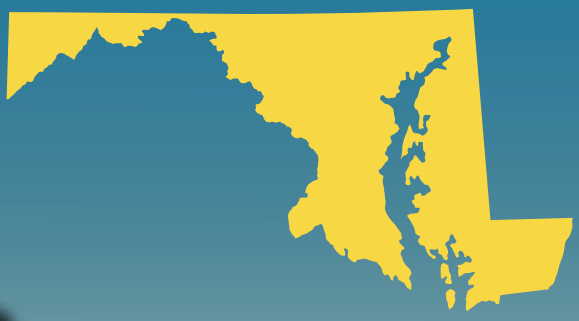
ENERGY & HEALTH IN MARYLAND

A BRIEFING FOR HEALTH ADVOCATES



A REPORT OF THE
MARYLAND ENVIRONMENTAL HEALTH NETWORK

Energy & Health in Maryland:
A Briefing for Health Advocates

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The authors express their gratitude to the following people who gave generously of their time and expertise in reviewing this report or serving as technical advisors. Responsibility for all views expressed here as well as for any errors or omissions lies entirely with the authors.

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The Maryland Environmental Health Network gratefully acknowledges support for this work from the Jacob & Hilda Blaustein Foundation, the Zanvyl & Isabelle Krieger Fund, the Town Creek Foundation, the Abell Foundation, and the BGE Green Grants program.

The Maryland Environmental Health Network is a project under the fiscal sponsorship of the Association of Baltimore Area Grantmakers (ABAG). This report is solely the responsibility of project staff and does not reflect the opinions of our funders, ABAG members, or ABAG Board.

ENERGY & HEALTH IN MARYLAND:
A BRIEFING FOR HEALTH ADVOCATES

Table of Contents:

EXECUTIVE SUMMARY

As public health advocates, we are trained to consider many factors that affect health, but energy policy is not one of them. Yet how we generate and use energy has health effects we cannot deny.

Cancer rates, respiratory illness, cardiovascular disease, birth outcomes, and mental health issues are some of the documented health problems linked to how our society has chosen to generate energy. Significant health benefits would accrue to Marylanders by investing in local renewable energy generation and moving to clean vehicle fuels, as well as by reducing our energy consumption and increasing our energy efficiency. These actions will also help reduce greenhouse gas emissions, another significant threat to health.

Clean and healthy power sources such as solar and wind are sometimes critiqued as expensive. But the true cost of renewable energy is lower than we think, because the health and social benefits are rarely accounted for.

The costs of asthma emergency room visits, for instance, or the savings from reduced rates of cardio-vascular disease do not show up on utility bills. Individuals and society pay the price. Health advocates must highlight the hidden costs of dirty energy and raise the promise of health benefits and savings from clean energy.

Major strides have been made in promoting off-shore wind in Maryland and setting standards for clean air. But significant problems remain; old polluting paper mills and trash-burning incineration are still part of our state Renewable Portfolio Standard. Exporting shale gas from the Cove Point facility in southern Maryland, or drilling in western Maryland's Marcellus Shale would further increase our reliance on fossil fuels.

The public health community can play a role in advocating for clean energy choices. Maryland health advocates should speak out on energy policy, because:

- **Energy choices are implicated in our biggest health epidemics**
- **When we switch to clean energy, health benefits are seen soon after implementation**
- **Important energy policy decisions are being made now in Maryland**
- **Health voices are non-partisan and can mobilize new political will for clean energy**

Health educators, clinicians, scientists, community health activists and employees of health care institutions can help move Maryland towards a clean and healthy energy system that reduces our greenhouse gas emissions and cleans our air. We have a responsibility to the public health to make this happen as quickly as possible. A clean and healthy energy supply can be grown to meet Maryland's needs.

I. ENERGY AND HEALTH IN MARYLAND: AN INTRODUCTION

Everyone needs energy. Yet the ways we produce the energy we need and the ways we use energy have consequences for our health that are often overlooked. Both the production of energy in Maryland and the use of energy in our homes, schools, businesses and public buildings release toxic substances into our air, water and soil, exposing people to pollution that causes disease. Combustion of fossil fuels to power equipment and vehicles adds another layer of pollution.

Issues of justice and fairness are involved; pollution is not evenly distributed across our communities.

Especially in its impact on air quality, energy production and use take a toll on human health. Air pollution is no longer a suspected carcinogen; it is fully documented to cause cancer. Impacts on birth outcomes, rates of respiratory illness, and cardio-vascular disease are also documented.

Maryland's poor air quality persists even though we have adopted clean air laws and regulations. As of December 2013, thirteen of Maryland's 24 jurisdictions were in non-attainment status for two EPA "criteria air pollutants": ozone and particulate matter. The Baltimore-Washington corridor ranks 8th in the American Lung Association's list of the most ozone polluted metro areas of the country in 2013.[1]

Issues of justice and fairness are involved; pollution is not evenly distributed across our communities. The uneven impact of pollution reflects deep fault lines in our society and contributes to significant health disparities for low income communities and people of color.

Air pollution especially exemplifies this inequity. For example, highways and heavy industry tend to be located near where people of color and low-income people live. Even strict emissions limits for individual power plants, incinerators or factories do not prevent multiple polluters from being sited in the same community. Thus, industrial and traffic emissions can be concentrated in specific communities, creating higher exposures to disease-causing pollutants for those living nearby, and leading to significant health disparities.

While resources pour into promoting health education, increasing health care access, and expanding insurance coverage, health disparities persist. More Americans now have health insurance coverage, yet many continue to be exposed to spikes in ground level ozone or on-going particle pollutant levels that cause debilitating chronic health problems. Moreover, we fail to monitor pollution levels in the very communities that are disproportionately exposed to air pollution; as a result, regulators and community members are left guessing about what is in the air we breathe.

Finally, the same sources that generate toxic air emissions also release greenhouse gases causing global warming. The health impacts of climate disruption are no longer in the future. Communities must now invest in cooling stations during heat waves and cope with new insect-borne diseases. Health services are disrupted during extreme weather events, such as Katrina and Superstorm Sandy. Increasingly greenhouse gases are understood to be a pollutant and a health threat.

Maryland's energy choices must be viewed through the lens of public and personal health impacts. As a public health community, if we are serious about addressing health disparities, building healthy communities, achieving health equity, and protecting our children, we must address energy policy. Energy policy is health policy.

II: HEALTH IMPACTS OF ENERGY-RELATED POLLUTION

What is the clinical basis for a claim that energy policy and health policy are linked? It lies predominantly in the impact of energy production and use, in its many forms, on air quality, and how poor air quality is implicated in some of our most serious health epidemics.

No one can choose what they breathe. No one can choose *not* to breathe.

Water and soil contamination from energy sources can be serious threats to health as well. These kinds of pollution sometimes come to light in dramatic and newsworthy forms, so they draw public attention. For instance, contamination of drinking water from discharged fracking fluids threatened Pittsburgh's water supply in 2009. Superfund sites and the Fukushima disaster are other high profile examples of soil and water contamination.

Less visible are the dead streams from coal mine tailings and toxic coal ash disposed of in landfills, which also create local health problems that cannot be quickly remedied. Radioactive releases from nuclear power plants, the release of hazardous chemicals into water supplies, noise pollution from gas compressor stations, and contamination of soil with lead, PCBs, and mercury are further examples. These are all serious impacts.

However, air pollution has a claim beyond these. No one can choose what they breathe. No one can choose *not* to breathe.

To make the case for clean and healthy energy, we focus primarily on air pollution. Bringing bottled air to a community that is breathing in toxics is not an option. For air pollution, there is no equivalent to capping the soil in a contaminated industrial site. The only solution is to go to the sources – which are closely linked to how we produce and use energy.

THE HEALTH BURDEN OF AIR POLLUTION

The American Lung Association characterizes particle pollution and ozone as the most harmful forms of US air pollution. A mix of solid and liquid particles, particulate matter (PM) is usually visible as smog. Particle pollution that can enter the body falls within the size range of 10 microns in diameter and smaller. PM 10 and smaller can be breathed in, while PM 2.5 comprises particles small enough to pass through the lungs and into the blood stream. The composition of the particles themselves is not specified in these designations and can be complex.

Ground level ozone develops through mixing emissions such as nitrogen oxides, carbon monoxide, and volatile organic compounds coming from tailpipes and smokestacks, with sunlight as a catalyst. This form of ozone, distinct from the protective ozone layer in the atmosphere, causes short-term difficulty breathing, and also can cause long term scarring of the lungs.

The local news will routinely report homicide deaths: 235 Baltimore City homicides in 2013. But deaths from air pollution are three to four times higher and garner no public attention.

A 2013 study by the Massachusetts Institute of Technology (MIT) Laboratory for Aviation and the Environment tracked data on emissions from six energy use sectors.[1] The study concluded that over 200,000 early deaths among Americans each year are due to air pollution. The American Heart Association in 2010 noted that the body of evidence had grown since 2004, when they first published the association between heart disease and fine particulate matter.[2] The New York City health department published an analysis documenting 3200 annual deaths attributable to PM 2.5.[3]

MIT also mapped PM 2.5 emissions for 5695 American cities using 2005 data and ranked Baltimore as having the highest rate of air pollution deaths, with 130 deaths per 100,000. With a population of 621,000, this means 807 Baltimoreans die from air pollution related causes each year. The local news will routinely report homicide deaths: 235 Baltimore City homicides in 2013. But deaths from air pollution are three to four times higher and garner no public attention.[4]

In 2011, the Maryland Department of Health and Mental Hygiene identified cardiovascular disease as the primary cause of death in the state, followed by cancer, stroke, and Chronic Obstructive Pulmonary Disease (COPD).[5] Asthma is another Maryland epidemic, the one that most affects children.In Maryland, almost 12% of children currently have asthma.[6]

A 2014 article in *Environmental Health* showed how Maryland communities of color and low income people are overburdened by "noxious land uses" as well as being medically underserved.[7] In Maryland, as compared to whites, people of color face higher cancer risks from hazardous air pollutants and are likely to live with more facilities per square mile that emit EPA criteria air pollutants. Maryland's low-income families experience increased cancer risk and likelihood of living near facilities emitting criteria air pollutants. They are also more likely to live near a Superfund site, as defined by the 1980 federal law designed to clean up sites with hazardous contamination.[8] The American Lung Association provided a nuanced discussion of the complex relationship between air pollution and the disparities of race, class, income and other factors in their 2013 State of the Air report.[9]

CANCER

Cancer is the second leading cause of death in Maryland, responsible for 23.7% of all Maryland deaths in 2009. The American Cancer Society found that in 2010, an estimated 27,700 Maryland adults were diagnosed with cancer.[10] The Center for Disease Control and Prevention (CDC) report that the Maryland rate of cancer incidence for all forms combined in 2010 was 503.8 cancers per 100,000 population.[11]

The President's Cancer Panel warned in 2010 that "environmental contributors to the development of cancers have been grossly underestimated."[12] In 2013, the International Agency for Research on Cancer of the World Health Organization (WHO) classified both outdoor air pollution generally and particulate matter specifically as carcinogenic to humans.[13] Specifically, the WHO cancer agency identified lung and bladder cancer as being caused by air pollution. According to the CDC, in 2010 Maryland's bladder cancer rate was 18.9 per 100,000 (ranking 37th highest among states) and 57.4 for lung cancer (36th among states).[14]

An April 2014 article published in the American Journal of Preventive Medicine documented the positive association between childhood leukemia and exposure to traffic during the postnatal period, but not during the prenatal period.[15] The study suggested that precautionary public health messages and interventions be considered.

CARDIOVASCULAR DISEASE

Cardiovascular disease and stroke are the first and third causes of mortality, respectively, among Marylanders. 37.4% of Maryland's adults reported high cholesterol and 30.1% reported high blood pressure in 2009; both of these conditions are major risk factors for heart disease and stroke.[16]

High blood pressure, stroke and heart attack have all been associated with poor air quality. The American Heart Association characterized the pathophysiology of air pollution and heart disease in their updated statement in 2012 as follows:

> *"Air pollutants have been linked with endothelial dysfunction and vasoconstriction, increased blood pressure (BP), prothrombotic and coagulant changes, systemic inflammatory and oxidative stress responses, autonomic imbalance and arrhythmias, and the progression of atherosclerosis."*[17]

New York City found that cardiovascular disease hospitalizations attributable to PM 2.5 were highest in poorest neighborhoods. The NYC health department reported that three-fifths of cardiovascular disease admissions among adults age 65 and older were related to PM 2.5.[18]

RESPIRATORY ILLNESS

Asthma and Chronic Obstructive Pulmonary Disease (COPD) are two major respiratory diseases. Maryland ranks 5th in the nation in prevalence of adult asthma, and 11.9% of Maryland's children have asthma, with sharp racial disparities masked by that average.[19] Asthma is linked to air pollution; particulate matter, ground level ozone, nitrogen oxides and volatile organic compounds (VOCs) trigger symptoms. Vehicle exhaust contributes to high levels of asthma in urban areas.

In 2011, Maryland was ranked as 5th worst in the nation for air pollution emitted from coal and oil burning power plants.[20] Trash-to-energy operations further add to ambient air pollution, emitting particulate matter, dioxins, PCBs, acid gases, polycyclic aromatic hydrocarbons and heavy metals like lead, arsenic and mercury.[21, 22] Fracking operations are creating smog conditions in states where air quality has previously

been pristine.[23] If Maryland were to allow shale gas drilling, such operations would emit VOCs and generate new traffic related air pollution known to trigger asthma and other respiratory symptoms.[24]

COPD is the 4th leading cause of death in Maryland.[25] Like asthma, COPD has been found to worsen with exposure to increased air pollution. A large-scale epidemiological study from Denmark found long-term exposure to traffic-related air pollution contributed to the development of COPD, and possibly enhanced susceptibility to the development of COPD in people with diabetes and asthma.[26]

REPRODUCTIVE, DEVELOPMENTAL, AND BIRTH OUTCOMES

Preterm birth and other poor birth outcomes have been longstanding public health concerns in Maryland. In 2012, 12.7% of all babies in the state were born prematurely, as compared to 11.5% nationally.[27, 28] The disparity in urban areas such as Baltimore has reached as high as 14% in recent years.

The evidence base for environmental contributors to preterm birth or low birth weight is characterized by the Collaborative on Health and the Environment as strongest for tobacco smoke, followed next by the many forms of air pollution.[29] Epidemiological and animal studies show that there is a link between shorter gestation and the level of particulate matter, sulfur dioxide, nitrogen dioxide, and other nitrogen oxides in the ambient air.[30]

Poor air quality has been associated with pregnancy-induced hypertension, a contributing factor in preterm birth and low birth weight. VOCs used in hydraulic fracturing, such as benzene, ethylbenzene, toluene, & mixed xylenes have been linked to altered neurodevelopment, and may be associated with developmental disorders such as learning disabilities, attention deficit hyperactivity disorder (ADHD), and autism.[31] VOCs have also been linked with poor sperm quality in men, and difficulty achieving or maintaining pregnancy in women.[32, 33] A recent study found that pregnant women exposed to incinerator emissions, even at very low levels, had higher rates of preterm birth.[34]

Two recent studies look at birth outcomes in proximity to oil and gas wells. In Colorado, a study using 12 years of birth data from counties with high volume hydraulic fracturing found higher rates of certain birth defects the closer a mother lived to a well.[35] In a study looking at Pennsylvania birth data, lower birth weight babies were observed for mothers living near gas wells.[36]

MENTAL HEALTH AND SOCIAL IMPACTS

A growing body of research supports damaging effects of air pollution on the brain. Mental and social health impacts include depression, dementia, premature aging of the brain, social disruption from industrial operations, and impacts on community quality of life.

Studies show that older people exposed to greater air pollution experience a faster decline in cognitive abilities than those in areas with better air quality.[37, 38] A recent review summarized the evidence supporting the link between air pollution and stroke, Alzheimer's disease, neuro-developmental disorders and Parkinson's disease.[39] Exposure to black carbon was found to reduce cognitive abilities in a prospective birth cohort study of children in Boston.[40] Another study of children exposed in utero to polycyclic aromatic hydrocarbons (PAHs) found greater attention problems and depression.[41]

Noise pollution, such as the constant din from fracking operations, is a well-established contributor to mental disorders. A 1999 WHO review summarized the symptoms associated with noise pollution as "anxiety; emotional stress; nervous complaints; nausea; headaches; instability; argumentativeness; sexual impotency; changes in mood; increase in social conflicts, as well as general psychiatric disorders such as neurosis, psychosis and hysteria."[42]

Studies of mental health in communities affected by fracking show a cumulative effect from many different aspects of the energy industry:

"The stresses of social change, uncertainty, isolation, inadequate housing and infrastructure, and substandard services may combine in ways that significantly affect communities' quality of life. Chronic psychological stress has been linked to respiratory health, both independently and in combination with air pollution exposures."[43]

LIFE EXPECTANCY

Life expectancy in Maryland in on par with the national average; in 2010, the average life expectancy in the US was 78.9 years and the average in Maryland was 78.8.[44] However, the state average masks large disparities. In Baltimore City, there can be a 20 year disparity in average lifespan between neighborhoods just a few miles apart.[45] In its 2011 report Chronic Disease in Maryland, the Department of Health and Mental Hygiene summarized the impact of a range of chronic diseases by saying "for the first time, children are expected to have a shorter life expectancy than their parents."

A 2009 study found that life expectancy was increased by half a year for every decrease of 10 micrograms per cubic meter of PM2.5 and that reductions in air pollution resulted in an average 15% increase in life expectancy in the US.[47] Many factors contribute to lower life expectancy and higher mortality and morbidity rates among these populations.[48] With regards to air pollution, the most vulnerable populations are people of color, low income families, people with low levels of education, and working class people.[49]

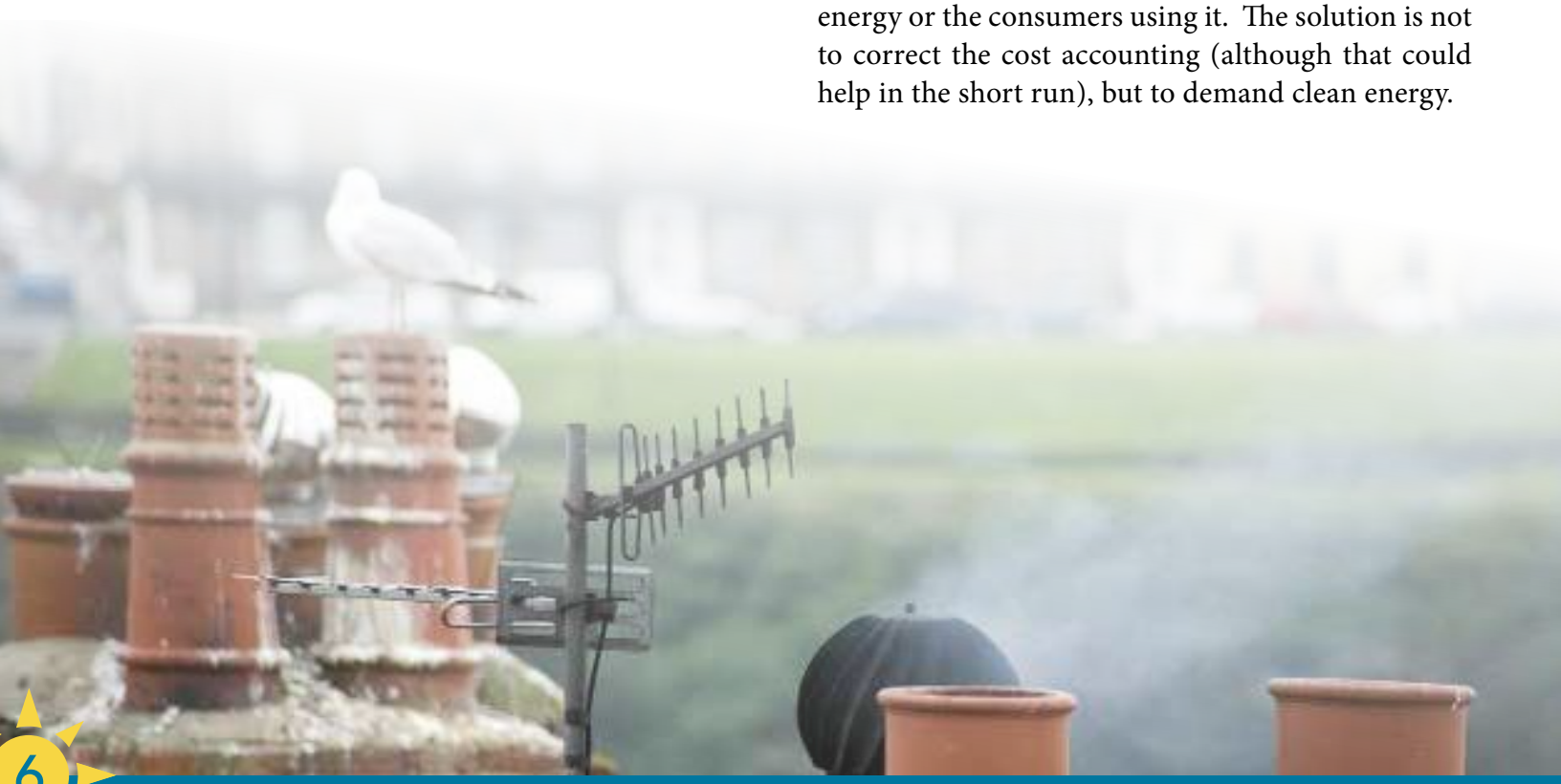
In its 2010 Health Disparities Report Card, the Baltimore City Health Department framed the imperative to address health equity issues in relationship to health disparities:

> *"Health disparities such as those in Baltimore are called health inequities when they are the result of unfair and systematic social, political, economic, and environmental policies and practices. Health inequities are thus the subset of health disparities that are unjust and avoidable. They can be prevented and eliminated with appropriate action."*[50]

Our argument for a health approach to energy policy is exactly this. It is a cause of health inequities that can be prevented and eliminated.

Air pollution from energy sources is a cause of health inequities that can be prevented.

If the health costs of air pollution were reflected in the price we pay for energy, it would be cause for consumer outrage. Instead, almost all health costs of air pollution derived from vehicle exhaust, power plants, poor building ventilation, inadequate indoor combustion, and other energy sources are externalized. This means that they are borne by society at large or by individuals, but not by the industries producing the energy or the consumers using it. The solution is not to correct the cost accounting (although that could help in the short run), but to demand clean energy.



III: ENERGY GENERATION AND USE IN MARYLAND

If Maryland health advocates, public health professionals, and clinicians are to speak out for cleaner and healthier energy, we must be armed with a clear understanding of how we currently generate and use energy in our state.

In the quest for clean and healthy energy sources, electricity beats out all other forms of power for one reason: it can be generated from clean renewable sources. A home heated with oil, a gas stove, and a car fueled by gasoline are each wedded to fossil fuels. By contrast, an electric vehicle, a home heated with efficient electrical systems, and an electric range or microwave oven can be powered by cleaner sources, if the local electricity supply is dominated by renewable energy. Appliance standards are making electrical devices steadily more efficient, and as their sources of power shift from fossil fuels to wind and solar, their use becomes cleaner.

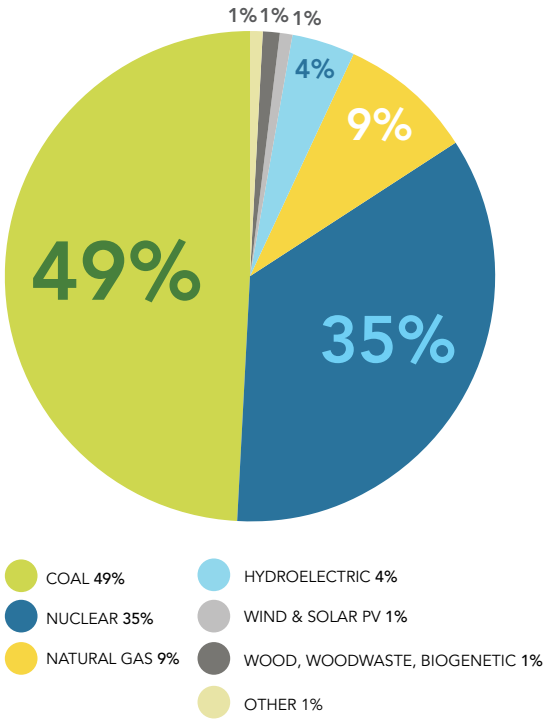
Electricity beats out all other forms of power because it can be generated from clean and healthy renewable sources.

We can think of electricity as being indifferent to the source of its power. Electricity in itself carries no positive or negative health consequences, until we examine how it is generated, transmitted and stored. While transmission and storage of clean-sourced electricity is not without safety and health implications, electricity generated from solar and wind sources involves no combustion, the principal cause of air pollution.

MARYLAND'S ELECTRICITY GENERATION

Generating all of Maryland's energy needs from clean healthy sources means focusing on electricity. However, as the chart illustrates, Maryland has a long way to go in generating our electricity from clean fuels.

MARYLAND ELECTRICITY GENERATION BY FUEL
SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION (2011)



The following discussion focuses on four energy sources that carry serious health implications:

- Natural gas now being extracted from under-ground formations such as the Marcellus Shale in Pennsylvania – a national boom in gas drilling began about ten years ago;
- Energy generated from incineration of trash and other waste products, which Maryland deems to be a "renewable" resource;
- Coal, the environmental and health impacts of which are severe both in how it is mined (mountain-top removal) and in the toxics generated by its combustion; and
- Nuclear power, which becomes a focus of concern in the aftermath of disaster, but carries other threats that receive little on-going attention.

SHALE GAS

Much of the controversy over natural gas stems from its role in reducing our national and state reliance on coal and the claim that it serves as a bridge to cleaner energy sources. In fact, both the climate impact and the health calculus for natural gas are more complex and troubling.

Maryland could join the shale gas boom by allowing drilling in Western Maryland now and in central Maryland in the future. But Maryland will feel the impact of unconventional natural gas development – often called "fracking" - whether we drill or not. Drilling in the neighboring states of West Virginia and Pennsylvania could affect our waterways and airsheds, and exporting liquefied gas from Cove Point in Calvert County could drive construction of new compressor stations and pipelines throughout Maryland.

Horizontal hydraulic fracturing is a method of drilling deep wells into shale formations, where methane gas is released by injecting millions of gallons of fresh or recycled water mixed with toxic chemicals and sand. Bringing the gas to market involves building new pipelines and compressor stations. The Marcellus shale play runs under two western Maryland counties, and the Taylorsville shale play runs under portions of central Maryland.

A $3.8 billion investment has been approved to turn the liquefied natural gas (LNG) facility in southern Maryland at Cove Point into an export facility, where fracked gas will be shipped to Asia. The project will necessitate building a special purpose power plant as well as new pipelines and compressor stations through central Maryland to move gas from Pennsylvania and other fracking states. A US Department of Energy study recently found that the 20 year greenhouse gas impact of exporting LNG to China would be worse than if China burned its own coal supplies.[51]

Maryland is unique among states in conducting a public health study of fracking and assessing hazards before deciding whether to allow drilling. However, that study is confined to western Maryland and does not fully cover the health impacts of pipelines, compressor stations, and export facilities. Pipeline leaks, noise from compressor stations, and the threat of explosions are worthy of full analysis. In the first few months of 2014, explosions related to the gas industry occurred in Manitoba, Canada (January), Kentucky and southwestern Pennsylvania (February), and Washington state and New York City (March).

The rapid growth of the industry, its exemption from federal environmental protection laws, limited oversight capacity in states, and intimidating practices from the industry have all contributed to the lack of public health data and studies of fracking. A highly protested Pennsylvania law has effectively gagged medical providers from disclosing the fracking chemicals their patients have been exposed to. Health effects from the shale gas industry are just beginning to be assessed and new concerns such as birth defects and radiation exposure are emerging, and need further study.

Moreover, the largest use of natural gas in Maryland is for space and water heating, both of which can be replaced by efficient electrical systems powered by renewable solar and wind energy. This is important because natural gas (along with oil and propane) for space and water heating must be almost completely eliminated if Maryland is to reach the necessary goal of reducing greenhouse gas emissions by 90% by 2050.

Reported health problems related to fracking include increased rates of asthma, birth defects, low birth weight babies, sexually transmitted diseases, skin rashes, nosebleeds, and domestic violence. Greenhouse gas emissions from methane (more potent than CO2 in the near term), water and air threats, radiation, explosions, worker safety, and chemical exposures are among the areas that need further study. A reasonable position for health advocates to adopt with regard to shale gas is one of skepticism and insistence on more health research and health impact analysis.

BIOMASS AND WASTE INCINERATION

Maryland continues to generate electricity by burning waste products, including municipal solid waste, wood waste, and a byproduct of the paper-making process called "black liquor." These sources are all currently included in the state's Renewable Portfolio Standard, or RPS which means they can receive subsidies that are underwritten by Maryland rate-payers. Trash-burning is called "waste to energy" or WTE, whereas black liquor and wood waste both fall under the category of "biomass." The biomass can come from any state in the same electricity grid as Maryland, while the trash incineration can only come from Maryland, according to the RPS law.

The Energy Recovery Council cites 85 incinerators, operating in 23 states, disposing approximately 30 million tons of municipal solid waste each year and recovering from household waste approximately 15 million megawatt hours of energy per year.[52] However, waste incinerators frequently burn non-household items like tires and the insides of automobiles, and almost any type of incineration releases particulates and toxic chemicals into the air.

A 2008 report from the British Society of Ecological Medicine catalogued the health threats from incineration: incinerators burn materials that result in toxic ash; they release dioxins, particularly at the time of start-up and shut-down, when emissions are not subject to standard monitoring; they emit ultra-fine particulates implicated in cardiovascular and cerebrovascular mortality.[53] A 2013 study of birth outcomes in Italy found that "maternal exposure to incinerator emissions, even at very low levels, was associated with preterm delivery." [54]

A 2011 study by the Environmental Integrity Project found that trash incinerators produce more pollution per kilowatt hour of energy generated than each of Maryland's four largest coal-power plants, and these emissions include toxic pollutants such as mercury and lead. The report also found that waste-to-energy facilities are expensive to construct and provide fewer jobs and economic benefits than options such as recycling and source reduction.[55] Additional community concerns are the increase in truck traffic to haul in waste and the proper disposal of incinerated ash.

Maryland hosts three trash incinerators (in Montgomery County, Baltimore City, and Harford), as well as a sewage sludge incinerator in Upper Marlboro, tire incineration in the Harford trash incinerator and in cement kilns in Hagerstown and Union Bridge. The nation's largest medical waste incinerator is in southeast Baltimore.

In addition to trash incineration, the burning of wood waste and black liquor also poses health problems. Between 2006 and 2012, black liquor and wood waste accounted for 50% of the subsidies given under Maryland's RPS. Most go to out of state paper mills, resulting in no economic benefits for Marylanders and perpetuating health and environmental damage in Maryland and other states. Air pollution and carbon emissions from these dirty biomass sources travel across state borders; they generate nitrogen oxide and sulfur dioxide both of which are linked to an array of adverse respiratory effects such as exacerbation of asthma.

COAL

In a 2010 report, the Clean Air Task Force estimated annual U.S. deaths from coal-fired power plants related to air pollution at 13,200, as well as 9700 hospitalizations and 20,000 heart attacks.[56] Similar estimates have been made by the American Lung Association. Coal's smoke stack sources of particulate matter, mercury, and toxic gases affect local air quality, as well as contributing to regional pollution.

The amount of gases and particulate matter (PM) emitted can be reduced by "scrubbing" technology and by the type of coal being burned. The claim of "clean coal" is misleading however since technologies that eliminate nitrogen oxides, sulfur dioxide and carbon emissions are very expensive and rarely deployed.[57] Carbon capture and storage is being explored in China which is heavily dependent on coal, and where the associated health costs are becoming extreme. In some places, Chinese scientists calculate air pollution to be responsible for 1 in 20 deaths.[58]

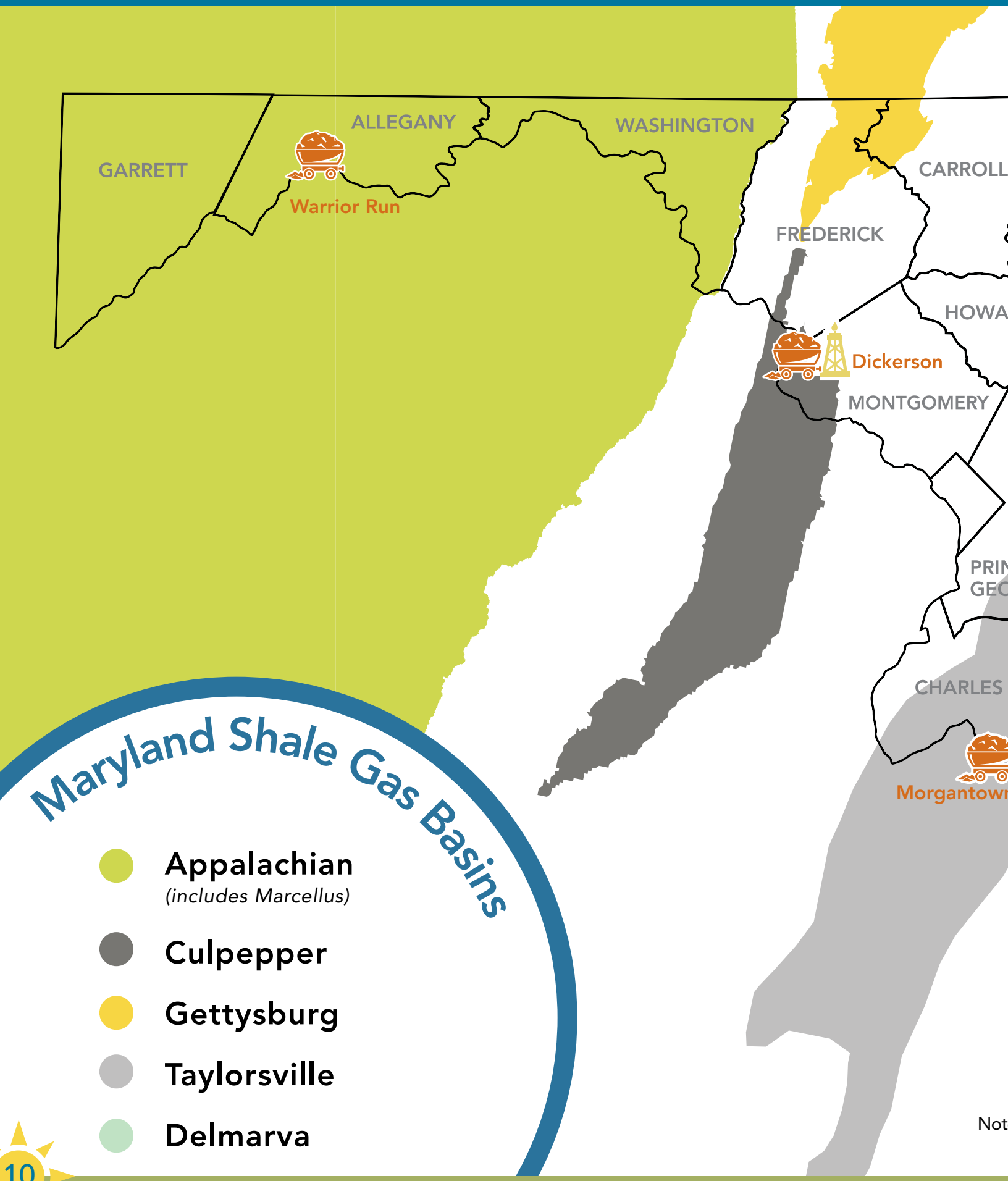
Communities located near coal export facilities, such as Baltimore, the third largest coal export port in the US, suffer from coal dust. Other communities experience the effects of toxic coal ash, as was released into and poisoned Cape Fear River in North Carolina in March 2014. Toxic chemicals used to process coal spilled into the Elk River in West Virginia in January 2014, affecting the drinking water of 300,000 people. The greenhouse gas impact of coal adds greatly to its health threats since coal remains the largest source of greenhouse gas emissions from the electricity sector.

NUCLEAR POWER

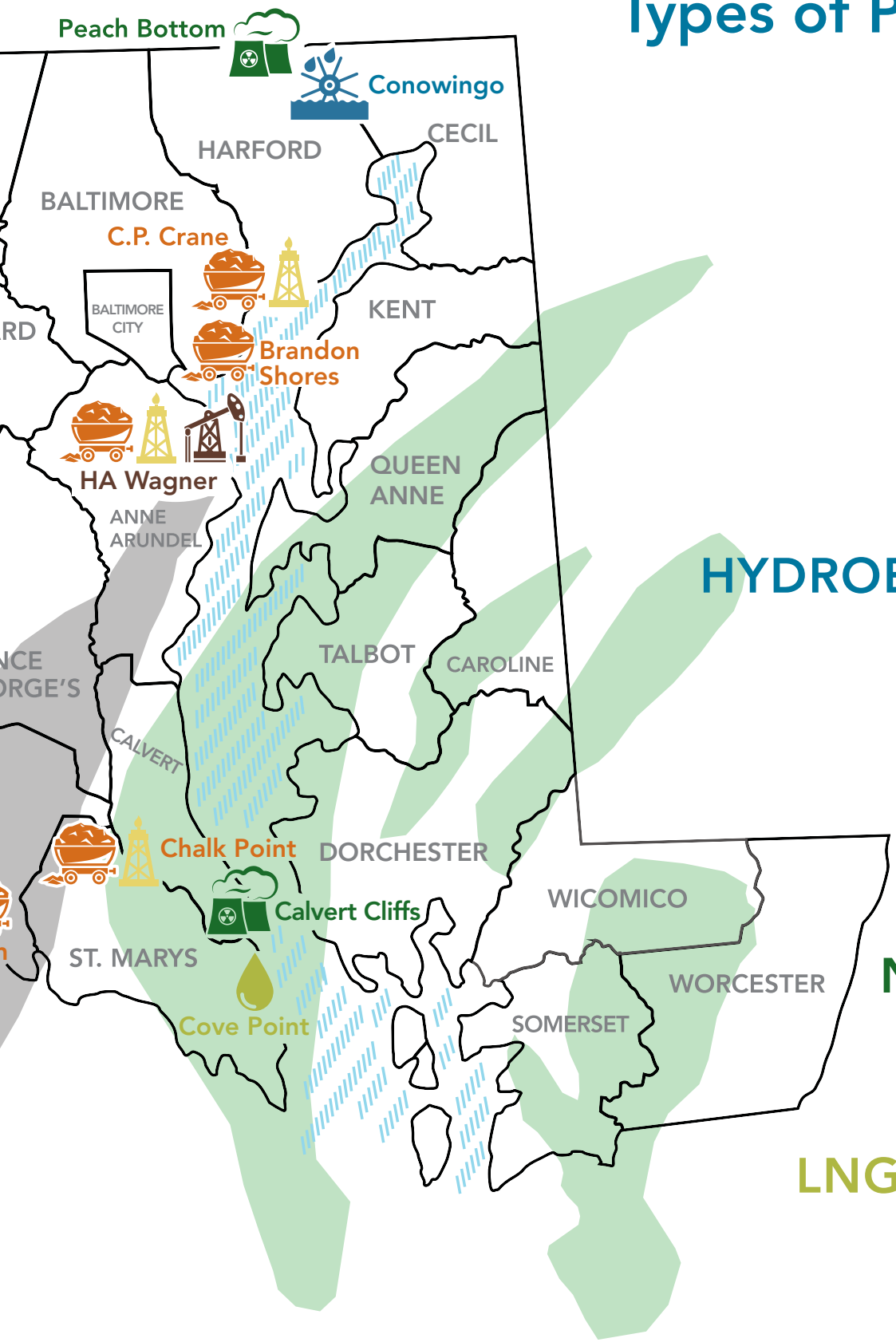
Maryland's single nuclear power plant is located at Calvert Cliffs. Nuclear power plants do not generate the "criteria air pollutants" covered by the US Clean Air Act at the power plant. However, nuclear reactors routinely vent radioactive air into the atmosphere and discharge radioactivity to water bodies, with little monitoring.

For instance, the Nuclear Regulatory Commission does not require monitoring of rainwater or private wells that may become contaminated from radioactive rain. Yet, all nuclear power plants emit radioactive water vapor. Radioactive water may especially affect pregnant women.[59] Private drinking water wells near nuclear plants may be affected by radioactive rain.

Maryland's Shale Gas Basins & Majo



or Power Plants



Types of Power Plants

COAL

OIL

HYDROELECTRIC

GAS

NUCLEAR

LNG EXPORT

e: Power plant locations are approximate. For details on individual plants, see Maryland Power Plant Research Program.

Sources: U.S. Geological Survey & Maryland Power Plant Research Program

While much recent discussion has focused on the health effects of the Fukushima disaster, there is little public health dialogue about the long-term health effects of nuclear power under normal operating conditions. Significant health effects have been associated with uranium mining and milling, such that there is now a compensation program for uranium miners. Studies of cancer rate declines in Germany[60] and California[61] associated with nuclear plant closures have been controversial and the issue requires further research.

Nuclear power carries health risks also in the form of low-level radioactive waste that is disposed out of state. While the federal government had committed to opening a geologic repository for spent fuel disposal in 1998, there is still no approved repository site. In the meantime, spent fuel is piling up at reactor sites in densely packed spent fuel pools and, in many cases, in dry casks. Calvert Cliffs is no exception. While the risk of severe radioactivity releases from such sources is officially rated as very small, that was also the official position on Fukushima and Three Mile Island.

RENEWABLE ENERGY

Solar and wind are the two clean and healthy energy sources that can grow in Maryland. Our state's requirement for renewable energy – the Renewable Portfolio Standard (RPS) – calls for 20% of our energy to be supplied from renewable sources by 2022. In 2013, this mandate resulted in about 8% of Maryland's energy coming from sources the state defines as renewable.[62]

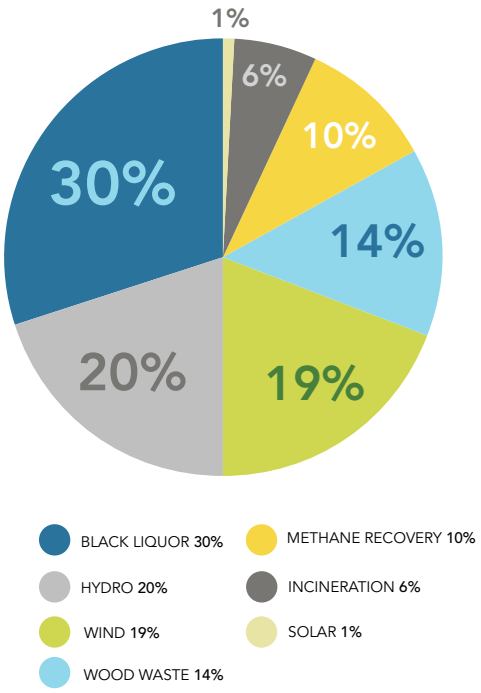
The RPS mandate puts us ahead of many other states. It contains a carve-out for solar energy, and temporary incentives beyond the RPS are in place to encourage the growth of the solar market. Off-shore wind legislation which passed in 2013 sets the stage for future growth of offshore wind energy.

However the RPS allows significant subsidies to be given for polluting energy sources - incineration of trash and burning of wood waste and "black liquor", as discussed above. Over the past eight years, 44% of RPS credits went to black liquor and wood waste sources. About 6% of the RPS credits went to incineration. Combined, these two dirty sources soaked up half the subsidies.

Burning trash, black liquor, and wood waste generates nitrogen oxide and sulfur dioxide emissions at levels close to coal and much greater than oil and natural gas. These fuels also emit a host of other hazardous emissions including particulates, volatile organic compounds, arsenic, and carbon monoxide.

Before Maryland's goals for renewable energy can be deemed truly health-promoting, our state must replace incineration and black liquor with clean renewables such as wind and solar.

2006-2013 MARYLAND DISTRIBUTION OF MARYLAND RENEWABLE ENERGY CREDITS
SOURCE: PJM-ENERGY INFOMATION SERVICE



One form of renewable energy that is not reflected in the chart is geothermal energy, recovering the earth's own heat. Electricity can be generated by drilling directly into geothermal reservoirs where its heat is converted into electricity at a geothermal power plant. At the residential level, heat can be used directly for space heating and cooling. Although expensive to install, the EPA considers geothermal heat pumps to be one of the most efficient heating and cooling systems available.

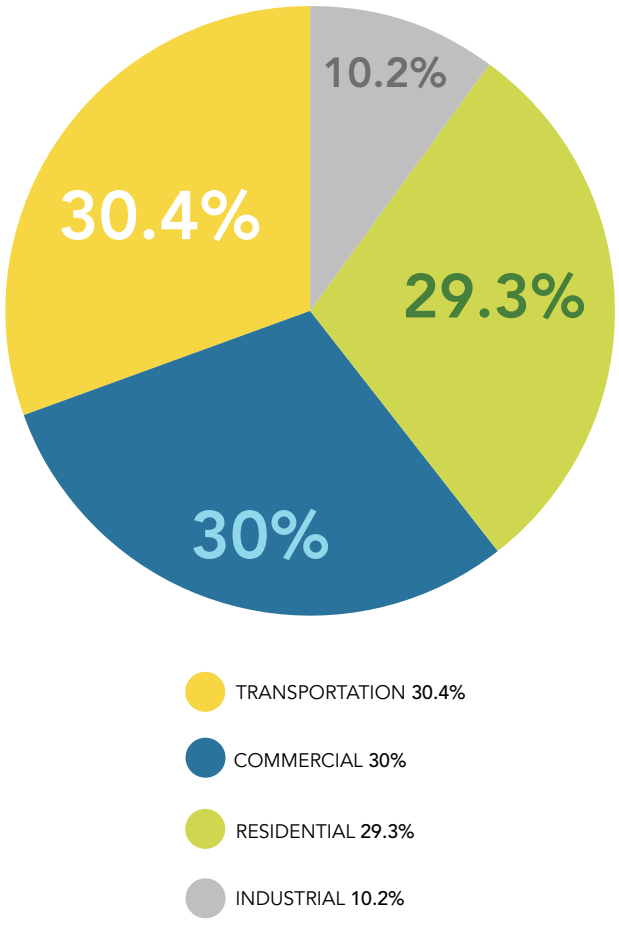
Solar arrays of photovoltaic (PV) panels harvest energy from sunlight and are installed on roofs and large ground arrays such as parking lots. The mining of raw materials for manufacture of PV cells and the proper disposal of panels at the end of their useful life can pose health and safety concerns. Other than these, solar energy is benign from a health point of view. It carries additional advantages in being a "distributed" form of energy, meaning that individuals and communities, as well as utility companies, can own the means of energy production. With advances in storage technology, community solar capacity will help communities become more resilient in the face of extreme weather and thus better able to maintain critical health services during power outages.

Energy from wind currently comes from land-based turbines located along mountain ridges, often in the flight path of migratory birds. Installation of land-based wind turbines can destroy natural habitat and add new noise pollution to a previously quiet area. These are among the reasons that off-shore wind is advantageous. The health impacts of off-shore wind energy are similar to those of solar – mostly limited to the pollution and disruption generated at the time of manufacture and installation. Once installed, wind turbines generate no air pollution.

MARYLAND'S ENERGY USERS:

In addition to demanding that our energy come from clean and healthy sources, health advocates can also pay attention to what energy is used for. Maryland's transportation, residential, and commercial sectors are relatively equal in their use of energy. Industrial pollution is an appropriate focus of attention because it is a "point source"; pollution is visible from smokestacks and discharge pipes. However, industry is the smallest energy user in Maryland.

MARYLAND ENERGY USE BY SECTOR 2011
SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION



All sectors can contribute to a healthier environment by purchasing more efficient equipment, insulating their buildings, and taking steps to conserve overall usage. Energy efficiency and conservation promote health by cutting down on the overall use, or slowing the rate of growth in demand for energy, regardless of whether it is generated in a healthy or unhealthy way, from a clean or dirty source. In public health terms, conservation and efficiency can be thought of as harm reduction. Both have tremendous value in economic and environmental terms, but the most ambitious health agenda for energy seeks not just to reduce harm but to eliminate it, by moving all energy uses to clean technologies.

Health is best protected by moving all energy production to clean technologies.

Mass transit systems are an example of a societal investment not fully valued for its health impact, reducing both vehicle emissions and traffic fatalities. Another health benefit is that transit users walk more than car users; a 2007 study documented the lower body mass index of New York City residents living in walkable neighborhoods with good access to public transit. Yet health cost savings are not used to offset the cost of a mass transit project. Likewise at the consumer level, home heating choices are rarely made on the basis of healthy fuels. By contrast, the market for electric and hybrid cars has grown because some buyers value both higher mileage and low to zero emissions.

All forms of energy use that contribute to greenhouse gas production are a threat to human health. Renewable energy sources produce greenhouse gases (GHGs) only at the time of construction, not at the time they are used. By contrast fossil fuels (oil, gas, coal) and incineration are inherently meant for continuous burning and they release GHGs continuously as a result. Thus placing a priority on renewable energy sources over all fossil fuels and incineration is logical from a health and climate standpoint.

TOXIC VS. HEALTHY VEHICLES:

We don't focus on transportation as a major health threat. But if all vehicles became electric powered, the health implications would be significant.

Fossil fuels power most vehicles, creating pollutants and greenhouse gases. CAFE (corporate average fuel economy) standards for vehicle fuel efficiency have reduced carbon emissions and EPA regulations for specific pollutants have achieved improvements in other emissions, but a critical failure has been to address toxic aromatics in gasoline, which replaced lead in the 1980's. Diesel exhaust standards are far behind gasoline standards.

MIT's Laboratory for Aviation and the Environment showed that emissions from road transportation are the most significant contributor to the approximately 200,000 early deaths from air pollution that occur annually in the United States.[65]

Numerous studies identify traffic exhaust as a health threat. A 2010 study concluded that children exposed to traffic-related pollution while at school were more likely to develop asthma.[66] Another study found that exposure to pollution from cars and trucks could cause asthma in children at an early age, with symptoms persisting though the age of eight.[67] A 1995 study of births in Beijing found a relationship between gestational age and the level of sulfur dioxide and particulate matter exposure of the mothers during pregnancy. [68] These results were replicated for fine particle air pollution in a study of births in North Carolina over 5 years.[69]

A 2007 study published in The Lancet found that exposure to traffic had an adverse effect on the lung development of children living within 500 meters of a freeway in Southern California, independent of the overall regional air quality.[70]

Current gasoline formulations contain benzene and other toxics, so-called aromatics which reduce "engine knock". An alternative is ethanol. While ethanol is controversial because of its impact on agriculture and food production, its health advantages over the current additives of benzene, toluene, and xylene are clear.[71] A 2009 U.S. Environmental Protection Agency study found that vehicle emissions were responsible for 30% of the overall average cancer risk from air pollution, primarily because of benzene in gasoline. The EPA study found that the Baltimore and D.C. metro areas are among those in the US with an elevated risk of cancer due to air pollution. An EPA regulation requiring a 38% reduction in benzene in gasoline[72] took effect in 2011.

Given these documented health impacts of current transportation systems, policies that increase mass transit and Maryland's fleets of electric and hybrid vehicles are health protective. In an increasingly crowded world, moving populations away from highways will not be an option. Instead, we can make the health case for investing in electric vehicles, mass transit systems, and cleaner vehicle fuels.

IV. MARYLAND'S CLEAN & HEALTHY ENERGY FUTURE

What steps must we take to move Maryland to a clean and healthy energy future? The strategy must combine eliminating dirty energy sources and uses while actively advocating for the policies that will build more clean energy capacity.

Shuttering or cleaning up the highest polluting of Maryland's remaining coal-fired plants remains an important step. Building new coal fired power plants and nuclear power plants is unlikely because these plants are expensive to build and no longer compete with gas. However, we have seen that on the basis of health, increasing reliance on natural gas and incineration would be steps in the wrong direction.

Investing in solar and wind energy can move us on three fronts at once: generating minimal pollution, creating a significant local economic stimulus, and creating a more resilient energy system.

About 60% of Maryland's total energy used is generated within our borders. This statement may seem irrelevant to health. But in fact, as we increase our investment in local wind and solar energy, the percent of energy generated locally will also increase, and with it come both health and economic benefits. Investing in solar and wind energy can move us on three fronts at once: generating minimal pollution, creating a significant local economic stimulus, and creating the basis for a more resilient energy system.

Local resilience in the face of extreme weather events has health value. Disruption of health care services during power outages extends far beyond the impact on hospitals, which survive on back-up generators. People lose their use of electric wheelchairs and other home medical equipment, as well as air conditioning, home heating, ability to cook, or keep medications refrigerated. Two recent examples of how health was put at risk during power outages come from New York City and Western Maryland.

The Clean Energy group reported in a February 2014 report:

> *"More than 400 New York City Housing Authority buildings containing approximately 35,000 housing units lost power, heat, and/or hot water during Superstorm Sandy…. The effects in New York were so severe and protracted that a federal court has ruled that the city violated the Americans with Disabilities Act: The disabled elderly were stranded in high-rise housing with no elevator service and could not access emergency services, nor did emergency shelters and other facilities have electricity to power ventilators or charge wheelchair batteries."* [74]

A 2013 community stakeholder meeting in Garrett County, MD cited the power outages and flooding during the same storm. The level of service disruption, including the impact on first responders and the county hospital, took the county by surprise.[75]

Our energy grid is a regional system that Maryland participates in but does not control. Investing in photovoltaic cells with battery storage begins the process of building a different energy system, one which creates local resilience in the face of extreme weather, while reducing long-term reliance on coal-fired and nuclear sources. The Abell Foundation's report *Clean Energy for Resilient Communities* details the advantages for low income and other vulnerable populations, and documents best practices in creating local resilient power sources.[76]

The Institute for Energy and Environmental Research is currently engaged in developing a road map for creating a 100% Renewable Maryland. One of the advantages will be creating a more democratic energy system. IEER states that " 'democratization' means an energy sector in which individuals and communities can control their energy demand as well as produce energy for themselves and others to a far greater extent than today". This becomes not just an economic goal, but a public health goal as well, when the ancillary benefits of community resilience and power supply security are factored in.

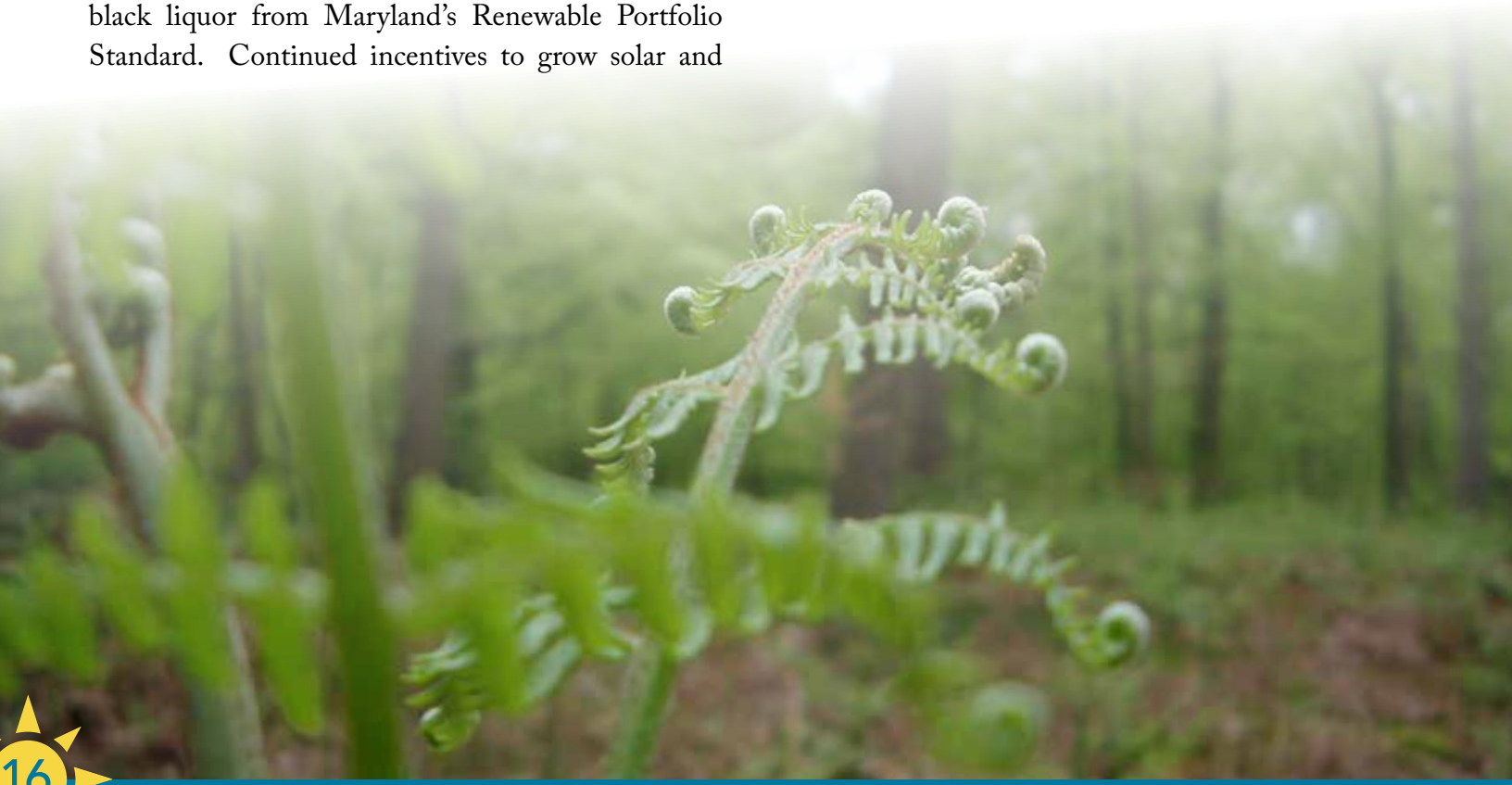
In Germany, renewable energy production has become a significant local economic stimulus, with 50% of all renewable energy production in the hands of local communities and individuals.[77] In Washington DC, an organized movement has resulted in solar collectives in every one of DC's 8 wards and a new law to support community projects. Over two years, the number of solar projects mushroomed from under 100 to over 500, and demand continues to grow, bringing a stabilizing effect on communities and creating local jobs. Advocates have proposed laws to promote community solar in Maryland but to date these initiatives have been opposed by utility companies.

When viewed through a health lens, Maryland's legislative mandate to reach 20% renewable energy by 2022 – or even the more ambitious proposal to aim for 25% by 2020 – falls short on several counts. It is not aggressive enough to address climate change, not clean enough to address air pollution, and not sufficiently attentive to issues of equity and economic justice.

To address climate change, we need to move faster. One proposal is to adopt a goal of 40% renewable energy by 2025. That proposal should be married with elimination of trash incineration and black liquor from Maryland's Renewable Portfolio Standard. Continued incentives to grow solar and enabling measures for community solar collectives are also needed. This combination of measures will move Maryland faster towards a safe and healthy energy supply.

Research is underway to specify how Maryland can move to renewable energy at a faster pace. The Institute for Energy and Environmental Research is conducting a multi-year research project to detail the steps to a fully renewable energy system in Maryland before 2050. The National Renewable Energy Lab has published a Renewable Electricity Futures Study in December 2012. The book *Carbon-Free and Nuclear-Free, A Roadmap for U.S. Energy Policy* assessed the options and issues in detail in 2007.

A 2013 study from Cornell University outlined how New York State could generate all of its energy needs from renewable sources by 2030. A Stanford University professor has launched The Solutions Project, which offers a high-level snapshot for every state to transition to 100% renewable energy, including estimating health savings and long-term jobs created. For Maryland, the Solutions Project estimates avoided health costs at $10.3 billion annually, or 4% of GDP. More in-depth research and analysis is needed along these lines.



V: CALL TO ACTION ON ENERGY POLICY FOR HEALTH PROFESSIONALS & INSTITUTIONS

Maryland's health professionals, community health activists, and public health advocates have many reasons to make energy issues into health issues. We have embraced our food system, the built environment, and gun violence as legitimate public health issues. The time has come to do the same for energy policy.

We have embraced our food system, the built environment, and gun violence as legitimate public health issues. The time has come to add energy policy.

There are compelling arguments for Maryland's health community to take action:

ENVIRONMENTAL POLLUTION IS A PUBLIC HEALTH CRISIS:

The World Health Organization attributes almost 25 % of all disease to environmental exposures.[78] In the U.S., addressing the burden of disease caused by pollution is perhaps the most neglected field of medical research and clinical care. The National Institute of Environmental Health Sciences had a budget of less than $700 million in 2012,[79] while the economic burden of environmentally related diseases in childhood alone was estimated in 2008 at $76.6 billion annually.[80] This included the costs of childhood lead poisoning, prenatal methylmercury exposure, childhood cancer, asthma, intellectual disability, autism, and attention deficit hyperactivity disorder.

NEW FEDERAL PROTECTIONS UNLIKELY:

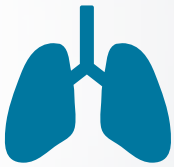
National environmental health policy has been mired in political dysfunction, with Congress failing to pass clean energy legislation in 2009. Advocates have had to work to prevent the roll-back of Clean Air Act and Clean Water Act provisions. The mushrooming gas industry is exempt from federal environmental protection laws, placing almost all the regulatory burden on states. As a result, states are where the action is, in terms of setting high standards that lead to a healthy energy system. Maryland's actions can influence other states.

MARYLAND CAN LEAD ON RENEWABLES:

Maryland is already a leader in energy policy. We passed off-shore wind legislation in 2013 and a Healthy Air Act in 2006. Maryland controls what it deems to be renewable energy in its the Renewable Portfolio Standard, and can increase the amount of clean energy required by the RPS as well as eliminating incineration and black liquor. Decisions to tighten coal-fired power plant permits and promote clean renewables such as wind and solar are state decisions, subject to influence by citizens and advocates. Challenging national infrastructure decisions, such as the push at Cove Point for an LNG export facility and its attendant impacts on Maryland communities, are opportunities to call for investment in healthy and safe infrastructure. As a small state, we have the advantage of an accessible state legislature, where health advocates can make their voices heard.

HEALTH BENEFITS FROM IMPROVED AIR QUALITY WILL BE IMMEDIATE:

When air pollution is reduced or eliminated, health improves. A 2009 study looked at how changes in fine particulate pollution in 51 US metropolitan areas correlated with life expectancy and concluded that a "reduction in … fine-particulate air pollution contributed to significant and measurable improvements in life expectancy."[81] A study of changes in health markers during and after the Beijing Olympics demonstrated how rapidly health status can improve (or decline) in response to regional air quality changes.[82] In Maryland, closing coal-fired power plants and refusing to build incinerators will reduce morbidity and mortality and represent major public health achievements in specific communities.



HEALTH CONCERNS ARE UNIVERSAL:

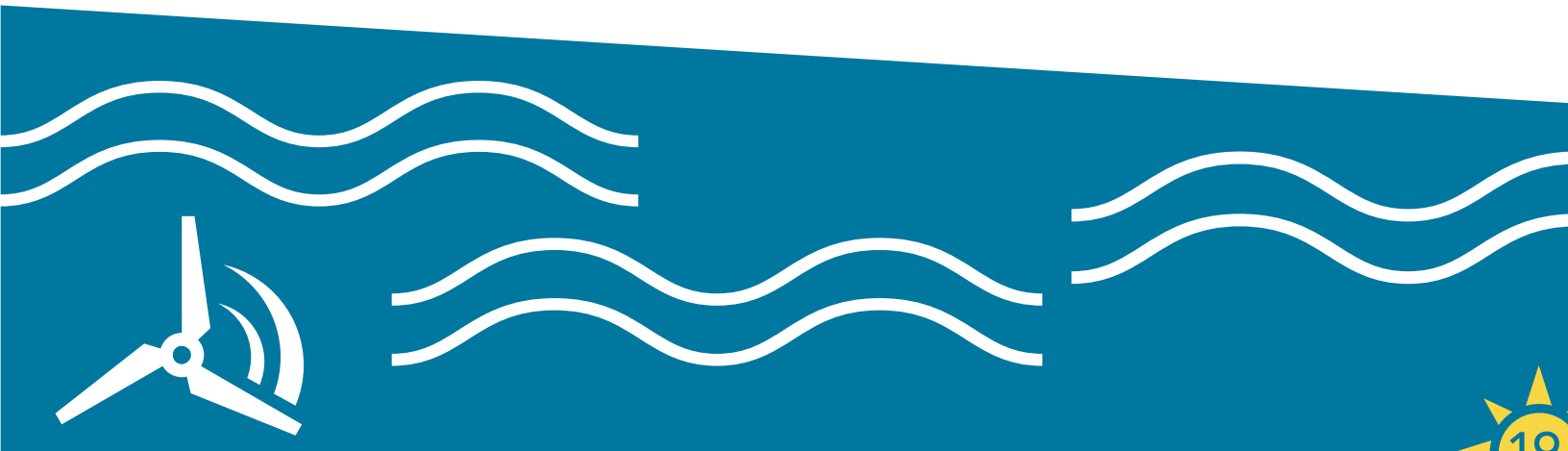
Personal health is valued across party lines, and as non-partisans, health advocates speak for all Maryland residents, especially those most vulnerable to health threats and risks. Both the public and policy-makers give weight to the opinions of environmental health scientists, epidemiologists, and toxicologists, the concerns of physicians, nurses, pharmacists and health care administrators, and the views of community health advocates. Speaking about health brings some of our thorniest societal problems into clearer perspective.

CONCLUSION

The health impacts of energy use and production are so significant that they clearly merit the attention of health advocates. The case for activism on energy policy from the health care and public health sector is strong. If the missions of health professions and institutions are to promote health, we must recognize and address the impact our energy systems are having on Maryland's health status.

This moment is ripe with innovation and promise. Public health professionals, clinicians, environmental health researchers and community health advocates can contribute significantly to the public discourse on energy choices. Ambitious renewable energy goals – and achievements – are realistic and necessary. For instance, the European Commission reports that in 2010 renewable energy across all member countries comprised 20% of total production. Climate Central reported that three EU countries have already met their 2020 goals for renewable energy.

Every individual who cares about health can speak up for clean energy. Every institution whose mission is to promote health can exercise their consumer choice and purchase clean renewable energy. Every professional with a medical or health background can support the reforms that will lead Maryland to a clean and healthy energy future. The collective effect of a diverse and urgent chorus of health voices speaking out on energy policy can lead us to a healthier Maryland.



GLOSSARY OF TERMS

Air Toxics: pollutants known or suspected to cause adverse health or environmental impacts, also called hazardous air pollutants, or HAPs. They may disrupt reproductive processes, cause birth defects, or trigger respiratory problems. Air toxics come from vehicle and equipment exhaust, consumer products such as paints, and industrial emissions. EPA has designated 187 hazardous air toxics, found at: www.epa.gov/ttn/atw/188polls.html

Biomass Fuels: fuels derived from organic matter, including wood and crops, and used to generate heat and electricity. Biomass fuels encompass a broad range of solids, gases, and liquids that result from living organisms or from the wastes and by-products of human activities.

Carbon Monoxide (CO): an odorless, colorless, and highly poisonous gas because it blocks oxygen in the blood from being delivered to the rest of the body. It is a product of incomplete combustion, from sources such as vehicle exhaust, gas stoves and poorly functioning home heating furnaces.

The Clean Air Act: originally passed in 1973 and amended in 1990, is a United States federal law designed to protect human health and the environment from the effects of air pollution. Under the Clean Air Act, the Environmental Protection Agency (EPA) is required to regulate emissions of pollutants that "endanger public health and welfare" and to establish National Ambient Air Quality Standards (NAAQS). State and local governments also monitor and enforce Clean Air Act regulations, with oversight by the EPA.

Coal Ash: a byproduct of coal-burning at power plants, coal ash is disposed in liquid form in surface impoundments or in solid form at landfills. It contains toxics such as mercury, cadmium and arsenic associated with cancer and has the potential to injure all major organ systems and damage physical health and development.

Criteria Pollutants: EPA regulates six common air pollutants defined under the Clean Air Act known as criteria pollutants: particle pollution, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead.

Emissions: substances given off into the air, usually from a source such as vehicles and commercial or industrial facilities.

Externalized Costs: refers to costs that are not reflected in the price of a product. Examples include the cost of disposal at the end of a product's useful life, the environmental degradation caused by emissions, pollutants and wastes that production creates, and the cost of health problems caused by toxic ingredients.

Greenhouse Effect: refers to the trapping and build-up of heat in the atmosphere near the Earth's surface. Some of the heat flowing out from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, methane and other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gases: any gas that traps heat in the atmosphere. The EPA lists the following as the main greenhouse gasses:

> **Carbon Dioxide (CO_2):** a naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal human caused greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a global warming potential (GWP) of 1.
>
> **Methane (CH_4):** a hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 25 times that of carbon dioxide (CO_2), according to the IPCC's Fourth Assessment Report (AR4). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills,

animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

Nitrous Oxide (N2O): a powerful greenhouse gas with a global warming potential of 298 times that of carbon dioxide (CO2). Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Fluorinated Gases: powerful synthetic greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons) and are often used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants. These gases are emitted in small quantities compared to carbon dioxide (CO2), methane (CH4), or nitrous oxide (N2O), but are potent greenhouse gases, with high global warming potential.

Horizontal Drilling & Hydraulic Fracturing: two methodologies associated with natural gas extraction. Wells are drilled horizontally after reaching a certain vertical depth, to reach a seam of gas from a shale formation. A mixture of water, sand, and chemicals is pumped at high pressure into the well to release the gas. The term "fracking" is popularly used to refer to the whole process, the drilling of the well and the entire operation of a gas well pad.

Liquefied Natural Gas or LNG: natural gas when intensely compressed takes a liquid form that is clear, colorless, odorless, and highly flammable. It is primarily methane, cooled to -260 degrees F.

Ozone (O3): a molecule made up of three atoms of oxygen. Ozone occurs naturally in the stratosphere (upper atmosphere) and provides a protective layer shielding the Earth from harmful ultraviolet radiation. By contrast, breathing ground level ozone can cause lung function damage and inflammation of the airways. This form of ozone is created primarily by photochemical reactions between volatile organic compounds (VOCs) and nitrogen oxides. Significant sources of VOCs are chemical plants, gasoline pumps, oil-based paints, auto body shops, and print shops. Significant sources of nitrogen oxides are power plants, industrial furnaces and boilers, and motor vehicles.

Smog: a combination of smoke and other particulates, ozone, hydrocarbons, nitrogen oxides and other chemically reactive compounds which, under certain conditions of weather and sunlight, results in a murky brown haze that causes adverse health effects.

Particulate Matter: particle pollution, also known as particulate matter, consists of a mixture of solids and liquid droplets. Particle size is critical. Particles less than 10 micrometers in diameter (PM10) are small enough to enter the lungs. Ten micrometers is smaller than the width of a single human hair. PM 2.5 is small enough to enter the bloodstream from the lungs. Sources of fine particles include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

Renewable Portfolio Standard (RPS): Maryland law requires all electricity suppliers in the state to derive a minimum percentage of energy from defined sources deemed to be renewable. Suppliers may comply with the law by purchasing Renewable Energy Credits (RECs) from renewable electricity generators. Sources that are considered renewable include wind, solar, biomass, trash incineration, methane recovery, hydroelectric, and geothermal power. The solar and trash incineration must come from within Maryland, while the other sources can come from anywhere in the regional electricity grid.

Renewable Energy: resources that are restored or replenished in supply over short periods of time and do not diminish. Such sources include the sun, wind, moving water, and the earth's heat (geothermal). Defining waste products such as trash and wood waste as "renewable" in Maryland's RPS is controversial.

Shale Gas: natural gas that is trapped within shale formations. Shale is fine-grained sedimentary rock that can be rich sources of petroleum and gas. Over the past decade, the combination of horizontal drilling and hydraulic fracturing has allowed access to large volumes of shale gas that were previously uneconomic to produce.

Sulfur: a yellowish nonmetallic element present in many fossil fuels whose combustion releases sulfur compounds harmful to the environment and to health. Some fossil fuels are categorized according to their sulfur content, with lower sulfur fuels usually selling at a higher price.

Sulfur dioxide (SO2): a toxic, irritating, colorless gas that is formed by the combustion of fossil fuels. Power plants using coal or oil high in sulfur content can be major sources of SO2 and other sulfur oxides contribute to the problem of acid deposition. SO2 is a criteria air pollutant.

Sulfur oxides (SOx): compounds containing sulfur and oxygen, such as sulfur dioxide (SO2) and sulfur trioxide (SO3) that are formed primarily by the combustion of sulfur-containing fossil fuels, especially coal and oil. Considered major air pollutants.

Volatile Organic Compounds (VOCs): both human-made and naturally occurring chemical compounds that evaporate easily at room temperature and enter the surrounding air. From many sources such as household cleaners, industrial processes, pesticides and building materials, they are not regulated except in the case of formaldehyde by HUD for mobile homes and by OSHA for worker exposures.

This Glossary of Terms was compiled by MdEHN staff from the following sources:

American Lung Association
California Environmental Protection Agency Air Resources Board
Maryland Public Service Commission
Physicians for Social Responsibility
U.S. Energy Information Administration
U.S. Environmental Protection Agency
Union of Concerned Scientists

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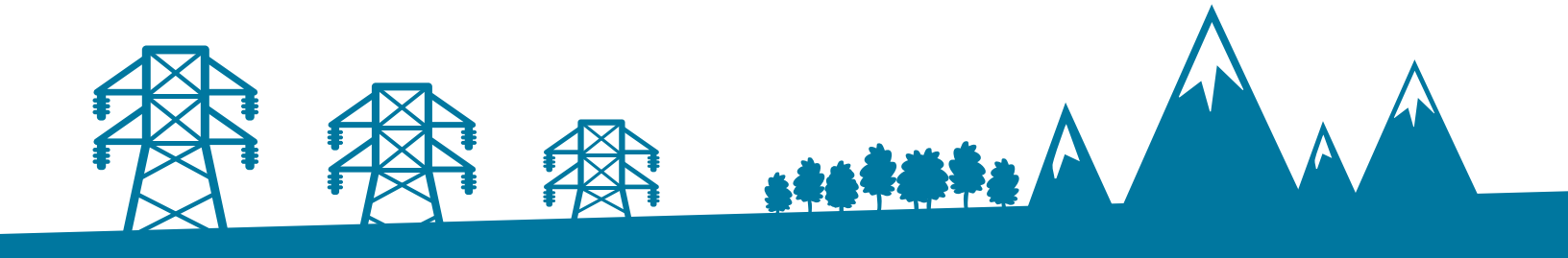

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