



AIChE[®]

ENERGY FORUM

Cohosted by the AIChE Fellows
and the Commission on Energy Challenges
October 30, 2005 • Cincinnati, OH

Energy Forum Agenda



3:30-3:35 PM **Opening - Dr. John Chen**

3:35-4:00 PM **Vignettes on Energy Challenges**

Dr. Dale Keairns

Mr. James Smith

Dr. Jeffrey Sirola

Dr. Amos Avidan

4:00-5:00 PM **Open Forum - Moderated by Dr. John O'Connell**

Energy Forum

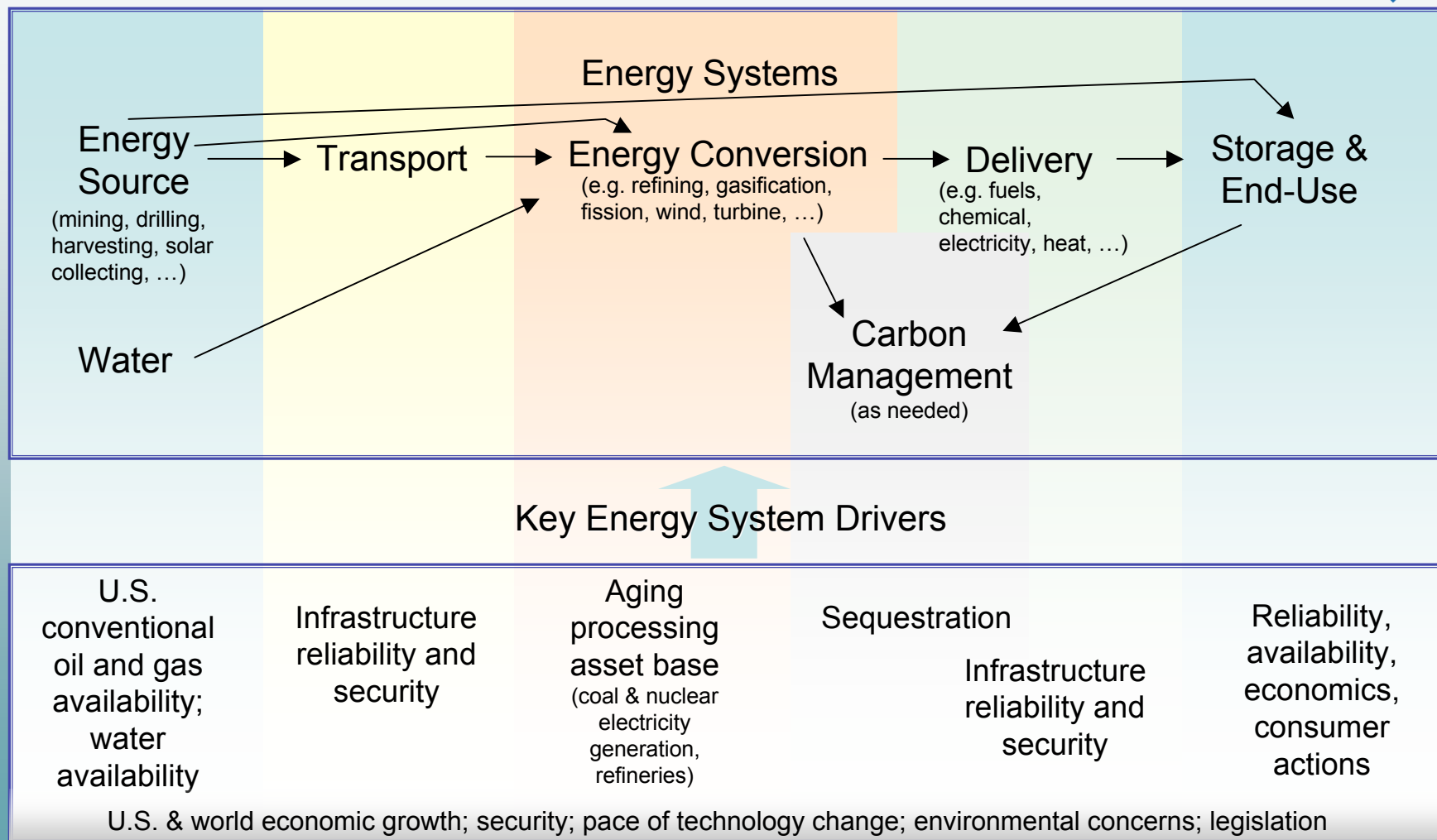
Dr. John Chen, Exofficio, Commission on Energy Challenges



- What are the highest priority initiatives to which the chemical engineering profession could have the most beneficial impact?
- What new initiatives should AIChE undertake to meet energy challenges?

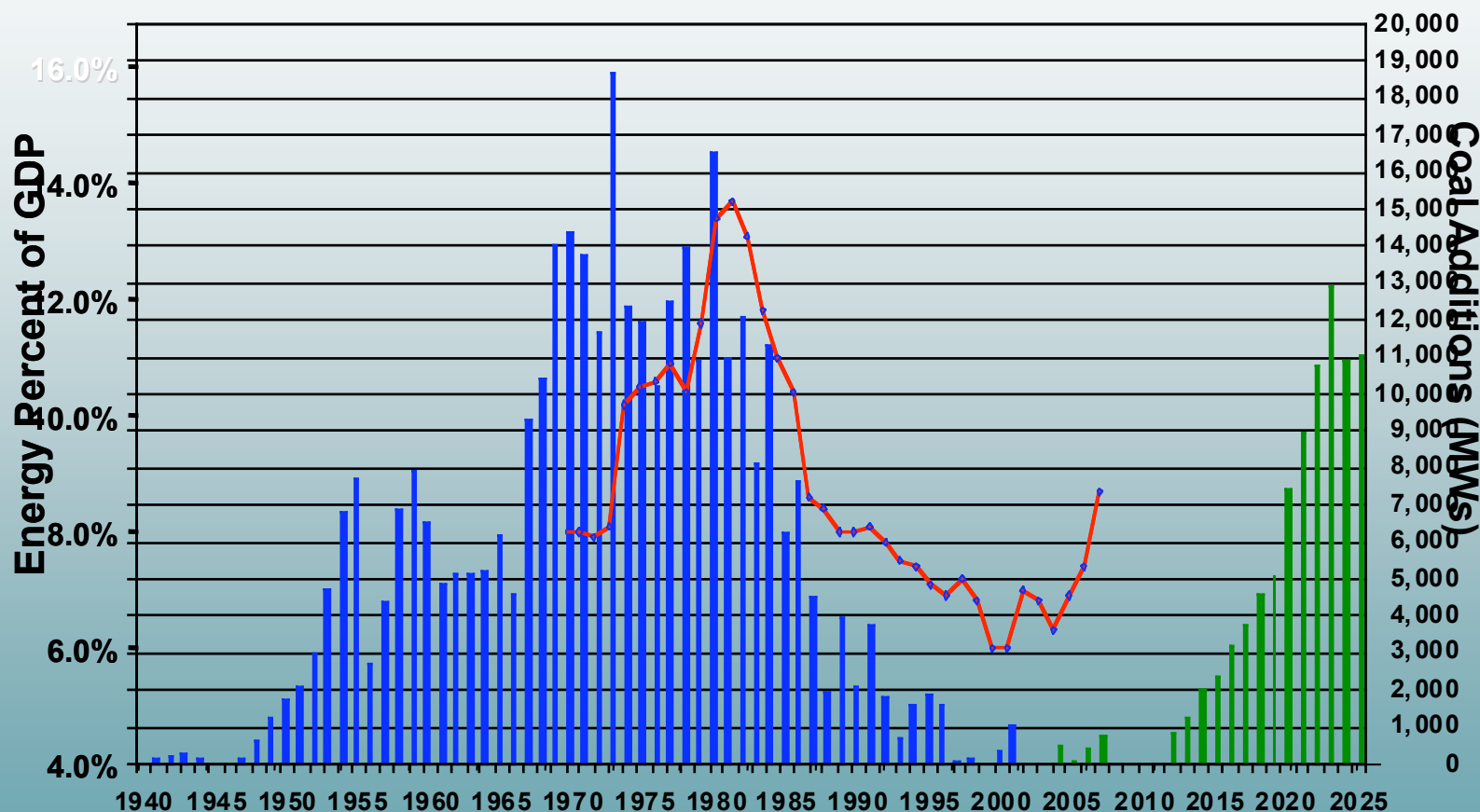
Energy Systems Scope

Dr. Dale Keairns, Commission on Energy Challenges



How will we respond?

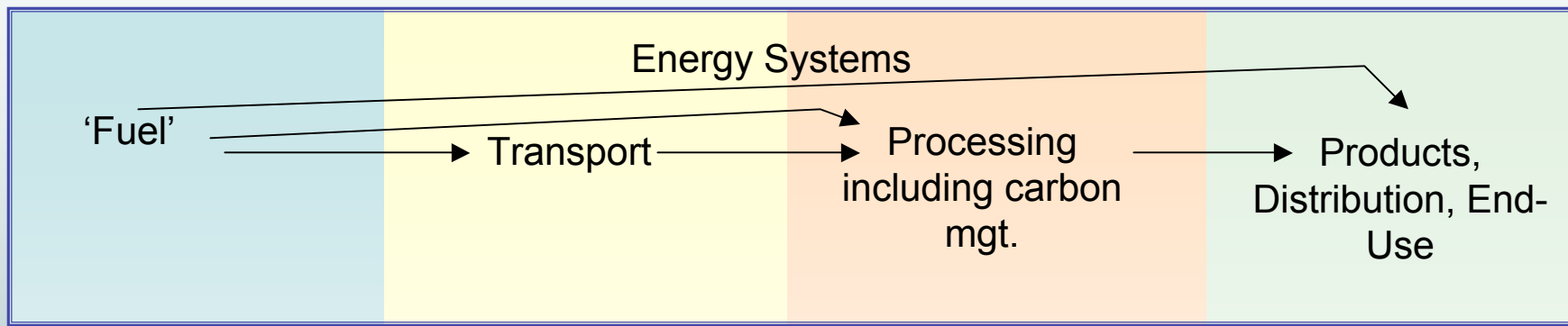
Dr. Dale Keairns, Commission on Energy Challenges



How Will the Nation's Industry Prepare to Meet the Challenge?

ChEs – Key to meeting the Challenge

Dr. Dale Keairns, Commission on Energy Challenges



What are the choices – What 'handles' to turn?

Supply Options	Infrastructure	Processing	Energy Use/ Rejected Energy
<ul style="list-style-type: none"> • Increased conventional oil & gas (including LNG) • Unconventional oil & gas • coal • nuclear • renewables 	<ul style="list-style-type: none"> • Central processing and distributed generation • Electricity grid design - real-time analysis & control • Liquids & gas infrastructure 	<ul style="list-style-type: none"> • Central processing and distributed • Improved Efficiency • Minimum environmental impact • 'Green' Chemistry 	<ul style="list-style-type: none"> • Reduce demand (fuel economy standards, culture change, etc) • Improve end-use efficiency

Oil and Gas - The Challenges Ahead

James Smith, Commission on Energy Challenges



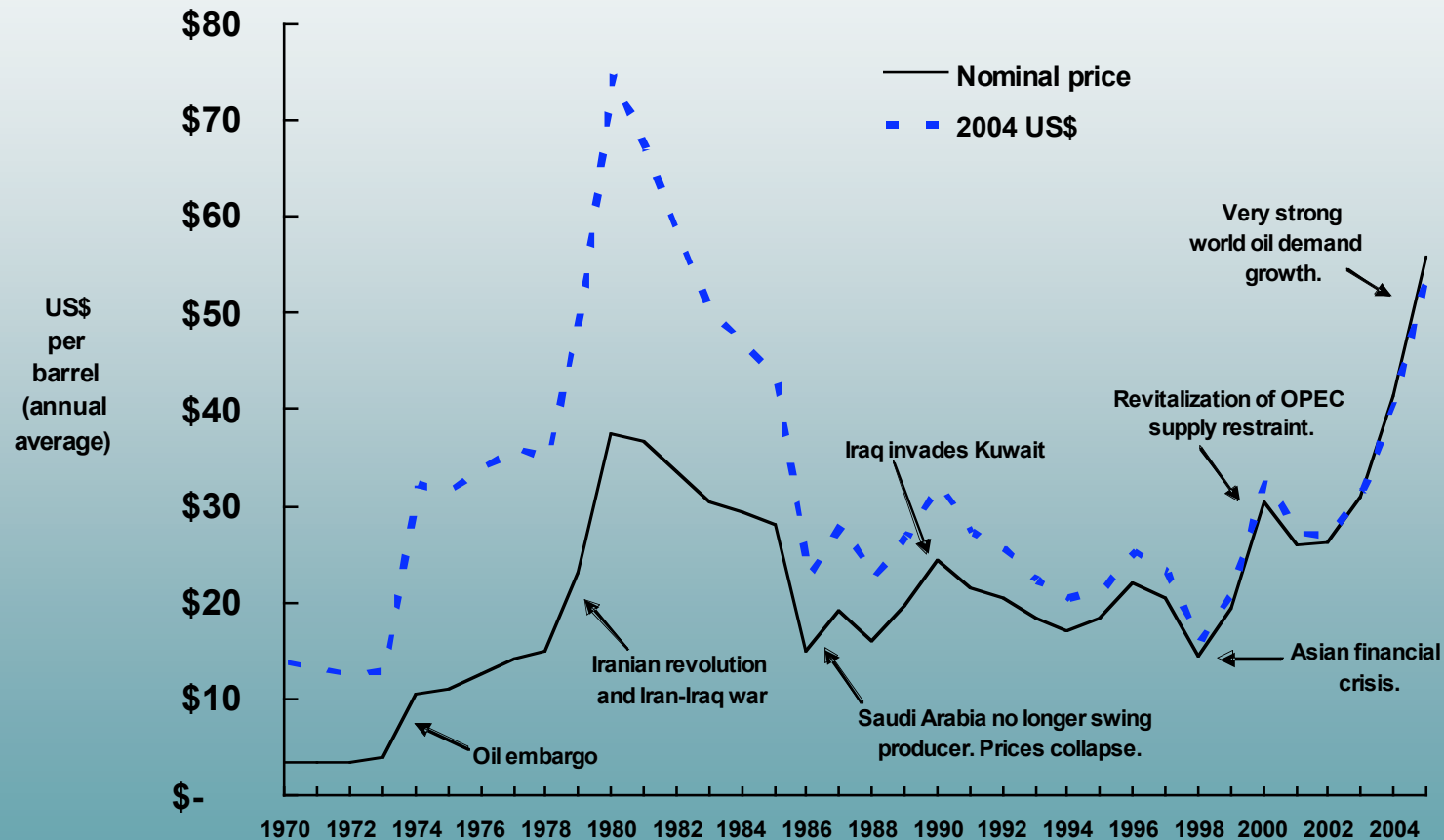
- What do today's high oil prices mean?
- What challenges does the current situation present?
 - Below ground
 - Above ground
- What role will technology play in surmounting these challenges?

What do high oil prices mean?

James Smith, Commission on Energy Challenges



Crude Oil Prices in Nominal and Real US Dollars, 1970–2005



Above and Below Ground Challenges

James Smith, Commission on Energy Challenges



Below Ground

- Conventional Oil
 - A finite resource?
- Unconventional Oil and Alternatives
 - What role will they play and under what conditions?

Above Ground

- Geopolitics
- Access to Opportunities
- Market Reform
- Rising Costs
- Climate Change

The Central Role of Technology

James Smith, Commission on Energy Challenges



Even with greater efficiency, it looks as though the world could be using 50 percent more oil 25 years from now.

How will we manage?



- Upstream
 - Remote locations
 - Extending existing production
- Downstream
 - New refining capacity
 - Cleaner, “lighter” products
- Unconventionals
 - Extra heavy oil
 - Fischer-Tropsch synthesis
 - Shale
- Renewables
 - Ethanol
 - Biodiesel
- Life After Hydrocarbons
 - Hydrogen?

Energy Sustainability Challenge

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



- World population stabilizing below 10 billion
- 6-7 X world GDP growth over next 50 or so years
- 3.5 X increase in energy demand
(7 X increase in electricity demand)
- Most growth will be in the developing world

Global Energy Demand, Quads

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



Region	Year		
	2000	2025	2050
North America	90	100	120
Latin America	35	80	150
Europe	110	110	130
Africa	15	60	200
Asia	135	450	900
World	385	800	1500

Global Energy Consumption, 2000

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



	Quads	Percent	GTC
Oil	155	40	3.5
Natural Gas	85	22	1.2
Coal	90	23	2.3
Nuclear	25	7	
Hydro	27	7	
Solar	3	1	

50-Year Global Energy Demand

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



- Total energy demand – 1500 Quads
- New electricity capacity – 5000 GW
 - One new world-scale 1000 MW powerplant every three days
 - Or 1000 square miles new solar cells per year
- Carbon emissions growing from 7 GT/yr to 26 GT/yr
 - More, if methane exhausted
 - More, if synthetic fuels are derived from coal or biomass

Global Reduced Carbon

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



- Recoverable Gas Reserves – 75 GTC
- Recoverable Oil Reserves – 120 GTC
- Recoverable Coal – 925 GTC
- Estimated Oil Shale – 225 GTC
- Estimated Tar Sands – 250 GTC
- Estimated Remaining Fossil (at future higher price / yet-to-be-developed technology) – 2500 GTC
- Possible Methane Hydrates – ????? GTC
- Terrestrial Biomass – 500 GTC
- Peat and Soil Carbon – 2000 GTC

Factoids

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



- Current Fossil Fuel Consumption – 7 GTC/yr
- Current Chemical Production – 0.3 GTC/yr
- Current Cultivated Crop Production – 6 GTC/yr
 - Current energy crop production – 0.01 GTC/yr
- Annual Terrestrial Biomass Production – 60 GTC/yr
- 2.2 GTC/yr Carbon Dioxide Dissolve in Ocean
 - At 360ppm compared to preindustrial 280ppm
- Future Energy Requirement (same fossil mix) – 26 GTC/yr
- Future Energy Requirement (from coal or biomass) – 37 GTC/yr
- Future Chemical Demand – 1.5 GTC/yr
- Future Crop Requirement – 9 GTC/yr

Sustainability Challenges

Dr. Jeff Sirola, Exofficio, Commission on Energy Challenges



- Even with substantial lifestyle, conservation, and energy efficiency improvements, global energy demand is likely to more than triple within fifty years
- Atmospheric addition of even a few GTC/yr of carbon dioxide is not sustainable
- In the absence of a carbon sequestration breakthrough, reliance on fossil fuels alone is not sustainable
- Because of limited arable land, available water, harvesting resources, and competition for foodcrops, biomass may not be an optimal method to capture solar energy
- Nuclear, geothermal, and other forms of solar energy capture may be increasingly important sources of primary energy
- In situations where electricity is not an optimal energy carrier for reliability, mobility, or other reasons, new energy carriers, storage, and transportation systems, will need to be developed

What initiatives should AIChE consider?

Dr. Amos Avidan, Chair, Commission on Energy Challenges



Preliminary Ideas:

1. **Internal:** More Energy focus in AIChE programs, publications, and activities?
2. **External:** Education and dissemination?
 - Energy technology clearing house – members, companies, universities, government, NGOs
 - Energy book series
 - More energy focus in ChE education
3. **Government R&D \$:** Lobby for more energy programs?

What initiatives should AIChE consider?

Dr. Amos Avidan, Chair, Commission on Energy Challenges



Preliminary Ideas (continued):

4. **Collaborative R&D Consortia?**
5. **More public advocacy on energy issues?**
6. **More involvement in the professional community**
 - National Academies, other professional societies, ad-hoc commissions, etc.
7. **Other ideas?**
8. **Concerns?**

Open Forum

Dr. John O'Connell, Moderator, Chair of AIChE Fellows



- Share your ideas at the microphones located around the room
 - or
- Please use the suggestion cards to write your comments and suggestions
 - AIChE staff and volunteers will collect cards and deliver to the moderator.
- You may also send your suggestions and comments to energy@aiche.org

Share your ideas

Your voice and expertise are critical



ENERGY FORUM

