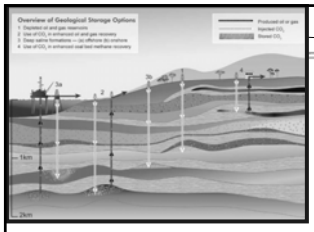


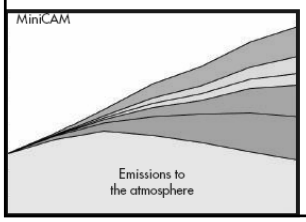
Oil and Gas Technical Work Group

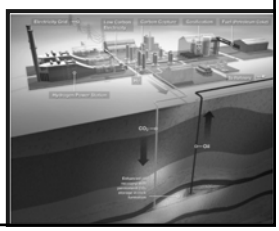
Governor's Sub-Cabinet for Climate Change

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
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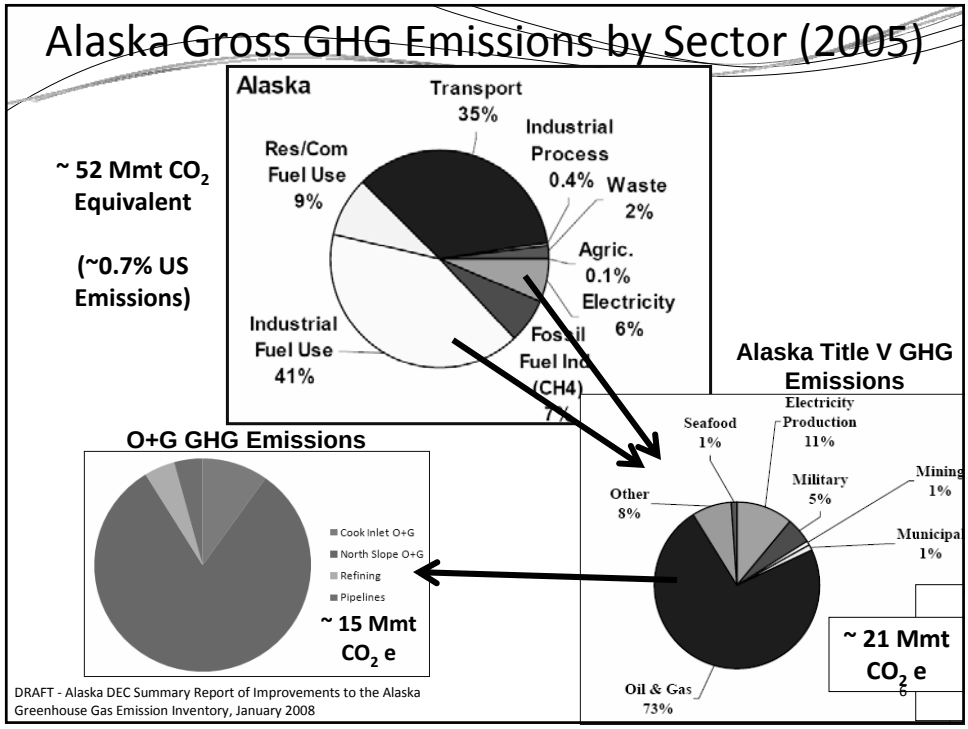
Alaska Gross GHG Emissions by Sector (2005)

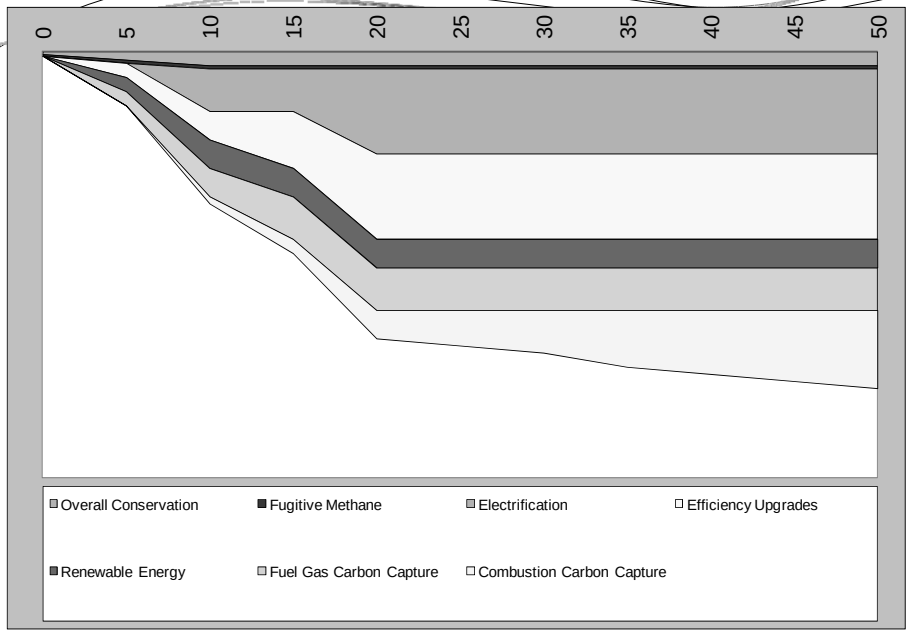


DRAFT - Alaska DEC Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory, January 2008

TWG working Options April 2, 2009

Conservation	1	Overall conservations activities, ie reduce liquid fuel consumption, other best practices
	2	Reduce Fugitive Methane Emissions
Thermal Energy Efficiency	3	Electrification of Oil and Gas Operations, with Centralized Power Production and Distribution
	4	Improved Efficiency Upgrades for Oil and Gas Fuel burning Equipment
	5	Use of Renewable Energy Sources in Oil and Gas Operations
Carbon Capture and Sequestration (CCS)	6	CCS from High CO2 Fuel Gas at Prudhoe Bay
	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



Conservation / Waste Reduction

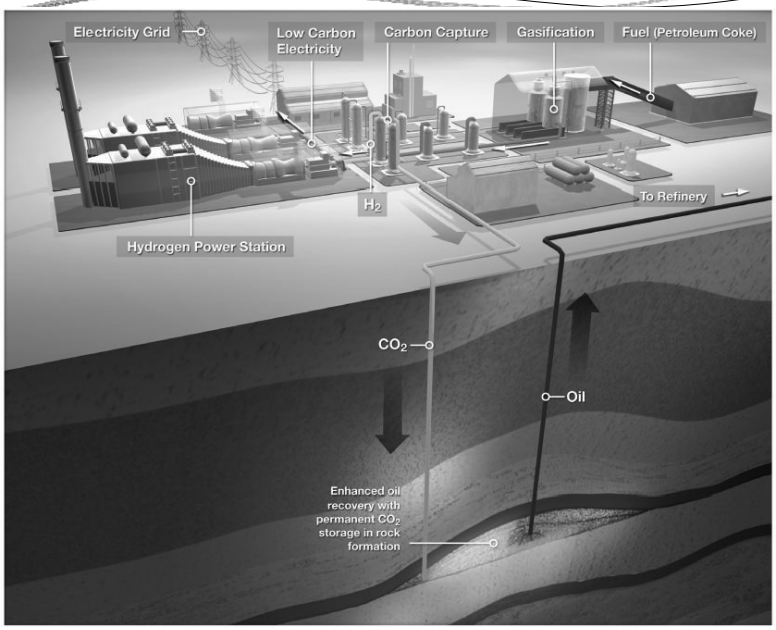
1) Conservation- Minimize, optimize, and reduce energy consumption, liquid fuels, gas, and electricity use.

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



IEA Greenhouse Gas R&D Programme - Storing CO2 Underground

Thermal Energy Efficiency

3) Electrification of North Slope facilities with centralized power production and distribution

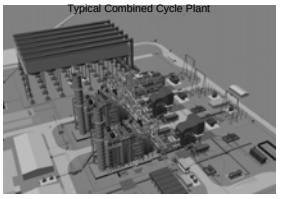
4) Improved efficiency upgrades for fuel burning equipment

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

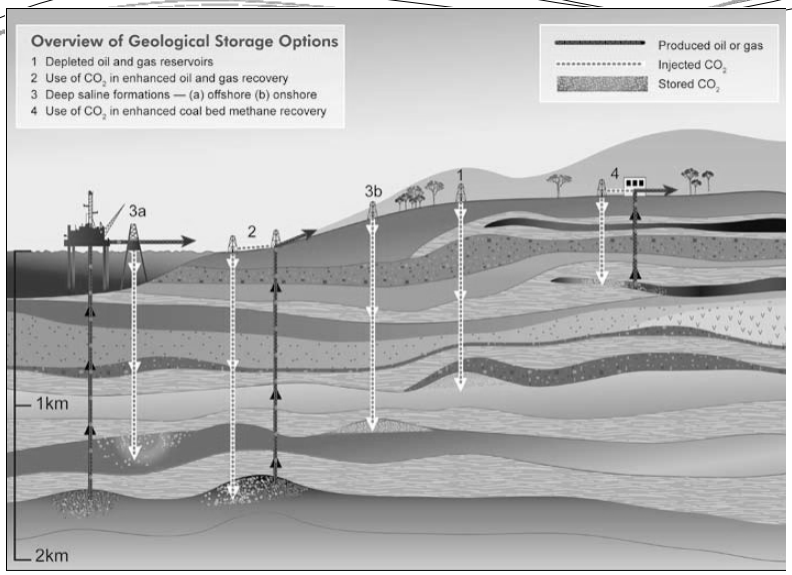


Figure TS.7. Methods for storing CO_2 in deep underground geological formations. Two methods may be combined with the recovery of hydrocarbons: EOR (2) and ECBM (4). See text for explanation of these methods (Courtesy CO2CRC).

IPCC Special Report on Carbon Dioxide Capture and Storage,2005

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 CO_2

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 CO_2

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 CO_2 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 CO_2 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 CO_2 from exhaust gas away from O&G fields. Ship CO_2 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_2e)	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!)

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Questions