Global Energy Perspectives

Efficiency and Decarbonization Revolution

Nebojša Nakićenović
International Institute for Applied Systems Analysis
Technische Universität Wien
naki@iiasa.ac.at

ALPS International Symposium on:
"Addressing Climate Change Harmonized with Sustainable Development"
RITE, Tokyo, Japan – 7 February, 2012

Global Energy Transformation

Efficiency and Decarbonization Revolution

Nebojša Nakićenović
International Institute for Applied Systems Analysis
Technische Universität Wien
naki@iiasa.ac.at

ALPS International Symposium on:
"Addressing Climate Change Harmonized with Sustainable Development"
RITE, Tokyo, Japan – 7 February, 2012

Energy Transformation

- The world is still on a carbon-intensive growth path with ever increasing GHG emissions
- 2° C stabilization requires a trend reversal of global emissions before 2020
- Global energy is based predominantly on fossil sources (more than 80%)
- 3 billion people lack access to modern forms of energy

Decarbonization Pathways

Framework conditions

Challenges:

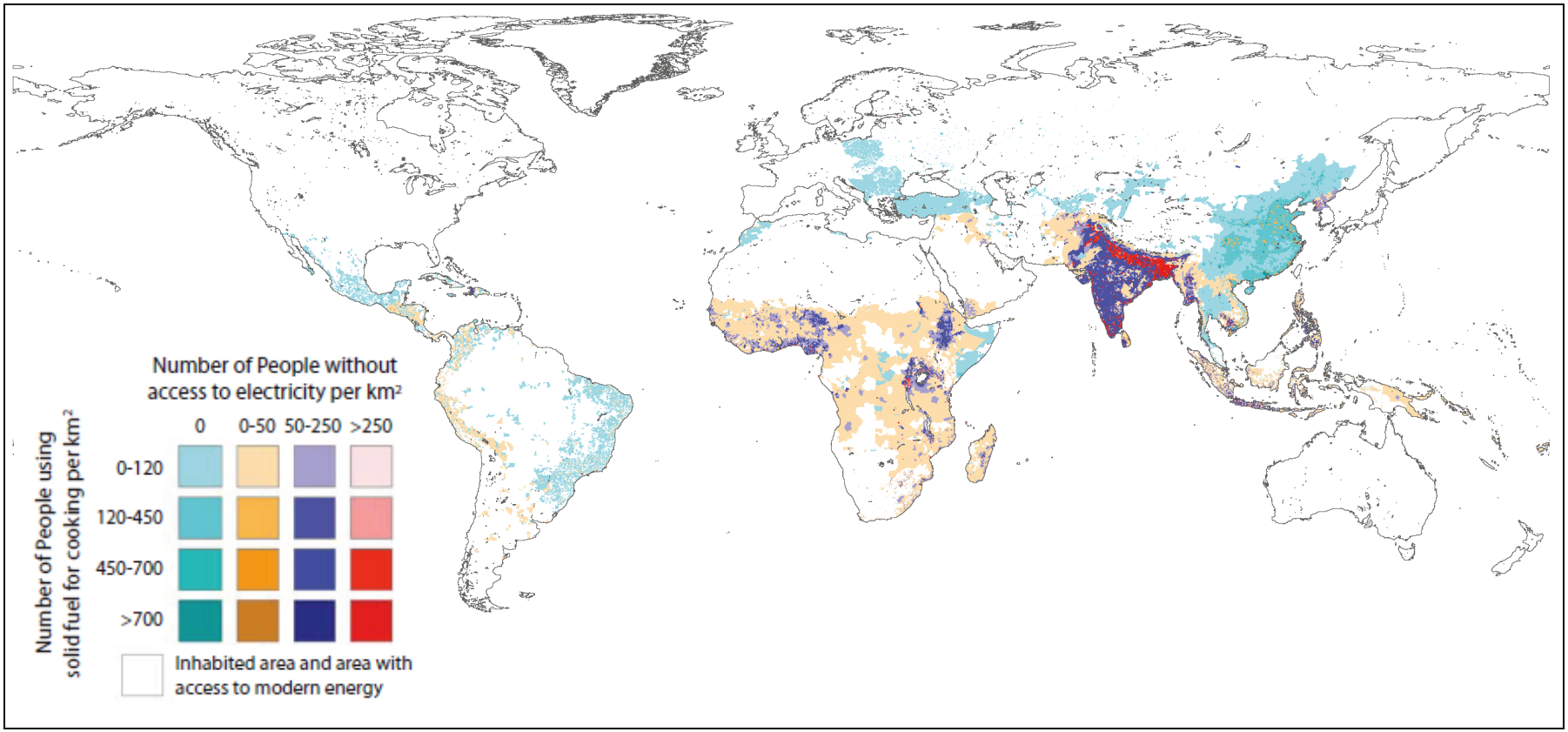
- Achieving universal energy access in the world
- Decarbonization of energy systems until 2050

Preconditions:

- The global primary energy demand should not increase significantly beyond the current levels
- Drastic improvements in energy efficiency (halving the global of CO_2 intensity of energy)
- Behavioral and lifestyles changes necessary

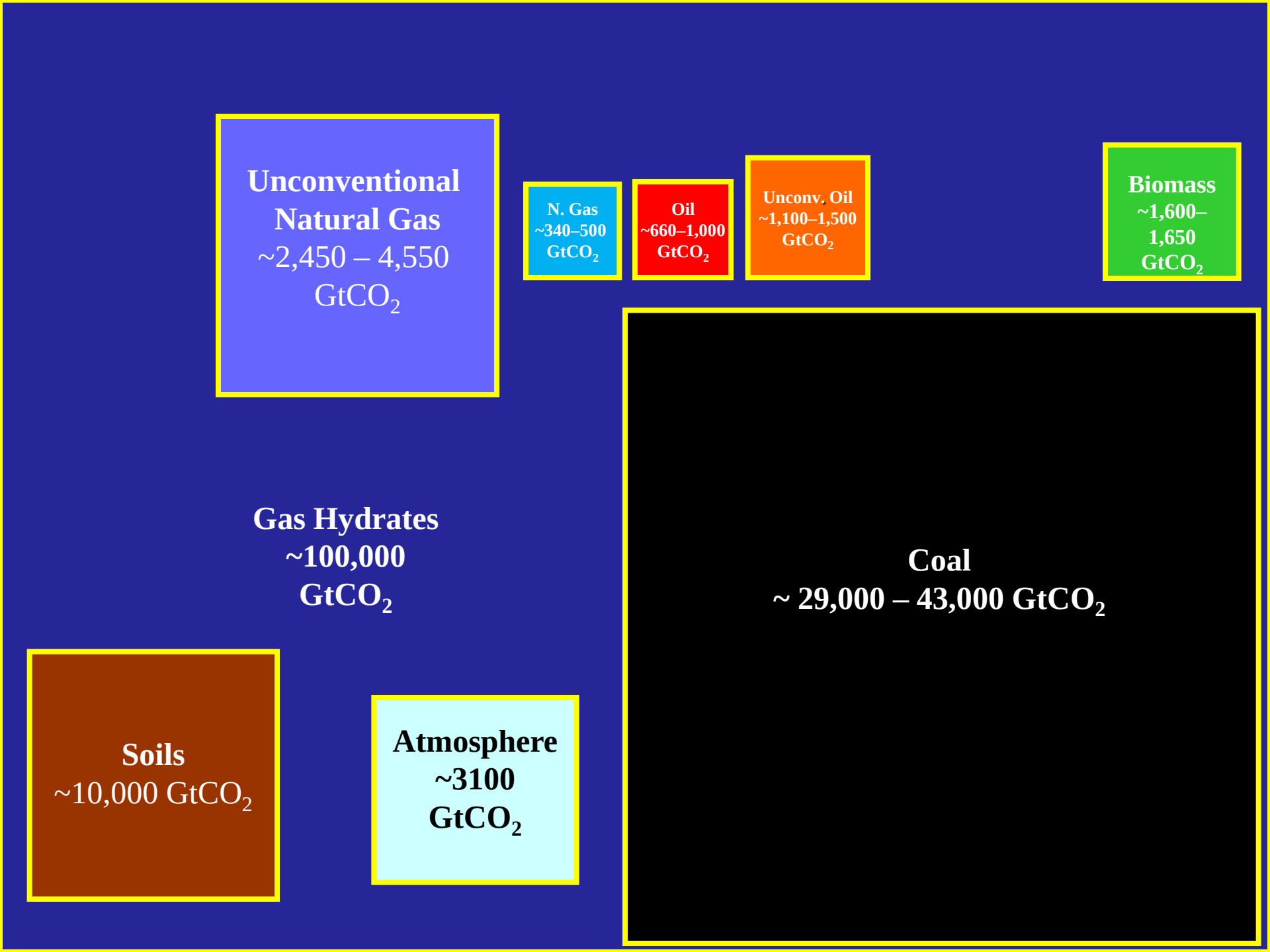
Mapping Energy Access

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

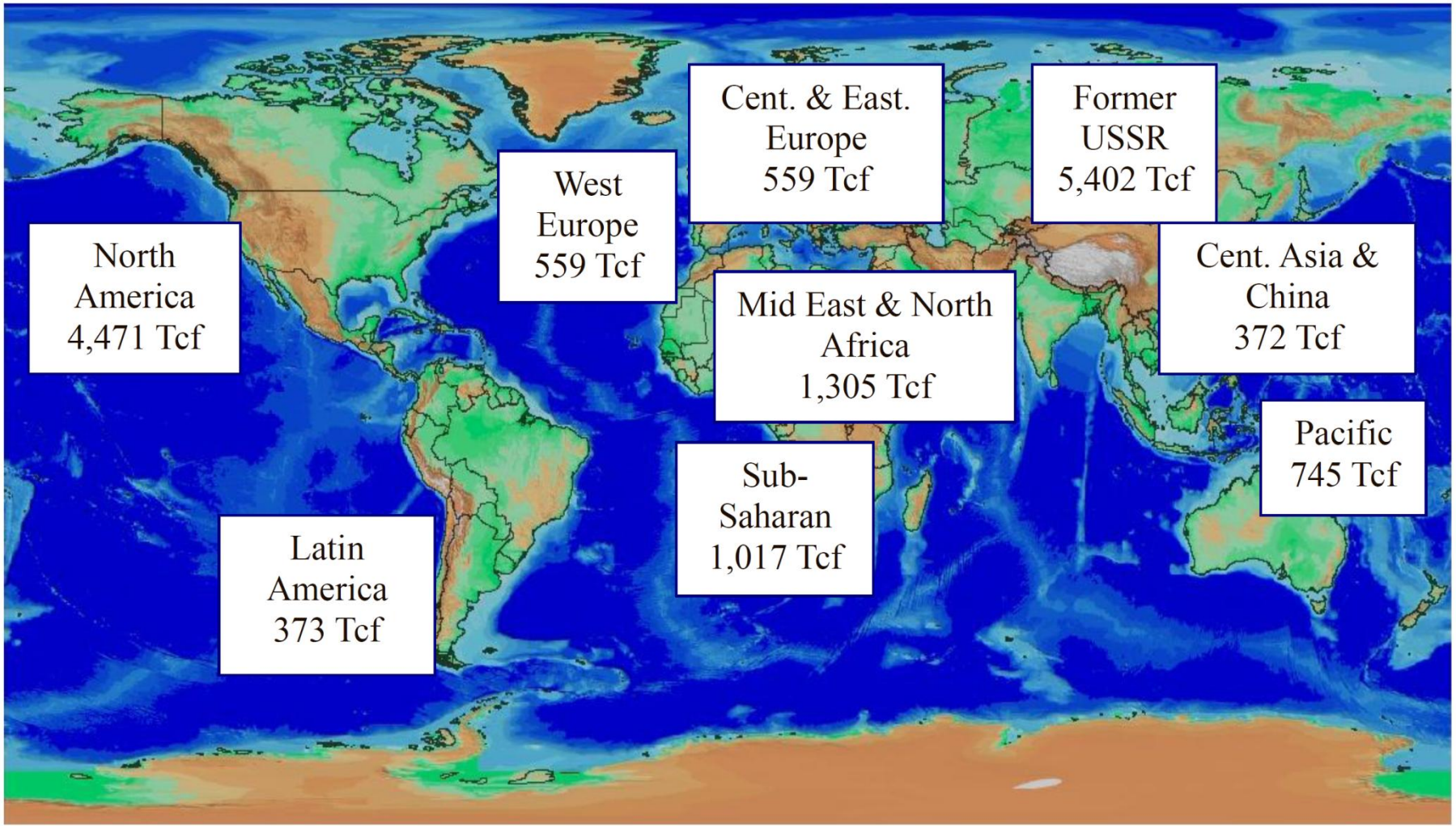


Source: Pachauri et al, 2011

Source: Modi, 2011


Unconventional Natural Gas
~2,450 – 4,550 GtCO2
N. Gas ~340–500 GtCO2
Oil ~660–1,000 GtCO2
Unconv. Oil ~1,100–1,500 GtCO2
Biomass ~1,600–1,650 GtCO2
Gas Hydrates ~100,000 GtCO2
Coal ~ 29,000 – 43,000 GtCO2
Soils ~10,000 GtCO2
Atmosphere ~3100 GtCO2

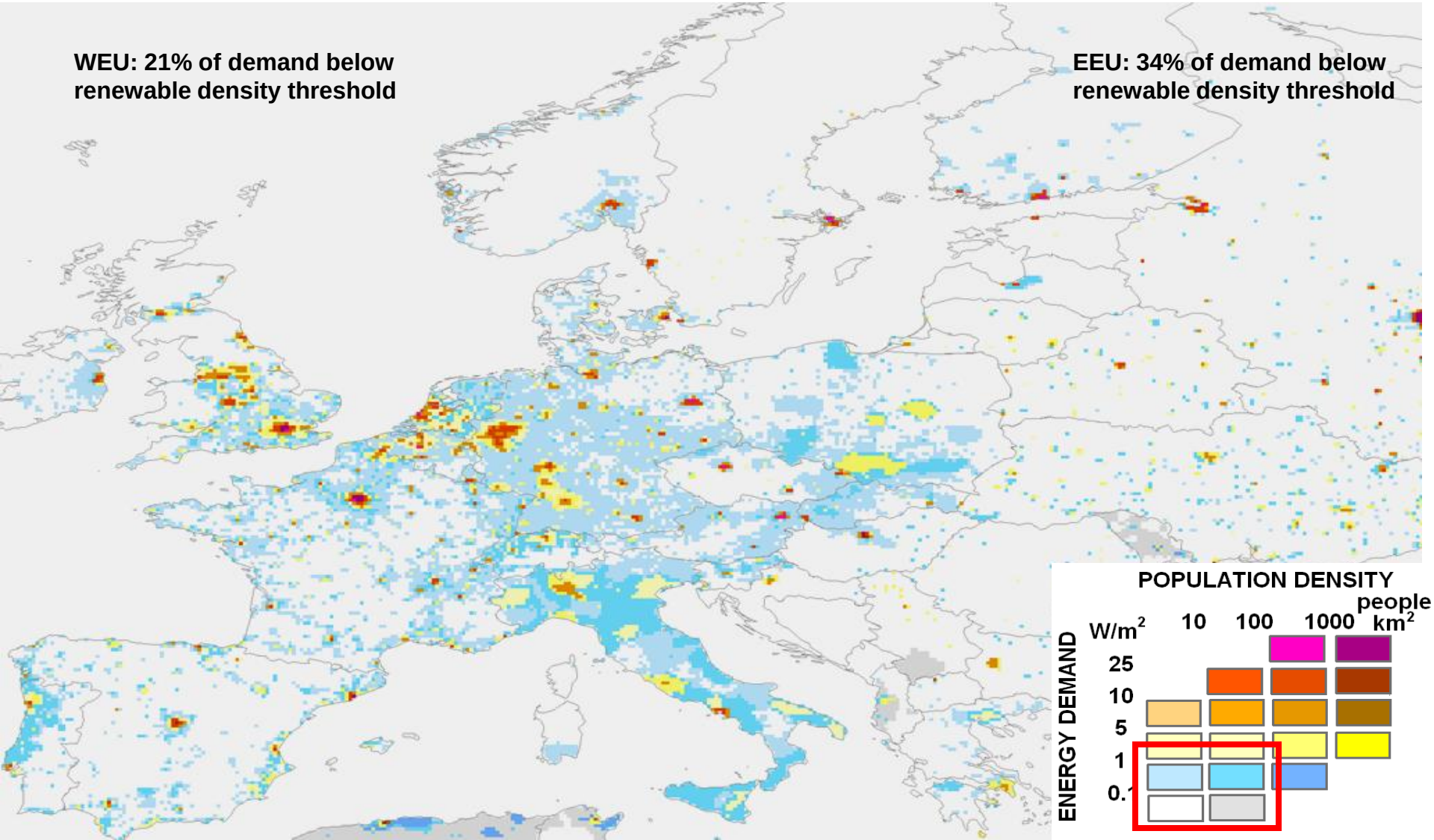
Estimated shale gas resource



14,803 TCF ≈ 15,600 EJ

IGU 2003, VNIIGAS 2007, USGS 2008, BGR 2009

Europe Population vs. Energy Demand Density



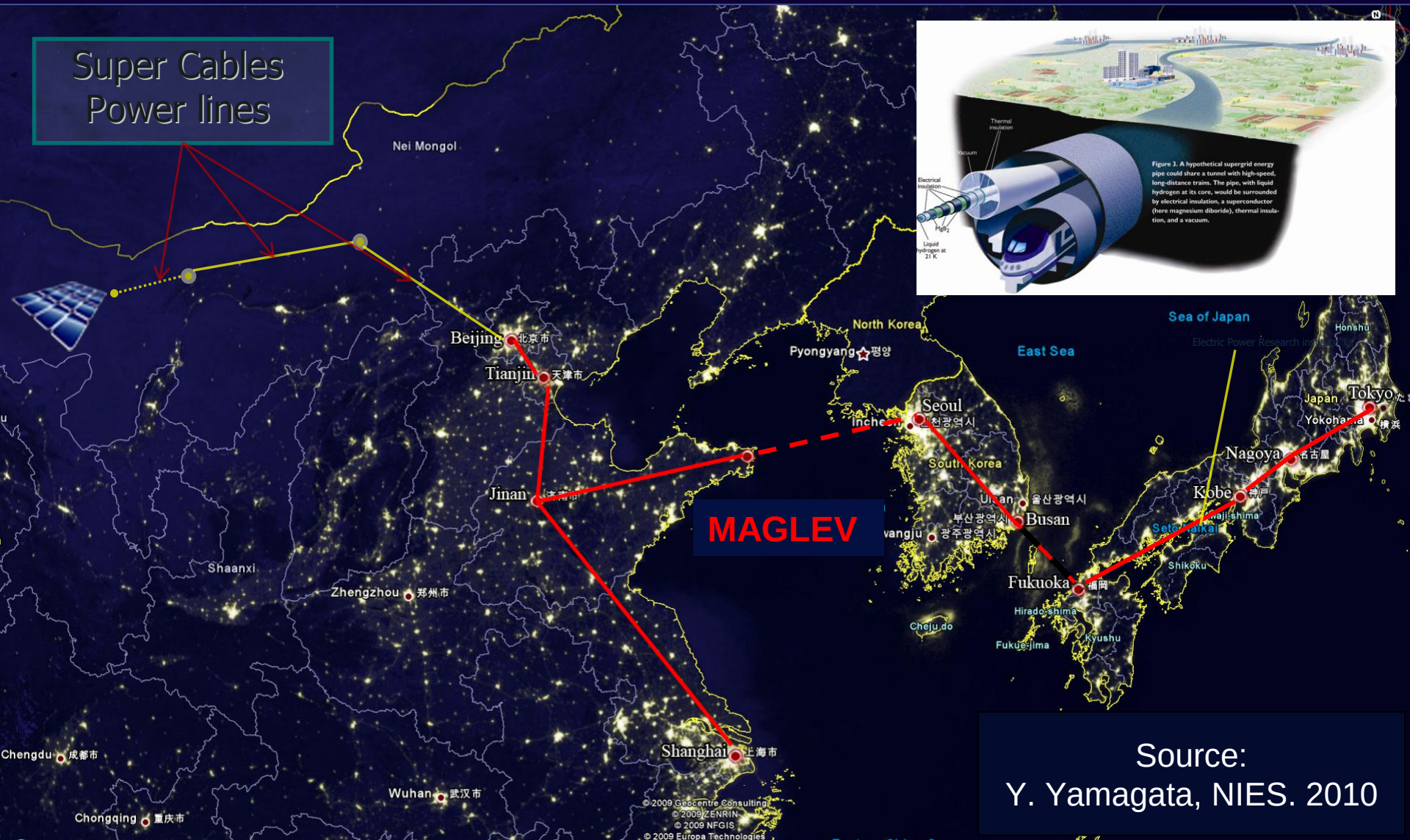
Energy and Water from Deserts

Source: Hasni, 2011

Energy for Europe (Desertec)

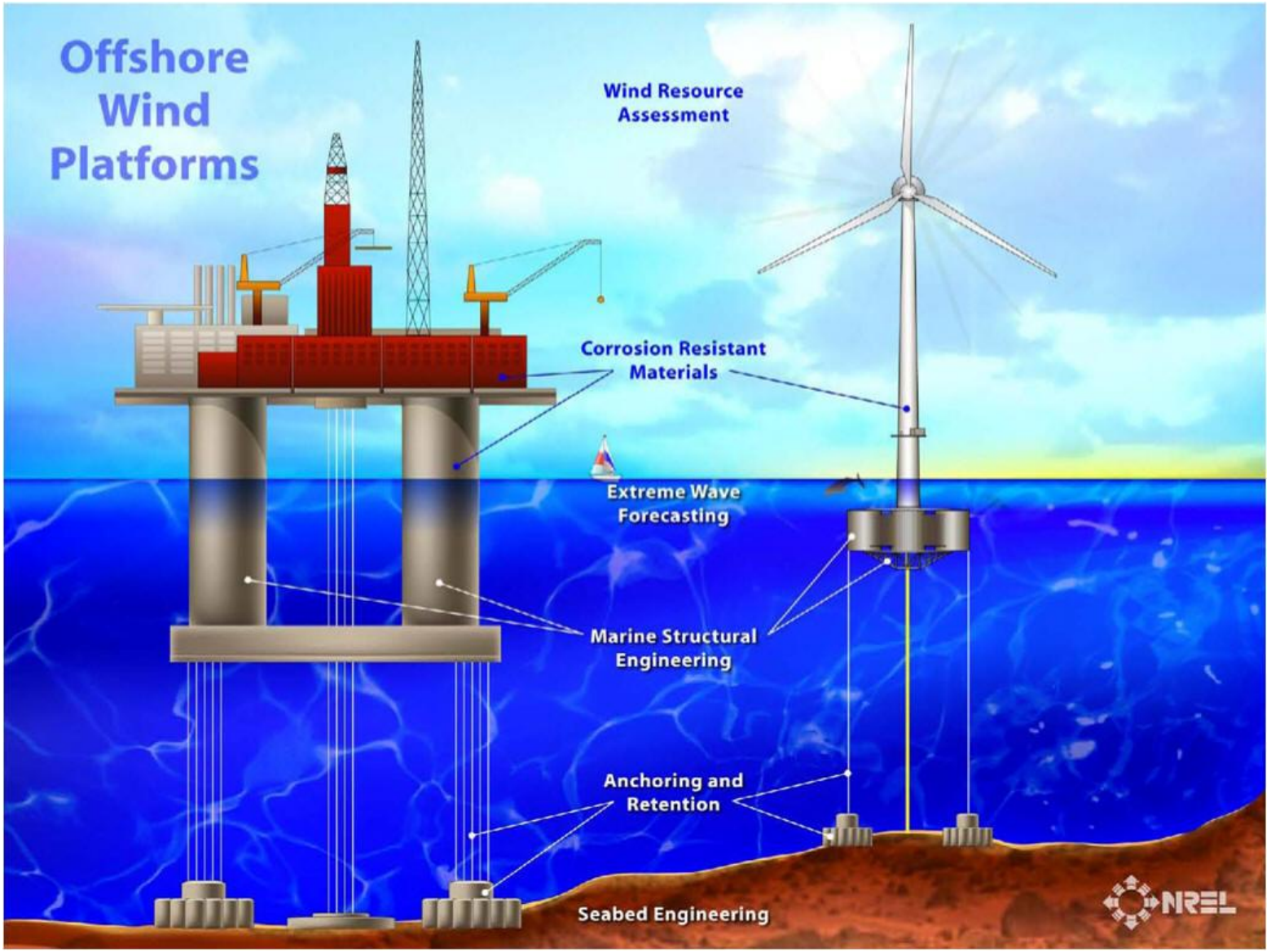
Source: Hasni, 2011

Potential Synergies between New Energy and Transport Infrastructures: Asian "Supergrid"



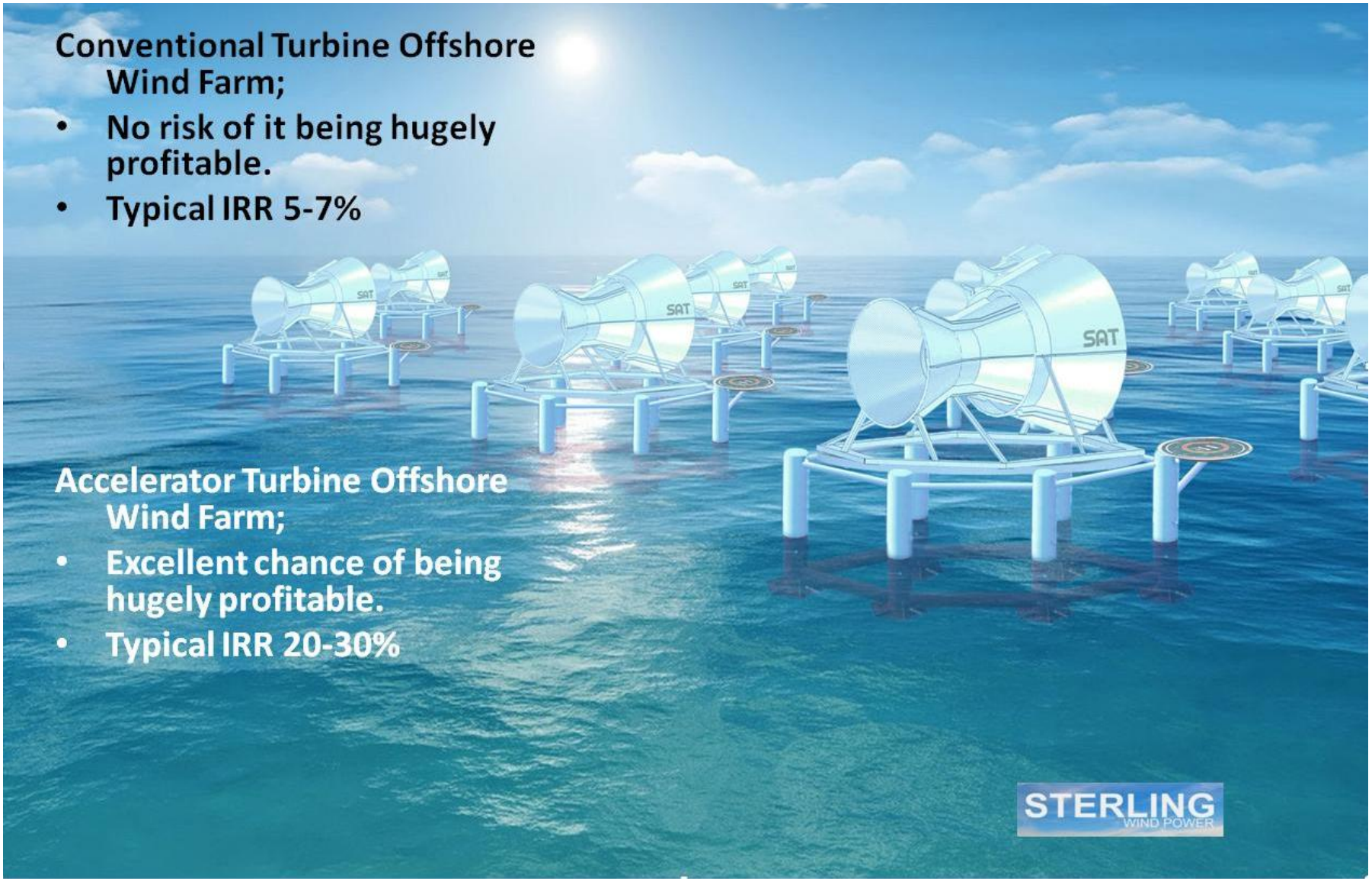
Source:
Y. Yamagata, NIES. 2010

Deep Offshore Ocean Wind



Source: NREL, 2011

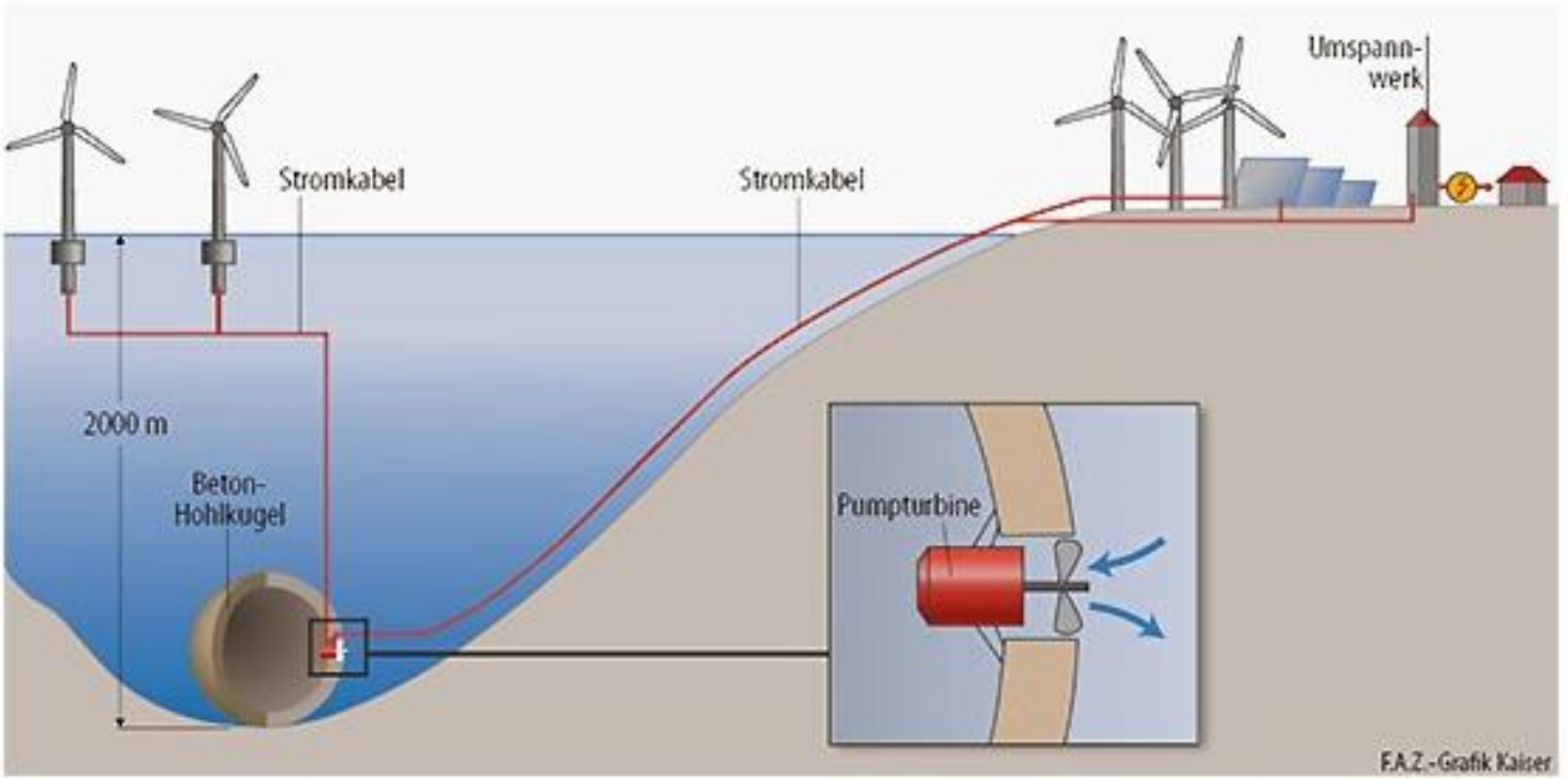
Deep Offshore Ocean Wind



Source: LA Wind, 2011

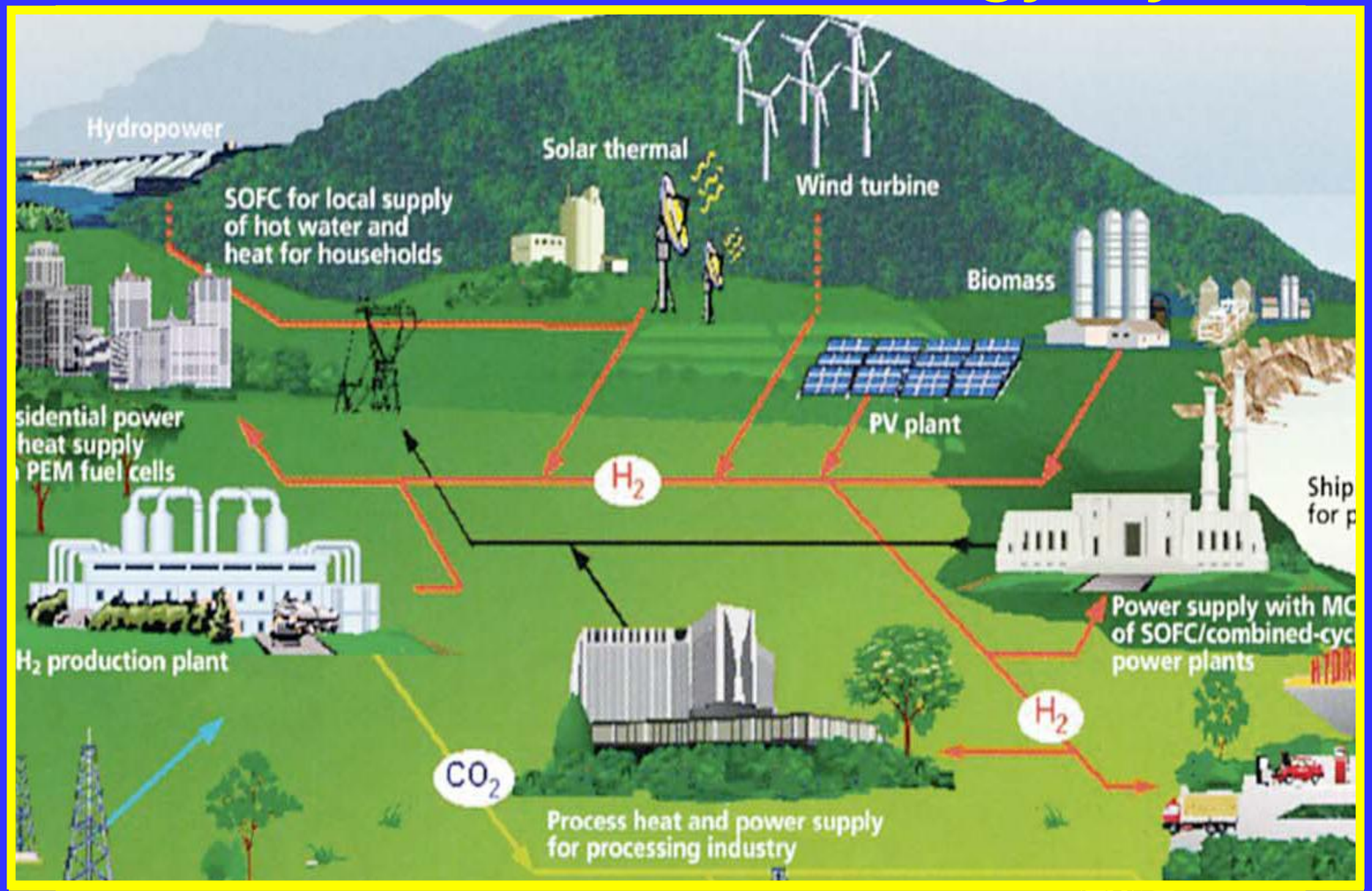
Deep Ocean Pumped Storage

~ 30m sphere @ 2000m ≈ 60MWh

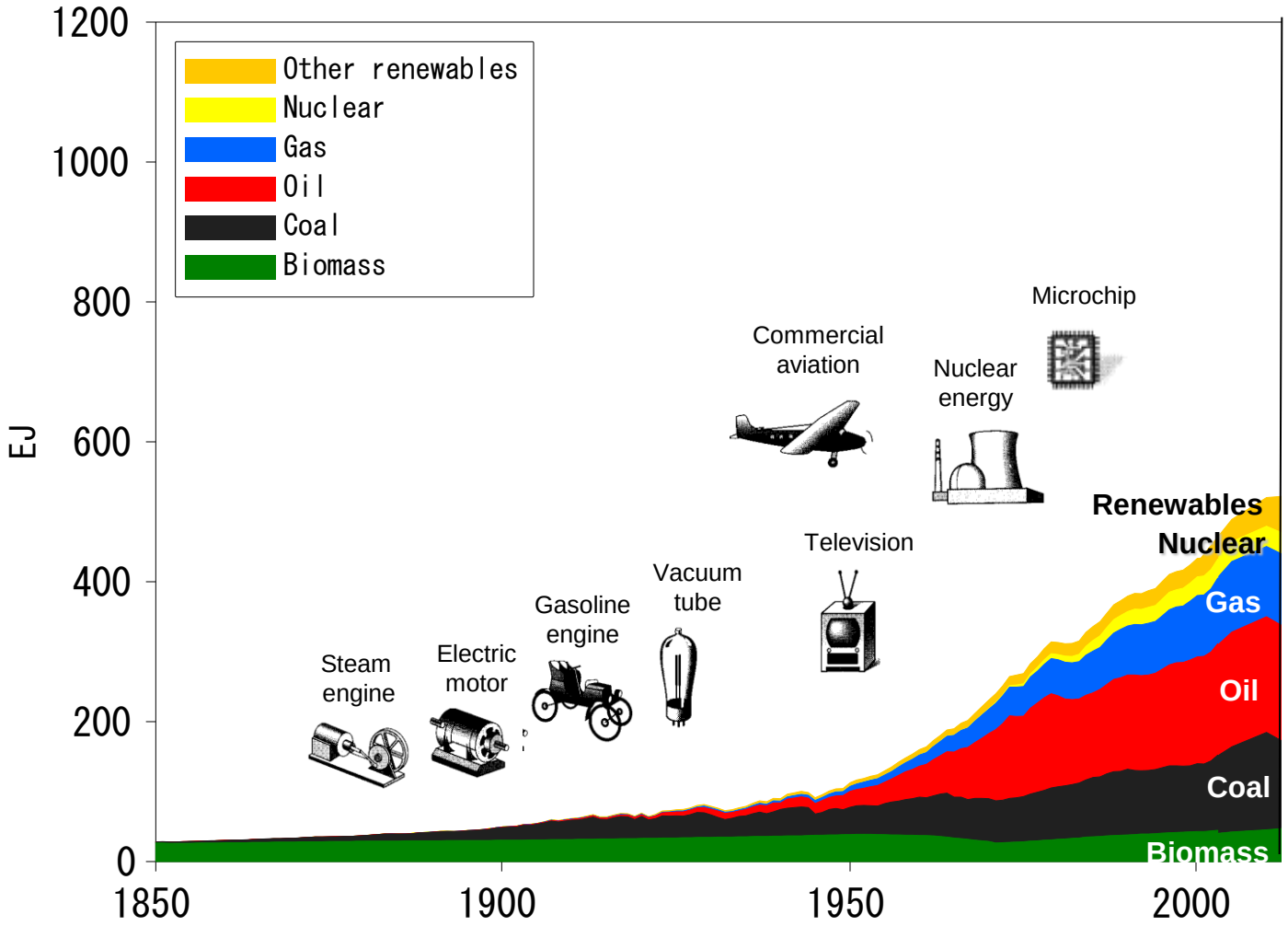


Source: Schmidt-Böcking, 2011; FAZ, 2011

A Vision of a Future Energy System

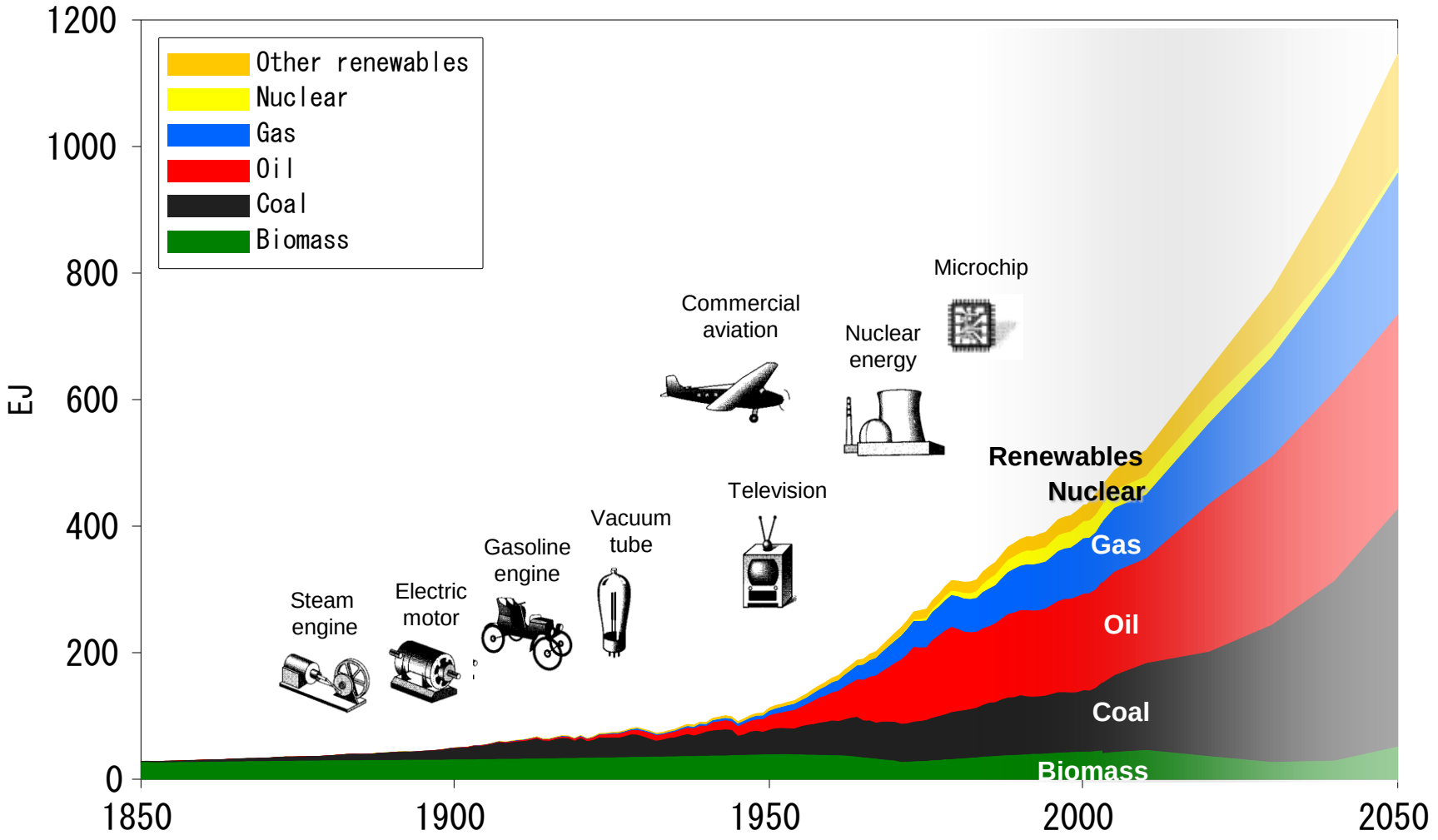


Global Primary Energy



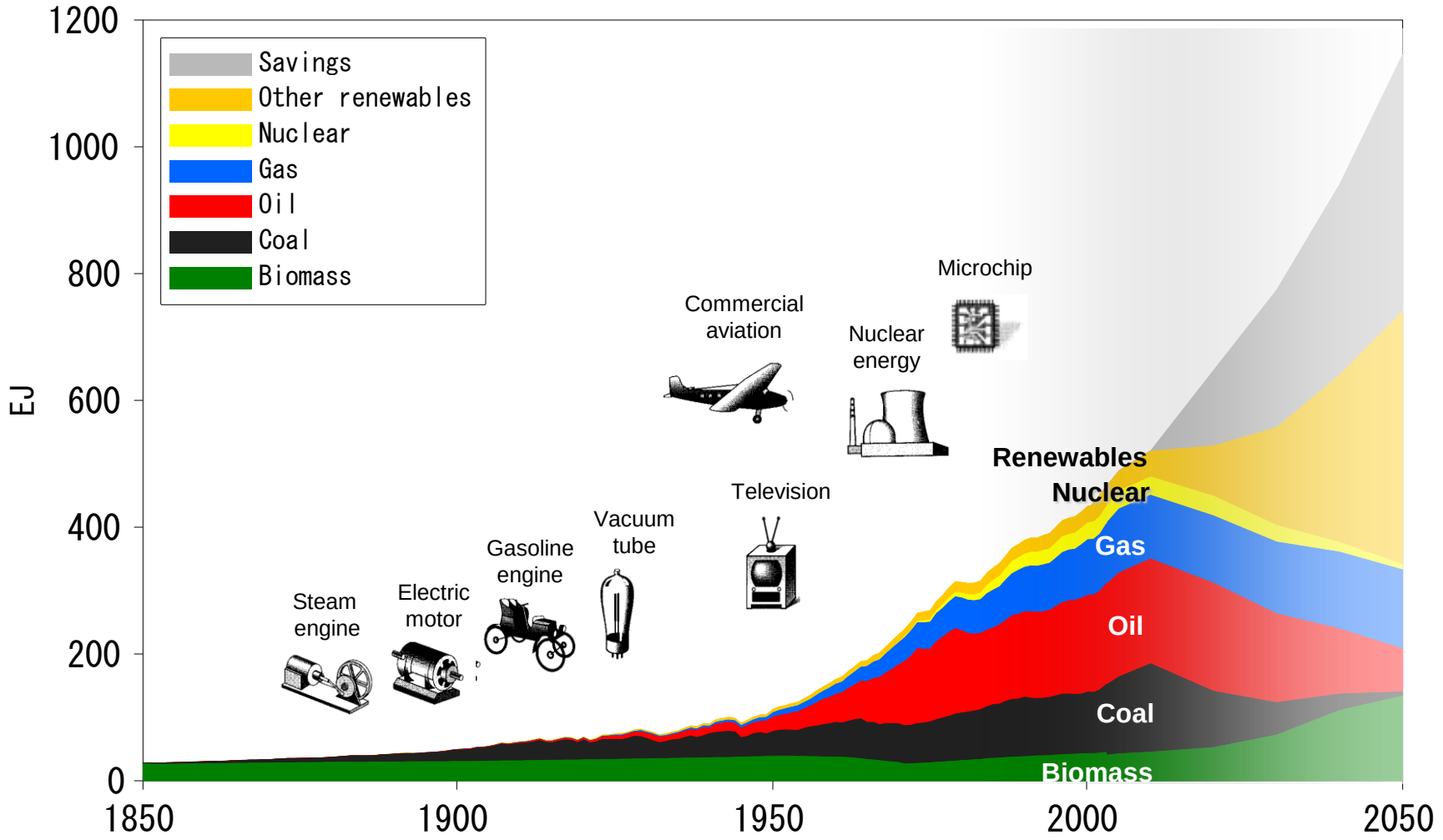
Global Primary Energy

Efficiency – Counterfactual



Global Primary Energy

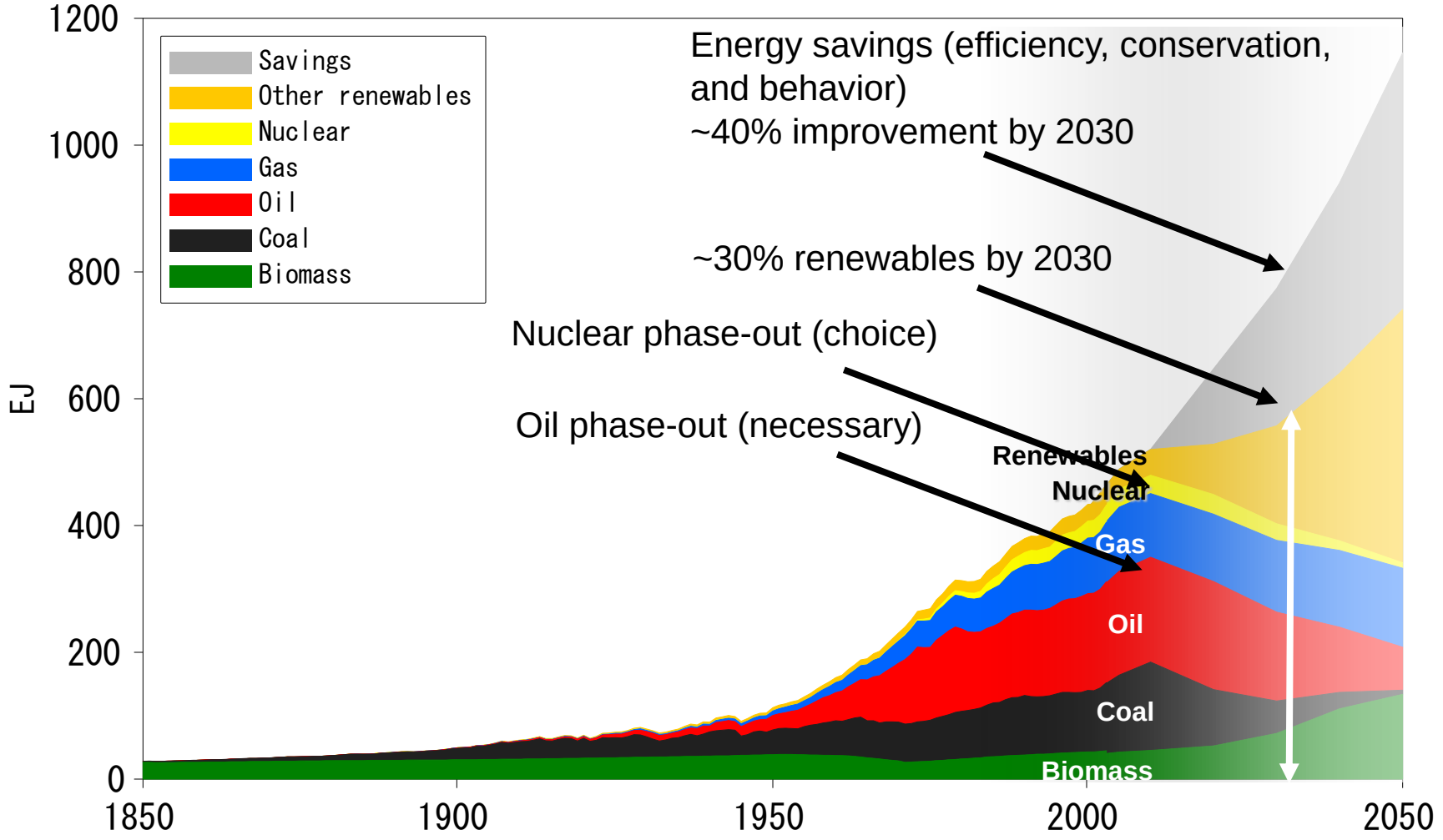
no CCS, no Nuclear



Source: Riahi et al, 2011

Global Primary Energy

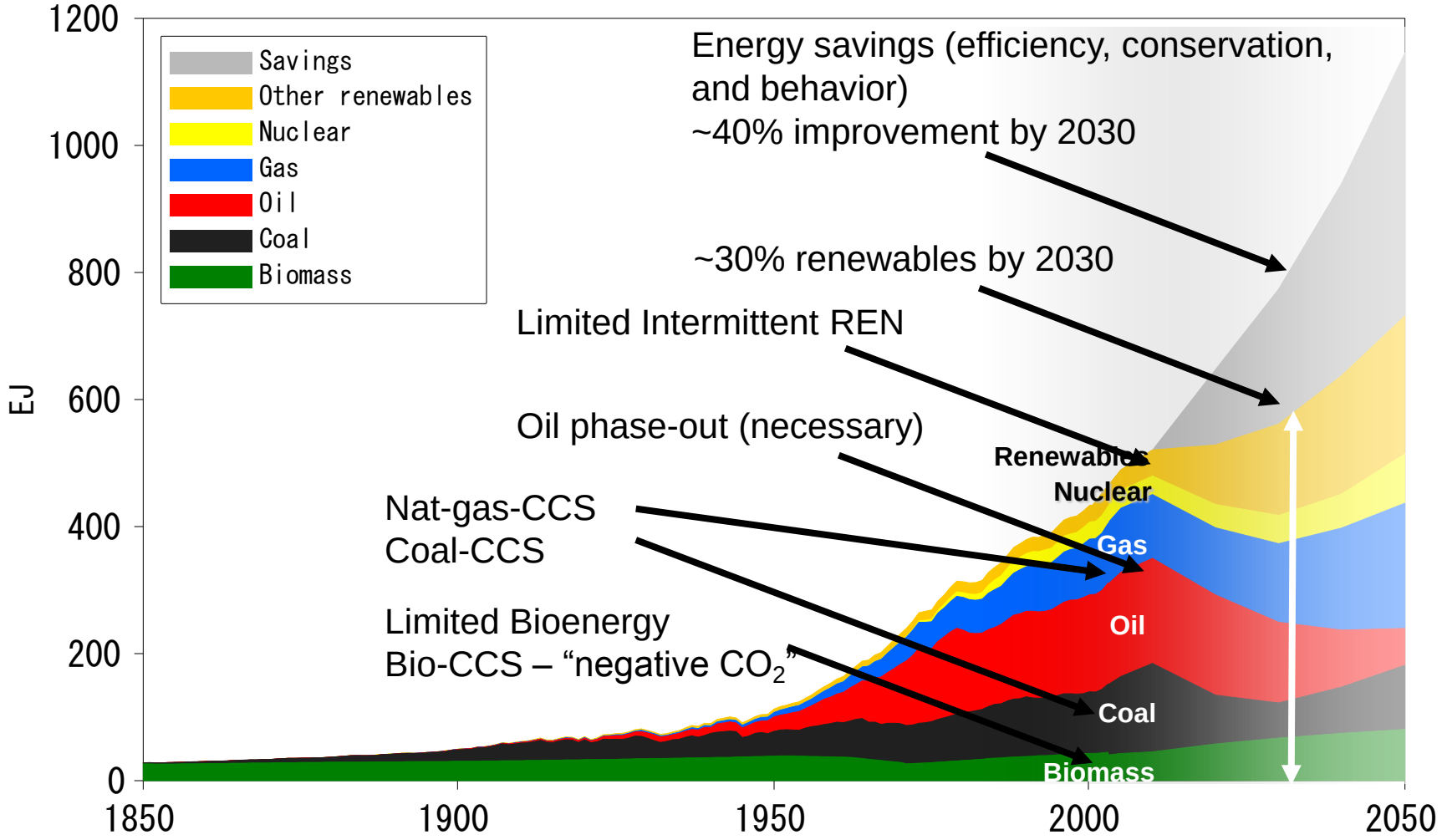
no CCS, no Nuclear



Source: Riahi et al, 2011

Global Primary Energy

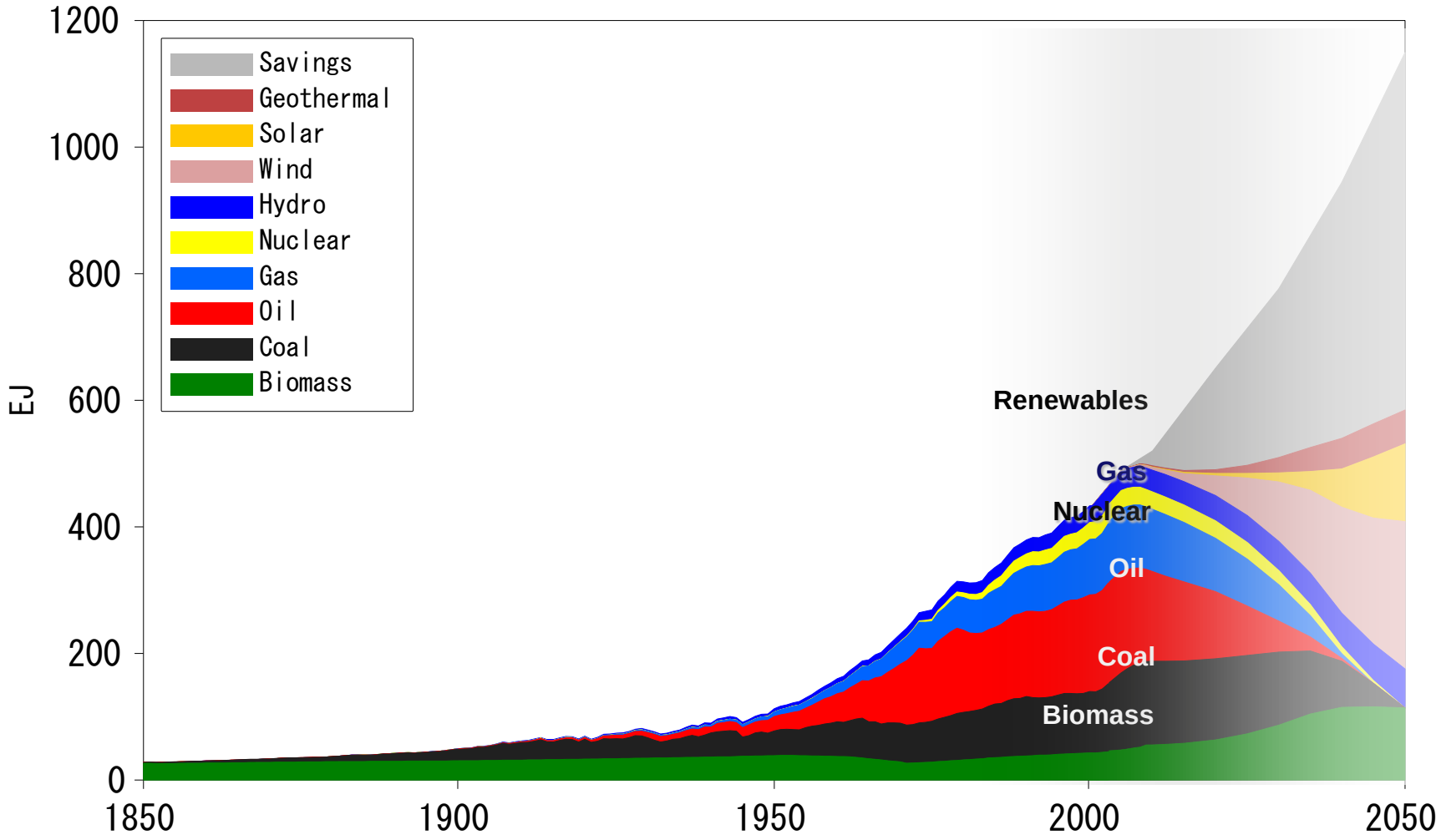
lim. Bioenergy, lim. Intermittent REN



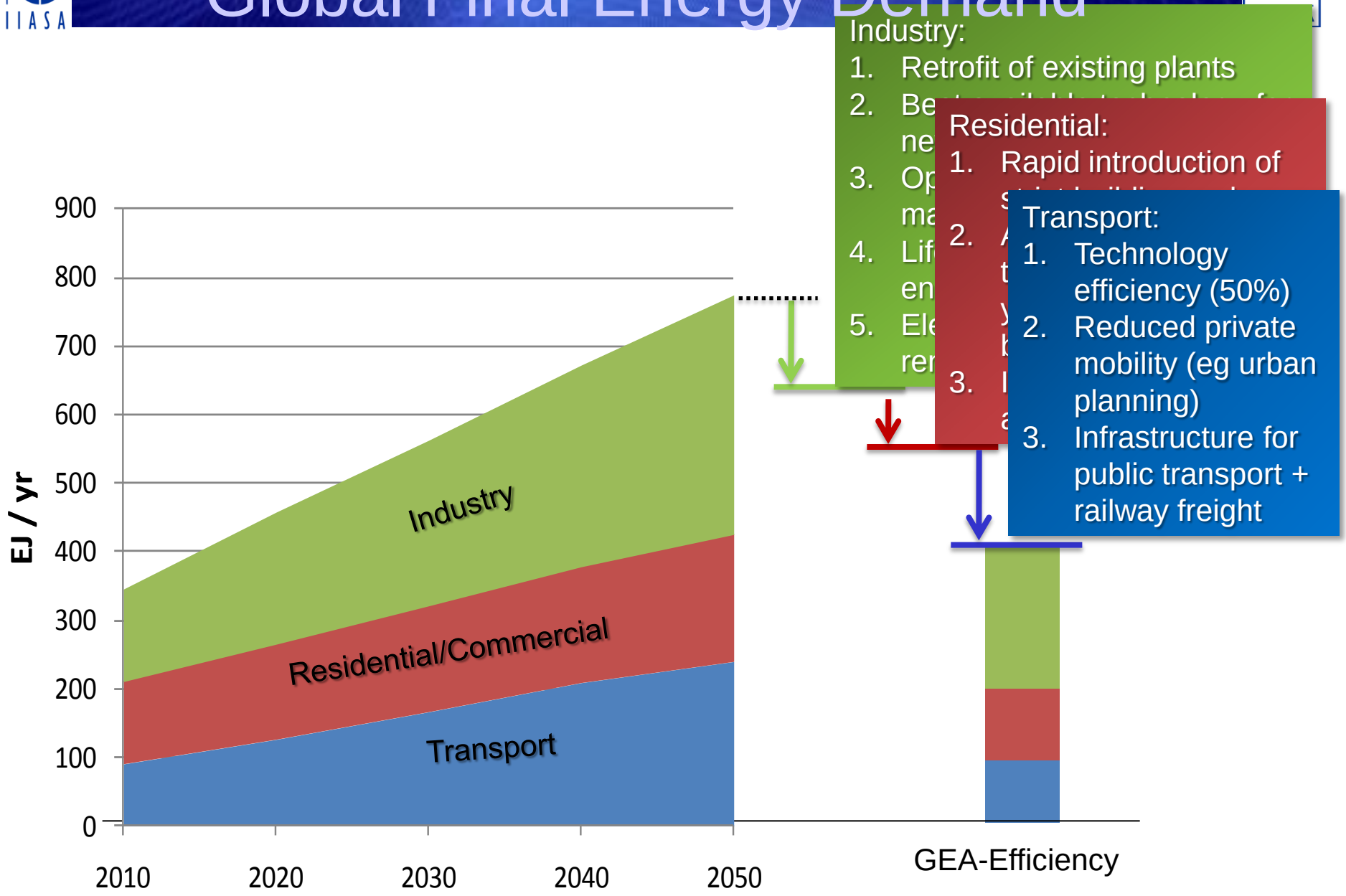
Source: Riahi et al, 2011

Global Primary Energy

WBGU Exemplary Pathway



Global Final Energy Demand



Source: Riahi et al, 2011

Global Energy Investments

Annual Energy Investments	Innovation RD&D [billion US$2005]	Markets Formation [billion US$2005]	Present Investments [billion US$2005]	Future Investments [billion US$2005]
	2010	2010	2010	2010 - 2030
Efficiency	>> 8	~ 5	300	~400
Renewables	> 12	~ 20	200	~400
Access	< 1	< 1	~ 9	~40
Total	> 50	< 150	1250	~1750

Source: Grubler et al, & Riahi et al, 2011

2012 INTERNATIONAL YEAR OF
SUSTAINABLE ENERGY
FOR ALL

2030 Energy Goals

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

Aspirational & Ambitious but Achievable

2012 INTERNATIONAL YEAR OF

SUSTAINABLE ENERGY FOR ALL

Drivers of Transformations

learning from the past

Vision – better future, normative perspectives

Abolition of slavery, Democracy, European Union

Crisis – "Gales of Creative Destruction"

The Great Depression, Structural adjustment programmers, financial market reforms after 2008

Technology – Rapid innovation diffusion

Substitution of carriages by cars, IT-revolution

Knowledge – research-driven, precautionary principle

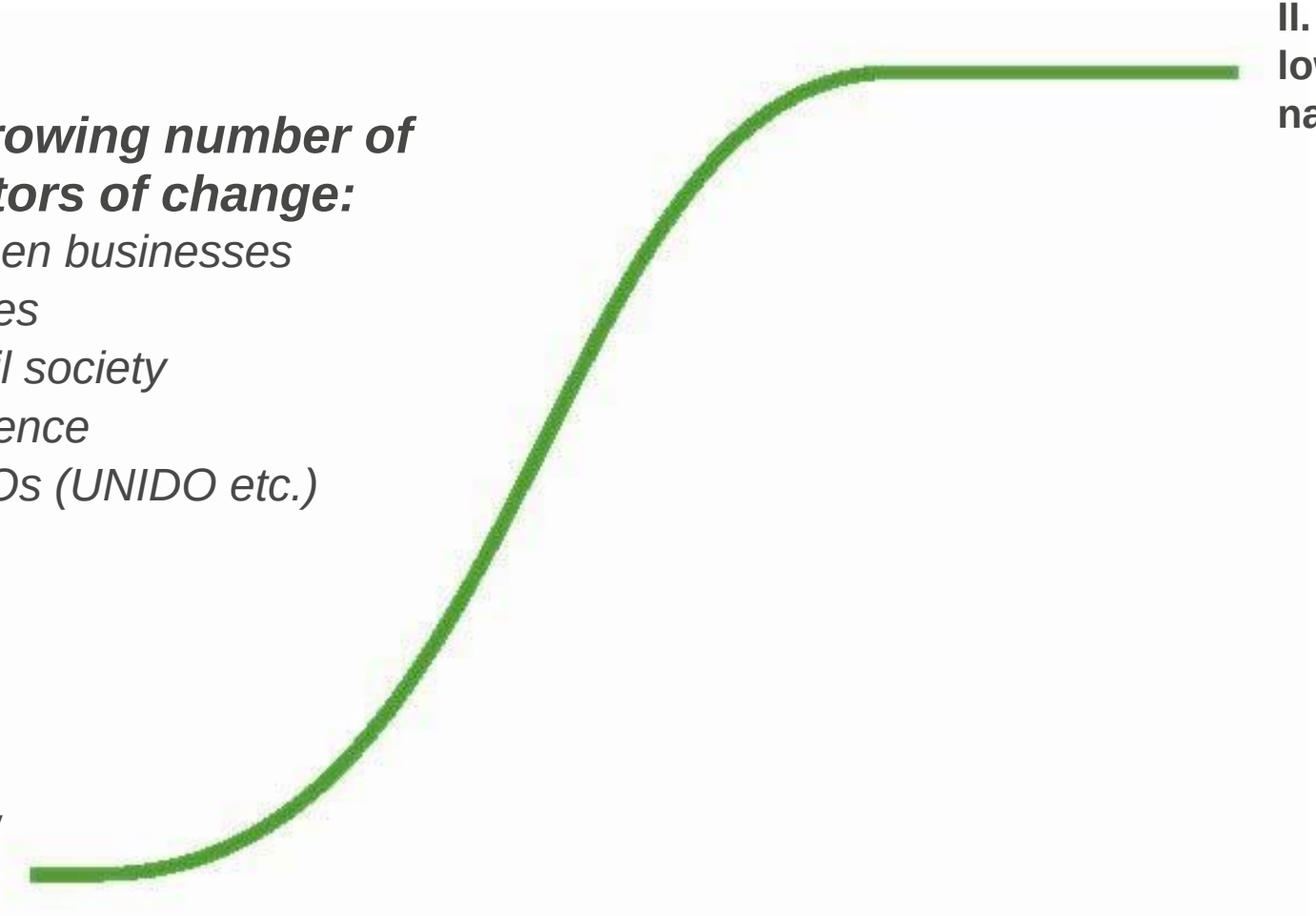
Protection of the ozone layers, climate change mitigation

Drivers of Transformations

”Decarbonization Revolution”

→ ***Growing number of actors of change:***

- *green businesses*
- *cities*
- *civil society*
- *science*
- *IGOs (UNIDO etc.)*

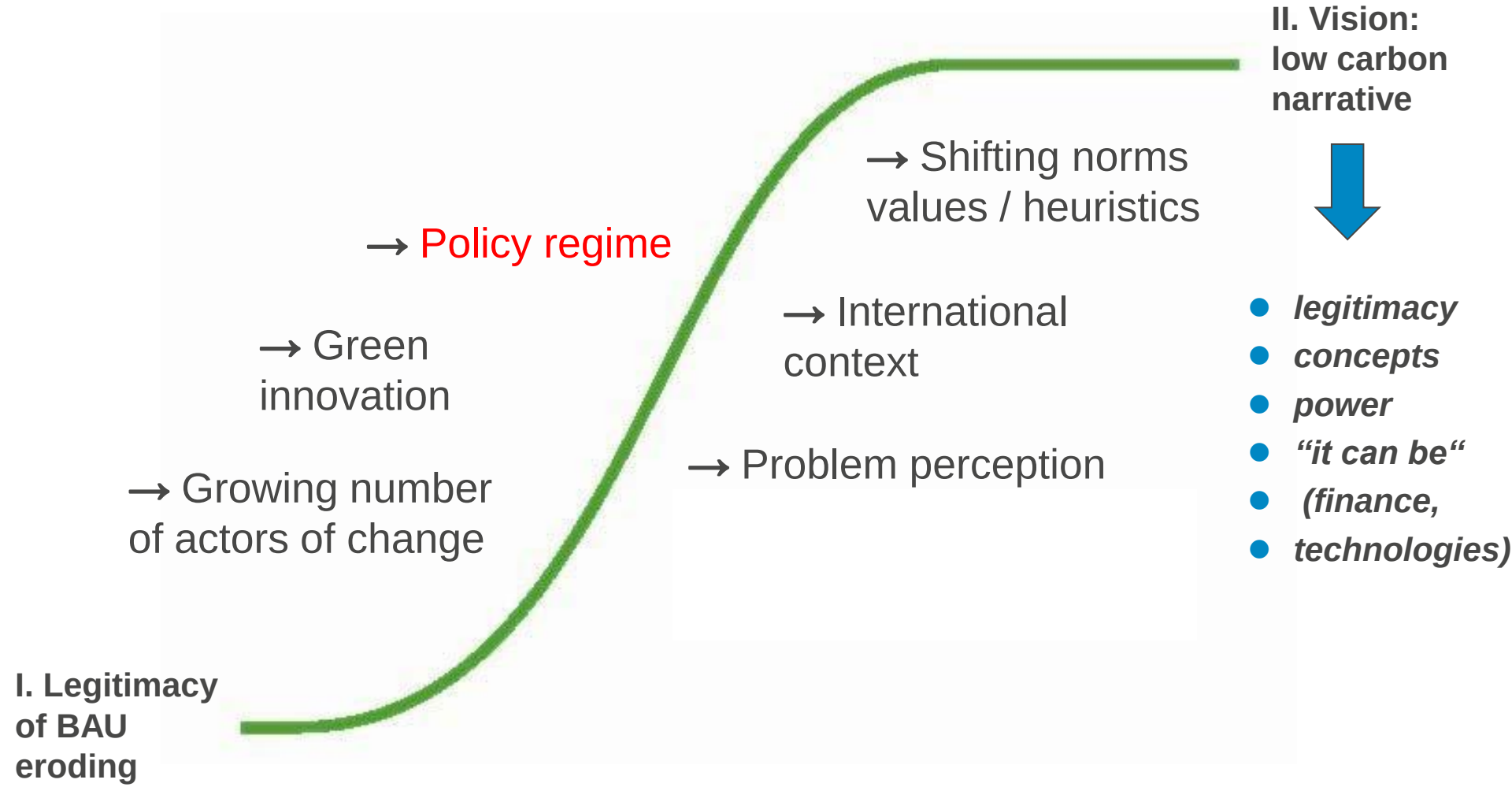


II. Vision: low carbon narrative

I. Legitimacy of BAU eroding

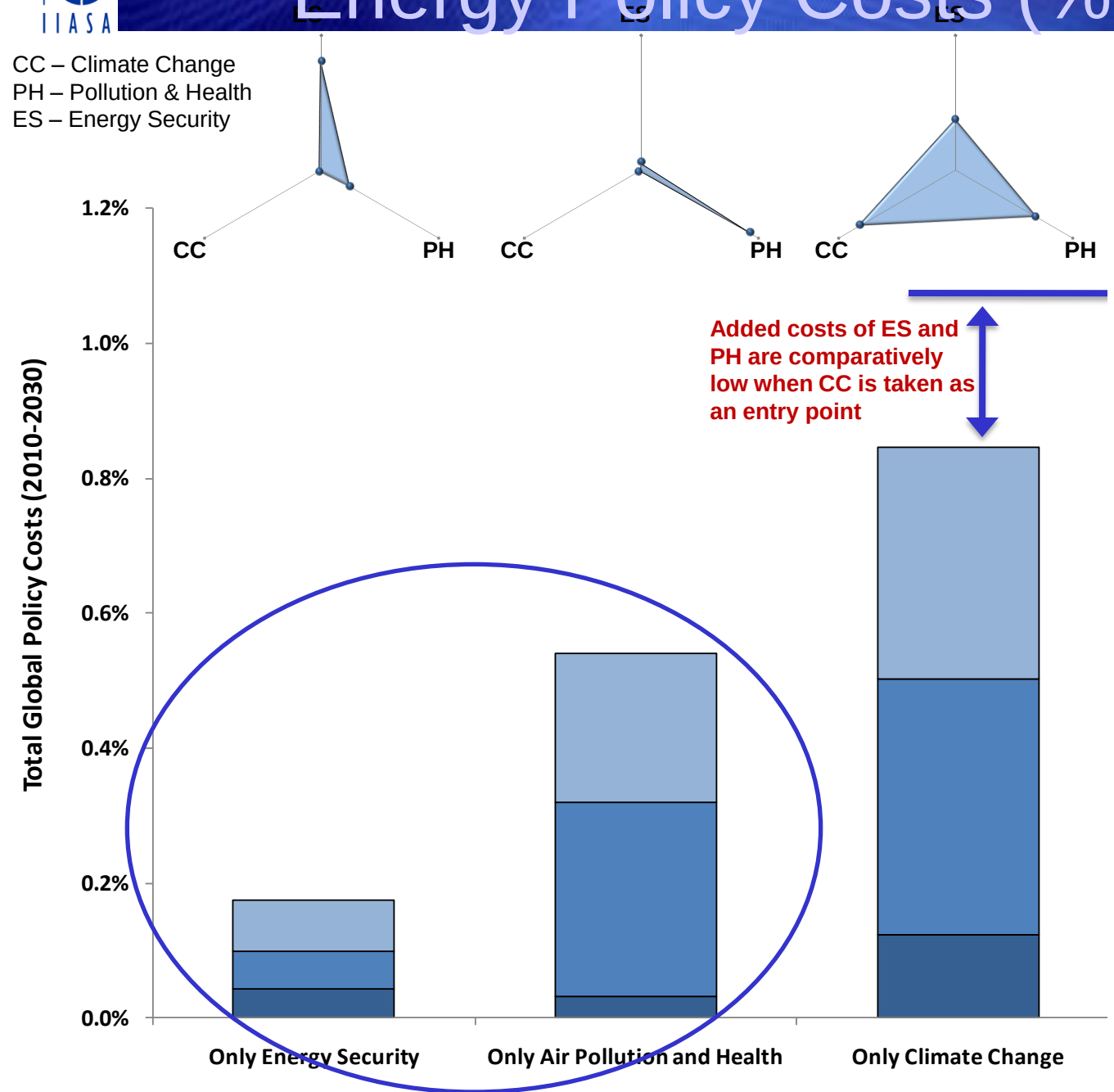
Drivers of Transformations

Multiple Drivers of Change



Energy Policy Costs (% GDP)

CC – Climate Change
PH – Pollution & Health
ES – Energy Security



McCollum et al

Frank Capra's The Unleashed Goddess (1958)