

Coal vs. Natural Gas Energy Production

Daniel Frazier, Renee Gomez, Nathan Westbrook





Roadmap

- Global energy demand on the rise!
- Why do we care?
- Overview of coal based energy production
- Overview of natural gas based energy production
- Quantifying environmental impact
- Coal vs. Natural Gas-The impacts and improvements
- Final verdict



Global Energy Demand Is Growing!

- Global energy demand grew by 8% from 2008-2012
- Demand projected to increase by 37% by 2040
- Development of renewables is being outpaced by energy demand growth
- How to meet this increasing demand?
 - Coal
 - Natural Gas



Question

Given the choice of either <u>coal</u> or <u>natural</u> <u>gas</u> based power production, which is better?

Let's take a look!



Environmental Concerns

- Traditional methods of energy production produce greenhouse gases.
 - Global warming
 - Other environmental concerns
- Important issue when comparing energy sources!





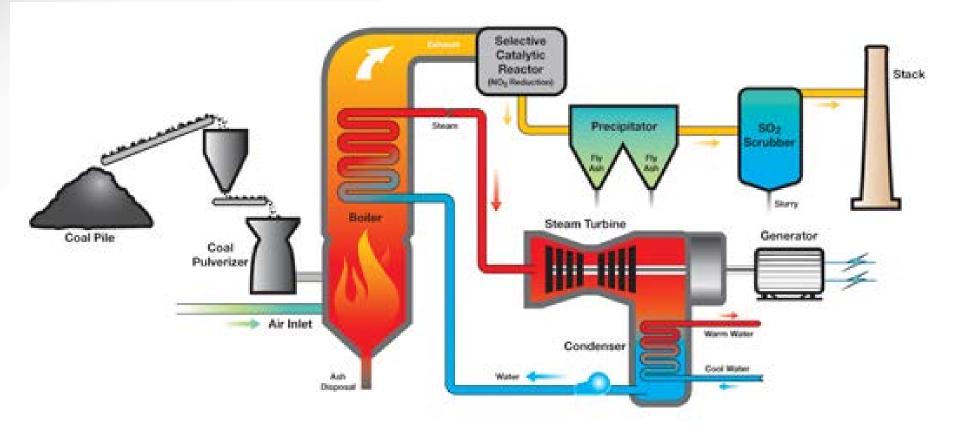
Coal Based Energy Production

- "Traditional" fuel for electricity production
- Accounts for ~40% of electricity production nationwide
- Used to produce electricity for public since first "Edison Plant" in NY in 1882.





Typical Coal Power Plant Process



Source: http://www.ascovalve.com/Common/Images/Coal_Plant_Simple.jpg



Impacts of Coal Based Power Production

- Significant water use to remove impurities
- Emission of CO₂, SO₂, NO_X, mercury compounds
- Leaves behind ash → requires disposal

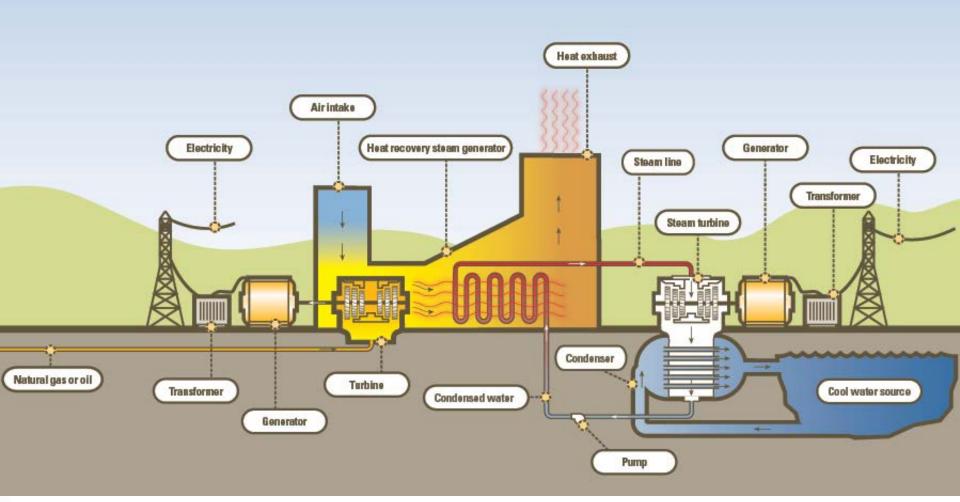


Natural Gas Based Energy Production

- Newer technology
- Accounts for ~28% of electricity production in the U.S.
 - But this number is growing!
- Results in significant reduction of GHG emissions at the plant level!
- Can be transported in pipeline → lower energy requirement than coal



Typical Natural Gas Power Plant Process



Source: http://www.c2es.org/publications/leveraging-natural-gas-reduce-greenhouse-gas-emissions

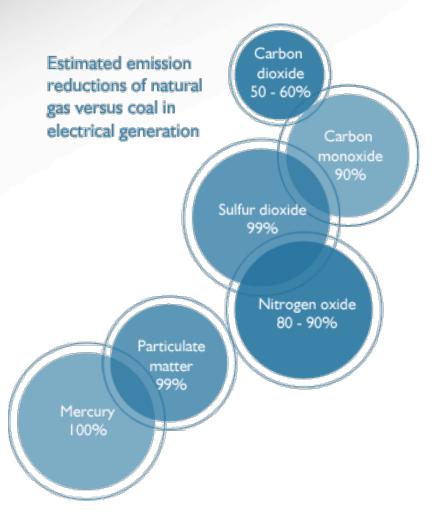


Impacts of Natural Gas Based Power Production

- Methane leakage in pipelines
- Hydraulic fracturing used to produce natural gas
- Impacts of hydraulic fracturing may outweigh NG benefits as fuel source



Is Natural Gas the Answer?



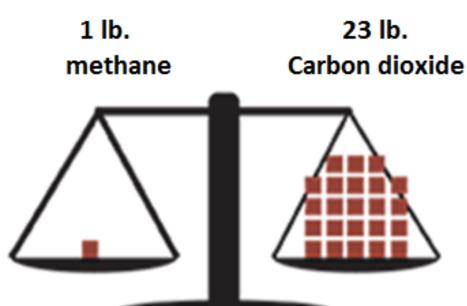




Background



- Methane
 - More potent GHG



- CO₂- ↑ atmospheric lifetime
- CH_4 \downarrow atmospheric lifetime

Heat Trapping Ability

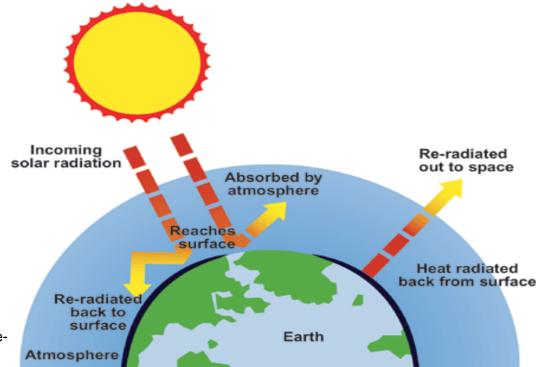


Quantifying Greenhouse Gas Emissions-Radiative Forcing:

RF=(incoming solar radiation)-(outgoing solar radiation)

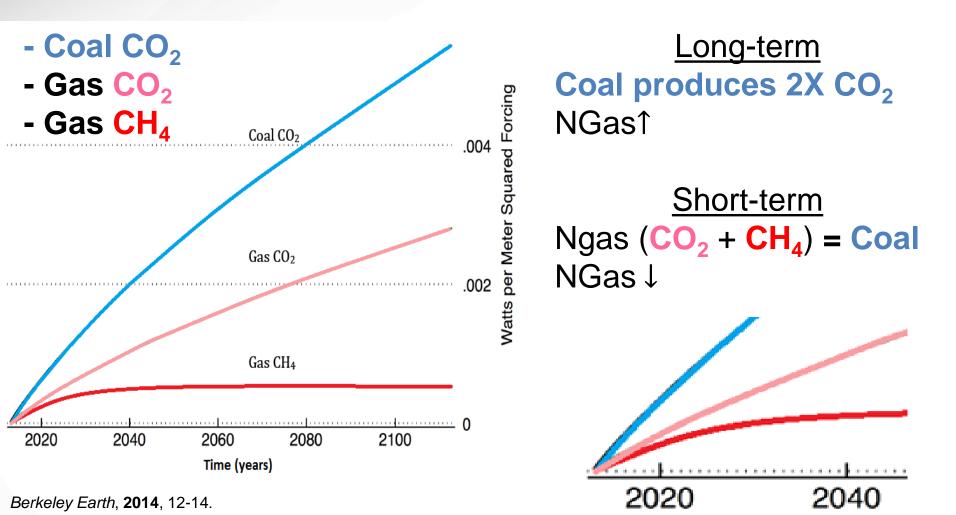
- Assess climate response of different GHGs
- Instantaneous measure
 - must consider future impacts

http://www.thetruthdenied.com/news/2014/04/25/debunk-climatechange-srm-with-cemenite/





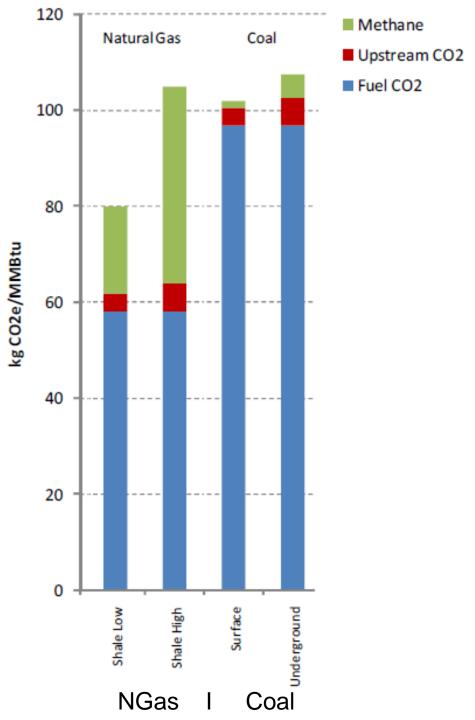
Comparison of RF Values of Coal and Natural Gas





Life Cycle Assessment

- 100 year period
 - Methane
 - CO₂
 - Upstream CO₂
 - Sale of fossil fuels



Climatic Change Letters. 2011



Greener Processes for Energy Conversion

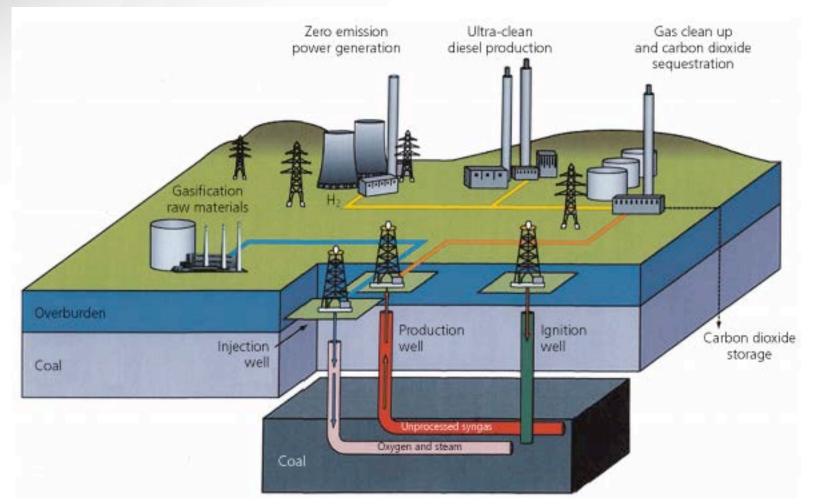
 New processes of converting coal to energy

• New methods of acquiring natural gas





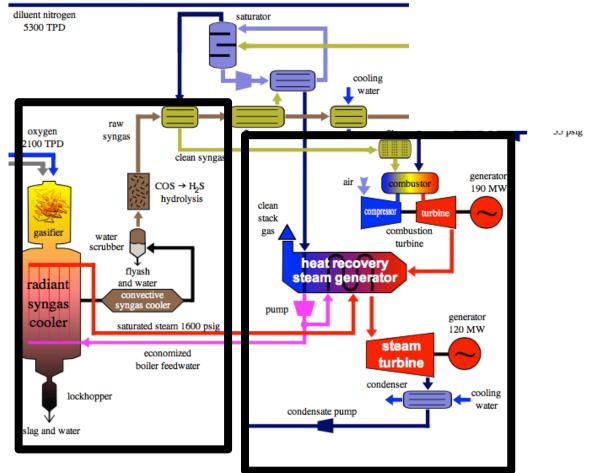
Underground Coal Gasification (UCG)



Proc. Inst. Civ. Eng.-Energy 2012, 165, 165-167.



Integrated Gasification Combined Cycle (IGCC)



http://large.stanford.edu/courses/2012/ph240/mao2/



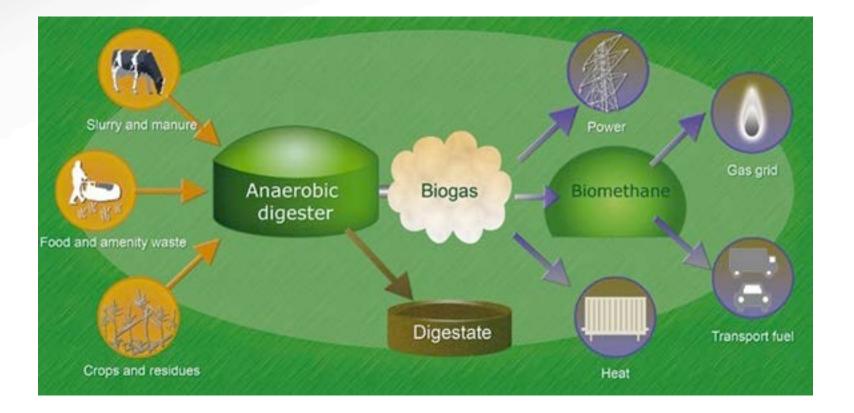
Comparison of IGCC with and without Carbon Capture and Storage (CCS)

| | IGCC | IGCC+CCS |
|--|-------|----------|
| Coal chemical power input (MW) | 1000 | 1000 |
| Gross power output (MW) | 513.4 | 459.3 |
| CO ₂ capture and compression (MW) | 0 | 32.1 |
| Net power output (MW) | 438.8 | 352.6 |
| Net efficiency (%) | 43.88 | 35.26 |
| CO ₂ specific emissions (g/kW h) | 770.1 | 95.9 |
| | | |

Appl. Energy 2014, 113, 1461-1474.



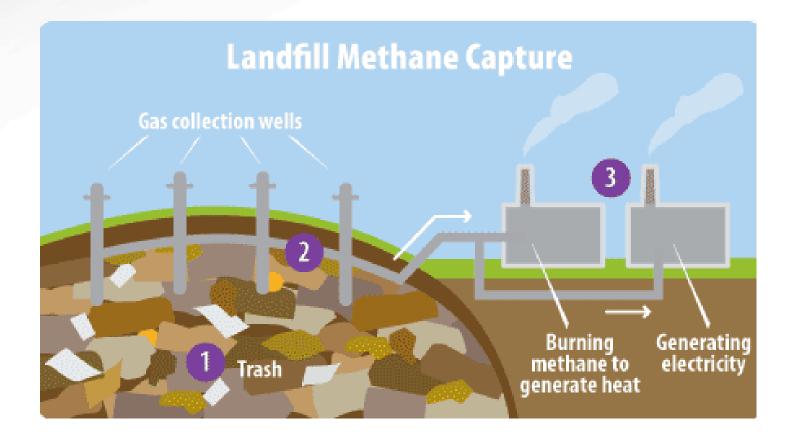
Biomass Conversion into Methane



http://www.upsbatterycenter.com/blog/biochemical-conversion-biomass-energy/



Methane Captured from Landfills



http://epa.gov/climatestudents/solutions/technologies/methane.html



Conclusions

- Coal vs. Natural Gas, which is better?
 - Evidence does not lend itself strongly to either side
- Future work
 - Reduce environmental impact of each approach through technological development
- Recommendation

– Underground natural gas fed power plant



Works Cited

- https://www.iea.org/Textbase/npsum/WEO20 14SUM.pdf
- http://static.berkeleyearth.org/memos/climateimpacts-of-coal-and-natural-gas.pdf
- http://www.scientificamerican.com/article/swit ch-to-natural-gas-slashes-power-plantpollution/
- https://www.encana.com/natural-gas/powergeneration.html



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