# Commonwealth of Virginia Reasons to Reduce Carbon Dioxide Emissions

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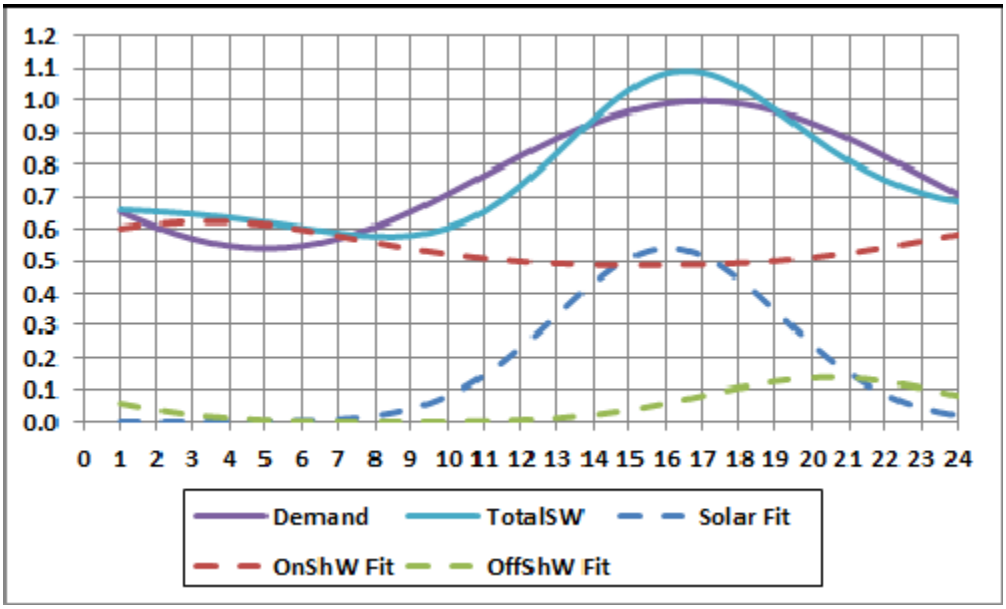
Global Warming Lecture: tinyurl.com/GlobalWarmingRoper2018

## Renewable Energy and Electricity Demand

Deploying wind energy and solar energy in the United States can supply the demand. Using time-of-day availability of solar, on-shore wind and off-shore wind power in the four U.S. time zones and reasonable values of availability, the following graph shows that wind and solar power can closely supply the time-of-day demand for electricity in the United States:




Modest battery storage can fill in the small differences between solar/wind electricity production and demand.

### Renewables Cost Less than Nuclear, Coal and Natural Gas

John Randolph of Virginia Tech has provided the following data about the Levelized economic favorability of renewable energy:

- Nuclear: $148/MWh
- Coal: $102/MWh
- Natural-gas-combined cycle: $60/MWh
- Utility solar: <$50/MWh
- Wind: <$45/MWH
- Efficiency (negawatts): <$25/MWh-?
- Lithium-ion batteries: $209/kWh in 2017 and expected to be $100/kWh by 2025

## Comparison of Virginia Solar and Wind Power with its Neighboring States

At the end of 2016, except for the end of 2015 for West Virginia:

| Type | Maryland | North Carolina | West Virginia | Tennessee | Virginia |
|---|---|---|---|---|---|
| **Solar (MW)** | 637.8 | 3,015.8 | 3.4 | 171.1 | 238.3 |
| **Wind (MW)** | 191 | 208 | 686 | 29 | (75)? |

So, Virginia has moderate experience with solar farms and no experience with wind farms compared to its neighboring states except Tennessee. Virginia would do well to study and emulate renewable energy development in North Carolina, which has similar topology to Virginia. Virginia's coal counties could lead in this.

**Ratios Other-States/Virginia**:

| Type | Maryland | North Carolina | West Virginia | Tennessee |
|---|---|---|---|---|
| **Solar (MW)** | 2.67 | 8.46 | 0.014 | 0.718 |
| **Wind (MW)** | 2.55 | 2.77 | 9.15 | 0.387 |

## Comparison of Virginia with Texas Solar Power

**Texas Solar**: 1800 MW; Population: 28.3 million, Area: 268,581 sq. mi.

**Virginia Solar**: 238.3 MW; Population: 8.4 million, Area: 42,774 sq. mi.

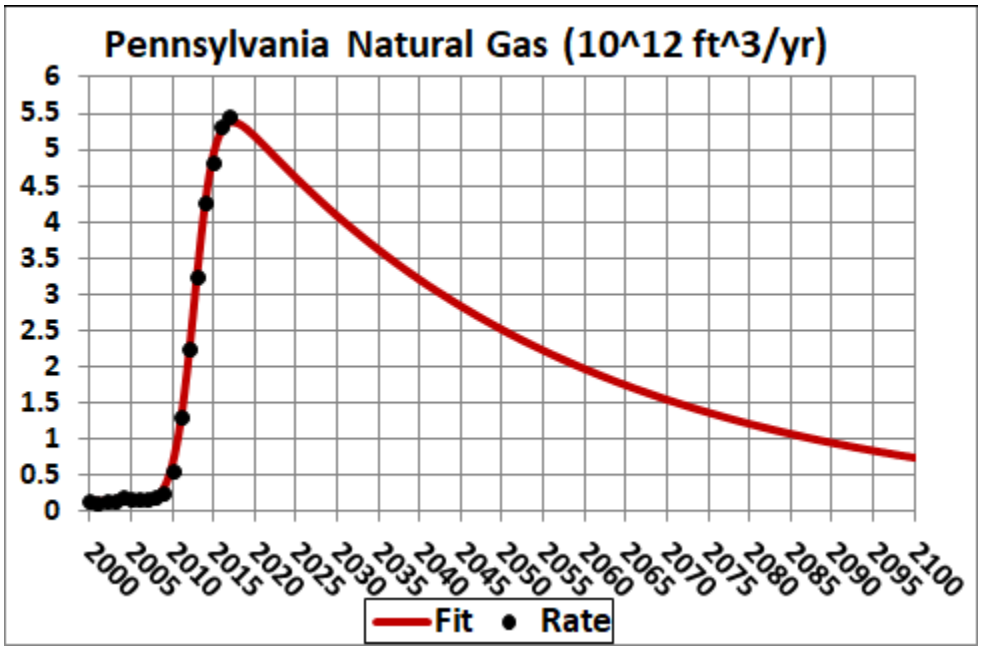
**Ratios Solar, Pop & Area TX/VA**: Solar: 7.55; Pop: 3.37; Area: 6.27

**Ratios Solar TX/VA**: MW/Pop: 2.24, MW/Area: 1.20

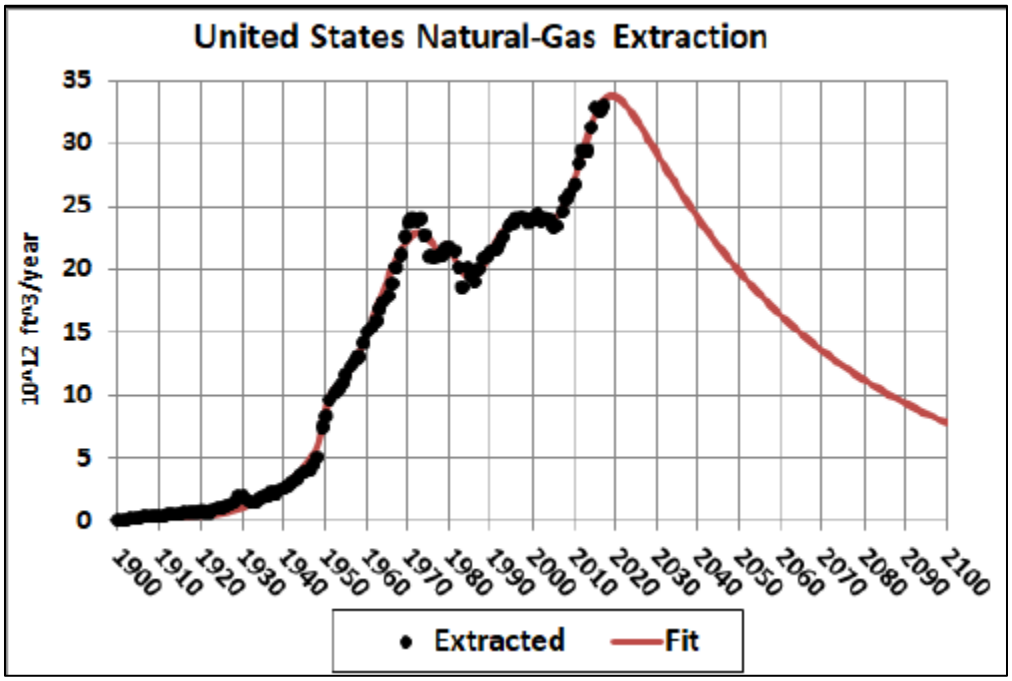
So, the major fossil-fuels state of Texas is far ahead of Virginia in solar energy and, of course, in wind energy.

# Natural Gas Extraction in the United States and Pennsylvania/West-Virginia (Marcellus-Shale Play)

Natural gas (NG) extraction that is used in Virginia comes from the Marcellus-Shale Play in Pennsylvania and West Virginia. Here is a graph of a fit to the NG extraction in Pennsylvania using high estimates of reserves and skewing determined by the detailed micro-study (Drilling Deeper) of the Marcellus shale play by J. David Hughes:




Natural gas extraction for the entire United States will peak within the next decade and then fall rapidly:




## Fugitive Methane

"Methane leaks from drilling sites and pipelines, over a 100-yer period, is 34 times more potent that carbon dioxide at trapping heat." So, extracting and burning methane may be as potent for global warming as mining and burning coal to produce electricity depending on the amount of fugitive methane.

So, it is not wise to depend on natural gas for future electricity production.

# What Should be Done in Virginia

## Solar Net Metering

- Greatly increase the percentage of electricity generation that power companies allow for rooftop net metering.
- Power companies should not charge for transmission for net metering because local solar generation greatly reduces the need for transmission lines since excess rooftop solar energy goes to neighbors. The price that power companies pay for rooftop solar should be greater than the price charged for grid electricity.
- Encourage buildings with rooftop solar to install modern backup batteries for grid resiliency.

## Community Solar Farms

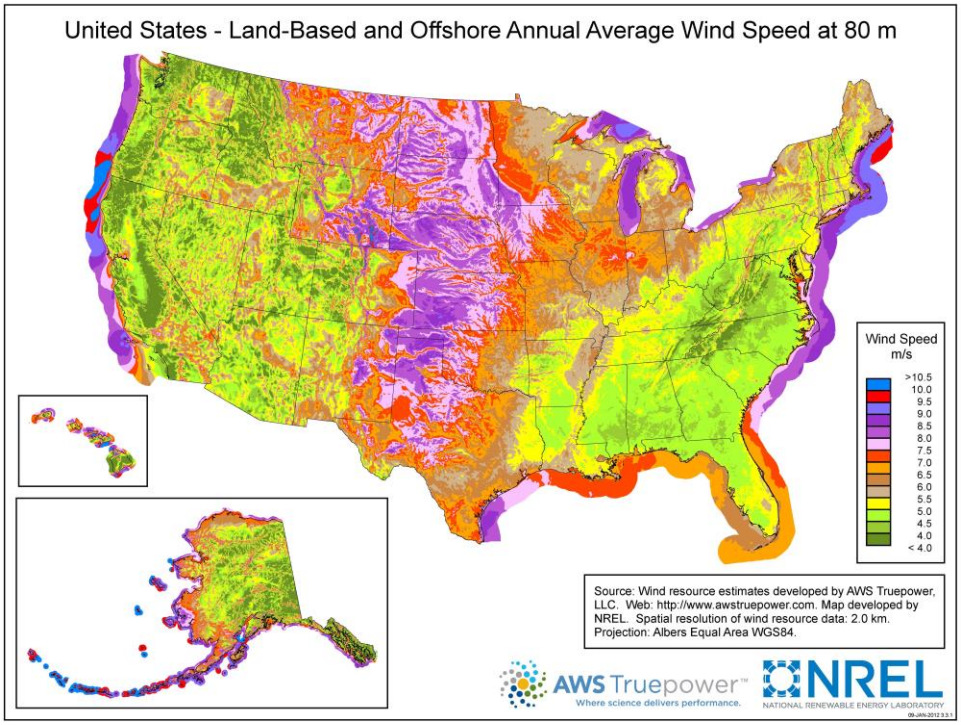
Allow communities to create solar farms or purchase from commercial community solar farms.

## Require Power Companies

- Build or buy more solar/wind energy, especially offshore wind energy.
- Build community microgrids across the state for grid resiliency.
- Build large battery facilities in microgrids for renewable-energy smoothing and grid resiliency.

## Offshore Wind Energy

This U.S. wind-energy map clearly shows that Virginia needs to develop offshore wind farms, not offshore oil extraction:




This document: https://tinyurl.com/VARenewEnergy