

***Assessing Today's Supplies to Fuel
Tomorrow's Growth***

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World Energy Outlook Series

- World Energy Outlook 1998
- World Energy Outlook 1999 Insights
Looking at Energy Subsidies: Getting the Prices Right
- World Energy Outlook – 2000
- World Energy Outlook – 2001 Insights
Assessing Today's Supplies to Fuel Tomorrow's Growth
- World Energy Outlook – 2002 (forthcoming)
- World Energy Outlook – 2003 Insights
Global Energy Investment Outlook (planned)



Why this study?

- growing concerns over energy security, resource availability, supply costs and investments

Objectives

- identify and analyse factors behind medium/long-term energy supply trends
- cost drivers at global and regional levels - backbone of the study
- 'fuel-neutral'- no recommendation for fuel mix
- no new set of projections



Outline of the Study

Executive Summary

I. Background to the Study

II. Oil

III. Gas

IV. Coal

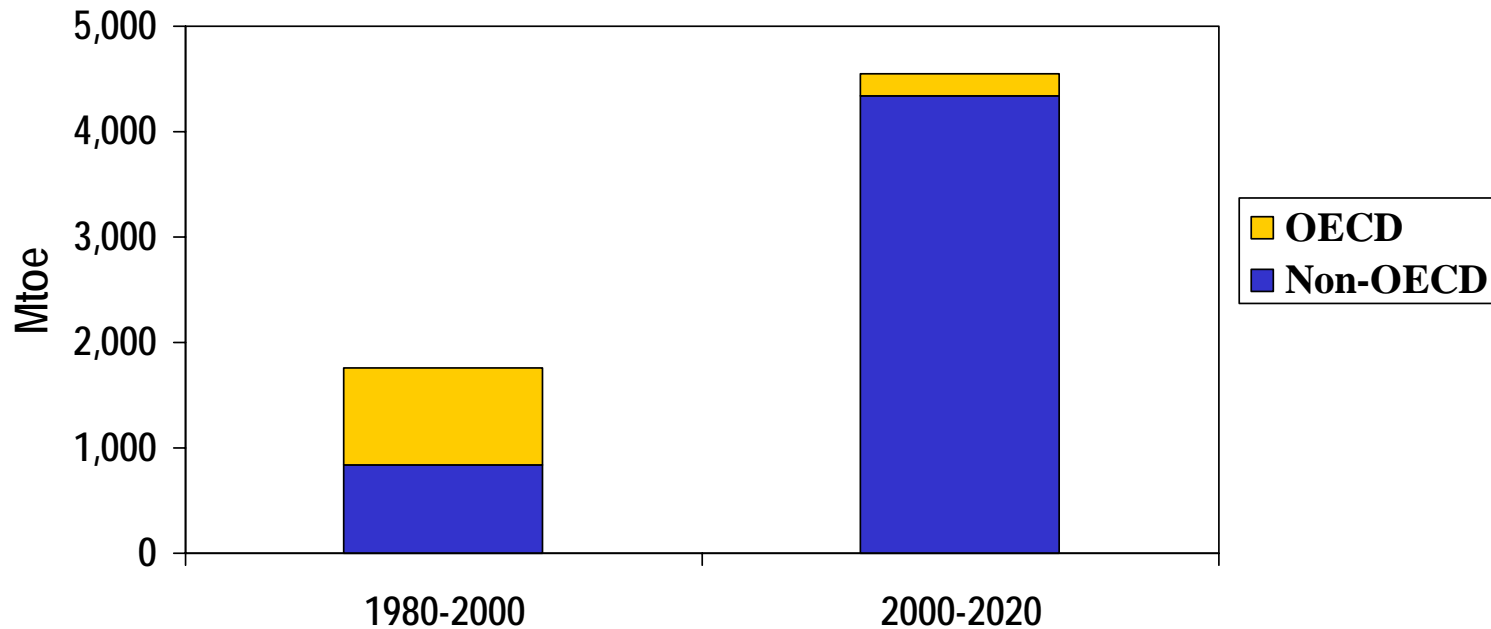
V. Renewables

VI. Nuclear Fuels

VII. Beyond 2020



Increase in Total World Energy Production



Between now and 2020, nearly all increase in world energy production will come from outside the OECD

Global Oil Supply Outlook

Main Findings (1)

- **Conventional reserves adequate to meet demand to 2020 and beyond**
- **More oil will be extracted from existing reservoirs, and more oil will be found**
- **Price stability and security of supply will depend on timely and massive investment**



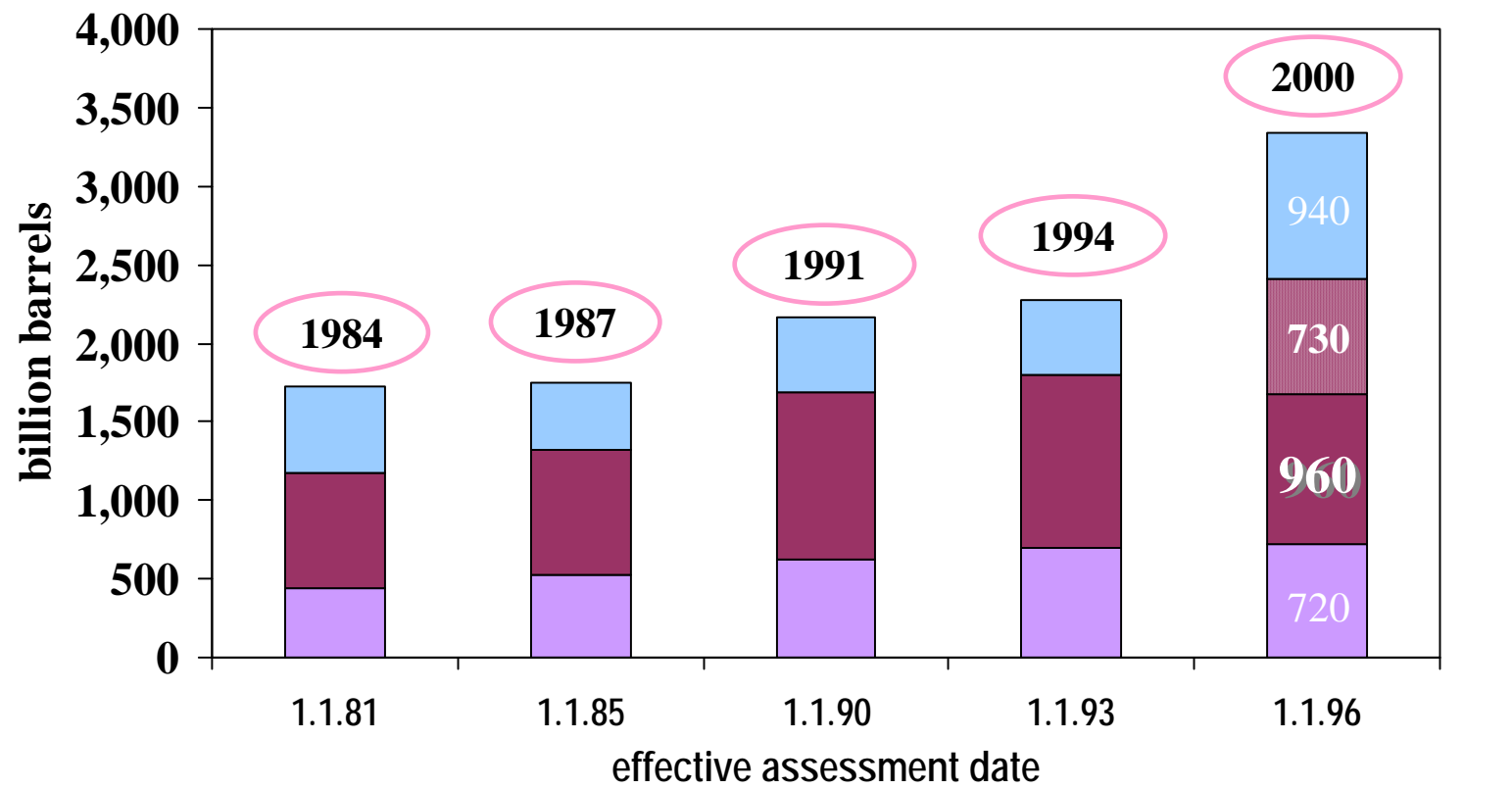
Global Oil Supply Outlook

Main Findings (2)

- Investment and costs will depend on
 - ◆ sources of supply
 - ◆ upstream technology
 - ◆ government policies and industry developments
- Much of the long-term supply growth will come from the Middle East and the FSU
- Unconventional oil could play an increasingly important role



USGS Resource Estimates



- Cumulative production
- Remaining reserves
- Reserves growth
- Undiscovered recoverable resources
- Year of Publication

Remaining reserves assessments in billion barrels:

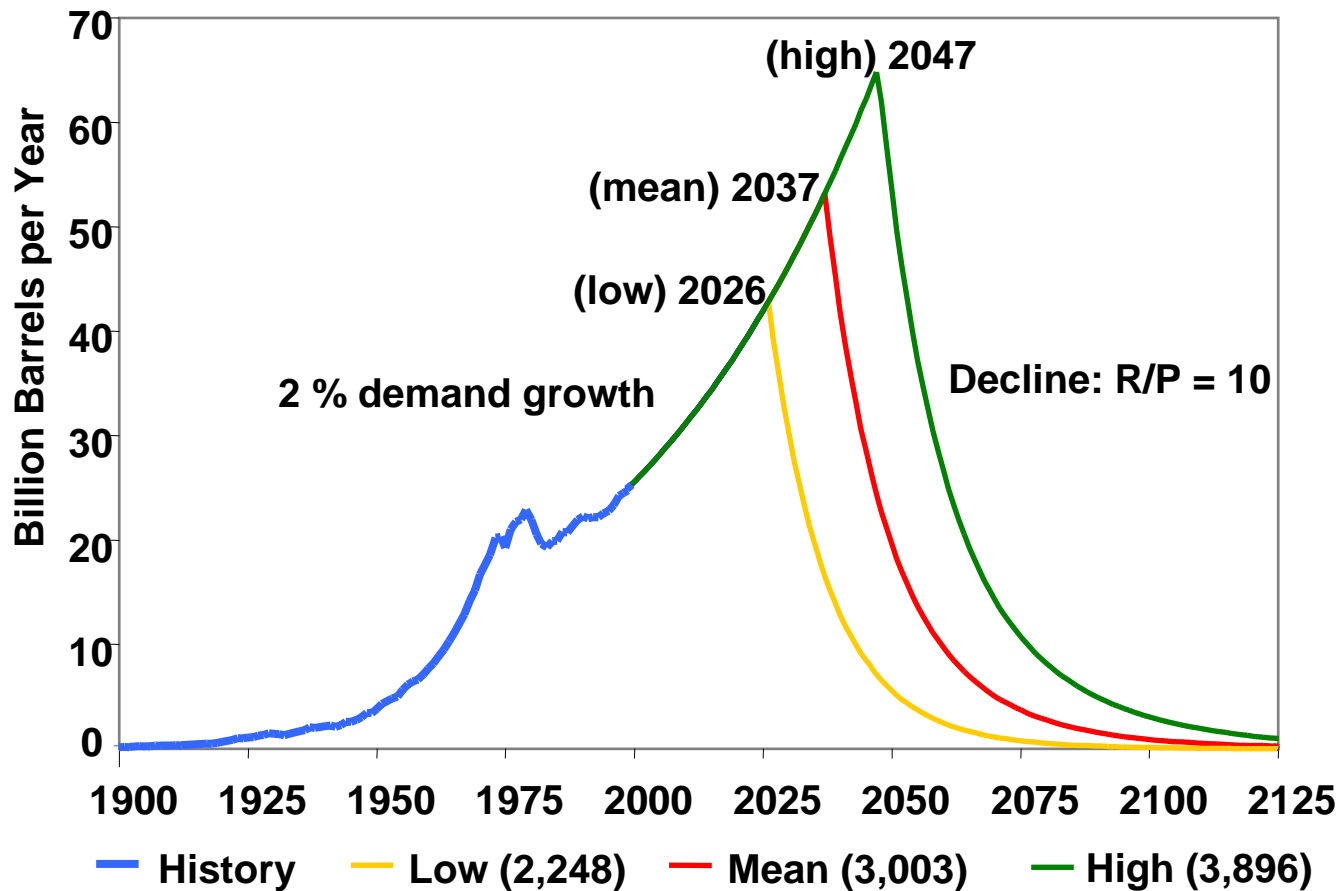
1,100 IHS Energy; 1,078 OPEC; 1,051 WEC



World Energy Outlook 2001

Insights

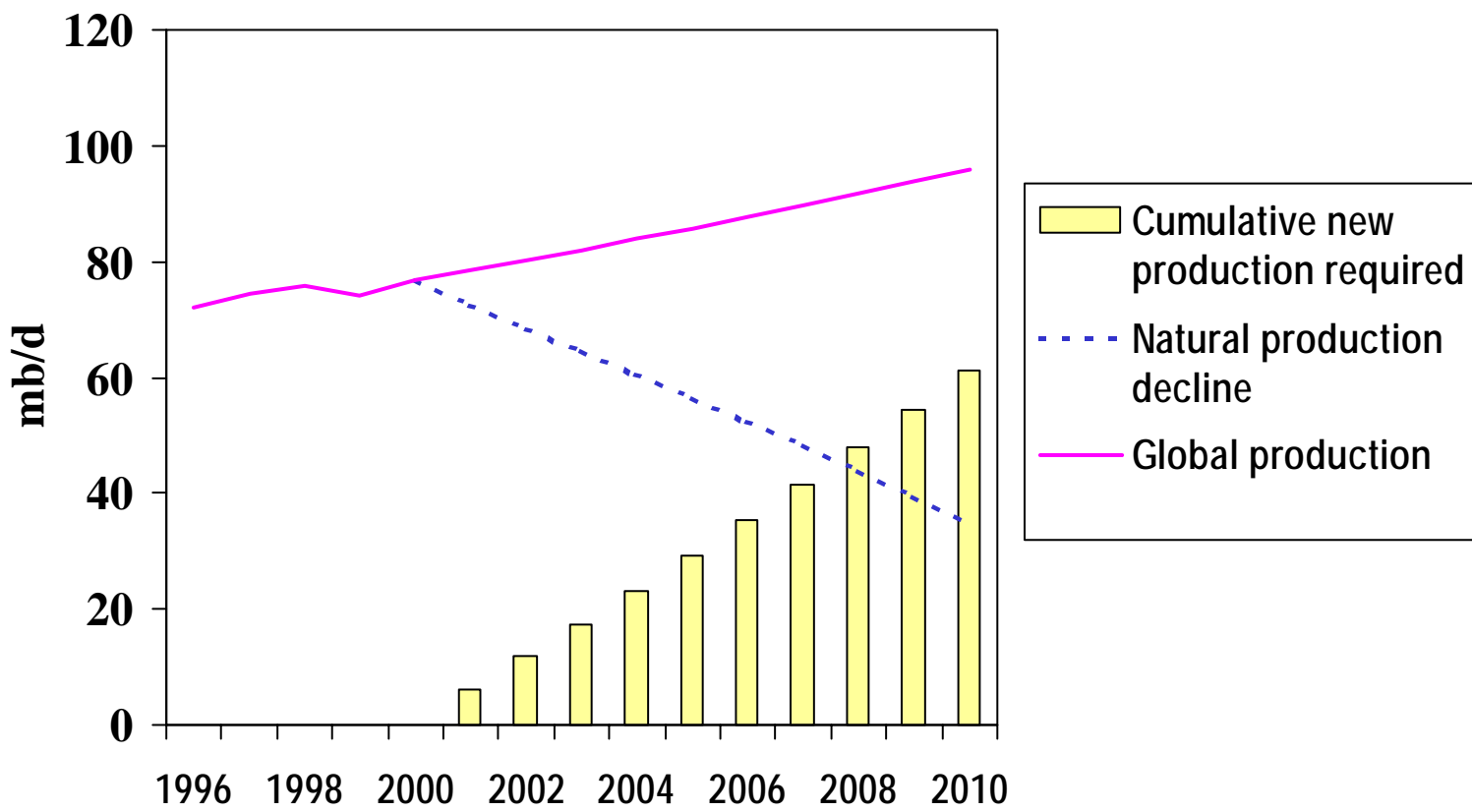
Longer Term Scenarios for Different Resource Estimates



Year of peak production varies with resource estimate and decline rate assumption



Impact of Decline Rate on Investment

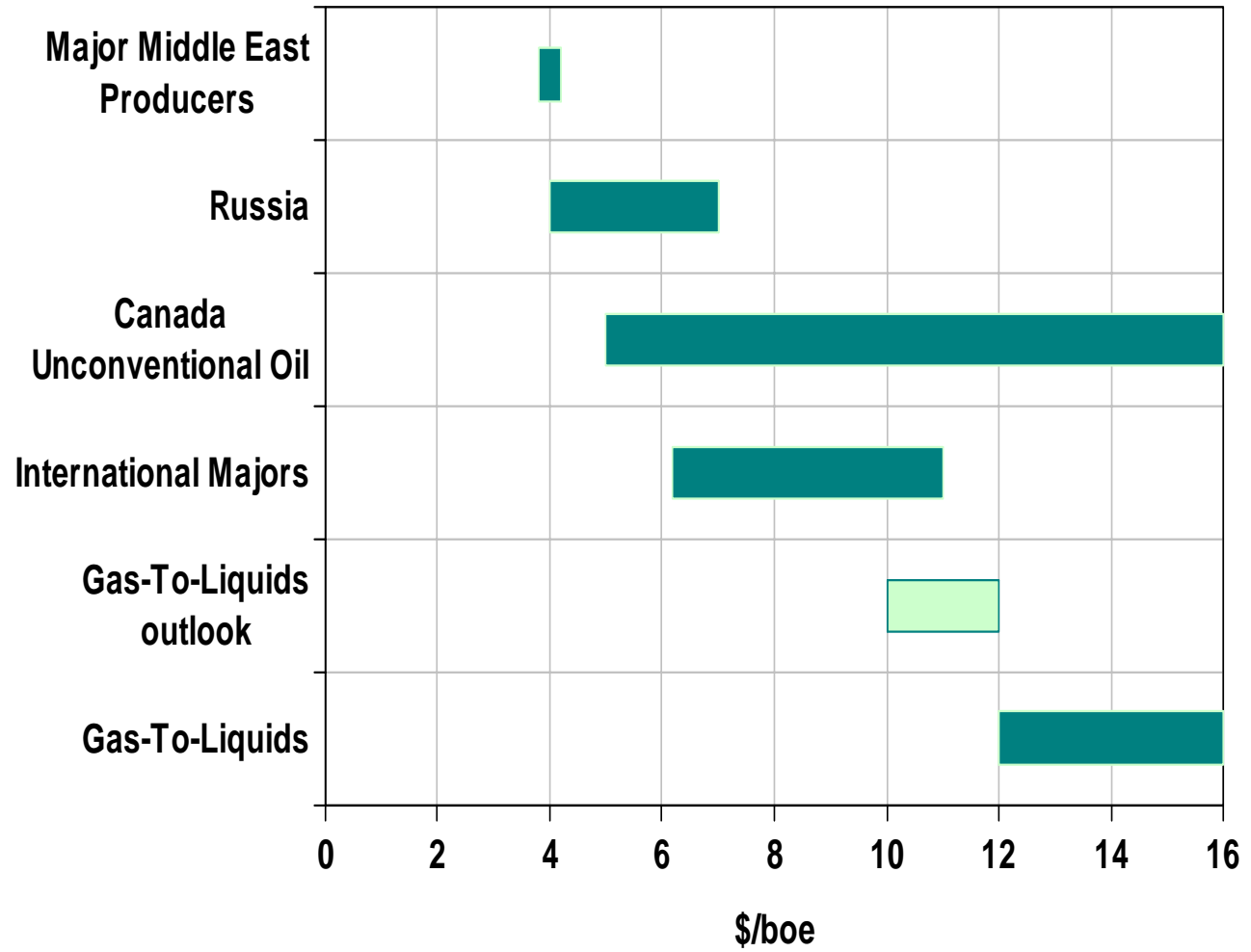


Decline rate assumption 5%; demand growth 2%

⇒ around 60 mb/d of additional production capacity



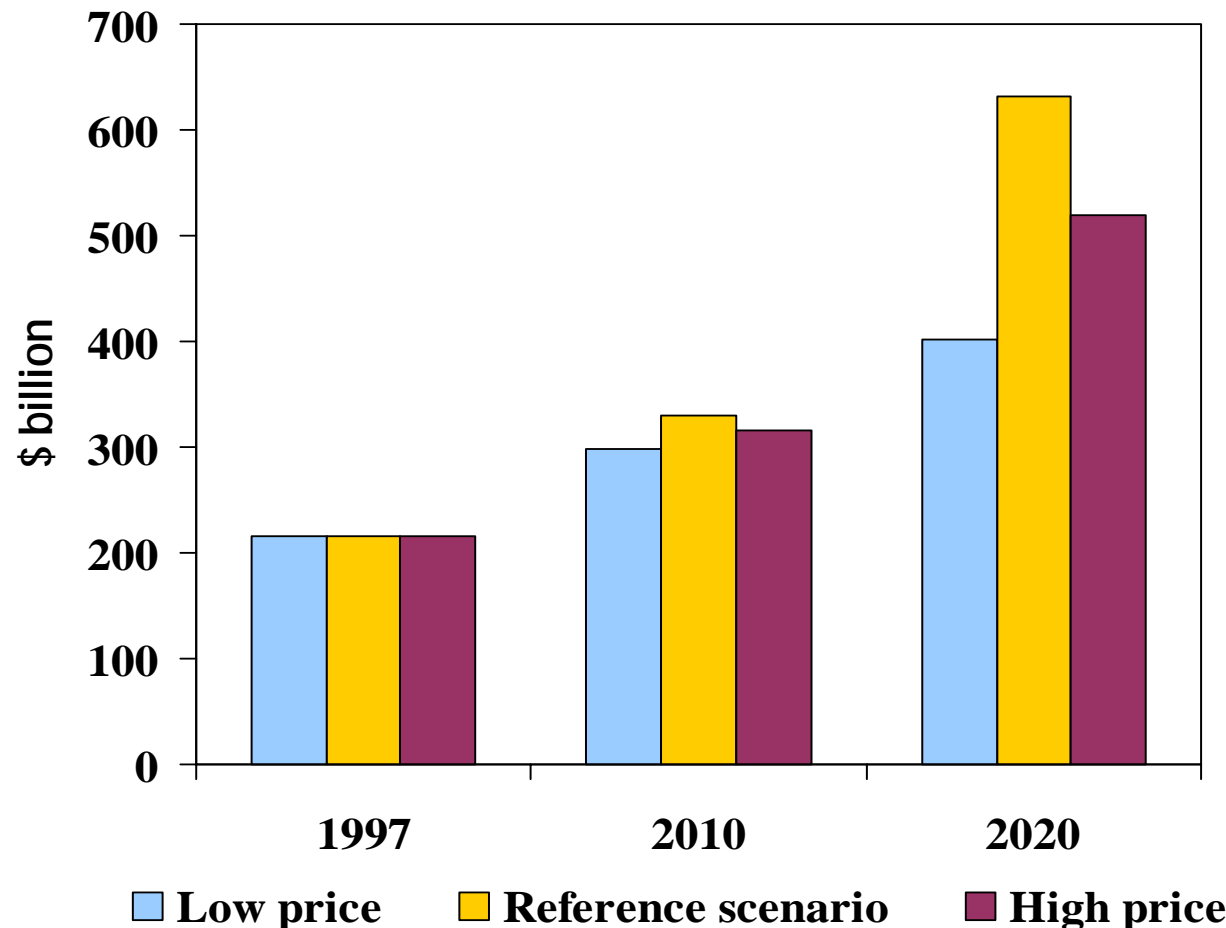
Oil Total Supply Costs



Major Middle East oil producers have a supply cost advantage



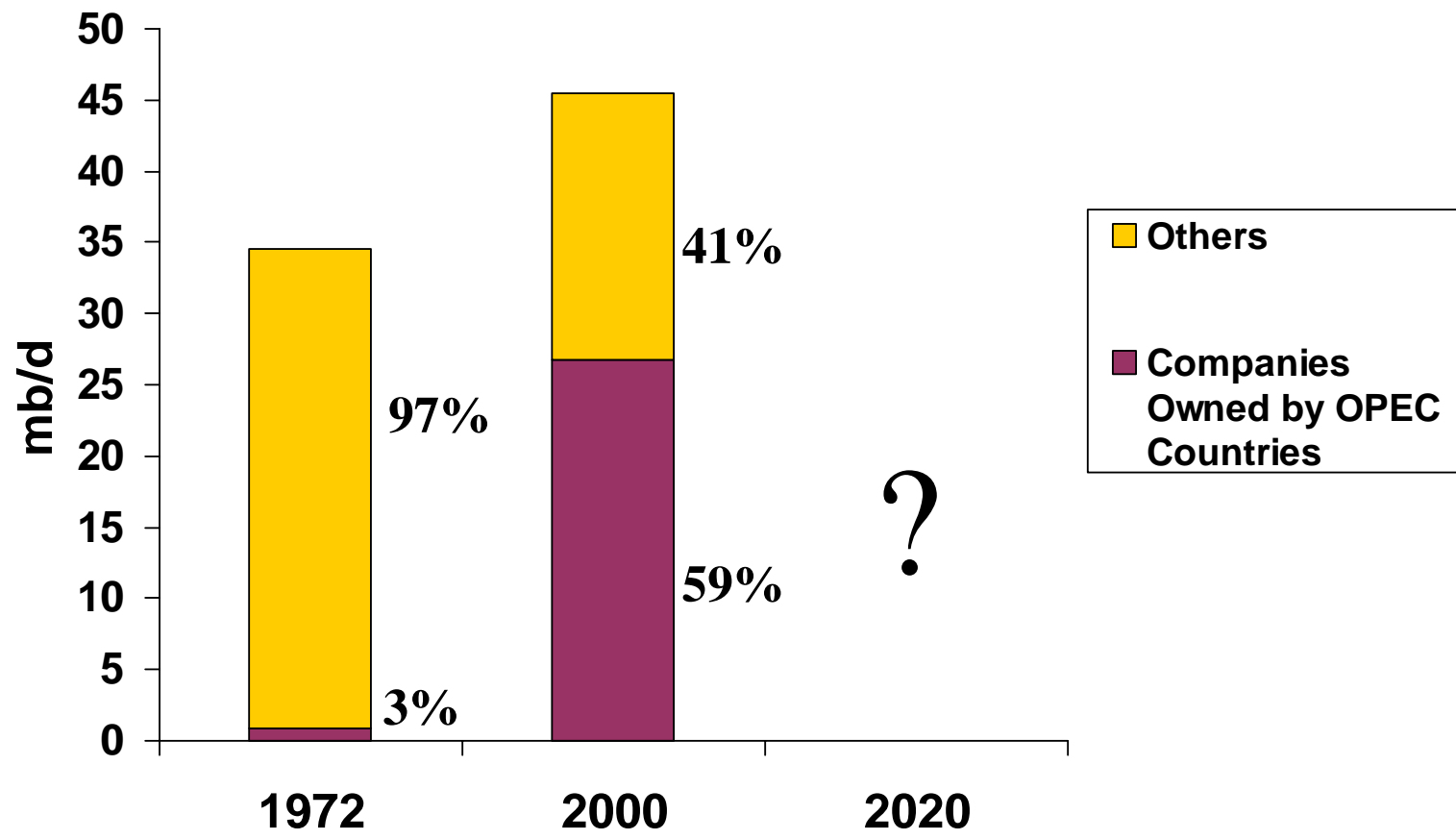
OPEC Annual Oil Revenues



High prices reduce demand, increase non-OPEC and unconventional oil production and lower OPEC annual revenues



The 20 Largest Oil Producing Companies



The majority of the Top 20 oil production is now operated by companies owned by OPEC countries.



Growing Oil Import Dependence in Asia

(%)	1975	1999	2010
OECD Pacific	92	90	92
China	0	28	61
India	58	62	85

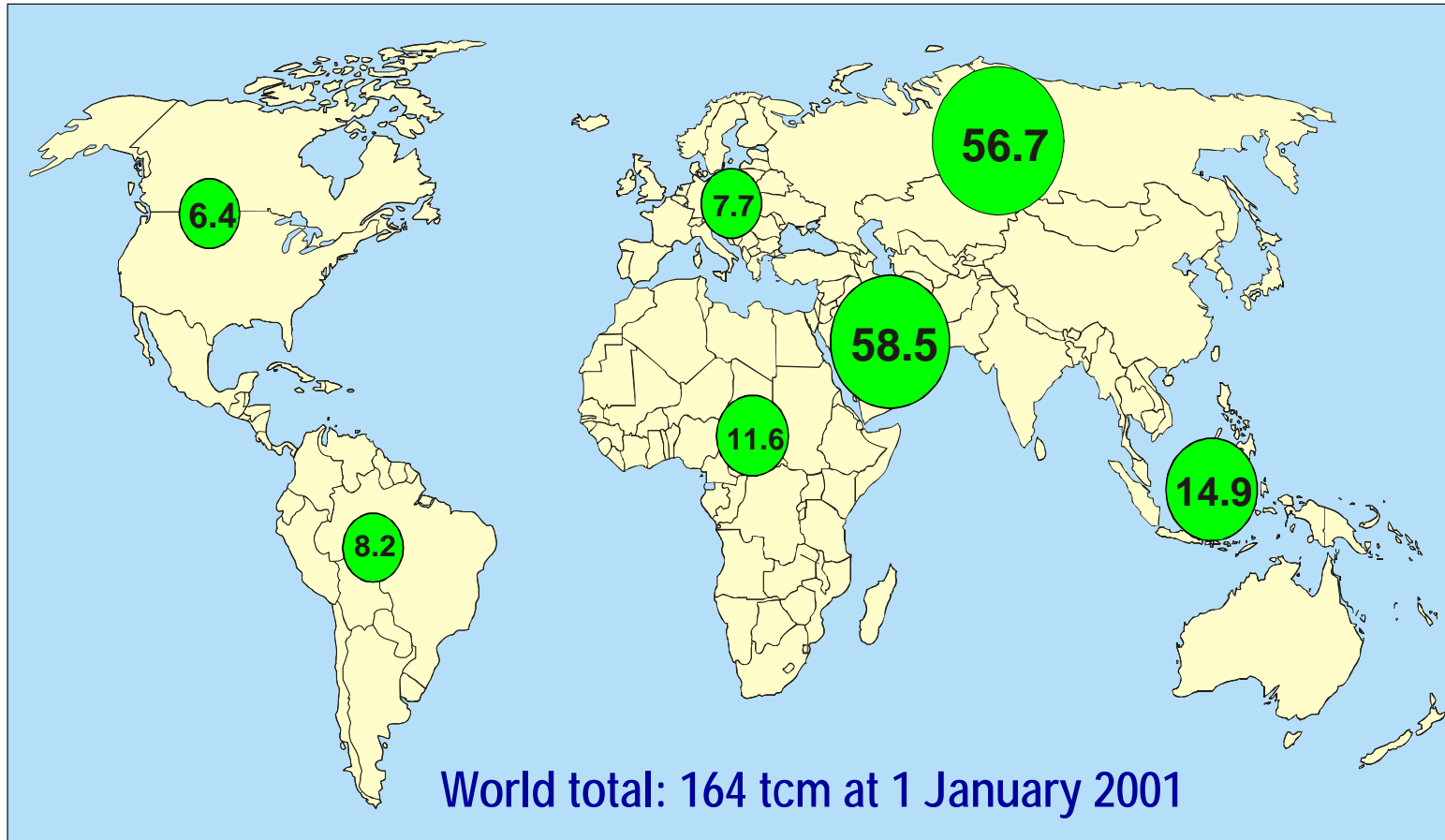
In all key Asian regions, reliance on imported oil, in particular from the Middle East, will increase significantly.

Global Gas Supply Outlook

- Gas markets poised for rapid growth
- Resources are abundant..
- ..but getting the gas to market could involve rising costs
- Costs will depend on
 - ◆ distance to market
 - ◆ upstream and transport technology
 - ◆ government policies
- New supply chains will promote market integration

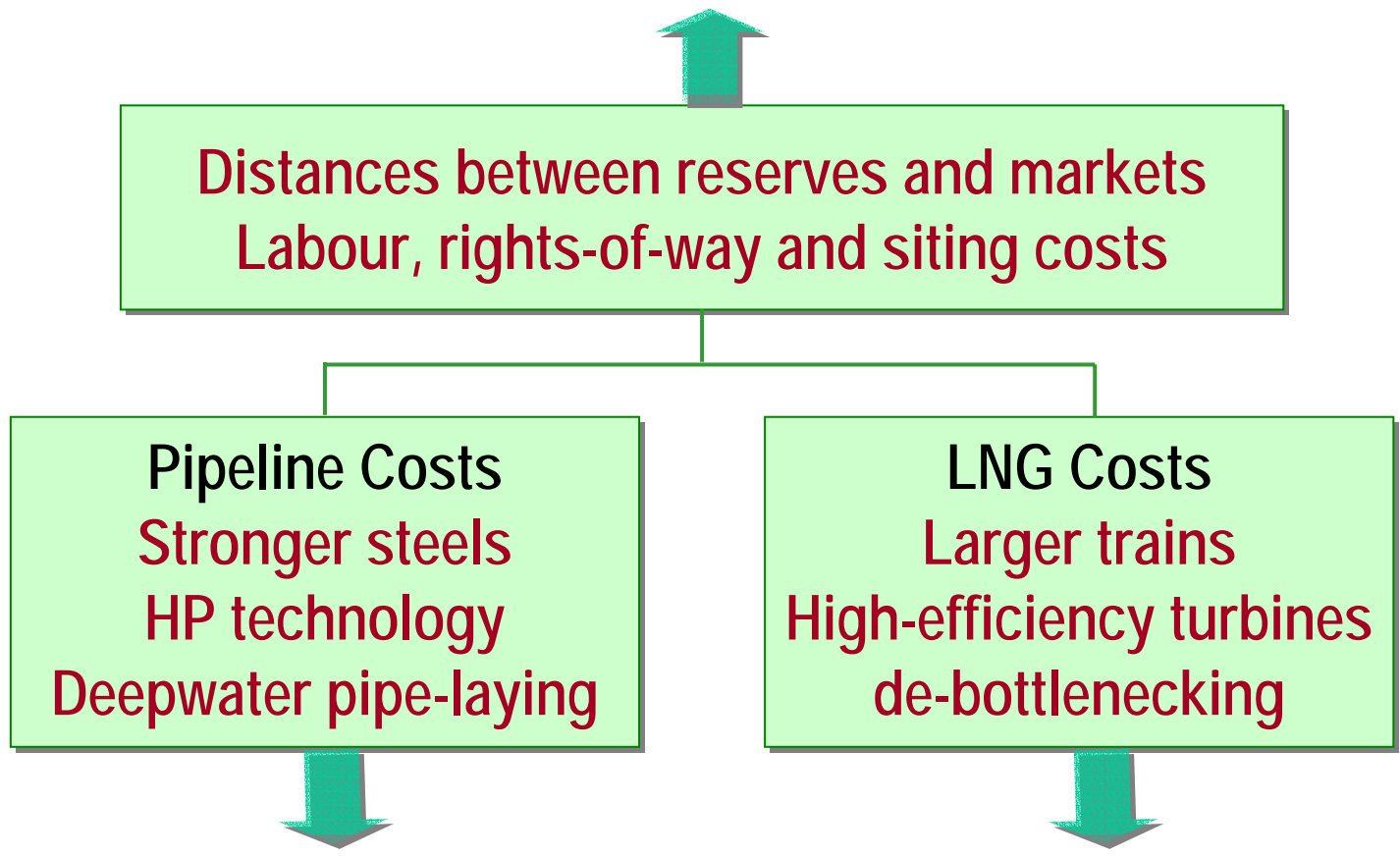


Proven Gas Reserves



Ultimate remaining resources (including proven reserves) are an estimated 453 - 527 tcm

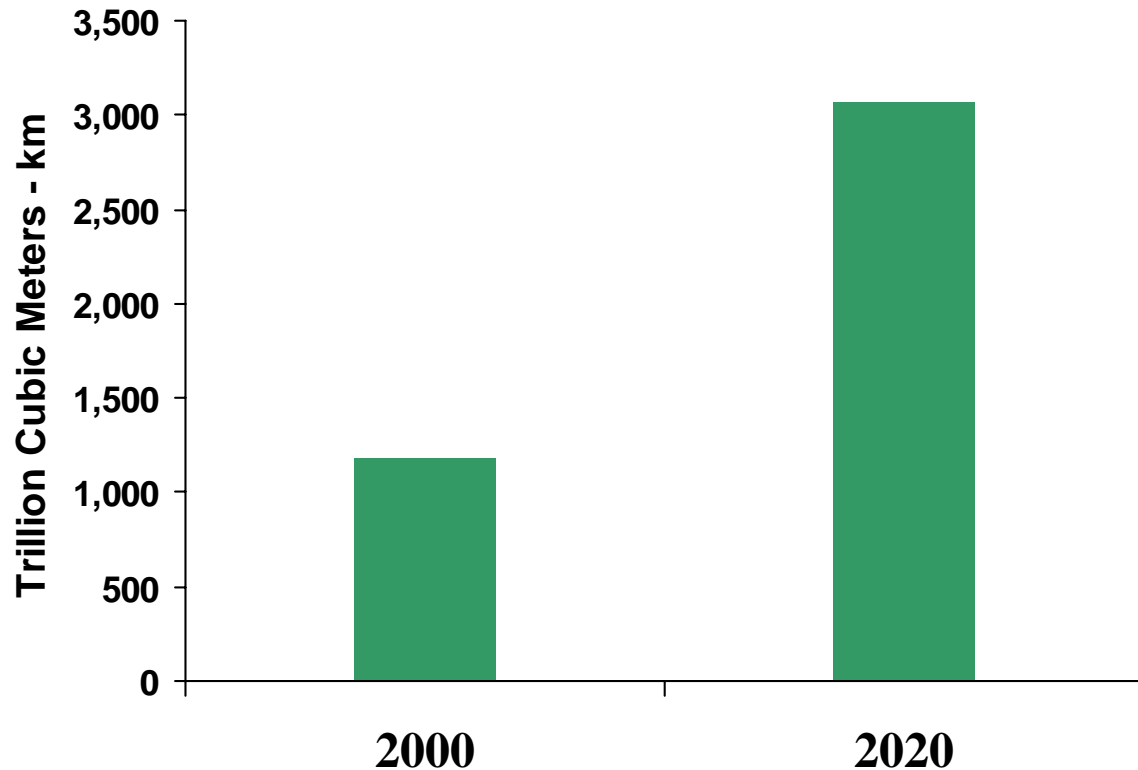
Gas Transport Costs



Transport costs likely to rise in many cases as supply chains lengthen



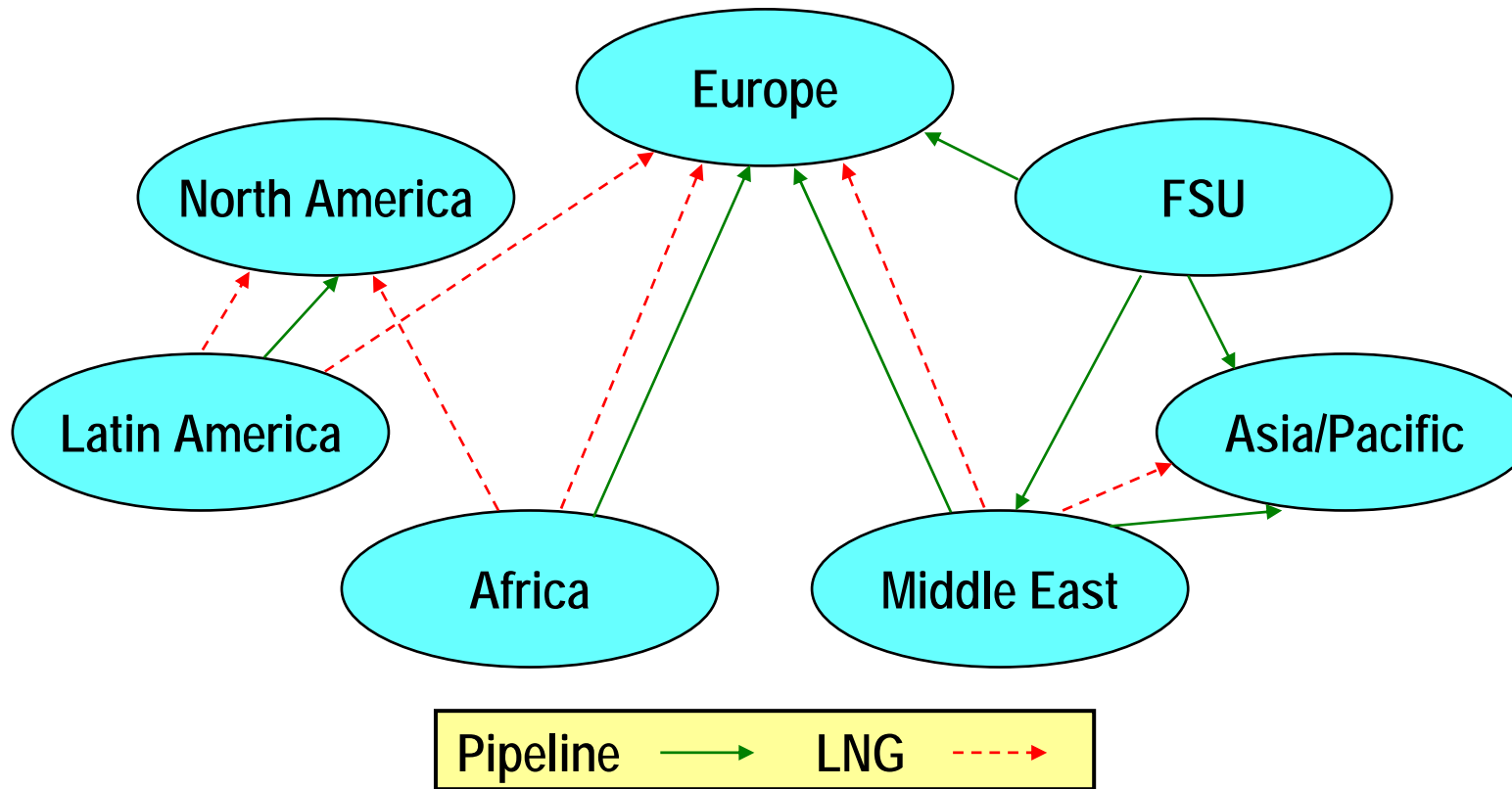
Europe: Increase in Natural Gas Transportation



Gas transportation distance will increase and security will become more important.

A Global Gas Market?

Potential New Gas Supply Chains



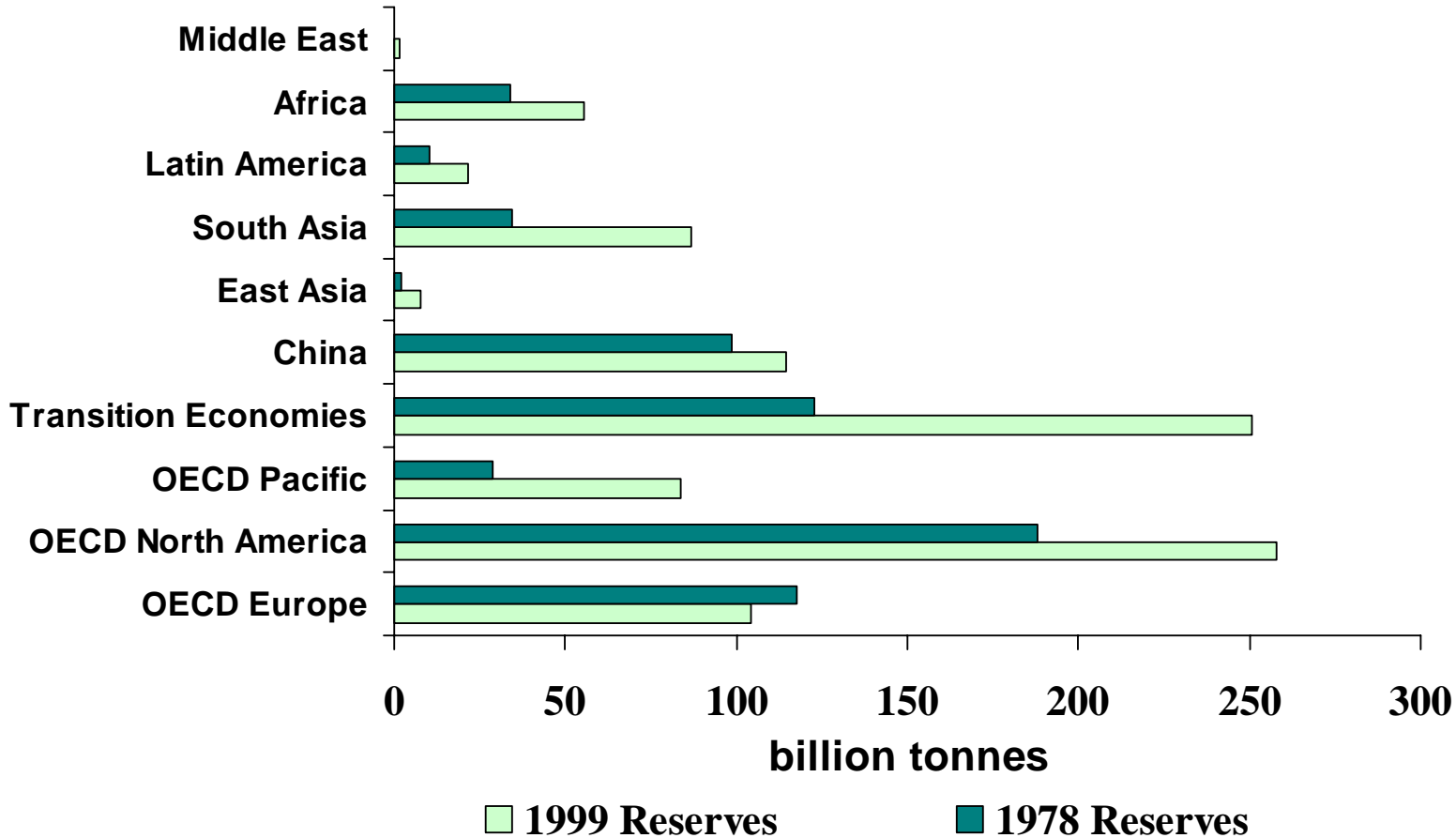
Expanding pipeline networks and new LNG projects will promote regional & global gas market integration

Global Coal Supply Outlook

- Coal remains the largest energy source for power generation
- Vast and widely dispersed coal reserves contribute to energy price stability and energy security
- Productivity improvements and competition keep coal supply costs stable
- Environmental concerns pose the greatest challenge to future coal supply
- Sustained investment in CCT are crucial to future of coal



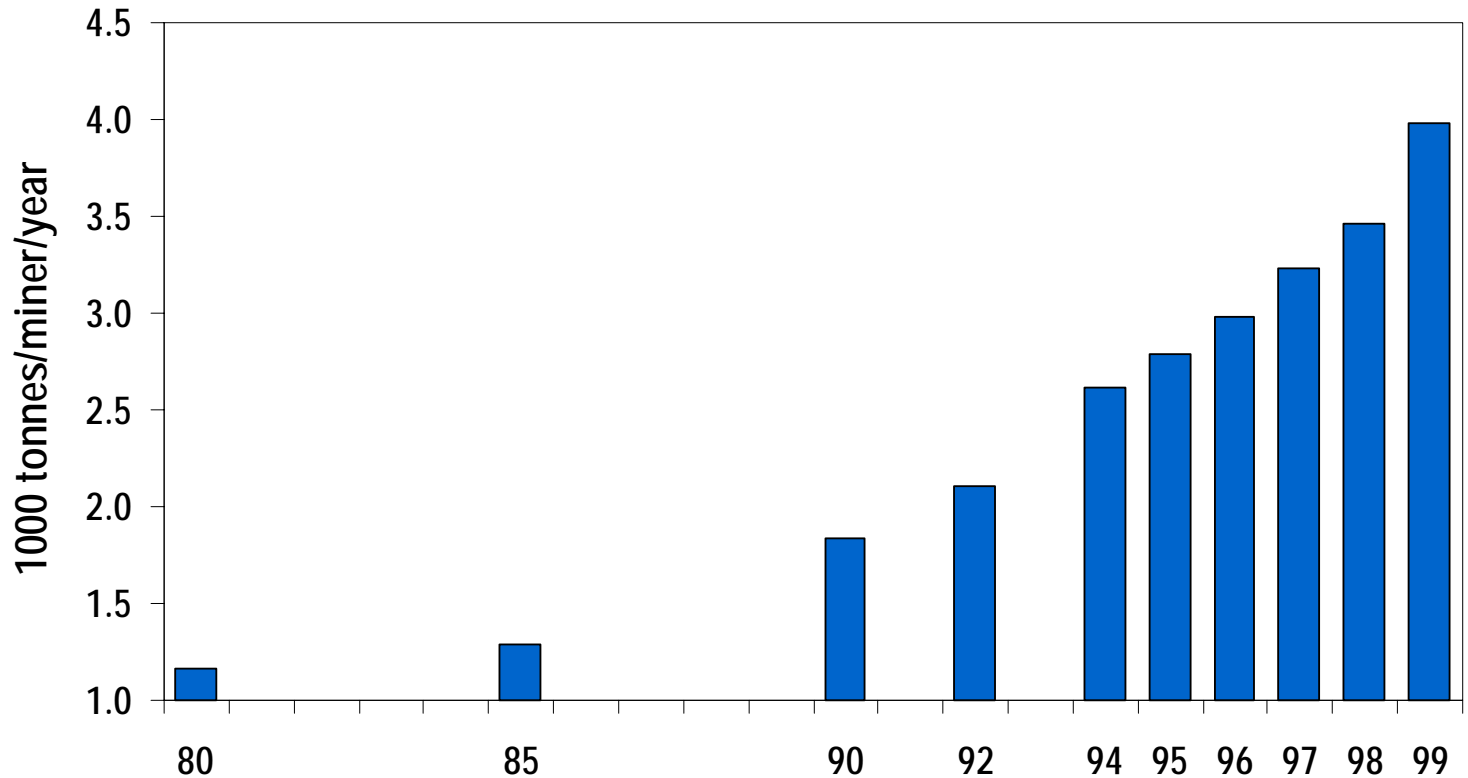
Proven Coal Reserves



Strong proved coal reserve growth closely correlates with strong coal production growth, which has occurred in regions with competitive commercial coal industries

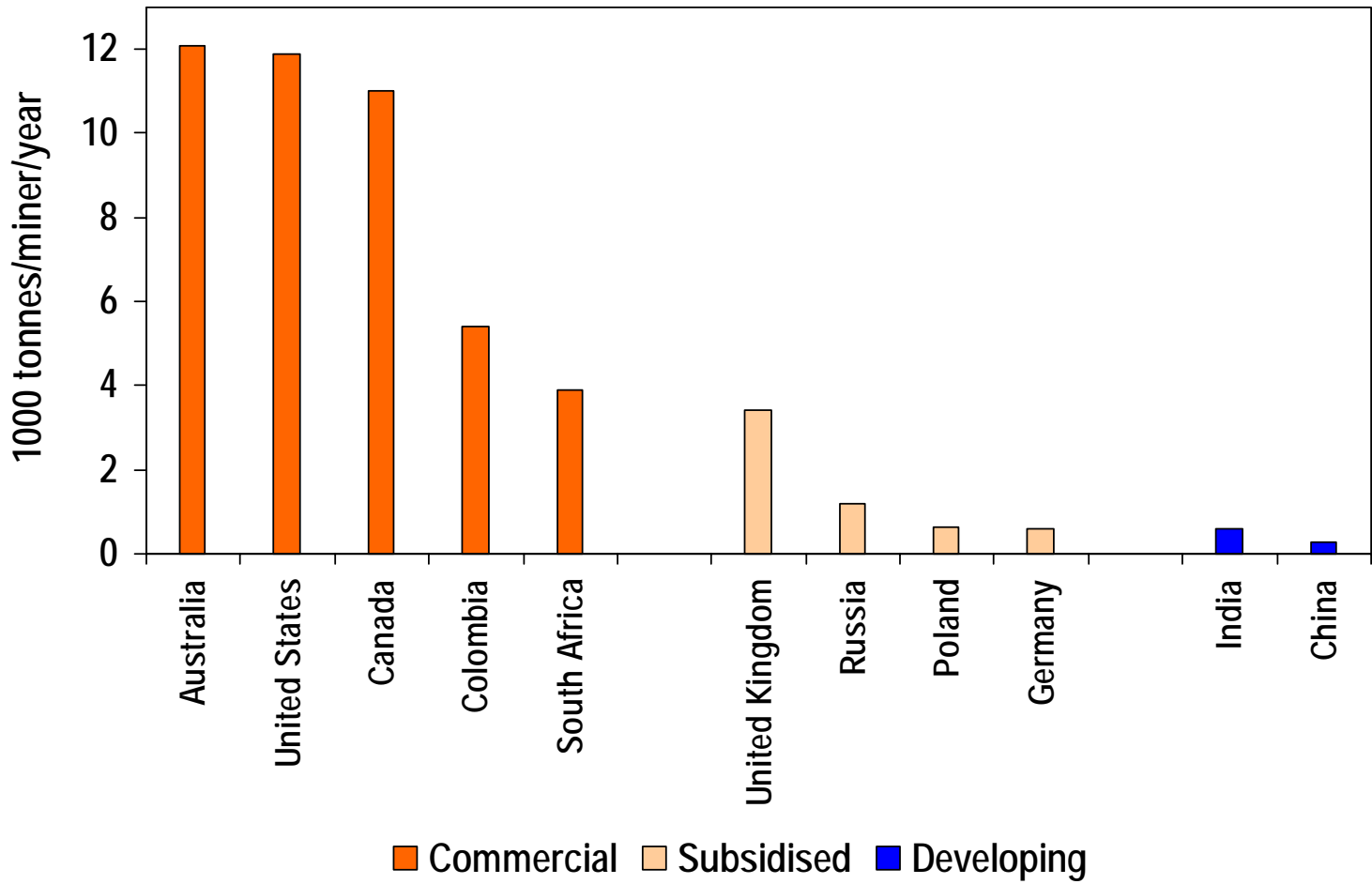


Global Coal Productivity



Advanced technology and economies of scale have reduced supply costs through improved mining productivity

Coal Productivity



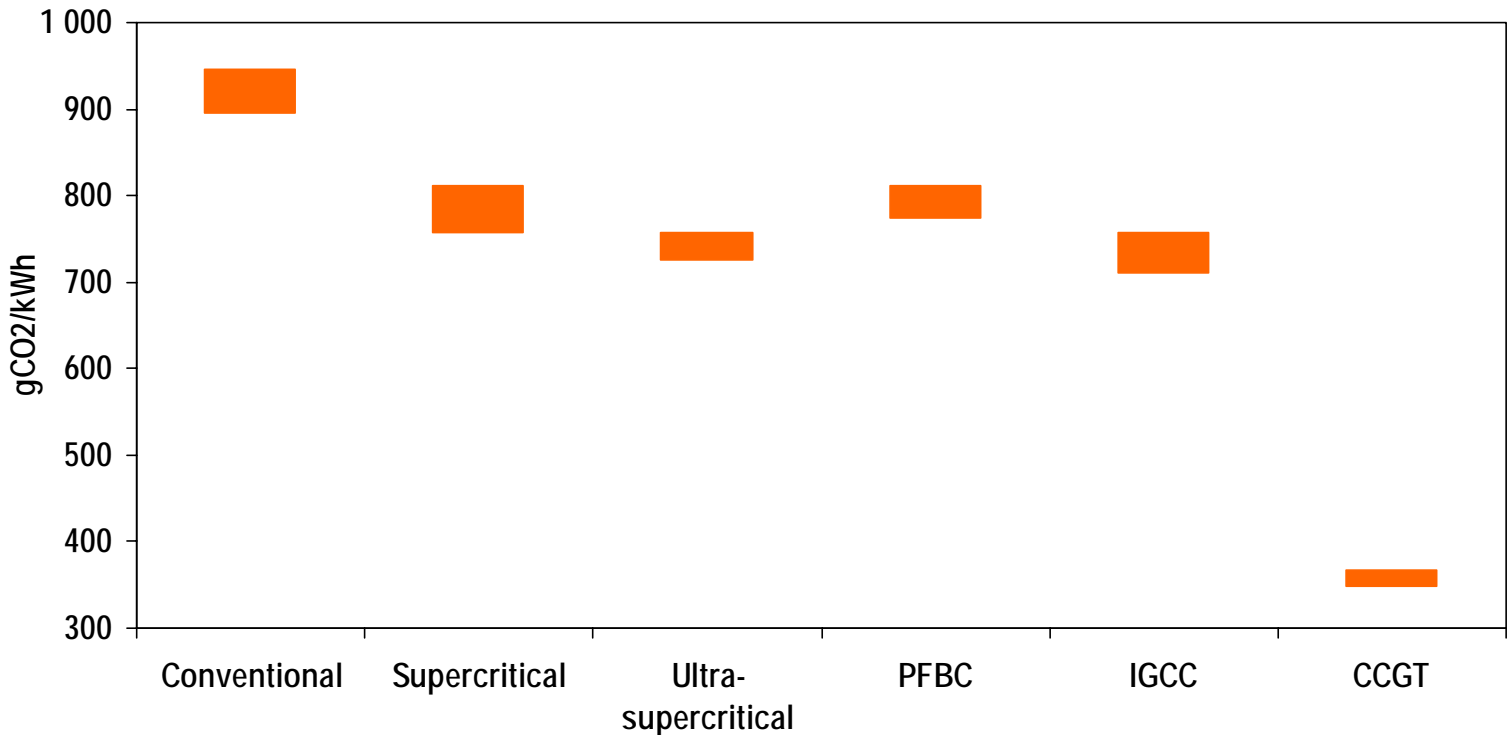
Advanced mining technology and management in key coal producing countries will ensure future productivity growth



Coal Prices

- **Less dependent on long-term contracts**
- **Rapid evolution of steam-coal spot market**
- **More flexible pricing mechanisms**
- **Sustained price increases unlikely →**
 - ◆ **diverse availability of competitively-priced coal**
 - ◆ **relative ease of market entry/exit for producers**

Impact of Environmental Policies



Future investments in coal supply hinge upon improvement of environmental performance

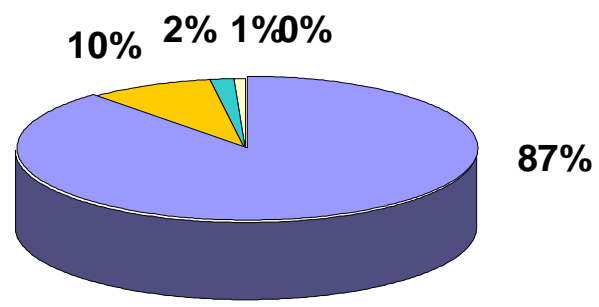
Global Renewable Energy Supply Outlook

- Resources are plentiful but present economic potential is limited
- Environmental protection and security of supply are the largest benefits
- Substantial cost reductions will be required
- Economics could improve if benefits are reflected in costs
- Government support will be necessary



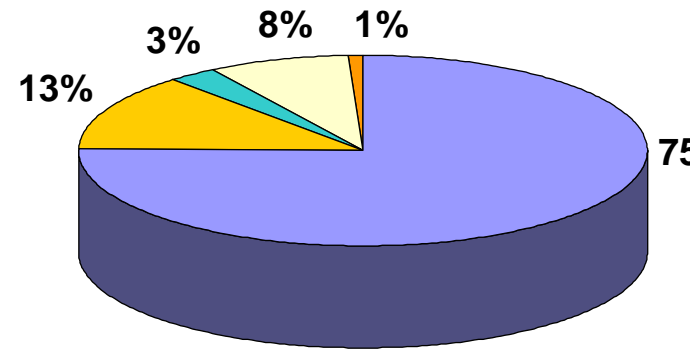
OECD Renewable Electricity Generation

1999



1 471 TWh

2020



1 921 TWh

■ Hydro ■ Bioenergy ■ Geothermal ■ Wind ■ Solar, Other

Most renewable energy is hydro, but the shares of wind, bioenergy and solar will increase

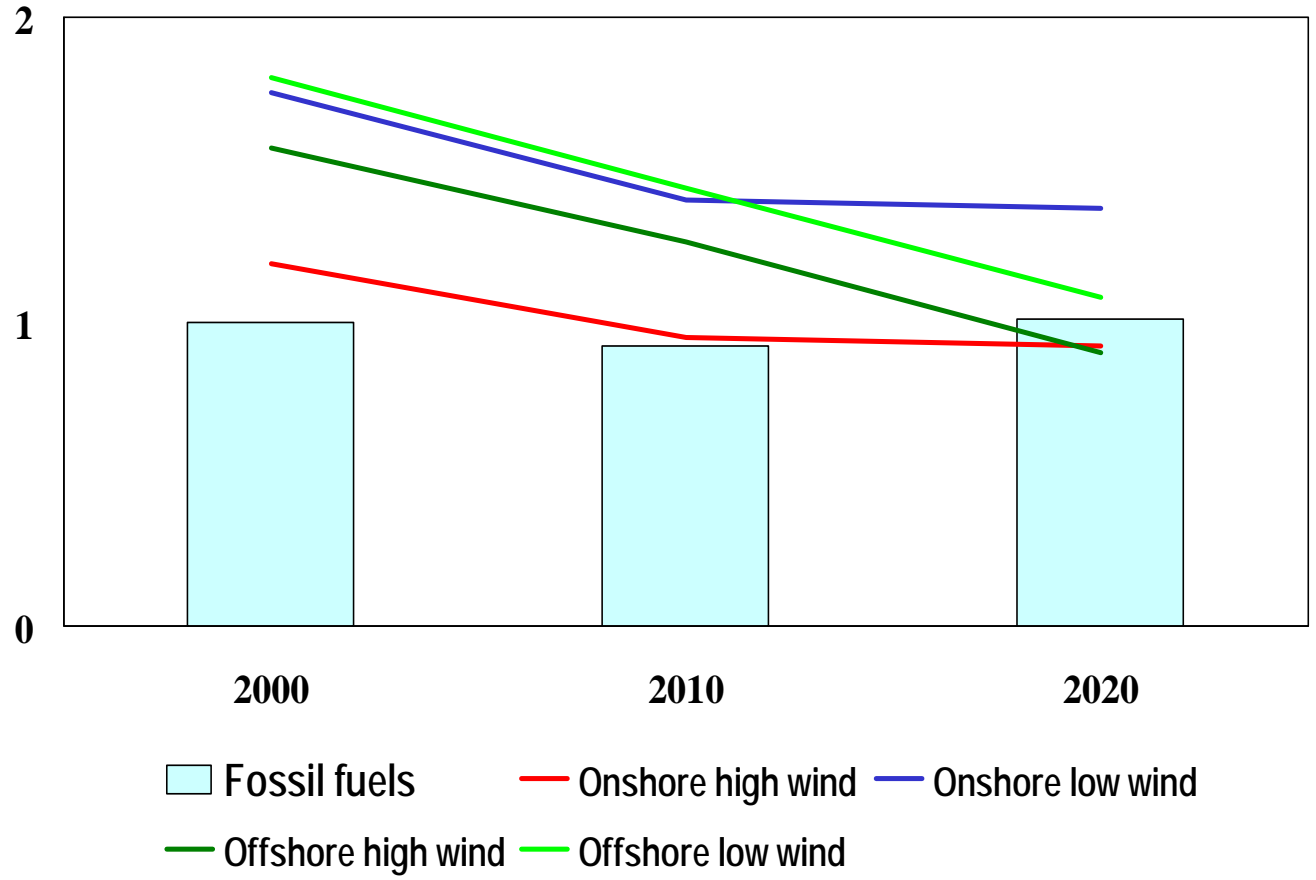


Renewable Electricity Cost Assessment

	<i>Current Cost</i>	<i>Cost Reductions by 2020</i>
Bioenergy	High	10%-15%
Wind onshore	Relatively low	15%-25%
Wind offshore	High	20%- 30%
Solar PV	Very high	30%-50%
Solar Thermal	Very high	30%+
Geothermal	High	10%
Hydro	Relatively low (higher for mini-hydro)	10%

The cost of renewables will continue to fall but the rate and timing are uncertain

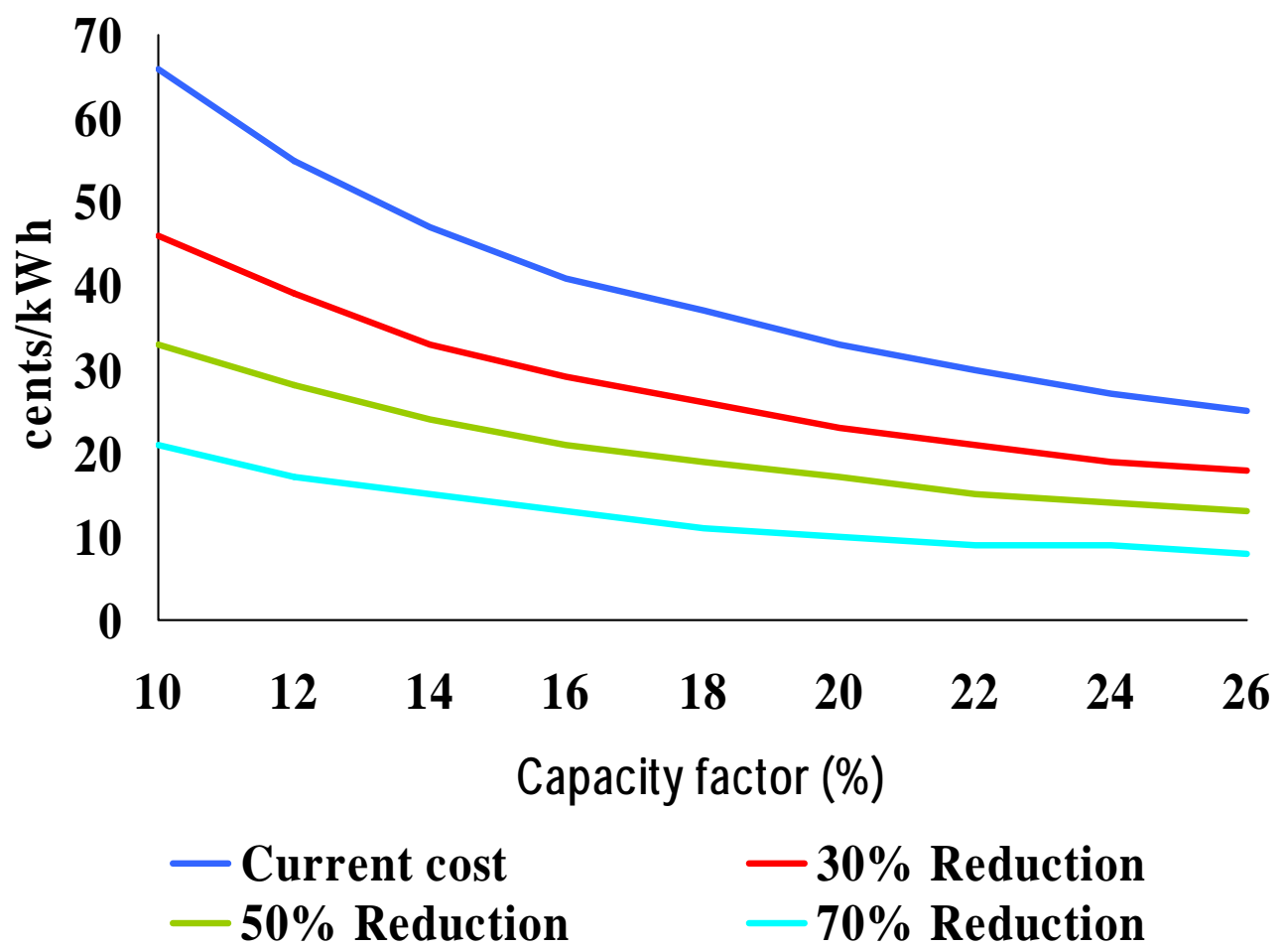
Generating Costs OECD Europe



Wind may compete with fossil fuels within the next decade but intermittence and site availability could limit development



PV Generating Costs



PV is capital intensive and large cost reductions are necessary for it to become competitive



Uranium Supply Outlook

- Abundant reserves
- No security of supply concern
- Key factors affecting supply
 - ◆ Demand for nuclear fuel
 - ◆ Secondary supplies of uranium
 - ◆ Future production in FSU countries
- Government policies are key



Beyond 2020

- Technology advances will affect choice & cost of future energy systems
- Key long-term supply uncertainties:
 - ◆ oil - recovery rates & unconventional oil
 - ◆ gas - transport costs & hydrates
 - ◆ coal - combustion technologies (demand)
 - ◆ renewables & nuclear - costs and environmental impact/policies
- Hydrogen & carbon capture could revolutionise energy supply



WORLD ENERGY OUTLOOK 2001 - INSIGHTS

Main Conclusions



Fuelling Tomorrow's World

- Proven energy reserves can meet demand to 2020 and well beyond
- The principal uncertainty in the energy supply outlook is cost
 - ◆ technology will lower costs
 - ◆ but rising demand will have to be met by more distant reserves
 - ◆ government policies matter too
- Prices will also influence timing and amount of investment



Massive Investment will be Needed

- Acquiring capital for the expansion of energy infrastructure is a major challenge
- Non-OECD countries will need the bulk of investment
- The lowering of market barriers will stimulate investment
- Increased FDI and partnerships reduce investment risk and cost of capital

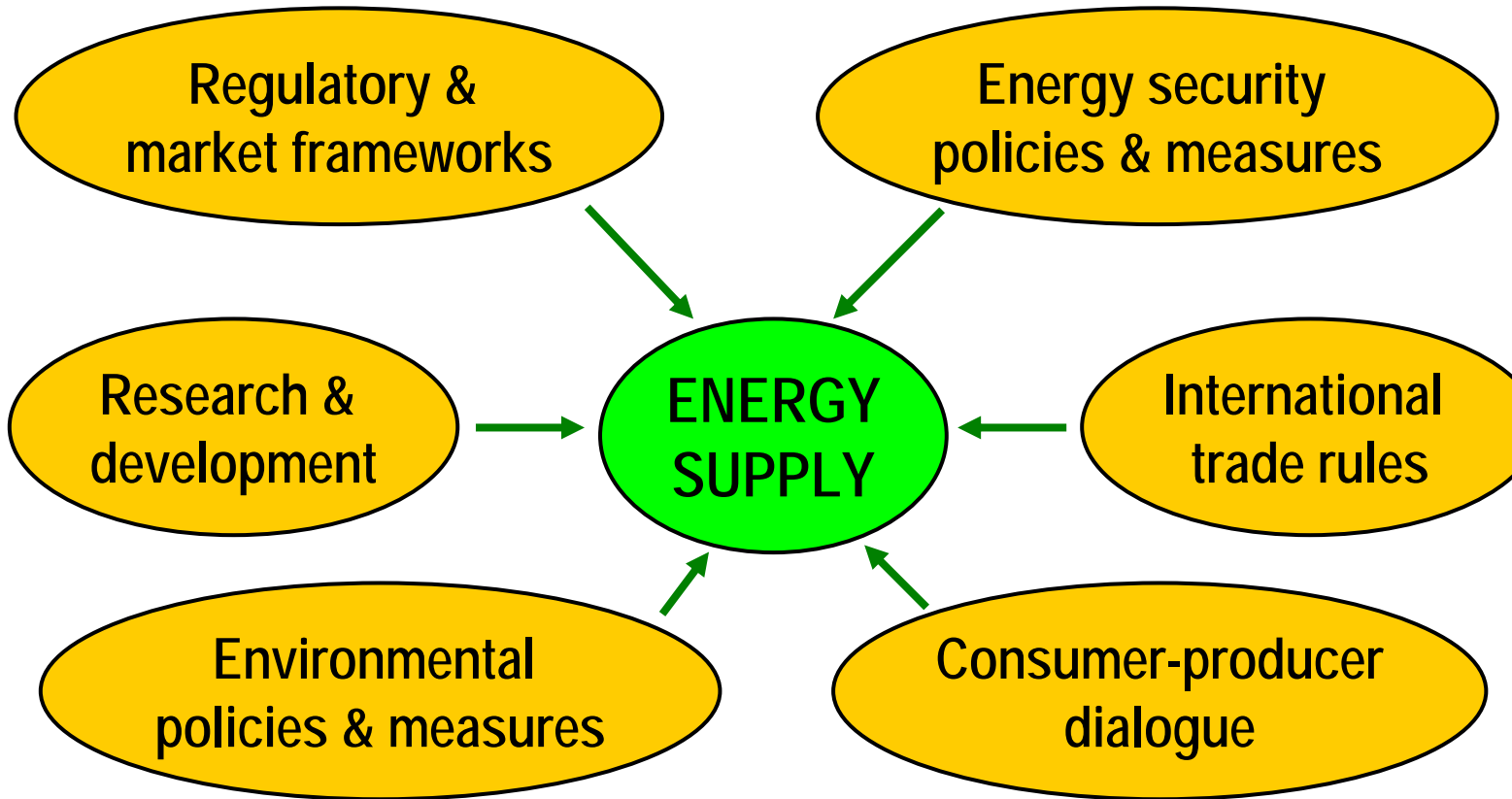


International Trade and Supply Security

- Trade in fossil fuels will grow faster than demand
- Oil - gas trade from Middle East and FSU to US, Europe and Asia will rise
 - ◆ supply chains will lengthen
 - ◆ security of international sea-lanes and pipelines will become more important
- Geopolitical implications



Role of Government



Government policies will shape the energy-supply landscape