Energy & Environment

Introduction and fundamentals

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Institute of Electricity Economics and Energy Innovation

07.03.2016

General information

- Monday 10:15-11:45
- Lecture room HSi1

Mo	29.02.2016	12:00	13:00	HS i1 (HSEG058J)
Mo	07.03.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	14.03.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	11.04.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	18.04.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	25.04.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	02.05.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	09.05.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	23.05.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	30.05.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	06.06.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	13.06.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	20.06.2016	10:15	11:45	HS i1 (HSEG058J)
Mo	27.06.2016	10:15	11:45	HS i1 (HSEG058J)

- Course documents
  - Presentations
  - Supplementary information

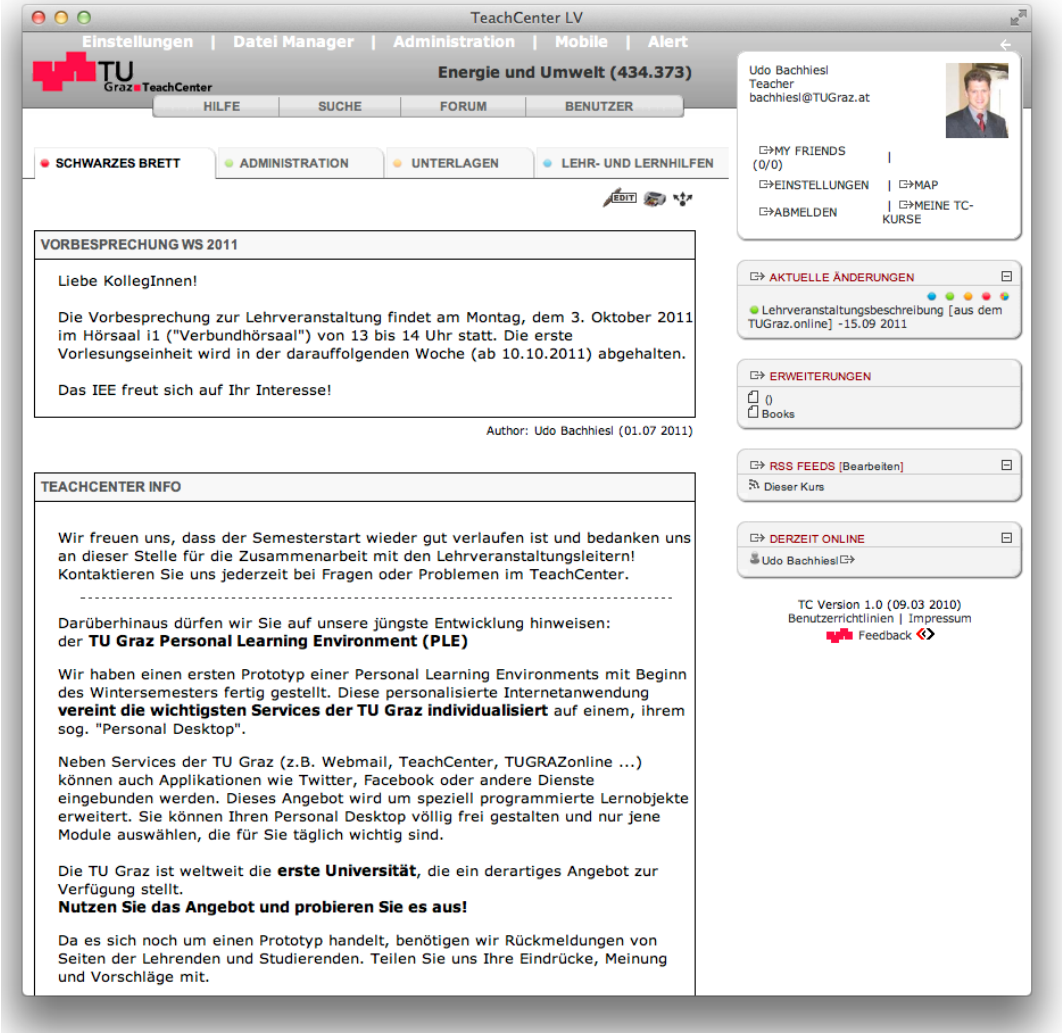
} Teach Center

- Exams: 27.06.2016, 28.06.2016

Quelle: ATLANTIS, IEE/TU Graz

TeachCenter

→ Electronic teaching and learning plattform



Content

1. Introduction and fundamentals
2. Sustainability
3. Climate change
4. Emission Trading
5. Life Cycle Assessment
6. Acceptance of RE, power plants, grid projects
7. Pollution
8. Environmental Management Systems

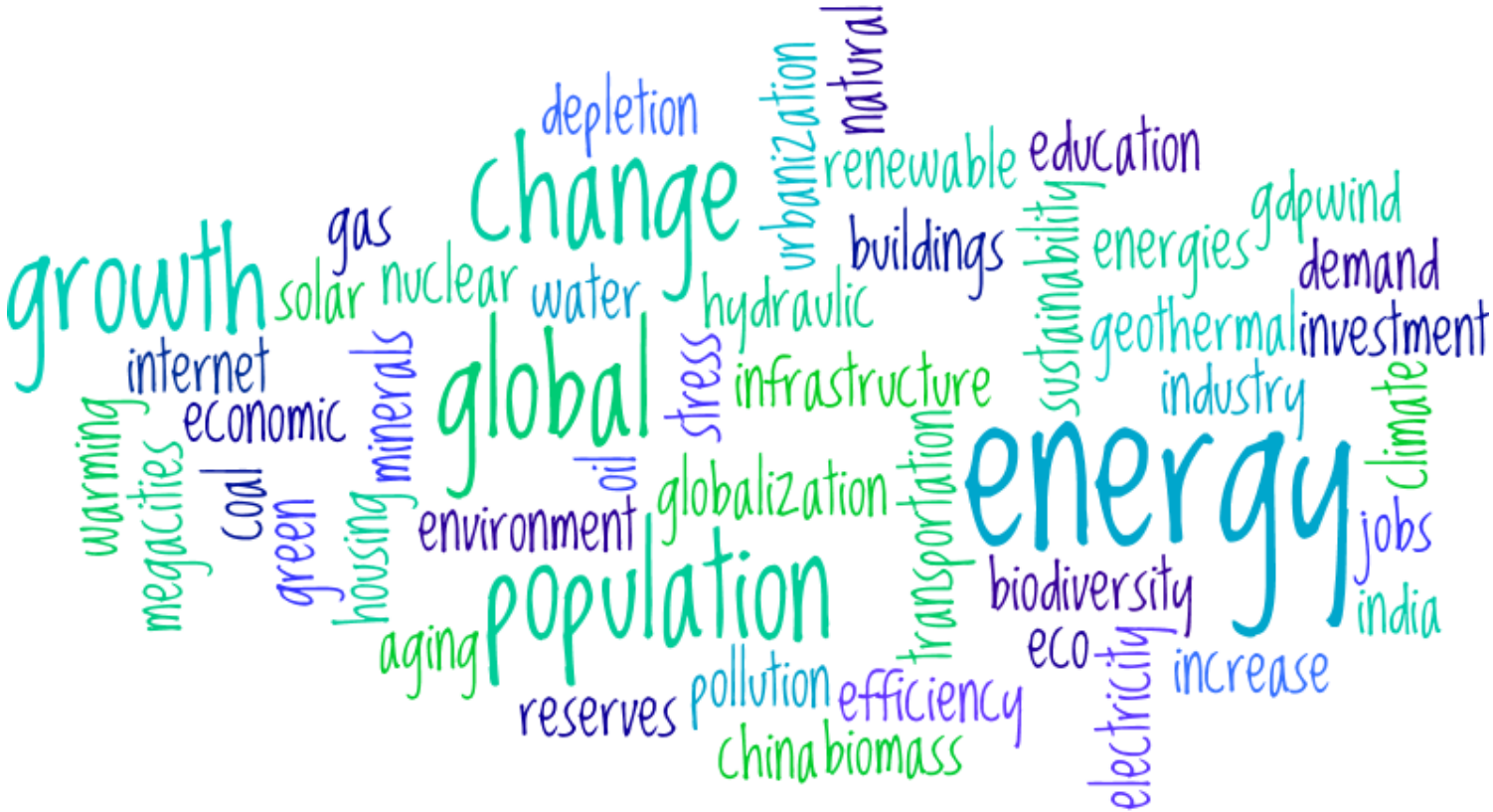
Questions?

Fundamentals

- Initial situation
- Outlook on the Global Agenda 2015
- World Energy Outlook
- Access to electricity

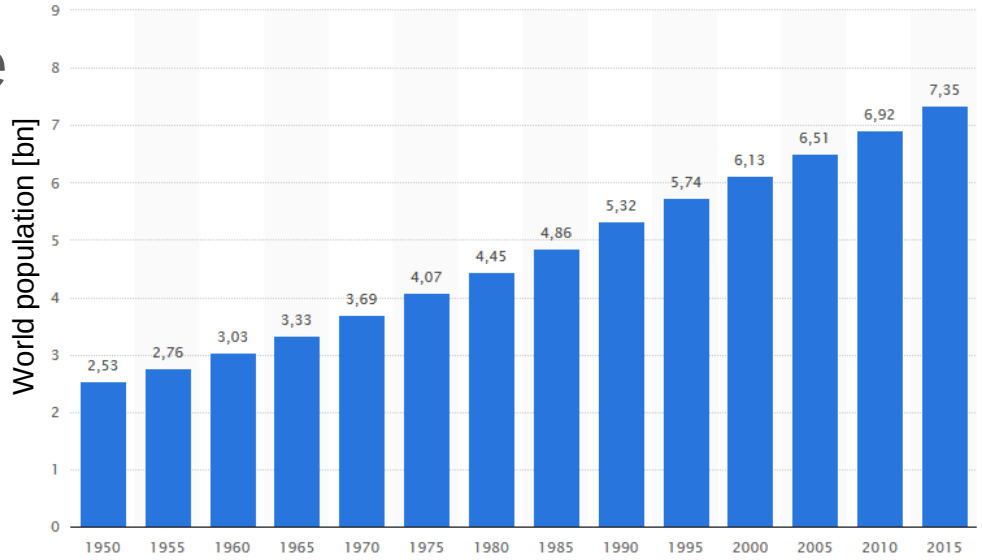
The world is changing

The world is changing



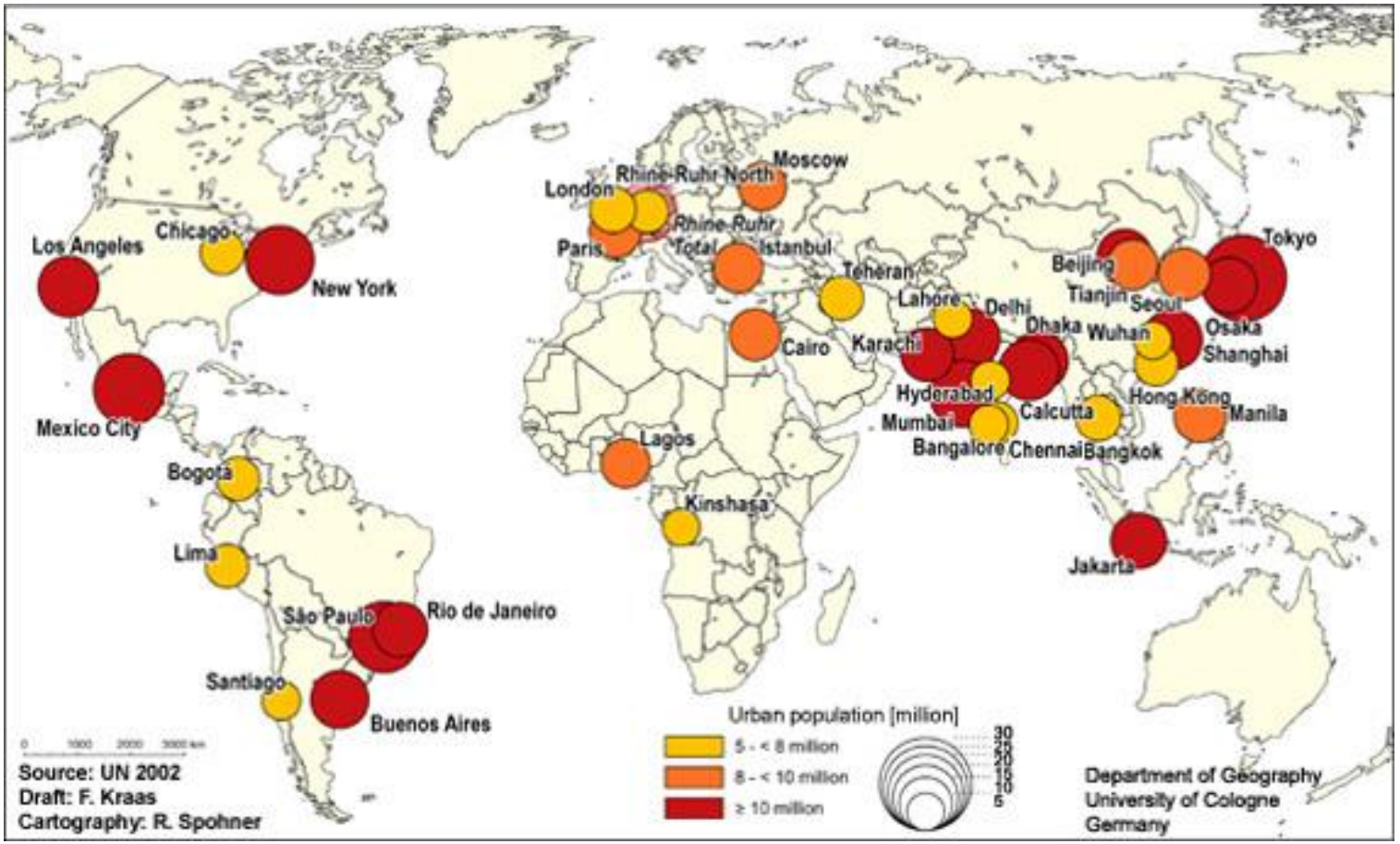
Initial situation

- 2015: 7,35 billion people
- More than 2 billion people without access to energy
  ➔ 4 out of 5 in developing countries
- Poverty as a global problem – Big differences in the distribution of wealth
- More and more people in mega-cities
  ➔Problems?



Source:
http://de.statista.com/statistik/daten/studie/1716/umfrage/entwicklung-der-weltbevoelkerung/

Megacities


Los Angeles
Chicago
New York
Mexico City
Bogota
Lima
São Paulo
Rio de Janeiro
Santiago
Buenos Aires
London
Rhine-Ruhr North
Rhine-Ruhr
Paris
Total
Moscow
Istanbul
Teheran
Cairo
Lagos
Kinshasa
Lahore
Delhi
Karachi
Dhaka
Hyderabad
Mumbai
Bangalore
Calcutta
Chennai
Bangkok
Jakarta
Beijing
Tianjin
Seoul
Tokyo
Wuhan
Osaka
Shanghai
Hong Kong
Manila
Urban population [million]
5 - < 8 million
8 - < 10 million
≥ 10 million
30
25
20
15
10
5
Source: UN 2002
Draft: F. Kraas
Cartography: R. Spohner
Department of Geography
University of Cologne
Germany

Growth factors

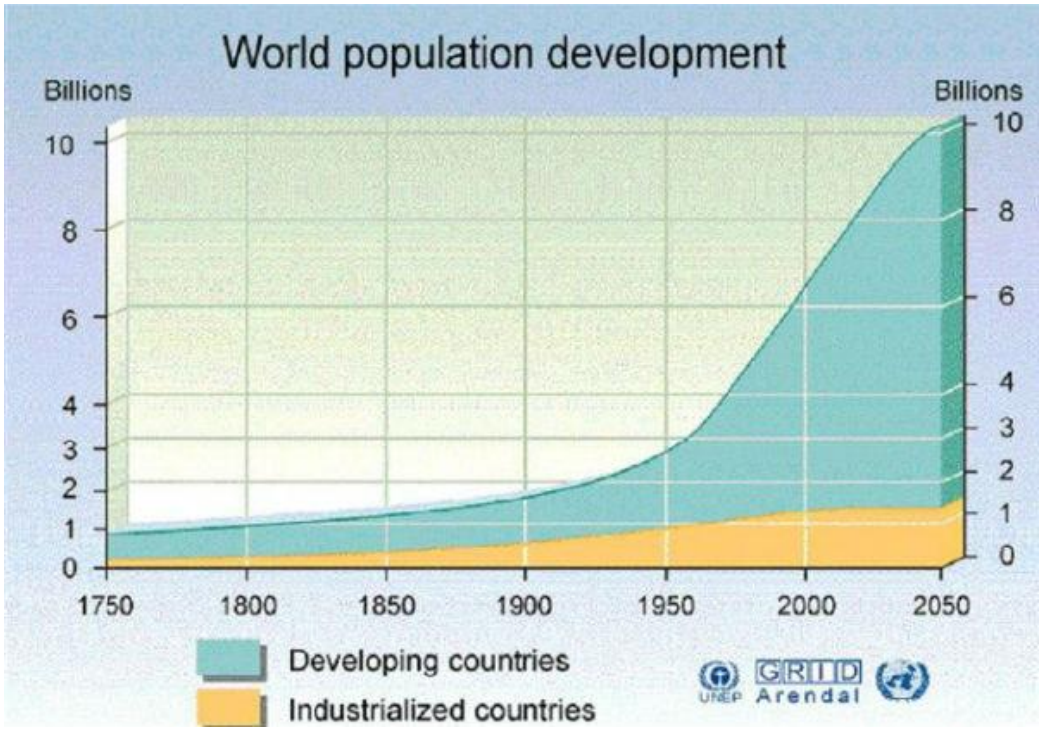
	1800	2000	Factor
Population (billion)	1	6	*6
Life expectancy (a)	35	75	*2
Working hours (/a)	3.000	1.500	/2
Freetime (h)	70.000	300.000	*4
Mobility (km/day)	0,04	40	*1.000
World income (trillion $)	0,5	36	*70
Global energy demand (Gtoe)	0,3	10	*35

Growth factors

Rapid growth in energy demand leads to some societal challenges:

- Local and global environmental pollution
- Limited resources and potentials (fossil fuels and renewable energies)
- Societal acceptance and risk aspects

Growth factors



Population growth leads to more environmental stress

1% increase in population = 1% increase in emissions

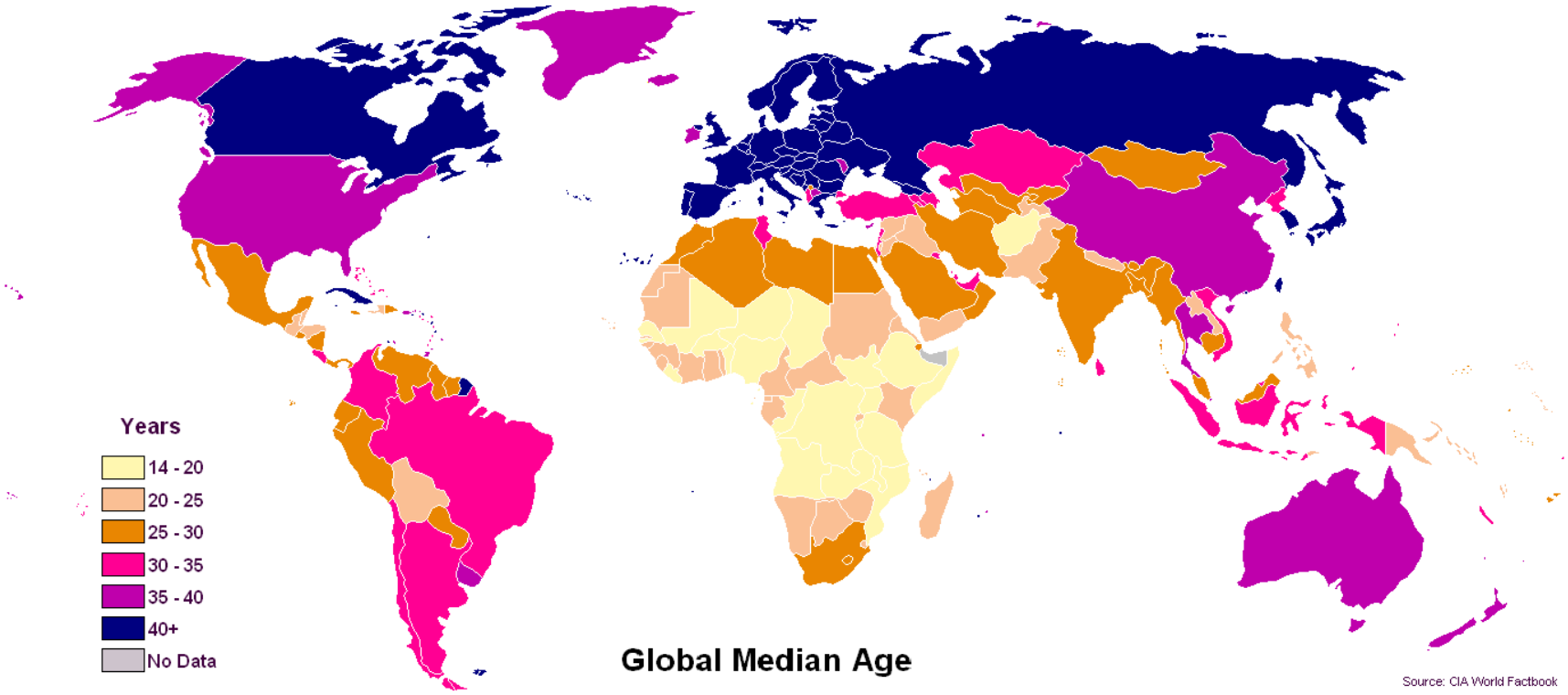
http://thewatchers.adorraeli.com/2012/06/14/population-growth-producing-more-environmental-stress/

Population: current situation

Average age of population

Uganda: 15

Europe, Canada, Japan: 40+

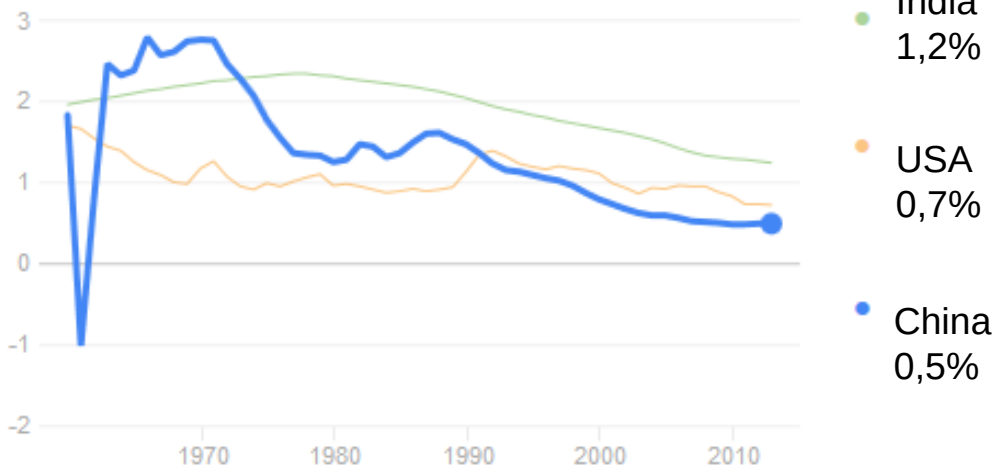


Source: CIA World Factbook

Population: current situation

The world' s most populous countries 2014

Population growth rate

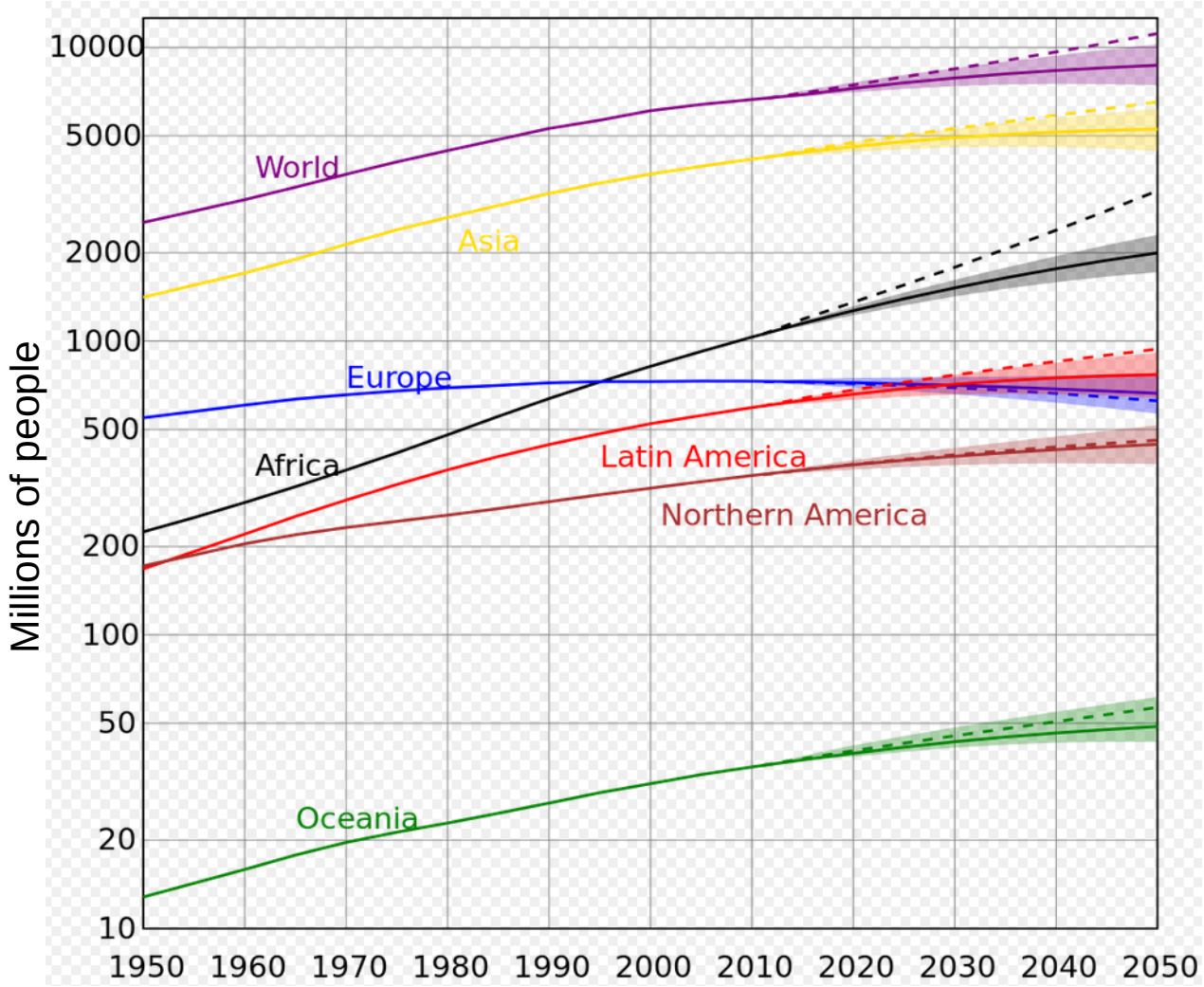


Country	Population (in 1.000)
China	1.355.693
India	1.236.345
EU	507.417
USA	318.892
Indonesia	253.610
Brazil	202.657
Pakistan	196.174
Nigeria	177.156
Bangladesh	166.281
Russia	142.470

Source: World Bank

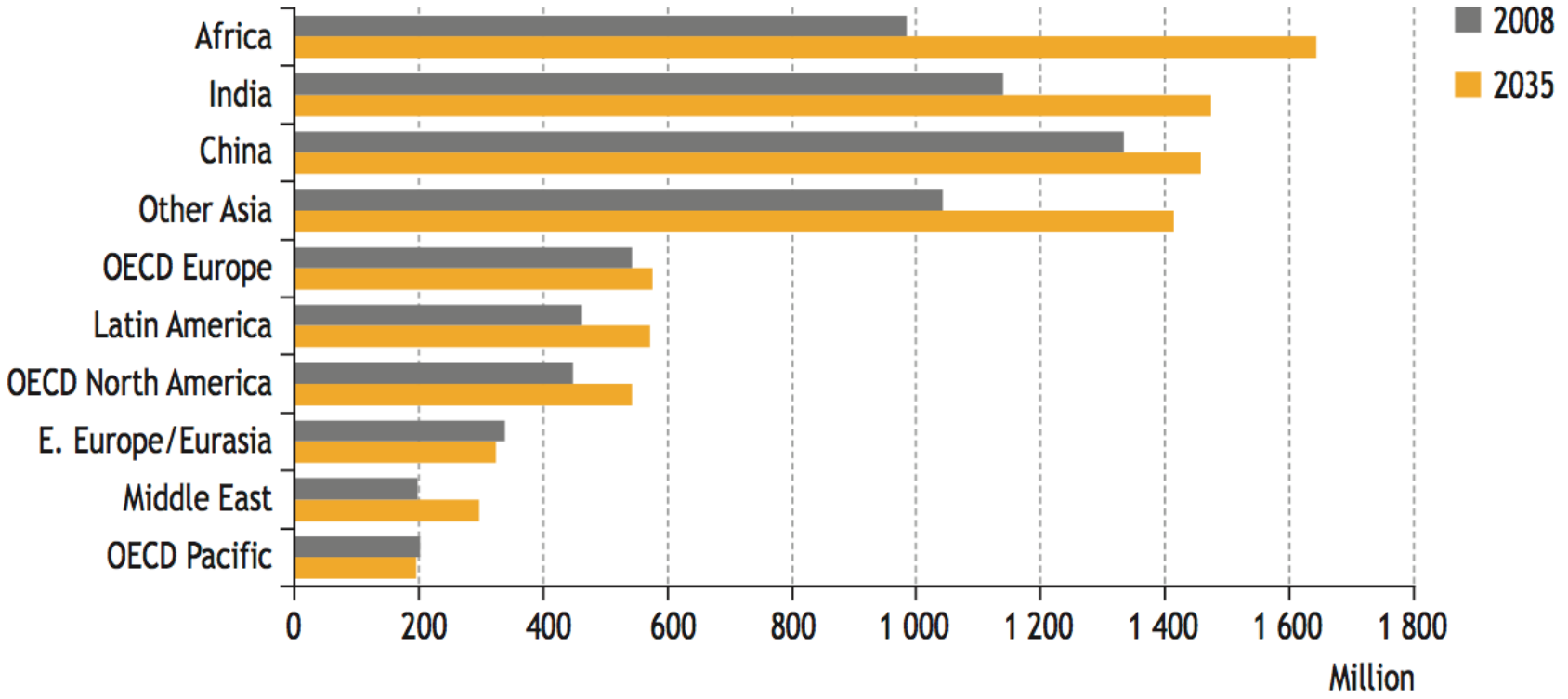
Source: CIA World Factbook

World population development



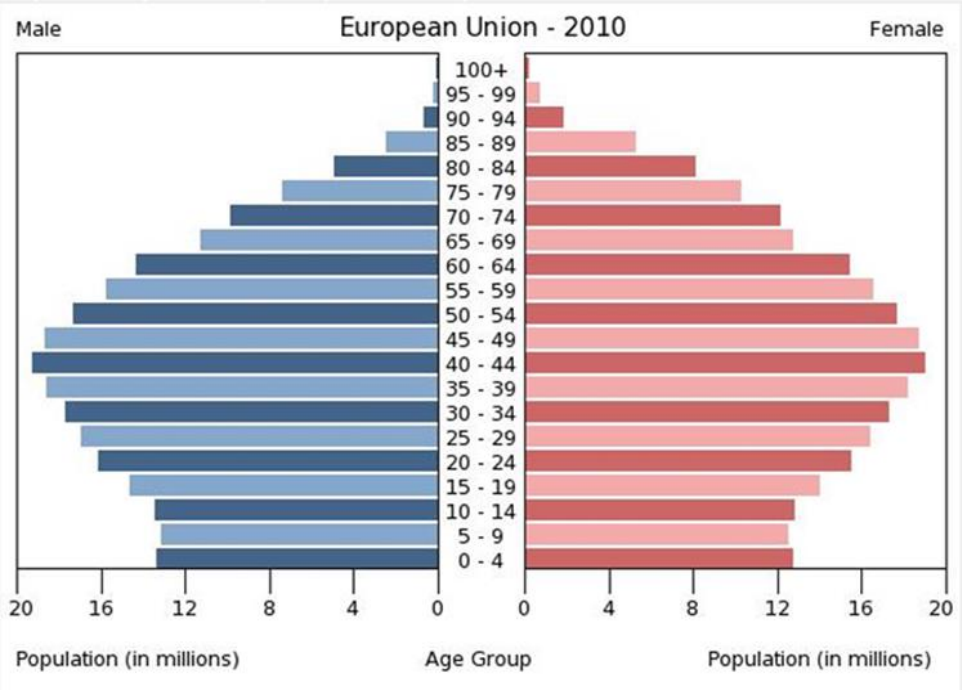
Source: CIA World Factbook

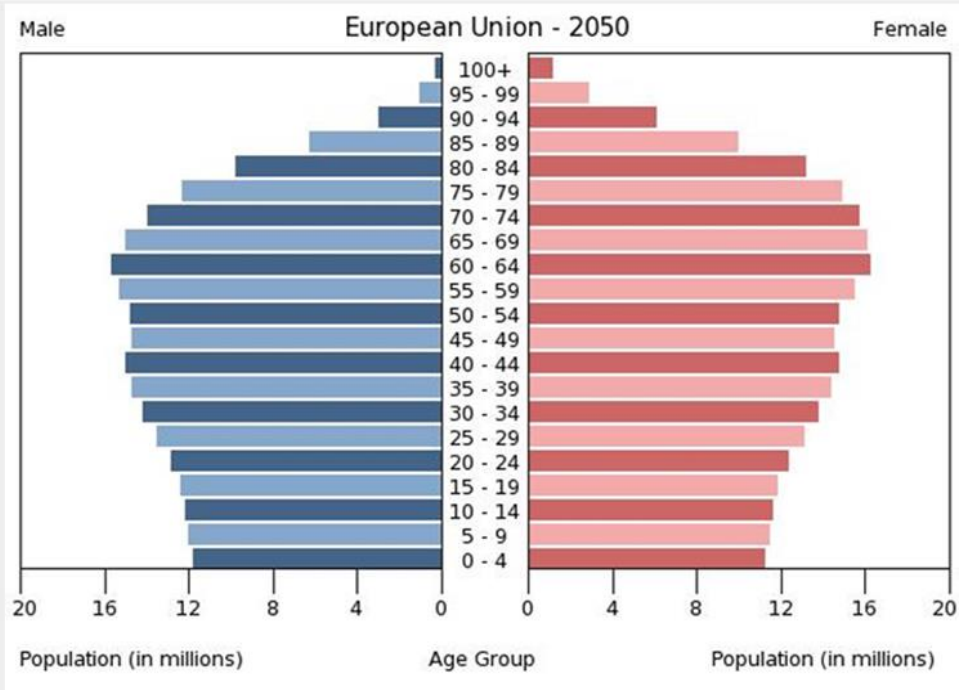
World population by major region



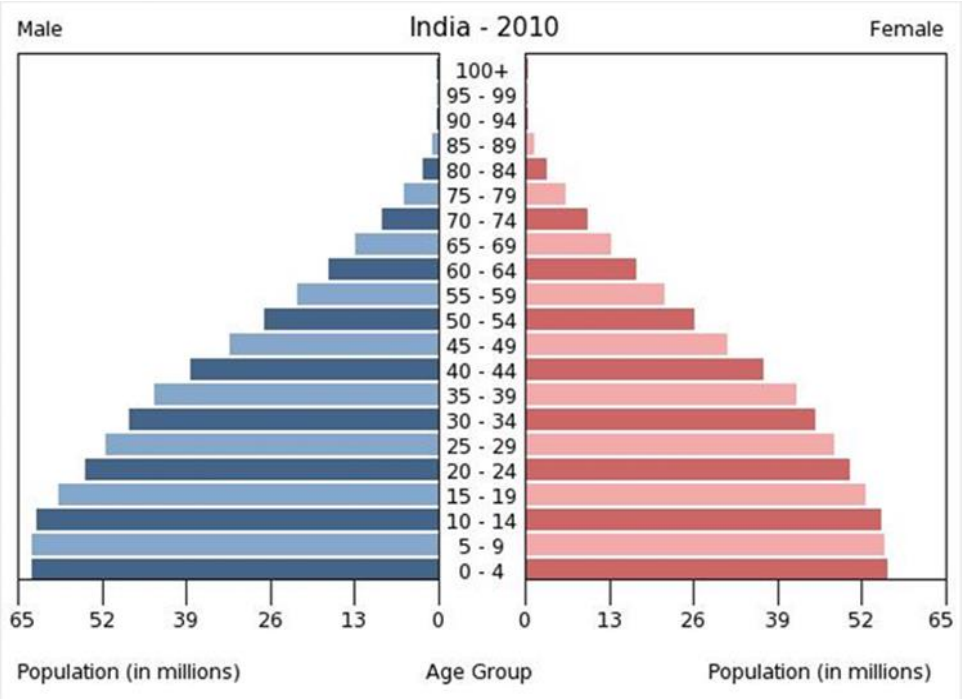
Sources: World Energy Outlook 2010, UNPD and World Bank databases, IEA analysis

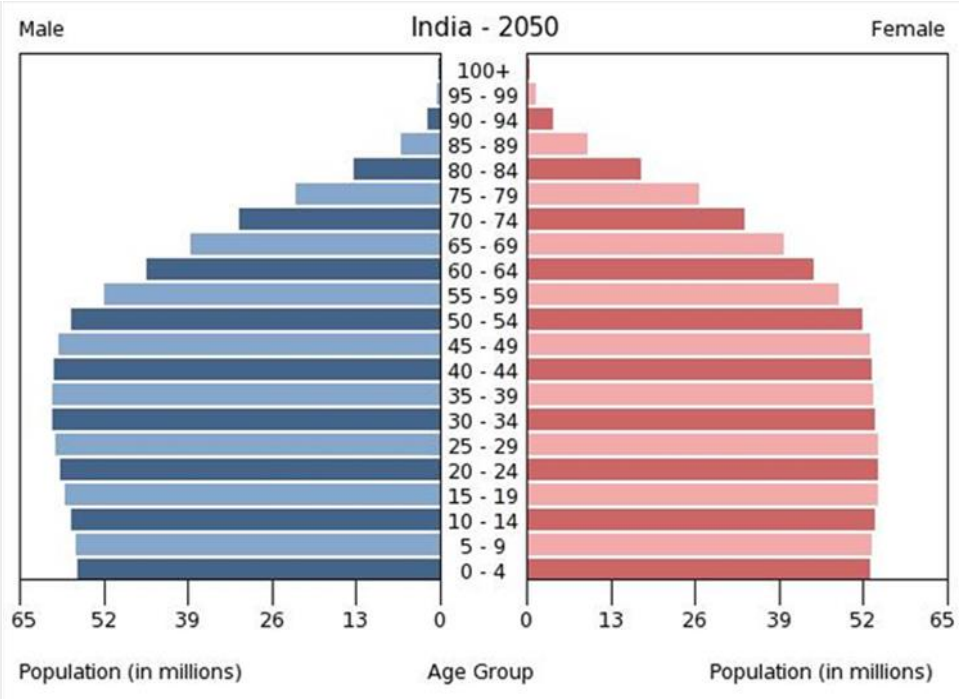
Population pyramid EU





Population pyramid India





Outlook on the Global Agenda 2015

- Top 10 trends 2015
- Future agenda

Outlook on the Global Agenda 2015

- 2015: 4th edition
- Analysis of the Top 10 trends
- Key regional challenges
- Emerging issues that will define our future

"By exploring the challenges we face today, together we can progress towards a better future."

Al Gore

Outlook on the Global Agenda 2015

Top 10 trends of 2015

1. Deepening income inequality
2. Persistent jobless growth
3. Lack of leadership
4. Rising geostrategic competition
5. The weakening of representative democracy
6. Rising pollution in the developing world
7. Increasing occurrence of severe weather events
8. Intensifying nationalism
9. Increasing water stress
10. Growing importance of health in the economy

Rising pollution in the developing world

Source: Outlook on the Global Agenda 2015

Rising pollution in the developing world

- Developing world learned about commercial models, infrastructure and technology from Europe and North America

  ➔ **Problem:** the world‘s carbon capacity cannot allow us to continue on this path

- Developing countries will suffer the most from weather-related disasters and increased water stress caused by global warming
- 2°C warming above pre-industrial temperatures
  - 4-5% of African and South Asian GDP loss
  - Developing countries are expected to bear 75-80% of impact costs

Rising pollution in the developing world

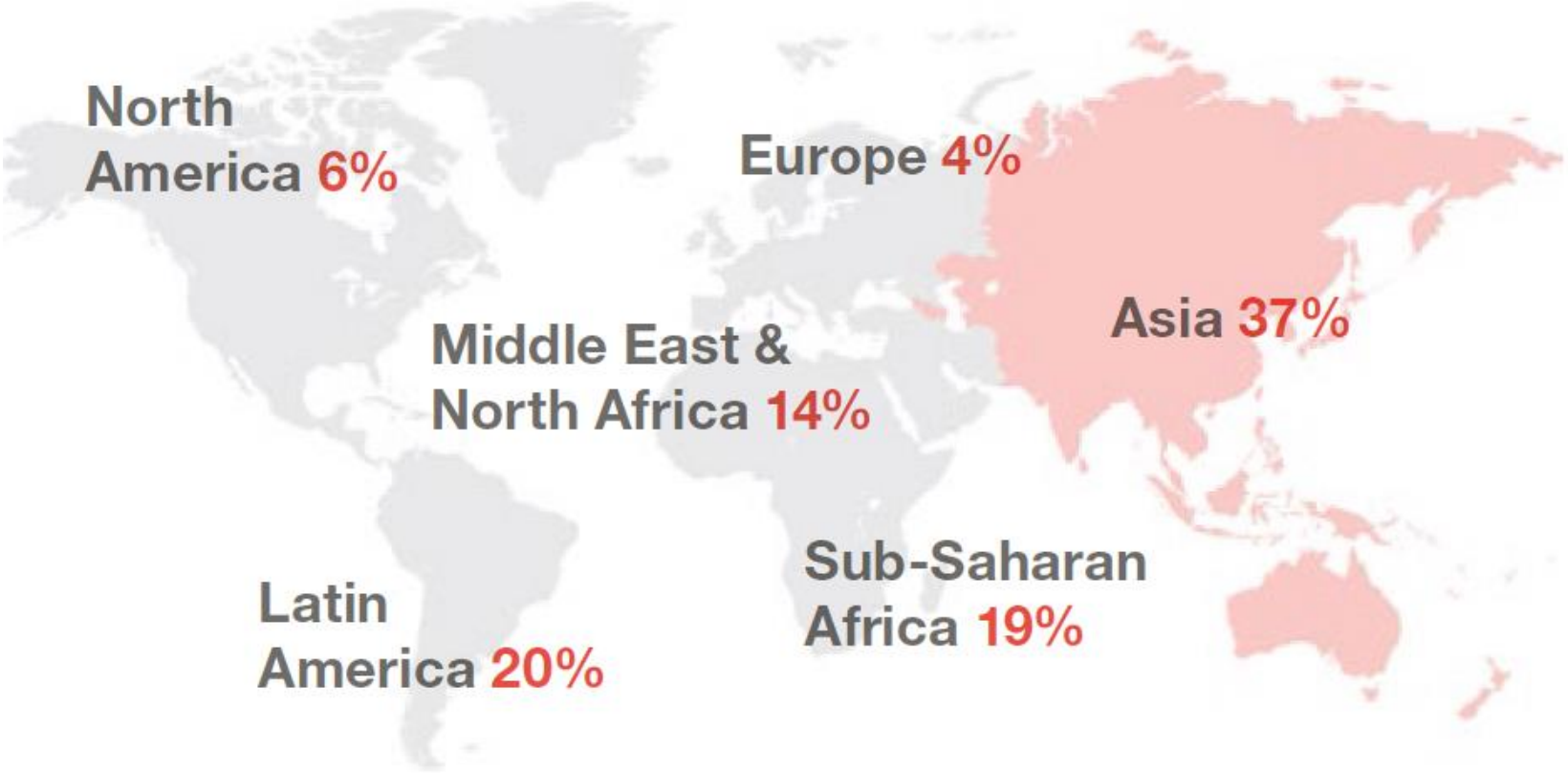
Solutions

- Investing in a power generation network that replaces coal
  - Renewables, nuclear, gas
  - Phasing out low-efficiency generators
- Ensure properly regulation of high-polluting industries
- Promote clean energies
- Funding from high-income countries to developing ones
- Cooperation to develop new low-carbon technologies and carbon capture

Once high-carbon solutions have been implemented, they are difficult to replace. Decisions being made today on power generation are crucial.

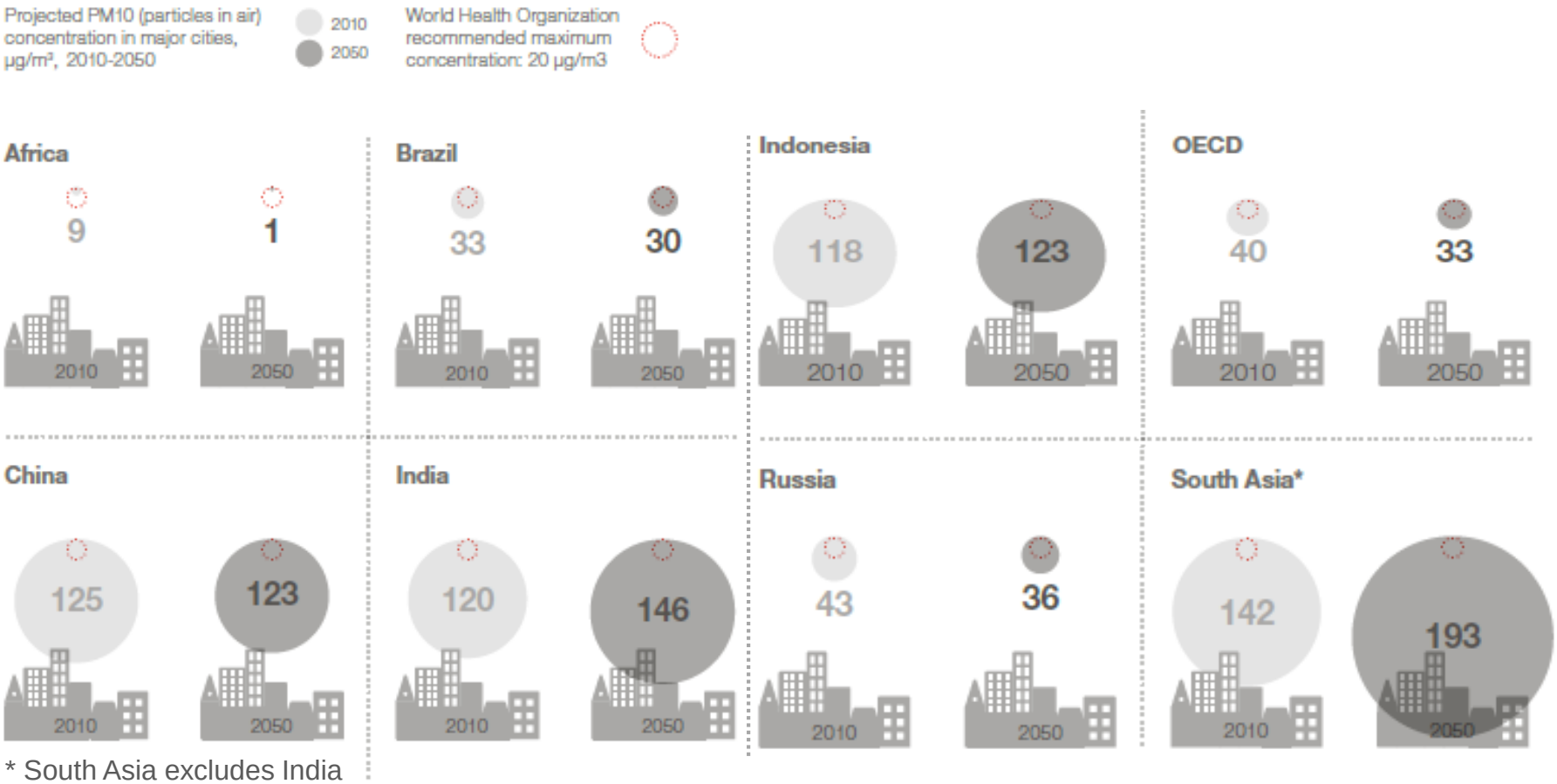
Rising pollution in the developing world

Which region will be most affected by rising pollution in the developing world in the next 12-18 months?



Source: Survey on the Global Agenda 2014

Rising pollution in the developing world



* South Asia excludes India

Source: OECD Environmental Outlook Baseline, 2012

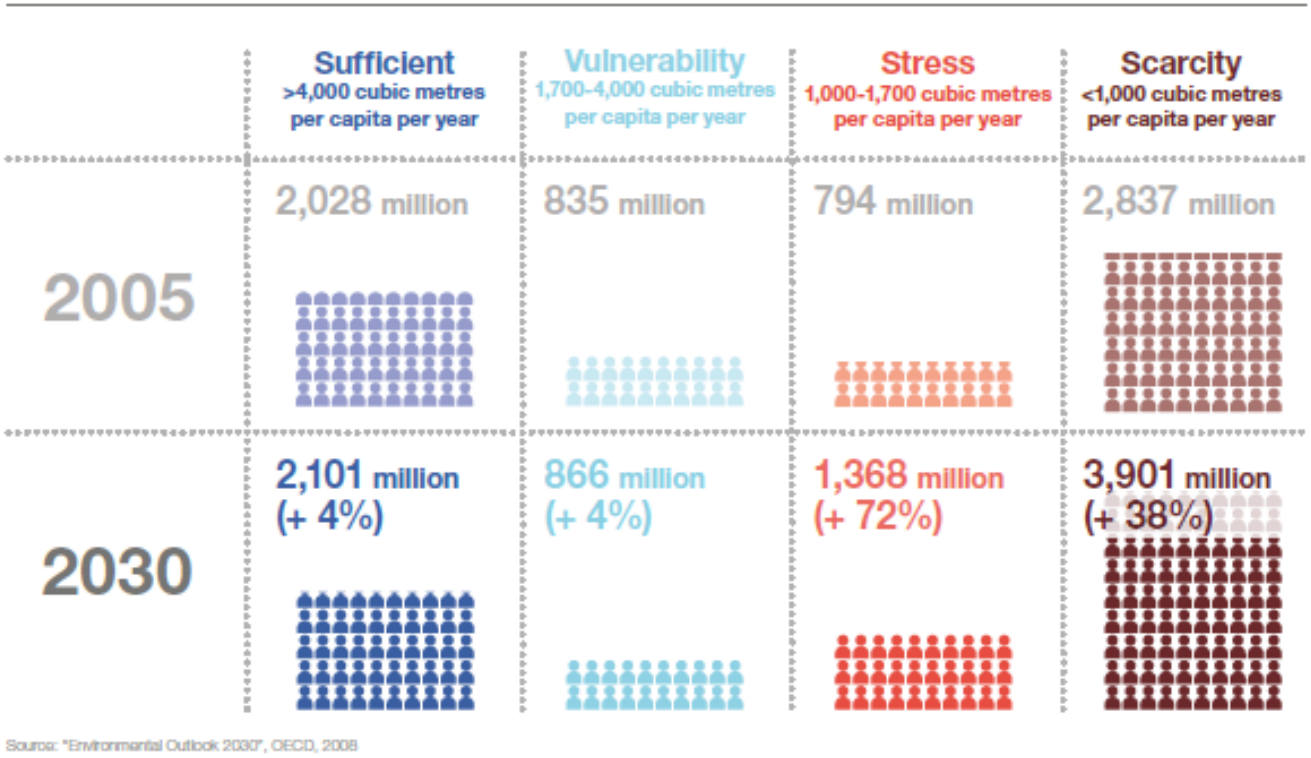
Increasing occurrence of severe weather events

- Major consequence of climate change
- More frequent, powerful and erratic
- Important: Adaption
- Costs of extreme weather events are highest for society's poorest

Source: REUTERS/Sean Gardner

Increasing water stress

How many more people will be living under severe water stress by 2030?



Asia: Resource-constrained water stress
Africa: Finance-constrained water stress

Outlook on the Global Agenda 2015

Future agenda

- Synthetic biology
- Brain-computer interaction
- Deep sea mining
- Emerging nuclear powers
- The evolution of monetary policy

Emerging nuclear power – a safe path to energy security?

- Increase in electricity demand in developing countries 5-6% /a
- 1% or less in developed countries
- Alternatives to meet electricity demand have to be found
- Increase in nuclear power for the next decades highest in China, Russia and India
- Nuclear power as important part to face the challenges of climate change and energy security

World Energy Outlook

International Energy Agency

- Autonomous agency
- Established in 1974
- Aims:
  - Promote sustainable energy policies
  - Improve transparency of international energy markets
  - Support global collaboration on energy technology
  - Find solutions to global energy challenges

Scenarios

Principally used scenarios

- Current Policies Scenario
- New Policies Scenario
- 450 Scenario (< 2°C, < 450 ppm CO_2 equ)

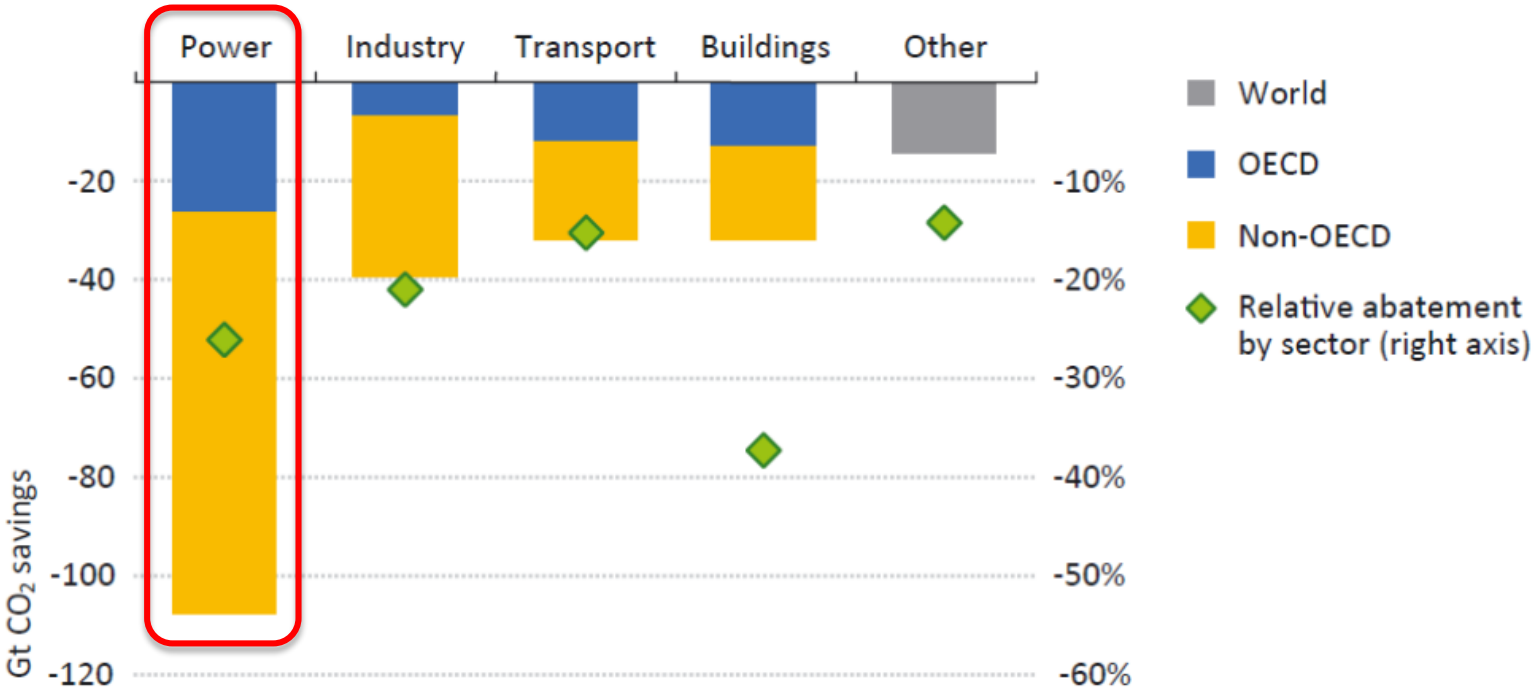
Three biggest contributors to emissions reduction:

1. China (30%)
2. US (15%)
3. India (10%)

Power sector offers largest possibility of additional abatement

World Energy Outlook

Cumulative CO_2 emissions reduction by sector and region in the 450 Scenario relative to the New Policies Scenario



- Power sector offers largest possibility of additional abatement

Source: IEA, World Energy Outlook 2014

World Energy Outlook

- Power sector
  - Every third GW of new capacity installed worldwide in past decade was low carbon (mainly RE)
  - 450 Scenario: After 2030 three of four GW added has to be low carbon technology

Source: www.oneyoungworld.com

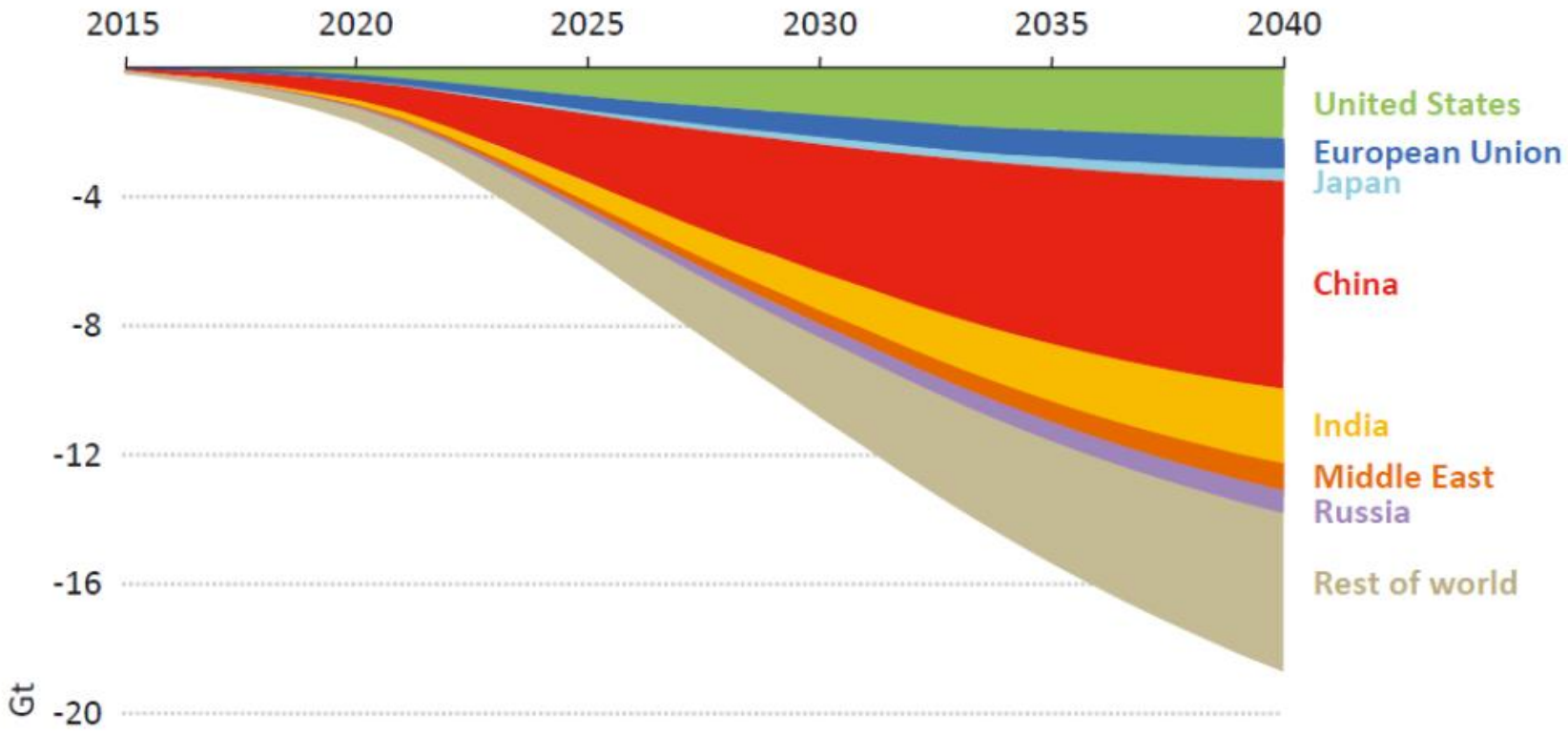
World Energy Outlook

- Differences between scenarios
  - Majority of emissions reductions in 450 Scenario after 2030

➔ **Reasons:** long lead times required to built up low carbon technologies

World Energy Outlook

Reduction in energy-related CO_2 emissions in 450 Scenario relative to the New Policies Scenario



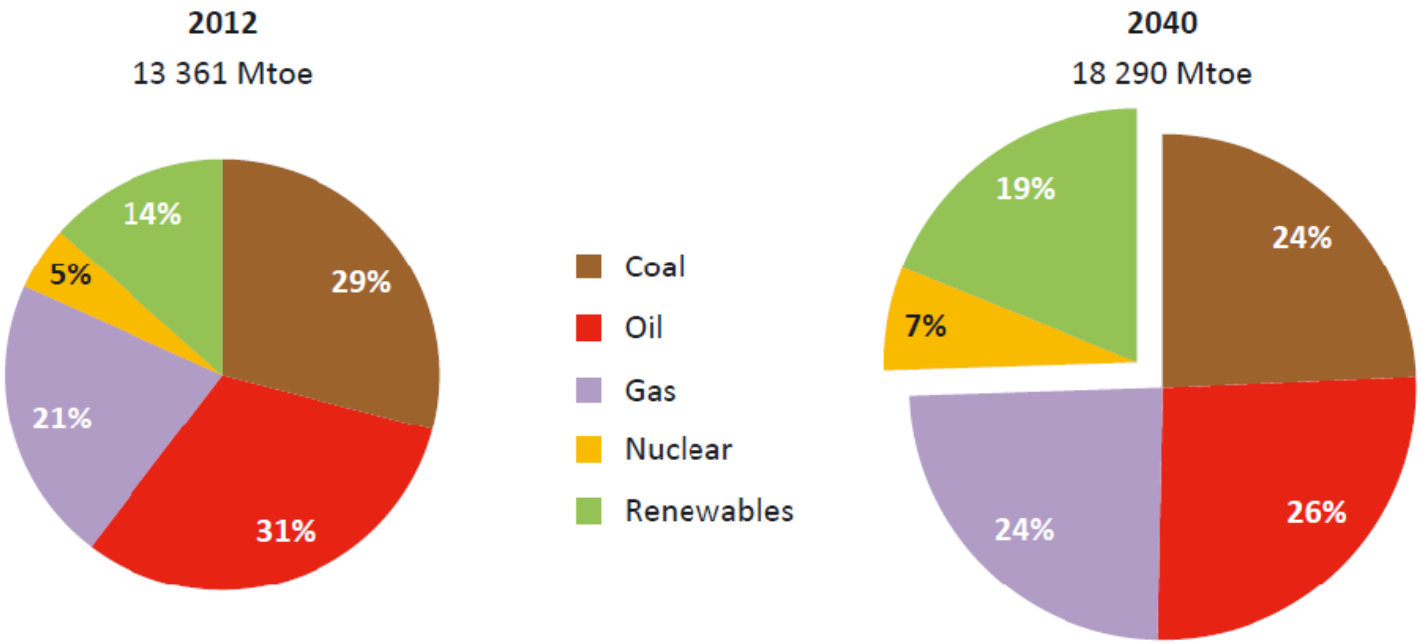
Source: IEA, World Energy Outlook 2014

Global energy trends

- Energy demand
  - New Policies Scenario: world primary energy demand increases by 37% between 2012 and 2040
  - Current Policies Scenario: increase by 50%
- Almost all energy demand growth comes from non OECD countries
  - Asia: 60%
- Share of fossil fuels in energy mix falls
- Share of low carbon fuels increases
- World oil supply rises from 90mb/d to 104 mb/d

World Energy Outlook

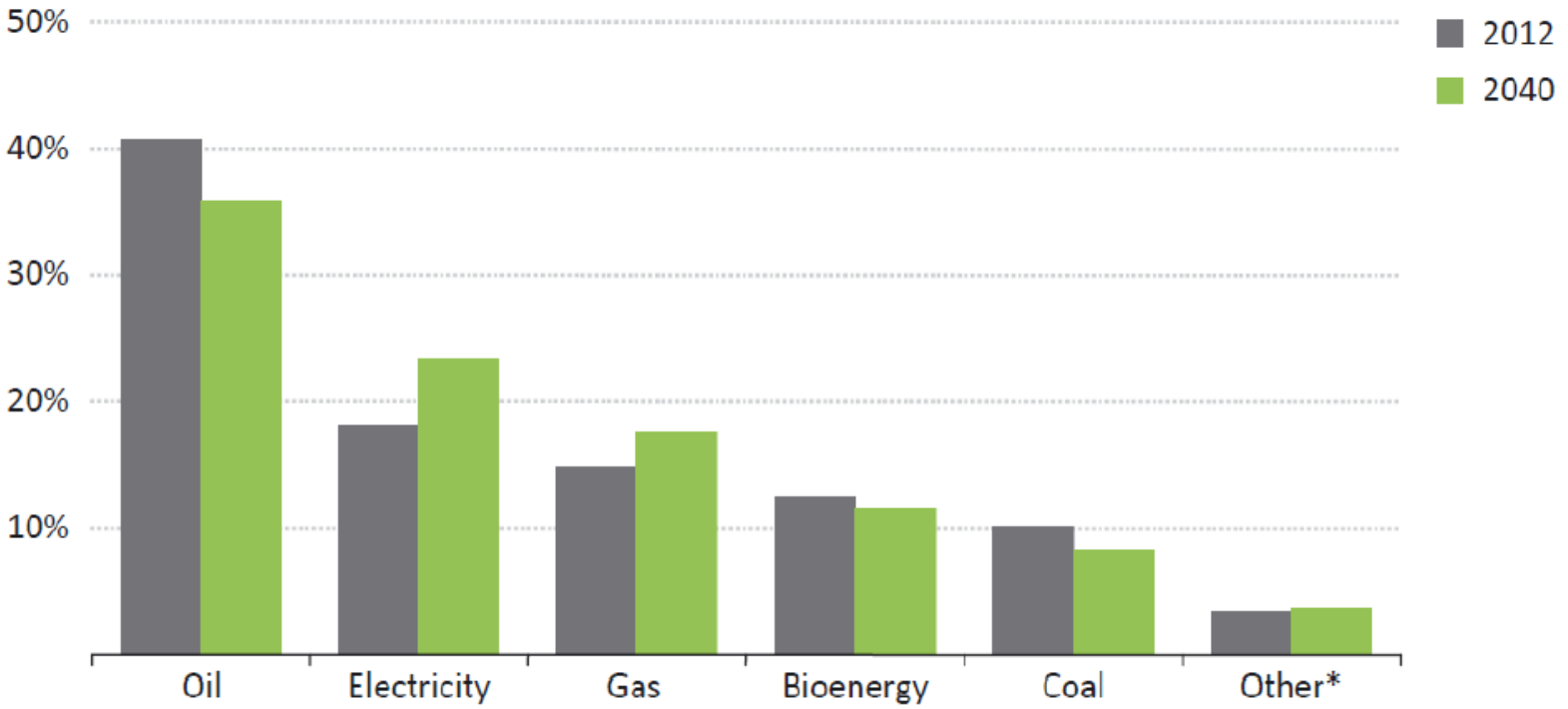
Fuel shares in world primary energy demand in the New Policies Scenario



Source: IEA, World Energy Outlook 2014

World Energy Outlook

Fuel shares in global final energy consumption in the New Policies Scenario



* Includes heat and renewables except bioenergy.

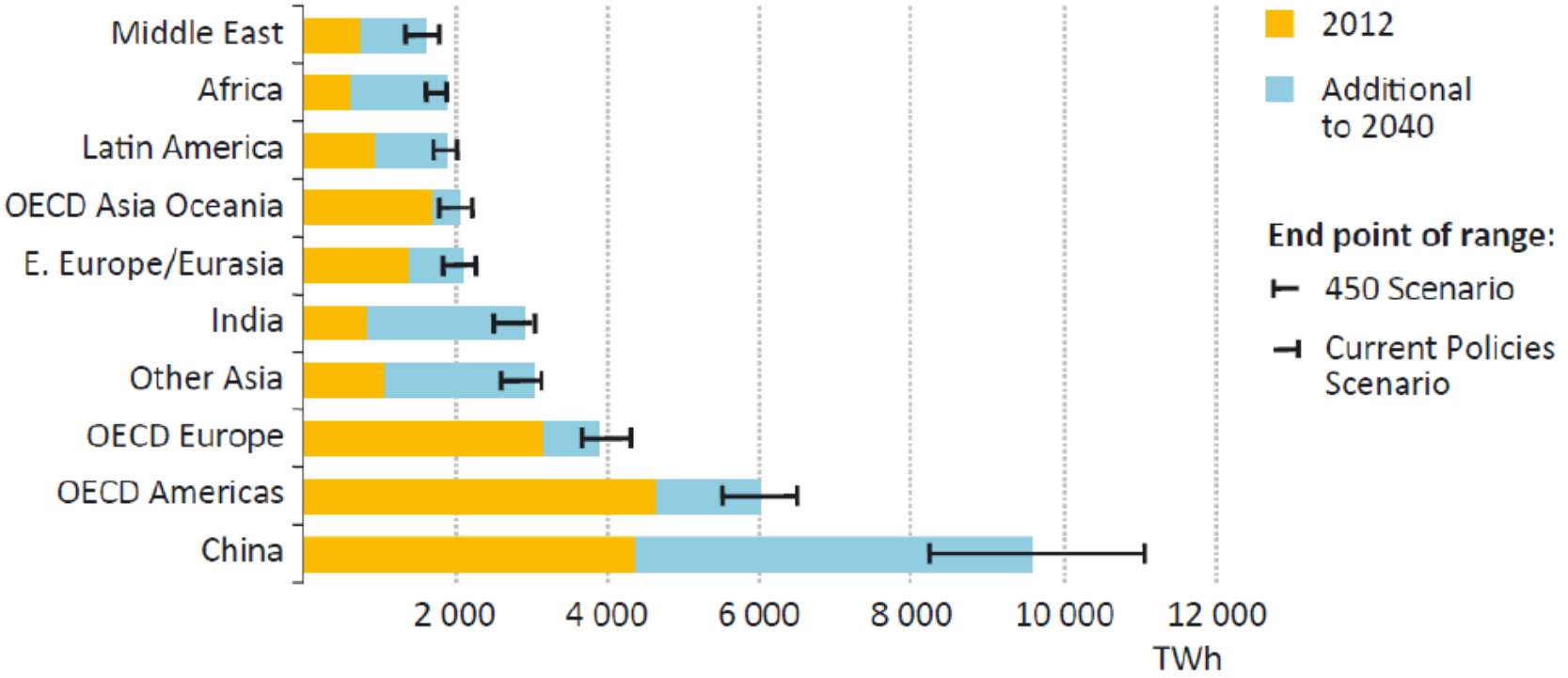
Source: IEA, World Energy Outlook 2014

Market outlook: Power sector

- Electricity remain fastest-growing final form of energy
- Current installed generation capacity nearly gets doubled until 2040
- Transformation away from fossil fuels
- Gas and nuclear replace the share of coal and oil
- RE generation nearly triples from 2013 to 2040

Market outlook: Power sector

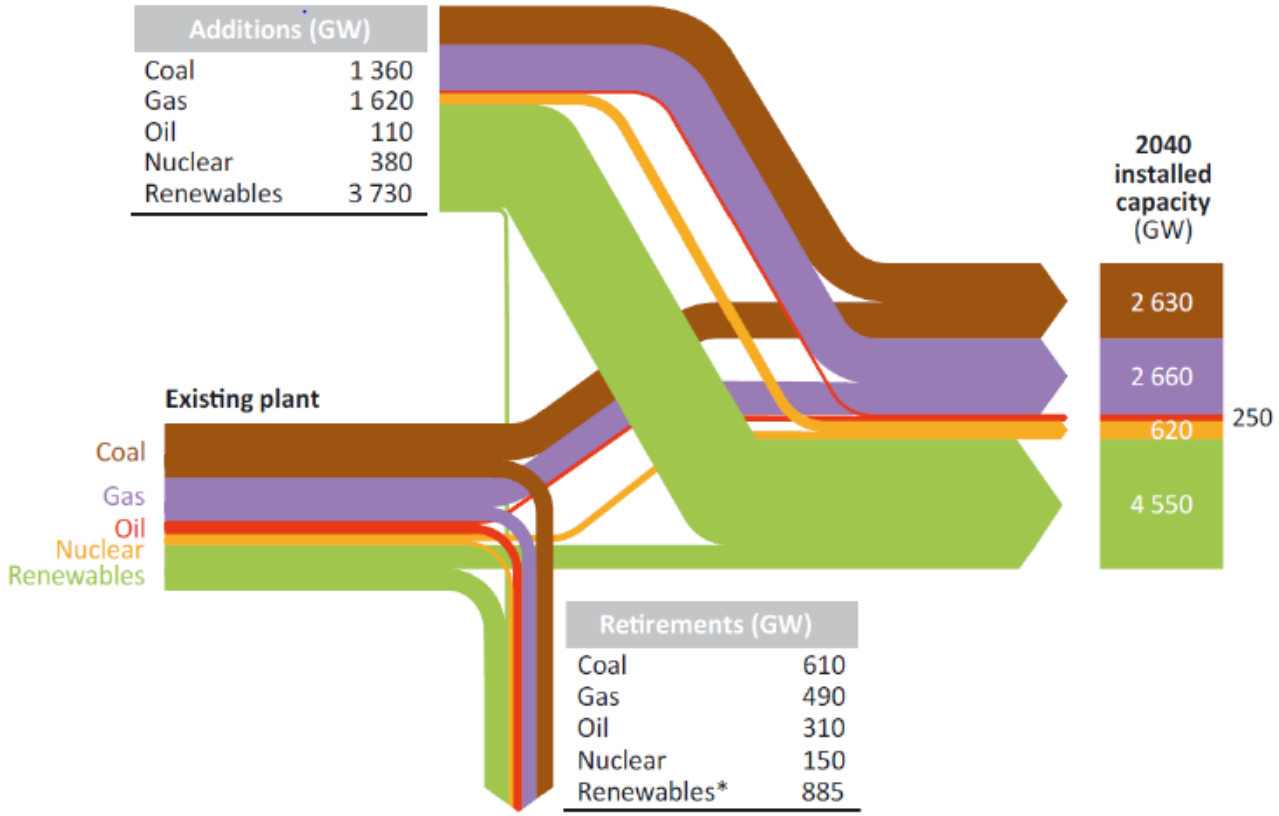
Electricity demand by region in the New Policies Scenario



Source: IEA, World Energy Outlook 2014

Market outlook: Power sector

Power generation capacity flows by source in the New Policies Scenario, 2014-2040

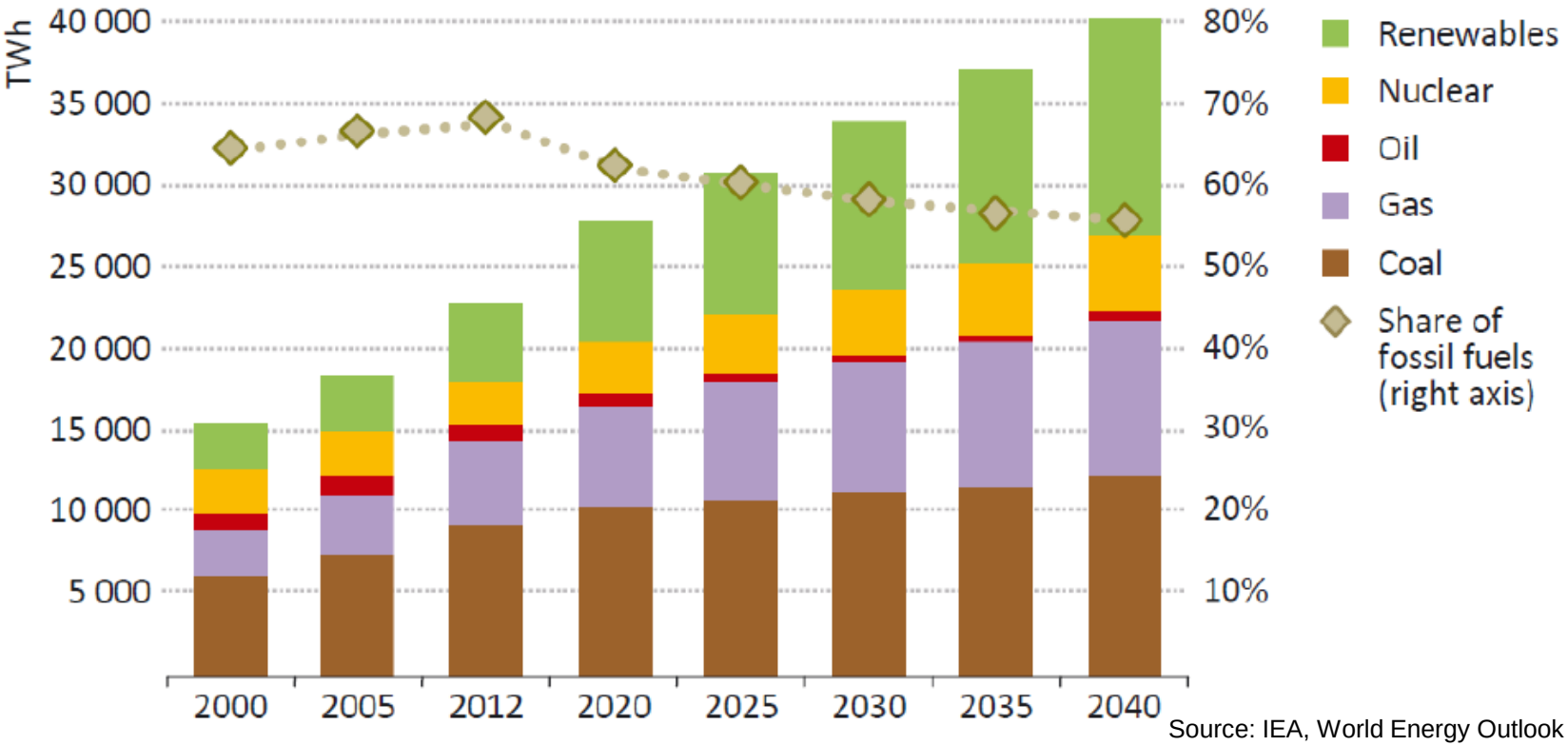


*Note: Over the projection period, a portion of renewable additions is retired, consistent with the average lifetime assumption for wind and solar PV of 25 years.

Source: IEA, World Energy Outlook 2014

Market outlook: Power sector

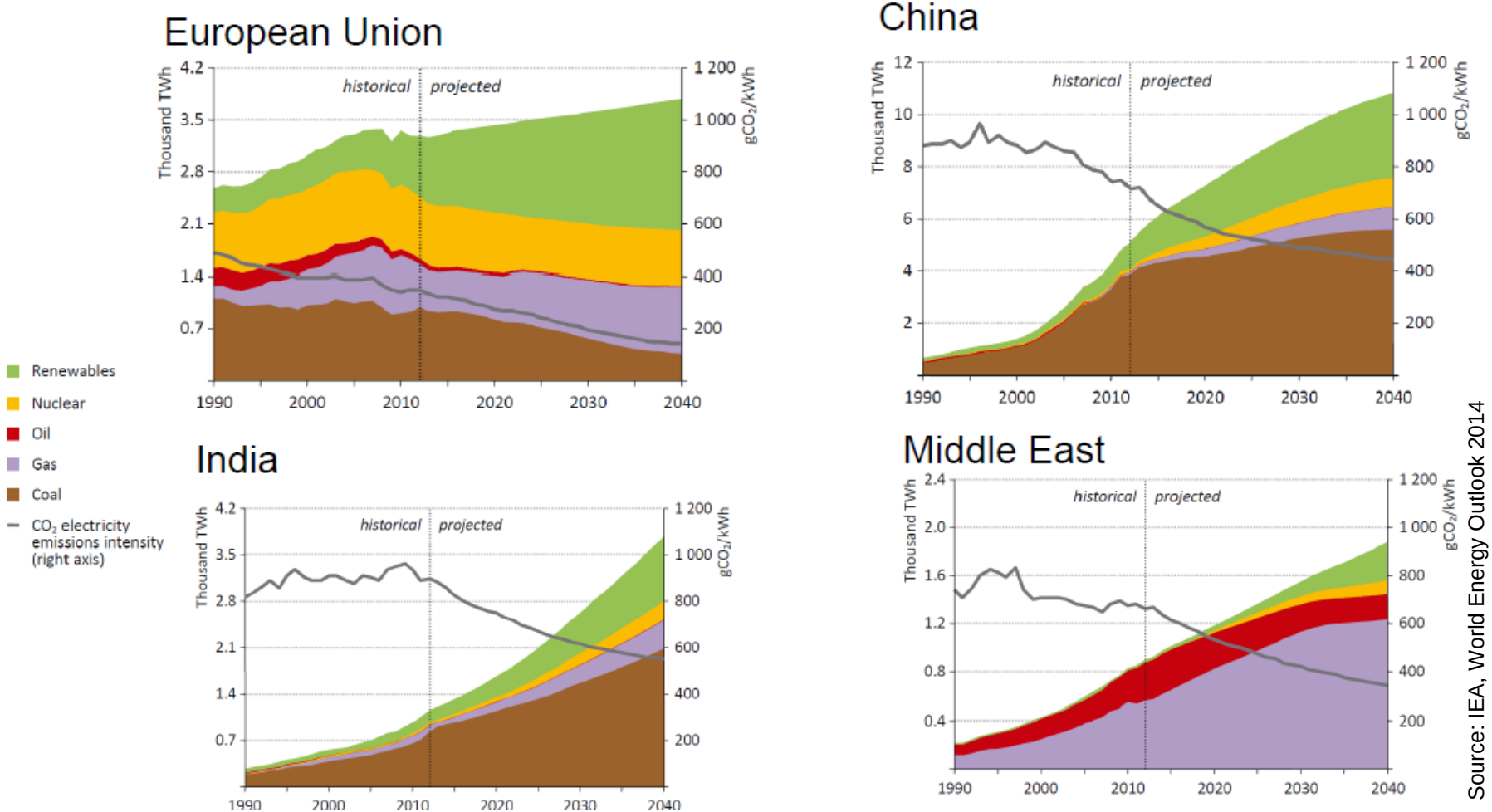
World electricity generation by source in the New Policies Scenario



Source: IEA, World Energy Outlook 2014

Market outlook: Power sector

Power generation and CO_2



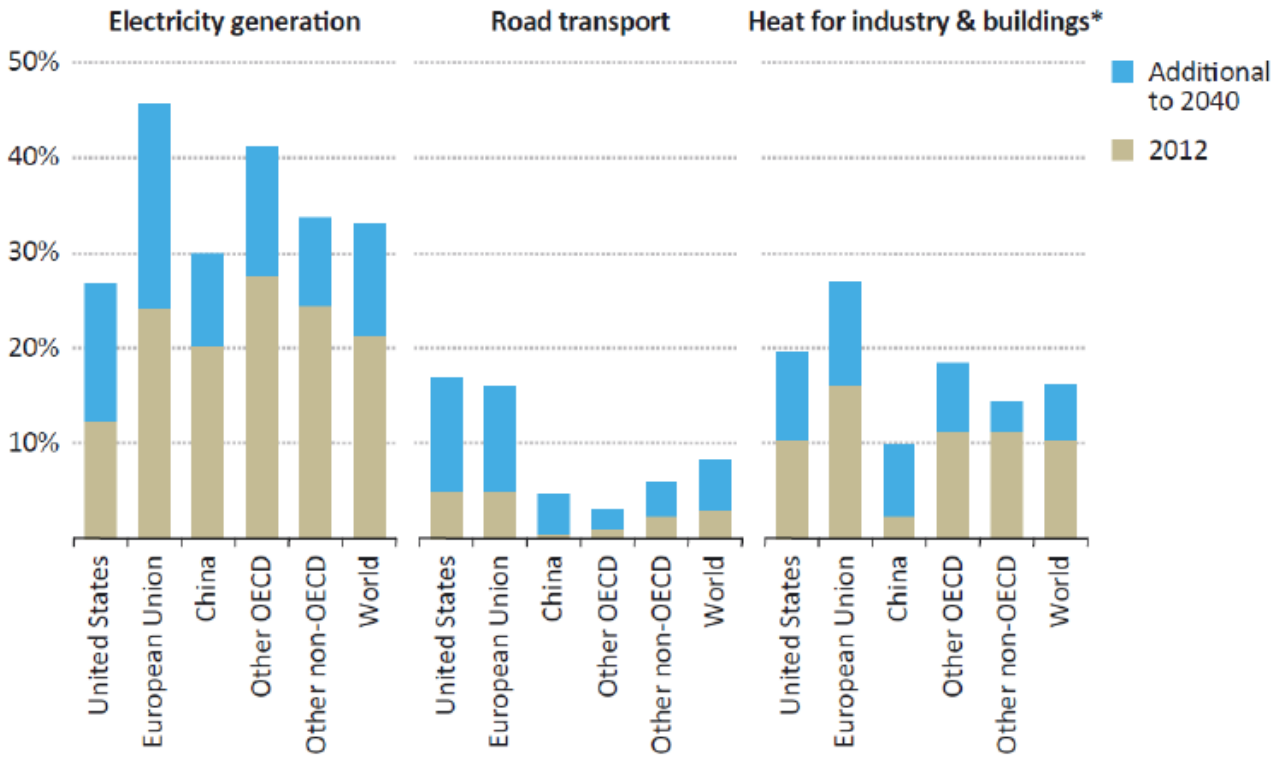
Source: IEA, World Energy Outlook 2014

Market outlook: Renewable energy

- RE are rapidly increasing and drive up their share (primary energy) from 13% to 19%
- Wind power capacity additions are second largest behind gas fired capacity
- PV sees second largest increase among RE
- Two thirds of investment in new power plants go to RE among OECD countries
- EU remains largest financial supporter of RE
- Avoided CO_2 emissions through RE
  - 3 Gt in 2012
  - 7,2 Gt in 2040

Market outlook: Renewable energy

Share of global renewables consumption by sector and region in the New Policies Scenario

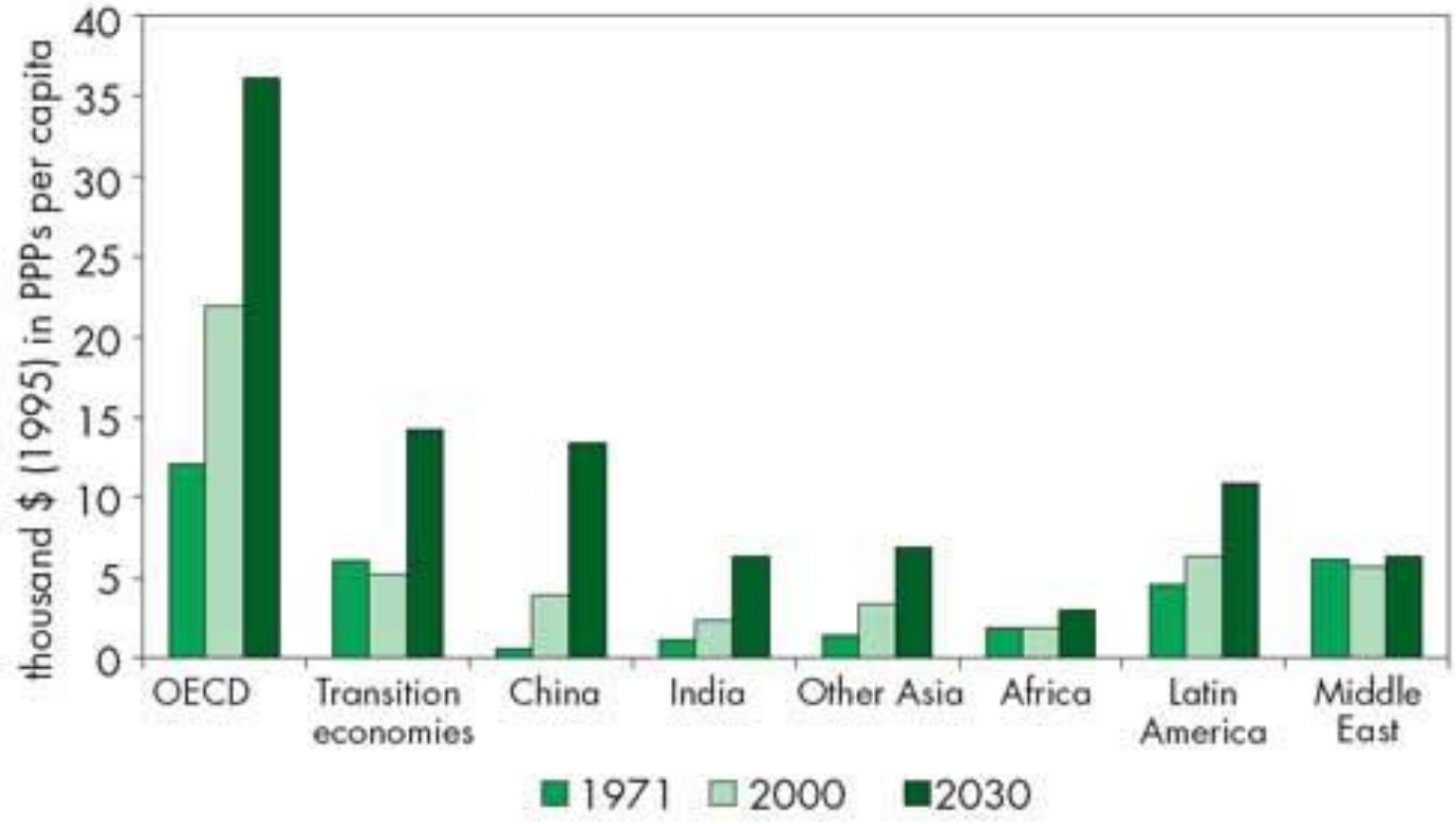


* Excludes traditional use of solid biomass in households.

Source: IEA, World Energy Outlook 2014

Access to electricity

Global per capita income



Biomass used for heating and cooking

	Million	% of total population
China	706	56
Indonesia	155	74
Rest of East Asia	137	37
India	585	58
Rest of South Asia	128	41
Latin America	96	23
North Africa/Middle East	8	0,05
Sub-Saharan Africa	575	89
Developing countries	**2.390**	**52**

Source: IEA, World Energy Outlook 2009

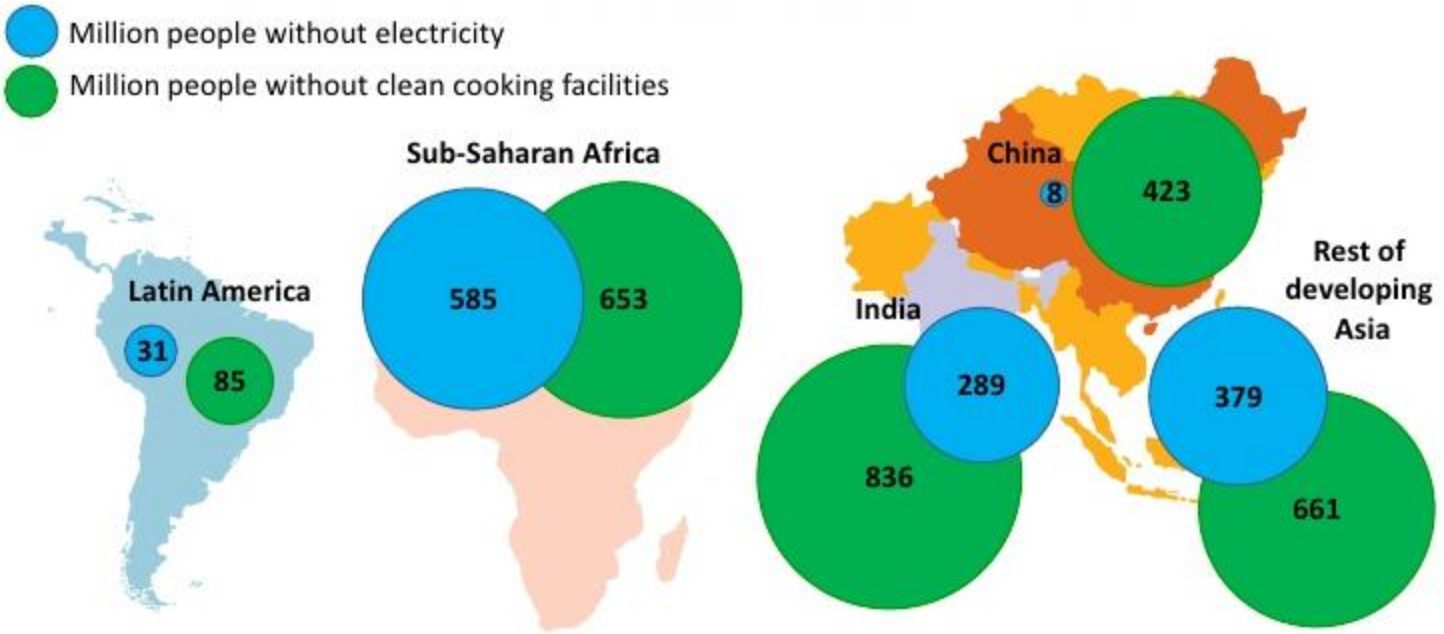
Energy and population

The relationship between per-capita final energy consumption and income in developing countries

Source: IEA, World Energy Outlook 2014

Energy and poverty

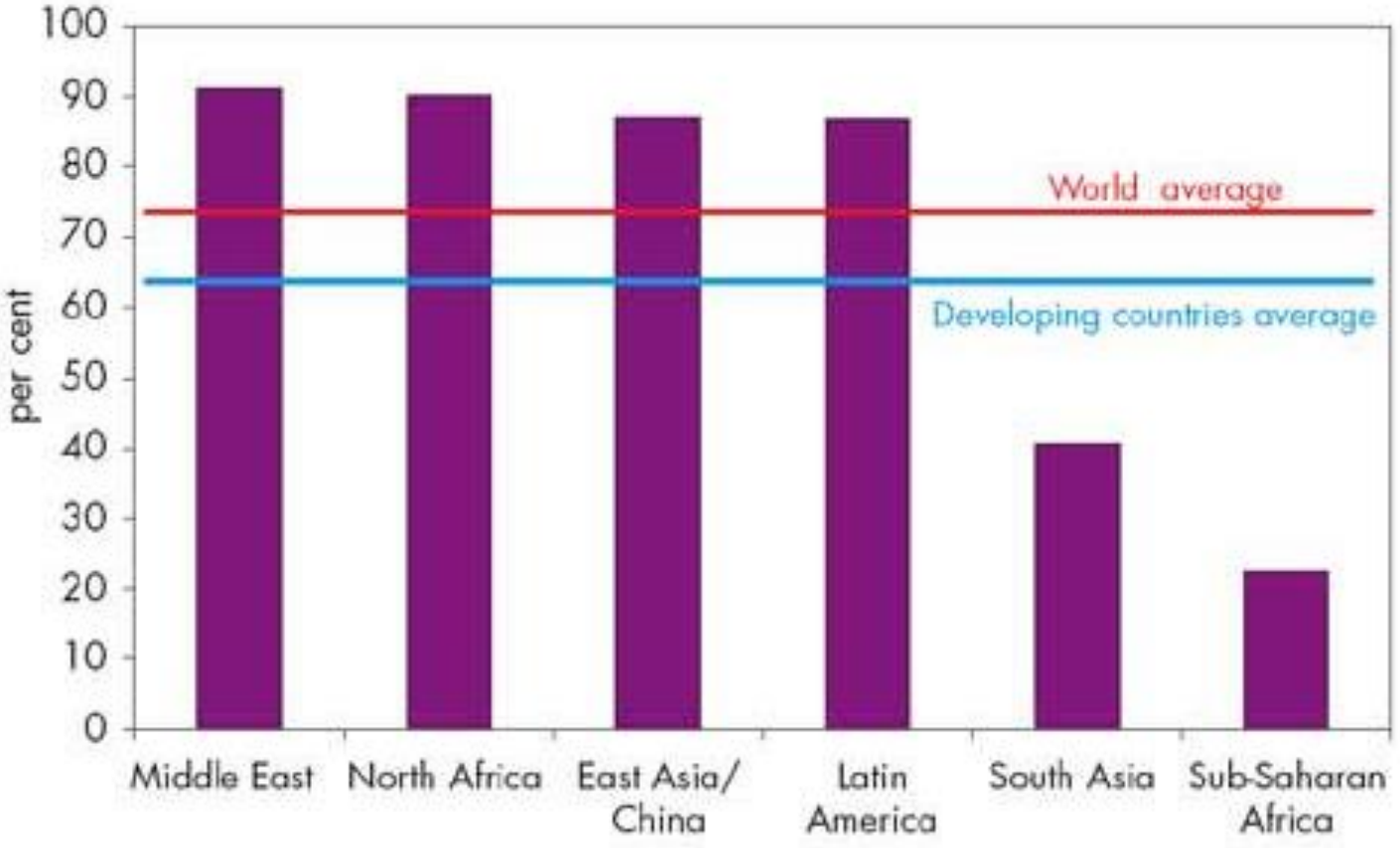
Energy poverty is widespread



In Sub-Saharan Africa only 30% of the population has access to electricity, in rural areas the share drops to 14%

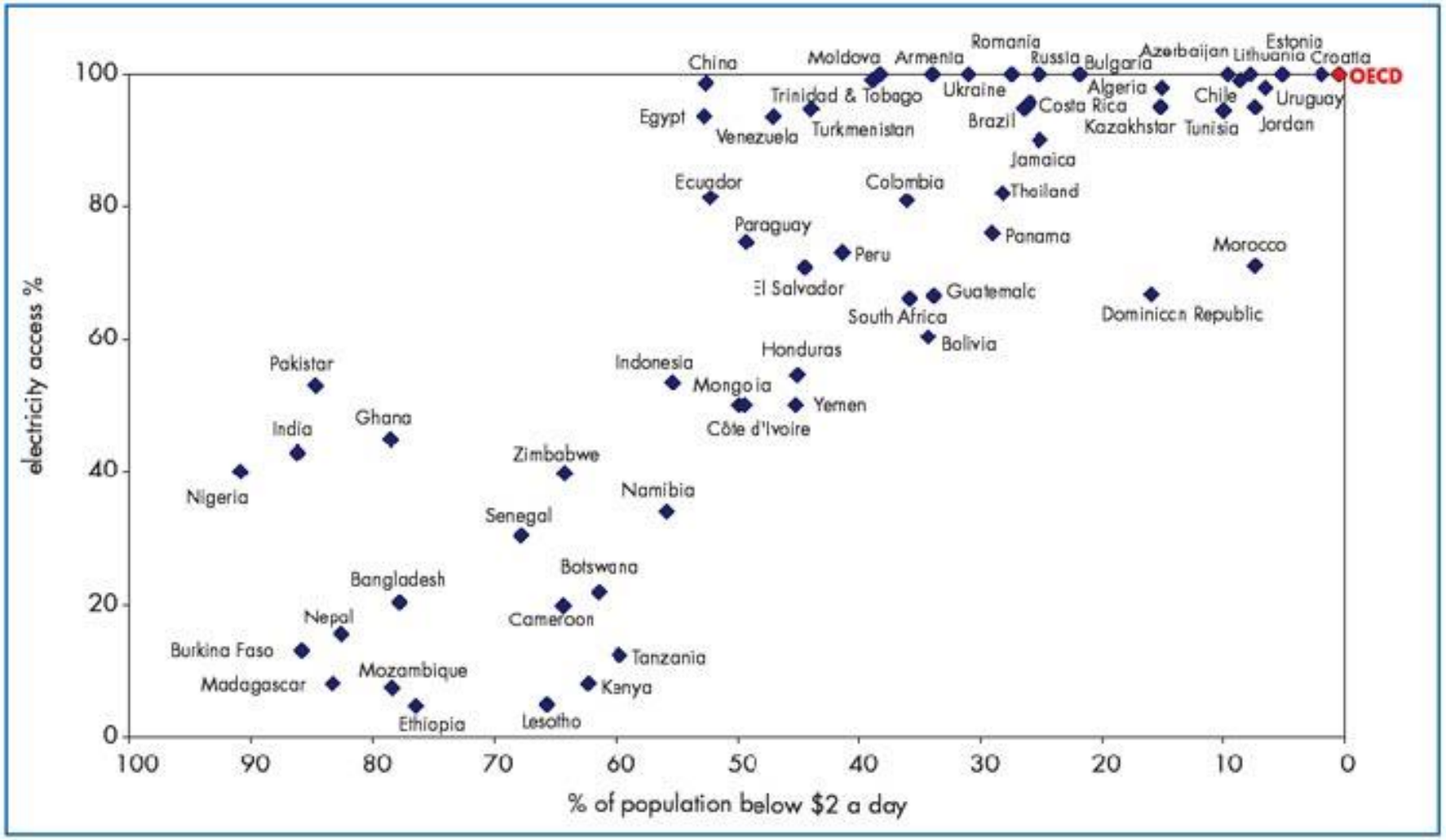
Source: IEA, World Energy Outlook 2013

Global state of electrification



Source: IEA, World Energy Outlook 2007

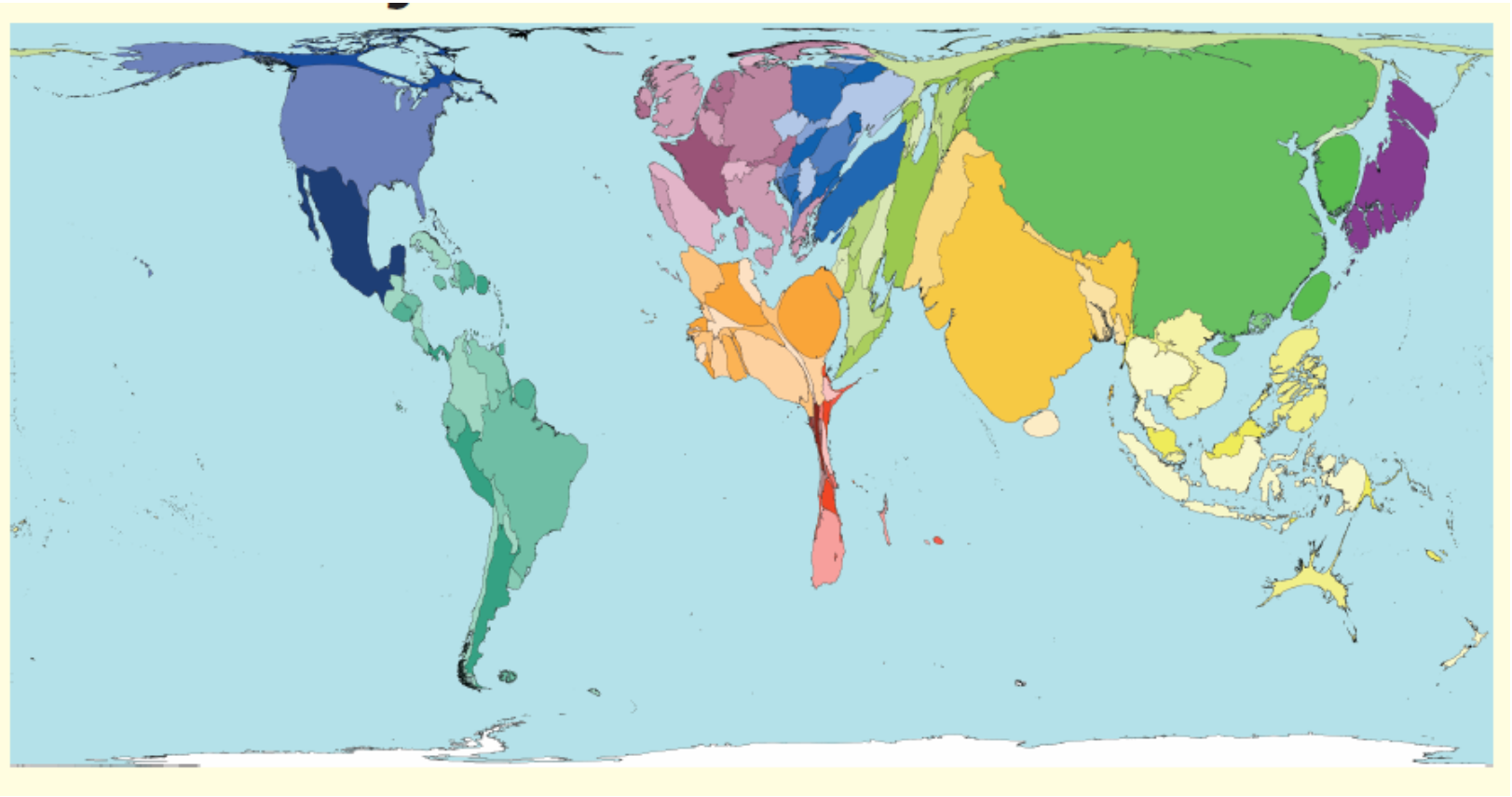
Poverty and electrification



Source: IEA, World Energy Outlook 2007

World map

Territory size shows the proportion of all people with some electrical power in their homes living there



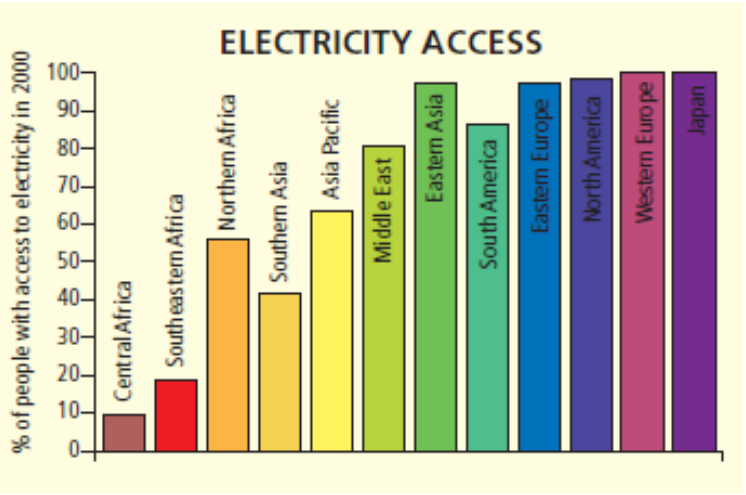
Source: www.worldmapper.org, Map 346

Electricity access

LOWEST ACCESS TO ELECTRICITY

Rank	Territory	Value	Rank	Territory	Value
171	Dem People's Republic Korea	20.0	191	Madagascar	8.0
171	Cameroon	20.0	192	Kenya	7.9
178	Eritrea	17.0	193	Mozambique	7.2
179	Cambodia	15.8	194	Democratic Republic of Congo	6.7
180	Nepal	15.4	195	Myanmar	5.0
181	Burkina Faso	13.0	195	Malawi	5.0
182	Angola	12.0	195	Lesotho	5.0
182	Zambia	12.0	198	Ethiopia	4.7
184	United Republic of Tanzania	10.5	199	Uganda	3.7
190	Togo	9.0	200	Afghanistan	2.0

*percentage of population with electricity access in 2002**



Source: www.worldmapper.org, Map 346

Thank you for your attention!

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