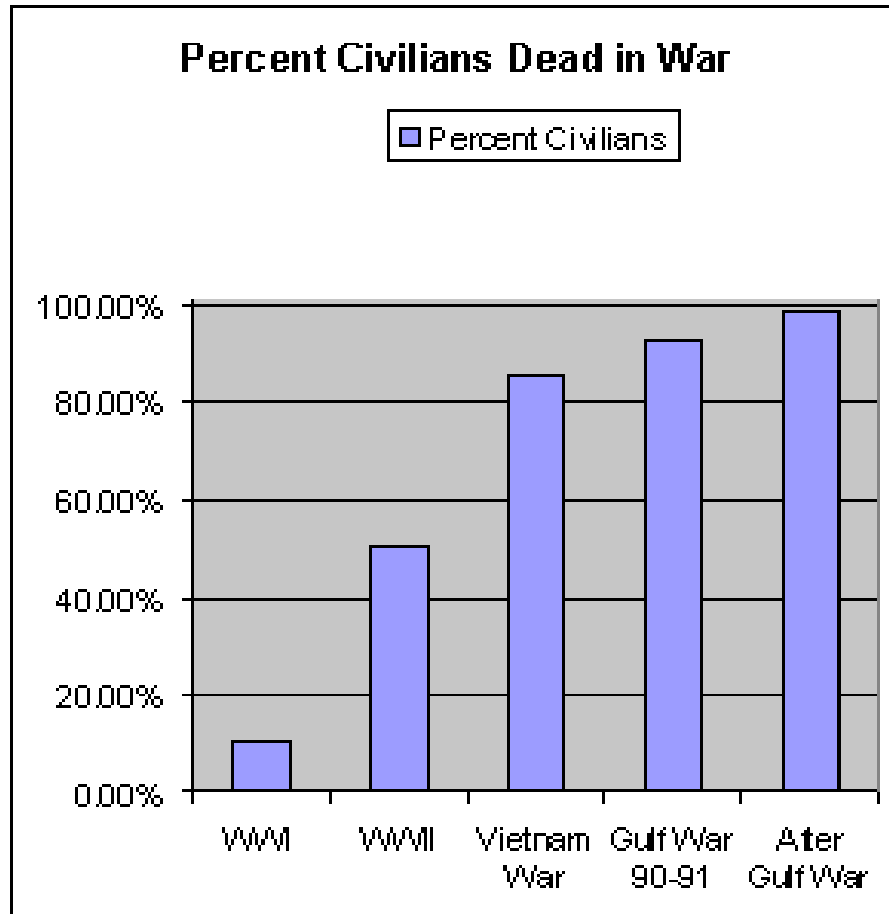
Ground level vs. High altitude (space war)

Manned vs. unmanned weapon platforms

Hardware vs. software, Etc.



Defense: victims of war



Picasso: Guernica

The historic trend - Percentage of Civilians as Casualties of War – up from 11% to 99%

Source: PeaceAware Factsheet

Defense: against what?

Weapons	Precision	Guidance	Destruction
Guns/cannons	limited	ballistic	Men
Conventional bomb	limited	ballistic	Men
Missiles	high	target seeking	Infrastructure
Atom bomb	high	target seeking	Infrastructure
Laser weapons	high	target seeking	Tactical targets
Chemical	low	target seeking	Population
Biological	low	none	Population
Digital/Cyber warfare	low	None	None

Attack and destruction

versus

Paralysis



Cyber War

Obama Administration prepares to boost US's cyber warfare capabilities



High altitude

versus

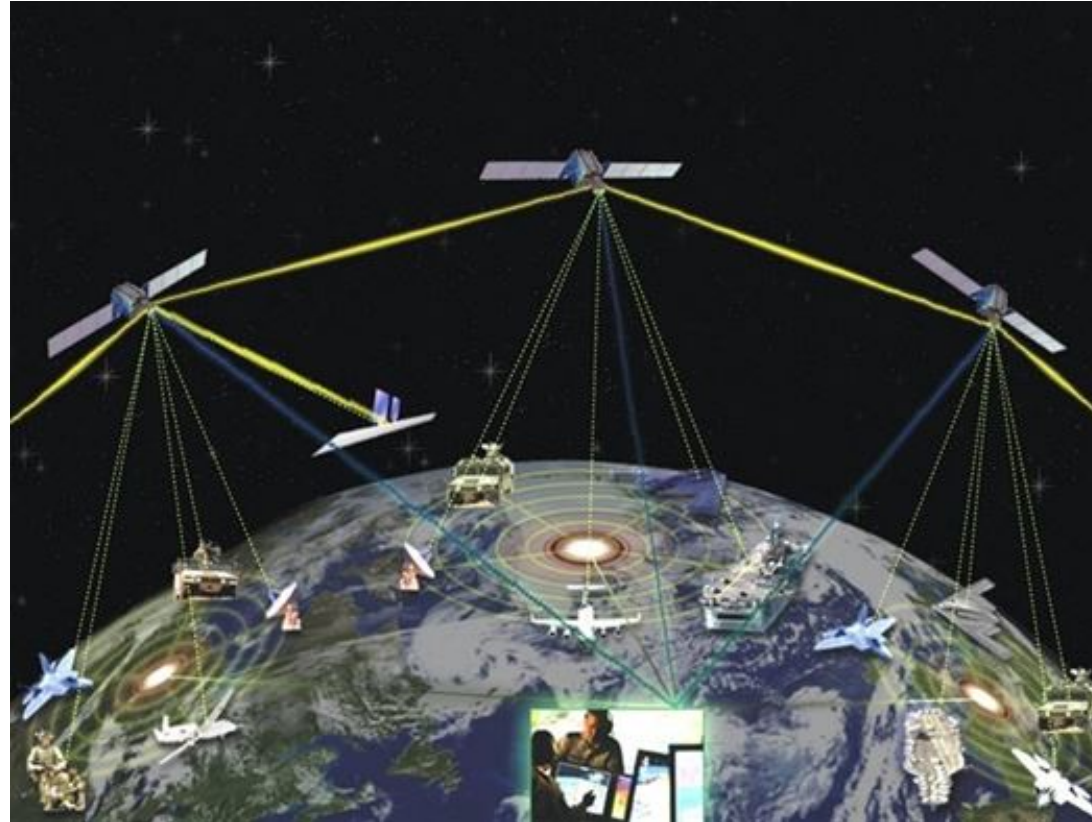
Terrestrial level

Space backbone layer

Airborne network layer

Tactical layer

Terrestrial network layer



The one who
dominates the space
level will be the winner

Path dependency

versus

Defense capability



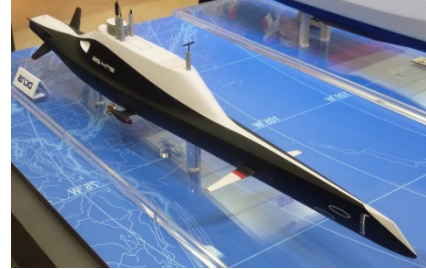
F35 Manned fighter jet. RAND Corp (2015): Can't Turn, Can't Climb, Can't Run



Frigates. Escort vessels for transport convoys: 2WW scenario



Coastal missile torpedo corvettes: Vulnerable weapon platform 2WW scenario



French submarine concept design



Naval Strike Missile (NSM) developed by the Norwegian company [Kongsberg Defence & Aerospace](#)



NSM launch vehicle

Attack on man

versus

his genome



Biological warfare ?



Sector: Construction

Needs: homes, offices, culture, industry, etc.

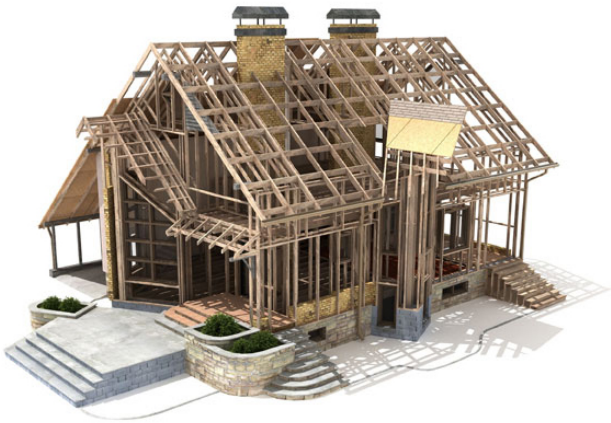
Space: size, density

Settlements: horizontal/vertical - suburban/urban

Production: craftsmanship – mass production

Digitalization: Building Information Management

Technology: robots, 3Dprinting, materials



New cities built from scratch



\$45B Lusail City – Qatar’s largest real estate project, will be home to 200,000 with a scheduled completion date of 2019

Megaprojects Set to Explode to 24% of Global GDP Within a Decade

3D printing and productivity

2015 World's first 3D-printed apartment building constructed in China



3D printing and design

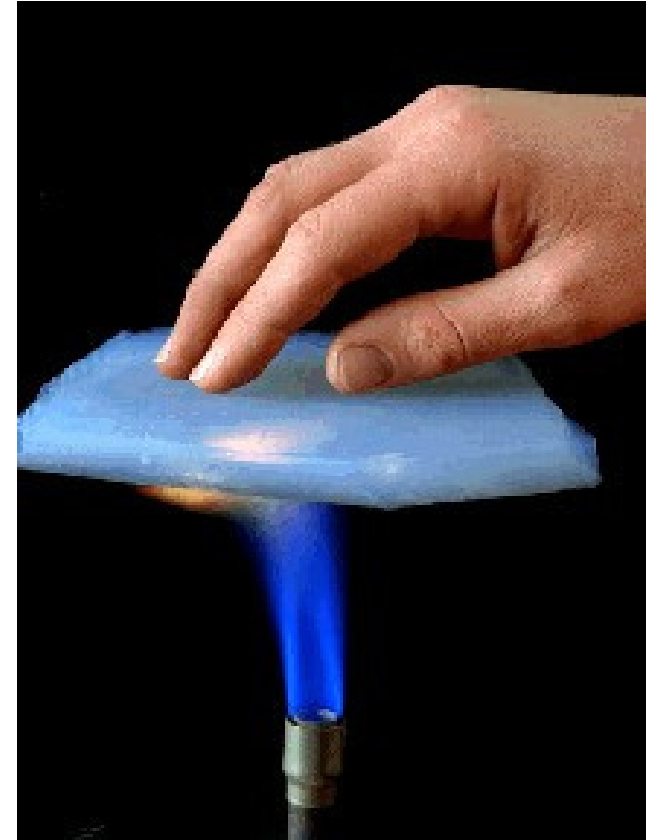


Construction robots and efficiency

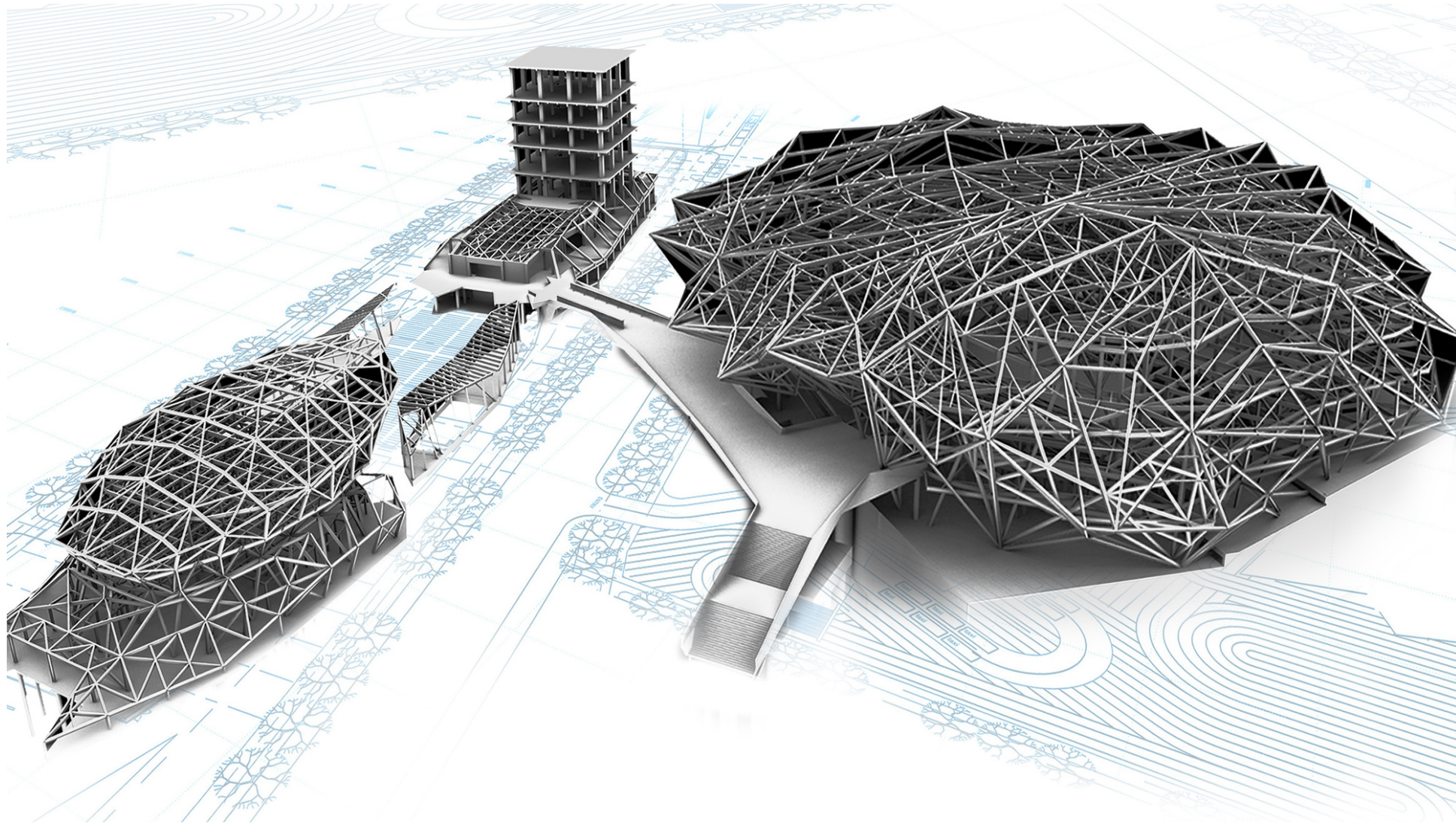


New materials and new opportunities and designs

Aerogel super insulation material



Building Information Modeling – to make it all happen



Sector: Transport

Intelligent vs. unintelligent (human) transport systems

Electrification on the roads, at sea and in the air

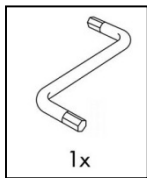
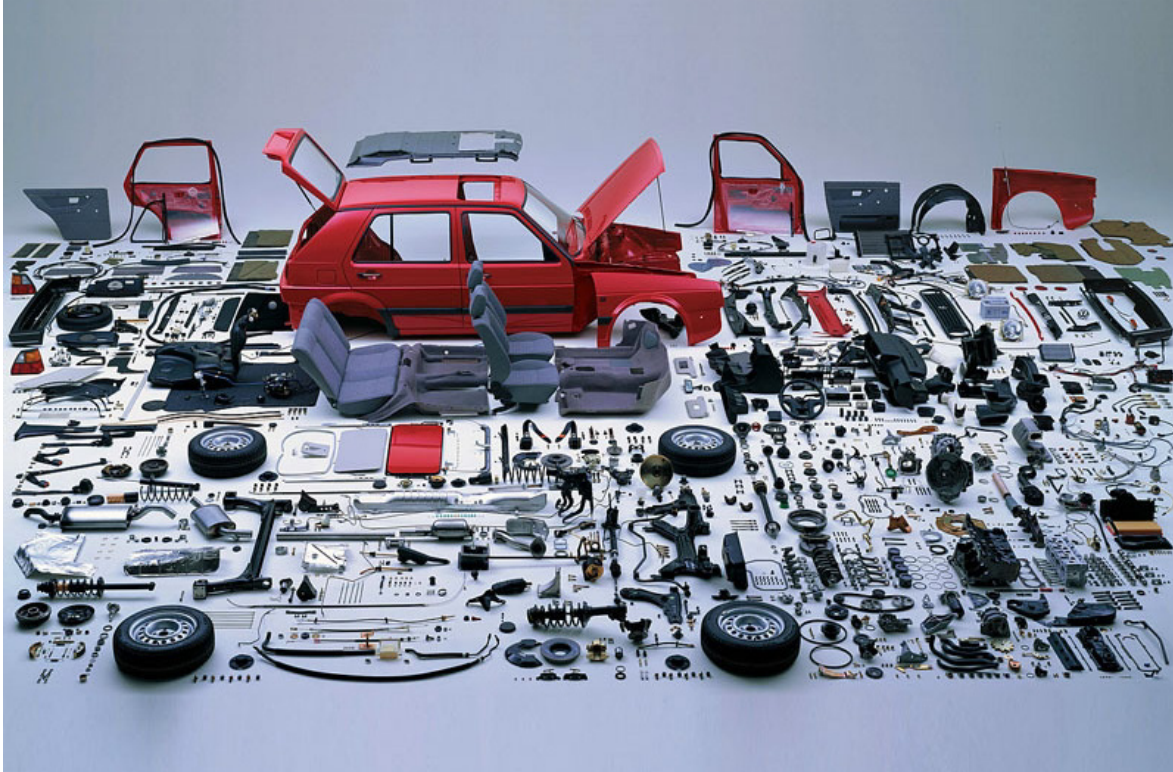
Digital communication and our need to travel

Flexibility/degree of freedom of transport systems

The effect on international cargo of decentralized production

Maintenance of existing infrastructure



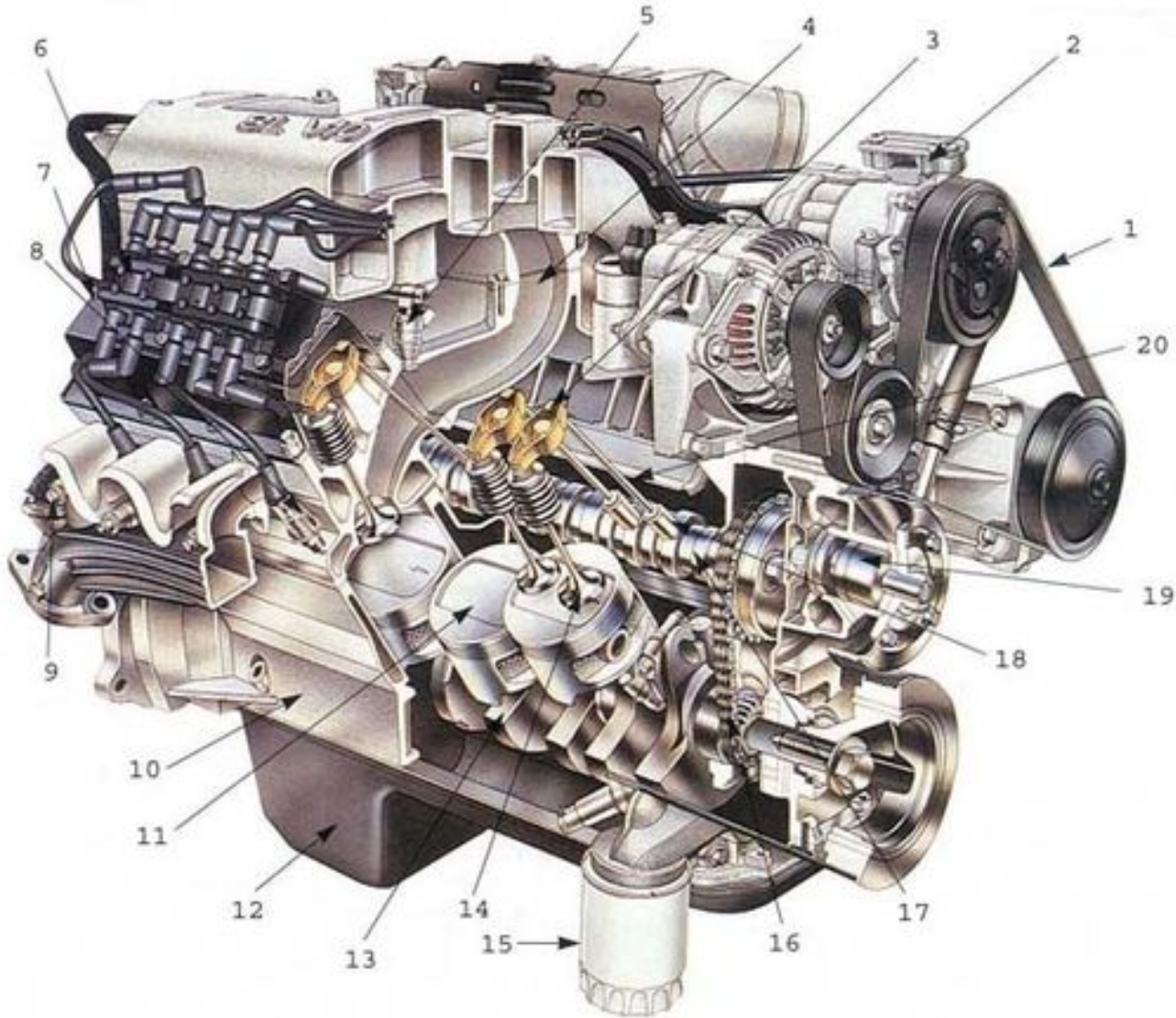


IKEA car kit

1x



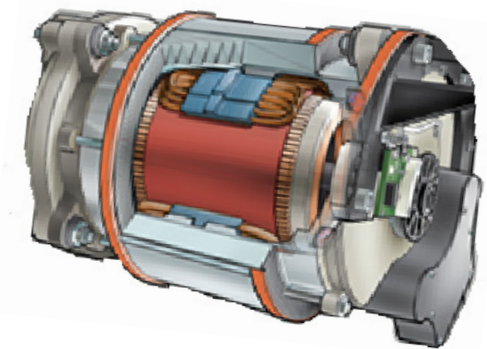
GMs skateboard



850 kilo – 550 Hp

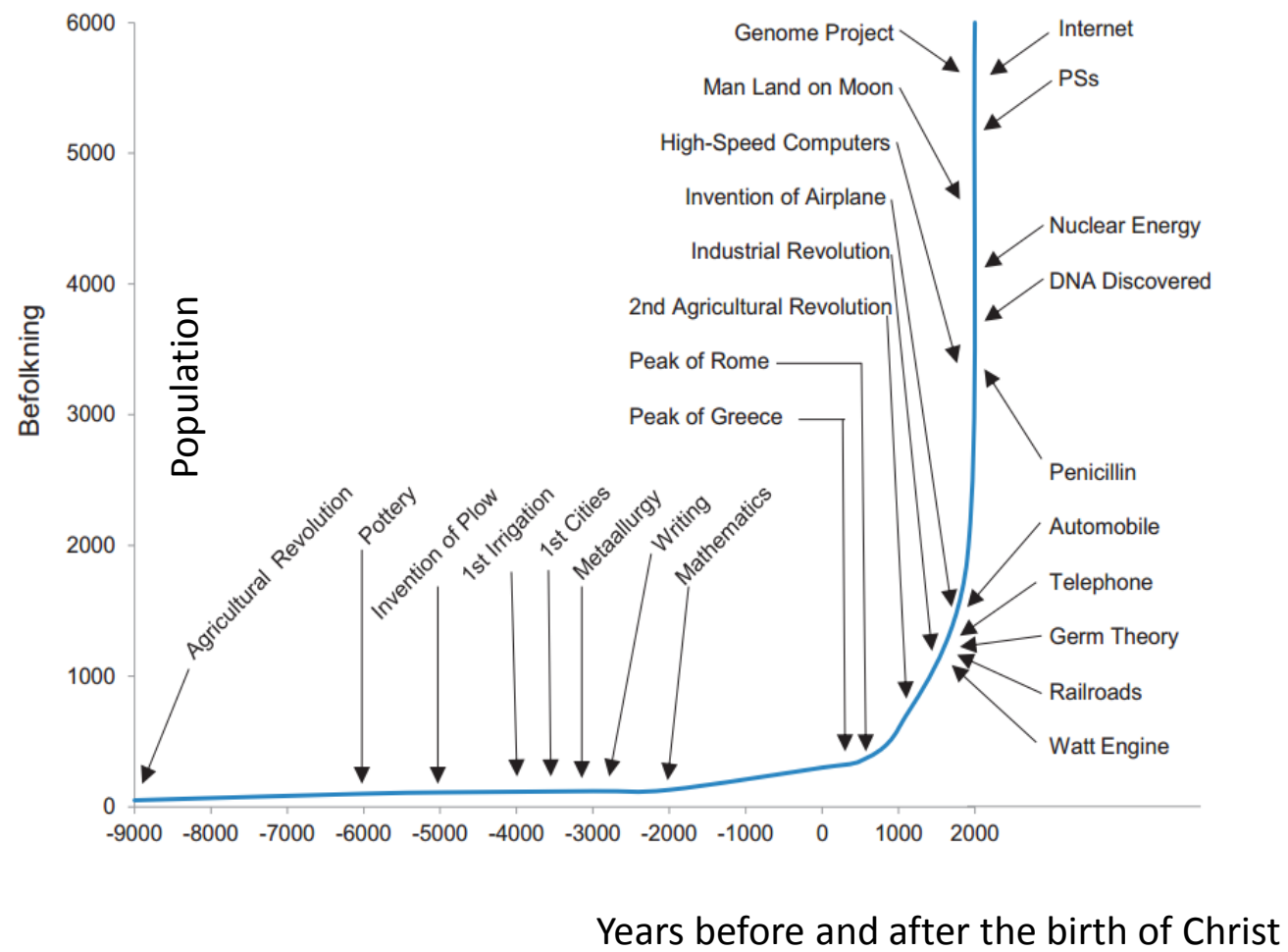
About the same torque

Engine	Weighth kg	Power kW/kg	kW/kg ratio
Ford model T (1908)	320	0,28	1
GM 6,6 l V8 Turbo diesel	850	0,65	2,3
Nissan fuel cell (2016)	45	2,5	10
Tesla model S electric	35	8,5	30



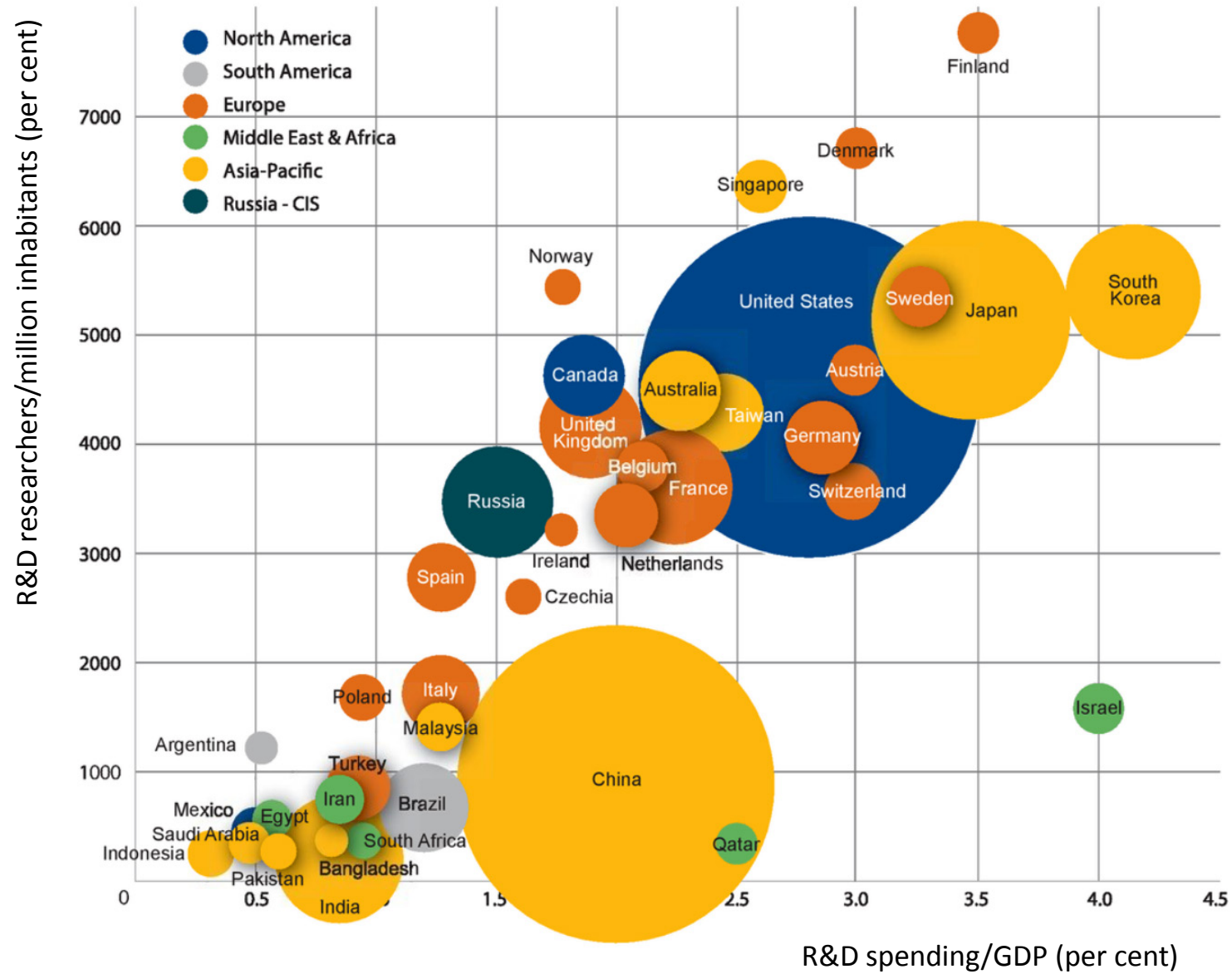
35 kilo – 300 Hp

Technological development: Innovation breakthroughs in history



Source: the Norwegian productivity commission NOU 2015-3

Technology: future research and development



Source: WB/OECD data

How long before a real space elevator **becomes** technically viable?



Thank you for your patience