apCAP:

A Climate Action Plan for Robert Allerton Park and Conference Center at the University of Illinois at Urbana-Champaign

V 2 Oct 2013
Executive Summary

In 2008, the University of Illinois at Urbana-Champaign signed the American College & University Presidents’ Climate Commitment. This action committed the campus to carbon neutrality by the year 2050. It also lead to the development of the Illinois Climate Action Plan (iCAP), a detailed plan that lays out strategies for achieving the 2050 commitment. Inspired by this pledge and as a part of the iCAP, Allerton Park has created the following Allerton Park Climate Action Plan (apCAP). This Plan is created to assist in meeting the University’s iCAP climate commitments by describing the Park’s role in the path toward carbon neutrality on a localized scale. As a leading entity in campus environmental conservation and sustainability and a valued asset within the state of Illinois, the Park plays an important role as a model for the campus community, state conservation areas, and historic properties. This Plan represents a roadmap for a climate neutral future at Allerton, it outlines strategies, initiatives, and targets toward meeting the goal of carbon neutrality by 2035.

apCAP

A vibrant teaching, recreational, and natural areas sanctuary for nearly 100,000 visitors each year, Allerton Park is a unique cultural and environmental asset for the University of Illinois. It serves as a bridge between the public, resource conversation, and the educational and research resources of the University. It also provides a learning laboratory for the demonstration of sustainable technologies to educate and prepare individuals with skills required to tackle the challenges of a sustainable society – as envisioned by the University of Illinois’ Strategic Plan. The Campus Strategic Plan also commits the campus to “… carefully stewarding and enhancing the resources entrusted to the institution.” The Allerton Park Climate Action Plan (apCAP) is one step in the journey toward accomplishing that goal. And as statewide asset, it is hoped that this plan can become a model for similar assets (State Parks, etc.) across the state as it grapples with the realities of climate change and awareness.

The majority of emissions attributable to Allerton Park are connected to its mission as an open and accessible natural area and garden; about 75% the direct result of visitor travel related emissions. The remaining emissions are a result of the need to heat, cool, and operate park buildings, on-site vehicle use, and waste management. Of these, purchased electricity dominates emissions sources (60% of non-visitor travel emissions).

Allerton strives to significantly reduce emissions from transportation by encouraging alternative modes of commuting to the Park, exploring movement and parking patterns, encouraging telecommuting when applicable and improving bicycling infrastructure. This Plan calls for: aggressive energy conservation and green standards for any new or renovation projects; a move toward electrified, high efficient, geothermal building heating and cooling systems; and the installation of an Allerton Park Renewable Energy Farm. The apCAP also calls for increased recycling, sustainable conservation practices, and setting up local food and composting systems, water conservation, and a local carbon registry to take advantage of the Parks natural assets. The cumulative effect of this conserve (everything) and load (with renewables) philosophy will bring Allerton to a net zero energy and emissions status before 2035.
The primary goals this Plan are:

- Attain carbon neutrality and energy independence by 2035; and
- Establish education and outreach programs to convey these efforts to a broader public.

Approach

This Plan promotes a 3-step process that includes a combination of energy conservation, changes in energy supply, and renewable energy generation strategies to achieve carbon neutrality and energy independence.

- First, reduce Allerton Park’s energy footprint. Energy conservation is the most economic and cost effective strategy available. Building, transportation, service & operations, and waste energy systems are considered. The energy conservation goal is more than 30% by 2035 with most of the strategic implementations occurring before 2020.
- Next transition off fossilized energy supply systems (coal specifically) – sooner, and on-site natural gas (later in the process), by moving to highly efficient electrified systems (such as geothermal). This transition will reduce more than 30% of on site emissions by 2035. Most of this transition is planned to be in place before 2025.
- Work with partners to develop on-site renewable energy generation systems that incorporate a diverse range of renewable energy sources such as wind, biomass, and solar. Use on-site renewables to eliminate all remaining emissions by the end of the planning period (2035).

Commitments

Building Energy. Allerton Park will re-evaluate and re-commission its building stock to improve energy efficiency. The goal is a 30 percent reduction in building energy usage by 2020. All new construction and major renovation projects will be required to demonstrate a LEED Platinum standard and net-zero energy and carbon neutral commitment. Allerton Park will work to meet all its building heating and cooling demand with geothermal or other highly efficient electrified systems by 2035 (more than half by 2025).

Financing. Allerton will establish a dedicated funding pool for energy conservation projects within the next three years. This “clean energy” fund will allow for both internal (visitor fees, contributions, energy savings reinvestment, capital programs, etc.), and external (programs, rebates, donations, outside investors) participation. It will be established as a capital infusion and coordination mechanism aimed at physical energy and energy cost reductions that also allows for the sustained maintenance of these investments.

Operations. The goal is a more than 35 percent reduction in operations energy use by 2025. This is accomplished mainly through facility refrigerant management, kitchen operations and appliances, and cleaning approaches.

Park Lands and Gardens. Allerton will develop (2014) a sustainable landscape and garden maintenance plan (Grounds and Gardens) applicable to all areas controlled by the Park. It will implement a pilot
program by 2015. The goal is to increase xeriscaped, no-mow, and no-tree removal zones, to promote native prairie and river bottom habitat reclamation, reduce harmful chemical use and encourage carbon sequestration and other ecological benefits.

**Renewable Energy.** Allerton will exceed the State of Illinois Renewable Portfolio Standards (ILRPS) by supplying at least 5 percent of all its electrical energy needs through renewable energy generation systems by 2015 and 100 percent by 2035. At least one utility scale wind turbine will be installed by fiscal year 2020.

**Procurement, Food, and Waste.** Allerton will implement full-cost accounting and life-cycle analysis structures on all park purchases in fiscal year 2014. The park will also exceed the state local food procurement standards by making more than 30 percent of food purchases from local sources (within 100 miles) by 2015. Allerton will commit to a Net-Zero Waste facility policy by 2014, a large-scale food composting project by 2015, and target an increase in the facility’s waste diversion rate to 75 percent by 2025. By 2020 the park should eliminate 90 percent of its solid waste emissions and 77 percent of its wastewater emissions.

**Transportation.** Visitor commuting (external transportation) is by far the Park’s largest source of emissions, comprising 73% of total emissions in 2011 and contributing an estimated 1,300 metric tons of CO2e gasses to the atmosphere. As a result, Allerton will develop (by 2014) and implement (by 2015) a transportation plan, which takes into account incentives for carpooling, transit services, and biking. The goals are a 10 percent reduction in external and more than 70 percent for internal transportation (staff commuting, service operations, and freight), both by 2020.

**Water.** Allerton will ramp up water conservation efforts, with a potable water reduction target of 20 percent by 2015.

**Outreach and Follow Through.** Allerton will assign specific individuals the task of implementing the commitments and strategies outlined in this plan. Allerton will integrate an annual review process that will track progress related to each commitment. Allerton will also engage the staff, administrators, and board members along with the general University Community (students, faculty, and staff), Park volunteers, and the surrounding community in the creation, data collection, analysis, and progress review process for implementing this plan. The progress of the Plan will be monitored and publicized.

**Educational and Research Opportunities**

All the strategies, inventories, and initiatives outlined and detailed in the following plan represent educational and research opportunities for the University of Illinois and the surrounding area on the topics of environmental sustainability and energy efficiency. The Park holds many assets of value for both short and long term study. Its remote location and potential for on-site living arrangements give it the potential to become a valued living, learning laboratory and study site for assessing the relationship between food, water, energy, material goods, buildings and general human societies and ecosystems and ecosystem services.
Next Steps

This Plan provides a framework for action and a structure for which more detailed analysis, dialogue, and refinement can (and should) take place. It is intended to provide a carbon neutral vision for the Allerton facility with stretch goals and specific strategies for their achievement. More detailed plans and micro-level implementation strategies will develop and evolve in the coming months and years. It is hoped that over time, the apCAP and what it represents, becomes endemic to Park operations, purchasing, capital improvements, and general approach to decision making.
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1. Introduction

Allerton Park is a 1,517-acre (614 ha) park, nature center, and conference center located on the upper Sangamon River in rural Piatt County near Monticello, Illinois. The Park, house, and farms were donated to the University of Illinois in 1946 by Robert and John Gregg Allerton. The Allerton Natural Area within the park is a National Natural Landmark.

A vibrant teaching, recreational, and natural areas sanctuary for nearly 100,000 visitors each year, Allerton Park is a unique cultural and environmental asset for the University of Illinois. It serves as a bridge between the public, resource conversation, and the educational and research resources of the University. It also provides a learning laboratory for the demonstration of sustainable technologies to educate and prepare individuals with skills required to tackle the challenges of a sustainable society.

Figure 1. Allerton Land Use Map

Allerton Park has a long history of leadership in conservation activities and sustainable practices. Its core mission is described as helping people to experience and engage natural systems.

One of Allerton Park’s defining ecological characteristics is its location along the largely riparian terrain of the Sangamon River (figure 1). Riparian ecosystems are naturally resilient, provide linear habitat...
connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change. Because riparian systems and the projected impacts of climate change are highly variable geographically, there is a pressing need to develop a place-based understanding of climate change threats to riparian ecosystems. It is important to consider how land use actions may be modified to enhance the resilience and decrease vulnerability of riparian ecosystems to climate change. Such modifications may include accelerating land restoration, making innovative water management decisions, and putting the emerging field of restoration genetics into practice. The implementation of a land management plan would provide a pilot research opportunity in Illinois. It is rare that the effects of the restoration and reconstruction of a landscape can be investigated with the wealth of background data that currently exists for Allerton Park.

In terms of energy systems, in 2005 it purchased a wood-fueled boiler system to heat park maintenance facilities, taking advantage of deadfall and other extraneous biomass. Since then, there have been significant energy conservation upgrades made to the Allerton mansion (the Park’s largest energy-consuming structure) with an overall improvement of more than 60% in efficiency savings. An additional wood burner was purchased in 2009, and in 2011, a geothermal heating and cooling system was installed in the Evergreen Lodge - formerly supplied by an electric heating system. Through these gradual yet consistent changes in energy efficiency and infrastructure, Allerton hopes to educate and inform both visitors and staff on the Park’s progress toward alternative, sustainable energy sources while maintaining a strong focus on carbon neutrality by 2035.

The apCAP is organized into 6 substantive sections. Following the Introduction, the Allerton Carbon Emissions Inventory (Section 2) calculates green-house-gas (GHG) emissions for the baseline (2011)\(^1\) year and projects future emissions to 2035. Section 3, Pathway to Neutrality and Independence outlines the broad approach of the plan; Section 4, Goals and Strategies details specific goals and strategies needed in order to reach carbon neutrality and energy independence. It describes 4 major component areas and their relevant strategies: buildings, transportation, operations, and waste. The results of implementing these strategies are outlined in Section 5, Summary Results. This both summarizes the detailed descriptions in Section 4 and demonstrates how Allerton can achieve the desired 2050 goal of carbon neutrality. Section 6, Appendices, contains much of the background information, references, and parallel information needed to complete the document.

### 1.1 Process

The process for building the apCAP starts with the release of a draft plan. This provides the basis for both internal and external discussion and where challenges to the plan can be aired. It is followed by an internal review process where the challenges can be addressed more directly by key Park administrators and staff. Once the review has been completed, another version of the draft will be circulated for refinement and potential adoption.

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\(^1\) 2011 represents the most accurate (relevant to current conditions) and economically feasible date to gather relevant emissions data for the facility
The hope is that the adopted becomes the basis for future analysis, discussion, scholarship, and research. Allerton Park also encourages neighboring communities to engage in the climate action planning process and together produce a more robust and communicative agenda for mitigating emissions at a regional scale.

2. Allerton Carbon Emissions Inventory

2.1 Inventory of Current Emissions

Based on data collected at the Park, total emissions attributable to the Park is 1,910 MTCO2e (million metric tons of carbon dioxide equivalent). 1321 MTCO2e, or 75 percent of this total are the result of transportation based emissions, a large portion of which (73%) of which are the product of visitor based transit emissions. Minimally occupied vehicles driven (an average round trip distance of Champaign-Urbana is used) are estimated to be the leading contributor to this total. The remaining 589 MTCO2e can be assigned directly to park facilities and operations and is the basis of this plan (figures 2 and 3). These emissions are driven in large part by the buildings in use at the Park (406 MTCO2e, or 69% of these emissions).

<table>
<thead>
<tr>
<th>Emissions by Sector</th>
<th>MT CO2e</th>
<th>MT CO2e (Other)</th>
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<tr>
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<td></td>
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<tr>
<td>Transportation</td>
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<tr>
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<tr>
<td>Internal Transportation</td>
<td></td>
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<td>Services &amp; Operations</td>
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<td></td>
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<tr>
<td>Waste</td>
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<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>589</td>
<td>1,321</td>
</tr>
</tbody>
</table>

Figure 2. Allerton emissions by Sector.
Figure 3. Total Emissions (right), are based in large part on External Transportation issues and are handled as a separate portion of this plan. All other emissions (left) begin the basis for mitigation and conservation efforts described below.

Figure 3 below describes Allerton Park Park’s current GHG emissions. Emissions generated by energy production used in heating, cooling, and generating electricity for buildings are the main contributor to on-site Allerton GHG emissions. The primary source of emissions in this category is purchased electricity from the Ameren Illinois, which produces 75 percent of its electricity by means of coal-fired power plants. This electricity is currently used on-site to service buildings and to power the Park’s fleet of electric service vehicles. Natural gas (also purchased from Ameren) plus gasoline and diesel fuel purchased from other sources are also responsible for a large portion of Allerton GHG emissions. These primary emission contributors account for more than 85 percent of Park GHG emissions and need to be targeted aggressively in order to achieve carbon neutrality goals.

Refrigerant emissions at Allerton have been found to be significant as a result of the facility’s usage of older equipment that uses R-22 – notoriously one of the most environmentally damaging refrigerants. And since Allerton is a major water user and waste water generator, the significance of indirect GHG emissions associated with water use is an important component, as the Allerton water system is facility-owned and operated and conservation savings will directly impact the Park.
2.2 A Projection of Future Carbon Emissions

Allerton carbon emissions have stabilized somewhat over the past decade as a result of a handful of significant, localized conservation efforts throughout the Park. Nonetheless, this projection, which is based upon past performance, also indicates the still-present critical need to continue significant decreases in emissions in order to reach carbon neutrality. As described above, Allerton purchased electricity has a profound impact on emissions. However, one difficulty in assessing this trend-based projection is that energy consumption alone does not tell a complete story. In fact, even though a reduction in energy use would have a positive effect on emissions, because natural gas produces about half as much CO₂ (per energy output) as coal (purchased electricity’s primary source), actions such as adjustments in the Park’s source energy production fuel mix could easily overshadow these energy reduction effects.

Allerton has already shown that it is capable of successfully taking on the energy problem, achieving a 70 percent reduction in annual heat-related energy consumption since 2008 as a result of the installation of a new modulating boiler system in the Robert Allerton mansion - the Park’s primary consumer of energy and producer of emissions. However, heating and cooling of facility buildings remains a central focus. Allerton currently maintains eight climate-controlled administrative buildings as well as four tenant-occupied houses. These structures each possess their own individual heating and cooling systems which vary widely, some of which include wood or natural gas boiler systems, air conditioning units, and a geothermal heating and cooling system. Identifying and securing efficient, renewable, and clean energy resources for heating and cooling of buildings stands to produce the largest reduction in Park emissions of any singular activity while reducing the facility’s dependence on purchased electricity stemming from coal-based production.
A projection of current carbon emissions from 2005 to 2035 is used as the basis for discerning potential future strategies for mitigation (figure 5).

![Annual Carbon Emissions: 2004 - 2035](image)

**Figure 5.** Allerton annual carbon emissions from fiscal year 2005 through fiscal year 2011 with projections to 2035

### 3. A Pathway to Neutrality and Independence

This Plan promotes a 3-step process (figure 6) that includes a combination of energy conservation, changes in energy supply, and renewable energy generation strategies (figure 7) to achieve carbon neutrality and energy independence (figure 8 integrated approach).

- **First,** reduce Allerton Park’s energy footprint. Energy conservation is the most economic and cost effective strategy available. Building, transportation, service & operations, and waste energy systems are considered. The energy conservation goal is more than 31% by 2035 with most of the strategic implementations occurring before 2020.

- **Next** transition off fossilized energy supply systems (coal specifically) – sooner, and on-site natural gas (later in the process), by moving to highly efficient electrified systems (such as geothermal). This transition will reduce more than 35% of on site emissions by 2035. Most of this transition is planned to be in place before 2025.

- **The final 34%** of the emissions will be eliminated by on-site renewables (by 2035). This third transitions non-renewable source electricity to on-site renewable electricity generation.
Figure 6. The path toward carbon neutrality and energy independence for Allerton Park follows three basic transitory steps.

Electricity Consumption (kWh) by Source

Figure 7. A transition path away from carbonized fuel sources and toward energy independence for Allerton Park.
Figure 8. The final mitigation wedge for the Allerton Climate Action Plan outlines a strategy for climate neutrality and energy independence by the year 2035.

4A. Goals and Strategies – Energy Use Conservation

Based on the above pathway, the following are the specific targets and scenario strategies that will enable Allerton to satisfy its commitments and reach the stated 2035 goal of carbon neutrality and energy independence. The first section here is about energy conservation. Allerton Park aims to reduce 30 percent of its energy use from 2011, and most of the strategies will be implemented by 2020.

Methodology

Emissions are inventoried by relevant energy sectors. The sectors analyzed are:

- **Transportation.** External Transportation: Visitor trips and staff commuting.\(^2\) Internal Transportation: Transport for staff, workers, and (occasionally) guests inside of the Park.
- **Buildings.** All on-site building operations.
- **Services and Operations.** Services provided to visitors and guests + maintenance of formal gardens, natural areas, buildings, and landscaping.
- **Waste.** Solid waste (trash) + pumping and treatment of the Park’s domestic water supply.
- **Water.** Water consumption and its associated energy use in Allerton Park.
- **Other.** Space and growth management; Landscape restoration and adaptation.

\(^2\) External transportation emissions represents a larger scoping issue and is treated externally to the main part of the plan.
For the first four sectors (which have significant and quantifiable associated emissions), historical trends from 2005 to 2012 with projections to 2035 are evaluated. Sectors are further subdivided by relevant sourcing categories for tracking purposes.

For the purposes of tracking and the articulation of a coherent plan of action, the sectors and subsectors are based on the above and are as follows:

**Transportation:**
- External (Including visitor transportation and staff commuting)
- Internal (including gas-powered vehicles, diesel vehicles and electric vehicles)

**Buildings:**
- Building Electricity (including cooling, lighting, computer & electronics, electric hot water, and guesthouse room appliances)
- Building Natural Gas (including building heating and water heating)
- Building Refrigerants

**Service & Operations:**
- S&O Electricity (including refrigeration, kitchen operations, cleaning, and other maintenances)
- Gas-Powered Equipment
- S&O Diesel

**Waste**
- Solid Waste
- Wastewater

**Water**

**Other Emission Reduction Strategies**
- Space Growth and Management
- Landscape Restoration
- Landscape Adaptation

### 4.1 Transportation

Allerton Park is unique in the sense that it is not centrally located within a city or near the main University campus. This challenges the facility to search for creative and innovative solutions with regard to sustainable transportation alternatives. Emissions generated from external transportation account for 73 percent of the total scope 3 emissions linked to Allerton Park. This largely includes commuting from outside the Park for both visitors and workers (73 percent). Internal transportation accounts for 0.2 percent of the scope emission. These are fleet emissions generated on-site (1 percent).

The target for this section is to reduce total transportation emissions by at least 50 percent by 2025, and 73 percent of internal transportation by 2020. This aggressive target will require strategic thinking in all components of transportation-based emissions.
External Transportation

External transportation emissions are considered separately as a result of the magnitude and scope of its emissions and due to the nature of Allerton Park’s landscape and its ability to naturally ‘sequester’ potential emissions.

Approach to Considering External Transportation. The majority of emissions addressed by this Plan fall within Scopes 1 and 2. However, two Scope 3 emissions sources are discussed as well: 1) transmission losses from purchased electricity (calculated directly into purchased electricity costs); and 2) external transportation (i.e. visitor and staff commuting). 98 percent of external transportation associated with the Park pertains to visitor trips and is a significant source of emissions, accounting for 69 percent of total emissions - more than double the sum of all others.

While not being able to directly control external transportation choices, Allerton Park recognizes its critical role in promoting sustainable forms of transportation through the creation of infrastructure and on-site programs which encourage green alternatives. Although emissions and reduction strategies are presented in this category, external transportation is considered separately when addressing emissions totals on a larger scale and across sectors given the scope of the emissions.

What are Scope Emissions? According to the U.S. EPA, GHG emissions may be classified into three “scopes” based on emissions sources:

- **Scope 1**: Emissions from sources that are owned or controlled by an entity.
- **Scope 2**: Emissions resulting from the generation of electricity, heating and cooling, or steam generated off-site but purchased by an entity.
- **Scope 3**: Indirect GHG emissions from sources not owned or directly controlled by an entity but nonetheless related to the entity’s activities.

General approach to sequester external transportation emissions. Natural habitat areas at Allerton Park are one of the facility’s largest climate assets. The annual carbon sequestered by the areas 1,529 acres of mature woodland is matched here with the Park’s largest emissions source: transportation.

Carbon sequestration is the process through which land management practices absorb and sink carbon dioxide (CO2) from the atmosphere. Sequestration activities can affect climate change by enhancing carbon storage in trees and soils, preserving existing tree and soil carbon, and by reducing emissions of CO2, methane (CH4), and nitrous oxide (N2O).

The USDA estimates that mature woodlands in North America have the potential to sequester on average 0.71 metric tons of CO2 per year. This asset may be amplified in the future by setting priorities to further develop natural areas as well as encouraging regional connectivity with contiguous property owners.
Figure 8. The apCAP approach to external transportation emissions sequester. Left: Allerton External Transportation related carbon emissions in 2011. Right: Annual carbon sequestration potential from natural woodland habitat at Allerton Park.

Emission Breakdown.

External transportation GHG emissions are derived from one source: Gasoline consumption from automobiles. In 2011, external transportation produced a total of 1,321 metric tons of emissions while consuming 148,579 gallons of gasoline.

Figure 9. Total External Transportation Emissions over Time.
Visitor Transportation Emissions
Allerton Park welcomes over 100,000 visitors each year. Those visitors are mostly coming from miles away. Though the park is a property of University of Illinois, the distance between the University and the park is about 30 miles. Currently the two places are sparsely served by bus service, and people are coming to the park mainly by gas or diesel-powered personal vehicles. This part accounts for the single largest emissions of the Scope 3 emissions of Allerton.

Analysis Methods
- **Average Fuel Efficiency = 23.8 miles**: In 2009, the Bureau of Transportation Statistics estimated that light-duty vehicles in the U.S. averaged 23.8 mpg
- **Average Driving Distance = 52 miles**: 52 miles is the roundtrip distance from Champaign-Urbana to Allerton Park

**Visitor Trips = 66,704 in 2011**: Trips were calculated through the use of a simple traffic counter sensor
• **Gallons of Gasoline = (Driving Distance / Fuel Efficiency) x Trips:** Gallons of Gasoline were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator

How to Track Visitor Transportation Emissions:

• Take Average Distance=52 Miles (D)
• Use traffic sensor counts to get visitor trips (N)
• Take 0.009 MTCO2e/Gallon as emission factor (f) for gasoline or go to EPA site to get the newest emission factors: http://www.epa.gov/cleanenergy/energy-resources/calculator.html

**Formula:** Visitor Transportation Emissions (MTCO2e) = f*D*N/E

Reduction Targets

• 10 percent of 2011 levels from 1,300 (2011) to 1,170 (2018) MT CO2e

Strategies for Reduction

• **ETV1. Efficiency Incentives, 2018 (2 percent: 26 MT CO2e)**
  o Create GHG incentives for visiting cars based on their relative efficiencies (with any resultant revenue used to further reduce transportation emissions).

• **ETV2. Master Transportation Plan, 2017 (2 percent: 26 MT CO2e)**
  o Implement a Master Transportation Plan which takes into account incentives for carpooling, transit services, and biking.

• **ETV3. Bike Infrastructure, 2018 (4 percent: 52 MT CO2e)**
  o Construct bicycling infrastructure. This includes working with the surrounding area to improve bicycle feeder routes to the Park.

• **ETV4. Bike Sharing Program, 2018 (2 percent: 26 MT CO2e)**
  o Create a subsidized bike sharing program.

Successful transportation demand management programs incorporate incentives for commuters to switch from Single Occupancy Vehicles (SOVs) to active transportation modes. A reduction of SOVs driven to and within the Park, which translates into fewer vehicle miles traveled, is one metric for success in reducing transportation emissions. There are a number of opportunities that Allerton might undertake to affect this change. Options for vanpooling and carpooling along with incentives for their use should be implemented. A “Guaranteed Ride Home” in cases of emergency would help to alleviate the concerns of visitors with children and families that utilize these alternative commuting choices. It would be beneficial to conduct a revisioning of alternative transportation that would allow employees and visitors incentives for smart commuting. Various incentives will likely increase the success of these projects such as mandating parking near peripheral areas of the park for able-bodied people to encourage alternative means within the premises and offering preferred parking to car poolers or low emissions vehicles.
To address visitor commuting from a wide range of places, Allerton Park also needs regional planning effort to reduce visitor commuting emissions while welcoming increasing number of visitors. Allerton Park is currently in the midst of discussing regional transportation solutions with the Champaign County Rural Transit authority (CRIS). Through this dialogue, a regional transit plan will be formed which provides bus services to the area during peak visiting times. Likewise, in order to promote alternative means of regional transportation to the Park, Allerton plans to advertise the Zipcar service on its website. This is a membership-based car sharing program with high efficiency, hybrid cars available by the hour. Car sharing reduces trips and each car share vehicle is expected to take 15 personal vehicles off the road. There are currently 10 Zipcars in Champaign-Urbana with more than 500 members. Allerton Park will also offer employees sustainable transportation options for making off-site business trips to and from common destinations such as Monticello and Champaign-Urbana. In doing so, the Park will purchase one electric car by 2019.

The facility is also engaged in a dialogue with the University, the Champaign–Urbana Bike Project and campus Facilities and Services on how to implement a bike sharing program capable of supplying visitors with bicycles for transportation within and beyond the Park as well as providing a place, tools, and supplies for minor repairs of bicycles. Adequate access to bicycles for visitors and staff can help reduce the Park’s internal and external transportation footprint given several destination points which are not easily walkable such as the Allerton Mansion to the Sun Singer statue (2.5 miles round trip).

The Department of Urban and Regional Planning and the University has drafted a Bike Master Plan that should be approved and implemented. This Plan depicts proposed bike routes to be completed in phases over the coming years with the goal of promoting a safer and more attractive environment for pedestrian and cyclists. Proposed routes will also eventually be linked with the City of Monticello’s plan to extent a route out to the Park as well as Piatt County’s Heartland Pathways system to promote biking as a safe and efficient from of alternative transportation to and from the Park. A substantial increase in convenient and safe bicycle parking on-site would also encourage more biking from the surrounding area including Monticello.

Staff Commuting Annotations

Analysis Methods
The same methodology for calculating visitor transportation was applied to staff commuting—approximate driving distances were calculated using internal employee/journey-to-work data (Home City x Days Worked per Year).

How to Track Visitor Transportation Emissions:
- Get average mpg (E) for light-duty vehicles in the U.S. from the Bureau of Transportation Statistics’ spreadsheet:
- Using internal employee/journey-to-work data to get average staff commuting distance (D)
- Using internal employee/journey-to-work data to get number of staff trips (N)
• Take 0.009 MT CO2e/Gallon as emission factor (f) for gasoline or go to EPA site to get the newest emission factors: [http://www.epa.gov/cleanenergy/energy-resources/calculator.html](http://www.epa.gov/cleanenergy/energy-resources/calculator.html)

**Formula: Staff Transportation Emissions (MT CO2e) = f*D*N/E**

**Reduction Target:**
10 percent of 2011 levels from 21 (2011) to 19 (2018) MT CO2e

**Strategies for Reduction**

- **ETS1. Telecommuting, 2017 (3 percent: 0.63 MT CO2e)**
  - Explore possibilities for telecommuting

- **ETS2. Carpool Incentives, 2018 (7 percent: 1.5 MT CO2e)**
  - Develop an incentive program for employees who choose to carpool (eg. preferred parking spaces), 2018 (7 percent)

Flexible scheduling and/or telecommuting are options to reduce staff commuting emissions and have further prospects of reducing other associated emissions. Allerton recognizes that there are supervisors who are uncomfortable with the idea of telecommuting. It would be important to develop a program that provides training sessions for supervisors on how to effectively manage performance and productivity. It would also be best to have standard, objective criteria in place for supervisors to evaluate whether a telecommuting arrangement is a good fit for each position and each employee.

**External Transportation Summary**

External transportation associated emissions are huge and hard to deal with. The external transportation strategies are mostly behavior-related policies rather than investments, thus they don’t require much firsts cost and should be started as soon as is feasible, and therefore 2014 is the expected implementation date.

<table>
<thead>
<tr>
<th>Visitor Transportation Emissions: 1,300 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETV1. Efficiency Incentives</td>
<td>2</td>
<td>26</td>
<td>2018</td>
</tr>
<tr>
<td>ETV2. Master transportation plan</td>
<td>2</td>
<td>26</td>
<td>2017</td>
</tr>
<tr>
<td>ETV3. Bike infrastructure</td>
<td>4</td>
<td>52</td>
<td>2018</td>
</tr>
<tr>
<td>ETV4. Bike sharing program</td>
<td>2</td>
<td>26</td>
<td>2019</td>
</tr>
<tr>
<td>Overall</td>
<td>10</td>
<td>130</td>
<td>2018</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Staff Commuting Emissions: 21 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETS1. Consider telecommuting</td>
<td>3</td>
<td>0.6</td>
<td>2017</td>
</tr>
<tr>
<td>ETS2. Develop carpooling incentive</td>
<td>7</td>
<td>1.5</td>
<td>2019</td>
</tr>
<tr>
<td>Overall</td>
<td>10</td>
<td>2.1</td>
<td>2018</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total External Transportation Emissions 1,321 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>132</td>
<td>2018</td>
</tr>
</tbody>
</table>

**Priorities**

- **Master Transportation Plan:** The transportation plan for Allerton Park is currently underway and is to be finished in 2017.

- **Staff commuting strategies:** Staff commuting is the most manageable part among the external transportation and should be implemented before 2018.
• **Visitor transportation programs and initiatives**: Visitor transportation has a large potential for emission reduction. However, there are more uncertainties here and the bike infrastructure needs some initial costs. These strategies should be started early but actual implementation will be considered as a long-term process.

**Challenges**

Allerton Park has a limited control of external transportation sector overall, thus the strategies in sum can reduce very small share of the emissions. However, many behavior-related incentives have longer impacts and may bear larger potentials for the future.

**Mitigation Wedges for External Transportation**

![Graph showing mitigation wedges for external transportation]

**Internal Transportation**

On-site vehicles emit GHGs through the direct use of purchased electricity, gasoline, and diesel. Allerton Park currently own five gasoline-powered cars, one diesel powered cars and six electric vehicles. To affect a reduction in fleet emissions, Allerton should commit to purchasing only vehicles that are in the top fuel-efficient categories. Bio-diesel options should be enhanced. Electric vehicles for both external and internal use should also be considered as the Park moves toward renewable electricity generation. Charging stations for many vehicles would then be a more realistic venture. Likewise, support should be given to any alternative transportation project proposed in Piatt County which is linked to the Allerton facility or surrounding areas. The facility currently owns and operates six electric carts and the installation of a solar-powered charging station for these carts is completed in late 2013.

**Internal Transportation Emissions**
Emission Breakdown

Internal Transportation GHG Sources:

- Purchased Electricity (Ameren)
- Gasoline
- Diesel

How to Track Internal Emissions?

- Electric cars will be soon charged with solar panels, so their emissions can be assigned 0.
- Gasoline (G gallons) and Diesel (D gallons) consumption can be obtained from filling slips.
- According to EPA, gasoline emission factor (Fg) is 0.009 MTCO2/gallon; diesel emission factor (Fd) is 0.01 MTCO2/gallon.

Formula: Internal Transportation Emissions (MTCO2e) = Fg*G+Fd*D
Gas-Powered Vehicles

Analysis Method
Consumption data for gasoline-fueled internal vehicles was obtained through reviewing filling slips. These slips included information on vehicle type plus type and amount of fuel used. Gallons of fuel were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator. It produced a total of 5.9 metric tons of emissions in 2011 while consuming 662 gallons of gasoline. This represents a total of 69 percent of Internal Transportation sector emissions and 1 percent of all Park emissions.

On-Site Vehicles
- 5 gasoline-powered vehicles
- 1 diesel-powered vehicle
- 6 electric carts

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>MT CO2e</th>
<th>Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Dodge</td>
<td>4.70</td>
<td>529</td>
</tr>
<tr>
<td>Gator</td>
<td>1.00</td>
<td>113</td>
</tr>
<tr>
<td>Golf Cart</td>
<td>0.11</td>
<td>12</td>
</tr>
<tr>
<td>Blue Suburban</td>
<td>0.04</td>
<td>5</td>
</tr>
<tr>
<td>DNR ATV</td>
<td>0.03</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5.88</strong></td>
<td><strong>662</strong></td>
</tr>
</tbody>
</table>
Total 2011 Gasoline Usage = 662 gallons

Total Emissions = 5.9 Metric Tons of CO2 (*On-Site VMT unknown*)

Reduction Target
- 60 percent of 2011 levels from 5.9 (2011) to 2.4 (2020) MT CO2e

Strategies for Reductions:
- **General:** Increased Fuel Efficiency and Purchasing Standards
- **ITG1. Replace Green Dodge Pickup, 2018 (50 percent: 2.95 MT CO2e)**
  - Assess replacing Green Dodge pickup (55% of total S&O emissions) with a more fuel efficient alternative.
- **ITG2. Replace Gator, 2020 (10 percent: 0.59 MT CO2e)**
  - Assess replacing the Gator (consumes 45% of total on-site transportation gas) with a more fuel efficient alternative.

*Diesel Vehicles*

Analysis Method
Consumption data for a diesel-fueled internal vehicle (Kubota) was obtained through reviewing filling slips. These slips distinguished the vehicle type as well as the amount of fuel used. Gallons of diesel were then converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator. It produced a total of 0.6 metric tons of emissions in 2011 while consuming 52 gallons of diesel. This represents a total of 7.1 percent of Internal Transportation sector emissions and 0.1 percent of all Park emissions. Electrical demand at Allerton is categorized into only one subclasses: The Park’s Kubota (1 in total).

Reduction Target:
- 50 percent of 2011 levels from 0.63 (2011) to 0.32 (2018) MT CO2e.
Strategies for Reduction:

- **ITD1. Kubota Replacement, 2018 (50 percent: 0.32 MT CO2e).**
  - Assess replacing Kubota with a more fuel efficient alternative if possible.

**Electric Vehicles**

**Analysis Method**

Consumption was observed through utility metering of kilowatt hours (kWh) for the Park’s fleet of 6 electric carts. Kilowatt hours were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator. It produced a total of 2 metric tons of emissions in 2011 while consuming 2,075 kilowatt hours of electricity. This represents a total of 24 percent of Internal Transportation sector emissions and 0.3 percent of all Park emissions. Electrical demand at Allerton is categorized into only one subclasses: The Park’s electric cart fleet (6 in total).

**Reduction Target**

- 100 percent of 2011 levels from 2 (2011) to 0 MT CO2e.

**Strategies for Reduction:**

- **ITE1./RES5 Solar Charge Station, Ongoing (100 percent: 2 MT CO2e)**
  - Installation of a solar recharge station.

**Internal Transportation Summary**

The primary way to reduce internal transportation emissions is to replace existing vehicles to more fuel-efficient ones. This does not involve too many efforts but requires a significant investment. The suggested deadline for replacement of all existing vehicles are 2020 and new vehicles should meet or surpass EPA fuel economy standards by the time.

<table>
<thead>
<tr>
<th>Gas-Powered Vehicle Emissions: 6 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITG1. Replace Green Dodge pickup</td>
<td>50</td>
<td>3</td>
<td>2018</td>
</tr>
<tr>
<td>ITG2. Replace Gator</td>
<td>10</td>
<td>1</td>
<td>2020</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>67</strong></td>
<td><strong>4</strong></td>
<td><strong>2020</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electric Car Fleet Emissions: 2 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITE1. Solar charge station</td>
<td>100</td>
<td>2</td>
<td>Ongoing</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>100</strong></td>
<td><strong>2</strong></td>
<td><strong>Ongoing</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kudota (Diesel) Emissions: 0.63 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITD1. Kubota replacement</td>
<td>48</td>
<td>0.3</td>
<td>2018</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>48</strong></td>
<td><strong>0.3</strong></td>
<td><strong>2018</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Internal Transportation Emissions: 8.6 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>6</td>
<td>2020</td>
<td></td>
</tr>
</tbody>
</table>

**Priorities**

1. **Solar Charge Station.** A solar charge station for the electricity cart fleet in the park is already in plan and should be completed soon.

2. **Vehicle Replacement.**

**Challenges**
To completely eliminate internal transportation emission, vehicle replacement by EVs are necessary. However, this is not feasible in the short term. Another mitigation opportunity to look at is the biofuel mix required by Renewable Fuel Standard (RFS) and the park may consider to adopt more aggressive standards of biofuel (such as adoption of E85 when the market is dominated by E10).

*Mitigation Wedges for Internal Transportation*

![Graph showing mitigation wedges for internal transportation.]

4.2 Buildings

Allerton Park has in total 10 climate controlled buildings with a total footage of 51,273 sq.ft. Half of them are open to visitors. These buildings emit GHGs through the use of purchased electricity, natural gas, and refrigerants. They make up 69 percent of total Park emissions (excluding external transportation). The most significant is Allerton Mansion, which accounts for 63 percent of the total park building footage and 80 percent of the total emissions.

<table>
<thead>
<tr>
<th>Building</th>
<th>ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visitor Buildings</strong></td>
<td></td>
</tr>
<tr>
<td>Allerton Mansion</td>
<td>32,229</td>
</tr>
<tr>
<td>Gatehouse</td>
<td>2,208</td>
</tr>
<tr>
<td>House in the Woods</td>
<td>1,964</td>
</tr>
<tr>
<td>Visitors Center</td>
<td>1,900</td>
</tr>
<tr>
<td>Evergreen Lodge</td>
<td>1,860</td>
</tr>
<tr>
<td><strong>Regency Building</strong></td>
<td>1,600</td>
</tr>
<tr>
<td>Break Room</td>
<td>1,670</td>
</tr>
<tr>
<td>Shop / Shed</td>
<td>3,342</td>
</tr>
<tr>
<td>Garage</td>
<td>3,500</td>
</tr>
<tr>
<td>Shed</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Total Square Footage</strong></td>
<td>51,273</td>
</tr>
</tbody>
</table>
Total Building Sector Emissions

The emissions of building sector in Allerton Park saw a dip in 2011 because of the installation of new VAV system and boiler in Allerton Mansion. However, the extreme weather and increased usage in 2012 has triggered Allerton’s building energy usage to bounce back a little in 2012. We project that under the business as usual scanrio, climate change and increasing visitors of the park will drive up the total building emissions of the park. In 2035 the total CO2 emissions in Allerton Park will rise to about 800 MT CO2e, around twice of the current emissions.
**Building Energy Conservation**

Building energy conservation is considered the easiest and most cost-effective way to achieve reductions in GHG emissions. Opportunities for conservation at Allerton are great.

A recent evaluation of potential Energy Cost Reduction Measures (ECRMs) at Allerton was performed on-site with guidance from the Smart Energy Design Assistance Center (SEDAC) at the University of Illinois. Through this evaluation, conservation strategies were identified which will significantly reduce Park energy use. As a starting point, the Allerton will commit to carrying out all of the ECRMs as an extension of the Park’s evaluation. These measures will be translated uniquely to fit Allerton Park with a target date for completion of 2022.

The ECRMs for potential energy savings can be broken down into seven categories: lighting, envelope, retro-commissioning (RCx), information technology (IT), behavioral changes, other HVAC, and hot water.

**Lighting:** Allerton is in the process of retrofitting older incandescent and T12 fluorescent lighting fixtures by replacing them with more energy-efficient fixtures and electronic ballasts. A complete lighting retrofit would reduce energy consumption in the Allerton Mansion alone by ~20 percent; a very small amount of this is due to the use of occupancy sensors and day lighting controls. Extending this retrofit to smaller buildings, replacing other lighting fixtures (besides T-12s), and a wide deployment of both occupancy and daylight sensors (which can reduce lighting use by 20 percent to 80 percent depending on location) should be able to provide significantly more additional energy savings.

**Envelope:** The majority of envelope-related savings at Allerton are derived from window replacement and roof insulation, assuming that only 1 percent of energy used at Allerton can be saved by weatherization. Entry-way retrofits should also be considered to reduce heat loss during entry and exit as well as improvements in insulation in areas besides roofs. Additionally, savings related to chilled water may be realized through either weatherization or wall insulation. Likewise, decreasing heat gain through roofs due to improved reflectivity or vegetative roofs holds a relevant savings potential. Improvements to building envelope, weatherization, improving insulation levels in roofs and other areas, and tightening building infiltration and exfiltration is crucial in reducing facility energy use. Allerton’s target for envelopes is five percent.

**Building (Retro) Commissioning:** Commissioning for existing buildings (sometimes referred to as retro-commissioning or RCx) is a systematic process for investigating, analyzing, and optimizing the performance of building systems by improving their operation and maintenance to ensure their continued performance over time. This process helps make the building systems perform interactively to meet current facility requirements. On the main campus, University RCx teams have found a 29 percent average reduction in energy use and emissions for the 14 existing buildings (2,347,170 sq. ft.) they have examined. This success rate shows that there is enormous potential for this reduction strategy at Allerton.

On-site RCx activities may include: repairing and recalibrating sensors, valves and dampers, upgrading control systems, demand control ventilation, and implementing scheduling for air handling units, among others. The Allerton RCx program shall be augmented by several Energy Service Company (ESCO)
In order to achieve these targets, Park investment in energy conservation will need to increase above the Robert Allerton mansion since 2008 as a result of the installation of a new modulating boiler system. Taking on the energy problem, achieving a 70 percent reduction in heat-related energy consumption in the Robert Allerton mansion since 2008 as a result of the installation of a new modulating boiler system.

Information Technology (IT) and Electrical Equipment: A strong potential for savings may be realized from the purchase of ENERGY STAR® equipment such as computers and printers. Thin client computers being deployed today offer the potential for a 90 percent reduction in energy use compared to desktop computers. A broad deployment of low-energy computing equipment, server virtualization, consolidation of IT facilities (web servers, file servers, terminal servers) and reduction in the total number of server instances can all yield significant savings on both costs, equipment purchase expenses, and IT costs. Use of standards which are more aggressive than ENERGY STAR® for all equipment purchases (i.e. washers and dryers, refrigerators, etc.) can yield substantial additional savings. Likewise, decentralized IT systems result in a disparity of various technology practices. For example, many IT groups discourage users to enact computer power management settings or turn off their computers in the evening and the weekends to allow for security upgrades. However, technologies such as Wake or LAN can allow computers to be powered down and reactivated for upgrades.

Behavioral Changes and Incentives: Allerton believes a well-designed incentive and education program can reduce facility-wide energy consumption by at least 5 percent. Such a program should seek to ensure that cost savings from energy conservation measures benefit building users (e.g. “energy rebates” given to high-performing departments, or energy-driven reductions in overhead rates). In addition, adding real-time energy displays in buildings and via electronic media can help promote awareness and incentive for improvement. Many buildings have limited or no control over their thermostat settings. However, some workers that occupy these spaces do get a substantial influence in setting building temperatures and enacting more reasonable settings. This will require behavioral change from individual units and the building occupants.

Other HVAC: This category includes conversion from constant air volume reheat to variable air volume, eliminating summer steam usage (reheat), heat recovery, variable speed drives for fans and pumps, and steam system maintenance (including trap replacement and pipe insulation).

The Park also plans to institute temperature schedules by 2013, further reducing energy consumption. Following the Guidelines for Energy Conservation and Computing Equipment, developed by the Campus Information Technologies and Educational Services division, it is imperative to make sure all computers are turned off or are in a “power saving” mode when not in use. Units are also encouraged to purchase laptop computers, which draw significantly less amounts of power than desktop systems.

Evaluation. These targets will be constantly re-evaluated based on performance measures and changes in technology on at least an annual basis. Allerton has already shown that it is capable of successfully taking on the energy problem, achieving a 70 percent reduction in heat-related energy consumption in the Robert Allerton mansion since 2008 as a result of the installation of a new modulating boiler system. In order to achieve these targets, Park investment in energy conservation will need to increase above
current levels. Additionally, individual entities associated with the Park will need to be incentivized so that they seek to reduce their consumption, buy efficient equipment, and invest their own funds.

**Emissions form Allerton Buildings**

Building GHG Sources include:

- Purchased Electricity (Ameren)
- Purchased Natural Gas (Ameren)
- Refrigerants

![Emissions by Source over Time](image)

**Building Electricity**

**Analysis Method**

An energy audit, assisted by the Smart Energy Design Assistance Center (SEDAC), was conducted for all climate-controlled buildings at the Park. This included, among other things, quantifying electrical (kWh)
demand for Building subclasses. Kilowatt hours were converted to metric tons of CO2 using the Electricity Emission factor for Midwest ISO.

Building electrical systems produced a total of 248 metric tons of emissions in 2011 while consuming 298,161 kilowatt hours of electricity. This represents a total of 62 percent of Building sector emissions and 42 percent of all Park emissions. Electrical demand at Allerton is categorized into 5 subclasses:

1. Building Cooling and Heating
2. Computers and Electronics
3. Guest Room Appliances
4. Lighting
5. Electric Hot Water

Total 2011 Electricity Usage = 298,161 kWh

Total Emissions = 248 Metric Tons of CO2

Building Electricity Usage
As compared to most public buildings, building cooling accounts for a relatively large proportion of Allerton Park’s electricity usage. This is partly due to the old cooling systems and high leakage rate of the buildings. Also, it’s very inefficient to heat water with electricity, which accounts for 4% of the total electricity usage. Lighting is under retrofit process in the buildings across the park and we can see a diminishing proportion of lighting emissions.

How to Track Building Electricity Emissions:

- Read electricity (E) for buildings in Allerton Park in kWh from utility bills.
• Obtain up-to-date emission data (f in lb/MWh) for U of I from EPA site: http://cfpub.epa.gov/egridweb/view_egcl.cfm. If the newest data cannot be located, use f=1,150 lb/MWh
• Transfer f into MTCO2/kWh form by f (MT/kWh)=f (lb/MWh) * (1 MT/2,205 lb) * (1 MWh/1,000 kWh)=f (lb/MWh) / 2,205,000

**Formula: Building Electricity Emission (MT CO2e) = E (kWh)*f(lb/MWh)/2,205,000(MWh*MT/kWh/lb)**

**Building Electricity Emissions over Time**

![Graph of Building Electricity Emissions over Time](chart)

**Cooling and Heating**

**Method:** Electric heating and cooling was quantified by using the sum total of seasonal variations in building electrical usage above baseline levels (as exemplified within the bar chart below). This variation served to distinguish heating and cooling from regular building operations. Furthermore, heating and cooling categories were separated by observing heating and cooling degree days, indicating periods of relevant building heating and cooling by means of an ambient 65 degree baseline standard.
Allerton Mansion Electricity Usage: 4/10 through 8/12 (The Allerton Mansion is the Park’s largest electricity-consuming building): **246, 217 kWh in 2011**

Reduction Target:
- 17 percent of 2011 levels from 144 (2011) to 119 (2017) MT CO2e

Strategies for Reduction:
- **BCH1.** Install BAS, 2017 (6 percent: 11.5 MT CO2e)
  - Installation of a computer-based building automation system (BAS) that monitors and controls major building systems, including HVAC and lighting, 2015 (5 percent: 7.2 MT CO2e)
  - Training of relevant staff to use the system, analyze output, make necessary adjustments and identify investment opportunities, 2015 (1 percent: 1.4 MT CO2e)
- **BCH2.** Install variable speed drives, 2017 (2 percent: 2.9 MT CO2e)
- **BCH3.** Repair sensors, valves and dampers, 2016 (5 percent: 7.2 MT CO2e)
  - (Source: http://www.buildinggreen.com/auth/article.cfm/2010/9/29/Retrocommissioning-Big-Savings-for-Big-Buildings/)
- **BCH4.** Retrofit Envelope, 2017 (4 percent: 5.8 MT CO2e)
  - Roof and wall insulation, 2015 (1 percent: 1.4 MT CO2e)
  - Weatherization, 2015 (1 percent: 1.4 MT CO2e)
  - Entry-way retrofits, 2015 (1 percent: 1.4 MT CO2e)
  - Improved reflectivity or vegetative roofs, 2017 (1 percent: 1.4 MT CO2e)

**Lighting**
**Method:** Lighting was quantified by conducting a lighting inventory for all buildings and outdoor lighting combined with an occupancy/usage analysis.
• Lighting kWh = (Sum of Bulb Wattages / 1,000 kilowatt conversion) x Hours of Use

Reduction Target:
• 60 percent of 2011 levels from 74 (2011) to 30 (2015) MT CO2e

Strategies for Reduction
• **BL1. Replace incandescent bulbs and T12 fixtures, 2015 (50 percent: 37 MT CO2e)**
  o Replacement of all incandescent bulbs and T12 lighting fixtures with energy-efficient CFL bulbs and electronic ballasts, 2015
  o Source: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pg_w_code=LB
• **BL2. Install occupancy sensors and day-lighting controls, 2015 (10 percent: 7.4 MT CO2e)**
  o Installation of occupancy sensors and day lighting controls, 2015

**Computer & Electronics**
**Method:** Kilowatt Hours for Computers and Electronics were measured through the use of a watt meter for server systems and by observing electrical demand + hours of usage for computers and other electronic equipment

Reduction Target:
• 40 percent of 2011 levels from 12 (2011) to 7 (2015) MT CO2e

Strategies for Reduction
• **BCE1. Use more aggressive standard than ENERGY STAR, ongoing (15 percent: 1.8 MT CO2e)**
  o Use of more aggressive standards than ENERGY STAR® for all equipment purchases (i.e. washers and dryers, refrigerators, etc.), ongoing
  o (Source: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfolio_manager_intro)
• **BCE2. Usage of thin client computers, ongoing (10 percent: 1.2 MT CO2e)**
  o Usage of thin client computers (90 percent reduction in energy use compared to desktop computers), ongoing
• **BCE3. Deploy low-energy IT computing equipment, ongoing (10 percent: 1.2 MT CO2e)**
  o Broad deployment of low-energy computing equipment, server virtualization, consolidation of IT services (web servers, file servers, terminal servers) and reduction in the total number of server instances, ongoing
• **BCE4. Implement Wake or LAN Technology, 2015 (5 percent: 0.6 MT CO2e)**
  o Implementation of technologies such as Wake or LAN (33 percent annual savings) that allow computers to be powered down and reactivated for upgrades, 2015
  o (Source: http://www.1e.com/it-efficiency/software/wakeup-wake-on-lan/)
**Electric Hot Water**

This category includes using instantaneous and semi-instantaneous hot water heaters, increasing insulation on hot water tanks, utilizing recovered heat from chiller condensers and other sources, and temperature setbacks.

**Method:** Electrical demand was documented according to system specifications and requirements displayed on individual water heating units.

**Reduction Target:**
- 36 percent of 2011 levels from 9.9 (2011) to 6.3 (2020) MT CO2e

**Strategies for Reduction**
- **BEHW1.** Use instantaneous hot water heaters, 2020 (25 percent: 2.5 MT CO2e)
  - Use of instantaneous and semi-instantaneous hot water heaters, 2020
  - (Source: http://energy.gov/energysaver/articles/tankless-or-demand-type-water-heaters)
- **BEHW2.** Increase in insulation, 2015 (3 percent: 0.3 MT CO2e)
  - Increase insulation on hot water tanks
- **BEHW3.** Utilize recovered heat, 2017 (3 percent: 0.3 MT CO2e)
  - Utilization of recovered heat from chiller condensers and other sources
  - (Source: http://www.stanford.edu/group/narratives/classes/08-09/CEE215/ReferenceLibrary/Chillers/York%20Engineering%20Updates/Reduced%20condenser-water%20flow%20rate_energy-saving%20miracle%20or%20mirage.pdf)
- **BEHW4.** Lower temperature setbacks, 2015 (5 percent: 0.5 MT CO2e)

**Guest Room Appliances Strategy**

**Method:** Appliances were inventoried according to their respective electrical demands. These were then multiplied by hours of occupancy/usage. On average, guest rooms in 2011 were occupied 1/3 of all days. Telephones and alarm clocks were in service year-round while, during occupancy periods, TVs were assumed to have been used for 3 hours, blow dryers for 3 minutes, and irons for 10 minutes.

**Reduction Target:**
- 35 percent of 2011 levels from 7.4 (2011) to 4.8 (2015) MT CO2e

**Strategies for Reduction:**
- **BA1.** Use more aggressive standard than ENERGY STAR, 2013/ongoing (30 percent: 2.2 MT CO2e)
  - Set aggressive standards (surpassing ENERGY STAR®) for all equipment purchases
• BA2. Turn appliances to economy modes, 2015 (5 percent: 0.4 MT CO2e)
  o Turn appliances to economy modes when applicable

**Building Electricity Summary**

Building emission is the largest scope 1&2 emission sector and building electricity accounts for more than half of the emissions in building. It requires multiple efforts to make building electricity usage more efficient and this also involves considerable initial investments. However, most of those investments have a reasonable payback period, so they should be implemented at early stage. Allerton Park should complete most of its building electricity emission reduction projects by the end of 2015 and complete all the projects by 2020.

<table>
<thead>
<tr>
<th>Building Cooling &amp; Heating Emissions: 144 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCH 1. Install BAS</td>
<td>6</td>
<td>9</td>
<td>2017</td>
</tr>
<tr>
<td>BCH 2. Install variable speed drives</td>
<td>2</td>
<td>2.5</td>
<td>2017</td>
</tr>
<tr>
<td>BCH3. Repair sensors, valves and dampers</td>
<td>5</td>
<td>7</td>
<td>2016</td>
</tr>
<tr>
<td>BCH4. Retrofit Envelope</td>
<td>4</td>
<td>6</td>
<td>2017</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>17</td>
<td>25</td>
<td>2017</td>
</tr>
<tr>
<td>Lighting Emission: 76 MT CO2e</td>
<td>% Reduction</td>
<td>MT CO2e Reduction</td>
<td>Completion Date</td>
</tr>
<tr>
<td>BL1. Replace incandescent bulbs and T12 fixtures</td>
<td>50</td>
<td>36</td>
<td>2015</td>
</tr>
<tr>
<td>BL2. Install occupancy sensors and daylighting controls</td>
<td>10</td>
<td>7</td>
<td>2013</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>60</td>
<td>43</td>
<td>2015</td>
</tr>
<tr>
<td>Computer/Electronics Emissions: 12 MT CO2e</td>
<td>% Reduction</td>
<td>MT CO2e Reduction</td>
<td>Completion Date</td>
</tr>
<tr>
<td>BCE1. Use more aggressive standards than ENERGY STAR</td>
<td>15</td>
<td>2</td>
<td>Ongoing</td>
</tr>
<tr>
<td>BCE2. Usage of thin client computers</td>
<td>10</td>
<td>1</td>
<td>Ongoing</td>
</tr>
<tr>
<td>BCE3. Deploy low-energy IT computing equipment</td>
<td>10</td>
<td>1</td>
<td>Ongoing</td>
</tr>
<tr>
<td>BCE3. Implement Wake or LAN Technology</td>
<td>5</td>
<td>1</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>40</td>
<td>5</td>
<td>2015</td>
</tr>
<tr>
<td>Electric Hot Water Emissions: 19 MT CO2e</td>
<td>% Reduction</td>
<td>MT CO2e Reduction</td>
<td>Completion Date</td>
</tr>
<tr>
<td>BEHW1. Use instantaneous hot water heaters</td>
<td>25</td>
<td>3</td>
<td>2020</td>
</tr>
<tr>
<td>BEHW2. Increase insulation</td>
<td>3</td>
<td>0.3</td>
<td>2013</td>
</tr>
<tr>
<td>BEHW3. Utilize recovered heat</td>
<td>3</td>
<td>0.3</td>
<td>2017</td>
</tr>
<tr>
<td>BEHW4. Lower temperature setbacks</td>
<td>5</td>
<td>1</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>36</td>
<td>4</td>
<td>2030</td>
</tr>
<tr>
<td>Guest Room Appliances Emissions: 7 MT CO2e</td>
<td>% Reduction</td>
<td>MT CO2e Reduction</td>
<td>Completion Date</td>
</tr>
<tr>
<td>BA1. Use more aggressive standard than ENERGY STAR</td>
<td>30</td>
<td>2</td>
<td>2013/Ongoing</td>
</tr>
<tr>
<td>BA2. Turn appliances to economy modes</td>
<td>5</td>
<td>0.4</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>35</td>
<td>3</td>
<td>2015</td>
</tr>
<tr>
<td>Total Building Electricity Emissions: 247 MT CO2e</td>
<td>% Reduction</td>
<td>MT CO2e Reduction</td>
<td>Completion Date</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>78</td>
<td>2020</td>
</tr>
</tbody>
</table>

**Priorities:**

1. **Lighting Retrofits:** Changing to more efficient lights have an instant payback and the largest reduction potential.

2. **Building Heating and Cooling:** Building heating and cooling requires considerable initial investments and efforts, though most measures have reasonable payback period.

3. **Appliances:** Changing to more efficient appliances are ongoing and don’t have a definitive date since it’s contingent on when the current appliances are approaching the end of their life circles. However, it might be possible that the energy costs saved by efficient appliances can justify decisions to replace older appliances earlier in their life-circles.

**Challenges:**
Electrical hot water system is auxiliary to the gas heater. Retrofitting the electrical system itself does not have a significant saving potential.

**Mitigation Wedges for Building Electricity**

![Mitigation Wedges Graph](image)

**Building Natural Gas**

**Analysis Method**

An energy audit, assisted by the Smart Energy Design Assistance Center (SEDAC), was conducted for all climate-controlled buildings at the Park. This included, among other things, quantifying natural gas (in therms) demand for Building subclasses. Therms were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator.

Building and water heating from natural gas was quantified by the sum total of seasonal variations in usage above baseline levels (as exemplified within the bar chart below). This variation served to distinguish building heating from water heating. Heating degree days (periods of relevant building heating by means of an ambient 65 degree baseline standard) were also used to verify seasonal natural gas usage with building heating.

**How to Track Building Natural Gas Emissions?**

- Obtain building natural gas usage data (N) in therms from utility bills.
- Emission factor: 0.005 MTCO2e/therm

**Formula:** Building Natural Gas Emissions (MTCO2e) = f*N
Natural gas demand at Allerton is categorized into 2 subclasses:

- Water heating
- Building Heating

It produced a total of 128 metric tons of emissions in 2011 while consuming 25,545 therms of natural gas. This represents a total of 32 percent of Building sector emissions and 22 percent of all Park emissions.

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Therms</th>
<th>MT CO2 E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Heating</td>
<td>20,181</td>
<td>101</td>
</tr>
<tr>
<td>Water Heating</td>
<td>5,364</td>
<td>27</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25,545</td>
<td>128</td>
</tr>
</tbody>
</table>
Building Natural Gas Emissions over Time

Building Heating
Method: Natural gas demand was documented according to system specifications / requirements displayed on individual heating systems

Reduction Target:
- 100 percent of 2011 levels from 101 (2011) to 0 (2035) MT CO2e

Strategies for Reduction:
- BH1. Retrofit Envelope, 2019 (2 percent: 2 MT CO2e)
  - Roof and wall insulation, 2015 (0.5 percent: 0.5 MT CO2e)
  - Weatherization, 2015 (0.5 percent: 0.5 MT CO2e)
  - Entry-way retrofits, 2015 (0.5 percent: 0.5 MT CO2e)
  - Improved reflectivity or vegetative roofs, 2019 (0.5 percent: 0.5 MT CO2e)
- BH2. Conduct Building (Retro) Commissioning, 2017 (15 percent: 15 MT CO2e)
  - Repair and recalibration of sensors, valves and dampers, 2016 (2 percent: 2 MT CO2e)
  - Heating system maintenance (including trap replacement and pipe insulation), 2016 (2 percent: 2 MT CO2e)
  - Heat recovery, 2016 (1 percent: 1 MT CO2e)
  - Upgrades to control systems, 2017 (2 percent: 2 MT CO2e)
  - Implementation scheduling for air handling units, 2013 (3 percent: 3 MT CO2e)
  - Direct-digital control command center to monitor temperature control and alarms, 2017 (5 percent: 5 MT CO2e)
  - (Source: http://www.greenbiz.com/blog/2011/03/31/retro-commissioning-revenue-could-skyrocket-beyond-18b-2014)
- BH3. Install Building Automation System, 2017 (3 percent: 3 MT CO2e)
Installation of a computer-based building automation system (BAS) that monitors and controls major building systems, including HVAC and lighting, 2017 (2 percent: 2 MT CO2e)

Training of relevant staff to use the system, analyze output, make necessary adjustments and identify investment opportunities, 2015 (1 percent: 1 MT CO2e)

- BH4. Behavioral Changes and Incentives, 2017 (5 percent: 5 MT CO2e)
  - “Energy rebates” given to high-performing Park offices and entities, 2016 (1 percent: 1 MT CO2e)
  - Energy-driven reductions in overhead rates, 2016 (1 percent: 1 MT CO2e)
  - Addition of real-time energy displays in buildings via electronic media to promote awareness and incentives for improvement, 2017 (3 percent: 3 MT CO2e)

**Water Heating**

**Method:** Natural gas demand was documented according to system specifications/requirements displayed on individual water heating units

**Reduction Target:**
- 15 percent of 2011 levels from 27 (2011) to 23 (2016) MT CO2e

**Strategies for Reduction:**
- **BWH1.** Fix traps and ducts, 2016 (2 percent: 0.5 MT CO2e)
  - Fix hot water traps and clean ductwork
- **BWH2.** Install mechanical timer, 2016 (5 percent: 1.4 MT CO2e)
  - Install 24-hour mechanical timer on water heaters and schedulers
- **BWH3.** Right-sized water tanks, ongoing (5 percent: 1.4 MT CO2e)
  - Choose smaller, right-sized water tanks when replacing
- **BWH4.** Temperature setbacks, 2015, (3 percent: 0.8 MT CO2e)
  - Install temperature setbacks or the lower setback temperature if setbacks have been installed

**Building Natural Gas Summary**

<table>
<thead>
<tr>
<th>Building Heating Emissions: 101 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1. Retrofit envelope</td>
<td>2</td>
<td>2</td>
<td>2015</td>
</tr>
<tr>
<td>BH2. Conduct building retrofit commission</td>
<td>13</td>
<td>15</td>
<td>2017</td>
</tr>
<tr>
<td>BH3. Install BAS</td>
<td>3</td>
<td>3</td>
<td>2017</td>
</tr>
<tr>
<td>BH4. Behavioral change and incentives</td>
<td>5</td>
<td>5</td>
<td>2019</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>17</strong></td>
<td><strong>25</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Heating Emissions: 27 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BWH1. Fix traps and ducts</td>
<td>2</td>
<td>1</td>
<td>2016</td>
</tr>
<tr>
<td>BWH2. Install mechanical timer</td>
<td>5</td>
<td>1</td>
<td>2016</td>
</tr>
<tr>
<td>BWH3. Right-sized water tanks</td>
<td>5</td>
<td>1</td>
<td>Ongoing</td>
</tr>
<tr>
<td>BWH4. Temperature setbacks</td>
<td>3</td>
<td>1</td>
<td>2015</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>15</strong></td>
<td><strong>4</strong></td>
<td>2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Building Gas Emissions: 128 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>24</strong></td>
<td><strong>29</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The “one-fell-swoop” approach to eliminate all natural gas emissions is the geothermal system to be installed in 2035. However, before that, there are several other short-term strategies mitigating a
fraction of the total emissions. Though these approaches require a significant first costs, most of the short-term natural gas strategies can also help cutting building electricity emissions. Those short-term building natural gas emission reduction projects are to be completed by the end of 2015.

**Priorities**

1. Retrofit Envelop: Some projects for building envelope is currently underway in the park, thus this can be an immediate measure and should be completed by the end of this year.
2. Building Retro-commissioning and Behavior Incentives: Building retro-commissioning has by far the most energy saving potential among all short-term strategies. Behavioral change incentives can be started with no cost and have long-term impacts. Both measures can at the same time help reducing building electricity emissions.
3. Water Heating Efficiency: Retrofitting water heaters has limited emission cutting potential but it is easy and generates an instant payback.

**Challenges**

The most important strategy here is geothermal system to be installed in 2035. It’s hard to justify in aspects of economy and feasibility to make an earlier installation. There are also uncertainties around future technology advancement. Things such as “Variable Refrigerants Flow” (VRF) system could prove to be more feasible and cost-effective in energy saving.

**Mitigation Wedges for Building Natural Gas**

**Building Refrigerants**

As a result of leaky and outdated AC units, Allerton Park purchased 17 gallons of r-22 refrigerants (equivalent of 30 MT CO2e) 1 in 2011 to compensate for system losses. This number was converted to equivalent metric tons of CO2 to account for the year’s refrigerant emissions.
### Analysis Method

Refrigerant use was quantified by inventorying the gallons of r-22 (17) purchased by the Park in 2011 to replace system leakages.

### How to Track Building Refrigerants Emissions

- Obtain system leakages by inventorying the gallons of r-22 (17) (R) purchased by the Park.
- Emission factor for r-22: 1.36 MTCO2e/gallon.

**Formula:** Building Refrigerant Emissions (MTCO2e) = $f \times R$

<table>
<thead>
<tr>
<th>Building</th>
<th>Refrigerant Type</th>
<th>Age of Unit (yrs)</th>
<th>SEER</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate House</td>
<td>r-22</td>
<td>18</td>
<td>10</td>
<td>2 - 4</td>
</tr>
<tr>
<td>House in the Woods</td>
<td>r-22</td>
<td>3</td>
<td>13</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Visitors Center</td>
<td>r-22</td>
<td>30</td>
<td>8</td>
<td>2 - 5</td>
</tr>
<tr>
<td>Regency</td>
<td>r-410a</td>
<td>4</td>
<td>14</td>
<td>1 - 2</td>
</tr>
<tr>
<td>Evergreen Lodge</td>
<td>Geothermal</td>
<td>3</td>
<td>na</td>
<td>1 - 5</td>
</tr>
<tr>
<td>Allerton Mansion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Library</strong></td>
<td>r-22</td>
<td>3</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td><strong>Gallery / Basement</strong></td>
<td>r-22</td>
<td>3</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td><strong>Dining Room</strong></td>
<td>r-22</td>
<td>3</td>
<td>13</td>
<td>2 - 3</td>
</tr>
<tr>
<td><strong>Pine Room</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Butternut Room</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Rooms 1, 10, 11, and Marketing</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>3 - 1</td>
</tr>
<tr>
<td><strong>Room 3, IT, Laundry</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>2 - 1</td>
</tr>
<tr>
<td><strong>Rooms 2, 9, Copy Room</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>2 - 1</td>
</tr>
<tr>
<td><strong>Director, Room 8, Brick Room</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>4 - 1</td>
</tr>
<tr>
<td><strong>Rooms 4, 5, 6</strong></td>
<td>r-22</td>
<td>6</td>
<td>na</td>
<td>5</td>
</tr>
<tr>
<td><strong>Rooms 7, 12, 13, 14</strong></td>
<td>r-22</td>
<td>24</td>
<td>na</td>
<td>5</td>
</tr>
<tr>
<td><strong>Rooms 15, 16 and Business Office</strong></td>
<td>r-22</td>
<td>18</td>
<td>na</td>
<td>2 - 1</td>
</tr>
</tbody>
</table>
Building Refrigerants Emissions over Time

Reduction Target:

- 100 percent of 2011 levels from 30 (2011) to 0 (2035) MT CO2e

Strategies for Reduction:

- **BC1.** Fix System Leakage, 2013 (20 percent: 6 MT CO2e)
  - Fix leaky systems, reducing leakage to potentially 5% or less
  - (Source: LEED-EB)
- **BC2.** Phase in geothermal systems by 2035 (100 percent of remaining: 24 MT CO2e)

Building Refrigerants Summary

<table>
<thead>
<tr>
<th>Building Refrigerants Emissions: 30 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC1. Fix system leakage</td>
<td>20</td>
<td>6</td>
<td>2013</td>
</tr>
<tr>
<td>Total Building Refrigerant Emissions: 30 MT CO2e</td>
<td>20</td>
<td>6</td>
<td>2015</td>
</tr>
</tbody>
</table>

Though refrigerants emissions are a small part of the total building emissions, systems with leaking refrigerants really are a big down for Allerton Park to be a pioneer in carbon neutral, since this is a problem that should be solved in the last decade. Allerton Park should fix its leaking system as soon as possible.

Priorities:

1. **Fix system leakages:** This is nothing new and pioneering, and it’s hard to imagine that a place heading for carbon neutrality still has a leaking system. This should be the top priority among everything.
2. **Geothermal System:** By 2035 the geothermal system will be installed to eliminate all the remaining refrigerant emissions.
Challenges:

There are still considerable amount of refrigerant emissions remaining between the period of fixing the system leakage and installing the geothermal system. Optimally, Allerton Park can find ways to mitigate these emissions. Increasing the overall system efficiency and reducing building energy demand (such as efficiency measures for building electricity and natural gas sectors) can be significant.

*Mitigation Wedges for Building Refrigerants*

![Graph showing mitigation wedges for building refrigerants]

4.3 Services & Operations

Services & Operations in Allerton is not a very huge emission sources, but the way it is composed is very diverse. D and gasoline are used to power machinery and equipment for gardens and lawns (50 acres) maintenance as well as natural areas (1,640 acres) upkeep. Electricity is used to carry out general operations and services for visitors, guests and staff, which include kitchen operations, refrigeration, cleaning, and other maintenance.
Total Services & Operations Emissions

Emission Breakdown
Services & Operations GHG Sources:
- Purchased Electricity (Ameren)
- Gasoline
- Diesel

Total Sector Source Emissions = 88 MT CO2e
S&O Electricity

Analysis Method

An energy audit, assisted by the Smart Energy Design Assistance Center (SEDAC), was conducted for all climate-controlled buildings at the Park. This included, among other things, quantifying electrical demand (kWh) for Services and Operations subclasses. Kilowatt hours were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator. It produced a total of 75 metric tons of emissions in 2011 while consuming 89,484 kilowatt hours of electricity. This represents a total of 85 percent of Services and Operations sector emissions and 13 percent of all Park emissions.

Operations electricity demand at Allerton is categorized into 4 subclasses by service:

- Kitchen Operations
- Refrigeration
- Cleaning
- Other Maintenance

<table>
<thead>
<tr>
<th>Service</th>
<th>MT CO2 E</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen Operations</td>
<td>28</td>
<td>33,113</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>38</td>
<td>45,642</td>
</tr>
<tr>
<td>Cleaning</td>
<td>5</td>
<td>6,265</td>
</tr>
<tr>
<td>Other Maintenance</td>
<td>4</td>
<td>4,475</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>75</strong></td>
<td><strong>89,494</strong></td>
</tr>
</tbody>
</table>

Total 2011 Gasoline Usage = 89,494 kWh

Total Emissions = 75 MT CO2e
How to Track S&O Electricity Emissions

- Read electricity (E) for S&O in Allerton Park in kWh from utility bills.
- Obtain up-to-date emission data (f in lb/MWh) for U of I from EPA site: http://cfpub.epa.gov/egridweb/view_egcl.cfm. If the newest data cannot be located, use f=1,150 lb/MWh
- Transfer f into MTCO2/kWh form by $f(\text{MT/kWh})=f(\text{lb/MWh}) \times (\frac{1}{2,205,000})$

**Formula:** S&O Electricity Emission (MT CO2e) = $E(\text{kWh}) \times f(\text{lb/MWh}) / 2,205,000$ (MWh*MT/kWh/lb)

**Refrigeration**

**Method.** Electrical demand for refrigeration was documented according to system specifications/requirements displayed on individual refrigeration units.

**Reduction Target:**
- 50 percent of 2011 levels from 38 (2011) to 19 (2020) MT CO2e.

**Strategies for Reduction:**
- **SOER1. Decommission Inefficient Units, 2020 (35 percent: 13 MT CO2e)**
  - Prioritize necessary refrigeration needs, decommissioning inefficient and/or unnecessary units.
- **SOER2. Right-Sizing, ongoing (15 percent: 6 MT CO2e)**
  - Choose smaller, right-sized units when making replacements.

**Kitchen Operations**

**Method.** Kitchen appliances were inventoried according to their respective electrical demands. These were then multiplied by hours of service/usage (kWh) and converted to metric tons of CO2.

**Reduction Target:**
- 35 percent of 2011 levels from 28 (2011) to 18 (2025) MT CO2e.

**Strategies for Reduction:**
- **SOEKO1. Surpass Energy Star standards, 2025 (30 percent: 8.4 MT CO2e)**
  - Set aggressive standards (surpassing ENERGY STAR®) for all equipment purchases.
- **SOEKO2. Appliance Economy Mode, 2015 (5 percent: 1.4 MT CO2e)**
  - Turn appliances to economy modes when applicable.
Cleaning Strategy
Method. Cleaning appliances were inventoried according to their respective electrical demands. These were then multiplied by hours of service/usage (kWh) and converted to metric tons of CO2.

Reduction Target:
- 35 percent of 2011 levels from 5.25 (2011) to 3.41 (2025) MT CO2e.

Strategies for Reduction:
- **SOEC1. Surpass Energy Star standards, 2025 (30 percent: 1.6 MT CO2e)**
  - Set aggressive standards (surpassing ENERGY STAR®) for all equipment purchases.
  - (Source: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfolio_manager_intro)
- **SOEC2. Appliance economy mode, 2015 (5 percent, 0.3 MT CO2e)**
  - Turn appliances to economy modes when applicable.

Other Maintenance
Method. Other non-regular maintenance activities were assumed to account for the remaining kilowatt hours in the building energy assessment. These activities include, but are not limited to: repairs, installations, specially requested activities, etc.

Reduction Target:
- 10 percent of 2011 levels from 3.75 (2011) to 3.38 (2025) MT CO2e.

Strategies for Reduction:
- **SOEO1. Standards for external entities, 2025 (10 percent: 0.5 MT CO2e)**
  - Require internal and external entities to abide by Park emissions reductions standards for non-regular maintenance and service activities when possible.

Gas-Powered Equipment

Analysis Method
Consumption data for gas-fueled Services and Operations machinery was obtained from filling slips. These slips included a machinery description plus type and amount of fuel used. Gallons of gasoline were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator. It produced a total of 3.5 metric tons of emissions in 2011 while consuming 395 gallons of gasoline. This represents a total of 4 percent of Services and Operations sector emissions and 0.6 percent of all Park emissions.

Services and Operations gasoline demand is categorized into 8 subclasses by individual machine / type:
- Gas Can (used to fuel smaller equipment such as weed whackers and lawn mowers)
- Fire Truck
- Lift Truck
- Dump Truck
- 34738 Tractor
- John Deere
- Power Washer
- Fulgurator

<table>
<thead>
<tr>
<th>Machine</th>
<th>Gallons</th>
<th>MT CO2e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Can</td>
<td>181</td>
<td>1.600</td>
</tr>
<tr>
<td>Fire Truck</td>
<td>151</td>
<td>1.300</td>
</tr>
<tr>
<td>Lift Truck</td>
<td>19</td>
<td>0.169</td>
</tr>
<tr>
<td>Dump Truck</td>
<td>18</td>
<td>0.160</td>
</tr>
<tr>
<td>34738 Tractor</td>
<td>14</td>
<td>0.124</td>
</tr>
<tr>
<td>John Deere</td>
<td>11</td>
<td>0.098</td>
</tr>
<tr>
<td>Power Washer</td>
<td>1.5</td>
<td>0.013</td>
</tr>
<tr>
<td>Fulgurator</td>
<td>0.4</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>394.5</strong></td>
<td><strong>3.5</strong></td>
</tr>
</tbody>
</table>

**Total 2011 Gasoline Usage = 395 gallons**

**Total Emissions = 3.5 Tons of CO₂**

How to Track S&O Gasoline Emissions:
- Gasoline (G gallons) consumption can be obtained from filling slips.
- According to EPA, gasoline emission factor (F) is 0.009 MTCO2/gallon.

**Formula:** S&O Gasoline Emissions (MTCO2e) = F*G

**Reduction Target:**
- 15 percent of 2011 levels from 3.5 (2011) to 3.0 (2025) MT CO₂e
Strategies for Reductions:

- **SOG1. Purchasing and Replacement, 2025 (5 percent: 0.2 MT CO2e)**
  
  - Set purchasing standards for machinery (including rental equipment) based on fuel efficiency and identify outdated or inefficient candidates for replacement

- **SOG2. Landscaping, 2020 (10 percent: 0.4 MTCO2e)**
  
  - Increase no-mow, xeriscaped and low-maintenance landscape. A potential currently exists for at least 13 acres of conversion, 2020 (10 percent)
  - Gas Can (used to fuel small equipment, eg. weed whippers, etc.) + Firetruck = 84% gas S&O consumption.

**S&O Diesel**

**Analysis Method**

Consumption data for diesel-fueled S&O machinery was obtained from filling slips. These slips included a machinery description plus type and amount of fuel used. Gallons of diesel were converted to metric tons of CO2 using the EPA’s online GHG Equivalency Calculator. It produced a total of 9.61 metric tons of emissions in 2011 while consuming 807 gallons of diesel. This represents a total of 11 percent of Services and Operations sector emissions and 1.6 percent of all Park emissions

Diesel demand at Allerton is categorized into 9 subclasses by individual machine:

- Toro Z-Turn
- Backhoe
- Bobcat
- Toro 580D
- Kubota Tractor
- Vermeer Chipper
- Drip Torch
- Rental Jackhammer
- Rental Scissor Lift

<table>
<thead>
<tr>
<th>Machine</th>
<th>Gallons</th>
<th>MT CO2e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toro Z-Turn</td>
<td>220</td>
<td>2.61</td>
</tr>
<tr>
<td>Backhoe</td>
<td>169</td>
<td>2.01</td>
</tr>
<tr>
<td>Bobcat</td>
<td>133</td>
<td>1.58</td>
</tr>
<tr>
<td>Toro 580D</td>
<td>103</td>
<td>1.22</td>
</tr>
<tr>
<td>Kubota Tractor</td>
<td>100</td>
<td>1.19</td>
</tr>
<tr>
<td>Vermeer Chipper</td>
<td>66</td>
<td>0.78</td>
</tr>
<tr>
<td>Drip Torch</td>
<td>8</td>
<td>0.09</td>
</tr>
<tr>
<td>Rental JackHammer</td>
<td>6</td>
<td>0.07</td>
</tr>
<tr>
<td>Rental Scissor Lift</td>
<td>5</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>807</strong></td>
<td><strong>9.61</strong></td>
</tr>
</tbody>
</table>
Total 2011 Diesel Usage = 807 gallons

Total Emissions = 9.61 Metric Tons of CO2

How to Track S&O Diesel Emissions:
• Diesel (D gallons) consumption can be obtained from filling slips.
• According to EPA, gasoline emission factor (F) is 0.01 MTCO2/gallon.
  
  **Formula:** S&O Diesel Emissions (MTCO2e) = D*G

Reduction Target:
• 5 percent of 2011 levels from 9.6 (2011) to 9.1 (2025) MT CO2e.

Strategies for Reduction:
• **SOD1.** Purchasing Standards, 2025 (5 percent: 0.5 MT CO2e)
  o Set purchasing standards for machinery (including rental equipment) based on fuel efficiency and identify outdated or inefficient candidates for replacement.
Service & Operations Summary
The focuses here are on the appliances used for service and operations. All the strategies are planned to be implemented by the end of 2025.

### Refrigeration Emissions: 38 MT CO2e

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOER1. Decommission inefficient units</td>
<td>50</td>
<td>13</td>
<td>2020</td>
</tr>
<tr>
<td>SOER2. Choose right-sized units</td>
<td>15</td>
<td>6</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Overall</td>
<td>50</td>
<td>19</td>
<td>2020</td>
</tr>
</tbody>
</table>

### Kitchen Operations Emissions: 28 MT CO2e

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOEK01. Surpass ENERGY STAR standards</td>
<td>30</td>
<td>8</td>
<td>2025</td>
</tr>
<tr>
<td>SOEK02. Appliance economy mode</td>
<td>5</td>
<td>1.4</td>
<td>2015</td>
</tr>
<tr>
<td>Overall</td>
<td>35</td>
<td>10</td>
<td>2025</td>
</tr>
</tbody>
</table>

### Cleaning Emissions: 5 MT CO2e

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOEC01. Surpass ENERGY STAR standards</td>
<td>30</td>
<td>2</td>
<td>Ongoing</td>
</tr>
<tr>
<td>SOEC02. Appliance economy mode</td>
<td>5</td>
<td>0.25</td>
<td>2015</td>
</tr>
<tr>
<td>Overall</td>
<td>35</td>
<td>2</td>
<td>2015</td>
</tr>
</tbody>
</table>

### Other Maintenance Emissions: 4 MT CO2e

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOEO1. Standards for external entities</td>
<td>10</td>
<td>0.5</td>
<td>2025</td>
</tr>
<tr>
<td>Overall</td>
<td>10</td>
<td>0.5</td>
<td>2025</td>
</tr>
</tbody>
</table>

### Diesel Emissions: 10 MT CO2e

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOD1. Purchasing standards</td>
<td>5</td>
<td>0.5</td>
<td>2025</td>
</tr>
<tr>
<td>Overall</td>
<td>5</td>
<td>0.5</td>
<td>2025</td>
</tr>
</tbody>
</table>

### Gasoline Emissions: 4 MT CO2e

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOG1. Purchasing and Replacement</td>
<td>5</td>
<td>0.2</td>
<td>2025</td>
</tr>
<tr>
<td>SOG2. Landscaping</td>
<td>10</td>
<td>0.4</td>
<td>2020</td>
</tr>
<tr>
<td>Overall</td>
<td>15</td>
<td>0.6</td>
<td>2025</td>
</tr>
</tbody>
</table>

### Total Services & Operations Emissions: 88 MT CO2e

<table>
<thead>
<tr>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>31</td>
<td>2025</td>
</tr>
</tbody>
</table>

Priorities:
1. **Purchase Standards**: This is an ongoing mission for the park to replace its old service and operations’ appliances with ones at least complying ENERGY STAR standards. And it would also be ideal that the park replaces its poorly efficient appliances earlier in their life-cycle, since the energy costs saved by new appliances are likely to justify the investment.

2. **Maintenance Energy Savings**: These strategies include adopting more efficient equipment, decommissioning inefficient appliances and turning appliances to economy modes. They are focused on the way that the park staff use the equipment. Somewhere around 2013-2014 is the deadline for implementation of all those strategies.

3. **Landscaping**: This is the most costly strategy in this sector and the effects are limited thus it’s not a priority for now.

**Challenges:**

Service and Operations has a variety of emitting sources. This adds to the complexity of service and operations’ emission reduction actions.

**Mitigation Wedges for Service & Operations**

4.4 **Waste**

Allerton Park has full on-site water pumping and treatment facility and contracted waste disposal program (Area Waste Disposal). Those systems are electricity-powered and have associated GHG emissions. Apart from that, solid waste also emits GHGs in the process of waste disposal operations such as landfilling, incineration without energy recovery and other treatment operations like composting. The emissions include carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), along with three fluorinated gases.
Emission Breakdown

Waste GHG Sources:
- Solid Waste (trash)
- Purchased Electricity (Ameren)

Total Waste Sector Emissions = 86 MT CO2e

Solid Waste

Analysis Method
Consumption data for solid waste was obtained by reviewing pickup dates from Area Disposal and extrapolating tonnage of waste produced based upon container volume and average trash weight. Tons of trash were converted to metric tons of CO2 based upon EPA estimates. On-site solid waste produced
a total of 59 metric tons of emissions in 2011 while also producing 59 tons of trash. This represents a total of 69 percent of Waste sector emissions and 10 percent of all Park emissions

Solid waste demand is categorized into a single subclass:

- Trash (tons)

**How to Track Solid Waste Emissions:**

- Obtain Consumption data for solid waste was by reviewing pickup dates from Area Disposal and extrapolating tonnage of waste (S) produced based upon container volume and average trash weight.
- Use emission factor (f) of 1 (MTCO2e)/(Ton of solid waste)

**Formula:** Solid Waste Emissions (MTCO2e) = f*S

**Reduction Target:**

- 10 percent of 2011 levels from 59 (2011) to 6 (2023) MT CO2e

**Strategies for Reduction**

- **WSW1.** Recycling and Composting, 2022 (85 percent: 50 MT CO2e)
  - The EPA estimates that 75% of all solid waste is recyclable, 2022 (45 percent given current 30 percent rate)
  - Install park-wide recycling infrastructure with a bottle/can deposit program
  - Develop a durable goods reuse cataloging system
  - Develop incentives for reducing trash (eg. charging for waste)
  - On-site composting: GreenWaste.com estimates that food diversion could result in a 33% to 85% reduction in total solid waste, 2023 (40 percent)
  - Source: [http://www.greenwaste.com/recycling-stats](http://www.greenwaste.com/recycling-stats)

- **WSW2.** Purchasing, 2022 (5 percent: 3 MT CO2e)
  - Use carbon and other environmental indicators for purchasing criteria, 2021
  - Implement full-cost accounting and life-cycle analysis structures for major purchases and categories with a cost threshold to be determined, 2022
  - Set and enforce minimum recycled content standards, 2021

**Wastewater**

**Analysis Method**

Consumption was observed through utility metering of kilowatt hours (kWh) for the Park’s pumping and treatment station. Kilowatt hours were converted to metric tons of CO2 using the Electricity Emission factor for Midwest ISO. Park wastewater produced a total of 27 metric tons of emissions in 2011 while also consuming 32,938 kilowatt hours of electricity. This represents a total of 31 percent of Waste sector emissions and 4.6 percent of all Park emissions.

Solid waste demand is categorized into a single subclass:
Kilowatt hours used to pump and treat the Park’s domestic water supply

How to Track Wastewater Emissions:

- Read electricity usage (E) for wastewater in Allerton Park in kWh from utility bills.
- Obtain up-to-date emission data (f in lb/MWh) for U of l from EPA site: http://cfpub.epa.gov/egridweb/view_egcl.cfm. If the newest data cannot be located, use f=1,150 lb/MWh
- Transfer f into MTCO2/kWh form by f (MT/kWh)=f (lb/MWh) * (1 MT/2,205 lb) * (1 MWh/1,000 kWh)=f (lb/MWh) / 2,205,000

**Formula: Wastewater Emission (MT CO2e) = E (kWh)*f(lb/MWh)/2,205,000(MWh*MT/kWh/lb)**

Reduction Target

- 48 percent of 2011 levels from 27 (2011) to 14 (2025) MT CO2e

Reduction Strategies

- **WEW1.** Low-flow fixtures, 2022 (30 percent: 8 MT CO2e)
  - Mandate low-flow fixtures where applicable.
  - Source: http://www.pacinst.org/reports/urban_usage/appendix_e.pdf
- **WEW2.** “True cost of water” charges, 2022 (3 percent: 1 MT CO2e)
  - Include "true cost of water" charges within the energy billing program and use these funds for future water efficiency improvement projects.
- **WEW3.** Non-potable water, 2025 (15 percent: 4 MT CO2e)
  - Begin utilizing non-potable water, including untreated raw water, sump pump discharge, cooling wastewater, stormwater and graywater.

**Waste Summary**

Waste emissions consist of two different sectors- wastewater and solid waste. A very large percentage of waste emissions are reducible, but those measures require time and efforts. We develop a series of strategies that consist of early, easy efforts as well as more time-consuming efforts. The target is by 2015 the park should eliminate 90% of the solid waste emissions and by 2017 77% of the wastewater emissions.

<table>
<thead>
<tr>
<th>Solid Waste Emissions: 59 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSW1. Recycling and composting</td>
<td>85</td>
<td>50</td>
<td>2023</td>
</tr>
<tr>
<td>WSW2. Purchasing</td>
<td>5</td>
<td>3</td>
<td>2022</td>
</tr>
<tr>
<td>Overall</td>
<td>90</td>
<td>53</td>
<td>2023</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waste Water Emissions: 27 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEW1. Low-flow fixtures</td>
<td>30</td>
<td>8</td>
<td>2022</td>
</tr>
<tr>
<td>WEW2. &quot;True cost of water” charges</td>
<td>3</td>
<td>1</td>
<td>2022</td>
</tr>
<tr>
<td>WEW3. Non-potable water</td>
<td>15</td>
<td>4</td>
<td>2025</td>
</tr>
<tr>
<td>Overall</td>
<td>48</td>
<td>13</td>
<td>2025</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Waste Emissions: 86 MT CO2e</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>77</td>
<td>66</td>
<td>2025</td>
</tr>
</tbody>
</table>
Priorities:

1. **Low-flow fixture and pricing**: These measures are easy and can encourage people to use water more efficiently. The behavior-related change will have very long-lasting impacts.
2. **Purchase Standards**: This strategy can be implemented simultaneously with other purchase standard strategies.

Challenges:

“Recycling and Composting” is the most effective measure for solid waste but this strategy requires infrastructure upgrade and management system change, thus will take longer time. Non-potable water is the most effective wastewater measure but it requires modifications in the pipeline system as well as the supply resources. These two methods are time-consuming and will be implemented around 2015-2017

*Mitigation Wedges for Waste*

4.5 Water

Water and energy are intricately linked. The challenge of reducing Allerton Park GHG emissions should involve looking at the importance of water in at least two ways: 1) treated water and wastewater relevant to indirect GHG emissions; and 2) energy efficiency’s relationship to water use. Water usage at Allerton is unique in the sense that the domestic water and treatment facility are owned and operated by the Park, in turn enhancing opportunities for taking liberal, proactive approaches toward water-related emissions reductions. The 4H Memorial Camp, a contiguous property to the northwest, is also fully serviced by Allerton’s on-site water system. The camp’s water use functions under contractual agreements with the Park equivalent to rates paid by residents of Monticello, Illinois (five miles east of the Park). Between 2009 and 2011, the 4H Memorial Camp was responsible for about 75% of the facility’s total water use, paying slightly more than $3,000 per year on average.
Water Consumption

Water-related emissions can also be viewed as a further incentive for improving energy efficiency in fiscal year 2009, the Allerton facility, combined with 4H Memorial Camp used 2,613 kgal (1 kgal = 1,000s of gallons) of water. In fiscal year 2010, combined usage was 1,277 kgal and in 2011, 1,408 kgal. The costs associated with these amounts of water use were $4,330; $2,147; and $2,579 respectively. It is important to note that dollar amounts for the Allerton facility are unpaid sums due to the Park’s ownership of the domestic and waste water treatment facility. Effective immediately, these amounts should be paid by the Park and placed into a long term maintenance fund for the Allerton water system. Given that this system is roughly 50 years old, significant repairs and upgrades should be made regularly with a focus on energy efficiency and low emissions practices. Autonomous control of the facility’s water extraction, use, and treatment is a strong advantage to the Park’s commitment to carbon neutrality and the ability to independently finance repairs and maintenance of this system is crucial part of this.

Table XX. Water consumption breakdown at Allerton Park and 4H Memorial Camp by volume for 2009 – 2011

<table>
<thead>
<tr>
<th></th>
<th>Allerton Mansion</th>
<th>Allerton Park</th>
<th>Park Total</th>
<th>4H Memorial</th>
<th>Annual Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009</strong></td>
<td>446</td>
<td>43</td>
<td>489</td>
<td>2,124</td>
<td>2,613</td>
</tr>
<tr>
<td><strong>2010</strong></td>
<td>415</td>
<td>48</td>
<td>463</td>
<td>814</td>
<td>1,277</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td>284</td>
<td>51</td>
<td>335</td>
<td>1,073</td>
<td>1,408</td>
</tr>
</tbody>
</table>

Table XX. Water consumption breakdown at Allerton Park and 4H Memorial Camp by monetary amount for 2009 – 2011

<table>
<thead>
<tr>
<th></th>
<th>Allerton Mansion</th>
<th>Allerton Park</th>
<th>Park Total</th>
<th>4H Memorial</th>
<th>Annual Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009</strong></td>
<td>1,533.33</td>
<td>861.20</td>
<td>2,394.53</td>
<td>4,329.67</td>
<td>6,724.20</td>
</tr>
<tr>
<td><strong>2010</strong></td>
<td>1,481.17</td>
<td>870.07</td>
<td>2,351.23</td>
<td>2,147.17</td>
<td>4,498.40</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td>1,263.33</td>
<td>874.77</td>
<td>2,138.10</td>
<td>2,578.83</td>
<td>6,855.03</td>
</tr>
</tbody>
</table>

Table XX. Water consumption breakdown at Allerton Park and 4H Memorial Camp by percent for 2009 – 2011

<table>
<thead>
<tr>
<th></th>
<th>Allerton Mansion</th>
<th>Allerton Park</th>
<th>4H Memorial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009</strong></td>
<td>17%</td>
<td>2%</td>
<td>81%</td>
</tr>
<tr>
<td><strong>2010</strong></td>
<td>32%</td>
<td>4%</td>
<td>64%</td>
</tr>
<tr>
<td><strong>2011</strong></td>
<td>20%</td>
<td>4%</td>
<td>76%</td>
</tr>
</tbody>
</table>
Since the Allerton Park facility, combined with the 4H Memorial Camp, is a major water user, the baseline GHG emissions study should include an effort to determine the significance of indirect emissions due to water use, beginning with the installation of a more accurate metering system for individual building which is capable of identifying large sources of consumption. Significantly reducing Park and 4H water use will require greater understanding of how water is used on-site. Metered water use sources in 2011 included:

- Allerton Mansion – 20 percent
- Allerton Park (including administrative, guest, and park buildings) – 4 percent
- 4H Memorial Camp – 76 percent

**Water Strategies**

Making certain energy efficiency improvements related to water use is another way to reduce GHG emissions. This is because the economic value of energy efficiency is often greater than just the economic value of the energy saved. For example, energy efficiency improvements that reduce cooling loads will save a proportional amount of cooling tower water. When cooling towers use less water, they require proportionately fewer chemicals, maintenance, labor, etc. Therefore, a cooling efficiency improvement will result in savings in the cost of energy, the cost to produce water, the cost to discharge water, the cost of cooling tower chemicals, and the cost of cooling tower maintenance. Economic justification is easier when all of these true cost savings are captured. The Illinois Sustainable Technology Center has performed true cost of water accounting for Ford and Caterpillar, and the results have shown that the actual cost to use water can be 5 to 20 times greater than the cost of the water alone.

A major way in which Allerton must improve this kind of efficiency is to utilize efficient water fixtures, including low-flow aerators for faucets, dual-flush and high efficiency toilets, high-performance low-flow showerheads, and pint urinals. These fixtures will be implemented at the 4H Memorial Camp as well through the use of billing incentives while newer technologies to improve upon these efficiencies will be researched and harnessed on both the Park and Camp sides. In turn, the longevity of water-related infrastructure is expected to increase due to decreased volume and strain on the system. Non-potable sources of water will also be utilized when appropriate, including untreated raw water, sump pump discharge, cooling tower wastewater, storm water, and gray water. By implementing a raw water system across the facility, Allerton could take advantage of lower-cost, non-treated raw water on-site. Allerton will explore possibilities of connecting to a raw system and investigate ways to use other non-potable sources in this system.

A next step would be to conduct an analysis to account for the true cost to use water at Allerton.

**Reduction Targets**

- 40 percent of 2011 levels

**Strategies**

- **WW1. “True Cost of Water”**
  - Commission an internal, University-assisted study to determine a detailed water use baseline, the “true cost of water,” and the related emissions
• **WW2.** Maintenance Fund  
  - Beginning in fiscal year 2014, the Park will begin paying monthly water utility bills to a long term maintenance fund. Future repairs and upgrades will be made with a focus on energy efficiency and low emissions practices as recommended by the commissioned study of on-site water consumption.

• **WW3.** Non-potable Water  
  - Begin utilizing non-potable water, including untreated raw water, sump pump discharge, cooling wastewater, stormwater and graywater.

• **WW4.** Raw water system  
  - Connect to a raw water system by 2020.

---

### 4.6 Other Emission Reduction Strategies

**Space and Growth Management**

Projected carbon emissions for a business-as-usual scenario indicate increasing levels of annual emissions due to existing substandard efficiencies despite no new construction in recent years. As a result, Allerton will pursue strategies to ensure no increase in square footage while seeking to implement retrocommissioning processes (see Energy Conservation section) to amend inefficient and outdated building features. When new construction is necessary, the Park will implement green building requirements that will improve building performance levels, requiring a LEED Silver certification for any new buildings and renovations. With regard to financing such projects, results by the Rocky Mountain Institute show that there is no correlation between the level of LEED achieved by a building project and the project cost.

Federal, state and local codes, ASHRAE, and AIA are targeting widespread deployment of net-zero commercial buildings by 2030, and the Department of Energy is seeking to make net-zero buildings financially viable by 2025. A net-zero building is one that generates as much energy as it uses over the course of an average calendar year.

Allerton has committed to sustainable building design by relevantly adhering to the University’s Facility Standards and Design Guidelines. These guidelines require all new construction and major renovations over $5 million be certified at a minimum Silver level building under the U.S. Green Building Council’s LEED rating system. All projects less than $5 million are to be designed to Silver standards, but are not required to be certified.

Allerton will implement a freeze on new buildings and building additions once any currently planned projects are completed. Any new space must take an existing space of equal or greater size (or of equal or greater energy usage) out of commission. Furthermore, any building retrofits will be required to “do no harm;” that is, it should not increase the energy consumption of a building—if necessary by packaging together additional energy conservation and renewables as part of a project. New building projects will be net-zero or replace an existing building. These can be facilitated by a marketplace for...
space. All projects currently in planning require at least a 30 percent improvement in the proposed building performance rating compared with the baseline building performance rating, as calculated using the latest version of ANSI/ASHRAE/IESNA Standard 90.1.

Finally, the Allerton space market will include the demolition of buildings with poor energy performance, high deferred maintenance burdens, and low historical value. Park buildings that are seen as approaching a deferred maintenance efficiency value that is higher than their current replacement value will be considered for removal or renovation.

**Space and Growth Management Strategies**

**Reduction Target**

- Incorporate a "no net increase in space" policy for the entire facility by 2013, including auxiliary units and rental space.
- Any new buildings or major renovations should be net energy neutral or a net energy provider by 2025.

**Strategies**

- **OSGM1.** Space marketplace
  - Implement a space marketplace to enable rewards for space reduction and swaps
- **OSGM2.** LEED certification
  - Move LEED certification requirements from Silver to Gold for new buildings and major renovations by 2014 and LEED Platinum by 2015. Apply LEED Gold construction standards without certification for all other construction projects
- **OSGM3.** Surpassing the Standard
  - Currently planned projects should be required to demonstrate at least a 30 percent improvement in building performance over the latest ASHRAE Standard 90.1 baseline for total building energy.

**Landscape Adaptation**

Allerton Park has been one of the most important natural areas for research in central Illinois. A long and diverse literature exists regarding the flora and fauna of the local environment. Some of these investigations were short-term, one-time studies; others are more long-term in nature.
**Landscape Restoration**

Allerton Park offers a unique opportunity for restoration of the prairie/forest ecosystem left in Illinois. The park and associated agricultural land covers almost 4,000 acres. Allerton Park occupies both sides of the Sangamon River, a high quality stream, complemented by large acreages of one of the largest and highest quality floodplain and upland forests left in Illinois. This matrix of communities and its overall size supports many remnant populations of vertebrates and plant species which were common throughout the Grand Prairie before European settlement.

The restoration of four sections of cropland adjacent to Allerton Park would be a major contribution to enhancing carbon sequestration associated with the Park. The technology and expertise to conduct a restoration of this scale and magnitude is currently available. The primary issue facing such a project is the recovery of revenue lost to the park from the conversion of 2,560 acres of row crops to prairie. To address this issue, several avenues could be realistically pursued if the University embraced the concept and put its full support behind it.

For example, as new farmland is gifted to the University, it could be substituted for acres taken out of production at Allerton Park. This could be based on soil productivity or on an acre-for-acre basis. A fund appeal to alumni and faculty promoting the project and soliciting donations toward completing the project would be very well received, resulting in an endowment at some point in the future. It would be...
fitting that this objective be achieved and these research opportunities supported by Illinois' only Land Grant College.

If complete restoration is not an option for certain parcels of land, the modification of agricultural practices (proposed in Section 2.5) is another method of carbon sequestration in soil. Reforestation on marginal crop and pasture lands transfers atmospheric CO2 to new biomass. For this process to be successful it is important to either manage such forests in perpetuity or use the wood from them for biochar, bio-energy with carbon storage, or durable products.

The University of Illinois-owned agricultural land north of Allerton Park could provide a unique opportunity to research the use of native prairie vegetation for biofuels. Using native prairie plants would provide ecosystem services such as providing grassland bird habitat, minimizing surface water runoff, reducing sediment load into waterways, etc. in addition to biofuel stock. A minimum of 200 acres could be set aside as a prairie restoration, harvesting 100 acres for biofuel use leaving the remaining area for grassland birds and other wildlife to use.

With regard to landscaping, choosing native plants is beneficial from both an ecological and conservation standpoint. While native plants generally require less maintenance, converting turf grass and other shallow-rooted plants to natural prairies or woodlands can also increase the amount of carbon capture. At the University of Illinois, students in the Department of Natural Resources and Environmental Sciences have started the process of developing a local carbon registry for the local purchase of carbon offsets. This and related efforts may be applied to Allerton and should be studied and incentivized.

**Landscape Adaptation Targets**

- Develop a land management plan which focuses on bolstering ecological resilience in the region
- Implement a no net increase in maintained lands policy immediately
- Develop and implement a plan devoted to planning for and implementing sustainable landscapes and landscape maintenance practices
- Convert at least 9 acres (50 percent) of no-mow lands to natural habitat by 2020

**Strategies**

- **OSLA1.** Restore croplands
  - Restore adjacent cropland to Allerton Park through land swaps, taking into account average crop yields in other locations
- **OSLA2.** Collaboration opportunities
  - Collaborate with federal and state initiatives for environmental conservation and management
- **OSLA3.** Biomass energy
  - Consider using native prairie vegetation to supplant non-renewable forms of energy used on-site
- **OSLA4.** Prioritize native plants for landscaping purposes
- **OSLA5.** Carbon offset purchase
4B. Goals and Strategies - Fossil Fuel Dependence Mitigation

Deinvestments in Fossil Fuels
In 2009, 75 percent of Ameren IP’s commercial electricity was generated using coal-fired power plants. These coal-burning systems are likely to be comprised of some of the most high maintenance and oldest equipment available. However, frequent use is due to coal generally being available at a lower price per MMBtu as compared to natural gas or other sources. To date, purchased electricity from Ameren stands as Allerton’s lone investment in coal-based energy systems. Given that 60 percent of on-site emissions come as a result of purchased electricity, improved efficiency and transitioning to renewable electricity sources are the most feasible forms of reducing coal dependence at Allerton.

The planned retirement of coal-fired power plants in Midwest grid will reduce 63-75 MT CO2 emissions annually from 2012 to 2015. However the effect of this emission reduction will not last to 2035, since the park will be electricity independent by that time and the grid natural gas emissions in place of coal emissions will also be eliminated.

Reduce Coal Dependence

- Incentivize the establishment and use of a local carbon registry for purchasing local carbon offsets

Geothermal Systems
Geothermal systems for cooling and heating have much higher efficiency (COP can be higher than 10) than the current systems in the park. Moreover, to fix all the energy use in the park in a form that can be...
met by renewable generation, it’s advisable to replace on-site fossil fuel use by electric systems. For those reasons, Allerton Park will install geothermal systems for heating and cooling before 2035.

System Size
Geothermal systems have the potential to mitigate building cooling, heating and refrigerant emissions in Allerton Park. With our carbon emission projections and conservation strategies, the remaining CO2 emissions of these three sectors without geothermal and other renewable energy applications would be:

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Emissions (MTCO2E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Cooling</td>
<td>511</td>
</tr>
<tr>
<td>Building Heating</td>
<td>116</td>
</tr>
<tr>
<td>Building Refrigerants</td>
<td>41</td>
</tr>
</tbody>
</table>

Geothermal systems are mostly sized with the larger of heating or cooling demand. However, in Allerton Park almost all cooling demand is already met by electric systems, thus the system only needs to be sized enough to meet the heating demand of the park in order to eliminating on-site natural gas usage.

With our projections, there will be 3,800 MMBtu of heating demand by 2035 in business-as-usual scenario. Among this, 1,400 MMBtu (38%) is likely to be offset by the conservation efforts listed in this plan. The other 2,400 MMBtu will leave 116 MTCO2 emissions from natural gas if not eliminated. Thus, the planned annual heating load of geothermal system in Allerton Park will be 2,400 MMBtu.

To keep the underground temperature unchanged from year to year, annual cooling load of the geothermal system needs to be designed close or equal to the annual heating load. Thus, the designed heating load for geothermal system will also be 2,400 MMBtu by 2035, and that will account for approximately half of the total remaining cooling load (the other part of cooling load is also fueled by electricity, thus it can be met by renewable generation).

Reduction Targets
- 39 percent of projected building cooling emissions in 2035 levels from 511 MT CO2e to 311 MT CO2e 200 MT CO2e. With Illinois Renewable Energy Portfolio Standards reducing 25 percent of the remaining emissions from 200 MT CO2e to 150 MT CO2e
- 100 percent of projected building heating emissions from 116 MT CO2e to 0
- 100 percent of projected building refrigerant emissions from 41 MT CO2e to 0
- That is in total 417 MT CO2e, which accounts for 35% of the total projected emissions.

Fossil Fuel Dependence Mitigation Summary
Fossil fuel dependence mitigation is contributing to about one-third of total CO2 reduction in this apCAP. It consists of two parts: the first is to move away from coal supply of electricity, which is dependent on the actions from larger entities such as coal-fired power plant retirement in Midwest ISO and the retirement of Abbott coal plant in the campus of U of I; the second is the park-wide implementation of geothermal systems for cooling and heating. Both are relatively long-term efforts and
the time of completion is contingent on various factors. The park aims to complete these projects by 2025 and no later than 2035.

Challenge:

**Deinvestment in fossil fuels:** This wedge is out of our control and is totally dependent on some larger entities. If they fail on their part, the park needs to consider compensating by adopting larger amount of renewable energy generation.

**Geothermal systems:** A transition to geothermal supply of heating and cooling has the potential of increasing energy efficiency, embracing more renewables from the grid and laying an important foundation for the future energy independence with on-site renewable. However this requires considerable initial investment (costlier than building conservation measures but cheaper than most other renewable generation options) and has a longer payback period (between 20-30 years). The park could put this as a long-term target to wait for lowering costs with technology advancement and increasing incentives on this. Alternatively, other high efficiency cooling and heating technologies (such as Variant Refrigerant Flow (VRF) systems) can also be future options.

## 4C. Goals and Strategies - Renewable Generation Transition

With regard to energy generation, Allerton Park’s primary objective is to maintain annual facility carbon emissions at the lowest possible rate by maximizing responsible, low-emitting energy sources. With this goal in mind, the Park has made a commitment, effective immediately, to abstain from purchasing energy derived from coal-based generation facilities whenever possible. This primarily includes significantly reducing the amount of purchased electricity from Ameren Illinois - generating 75 percent of its total electricity from coal-fired power plants as of 2009. Coal combustion generates over 200 lbs of CO2 per MMBtu of energy released, whereas alternative forms such as natural gas (currently a significant energy source for the facility) generates about 120 lbs of CO2 per MMBtu. Allerton will focus on emphasizing a larger role for the lowest-emitting energy sources in the near term. This will be done in tandem with addressing building inefficiencies such as lack of insulation and substandard or leaky windows in order to increase the effectiveness of existing renewable energy sources. Addressing inefficiencies and utilizing sources such as natural gas in the short term will substantially lower GHG emissions as well as acting as a bridge to a more intensive use of renewable energy systems in the long term such as on-site electricity generated from the installation of solar panels and wind turbines.

### 2025 Emissions

The total emissions of the park are 497 metric tons of CO2e in 2011. In the business-as-usual scenario projection, the park will emit 756 metric tons of CO2e in 2025. Conservation measures, geothermal system, reinvestment in coal-fired power generation and the Illinois Renewable Energy Portfolio Standard for off-site electricity are projected to reduce the emissions to 496 metric tons of CO2e. This shows that by the above-mentioned measures alone, it’s still very hard for Allerton Park to attain carbon neutrality in the future.
In this plan, the on-site renewable energy generation for Allerton Park will be mainly implemented from 2025 to help attain carbon neutrality by 2035.

2010 Total Emissions: 497 MT CO2e

Renewable Energy Strategies

Reduction Target

- Eliminate all the remaining emissions by 2035 (around 30 percent: 280 MT CO2e, 560,000 kWh Electricity per Annum).
• 60 percent of total park energy from renewable sources (including grid renewables and geothermal sources).

Reduction Strategies
• **RE1.** Wind Turbine, 2035 (202 MT CO2e)
  o Install at least one on-site utility-scale wind turbine to be constructed by fiscal year 2020 with a goal of additional turbines if feasible (about 130kW of capacity, annual power contribution of 450,000 kWh)
• **RE2.** Solar Panels, 2025 (56 MT CO2e)
  o Install solar panels of 90 kW capacity (about 110,000kWh annual power contribution).
• **RE3.** Wood Burning Boiler System, Ongoing (7 MT CO2e)
  o Maintain and look for opportunities to expand the current wood burning boiler system fueled by fallen timber and invasive tree species from on-site locations.
• **RE4.** Generation Facility Commissioning, Ongoing (15 MT CO2e)
  o Commission a detailed study by 2013 that examines Allerton Park energy generation and distribution systems, specifically tasked with distributing thermal energy more efficiently (e.g. hot water distribution, regeneration, geothermal use, etc.)
• **ITE1./RE5** Solar Charge Station, 2013 (100 percent: 2 MT CO2e)
  o Installation of a solar recharge station. (*This emission reduction is counted as internal transportation reduction*)

Renewable Energy Summary
Renewable energy plays an important role to attain carbon neutrality in the park. But it’s the furthest long-term strategy and we should not solely rely on them. The most efficient way is to conserve and conserve more and leave the lowest demand for renewable energy.

<table>
<thead>
<tr>
<th>Renewable Energy Generation</th>
<th>% Reduction</th>
<th>MT CO2e Reduction</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE1. Wind Turbine</td>
<td>72</td>
<td>202</td>
<td>2035</td>
</tr>
<tr>
<td>RE2. Solar Panels</td>
<td>20</td>
<td>56</td>
<td>2025</td>
</tr>
<tr>
<td>RE3. Wood Burning Boiler System</td>
<td>3</td>
<td>7</td>
<td>Ongoing</td>
</tr>
<tr>
<td>RE4. Generation Facility Commissioning</td>
<td>5</td>
<td>15</td>
<td>Ongoing</td>
</tr>
<tr>
<td><strong>Total Remaining Emissions:</strong> 280 MT CO2e</td>
<td>100</td>
<td>280</td>
<td>2035</td>
</tr>
</tbody>
</table>

Priorities:
1. Wood Burning Boiler and Generation Facility Commissioning: These measures are dealing with existing systems and are of lower costs.
2. Solar Panels: Solar panels have a long payback period but they are more flexible. We can leave grounds for their installation but new technologies allow to mount PV panels on building roof/façade/glass.

Challenges:
To eliminate the remaining emission, the measure that have the most potential is wind power generation. However, this requires considerable initial costs as well as large area of spaces. We want to
wait and see how much potential other measures can achieve, and then try to make minimal wind turbine investments to attain carbon neutrality at the end.

5. Summary Results

Mitigation Wedges

<table>
<thead>
<tr>
<th>Wedge</th>
<th>Completion Date</th>
<th>Wedge</th>
<th>Completion Date</th>
<th>Wedge</th>
<th>Completion Date</th>
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</thead>
<tbody>
<tr>
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<td>2017</td>
<td>Building Refrigerants</td>
<td>2017</td>
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<tr>
<td>Cooling &amp; Heating Electricity</td>
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<td>Building Heating Measures</td>
<td>2017</td>
<td>Building Refrigerants Elimination</td>
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<td>Lighting Retrofits</td>
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<td>Water Heating Measures</td>
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<td></td>
<td></td>
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<td>Computer/Electronic Measures</td>
<td>2015</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Hot Water Measures</td>
<td>2020</td>
<td>Guesthouse Appliances Measures</td>
<td>2015</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Internal Transportation 2020 | Service & Operation 2025 | Energy Source 2035 |
Replacement 2020 | Maintenance Measures 2022 | Renewable Energy 2035 |
Solar Charge Station Ongoing | Solid Waste Reductions & Recycling 2023 | Coal Mix 2017 |
Wastewater Reduction 2025 | Geothermal System 2035 |

Strategies Summary

Our research and calculation shows that to eliminate Allerton Park’s current emissions and future projected emissions growth by 2035, three broader categories of measures are required: (1) Energy conservation; (2) Energy mix change; and (3) On-site renewable energy. By the amount of potential carbon reduction, each of the three measures is approximately holding a one-third share.
**Energy conservation** includes strategies to retrofit the current systems and replace the inefficient equipment with more efficient ones to lower the total energy demand of the park. For those major sectors like building and service & operation, 30 percent of emission reduction are expected. For smaller sectors like waste and internal transportation, more than 70 percent of reduction are expected. Overall the park is expected to conserve more than 30 percent of its energy demand.

**Energy mix change** includes both external change and internal change. The external change is the change in energy mix of purchased electricity. The new EPA air pollution standards are phasing coal plants out of the power generation mix and Illinois Renewable Energy Portfolio Standards will require 25% of renewable energy generation by 2025. These external changes will significantly lower the park’s carbon emission before achieving energy independence. The internal change is mainly transferring natural gas usage and low efficient electric cooling systems to high efficient geothermal systems.

**On-site renewable energy generation** is to eliminate the remaining electricity emissions. The main measure will be wind turbine installation along with some PV panels. Currently the park already has biomass heating systems, which can supplement the heating system in the future.

**Priorities:**

*Conserve, conserve and conserve more:* Energy conservation strategies are the most economic, feasible, efficient and convenient measures. The earlier those conservation measures are implemented, the longer period the park can receive the return of energy cost saving, and the larger long-term impacts those measures will make with behavioral change influence. Thus Building, transportation, service & operation and waste energy reduction measures should all be top priorities and implemented by 2018. Those measures are also ongoing and the park needs to keep monitoring and optimizing energy use beyond 2018.

**Energy mix change:** This part of reduction is not totally in our own hand, but the Ameren is likely to complete the external change reduction effects by 2025. The final deadline for implementing geothermal system will be 2035. But technology advances could make geothermal system more economic and feasible in the next 10 years, thus the park could possibly install the system earlier. And other systems like Variant Refrigerant Flow systems are also of interests and worth looking at.

**Challenges:**

At present, balancing the emissions by renewable energy requires huge initial costs, long payback period and a considerable amount of land spaces. Thus large-scale implementation of those systems should only be carried out after the park has reached the maximum conservation potential.

**Funding Opportunities**

Funding is a core challenge of realizing the APCAP goals. Fortunately, many GHG reduction strategies are no-cost, low-cost, or will pay back investment costs over time. New funding and tracking mechanisms are needed to verify cost savings and recycle a portion of those savings into other initiatives and projects.
The institutional culture needed to evaluate, fund, and verify the costs and GHG reductions for the actions in the APCAP is only partially in place. Achieving APCAP goals will require operational and accounting changes that affect all departments and units.

A host of funding opportunities exists for these efforts including:

- Energy Service Companies (ESCOs)
- Revolving Loan Fund
- Improved Fundraising efforts (U of I Foundation involvement)
- Academic Facilities Maintenance Fund Assessment (AFMFA )
- Student Sustainability Committee
- Energy Billing Savings
- Corporate Partnerships
- Public/Private Partnerships

A more concerted effort for financing and funding the long-term commitment needed by Allerton Park will require additional resources. Approaches to “offset” these monetary needs include:

Establish a dedicated, centrally coordinated funding pool for APCAP projects. This “clean energy” fund should allow for both internal (fees, staff contributions, energy savings reinvestment, capital programs), and external (programs, rebates, donations, outside investors) participation in the fund. It should be established as a capital infusion and coordination mechanism aimed at physical energy and energy cost reductions that also allows for the sustained maintenance of these investments.

**Create a revolving climate loan fund.** A revolving loan fund is an effective way to initiate and sustain key components of the APCAP. A successful revolving loan fund will require initial capitalization, strategic loans, effective cost tracking, and verification to confirm projected cost savings and GHG reduction benefits are realized. The loan fund would provide capital for high-performance, energy efficient campus design, operations, maintenance, and occupant behavior projects.

**Pursue grants that reduce GHG emissions.** An area of specific interest is grants for implementing APCAP goals associated with building efficiency projects.

**Visitor and staff green commitment.** This fee would help Allerton achieve ambitious climate action goals and also give the staff a sense of parity and shared commitment with visitors. It would entail the creation of an internal donations strategy and process for staff to contribute to the visitor green fee or centralized pool.

**Assess GHG incentives for vehicular traffic.** A GHG incentive for cars will be instituted based upon their relative efficiencies by 2015. This may simply come in the form of creative solutions such as preferred parking. However, any potential monetary revenue will be used toward additional efforts to reduce transportation emissions.

**Develop an integrated donations strategy.** Moving to a low GHG economy is swiftly emerging as the defining issue of this time. Donors will want to support apCAP efforts - especially if they see Allerton
taking on a leadership role. Involving the U of I Foundation is essential to ensure clear messaging and a comprehensive, integrated approach. Furthermore, Allerton needs to establish a priority list of sustainability projects and assign a high-level liaison to support fundraising and implementation of such projects.

**Green marketing.** Establishing Allerton Park as a leader in climate response and implementation has significant marketing value that should not be overlooked. Money follows good projects that are visible and easily understood. Sustainability is becoming a core value of the institution, and continuing to build this reputation, supported by a good marketing program, is essential to gaining financial support for this effort.

### Future Climate Action Planning

The future of Allerton’s climate plans is as important as this initial response, answering the question of how the Park will continue on in the process toward carbon neutrality. Operationally, the Park will use the APCAP and the President’s Climate Commitment to provide a basis for regular review and critique. The University’s Campus Strategic Plan tracking system will provide a basis for monitoring and accountability. Likewise, specific duties will also be assigned to designated committees and groups, creating a detailed plan and report on progress.

Allerton Park is working diligently to enhance its engagement activities in the arena of sustainability. Over the course of the next year, Allerton hopes to build upon this Plan as a focal point for activity, stimulating public dialogue and creating a sense of community-based sustainability around the Plan. The aim is to develop an interdisciplinary approach which impacts Park visitors, staff, students, and the surrounding area. In turn, each of these groups will be exposed to the entire breadth of the Plan—and by extension the physical realities of the Park—empowering each respective group to contribute to an evolving plan through their own unique participation.

Student groups at Illinois will continue to be very active in the Park’s sustainability efforts. There are more than ten environmentally oriented, registered student organizations on the University campus. Already, the Student Sustainability Committee (SSC) has been integral in providing grant writing assistance for sustainable initiatives at the Park including a proposal in 2012 for a solar charging station for the facility’s fleet of electric carts.

Likewise, various University departments have been indispensable in promoting Allerton’s energy and sustainability goals. The Natural Sources Department (NRES) typically offers general support to the Park alongside research and education opportunities. Similarly, the U of I Extension offers gardening information and support. Another active State-based entity involved in the Parks’ sustainable development is the Illinois Department of Natural Resources (IDNR). The IDNR offers valuable assistance with regard to burn areas in natural and restored areas as well as material gathering and wildlife surveys. Allerton Park intends to continue to develop these partnerships, as well as encouraging new interactions with relevant community groups and individuals, in its pursuit of climate neutrality.
Accurate metering measures are crucial to determining the true future benefit of completed conservation projects and guides future investments in energy reduction. Accordingly, Allerton will repair, replace, or upgrade less than adequate utility meters through a series of projects with a focus on the currently conglomerated electrical and water metering of certain Park buildings. As a result, dependable utility metering will exist for on-site buildings, comprising approximately 97 percent of Allerton’s annual internal emissions production.

Currently, the Park is modifying its website in order to facilitate and recruit volunteer support while employing an on-site volunteer coordinator to direct volunteer efforts related to the implementation of climate action strategies and sustainable initiatives. Furthermore, the University’s Office of Public Engagement, coupled by the Student Sustainability Committee, has joined in an effort to engage the Park and the surrounding community in a shared discourse on the critical sustainability and climate issues ahead. Grants have already been submitted to various entities through the support of these groups in order to obtain funds to further Allerton’s drive for carbon neutrality and maximum energy efficiency.

Implementing the previously outlined strategies will require a major shift in culture both at the Park as well as within the surrounding community. Works-in-progress with regard to the overall sustainability initiative will help to address this needed change. Paralleling the University’s 2007 Campus Strategic Plan, Allerton has identified sustainability as a new core initiative. In response to this initiative, and backed by strong advocacy from student groups, an administrative Sustainability Council, an Office of Sustainability, and several related task forces on specific sustainability issues were formed to assist in the investigation and implementation of opportunities to integrate sustainability into the campus culture – and by extension, Allerton Park. Allerton intends to utilize these groups to bolster implementation of the apCAP. These opportunities include Allerton’s response to the climate crisis. Significant efforts are underway in addressing each of the Park’s core components of its mission—education, recreation, research, and public engagement, alongside with campus operations, as they relate to this core initiative.

6. Appendices

A Glossary of Acronyms

AASHE – Association for the Advancement of Sustainability in Higher Education
ACUPCC – American College & University Presidents’ Climate Commitment
AFMFA – Academic Facilities Maintenance Fund Assessment
ANSI – American National Standards Institute
ARRA – American Recovery and Reinvestment Act
ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME – American Society of Mechanical Engineers
CAP – Climate Action Plan
CAV – Constant Air Volume
CBECS - Commercial Buildings Energy Consumption Survey
CO2 – Carbon Dioxide
ECE – Electrical and Computer Engineering
EPP – Environmentally Preferable Purchasing
ESCO – Energy Service Company
EUI - Energy Use Intensity
GEMS – Global Electric Motorcars
GHG – Greenhouse Gas
GSF – Gross Square Foot
HR – Human Resources
HVAC – Heating, Ventilating, and Air-Conditioning
IESNA – Illuminating Engineering Society of North America
ILRPS – Illinois Renewable Portfolio Standard
IPCC – Intergovernmental Panel on Climate Change
ISTC – Illinois Sustainable Technology Center
IT – Information Technology
Klbs – thousand pounds
kWh – kilowatt hours
LEED – Leadership in Energy and Environmental Design
MISO – Midwest Independent Standards Operator
MMBTU – One Million British Thermal Units
MTD – Mass Transit District
MTE – Metric Ton Equivalent
MW – Megawatt
PACE – Property-Assessed Clean Energy
PCAP – Presidents’ Climate Action Plan
PV – PhotoVoltaic
RBRC – Rechargeable Battery Recycling Corporation
RCx – Retro-Commissioning
RPS – Renewable Portfolio Standard
SECS – Students for Environmental Concerns
SOV – Single Occupancy Vehicle
SSC – Student Sustainability Committee
VAV – Variable Air Volume

Bibliography