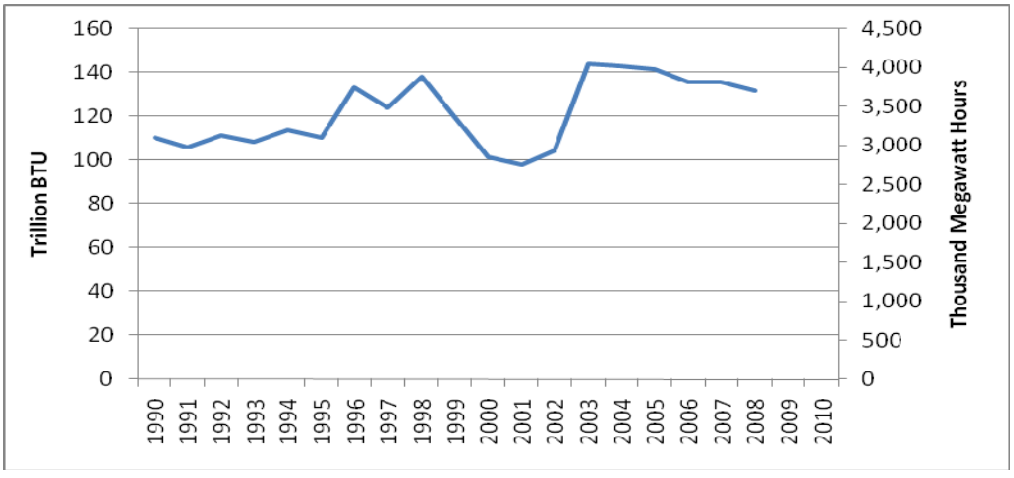
SECTION 6 - RENEWABLES

- Renewable energy is defined in the Virginia Electric Utility Regulation Act as energy derived from:
  - Sunlight;
  - Wind;
  - Falling water;
  - Biomass, sustainable, or otherwise (the definitions of which shall be liberally construed);
  - Energy from waste, including municipal solid waste;
  - Wave motion and tides; and
  - Geothermal power.
- Virginia's renewable resources include:
  - Biomass and waste;
  - Wind, both offshore and on-shore, and hydrokinetic;
  - Hydroelectric, both pumped storage and run-of-river;
  - Low temperature geothermal; and
  - Solar.
- Renewable energy resources often require a large up-front investment.
- Some technologies are not cost-competitive against traditional fuels.
- Hydro, biomass, waste-to-energy, landfill gas, and a small amount of solar provide about 2.8 percent of the electricity generated in Virginia in 2008.
- Ethanol provided approximately six percent of gasoline consumption in Virginia during 2008. Biodiesel met a small percentage of the diesel fuel and heating oil markets. The market for biodiesel was challenging as costs of traditional diesel and heating oil were generally less than biodiesel.

Figure 6-1: Renewable Energy Production in Virginia, 1990–2008[1]



[1] EIA, Virginia Electricity Profile, 2008 edition, http://www.eia.doe.gov/cneaf/electricity/st_profiles/virginia.html

- A Virginia Tech Center for Coal and Energy Research study found that Virginia has significant technical potential for renewable energy development.

Table 6-1: Virginia's Technical Renewable Energy Potential Generating Capacity[2]

Renewable Energy Resource	2007 Installed Capacity in Virginia (MW)	Potential Installed New Capacity in Virginia (MW)	Capacity Factor
Land-based wind	0.07	1,793	30–45%
Offshore wind	0	28,100	35–40%
Solar PV	0.91	11,000–13,000	14%–20%
Biomass combustion	418	760	83%
MSW/landfill gas	254	30	90%
TOTAL	673	41,840–43,840	

- There are three markets for renewable electricity produced in Virginia.
  - The primary use of renewable electricity has been for on-site use, either grid connected or off-grid. They typically use solar photovoltaic or small wind to produce the electricity.
  - Virginia's electric utilities are a second market. Larger projects, such as from biomass or wind, can sell their output to the utilities. These sales would typically be tied to a utility's renewable portfolio standard.
  - The third market is to sell power in the PJM marketplace. Renewable electricity system developers can gain access to higher-priced markets in other states through the PJM.
- Renewable energy project developers can gain additional value by selling the Renewable Energy Credits (RECs). RECs are a certificate that represents the value of the renewable project to the environment.
- REC markets in states with a mandatory renewable portfolio standard have a higher value than in Virginia.
- Virginia provides a number of incentives to advance renewable energy technology and production. These are intended to help early adoption of the technologies and provide the jobs and environmental co-benefits from renewable energy production and use. They include:
  - A renewable portfolio standard calling for 15 percent of 2007 base-line electric production from renewable sources, with utilities eligible to receive an enhanced rate-of-return for meeting the standard.
  - An enhanced rate of return for utility investments in renewable electric generating facilities.

[2] VCCER: A Study of Increased Renewable Energy Resources in Virginia. November 11, 2005, Updated Jan 16, 2006, http://www.energy.vt.edu/Publications/Incr_Use_Renew_Energy_VA_rev1.pdf

- Net metering in which excess electricity from residential (up to 10 kilowatts) and small commercial (up to 500 kilowatts) projects is credited to the customer at the retail power rate (i.e. runs the meter backwards).
- A biofuels production incentive fund with a higher incentive for liquid fuels produced from non-conventional resource.
- Income tax credits for green jobs and jobs related to clean fuel vehicles and fueling systems.
- Grants for manufacturers producing solar panels in Virginia.
- Grants from the Tobacco Indemnification Commission for R&D and energy businesses development in Southside and Southwest Virginia.
- Rebates and other financial support using American Recovery and Reinvestment Act funding.
- A streamlined permitting process for renewable electric projects 100 megawatts and smaller (20 megawatts and smaller for biomass and waste to energy).
- Creation of the Virginia Coastal Energy Research Consortium (VCERC) to develop coastal energy technologies.
    - Twenty percent of revenue from offshore oil and gas production is to be provided to VCERC.
- The Virginia Offshore Wind Development Authority to assist development of an offshore wind industry in Virginia.
- The Universities Clean Energy Development and Economic Stimulus Foundation to support R&D of alternative fuels, clean energy production, and related technologies.
- Creation of the Virginia Wind Energy Collaborative and Onshore Wind Test Center at James Madison University.

Biomass and Waste-to-Energy

- Biomass and waste products include:
    - Wood and wood waste, including wood, sawdust, wood chips, and slash.
    - Energy crops such as fast growing trees, corn, barley, warm season grasses, winter cover crops, and others.
    - Agricultural waste such as crop residue, animal litter; and waste from food processing.
    - Municipal solid waste and landfill gas generated from waste.
    - Construction debris.
    - Algae.

- Biomass and waste is used as a fuel to generate electricity, make steam or heat, and make liquid fuels.

Table 6-1: Biomass Generated Electricity (MWh) 2000-2007[3]

Year	Municipal Waste	Wood and Wood Waste	Other Waste	Total Biomass
2000	461	1,677	6	2,144
2001	991	1,148	5	2,144
2002	1,106	1,408	4	2,518
2003	1,100	1,588	27	2,714
2004	1,148	1,764	42	2,954
2005	1,132	1,800	47	2,979
2006	662	1,780	17	2,458
2007	753	1,792	20	2,566

Table 6-2: Biomass and Waste-to-Energy Projects[4]

Project	Energy Produced
Fairfax County Covanta WTE plant	124 MW of electricity
Alexandria/Arlington Covanta WTE plant	29 MW of electricity
SPSA WTE plant	60 MW plus steam
Harrisonburg WTE plant	2.5 MW plus steam
Dominion Multitrade (sawdust and wood chips)	80 MW of electricity and steam
Dominion Altivista (wood chips co-fired with coal)	2 MW electricity
21 Landfill Gas generating plants	20.6 MW electricity
Sussex County Landfill	Process gas for Honeywell in Hopewell
Wood pellet manufacturing plants	Wood pellets for domestic/export markets
Six industrial CHP (wood, wood waste, black liquor)	182 MW electricity and steam
Institutional boilers such as Piedmont Geriatric Hospital and Longwood University	Steam
Piedmont Bioproducts	Green diesel
Five in-state biodiesel producers	Biodiesel
Osage	Ethanol
Five commercial biodiesel plants (soy, canola, waste greases)	Biodiesel
Farm and coop biodiesel operations (unknown number)	Biodiesel; filtered vegetable oil
Louisa County pellet plant	Wood pellets

- Virginia has substantial biomass resources. While the total amount available has not been inventoried, some individual biomass resource assessments have been completed.

[3] VEPT, http://www.energy.vt.edu/vept/renewables/biomass/renew_gen.asp, June 29, 2010
[4] Virginia Cooperative Extension, "Preliminary Residual Biomass Inventory for the Commonwealth of Virginia: Geographic Information System Based Multi-Feedstock Bioresidue Assessment"

Table 6-3: Biomass and Waste Inventories

Type of Biomass	Amount of Resource
Wood	16 million acres of forestland
Forest slash	2,253,244 dry tons
Sawdust and sawmill waste	2,538,140 dry tons
Crop residues	750,137 dry tons
Animal wastes	1,045,946 dry tons
Municipal solid waste	2,016,587 tons
Landfill gas	66 landfills; 21 operational projects; 11 candidate landfills
Construction debris	593,211 tons
Food processing waste	763,022 tons

- The law establishing Virginia's Renewable Portfolio Standard (RPS) placed a 1.5 million ton per year limit on use of woody material also used for paper manufacturing under the RPS.
- Multiple biomass-fired projects are under development. A sample of announced projects include:
  - Biomass co-firing in the Dominion Virginia City Hybrid Generating Station;
  - Fauquier County Landfill WTE project;
  - Two construction debris pellet plants in the Richmond region (Cephas Industries, Environmental Solutions);
  - Greensville wood pellet plant;
  - Van de Hyde Dairy digester in Pittsylvania County;
  - Wise County Correctional Unit waste wood burner;
  - Roanoke Regional Water Treatment Plant biogass digester;
  - Christiansburg Water Treatment Plant biogass digester;
  - Women's Correctional Center biomass boiler; and
  - Three LFG projects (Rockingham Hospital, Toigo Greenhouse, Martinsville Landfill) using the gas for heat and hot water and generating electricity.
- The Virginia Coastal Energy Research Consortium (VCERC) operates a test site growing algae to be used in producing biodiesel and other drop-in liquid fuels.
  - VCERC is developing an algae-to-biodiesel reformer technology to produce biodiesel meeting ASTM commercial diesel specifications.[5]

[5] The VCERC Algae Research Report is available at: http://www.vcerc.org/VCERC%20Final%20Report%20--%20Algal%20Biodiesel%20Studies.pdf

- The Virginia Institute for Marine Sciences is working with Statoil and other partners to develop the technology to grow algae in open water. The algae would be harvested for diesel fuel production.
- The Hopewell wastewater treatment plant is developing an algae project to strip excess nutrients out of the wastewater in algae ponds. The algae will be available as a feedstock for energy production.

Hydroelectric Power

- Virginia is home to 24 conventional hydropower facilities with a combined capacity of 439 megawatts, and two pumped storage facilities with a combined capacity of 2756 megawatts.

Table 6-4: Conventional Hydropower Generation

Year	Owner	Name	County	Summer Capacity (MW)
1927	Allegheny Energy Supply Co LLC	Luray	Page	1.6
1923	Allegheny Energy Supply Co LLC	Newport	Page	1.4
1912	Appalachian Power Co	Buck	Carroll	8.4
1912	Appalachian Power Co	Byllesby 2	Carroll	21.6
1939	Appalachian Power Co	Claytor	Pulaski	74.8
1964	Appalachian Power Co	Leesville	Campbell	40
1954	Appalachian Power Co	Niagara	Roanoke	3.6
1903	Appalachian Power Co	Reusens	Campbell	22.5
1993	Appomattox River Associates LP	Brasfield	Appomattox	3
1933 & 1981	Aquenergy Systems Inc	Fries Hydroelectric Project	Grayson	5.4
1987	Bedford City of	Snowden	Amherst	5
1938	Danville City of	Pinnacles	Patrick	11.1
1930	Dominion Virginia Power	Cushaw	Amherst	7.5
1987	Dominion Virginia Power	North Anna	Louisa	1
1920	Georgia Pacific Corp-Big Island Mill	Georgia Pacific Big Island	Bedford	0.4
1983	Holcomb Rock Company	Coleman Falls	Bedford	1.5
1920	Holcomb Rock Company	Holcomb Rock	Bedford	1.8
1924	Martinsville City of	Martinsville	Henry	1.3
1934	Radford City of	Radford	Pulaski	1
1986	Ridgewood Power Management LLC	Emporia	Greensville	2.4
1915	Ridgewood Power Management LLC	Halifax	Halifax	1.6
1990	STS HydroPower Ltd	Schoolfield Dam	Pittsylvania	4.5
1952 & 1953	USCE-Wilmington District	John H Kerr	Mecklenburg	204
1953	USCE-Wilmington District	Philpott Lake	Henry	14

Table 6-5: Pumped Storage Power Plants

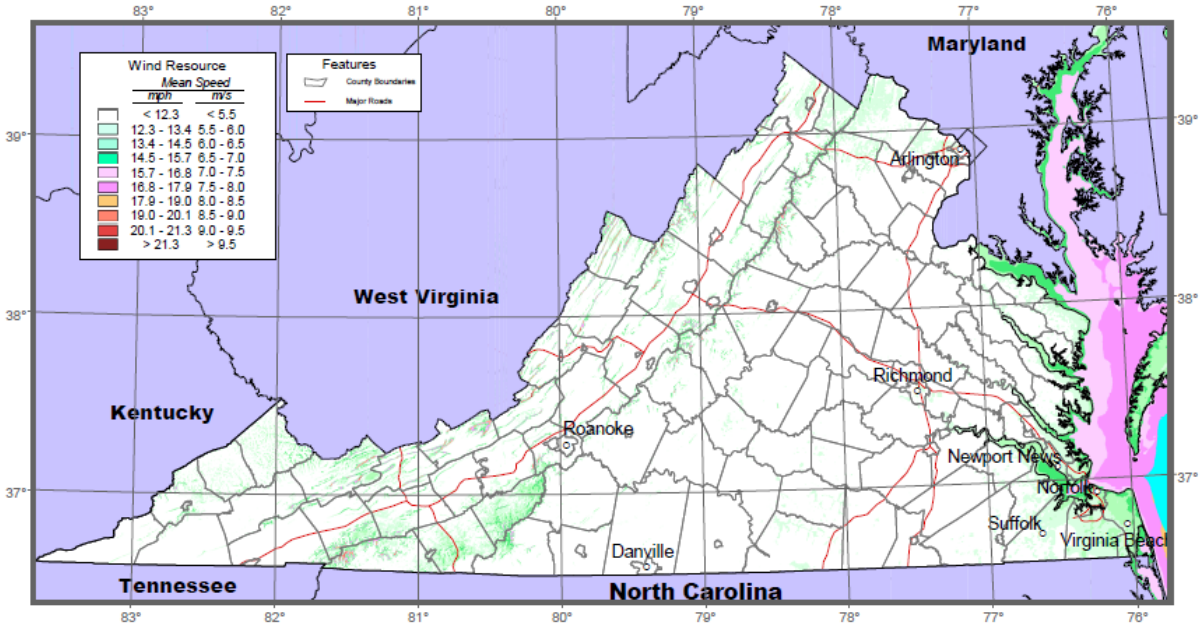
Plant	Capacity (MW)
Dominion Bath Power Station	2100
Appalachian Power Smith Mountain Lake	656

- Most sites in Virginia capable of hosting hydroelectric power generation have been developed.
- There are a few low-head hydro sites with existing impoundments available for development.
    - An inventory of potential sites was completed in the 1980s.
    - The cost of cleaning out sediment in the impoundment and retrofitting the dams, fish ladders, and power plants have has been the primary impediment to developing these sites.
    - A few impoundments are being removed to open streams to fish migration.

Onshore Wind

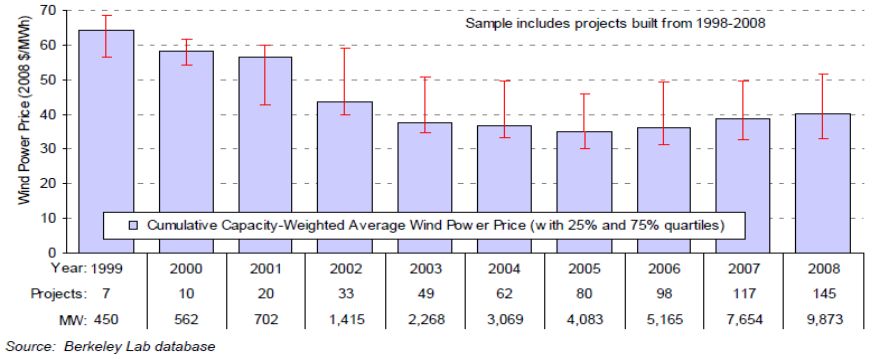
- Onshore wind resources suitable for commercial wind power generation are found along the ridges of the Appalachian Mountains and along the coast.
- The Virginia Wind Energy Collaborative provides support to individuals and localities to assess the proper locations for and uses of wind power generation. The Collaborative provides, among other products, maps showing wind speeds and wind densities at varying heights above the ground to help identify suitable locations for wind projects.

Figure 6-2: Virginia Wind Speeds – 70 meter height



- There are a number of onshore wind projects under development in Virginia, including:
  - One 39 megawatt wind project is under construction in Highland County;
  - Two wind developers have proposed commercial scale wind farms in Wise and Roanoke Counties; and
  - Community-scale wind projects (one to five megawatts in size) have been proposed for the NASA facility on Wallops Island and on Port Isabel near Tangier Island.
- Onshore wind resources suitable for farm or residential wind generation are found in many areas across Virginia. These projects typically qualify for net metering installations.
  - Suitability of any site must be assessed on a case-by-case basis.
  - The Virginia Wind Energy Collaborative developed the Wind Landscape Classification System for Virginia to assist landowners and local officials assess the suitability of sites for wind projects.
- Wind power only provides power when wind speeds are sufficient to run the turbines.
  - The percent of time a power plant runs is called its capacity factor, typically around 30 percent for Virginia onshore wind sites.
  - Intermittency means that the generation resource cannot be fully counted as generation capacity and other generation capacity must be available to provide power at times the wind projects are not generating.
- Wind projects have high capital costs and low marginal or operating costs. The average wholesale cost of power from a new onshore wind project in 2008 ran about five cents per kilowatt hour, including the effects of federal tax credits and production grants.[6]
  - Virginia projects would typically be on the high side of cost estimates as they would be smaller and would have increased construction costs due to ridge location.

Figure 6-3: Capacity-Weighted Average Wind Power Prices, 1999-2008[7]



Source: Berkeley Lab database

[6] Researchers at the Lawrence Berkley Laboratory's Energy and Environment Division, in an *Alternative Windpower Ownership Structures: Financing Terms and Project Costs*, estimate that a typical 50-MW wind plant would deliver power at just under 5 cents/kWh if financed by a wind developer.

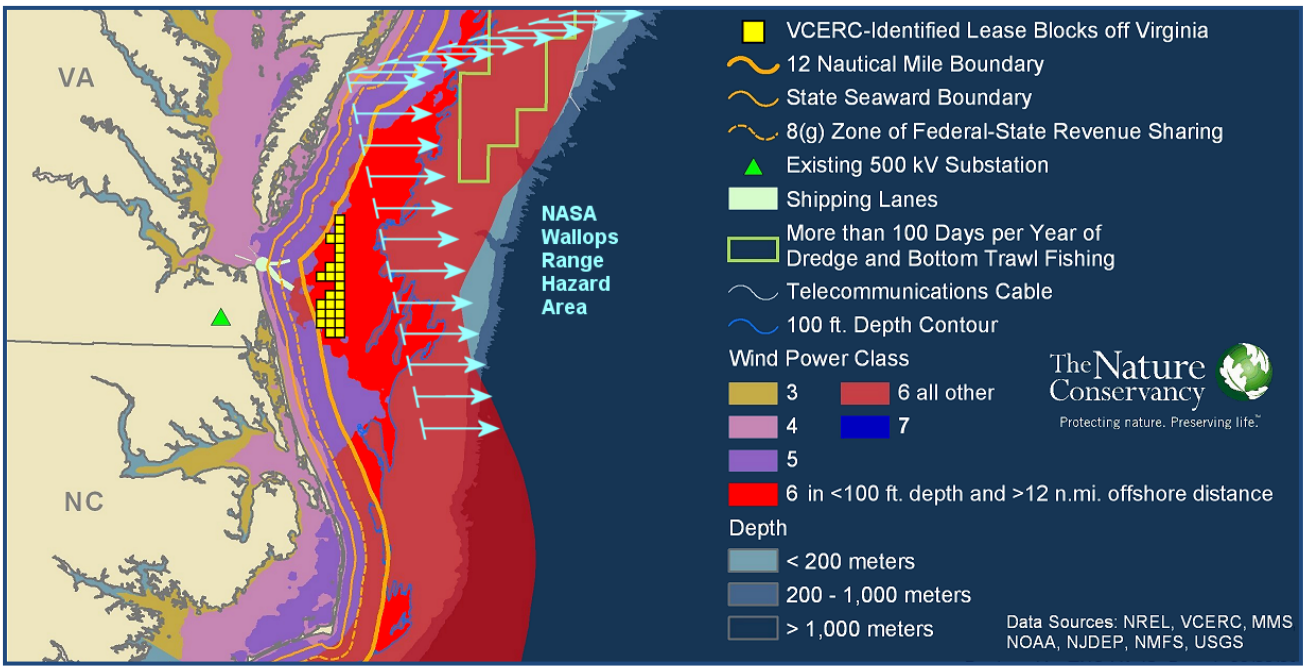
[7] Lawrence Berkley Laboratory, 2008 Wind Technologies Market Report, http://www1.eere.energy.gov/windandhydro/pdfs/46026.pdf, page 26, June 29, 2010

- Offshore wind projects support multiple jobs during their construction. They require few employees for operation and maintenance.

Offshore Wind

- Virginia has substantial offshore wind resources, primarily in federal waters.
  - The Virginia Coastal Energy Research Consortium (VCERC) has completed two years of study on offshore wind.
  - They show there is over 3,000 megawatts of offshore wind capacity in waters with depth less than 30 meters. This depth allows use of conventional foundations, improving the cost effectiveness of the technology.[8]

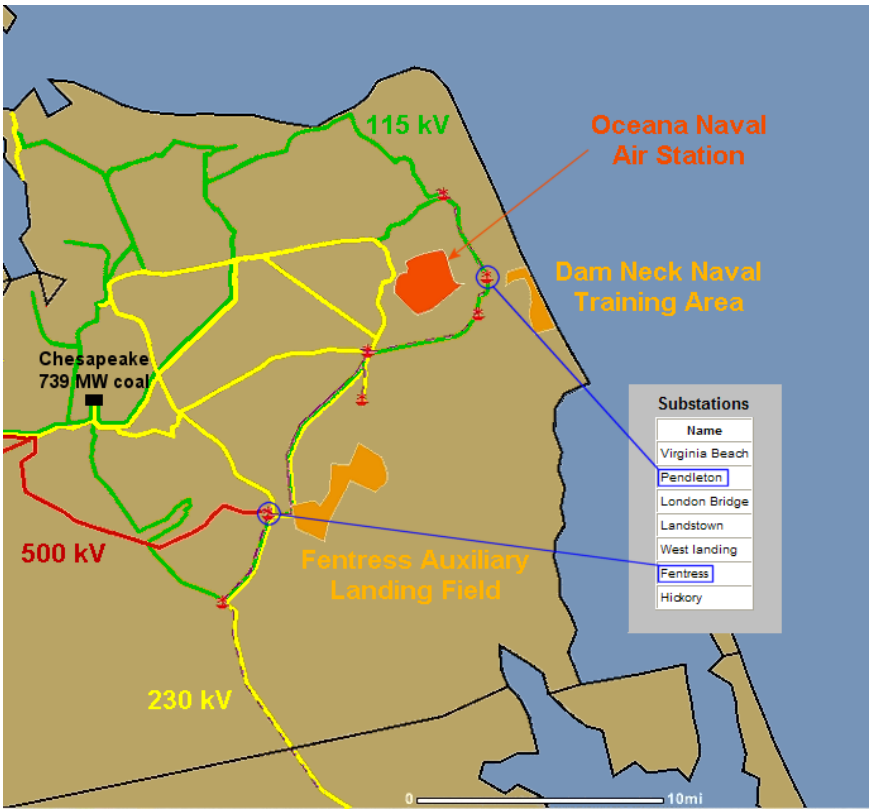
Figure 6-4: Virginia Offshore Wind Potential Analysis



[8] The VCERC offshore wind study is available at: http://www.vcerc.org/VCERC_Final_Report_Offshore_Wind_Studies_Full_Report_newest.pdf

- The high-voltage transmission grid is located close to the shore in Virginia Beach, offering lower cost connection of offshore wind projects to the grid.

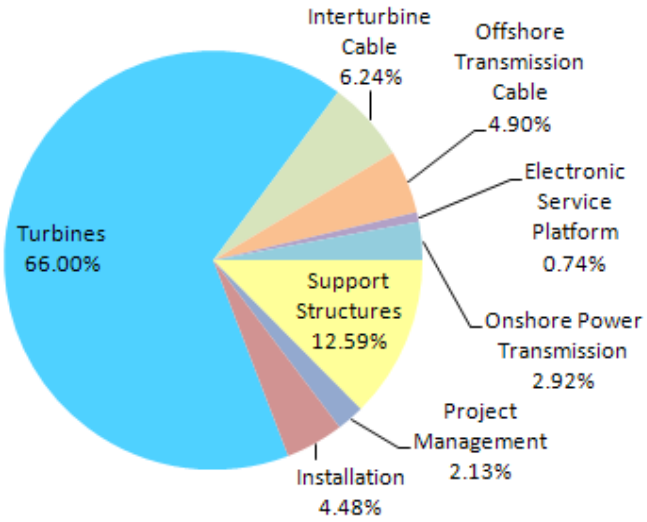
Figure 6-5: Offshore Wind Grid Access Points[9]



- The Port of Hampton Roads offers highly suitable port, manufacturing, and project development sites to support offshore wind development and wind turbine and supply chain manufacturing.[10]
- Offshore wind can support new jobs in project construction and operation, and in supply chain businesses.
- Offshore wind technology is estimated to cost between $125 and $225 per megawatt hour (12.5 to 22.5 cents per kilowatt hour). This would not be competitive with other power sources in today's market.
- VCERC estimates capital cost for a 588-megawatt wind project offshore Virginia to be (2008 dollars):
    - Plant cost at offshore busbar: $ 1,748 million
    - Transmission cost to Fentress: $ 153 million
    - Total plant investment: $ 1,901 million (~ $3,230 / kW)

[9] Presentation at the Virginia Manufacturing Association, 2010 Energy Summit, VIRGINIA WIND POWER OPPORTUNITIES - JOBS FOR VIRGINIA, March 2010
[10] The VCERC port study is available at: http://www.vcerc.org/FINAL%20HRMARITIME.pdf

Figure 6-6: Capital Cost Categories for Offshore Wind

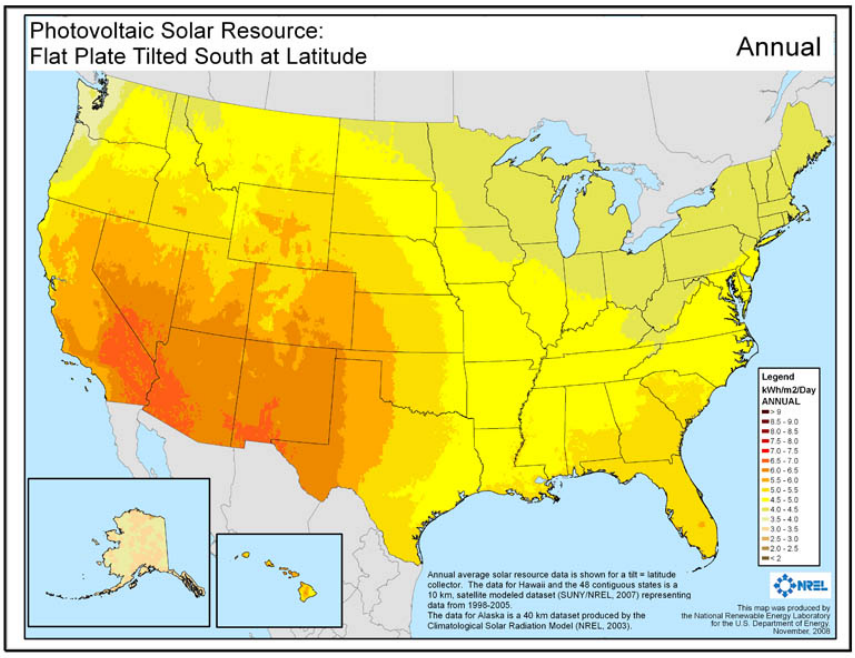


- Two companies have submitted unsolicited proposals to the federal Bureau of Ocean Energy Management, Regulation and Enforcement (BOE), formerly the Minerals Management Service, to lease waters off of Virginia's coast for offshore wind development.
- The BOE is the leasing agent for offshore waters suitable for offshore wind development.
    - The BOE, the state government, and interested localities are developing a Request for Interest to start the leasing of offshore Virginia waters for wind development.
- Offshore wind projects will need to be developed in areas not in conflict with Navy and other Department of Defense shipping, fishery, and other uses of the offshore areas.
- Virginia Governor McDonnell has joined the U.S. Secretary of the Interior and governors from nine other states to form the Offshore Atlantic Wind Energy Consortium to cooperate on developing offshore wind resources along the Atlantic coast.
- Regional electric transmission issues affecting wind are addressed through the PJM Interconnection.
    - PJM has begun an effort to assess the effect of state renewable portfolio standards and plans for offshore and onshore wind development. PJM plans to include these factors in its 2011 Regional Transmission Expansion Plan (RTEP).
- The Federal Energy Regulatory Commission (FERC) policies and cost-allocation structures that socialize costs by providing all end-users to pay for transmission system upgrades may subsidize transmission of Midwestern wind to the East Coast and undermine the economics of offshore wind and other Virginia-based renewable electricity resources.

Solar Power

- Solar-power can be used to generate electricity through photovoltaic cells or concentrating thermal plants, or to produce hot water for domestic or commercial use.
- Virginia has ample solar intensity to support photovoltaic and thermal uses. Virginia is not suited for concentrating thermal systems.

Figure 6-7: Solar Resource Map



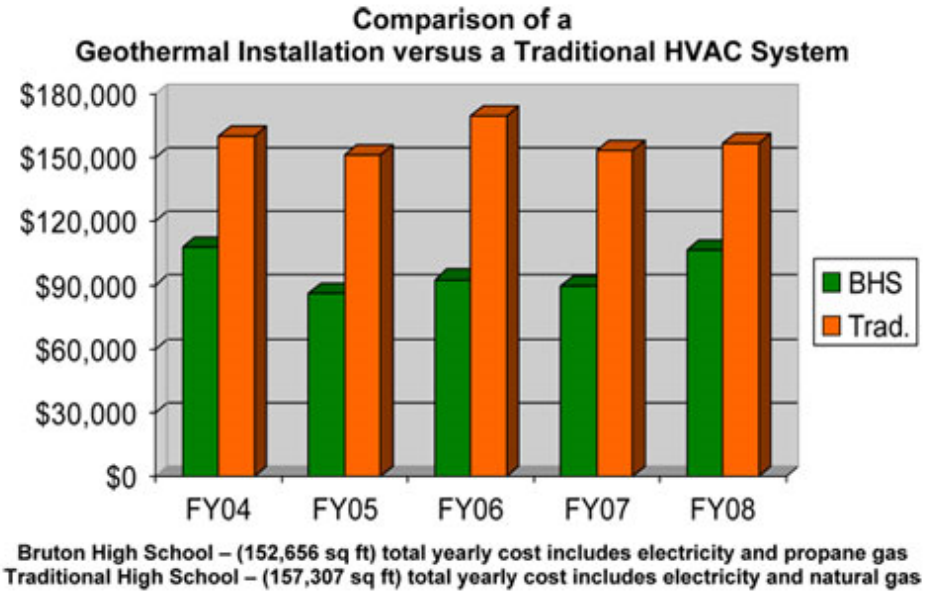
- Solar system owners can take advantage of Virginia's net metering laws to sell excess power generation back to the owner's electric utility.
- Solar systems can be cost effective when the installation avoids installation of electric line extensions.
- Solar is an intermittent power source, only generating power when the sun shines.
    - Battery technologies provide the potential to solve the intermittency problem with solar. Additional research and development leading to scale-manufacturing is needed to bring battery costs down.
- Solar thermal systems are cost effective for hot water and swimming pool heating.
    - Solar hot water systems typically have a five to eight year simple payback when compared to electric hot water heating.[11]
    - Newer technologies, such as evacuated tube collectors, have the potential to improve the cost effectiveness of solar thermal systems.

[11] House Energy, Solar Energy Systems Costs and Payback, http://www.house-energy.com/Solar/Costs-Payback-Solar.htm; and the Florida Solar Energy Center, Solar Hot Water simple calculator, http://www.fsec.ucf.edu/en/consumer/solar_hot_water/homes/calculator/SHW-calculator_simple.xls, June 13, 2010

Geothermal Energy

- Geothermal energy can provide heating and cooling through use of geothermal heat pumps.
- York County Schools have geothermal systems operating wells in nine school facilities. Energy costs for a typical York County geothermal school were reduced by approximately $60,000 per year.

Figure 6-3: Geothermal Heat Pump and Traditional Heating and Cooling Energy Costs[12]



- There are limited low-temperature geothermal resources in Bath County that are suitable for water and space heating.
- Hot-rock geothermal resources are found near the Virginia Atlantic coastline. Due to the depth of these rocks, they are not economical with current technology.

[12] York County Schools, Green YCSD Geothermal Heating and Cooling, http://yorkcountyschools.org/greenYCSD/geothermal.aspx