Transformational Change Toward Decarbonization

Initial Findings of the Global Energy Assessment

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Global Energy Challenges

- Affordable access to energy and food (a prerequisite for reaching MDGs)
- Energy and ecosystems services
- Security and reliability of systems
- Deep GHG emissions reductions
- Technology R&D and investment
- Confluence of multiple crises

Confronting the Challenges of Energy for Sustainable Development: The Role of Scientific and Technical Analysis

IIASA

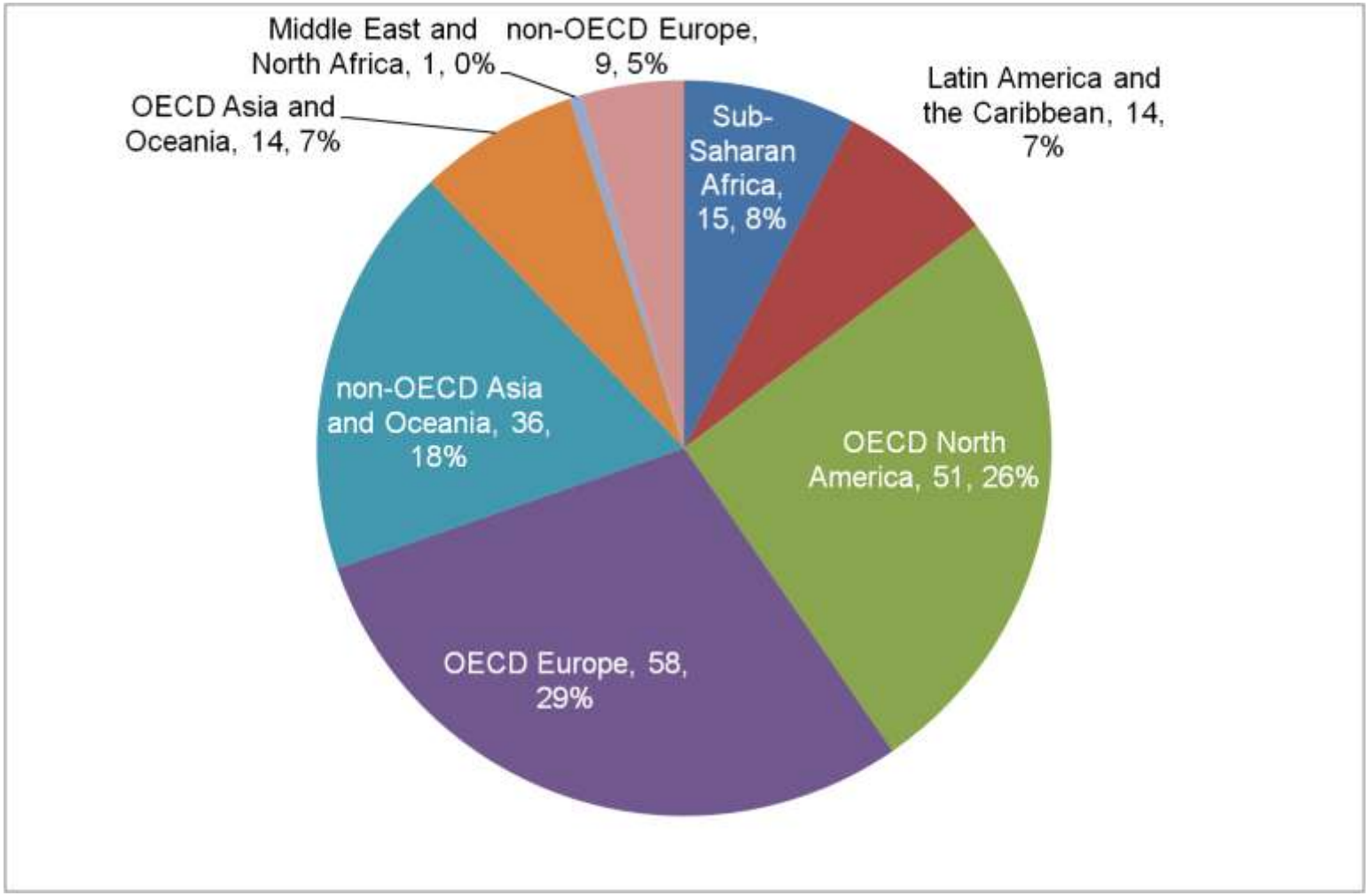
International Institute for Applied Systems Analysis
and its international partners present

www.GlobalEnergyAssessment.org

GEA Objectives Include:

- ***Science based, comprehensive, integrated, and policy-relevant*** analysis of issues and options related to:
  - Energy and sustainability challenges
  - Resource and technology options, demand and supply
  - System issues, scenarios
  - Policy options
- Local, regional, and global dimensions

GEA Analysts



198 persons, including CLAs, LAs, ExComm Co-Chairs

Sponsoring Organizations

International Organizations

GEF
IIASA
UNDESA
UNDP
UNEP
UNIDO
World Bank (ESMAP)

Industry groups

First Solar
Petrobras
WBCSD
WEC

Governments/Agencies

Austria
European Union
Germany
Italy
Norway*
Sweden
USA (EPA, DoE)
UAE*

Foundations

UN Foundation
Climate Works Foundation

NOTE: * = in negotiations

Concepts and Approach

- GEA structure is organized around **Knowledge Clusters** comprising **Knowledge Modules**
- Structure is being determined through an ongoing consultative process
  - Outline presented here is evolving
- Knowledge Clusters and Modules will be tightly integrated
  - sequential numbering in this presentation **does not** imply a sequential or linear approach within the GEA

Integration of Knowledge Clusters

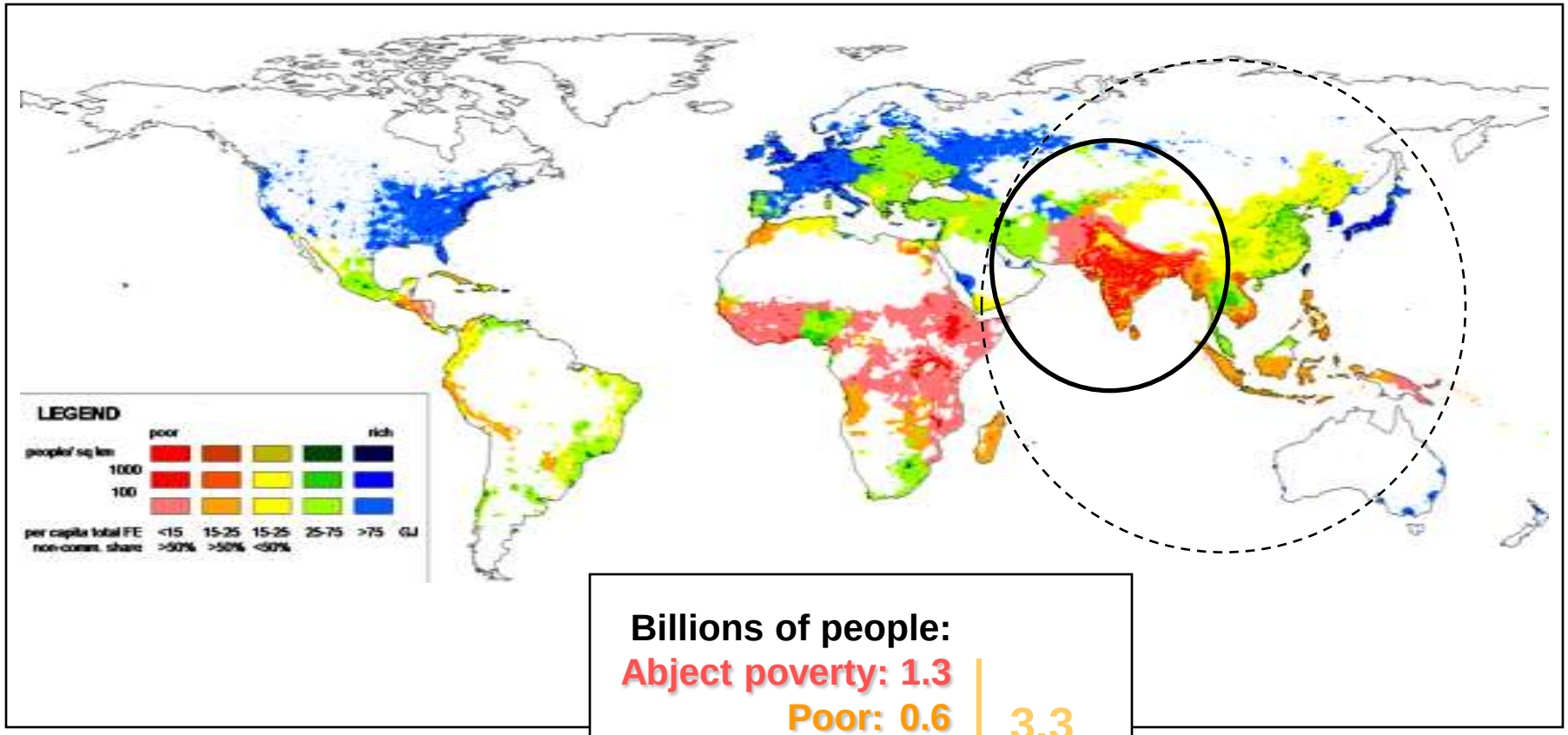
- **Cluster I** characterizes nature and **magnitude** of challenges, and express them in selected indicators
- **Cluster II** reviews existing and future resource and technology **options**
- **Cluster III** **integrates** cluster II elements into systems, and links these to indicators from Cluster I
  - This will include energising of rural areas, land use, water, urbanisation, life-styles, etc.
  - Scenarios, using numerical models and storylines, will be used for the **integration**, in an **iterative** fashion
- **Cluster IV** assesses policy options, and specifically identifies **policy packages** that are linked to scenarios meeting the needs, again in an **iterative** fashion.

Overall Scenario Framework

- Overarching scenario logic that is simple and flexible
- Provide an organizing principle for storylines:
  - Narratives of “contrasting” worlds
  - Internally consistent descriptions of how objectives are met under different developments (interplay between external factors & set of energy measures as well as resulting characteristics of the transformation)
- Need to define main dimensions, eg:
  - drivers of change to achieve the necessary transition (eg, public awareness vs technology breakthroughs)
  - broader energy responses (eg, demand pull vs supply push)
  - policy environment (eg, regional vs global concerns)

Mapping Energy Access

Final energy access (non-commercial share) in relation to population density



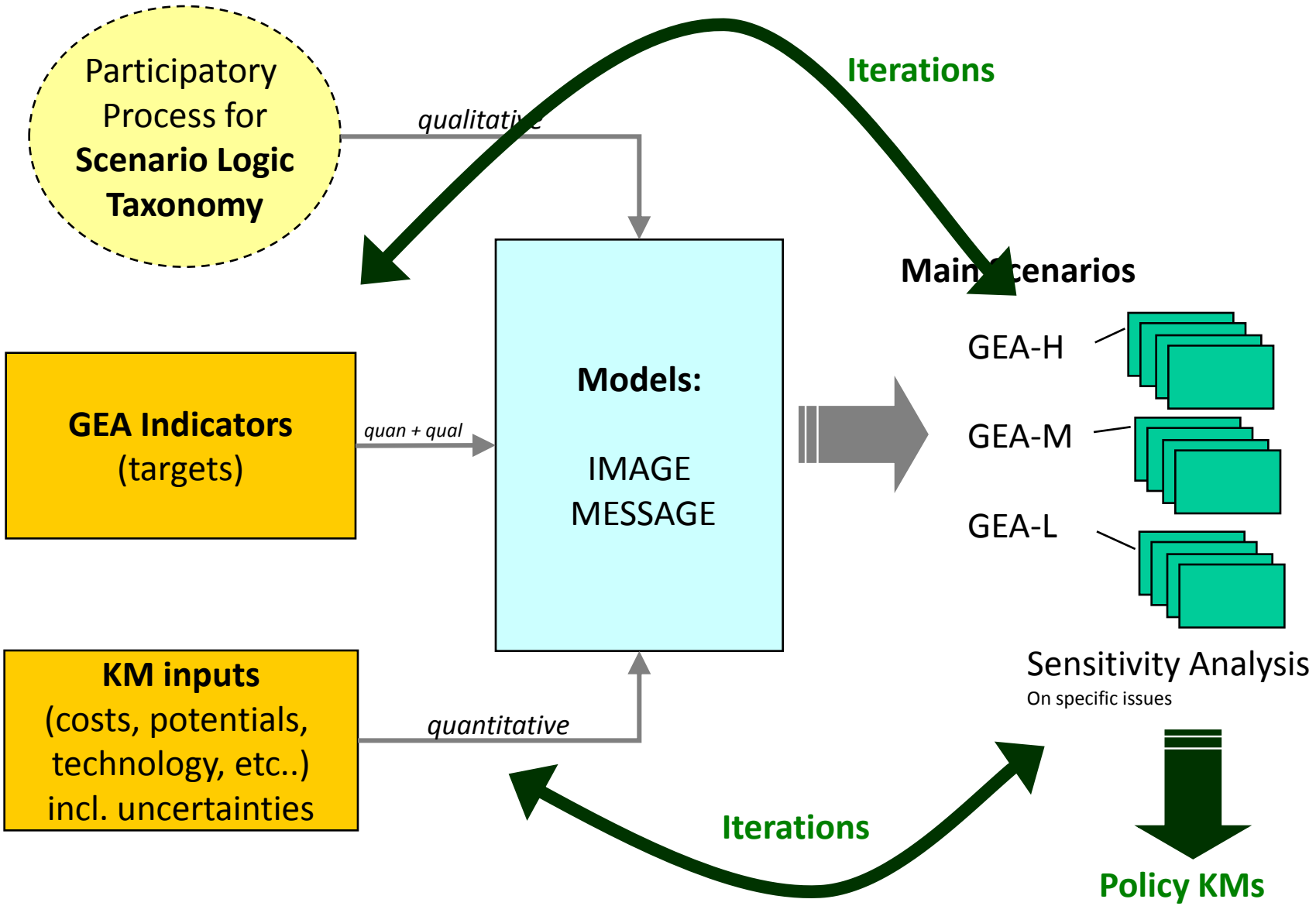
Billions of people:

Abject poverty: 1.3
Poor: 0.6
Less poor: 1.4
3.3

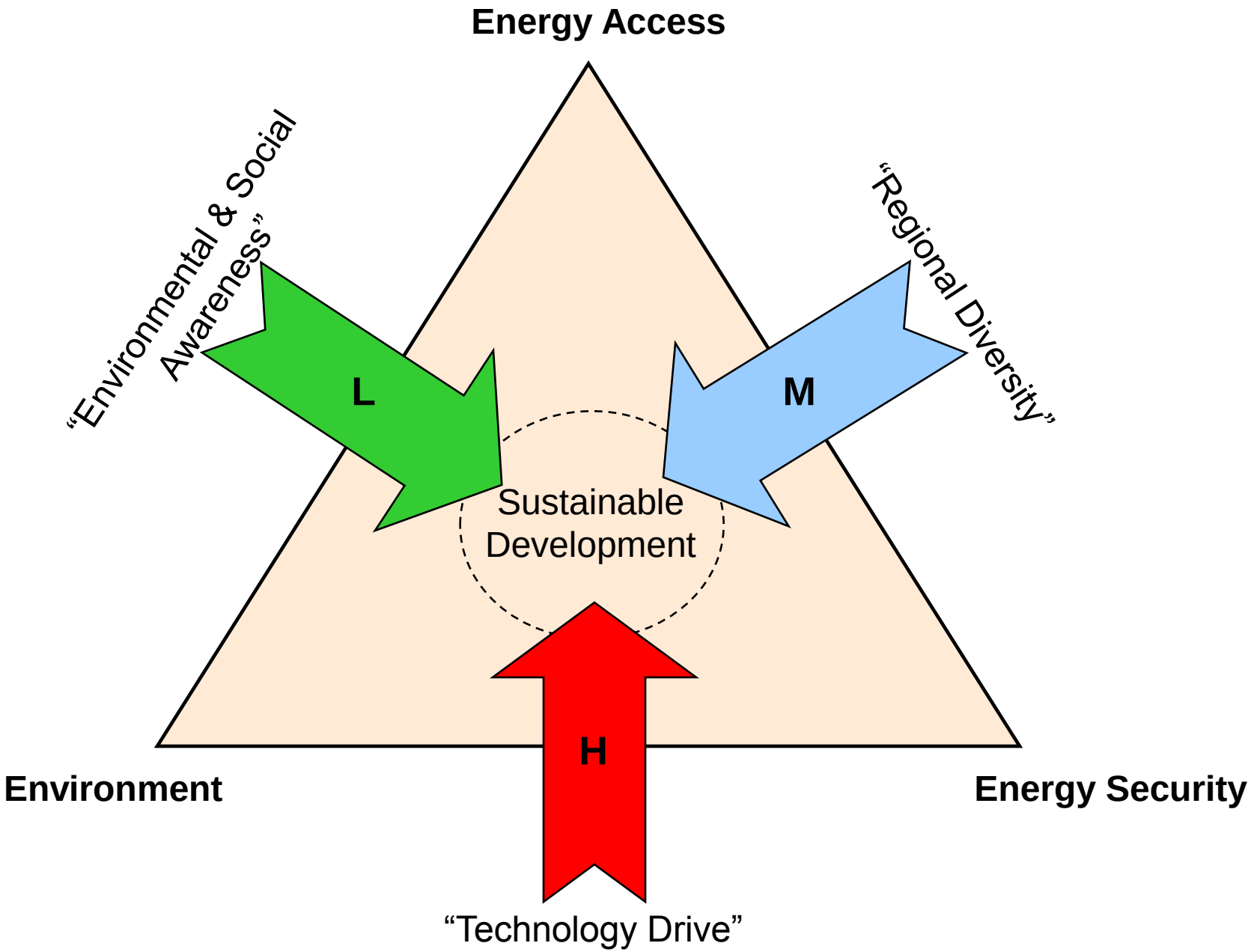
Middle class: 1.4
Rich: 1.2
2.8

Source: Gruebler et al, 2009

Scenario Development Process



GEA Scenarios & Energy Challenges

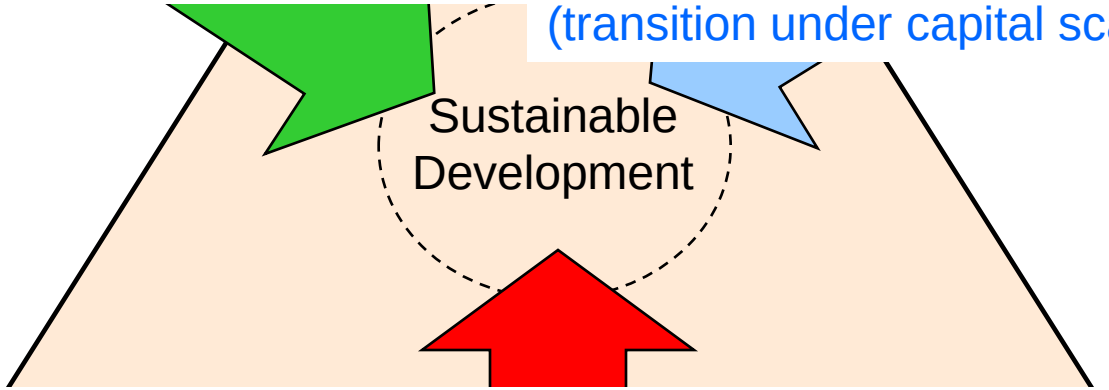


Scenario Characteristics

Energy Access

- Very high efficiency & rapid energy intensity improvements
- behavioral/life-style changes, including mobility, diets toward less meat, interconnected homes, etc..
- Sensitivity: 0-nuclear & 0-CCS cases
- Very stringent climate targets (400 ppm equ. with overshoot or 450 ppm without)

- Heterogeneous combinations, eg C&B
- Different regions with different degree of fulfillment of SD criteria
- Rapid access and security improvements
- Intermediate climate targets (550 ppm equ. or 500 ppm with overshoot) and implications of delayed participation
- Sensitivity: implications of financial crises (transition under capital scarcity);



Env

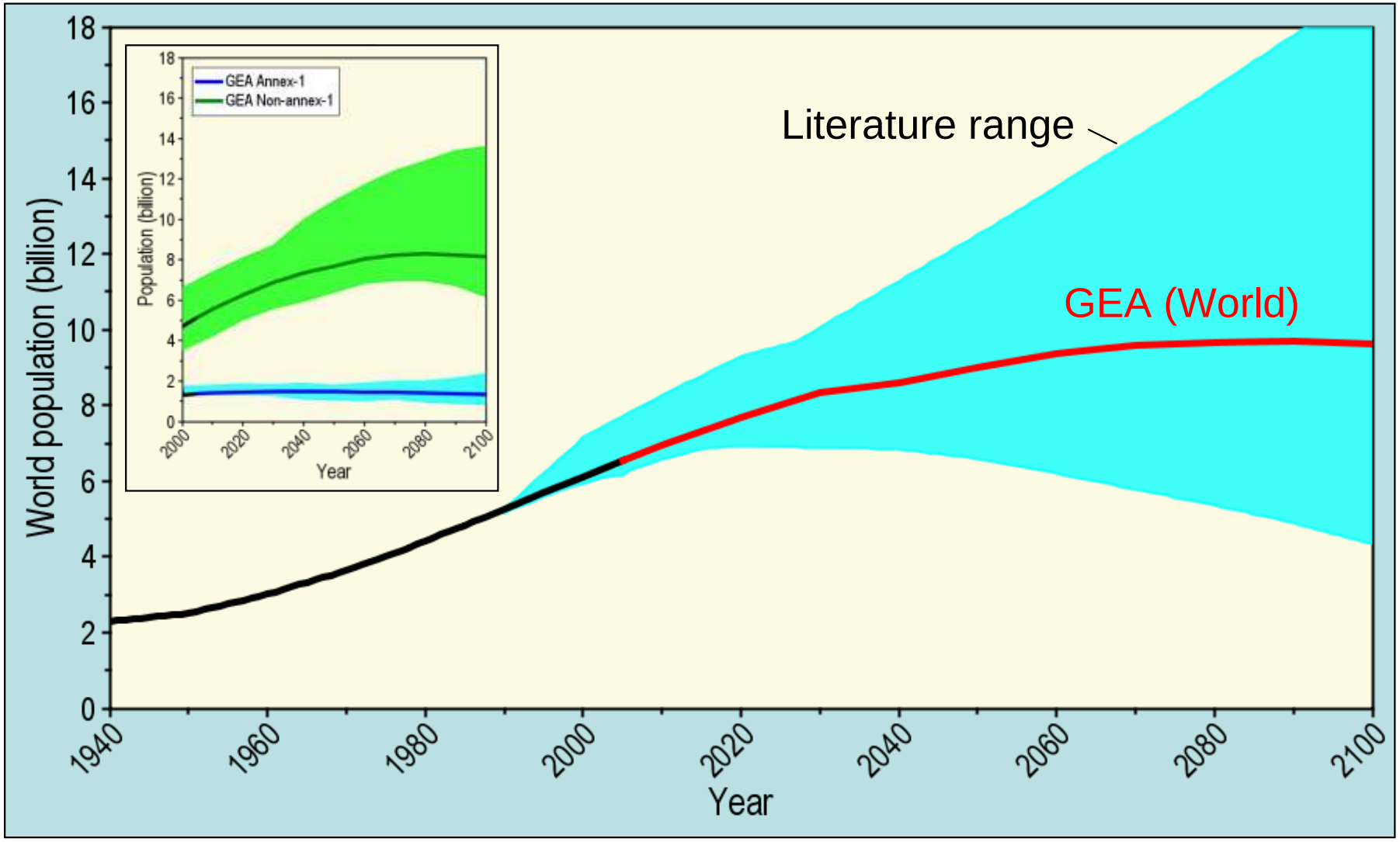
- Massive supply-side changes and new infrastructures
- Eg: H2 + very cheap CCS, nuclear and renewables
- Intermediary energy intensity improvement (higher demand than C)
- stringent climate targets (450 ppm equ. with high overshoot or 500 ppm)

"Technology Push"

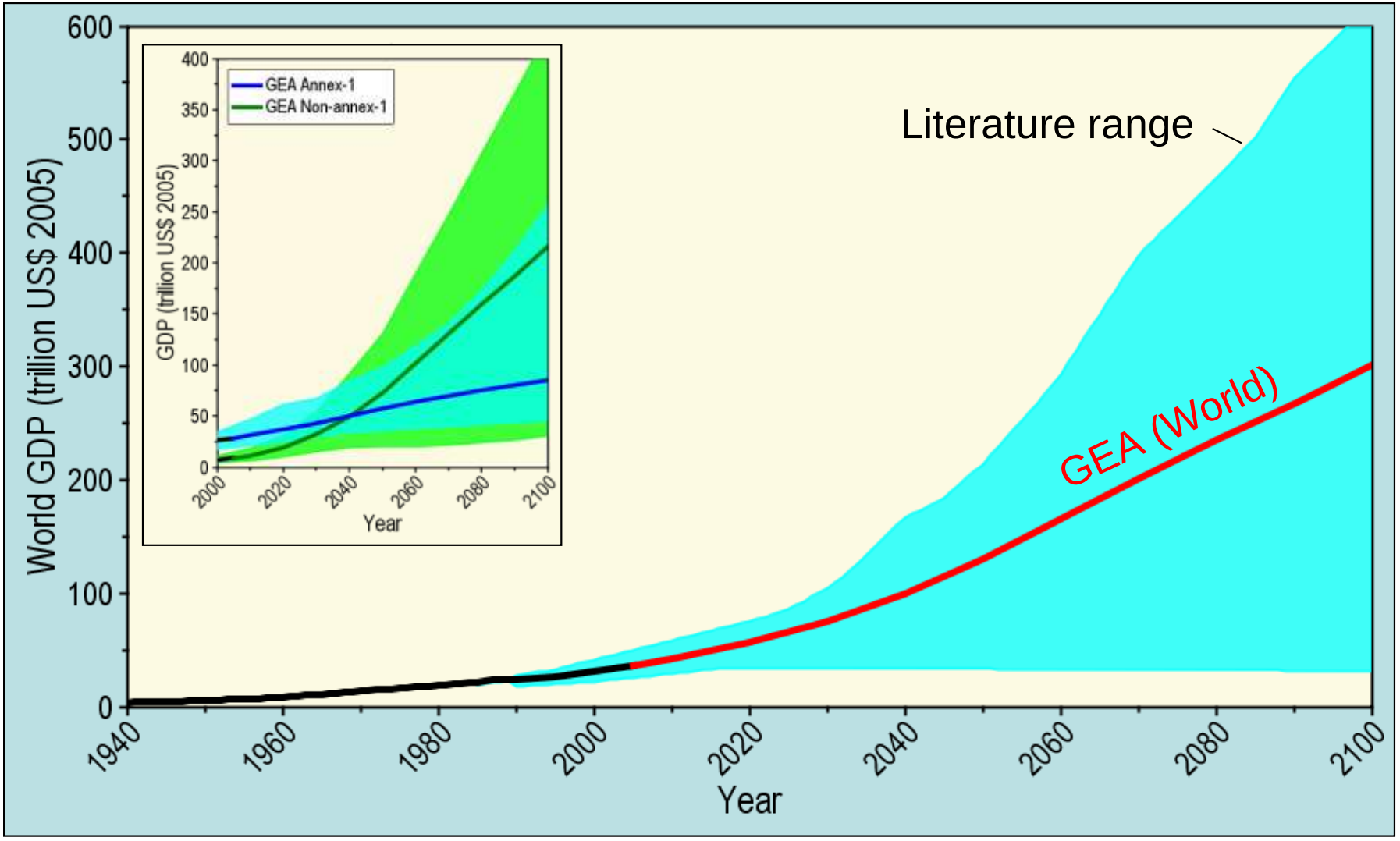
Modeling set-up

- One Counterfactual (WEO & intermediate IPCC scenario B2)
- 3 fulfillment and transformational scenarios
- Counterfactual only for showing benefits of policy packages (and avoided impacts)
- Emphasis on 3 sustainability transformations
- 3 Modeling teams to develop all scenarios or just variants

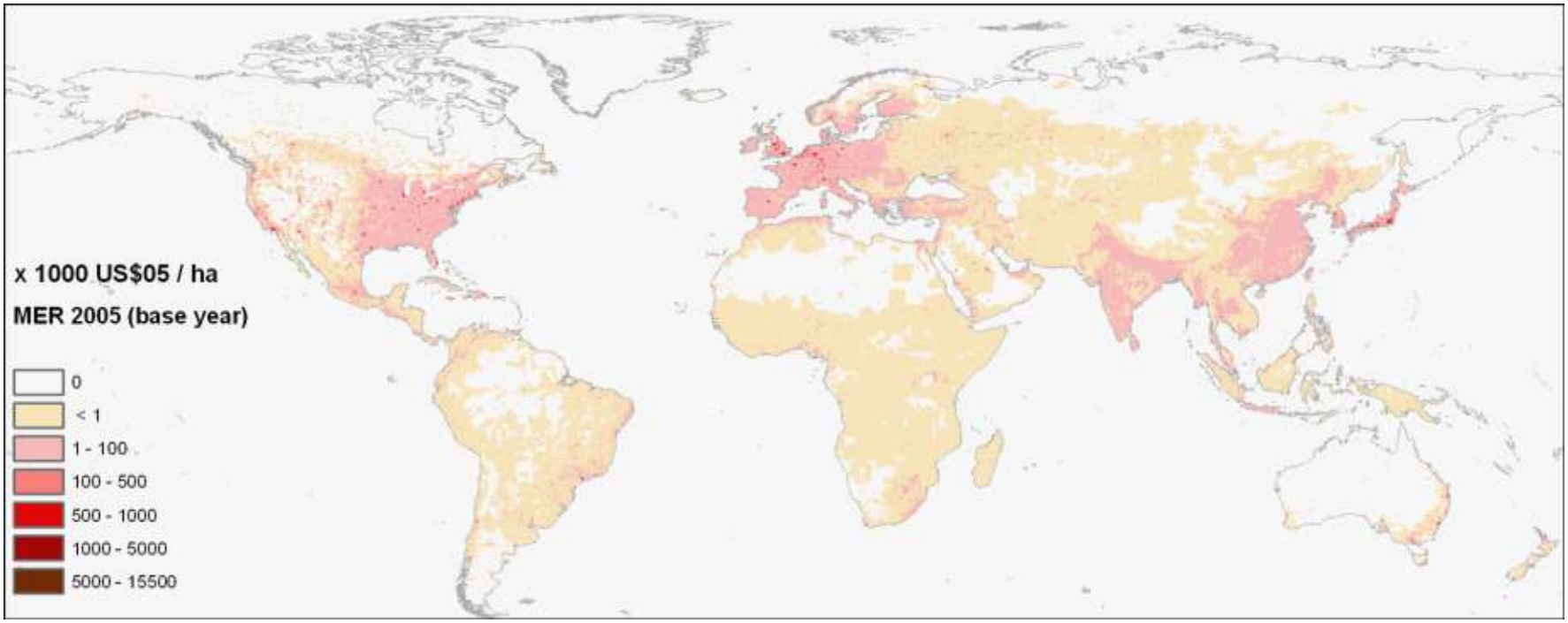
Global Population Projections



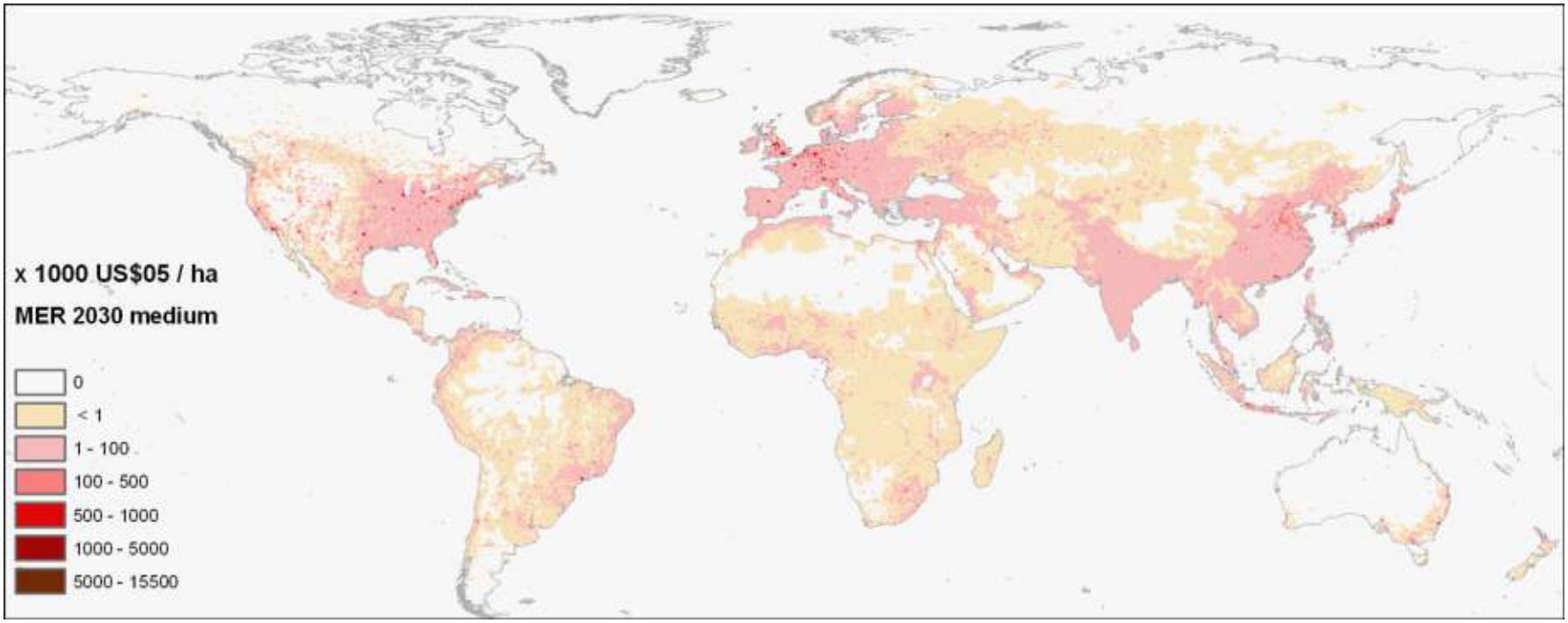
Global Economic Development



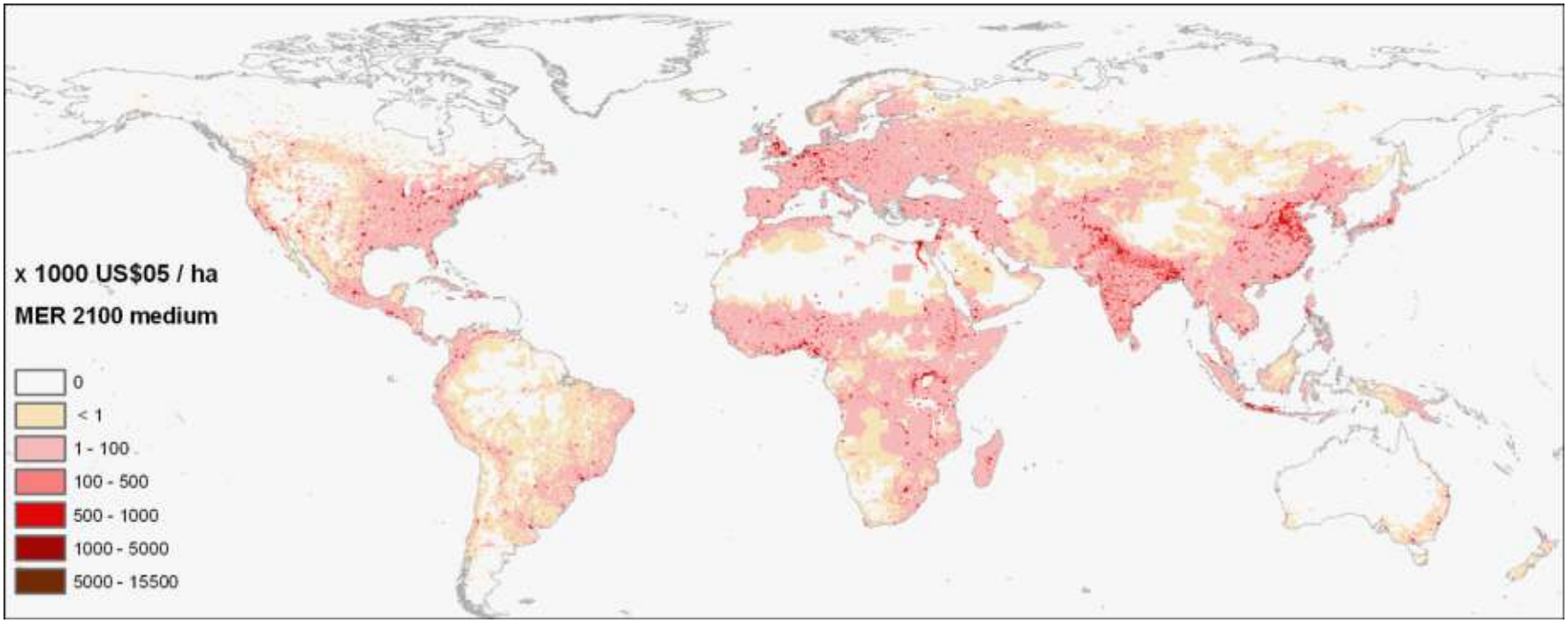
GDP, GEA-M


x 1000 US$05 / ha
MER 2005 (base year)
0
< 1
1 - 100
100 - 500
500 - 1000
1000 - 5000
5000 - 15500

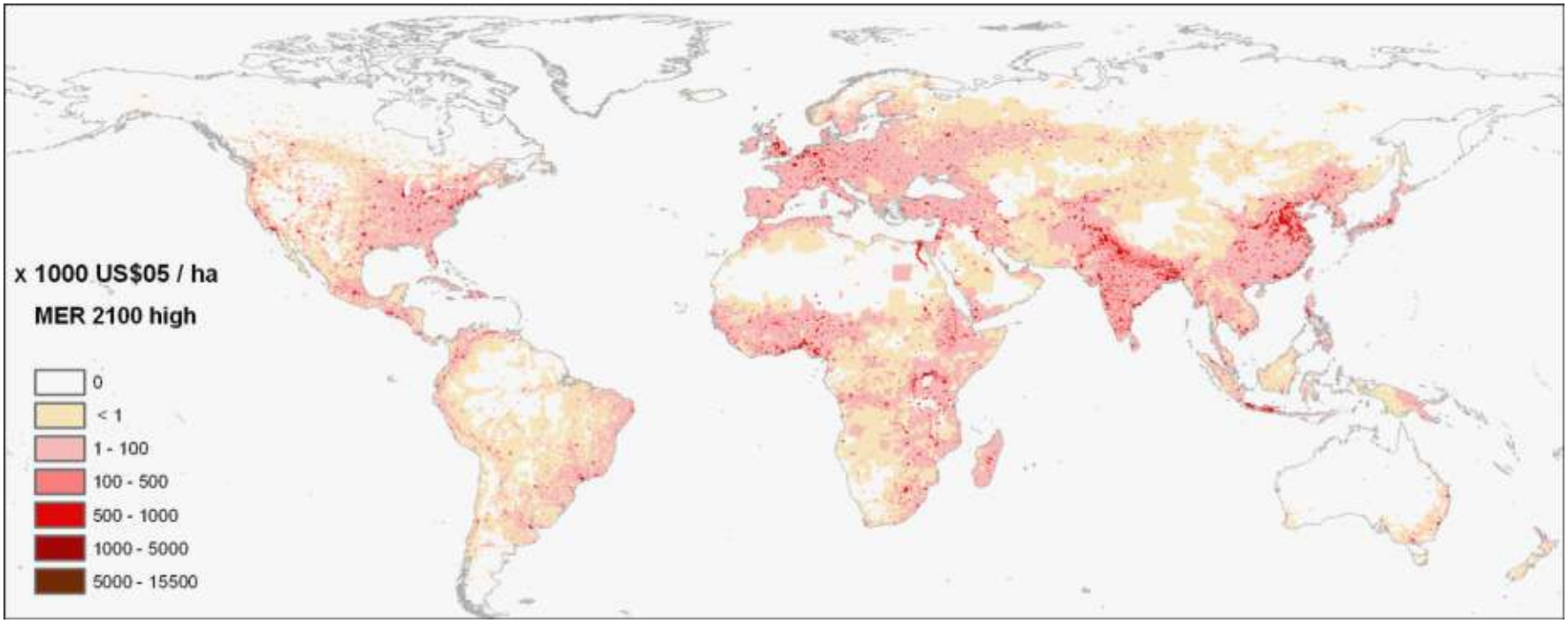
GDP, GEA-M


x 1000 US$05 / ha
MER 2030 medium
0
< 1
1 - 100
100 - 500
500 - 1000
1000 - 5000
5000 - 15500

GDP, GEA-M


x 1000 US$05 / ha
MER 2100 medium
0
< 1
1 - 100
100 - 500
500 - 1000
1000 - 5000
5000 - 15500

GDP, GEA-H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MER 2100 high
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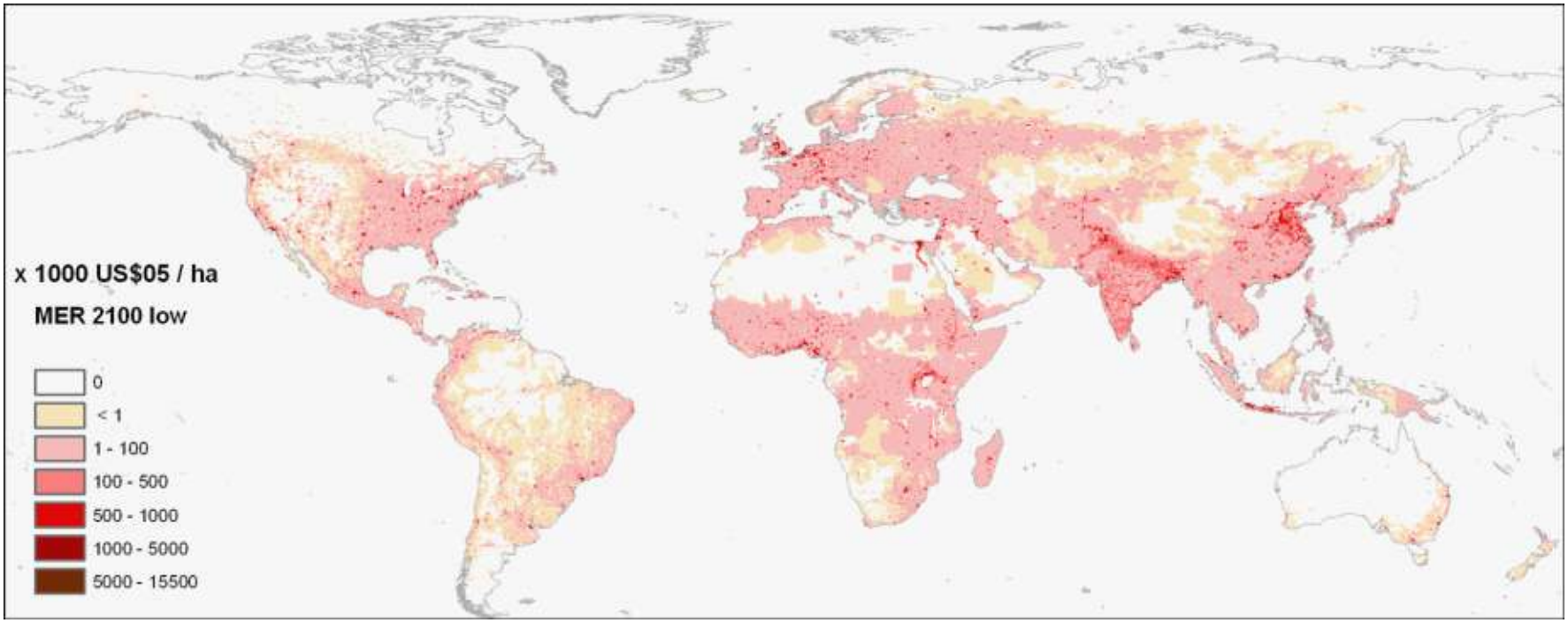
100 - 500
500 - 1000
1000 - 5000
5000 - 15500

GDP, GEA-L


x 1000 US$05 / ha
MER 2100 low
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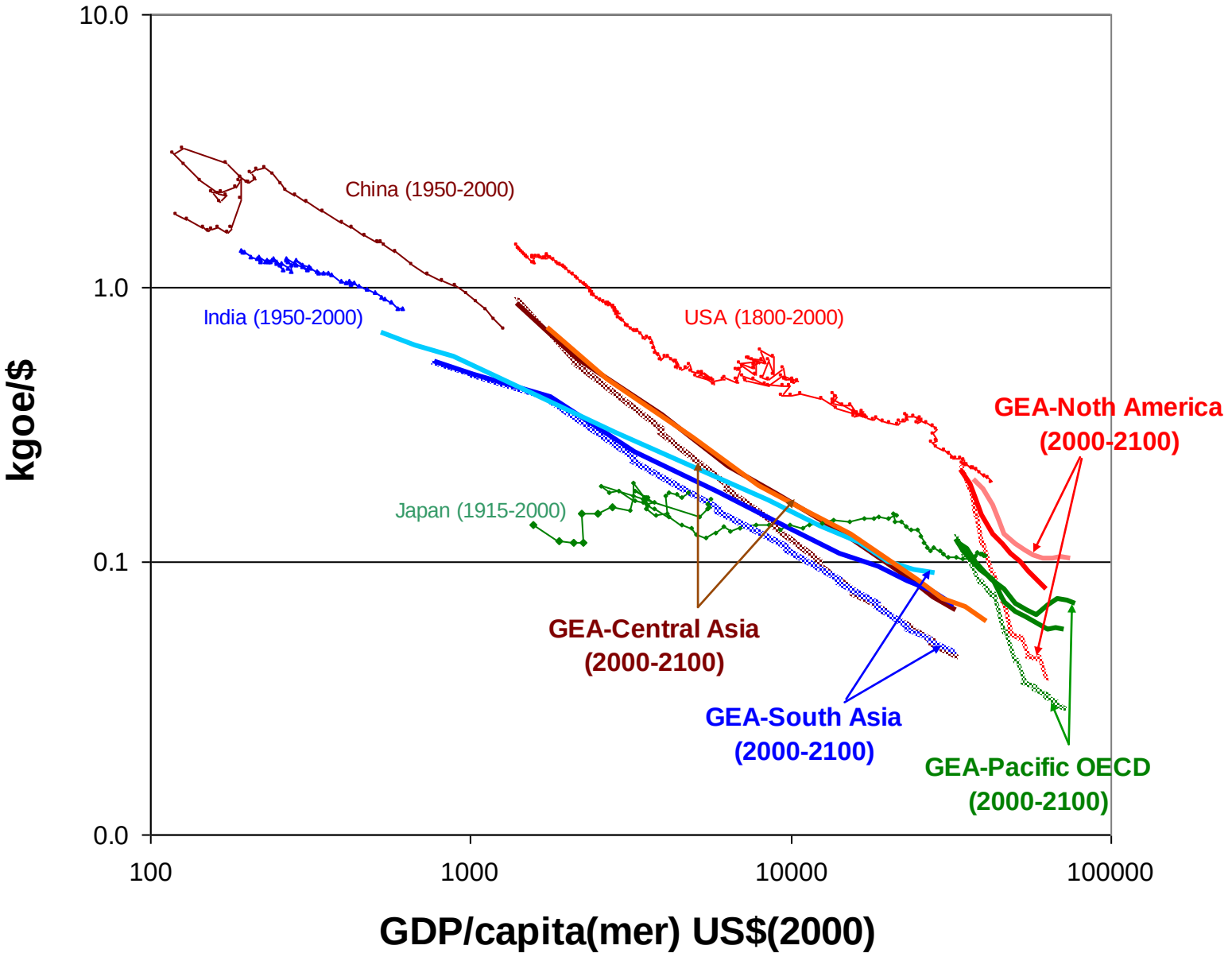
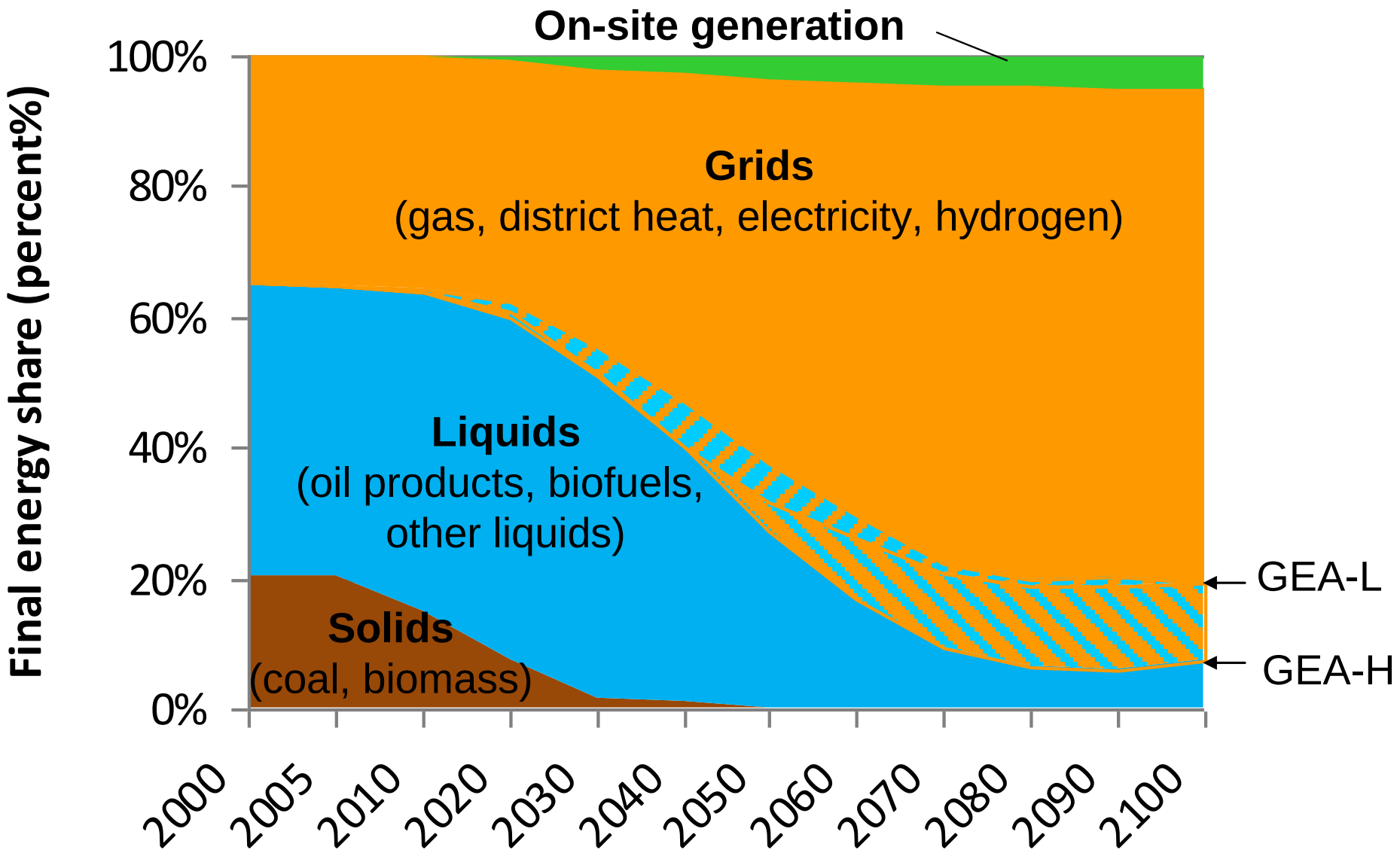
1 - 100
100 - 500
500 - 1000
1000 - 5000
5000 - 15500

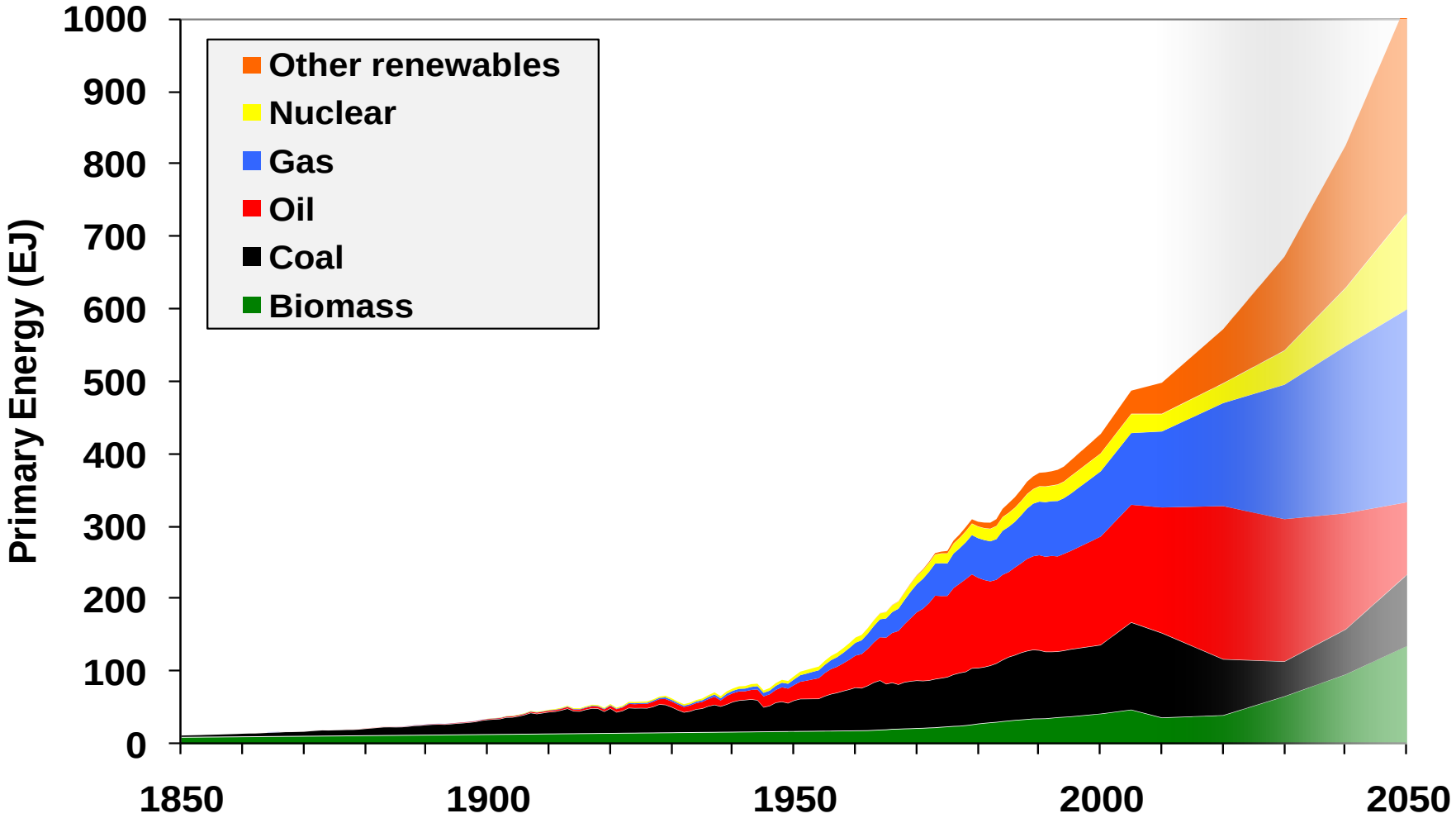
Energy Intensity Improvements



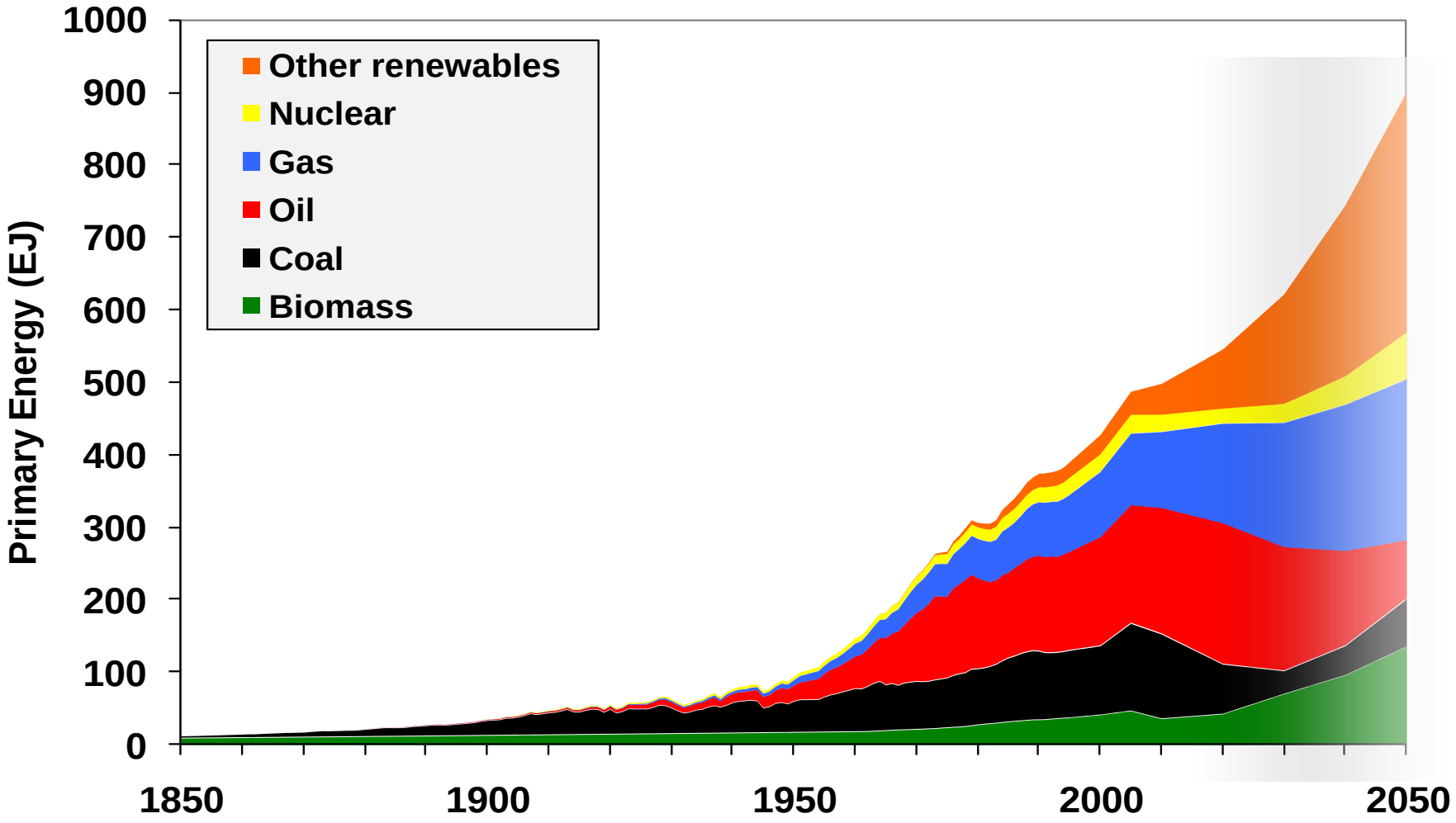
Final Energy Transformations



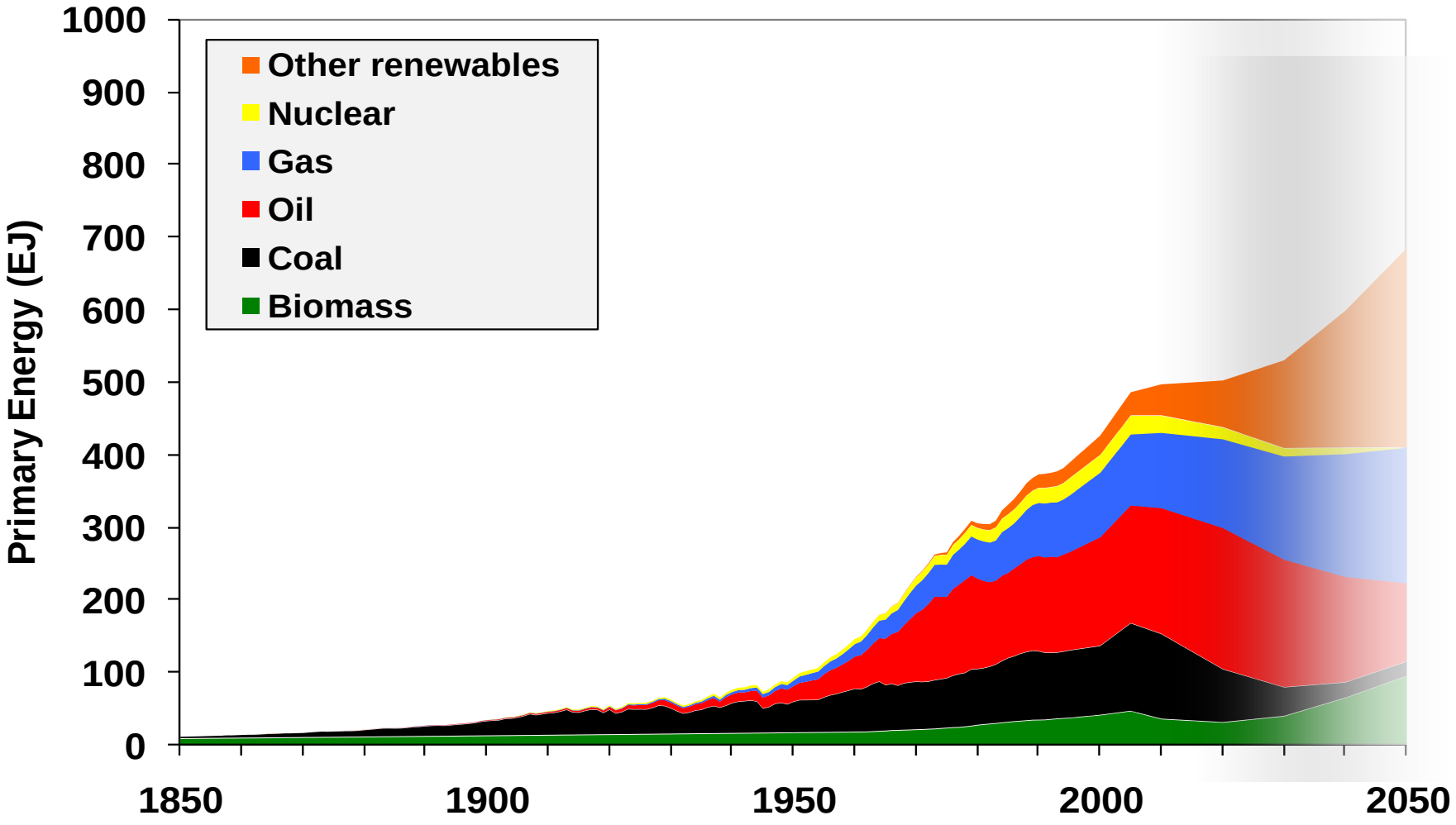
Global Primary Energy



Global Primary Energy

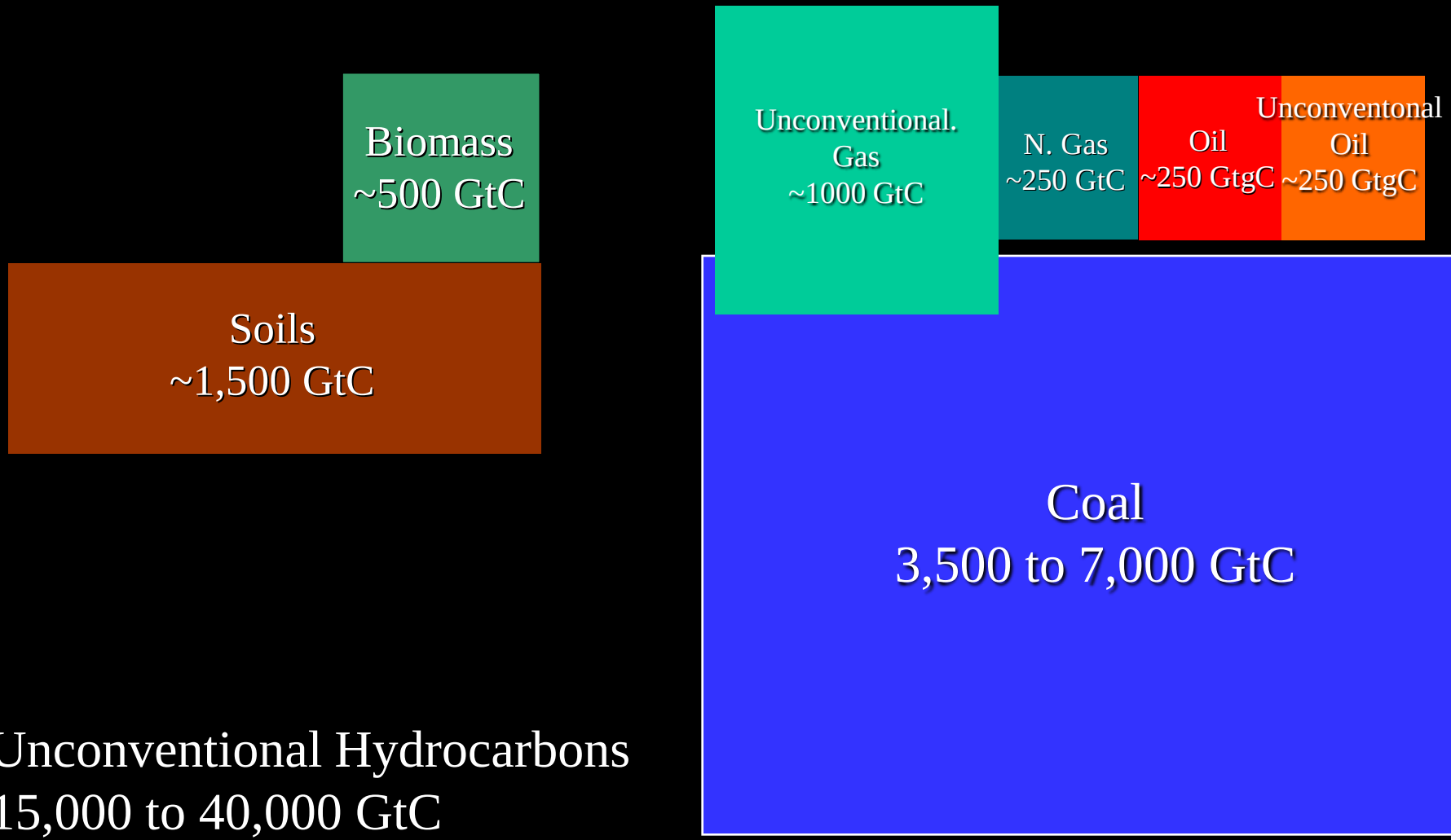


Global Primary Energy



Carbon Reservoirs

Atmosphere 800 GtC (2004)



Unconventional Hydrocarbons
15,000 to 40,000 GtC

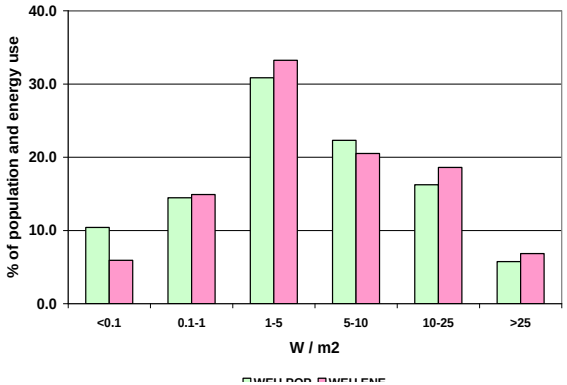
Methane Hydrate

Only one third of sedimentary basins has been searched for oil with modern techniques

Far more exploration wells (*each yellow dot represents 2,000*) have been drilled in the U.S. than in any other country.

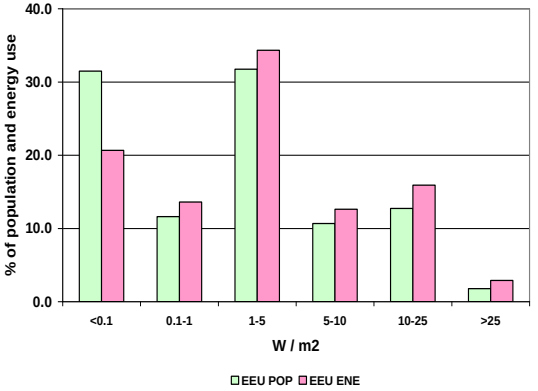
Europe Population vs. Energy Demand Density

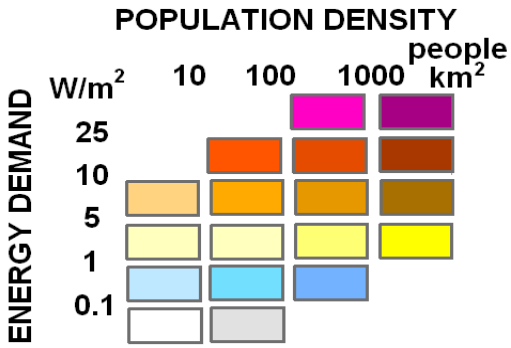
Note in particular renewable supply density threshold of maximum 0.5-1 W/m^2



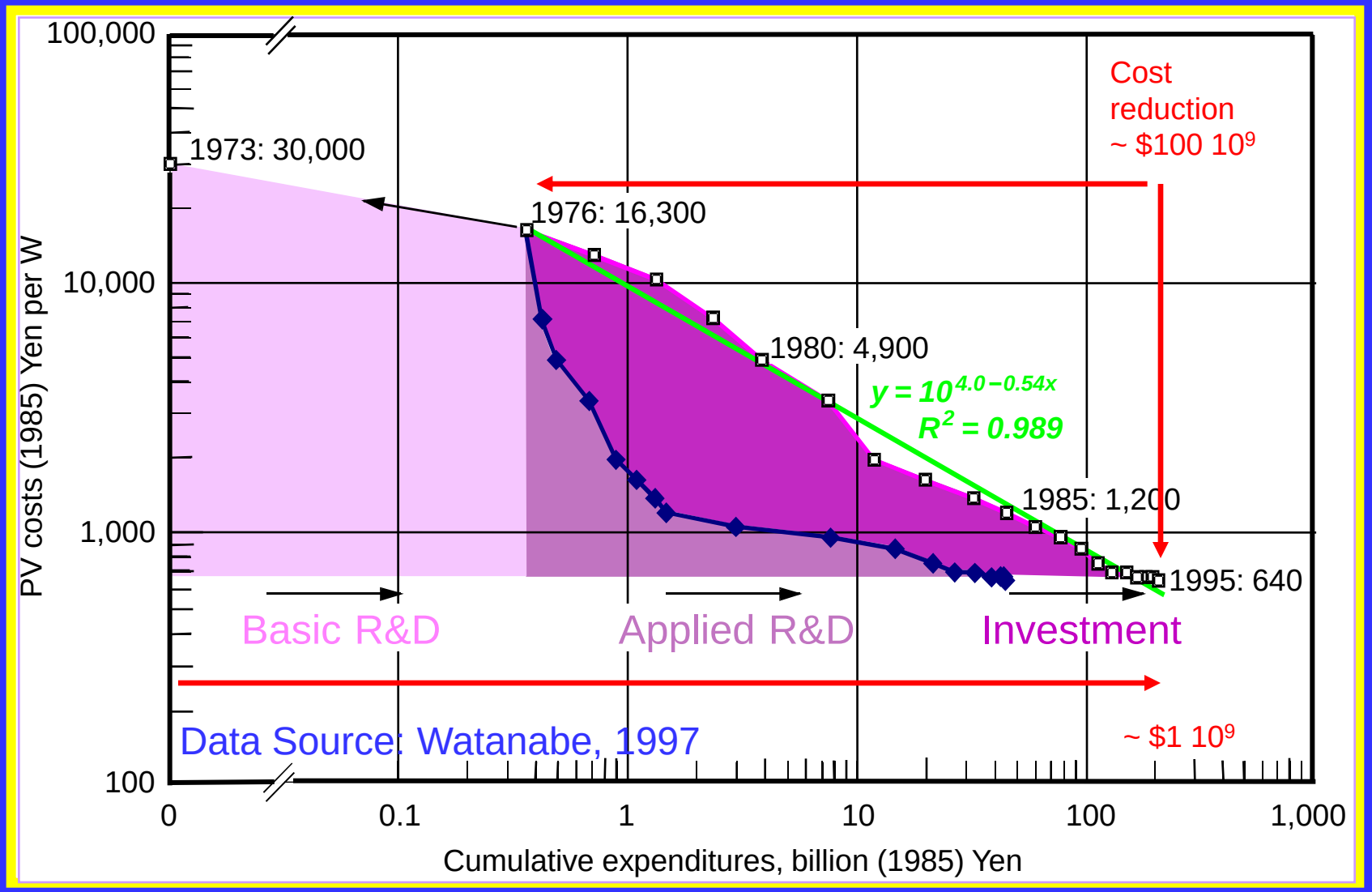
WEU: 21% of demand below renewable density threshold

EEU: 34% of demand below renewable density threshold

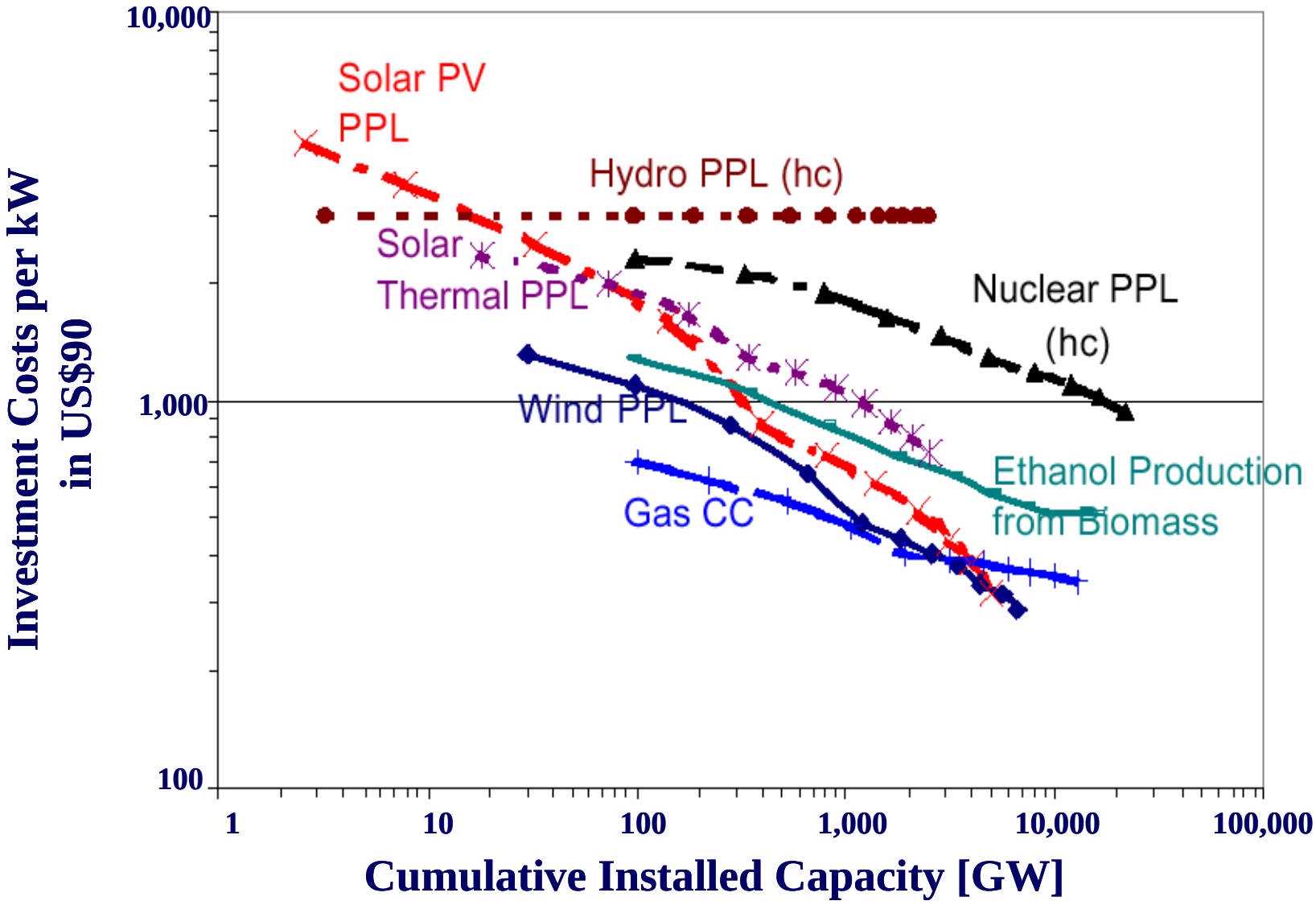




Japan - PV Costs vs. Expenditures



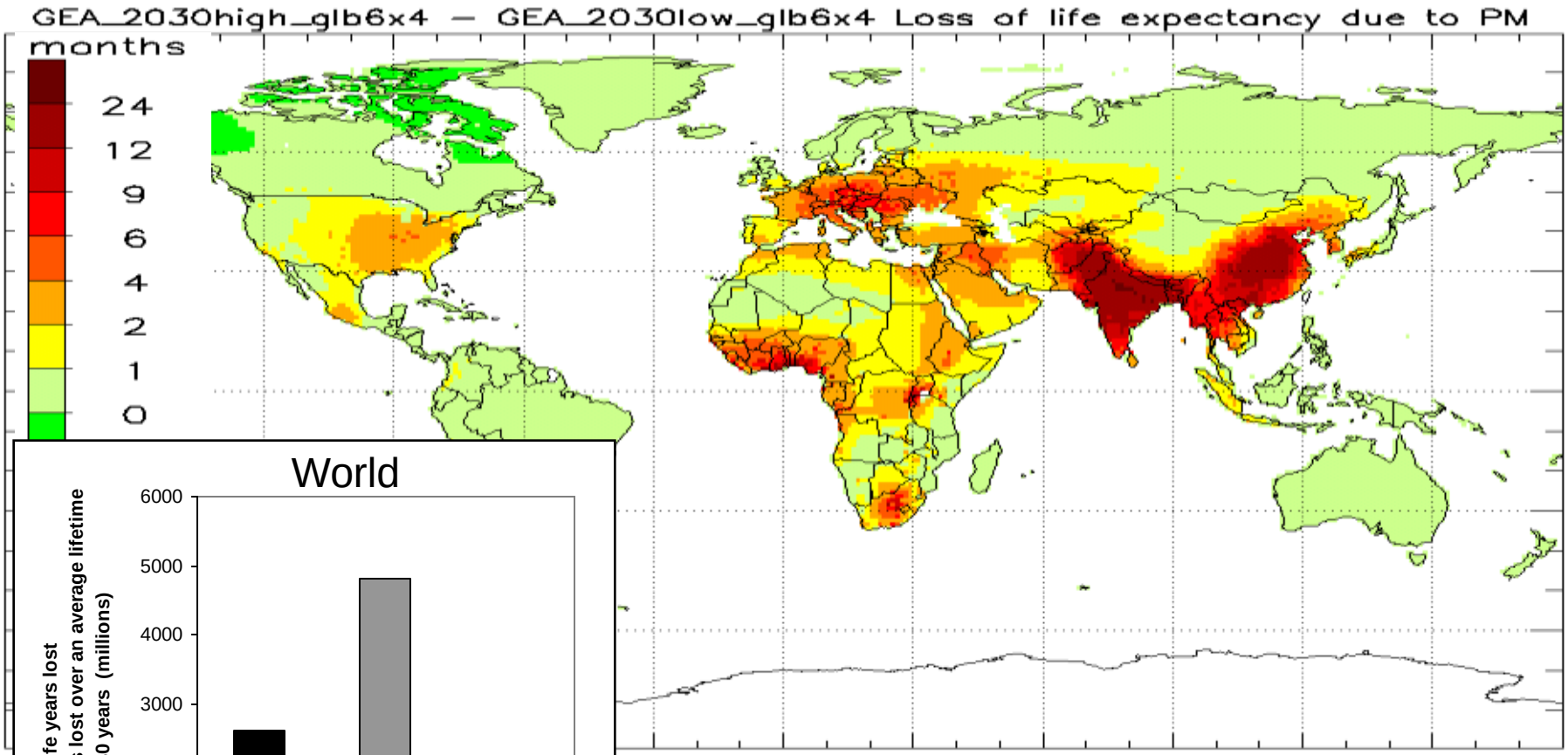
Future Technology Learning



Source: Riahi, 2009

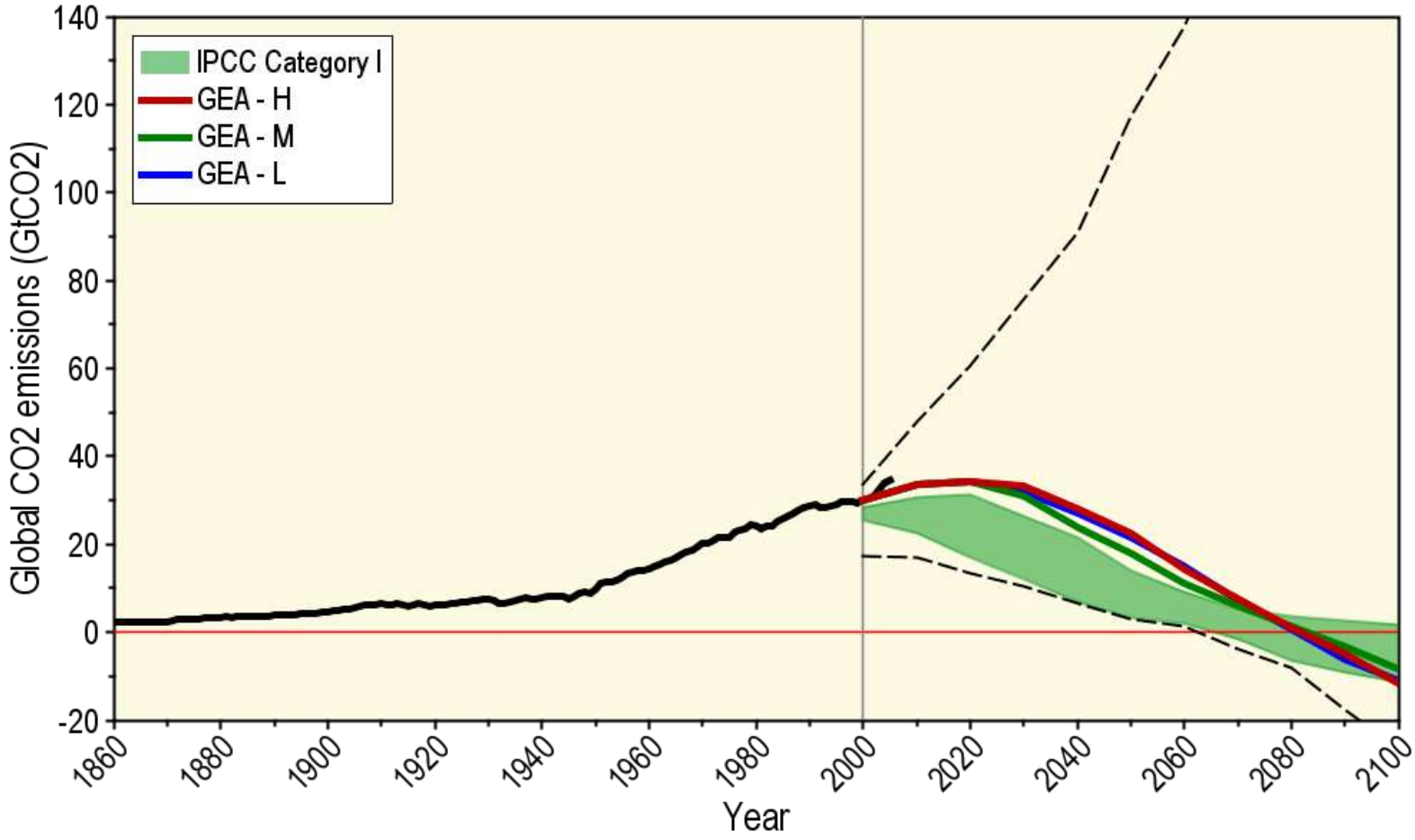
Health Benefits of Pollution Control

(loss of stat. life expectancy - PM)



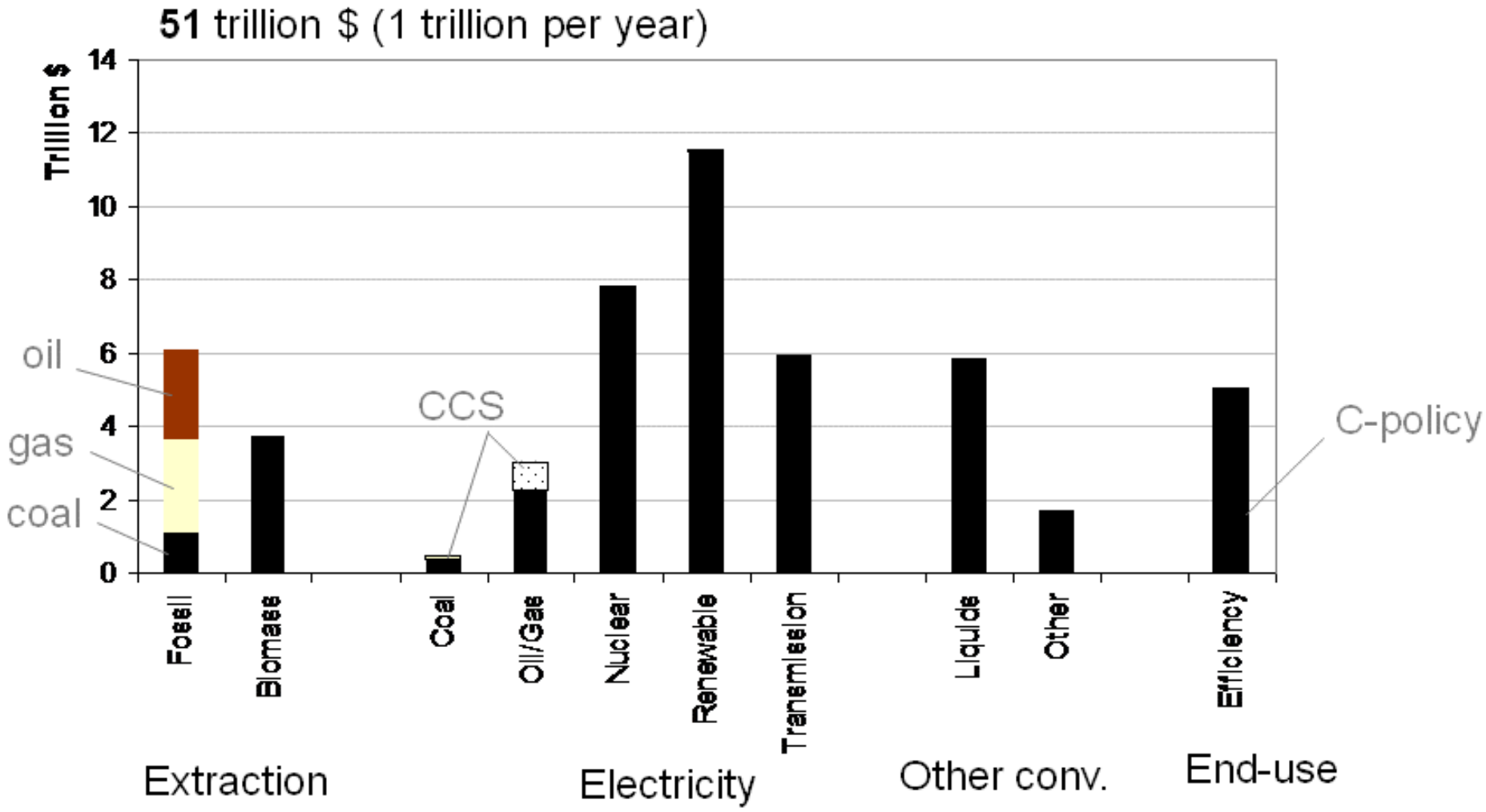
Source: Smith et al, 2009

Global Carbon Emissions



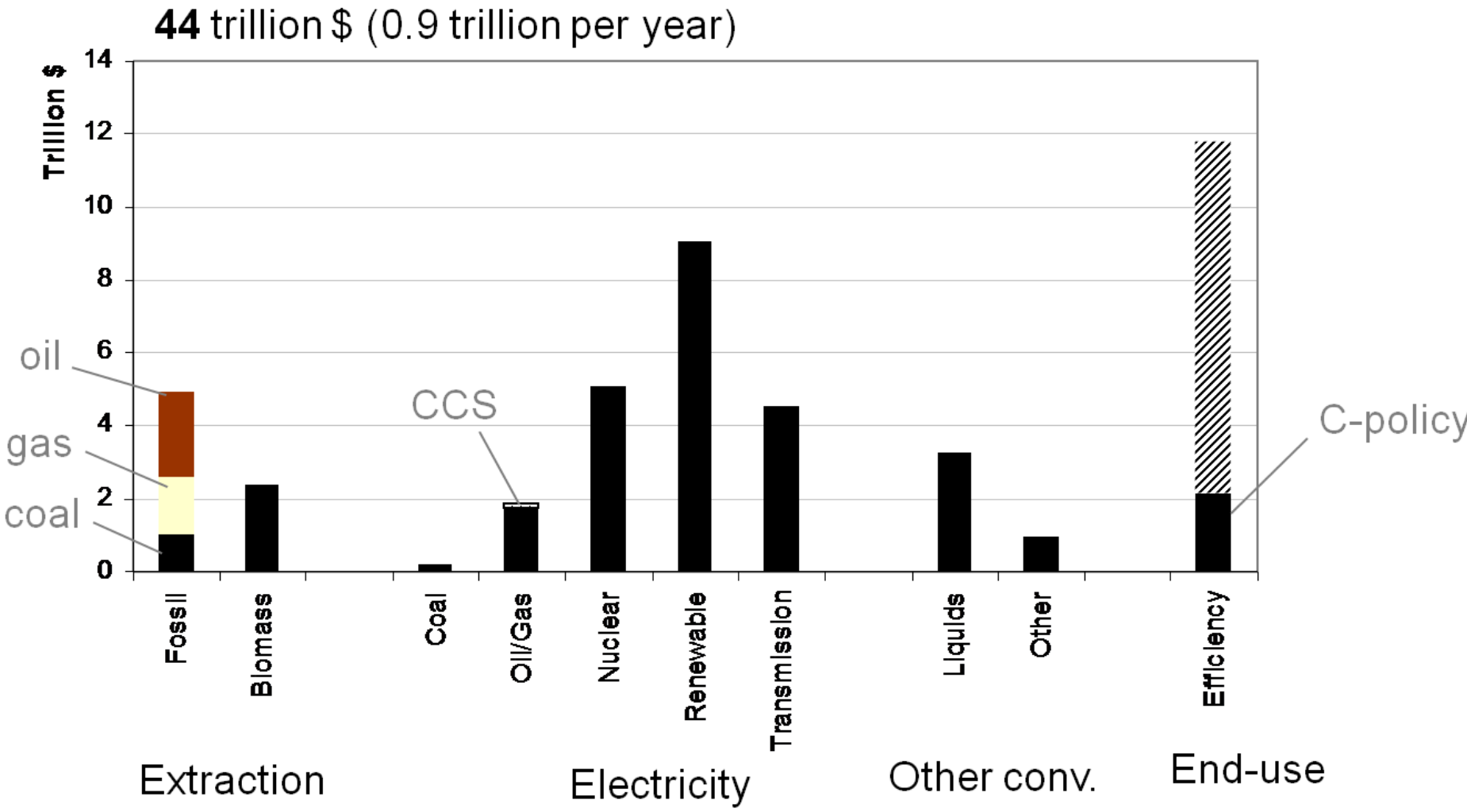
Energy Systems Investments

GEA-M

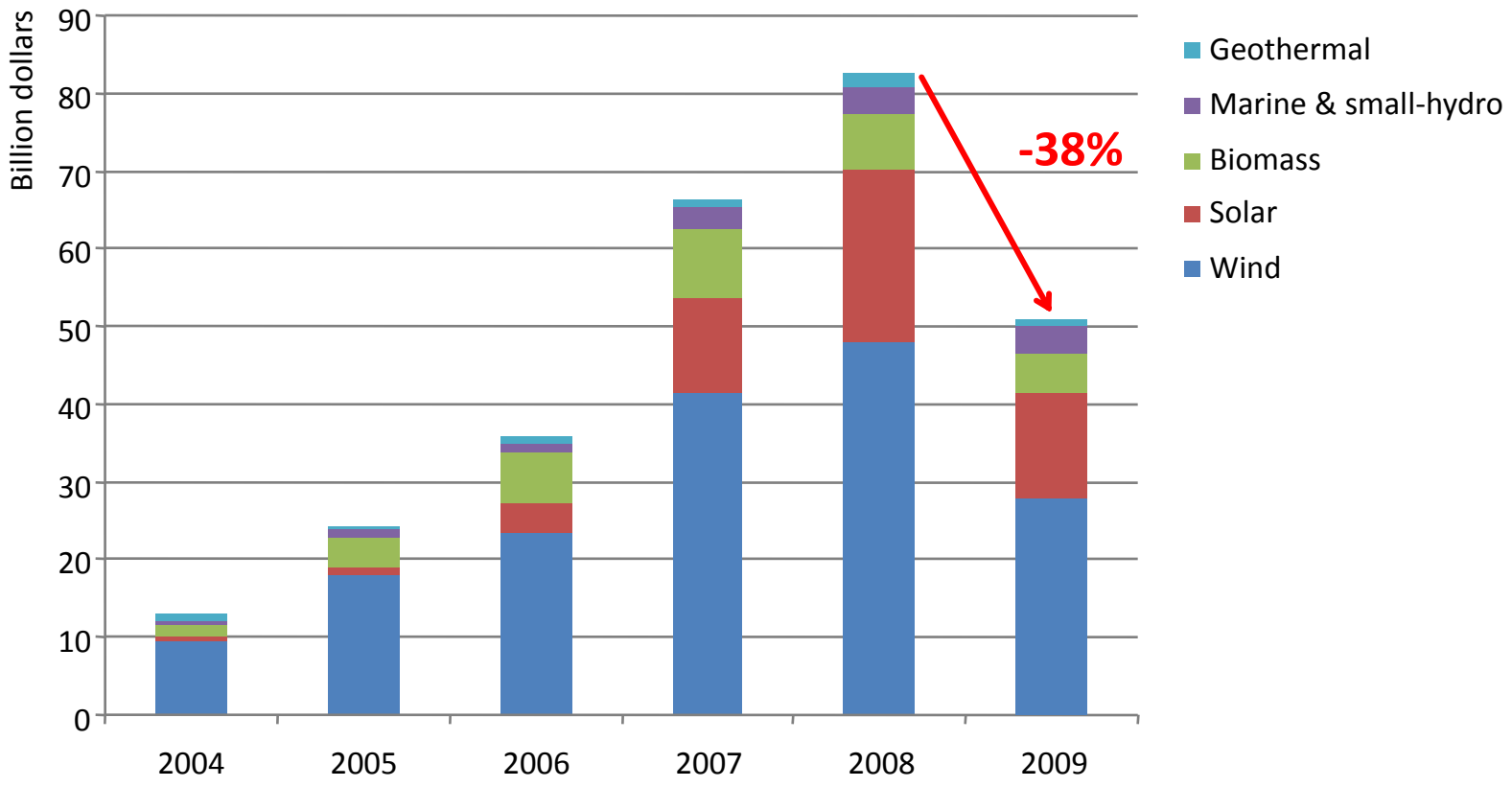


Energy Systems Investments

GEA-L

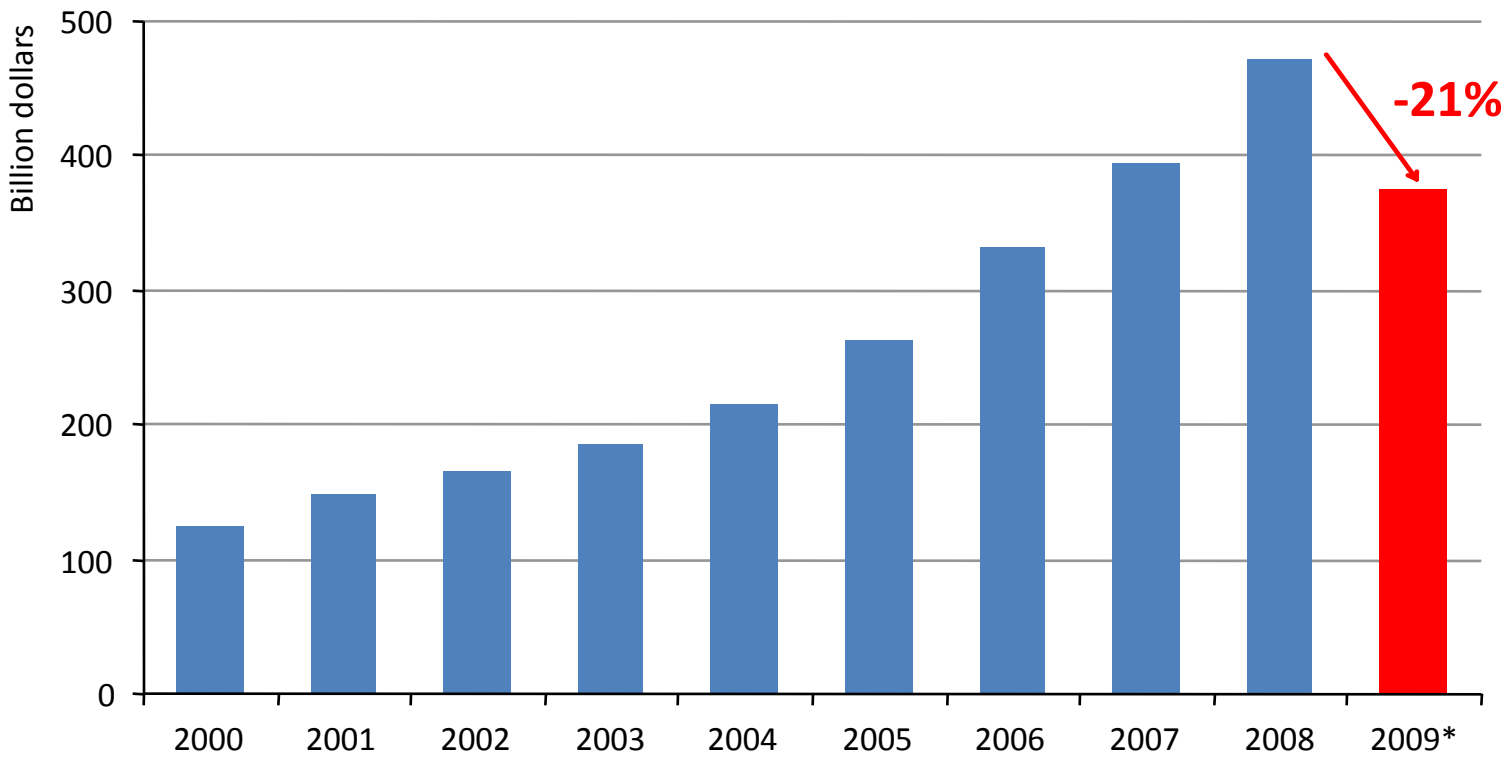


Global Investments in New Renewables



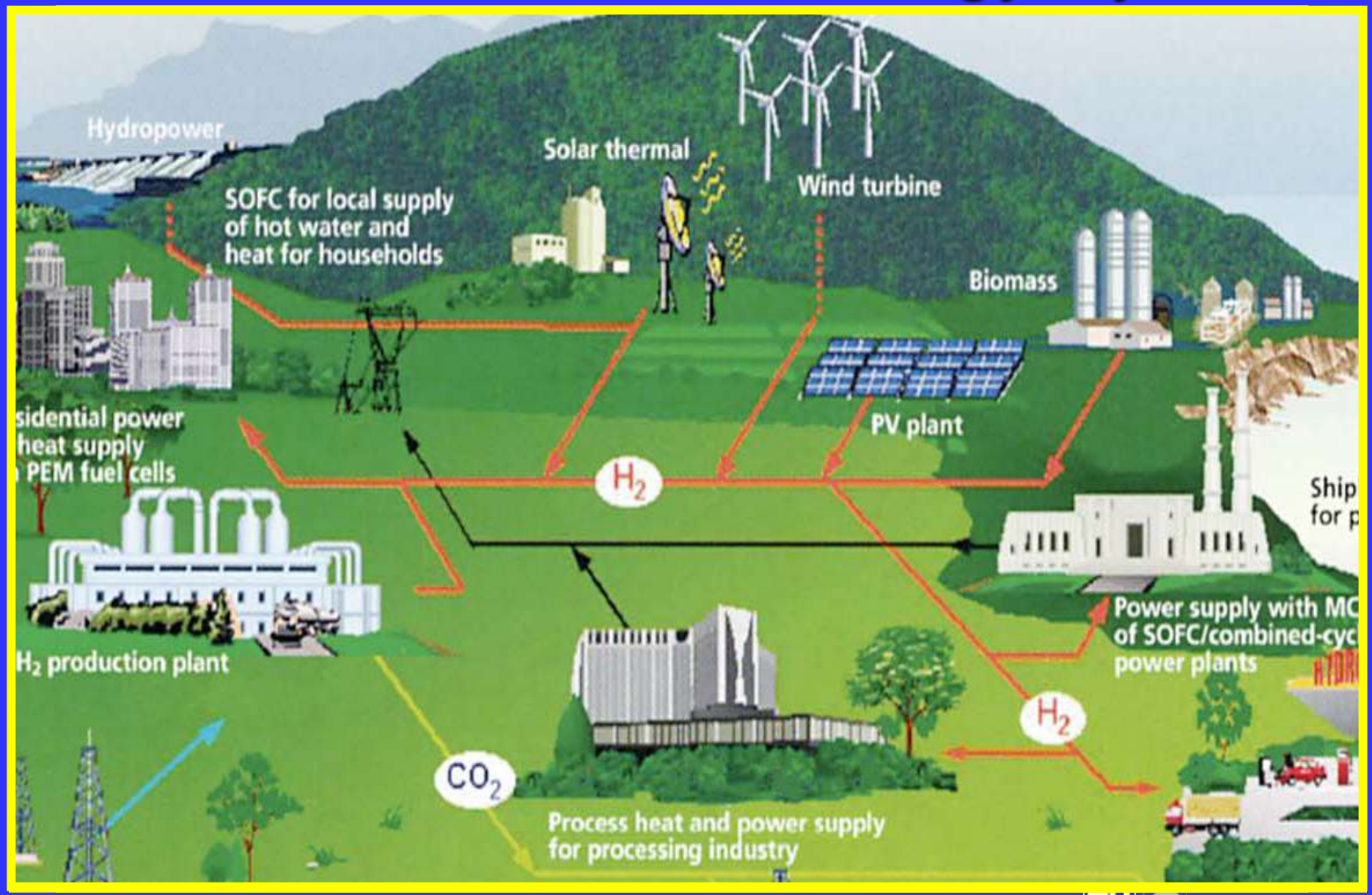
Source: IEA, 2009

Global Investments in Upstream Oil and Gas



Source: IEA, 2009

A Vision of a Future Energy System



Towards a more Sustainable Future

- The *magnitude of the change* required in the global energy system will be huge
- The challenge is to find a way forward that addresses *simultaneously* climate change, security and equity issues.
- *Paradigm change is needed*: radical improvements in energy end-use efficiency, new renewables, advanced nuclear and carbon capture and storage.

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