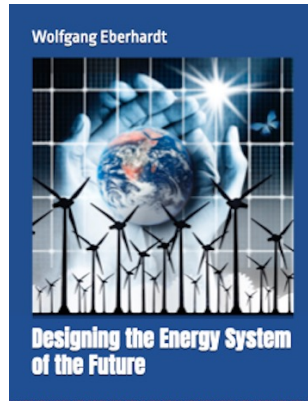
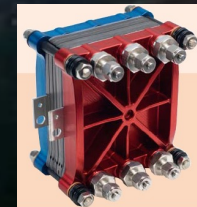
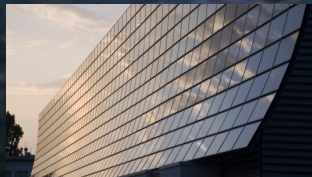




The Energy System of the Future

How to combat climate change and pollution

W. Eberhardt



We focus on Carbon-Dioxide.....

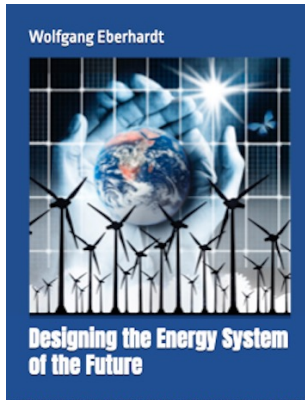
.....to combat climate change

THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon
the Temperature of the Ground.* By Prof. SVANTE
ARRHENIUS *.

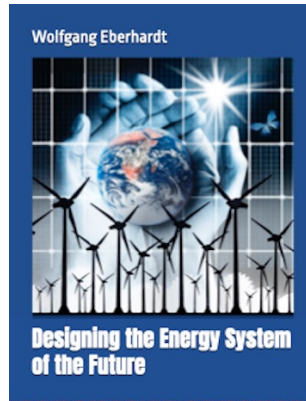


Present State of the World Energy System

- The rise of the CO₂ in the atmosphere is predominantly man made (burning of fossil fuels)
- This causes the world wide climate to change (global warming)
- How much climate change can our society afford? (social and economic consequences)
- Additional (local) effects:
 - Environmental pollution by carbon particles and heavy metals
 - Health risks and premature deaths

We need to make changes now → This implies the use of existing technologies (with improvements)

--- and we will have immediate local benefits



Drivers:

Increasing Population

Increase in Standard of Living

Dependency on Foreign Sources
International Security

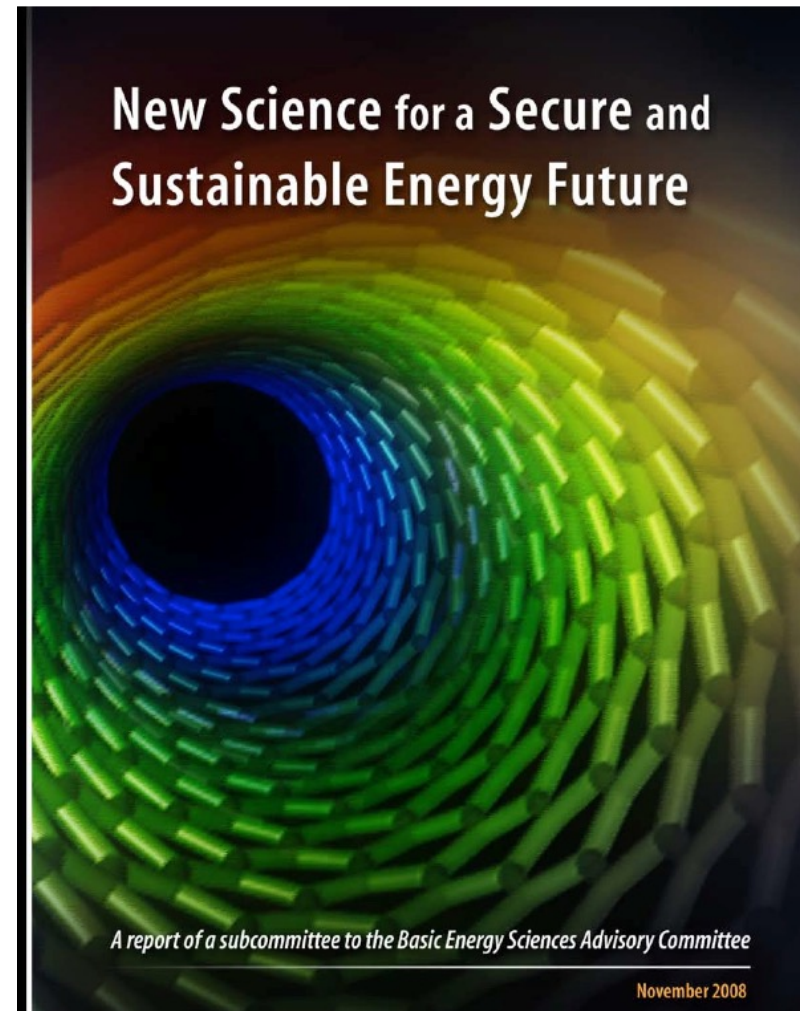
Pollution – Global Warming

Solutions:

Generating Electricity without CO₂

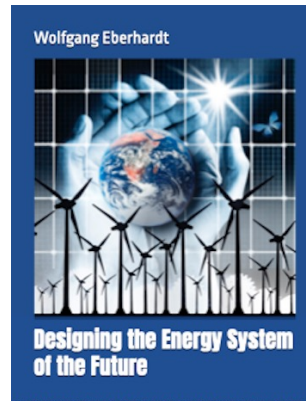
Making Fuels from Sunlight

Revolutionizing Energy Efficiency

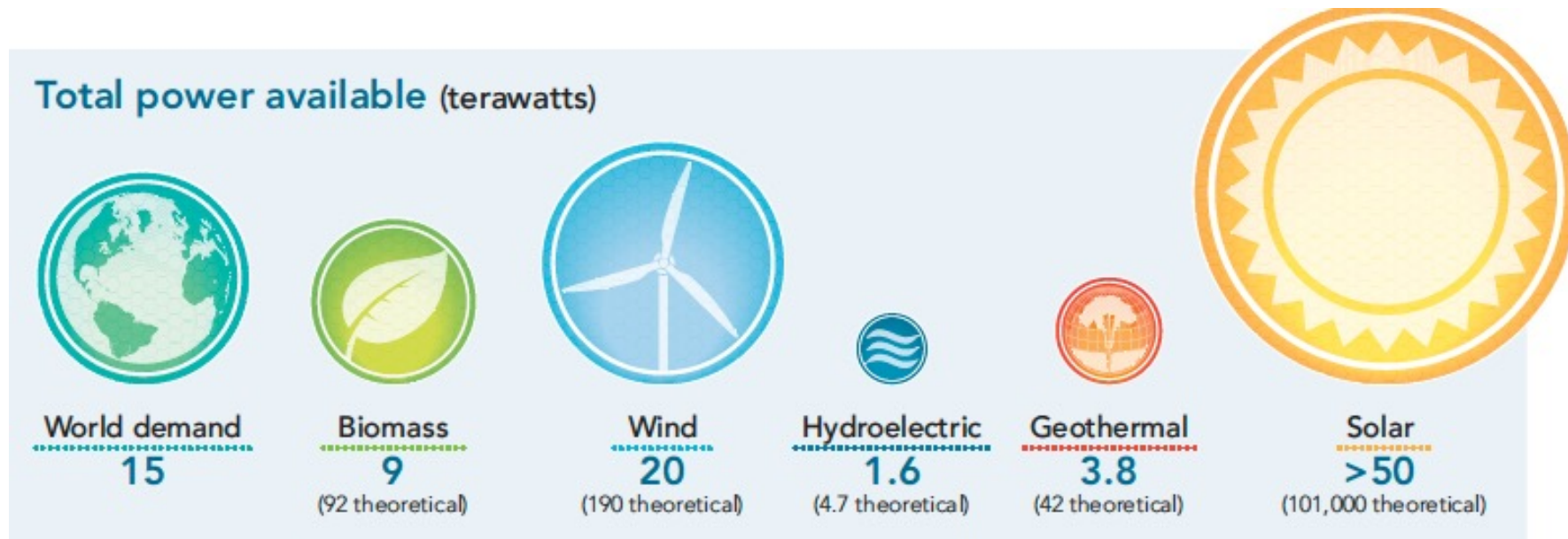


U.S. Dep. of Energy, BES reports (2008)
<http://www.sc.doe.gov/bes/reports/list.html>

Challenges for the Future Energy-System

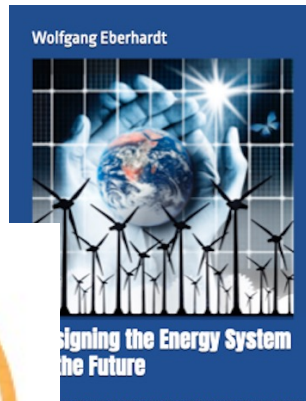


Potential of renewable Energy Sources



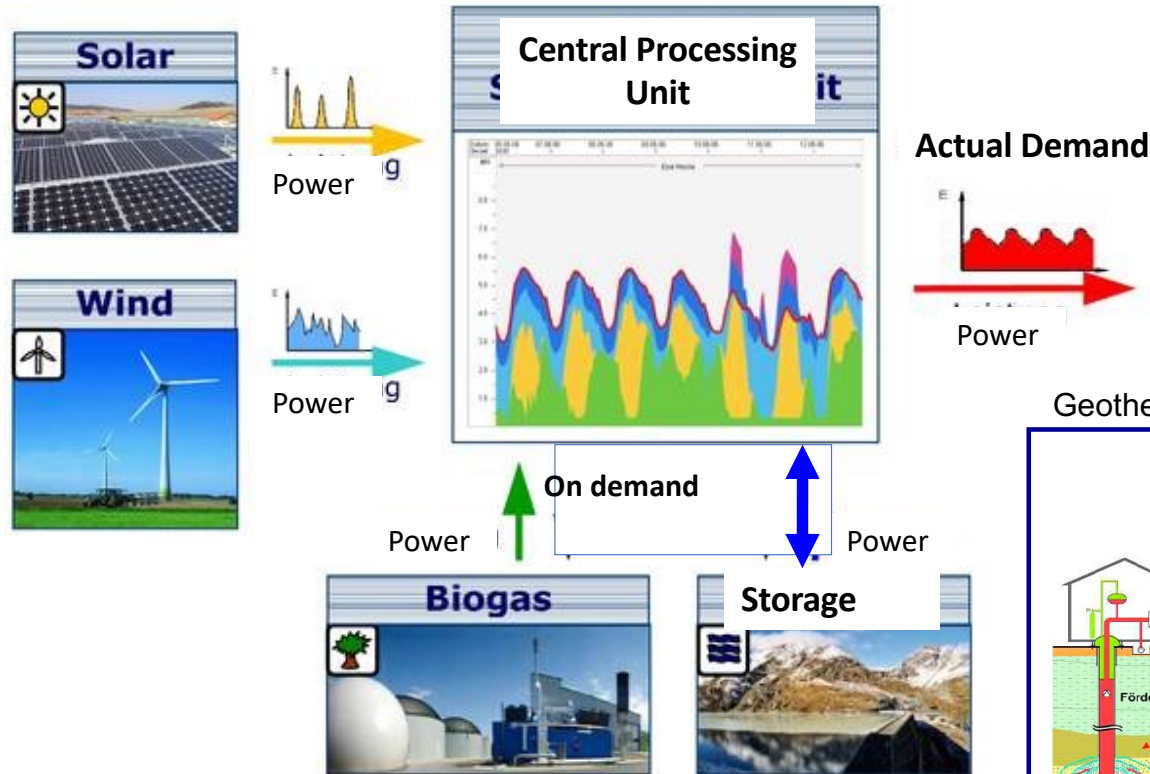
Science **329**, 786 Aug 13, 2010

In one hour as much solar energy hits the earth..... as we use in one year

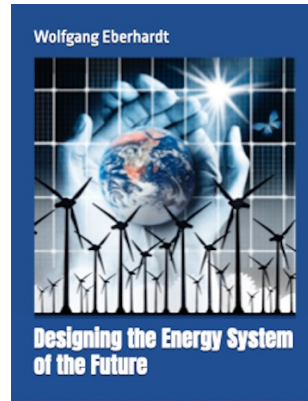


Energy system of the future
... renewables can cover the base load

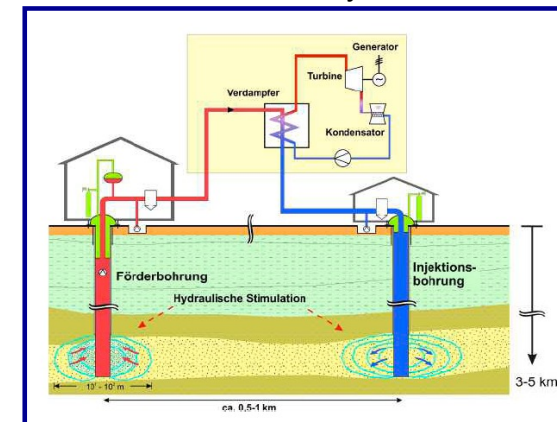
International cooperation



www.kombikraftwerk.de



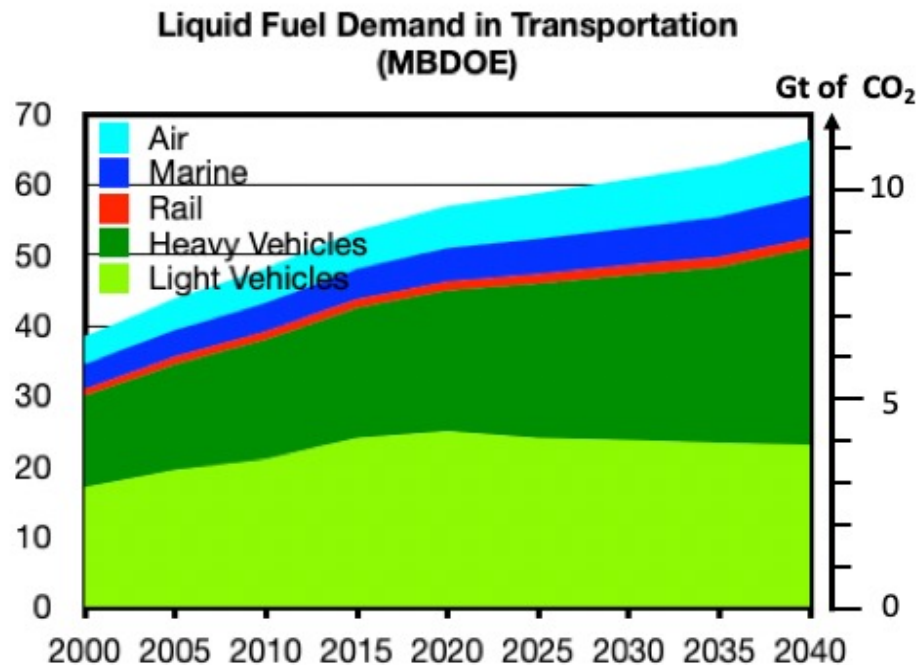
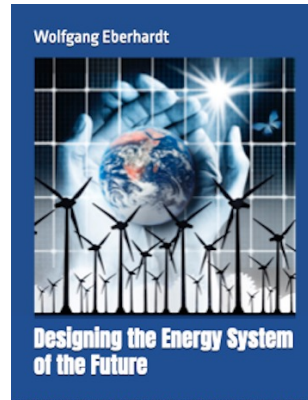
Geothermal Electricity



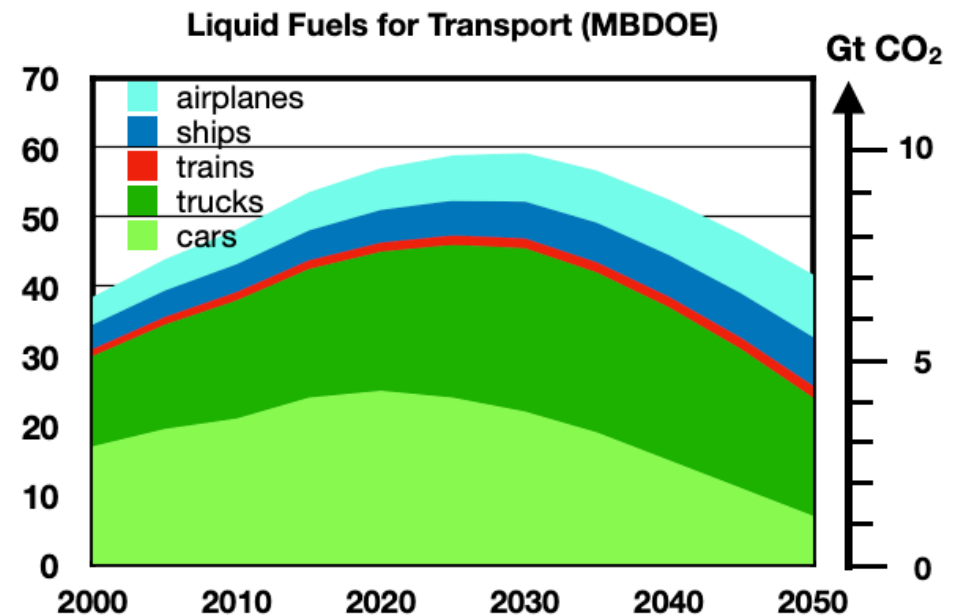
Nuclear Power Plants

Liquid Fuels for Transport

Transport is responsible for $\geq 25\%$ of the CO₂ emissions worldwide

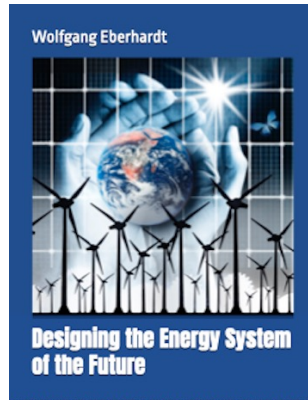


ExxonMobil (2018)

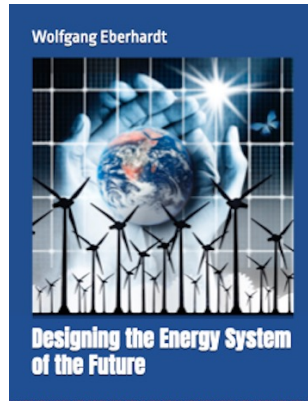
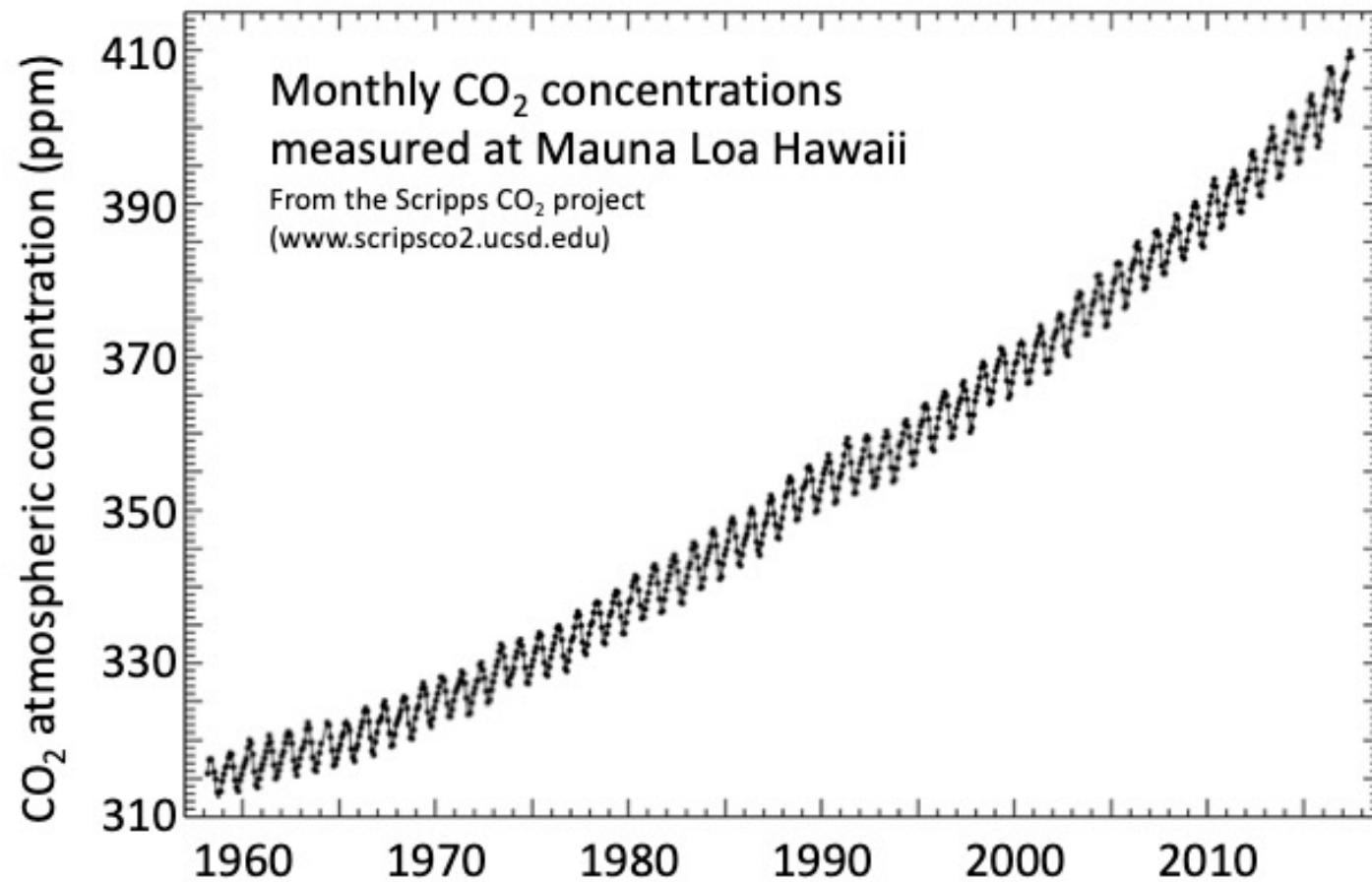


Bloomberg NEF (2021)

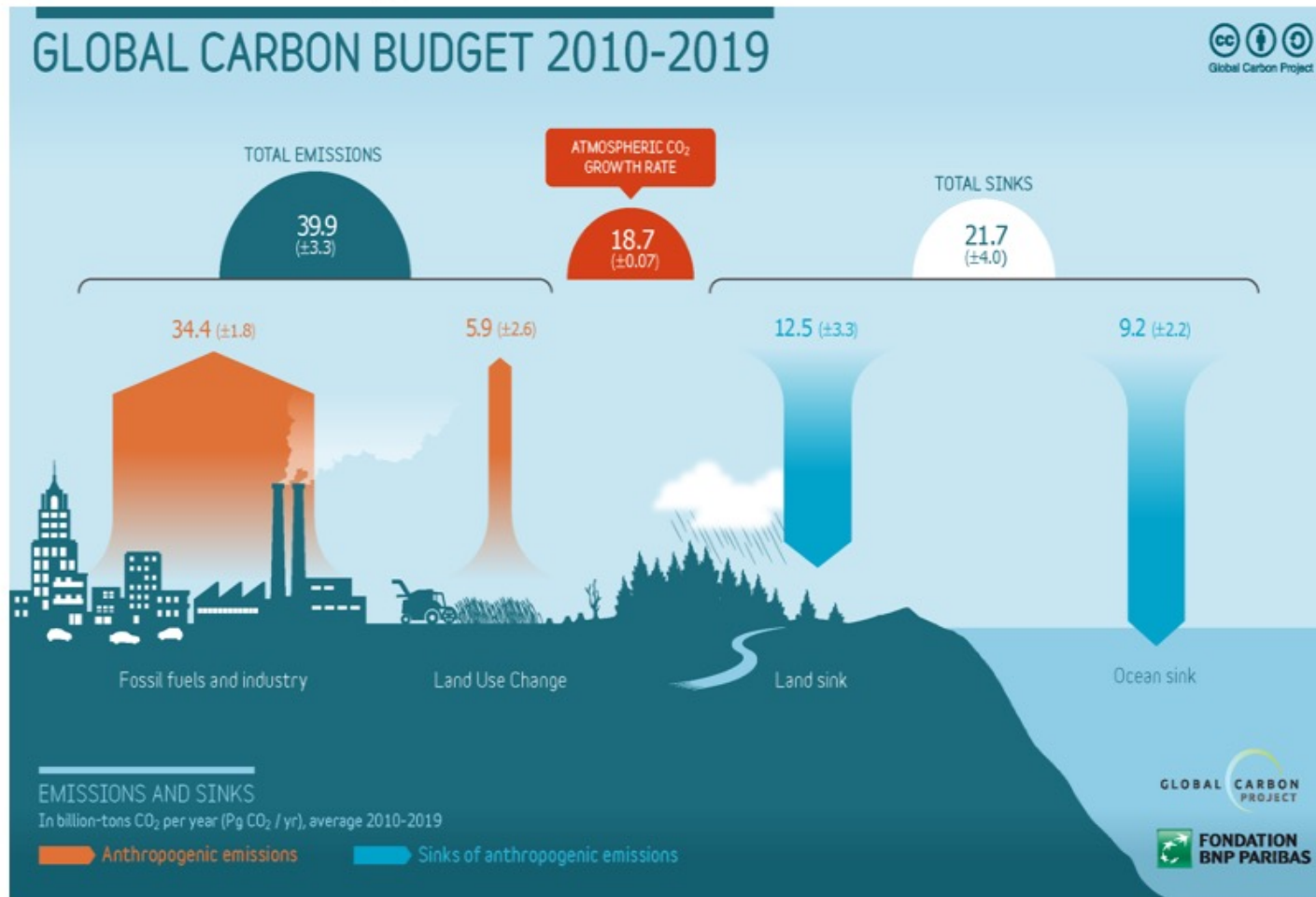
Electrical truck makes it over the Alps



How much do we need to reduce CO₂ emissions.....
.....in order to win the war on 'climate change'?



Global Carbon Budget



Data source: Friedlingstein et al. 2020 Global Carbon Budget 2020. Earth System Science Data.

Wolfgang Eberhardt



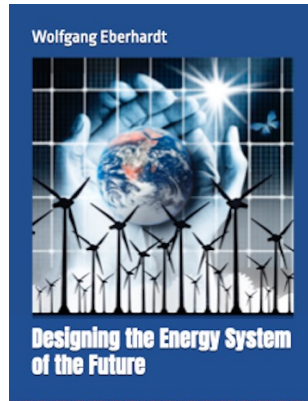
**Designing the Energy System
of the Future**

Conclusions from the “Keeling-Curve”

- (less than) half of the CO₂ emissions are deposited into the atmosphere (measured since 60 years)
- With increasing CO₂ concentration the absorption by biomass on land and in the oceans is increasing



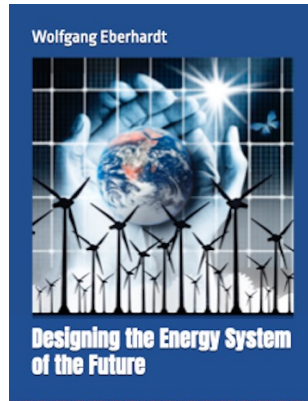
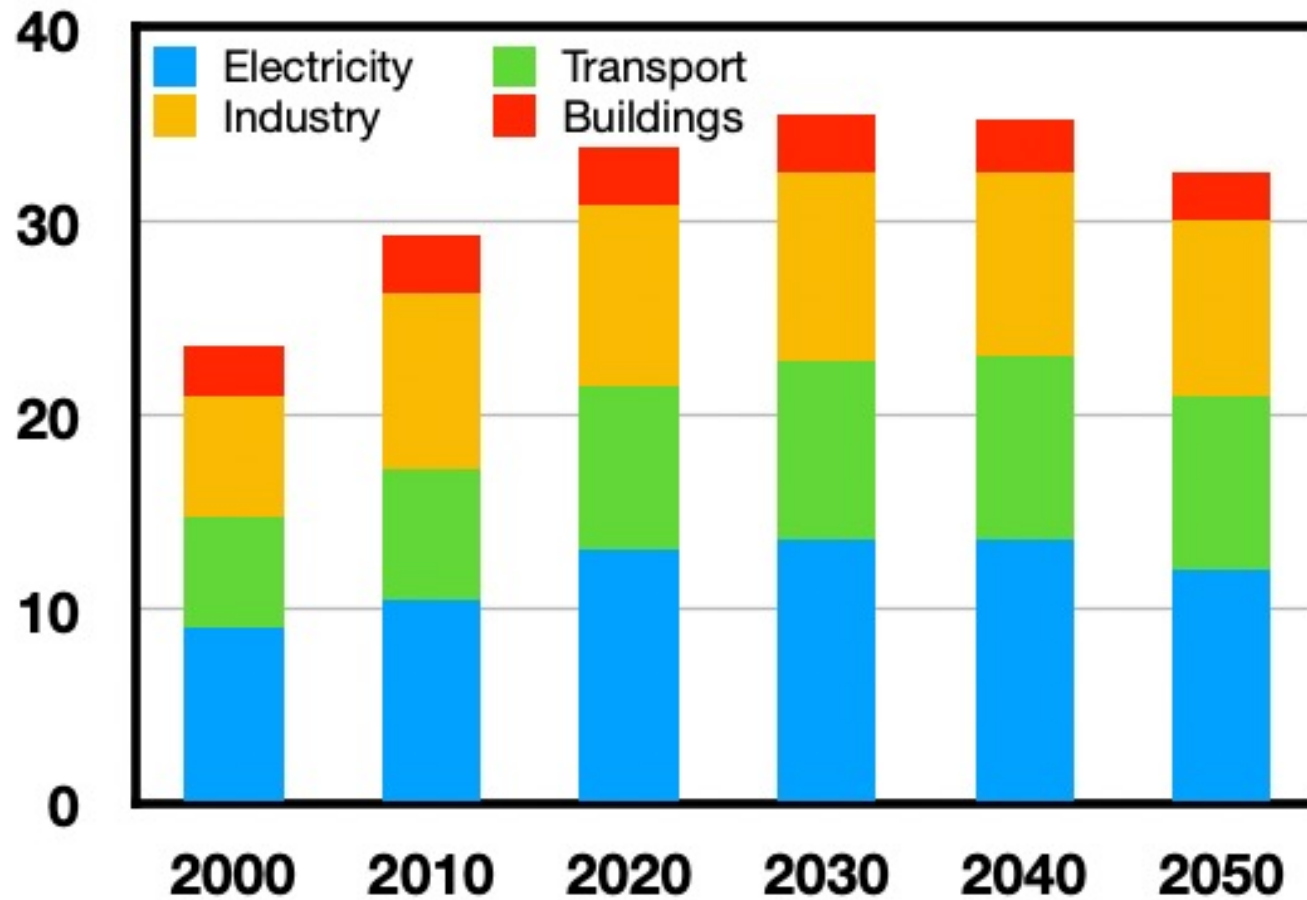
- As soon as we have lowered the CO₂ emissions by 50%, the CO₂ concentration in the atmosphere will decline → we have won the battle against climate change



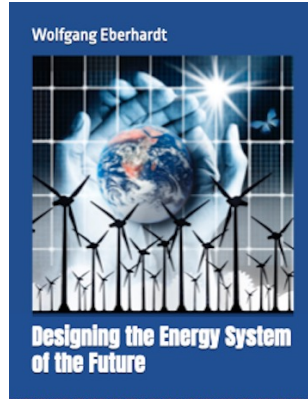
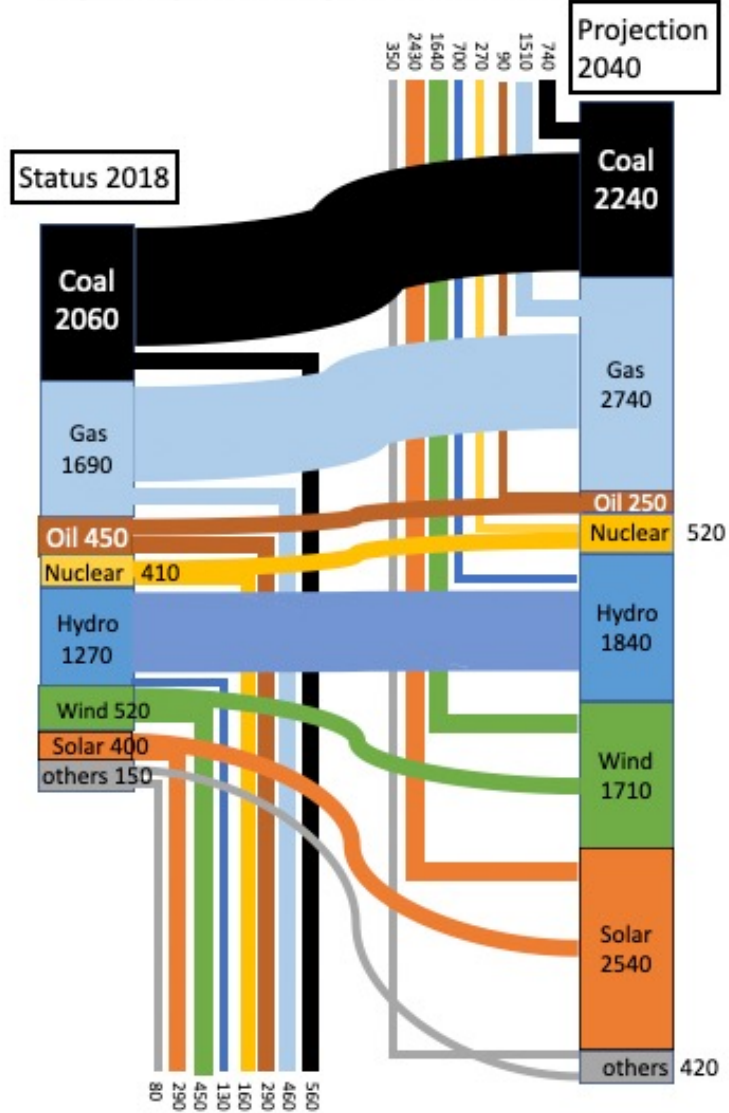
Today's state (2019).....

.....we totally miss the 'Paris goals'!!!

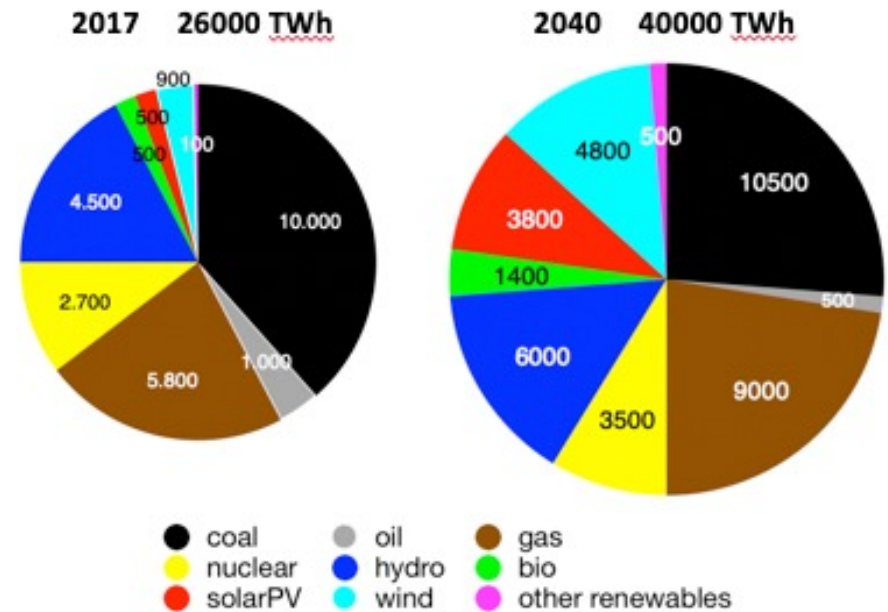
CO₂ Emissions (Gt CO₂)



World power plants capacity development 2018-2040



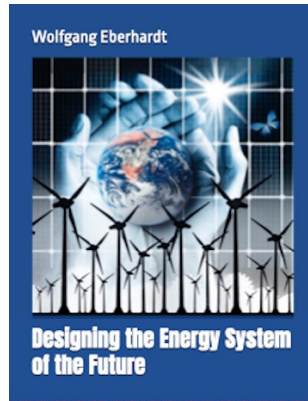
IEA outlook on electricity generation



Source: IEA 2019

Summary

- The Change of the Energy System is technically and economically possible
- Climate change and local pollution will be drastically reduced
- Major Measures to be implemented:
 - Elimination of coal based power plants
 - Ban of combustion engines for land based transport
 - Heat pumps for new buildings
- The (worldwide) change of the energy system is absolutely mandatory ---- it will open up new market opportunities --- The fate of our world will be decided in South East Asia and Africa
- We urgently need a long term vision and steady development
--- protected against lobbying and political interests



We have to start NOW
.....and we can make it!!!

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