Renewables Comparison

Wind vs. Solar Energy

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Goal of the project

To determine whether wind energy or solar energy is a more efficient and sustainable alternative to coal energy for commercial use.

Alternatives to Coal Energy:

Wind Energy and Solar Energy, but what are they?

Wind energy is generated by: Wind turbines- which are turbines with a large vaned wheel that is rotated by wind to generate electricity

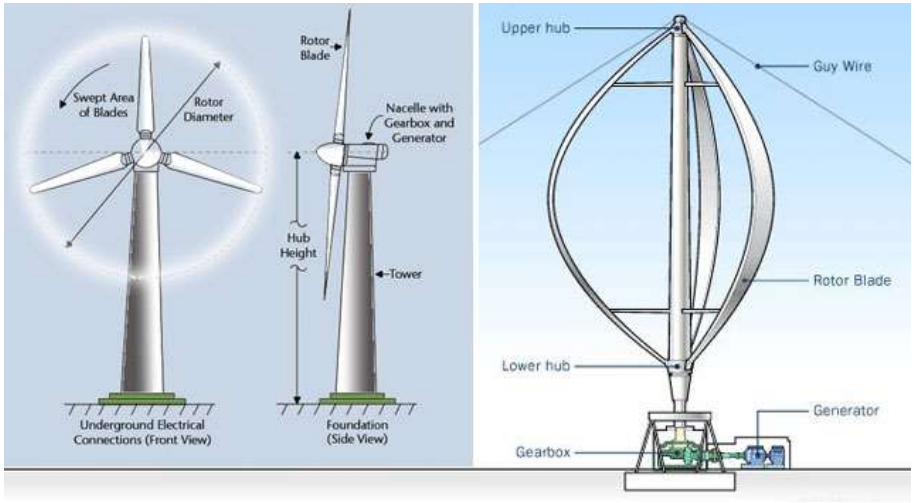
Solar energy is generated by: Solar panels- which are panels that absorb the sun’s rays to be converted to generate electricity or heat

Solar Technology

Photovoltaic (PV) captures sunlight and converts it directly to electricity with panels made with semiconductor materials.

Concentrating Solar Power (CSP) systems use mirrors and lenses to focus the sun’s light energy and convert it to heat. The heat creates steam which will turn a turbine creating energy.

Wind Technology



Horizontal Axis design are windmills with a long thin base and have 2-3 propeller-like blades extending outwards from the top of the windmill which rotate as the wind blows. The blades spin a shaft inside of the turbine and the moving shaft spins a generator to create electricity.

Vertical Axis design include windmills that have their blades more parallel to the base so that they when they spin, it is about the base rather than perpendicular to it. Internally, vertical axis windmills generate electricity the same way the horizontal axis designs do.

Why Wind vs. Solar?

Fastest growing renewable options

Nuclear/Hydroelectric only ~1% growth

Almost unlimited space

Ocean tethered t

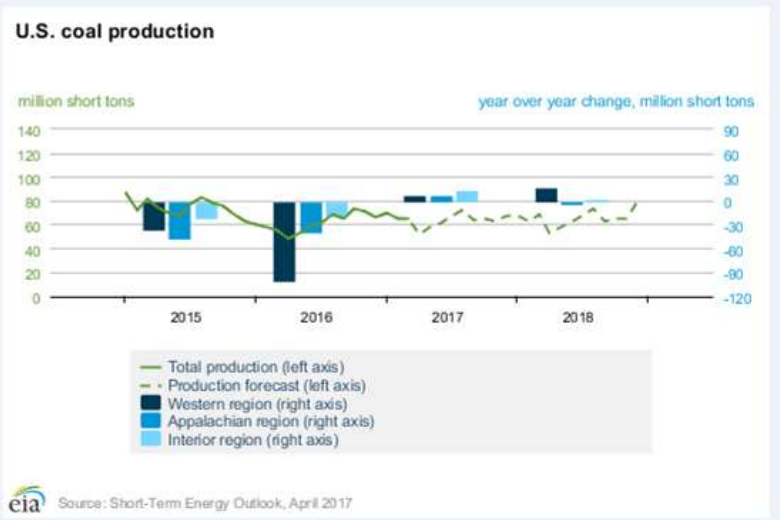
Scale flexibility

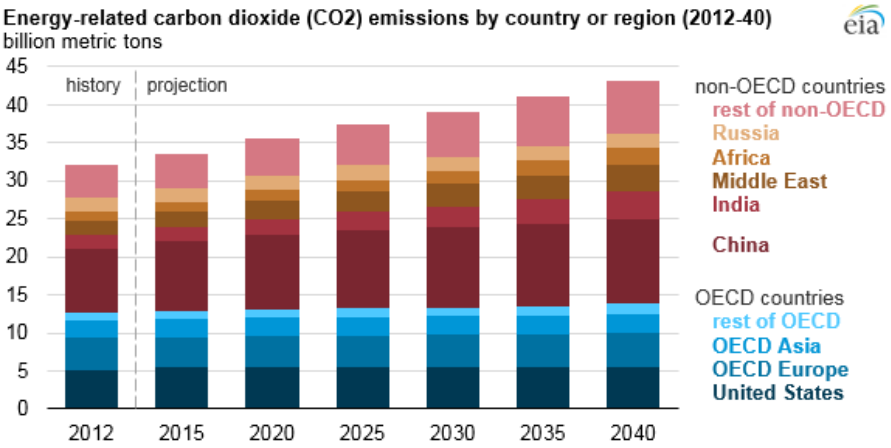
Why Renewables?

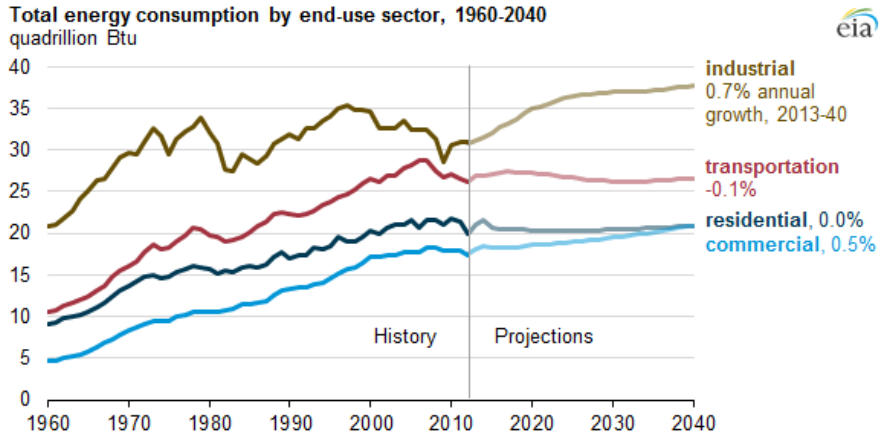
Coal production down

Energy demand increase

CO2 emissions rising







Scope

Through the analysis of Cost-Benefit Analyses, Life Cycle Analyses and other important impacts, we will be able to conclude whether solar power or wind power is commercially better suited to be a main source of energy in the U.S.

Aspects to Consider

- Cost-Benefit Analysis
- Life-Cycle Assessment
- Durability
- Noise
- Location
- Innovations

Functional Units

CBA

Cost per energy output (dollar/ kilowatt hours)

LCA

CO2 per energy output (gram CO2 e/ kilowatt hours) .

Cost Benefit Analysis Boundaries

New Plant Construction

Operation of Plant

Maintenance of Plant

Assumptions

CO2 abatement = $50 per metric ton

Same cost of land

Based on avoided emissions and avoided costs

Same new plant used to process energy received

Transmission lines same for both wind and solar

Construction takes 1.5 years

CBA

CO2/MWH: Fossil Fuel Plants

Baseline reduction

Used coal for comparison

Different missions

Table 1. CO_2 Emissions per MWH: Fossil Fuel Plants			
Heat Rate (Btu/KWH)	**Gas CC**	**Coal**	**Gas SC**
New Plant (1)	6,430	8,800	9,750
Old Plant (2)	7,050	10,498	10,850
Efficiency			
New Plant	53.1%	38.8%	35.0%
Old Plant	48.4%	32.5%	31.5%
CO_2 Emissions: Pounds per MWH (3)			
New Plant	752.3	1,812.8	1,140.8
Old Plant	824.9	2,162.6	1,269.5
Footnotes:			

CBA

Avoided Emissions Capacity

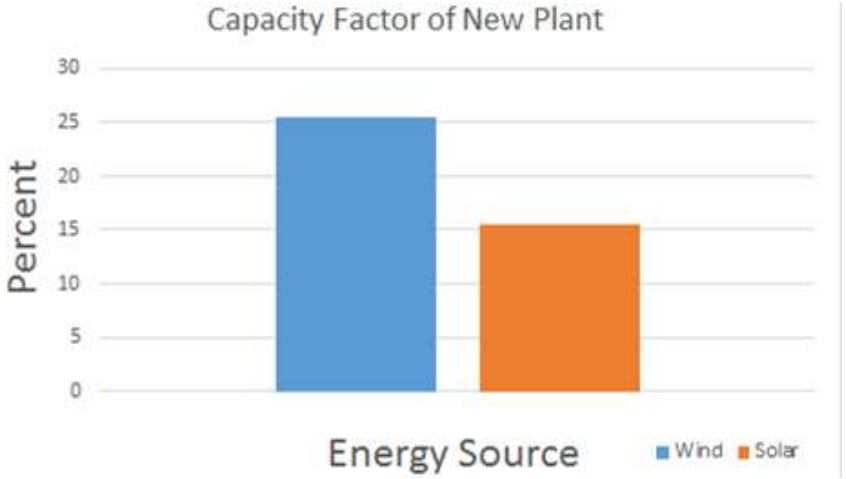
% of time online (nationwide)

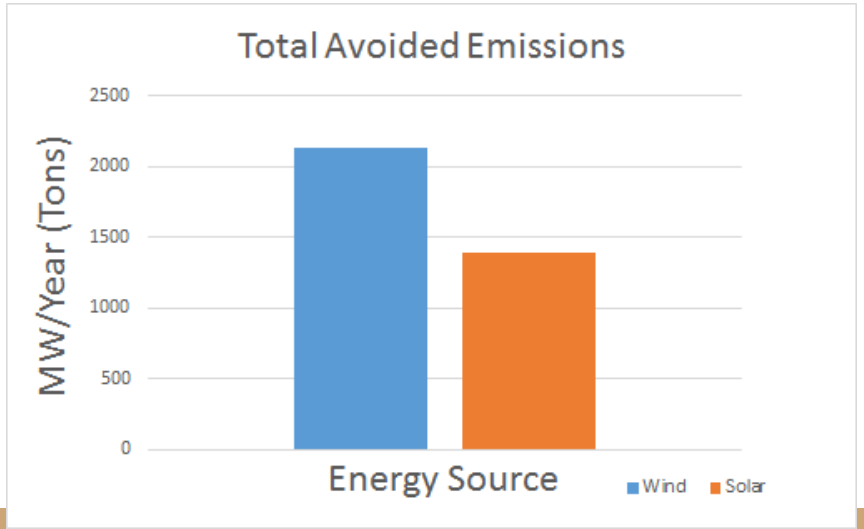
On/off peak times

Demand high during day

Storage needed for off-peak

92% for gas turbine





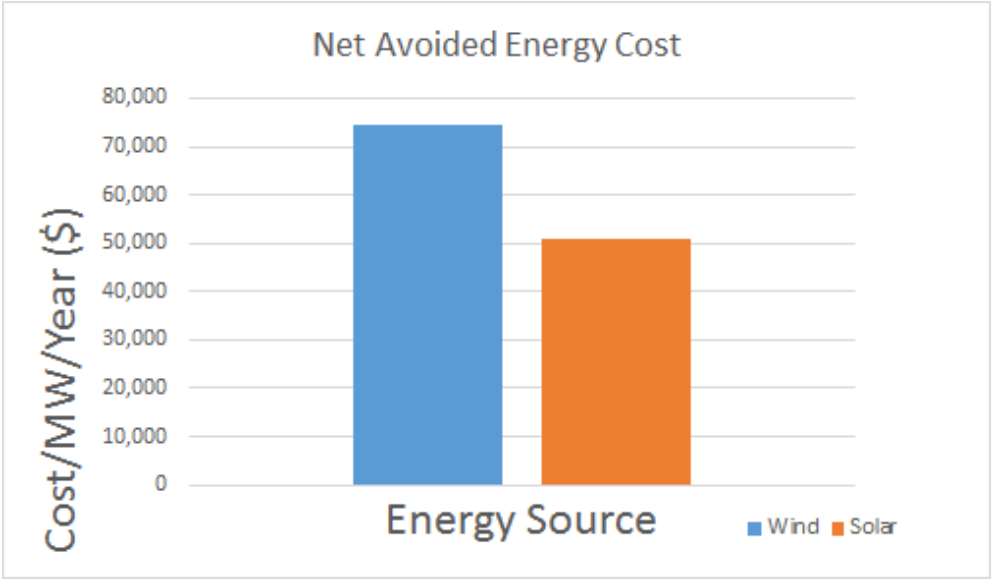
CBA

Energy Cost per MWH

No cost for sun and wind

O&M minimal

Based on capacity



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Overall Net Benefits

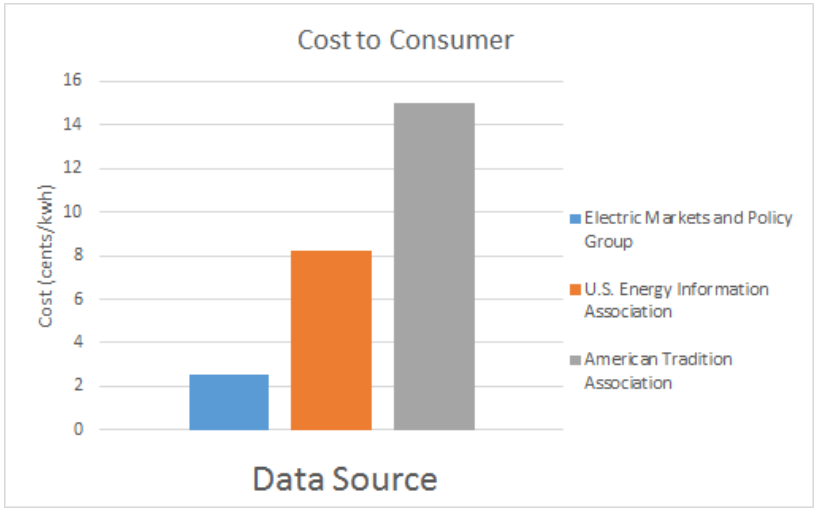
	Wind	Solar
Avoided Emissions	$284,526	$185,338
Avoided Energy Cost	$98,925	$67,732
Avoided Capacity Cost	$70,482	$46,425
Fixed Cost Incurred	$-162,687	$-181,434
Other Costs(Periodic O&M)	$-7,755	$-4,713
Total Net Benefits/MW/Year	$283,311	$113,349

Wind Power 2013 Studies

Electric Markets and Policy Group (Berkeley)

U.S. Energy Information Association

American Tradition Institute



Data Sources

Electric Markets and Policy Group (Berkeley)

-Market report

-Wind power funding/subsidies

U.S. Energy Information Association

-Independent source/ 3rd party

American Tradition Institute

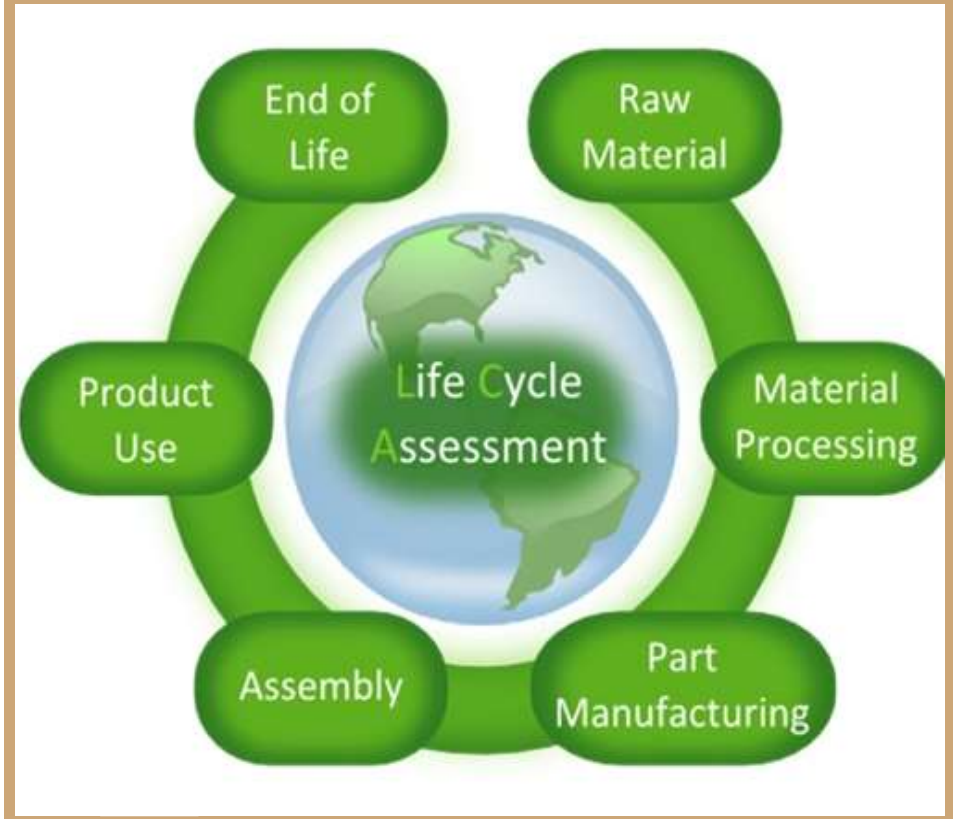
-Right wing nonprofit

-Fought against global warming “fear mongering”

Brookings Institution (Princeton)

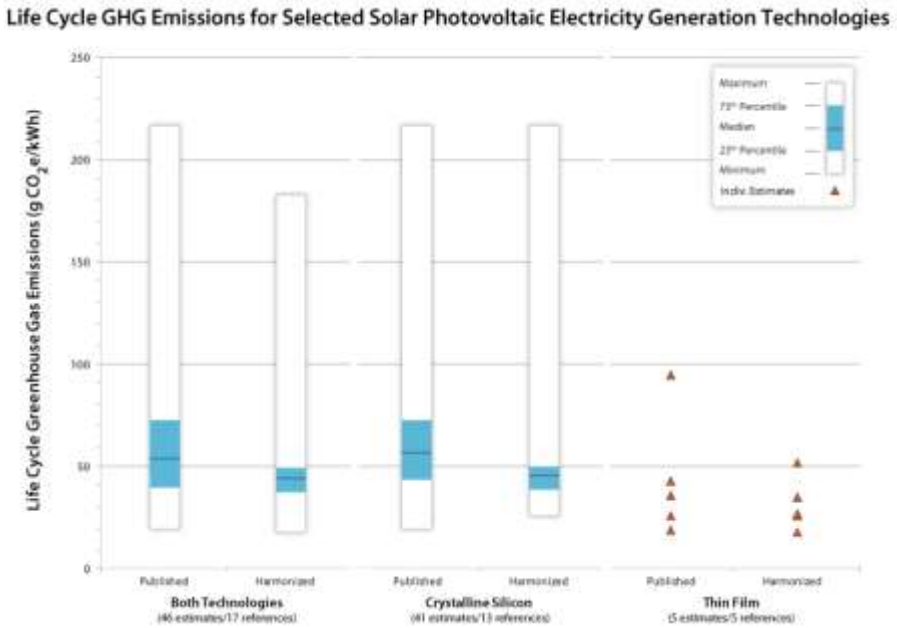
- Focuses on Global Economy and Development

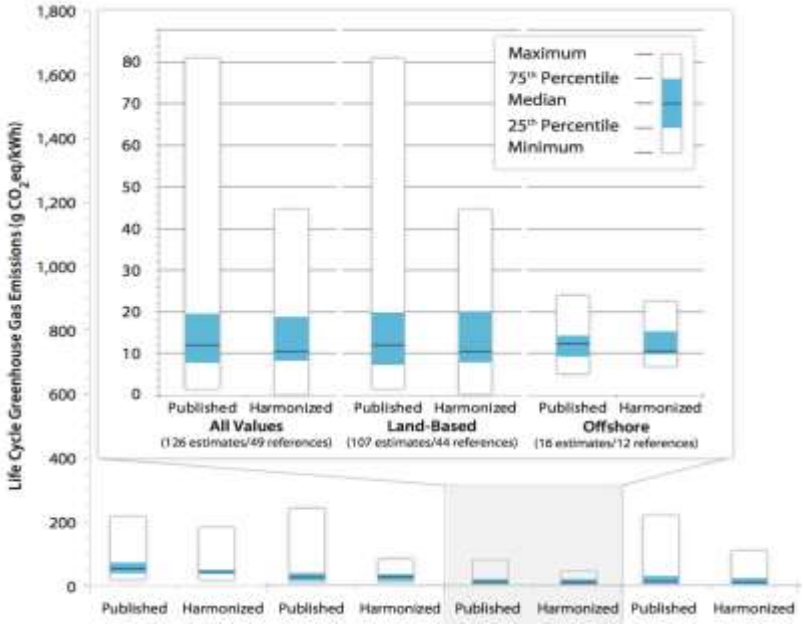
Life Cycle Assessment Boundaries



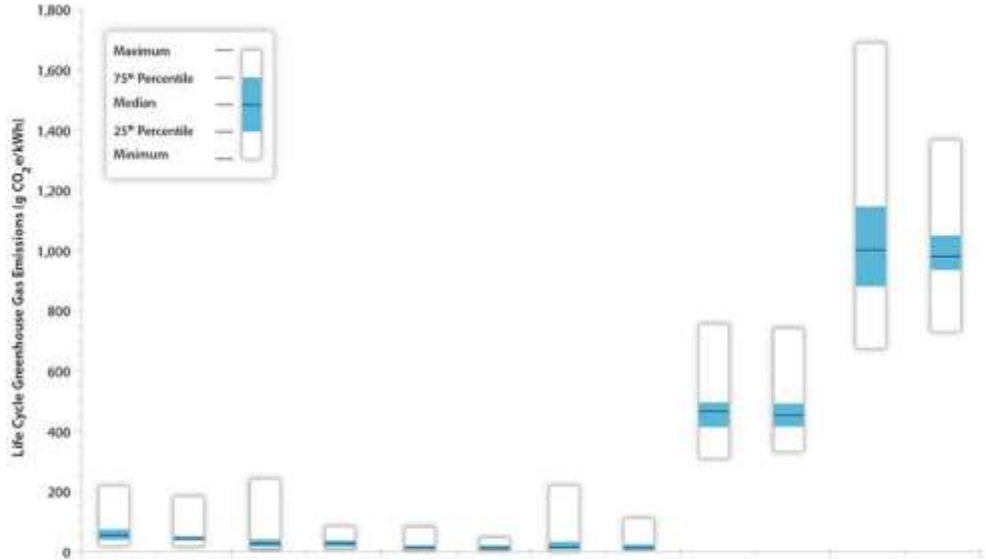
Life Cycle Assessment

Life Cycle Assessment Harmonization Project





Life Cycle Assessment



	Photovoltaics (C-Si and Thin Film)	Concentrating Solar Power (Trough and Tower)	Wind (Offshore and Onshore)	Nuclear (Light Water)	Natural Gas CC (Conventional and Unconventional)	Coal (Sub- and Supercritical, IGCC, Fluidized Bed)
Estimates	46	36	126	99	61	164
References	17	10	49	27	45	53

*CC = combined cycle

New Solar Innovations

Sistine Solar

Solar skin

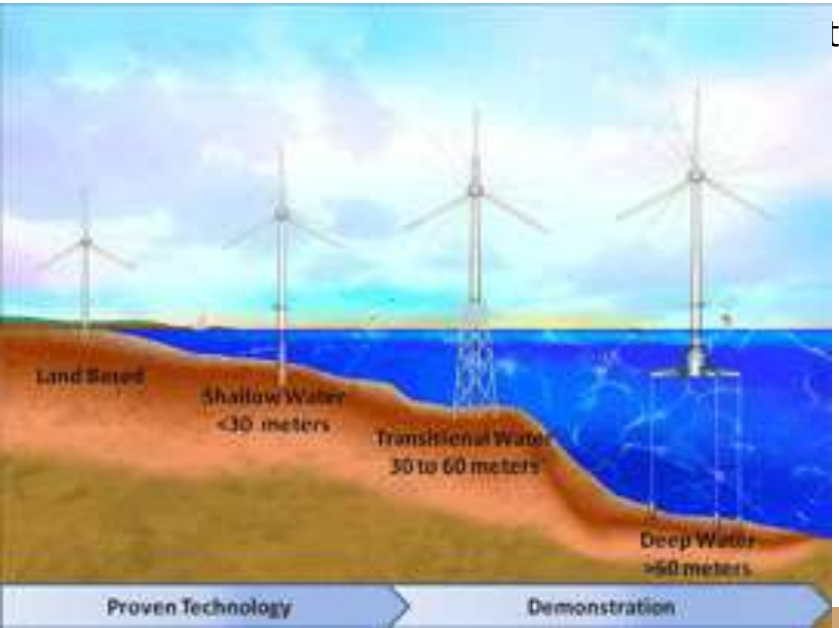
Elon Musk

Roof panels

New Wind Innovations

Offshore wind technologies

According to National Renewable Energy Laboratory, there is a gross wind power resource of 4,223 GW/year off the coast of the United States



ted in regions too deep for regular foundations

Bladeless Wind Turbine

- Takes advantage of vortex of wind created when air moves around an object
- Made of carbon fiber and fiberglass
- Motor at the base to improve stability
- Completely silent and birds are free to fly around them

costs

Generation and carbon foot print reduction about 40%

53%

OFF IN MANUFACTURING COSTS.

51%

OFF IN OPERATING COSTS.

80%

OFF IN MAINTENANCE COSTS.

40%

GLOBAL POWER GENERATION COSTS REDUCTION.

40%

CARBON FOOT PRINT REDUCTION.

VORTEX
Bladeless

Durability/ Maintenance

Solar

Minimal maintenance

Predicted 30 year life span

80% power after 20 years

Wind

Varies greatly

Gearbox type requires annual maintenance

Direct drive needs very little maintenance

Predicted 20-25 year life span

Location/Integration Options

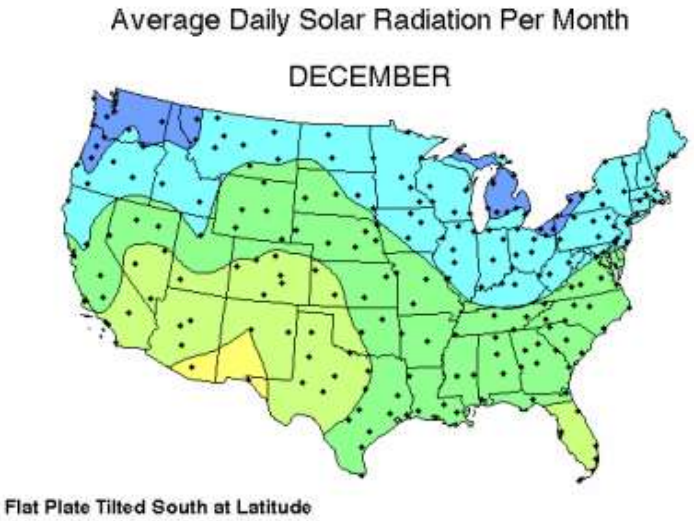
Solar

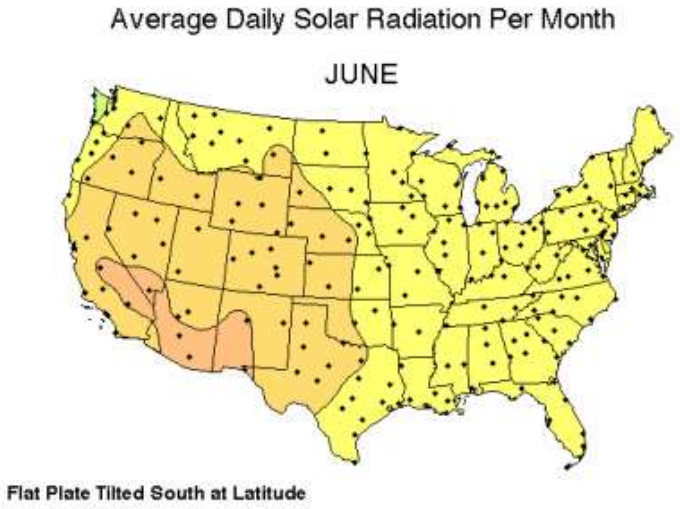
- Few limitations to location
- Can be mounted nearly anywhere
- Must be facing the Sun

Wind

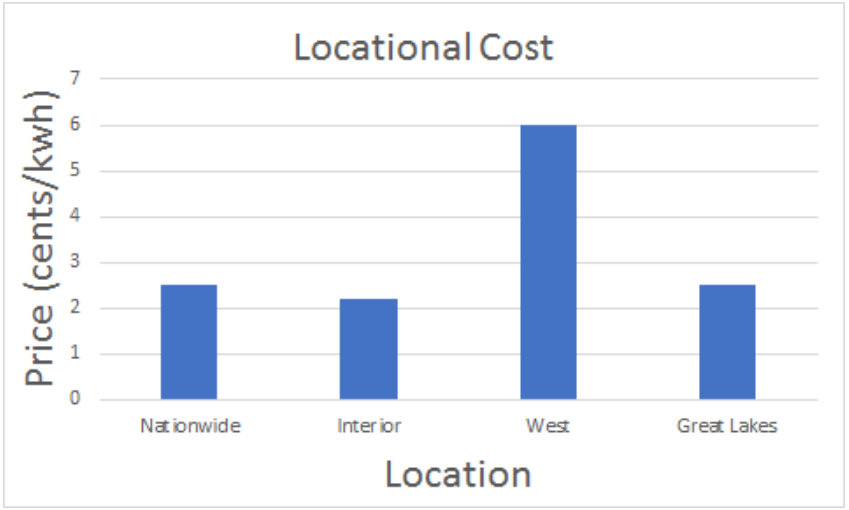
- Must be 30 feet above anything within 500 feet
- Very unfavorable in urban areas

Location/Integration Options

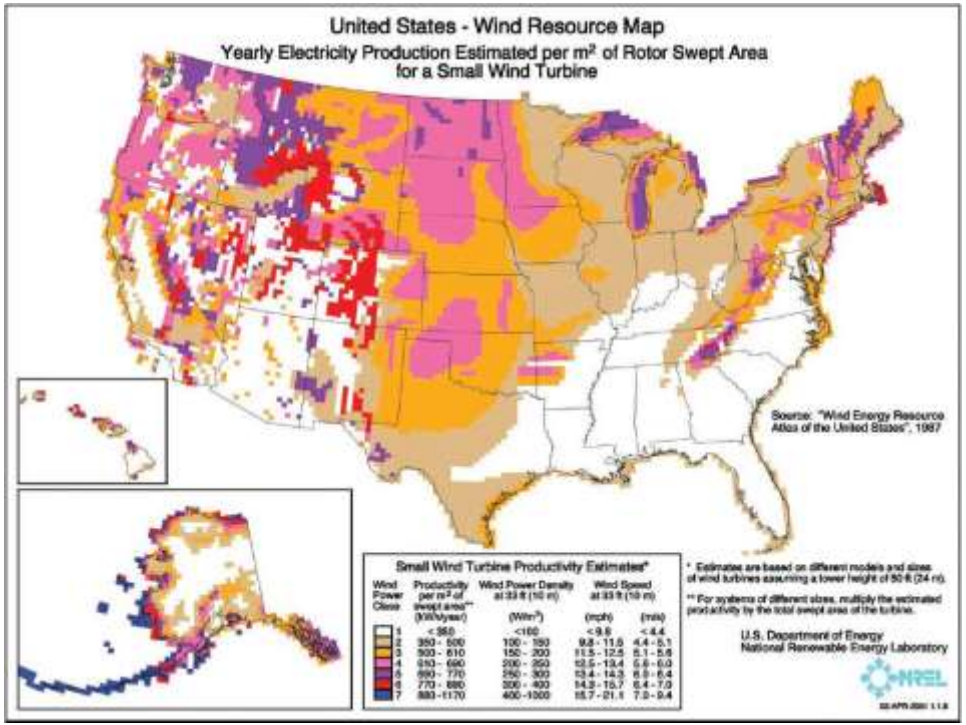




Location/Integration Options

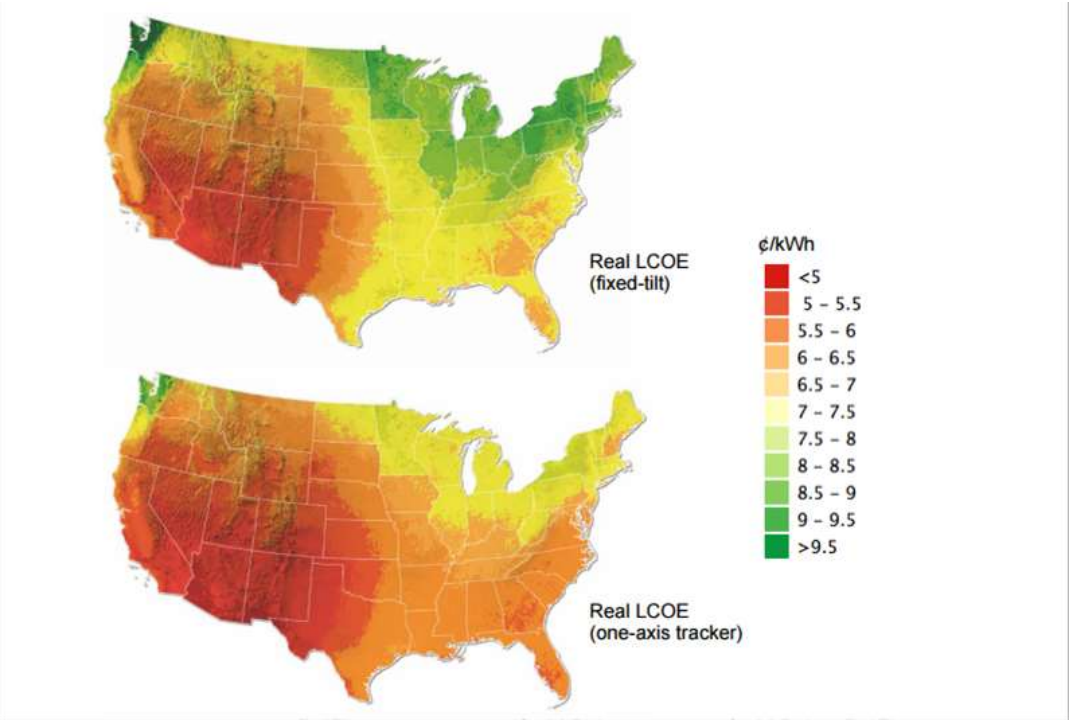


*Department of Energy, 2014



Solar Cost/kwh by Location

*DOE 2016 report



Noise

Solar

- Completely silent during operation

Wind

- At high wind speeds, small turbines operate around 100 dB
- Can potentially be bothersome if near houses

Conclusions

Wind more carbon efficient

Wind more cost effective

Location very impactful on implementation

Solar growing at a faster rate

Source	Production Growth 2014-2015	Generation (GWH/Year)
Wind	5.0%	295.2
Solar	35.2%	35.8

Energy Information Association