Community Energy Plan

An element of Arlington County's
Comprehensive Plan
Update Adopted September 2019

Arlington Initiative to **Rethink Energy** | CARBON 2050 NEUTRAL

ARLINGTON
VIRGINIA

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Executive Summary

In 2013, Arlington County adopted a Community Energy Plan, as an element of the County's Comprehensive Plan, (2013 CEP) to serve as both an integrated energy policy and climate action framework. The 2013 CEP's Goals and Policies are consistent with the County's innovative land use planning for transit-oriented design, preservation of green and open space, and economic development grounded in diverse markets and drivers as well as innovative technologies.

Markets, technologies, innovative systems and program design have revolutionized the energy sector over the five years since adoption of the 2013 CEP. For that reason, the 2019 Community Energy Plan (2019 CEP) is a living document that seeks to incorporate and deploy those rapidly-evolving sector developments, and to play forward the 2013 CEP to its highest and best use in Arlington County over the next five years.

Buildings account for over 60% of energy use within the County. Through its energy program - Arlington Initiative to Rethink Energy (AIRE) - the County has enjoyed an early leading role in building science, energy efficiency programming, establishment of a community solar cooperative, vehicle electrification and zero-emissions fuels, and expansion of policy and financing options for energy efficiency upgrades and renewables.

AIRE's programs, activities, and partnerships save government, residents and businesses more than $4 million annually in avoided utility costs, through a diverse portfolio that includes a Commercial Green Building Program,[1] Residential Green Home Choice, a government sites and facilities retrofit program, the Arlington Solar Cooperatives Program, and other electrification (transportation) and clean energy alliances. Through program implementation and existing partnerships, the County experienced a 24% reduction in emissions 2007-2016, despite a 10% increase in population. Government facilities reduced emissions during the same period by more than 11% despite an increase in the County's physical footprint and services, e.g., a 17% growth in County facility square footage. Also, AIRE participates in established and expanding efforts to enhance the County's local economic development, both as a magnet for energy-sector businesses and through the benefits new and existing businesses reap in an energy-advanced environment.

As noted above, during this same period the energy sector has experienced rapid evolution and dynamic advancements. Renewable energy has proliferated through a combination of increased efficiency and generation, affordability, expansion of financing and ownership models and, in Virginia, new legislation to advance energy conservation and security as well as funding and commitments to pilot land-based and

[1] More than 10 million square feet in high-performance, energy efficient, and low-emissions commercial building space to date.

offshore wind projects. Vehicle electrification is a rapidly growing market. “Energy Storage” systems have reached a level of diversity and sophistication that is capable of driving market uptake and reducing costs.

In addition, building science continues to expand and deliver higher-performing buildings. While the 2013 CEP recommended a District Energy model for Arlington’s urban corridors, contemporary energy markets and opportunities now recommend decentralized distributed energy systems using various options of energy generation and localized storage and distribution. The more diverse distributed energy approach allows for regional/local customization from a suite of mechanisms and strategies that includes energy efficiency, renewable energy resources, microgrids, storage, fuel cells, automated building performance systems, and demand-response protocols. This new model not only enhances reliability, consistency, and quality of energy resources to customers, but also offers resilience to emergencies, hazards, and climatic events.

Concurrent with rapid progress and expansion in the energy sector, scientists have tracked and recorded heightened global emissions and accelerated climate impacts. In response, governments have amended prior energy and climate actions plans to amplify and accelerate goals and expand strategies and measures. In 2017, the Commonwealth updated legislation enabling local jurisdictions to create viable Property Assessed Clean Energy (PACE) programs as a financing mechanism for energy efficiency upgrades to commercial buildings. In 2018, Virginia not only adopted a more aggressive Virginia Energy Plan, but also ratified SB 966 (Grid Transformation and Security Act) and earmarked substantial funding for energy-efficiency programs and projects over the next ten years. In the proliferation of adjusted goals and targets and heightened investment by governments, Arlington County’s leadership role has been challenged by other local governments’ energy initiatives and actions. AIRE invites this competition and actively promotes and represents the seminal role and capacity of local governments to promote and accelerate Virginia’s energy objectives and goals.

Consequently, the 2019 CEP is structured around new principal goals: 1) a 2050 emissions goal to achieve Carbon Neutrality,[2] which is a change from the 2013 goal of 3.0 metric tons (mt) of CO_2e/capita/year); 2) an accelerated community renewable energy goal of 100% by 2035; 3) an accelerated government operations renewable energy goal of 50% by 2022 and 100% by 2025; and 4) addition of Equity as a focus area to inform design, investment and implementation of the 2019 CEP.

The 2019 CEP is a substantive update that integrates new models, strategies and technologies, adjusts relevant targets, and introduces the potential for emerging, innovative, and expanded, performance-based partnerships. Arlington County now has the opportunity to strategize and implement as a jurisdictional leader, regional collaborator, and statewide catalyst. Arlington can apply the 2019 CEP update as a roadmap for stretch-goals, increase its energy role as an incubator and pilot platform, revolutionize transportation again in the region, and embed social equity standards and goals into its power plan. The goal is to use new energy programs, policies and partnerships to secure economic competitiveness, resilience, and a new level of sustained desirability for residents, businesses, and visitors. The 2019 CEP is a platform for transformative thinking and dynamic implementation.

[2] “Carbon Neutrality” and “net zero carbon emissions” are synonymous in our use in the CEP.

Chapter 1
Background

Arlington's History of Energy and Environmental Leadership

For over twenty years, Arlington County has been at the forefront in responding to energy sector challenges and opportunities, and is recognized nationally for innovative land use planning, sustainability, and climate action.

Transit-oriented development around Metro corridors and high-quality transit service has been a foundational policy for the County for more than 50 years. These smart-growth principles stemmed from the County's General Land Use Plan and led to the development of high-density, mixed-use communities around Metro stations, a strong focus on walkability, and implementation of a green building incentive program for the private sector. The CEP aims to layer intelligent energy planning onto the successful land use and transportation planning and implementation efforts.

"Green buildings," which incorporate land use, building design, and construction strategies to reduce their environmental footprint and impacts, have been a growing trend since the 1990s.

In October 1999, the Arlington County Board adopted a Pilot Green Building Incentive initiative developed by individuals that would later form the County's Arlington Initiative to Rethink Energy (AIRE) Program. Now in its 20th year, the Green Building Incentive Program grants bonus density and/or height exceptions to developers that construct high-performance buildings pursuant to the U.S. Green Building Council's LEED®[3] green building rating system and, more recently, Viridiant's EarthCraft rating system. This voluntary program applies to site plan projects, including multi-family, affordable housing, hotel, office, and mixed- use development. The Columbia Pike Form Based Code includes green building commitments as well. Numerous builders have taken advantage of the incentives offered, providing Arlington residents and tenants with high quality, sustainable buildings. As of 2019, the program has certified more than 13 million square feet of commercial and multifamily construction, saving residents and building owners roughly $3 million per year in operational and utility costs. The program has been updated over time and encourages the building industry to achieve higher levels of energy efficiency and deploy a portfolio of construction and operational sustainability measures.

In 2007, the County launched the Arlington Initiative to Rethink Energy (AIRE) program. AIRE was created to reduce the energy-related costs and the carbon footprint of County government operations and to educate businesses and residents about improving energy performance while reducing greenhouse gas (GHG) emissions. The first specific goal for AIRE was to reduce Arlington County government's carbon

[3] The US Green Building Council's LEED® green building rating system is an internationally-recognized standard for Leadership in Energy and Environmental Design for building development and construction.

emissions by 10% by 2012, compared to 2000 levels.[4] In addition, the County established multiple energy efficiency programs for businesses and residents. Arlington also established itself as a regional leader in energy and climate action.

Additional goals for the program included: working with businesses and residents to reduce energy use; increase purchases of green power; complete a climate action plan for the community; and engage with other local and regional stakeholders toward these goals.[5]

By 2012, the GHG emissions from County government operations were 11.3 percent lower than 2000 levels, exceeding the AIRE goal of a 10 percent reduction. This was achieved through a combination of improved energy efficiency in buildings and streetlights, use of biodiesel in heavy vehicles, increased use of green power, and a reduction in GHG emissions from the electric grid.

The Community Energy Plan Project

On January 1, 2010 the Arlington County Board launched the Community Energy Plan (CEP) project, focused on community-wide greenhouse gas reductions.[6]

To develop the CEP, AIRE conducted numerous internal working sessions involving consultants and County staff, implemented a diverse schedule for public facilitation, engagement, and polling strategies, and recruited community leaders, energy industry specialists, and citizen groups to form a Community Energy and Sustainability Task Force (Task Force). Supported by public consensus, the Task Force approved the goals and policies outlined in the CEP, which were designed to drive the primary goal of reducing community-wide emissions from its then-current rate of 12.9 mt CO_2e/capita/year to 3.0 mt CO_2e/capita/year by 2050 (the standard then-adopted by Copenhagen, Denmark[7]).

The Arlington County Board unanimously adopted the CEP in 2013 as an element of the County's Comprehensive Plan and to meet the County Board's 2010 goal to produce and implement a community climate action plan.

As a Comprehensive Plan Element, the CEP is reviewed every five years to ensure the long-term document is current and relevant in a dynamic energy sector. This 2019 iteration is an update capturing a series of changes in markets, policies, and advancements in energy-related technology. The update also elevates and/or accelerates primary emissions and renewable energy goals from the original CEP and creates platforms for continuing progress in the sector. Arlington County's continued ability to lead and innovate (as a leader in the energy sector and sustainability agent) requires a CEP that assimilates these bold changes, with dynamic capacity to incorporate future advancements.

Revising the 2050 Goal

For this update, staff and consultants constructed a new community energy model building upon energy use and emissions data from the County's 2007, 2012, and 2016 GHG inventories. This model was informed by the analysis performed in 2010-2011 for the 2013 adopted CEP. However, the substantial changes in energy markets and technologies – and lessons learned from AIRE's analyses of district energy since 2013 – pointed to a shift in priorities,

[4] https://betterbuildingsinitiative.energy.gov/implementation-models/rethink-energy

[5] Morrill, J., J. Kelsch and W.Roper, "Making Fresh AIRE Out of Thin Air," 2008 ACEEE Summer Study on Energy Efficiency in Buildings, Washington DC.

[6] https://docs.google.com/gview?url=https%3A%2F%2Farlington.granicus.com%2FDocumentViewer.php%3Ffile%3Darlington_614e90e5e35765bb66759b38e5a2a75f.pdf%26view%3D1&embedded=true

[7] The City of Copenhagen later adopted CPH 2025, a climate protocol developed to meet a goal of carbon neutrality by 2025. https://kk.sites.itera.dk/apps/kk_pub2/index.asp?mode=detalje&id=983

including realigning distributed generation options, and increased focus on renewable energy, electrification (of transportation), policy and financing instruments, and strategic partnerships that leverage resources. This implementation pivot proved consistent with the Arlington County Board's ultimate direction to elevate and/or accelerate the CEP's foundational goals.

This model estimated energy use and emissions to 2050, based on current markets, technological innovations, and recent and expected federal and state policy initiatives. The model also used updated demographic and economic development forecasts for the Arlington community from County planners. To address flexibility and adaptability, consultants provided their expert view of emerging trends in technologies and markets to help gauge the expected pace of change in the near future.

A conceptual table that generally mapped primary (but not all) strategies driving the 2013 CEP goal of 3.0 mt CO_2e per capita has been modified to reflect the 2019 CEP amended goal of Carbon / Carbon Neutrality by 2050, see Figure 1 below.

As scientific evidence of human-caused climate change mounts, there is increased urgency to decarbonize more aggressively. Taking full advantage of the technologies, market opportunities, and distributed energy resources can produce deeper emissions reductions in the future. Deeper efficiency gains, utility-scale renewable energy, extensive electrification of transportation, and taking advantage of future opportunities can lead us to a goal of Carbon Neutrality. This 2019 CEP outlines both necessary and "reach" targets and policies for achieving the County's Carbon Neutrality goal.

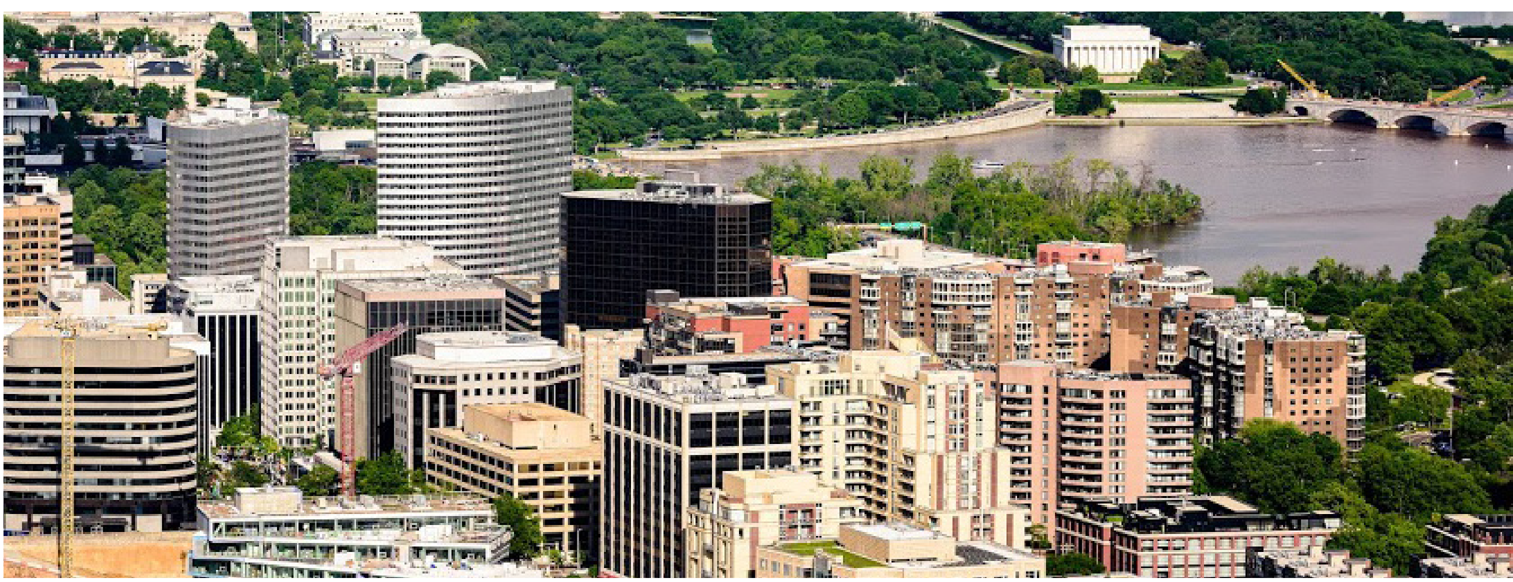


Figure 1: Key factors for reducing community greenhouse gas emissions for Carbon Neutrality

SECTOR	KEY FACTORS
Electric grid	• Persistent shift toward the use of cleaner fuel sources • Efficiency of electricity generators • Resulting CO_2e emissions rate
Buildings	• Future "reach" building codes • Expanded investment in energy efficiency programs • Reduced use of gas as an energy resources • Diversification of utility programs and partners • Future-facing land use approaches that promote energy efficiency
Transportation	• Substantial uptake in rates of multi-modalism • Substantive reduction in VMT[8] per capita • Fuel economy • Saturation of vehicle market by EVs • Supra-regional EV market (drive-through)
Renewable power (RE) (electricity)	• Use on-site by residents and businesses • Substantial off-site RE (utility scale) • Local aggregation • Cross-jurisdictional aggregation and partnerships

[8] Vehicle Miles Travelled

Figure 2: Greenhouse Gas Emissions (metric tons CO_2e) with baseline year provided. It's important to note that a community's carbon footprint is the product of many factors, including energy prices and state and federal policies.

LOCALITY OR COUNTRY	BASELINE YEAR	TARGET YEAR	GREENHOUSE GAS EMISSIONS REDUCTION TARGET
United States	2005	2025	26-28%
Denver	2005	2050	80%
Montgomery County, MD	2005	2050	80%
Portland, OR	1990	2050	80%
Prince George's County, MD	2008	2050	80%
Toronto	1990	2050	80%
Indianapolis	N/A	2050	Carbon Neutral
San Francisco	1990	2050	Carbon Neutral
New York City	2005	2050	Carbon Neutral
Arlington County, VA	**2007**	**2050**	**Carbon Neutral**
London	N/A	2050	Zero Emissions
Seattle	2008	2050	Zero Net Core Emissions
Washington, D.C.	2006	2050	Carbon Neutral

Chapter 2
Foundation for the Plan

Vision Statement

Arlington has assumed a strong leadership role in sustainability and energy innovation through programs, projects and policies that have reduced and optimized government and community use of essential resources, including energy. The 2019 CEP Update allows us not only to measure our progress and success since 2013, but to contemporize the Plan with the new markets, technologies, design and financing mechanisms, and partnerships that have emerged under the energy sector's dynamic transformation over the past five years. This approach is necessary to ensure Arlington's energy leadership and performance, and to prime the County for easy on-boarding of new developments that will continue to emerge from and for the energy sector.

Consequently, the fundamental goals of the Community Energy Plan have similarly evolved to:

- incorporate new strategies for the transition from fossil fuels-based energy resources to cleaner sources of energy
- promote use and availability of diverse renewable energy resources and models
- accelerate development of distributed, resilient energy systems, which offer blended options for energy efficiency, renewables, storage, automated building management, vehicle-to-grid behavioral changes, and other system elements and technologies
- harden key facilities and community resources against power outages and resulting reduction or interruption of vital community services
- stabilize energy rates and costs simultaneous with expanded energy resource and systems technologies
- integrate transportation as part of the energy grid (electrification of vehicles), with first-order focus on expanding multi-modalism
- leverage energy sector developments to support regional economic expansion
- seek new financing mechanisms that enhance energy equity and expand local sector opportunities
- expand public-private partnerships to amplify and optimize the local energy sector
- track and/or pilot alternative technologies, models, and transactional tools that can close any remaining delta to attain Carbon Neutrality

Ultimately, the Arlington Community Energy Plan is a blueprint to focus and guide efforts, policies, and actions toward a sustainable, desirable and competitive future. This CEP is a catalyst for new economic development and sustainable growth in Arlington. A growing number of businesses are focused on the energy sector, on both the supply and demand sides of the equation. Clean energy and innovations in efficiency are among the fastest growing economic sectors, and already serve as economic engines within and magnets for Arlington's commercial, residential, and retail markets. Sustained implementation of the CEP will support smart development, lower operating costs, and enhance energy reliability.

Purpose and Execution of the Plan

The purpose of the CEP is to define Arlington's energy goals and identify energy policies that will drive Arlington to remain economically competitive, environmentally committed, and strategically served by secure, consistent and reliable energy sources and programs that are equitably available to all constituents.

The County uses carbon dioxide equivalent (CO_2e) emissions as a proxy for overall energy productivity, as CO_2e reflects both the amount of energy consumed and the environmental burden from that energy use.

The baseline for Arlington's CEP is calendar year 2007. That year, the community as a whole was responsible for generating 12.9 metric tons (mt) of CO_2e/capita/year.[9] In 2013, Arlington County set a carbon emissions target of 3.0 mtCO_2e per capita per year by 2050. At that time, this 2050 goal matched the emissions rate in the benchmark city, Copenhagen. Dramatic improvements and opportunities since 2013 in technology, market and finance solutions, electrification, expansion and affordability of renewable energy, new energy efficiency models and technologies, code and policy changes, and other strategies have occurred, driven in great part by invention, commerce, and accelerated impacts from climate volatility. As a result, Copenhagen and other cities (see examples in Figure 2 above) have made bold modifications in their 2050 goals. Arlington County has joined this list of climate leaders and amended the 2019 CEP to reflect a 2050 goal of Carbon Neutrality.

The CEP was developed and adopted as the County's comprehensive conceptual protocol in furtherance of energy, climate, and sustainability goals; but is operationalized through the Community Energy Plan Implementation Framework (CEP Implementation Framework). More specifically, the CEP Implementation Framework lays out the strategies and tools the County will deploy to advance CEP and Comprehensive Plan objectives. Both the CEP and the CEP Implementation Framework are scheduled for updates on a five-year cycle, supplemented by administrative processes that allow for timely actions, as needed.

The CEP and CEP Implementation Framework are defined by the following terms:

Goals are the six primary areas around which the County will implement the Community Energy Plan and form the basis of the CEP and CEP Implementation Framework;

Policies are the statements of intent or commitments made by County leadership governing the implementation of the CEP-related projects. Policies are explained in detail in the CEP, whereas in the CEP Implementation Framework the policies are provided in summary format for context;

Strategies, explained in the CEP Implementation Framework, represent approaches for implementation of policy and should evolve over time as new tools emerge, new processes and models are designed, and the benefits and risks associated with a concept change in response to changes internal or external to the County; and

Tools in the CEP Implementation Framework provide the mechanisms to carry out the strategies. Examples of existing and potential tools are explained in the text of the CEP Implementation Framework and a longer list of tools is summarized in Appendix B of the CEP Implementation Framework. However, neither list of tools is intended to be exhaustive or prescriptive; they are an illustrative set of examples of how the strategies could be accomplished. The tools described herein will require the application of resources—whether human or capital—to realize the CEP's goals.

[9] This number was originally 13.4 mt CO_2e/capita/year but was adjusted due to GHG inventory methodology updates and improved data.

Chapter 3

Implementation Progress and Emerging Trends

This section details progress made to date toward the 2050 Carbon Neutrality CEP goal, as well as detailing the changing landscape in the energy sector.

Implementation

Arlington increased its emphasis on energy and climate matters with the 2007 launch of the AIRE program and adoption of the 2013 CEP. Since then, Arlington County, Arlington Public Schools, and the community have launched numerous initiatives and reached critical energy thresholds, including:

- Reduced community greenhouse gas emissions by 24% (2007-2016), even as population increased by 10%,
- Reduced energy consumption in buildings by 11% (2007-2016),
- Reduced energy consumption in transportation by 13% (2007-2016),
- Reduced energy intensity in County government buildings by 10% (2007-2017),
- Established the Commonwealth's first local Commercial Property Assessed Clean Energy (PACE) Program,
- Generated approximately 13 Million square feet of LEED-certified commercial space under the County's Green Building Incentive Program,
- Growth in ENERGYSTAR-labeled buildings from 6 in 2007 to 73 in 2018, now totaling 24 million square feet of commercial and institutional space,
- Established the County's Solar Co-op. The 118 systems installed through solar co-ops have more than doubled the number of photovoltaic systems in Arlington,
- Completed Discovery Elementary School which is the first net-zero energy school in Virginia. Two more net-zero schools are under construction (Reed School and Alice West Fleet Elementary),
- Managed the Green Home Choice Program, resulting in an average 50% reduction in energy costs for 325 homes,
- Launched the Home Energy Rebates program that generated nearly $10 in private investment for every dollar in public incentive in home energy efficiency, and
- Earned the United States Green Building Council's Leadership in Energy and Environmental Design (LEED) Platinum Community Certification (the first community in the nation to be certified Platinum).

In addition, County AIRE staff have established partnerships with:

- Arlington Public Libraries, to create the award-winning Energy Lending Library, helping library patrons cut their energy bills and make their homes more comfortable,
- Arlington County's Facilities divisions, to design,

build and maintain energy efficient buildings,

- Arlington County's Facilities and Equipment Divisions, to support uptake in electric vehicles and the installation of electric vehicle charging infrastructure,
- Arlington County's Housing Division, to ensure equitable, healthy, energy efficient housing options,
- Arlington Economic Development, to attain LEED Platinum Community certification (first in the country),
- Solid Waste Management, to aid in the development of the County's Zero Waste Plan
- The County Manager's Office, as technical and strategic support in legislative and regulatory matters,
- As active representatives and participants at the regional, state and national levels, including but not limited to the Metropolitan Washington Council of Governments, Northern Virginia Regional Commission, the Net-Zero Coalition, Mid-Atlantic PACE Alliance, the Virginia Energy Efficiency Coalition, United States Green Building Coalition, Virginia Energy Purchasing Governmental Association, and the Virginia Energy Efficiency Advisory Committee,
- Arlington Public Schools, to build energy efficient and LEED certified schools striving for Net Zero Energy,
- George Mason University and Virginia Tech University, to support student development and energy initiatives, and
- Nonprofits EcoAction Arlington (formerly known as Arlingtonians for a Clean Environment) and Solar United Neighbors, to continue the support of the award-winning Energy Masters program and energy education in schools, and increase the number of Arlington solar PV systems.

The most recent greenhouse gas emissions inventory completed in 2018 shows that Arlington produced an estimated 9.1 mt CO_2e/capita in 2016. Some of this progress can be attributed to regional trends such as the reduced use of coal for electricity generation and more efficient electric power generation. The remainder of the emissions reductions can be attributed to local actions, including declining residential and commercial energy use. This shows that local programming for building energy efficiency and continued smart growth and transit-oriented design principles have been effective in reducing carbon emissions.

An Evolving Energy Sector

The mid- and long-term goals framed by the 2019 CEP Update reflect five years of rapid energy sector development, legislative action, policy statements, scientific findings, emerging technologies, and design innovations affecting the generation of energy resources as well as transmission and distribution models. Key changes that most influence Arlington County include:

- Arlington County's ratification of the We're Still In Resolution (June 20, 2017), confirmed the County's direct adoption of the Paris Climate Accord;
- The Commonwealth's 2018 Grid Transformation and Security Act (GTSA) authorizes funding for energy efficiency, sets aggressive goals for renewable energy installations, and provides a conceptual framework for grid reliability and cybersecurity;
- As of May 2019, the mayors of 94 cities signed the Net-Zero Carbon Buildings Declaration committing that all new buildings will operate at net-zero carbon by 2030;[10]
- The updated Virginia Energy Plan (October 1, 2018), which increases the Commonwealth's commitment to energy efficiency under the GTSA, creates opportunities for new job creation and business opportunities, and improves consumer access to renewable energy;
- The October 2018 UN Intergovernmental Panel on Climate Change (IPCC) Report, finding that human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, and there is high confidence that global temperatures are likely to increase by 1.5°C between 2030 and 2052 if greenhouse gas levels continue to increase at the current rate;
- In November 2018, U.S. Global Climate Change Research Program (USGCRP) released Volume II

[10] https://www.c40.org/cities

of the Fourth National Climate Assessment (NCA4), which forecasts that without major reductions in greenhouse gas emissions, the increase in annual average global temperature relative to preindustrial times could reach 9°F (5°C) or more by the end of this century;

- New energy efficiency technologies continue to emerge, such LED lighting and ultra-efficient HVAC systems such as Variable Refrigerant Flow. These efficiency options and the falling cost of renewables has enabled the construction of more net-zero buildings;
- Public transit, bicycle and electrified scooter, Electric Vehicles, car sharing, and ride-hailing have gained rapid market penetration, and autonomous vehicles are being piloted to transform the transportation sector;
- Coal-based electricity generation has receded, renewable energy generation has increased, and overall, electricity generation has become cleaner;
- Compatibility and demand for distributed energy systems is increasing (microgrids, demand response, storage, energy efficiency and renewables blended models) to promote reliability, operability, and power supply security;
- New energy innovation and energy systems companies are locating in Arlington County (e.g., Fluence, OPOWER/Oracle, ConnecDER, and others);
- As carbon footprints and energy use fall, there is increased emphasis on energy equity to ensure that access to energy upgrades, participation in energy programs, and the movement toward a clean, reliable and secure grid is also shared with low-to-moderate and disadvantaged communities;
- There are increasing opportunities for diverse, strong and active partnerships among the County, Investor-Owned Utilities, Virginia's environmental and regulatory agencies, economic development agencies, and affordable housing entities;
- Utility models and transactional strategies have expanded;
- Other localities have adopted even more aggressive goals, such as Washington, D.C.'s plan for 100% renewable electricity by 2032; and
- Conversely, federal support for energy and climate programs has significantly declined in recent years. Examples include abandonment of the EPA's Clean Power Plan, withdrawal at the nation-level from the Paris Climate Accord, and proposals to weaken Clean Air protocols and Corporate Average Fuel Economy (CAFE) standards for vehicles. In response, governments have amended prior energy and climate actions plans to amplify and accelerate goals and expand strategies and measures.

Chapter 4
Current Conditions

Sources of Arlington's Energy

Over one-third (38 percent) of the energy used in Arlington ("site energy") is in the form of electricity, the vast majority of which is produced outside the County and transmitted via the electric grid (see Figure 3) for use in buildings.

About 38 percent of the energy used in the County is supplied by gasoline and diesel for the cars, trucks, and buses used within County borders. The remaining 23 percent is from natural gas and heating oil, primarily used for space and water heating in homes, businesses, and other building types.

However, more than half of the energy used to generate, transmit, and distribute electricity is wasted before it even enters a house, apartment, or office (see Figure 4).

This means that although electricity represents 38 percent of the energy used within the community, the total energy burden required for electricity (the "source energy") is much larger, and in fact is over half of Arlington's total source energy needs in 2016. Consistency, continuity, and quality of electrical power substantially impacts local economies, delivery of core services, and public health, safety and welfare. Reducing energy use from the grid, using less natural gas in buildings, and increasing on-site solar makes businesses and homes less vulnerable to market and

Figure 3: 2016 Arlington Energy Sources

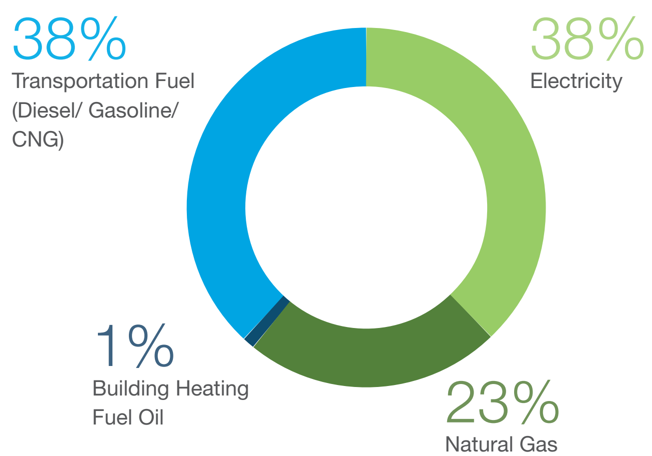
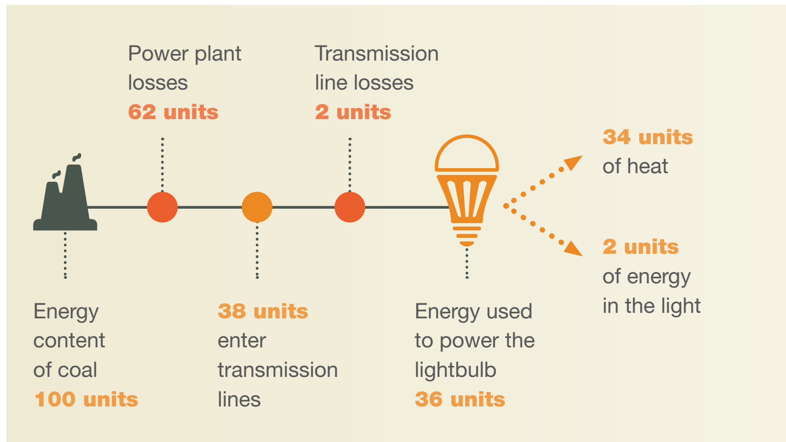


Figure 4: Energy Losses During Generation and Transmission[11]



[11] Reproduced with permission from "What You Need to Know About Energy, 2008" by the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

price volatility. In addition, dependence on energy supplies from distant sources carries the risk of short and long-term supply interruptions from storms and other natural and man-made disasters, with escalating, adverse effects on businesses and the County's most vulnerable residents. Also, with information technology now at the core of business and security practices around the world, interruptions in electric power supply can be catastrophic for businesses and residents alike.

Arlington's Energy Use Profile

More than 61% of Arlington's energy use is connected to building sector consumption – distributed across commercial and multifamily buildings, single-family homes, workplaces, and shopping areas. The remainder (39%) is associated with transportation-related energy use, including vehicles, public transportation, signalization, and electric and hybrid vehicle charging infrastructure (see Figure 5).

Arlington's built environment includes a rich variety of housing types and commercial spaces, further diversified by age and construction type. These differing building styles and uses will require different approaches to achieve improved energy performance.

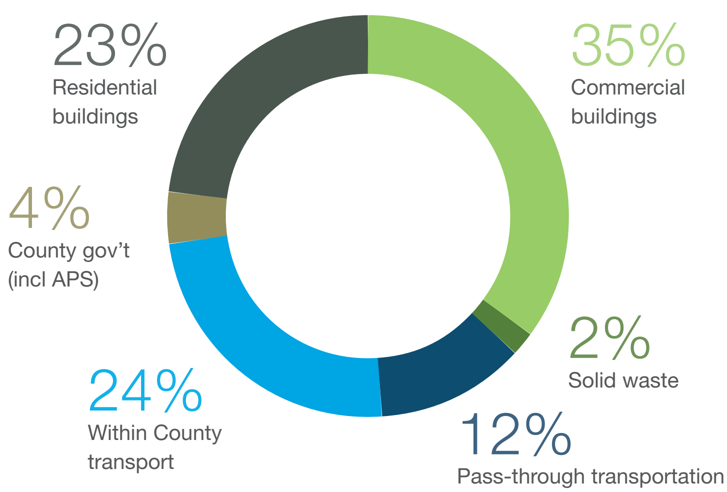
Arlington is an urban county with award-winning transit-oriented development and innovative transportation demand management programs. As a result, less than 40 percent of its energy is used for transportation including personal and commercial vehicles, buses, and rail. A negligible amount is used for transportation infrastructure such as streetlights and traffic signals.

Energy use in transportation is primarily from personal vehicles, commercial fleets, rail, and bus transit. Of the energy use related to transportation, nearly half is from non-residents who commute to jobs in Arlington, travel through the County, or travel to one of the County's numerous retail options.

Arlington's smart growth planning – characterized by compact, transit-oriented development - has resulted in lower vehicle ownership by residents than in many other jurisdictions,[13] with a substantial portion of trips made by transit, walking and/or bicycling.[14]

However, despite careful planning and energy programming, Arlington's energy density per capita (buildings and transportation) is about twice as high as modern European cities, revealing inefficiencies in the use of energy resources. This energy inefficiency costs Arlington residents and businesses about $280 million each year.

Figure 5: 2016 Arlington Greenhouse Gas Emissions by Sector, 2016[12]



[12] This assessment does not factor in Federal installations in Arlington such as the Pentagon or Ronald Reagan Washington National Airport.

[13] For 2015 (most recent year assessed), the national average of households without vehicles was 8.7%. By contrast, Arlington County's share of households without a vehicle was 13.4%. http://www.governing.com/gov-data/car-ownership-numbers-of-vehicles-by-city-map.html.

[14] The 2015 national combined average of commuters using public transit, walking, or biking equaled 8.6% of all commuters (https://www.bts.dot.gov/content/commute-mode-share-2015). For the most recent year assessed (2013) that same combined non-vehicular share of Arlington commuters was 35% (https://transportation.arlingtonva.us/performance-measures-2014/mobility/mode-share).

The Benefits of a Community Energy Plan

Economic Competitiveness

The energy sector is a dynamic economic engine that continues to drive new and continued employment. In 2017, it represented 6.5 million jobs in the U.S., adding 133,000 jobs over 2016 rates (a 2% increase) and accounted for 7% of all new jobs created in 2017.[15] More specifically, Energy Efficiency employed 2.25 million Americans, adding 67,000 net jobs in 2017.

A closer analysis, though, reveals relatively flat (yet sustained) employment in energy efficiency upgrades installation, but roughly 63,000 new jobs in professional services. This suggests that current job growth and opportunity in Energy Efficiency is tracking the sector's evolution and currently generating employment in building science, modeling/analytics, project design, financing, and other non-construction jobs.[16]

The renewables markets employ nearly 800,000 workers, with greatest current growth in the solar (25.4%) and wind (16%) industries from 2016 to 2017. Not surprisingly, over the same period, employment in energy storage surged 235%, supported by 55,000 separate jobs associated with grid modernization.[17]

In the Motor Vehicles sector, employment in the hybrid market has seen reductions, but job growth has increased in the fuel-efficiency and all-electric vehicle industries. At present, it is estimated that 26 percent of all employment under this sector (650,000 jobs) are engaged in optimizing fuel economy and efficiency or the transition to alternative-fuel vehicles.[18]

The CEP anticipates that Arlington County will seek out and build on partnerships to increase local incubation and piloting of new companies and technologies, develop opportunities for equity in these employment markets, and to create economic and employment opportunities through implementation of resilience, resource and grid diversity, electrification and the foundational platform of energy efficiency.

> "Energy Efficiency" creates more jobs per dollar than traditional energy-supply investments. While the latter tends to locate jobs and investment capital outside the jurisdiction, economic and job growth are concentrated locally under the energy efficiency market. Further, energy efficiency promulgates multiple tiers of employment: 1) direct jobs for construction management, installation, and maintenance, 2) indirect jobs among related supply and service chains; and 3) induced jobs generated from increased local spending of energy efficiency-related income.
>
> *USAID: Economic and Employment Impacts of Energy Efficiency*

Implementation of the CEP will advance economic competitiveness at the local level in the form of cascading or "cross-elasticity" impacts, such as decreased energy costs to consumers and the increased local spending power derived from those savings, as well as public health savings from a cleaner environment (see below).

Another key positive impact from energy efficiency is the avoided significant construction and operational

[15] U.S. Energy and Employment Report, Energy Futures Initiative, National Association of State Energy Officials (May 2018), pp. 13-14.

[16] Ibid.

[17] "In Demand: Clean Energy, Sustainability and the New American Workforce, Environmental Defense Fund (January 2018)

[18] U.S. Energy and Employment Report. at 15.

costs of flex-infrastructure - such as peaker plants - that would otherwise be necessary to serve peaks and fluctuations in energy demand. Avoided costs in the United States can be as high as $200/KW.[19] For these and other reasons, energy efficiency is recognized as the least costly resource available to power utilities.

Environmental Commitment

Energy efficiency is a cheap, fast, and clean way to reduce greenhouse gas pollution in the near term. Critically, it is the most potent tool to reduce emissions at the most emissions-intensive source.[20] In 2013, Americans avoided greenhouse gas emissions equivalent to the annual electricity use of over 58 million homes through choices they made with energy-saving measures and energy-efficient homes.

While Arlington County's key emissions policy for transportation is to continue to increase use of alternative and public forms of transportation and reduce VMT, a complete approach must address necessary vehicle trips. One of the most significant advancements in emissions reductions and air quality improvements since adoption of the original CEP is expanding electrification of transportation. Electric vehicles have experienced sharp market uptake in the passenger vehicle sector. In addition, research and development are transforming the medium- to heavy-vehicle market sectors. Simultaneously, electric vehicle charging infrastructure has improved and diversified to offer faster charging times and greater mileage-per-charge. These improvements directly respond to primary consumer insecurities and act to overcome market barriers. In addition, the coupling of electrification of transportation with renewable energy at the source has compounded the ability of communities and governments to meet more aggressive energy and air quality goals.

Additionally, energy efficiency, conservation and increased deployment of renewable energy resources results in improved air quality and healthier environments. For example, internal combustion engine passenger and heavy-duty vehicles are key sources of ambient ozone precursors (such as nitrogen oxides and hydrocarbons), particulate matter, and other smog-forming pollution. Studies claim that in the United States, particulates alone are responsible for up to 30,000 premature deaths each year.[21]

Several more comprehensive analyses of the impact of alternative fuel vehicles on reduction of "criteria" pollutants have been conducted in the Southwest Region of the United States (see Table 1). Although

Table 1. Percent Reduction in Emissions in 2013 Compared to New Gasoline Vehicle

	BATTERY ELECTRIC VEHICLE (BEV)	PLUG-IN HYBRID ELECTRIC VEHICLE W/ 10-MILE ELECTRIC RANGE (PHEV10)	PLUG-IN HYBRID ELECTRIC VEHICLE W/ 40-MILE ELECTRIC RANGE (PHEV40)	COMPRESSED NATURAL GAS VEHICLE (CNG)
VOC	99.5%	40.9%	63.7%	84.0%
NOx	76.1%	29.9%	48.3%	70.4%
PM10	44.8%	14.1%	25.6%	24.0%
PM2.5	59.9%	17.4%	34.0%	25.4%
SO_2	93.0%	39.5%	55.0%	38.0%
CO	99.6%	17.1%	53.9%	0.4%
GHG	42.6%	28.3%	30.2%	19.2%

SWEEP: Southwest Energy Efficiency Project. September 2013 (Maricopa County)

[19] USAID: Economic and Employment Impacts of Energy Efficiency, https://www.usaid.gov/energy/efficiency/economic-impacts

[20] https://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/~/media/204463a4d27a419ba8d05a6c280a97dc.ashx

[21] Union of Concerned Scientists, https://www.ucsusa.org/clean-vehicles/vehicles-air-pollution-and-human-health

climate zones in this region have a compounding effect on the overall generation of ambient ozone, the research is demonstrative of air quality improvements that can be upscaled or downscaled according to local climate and the share of local greenhouse gas emissions produced by transportation sources (39% in Maricopa County, Arizona vs. 36% in Arlington County).

capacity for local power plants. Photovoltaics also reduce stress on the grid by generating electricity locally. Where demand and conditions support financial feasibility, storage is increasingly coupled with renewable solar energy systems to fill gaps, such as transfer during off-peak use and to increase reliability and consistency where current infrastructure is intermittently insufficient.

Energy Security

Energy efficiency measures help improve the reliability of the local electric grid by lowering peak demand and reducing the need for additional generation and transmission assets. Energy efficiency also diversifies utility resource portfolios and can be a hedge against uncertainty associated with fluctuating fuel prices and other risk factors.

Investment in Arlington's energy infrastructure and diversification of energy resources and models will secure reliability, consistency, and quality of our power supply. Options include local energy generation, energy through renewables or other distributed energy sources, investing in supplemental and/or backstop technology such as battery or other storage mechanisms, and creating customized microgrids that offer reliability against interruptions or inoperability.

Renewable energy, especially solar photovoltaics (PV), helps flatten the demand on the electric grid because the sun tends to shine brightest when electricity demand is the highest. This results in increased

Energy Equity

Energy Equity is the fair distribution of the burdens and benefits from energy production and consumption; including but not limited to how accessible and affordable the energy supply is across a population and sensitivity to its socio-economic complexity. Community energy leadership is not limited to climate mitigation and adaptation. Instead it provides a suite of diverse benefits that range from simple comfort and energy cost-stabilization, to improved indoor air quality and healthier building environments, increased property value, and reliability and consistency of energy supply. These attributes are especially valuable to underserved populations, low-to-moderate income and/or disadvantaged communities, seniors, and the chronically ill or health-vulnerable.

Under the 2019 CEP, the County Board provided guidance that Arlington's energy and climate strategy should incorporate Energy Equity not simply as a goal or policy, but as an established focus (along with Energy Security, Economic Competitiveness, and Environmental Commitment) informing the CEP in total.

Figure 6: Community Energy Plan goal areas

BUILDINGS | RENEWABLE ENERGY | COUNTY GOVERNMENT OPERATIONS | EDUCATION | TRANSPORTATION | RESILENCE

Chapter 5
Approach

The goal of Carbon Neutrality by 2050 is ambitious, but not inconsistent with rapid improvements in infrastructure and the demonstrated trend of significant advances in operational and cost efficiency over the next 25 years (refer to Appendix B). Carbon neutrality will, however, require the County to take a comprehensive and continuously evolving approach including but not limited to:

- expansion of energy efficiency strategies and measures;
- distributed energy programs, such as renewables and energy storage;
- increased use of renewable energy resources;
- cross-market activity, such as electrification of transportation;
- research, tracking and, when possible, piloting new technologies
- increased consolidation and partnership models that allow for economies of scale in new energy models, technologies, and transactions
- increased innovative policies at the local level, as well as active participation in adoption of legislation by the Commonwealth, e.g., mandatory Renewable Portfolio Standard,
- County government implementation advancements; and
- broadening of energy literacy across all segments of the community.

Approach and Process

To better understand and address Arlington's energy use, four primary goal areas are identified – buildings, distributed energy, renewables, and transportation – with supporting goal areas that deploy County government activities, increased partnerships and financing mechanisms, education and human behavior, and resilience planning. In 2013, Arlington County conducted a greenhouse gas inventory[22] to quantify the community's carbon footprint at the time. Inventories are traditionally used to model a customized roadmap that rolls up into an adopted CO_2e goal (typically plotted against a 2050 horizon). As a result of the design, technology, cross-market, and other advancements within the energy sector since 2013, Arlington's current target CO_2e levels are shown in tabular format in Figure 7 or by the "wedge graph" (Figure 8).

Figure 7: Arlington County Per Capita GHG Milestones

YEAR	TARGET PER CAPITA CO_2e EMISSIONS
2007 (baseline)	12.9 mt
2020	7.5 mt
2030	4.3 mt
2040	2.0 mt
2050	Carbon Neutral

[22] Greenhouse gas inventories are estimates of a community's carbon footprint based on compendium of data and assumptions. They factor in an estimate for methane leakage but there is uncertainty how accurate this and other assumptions are.

While the wedge graph represents the best-known approach at the time it was created, it should be updated periodically to account for new information and new technologies. All elements of the plan must be addressed in some combination to achieve the transformational goal recommended by the CES Task Force and adopted by the County Board.

Figures 8 and 9 show the difference in the community's GHG emissions goals in CEP 2013 and CEP 2019, with the addition of a cross-hatch layer in Figure 8 representing future opportunities that may act as a bridge to Carbon Neutrality by 2050. The remainder of this document details the goals, policies, and strategies within each goal area to attain Carbon Neutrality by 2050.

Figure 8: Arlington County Greenhouse Gas Emission Reductions from Business-As-Usual ($MTCO_2e$) Graph

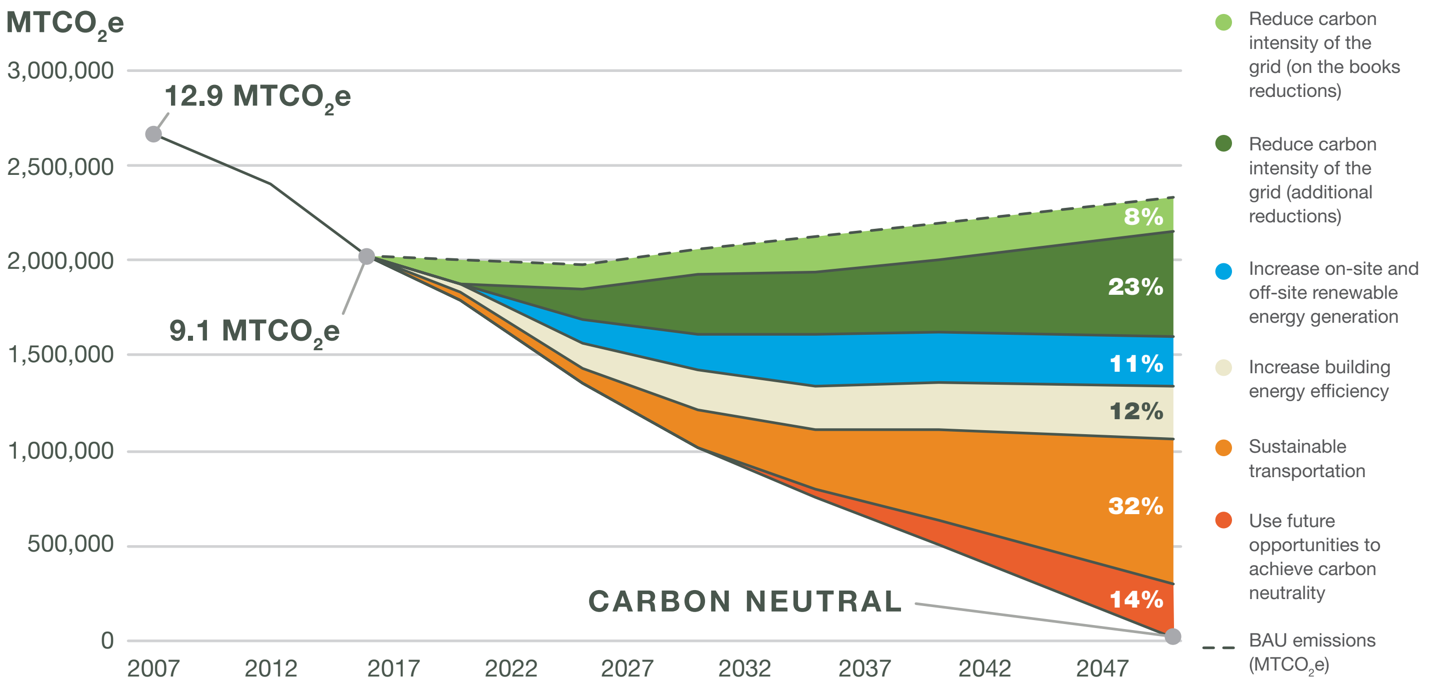


Figure 9: Arlington County Per Capita GHG Projections

YEAR	TARGET MT /PERSON CO_2e 2013 CEP	REVISED * GETTING TO 3.0	GETTING TO CARBON NEUTRAL 2019 CEP
2007 actual	12.9	12.9	12.9
2012 actual	--	11.3	11.3
2016 actual	--	9.1	9.1
2020 goal	9.3	7.6	7.5
2030 goal	5.8	5.0	4.3
2040 goal	4.1	3.8	2.0
2050 goal	3.0	3.0	Carbon Neutral

* Per 2019 modeling with accelerated interim targets

Chapter 6
Goals and Policies

Buildings

Goal 1 (G1): Increase the energy and operational efficiency of all buildings

Policy 1.1: By 2050, total building energy usage in Arlington should be, at a minimum, 38% lower than 2016 levels (despite growth in number of households and corresponding economic activity).

Policy 1.2: Promote and incentivize new buildings to be designed, constructed, and operated more efficiently than is required by code.

Policy 1.3: Pursue funding opportunities and partnerships for energy efficiency programs and projects that reflect regional needs and characteristics and promote significant local participation.

Policy 1.4: Advance energy equity to respond to underserved communities.

Buildings currently account for just over 60 percent of energy consumption in Arlington. Consequently, the County's success in achieving greenhouse gas emissions goals is largely dependent upon policies, programs, and projects that substantially reduce or conserve energy consumption in new or existing properties across the building sector. Reduced energy usage in new and existing buildings is often the most cost-effective approach as well. Another direct benefit of reduced consumption is lower utility costs to businesses and residents, providing a variety of potential co-benefits through increased spending power. Moreover, as previously noted, building and energy efficiency upgrade technologies have advanced to demonstrate energy efficiency models that also improve indoor air quality.

Cutting building energy usage requires a three-pronged, complementary approach: reductions required by building code, voluntary energy efficiency improvements that go beyond code, and programs and project that reflect the region and are capable of stimulating regional interest and uptake.

Code establishes an efficiency "floor" to ensure a minimum level of performance, while programs that go beyond code push the market forward and generate innovative energy efficient technologies. AIRE manages several programs that provide non-financial incentives to encourage building owners to go beyond code, including the Green Building Density Incentive Program, Commercial Property Assessed Clean Energy financing program (C-PACE), and Green Home Choice, (excluding the former Residential Energy Efficiency Rebate Program).

As of September 2018, the applicable building code for residential and non-residential buildings is the Virginia Energy Conservation Code (VECC) 2012, which will ensure that new buildings – and major renovations, on average – are approximately 30% more efficient than the 2004 Virginia Energy Conservation Code. Although future building codes will likely continue to improve energy efficiency requirements, more must be done to achieve Arlington's greenhouse gas reduction goals.

The ideal time to install energy efficiency upgrades is when a building is being renovated. Typically, 2-4% of the nation's building stock is renovated each year; and current data suggests that in Arlington the rate may be even higher. Thus, by 2050 all or most of Arlington's existing residential and non-residential buildings will likely have been either renovated or demolished. Coupled with continuing innovations in technology, building code upgrades will play a significant role in achieving multiple, primary CEP goals.

Energy efficiency improvements are achieved through careful design, selection, and installation of building envelope measures (such as insulation and air sealing), windows, lighting, and heating, ventilation, and air conditioning (HVAC) systems. At present, third-party programs funded through the Commonwealth are not modeled to regional interests and needs and, as a result, generate minimal uptake by the public. Carbon Neutrality by 2050 presumes the opportunity to participate and/or partner in the design and implementation of such programs on a local level. This approach has generated tangible, substantial energy efficiency outcomes in other states and jurisdictions with regulatory and financial frameworks for these collaborations.

There are also opportunities to reduce building energy use through external strategies, such as effective landscaping, tree planting, shading, site design, and other factors that reduce the urban heat island effect and building energy usage.

Each category or class of structures within the building stock requires a different approach. To this end, the County runs an array of programs designed to address the specific needs of the various building sectors. For example:

- The County's Green Building Program incentivizes energy-efficient new commercial and multi-family residential buildings.
- The Commercial Property Assessed Clean Energy (C-PACE) program deploys a unique financing mechanism to encourage energy efficiency and renewables installations for new and existing commercial buildings.
- Energy efficiency in the affordable housing sector is complex, but the County leverages state incentives, expands potential partnerships (e.g., non-profit organizations, foundations), and is compatible with a diverse and flexible suite of financing models that integrate credit enhancements, incentives, and creative investment offerings.
- In the residential market, AIRE previously implemented successful incentive programs that generate substantial returns-on-investment and drives behavioral change through focused education.

Through deployment of renewable energy and demand-side management approaches, energy efficiency, building science, and current and emerging technologies, buildings can reduce demand and generate enough renewable energy to be a "net-zero" in energy consumption. Arlington County has already facilitated net-zero energy development, including Discovery Elementary School and other upcoming projects (including Alice West Fleet Elementary) The County will continue to advocate for net-zero projects to demonstrate the feasibility of net-zero energy concepts at scale.

There are 73 ENERGY STAR buildings in Arlington, totaling over 24 million square feet.

Resilience

Goal 2 (G2): Ensure Arlington's energy resilience

Policy 2.1: Seek opportunities to develop or facilitate projects that make Arlington's energy infrastructure more resilient.

Policy 2.2: Enhance Arlington's approach to energy assurance.

Policy 2.3: Assess microgrid (islanding) options for highest response, delivery and continuity of critical services.

Policy 2.4: Use the principles of biophilic urban design to harness the ability of nature to mitigate our need for energy.

A resilient, reliable, and secure energy infrastructure is critical to Arlington. The grid and other infrastructure are vulnerable to disruptions from extreme weather, deliberate attacks, climate change, load demand and grid sensitivity, and other influences or vulnerabilities. Outages, interruptions, and inoperability adversely impact both residents and businesses. Common and necessary services such as transportation and conveyance of goods and services are affected. Negative impacts are even more severe for seniors, disadvantaged communities and medical-needs residents. On a fundamental and pervasive scale, unreliability creates challenges to economic potential and public health and safety.

Since the construction of the Metro system, Arlington's focus on transit-oriented development has encouraged density near transit corridors. As the County has grown, development has resulted in more impervious coverage and large buildings, both of which absorb the sun's heat on long summer days and radiate that heat throughout the day and night. This "heat island effect" results in higher ambient temperatures in urban areas, increasing summertime peak energy demand (primarily for air conditioning), greenhouse gas emissions, and heat-related illness.

Urban planning and land use tools can be used to reduce heat island effects. Planting trees, increasing landscape coverage, and reducing paved areas all help reduce local temperatures. Light-colored roofing, building materials, and pavement remain cooler than relatively dark-colored materials. Vegetation can be incorporated into building designs using green walls, planted terraces, and green roofs. This "biophilic" approach to urban design incorporates the multiple benefits of natural space, allowing residents to connect with the natural world while addressing the increased energy demands created by heat island impacts.[23]

Site-specific conditions and opportunities will inform Arlington's energy resilience planning. Critical facilities like hospitals, emergency operations centers, public safety facilities, and other essential services (such as communications, transportation, and wastewater) are the highest priority. Presently, the primary focus is on continuity of government, public safety, and emergency response operations, but this does not preclude the possibility of public-private partnerships and collaborative planning to ensure continuity of key business operations, urban core buildings and facilities, and primary neighborhood retail providers.

Prior design and functional challenges to resiliency have been resolved through the emergence of distributed generation systems, including microgrids, battery storage, fuel cells, renewable energy resources, and building technologies. These systems are scalable and can be readily customized for community size and demand, vulnerabilities, and pre- and post-emergency planning. Consistent with other adaptive management systems, the investments in energy resilience are assessed through principles of risk mitigation and management calculations measured against the economic, social and environmental costs of inaction.

Arlington will evaluate numerous technologies and projects to enhance the community's energy resilience. A few key examples are:

Local Energy Supply

Most buildings get their electricity from the electric grid, a vast network of power plants and communities connected by thousands of miles of wire with numerous points of potential failure, leaving the grid vulnerable to power outages. Localized generation that deploys renewable energy technologies, combined heat and power, and other distributed energy sources

[23] This integration of trees and natural resources into the built environment intersects with the Resource Stewardship outlined in Strategic Directions Chapter of Arlington's Public Spaces Master Plan.

gains reliability through proximity. Localizing energy systems also provides for "islanding" of buildings or districts, so that power supply is not vulnerable to cascading failures within a vast integrated grid system.

This 2019 CEP modeling assumes 20 Megawatts of combined heat & power (CHP) capacity at critical facilities in Arlington by 2050. Conventional gas-fired CHP carries a modest carbon emission penalty compared to grid power due to the mix of power on the electric grid, including nuclear baseload, renewables, and increasingly efficient natural gas-fired combined-cycle power plants. However, the resilience aspect of CHP remains an option in the toolbox for long-term energy security.

Energy Storage and Backup Generators

Pairing batteries or other energy storage options with solar photovoltaic systems can allow buildings or districts to operate when the grid is down. Another strategy to address grid outages is having a backup option to provide power when the grid is down. Many commercial buildings have backup generators for this purpose. In recent years, there has been an increase in sales of residential backup generators.

Microgrids

Microgrids provide a third way to stay critically-responsive during a grid outage. A microgrid is a local electricity distribution system that can operate while connected to the main grid or independently when it is disconnected from the grid. These systems can use local energy generation and/or energy storage to provide power when the grid is down. They make the most sense in critical facilities where 100% reliable power is a necessity. Arlington is home to several critical facilities such as Joint Base Fort Myer/Henderson Hall and the Virginia Hospital Center, both of which could benefit from an on-site microgrid.

Further, upscaling any such system to aggregate critical facilities and services and/or large-scale end-users promotes cost-effectiveness within the aligned investment.

Trees and Tree Canopy

Trees play an important role in moderating ambient temperatures, providing shade, absorbing stormwater, and storing carbon. Arlington's trees currently store over 180,000 metric tons of carbon in trunks, branches, and roots. Every year, an additional 8,700 metric tons of carbon is stored in trees as they grow. Gaining or losing tree canopy will affect local temperatures and the ability to meet the County's 2050 Carbon Neutrality Goal. For example, a loss of 5% of our tree canopy would amount to about 9,000 tons of carbon that would need to be offset by planting new trees and/or other measures to reduce carbon. Similarly, a gain in tree canopy – along with other heat island mitigation measures – would complement efforts to meet the CEP goals, both from carbon storage and by reducing the air conditioning burden in buildings.

Smart tree canopy management is important to preserve healthy mature trees, while also helping avoid tree damage to power lines during storms. Planting climate change-resilient species will help mitigate for tree removal and loss that does occur.[24] In addition, protecting and providing healthy soil for trees is a significant component of canopy management, as a substantial amount of carbon is stored underground.[25]

Arlington's trees save an estimated $1 million per year in avoided energy costs due to shading and reduced heat island impacts.[26] Preserving trees and natural areas offer ancillary human health benefits. Arlington's Tree Replacement Policy and Tree Canopy Fund program support the preservation and enhancement of Arlington's tree canopy.[27]

[24] https://www.nrs.fs.fed.us/atlas/tree/

[25] https://www.sciencedaily.com/releases/2015/10/151020121127.htm

[26] https://environment.arlingtonva.us/i-tree-eco/

[27] https://environment.arlingtonva.us/trees/plant-trees/

Renewable Energy

Goal 3 (G3): Increase Arlington's renewable energy resources

Policy 3.1: Government operations will achieve 50% Renewable Electricity by 2022, and 100% Renewable Electricity by 2025.

Policy 3.2: The community will achieve 100% Renewable Electricity by 2035.

Policy 3.3: Become a solar leader with installation and use of 160 megawatts (MW) of on-site solar electricity.

Policy 3.4: Optimize the use of renewable energy technologies in the public, private, and non-profit sectors, from a variety of on- and off-site sources, transactional options, cooperatives and diverse utility models.

The use of renewable energy, particularly solar photovoltaics (solar electricity) and solar water heating (solar thermal) can reduce operating costs for businesses and homes and contribute zero greenhouse gas emissions. In addition, since solar photovoltaics (PV) generate electricity largely coincident with summer cooling demands, the use of solar PV helps reduce the summer peak demand for electricity. Renewables combined with energy efficiency measures can result in net zero energy or very low energy buildings, further reducing the strain on the grid.

Arlington's largest solar installation is the 497-kW system on Discovery Elementary, the first net-zero energy school in Virginia.

When sufficiently aggregated, technology options such as solar photovoltaics and thermal energy storage, can shave peak electric demand and promote operability of power supply when demand is highest. In addition to horizontal rooftop systems, solar PV can also reduce peak electric demand when mounted on vertical south- and west-facing facades. Arlington's buildings provide ample opportunities for mounting solar PV in a variety of configurations, both horizontal and vertical.

For sense of scale,160 MW is equivalent to the peak power needs of about 40,000 households. However, much of the solar PV capacity is likely to be on larger, multistory buildings, where large roof and wall surfaces are available and unobstructed by trees and other shading.

Since the 2013 adoption of the CEP, contractual power purchase agreements (PPAs) for off-site renewable energy have emerged as an effective option for large energy users. In these arrangements, an energy user signs a contract to buy the energy output from solar and/or wind installation(s) on remote site(s). These 'utility-scale' projects deliver the electric power to the wholesale market on the electric grid, and the transaction is settled through a financial contract.

The modeling to meet the County's Carbon Neutral by 2050 goal assumes Arlington residents, businesses and institutions satisfy 100% of their electricity needs that are not already met by on-site generation, through transactional options, utility models, and substantive efficiency increases forecast and based upon current research and development.

While the cost of renewables continues to fall, government can play a crucial role in hastening their adoption, as reflected in Policy 3.3. In addition, local governments can facilitate financing options like Arlington's Property Assessed Clean Energy (PACE) Program, local aggregation (e.g., such as Arlington's Solar Co-Op), and cross-jurisdictional aggregation and partnerships.

Transportation

Goal 4 (G4): Move more people with fewer greenhouse gas emissions

Policy 4.1: Reduce the amount of carbon produced from transportation to 0.5 mt CO_2e/capita/year by 2050. Milestones include (vs. 3.7 mt in 2007):

- *2020: 2.7 mt CO_2e/capita/year*
- *2030: 1.7 mt CO_2e/capita/year*
- *2040: 0.8 mt CO_2e/capita/year*

Policy 4.2. Reduce vehicle miles traveled (VMT) and increase use of alternative and public transportation (multimodalism).

Policy 4.3 By 2022, the County shall assess and produce a comprehensive plan for an optimal transition of government fleet (including County and Schools transit) to carbon-neutral transportation no later than 2050. This plan shall include a timeline and milestones sufficient to inform the 2022 CIP (covering FY 2023 – FY 2032), with a progress report to the County Board by the end of 2021 to include analysis of transition of sedans to zero emissions vehicles. This plan will address influences and factors including (but not limited to): the diversity of the County fleet; electric vehicle availability for County needs; capital cost; charging infrastructure needs; vehicle operating and maintenance costs; and the overall economics of vehicle ownership.

Policy 4.4. Promote and encourage electric vehicles in the private and commercial sectors including supporting convenient charging stations throughout Arlington.

Reducing Arlington's transportation-related carbon emissions from 3.7 to 0.5 mt CO_2e/capita/year by 2050 represents an 88% decrease in CO_2 emissions from transportation sources. This may seem like an ambitious target, but if vehicles drove 8% less, were 75% more fuel efficient, and were predominantly electric vehicles (using mostly renewable energy) by 2050, the transportation contribution to the CEP strategic framework supports Arlington's 2050 goals.

Arlington County has been and continues to be a national leader in transit-oriented development and increasing transportation efficiency. Many of the CEP transportation sector strategies and tools track closely with the County's Master Transportation Plan (MTP).

The CEP acts in concert with the MTP by sharing a common vision: make Arlington a community that includes walkable, mixed-use neighborhoods that are well served by public transportation and bicycle/pedestrian facilities. Providing reliable multimodal transportation options allows improved quality of life for residents, employees and visitors who can spend more time at home, work, and play and less time traveling. The primary means by which the County will achieve this vision are by: 1) effectively blending Master Transportation Plan (MTP), General Land Use Plan, and Community Energy Plan implementation to reduce vehicle miles traveled, 2) advocating and encouraging improvements in vehicle fleet efficiency, and 3) supporting a shift toward improved vehicle fuels that have a lower carbon content.

Goal #2 of the MTP, Move More People Without More Traffic, seeks to reduce the number of single-occupant-vehicle trips by providing residents and workers with more travel choices, such as transit, walking, bicycling, carpooling, and telecommuting.

Consistent with the philosophy of "affordable living," Arlington will remain mindful of the unique transportation needs of each portion of the population and ensure that all modes are truly accessible and equitable for all. For example, Arlington County and the District Department of Transportation offer discounted annual Capital Bikeshare memberships to their lower-income clients. Arlington is also incorporating multimodal infrastructure in both capital and maintenance projects to support all transportation modes.

The success of these measures is evidenced in Arlington embracing multimodalism, which comprises a robust share of non-vehicular trips. There remains, however, the need for strategies to address unavoidable, emissions-producing transportation.

For vehicular trips of necessity, the County advocates the use of fuel-efficient vehicles, such as plug-in hybrid or electric vehicles. Moreover, the County's strategic objectives look to "fueling" electrification of vehicles with renewable energy, e.g., homes, businesses, multifamily buildings, and government fleets that are powered by roof-top, on-site, or large-scale off-site solar systems. This approach demonstrates a critical change within the energy grid whereby the power delivery system is transitioning from a buildings-driven grid to a buildings-and-transportation-driven grid.

Policy- and Market-Based Demands of Electrification

Some economic studies predict that electric vehicles will comprise up to 70% of the vehicle purchase market by 2050.[28] Mass changeover and "fuel-switching" across the transportation sector must, however, be accompanied by policy and market-based solutions to the impacts of change. Successful reinvention of a service economy this large demands proactive, deliberate thinking and planning that

The Global EV Market and Forecast

The current global EV passenger-vehicle market is estimated to grow at a rate of 22.3% annually through 2025, and the commercial EV market is projected for annual growth of 24.1% over the same period. This growth will generate market and employment opportunities in systems integration, vehicle and engine manufacturing, and component providers such as a battery storage and charging infrastructure.

A primary indicator of market growth is profitability – the point at which market price and demand dynamics drive a positive revenue over production costs scenario. Financial institutions are predicting that EV losses will peak in 2023, and that sales will go positive over production costs by 2029. Conversely, these sources estimate that loss of sales volume for internal combustion engine (ICE) vehicles will result in negative profitability by 2028.

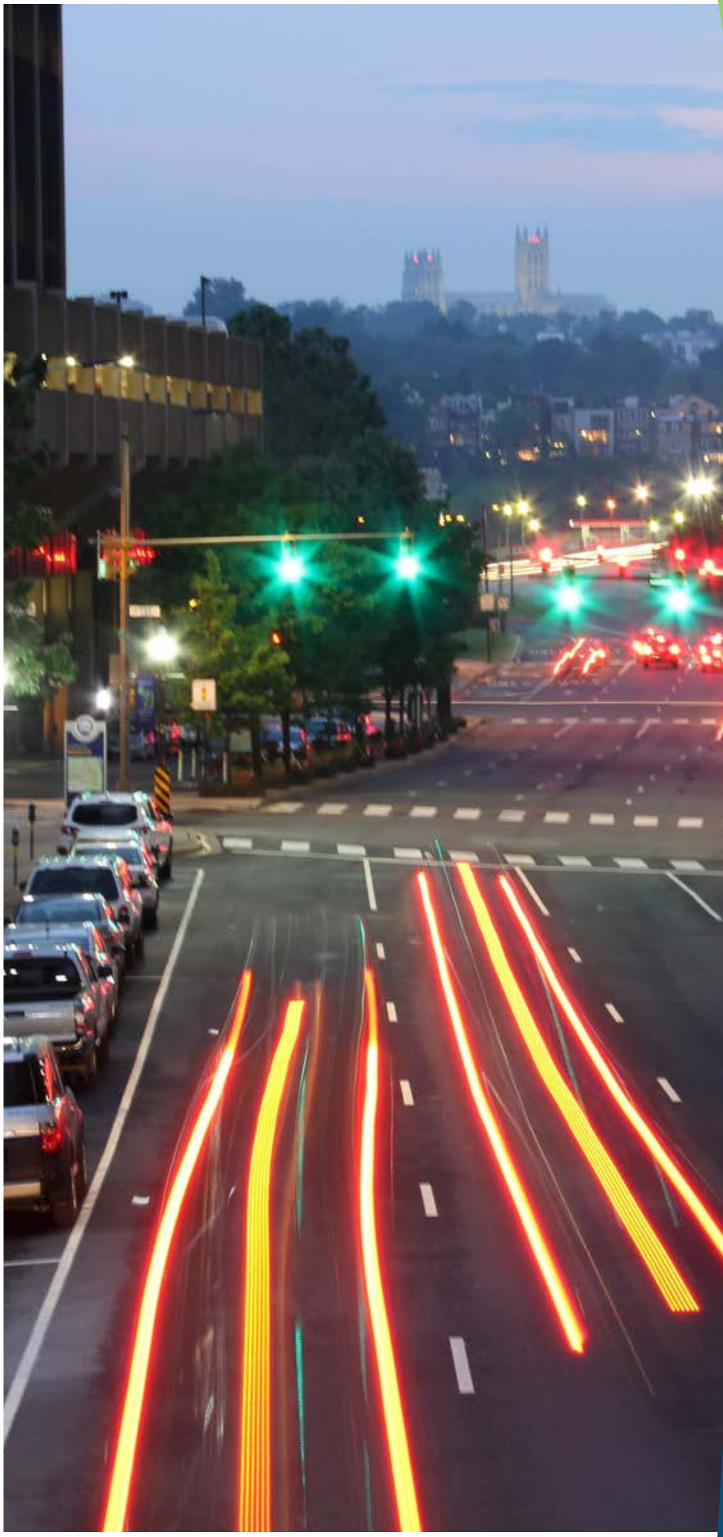
Initially, the EV Market experienced several Inhibiting Factors that suppressed more rapid market penetration, including high purchase price, a nascent charging infrastructure network, and the need for more policy, regulatory and transition-economy measures. Trending and positive Market Impact Factors are rapidly emerging to accelerate and expand market growth, including:

- Increased public demand for fuel-efficient, high-performance, low-emissions vehicles
- Proactive government initiatives and policies
- Technological advancements
- Low fuel economy and serviceability
- Greater choice of models and flattening of purchase prices

[28] https://www.forbes.com/sites/energyinnovation/2017/09/14/the-future-of-electric-vehicles-in-the-u-s-part-1-65-75-new-light-duty-vehicle-sales-by-2050/#19897541e289

optimizes the Market Impact Factors (see text box),[29] such as:

- Federal and state policies, such as the Corporate Average Fuel Economy (CAFE) standards, simultaneously drive environmental, economic, and social/public health goals. Current standards would nearly double vehicle fuel economy by 2025 to 47 miles per gallon for passenger vehicles and light trucks (combined). Conversely, present efforts to weaken CAFE protocols will increase emissions and impacts.
- Federal, State and local government incentives, rebates and subsidies, focused on EV vehicle ownership and charging infrastructure, to replicate tangible market penetration as evidenced in other countries.[30]
- Importantly, Federal and State governments must develop reasonable means-based fees and taxes to recover government infrastructure funds currently raised through gas taxes.
- State and local jurisdictions can leverage respective resources to ensure and map a responsive electric vehicle charging infrastructure (EVSE) network, as a resource to alleviate range or location anxiety.
- Advanced technology and more vehicle model choices are rapidly entering the marketplace to accelerate demand, so that the market share can achieve a reasonable price-point for all vehicle purchasers.
- In addition, new purchase, lease, ride-share, and call-ride mechanisms should be developed that specifically address energy equity and market accessibility to low- and moderate-income communities.
- Also, reinvention of the employment sector that currently serves the internal combustion engine (ICE) model (e.g., oil industry jobs and ICE mechanics) is needed so that energy and environmental transformation concurrently offers new employment and wage opportunities.



[29] Note that Arlington County is not in a position to exercise broad authority over these matters, but it can adopt policies and exercise influence in aggregation with other local governments and regional authorities.

[30] For example, in Oslo, 60% of EVSE installation is covered by grants, and in China large metropolitan areas such as Beijing and Shanghai are committed to specific charge-point goals and new building standards that require EVSE wire conduit installations. The City of San Francisco, has adopted a 10% floor on Level 2 charging spaces for all new building parking lots and garages.

County Government Activities

Goal 5 (G5): Lead by example and integrate CEP goals into all County Government activities

Policy 5.1: Reduce County government CO_2e emissions to be carbon neutral by 2050, compared to 2007 levels, and improve energy security throughout County operations. Milestones include:

- *2020: 42% below 2007 CO_2e level*
- *2030: 67% below 2007 CO_2e level*
- *2040: 84% below 2007 CO_2e level*

Policy 5.2: Integrate Community Energy Plan policies into County planning, policy development, and internal standards across all departments, state legislative agendas, and other activities

Policy 5.3: Ensure Arlington's long-term economic competitiveness by expanding and enhancing Arlington government's leadership role among the localities in the Greater Washington Region, and aggressively seek opportunities to collaborate and partner with the private sector, universities, utilities and other stakeholders to promote and encourage innovative programs and pilots that support CEP goals.

Policy 5.4: Diversify AIRE County- and Community-Facing Programs to implement a contemporized and adaptive portfolio.

Policy 5.5: The design and construction of new and Major renovations of County facilities should presume Net Zero Ready targets, and the design and building of new and Major renovations of County facilities should achieve energy efficiency targets consistent with Arlington County Government's Facility Sustainability Policy for New Construction and Major Renovation.[31]

Arlington County has cut electricity use by more than half at Central Library through energy efficiency (2000-2018). Central Library also has a 60-kW solar PV system, added to the roof in 2011 with federal funds.

Arlington County recognizes the need to institutionalize the changes recommended in the CEP. Arlington County government operations use only about 4% of the community's total energy use. However, County government should lead the way in CEP implementation by reducing operational costs and the carbon footprint of its facilities, fleet, and other operations. Doing so will require investment in energy programs, collaboration across all County departments, and strong partnerships throughout the community.

To ensure that County government is adequately implementing the CEP, all County departments look to incorporate energy considerations into policy development, project planning, and other processes. For instance, the annual budgeting process and the biennial Capital Improvement Program process should indicate how they relate to CEP implementation. In addition, the annual legislative agenda commonly reflects the energy priorities of the County and its commitment to implementing the CEP.As an example of this cross-cutting approach, Arlington recently updated the Facility Sustainability Policy for public sites and facilities. The Policy specifies that County projects will strive to incorporate the highest environmental standards using LEED, Net Zero Energy, and EarthCraft Virginia green building standards for County facility renovation and new construction. The purpose of the updated Policy is to:

- reduce costs through energy and water efficiency,
- achieve high-performing, durable, and efficient buildings that are easy to operate and maintain,
- invest in healthy indoor environments for staff and visitors, and
- set a community standard for sustainable building practices.

[31] This policy is an Administrative Regulation for County government facilities.

The Policy includes a comprehensive list of Guiding Principles to clearly define Arlington County's sustainability priorities in order to build well-functioning, easy to maintain buildings and facilities with low energy demands and excellent indoor environmental quality:

- Function - Achieve high performing and efficient building operations with systems and components that are easy to use and maintain. Ensure the building operates as intended and reduce long-term operating costs.
- Energy - Use integrated design and passive strategies to minimize heating, cooling, and lighting loads and reduce long-term operating costs.
- Human Experience - Support occupant health and well-being.
- Durability - Select quality materials, systems, and equipment to reduce maintenance, operations, and replacement costs.

CEP implementation will dovetail with implementation of other elements of the County's Comprehensive Plan such as the Master Transportation Plan, General Land Use Plan, Affordable Housing Master Plan, Public Spaces Master Plan, and Urban Forest Master Plan. For example:

- ensuring Site Plan projects incorporate CEP goals and policies in addition to land use and transportation goals and policies,
- providing the majority of Arlington residents with multimodal transportation options will help reduce vehicle miles traveled and greenhouse gas emissions,
- creating energy efficient affordable housing, making living more affordable for its tenants and reduce the community's emissions,
- maintaining tree canopy and green space reduces the heat island effect, making buildings less expensive to cool.

In addition, the Commonwealth's annual legislative agenda commonly generates proposed bills that may impact the energy priorities of the County and its commitment to implementing the CEP. The County is expanding partnerships with other jurisdictions and regional organizations to proactively address energy issues and consolidate the shared objectives, initiative and influence of local governments throughout Virginia.

Implementation of the CEP will result in more reliable energy supplies at more stable prices, which will position Arlington well for businesses in the future. In addition, numerous innovative companies are already working in the clean energy sector in Arlington. Implementation of the CEP will help define Arlington as a center of excellence in energy issues and attract firms consistent with Arlington's vision for a healthy business environment for 'smart jobs.'

Education and Behavioral Change

Goal 6 (G6): Advocate and support residents and businesses acting to reduce their energy usage

Policy 6.1: Engage and empower individuals to reduce energy use

Policy 6.2: Increase the level of professional expertise and work force in the community related to energy

Policy 6.3: Ensure recognition of extraordinary efforts made to help the community reach the CEP goals

Policy 6.4: Increase the number of buildings that disclose energy use through benchmarking

Policy 6.5: Design and implement programs that address energy equity issues, including without limitation seniors, underserved, low-to-moderate income or disadvantaged communities, and challenges unique to the rental market

To achieve the CEP's ambitious energy and carbon emissions targets, Arlington County must engage, educate, incentivize and empower the community to take personal action to reduce energy usage. New technologies, more efficient buildings, cleaner sources of energy, and more efficient and cleaner sources of transportation continue to be made available, but individuals must embrace these new opportunities for Arlington to realize its full energy potential. To reach Arlington's diverse population, education efforts will be needed using customized approaches and channels, including person-to-person contact, social and print media, events, and a variety of effective messaging.

Because the vast majority of buildings in the County are privately owned, education plays a crucial role in encouraging building owners and managers to make energy upgrades and improve behavior. Similarly, while the County continues to improve its transportation options, residents must increasingly take advantage of these options. Finally, in addition to the short-term energy savings, educational efforts will help yield longer-term benefits by helping build support for future energy policies and the CEP.

Arlington incentivized homeowners to reduce their energy use. This generated about $10 of private investment for every County dollar spent.

Residential buildings account for over one-quarter of building energy demand in Arlington. The County must ensure its residents are aware of the energy savings opportunities that are available to meet its ambitious targets and to help residents save on their energy bills. When institutionalized, behavioral changes and no- and low-cost improvements can have a sizable impact on energy usage.

Arlington's business community and workforce should be prepared to meet a growing demand for energy improvements, and to do so our skilled workforce must be equipped to facilitate energy improvements. As such, the County must encourage adequate energy training for workers.

While Arlington's energy and carbon dioxide goals are achievable with existing technologies, there is always opportunity for innovation. The County will continue to recognize those who are innovative and make outstanding efforts to address energy issues. Providing appropriate recognition for successful innovation and implementation will help to ensure that energy generation, transmission, storage, and use continue to be in the forefront of public understanding.

A voluntary energy benchmarking and building labeling program can inform tenants and prospective buyers about energy use and costs in commercial buildings. Such a program can help make tenants and building owners aware of how well a building is performing and the level of savings that are available.

Glossary of Terms

The following is a summary of selected terms and abbreviations used in the Community Energy Plan; the list is not exhaustive. In some cases, terms are defined in the body of the text and may not be repeated here

TERM	DEFINITION
Air Pollutants	In addition to greenhouse gases, these include sulfur dioxide (SO_2), nitrogen oxide (NOx), hydrogen chloride (HCl), hydrogen fluoride (HF), carbon monoxide (CC), and non-methane volatile organic compounds (NMVOC).
BEV	Battery electric vehicle, also known as an electric vehicle.
Btu	British thermal unit (BTU or Btu) is a unit of energy defined as the amount needed to heat one pound of water one-degree Fahrenheit. For the purposes of the Community Energy Plan, 1,000 Btus are labeled kBtu, while 1,000,000 Btus are labeled MM Btu.
Building Code	Legally required construction practices.
Carbon Dioxide	(CO_2) The most common greenhouse gas, carbon dioxide is produced in large amounts when fossil fuels are burned. Worldwide, over 70% of man-made greenhouse gas emissions are from the use of energy; in Arlington, over 98% of our GHG emissions are from the use of energy.
Carbon Dioxide Equivalent	Where the “e” in CO_2e is used to denote the term “equivalent”: Greenhouse effect of the other five greenhouse gases identified in the Kyoto Treaty expressed in equivalents of carbon dioxide. This unit of measure is used to allow the addition of or the comparison between gases that have different global warming potentials (GWPs). Since many greenhouse gases (GHGs) exist and their GWPs vary, the emissions are added in a common unit, CO_2e. To express GHG emissions in units of CO_2e, the quantity of a given GHG (expressed in units of mass) is multiplied by its GWP.

TERM	DEFINITION
Carbon Neutral / Carbon Neutrality	Net zero carbon dioxide (CO_2) emissions are achieved when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO_2 removals over a specified period. Net zero CO_2 emissions are also referred to as carbon neutrality.
CHP	See "Cogeneration."
Clean and Renewable Energy	This phrase is used to indicate some combination of renewable energy and cogeneration (CHP) energy sources.
CO_2	See "Carbon dioxide"
CO_2e	See "Carbon dioxide equivalent"
Cogeneration	Generating electricity in such a way that most of the heat produced is also used purposely, such as space heating or generating chilled water. A common definition is that an average minimum overall fuel efficiency of 70% is expected. Peak efficiency would typically exceed 90%. Also known as "CHP."
Combined Heat and Power	See "Cogeneration."
Commercial Buildings	Non-residential buildings; often owned or operated by for-profit entities, including offices, retail stores, restaurants, and warehouses.
Community Energy Project	Project that led to the CES Task Force Report and now this Community Energy Plan that provides high-level goals and policies for energy generation, distribution, storage, and use in the greater Arlington community from now to the year 2050.
CNG	Compressed natural gas, an alternative transportation fuel.
Daylighting	Designing buildings to maximize the use of natural daylight to reduce the need for electricity.
Decarbonization	Decarbonization is framed around decreasing the ratio of carbon dioxide (CO_2) or all greenhouse gas emissions related to primary energy production. While full decarbonization means zero unabated (not captured by carbon sequestration or storage) CO_2 emissions from energy generation and industrial processes, decarbonization doesn't imply zero emissions, as emissions can be balanced by carbon sequestration if adequate reductions or enhanced carbon sinks exist. To effectively communicate the scale of change needed, the term must be accompanied by a timeframe and rates of decarbonization.
DEE	See "District Energy Entity"

TERM	DEFINITION
District Cooling	Cooling services delivered via district energy systems.
District Energy	Networks that deliver heating or cooling to energy consumers carried through the medium of chilled or hot water, or (in older systems) steam. Heating and cooling is transferred to the home or buildings via a heat exchanger.
District Energy Entity	While individual buildings that are customers in a district energy network are owned by property owners and developers, a District Energy Entity (DEE) would operate and maintain the district energy network, i.e., the horizontal infrastructure of district energy piping and equipment. The DEE can also wholly or partially own the district energy network and can be publicly owned, privately owned, or a public-private partnership.
District Heating	Heat services delivered via district energy systems.
Energy Assurance	Energy assurance is an activity; whereas resiliency is the ultimate goal of that activity. Energy assurance involves a vast array of activities and falls into three main categories: preparation and planning, mitigation and response, and education and outreach.
Energy Equity	To ensure that access to and the impact of energy upgrades, participation in energy programs, and the movement toward a clean, reliable and secure grid is equitable across all socioeconomic and racial and ethnic groups, including low-to-moderate income and disadvantaged communities.
Energy Literacy	An understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply this understanding to answer questions and solve problems. An energy-literate person knows how much energy they use, for what purpose, and where the energy comes from.
ENERGY STAR®	Joint U.S. Environmental Protection Agency and U.S. Department of Energy programs http://www.energystar.gov/ supporting energy efficiency as a cost-effective way to reduce greenhouse gas emissions in home, buildings, industry and equipment.
EU	European Union
EV	Electric Vehicle
Fossil Fuels	Combustible material obtained from below ground and formed during a geological event. For purposes of the Community Energy Plan, examples of such fuels include coal, oil and natural gas.
GHG	See “Greenhouse Gases”

TERM	DEFINITION
Greenhouse Gases	A greenhouse gas absorbs and re-radiates heat in the lower atmosphere, trapping heat on Earth that would otherwise be radiated to outer space. The main greenhouse gases are carbon dioxide (CO_2), methane (CH4), chlorofluorocarbons (CFCs) and nitrous oxide (N_20), sulphur hexafluoride (SF6), hydrofluorocarbons (HFC) and perfluorinated carbons (PFC). The most abundant greenhouse gas is carbon dioxide (CO_2).
IECC	International Energy Conservation Code - a model energy building code produced by the International Code Council (ICC). The code contains minimum energy efficiency provisions for residential and commercial buildings, offering both prescriptive- and performance-based approaches. The code also contains building envelope requirements for thermal performance and air leakage. Primarily influences US and Latin American markets.
Institutional Buildings	Nonresidential buildings generally owned by public administration, education, public or private healthcare facilities and other not-for-profit entities.
kBtu	See “Btu”
Kilowatt	A unit of power equal to 1,000 watts.
kW	See “Kilowatt”
Megawatt	A unit of power equal to one million watts.
Metric Ton	Unit of weight equal to 1,000 kilograms. Often used in the Community Energy Plan as a measure of greenhouse gas emissions. 1 mt = 1.102 US ton.
Microgrid	A local electricity distribution system containing loads and distributed energy resources, such as distributed generators, storage devices, or controllable loads, that can be operated in a controlled, coordinated way. A microgrid can connect and disconnect from the main power grid to enable it to operate in both grid-connected or island-mode.
mt	See “Metric Ton”
MW	See “Megawatt”
Net Zero Energy Building	A building that produces enough energy on-site to meet its annual energy demand
Per Capita	For each person in the total population being considered; generally referred to as a resident.
PHEV	Plug-in hybrid electric vehicle, a hybrid electric vehicle whose battery can be recharged by plugging it into an external source of electric power, as well by its on-board engine and generator.

TERM	DEFINITION
PV	See "Solar Photovoltaic Systems"
Renewable energy	Energy generated from sources that are naturally occurring and replenishable through natural forces over a short period of time, most commonly sun, wind, water and various animal and plant derived fuels.
Resilience	The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions caused by deliberate attacks, accidents, climate change, or weather-related threats or incidents.
Site Energy	See "Source Energy"
Solar Photovoltaic Systems	Systems that directly convert sunlight into electricity either for use locally or for delivery to the electric grid.
Solar Thermal (water heating) Systems	Systems that directly convert sunlight into heat, generally for domestic hot water though they can also be used to produce space heating.
Source Energy	The total amount of raw fuel that is required to operate an energy-using device or facility. Source energy includes all transmission, delivery, and production losses, thereby enabling a complete assessment of energy efficiency in a building. On the other hand, "Site Energy" is the amount of heat and electricity consumed by a building as reflected in utility bills.
Sustainability	Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.
TOD	See "Transit-Oriented Development"
Transit-Oriented Development	Land development that considers transportation choices as a means of reducing oil and other energy use. Typically, it would combine public transit with walkable, mixed-use communities, and approaches to minimize the impact of individual vehicles and commuting.
VMT	Vehicle Miles Travelled

Credits

Arlington County thanks numerous individuals and organizations for contributing to the development of the original CEP and revising the CEP. This Plan could not have become a reality without the time and effort of numerous people. In addition to the stakeholders listed below for this CEP revision, Appendix A contains the individuals and groups that were instrumental in the CEP's creation and 2013 adoption as an element of the County's Comprehensive Plan.

Arlington County Board

Christian Dorsey, Chair
Libby Garvey, Vice-Chair
Erik Gutshall, Member
Katie Cristol, Member
Matt de Ferranti, Member

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Roger Munter
Sarah Crawford
Shannon Flanagan-Watson
Vincent Verweij

Environment and Energy Conservation Commission (E2C2) Energy Committee members

E2C2 members

November 5, 2018 CEP Forum participants

May 30, 2019 CEP Forum participants

June 4, 2019 CEP Open House participants

Appendix A
Individuals and Groups Involved in Creating CEP 2013

Arlington County Board (2013)

J. Walter Tejada, Chair

Jay Fisette, Vice-Chair

Libby Garvey, Member

Mary Hynes, Member

Christopher Zimmerman, Member

Barbara Donnellan – County Manager

Stephen MacIsaac – County Attorney

Community Energy and Sustainability Task Force & Community Energy Advisory Group

Businesses:

Andrew McGeorge+, Monday Properties, Senior Associate

Brian Coulter#, JBG, Chief Development Officer and Eileen Nacev+, Director of Sustainability

Kevin Shooshan+, The Shooshan Company, Development Manager

Scott Brideau, Little Diversified Architectural Consulting, Studio Principal

Tom Grumbly#, Lockheed Martin, Vice President for Civil & Homeland Security, Washington Operations

Scott McClinton#, Marriott International, General Manager, Crystal City Marriott

Colleen Morgan, SRA International, Director of Sustainable Environmental & Energy Resources

Chris Mallin, Turner Construction, Sustainability Director

Jim Cole#, Virginia Hospital Center, President and Chief Executive Officer and Carl Bahnlein+, Chief Operating Officer

Mitchell Schear#, Vornado/Charles E. Smith, President and Jonathan Gritz+, Sustainability Manager

Local, State and Federal Government:

Barbara Donnellan#, Arlington County, County Manager and Marsha Allgeier+, Deputy County Manager

Jay Fisette, Arlington County Board, Task Force Chair

Bradley Provancha, Pentagon, Deputy Director, Defense Facilities Directorate

Mary Margaret Whipple, Commonwealth of Virginia Senate, State Senator

Tim Torma*, US EPA Smart Growth Program, Senior Policy Analyst

Educational Institutions:

Christopher Applegate+, NVCC, Arlington Center Director

Patrick Murphy, Arlington Public Schools, Superintendent

Saifur Rahman, Virginia Tech Advanced Research Institute, Professor of Electrical and Computer Engineering

Energy and Energy Technology Industry:

Alexei Cowett+**, Energy Efficiency Specialist

Deborah Johnson#, Dominion Virginia Power, Senior External Affairs Manager and Phillip Sandino+, Director - Customer Solutions

Martha Duggan, PV and Renewable Energy Specialist

Melissa Adams, Washington Gas, Division Head, Sustainability and Business Development

Michael Chipley+, President, The PMC Group LLC

Scott Sklar, PV and Renewable Energy Specialist

Citizens:

Larry Finch#, Arlington Civic Federation, Chair of Environmental Affairs Committee and Joe Pelton+

Shannon Cunniff, Environment & Energy Conservation Commission, Chair

Inta Malis, Planning Commission, Member

Nonprofits/Associations:

Annette Osso+, Virginia Sustainable Building Network, President

Brian Gordon, Apartment and Office Building Association (AOBA), Virginia Vice President of Government Affairs

David Garcia+, Education and Outreach Specialist

Phil Keating#, Arlington Chamber of Commerce, Chair and Michael Foster+

Nina Janopaul, Arlington Partnership for Affordable Housing (APAH), Executive Director

Eric Dobson+, NAIOP, Dir. - Government Relations and Communications

Dean Amel, Arlingtonians for a Clean Environment, Honorary Board Member

Tim Juliani, Center for Climate and Energy Solutions,[33] Director of Corporate Engagement

Regional Transportation Authorities:

Margaret McKeough#**, Metropolitan Washington Airports Authority (MWAA), Executive Vice President and Chief Operating Officer

Nat Bottigheimer#, Metropolitan Washington Area Transit Authority (WMATA), Assistant General Manager, Planning and Joint Development and Rachel Healy+, Sustainability Project Manager

* Also serving as a liaison to the Transportation Commission

** Also serving as a liaison to the Arlington Economic Development Commission

Task Force only

+ Advisory Group only

[33] Formerly the Pew Center on Global Climate Change

Community Energy Project Core Technical Working Group

Arlington County:

Laura Conant*, Arlington County, Energy & Climate Analyst

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Joan Kelsch, Arlington County, Green Building Programs Manager

John Morrill, Arlington County, Energy Manager

Chris Somers, Arlington County, Community Energy Analyst

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Cindy Palmatier, Garforth International llc, Business Manager/Administrator

Timothy Grether, Owens Corning Inc., Project Manager

Dr. Stefan Blüm, MVV decon GmbH, Head of Department Clean Energy

Gerd Fleischhammer, MVV decon GmbH, Energy and Environmental Engineering Consultant Ole Johansen, MVV decon GmbH, Senior Consultant and Project Manager

Norbert Paetz, MVV decon GmbH, Senior Consultant

Dale Medearis, Ph.D, Northern Virginia Regional Commission, Senior Environmental Planner

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Samantha Kinzer, Northern Virginia Regional Commission, Environmental Planner

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Crystal City BID, Angela Fox, President/CEO

E*TRADE Financial Account/CB Richard Ellis | Global Corporate Service, Patrick Andriuk, Senior Facilities Manager

Main Event Caterers, Joel Thévoz, Chef / Partner

NAIOP Northern Virginia, Eric Dobson, Director-- Government Relations and Communications

Rosslyn BID, Cecilia Cassidy, Executive Director

Columbia Pike Revitalization Organization, Takis Karantonis, Executive Director

Citizens:

Arlington County Green Party, Steve Davis, Member

Historical Affairs and Landmark Review Board (HALRB), Isabel Kaldenbach, past chairman

Housing Commission, Michelle Winters, Member

Information Technology Advisory Commission (ITAC), Joe Pelton, Chair

Rock Spring Congregational United Church of Christ, Rev. Dr. Janet L. Parker, Pastor

Wooster & Mercer Lofts Association, Eric Tollefson, President

Local, State and Federal Government:

City of Alexandria, William Skrabak, Director, Office of Environmental Quality

City of Falls Church, Brenda Creel, General Manager for Environmental Services

Fairfax County, Kambiz Agazi, Environmental Coordinator

Loudoun County, Andrea McGimsey, Supervisor, Loudoun County Board of Supervisors

U.S. Department of Commerce, Ryan Mulholland, Renewable Energy Trade Specialist

VA Department of Mines, Minerals and Energy, Steve Walz, Director

Educational Institutions:

Arlington Public Schools, Sally Baird, Board Chair

Arlington Public Schools, Scarlet Jaldin, Student, Washington-Lee High School

Arlington Public Schools, Thomas O'Neil, Member, Facilities Advisory Council

Arlington Public Schools, Clarence Stukes, Assistant Superintendent, Facilities & Operation

APS Advisory Council on School Facilities and Capital Programs, Thomas O'Neil, Member

George Mason University, Dann Sklarew, Associate Professor/Associate Director

George Mason University, Potomac Environmental Research and Education Center and Lenna Storm, Sustainability Manager

Marymount University, Dr. Sherri Hughes, Provost

Northern Virginia Community College, Dana Kauffman, Director, Community Relations

Westwood College, Sean Murphy, Director of Campus Operations

Non-Profits:

American Association of University Women (AAUW), Marcy Leverenz, Member

Arlington Heritage Alliance, Edwin Fountain & Tom Dickinson, Board Members

Leadership Arlington, Betsy Frantz, President & CEO

Metropolitan Washington Council of Governments (COG), Stuart Freudberg, Environmental Programs Director

Northern VA Regional Park Authority, Martin Ogle, Chief Naturalist

Sierra Club VA Chapter, Mt. Vernon Group, Rick Keller, Energy Chair

The Nature Conservancy, Peter Hage, Director of Resources, Technology and Information Systems

Virginia Sustainable Building Network, Annette Osso, Executive Director

Appendix B

Post-2013 Renewable Energy Progression, Projections, and Potential

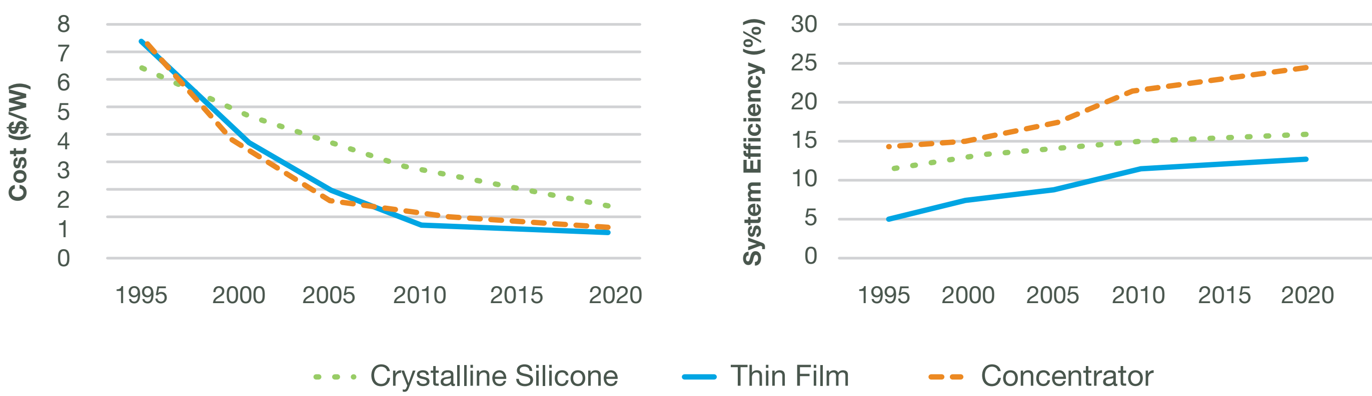
Progression

The U.S. Energy Information Administration (EIA) estimates that 23% of all new electricity generating capacity in the United States came from solar installations in 2018—second only to natural gas.

For historical context, in 1955 Hoffman Electronics-Semiconductor Division first introduced photovoltaic products with only a 2% efficiency, with an energy cost of $1,785/Watt (USD).[34] Modern day solar panels have an average efficiency of 26-28% and an energy cost of $2.67 to $3.43/Watt (USD), although this still means that much of the sun's solar radiation still goes to waste even under the most ideal circumstances.[35] In addition, while solar PV industry has experienced significant, rapid advancement over the past decade,[36] the exponential growth envisioned by researchers, governments and the private sector is dependent upon the ability to produce downscaled renewable systems that operate at even greater conversion efficiency.

PV System Capital Cost

PV System Efficiency



[34] https://sites.lafayette.edu/egrs352-sp14-pv/technology/history-of-pv-technology/

[35] https://arstechnica.com/science/2017/02/for-a-brighter-future-science-looks-to-re-energize-the-common-solar-cell/

[36] Since 2010, the solar PV cost/Watt has dropped 73%. By 2030, total installed costs could fall between 50% and 60% (and battery cell costs by even more), driven by optimization of manufacturing facilities, combined with better combinations and reduced use of materials. International Renewable Energy Agency (IRENA) Report, Electricity Storage and Renewables: Costs and Markets to 2030 (October 2017). Since 2012, solar panel efficiency has increased by roughly 35%.

Technology Projections

Since the creation of the first solar panels in 1954, silicon has been the primary material used in solar cells. The limited capacity of silicon to create usable energy, however, has generated investments in alternative materials.

In 1996 the National Renewable Energy Laboratory of the U.S. Department of Energy (NREL) launched the National Center for Photovoltaics (NCPV), which tracks the efficiency performance for the following range of existing and emerging photovoltaic technologies (plotted from 1988 to the present[37]):

- Multijunction cells
- Single-junction gallium arsenide cells
- Crystalline silicon cells
- Thin-film technologies, e.g., perovskites
- Emerging photovoltaics

By way of example, two technologies have demonstrated significant efficiency improvements:

- Multijunction cells rely mainly on a design that layers existing silicon cells to magnify conductivity. In December 2018, the U.S. Department of Energy announced that through a public-private partnership (SpectroLab, a Boeing subsidiary), a multijunction cell has been produced that achieves more than 40% efficiency. According to SpectroLab, the highly efficient units allow for the use of fewer cells overall to achieve the same power output as conventional silicon cells. As a result, the technology may allow for lower PV system space requirements and installation costs, at $3 per watt, and electricity production costs of $0.08–$0.10 cents per kilowatt-hour.[38]
- "Perovskite" (CaTIO3) is a naturally occurring mineral that displays a wide variety of useful properties, most importantly a high level of superconductivity. Equally important, a process has been developed that uses synthetic materials to mimic the crystal structure found in the naturally occurring mineral. Because perovskites can be synthetically produced, they are highly hold the potential to be both cheaper to produce and easier to work with than silicon.[39] Like other thin-film technologies, perovskite solar cell "rolls" are flexible, lightweight, and semi-transparent; and can be incorporated into parts of buildings besides just the roof. Additionally, their lightweight nature means less physical stress on roofs, walls, or wherever they may be installed.[40]
- The current major limitation is the material's decomposition rate. If this technical hurdle can be overcome and panel efficiency continues to escalate, perovskite solar cells are potentially a high-efficiency, low-cost solar technology, and could be a future replacement for traditional silicon solar panels.[41]

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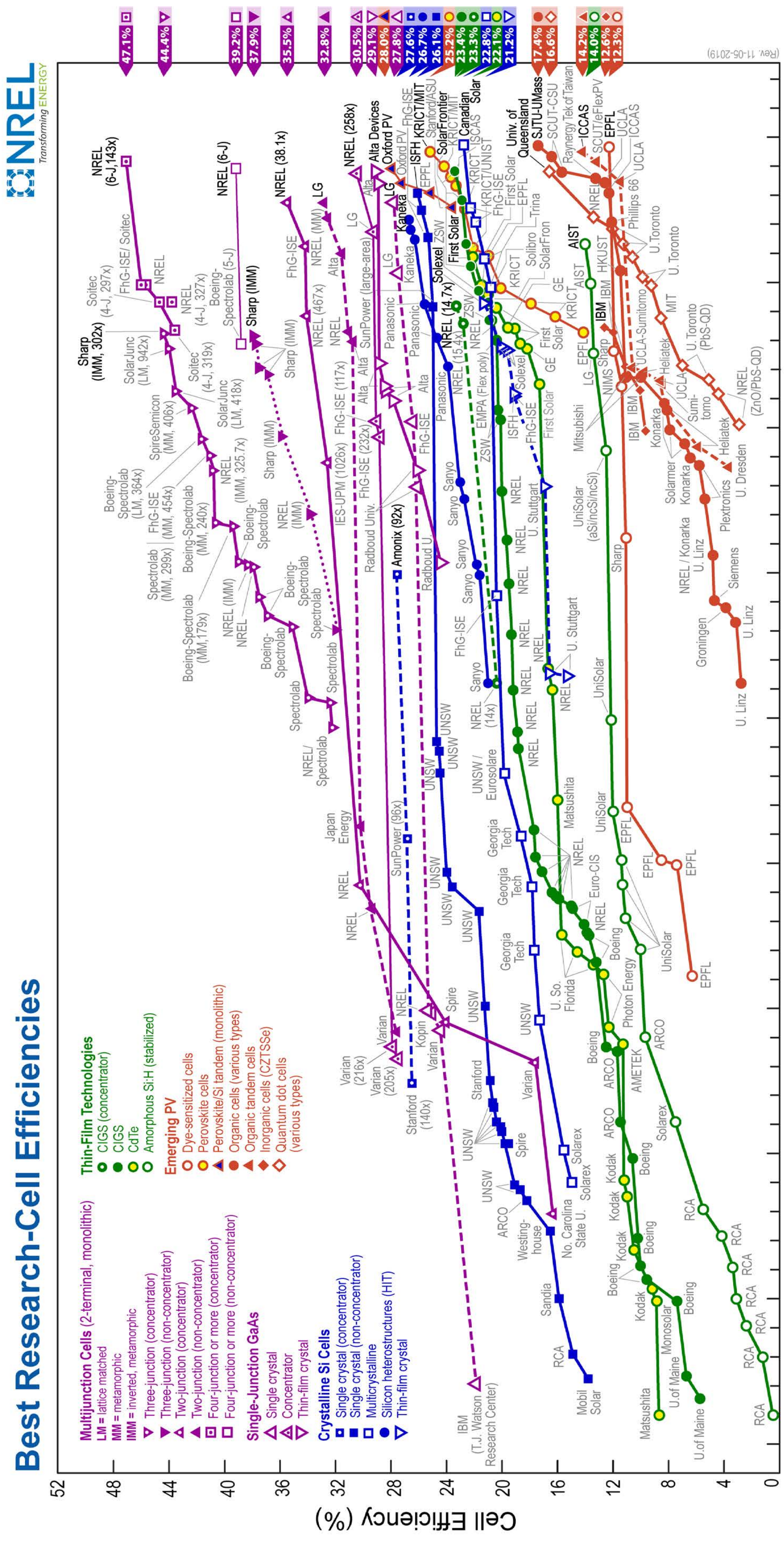
[37] https://www.nrel.gov/pv/module-efficiency.html

[38] https://www.energy.gov/articles/new-world-record-achieved-solar-cell-technology

[39] In the past 7 years alone, solar cells created with perovskites have gone from an efficiency rating of just 3.8% to 20.1%.

[40] TIME Magazine, "Inside the Technology That Could Transform the Solar Power Industry" (June 4, 2018); http://time.com/5297011/solar-energy-perovskite-national-lab/

[41] https://news.energysage.com/perovskite-solar-cells/


Best Research-Cell Efficiencies
NREL
Transforming ENERGY
Multijunction Cells (2-terminal, monolithic)
LM = lattice matched
MM = metamorphic
IMM = inverted, metamorphic
Three-junction (concentrator)
Three-junction (non-concentrator)
Two-junction (concentrator)
Two-junction (non-concentrator)
Four-junction or more (concentrator)
Four-junction or more (non-concentrator)
Single-Junction GaAs
Single crystal
Concentrator
Thin-film crystal
Crystalline Si Cells
Single crystal (concentrator)
Single crystal (non-concentrator)
Multicrystalline
Silicon heterostructures (HIT)
Thin-film crystal
Thin-Film Technologies
CIGS (concentrator)
CIGS
CdTe
Amorphous Si:H (stabilized)
Emerging PV
Dye-sensitized cells
Perovskite cells
Perovskite/Si tandem (monolithic)
Organic cells (various types)
Organic tandem cells
Inorganic cells (CZTSSe)
Quantum dot cells (various types)
Cell Efficiency (%)
(Rev. 11-05-2019)

Technological Potential and CEP Approach and Assumptions

Renewable energy (primarily solar photovoltaics or solar PV) plays a key role in modeling for Arlington County to meet its 2050 greenhouse gas (GHG) emissions reductions goals. In 2012, three studies were conducted that would either challenge or support a scenario of 160 MW of solar energy in Arlington by 2050:

- SAIC, in a report prepared for Arlington County to identify the technical feasibility of the 160 MW of solar recommended by the CEP Task Force, found "ample" roof area to generate 160 MW, based on review of GIS images of building roofs greater than 5,000 sf. Overall, the report identified nearly 13,000,000 sf of "suitable" roof area to accommodate 160 MW or more by 2050, without including any residential or small commercial properties, or non-horizontal orientations. Thirteen million square feet is less than two percent of the County area; and
- Northern Virginia Regional Commission (NVRC) conducted an analysis using a GIS-based, LIDAR-mapped Solar Capacity Decision-Support Tool, which arrived at a larger capacity of over 400 MW

Importantly, both studies were calculated at a then-standard efficiency rate of 17%-19% for solar modules/panels. Today, the range is a minimum of 21%, which certain panels offering up to 28%. As noted above, research and development are presently focused on pilot models that offer 40%-44% efficiency.

For purposes of the CEP and based on the prior studies and technology updates above, AIRE staff recommends retaining the estimate of 160 MW as a target for 2050.

The updated GHG inventory and energy intensity modeling informs a blended-sector and technology approach that recommends a 2050 emissions reduction target of Carbon Neutrality. This amended target reflects:

- Technological advancements to date
- Continuing pace and arc of technological advancements (elasticity), e.g., current advancements reasonably predict a doubling of solar efficiency by 2035
- Sector-based transitions such as electrification of transportation
- Best practices and consensus among comparable jurisdictions (not only regional)
- Market drivers
- A suite of measures and strategies that can operate in combination to fill gaps in individual performance with over-performance under other measures (flexibility, adaptability).

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