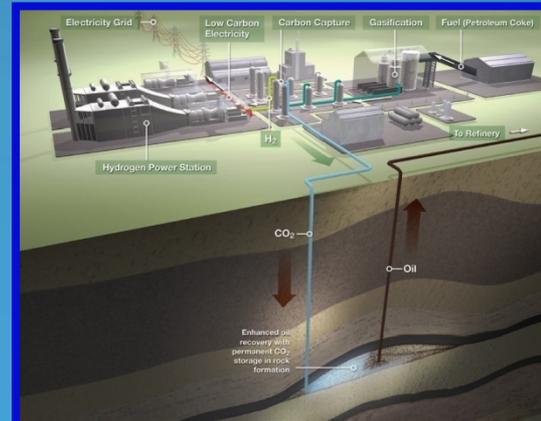
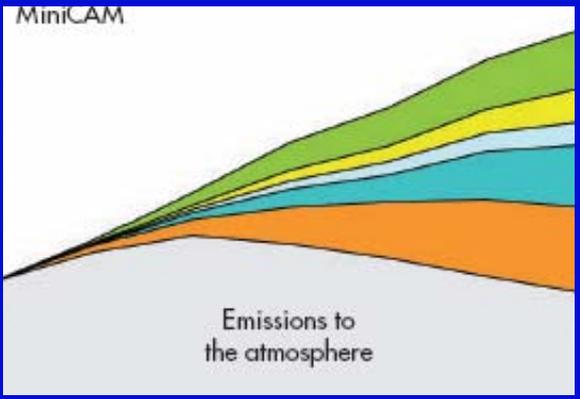


Oil and Gas Technical Work Group Governor's Sub-Cabinet for Climate Change Status report to the MAG -

Options to reduce GHG emissions from O&G

Operations

April 2, 2009 Anchorage



Overview

- Enduring Themes
- Progress on Quantification
- Timeline
- Option Review / Quantification Status
- Learnings / Summary

Enduring Themes in Options to Reduce GHG Emissions in Alaska

- Support economic vitality of Alaska
- Encourage capital investment
- Ensure regulatory simplicity

Oil & Gas TWG Update on Option Development and Review--Quantification Progress to date

- TWG has been meeting since last MAG. Most options in second and third iterations.
- Excellent support from ICF and industry experts. Meetings very productive.
- Preliminary results of quantification still under analysis, gaining a better understanding of significant assumptions and economic drivers. Results vary widely based on the assumptions .
- Parameters for prioritization not yet finalized, however ranking should be achievable as the quantification gets more refined.

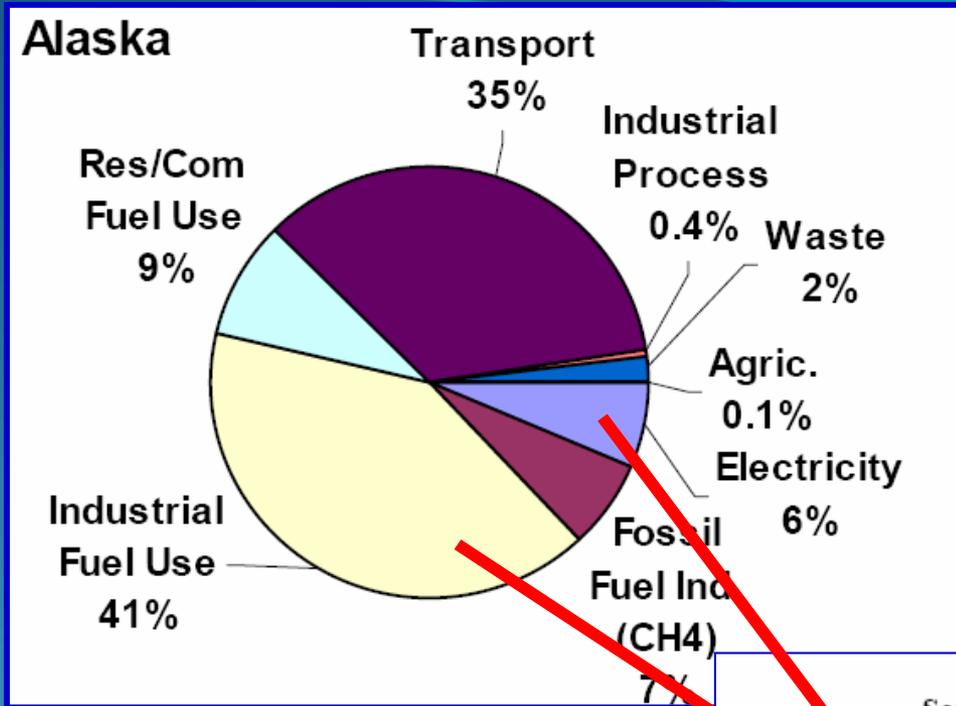
Timeline

- March 26 - April 23 High level quantification estimates completed, final TWG review
- March 26 - May 9 Reformat and complete documentation of options, determine ranking methodology
- April 23 - May 9 Final quantification review
- April 23 - May 9 Develop recommendations on incentives to improve option viability
- May 14 Proposed interim presentation to MAG
- May 15 - June 11 Rework and rank options
- June 18 - Final MAG presentation

Alaska Gross GHG Emissions by Sector (2005)

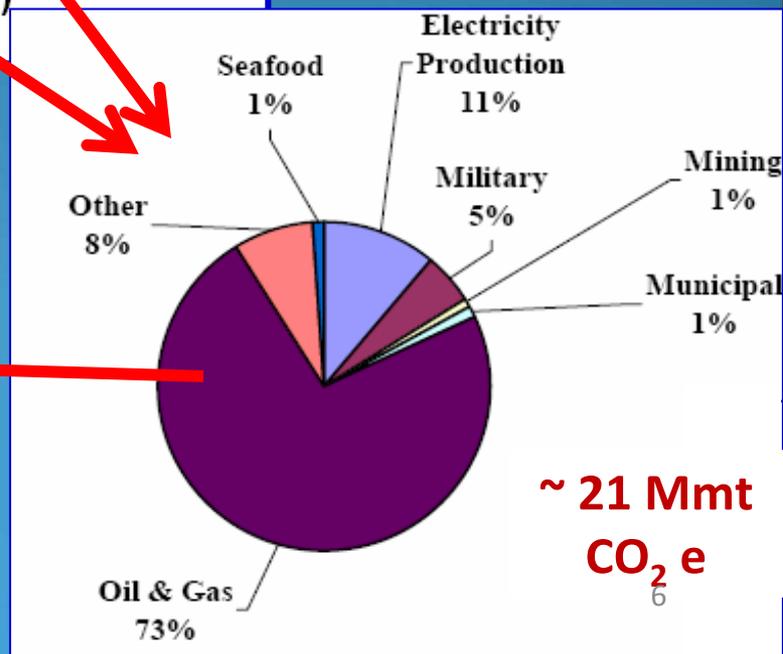
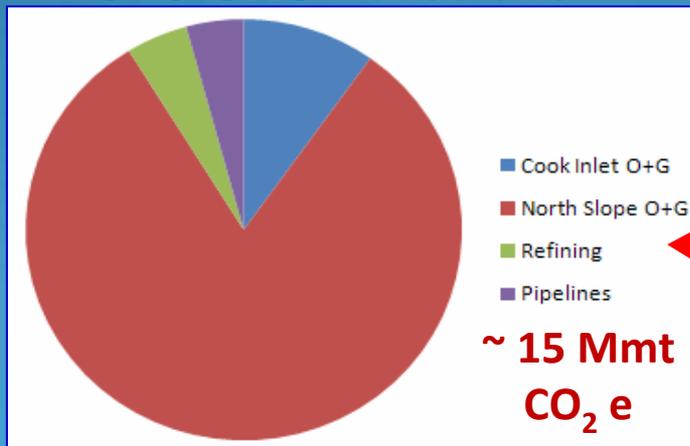
~ 52 Mmt CO₂ Equivalent

(~0.7% US Emissions)



Alaska Title V GHG Emissions

O+G GHG Emissions



TWG working Options April 2, 2009

Conservation

1 Overall conservations activities, ie reduce liquid fuel consumption, other best practices

2 Reduce Fugitive Methane Emissions

3 Electrification of Oil and Gas Operations, with Centralized Power Production and Distribution

Thermal Energy Efficiency

4 Improved Efficiency Upgrades for Oil and Gas Fuel burning Equipment

5 Use of Renewable Energy Sources in Oil and Gas Operations

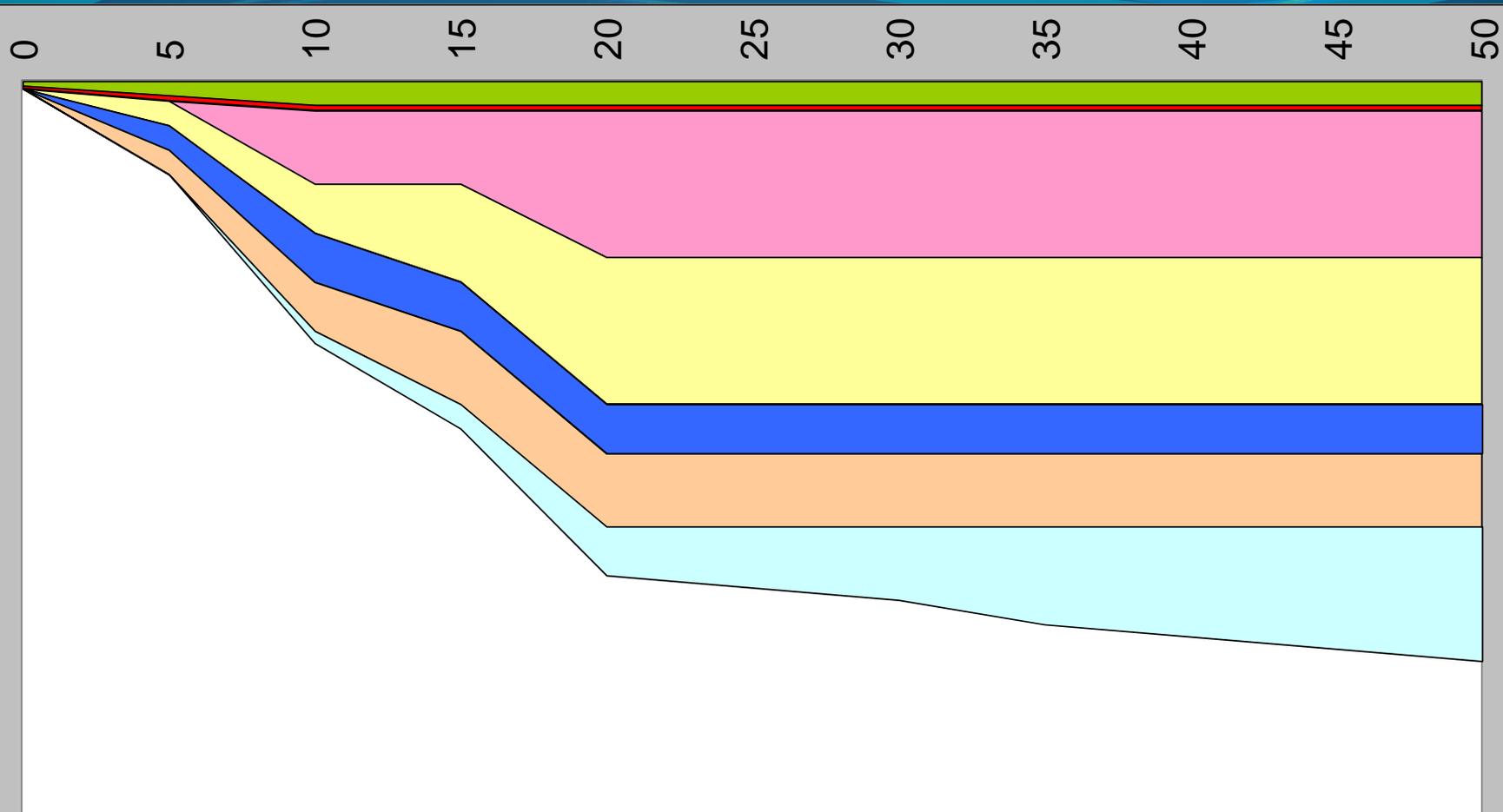
6 CCS from High CO2 Fuel Gas at Prudhoe Bay

Carbon Capture and Sequestration (CCS)

7 CCS from Combustion Sources in and near Existing Oil and Gas Fields - Focus North Slope

8 CCS away from Known Geologic Traps - (Interior Alaska)

O&G TWG Conceptual GHG Reduction Timeline



- Overall Conservation
- Fugitive Methane
- Electrification
- Efficiency Upgrades
- Renewable Energy
- Fuel Gas Carbon Capture
- Combustion Carbon Capture

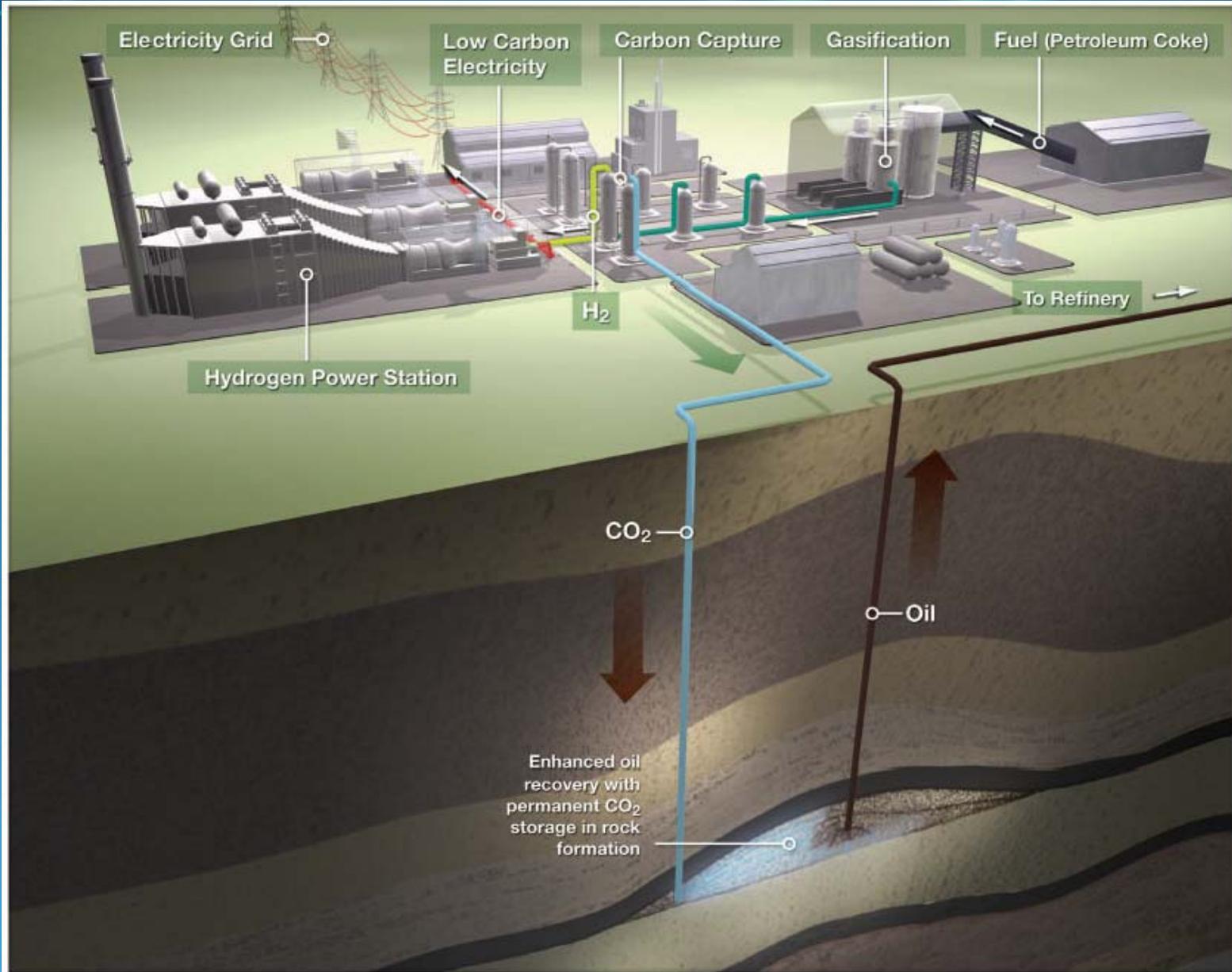
Conservation / Waste Reduction

- 1) Conservation- Minimize, optimize, and reduce energy consumption, liquid fuels, gas, and electricity use.
- 2) Reduce Fugitive Methane Emissions--Assess potential reductions of fugitive methane;

Quantification Status—approach, complexities, challenges, issues

- No attempts to quantify conservation, keep as qualitative
- Fugitive methane quantification costs/reductions ongoing
 - Major uncertainties exist in fugitive methane estimates, but appear much less than original CCS/DEC reports. Numbers small when compared to other options.

Thermal Energy Efficiency at Oil and Gas Operations



Thermal Energy Efficiency

- 3) Electrification of North Slope facilities with centralized power production and distribution
- 4) Improved efficiency upgrades for fuel burning equipment
- 5) Use of renewable energy sources for power generation

Electrification of North Slope facilities with centralized power production and distribution

Quantification Issues

- Requires major upgrade and expansion of the entire grid infrastructure on the North Slope
- Will have an overall major efficiency improvement meaning less gas burned and thus significantly reduced GHG emissions.
- Some equipment is already currently at a reasonable thermal efficiency
- Quantification Status Discussion
 - Approach
 - Complexity
 - Challenges



Efficiency upgrades for fuel burning equipment, especially gas turbines

Quantification Issues

- Efficiency improvements mean less gas burned, resulting in reduced GHG emissions.
- Improvements can be made through upgrading existing industrial gas turbines to modern aero-derivatives, or by addition of waste heat to existing turbines (only former is being quantified.)
- Some equipment is already at its optimal or near optimal (not all equipment is included)
- Quantification Status Discussion
 - Approach
 - Complexity
 - Challenges

Use of renewable energy sources for power generation

Quantification Issues

- The focus is on the North Slope, but it may have application to oil and gas operations elsewhere, including onshore Cook Inlet facilities.
- Wind power is a potential resource, but is an unproven industrial technology for North Slope operations.
- Could be effective in augmenting power generation for electricity by reducing gas usage and GHG emissions as part of a more comprehensive hybrid option combining aspects of 1-4 and 6.
- Quantification Status Discussion
 - Approach
 - Complexity
 - Challenges

Carbon Capture and Geologic Sequestration

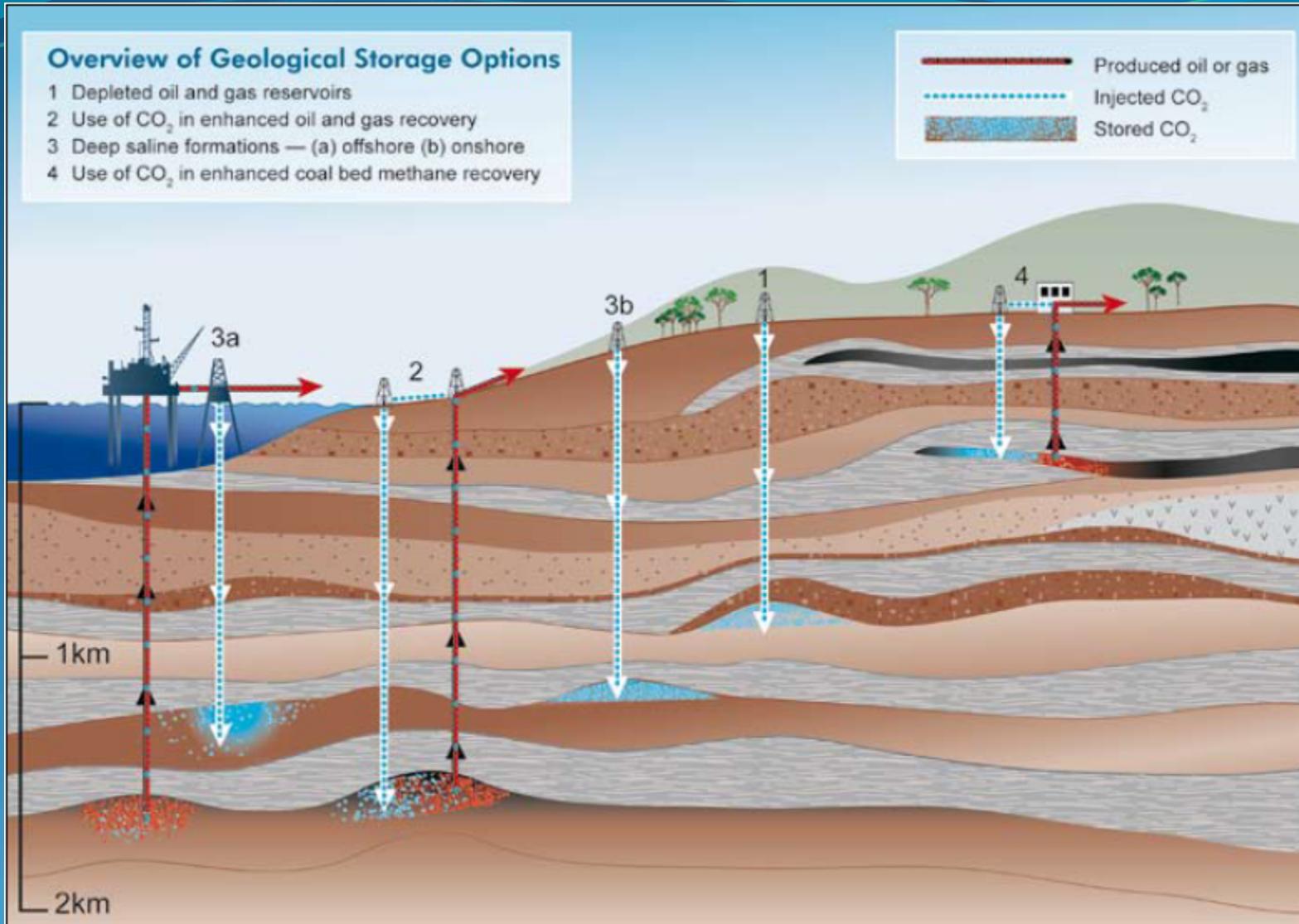


Figure TS.7. Methods for storing CO₂ in deep underground geological formations. Two methods may be combined with the recovery of hydrocarbons: EOR (2) and ECBM (4). See text for explanation of these methods (Courtesy CO₂CRC).

Carbon Capture and Geologic Sequestration

- 6) Remove CO₂ from fuel gas at Prudhoe Bay. Use for EOR.
- 7) Remove CO₂ from exhaust gas at Prudhoe Bay. Use for EOR.
- 8) Remove CO₂ from exhaust gas at interior power plants or refineries. Ship CO₂ to known reservoir or explore for nearby sequestration site.
 - Note: This is mostly non oil and gas facilities

Aspects of Carbon Capture and Geologic Sequestration

- 1) Find appropriate storage reservoir
- 2) Drill Injection Wells
- 3) Capture CO₂
- 4) Compression and dehydration
- 5) Pipelines for Transport
- 6) Compression and Injection
- 7) Long Term Monitoring

Aspects of Carbon Capture and Geologic Sequestration

- 1) Find appropriate storage reservoir
- 2) Drill Injection Wells
- 3) Capture CO₂
- 4) Compression and dehydration
- 5) Pipelines for Transport
- 6) Compression and Injection
- 7) Long Term Monitoring

CCS in oil/gas fields – may already have some of the needed facilities

Remove CO₂ from fuel gas at Prudhoe Bay. Use for EOR

Quantification Issues

- Option supports early enhanced oil opportunities and provides reduced CO₂ emissions
- Could be stand alone
- Technology will be needed/required for eventual gas sales (acts as big pilot for major gas sales)

Lessons learned

- Biggest drivers are CO₂ capture costs and value from additional oil from EOR
- Choice of field for EOR critical (infrastructure, reserve potential, etc)
- Parasitic energy losses for capture likely compensated by EOR gains

Remove CO₂ from exhaust gas at Prudhoe Bay. Use for EOR

Quantification Issues

- Supports early enhanced oil opportunities and provides reduced CO₂ emissions.
- **Considerably** more efficient and cost effective to first maximize energy efficiency options. (Realistically only practical when combined with centralized energy efficiency.)

Lessons learned

1. Gas line impacts **supply**/demand aspect of CO₂ for EOR.
2. Biggest drivers are CO₂ capture costs and value from EOR.
3. Choice of field for EOR critical – cross unit boundary issues.

Remove CO₂ from exhaust gas away from O&G fields. Ship CO₂ to known reservoir or explore for nearby sequestration site.

Quantification Issues

- Reduces CO₂ emissions.
- Primary focus on coal power generation, some refineries
- MUCH more efficient to first maximize energy efficiency.
- Could be required to meet ambitious long-term GHG reduction goals being discussed in Federal Government.

Lessons Learned

1. Capital costs huge , can be twice cost of plant w/out CCS
2. Unknowns: Exploration costs, pipeline length/costs, Regulatory requirements for long term storage.
3. DOE / NETL in large scale testing mode
4. Recommend we defer quantification step until more information on costs and regulations are available.

Summary - Implementation Challenges/Issues

- Economics
- Many options are Mega Projects - Significant overlapping resource requirements among options, and with construction related to major gas sales.
 - **So - Even with no economic constraints, we can't do everything.**
- Cross Unit issues will delay full implementation- affects power generation, CO₂ transport, regulated power utility issues, commercial issues between different owners.
- Most options are not stand alone, but may be most effectively implemented as some kind of a hybrid scheme
 - ie improving energy efficiency of individual pieces of equipment while centralizing power, thereby adding carbon capture technology to the fewest pieces of machinery, etc.

Summary Options – Stand alone*

#	Option Description	Estimated target emissions (in MMT CO ₂ e)	Remainder after max reductions (2-5-09)	Current Working Estimate (4-2-09)	Comments/ Assumptions	Final Estimates
	Conservation (NS)	12.0	~11.4	?		
1	Best Conservation Practices	12.0	~11.5	?		TBD?
2	Reduce Fugitive Methane	12.0	~11.9	~11.9	No actual measurements available	TBD
	Thermal Energy Efficiency (NS)	12.0	~4.0			TBD
3	Electrification, Centralized Power	12.0	~4.0	~6	27-52% efficiency improvement	TBD
4	Improved Efficiency Equipment	12.0	~6.0	~9	27-37% efficiency improvement	TBD
5	Renewable Energy	12.0	~11.0	?		TBD
	Carbon Capture and Storage (NS)	12.0	~.5-1.0			
6	CCS from High CO ₂ fuel at Prudhoe	12.0	~11.0	~11		TBD
7	CCS from Combustion Sources	12.0	~.5-1.0	?	Very expensive, ability to implement on NS uncertain	TBD
8	CCS away from O&G fields	3.0	~2.5	~2.5		TBD?

*All numbers are rounded approximations only

Total NS emissions ~ 12 MMT, Total Interior emissions ~ 3 MMT

Incentives for long term viability for GHG reductions – Initial discussions

- Encourage capital investment
- Streamline/simplify (in some cases identify) regulatory environment
- Encourage maximization of ultimate hydrocarbon recovery
- Prepare for implications of potential Federal Carbon regulations to Alaska

Note: All GHG emission estimates based on Title V stationary source emissions based on fuel burned from 2002. ie no accounting for new developments or gas pipeline

Enduring Themes in Options to Reduce GHG Emissions in Alaska

- Support economic vitality of Alaska
- Encourage capital investment
- Ensure regulatory simplicity (consistency!)

Timeline

- March 26 - April 23 High level quantification estimates completed, final TWG review
- March 26 - May 9 Reformat and complete documentation of options, determine ranking methodology
- April 23 - May 9 Final quantification review
- April 23 - May 9 Develop recommendations on incentives to improve option viability
- May 14 Proposed interim presentation to MAG
- May 15 - June 11 Rework and rank options
- June 18 - Final MAG presentation

Questions