



Community Microgrid Initiative Overview for LPA

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Mission

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

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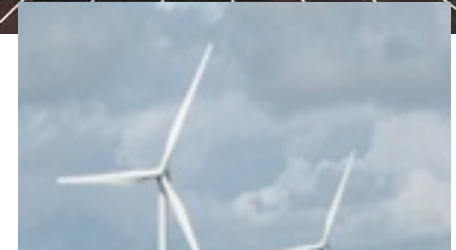
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*Vice Chairman, Galvin Electricity Initiative; Former
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- From 2020 onward, all new electricity generated in the U.S. will come from at least:
 - 80% renewable sources**
 - 50% distributed sources**
- By 2020, established policies and programs will foster successful fulfillment of the above objectives



We have helped bring more than 1 gigawatt of clean local energy online – enough to provide peak power to San Jose.



Wholesale DG is the Critical & Missing Segment

Project Size

50+ MW

500 kW

5 kW

Central Generation

Serves Remote Loads



Wholesale DG
Serves Local Loads



Retail DG

Serves Onsite Loads



Behind the Meter

Distribution Grid

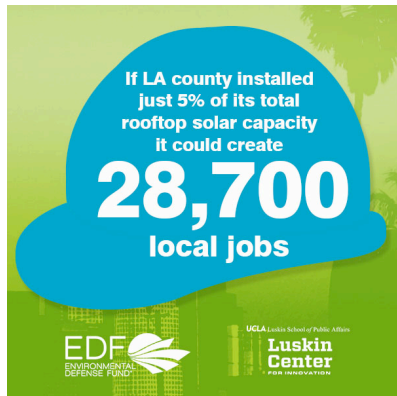
Transmission Grid



Los Angeles

“An enormous opportunity exists for solar energy to expand on California’s rooftops, rather than in its deserts, due to vast areas of undeveloped rooftop space and suitable conditions in California cities.”

UCLA Luskin Center for Innovation, Nov 2013



San Francisco

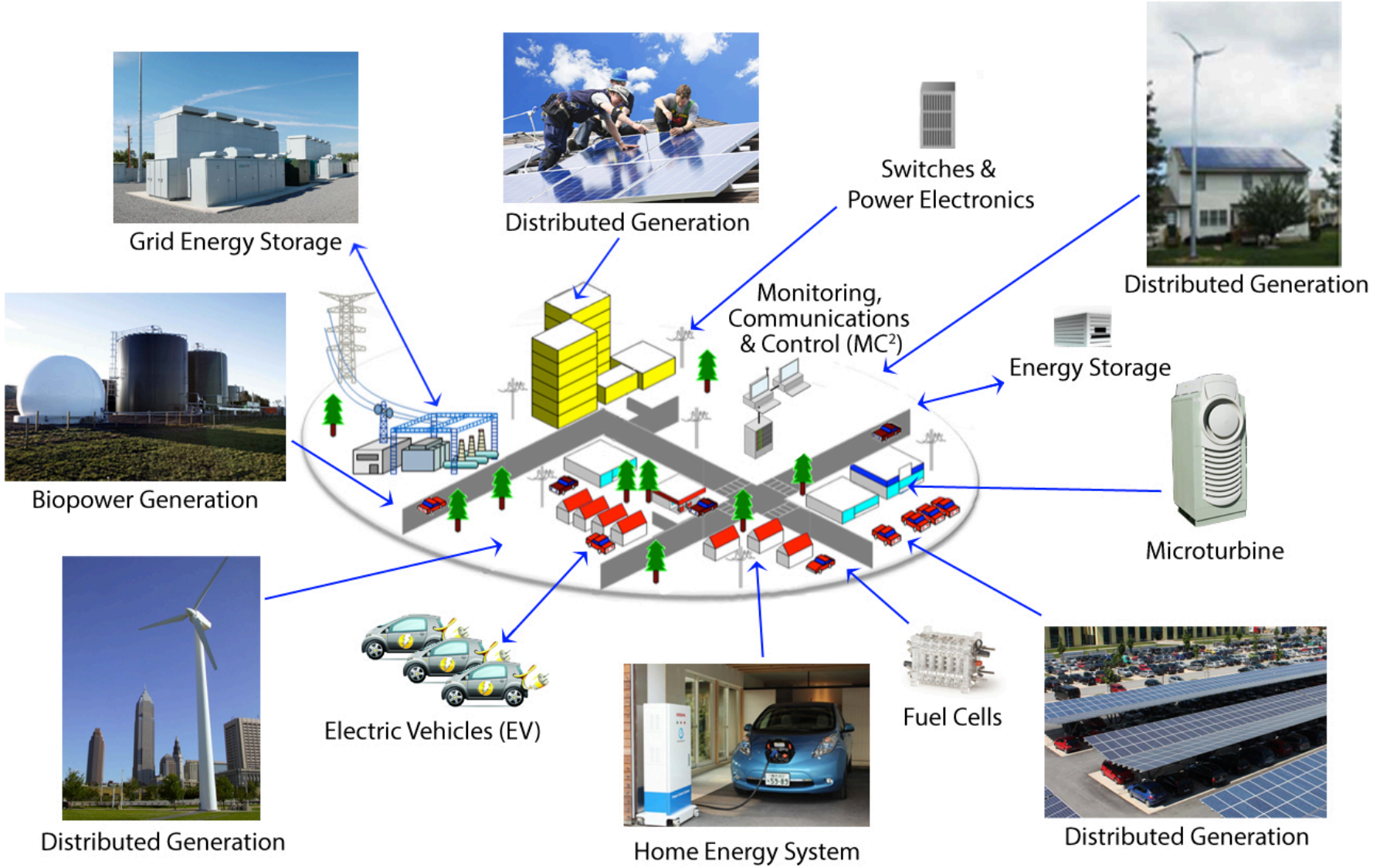
“Significant solar potential exists today in San Francisco – for example, as much as 50 MW of new, local clean energy in the Bayview-Hunters Point area alone – offering substantial economic and environmental benefits.”

Clean Coalition, Dec 2013

50 MW New Solar in Hunters Point Equals:

- \$200M:** Added regional economic stimulation
- \$100M:** Added local wages
- 1,270 Job-Years:** New regional employment
- \$5.8M:** Added state sales taxes

A Modern Power System



1

Accelerate clean energy & sustainability

- Achieve 25% or more of the total energy consumed in a community from local renewables

2

Improve grid reliability & resilience

- Leverage dynamic grid solutions: advanced inverters, demand response, energy storage, and local reserves (e.g. CHP)

3

Optimize for cost-effectiveness

- Across DG, dynamic grid solutions, and physical locations, leading to financially viable deployments

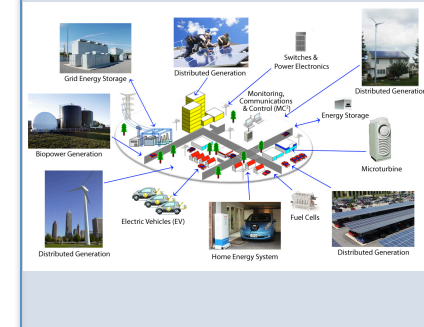
4

Capture local economic benefits

- Secure predictable energy prices, reduce transmission-related costs & inefficiencies, and increase local investment & jobs

Modern Distribution Grid

- More clean energy now
- Improved grid performance
- Stronger long-term economics



Example: A Dynamic Distribution Grid



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

Overview

- Innovative project in the Bayview-Hunters Point area of San Francisco, in collaboration with Pacific Gas & Electric
- Model for achieving 25% of the total energy consumed in the area from local renewables, while maintaining or improving grid reliability and power quality using dynamic grid solutions
- The Hunters Point substation serves ~20,000 customers (about 90% residential, 10% commercial/industrial)



Hunters Point Substation Boundary

Legend

- Red pin: Redev Zone
- Yellow pin: Substation boundary

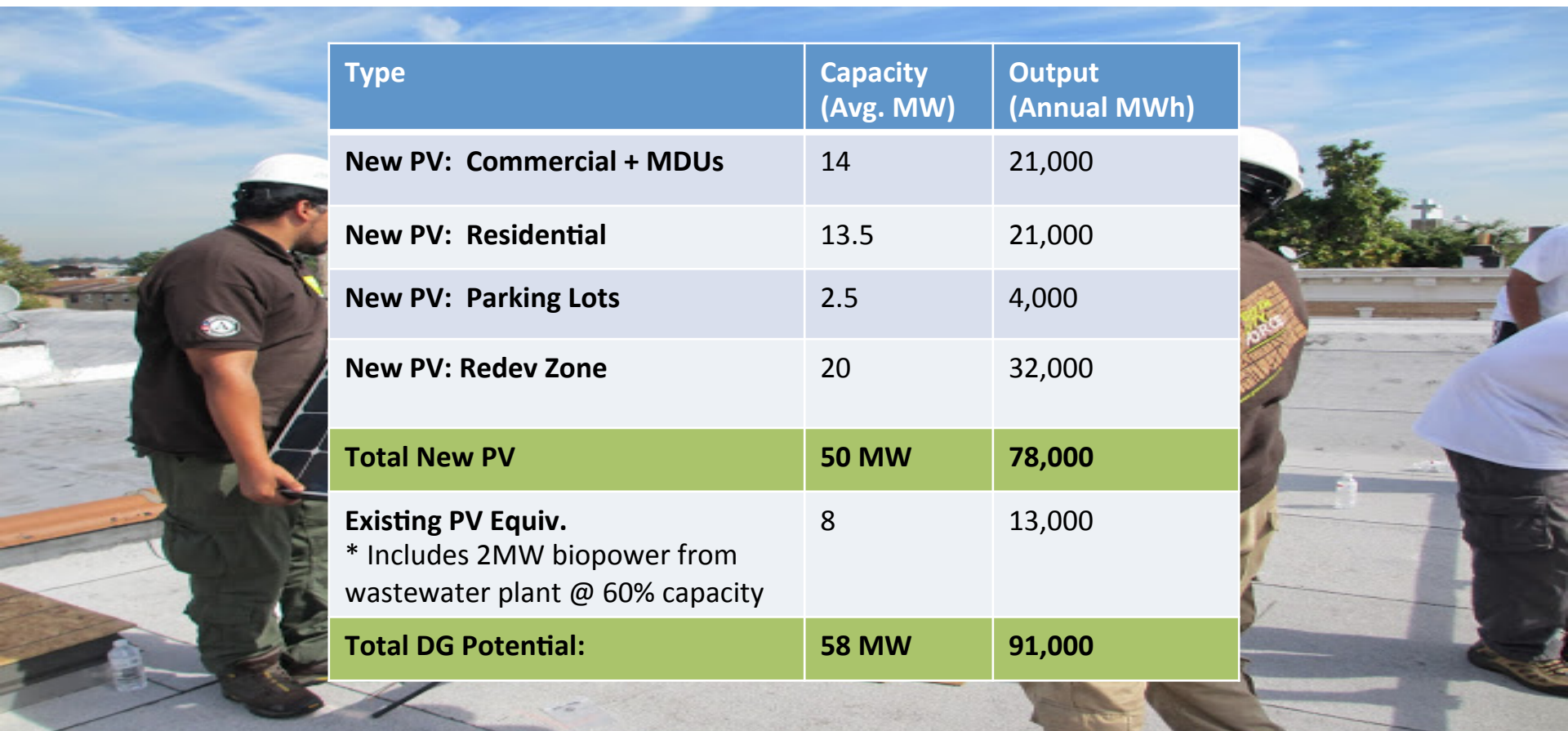


Hunters Point Reasonable DG Potential = 58 MW, Over 25% Total Energy

DG Potential: **Over 25% of Total Load (320,000 MWh)**

- **New PV in Bayview** = 30 MW, or 46,000 MWh
- **New PV in HP Redev Zone** = 20 MW, or 32,000 MWh
- **Existing DG** = 8 MW (PV equivalent), or 13,000 MWh

Type	Capacity (Avg. MW)	Output (Annual MWh)
New PV: Commercial + MDUs	14	21,000
New PV: Residential	13.5	21,000
New PV: Parking Lots	2.5	4,000
New PV: Redev Zone	20	32,000
Total New PV	50 MW	78,000
Existing PV Equiv. * Includes 2MW biopower from wastewater plant @ 60% capacity	8	13,000
Total DG Potential:	58 MW	91,000



Potential PV: Commercial Rooftops + MDUs

Highlights:

- Number of visually-sited highest value “A” sites = **74**
 - Total PV-potential rooftop square feet = **1.6M**
 - Total participating sq. ft. @ 50% = **891K**
- Total average generation, participating rooftops = **14 MW**

Hunters Point Rooftops - Commercial + MDUs

Assumptions

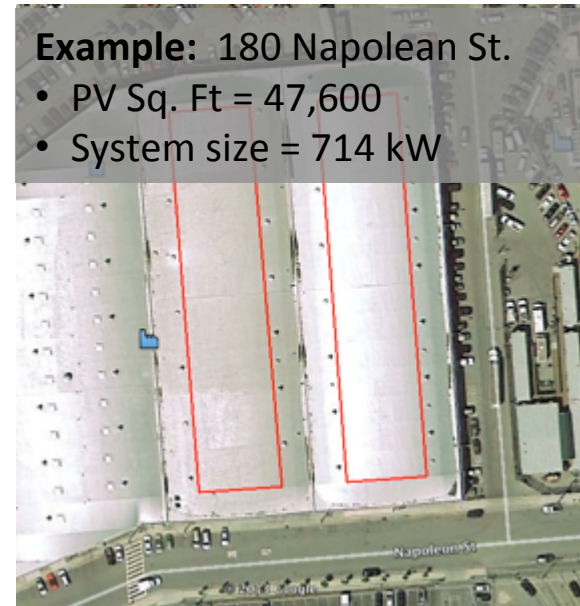
Watts/sq. ft.	15
PV hrs./yr.	1570
Participation Factor	50%

Results

Total Sq. Ft.	1,627,605
Total Sq. Ft. Participating	891,605
Total Watts Participating	13,374,068
Total PV in MW	14
Total PV in Annual MWhr	21,333
Average kW per site	357

Example: 180 Napoleon St.

- PV Sq. Ft = 47,600
- System size = 714 kW



Potential PV: Parking Lots

Highlights:

- Number of visually-sited highest value “A” sites = **13**
- Total PV-potential parking lot square feet = **348K**
 - Total participating sq. ft. @ 50% = **174K**
- Total average generation, participating parking lots = **2.5 MW**

Hunters Point Parking Lots

Assumptions

Watts/sq. ft.	15
PV hrs./yr.	1,570
Participation Factor	50%

Results

Total Sq. Ft.	348,400
Total Sq. Ft Participating	174,200
Total Watts Participating	2,613,000
Total PV in MW	2.5
Total PV in Annual MWh	4,102
Average kW per site	402

Example: 1485 Bay Shore Blvd

- PV Sq. Ft = 37,800
- System size = 567 kW



Potential PV: Residential Rooftops

Highlights:

- Total residential sites = 14,000
- Average PV-viable square feet per residence (from 50 sites) = **343**
 - Total PV-potential residential square feet = **3.6M**
 - Total participating sq. ft. @ 25% = **900K**
- Total average generation, participating rooftops = **13.5 MW**

Hunters Point Rooftops - Residential

Assumptions

Watts/sq. ft.	15
PV hrs./yr.	1570
Participation Factor	25%

Results

Total HH	14,000
Average PV-viable sq. ft. per HH	257
Total PV-viable Sq. Ft.	3,601,920
Total PV-viable Sq. Ft. Participating	900,480
Total PV in Watts	13,507,200
Total PV in MW	13.5
Total PV in Annual MWh	21,206
Average PV system size per HH, kW	4

Example: 50 average rooftops

- Average PV Sq. Ft = 343
- Average system size = 5 kW



\$200M in Private Investment + Operations & Maintenance Over 20 Yrs. Equals:



Photo courtesy of GRID Alternatives

Economic Benefits



\$200M: Added regional economic stimulation

\$100M: Added local wages, near-term plus annual

1,270 Job-Years: New near-term regional employment

520 Job-Years: New ongoing regional employment

\$10M: Site leasing income for property owners

\$5.8M: Added construction-related state sales taxes

\$200M in Private Investment + Operations & Maintenance Over 20 Yrs. Equals:



Photo courtesy of GRID Alternatives

Energy Benefits



Cost Parity: Solar vs. combined cycle natural gas, LCOE

\$260M: Energy dollars spent on local vs. remote generation

\$38M: Avoided transmission access charges

\$30M: Avoided costs for new transmission capacity

\$12M: Avoided costs from transmission line losses

\$30M: Avoided costs from reducing power interruptions

\$200M in Private Investment + Operations & Maintenance Over 20 Yrs. Equals:



Photo courtesy of GRID Alternatives



Environmental Benefits

78M lbs.: Annual reductions in GHG emissions

- 6,660: Equivalent in cars removed
- 8,720: Equivalent emissions offset, # of homes

15M Gallons: Annual water savings

375: Acres of land preserved

Hunters Point Project Deliverables

DG Survey

- Identified 50 MW of new PV potential: commercial, residential, parking lots
- Existing DG includes 2 MW wastewater biopower (6.5 MW PV equiv.)



Benefits Analysis

- DG Economic: \$200M in local stimulus, \$100M going to local wages
- DG Environmental: 78M lbs. of GHG eliminated per year, 15M gallons of water saved per year, 375 acres of land preserved



Baseline Model

- Required data sets and circuit model from PG&E
- Model of existing powerflow, validated by PG&E

2Q 2014

Optimized Scenarios

- Optimal mix of DG, dynamic grid solutions, and physical locations
- Cost-optimized scenarios

3Q 2014

Results

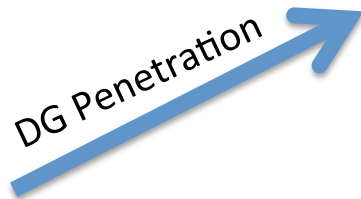
- Standardized reports, modeling, and methodologies, setting the stage for implementation (Phase 2) and industry-wide scalability
- Streamlined & scalable procurement & interconnection

4Q 2014

“Plug-n-Play” Deployment Opportunity

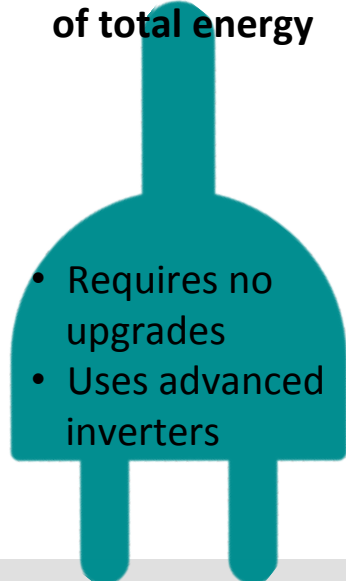
Planning for local capacity in the distribution grid, then upgrading the grid as appropriate, enables “Plug-n-Play” distributed energy – creating scale and simplicity.

DG connects in bulk quantities based on defined substation targets and locations. For example:



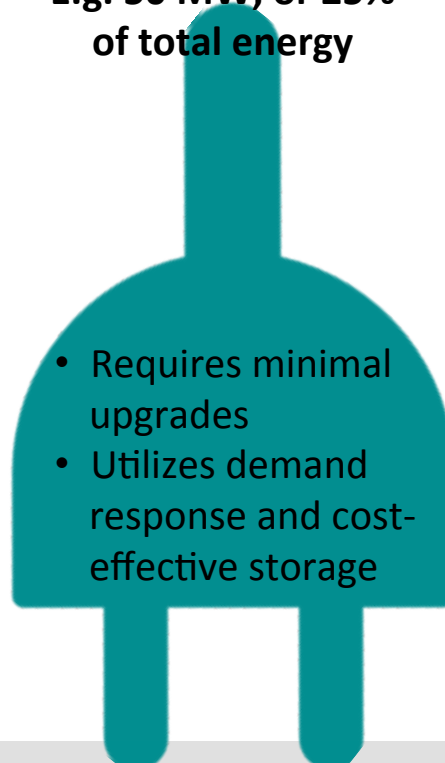
1. No Cost

E.g. 25 MW, or 10% of total energy



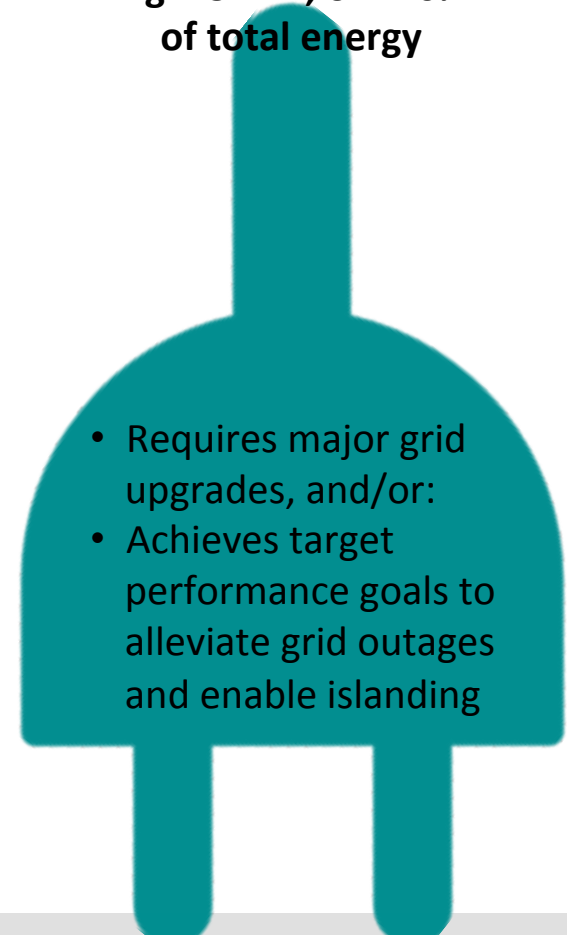
2. Low Cost

E.g. 50 MW, or 25% of total energy



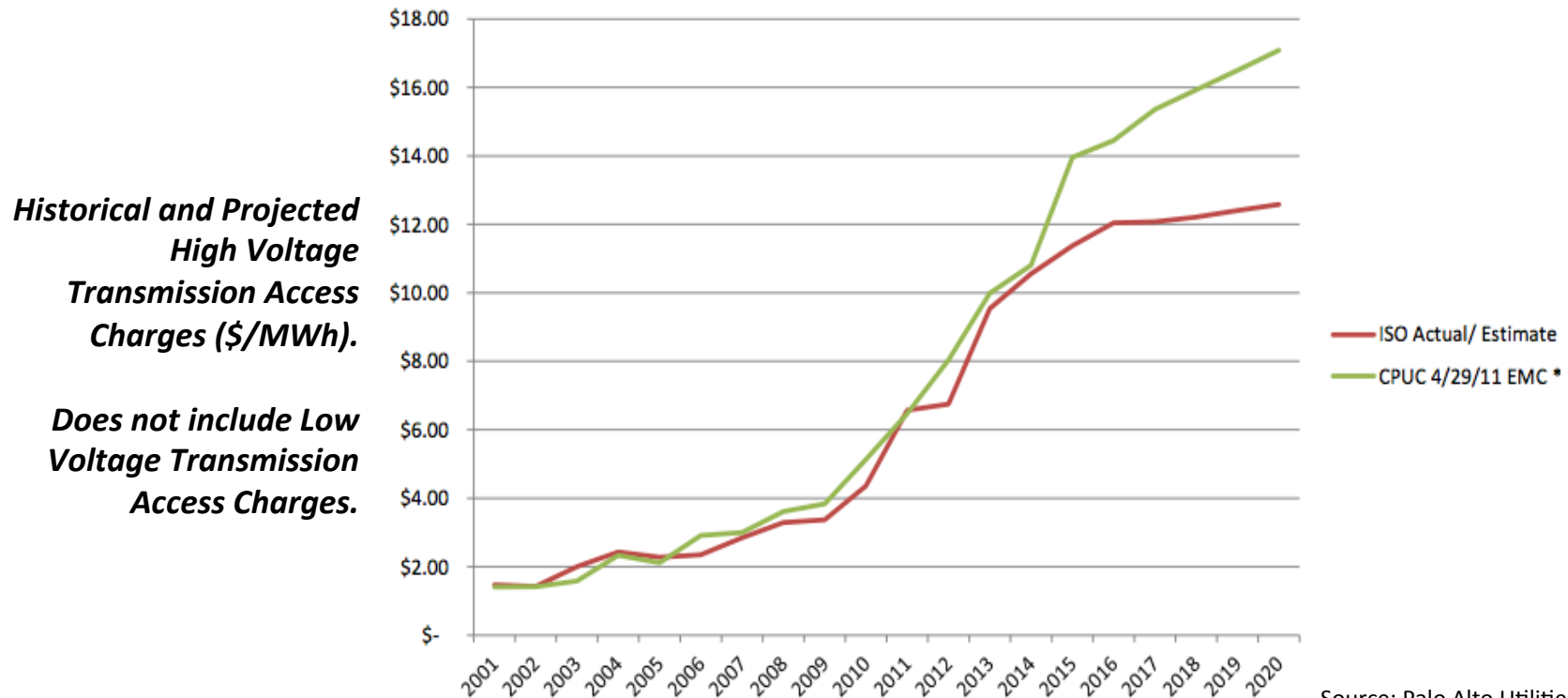
3. More Cost

E.g. 75MW, or >40% of total energy



Opportunity: Shift Costs from Transmission to Distribution

- Under a business as usual scenario, new incremental transmission investments will reach **\$80 billion** over the next 20 years, imposed on California ratepayers
- Levelized over 20 years, this approaches **3 cents/kWh** – or roughly 25% of the wholesale cost of electricity, or 33% of the energy price of centralized solar
- Avoiding half of these charges, for example, would **free up roughly \$40 billion** for modernizing the distribution grid incl. local renewables, storage, etc.

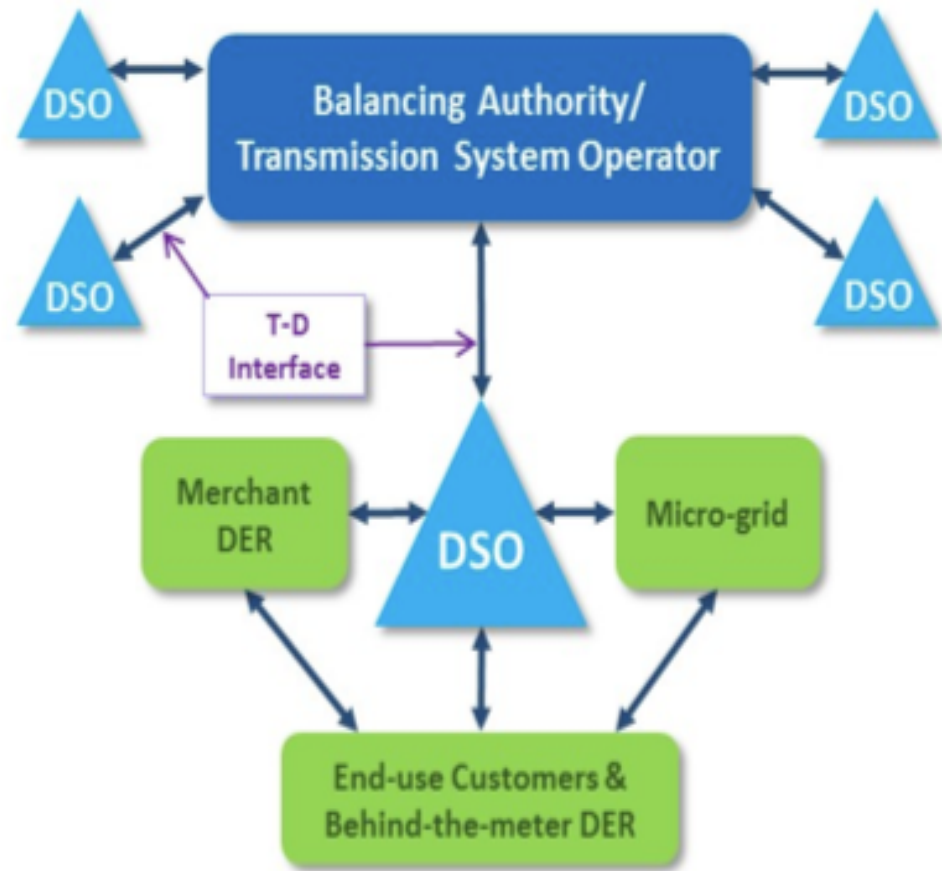


Utility of the Future: “Distribution System Operator”

The Distribution System Operator (DSO) will:

- ▶ In real time, reliably operate the local distribution system, optimizing all Distributed Energy Resources (DER): micro-grids, diverse small-scale generation, self-optimizing customers, energy storage, power flow control devices, demand response, etc.
- ▶ Create a more stable and predictable interchange with the Transmission System Operator (TSO) that relies on more local balancing of resources

Future “Integrated Distributed” Electricity System (High-DER, Multi-directional energy flows & Multi-level optimizations)



Source: 21st Century Electric Distribution System Operations, May 2014

Peek at the Future of Bayview-Hunters Point



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