Clean Coalition

Making Clean Local Energy Accessible Now

Renewables-driven Microgrids for Data Centers

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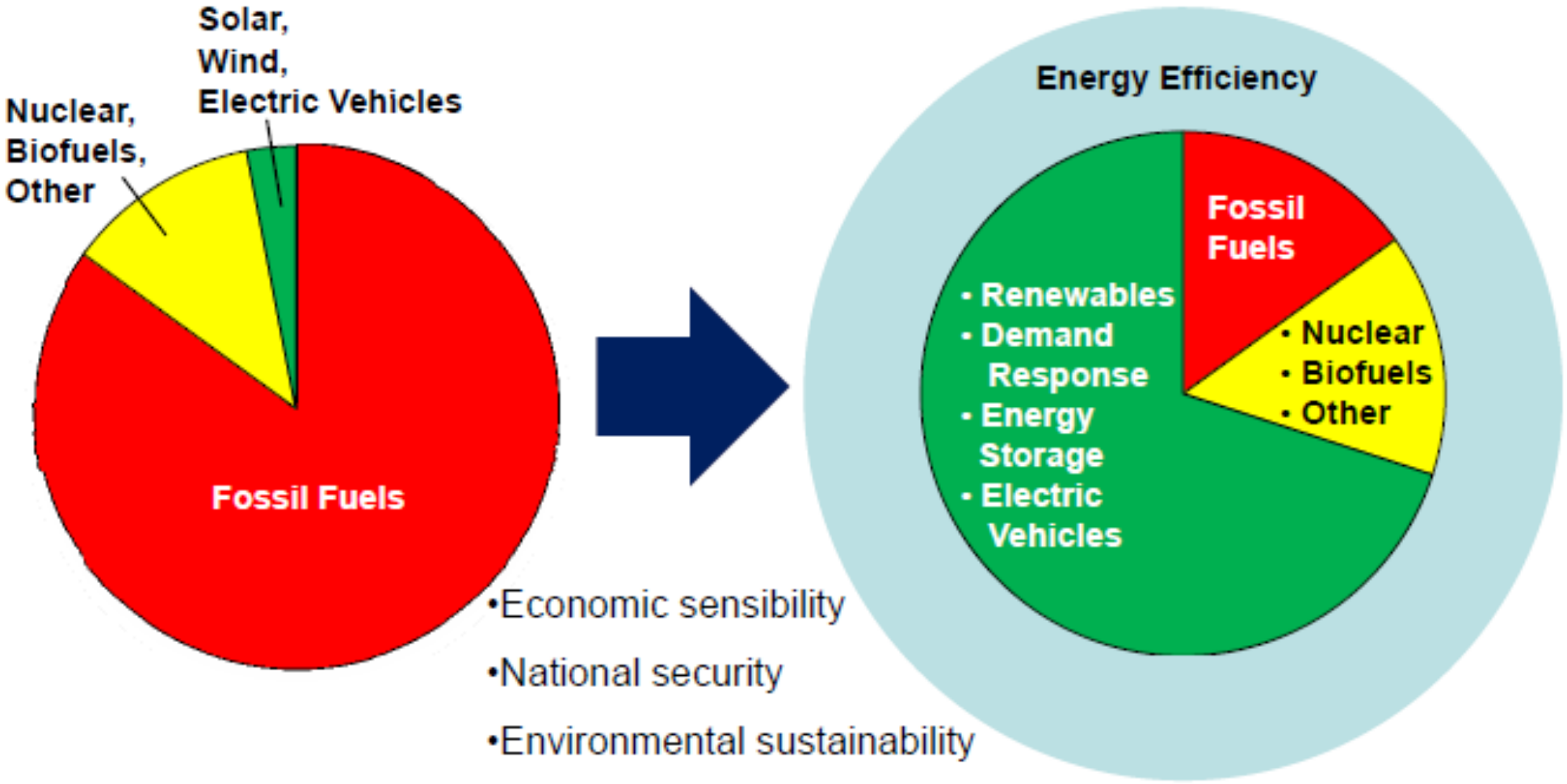
Clean Coalition (non-profit) Mission

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

Clean Coalition Vision



The $6 trillion energy market will transition to Smart Energy

WDG Unleashes Renewables

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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

WDG Unleashed Solar in Germany

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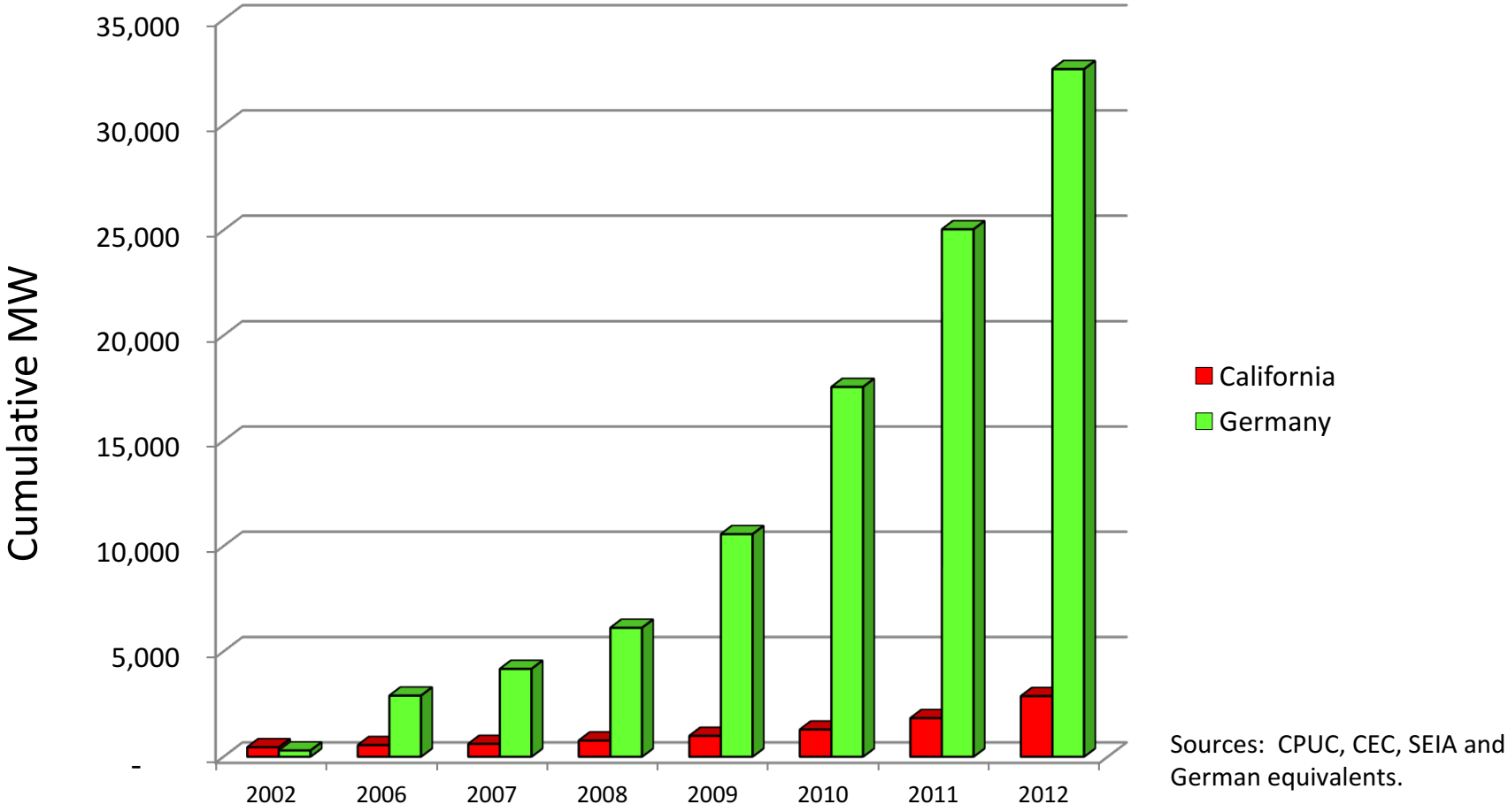
Solar Markets: Germany vs California (RPS + CSI + other)



Sources: CPUC, CEC, SEIA and German equivalents.

Germany deployed over 10 times more solar than California in the decade from 2002 despite California having 70% better solar resource

Community Microgrid Vision

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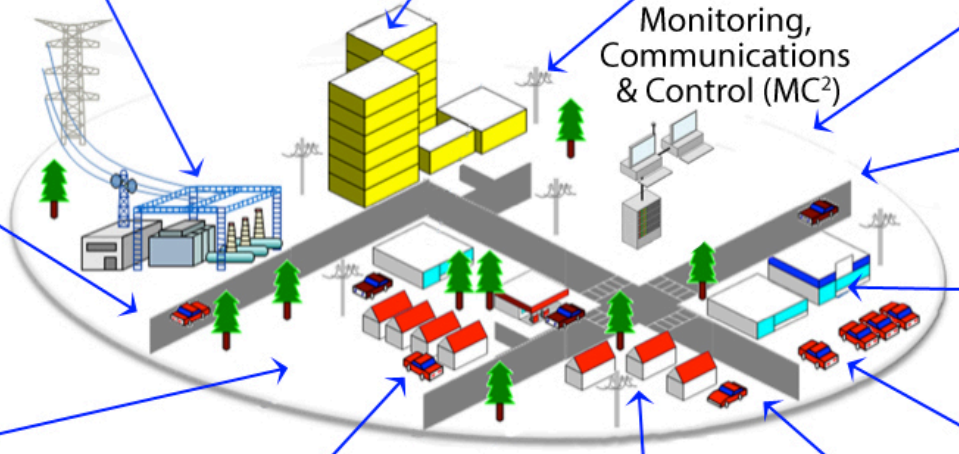
Grid Energy Storage

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

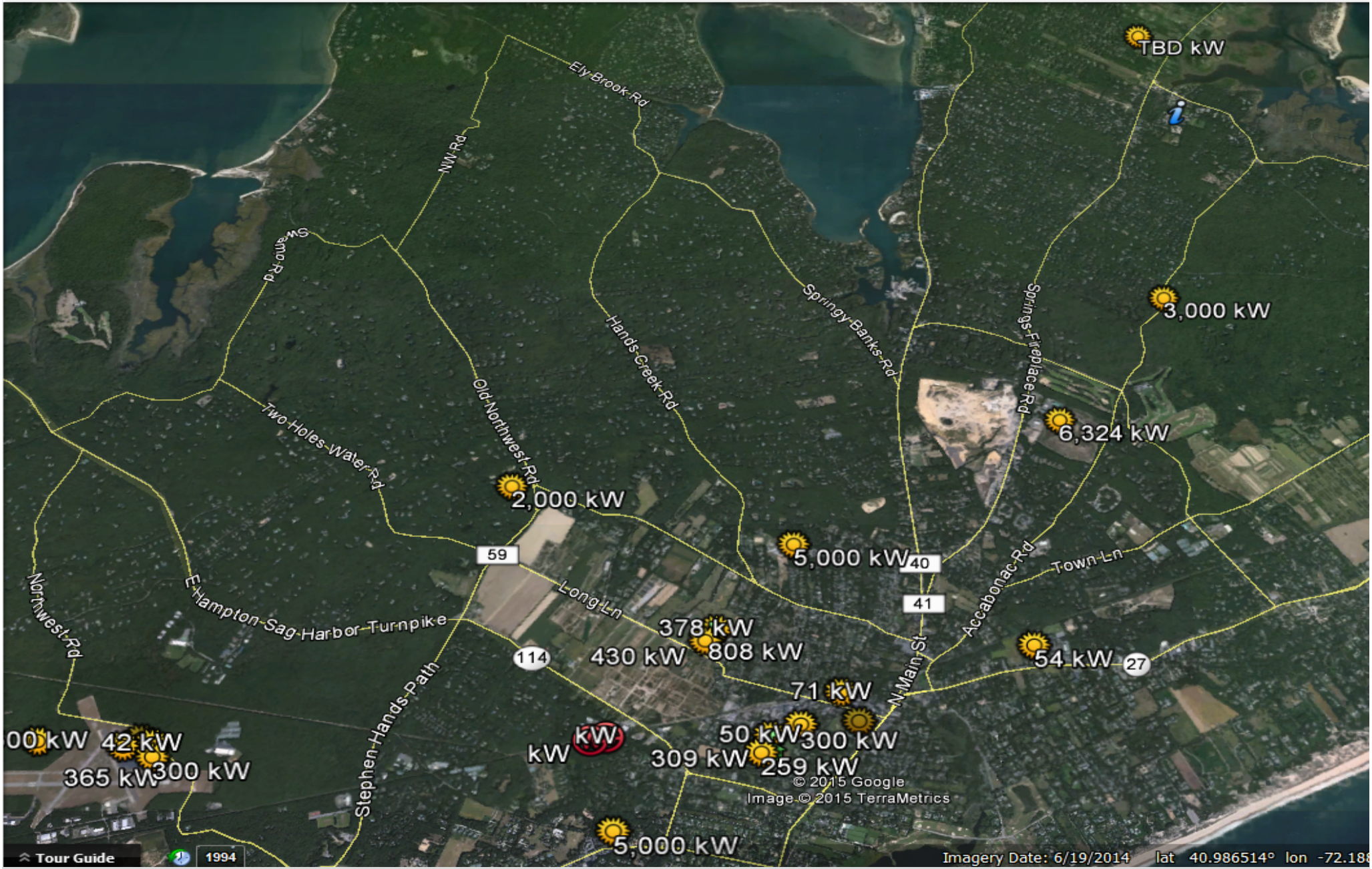
What is a Community Microgrid?

A Community Microgrid is a new approach for designing and operating the electric grid, stacked with local renewables.

Key features:

- A targeted and coordinated local grid area served by one or more distribution substations
- High penetrations of local renewables and other Distributed Energy Resources (DER) such as energy storage and demand response
- Staged capability for ongoing renewables-driven power backup for critical and prioritized loads across the grid area
- A solution that can be readily extended throughout a utility service territory – and replicated into any utility service territory around the world

Long Island Community Microgrid – Map View



Long Island Community Microgrid - Diagram

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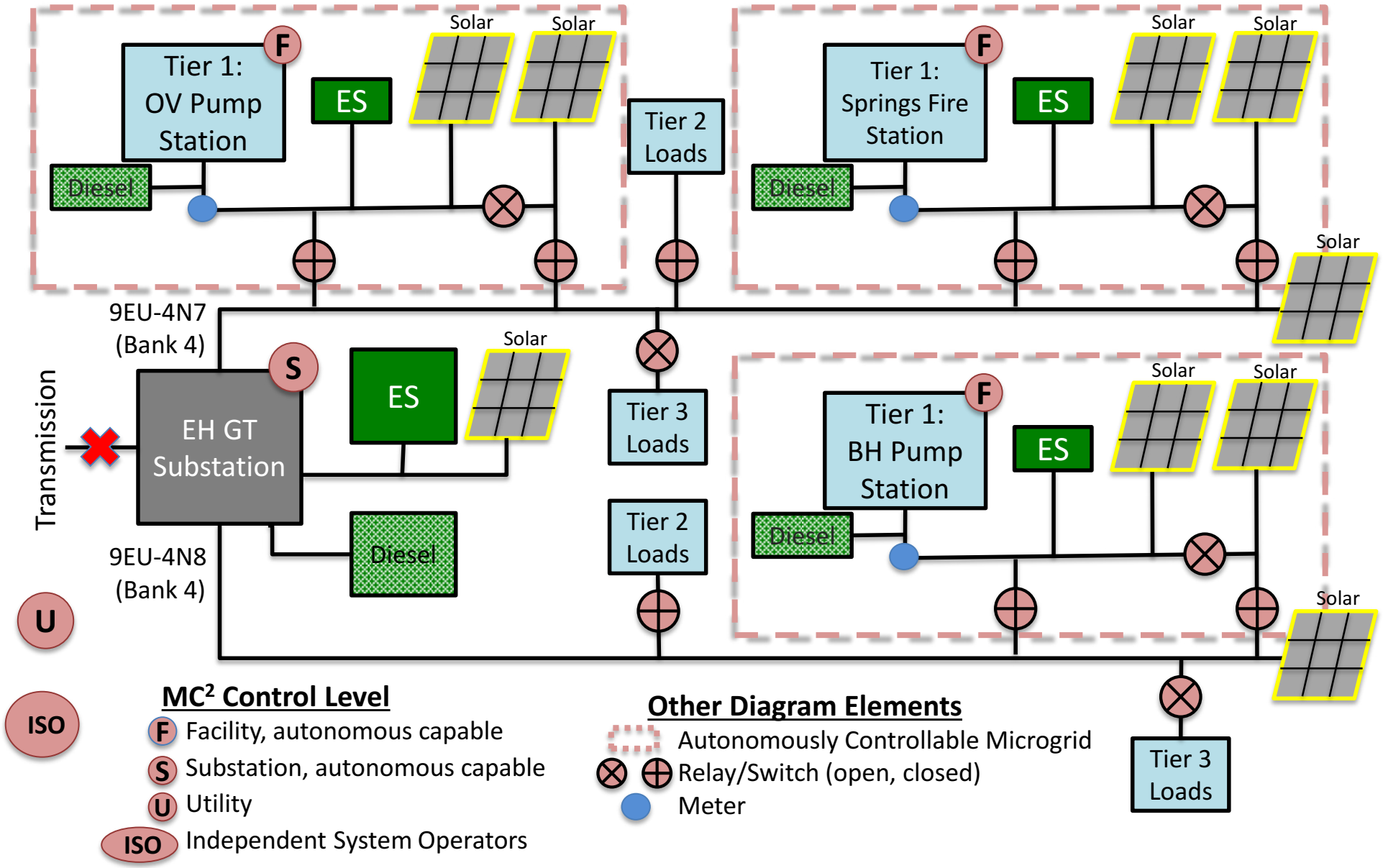


MC² Control Level

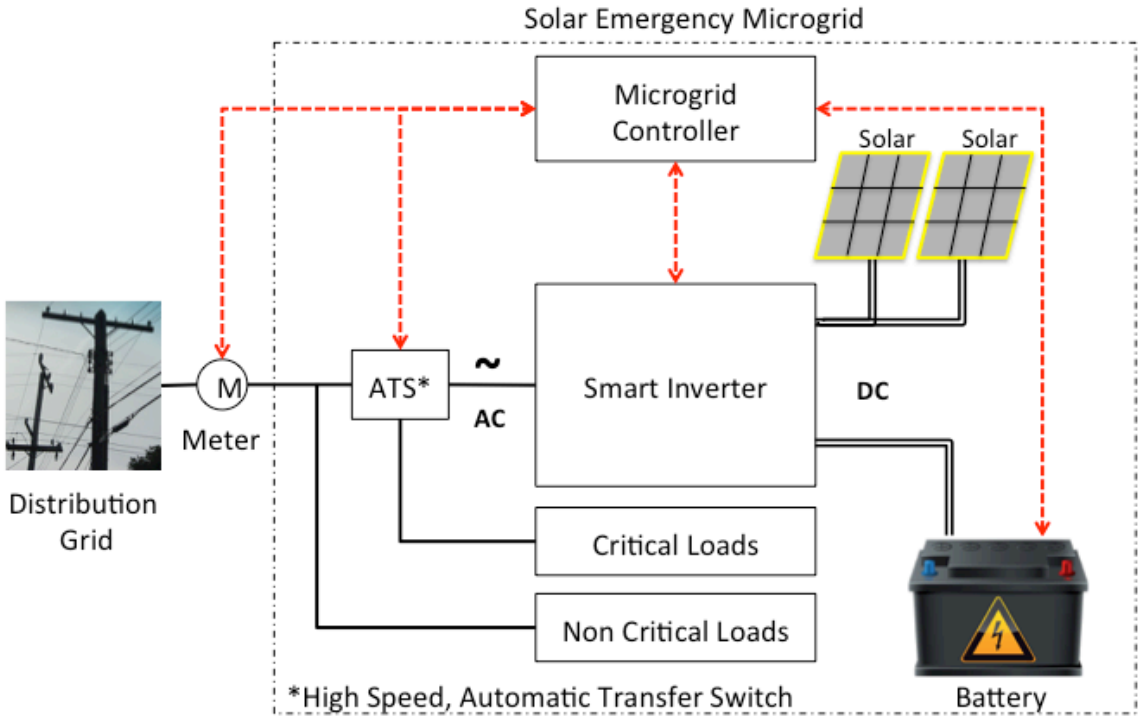
- F Facility, autonomous capable
- S Substation, autonomous capable
- U Utility
- ISO Independent System Operators

Other Diagram Elements

- Autonomously Controllable Microgrid
- Relay/Switch (open, closed)
- Meter

Solar Emergency Microgrid overview

- A Solar Emergency Microgrid (SEM) has 3 basic components:
  - Solar; energy storage; and monitoring, communications & control
- A SEM provides <u>indefinite</u> back-up power for critical loads
  - Ideal for police and fire stations, emergency operations centers and shelters, critical communications and water infrastructure, etc
- Displaces dirty, expensive, non-renewable diesel generators



UCSB Community Microgrid – Area Map

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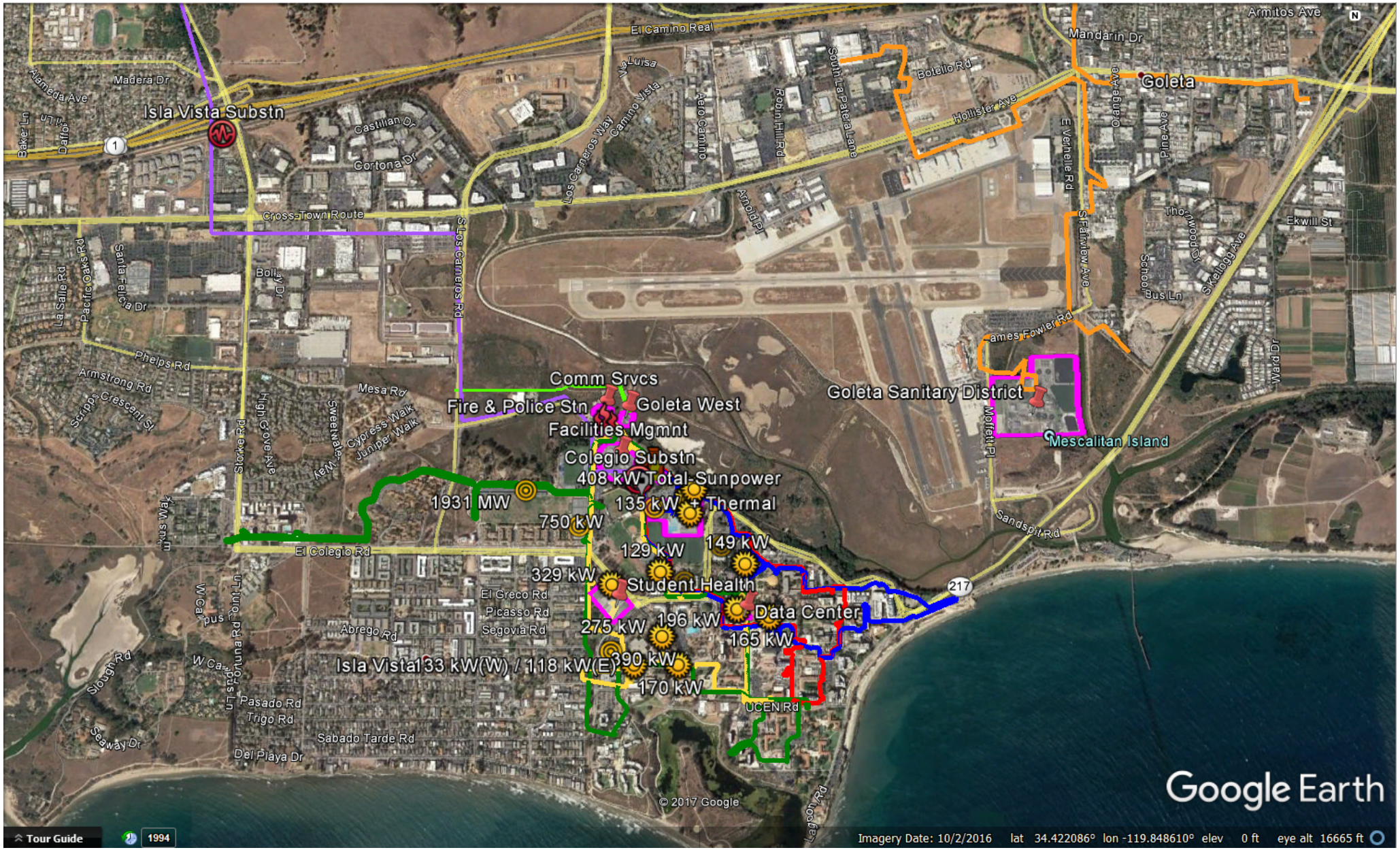

UCSB Community Microgrid – Phase 1

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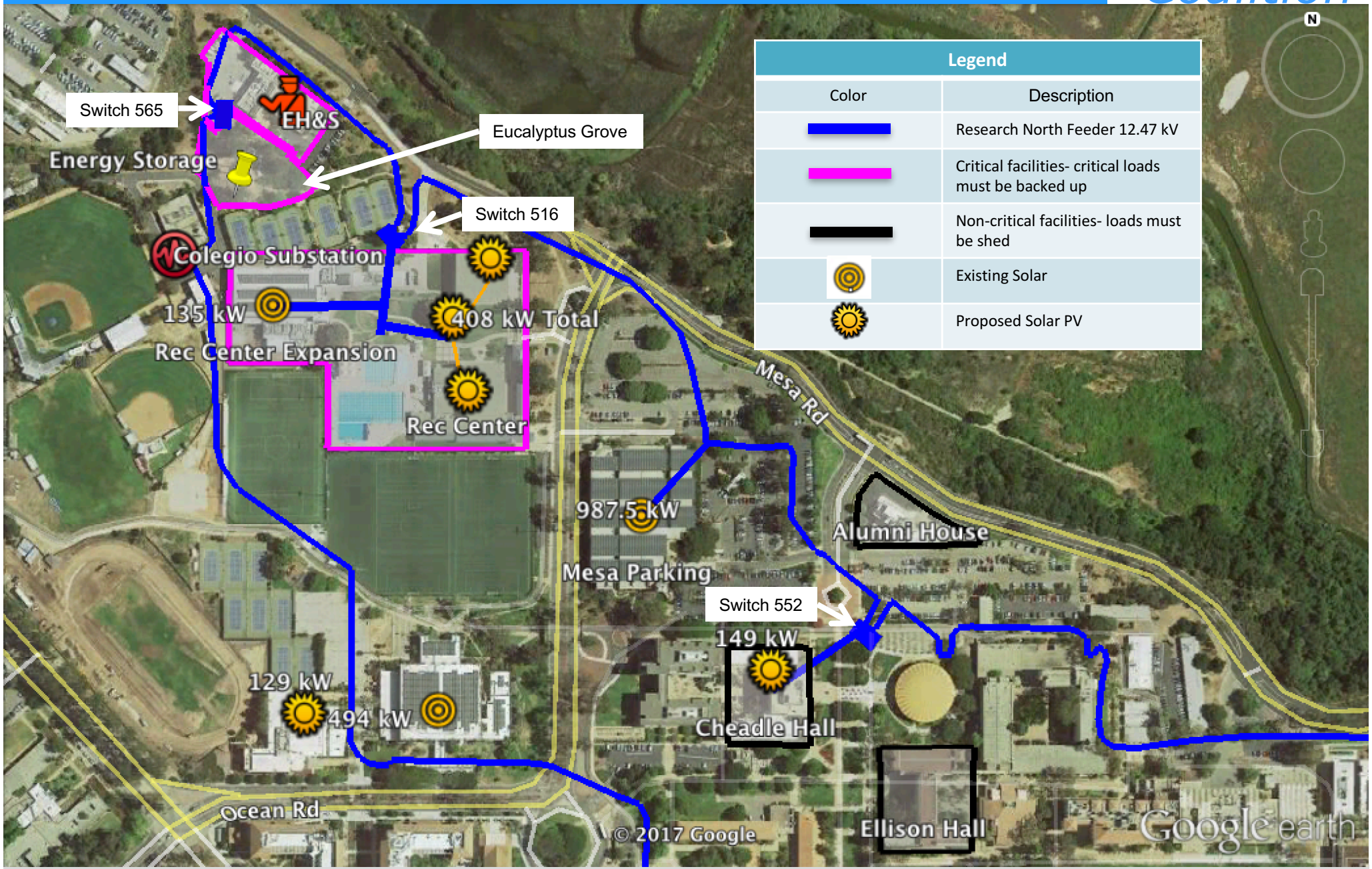

UCSB Community Microgrid – Phase 1 + 2

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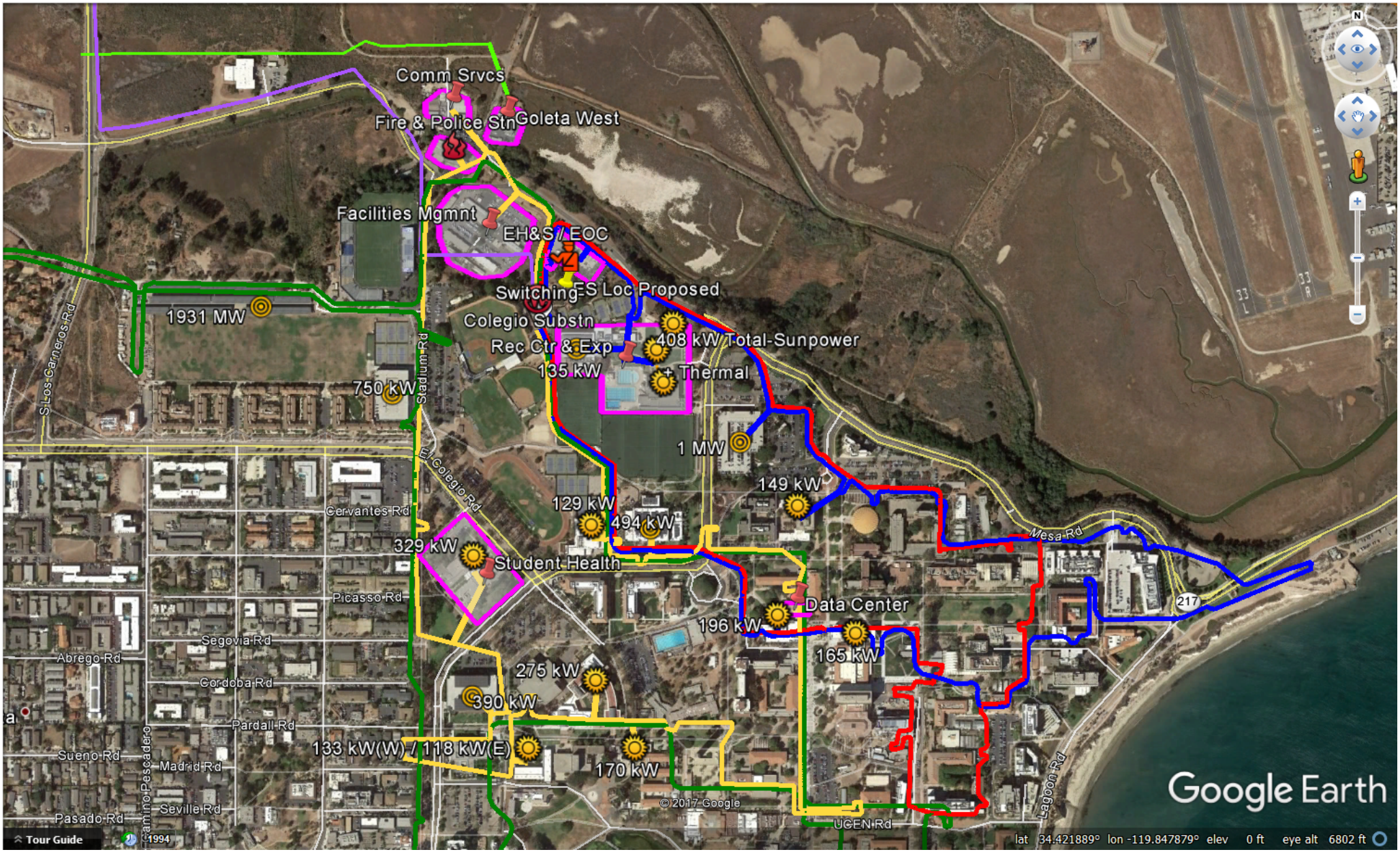

UCSB Community Microgrid – Phase 1

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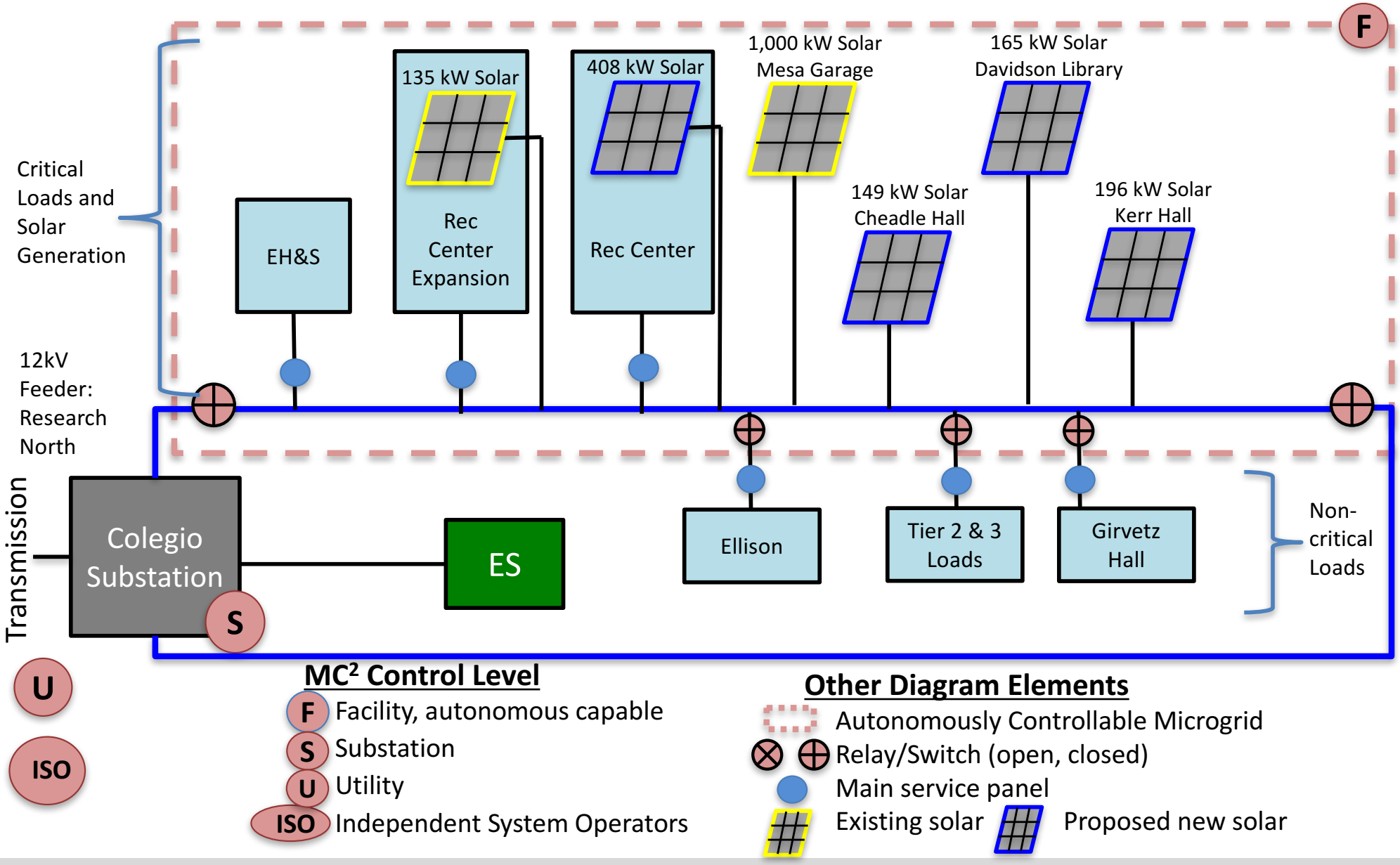

UCSB Community Microgrid – Phase 2

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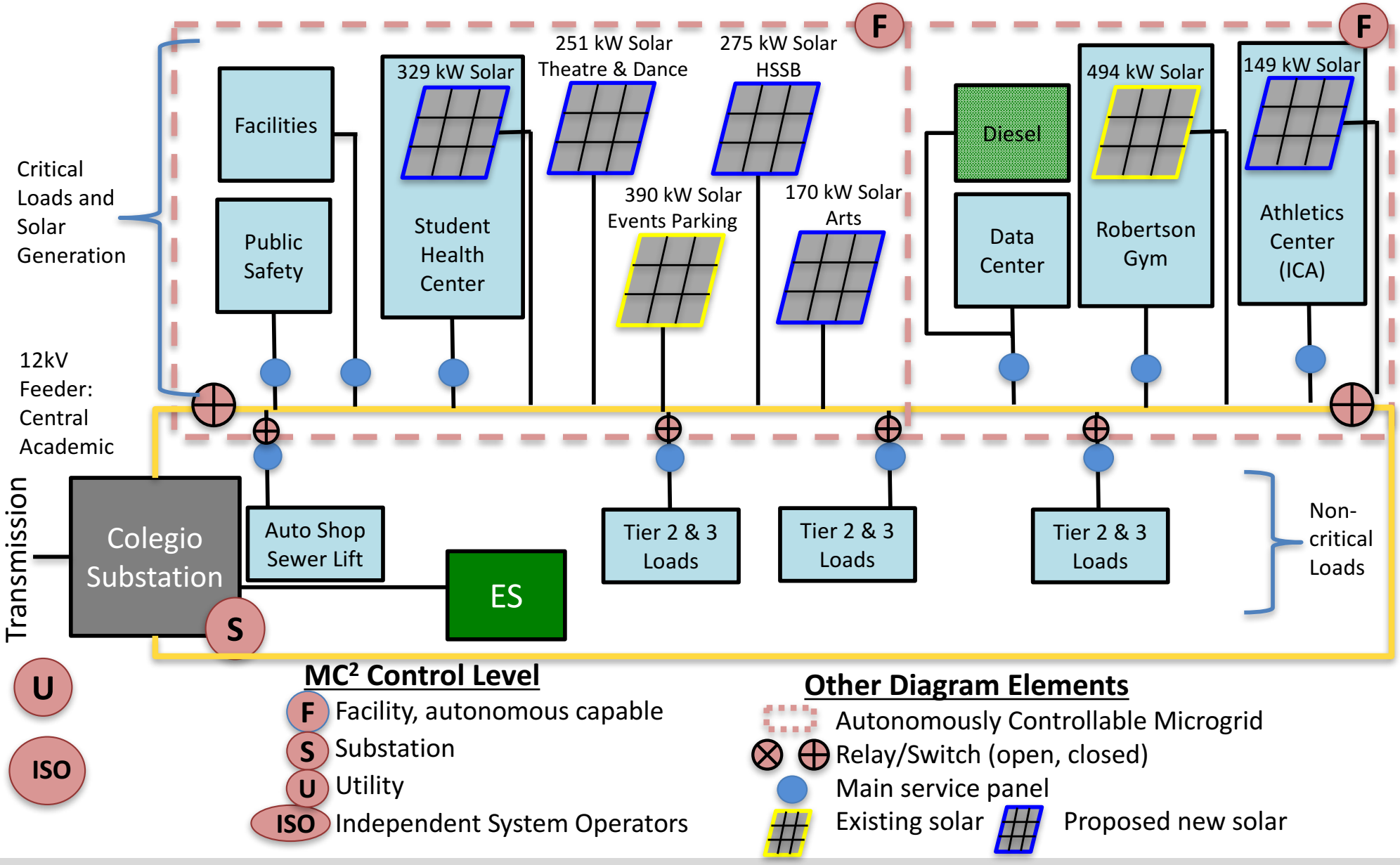

Renewables for Data Center Energy & Resilience

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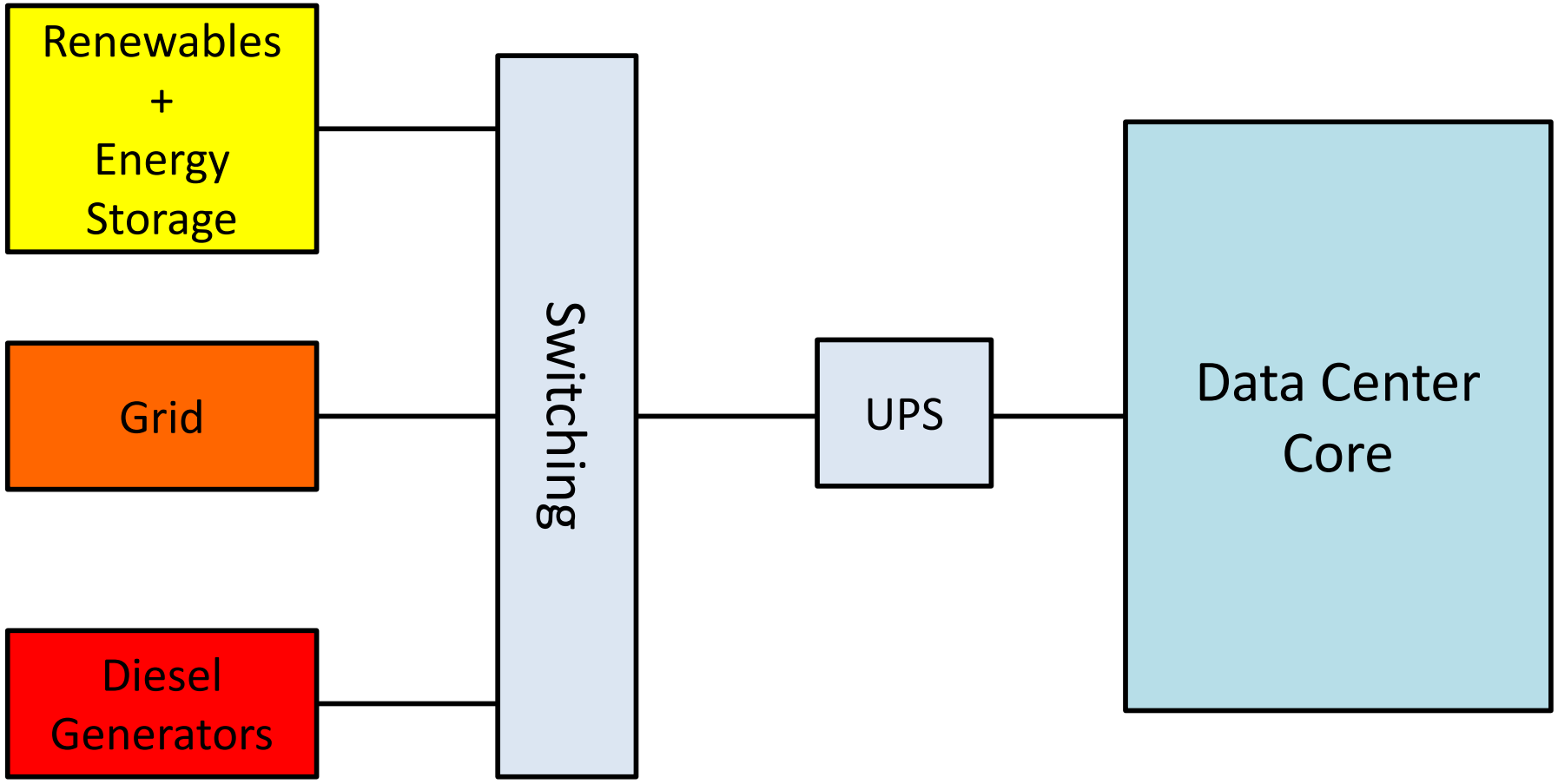
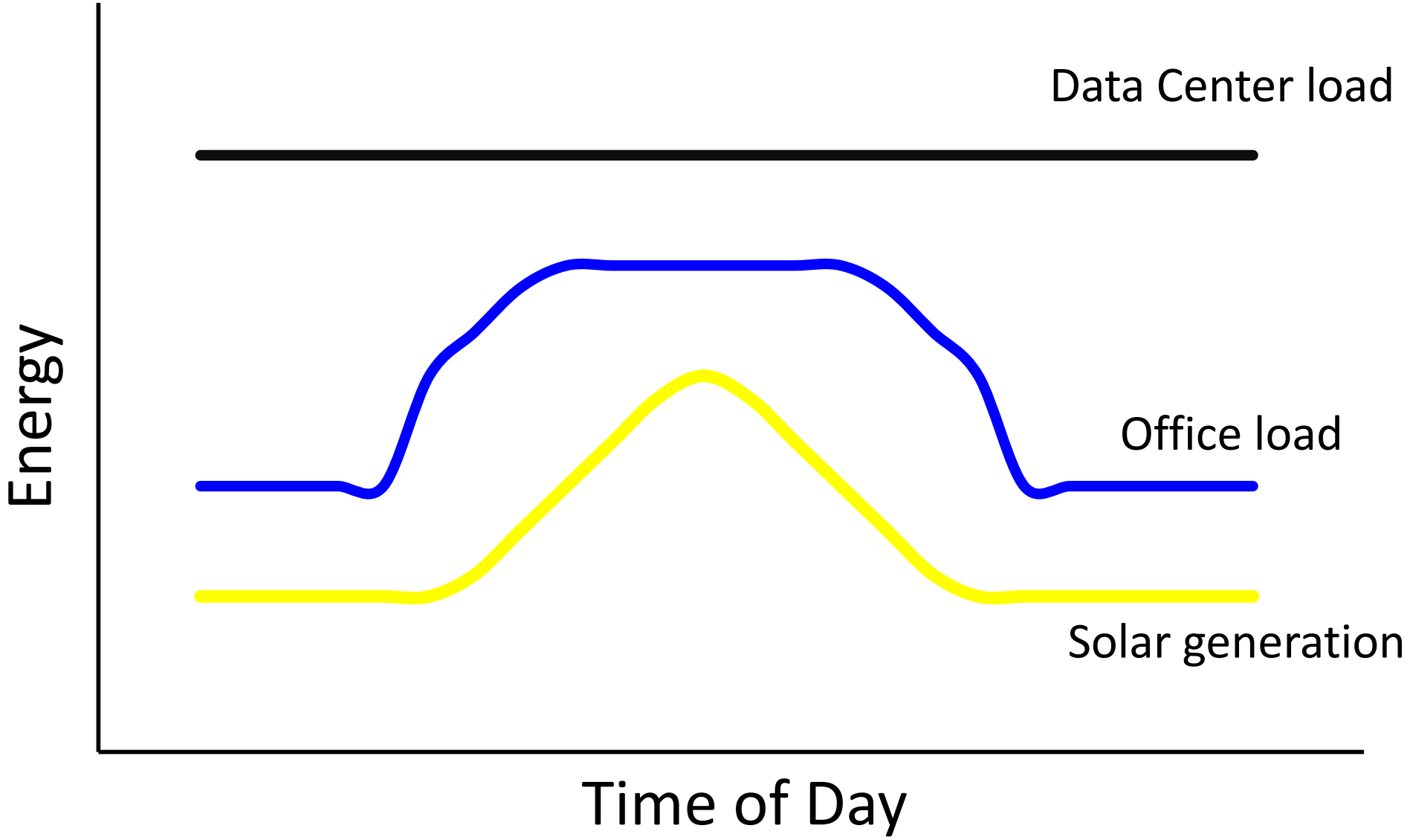


Solar and Load Profiles – Data Center Challenge



Local Solar + Energy Storage = Indefinite Energy

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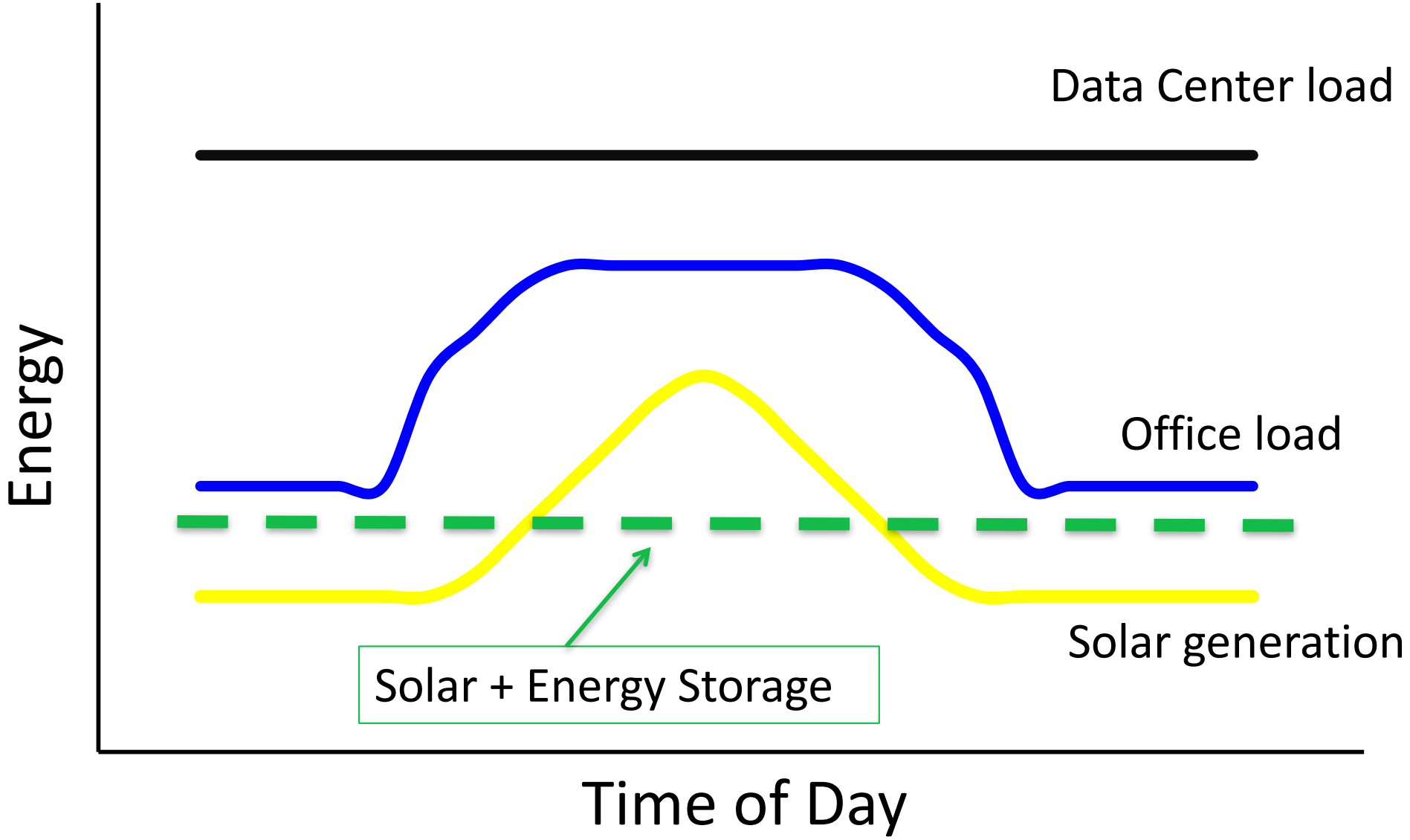

Local Solar + Energy Storage to Replace 1MW of Diesel

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- Assumptions
  - 20% solar capacity factor (typical for MW-scale solar in California)
  - Worst solar day is 10% of average (ie, 2% capacity factor)
  - 2 acres of siting required per 1 MW of solar
  - Requires 24x7x365 performance
- Calculations
  - 24 MWh of replenishment solar required daily (1 MW x 24 hr)
  - 50 MW of solar required (50 MW x .02 capacity factor x 24 hr)
  - 24 MWh of energy storage required

Opportunity: Local renewables + energy storage can provide indefinite backup power.

Challenge: Data centers have large flat loads; 100% solar is tough.

Other Plays for Local Renewables + Energy Storage

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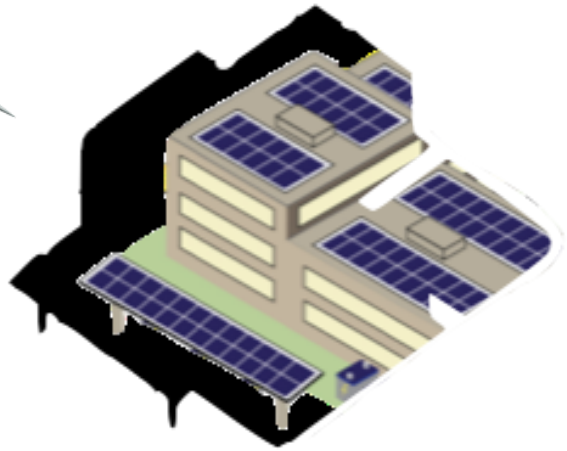
- Diversify renewables
  - Wind & solar generation profiles are highly complementary
  - One 3MW wind turbine averages 24 MWh/day



- Diversify geography
  - Demand Response (DR) combined with renewables + energy storage = big UPS
  - Fail-over strategies can allow significant reduction in energy usage

Cloud offers geo redundancy

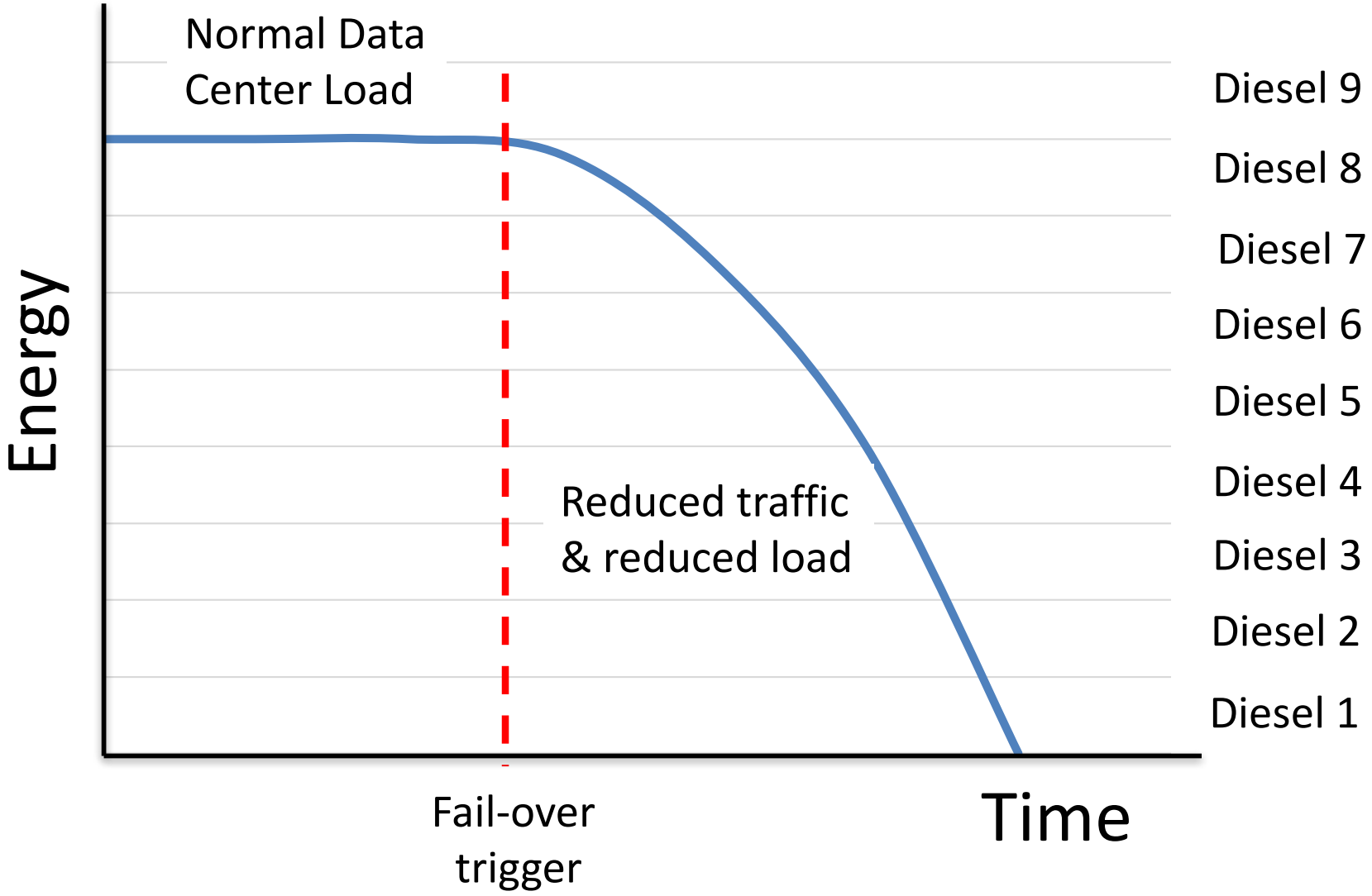
- Monetize energy storage in markets like DR and frequency regulation
  - Markets typically cover 35% of energy storage costs while tax credits cover another 30%

35% Resilience

35% Markets

30% Federal tax credits

Demand Response (DR) Opportunity



DR + Renewables + Energy Storage = Big UPS

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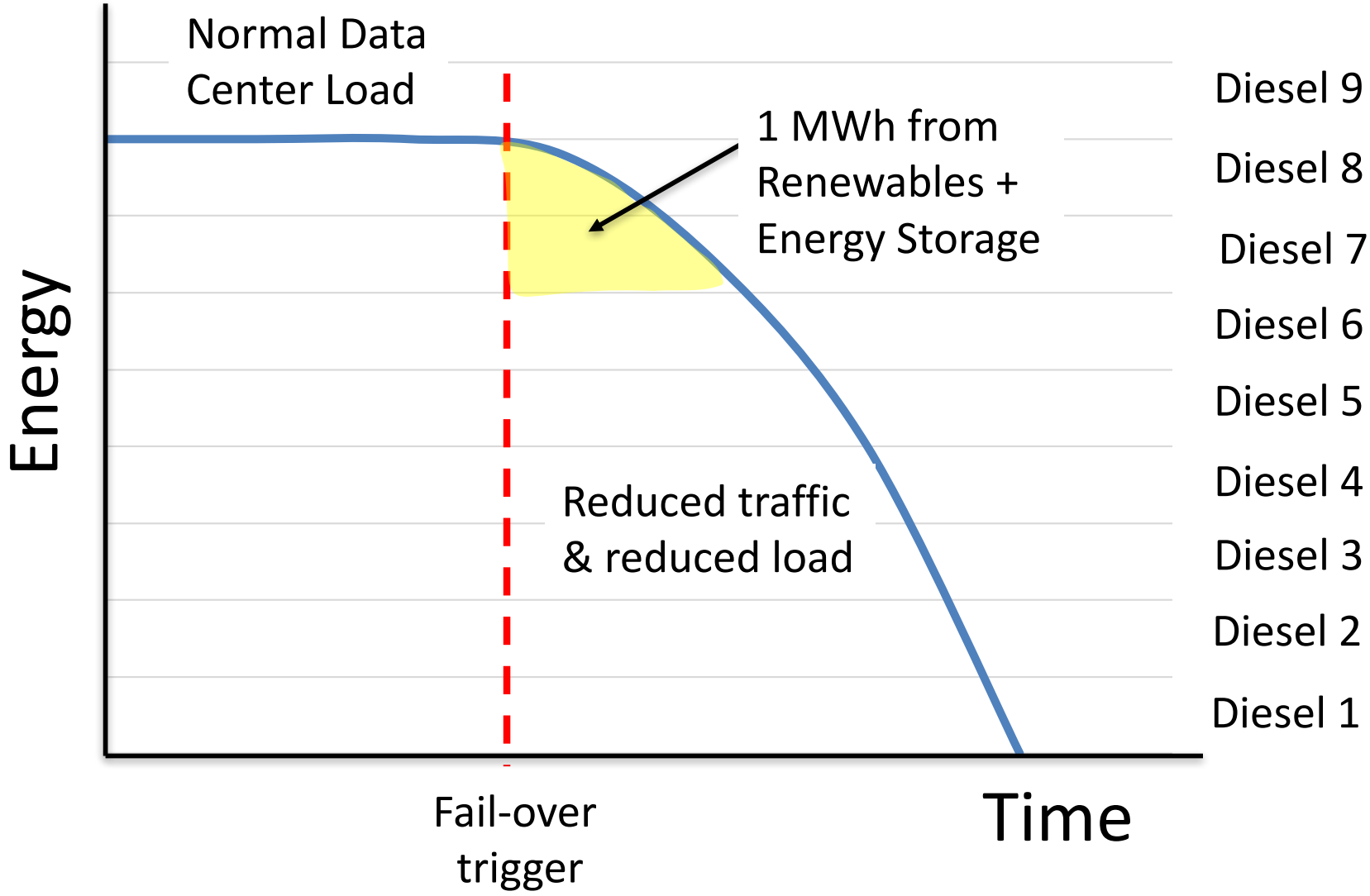

DR + Renewables + Energy Storage = Success

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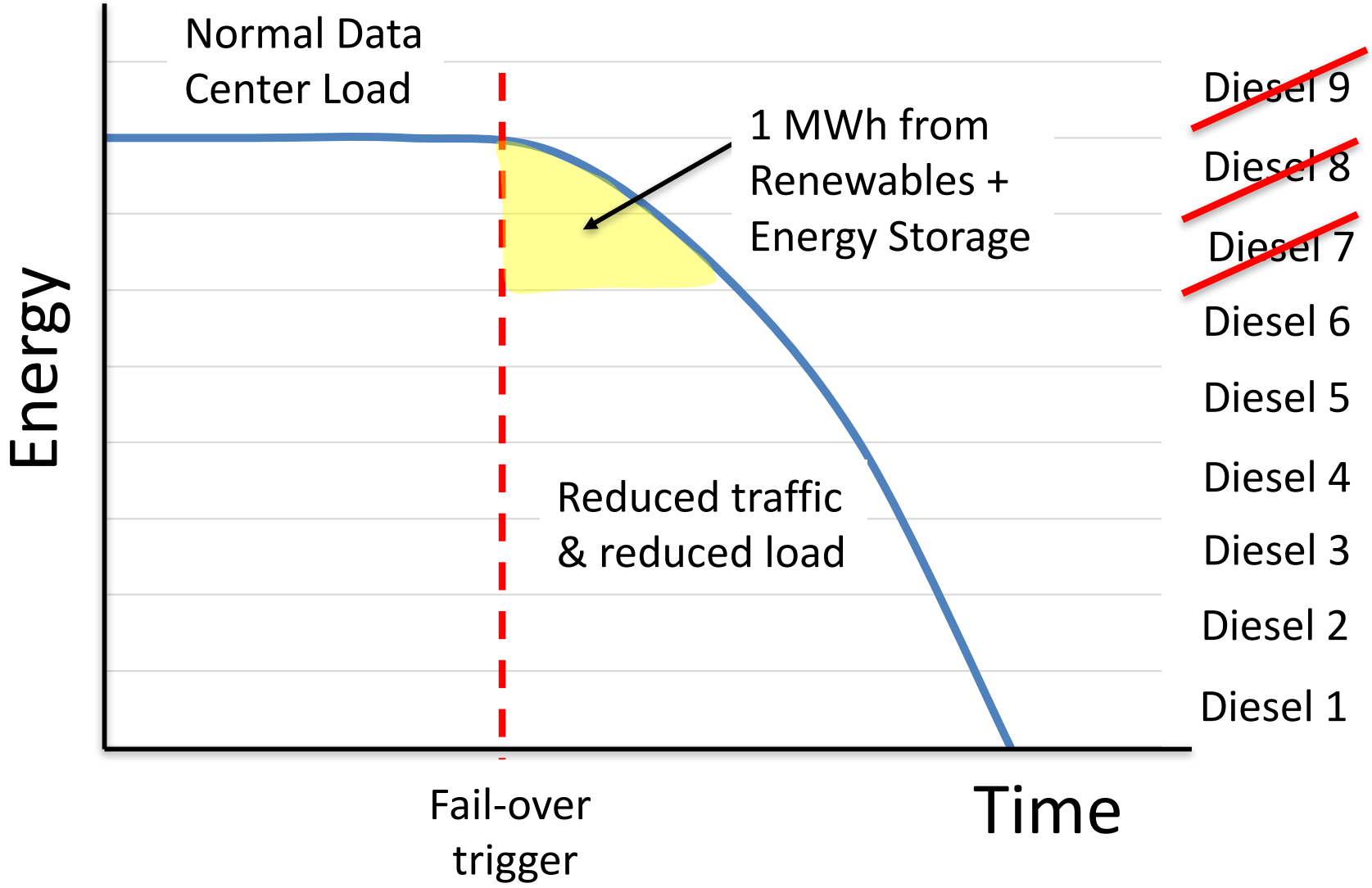

Multiple Pathways to Replacing 1MWh of Diesel

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- 1 MWh of energy storage with small solar or other renewables
- 2 MW of solar supplies 1 MWh of energy on worst weather day in California

Replacing 1 MWh of Diesel with
local renewables + energy storage is easy

Seeking Data Center Pioneers

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- Local renewables + energy storage is increasingly viable, including for a portion of data center requirements

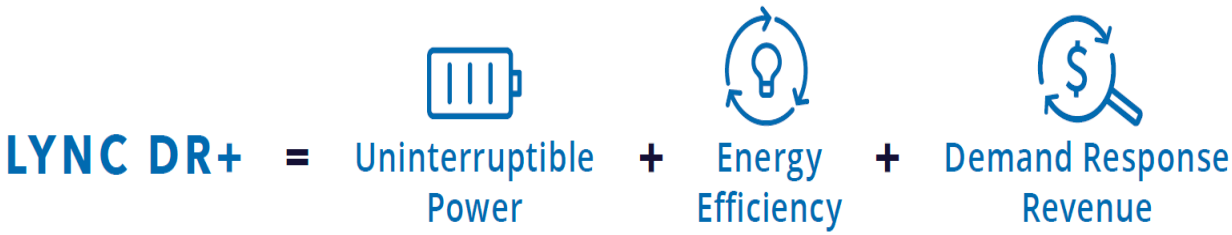
- Challenges exist for data center pioneers to help overcome

The Clean Coalition is seeking data center pioneers to conquer the next renewables frontier!

Backup

LYNC DR®+: Energy Resiliency for Datacenters

- Ensures critical loads stay operating when the grid goes down
- Enables revenue from demand response and savings from peak shaving
- Reduces power penalty from traditional double conversion UPS



Transform a cost center into a revenue-earning and cost-reducing asset

LYNC DR®+: Energy Resiliency for Datacenters

Example Case Study: Replacement of a 1 MW diesel generator with LYNC DR+

- **New construction in CA**
- **1 MW / 2 MWh battery energy storage: Estimated Capex - $2,750,000**
- **Provides 1 MW of UPS power during an outage and carries load during migration of datacenter traffic to a redundant site**
- **SGIP Incentives and ITC will reduce Capex: Up to 50%**
- **When grid is operating normally, can further monetize the asset:**
  - **Utility demand response**
  - **CAISO wholesale markets**
  - **Peak shaving**

German solar is mostly local (on rooftops)

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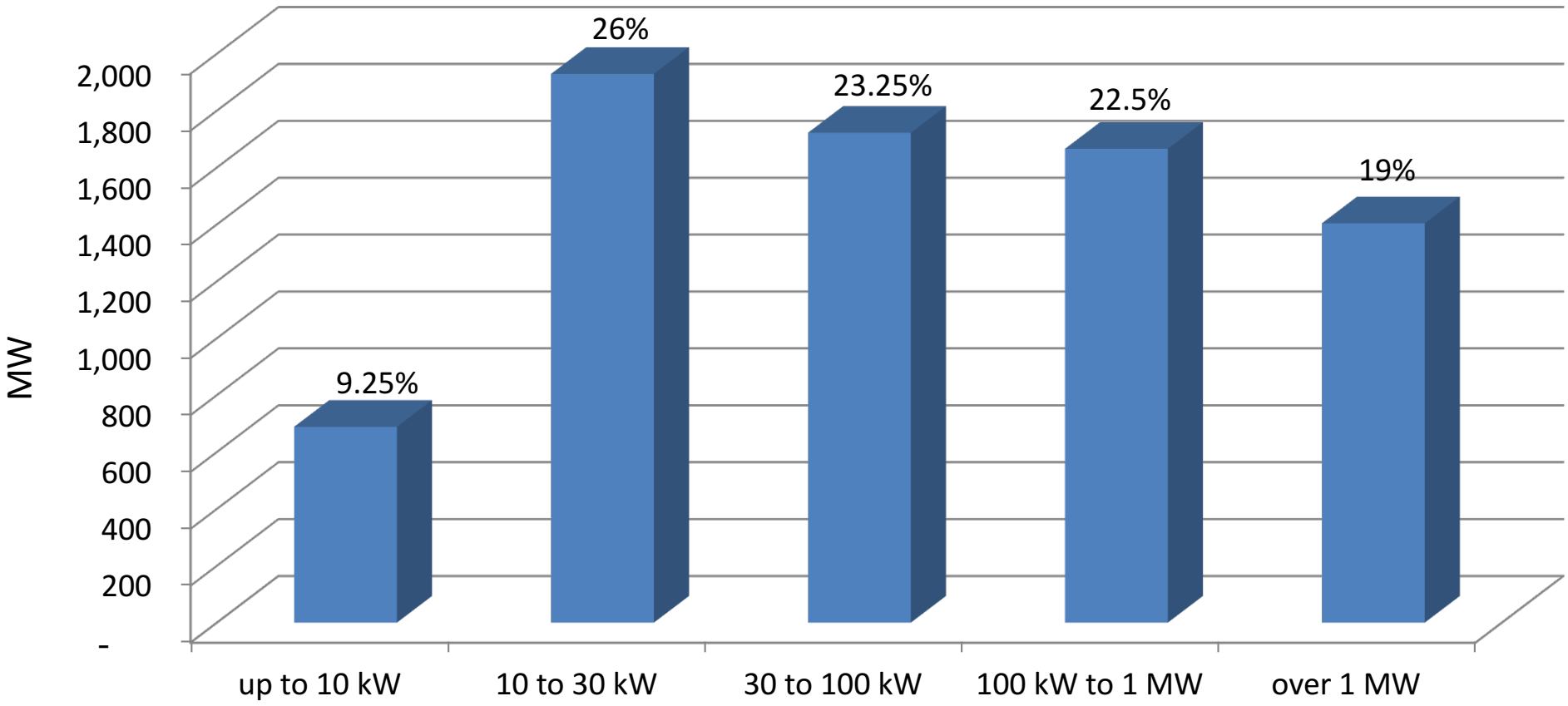
German Solar Capacity Installed through 2012



Source: Paul Gipe, March 2011

Germany's solar deployments are almost entirely sub-2 MW projects on built-environments and interconnected to the distribution grid (not behind-the-meter)

German rooftop solar is 4 to 6 cents/kWh today

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Project Size	Euros/kWh	USD/kWh	California Effective Rate $/kWh
Under 10 kW	0.1270	0.1359	0.0628
10 kW to 40 kW	0.1236	0.1323	0.0611
40.1 kW to 750 kW	0.1109	0.1187	0.0548
Other projects up to 750 kW*	0.0891	0.0953	0.0440

- Conversion rate for Euros to Dollars is €1:$1.07
- California's effective rate is reduced 40% due to tax incentives and then an additional 33% due to the superior solar resource

Replicating German scale and efficiencies would yield rooftop solar today at only between 4 and 6 cents/kWh to California ratepayers

* For projects that are not sited on residential structures or sound barriers.