Mandatory Solar in New Home Construction

Case Study

CITY OF Fremont

Presentation Overview

1. BACKGROUND ON FREMONT

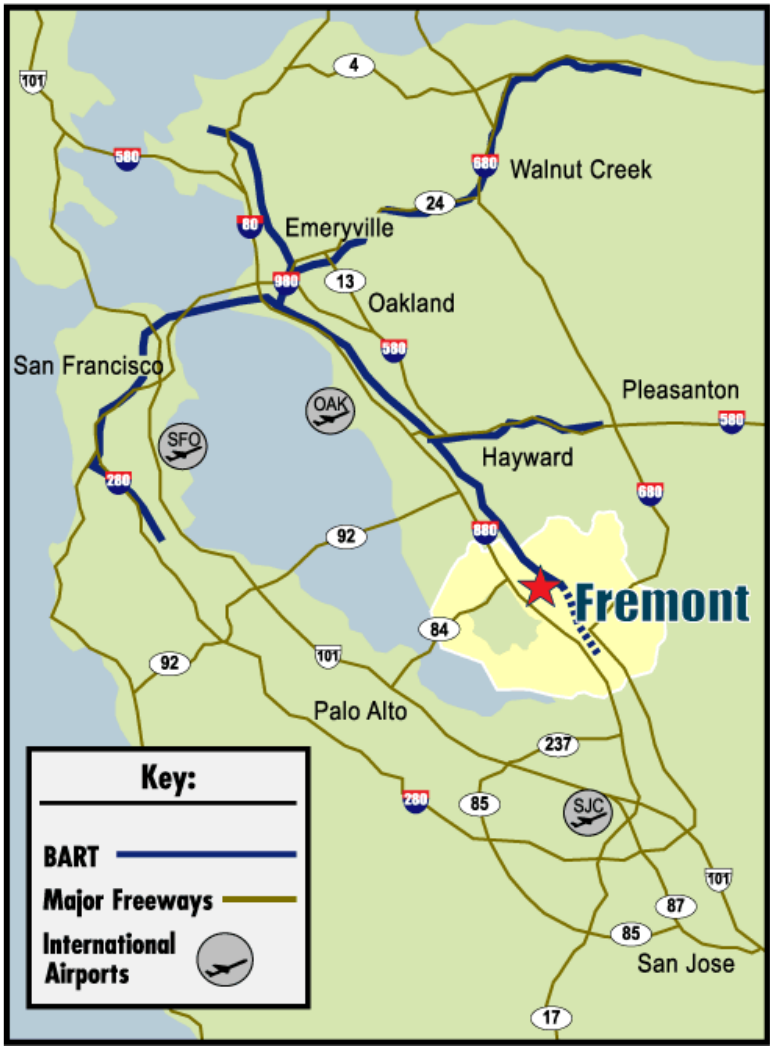
2. THE CASE FOR RESIDENTIAL SOLAR

3. ADOPTION PROCESS

Background on Fremont Sustainability Efforts

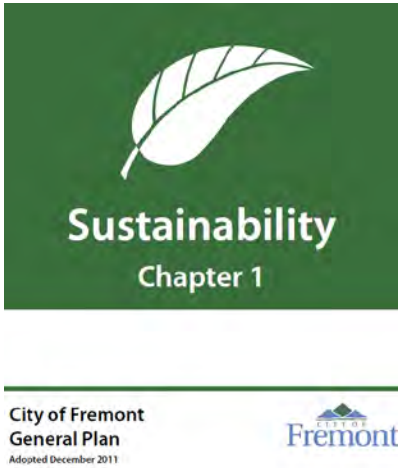
About Fremont, CA

- Located in Alameda County
- Incorporated in 1956
- From historic farmland → suburban sprawl
- Current population of 232,206
- 4th largest City in Bay Area
- 92 sq. mi.
- “Silicon Valley East”

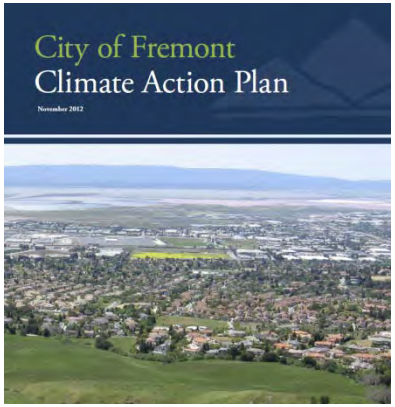


Fremont's Sustainability Vision

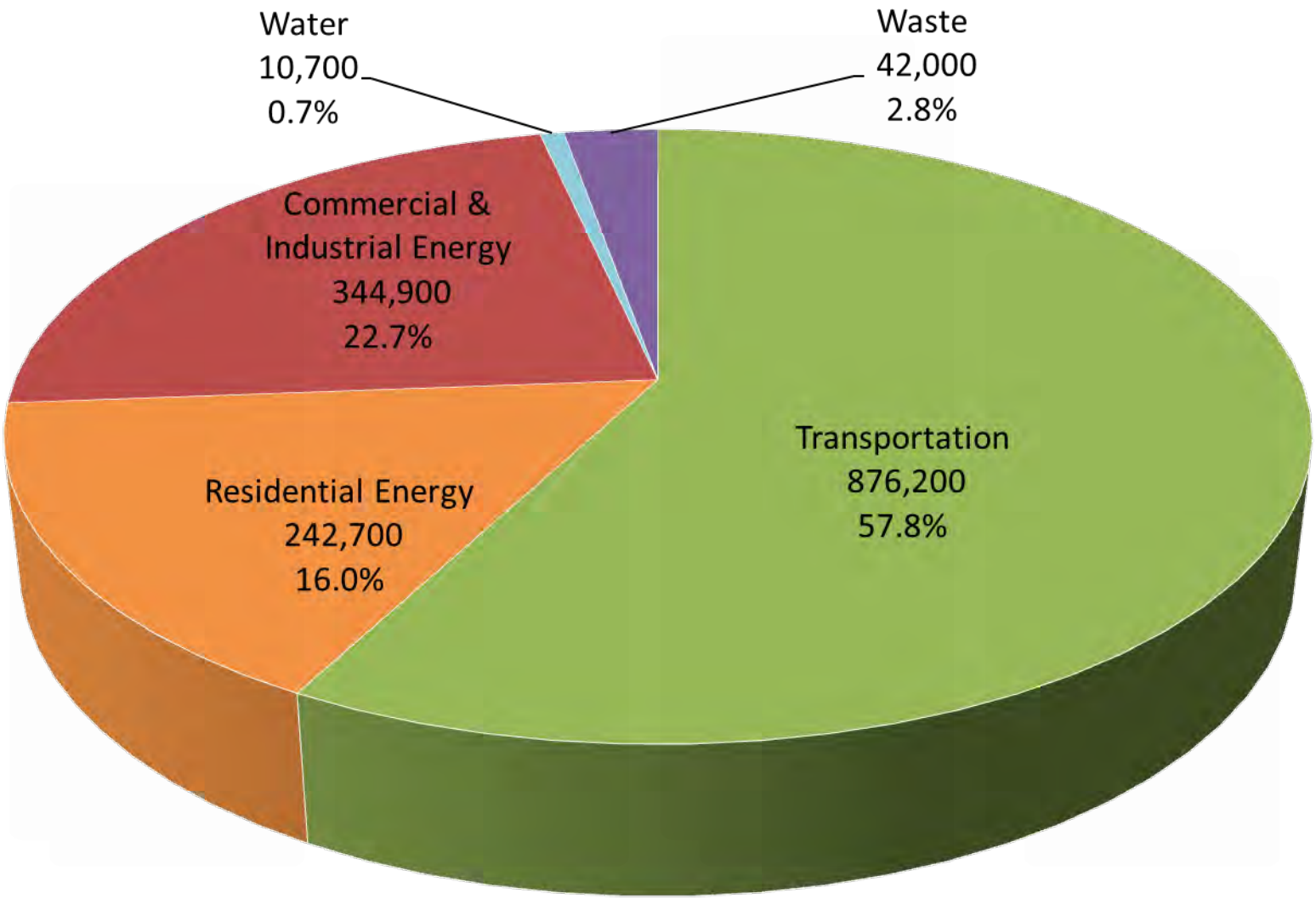
- General Plan (December 2011)
  - *Sustainability Element* as 1st Chapter
  - Fremont to "serve as a national model of how an auto-oriented suburb can evolve into a sustainable, strategically urban, modern city."



- Climate Action Plan (November 2012)
  - Roadmap for reducing the City's GHG emissions 25% by 2020 from a 2005 baseline.



Fremont's GHG Emissions by Sector ($MTCO_2e$)



GHG Emissions by Household

Household Comparison

- A Fremont home emits an average of 3.65 $MTCO_2e$ every year.

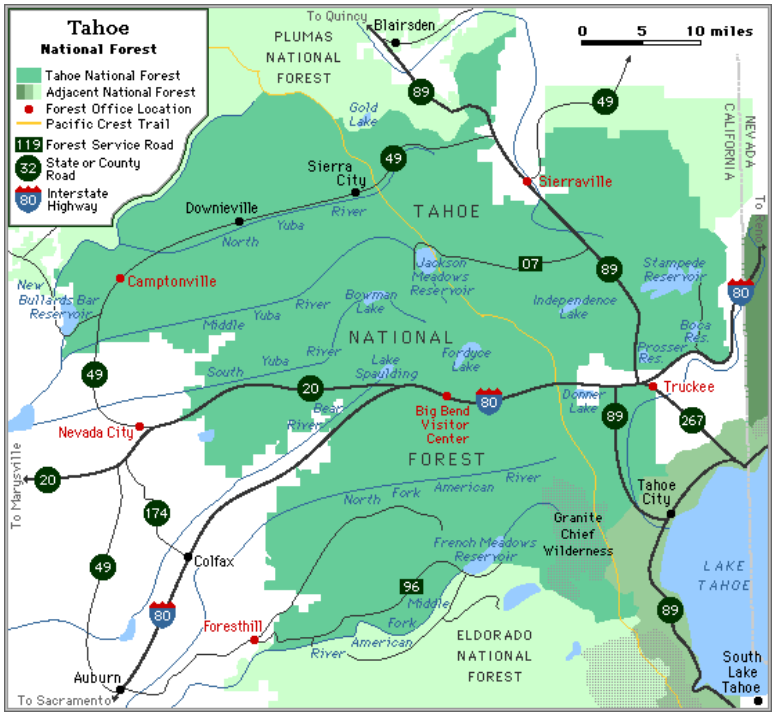
Vehicle Comparison

- Over 1 year, a standard passenger vehicle emits 4.75 $MTCO_2e$.

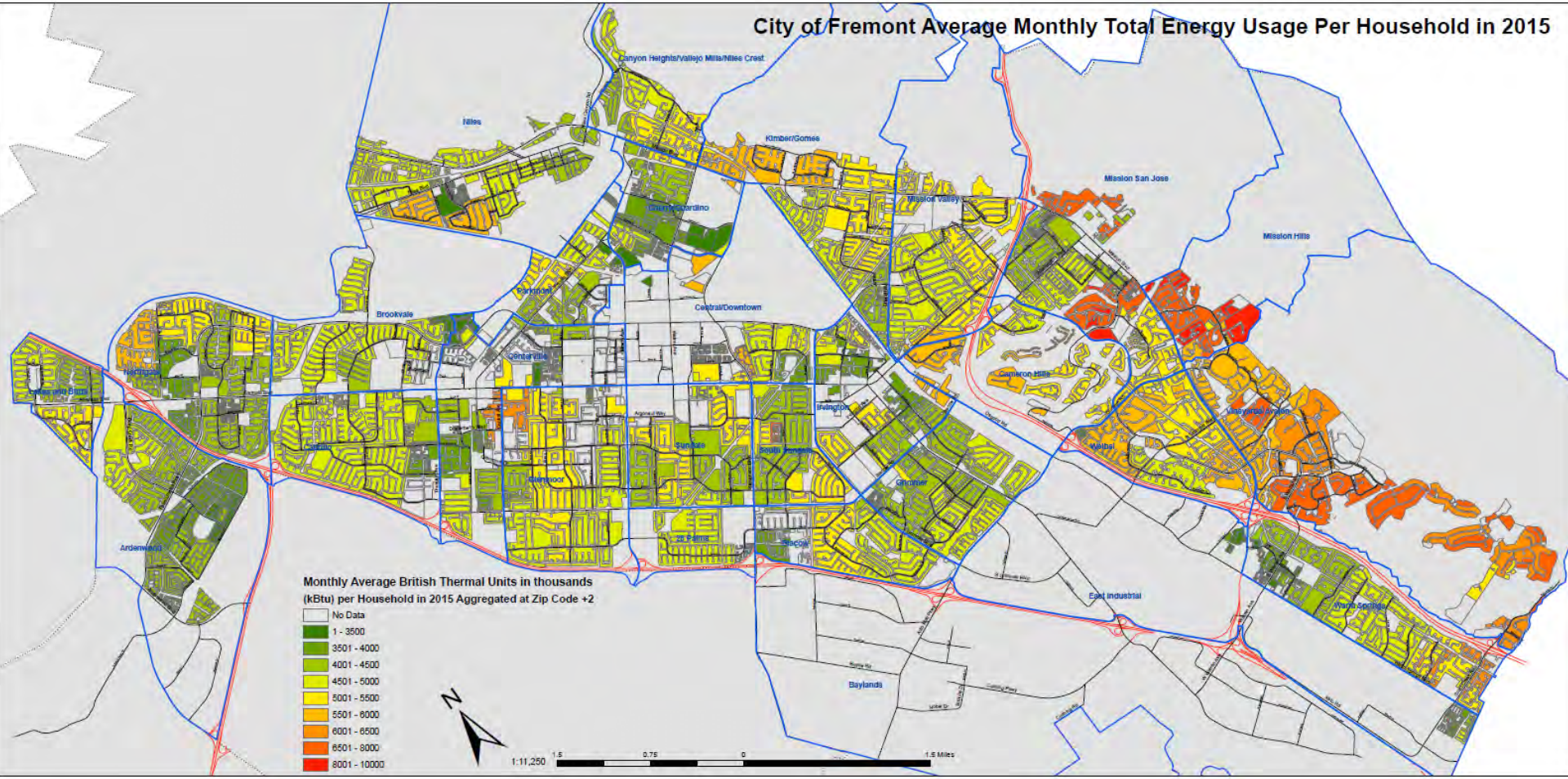
GHG Equivalency

- It would take over 1,000 mi^2 of forest to sequester the total CO_2 emitted by Fremont's households & passenger vehicles.

  ~2/3 Tahoe National Forest



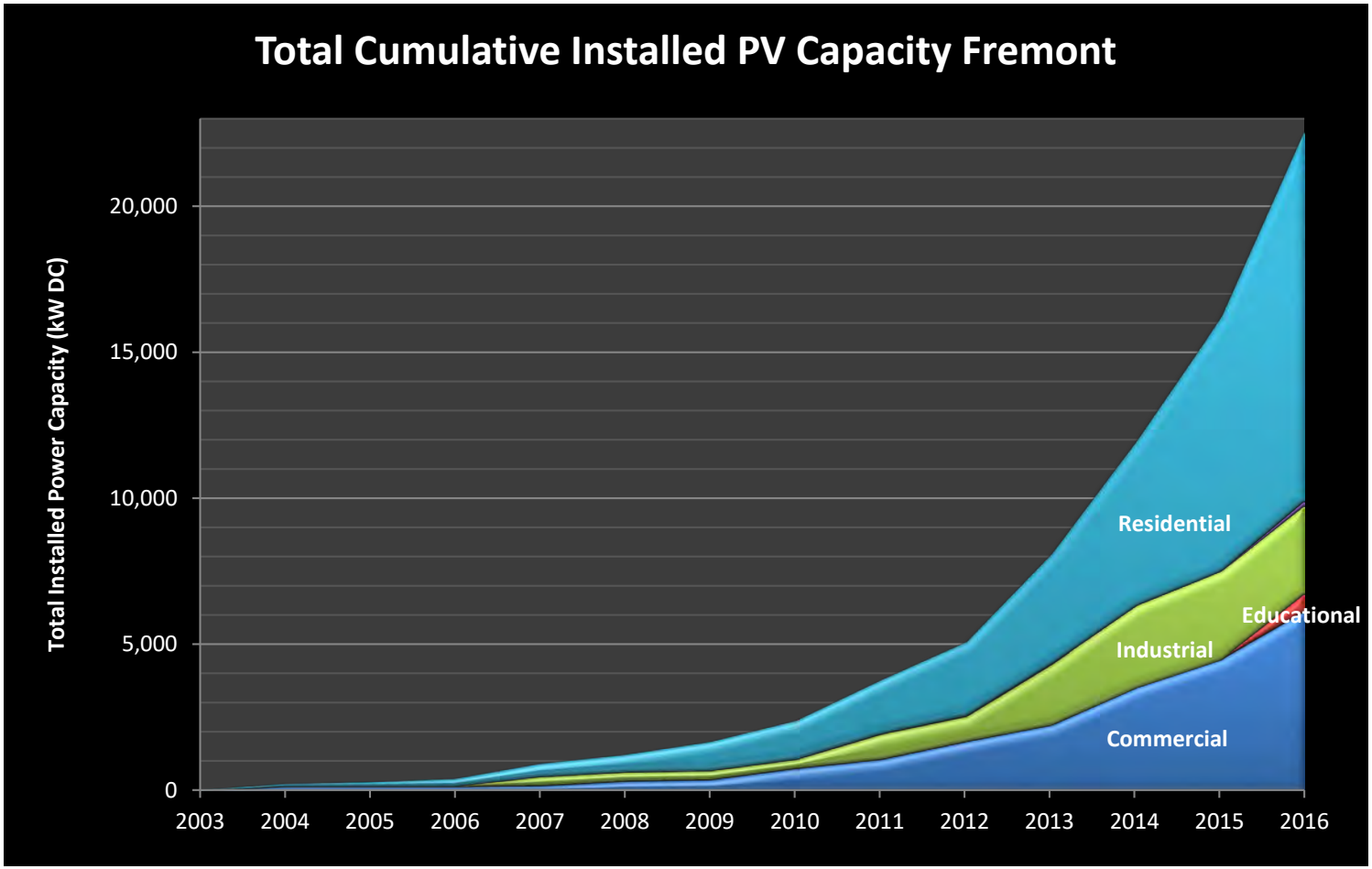
Average Household Energy Usage by Fremont Neighborhood



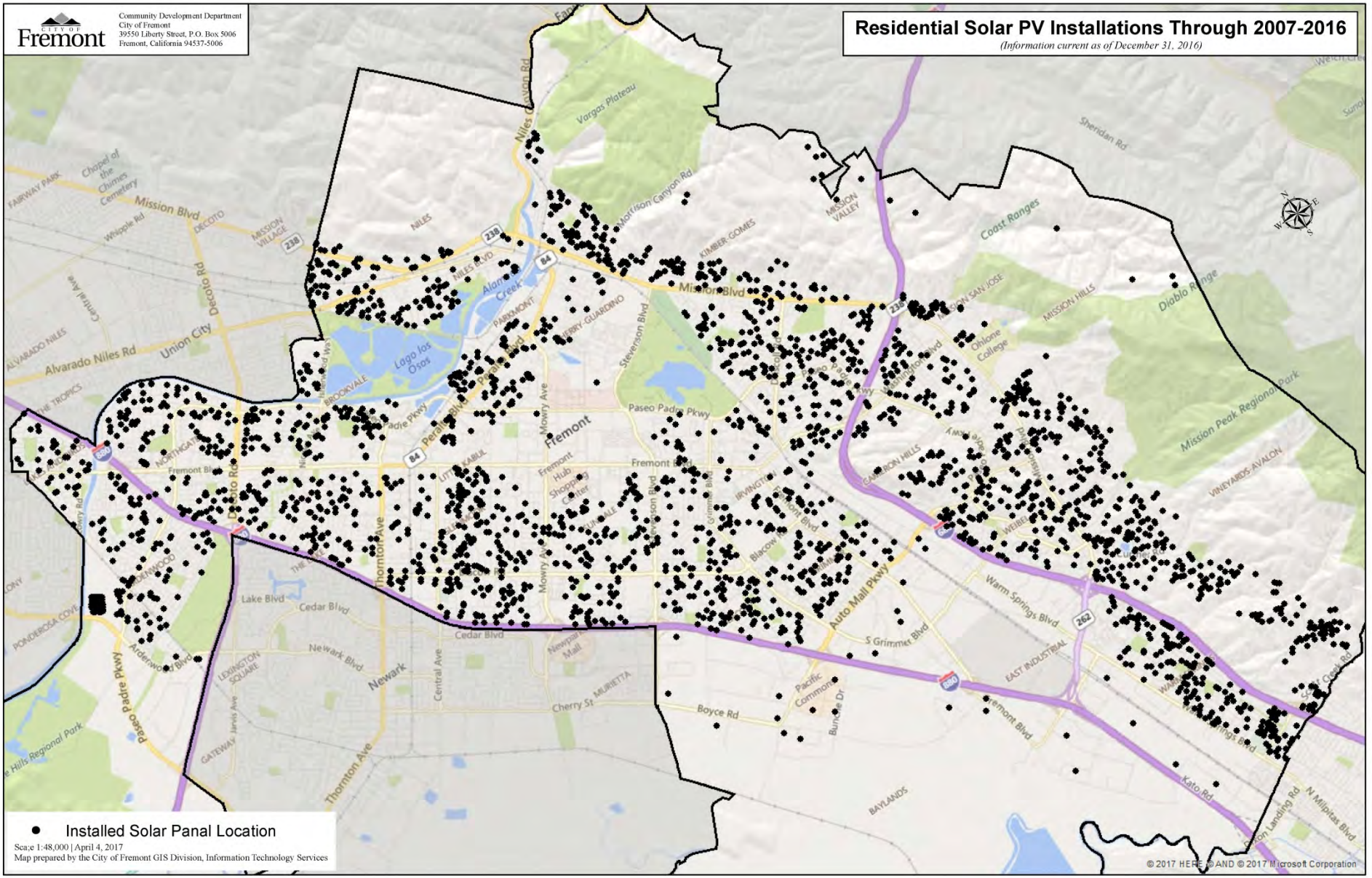
The Case for Requiring Solar

Existing Solar in Fremont

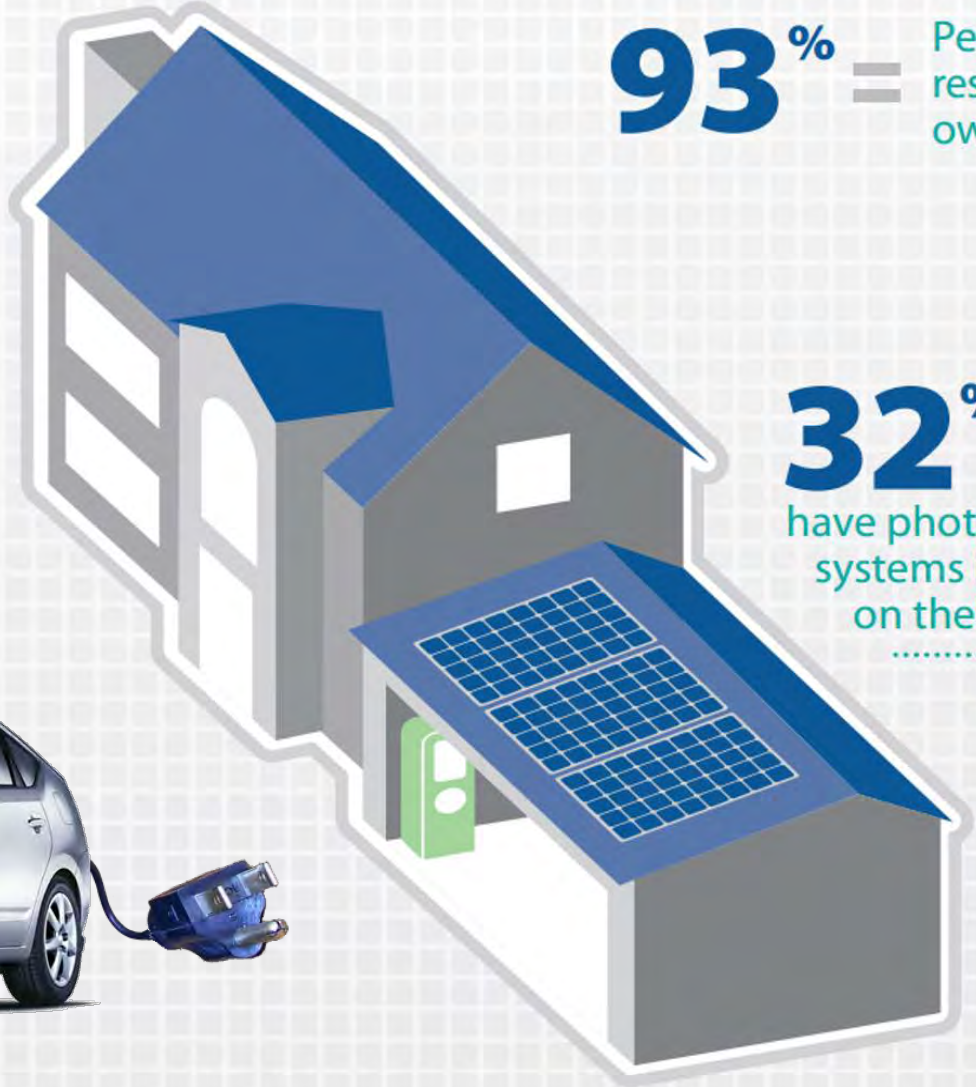
- 22.6 MW of solar installed by end of 2016:
  - 2,837 homes (12.7 MW) & 70 businesses (9.9 MW)



Residential Solar Installations



The EV-PV Connection



93% = Percentage of respondents who own their home

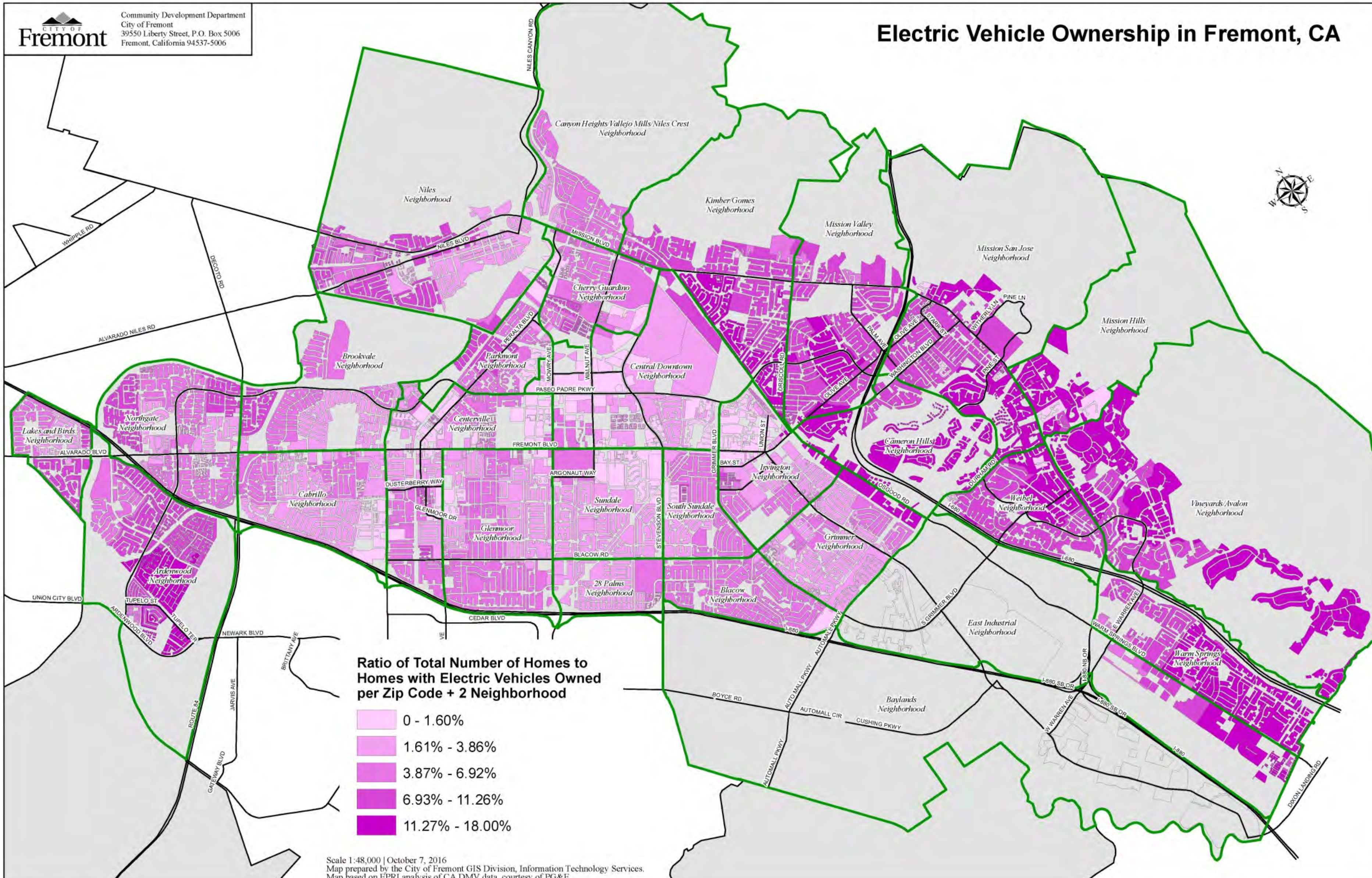
32% have photovoltaic systems installed on their home

16% plan to install solar

EV Ownership in Fremont

- Almost 5,000 EV owners in Fremont (Dec 2016 CVRP Data)
- 1/3 of all EVs in Alameda County with only 14% population
- 94539 has more EVs than any other zip code in CA!

EV Concentrations by Neighborhood



New Residential Developments

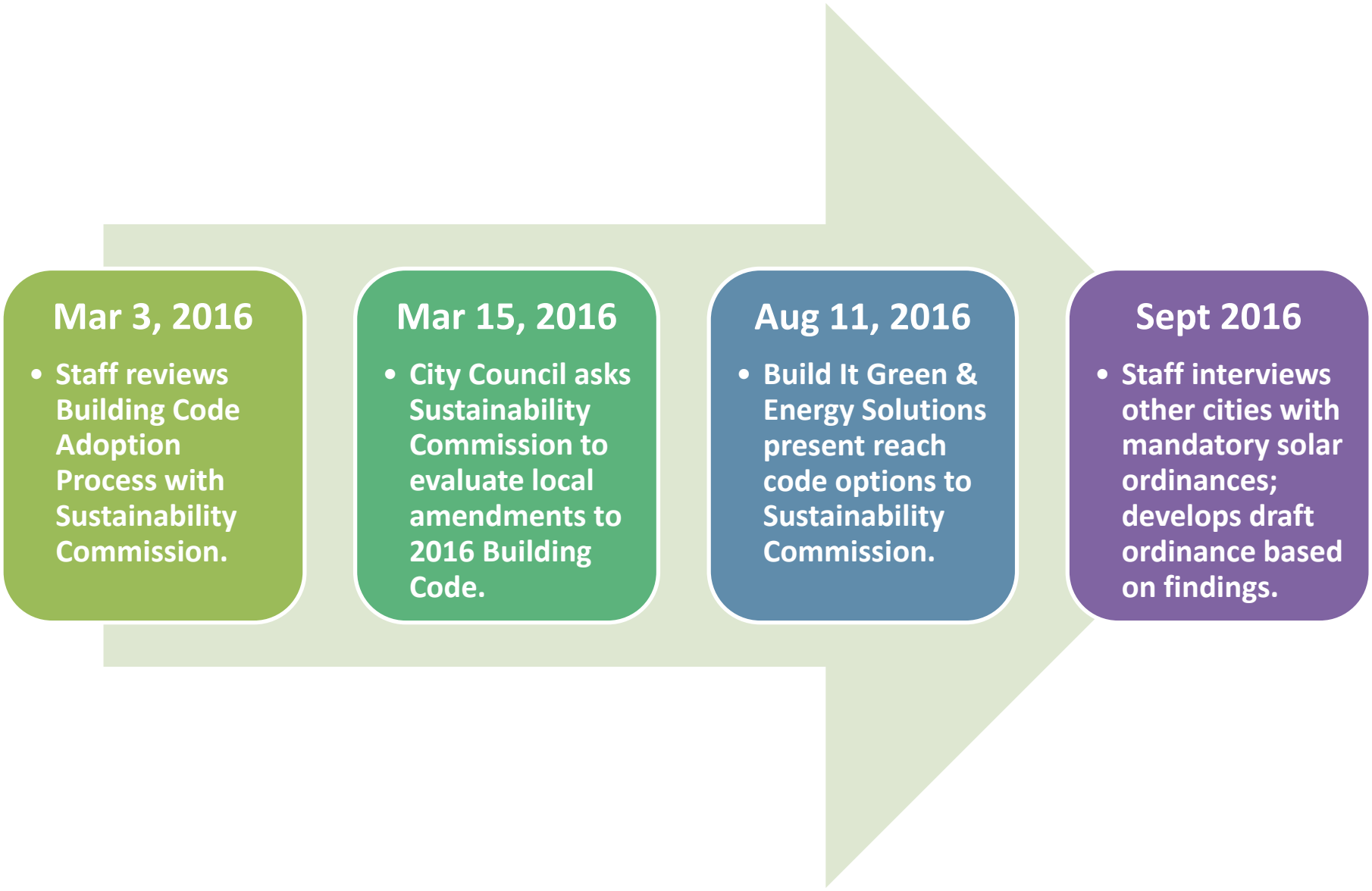
- 75,420 existing housing units (3.8% have PV)
- 6,229 new units planned before 2020

  = Major opportunity for new solar installs!

	Projected # of Units	Est Ave Sq Ft per Unit	Total Sq Ft	Min PV System Size	Potential PV Installed
Single Family Detached	782	*2,700*	2.1M	*2.7 kW*	2,111 kW
Single Family Attached	1,399	*1,650*	2.3M	*2.1 kW*	2,938 kW
Multifamily	4,048	*1,050*	4.3M	*1.7 kW*	6,882 kW
TOTAL	**6,229**				**11.9 MW**

Mandatory Solar Ordinance Adoption Process

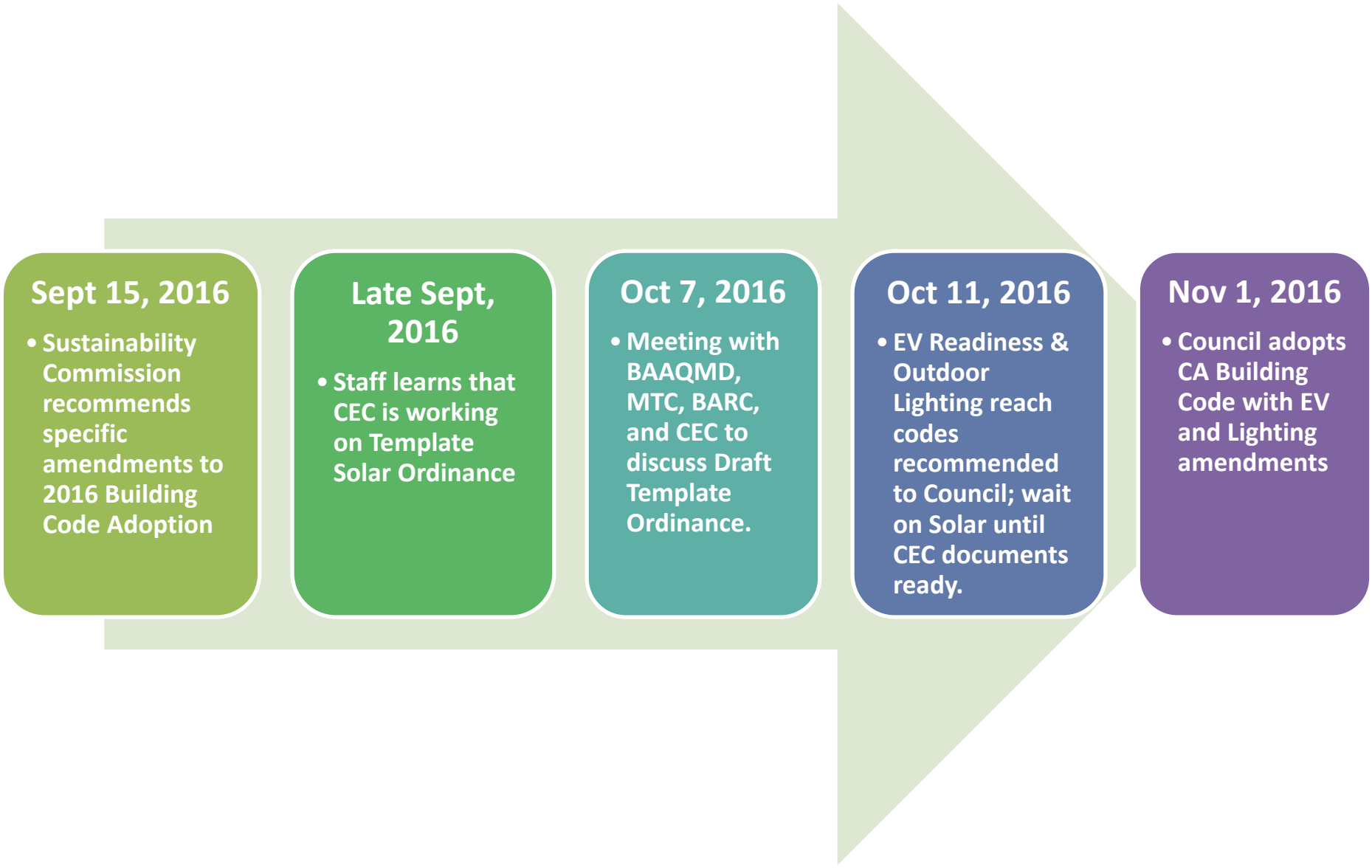
Adoption Timeline (start)



Cities with Mandatory Solar in 2016

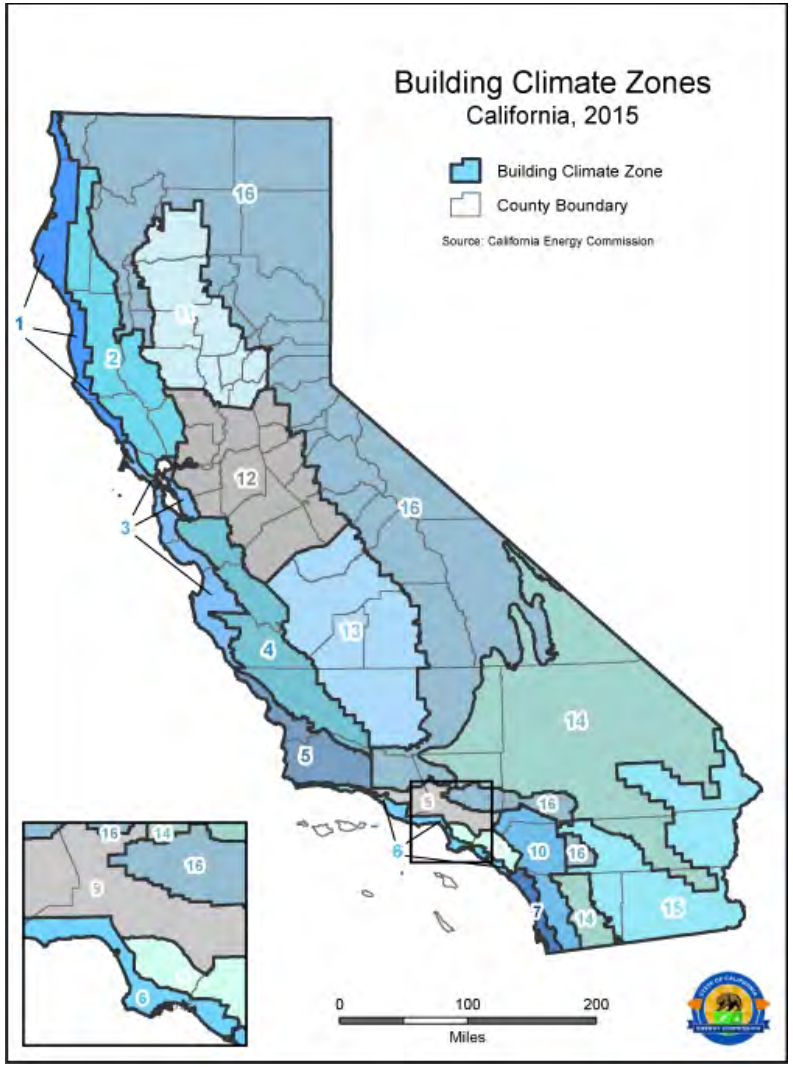
Jurisdiction	Requirement	Enacted	In Effect
Culver City	**Requirement** = 1 kW solar per every 10,000 sf in new MF and Non-Res construction or renovations over 10,000 sf.	**Mar-08**	**Spring-08**
Sebastopol	**Requirement** = 2 watts/sf conditioned space, or 75% of electric load in new Res & Non-Res, alterations over 50% sf, or additions over 1,800 sf. **Alternatives** = Other renewable energy sources, exceed mandatory energy reqs. by 10%, or fee paid by builder.	**May-13**	**Jul-13**
Lancaster	**Requirement** = 1-1.5 kW over 7,000 sf lots| 1.5+ kW over 100,000 sf lots. Builders can aggregate requirements of a subdivision & divide among units. **Alternatives** = Builders can meet requirement through purchase of RECs.	**Mar-13**	**Nov-13**
Santa Monica	**Requirement** = 1.5 watts/sf conditioned space new Res; 2 watts/sf of building footprint new MF & Non-Res. **Exception** = Provision reduced or waived due to lack of unshaded areas.	**Apr-16**	**May-16**
San Francisco	**Requirement** = 10 watts/sf of solar PV and/or 100 kBtu/sf of solar hot water for "solar zone“ area (15% of roof area) in all new construction ≤10 stories with min. 2,000 sf gross floor area & min. 150 sf solar area. **Exceptions** = Laboratories and internet server operations. **Alternatives** = Installation of living roof.	**Apr-16**	**Jan-17**
San Mateo	**Requirement** = ≥1 kW new SF Res; ≥2 kW new MF 3-16 units; ≥3 kW new MF 17+ units & Non-Residential <10,000 sf; ≥5 kW new Non-Res 10,000+ sf. **Alternatives** = ≥40 sf collector solar hot water system.	**May-16**	**Jan-17**

Adoption Timeline (con't)

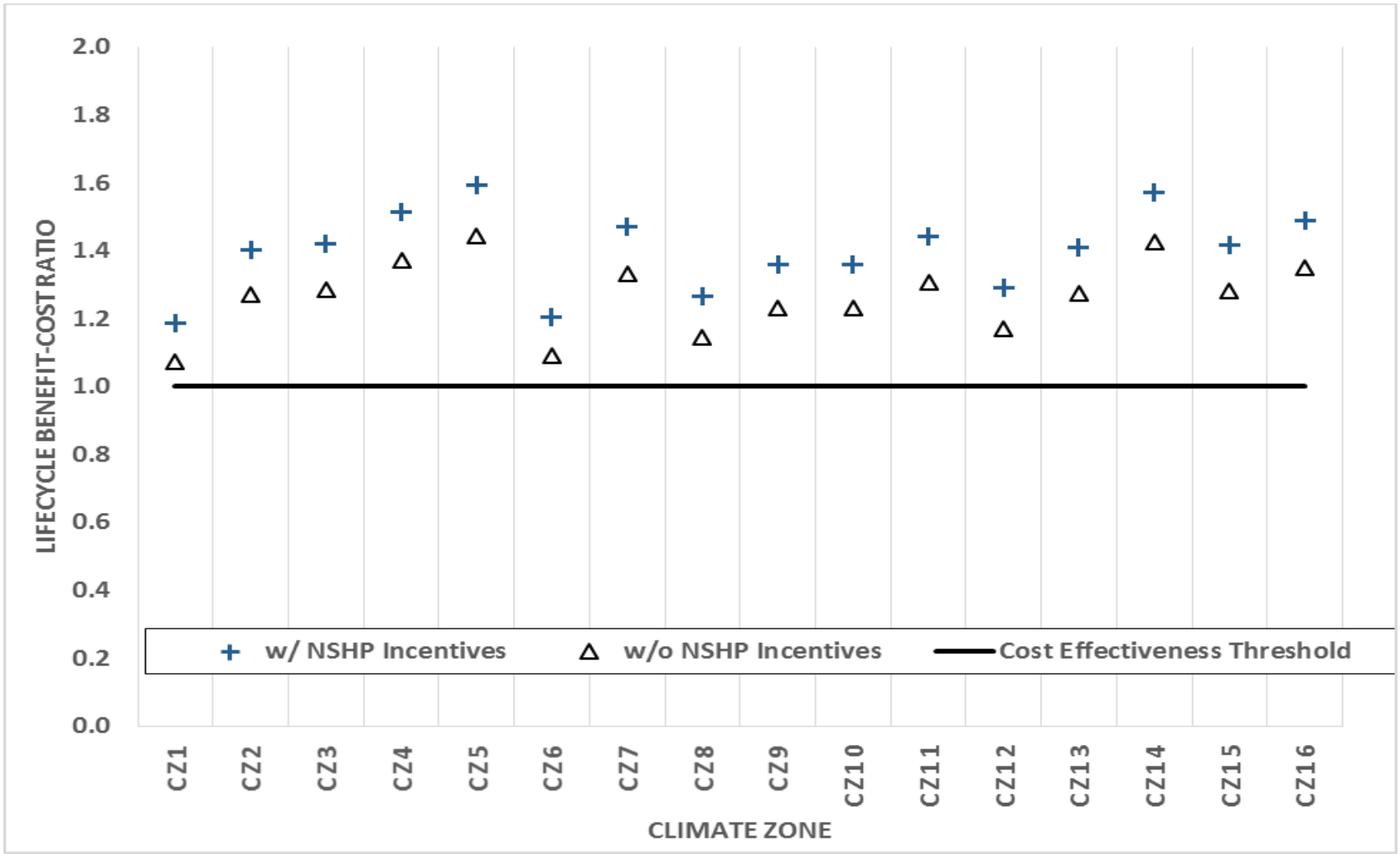


New 2016 Cost Effectiveness Study

- Provides cost-effective system sizing based on CA climate Zones
- Min. PV size based on % of total building “time dependent valuation” (TDV) of energy use
  - TDV values energy use differently depending on the fuel source, time of day, and season.
  - Reflects “societal value or cost” of energy including long-term projected costs of energy
  - Electricity used (or saved) during peak periods of the summer has a much higher value than electricity used (or saved) during off-peak periods



Single Family Cost Effectiveness



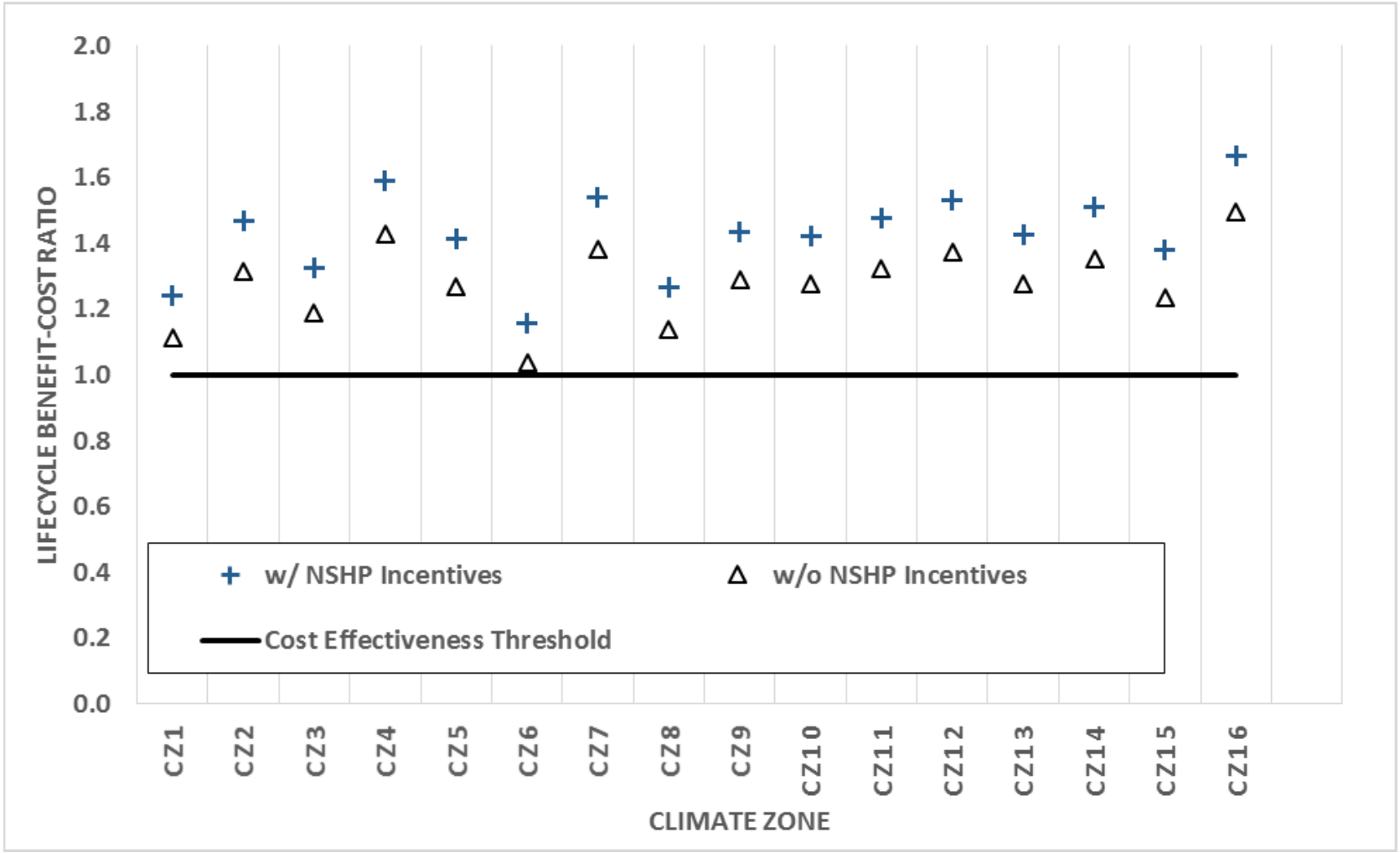
Single Family PV Packages

Climate Zone	PV Capacity (kW)	Elec Savings (kWh)	% Carbon Savings[1]	Package Cost[2]	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
CZ1	3.0	4,041	30.4%	$12,301	$719	17.1	1.07
CZ2	2.5	3,857	33.7%	$10,041	$694	14.5	1.27
CZ3	2.6	4,049	42.5%	$10,448	$732	14.3	1.29
CZ4	2.3	3,647	36.0%	$9,226	$688	13.4	1.37
CZ5	2.3	3,810	41.9%	$9,226	$725	12.7	1.44
CZ6	2.5	3,892	46.8%	$10,041	$596	16.8	1.09
CZ7	2.2	3,546	48.4%	$8,819	$639	13.8	1.33
CZ8	2.6	4,058	51.7%	$10,448	$652	16.0	1.15
CZ9	2.5	4,026	47.1%	$10,041	$674	14.9	1.23
CZ10	2.5	4,108	46.1%	$10,265	$688	14.9	1.23
CZ11	3.5	5,533	44.9%	$14,155	$1,007	14.1	1.31
CZ12	2.9	4,582	40.4%	$11,894	$757	15.7	1.17
CZ13	3.7	5,680	47.2%	$14,969	$1,040	14.4	1.27
CZ14	2.5	4,528	37.2%	$10,265	$796	12.9	1.42
CZ15	4.6	7,670	63.8%	$18,676	$1,303	14.3	1.28
CZ16	2.5	4,187	25.7%	$10,041	$738	13.6	1.35

[1] Based on CA electricity production and equivalent CO_2 emission rates of 0.724 lbCO_2e / kWh & 11.7 lb-CO_2e / therm.

[2] Includes 10% markup for builder profit and overhead. $0.50 / W NSHP incentive not applied to package costs

Multifamily Cost Effectiveness



Multifamily PV Packages

Climate Zone	PV Capacity (kW)	Elec Savings (kWh)	% Carbon Savings[1]	Package Costs[2]	Utility Cost Savings	Simple Payback	Lifecycle Benefit-Cost Ratio
CZ1	1.6	2,141	35.5%	$5,951	$361	16.5	1.11
CZ2	1.4	2,191	39.2%	$5,207	$373	14.0	1.32
CZ3	1.5	2,368	46.6%	$5,579	$361	15.5	1.19
CZ4	1.3	2,093	39.8%	$4,835	$376	12.9	1.43
CZ5	1.4	2,355	46.9%	$5,207	$360	14.5	1.27
CZ6	1.5	2,368	49.5%	$5,579	$315	17.7	1.04
CZ7	1.3	2,129	46.2%	$4,835	$364	13.3	1.38
CZ8	1.5	2,373	48.9%	$5,579	$345	16.2	1.14
CZ9	1.4	2,287	45.4%	$5,207	$365	14.3	1.29
CZ10	1.4	2,282	44.3%	$5,207	$362	14.4	1.28
CZ11	1.7	2,707	44.2%	$6,322	$456	13.9	1.32
CZ12	1.5	2,354	41.1%	$5,579	$417	13.4	1.37
CZ13	1.8	2,782	45.9%	$6,694	$466	14.4	1.28
CZ14	1.3	2,336	38.5%	$4,835	$356	13.6	1.35
CZ15	2.1	3,513	54.9%	$7,810	$526	14.8	1.24
CZ16	1.3	2,208	30.8%	$4,835	$394	12.3	1.49

[1] Based on CA electricity production and equivalent CO_2 emission rates of 0.724 lbCO_2e / kWh & 11.7 lb-CO_2e / therm.

[2] Includes 10% markup for builder profit and overhead. $0.50 / W NSHP incentive not applied to package costs

2016 Study Conclusions

- Finds solar PV in new residential developments are feasible and cost-effective in all 16 California climates zones.
- Cities can pass a local ordinance using the 2016 Cost-Effectiveness study as the basis if:
  - Buildings are required to first meet the mandatory Energy Code compliance without the use of the PV compliance credit (PVCC).
  - PV system sizes are based on the capacities shown in the study.

CEC Template Ordinance

- Designed according to Cost-Effectiveness study recommendations
- Applies to Residential (Single & MF) building types
- Provides prescriptive system sizes for units ≤4,499 sq. ft.
- For units/buildings ≥4,500 sq. ft., developers must model the system size to meet a minimum percentage of TDV energy usage
- Ordinance can be adopted as is, or with modifications

PV System Sizing in Ordinance

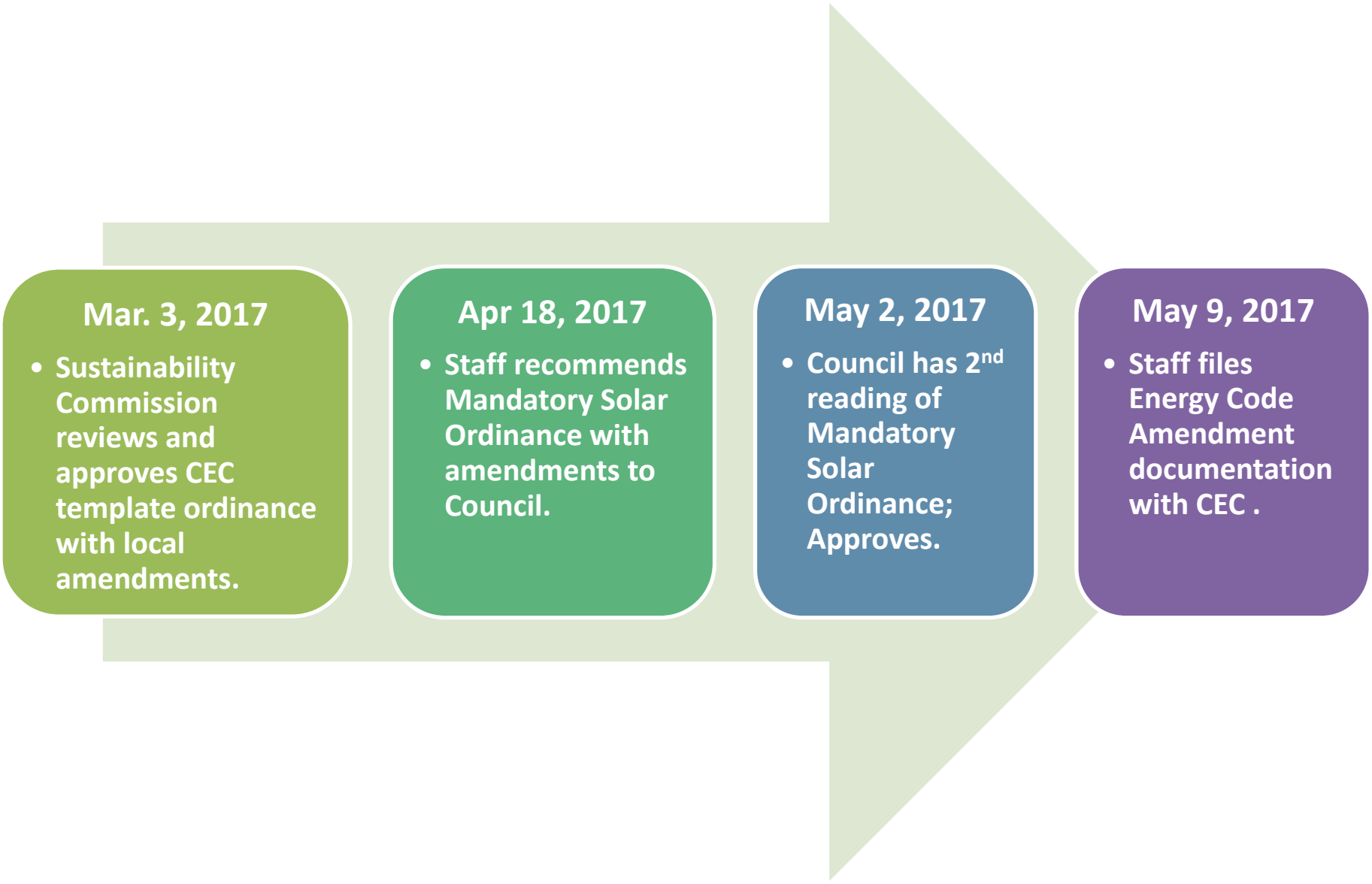
Climate Zone 3 (Fremont)

Minimum PV System Size required to meet Solar PV Ordinance	
Conditioned Space (ft^2)	**PV Size (kW DC)**
Less than 1000	1.5
1000 - 1499	1.7
1500 - 1999	2.1
2000 - 2499	2.4
2500 - 2999	2.7
3000 - 3499	3.0
3500 - 3999	3.2
4000 - 4499	3.5
4500 +	55% TDV Energy Use

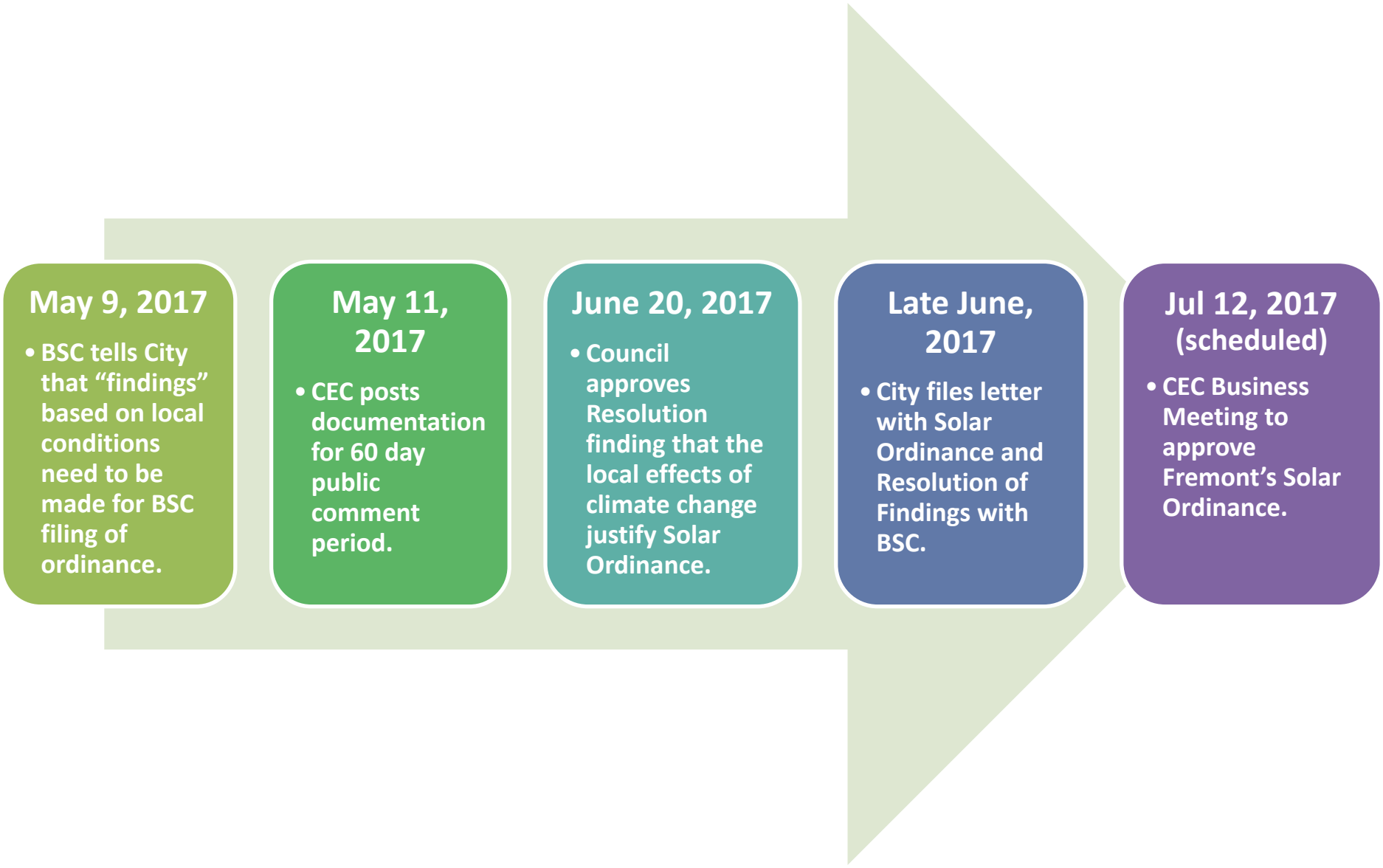
Proposed Local Modifications

- Include all residential development types
- Provide for alternative compliance options:
  - Renewable energy systems other than rooftop solar, including ground-mounted or carport solar & wind energy systems
  - Increased energy efficiency (CALGreen Tier 1)
- Account for possible expanded system sizes:
  - Require developer to offer expanded system size to buyer.
  - Require developer to provide solar readiness beyond required system sizes per mandatory “solar zone” & “solar pathway”
  - Encourage developer to consider use of expandable technology
- Encourage an all-electric building energy system design

Adoption Timeline (con't)



Adoption Timeline (end)



Alignment with CA Goals

California Zero Net Energy (ZNE) Goal:

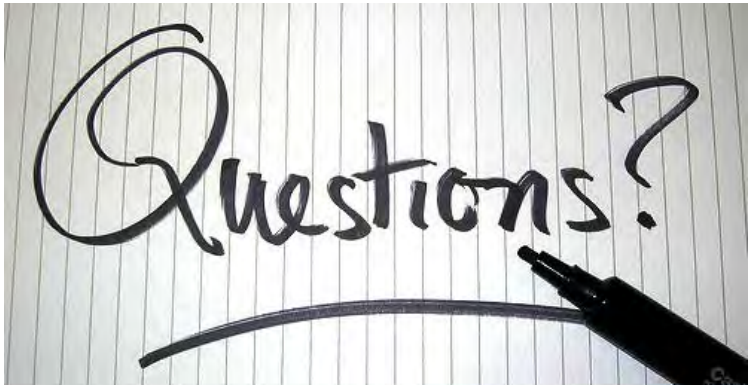
- All new Res. by 2020; All new Non-Res & 50% existing Non-Res by 2030

CA Renewable Portfolio Standard:

- 33% renewable by 2020 & 50% by 2030

Statewide GHG Reduction Goal:

- 40% below 1990 levels by 2030 & 80% below by 2050



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