

Nuclear or Natural Gas?

For the Baseload Energy of the Future



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“The argument basically goes like this. When the wind isn’t blowing and the sun isn’t shining, renewables like solar and wind aren’t producing electricity. What happens during that time when we need energy? We need something more reliable — something that produces electricity all the time and that we can rely on. That’s baseload power.”

-Renewable Energy World

Two Options for the Baseload, Nuclear and Natural Gas, Across Four Dimensions

Economic

The costs associated with plant construction and day-to-day electricity production.

Environmental

The effects on local ecology and global greenhouse gas emissions

Safety & Reliability

The severity and impact on grid of accidents and failures, as well as the feasibility of safe plants and transportation nationwide.

Policy

The way the energy source is handled in the public sphere, through subsidization, regulation, and public opinion.

1. Economic Dimension



Initial Construction | Production Costs



Initial Construction

Nuclear

- Capital costs account for a majority of the total cost
- Plant construction rarely follows estimated timeline
- Difficulty financing new plants due to previous incidents (Three mile, Fukushima)

Natural Gas

- Existing network of well developed pipelines and processing plants
- Relatively cheap construction of drilling wells

Production Costs

Table 1a. Estimated LCOE (weighted average of regional values based on projected capacity additions) for new generation resources, plants entering service in 2022

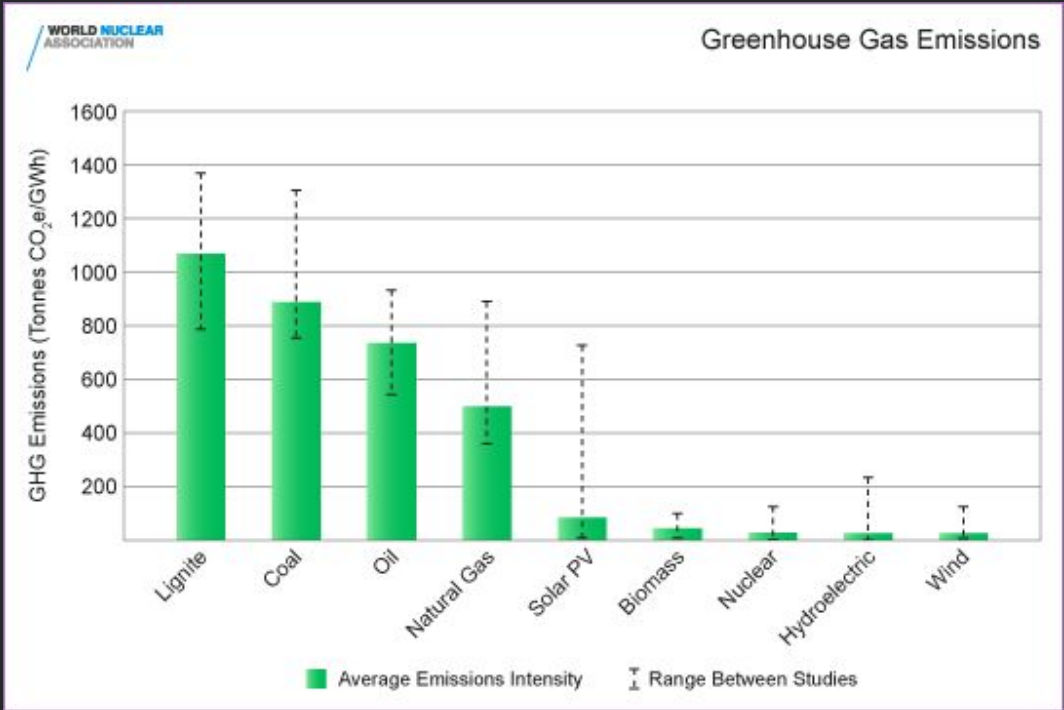
U.S. Capacity-Weighted ¹ Average LCOE (2015 \$/MWh) for Plants Entering Service in 2022								
Plant Type	Capacity Factor (%)	Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System LCOE	Levelized Tax Credit	Total LCOE including Tax Credit ²
Dispatchable Technologies								
Advanced Coal with CCS ³	N/B							
Natural Gas-fired								
Conventional Combined Cycle	87	12.8	1.4	41.2	1.0	56.4	N/A	56.4
Advanced Combined Cycle	87	15.4	1.3	38.1	1.1	55.8	N/A	55.8
Advanced CC with CCS	N/B							
Conventional Combustion Turbine	30	37.1	6.5	58.9	2.9	105.4	N/A	105.4
Advanced Combustion Turbine	30	25.9	2.5	61.9	3.3	93.6	N/A	93.6
Advanced Nuclear	90	75.0	12.4	11.3	1.0	99.7	N/A	99.7

2. Environmental Dimension

Global ramifications | Local impact



Emissions and Pollution



http://www.world-nuclear.org/uploadedImages/org/Nuclear_Basics/Lifecycle%20greenhouse%20gas%20emissions.png

Surrounding Areas

Nuclear

- Mining
- Safe/accepted ways to deal with radioactive waste
- Minimized human interaction

Natural Gas

- Disruption of ecosystems
- Accident prone with communities affected

3. Safety & Reliability Dimension



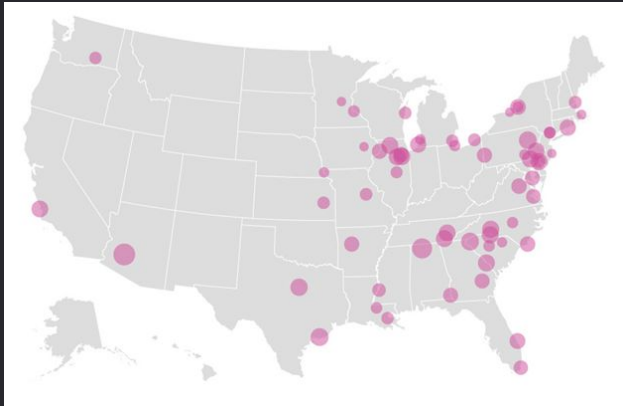
Restrictions and Regulations | Reliable Power Grids



Location, Location, Location...

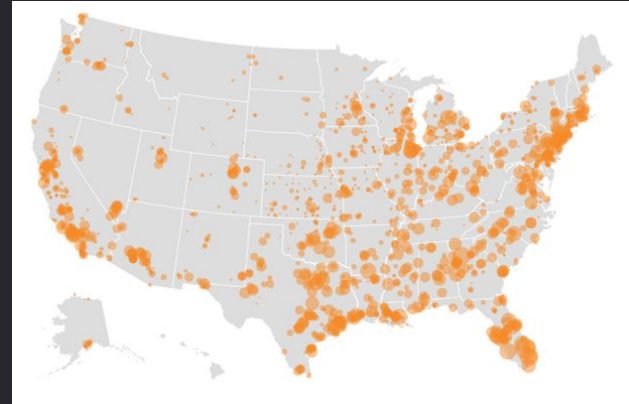
Nuclear

- Earthquakes
- Tsunamis
- Access to cooling water



Nuclear plants, 03-2017

Natural Gas plants, 03-2017



Natural Gas

- Less restricted
 - Wet and dry cooling

Reliability and Grid Impacts

Nuclear

- Accidents
 - 1-1.5 per year
 - Higher severity
- High impact
 - Small systems

Natural Gas

- Robust to most outages
 - Incidences rare
- Few “critical” points
 - Many wells
 - Widespread storage
 - Unmanned distribution

4. Policy Dimension



Subsidization | Regulation | Public Opinion



Subsidization

**Table ES2. Quantified energy-specific subsidies and support by type, FY 2010 and FY 2013
(million 2013 dollars)**

Beneficiary	Direct Expenditures	Tax Expenditures	Research & Development	DOE Loan Guarantee Program	Federal & RUS Electricity	Total	ARRA Related
2013							
Coal	74	769	202	-	30	1,075	129
Refined coal	-	10	-	-	-	10	-
Natural Gas and Petroleum Liquids	62	2,250	34	-	-	2,346	4
Nuclear	37	1,109	406	-	109	1,660	29

Regulation

Natural Gas

- Can easily be NSPS and ESPS compliant
- Vast majority of Natural Gas operators surveyed indicate that increased regulations would not be substantially detrimental

Nuclear

- Can easily be NSPS and ESPS compliant
- Further bound by the U.S. NRC
- Can store 90 days of fuel for guaranteed profitability under DOE proposal
- Approximately \$60 Million in regulatory compliance costs annually per plant

Public Opinion

U.S. Should Place "More Emphasis" on Each Source of Domestic Energy Production, by Party ID

Do you think that as a country, the United States should put more emphasis, less emphasis, or about the same emphasis as it does now on producing domestic energy from each of the following sources -- ?

	All Americans	Republicans	Independents	Democrats
	%	%	%	%
Solar power	76	68	74	87
Wind	71	59	68	83
Natural gas	65	78	62	59
Oil	46	71	43	29
Nuclear power	37	49	35	30
Coal	31	51	26	21

March 7-10, 2013

5. Conclusion and Recommendation



Final Comparison

Dimension of Analysis	Baseload Choice	Reason for Choice
Economic	Natural Gas	Without increased government subsidization, initial capital costs outweigh Nuclear's production advantage
Environmental	Nuclear	No emissions or harming of ecosystems
Safety & Security	Natural Gas	More flexibility in siting, which in turn allows for less impact on grid stability
Policy	Natural Gas	High public support and low regulatory costs

THANKS!

ANY QUESTIONS?



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