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COMMENTS FOR THE OFFSHORE WIND WORKING GROUP

Offshore wind power for electricity generation is spreading to many countries around the world – beginning in Denmark. With its spread, technology improvements, larger turbines and economies of scale, its costs per MWh have been steadily decreasing to the point where it is now cost-competitive with coal and nuclear power. Its potential is huge. The total offshore wind power potential for the U.S. is twice the current total average demand.[1] There is enough wind power off the Delaware coast - if fully developed - to supply all of the state's electricity needs. Offshore wind power in the U.S. is being seriously considered by East Coast states from North Carolina to Massachusetts, as well as on the West Coast, Great Lakes and Gulf of Mexico. The first commercial U.S. wind farm started generating power off Rhode Island in 2016.[2]

Some will say that wind power cannot be used to supply most of our electricity needs because the power it generates is not constant. That is true for a single turbine, but with coupled offshore wind farms spread over a wide geographical area – for example from North Carolina to Massachusetts– the variability will be far less, especially if substantial solar power is supplied to the grid backed by energy storage in the batteries of a large fleet of electric vehicles, as in the GIV (Grid Integrated Vehicles) and EVs (Electric Vehicles) concepts,[3] as described by Prof. Willett Kempton (UD) and co-workers.

Some will say that we should not be developing offshore wind power because natural gas-fired turbines can now generate power at a lower cost. That may be true if by 'cost' you mean only what appears on a utility bill. Economists also consider what they call 'externalities,' which include all of the costs to society of a particular technology, including damage to society that does not appear on a utility bill, such as damage to human health and the costs of climate change caused by burning fossil fuels, which are likely to be substantial.

In 2017 Hurricanes Harvey and Irene caused between 130 and $200 billion in damage to the U.S. mainland.[4] The damage caused by Hurricane Maria to Puerto Rico is estimate to be as high at $95 billion.[5] That comes out to more than $1000 for every person in the U.S.

One way to evaluate the damage to society for each ton of CO2 - or of other important greenhouse gases (GHGs) like methane (CH4) and nitrous oxide (N2O) - is the social cost of carbon (SC-CO2), the cost of the damage caused by each additional ton of CO2 emitted – or the cost of the damage avoided by reducing emissions of CO2 by a ton,[6] as for example by replacing fossil fuels for power generation with offshore wind. The amount of the SC-CO2 depends on the categories of damage included and the discount rate used, but it is generally agreed that some difficult-to-estimate damages are not currently included, and the number is expected to increase with time. The value in early 2017 was about $40/ton of CO2.[7]

Although burning natural gas (mostly methane) may produce only about half as much carbon dioxide – the major contributor to climate change - as burning coal in a power plant, any combustion that uses the oxygen in air will produce oxides of nitrogen (NOx), which in the presence of hydrocarbons and sunlight on warm days produce ozone – sometimes with serious damage to human health.[8] Another serious problem with natural gas is its leakage into the atmosphere before it ever gets to a power plant. Methane is such a powerful greenhouse gas and so much of it leaks that the climate benefit of burning it, instead of coal, is lost.[9] Measurements show that drilling for methane by fracking shale produces much higher methane emissions than previously estimated.[10]

Because of Delaware's low elevation (only about 60 feet – the lowest for any state in the country), its relatively long and sinking coastline, the cost of damage to Delaware for each ton of added CO2 is likely to be higher than the national average. This suggests that we ought to be a national leader in reducing our greenhouse gas emissions, but we clearly are not, as seen by the numbers below for the Renewable Portfolio Standards (The RPS is the required percentage of electrical energy sold that is generated from renewable energy sources) for five coastal states.[11]

State	**RPS Goals by State**
HI	30% by 2020; 40% by 2030; 70% by 2040; 100% by 2045
NY	29% by 2015; 50% by 2030
CA	33 by 2020; 40% by 2024; 50% by 2030
RI	14.5% by 2019: 38.5% by 2035
DE	25% by 2025; wth no goals for later years

Another reason for developing our large offshore wind resource is for the jobs and revenue it could generate. Delaware is located about midway between North Carolina and Massachusetts, and could provide a central port for collecting wind turbine components sent by ship and rail and shipping them out to locations along the Atlantic Coast for assembly and installation. We might even build some components right here in Delaware. As RPS requirements in several states continue to grow, the tremendous damage caused by climate change becomes more obvious, and the vehicle fleet transitions from gasoline and diesel fuel, the demand for electricity from renewable energy sources will go up and its costs will go down.

One additional incentive to develop wind farms along the East Coast is the promise by Google to help fund a $5 billion DC (direct current) underwater cable to link wind farms for hundreds of miles along the coast – each 15 to 20 miles from shore.[12] (DC is preferable to AC (alternating current) for electricity transmission under water because the energy loss is much less.) For more information of how the connected wind farm system would work and its advantages, see an article in Popular Science.[13]

Wind and solar power are the future. The sooner we get to 100% renewables, the better.

Chad Tolman

[1] 2016 Offshore Wind Energy Resource Assessment for the United States, Walt Musial et al., National Renewable Energy Laboratory. At: https://www.nrel.gov/docs/fy16osti/66599.pdf

[2] List of Offshore Wind Farms in the United States, Wikipedia, https://en.wikipedia.org/wiki/List_of_offshore_wind_farms_in_the_United_States

[3] The Grid-Integrated Vehicle with Vehicle to Grid Technologies - Articles and Papers on GIV and EVs, Willett Kempton et al., University of Delaware at http://www1.udel.edu/V2G/ArticlesandPapers.html

[4] Which hurricane seasons caused the most damage?, Time, David Johnson, Sept. 23, 2017. At http://time.com/4952628/hurricane-season-harvey-irma-jose-maria

[5] Hurricane Maria could be a $95 billion storm for Puerto Rico, Jill Disis, CNN Money, Sept. 28, 2017. At: http://money.cnn.com/2017/09/28/news/economy/puerto-rico-hurricane-maria-damage-estimate/index.html

[6] Estimating the Benefits of Reducing Greenhouse Gas Emissions, EPA, https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

[7] The true cost of carbon pollution, Environmental Defense Fund. At: https://www.edf.org/economics/social-cost-carbon

[8] Health Effects of Ozone Pollution, EPA, Jan. 19, 2017. At: https://www.epa.gov/ozone-pollution/health-effects-ozone-pollution

[9] Methane Leaks Erase Benefits of Fracked Gas, Countless Studies Find, Joe Romm, Feb. 2016, Think Progress at https://thinkprogress.org/methane-leaks-erase-climate-benefit-of-fracked-gas-countless-studies-find-8b060b2b395d

[10] New Study Funds Higher Methane Emissions from Fracking, Nick Cunningham, Nov. 29, 2013. At: https://oilprice.com/Energy/Energy-General/New-Study-Finds-Higher-Methane-Emissions-from-Fracking.html

[11] State Renewable Portfolio Standards and Goals, National Conference of State Legislatures, Aug. 1, 2017. At http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

[12] Google joins $5 billion U.S. offshore wind grid project, Scott Malone, Reuters, Oct. 12, 2010. At: https://www.reuters.com/article/us-marubeni-google/google-joins-5-billion-u-s-offshore-wind-grid-project-idUSTRE69B0ZA20101012

[13] Hundreds of Miles of Wind Farms, Networked Under the Sea, David Roberts, Popular Science April 28. 2011. At: https://www.popsci.com/technology/article/2011-04/ambitious-east-coast-wind-farm-could-produce-cheap-electricity-grand-scale