Arlington County Community Energy Plan: An Analysis

Engaging the Future

XMNR Team Cinco Squared
2013
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Executive Summary
Cinco\textsuperscript{2}, a team of 2014 Virginia Tech XMNR students, has prepared this report for Rich Dooley, Community Energy Coordinator for Arlington County, VA. The report acts as an implementation strategy and timeline for the Arlington County Community Energy Plan. The document is primarily looking at short, medium and long-term goals for the Arlington CEP and potential drivers and strategies for implementing the plan. The four target areas include buildings, transportation, renewables, and district energy. The document also investigates measures for adapting to changing climate conditions such as potential Potomac River flooding, severe storms, and vulnerability to electric power outages (Appendix A).

Introduction
Arlington County, located immediately west of the Potomac River within the D.C. Metro area has been progressive in their approach of climate change and energy issues with the development of their Draft Community Energy Plan (CEP) and corresponding Community Energy Implementation Framework (CEIF). Arlington consists of wooded areas, residential homes, parks, highly developed urban “corridors” characterized by high-rise buildings, robust public transit facilities, and other commercial development. Arlington is also adjacent to the Pentagon, National Airport, and a military base. It’s no surprise then that energy security and reliability are key issues for Arlington County.

Implementation of the broad plan requires thoughtful planning, goal setting and engagement strategy capable of bringing together diverse stakeholders such as utility companies, developers, volunteer organizations, businesses, county government entities, and community members. The CEP empowers the community to define its own energy future, in spite of volatile political, economic, and natural resource conditions. See Appendix C for a narrative vision of Arlington in 2050.

The four “target” areas as defined by the CEP include buildings, transportation, renewables, and district energy (Arlington 2013b). Establishing short, medium and
long-term goals for each of these target areas will be critical for the overall success of the CEP and will allow for timely engagement of key stakeholders and smooth transitions for achieving CEP goals.

Buildings
Commercial buildings will be the largest priority for overall carbon and energy footprint reduction for the Arlington CEP. Short-term solutions for improving the energy efficiency of existing commercial buildings in Arlington include the use of smart building applications such as analytic management systems to control and benchmark emissions, energy use, mechanical systems, and water usage (Accenture 2011). Additionally, retrofitting older buildings with energy efficient features combined with financial incentives to owners is a short to medium-term solution that can lead to substantial increases in energy efficiency. These retrofits can occur in stages over the next couple of decades, allowing owners to determine the scope of the retrofit that is financially suitable at that time.

All new construction of commercial buildings will be required to be LEED certified. Green building is increasingly seen as a positive business opportunity, especially in Arlington. The Arlington market environment as well as existing green building incentives by Arlington County makes this goal approachable in the short-term.

Residential single-family dwellings present a different set of short-term goals. An immediate goal would be to establish local educational programs in Arlington County schools focused on how to “green-up” homes and how to conserve energy on an everyday basis. Program topics can include energy efficient lighting, appliances, good energy habits, public transportation, and recycling. These topics can then be applied at home and implemented throughout Arlington’s residential areas. Additional short-term goals include utilization of tankless water heaters, solar water heaters, and ductless air conditioning systems. These smaller actions compounded through the entire area exhibit the true energy savings that can be realized.

These short-term goals can be enhanced with financial incentives for significant improvements, particularly for older housing requiring window and roof replacement, heating and air conditioning replacement or installation – including solar panels.

Mid-term goals for commercial buildings may be derived from benchmarks that have been provided from multi-year analysis of smart building management systems that track usages in various categories. Financial incentives and regulatory changes likely have already been determined and implemented, respectively, allowing for changes in particular areas. The financial benefits are highlighted in the following table. The table shows where the amount of incentive versus investment made allows owners to determine the specific improvements to make to their buildings.
Table 1. Business Benefits Expected From Green Building Investments

<table>
<thead>
<tr>
<th>Benefit</th>
<th>New Green Building</th>
<th>Green Retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased Operating Costs Over One Year</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>Decreased Operating Costs Over Five Years</td>
<td>15%</td>
<td>13%</td>
</tr>
<tr>
<td>Increased Building Value for Green versus Non-Green Projects (According to AEC Firms)</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>Increased Asset Value for Green versus Non-Green Projects (According to Owners)</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>Payback Time for Green Investments</td>
<td>8 years</td>
<td>7 years</td>
</tr>
</tbody>
</table>


Long-term goals for buildings in Arlington County would be all new LEED-certified construction, and complete (100%) overhauls or retrofits of existing buildings both commercial and residential. This may also mean that with the advent of district energy, some traditional residential development will be relocated and transitioned to higher-density residential development. Additionally, facilities such as schools and may find their physical footprint reduced, as increased remote learning, mobile learning and remote workplace opportunities are realized.

**Transportation**

The Arlington CEP/CEIF presents a mature strategy leading toward incremental targets of reducing carbon produced by transportation to 1 mt CO2e/capita/year by 2050 given the baseline of 3.7 mt CO2e/capita/year in 2007. This drop of 73% will require driving 20% less, using vehicles that are 75% more fuel efficient, and burning fuels that produce 30% less carbon. Aside from improving transportation technologies, people will need to be given more transportation choices including small autonomous electric vehicles, public transit, walking, bicycles, car-pooling, and telecommuting. As an illustration of changes already taking place, sharing vehicles in North America has increased steadily from 2000-2010 from 153 cars to 10,405 cars. Car sharing memberships have increased from 2,502 to 516,100 persons. Car sharing provides the benefit of lower ownership and maintenance costs. While a car used to be the ultimate symbol of freedom and independence, consumers are increasingly viewing car ownership as an expense and a burden (Future of Car Sharing 2012).

Millennials tend to be less interested in driving than earlier generations. There are, of course, many reasons for this attitude including rising gas costs, an anemic economy, depressed wages, concern for the environment, and increasing urbanization – all of which seem to be trending up in the near future. The combined effect of these factors is leading to a population that is open to new and more energy-efficient transportation. As Sheryl Connelly, head of global consumer trends at Ford, said, “Young people value access over ownership (Connelly, 2013).”
Short-term transportation goals for Arlington will attempt to reach a carbon goal of 2.7 mt CO2e/capita/year. The first step in achieving this goal is to convert heavily used municipal vehicles and public transport to alternative fuel sources such as natural gas, biofuels or electricity. Incentives should be created to encourage bicycle use, hybrid car use, electric car use and car sharing programs. An example low-cost incentive for car sharing could be providing exclusive parking areas for vehicles that are shared by at least four persons. Another simple short-term goal would be encouraging residents to join a local online database for carpooling that links drivers and riders. Infrastructure improvements to roadway systems around Arlington could also provide energy savings. For example, conducting a detailed study to optimize traffic light timing may reduce idle times while driving, thus reducing the amount of fuel and emissions required to travel throughout the local area.

Capital Bikeshare puts shared bicycles available for short-term usage to members. Stations are located in Washington, D.C., Arlington, and Alexandria for day and evening trips. Daily ridership has steadily increased since the project’s inception, which replaced a test system called Smartbike DC. Riders can use a smartphone app to locate the nearest bike to their location and the nearest docking station with an open bike parking spot at the completion of their trip (Capital Bikeshare 2013).

Mid-term goals for Arlington (target dates between 2030 and 2040) will attempt to reach a carbon goal of 2.0 mt CO2e/capita/year and 1.7 mt CO2e/capita/year respectively. With the advancement of local district energy systems, more vehicles could be converted to electric power from antiquated fuels such as gasoline and diesel. At this point, disincentives for vehicle owners using their vehicles frequently could be strengthened, encouraging a switchover to public transportation. Access to three wheel bicycles (for older or physically limited individuals), electric bicycles will be widespread and affordable by this phase as an extension of bikeshare programs that are used by the community. Car sharing and public access to autonomous vehicles will also be ubiquitous, resulting in direct savings for cost of ownership and reduction in carbon emissions since the vehicles are hyper-efficient and powered by the District Energy grid.

Long-term goals (target date of 2050) for Arlington will attempt to reach a carbon goal of 1.0 mt CO2e/capita/year. Public transportation system changes include converting large buses to smaller, more efficient autonomous mini-buses that run more frequently through suburban neighborhoods as well as connecting with the Metro and commercial zones. Also, Arlington can create covered pedestrian corridors to link high-density pedestrian zones, visibly and fiscally raising the pedestrian in the hierarchy of transportation modes while protecting pedestrians from inclement weather. These corridors could be funded via public and private contribution and savings from reduced dependence on non-renewable fuel sources.

Other innovative long-term goals would be to develop multiple neighborhood post offices throughout Arlington that provide one-stop access to government services
including driver services, voting registration, identification of volunteer opportunities, access to public computers, recycling of hazardous materials, management of electronic/data waste, county record management, shipping and mailing services.

**Renewables**

Arlington County (Arlington 2013a) has established two goals for increasing the amount of energy received from renewable resources. These goals are:

- Install and utilize 160 MW of solar electricity by 2050
- Increase the use of renewable energy technologies for public, private and non-profit sectors.

The first goal will require approximately 14 million square feet of solar panel surface area to meet targets. Bringing businesses, local government and developers on board with implementing solar programs on building rooftops will be critical for achieving this goal. Establishing metrics and ways to track progress for the second goal will be essential to achieving long-term renewable energy goals.

Local incentives for implementing rooftop solar panels will need to be created, but with the Dillon’s rule in Virginia, the current political climate impedes progress. Implementing Power Purchase Agreements (PPAs), Renewable Portfolio Standards (RPS), and other incentive programs are currently at the mercy of state legislators.

Immediate short-term goals for renewable energy include removal of legislative barriers to creating incentives, establishing Property-Assessed Clean Energy financing programs, establishing educational programs for renewable energy, and partnering with Dominion Power on their solar pilot project. Mid and long-term goals include placement of approximately 14 million square feet of solar panels on building rooftops, which would generate the required 160 MW of solar electricity, and investigation of further renewable energy sources. These sources could include biomass, geothermal, and wind energy. Table 2 on the following page highlights some of the implementation strategies associated with renewable energy for Arlington County.
Table 2. Renewable Energy Implementation Risks and Opportunities

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Risks</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide incentives:</td>
<td>- Too costly for Arlington to provide grants, incentives or rebates.</td>
<td>- Improve access to capital through Property-Assessed Clean Energy Financing program.</td>
</tr>
<tr>
<td></td>
<td>- Federal tax credit ends in 2016.</td>
<td>- Use Harrisonburg, VA model ordinance to provide local tax incentive.</td>
</tr>
<tr>
<td>Eliminate regulatory and legislative barriers:</td>
<td>Dillon’s Rule:</td>
<td>- Work with businesses, lawmakers and non-profits to remove barriers for private investments.</td>
</tr>
<tr>
<td></td>
<td>- PPAs not allowed under current VA law.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- VA does not have mandatory RPS</td>
<td></td>
</tr>
<tr>
<td>Encourage developers to integrate renewable E-technology into development design processes.</td>
<td>- Build awareness of BIPV and other integrated technology within the building design community via collaboration and educational events.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Building Integrated Photovoltaics (BIPV): vertical windows with PV and electricity-generating solar shingles on roofs</td>
<td></td>
</tr>
<tr>
<td>Partner with local utilities to optimize power grid.</td>
<td>- Dominion Power is looking into testing system performance with solar PV installations. Arlington would partner with them on this project.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Dominion Power (VA)</td>
<td></td>
</tr>
<tr>
<td>Encourage Solar Thermal Technology</td>
<td>- Misunderstanding or misconceptions about weather-dependent technologies.</td>
<td>- Educational opportunities related to utilization of this technology.</td>
</tr>
<tr>
<td>Source: Arlington 2013a, 2013b.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**District Energy**

District energy (DE) is an old concept that has seen renewed interest in recent decades, especially in dense urban areas with security and resiliency concerns. District energy is a major facet of the Arlington CEP and is arguably the primary long-term goal for the plan.

In dense urban areas, a district energy plant can provide heat, cooling, and power to entire neighborhoods or compact commercial areas. Individual buildings do not need to operate boilers and chillers, but instead tap into the hot and cold water provided by the district energy plant. The system is successful because of economies of scale. The plant delivers energy demands as needed, freeing individual buildings from the burden of supporting partial loads at off-peak times.
District energy also provides an opportunity to retain more energy per dollar spent than the traditional power plant/power grid interface. It has been estimated that with traditional systems, buildings have a 91% inefficiency rate due to power loss during delivery from plant to end user (Sisson 2013).

A key component of a DE system is the combined heat and power (CHP) plant. The energy source for the CHP plant is flexible. Many existing systems are moving away from the combustion of coal and gas and toward renewables like biomass (usually urban wood waste) and solar. Through the adoption of cleaner burning fuel sources, emissions are reduced without reduction in output. Emissions are inherently lower in a district energy system, as many individual systems operating independently will produce excess emissions as a byproduct of heat, cooling and power generation (Boston University 2010). Instead, one efficient plant can replace those systems and tailor its production to meet peak and off-peak demand.

One of the greatest immediate challenges facing Arlington is the fact that there are no local utilities to establish and operate a district energy system. However, there are examples of other municipalities in the United States that have faced this problem and responded to the challenge by establishing local utilities to manage their DE system.

In 1979, the company District Energy was created in St. Paul, Minnesota to provide thermal heat energy to a downtown section of the city. District Cooling St. Paul was formed in 1993 to provide cooling to the downtown region. Today 80 percent of the buildings in the core area receive heat from District Energy and 60 percent of buildings receive cooling services from District Cooling (District Energy St. Paul 2013b). Local customers include the State Capitol complex, commercial and office buildings, and residential buildings. The majority of District Energy’s output is produced from biomass in the form of urban waste wood. The wood is supplied by District Energy’s affiliate, Environmental Wood Supply (District Energy St. Paul 2013a). The St. Paul district energy system could serve as a model of how a DE utility was established and continues to operate today.

One square mile of downtown Seattle, Washington runs on thermal energy and steam provided by Seattle Steam, a private utility established in 1893. In 2009, Seattle Steam began construction on a new boiler plant. Upon completion, the district energy operations will run entirely on biomass in the form of clean urban waste wood (Seattle Office of Sustainability and Environment 2013). Customers of the district energy system include hospitals, museums and food plants that utilize the generated steam in their sterilization, humidity control and cooking processes in addition to energy.

Adoption of a district energy system requires a significant commitment from all parties. The establishment of a strong partnership between Arlington County, the specified users, and the managing utility will be necessary in order to solidify responsibilities of ownership and operations. Funding solutions have to be identified and secured; a plan that suggests a taxpayer-reliant system will meet
much more political and social opposition than a revenue or bond supported system. Commitment of the potential customers must be garnered, as incorporation into the system will require significant infrastructure improvements to individual properties and public land. Throughout the comprehensive process to win the support of all key stakeholders, risk management must be addressed. Every stakeholder will be concerned about the risk they will undertake in the short term and long term. A successful implementation plan will address those concerns and provide clear assurances to each stakeholder. A key component of a successful district energy system will be oversight. Establishment of an oversight committee will be necessary to ensure compliance with national, state and local regulations concerning operational safety, environmental sensitivity and permit acquisition and adherence. Oversight will fall to the local government at either the city or county level.

Short-term goals for an Arlington DE system could begin with a plan to conduct a feasibility study to identify one neighborhood to host a district energy plant from the two possible locations, Crystal City and Rosslyn. The ideal location will be determined based on current infrastructure, future development and compatibility of existing buildings with a district energy system.

The feasibility study could then be used to identify and acquire a location for the plant and determine the boundaries of the district. The location should be centralized within the district, with enough space to expand operations both in the total output capacity of the system and to construct future onsite structures on the site to deliver alternate fuel sources.

A partnership with an existing private utility to construct and manage the district energy combined heat and power plant should be pursued. An ideal partner is Dominion Power (Dom), which already provides power to most of the region. Arlington County can capitalize on Dom’s expertise and the company’s efforts become more sustainable. Dom already works to diversify its fuel sources with renewable products, reduce emissions and protect the environment (Dominion Power 2013). The company can maintain relationships with a current cluster of customers by developing a new method for power delivery to the district. Dom would also have the ability to integrate the district energy plant seamlessly into the existing grid while introducing district energy into new markets within its operations area. Dom’s reputation will benefit from spearheading a system that reduces emissions, conserves energy, and is less susceptible to damage from weather related events.

Other short-term DE goals include:

- Develop an implementation plan for the physical changeover of individual properties to district energy. Not all systems will be configured in a compatible manner.
• Start a dialogue with property owners to highlight the benefits of tapping into a district energy system, discuss potential fiscal incentives to participate, and approach the issue of risk management as the project moves forward.
• Begin negotiations with Dominion Power or a similar private entity willing to commit to the public/private partnership with Arlington County.
• Implement regulations and guarantee incentives to encourage developers to include piping infrastructure in their foundation construction.

Medium-term goals for the Arlington DE plan should start with finalizing and guaranteeing fiscal incentives for existing properties, both commercial and residential, to install the necessary infrastructure for connecting to the local district energy system. During this time, construction on the local CHP plant should begin, so that energy generation can occur well in advance of taking the DE system online. Also during this time, all properties that are going to be in the first group of DE-powered facilities should begin upgrading their internal power infrastructure to accommodate the new system. Also during this time, plans for a second CHP plant in Arlington County should be considered.

Long-term goals for the Arlington County DE system include taking the system online, measuring the DE system for efficiency, and continuing to look for alternative fuel sources. Plans for a second or third district energy plant should be underway, with the goal of connecting almost all of Arlington County to a district energy system.

Conclusion
Arlington County’s efforts to lead the way in climate mitigation will have a positive impact on the county moving toward 2050. Ultimately, climate related issues are not a standalone problem but weave into the fabric of the daily lives of Arlington residents, workforce, government and natural resources. While the Community Energy Plan represents a specialized plan to address climate threats, energy is a small part of the framework to make the greater comprehensive master plan for the county more sustainable for generations to come. The county may consider looking toward integrating energy and climate mitigation more fully into other issues which can bolster community resiliency; clean water supply, responsible and innovative waste management, low impact stormwater management, and open access to a healthy food chain. Additionally, climate adaptation (Appendix A) can provide a complimentary approach to energy and climate mitigation strategies in order to create a more prosperous, efficient and resilient Arlington.
References


Appendix A

Climate Adaptation in Arlington
Why is Climate Adaptation important to Arlington?

Climate adaptation is the process of preparing for and implementing actions in response to the effects of climate change. While climate mitigation strategies are designed to reduce human impact on climate change, climate adaptation strategies reduce or address potential future climate impacts on humans and the environment.


In June 2009, the U.S. Global Change Research Program issued a report summarizing the impacts of climate change on the United States (USGCRP 2009). The report included a summary of specific climate change impacts to southern U.S. states. The specific impacts identified are:

- Sea level rise and the likely increase in hurricane and storm intensity. Storm surge impacts will also increase.
- Water shortages, especially in high-demand areas.
- Air and water temperatures will increase and may cause heat-related stresses for people, plants and animals.
- Ecological disruptions such as wetland salinization and invasive species outbreaks.
- Quality of life will be affected by increasing water scarcity, heat stress, severe weather events and reduced availability of insurance for at-risk properties.

The Potomac River lies along Arlington’s northern and eastern boundaries. The Potomac River is a tidal river that is affected by tides, sea level, and storm surge. Therefore any increases in sea level and storm surge would have tremendous impact on Arlington’s low-lying areas. Given Arlington’s geographic location in the mid-Atlantic region of the United States, threats of severe storms and increased hurricane intensity also may have significant implications for Arlington’s resiliency to climate change impacts. It will also be important to assess Arlington’s current stormwater systems and ensure that stormwater infrastructure be upgraded where necessary to handle increased storm surge and runoff volumes.

Arlington, VA will also experience an increase in air and water temperatures, which will lead to significant ecosystem and human health impacts. Human health impacts include higher rates of vector-borne disease, stress from heat waves, and respiratory problems. Planning for these effects will help protect the young and elderly, those in high-density areas, homeless individuals and other underprivileged populations in Arlington. Water shortages in dense areas such as Arlington could also threaten the population and lead to weaknesses in the local economy.

As Arlington looks to implement their Comprehensive Plan, for which the Community Energy Plan (CEP) is a part, establishing some climate adaptation measures in addition to climate mitigation strategies will be essential for
maintaining Arlington as being a safe, healthy, prosperous, and stable community in which to live, work and play (Arlington 2011).

**What can be done?**

Vulnerability assessments will need to be conducted in Arlington in order to prioritize areas where damage may take place or any risks to natural system, human or economic well-being are likely. By conducting these assessments, it will be possible to prioritize planning actions and develop collaborative solutions between government, research universities, private industry, utilities and the public. Some possible response actions include engineered solutions, zoning changes, public health initiatives, and policy measures.

In light of the high population density of Arlington, it will be important to expand and diversify the water supply, improve monitoring of disease outbreaks, and strengthen access to emergency medical services. Arlington also is home to a large number of security organizations and businesses that depend on a stable electric energy supply. Measures to strengthen and stabilize the local energy grid include moving overhead power lines underground, and by the development of local, diversified fuel-source micro-grids through district energy (DE) systems. The Arlington CEP recommends the development of DE systems in Arlington from an energy efficiency perspective, but would also allow for increased energy security and resiliency for Arlington.

It will be important for Arlington to analyze flooding issues and conduct an inventory of built (roadways, bridges, utilities) resources. Identifying vulnerable areas will help establish where shoreline protection measures need to be implemented. Shoreline measures can include naturalizing the shoreline where possible, constructing seawalls and conducting dredging activities.

These are just a sampling of the climate adaptation measures that would allow Arlington to be a more resilient and secure community. The following table provides a set of detailed measures for Arlington County that will serve as guidelines for developing a climate adaptation plan.

**Table 1: Climate Change Impacts and Climate Adaptation Goals and Actions**

<table>
<thead>
<tr>
<th>Impact 1: Sea level rise and the likely increase in hurricane and storm intensity. Storm surge impacts will also increase.</th>
<th>Preparedness Action:</th>
</tr>
</thead>
</table>
| **Goal:** Reduce property damage from erosion, flooding events, sea level rise and high wind events | • Update Arlington’s flood management program to take into account anticipated rises in Potomac River levels and increased intensity of storm-related flooding  
• Move or demolish infrastructure in potentially hazardous areas  
• Change zoning to prohibit development in flood-prone areas  
• Implement building codes that require more flood-resistant structures in low-lying areas  
• Implement building design standards that are resistant to high-wind events  
• Identify areas that would allow overhead power lines to be moved underground |
<p>| Increase stormwater system capacity | • Establish long-term funding mechanisms such as |</p>
<table>
<thead>
<tr>
<th>Impact 2: Water shortages, especially in high-demand areas.</th>
<th>Preparedness Action:</th>
</tr>
</thead>
</table>
| **Goal:** Expand and diversify water supply | • Coordinate with regional water authorities on groundwater resources, surface water reservoirs, and water quality  
• Implement water reclamation techniques for any development or redevelopment projects |
| **Goal:** Reduce water demand and improve efficiency | • Modify building codes to require low flow plumbing fixtures and other water conservation measures  
• Provide financial incentives for efficient appliances  
• Promote best management practices for utilizing stormwater. This can include rain barrels, rain gardens, “water-wise” gardening and landscaping techniques  
• Provide incentives for individual water conservation measures  
• Develop community educational outreach programs for water conservation and efficiency  
• Educate businesses or other organizations that are high-volume water users about retrofits and upgrades to improve efficiency and conserve water |
| **Goal:** Increase drought preparedness | • Increase authority to implement seasonal water restrictions and other emergency measures when necessary  
• Update drought management plans |

<table>
<thead>
<tr>
<th>Impact 3: Air and water temperatures will increase and may cause heat-related stresses for people, plants and animals.</th>
<th>Preparedness Action:</th>
</tr>
</thead>
</table>
| **Goal:** Reduce impacts of extreme heat events | • Open cooling centers during extreme heat events  
• Increase use of shade trees to reduce temperatures in urban areas  
• Design and develop shaded parking lots  
• Enhance outreach on air quality hazards such as ozone pollution associated with high temperature days |
| **Goal:** Improve disease monitoring and protection measures | • Enhance monitoring for known and potential diseases moving into the area  
• Enhance mosquito control measures and be prepared to develop additional vector programs if necessary  
• Update community emergency planning for disease outbreaks and other community health threats |
| **Goal:** Design and reconstruct transportation infrastructure to handle changes in temperature more effectively | • Increase maintenance frequency of asphalt roads that may be adversely affected by extreme high temperatures  
• Utilize heat-tolerant materials for road and bridge surfaces where possible |

<table>
<thead>
<tr>
<th>Impact 4: Ecological disruptions such as wetland salinization and invasive species outbreaks.</th>
<th>Preparedness Action:</th>
</tr>
</thead>
</table>
| **Goal:** Reduce shore erosion | • Preserve ecological buffers to allow for inland beach migration  
• Enhance shoreline protection where shoreline retreat and accommodation are not possible |
Maintain or enhance shoreline habitat

- Preserve ecological buffers to allow for inland migration of wetlands, salt marshes and other shoreline habitats
- Preserve and enhance existing wetlands where possible

Protect and enhance existing terrestrial habitats

- Use landscaping best management practices, such as native plant species, rain gardens and encouraging the removal of invasive species
- Promote adopt-a-tree programs in urban areas
- Require that all urban landscaping consist of non-invasive, flood-and-drought-tolerant, 75% perennial native plants

Impact 5: Quality of life will be affected by increasing water scarcity, heat stress, severe weather events and reduced availability of insurance for at-risk properties.

Goal: Increase preparedness and ability to respond to potential adverse climate change conditions

| Preparedness Action: | Expand Arlington County emergency plans to consider climate change related emergencies such as water supply disruptions, food supply disruptions, severe drought, loss of electricity, damage or contamination of water supply systems, disease outbreaks and other public health issues. | Identify and conduct outreach on evacuation routes and emergency transport networks. | Ensure that emergency centers have renewable back-up sources of energy. | Conduct outreach and public education about the health risks and need for emergency preparedness for climate change impacts. |

*Modified from Source: Alexandria 2011

Where do we go from here?

Development of a climate adaptation strategy for Arlington County will require collaboration and cooperation from various stakeholders, including government, private sector, nonprofit and the public. In order put these strategies and response actions in place, Arlington County will need to establish implementation timelines and establish short, medium and long-term goals for climate adaptation measures. This approach can be similar to what is being proposed for the Arlington CEP in the main document that accompanies this appendix. Additionally, Arlington should set up an evaluation mechanism that assesses the success of any implemented measures and progress against the implementation timeline. These evaluation mechanisms will allow planners to respond to dynamic financial and political situations while allowing for faster progress in achieving climate adaptation goals. Establishing mechanisms will also allow for transparent reporting to the community and other stakeholders on the implementation progress. With careful planning, collaboration and willingness to respond to changing climate conditions, Arlington County can remain a secure, safe, prosperous and resilient community that is prepared to face future climate challenges.
References


Appendix B

Cutting Edge Technologies
<table>
<thead>
<tr>
<th>Technology</th>
<th>Description</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Example(s)</th>
</tr>
</thead>
</table>
| Pedestrian Power                                    | Flooring system that converts energy from human foot traffic into electricity. The system uses piezoelectric technology to measure pressure, acceleration, and force from footsteps and converts it into an electrical signal. | - Generates about 1-5 watt/sec/sqft of electricity with pedestrian traffic (about 10W/sec/sqft if used on a dance floor).  
- Can produce considerable amounts of energy in high traffic areas. | - Not yet cost effective at $100-$200/sqft  
- Could get worn out quickly and need replacing | Energy Floors  
POWERleap |
| Nanotechnology Building Envelopes                   | Insulation that is a nanotechnology coating that can be painted onto buildings. | - Greatly reduces heat transfer to keep buildings cooler in summer and warmer in winter. Can be painted onto windows so heat isn’t transferred through windows and allows for daylighting.  
- Qualify for a number of LEED point categories | - Exposure to nanoparticles could lead to adverse health effects | Nansulate® coatings  
Thermilate |
| Energy Harvesting Trees                             | Artificial trees that harvest solar and wind energy. The “nanoleaves” are made of thermo- and photovoltaic cells to harvest the sun's energy and infrared radiation into electricity. The petioles (where leaf connects to branch) are made of nanopiezovoltaics to generate electricity from the movements caused by wind or rain. | - Electricity generated in an aesthetically pleasing way  
- Broadleaf trees provide: 33500 kWh-7000kWh per year  
- Ever green trees provide between 2500kWh and 7000kWh per year  
- Treepods use solar energy to clean the air of CO₂ and provide light at night | - Expensive – A tree with a 20-ft diameter canopy could cost $12,000-$20,000 and produce about 120,000 kW hours over a 20-year life span. That would equal 13.5 cents/kW hr which is not competitive enough (most power averages at 5 cents/kW hr)  
- Not sure how they will hold up during storms or with snow loading. | SolarBotanic Treepods |
| Rain Droplets Harnessing Energy                     | Energy harvested from raindrops hitting piezoelectric surfaces               | - Great in areas that get little wind or sun, or in conjunction with solar and wind harvesting | - Doesn’t produce much energy yet (1 square meter of surface can produce 1 watt-hour/year) | CEA/Leti-Minatec |
| Playgrounds as Energy Producer (Harnessing People Power) | Creates energy through playing on swings, merry-go-rounds, spinning seats, skipping ropes, seesaws, and roundabouts. | - Can be used in a variety of settings, such as music festivals  
- Teaches kids about renewable energy | - Isn’t reliably renewable since it requires human effort | Kinetic Energy Playground |
Appendix B: Sources


Appendix C

Scenario 2050: The Powering of Arlington
The year is 2050. My assignment is to find out what happened to make Arlington County the most energy efficient municipality in the United States . . . and discover why property values have skyrocketed when other coastal cities seem to be crumbling under their own weight. The approach to Arlington by air along the Potomac River presents a mix of wooded spaces, single homes, common areas, and highly developed “urban corridors” characterized by high-rise buildings, public transit networks, and rooftop solar collectors.

Disembarking from the plane, I forego the autonomous electric taxi and hop onto the Metro for my friend Rich’s place in Clarendon. He lives in an established suburban neighborhood where trees keep the street shady and cool. The GPS-assisted Bikeshare bike guides me through back streets from the Metro stop to my destination. The aesthetic “village” atmosphere blends with state-of-the-art energy-saving retrofits for single homes from vehicle charging stations on the street to solar water heaters, photovoltaic siding, active-LED windows, and speed bumps that generate electric energy. A “Village Post Office” is within walking distance of Rich’s house. Secure mail boxes (refrigerated with a hybrid solar and geothermal heat pump) enables efficient delivery of everything from fresh produce from regional farms to home supplies and designer clothing ordered online.

Walking toward Glebe Road, high-rise condominiums and apartments rise in close proximity to commercial buildings, retail outlets, restaurants, hotels, and public transport. Pedestrians feed energy to the grid through the pressure-sensitive sidewalk (the “Jump for Arlington” program) and electric vehicles can be checked out by the hour for a fixed fee when needed. Buildings in the Clarendon corridor are all connected to a District Energy system that powers the county and “waste” energy provides heating and cooling for energy-intensive areas that utilize 4-pipe distribution systems. This has reduced energy consumption in Arlington by 70% compared to 2012 levels. Furthermore, in spite of extreme weather, flooding, and temporary outages from falling trees, the electricity micro-grid provides a secure source of energy for residents, businesses, and public services through redundant underground backup systems.

All of this didn’t happen by itself. I look forward to my appointment at Virginia Tech’s Center for Leadership in Global Sustainability. Three elder community members await my arrival . . . their gray hair contrasts with the sparkle and passion in their eyes. They reflect on their early years when business interests seemed at odds with community interests and when environmental protection was eclipsed by political intrigue and short-term economic gains. Even the political environment in 2012 under the Virginia Dillon Law allowed only limited autonomy from the state to pursue municipal energy development goals.

The emeritus leaders whom I met praised a new generation of entrepreneurs who developed the “Arlington Brand” that now drives a continuous improvement process in the energy sector. They described how the community started with public transit improvement efforts, green building initiatives, school improvements, and home energy saving retrofits. It was only 35 years ago that a small group of county officials, business leaders, civic groups, and community members banded together to define a vision for Arlington’s Community Energy Plan (CEP). This plan
empowered the community to define its own energy future, in spite of volatile political, economic, and natural resource challenges. And that was only the beginning.
Other plans followed as new leaders adapted to new challenges and embodied the same collaborative spirit displayed by their mentors. These plans included adaptation to changing climatic conditions that affect the power grid including Potomac flooding, severe storms, and vulnerability to electric power outages. Collectively the new leaders demonstrated a collaborative approach that allowed them to 1) define a common **direction** for Arlington, 2) **align** community members to achieve their energy goals and 3) secure long-term **commitment** from key stakeholders to make it happen.

The final lessons that the leaders shared with me are deceptively simple:
- Get involved in the community to leverage your personal experience and skills
- Engage diverse groups so you can discover their interests and tap into their strengths
- Build up institutional and leadership capacity within the community
- Ask difficult questions about the energy future and the lifestyle that you value
- Learn the languages of business, politics, science and environment and become an interpreter when necessary to bridge differences in understanding
- Keep learning and growing through observation, reflection, and action
- Be persistent. Never give up.
- Be passionate and share that passion with others.

As my plane took off, I glanced west over Rosslyn with Clarendon in the distance. While others noticed the glittering lights and gleaming buildings, I saw people helping each other to help themselves.
Appendix D

Abbreviations and acronyms
BIPV  Building Integrated Photovoltaics
CCP  County Comprehensive Plan
CEIF  Community Energy Implementation Framework
CEP  Community Energy Plan
CHP  Combined Heat & Power Plant
CO₂  Carbon Dioxide
CO₂e  Carbon Dioxide Equivalents
DE  District Energy
DOM  Dominion Power
LEED  Leadership in Energy and Environmental Design
MT  Metric Ton
MTP  Master Transportation Plan
MW  Megawatt
PACE  Property-Assessed Clean Energy Financing
PPA  Power Purchase Agreements
RPS  Renewable Portfolio Standard
TP  Transportation Plan