Clean Coalition

Making Clean Local Energy Accessible Now

Planning the Grid

To Optimize Distributed Energy Resources

Presenters

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Clean Coalition Mission and Advisors

Clean Coalition

Mission

To accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

Board of Advisors

Jeff Anderson
Co-founder and Former ED, Clean Economy Network

Josh Becker
General Partner and Co-founder, New Cycle Capital

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CEO, Palo Alto Tech Group;
Councilman & Former Mayor, City of Palo Alto

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President, Natural Capitalism Solutions

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Founding Director, DOE SunShot Initiative

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Director, Colorado State University's Center for the New Energy Economy, and Former Colorado Governor

Terry Tamminen
Former Secretary of the California EPA and Special Advisor to CA Governor Arnold Schwarzenegger

Jim Weldon
Technology Executive

R. James Woolsey
Chairman, Foundation for the Defense of Democracies; Former Director of Central Intelligence (1993-1995)

Kurt Yeager
Vice Chairman, Galvin Electricity Initiative; Former CEO, Electric Power Research Institute

Clean Coalition Objectives

- From 2020 onward, all new electricity generated in the U.S. will come from at least:
  - **80% renewable sources**
  - **25% local renewable sources**

- By 2020, policies and programs will ensure the successful fulfillment of the above while reflecting the full value of local renewable energy including economic, environmental, and resilience benefits.

A Modern Power System: Smarter, More Distributed

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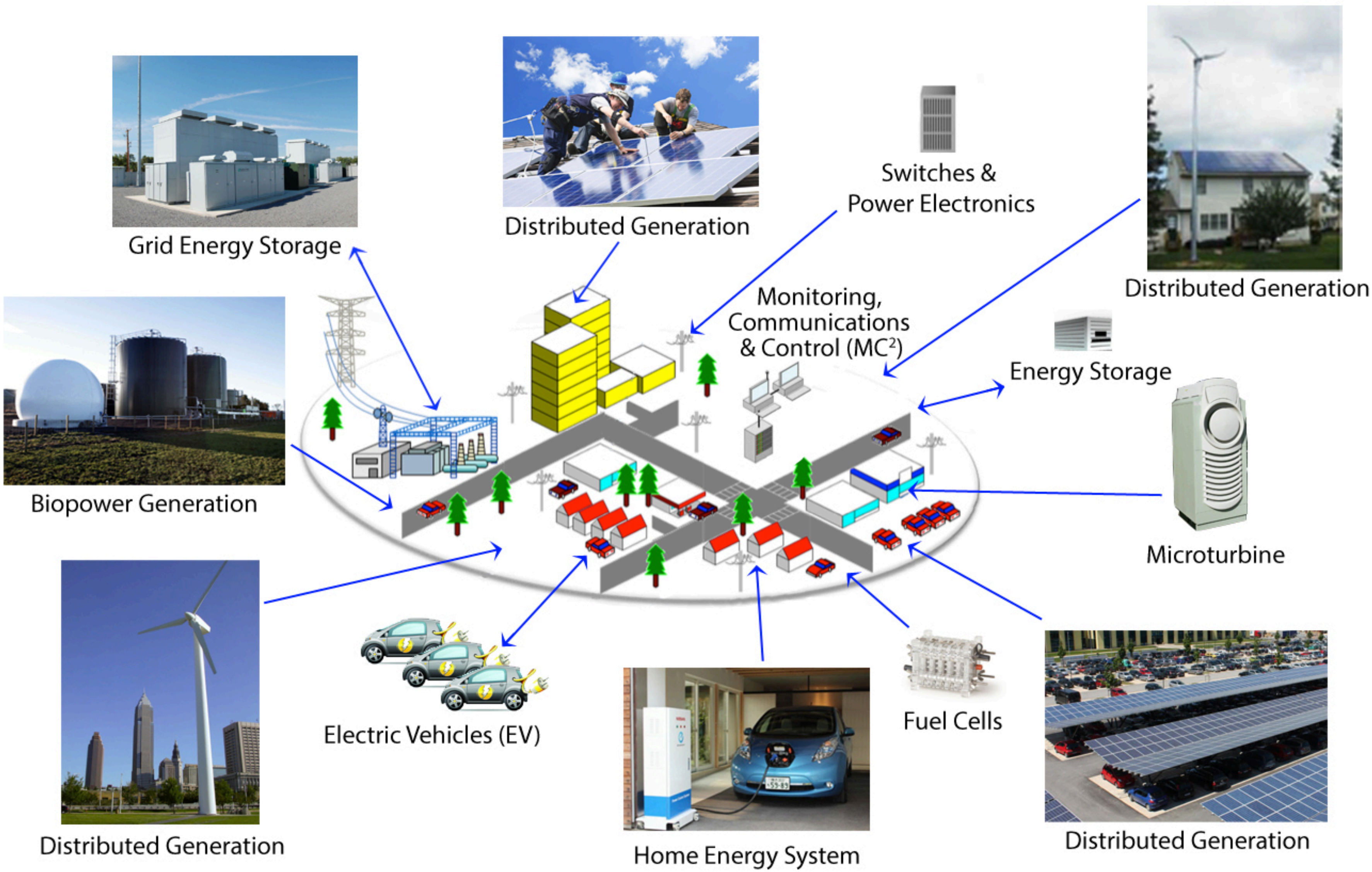


Community Microgrid Initiative: Accelerating the Transition to a Modern Power System

Clean Coalition

Objectives

1. **Reach 25% or more of total energy consumed as local renewables while improving grid reliability**
2. **Achieve technical and economic viability with cost-effective outcomes for communities and ratepayers**
3. **Accelerate and scale deployments by partnering with utilities, utility commissions, and technology providers**
4. **Strengthen local economies through increased community investment, stable energy prices, and reduced system costs**

Result: A smarter distribution grid featuring more clean energy now, improved grid performance, and stronger long-term economics

Hunters Point Community Microgrid Project

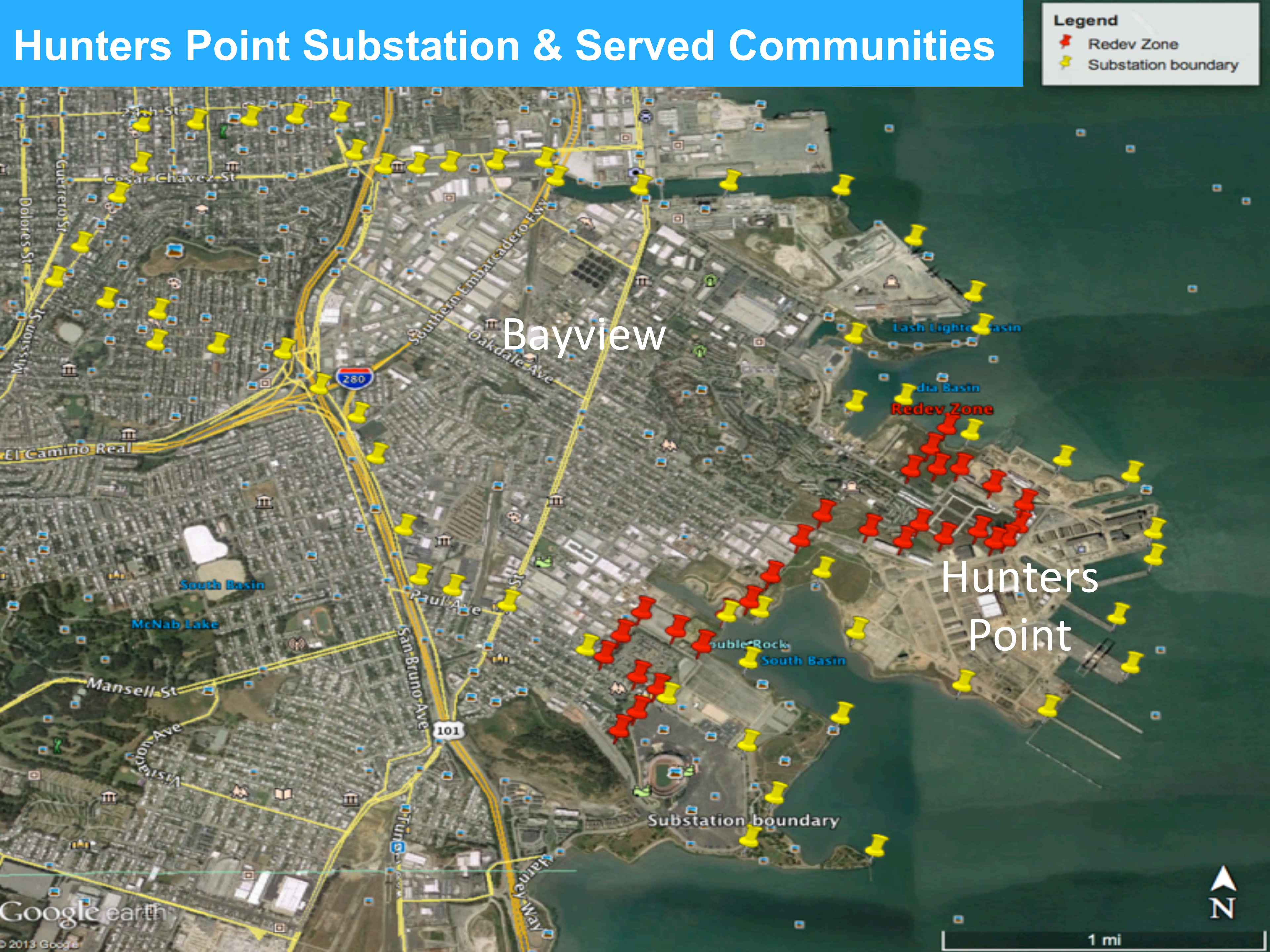
Clean Coalition

Overview

- Innovative project in the Bayview-Hunters Point area of San Francisco, in collaboration with PG&E
- Showcase location demonstrating the value of Community Microgrids, including "DER Optimization"
- Scalable approach using existing tools that can be replicated easily by any utility, for any community area

The Hunters Point substation serves ~20,000 customers (about 90% residential, 10% commercial & industrial)

Hunters Point Substation & Served Communities



Example DER Optimization: Advanced Inverters

1. 6AM:
   - No PV impact
2. Noon:
   - 20MW PV causes overvoltage
3. Noon:
   - 20MW PV with advanced inverters set at 0.9 power factor stabilizes voltage

Methodology, DER Optimization: 4 Steps

Utility Data

- Customer & transformer loads
- Network model & circuit map
- Equipment list & upgrade plans
- O&M schedule

Other data

- Solar insolation
- Weather forecasting
- Assumptions for DR/ EE/EV charging, etc.
- Performance specs, e.g. storage

4. Higher DG + DER Capacity

- **Increase storage & local reserves (e.g. CHP) to flatten peaks and island essential services. Include system deferrals.**
- **Optimize via locations, sizes, types & costs**

3. Medium DG + DER Capacity

- **Add lower-cost DER options such as DR/EE, EV charging, & cost-effective storage. Include system deferrals.**
- **Optimize via locations, sizes, types & costs**

2. Baseline DG Capacity

- **Vary locations & sizes of DG to define existing substation(s) capacity w/no upgrades. Include system deferrals.**
- **Use load tap changers, advanced inverters, etc. to manage voltage issues**

1. Baseline Powerflow

- **Acquire all data sets, validate data accuracy**
- **Model existing powerflow, including existing DG**

- **Validate with utility & technology vendors**
- **Maintain or improve grid reliability & power quality**

<u>Higher Cost</u>
DG + DER capacity

<u>Medium Cost</u>
DG + DER capacity

<u>Low Cost</u>
DG capacity

Baseline DG Capacity: Optimal Locations

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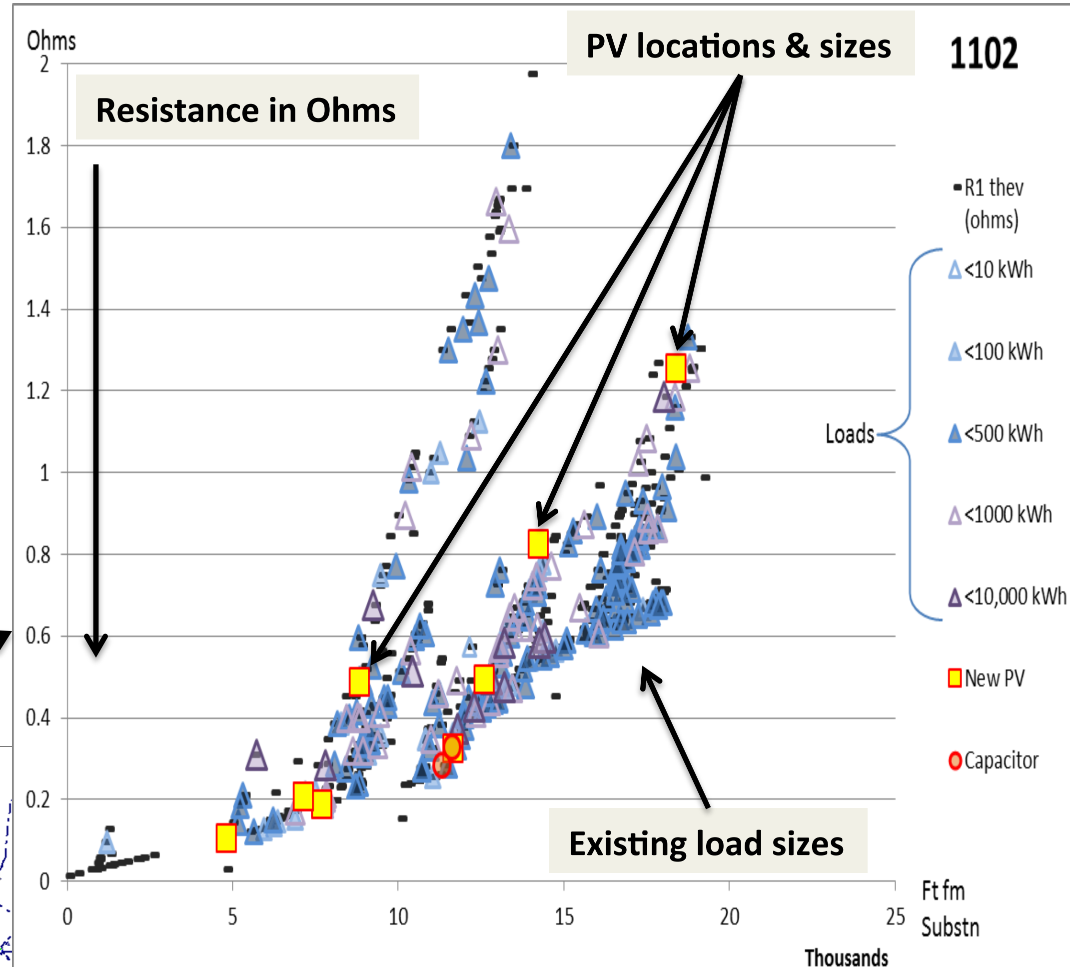
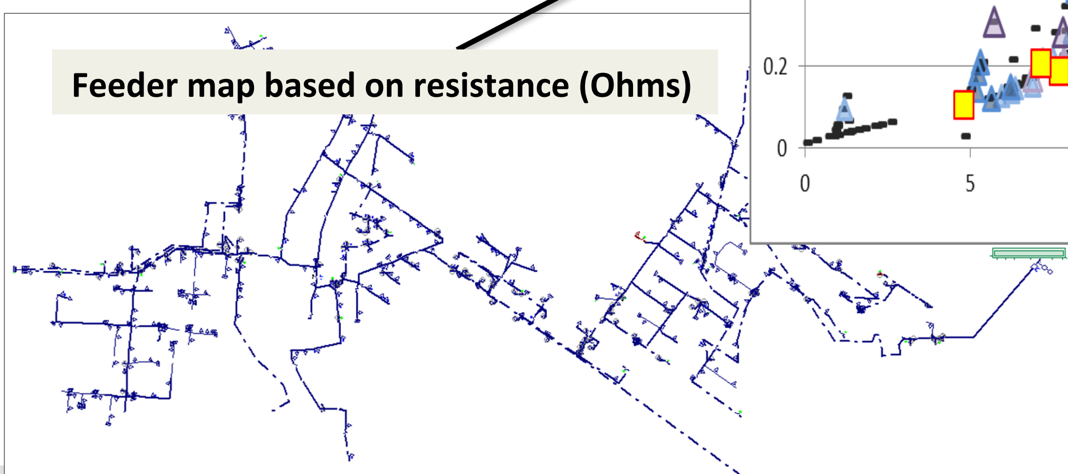
Two criteria for finding optimal PV locations and sizes:

1. <u>Robust feeder locations</u>: less resistance (lower Ohms) means more capacity for local generation
2. <u>Matching load types</u>: higher loads during daytime means better match for PV generation





Additional Optimization: "Substation-as-a-System"

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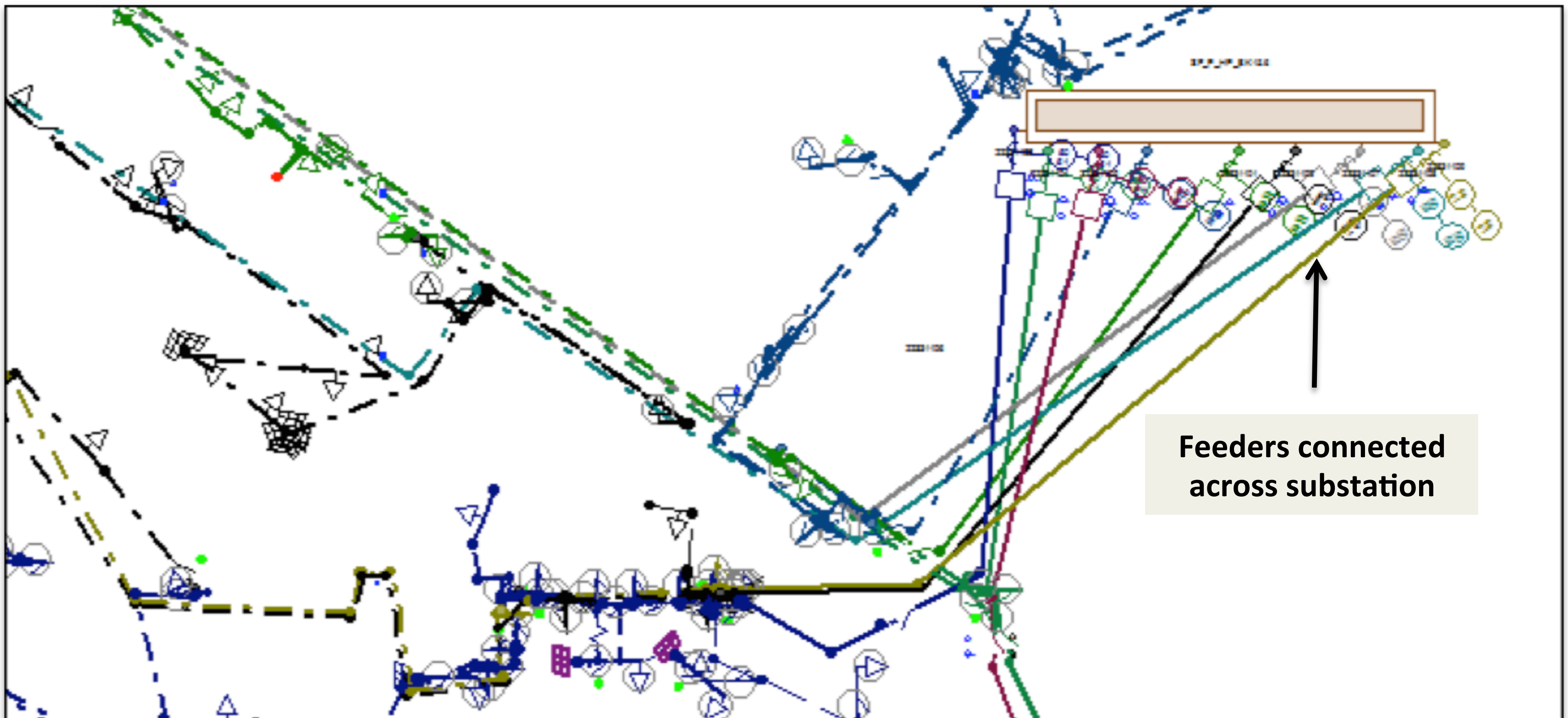
Connected feeders enables substation-wide optimizations, such as:

1. Local Balancing: e.g. over-generation on certain feeders consumed by load on other feeders connected at the substation
2. Optimizing DER such as storage and demand response across the substation feeders
3. Optimizing settings, e.g. load tap changers, across the substation feeders



Initial Results: Baseline DG Capacity

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- **Reached 30 MW of new PV, or 25% of total energy**
  - 20 MW added to select Commercial & Industrial sites matching low resistance locations with higher daytime loads
  - 10 MW added to select Residential sites (multiple dwelling units) matching more robust feeder locations
  - Excludes Redev Zone (feeders, expected loads, etc.)

- **No negative impacts**
  - No Out-of-Range voltages. Voltage regulation achieved using existing Load Tap Changers (advanced inverters not needed yet).
  - No backfeeding to Transmission. Some “crossfeeding” between connected feeders in the same bank.

Baseline DG Capacity: Voltages & Major Power Flows, Weekdays (no PV vs. PV)

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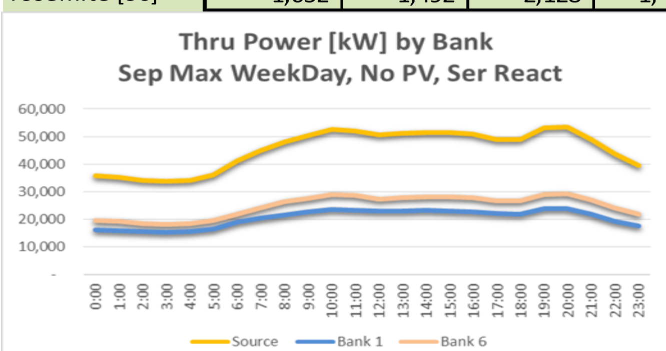
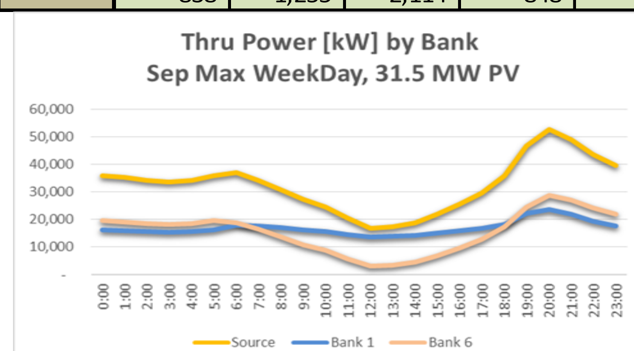
		PV: None			PV: 20 C&I + 10 Res		
		No PV			Sep PV 20+10+1.5	33,531	
		Sep WkDay Max Load Profiles			Sep WkDay Max Load Profiles		
Voltage Summary		Min	Avg	Max	Min	Avg	Max
		V_Base, all monitored pts			V_Base, all monitored pts		
22331101	Bank 6 [52]	121.6	122.9	123.9	121.0	122.7	123.7
22331102	Bank 6 [52]	117.5	119.6	122.8	116.6	119.8	122.7
22331107	Bank 6 [52]	115.5	118.4	123.0	114.5	118.5	122.9
22331108	Bank 6 [52]	117.0	119.1	123.1	116.0	119.1	123.0
22331109	Bank 6 [52]	116.6	119.8	123.0	115.7	119.8	122.9
22331106	Bank 1 [51]	121.2	122.6	124.6	120.8	122.7	123.7
22331105	Bank 1 [51]	121.9	123.3	125.3	121.6	123.3	124.4
22331104	Bank 1 [51]	123.0	124.7	126.5	122.7	124.6	125.6
22331103	Bank 1 [51]	118.2	122.4	124.7	117.7	122.4	123.8
22490401	Yos [96]	118.1	121.7	125.2	117.6	122.2	124.7
22490402	Yos [96]	121.6	123.6	125.3	120.7	123.6	124.7

Bus Rpt	kW Thru Pwr					kW Thru Pwr				
	Min	**Avg**	**Max**	**Noon**	**NoonDif**	**Min**	**Avg**	**Max**	**Noon**	**NoonDif**
Source [47]	33,680	45,431	53,435	50,534		16,844	32,501	52,657	16,844	(33,690)
Bank 1 [51]	15,359	20,461	23,888	22,951		13,729	16,927	23,678	13,729	(9,222)
Bank 6 [52]	18,216	24,793	29,312	27,373		3,049	15,458	28,749	3,049	(24,324)
Yosemite [96]	1,052	1,492	2,128	1,464		838	1,255	2,114	848	(616)





Baseline DG Capacity: LTC action, Per Feeder Power, Weekdays (no PV vs. PV)

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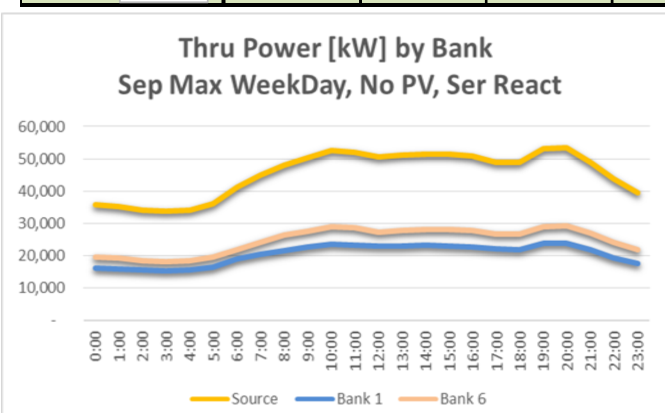
PV: None

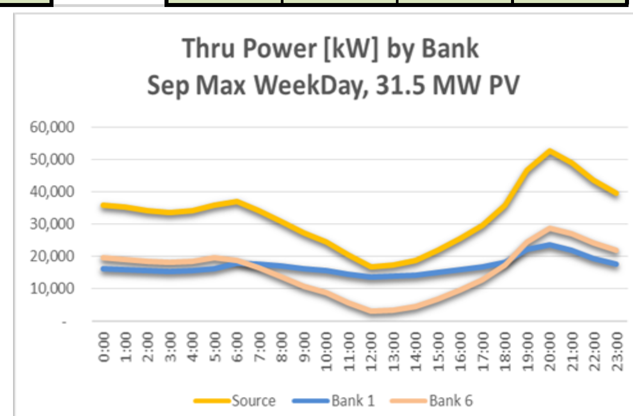
Tap Change Summary		Tap Changes	Min Tap	Max Tap	Average Tap
Yosemite [96]		1	13	14	13
Bank 1 [51]		2	9	11	9
Bank 6 [52]		1	9	10	9
		Sep WkDay Max Load Profiles			
Feeders		kW Thru Pwr			
		Min	Avg	Max	Noon
1101	Bank 6 [52]	3,548	5,046	6,541	6,236
1102	Bank 6 [52]	4,227	5,946	7,290	6,559
1107	Bank 6 [52]	2,918	4,079	4,965	4,493
1108	Bank 6 [52]	2,718	3,933	5,527	3,969
1109	Bank 6 [52]	4,797	5,779	6,890	6,106
1106	Bank 1 [51]	4,406	5,892	7,047	6,925
1105	Bank 1 [51]	3,484	4,799	5,689	5,447
1104	Bank 1 [51]	3,678	4,729	5,503	5,256
1103	Bank 1 [51]	3,788	5,038	6,405	5,319
401	Yos [96]	646	889	1,212	893
402	Yos [96]	406	602	914	571

PV: 20 C&I + 10 Res

Tap Change Summary		Tap Changes	Min Tap	Max Tap	Average Tap
Yosemite [96]		2	13	14	13
Bank 1 [51]		1	9	10	9
Bank 6 [52]		3	8	10	8
		Sep WkDay Max Load Profiles			
Feeders		kW Thru Pwr			
		Min	Avg	Max	Noon
1101	Bank 6 [52]	1,756	3,330	4,953	1,756
1102	Bank 6 [52]	757	3,716	7,155	757
1107	Bank 6 [52]	832	2,674	4,880	832
1108	Bank 6 [52]	(440)	2,259	5,426	(397)
1109	Bank 6 [52]	98	3,472	6,321	98
1106	Bank 1 [51]	3,929	4,744	6,355	3,929
1105	Bank 1 [51]	1,368	3,236	5,456	1,368
1104	Bank 1 [51]	3,678	4,535	5,492	4,749
1103	Bank 1 [51]	3,660	4,410	6,370	3,681
401	Yos [96]	343	679	1,199	347
402	Yos [96]	406	575	913	501

Feeder "Crossfeeding"





Baseline DG Capacity: Voltages & Major Power Flows, <u>Weekends</u> (no PV vs. PV)

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		PV: None Min	PV: None Avg	PV: None Max	PV: 20 C&I + 10 Res Min	PV: 20 C&I + 10 Res Avg	PV: 20 C&I + 10 Res Max
		V_Base, all monitored pts			V_Base, all monitored pts		
22331101	Bank 6 [52]	122.1	123.1	124.1	121.7	123.0	123.9
22331102	Bank 6 [52]	118.6	120.8	124.0	118.5	121.1	123.8
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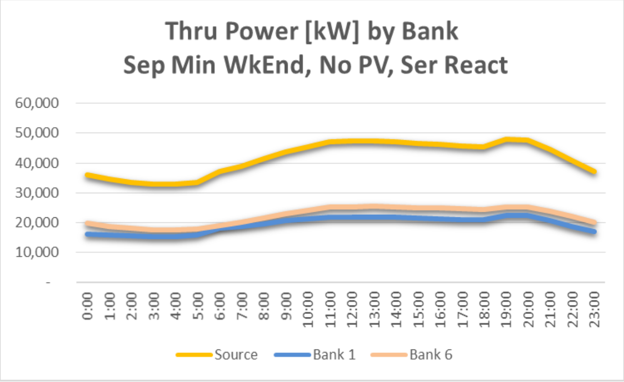
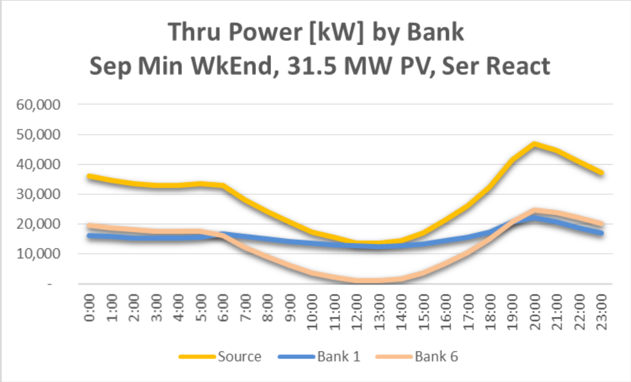
22490402	Yos [96]	122.2	123.8	124.9	121.3	123.7	124.8

	kW Thru Pwr (PV: None)					kW Thru Pwr (PV: 20 C&I + 10 Res)				
	Min	Avg	Max	Noon	NoonDif	Min	Avg	Max	Noon	NoonDif
	32,850	41,741	47,846	47,342		13,597	28,846	47,014	13,704	(33,638)
	15,195	19,370	22,421	21,875		12,597	15,841	22,210	12,662	(9,213)
	17,545	22,218	25,461	25,281		944	12,904	24,611	985	(24,296)
	1,042	1,439	1,957	1,542		921	1,202	1,942	925	(617)





Baseline DG Capacity: LTC action, Per Feeder Power, Weekends (no PV vs. PV)

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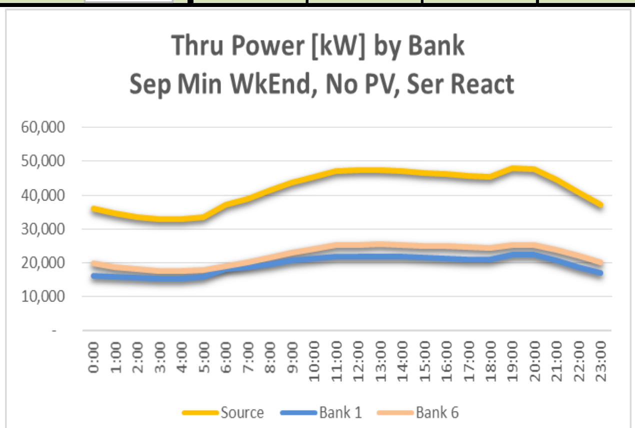
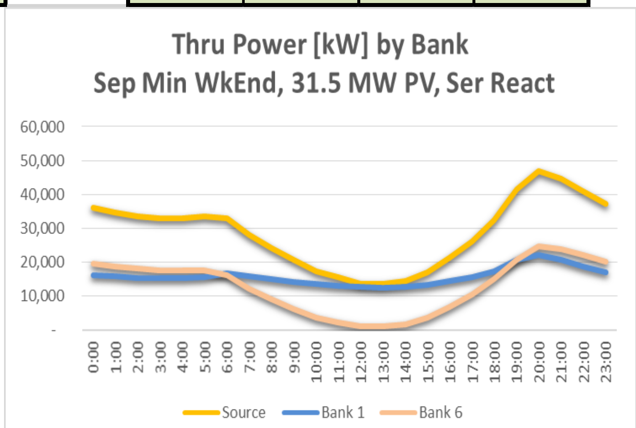
Tap Change Summary	PV: None – Tap Changes	PV: None – Min Tap	PV: None – Max Tap	PV: None – Average Tap	PV: 20 C&I + 10 Res – Tap Changes	PV: 20 C&I + 10 Res – Min Tap	PV: 20 C&I + 10 Res – Max Tap	PV: 20 C&I + 10 Res – Average Tap
Yosemite [96]	2	12	14	13	2	13	14	13
Bank 1 [51]	2	8	10	8	1	8	9	8
Bank 6 [52]	1	9	10	9	2	8	9	8

Feeders		Sep WkEnd Min Load Profiles, no PV – kW Thru Pwr – Min	Avg	Max	Noon	Sep WkEnd Min Load Profiles – kW Thru Pwr – Min	Avg	Max	Noon
1101	Bank 6 [52]	3,417	4,387	5,367	5,304	828	2,673	4,310	828
1102	Bank 6 [52]	4,114	5,381	6,459	6,090	271	3,157	6,324	295
1107	Bank 6 [52]	2,820	3,644	4,304	4,133	473	2,245	4,220	482
1108	Bank 6 [52]	2,700	3,765	5,119	4,076	(327)	2,091	5,018	(292)
1109	Bank 6 [52]	4,469	5,033	5,745	5,668	(331)	2,732	4,793	(331)
1106	Bank 1 [51]	4,331	5,484	6,333	6,327	3,314	4,337	5,987	3,335
1105	Bank 1 [51]	3,377	4,292	4,953	4,927	842	2,732	4,771	853
1104	Bank 1 [51]	3,675	4,668	5,417	5,209	3,675	4,474	5,405	4,703
1103	Bank 1 [51]	3,776	4,922	6,078	5,407	3,752	4,295	6,043	3,769
401	Yos [96]	636	851	1,104	921	372	641	1,092	375
402	Yos [96]	405	587	851	620	405	560	849	550

Feeder Backfeeding





Observation: For PV, C&I Customers Are Optimal

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Lowest Hanging Fruit

1. Most Generation

Larger rooftop spaces generate more energy

2. Lowest System Costs

Larger systems reduce overall costs

3. Best Grid Locations

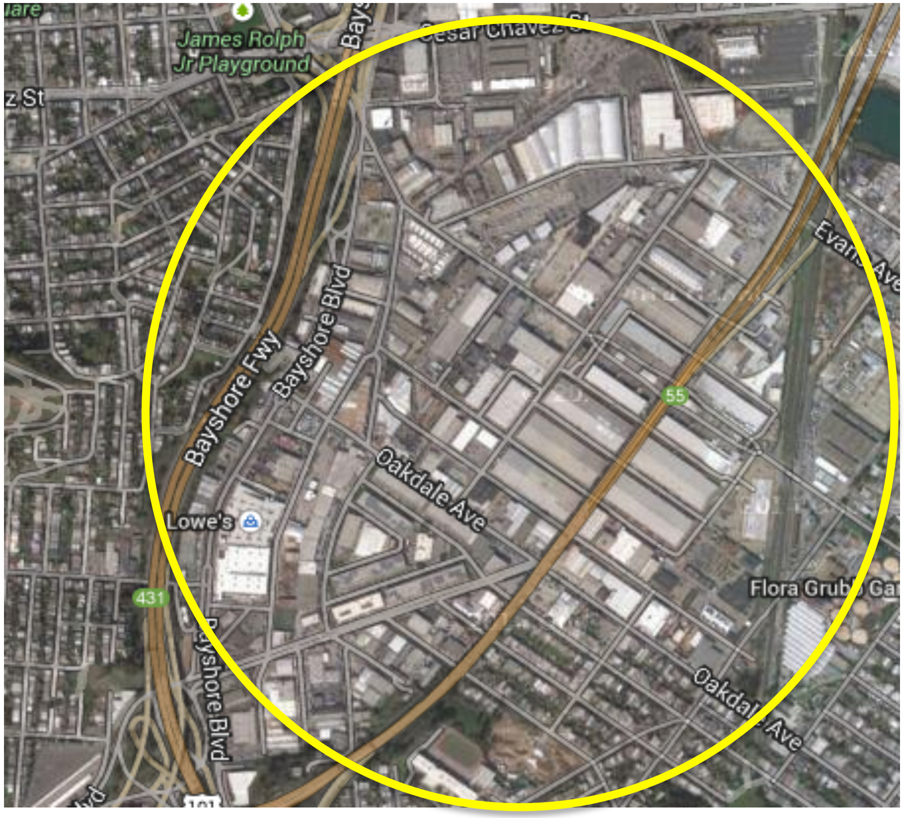
Large loads served by robust feeder segments

4. Matching Load Profiles

Larger daytime loads match solar generation

5. Financially Motivated

Larger bills w/demand response charges, plus rooftop leasing opportunity



Hunters Point Load Profiles: C&I Match for PV

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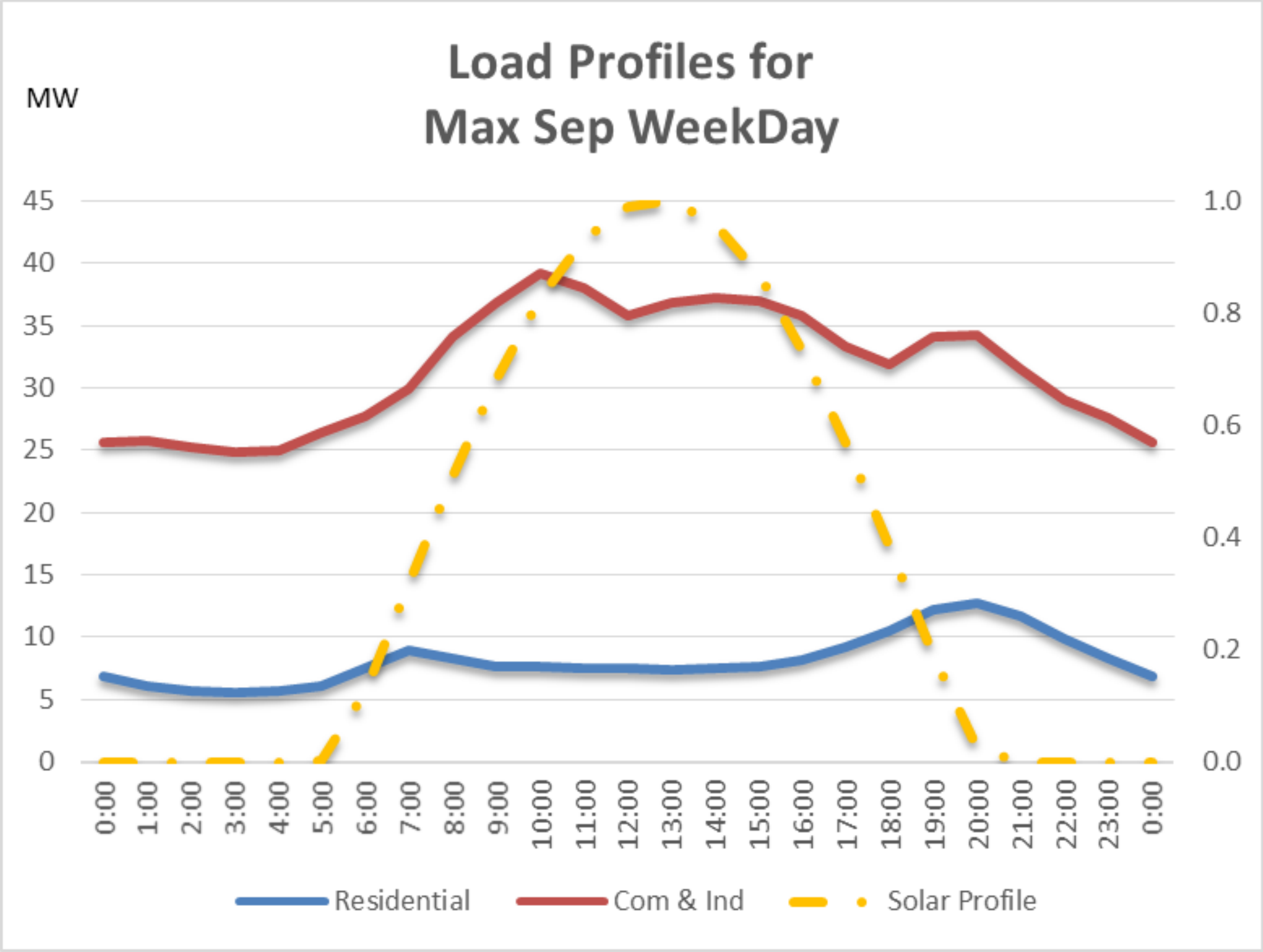

Scalability: Capacity Modeling Enables “Plug-n-Play”

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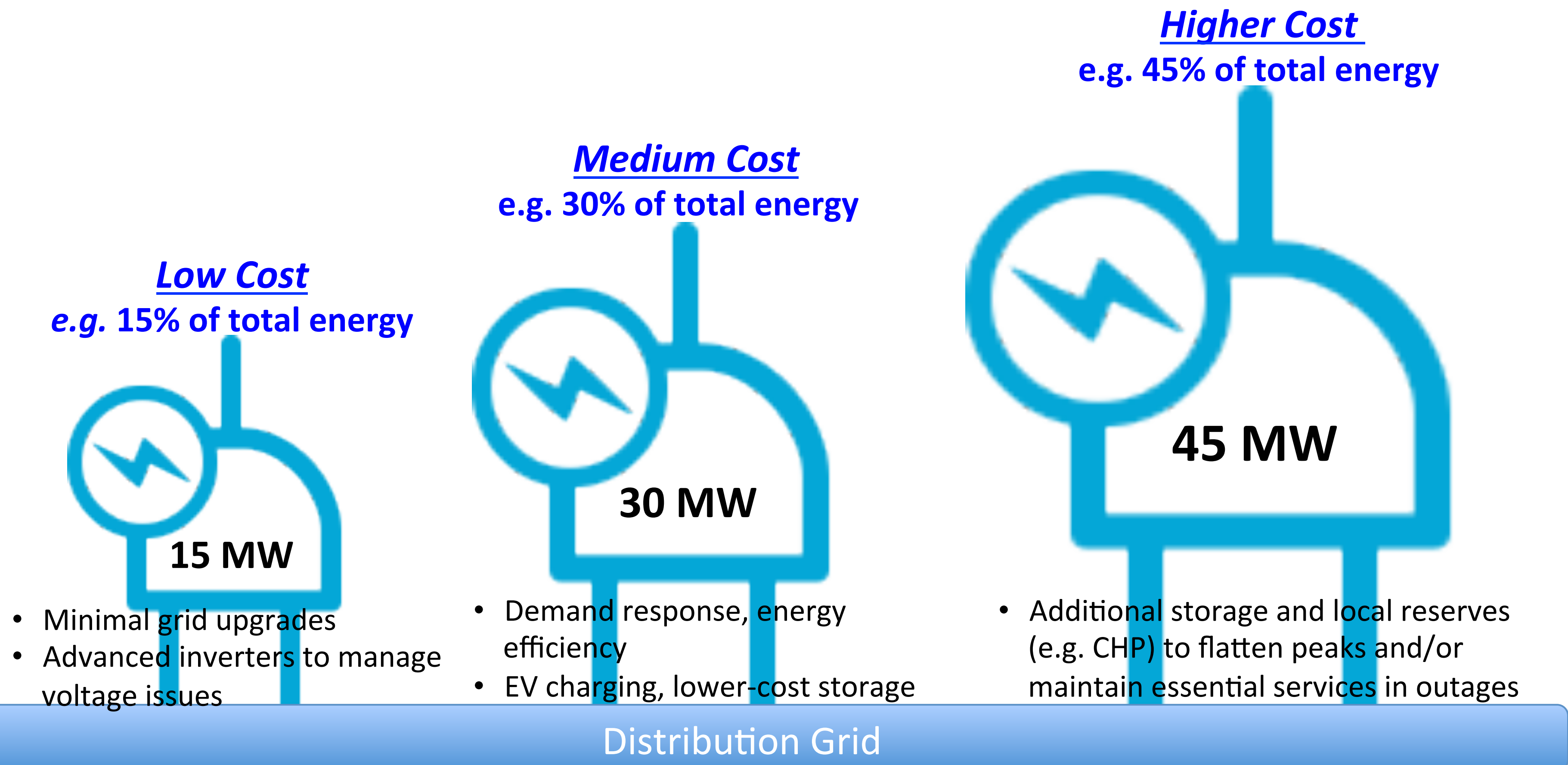
Connecting “one rooftop at a time” is expensive and disruptive. The industry can achieve scale and simplicity by planning for cost-effective local renewable capacity. This “Capacity Planning” enables renewables to connect in bulk – a “Plug-n-Play” model – and is analogous to how the industry plans for transmission capacity. Examples:



Next Steps: Q4 '14 – Q1 '15

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- **Medium DG + DER Capacity**
  - Add lower-cost DER solutions including DR, EE, EV charging, and cost-effective storage to reduce evening ramp, for example
  - Run cost analysis including equipment/T&D deferrals
  - Adjust (increase) local renewables if optimal
- **Higher DG + DER Capacity**
  - Add more storage plus local reserves (e.g. CHP) to further flatten load shapes, simplify transmission needs, and maintain essential services in case of outages
  - Run cost analysis including equipment/T&D deferrals
  - Adjust (increase) local renewables if optimal
- Leading to final reports, including methodology spec and recommendations for scalable and accelerated procurement & interconnection

Peek at the Future of Bayview-Hunters Point

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Ecoplexus project at the Valencia Gardens Apartments in SF. ~800 kW serving ~80% of the total annual load.

Q&A

- Thanks for listening
- Questions, thoughts, ideas?