TCAAP Energy Integration Resiliency Framework Phase 1: Policy White Paper

RAMSEY COUNTY

ARDEN HILLS

EVER-GREEN ENERGY™

Burns & McDonnell SINCE 1898

cee Center for Energy and Environment

Fresh Energy

Acknowledgements

The Project Team would like to thank the City of Arden Hills, Ramsey County, the Energy Resiliency Advisory Board, and the Joint Development Authority for all of their input and guidance in the development of this White Paper. Their insights proved invaluable as the Project Team developed the outline and content for this document. Their continued support will also be critical as the broader Energy Integration and Resiliency Framework is completed.

About the Project Team

Ever-Green Energy

Ever-Green Energy has transformed decades of experience in engineering, system development, and utility ownership and management into one of the country's foremost experts on the advancement of community energy systems. The Ever-Green team delivers projects from concept to construction to industry-leading system operations. Ever-Green is a consulting, operation, and management firm with the experience to help communities, colleges and universities, and government organizations advance the study, development, and operation of integrated energy systems. Ever-Green is uniquely qualified to assist communities with finding sustainable solutions for integrating energy needs and securing their system's energy future.

Burns & McDonnell

Burns & McDonnell, headquartered in Kansas City, MO, is a full-service engineering, architecture, construction, environmental and consulting solutions firm. The company's multidisciplinary staff of nearly 5,000 employee-owners includes engineers, architects, construction professionals, planners, estimators, economists, technicians, and scientists, representing virtually all design disciplines. Burns & McDonnell plans, designs, permits, constructs, and manages facilities all over the world, with one mission in mind: "Make our clients successful."

Center for Energy and the Environment

The Center for Energy and Environment is a nonprofit organization that promotes energy efficiency to strengthen the economy while improving the environment. CEE conducts research and develops programs so that: businesses operate more efficiently and profitably; government agencies and nonprofits spend less on facilities and functions; utilities achieve their energy-efficiency goals at least-cost; and households save money and improve comfort.

Fresh Energy

For more than 20 years, Fresh Energy has transformed widely held economic and environmental ideas into smart energy policy. Fresh Energy works in the realm of public policy, changing the rules that govern our energy system. The organization's efforts focus on energy efficiency, clean energy, transportation and land use, and carbon reduction.

Contents

Executive Summary

Located in Arden Hills, Minnesota, the Twin Cities Army Ammunitions Plant (TCAAP) is a 427-acre site that has recently gone through an extensive demolition and site environmental remediation program, and stands ready to be redeveloped into an attractive addition to the Arden Hills community. Ramsey County (County) and Arden Hills (City) have engaged in a partnership through the formation of a Joint Development Authority (JDA) to craft a bold and deliberate energy framework. This framework will develop appropriate planning guidelines and policies with careful consideration of local resources, stakeholder interests, project goals, and the best available technologies for implementation over the next 50 years.

TCAAP offers an incredible opportunity for the County, the City, and the surrounding community to build a forward-looking community that is prepared for the energy and environmental issues of the new generations who will live, work, and recreate there. With efficient buildings, the site can provide low-cost energy for residents and tenants. Innovative energy supply systems can be designed for reliability and resiliency. Increased use of local renewable energy systems can reduce the site's environmental footprint. With planning and leadership, the JDA can plan its streets with low-carbon energy sources in mind, request developments that meet energy and environmental standards, and engage future residents about the community's energy use and their role as stewards of that vision.

This Policy White Paper serves several purposes. It provides a unifying vision for the site's energy future looking out over 50 years, and identifies the most beneficial opportunities for energy efficiency and efficient energy supply options. It presents policy actions that the JDA, the City, and the County can consider to support that energy future, including through the TCAAP Redevelopment Code, the County RFP process, and future City or County ordinances. This paper also outlines immediate-term, near-term, and long-term actions that can help the JDA, the City, and the County achieve a bold energy vision for the site.

Developing the White Paper is the first of a two-phase project. Phase two will produce an energy resiliency framework with more details about how the JDA can technically achieve the vision and recommendations put forth in this paper. Phase two will be completed in March 2015.

Energy Resiliency Advisory Board

The County and the City recently established the Energy Resiliency Advisory Board (ERAB) and appointed community stakeholders to help define TCAAP's energy vision. This vision forms the basis for the White Paper and the Energy Integration and Resiliency Framework, and also sets a common language for stakeholders that are engaged in the development of the TCAAP site.

The ERAB envisions TCAAP as a vibrant development that leverages long-term energy strategies and infrastructure to attract investment and partnership, and achieves sustainable benefits for the City and the surrounding community.

The following guiding principles have been established to influence energy supply and energy efficiency decisions at TCAAP:

- Establish TCAAP as a national model for development of integrated energy systems
- Develop a resilient community for energy and other utilities
- Implement infrastructure solutions that are flexible and scalable over the next 50 years
- Deliver a model of efficient energy and water usage that minimizes TCAAP's impact on the environment
- Create an economically competitive and attractive environment for developers and businesses

Key Recommendations

While many energy supply and energy efficiency opportunities are possible at TCAAP, our Project Team recommends immediate-term, near-term, and long-term steps to consider as the JDA advances the development of TCAAP and pursues the energy vision.

Immediate-Term (2015)

- The JDA, City, and County should develop a coordinated plan for the installation of comprehensive energy infrastructure grids as the Spine Road and other early roads are built. These grids should include allowances for thermal grids as well as gas and electric grids. This basic infrastructure plan can also address high efficiency street lighting needs throughout the site.
- The City should review and adopt recommended changes to the TCAAP Redevelopment Code for greater allowance of energy efficiency and renewable energy.
- The JDA, City, and County should initiate conversations with the Arden Hills Army Training Site (AHATS) and Xcel Energy to discover opportunities to partner and develop innovative infrastructure and available renewable energy sources together while exploring opportunities to utilize microgrid or other smart grid modernization demonstrations.
- The JDA, City, and County should complete an assessment of the potential for on-site solar PV, solar thermal, and passive solar building design based on street layout and building orientation, as

well as community wind potential. The potential to utilize the existing groundwater being treated on TCAAP as an energy source should also be investigated.

- The JDA, City, and County should initiate conversations with the Minnesota Department of Commerce and the Minnesota Department of Employment and Economic Development, local foundations, and the Saint Paul Port Authority to explore funding mechanisms to attract developers, businesses, and future TCAAP residents. The JDA should also reach out to the US Department of Energy and the US Department of Commerce's Economic Development Authority on forthcoming grant opportunities.
- The JDA and County should develop specific criteria and standards to reward potential developers for innovative energy projects in their request for proposal (RFP) criteria. This could include rewarding developers for agreeing to meet certain energy standards, installing high efficiency energy systems, utilizing renewable energy supply technologies, or agreeing to receive thermal energy from a community district energy system.
- The JDA, City, and County could identify additional partnerships and funding opportunities to support innovative and sustainable infrastructure and demonstrations. Partners could include the University of Minnesota or the US Department of Energy.
- The JDA, City, and County should develop energy standards and a process for review that support the design and construction of energy-efficient and resilient buildings.

Near-Term (2016 – 2020)

- The County should create awareness with clean energy businesses of the potential for collaboration and innovation at TCAAP.
- The JDA should consider establishing an advisory committee of regional energy experts that will provide energy-focused feedback after initial site development. In certain circumstances where approaches intersect, transportation and housing experts could be included to maximize synergies.

Long-Term (Beyond 2020)

- The City could consider including prioritization of energy efficiency, climate change adaptation, or energy resilience as part of its comprehensive plan, in order to facilitate strategic use of the Planned Unit Development process or other tools to allow flexibility for resilient energy uses at the site.

- The JDA could establish TCAAP as a clean energy incubator for advanced energy supply and storage technologies.
- To capture long-term energy efficiency on the TCAAP site, the JDA could collaborate with local utilities and third-party organizations to provide ongoing building energy usage monitoring and recommissioning services to maintain optimal energy performance.
- The JDA might seek collaboration with Xcel Energy and or technology companies seeking a specific site to demonstrate the value of larger-scale energy storage and electric vehicles.
- The JDA could collaborate with Xcel Energy to engage local residents and business in an energy disclosure program.
- As TCAAP development matures, the JDA or City may seek utility partnership in piloting innovative demand response technologies and strategies to help businesses and homes save money.

Next Steps

While the City and County are working on a number of fronts to differentiate TCAAP as a national model for site development, some immediate actions should be taken to continue progression toward TCAAP's energy vision. The following specific actions are needed to prepare the site for long-term energy conservation and resilience:

- The City and County should begin a comprehensive utility coordination effort with private and public utilities in preparation for the build-out of early road infrastructure. Thermal energy grids should be included in this discussion.
- The JDA should provide this White Paper to AHATS leadership and begin discussions about possible collaboration.
- The JDA should provide this White Paper to Xcel Energy leadership and begin discussions about possible collaboration.
- Through work on the Energy Integration and Resiliency Framework, the Project Team will begin developing cost-benefit analyses on those technologies that have the greatest viability in the early stages of TCAAP development. The Project Team will also provide an implementation plan and conceptual blueprint for the development of TCAAP's energy future.
- The JDA should develop marketing and promotional material for the TCAAP site that includes references to the energy vision.

Policy White Paper

1. Introduction

Since 1941, the Twin Cities Army Ammunitions Plant (TCAAP) has played a significant role in the incorporation and development of the City. The 427-acre site, now owned by Ramsey County (County), has recently gone through an extensive demolition and site environmental remediation program. The TCAAP site offers an incredible opportunity to the City, County, and the surrounding community. This area offers the potential to meet the demands of local growth, while setting a framework that balances economic competitiveness and sustainable development. As such, the development of appropriate planning guidelines and policies requires careful consideration of local resources, stakeholder interests, project goals, and the best available technologies for implementation.

In November 2012, the Ramsey County Board and Arden Hills City Council approved a Joint Powers Agreement (JPA), which establishes a partnership between the County and the City with the goal of the remediation and productive reuse of the TCAAP site. This agreement included the formation of a JDA to which will be the governance entity for development decisions at the site. The City and County have their respective rights and responsibilities, but are closely coordinating their activities through the authorities given to the JDA. In addition to its governance role as a JDA member, the County is the owner of the TCAAP site and has the rights and responsibilities of an owner.

Recently, the JDA decided to develop an Energy Integration and Resiliency Framework (framework) in order to prepare a foundation for effective energy policy for the next 50 years. The framework will be developed in two phases. Phase one includes development of a vision statement and a White Paper that provides an overview of relevant energy issues on the site, along with an assessment of what technologies could be possible at TCAAP. Phase two will provide a detailed analysis of the White Paper recommendations, with assessment based primarily upon the energy related investment return, energy supply reliability, energy efficiency, environmental impact, and economic competitiveness for the TCAAP site. To provide advice during the framework development process, the JDA formed an Energy Resiliency Advisory Board (ERAB). The County contracted with a team of industry experts led by Ever-Green Energy to develop the framework.

The Project Team of Ever-Green Energy, Center for Energy and Environment, Fresh Energy, Burns & McDonnell (Project Team), and TCAAP leadership have worked to establish a common vision for site development that can help guide the planning efforts of the JDA, and the funding and financing efforts for developers, while establishing a national model for responsible development. This vision will guide research, recommendations, policies, and actions throughout development and well into implementation. The vision is also important to align project goals and long-term potential for the area. Through development, the energy vision will allow for an innovative approach to the role of local government policy in managing clean energy transition at the "distribution edge," where utility service ends and customers have begun adopting new approaches to energy consumption.

2. Vision Statement and Guiding Principles

In order to establish clearly defined goals for the energy future of the TCAAP site, the ERAB, the City, the County, and the Project Team participated in a coordinated effort to establish an energy vision statement for TCAAP. The purpose of this vision is not only to form the basis for the development of the White Paper and framework, but also set a common language for stakeholders to as they develop the energy plan for TCAAP.

2.1. Process

The Project Team and the County met with ERAB and the City to discuss various factors, themes, and concepts for the site that they felt would be important for the development of the TCAAP site as it relates to energy planning. In September 2014, ERAB brainstormed concepts for the TCAAP site. These ideas were consolidated into the vision statement and guiding principles, which have been adopted by ERAB and are listed below.

Vision Statement

TCAAP will be a vibrant development that leverages long-term energy conservation and resilience to attract investment and partnership, and achieves sustainable benefits for Arden Hills and the surrounding community.

Guiding Principles

- Establish TCAAP as a national model for development of integrated energy systems
  - Develop a transparent model that garners national attention and local community pride
  - Deliver environmental, economic, and social benefits to the community beyond the TCAAP site
  - Deliver a high-quality model that provides educational opportunities for the greater community
- Develop a resilient community for energy and other utilities
  - Endeavor to make investment in renewables economically attractive
  - Pursue opportunities that reduce consumption, capture residual energy, and reuse local resources
  - Be self-sufficient to the extent possible and practical using local and renewable sources of

energy

- Implement infrastructure solutions that are flexible and scalable over the next 50 years
  - Cultivate a platform that enables integration of future technological advances and more efficient forms of energy
  - Develop a smart grid on the TCAAP site
- Deliver a model of efficient energy and water usage that minimizes TCAAP's impact on the environment
  - Introduce a comprehensive policy approach that promotes efficient utilization of all resources
  - Foster the advancement of behaviors and technologies that decrease the consumption of energy and natural resources
- Create an economically competitive and attractive environment for developers and businesses
  - Build a framework that is financeable, high quality, and sellable in private markets
  - Prepare TCAAP to become a vibrant community that attracts people, developers, businesses, and connects to surrounding communities.

The ERAB has adopted this vision statement and these guiding principles to guide the Project Team as it evaluates and recommends various alternatives for demand-side management, energy supply alternatives, and policies that could be implemented to support achievement of the energy goals at the TCAAP site.

3. Unique Opportunities for the TCAAP Site

The TCAAP site is in the unique position of becoming a flagship for site redevelopment in suburban and urban communities. Beyond being a "greenfield," TCAAP has a number of characteristics that make it special. The following opportunities have been identified as having additional influence on realization of the energy vision for TCAAP.

3.1. Primary Infrastructure Investments

As the County nears completion of demolition activities at TCAAP, the area will be essentially a green-field site. As such, a number of infrastructure investments will be necessary to prepare the site for development. Thoughtful and coordinated installation of infrastructure throughout the TCAAP site prior to development will set the foundation for leveraging future energy source options and technological advances as they become available and viable. This is an immediate need and these opportunities should be planned in a coordinated manner to optimize efficiency and reduce overall cost.

3.1.1. Gas Pipeline

The local gas utility is expected to install gas line infrastructure that will service the expected development on the TCAAP site. This pipeline could also be utilized in the future to deliver biogas or hydrogen as fuel sources if they become viable alternatives. A properly sized gas pipeline will also be important for any gas-fired combined heat and power systems that are implemented on the site.

3.1.2. Electrical Distribution

The local electric utility is expected to install electric distribution infrastructure to meet the development at TCAAP. Consideration should also be given to the possibility of future on-site generation from several of the energy supply alternatives described later in this White Paper, even to the extent that TCAAP is a net exporter of electricity at certain times of the day or periods of the year. For example, if a large solar farm were installed in partnership with the AHATS, there could be times when electric generation would exceed the electrical needs of both TCAAP and AHATS. A similar scenario could occur if large-scale combined heat and power (CHP) was integrated into TCAAP's energy plan. Consideration of these export events should be given when designing the electrical infrastructure on-site and interconnections to the transmission system.

3.1.3. Thermal Heating and Cooling Grids

District hot water and chilled water distribution systems allow for the transfer of thermal energy from various sources to consumers throughout the district and leverages the diversity of buildings in the area to increase system efficiency. District heating and cooling also allows the aggregation of thermal loads that can be used with CHP plants or distributed renewable generation for far greater system efficiencies than stand-alone heating systems in each building. District heating and cooling networks are versatile infrastructure systems that can be integrated with various technologies such as thermal energy storage and on-site power generation for CHP, as well as future energy sources as they become available. The use of this infrastructure is growing globally and is currently in place in large and small communities across the United States, including more than 24 systems in the Twin Cities metro area.

3.1.4. Low-Temperature Water Loop

Distinct from district heating and cooling loops, certain less-dense areas of TCAAP may benefit from the utilization of low-grade energy to meet their heating and cooling needs. For example, in the residential areas of the Hill and Creek, the homes could leverage energy from the existing treated ground water or geothermal wells and utilize ground or water-source heat pumps to heat and cool their homes. To do this, a core water loop would need to be installed in the residential areas prior to development. To keep the costs of this infrastructure as low as possible, installation could be coordinated with street construction for the area.

3.1.5. Direct Fiber Broadband

Over the next 50 years, a reliable, state-of-the-art communications infrastructure that supports an intelligent grid will be a backbone of the energy supply system. This infrastructure would also allow for "smart" advanced metering, communications, and controls, which will provide end users with greater information and control over their energy usage. Use of such advanced communication infrastructure will allow individual technologies and buildings to improve performance as a result of real-time conditions, and also allow future energy consumers to be more engaged and responsive. Many energy efficiency innovations rely on the opportunities to connect customers, equipment, utilities, and supply technologies across an advanced communication infrastructure. As an added benefit, a municipally-owned system could provide an additional revenue source for the owner. An advanced communications infrastructure would also offer piloting and demonstration opportunities for the growing field of intelligent energy technologies. A reliable and advanced communications infrastructure has co-benefits for attracting businesses that rely on access to high-speed internet and communications technologies. This infrastructure should be deployed as part of the street utilities, once again to lower the initial cost of installation.

3.2. AHATS Partnership on Energy Supply Alternatives

The AHATS site has developed a master plan for the buildings on its site that includes the goal of net-zero energy, water, and waste, and are currently working on implementation plans to achieve this goal.

While AHATS intends to operate on a microgrid itself, its leadership is open to discussing the possibility of developing a microgrid plan that cooperates with TCAAP's energy supply plans. The efficiency and economic competitiveness of both sites' energy plans should benefit from this cooperation.

Some of the solutions being discussed by AHATS include energy supply alternatives that are similar to those recommended in this White Paper, including geothermal and solar collection systems. As such, coordination with AHATS on potential energy supply solutions could provide greater efficiency, economic competitiveness, and environmental and financial benefits for the community.

While AHATS operates throughout the week, their greatest activities occur on the weekends. This load profile could complement the loads of many of the commercial areas of TCAAP and the two sites could leverage this diversity to establish a more efficient energy consumption profile for the greater area.

AHATS has already begun implementing a number of energy conservation measures that distinguish the site as a leader for energy efficiency within the Army and the state of Minnesota. AHATS will continue to improve its energy efficiency as technology continues to advance. Many of the demand-side management opportunities listed in this White Paper could also be utilized on the AHATS site. Cooperation between AHATS and TCAAP has the potential to be a very dynamic and beneficial partnership for both sites.

3.3. Electric Vehicles Demonstration Platform

The energy system of the future includes electric vehicle (EV)-friendly streets and buildings that minimize barriers for users. More users will mean more grid flexibility and resiliency and make our communities cleaner, quieter, and more financially sustainable. While the benefits for the residents of Arden Hills would be visible locally, the value of mobile energy storage has broader benefits for the energy customers of Minnesota.

As utilities more closely examine the benefits and challenges of a growing electric fleet, the City may have the opportunity to partner with its electricity service provider in a unique way. A demonstration platform with extensive electrical vehicle charging facilities, decentralized energy storage in homes and buildings, and the communication infrastructure for advanced demand response would not only be the first of its kind in Minnesota, but in the country. Such a project could attract other business investors, foundation support, and government collaborators.

3.4. Public Transit Facility Siting

Located in a growing region of the metropolitan area, TCAAP could benefit from a comprehensive transit strategy that focuses on access and economic opportunity and includes strong consideration of biking, pedestrian, and transit connections. An immediate opportunity is the potential siting of a public transit facility, integrating large fleets of EVs. With no existing loads on site, a facility that may house dozens of electric hybrid buses at night and EVs during the day could provide a predictable energy load. Combined with other large-scale energy storage and on-site renewables, the nature of this load growth could open up opportunities for additional utility innovative technology demonstration.

Engaging potential partners on a comprehensive transit strategy could result in mutually beneficial development and operational costs, and a model of collaboration between the energy and transportation sectors.

3.5. Planning Streets for Optimal Building Orientation

In Minnesota, building orientation has a significant impact on heating and cooling needs, and can also increase the potential for rooftop solar systems. Windows on the south side of a building gain heat throughout the day, while windows facing north lose heat. The optimal orientation for PV systems is facing south-southwest to generate solar electricity when it is needed the most – late in the day during peak demand. For these reasons, there is an opportunity for subdivision plans to consider optimal building orientation for energy purposes. The first factor to consider is street orientation as it is common practice to develop a building or home parallel to the street. The second factor is flexible zoning that allows for buildings to be oriented in different directions within the boundary of a site. While street-facing entrances will increase site walkability, canted buildings could offer opportunities for welcoming public outdoor spaces.

Landscaping placement can also play a role in buildings' energy consumption. Deciduous trees can provide passive cooling on the west side of a building during the summer, while conifers on the north side can buffer the wind. Tall trees planted to the south can also hinder access to solar.

3.6. Coordination with Public Works

The infrastructure needs of community energy systems (microgrids, CHP, district heating and cooling, etc.) can be extensive and expensive. The cost of constructing these facilities can be drastically reduced when constructed in conjunction with other large-scale utilities (water main, sanitary, storm sewer, etc.). District energy facilities are the most conducive to shared construction, and typically coordinated construction can experience cost savings of up to 35% for the installation of a district energy system, primarily due to the reduction in civil construction and surface restoration.

Another advantage of cooperative construction of municipal utilities and district heating is the possibility of reduced excavation and cost for the installation of municipal utilities. In Minnesota, water main lines are typically installed at a minimum depth of seven feet to prevent freezing. To prevent contamination of the drinking water, the sanitary sewer must be installed deeper than the water main, typically ten feet deep or more. Because district heating systems have residual heat loss through the transmission system (minimal, but tangible), there is a heat affected zone around the district heating pipes. This heat affected zone follows a triangular shape down and away from the district heating pipes. Locating the water main in the heat affected zone reduces the potential for freezing, allowing for shallower installation for both the water main and the sanitary sewer.

3.7. Snow and Ice Melt Systems

Snow and ice melting (SIM) systems use low-grade heat from a variety of potential sources (solar thermal, ground source heat pumps, waste heat recovery, etc.) to provide a safe and reliable way to keep street and sidewalk surfaces clear of snow and ice, without the need for environmentally damaging salts or intensive maintenance efforts. SIM systems circulate water mixed with antifreeze at approximately 100 degrees Fahrenheit through small tubes located under surface of the sidewalk or pavement to heat the surface, preventing the accumulation of snow or ice. The water then drains naturally into the storm drain system without the harmful contaminants associated with traditional snow removal and storage. A SIM system could provide a significant financial benefit to the City due to the reduced maintenance requirements, as well as a defining feature for the development.

4. Expected TCAAP Development

The City, the County, and the JDA have been working to develop the master plan for development of the TCAAP site. During the master planning process, they have identified five major areas of development for the site. These areas of the development are the Thumb, Town, Hill, Creek, and Flex. These areas are classified in the table below based on the current status of the master planning process.

Development Area	Zoning Classification	Estimated Unit Density	Number of Acres	Maximum Building Height
Thumb	Campus Commercial	1 Story Bldg/4 Acres	46 Ac	45’
Town	Office Mixed Use	20-40 Units/Acre	25 Ac	65’
	Retail Mixed Use	20-40 Units/Acre	16 Ac	65’
	Mixed Use	8-10 Units/Acre	11 Ac	55’
	Neighborhood	3-4 Units/Acre	48 Ac	40’
Hill	Neighborhood	3-4 Units/Acre	62 Ac	40’
Creek	Neighborhood	3-4 Units/Acre	42 Ac	40’
Flex	Flex Office	2 Story Bldg/4 Acres	75 Ac	45’

Using the property density and proposed usage, the Project Team developed an estimate of the energy usage for each area of the development.

Total Project Energy Consumption by Area			
Area	**Load (Kbtu)**	**Square Feet**	**% of Load**
Thumb	264,065,599	3,402,907	26%
Office	188,467,390	2,428,703	18%
Retail	63,852,464	682,184	6%
Mixed Use	32,790,602	350,327	3%
Multi-Family	34,990,409	1,599,240	3%
Town (low-density)	46,614,676	1,178,944	5%
Hill	13,775,509	348,400	1%
Creek	9,252,207	234,000	1%
Flex	366,704,807	3,917,786	36%
TOTAL	**1,020,513,663**	**14,142,492**	**100%**

Based on the load disparity between the different areas of development, the proposed energy supply alternatives and demand-side management strategies will be more applicable in some development areas than in others. For example, community energy systems are most efficient and economical in areas with higher load density, thus such a system could prove to be more challenging to implement in the Hill and Creek areas of the development. This White Paper will provide energy supply alternative (energy supply) and demand-side management (energy efficiency) options that are more applicable for each of the development scenarios that have been identified for the TCAAP site.

5. Energy Supply Alternatives

While reviewing the energy supply alternatives that are currently available to the TCAAP site or could become available over the next 50 years, the Project Team evaluated two types of energy supply options: electric and thermal. The options identified are described in detail below.

Key Takeaways: Energy Supply Strategies

- Development of solar PV and solar thermal systems, in collaboration with AHATS, could meet a significant portion of the energy needs on-site. Integration with energy storage would increase the reliability of these energy sources.
- Combined heat and power would fit well in the commercial and light industrial areas of TCAAP such as the Town and the Thumb, where there are coincidental electric and thermal loads.
- Ground-source and water-source heat pumps could be an efficient and cost-effective energy supply solution for the residential areas of TCAAP. This technology could leverage the low-grade energy available in the ground water currently being treated on-site.
- Development of a microgrid in collaboration with AHATS would provide TCAAP with a reliable, resilient energy solution that mitigates the risk of market volatility and grid disruptions.

5.1. Electric Energy Supply Alternatives

The local electric utility, Xcel Energy, is expected to distribute electricity to all of the development within the TCAAP site. The following technologies could work in collaboration with the electric grid to optimize the utilization of local electricity supply and improve the overall efficiency of TCAAP.

5.1.1. Solar Photovoltaic Panels

Through the utilization of solar radiation and photovoltaic technology (PV), renewable electricity can be generated and provided to a community grid, microgrid, or individual end-user on the TCAAP site. The National Renewable Energy Laboratory's (NREL) Renewable Resource Data Center (RReDC) provides access to renewable energy resource data, maps, and tools. Based on the average annual solar radiation data, the City receives between 2 to 3 kWh/m2/day, which is slightly below the national average, yet still considered viable. Even so, according to NREL, solar is Minnesota's largest energy resource by technical potential.[1] Community solar projects allow residential and commercial customers

[1] Lopez, A. July 2012. *U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis*. National Renewable Energy Laboratory (NREL). Accessed Jan. 2013. http://www.nrel.gov/gis/re_potential.html

to subscribe to a larger solar facility and receive credit for their subscribed portion of the project directly on their electricity bill as if the facility was located onsite.

Rooftop solar PV arrays are viable options for TCAAP residents and commercial buildings, as long as building or roof orientation and structural provisions for the panels are incorporated into the building design standards. Additionally, ground-mounted solar systems, which currently tend to be more cost-competitive, are also optional. TCAAP is located within Xcel Energy's service territory, which allows solar owners to access economically favorable utility-tariff options, such as retail net-energy metering. Commercial Xcel Energy customers can also apply for production-based incentives for projects that interconnect by 2024.

5.1.2. Wind Generation

The generation potential of wind turbines is highly dependent on the equipment installed and the wind velocities available on the site. Based on the Minnesota Department of Commerce Wind Map, TCAAP receives an average wind speed of 0.0-4.9 mph at 30 meters elevation. While large-scale wind energy is generally not well suited for high density residential and commercial areas, wind generation is technologically efficient as it is wholly fueled by a renewable resource. Although wind generation in the TCAAP region does not appear to be as cost efficient as it is in other areas of the state, wind technology advancements may support the future development of localized wind turbines in certain areas of the site. A small-scale community wind approach might be viable in future years, especially as technologies continue to develop that may capture lower-quality wind resources. Prior to considering implementation of any wind generation technologies, a short-term independent resource study would be necessary to discern appropriate scale and technology approach. Regarding utility-scale wind generation, grid infrastructure needs may include technologies that help smooth out generation output to meet needed loads, such as integration with a thermal storage tank or additional transmission infrastructure.

5.1.3. Fuel Cell CHP

Fuel cell electric power generation is a non-combustion based process. Fuel cells produce a direct current through an electrochemical process. The electrochemical process combines fuel with oxygen from the ambient air to produce electricity, heat, and water. Heat generated through the electrochemical process can be captured and used to generate hot water for onsite heating or district heating.

Fuel cells can also be used as back-up and portable electrical supply; however, the CHP process increases the efficiency of onsite fuel cell power generation. CHP integration is currently most commonly used with hot water district energy systems and larger commercial facilities, which have more constant heating loads, and where customers require coincident electric and hot water/space heating demand. As with other CHP applications, these systems can increase the overall efficiency of producing power from 33 percent to nearly 75 percent, when compared to traditional electricity generation.

The capital costs for this technology are high, thus to enhance the economic viability, it is important that continuous thermal energy is integrated with the fuel cells and the most prevalent and economic application of fuel cell energy involves production of both heat and electricity.

5.1.4. Microturbine (Small-Scale) CHP

Microturbines are small combustion turbines that burn gaseous or liquid fuels producing electrical output ranging from 30-330 kW. Thermal output from a microturbine generates exhaust temperatures at 500 to 600 degrees Fahrenheit, allowing for CHP by capturing waste heat to generate hot water for space heating, domestic hot water, or district heating. Microturbines are very modular, meaning that units can be connected in parallel to increase generation capacity over time as development and load materializes.

Microturbines are most applicable for distributed generation situations due to high utilization and low emissions requirements. As microturbines are good fits for CHP systems, ideal candidates for microturbine generation include clusters of commercial and residential buildings, institutional entities, and industrial operations needing hot water for manufacturing processes. Determining factors for suitability of microturbine technology are the ability to utilize all of the waste heat provided for local thermal energy needs, limited footprints, high cost of power, and high power reliability requirements.

5.1.5. Large-Scale CHP

Large-scale CHP integrated with district heating and cooling is an efficient and clean approach to generating electric power and thermal energy for multiple buildings from a single fuel source, or a multiple set of locally available fuel sources. CHP can meet all or a portion of the site electricity needs and places power production at or near the end-users' sites so that the heat released from power production can be used to meet the local thermal requirements. While there are multiple technologies available for implementing CHP for a site and district energy system, the primary goal is to efficiently cogenerate power and thermal energy for local buildings distributed through a district energy system. For any sized CHP system, the prime fuel can be natural gas, biogas, biomass, or a number of other fuels.

Due to the greenfield characteristics of the site, TCAAP has the opportunity to economically implement CHP coupled with a new district heating and cooling system in the higher density areas of the TCAAP development. A CHP plant coupled with district energy generally requires a higher level of energy usage density to minimize the cost of the distribution piping and energy transfer stations at each of the buildings. Commercial applications such as hospitals, nursing homes, laundries, and hotels with large hot water needs are also well-suited for CHP, because of the steady demand for electricity and thermal energy. Institutional applications and residential and recreational facilities are also excellent prospects for CHP. Implementation of district energy with CHP at TCAAP is most applicable with the aggregation of both higher density commercial, industrial, or multi-family residential buildings, such as within the central district of the Town or Thumb.

5.1.6. Battery Storage

Battery storage systems store electrical energy for use at a later time. Batteries store electric generation when generation is greater than demand. Battery storage is sparsely utilized across the United States due to the current market costs associated with battery bank installation; however, costs are beginning to slowly decrease due to scale up of production combined with large government incentives. Battery storage can be a favorable solution in the future for applications that place a higher value on power reliability and the establishment of microgrids, such as the AHATS site or the Thumb.

5.1.7. Electrical Microgrids

Microgrids are defined by the US Department of Energy to be "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode." A microgrid that integrates and controls multiple local generation and storage assets (e.g., PV arrays, wind turbines, diesel generators, combustion turbines, fuel cells, battery systems, and CHP) can be designed to provide onsite generation for local loads whether connected to the regional electrical grid or operating independently from the grid. In the event of grid failure, such as the TCAAP substation disconnecting power from Xcel Energy, power can be provided through a combination of generation sources within the site (solar PV, CHP, battery storage, etc.). All microgrid options require the use of a control system that can integrate and manage power generation to meet demands and dispatchable sources of power. Dispatchable generation includes power sources that can be turned on or off or can adjust their power output on demand.

By allowing multiple generation assets to provide power for a common load, microgrids greatly increase both the reliability of power and its onsite generation efficiency. Typically, the greatest beneficiaries of microgrids are customers with large, mission critical facilities. In addition to greater energy security, microgrids offer a variety of economic benefits ranging from greater efficiency of operation to the ability to facilitate participation in demand response and interruptible rate programs provided by Xcel Energy.

Precedent

Fort Collins Microgrid: The Fort Collins Microgrid in Colorado is a collaborative demonstration of how a mixed portfolio of distributed energy generation resources can be used to provide increased efficiency and penetration of renewables. The microgrid is powered by five main generators, including the main campus facilities at Colorado State University, but also includes a large brewery, a laboratory, and city facilities. The project was mobilized by a $6.3 million grant from the US Department of Energy with $4.7 million from national and local investors. All in all, the system will contain 345 kW of solar, 700 kW of combined heat and power, 60 kW of microturbines, and 5 kW of fuel cells and hopes to reduce peak loads by 20% to 30%.

5.2. Thermal Energy Supply Alternatives

The local natural gas utility is expected to provide natural gas transmission to all of the development within the TCAAPP site. With the installation of natural gas and electric infrastructure, buildings could install tradition thermal generation technologies such as boiler, furnaces, electric-driven chillers, and packaged air conditioning units. However, the following technologies could work in collaboration with the electric and natural gas grids to optimize the utilization of local thermal energy and improve the overall efficiency of TCAAP.

5.2.1. Thermal Energy Storage

Thermal energy storage is the process by which thermal energy in the form of hot or chilled water is stored in a large tank for district energy distribution at a later time. The benefit of thermal energy storage (TES) is the ability to generate thermal energy while both production costs and load demand are low and store the energy for high demand, high cost periods. Demand met during high demand, high cost periods by the TES tank shift load responsibility away from the central utility plant, reducing peak demand of the system during costly hours. Thermal storage allows for predictable operations of equipment at a central utility plant, increasing equipment efficiency by operating at optimal outputs. TES also provides additional system backup in the event of a gas or electric grid service disruption, or if ambient conditions exceed design conditions of the central utility plant equipment.

TES tanks can be integrated into a number of different structures, such as a parking ramp, underneath a park or adjacent to an industrial process facility. Optimal TES sizing depends on a balance between increasing tank capacity to reduce fixed costs on a dollars per gallon basis and maintaining acceptable tank dimensions. However, chilled water tank capacity when installed at the beginning of a district cooling or heating project can benefit the connected system by reducing the number of chillers or boilers, improving the economics of TES.

5.2.2. Absorption and Adsorption Cooling

Absorption and adsorption chillers utilize a heat source to provide the energy needed to drive the cooling process. The fuel sources for the heat can vary from biomass fuels, fossil fuels, waste heat, steam, to hot water. Absorption chillers remove the necessity of electric driven compression motors typically found within standard compression chillers, reducing the load on the electrical grid.

Applications of absorption and adsorption chillers will typically be determined by the availability of a heat source. This can be waste heat from the jacket of a reciprocating engine or combustion turbine or hot water generated through a solar thermal installation. Adsorption and absorption chillers are also more cost effective in areas where electric costs to operate standard compression chillers are high.

5.2.3. Solar Hot Water Heating

Solar hot water systems are composed of solar collectors and a fluid moving between the collector and a hot water reservoir. Typically the heated fluid is pumped from the tank to the heat exchanger where heat is extracted into the air to heat the space, returning the cooled fluid to the tank for reheating through the collector.

Solar thermal systems are most commonly installed on residential and small commercial buildings, however, large shared systems are also possible, such as in Saint Paul, MN. These systems typically have high capital costs, although savings come in the form of avoided natural gas costs. In climates where temperatures and necessary solar radiation are low, supplemental heat may be needed to maintain effective heating temperatures. In an effort to further improve economic viability, a solar thermal system used for heating in the winter can be used in conjunction with absorption and adsorption chillers for air conditioning in the summer months.

5.2.4. Solar Cooling

Cooling can be provided through solar radiation in a number of ways. As discussed previously, absorption and adsorption cooling processes require a heat source. Solar hot water can provide the necessary heat source required to cool through these processes.

In addition to solar cooling through solar thermal generation, solar cooling can be accomplished through solar PV utilization. In this process, electricity generated through the solar PV array is used to power a standard air conditioning unit. Some air conditioners are now being manufactured to operate using DC power. In the event a DC powered air conditioning unit is not installed, a DC to AC inverter is necessary to power the air conditioner.

Applications for solar cooling are best suited when natural gas prices are high. Capital investments related to the installation of a thermal system are offset by the avoided costs of natural gas otherwise necessary for heating sources to absorption and adsorption cooling processes. Solar cooling through electric generation of a solar PV is best suited where electric costs are high or uncertain. Capital investments related to the installation of a solar PV system are offset by the avoided costs of electricity otherwise necessary for operating standard air conditioning units.

5.2.5. Ground and Water Source Heat Pumps for Heating and Cooling

Heat pumps refer to a system in which refrigeration equipment is used to both heat and cool a space. As opposed to generating heat or removing heat, a heat pump simply transfers heat from one medium to another. By doing so, a heat pump is able to transfer more energy than needed to operate the equipment. This leads to fuel efficiencies greater than 100 percent water source heat pumps are very efficient while in heating operation. Ground source heat pumps utilize ground heat during the winter to heat the circulating water in order transfer heat from the water into the air through heat pump operation. The opposite is done in the summer with the same equipment to cool or remove the heat from the building.

In addition to stand-alone ground source heat pumps, TCAAP has the opportunity to implement water source heat pumps utilizing ground water piped from the wells on the east end of the TCAAP site as the heat sink and heat source for building water source heat pump systems through a district energy network. An example district energy system that has implemented a water source heat pump district energy system is the Southeast False Creek Neighborhood Energy Utility located in Vancouver, BC. Thermal energy is captured at a central energy center using a heat exchange process that is integrated with the city wastewater pump station. This supplies 70% of the utility’s thermal energy production. The remaining 30% is supplied by high-efficiency natural gas boilers that provide supplemental heat on the coldest days of the year. A distribution pipe system sends thermal energy (heated water) from the energy center to district energy system buildings. Each building has an energy transfer station that transfers this thermal energy to the building's mechanical system via heat pumps, that in turn distributes heat and hot water to building occupants.

Water-source heat pump systems typically range in size from 1.5 to 25 tons on a stand-alone basis, making them ideal for residential and small to medium-sized commercial buildings. Water source heat pumps are applicable across all climates as they rely on ground heat as opposed to ambient air temperatures. For TCAAP, water source heat pumps could be an option in the small commercial and residential customer buildings.

5.2.6. Air Source Heat Pump for Heating and Cooling

Air source heat pumps operate identically to standard packaged AC units during the summer time. What differentiates a heat pump from a packaged AC unit is the ability to reverse the refrigerant flow with a reversing valve near the compressor. This allows for the air source heat pump to operate as a heating unit during the winter time.

Air source heat pumps can be installed in most regions of the United States with increased efficiencies during many months out of the year. Air source heat pumps are best suited in relatively moderate climates, such as the south-eastern United States. In colder climates, such as TCAAP, electric resistance heating is necessary to aid in preheating the air before going through the heat pump to achieve desirable supply temperatures. This process of preheating reduces overall efficiency of the air source heat pump, dropping its economic viability. While the capital cost for air source heat pumps are currently not exorbitant, TCAAP's climate will hinder overall efficiency of the system during the winter time.

6. Energy Efficiency Strategies (Demand-Side Management)

Energy efficiency includes a portfolio of strategies to manage and reduce energy use at the building and customer level.[2] Pursuing opportunities to minimize site energy consumption is a critical strategy to keep energy costs low for site users, and will help reduce capital investments in the energy supply infrastructure required to serve the site.

The following energy efficiency strategies are proposed according to the scale at which they would apply: moving from the whole site, through the neighborhood, through the building, and into individual resident or tenant scales. Recommendations fit into four categories:

- Advanced communication infrastructure for the site
- Building co-location within individual neighborhoods
- Efficient building construction and design
- Resident or tenant behavior.

Each type of strategy includes a spectrum of specific technologies and programs, some of which can be implemented independently, and others as part of a portfolio along with energy supply strategies. This section highlights the most promising opportunities (see Table 3 for a summary list). A complete list of efficiency and demand-side strategies is included in Exhibit III.

Key Takeaways: Energy Efficiency Strategies

- Advanced communications and metering will allow for operational monitoring programs and lay the groundwork for future energy feedback or microgrid integration.
- Location planning for different types of buildings and their electricity or thermal energy use can create more efficient energy supply opportunities.
- Energy efficiency includes not only how buildings are built, but the ongoing actions of residents and tenants. Ongoing monitoring and commissioning can help manage energy use.
- Demand side strategies also include building solar-ready or electric-vehicle-ready homes, which have an orientation and wiring needed to accommodate these technologies.

[2] Broad efficiency and energy management strategies are often combined under the category of "demand-side management," but we use "energy efficiency" generically for ease of communication.

Table 3. Demand-Side Management technologies and strategies.

Demand-Side Management	Impact Time Horizon: Near Term (2025)	Impact Time Horizon: Long Term (2050)	Residential Single-Family	Residential Multi-family	Mixed Use	Office Campus	Flex	Retail	Street Areas
Advanced Infrastructure									
Broadband & wireless infrastructure			●	●	●	●	●	●	●
Advanced metering infrastructure			□	□	●	●	●	●	●
Energy & water submetering				●	●	●	●	●	
Building Co-Location									
Complementary Thermal Loads				●	●	□	□	●	
Complementary Electrical Loads				●	●	□	□	●	
Efficient Construction & Design									
Advanced Building Envelope Design			●	●	●	●	●	●	
Single-Family and Low-Density Homes			●	●	●	●	●	●	
Commercial and High-Density Residential			●	●	●	●	●	●	
Advanced and Monitoring-Based Commissioning				□	●	●	●	●	
Direct Current Utilization			●	●	□	□	□	□	
High Efficiency Appliances and Smart Plugs			●	●	□	□	●	□	
High-Efficiency Street Illumination									●
Building Occupant Behavior									
Commercial Building Benchmarking				□	●	●	●	●	
Community Energy Programs			●	●	□	●	●	□	
Live-In Demonstration Homes			●	●					

- Site energy savings and benefits likely
- Site energy savings and benefits possible

- ● Intended application
- □ Possible application
- Not applicable

6.2. Advanced Communication Infrastructure

Numerous innovations in energy efficiency rely on the opportunities to connect customers, equipment, utilities, and supply technologies across an advanced communication infrastructure. Advanced infrastructure includes meters that log energy consumption at frequent intervals, the hardware and software to distribute these data to a utility or customer platform, and the communications platform itself, (e.g. the internet and Wi-Fi access points). Use of such advanced communication infrastructure will allow individual technologies and buildings to improve performance as a result of real-time conditions, and also allow future energy consumers to be more engaged and responsive. As a recent report *The New Energy Consumer* describes, "[the] growing emphasis on personalization and connectedness are disrupting the marketplace and creating a need to engage consumers on their terms."[3] Some specific examples of current or emerging technologies that require a reliable advanced communications infrastructure are:

- Residential thermostats that are Wi-Fi enabled and tie into home security systems, to automatically save energy when a home is vacant
- EV stations that respond to signals of excess renewable capacity to begin charging
- A microgrid central communications system that controls sheddable loads to manage peak load and power quality.

6.2.1. Advanced Metering Infrastructure

"Advanced metering" generally refers to two-way utility meters that can both send and receive signals, and log or communicate customer energy use at short time intervals. Some states (notably California) now require utilities to install advanced meters. The State of Minnesota does not currently require this, however, over the course of TCAAP development this could change. In the near-term, utilities could deploy advanced meters across TCAAP as a pilot demonstration, along with corresponding program pilots.[4] The ability to saturate whole neighborhoods with advanced meters means that demonstration projects can focus on the aggregated benefits of operations at the larger distribution level. Potential pilots could include demand response, real-time energy use feedback, or possibly new innovative tariff schedules designed for energy conservation.

[3] "The New Energy Consumer: Architecting for the Future." Accenture, 2014.

[4] Note that the additional costs of installing advanced meters would need to be approved by the appropriate state regulatory authority, depending on the defined purpose.

6.2.2. Energy and Water Submetering

Submetering can be used to measure separate energy uses (for example, lights or cooling) beyond the individual customer or building level in order to enhance feedback and management of efficiency opportunities. This management can occur in real-time, depending on the type of metering and communication. Water submetering is also included as many of the same savings benefits apply, and feedback to consumers could easily be bundled with energy. Reducing water pumping and treatment has environmental and energy savings benefits as well. This type of advanced infrastructure, like advanced metering, would be beneficial to enable many of the energy efficiency strategies described below, such as continuous commissioning or customer feedback programs.

Precedents

San Diego Advanced Metering: San Diego Gas & Electric has implemented advanced metering across its entire service territory. Through an opt-out program they have installed 57,000 programmable controllable thermostats in homes and have reported over 98% customer satisfactory. This program has become a model for utility advanced metering infrastructure (AMI) programs across the country and prepares building and customers for possible future performance-based regulation.[5]

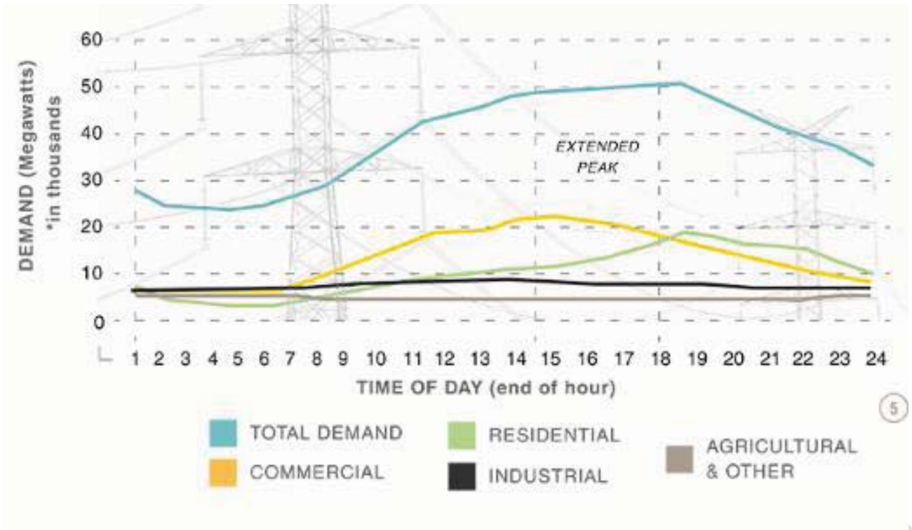
New Orleans Advanced Metering: The City of New Orleans provided match funding when Entergy New Orleans received a $5 million US Department of Energy smart grid grant. Starting in 2011, Entergy piloted an opt-in AMI program that outfitted customers with smart meters, online portals, in-home displays, and programmable thermostats. The utility and city partnered to garner strong community participation and engaged customers in a variety of training sessions. Overall, 58% - 67% of customers saved energy and at the end of the program 96% of participants wanted to be permanently involved in the program. On average, users reduced their total energy consumption by 6% - 8%.

6.3. Building Co-Location

Building co-location is a demand-side management strategy that is uniquely appropriate for greenfield and large infill development. By considering the daily or seasonal timing of different types of energy use, site developers can facilitate buildings with complementary load schedules. Buildings with complementary heating, cooling, and hot water needs, or with inverse demand schedules, can be clustered to optimize use of energy resources. The primary benefit is more efficient utilization of small scale, onsite energy supply systems such as distributed solar or CHP.

[5] Spotlight on Advanced Metering Infrastructure. International Smart Grid Action Network. (2013). http://www.cleanenergyministerial.org/News/ArtMID/1406/ArticleID/27/ISGAN Releases-Advanced-Metering-Infrastructure-Case-Book

Figure 1. Example time-of-day electricity demand for different customer segments



Co-location can be additionally beneficial when planned in conjunction with future customer rates that might reflect time of use or real-time demand costs. Such rates will provide cost signals to help direct the time of day or week when energy is consumed. While building co-location requires advanced planning, this can also be used to coordinate planned maintenance to share costs.

6.3.1. Complementary Thermal Loads

Complementary thermal loads come from customer types that use (or perhaps through feedback can be encouraged to use) thermal energy at different times of day. For example, buildings that are occupied, and therefore heated, at different times of the day or week. Complementary thermal loads can also include buildings or processes with high thermal requirements, such as laundry facilities, which can ensure use of waste heat resources from CHP throughout the year. Attracting such high heat customers as anchor loads and locating them on strategic points throughout a thermal supply network can lower unit costs of energy for all users.

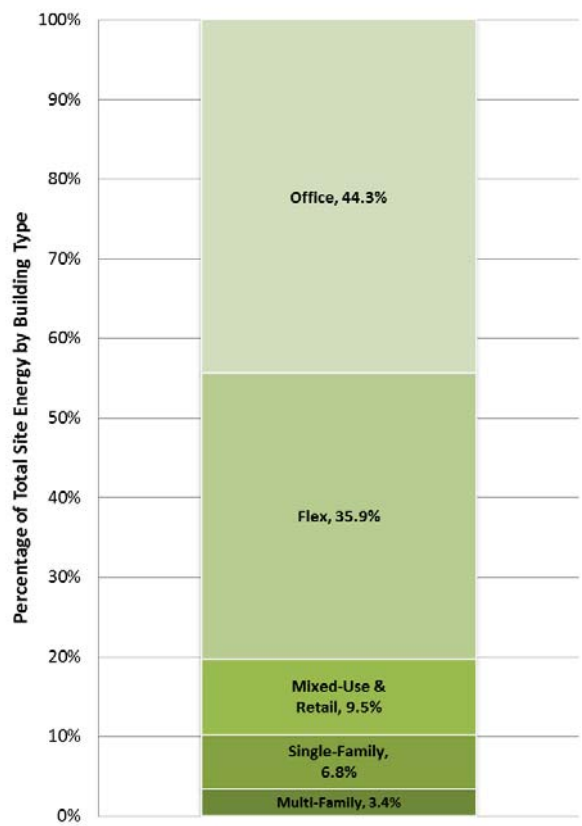
6.3.2. Complementary Electrical Loads

Similar to thermal loads, complementary electric loads come from customers that use electricity at different times of the day or season. Unlike thermal energy, electricity cannot currently be stored at low cost. Complementary building types can help lower the needed capacity of any on-site electricity supply technologies, and also amortize the cost over a larger number of electricity sales. Examples of complementary loads might include mixing weekday and weekend operations, or a high concentration of EVs that are charging overnight.

Precedent

Amazon Co-Location: Currently in Seattle, Amazon is working to locate a number of new buildings within two blocks of an existing building that houses a high volume of data centers. In this instance, one multi-story data center building will provide enough thermal energy for more than three, full-block, multi-story buildings. High electricity consumers or large thermal waste producers such as data centers offer great opportunities for sharing heat – preconditioning air for adjacent buildings, or through district systems. Seeking development opportunities like this would allow for cooperative efficiency and overall reduced customer energy costs.

Figure 2. TCAAP energy consumption distribution projection by building type



6.4. Efficient Construction and Design

In the Midwest 40% of total energy use goes to providing buildings with the energy to heat and cool buildings, to ventilate occupied spaces, and to provide users with electricity. With 427 acres of greenfield, implementing energy efficient design practices on TCAAP would have substantial and long-lasting impacts. By constructing buildings with higher performing envelopes, efficient mechanical systems, and responsive technologies, some buildings can cost-effectively be built to consume as much as 80% less energy than the average building or home.

A wide array of efficient design strategies could be applied on TCAAP, as is noted in the comprehensive list in Exhibit III, but five high-impact approaches are highlighted in this section:

- Advanced building envelope design and heating systems
- Advanced and monitoring-based building commissioning
- Direct current utilization
- High-efficiency appliances and installation of smart plugs
- High-efficiency street illumination

Each of these strategies is seen as particularly relevant for TCAAP and could be implemented through the development process, through city policy, or strategic partnerships.

6.4.1. Advanced Building Envelope Design and Alternative Heating Systems

In Minnesota, residential and commercial building and energy codes are set at the state level. While enforced at the local level, cities and counties currently do not have the authority to adopt a more stringent building code. While the City cannot adopt a more stringent energy code for TCAAP, the JDA could urge developers to meet higher energy design standards through the request for proposal process. The JDA may choose to elect a third-party set of energy or sustainability guidelines (e.g. SB 2030 or LEED) as a requirement or goal of buildings on the site, or they may choose to encourage a select number of custom development guidelines.

The following subsections go into further detail about the design elements that will have the greatest energy impact by building type.

6.4.1.1. Single-Family and Low-Density Homes

Starting in February 2015, Minnesota will begin enforcing the 2012 energy code (IECC). The updates will require homes to be more well-sealed and insulated,[6] to have increased window efficiency, and will require 75% of permanent lighting to be high efficiency. While these changes will result in more efficient single-family houses and townhomes compared to current residential code, as part of the

[6] International Energy Conservation Code 2012
http://publicecodes.cyberregs.com/icod/iecc/2012/icod_iecc_2012_re4_sec003_par005.htm

energy vision, TCAAP may wish to develop homes that are above these minimum energy standards. Below are five low-cost standards that could be required for all low-density residential developments. Each has a near-term or mid-term payback.

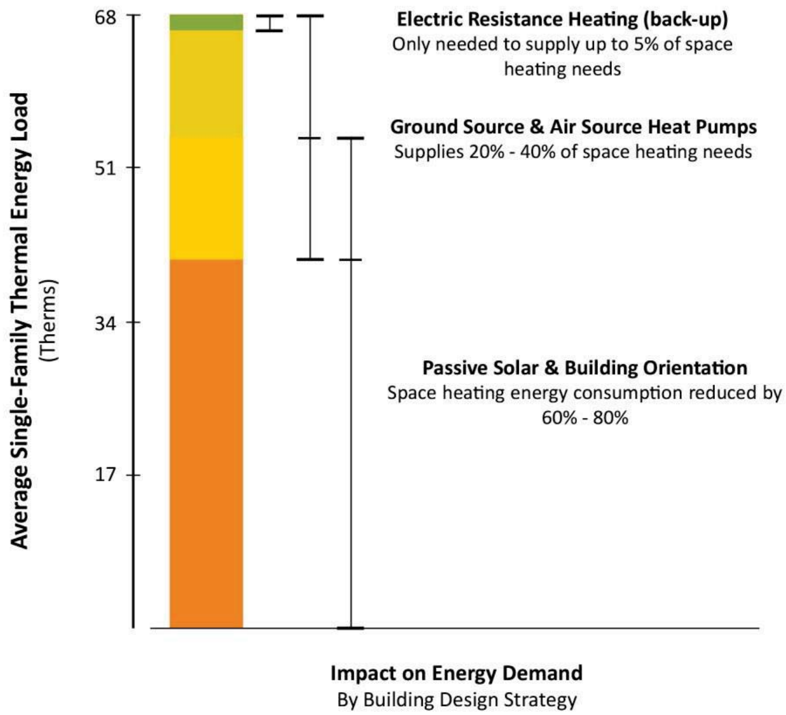
- **Passive Ventilation Design:** Operable windows on east and west walls
- **Combined Hot Water and Heating System:** 95% efficiency for both outputs
- **Energy-Efficiency Lighting:** 100% of permanent lamps to be energy efficient
- **Hard-Wired Programmable Thermostat:** Allows a homeowner a non-battery powered option
- **Solar-Ready Roof:** Structurally suited with at least one roof slope facing west, south, or southwest

While not suitable for all homes on the site, select clusters of homes or a whole neighborhood could be elected to pioneer groundbreaking efficiency design standards. To do this, the JDA may ask developers to meet more advanced energy design guidelines in select TCAAP areas (e.g. 5% of the residential area or a specific neighborhood or development). The following strategies could reduce the thermal energy load by 60% to 80%.[7] [8] Combined with cost-effective renewable heating technologies, this would allow a home or group of homes to entirely avoid reliance on natural gas. On average, avoiding this connection would save developers a one-time fee of $500 to $1,000 or more per house.[9] If the JDA seeks a third-party design guideline for developers, it is recommended that the guideline include these cost-effective standards and prioritize them for any model energy homes.

- **Low-Load Envelope:** Wall insulation R-28 or better, ceiling insulation R-55 or better, slab R-value 10 or better; Equivalent would be a house with a space heating EUI of less than 6 KBTU/SF/year
- **Passive Solar Design:** Proper orientation, massing, and building transparency to maximize solar heat gain; transparent façade to face south or within 30 degrees
- **Heat Pump:** Install a ground source or air source heat pump sized to cover all heating and cooling loads year round, with electric resistance heating as back-up system (replaces the need for a combined hot water and heating system)

[7] http://www.mncee.org/getattachment/623786cd-c32f-4ba7-80fc-b229f1fa8a37/
[8] http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/29236.pdf
[9] https://www.xcelenergy.com/staticfiles/xe/Marketing/Files/MN-Service-Guide.pdf

Figure 3. Low-Load Homes. Building strategies that will reduce space-heating demand by 60% to 80%.



6.4.1.2. Commercial and High-Density Residential

Similar to the residential code, in the spring of 2015 a new commercial energy code will be made effective across Minnesota. Early load projections for TCAAP show that commercial buildings and high-density residential buildings will consume approximately 93% of total site energy. The updated commercial energy code will require increased building performance, but mostly in the way of increased heating, cooling, and ventilation efficiency. Beyond code, there will still be many near-term and mid-term payback design strategies that could be employed to reduce the energy demanded by the commercial sector.

To develop building stock that is more energy efficient than code, the JDA will have to work through the request for proposal process to communicate the desire for more energy advanced designs. Selecting a sustainable commercial development guideline would provide the least burden for the City, as it would be reviewed by a third-party. Below we discuss some of the innovative strategies that developers could use to meet energy performance standards and keep first-costs low.

- **Passive Solar Design:** Large south facing transparency as façade to a shared space

- **Double Envelope Glazing:** Two layers of glazing on south facing facades (or more); Acts as a large solar heat gain. (Considered to be part of a thorough passive solar design.)
- **Passive Ventilation:** Utilize natural crosswinds by placing operable windows and skylights, accessible to occupants, across the building
- **Daylighting:** Interior lighting controls and skylights; Exterior louver systems to help deflect or bounce light further inward
- **Variable Refrigerant Flow System:** A heating and cooling distribution system that reduces fan energy and redistributes excess conditioned air so heating and cooling is not duplicated
- **Under Floor Air Distribution System:** Conditioned air is released through the floor to reduce distribution system energy

These strategies will reduce operating costs for owners, tenants, residents, and create healthier and more productive living and working environments.[10] Specific strategies such as double envelope glazing or under floor air distribution systems may not be prescribed in a building standard, but are excellent strategies for passive solar design and increasing the floor to ceiling height in a building – leading to improved daylighting. Other approaches, such as use of variable refrigerant flow (VRF) ventilation systems are particularly effective in multi-use buildings.[11]

6.4.2. Advanced and Monitoring-Based Commissioning

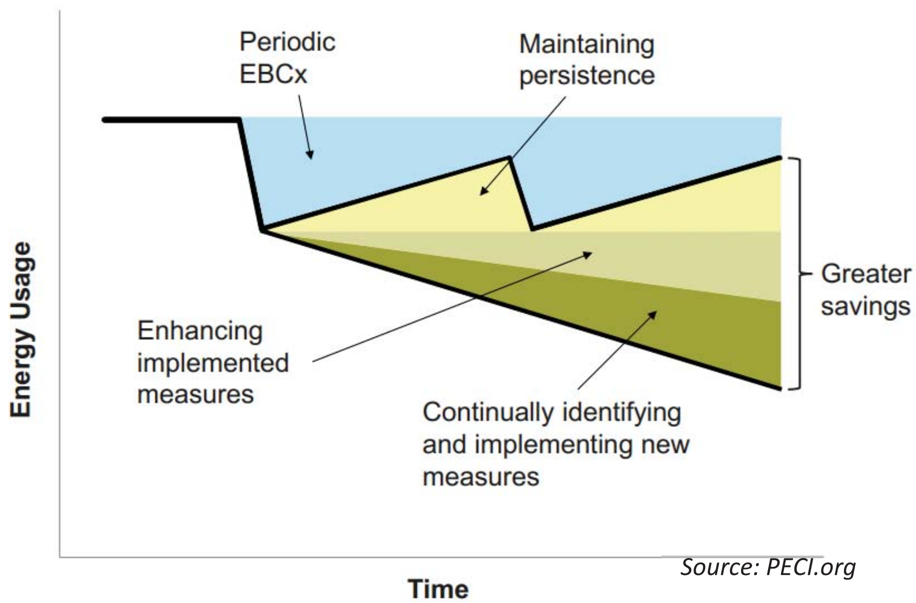
Heating, cooling, and ventilation account for 45% to 60% of a commercial building's total energy consumption, depending on use and size.[12] Properly calibrated building mechanical systems are essential for achieving site energy and natural resource efficiency. Commissioning is the process of checking calibrations and set-points before a building is occupied, a process that is now an industry best practice. Air leakage testing and sealing are currently not included in this process, but could be responsible for additional heating energy reductions of 5% to 35%.[13] Testing both mechanical and building systems would result in an "advanced commissioning" process and would be applicable to all commercial structures and homes.

Like automobiles, building instruments need adjusting as they age and building uses change. Without proper energy maintenance, buildings will experience increased energy consumption over time.

[10] Fidk, W.J., O. Seppanen. *Relation of SBS-Symptoms and Ventilation System Type in Office Buildings.* LBL. (2002). http://energy.lbl.gov/ie/pdf/LBNL-50046.pdf
[11] Amarnath, Ammi, et. al. *Variable Refrigerant Flow: An Emerging Air Conditioner and Heat Pump Technology.* ACEEE. (2008). http://www.aceee.org/files/proceedings/2008/data/papers/3_228.pdf
[12] EIA. Major Fuel Consumption by End Use for all buildings.
[13] Emmerich, McDowell, and Anis 2005

Monitoring-based commissioning is the process of continuously monitoring building energy consumption to identify new inefficiencies so they can be addressed immediately. While ongoing commissioning activities have upfront costs, monitoring-based commissioning will reap more energy savings at a lower unit cost, and tie-in with advanced metering and communications infrastructure at the site.[14] This strategy will be most cost-effective for large commercial buildings, particularly those approaching 100,000 square feet or larger.

Figure 4. Energy saving benefits of monitoring-based commissioning. The bottom wedge represents the additional energy savings that could be achieved



Source: PECI.org

6.4.3. Direct Current Utilization

The fastest growing use for all energy consumed in the home is the electricity used to run appliances and electronics. As of 2009, appliances, electronics, and lighting comprised 35% of all energy consumed, second only to space heating.[15] Of this 35%, approximately 20% of this energy is demanded by electronics that run on direct current (DC) power, which is currently provided when standard outlet AC current is run through a converter box.[16] This is true for electronics such as computers, laptops, smartphones, and flat screen TVs. The result is that 13% or more of demanded electricity in

[14] http://esl.tamu.edu/continuous-commissioning
[15] EIA. March 2013. (http://www.eia.gov/todayinenergy/detail.cfm?id=10271)
[16] Presentation: Greg Reed, Director of the Power and Energy Initiative at the University of Pittsburgh.

commercial offices,[17] and 20% to 32% of the demanded electricity overall is lost when power is converted from AC to DC.

Supplying buildings with the necessary infrastructure to avoid these conversion losses is an innovative efficiency strategy. An important synergy exists in that electricity generated from photovoltaics and stored in batteries is direct current. Whether solar energy is roof-top generated, or supplied locally on a microgrid, the opportunity to make use of the direct current resources exists for houses, multi-family buildings, and offices.

Homes may have a select number of rooms wired with both AC and DC to install plug-and-play outlet technologies that allow users to have access to both types of current – within a room or within one outlet. While many of these plug-and-play technologies are not ready for full-scale use, building homes that are PV and electric car ready can realize major energy savings over the life of the home. This set of technologies might be appropriate for demonstrating in a small network of homes on the site. The costs of adding plug-and-play technologies or DC wiring to a house will have some additional development costs, but seeking utility or technology company collaborators could result in a platform for demonstration.

Precedent

Commercial District Microgrids: DC microgrids supplying a small number of buildings with DC power are popping up in other parts of the world. Xiamen University in China is connecting an on-site 150 kW rooftop solar array to DC-driven LED lighting systems, servers, and banks of computers. Standards for such wiring have also been developed by Emerge Alliance in California.[18] There may be opportunities for developing a DC microgrid set-up for a commercial office campus on the TCAAP site, especially if the company has substantial data center loads.

6.4.4. High-Efficiency Appliances and Smart Plugs

The US Department of Energy's ENERGY STAR program is the leading certifier of energy efficient consumer electronics and appliances and has expanded to many new products in the last few years. Currently there are over 45 different product categories that have certified products, both for commercial and residential applications. For example, ENERGY STAR refrigerators use 15% less

[17] Foster Porter, Suzanne, et. al. Reviving the War of Currents: Opportunities to Save Energy with DC Distribution in Commercial Buildings. ACEEE Summer Study. (2014).
[18] http://www.technologyreview.com/news/427504/edisons-revenge-the-rise-of-dc-power/

electricity, and washing machines 40% to 50% less than new appliances meeting minimum industry standards.

While the cost of ENERGY STAR appliances is more than industry standard products, these products will usually pay for themselves within five to ten years.[19] While smart upfront purchasing alone results in energy and cost savings on its own, electronics draw power even when they are not in use. Connecting consumer electronics to Wi-Fi enabled smart outlets can save up to 5% to 10% of the resulting electricity demand.[20]

There are an increasing number of $10 to $50 plug-and-play technologies that can be installed in standard outlets. When applied in a targeted way in an apartment, house, or office, these technologies can pay for themselves in a matter of only a few years. These concepts can also be implemented in a more permanent way by buying high-efficiency appliances and electronics that have built-in advanced metering capabilities. In ten to twenty years remote connectivity may be a mainstream functionality of consumer electronics. Demonstrating this next generation of connectivity would be an opportunity for the TCAAP site. In the long run, this type of connectivity would also allow utilities to send price signals directly to consumer electronics, saving residents, and businesses money.

6.4.5. High-Efficiency Street Illumination

Installing high-efficiency lighting technologies can save the City costs on both electricity and operation and maintenance, since efficient lighting technologies have longer lifetimes. Light emitting diodes (LEDs) are the current leading technologies, and are able to illuminate a street surface with an efficiency of 90% compared with the most common incumbent streetlights which are only 34% efficient.

Beyond the TCAAP site, there would be additional opportunity to convert existing street lighting to be more efficient through broader local policy action. While LEDs are reaching market parity, where they are nearly cost competitive with less efficient lamp technologies, organic LEDs, which are a thin and flat technology, can be applied in new ways, and can create local beauty and destinations for visitors. The benefits of converting to high-efficiency street lighting not only include energy savings, they also include better illuminated streets that are safer, easier to navigate, and come with less light pollution.

[19] Responsible Energy. *Appliance Energy Costs.* MGE. https://www.mge.com/images/PDF/Brochures/residential/ApplianceEnergyCosts.pdf

[20] Lanzisera, Steven, et. al. *Communicating Power Supplies: Bringing the Internet to the Ubiquitous Energy Gateways of Electronic Devices*. IEEE Journal. (2014). http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6778069

Precedent

High Efficiency Streetlights: The state of Vermont has worked with its utilities to implement a high-efficiency streetlight upgrade program that is seeing average energy bill savings of 25% in participating cities.[21] Similarly, in Missouri and Kansas, 25 small and medium-sized cities (up to 25,000 people) are collaborating to install more efficient lighting. Each city is only retrofitting a portion of its streetlights, but the average savings per city is anticipated to be just over $130,000.[22]

6.5. Building Occupant Behavior

As building systems and infrastructure become more and more efficient, the ways that building occupants are motivated to change their habits can tap the next frontier of energy savings. Building experts estimate that homes can use two to three times more energy as an identical home built to the same design standards, based solely on the habits of the people who live there.[23] Commercial buildings exhibit less variation but are still driven by tenant behavior. TCAAP has the opportunity to host a variety of behavior-based initiatives that provide energy saving and learning opportunities for occupants in homes, condos, and offices. Programs such as building benchmarking, community-based behavior programs, and innovative energy demonstrations help to educate consumers and modify their energy use behaviors. Programs like these would grow connectivity across the city and engender pride for residents across Arden Hills and Minnesota.

6.5.1. Commercial Benchmarking

Building benchmarking is the ongoing tracking of building energy consumption so that usage can be compared over time and to other similar buildings to identify when building energy consumption is unusually high. The JDA or the City could facilitate such a program encouraging energy awareness, competition amongst businesses, and establish future incentive programs for top performance. Publicly disclosing benchmarking information offers benefit beyond the City. More than a dozen cities across the country, including Minneapolis, MN, disclose this information, which creates opportunities for researchers and analysts to innovate around the information. A JDA or City benchmarking and disclosure program would offer unique information, as no suburban city data sets exist in Minnesota.

---

[21] Arnold, Gabe, et. al. *A Win-Win-Win for Municipal Street Lighting: Converting Two-Thirds of Vermont's Street Lights to LED by 2014.* ACEEE Summer Study on Energy Efficiency in Buildings. (2012). http://www.aceee.org/files/proceedings/2012/data/papers/0193-000144.pdf

[22] Mid-American Regional Council. *Smart Lights for Smart Cities.* (2013). http://www.marc.org/Environment/Energy/pdf/Smart-Lights-Final-Report.aspx

[23] Parker, Danny et al. *Accuracy of the Home Energy Saver Calculation Methodology.* ACEEE Summer Study on Energy Efficiency in Buildings (2012).

Providing this information would draw national attention and offer learning opportunities that could be replicated in other small and medium cities across the country as this practice grows.

6.5.2. Community Energy Programs

A community energy program could help connect neighborhoods with their collective energy usage and help residents and businesses engage with existing utility programs and incentives. Individual residents could learn how to better maximize existing energy programs and help inspire future rebate options. Neighborhood level information (e.g. energy use or solar subscriptions) and engagement could also highlight cost-effective opportunities for individuals, businesses, and schools to invest in on-site renewables and community solar. Such a program could be implemented across the entire city at any phase in TCAAP's development. The school district, through its STEAM curriculum, could engage the program in a concentrated way as an opportunity for hands on learning and problem solving. The JDA could partner with Xcel Energy to deliver such a program as it helps Xcel Energy achieve mandated energy savings while growing opportunities for whole-city economic development and improvements.

Precedent

Pecan Street's work in Austin TX: Pecan Street, Inc. is a research and development lab out of the University of Texas that deploys and tests smart grid technologies. The first site for this work was the Mueller neighborhood in Austin TX, a 700-acre planned redevelopment, where residents voluntarily elected to join the smart grid effort. The resulting attention and participation has made Mueller a community demonstration district for learning and engagement, where residents can boast about their community's extensive Solar PV and EV penetration.

6.5.3. Live-In Demonstration Homes

In current markets, developers and residents frequently pay a premium to outfit their homes with the most-cutting edge technologies. Therefore, a small-scale piloting program can garner value and national attention, and would fit within the approach presented by many US Department of Energy programs.[24] The JDA could invite partnership with technology companies, architects, developers, and utilities to create near net-zero live-in demonstration homes with innovative features. For example, homes might be wired so that electronics and inductive EV charger can charge directly from current running from the homes solar panels. These homes could be rentable online for out-of-town guests or business associates, providing a tangible "future living" experience. Project partners and the JDA could

[24] See, for example, http://www.energy.gov/eere/better-buildings-neighborhood-program/better-buildings-neighborhood-program and http://www.energy.gov/eere/buildings/zero-energy-ready-home.

host an annual forum to gather feedback from those that live in and around the homes. This opportunity for public learning would draw broad community engagement and national attention.

7. Technology Evaluation

7.1. Evaluation Methodology

To provide the TCAAP site with an energy plan that achieves the goals provided in the energy vision statement, the Project Team developed a qualitative ranking system based on the alignment of a given technology, strategy, or option with the guiding principles. This ranking will allow the JDA, the County, and the City to make decisions based on the applicability of each these technologies, strategies, and options for the TCAAP site. Each technology, strategy, or option was ranked for its alignment with each guiding principle on a scale of one to five, with five having the greatest alignment and one having the least alignment. The rankings were then aggregated to evaluate how each option contributes toward the energy vision statement as a whole. In the narratives that follow, the areas where the technology, strategy, or option most or least aligns with the guiding principles are highlighted. The complete evaluation of each technology, strategy, or option is included in the following matrix.

7.2. Technology Applicability Matrix

Guiding Principles	Integrated Energy Systems National Model	Resilient Energy & Utility Community	Flexible Infrastructure Solutions	Efficient Energy and Water Usage	Economically Competitive & Attractive	TCAAP Application Score	TCAAP Applicability Ranking
Demand-Side Management Alternatives							
Advanced Communication Infrastructure							
High-Speed Fiber & Wireless Infrastructure	High	High	High	Medium	Med-High	22	**HIGH**
Advanced Metering Infrastructure	High	High	High	High	Medium	23	**HIGH**
Energy & Water Submetering	High	Med-Low	High	High	Med-Low	19	**MED-HIGH**
Building Co-Location							
Complementary Thermal Loads	Med-High	Med-High	Medium	Med-High	Med-High	19	**MED-HIGH**
Complementary Electrical Loads	Med-High	Med-High	Medium	Med-High	Medium	18	**MED-HIGH**
Efficient Construction & Design							
Advanced Building Envelope Design & Heating Systems	High	High	Medium	High	High	23	**HIGH**
Advanced & Monitoring-Based Commissioning	High	Medium	Med-Low	High	High	20	**MED-HIGH**
Direct Current Utilization	Med-High	High	High	Medium	Low	18	**MED-HIGH**
High-Efficiency Appliances & Smart Plugs	High	Med-High	Med-high	Med-High	Med-High	21	**MED-HIGH**
High-Efficiency Street Illumination	High	Med-High	Med-high	High	Med-High	22	**HIGH**
Building Occupant Behavior							
Commercial Benchmarking	Med-High	Low	Med-Low	Med-High	High	16	**MEDIUM**
Community Energy Programs	Med-High	Medium	Med-Low	Med-High	Medium	16	**MEDIUM**
Electric Vehicles	Medium	Med-High	Medium	High	Medium	18	**MED-HIGH**
Live-In Demonstration Homes	High	High	Low	Medium	High	19	**MED-HIGH**
Energy Supply Alternatives							
Electricity							
Grid Power	Low	Low	Medium	Low	High	11	**MED-LOW**
Solar Photovoltaic	Med-High	Med-High	Med-High	High	Med-High	21	**MED-HIGH**
Wind Generation	Med-High	Med-High	Medium	High	Medium	19	**MED-HIGH**
Fuel Cell CHP	High	High	Med-High	High	Low	20	**MED-HIGH**
Small Scale CHP	High	High	Med-High	High	Medium	22	**HIGH**
Large Scale CHP	High	High	Med-High	High	Med-High	23	**HIGH**
Battery Storage	High	High	Med-High	High	Low	20	**MED-HIGH**
Electrical Microgrid	High	High	High	Med-High	Medium	22	**HIGH**
Thermal							
Thermal Energy Storage	High	High	Medium	Med-High	Med-High	21	**MED-HIGH**
Absorption and Adsorption Cooling	Med-High	High	Medium	Med-High	Med-Low	18	**MED-HIGH**
Solar Heating	Med-High	Med-High	Medium	High	Med-Low	18	**MED-HIGH**
Solar Cooling	Med-High	Med-High	Medium	High	Med-Low	18	**MED-HIGH**
Water Source/Ground Source Electric Heat Pump - Building	Medium	Med-High	Medium	High	Medium	18	**MED-HIGH**
Water Source/Ground Source Electric Heat Pump - District Energy Model	High	Med-High	High	High	Med-High	23	**HIGH**
Air Source Electric Heat Pump	Medium	Med-Low	Low	Low	Low	8	**LOW**

On the side of energy efficiency, the highest priority technologies and strategies will be the investment in energy efficient buildings and communication infrastructure that will allow for future energy saving technologies. The most cost-effective energy resource available to a consumer is energy efficiency and it the cornerstone of resilient development. Investing in advanced building envelope design, advanced and ongoing commissioning, high-efficiency public lighting, and opportunities to enable shared thermal energy all received high ranking for this reason. In the area of energy supply, water-source heat pumps would be a good energy solution for the residential areas of TCAAP, with energy coming from both geothermal wells and the treated groundwater as long as it is available. In the denser and higher load areas of TCAAP such as the Town and the Thumb, various-scaled CHP can help the area achieve the energy vision set by the ERAB. Collaboration with the adjacent Arden Hills Army Training Site may affect the scoring of some of the other energy supply alternatives, including the development of a community solar system for both sites. The following section will distinguish and prioritize key policy, program, and incentive options that could be used to enable these strategies.

8. Policy and Regulation Opportunities

This section provides an overview of potential policies that would support the advanced energy efficiency and energy supply side options described above. In many cases, the policy jurisdiction could be the JDA, the City, or the County. Partnering with entities such as Xcel Energy, AHATS, or the University of Minnesota to help implement existing policies could bring additional resources to the site.

Key Takeaways: Policy and Regulation

- Investments in electricity and natural gas infrastructure are under the purview of Xcel Energy and subject to state regulation of prudent investments. Piloting or demonstration of technologies that benefit all customers would be allowed.
- Numerous existing policies and programs could provide technical or financial assistance, including Xcel Energy's Energy Design Assistance program for new construction, Minnesota's SB 2030 program, or Xcel Energy's Renewable Development Fund.
- The current TCAAP Redevelopment Code provides beneficial flexibility in use types at the site and neighborhood level. Processes that allow for evolving energy design and technology innovations in the form-based code could be considered.
- RFP specifications can build on the existing Minnesota SB 2030 energy performance standards for commercial buildings, which provide a unifying statewide policy framework, technical assistance, and ongoing benchmarking capabilities.
- Future municipal ordinances and programs would help support ongoing efficient energy use at the site and help unify TCAAP and the wider Arden Hills community. These include building or neighborhood energy challenges, educational programs, and high efficiency lighting standards.

8.1. Site Energy Jurisdictions

While the JDA, City, and County have wide jurisdiction over the site development and its resulting energy loads, any utility energy infrastructure investments would be subject to state regulatory authority. Xcel Energy, an investor-owned utility, serves the TCAAP site for both electricity and natural gas. While the regulatory environment is different for electricity and natural gas utilities, in practice both are subject to regulatory oversight in exchange for being granted exclusive retail service territories.[25] In contrast, district heating and cooling systems are not subject to state regulation.

The Minnesota Public Utilities Commission (PUC) regulates both service standards and rates. Utilities are required to provide "adequate, efficient, and reasonable service" and in turn are allowed to recover reasonable and prudent expenses through rates set equally across their service territory. This balance is weighed by the PUC, with input from the Minnesota Department of Commerce, Division of Energy Resources, and the Attorney General. The PUC has latitude and ultimate authority to determine prudent investments, in line with the goals of Minnesota state policy.

This has important implications for the energy development at TCAAP:

- Xcel Energy is restricted from making higher cost infrastructure investments (e.g. in distribution infrastructure, smart meters) that are not determined to be prudent, or whose benefits would only accrue locally to customers at the TCAAP site. However, piloting or demonstrating such systems to the benefit of all customers would be allowed.
- Customer or third-party owned electricity systems above 1 MW are subject to broad regulatory oversight on a number of issues including the amounts paid for excess generation, interconnection requirements, and standby rates. This would include, for example, a third-party owned CHP system.
- Customer-owned systems under 1 MW in size are subject to a more supportive regulatory environment. Minnesota law requires utilities to allow for "net metering" of these facilities, requiring payment from the utility for electricity sent back to the grid.[26]

The utility would also be required to file a certificate of need for any utility-controlled large energy facilities on the site, which would require approval by the PUC. These facilities would include transmission lines, substations, or utility generation. The certificate of need would have to show both the need for the service being provided by the infrastructure and justify the level of investment being proposed, for example, justifying the expense for undergrounding distribution lines.

8.2. Overview of Existing Policies and Programs

Future energy investments at the TCAAP site will be strengthened if developers make full utilization of existing programs. While programs will likely change over the course of development, with new

[25] Electricity may be sold to customers only by the utility assigned to that exclusive territory, except in limited circumstances. Natural gas utilities are not assigned exclusive territories, but since the Public Utilities Commission is required to prevent unnecessary duplication of gas delivery infrastructure, this becomes the de facto operation.

[26] Solar facilities over 40kW and under 1MW are restricted to 120% of the customer's annual electricity use, and wind facilities of the same size restricted to 120% of the customer's maximum annual demand.

offerings likely in the realm of intelligent efficiency and customer engagement, below is a list of current programs that would be beneficial.

8.2.1. Energy Design Assistance

This program is within Xcel Energy's Conservation Improvement Program (CIP) portfolio for new construction. This program, designed for architects and builders, provides technical assistance for new construction projects. The program includes energy modeling, planning, rebate opportunities, and measurement and verification once a project is complete. Energy Design Assistance can also help a project comply with different certification standards, such as LEED or the Minnesota's Sustainable Buildings 2030 (described below).

8.2.2. Sustainable Buildings 2030

SB 2030 is a Minnesota program that sets standards for new commercial buildings to reduce their energy use a certain percent below typical construction, with a goal of achieving net-zero construction by 2030. All projects that receive State bond funds are required to meet the standards. The program contains energy design plan reviews and benchmarking of building energy use.

8.2.3. Renewable Development Fund

This is a funding source administered by Xcel Energy to support renewable projects across their service territory. The fourth cycle of funding, approved in March of 2014, totaled $42 million across 29 grant awards. Projects included numerous solar PV systems as well as a microgrid demonstration project and research and development funding.

8.3. Smart Grid Demonstrations

Minnesota currently has limited advanced metering infrastructure, but utilities are asked by the PUC to demonstrate planning and demonstration experience. Numerous technologies could be included under this umbrella, including demonstration of advanced meters, outage and reliability reports, and microgrid demonstrations. Planning for such developments in conjunction with the utility would allow investments to inform larger policy decisions and help educate Minnesota's energy community. In addition, there is the potential to attract national funding for technology and research demonstrations.

8.4. Local Zoning Context

The City has been developing a form-based TCAAP Redevelopment Code that allows for flexibility in site use types, balancing a scale and form suitable to the existing City context, while creating opportunities for new types of development. The form-based code approach moves away from strict land use zoning designations towards a holistic view of the site, providing flexibility in how different use types interact, provided developments meet more prescriptive physical guidelines.[27]

This approach has general implications for innovations in future site energy use. At the site and neighborhood level, use types and locations are flexible, which facilitates attracting energy loads with certain local energy benefits. Developers and energy planners will be able to identify building types with beneficial energy services – for example, high thermal loads or elastic (responsive or sheddable) electrical loads. At the individual building level, the reliance on specific requirements for individual architectural details may limit low energy, passive, or net-zero building designs. Attention to broader allowances and flexibility for innovative building design are beneficial should they meet the needs of the TCAAP energy framework.

The Project Team recognizes the approval process for the TCAAP Redevelopment Code is moving quickly, and that tangible, consistent guidelines are critical for moving development forward towards a unified sense of place. Exhibit IV includes specific suggestions for updates to the TCAAP Redevelopment Code that can further encourage the use of onsite low-carbon energy supplies and efficient design. Some specific components of these recommendations include:

- Allowance of certain renewable materials for shading or screening.
- Allowance of certain building shading or glazing techniques that can reduce a buildings cooling or heating demand.
- Recommendations to encourage consideration of solar potential and optimized shading in site street orientation and landscaping plans.

However, given that the specific designs required to achieve the energy vision are site, building, and use-type specific, and that many technologies and strategies are still emerging, identifying opportunities for additional future flexibility could further assist in attracting innovative energy demonstration and design projects that could serve as flagship developments. This could include a process for new technology review at specified time increments, or a designation or allowance of energy "demonstration" buildings when certain strict performance and educational criteria are met.

[27] City of Arden Hills, Draft TCAAP Redevelopment Code, August 2014.

Precedent

Bullitt Foundation Headquarters in Seattle, WA: The headquarters of Seattle's Bullitt Foundation is a groundbreaking example of low energy use design. The building makes use of several innovative design techniques, including high ceilings for daylighting, dynamic exterior window shades, and a large solar overhang. Seattle's local zoning context restricted many of the needed design elements, but local leadership and enthusiasm helped move the project forward to create an internationally renowned destination.[28]

8.5. Policies and Paths for Implementation

Translating demand-side management and supply-side strategies into on-the-ground results requires not only visionary goals, but visionary policies and development processes. There are many possible policy actions and multiple parties that could carry out these actions over the TCAAP development timeframe: the JDA, the City, the County, utilities, state or federal government, or local associations.

In addition to clear policies, strong partnerships with businesses, investors, and utilities are invaluable to fulfilling the TCAAP energy vision. Providing a flexible site context and marketing to businesses driven by corporate sustainability goals could increase opportunities for future demonstration and expedite later phases of development. While many policy actions may be carried out by one authority, there are many opportunities for collaboration. Outlined below are a number of policy approaches and a discussion of the opportunities, challenges, and recommended first steps.

8.5.1. Implementation Path: Development Request for Proposal Process

The City's TCAAP Redevelopment Code will provide guidance to builders and developers about the site, form, and height of buildings, but requirements for building energy-efficiency and connectivity are not provided. To execute the recommended energy demand and supply-side strategies comprehensively, the most effective tools will be design and construction standards requested through the County's RFP process.

8.5.1.1. Commercial Design and Development Guidelines

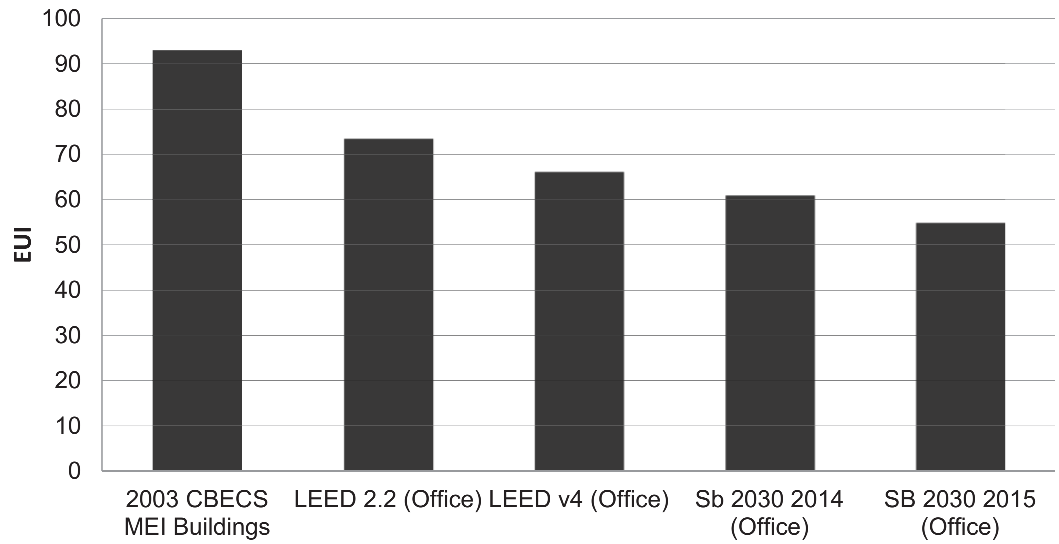
There are numerous green development guidelines available in the marketplace, one of the most popular being the LEED standards from the US Green Building Council. However, for the Minnesota market, the State SB 2030 energy performance standard has multiple advantages over other voluntary guidelines.

[28] http://ensia.com/features/code-green/

- **Linked to utility rebates and resources:** For commercial development, the SB 2030 Guidelines provide the greatest benefit for developing buildings that are focused on energy efficiency and measurement. The SB 2030 program is tied to utility rebates and additional energy design assistance, giving developers an integrated process for learning about current and future utility rebates.
- **Well-established and designed for implementation over time:** Designed as a guideline for state funded buildings in Minnesota, the SB 2030 program is well-established and has statutory support as well as a growing constituency.[29] The performance-based requirements will progress over time to coincide with technology and building science advances, making it well-suited for scalability. Comparatively, the SB 2030 energy guidelines would on average gain 8% to 10% more energy savings compared to LEED (see Figure 5).
- **Financial Flexibility:** The guideline offers financial flexibility by providing an alternative cost-effectiveness path, a backstop for developer investment.
- **Energy focused and tied to ongoing measurement:** SB 2030 is designed to work with the Minnesota Buildings, Benchmarking, and Beyond (B3) program, a broader set of sustainability guidelines (like LEED), but allows a developer to focus on energy impacts alone. As part of SB 2030 or B3, building energy and carbon are automatically benchmarked, a potential asset to the City for future program implementation.

[29] St. Paul currently requires all public buildings or publicly bonded buildings to meet the SB 2030 energy guidelines.

Figure 5. Comparison of Energy Usage Intensity (EUI) impact across design and construction standards[30]



The JDA could work with Xcel Energy to create an expedited process for completing the development requirements and make use of Xcel Energy's conservation programs. For example, Xcel Energy's Energy Design Assistance Program could create a service path that specifically addresses SB 2030 buildings and their requirements.

8.5.1.2. Low-Density Residential Design and Development Guidelines

For single-family homes and low-density residential development, implementation of a low-cost energy-focused set of guidelines is more challenging. One more modest option is Minnesota Green Path, which offers a relatively cost-effective path towards two different levels of home energy-efficiency and sustainable site development.[31] Requiring homes to be Green Path Certified, for example, is one way to avoid additional burden on plan reviewers, as the certification process would be administered by a third-party. Prioritized permitting and upfront financial incentives could be offered, the first for homes that meet the MN Green Path Advanced Certification and the second for homes that achieve MN Green Path Master Certification.

[30] Based on EUI calculations using SB 2030 design software and the average EUI for a sample of office buildings used in the 2012 study, *Postoccupancy Energy Consumption Survey of Arizona's LEED New Construction Population.*
[31] http://www.mngreenpath.org/wp-content/uploads/2013/10/Electives-Checklistv2.pdf

8.5.2. Implementation Path: Development Incentives

8.5.2.1. Density Bonuses

The TCAAP Redevelopment Code is form-based and by nature does not specify allowed densities, although density is an important variable for enabling development and some degree of energy resiliency. One of the more flexible incentives that the City and County could offer to a developer is a density bonus for meeting energy efficiency standards, or participating in a program such as Energy Design Assistance. By providing this leeway, developers have more freedom to find an economically viable project. For TCAAP, such an incentive may come in the form of a height bonus, or an orientation variance.

Density would also further support district energy systems and energy islands. While the exact building uses that will be developed on the site are unknown, high thermal energy users such as laundromats or breweries, and thermal energy producers such as data centers are examples of businesses that can help anchor an underground district system. Offering height or other variances for these types of developments could greatly increase the potential for such a system.

8.5.2.2. Tax and Financial Incentives[32] [33]

The future cost savings from energy efficiency and clean energy will be a consideration for some businesses, but having financial incentives available to developers will be beneficial. In addition to expedited permitting opportunities, the JDA should seek third-party funding to incent and fund enhanced energy performance and innovative energy engagement opportunities. Federal grants, state loans, private businesses, and utility funding, and foundations are all potential sources for these incentives. The JDA should prioritize the development of these opportunities so that these dollars could be used in the immediate-term stages of development.

Many of TCAAP's large infrastructure decisions will occur between 2014 and 2016. For this reason, incentives that can help cover upfront capital costs will be very important. One tool that is frequently used in large redevelopment projects is tax incremental financing (TIF), however the City and County have determined not to apply this tool at TCAAP.

The US Department of Energy has several funding opportunities a year that enable cost-shared funding for approaches such as efficient home improvements or net-zero homes, microgrid demonstrations, feasibility studies for integrated deployment of renewables, local approaches to reduce permitting

[32] Angel Tax Credit: Businesses headquartered in Minnesota with fewer than 25 employees and engaged in the research and development of qualifying high-technology can qualify for up to $1 million in angel tax credits.

[33] Research and Development Tax Credit: The tax credit for R&D expenditures is 10%, up to the first $2 million in eligible expenses. The credit is 2.5% for eligible expenses above $2 million.

costs for solar PV, and other opportunities. The US Department of Commerce Economic Development Authority has additional opportunities that include regional innovation grants to spur development, such as energy research parks. Both agencies also provide technical assistance.

Outside of government and partnership with flagship companies and investors that work in the energy and technologies sectors, foundations are a source of funding that the JDA should explore. Starting conversations about TCAAP's energy vision and its special opportunities with a few targeted foundations may be invaluable.

Other large sustainable development projects, like Colorado's Stapleton project,[34] marketed state incentive programs for businesses to help draw commercial developers. The JDA could advertise the similar incentives and tax breaks that Minnesota has to offer along with attractive partnerships that may develop.[35][36] Incentives targeted to research and development businesses may attract high-tech businesses that would have higher energy loads and affect the opportunities for alternative energy supply that could be developed on-site.

8.5.3. Implementation Path: City-Wide Ordinances

TCAAP is envisioned to be a premier energy development, providing benefits for the community beyond the site. While development standards and incentives will help procure the necessary physical environment for energy demonstration and collaboration, community-based policies and programs will help to deliver benefits to residents across the community and integrate the new development into the City.

A number of demand-side management and alternative energy supply opportunities require action outside of the scope of zoning or development guidelines. The following policy options are opportunities for the City to utilize its authority and processes to engage residents and businesses and effectively use local resources.

8.5.3.1. High-Efficiency Street Lighting Ordinance

A City-wide high-efficiency lighting ordinance would lower energy use and help reduce operation and maintenance costs across the City. If the City elects to include a high-efficiency streetlight clause in the TCAAP Redevelopment Code, a City-wide policy would help to tie the neighborhoods together. For any

[34] http://www.stapletondenver.com/business-ready/starting-a-business

[35] Angel Tax Credit: Businesses headquartered in Minnesota with fewer than 25 employees and engaged in the research and development of qualifying high-technology can qualify for up to $1 million in angel tax credits.

[36] Research and Development Tax Credit: The tax credit for R&D expenditures is 10%, up to the first $2 million in eligible expenses. The credit is 2.5% for eligible expenses above $2 million.

streetlights that are owned by the local utility, the City may seek purchase of this infrastructure or engage the utility about streetlight rebate opportunities that might be available.

Beyond adopting an ordinance, the City could seek opportunities to partner with companies that are developing innovative lighting technologies such as organic LEDs, which could be applied on the streets in high-visibility areas such as the Gateway overlay zone.

8.5.3.2. Commercial Energy Challenge

The City could work with a third-party building or an energy organization to initiate a commercial energy challenge program tied to awards and financial incentives. The program could be modeled after the Building Owners and Managers Association's current Kilowatt Crackdown program, a modified version of that program, or after another of many successful challenge programs that cities are trying across the United States. The City could work with local businesses to instigate a business association or committee that could advise in the creation of the initiative and build program participation. Program incentives could be funded by government or foundation dollars. The City and partners could establish an energy savings revolving fund to create a sustainable source of funding.

8.5.3.3. Neighborhood Energy Disclosure

The City and partners could approach Xcel Energy about implementing a neighborhood-based program to engage the community through aggregated neighborhood energy information, customer choices, and existing utility programs. The City could work with Xcel Energy and a third-party organization to create a platform for visualizing and sharing community energy data and facilitating competition amongst neighborhoods. In addition to utility incentives, the City could seek funding opportunities for incentives to homeowners that complete home improvements.[37]

8.5.3.4. Facilitating Home Owner Association Energy Goals and Incentives

To help guide newly forming homeowner associations on the TCAAP site, the City could adopt energy vision language that homeowner associations would help maintain. Commonly, homeowner association's standards and decisions are only subject to the rules of zoning code. However, providing visionary recommendations and incentives, such as for rooftop solar, would encourage developers and residents to invest in and uphold common aesthetic and resiliency values. A stand-alone TCAAP homeowner association guideline or clause would provide the necessary guidance.

8.5.3.5. Solar Energy Enabling Policies

[37] St. Louis Park incentive program

The greenfield development at TCAAP provides the opportunity to optimize the deployment of solar (both PV and solar thermal) by creating a unified plan for the solar benefits across the site. Planning of the electricity distribution infrastructure and any advanced metering capabilities brings the opportunity to work with the utility to identify where large-scale solar PV might have the highest value to the electrical grid. Further, the City or County could use solar mapping tools during a site planning process to identify how building locations and orientation may optimize the use of the solar resource, as one additional factor to consider when making a plan. The City can make use of technical assistance resources available through the Minnesota Grow Solar Partnership for planning, zoning, or permitting tools to facilitate solar adoption in areas where it will bring maximum benefit.

8.5.3.6. Electric Vehicle Enabling Policies

Minnesota has supported EV adoption through a range of state-level actions, and the City could invest a variety of approaches, such as in public EV charging stations for on and off-street parking. As non-utilities are authorized by state law to sell electricity for purposes of EV refueling, the City could develop an approach to, for example, charge vehicles for a fee based on the time of day, reflective of average electricity rates. In addition, by 2015 a lower customer-optional rate for EV charging at home, also called an "off-peak" rate, will be offered through Xcel Energy, including a 100 percent renewable option. The City could take steps to ensure residents, workplaces, and the public are able to maximize access to EV charging infrastructure. Such policies would increase EV visibility, and help enable consumer awareness and adoption as an increasing number of EVs come on the market and at lower costs. Such charging stations could be tied to on or off-site renewable electricity sources. Additional opportunities to collaborate with local businesses and public transit facilities could include road-access rules, as empowered by Minnesota statute, for neighborhood and medium speed EVs internal to the community. These policy options could grow as site development matures.

Precedent

The City of Cambridge, MA implemented an EV charging station pilot program in 2012 with 10 stations. While an evaluation of this pilot will be released soon, early benefits have included improvements to user interface and fee structure.[38] The City hopes that this pilot will pave the way for private investment in public EV charging station.

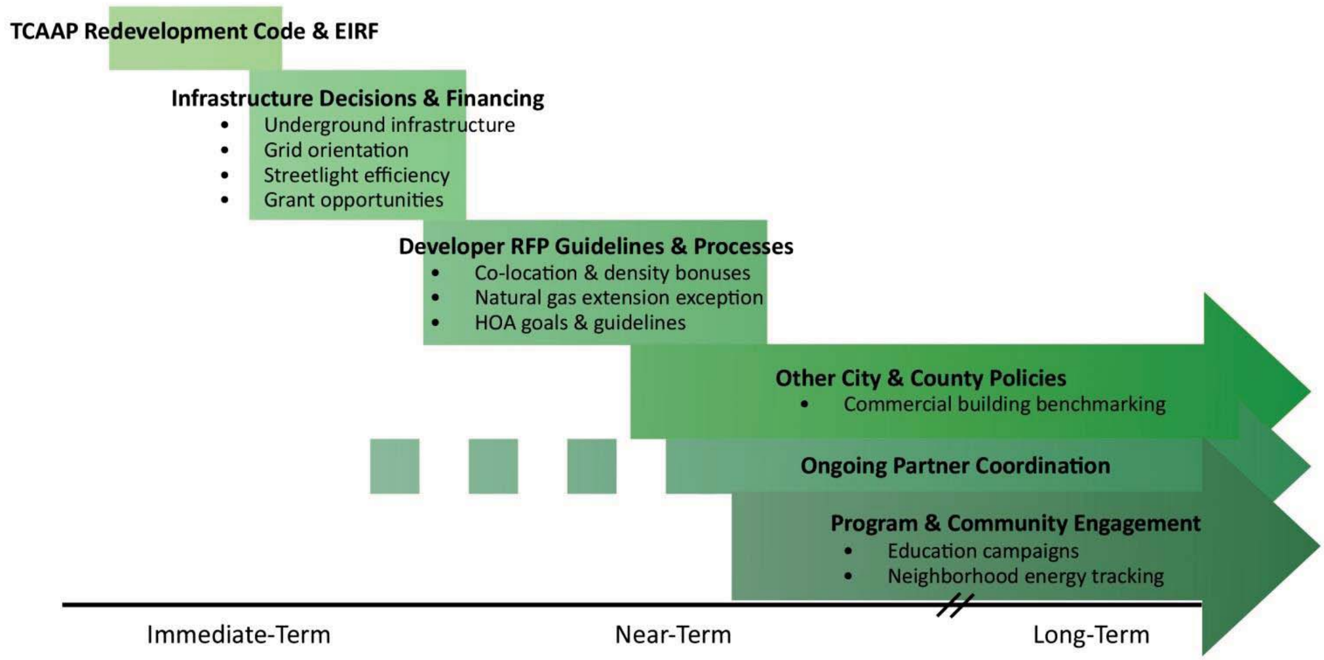
8.5.4. Phasing of Policy Opportunities

As mentioned above, some policy opportunities are immediate, such as the possibility to include energy efficiency and renewable energy flexibility within the TCAAP Redevelopment Code. Other policies are relevant farther into the future, when TCAAP's future residents and businesses are occupying the site.

Figure 6 below helps to navigate the timeline and phasing of opportunities. In general:

- Immediate-term actions include adoption of the TCAAP Redevelopment Code, identification of potential partners and funding opportunities, and adoption of policies affecting major infrastructure decisions, such as spine road utilities, street orientation, and lighting.
- Near-term actions include development of RFP guidelines and processes, including identification of any energy standards or tools such as SB 2030, Minnesota Green Path, or Energy Design Assistance that might guide energy management at the site. This would also include initiating and/or maintaining partnerships with entities such as AHATS, Xcel Energy, or the University of Minnesota.
- Long-term actions include policies that will assist in maintaining and showcasing the site energy vision, including commercial building benchmarking, education campaigns, or neighborhood energy tracking programs.

[38] http://www.cambridgema.gov/CDD/Transportation/programs/currentprograms/electricvehicles.aspx


TCAAP Redevelopment Code & EIRF
Infrastructure Decisions & Financing
Underground infrastructure
Grid orientation
Streetlight efficiency
Grant opportunities
Developer RFP Guidelines & Processes
Co-location & density bonuses
Natural gas extension exception
HOA goals & guidelines
Other City & County Policies
Commercial building benchmarking
Ongoing Partner Coordination
Program & Community Engagement
Education campaigns
Neighborhood energy tracking
Immediate-Term
Near-Term
Long-Term

9. Conclusions

The TCAAP site offers the City and County a unique opportunity to achieve a transformative energy vision that could be a model for the nation. This area offers the potential to meet the demands of local growth, while setting a foundation that balances the development goals of the JDA, funding and financing efforts for developers, and establishes a model for responsible development.

As the development of TCAAP is slated to begin in 2015, with the initial infrastructure scheduled to begin construction in mid-summer, several energy-related decisions and investments will need to take shape over the next six months. The Project Team has identified immediate-term, near-term, and long-term actions that could be taken to support achievement of the energy vision adopted by the ERAB. Some of the actions described are fairly straightforward, while others will take additional investigation, or collaboration and partnering with others to accomplish.

9.1. Immediate-Term (2015)

- **Early infrastructure Investment:** The Project Team recognizes the critical development timeline that the JDA, City, and County are managing and for that reason suggests that infrastructure be installed that provides maximum flexibility for the site while allowing for early integration of available energy sources. Beyond traditional transmission grids like natural gas and electric transmission lines, this would include thermal energy grids and direct fiber broadband. In addition, the Project Team recommends that a comprehensive coordination effort amongst all of these utilities to minimize conflicts and reduce the cost of installation.
- **Increase zoning and development processes for flexibility and high-performance:** While making near-term decisions that ensure flexibility is the key to get started, the Project Team recommends that the City considers applying a future overlay district that specifically addresses requirements for innovative energy infrastructure and net-zero buildings. As an alternative, the City could add an Energy Resiliency section to the TCAAP Zoning Code and provide more opportunities for variances such that building orientation or open space may contain a percentage of ground-mounted solar.
- **Initiate conversations with the Arden Hills Army Training Site (AHATS) and Xcel Energy**: The Project Team recommends that the JDA, City, and County initiate conversations with AHATS and Xcel Energy to discover the opportunities to partner to develop innovative infrastructure and available renewable energy sources. The JDA, City, and County could express to Xcel Energy its TCAAP vision and guiding principles and explore opportunities to utilize a microgrid or other smart grid modernization demonstrations.

- **Assess potential on-site resources:** the JDA, City, and County should complete an assessment of the potential for on-site solar PV, solar thermal, and passive solar building design based on street layout and building orientation, as well as community wind potential. The potential to utilize the existing groundwater being treated on TCAAP as an energy source should also be investigated. This could help inform site planning and incentives that could be made available to developers.
- **Pursue energy efficiency funding opportunities and funding opportunities for innovative clean energy infrastructure:** Identifying financing opportunities early will lead to more appealing offerings for developers. Continuing conversations with the Minnesota Department of Commerce and Minnesota Department of Employment and Economic Development, local foundations, and the Saint Paul Port Authority to explore funding mechanisms that attract developers, businesses, and future TCAAP residents, is an important immediate-term action. Reaching out to the US Department of Energy and the US Department of Commerce's Economic Development Authority on forthcoming grant opportunities is also an action to take at this time. These financing opportunities could provide the funding needed to make significant progress toward the energy vision for TCAAP.

  If any of these sources show potential as feasible funding streams, the JDA, City, and County should look for opportunities to structure the Energy Integration and Resiliency Framework - due at the end of March 2015 - such that it provide information that will support application processes. Documentation may include technical feasibility studies or site assessments. Communicating this to the Project Team could help shape TCAAP's energy framework and help streamline funding opportunities.
- **Align the County's land development strategy with the adopted energy vision**: As it develops its requests for proposals for site development, the JDA and County could reward potential developers for innovative energy projects in their scoring criteria. This could include rewarding developers for agreeing to install high-efficiency energy systems, renewable energy supply technologies, or agreeing to receive thermal energy from a community district energy system.
- **Approve energy standards and a process for review:** Actions that support the design and construction of energy-efficient, resilient buildings will be an important intermediate action. Before the JDA and County releases development RFPs or responds to inquiries from developers, it will be necessary to have high-performance energy building standards in place. The Project Team recommends that the JDA and County determine if Sustainable Buildings 2030 (commercial) and Minnesota Green Path (residential) or other development guidelines outside of the zoning code, are going to be included as incentives or requirements for developers. If there are other standards

outside of a chosen set of guidelines or certification, these will need to be delineated and a process for reviewing and verifying that they are met will need to be finalized.

9.2. Near-Term (2016 – 2020)

- **Create awareness with clean energy businesses of the potential for collaboration and innovation:** The County could initiate conversations with a targeted group of clean energy companies to gauge opportunities for collaboration. Discovering what businesses are interested in piloting technologies, investing in direct development, or providing low-cost access to cutting-edge technologies will further inform the JDA of what resources they have to offer prospective developers. Drawing early investors will help other development to follow.
- **Ongoing energy opportunity oversight:** To help the JDA and the County engage in and seek energy opportunities over time, they could consider establishing an advisory committee of regional energy experts that will provide energy-focused feedback. This may exist as an extension of the already formed JDA or as a separate body. As a separate body, the committee could make suggestions to the JDA on broader energy development issues and bring innovative opportunities to the JDA and the County, and in certain circumstances where approaches intersect, transportation and housing experts could be included to maximize synergies.

9.3. Long-Term (Beyond 2020)

- **Bring flexibility for future energy needs into the local context:** The City could consider including prioritization of energy efficiency, climate change adaptation, or energy resilience as part of its comprehensive plan, in order to facilitate strategic use of the Planned Unit Development process or other tools to allow flexibility for resilient energy uses at the site.
- **Clean Energy Incubator:** The JDA could establish TCAAP as a clean energy incubator for advanced energy supply and storage technologies. Portions of the site could be established to pilot new technologies by integrating them into the core energy infrastructure that serves local businesses and residents.
- **TCAAP Energy Efficiency Maintenance Program:** To capture long-term energy efficiency on the TCAAP site, the JDA could collaborate with local utilities and third-party organizations to provide ongoing building energy usage monitoring and recommissioning services to maintain high energy performance. The JDA could incentivize such a program by making it a prerequisite for participation in other programs and gaining access to other resources.
- **Clean EV and energy storage infrastructure**: While some EVs and energy storage opportunities may be realized in the earlier phases of development, as technologies advance, the JDA might

seek collaboration with Xcel Energy and or technology companies seeking a specific site to demonstrate the value of larger-scale energy storage and EVs. These opportunities could be sought at opportune times throughout development.

- **Neighborhood Energy Engagement and Disclosure Initiative:** The JDA could collaborate with Xcel Energy to engage local residents and business in an energy disclosure program. Arden Hills could collaborate with the school district and the existing STEAM curriculum goals to grow learning opportunities and build strong city-wide participation, beyond merely the TCAAP site.
- **Advanced Demand Response Pilot:** As TCAAP development matures, the JDA or the City may seek utility partnerships in piloting innovative demand response technologies and strategies to help businesses and homes save money. TCAAP buildings and residences equipped with advanced communication and metering technologies will be well suited for this opportunity.

Exhibit I – Definitions

The following definitions are provided for those unfamiliar with energy system terminology:

Air Handling Unit (AHU) – A central unit consisting of a blower, heating and cooling elements, filter racks or chamber, dampers, humidifier, and other central equipment in direct contact with the airflow. This does not include the ductwork through the building.

Active solar – As an energy source, energy from the sun collected and stored using mechanical pumps or fans to circulate heat-laden fluids or air between solar collectors and a building.

Alternative-rate Energy Efficiency program assistance – An Energy Efficiency (demand-side management) program assistance that offers special rate structures or discounts on the consumer's monthly electric bill in exchange for participation in Energy Efficiency programs aimed at cutting peak demands or changing load shape. These rates are intended to reduce consumer bills and shift hours of operation of equipment from on-peak to off-peak periods through the application of time-differentiated rates. For example, utilities often pay consumers several dollars a month (refund on their monthly electric bill) for participation in a load control program. Large commercial and industrial customers sometimes obtain interruptible rates, which provide a discount in return for the consumer's agreement to cut electric loads upon request from the utility (usually during critical periods, such as summer afternoons when the system demand approaches the utility's generating capability).

Arden Hills Army Training Site (AHATS) – A military training area of Minnesota National Guard and the Minnesota Department of Military Affairs that is directly adjacent to the Rice Creek Commons Project to the east.

ASHRAE Bin temperature data – Temperature frequency in 5 F intervals available from American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Boiler – A device for generating steam for power, processing, or heating purposes; or hot water for heating purposes or hot water supply. Heat from an external combustion source is transmitted to a fluid contained within the tubes found in the boiler shell. This fluid is delivered to an end-use at a desired pressure, temperature, and quality.

British Thermal Unit (Btu) – The amount of heat required to raise the temperature of one pound of water 1 degree Fahrenheit. The Btu is a small amount of heat equivalent to the heat released by a burning matchstick. For district heating systems, heat is often measured in million Btus (MMBtu) which is equivalent to one million Btu's.

Building Commissioning - a building performance quality assurance process that begins during design and continues through construction, occupancy, and operations. Commissioning ensures that the new building operates initially as intended by design and that building staff are prepared to operate and maintain its systems and equipment.

Capacity – The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, adjusted for ambient conditions.

Chiller – Any centrally located air conditioning system that produces chilled water in order to cool air. The chilled water or cold air is then distributed throughout the building, using pipes or air ducts or both. These systems are also commonly known as "central chillers," "centrifugal chillers," "reciprocating chillers," or "absorption chillers." Chillers are generally located in or just outside the building they serve. Buildings receiving district chilled water are served by chillers located at central physical plants.

Chilled Water – The product of a Chiller that is distributed through a building or, in the case of a District Cooling system, other adjacent buildings for the purposes of air conditioning.

Coefficient of Performance (COP) – Ratio of work or useful output to the amount of work or energy input, both represented in the same unit. Used generally as a measure of the energy-efficiency of chillers and heat pumps.

Combined Heating and Power (CHP) – A plant designed to produce both heat and electricity from a single heat source.

Conservation – A reduction in energy consumption that corresponds with a reduction in service demand. Service demand can include buildings-sector end uses such as lighting, refrigeration, and heating; industrial processes; or vehicle transportation. Unlike energy efficiency, which is typically a technological measure, conservation is better associated with behavior. Examples of conservation include adjusting the thermostat to reduce the output of a heating unit, using occupancy sensors that turn off lights or appliances, and car-pooling.

Constant Air Volume (CAV) – A system designed to provide a constant air flow. This term is applied to HVAC systems that have variable supply-air temperature but constant air flow rates. Most residential forced-air systems are small CAV systems with on/off control.

Consumer (energy) – Any individually metered dwelling, building, establishment, or location using natural gas, synthetic natural gas, and/or mixtures of natural and supplemental gas for feedstock or as fuel for any purpose other than in oil or gas lease operations; natural gas treating or processing plants; or pipeline, distribution, or storage compressors.

Cooling Degree Days – A degree day is the difference in temperature between the outdoor mean temperature over a 24-hour day and a given base temperature. Cooling degree days occur when the outdoor mean temperature is above 65 F.

Cubic Feet per Minute (CFM) – A common means of assigning quantitative values to volumes of air or fluid in transit.

Customer conversion – The equipment in a customer building mechanical room that transfers thermal energy from the district heating system to the building systems to allow the heat to be distributed throughout the building. The customer conversion usually consists of heat exchangers, pumps, piping, control sensors, and control valves to enable heat to be efficiently transferred from the higher temperature district heating system to the lower temperature building system.

Daylighting – Designing buildings to maximize the use of natural daylight to reduce the need for electricity.

Demand-Side Management (Energy Efficiency) – A utility action that reduces or curtails end-use equipment or processes. Energy Efficiency is often used in order to reduce customer load during peak demand and/or in times of supply constraint. Energy Efficiency includes programs that are focused, deep, and immediate such as the brief curtailment of energy-intensive processes used by a utility's most demanding industrial customers, and programs that are broad, shallow, and less immediate such as the promotion of energy-efficient equipment in residential and commercial sectors.

Demand-side management costs – The costs incurred by the utility to achieve the capacity and energy savings from the Demand-Side Management Program.

Differential temperature (dT, delta T) – The difference between the supply temperature and return temperature of the district heating water delivered to users. This is an indication of the amount of energy delivered to the customer.

Distributed Control System (DCS) – A control system of an energy production plant and process wherein control elements are not only located in central location but are also distributed throughout the system with each component sub-system controlled by one or more controllers so the intelligence is distributed across the sections of the system.

Distribution – The delivery of energy to retail customers.

District energy – A thermal energy delivery system that connects energy users with a central production facility.

Diversified load – The actual peak load on an energy system. The diversified load is less than the sum of the peak loads of individual users due to the difference in time of day that each individual user realizes their peak load.

Distribution system – The underground piping network that delivers hot water from an energy production facility to the customer buildings. Hot water is circulated through this distribution system using pumps that are located at the production facility.

Domestic hot water – Potable water that is heated for use in faucets, showers, laundry, and similar uses.

Energy Conservation Measure (ECM) – This includes building shell conservation measures, HVAC conservation measures, lighting conservation measures, any conservation measures, and other conservation measures incorporated by the building. However, this category does not include any Energy Efficiencyprogram participation by the building. Any Energy Efficiency program participation is included in the Energy Efficiency Programs.

Energy Transfer Station – Equipment installed at the point of customer connection to the district energy system. The energy transfer station is utilized to transfer and measure the thermal energy delivered from the district energy distribution network to the customer’s building(s) or other thermal loads.

Energy Usage Intensity - The quantity of total energy that a building consumes per square foot per year. Energy is usually expressed in terms of thousand british thermal units (KBtu/SF/year).

Energy Utilization Index (EUI) – Measure of the total energy consumed in cooling or heating of a building or facility in a period, expressed as British thermal unit (Btu) per (cooled or heated) gross square foot.

Equivalent Full Load Hours – Annual energy usage divided by the peak capacity used.

Fixed Operations and Maintenance (FOM) – Costs other than those associated with capital investment that do not vary with the operation, such as maintenance and payroll.

Fuel Cell CHP – Electrochemical power generation process generating both electricity and thermal energy suitable for making steam or hot water.

Geothermal energy – Hot water or steam extracted from geothermal reservoirs in the earth's crust. Water or steam extracted from geothermal reservoirs can be used for geothermal heat pumps, water heating, or electricity generation.

Geothermal plant – A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from hot water or by natural steam that derives its energy from heat found in rock.

Green Spine – The corridor through the Rice Creek Commons development that will be designated green space for the use of stormwater management, recreational trails, and parks.

Greenhouse gases (GHG) – Those gases, such as water vapor, carbon dioxide, nitrous oxide, methane, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride, that are transparent to solar (short-wave) radiation but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface.

Ground Source Heat Pump – A heat pump in which the refrigerant exchanges heat (in a heat exchanger) with a fluid circulating through an earth connection medium (ground or ground water). The fluid is contained in a variety of loop (pipe) configurations depending on the temperature of the ground and the ground area available. Loops may be installed horizontally or vertically in the ground or submersed in a body of water.

Heat pump – Heating and/or cooling equipment that, during the heating season, draws heat into a building from outside and, during the cooling season, ejects heat from the building to the outside. Heat pumps are vapor-compression refrigeration systems whose indoor/outdoor coils are used reversibly as condensers or evaporators, depending on the need for heating or cooling.

Heating Degree Days – A degree day is the difference in temperature between the outdoor mean temperature over a 24-hour day and a given base temperature. Heating degree days occur when the outdoor mean temperature is below 65 F.

Heat exchanger – A pressure vessel that contains plates or tubes and allows the transfer of heat through the plates or tubes from the district heating system water to the building heat distribution system. A heat exchanger is divided internally into two separate circuits so that the district heating system water and the building heat distribution system fluids do not mix.

Heating coil – A heating element made of pipe or tube that is designed to transfer heat energy to a specific area or working fluid.

Hot water supply and return lines – The district heating system piping that distributes hot water for heating purposes to customers (supply) and returns the cooler water to the Plant for reheating (return).

Kilowatt (kW) – A unit of power equal to one thousand Watts (W)

Kilowatt-hour (kWh) – A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu.

Load – The amount of energy used by a customer. Typically refers to the Peak Load on the system.

Medium temperature hot water – Thermal heat transferred via hot water at a temperature between 190 °F and 250 °F.

Megawatt (MW) – One million Watts (W)

Megawatt-hour (MWh) – One thousand kilowatt-hours

Microgrid – A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

Million BTU (MMBTU) –One million British Thermal Units (BTU). One MMBTU is equivalent to 293.07 kWh.

Net Present Value (NPV) – The difference between the present value of the future cash flows from an investment and the amount of investment. Present value of the expected cash flows is computed by discounting them at the required rate of return. A zero net present value means the project repays original investment plus the required rate of return. A positive net present value means a better return, and a negative net present value means a worse return, than the return from zero net present value.

Non-diversified load – The sum of the peak loads of individual users. This is a theoretical maximum system peak load.

Normalized – Adjusted annual data of monthly building usage values measured on different monthly heating degree scales to a common scale prior to averaging.

N+1 Redundancy – A measure of system component redundancy to provide backup in the event of failure of any one component. N+1 refers to the number of units installed to carry normal load plus one additional unit as backup. For example, if a system has three chillers to achieve the total design load, each is rated at 33% of the total load, or N=3. For this example, an N+1 system will have a total of four chillers of 33% capacity for a total installed capacity of 133% with one chiller providing backup in the event of failure of any one chiller.

Operations and Maintenance (O&M) – The activities related to the performance of routine, preventive, predictive, scheduled, and unscheduled actions aimed at preventing equipment failure or decline with the goal of increasing efficiency, reliability, and safety.

Outside Air Temperature (OAT) – A measure of the air temperature outside a building. The temperature and humidity of air inside and outside the building are used in enthalpy calculations to determine when outside air can be used for free heating or cooling.

Passive solar heating – A solar heating system that uses no external mechanical power, such as pumps or blowers, to move the collected solar heat.

Peak load/ Peak demand– The maximum load during a specified period of time

Photovoltaic and solar thermal energy – Energy radiated by the sun as electromagnetic waves (electromagnetic radiation) that is converted at electric utilities into electricity by means of solar (photovoltaic) cells or concentrating (focusing) collectors.

PSI – An abbreviation for pounds per square inch. PSI is a unit of pressure measurement.

Rice Creek Commons (RCC) – The name of the land development project that is being led by Ramsey County, as the land owner, on the site formerly known as the Twin Cities Army Ammunitions Plant (TCAAP).

Recommissioning - A type of commissioning that occurs within an existing, operating building to identify ways the building operation is sub-optimal. The decision to recommission may be triggered by a change in building use or ownership, the onset of operational problems, or some other need. Renewable energy resources – Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action

Resiliency – The ability to withstand disruptions to the regional or national energy grids or significant volatility to the market price for energy sources.

Return on Investment (ROI) – The earning power of assets measured as the ratio of the net income (profit less depreciation) to the average capital employed (or equity capital) in a company or project. Expressed usually as a percentage, return on investment is a measure of profitability that indicates whether or not a company is using its resources in an efficient manner. For example, if the long-term return on investment of a company is lower than its cost-of-capital, then the company will be better off by liquidating its assets and depositing the proceeds in a bank.

Seasonal energy efficiency ratio (SEER) – Ratio of the cooling output divided by the power consumption. It is the Btu of cooling output during its normal annual usage divided by the total electric energy input in watt hours during the same period. This is a measure of the cooling performance for rating central air conditioners and central heat pumps.

Service line/service piping/customer connection – The segment of the district heating distribution system that extends from the main lines to the inside of the customer building. The service line is typically sized to meet the peak hot water flow requirements for the individual building served by the piping.

Square Foot (SQ FT or ft^2) – Unit of measure to quantify the footprint area of a customer building, used to estimate the Load of a building based on the usage of the building.

Source Energy - The total amount of raw fuel that is required to operate an energy-using device or facility. Source energy includes all transmission, delivery, and production losses, thereby enabling a complete assessment of energy efficiency in a building. On the other hand, "Site Energy" is the amount of heat and electricity consumed by a building as reflected in utility bills.

Solar cooling – The use of solar thermal energy or solar electricity to power a cooling appliance.

Solar Photovoltaic Systems (PV) – Systems that directly convert sunlight into electricity either for use locally or for delivery to the electric grid.

Solar Thermal – Systems that directly convert sunlight into heat, generally for domestic hot water though they can also be used to produce space heating.

Substation – Facility equipment that switches, changes, or regulates electric voltage.

Sustainability - Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.

Therm – One hundred thousand (100,000) Btu

Thermal energy – Energy that is generated and measured in the form of heat.

Thermal Energy Storage – The storage of heat energy during utility off-peak times at night, for use during the next day without incurring daytime peak electric rates.

Thumb – That portion of the Rice Creek Commons development that is at the extreme northwest of the site, and is separated from the remainder of the site by Rice Creek.

Transit Oriented Development (TOD) – Land development that takes into account transportation choices as a means of reducing oil and other energy use. Typically it would combine public transit with walkable, mixed-use communities, and approaches to minimize the impact of individual vehicles and commuting.

Waste Heat Recovery – An energy conservation system whereby some space heating or water heating is done by actively capturing byproduct heat that would otherwise be ejected into the environment. In nonresidential buildings, sources of waste heat include refrigeration/air-conditioner compressors, manufacturing or other processes, data processing centers, lighting fixtures, ventilation exhaust air, and the occupants themselves. Not to be considered is the passive use of radiant heat from lighting, workers, motors, ovens, etc., when there are no special systems for collecting and redistributing heat.

Water source heat pump – A type of (geothermal) heat pump that uses well (ground) or surface water as a heat source. Water has a more stable seasonal temperature than air thus making for a more efficient heat source.

Variable Air Volume (VAV) – An HVAC system that has a stable supply-air temperature, and varies the air flow rate to meet the temperature requirements. Compared to constant air volume (CAV) systems, these systems conserve energy through lower fan speeds during times of lower temperature control demand.

Variable frequency drive – an electronic controller that controls the speed of an electric motor by modulating input frequency and voltage to match motor speed to the specific demands of the work being performed.

Exhibit II – Green Zoning Incentives Adopted by Other Localities

The following includes examples of comprehensive zoning and incentive plans from cities across North America.

1. Green Zoning Ordinances and Incentives

This Exhibit includes examples of recently adopted green zoning and incentive plans from cities across the U.S., including New York, Philadelphia, Pittsburgh, Nashville, Arlington, and Seattle. Many localities have used LEED standards as guidelines, but any prescriptive or performance-based building standard could apply. In some cases, specific elements would not be relevant under current Minnesota law, where local governments are not allowed to require building guidelines more stringent than state code for energy efficiency. Rather than requiring the entire standard, individual pieces may apply. These examples are meant to show the breadth of activities being pursued by local governments to incent and attract green development.

Much of the following content was developed by the US Green Building Council.

1.1. New York City, NY – Changes to Zoning Ordinances

In April 2012, the City of New York adopted a citywide zoning amendment to remove several zoning impediments to the construction of green buildings. Some specific features of the adopted text are listed below:[39]

- Enable sun control devices and awnings to project over streets and sidewalks to the same 2-foot-6-inch dimension permitted for these devices within the property line under the zoning.
- Allow solar panels on flat roofs anywhere below the parapet, regardless of building height. Portions of taller solar installations that are higher than 4 feet would be subject to limits on roof coverage and height. On sloping roofs, panels would be allowed to be flat-mounted (less than 18” high).
- Allow low-lying features such as green roofs, recreational decks, other stormwater detention systems and skylights anywhere below the parapet, regardless of building height. A guardrail no more than 30% opaque would be allowed up to 3’6” above the top surface of the roof. Greater volume, similar to what is already allowed in many Special Districts, would be allowed

[39] http://www.nyc.gov/html/dcp/html/greenbuildings/index.shtml

above the maximum building height to accommodate modern bulkheads, with requirements for setback and screening of equipment.

- On buildings taller than 100 feet, a wind turbine assembly may rise up to 55' above the rooftop (including the pole and rotor), provided it is set back at least 10 feet from any property line. On waterfront blocks[40] in medium- or higher-density residential districts,[41] commercial[42] or manufacturing districts,[43] all buildings could install rooftop turbines up to half the height of the building or 55 feet, whichever is less. Free-standing turbines would be allowed in commercial and manufacturing areas on waterfront blocks. All wind installations must comply with requirements set forth by the Department of Buildings.
- Air conditioners installed in a window or through-wall sleeve can waste large amounts of energy. Central air or ductless mini-split systems are significantly more efficient. The proposal would allow greater flexibility for the location of air conditioning condenser units for these more efficient systems for one- and two-family residences.

1.2. Will County, IL – Greening of Zoning Ordinance

In 2012, Will County updated the county zoning ordinance to both remove impediments and encourage adoption of green building and sustainability practices. The updates make use of State allowance for expanded administrative adjustment and expanded Planning and Zoning Commission Authority, and include:[44]

- Incentives to incorporate LEED-ND within a Planned Unit Development process
- Relaxed regulations for small (accessory) wind energy systems
- Express allowances for solar and geothermal energy systems, community gardens, and EV charging stations
- Landscape regulations that encourage bioretention

1.3. Milwaukee, WI – Created Development Incentive Zone[45]

The Brewery in Milwaukee, Wisconsin, is a new 20 acre development on the site of the former Pabst Brewery, which closed in 1996. Developers are working to revitalize the complex into a variety of

[40] http://www.nyc.gov/html/dcp/html/zone/glossary.shtml#waterfront_area
[41] http://www.nyc.gov/html/dcp/html/zone/glossary.shtml#residence_district
[42] http://www.nyc.gov/html/dcp/html/zone/glossary.shtml#commercial_district
[43] http://www.nyc.gov/html/dcp/html/zone/glossary.shtml#manufacturing_district
[44] http://www.willcountygreen.com/initiatives/green_building_and_zoning_code_project.aspx
[45] http://www.thebrewerymke.com/index.htm

residential, office and retail uses in both historic and new buildings. They are working with the City's Office of Environmental Sustainability on green-building practices and have completed LEED-ND Stage 1 review at the Platinum level. The City also created a Tax Incremental Finance District to help fund infrastructure, such as new public streets, for the Brewery project. In 2006, the City created a Development Incentive Zone for the brewery site to replace the underlying zoning standards with performance standards. The underlying zoning district's permitted and special uses become permitted as a matter of right in the overlay district. In January 2008, the City Common Council adopted an amendment to the Brewery Development Incentive Zone to include sustainability guidelines. The guidelines cover many principles found in the LEED-ND rating system, such as the preservation and reuse of historic buildings, recycling of construction demolition, landscaping, efficient street lighting, heat island reduction, water efficiency, stormwater management, and green building practices.

1.4. El Paso, TX[46]

In January 2011, the El Paso City Council unanimously approved a substantial new plan for the city's future. Connecting El Paso seeks to direct population growth and to incorporate former industrial sites into the urban fabric by promoting smart growth planning and transit-oriented development under the city's new transit plan. While not a comprehensive plan for the entire city, Connecting El Paso serves as a comprehensive plan for four transit growth areas: Remcon Circle, 5 Points, the Oregon Corridor, and the 450-acre former ASARCO site. Among the plan's eight policy recommendations is a proposal to use LEED-ND both to rate development projects and to prioritize infrastructure investments, permitting and grants. This recommendation included a suggestion that the City partner with the local USGBC chapter to provide education about LEED-ND to city staff and building professionals.

On September 11, 2007, the El Paso City Council unanimously adopted the Green Building Grant Program, providing grants for commercial and multi-family, multi-story residential projects earning LEED certification. Grants are awarded only upon receipt of a certificate of occupancy and review of LEED certification wherein ten (10) of the seventeen (17) available points in Energy & Atmosphere credit category must be earned. Grants are awarded at increasing intervals determining on level of certification. Maximum grant allowance is $200,000 for LEED Platinum for new construction and $400,000 for LEED Platinum for "multistory existing buildings" that are mixed use and that have been 50% vacant for 5 years, and as further defined by the City.

[46] Connecting El Paso: http://planelpaso.org/wp-content/reports/Connecting%20El%20Paso%20Report_120910_lores.pdf

1.5. Boston, MA[47] - Columbia Point Redevelopment

In June 2011, the Boston Redevelopment Authority unanimously voted to adopt the Columbia Point Master Plan. Covering 412 acres, the Columbia Point peninsula is located 2 miles from downtown Boston and contains some of Boston's most important institutions, but is currently underutilized. Developed through an extensive public involvement process and a strong focus on the infusion of sustainability principles throughout, the Master Plan requires that all new development be LEED certifiable at the Silver level with a goal of Gold and all new multiple building developments must have at least one LEED Silver certified building. Throughout the Master Plan document, all policies and implementation actions which relate to LEED-ND are identified with a leaf symbol.

1.6. Columbia, SC[48] -Green Building Incentive Program

On March 30, 2010, the Green Building Incentive Program was established. This program, funded by the American Recovery and Reinvestment Act of 2009, was designed to stimulate green building construction in the area by providing financial incentives to those who construct to green building program standards. To be eligible, projects can't be government projects or required by law to meet green building standards. Commercial projects must be built to achieve LEED Certification and one or two family residential projects must achieve certification under LEED for Homes, EarthCraft Homes, HealthyBuilt Homes, ICC 700 National Green Building Standard, Build Green Greater Columbia Program, or other national residential green building standard.

1.7. Bar Harbor, ME - Density Bonus

On June 13, 2006, Bar Harbor amended its municipal codes to award a density bonus of an additional market-rate dwelling unit for construction projects in which all dwelling units meet LEED standards. This bonus applies to projects within a Planned Unit Development and compliance is determined by either application or by affidavit for adherence during construction.

1.8. Calgary, AB – Fee Reduction/Waiver

In the spring of 2007, the City Council passed the Calgary Building Permit Bylaw allowing for a fee reduction for all private projects pursuing LEED or BuildGreen certification.

[47] Columbia Point Master Plan: http://www.bostonredevelopmentauthority.org/planning/planning-initiatives/columbia-point-master-plan

[48] http://www.usgbc.org/Docs/Archive/General/Docs691.pdf All subsequent information in this section is directly copied from this document.

1.9. Chatham County, GA – Tax Break

In May, 2006, the Board of Commissioners of Chatham County passed an ordinance amending Chapter 7 of the county code that gives full property state and county tax abatement for commercial buildings achieving LEED Gold certification for the first five years, then tapering off by 20% each year until the tenth year. Qualifying projects are new or expanding businesses in an enterprise zone that increase employment opportunities.[49]

1.10. Cincinnati, OH – Tax Break

On May 9, 2007, the City of Cincinnati amended legislation that established and defined The City of Cincinnati Community Reinvestment Area, adding an automatic 100% property tax exemption for developments that meet a minimum of LEED Certified for newly constructed or rehabilitated commercial or residential buildings. For buildings that meet LEED Certified, Silver and Gold, the maximum amount of abatement per dwelling unit is $500,000 over 15 years for new construction or over 10 years for renovation/ remodel. There is no maximum for LEED Platinum.

1.11. Costa Mesa, CA – Fast-track Permitting and Fee Reduction/Waiver

On September 4, 2007, the Costa Mesa City Council approved a resolution that established a green building incentive program for private development, effective September 5, 2007 through June 30, 2008. The program encourages green building practices through various incentives, including priority permitting and fee waivers for all green installations and fee reductions to cover the cost of LEED certification.

1.12. Harris County, TX – Tax Break

On May 20, 2008, the Harris County Commissioners Court adopted an ordinance establishing a partial tax abatement for costs incurred by developers to certify buildings with the U.S. Green Building Council. Buildings that meet the Certified level would be eligible for tax abatements of 1 percent of the construction costs. Buildings with higher ratings would get higher discounts with buildings that meet the platinum certification level eligible for tax abatements of 10 percent of the construction costs.

1.13. Hillsborough County, FL – Expedited Permitting

On May 14, 2007, Hillsborough County Manager approved the Residential Green Homes Policy, offering expedited permitting to home builders with a completed scorecard from either the LEED for Homes program or the Florida Green Home Standard Checklist. Scorecards must be supplied by a LEED

[49] See pages 79-85 of the County Code

for Homes provider or a qualified, third party green home certifier. On October 9, 2007, the Hillsborough County Board of Commissioners updated its Development Review Procedures Manual, allowing for expediting plan reviews for projects with a completed scorecard from either the U.S. Green Building Council or the Florida Green Building Coalition. The policy is effective January 1, 2008.

1.14. Honolulu, HI – Tax Break

A 2004 ordinance provides an exemption from real property taxes on the building improvements for a period of one year on all new commercial, resort, hotel and industrial construction that achieves LEED Certification.

1.15. Mecklenberg County, NC - Rebates

On December 18, 2007 the Mecklenberg County Board of Commissioners approved an amendment to the County Fee Ordinance to include the Green Building Rebate Program, offering permit fee rebates to projects with proof of LEED certification. Rebates increase proportionate to the level of certification achieved: 10% reductions for LEED Certified, 15% for LEED Silver, 20% for LEED Gold and 25% for LEED Platinum. Projects with proof of Green Globes certification are also eligible.

1.16. Pasadena, CA – Grant and Free Technical Assistance

Developers who exceed the minimum certification will qualify for a rebate from Pasadena Water and Power. The Pasadena Water and Power High-Performance Building Program matches one month's electricity savings for each percent efficiency better than code that the building performs (capped at $100,000). Additionally, developers who include affordable housing will earn a construction tax rebate of $1000 per unit. Pasadena Water and Power's LEED Certification Program offers $15,000 grants for applicants who achieve LEED Certified ($20,000 for Silver, $25,000 for Gold and $30,000 for Platinum). $1000 per unit. Pasadena Water and Power's Pasadena LEED Certification Program offers $15,000 grants for applicants who achieve LEED Certified ($20,000 for Silver, $25,000 for Gold and $30,000 for Platinum).

1.17. Oakland, CA – Free Consultation/Promotional Services

Oakland's 2005 Ordinance also promotes the use of green building strategies in private sector development by offering free technical assistance, green building guidelines and public promotion for qualified projects.

1.18. Portsmouth, NH – Density Bonus

Through an update in its zoning ordinance on April 4, 2007, the City Council of Portsmouth adopted a density bonus for private projects that use LEED. In Central Business District A, projects benefit from a

0.5 increase in Floor Area Ratio that meet appropriate open space requirements and that also build to a minimum of LEED Certified.

1.19. Pittsburgh, PA – Density Bonus

On November 26, 2007, the Pittsburgh City Council approved an amendment to The Pittsburgh Code entitled "Sustainable Development Bonuses," granting a density bonus of an additional 20% Floor Area Ratio and an additional variance of 20% of the permitted height for all projects that earn LEED for New Construction or LEED for Core and Shell certification. The bonus is available in all nonresidential zoning districts.

1.20. Sarasota County, FL – Fee Reduction, Expedited Permitting, Fast-track Permitting

On March 18, 2005, the county passed a resolution mandating that all government county buildings be LEED certified. Additionally, the county is providing a fast-track building permit incentive and a 50% reduction in the cost of building permit fees for private contractors who use LEED. On August 22, 2006, the county approved a Green Development Incentive Resolution (#2006-174) that provides fast-track permitting for residential and commercial green developments. Incentives apply to projects pursuing LEED for Neighborhood Developments (ND) or FGBC Green Development Standards.

Exhibit III – Complete Energy Efficiency Opportunities

The table below includes the full list of energy efficiency opportunities that were considered options for the site, where they have near or long term applicability, and which sections of the site they may be relevant for.

Demand-Side Management	Impact Time Horizon								
	Near Term (2025)	Long Term (2050)	Residential Single-Family	Residential Multi-family	Mixed Use	Office Campus	Flex	Retail	Street Areas
Advanced Infrastructure									
Broadband & wireless infrastructure			●	●	●	●	●	●	●
Advanced metering infrastructure			●	●	●	●	●	●	●
Decentralized energy storage			●	●	●	●	●	●	
Energy & water submetering			●	●	●	●	●	●	
PV Panel-level submetering				●	●	●	●	□	
EV-specific "second meter" at work and home (utility owned)			●	□					
Other "rough-ins" for EV charging (solar carports optional)			●	●	●	●	●	●	
In-pavement induction charging for EVs			□	□	□	□	□	□	□
Solar PV mounted on street-light poles									●
Intelligent high-efficiency street lighting									●
Streetlight pole mounted information devices (i.e. shared public infrastructure)									●
Building Co-Location									
Buildings with complementary load shapes are co-located to share heating and cooling systems				●	●	□	□	●	
Shared or Co-oped Commercial spaces (reduce overall load)				●	●	●	●	□	
Shared hot water heat recovery systems for service and restaurants that are co-located					●			●	
Shared pre-heating process water							●		
Efficient Construction & Design									
Incentives for smaller residential footprints			●	□					
Above ground grid orientation & building orientation			●	●	●	●	●	●	

Site energy savings and benefits likely
Site energy savings and benefits possible

● Intended application
□ Possible application
Not applicable

Demand-Side Management	Impact Time Horizon: Near Term (2025)	Impact Time Horizon: Long Term (2050)	Residential Single-Family	Residential Multi-family	Mixed Use	Office Campus	Flex	Retail	Street Areas
Efficient Construction & Design (continued)									
Passive solar building massing & interior adjacencies			●	●	●	●	●	●	
Underground EV garages as energy storage				●	●	●			
Energy Star appliances & electronics			●	●	●	●	●	●	
Meter-integrated or Modular Communication Interface-ready devices			●	●	●				
Smart plug systems			●	●	●	●	●	●	
Incentives for Variable Refrigerant Flow systems				□	●	●	●	●	
Condensing magic pak technologies				●					
Ground source and air source heat pumps			●	□	□	□	□	□	□
Combined natural gas hot water and heating systems			●	●	□			□	
Shared hot water storage			●	●	●				
Efficient building envelope development standards			●	□	●	●	●	●	
Commercial building air-leakage testing (commissioning)			●	●	●	●	●	●	
Monitoring-Based Commissioning				●	●	●	●	●	
DC power for converter based electronics			●	●	□	□	□	□	
Demand-response ready buildings					□	□	□	□	
Proximate bicycle parking (covered)				●	●	□	□	●	□
Solar-ready buildings (orientation, structure, chase for electrical)			●	●	●	●	●	●	
Building Occupant Behavior									
Community Energy Innovations forums									
Community-based behavior programs			●	●	□	●	●	□	
Regular & ongoing neighborhood "energy smart parties"			●	●	□	●	●	□	
Facility owner-run occupant energy behavior programs				●	●	●	●		
Building benchmarking & disclosure			●	●	●	●	●	●	

Site energy savings and benefits likely
Site energy savings and benefits possible

● Intended application
□ Possible application
Not applicable

Exhibit IV – Recommended Modifications to TCAAP Redevelopment Code

This section contains recommendations for modifications of the TCAAP Redevelopment Code to be considered based on energy vision principles.

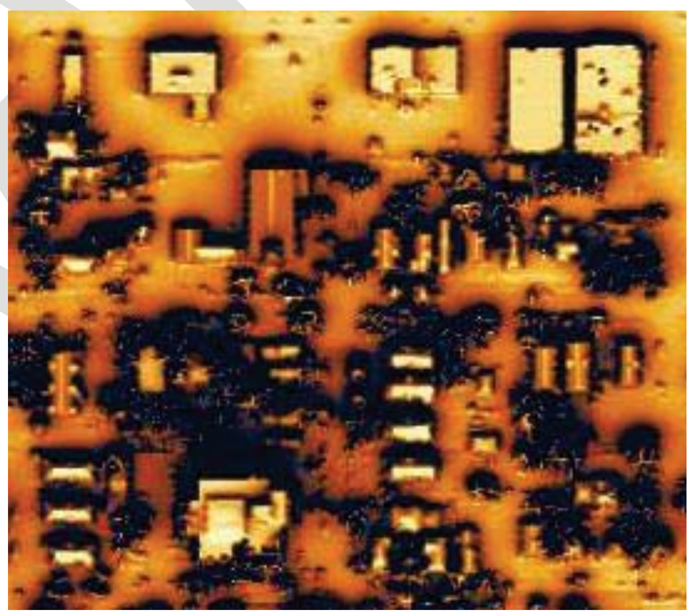
Our recommendations focus on general efficiency or renewable energy strategies, recognizing that individual strategies will be use-type- and site-specific, and therefore challenging to capture through overall guidelines. Considerations include shading of rooftop solar, efficient outdoor lighting, and allowance of passive energy building design techniques, especially for passive heating and cooling, daylighting, and wind blockage.[50] In addition, we specify recommendations that may allow for additional flexibility for unique flagship or demonstration buildings.

1.1. Purpose and Intent

- Consider specifically adding ERAB energy and carbon goals within the Purpose and Intent (e.g. Creating equitable, sustainable, *resilient, efficient,* and affordable development options…)

3.3 Development Review Process

Table 3-3 Administrative Modifications:



Credit: University of Minnesota Solar Suitability

- 1.b: location of regulated street – consider adding an indication that the review may also consider alterations to street location in order to increase rooftop solar energy potential. (e.g. add criteria: “*May consider changes in potential output from rooftop solar energy systems.”)*
- 2-d: Sidewalk and streetscape standards criteria – consider specifying that “*desired reduction in building energy use, or increased solar PV or solar thermal shading*” are examples of the development context that changes can be

[50] For an interesting example of new low energy use design options, see this case study of Seattle’s Bullit Center: http://blog.2030palette.org/case-study-the-bullitt-center/

based on.

Section 3.3(e) Major Modifications:

- Flagship Energy Demonstrations: Recommend adding language that would support flexibility for innovative flagship or demonstration buildings that meet strict energy guidelines and serve an educational, marketing, and site investment purpose. For example:
- Under 3.3(e)i: 3. "the extent to which the proposal provides public benefits…, *is a net-zero or equivalent energy use building with community educational and technology demonstration value*.

Credit: Bullitt Foundation Headquarters, Seattle. WA.

- Alternatively, the Code could include a reference to "Flagship Energy Demonstration Buildings," possibly as a use category, which would receive joint review and approval. The definition of "Flagship Energy Demonstration Building" could be forthcoming subject to Council approval.

4.0 Definitions

Suggested Modifications:

Street Screen: "A freestanding wall, *living or renewable material fence*, or combination fence…"

Suggested Additions:

Building Orientation: How a building is positioned to designate its natural, identifiable, or welcoming frontage, which may not require parallel alignment with a specified axis. (as in section 7.2 "it is required that buildings be *oriented* towards pedestrian priority frontages.)

Demonstrated reduction in energy use: Proposed building design demonstrates energy reduction using building modeling results from program such as Energy Design Assistance, SB 2030, or equivalent.

Net-Zero Building: A building that minimizes site energy requirements and supplies the remainder with on-site renewable energy systems, on an annual basis.

Renewable Energy System: A device that generates electricity or heat using only energy sources that are not depleted when used, including solar, wind, or geothermal energy.

Site Energy Use: Energy consumption as measured by use at the building site, as opposed to by primary energy sources, such as upstream fuels for electricity generation.

Section 6.0 Building and Site Development Standards:

- Sections 6.2 – 6.6, (i) Principal Building Standards
  - Consider adding: *building may be allowed 10 percent building maximum height increase for demonstrated reduction in site energy use of 5 percent or greater from said design modification*. (see definitions)[51]

Section 7.0 of the Zoning - Building Design Standards:

- 7.1 Purpose and Intent (e) Consider adding "Increase the quality, adaptability, *resilience, efficiency*, and sustainability…"
- 7.3: Façade Composition (iii) Façade Transparency Required:
  - Consider adding 2. *All northern façade upper floor(s) may have a 40 percent maximum transparency, to reduce heat loss*.[52]

In Section 10.0 - Streetscape and Landscape Standards:

- 10.2 Street Trees and Streetscape
  - (e) Consider adding: *Street tree mature height and species may be prioritized according to associated energy benefits, such as preventing shading of rooftop solar systems and lowering building heating or cooling requirements.*
- 10.4 Street Lighting and 10.5 Exterior Lighting
  - Consider additional provisions 10.4 (e) and 10.5 (a*): all exterior lighting shall be high efficiency lighting, such as LED lamps.*
  - Alternatively, *all exterior lighting should be high efficiency lighting, such as LED lamps.*

Credit: Eastern Michigan University eastern sun shading screens

[51] Reduction in energy use could apply to increased daylighting and / or increased passive heating.
[52] 35 to 40 percent glazing is generally considered good practice for energy efficiency (see http://windows.lbl.gov/daylighting/designguide/LBNL_Tips_for_Daylighting.pdf p. 33)

Subdivision Review Process

- Incentivize or solicit an energy review for subdivision plans, specifically for solar energy potential and landscaping energy benefits.[53] This would allow optimization of rooftop orientation and shading to be one consideration for street alignment and grading during the subdivision process. Precedents exist for encouraging appropriate solar orientation for new development.[54]

In addition to the specific suggestions above, the Project Team suggests consideration of:

- A section that addresses the desired aesthetic use of renewable materials, for consistency and uniformity across developments (e.g. preferred locations for solar PV are rooftops, parking lots, solar shades, kiosks, bus stations, etc.)
- A specified process for review of new energy technologies and materials that allows the code to be updated as new technologies and building materials reach the market.

Building materials were not available to review at this time. We suggest inclusion of innovative building materials such as building integrated photovoltaics (BIPVs) to be used as PV shingles or brick façades.

[53] See for example http://www.corridordevelopment.org/pdfs/Green_space/HUD_11Energy.pdf from the Metropolitan Design Center at the University of Minnesota.
[54] For precedents and guidelines for solar energy site planning, see, American Planning Association, "Planning and Zoning for Solar Energy," at https://www.planning.org/research/solar/faq.htm.