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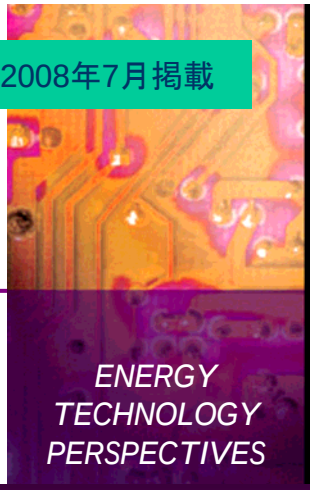
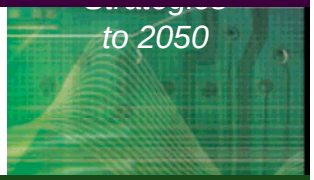


Energy Technology Perspectives 2008

Scenarios and Strategies to 2050



Dr Peter Taylor

Acting Head, Energy Technology Policy Division

IEEJ Workshop, Tokyo, 7 July 2008

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Background

- Request for alternative scenarios by the G8 at the Gleneagles summit (2005)
- ETP2008 publication launched in Tokyo on 6 June 2008
- Conclusions reported to both G8 Energy Ministers meeting (June) and G8 Leaders summit (July)

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Goals of ETP2008

- This is a study about the role of technology in reducing CO_2 emissions
- It presents key technology roadmaps that specify development needs
- The results can support enhanced international technology cooperation
- It is *not* meant for country target setting in a post-Kyoto framework
- It is *not* a study about climate policy instruments

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Content of ETP2008

- **Scenario analysis**
  - **Baseline WEO2007 Reference Scenario**
  - **Global stabilization by 2050 (ACT)**
  - **Global 50% reduction by 2050 (BLUE) – *consistent with WEO2007 450 ppm case***
- **How to get there**
  - **Short and medium term technology policy needs**
  - **Special attention for technology roadmaps**
- **Technology chapters**
  - **Power sector**
  - **End-use sectors**

ACT Scenarios

- Energy CO_2 emissions in 2050 back to the level of 2005
- Revision of ACT as published in ETP2006
  - Options with a marginal cost up to USD 50 / t CO_2 – worldwide (*model outcome*)
  - Cost estimate has doubled from ETP2006
- ACT implies a significantly adjusted energy system

BLUE Scenarios

- -50% energy related CO_2 in 2050, compared to 2005
  - This could be consistent with 450 ppm (depending on post-2050 emissions trends)
- Options with a marginal cost of up to USD 200/t CO_2 needed (*model outcome*)
  - Significantly higher cost with less optimistic assumptions
- BLUE is uncertain, therefore a number of cases needed
- BLUE is only possible if the whole world participates fully
- BLUE implies a completely different energy system

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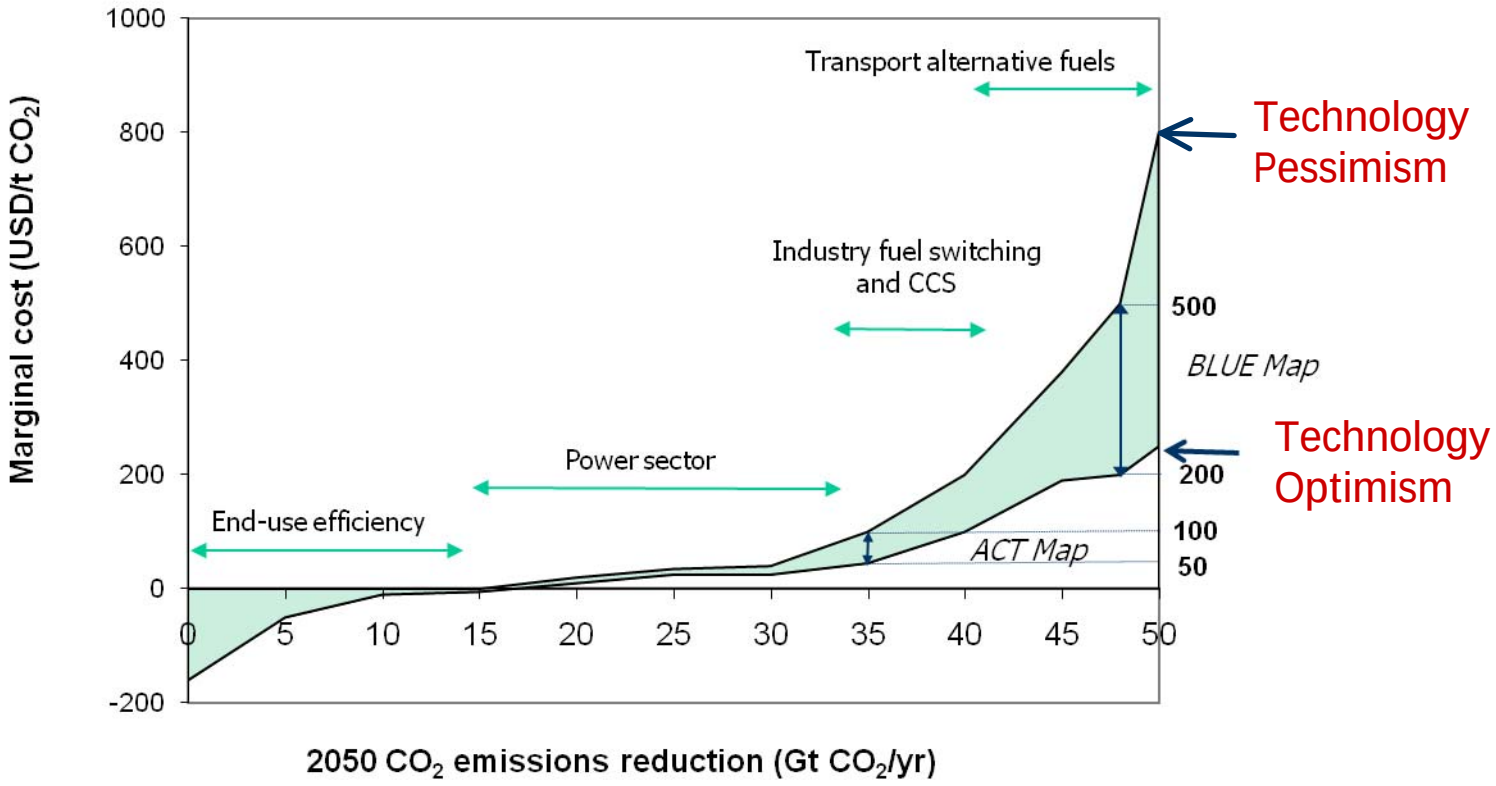
A New Energy Revolution?



To bring emissions back to current levels by 2050 options with a cost up to USD 50/t are needed. Reducing emissions by 50% would require options with a cost up to USD 200/t.

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Sectoral Energy Use

GDP 2050 is four times that of 2005 (growth 3.3 % /yr)

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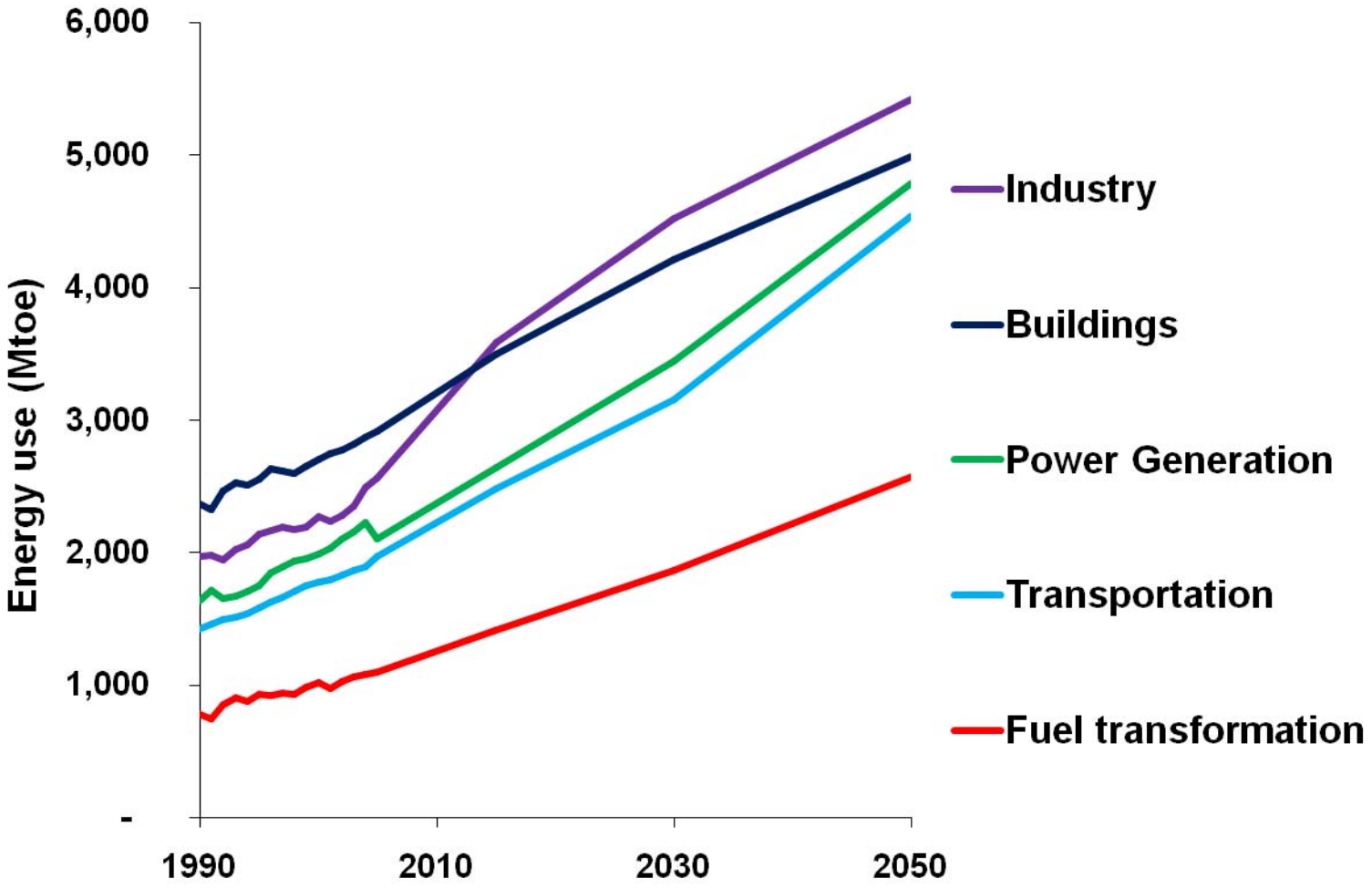

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Final Energy Use

Doubles in Baseline, significant savings in Policy scenarios

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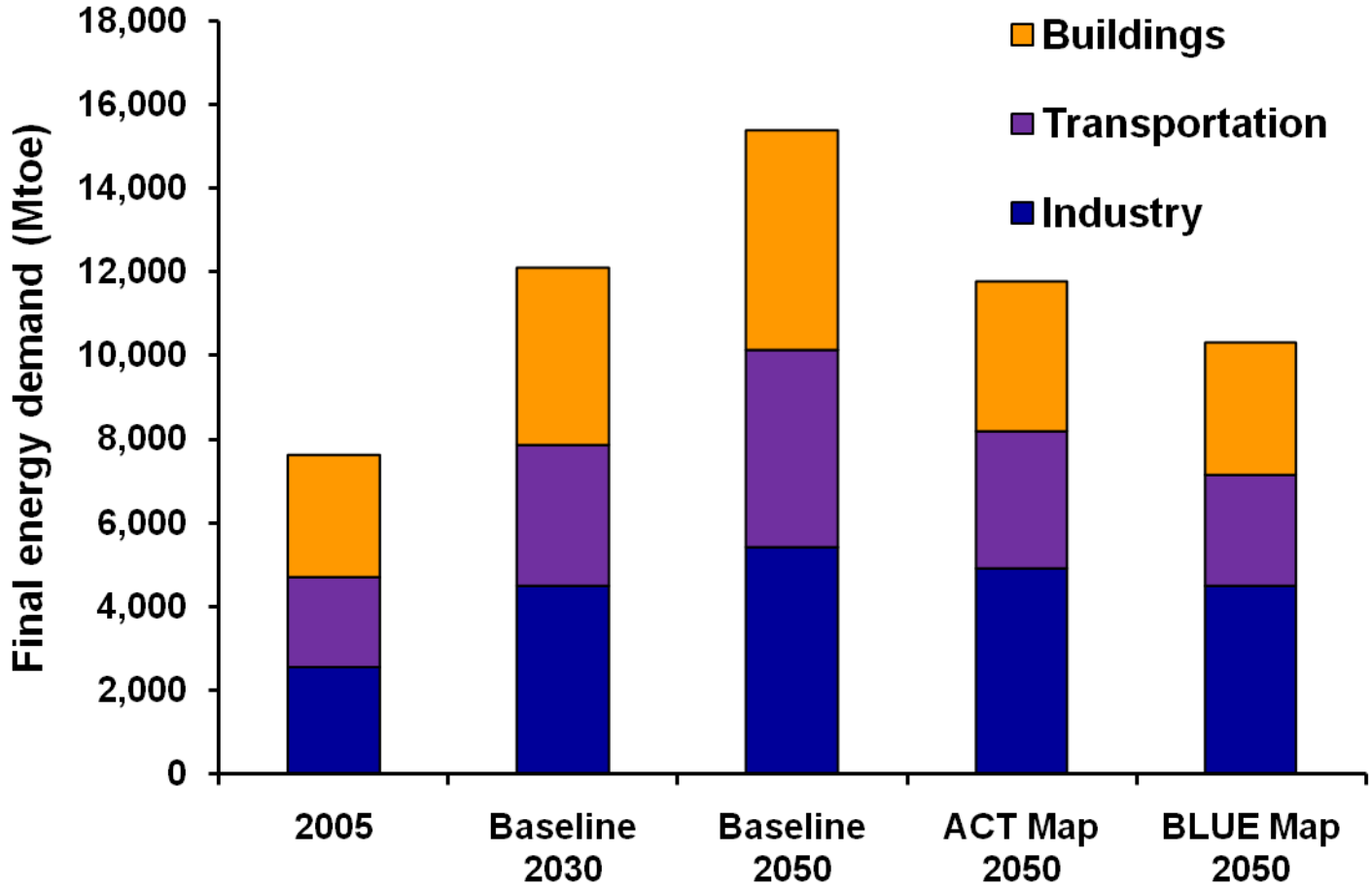

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Primary Energy Demand

Important supply security benefits

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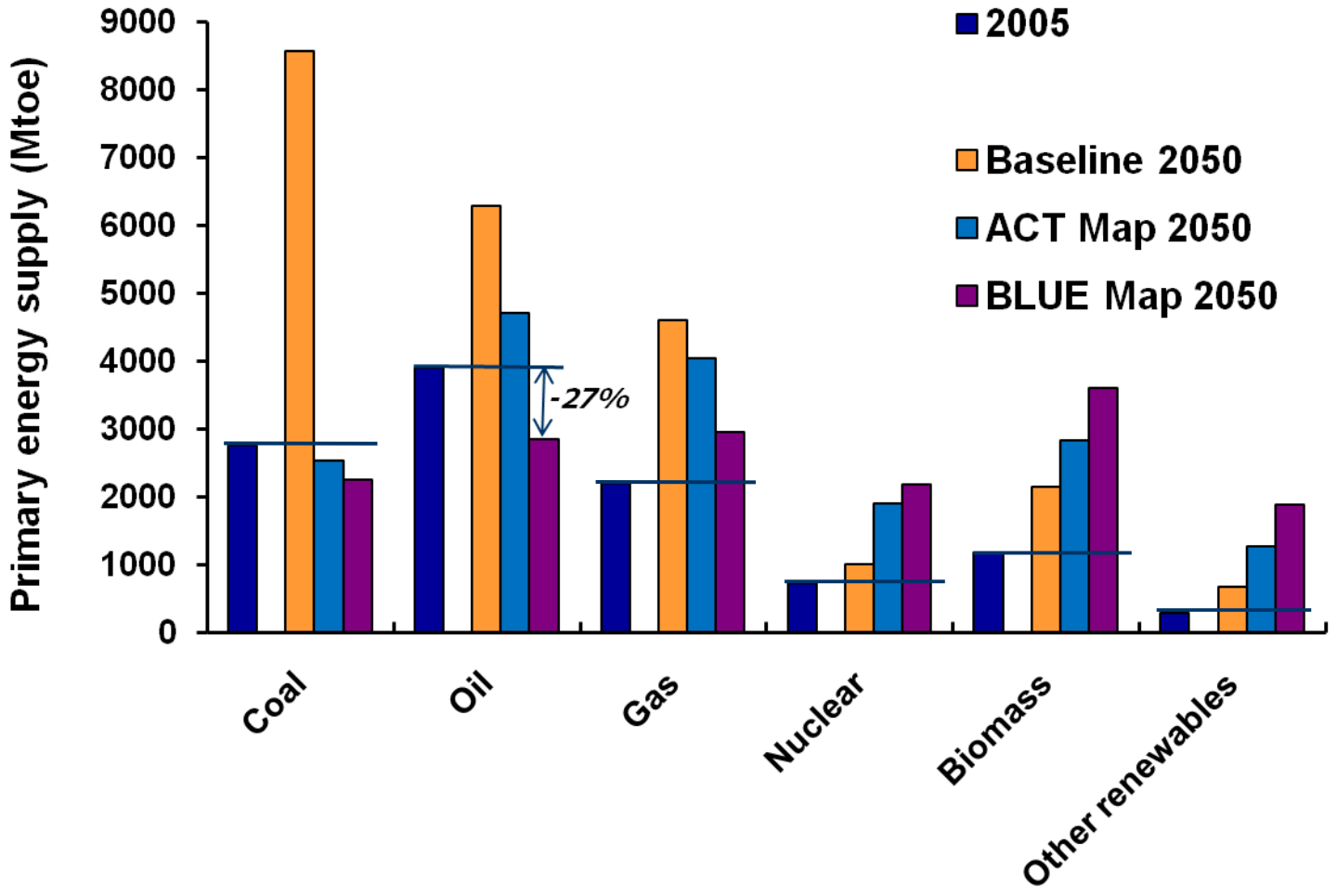

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Contributions of Technology Wedges

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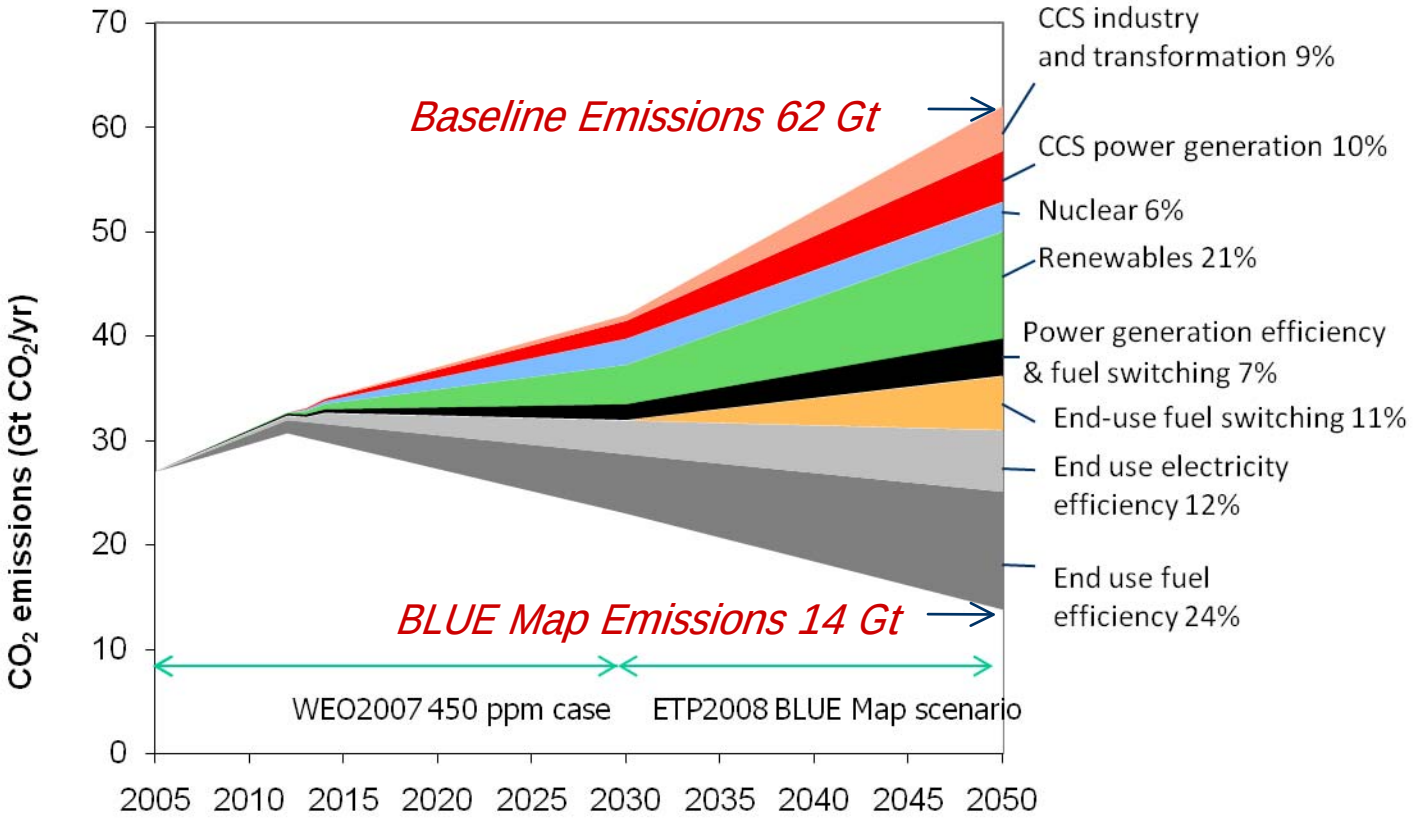

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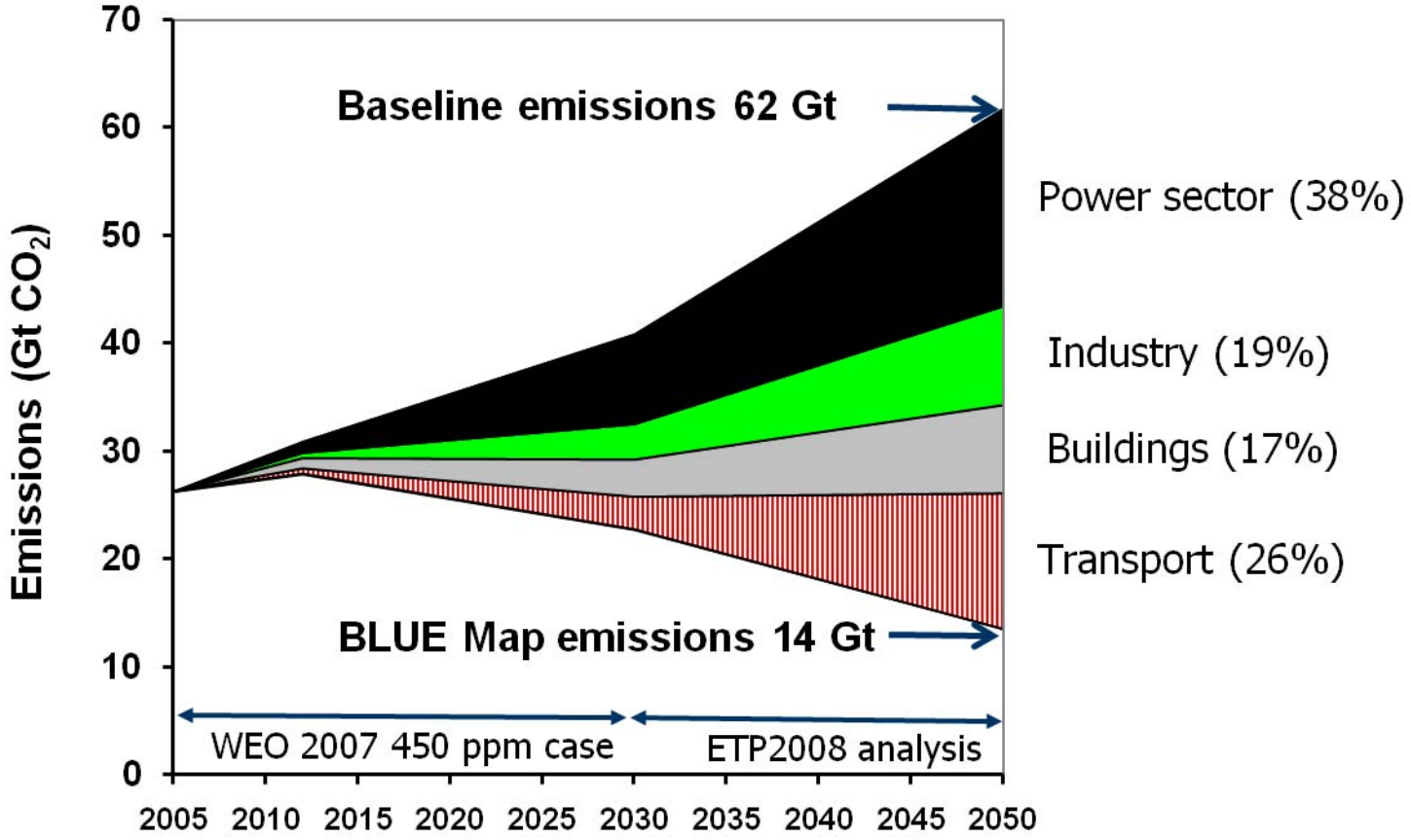
Sector Contributions



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Emissions Reduction

	ACT Map [%]	BLUE Map [%]	ACT Map [%]	BLUE Map [%]
Reference	2005	2005	Baseline 2050	Baseline 2050
Power sector	-43	-71	-81	-90
Other transformation	16	-62	-51	-84
Transport	31	-30	-42	-69
Industry	65	-21	-18	-60
Buildings	-2	-41	-36	-61
Total	2	-48	-57	-78

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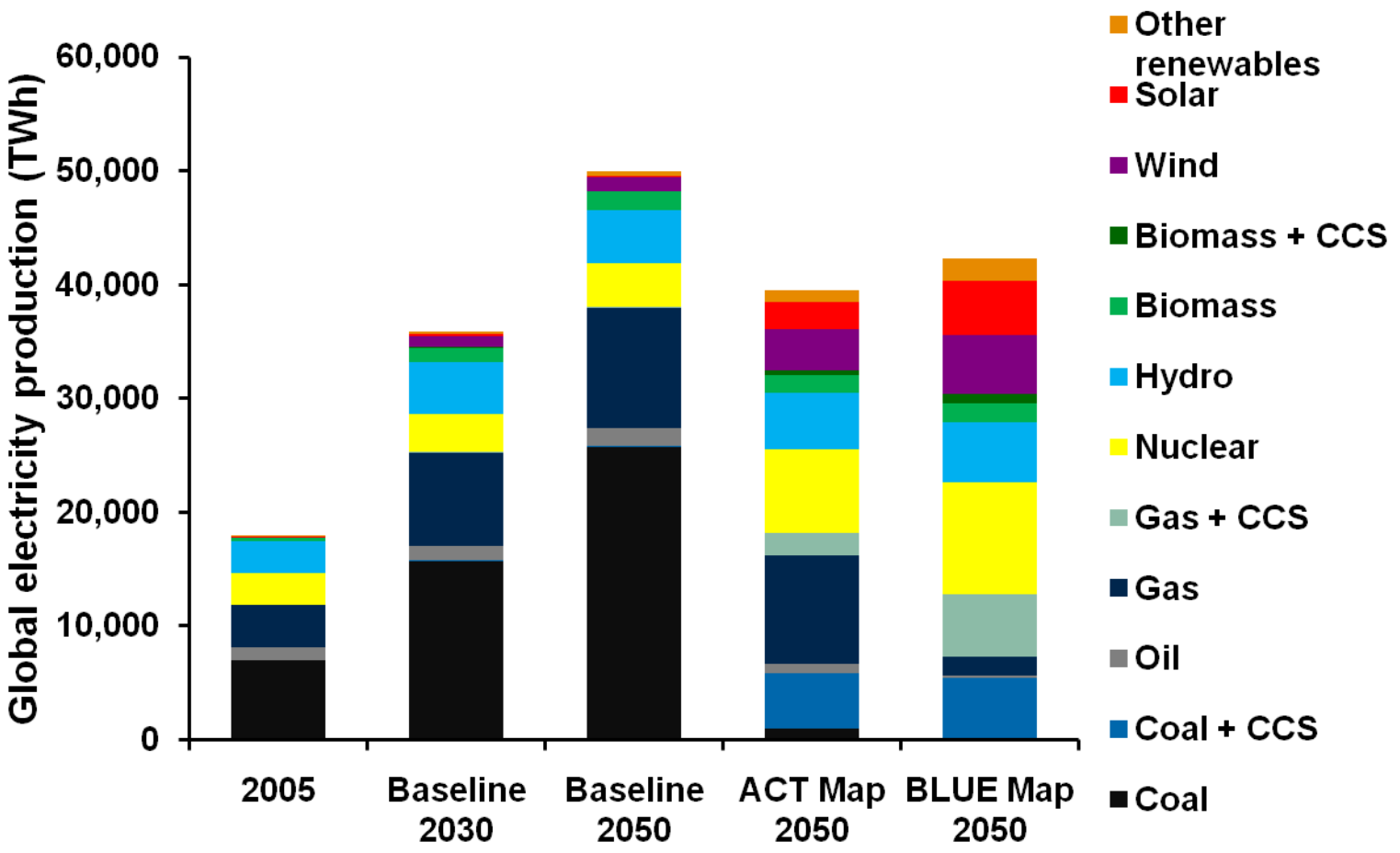
Power Generation Mix



¼ nuclear and fossil + CCS, nearly half renewables

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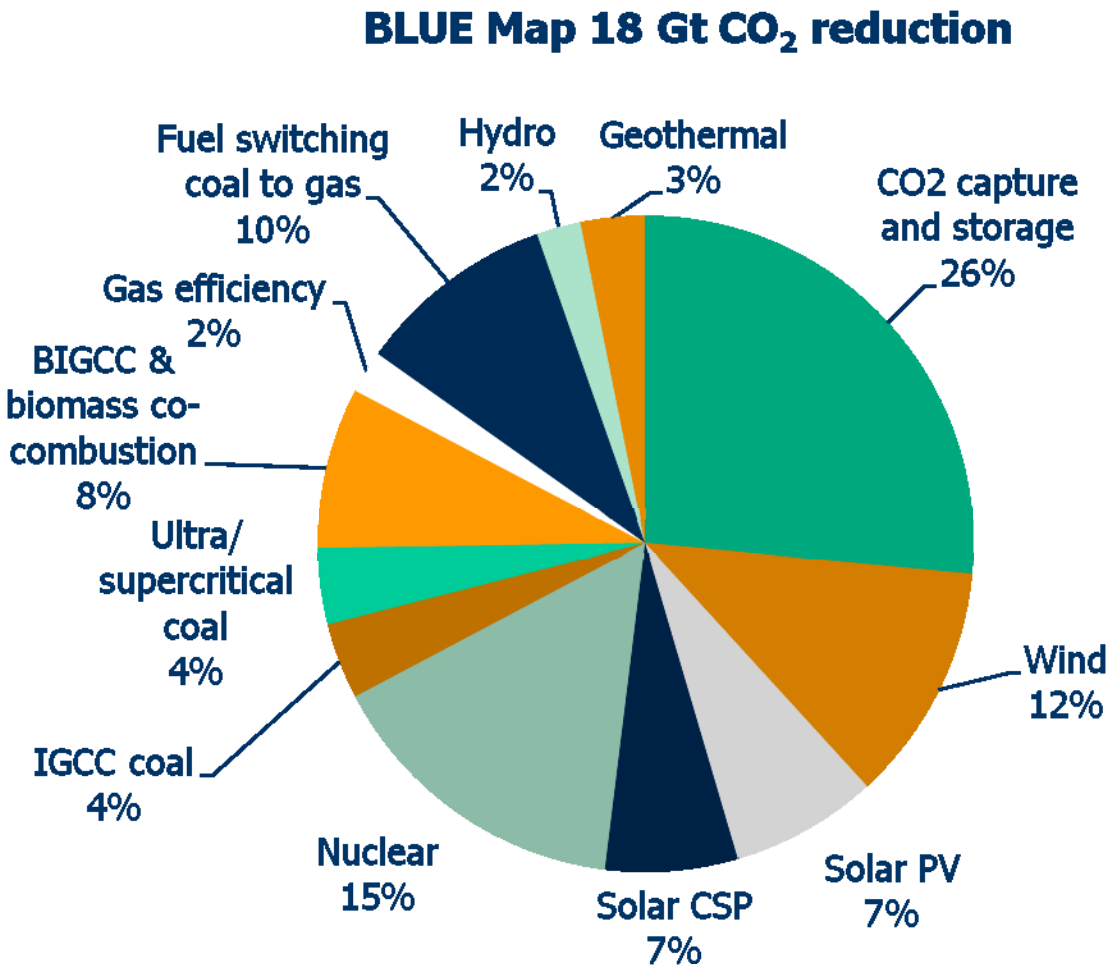
Power Sector CO_2 Reductions



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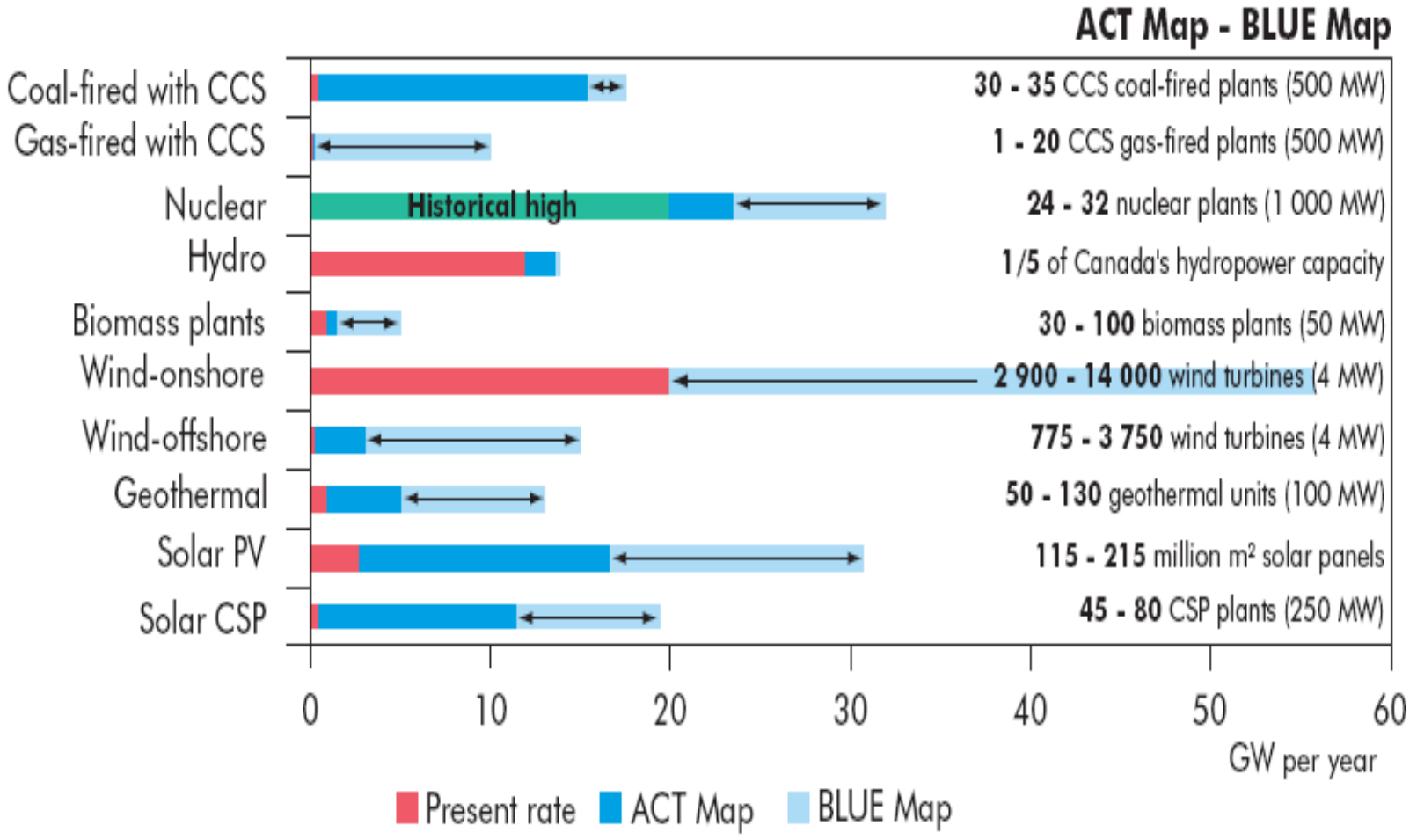
Average Annual Power Generation Capacity Additions, 2010 – 2050



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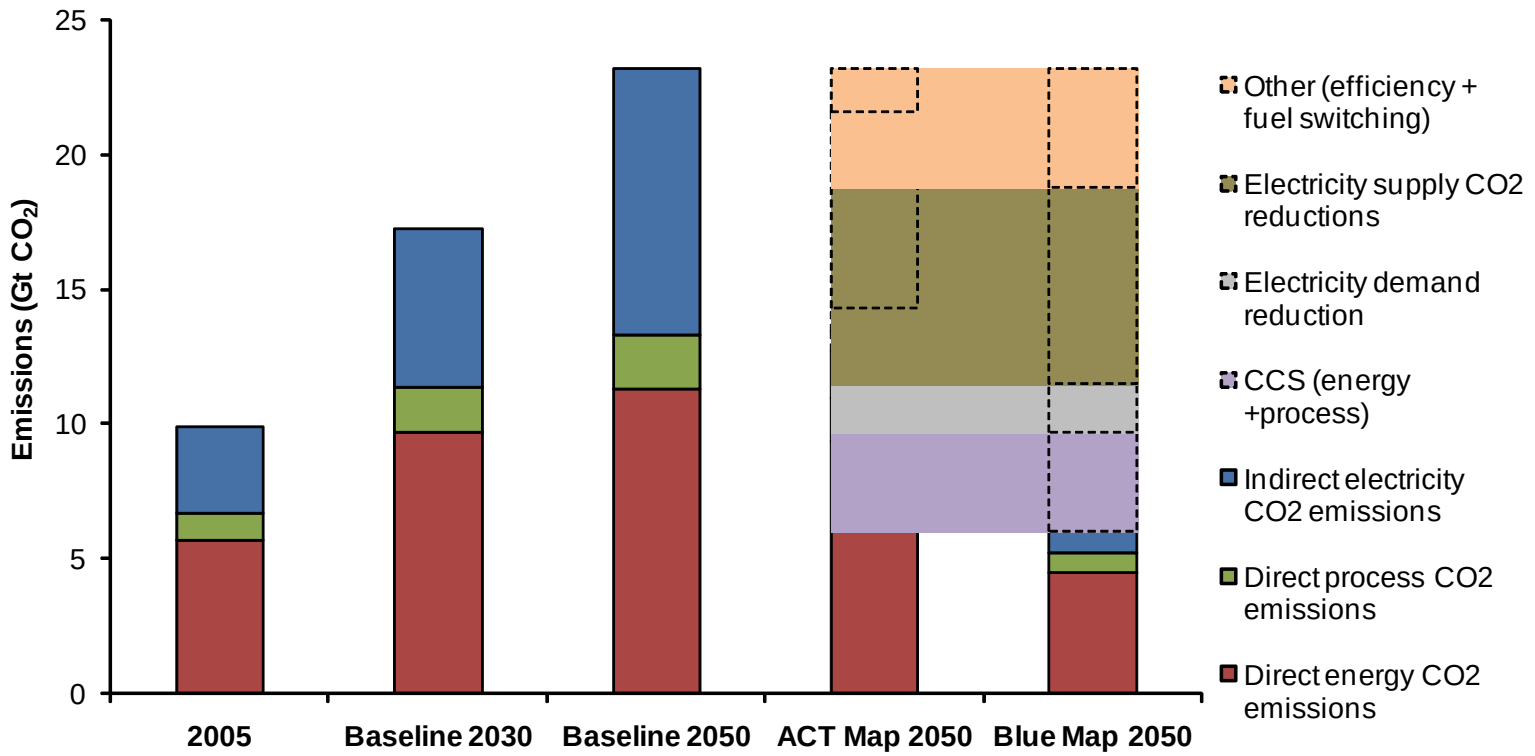
Industry CO_2 Reductions



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Industry Technology Areas

- BAT potential 19-32%
  - Part of that will be taken up autonomously
- New technology is key
  - CCS can play a special role
  - Life cycle perspective needed (systems options)
  - Important opportunities for cost-effective new technologies

Buildings & Appliances CO_2 Reductions

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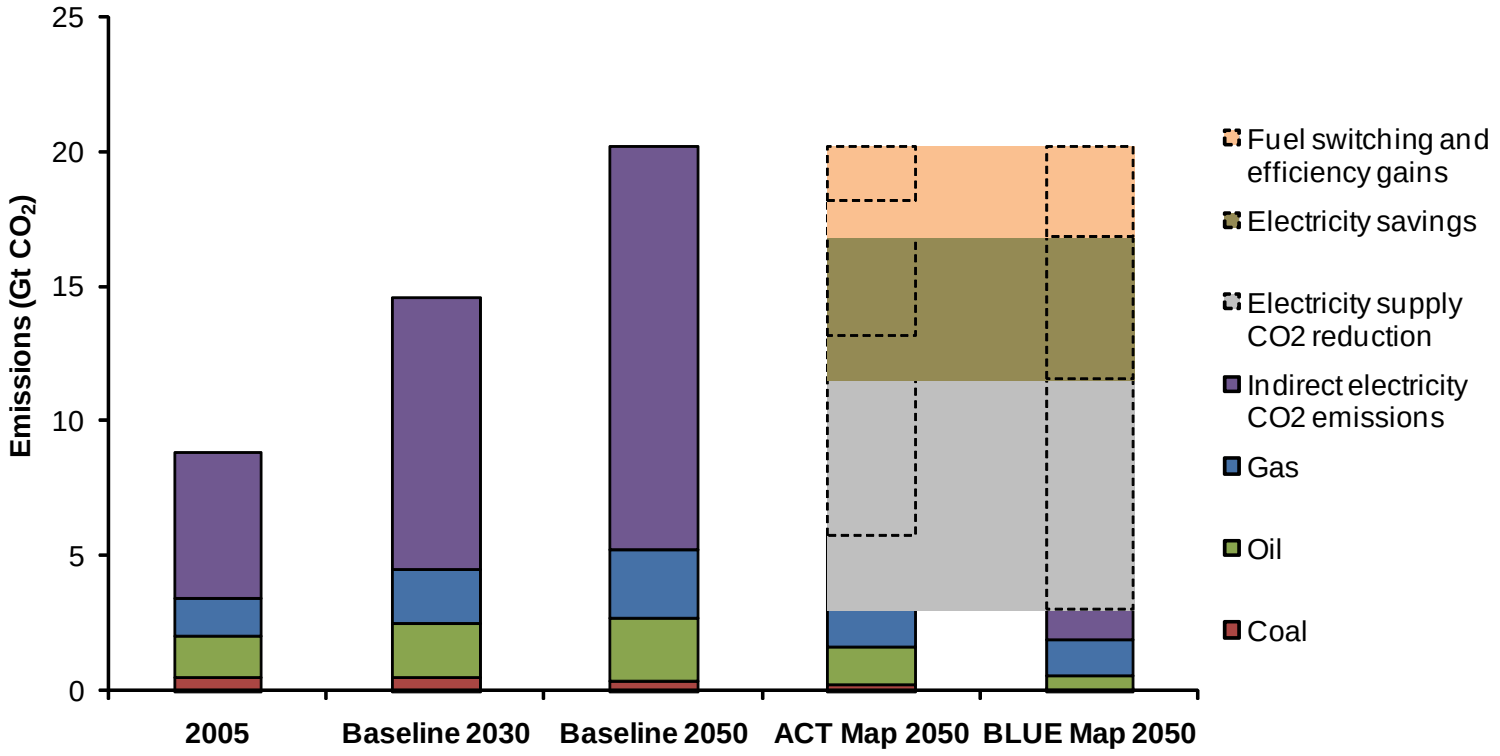

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Buildings Sector Savings by Sector and End-use in BLUE Map

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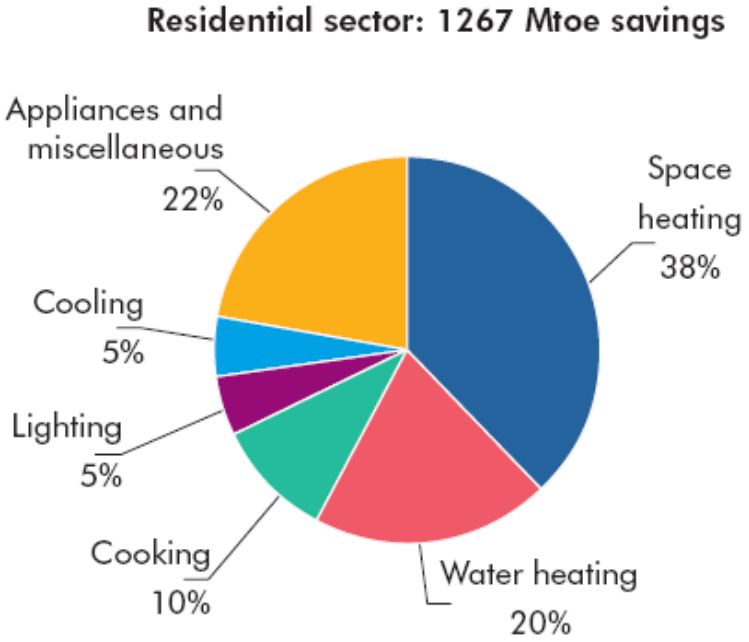

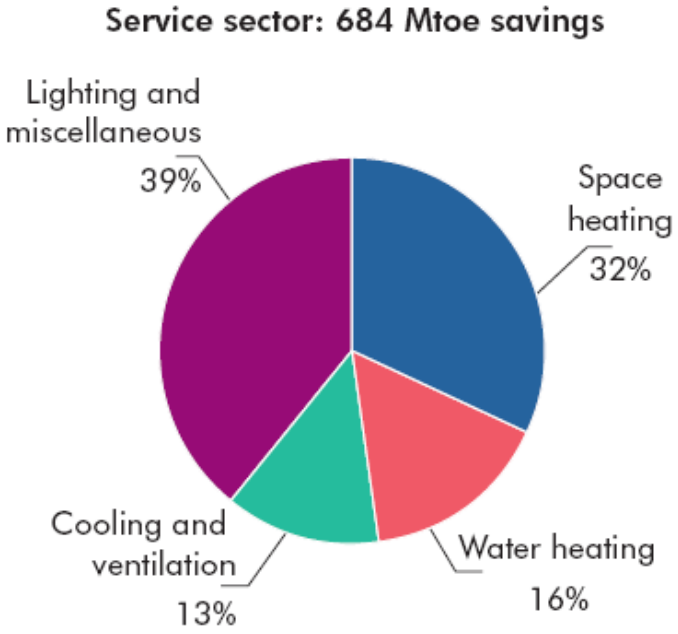

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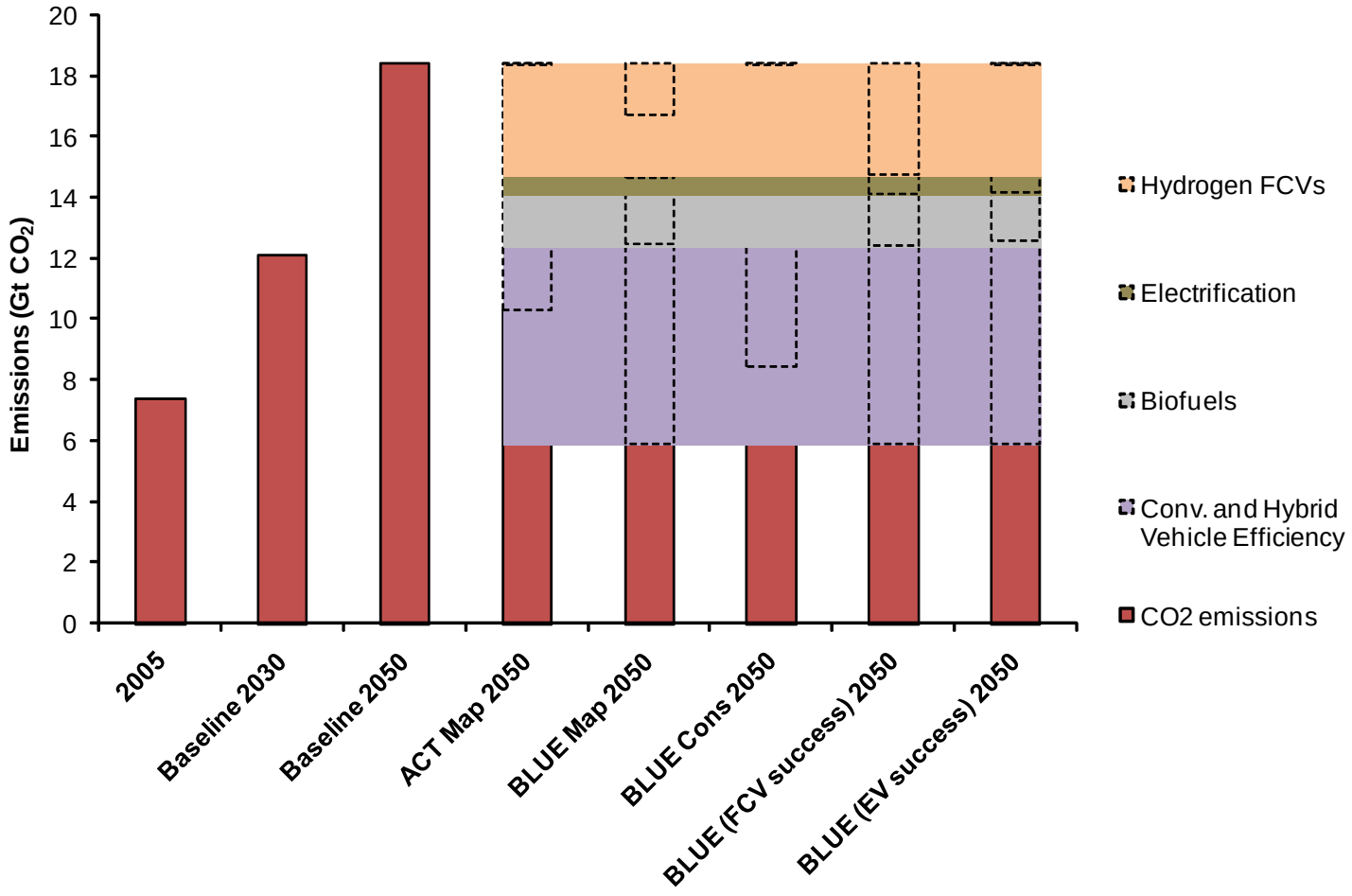
Transport CO_2 Reductions



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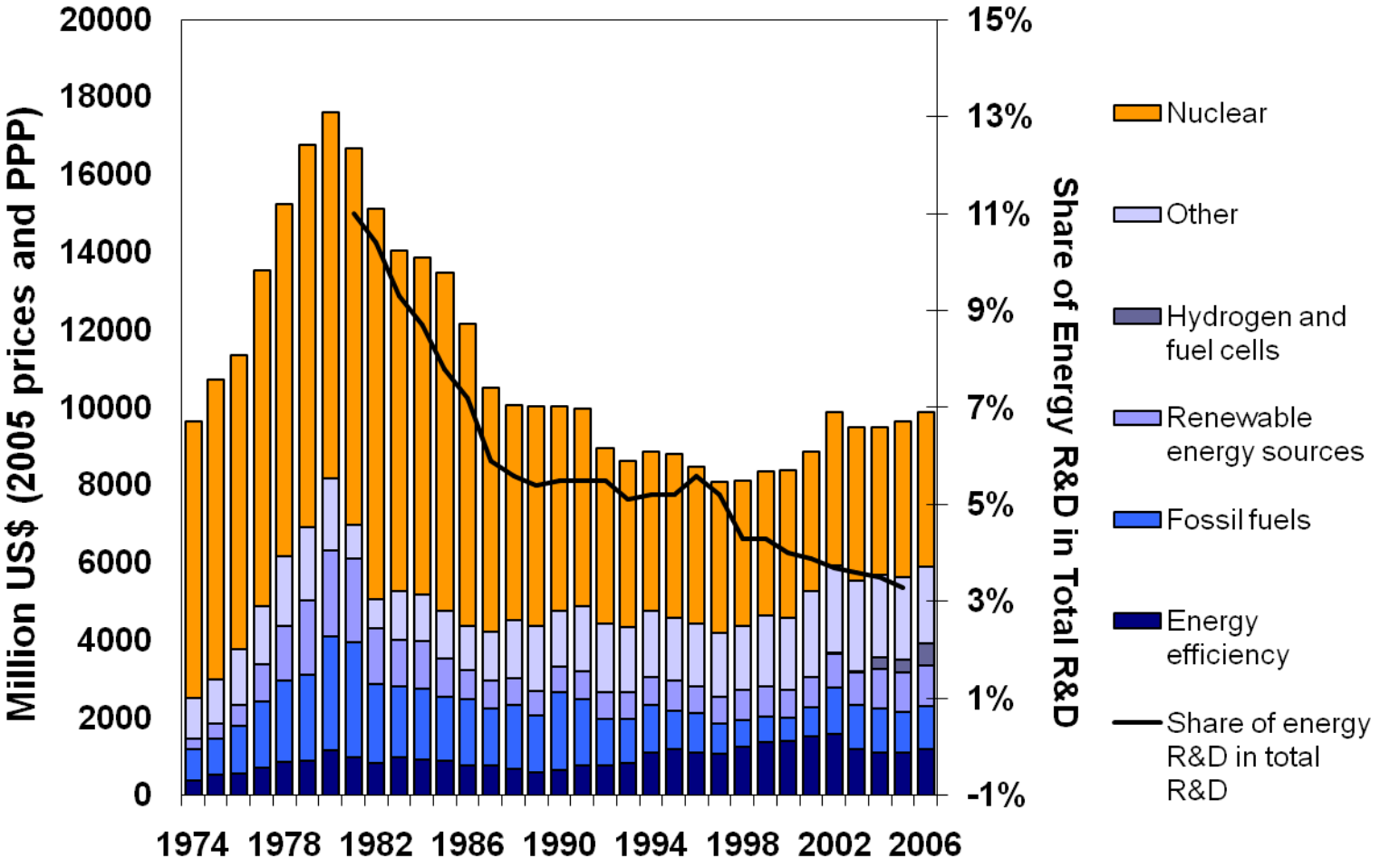
Public RD&D Trends in IEA



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Private Sector RD&D Trends

- **Private Sector - Difficult to get a correct picture**
  - Data deficiency
  - Difficulty of decomposing large conglomerates RD&D
  - Impact of non-energy related innovations
  - Increasingly complex pattern – Privatisation
- **Top 10 Spenders (non-energy RD&D included)**

Sector (in the 2000s)	2005 USD/yr
Power generation	2.2 – 2.6 billion
Oil and gas	4.0 – 5.2 billion
Automobiles	38 - 52 billion
Building	1.5 – 1.7 billion
Manufacturing	
Chemical	7 – 10 billion
Pulp and paper	600 – 640 million
Industrial metals	1.7 to 2.2. billion
Industrial equipment (global 8 firms)	13 – 15 billion

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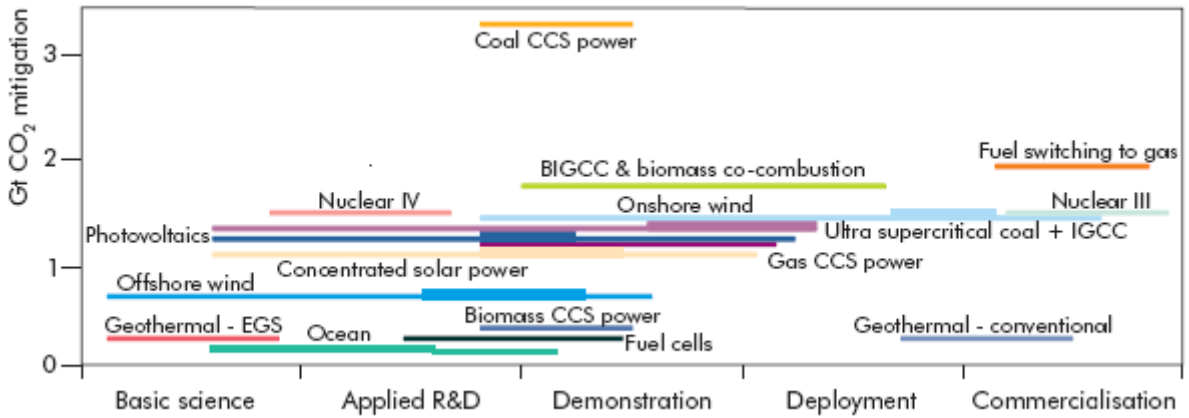
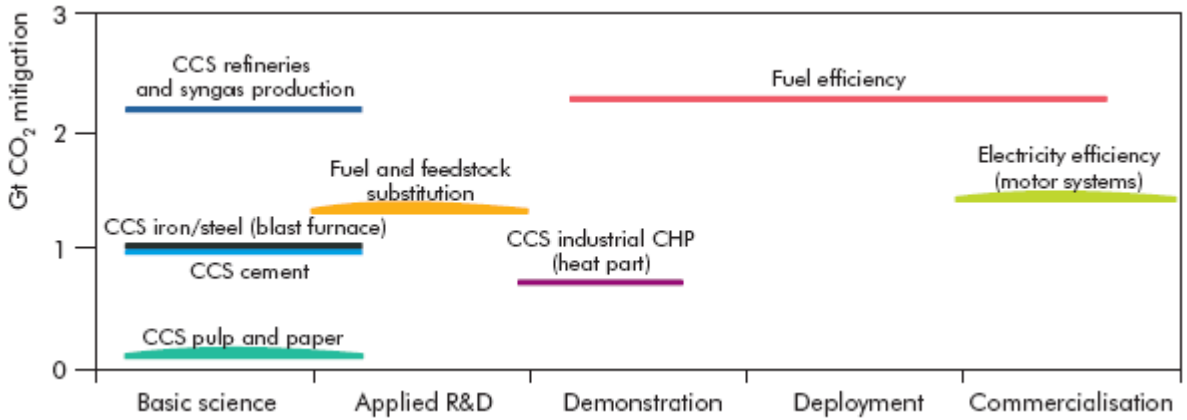
Technology RD&D Needs

- **Power generation**



- **Industry**



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Energy RD&D – Key Messages

- Both public and private energy RD&D investments have declined since the early 1980s
- Current IEA Governments energy RD&D - USD 10 billion/yr
- Nuclear dominates government RD&D
- Companies energy RD&D - USD 40-60 billion/yr
- Information about industrial energy RD&D trends is scarce
- Unclear how much RD&D would be “sufficient” to meet the goals
  - Literature suggests USD 10-100 billion/yr additional investments
- Leave it to industry or role for government ?
- Cooperation or competition model ?

Total Cumulative Investment Needs (2005-2050)

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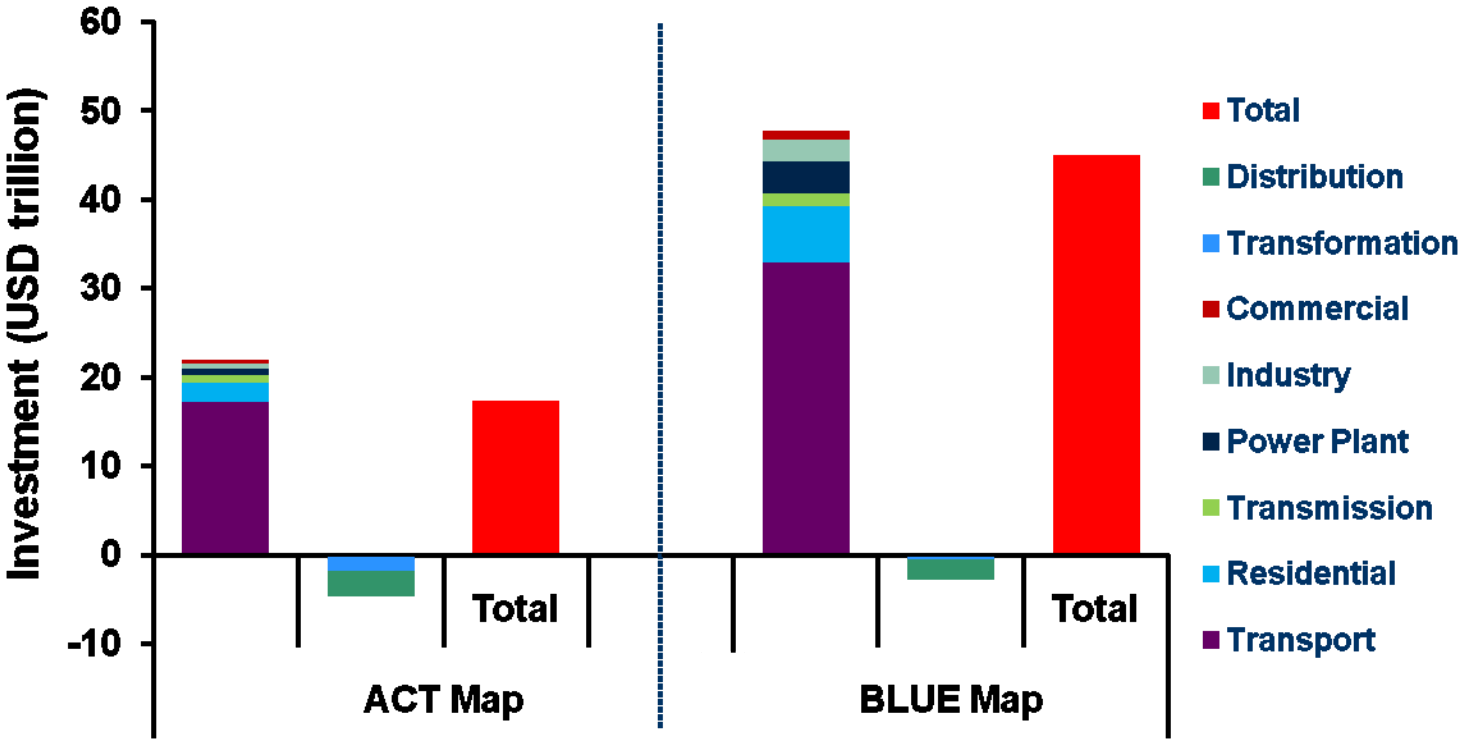

Demand-side investments dominate additional investment needs above the Baseline scenario, energy efficiency helps to reduce upstream investment needs in energy supply and transportation infrastructure

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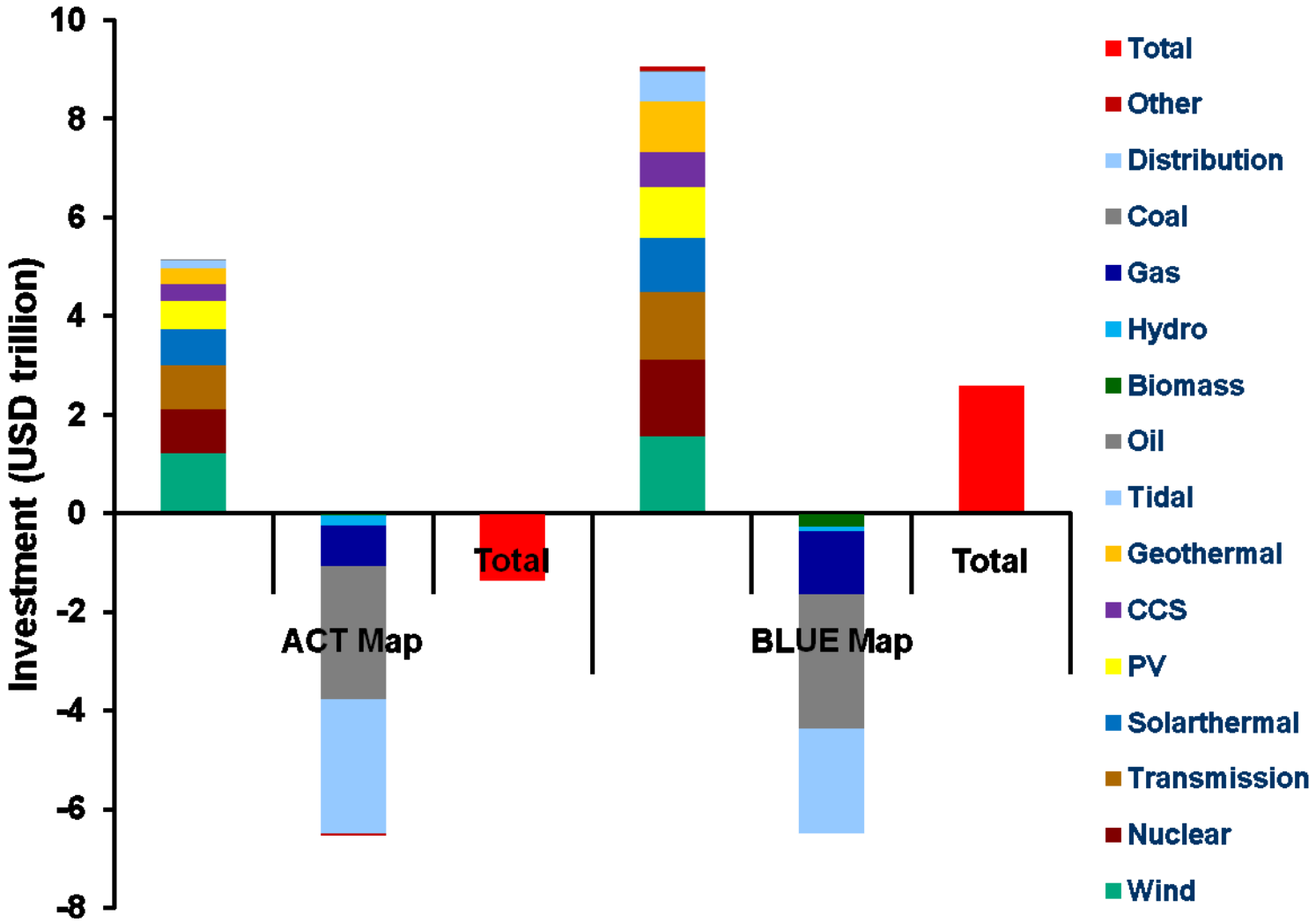
Cumulative Additional Investment in the Electricity Sector (2005-2050)



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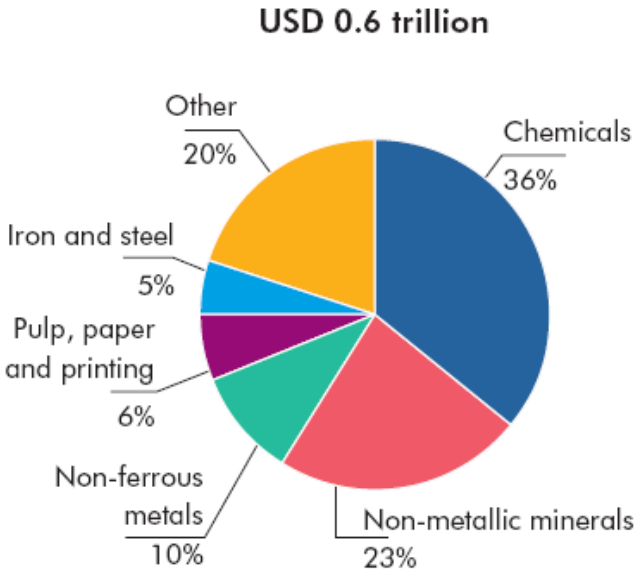
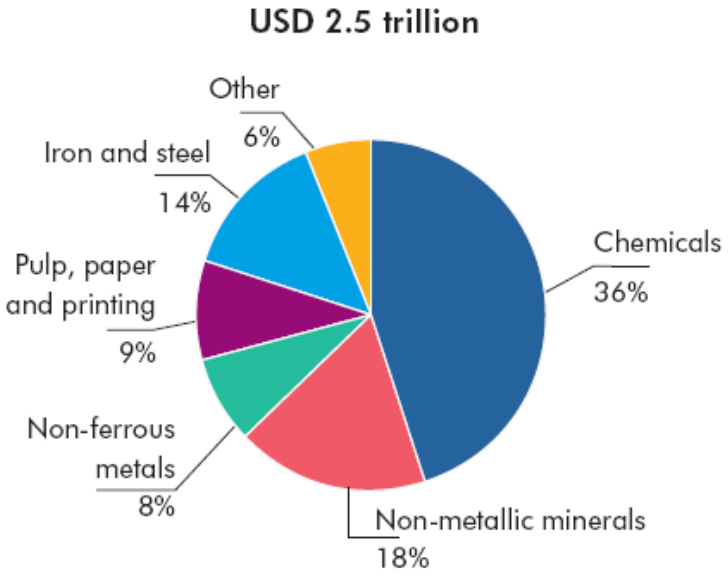
Cumulative Additional Investment in Industry (2005-2050)





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Investment – Key Messages

- ACT: $17 trillion above Baseline (0.4% of GDP)
- BLUE: $45 trillion above Baseline (1.1% of GDP)
- Demand side investments dominate (80 %)
- Even in BLUE undiscounted fuel savings exceed additional investment needs
- The problem for BLUE is not just cost, but:
  - ensuring timely investment, and
  - sharing the investment burden
- Current financing mechanisms are nowhere near enough to achieve BLUE scenario

Roadmaps

17 technology roadmaps provide 87 % of CO_2 savings under the Blue scenario

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- **Potentials**
- **Pathways to commercialization**
- **Technology targets**
- **How to get there**
- **Key actions needed**
- **Key areas for international cooperation**

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Key Technology Options (Roadmaps)

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- **Supply side**
  - CCS power generation
  - Nuclear III + IV
  - Wind
  - Biomass – IGCC & co-combustion
  - Solar – PV
  - Solar – CSP
  - Coal – IGCC
  - Coal – USCSC
  - 2nd generation biofuels
- **Demand side**
  - Energy efficiency in buildings
  - Heat pumps
  - Solar space and water heating
  - Energy efficiency in transport
  - Electric and plug-in vehicles
  - Fuel cell vehicles
  - CCS in industry
  - Industrial motor systems

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Roadmaps – Example CCS
10 % of CO_2 reduction potential in BLUE Map

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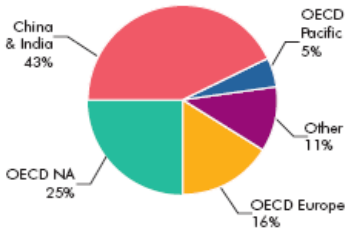
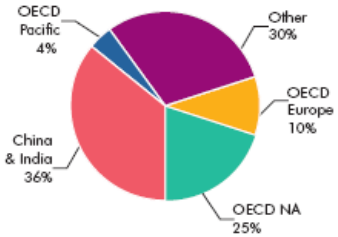
CO_2 Capture and Storage - Fossil-Fuel Power Generation

ACT 2.89 Gt savings 2050



Blue 4.9 Gt savings 2050



Other developing Asia, Middle East and Transition Economies

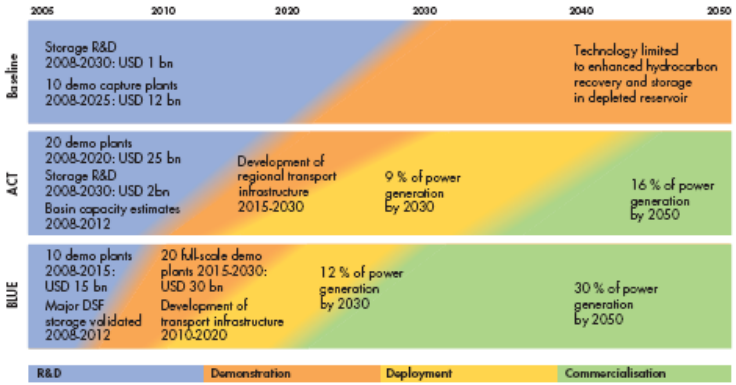
	Global Deployment Share 2030	RDD&D Inv. Cost USD bn 2005-2030	Commercial Inv. Cost* USD bn 2030-2050
OECD NA	35%	25-30	160-180
OECD Europe	35%	25-30	100-120
OECD Pacific	10%	7-8	30-40
China & India	15%	10-12	280-300
Other	5%	3-4	60-70

	Global Deployment Share 2030	RDD&D Inv. Cost USD bn 2005-2030	Commercial Inv. Cost* USD bn 2030-2050
OECD NA	35%	30-35	350-400
OECD Europe	35%	30-35	150-200
OECD Pacific	10%	10-12	70-80
China & India	15%	12-14	450-500
Other	5%	4-5	300-350

Technology Targets

	ACT: Emissions Stabilisation	BLUE: 50% Emissions reduction
RD&D		
Capture technologies for three main options (post-combustion, pre-combustion, and oxy-fuelling)	Technologies tested in small- and large-scale plants. Cost of CO_2 avoided around 50 USD/t by 2020. Chemical looping tested	
Demonstration targets	20 large-scale demo plants with a range of CCS options, including fuel type (coal/gas/biomass) by 2020	30 large-scale demo plants with a range of CCS options, including fuel type (coal/gas/biomass) by 2020
New gas-separation technologies: membranes & solid adsorption	New capture concepts: next-generation processes, such as membranes, solid absorbers and new thermal processes	
Technology transfer	Technology transfer to China and India	Technology transfer to all transition and developing countries
Deployment		
Regional pipeline infrastructure for CO_2 transport	Major transportation pipeline networks developed and CO_2 maritime shipping	
Deployment targets	Early commercial large-scale plants by 2015 (ZEP, ZeroGen, GreenGen)	30% of electricity generated from CCS power plant

Technology Timeline



Key Actions Needed

- Develop and enable legal and regulatory frameworks for CCS at the national and international levels, including long-term liability regimes and classification of CO_2.
- Incorporate CCS into emission trading schemes and clean development mechanisms.
- RD&D to reduce capture cost and improve overall system efficiencies.
- RD&D for storage integrity and monitoring. Validation of major storage sites. Monitor and valuation methods for site review, injection & closure periods.
- Raise public awareness and education on CCS.
- Assessment of storage capacity using Carbon Sequestration Leadership Forum methodology at the national, basin and field levels.
- New power plants built after 2020 to have CCS.
- New power plants to be "capture-ready" after 2015.

Key Areas for International Collaboration

- Development and sharing of legal and regulatory frameworks.
- Develop international, regional and national instruments for CO_2 pricing, including CDM and ETS.
- Raise public awareness and education.
- Sharing best practices and lessons learnt from demonstration projects (pilot and large-scale).
- Joint funding of large-scale plants in developing countries by multi-lateral lending institutions, industry and governments.
- Development of standards for national and basin storage estimates and their application.
- Organizations: CSLF, IEA GHG, IEA CCC, IPCC.

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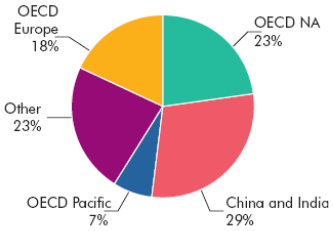
Roadmaps – Example Efficiency Buildings and Appliances

15% of CO_2 reduction potential in BLUE Map

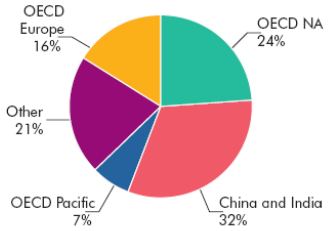
Energy efficiency in buildings and appliances

ACT 6.5 Gt CO_2 savings 2050



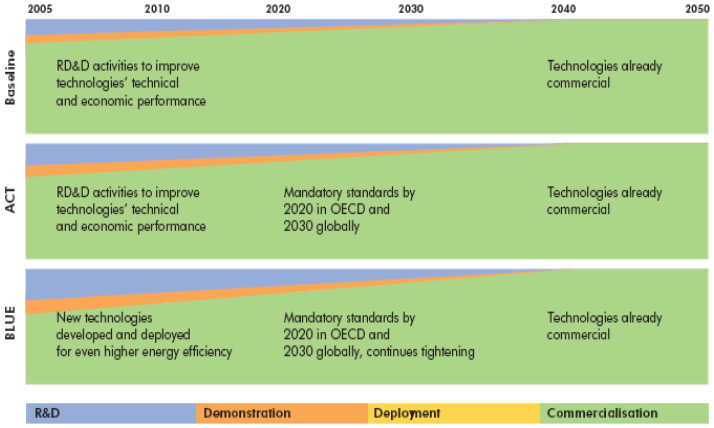
	Commercial Inv. Cost USD bn 2005-2050
OECD NA	1 100-1 200
OECD Europe	850-950
OECD Pacific	300-400
China & India	1 000-1 200
Other	1 800-2 000

BLUE 7.0 Gt CO_2 savings 2050



	Commercial Inv. Cost USD bn 2005-2050
OECD NA	1 500-1 700
OECD Europe	950-1050
OECD Pacific	450-550
China & India	1 500-1 800
Other	2 200-2 500

Technology timeline



Technology targets

	ACT: Emissions Stabilisation	BLUE: 50% Emissions Reduction
Diffusion		
Limit standby power use to 1-Watt.	Implemented in OECD countries between now and 2030; and globally by 2040	Implemented in OECD countries between now and 2020; and globally by 2030
Tighten or establish minimum energy efficiency standards for all major existing appliances	New appliances standards shifted to LLCC between now and 2020 in OECD and by 2030 globally	New appliance standards shifted to BAT between now and 2020 in OECD and globally by 2030.
Mandatory standards across full range of mass-produced equipment	Appliances brought under standards by 2030 in OECD and by 2040 globally	Standards for appliances by 2020 in OECD and 2030 globally. Continuous tightening required
Building codes	Cold countries at "low-energy" standard from 2015 and globally from 2030	Cold countries to meet "passive house" levels by 2015, and globally from 2030
Adopt best practice in lighting efficiency	Policy must shift to LLCC from 2015	Policy must begin shift to BAT from 2025 onwords
Promote low-energy houses and fuel switching	Simplified planning requirements to encourage low-energy buildings and alternative fuel sources (especially solar)	

Key actions needed

- Monitor energy efficiency improvements in existing buildings and appliances. Need to collect consistent and comprehensive data on end-use consumption and energy efficiency worldwide.
- Implementation of mandatory minimum efficiency performance standards (MEPS), harmonised at a high level of efficiency and implemented worldwide, ongoing tightening will be required.
- International standards need to be reviewed regularly to ensure adequate vigor.

Key areas for international collaboration

- Establish a common set of efficiency "tiers" from which countries could draw when they establish minimum energy performance standards.
- Facilitate the rapid exchange of BAT in the buildings sector to ensure rapid uptake worldwide.
- Promote the diffusion of passive house design, construction techniques and energy technologies.

In support of the G8 Plan of Action

IEEJ:2008年7月掲載

Key Messages from ETP2008

- **Deep emission cuts are technically achievable**
  - Significant investment required
  - Credible long-term targets needed
- **This change is urgent**
  - Capital stock turnover is slow
  - Technology development needs time
  - Non-cost barriers should be addressed
- **Global energy technology revolution needed**
  - Cooperation with DCs is essential

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INTERNATIONAL ENERGY AGENCY

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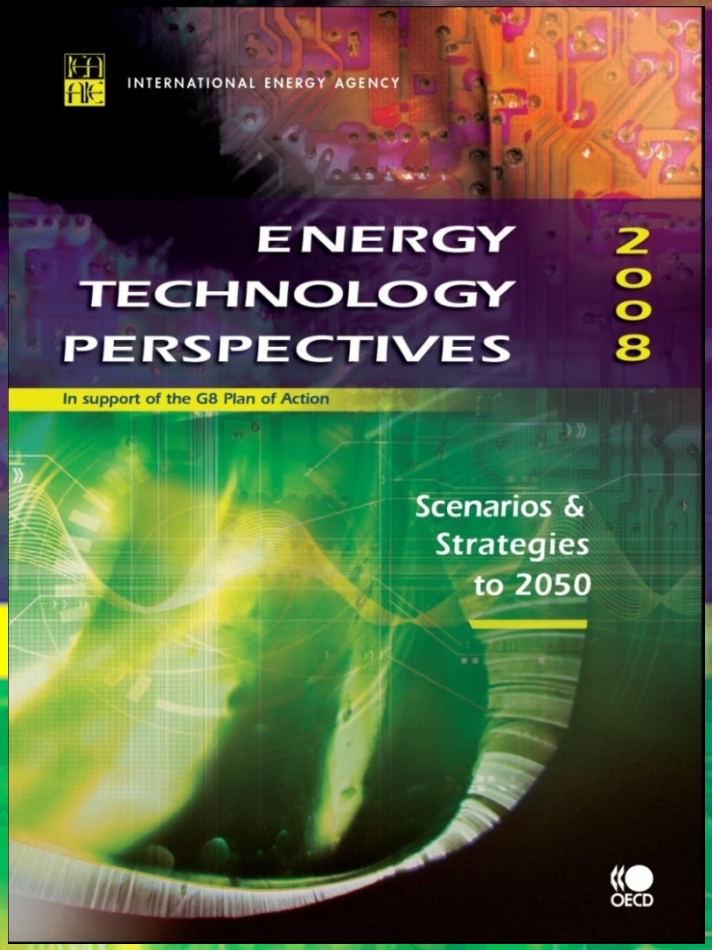
Thank You !



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