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science for global insight

SYSTEMS APPROACHES TO GLOBAL (ENVIRONMENTAL) CHALLENGES

Professor Dr. Pavel Kabat

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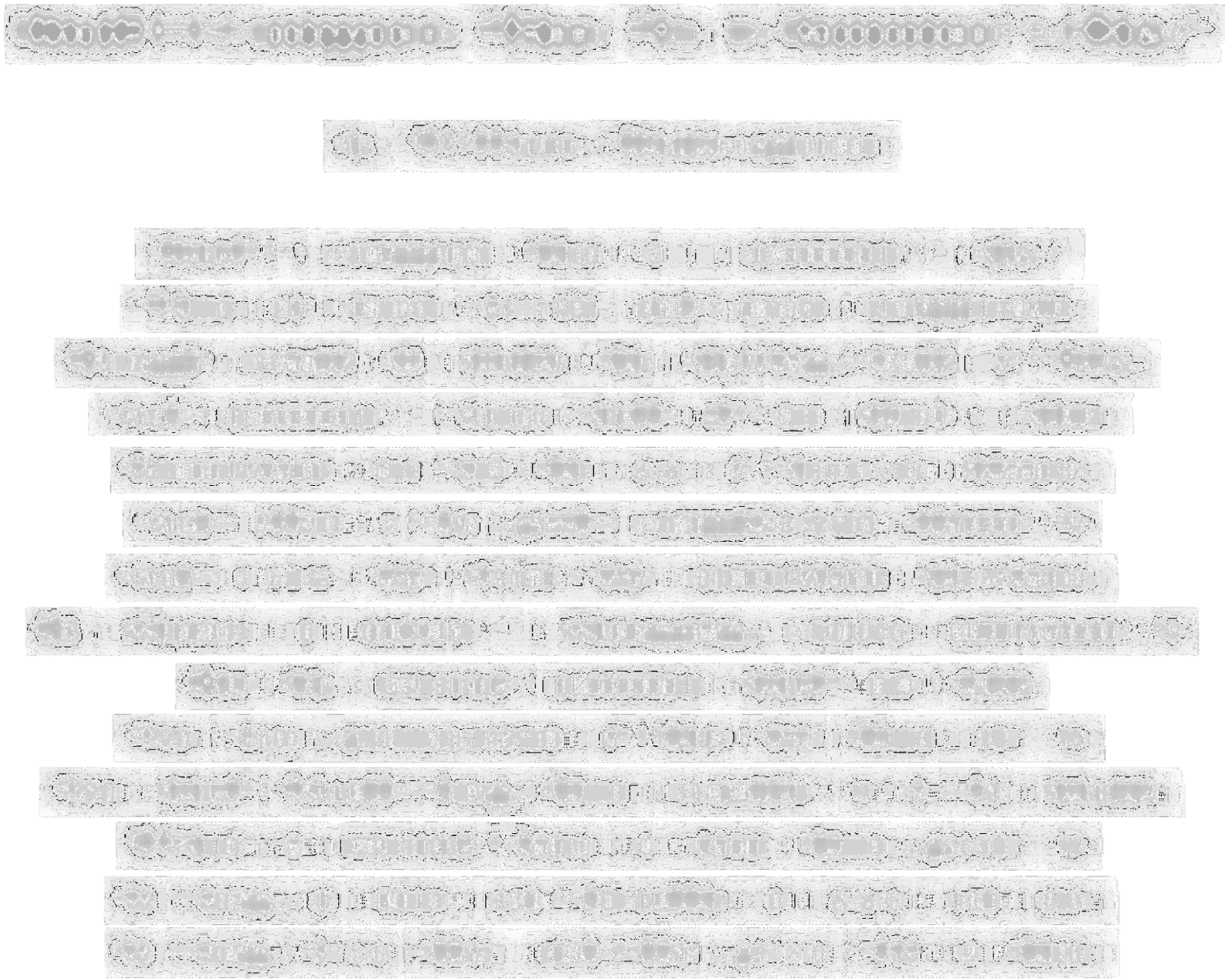
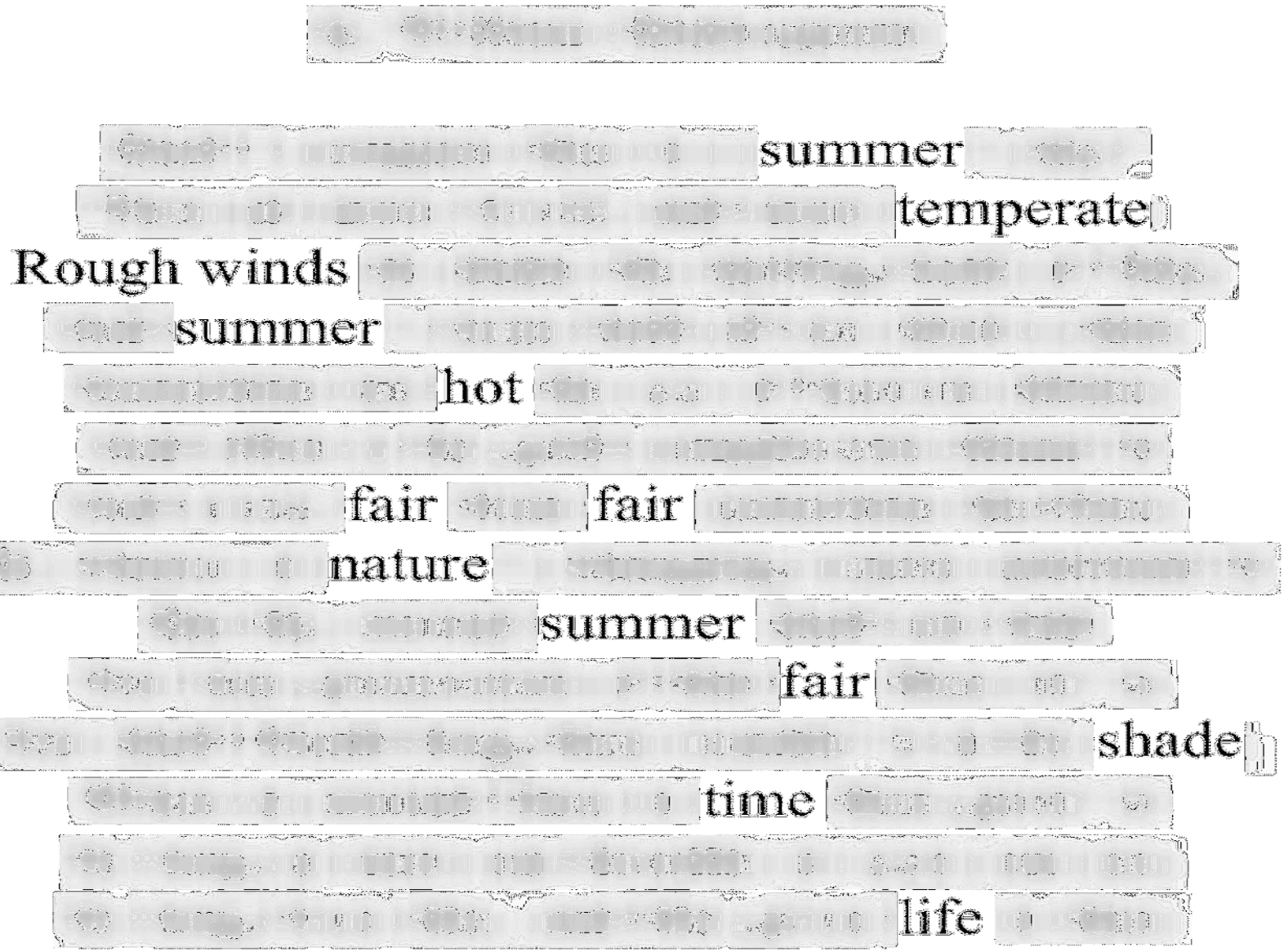
Chief Executive Officer

Professor, Earth System Science

Wageningen University



Summer


summer
temperate
Rough winds
summer
hot
fair
fair
nature
summer
fair
shade
time
life

Shall I Compare Thee To A Summer's Day?

by William Shakespeare

Shall I compare thee to a summer's day?
Thou art more lovely and more temperate.
Rough winds do shake the darling buds of May,
And summer's lease hath all too short a date.
Sometime too hot the eye of heaven shines,
And often is his gold complexion dimm'd;
And every fair from fair sometime declines,
By chance or nature's changing course untrimm'd;
But thy eternal summer shall not fade
Nor lose possession of that fair thou ow'st;
Nor shall Death brag thou wander'st in his shade,
When in eternal lines to time thou grow'st:
So long as men can breathe or eyes can see,
So long lives this, and this gives life to thee.

SUSTAINABLE DEVELOPMENT GOALS

Integrated Systems approach to SDG-Pathways

We lack a truly integrated, comprehensive quantitative understanding of sustainable development pathways, accounting for the inter-linkages between the economy, technology, environment, climate, human development and planetary boundaries.

The Key Global Challenges

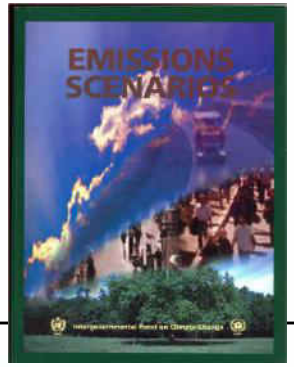
Access

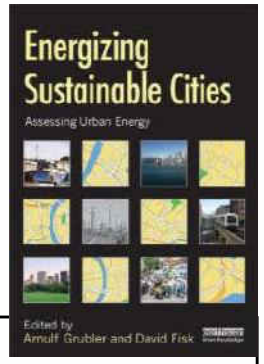
Climate Change

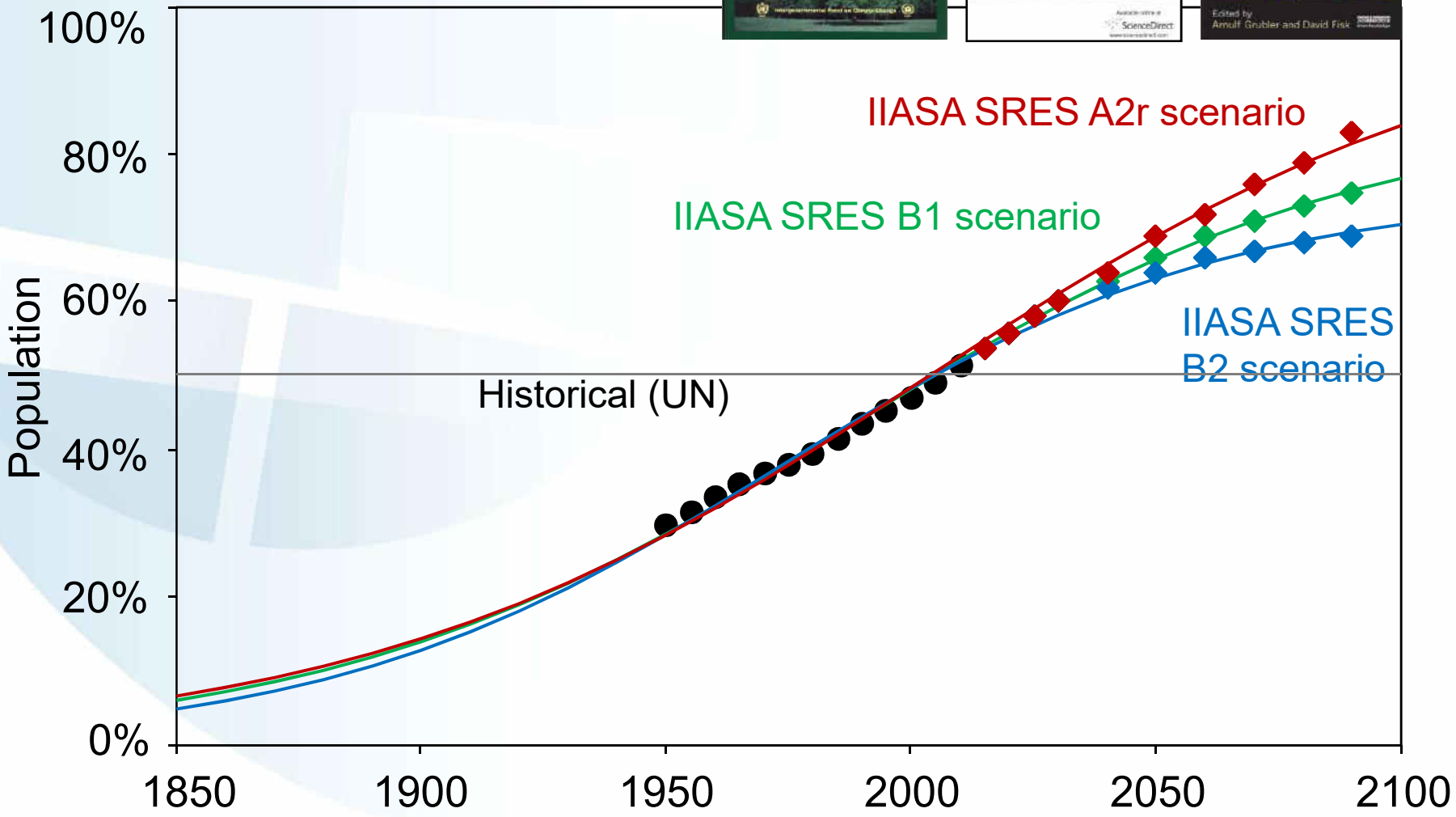
Pollution
Health Impacts

Security

Urbanization World

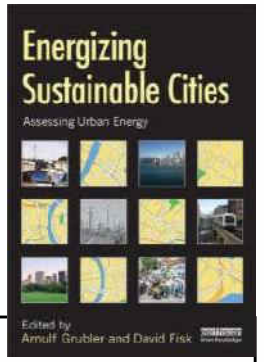


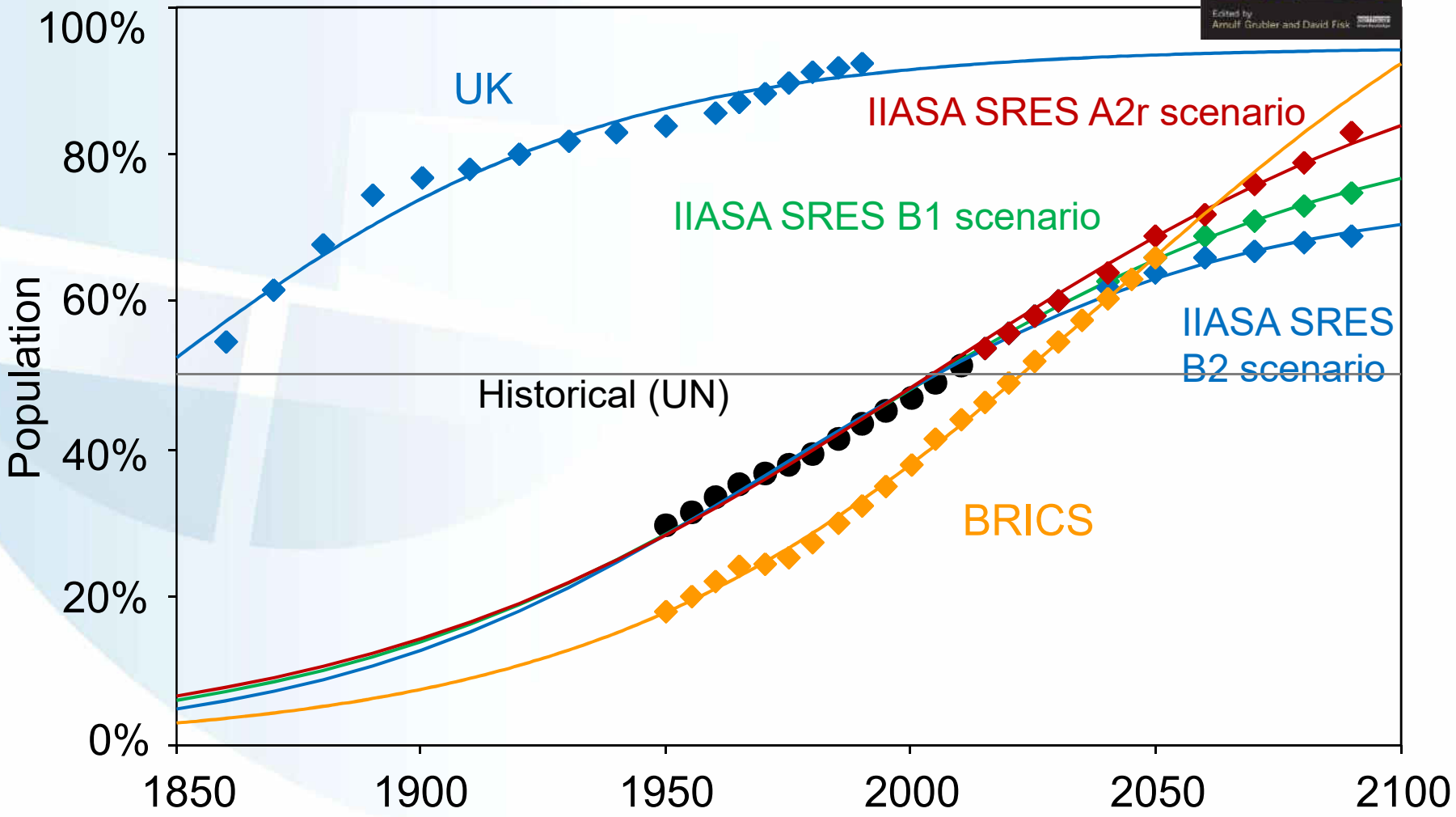




Source: Grubler et al. 2012

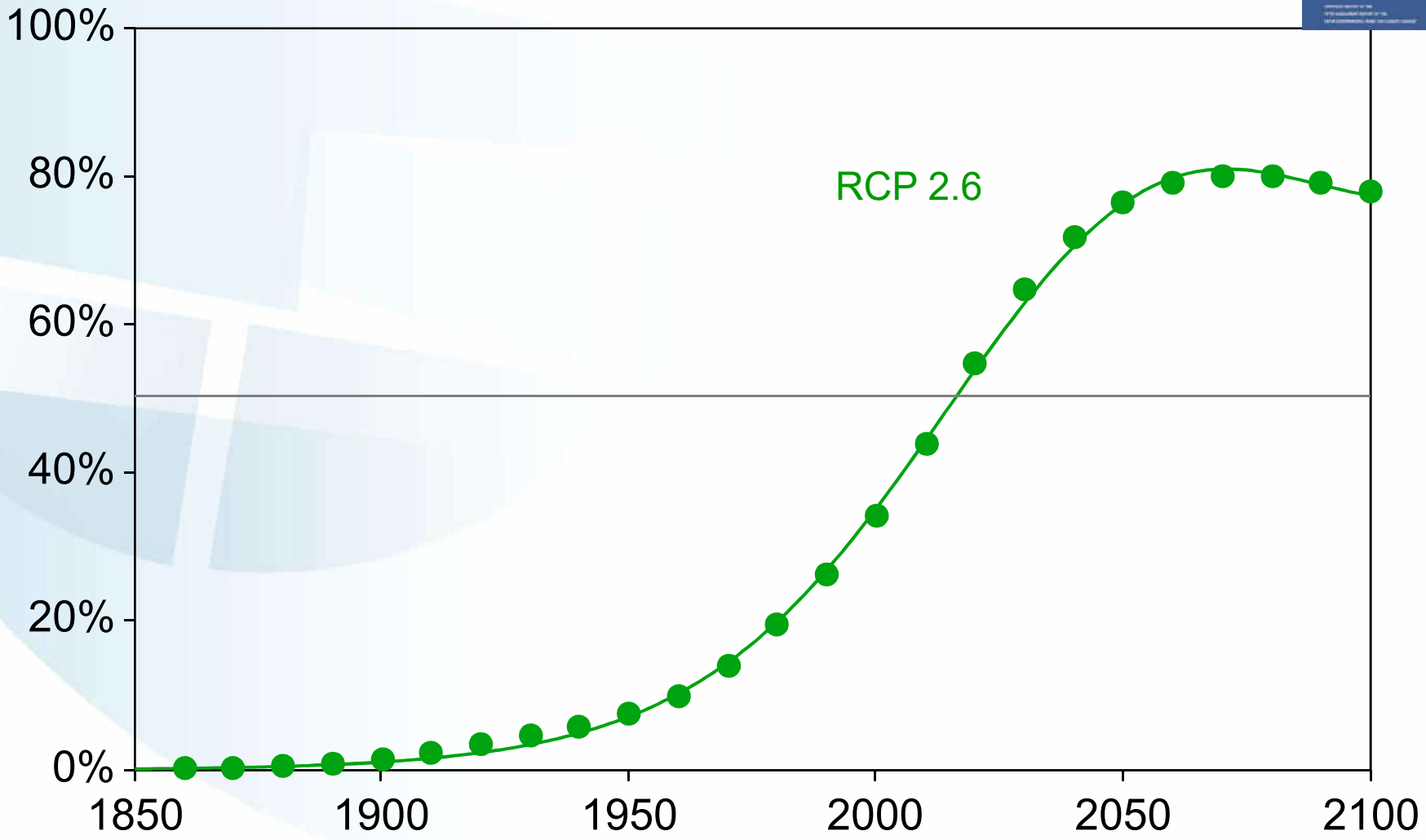
Urbanization World, UK, BRICs



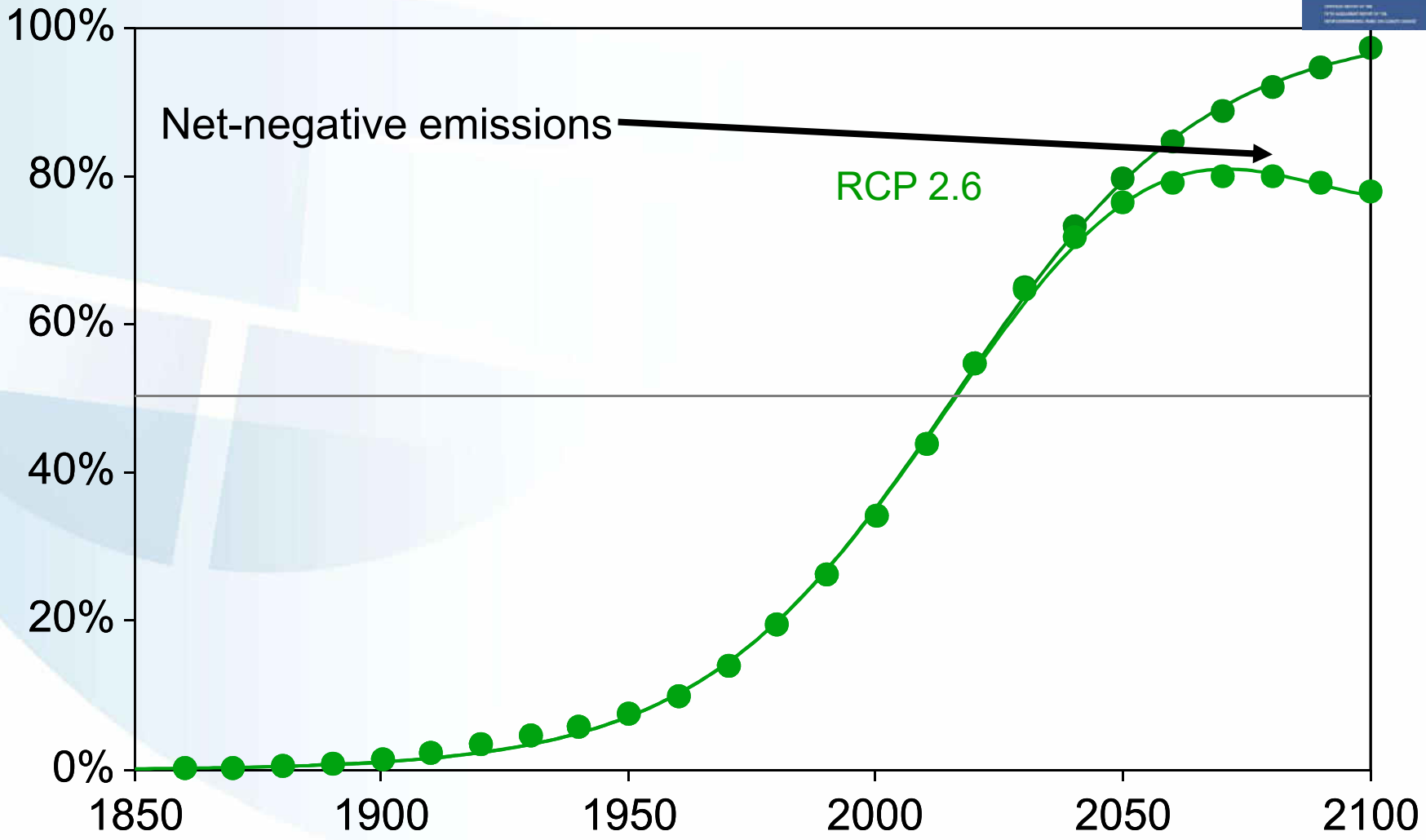


Source: Grubler et al. 2012

Cumulative Carbon Emissions



Cumulative Carbon Emissions



Sustainability Transformation

"Doing More with Less" within Boundaries

Transformation Diffusion

Vision: Sustainable Future

→ Values and norms

→ Growing number of actors of change:

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

→ Policy regimes

→ Increasing problem perception

Legitimacy of BAU eroding

Time

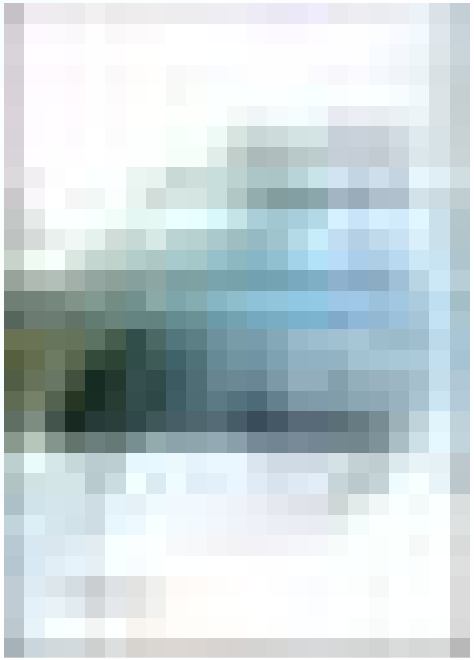
Source: WBGU, 2011

Some Systems Analysis Highlights in Environmental Domain 2011-2015

Power of systems analysis (IIASA)

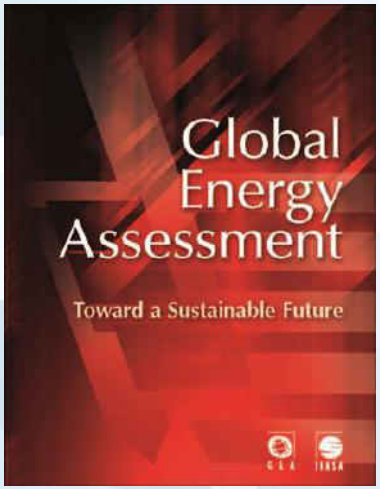
- Interdisciplinary and Cross-Sectoral – Global Energy Assessment (GEA)
- Science to Policy – GAINS (Europe, France & Global)
- Education Attainment – Population

IIASA Highlights 2011-2015

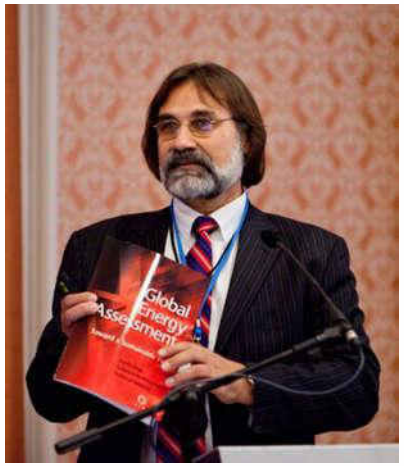


www.iiasa.ac.at/Highlights2015

GLOBAL ENERGY ASSESSMENT



2006-12: GEA defines a new global energy policy agenda—one that transforms the way society thinks about, uses, and delivers energy.



GEA guides targets of UN Secretary-General's

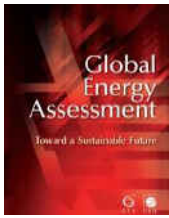
SUSTAINABLE ENERGY FOR ALL

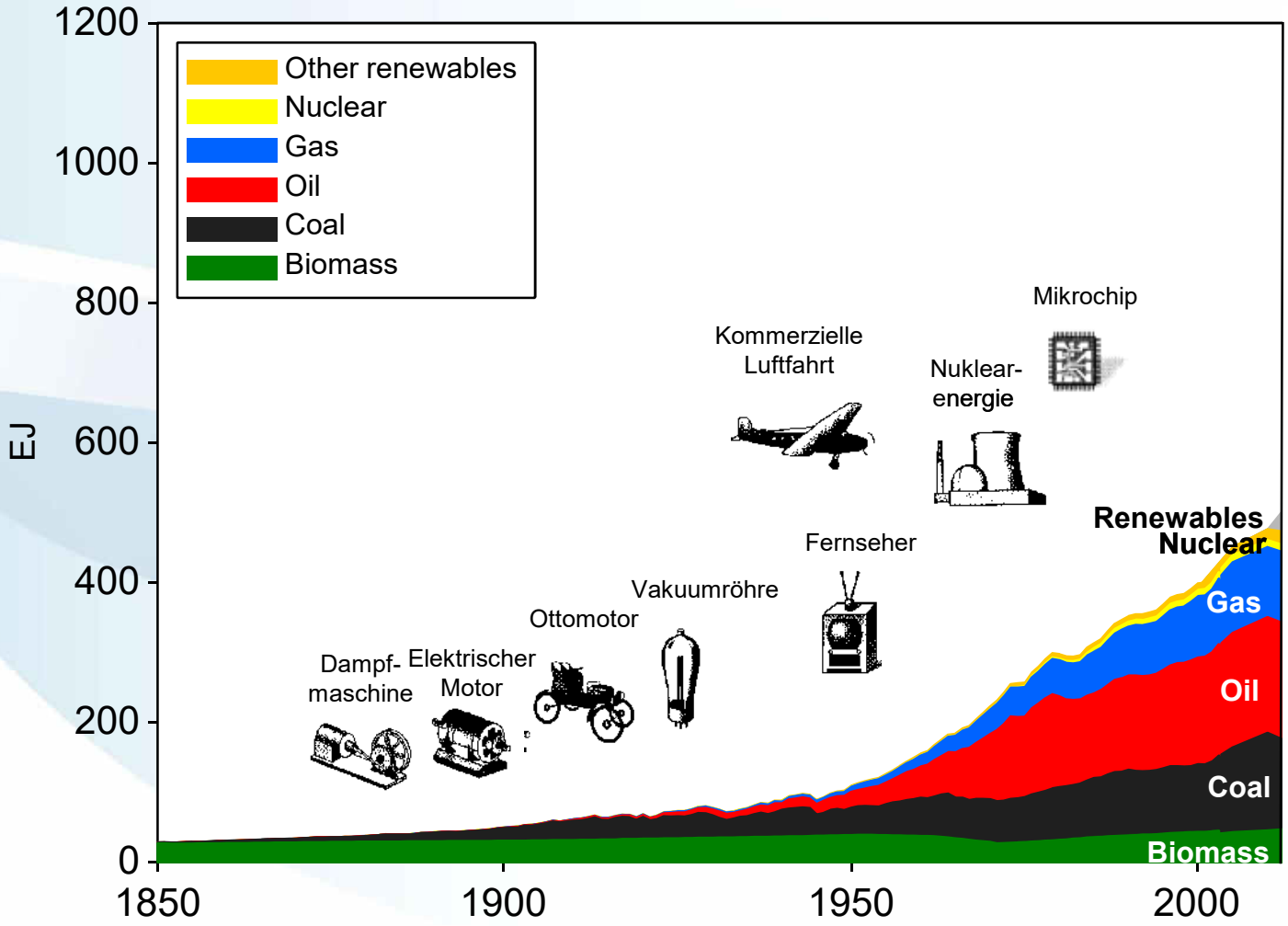
GEA became basis for adoption of Sustainable Development Goal # 7

7 AFFORDABLE AND CLEAN ENERGY

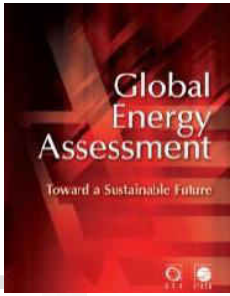
Global Primary Energy

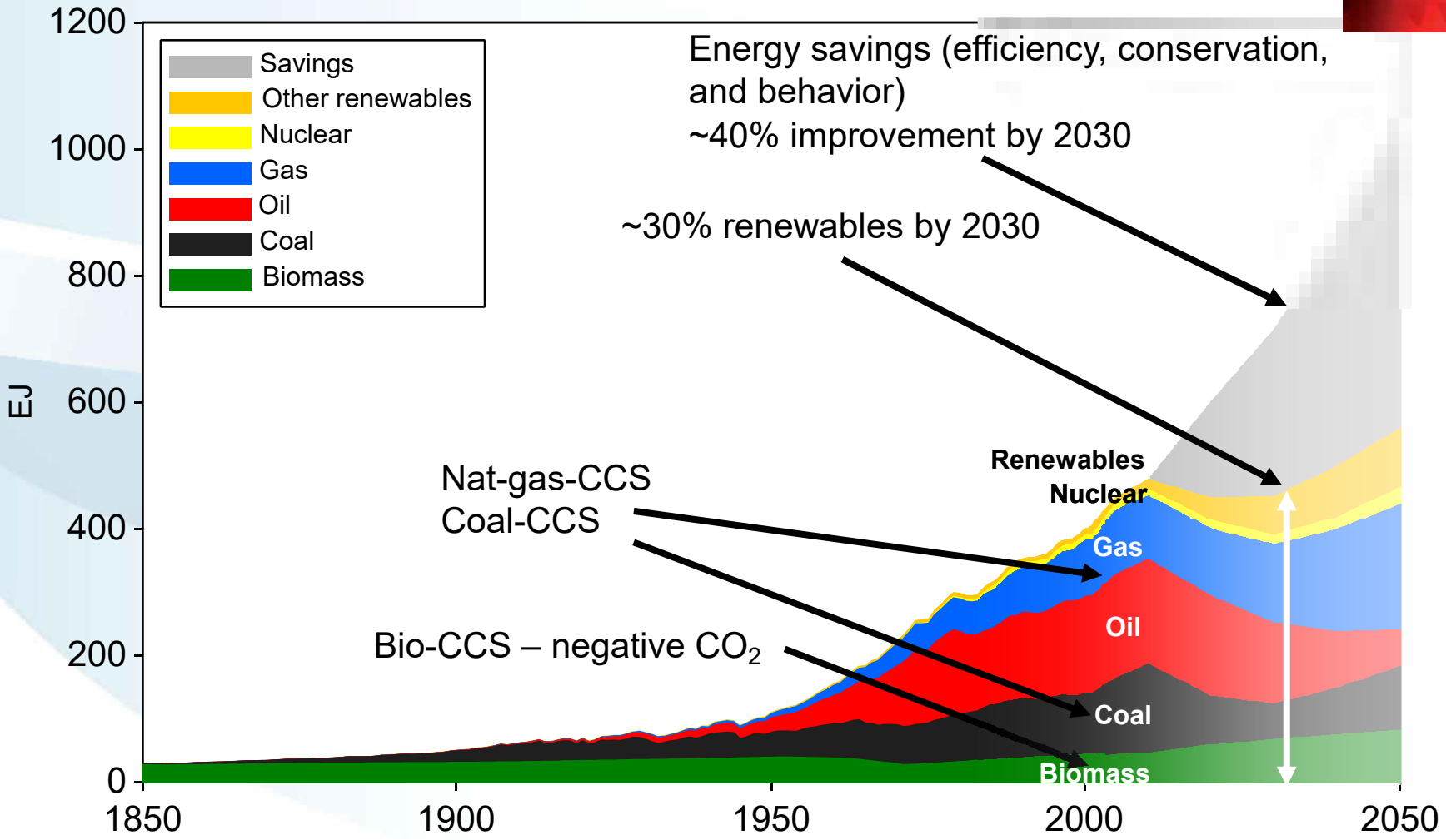
Historical Evolution





Global Primary Energy
A Transformational Pathway

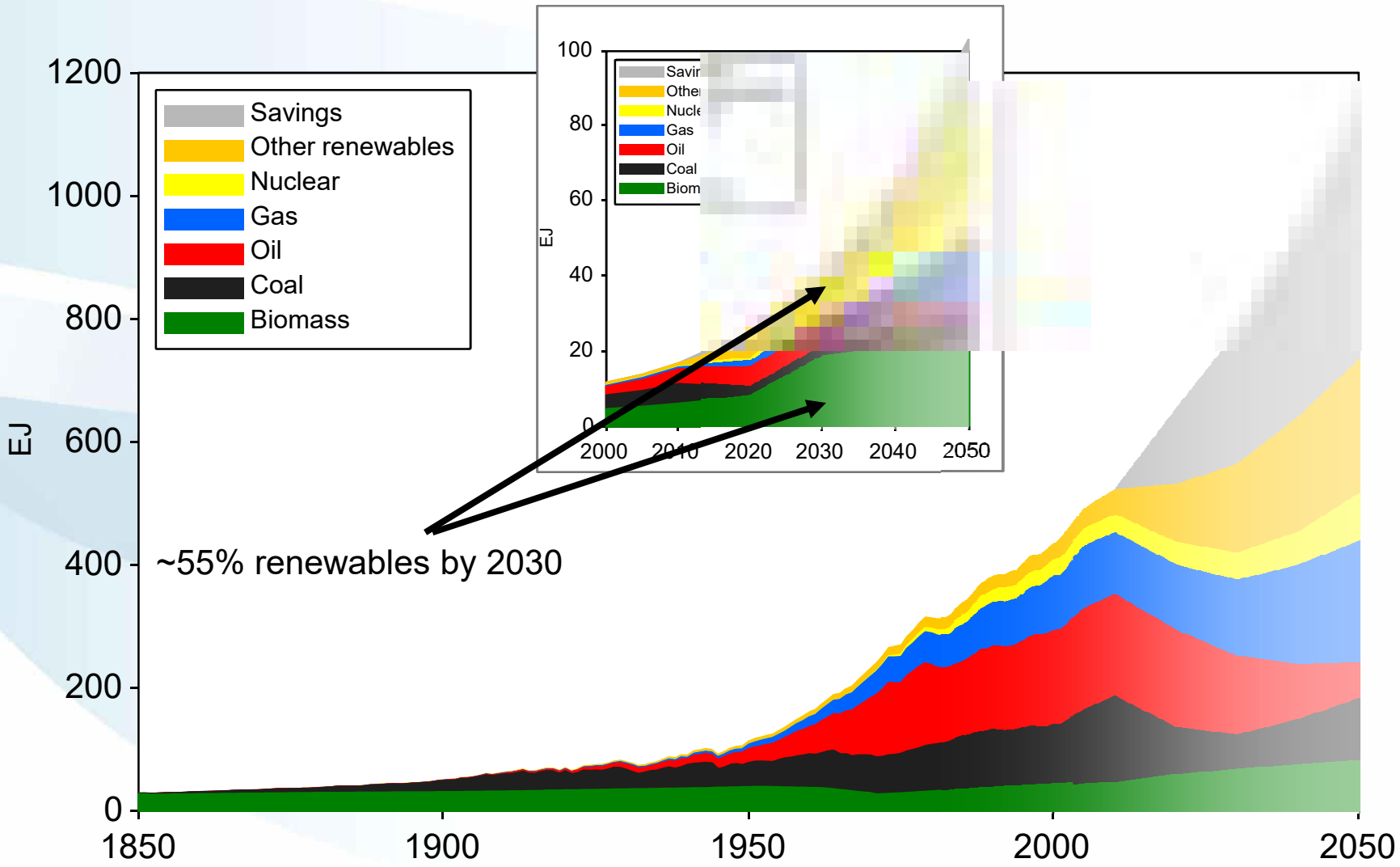




Source: Riahi et al, 2012

Global Primary Energy

Sub-Saharan Africa



Source: Riahi et al, 2012

Global Energy Resources

in EJ (10^{18}J)

	Historical production through to 2005	Production 2005	Reserves	Resources
Conventional oil	6069	147.9	4900–7610	4170–6150
Unconventional oil	513	20.2	3750–5600	11,280–14,800
Conventional gas	3087	89.8	5000–7100	7200–8900
Unconventional gas	113	9.6	20,100–67100	40,200–121,900
Coal	6712	123.8	17,300–21,000	291,000–435,000
Conventional uranium[b]	1218	24.7	2339	7420
Unconventional uranium	n.a.	n.a.	n.a.	4100

n.a. Not available

a. The data reflect the ranges found in the literature; the distinction between reserves and resources is based on current (exploration and production) technology and market conditions.

b. Reserves, and resources of uranium are based on a once-through fuel cycle operation. Closed fuel cycles and breeding technology would increase the uranium resource dimension 50-60 fold. Thorium-basd fuel cycles would enlarge the fissile-resource base further.

Source: GEA

Global Renewable Potentials

in EJ (10^{18} J) per year

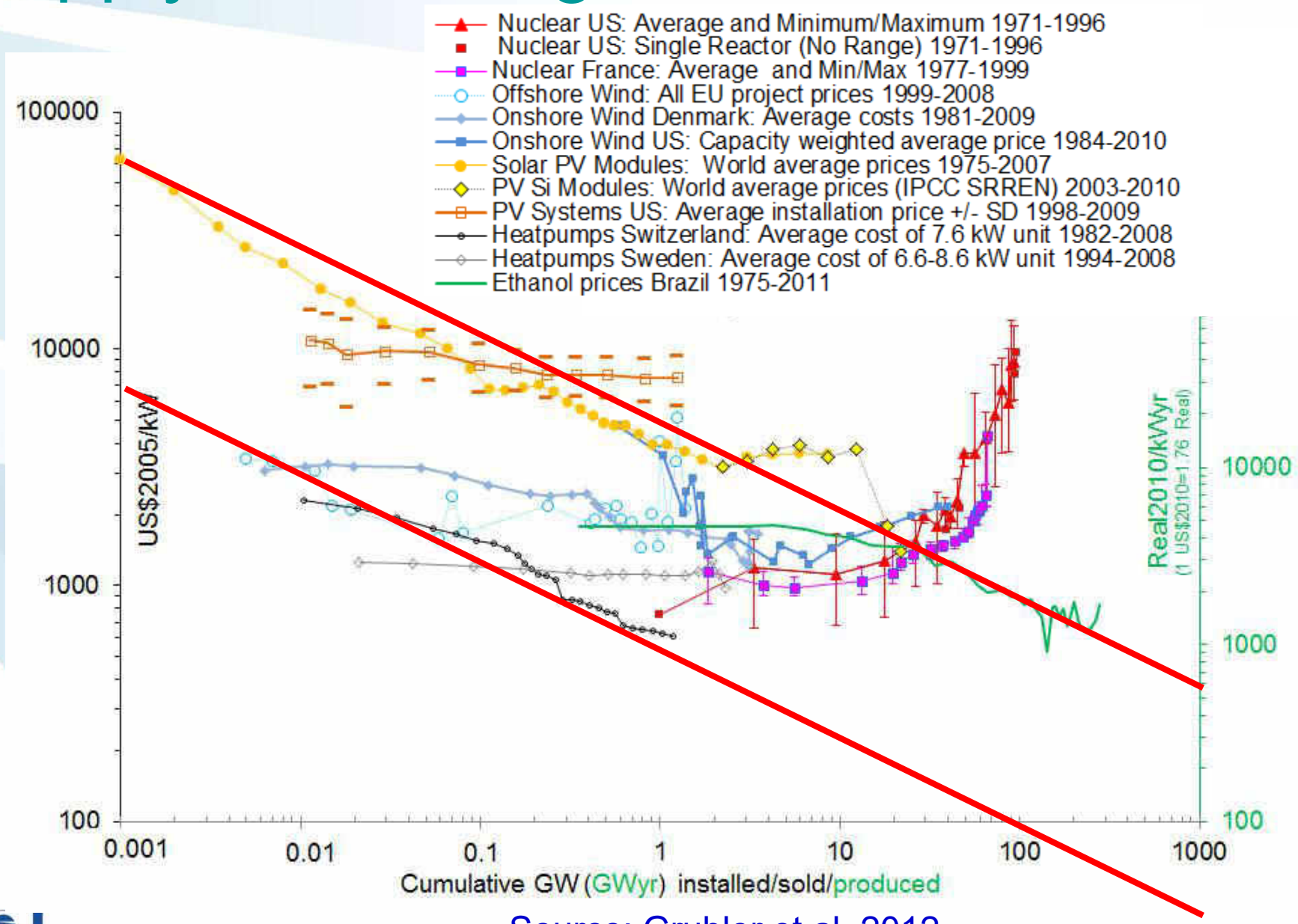
Resource	Utilization (2005)	Technical Potential	Theoretical Potential
Biomass	42.4	160-270	1330
Geothermal	2.3	810-1400	1500
Hydro	11.7	50 - 60	160
Solar	0.5	62,000 - 280,000	3,900,000
Wind	1.3	1250 - 2250	110,000
Ocean	n.e.	3240 - 10,500	1,000,000

n.e. Not estimated

a. The data are energy-input data, not output. Considering technology-specific conversion factors greatly reduces the output potentials. For example, the technical 3150 EJ/yr of ocean energy in ocean thermal energy conversion (OTEC) would result in an electricity output of about 100 EJ/yr.

Source: GEA

Supply Technologies Cost Trends



Source: Grubler et al, 2012

GAINS POLICY APPLICATIONS

Convention on Long-range Transboundary Air Pollution

1994	Second Sulphur Protocol
1999	Gothenburg Multi-pollutant/multi-effect Protocol
2012	Revision of the Gothenburg Protocol

European Union

1999	National Emission Ceilings Directive
2004	Thematic Strategy on Air Pollution
2010	Energy & Climate package, etc.
2013	Revision of the Thematic Strategy

Further analyses for UNFCCC, Arctic Council, UNEP, Chinese, Japanese and Korean Governments

GAINS: CLEANING EUROPE'S AIR

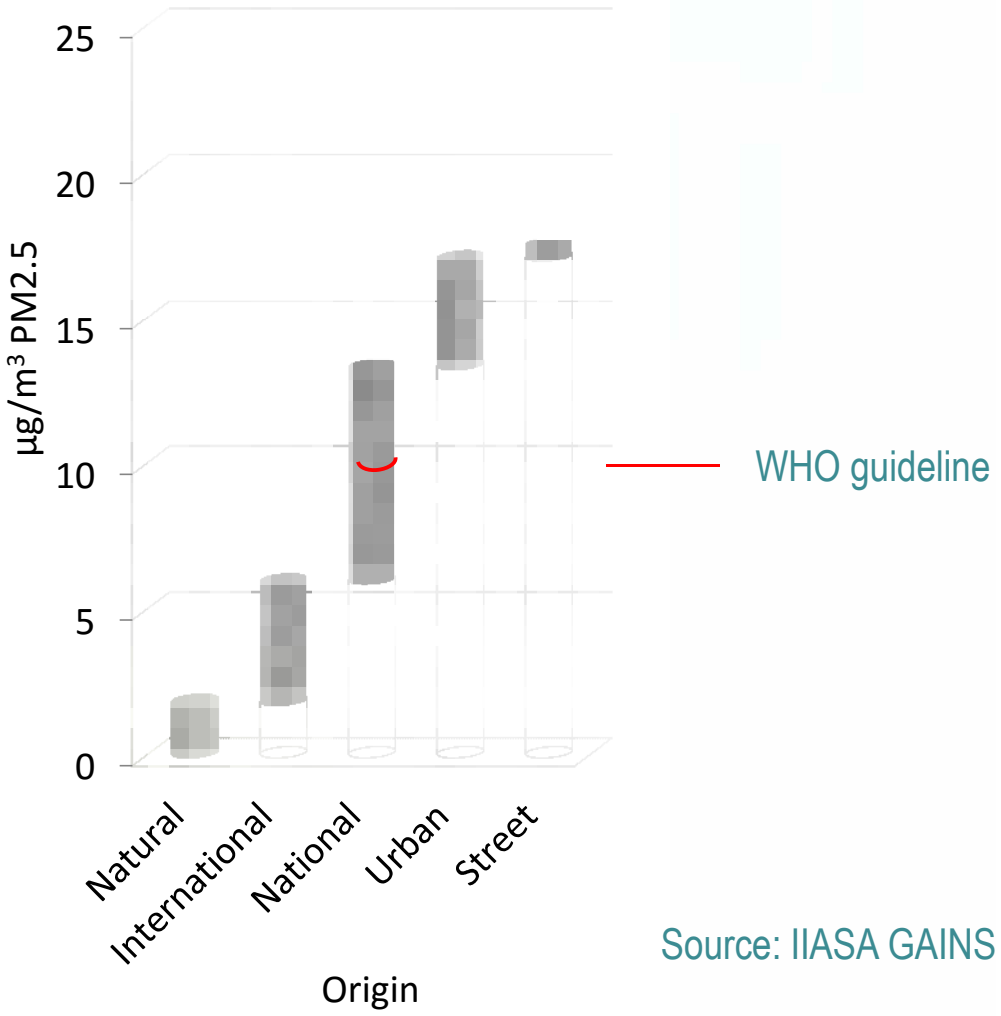
Dec 2013: European Commission proposed a new package of measures to reduce air pollution. Poor air quality is the number one environmental cause of premature death in the European Union. By 2030, the package will:

- Avoid an extra 58,000 premature deaths
- Protect an extra 123,000 km2 of ecosystems from nitrogen pollution (more than half the area of Romania)
- Save 19 000 km2 forests from acidification by the year 2030.

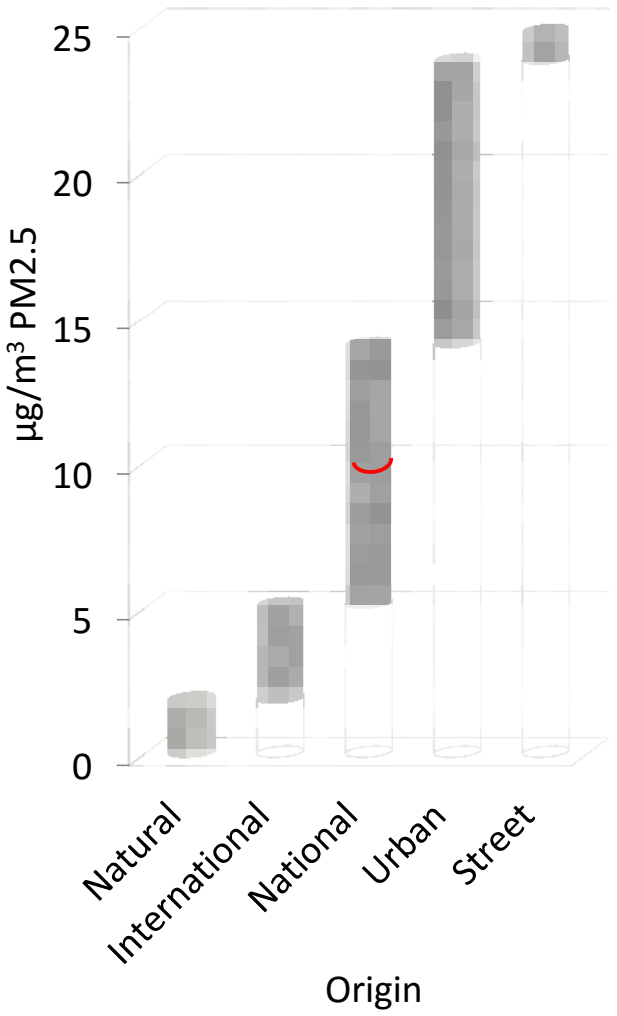
IIASA's GAINS model guided European policymakers at every step of this process.

Origin of PM2.5 in France - 2009

France – average of 293 urban stations modelled in GAINS



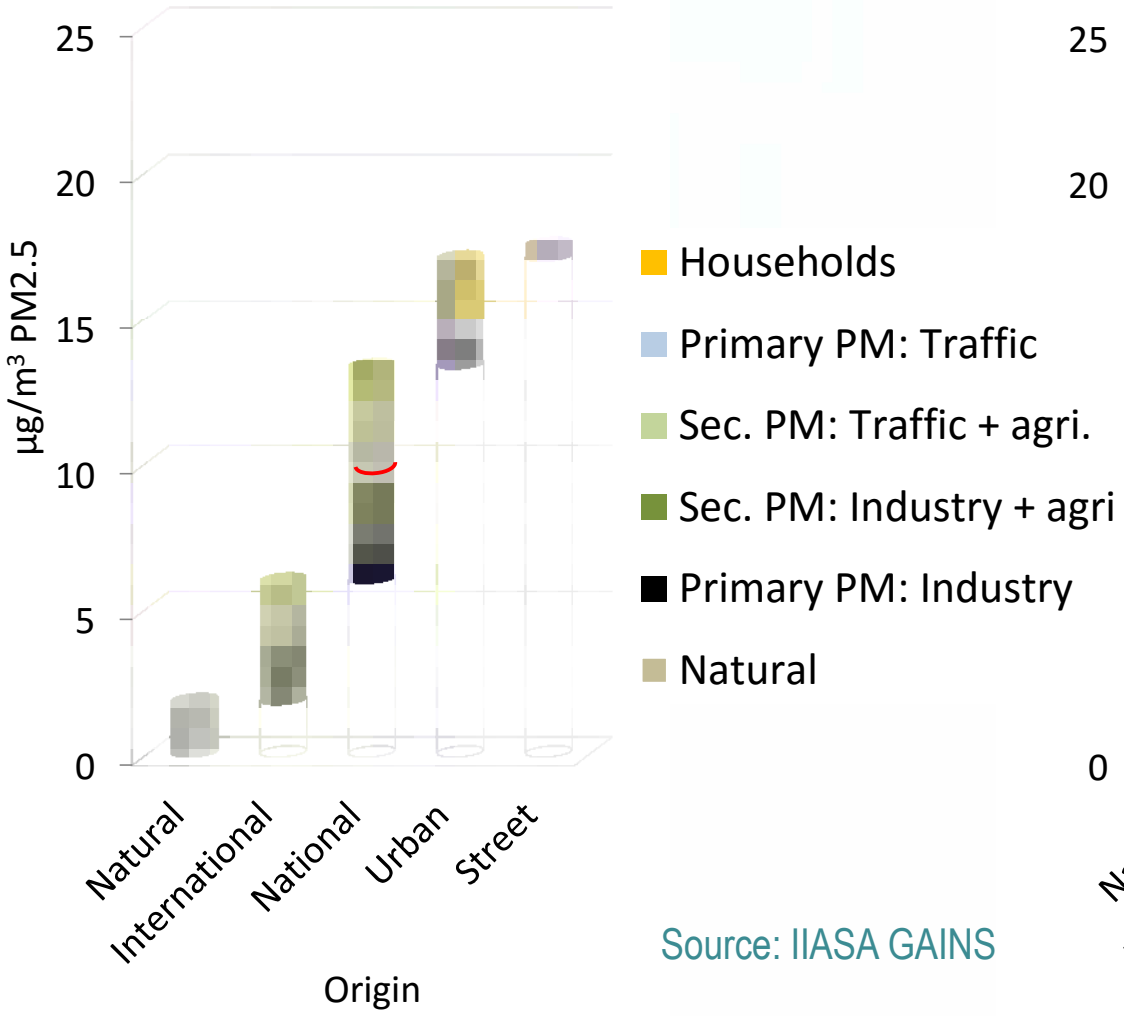
Lyon, Centre Ville



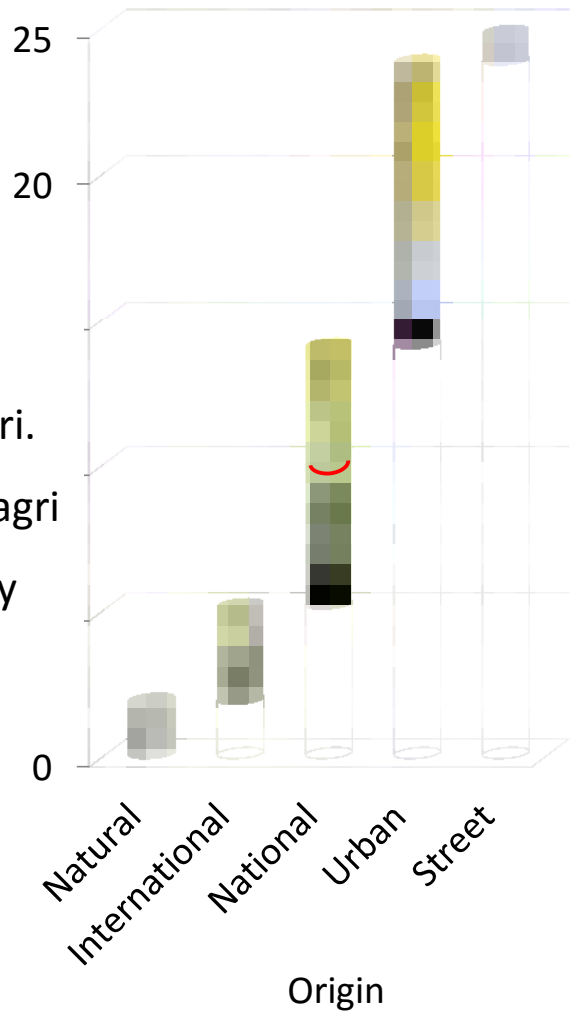
Source: IIASA GAINS

Origin of PM2.5 in France - 2009

France – average of 293 urban stations modelled in GAINS

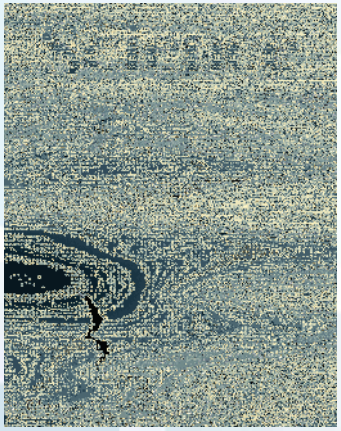


Lyon, Centre Ville



Source: IIASA GAINS

GAINS: HELPING TO TACKLE GLOBAL WARMING, GLOBAL HEALTH & GLOBAL FOOD PRODUCTION

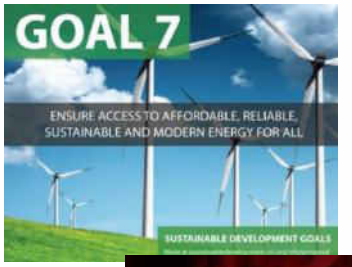


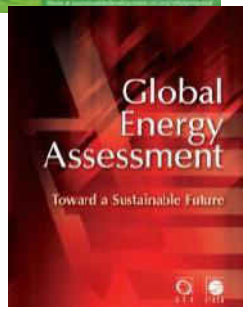
GAINS identified 14 key air quality measures that if implemented could slow the pace of global warming, save millions of lives, and boost agricultural production.

Feb 2012: The governments of Bangladesh, Canada, Ghana, Mexico, Sweden and the United States launched the Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

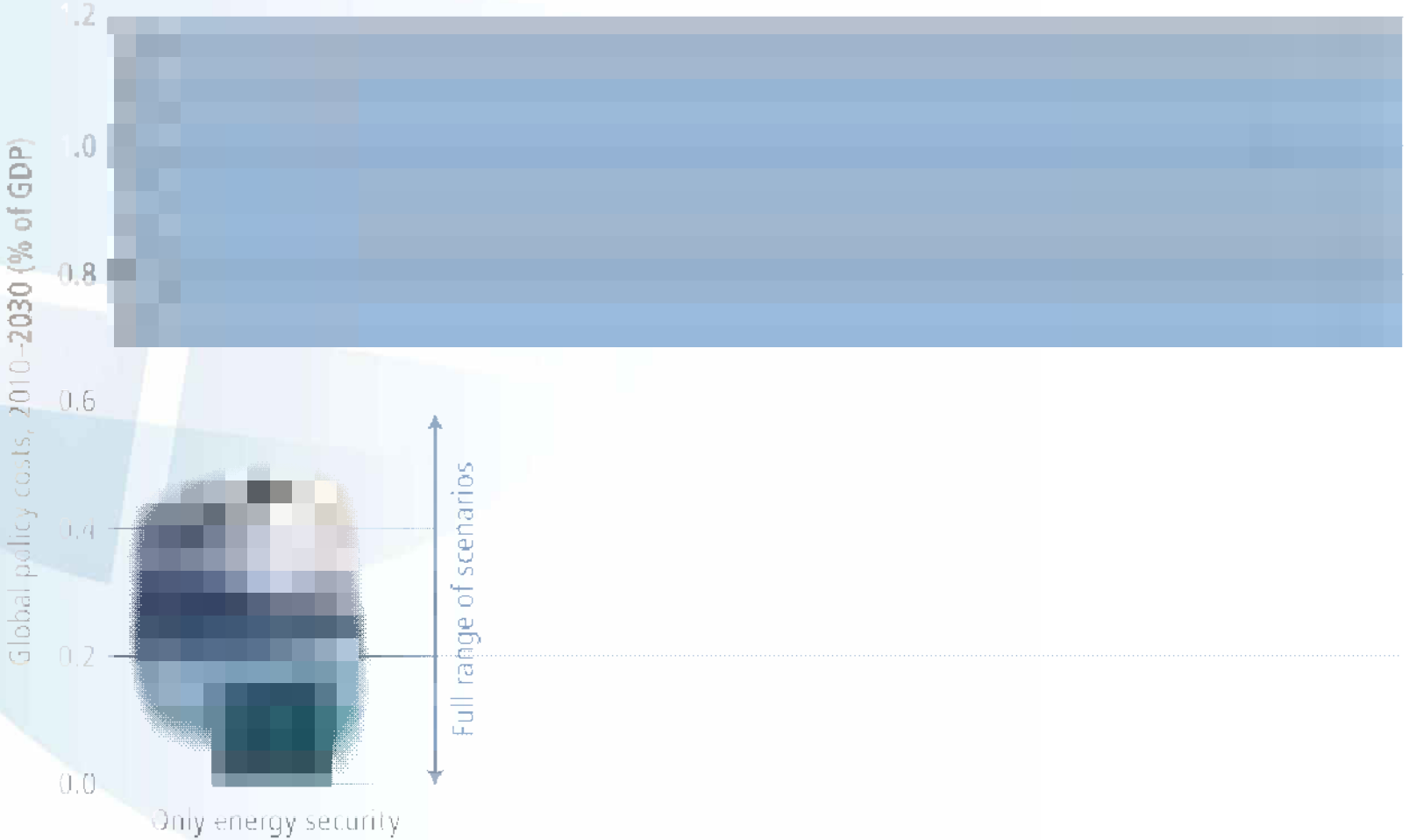
2012 INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL





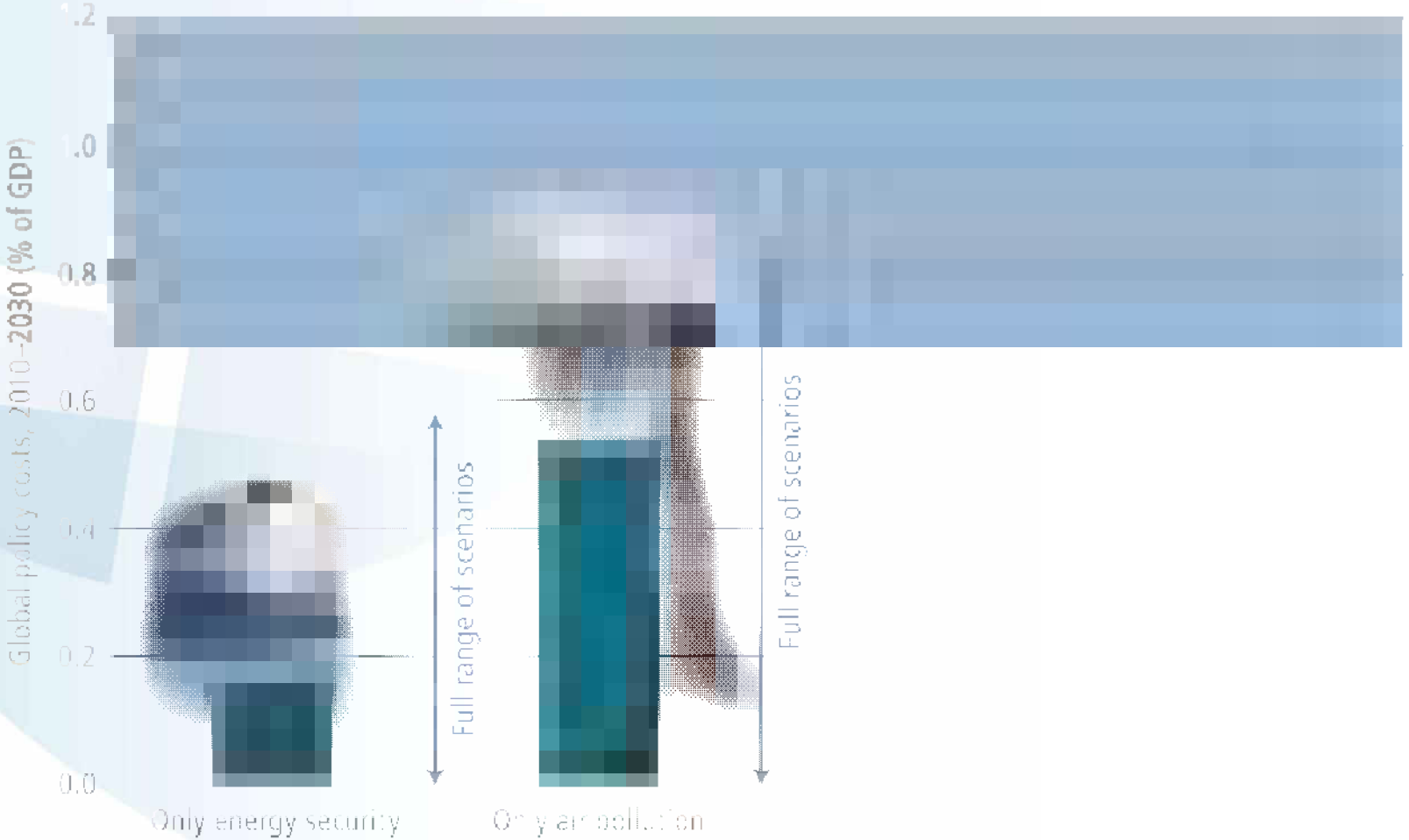
- 7.1 by 2030 ensure universal access to affordable, reliable, and energy services
- 7.2 increase substantially the share of renewable energy in the global energy mix by 2030
- 7.3 double the global rate of improvement in energy efficiency by 2030
- 7.a by 2030 enhance international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies, and promote investment in energy infrastructure and clean energy technologies
- 7.b by 2030 expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, particularly LDCs and SIDS

GEA: MULTIPLE BENEFITS OF INTEGRATED POLICIES



Source: McCollum, Krey, Riahi, 2012

GEA: MULTIPLE BENEFITS OF INTEGRATED POLICIES



Source: McCollum, Krey, Riahi, 2012

GEA: MULTIPLE BENEFITS OF INTEGRATED POLICIES

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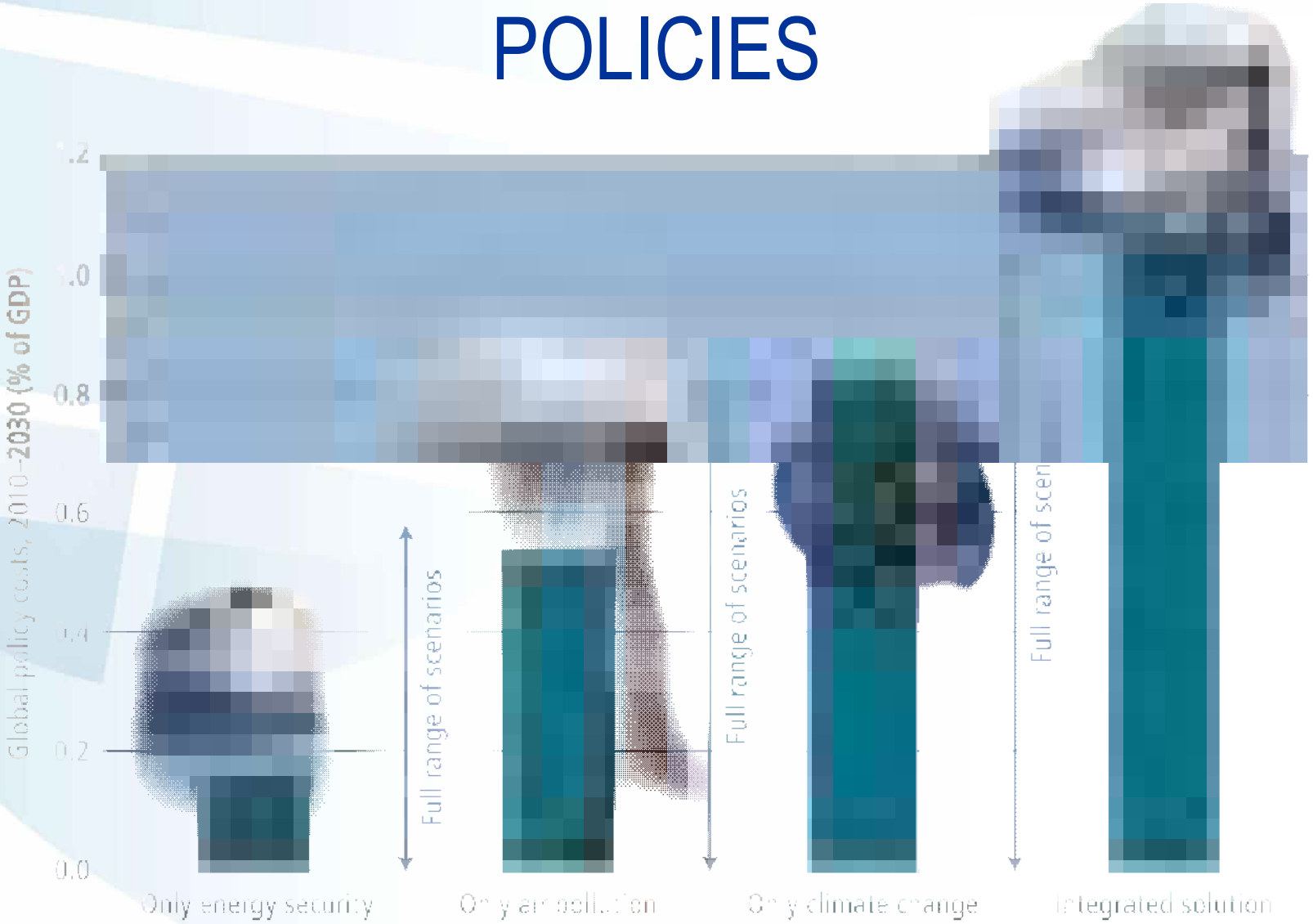
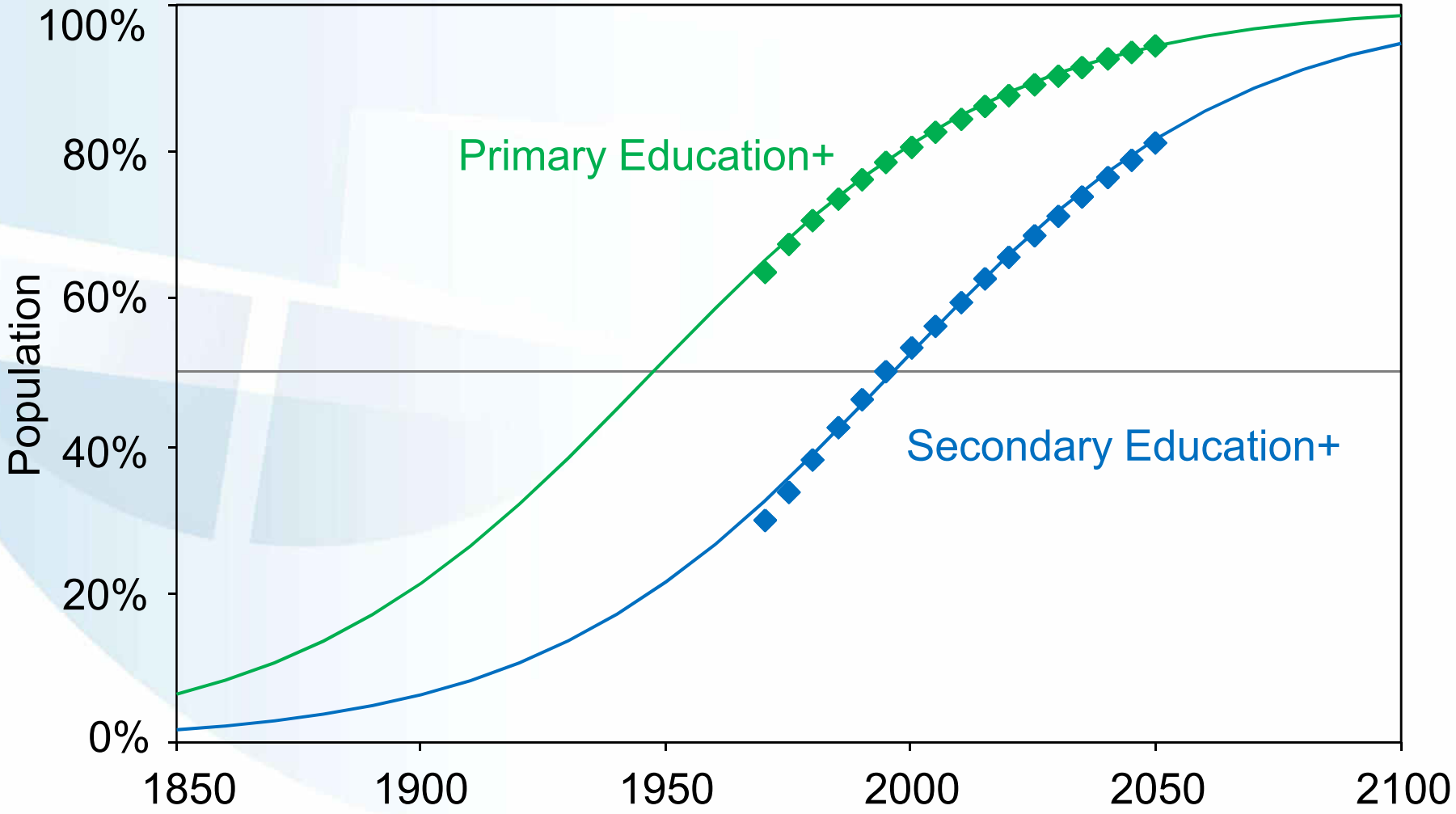


Source: McCollum, Krey, Riahi, 2012

Global Educational Attainment



Source: Lutz et al., 2007

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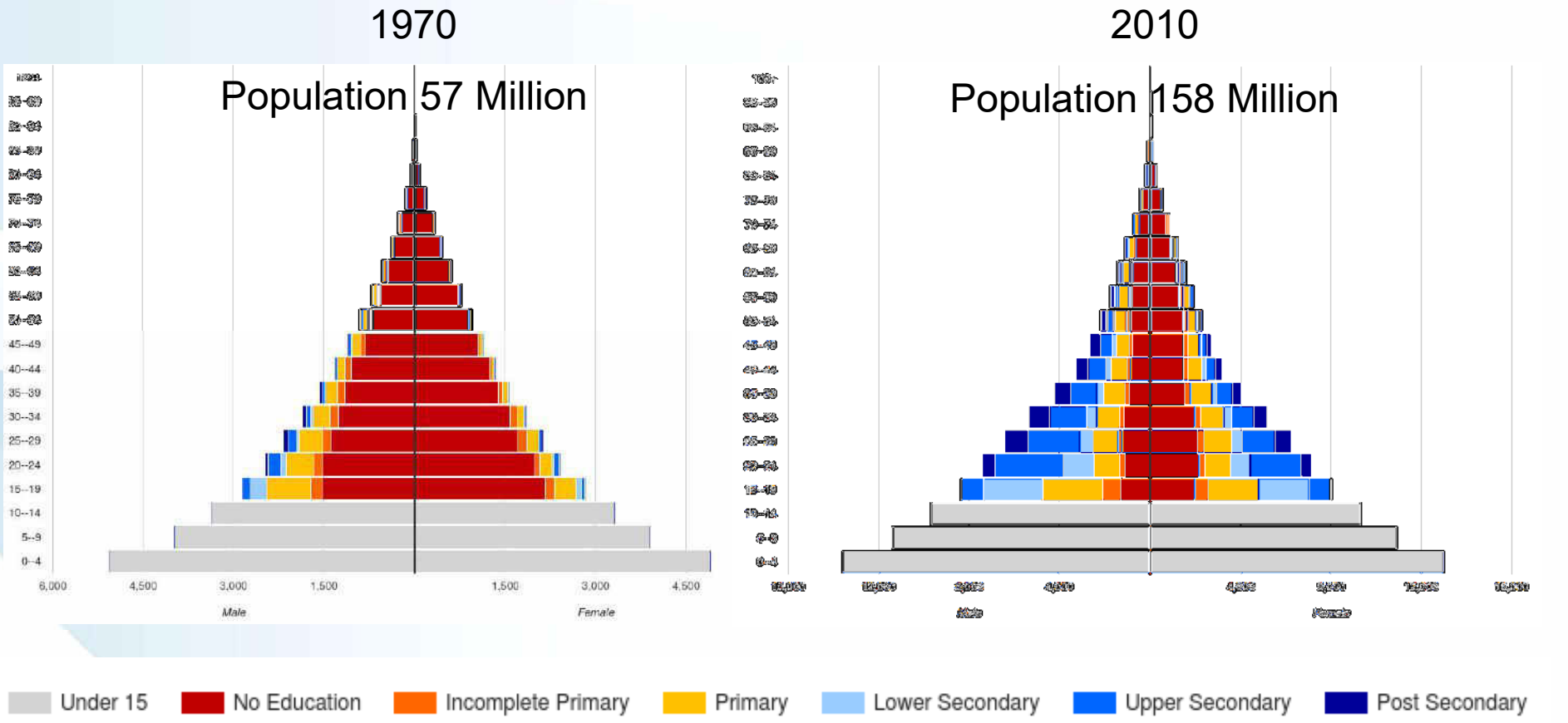
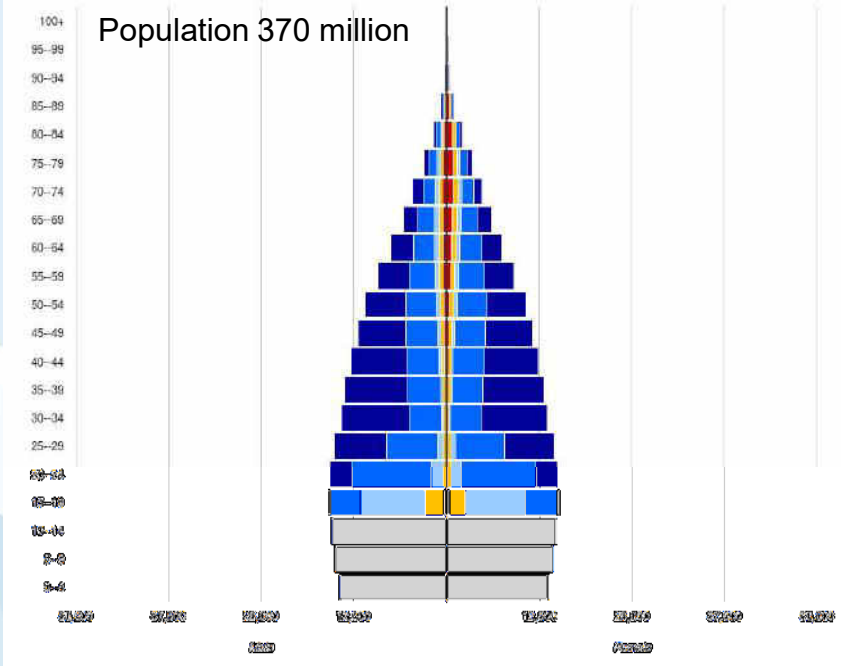
Population of Nigeria by level of education

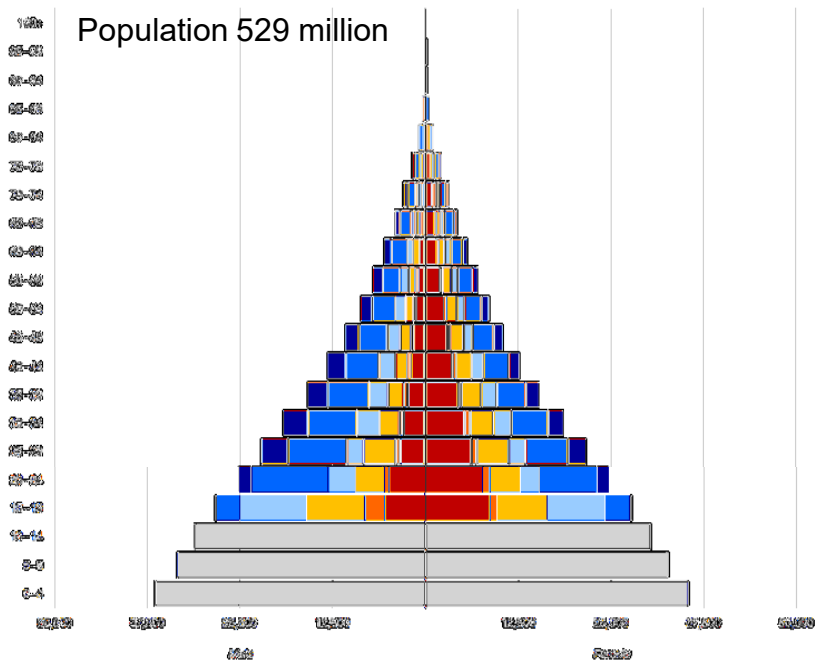


Source: Wittgenstein Centre Data explorer (2015)

Future population of Nigeria by level of education

2060





SSP1: Rapid social development: Sustainability / Rapid technology / High environmental Awareness / Low energy demand / Medium-high economic growth /Low population growth / Increase in human capital

SSP3: Stalled development: Fragmentation / Slow technology / Development (dev-ing) Reduced trade / Very slow economic growth/ Very high population growth / Stagnation in human capital

working age pop. w. low edu: 5%
pop. <20: 32%

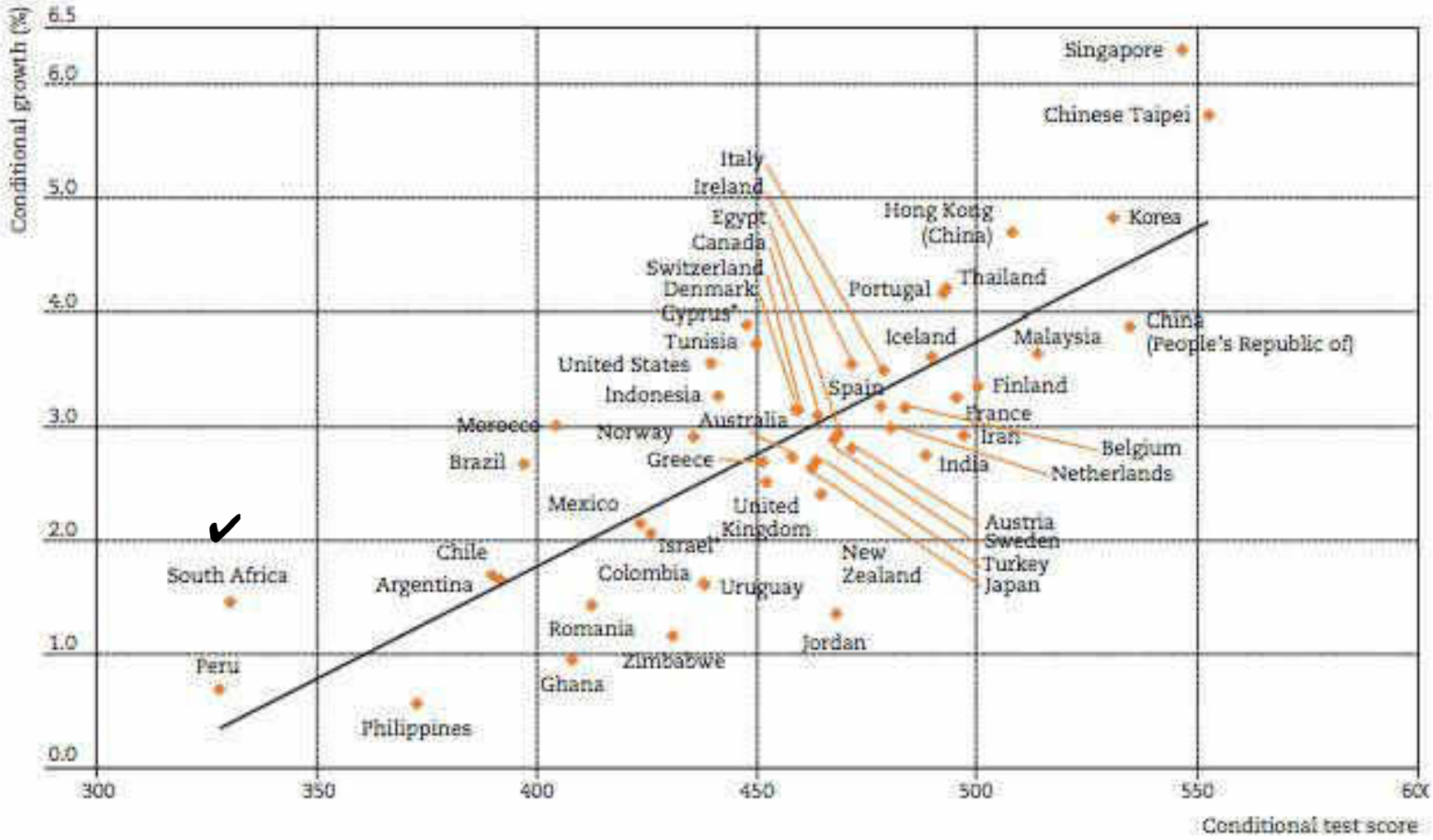
working age pop. w. low edu: 41%
pop. <20 : 48%

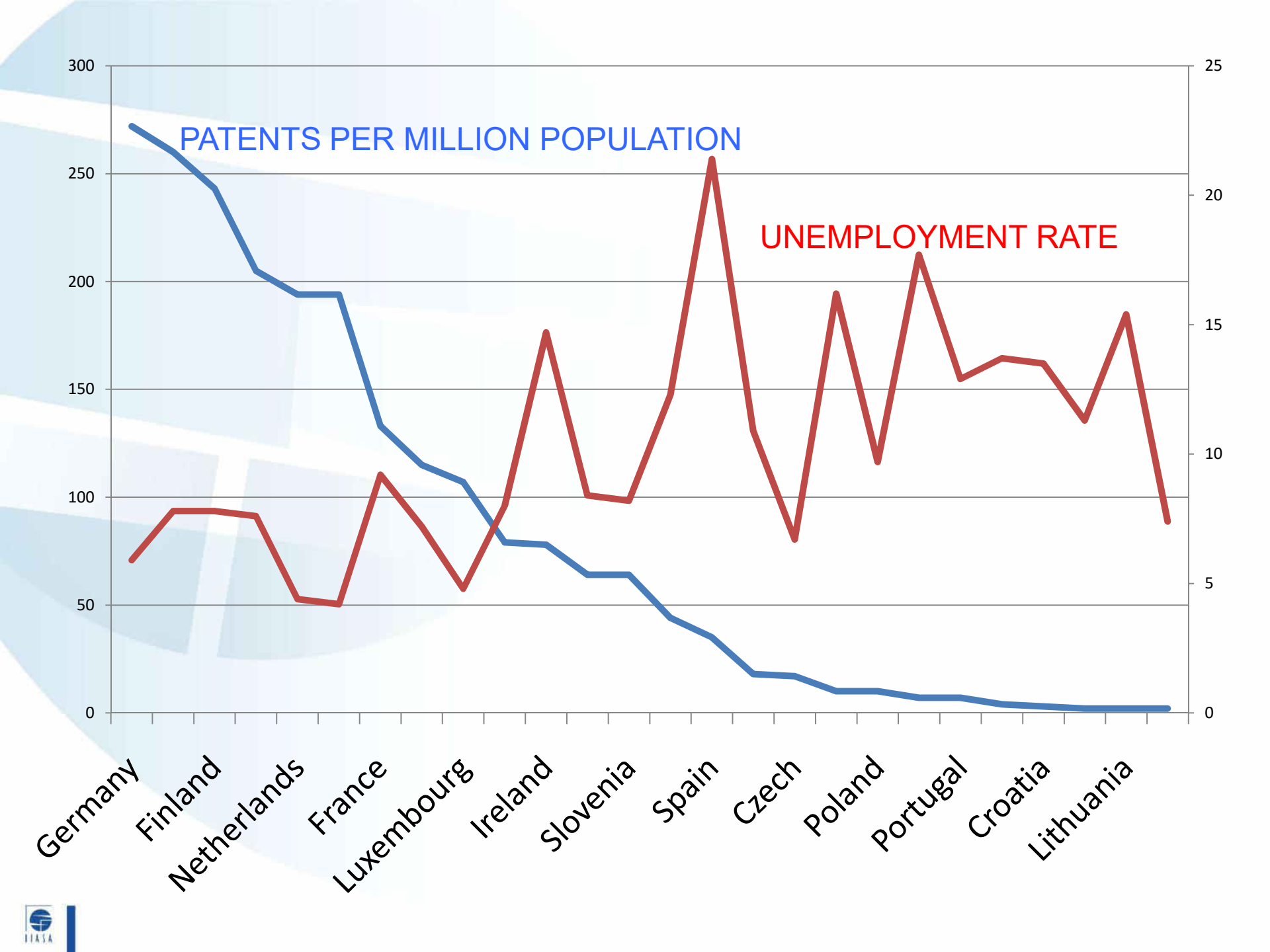
Under 15 | No Education | Incomplete Primary | Primary | Lower Secondary | Upper Secondary | Post Secondary

Source: Wittgenstein Centre Data explorer (2015)

KNOWLEDGE CAPITAL: GROWTH VERSUS TEST SCORES

FIGURE 2.1 KNOWLEDGE CAPITAL AND ECONOMIC GROWTH RATES ACROSS COUNTRIES




PATENTS PER MILLION POPULATION
UNEMPLOYMENT RATE
300
250
200
150
100
50
0
25
20
15
10
5
0
Germany
Finland
Netherlands
France
Luxembourg
Ireland
Slovenia
Spain
Czech
Poland
Portugal
Croatia
Lithuania

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European Commission

science for global insight

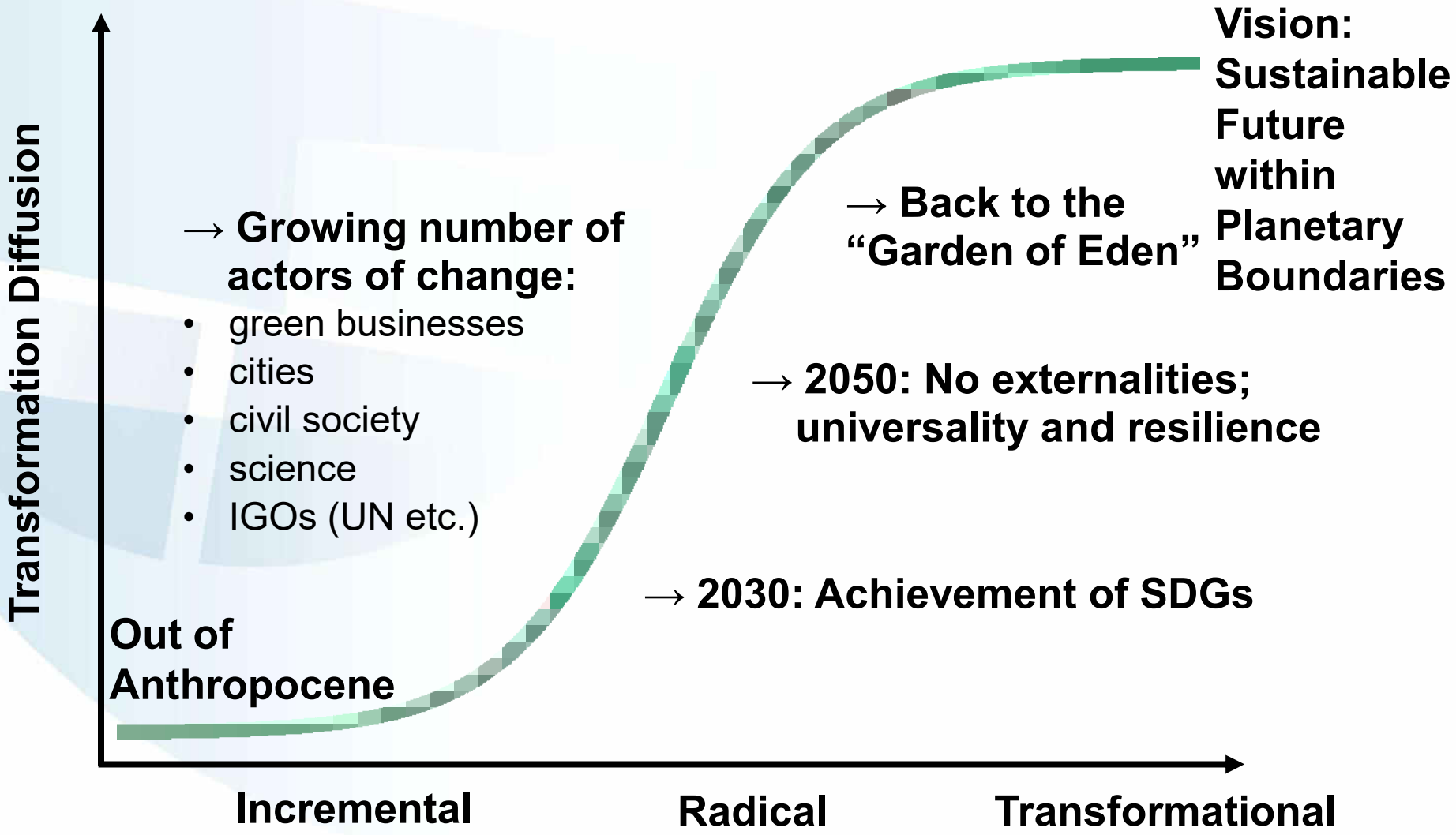
New EC-JRC/IIASA Centre of Expertise on **Population and Migration**

Brussels, 20 June 2016

Wolfgang Lutz & Anne Goujon
World Population Program, IIASA

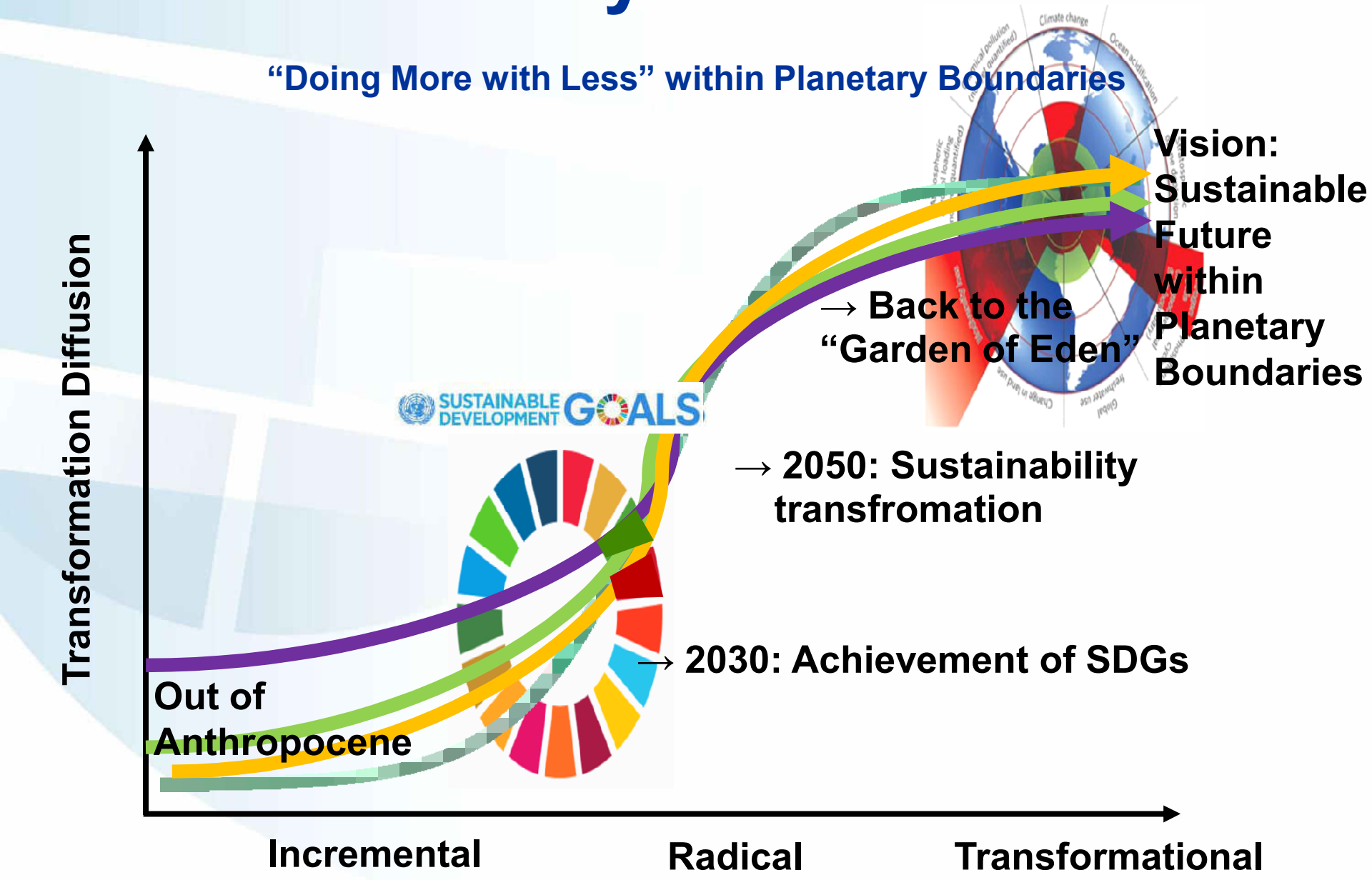
Sustainability Transformation

"Doing More with Less" within Planetary Boundaries



Source: After WBGU, 2011

Sustainability Transformation



Source: After WBGU, 2011

Strategic objective of TWI2050

The World in 2050 project will explore the design of sustainable development pathways at the global and regional scales that achieve convergent economic development within planetary boundaries

Source: Rockstrom, 2014

The World in 2050 "Consortium"

- AIMES
- Brazilian Federal Agency for the Support and Evaluation of Graduate Education (CAPES)
- Centre for Integrated Studies on Climate Change and the Environment (CIRED)
- Commonwealth Scientific and Industrial Research Organization (CSIRO)
- Earth League, whole Earth system modelling initiative
- **Earth Institute, Columbia University**
- Energy Planning Program, COPPE, Federal University of Rio de Janeiro
- Fondazione Eni Enrico Mattei (FEEM)
- Future Earth
- German Development Institute (DIE)
- Global Ocean Ecosystem Dynamics (GLOBEC)
- Indian Institute International Futures
- Indian Institute of Technology (IIT)
- International Energy Agency (IEA)
- International Food Policy Research Institute (IFPRI)
- International Monetary Fund (IMF)
- **International Institute for Applied System Analysis (IIASA)**
- Intergovernmental Panel on Climate Change (IPCC)
- Joint Global Change Research Institute at Pacific Northwest National Laboratory (JGCRI/PNNL)
- Mercator Research Institute on Global Commons and Climate Change
- National Center for Atmospheric Research (NCAR)
- National Institute for Environmental Studies (NIES)
- National Renewable Energy Laboratory (NREL)
- Organisation for Economic Co-operation and Development (OECD)
- Potsdam Institute for Climate Impact Change (PIK)
- PBL - Netherlands Environmental Assessment Agency
- Research Institute of Innovative Technology for the Earth (RITE)
- Stanford University
- **Stockholm Resilience Centre**
- **Sustainable Development Solutions Network (SDSN)**
- The City University of New York (CUNY)
- Tsinghua University
- UN Population Division
- UN DESA
- UNEP- World Conservation Monitoring Centre (UNEP-WCMC)
- University of Hamburg
- World Bank

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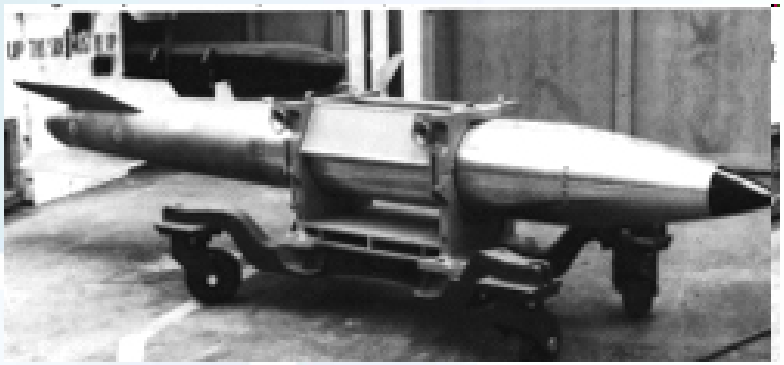
Wageningen, Netherlands

THE EARLY 1970s



Sources: nuclearweaponarchive.org, The Guardian

Sources: US Department of Interior, IIASA

24 MEMBER COUNTRIES (NMOs)

- International, independent, in terdisciplinary
- Research on major global problems
- Solution oriented, integrated systems analysis

24 MEMBER COUNTRIES

Representing:

71% of the world's economy

US$54,797,000 million from World GDP of US$77,302,000 million

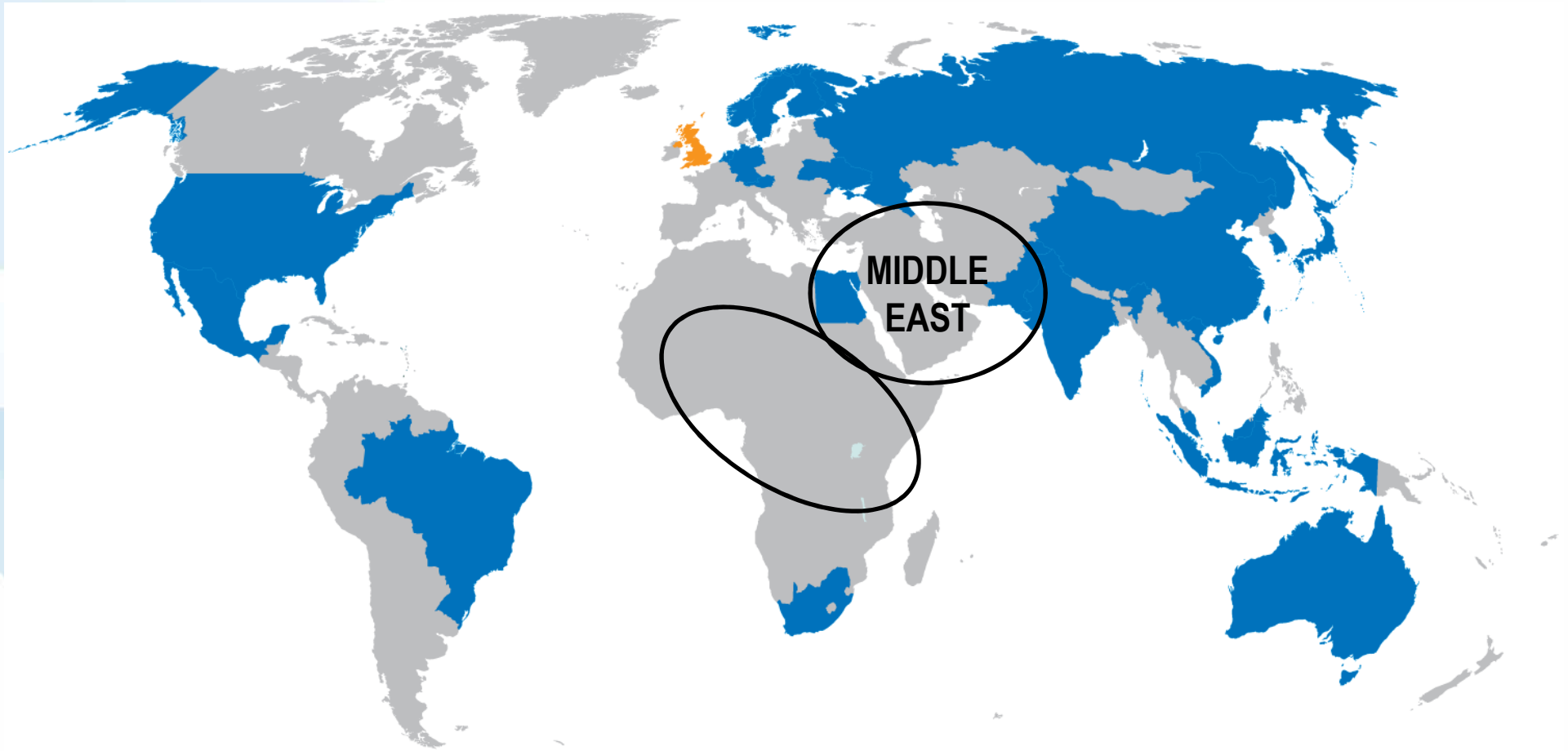
(including 8 of the world's 10 largest economies)

63% of the world's population

4,599.7 million people from World population of 7,247.9 million

Sources: GDP figures from IMF (2014); population figures from IIASA (2015)

24 COUNTRIES - NATIONAL MEMBER ORGANIZATIONS



25 expected by end of 2015
(See IIASA membership strategy)

IIASA GLOBAL HUB & TRULY INTERNATIONAL

- 1,445 visitors & collaborators in 2014
- Plus ~25% of IIASA alumni (3,505 people worldwide) remain actively involved in IIASA research
- Plus ~600 partner institutions
- In sum, ~2500 researchers from some 65 countries involved in IIASA's research network (external faculty)
- And it is not just research networks: IIASA researchers took part in 112 advisory boards and steering committees in 2014

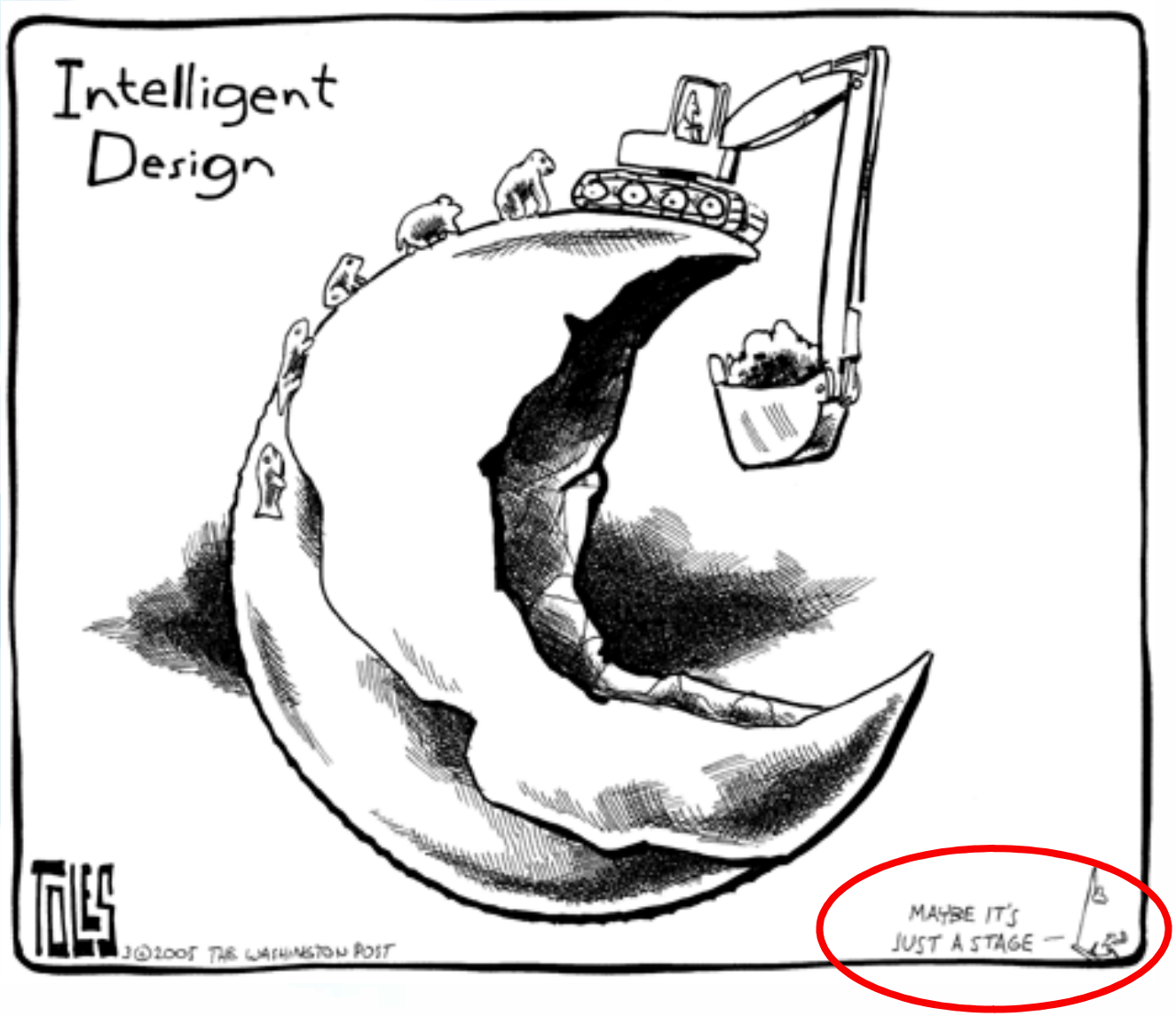
IIASA is very much interested to enhance collaboration with France even further and we hope to welcome France back as IIASA member country

A propos: **The Anthropocene**

- For the first time in the Earth's history are the major processes dominated by a single species:
- **Homo (not-so much) -sapiens** ?
- The current era is therefore so unique that is has been labeled the '**Anthropocene**'

- **What are the consequences and can we manage this?**

The UN Millennium Ecosystem Assessment



Washington Post

30 March 2005

VISION…..

If one does not know to which port one is sailing, no wind is favorable

Photo: David McGrath

Earth System Science Partnership
IIASA

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

Thank you and welcome soon at IIASA !!