UNIVERSITY OF MARYLAND EXTENSION

extension.umd.edu | FS—1188 | February 2022

Maryland’s Energy Market: The State Consumes More Energy than it Produces

To better understand the role that solar PV plays in Maryland’s energy market, we’ll start by considering the state’s total energy sector. Maryland currently consumes nearly five and a half times as much energy as it produces (EIA, 2021k), while ranking as the eighth lowest state in terms of per capita energy consumption (EIA, 2021h) and energy-intensity per real GDP dollar (EIA, 2021f). The transportation, residential, and commercial sectors of the state each consume about three-tenths of in-state energy use, while the industrial sector (which includes agriculture) consumes the remaining one-tenth (EIA, 2021g). The energy produced and consumed in Maryland is derived from many different renewable and non-renewable resources (Figure 1).

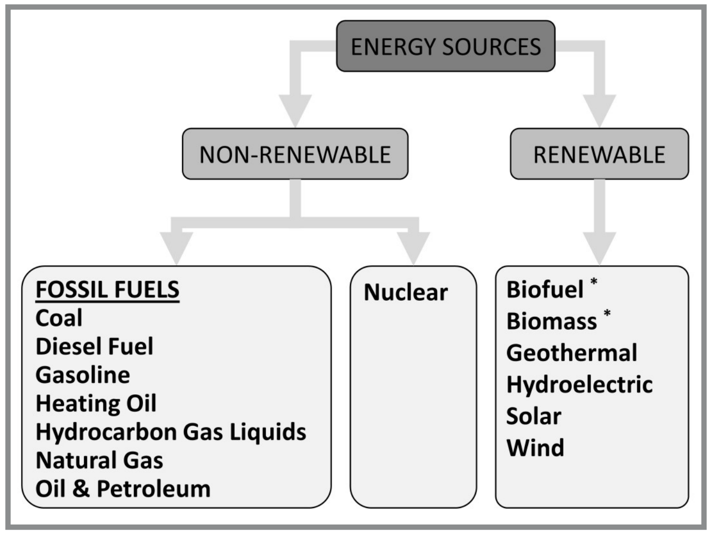

Figure 1. Flow chart showing the different types of energy resources

**Biomass and biofuel may be renewable sources depending on various factors. Biomass, and its biofuel derivatives, may be considered renewable because its inherent energy comes from the sun and can be regrown in a relatively short timeframe. However, biomass can also be a non-renewable energy source if the biomass feedstocks are not replenished as quickly as they are used. A forest, for instance, could take hundreds of years to re-establish depending on the type of forest management employed.*

Most Energy Consumed in Maryland is From Non-renewable Energy Sources, Including Uranium Ore and Fossil Fuels

In 2019, the top four energy sources consumed in Maryland were petroleum (35.0%), natural gas (23.0%), nuclear electric power (11.6%), and coal (5.7%) (EIA, 2021l), as shown in Figure 2. These non-renewable energy sources cannot be made or "renewed" easily. The supply of non-renewable energy sources is limited by how much we can mine or extract from the earth. However, these non-renewable resources can be acquired and stored for later use. The amount of energy generated and delivered to customers from these resources can be easily varied based on the actual amount of electricity needed at a given time. For this reason, they’re considered dispatchable resources. Many of these non-renewable resources are associated with major environmental impacts, including carbon dioxide emissions from fossil fuels or radioactive waste from nuclear sources.

Maryland has no economically recoverable crude oil reserves or production, nor are there any petroleum refineries. Petroleum products arrive in Maryland by pipeline from other states and by ship from abroad. Similarly, Maryland has few economically recoverable natural gas reserves so there is little to no natural gas production. Although Maryland's westernmost counties overlie part of the natural gas-rich Marcellus Shale, the state enacted a permanent ban on hydraulic fracturing in 2017. Instead, Maryland's natural gas needs are met by supplies that enter the state by way of several interstate

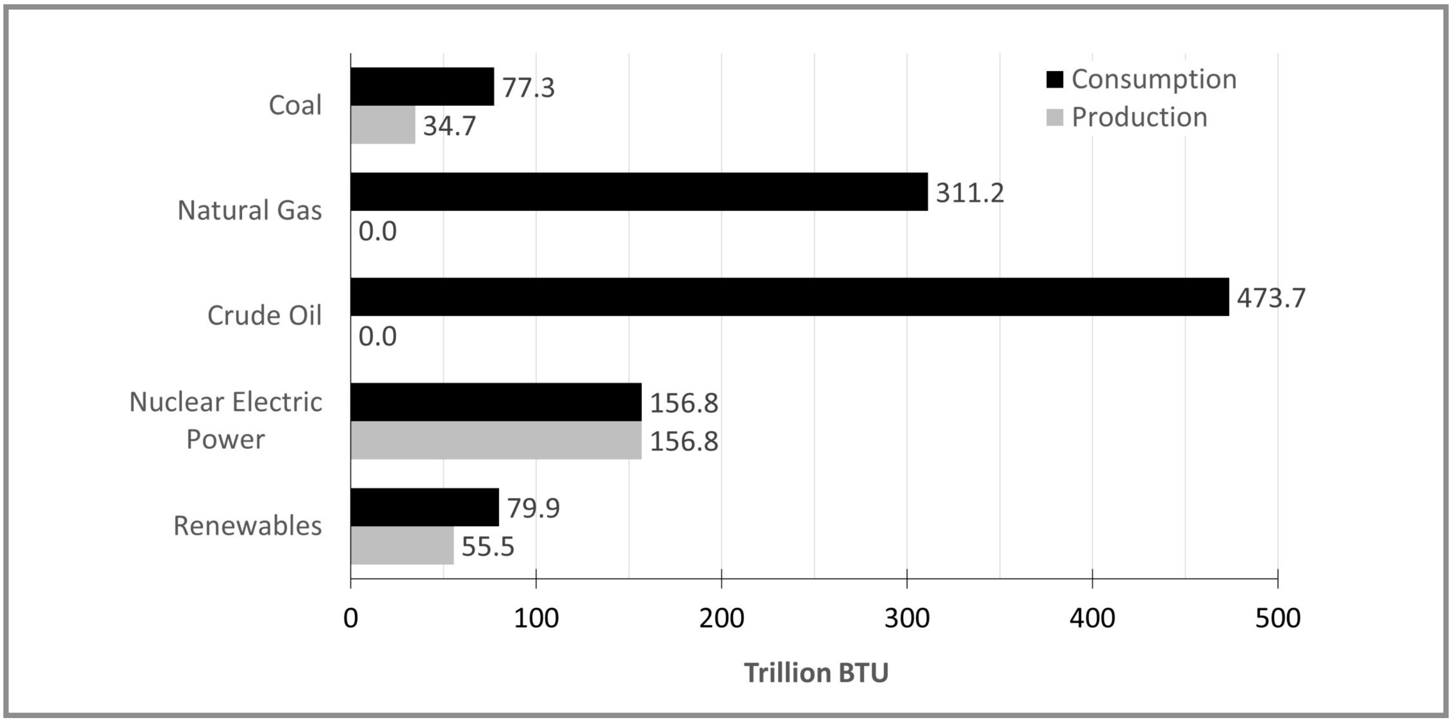

Figure 2. Primary energy production and consumption in Maryland by source for 2019 (data from EIA, 2021i; EIA, 2021l).

pipelines and a liquefied natural gas (LNG) input terminal. While the coal mined in Maryland's western-most counties (Allegany and Garrett) accounts for only 0.2% of U.S. coal production, around 20% of this coal mined within the state is burned at industrial facilities (EIA, 2020).

These non-renewable resources are used in various ways to support different sectors of the state's economy. While around 90% of Maryland's petroleum is consumed by the transportation sector, the remaining amount is almost equally shared by the industrial, residential, and commercial sectors (EIA, 2021j). The residential and commercial sectors also accounted for about one-third and one-quarter of the state's natural gas consumption, respectively (EIA, 2021d); with 40% of households in the state using natural gas as their primary fuel for heating (U. S. Census Bureau, 2019).

Over 11% of Maryland households use propane, fuel oil or kerosene for heating (U. S. Census Bureau, 2019). Agricultural operations also use propane for various applications, including livestock barn heaters or water heating within dairy barns. Natural gas is not as common in agricultural operations since it is largely delivered via pipeline. However, natural gas is commonly used as an input for many agriculture-related products including nitrogen-based fertilizers. The price of these fuels will typically follow petroleum pricing since their production is linked to petroleum extraction and refining. Fuel prices fluctuate in response to delivery costs, storage, forward contracting and other factors.

Coal-fired generating plants historically supplied more than half of the United States' net electricity generation (Figure 3) and half of Maryland's net electricity generation (Figure 4). While 20% of the coal currently consumed in Maryland's coal-fired power plants is mined within the state, the overall share of coal-fired generation is rapidly declining in favor of natural gas-fired generation (EIA, 2021b). Most of Maryland's remaining coal-fired power plants are either undergoing, or planned to undergo, a decommissioning process due to their advanced age (EIA, 2021e). While Maryland's only nuclear power plant, Calvert Cliffs, accounts for the majority of the state's electricity net generation (38% in 2019), the electric power sector also accounts for more than one-third of the state's natural gas consumption (EIA, 2021b). For a primer on these energy sources, see University of Maryland Extension Brief EBR-63, "Energy in Homes, Businesses, and Farms is Typically Supplied as Heat or Electricity."

Renewable Energy Sources are Naturally Replenishing and Virtually Inexhaustible

Renewable energy is flow-limited which means the amount of energy available per unit of time is limited.

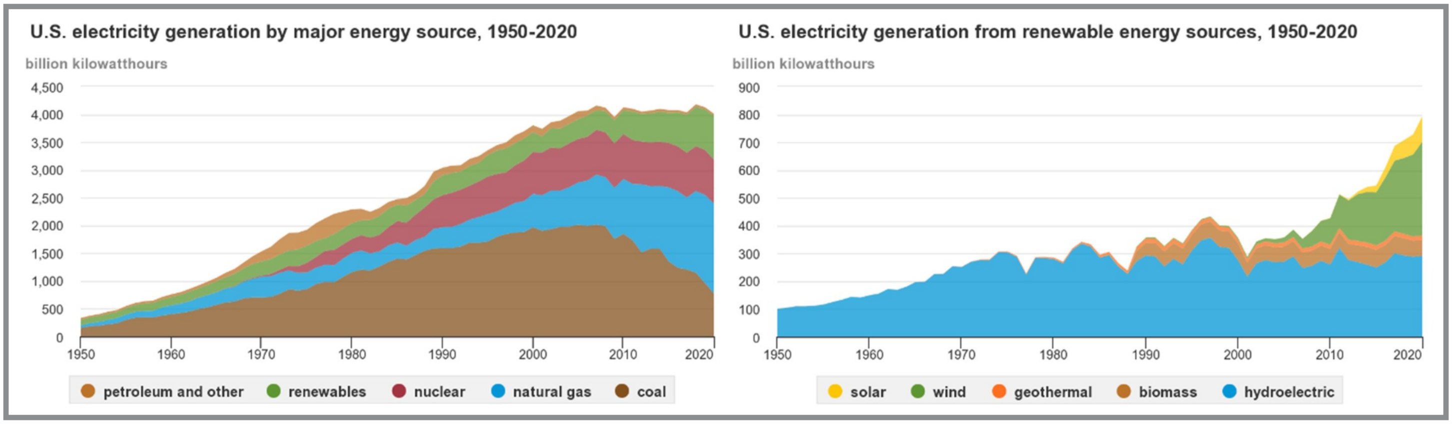

Figure 3. United States net electricity generation by a) major energy source; and b) renewable energy sources, 1950-2020 (EIA, 2021c).

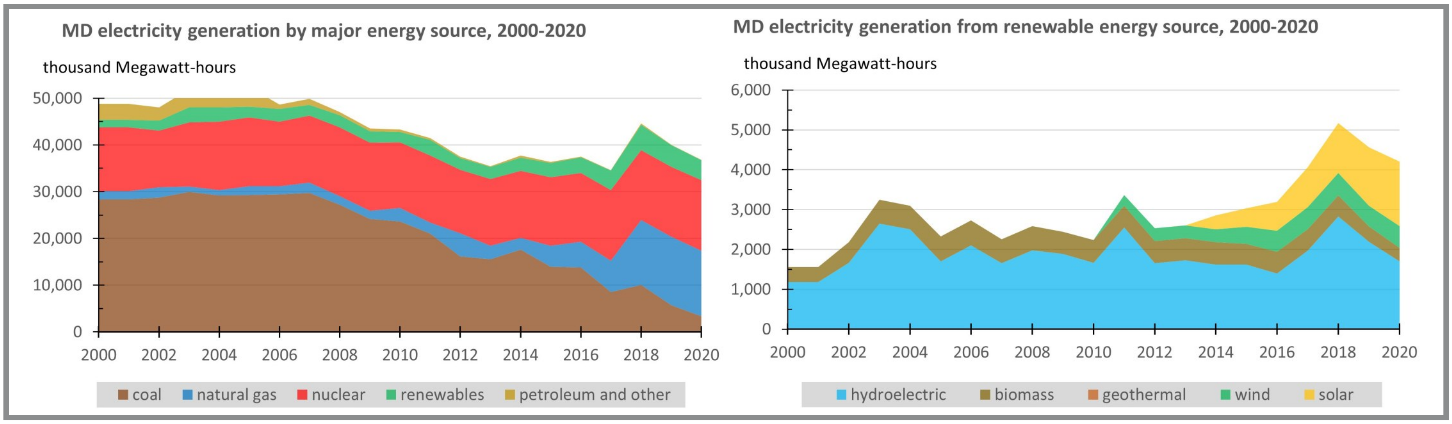

Figure 4. Maryland net electricity generation by a) major energy source; and b) renewable energy sources, 2001-2020. (Data from EIA, 2021b*)*

The Intergovernmental Panel on Climate Change defines renewable energy as "any form of energy from solar, geophysical or biological sources that is replenished at a rate that equals or exceeds its rate of use" (Verbruggen et al., 2011).

Renewable energy relies on ongoing natural cycles (such as solar radiation, rain, or Earth's internal heat) as opposed to stored fossil energy created over long periods of time. While Maryland's renewable energy resources are widely distributed across the state, biomass, hydropower, and solar are the top three in terms of primary energy consumption. Figure 5 highlights the total energy consumption of various energy resources and their derivatives within the state. Renewable resources currently provide around 11.3% of Maryland's in-state net electricity generation (EIA, 2021b).

Biomass *(*e.g., wood, agricultural crops, municipal garbage) can be converted into biogas or biofuels (e.g., ethanol and biodiesel) or burned directly to produce heat and/or steam. The combustion process is similar to fossil fuel, but the original biomass fuel is grown through photosynthesis and can be considered carbon neutral. While biomass can be easily stored and transported, it potentially competes with food crops and typically has multi-year growth cycles. As of June 2021, biomass is used to generate over 8% of Maryland's renewable electricity at facilities using landfill gas, municipal solid waste, and wood and wood waste (EIA, 2021b). About 80% of the state's total biomass capacity comes from two facilities using municipal solid waste (EIA, 2021e), including the 57-megawatt facility in Baltimore and the 54-megawatt facility in Montgomery County.

Consumers can reduce their dependence on petroleum diesel by purchasing an alternative fuel such as biodiesel. Many common forms of residential biomass stoves are available in scaled-up versions for farm, shop, and ranch applications.

Hydropower, or hydroelectric power, uses a direct mechanical-to-electrical conversion as water turns a turbine. Although hydroelectric resources are somewhat dispatchable with water stored behind a dam, they do require significant mechanical maintenance, albeit to a

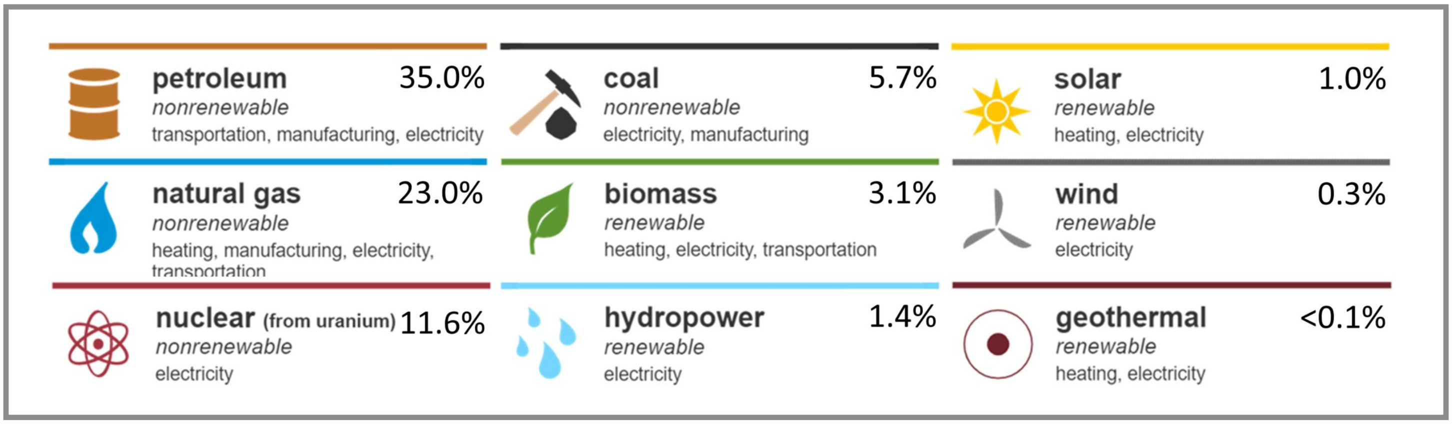

Figure 5. Maryland primary energy consumption estimates by source in 2020. A small number of sources not included above are net electricity imports and coal coke. The sum of individual percentages may not equal 100% because of independent rounding. (Graphic adapted from EIA, 2021m; Data sourced from EIA, 2021i).

comparable, or lesser extent, than fossil fuel plants (NREL, 2021). Hydroelectric operations also cause at least some ecological disturbance (IFC, 2018; Moran et al., 2018; Mussa et al., 2018).

Seasonal and long-term variations in precipitation, such as droughts, can also have significant effects on hydropower production. Hydropower currently accounts for over 40% of Maryland's renewable electricity generation, with the Conowingo hydroelectric generating station accounting for most of the state's hydroelectricity (EIA, 2021b). Flowing streams, irrigation ditches, and existing pipelines are the most likely locations for small hydropower systems capable of offsetting the energy consumed in homes, farms, or businesses.

Wind power is a direct mechanical-to-electrical conversion source which uses wind as a free fuel source to drive turbines, but only functions when the wind is active. The conversion device (i.e., wind turbine) requires a relatively small footprint for installation. While windmills are still operated on some farms and ranches to supply water for livestock, modern applications of wind energy are mainly used for electricity generation. In fact, wind energy provided about 13.0% of Maryland's renewable electricity generation in 2020 (EIA, 2021b). While almost 200 megawatts (MW) of utility-scale wind farms are currently being operated along Maryland's western Appalachian Mountain crests, Maryland's largest wind energy potential is offshore. Two major wind projects are currently planned off Maryland's Atlantic coastline, including a 250 MW and a 120 MW project located 17 and 20 miles offshore (Prensky, 2020), respectively.

Geothermal power uses Earth's heat to generate electricity and/or heat energy. While the fuel source is free, there are very few places globally that have sufficient geothermal resources to make this technology more prevalent. In Maryland, geothermal heat pumps, also known as ground source heat pumps (GSHPs), are commonly used to heat and cool buildings using the near constant temperature within the ground. GSHPs are very different from combustion appliances since the heat pump transfers heat from the ground to a building via circulating fluid. As a result, GSHPs can be over 400 percent efficient, meaning they can convert one unit of electricity to four or more equivalent units of heating or cooling (Hanova et al., 2007). For reference, traditional fossil fuel furnaces have efficiencies around 70 to 90 percent. Relative to air-source heat pumps, they are typically quieter, last longer, require less maintenance, and do not depend on the temperature of the outside air (Wu, 2009). GSHPs rely on electricity to operate the compressor and pump, thereby facilitating the heat transfer.

Solar energy can either be collected as thermal energy (i.e., heat) or converted into electricity (e.g., concentrated solar power, photovoltaics). The Sun produces the largest amount of energy over one year compared to all other forms of renewable and non-renewable energy combined (Table 1). While traditional energy forms, like fossil and nuclear, decline as their reserves are used, our solar resource will remain constant indefinitely. Data sourced from Perez and Perez, 2015.

Solar thermal energy systems are commonly used to heat air and water in homes, greenhouses, other buildings, and swimming pools; or high-temperature fluids in solar

Table 1. Solar energy potential

Year	Global Rate of Energy Use (TWy/y)
2015, *actual*	18.5
2050, *projected*	28
Renewable Resources	**Global Rate of Renewal (TWy/y)**
Solar	23,000
Wind	75 – 130
OTEC	3 – 11
Biomass	2 – 6
Hydro	3 – 4
Geothermal	0.2 – 3.0+
Waves	0.2 – 2.0
Tidal	0.3
Finite Resources	**Global Amount of Resource (TWy)**
Coal	830
Petroleum	335
Natural Gas	220
Uranium	185+

Data sourced from Perez and Perez, 2015.

thermal power plants. Direct solar-to-thermal, or concentrated solar power (CSP) uses steam from a superheated fluid to spin a turbine. While CSP requires direct cloud-free sunlight for many hours daily throughout the year, solar energy can also be directly converted to electricity using photovoltaics (PV). The word "photovoltaic" comes from the Greek word *photo*, meaning light, and *Volta*, named after Alessandro Volta, a pioneer in electrical energy who is credited with the invention of the electrical battery. So the word photovoltaic implies light-to-electricity.

Between 2010 and 2020, installed solar capacity increased over 37 times for all the U.S. and increased over 100 times for Maryland alone (Figure 6). As of 2021, solar energy accounts for over 6% of U.S. renewable electricity (Figure 3) and over 38% of Maryland's renewable electricity (Figure 4). Roughly two-thirds of Maryland's solar generation is derived from small-scale solar PV (e.g., rooftop systems), with utility-scale projects (i.e., solar farms) accounting for the remainder (EIA, 2021b). By early 2021, Maryland had installed over 1,200 megawatts (MW) of solar-generating capacity (EIA, 2021a).

References

EIA. (2020). *Annual Coal Report*: Table 1 - Coal Production and Number of Mines by State and Mine Type, 2019 and 2018. U. S. Energy Information Administration. Washington, DC. (October 5, 2020). Retrieved from https://www.eia.gov/coal/annual/

EIA. (2021a). *Electric Power Monthly: Table 6.2.B. Net Summer Capacity Using Primarily Renewable Energy Sources* and by State, June 2021 and 2020 (Megawatts). Energy Information Administration. Washington, DC.

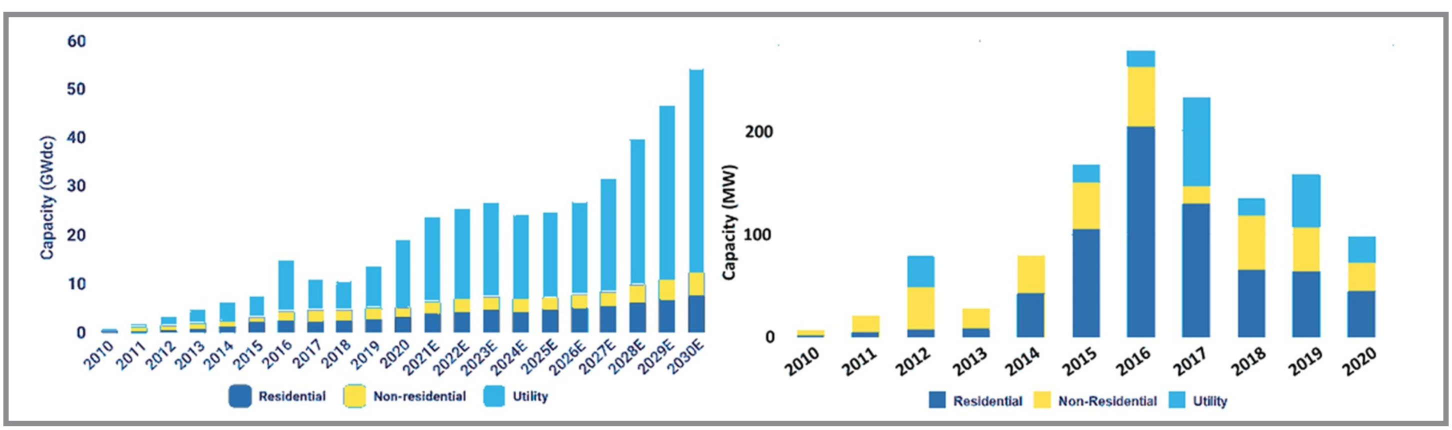

Figure 6. a) U.S. solar PV installations and forecast, 2010-2030E ([SEIA, 2021a](#)); [and b](#)) Maryland annual solar installations, 2010-2020 ([SEIA, 2021b](#)).

(August 24, 2021). Retrieved from https://www.eia.gov/electricity/monthly/

EIA. (2021b). *Electricity Data Browser*: *Net Generation for all sectors, Maryland, monthly 2001-2021*. U. S. Energy Information Administration. Washington, DC. Retrieved from https://www.eia.gov/electricity/data/browser/

EIA. (2021c). *Electricity Explained: Electricity in the United States.* Energy Information Administration. Washington, DC. (March 18, 2021). Available at https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php

EIA. (2021d). *Natural Gas Consumption by End Use*. U. S. Energy Information Administration. Washington, DC. (August 31, 2021). Retrieved from https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SMD_a.htm

EIA. (2021e). *Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860)*. U. S. Energy Information Administration. Washington, DC. (August 24, 2021). Retrieved from https://www.eia.gov/electricity/data/eia860m/

EIA. (2021f). *State Energy Data System (SEDS*): *1960-2019 (complete): Table C10 - Total Energy Consumption Estimates, Real Gross Domestic Product (GDP), Energy Consumption Estimates per Real Dollar of GDP, Ranked by State, 2019*. U.S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/seds-data-complete.php?sid=US#Consumption

EIA. (2021g). *State Energy Data System (SEDS): 1960-2019 (complete): Table C11 - Energy Consumption Estimates by End-Use Sector, Ranked by State, 2019*. U.S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/seds-data-complete.php?sid=US#Consumption

EIA. (2021h). *State Energy Data System (SEDS): 1960-2019 (complete): Table C14 - Total Energy Consumption Estimates per Capita by End-Use Sector, Ranked by State, 2019*. U.S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/seds-data-complete.php?sid=US#Consumption

EIA. (2021i). *State Energy Data System (SEDS): 1960-2019 (complete): Table CT2 - Primary Energy Consumption Estimates, 1960-2019, Maryland (Trillion Btu).* U. S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/seds-data-complete.php?sid=MD

EIA. (2021j). *State Energy Data System (SEDS): 1960-2019 (complete): Table F16 - Total Petroleum Consumption Estimates, 2019*. U. S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/sep_fuel/html/fuel_use_pa.html

EIA. (2021k). *State Energy Data System (SEDS)*: *1960-2019 (complete): Table P3 - Total Primary Energy Production and Total Energy Consumption Estimates in Trillion Btu, 2019*. U.S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/sep_prod/SEDS_Production_Report.pdf

EIA. (2021l). *State Energy Data System (SEDS): 1960-2019 (complete): Table PT2 - Primary Energy Production Estimates in Trillion Btu, Maryland, 1960-2019*. U.S. Energy Information Administration. Washington, DC. (June 25, 2021). Retrieved from https://www.eia.gov/state/seds/seds-data-complete.php?sid=MD

EIA. (2021m). *What is Energy? Sources of Energy.* U. S. Energy Information Administration. Washington, DC. (May 7, 2021). Available at https://www.eia.gov/energyexplained/what-is-energy/sources-of-energy.php

Hanova, J., Dowlatabadi, H., & Mueller, L. (2007). *Ground Source Heat Pump Systems in Canada.* Resources for the Future. Washington, DC. Available from https://core.ac.uk/download/pdf/9308461.pdf

IFC. (2018). *Environmental, Health, and Safety Approaches for Hydropower Projects.* International Finance Corporation (IFC), World Bank Group. Washington, DC. (No. 125192). Available from https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_ehshydropwer

Moran, E. F., Lopez, M. C., Moore, N., Müller, N., & Hyndman, D. W. (2018). *Sustainable hydropower in the 21st century*. Proceedings of the National Academy of Sciences, 115(47), 11891-11898. Available from https://www.pnas.org/content/pnas/115/47/11891.full.pdf

Mussa, M., Teka, H., & Ayicho, H. (2018). *Environmental Impacts of Hydropower and Alternative Mitigation Measures*. Current Investigations in Agriculture and Current Research, 2, 184-186. Available from http://dx.doi.org/10.32474/CIACR.2018.02.000133

NREL. (2021). *Electricity Annual Technology Baseline (ATB) Technologies and Data Overview*. National Renewable Energy Lab. Available from https://atb.nrel.gov/electricity/2021/index

Perez, M. & Perez, R. (2015). Update 2015–A fundamental look at supply side energy reserves for the planet. *Natural Gas,* 2(9), 215. Available from http://ws.asrc.albany.edu/people/faculty/perez/2015/IEA.pdf

Prensky, M. (2020). Larger offshore wind turbines approved off Ocean City. Here's what you need to know. *Delmarva Now*. (August 21, 2020). Available from https://www.delmarvanow.com/story/news/local/maryland/2020/08/21/larger-wind-turbines-approved-off-oc-coast-what-you-need-know/3406593001/

SEIA. (2021a). *Solar Industry Sets Records in 2020, On Track to Quadruple by 2030*. Solar Energy Industries Association. Washington, DC. (March 16, 2021). Available from https://www.seia.org/news/solar-industry-sets-records-2020-track-quadruple-2030

SEIA. (2021b). *State Solar Spotlight: Maryland Solar*. Solar Energy Industries Association. Washington, DC. (May 6, 2021). Available from https://www.seia.org/state-solar-policy/maryland-solar

U. S. Census Bureau. (2019). *House Heating Fuel: American Community Survey, 2019* 1-year Estimates: Table B25040 - House Heating Fuel. Retrieved from https://censusreporter.org/tables/B25040/

Verbruggen, A., Moowmaw, W., and Nyboer, J. (2011). Annex I: Glossary, Acronyms, Chemical Symbols and Prefixes. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. PichsMadruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available from https://www.ipcc.ch/site/assets/uploads/2018/03/Annex-I-Glossary-Acronyms-Chemical-Symbols-and-Prefixes-1.pdf

Wu, R. (2009). *Energy Efficiency Technologies – Air Source Heat Pump vs. Ground Source Heat Pump*. Journal of Sustainable Development, 2(2), 14-23. Available from http://dx.doi.org/10.5539/jsd.v2n2p14

Reviewed by

Daniel Bacellar, PhD
Center for Environmental Energy Engineering (CEEE)

Arjun Makhjani, PhD
Institute for Energy and Environmental Research

Fariborz Mahjouri, PhD, PE
Aurora Energy

DREW SCHIAVONE
dschiavo@umd.edu

This publication, *Maryland's Energy Market: The State Consumes More Energy than it Produces* (FS-1188), is a part of a collection produced by the University of Maryland Extension within the College of Agriculture and Natural Resources.

The information presented has met UME peer review standards, including internal and external technical review. For help accessing this or any UME publication contact: itaccessibility@umd.edu

For more information on this and other topics, visit the University of Maryland Extension website at extension.umd.edu