

IPEC 2011 Conference

Sustainable Environmental Strategies for the Marcellus Shale Play

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Outline

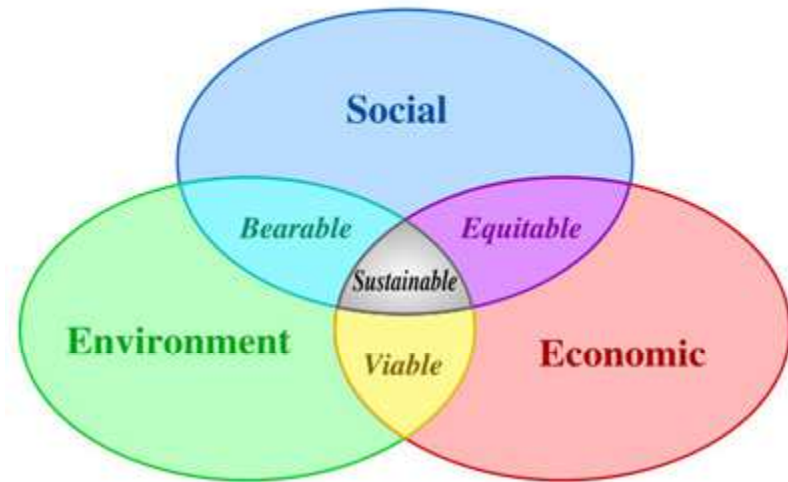
- Sustainability 101
 - Corporate Citizenship
- Sustainability Evaluations
 - Carbon and Water Footprint Basics
 - Life-cycle and Systems Approach
- Green and Sustainable Practices
 - What being “Green” means
 - Examples and opportunities
- Recent Developments

Sustainability 101

Definition: *“Meeting the needs of the present without compromising the ability of future generations to meet their own needs.”*

(UN Brundtland Commission -1987)

*Marcellus Shale:
A Sustainable Technology?*



“The Triple Bottom Line”

Carbon Footprint Basics



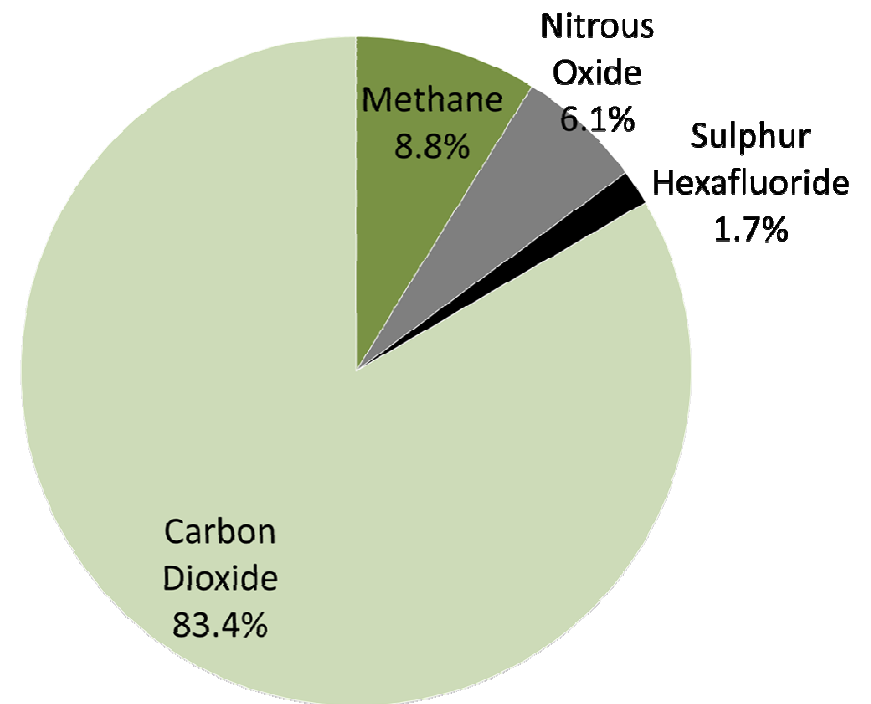
A carbon footprint

- Measure of the amount of greenhouse gases produced.
- A significant component of sustainable practices.

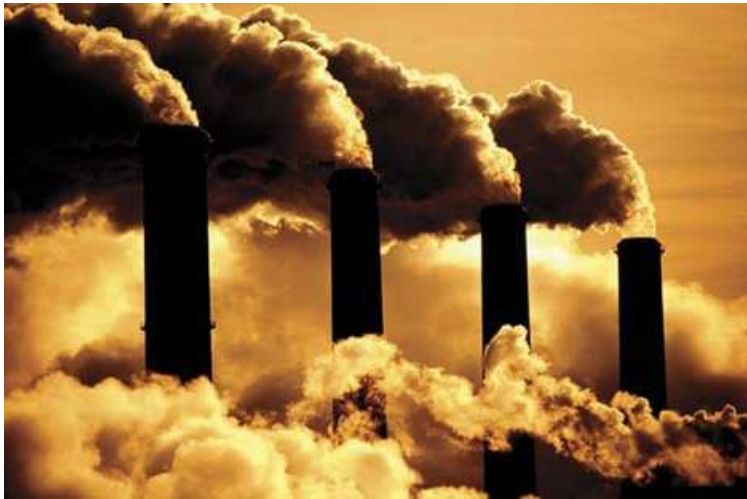
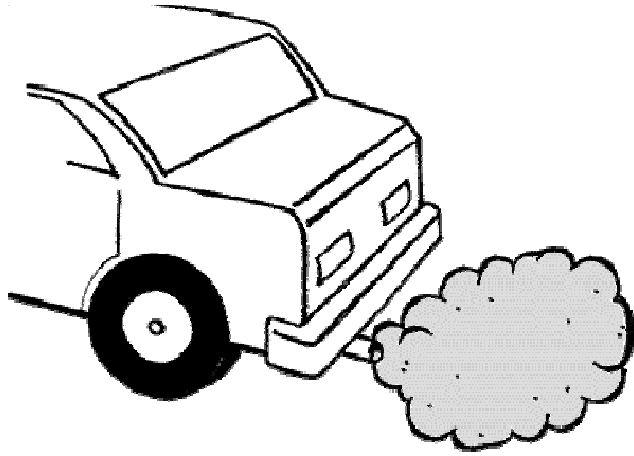
CO₂ vs. CO₂e

- CO₂ equivalent (CO₂e) is the standard for carbon footprint.
- CO₂e takes into account the heat trapping index of the greenhouse gases.
- CO₂e provides a single metric that accounts for all greenhouse gas emissions.

Four Main Contributors to Greenhouse Gas Emissions



Carbon Footprint Basics

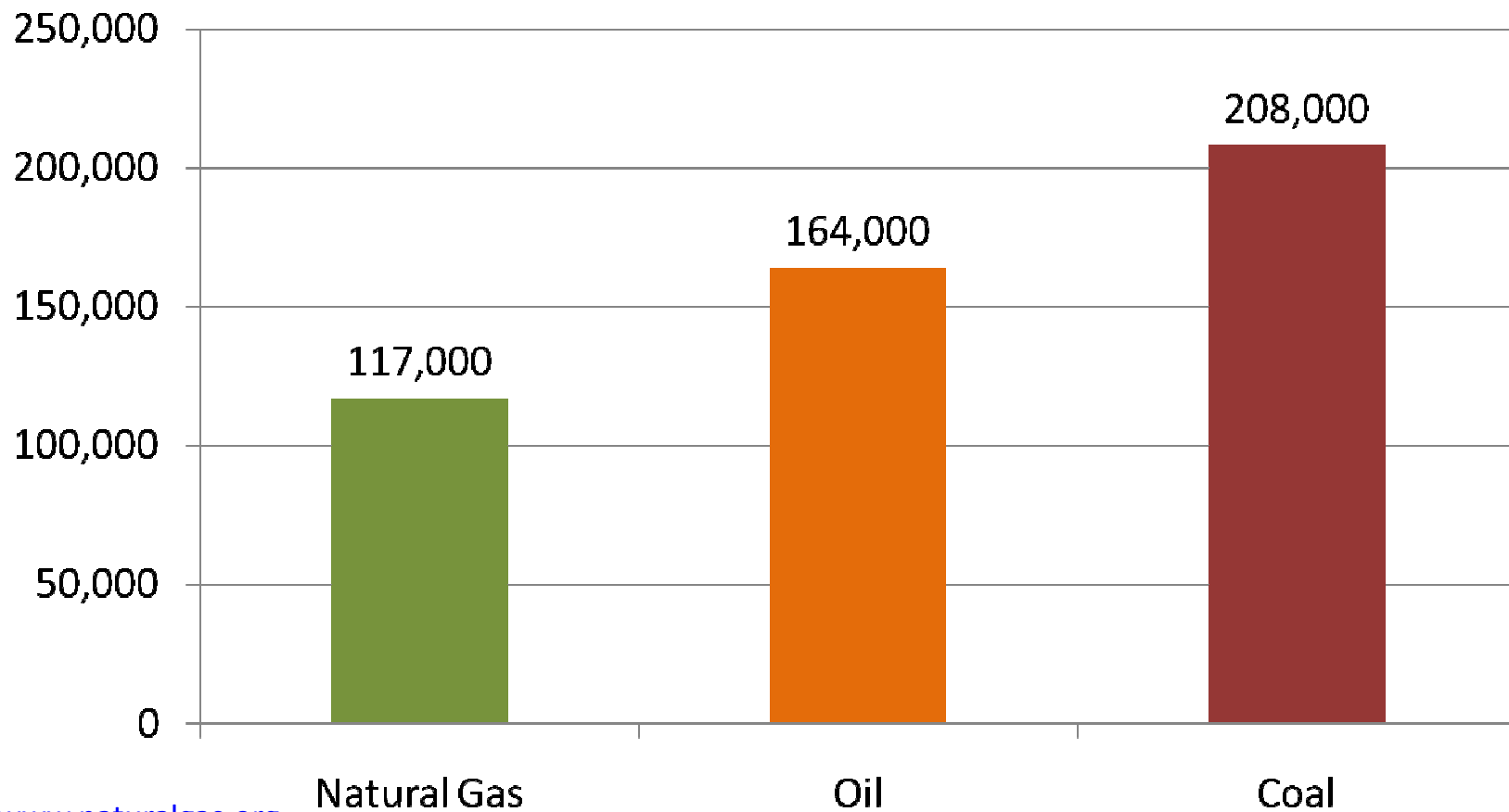


Carbon footprint components:

1. **Primary footprint** - direct emissions of CO₂e from the burning of fossil fuels including domestic energy consumption and transportation
2. **Secondary footprint** - indirect CO₂e emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown.

CO₂ emissions of Fossil Fuels

Pounds of CO₂ per Million BTU of Energy Input

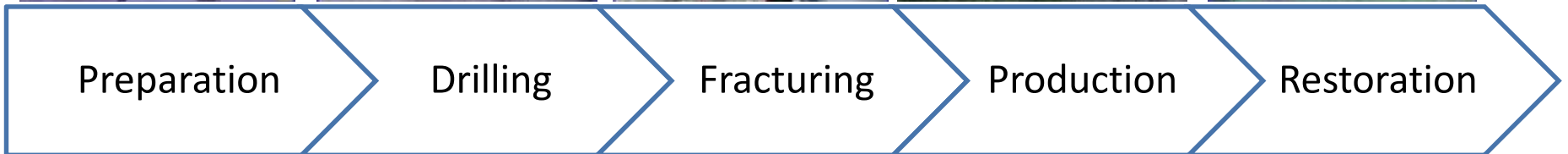


Source: www.naturalgas.org

Life-Cycle Approach



TYPICAL LIFE-CYCLE



MARCELLUS SHALE LIFE-CYCLE

Technical Excellence Practical Experience Client Responsiveness

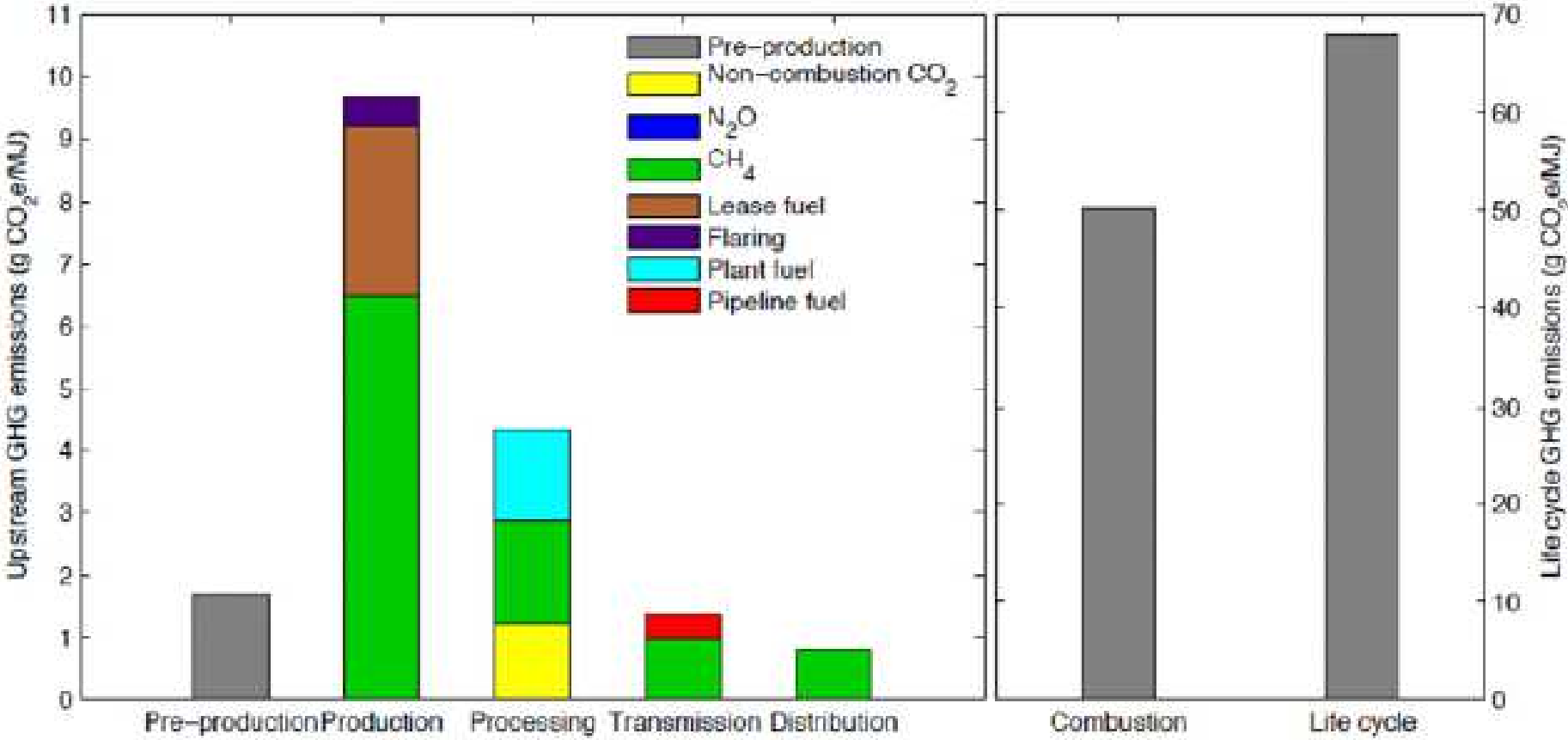
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ISO 14040/14044 Life-Cycle Assessment Framework



- Framework for sustainable evaluations:
 - Count everything
 - Don't count twice
 - Produces recognized and defensible results
 - Carbon footprint
 - Water footprint

Life-Cycle GHG from Marcellus Gas



No carbon capture is included after combustion.

Source: Jiang et. al. "Life cycle greenhouse gas emissions of Marcellus shale gas", Carnegie Mellon University (2011).

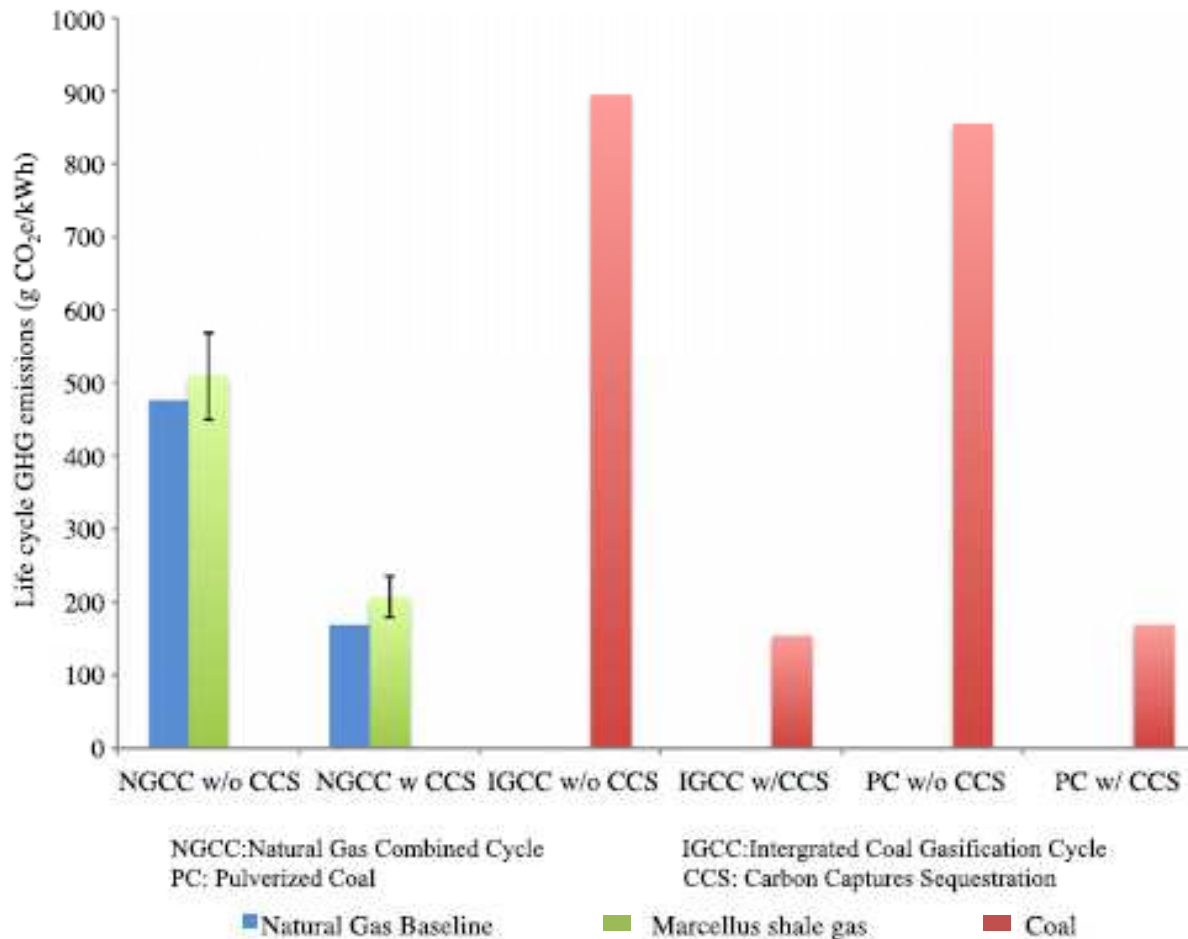
Carnegie-Mellon Study

- GHG emissions similar to conventional gas plays
 - Only about 3% higher
- Study funded by Sierra Club
- Disagrees with Cornell Study
- 1/2 water reused
- 1/2 raw water from a treatment plant

Source: Jiang et. al. “Life cycle greenhouse gas emissions of Marcellus shale gas”, Carnegie Mellon University (2011).



Comparison Life-Cycle GHG from current domestic natural gas sources



Source: Jiang et. al. "Life cycle greenhouse gas emissions of Marcellus shale gas", Carnegie Mellon University (2011).

Water Footprint Basics

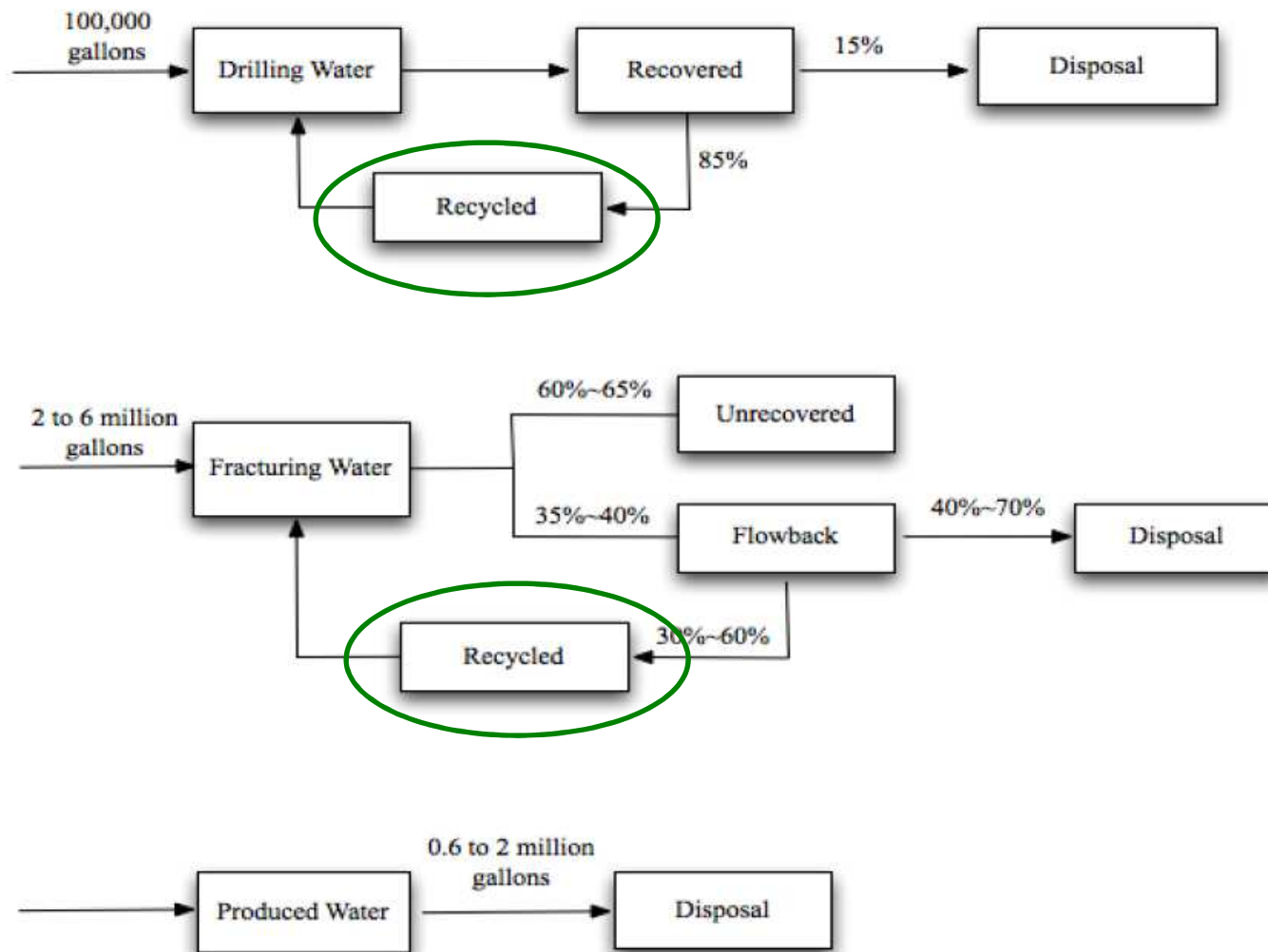
- Freshwater
- Wastewater
- Municipal water

A key aspect of carbon footprint is the water cycle.

- Municipal water is highly energy-intensive, with 1000 to 6000 kWh needed per million gallons



Water Life-cycle in Marcellus Shale Development



Source: Jiang et. al. "Life cycle greenhouse gas emissions of Marcellus shale gas", Carnegie Mellon University (2011).

Water Management

Langan designed centralized water management project

Langan project

Over 65 percent of flowback water is now recycled, a dramatic increase from previous years.

Marcellus shale natural gas wells use 0.2% of the daily statewide total water withdrawal.



Natural Gas

When the wind doesn't blow and the sun doesn't shine

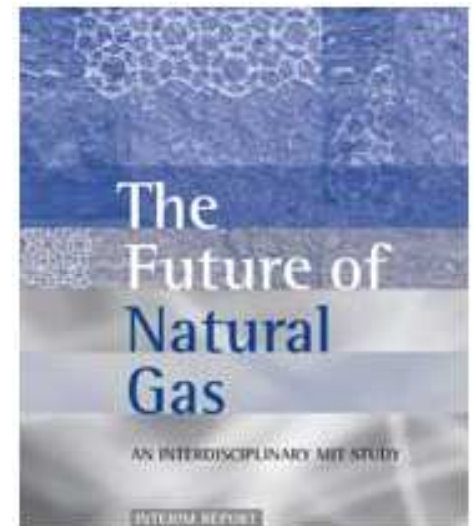


Natural Gas “Green” Credentials

- Sustainable Technology
 - Low carbon footprint
 - Commercially available now
 - Part of a diversified renewable energy strategy

- MIT Report: The Future of Natural Gas

<http://web.mit.edu/mitei/research/studies/naturalgas.html>



Green and Sustainable Ideas

Shell Onshore Tight/Shale Oil & Gas Operating Principles:

http://www-static.shell.com/static/usa/downloads/2010/onshore/onshore_principles.pdf

- Reduce use of potable water and use of non-potable water
- Recycle fracturing fluid and flowback water
- Store, treat and dispose off site.
- Measure, catalog and report water emissions
- Test for fugitive vapor emissions
- Reduce trucking by using pipelines
- Best practices for developing and reclaiming sites



Green Well Completion

- Minimizes the release of GHGs, notably methane.
- Minimizes the release of VOC's that result in odor complaints.
- Maximizes the recovery of the resource by diverting gas to the salesline instead of the atmosphere.



Photo courtesy of
Devon Energy

Beneficial Re-use of Fill Materials

Steel slag

Drill cuttings

Amending on-site soils

Re-used concrete

Brownfield soil cap





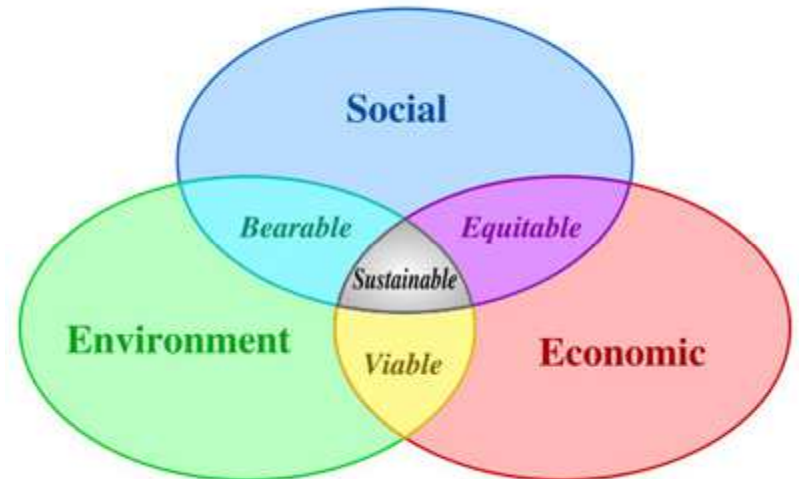
Natural Gas Fleet

25% reduction in GHG Emissions
from conversion to Liquefied Natural
Gas or Compressed Natural Gas
Vehicles.

Benefits of a Sustainability Strategy

Why pursue a sustainability strategy?

- Recognition:
 - Supports Corporate Social Responsibility (CSR) goals
 - Supports productive relationships with regulatory agencies
 - Supports positive community relations
- Cost savings:
 - Improved efficiency, notably in reduced costs.



Recent Developments

- Governor's Commission Report
- Citizens Commission Report
- Legislation. . . .



Governor Corbett's Marcellus Shale Advisory Commission Report

July 2011

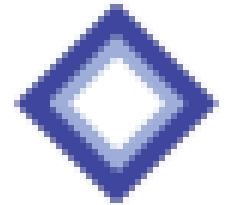


Governor's Marcellus Shale
Advisory Commission

- Key sustainable recommendations:
 - Incentives for use of natural gas in transportation
 - Incentives for rail, rather than trucking
 - Monitor and protect natural resources
 - Local impact fee
 - Positive relations with communities

Citizens Marcellus Shale Commission

October 2011



- Community and environmental activists
 - Only one engineer (retired) and no geologists
- Many suggestions (some useful, some not)
 - Grout full length of borehole
 - Use advanced well sealants
 - Planning/scheduling of water withdrawals
 - Aquifer tests
 - Water use fees
 - Jobs for Pennsylvanians
 - Siting of compressor stations away from residents

Recent Developments

"This bill contains many of the provisions contained in our proposal, and I am pleased to see the legislature working toward a final bill. . . . "

- Governor Tom Corbett 11-7-11

- Bill winding its way through the legislature. . .

Questions?



Technical Excellence

Practical Experience

Client Responsiveness

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