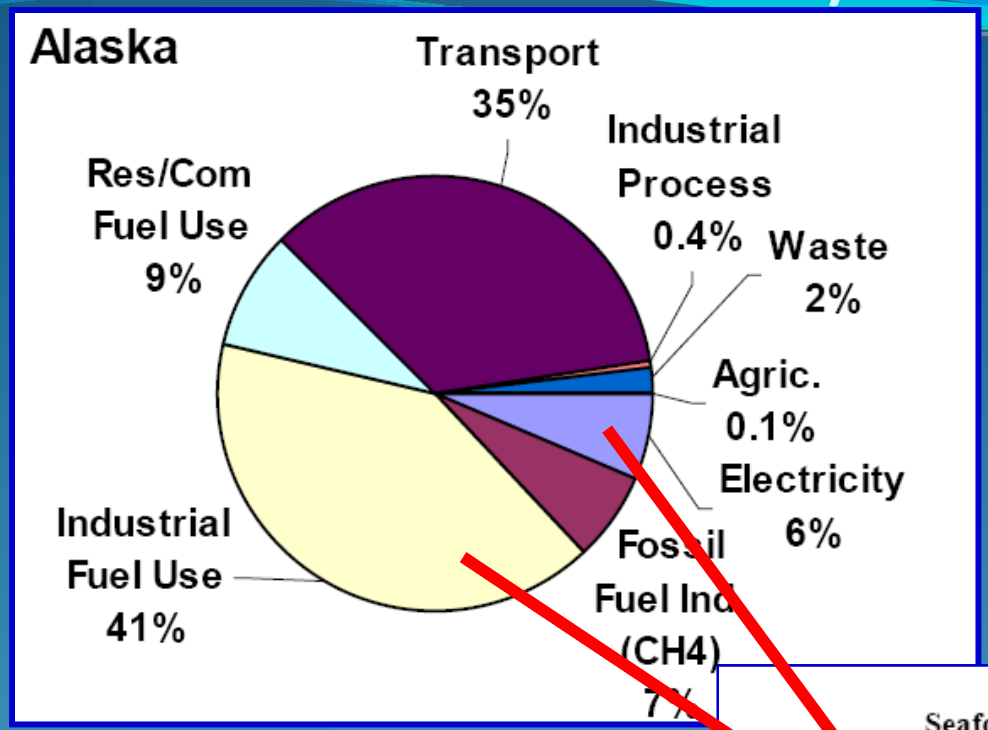
Climate Change Sub Cabinet
Research Needs
Oil and Gas
Mitigation

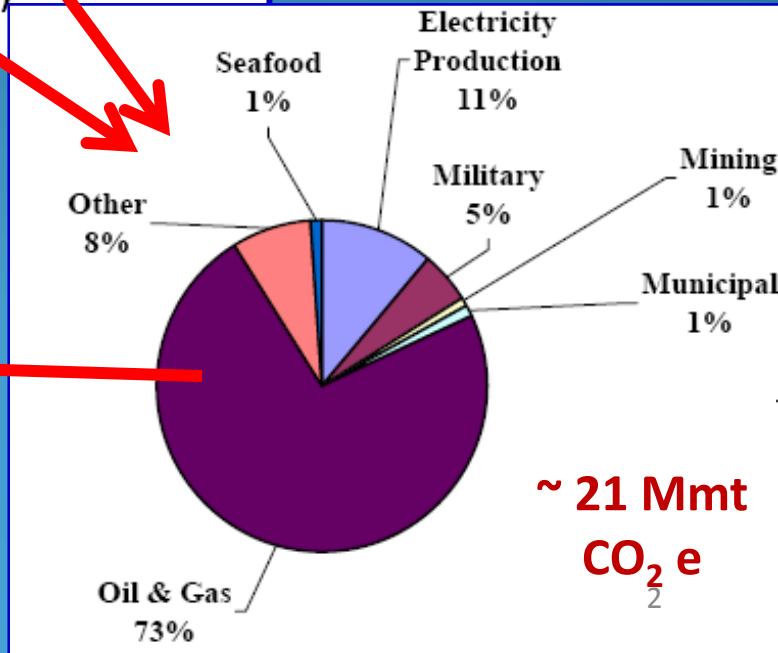
Alaska Gross GHG Emissions by Sector (2005)

~ 52 Mmt CO_2 Equivalent

(~0.7% US Emissions)

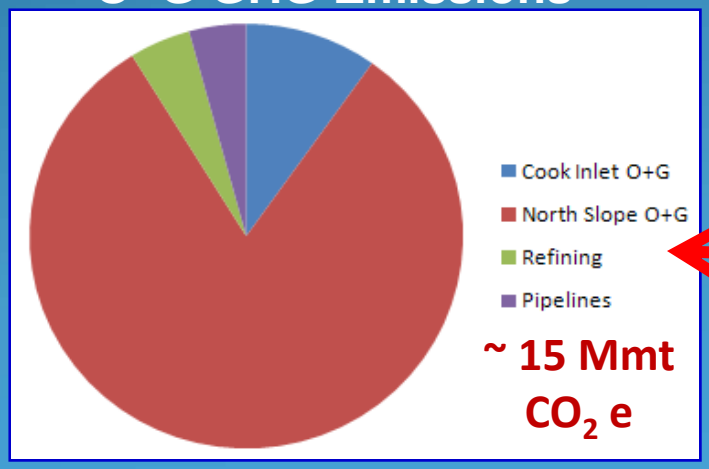


Alaska Title V GHG Emissions



~ 21 Mmt CO_2 e

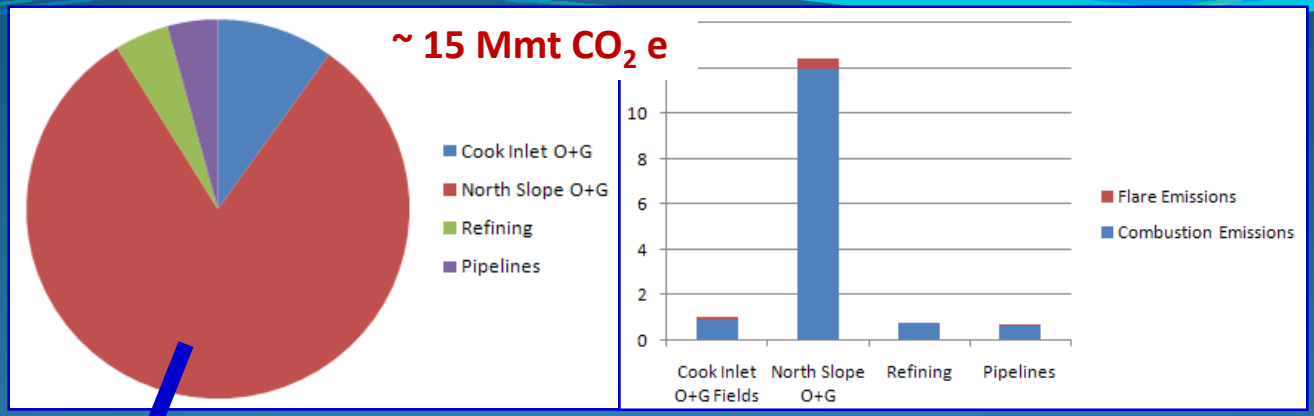
O+G GHG Emissions



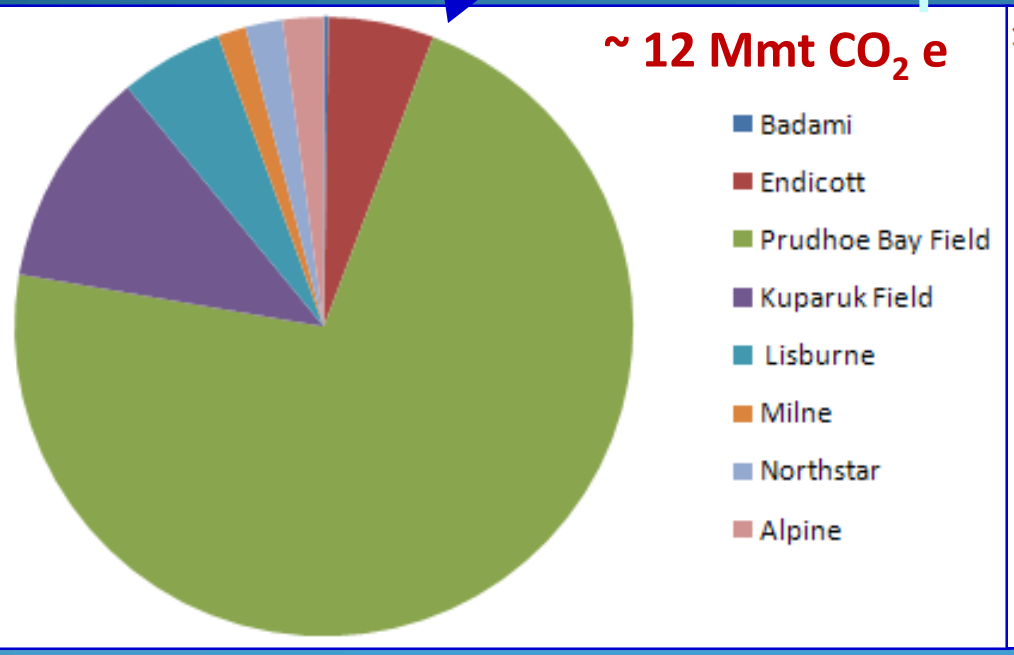
~ 15 Mmt CO_2 e

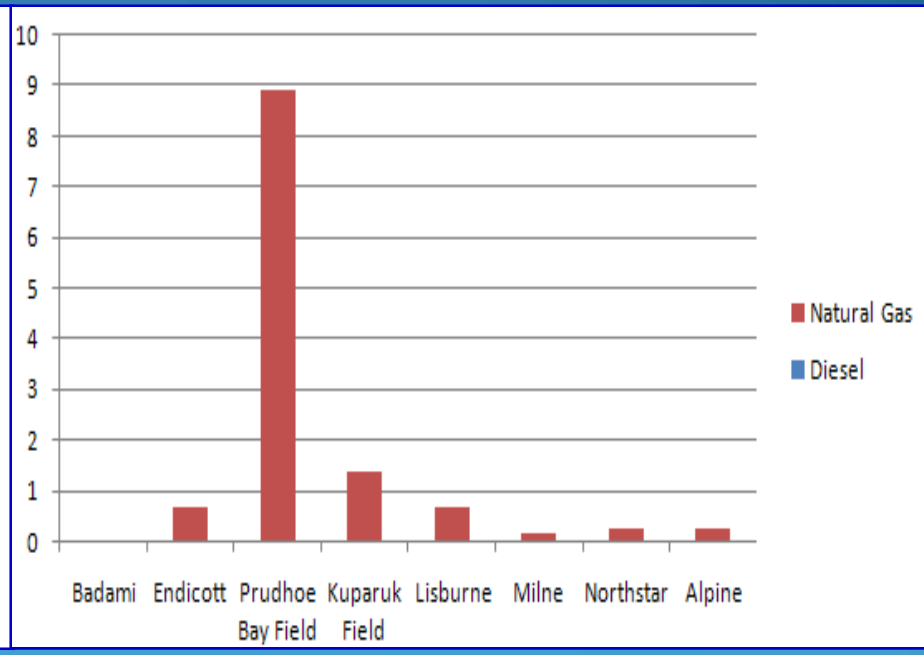
DRAFT - Alaska DEC Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory, January 2008

Alaska Title V O+G GHG Emissions



North Slope O+G Emissions





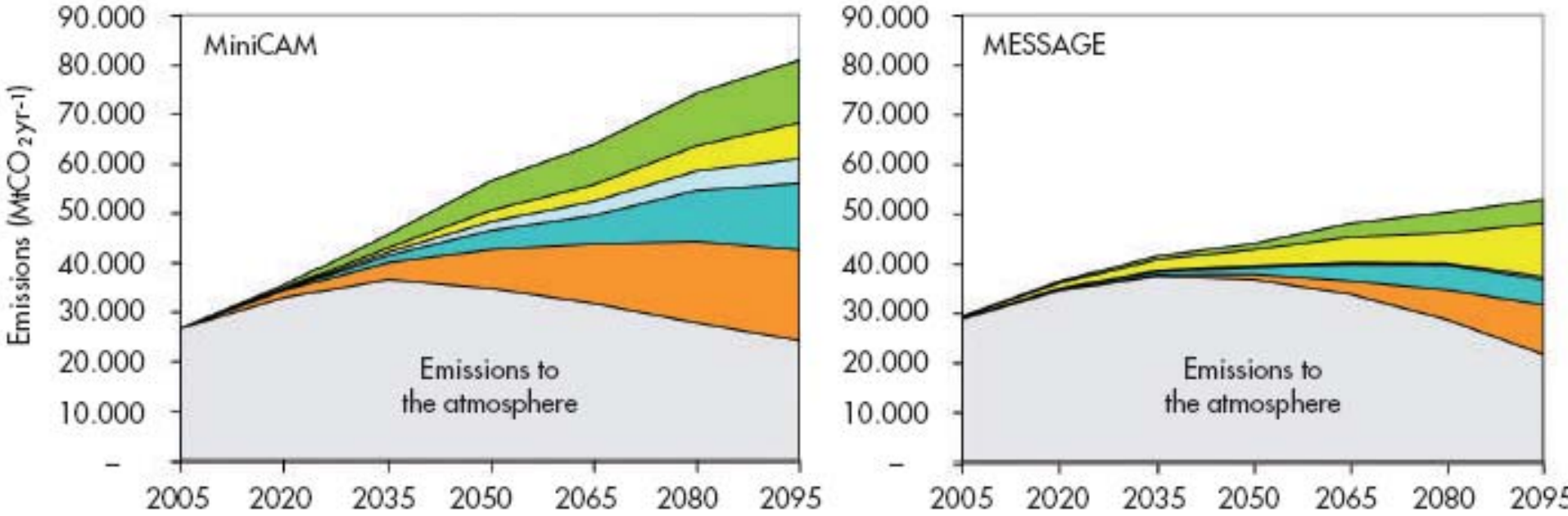
North Slope emissions predominantly due to combustion of natural gas

Generated from *ADEC Alaska Industrial Inventory Calculator.xls*. Based on 2002 fuel consumption. Spreadsheet used to prepare *DRAFT - Alaska DEC Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory, January 2008*

TWG working Options February 5, 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)

IPCC Models



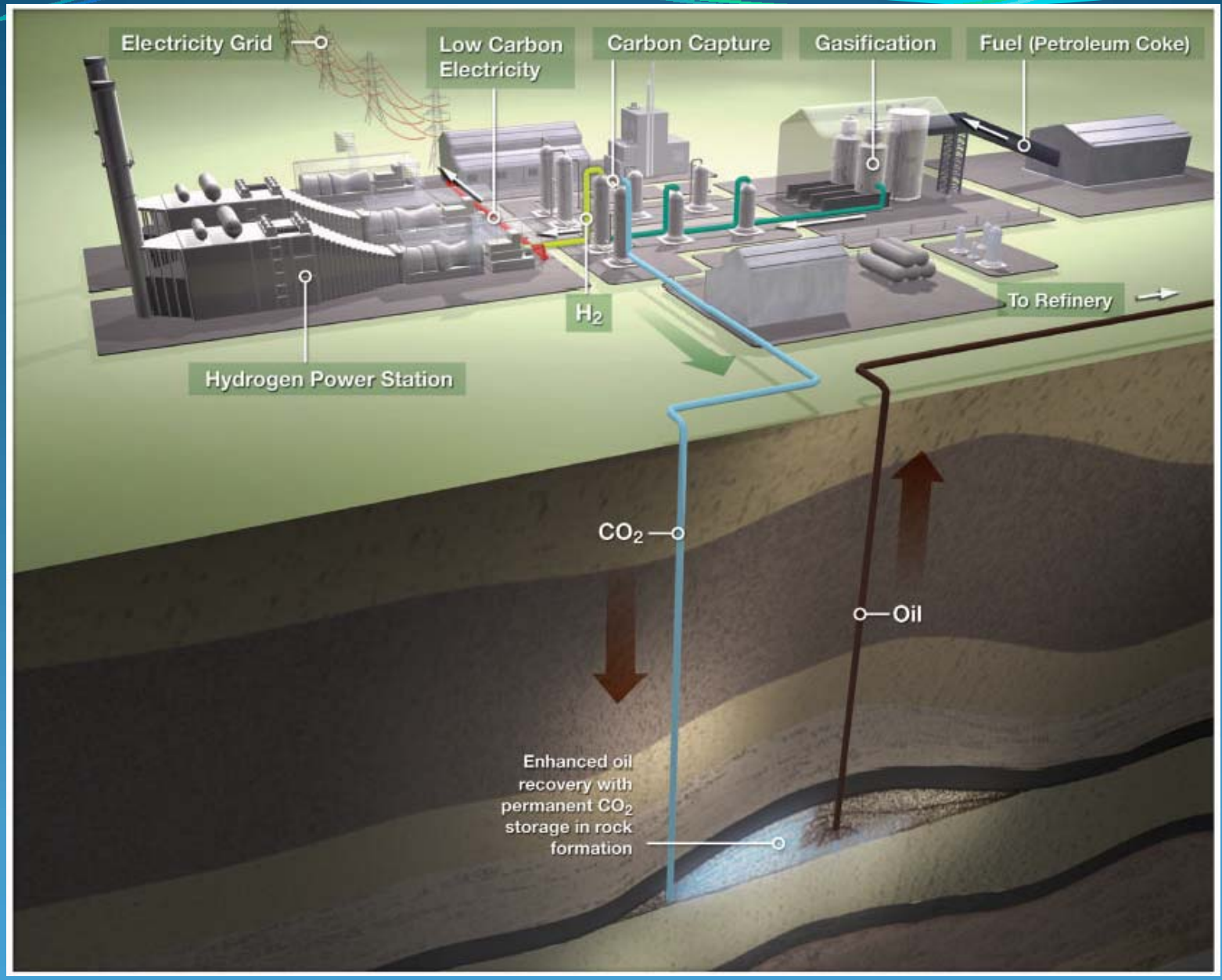
Illustrative examples of the potential global contribution of CCS based on two alternative integrated assessment models (MESSAGE and MiniCAM) from the IPCC Special Report on Carbon Dioxide Capture and Storage

IPCC Special Report on Carbon Dioxide Capture and Storage,2005

Technical

- Feasibility of various entrained and exhaust CO_2 capture technologies for North Slope and Cook Inlet
- Study where renewable energy sources co-exist with Oil and Gas operations
- Feasibility of using hydrogen produced from methane as a fuel source
- Feasibility of producing power on North Slope, capturing and sequestering the emissions there, and using long term transmission lines to deliver power to markets
- Bathymetry and Detailed DEM information (Industry is currently collecting this information but it is not made public)
- Regionally appropriate baseline physical mapping and imagery including bathymetry
- Regionally appropriate baseline mapping an monitoring of surface and subsurface (groundwater) hydrology

Thermal Energy Efficiency at Oil and Gas Operations



CO2 storage

- Evaluate capacity of geologic and biologic sequestration in different regions of the State of Alaska
- Evaluate the feasibility of saline reservoir sequestration in non-marine basins prevalent throughout Alaska
- Evaluate enhanced hydrocarbon recovery options using CO2 flooding and pressure support

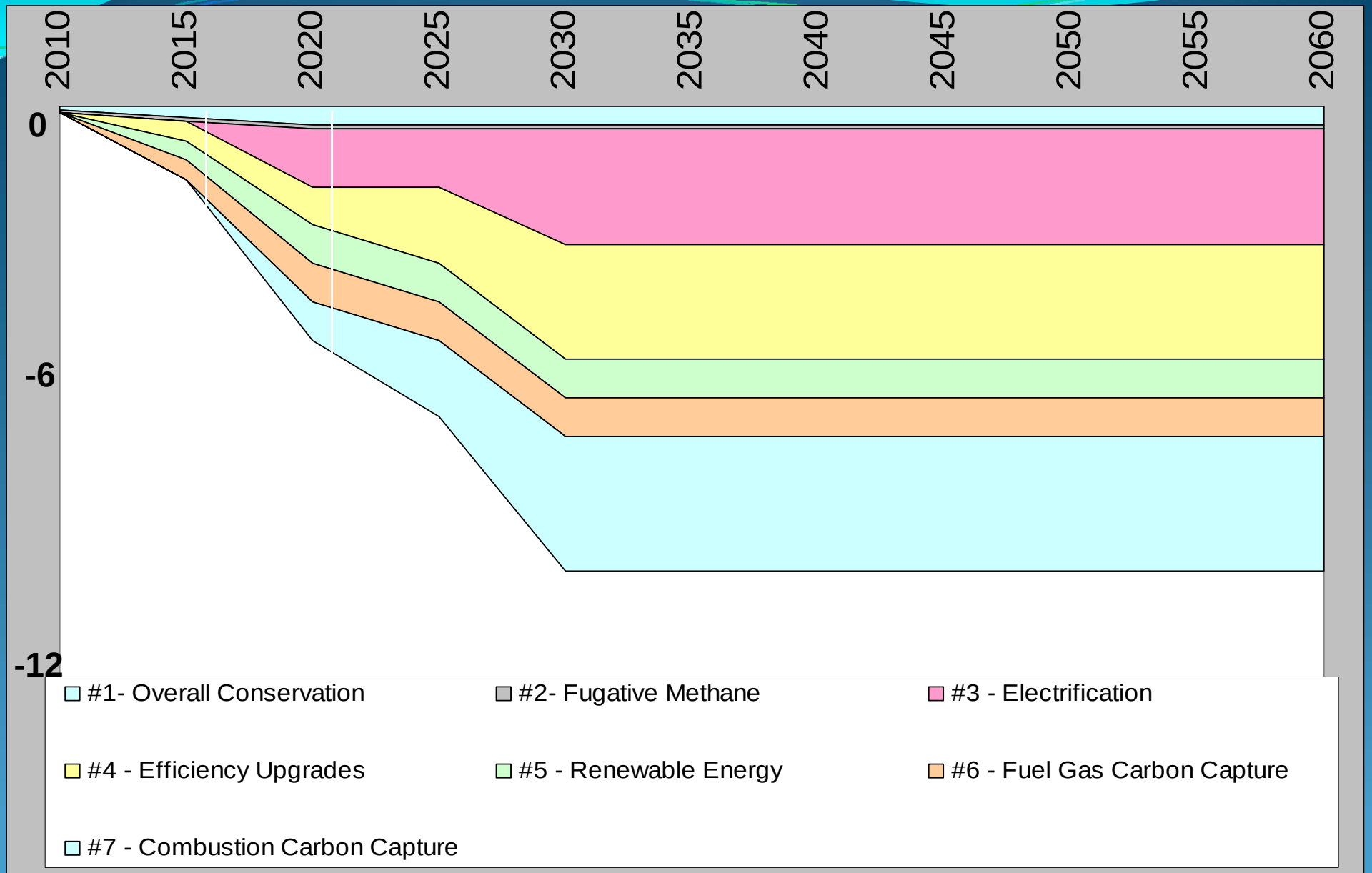
Infrastructure

- Identify critical infrastructure risks associated with:
  - Changes in permafrost
  - Changes in surface and subsurface hydrology
  - Sea level changes
  - Changes in habitats and wetlands
  - Changes in season lengths
  - Coastal erosion from reduced sea ice
  - Changes in shipping scenarios
  - Data sets, maps, and digital information needed for long term monitoring and forecasting of environmental change
  - Engineering change needed in operations, i.e., platform design

Economic

- Short and long term value of carbon
- Short and long term value of natural gas
- Impact of various incentives to major capital improvement investment
- Potential impact of carbon mitigation efforts on royalty revenue stream coming to the State of Alaska from O&G production

Conceptual NS GHG Reduction Timeline



Discussion

Conservation / Waste Reduction

1) Conservation Best Practices, ie:

- Consumption of liquid fuel at/in support of North Slope Oil Fields;
- Minimize fuel required for operation of flares;
- Optimize existing process to minimize energy consumption;
- Reduce miles driven in support of operations by employees and contractors;
- Increase fuel economy of vehicles used in support of operations;
- Cut electricity use in offices and camps.

Conservation / Waste Reduction

2) Reduce Fugitive Methane Emissions

- Refine fugitive methane inventories;
- Assess potential reductions of fugitive methane;
- May be

Conservation/Waste Reduction

Benefits:

- Some GHG emission reductions
- Raise awareness, cultivate culture that could spread outside of the work environment

Barriers to implementation:

- Leak inventory is statistical

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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

Thermal Energy Efficiency

Benefits:

- Significant GHG emission reductions (up to 70%)
- Major efficiencies mean less gas burned, more available for eventual sale

Barriers to implementation:

- Cost
- Cross Unit complications, royalty rules
- Permitting and regulatory hurdles

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Carbon Capture and Geologic Sequestration

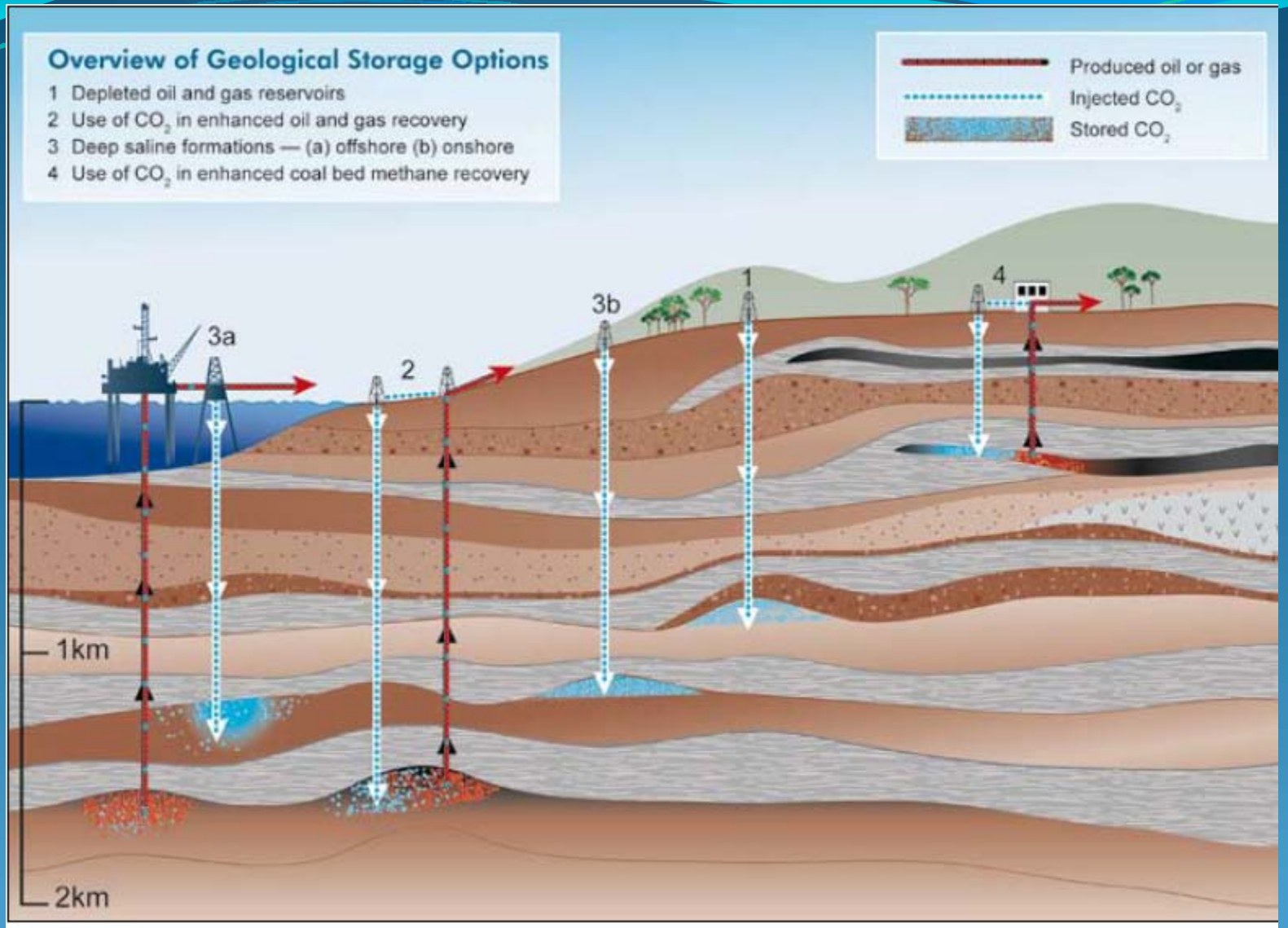

Figure TS.7. Methods for storing CO_2 in deep underground geological formations. Two methods may be combined with the recovery of hydrocarbons: EOR (2) and ECBM (4). See text for explanation of these methods (Courtesy CO2CRC).

IPCC Special Report on Carbon Dioxide Capture and Storage,2005

Carbon Capture and Geologic Sequestration*

6) CCS from fuel gas at Prudhoe, before combustion. Sequester in nearby reservoirs where enhanced oil recovery can be used.

7) CCS from Prudhoe generators exhaust gas, after combustion. Sequester in nearby reservoirs where enhanced oil recovery can be used.

8) CCS from Interior Power Plants. Ship CO_2 to known reservoir or explore for nearby sequestration site. (This option is much more difficult and expensive to enact without a proven reservoir.)

* Carbon capture is currently very expensive technology, untested in Alaska, and power (and water) intensive. See Appendices on write ups for details.

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Carbon Capture and Geologic Sequestration

Benefits:

- Significant GHG emission reductions (up to 90%)
- Early Enhanced Oil Recovery opportunities
- Capture of entrained CO_2 will be required for gas sales anyway.

Barriers to implementation:

- Cost, parasitic power requirements
- Space availability at existing facilities
- Regulatory environment uncertain (EPA injection rules, pore space ownership, long term liability, long term monitoring requirements…)

Summary

- Short Term: Best practices and Conservation can be implemented almost immediately. Need to analyze then minimize fugitive emissions.
- North Slope has highest emissions for O&G sector, increased energy efficiency there could result in significant emissions reductions . Will require massive investments and changes to regulatory environment. Eventual gas sales will dramatically change the economic and GHG emissions picture.
- North Slope Carbon Capture and Geologic Sequestration could be used to further significantly reduce emissions. Technology is in early stages, will require major facilities upgrades, and additional fuel will be burned.
- Many options also applicable to Cook Inlet and other O&G operations.

Summary Options –Stand alone*

#	Option Description	Estimated target emissions (in MMT CO_2e)	Remainder after max reductions	Cost Estimate $ - Millions $$ -10's of Millions $$$ - 100's of Millions $$$$ - Billions	Technical Risk	Earliest Possible Implementation
	Conservation	**12.0**	→ **11.4**			
1	Best Conservation Practices	12.0	11.5	0-$$	Low-Medium	0-2 yrs
2	Reduce Fugitive Methane	12.0	11.9	$-$$	Low	1-5 yrs
	Thermal Energy Efficiency	**12.0**	→ **4.0**			
3	Electrification, Centralized Power	12.0	4.0	$$$$	Medium	10 yrs
4	Improved Efficiency Equipment	12.0	6.0	$$-$$$$	Low	5 yrs
5	Renewable Energy	12.0	11.0	$$-$$$$	High	5 yrs
	Carbon Capture and Storage	**12.0**	→ **.5-1.0**	But Major Resources Wasted!!		
6	CCS from High CO_2 fuel at Prudhoe	12.0	11.0	$$$	Low	5-10 yrs
7	CCS from Combustion Sources	12.0	.5-1.0	$$$$	High	10 yrs
	Non O&G					
8	CCS away from O&G fields	**3.0**	**2.5**	$$$$	High	15 yrs

*All numbers are rounded approximations only

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

Summary Options – Sequential*

#	Option Description	Estimated target emissions (in MMT CO_2e)	Remainder after max reductions	Cost Estimate $ - Millions $$ -10's of Millions $$$ - 100's of Millions $$$$ - Billions	Technical Risk	Earliest Possible Implementation
	Conservation	**12.0**	**11.5**			
1	Best Conservation Practices	.3-.8	.1-.3	0-$$	Low-Medium	0-2 yrs
2	Reduce Fugitive Methane	.2	.05-1.0	$-$$	Low	1-5 yrs
	Thermal Energy Efficiency	**11.5**	**4.0-5.0**			
3	Electrification, Centralized Power			$$$$	Medium	10 yrs
4	Improved Efficiency Equipment			$$-$$$$	Low	5 yrs
5	Renewable Energy	1.0	.1	$$-$$$$	High	5 yrs
	Carbon Capture and Storage	**4.0-5.0**	**.5-1.0**			
6	CCS from High CO_2 fuel at Prudhoe	**1.0**	**.1**	$$$	Low	5-10 yrs
7	CCS from Combustion Sources			$$$$	High	10 yrs
	Non O&G					
8	CCS away from O&G fields	**3.0**	**2.5**	$$$$	High	15 yrs

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

Enabling Themes in Facilitating GHG Reductions

- Support economic vitality of Alaska
- Create an economic climate that encourages capital investment
- Ensure Regulatory Simplicity

Research Recommendations

- Economic Studies
  - Short and long term value of carbon
  - Short and long term value of natural gas
  - Impact of various incentives to encourage major capital improvement investments

Research Recommendations (cont.)

- Technical Studies
  - CO_2 capture technologies for North Slope and Cook Inlet
  - Determine where renewable energy sources co-exist with Oil and Gas operations
  - Feasibility of using hydrogen produced from methane as a fuel source
  - Feasibility of producing power on North Slope, capturing and sequestering the emissions there, and using long term transmission lines to deliver power to markets

Overview

- Enabling Themes
- Inventory Analysis Conclusions
- Options Review
- Summary

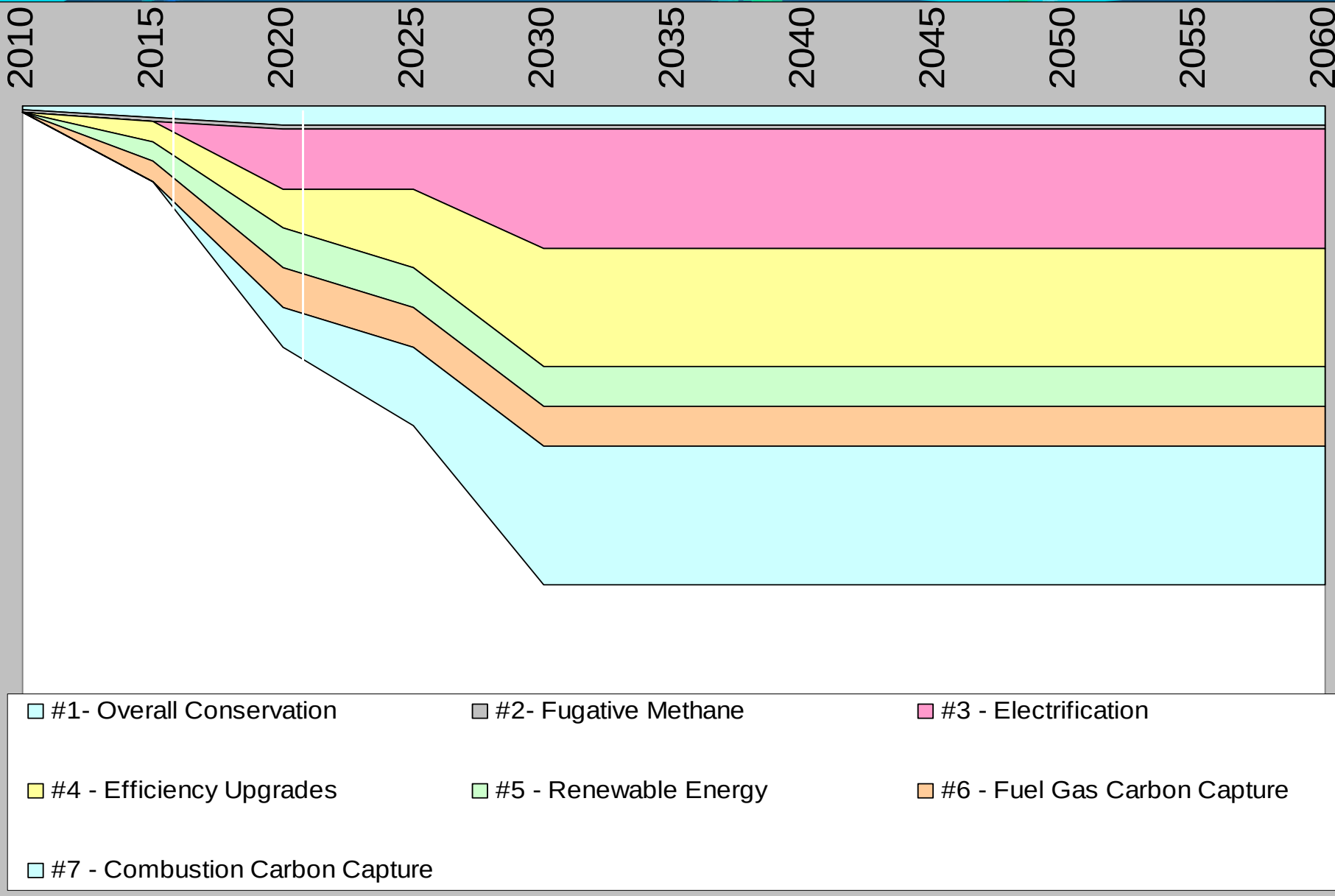
Enabling Themes

- Support economic vitality of Alaska
- Encourage capital investment
- Ensure Regulatory Simplicity

Inventory Analysis Conclusions

- 15 Mmt CO_2e for O&G of 52 Mmt CO_2e Alaska Gross GHG emissions
- 12 Mmt CO_2e from NS Operations, Fuel gas consumption largest component
- Option recommendations address inventory conclusions
- Many lessons learned from North Slope can be applied to Cook Inlet and other O&G operations

O&G TWG Conceptual GHG Reduction Timeline



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