Climate Neutral for a Healthy, Prosperous Menlo Park

Making Clean Local Energy Accessible Now

Peninsula Advanced Energy Community (PAEC)

Task 2.2: Best Practices Report

Prepared for
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MENLO SPARK

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Clean Coalition
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About Menlo Spark

Menlo Spark is a nonprofit initiative that is collaborating with city government, businesses, and residents to achieve a climate-neutral Menlo Park within ten years. By helping to weave together novel energy, transportation, land use and building policies and projects in the city that contribute to sustainability, Menlo Spark is spearheading a unified strategy for progress towards the ultimate goal of carbon neutrality. To learn more about Menlo Spark, visit www.menlospark.org.

About the Clean Coalition

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

The Clean Coalition drives policy innovation to remove barriers to procurement and interconnection of distributed energy resources (DER) — such as local renewables, advanced inverters, demand response, and energy storage — and we establish market mechanisms that realize the full potential of integrating these solutions. The Clean Coalition also collaborates with utilities and municipalities to create near-term deployment opportunities that prove the technical and financial viability of local renewables and other DER.

Visit us online at www.clean-coalition.org.

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I. Vision of an Advanced Energy Community

An Advanced Clean Energy Community (AEC) not only saves energy, but also pursues deep and cost-effective energy strategies that maximize CO2e reductions and accelerate deployment of new technology.

An AEC requires all new buildings (including major renovations) to meet Zero Net Energy (ZNE) standards, including enough on-site renewables to be grid positive**,** with Solar Emergency Microgrids on all large campuses (e.g., schools, hospitals, shopping centers, office parks, civic centers > 250,000 sq. ft.), reduced fossil fuel use in buildings, and 100% electric vehicle (EV) charging capability.[1] Additionally, all new city vehicles will be electric or zero carbon, where feasible.

In addition to the above requirements for new buildings and transportation, the AEC will actively promote deep energy retrofits. The initial focus will prioritize retrofitting the most inefficient existing buildings serving low income tenants through subsidies, rebates and on-bill financing to ensure zero upfront costs. The AEC will similarly promote renewable energy, efficiency and ZNE retrofits with a combination of incentives and low cost financing. The AEC will assist businesses with the installation of EV chargers on existing parking facilities, with the charger count based on site specific information and funding availability.

The AEC will create a carbon mitigation fund by developing a new revenue stream, such as an increase in the Utility User Tax (UUT), a carbon fee on fossil energy (natural gas, propane and the fossil fuelled portion of electric portfolios), a portion of development fees, an increase in permitting fees (rebated for AEC measures), or other potential municipal revenue sources. This fund would support building electrification (replacing natural gas), energy storage, new renewable energy technology, and accelerated EV deployment.

Numerous reports discuss green cities and clean energy guides for communities. DNV GL recently summarized a shared vision for smart green cities.[2] The report notes that the energy sector currently has significant potential for disruption and growth. Regulatory, technological, and community-driven changes are opening the market for innovative products and services at the city level. Cities, utilities, and community stakeholders can work more closely to achieve mutual goals (see Figure 1).

[1] 10% will be charger ready with wiring, conduit, and breakers; 10% will be conduit & panel ready installed; and 80% pre-planned with installed conduit at critical junctures such as wall penetrations and trenching
See, for example:
https://www.dropbox.com/s/kqnaoeg287nfcwu/EV%20Ready_Leg%20Digest_2.28.2017_SFGBC.pdf?dl=0

[2] DNV GL Green Cities Report, 2015 https://www.dnvgl.com/energy/themes/smart-green-cities.html

Figure 1: How Cities, Utilities, and Stakeholders Collaborate to Achieve Mutual Goals

Source: DNV GL, 2016

A May 2015 McKinsey report explores a similar concept to AECs in the more broadly termed "*Green Districts*." [3] Portland, Oregon– based nonprofit EcoDistricts notes that green districts are interesting because they are "small enough to innovate quickly, and big enough to have a meaningful impact."[4] Table 1 below defines McKinsey's version of a *Green District* with 25 energy, water and sustainability elements.

[3] http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/building-the-cities-of-the-future-with-green-districts
[4] The EcoDistricts Framework: Building Blocks of Sustainable Cities, EcoDistricts, May 2013, wsdot.wa.gov.

Table 1: McKinsey's version of a Green District

Twenty-five technologies and design elements move beyond green buildings to green districts.

Systems — ▸ Design elements ◆ Technologies

Resources	Green buildings	Moving beyond green buildings to district scale		
	Buildings	Transport	Open space	Utility infrastructure
Energy[1]	◆ Solar water heating ▸ Building envelope[2] ▸ Efficient windows ▸ Building design[3] ◆ Rooftop photovoltaic systems ◆ Energy-efficient lighting ◆ Power-use sub-metering	▸ Dedicated bus/ car-pool lanes ▸ Bike infra-structure ▸ Pedestrian-only streets ▸ Pedestrian-friendly street-scapes[4]	◆ Energy-efficient street lighting ▸ Trees/urban forestry	◆ Pneumatic waste-transport system ◆ Combined heat and power ◆ Liquid-desiccant air conditioning
Waste	N/A	N/A	◆ "Smart" waste bins (eg, solar-powered com-pactors)	◆ Composting ◆ Anaerobic digestion
Water	▸ Green roofs ◆ Water-use submetering ◆ Water-efficient faucets and appliances ◆ Rainwater collection	▸ Permeable pavement and green alleys	N/A[5]	◆ Gray-water system

[1]All forms of energy, including electricity, fuel for vehicles, and natural gas.
[2]Combination of best practices for insulation, roofing, wall materials, and so on.
[3]Optimal building configuration, layout, and orientation.
[4]Wider sidewalks, less surface parking, and distributed mix of uses, including street-level retail, less surface parking, and wider sidewalks.
[5]Solutions to reduce runoff in open spaces are highly dependent on specific configuration and terrain, so costs and benefits are highly variable.

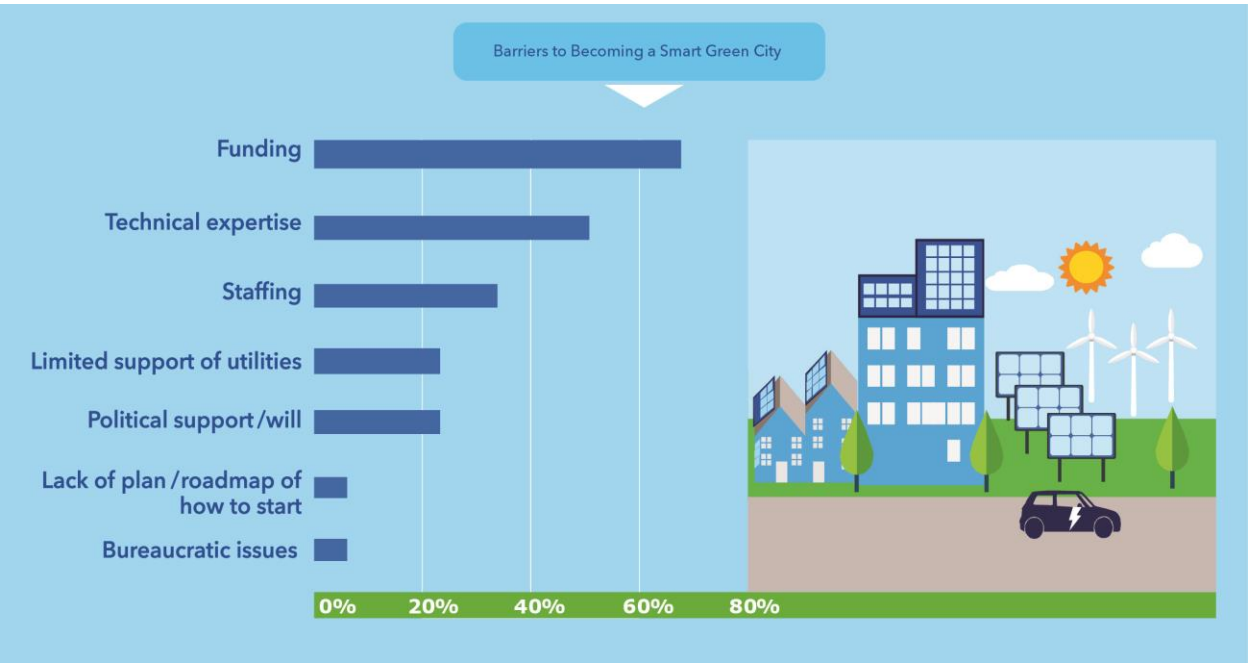
McKinsey&Company

The study concludes that Green Districts are not only environmentally beneficial, but also economically viable with an estimated breakeven rate of three to five years for the investment. In three case studies, green districts have roughly 10 percent higher construction costs overall, but not every green solution costs more than the conventional alternative.[5] Although the technology is mature for Green Districts, there are several barriers to cities becoming smarter and greener (*see Figure 2*).[6] The number one barrier is funding. Other significant challenges include: lack of technical expertise; the inability to properly assess new technologies, equipment and strategies; and limited staff resources.

[5] Total costs were estimated at $35 million to $70 million per square kilometer, or $1,000 to $4,000 per resident. However, annual owner operating costs are lower, with savings of $250 to $1,200 per resident, yielding an internal rates of return ranging from 18 percent to 30 percent. Substantial benefits of improved environmental quality also accrue though these have not been quantified.

[6] DNV – GL Green Cities Report, 2015.

Figure 2: Barriers to Becoming a Smart Green City



Source: DNV GL Smart Green Cities Report, 2015, based on interviews with cities across the U.S.

This analysis highlights the best practices for overcoming barriers to success in cities, counties and local jurisdictions around the world, where they apply most to San Mateo County and cities within the County. Finally, the Rocky Mountain Institute issued a Community Energy Resource Guide in 2015 that details the steps and community collaborations necessary to successfully implement clean energy strategies.[7]

II. Best Practices for Consideration

Many reports document and summarize the best clean energy practices in the United States and abroad. C40, which is supported by The Bloomberg Philanthropy, recently released the Cities100 Guide, with successful sector by sector city solutions addressing climate change.[8] The Rocky Mountain Institute, a Menlo Spark partner, has a model sustainability and climate action planning report for Fort Collins and an excellent Community Energy Resource Guide.[9] In 2014 Redstone Strategies Group issued a report showing how Menlo Park could become climate neutral by stringing together sustainability measures that have been proven in other cities.[10] Another city specific resource is Boulder's Sustainable Energy Plan, which identifies a host of strategies to reduce greenhouse gas (GHG) emissions and

[7] RMI, Community Energy Resource Guide, December 2015; www.rmi.org/community_energy_guide
[8] http://www.sustainia.me/cities/; Another helpful C40 guide is here: http://www.cam3.c40.org/#/main/home
[9] http://www.rmi.org/Knowledge-Center/Library/80FortCollinsReport-WEB_2014-02; http://www.rmi.org/community_energy_guide
[10] http://menlospark.org/what-we-do/

make communities "*ClimateSmart*."[11] The strategies are organized by the main ways energy is used: in homes, businesses, industries, government operations, and transportation. The Plan identifies 20 key recommended first-tier actions out of 35 total. Most of the actions have associated costs, cost savings, and GHG reduction impacts quantified, while 5 actions focusing on planning, educational, and revenue generating efforts were not quantified.

The most effective clean energy ordinances, reach codes, zoning, building and energy codes, policies, initiatives, permitting processes, and advanced energy technology programs are analyzed in this report for the following categories of measures and summarized in Table 2 listing potential measures for municipal ordinances and Table 3 listing additional measures:

1. Renewables (RE)
2. Energy Efficiency (EE)
3. Zero Net Energy (ZNE)
4. Electric Vehicle Charging Infrastructure (EVCI)
5. Additional Clean Energy Measures

[11] http://www.bouldercounty.org/doc/publichealth/susenrgypln.pdf

Table 2: Summary of Advanced Energy Community Policy Best Practices that could be Model Ordinances

Renewable Energy (RE)	Energy Efficiency (EE)	Zero Net Energy (ZNE)	Electric Vehicle Charging Infrastructure (EVCI)	Additional Clean Energy Measures
Solar Rooftops [RE1] (mandatory ordinances) could also include cool roofs, or other alternatives, e.g. the City of San Mateo **Solar Carports [RE2]** over parking, could be coupled with energy storage and/or EV Charging, e.g. Redwood City **Zoning or Building Codes [RE3]** requiring 100% Renewable Energy, covering electricity & gas, e.g. Menlo Park **Solar or Zero Carbon Water Heaters [RE4]** requiring new water heaters to be solar or a non-fossil fuel alternative such as heat pumps, e.g. Hawaii	**Reach Codes for New Construction [EE1]** efficiency improvement over title 24, e.g. Palo Alto **Point of Sale [EE2]** energy audits and disclosure, e.g. Austin **ECBO: Existing Commercial Building Benchmarking Ordinance [EE3],** Buildings report energy use + audit each year ***or*** retro-commissioning every 5 years, e.g. San Francisco	**Reach Codes [ZNE1]** for CA ZNE, e.g. Santa Monica **Financial Incentives [Fees2]**: New Climate Impact Fee, fully refunded for ZNE, e.g. City of Watsonville	**City Ordinance & Zoning [EVCI1]**: Minimum parking spaces required with pre-wiring or EV Chargers for **new** homes, multi-family, commercial or parking, e.g. Fremont	**Fees [Fees1]** for Fossil Fuel Use or Carbon, e.g. Palo Alto Natural Gas offset fees

Note: All of the policies listed here are explained further in the following text.

Table 3: Summary of Additional Advanced Energy Community Policy Best Practices

Note: All of the policies listed here are explained further in the following text.

Renewable Energy (RE)	Energy Efficiency (EE)	Zero Net Energy (ZNE)	Electric Vehicle Charging Infrastructure (EVCI)	Additional Clean Energy Measures
Financing: Rebates, PACE, on-bill financing etc., e.g. PAYS, North Carolina **New technology** – in-pipe hydro, Pressure Relieving Valve (PRV)/Turbine technology, e.g. Portland – Lucid project **Permitting** improvements, e.g. Irvine	**Audit programs** – especially those assisting low-income multi-family buildings, e.g. New York City's Retrofit Accelerator **Incentives –** for more efficient homes, e.g. Colorado **Permitting -** fees waived and/or expedited, e.g. Encinitas **Building Electrification** / Natural Gas Replacement, e.g. Boulder	**District Approaches –** ZNE buildings sharing resources, e.g. Cambridge **RFP & Lease Language -** Zero-energy consumption and carbon-neutral buildings at community colleges, **e.g.** Los Angeles **Existing Building Retrofits** Energiesprong, ZNE overhauls with modular components e.g. the Netherlands	**City Charging Stations** – using free services through a vendor, e.g. San Carlos **Incentives** - preferred parking, free charging or low/no cost charging, e.g. San jose **Streamlined Permitting,** e.g. San Diego **City EV "First" purchasing policy,** e.g. Seattle	**Innovations through CCEs** - aggregated solar, EV deployment, e.g. Sonoma Clean Power **Solar Emergency Microgrids** *(see PAEC task 5)* **Energy Storage –** partnering with a vendor to combine storage with solar & EV Charging, e.g. Lancaster

III. Renewable Energy Best Practices (RE)

Cities around the world have instituted policies supporting renewable energy, which can include solar power, wind power, hydroelectric power, geothermal energy, and wave or tidal power. In California, the most common local renewable programs are focused on solar or photovoltaic (PV) power. The following is a summary of some of the most effective local RE policies and programs.

A. Solar Rooftops

The Bay Area Air Quality Management is currently drafting model language for a solar rooftop ordinance.[12] Several cities have already adopted mandatory ordinances requiring solar for new or renovated buildings, including but not limited to these examples:

- The City of Lancaster adopted mandatory solar requirement for new homes. As of January 1, 2014, a minimum of 0.5 – 1.5 kW photovoltaics (PV) systems must be installed on new homes.[13]
- Culver City has required since 2008 that all new construction (including additions and renovations) greater than 10,000 square feet must install a minimum of 1 kW of solar photovoltaic power.[14]
- The City of Sebastopol adopted a mandatory solar requirement for Residential and Commercial buildings in 2013, of either 2 watts per square foot of conditioned building area or a PV system that provides at least 75% of the building's annual electricity load.[15]
- San Francisco requires as of January 2017 that all new construction under 10 floors install solar panels or solar water heaters on top of new buildings, both residential and commercial.[16]
- San Mateo requires as of January 2017 that all new construction must install either solar panels or solar water heaters on top of buildings (includes both residential and commercial). All commercial and high-rise multi-family residential buildings must also have cool roofs.[17]
- Commercial Zones in France, including Paris, must have new buildings either partially covered in plants or solar panels as of March 2015.[18]

Rooftop solar requirements have become less of a priority in San Mateo County, where Peninsula Clean Energy (PCE) will transition to 100 percent renewable grid power in the next five years; and new homes will very likely include solar panels to meet the ZNE code requirements in 2020.

B. Solar Carports

[12] Personal communication, Kim Springer, kspringer@smcgov.org, San Mateo County, 1/30/17
[13] http://programs.dsireusa.org/system/program/detail/5624
[14] http://www.culvercity.org/Home/ShowDocument?id=440
[15] http://energy.gov/savings/city-sebastopol-mandatory-solar-requirement-residential-and-commercial-buildings
[16] http://www.pv-tech.org/news/paving-the-way-san-francisco-first-big-us-city-require-rooftop-solar
[17] http://www.cityofsanmateo.org/index.aspx?NID=3298
[18] https://thinkprogress.org/france-says-new-roofs-must-be-covered-in-plants-or-solar-panels-a3906ff11b99#.9cu81n8vs

Palo Alto adopted a groundbreaking solar carport policy for public parking lots in 2014 that includes energy storage and EV charging.[19] The City issued a Request for Proposals (RFP) to lease the solar siting rights to install solar parking canopies on Palo Alto's City-owned parking structures.[20] Komuna Energy was selected to build, own, and operate solar parking canopies atop four of Palo Alto's five City-owned parking structures. The ability to structure the RFP as a competition for leasing rights was facilitated by the City of Palo Alto Utilities' Feed-In Tariff (FIT) program. A standardized Power Purchase Agreement (PPA) streamlines the process for selling solar energy to the utility at a fixed rate of 16.5 cents per kilowatt-hour for a 25-year period. Note that the FIT made these solar canopy projects possible, since net energy metering is not viable at these sites. Net energy metering limits the maximum size of a renewables project to the size of the site load, and the parking structures have small loads versus their solar potential

Simultaneously to installing the solar carports, Komuna is upgrading the electrical capacity, installing a number of EV chargers, and enabling the city to add further chargers, obtained from a recent Bay Area Air Quality Management grant.

We recommend this measure as it will improve community resilience by coupling solar generation and energy storage, provide additional workplace, public and fleet electric vehicle charging infrastructure (EVCI), and reduce diurnal emissions from gasoline vehicles (e.g., fugitive VOC emissions that evaporate from parked cars during the day) through canopy shading.

C. Solar or Carbon Neutral Hot Water Heating

As of January 1, 2010, all new single-family dwellings built in the State of Hawaii are required to have a solar water heater.[21] The state allows for variances and provides detailed technical information and cost-effectiveness calculators supporting the measure. While this is an excellent program for Hawaii, and California also has several programs supporting solar hot water heaters with incentive funds (see incentives and rebates below), we find the flexibility of a carbon neutral hot water heating policy allowing the now mature heat pump technology to be more appropriate for the region. Electric heat pump water heaters are more cost competitive than solar and are particularly appropriate given the low carbon grid power available throughout the County. Currently, San Mateo County has 75 percent carbon free power with the launch of PCE in October 2016, and a commitment to carbon free grid power by 2021. One important co-benefit of non-fossil fuel water heaters is the elimination of combustion sources within homes and businesses that

[19] http://www.clean-coalition.org/press-releases/city-of-palo-alto-to-solarize-city-owned-parking-structures-and-enable-its-electric-vehicle-future/
[20] http://www.cityofpaloalto.org/gov/depts/utl/news/details.asp?NewsID=3445&TargetID=235,310
[21] Act 204, June 26, 2008, now HRS 196-6.5; http://energy.hawaii.gov/resources/solar-water-heater-variance

can expose occupants to pollutants, including potentially hazardous levels of carbon monoxide where ventilation is lacking.

We recommend a similar approach to the Hawaiian law, but with more flexibility. Specifically, adoption of a non-fossil fuel or carbon neutral water heater policy requiring all new water heaters (not just new construction) be solar or heat pumps. We recommend that this policy be coupled with an incentive program and technical support to assist home and business owners with the transition and minimize costs.

D. Financing: Incentives, Rebates, PACE, and On-bill Financing

Many cities have generous incentive and rebate programs supporting local solar and renewable energy. The San Francisco Public Utilities Commission offers solar rebates of up to $2,800 for residential, up to $7,000 for low-income residential and up to $50,000 for commercial.[22] Although the statewide California Solar Initiative ran out of rebates for single family rooftop PV, the program continues with rebates for solar water heaters ($4,366) as well as programs for affordable housing.[23] San Francisco Bay Area cities have collaborated on the SunShares PV Buydown program that leverages group purchasing among cities for wholesale solar pricing and discounts for residential customers, with some level of product screening among participating vendors.[24]

Property Assessed Clean Energy (PACE) loans offer long-term private financing for renewable energy and energy efficiency upgrades to homes and businesses.[25] PACE is already available throughout San Mateo County. This program can be helpful towards achieving energy improvements in the commercial sector, particularly where tenants pay some or all of the property tax bill, in order to overcome split incentives in leased commercial space. However, for most home owners in San Mateo County, where home values are high, they can likely obtain a home equity loan to accomplish the same clean energy projects at much lower, more favorable rates than current PACE loan rates. Therefore, we recommend PACE loans for commercial property improvements.

Pay As You Save (PAYS) is an on-bill financing tool that enables utility customers to purchase and install cost-effective energy efficiency upgrades without upfront payment,

[22] Additional incentives are also available for multi-family & nonprofits. https://energy.gov/savings/city-san-francisco-solar-energy-incentive-program

[23] Single-family Affordable Solar Homes Program (SASH) rooftop solar and Multifamily Affordable Solar Housing (MASH) Program rooftop solar. More info at: http://www.gosolarcalifornia.ca.gov/csi/index.php http://www.pge.com/en/myhome/saveenergymoney/solar/waterheating/faq.page http://www.gridalternatives.org/learn/sash#sthash.HbkFpeM5.dpuf; http://www.gosolarcalifornia.ca.gov/affordable/mash.php

[24] Anaheim, Truckee, Ukiah & other cities have similar programs. http://www.bayareasunshares.org

[25] Note that this financing applies to energy efficiency and other projects in addition to RE. PACE-enabling legislation is active in 33 states plus D.C., and PACE programs are now active (launched and operating) in 19 states plus D.C. Residential PACE is currently offered in California, Florida, and Missouri. ***See***: http://pacenation.us; https://www.bayren.org/financing/pace

personal loans, or property liens. PAYS programs are currently in place in rural Kentucky, Kansas, and North Carolina, as well as select Bay Area water utilities.[26] Various versions of on-bill financing are already available in San Mateo County; however, customer awareness is limited and the scope of projects is restricted. For instance, PG&E on-bill financing may be used for efficiency improvements, but not for renewables.

We recommend improved marketing of on-bill financing and expansion of the program to cover RE, ZNE, and EVCI, in addition to EE measures, with higher available loan amounts. In particular, we recommend that cities create a carbon neutral transition package utilizing on-bill financing to facilitate residential and commercial conversions to renewable and non-fossil fuel appliances and vehicles, as discussed in the "Additional Measures" section below.

E. Zoning or Building Codes

The City of Menlo Park recently adopted new zoning regulations that require new developments to utilize 100% renewable energy for both electricity and natural gas through several flexible choices, including energy credits.[27] An on-site renewable energy feasibility study is also required, and projects must install a minimum of 30% of the maximum feasible on-site renewable energy generation potential found in the study.

This is an effective way to ensure that new buildings do not increase carbon emissions.

F. Permitting Improvements

California state mandate AB2188 requires cities and counties to adopt an ordinance that creates an expedited, streamlined permitting process for residential rooftop solar energy systems of less than 10 kilowatts by Sept. 30, 2015.[28] Although several California cities have incentives in addition to the state mandate AB 2188, this is not a productive area of focus for PAEC cities given the current streamlined permitting requirements. However, some cities such as Palo Alto may have room for solar permitting improvements.

The following solar permitting programs stand out as exemplary:

- The City of San Diego expedites permitting for residential, commercial, and industrial development projects that utilize photovoltaic systems (solar panels) to generate a certain percentage of the project's energy needs.[29]

[26] http://cleanenergyworks.org/about/ https://www.bayren.org/pays
[27] https://www.menlopark.org/1148/Approved-documents 0
[28] https://energycenter.org/permitting/guidebook/implementation
Best solar permitting practices can also be found here: http://www.irecusa.org/publications/solar-permitting-best-practices/
[29] https://www.sandiego.gov/development-services/industry/incentive/sustainable

- The City of Irvine has waived all permit and plan check fees for solar panels and solar hot water heating systems.[30]
- The City of Berkeley offers a streamlined permitting procedure for small solar PV rooftop systems (10kW AC or less) for single family and duplex homes, which allows for the use of standard plans and electronic submission of applications.[31]
- Santa Ana offers streamlined residential roof top solar plan check and permitting process for qualifying projects.[32]

G. Innovation through CCEs

Figure 3: Energy Aggregation

Community Choice Energy (CCE) is a power arrangement (see *Figure 3)* that allows a city or county to take over the purchasing of power, and leave grid management, billing, maintenance, and repair to the utility (PG&E in San Mateo County).[33] CCE is often used in place of the legal term "Community Choice Aggregation (CCA)". Benefits of CCE include: competitive, often cheaper electricity rates; consumer energy choice; significant reductions in GHG emissions; new local and in-state renewable power development; and new jobs and energy programs for the community. San Mateo County is the latest county to launch a CCE with PCE in October 2016, with a base portfolio that is 50 percent renewable and 75 percent carbon-free, with announced plans to achieve 100 percent renewable by 2021.[34] Below is information about community solar projects, which could be fostered by CCEs.

The remainder of innovations potentially possible through CCEs will be discussed separately in the "Additional Measures" section below.

1. Medium Scale Solar

[30] https://legacy.cityofirvine.org/cityhall/cd/buildingsafety/solar_installations/default.asp
[31] http://www.ci.berkeley.ca.us/solarpvpermitguide/
[32] http://www.ci.santa-ana.ca.us/pba/buildingsafety/ResidentialSolar.asp
[33] For information about CCEs, see for example: http://cleanpowerexchange.org; www.leanenergyus.org
[34] http://www.peninsulacleanenergy.com/

Community solar programs have become widely available throughout the United States.[35] These are typically medium scale ground-mounted systems of 1-2 MW, where the actual generation of solar electricity does not occur at the customer's home or business site. Instead, the customer subscribes to a portion of a shared solar energy facility (much like a resident may invest in a community garden) located elsewhere in the community, and the power generated results in each subscriber receiving their portion of the benefit based on their investment. The state of Massachusetts has developed model zoning language for cities to support local small and medium scale solar installations.[36] Similarly, Michigan provides a guidebook.[37]

Note that the separate the Clean Coalitions' Solar Siting Survey report determined the Technical Siting Potential for commercial-scale solar photovoltaic (PV) installations within the core PAEC region. In addition to assessing the Technical Solar Potential, the Clean Coalition also evaluated the Interconnection Hosting Capacity (ICA) of the nearest feeder line for the prospective solar sites. By combining this data, the Solar Siting Survey highlights the optimal locations to connect local solar to the grid, where the value is greatest and interconnection the quickest and cheapest.

H. New Technology

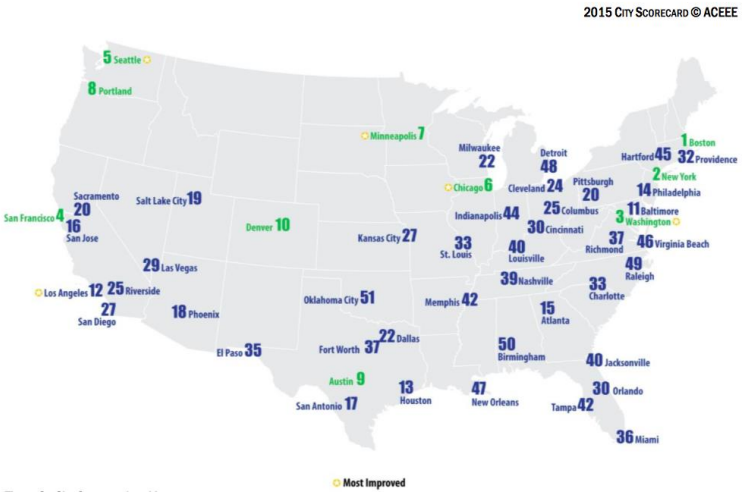
The Stanford University-based Solutions Project estimates that California can transition to 100 percent renewable power by 2050, which would save roughly $7,400 per person in annual energy, health, and climate costs.[38] Such an effort requires investment in both well-known renewable energy (wind and solar) and new and varied renewable technology, such as wave, tidal or micro-hydro, and geothermal energy.[39] One innovative renewable energy project that has been supported by municipal government is called in-pipe hydro, or Pressure Relieving Valve (PRV)/Turbine technology. This technology places a turbine inside major water main vaults to capture the energy of water when the pressure is stepped down. Lucid Energy worked with the Portland Water Bureau and Portland General Electric to install a 200kW *LucidPipe*™ (PRV) Power System in a PWB water pipeline in Portland, Oregon, which came online in January 2015.[40] The City of Keene, New Hampshire uses similar PRV technology at its water treatment facility.[41]

[35] For example, totaling 40,000 kW in 2013; https://www.michigan.gov/documents/mdcd/Michigan_Community_Solar_Guidebook_437888_7.pdf
[36] http://www.mass.gov/eea/docs/doer/green-communities/grant-program/model-solar-zoning.pdf
[37] https://www.michigan.gov/documents/mdcd/Michigan_Community_Solar_Guidebook_437888_7.pdf
[38] http://thesolutionsproject.org/wp-content/uploads/2015/03/100_California.pdf
[39] See for example: http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy; https://energy.gov/science-innovation/energy-sources/renewable-energy
[40] See for example: http://www.lucidenergy.com; http://rentricity.com
[41] http://rentricity.com/keene/

We recommend the installation of PRV technology during the replacement of any major water main valves or vault boxes that have accessible or nearby power infrastructure.

IV. Energy Efficiency Best Practices (EE)

Figure 4: City Model Energy Efficiency Policies



Energy efficiency policies can make cities more livable, competitive, and resilient, and can spur economic growth.[42] Dozens of cities and regions have model energy efficiency policies, as shown in the 2015 City Scorecard by ACEEE and ICLEI's State of California Local Climate Action report (*see Figure 4)*.[43] The best policies are highlighted below in two categories, New Buildings and Renovations and Existing Buildings.

A. New Buildings & Renovations

New buildings are a critical target for energy savings, because energy efficiency can be addressed more cost effectively when the building is being constructed than by retrofitting it later on. Mandatory building energy codes are one of the most effective ways to improve the efficiency of new buildings and those undergoing major renovation.

1. Reach Codes

A number of cities and regions have adopted "reach codes" that advance energy efficiency requirements to meet upcoming, more stringent standards early. The following examples apply to new buildings or major renovations:

- Initiated in 2009, the Massachusetts Stretch Code applies to 189 Municipalities as of January 2017.[44] Although the standard "non-stretch" energy provisions of the code

[42] http://californiaseec.org/wp-content/uploads/2016/09/ACEEE-City-EE-Scorecard-2015.pdf
[43] State of California Local Climate Action 2016, ICLEI, 2016: http://californiaseec.org/wp-content/uploads/2016/10/State-of-Local-Climate-Action-California-2016_Screen.pdf
[44] In accordance with M.G.L. c. 143, § 94; see http://www.mass.gov/eopss/docs/dps/8th-edition/13-energy-efficiency.pdf and http://www.mass.gov/eopss/docs/dps/8th-edition/13-energy-efficiency.pdfhttp://www.mass.gov/eea/docs/doer/green-communities/grant-program/stretch-code-towns-adoption-by-community-map-and-list.pdf; http://www.mass.gov/eopss/consumer-prot-and-bus-lic/license-type/csl/stretch-energy-code-information.html

is based on the IECC 2012 as of July 1, 2014, the stretch code will continue to be based on amendments to the IECC 2009 (and ASHRAE 90.1-2007 for large commercial buildings) until the next update.

- The Oregon Reach Code provides optional standards for the effective use of energy and the utilization of renewable energy technologies in the construction and design of buildings to promote approaches and techniques for achieving effective energy use and reducing negative impacts of the built environment.[45] The code is intended to provide flexibility to permit the use of innovative approaches and techniques to reduce energy use and support renewables.
- Currently, the City of Austin abides by the 2012 International Energy Conservation Code (IECC) with local amendments aimed at a 10-15% improvement in efficiency.[46]
- Although California's Title 24 energy code is one of the most advanced in the world, some cities have adopted stretch codes.[47] Palo Alto has a reach code that goes 10 percent or more beyond the new 2016 code cycle. Santa Monica recently applied to improve energy efficiency by 15% above Title 24 2016 for all new single-family homes, duplexes and low-rise multi-family dwellings and achieve an Energy Design Rating (EDR) of zero, "zero out" TDV energy use. Marin County adopted the California Green Building Standards Code.

With the upcoming stringent energy standards of 2016 Title 24 implementation, the cost-effectiveness of new stretch codes is difficult to demonstrate, as the City of Palo Alto recently found. Further, grid power approaching zero carbon and the anticipation of ZNE standards in the next Title 24 code cycle make this approach less impactful. Efficiency gains for natural gas heating and appliances remain helpful.

2. Energy Performance Monitoring

U.S. EPA's free *ENERGY STAR Portfolio Manager*® is an online tool to measure and track energy and water consumption, as well as GHG emissions from buildings.[48] It is currently used by 40% of commercial buildings in the U.S. and can save builders a lot of money. For instance, a recent survey of U.S. architecture, engineering, and construction firms using Energy Star certification and Portfolio Manager for buildings found that operating costs have decreased on average by 11 percent over one year and by 28 percent over five years, with an average payback time of seven years for green investments.[49]

[45] http://www.bcd.oregon.gov/notices/Adopted_Rules/2011/070111_ReachCode_pr.pdf
[46] http://www.austintexas.gov/edims/document.cfm?id=250789
[47] http://www.energy.ca.gov/title24/2016standards/ordinances/
[48] https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager
[49] World Green Building Trends: Business Benefits Driving New and Retrofit Market Opportunities in Over 60 Countries, McGraw-Hill Construction Research & Analytics, 2013. https://www.energystar.gov/buildings/facility-owners-and-managers/new-construction/why-design-earn-energy-star/sell-others-idea-energy

The City of Menlo Park recently adopted a mandatory monitoring policy for energy performance in new buildings through updated zoning regulations. All new buildings in the M2 district (to which the updated zoning applies) need to monitor and maintain energy efficiency by enrolling in EPA's Energy Star Building Portfolio Manager.[50] This policy was included in the new zoning regulations in response to concerns that buildings do not always perform at their specified efficiency levels over time; thus, monitoring is needed to ensure compliance and continued operational performance.

We recommend the adoption of this simple approach to ensure long lasting energy efficiency benefits for buildings as they are designed to operate.

3. Incentives

Since June 2014, the New York State Energy Research and Development Authority (NYSERDA) Low-rise Residential New Construction Incentive Program began offering significantly higher incentives for homes designed for net zero energy performance.[51] Builders can avail $2,000-$8,000 per unit under three performance tiers, with the highest amount for net zero homes. Incentives are available to support the achievement of increased levels of energy performance, up to and inclusive of homes or dwelling units that are designed and constructed to achieve net zero energy performance.

Colorado's Energy Saving Mortgage Program incentivizes both the purchase of efficient homes and efficiency renovations in refinanced homes.[52] Home buyers can earn a credit of up to $8,000 on their mortgage for net-zero homes or a percentage of that credit for homes scoring between 50 and zero on the Home Energy Rating System (HERS) Index Scale. Home owners can earn up to $8,000 in incentives for efficiency retrofits to existing homes as well.

Both the NYSERDA and Colorado Energy Saving Mortgage incentives are timely and strongly recommended.

4. Permitting

Culver City plan check and permit fees up to $5,000 per project may be waived for energy efficiency improvements located in the AIP (Area Improvement Plan).[53] The City of San

[50] https://www.menlopark.org/1148/Approved-documents
[51] http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-2309-Low-Rise-Residential-New-Construction-Program
[52] See more at: http://database.aceee.org/state/financial-incentives#sthash.9t45pcv0.dpuf;
[53] http://www.culvercity.org/Home/ShowDocument?id=902

Diego expedites permits for energy improvements, in addition to PV installation as noted above.

Fee waivers and expedited permits should be considered for all RE, EE, ZNE, and EVCI projects.

B. Existing Buildings

Fewer policies, particularly mandatory goals, curb energy use in existing buildings. However, Minnesota adopted a Sustainable Building 2030 goal (Chapter 278) in 2008, requiring that every five years, total carbon emissions from building energy use be reduced by 10% to a final reduction of 100% by 2030 compared with the MN 2003 baseline of building average energy use.[54] It requires that all buildings be scientifically benchmarked and real reductions in energy consumption measured and that utilities develop and implement programs to help building owners achieve the energy savings goals through design assistance, incentives, and verification. It also requires analysis and evaluation of the effectiveness and cost-effectiveness of Sustainable Building 2030 performance standards, conservation improvement programs, and building energy codes.

This program is a wonderful compliment to upcoming ZNE standards for new buildings. Cities and counties can adopt this as an umbrella strategy by combining incentives, benchmarking, time of sale improvement requirements, and targeted assistance for EE retrofits.

1. Benchmarking, Rating, Audits and Energy Use Transparency[55]

Building benchmarking, rating, audits, and energy use transparency policies have gained traction at the city level in recent years. While these policies do not directly require upgrades or changes in behavior, the information they yield is critical for quantifying and evaluating building energy use patterns in order to identify potential and realized energy savings throughout a city's building stock. Benchmarking and energy use transparency can increase investment in energy efficiency improvements by providing information about their impact. In fact, the process of benchmarking itself can reduce energy use. In an analysis by the Environmental Protection Agency, energy consumption decreased by 7% over three years in a pool of 35,000 benchmarked buildings.[56]

a. Benchmarking, ECBOs and BESOs

[54] https://www.leg.state.mn.us/docs/2010/mandated/100310.pdf
[55] ACEEE, 2015
[56] ENERGY STAR Portfolio Manager: Data Trends: Benchmarking and Energy Savings. Washington, DC: US Environmental Protection Agency. https://www.energystar.gov/sites/default/files/buildings/tools/DataTrends_Savings_20121002.pdf

A growing number of local governments in the Bay Area are considering adopting policies to improve the energy efficiency of existing building stock.[57] Local governments have an array of policy options available, including requirements for benchmarking, energy disclosure or upgrades. A Residential Energy Conservation Ordinance (RECO) or its commercial counterpart, CECO, can improve the energy efficiency of existing homes and commercial properties and reduce GHG emissions. BayREN has developed RECO policy tools that build the capacity of local jurisdictions to adopt these policies, support regional consistency, and maintain flexibility for cities to tailor the policy to meet their local needs.[58] For now, BayREN is focused on making significant improvements to the performance of California's nine million single-family homes for these reasons:

- In California, the residential sector is responsible for producing 18% of total greenhouse gas emissions.
- More than two-thirds of California's residential buildings were built before 1982 and therefore predate the energy performance requirements from the CEC.
- The number of existing homes sold each year is triple the number of new homes that are built. By improving the existing building stock, GHG emissions can be greatly reduced in a building sector that would otherwise remain relatively stagnant.

The California Public Utilities Commission (CPUC) Long Term Energy Strategic Plan includes a goal to reduce energy consumption in existing homes by 20% by 2015 and 40% by 2020 and lists RECOs as a role for local governments in reaching this goal. RECOs and CECOs have many benefits associated with increased energy efficiency including improved durability, occupant comfort and indoor air quality, lower utility bills, increased property value,[59] creation of green jobs, reductions in GHG emissions and other air pollutants

[57] Stop Waste.org, Residential Energy Conservation Ordinances: A regional approach to home energy efficiency; https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=0ahUKEwid4PHAiOPRAhUB-2MKHVeqD2IQFghKMAc&url=http%3A%2F%2Fwww.albanyca.org%2FModules%2FShowDocument.aspx%3Fdocumentid%3D27636&usg=AFQjCNHouIiEFGWGS64jdTNu0o910xfsBQ

[58] BayREN Codes and Standards Report, 2015, page 30. https://www.bayren.org/sites/default/files/_2015_BayREN_C%26S_Annual_Report_Final__6.pdf

[59] A recent study conducted by UC Berkeley and UCLA found that energy-efficient or green homes are valued at an average of up to 9% more than comparable non-green homes. http://www.stopwaste.org/about/news/homes-green-labels-sell-more
A key finding from the 2016 National Association of Home Builders (NAHB) *Housing Preferences of the Boomer Generation: How They Compare to Other Home Buyers* report found that 80% or more of all home buyers, across generations, felt that a home's energy saving features would positively influence purchasing decisions. https://builderbooks.com/housing-preferences-of-the-boomer-generation-how-they-compare-to-other-home-buyers.html
Additional reports show the value of energy efficiency features for homebuyers, which may result in higher purchase prices or shorter market times.

- *Zillow's Consumer Housing Trends Report 2016* listed energy efficiency as a feature that drives selection of a specific home. https://www.zillow.com/research/zillow-group-report-2016-13279/
- In Remodeling Magazine's *2016 Cost vs. Value Report*, a fiberglass attic insulation project produced the top return on cost of any of the 30 projects included in the report. The report found that within a year of the project's completion the price of a home at resale would yield a 116.9% return on investment. http://www.remodeling.hw.net/cost-vs-value/2016/trends

associated with the generation of energy, water conservation, and reduced reliance on fossil fuels.

However, RECOs and CECOs have proven to be difficult for cities to adopt and implement, due to the high cost of local enforcement, political opposition from the real estate community, and questions around value where checklist approaches are utilized. Furthermore, performance measures may be eclipsed by updates to Title 24 energy code. Thus, many areas are transitioning to more flexible Building Energy Saving Ordinances (BESOs). RECOs and BESOs that target residential and/or multifamily buildings are found in cities including Berkeley, CA, Boulder, CO, Burlington, VT, and San Francisco, CA.[60] The following programs are examples of municipal programs employing benchmarking, auditing, energy standards or some combination of these elements:[61]

- Point of sale ordinances such as Berkeley's RECO policy require homes to meet energy efficiency standards when sold.[62] However, as of December 1, 2015, the RECO has been replaced by a BESO, which no longer requires energy and water efficiency improvement measures. Instead, BESO requires Berkeley building owners to complete energy assessments (e.g., audits) and publicly report the building's energy efficiency information with the goal of helping building owners save energy and motivating them to participate in whole-building energy efficiency programs.[63]
- Austin's Energy Conservation Audit and Disclosure (ECAD) ordinance requires energy audits and disclosures, similar to Berkeley, but covers all buildings, not just homes.[64] ECAD promotes energy efficiency by identifying potential energy savings in homes, businesses, and multifamily properties. The ECAD Ordinance also requires multifamily buildings that are high-energy users (exceeding 150% of average energy use for multifamily properties) to make energy efficiency improvements to reduce energy use by at least 20%.
- Boulder's Green Building and Green Points Program requires homebuilders to meet certain Home Energy Rating System (HERS) rating thresholds when constructing new developments.[65] Renovations that add over 500 square feet to preexisting housing have to meet an energy efficiency requirement that may trigger mandatory upgrades. Boulder's SmartRegs require all rental properties (which compose over 50% of the local housing stock) to meet minimum energy efficiency requirements by a specified date.

[60] Find ACEEE's toolkit her: http://aceee.org/sector/local-policy/toolkit/residential-disclosure
[61] Another good summary of local programs can be found here: https://laexistingbuildings.org/resources/
[62] http://www.ci.berkeley.ca.us/reco/ www.cityofberkeley.info/BESO
[63] http://www.ci.berkeley.ca.us/EnergyOrdinanceUpdate/
[64] Chapter 6-7 Energy Conservation of the Austin City Code; http://austinenergy.com/wps/portal/ae/energy-efficiency/ecad-ordinance/energy-conservation-audit-and-disclosure-ordinance/!ut/p/a1/lZBPU4MwEMU_iweOaRZoK3qjUWlLKwdHpFycEAJkhiZMCO3UTy_9M-o4Vuvedvft7Ps9nOIEp5JuREmNUJLW-z4dv4LjOVMCziy4djzwAzIJR_GjfeNB
[65] https://www-static.bouldercolorado.gov/docs/PDS/forms/902_GP%20Guideline%20Booklet.pdf?_ga=1.177826215.364792868.1485549239

- San Francisco's Existing Commercial Building Benchmarking Ordinance (ECBO) requires property owners to report total energy use annually and complete an energy audit, or conduct retro-commissioning every 5 years.[66] This results in equity improvements by lowering energy bills for renters.
- Los Angeles adopted the Existing Building Energy and Water Efficiency ordinance (EBEWE) in December 2016, which will make public the annual energy and water use of all buildings in the City over 20,000 square feet and will require buildings to take efficiency actions at least once every five years, such as energy audits or retrofits to reduce energy and water use.[67]
- Kansas City's Energy Empowerment Ordinance adopted in 2015 requires energy benchmarking and reporting, which will yield equity improvements resulting in lower energy bills for renters.[68]
- Combining benchmarks, audits, and data, New York City's Retrofit Accelerator offers free technical assistance to owners of buildings in low and moderate-income neighborhoods and assists with energy upgrades. Since its 2015 launch, Retrofit Accelerator has identified 1,000 projects for energy upgrades and estimates GHG reductions of 9,000 metric tons of CO2 over three years from at least 500 completed or initiated retrofits, which will result in $5 million in annual cost savings.[69]

Many benchmarking efforts include commissioning and retro-commissioning of facilities, which is currently done in at least 25 cities or counties in California.[70] This can improve operations and increase energy efficiency of existing buildings. Retro-commissioning measures often have a very desirable payback, especially in larger buildings. However, retro-commissioning can also be difficult to implement due to lack of committed budget training and motivation of facilities managers and engineers for effective adoption and behavior change.

The County of Los Angeles has developed a strong retro-commissioning program by compellingly communicating the opportunities for reducing energy use (e.g., showing instances of simultaneous heating and cooling) and improving facilities operations to provide better management and budget support; by combining retro-commissioning activities with their use of the EEMIS utility management system to analyze energy use; and by sharing project results. For example, retro-commissioning of 80 large facilities resulted in an average cost of $1.20 per square foot, and average annual energy savings of $0.50 per square foot.

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[66] https://sfenvironment.org/article/san-franciscos-existing-commercial-buildings-ordinance
[67] http://clkrep.lacity.org/onlinedocs/2014/14-1478_ORD_184674_12-15-16.pdf
http://mynewsla.com/government/2016/12/13/la-takes-major-step-in-reducing-building-energy-consumption/
[68] http://cityclerk.kcmo.org/LiveWeb/Documents/Document.aspx?q=N3Zet8doUaC6bG7ssQgYWOXMAwgRm0DSLOVO950ZJpjL15vtkjUygLevztfwWLfh
[69] http://solutions.sustainia.me/cities/#
[70] ICLEI 2016, p. 32

Multifamily housing can be one of the toughest sectors to achieve energy improvements, yet the most valuable for low-income housing where energy upgrades can yield big savings to tenants on their utility bills. The Regional Energy Efficiency Organizations (REEOs) recently issued a report detailing the most successful programs that have achieved deep energy savings in the multifamily housing sector through energy efficiency upgrades.[71] The report discusses barriers such as split incentives, opportunities for program and policy efforts, and eight exemplary case studies from across the country. In addition to the NYC Retrofit Accelerator discussed above, the following programs have been successful in achieving deep energy retrofits in multifamily buildings:

- Florida's Multifamily Energy Retrofit Program includes substantial outreach and differentially priced 15-year loans; for-profit applicants receive loans at one percent interest and Not-for-profit applicants receive zero percent interest loans. A portion of the loans may be forgiven.
- The City of Chicago Energy Benchmarking has been a big success in part because the City offered a full-time help center, free training, and pro-bono assistance to facilitate implementation of the benchmarking ordinance and data verification.
- Energy Outreach Colorado is exceptional at leveraging, maximizing, and managing funding from many different sources.
- Massachusetts Low-Income Multifamily Energy Retrofit Program has a "turnkey" approach to handling all aspects of implementation plus its coverage of the full cost of the approved measures means clients are highly motivated to participate and are free to use their own potentially scarce resources for other needs.

BESOs and policies requiring benchmarking, auditing, and energy efficiency goals for existing buildings should be adopted including technical assistance for multi-family building owners, like New York City's Retrofit Accelerator program, as well as programs in Florida, Chicago, Colorado, and Massachusetts.

b. Audits

In addition to the mandatory programs above, several voluntary audit programs have been successful:

- The non-profit Rising Sun Energy Center runs the California Youth Energy Services program, which provides energy and water efficiency services, called Green House Calls, to households throughout the Bay Area.[72] Local centers hire youth teams over the summer at a cost of roughly $150,000. Residents that sign up for the Green House Call receive two trained youth Energy Specialists at their home to check for

[71] Regional Energy Efficiency Organizations (REEOs), Multifamily Energy Efficiency Retrofits: Barriers and Opportunities for Deep Energy Savings, Dec. 2016. https://eepartnership.org/program-areas/high-performance-buildings/multifamily-building-energy-efficiency/

[72] http://risingsunenergy.org/programs/green-house-call-residents/

resource conservation opportunities, install new equipment to help save energy, water, and money, and give customized recommendations for more savings. This program is funded by California utility customers and administered by PG&E under the auspices of the California Public Utilities Commission. It is not yet available in San Mateo County.

- Acterra's Green@Home program offers home energy audits to help local residents take action to reduce climate change by making their homes more energy efficient. The program has been supported recently in Cupertino, Sunnyvale, Mountain View, and Santa Clara County.[73]
- BayREN offers a $300 rebate for home energy assessments and a hotline to speak with a Home Upgrade Advisor.[74]
- San Mateo County Energy Watch offers no-cost, no-obligation energy assessments to businesses to evaluate opportunities for energy and cost savings.[75] The results are detailed in a report containing recommended energy-efficiency upgrades, anticipated energy cost savings, retrofit costs, and the dollar amount of instant rebates or calculated incentives. Though the program is focused on lighting retrofits, it can also identify other energy-efficiency projects for boilers, chillers, computer power management, energy management systems, and retro-commissioning.

All the above services are valuable. We recommend that PAEC cities expand the free Energy Watch audits to cover homes as well as businesses and to evaluate HVAC systems in addition to lighting and appliances, potentially incorporating California Youth Energy Services and/or Green@Home.

c. Transparency

Simply reporting energy use can lead to retrofits and improvements that conserve energy. Chicago has an ordinance that requires access to energy use at the time of listing a home or apartment for sale or rent, in addition to benchmarking for existing municipal, commercial, and residential buildings larger than 50,000 square feet to track whole-building energy use.[76] The data is reported to the city annually, and owners must verify data accuracy every three years.

Chicago's time-of-listing requirement allows home buyers and renters access to energy use information when they are searching for housing. Using the MyHomeEQ system developed by Elevate Energy, realtors can enter utility account information for a home and sync energy use information to the MLS. This provides a reporting method for energy use information that is standardized, automatic, and easy to understand.

[73] http://www.acterra.org/programs/greenathome/
[74] https://www.bayareaenergyupgrade.org
[75] http://www.smcenergywatch.com/lighting-retrofits
[76] ACEEE, 2015

Figure 5: City of Vilnius Online Energy Use Maps

The City of Vilnius in Lithuania has established energy use reporting for multi-family buildings (*See Figure 5)*. The program supports energy efficiency upgrades in old apartment buildings via an interactive, user-friendly online energy map, enabling residents to see the benefits of undertaking renovations.[77]

Where data privacy issues can be overcome, cities and counties should consider providing online energy use tracking for multi-family housing buildings in concert with enhanced technical assistance for energy efficiency retrofits of old buildings.

2. Incentives, Rebates and Special Financing

Most utilities offer incentives and rebates for home and business energy efficiency upgrades. Energy Upgrade California provides many rebates to homeowners in the Bay Area, which are funded through a public goods charge on energy utility bills.[78] The program requires the use of certified contractors who help homeowners access all rebates.

The Basic Upgrade Package provides up to $3,150 for any combination of the following: air sealing, attic insulation, duct sealing, hot water pipe insulation, thermostat shut-off valves, and carbon monoxide monitors. The Advanced Upgrade Package provides up to $6,500 for additional energy improvements, including efficient windows, heating, air conditioning, and solar and tank-less water heaters.

Similar to Energy Upgrade CA, the emPower Program operating in Santa Barbara, San Luis Obispo, and Ventura counties simplifies the process of energy efficiency upgrades for homeowners through pre-screened contractors, a standardized menu of upgrades, and available financing.[79]

More than 25 local governments in California have implemented revolving energy funds for energy efficiency and sustainability projects that are replenished by cost savings generated by the projects.[80] Through a revolving energy fund, a local government can control its own project eligibility rules and timelines. The Western Riverside Council of Governments (WRCOG) territory has incorporated a new approach that uses income from its administration of the HERO (PACE) Program to support more projects in local

[77] http://solutions.sustainia.me/solutions/online-tool-tracks-apartment-energy-use/
[78] http://www.EnergyUpgradeCA.org/
[79] ICLEI 2016, p. 38
[80] ICLEI 2016, p. 31

governments across its sub-region. A new type of revolving energy fund is also planned by the Silicon Valley Clean Energy Authority (SVCE), a partnership of 12 local governments formed in March 2016 that has committed to providing its Santa Clara customers with 100% clean electricity upon starting operation in 2017. SVCE will be setting aside a percentage of its revenue to invest in local renewable energy projects and energy programs.

PAEC cities can work together to promote the regional financing and rebate programs.

C. Efficiency Efforts in Water Services[81]

Water utilities can play an important role in the energy efficiency of a city, by improving pumps and motors and generating on-site energy through wastewater. In addition, the close relationship between water demand and energy demand means that improvements in water efficiency result in energy savings. According to the EPA's ENERGY STAR program, upgrading municipal water supply and wastewater systems to minimize leaks and improve the efficiency of pumps and motors can readily achieve 10% energy savings, resulting in collective savings of about $400 million and 5 billion kilowatt-hours (kWh) annually.[82]

Austin Water, the city-owned water utility, has reduced its total gallons per capita per day water use by 22% since 2006 through successful conservation efforts. Austin Water offers rebates for residential and commercial customers such as WaterWise landscaping, rainwater harvesting, free showerheads, and other products and actions. Austin Water also tracks its energy efficiency at the facility, process, and system levels with a goal of 3% reduction in kWh/MG per year until 2020.

Water conservation and storm water management are central components of Atlanta's sustainability plan, Power to Change Initiative. Under this initiative, all city facilities, including the Department of Watershed Management, are striving to meet a 20% energy reduction by 2020. At this point, every city water and wastewater treatment plant has undergone energy efficiency upgrades, including the R. M. Clayton Water Reclamation Center (WRC) where a combined heat and power system eliminates open-air gas flaring and produces up to 20% of the plant's electricity needs, saving the city more than $1 million annually.

The PAEC region has already made significant efforts to improve water conservation during California's drought. However, efforts to improve the energy efficiency of pumps and other water system conveyance assets could be explored and promoted.

[81] ACEEE, 2015
[82] EPA; Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities. Washington, DC. http://www.epa.gov/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf

V. Zero Net Energy Best Practices (ZNE)

Zero net energy (ZNE) buildings are becoming the new standard for achieving significant energy savings and reducing carbon emissions from the built environment, with hundreds of ZNE buildings already in use.[83] California is setting the highest levels of performance with ZNE policies leading to massive energy savings and carbon emission reductions.

Generally, ZNE goals mean that buildings use a combination of improved efficiency and distributed renewable energy generation to meet 100 percent of their annual energy needs.[84] There are alternate definitions, some of which focus on zero carbon instead of energy: "meeting the balance of energy needs from sources that do not produce CO_2 emissions and therefore result in zero net CO_2 emissions."[85]

In 2008, California set bold energy use reduction goals for all new homes to be ZNE by 2020 and commercial buildings by 2030.[86] The California Energy Commission is supporting these standards with a Research Roadmap for Getting to ZNE Buildings, funding and addressing research, development, demonstration and deployment (RDD&D) gaps, as well as demo projects (see *Figure 6: Roadmap to City ZNE Policy*).[87] In

How to Achieve a ZNE Building:

1. Develop an ***integrated systems approach*** that minimizes energy use and increases comfort, through an air-tight, ***well-insulated*** building shell, design for ***daylighting***, and siting to maximize ***passive cooling and ventilation***.
2. Apply highly ***energy-efficient technologies*** including HVAC, lighting, and control equipment.
3. Optimize the way the building operates and how people use it, including ***management of plugged-in devices*** and controls.
4. Install ***renewable generation*** to meet the remaining energy needs of the building ***or utilize carbon free grid power***.

HVAC Systems Play a Key Role. The Heating, ventilation and air conditioning (HVAC) systems designed for ZNE buildings do not use standard packaged units. Four HVAC trends are important:

1. Decoupling ventilation air from space conditioning, for example via radiant floor heating & cooling combined with a Heat Recovery and Ventilation (HRV) system;
2. Including energy recovery on the return air supply, typically via HRV;
3. Considering alternatives to forced-air ducted distribution systems; and
4. Integration of heat pumps, typically ground-(geothermal) or air-source (electric) heating and cooling.

[83] Newbuildings.org and http://netzeroenergycoalition.com/inventory-infographic/
[84] http://energy.gov/eere/buildings/downloads/common-definition-zero-energy-buildings
[85] http://architecture2030.org/files/roadmap_web.pdf
[86] http://www.energy.ca.gov/title24/2016standards/rulemaking/documents/2016_Building_Energy_Efficiency_Standards_FAQ.pdf; http://www.californiaznehomes.com; also note that the U.S. Department of Energy issued guidelines in 2008.
[87] http://www.energy.ca.gov/contracts/RFP-15-315/ http://www.energy.ca.gov/contracts/GFO-15-308/

Figure 6: Roadmap to ZNE Cities

Source: www.energycenter.org/zne

addition, PG&E's Prop 39 ZNE Pilot Program provides commercial project design and technical assistance services for ZNE school projects.[88]

A. Reach Codes & City Ordinances

Cities and counties that advance ZNE are increasing economic development and demonstrating community leadership, ingenuity, and resilience.

The City of Lancaster adopted a ZNE Home Ordinance in February 2017 that allows three ways to comply.[89] All new homes must:

- Install a solar system equal to two watts per square foot of the home, achieving a ZNE home;
- Pay a ZNE mitigation/in lieu fee, equal to $1.40 per square foot of the home; or
- A combination of the first two options.

Homeowners subject to the ordinance receive a 50% discount on the energy generation portion of the home's energy bill for 20 years through Lancaster Choice Energy. Santa Monica also recently adopted a ZNE reach code that requires all new single-family homes, duplexes and low-rise multi-family dwellings to be 15% above Title 24 2017 energy efficiency requirements, and achieve Energy Design Rating (EDR) of zero "zero out" TDV energy use.[90]

[88] http://www.pge.com/includes/docs/pdfs/b2b/purchasing/bidopportunities/COA_Proposition39ZeroNetEnergyPilotProgram.pdf
[89] http://www.cityoflancasterca.org/Home/Components/News/News/7733/20?utm_source=March+2017+Municipal+Newsletter&utm_campaign=2015+November+24+Municipal&utm_medium=email
[90] https://www.smgov.net/Departments/OSE/Categories/Green_Building/Energy_Reach_Code.aspx

The City of Hayward adopted a ZNE Policy for Municipal Buildings in 2015, requiring all new city building that begin design after 2025 be ZNE.[91] The policy also requires existing city buildings for which renovations exceed 50% of the building's value and begin design after 2025 be ZNE, similar to and supporting state requirements.

Santa Barbara County adopted a similar measure in 2014 with an additional provision that departments shall also take measures toward achieving ZNE for 50% of existing Santa Barbara County owned facilities by 2025 and the remaining 50% by 2035.[92]

San Mateo County is supporting cities advancing ZNE policies ahead of the state requirements.[93]

Strong consideration should be given to adopting ZNE reach codes like the code recently adopted by the City of Santa Monica.

B. District and Voluntary Approaches

Overarching voluntary programs such as Architecture 2030 and Bioregional are encouraging widespread implementation of green standards and construction of ZNE and carbon neutral developments.[94] Other examples of regional and city targets include:[95]

- Vancouver aims for all new construction to be carbon neutral beginning in 2020.
- Santa Clara County worked with Sage Renewables to create a ZNE Plan for the County's existing multi-city block Government Center, including their County Offices, Courthouse and Jails. [96] The ZNE Study included the 400,000 square foot county government center, an RFP for a 6 MW fuel cell, tariff analyses and emissions study, a review of on-site and off-site renewable energy technology, and an 11 MW solar PV RES-BCT analysis.
- In 2012, Tucson & Pima Counties in Arizona adopted a voluntary Net-Zero Energy Standard that has a prescriptive approach, with alternate performance criteria for both residential and commercial buildings that cannot use the prescriptive path to achieve a net-zero certification by using energy modelling software.[97]
- Getting to Zero: A Pathway to a Carbon Neutral Seattle includes ZNE buildings.
- Architecture 2030 launched its voluntary peer to peer 2030 Districts project in Seattle in 2011, with a goal to cut energy use and carbon 50% by 2030 (among other

[91] Executive Order B-18-12; http://eecoordinator.info/haywards-new-municipal-building-zero-net-energy-policy/
[92] https://santabarbara.legistar.com/LegislationDetail.aspx?ID=1639014&GUID=3D00C2BA-27D0-4604-96F4-E445A7F60637
[93] http://www.smcenergywatch.com/node/191
[94] http://architecture2030.org/ and http://architecture2030.org/http://www.bioregional.com
[95] Integral Design Group study of City Net Zero Policies & Projects: http://newbuildings.org/sites/default/files/20140530PolicyBestPracticesCambridgeNZTF.pdf; http://www.netzerocambridge.org/
[96] http://www.sagerenew.com/santa-clara-county/
[97] http://www.pima.gov/netzero/ http://www.pima.gov/netzero/Documents/Net-Zero-Code-Final.pdf

goals).[98] Now operating in fifteen large cities – Seattle, Cleveland, Los Angeles, Pittsburgh, Denver, San Francisco, Stamford, Dallas, Toronto, Albuquerque, San Antonio, Grand Rapids, Austin, Portland ME and Ithaca, the 2030 Districts comprise over 290 million square feet that are currently being transformed. Note that *Architecture 2030* recently adopted a goal of Zero Net Carbon (vs. Zero Net Energy).

- Fort Collins Zero Energy District (Fort ZED) brings the city, developers, design team, and the local municipal energy utility together in planning a two-block district to be Zero Energy (and water) as a district system, with integrated energy and water strategies, including a microgrid, and with a goal to become Net Zero by 2024.[99]
- Cambridge, MA adopted a Net Zero 25-Year Action Plan in 2015 with a target for new buildings to achieve net zero beginning in 2020, starting with municipal buildings and phasing in the requirement for other building types between 2022-2030.[100] The Plan also targets improvements to existing buildings with a Building Energy Use and Disclosure Ordinance (BEUDO), supports increases in renewable energy generation, and requires LEED gold buildings.
- Palo Alto, as part of its climate action plan, is also supporting ZNE buildings and looking to phase out natural gas use in buildings.[101] The Downtown Palo Alto Net Zero Energy (DPANZE) Initiative seeks to achieve Net Zero Energy (NZE) for at least 100 existing commercial buildings in downtown Palo Alto by year-end 2017.[102]
- The San Diego Regional Energy Partnership recently created a Zero Net Energy Roadmap for Local Government.[103]
- The City of Atherton Civic Center Project is using Measure L funds for a new $43 million Zero Net Energy civic center with a microgrid, slated to be complete in 2019.[104]
- Also, the University of California System pledges to be carbon neutral by 2025;[105] ZNE buildings will play a key role.

C. RFP & Lease Language

Several institutions have utilized RFPs and lease language to advance sustainability and ZNE goals, including the following:

[98] http://architecture2030.org/programs/2030-districts/
[99] http://www.fcgov.com/utilities/img/site_specific/uploads/2011_REPS_FortZED_pres_.pdf http://fortzed.com/news/
[100] http://www.cambridgema.gov/CDD/Projects/Climate/NetZeroTaskForce
[101] http://www.cityofpaloalto.org/services/sustainability/sustainability_and_climate_action_plan/default.asp
http://paloaltoonline.com/news/2014/12/24/palo-alto-looks-to-fuel-switch-away-from-natural-gas
[102] http://www.clean-coalition.org/site/wp-content/uploads/2015/03/DPANZE-Initiative-Overview-24_jb-16-Dec-2014.pptx
[103] http://energycenter.org/zne
[104] http://www.ci.atherton.ca.us/civiccenter
[105] http://www.ucop.edu/initiatives/carbon-neutrality-initiative.html

- New York University adopted a Green Lease Guide in 2011 that aims to provide guidelines and sample provisions to reduce the carbon footprint and increase overall sustainability of the facilities that it occupies as a tenant.[106]
- The Department of Defense, in its May 2010 Annual Energy Management Report, set a goal for Fort Carson to be a Net Zero installation by the year 2020.[107] In accordance with this stated goal, it has been determined that the Butts Plateau and 13th Combat Aviation Brigade (CAB) complex will be a Net Zero campus. In support of Fort Carson's Net Zero objective, all new vertical construction is to be Net Zero Ready, including buildings designed and constructed to minimize energy and water use and limit the amount of waste produced. The RFP language notes that "Increased preference will be given to proposals that exhibit significant energy reduction (well beyond 40%) through the use of passive design strategies, prior to the inclusion of renewable energy."
- Zero-energy consumption and carbon-neutral buildings have been embraced by Community Colleges in Los Angeles through RFP language. The LA Community College District Green Design Guidelines were updated in 2016.[108] Projects shall be built in a manner that maximizes all possible sustainable attributes including, but not limited to, state-of-the-art building design, mechanical design, and material selection, and building integrated renewable energy generation systems to achieve zero-energy consumption and a carbon-neutral profile upon completion.
- One utility RFP calls for a list of proposed design measures for buildings to achieve a very low energy footprint in the range of 16-22 kBtu/sf or less along with supporting documentation and analysis.[109]

PAEC institutions such as school districts, should consider adopting the green RFP and leasing language utilized by the community colleges of Los Angeles.

D. Financial Incentives

In 2011, the city of Lancaster set a goal to become the first net-zero energy city, defined as producing or procuring more electricity within city limits from renewable sources than is consumed. [110] In addition to the solar requirements discussed above, Lancaster's Zero Energy Road Map includes a Better Built Home Program.[111] This voluntary program offers builders incentives for incorporating features such as LED lighting, WaterSense fixtures,

[106] http://www.scps.nyu.edu/export/sites/scps/pdf/real-estate/sbe-green-lease.pdf
[107] http://apps1.eere.energy.gov/buildings/publications/pdfs/rsf/annotated_rfp_ftcarson.pdf
[108] http://az776130.vo.msecnd.net/media/docs/default-source/contractors-and-bidders-library/standards-guidelines/Sustainable-Design-Standards/laccd-sustainability-design-standards-2016.pdf?sfvrsn=0
[109]https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwi3p52QisbRAhXrqVQKHS3HBP0QFggcMAA&url=https%3A%2F%2Fnewbuildings.org%2Fwp-content%2Fuploads%2F2016%2F10%2FNBI_ZNE_ToolsResources_12.9.2016.pdf&usg=AFQjCNG-eDMv5lfBp97OedWNEdiEggmA7g&sig2=Ze_HpPZBB3nNhePOH7t4Iw
[110] https://energycenter.org/case-study-lancasters-zne-goal
[111] http://www.cityoflancasterca.org/Home/Components/News/News/5023/1952

graywater systems, vehicle charging stations, energy storage systems and ENERGY STAR appliances into new homes – features that provide long-term cost-savings and environmental benefits. Incentives include a 25% discount on city-imposed impact fees, a waiver for backyard landscaping requirements, and the use of recycled water for dust control at no charge. The estimated value of these incentives is $9,000-$12,000 per home. The program was developed with input from a working group that included participants from the Building Industry Association and KB Home and launched in January 2015.

The City of Watsonville adopted The Carbon Fund Ordinance in 2015 establishing a Carbon Fee to be charged to all development projects, except single family residential alterations, temporary buildings, and/or building area that is not used as conditioned space.[112] The goal is to encourage the implementation of renewable energy in development projects. The money collected from the Carbon Fee is placed in a separate account to be used for citywide GHG reduction projects. Fees are reportedly reimbursed for ZNE projects.

Similar to the California funding programs discussed above, Massachusetts has a Pathways to Zero Grant Program worth $3.5 million to spur the development of Zero Net Energy Buildings through feasibility studies, integrated design, construction funding, public awareness, workforce development, and efforts to develop and standardize best practices.[113]

Financial incentives such as the climate impact fee adopted by the City of Watsonville are an excellent way to incentivize and reward ZNE buildings and provide revenue for much needed energy retrofits for existing buildings, as well as other GHG mitigation measures.

E. Existing Building Retrofits

The Dutch Energiesprong (Energy Leap) initiative involves completely wrapping houses with insulated panel-facades that snap on like Legos.[114] Insulated roofs are adorned with 24 high-efficiency solar panels, while heat pumps, hot water storage tanks, and ventilation units are stored in garden sheds. The Rocky Mountain Institute is working to bring the program stateside beginning in New York City.[115] Market development teams have also been established in the United Kingdom and France.

[112] http://cityofwatsonville.org/permits-plans/climate-action-plan/carbon-fund-ordinance http://aceee.org/files/proceedings/2014/data/papers/10-430.pdf
[113] http://database.aceee.org/state/financial-incentives#sthash.9t45pcv0.dpuf; http://www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/zero-net-energy-bldgs/
[114] http://www.energiesprong.eu; http://blog.rmi.org/blog_2016_10_14_getting_to_net_zero_carbon_in_multifamily_homes https://www.youtube.com/watch?v=l3WBT2eAArI
[115] http://blog.rmi.org/blog_2016_10_14_getting_to_net_zero_carbon_in_multifamily_homes

ZNE and all-electric homes are taking off. The Department of Energy issued Zero Energy Ready Homes certification guidelines beginning in 2008.[116] Since then, the concept has become mainstream with 6,000 ZNE units already built, according to the Net Zero Energy Coalition, illustrated by an infographic.[117] A California company called City Ventures has produced over 100 homes that are all electric without any additional cost premium on the homes.[118] Other states are also developing ZNE and all-electric homes. Grow Community on Bainbridge Island, WA has at least 20 fossil fuel free homes that are electrically powered with air source heat pumps and heat exchangers to keep them warm and well ventilated in winter.[119]

There are buildings of many types and sizes where ZNE has been achieved with acceptable incremental costs, with design and construction running from 0 to 15% more than conventional construction costs.[120] Some commercial buildings have achieved ZNE (or near ZNE) at little or no additional cost with a project team that utilizes an integrated design process. ZNE buildings also provide significant operational cost savings to residents and businesses, and bolster innovation and technological development.

More than one-quarter of the many ZNE and ultra-low energy buildings are larger than 50,000 square feet. Of those, half are over 100,000 ft^2. These larger buildings, which are more complex to design, construct and operate, clearly show the potential of ZNE for larger properties, per an ACEEE study in 2014.[121]

As discussed in the EE section, retrofitting existing buildings should be a high priority, including potential consideration of an Energiesprong ZNE conversion demonstration.

VI. Electric Vehicle Charging Infrastructure (EVCI) Best Practices

Local promotional activities, including the installation of EVCI, have been accelerating the electric vehicle market (*see **Table 4**: EV Promotion Activities*).[122, 123] The 30 cities in California with the highest electric vehicle uptake —8 to 25 times the U.S. electric vehicle uptake—have seen the implementation of abundant, wide-ranging electric vehicle promotion programs involving parking, permitting, fleet procurement, utilities, education, and private, workplace, and public charging. Note, for purposes of this section, EVCI generally refers to Level 2 charging but may also include Level 1 charging (particularly for workplace charging) and fast charging (transportation corridors).

[116] https://energy.gov/eere/buildings/zero-energy-ready-home
[117] http://netzeroenergycoalition.com/inventory-infographic/
[118] http://www.greenbuildersjournal.com/why-do-we-sell-all-electric-homes/; http://www.cityventures.com/
[119] http://www.bioregional.com/grow-community/
[120] http://newbuildings.org/sites/default/files/ZNE_CommsToolkit_FAQ_CA.pdf
[121] In this study of more than 20 office buildings and more than ten multifamily buildings, 24% of the 33 ZNE verified buildings are renovations of existing buildings; and 25% of the ZNE buildings are privately developed. http://aceee.org/files/proceedings/2014/data/papers/5-1224.pdf
[122] ICCT, Sept 2016 http://www.theicct.org/ev-markets-calif-cities-sept2016
[123] http://www.theicct.org/EV-capitals-of-the-world

Table 4: Categories of Electric Vehicle Promotion Actions (source: ICCT, 2016)

City government	Regional government	Utilities	Nonprofits and media	Businesses
• City-owned public chargers • City-owned electric vehicles • Building codes require chargers • Streamlined charger permitting • Reserved parking at public chargers • Waived parking fees at meters • City electric vehicle strategy • Informational website • Outreach events	• Public Fleet Project • County-level fiscal incentives for electric vehicles • County-level building codes require chargers • Air quality management district (AQMD) electric vehicle rebate • AQMD charger rebate • AQMD outreach events	• Fiscal incentives for electric vehicles • Electricity rate discount for electric vehicles • Time-of-use electricity rates available for electric vehicles • Informational website	• Participation in Electric Drive Week • Other outreach events • Media coverage promoting electric vehicles	• Electric vehicle only dealerships • Electric vehicle company headquarters or manufacturing in city • Electric vehicle component manufacturing • Charger company headquarters • Electric vehicle only car sharing • Electric vehicle fleet purchases • Workplace charging

A. City Ordinance & Zoning

California's Green Building Standards Code (CALGreen, Title 24, Part 11), was the first state-adopted green building code in the nation. It includes both mandatory and voluntary measures that ensure residential and commercial new construction projects are ready for EV infrastructure.[124] The new 2016 CALGreen Code increased the threshold for non-residential parking lots from 3% of lots with 51 or more parking spaces to 6% of lots with 10 or more parking spaces to be prewired for electric vehicle supply equipment (EVSE). Local jurisdictions have authority to adopt their own EV-readiness building codes standards beyond CALGreen's mandatory requirements, and a number have and are doing so.[125]

At present, the City of San Francisco has *proposed* the most advanced EV Electric Vehicle Readiness Ordinance for new construction and major alterations. This comprehensive ordinance requires that:

1) Electrical capacity is sized to simultaneously charge vehicles in 20% of parking spaces. At this electrical capacity, load management systems can readily be installed later as needed to enable cost-effective EV charging to 100% of parking spaces.
2) 10% of parking spaces have full circuits (breakers, conduit, wiring, etc.) enabling simple installation and activation of standard Level 2 chargers.

[124] Center for Sustainable Energy, https://energycenter.org/sites/default/files/docs/nav/transportation/plug-in_sd/Plug-in%20SD%20Installation%20Best%20Practices%20Report.pdf
[125] http://www.bayareapevready.org/assets/Bay-Area-PEV-Readiness-Plan-Background-and-Analysis-web.pdf

3) 10% have conduit installed from the electrical panel(s) to each parking space enabling either Level 2 chargers or the option to upgrade selected circuits to higher amperages.
4) 80% are "EV Capable" with project plans indicating the path of future wiring to each parking space and conduit is installed at critical points such as trenches, concrete wall penetrations, etc.

There is an option to install fast chargers to meet the EV-ready requirements. San Francisco officials estimate that installing such infrastructure during construction is expected to save developers and the city 75 percent of the cost to retrofit buildings and parking spaces to meet future EV-charging needs.[126]

Taking a slightly less extensive approach, Oakland's EV Ready code for multi-unit dwellings essentially requires the above except the 10% percent only conduit run is not required.[127] Likewise, the City of Fremont's recently enacted EV Ready code essentially requires (along with the panel capacity, wiring, conduit, etc.) that Level 2 EV chargers be installed in 10% of the parking spaces.[128]

The City of Palo Alto also has some of the most advanced EV charging requirements. In addition to the requirement that homes be pre-wired to accommodate chargers, the following requirements exist for other buildings:[129]

- **Multi-family residential** – one charging outlet and/or one EVSE for each housing unit, plus installation of electric wiring for one quarter of visitor spaces, which exceeds the requirements of California Senate Bill 880.[130]
- **Hotels** – all new construction must accommodate EVs at 30% of public spaces. This accommodation can be either a 120V outlet or actual charging equipment, but all parking must have at least 1 in every 10 spaces set up to include *installed* EVSEs.
- **Commercial Development** – 25% of all spaces must accommodate plug-in vehicles, with at least 5% of all spaces equipped with charging equipment.

Palo Alto officials project increased costs of less than 1%, and note that it is more difficult and costly to add wiring for an electric-car charging station after a building is built than to pre-wire.[131] In total, over 15 businesses and institutions in Palo Alto have over 30 EV

[126] https://www.solarreviews.com/news/san-francisco-proposes-ev-charger-ordinance-for-city-030217/
[127] https://oakland.legistar.com/LegislationDetail.aspx?ID=2867571&GUID=9B9DF1D2-EF8D-470F-85F8-26BDCD2D4914&Options=&Search=
[128] http://docketpublic.energy.ca.gov/PublicDocuments/16-BSTD-07/TN215519-2_20170123T115220_Freemont_Ordinance.pdf http://www.codepublishing.com/CA/Fremont/html/Fremont18/Fremont18183.html#18.183.172
[129] Earthtechling, Beth Buczynski. "Palo Alto Requires Homes To Be Prewired for Electric Cars." *Green Technology*. N.p., 11 Oct. 2013. Web. 27 June 2016.
[130] http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0851-0900/sb_880_bill_20120229_chaptered.pdf
[131] Kim, Sussanna. "Calif. City Requires Electric Car Charging Stations for New Homes." *ABCNews.GO*. ABC, 2 Oct. 2013. Web. 24 June 2016.

charging stations (most with multiple charging ports) open to the public for use as of June 2016.[132]

Additional examples of EV Charging requirements for *new* land uses are summarized in Table 5.[133]

Table 5: City Policies Requiring EV Chargers for New Developments

Building or Land Use Type	Number/Percent of Spaces Pre-wired for EV charging	Number/Percent of Spaces required to install EV Charging	Local Jurisdiction
Commercial & Multifamily		10% must have EVSE	Fremont
Hotel	25% guest parking	10% must have L2 EVSE	City of Palo Alto
Non-residential	25% guest parking	5% must have L2 EVSE	City of Palo Alto
Commercial & Multifamily	10% of spaces prewired	3% installed EVSE	San Mateo
Multifamily		3% installed EVSE	City of Emeryville
Commercial & Multifamily	5% of spaces	2 spaces plus 1%	Menlo Park
All	Electrical capacity to charge 20% simultaneously; 10% of spaces pre-wired; 10% of spaces planned & conduit installed 80% are EV Capable		City of San Francisco
Multifamily	Electrical capacity to charge 20% simultaneously; 10% of spaces pre-wired; 90% are "EV Capable"		Oakland
Commercial	Electrical capacity to charge 20% simultaneously; 10% of spaces pre-wired; 10% are "EV Capable"		Oakland
Parking lots	20% of spaces		City of New York

[132] Plug-Share Map

[133] http://www.hcd.ca.gov/codes/calgreen/docs/CALGreen-Report-to-Legislature-2014.pdf
http://www.cbia.org/go/government-affairs/cbia-reports1/july-28-2014/standards-commission-adopts-ev-ready-mandate/
http://ladbs.org/LADBSWeb/LADBS_Forms/PlanCheck/2014/2014LAAmendmentforGreenBuildingCode.pdf
https://www.cityofpaloalto.org/civicax/filebank/documents/42607
http://www.cityofpaloalto.org/civicax/filebank/documents/43396
http://legistar.council.nyc.gov/View.ashx?M=F&ID=2742985&GUID=213BB9B6-B442-409E-876D-AED419DDC04B
http://www.greencarreports.com/news/1089035_nyc-law-to-make-20-percent-of-new-parking-spaces-electric-car-ready
http://www.cityofsanmateo.org/DocumentCenter/View/47766
http://www.ci.emeryville.ca.us/DocumentCenter/View/814
Personal Communication with Rafael Reyes, VP, Community Initiatives Prospect Silicon Valley, 408-409-5534, rafael.reyes@prospectsv.org via Sven Thesen, sventhesen@gmail.com

non-residential	10% of spaces		City of Cupertino
Non-residential	3% pre-wired if over 20 spaces		City of Berkeley
Office	3% of spaces if over 100 spaces		City of Sunnyvale
Commercial parking	1-3% of over 50 spaces		CALGreen 2014
Multifamily	25% guest parking + 1 per dwelling unit		City of Palo Alto
Multifamily	5% of all spaces		Los Angeles, Cupertino
Multifamily	3% of spaces if over 16 units		CALGreen 2014
Multifamily	12.5% of all spaces		City of Sunnyvale
Residential	10% (or 1 space if <10 spaces)		City of Berkeley
Residential	1 per dwelling unit		CALGreen 2014, Cupertino, Los Angeles, Palo Alto, Sunnyvale

For existing parking facilities, Norway (with both the highest per capita EV density at 5% and annual sales market share ~30%)[134] has recently implemented an ordinance requiring existing public for-pay garages (typically airports, downtown garages etc) to provide EVCI in 6% of the parking spaces by January 1, 2018.[135]

We recommend adoption of a mandatory EVCI policy for new developments similar to the policy proposed in San Francisco with the addition that chargers also be installed as part of the first 10% deployment; and consider policy goals for existing public parking garages similar to that of Norway.

B. City Charging Stations & Funding Programs

California metropolitan areas are already leaders in public and workplace charging deployment.[136] In particular, the Los Angeles and San Francisco areas, with over 2,700 and 1,500 public charge points respectively, have seen the installation of much more public charging than other cities. Similarly, the San Jose area with its many high-tech employers, show much greater workplace charger deployment than the rest of the state, with over

[134] December 2016 Data, https://en.wikipedia.org/wiki/Electric_car_use_by_country
Also see: ICCT, Global EV Capitols, http://www.theicct.org/sites/default/files/publications/Global-EV-Capitals_White-Paper_06032017_vF.pdf
[135] Email conversation with Leif Richard Bones Egge, of the European EVCI company Ensto & Sven Thesen; Original Norwegian: " § 35.Lademulighet
På parkeringsområdet skal det tilbys lademulighet for ladbar motorvogn på et tilstrekkelig antall parkeringsplasser, det vil si at det i alminnelighet til enhver tid er en ledig plass med lademulighet. Virksomheten har likevel ikke plikt til å tilby lademulighet på mer enn seks prosent av det totale antallet plasser. Trer i kraft 1.1 2018."
[136] ICCT, 2016.

1,400 charge points, based on data from the U.S. Department of Energy Workplace Charging Challenge program.

1. EVCI Siting Protocols

Many cities have struggled with the installation or "make ready" cost of installing EV chargers, particularly that of trenching electrical wires, upgrading transformers and/or panels and other siting barriers in addition to the cost (acquisition and operation) of the chargers themselves. When considering installing and operating EVCI, cities are encouraged to take a methodological, planned approach to:

- Minimize both EVCI capital and operating costs;
- Keep both EV and internal combustion engine (ICE) drivers satisfied.

To accomplish the above, cities are advised to conduct the following site specific EVCI planning and assessment protocol:

1) Identify potential sites and for each site, list all city owned or operated parking facilities, including their operating data (number of spaces, hours of operation, parking fees if any, populations served, etc.);
2) Establish goals for EVCI (by individual parking facility, including population served, charger levels, types and numbers);
3) Determine electrical capacity and cost to accommodate scenarios with 10 percent and 20 percent of the parking spaces;
4) Identify potential locations, taking into account spots for expansion, competition for "alpha" parking spots, and areas that require significant (and costly) trenching;
5) Estimate capital and operating costs, plus internal and external funding opportunities;
6) Review the above data and optimize EVCI locations and design.

Based on the above assessment, cities are encouraged to design installation programs that minimize costs. For example, the city of San Mateo, to reduce their EVCI costs, utilized decked parking structures to avoid trenching electrical conduits, while Menlo Park, due to electrical capacity and funding constraints, opted to install a simple bank of 110v outlets (which still meets the needs of the typical commuter by providing between 50 and 80 miles of range per 8-hour charge; see Figure 7). Finally, the Ready Set Charge California report has many tips and sample codes for municipalities to adopt to support EVCI.[137]

[137] http://www.rmi.org/Content/Files/Readysetcharge.pdf

Figure 7: Workplace Charging

These Level 1 chargers at a Menlo Park workplace provide more than enough energy for the typical commute. Photo by Blake Herrschaft

2. EVCI Funding and Financing

There are several major EVCI funding and financing opportunities that cities can utilize:

- The Bay Area Air Quality Management District (BAAQMD) *Charge!* 2017 program provides up to three quarters of the cost of public chargers with additional funding where EVCI is coupled with solar or if fast charging or multiple ports are offered.[138]
- The Pacific Gas & Electric (PG&E) EV Charge Network will cover all the make-ready costs and a 25% and 100% discount on the EVSE costs for 7,500 EV charging stations planned for apartments, condominium complexes, and workplaces over the next three years.[139] Any city, building owner or employer within PG&E's service territory, including Community Choice Aggregation and Direct Access customers, can sign up for EVCI installation.[140]

[138] http://www.baaqmd.gov/?sc_itemid=F026D4AC-FE69-4FBD-9232-187E17FC428D
[139] https://www.pge.com/en_US/residential/solar-and-vehicles/options/clean-vehicles/charging-stations/ev-charging-infrastructure-program.page
[140] https://www.pge.com/en_US/residential/solar-and-vehicles/options/clean-vehicles/charging-stations/interest-form.page

- DRIVE California's Alternative & Renewable Fuel & Vehicle Technology Program periodically provides grants for EV charging stations.[141]
- Volkswagen's diesel settlement and their Electrify America program also provides grants for EVCI.[142]
- Low Carbon Fuel Standard (LCFS) credit sales can be used by municipalities that own and operate their own utilities. For example, the City of Palo Alto's Utility uses a portion of their LCFS revenue to fund EVCI with an emphasis on the Palo Alto Unified School District, multi-unit dwellings and non-profits.[143]

In addition to the above, some cities have used public-private partnerships (typically advertising or power purchase agreement (PPA) financing) to help cover the costs and handle the logistics of EVCI installation. For example, the EV service provider (EVSP) Green Charge, offers EVSP bundled with energy storage or solar power at no upfront cost to cities through a shared cost savings of avoided peak power use (*see "Other Measures" below for more information*). Also, the EVSP Volta provides free/reduced cost EVCI in exchange for advertising.[144]

Another appealing option is BMW's new Light and Charge system that installs EV charging stations by replacing conventional streetlights at any location where suitable parking is available with the combined modular, efficient LED street lights that integrate EV chargers.[145] These avoid the high construction costs of stand-alone chargers by co-location with existing power access points. However, one pitfall to consider is whether this invites on-street parking that could cause potential conflicts with bike lanes.

We recommend that cities and counties utilize PAEC's EVCI site assessment protocol, immediately apply for those locations for potentially free EVCI from PG&E, and evaluate participating in the BAAQMD's Charge 2017 Program, particularly if there is simultaneous solar installation potential.

C. EV Adoption Incentives

California's Plug-in Electric Vehicle Collaborative has a database of incentives available for EVs and EVCI.[146] Cities and counties can support EVs not only by providing EVCI directly, but also by allowing EV parking to count towards or reduce minimum parking

[141] http://www.energy.ca.gov/drive/funding/
[142] https://www.electrifyamerica.com
[143]http://www.cityofpaloalto.org/gov/depts/utl/residents/sustainablehome/electric_vehicles/ev_chargers_for_organizations.asp
[144] http://voltacharging.com/home
[145] https://cleantechnica.com/2015/06/29/bmw-streetlight-ev-charging-unveiled/
[146] https://www.driveclean.ca.gov/pev/Incentives.php

requirements (e.g., Seattle-Tacoma, WA[147]) or by offering preferred and/or discounted parking. For example, the City of San Jose's Clean Air Vehicle Parking Program has a temporary incentive that allows free parking for qualifying vehicles at city owned garages, parks and the downtown core.[148] More recently, San José adopted a nominal pricing policy ($1.25 per session, plus a per kilowatt hour fee set to $0.25/kWh during the day and $0.20/kwh at night) at city-owned EV charging stations in order to maintain charging availability.[149] The pricing incentive discourages drivers from taking advantage of free parking or free charging and reserves availability for real EV charging demand.

Alternatively, parking enforcement can help support and maintain EVCI. For example, a 2011 California state law, AB 475, allows parking in designated EVSE parking spaces only by vehicles that are connected expressly for electric charging[150] Municipal enforcement of this law will not only support EVCI and EV uptake in the community but also can help fund effective education and outreach for community EV plans.

Note: PAEC cities should consult with San Mateo County as the EVCI parking rate recommendations are developed. This will ensure that parking enforcement staff are aware of and effectively supporting AB 475, and consider flexibility for mandatory minimum <u>additional</u> parking requirements for EVCI, plus provide low or no cost charging for nearby multi-unit dwelling residents.

D. Streamlining EVCI Permitting

Ease of permitting is an important factor supporting EVCI, including the following best practices:[151]

- **Comprehensive website content:** permitting information regarding EV installation can be hard to obtain. Clear and regionally consistent website information would make it easier for contractors and applicants to follow requirements. For example, San Diego posts a template produced by the United States Department of Energy, which serves as a tool that jurisdictions can adopt and implement. While more upfront coordination may be needed to implement this resource, it would save city staff time in the long run and ease the process for applicants.

[147] RMI, RSC, 2016, (see Ready, Set, Charge) www.ReadySetCharge.org
[148] RMI RSC, 2016
[149] http://www.sanjoseca.gov/index.aspx?NID=3800
[150] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120AB475&search_keywords=
[151] https://energycenter.org/sites/default/files/docs/nav/transportation/plug-in_sd/Plug-in%20SD%20Permitting%20and%20Inspection%20Report.pdf; http://www.pevcollaborative.org/sites/all/themes/pev/files/PEV_Permitting_120827.pdf

- **Permitting guide**: The cities of Chula Vista and Oceanside have model guides for permitting EV chargers.[152]
- **Specific and fillable permit application forms** (e.g., Chula Vista) - not all building departments have the resources to implement online permit platforms that support electronic submittals. However, providing fillable PDF applications and compliance documents (when applicable) on jurisdiction websites can decrease applicant wait times at the permit counter. Further, providing online PDFs that allow electronic signatures potentially can lead to alternate submittal processes, such as via email. Additionally, these fillable applications may assist with the internal tracking of application volume, as well as general tracking of EVSE installations in the jurisdiction.
- **Online permitting and inspection services** - Online permit services can optimize the permit application and plan review process by providing a digital method to submit applications, as well as capture and track reviewer comments and feedback. Reviewing commercial applications typically involves multiple reviewers from different divisions. Also, online permit platforms can offer plan review features that improve both internal and applicant communication on the status of reviews. The City of San Diego provides online permitting for residential EVSE through their SimplEPermit system that can be used by homeowners, property owners, and contractors. Rather than visiting the permitting desk, applicants can access online permitting 24 hours per day, seven days a week and pay fees online. Online permitting reduces backlogs at the permit counter and frees up time for counter staff to focus on more complex permit applications.
- **Permit fee incentives** - Jurisdictions can consider adopting a fee incentive or waiver for EVSE installations, as some have done for solar photovoltaic installations. The City of Encinitas provides an "energy efficiency permit fee waiver" for residential EVSE applications. This reduces installation costs for applicants, incentivizes permit pulling, and allows Encinitas to track EVSE installations.
- **Plan review and inspection corrections lists** - When building department staff – permit reviewers and inspectors use lists that identify common corrections and provide solutions to addressing these corrections, it greatly assists in expediting the plan check and inspection process. These tools have been developed as a resource by the *Plug-in SD* program. The Tri-Chapter Uniform Code Council representing building departments in the greater Bay Area has adopted uniform guidelines for both residential and commercial EVSE permits that provide guidance for the 55 jurisdictions in the South Bay region of the Bay Area.[153]
- **Follow the National Electric Code (NEC) Requirements -** Some jurisdictions, either out of concern to address perceived potential dangers from new technologies or for other reasons, have added installation and permitting requirements above

[152] http://www.ci.oceanside.ca.us/civicax/filebank/blobdload.aspx?blobid=30053
http://www.chulavistaca.gov/departments/development-services/building/build- green/permits#nrev.

[153] RMI RSC, 2016.

and beyond those required by the National Electrical Code (*see Figure 8*). While within their rights, these jurisdictions are adding both complexity and cost to the permitting and installation process. These additional requirements, if they must be included, should also contain sundown provisions to eventually eliminate the non-NEC requirements.

Figure 8: Additional Disconnect Switches Required by some EV Charger Codes

The above disconnect switches address a bank of six EV chargers. Disconnect switches are not required by the NEC; however, at least one municipal jurisdiction in the Bay Area requires their use in any non-residential EV charger installation. Each switch adds $300-$500 to the charger installation cost. Photo by Sven Thesen

Note: where PAEC cities have not yet adopted the above best practices for EVCI permitting, we recommend collaboration on a package of permitting policies similar to policies adopted in the San Diego region.

E. Additional Measures

Cities can also promote EV deployment through a host of other activities:

- **Setting an example with city-owned electric vehicles** - The Plug-in Electric Vehicle Handbook for Fleet Managers by the Department of Energy provides basic information about different vehicle options and charging infrastructure.[154]
- **City electric vehicle strategy** - Public agency administrations can shape and introduce public policy for local elected officials to adopt by requesting that public

[154] https://www.opr.ca.gov/s_zero-emissionvehicles.php

fleets to be powered by electricity and other alternative fuels. For example, the City of Berkeley worked with Bay Area Rapid Transit (BART) to plan for EV readiness by providing electric charging infrastructure at new and existing stations.[155] The City of Palo Alto has an "EV first" policy where the default fleet replacement vehicle is an EV.[156]

- **Informational website** - Cities and agencies can provide resources and information for the public and for policy makers such as the resource centers maintained by BAAQMD, the Governor's Office of Planning and Research, and California's Plug-in Electric Vehicle Collaborative.[157]
- **Outreach events and Education** - The Plug-in Electric Vehicle Collaborative has an excellent model public education and outreach plan.[158] The CEC, MTC and others all have funded various EV Education and Outreach programs. Likewise the non-profit, Plug In America has and continues to organize National Drive Electric Week in PAEC cities. The 2016 event held in San Mateo included 37+ electric vehicles representing over 600,000 electric miles.

Figure 9: Participants at the 2016 San Mateo National Drive Electric Week event

Photo by Dave Atherton

Note: we recommend that PAEC cities work collaboratively with San Mateo County, BAAQMD and other regional agencies, plus Plug-in America and other non-profits to adopt and promote strategies and policies that accelerate EV adoption.

[155] RMI RSC, 2016
[156] http://www.cityofpaloalto.org/civicax/filebank/documents/56652
[157] http://www.baaqmd.gov/plans-and-climate/bay-area-pev-program/ev-resource-center
https://www.opr.ca.gov/docs/ZEV_Guidebook.pdf
http://www.pevcollaborative.org/resources
[158] http://www.pevcollaborative.org/sites/all/themes/pev/files/2016_AR_web.pdf

VII. Additional Clean Energy Measures

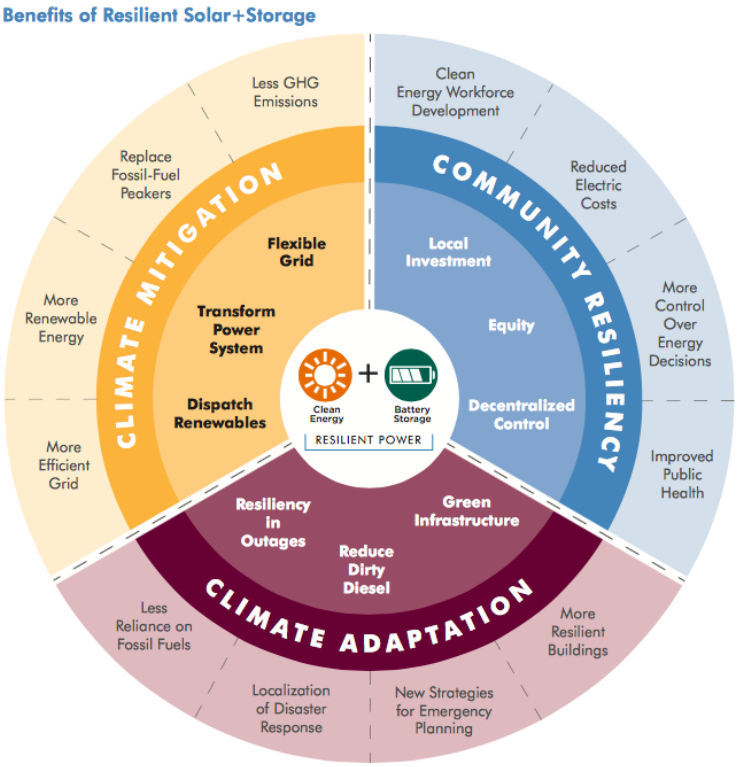
Many additional measures could play a key role in a model AEC, yet there is little existing city policy on these measures. Instead, the following brief review highlights some projects and flags the additional measures as worthy of more research.

A. Solar Emergency Microgrids

This item will be fully covered in Task 5 of the PAEC initiative.

B. Energy Storage

Figure 10: Resilient Solar + Storage



Source: Kresge Foundation

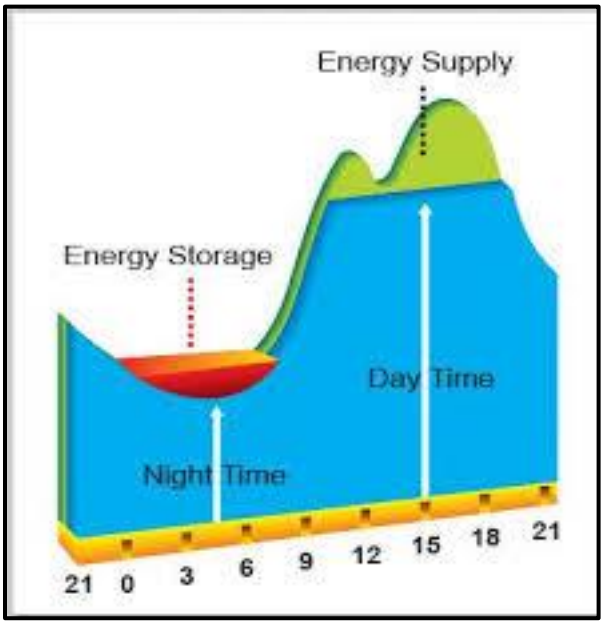
Energy storage is a key clean energy strategy to help meet renewable and ZNE goals and improve community resilience. Though California has an energy storage law (Assembly Bill 2514) that requires utilities to "determine appropriate targets to procure viable and cost-effective energy storage systems," cities can ramp up energy storage capacity even more.[159] A recent report funded by the Kresge Foundation, coined the term resilient power (RP), which is the application of solar and storage technologies in affordable housing and community facilities. [160]

The City of Lancaster has partnered with Green Charge Networks to install an energy storage system and electric vehicle charging station at the Lancaster Museum of Art and History.[161] The project is funded by a grant from the California Energy Commission and is estimated to cut

[159] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100AB2514
[160] http://kresge.org/sites/default/files/library/ceg_capital_scan_public_feb2017.pdf
[161] https://energycenter.org/case-study-lancasters-zne-goal

demand charges by $3,200 in the first year. Under the agreement, Green Charge Networks will own, operate, and maintain the system at no cost to the city.

Figure 11: Energy Storage and Peak Shaving



Redwood City recently partnered with Green Charge Networks to bundle energy storage and EV charging.[162] Installed in 2014, Redwood City has five electric vehicle charging station locations combined with energy storage, including two DC Fast Charging stations, installed at the Redwood Shores library and at the City's downtown parking garage. Green Charge Networks' intelligent energy storage is shaving multiple peaks per day (80 in May 2015; *see the diagram to the left for a visual of energy storage and peak shaving*) caused by the EV charging stations. The energy storage is expected to save nearly $7,000 annually in demand charges at the five Redwood City locations. The Redwood City energy storage equipment and installation came at no cost to the city, due to a shared savings agreement on avoided demand charges. Green Charge Networks has other projects that also bundle solar installations with the energy storage and/or EV charging.

Sunrun offers *BrightBox*™, which pairs solar energy generation (PV panels) with a home battery storage service for little to no money down through a monthly or prepaid lease (e.g., PPA). [163] Sunrun maintains, monitors, and insures the system for 20 years. The *BrightBox*™ can optimize when a home uses electricity generated directly from the home's solar system, stored in the battery, or sourced from the grid, and allows homeowners the capability to time shift when they use solar energy in order to minimize paying peak rate energy prices. Another company, Enphase, also offers battery energy storage coupled with solar.[164]

Cities can also get creative with incentives for energy storage or requirements for large new developments that could benefit from reduced demand charges. For example, utilities

[162] http://www.greencharge.net/green-charge-networks-and-chargepoint-partner-to-combine-intelligent-energy-storage-and-ev-charging/; http://greencharge.net/wp-content/uploads/2016/07/CS_RedwoodCity_1026_D.pdf
[163] https://www.sunrun.com/why-sunrun/about/news/press-releases/sunrun-launches-sunrun-brightbox™-solar-plus-energy-storage
[164] https://enphase.com/en-us/products-and-services/storage

in California have offered incentives for thermal energy storage, such as ice banks to offset energy use during peaks.[165]

We recommend resilient power (RP) development as a high priority for cities and counties.

C. Carbon Pricing and Fees

Carbon pricing and fees can aid in fuel switching, energy conservation, and GHG reductions. Palo Alto's recent "Carbon Neutral Natural Gas Plan" achieves carbon neutrality for the gas supply portfolio by: 1) purchasing high-quality environmental offsets equivalent to city and community natural gas emissions (~25% of carbon footprint), 2) pursuing efficiency strategies to reduce natural gas use, and 3) seeking opportunities to fund local offsets as a way to fund actual emissions reductions in Palo Alto and the surrounding region.[166] The fees can also fund local climate mitigations and may result in customers curbing natural gas use somewhat. The maximum rate impact is $0.1/therm, but the offsets will cost only $0.04/therm. The city will be evaluating proposals for how to reduce the reliance on offsets to achieve carbon neutrality, including reducing natural gas use, electrification, and the use of local mitigations.[167]

D. Carbon Zero

Architecture 2030, USGBC, and International GBCs have recently adopted zero carbon goals. In San Mateo County, where the grid is headed to zero carbon through PCE, the focus should be on carbon reductions more specifically rather than energy reductions more generally. Carbon Zero buildings without fossil fuel service can be achieved with existing technology and numerous buildings have been certified by the Living Building Institute.

In addition, retrofit projects to decarbonize buildings could be successful by tightening the thermal envelope, using ventilation heat recovery, replacing gas fired heating with heat pump technology (air, water or ground heat source), replacing water heating and pool heating with heat pump water heaters, replacing gas cooking with combinations of electric induction, and resistance and minimal bottled fuel (renewable alcohol or hydrogen, etc.). Electric needs may be met with any combination of on-site or grid-imported renewable electricity on an annual basis. The recent Net Zero Energy retrofit of the LinkedIn office building in Sunnyvale successfully avoided the use of natural gas and fossil fuels.

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[165] http://www.calmac.com/stuff/contentmgr/files/0/83be8115335d6976d7ddf97f4c06d28f/pdf/californias_permanent_load_shifting_program.pdf

[166] http://www.cityofpaloalto.org/gov/depts/utl/residents/sustainablehome/paloaltogreen_gas/paloaltogreen_gas_residential_.asp

[167] At current rates, 10 ₵/therm would add about $1.80 to the median residential customer's monthly bill during summer and $5.40 during winter, or about $43 per year.

Further, several cities are aiming to electrify all fossil fuel uses in an effort to reach zero carbon.[168] Palo Alto has been actively exploring the feasibility and cost-effectiveness of fuel switching or phasing out fossil fuels in buildings for many years. The city's current analysis shows some scenarios when electric heat pumps replacement of natural gas heaters is cost-effective; other scenarios are not cost-effective.[169] Variables such as natural gas costs can change the outcome dramatically.

The City of Boulder recently introduced an electrification approach that encompasses all fossil fuels and provides innovative financing. An estimated $279 million is spent on fossil fuels each year in Boulder and that money could be put to better use. Boulder's Whole Home Energy Transition Program bundles EE, RE, EVs and appliance replacement. The City uses specialized software to identify homes with potential for the voluntary program, provides customized estimates for homeowners, and assists with financing and project coordination.

E. Zero Carbon Thermal Grids

A district approach to thermal energy could provide a zero carbon solution for institutions and campuses. Stanford Energy Systems Innovations (SESI) provides real time thermal energy recovery and storage for heating and cooling by running hot and cold water loops from centralized water tank thermal storage to serve over 400 buildings across campus.[170]

District heating has also been done successfully in Hammarby-Sjostad in Stockholm, formerly a run-down, underused industrial district, which is now a thriving "eco-village". Hammarby-Sjostad's 25,000 residents benefit from a transportation system that generates 30 to 40 percent less carbon dioxide per household than a comparable district nearby, primarily because of 40 percent fewer trips by private car. It also has a wastewater-treatment system, the hot water from which is used in the local district's heating system, and substantially lower energy costs (by 32 to 39 percent).[171]

F. Mitigation of Urban Heat Islands [172]

The clustering of un-vegetated, impermeable surfaces in cities leads to the urban heat island effect. Roofs, parking lots, and streets absorb more heat than would be absorbed by moist, shaded surfaces. The annual mean air temperature of a city with at least one million people can be 1.8 to 5.4°F warmer than surrounding rural areas. Urban heat islands also

[168] Efforts in Boulder, CO, Palo Alto, and San Francisco were presented at the January 2017 RICAPS meeting; http://www.smcenergywatch.com/countywide-climate-action/support-for-cities
[169] Palo Alto's latest electrification study can be found here: http://www.cityofpaloalto.org/civicax/filebank/documents/55069
[170] https://sustainable.stanford.edu/campus-action/stanford-energy-system-innovations-sesi
[171] http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/building-the-cities-of-the-future-with-green-districts
http://www.districtenergy.org/assets/pdfs/2015-Canada-EvolvingEnergy/Plenaries/Plenary1-Sweden.pdf
[172] http://californiaseec.org/wp-content/uploads/2016/09/ACEEE-City-EE-Scorecard-2015.pd

increase the demand for electric cooling and the related energy use. To minimize this effect, cities are establishing urban heat island reduction related goals and implementing a variety of programs and policies, including incentives for cool surfaces like reflective roofs and adopting tree-planting ordinances. More tree-canopy cover, green roofs, and ground surfaces can reduce energy requirements for building heating and cooling, improve stormwater management, and reduce energy use at some wastewater treatment plants. Cool roofs reduce a roof's heat absorption. This reduces a building's energy use and a city's peak energy demand. Cool pavement, porous and reflective, also helps to mitigate heat islands. Porous pavements absorb and filter storm water and reflective pavements keep the ambient temperature cooler by simply reflecting incoming radiant heat.

G. Innovations through CCAs[173]

CCAs can foster innovation in several different ways. By law, they have decision-making authority over the sources of energy for electricity generation (abiding by and within the requirements of the state's Renewable Portfolio Standard and general law); and they also have the authority to set their own rates. This authority allows CCAs to increase the percentage of renewables in their power portfolios all the way to 100%, providing substantial GHG reductions. CCAs also can choose to support local and regional development of renewable resources, thereby generating local jobs and economic benefits.

Further, the rate-setting authority of public CCAs allows for incentivizing efficiency improvements and a transition away from fossil fuels through special rates (e.g., EV rates and discount rates for heat pumps). CCAs can accumulate substantial surplus revenue (none of which needs go to shareholders), which can be used to invest in local renewables, energy storage, community resiliency projects, increasing EV fleet deployment, replacing fossil fuel appliances and heating, deep energy retrofits, greater energy assistance for low-income households and small businesses, and local economic development.

CCAs are uniquely positioned to:

- Issue revenue bonds to finance renewable energy, energy storage capacity, and similar projects;
- Develop innovative programs tailored to specific local energy loads (e.g., flattening the duck curve, reducing peak demand, and improving demand response);
- Advance progress on local Climate Action Plans with programs that reduce GHGs, such as facilitating a transition away from non-renewable fuel sources or spurring the use of electric vehicles;
- Help raise public awareness around the issues of climate change and its threat to the biosphere, through coordinated and widespread public education campaigns;

[173] NBCEF Forum White Paper on Audacious Ideas to reach zero carbon: http://climateprotection.org/wp-content/uploads/2017/01/NBCEForumWhitePaper_V7_2016-1220_MASTER.pdf

- Provide special assistance to low income communities above and beyond current programs;
- Offer incentives to encourage energy conservation or to buy down the cost of a clean energy technology;
- Aggregate customers and/or projects and/or purchasing to achieve scale that enables projects, programs, or purchases that might otherwise not be feasible;
- Be more responsive to customer input through a public process where decision-making is done by local government accountable to its constituents;
- Take custody of public benefit funds collected by the CPUC for use in administering energy efficiency programs;
- Apply for grant funding available to governmental agencies;
- Collaborate with other agencies to explore new energy related technologies that serve the goal of GHG reduction such as biogas electricity generation from agricultural and food waste products;
- Support relevant water, transportation, waste management, or other sector activity that involves energy/community benefit.

The PAEC Initiative has a unique opportunity to work with PCE, San Mateo County's newly launched CCA (*discussed above in the RE section*). The following items are examples of potential projects with PCE.

1. Fuel Switching in Buildings

PCE adopted a goal to provide carbon free power by 2021, which makes fuel switching and electrification a very effective strategy to reduce GHG emissions. While highly efficient electric technology is already available for space and water heating, state policy barring rate-payer support for fuel-switching strategies for incentive programs has been a barrier to widespread adoption of these technologies. PCE could provide beneficial rates for building electrification, technical assistance, and incentives or rebates:

- PCE could offer incentive packages for replacing water and space-heating equipment fueled by natural gas, propane, and even resistance electric elements with electric heat pump technology. Electrifying building space conditioning, water heating, and other fossil-fuel appliances eliminates direct GHG emissions and creates new demand for clean electricity generation. CPUC regulations and their status as natural gas providers limit the ability of most Investor Owned Utilities to pursue fuel-switching strategies; however, community choice utility interests are aligned with fuel-switching benefits.
- Use of new high-efficiency standard electric water heaters is widespread. As the energy system evolves to a distributed model, thermal storage technology will provide options for stabilizing the local grid and increasing overall efficiency. PCE can conduct a pilot program to determine the effectiveness of water heaters as a capacity resource in a comprehensive local demand response system. The new

"Advanced Water Heater Standard" as well as other high-efficiency thermal storage devices for the home may be promising candidates for local pilot projects.

- Modern heat pump heat-recovery-ventilation (HRV) technology is in use in many commercial and public buildings. Advances in HRV technology can deliver multiple benefits for commercial and public buildings. Working with local property owners and industry experts, PCE could conduct pilot programs to identify new HRV technologies showing promise for larger buildings. This may require in-house technical expertise to guide program development.
- On-bill financing through PCE, such as the PAYS system (discussed above in the EE section) would be needed to support fuel switching because the upfront costs can be high, even though lifecycle costs are significantly lower.

2. Equal Access to Clean Energy Value

PCE can foster an equitable and sustainable local economy that serves all residents, through public-private partnerships, local renewables, energy storage, and microgrid development to provide energy stability, local investment, and job creation.

3. "Pay-for-Performance" or Metered Negawatt Market

Using the CPUC's open-source, open-data, open standard CalTrack engine, known as the Open Energy Efficiency Meter, PCE can develop a local trial "pay-for-performance" program for metered energy efficiency in residential and commercial properties.[174] In such a program, PCE could purchase affordable grid capacity and GHG reductions from local third party providers using existing Smart Meters. Offering incentivized performance contracts with third parties to achieve energy efficiency holds some promise that should be explored. Moving to "pay-for-performance" would not only reward deep energy retrofits, but also lower rates and provide benefits in avoided transmission and distribution costs. The metered efficiency "pay-for-performance" process would allow PCE to focus on investments that deliver both environmental and economic benefits for its customers.

4. Community Partnerships, Outreach and Leveraging Local Control

Local partnerships with community groups and other stakeholders can help create the political will for progressive and enabling policies that boost emerging opportunities such as microgrids and distributed energy resources. Local government partners can also support policies that foster the adoption of deep energy efficiency, microgrids, and local renewable energy generation. Further, as the main point of contact for county energy users,

[174] The Open Energy Efficiency Meter creates a standard weights and measures for energy efficiency that is reliable for both markets and grid operators. In simple terms, this means that using the meter, private companies, utilities, and regulators will all calculate the same level of savings for a given set of building efficiency projects. www/openeemeter.org

PCE can reach out to and educate its customers on an ongoing basis about renewable and energy efficiency audit services provided by other agencies to help homeowners plan energy efficiency and solar projects:

- PCE could work with community stakeholders to implement distributed energy resources and microgrids. Distributed energy resources and microgrid technologies are locally deployed strategies that require participation and coordination among community, business, and government partners. PCE has an opportunity to commit to and invest early in the disruptive transition to local generation, electrification, and cost control through proactive efficiency. These local projects are an opportunity to engage the community and stakeholders in defining and achieving the long-term environmental and economic goal. An ongoing, open dialogue with community stakeholders and integration of new opportunities can accelerate a transition to a clean energy economy.
- Analyzing local peak demand characteristics can inform policy and program development. Using building assessment and utility bill data, PCE is positioned to respond to local opportunities such as replacing natural gas furnaces with electric heat pumps that can provide both heating and cooling or strategically investing in EV charging infrastructure in an environment of fast-changing technological and industry advances.
- Maximizing local renewable energy will require a combination of smart technology to monitor and interact with local generation and efficiency resources and significant investment in generation, storage, and efficiency capacity. As a load serving entity, PCE is poised to lead locally driven grid coordination in order to capture economies of scale, reduce cost for its customers, and maximize GHG reductions. Local management of distributed energy offers opportunities that support the local economy through affordable energy rates, infrastructure investment, and project jobs. PCE can lead a shift from off-site to on-site power and increase the resilience of the local grid to serve community needs, like emergency response during natural disasters, public health and safety issues associated with changing temperatures, climate mitigation, and equitable access to clean power.

5. Advanced Grid Management

PCE could play a key role by supporting PG&E's efforts in advanced grid management aimed at maximizing clean local renewable energy. This would include incentives and technical assistance to customers to avoid peak loads when the grid needs "dispatchable" resources (e.g., in the evening at the "duck head"). Various strategies for grid friendliness may include: tight thermal management with insulation, heat recovery ventilation, thermal energy storage, demand response (loads that can be interrupted or discouraged and stored or timed), demand flexibility, battery storage, smart charging of EVs (timed or responsive

to grid signals), and timed or smart electric heat pump water heating with storage.[175] PCE could explore grid interactive devices and promote Ohm connect, which can interact with water heaters.[176] Further, electrification projects such as heat pump water heaters and furnaces could be financed through savings achieved by demand response and smart grid management programs.[177]

6. San Mateo County as a Renewable Energy Exporter

PCE could help San Mateo County become a net exporter of clean renewable energy from solar, wind, and other sources. PCE could set an aggressive community goal to deploy maximum efficiency and renewable energy resources that directly contribute to a reversal of climate change impacts. San Mateo County has ample potential solar and other renewable resources, which would allow it to become a net energy exporter when the resources are fully utilized locally.

7. Accelerating EV Deployment

The ICCT recently released a report about power utility best practices supporting EVs.[178] In California, several CCAs as well as municipal power providers have taken the lead with innovative programs.

Sonoma Clean Power (SCP) actively has promoted EVs through *Drive EverGreen*, which allows SCP customers to purchase or lease a new electric vehicle for $10,000 off the manufacturer's suggested retail price.[179] Further, SCP has partnered with the EVSP, eMotorWerks to provide up to 1,000 free smart charging units to SCP customers in 2017 while program funds last. Participants can also receive $250 for joining SCP's smart-grid charging rewards program.[180]

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[175] California Independent System Operator (CAISO), What the duck curve tells us about managing a green grid, 2016, https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf
https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf
Also see RMI, The Economics of Demand Flexibility, 2015. https://www.rmi.org/wp-content/uploads/2017/03/RMI-TheEconomicsofDemandFlexibilityFullReport.pdf

[176] See for example: https://www.ohmconnect.com; http://villagepower.com

[177] In particular, water-heater swaps might be more easily financed if they can be used as a grid load management resource. See for example:
https://www.greentechmedia.com/articles/read/report-smart-water-heaters-could-pay-back-200-per-year-in-grid-services
http://www.sciencedirect.com/science/article/pii/S030626191730096X

[178] http://www.theicct.org/literature-review-power-utility-best-practices-regarding-EVs

[179] http://sonomacleanpower.org/drive-electric/; http://sonomacleanpower.org/sonoma-clean-power-enters-world-electric-vehicles-new-incentives/

[180] http://sonomacleanpower.org/emotorwerks-deliver-1000-free-electric-vehicle-smart-charging-stations-sonoma-clean-power-customers/
https://sonomacleanpower.org/drive-evergreen-get-connected/

Marin Clean Energy (MCE), in collaboration with eMotorWerks, has recently launched the SmartCharge pilot program that adapts the timing for EV charging to help relieve grid congestion and maximize renewable energy capacity in California. SmartCharge participants are eligible for up to $150 worth of rewards that may be redeemed in cash or applied towards the purchase of EVSE equipment.[181]

The City of Palo Alto's utility has proposed to use their LCFS revenue as indicated in Table 6.[182] Although these funds are only available to municipal power providers, the programs serves as an example of how EVCI funding could be allocated to customers.

Table 6: City of Palo Alto LCFS Revenue Allocation for EV Programs

LCFS Program Area	Funds Expended Annually
Rebate of up to $3,000 for the installation of EVSE at non-single family residential buildings and parking areas. To ensure that funds are dispersed over many locations, a limit of 3 EVSEs per location is recommended for non-public locations. Similarly, allocation to all Palo Alto Unified School District (PAUSD) locations is recommended to be limited to $30,000 per fiscal year for EVSE installations.	$225,000 to $375,000
Discount the Utilities Connection fee related to the installation of EVSE in single family and multi-family residential applications for up to $3,000	$30,000 to $60,000
Discount off-peak electricity rate of residential customers with registered EVs who elect to be on the time-of-use electricity rate.	$40,000 to $150,000
Rebate of $300 for EV owners who provide CPAU access to information related to their EV charging patterns.	<$30,000
Fund programs designed to lower the cost of electric utility services for EV charging or to enable EVs owner to modulate charging patterns to lower their charging cost. Support pilot-scale City, Utility, and Community programs to expedite EVSE installation and EV adoption.	$50,000
Fund educational and outreach activities to facilitate early adoption of EVs at $20,000/year, $20,000/year to fund related staffing needs, and additional direct $40,000/year for marketing cost to promote EVSE installations in multi-family homes.	$80,000

This is an area where PCE could further innovate by enhancing outreach to customers, supporting community car-shares with EVs, and further incentivizing EV use.

[181] https://www.mcecleanenergy.org/smartcharge/
[182] http://www.cityofpaloalto.org/civicax/filebank/documents/53781

VIII. Summary

Numerous municipalities have implemented novel advanced energy programs including ordinances, zoning regulations, permitting practices, incentives, policies, fees, financing, and special programs. Several standout programs that could be woven together to form an AEC include:

- Solar carports on public parking lots through an RFP bidding process;
- 100% Renewable Energy for new buildings through zoning regulations;
- ZNE retrofits for existing buildings through "EnergieSprong";
- "PAYS" On-bill financing for renewable energy and efficiency retrofits;
- Deep energy retrofit programs with technical assistance for existing multi-family housing;
- Combined solar, energy storage, and EV Charging financed through a third party at no cost (through shared peak energy demand charge savings);
- Whole Home Electrification with technical and financing support provided by local government;
- Climate Impact Fees that are reimbursed for ZNE new developments;
- Comprehensive programs to boost EV charging infrastructure through vendors that can cover the costs, streamlined permitting for private EV chargers, and collaborations with multi-family building owners and employers to access free, or nearly free, PG&E chargers;
- 100% EV capable parking infrastructure for new developments; and
- Innovations accelerating deployment of renewable energy and EVs through Community Choice Energy agencies.

All of the energy measures identified in this report will provide significant benefits to cities throughout San Mateo County. The highest priority energy measures in the PAEC region will focus on decarbonizing and fuel switching. Finally, these best practice measures not only save a significant amount of energy usage and consumption, but have the potential to transform communities into resilient, economical and environmentally sound AECs of the future.