CARBONDALE NET ZERO ENERGY DISTRICT

2018 Feasibility Assessment - Draft

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Introduction

In 2017 the Town of Carbondale adopted a goal of creating a carbon-neutral community and achieving 100% reduction of carbon emissions by 2050, in addition to a 20% increase in energy efficiency over 2015 baseline by 2030 and obtaining 35 - 50% of energy from renewable sources by 2030.

Zero Energy Districts were identified as one means of reaching these goals in the 2017 Carbondale Climate and Energy Action plan. In 2018 the Carbondale Trustees asked CLEER to explore the concept of creating a Zero Energy District in the Carbondale community. The scope of the project included a scoping meeting/educational workshop to increase understanding of Zero Energy Districts and identify key issues and opportunities for locations in Carbondale; outreach to key stakeholders, property owners, residents and partners; preliminary analysis and identification of main topics requiring additional technical assistance; identify steps for project development; identify and pursue near term and longer term funding sources; connect with state and national resources working on ZEDs.

An educational workshop/scoping meeting was held on May 17 2018 with Shanti Pless, a national leader on Zero Energy District development from the National Renewable Energy Lab and Ed Mazria, Architecture 2030, considered one of the originators of the Zero Energy District concept.

As part of the workshop a mini-charrette was held to consider specific locations in Carbondale that would lend themselves well to a zero energy district and identified key issues, opportunities, and barriers. The charrette identified an area centered around the Third Street Center as the initial site for consideration. This site was chosen due to it including a variety of types of properties owned by entities interested and engaged in high

performance buildings and partnerships (the Roaring Fork School District; the Garfield Library District; Third Street Center) buildings with different types of uses, both new and older affordable housing units; and its central location and very public nature that could maximize the demonstration value of a potential project.

This report documents progress to date on pursuing the net zero district concept for the Town of Carbondale and provides a range of potential next steps and recommendations.

CLEER staff did extensive research on the existing systems and energy consumption of all of the buildings and sourced data from a variety of avenues, with varying levels of success. Subsequently, all data in this report should be considered approximate. Some of the data has been calculated from previous years energy bills, some has been estimated and some extrapolated from incomplete data sets.

The report provides information on overall district energy use for electricity, and compares it to electricity production from existing Solar PV systems. Roughly 200kW of additional Solar PV would need to be added to the site to provide 100% of current electricity consumption of all of the district buildings. However, the largest portion of the district's fossil fuel footprint can be attributed to natural gas consumption from heating, cooling and hot water supply and initial investigations are under way to assess the efficacy of a centralized approach to heating and cooling with Ground Source Heat Pump technology. Investigations were also conducted for a modular approach to heating and cooling that would utilize Air Source Heat Pump technology energized by electricity provided by additional Solar PV.

Each building or group of buildings in the district was assessed for overall electricity and gas consumption and all known energy efficiency and renewable energy measures made to date have been documented, along with the potential next steps required for each building to work towards a net zero district goal.

While this report is focused on the retrofit of existing buildings, it is also clear that the best opportunity for efficient and cost-effective achievement of net zero is in new construction projects and that net zero goals should be considered in the project design phase. Consequently, the information in this report should also be useful as a planning tool for the town when considering updates to the green building code and encouraging an increase in efficiency of new construction beyond current local energy efficiency codes.

Zero Energy Districts[1]

Zero Energy Districts also known as Net Zero Energy Districts (NZED) have the potential to improve the economic competitiveness, resiliency, environmental quality and energy independence of communities. Consisting of a range of multipurpose, energy efficient buildings, the net zero district extends the zero energy concept from single buildings to a collection of buildings, with the aim of using on site renewable energy production - mainly from solar PV – to equal or exceed the combined buildings energy use. There are several advantages to a district approach including the cost savings that may be found through economies of scale as it creates the opportunity to procure larger quantities of products and services to drive down unit costs. Conceptually, a centralized approach to energy planning may also afford the opportunity to use buildings with abundant roof space or land suitable for PV to provide energy to buildings with higher load densities and limited space for PV. With the addition of back up power and an "islandable microgrid" that can provide critical services in the event of a grid outage, integrating energy needs and supply across a district can also increase overall resiliency.

[1] Zaleski, Sarah, Shanti Pless, and Ben Polly. 2018. "Communities of the Future: Accelerating Zero Energy District Master Planning: Preprint." Golden, CO: National Renewable Energy Laboratory. NREL/CP-5500-71841 https://www.nrel.gov/docs/fy18osti/71841.pdf.

Summary of Proposed Site

In considering an appropriate site for creation of a Net Zero Energy District, the area around the Third Street Center (TSC) was a clear choice as TSC has already made significant strides towards mitigating the fossil fuel energy use of the building and has professed a strong interest in achieving net zero energy. Likewise, both the Garfield County Library District and the Roaring Fork School District have implemented some on-site and offsite solar PV purchases within the district boundary and are already moving towards the target of net zero energy for their facilities.

Incorporating a range of residential and commercial buildings within the district area paves the way to look for opportunities to benefit from economies of scale, by addressing the energy use of the district as a whole, and to identify potential technical or policy barriers that may need to be overcome in order to take a centralized approach.

Facility Name	Location	Ownership
Third Street Center	Third St	Third Street Center
Carbondale Branch Library	Sopris Ave	Garfield County Library District
Bridges High School	Sopris Ave	Roaring Fork School District
RFSD Housing	Third St	Roaring Fork School District
Second St Townhomes	Second St	Individual homeowners

Table 1: Net Zero Energy District Buildings and Owners

Furthermore, the selected area has characteristics that are conducive to the proposed strategy and technologies for achieving net zero energy, including solar ready rooftops, multiple parking areas that could incorporate solar carports and plans for exterior redevelopment that could be timed with the installation of ground source heat loops.

The district boundary intentionally incorporates the row of townhomes on second street in an effort to investigate a collaborative approach to alleviating utility expenses, through efficiency upgrades and renewable energy systems, to benefit the occupants of some of Carbondale's lower income housing. See Appendix 1: Site Map - District Boundary

District Energy Overview

A high-level analysis of current energy use and energy production within the district was conducted using various data sources including Xcel Energy utility bills, Black Hills utility bills, HERS reports, PV Watts, Garfield Energy Navigator and the Carbondale Climate Action Plan study. All data in this report should be considered approximate as it has been estimated from a variety of sources with a varying level of accuracy and in some cases extrapolated from incomplete data sets.

Electricity Data* Approximate Annual Totals		**Third St Center**	**Carbondale Branch Library**	**Bridges High School**	**2nd St Townhomes**	**RFSD Housing**	**Total for District**
Electricity consumption	kWh	116,312	102,459	202,000	140,000	106,000	666,771
Solar production	kWh	137,248	44,717	191,900	0	0	373,865
Solar as a percentage of total	%	118	44	95	0	0	56
Solar shortfall	kWh	-20,936	57,742	10,100	140,000	106,000	313,842
Additional solar capacity required for 100%	kW	0	38	0**	93	71	202

Table 2: District Electric Energy Data

Natural Gas Data*		**Third St Center**	**Carbondale Branch Library**	**Bridges High School**	**2nd St Townhomes**	**RFSD Housing**	**Total for District**
Annual gas consumption	kBtu	1,319,251	582,100	1,169,700	1,876,000	792,000	5,739,051

Table 3: District Gas Consumption Data
**All numbers are approximate and have been estimated or extrapolated from various sources including utility bills, Garfield Energy Navigator and PV Watts.*
*** To be achieved with efficiency measures*

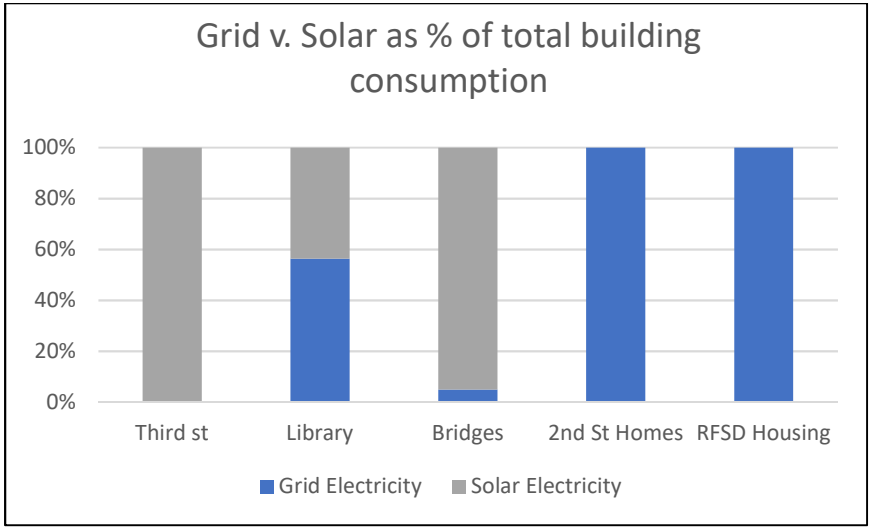

Figure 1: Comparison of grid supplied energy and solar supplied energy for each building

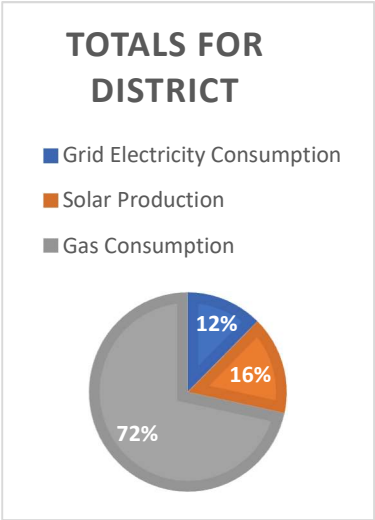

Figure 2: Total energy use/production by source

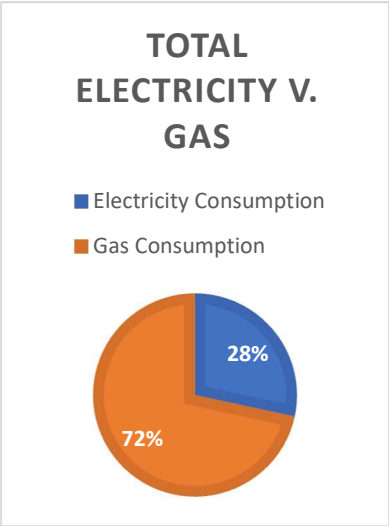

Figure 3: Total energy consumption by source

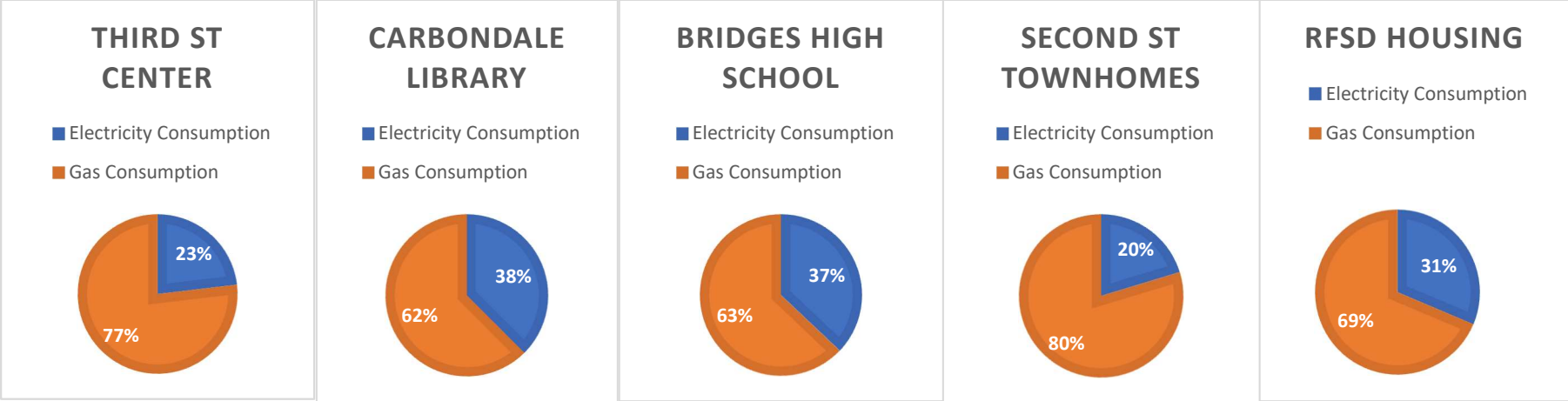

Figure 4: Total energy consumption by source for each individual building.

Technology Overview

Ground Source Heat Pump (GSHP):

GSHPs use large loops of buried tubing to exchange heat with the ground. The near constant temperature of the earth allows GSHPs to operate efficiently in even the coldest of climates. Basic sizing of a GSHP system is based on the square footage of conditioned space that require heating and on the subsequent BTU load requirements. However, substantial preliminary investment is required to establish feasibility and to provide the GSHP design and the mechanical designs to achieve heat delivery to each building or conditioned area. Once this has been completed then a total system implementation cost can be established.

Installation of Ground Source Heat Loops

Air Source Heat Pump (ASHP):

Air Source Heat Pumps (ASHP) consist of an outdoor heat exchange coil which extracts heat from ambient air, and an indoor heat exchange coil which transfers the heat to the indoors through ducts (recommended for new construction) or to indoor delivery units in a ductless system (for existing building retrofits). The latest models from Mitsubishi can achieve efficiencies of 30.5 SEER and the lower upfront capital costs can make air source heat pumps a more economically attractive option than ground source heat systems. With the advent of variable speed compressor technology ASHPs can now be used in climates where temperatures fall below 0° F, although the efficiency of the system drops significantly at very low temperatures.

On Demand Electric Water Heater:

On Demand Electric Water Heaters (also known as tankless or demand-type water heaters) heat water only as needed. Using a heating unit near the hot water use site, a tankless water heater heats up cold water instantly without the use of a water heater tank, avoiding costly heat loss that is typical of storage tank water heaters. Tankless water heaters have a higher initial cost than storage tank water heaters but this is offset by longer life expectancy (20 years versus 10 - 15 years for conventional storage tank water heaters) and lower operating costs. Tankless water heaters can be 8% - 34% more efficient than conventional storage tank water heaters depending on the gallons used daily.

Solar Thermal Domestic Hot Water (DHW):

Solar Thermal energy differs from Solar Photovoltaic in that solar thermal technology converts solar radiation into heat rather than electricity. A solar thermal domestic hot water (DHW) system consists of two main components: a solar collector which collects heat from solar radiation and a storage tank to collect the heated water.

Evacuated Tube Solar Thermal Panel

Solar thermal DHW heaters typically fit into two categories; active and passive. The basic difference is that active solar thermal DHW heater systems use electricity to power pumps and controls in order to move water through the system and passive does not use any energy other than solar radiation and natural convection to power the system.

Solar PV:

Solar Photovoltaic (PV) systems use light from the sun to generate electricity. Each cell consists of a semiconductor material (usually made from silicon) with a negative conductor on one side and a positive on the other. When solar light hits the cell the photon knocks loose electrons from their atoms and the electrons are forced in one direction to create an electric circuit which produces direct current (DC) electricity.

Solar Photovoltaic Panels

An on-site or rooftop solar system for a property can be installed as either a grid-connected system or a standalone system with battery storage. Some homeowners have hybrid systems that are connected to the utility grid but also incorporate battery storage for use during a grid outage.

Community solar gardens provide an alternative for residents and business owners that do not have suitable conditions for installing a PV system on their own site. There are several models for making a purchase in a community solar garden ranging from owning the actual equipment to a subscription to purchase the energy.

Energy Efficiency:

Before moving forward with additional solar PV and the addition of any new technologies, we recommend that all buildings go through a comprehensive analysis to identify potential energy efficiency savings. Although some of the sites have improved their building performance over time we think there are still opportunities for additional energy improvements.

Overview of Buildings within the District

Third Street Center

Energy Efficiency

The Third Street Center (TSC) is committed to becoming a net zero building and has invested in extensive energy efficiency upgrades throughout the years. The inefficient incandescent light bulbs have been replaced with LEDs and dimmers and lighting controls have also been installed throughout the building to maximize on the performance of the LEDs. As LEDs do not put out heat they are also advantageous for helping to keep cooling costs down.

A portion of the TSC was built in 1956, so insulation levels were extremely low and the level of air leakage was very high. During the original remodeling (2009), Building Performance Contractors completed an air sealing project that considerably reduced the air leakage in the building and added R-40 fiberglass insulation in the attic.

Additional efficiency measures include:

- Installation of a Tekmar TN4 thermostat that controls all the other thermostats in the building. According to the facility director, the building saw a 16% energy reduction in the first year;
- In 2012, TSC replaced 6 old rooftop units (RTUs) with newer models;
- Low flow devices have been installed throughout the facility;
- In 6 years, the building more than doubled its recycling, while also reducing in half the overall waste by investing in compost.

Heating and Cooling

There are a variety of heating and cooling systems in use at the Third Street Center (TSC). All of the domestic hot water use in the building is served by a solar thermal system, which can also provide heat to the central hydronic system in times of excess. The main hydronic heat system is served by two (2) Lochinvar Fire Tube boilers, each able to provide 600,000 BTUs with an efficiency rating of 97.5%. This system serves the Round Room area, the central core of the building and the offices off the Long Hall. The boilers are located at a substantial distance from the Long Hall and the heated fluid must travel through cast iron pipes set in an uninsulated concrete slab to reach the Long Hall area, so there is substantial heat loss that occurs when delivering to this location.

The four office spaces at the end of the Long Hall, known as the Quad, are served by roof top units (RTUs), one for each office. These Lennox modulating heat, variable speed furnaces have an efficiency rating of 97% and operate in tandem with Lennox EMD 14M-65 economizers to maintain indoor air quality and avoid the need for mechanical cooling.

The Community Hall (formerly known as the gym) is heated by two (2) Lennox RTUs with an efficiency rating of 80%.

In strategizing to make the TSC a net zero building, all of the heating and cooling systems would need to be converted to systems that are powered by electricity rather than natural gas, and then additional Solar Photovoltaic capacity added to the site.

TSC staff anticipate a multi-step, modular approach to the conversion that will reflect the layout of the building and the different requirements of each of the separate building areas. Preliminary investigations are underway to analyze the possibility of removing the RTUs in use by the Quad and Community Hall and potentially replacing them with a Ground Source Heat Pump system or Air Source Heat Pumps.

Further near-term investigations will center around the potential to use Air Source Heat Pump technology to heat the Round Room and the surrounding offices.

Next Steps:

- *TSC have secured grant funding to study the technical and economic feasibility of a GSHP system to be located under the planned parking lot to the East of the building. Results of the analysis will inform the potential system size and potential area to be heated.*
- *TSC staff will consult with an HVAC contractor to establish ballpark pricing and estimated equipment sizing for an ASHP strategy for the Round Room. Considerations include back up for extreme low temperature days.*

Electricity Use

TSC is currently powered by (3) Solar PV systems totaling 106 kW. The systems generate around 18% more energy than the building uses. This excess energy is currently being fed back on to the Xcel utility grid but there is an opportunity to apply the energy to a new electric fueled heat system to offset some of the buildings gas use.

Next Steps:

- *CLEER to analyze Xcel Energy bills and consult with Xcel Energy representatives to understand how to access the $13,000 solar credit currently "banked" on the account and how best to allocate the excess electricity generation moving forward.*

Bridges High School

Energy Efficiency

The Roaring Fork School District (RFSD) included efficiency upgrades to the Bridges High School and Administrative Buildings as part of a suite of projects undertaken with BOND funds.

At this stage, more information needs to be collected on measures taken to date in order to identify further efficiency opportunities.

Heating and Cooling

To be a net zero building, natural gas use will need to be addressed. According to data supplied by Black Hills Energy the building is currently using around 1,169,700 kBtus annually for space heating and cooling and hot water supply.

Electricity Use

RFSD has entered into a long-term contract to purchase electricity from community solar gardens in Garfield County. The contract includes 101 kW of capacity allocated to Bridges High School, sized to offset 95% of the current annual electricity use. The solar garden uses single axis tracker technology to produce an estimated 1900 kWh/kW, resulting in an estimated 191,900 kWh of solar electricity allocated to Bridges

High School on an annual basis. The School District intends for the remaining 5% of grid electricity use to be addressed through further efficiency measures or behavioral changes with an intent to reduce electricity consumption.

Next Steps:

- *Collect information on efficiency projects to date and assess further opportunities for efficiency measures to reduce natural gas consumption of the building.*
- *Collect information on heating, cooling and hot water systems and assess opportunities for replacement with electricity-based systems.*
- *Calculate electricity use for new systems and assess opportunities for on-site and offsite solar PV systems.*
- *Estimate capital investments required and investigate potential funding sources.*

Roaring Fork School District Housing

The Roaring Fork School District (RFSD) built housing to the highest efficiency standards that fit within the construction budget. Further information needs to be gathered to assess if there are further efficiency opportunities or if there are opportunities to convert the heating systems to an electric based system that could be offset with Solar PV energy production.

Annual electricity consumption for the housing units was estimated from a HERS report prepared for one of the 3-bedroom units. The report predicts annual energy consumption of 5,300 kWh/year/unit. Actual consumption per unit will vary depending on the size of the unit and on occupant behavior. For the purposes of this preliminary study, we have estimated that the RFSD housing will require approximately 106,000 kWh of electricity per year, the equivalent to roughly 70 kW of Solar PV capacity.

All of the homes have been “roughed-in” for rooftop solar PV systems and RFSD is currently pursuing a feasibility study on offsetting current electric energy use of the buildings with Solar PV. This could be with a roof-top approach or a ground mounted or carport array that could produce energy to be credited against aggregated meters.

Next Steps:

- *CLEER to perform solar feasibility assessment for RFSD Housing.*
- *Engage with the school district to collect further information on current systems and gauge interest in moving towards net zero.*

Second Street Townhomes

Energy Efficiency

The townhomes on 2nd St were built in 1972 and include a total of 20 units, each individually owned and metered. The units vary in square footage and design layout. As part of the net zero energy district project, CLEER provided an energy assessment to Mark Luttrell - located at 587 S. 2nd St. Some of the recommendations provided by Charles Cady, the energy analyst, were: improve air sealing, install pipe insulation and install new basement windows. The homeowner had previously installed a high-efficiency boiler and hot water heater and during the energy assessment he also received two new programmable thermostats, LED bulbs and pipe insulation. CLEER enrolled Mark in the CARE program, Energy Outreach Colorado's income qualified program, which allowed us to weatherize his home and reduce its air leakage at no cost to the homeowner. In total, Mark is going to save $201.58 in annual utility bills. See Appendix 2: Energy Assessment report.

Next Steps:

- *Contact each homeowner/tenant to either enroll them in the CARE program or get them signed up for an energy assessment so we can evaluate each unit separately.*

Heating and Cooling

The townhomes on 2nd St are currently heated by individual hydronic systems, consisting of natural gas fueled boilers and baseboard delivery. To eliminate fossil fuel consumption the systems could be converted so that electricity is used instead of natural gas and then the additional electric consumption offset by Solar PV.

One possible strategy would be to install Air Source Heat Pumps and On Demand Tankless Hot Water systems for each home. This conversion would cost an estimated $18,000 - $20,000 per home. Costs will vary due to differing home square footages and number of rooms per home. The ballpark per home estimate is based on the installation of (1) 4 ton Mitsubishi outdoor unit, (6) mini split indoor units, (1) tankless DHW system plus installation labor.

Electricity Use

Actual electricity consumption of each townhome will vary depending on the appliances and behavior of the individual occupants so for the purposes of this preliminary study, electricity consumption has been estimated from data gathered for the Town of Carbondale Climate Action Plan. Using this methodology, we anticipate that each building uses an annual average of 7000 kWh/year. High level analysis demonstrates that each unit could accommodate roughly 3 kW on each of the east and west facing roofs (for a total of 6 kW) which could produce 100% of the current estimated annual electricity use.

Next Steps:

- *Further calculations need to be made to assess the additional electrical consumption of the buildings should new space and domestic water heating systems be put in place.*
- *Further on site or off-site solar opportunities need to be identified, to offset the electricity use of new heating systems.*

Carbondale Branch Library

We currently have very limited information on the efficiency status of the library building or on the current heating and cooling systems.

Further outreach to the Garfield County Libraries facility manager will be required in order to understand current conditions and propose a strategy to move forward to net zero energy.

Electricity Use

An estimated 44% of the library's annual electric energy consumption is being provided by the 29 kW roof top Solar PV system. High level analysis demonstrates that it would be possible to add an additional 21 kW of Solar PV to the rooftop using conventional modules or up to 30 kW using high efficiency modules, which could bring the onsite solar production to close to 100% offset of current estimated annual electric consumption.

Next Steps:

- *Collect information on efficiency projects to date and assess further opportunities for efficiency measure to reduce natural gas consumption of building.*
- *Collect information on heating, cooling and hot water systems and assess opportunities for replacement with electricity-based systems.*
- *Corroborate potential for additional Solar PV and identify funding sources and/or financing mechanisms.*

See Appendix 3: Site Map – Parcels
See Appendix 4: Site Map - Existing Solar PV

Financing and Funding Opportunities

Colorado Commercial Property Assessed Clean Energy Financing

Colorado C-PACE offers low cost, long term loans allowing commercial and multifamily properties to finance qualifying energy efficiency, renewable energy, water conservation and other clean energy improvements on existing and new construction projects. Repayment occurs by way of a special assessment on the property tax bill and, as energy improvements can lower utility bills, well designed projects can be cash flow positive in year one.

Sustainability as a Service (SaaS) from Sustainability Partners

This innovative structure is suitable for upgrades and retrofits in existing buildings and can be used to implement new lighting, insulation, HVAC systems and more. Sustainability Partners invests in the engineering, materials, installation and maintenance of the new system and acts as a service provider that allows use of the system for a monthly usage fee (much like a utility company model) .The customer benefits from reduced energy bills, no operations and maintenance costs and no upfront capital investment or debt related to new system procurement.

Xcel Energy Solar*Rewards Program

Solar Rewards is an incentive program from Xcel Energy that provides monthly payments based on the energy produced by a grid interconnected photovoltaic system in exchange for the Renewable Energy Credits associated with the system. In 2019, Xcel Energy will allocate 24 MW of capacity to the Solar*Rewards Medium Program. Solar PV systems sized between 25 kW and 500 kW can generate an income stream of $0.0375 for every kWh produced over a contract period of 20 years.

Solar Power Purchase Agreement

A solar power purchase agreement (PPA) is a financial agreement whereby a developer installs a solar PV system on a customer's property at no upfront cost to the property owner. The developer sells the generated energy to the host customer at a rate that is typically lower than the local utility retail rate. The developer is responsible for the operation and maintenance of the system for the duration of the PPA agreement. At the end of the contract the customer may be able to extend the contract, purchase the system at its depreciated value or have the developer remove the system.

Grant funding

Local opportunities for grant funding include the Randy Udall Energy Pioneer Grant administered by Community Office for Resource Efficiency (CORE). Grant funding is available from $10,000 - $200,000 and there is an annual application deadline of May 1. A second opportunity is available from Federal Mineral Lease District funds (FMLD). The grant cycle is twice yearly with application deadlines in February and August, for funding amounts between $25,000 and approximately $500,000. Both grant opportunities require the applicant to provide matching funds.

Lessons learned and recommendations

1. Best practices for the development of Net Zero Energy Districts are predominantly focused around new construction and success hinges on creating a net zero master plan in the pre-design phase of project development.

   Recommendation: Examine ways that Town of Carbondale can encourage Net Zero Design for new construction through codes and policies and educating the design community.

2. Further investigation into the viability of a centralized ground source heat pump system is required to understand if there are economic savings at a larger scale. The costs of testing ($12,000 - $14,000) remain static for any system size but preliminary findings suggest that the bulk of the costs are proportional to the size of the system, including installation costs of $30 -$40 per square foot of building space to be heated, the mechanical engineering of the delivery systems for each building area, and the labor and installation of the delivery systems within each of the buildings.

   Recommendation: Finalize costs and viability for centralized GSHP system and compare to a modular approach.

3. Models for Net Zero Energy Districts suggest using on-site renewable energy systems to provide energy generation at a district scale. However, current utility and PUC rules prevent the siting of a solar array on a parcel owned by one entity to provide energy to a meter sited on a parcel owned by a different entity.

   Recommendation: Solar PV systems will need to be sited on the same physical parcel as the building for which they are providing energy but financial savings may be achieved by aggregating the purchase of several systems together.

4. Group purchase programs can provide financial savings to individuals. For example, a one-time purchase of (20) 6kW PV systems for the second street townhomes could result in a lower per unit cost than making individual purchases.

   Recommendation: Investigate the viability of a "solarize" program for lower income homeowners, perhaps in conjunction with Grid Alternatives (a solar development company specializing in low income solar access)

5. Creating a Net Zero Energy District within a retrofit situation requires replacing existing gas fueled heating, cooling and domestic hot water systems and replacing them with systems energized by electricity generated from renewable sources. High capital expenditures could prove to be a barrier to project success.

   Recommendation: Focus on a step by step approach for the district following a prioritized list of measures to be implemented over time.

6. While some outreach to stakeholders has been performed in order to collect data and information on the various buildings within the Net Zero Energy District, further education and outreach will be required to gain stakeholder buy-in.

   Recommendation: Convene a meeting among district stakeholders to educate on the concept of net zero, convey the importance of measuring energy consumption in order to manage it and gain commitment for further implementation of system and building monitoring and/or provision of full annual billing information.

Resource Information Contacts			
Contact	**Affiliation**	**Phone**	**Email/Website**
Jeff Gatlin	C.O.O., Roaring Fork Schools		jgatlin@rfschools.com
Patrick Tonozzi	Maintenance Manager, GarCo Libraries	970-379-9463	ptonozzi@gcpld.org
Peter D'Antonio	PCD Engineering	303-678-1108 x707	peter@pcdengineering.com
Taylor Critchlow	AEC Engineering	970-376-0038	taylor@aec-vail.com
Terry Proffer	Geothermal Manager, Major	303-210-4479	tproffer@gomajornow.com
Utility Contacts			
Xcel Energy (Electric)	Utility	800-895-4999	datarequest@xcelenergy
Black Hills Energy (Gas)	Utility	888-890-5554	custserv@blackhillscorp.com
Navigator	CLEER Utility Monitoring		http://garfield.buildingenergynavigator.com/

Site Map: District Boundaries

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Home Energy Assessment

Your Energy Smart Analyst:
Charles Cady
(970) 379-2961

Welcome to Energy Smart!

You have taken the first step to improving the comfort, safety, and efficiency of your home. The following report details the findings from the Home Energy Assessment on October 15, 2018.
Call your local Energy Resource Center with any questions or to discover available rebates that can help make these recommendations a reality.

Building Type: Townhome
Year Built: 1972
Square Footage: 1452
Primary Heating Fuel: Natural Gas
Number of Bedrooms: 3
Number of Occupants: 2

Your top priorities:

1. Air sealing
2. Pipe insulation
3. Basement windows

Made possible with generous support from your utility provider(s):

Luttrell Residence
587 S. 2nd St, Carbondale, CO 81623
markluttrell57@gmail.com
(970) 379-4351

Recommended Upgrades

Your Energy Smart Analyst:
Charles Cady
(970) 379-2961

What are these numbers?

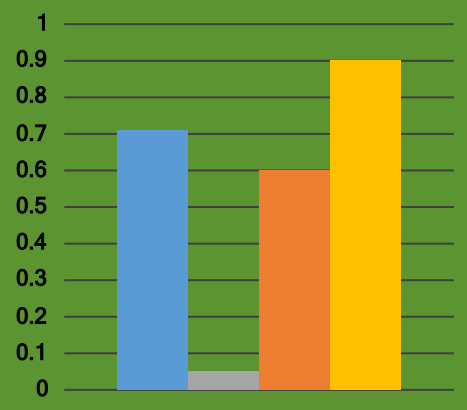
When we performed your Home Energy Assessment, we collected information that allows us to estimate energy savings on projects you might consider to save money on your energy bills. Below is a breakdown of those estimates.

Improvement	Estimated Cost	Estimated Savings (per year)	SIR (Greater than 1 means project will pay for itself with energy savings)
Add storm windows or install new windows to save energy and increase comfort.	$6,229.60	$9.93	0.0
Improve water heater 1	$1,814.77	$11.75	0.1
Increase attic insulation and coverage to save energy and increase comfort.	$759.88	$10.79	0.3

Air Sealing

Your Energy Smart Analyst:
Charles Cady
(970) 379-2961

Cubic Volume: 11616cf
Blower Door Flow Rate: 2032CFM50



Natural Air Changes per Hour (ACHn)

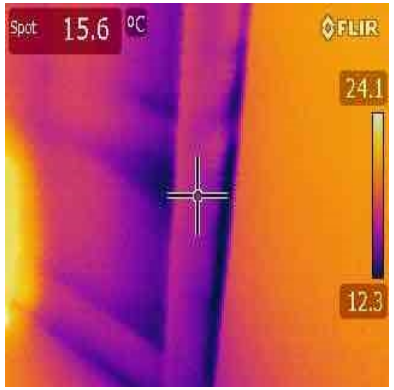
- **Your Home**
- Tight Home
- Average Home
- Leaky Home

cf = Cubic Feet. The volume of air contained in a 1' x 1' x 1' cube.
***CFM50** = Cubic Feet per Minute at 50 Pascals negative pressure. This number estimates how much air your home loses each hour.*
***ACHn** = Natural Air Changes per Hour. Expressed in the chart below as 0.71, this means that 71.00 % of the air in your home is lost to the outside every hour.*

Energy Smart Fact:

We conducted a blower door test on your home. This test uses a large fan to force air out of your house, lowering the pressure inside. Higher pressure outside then causes air to flow in through all unsealed cracks and openings, using the same pathways that allows warm air to leak outside during winter months. You can see your home's "natural" leakage rate on the chart in the sidebar.NOTE: If you have a natural draft furnace, boiler or hot water heater, it is critical to "test out" or retest your combustion appliances after air sealing to ensure proper operation that protects your family.

Major air entering around the kitchen vent



Air infiltration observed at the window and door trim.

Blower door set up for the pressure test.

Recommendations:

Air infiltration observed at the attic access,rear door, kitchen fan vent, and window trim.
The attic access should be caulked shut to keep out unwanted attic air.
The back door weatherstripping is damaged and should be replaced.
The vent in the kitchen cabinet could be boxed out to seal.
Door and window trim should be caulked to seal.

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Envelope - Roof

Your Energy Smart Analyst:
Charles Cady
(970) 379-2961

Primary Roof:
Unconditioned Attic
- **Construction:** Wood Frame
- **Exterior Finish:** Composition Shingles
- **Percentage of Total:** 100%
- **Existing R-Value:** 30
- **Recommended R-Value:** 49

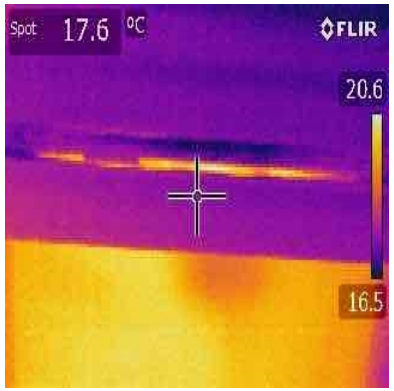
Secondary Roof:

- **Construction:**
- **Exterior Finish:**
- **Percentage of Total:** 0%
- **Existing R-Value:**
- **Recommended R-Value:**

Upgrading Roofs *– Roofs are typically considered for energy improvements when there is easy access to the existing insulation, such as an attic floor, or when you are re-roofing your home. Rigid foam insulation can be added to your roof deck to increase its thermal performance, savings you money on utility bills and making your home more comfortable.*

Energy Smart Fact:

Adding insulation to your attic can be one of the most impactful energy-saving upgrades to your home. We recommend air sealing all penetrations between your attic and your living space before considering any insulation project. Most rebate programs will also require air sealing to ensure proper moisture control is achieved.



Air infiltration at the attic access.

Recommendations:

Increase the attic insulation to R-49 to reduce summer heat gain and winter heat loss.
The access needs insulation as well,then should be sealed.

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Envelope - Windows

Your Energy Smart Analyst:
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Existing Window Type:
2-pane, wood/vinyl fr., Low-e

Recommended Window Type:
2-pane, wood/vinyl fr.

Square Footage of Windows:
Front: 64 s.f.
Right: s.f.
Back: 66 s.f.
Left: 78 s.f.

U-Factor *– This number refers to the ability of your windows to resist heat loss. It is the numerical reciprocal of R-Value.*
Low E *– These coatings are applied to glass when windows are manufactured, and help to reduce the window's emissivity, which can improve insulating properties, when properly applied.*
Gas Filled *– Noble gasses are used as an air barrier between panes of glass to help increase a window's thermal performance. The seals that keep these gasses trapped inside can fail over time, and should be inspected periodically.*

Energy Smart Fact:

Adding storm windows, insulating blinds, or replacing your current windows can save energy and make your home feel more comfortable. When replacing windows, install energy efficient windows with a U - Value of .28 or lower.

Recommendations:

Basement windows are single pane aluminum. Recommend replacement.

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Heating & Cooling

Your Energy Smart Analyst:
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(970) 379-2961

Heating System Type:
Boiler-Baseboard
Fuel: Natural Gas
Efficiency Rating (AFUE): 90
Recommended AFUE:

Secondary Heating System:

Cooling System Type:
None
Efficiency Rating (SEER):
Recommended SEER:

Fireplace Type:

AFUE *– Annual Fuel Utilization Efficiency (A measure of your heating system's efficiency. Higher numbers are better).*
SEER *– Seasonal Energy Efficiency Ratio (A measure of your cooling system's efficiency. Higher numbers are better).*

Energy Smart Fact:

Your home's Heating and Cooling systems were inspected for safety and efficiency. Older heating systems should be replaced with energy efficient, sealed combustion units. This is often a significant upgrade, so considerations beyond energy savings should be made. We always recommend ENERGY STAR certified equipment, when possible.

New gas boiler

Recommendations:

The heat pipes should be wrapped to reduce heat loss.
Replace the standard thermostats with programmable thermostats for greater system control and energy savings.

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Water Heating

Your Energy Smart Analyst:
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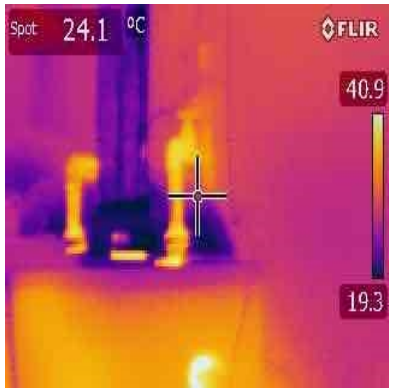
Hot Water System:
Storage
- **Fuel:** Natural Gas
- **Set Temperature:** 121
- **Solar Thermal Assist:** N/A
- **Pipes Insulated?:**
- **Efficiency Rating:** 0.55
- **Recommended Efficiency:** 0.67

***EF** – Energy factor is a metric used to compare the energy conversion efficiency of residential appliances and equipment. EF ratings vary by appliance size/type, but in general, bigger numbers are better.*

Energy Smart Fact:

Many hot water systems are set to temperatures that are too high for safety and energy efficiency. Keep your hot water temperature at or below 120˚F, and keep everyone in your family safe!

Standard gas water heater.



Heat radiating from unwrapped hot water pipes.

Recommendations:

The hot water pipes should be insulated to reduce heat loss.
An insulating blanket should be installed on the water heater to reduce standby heat loss.
Due to space limitations a foil ray blanket should be installed.

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Lighting & Appliances

Your Energy Smart Analyst:
Charles Cady
(970) 379-2961

Total # of Lamps: 19

Incandescent Lamps: 1
LED or CFL: 15
Florescent Tubes: 3

Refrigerator ENERGY STAR: True
kWh per Year: 438
Second Fridge ENERGY STAR: False
kWh per Year:
Freezer ENERGY STAR: False
kWh per Year:
Dishwasher ENERGY STAR: True
Clothes Washer ENERGY STAR: False
Dryer ENERGY STAR: False

Tips to reduce your baseload:

1) *Use smart strips for your big energy users like home entertainment systems*
2) *Use laptop computers instead of big towers – they use up to 90% less power!*
3) *Upgrade all of your appliances as they age, to Energy Star*

Energy Smart Fact:

Replace your incandescent and CFL lamps with LEDs. LEDs use about 20% of the energy and last up to 25 times longer than a traditional incandescent bulb. They also contain no toxic Mercury, and turn on instantly. Your refrigerator is usually one of the biggest consumers of electricity in your home. If your fridge is more than 10 years old, consider replacing it with an ENERGY STAR certified unit.

Recommendations:

When necessary replace your washer and dryer with ENERGY STAR models to reduce energy and water consumption.

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Financial Information

Energy Smart is here to help!

Energy Smart Financing
Utility Rebates
Energy Smart Rebates
(not available in all areas)

We installed the following energy-saving items in your home during our vist:

Quick Fixes Installed	Quantity	Cost
Bath Aerators:	0	$0.00
DHW Blankets:	0	$0.00
Kitchen Aerators:	0	$0.00
LED Bulbs:	0	$0.00
Pipe Wrap:	1	$12.00
Showerheads:	0	$0.00
Thermostats:	1	$60.00
Weatherstripping:	1	$37.00
Thermostat Setback:	0	$0.00
DHW Setback:	0	$0.00
TOTAL		$109.00

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1. Energy Smart Colorado has teamed up with Funding Partners to create Energy Smart Partners, LLC. **Click to Apply**

This program offers affordable energy efficiency loans to qualified residents located in the counties of Eagle, Gunnison, Lake, Pitkin, Routt and Summit. Financing is available to make eligible energy efficiency upgrades to reduce home energy costs.

2. Your electric utility provider is Xcel Energy.

Click for electric rebates

Your gas utility provider is Black Hills Energy.

Click for gas rebates

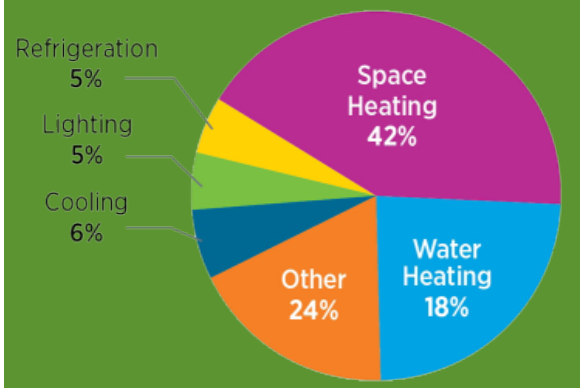
3. Energy Smart Colorado also has rebates available in many areas throughout western Colorado. **Click for more info**

Your Assessment Invoice					
Assessment Costs:		**Partner Contributions:**		**Your Costs:**	
Base Cost	$400.00	Electric Utility Copay	$0.00	Your Base Cost	$100.00
Additional Costs	$0.00	Gas Utility Copay	$299.00	Additional Costs	$0.00
Quick Fix Total	$109.00	Energy Smart Incentive	$110.00	Additional Quick Fix	$9.00
				Program Discount	$0.00
Assessment Total	**$509.00**	**Analyst Payment**	**$374.00**	**Your Total**	**$100.00**

Energy Advising

We're here to help!

How do our homes use energy?



Heating accounts for the biggest portion of your utility bills. Source: U.S. Energy Information Administration, AEO2014 Early Release Overview.

Have Questions?

The Energy Advisors at your local Energy Smart Colorado **Energy Resource Center (ERC)** will provide unbiased advice on the next steps toward making your home more comfortable and less costly to operate. They can help you with applicable rebates, incentives, contractors and best practices so you know you're making educated decisions that are right for **your** home.

Our Energy Advisors are expert consultants who can:

- Provide expert advice about energy upgrades
- Help you prioritize next steps for your home energy improvements
- Connect you with qualified contractors
- Assist you with applicable rebates and financing, and help you with the paperwork
- Connect you with your utility provider's incentive programs

You may receive a call from an Energy Advisor offering to review this assessment with you.
We look forward to working with you!

Call to speak with an Energy Advisor:
(970) 925-9775
(This is a free service!)

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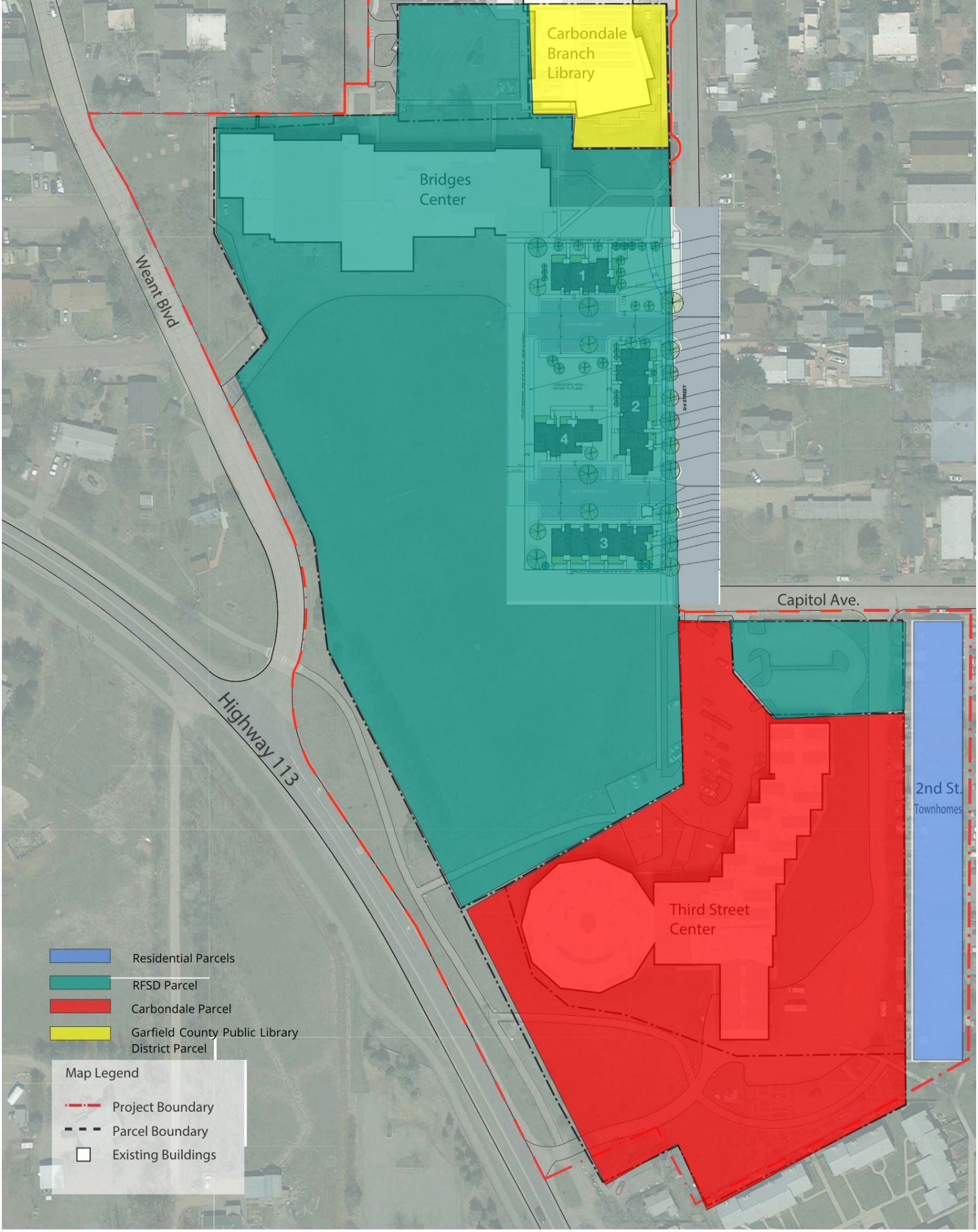

Site Map: Parcels

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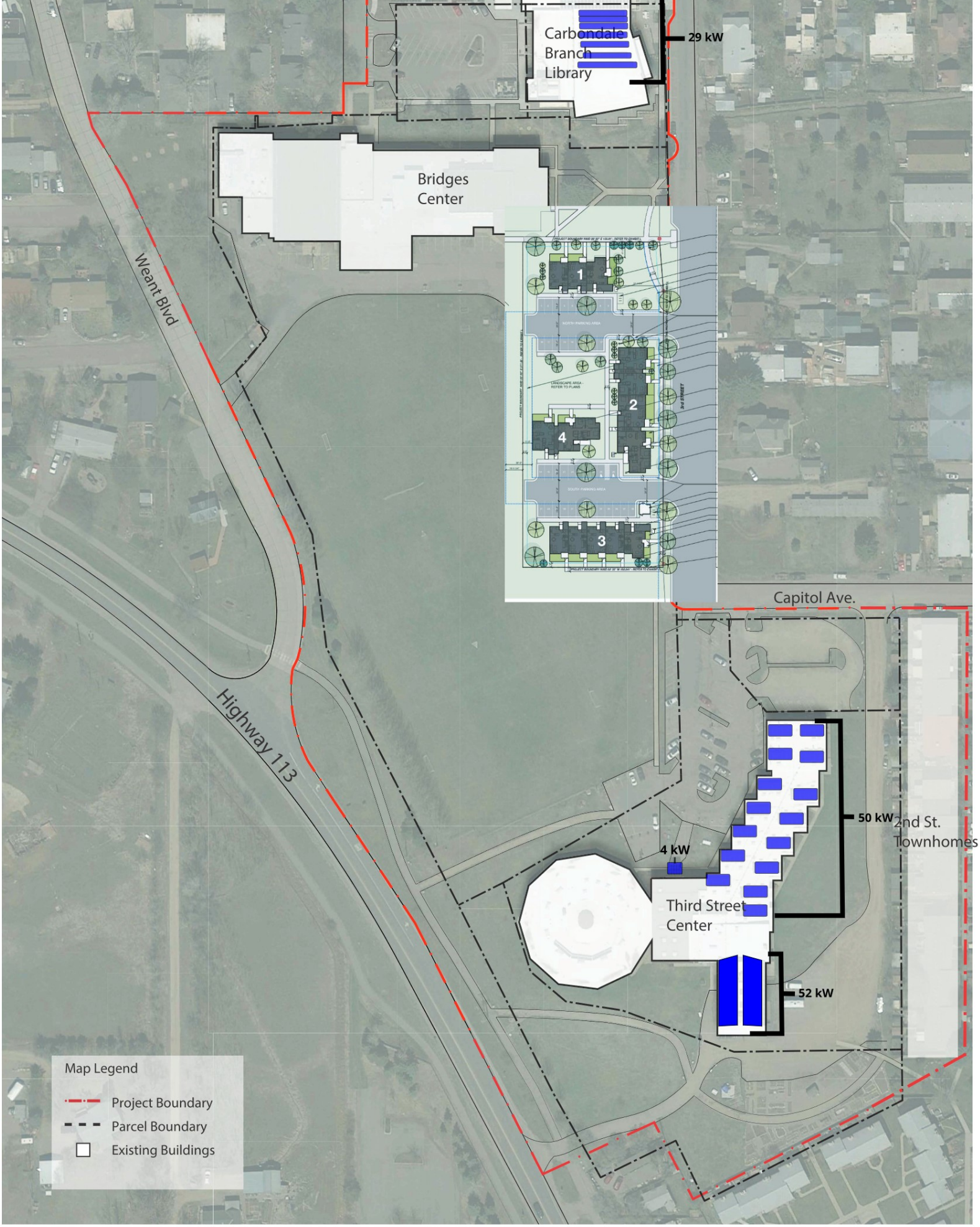

Site Map: Existing Solar PV

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