CO2 Capture and Storage Challenges and Goals

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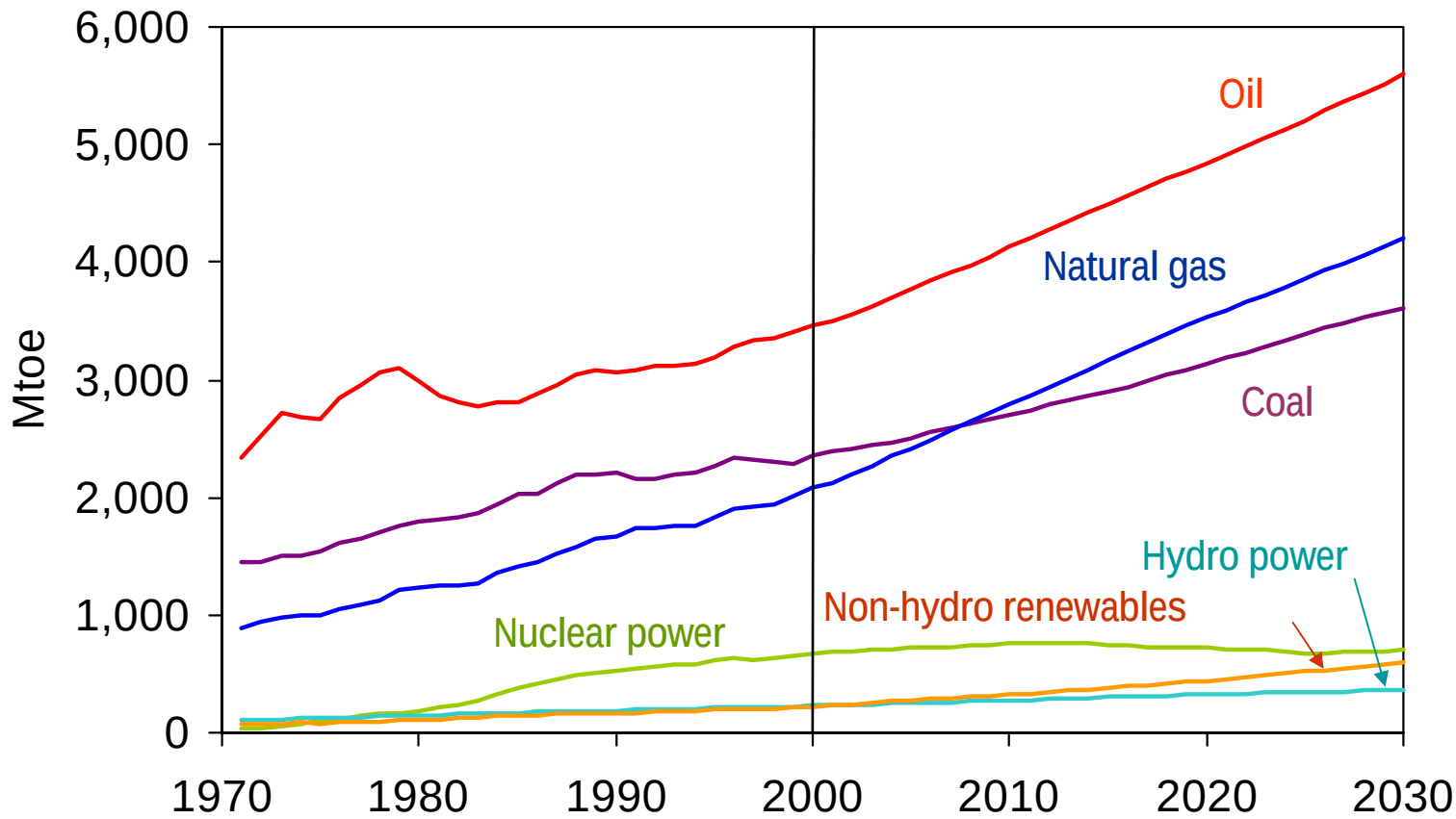
Jacek Podkanski

(jacek.podkanski@iea.org)

Energy Technology Collaboration Division

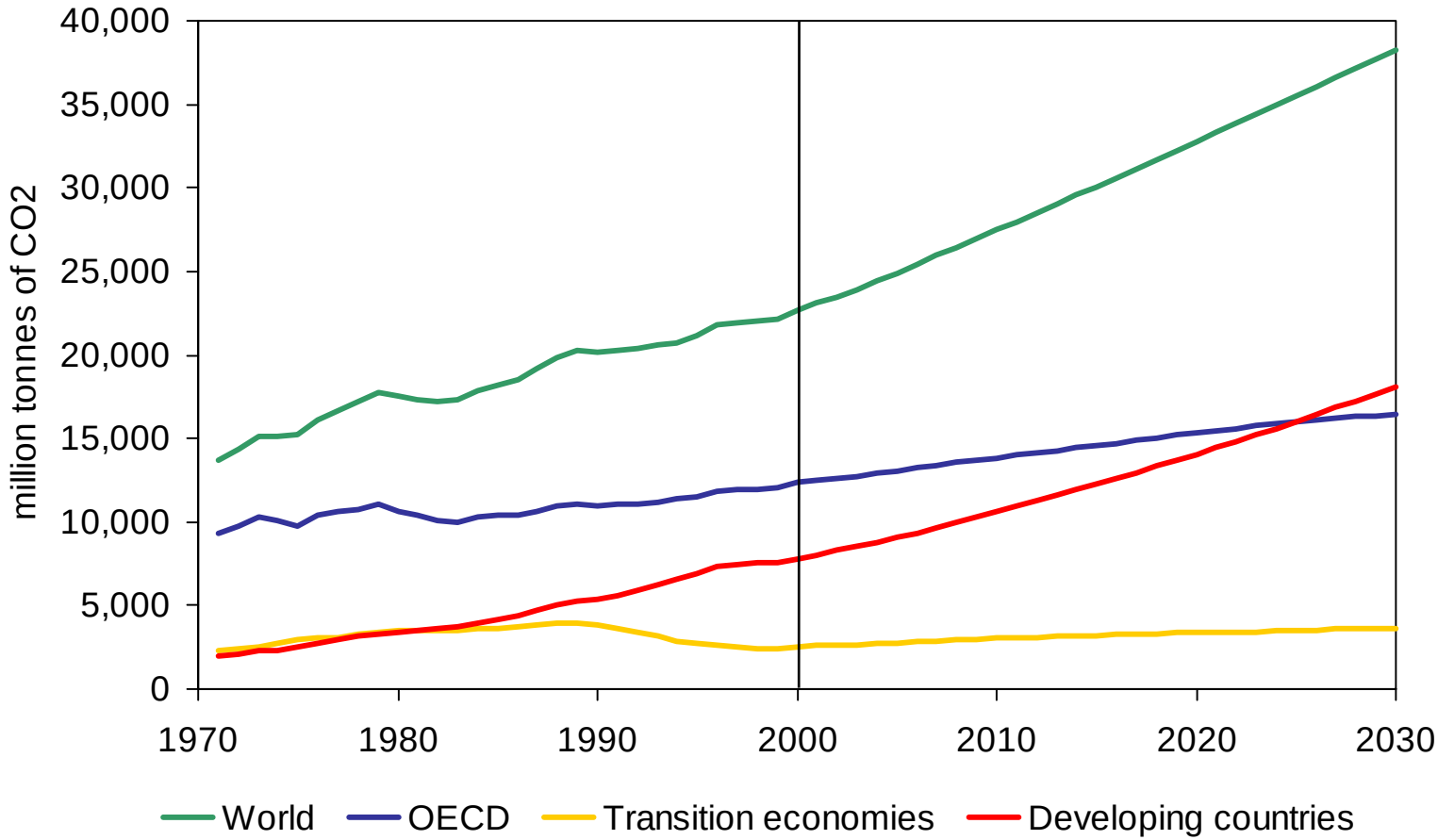
International Energy Agency

World Primary Energy Demand



Gas grows fastest in absolute terms & non-hydro renewables fastest in % terms, but oil remains the dominant fuel in 2030

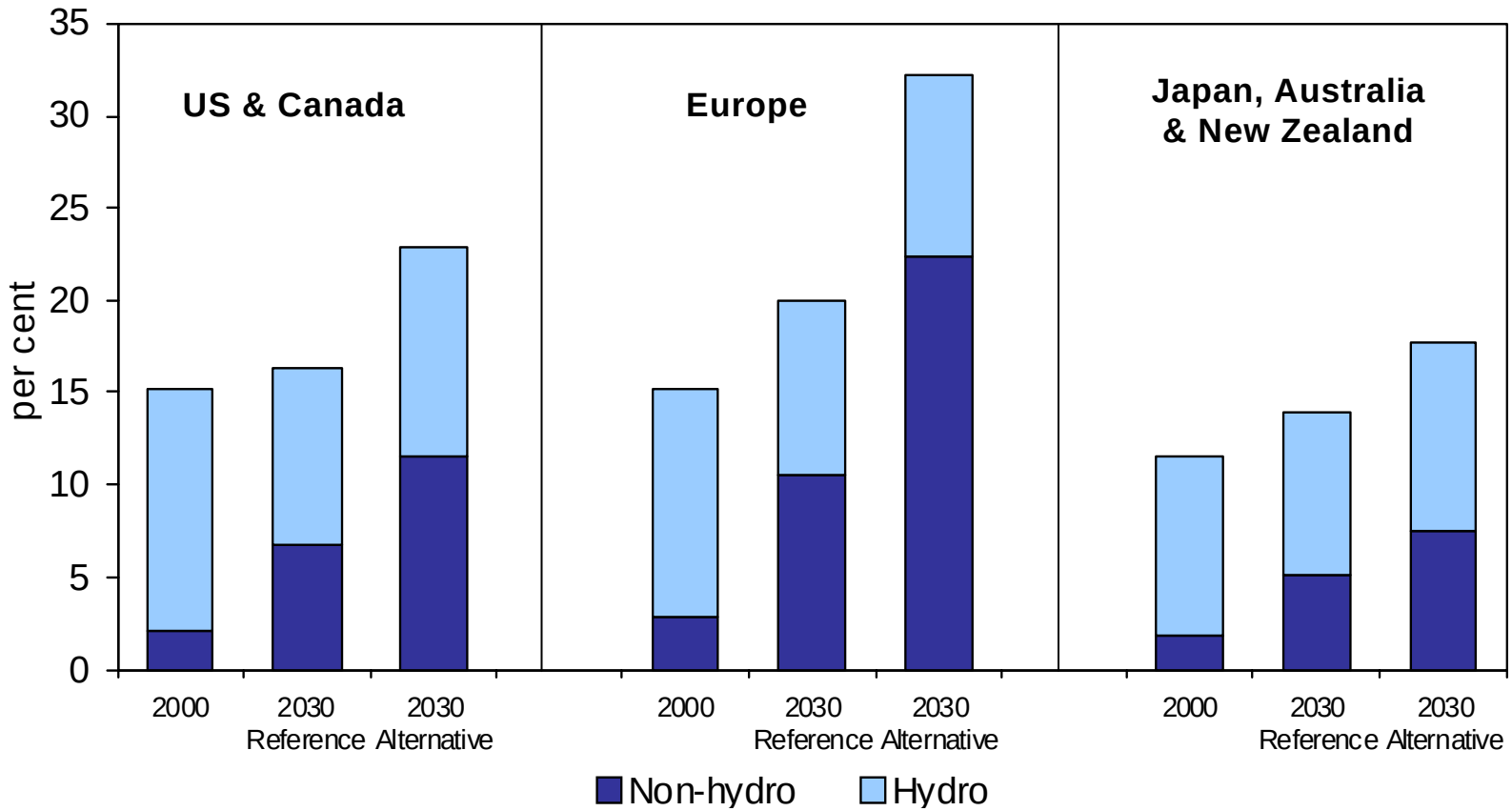
Energy-Related CO_2 Emissions



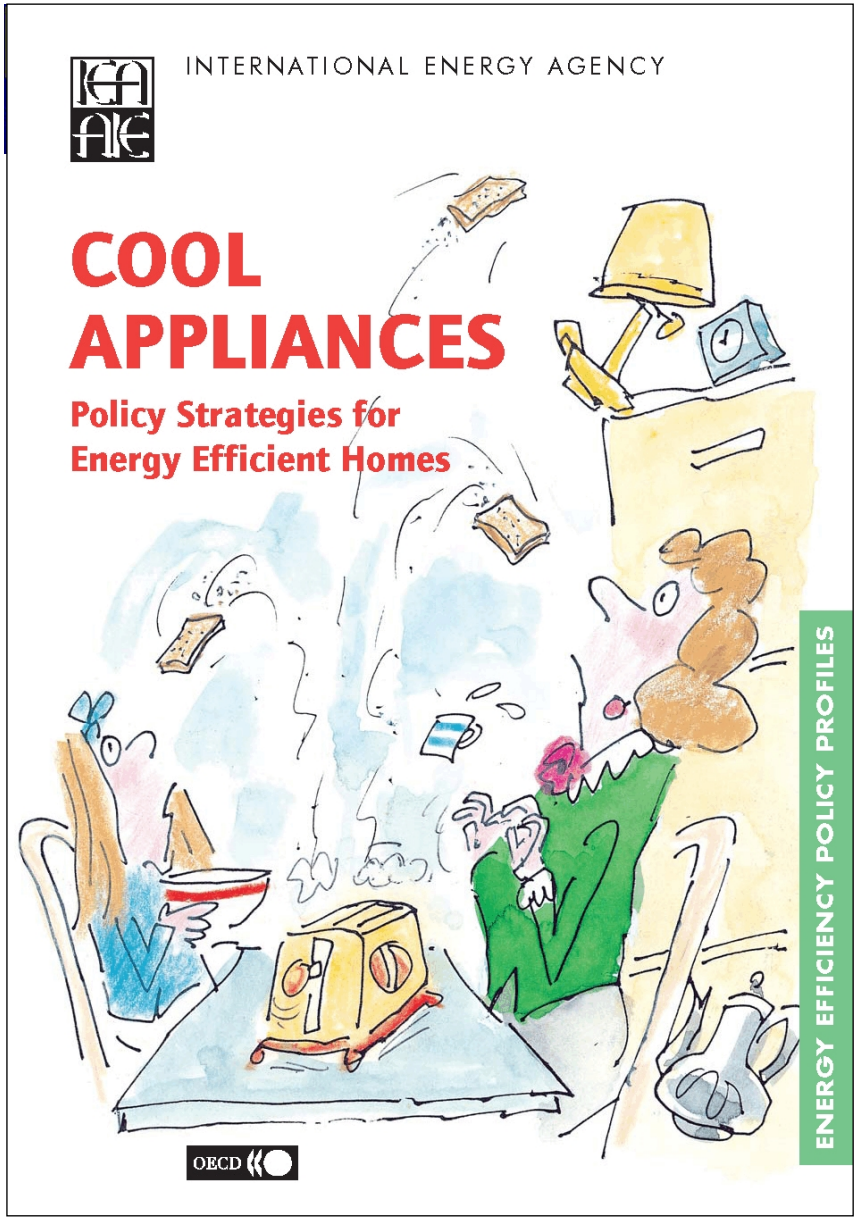
World emissions will increase by 1.8 % per year to 38 billion tonnes in 2030 – 70% above 2000 levels

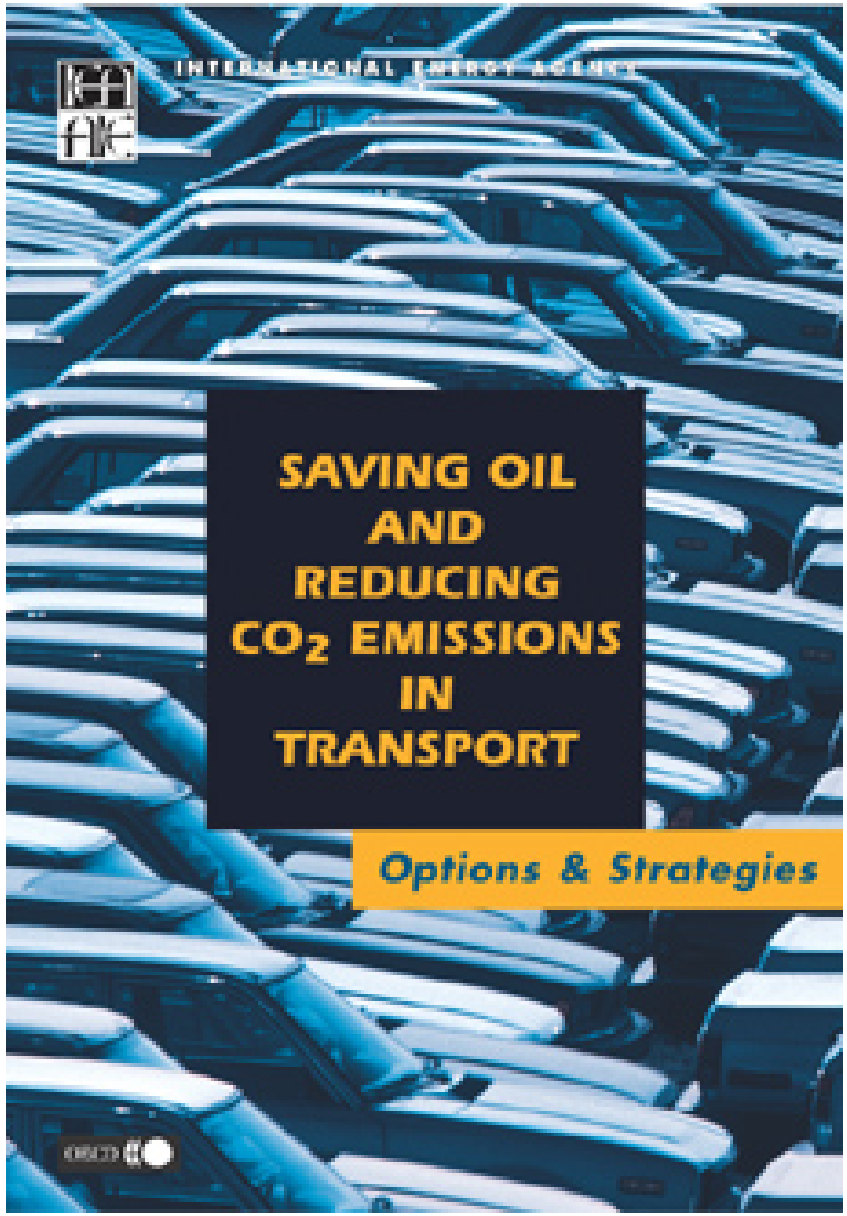
Importance of Increased Renewable Energy in Power Generation

WEO 2002 Alternative Policy Scenario



Non-hydro renewables can be greatly increased with additional policies.





INTERNATIONAL ENERGY AGENCY

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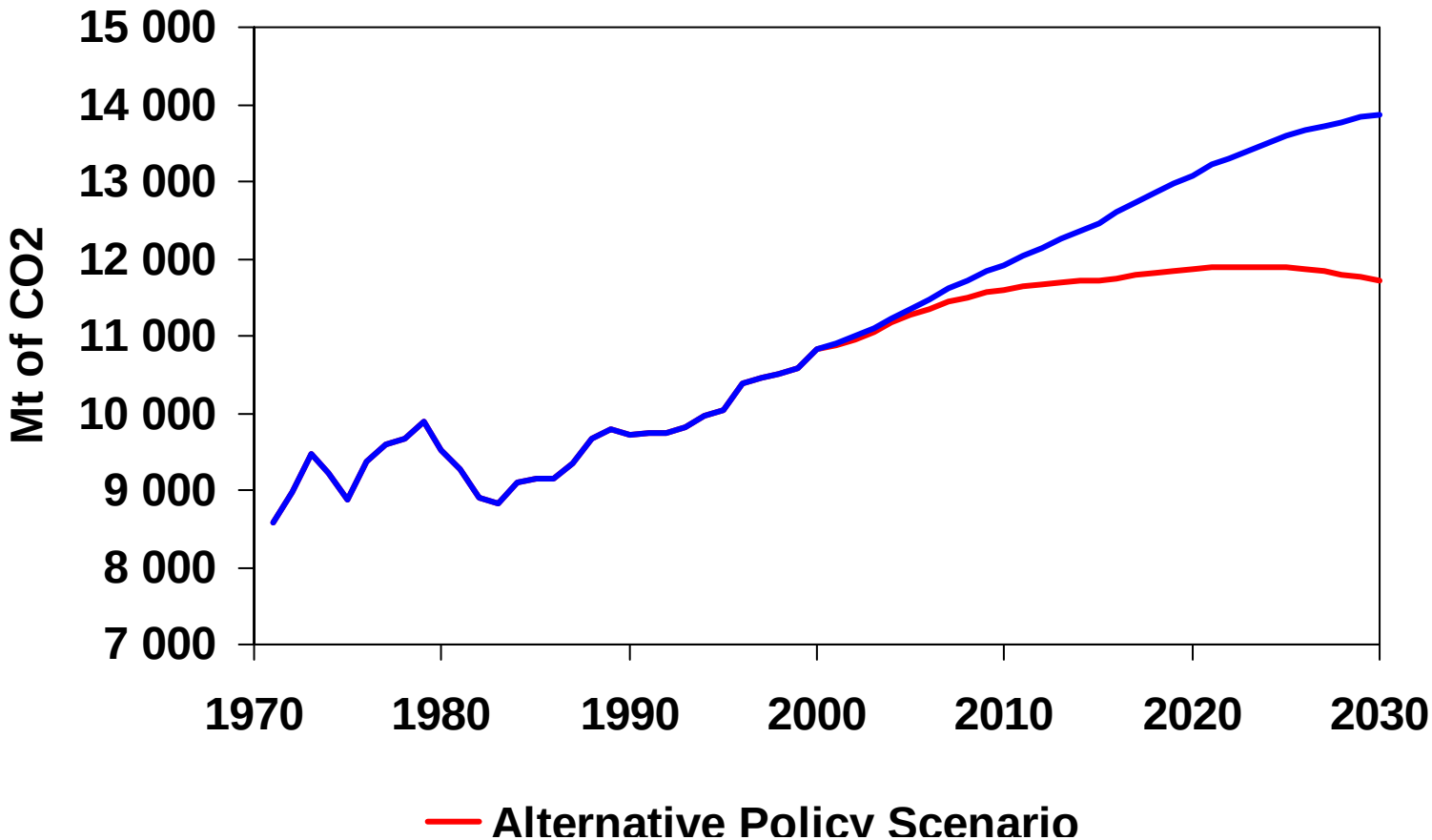
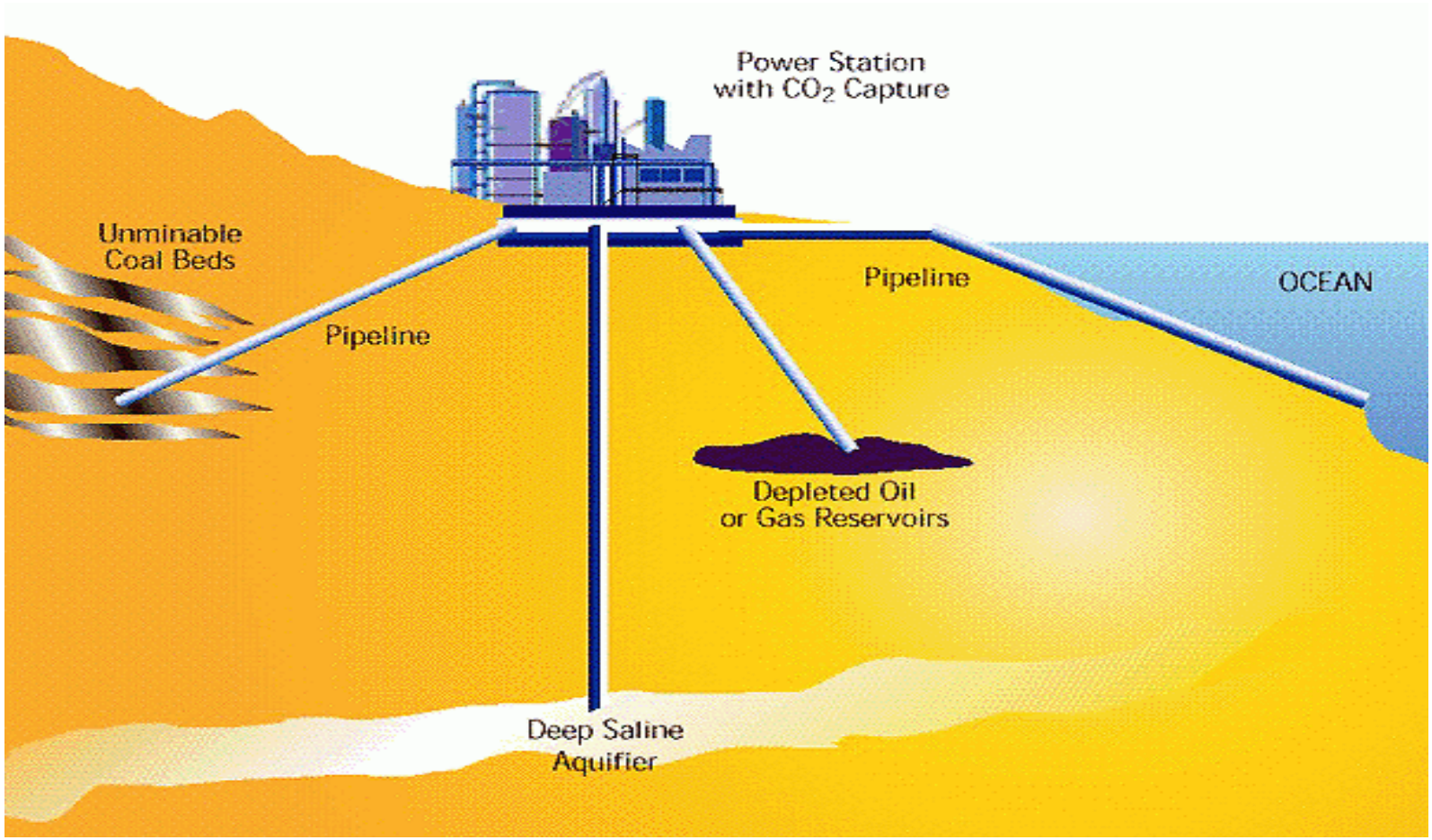
OECD CO_2 Emissions

WEO 2002 Alternative Policy Scenario

Effect of Increased Efficiency + Renewables



CO_2 Capture and Storage



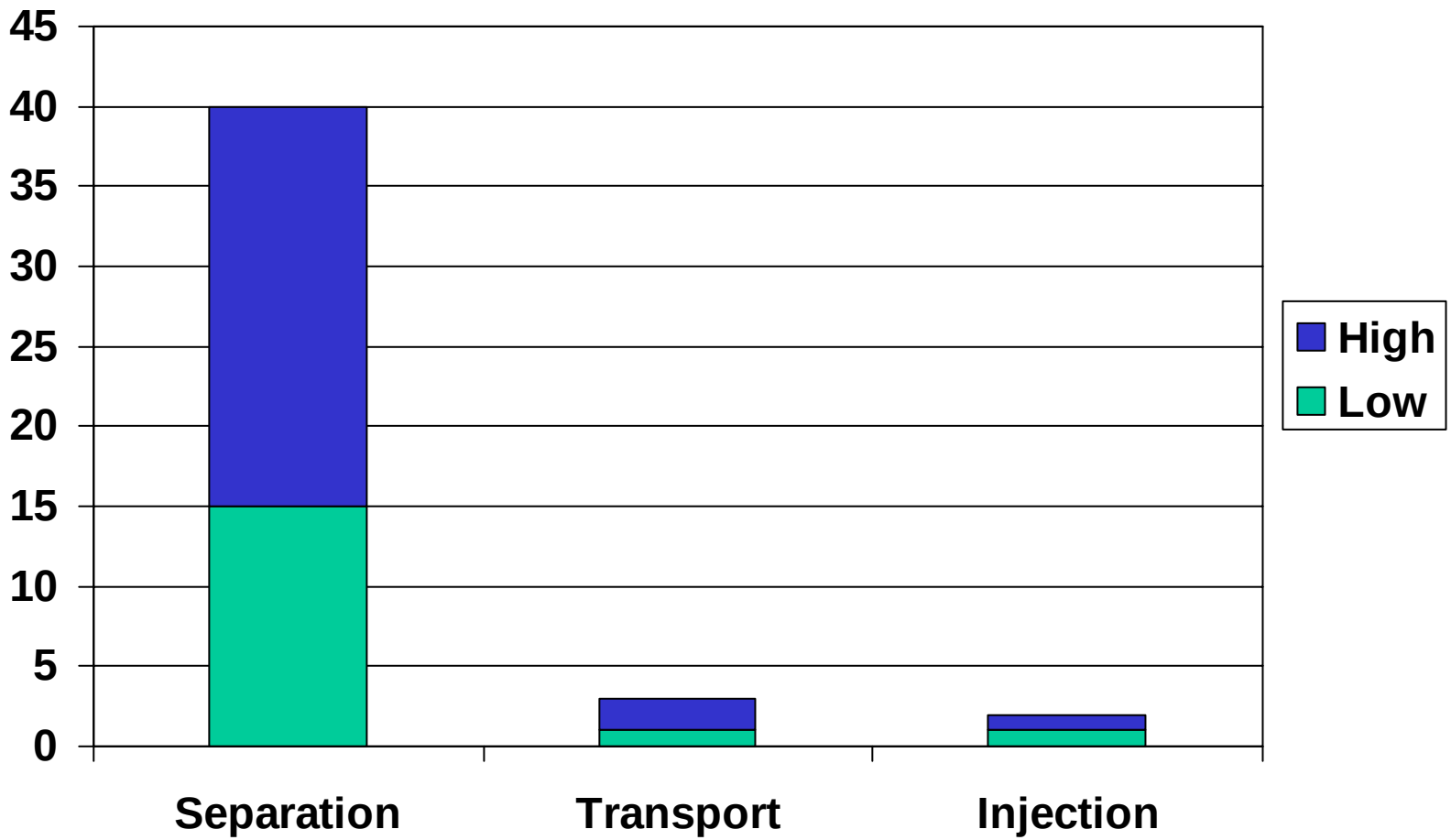
From IEA Greenhouse Gas Programme

Costs of Hydrogen [$/GJ]

	Future fuel/el. resource price	Fuel cost	Other prod cost	Transport cost	Refueling	Future Sup. Cost
Gasoline/diesel	Crude oil $25-$29/bbl	4-5	2	<1-1	2	8-10
Natural gas	Import price $3-4/GJ	3-4	NA	<1-1	4	7-9
H2 from natural gas –CO_2	3-5 $/GJ	3.8-6.3	1.2-2.7	2	5-7	12-18
H2 from coal – CO_2	1-2 $/GJ	1.3-2.7	4.7-6.3	2	5-7	13-18
H2 from biomass (gasif.)	2-5 $/GJ	2.9-7.1	5-6	2-5	5-7	14-25
H2 from onshore wind	3-4 cents/kWh	9.8-13.1	5	2-5	5-7	22-30
H2 from offshore wind	4-5.5 cents/kWh	13.1-18.0	5	2-5	5-7	27-37
H2 from thermal solar elec	6-8 cents/kWh	19.6-26.1	5	2-5	5-7	32-42
H2 from solar PV	12-20 cents/kWh	39.2-65.4	5	2-5	5-7	52-82
H2 from nuclear	2.5-3.5 cents/kWh	8.2-11.4	5	2	5-7	20-27
H2 from HTGR cogeneration	NA	NA	8-23	2	5-7	15-32

IEA Cost Estimates

$/tonne of CO_2
($/tonne of CO_2/100 km for transport)



Power Plants Without and With CO_2 Capture

Plant type	Year available	Reference cost ($/kW)	Add. Inv. ($/kW)	Eff. without capture (%)	Eff. loss with capture (%)	Add. fuel req. (%)
Coal steam cycle	2010	1075	750-825	43	-12	39
Coal steam cycle – advanced	2020	1025	700-800	44	-8	22
Coal IGCC	2010	1455	650-750	46	-8	21
Coal IGCC – advanced	2020	1260	350-400	46	-6	15
Gas CC	2010	400	350-450	56	-9	19
Gas CC – advanced	2020	400	400-500	59	-8	16

Leadership and Collaboration

- **Leadership**
  - by governments, &
  - by industry.
- **Collaboration**
  - among governments,
  - with industry,
  - the scientific and environmental community, &
  - involving multinational organizations.