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science for global insight



Transitions to Low-Carbon Economy

Nebojsa Nakicenovic

Deputy Director General

International Institute for Applied Systems Analysis

Professor Emeritus of Energy Economics

Vienna University of Technology

Fordham University Law School – 20 September 2017



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Transitions to Low-Carbon Economy & How to Finance it

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IIASA, International Institute for Applied Systems Analysis

A GLOBAL RESEARCH INSTITUTE

- **Established as a scientific bridge between East and West**
- **After Cold War ended focused on multiple dimensions of global change**
- **Now embarked on the new research strategy for the next decade**

23 IIASA NATIONAL MEMBER ORGANIZATIONS



- International, independent, interdisciplinary science
- research & big-data on major global problems
- Solution & policy oriented, integrated systems analysis

The Paris Agreement



Bildquelle: <https://www>

Limiting global
warming to
“well below”
2 degrees celsius

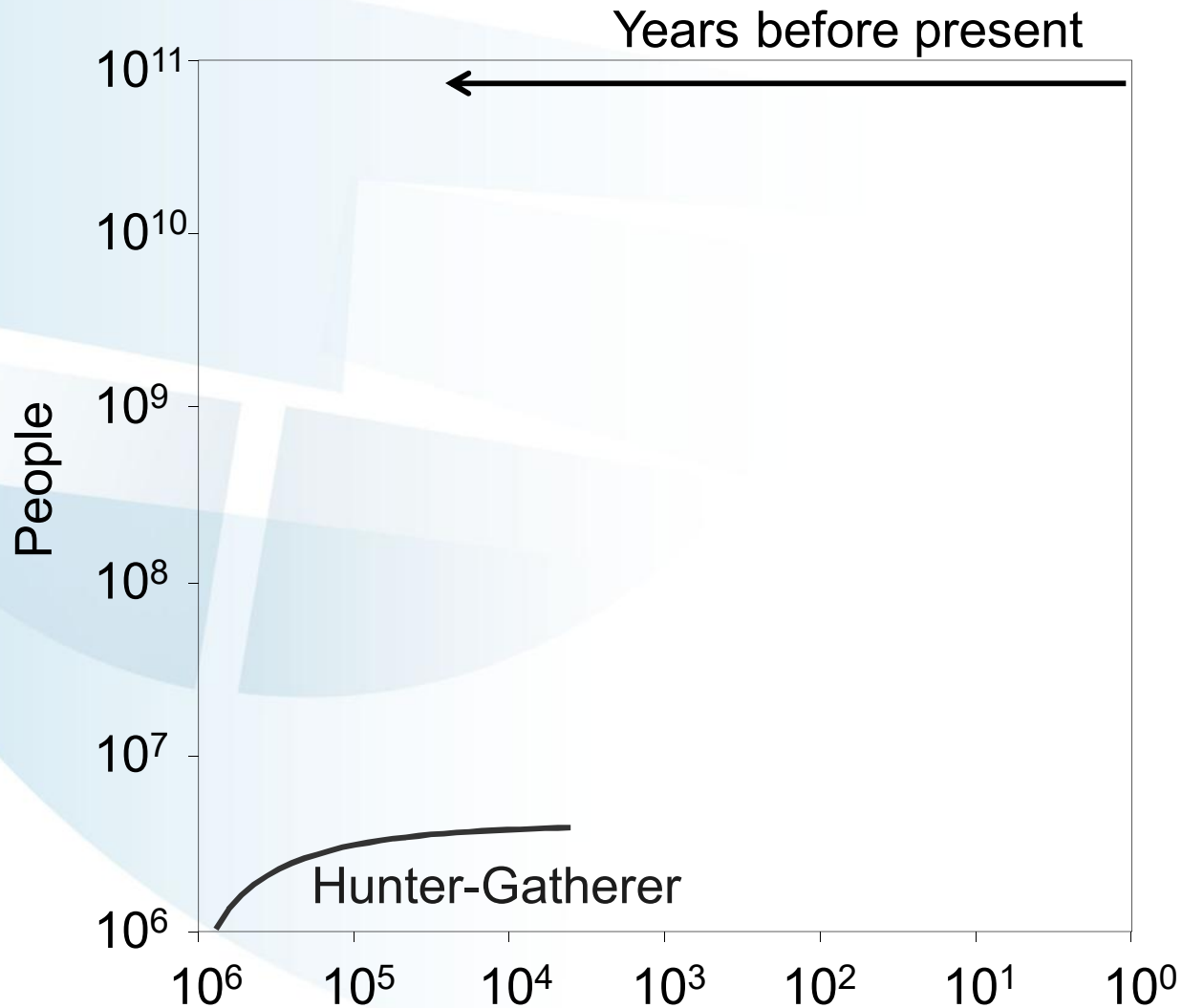
Achieving **net-zero**
GHG emissions by mid of
the 21st century

Regular review and
improvement of **nationally**
determined contributions

Mobilizing **\$100**
billion a year in
support by 2020
through 2025

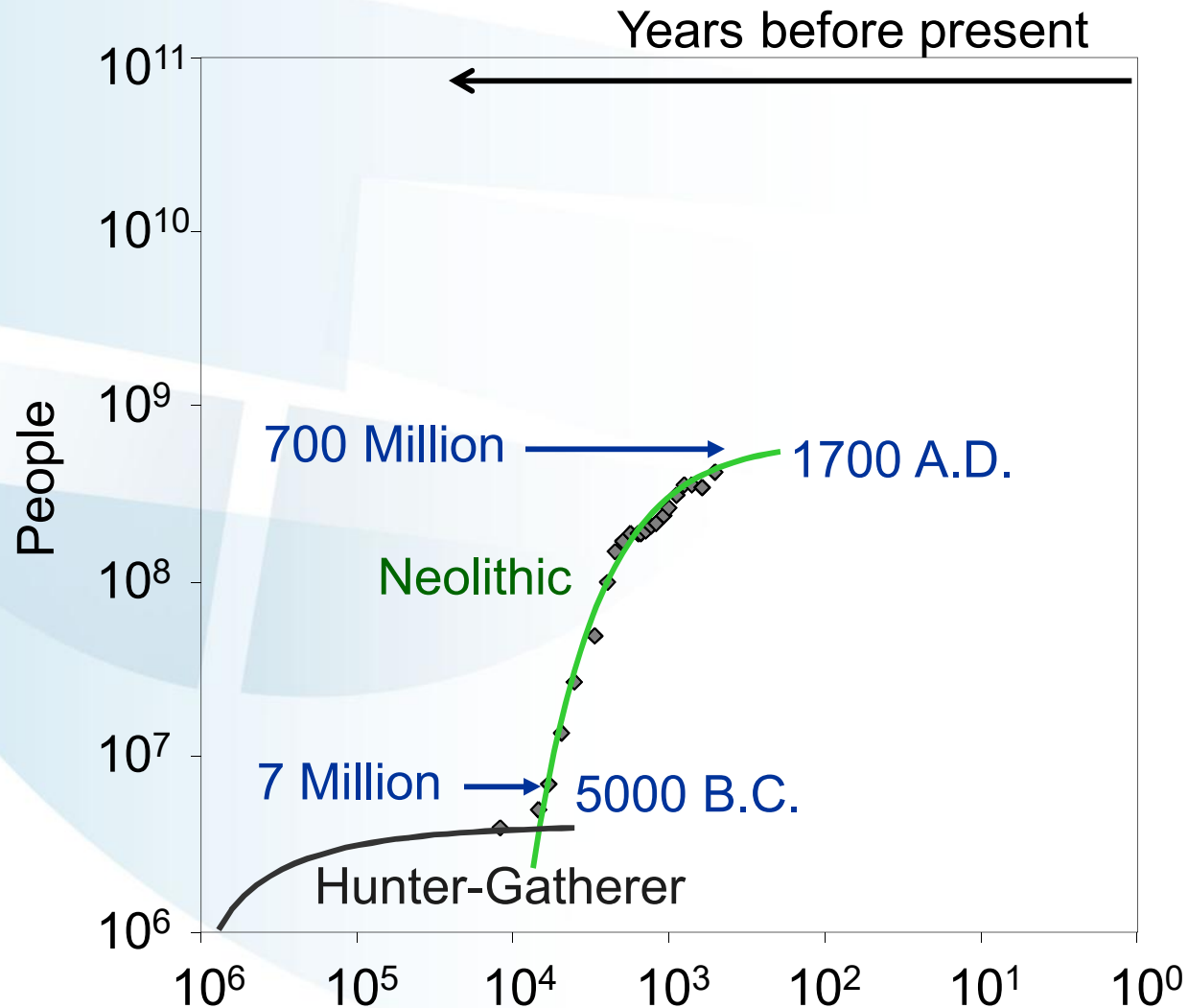
Source: Schellnhuber, 2016

Global Transformations



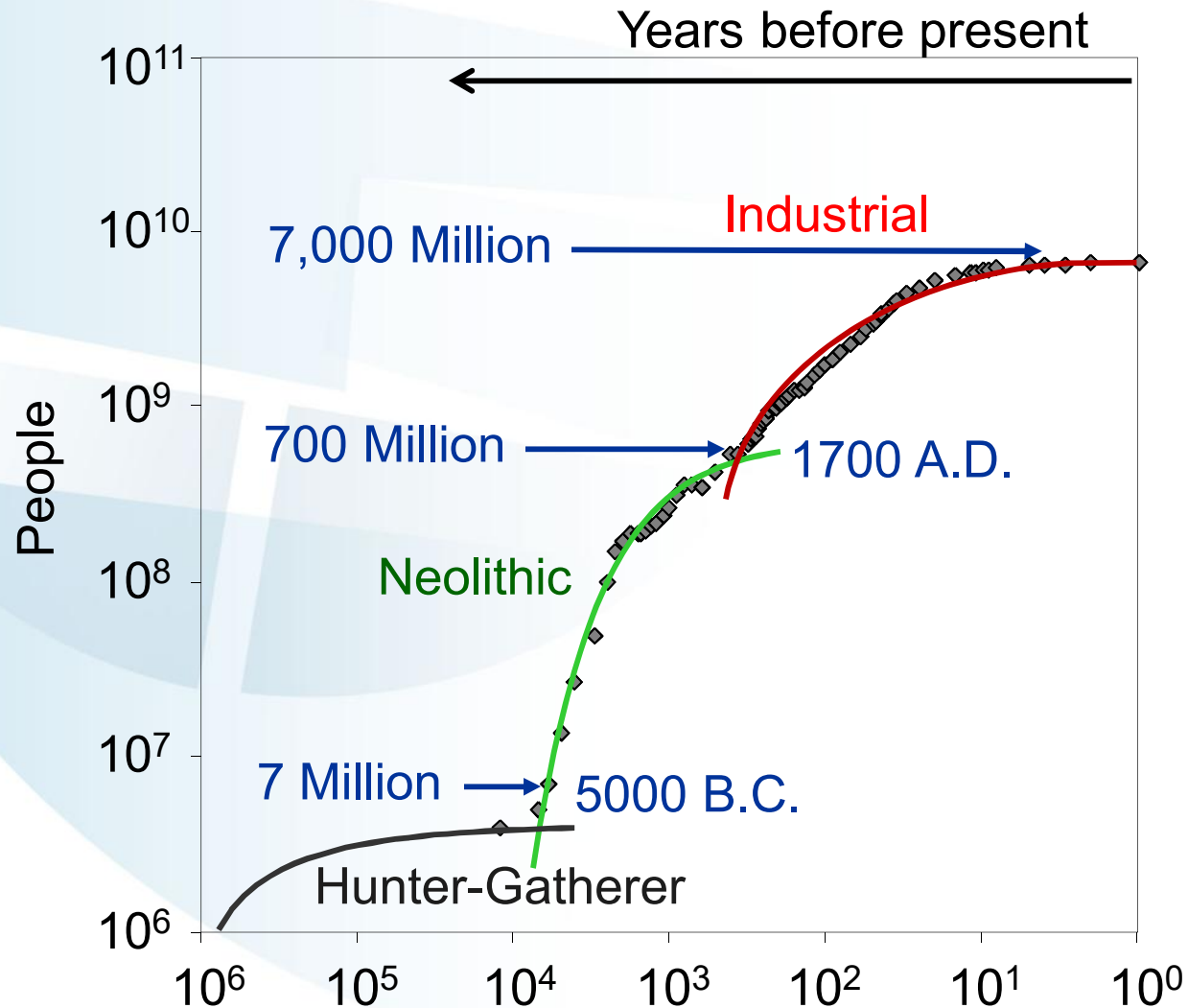
Global Transformations

Neolithic Revolution



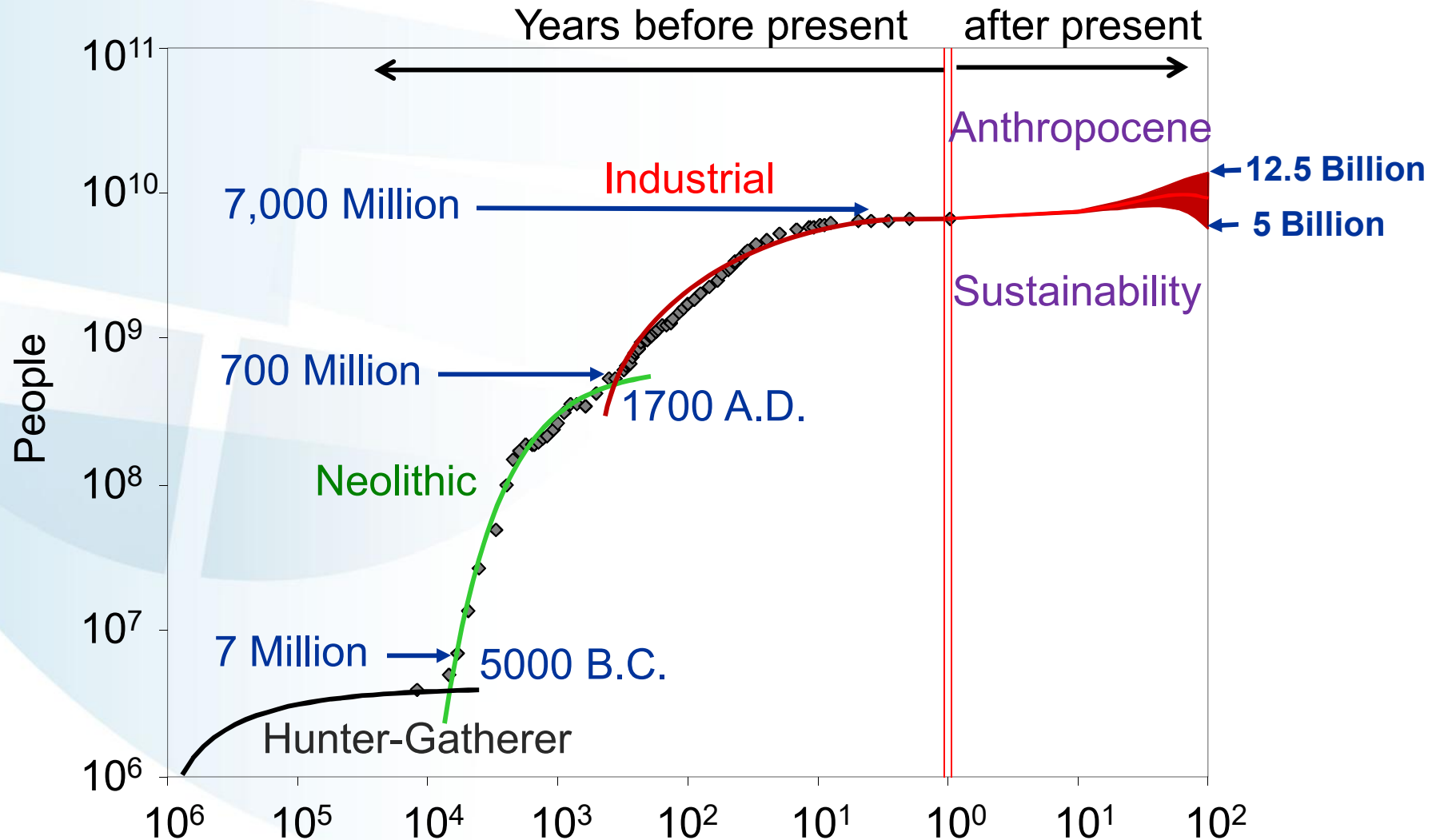
Global Transformations

Neolithic and Industrial Revolutions

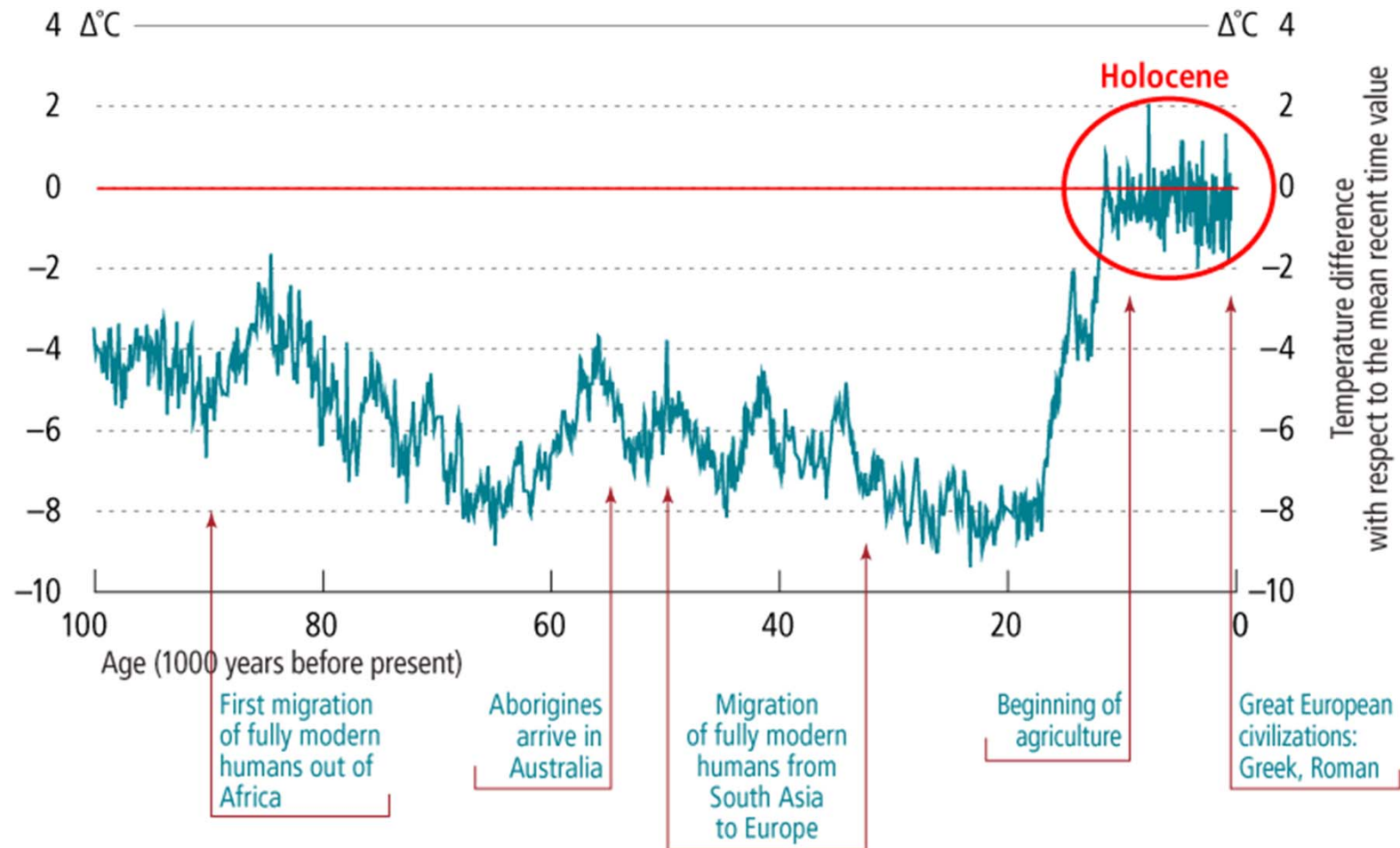


Global Transformations

Anthropocene — Sustainability

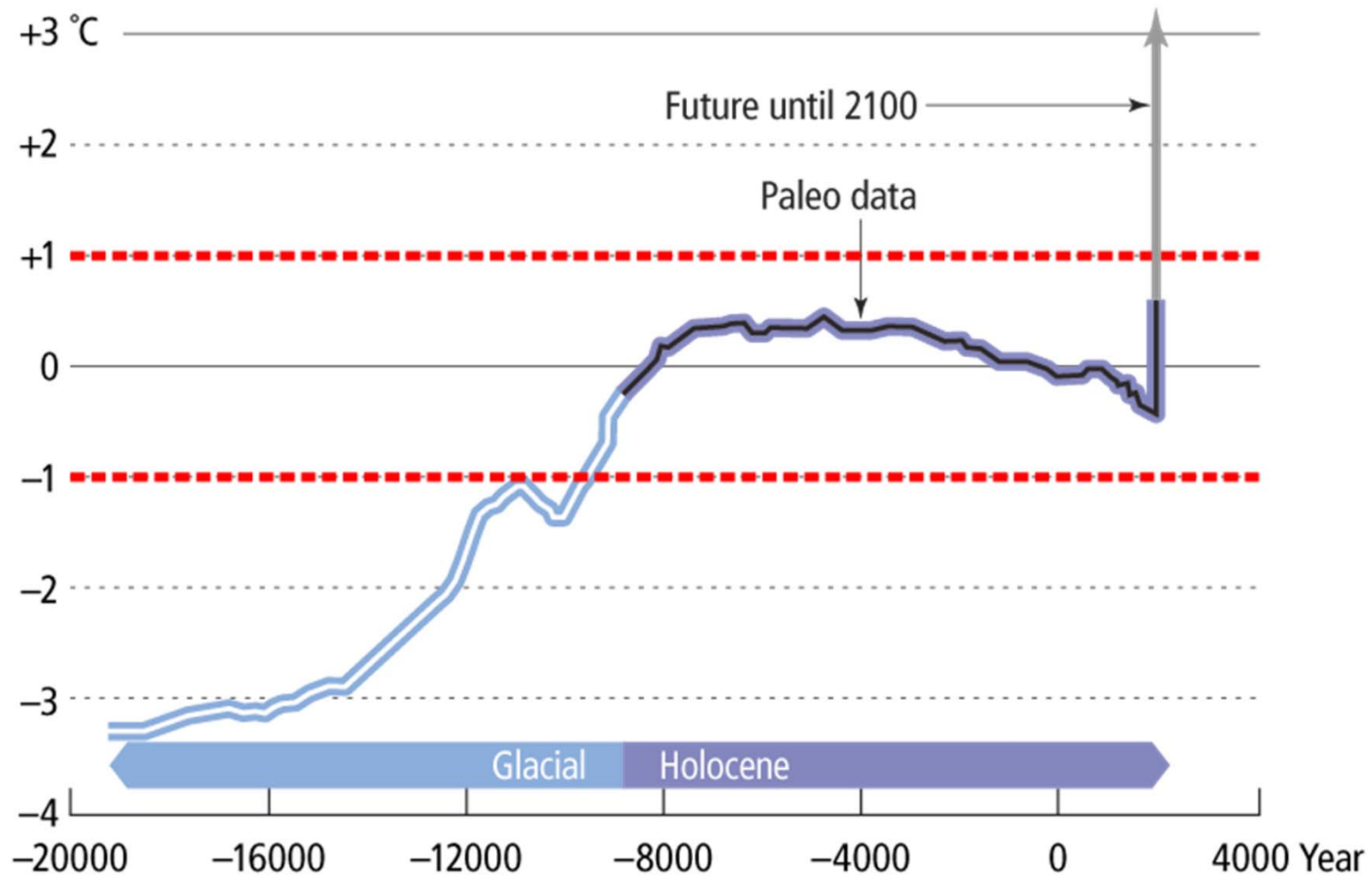


100,000-year ice-core record



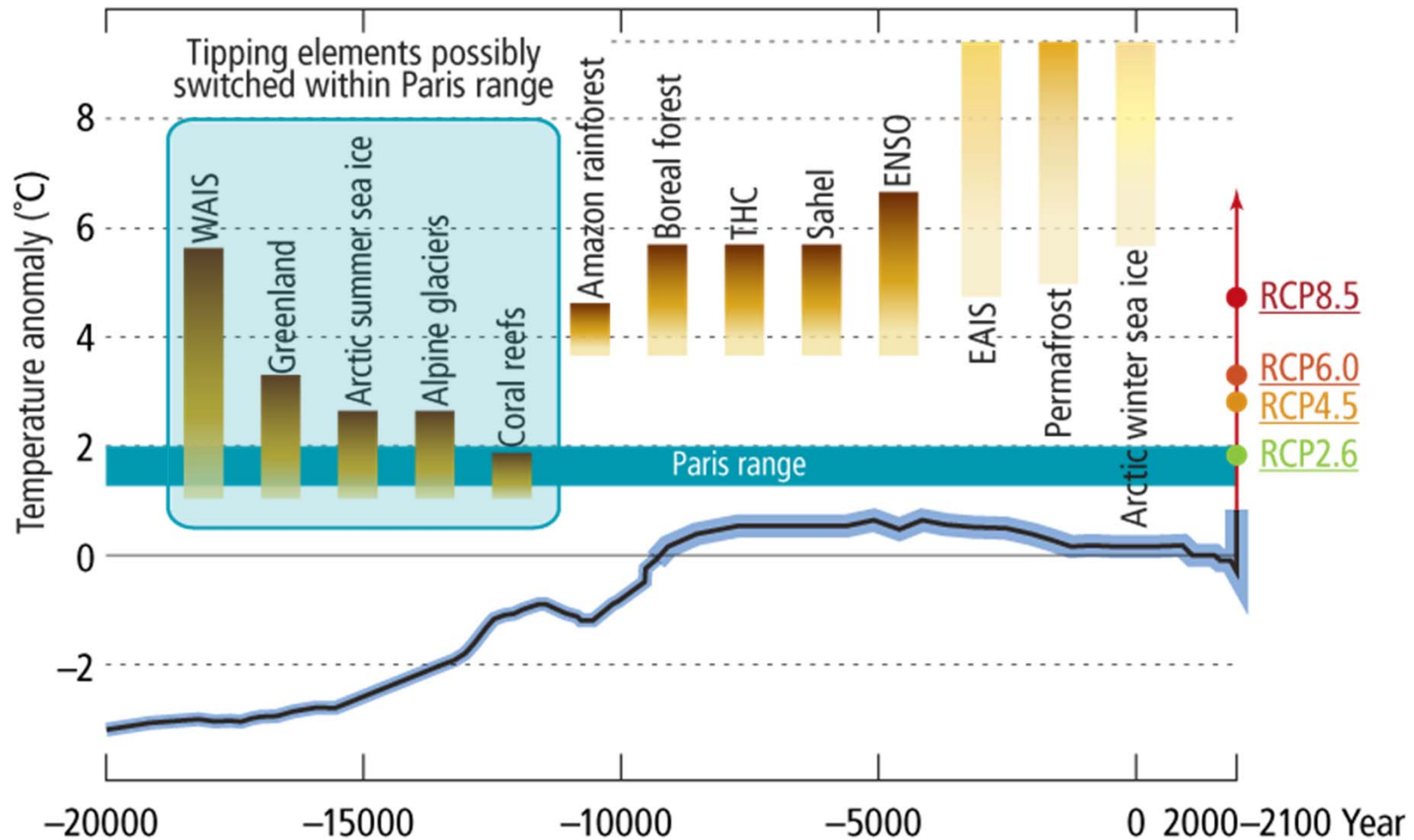
Source: Data from Petit et al. 1999, labeled as in Young and Steffen 2009.

Holocene Temperature Profile



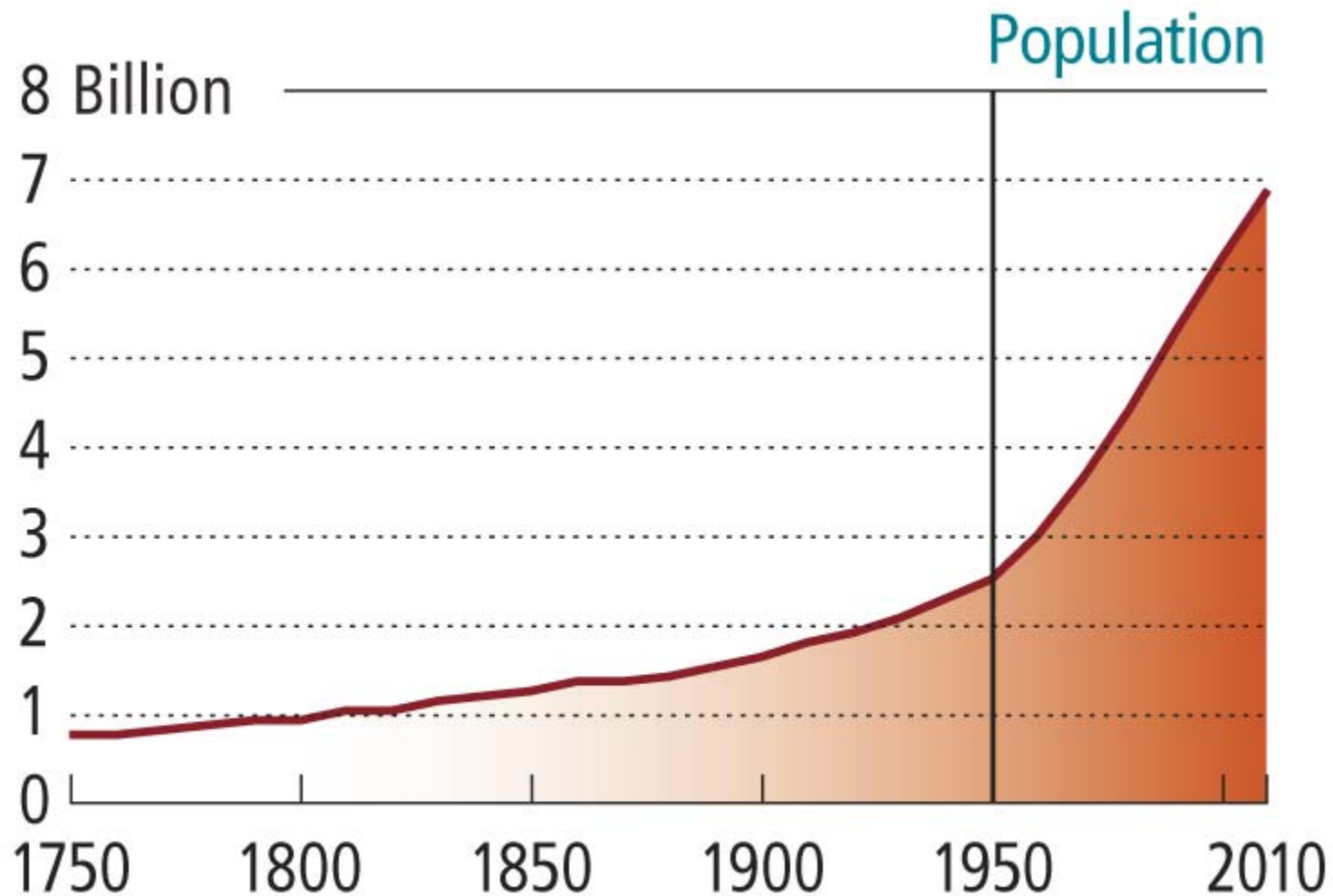
Adapted from Shakun et al. 2012 and Marcott et al 2013.

Tipping Elements & Paris



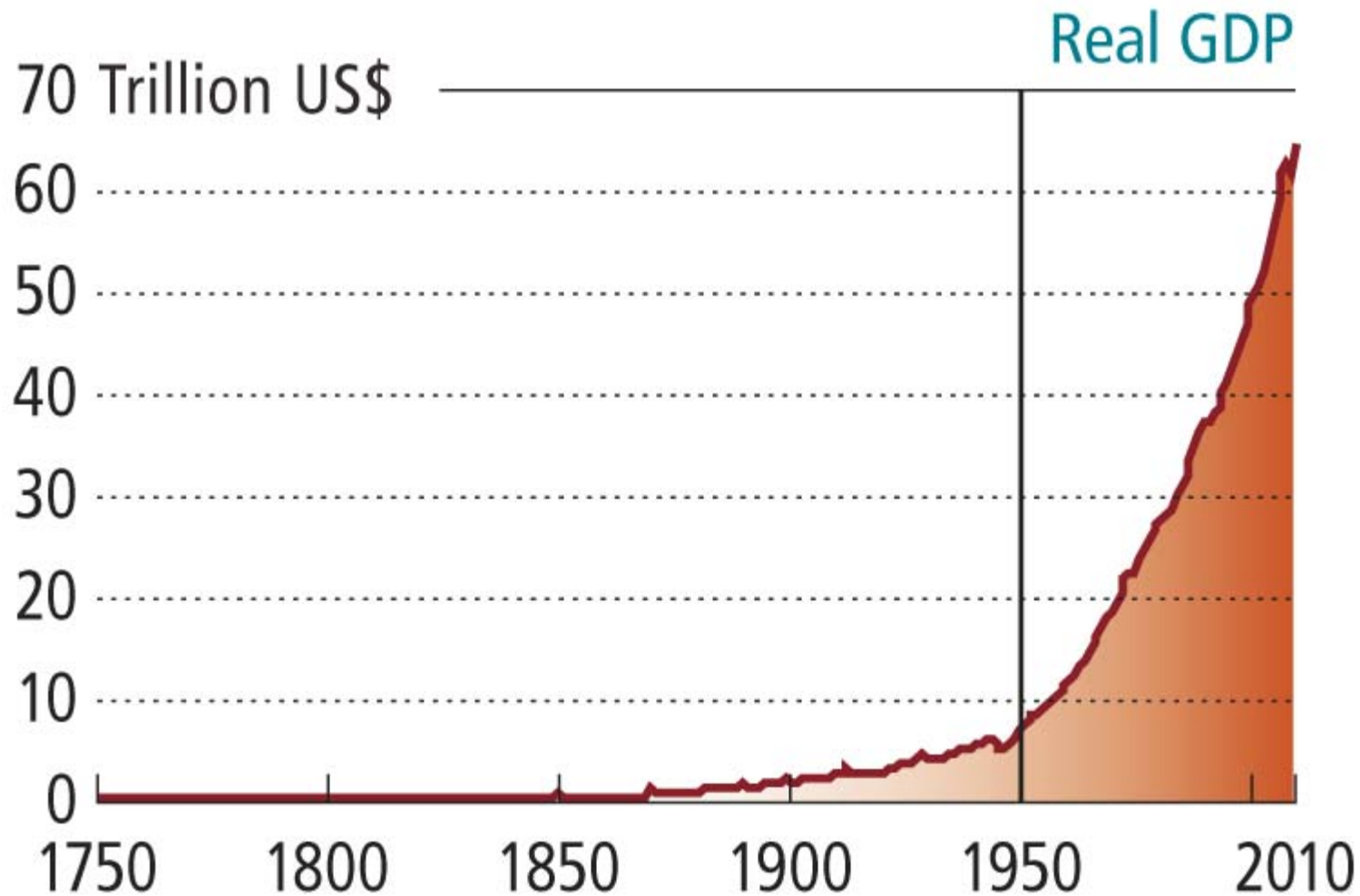
Adapted from Schellnhuber et al. 2016

The Great Acceleration



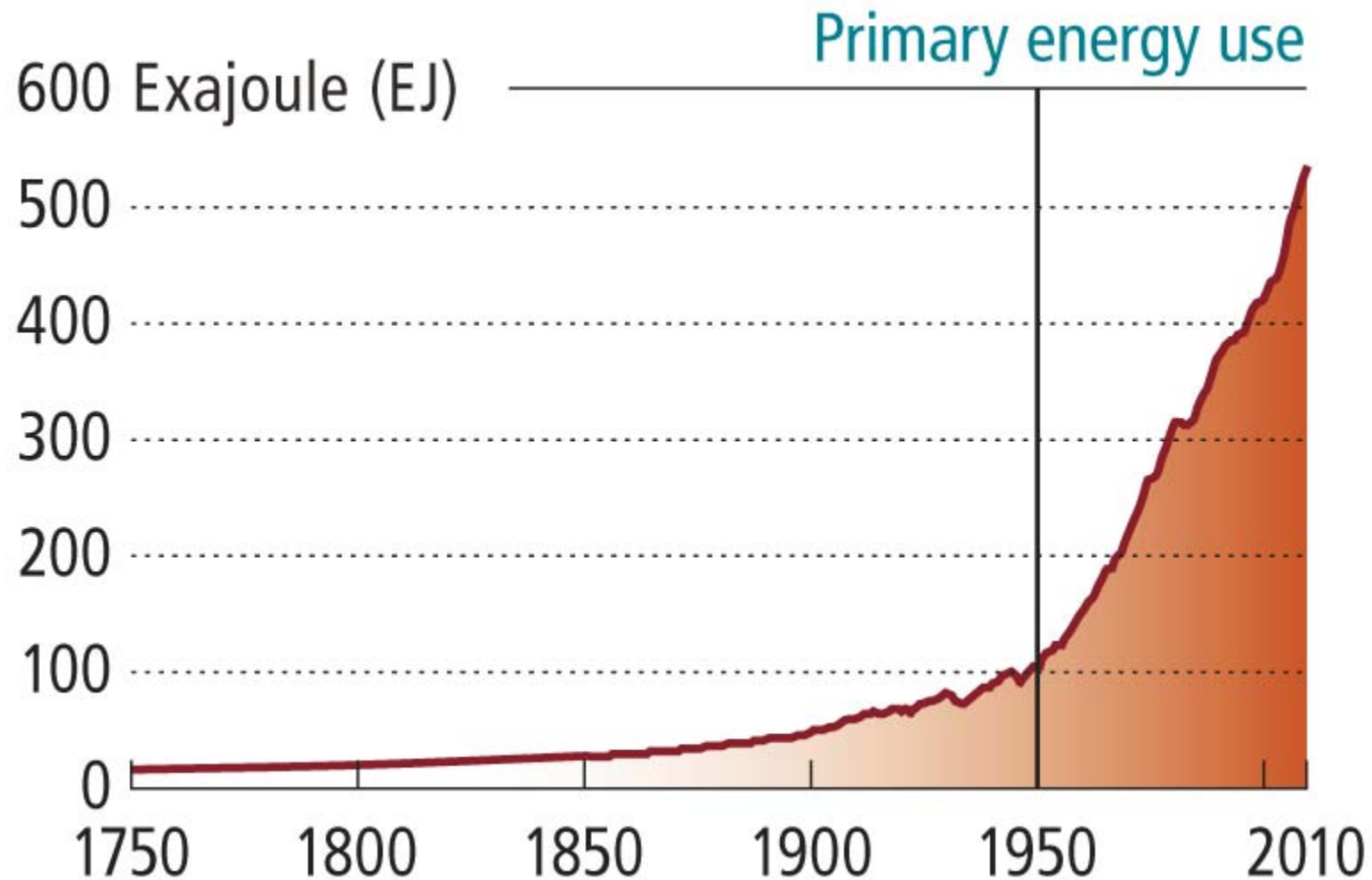
Source: Steffen et al. 2015

The Great Acceleration



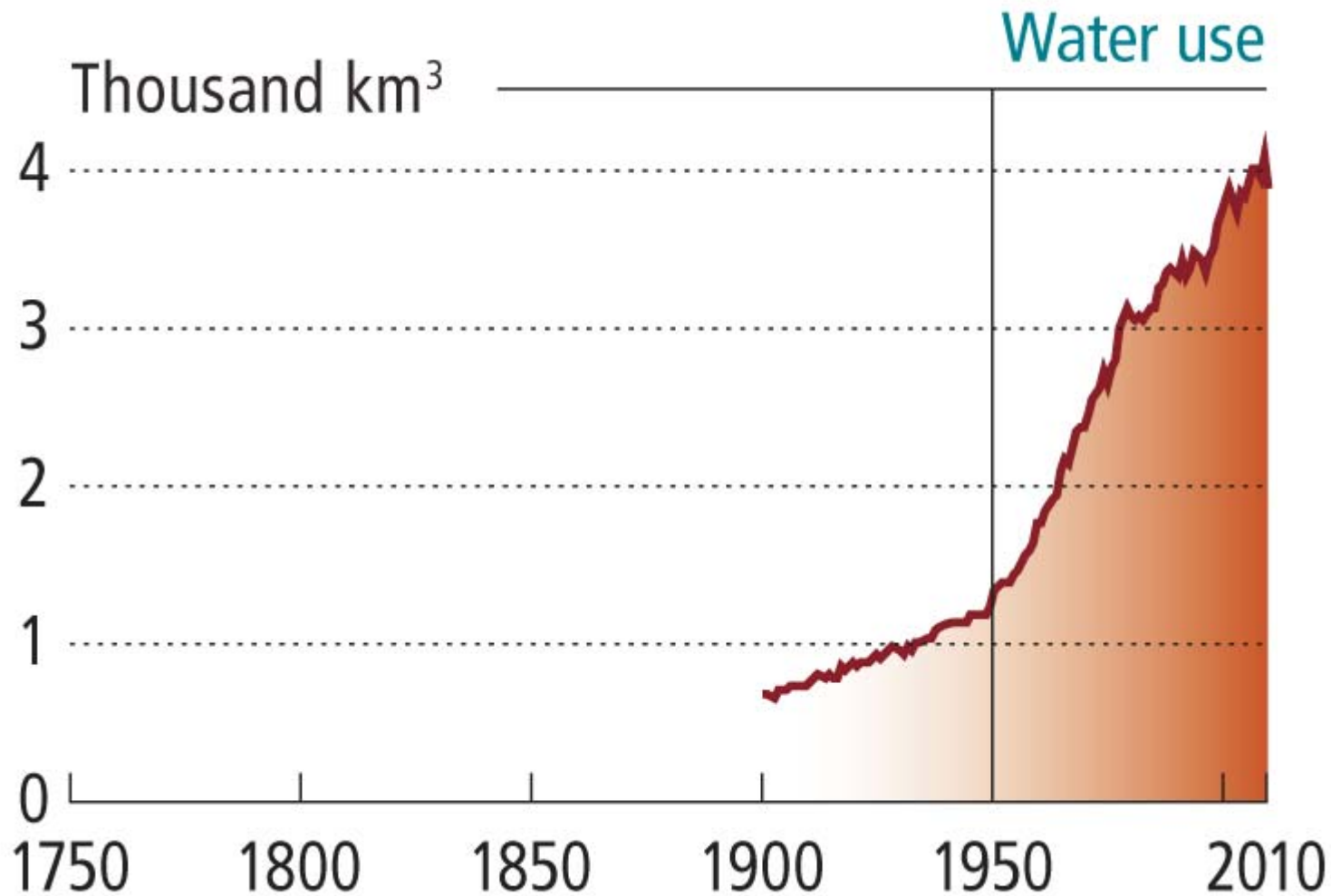
Source: Steffen et al. 2015

The Great Acceleration



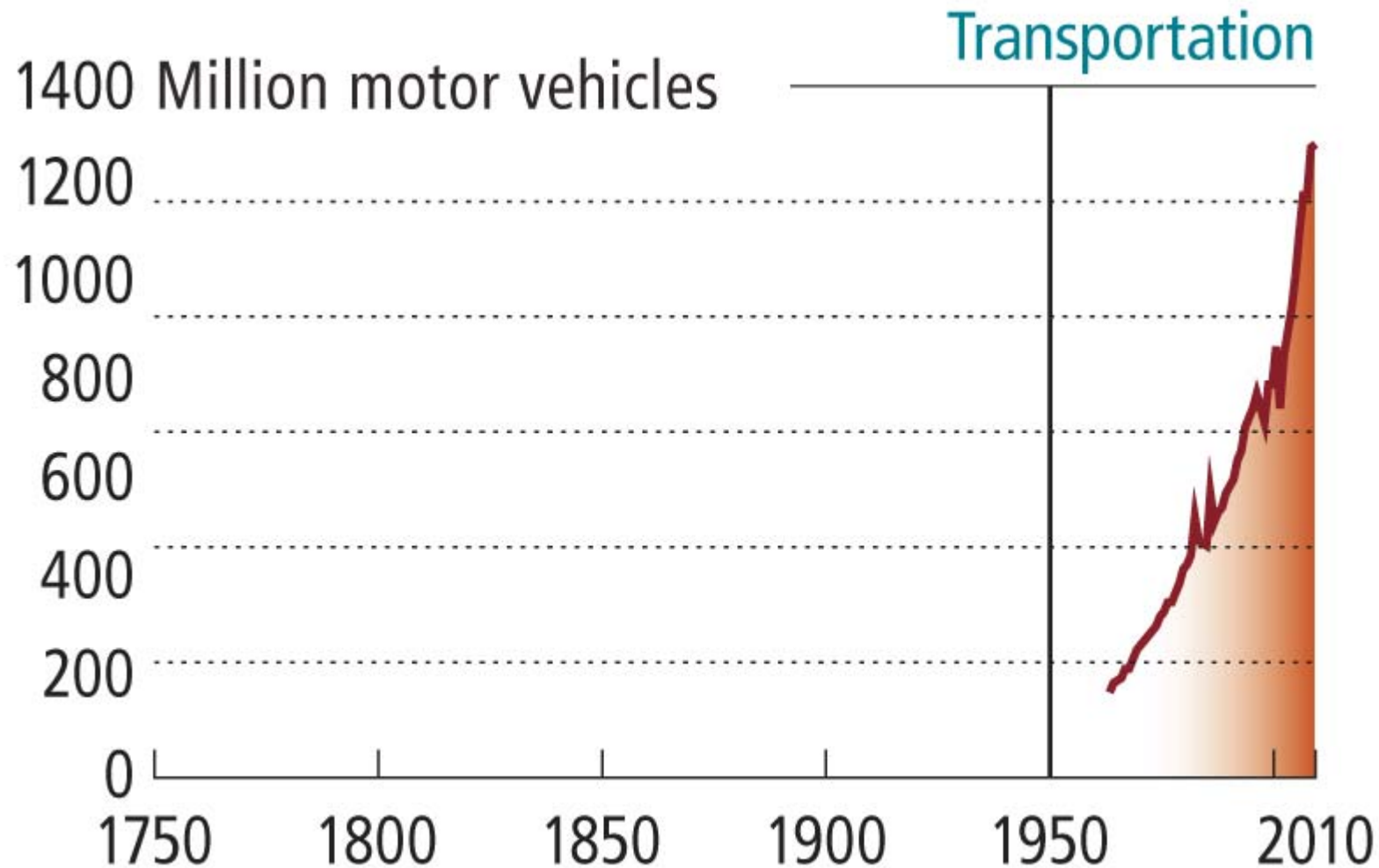
Source: Steffen et al. 2015

The Great Acceleration



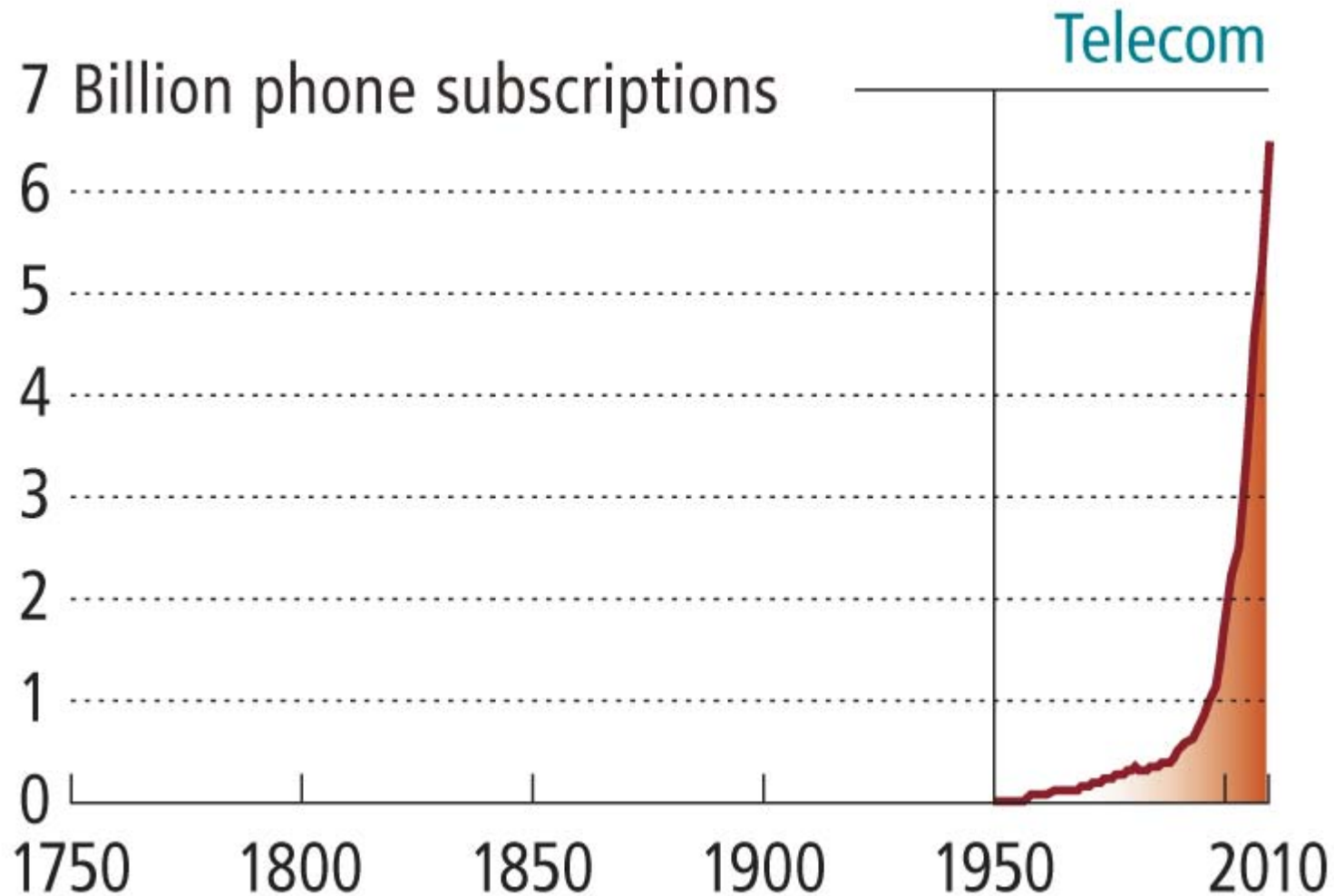
Source: Steffen et al. 2015

The Great Acceleration



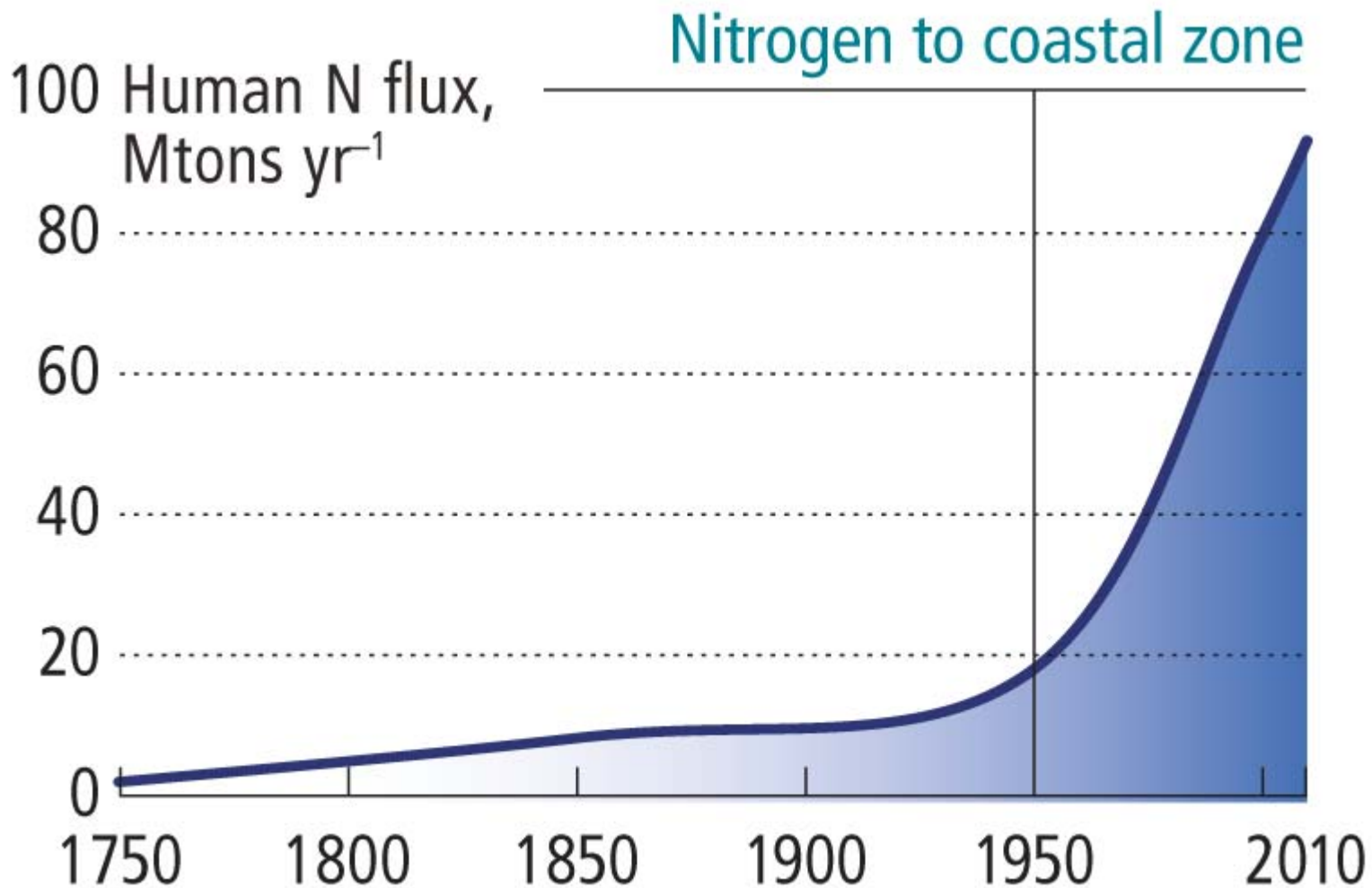
Source: Steffen et al. 2015

The Great Acceleration



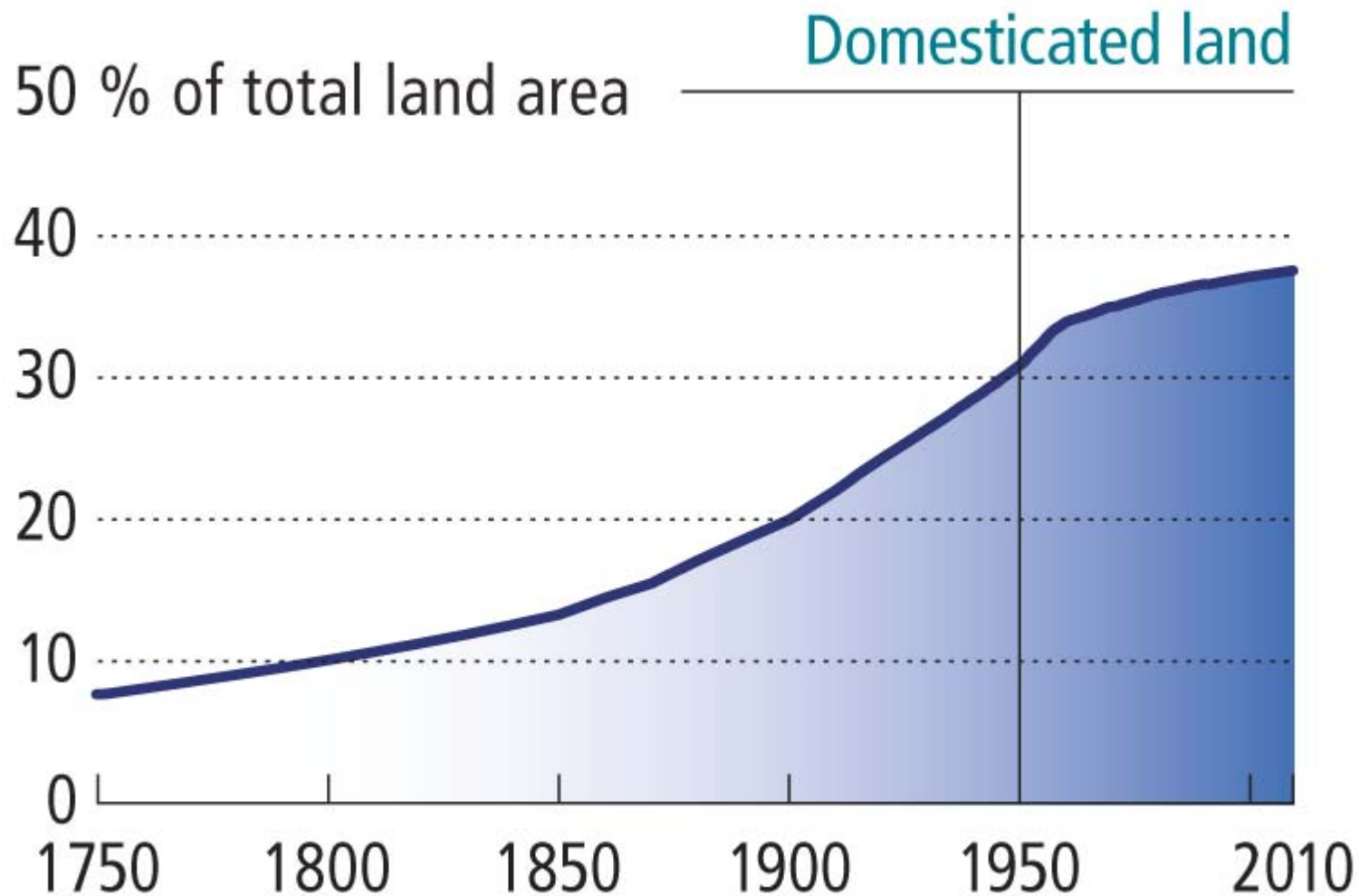
Source: Steffen et al. 2015

The Great Acceleration



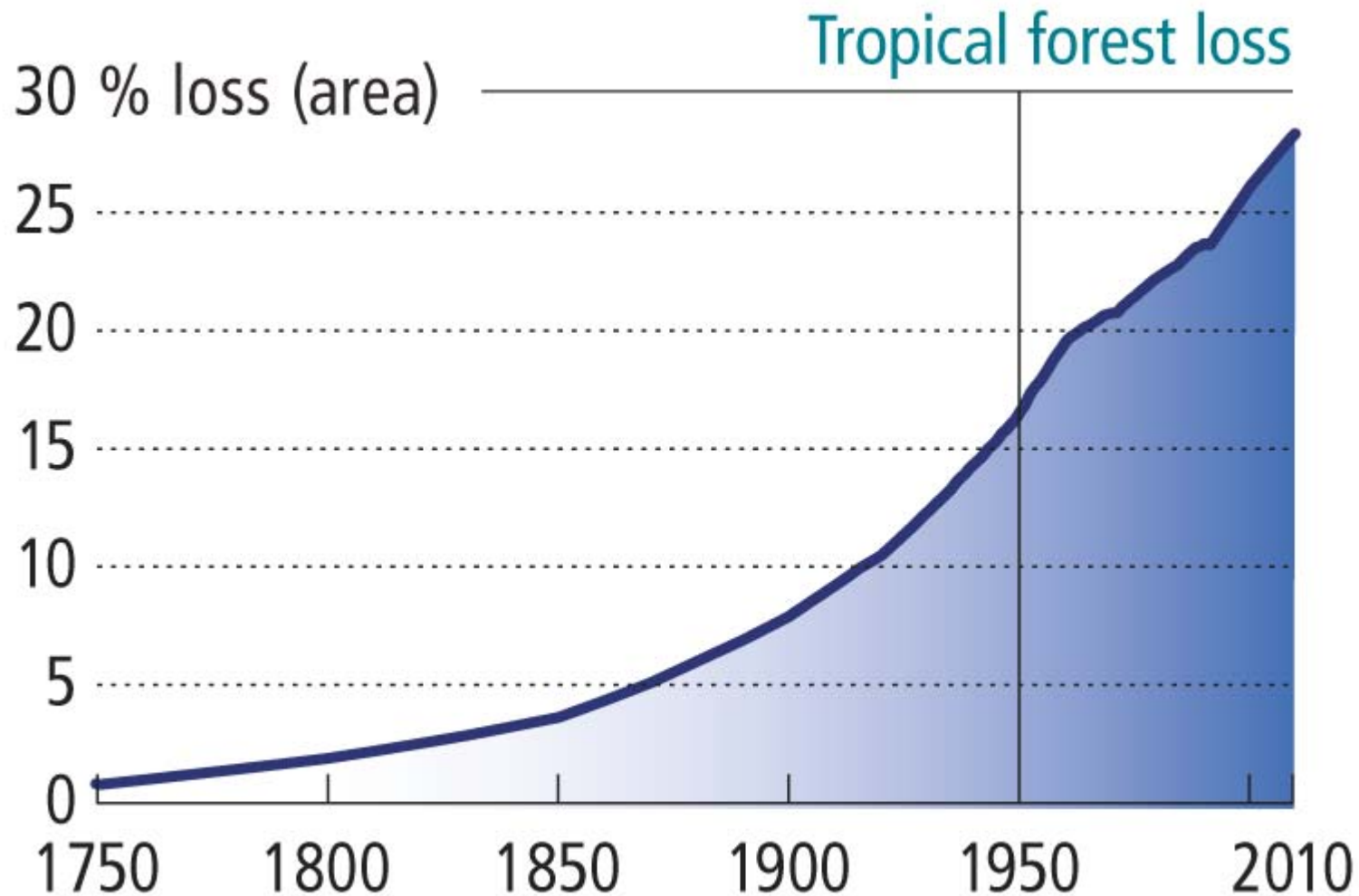
Source: Steffen et al. 2015

The Great Acceleration



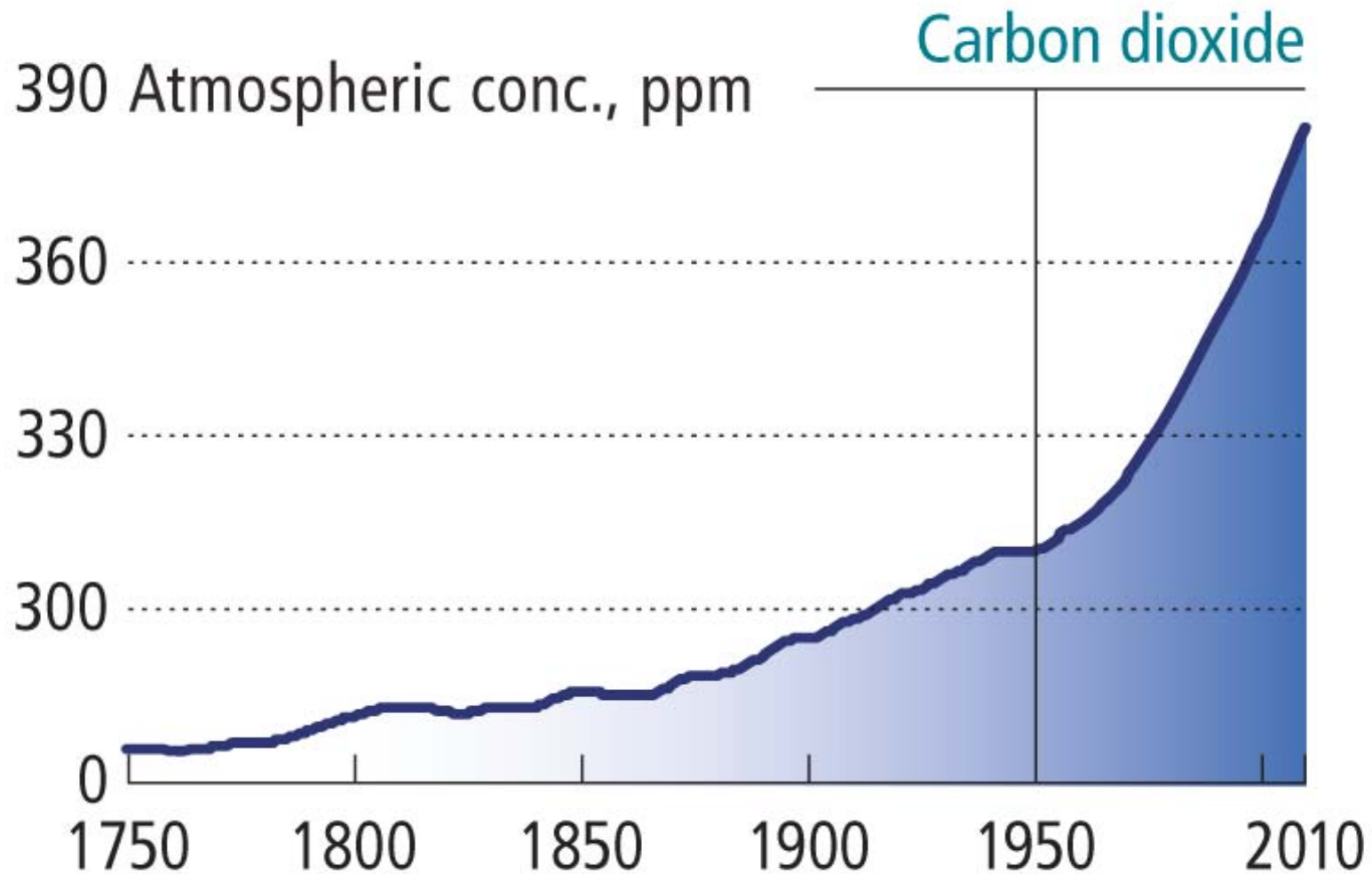
Source: Steffen et al. 2015

The Great Acceleration



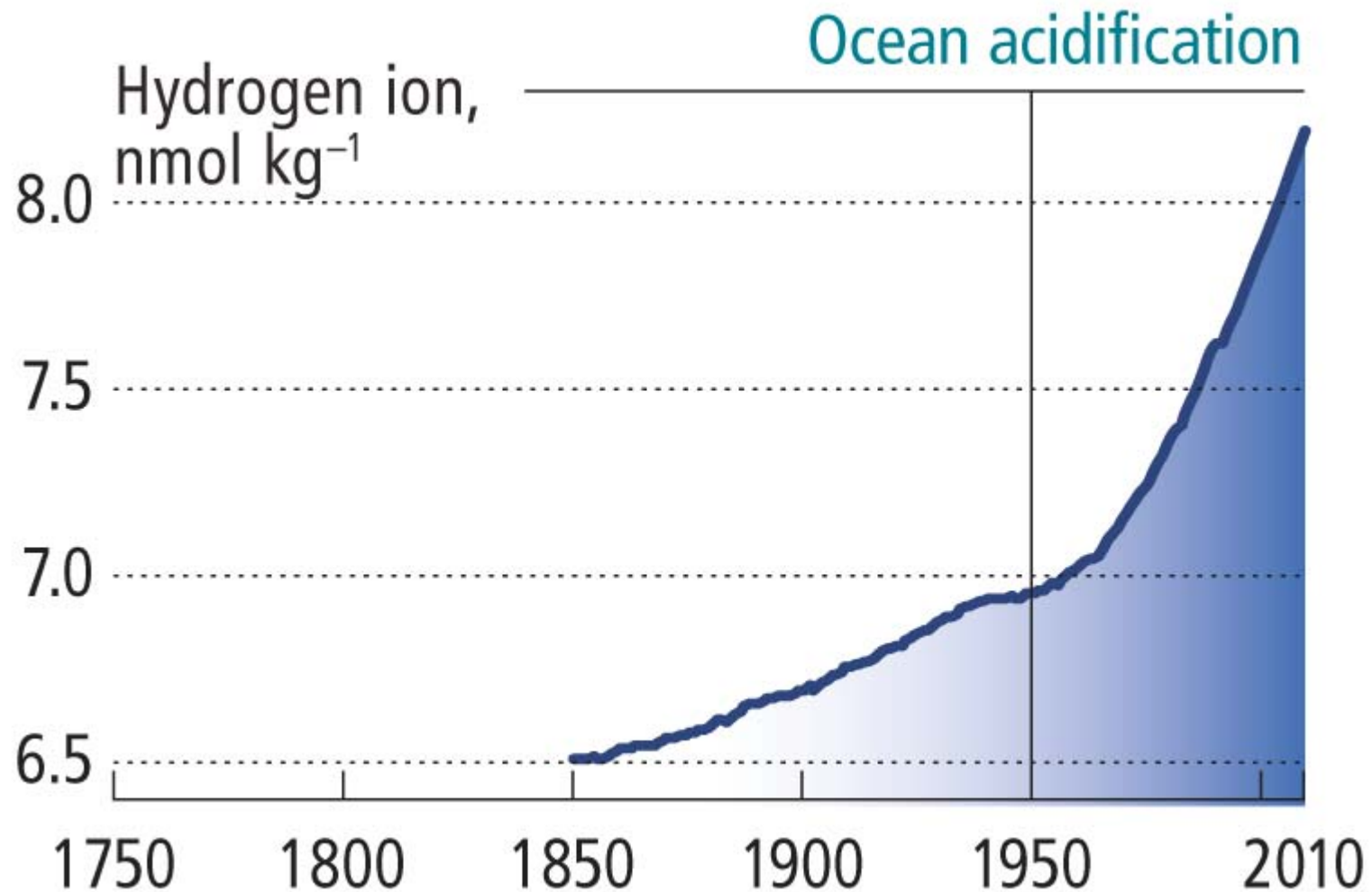
Source: Steffen et al. 2015

The Great Acceleration



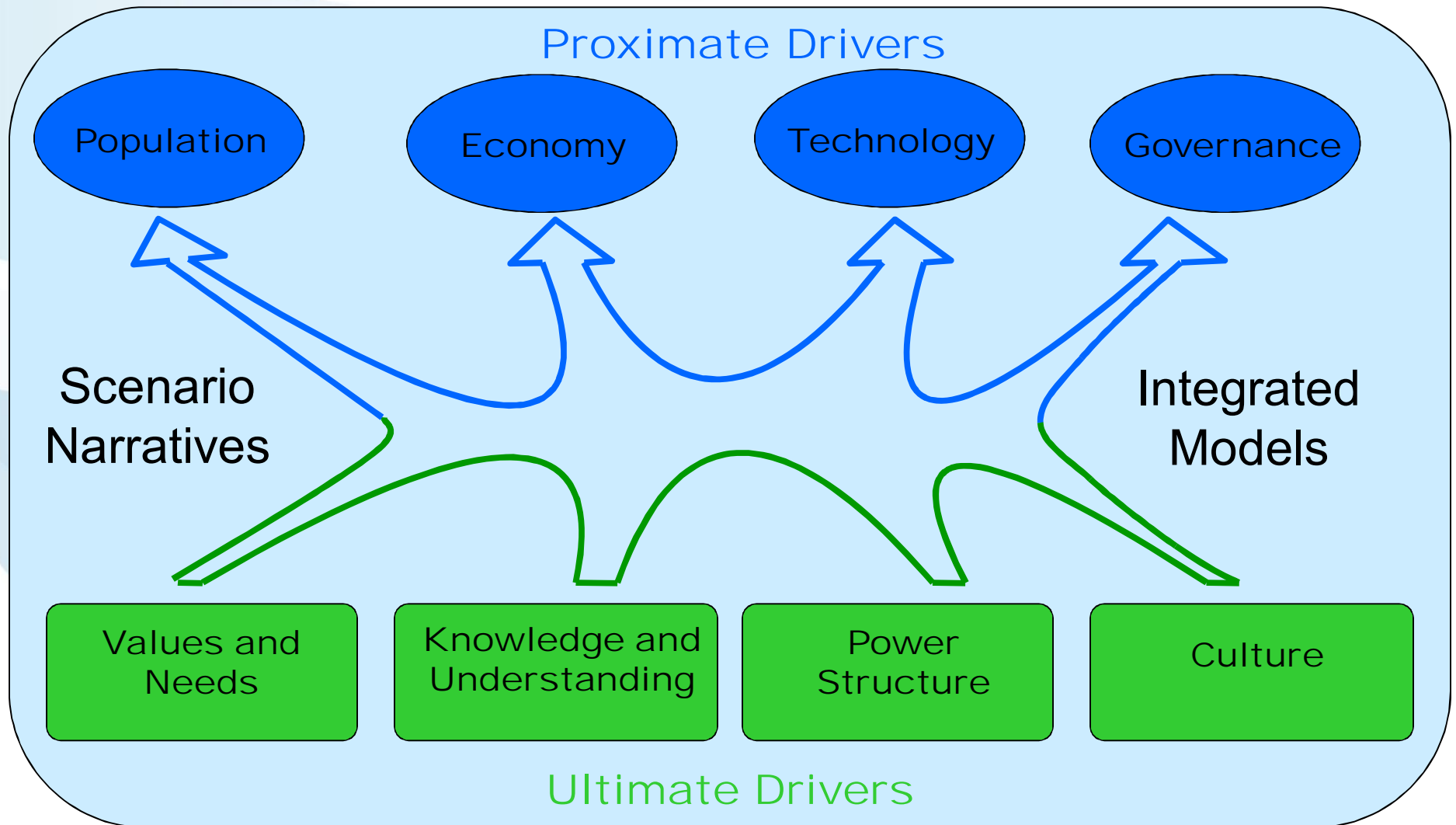
Source: Steffen et al. 2015

The Great Acceleration

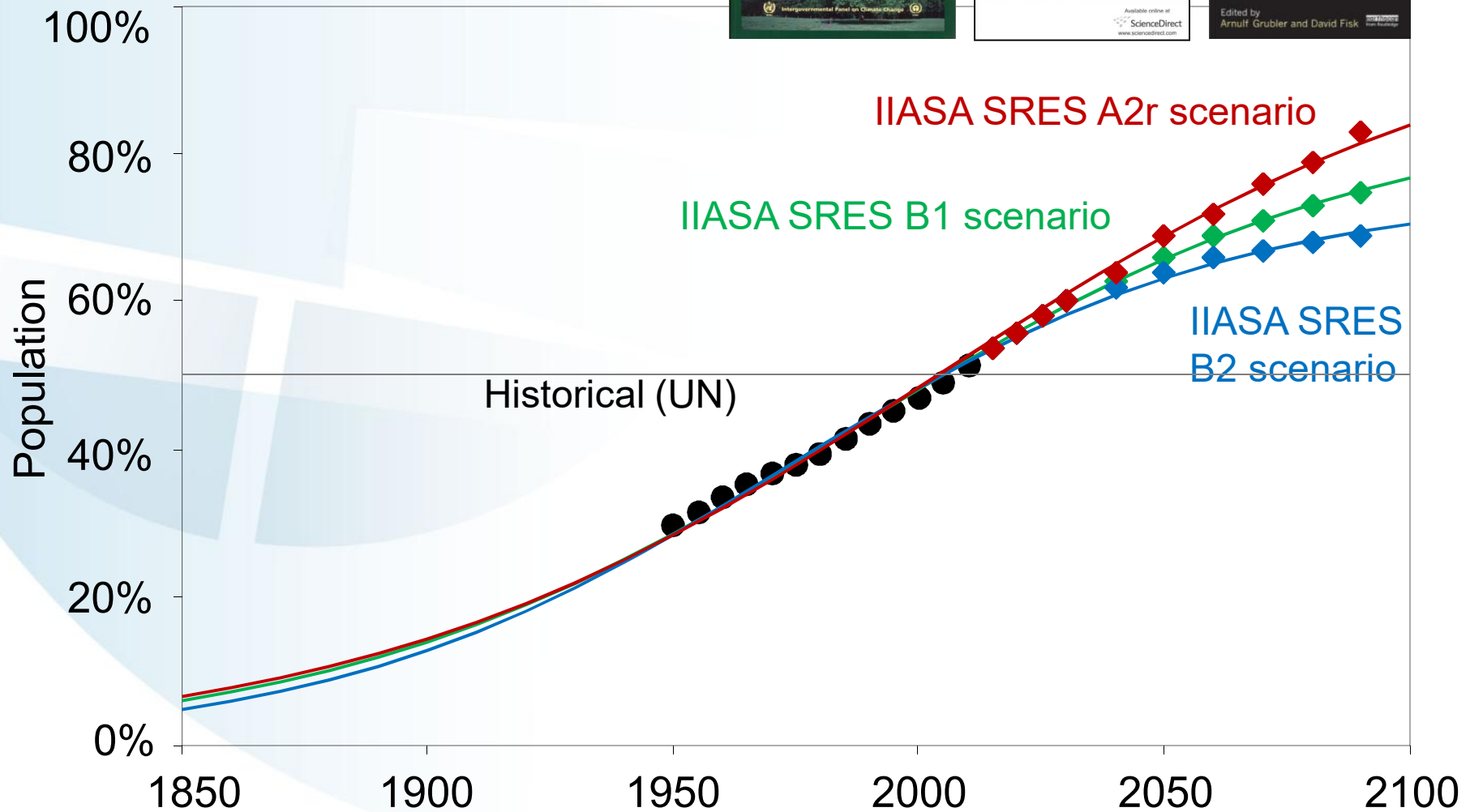
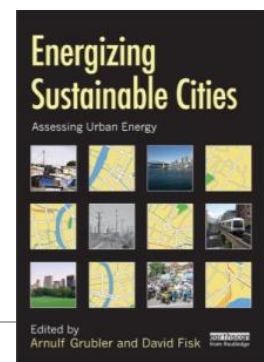
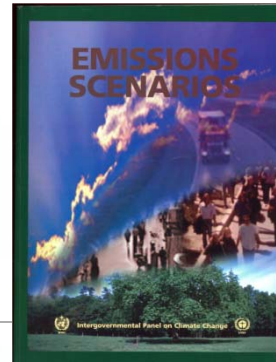


Source: Steffen et al. 2015

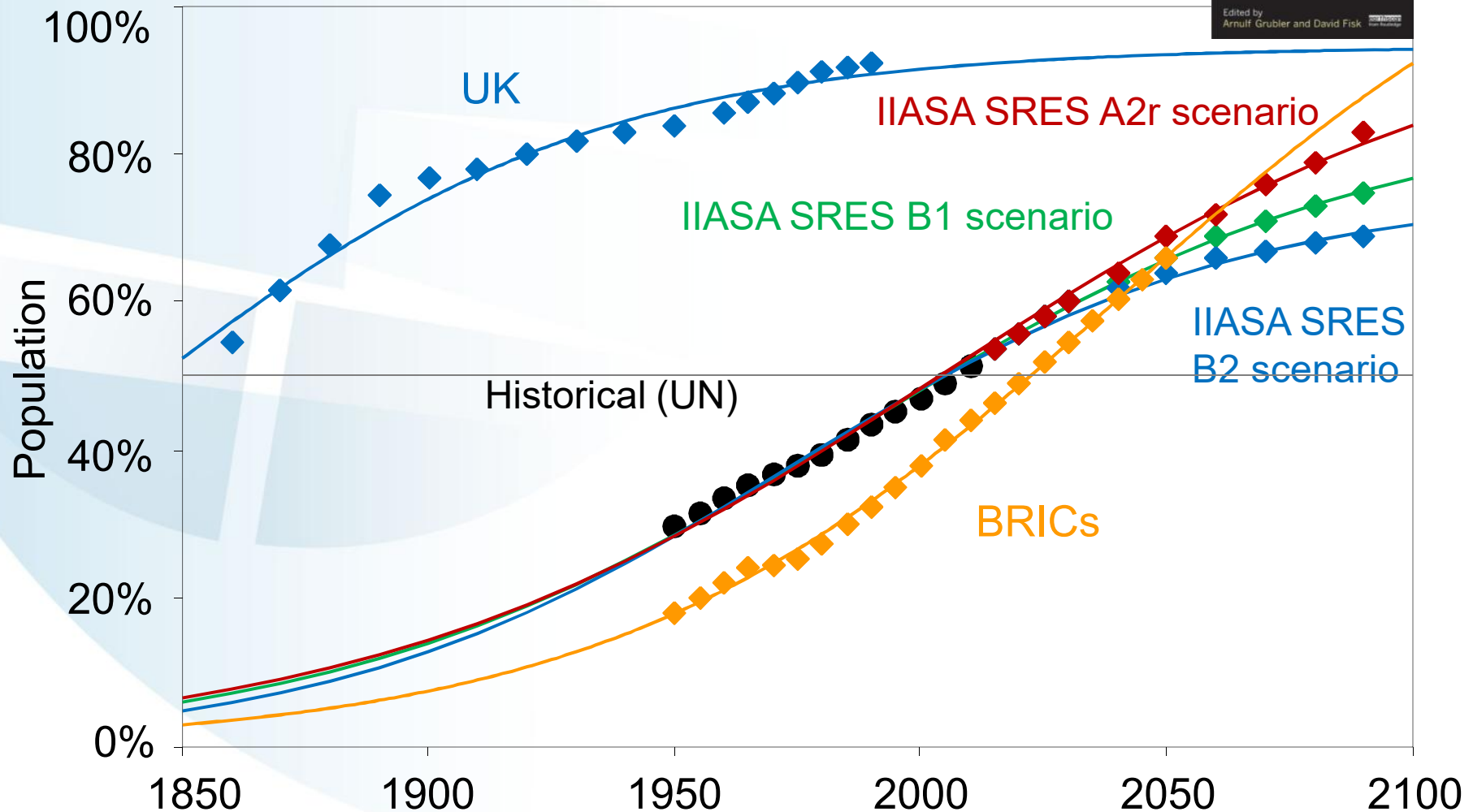
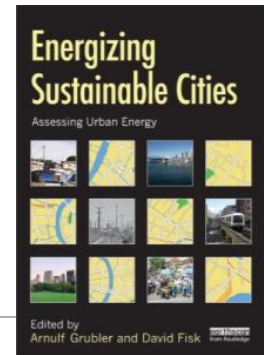
Possible Unified Analytical Approach



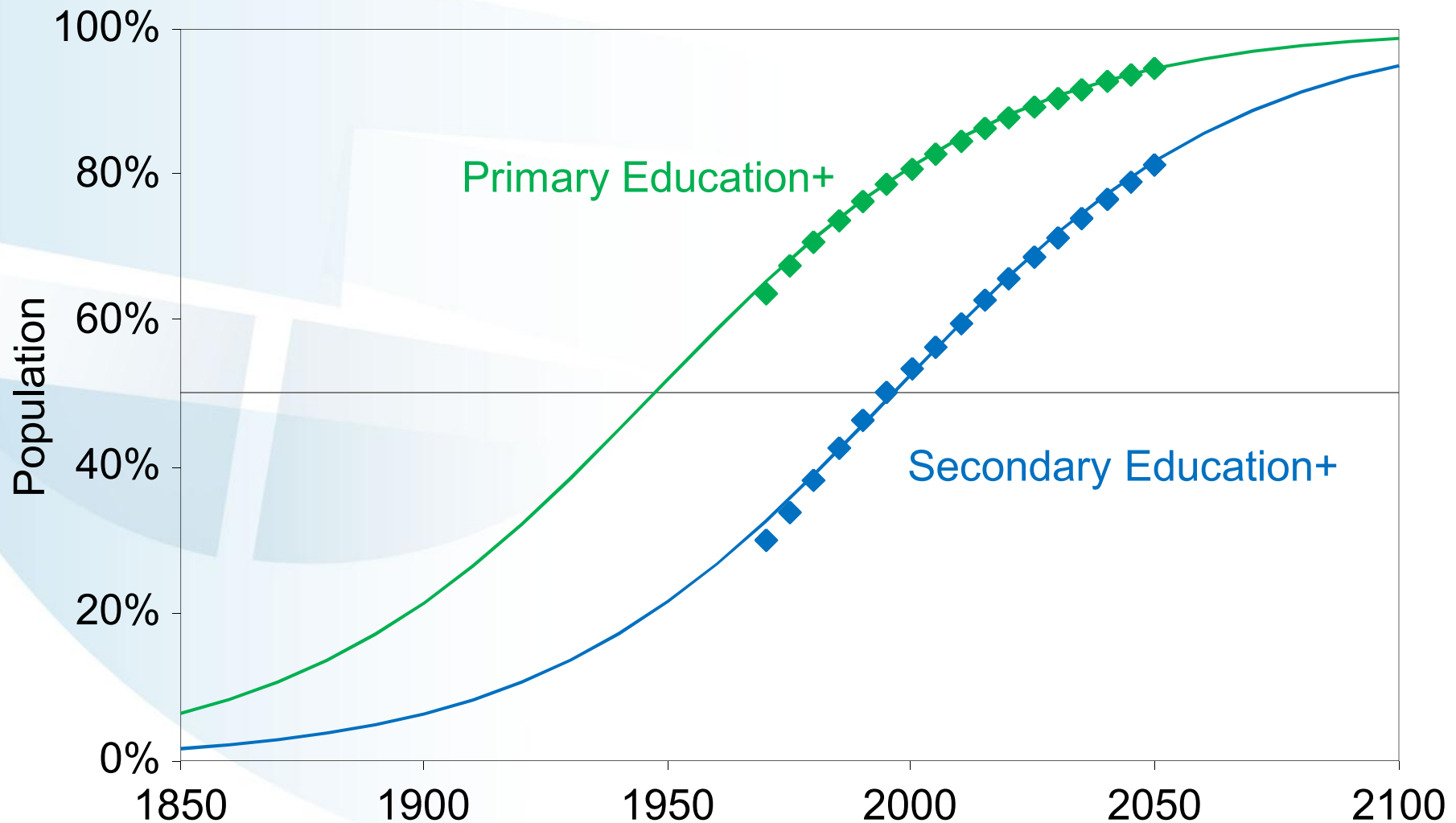
Urbanization World



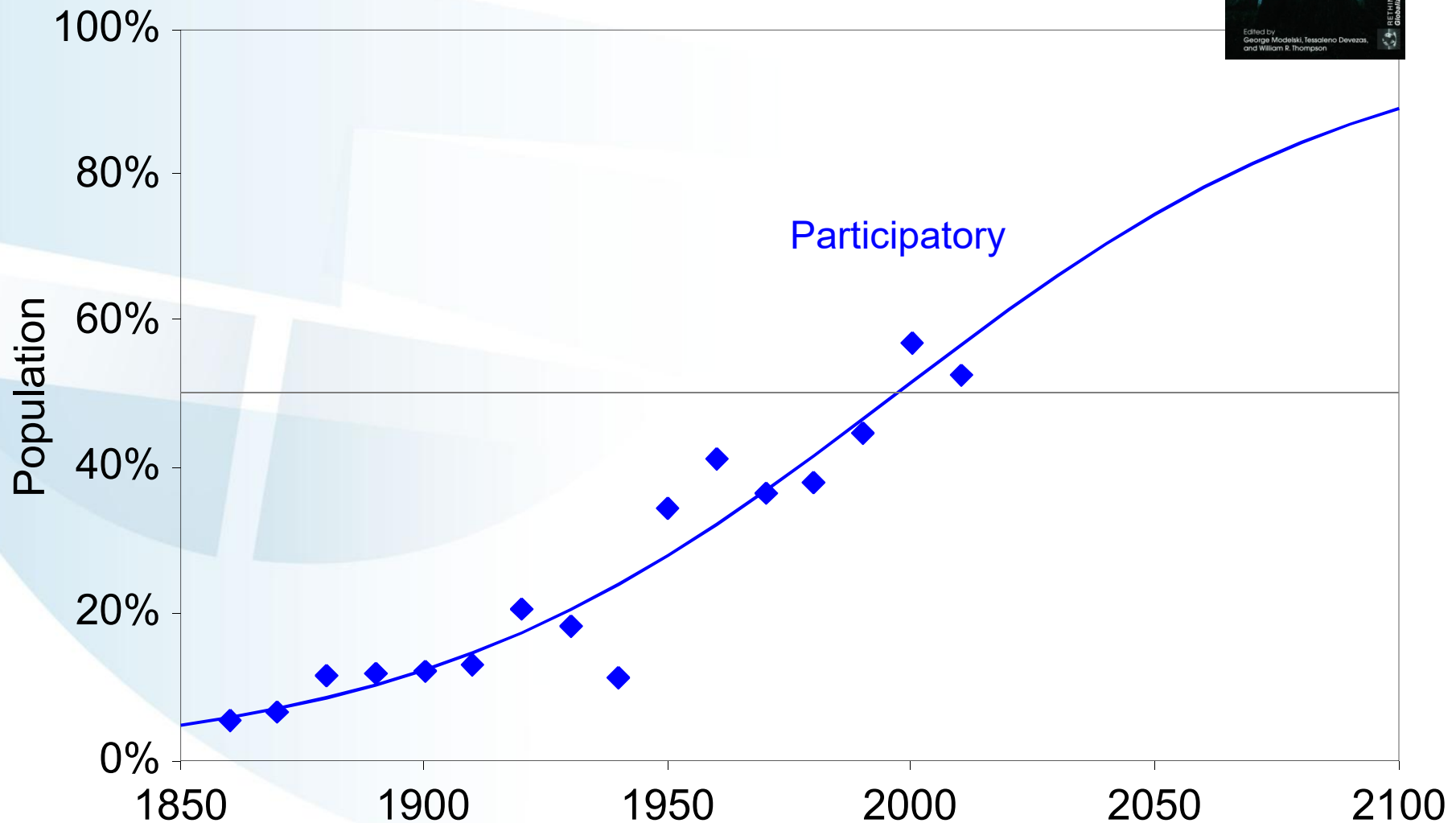
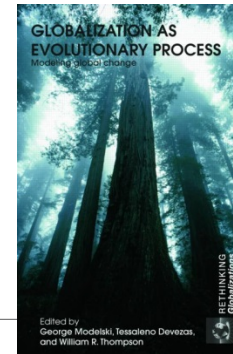
Urbanization World, UK, BRICs



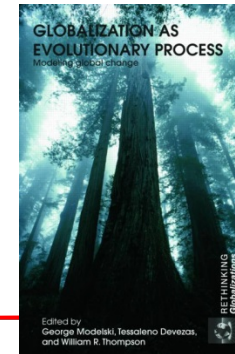
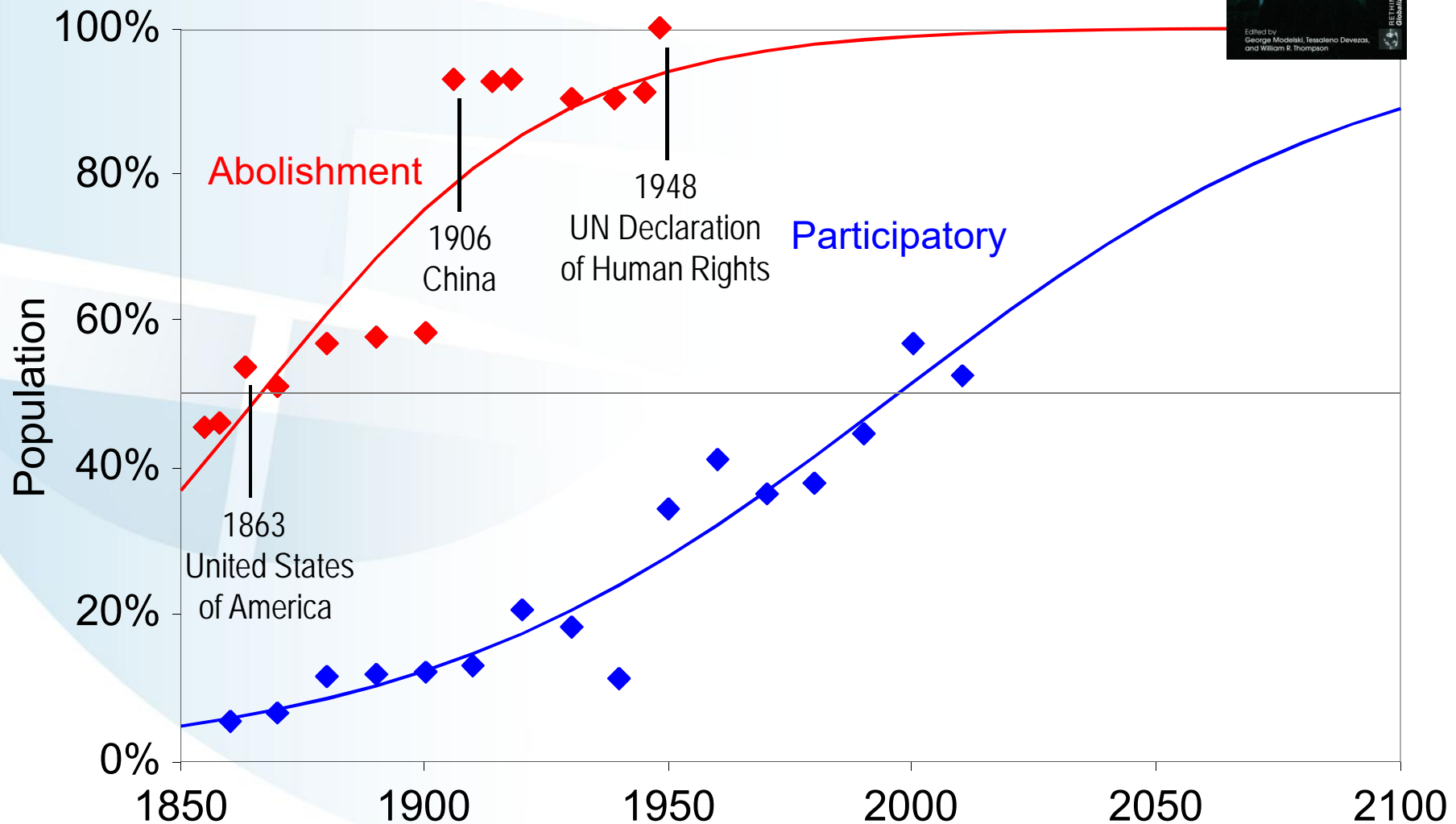
Global Educational Attainment



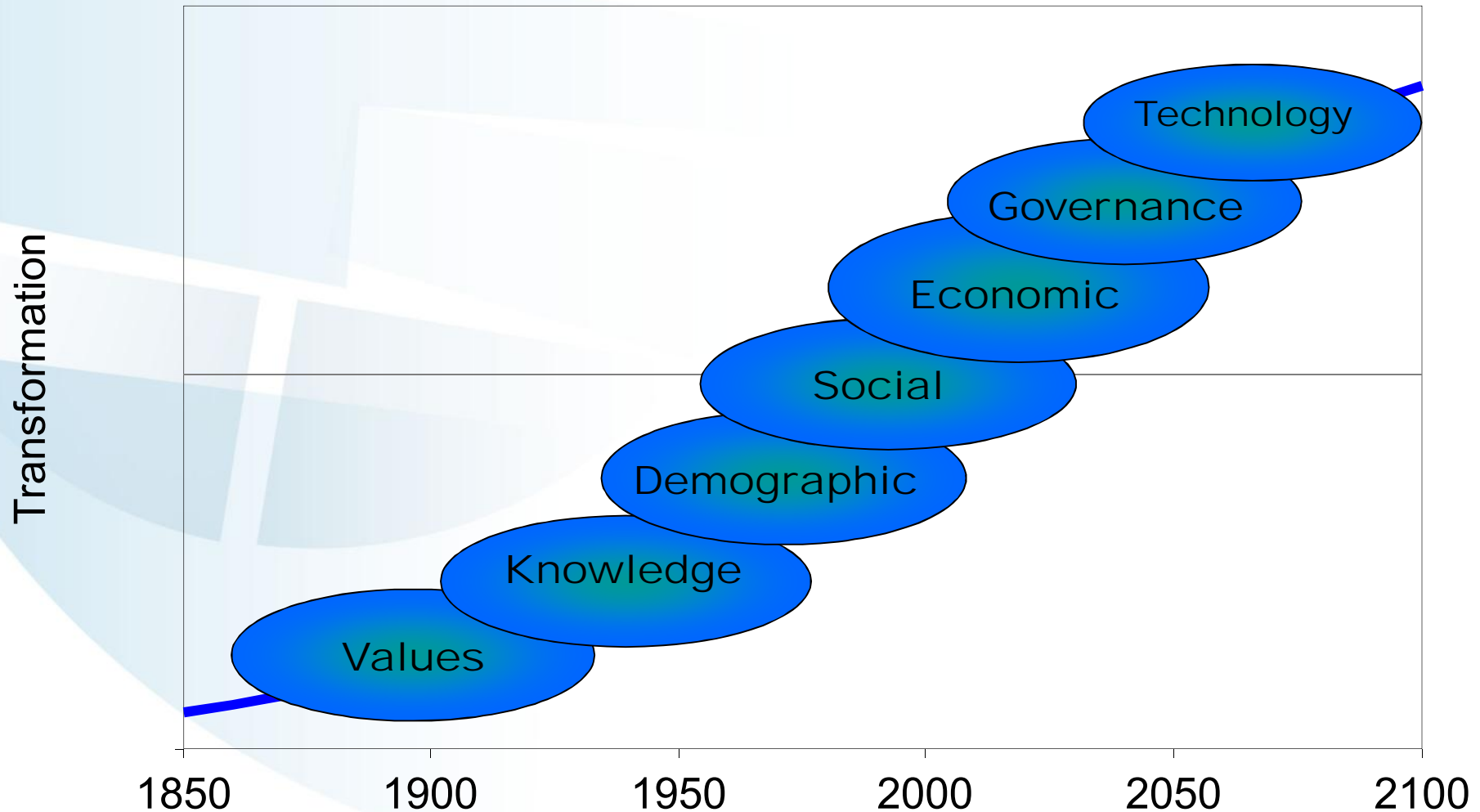
Participatory Governance



Participatory Governance Slavery Abolishment

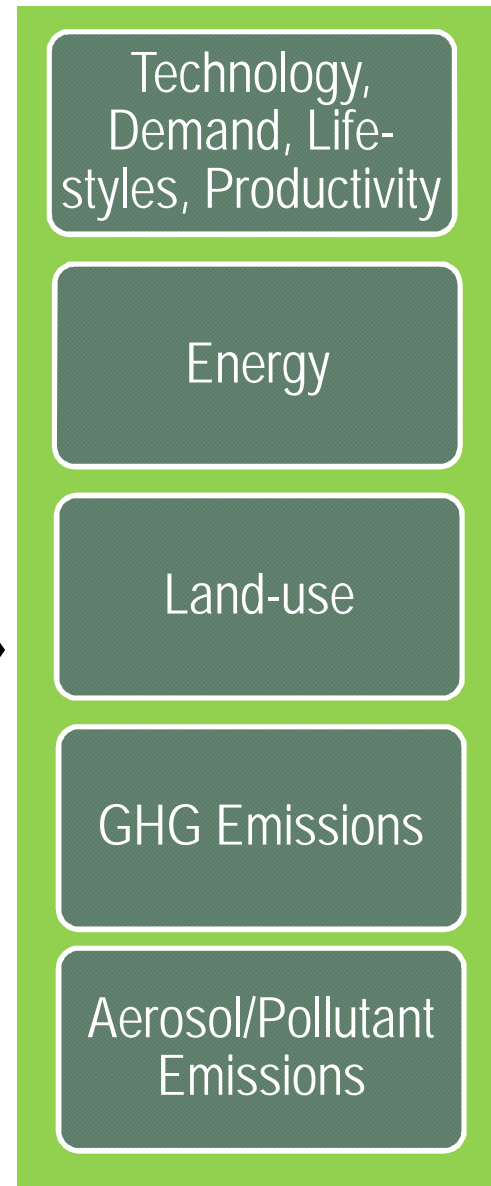
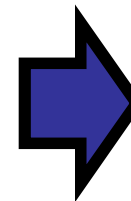
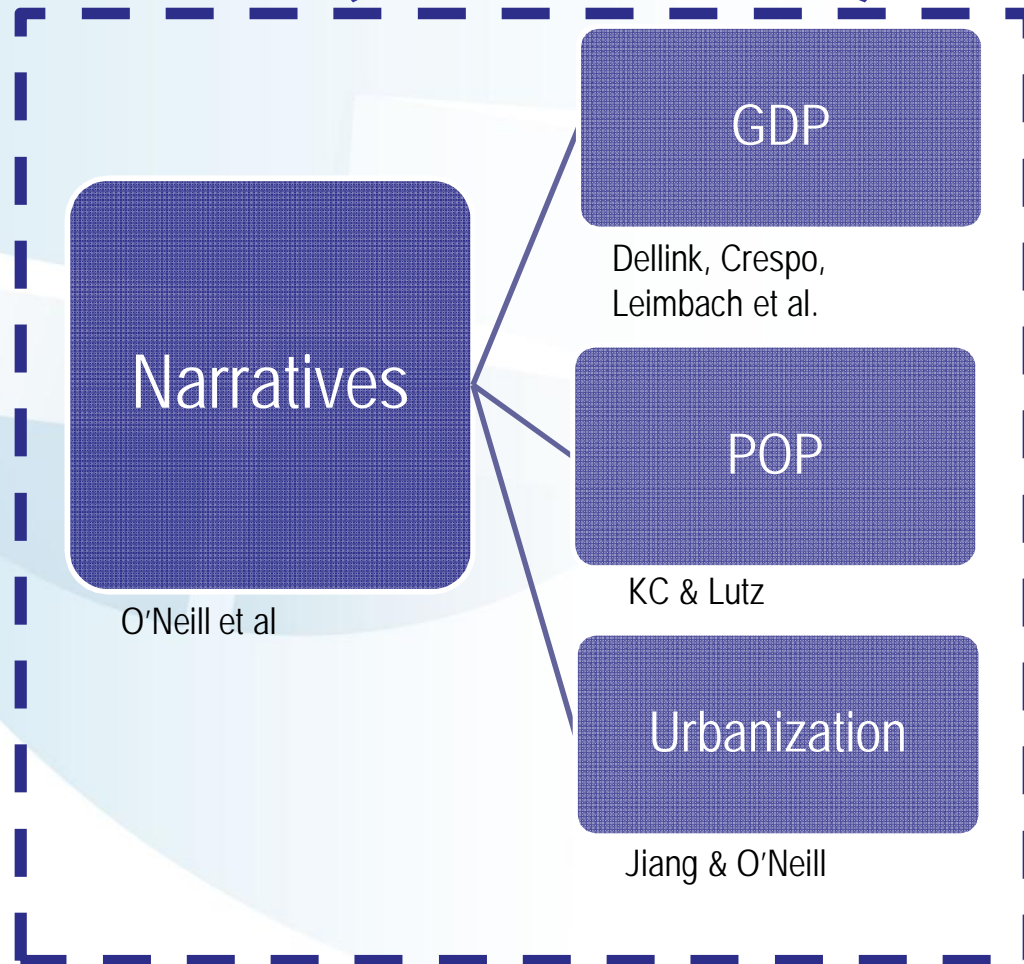


Dimensions of Transformation



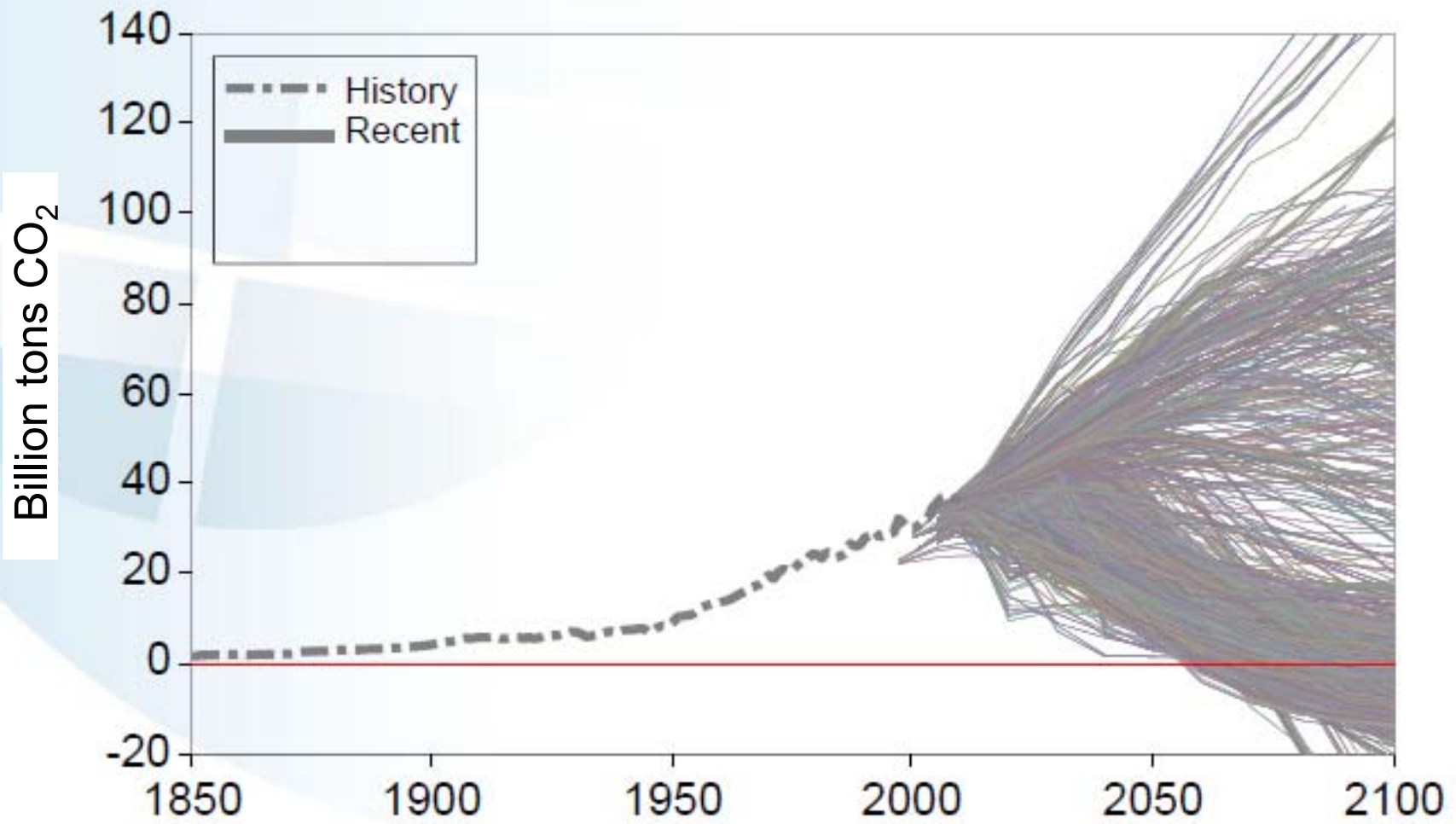
IAM Models, Narratives and Scenarios

SSPs (Basic Drivers)

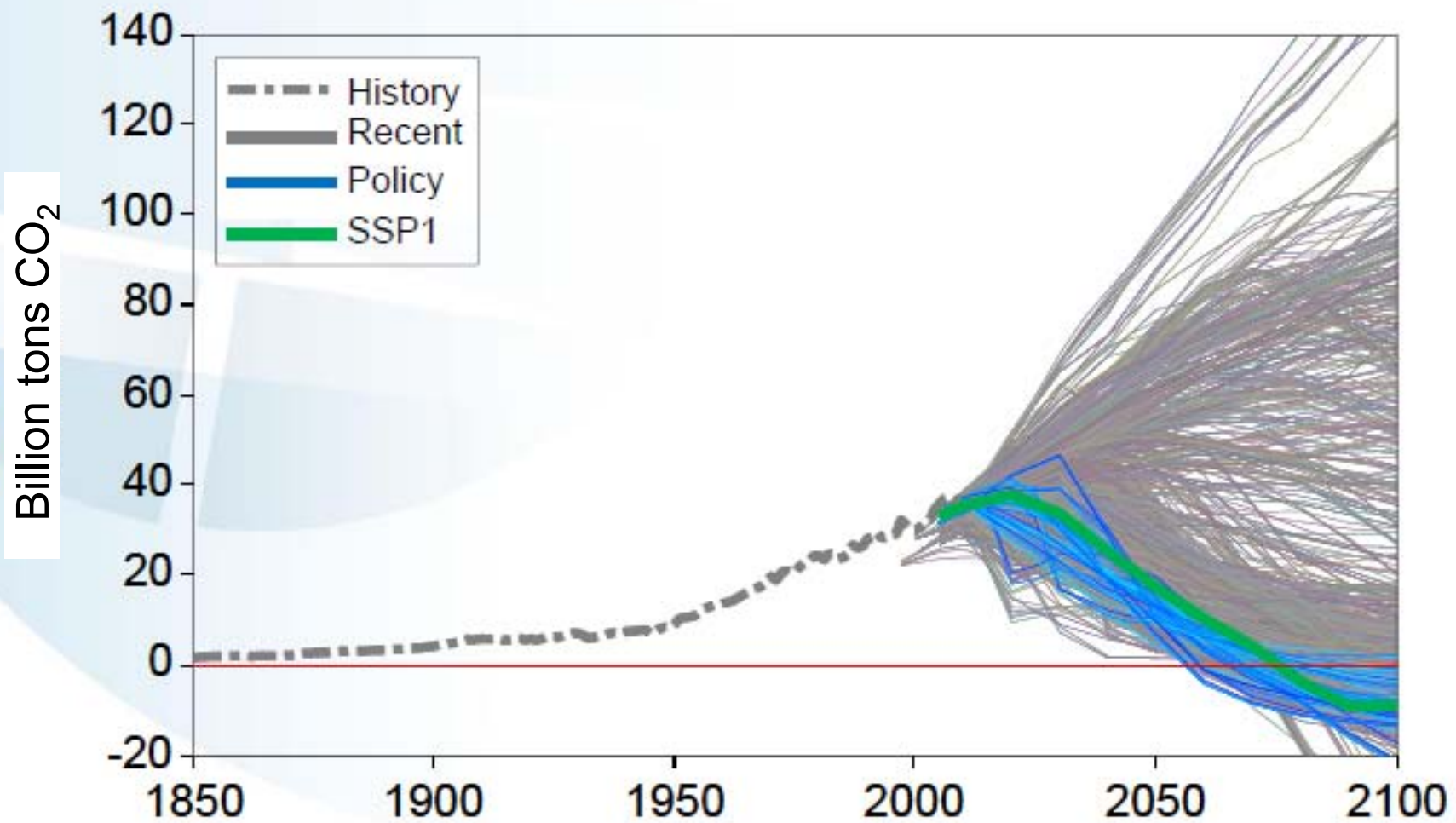


AIM/CGE, GCAM, IMAGE, MESSAGE-GLOBIOM, REMIND-MAGPIE, WITCH-GLOBIOM

Global Emissions CO₂

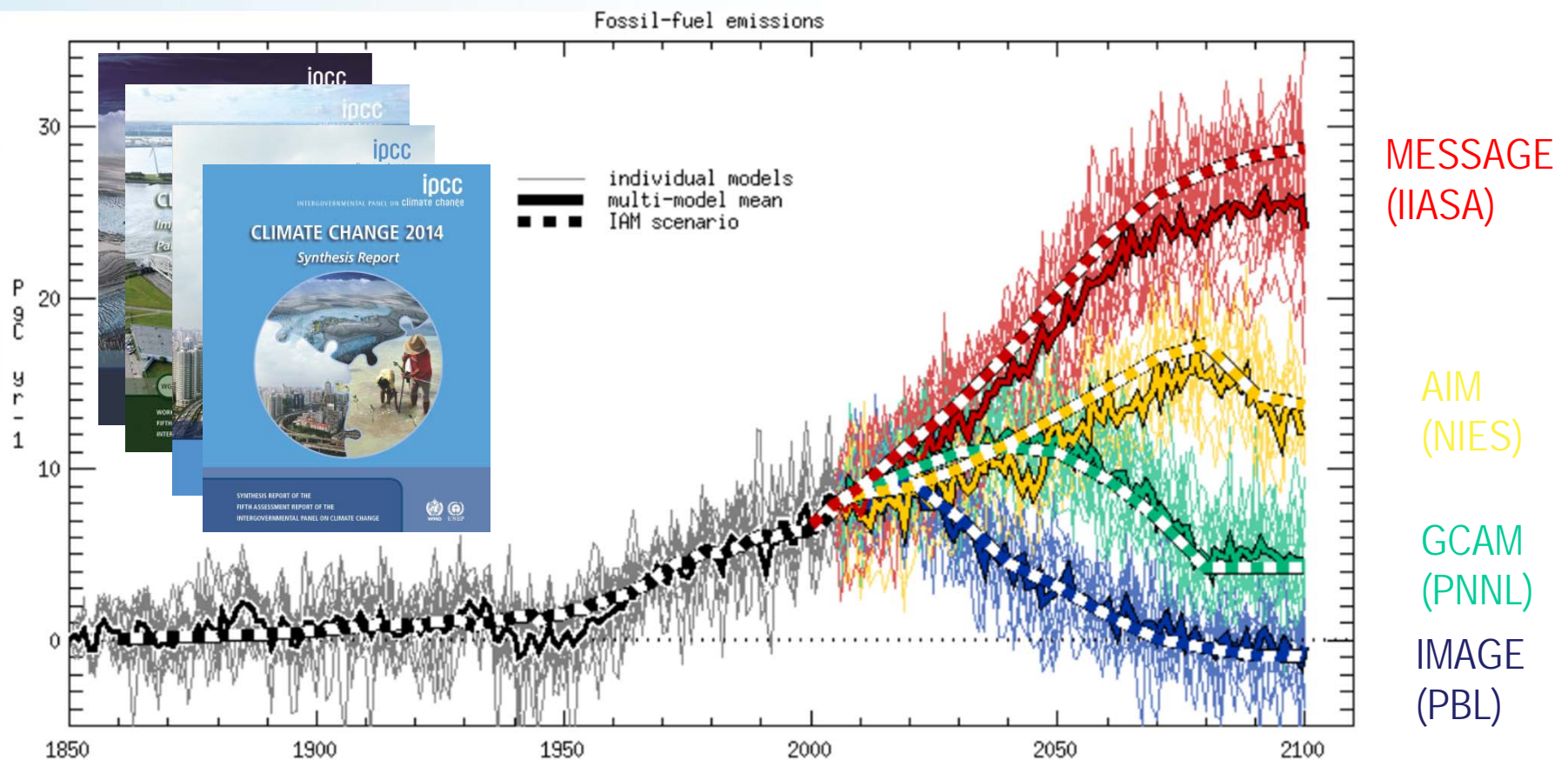


Global Emissions CO₂

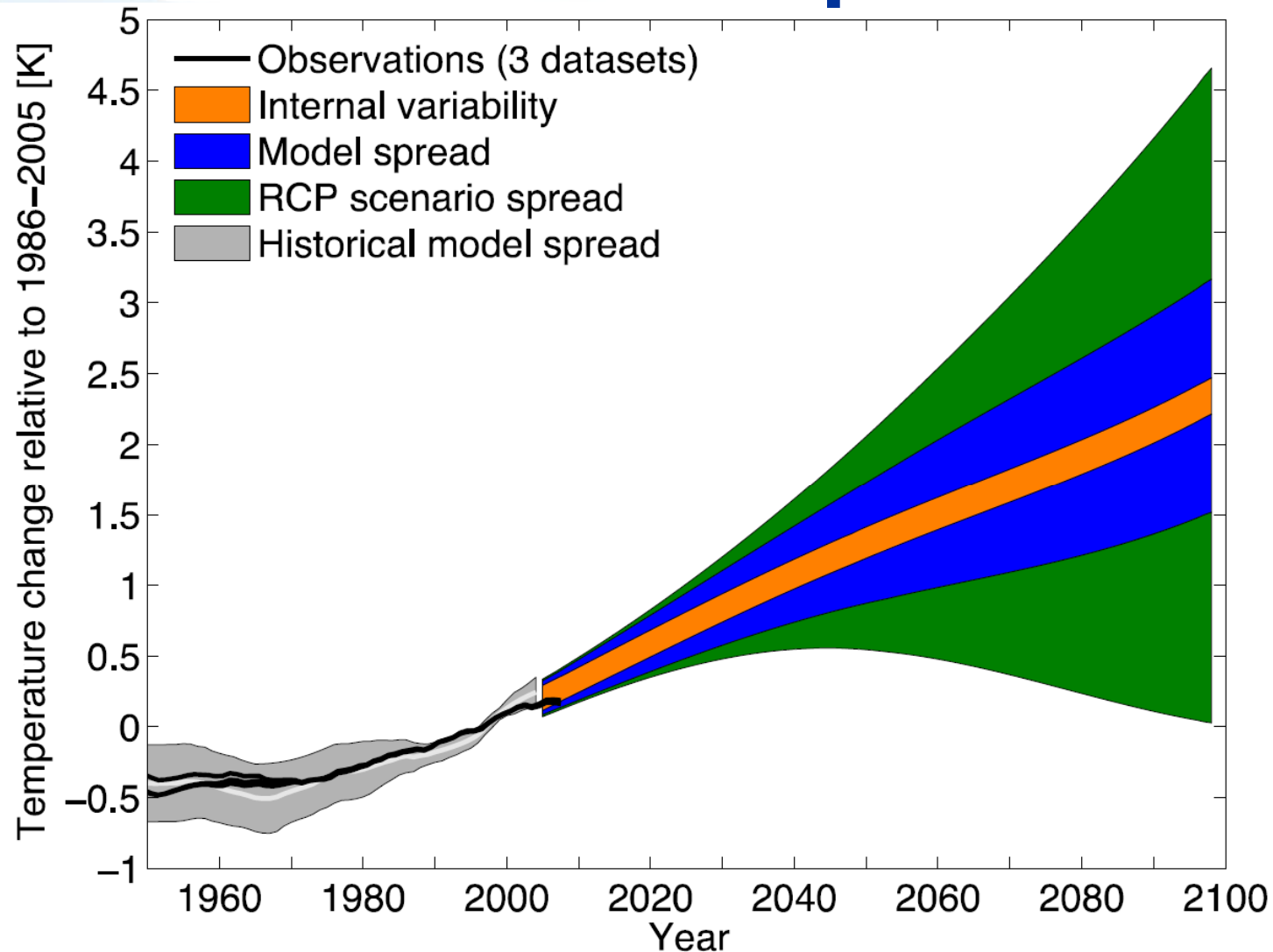


IPCC – RCPs – SSPs

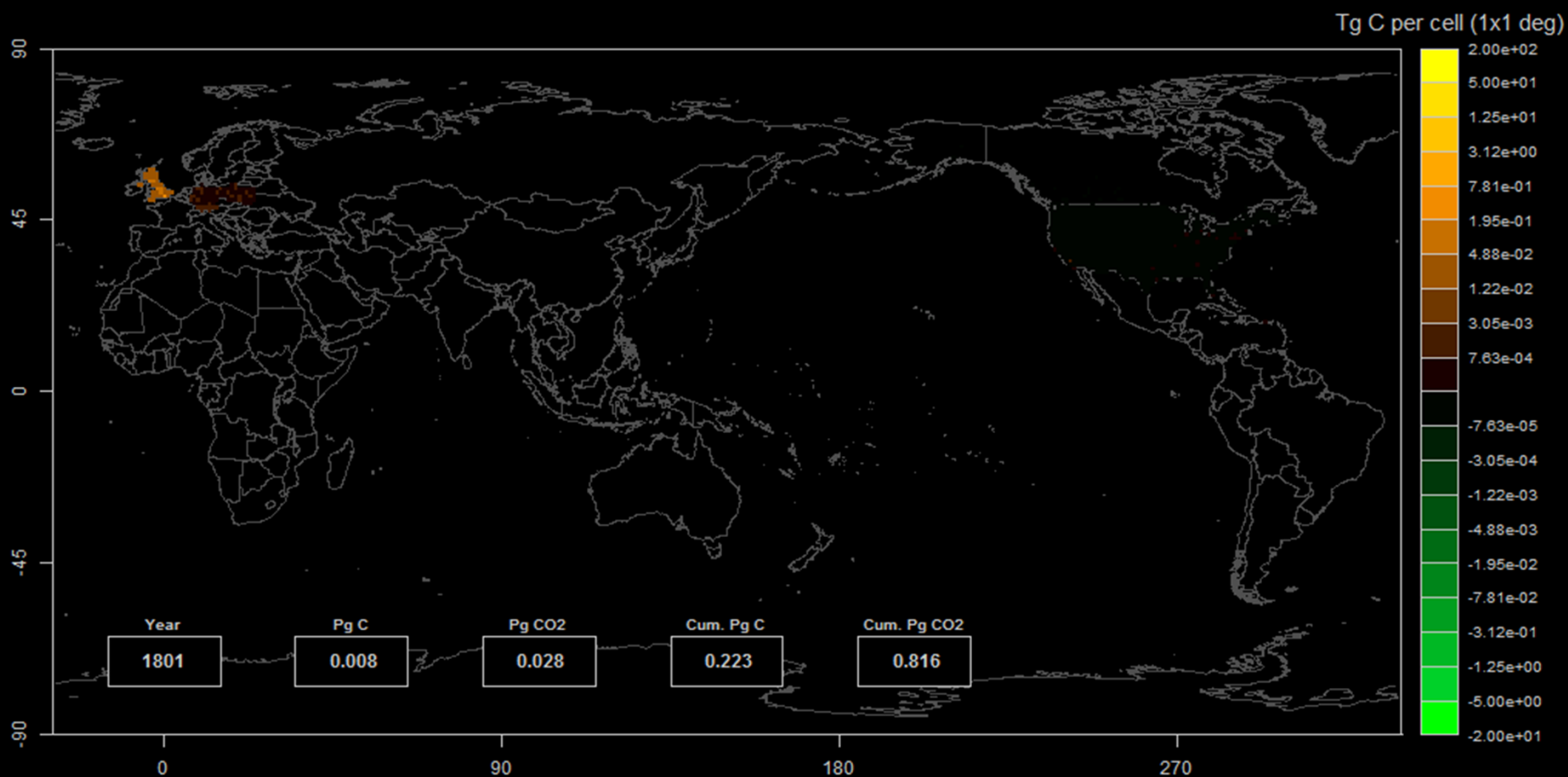
New community scenarios for climate mitigation, adaptation, vulnerability and impacts assessments



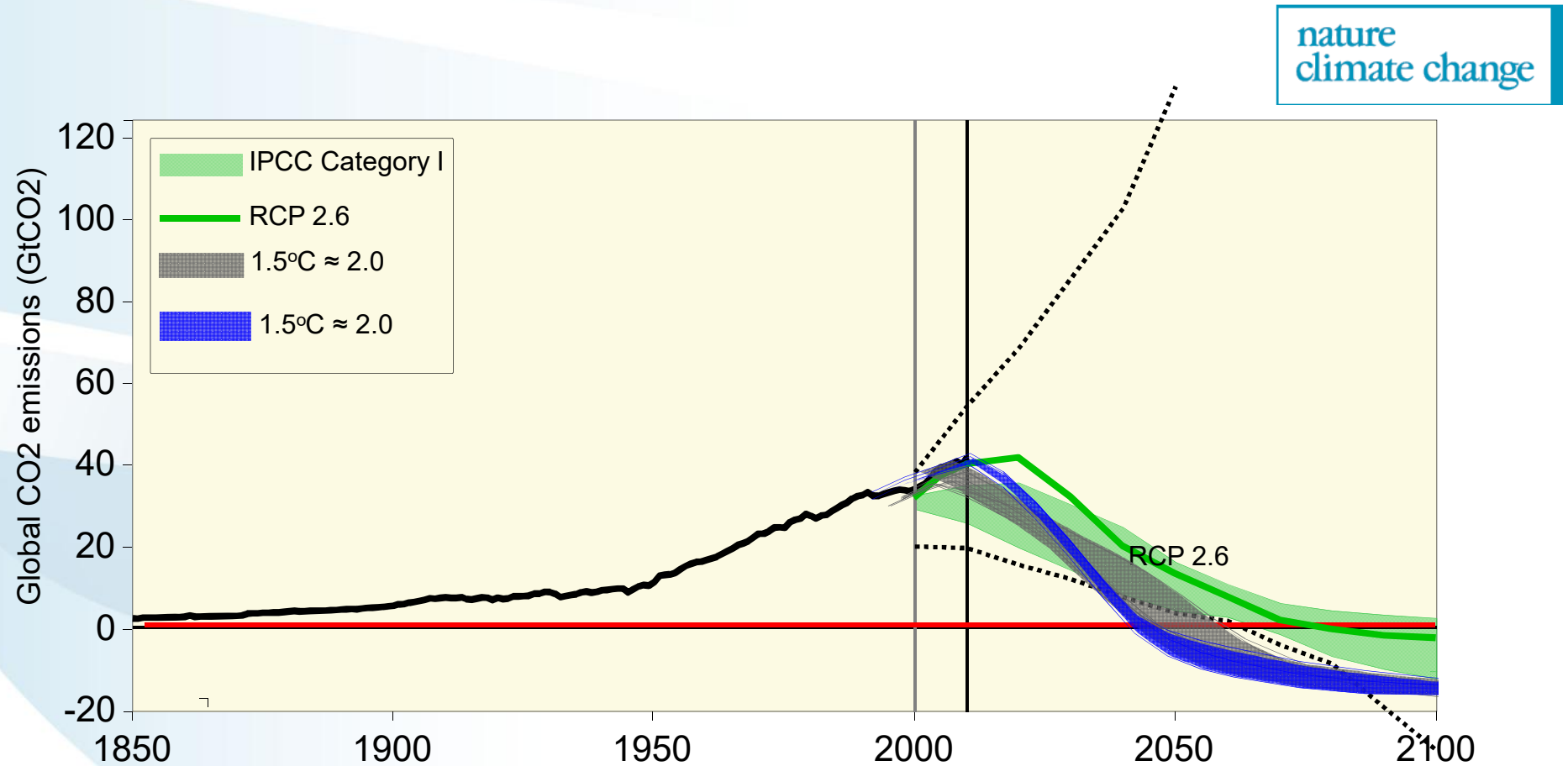
Sources of Uncertainty in Future Global Mean Temperature



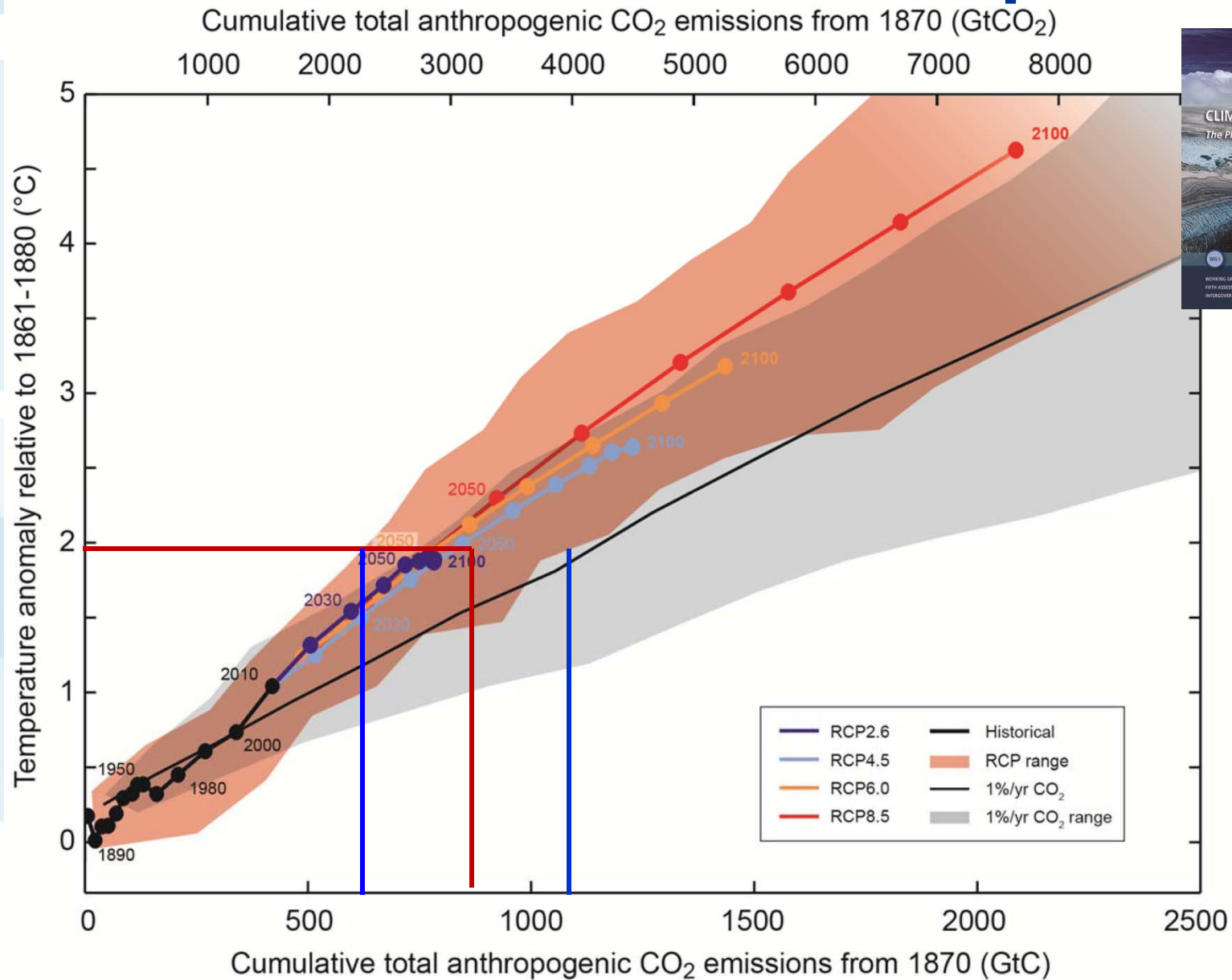
Global CO₂ Emissions



Global CO2 Emissions

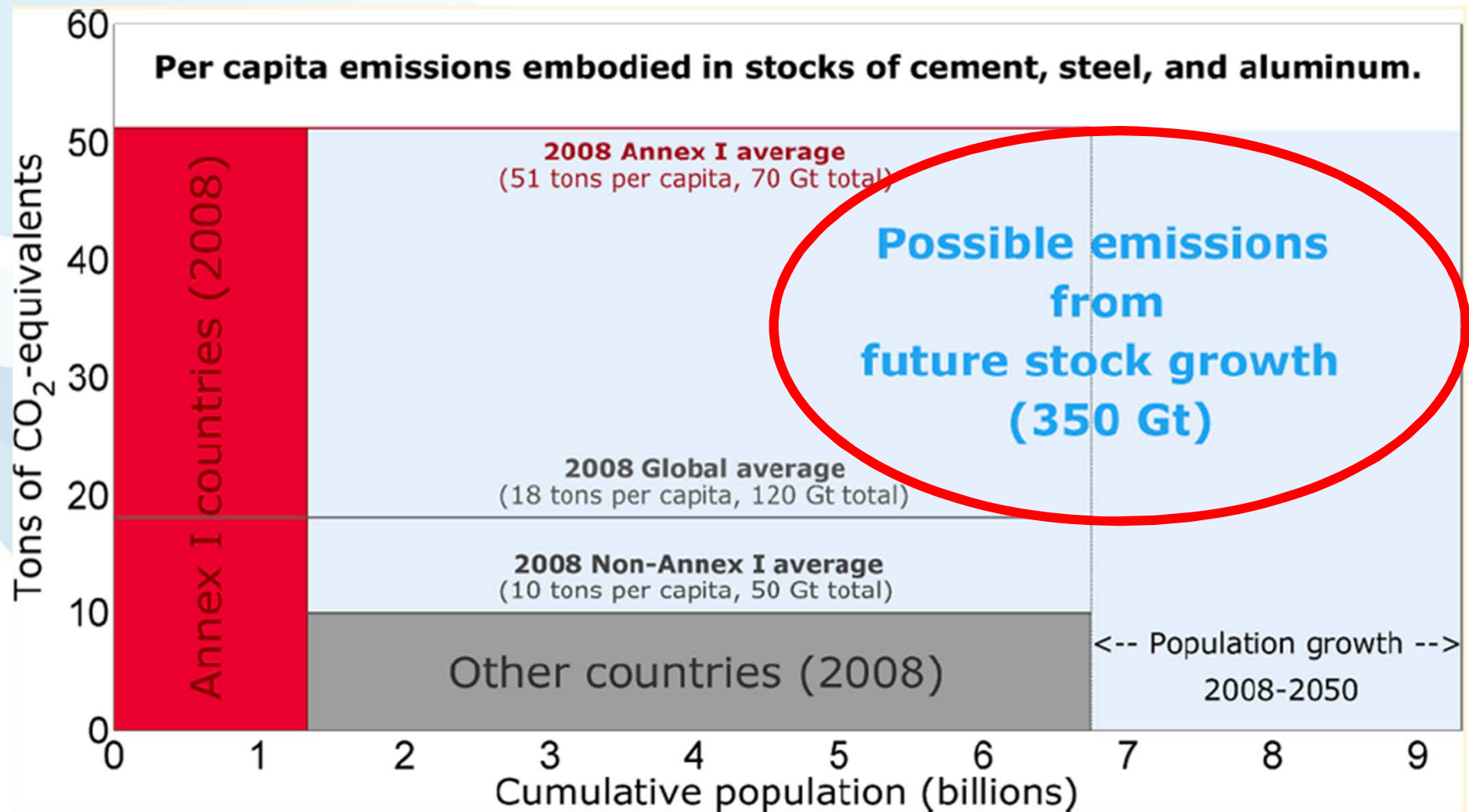


Cumulative Emissions & Temperature



Urban Embodied Emissions

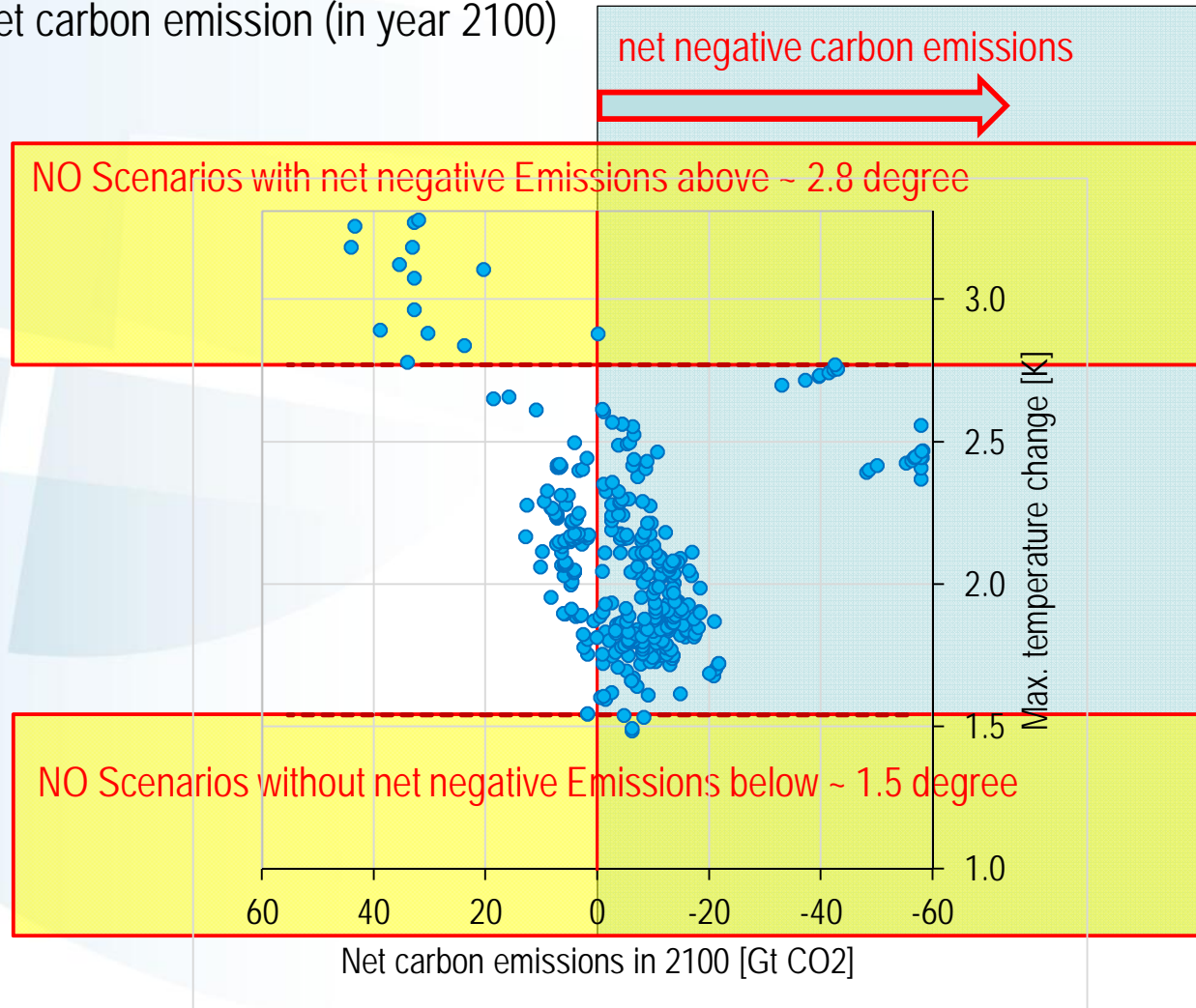
Compared to Global Budget of 800 GtCO₂ for 2°C



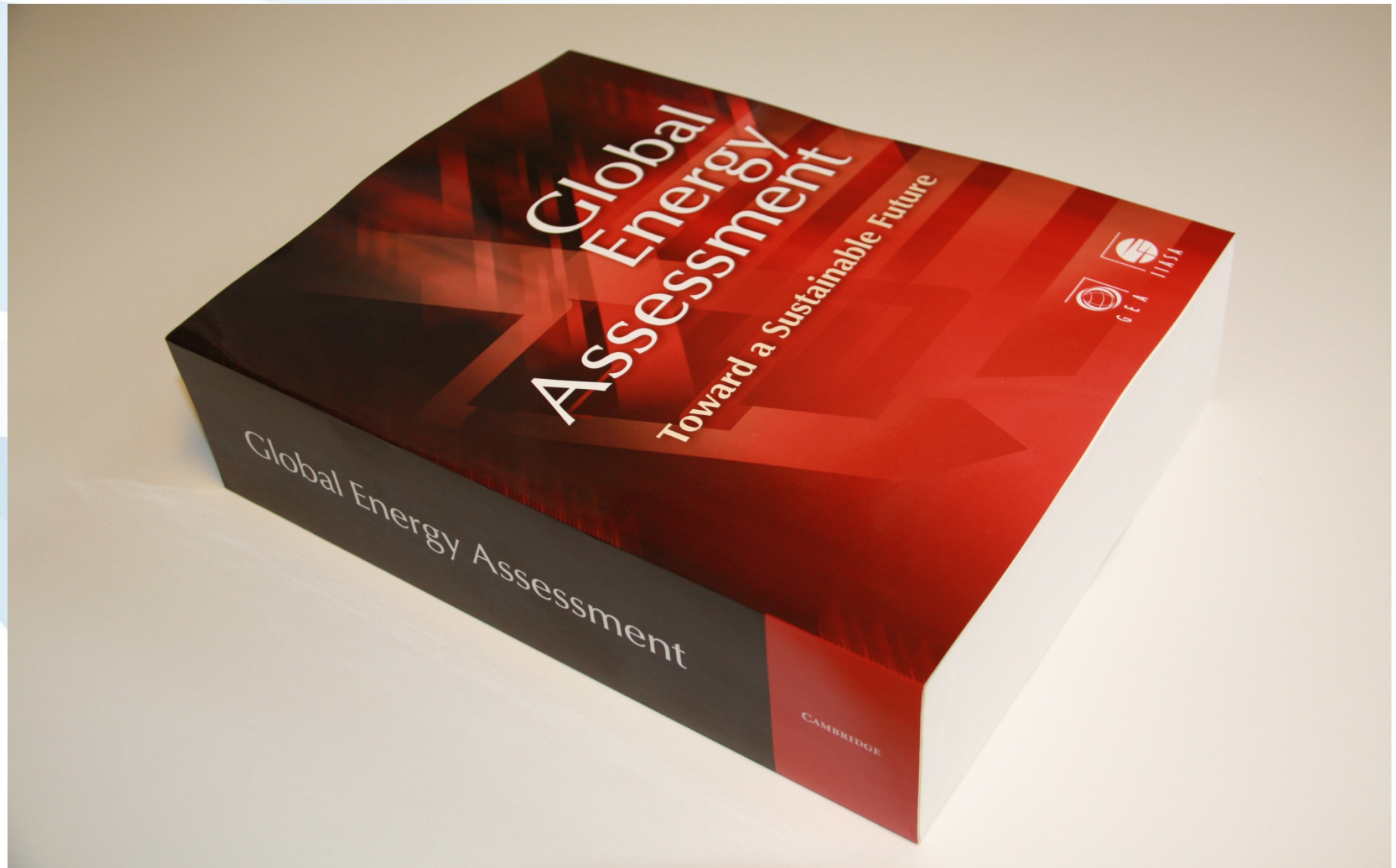
Net-negative CO₂ Emissions

Max. temperature change in 21th century

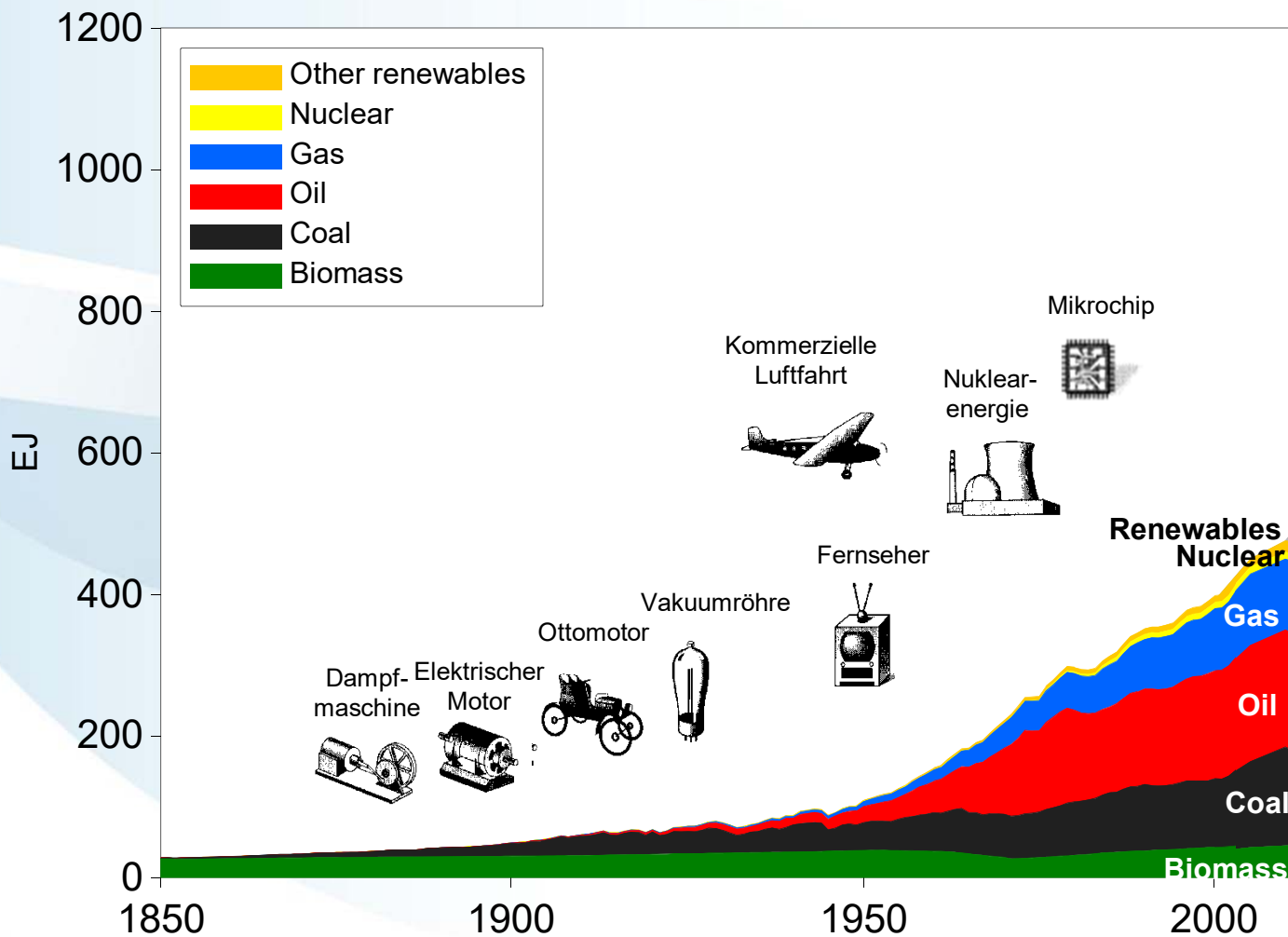
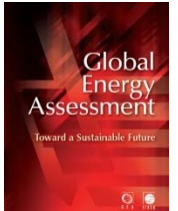
Net carbon emission (in year 2100)



www.GlobalEnergyAssessment.org

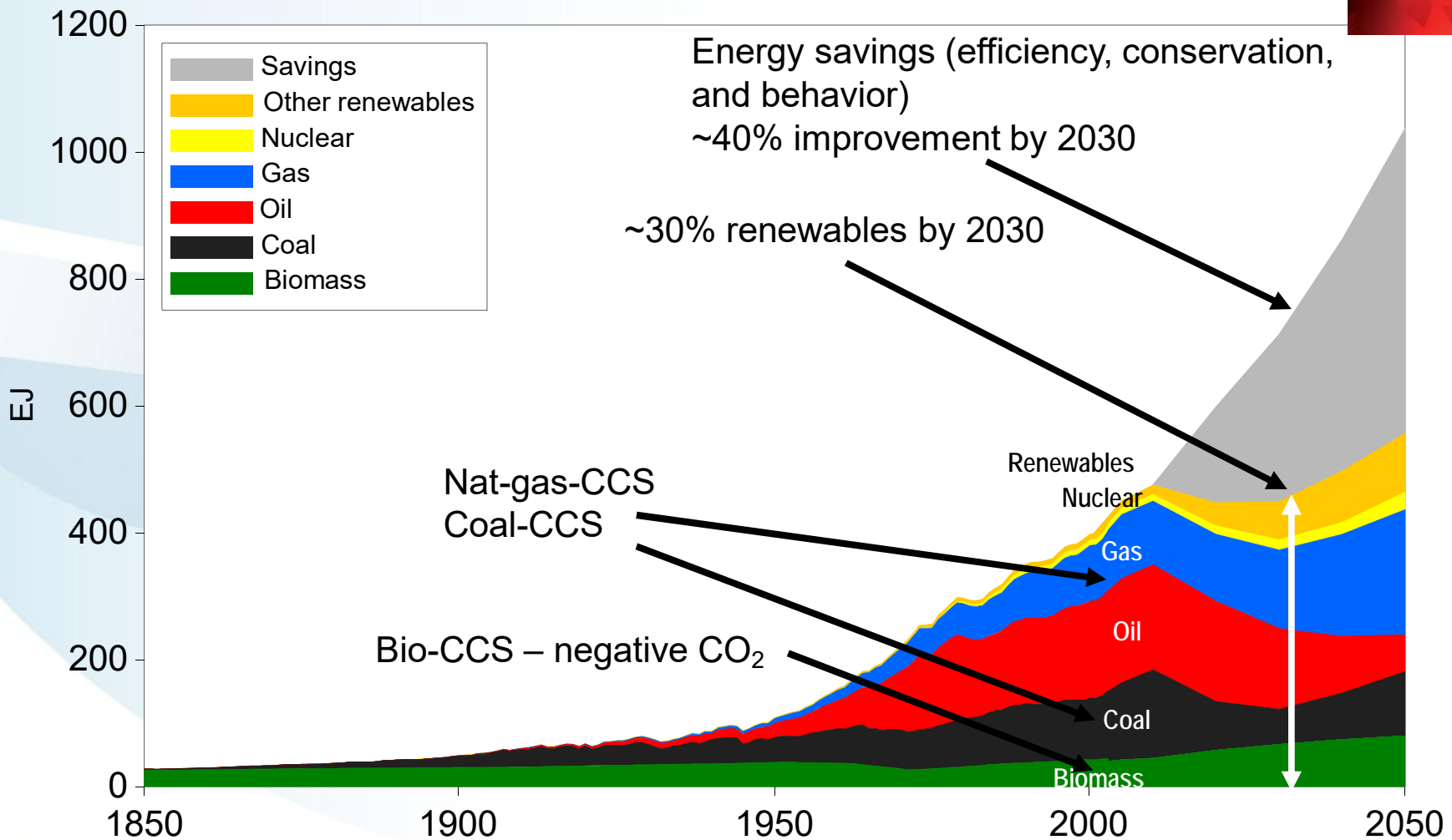
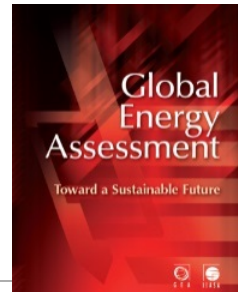


Global Primary Energy Historical Evolution



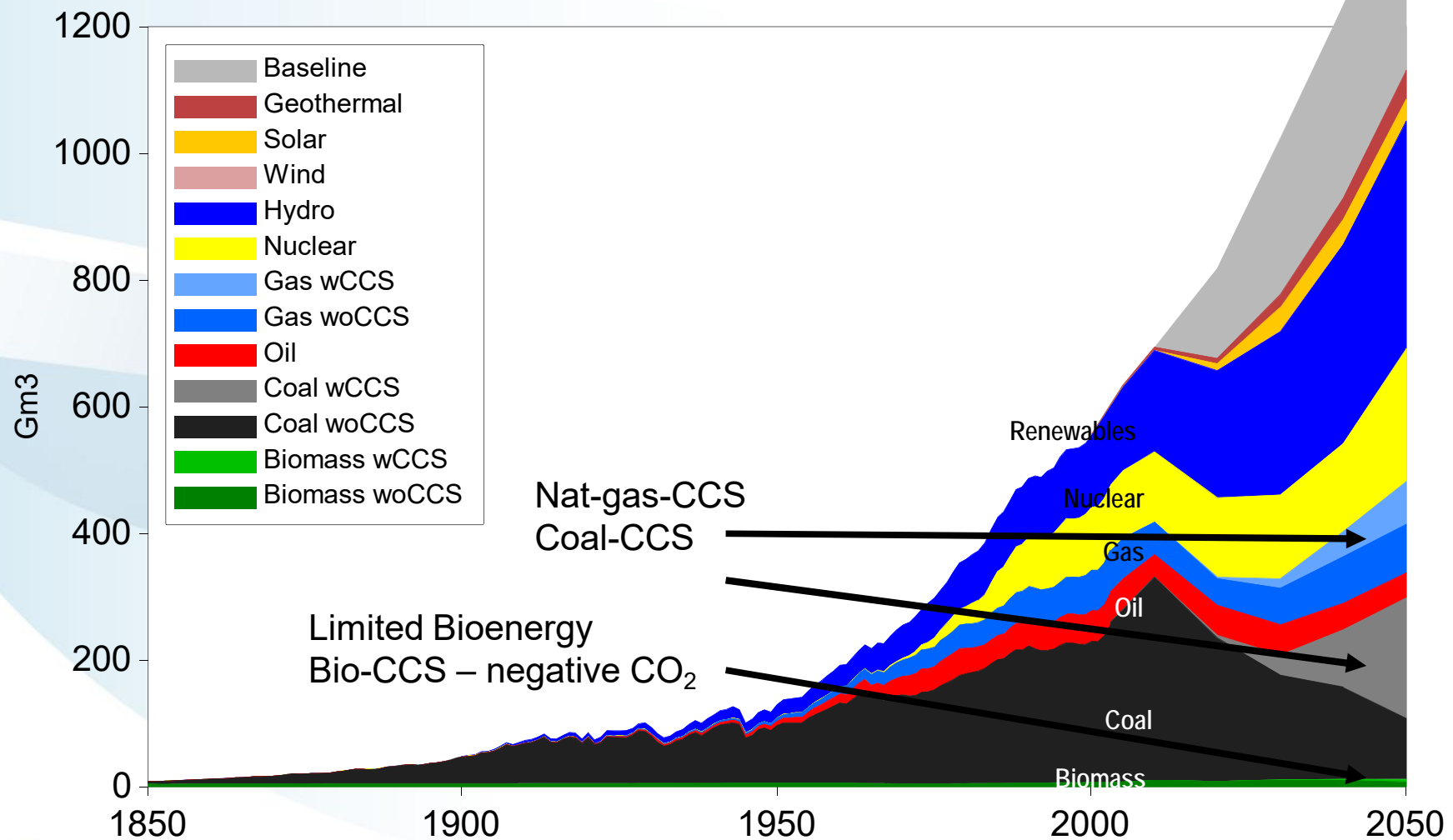
Global Primary Energy

A Transformational Pathway

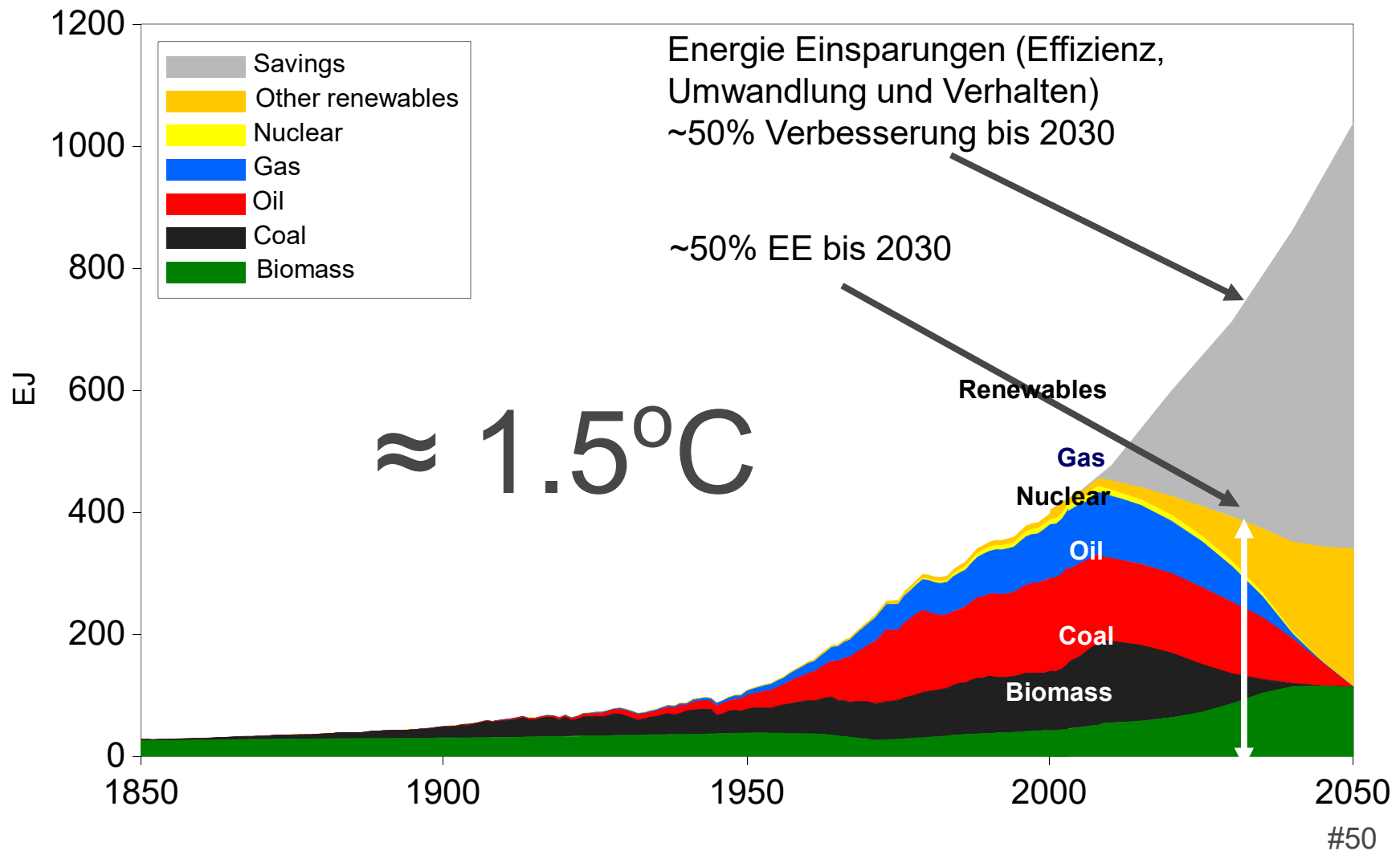


Global Water Withdrawals

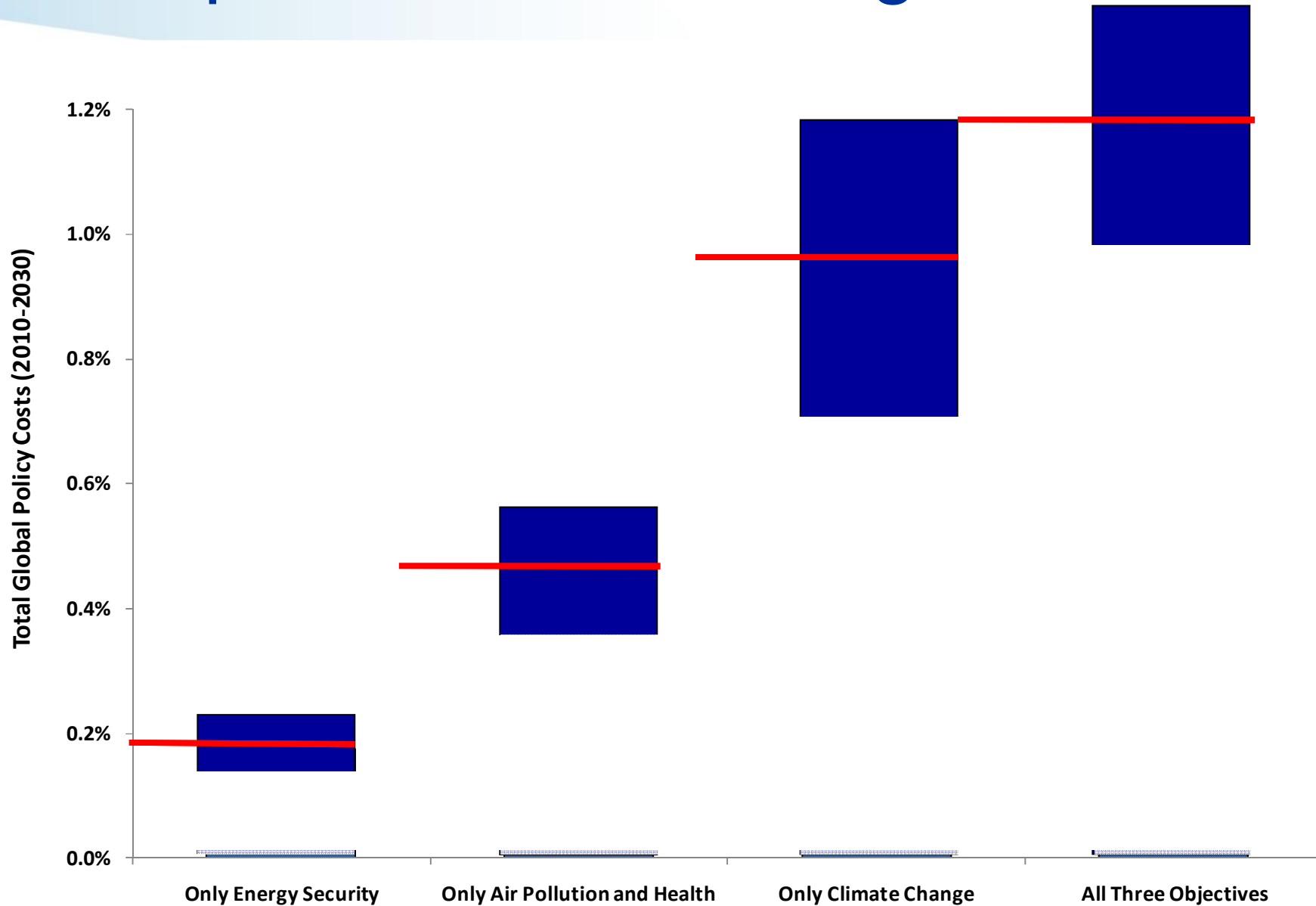
A Transformational Pathway

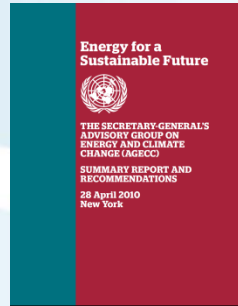
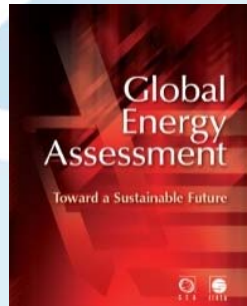


Global Primärenergie WBGU



Multiple Benefits of Integrated Policies





SUSTAINABLE ENERGY
FOR ALL



2030 GEA Goals and Targets

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

Aspirational & Ambitious but Achievable

SUSTAINABLE DEVELOPMENT GOALS



Interplay and the SDGs

- **Fundamentally, there are two agendas embedded in the SDGs**
 - We can call them (i) the human security agenda and (ii) the planetary boundaries agenda
- **The challenge is to make these agendas synergistic rather than competitive**
 - Consider the case of Africa and the issues of demographic trends and food security under the impacts of climate change



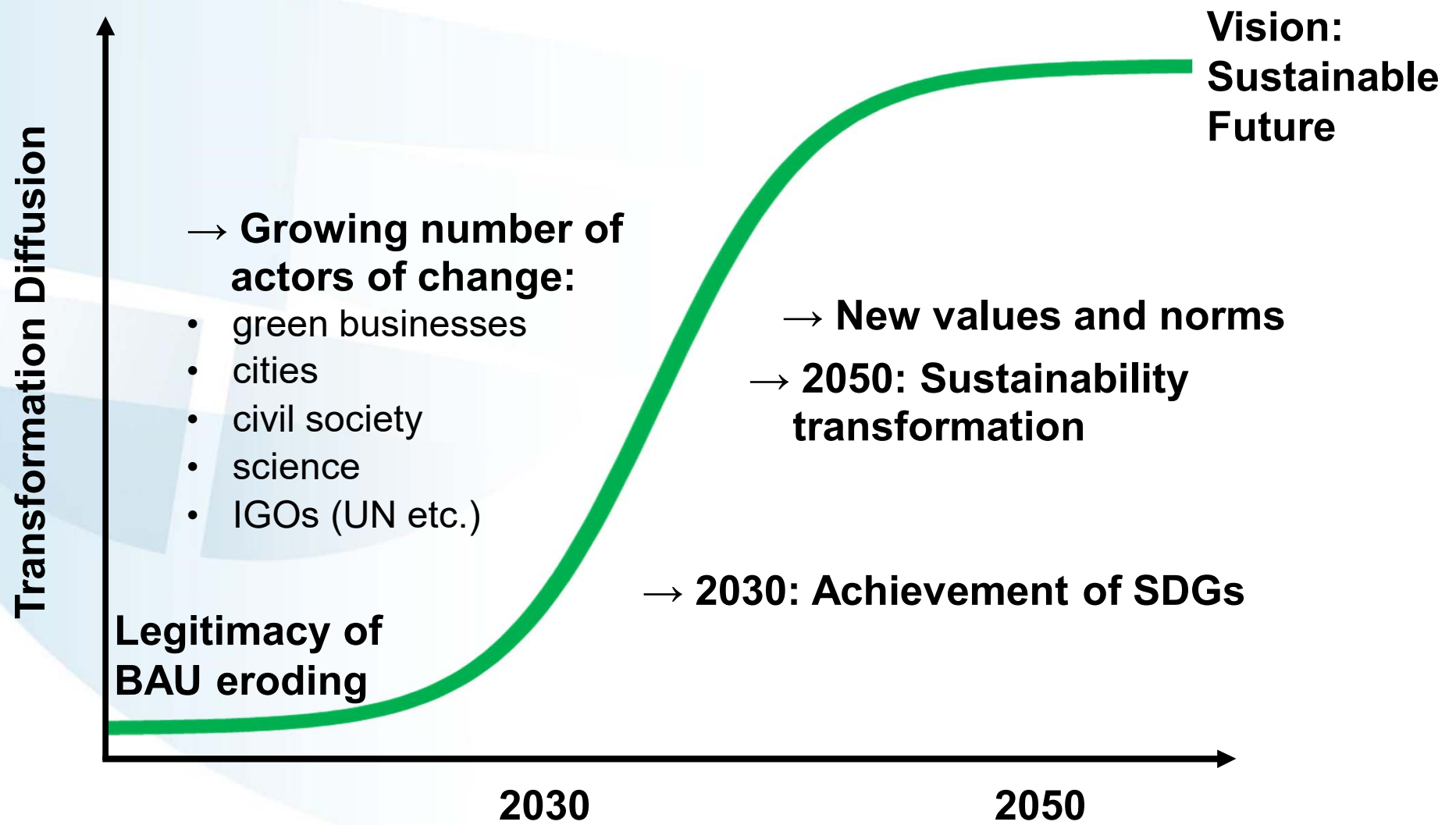
Oran Young, Program on Governance for Sustainable Development
Bren School, UCSB <http://www.gsdprogram.org>

The World in 2050 (TWI2050.com)

- ➡ SDGs and their targets basis for the 2030 target space to be achieved from base-year
- ➡ Second target space is 2050 and beyond for achieving sustainability for all and the planet
- ➡ Backcasting storylines join target spaces in broad terms through transformational change
- ➡ Model results and storyline interpretations result in sustainable development pathways

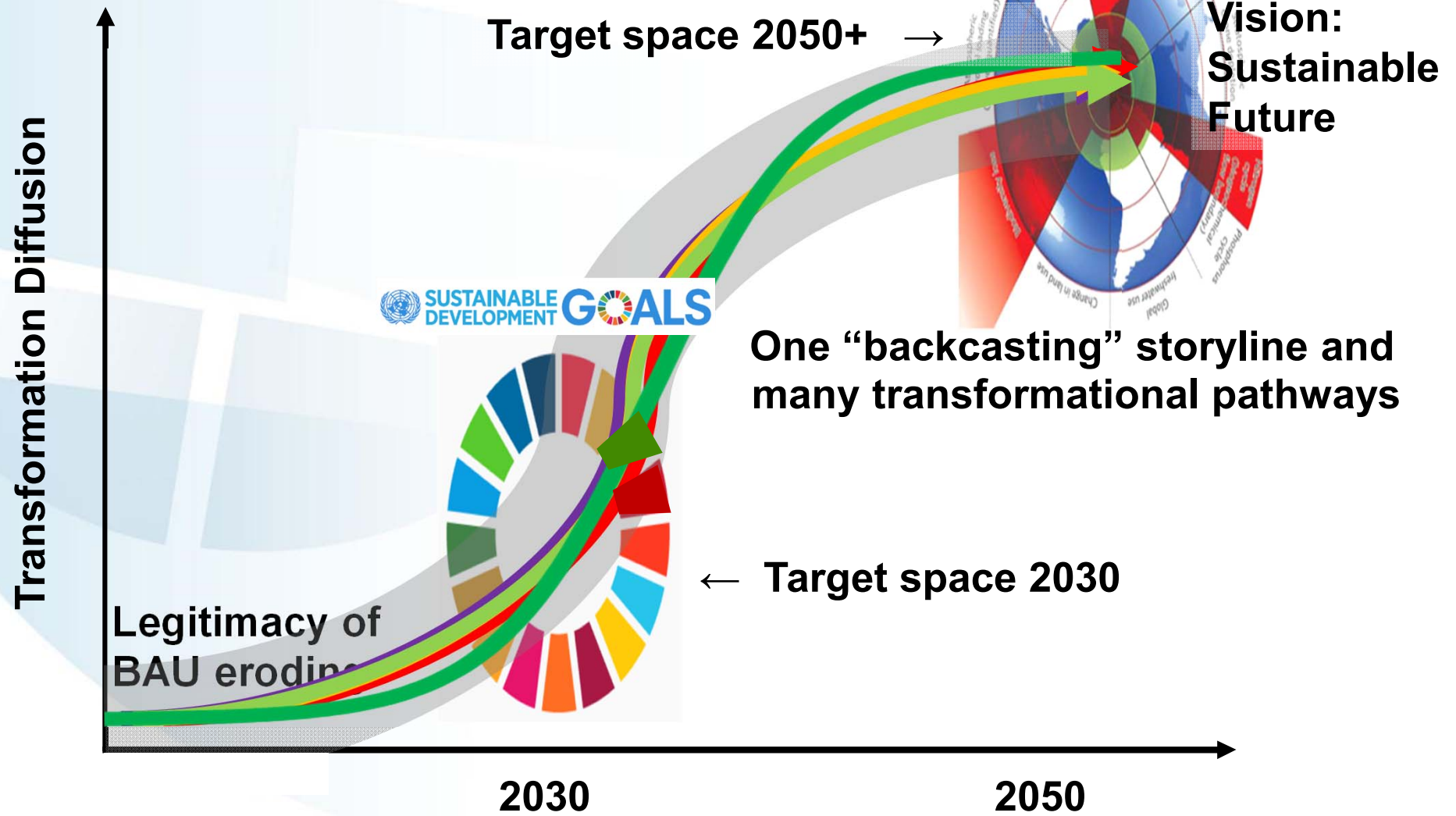
The World in 2050 (TWI2050.com)

“Doing More with Less” within Planetary Boundaries

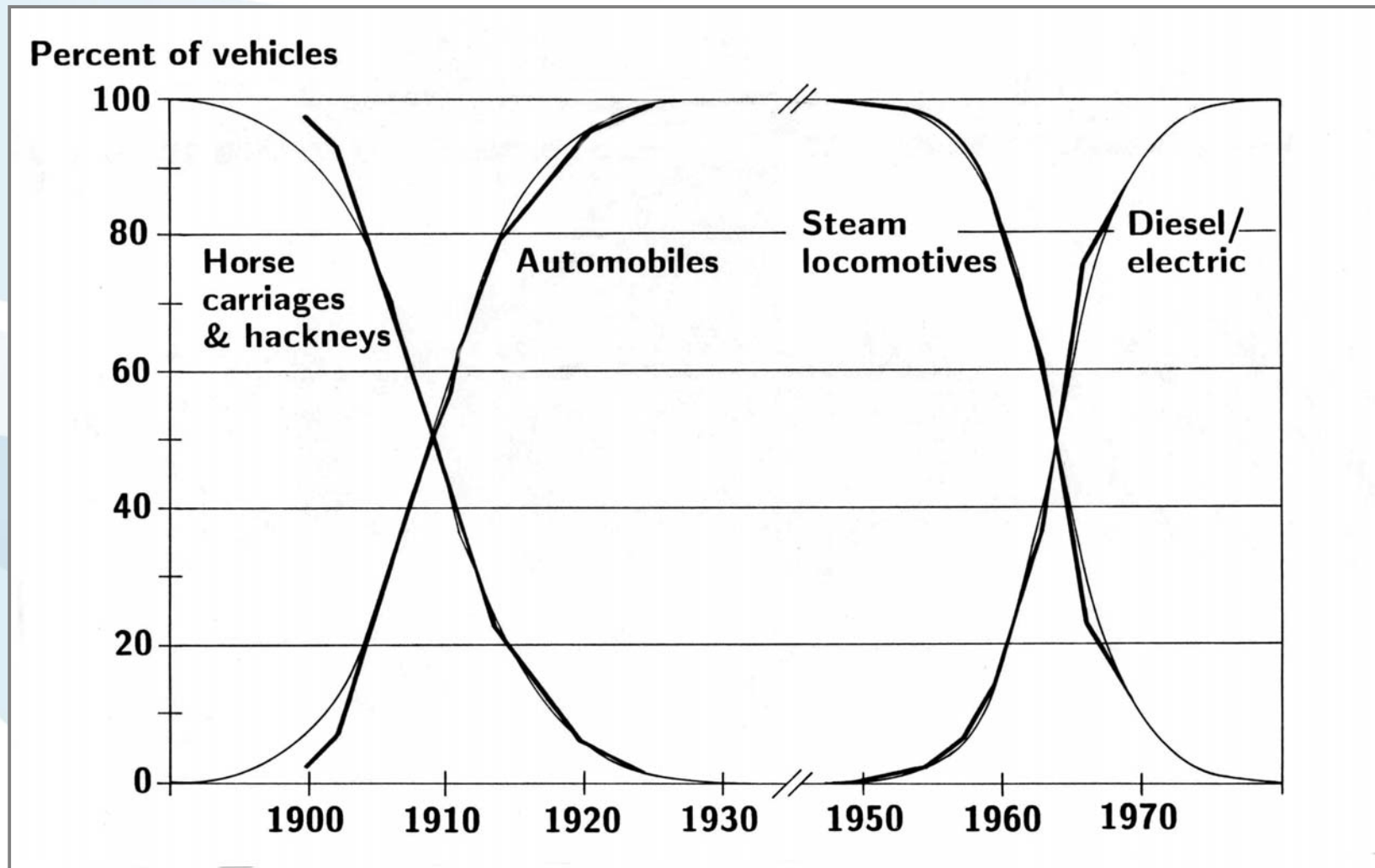


The World in 2050 (TWI2050.com)

“Doing More with Less” within Planetary Boundaries

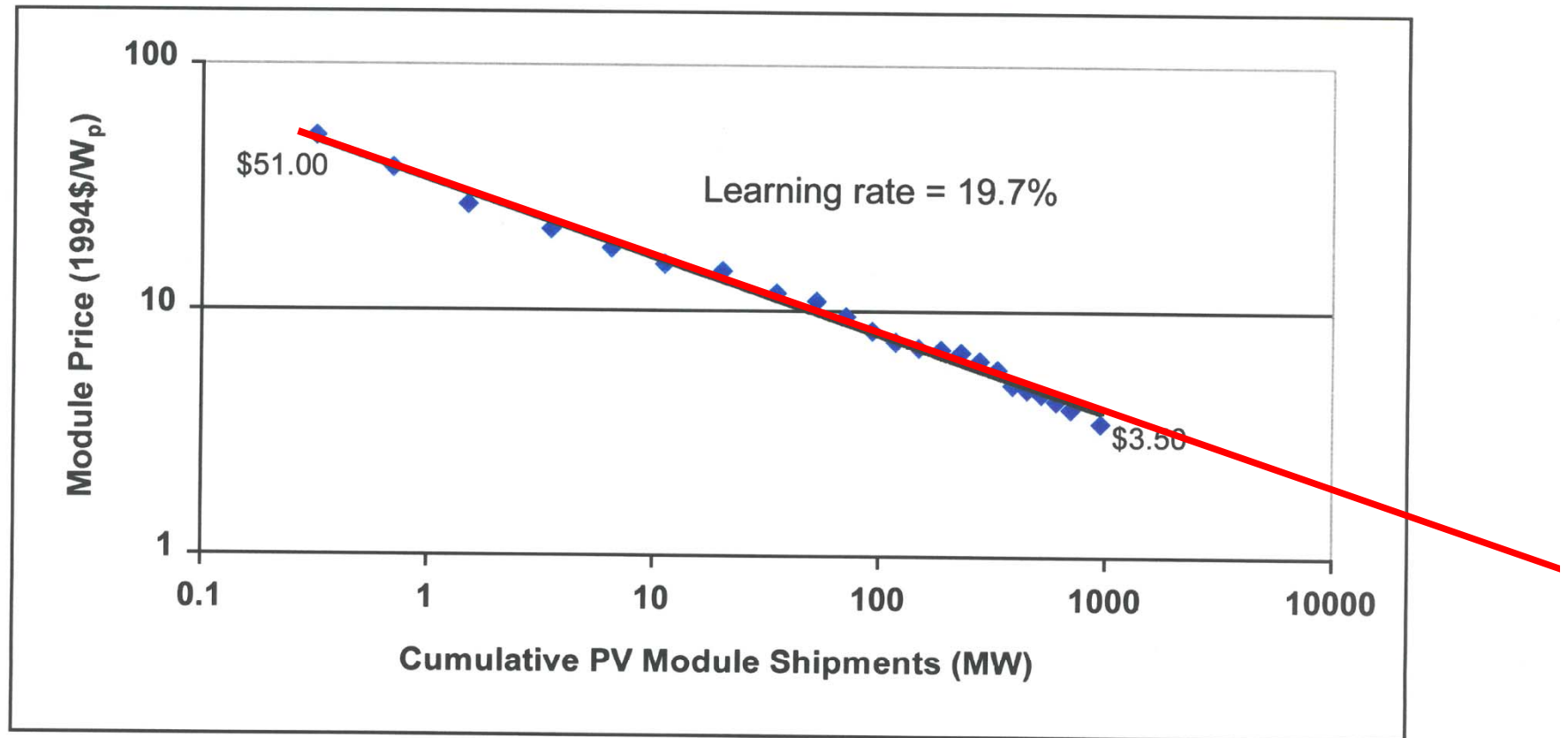


UK – Replacement within Vehicle Fleets



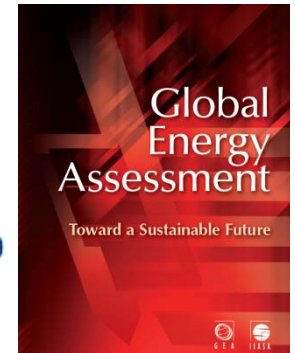
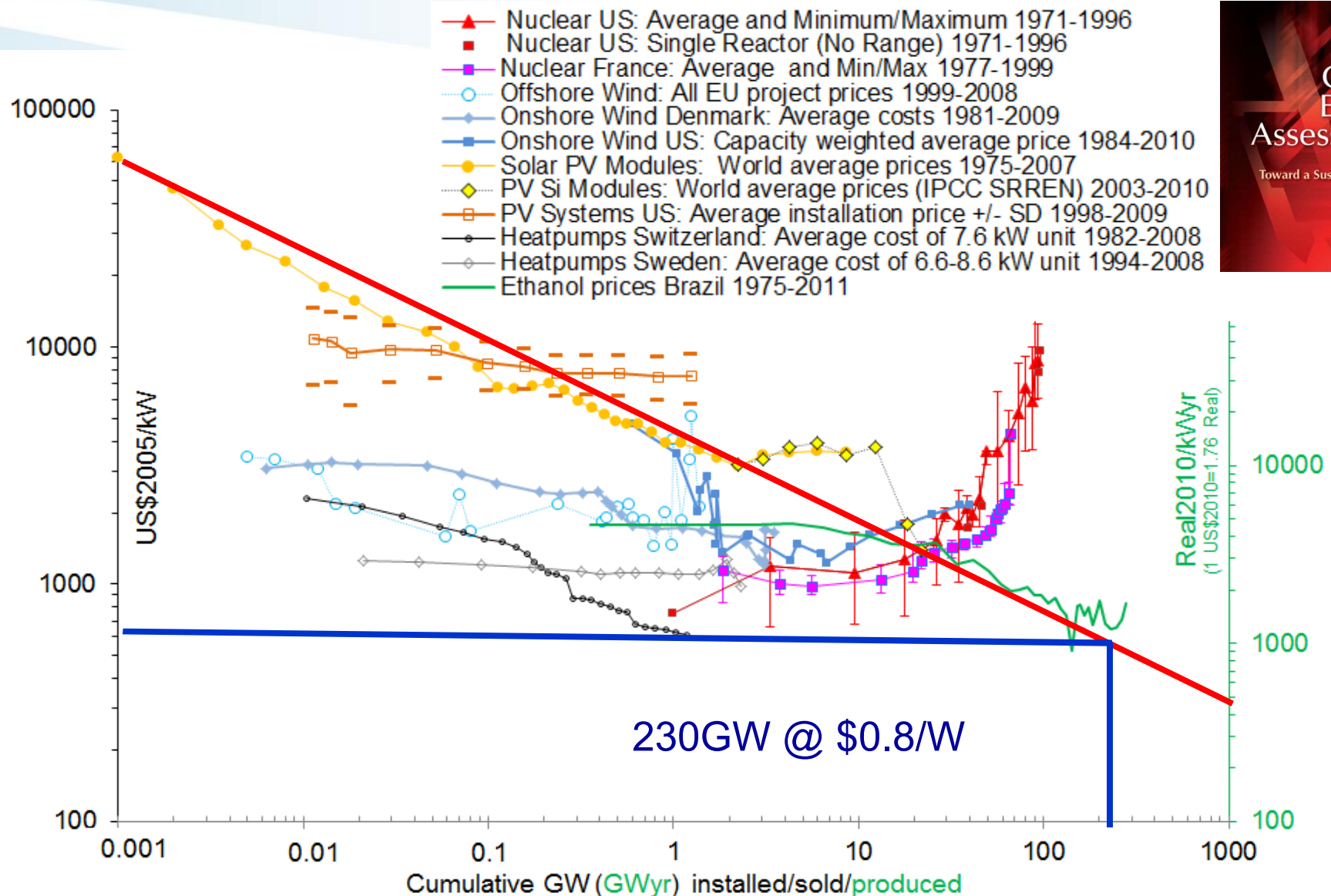
Solar PV Modules 1976–1998

(Harmon, 1999)



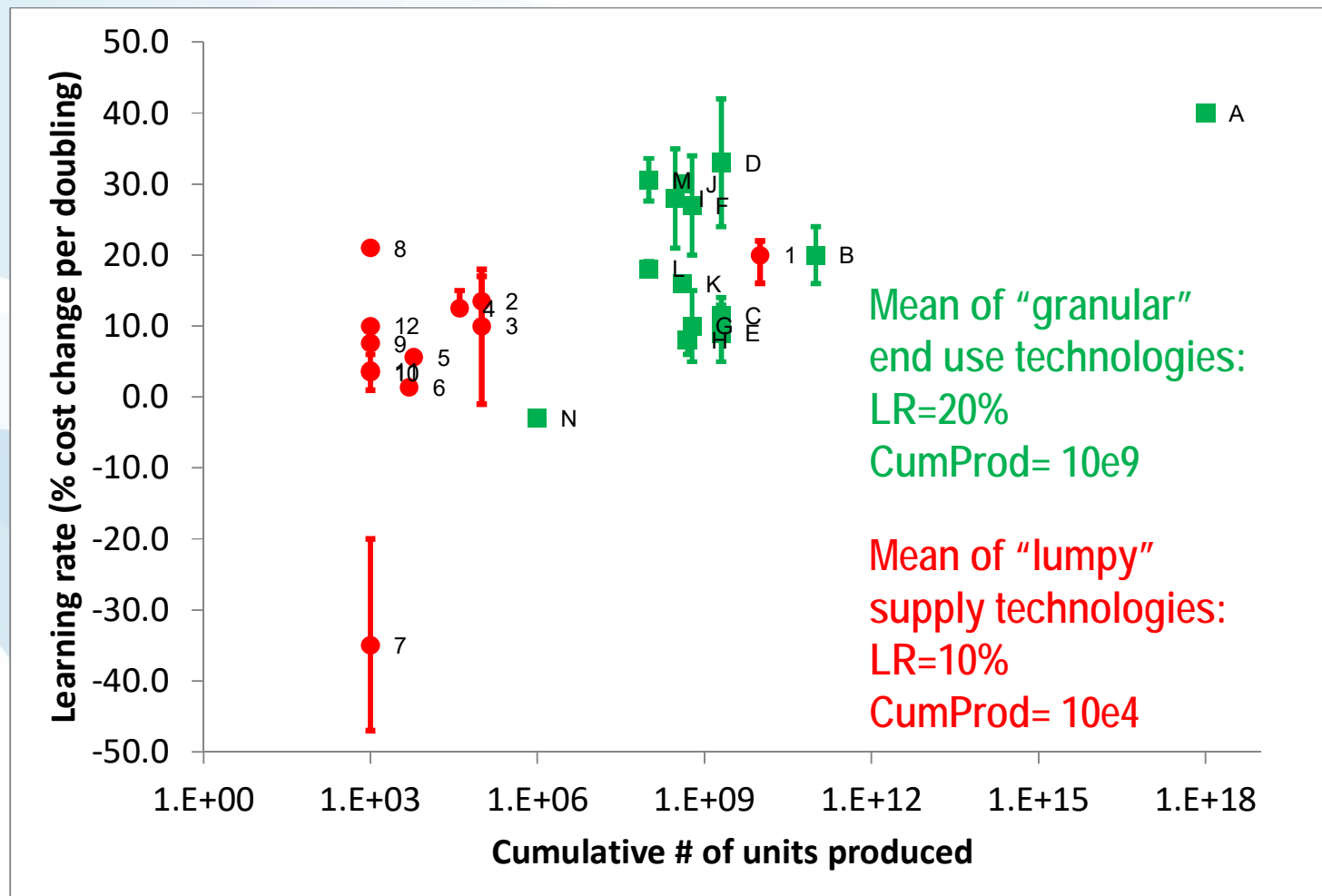
Data: Ayres (1998), Thomas (1999), Williams and Terzian (1993)

Supply Technologies Cost Trends



Cumulative Experience and Learning

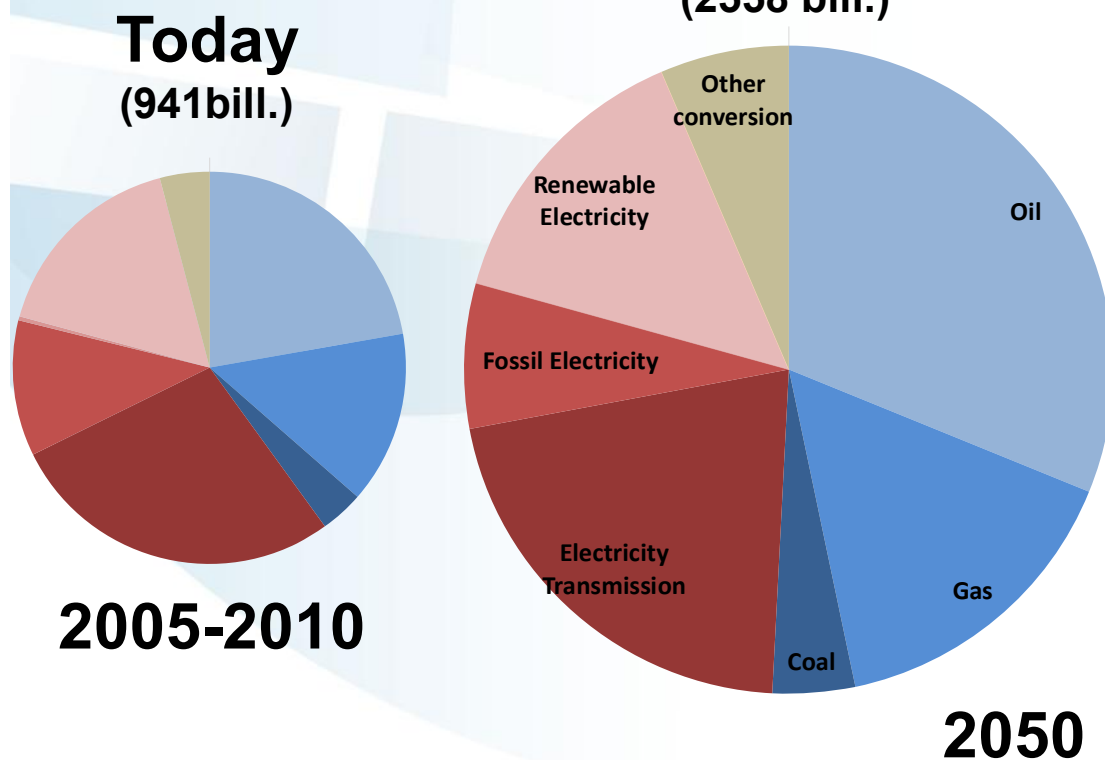
The Importance of “granularity”



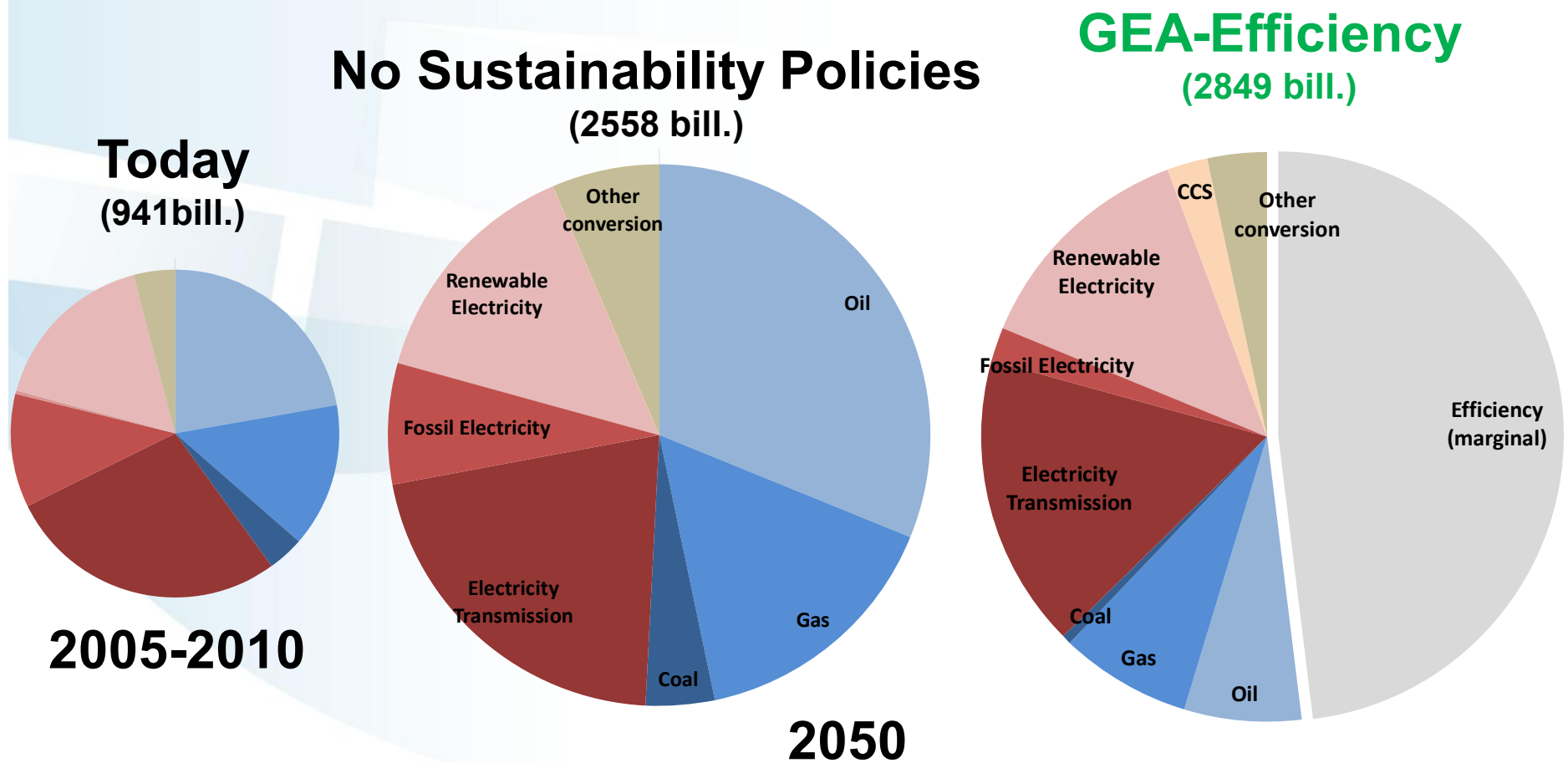
- A Transistors
- B DRAMs
- C Automobiles
- D Washing machines
- E Refrigerators
- F Dishwashers
- G Freezers (upright)
- H Freezers (chest)
- I Dryers
- J Calculators
- K CF light bulbs
- L A/C & heat pumps
- M Air furnaces
- N Solar hot water heaters
- 1 PV modules
- 2 Wind turbines
- 3 Heat pumps
- 4 Gas turbines
- 5 Pulverized coal boilers
- 6 Hydropower plants
- 7 Nuclear reactors
- 8 Ethanol
- 9 Coal power plants
- 10 Coal power plants
- 11 Gas pipelines
- 12 Gas combined cycles

Investment Portfolios World

No Sustainability Policies (2558 bill.)

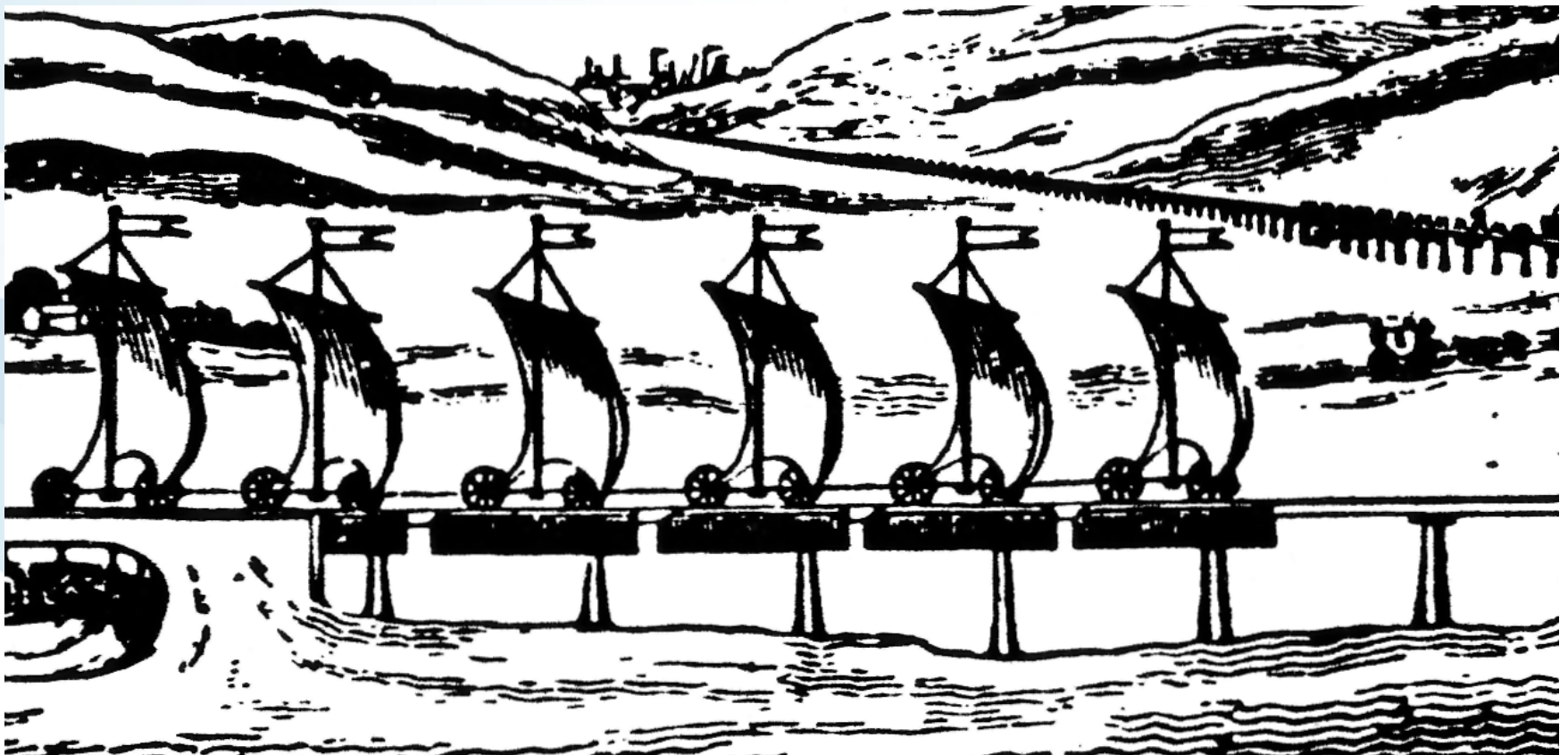


Investment Portfolios World



Vision of a Sailing Railway

Monorail using sails proposed by Henry R. Palmer in 1828





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THANK YOU

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