Clean Coalition

Making Clean Local Energy Accessible Now

The Community Microgrid Initiative:

The path to resilience and sustainability

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Clean Coalition

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Clean Coalition (nonprofit) mission

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

Expertise areas

Analysis & Planning

Full cost and value accounting for DER; siting analysis

- PG&E
- PSEG
- SCE

Grid Modeling & Optimization

Powerflow modeling; DER optimization

- PG&E
- PSEG
- SCE

Program and Policy Design

Grid planning, procurement, and interconnection

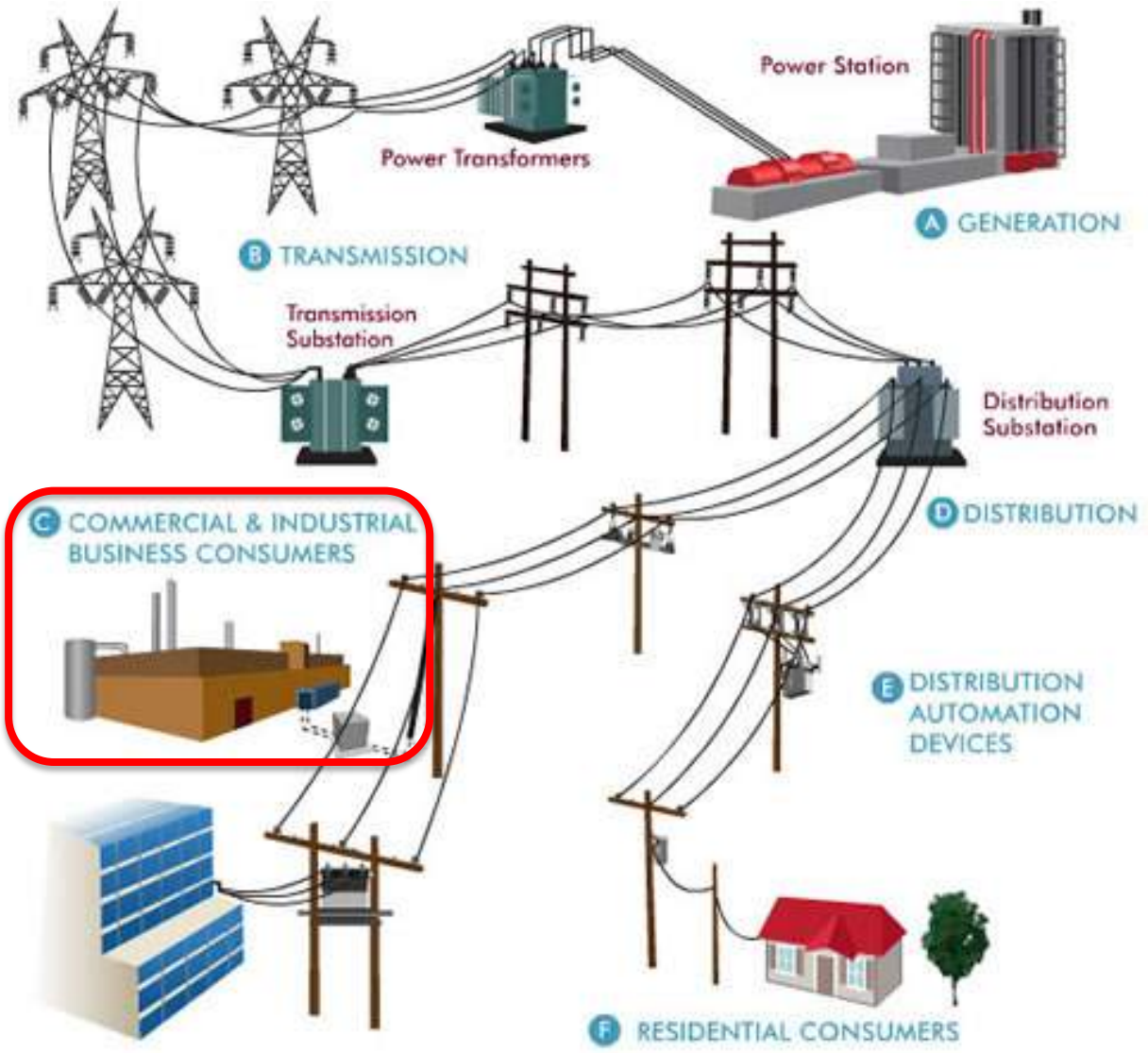
- LADWP, Fort Collins, PSEG
- City of Palo Alto (FIT and solar canopy RFP)
- RAM, ReMAT
- Rule 21 & FERC

Community Microgrid Projects

Design and implementation

- San Francisco, CA
- Long Island, NY
- Montecito, CA
- U.S. Virgin Islands

Traditional microgrids focus on single customers



Source: Oncor Electric Delivery Company

Community Microgrids serve up to thousands of customers

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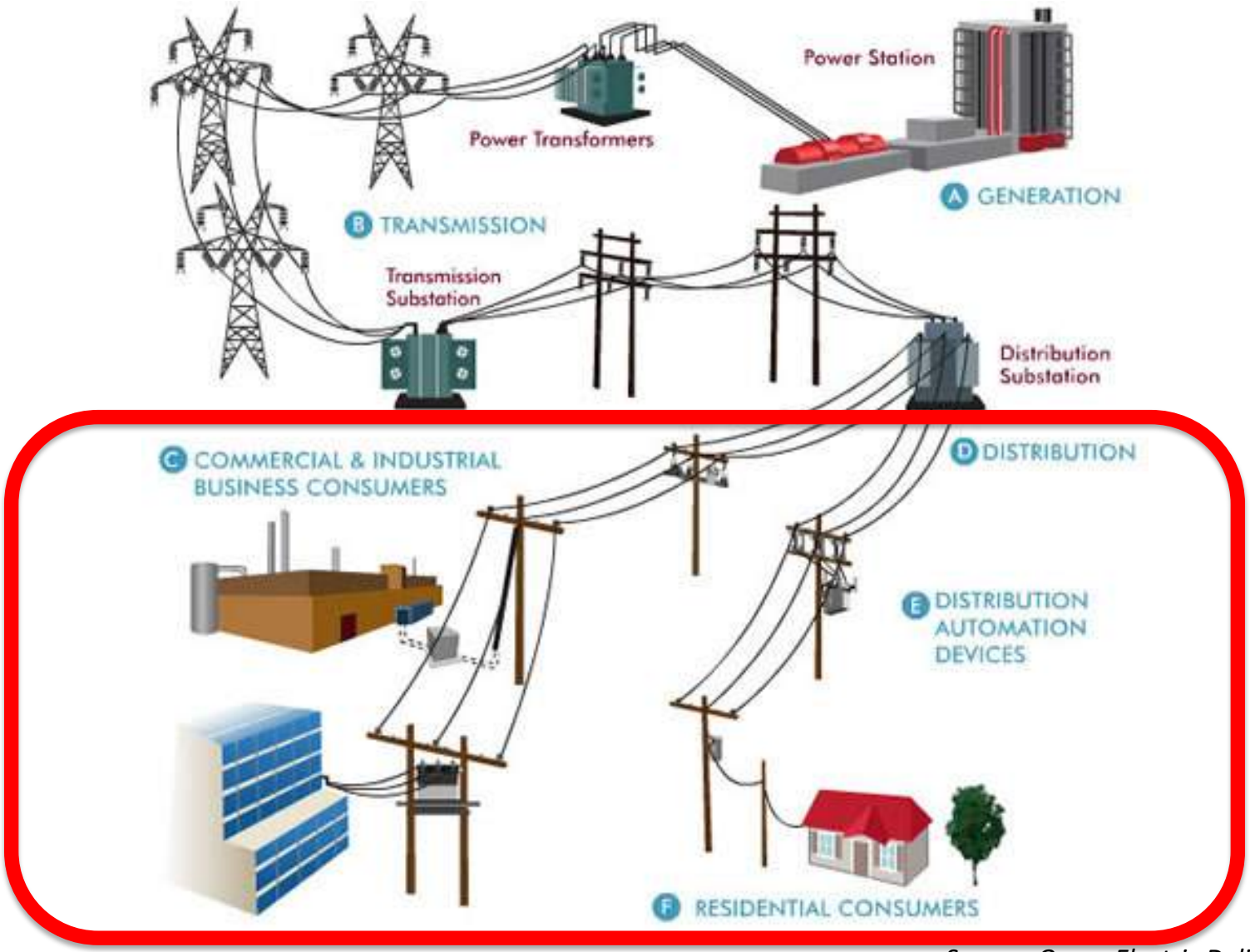
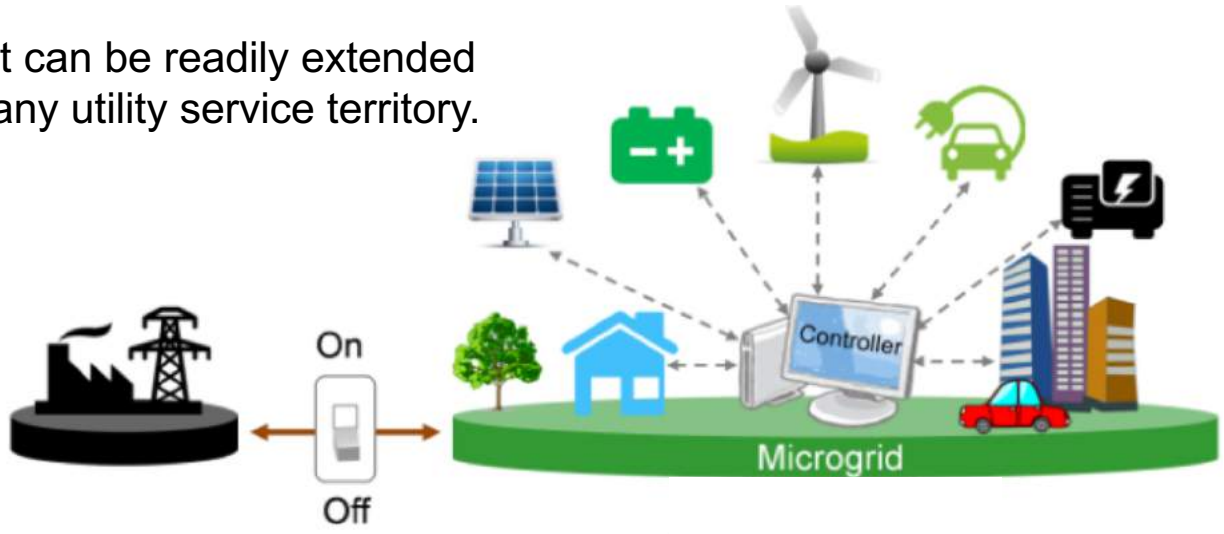


Source: Oncor Electric Delivery Company

Community Microgrid defined

A modern approach for designing and operating the electric grid, stacked with local renewables and staged for resilience.

- **"Islanding" from the grid:** A coordinated local grid area that can separate from the main grid and operate independently.
- **Components:** Solar PV, energy storage, demand response, and monitoring, communications, & control
- **Clean local energy:** Community Microgrids facilitate optimal deployment of distributed energy resources (DER).
- **Resilient:** Ongoing, renewables-driven backup power for critical and prioritized loads.
- **Replicable:** A solution that can be readily extended and replicated throughout any utility service territory.



Community Microgrid enabling policies lead to rapid proliferation of distributed energy resources

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Policies and programs to support development:

- Feed-in Tariff 2.0
  - Provides some certainty for developers and financiers, lowering costs
  - Features market-responsive pricing
  - Includes dispatchability and preferred location adders
  - Can support resilience and environmental justice/equity goals

- Streamlined interconnection of in-front-of-the-meter distributed energy resources

- Transmission Access Charges
  - Charges for transmission should no longer apply to distribution-connected generation, leading to lower transmission costs for load serving entities that choose clean local energy
  - Currently a massive market distortion in California and elsewhere

- Distribution System Operator (DSO)
  - Local balancing, local markets
  - Provides grid services with aggregated DER portfolio
  - Manages “ducklings” at local level instead of one giant “duck curve”

Opportunity: Untapped commercial and industrial (C&I) parking and rooftops

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- ✓ Largest rooftops and parking lots — most generation potential
- ✓ Largest daytime loads — matching peak solar production hours
- ✓ Largest utility bills, including demand charges — motivated customers
- ✓ Best solution for grid — system peak reduction, strong feeders already in place
- ✓ Most carbon emissions within cities

Solar on 25% of commercial and industrial rooftops = 25%+ annual energy use

North Bay Community Resilience Initiative

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Objective: make energy abundant, affordable, resilient, and sustainable

1. **Rebuild fire-destroyed areas with high levels of sustainability** in homes, buildings, and the electric grid, enabling a modern, distributed, and low-carbon system that delivers substantial economic, environmental, and resilience benefits.

2. **Establish a blueprint for rebuilding disaster-destroyed areas** in a timely and cost-effective manner that also maximizes the economic and resilience value of energy as a critical resource to ratepayers, property owners, and municipalities.

3. **Provide a model for operating a modern distribution grid** that incorporates optimal distributed energy resources, full interaction with the transmission system, and local energy markets — with resulting benefits across both grid operations and economics.

4. **Ensure that building codes are advanced** to achieve more resilient, safer, and cleaner building stock and communities.

5. **Lower ratepayer costs**: DER will be utilized to defer or avoid substantial costs including peak energy procurement and transmission & distribution (T&D) infrastructure investments.

North Bay Community Resilience Initiative

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Team

- Clean Coalition
- Sonoma Clean Power
- PG&E
- Rebuild North Bay
- Center for Climate Protection
- County of Sonoma, Energy & Sustainability Division
- Regional Climate Protection Authority
- Bay Area Air Quality Management District
- Design AVEnues, LLC — EE/ZNE expert Ann Edminster
- Stone Edge Farm Microgrid

Sonoma Clean Power

PG&E

Bay Area Air Quality Management District

Rebuild NorthBay Foundation

County of Sonoma Energy and Sustainability

wave Palo Alto

Ann V Edminster Design AVEnues LLC

center for climate protection

Stone Edge Farm Microgrid

North Bay Community Resilience Initiative: **Example location only**

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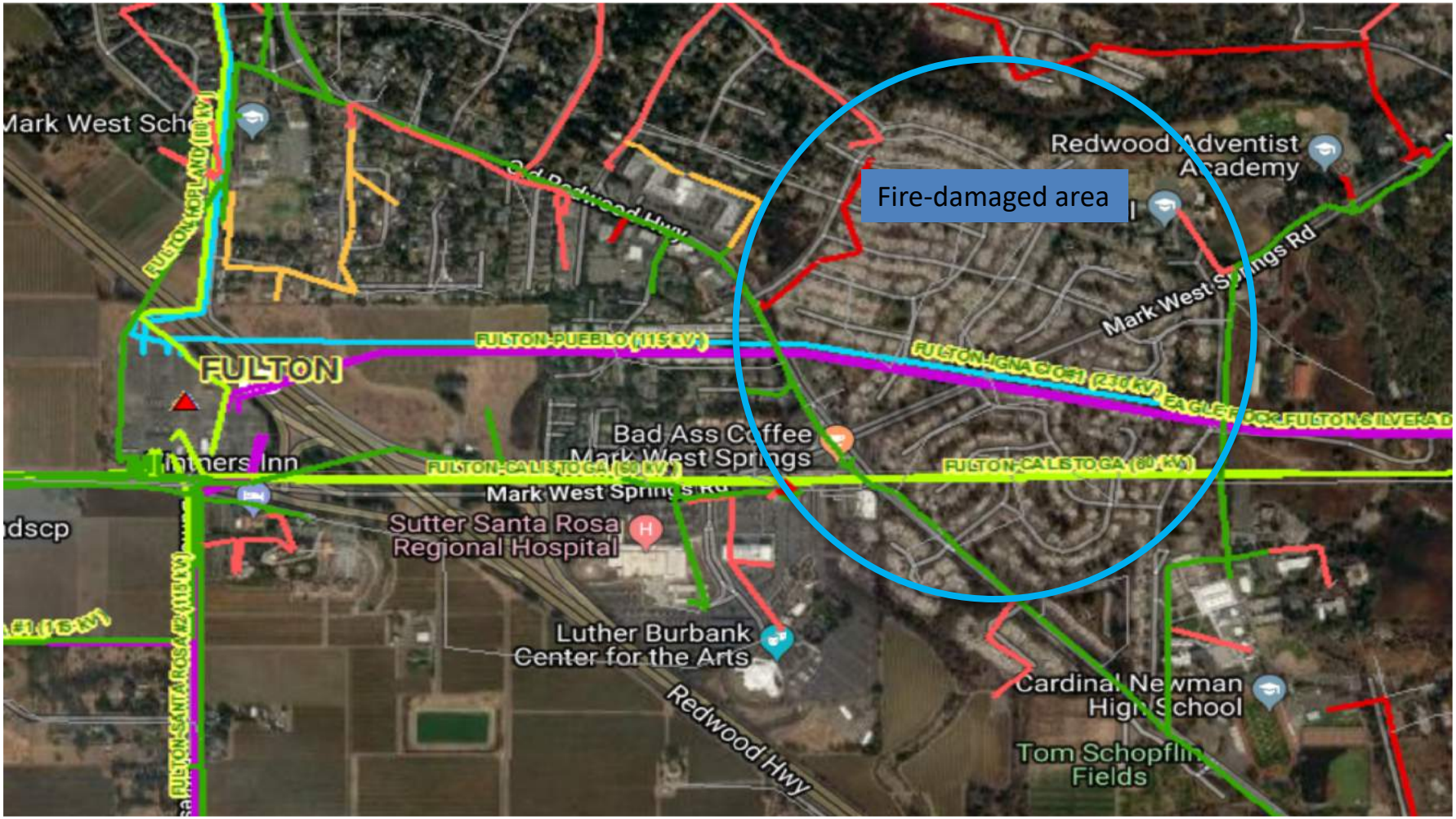
- Larkfield and the Old Redwood Highway Corridor – ideal for Community Microgrid
- Served by single substation, Fulton.



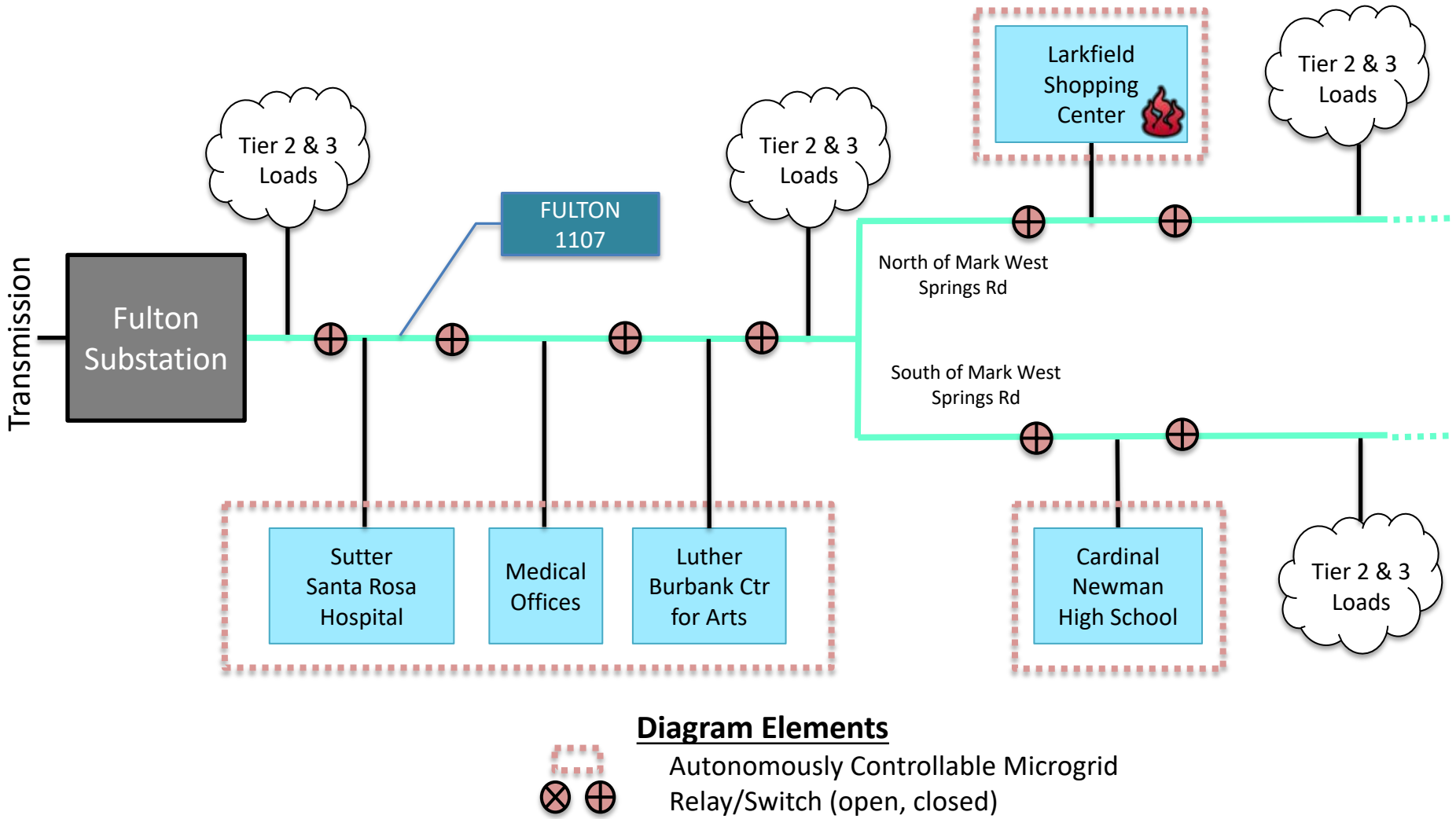
Example key sites:
critical, priority, large roofs & parking, etc.

Larkfield and the Old Redwood Highway Corridor

- Sutter Santa Rosa Regional Hospital
- Luther Burbank Center for the Arts
- Cardinal Newman High School
- Mark West School and area
- Larkfield Shopping Center
- Molsberry Markets
- John B Riebli School
- St. Rose School

Example: Larkfield and Old Redwood Highway Area Community Resilience block diagram

Clean Coalition



North Bay Community Resilience Initiative: Homes and buildings as grid partners

Clean Coalition

Ann V Edminster
DESIGN AVEnues LLC

- Well-designed and well-situated ZNE homes become a valuable part of the resource mix when combined with larger PV arrays on commercial and industrial structures.

Advanced Energy Rebuild for Homes

Clean Coalition

Support for Rebuild

- Sonoma Clean Power (SCP), Pacific Gas and Electric Company (PG&E), and Bay Area Air Quality Management District have joined efforts to help homeowners affected by the firestorms to rebuild energy-efficient, sustainable homes.
- The program is an enhancement to PG&E's long-standing California Advanced Homes Program, and offers two incentive packages tailored to Sonoma and Mendocino Counties.
- Each package has a flexible performance pathway or a simple prescriptive menu.

Sonoma Clean Power

PG&E®

Bay Area Air Quality Management District

Advanced Energy Rebuild for Homes

Clean Coalition

1 Advanced Energy Home

$7,500

Flexible Performance Path

- 20% above code
- 220V outlet at stove/range, water heater, and clothes dryer
- Design roof for additional structural loads associated with solar panels, and add conduit for future installation
- Electric Vehicle Charging Station - Equipment free from Sonoma Clean Power

2 All Electric Home

$12,500

Flexible Performance Path

- 20% above code, all electric end uses
- Design roof for additional structural loads associated with solar panels, and add conduit for future installation
- Electric Vehicle Charging Station - Equipment free from Sonoma Clean Power

$7,500

Simple Prescriptive Path

- 2016 Code High Performance Walls or 2016 Code High Performance Attics
- 2019 Code windows (Max U-factor 0.30, SHGC 0.23)
- High efficiency water heater: Heat Pump w/ EF of 3.0+ or gas tankless w/ EF of 0.92 with 220v outlet
- Heating/cooling ducts that are well sealed, insulated (R-8), and located primarily in conditioned space (note: buried deeply in attic insulation can qualify)
- WaterSense efficient plumbing fixtures
- Water efficient landscaping
- Energy Star Appliances
- 220V outlet at stove/range and clothes dryer
- Electric Vehicle Charging Station – Equipment free from Sonoma Clean Power

$12,500

Simple Prescriptive Path

All features of Advanced Energy Home plus...

- 2016 code High Performance Walls
- 2016 Code High Performance Attics
- Insulation inspected by a HERS Rater (QII)
- "Cool" roof
- Building Enclosure Airtightness verified by a HERS Rater (less than 3 ACH50)
- NEEA tier 3.0+ HPWH w/ controls
- High efficiency heat pumps for heating/cooling (EER of 12.5+, HSPF of 9.5+)
- Smart thermostat
- Compact plumbing design
- Induction cooking
- Electric or heat pump clothes dryer
- Electric Vehicle Charging Station – Equipment free from Sonoma Clean Power

+ Add solar to either option

$5,000

- Solar panel system designed to fully offset annual electric usage with battery storage sufficient to hold 30% of one summer day's production;

OR

- Pre-purchase of 20-year premium on 100% local renewable power (e.g., EverGreen or SolarChoice).

North Bay Community Resilience Initiative: Resilience, economic, and environmental benefits

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Example target: 30 MW Solar PV

Benefits over 20 years

Resilience

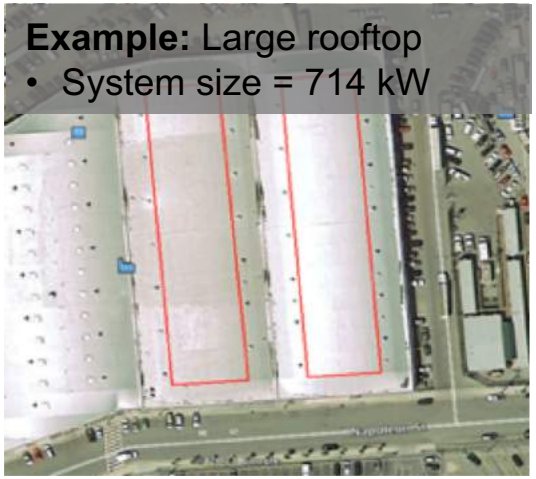
$50M: Avoided transmission costs
$20M: Avoided power interruptions

Economic

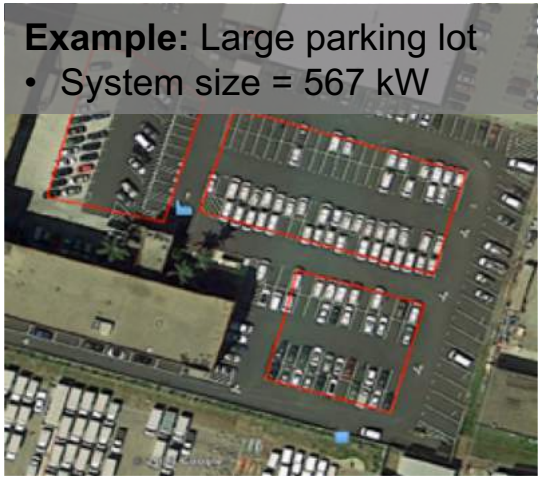
$120M: New regional impact
$60M: Added local wages
1,000 job-years: New near-term and ongoing employment
$6M: Site leasing income

Environmental

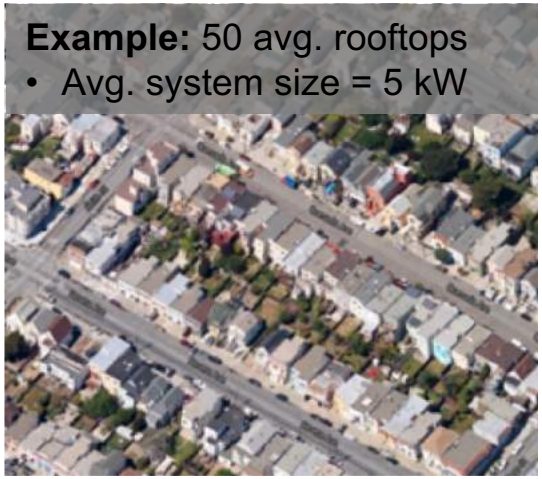
46M pounds: Annual reductions in GHG emissions
10M gallons: Annual water savings
225: Acres of land preserved



Commercial: 18 MW



Parking lots: 2 MW



Residential: 10 MW

Value of Resilience

How much does resilience cost and what is its value?

What does lack of resilience cost?

- **$119 billion**: Annual cost of power outages to the U.S.
- **$20 - $55 billion**: Annual cost to Americans of extreme weather and related power outages
- **$243 billion - $1 trillion:** Potential cost of a cyber attack that shuts down New York and D.C. areas

Resilience provided by Community Microgrids has tremendous value during a disaster

Clean Coalition

- **Powers critical loads until utility services are restored**
  - Eliminates need to relocate vulnerable populations (infirm, elderly, and disadvantaged)
- **Ensures continued critical services**
  - Water supply, medical and elder-care facilities, grocery stores, gas stations, shelters, communications centers
  - Avoids the cost of emergency aid logistics
- **Provides power for essential recovery operations**
  - Lighting for buildings, communications, water pumps for firefighting and flood control, emergency shelters, food refrigeration
- **Reduces dependence on diesel generators**
  - Diesel can be expensive and difficult to deliver in emergencies
  - Ongoing diesel maintenance requires regular operation with onsite air pollution
- **Keeps businesses open**
  - Serves the community and maintains revenue streams

But how do we determine the monetary value of resilience?

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Factors to consider

- **Cost of outages**: Varies by location, population density, facility type. Can include lost output and wages, spoiled inventory, delayed production, damage to the electric grid
- **Cost of storage**: Varies by size of electric load and size of critical load
- **Cost of islanding**: 3% - 21% of non-islandable solar+storage cost (figures from NREL)

Consequence of disaster	Resilience assessment metric
Unavailable electrical service	- Cumulative customer-hours of outages - Cumulative customer energy demand not served - Average percentage of customers experiencing an outage in a specified time period
Grid restoration	- Time to recovery - Cost of recovery
Monetary impact	- Loss of utility revenue - Cost of grid repair and replacement - Cost of recovery - Avoided outage cost - Lost business revenue
Community impact	- Critical services without power

Value of Resilience: $2,808/kW of critical load per year

Annually, resilience is worth $2,808 per kilowatt of critical load in the US

- Based on real-world scenarios run through the Clean Coalition VOR model
- Tier 1 = Critical load, usually 10% of total load — life-sustaining or crucial to keep facility operational during a grid outage
  - Tier 2 = Priority load (15%) — important but not necessary to keep operational during an outage
  - Tier 3 = Discretionary load (75%) — the remainder of the total load
- Based on keeping critical load online for **one day** on the worst-case solar day
  - If outage spans days with greater solar resource, may be able to keep Tier 2 or even Tier 3 loads online

Valuing resilience:
The Clean Coalition Value of Resilience (VOR) Model

Clean Coalition

The size of your load: How much electricity do you use per year?

The size of your critical load: What percentage of your electrical load is essential to keep running during an extended outage? For many facilities, this is 10%.

The length of outage you want to prepare for: Do you want to prepare for short outages of a few minutes, or prepare for outages lasting several days or more?

The cost of an outage: How much revenue or productivity do you lose per hour during an outage? If you don't have this figure, you can use the national average of $117 per kilowatt-hour, based on data from the Department of Energy's National Renewable Energy Lab (NREL).

Your energy storage system: The minimum and maximum state of charge you'd like to allow for your battery; the initial state of charge at the time of an outage; and your battery cost (including cost/benefit analysis for demand charge reduction), capacity, and round-trip efficiency.

The amount of sunshine in your area: Average amount of sunshine in your area, as well as the amount of sunshine on the worst 5 solar days of the year.

Clean Coalition Value of Resilience Model outputs

The tool calculates:

- The minimum battery capacity you need for resilience
- The total cost for a system at your site to monetize demand charge reduction
- Your total system cost, based on the required battery capacity
- **Resilience cost**: The total system cost for the resilience portion of your system
- **Resilience value**: The annual value of resilience provided by your system

Value of resilience for a Community Microgrid: One building at a corporate campus

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Cost of resilience

Item	Inputs	Units	Inputs		Calculation
Inverters	250	[kW]	$1,062	[$/kW]	$265,500
Battery for resilience	308	[kWh]	$ 256	[$/kWh]	$78,887
System islanding	2	controllers	$30,000		$60,000
Total system cost					$404,387
System cost offset by demand charge reduction					-$803,100
Total cost for resilience					**-$398,713**

Value of resilience

Item	Calculation	Units	Notes
Cost of outage	$117	[$/kWh]	$117 is nationwide average for surveyed customers
Size of critical load	12	[kW]	
Value of lost load per hour	$1,404		Cost of outage per kilowatt-hour x size of critical load
Days of outage to prepare for	1		
Annual value of resilience	**$33,696**		

- Cost of resilience = -$33,226 per kW of critical load
- Annual value of resilience = $2,808 per kW of critical load
- Break-even point = immediate

Value of resilience for a Community Microgrid: Medium-sized installation at large corporate campus

Clean Coalition

Cost of resilience

Item	Inputs	Units	Inputs		Calculation
Inverters	1,000	[kW]	$1,062	[$/kW]	$1,062,000
Battery for resilience	12,203	[kWh]	$ 256	[$/kWh]	$3,124,038
System islanding	9	controllers	$30,000		$270,000
Total system cost					$4,456,038
System cost offset by demand charge reduction					-$2,674,800
Total cost for resilience					**$1,781,238**

Value of resilience

Item	Calculation	Units	Notes
Cost of outage	$117	[$/kWh]	$117 is nationwide average for surveyed customers
Size of critical load	253	[kW]	
Value of lost load per hour	$29,601		Cost of outage per kilowatt-hour x size of critical load
Days of outage to prepare for	1		
Annual value of resilience	**$710,424**		

- Cost of resilience = $7,040 per kW of critical load
- Annual value of resilience = $2,808 per kW of critical load
- Break-even point = 2.5 years

Value of resilience for a Community Microgrid: Campus-wide installation at large corporate campus

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Cost of resilience

Item	Inputs	Units	Inputs		Calculation
Inverters	1,750	[kW]	$1,062	[$/kW]	$1,858,500
Battery for resilience	17,760	[kWh]	$ 256	[$/kWh]	$4,546,459
System islanding	18	controllers	$30,000		$540,000
Total system cost					$6,944,959
System cost offset by demand charge reduction					-$4,008,900
Total cost for resilience					**$2,936,059**

Value of resilience

Item	Calculation	Units	Notes
Cost of outage	$117	[$/kWh]	$117 is nationwide average for surveyed customers
Size of critical load	375	[kW]	
Value of lost load per hour	$43,875		Cost of outage per kilowatt-hour x size of critical load
Days of outage to prepare for	1		
Annual value of resilience	**$1,053,000**		

- Cost of resilience = $7,829 per kW of critical load
- Annual value of resilience = $2,808 per kW of critical load
- Break-even point = 2.8 years

Backup slides

The future of energy is distributed…

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California's distributed solar and efficiency saves $2.6 billion on power lines

- In March 2018, California's grid operator signed off on the state's **2017-2018 Transmission Plan**, which approved 17 new transmission projects combined at a cost of nearly $271 million.
- **20 transmission projects were canceled and 21 were revised** due to energy efficiency and residential solar power altering local area load forecasts.
- The projected savings from these changes is estimated to be **$2.6 billion.**

California ISO

The future of energy is distributed…

Clean Coalition

Sacramento Utility Pushes All-Electric Homes: "California Is Wasting Money to Build Homes With Gas"

SMUD
Sacramento Municipal Utility District

- On June 1, the Sacramento Municipal Utility District (SMUD) launched an incentive program to provide **rebates promoting electrification** in both retrofitted and new homes.
- SMUD's electrification rebate packages are worth up to **$5,000** for new homes and up to **$13,750** for gas-to-electric conversions in existing homes.
- 10% of California's GHG emissions come from burning fossil fuels for space and water heating in buildings. SMUD's electrification initiative helps achieve its 2050 GHG reduction target.

The future of energy is distributed…

Canada plan promises to transform cities and communities

- "Build Smart — Canada's Buildings Strategy" plan commits Ottawa to develop — and the provinces and territories to adopt — a series of **model building codes** requiring increasingly **higher levels of energy efficiency**.
- Under the plan, by 2030, every new building being built in the country will be required to meet a **net-zero-energy-ready** level of performance.
- In other words, in just over a dozen years or so, new buildings will be so well-designed and carefully built that they should be able to **meet all of their energy needs with renewable energy either generated on-site or nearby**.

The future of energy is distributed…

Vermont utility Green Mountain Power now pays customers over $30 per month to use their battery systems as a load-offsetting resource.

- Helps address the steep transmission access charge assessed by ISO New England. That charge **more than doubled** from $3 per kilowatt per month in 2016 to over $7 in 2017, and is **expected to increase** to over $9 in 2018.
- As more solar is installed on the distribution grid, **access to locally generated and stored solar energy** at times when electricity from transmission is the most expensive is a **grid benefit** that can **save money for utilities and customers.**

The future of energy is distributed…

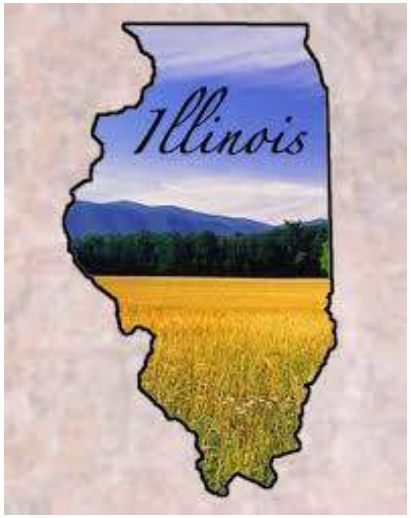
Clean Coalition

Illinois is now "transforming the regulatory compact" to embrace performance-based policy goals

ComEd

- Illinois team at RMI eLab Accelerator, featuring utility ComEd, are devising four broad policy goals for future legislation and compensation:
  - **Power sector decarbonization**
  - **100% renewables**
  - **Community development and equity**
  - **Beneficial electrification of other sectors, e.g EVs**

- Illinois now supports **shared utility + customer microgrids**. Joe Svachula, VP Engineering & Smart Grid Technology at ComEd: “It’s an important step forward in our effort to develop a more **secure, resilient, and reliable distribution system** in the future.”



The advantages of distribute energy resources

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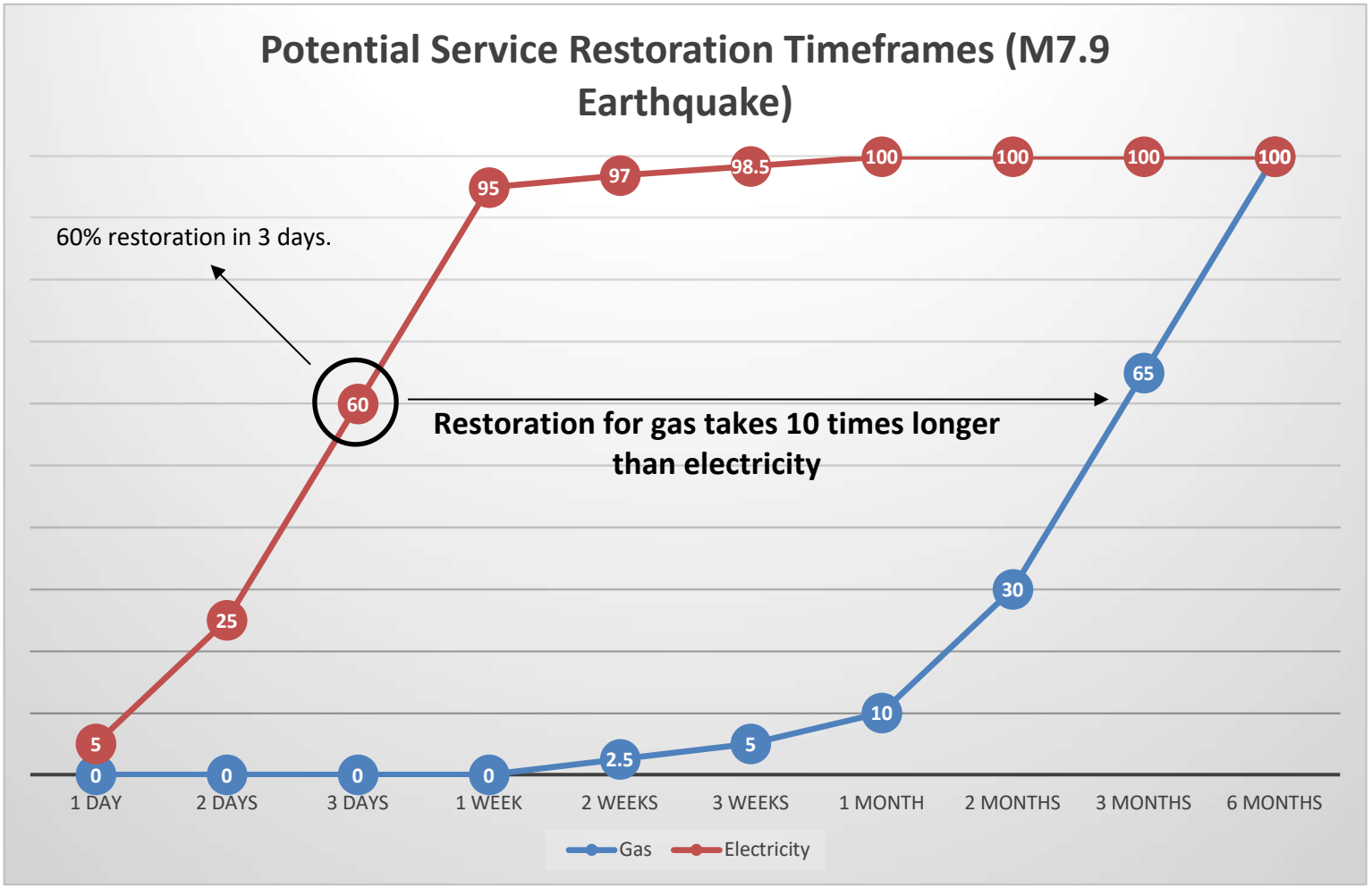
Value Category	Potential Benefits / Avoided Costs
Transmission	Avoided Transmission Capacity Costs Reduced Transmission Line Losses
Distribution	Avoided Distribution Capacity Costs Reduced Distribution Line Losses Increased Power/Voltage Quality Increased Hosting Capacity Reduced O&M Costs Increased Reliability, Resilience & Security
Generation	Energy Resource Adequacy Ancillary Services Flexibility for Renewables Integration
Customer, Societal, and Environmental	Increased Customer Choice Reduced CO_2 Emissions Reduced Criteria Air Pollutants Local Economic Stimulation (Jobs + Taxes) Improved Public Health Land and Water Conservation Improved Environmental Justice Outcomes

Sources: Newport Consulting Group, ICF Consulting

Restoration times for gas vs. electric service after a major urban earthquake



(Data source: San Francisco Lifeline Council Interdependency Study, 2014)

$1B+ weather events in U.S. Jan – Sept 2017

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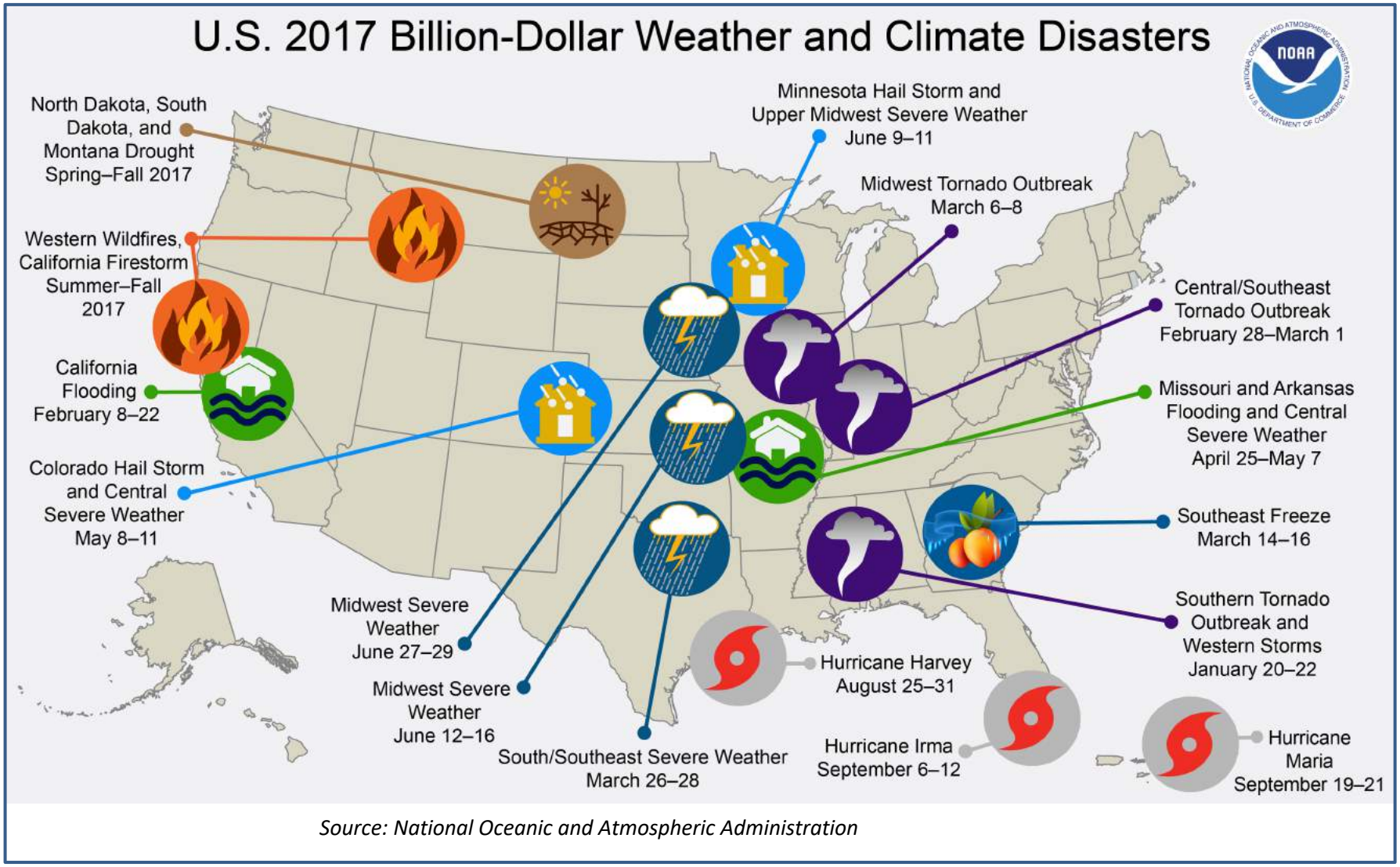

Source: National Oceanic and Atmospheric Administration