



International Institute for
Applied Systems Analysis
www.iiasa.ac.at

Strategies for achieving sustainable climate goals

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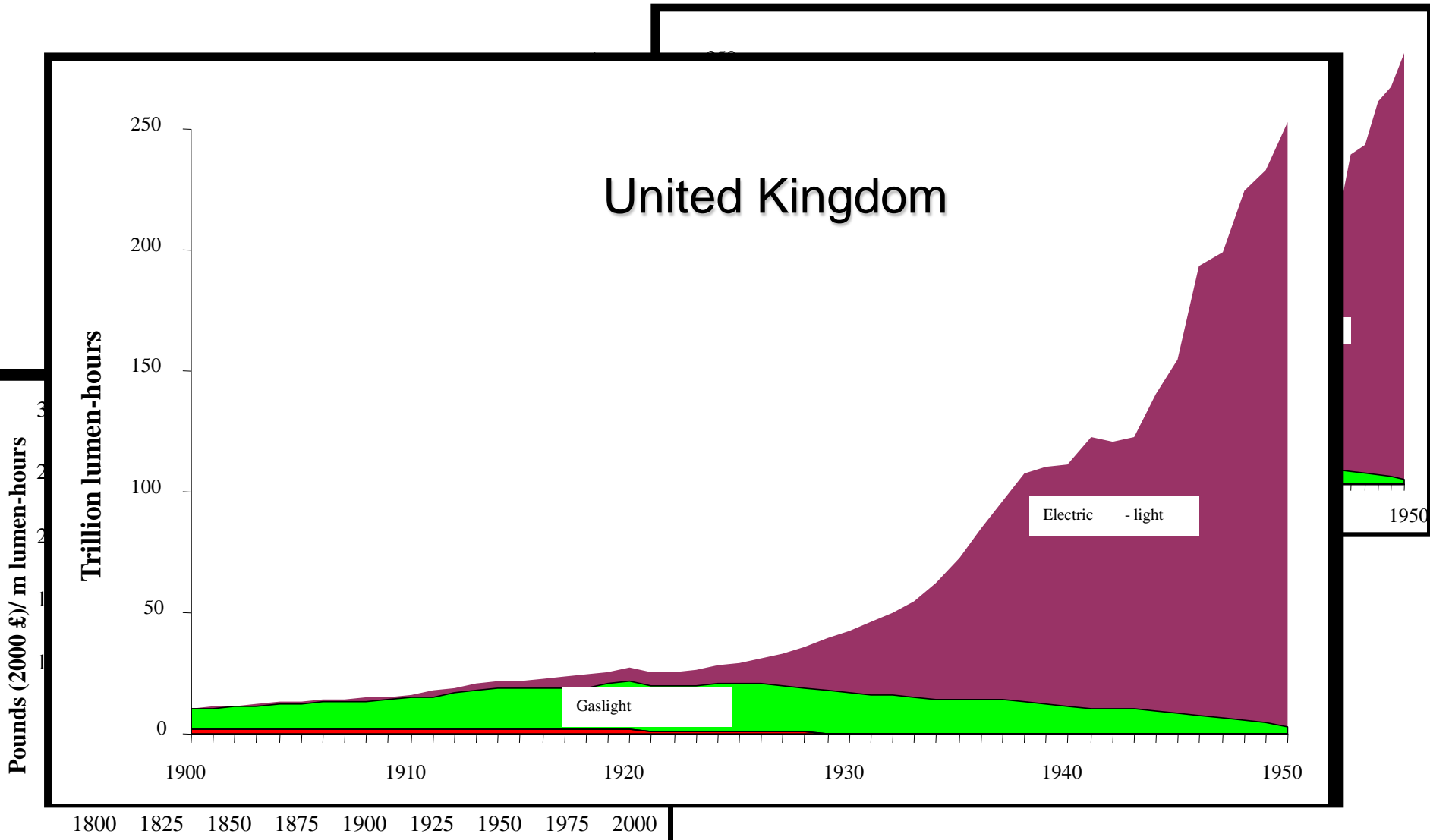
ALPS International Symposium, Moving toward Sustainable Climate Change Actions, hosted by Research Institute of Innovative Technology for the Earth (RITE) at the Technology International Forum, Tokyo – 4 February 2014



IIASA, International Institute for Applied Systems Analysis

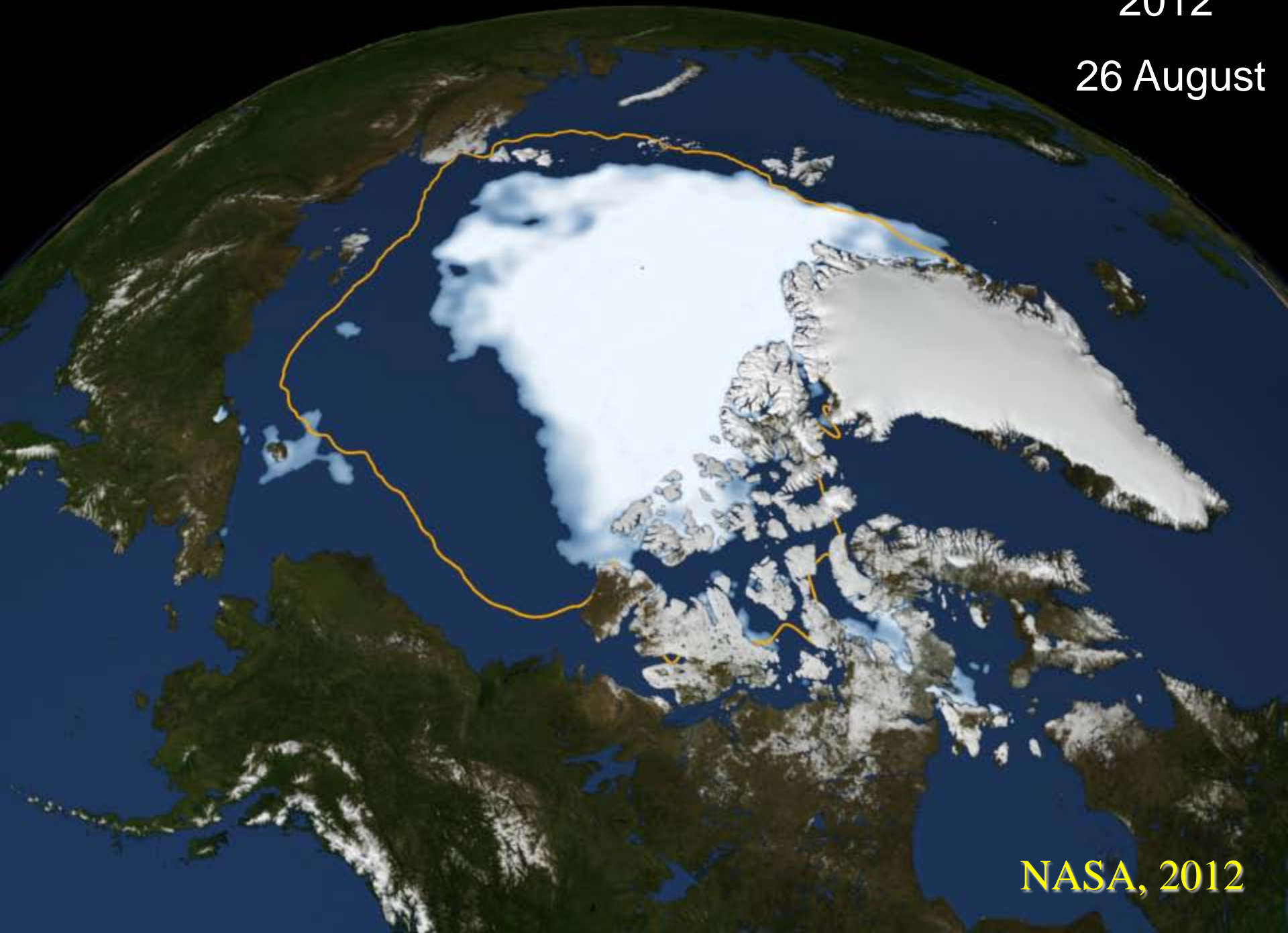


Astronaut Sunita Williams

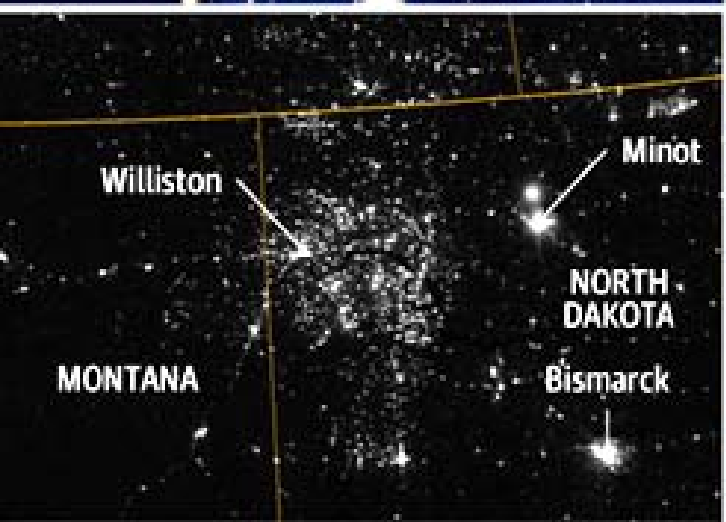
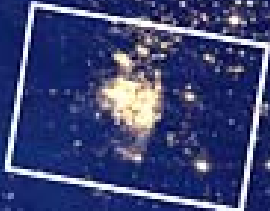


2012

26 August

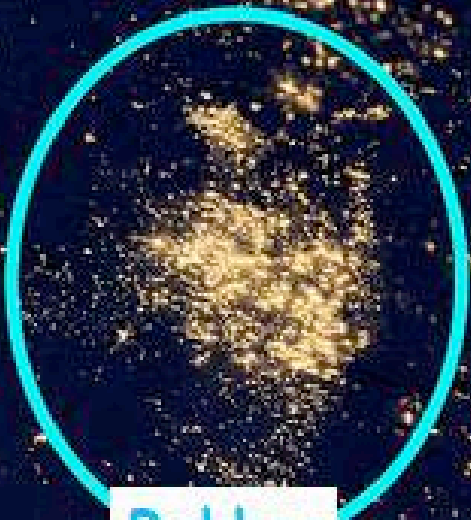


NASA, 2012



Regina

Winnipeg



Bakken

Duluth

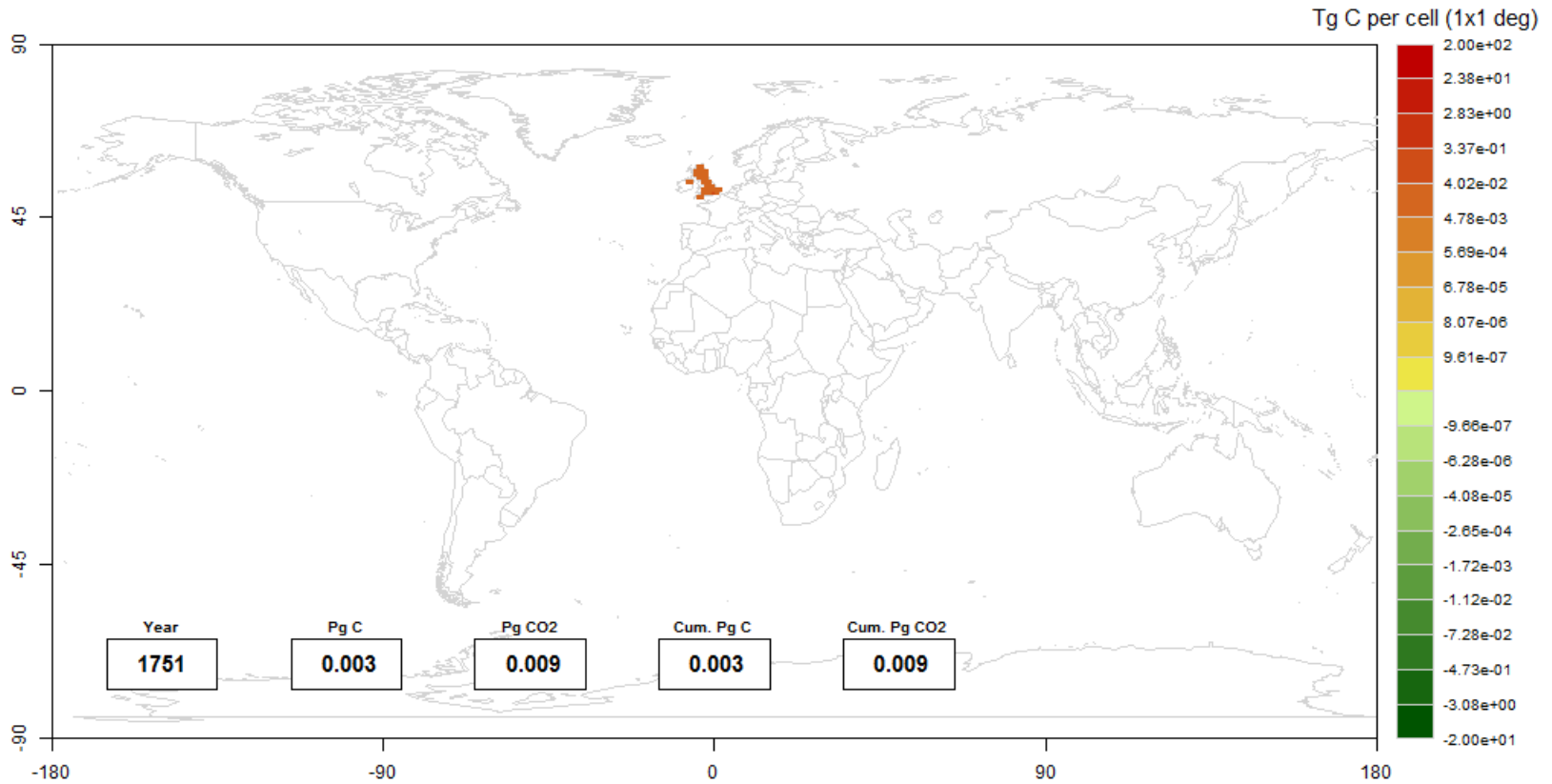
Bismarck

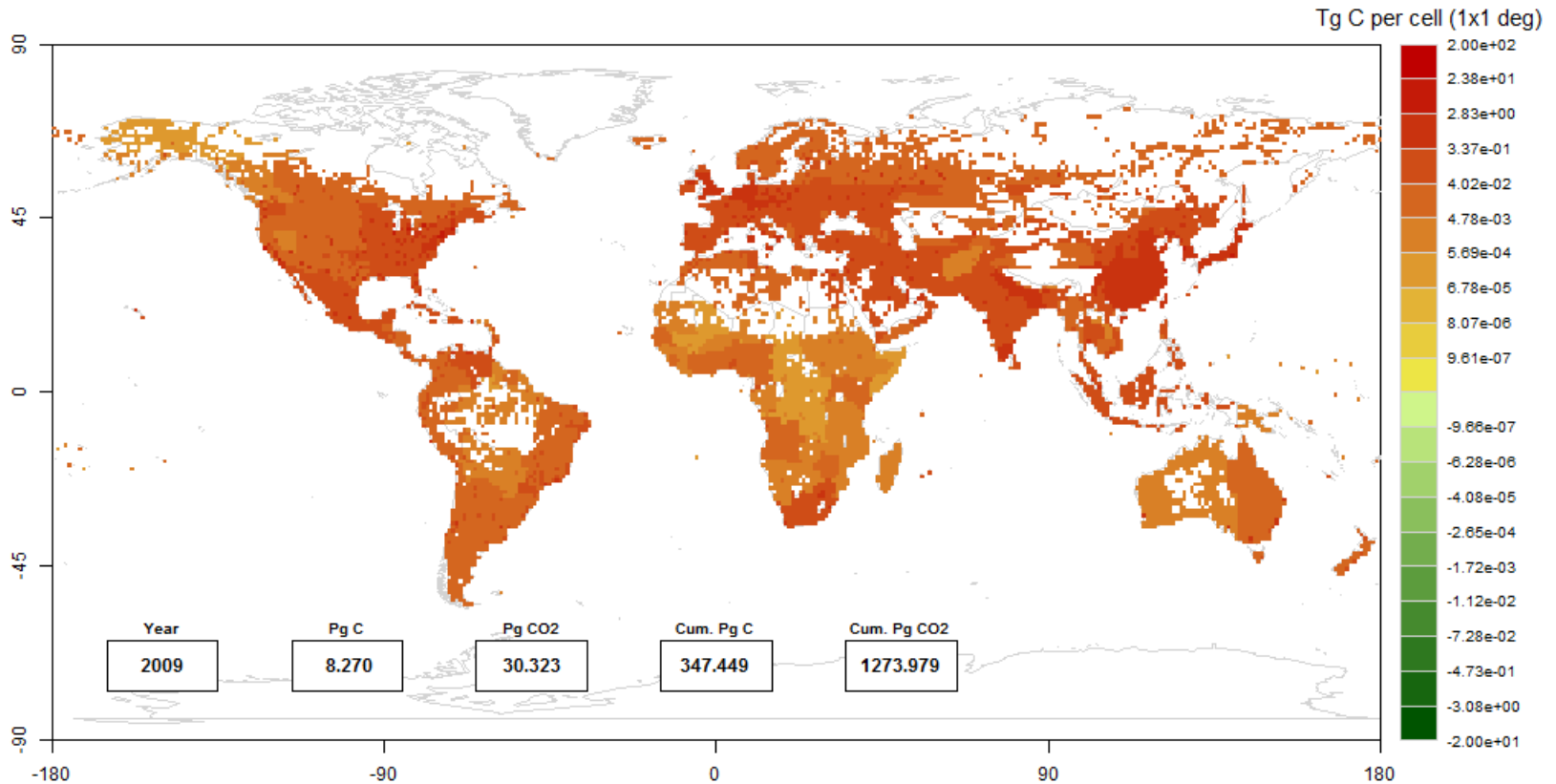
Fargo

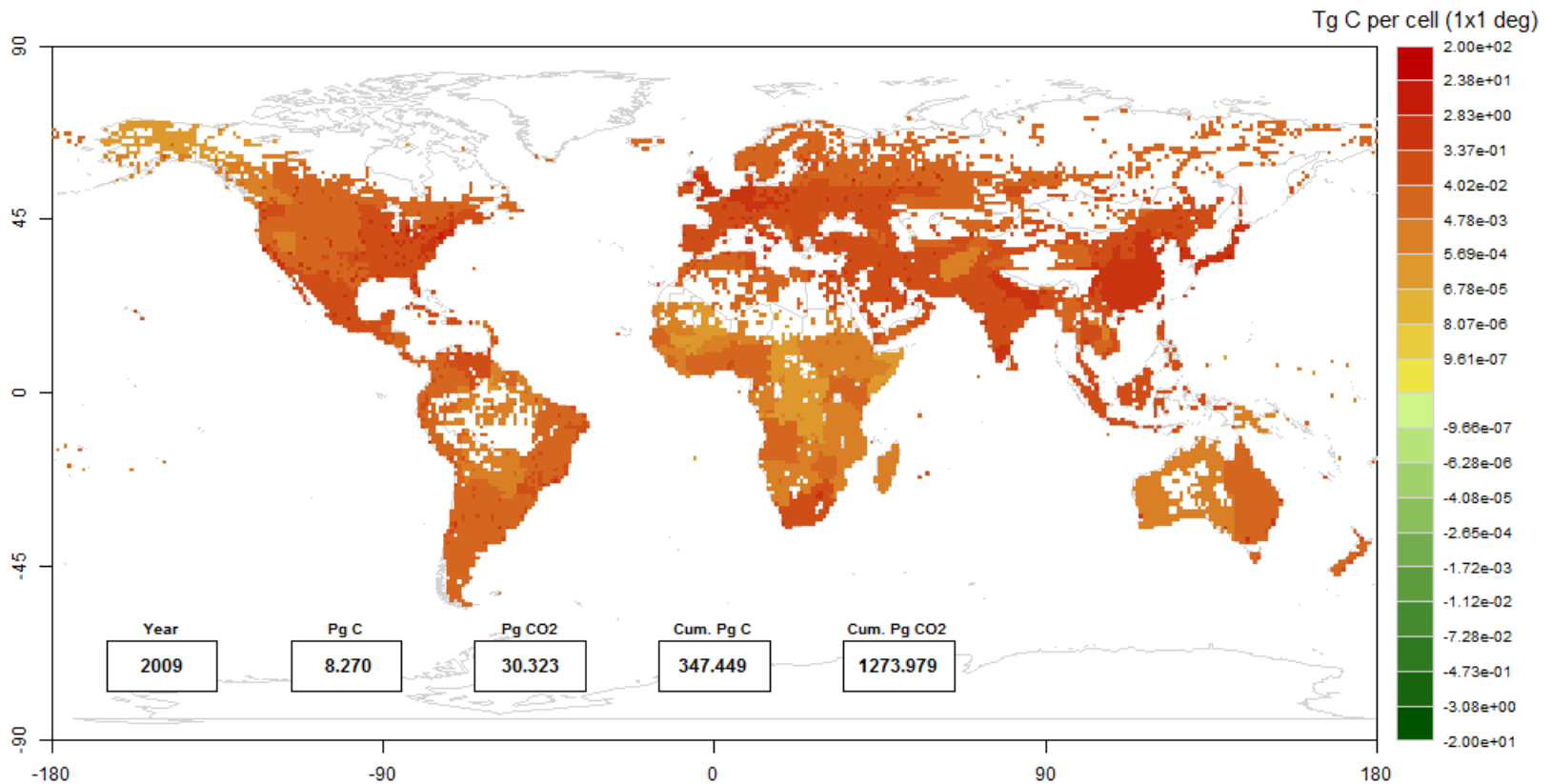
Rapid City

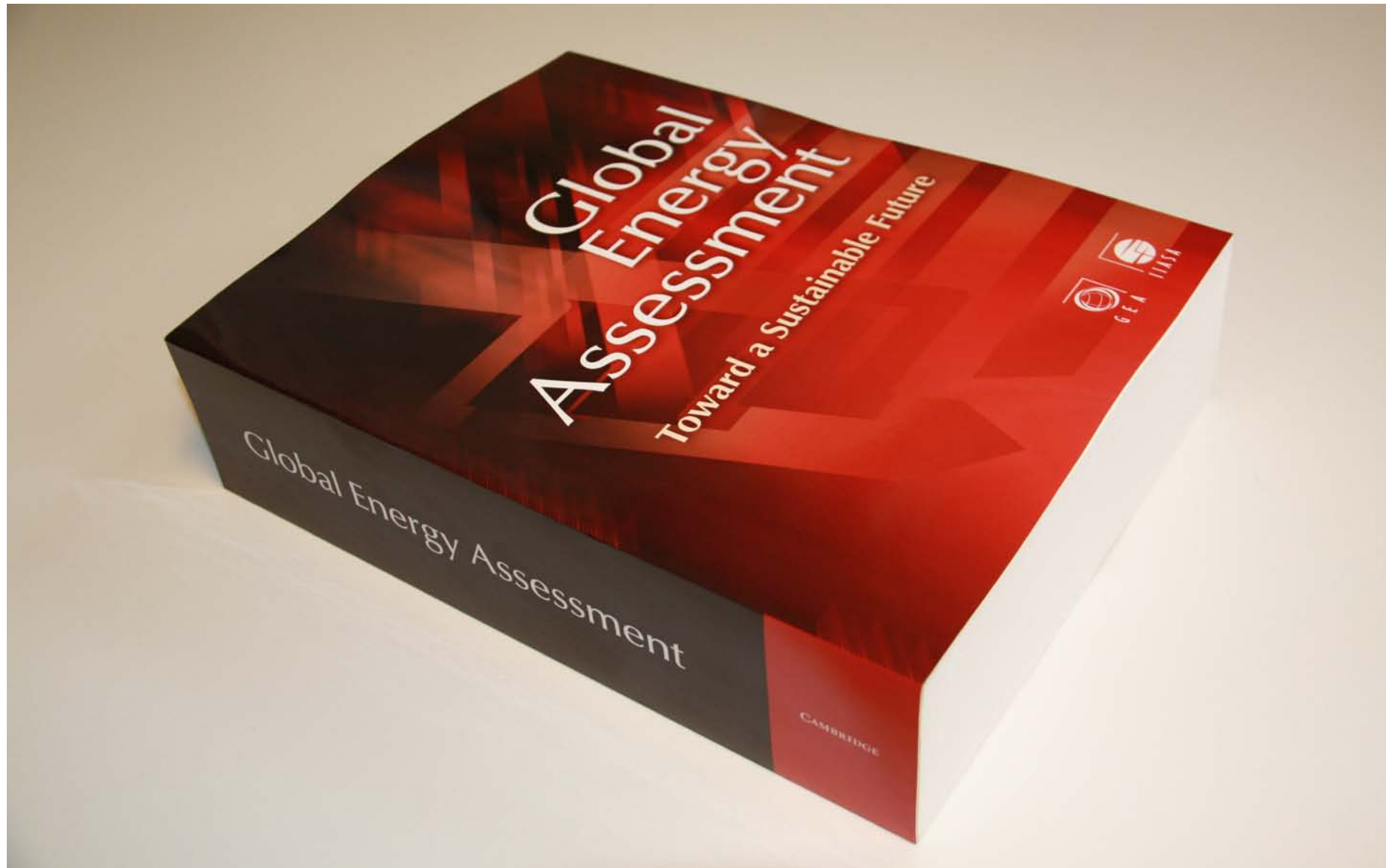
Minneapolis
St. Paul

- ➔ The industrial revolution led to unprecedented levels of affluence and production, but also inequity;
- ➔ The unintended consequences demonstrate significant impacts on our social and natural environments transcending planetary boundaries;
- ➔ Overcoming these formidable global challenges requires a fundamental transformation toward a sustainable future.









- **Total Effort: 300 Authors; 200 Reviewers**
> 6 years >> 6m € and >> 100 p-years
- **# of Reviewer comments: >6000**
- **# of Language Editors: 15**
- **# of Copy Editors: 15**
- **# of Figures: ~ 650**
- **# of Tables: ~ 380**
- **# of References: >7000**
- **# of Pages (Published): ~1864 Pages**
- **Single volume of 5.5 kg**



**Energy
Access**



Climate Change



**Energy
Security**



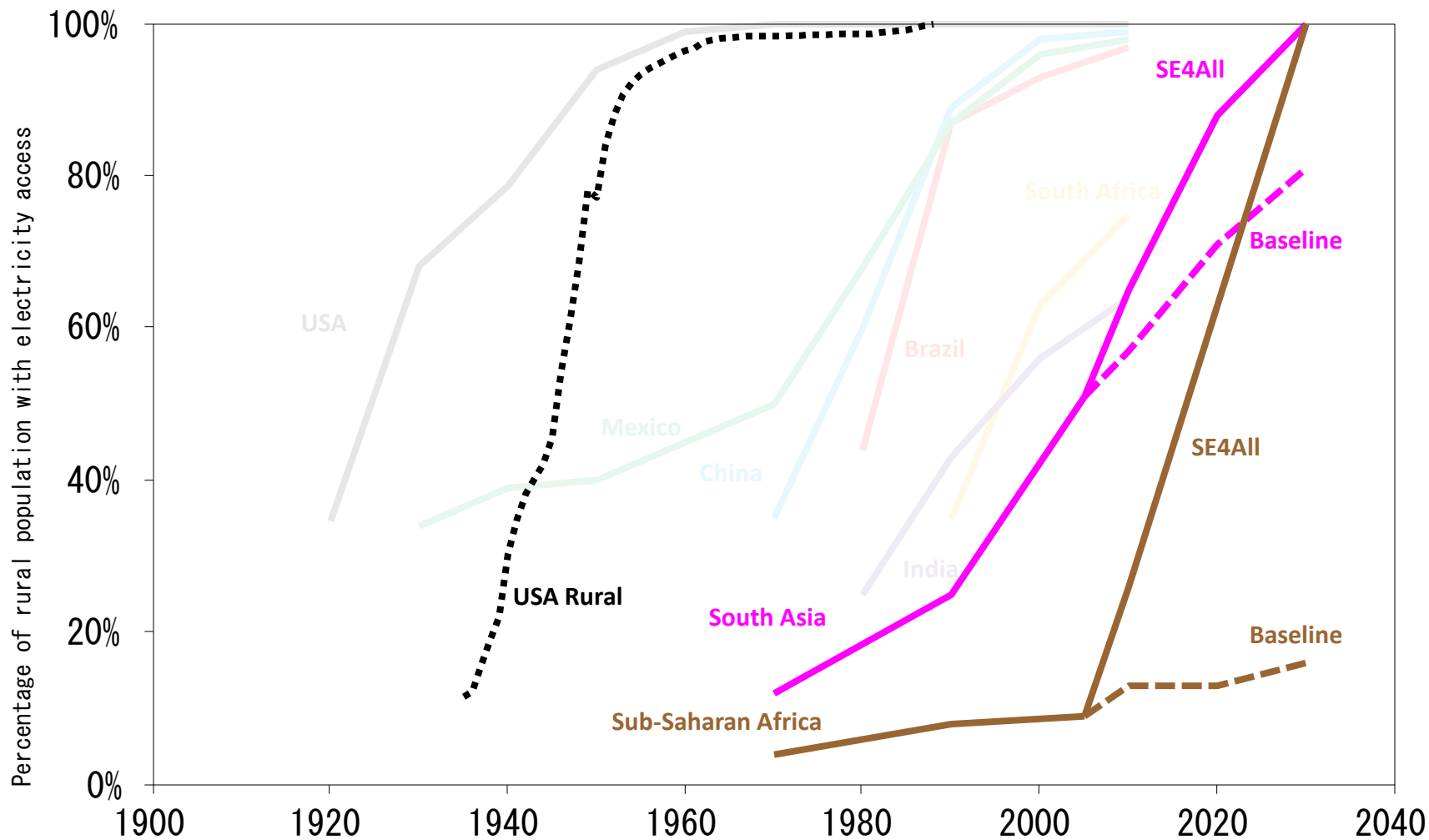
**Air Pollution
Health Impacts**



Source: Modi, 2011



Source: Modi, 2011 and Yumkella, 2013



Unconventional Gas
~900-2900 PgC

N. Gas
~190-240 PgC

Oil
~180-280 PgC

Unconv. Oil
~300-400 PgC

Biomass
~430-460 PgC

Cumulative Emissions for 2°C Stabilization



~500 PgC

Historical Emissions
~500 PgC

Preindustrial Atmosphere
~530 PgC

Gas Hydrates
~28,000 PgC

Present Atmosphere
~800 PgC

Carbon Storage Potential
~400-1500 PgC

Coal
~ 10,000 PgC



Brine Treatment Plant – Conemaugh River



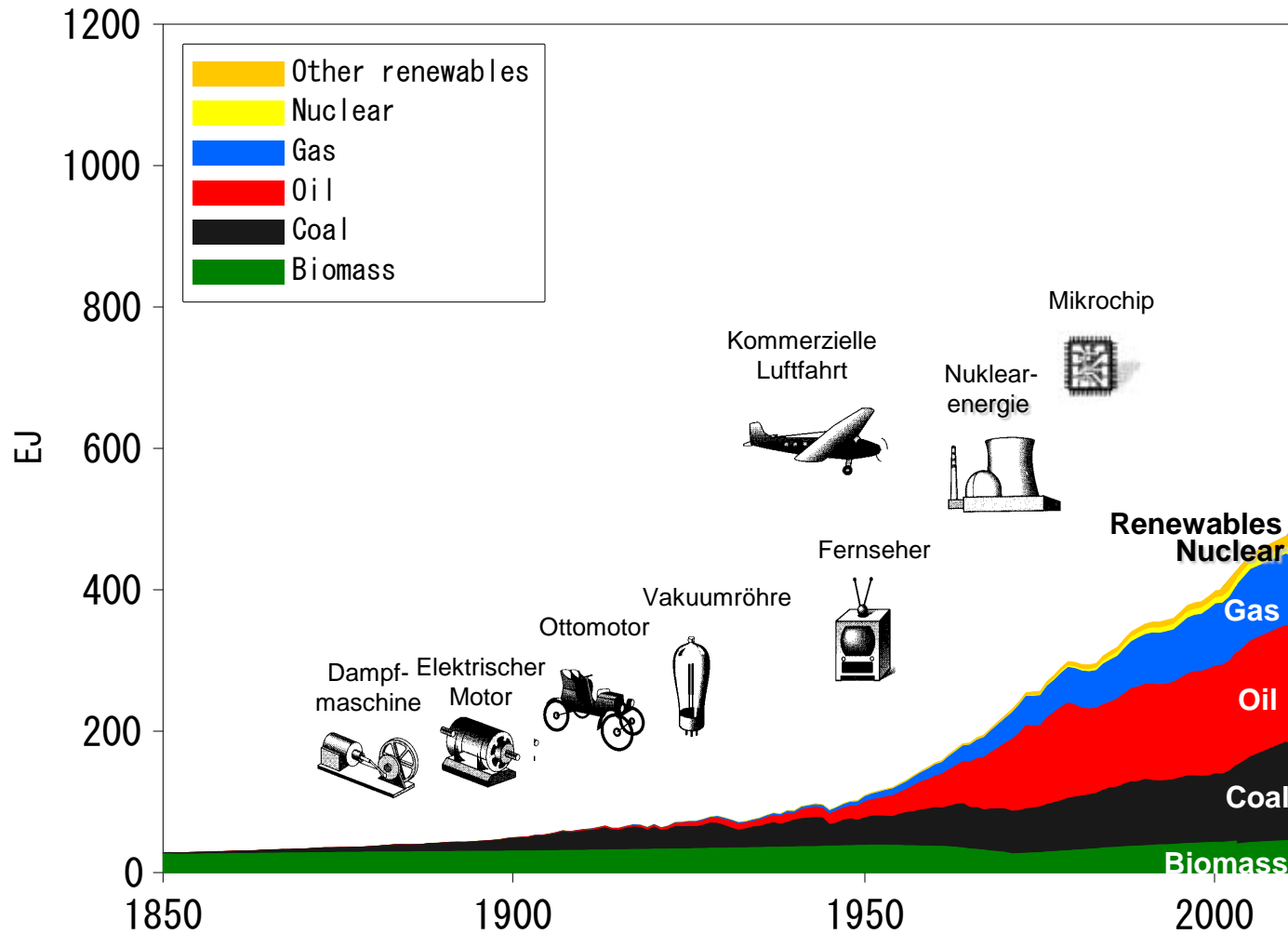


2012 INTERNATIONAL YEAR OF
SUSTAINABLE ENERGY
FOR ALL

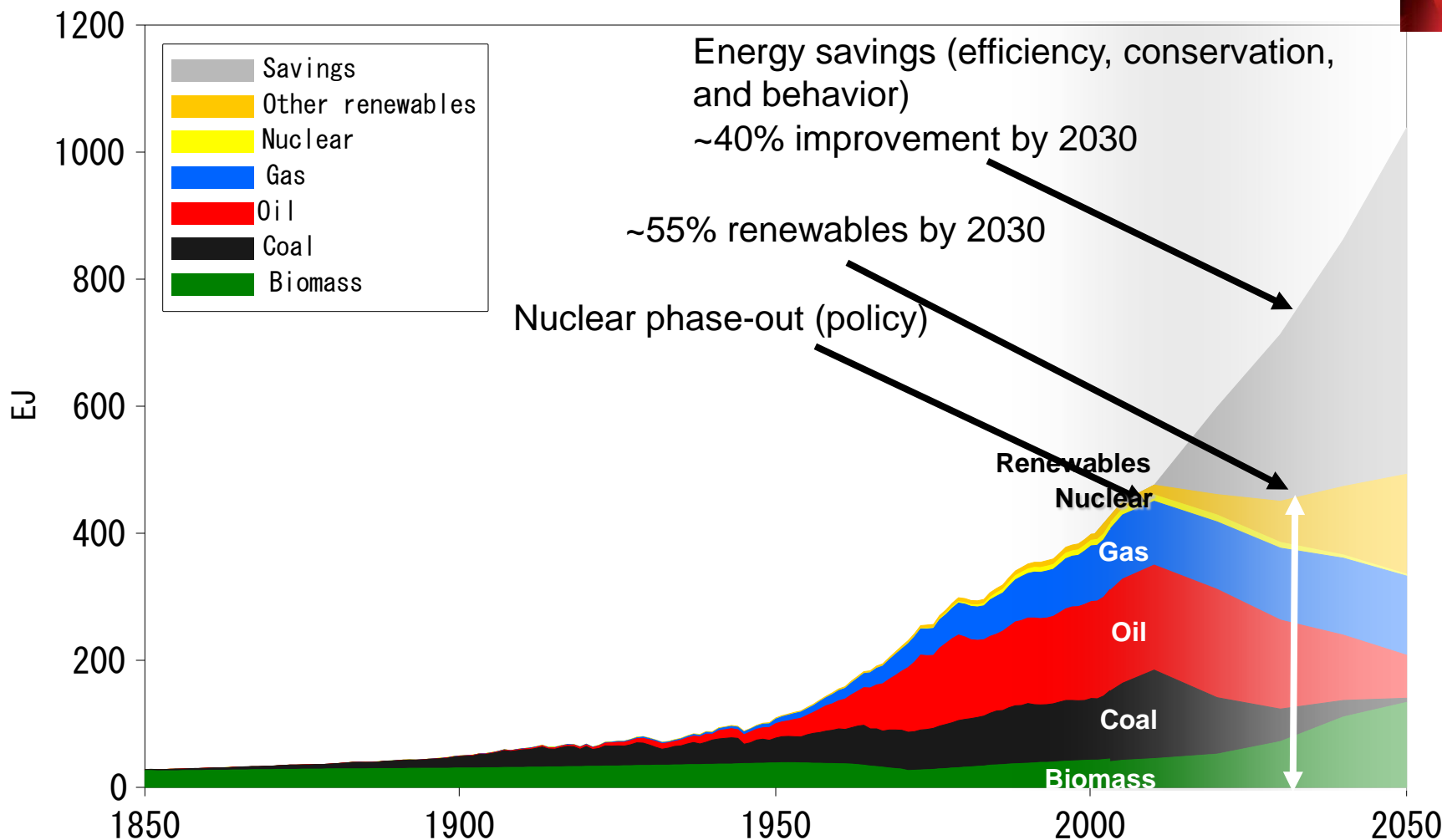
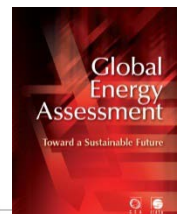
2030 Energy Goal

- Universal Access to Modern Energy
- Double Energy Efficiency Improvement
- Double Renewable Share in Final Energy

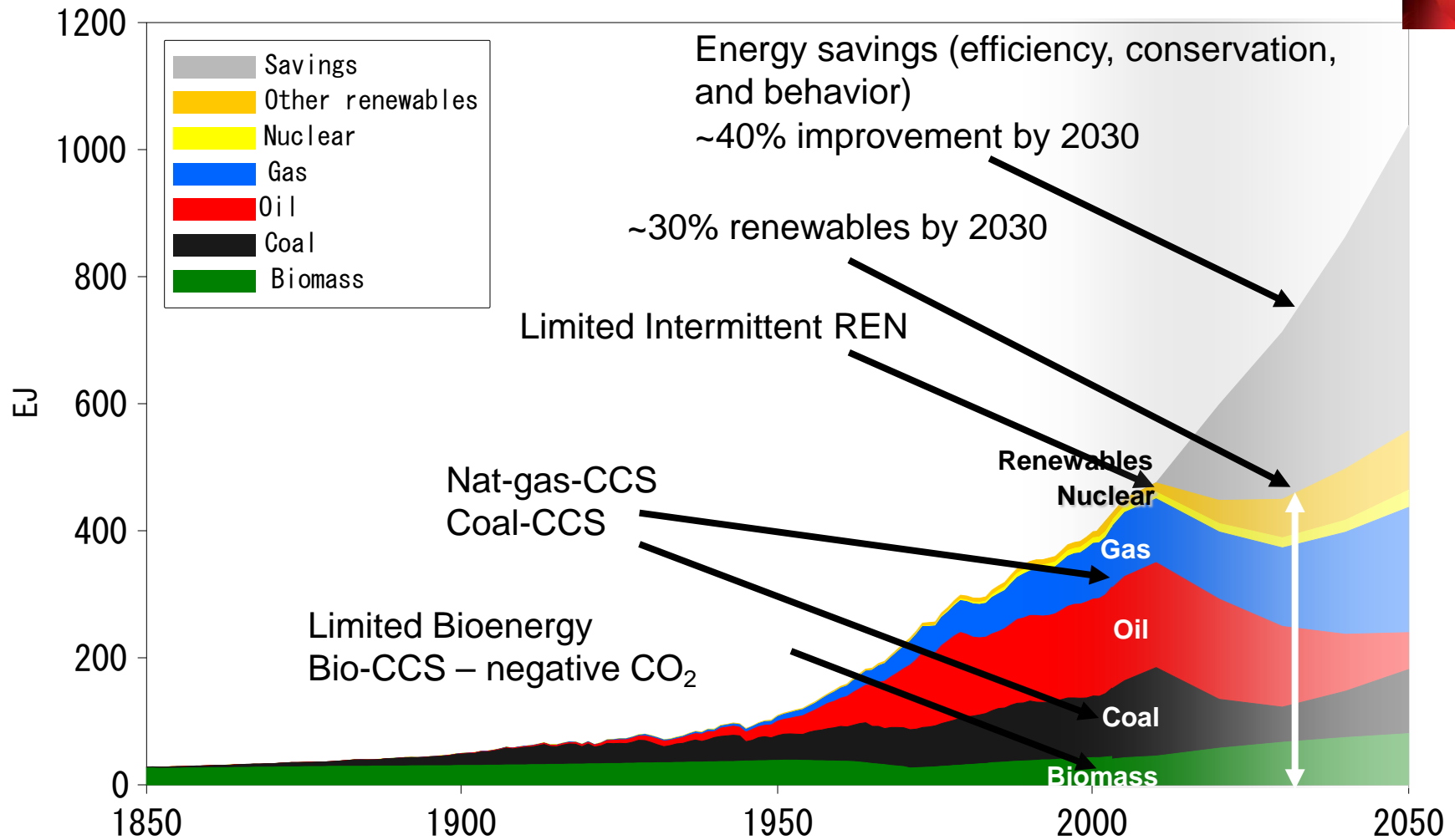
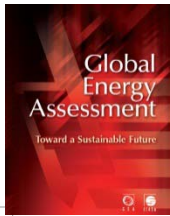
Aspirational & Ambitious but Achievable

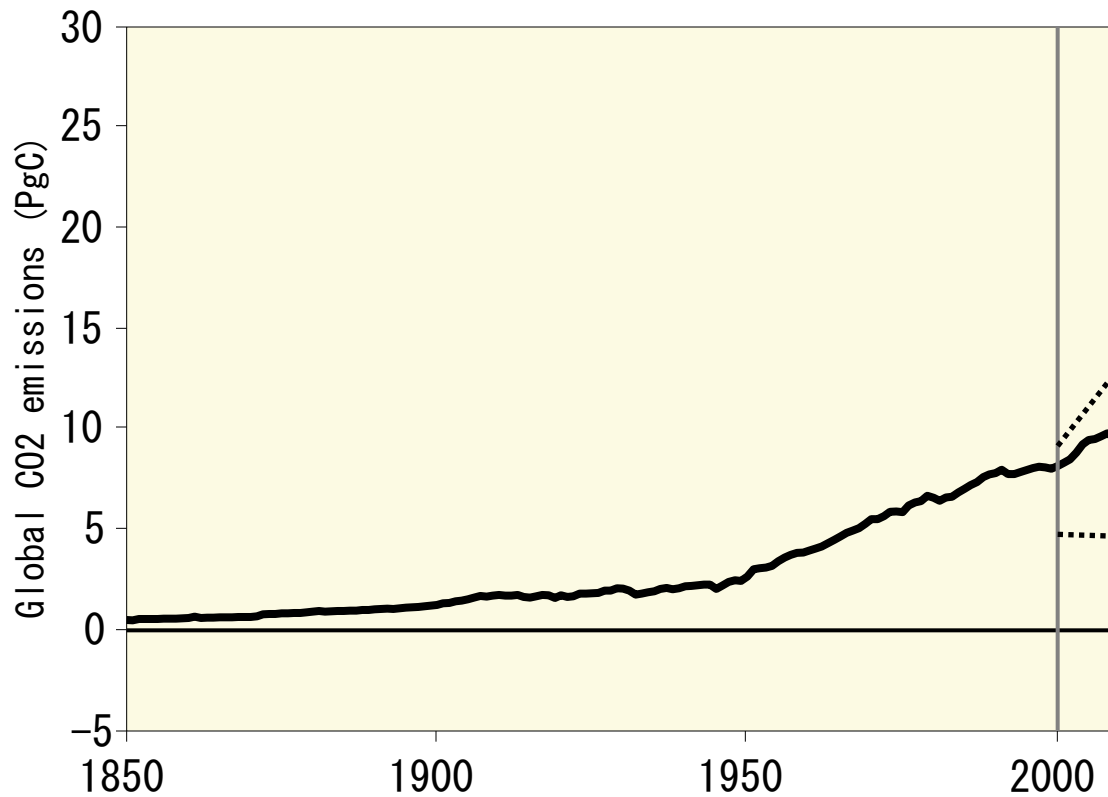


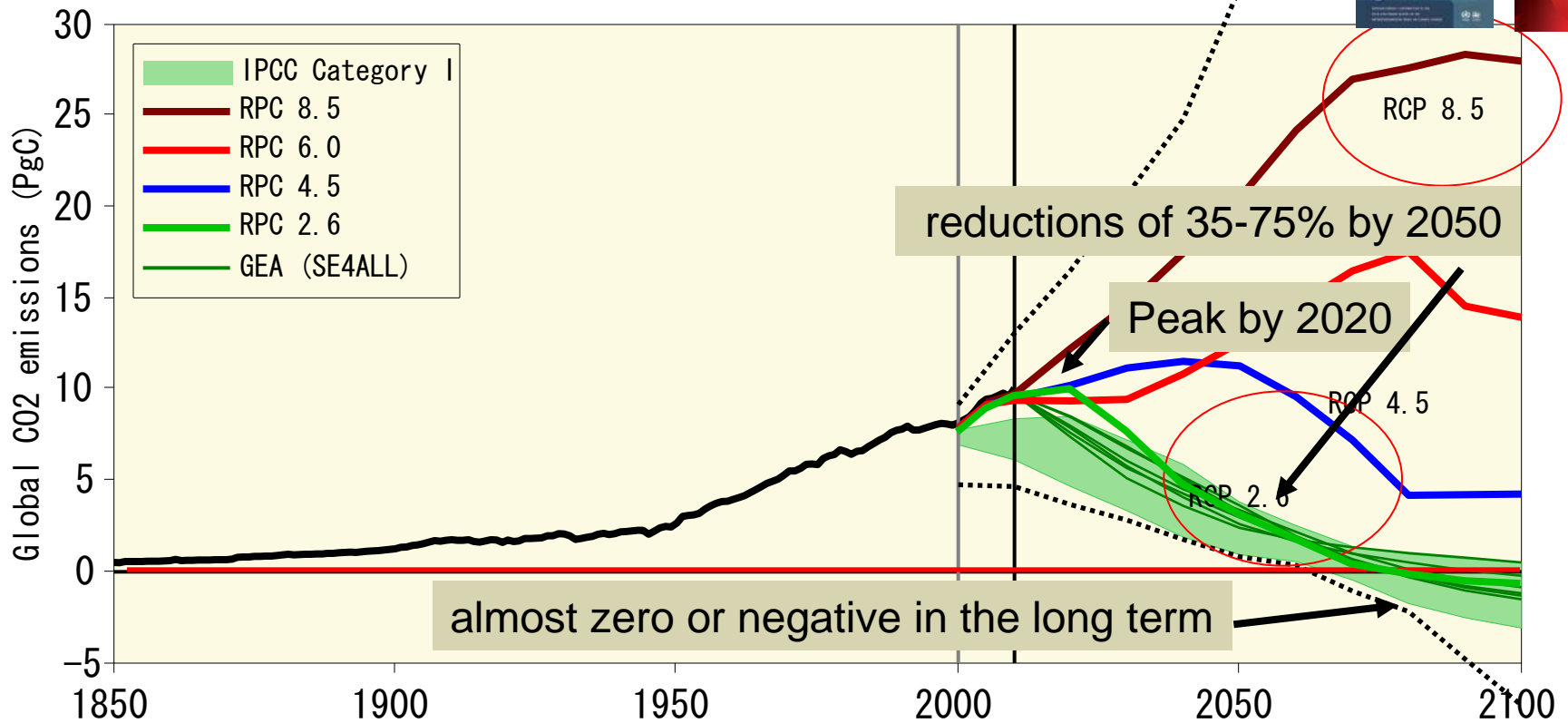
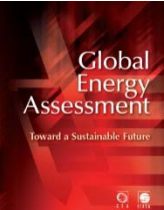
no CCS, no Nuclear

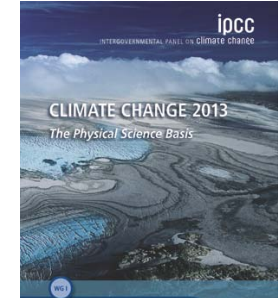


lim. Bioenergy, lim. Intermittent REN







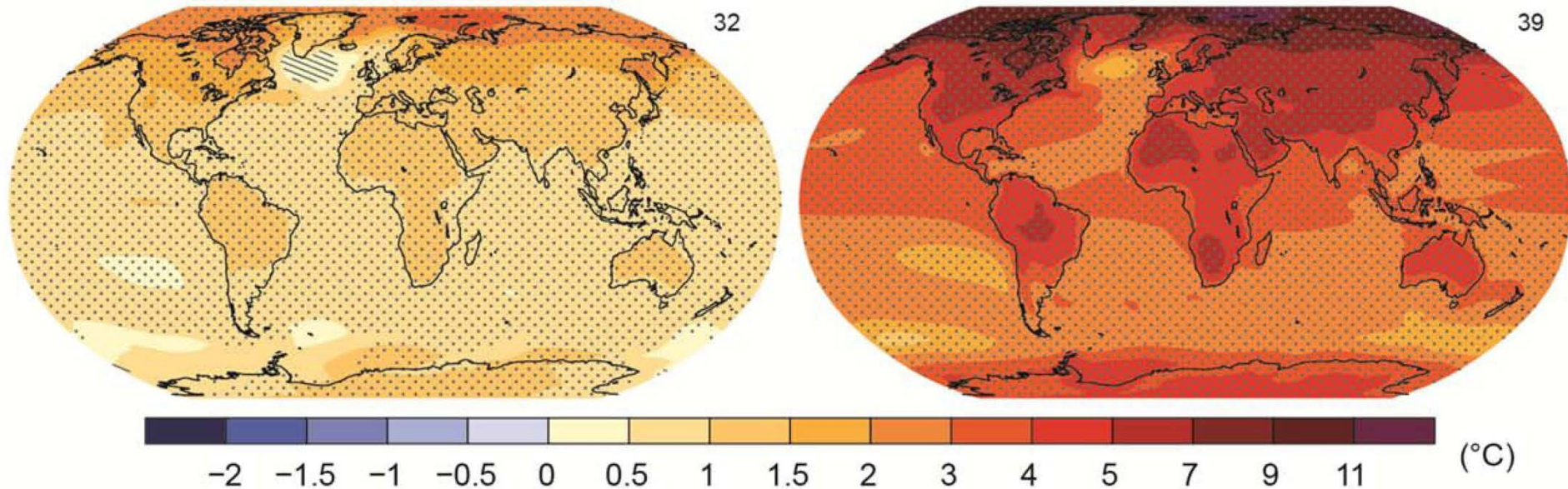


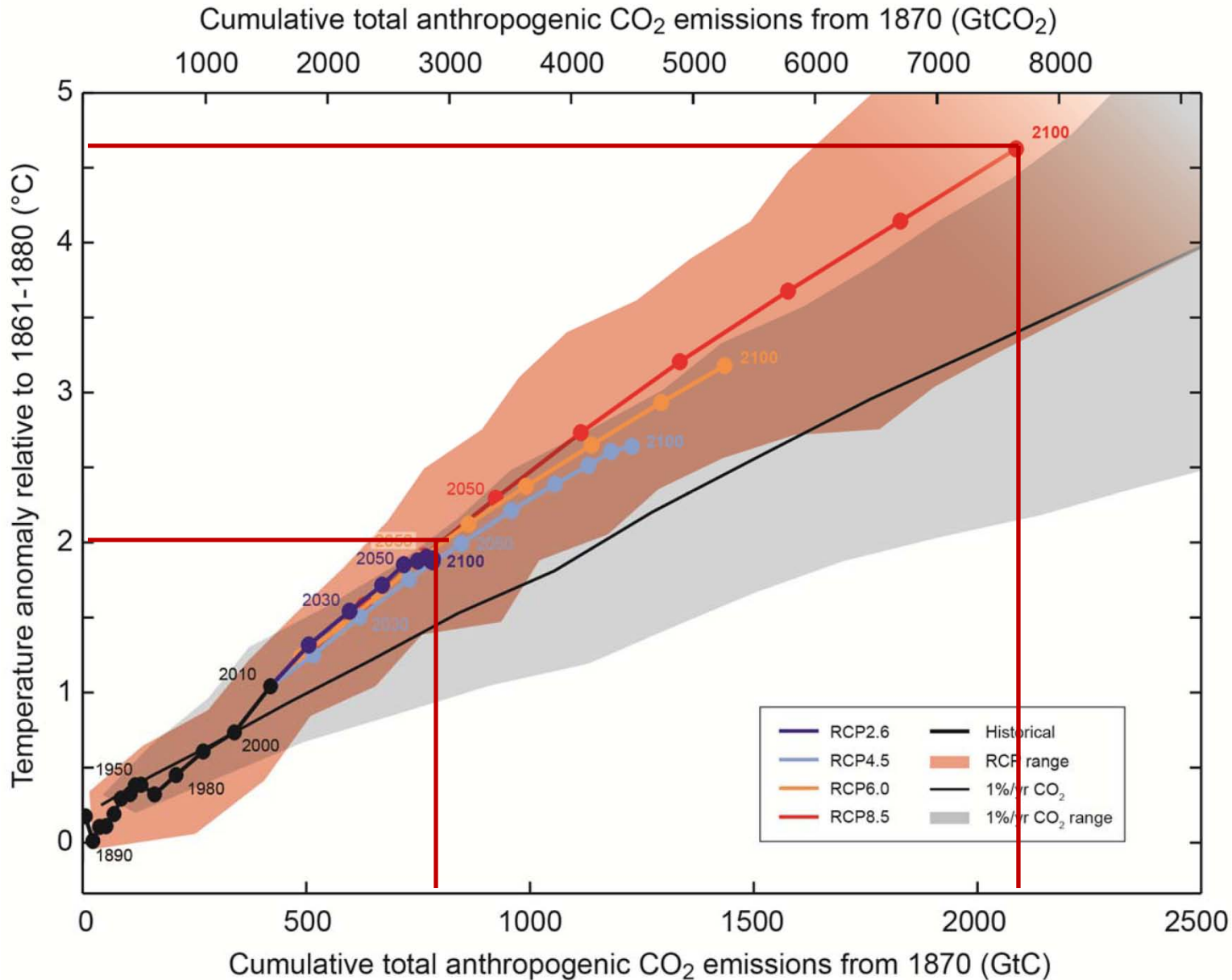
RCP 2.6

RCP 8.5

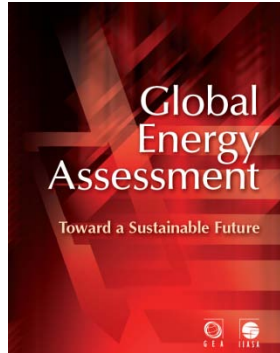
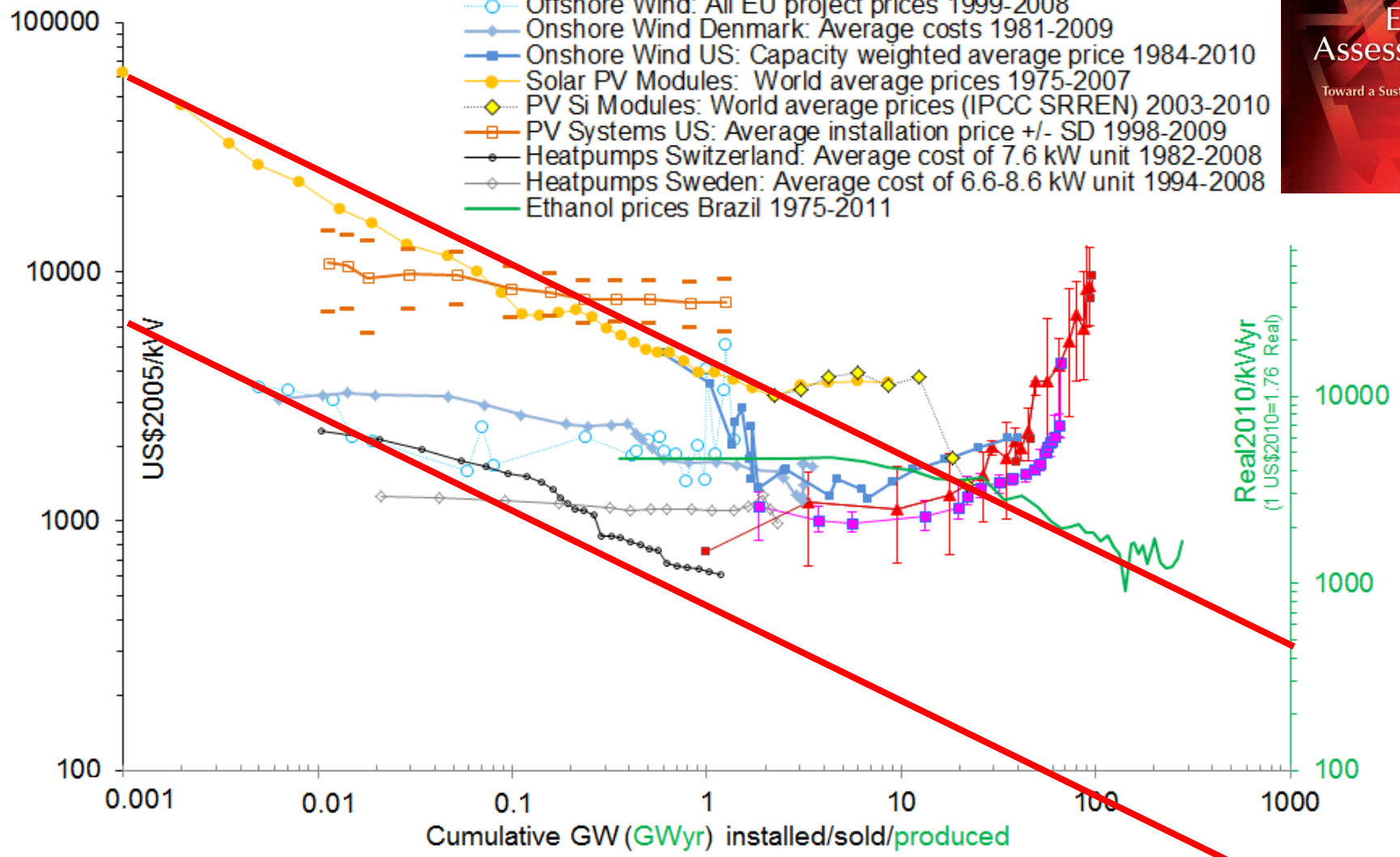
(a)

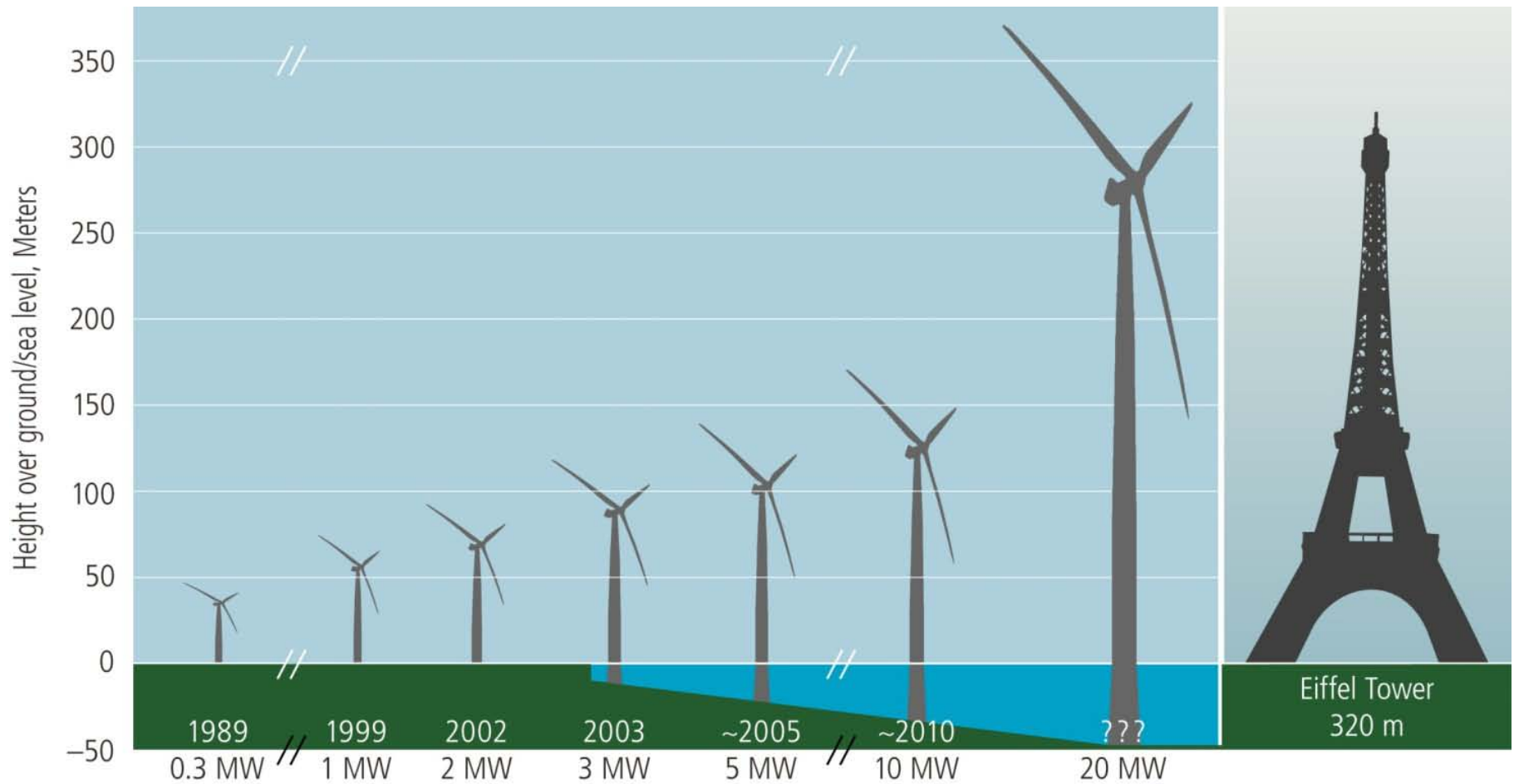
Change in average surface temperature (1986–2005 to 2081–2100)





- ▲ Nuclear US: Average and Minimum/Maximum 1971-1996
- Nuclear US: Single Reactor (No Range) 1971-1996
- Nuclear France: Average and Min/Max 1977-1999
- Offshore Wind: All EU project prices 1999-2008
- ◆ Onshore Wind Denmark: Average costs 1981-2009
- Onshore Wind US: Capacity weighted average price 1984-2010
- Solar PV Modules: World average prices 1975-2007
- ◆ PV Si Modules: World average prices (IPCC SRREN) 2003-2010
- PV Systems US: Average installation price +/- SD 1998-2009
- Heatpumps Switzerland: Average cost of 7.6 kW unit 1982-2008
- ◇ Heatpumps Sweden: Average cost of 6.6-8.6 kW unit 1994-2008
- Ethanol prices Brazil 1975-2011





Learning Rates US Wind Turbines

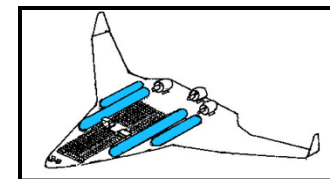
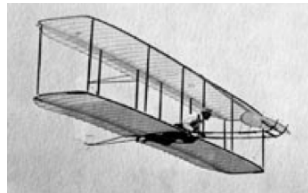
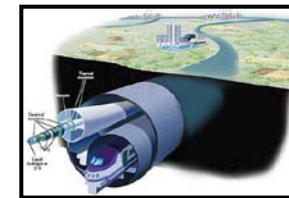
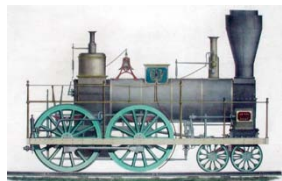
1850

1900

1950

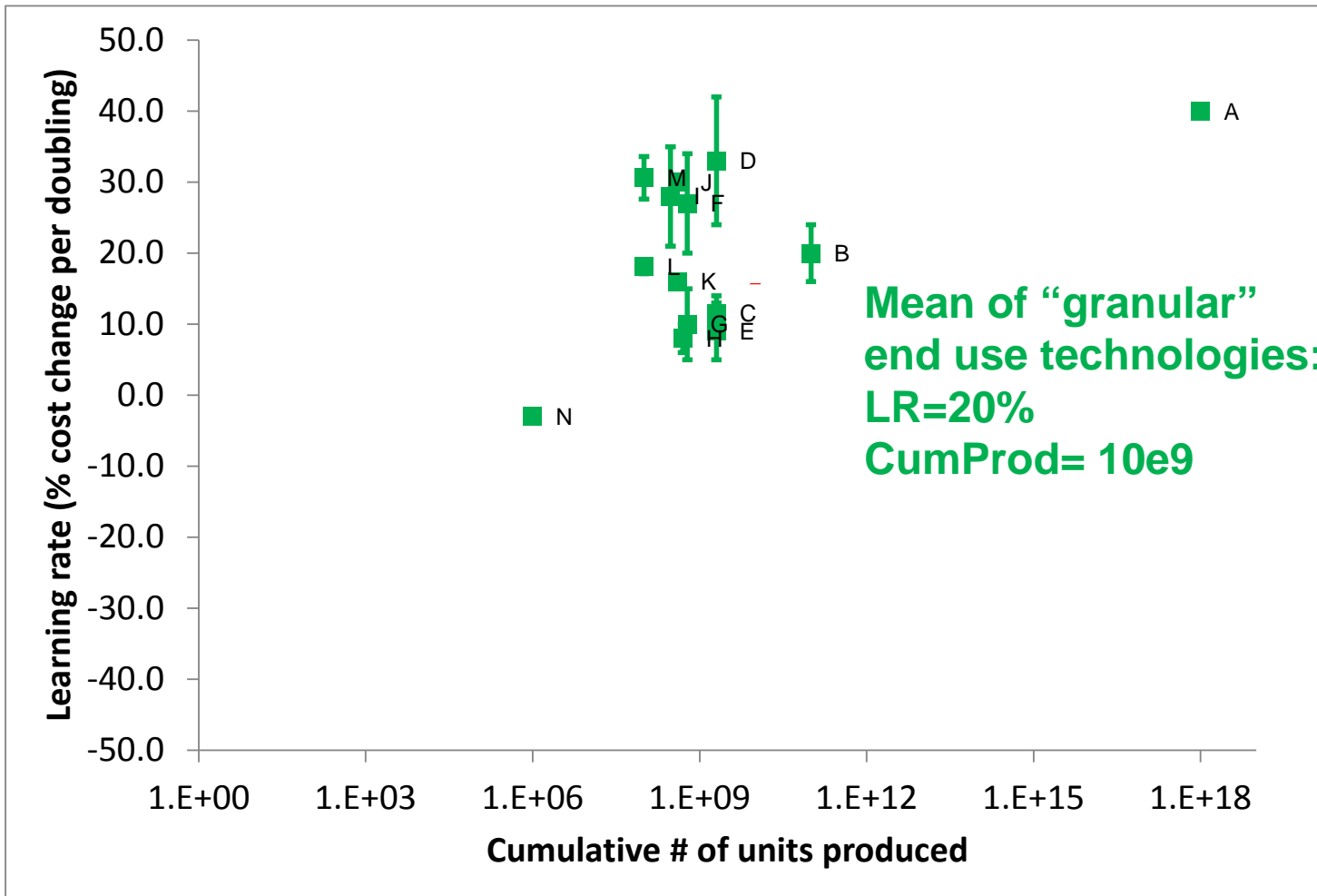
2000

2050

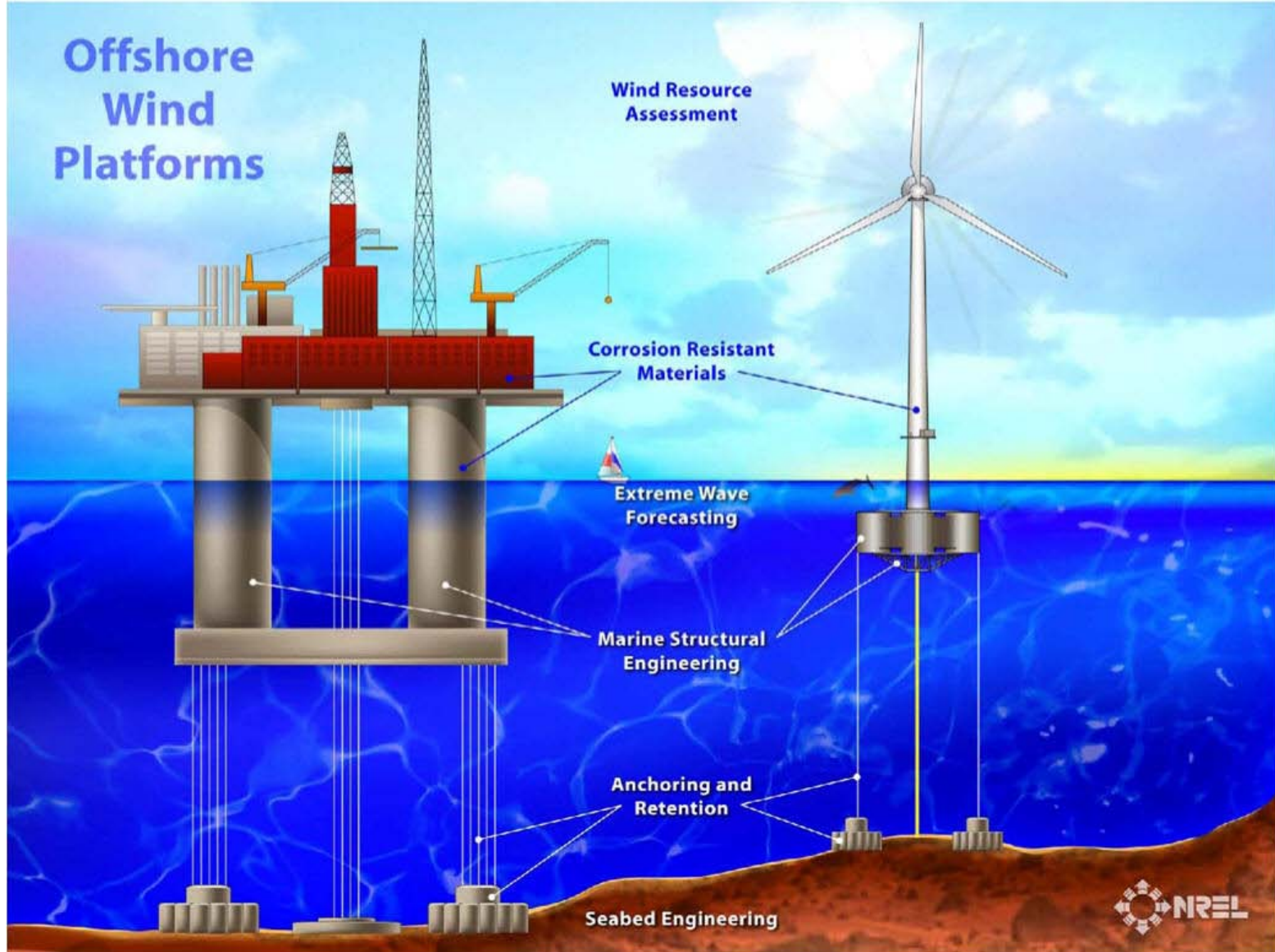


Cumulative Experience and Learning

The Importance of “granularity”



- A Transistors
- B DRAMs
- C Automobiles
- D Washing machines
- E Refrigerators
- F Dishwashers
- G Freezers (upright)
- H Freezers (chest)
- I Dryers
- J Calculators
- K CF light bulbs
- L A/C & heat pumps
- M Air furnaces
- N Solar hot water heaters

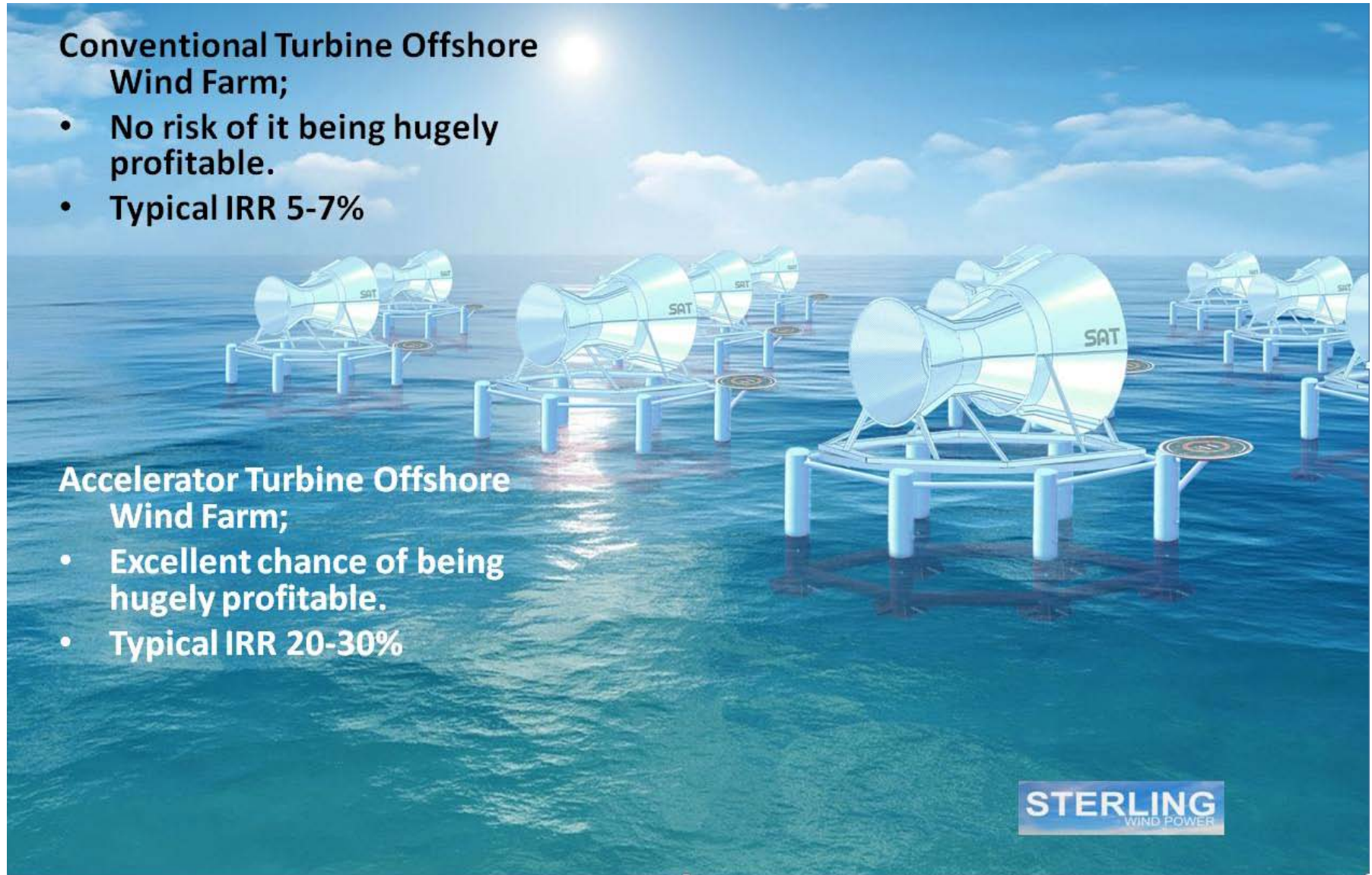


Conventional Turbine Offshore Wind Farm;

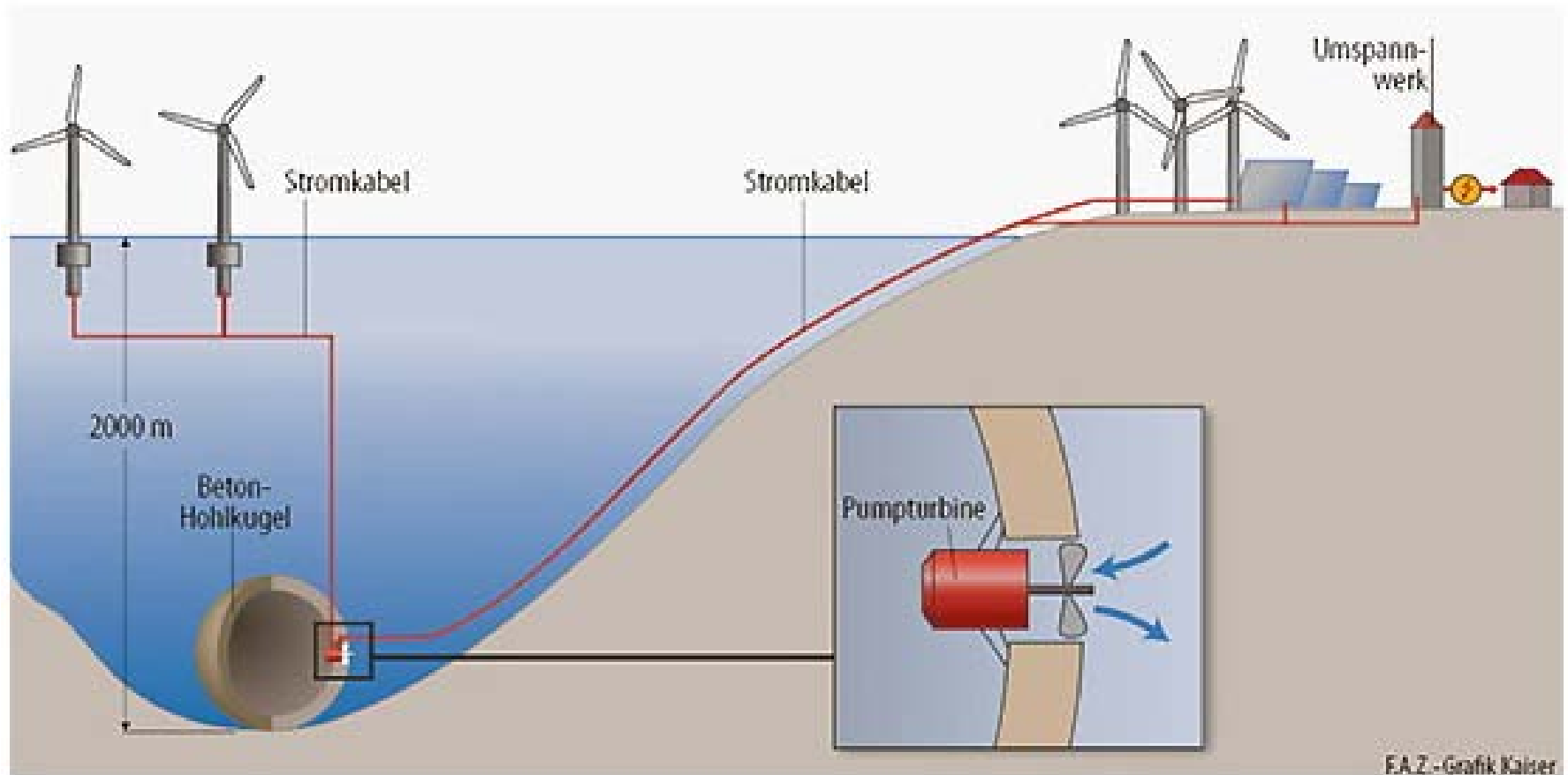
- No risk of it being hugely profitable.
- Typical IRR 5-7%

Accelerator Turbine Offshore Wind Farm;

- Excellent chance of being hugely profitable.
- Typical IRR 20-30%

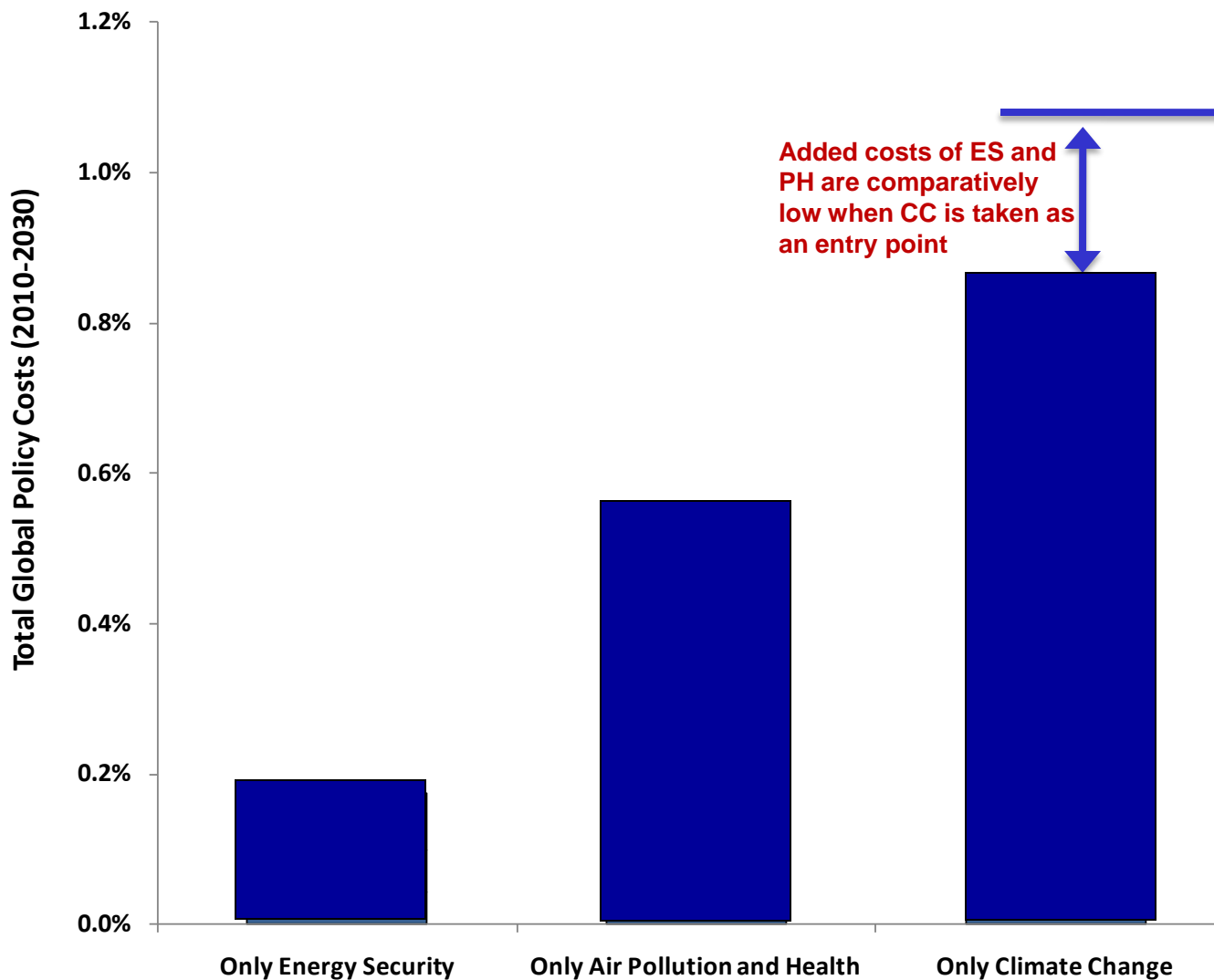


~ 30m sphere @ 2000m ≈ 60MWh





Annual Energy Investments	Innovation RD&D [billion US\$2005]	Markets Formation [billion US\$2005]	Present Investments [billion US\$2005]	Investment for SE4All [billion US\$2005]
	2010	2010	2010	2010 - 2030
Efficiency	>> 8	~ 5	300	260-370
Renewables	> 12	~ 20	200	260-410
Access	< 1	< 1	~ 9	40-60
Total	> 50	< 150	1250	1780 - 2440



Vision of a Sailing Railway

Monorail using sails proposed by Henry R. Palmer in 1828

TITLE MISSING

