POWER SECTOR APPROACHES TO CARBON CAPTURE AND STORAGE

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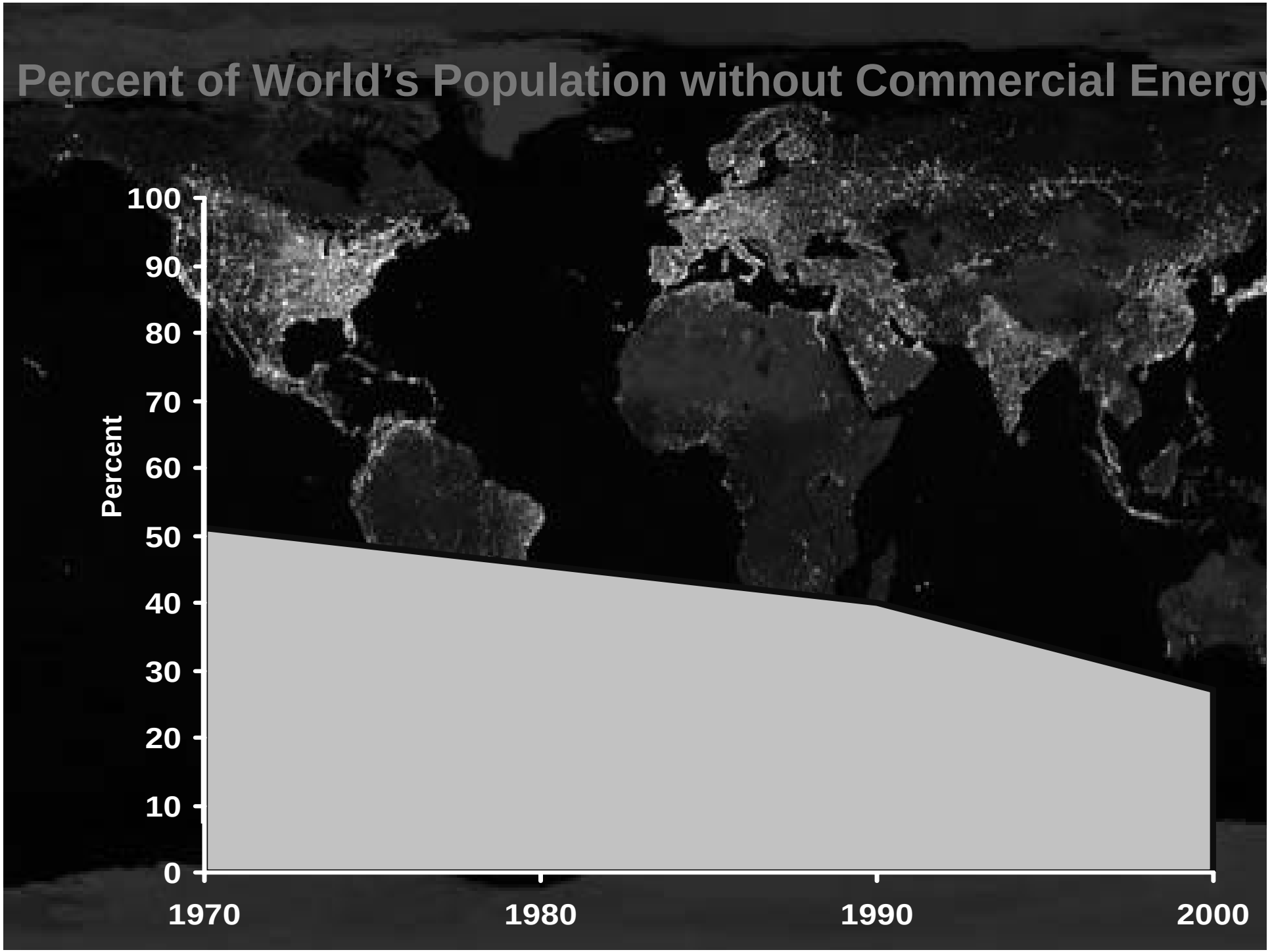
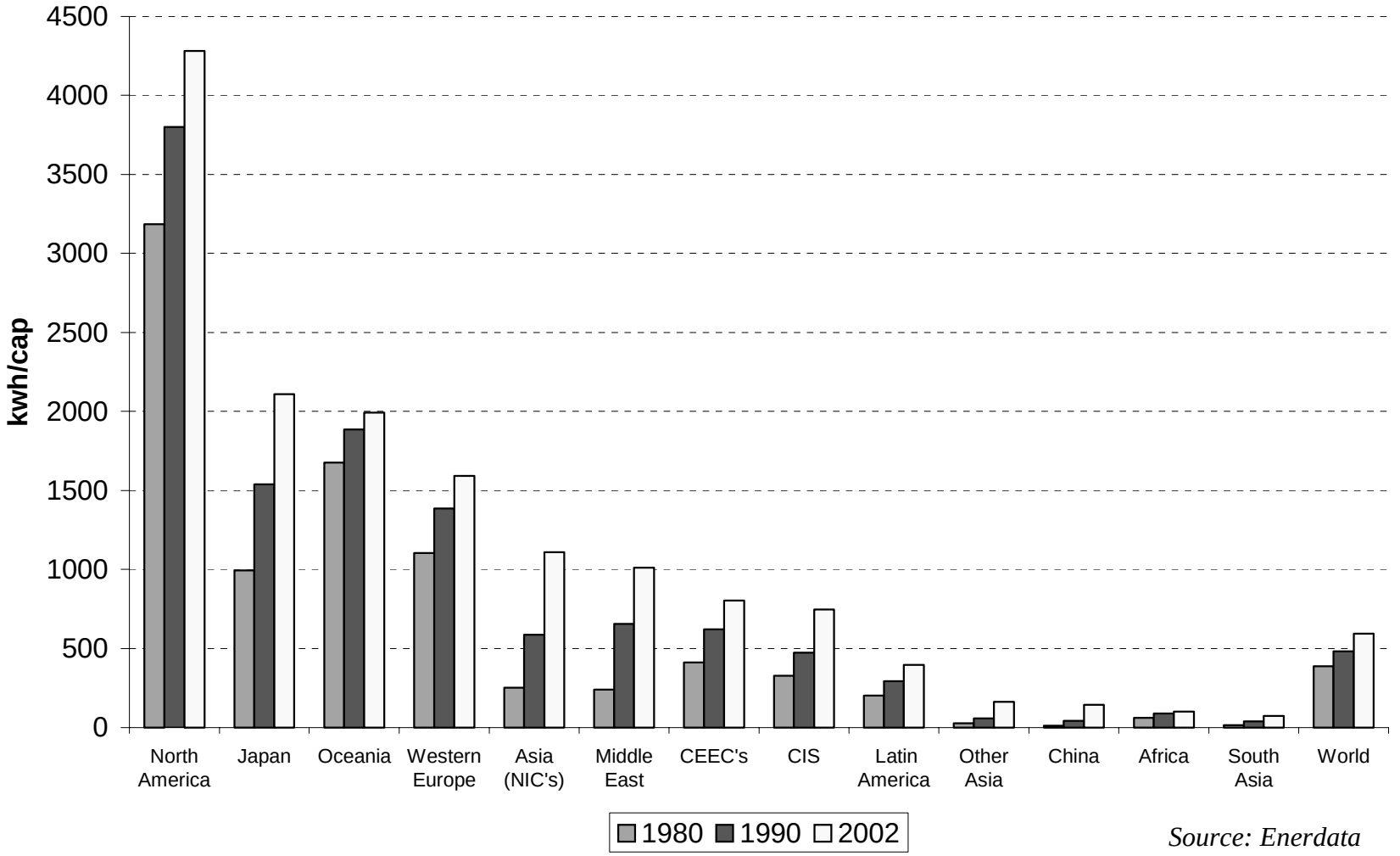
Human Welfare Requires Energy

Indicator of Human Welfare	Commercial Share of Total Energy		
	0-20 %	21-40 %	41-100 %
Life Expectancy (Years)	59.8	69.0	69.5
Probability of not surviving to 40	21.7	9.4	9.1
School Enrollment (%)	52.4	65.4	76.9
Children Underweight (%)	40.9	15.1	11.9
No Access to Clean Water (%)	20.9	22.8	12.8


Percent of World's Population without Commercial Energy
Percent
100
90
80
70
60
50
40
30
20
10
0
1970
1980
1990
2000

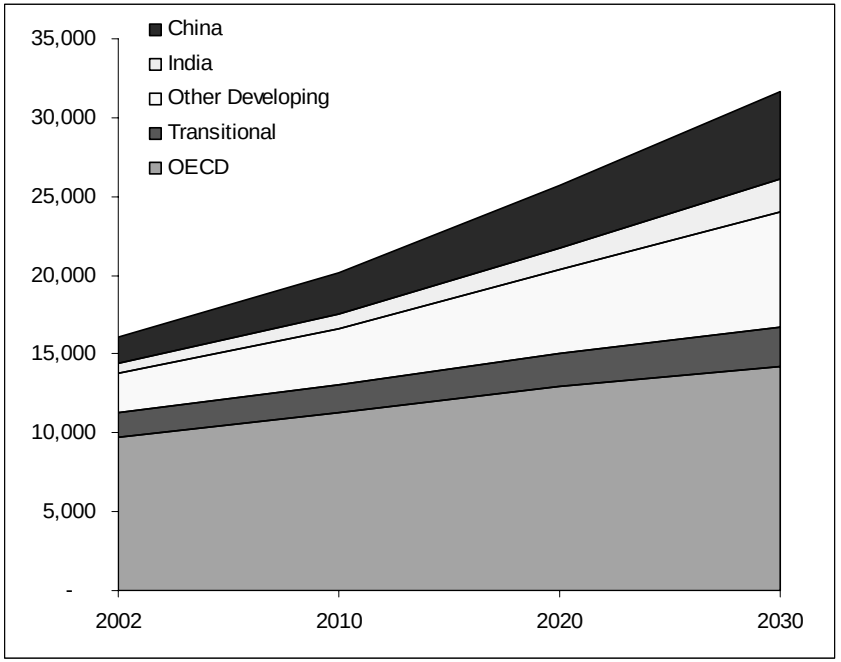
Household Electricity Consumption



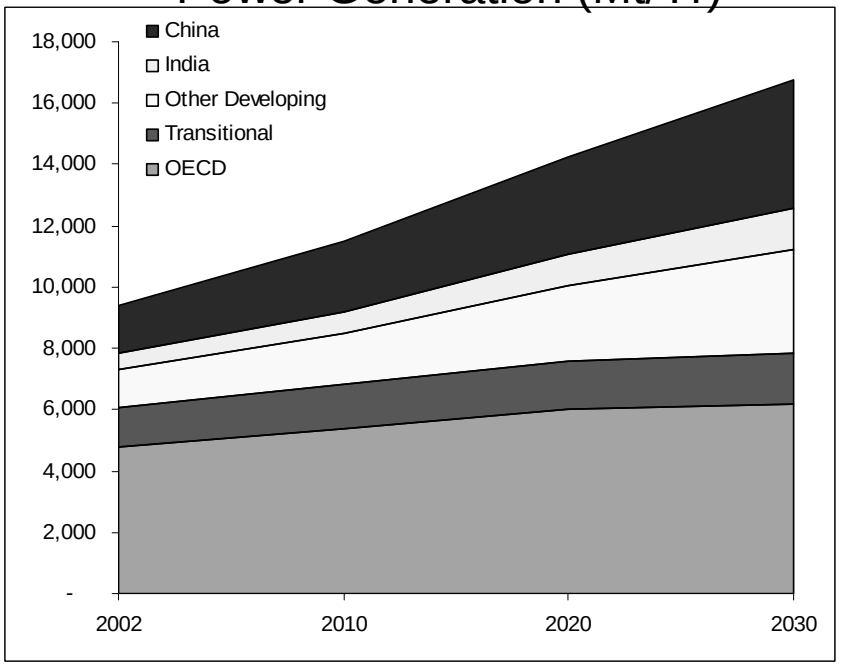
Source: Enerdata

Global power generation and its CO_2 emissions will increase.

Power Generation (TWh)

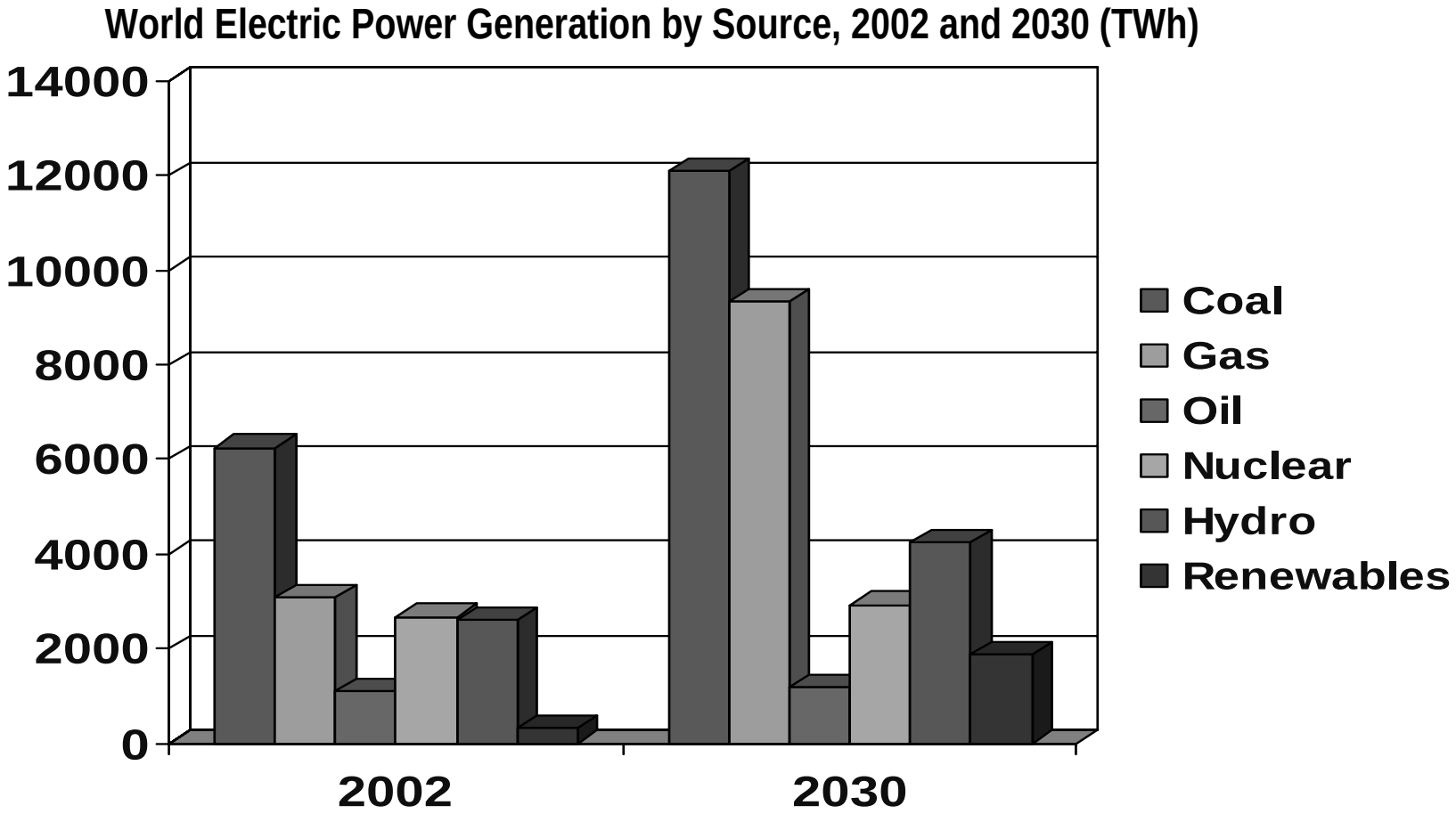


CO_2 Emissions from Power Generation (Mt/Yr)



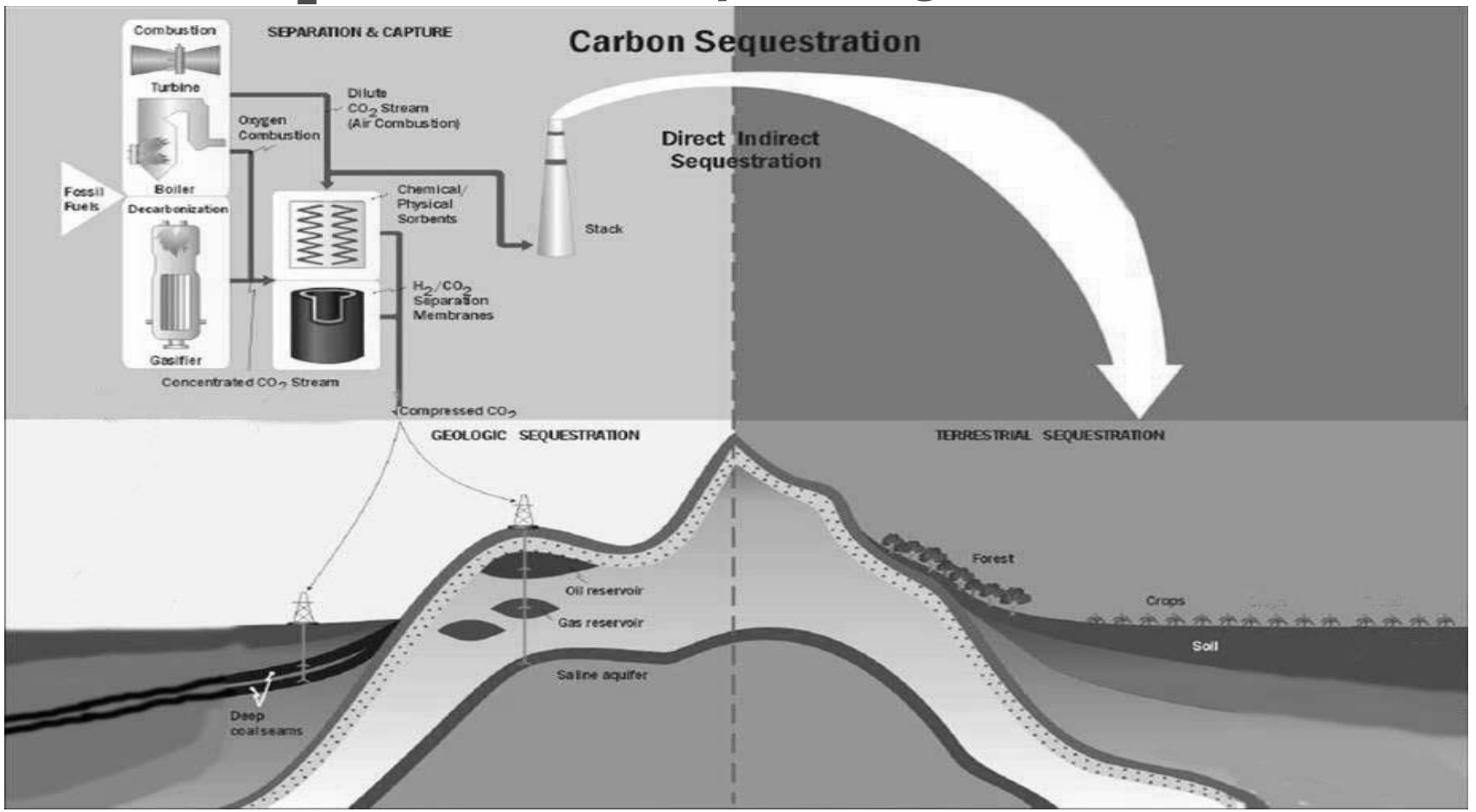
The largest increases will be in developing countries.

Fossil fuels will continue to be used globally for power generation.



Source: IEA, *World Energy Outlook*, 2004

Carbon Capture and Storage (CCS) can reduce CO_2 emitted from power generation.

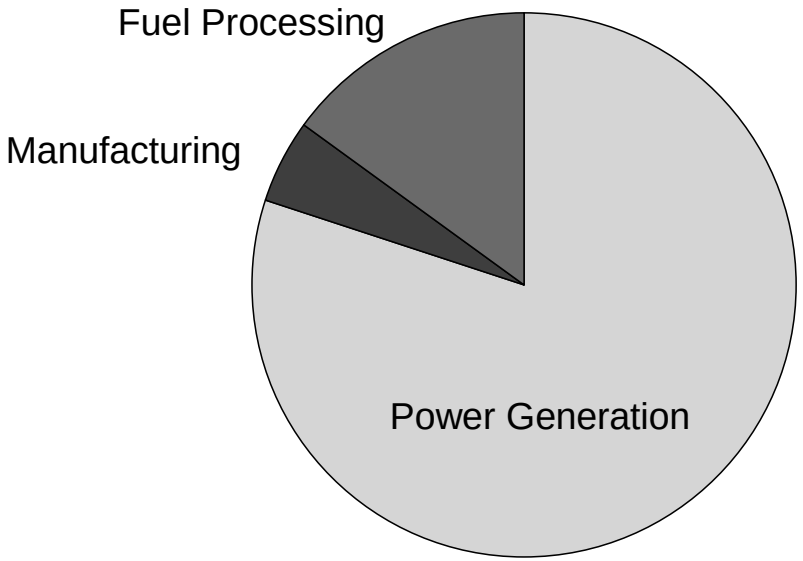


Source: U.S. Department of Energy

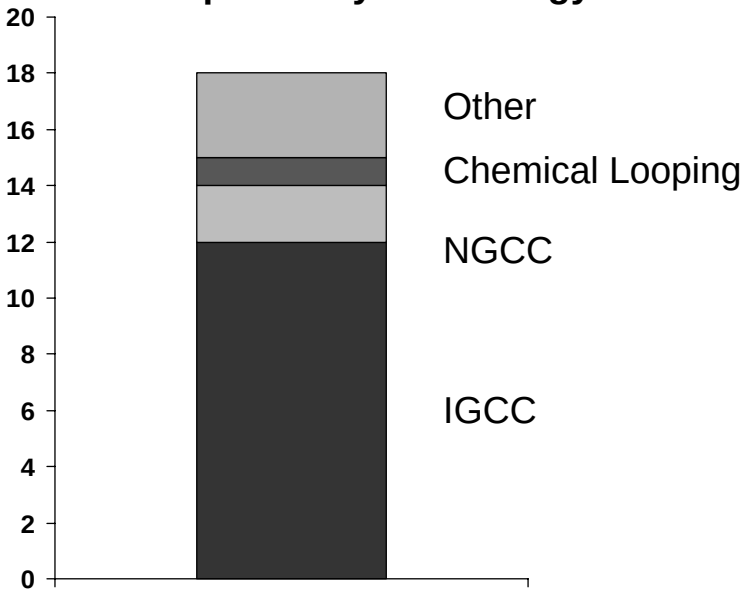
Greatest CCS potential is in power generation.

Gigatons (Gt) CO_2 Captured in 2050 (Total = 18 Gt)

Captured by Sector



Captured by Technology



Source: International Energy Agency, *Prospects for CO2 Capture and Storage*, December 2004

But CCS in power generation faces challenges…

Deploying CCS in power generation faces challenges…

- Developing cost-effective capture technologies
- Financing deployment
- Creating a viable legal/regulatory framework
- Building adequate human capacity
- Facilitating public awareness and acceptance

Collaboration is needed to advance the technology and overcome challenges.

- Among governments
- Within the power sector (including suppliers)
- Between government and industry
- Between power sector and oil & gas industry (including suppliers)

Potential benefits are large.

- Reach goals and solve problems faster
- Reduce costs to each participant
- Stimulate creativity and learn from each other
- Use complementary capabilities to solve problems

Yet, collaboration faces challenges.

- Competing interests and objectives
- Intellectual property

Still, partnerships and collaboration takes place.

Some examples…

International Partnerships

- **Carbon Sequestration Leadership Forum**
- **IEA Working Party on Fossil Fuels**
- **IEA Greenhouse Gas Programme**
- **Asia-Pacific Partnership**

Public-Private Partnerships

- **FutureGen (US)**
- **Coal21 (Australia)**
- **Clean Power Coalition (Canada)**
- **Cleaner Fossil Fuels Programme (UK)**
- **Zero Emission Power Plant Technology Platform (EC)**

Private Sector Alliances

- **General Electric / Bechtel - IGCC**
- **BP / General Electric – Hydrogen Turbines**
- **Statoil / Shell – CCS**
- **ConocoPhillips / Fluor- IGCC**

The Carbon Sequestration Leadership Forum (CSLF)

- ✓ International climate change initiative established in 2003
- ✓ Focus: Development of improved cost-effective technologies for the separation, capture, transport and long-term safe storage of CO_2
- ✓ Purpose: To make these technologies broadly available internationally; Identify and address wider issues relating to carbon capture and storage, i.e. to promote the appropriate technical, political, and regulatory environments for the development of such technology

CSLF Membership is Growing

Members Prior to 2005 (17)


Australia


Brazil


Canada


China


Colombia


E.C


France


Germany


India


Italy


Japan


Mexico


Norway


Russia


S. Africa

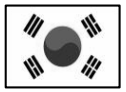

U.K.


U.S.A.

New Members in 2005 (4)


Denmark


Netherlands


S. Korea


Saudi Arabia

New Members in 2006 (1)


Greece

CSLF Strategic Plan guides future activities.

Strategic Plan Components:

- CCS Technology Development and Deployment
- Policy and Legal Framework
- Capacity Building
- Public Awareness and Acceptability
- **Involve Stakeholders**
- Collaboration with Other International Organizations

CSLF information-sharing mechanisms include stakeholders.

- Reporting at CSLF meetings
- International task forces
- Workshops and other events
- CSLF Website: http://www.cslforum.org
- Stakeholder registry: http://www.cslforum.org/cslfstake/
- Recognition of projects: http://www.cslforum.org/projects.htm

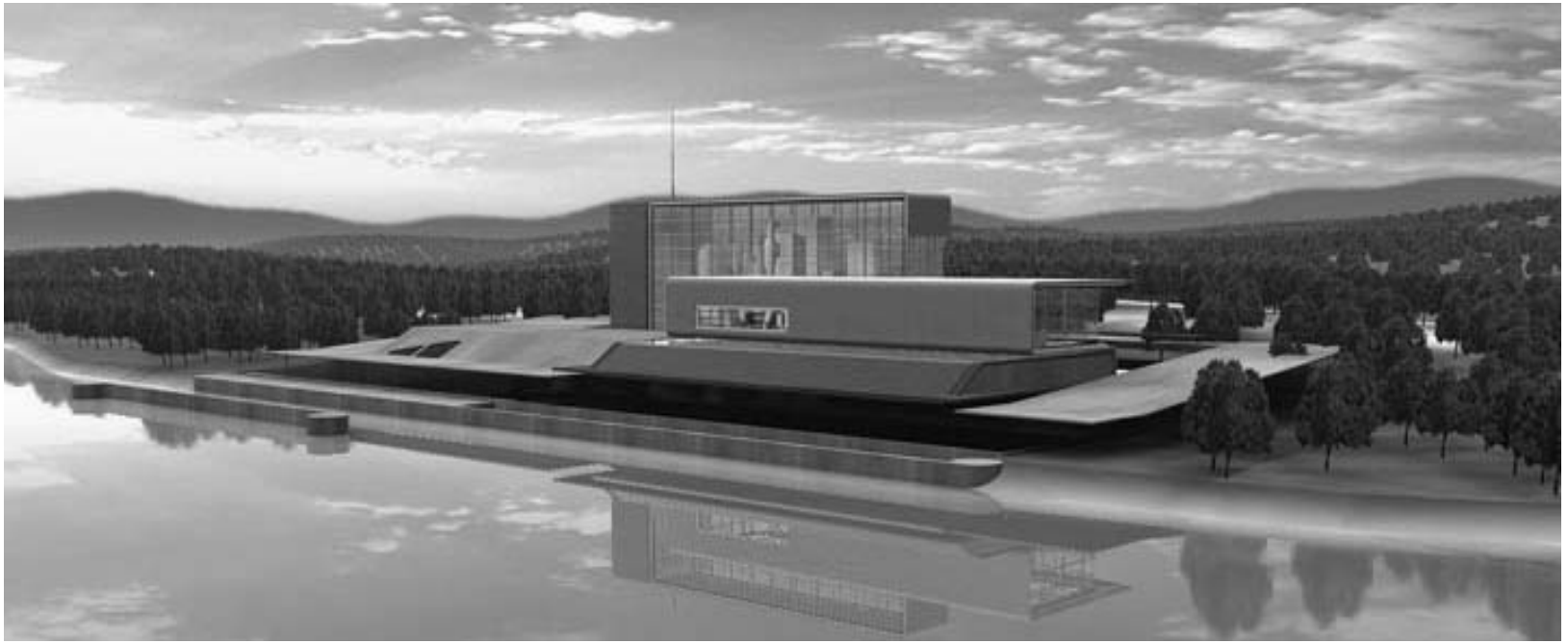
International collaboration on 17 CSLF projects covers all aspects of CCS.

- ARC Enhanced Coal-Bed Methane Recovery Project
- CANMET Energy Technology Centre (CETC) R&D Oxyfuel Combustion for CO2
- CASTOR
- CO_2 Capture Project
- CO_2 GeoNet
- CO_2 Separation from Pressurized Gas Stream
- CO2 SINK
- CO_2 STORE
- Demonstration of Capture, Injection and Geologic Sequestration of CO_2 in Basalt formations in India
- Development of China's Coalbed Methane Technology / CO_2 Sequestration Project
- ENCAP
- Frio Project
- Geologic CO_2 Storage Assurance at In Salah, Algeria
- ITC CO_2 Capture with Chemical Solvents
- Regional Carbon Sequestration Projects
- Regional Opportunities for CO_2 Capture in China
- Weyburn II CO_2 Storage Project

Information sharing on CSLF-recognized Projects

- Project sponsors should be willing to share non-proprietary project information with other CSLF Members.
- Visits to project site allowed for representatives of CSLF Members.
- Expected information from project sufficient to allow others to make improved estimates of technology's potential technical performance, costs, and benefits for future applications.
- The project should be started and major milestones reported prior to the expiration of the CSLF Charter (currently 2013).
- Summaries should be made available, in English, for CSLF website.

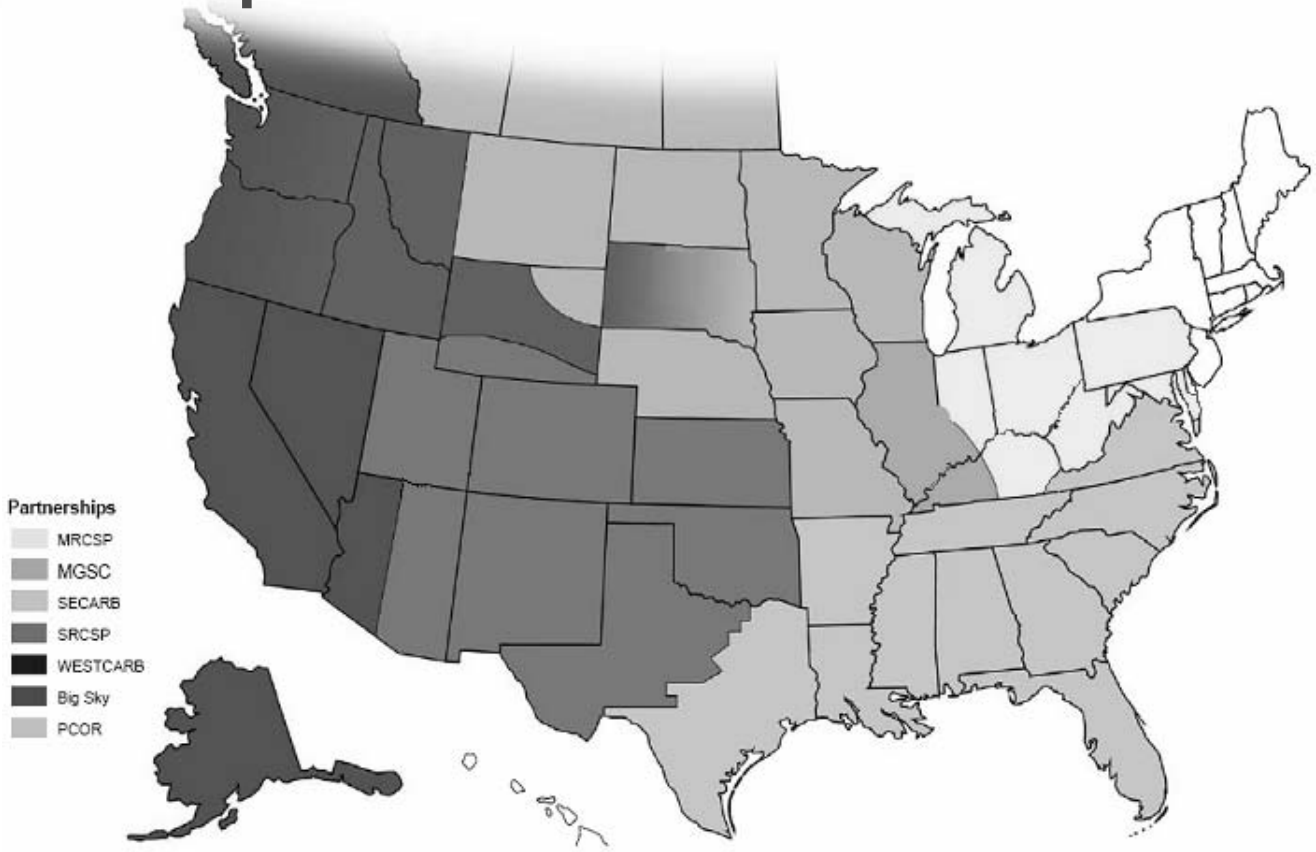
FutureGen: Public-Private Partnership with International Participation



- 10-year industry/government partnership involves many power generators.
- FutureGen combines IGCC with CCS and hydrogen production.
- 275 MW power plant will emit virtually no pollutants.
- Investment required is US $1 billion; site selection is now down to final four.

http://www.fe.doe.gov/programs/powersystems/futuregen/index.html

Regional Carbon Sequestration Partnerships



Numerous U.S. and Canadian power generators participate.

http://www.fe.doe.gov/programs/sequestration/partnerships/index.html

Power sector involvement in CCS is vital.

- Global power generation will continue to rely on fossil fuels for the foreseeable future.
- Carbon capture and storage is vital to that continued use.
- Key challenges require collaboration:
  - Technology development and deployment
  - Financing
  - Legal-regulatory framework
  - Capacity building
  - Public awareness
- Several collaborative mechanism are in place, but further collaboration would produce even greater benefits.