Clean Coalition

Making Clean Local Energy Accessible Now

PERFECT POWER INSTITUTE™

Community Microgrids

Creating a resilient power system with new utility business opportunities

Presenters

Greg Thomson
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Clean Coalition

John Kelly
Executive Director
Perfect Power Institute

ENERGY EFFICIENCY AND ENVIRONMENT | RELIABILITY, POWER QUALITY AND SAFETY | ENABLING CUSTOMER ACTION | OPERATIONAL EFFECTIVENESS

PEER™

Performance Excellence in Electricity Renewal

Empowering Utilities

Leveraging a Microgrid Approach

PERFECT POWER INSTITUTE™

Overview

- Who is PPI and what is PEER?
- What is a community/ utility microgrid?
- Why would a utility pursue a microgrid approach?
- How to ensure utility/ratepayer benefit?

BACKGROUND PERFECT POWER INSTITUTE

PPI Executive Advisory Committee

John Estey
CEO
S&C Electric Company

Clyde Kofman
Senior VP
Underwriters Laboratory

Suedeen Kelly
Partner Akin Gump
former FERC Com.

Anne Pramaggiore
CEO ComEd

Paul O'Neill
former CEO Alcoa &
Secretary of Treasury

John W. Rowe
Former Chairman and CEO
Exelon

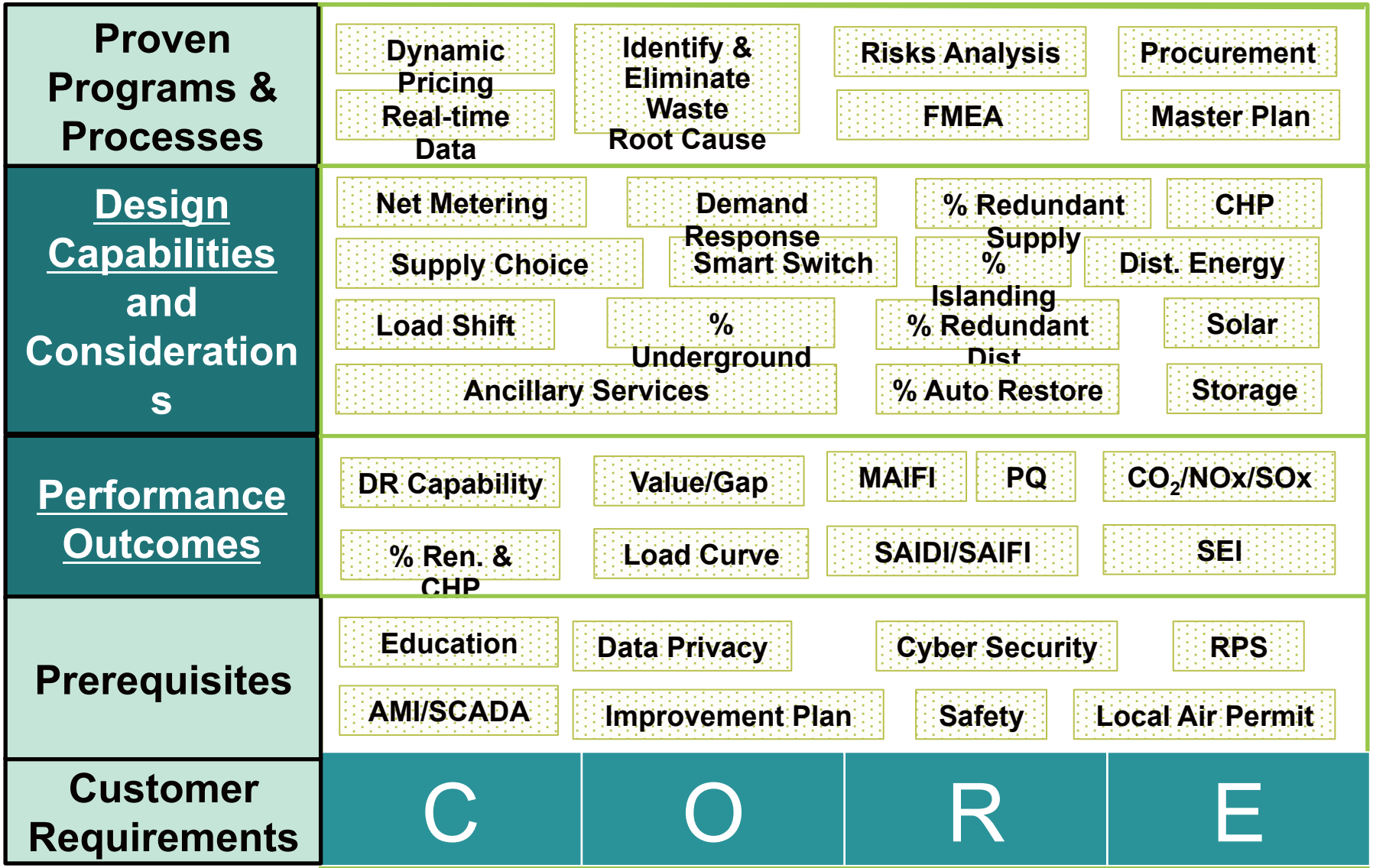
Defining Sustainable Power to Facilities

Sustainable design and assessment systems like LEED and PEER™ help industry professionals build the capability to transform industries and stimulate innovation.

Performance Excellence in Electricity Renewal ™

LEED, Energy Star, BPI

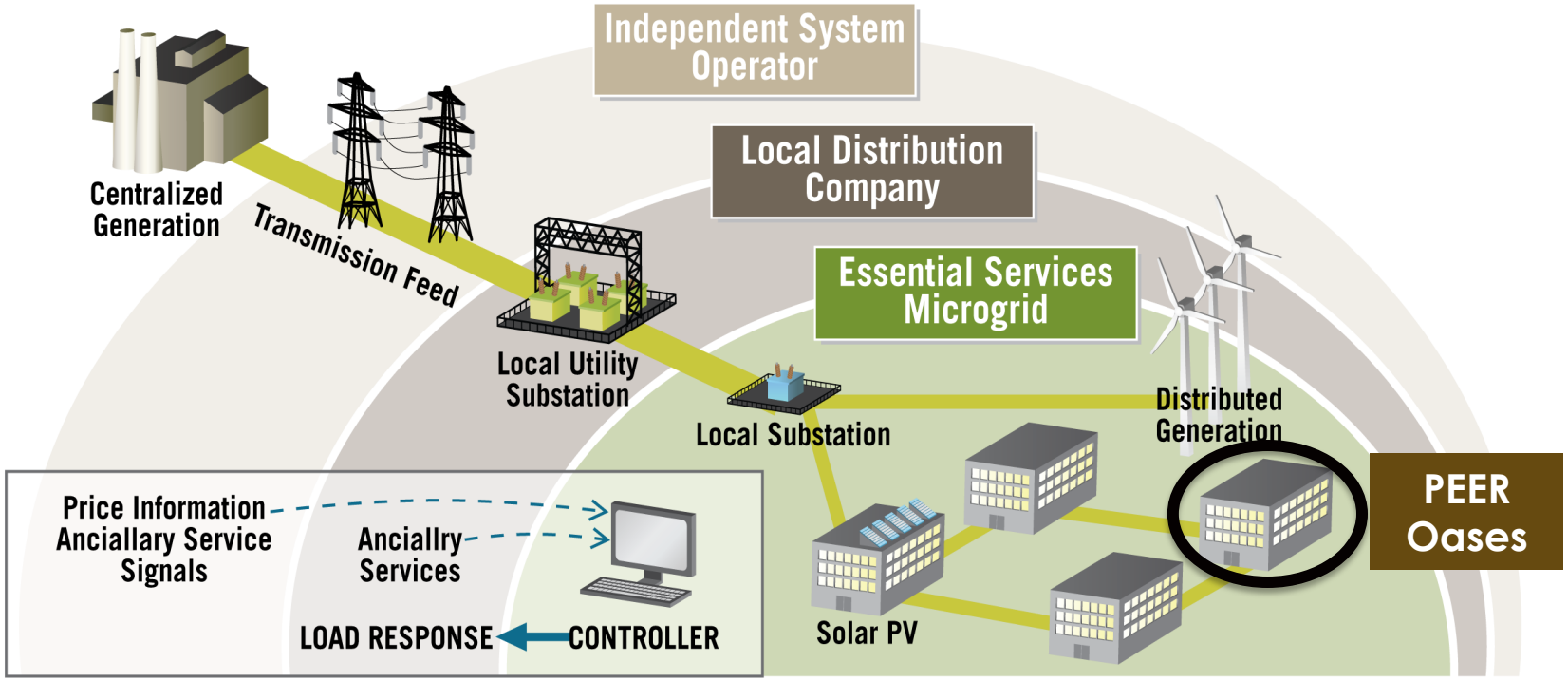
PEER™ BUILDING BLOCKS FOR SUSTAINALBE POWER



Microgrid Architecture

ISO (Federal) ▶ Utility (State) ▶ Microgrid (City)

- Utilities – cities (i.e. substation level)
- Private – campus, developments



Essential Services Microgrids help utilities achieve higher levels of performance by responding to signals and providing value-added services back to the bulk grid.

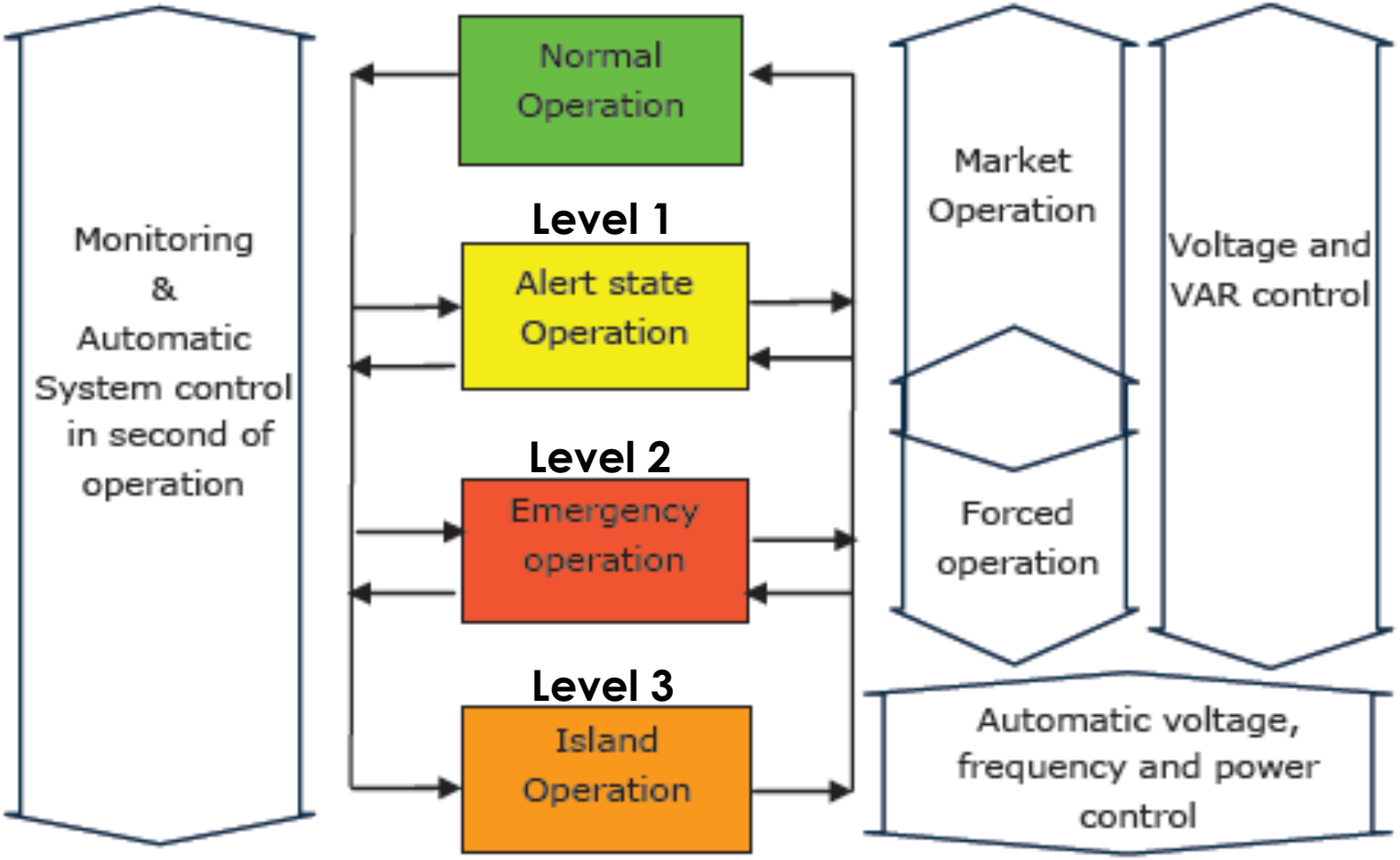
Microgrid Architecture

What is the Microgrid Architecture?	The microgrid architecture divides the electricity system into a network of smaller nodes that serve a distinct set of customers co-located or otherwise operating as a unit (development or city).
What is a Utility Microgrid?	A utility microgrid serves a distinct subset of customers within a defined geographic or functional boundary. Examples of utility microgrids include municipal utilities as well as cities and counties served by larger public utilities.
What is a Private Microgrid?	Private microgrids own the local power and thermal distribution systems that connect or network customers and/or buildings to improve power sustainability while generating revenue by providing grid services.
What is Facility Resiliency or PEER Oases™?	Buildings or microgrids capable of islanding critical public services during a grid outage. PEER Oases™ provide for islanding physical protection, communications with emergency response teams, cyber security, and diesel power backup for life safety.

Utility Microgrid Objectives

- Leverage local government resources and investment
  - Tree trimming, buried utilities, ComEd Rider LGC
- Leverage private investment in islanding for critical facilities, price response, and power quality service
  - Targeted tariffs such as DR, grid service payments, and TOU pricing (e.g. tiered and real-time)
- Justify need for increased grid modernization investment and new services:
  - Thermal distribution
  - Generation at substation for grid service
  - Utility microgrid controller

Utility Master Controller



http://www.energynautics.com/downloads/publikationen/Paper_Energynautics_Overview_Danish_Cell_Project.pdf

Utility and Ratepayer Objectives

- Power key facilities when the grid is lost
- Customer services
- Provide grid services
- Create a price responsive market and reduce market power
- Protect utility business model

- **Police/Fire**
- **Medical Center**
- **Assisted Living**
- **Schools**
- **Communications**
- **Shelters**
- **Hotels**
- **Fuel Stations**
- **Water, Waste Water, Flood Protection**
- **Residential Towers**

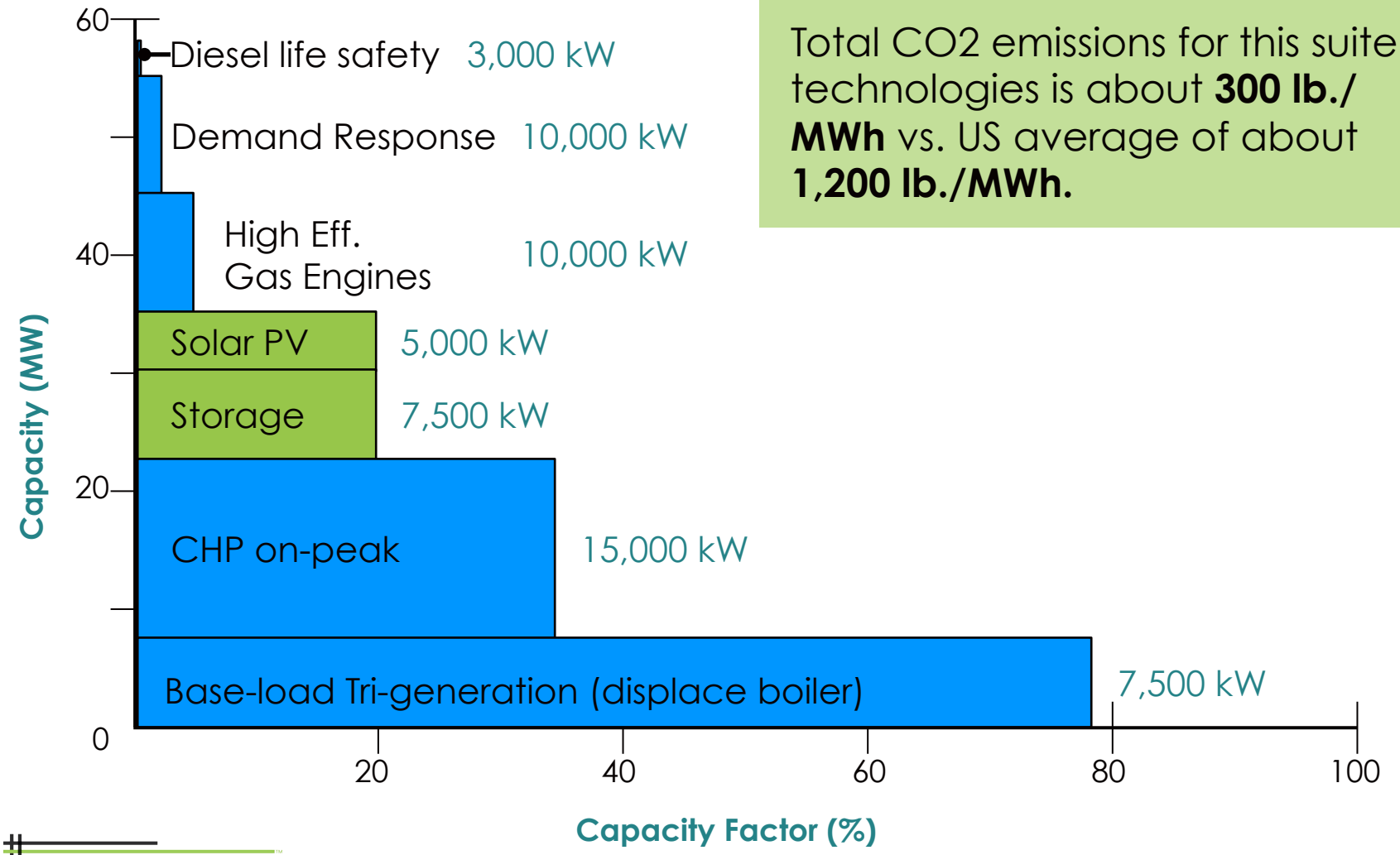
Grid Services

- ISO ancillary Services
- Price response
- Utility grid support (voltage, VAR's)
- Reduce peak demand and cost

Customer Services

- Lower cost
- Higher levels of power energy efficiency
- Lower emissions
- Renewable generation

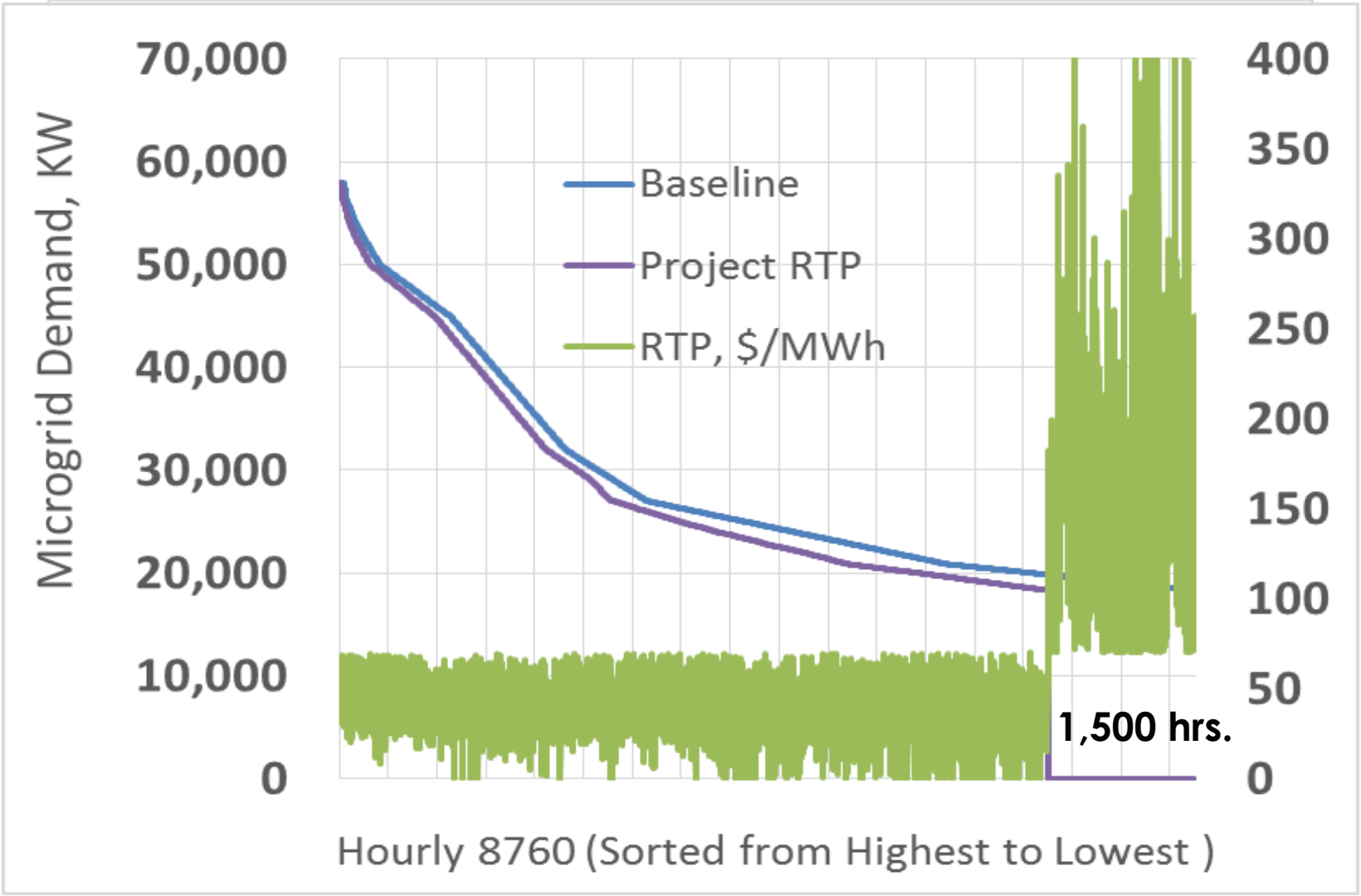
Microgrid Capability Case 1



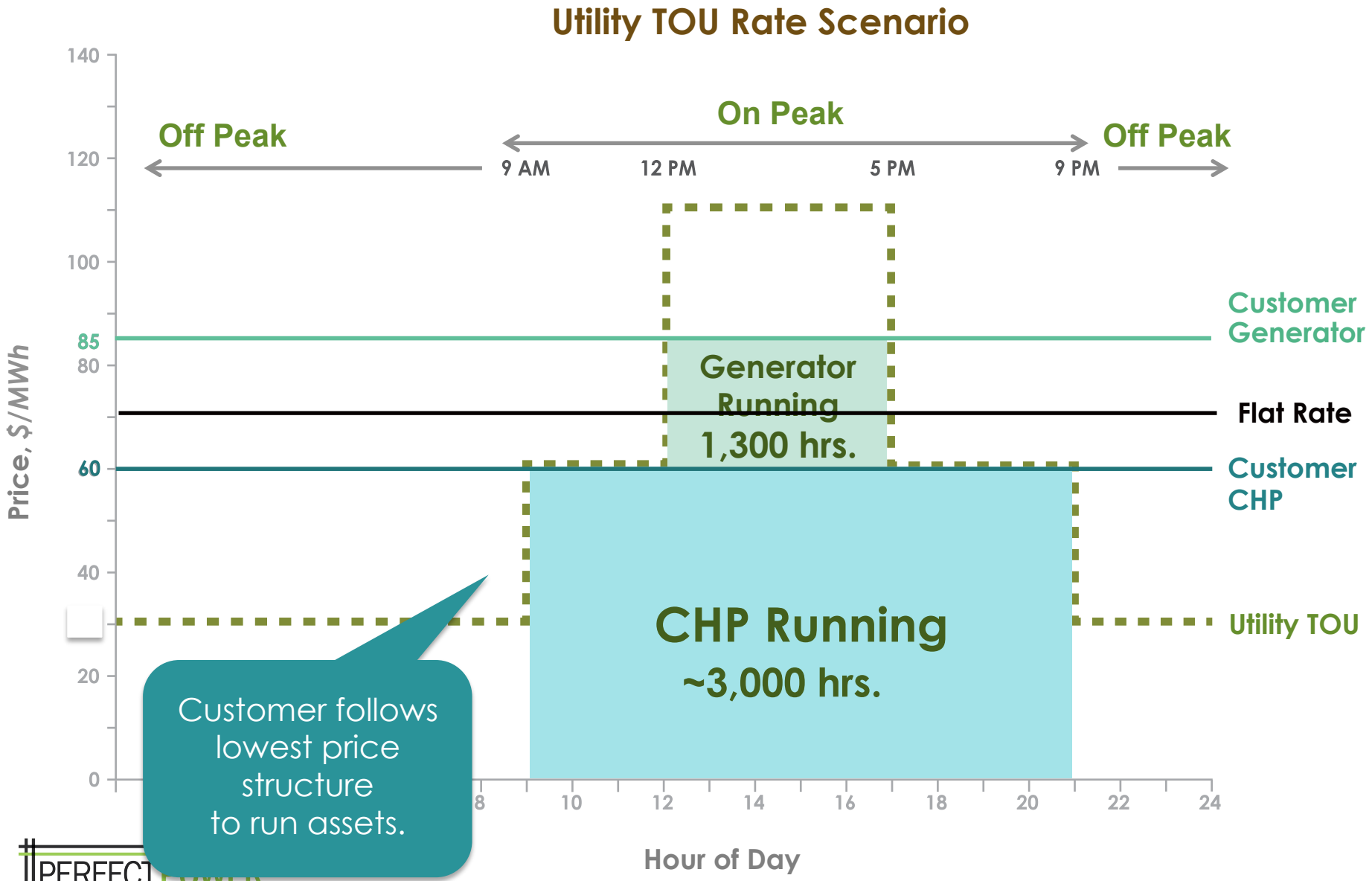
Total CO2 emissions for this suite of technologies is about **300 lb./MWh** vs. US average of about **1,200 lb./MWh.**

Utility Control Through Tariff

Real-time price (RTP)



Managing Customer Generation



Leveraging Customers

Pecan Street Consortium

BEST BUY

freescale™ semiconductor

intel

Landis+Gyr manage energy better

LG

ORACLE

SONY

SunEdison simplifying solar

Texas Gas Service A DIVISION OF ONEOK

Whirlpool

Summary/ Utility Microgrid Pilot

- Microgrid architecture and mapping (substation focus)
- Performance assessment and prioritization
- Planning with local governments – resource coordination
  - Smart grid goals and gaps
  - Priority circuits, undergrounding, tree trimming, power quality
  - Identifying and protecting critical facilities
- Targeted tariffs to attract city and private investment while protecting utility business model and ratepayer
  - Rider LGC: enabling local governments to invest
  - Islanding at critical facilities: DR, dynamic rates, grid service
- Utilities as the integrator (utility master controller)

Leverage PEER™

- To define sustainable power and establish a standard that justifies investment
  - Design guide
  - Project certification
  - Measurement and verification
  - Independent verification of benefits
- Educate staff, suppliers, regulators/legislators and stakeholders
  - One day PEER Associate course
  - Professional certificate of completion

Clean Coalition

Making Clean Local Energy Accessible Now

Community Microgrid Initiative

Overview

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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

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

Jeff Brothers
CEO, Sol Orchard

Jeffrey Byron
Vice Chairman National Board of Directors, Cleantech Open; Former Commissioner, CEC

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Patricia Glaza
Principal, Arsenal Venture Partners

Mark Z. Jacobson
Director of the Atmosphere/Energy Program & Professor of Civil and Environmental Engineering, Stanford University

Dan Kammen
Director of the Renewable and Appropriate Energy Laboratory at UC Berkeley; Former Chief Technical Specialist for RE & EE, World Bank

Fred Keeley
Treasurer, Santa Cruz County, and Former Speaker pro Tempore of the California State Assembly

Felix Kramer
Founder, California Cars Initiative

Amory B. Lovins
Chairman and Chief Scientist, Rocky Mountain Institute

L. Hunter Lovins
President, Natural Capitalism Solutions

Ramamoorthy Ramesh
Founding Director, DOE SunShot Initiative

Governor Bill Ritter
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**
  - **50% distributed sources**
- By 2020, established policies and programs will foster successful fulfillment of the above objectives

A Modern Power System

Clean Coalition

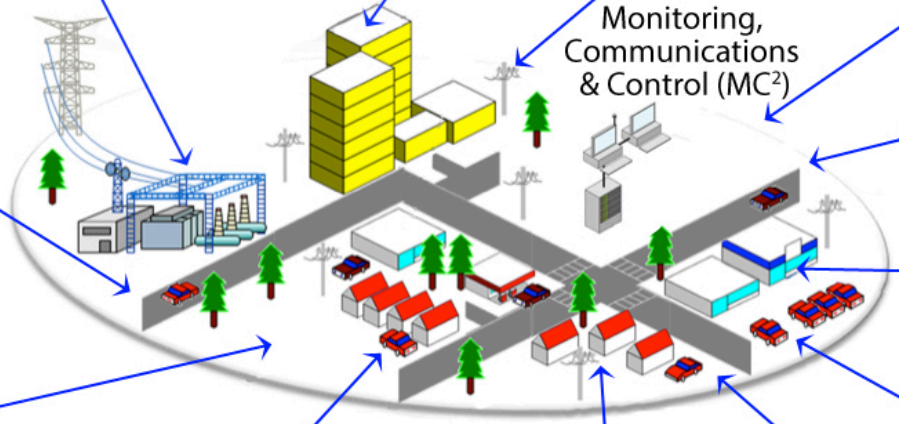
Grid Energy Storage

Distributed Generation

Switches & Power Electronics

Distributed Generation

Biopower Generation



Monitoring, Communications & Control (MC^2)

Energy Storage

Microturbine

Distributed Generation

Electric Vehicles (EV)

Home Energy System

Fuel Cells

Distributed Generation

Wholesale DG is the Critical & Missing Segment

Clean Coalition

Project Size

50+ MW

500 kW

5 kW

Wholesale DG

Serves Local Loads

Central Generation

Serves Remote Loads

Retail DG

Serves Onsite Loads

Behind the Meter

Distribution Grid

Transmission Grid

Distributed Renewable Potential: Examples

Clean Coalition

Los Angeles

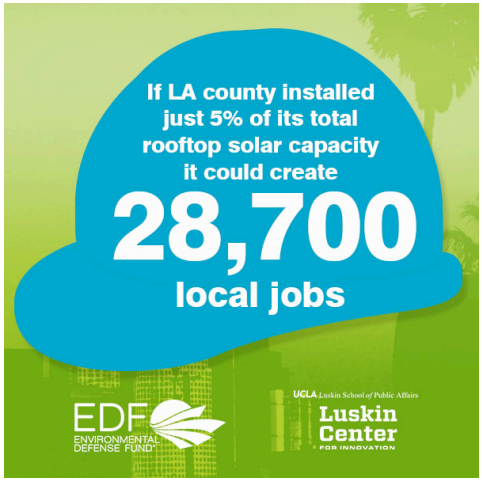
"An enormous opportunity exists for solar energy to expand on California's rooftops, rather than in its deserts, due to vast areas of undeveloped rooftop space and suitable conditions in California cities."

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:

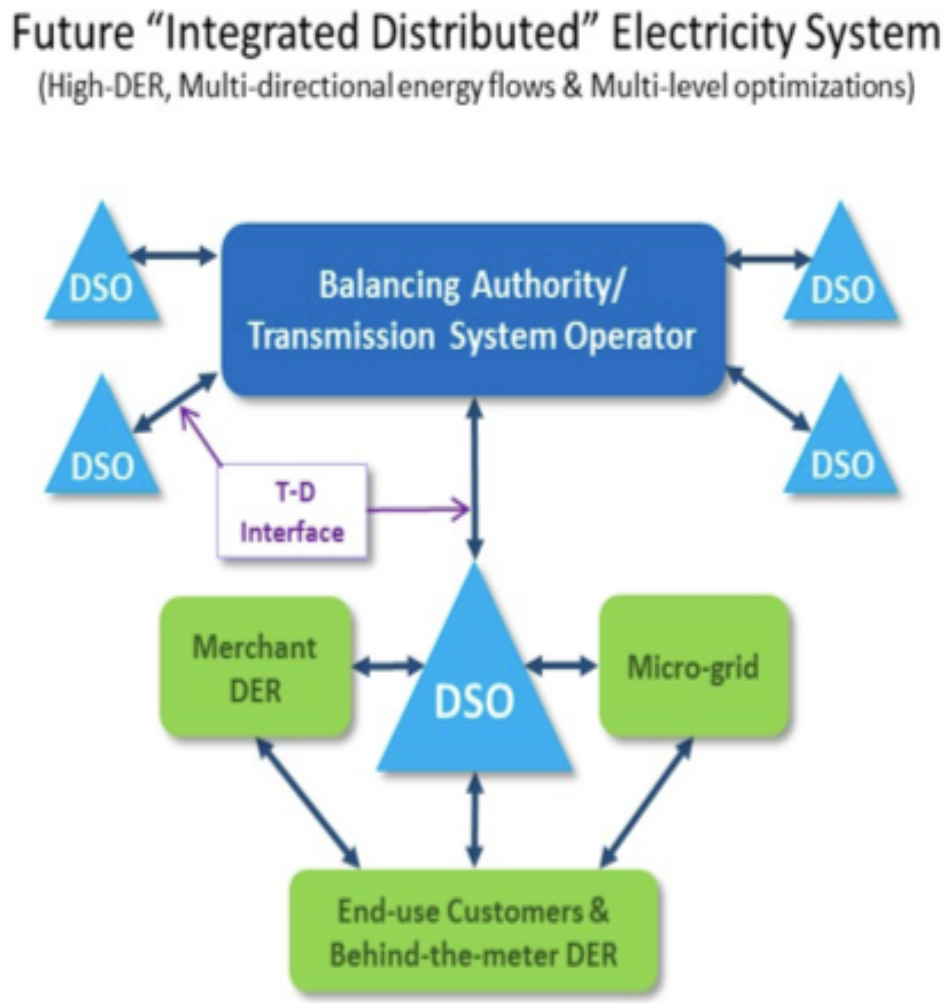
- **$200M:** Added regional economic stimulation
- **$100M:** Added local wages
- **1,270 Job-Years:** New regional employment
- **$5.8M:** Added state sales taxes

Utility of the Future: "Distribution System Operator"

Clean Coalition

"The Distribution System Operator (DSO) will:

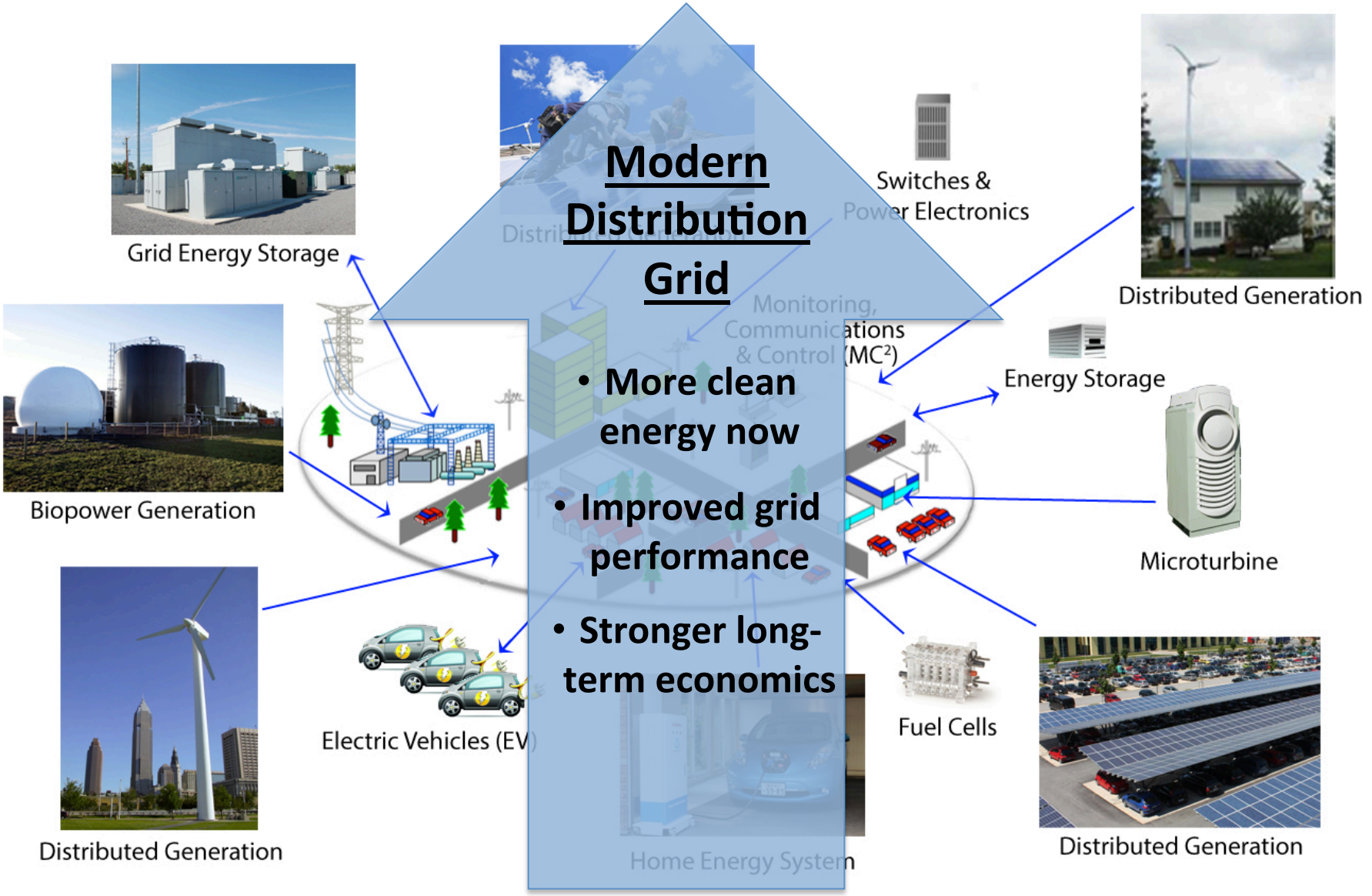
- In real time, reliably operate the local distribution system, optimizing all Distributed Energy Resources (DER)…"
- DER includes micro-grids, diverse small-scale generation, self-optimizing customers, energy storage, power flow control devices, demand response, etc…."
- This creates a more stable and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



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

Community Microgrid: Solution for Today

Clean Coalition



Community Microgrid Initiative: Objectives

1. **Bring high levels of local renewables to communities & utilities while maintaining or improving grid reliability and power quality**

2. **Demonstrate financially and technically feasible solutions that achieve industry adoption and scale**

3. **Partner with utilities, utility commissions, technology providers, and other community stakeholders to accelerate deployments**

4. **Strengthen local economies through community investment, more stable energy prices, and reduced transmission-related costs**

Example: A Dynamic Distribution Grid

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

Opportunity to Achieve Scale via "Plug-n-Play"

Clean Coalition

Planning the grid to support local generation, then upgrading the grid as needed, delivers scale, simplicity and "Plug-n-Play" deployment opportunities.

Local renewables connect in bulk based on defined distribution grid targets and locations. For example:

1. No Cost
E.g. 25 MW, or 15% of total energy

- Requires no upgrades
- Uses advanced inverters

2. Low Cost
E.g. 50 MW, or 30% of total energy

- Requires minimal upgrades
- Utilizes demand response and cost-effective storage

3. More Cost
E.g. 75MW, or 45% of total energy

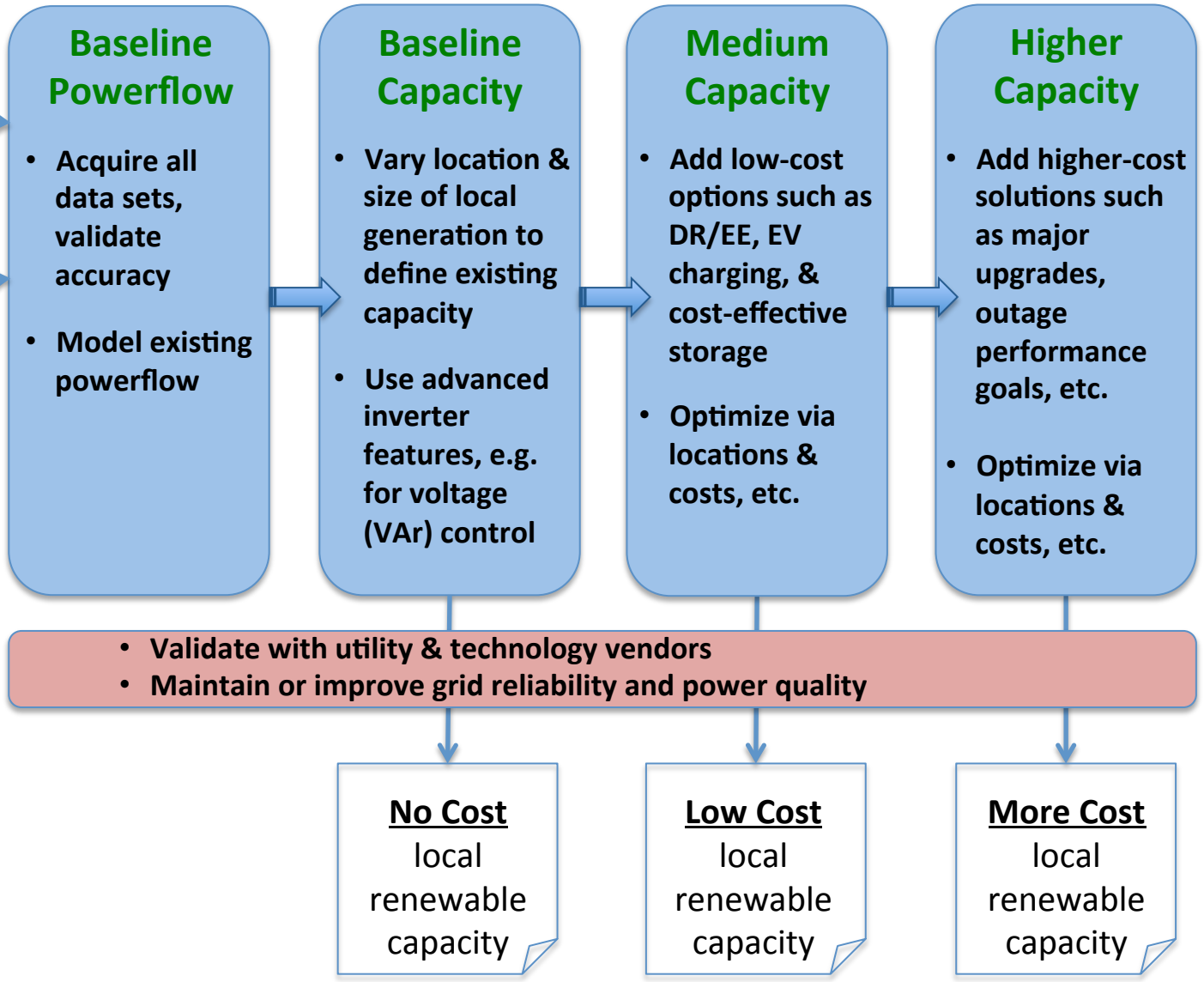
- Requires major grid upgrades, and/or:
- Achieves target performance goals to alleviate grid outages and enable islanding

Community Microgrid Optimization

Clean Coalition

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.
- Product performance specs, e.g. storage



Hunters Point Community Microgrid Project

Clean Coalition

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

Hunters Point Potential: 50 MW of New PV Achieving Over 25% Total Energy

Clean Coalition

Energy Benefits Over 20 Years

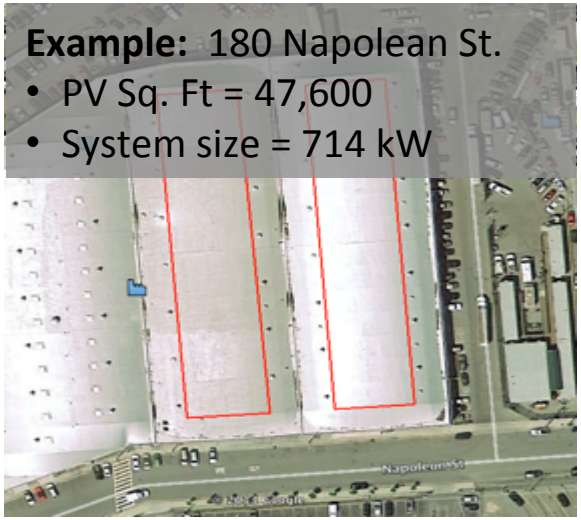
Cost Parity: Solar vs. combined cycle natural gas, LCOE

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

$80M: Avoided transmission-related costs

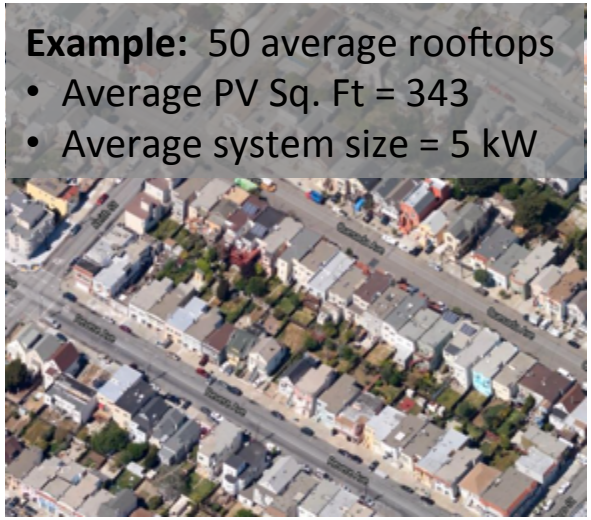
$30M: Avoided costs from reducing power interruptions

Commercial: 14 MW



Parking Lots: 2.5 MW

Residential: 13.5 MW



Total: Existing Structures @ 30 MW + Redev Zone @ 20 MW = 50 MW

Hunters Point Project Deliverables & Status

Clean Coalition

Local Renewable Survey	• Identified 50 MW of new PV potential: commercial, residential, parking lots • Existing renewables 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	✔
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

Peek at the Future of Bayview-Hunters Point

Clean Coalition

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