Policy Directions to 2050

Framework conditions for technology development and deployment

World Business Council for Sustainable Development

Focus area

Energy & Climate

Adam Kirkman Program Manager

IEA Paris 15-16 February 2007

The WBCSD Energy and Climate Trilogy

- *Facts and Trends to 2050* - Energy and Climate - dilemmas and challenges (2004)

- *Pathways to 2050* – scale of transition required to deliver a low carbon economy (2005)

- *Policy Directions to 2050* – creating the right frameworks to make it happen (2007)

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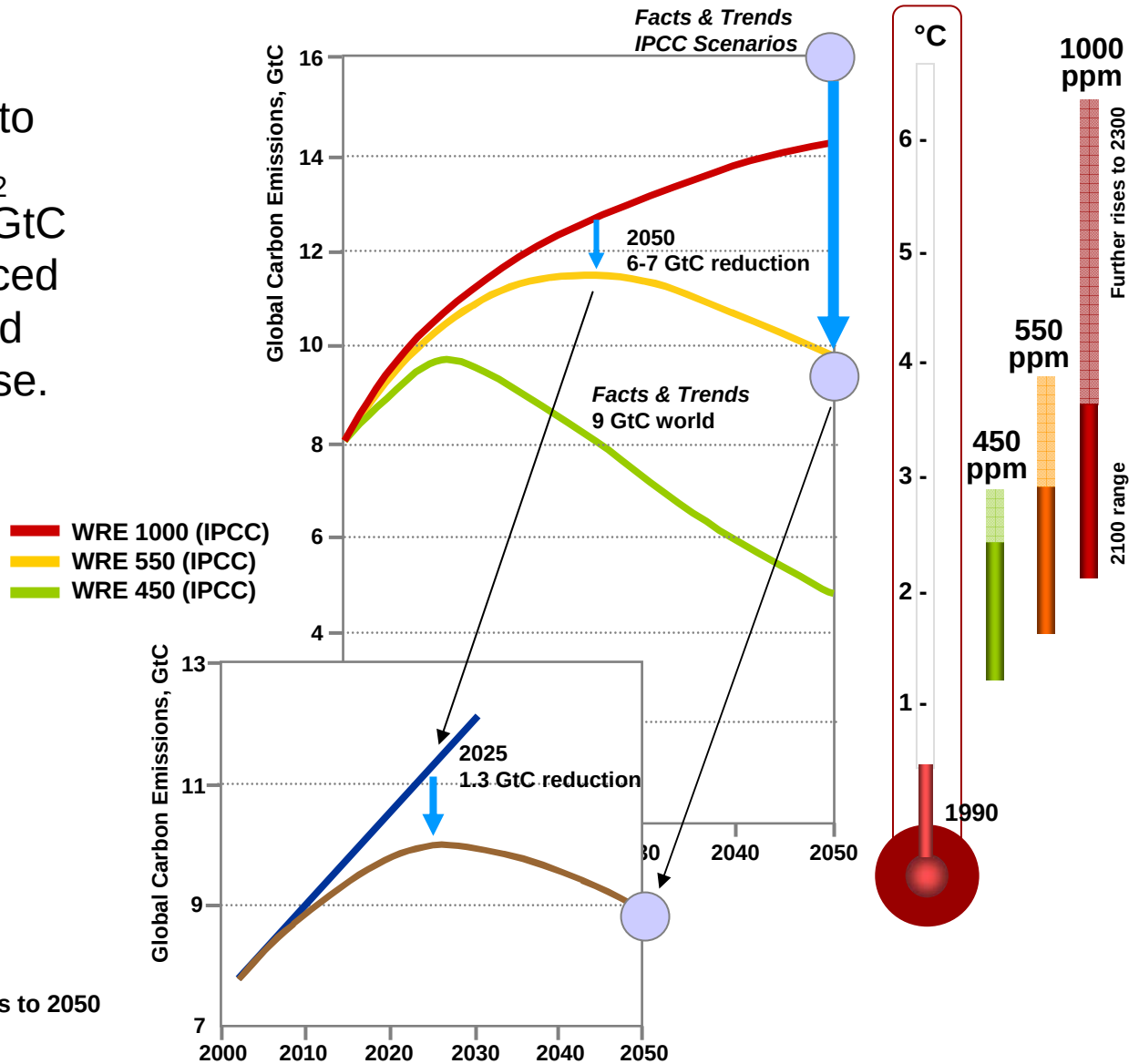
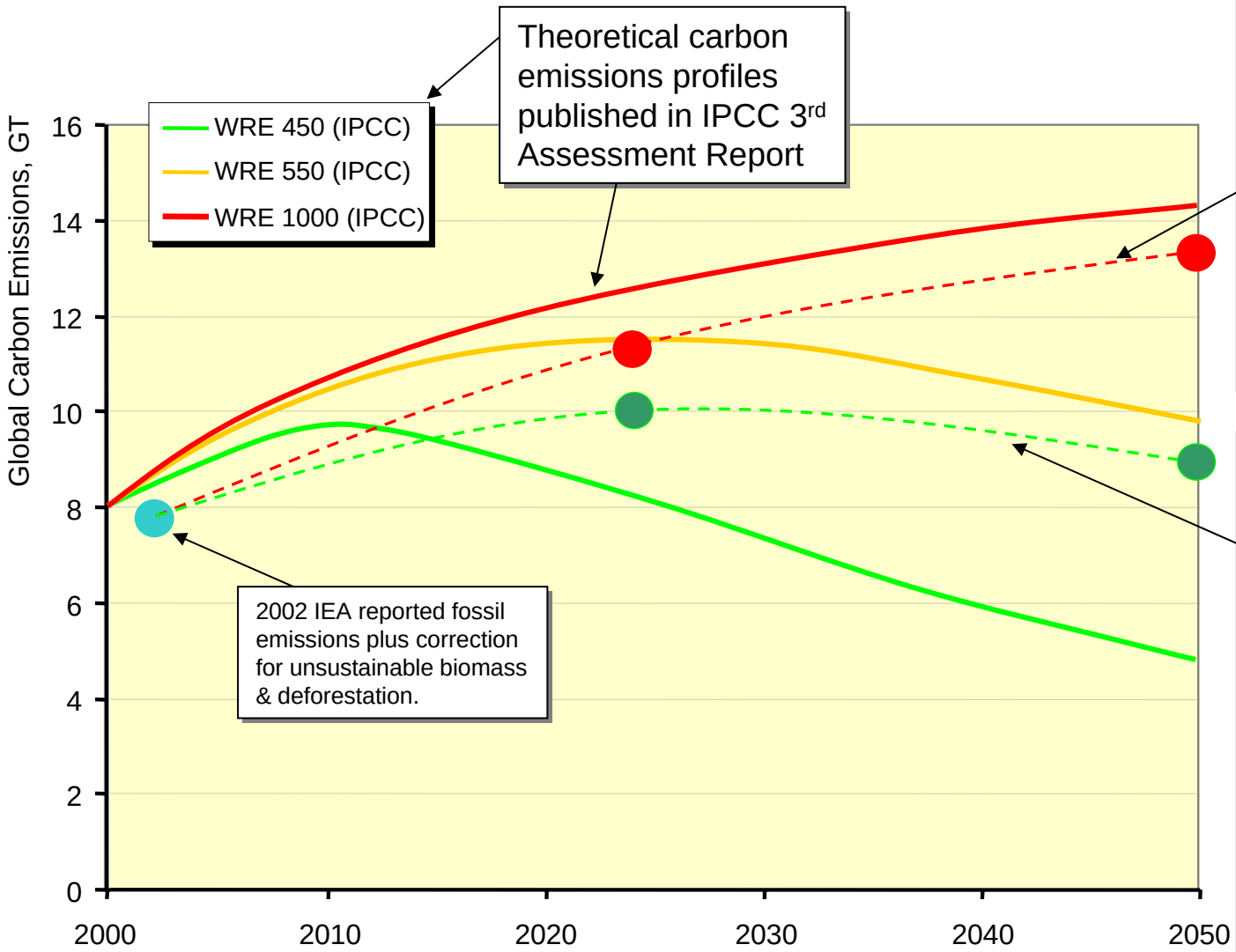
Pathways at a glance…

By 2050 we need to have reduced CO_2 emissions by 6-7 GtC with 1.3 GtC reduced by 2025, compared with the "BAU" case.



High and low carbon pathways



>900 ppm Trajectory Energy by 2050:

- Coal over 2x, no Carbon Capture & Storage (CCS), some coal to liquids.
- Oil up 50%
- Gas over 2x
- Biofuels make up 10% of vehicle fuel mix.
- Electricity 1/3 of final energy.
- Modest increase in nuclear.
- Renewables provide 1/3 of electricity generation.
- Vehicle efficiency up 50%.

<550 ppm Trajectory Energy by 2050:

- Coal up 50%, but half of power stations use CCS.
- Oil down 10-15%.
- Gas nearly 2-3x
- Biofuels make up 20% of vehicle fuel mix.
- Hydrogen has arrived.
- Strong shift to electricity as final energy (~50% final energy).
- Strong increase in nuclear.
- Renewables provide half of electricity generation.
- Vehicle efficiency up 100%
- Sustainable biomass practices

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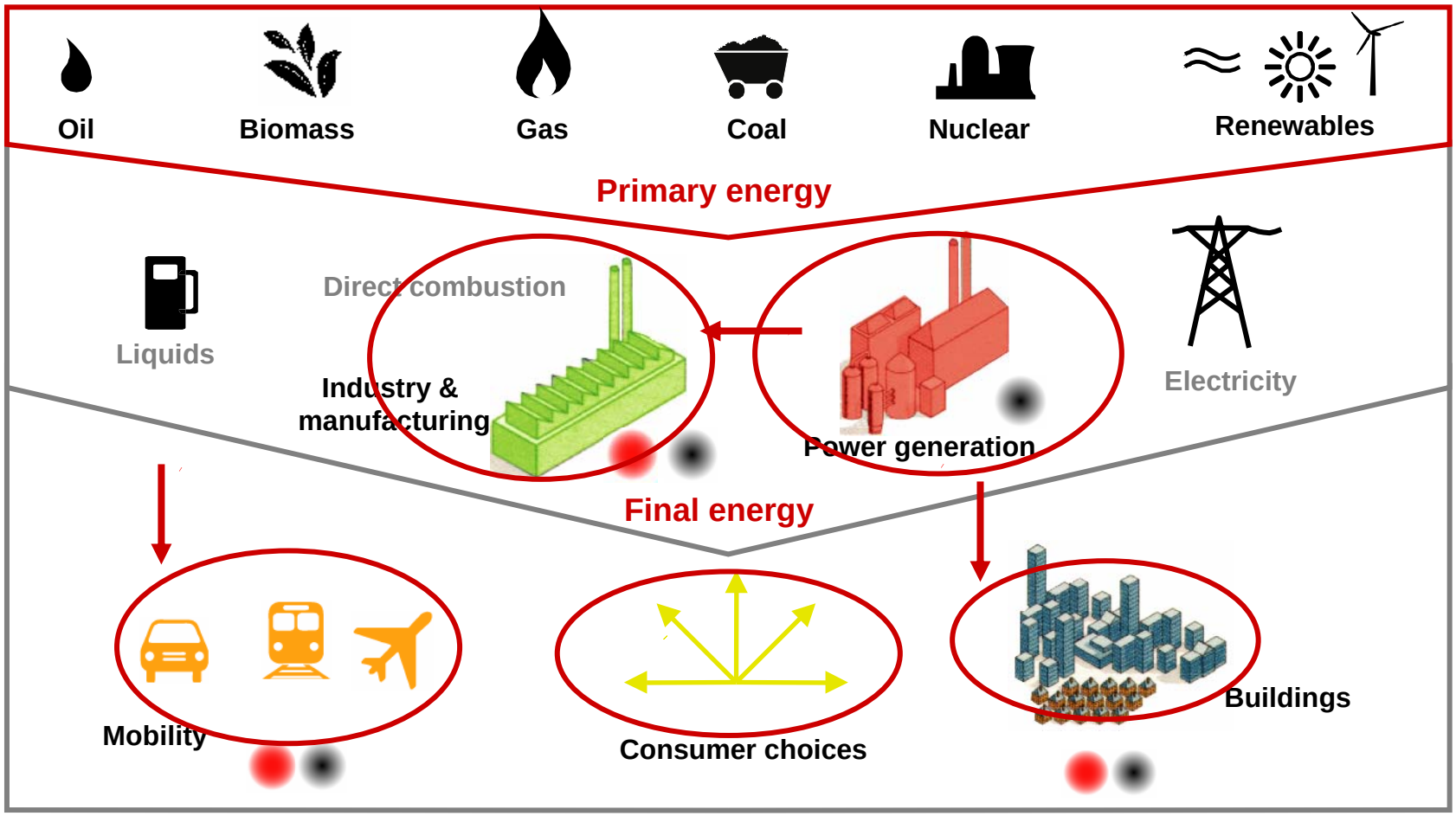
Energy flows and the global economy

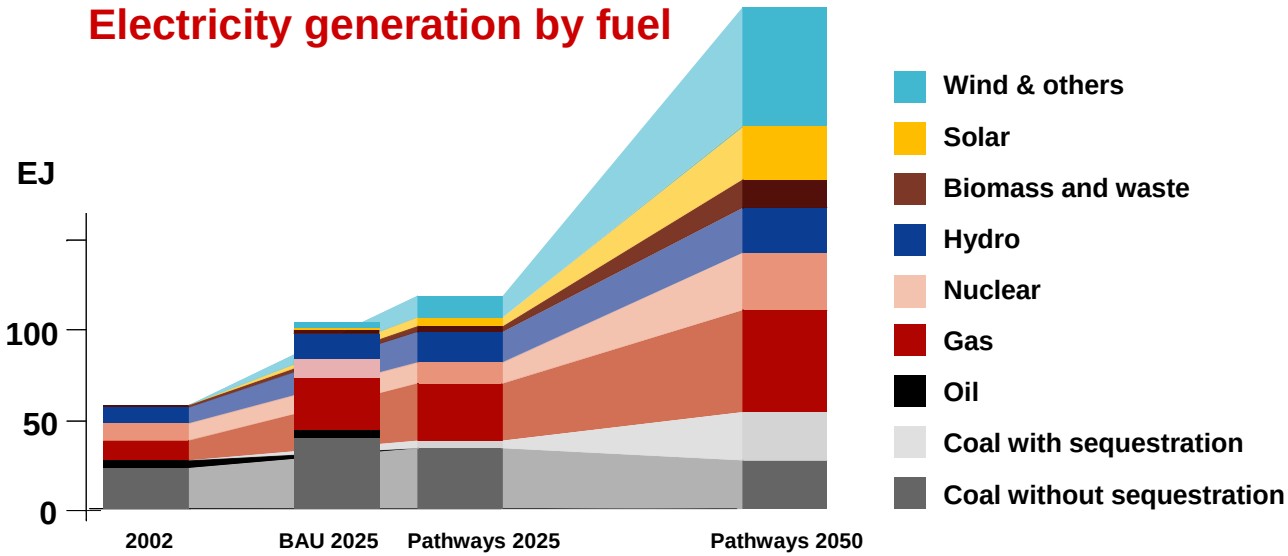


Milestones – what to achieve by 2025

By 2025 we must be well on the way, with technologies proven and energy policy aligned with the objective. For example, we need to have:

- Achieved **significant efficiency gains**, with developed countries improving by more than 2% annually
- Commercialised coal power generation with **carbon capture and storage** and have some 100 or more plants in operation globally
- Gained full public acceptance of **nuclear power** as a viable zero-carbon power generation option and restarted long term growth in this industry
- Achieved wide deployment of **high efficiency vehicles** (e.g. hybrid diesel) in developed countries, with developing countries following, and started deployment of zero emission vehicles
- Recognised the potential of **advanced bio-fuels** and reached a level of more than 5% bio-fuels in transport fuels globally
- Introduced **wind and solar power** on a large scale globally, with over 1 TW of installed wind capacity

What needs to happen in power generation?



By 2050

- **Natural gas** is the largest fossil contibutor to electricity generation;
- **Hydropower** more than doubles until 2050;
- **Wind, geothermal, wave and tidal power** increase nearly 160-fold from 2002;
- **Coal** use grows by 50% and half the generation capacity uses CCS.

Milestones by 2025

- Commercialized coal power generation with **carbon capture and storage** and have some 100 or more plants in operation globally;
- Gained full public acceptance of **nuclear power** as a viable zero-carbon power generation option and restarted long-term growth in this industry.

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Summary: features of 550ppm

Examples	By 2025:	By 2050:
Power generation:	▪ More than 100 CCS facilities are in operation.	▪ Coal use grows by 50% compared to 2002, and half of the capacity uses CCS.
Mobility:	▪ Around 375 million high-efficiency vehicles are on the road.	▪ Predominantly high efficiency vehicles with a wide fuel mix.
EU-25:	▪ « Wind and others » being 10-15 times the 2002 level.	▪ « Wind and others » being the largest power generation source.
China:	▪ Nuclear power capacity increases nearly 10-fold to 2002.	▪ Nuclear generation capacity as big as EU and North America combined today.
Japan:	▪ Energy use per GDP unit has fallen from 7 MJ/$ to 4.2 MJ/$.	▪ Energy efficiency continues to improve by more than 2% a year.

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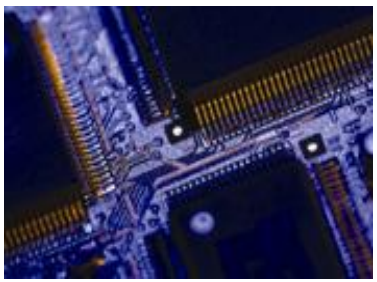
Dynamics of technological change

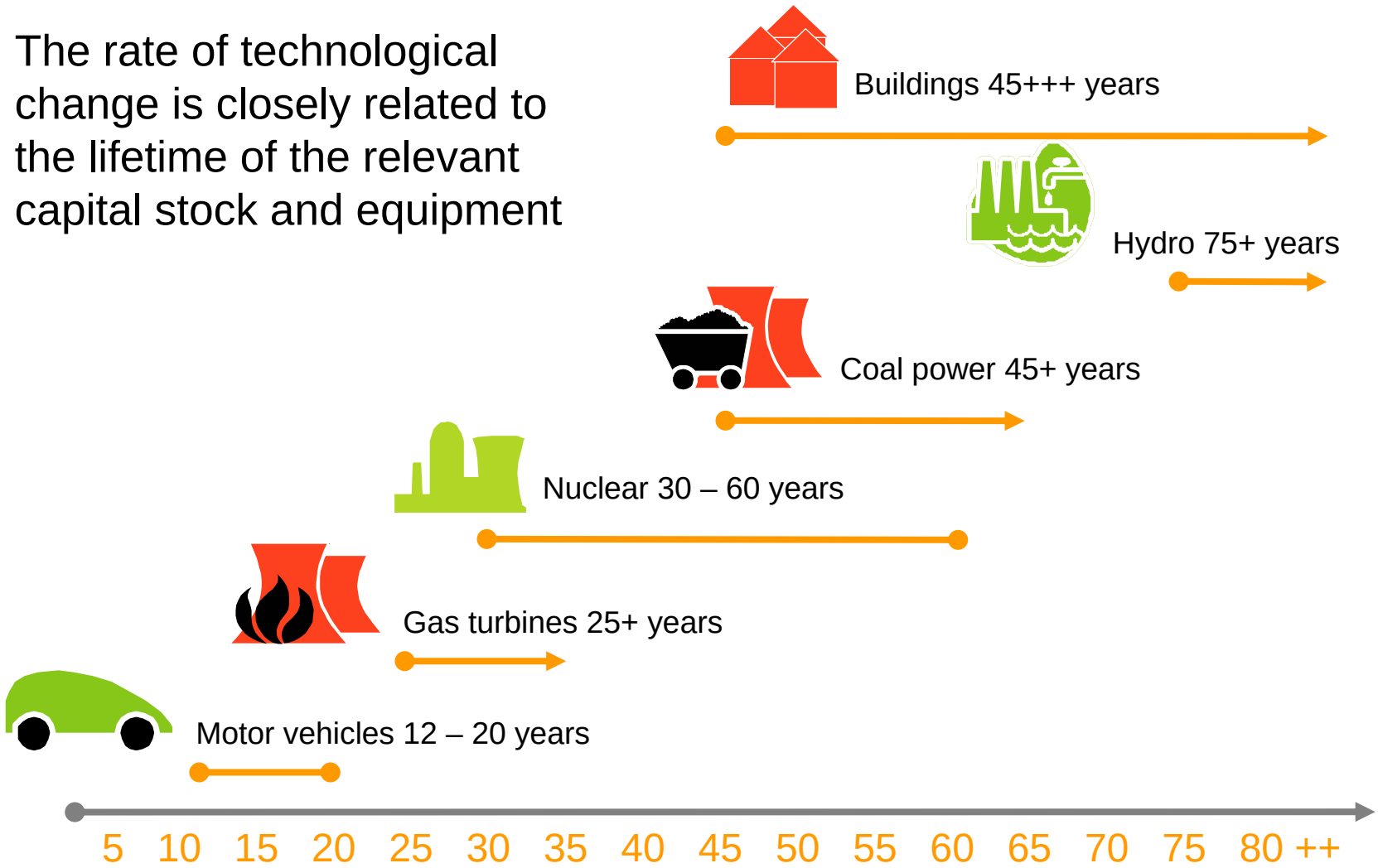


Many advocate that a rapid change in our energy infrastructure is the only solution to the threat of climate change. However:

- Major transitions at the global level will take time to implement
- The speed with which new technologies diffuse depends on many factors.

Size and lifetime matter!

The rate of technological change is closely related to the lifetime of the relevant capital stock and equipment



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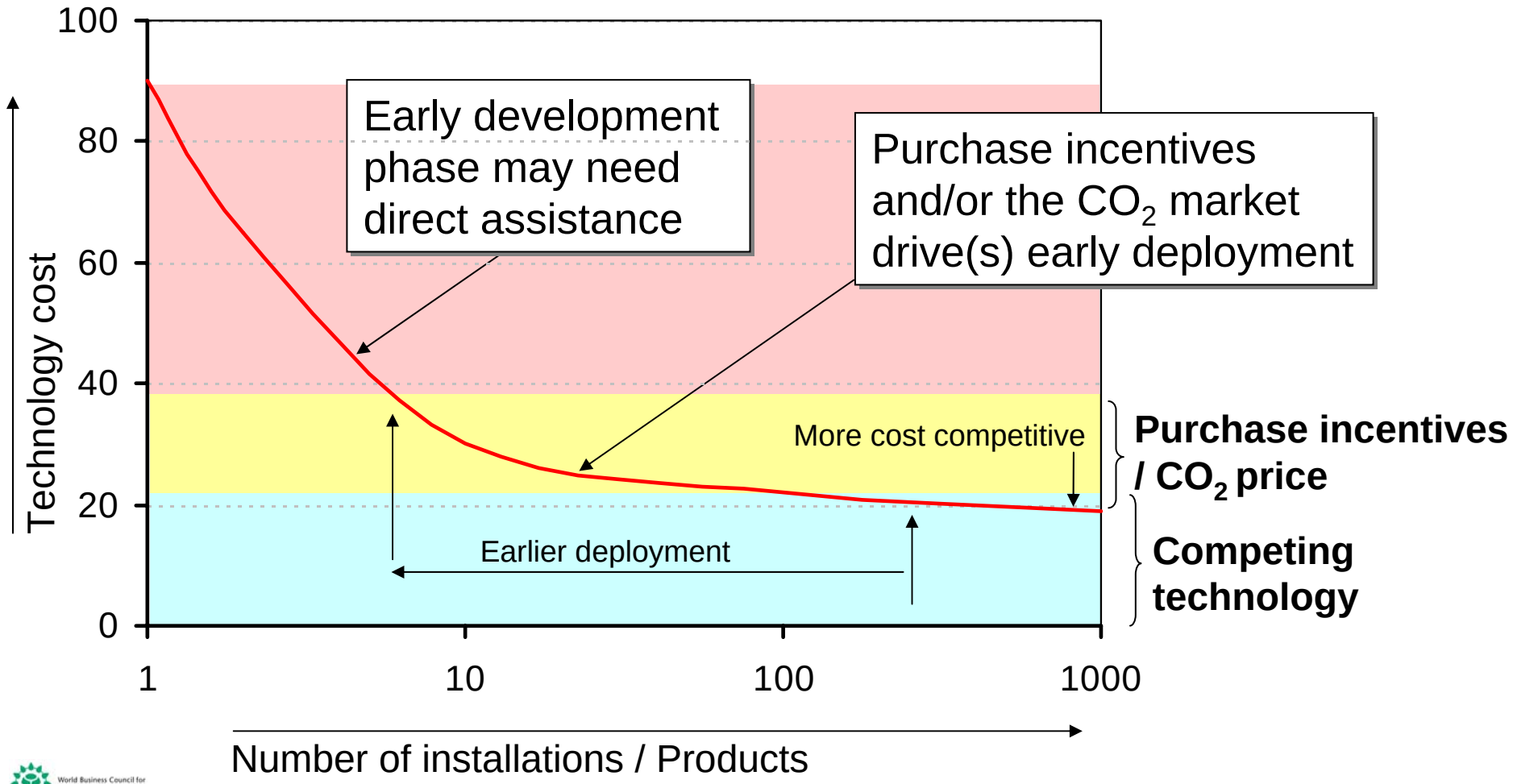
Developing and deploying technology

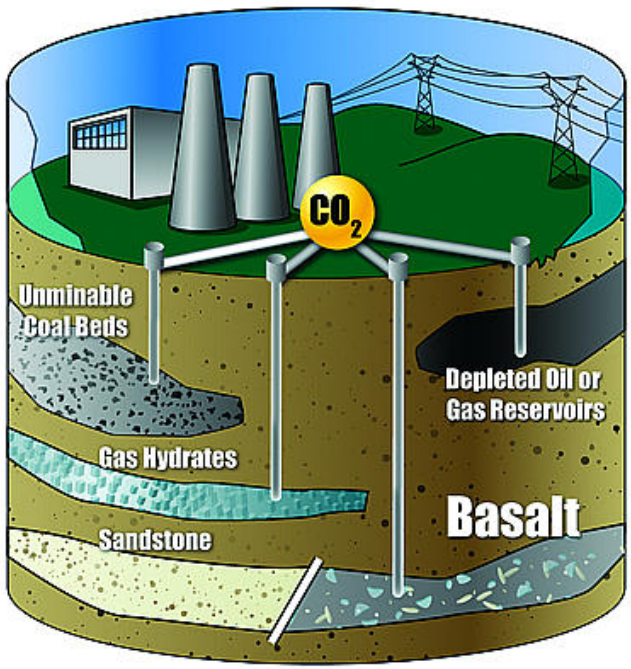
- Major technological breakthroughs are required to reduce energy intensity of the economy
- Governments need to support new technologies right the way through RD&D
- Some national priority setting and pre-selection likely
- Each technology is different requiring different policy approaches
- Technologies at near commercial stage need government support to achieve full scale deployment
- Long term or breakthrough technologies need to be brought right through RD&D pipeline
- Responsibilities need to be defined between the key stakeholders – government, industry, consumers

Technology development and deployment

The framework must focus on both the development of new technology and the rapid deployment of the both new and existing technology



Managing new technology risks



Direct and Indirect Incentives

- Well funded clean development networks with aggressive targets for pilot and near commercial demonstrations.
- R&D incentives
- Infrastructure funding
- CO_2 product labelling

Regulatory Uncertainty

- Multilateral financing mechanisms such as GEF
- Far-out issuance of reduction units as a special case within the project mechanisms

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Setting priorities

Sectors	Objectives	Technology
Power generation 	▪ Decarbonisation ▪ GHG emissions management ▪ Energy efficiency in generation and end-use ▪ Electricity as preferred energy carrier ▪ Smarter grids	▪ Renewables (wind, solar, hydro, tidal) ▪ Nucelar (3rd and 4th Generation) ▪ Clean coal (including gasification, CCS) ▪ Natural gas applications
Industry and manufacturing 	▪ Continuosly enhance energy efficiency ▪ Support for breakthrough technologies key in capital intensive sectors ▪ Rapid deployment of best available technologies ▪ Understand the product lifecycle	▪ Co-generation and combined cycle systems ▪ Fuel switching applications ▪ Process emissions control ▪ Low carbon feedstocks and materials use ▪ CCS ▪ Product innovation
Mobility 	▪ Vehicle efficiency ▪ Fuel efficiency ▪ Consumer awareness concerning mobility choices	▪ High efficiency drive trains (diesel and hybrid technologies) ▪ Biofuels (E10, E85) ▪ Fuel cell and battery technologies ▪ Hydrogen (technology and infrastructure)
Buildings 	▪ Energy efficiency ▪ Awareness raising ▪ Design innovation ▪ Materials use	▪ Energy efficient appliances ▪ Design innovation ▪ Alternative power systems (CHP, heat pumps) ▪ Materials use

Summary - How to meaningfully engage business

- Reduce uncertainty by aligning policy horizon with business innovation and investment cycle
- R&D friendly policies to drive innovation and secure early business commitment
- Remove barriers and disincentives that obstruct deployment
- Establish efficient markets and price signals to drive innovation and direct capital flows
- Government support in managing risk

A future international framework – What is needed?

1. A long-term goal (to 2050)

- ✓ Established by 2010
- ✓ Described as an emissions pathway (trajectory)

2. Technology development and deployment framework

- ✓ Expanded support for R&D
- ✓ Global technology standards
- ✓ Technology transfer driven by standards
- ✓ Risk management

3. Emissions management at national and sectoral level

- ✓ Bottom-up approach aligned with energy policy
- ✓ Sector by sector
- ✓ Expanded project mechanism
- ✓ Progressive inclusion of all countries

4. Linkage framework to encourage international trading

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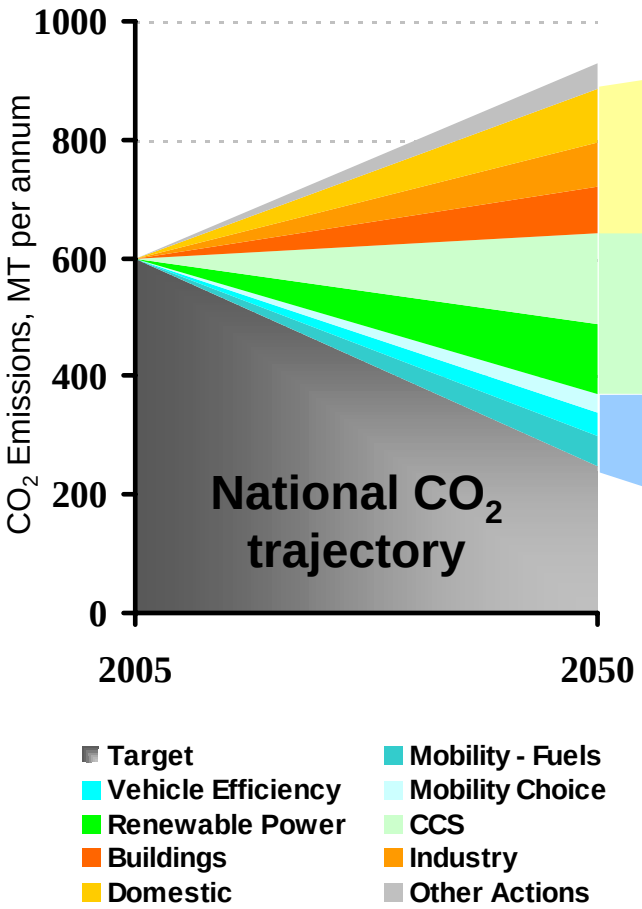
Opportunity starts at the national / sector level

A. Opportunity Wedges (National)
(Developed Country Example)



B. National/Sector Goals & Targets

Efficiency	Buildings Industry Domestic	xx % p.a. through to 20xx
Power Generation	Renewables CCS	xx MW p.a. by 20xx xx tonnes CO_2 p.a.
Mobility	Bio-fuels Efficiency Choice	xx litres p.a. by 20xx xx mpg by 20xx Hybrid / Diesel uptake Mass transit

C. National Policies

Buildings – adopt new country building standards, design awareness

Industry – Sectoral agreements, emissions trading, technology standards

Domestic – carbon labeling, increased product standards (e.g. standby energy)

Renewable Energy – renewables targets.

CCS – funding for infrastructure, tax cuts on capital investments, price signals for carbon via emissions trading

Biofuels – targets, support for manufacturing, CO_2 labeling

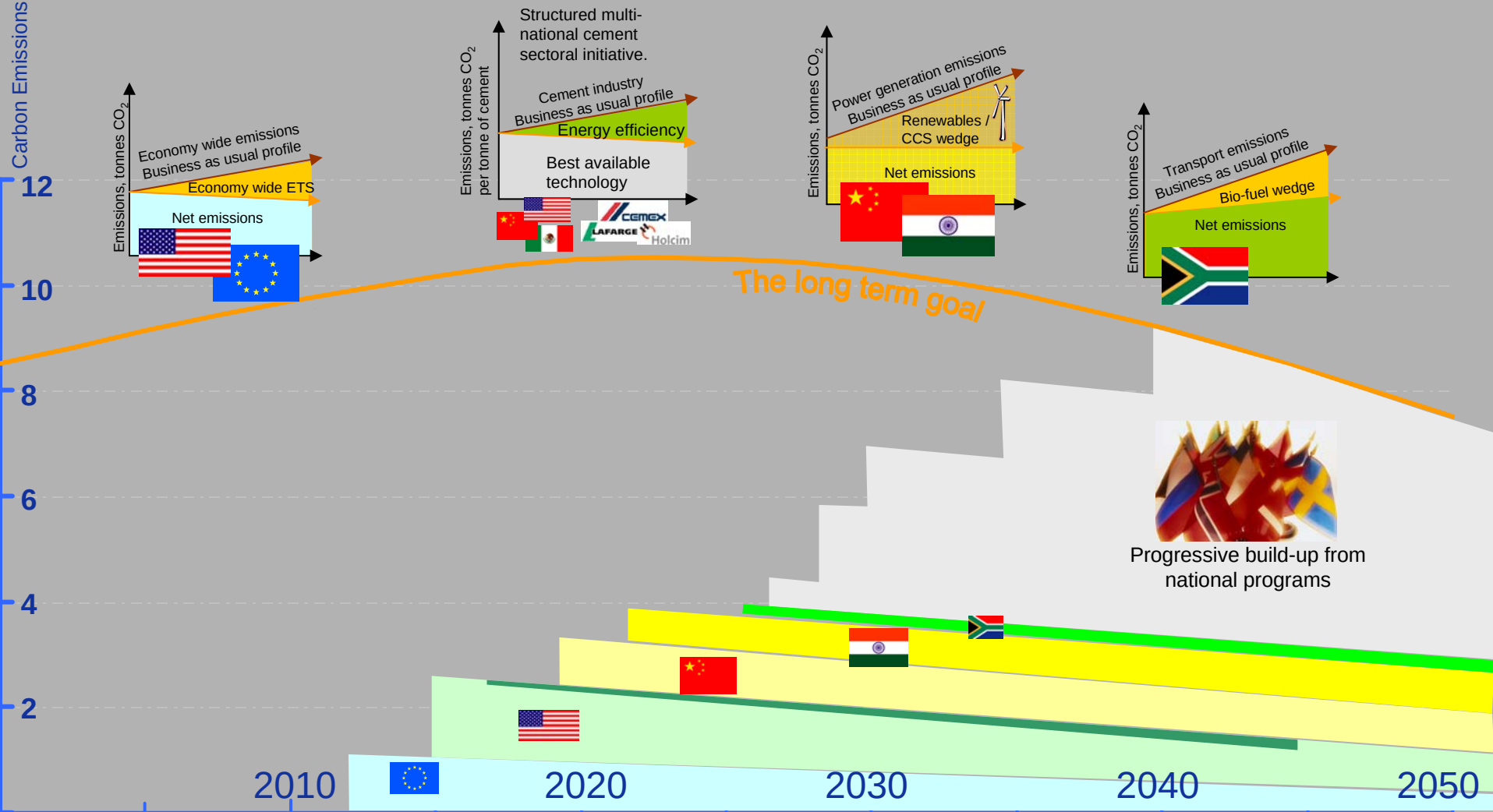
Vehicle Efficiency - support technology, incentives, sectoral agreements

Mobility Choice - consumer incentives, promote public/private partnerships for transport networks

Adapted from S Pacala and R Socolow (2004)

Progressive Build-Up from National Programs

A global GHG market remains an important goal of the revised international framework. But it is constructed bottom-up through a linkage framework, rather than a “big-bang” creation from the top.



Contact us

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Policy Directions to 2050

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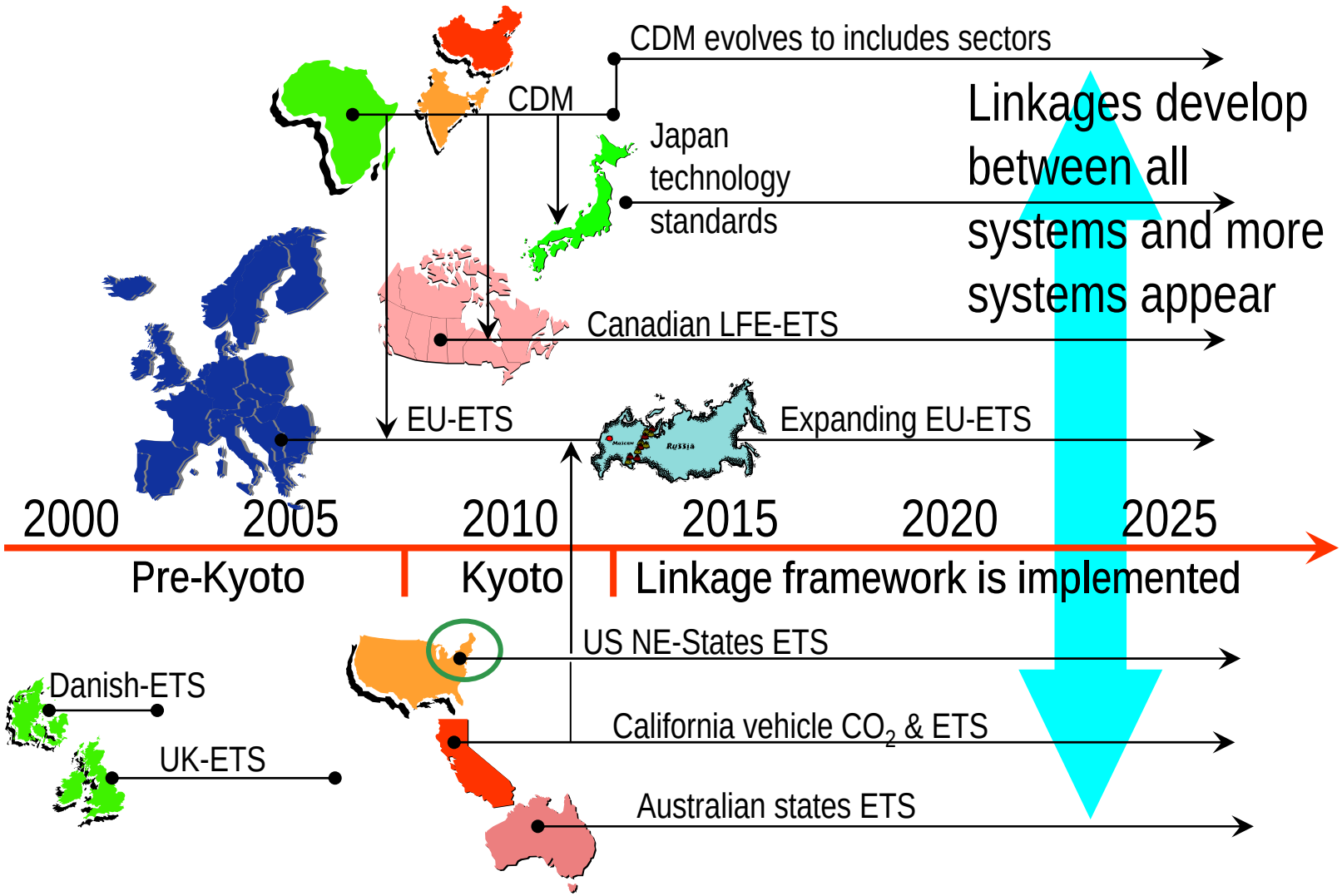
GHG markets are expanding globally



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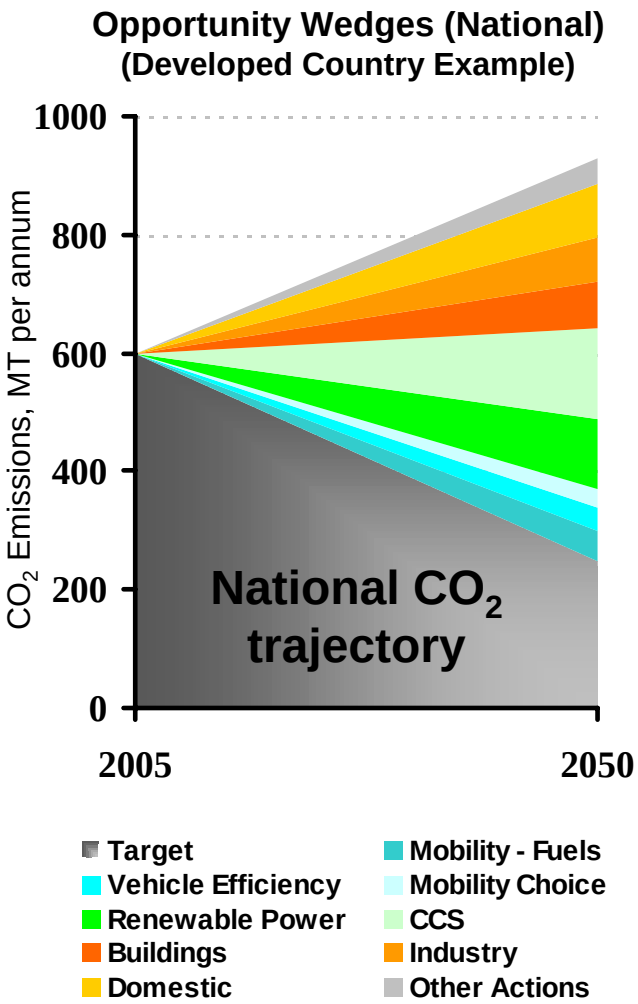
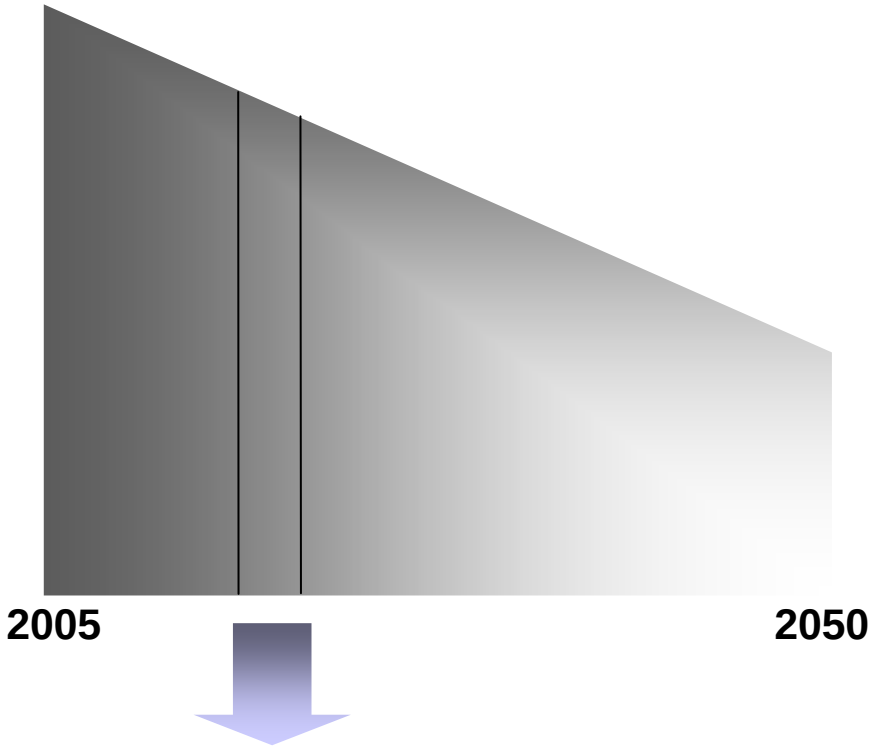
CO_2 targets and trading at national level

At the national level:

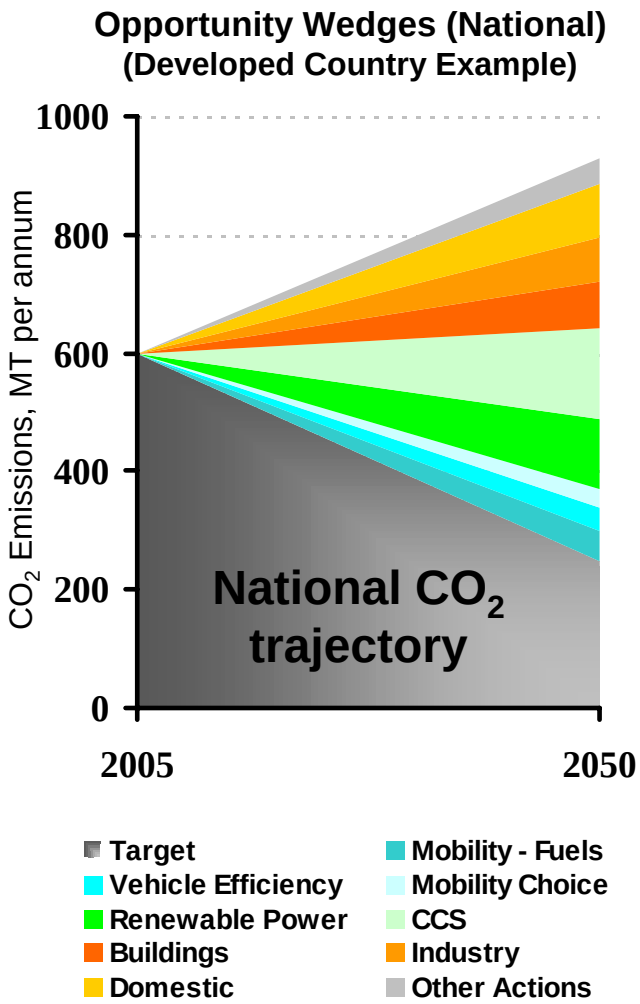


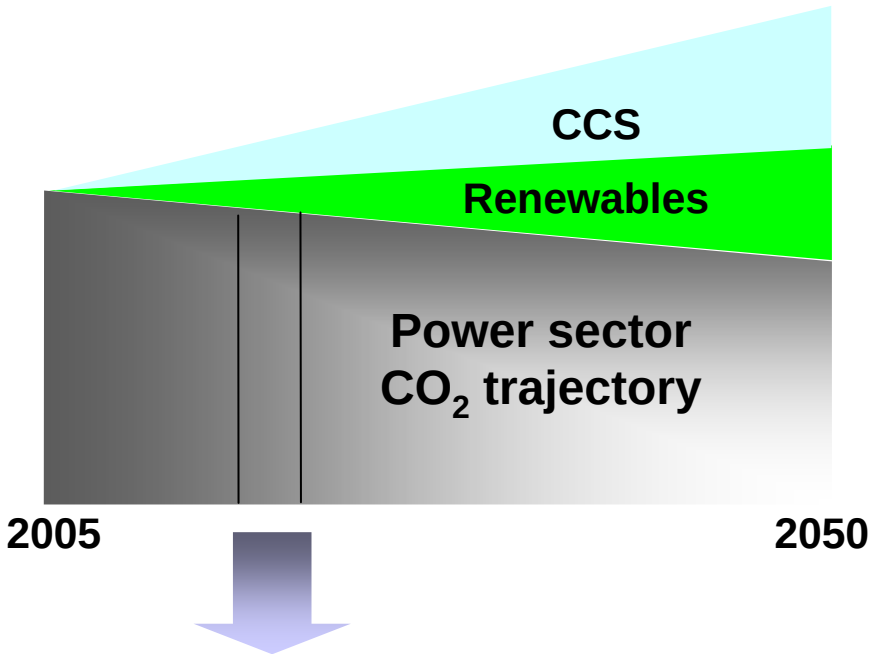


Trajectory for 2013 to 2018 for international allocation purposes.

CO_2 targets and trading derived from sectors

Or at the sector level only:





Trajectory for 2013 to 2018 for international allocation purposes.

Clean development partnerships & programs

Clean development partnerships and technology programs based on standards and benchmarking can drive new technology development.

Asia-Pacific Partnership on Clean Development & Climate

FutureGen ALLIANCE

FreedomCAR & Fuel Partnership

H2 EUROPEAN HYDROGEN AND FUEL CELL TECHNOLOGY PLATFORM

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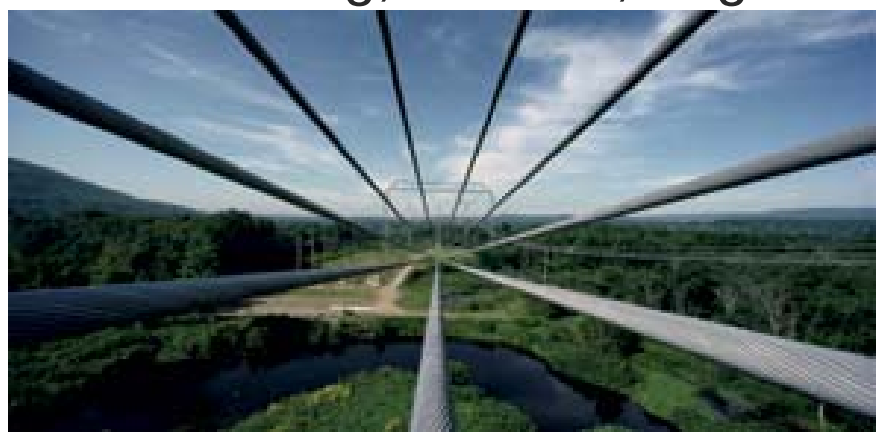
Action in key sectors

- Power Generation
  - Shift toward decarbonisation, emissions management and greater energy efficiency
  - Drive renewables, nuclear and clean coal (including CCS)
  - No single policy instrument likely to be sufficient on its own
  - Broad use of market mechanisms – depreciation schemes, tariffs, preferential financing, taxation, targets and emissions trading



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Action in key sectors

- Industry & Manufacturing
  - Focus on efficiency
  - R&D support for breakthrough technologies, and rapid deployment of best available technologies
  - Expand use of project based mechanisms (sectoral CDM)
  - Industry performance standards

- Mobility
  - Boost public and consumer awareness of mobility choices
  - Policies supporting vehicle efficiency and alternative fuels
  - Sector efficiency agreements and fleet incentives
  - Develop integrated public / private transport networks
  - Price signals (taxes, consumer incentives)

Action in key sectors

- Buildings
  - End use efficiency, innovative design
  - Performance standards, codes and ratings schemes
  - Many of the technologies for this sector exist today
- Consumers
  - Robust programs targeting efficiency in consumer goods and services
  - Education programs encouraging low carbon lifestyles
  - Recognizable consumer price signals throughout value chain

Pathways to 2050

Additional slides

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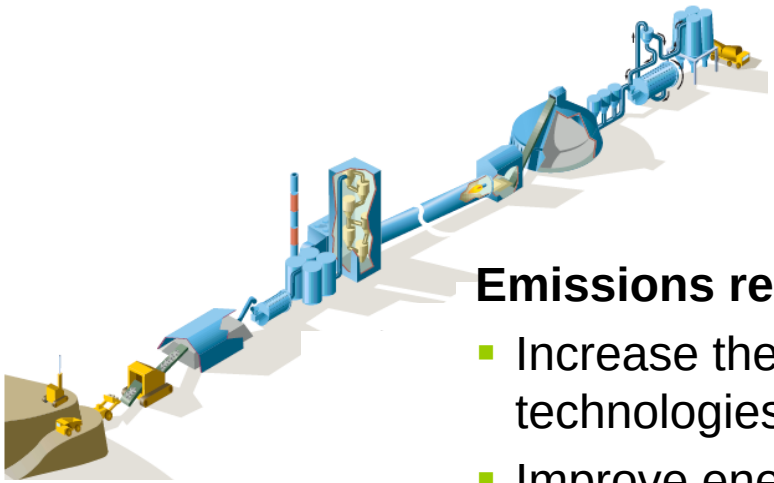
Industry and manufacturing: Wide portfolio of measures and options

Energy use and emissions levels are rising in industry and manufacturing due to:

- Rising population levels;
- Continuing economic growth (e.g., GDP per capita in China increases by more than a factor of 7 until 2050).



Emissions reduction measures:

- Increase the deployment of currently best available technologies (BATs) especially to developing countries;
- Improve energy efficiency and fuel conservation;
- Develop new low-energy and low-carbon intensive technologies;
- Shift towards electricity and bio fuels.

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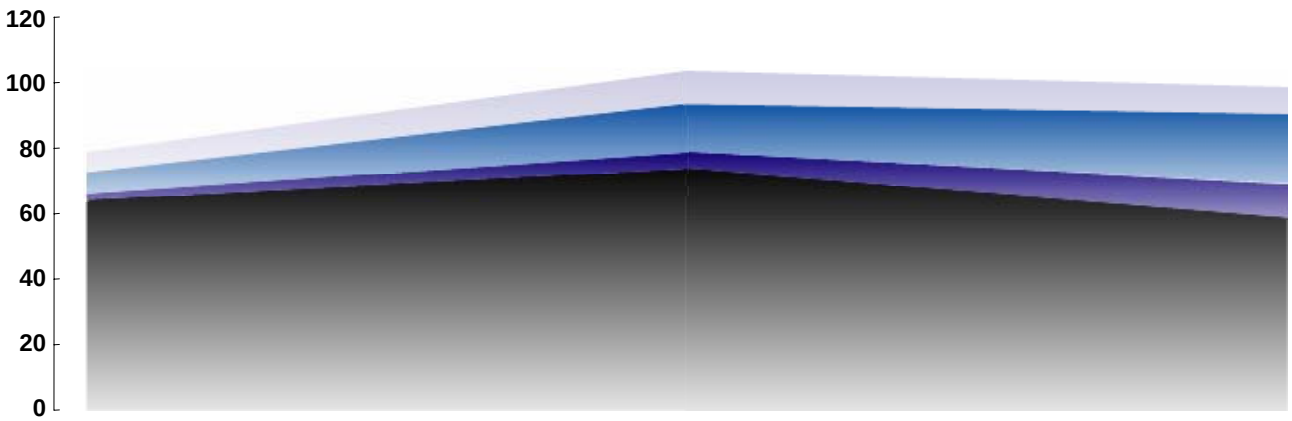
Developments in the Mobility Sector

Energy consumption in the mobility sector (EJ)



Marine bunkers

Aviation

Rail transport

Vehicles / Road transport

Trends

- Shift towards mass transportation, which is about seven times more efficient than a light duty vehicle;
- Need to significantly increase the deployment of highly efficient and hydrogen vehicles;
- Growing emissions in the aviation sector due to high demand and absence of a large-scale alternative to current conventional fuels.

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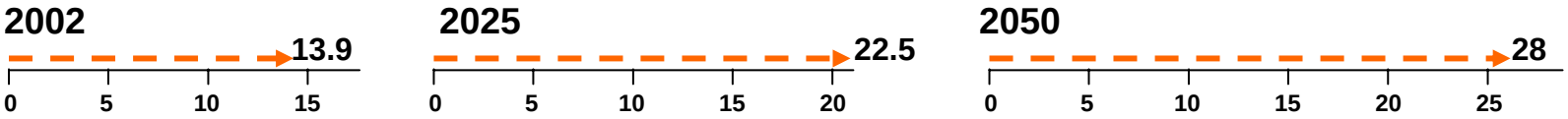
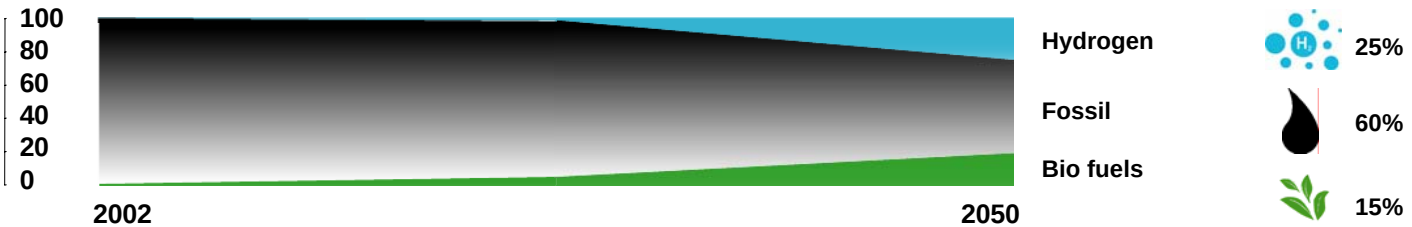
What has to change in road transport?

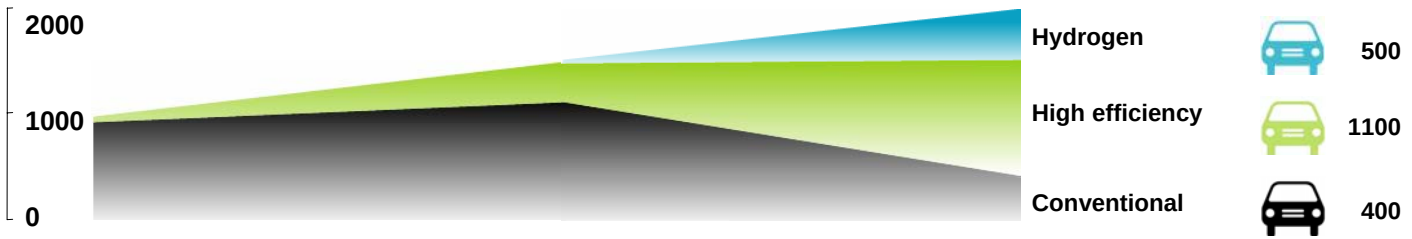
Road transport (vehicle-kms, trillions)



Fuel mix in road transport (%)



Vehicle distribution (millions)

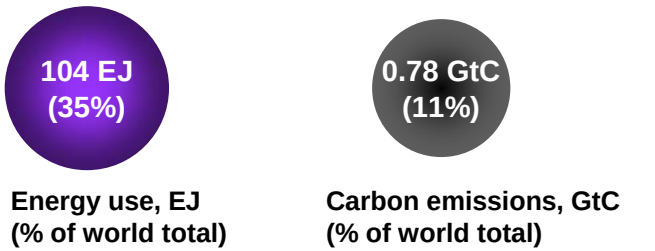


By 2050

Average vehicle efficiency has increased significantly and emissions from road transport have decreased by nearly 40%.

Megatrend shifts in buildings

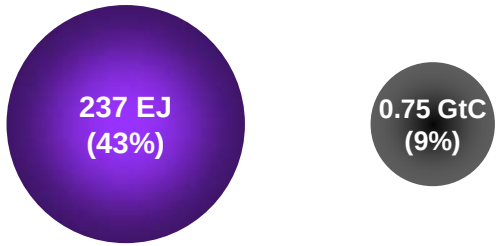
2002



Energy use, EJ (% of world total)

Carbon emissions, GtC (% of world total)

Pathways 2050



Energy consumption increases due to:

- Rising living standards;
- A growing service sector;
- The information economy;
- A shift from rural to urban living.

Energy consumption and emissions can be reduced by:

- Radical design;
- Placement;
- Efficient appliances;
- New materials;
- In-situ energy generation.

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Towards a zero-energy home

Ventilated double skin facades to reduce heating and cooling requirements

Wood as a building material with advantageous insulation properties, which also stores carbon and is often produced with biomass energy

Rooms that are not normally heated (e.g. a garage) serving as additional insulation

Solar photovoltaic panels for electricity production and solar thermal panels for water heating

Transparent design to reduce the need for lighting

New battery technology for the storage of the electricity produced by solar panels

Trees to provide shade and cooling in summer, and a shield against cold wind in winter

"Low-E" glass coating to reduce the amount of heat absorbed from sunlight through the windows (windows with the reverse effect can be installed in colder climates)

Heat pump systems that utilize the stable temperature in the ground to support air conditioning in summer and heating or hot water supply in winter

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The power of consumer choices

The different choices we make today can significantly affect our carbon footprint

Two families, two footprints (tons of carbon p.a.)

Household	4.09
Car travel	2.20
Air travel	3.11
Waste	0.25
Total:	9.65

Household	0.20
Car travel	0.23
Air travel	0.32
Waste	0.10
Total:	0.85

Source: BP carbon Calculator

Today:

- Energy characteristics of goods and services hardly affect our consumer choices;
- Lack of consumer awareness regarding energy and carbon issues.

By 2050:

- Society has understood that their choices affect the energy balance;
- The energy impacts of our choices become completely transparent;
- Products will have a low-energy and low-carbon value.

Consumer choices as a cross-cutting trend affect all the other megatrends.