CITY OF BOULDER
CITY COUNCIL AGENDA ITEM

MEETING DATE: August 19, 2014

AGENDA TITLE: Briefing on Recommendations of the Solar Working Group

PRESENTER/S:
Jane S. Brautigam, City Manager
Heather Bailey, Executive Director of Energy Strategy and Electric Utility Development
Yael Gichon, Energy Sustainability Coordinator
Kelly Crandall, Energy Strategy Coordinator
Jonathan Koehn, Regional Sustainability Coordinator

SUMMARY
The Solar Working Group was formed to explore the expansion of solar opportunities in Boulder. The group was comprised of industry professionals, technical, policy, and financial experts and engaged citizens. The group composed a report, attached to this memo, to present their recommendations and conclusions to City Council. The findings of the group range from ideas that can be completed in the short term to issues to consider if the city forms a municipal utility. Staff is pursuing some of the recommendations in the near future and hopes members of the group will continue to work with the city on the transition plan to form a utility as it relates to energy resources and solar energy in Boulder.

BACKGROUND
The Solar Working Group began seeking participants in September 2013 to address ways to incent the development of local, distributed solar as part of the utility of the future, with or without a municipal utility. It was also organized to discuss impacts to the current solar marketplace related to Boulder's municipalization process and how existing contracts between Boulder customers and Xcel related to participation in Xcel's Solar*Rewards and Solar*Rewards Community (community solar gardens) program should be handled. Membership was self-selected. The working group's purpose and

membership are available online at https://bouldercolorado.gov/energy-future/energy-future-solar-community-working-group.

The working group met five times from November 2013 through June 2014, and conducted a lively discussion on Basecamp (a project management website that the city uses for working groups). The working group touched on the following issues:

- Goals the city should have related to local solar
- Barriers to solar growth
- Financing opportunities, new business models
- Incentives and the value of solar tariff
- Facilitating technologies that enhance distributed generation
- Potential opportunities for approaching existing Solar*Rewards contracts as part of a transition to a municipal utility
- Possible modifications to the city's Solar Grants program
- Potential changes to zoning codes related to local renewable energy development

SUMMARY OF RECOMMENDATIONS FROM THE SOLAR WORKING GROUP

The Solar Working Group created a summary document of its recommendations, which is attached to this memorandum. It is available online at https://bouldercolorado.gov/energy-future/energy-future-solar-community-working-group. In sum, the group's recommendations include:

Setting a goal/target for installed solar

- Fund a study to determine how much solar can practically be installed in Boulder
- Continue modeling to determine how the impacts of declining storage prices, reducing peak load, electrifying transportation and other factors impact the affordability of solar
- Maintain a detailed analysis forecasting declining solar costs as 2017 approaches (when the investment tax credit sunsets) to understand the impact of incentives to keep solar viable

Transition from incentives to reducing barriers

- Explore Third Party Financing, on-bill financing, loan loss reserves and aggregating solar projects to overcome the barrier of financing
- Explore solar for low-income customers, expanding existing programs and establishing new ones
- Promote Solar Gardens and Remote Net Metering as solutions for customers who cannot site solar where the energy is consumed
- Investigate ways to reduce soft costs, such as changing permitting and siting codes/ordinances to facilitate solar development, and pursue becoming a platinum level Solar Friendly Community
- Set quality standards for panels, inverters, and other system components that connect with the city grid

Designing tariffs as a municipal utility
The group did not reach a consensus on the best choice for Boulder or even whether a monetary incentive is needed; further analysis on this topic is needed. However, if it is necessary or desirable to compensate solar generation, the group recommends considering implementation of one of the following programs:

- Net Metering
- Feed in Tariff
- Value of Solar Tariff

Additionally, analyze the impacts of the underlying rate design in conjunction with a tariff and a fair system for customers with high demand charges[1].

SUMMARY OF ACTIONS BY CITY STAFF

Based on the discussion with the Solar Working Group, city staff has taken the following steps:

- Consolidated many of the existing solar efforts in the city
- Created a one-stop-shop solar website, www.bouldercolorado.gov/solar
- Applied for Solar Friendly Communities certification, expected sometime this fall
- Begun designing a local solar study to better understand the resource capacity, technical and economic limitations

NEXT STEPS

Among the next steps that staff foresees resulting from this group include:

- Evaluating solar goals and targets in Energy Future/resource planning
- As part of transition planning, forming resource planning, energy services, and finance/rates working groups, which will work in collaboration to pursue many of the analyses recommended by the group such as:
    - siting for solar
    - impacts of storage, peak load reduction, electrifying transportation
    - economic considerations (incentives, tariffs, rate structures)
    - end user solar services
    - financing options
- Issuing an RFP for a local solar study
- Modifying the Solar Grants program to increase efficiencies and uptake
- If there is interest, planning a future study session related to zoning codes and updating the codes on renewable energy development, among other topics

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[1] The challenge for a city utility is to do a fair rate design for a business with high energy demand charges – a rate design that incentivizes them to invest in solar, either solar gardens or their own solar and storage system, so that the Boulder electric system is able to absorb their sudden demand needs without having to build extra capacity which is rarely used.

ATTACHMENTS

Attachment A: The City of Boulder Solar Working Group Report to City Council

The City of Boulder Solar Working Group Report to City Council

Solar Working Group Members:

John Street, Phil Wardwell, David Kline, Puneet Pasrich, Ken Gamauf, Ken Regelson, Matthew Lehrman, Michael Mendelsohn, Anne Guilfoile, Bill Ellard, Chad Parsons, Dan Kramer, Dave Hatchimonji, Galen Brown, James Barry, Jason Wiener, Jim Hartman, Kai Abelkis, Kelly Simmons, Lynn Segal, Meghan Nutting, Paul Melamed, Phil Klam, R.T. Weber, Scott Franklin, Steve Hoge, Timothy Schoechle, Todd Stewart, Duncan Campbell, Jeremy Epstein, John Johnson, Win Stevenson

August 2014

Executive Summary

Boulder's energy future is at a crossroads. Municipalization, carbon emission goals, grid reliability, and cost concerns represent critical inputs to future legal, regulatory and investment decisions the city may take. Solar energy offers a low carbon pathway to that energy future but raises numerous questions relevant to cost reduction trends, federal incentive policies, and city mechanisms to induce adoption.

Currently, 15 megawatts of solar capacity has been installed in the city to date, representing roughly 2% of the city's energy requirements. Although many barriers exist for installation of significantly more solar energy deployment, the City of Boulder has several important assets that it can draw on to use solar energy in the service of its energy, environmental, and economic goals: a good solar resource, an informed and motivated populace, and a vibrant local solar industry.

This report presents input from a community solar working group to the City Council as it continues its consideration of Boulder's energy future. Recognizing that solar will play a strong role in that future, the group considered principles and approaches to making the best use of Boulder's available solar resources in meeting its energy and environmental goals.

At a high level, the City's goals are to "ensure Boulder residents and businesses have access to reliable power that is increasingly clean and competitively priced. The community has also said it wants as much of its energy as possible to be generated locally".[1] Our hope is that this discussion will help to illuminate many of the most salient issues that should be considered to maximize renewable solar energy within the city.

The remainder of this report elaborates on the following points:

- Boulder builds from a strong base of existing solar installations in addition to its other renewable generating assets;
    - Boulder Housing Partners has been a national leader in multi-family solar installation for low income housing
- Given current prices and policies, and especially in light of the federal tax credit sunset in 2017, many customers in Boulder may require incentives to consider solar a good investment;
- The City can improve project economics by addressing barriers to solar implementation, reducing the need for incentives;
- Commercial rooftops and solar gardens offer a largely untapped solar resource with economics of scale more favorable than those in the residential sector;
- Under a municipal utility scenario, the City would have a number of opportunities to more closely shape the attractiveness of solar projects to its customers, e.g. by replacing net metering with an alternative such as a "value of solar" or other feed-in tariff

[1] https://bouldercolorado.gov/energy-future/energy-future-goals-and-objectives

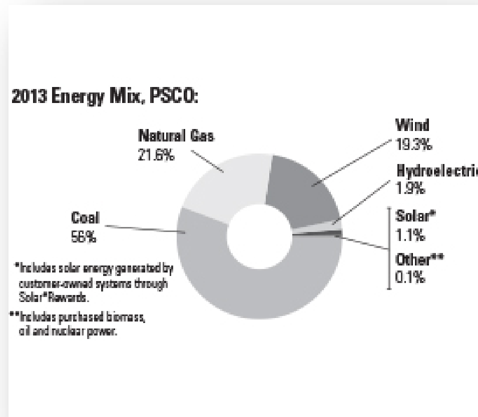
The members of this working group would like to thank Council for the opportunity to present these observations, and to City staff for facilitating and enabling this group, specifically Kelly Crandall, Yael Gichon, and Jonathan Koehn.

Contents

1. Recommendations for increasing local solar

- How much solar generation should Boulder target as a goal?
- The Impact of Electricity Storage
- Calculating an Incentive
- What to expect after the ITC sunsets in 2017?

In 2014, Boulder's PV capacity was 15 MW as determined by documents received from Xcel Energy. The vast majority of the PV is installed on private residences, with one community solar garden outside the City limits. This amount of PV generates 21,879 MWh annually – just under 2% of our total energy use of about 1.3 million MWh/year. The remaining 98% of Boulder's energy is sourced from Xcel's Public Service Company, and is predominantly coal (56%) and natural gas (21.6%).



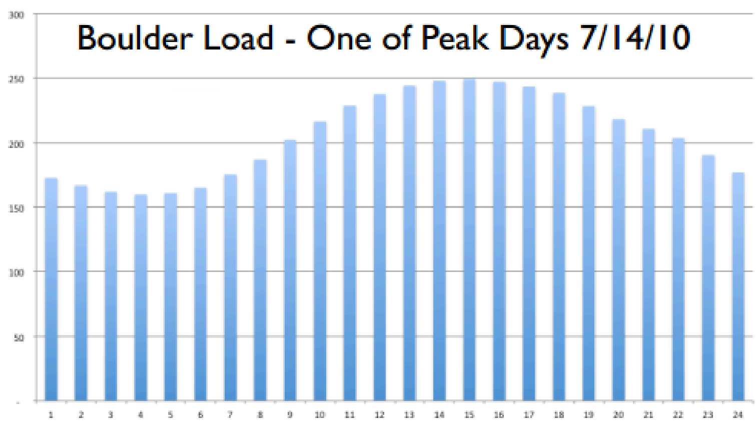
How much solar generation should Boulder target as a goal?

The short answer is we don't yet know how much we can deploy. There are two critical questions. First, how much solar can be reasonably installed using available rooftops, parking lots, and other unused spaces (e.g., roadside buffers such as adjacent US 36) in Boulder? Second, is there a reliability threshold for solar penetration on Boulder's electric grid? While the first question is relatively straight forward, the second is the subject of considerable debate, and is further complicated given the potential for advancing energy technologies such as battery storage, as well as not knowing how much the city will reduce its load with energy efficiency (EE) programs, demand reduction programs, storage technologies, and Time of Use (TOU) pricing. Nor can we say how much the load will increase from the possibility of electrifying the City's transportation sector.

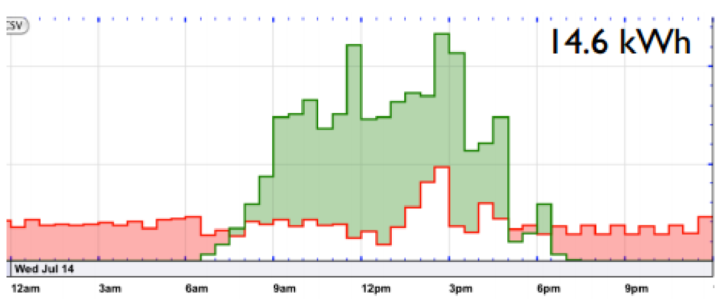
☛ To address the first question, we encourage the city to fund and move forward on their request for proposals for a study to determine how much solar can be practically installed based on good sun exposure on residential, commercial, industrial, and institutional buildings, parking lots, south facades of commercial buildings, and other unused space.

☛ To address the second question, we encourage the city to redouble its efforts to study and model current and future electric infrastructure and loads including various electric storage cost scenarios, implementation levels of EE, demand reduction mechanisms, and TOU pricing. The city should also model various scenarios of transport sector electrification, and the resultant impacts on energy use and carbon reduction. Additional modeling options could also include space and water heating electrification via efficient heat pumps and building ice and heat storage to take advantage of low energy prices of excess solar and wind energy, when available. As an example, a recent study provides a roadmap for converting California's entire energy infrastructure to one derived completely from wind, water, and sunlight generating electricity and electrolytic hydrogen.[2]

Understanding these constraints – the capacity and the reliability thresholds - is the first step towards setting a goal. The next step is understanding the economics. The City's current annual energy requirement is 1.3 million MWh over a peak load of 229 MW[3]. Importantly, the city must plan for both capacity and energy requirement plus reserves of 10-20% [4] *and* grid-stabilizing capabilities known as ancillary services. It is also important to recognize that the peak production output of the city's solar fleet will only moderately match the peak load requirements of electricity consumers. See charts below.



This is a chart of Boulder's load for a hot July day (upper chart). Source: Xcel.



The second chart is the PV Output (green bars) from a house in north Boulder. Note that there is no PV generation after 6 PM, yet the peak load (anything above 200 MW) continues until 10 PM.

2 http://web.stanford.edu/group/efmh/jacobson/Articles/I/CaliforniaWWS.pdf

3 It should be noted that 229 MW is capacity to handle a peak load, which may be reached for only a few hours per year. The generation capacity to generate the last 20-30 MW is very expensive, because it is rarely used. As stated by the New York Public Service Commission, "The [existing] bulk power system is oversized to meet the demands of a few peak demand hours per year."

4 "For those regions that do not have a Target Reserve Margin, NERC assigns a target of 15% for predominately thermal systems and 10% for predominately hydro systems" - from ISO-New England 2012 Long Term Reliability Assessment

Solar facilities in Colorado typically produce 1,550 kWh / kW (DC) deployed and degrade roughly 0.5% per year. Even avoiding degradation – at that rate of production – Boulder will need to install roughly 420 MW of solar capacity to meet 50% of the City's energy requirements, or over 20 MW per year for 20 years[5].

Assuming 20MW per year increments, at $2.50 per watt for installed solar, the cost would be $50M in the first year alone. However, industry costs will continue to decline, and have been tracking the Department of Energy's Sunshot Initiative goal of reaching $1 / watt for utility-scale systems by 2020. Nonetheless, the investment requirements are sizeable and will be difficult to achieve unless private capital is incentivized to invest in these systems.

The Impact of Electricity Storage

The expected impact of electricity storage has been well documented in the last year and half. We have seen numerous studies predicting the demise or retrenchment of traditional utilities as a result of competition from the 'killer-app' of solar + storage. The investment bank UBS reports that the "unsubsidized solar era begins – utilities' customers turn into competitors"[6]. Barclays states, "In the 100+ year history of the electric utility industry, there has never before been a truly cost-competitive substitute available for grid power. We believe that solar + storage could reconfigure the organization and regulation of the electric power business over the coming decade.[7]

Cost-effective energy storage will be a complete game-changer for electricity generators and for those responsible for power quality and grid balancing. Not only does storage make high levels of solar installations possible, but storage can eliminate peaks and valleys in use and generation. Also, most storage works faster than fossil & nuclear generation so balancing becomes much easier, and reliability can be greatly improved. "Of all the solutions, energy storage provides the maximum flexibility and results [but] at the highest cost."[8] Indeed, the cost of storage remains an issue. In any case, Amory Lovins shows how renewable power can be 'firmed' by a combination of existing fossil fuel plants and minimal storage. See Amory Lovins' presentation showing how the variability of renewables can be 'choreographed'. It is an elegant solution presented in this 4-minute video: www.youtube.com/watch?v=MsgrahFln0s.

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[5] A practical interim goal would be to produce 50% of Boulder's *daytime* energy needs from solar. Assuming two thirds of the City's need is during the day that would mean adding about 277 MW of capacity, or 20 MW per year for about 14 years. It should be noted that these additions to solar generating capacity, are a 'pay as you go' resource. This is because the energy they produce displaces expensive energy that the City would otherwise have to purchase at wholesale rates. For example, at a wholesale rate of $45 per MW hour or $0.045 per kWh, 20 MW of solar would save Boulder about $1,300,000 in wholesale electric costs every year, that it would otherwise have to assess and collect from its ratepayers.

[6] http://qualenergia.it/sites/default/files/articolo-doc/UBS.pdf

[7] http://blogs.barrons.com/incomeinvesting/2014/05/23/barclays-downgrades-electric-utility-bonds-sees-viable-solar-competition/

[8] Tom Bialek, chief engineer at SDG&E talks about how they are addressing the high rate of solar penetration in San Diego, which he estimates will double by the end of 2015 to nearly 12% of SDG&E's peak load today. http://www.utilitydive.com/news/how-sdge-is-dealing-with-high-penetrations-of-rooftop-solar/290227/

Calculating an Incentive

The following example showing the economics of a 10 kW PV system in today's dollars, illustrates a methodology for calculating an appropriate incentive.

Simple Methodology for Calculating an Incentive

Let's assume the costs for a 10kW system is $2.50/W = $25,000 (a reasonable cost assumption as costs continue to decline and through economies of scale for large projects or large aggregations of projects). The 30% federal Investment Tax Credit (ITC) leaves a net cost of $17,500 before any utility incentive program. If a business is the owner of the PV system, the business could also take advantage of accelerated depreciation for federal tax purposes and further reduce its investment. If the business is in the 30% tax bracket, in five years it would achieve tax savings of $6,375, leaving a balance of capital cost for the system of $11,125.

Today, Xcel offers $0.03 per kWh generated by the PV system, for 10 years, as part of its Solar Rewards program. This 10 kW PV system would produce 14,586 kWh/year. $0.03/kWh x 14,586 kWh/year = $438 in annual rebates from Xcel for a period of 10 years. In return, Xcel receives the RECs to satisfy the RPS.

Also, each year's solar generation produces savings of energy costs. Using an effective utility rate of $0.12 per kWh (including all taxes and charges, and anticipating increases in Xcel's rates), the energy saving on the utility electric bill is $1,750 annually.

For a business, $438 rebate + $1,750 saving/$11,125 net capital cost represents 20% return on investment annually for five years (after five years the investment is recouped), and a 5.08 year payback period. It would not be necessary to pay the rebate past 5 years.

For a resident, $438 rebate + $1,750 saving/ $17,500 net capital cost represents 12.5 % return on investment and an 8 year payback period. It would not be necessary to pay the rebate past 8 years.

It should be noted that Xcel's Solar Rewards program is funded by a 2% charge on every retail customer's electric bill, known as the Renewable Energy Standard Adjustment (RESA). Assuming the municipal utility has the ability to levy a similar charge, without violating its charter, then those funds could incent solar installations as follows. Assume for the sake of discussion that the average electric bill to be 10cts/kWh, and assume a goal of 5% renewable generation each year in the early years. In that scenario, the funds collected would be allocated to 5% of the customer base. Therefore a new solar customer would get an incentive = 10cts x 2% / 5% = 4cts/kwh. Xcel testimony in June of 2013 shows RESA revenues from Boulder to be $2,338,307.

This example shows how tax incentives and other incentives increase the desirability of solar to private owners. By making a relatively small investment, a City utility could incentivize a much larger investment of private capital.

A third type of customer, admittedly a special case, is a business with high electric demand charges. Some businesses with relatively low charges for energy (kWh) may have very large loads at irregular times. The challenge for a City utility is to do a fair rate design for this kind of business -- a rate design which incentivizes them to invest in solar, either solar gardens or their own solar and storage system, so that the Boulder electric system is able to absorb their sudden demand needs without having to build extra capacity which is rarely used. An example of that analysis can be found in the Appendix.

A fourth type of customer to consider are those with low income; including single family home owners and home renters, and multi-family low income housing and senior housing. This is a segment of the population that is impacted the most by rising electricity costs. The City needs to look at expanding existing programs and exploring successful programs such as California's SASH (Single Family Affordable Solar Homes) and MASH (Multi-Family Affordable Solar Homes) Programs. A description of these programs can be found in the Appendix.

What to expect after the ITC sunsets in 2017?

The federal ITC is presently scheduled to be reduced from 30% to 10% at the end of 2016, but may be extended by Congress as it happened for wind's PTC in 2009 and 2013. Another possibility is that the law is modified such that construction only needs to have begun before 2017 for the project to be eligible for the 30% ITC. This would effectively extend the deadline by the length of a given project's construction cycle.

Assuming no extensions to the ITC, it will be important to understand the impact of the step down, and how much additional incentive is needed to keep solar viable. Of course, it depends. Industry pundits have prepared detailed analyses to size the gap created by the ITC step-down.[9] There are many variables to forecast out to 2017: cost of energy, cost to install, cost of capital, etc. All of these costs are coming down, but not quickly enough according to the pundits. "Current projections by Bloomberg estimate that [national averaged values in 2017] will decline to around $2.15 per watt for residential rooftop systems and around $1.34 for large ground-mounted systems. Commercial systems will likely fall somewhere in the middle [$1.74]." However, pundits estimate that prices will need to be even lower to compensate for the ITC step-down. "For commercial customers, average all-in prices in 2017 will need to be between $1.33 to $1.60, assuming a cost of capital between 6 percent and 8 percent. Residential installations in 2017 will need to be reduced to a cost range of $1.98 to $1.65."

It appears that the national average solar LCOE will lose grid parity in 2017, and solar projects will need an additional incentive until the costs come down further. Looking more locally, the City can help and is already working to reduce soft costs. Tariff design (cost-of-energy) is equally important. Net metering at the full retail or a VOS tariff will help us get closer to grid parity. Boulder can also influence the cost of capital through On-Bill-Financing programs that include loan loss reserves, etc.

☛ We encourage the City to maintain a detailed analysis forecasting declining solar costs as 2017 approaches.

[9] - http://www.greentechmedia.com/articles/read/What-Happens-When-the-ITC-Expires
- http://www.greentechmedia.com/articles/read/peering-over-the-2017-horizon-for-solar-part-2
- https://financere.nrel.gov/finance/content/solar-PV-photovoltaics-value-tax-credits-equity-accelerated-depreciation-securitization

2. The Transition from Incentives to Reducing Barriers

- Enabling Third Party Financing
- Enabling Solar Gardens and Remote Net Metering
- Other Soft Cost Reductions and Becoming a Solar Friendly Community

The group spent a considerable amount time discussing ways to facilitate greater solar uptake with programs that leverage third party funds and that do not require direct incentives from the city utility.

Enabling Third Party Financing

One of the biggest constraints for the distributed market is financing. There are generally so few players willing to take on the risk of financing smaller solar projects – especially commercial scale projects – that the cost of capital ends up being very high, in fact, only seven commercial banks currently invest in solar projects.[10]

On-Bill-Finance, PACE, and Loan Loss Reserves

One simple way to finance solar projects for residential, commercial, and Solar Garden customers is **On-Bill-Financing** (OBF). Note that energy efficiency can also be financed by OBF. There is a detailed description of OBF in the Appendix of this report. Briefly, the customer pays an extra charge on his or her electric bill to amortize the debt for the upgrade, until it is fully paid. Program design is critical for successful uptake, optimizing resources, and minimizing risk. The essential considerations include service disconnect, bill neutrality, and transferability. Details are outlined in the appendix.

As an alternative, the State of Colorado is trying a new approach to financing efficiency improvements and solar systems using a variant of **Property Assessed Clean Energy** (PACE) payments. The C-PACE program requires that purchase money lenders agree to subordinate their liens to the C-PACE lien, which is paid by extra charges on the property owner's property tax bill. This program should be in operation in the fall of 2014.

A City utility could also establish a **loan loss reserve**, to compensate investors for defaults. This would reduce risk, and result in lower interest rates. Low-cost debt is currently being obtained via **securitization** by pooling the cash flows into liquid, tradable securities, and the loan loss reserve or similar credit enhancement would reduce risk to the senior positioned debt. The reserve should be significantly larger than the anticipated or historical rate of default. The City utility can devise ways to share the risk with the financiers or limit it to a manageable threshold. There are a number of ways to address this including establishing standards of creditworthiness, and putting a limit on the number of missed monthly payments on the electric bill that the reserve would cover.

Other ideas explored include forming a consortium of local banks, and inviting leasing or crowdsourcing companies to participate in City programs.

To enjoy better **economies of scale**, the City utility could act as a project aggregator, taking applications or agreements of intent to join a solar garden or other solar project, and putting them out to bid to

[10] http://www.solarreviews.com/news/crowdsourcing-solar-energy

developers as a large project or series of large projects, say $1 million or $1.5 million each.

The City utility can also set quality standards for panels, inverters, and other system components that connect with the City grid, part of a city administered program (such as OBF), or otherwise incentivized by the city.

Enabling Solar Gardens and Remote Net Metering

We believe solar gardens have an important role in a community's portfolio of renewable energy generation. Solar Gardens provide a necessary offering for those with inadequate space on their property, such as those with shading or subpar orientations.[1] Also, renters and residents of condominium buildings who have been traditionally excluded from investing in solar power can participate. Moreover, Solar Gardens enjoy improved economies of scale, optimal project siting, and the flexibility of a liquid investment. Solar gardens are typically ground-mounted, 50-year installations that avoid re-roofing issues, and avoid added structural expense of high-tilt solar carports. Boulder has suitable land that is not developable for other purposes. We recommend that the City identify these preferred locations for solar gardens as part of the up-coming RFP and additionally to designate solar gardens as a permitted use in the zoning code for those locations.

Remote Net Metering (RNM) is similar to solar gardens in that the generation occurs in a separate location than where the energy is consumed. RNM is another good solution for customers who cannot site solar where they consume it. Roughly 80% of Boulder’s consumption is from Commercial and Industrial users. Many of these do not have adequate roof space on-site to offset their energy consumption with solar generation. On the other hand, there are other low energy-intensive buildings, such as warehouses that have very large roof spaces and relatively low energy requirements. RNM creates synergy between these two types of properties and ensures that the roofs with the best potential are fully utilized.

Both Solar Gardens and Remote Net Metering offer a potential benefit for our low income community. Possibilities include Low Income Housing authority Solar Gardens for their properties that cannot have on-site solar to allowing residential and commercial customers who produce annual surplus of power to donate or sell at a reduced rate to a low income pool via RNM.

It is worth noting that both Feed-in-Tariffs and Value-of-Solar Tariffs can also accommodate remote generation, and credit the owner’s primary electric bill.

Other Soft Cost Reductions and Becoming a Solar Friendly Community

Soft costs associated with solar installations are defined by the National Renewable Energy Lab to include: customer acquisition, permitting, inspections, interconnection, installation labor, and financing. Of these, the City can do something about permitting, inspections, and financing (discussed above). The group discussed some options that the city could explore to reduce the soft costs associated with installing solar, such as putting an application form online, giving priority to processing solar projects (consider generic permits for common projects), and arranging for quick inspections.

Solar Friendly Communities (solarcommunities.org) is a program led by the Colorado Solar Energy Industry Association which aims to encourage the expansion of solar energy by making it easier for citizens to install solar systems on their homes and businesses. Communities can earn recognition at various levels by complying with certain standards related to their solar processes. The group recommended that the city pursue platinum level certification. Many of the soft cost reduction strategies discussed by the group are addressed through the Solar Friendly Communities Project.

3. Tariff Design

- Rate Design
- Net Metering
- Feed in Tariff
- Value of Solar Tariff
- The Solar Hedge

The Solar Working Group looked closely at the Value of Solar Tariffs (VOST) and debated its advantages as compared to Net Energy Metering (NEM) and Feed in Tariffs (FiT). The group did not reach a consensus on the best choice for Boulder or even whether a monetary incentive is needed. However, if Boulder deems it necessary or desirable to compensate solar generation for environmental and other beneficial attributes associtated with solar energy, then they will want to implement one of these programs.

The underlying **Rate Design** (e.g. inclining block, time of use, real-time pricing, demand charges, minimum bills, etc.) should be carefully considered in conjunction with NEM, VOST, and FiT. Each one of the riders can undervalue or overvalue PV output depending on how the rates are designed. Also, it is important to consider the impact of these mechanisms and rate design in the context of **other distributed energy resources** that can increase the value of PV to both the customer, to the system and to society. For example, under NEM, there is little or no incentive to install storage or to orient panels to better align PV output with customer peak, feeder peak or system peak. If the rates underlying NEM are designed to encourage other beneficial behavior, then we can maximize PV value as well (and NEM, VOST or FiT may ultimately become unnecessary entirely).

Net Metering is the default mechanism in most of the United States. Net Metering combined with an Incentive (typically a Performance Based Incentive - PBI) unbundles and pays for energy and the RECs separately. NEM is intended for behind-the-meter projects that can also take advantage of Time-of-Use tariffs, tiered pricing, etc. While Xcel offers a PBI in conjunction with NEM, it is not necessarily common across the country and each are paid for differently. That said, the solar economics generally don't work without the PBI, and those markets are not viable (with the exception of states with other local incentives or those where grid parity has arrived). Like a FiT, the PBI that is paid for the RECs is pre-determined with regressive steps for cummulative amounts of solar deployed. There are variations, but this is the typical model. Payment for the energy is made possible by NEM and tied to broader market rates, or the wholesale price of energy for the utility.

A **Feed-in Tariff** offers a long-term standardized contract with a pre-determined price for both RECs and energy. These projects interconnect on the utility side of the meter, and are not for net-metered customers. The price is set to enable the developer to cover his costs and make a reasonable profit, but without accurate cost data can lead to under-pricing with slow uptake or over-pricing driving irrational demand and boom/bust market behavior. FiTs often include a "tariff degression", a mechanism that ratchets down the price over time, typically by steps according to cumulative capacity installed in order to encourage technology cost reductions. Here again, the degression can create inappropriate pricing.

A **Value of Solar Tariff** is an alternative to Net Metering. Like a FiT, the VOST pays the solar owner one price for both the energy and the additional beneficial attributes of solar over the duration of the term of the agreement. Unlike a FiT, the VOST is not subject to a predetermined price degression. Rather the VOST is priced with a formula which can be changed by regulators and whose inputs (such as fossil fuel costs) will change from year to year, up or down. There are concerns that regulators can destabilize a local market with inconsistent long term pricing, especially where good-faith engagement and oversight on the part of electric utilities is absent. Transparent ratemaking and an open stakeholder process is crucial for a VOST to be successful. There are other questions that a 'buy-all, sell-all' VOST might create taxable revenue for the solar owner, and make them ineligible for the 30 percent federal Investment Tax Credit. To avoid this, the VOST must be designed such that the solar owner is "not selling their power into the market or to the utility, only receiving a bill credit, that never becomes cash, for the quantity of their generation, whether exported or not. There is no title transfer for the energy, no sale arrangement. No power purchase agreement. No term limitation as with FIT arrangements."[11]

The **Solar Hedge** enjoyed by many solar owners is allocated differently between a NEM, VOST and FiT. The Solar Hedge is the difference between a fixed-cost solar asset and a conventional fossil-based generation asset with escalating prices to cover rising fuel costs. Typically a FiT offers a single fixed price for all energy and additional beneficial attributes over a period of 15-20 years. In this case the solar hedge is enjoyed by the utility. On the other hand, Net Metering and VOST enable the solar owner to enjoy the solar hedge. Net Metering allows the solar owner to displace escalating fossil energy costs with fixed solar energy. Similarly, VOST pays the solar owner a price for the energy that keeps pace with the cost of conventional energy.

This has been a cursory review of the options and a more detailed analysis of the relative benefits of each of these must still be done before a final decision can be made. That said, a rigorous analysis of the value of solar would be useful for any of the three mechanisms. The Utility can use the results of such an analysis as a benchmark for a NEM/PBI or a FiT. This raises the question of whether it is better to price an incentive for value delivered or for filling an economic gap. Ideally, these two valuations are the same, but that would be a pure coincidence since they are moving in opposite directions. The economic gap is shrinking as solar costs decline and conventional energy costs increase. Whereas the value of solar (including avoided transmission costs, and environmental and societal benefits) is going up. The answer depends on the goal. If the goal is to achieve certain targets of solar deployment, then the

[11] http://www.rabagoenergy.com/blog/files/7e122e00fee74d130957e50188eca496-13.html

utility must focus on filling the economic gap. If the goal is philosophical and intellectual honesty, then a value of solar analysis is appropriate.

Papers comparing Net Metering, VOST, and FiT:

1. Nevada Net Energy Metering Impacts Evaluation (just released last week) - http://puc.nv.gov/uploadedFiles/pucnvgov/Content/About/Media_Outreach/Announcements/Announcements/E3%20PUCN%20NEM%20Report%202014.pdf
2. California Net Energy Metering Ratepayer Impacts Evaluation - http://www.cpuc.ca.gov/PUC/energy/Solar/nem_cost_effectiveness_evaluation.htm
3. Solar Electric Power Association - Ratemaking, Solar Value and Solar Net Energy Metering - http://www.solarelectricpower.org/media/51299/sepa-nem-report-0713-print.pdf
4. Regulatory Assistance Project - Designing DG Tariffs Well - http://www.raponline.org/press-release/designing-distributed-generation-tariffs-well-ensuring-fair-compensation-in-a-time-of

Appendix

- Opportunity Matrix
- On-Bill Repayment / Financing Notes
- Boulder Docket
- Programs to Reduce Load
- Incentive Calculation for a Business with High Demand Charges
- California's Affordable Solar Housing Programs

Opportunity Matrix

The following list of solar opportunities is excerpted from the working document for our group as we considered the top priorities for exploration by the City. Many of these are discussed in detail in the body of the report.

On-Bill Financing

On-Bill Financing for the repayment of a solar loan in monthly installments on a utility bill. There are existing working models and industry inertia for this method of financing and the default rate and administrative costs are low.

Strategies to Reduce Soft Costs

NREL has defined "soft costs" to include: customer acquisition, permitting, inspections, interconnection, installation labor, and financing. The City of Boulder can streamline permitting and inspections and reduce overall capital costs through financing options. State sales and use taxes are already exempt for solar through 2017. Local jurisdictions can choose to exempt it as well. Local building codes could also be revised to ensure that all new construction or substantial remodel is "solar friendly".

Property Tax Impacts

The City of Boulder, working with Boulder County, could explore ways to reduce the burden of personal (or real) property tax that is a substantial percentage of the cost.

Smart Grid

Implementing a smart grid in the city would include intelligent monitoring devices for grid conditions and renewable generation. It may also include advanced customer-facing technologies.

Value of Solar Tariffs

A methodology for valuing solar to compensate the customer for providing generation, while also including value to the utility, non-solar customers, and society. The Value of Solar is a substitute for net metering. It includes components for avoided fuel cost, avoided plant O&M (fixed), avoided plant O&M (variable), avoided generation capacity cost, avoided reserve capacity cost, avoided transmission capacity cost, avoided environmental cost, avoided voltage control cost. This is the Value of Solar to a non-solar customer as well as a solar customer, so this approach is a fair demonstration that there is no cost-shifting to non-solar customers, i.e., the solar customer gets credit for the money he or she saves the non-solar customer.

Net Metering and Virtual Net Metering

Traditional net metering includes the option to carry forward any net generation to the next month or year. Virtual net metering is a billing system that could be used in conjunction with concepts such as Community Solar Gardens.

On-Bill Repayment / Financing Notes

On Bill Finance (OBF) is a program financed by the utility, e.g. via rate payer funds, city bond, etc. A loan is made to the customer to pay for energy efficiency or solar PV upgrades. Regular monthly loan payments are collected by the utility on the bill until the loan is repaid. Typically credit is given to customers with one year of bill payment history. If the utility is not in the position to self-source the funding, then instead they can simply administer a loan program funded by a third party bank or leasing company. This variation is called On Bill Repayment (OBR).

Essential components to an OBR/OBF program

Service Disconnect. On-bill loans are tied to utility service and the threat of disconnecting power will keep defaults low. Note that the disconnect policy should not be more stringent than without the OBR program.

Bill neutrality. The expected savings must equal or exceed the new loan payments. The customer's net cash flow will improve after the loan. Bill neutrality mitigates risk to the lender.
Other considerations:

- A standard method/model can be used to curb over-zealous contractors.
- Excess savings (beyond bill neutrality) can be mandated to further mitigate risk.

Transferability. A special tariff can be assigned to the meter that is non-negotiable for new tenants / homeowners. The tariff is a bill adder that repays the loan. Transferability mitigates risk to the lender.

Low interest rates. Support from the utility – e.g. credit enhancements, loan loss reserve, subsidies, etc. – is needed to achieve low interest financing. Otherwise market rates will prevail. Lower default rates may result in cheaper financing.

Scale. Boulder may not be large enough to attract competitive third-party financing.

- Boulder can potentially piggyback on others' programs, e.g. Hawaii
- Use local banks, leasing companies, or crowd sourcing
- Fund internally

Lessons from other States

California is pursuing several pilots. However they failed to include transferability in the rules. They are not getting meaningful participation from banks.
Hawaii is implementing an OBR program and includes transferability.
Connecticut, NYSERDA, and others (need more research) have plans for an OBR program.
Fort Collins program has had very slow uptake

- 5-6% interest rates
- Loan terms of 5, 7, and 10 years make it very hard for bill neutrality on PV.

- Convenient alternatives and incentives
    - Instant approval from GE financing, whereas 24 hours approval from FC despite 10% money.
    - GE offers the contractor a SPIFF
- No transferability. Loans are tied to the person.

Comparisons to other programs

How does OBF compare to other financing programs wrto convenience and administrative cost?

- PACE, you must deal with the tax assessor in each town/county. Only loans so far. Trying to do leases. Real Property Liens will likely continue to slow progress. (Monitor State PACE with Paul Scharfenberger at OEC.)
- OBF program can aggregate over wider area (ideally state wide)
- OBF's transferability feature enables rental properties to participate
- More follow up needed on this question …

Credit underwriting process

For OBR, Commercial customers would still be subject to a thorough financial review, which could burden the process. In addition, banks can only loan on unsecured assets up to 30-50% of project cost due to cash flow and Debt Service Coverage Ratio (DSCR) limitations.

Alternatives to conventional banks

- use a leasing company (unregulated - can make credit decisions quickly, cheaply)
- use local banks – likely same DSCR limitation but could be more flexible.
- use crowd sourcing

Other Questions for follow up:

- What are upfront and ongoing costs of administering such a program?
- Credit questions
    - new entrant with no history?
    - new tenant taking over an existing OBR loan?
    - limits to loan amounts?
- How are payments amortized? Similar to mortgages?
- What are the legal issues to set up a program?
- How can the loan amount be increased to cover 100% of after tax system costs?
    - (Commercial) Look at coupling solar with demand shaving storage. Faster payback with larger loan amounts – both good for the lender.
    - Leasing company limits?

Boulder Docket

The Boulder Docket is an Xcel filing with the Colorado Public Utilities Commission (PUC) to clarify that Solar*Rewards contacts terminate if the customer is no longer an Xcel customer and to limit the ability of Boulder residents participate in solar gardens and Xcel's demand management programs. [12] Xcel argues in the filing that it needs to protect its non-Boulder ratepayers in the event Boulder withdraws from Xcel and sets up a municipal utility. The city sought feedback from the Solar Working Group on the best way to handle existing and new solar contracts preparing to have a conversation with Xcel and state regulators about what compensation, if any, is due to the utility company if Boulder decides to operateits own municipal utility.[13]

The Solar Working Group had these comments:

To ensure thatBoulder customers are not harmed, the city should consider taking over the existing solar contracts and providing net metering; or there needs to be a different creative solution that gets to a similar end.

It may not be necessary for the city to have the solar RECs. The RECs are necessary to demonstrate compliance with the state Renewable Energy Standard (RES), but if Boulder is obtaining more than 10% of its power supply from renewable energy as a municipal utility, the solar RECs are not necessary to meet state requirements.

It is reasonable to think about the net metering "bank" (the solar energy that has been generated in excess of what is used by customers on-site) as a benefit Xcel has received, so that cost should be subtracted from anything Boulder is asked to pay. However, the working group differs on whether there is actually a large net metering bank. On the one hand, installers may size to 100% of load instead of the 120% limit allowed by state law. On the other hand, most of those in the working group who had on-site solar seemed to have at least some bank.

In thinking about creative solutions to solar gardens there are two options at the time of municipalization: (1) take over any solar garden that is installed in Boulder, or (2) form a city solar garden. For the latter, financing would be straightforward, but interconnection could be difficult. The sooner the solar garden is developed, the better, because the the Investment Tax Credit (ITC) will drop in 2017. Emphasize the big-picture perspective that this is about values, not costs. This is not necessarily a ratemaking perspective In this vein, the discussion about the value of solar for net metering is critical to this docket. Xcel is saying that solar is worth its costs while others are saying solar is worth its value. Xcel is saying solar is very valuable from Boulder but not valuable generally.

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[12] The original application, filed in Proceeding No. 12A-155E, was determined by the Commission to be premature. Xcel re-filed the application in early 2014 in Proceeding No. 14A-0102E. Information about the first proceeding is available at http://www.dailycamera.com/news/boulder/ci_20964910/puc-rejects-xcel-bid-limit-boulder-access-energy.

[13] http://www.dailycamera.com/news/boulder/ci_20964910/puc-rejects-xcel-bid-limit-boulder-access-energy

Programs to Reduce Load

(1) Continue and augment existing programs to promote efficiency, such as: encouraging the substitution of LEDs for existing lighting; substitution of energy efficient windows for existing windows; exchange of inefficient appliances; promote installation of heat-exchange ventilators; better caulking and draft prevention; etc. Promote passive solar design elements in building renovations.

(2) To stimulate efficiency, consider adopting an ordinance similar to ordinances passed by many other municipalities, requiring energy audits by certified auditors (the present Boulder pilot program is voluntary). The results of the audit would be furnished to the building owner and to the City; the City would post the results on a website, which could be consulted by prospective purchasers and renters.

Year 1 – audits of all buildings ≥ 50,000 square feet
Year 2 – audits of all buildings ≥ 40,000 square feet
Year 3 -- audits of all buildings ≥ 30,000 square feet
Year 4 -- audits of all buildings ≥ 20,000 square feet
Year 5 -- audits of all buildings ≥ 10,000 square feet
Audits should be repeated every 5-10 years.

For residences, an energy audit could be required for all residences, including condos, exceeding, say, $300,000 in selling price, with a copy of the audit to be made available for prospective purchasers.

It should be recognized that many building owners are busy people and are simply unaware of how low building efficiency and higher energy costs affect their budgets and bottom lines. These audits would increase their awareness of the true cost of inefficiency, even if they do not contemplate a sale.

(3) Planning for the anticipated reduction in the peak load, shifting in time of the effective peak load (taking into account solar generation) and storage of energy to facilitate peak shifting and reduction (and to reduce expensive purchases of wholesale power). Planning for strategies to reduce peak load, such as TOU pricing design, charging stations for electric vehicles and plug-in hybrids in parking lots and parking garages, planning for vehicle to grid power storage. Planning to take full advantage of the Smart Grid to provide real time information, including pricing information, to customers and managers.

(4) Continue existing survey of available and suitable roof areas for solar systems AND feasibility of battery storage of power in buildings.

(5) To facilitate competition and comparison bids for solar systems, require solar installers bidding on City contracts to break down their bids into cost components: solar panels, racking, BOS, labor, profit margin and overhead; also to disclose experience in the field of solar installation, and possession of proper bonding and insurance. The City would also maintain a publicly available list of such contractors for the City, and of other contractors who agree that this information will be included with their name on the list, and agree to provide bids in the above format to all private parties who wish them to bid on a project.

(6) Plan to divide the City into microgrid areas, including solar and energy storage resources in each area, to increase resiliency in event of power problems. Plan to use the Smart Grid to instantly locate problems and reroute energy flows in case of a circuit interruption or problem.

(7) Continue planned upgrading of Boulder in the Solar Friendly Community program to achieve platinum grade.

(8) Work with Boulder County and large communities in Boulder County to achieve a uniform building permit application and uniform requirements for solar systems, reducing soft costs so installers and developers do not have tailor and custom-create each application according to the particular requirements of many different jurisdictions.

(9) Work with Boulder County to gain exemption of solar installations of 1 MW or less from personal property taxation under Colorado property tax law, thus removing a barrier and reducing soft costs.

(10) Involve the universities and colleges in Boulder in the solar program.

(11) Develop formpad legal agreements and paperwork, so that each large deal is not separately negotiated, thus reducing soft costs. A good starting point is the NREL SAPC library.

(12) Consider developing a “mini market” within the City, where solar and other producers can buy and sell excess generation and storage resources.

Incentive Calculation for a Business with High Demand Charges

A business with high electric "demand charges" represents a special case. Some businesses with relatively low charges for energy (kWh) may have very large loads at irregular times. For example, a business in Denver crushes cars and scrap metal; when its crushers operate (roughly 20 hours per month) it makes large demands for power on the system, i.e., the crushers have a high nameplate capacity - say 50kW each.

Xcel deals with this by imposing low energy charges, around $0.023 per kWh, but high demand charges, up to $15.52 every month per kW of capacity for the peak kW demand. Xcel takes the highest 15 minutes per year to establish the peak demand for billing. Thus, if the crushers operate at 100 kW capacity, Xcel bills $1,552 per month as a demand charge, while only charging $100-$200/month for energy.

The Community Solar Gardens (CSG) law offers an alternative to this billing practice. Section 3665 of the Colorado PUC Rules, allows a commercial/industrial customer on a demand tariff who invests in a CSG, to receive a billing credit which uses the "total aggregate retail rate." The total aggregate retail rate is the total of all charges, including energy and demand charges, for the most recent calendar year, divided by the customer's total electricity consumption for the year.

For example, suppose the customer invests in solar by investing in a CSG and buys 10 kW, which will produce 14,486 kWh per year, for which the customer receives bill credits. If the customer pays $200 in energy costs per month and $1552 in demand costs per month, that is an annual payment of $21,024 per year. If the customer uses 1,000 kWh per month for normal operations and 20 hours x 100 kW = 2,000 kWh for the crushers, that is a yearly usage of 36,000 kWh. Dividing the total cost - $21,024 - by the total electricity consumption - 36,000 kWh - yields a total aggregate retail rate for this demand tariff customer of $0.584 per kWh. Multiplied by the customer's 14,586 kWh per year of solar production credits from the CSG, yields credits worth $8,518. If the business had a net after-tax-benefit investment in the CSG of $11,125, it would recoup its investment in 1.3 years!

The challenge for a City utility, which is not subject to the CSG law and rules, is to do a fair rate design for this kind of business -- a rate design which incentivizes them to invest in solar, either solar gardens or their own solar and storage system, so that the Boulder electric system is able to absorb their sudden demand needs without having to build extra capacity which is rarely used.

California's Low Income Affordable Solar Home Programs

The Programs originated with California Assembly Bill 2723, which directed that a minimum of 10% of California Solar Initiative funds be set aside for programs assisting low-income households in accessing solar technology.

SASH: Single-Family Affordable Solar Housing

Program Goals

- Create broad community engagement with solar in low-income affordable housing.
- Provide education for low-income homeowners on the benefits of energy efficiency and solar technologies.
- Enroll and refer qualifying families to providers for energy efficiency services.
- Enable low-income families to access money-saving solar technologies by providing up-front incentives.
- Provide opportunities for community volunteers to participate and for public-private partnerships supporting low-income communities to develop.
- Support local green-jobs training and workforce development programs by enabling job trainees to participate in solar electric system installations.

Mash: Multi-Family Affordable Solar Housing

Program Goals

- Stimulate adoption of solar power in the affordable housing sector.
- Improve energy utilization and overall quality of affordable housing through application of solar and energy efficiency technologies.
- Decrease electricity use and costs without increasing monthly household expenses for affordable housing building occupants.
- Increase awareness and appreciation of the benefits of solar among affordable housing occupants and developers.