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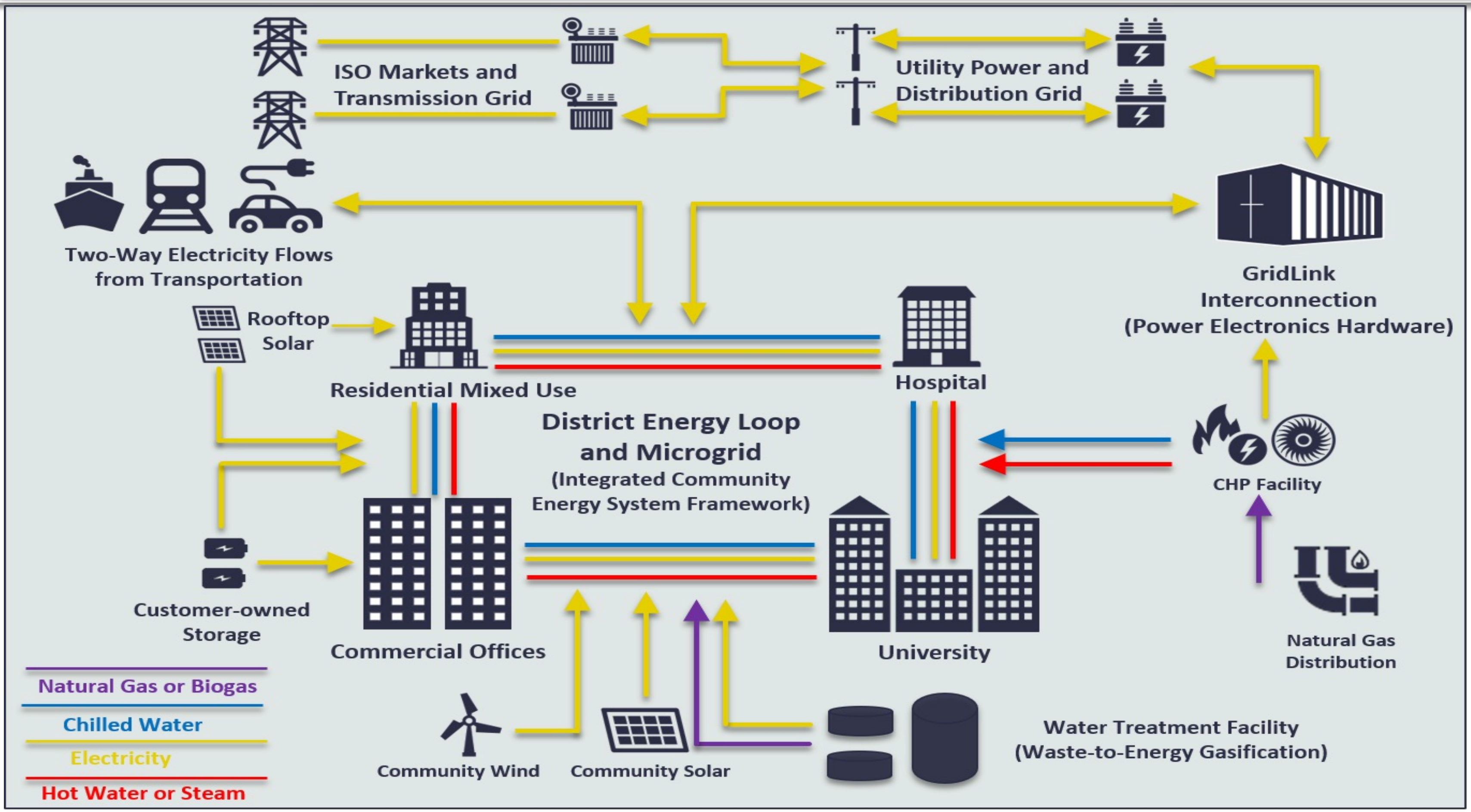
Business Model Summary

Introduction

Integrated Community Energy System: a multisided platform called GridLink will enable consumers to compete with the wide-area utility-owned power grid by electrically and institutionally networking local-area consumer-managed microgrids into an integrated community energy system ("ICES"). With GridLink, microgrids can safely and profitably transact with one other, the utility grid and certain transportation carriers.



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GridLink Electrical Networking: an innovative and patented configuration of off-the-shelf power electronics is pre-packaged in an eHouse that is factory tested and delivered to each microgrid site for installation. A GridLink eHouse is analogous to a router in a decentralized telecommunications and computing network. In this way, Pareto Energy may be thought of as the CISCO of decentralized power.

Key Attributes

Containerized:

- Comes pre-packaged in an eHouse
- Transformers and breakers are seated on either side of the eHouse on skids

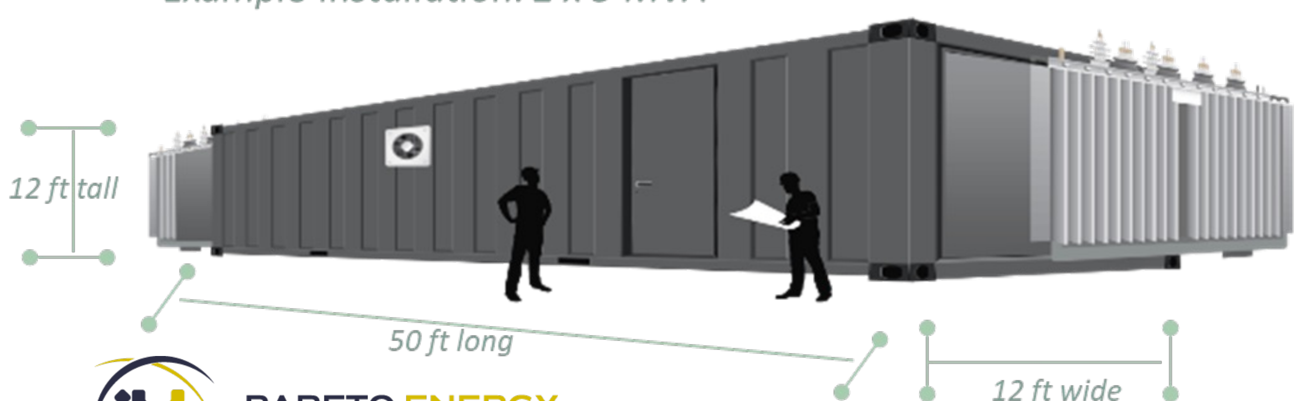
Installation:

- Pre-assembled, factory tested, certified, shipped to site and simply dropped-in onsite
- Transformers, breakers and switchgear assembled, pre-wired & certified at the factory

Customizable: Each eHouse arrives customized to meet site needs

Modularity and Scalability: eHouses can be stacked, linked or distributed throughout a property and centrally controlled on-site to meet demand above 2MW

Example installation: 2 x 5 MVA



Example GridLink Product Specs:
(medium voltage distribution grid connection)

Size: 12' x 12' x ~50'

Weight: 50 tons

Build Time: ~9 months

Cost: ~$1M per MW

Models: 5 MVA Unit/11 MVA Unit

GridLink's Core Components:

- Medium Voltage Power Converters
- IEEE Compliant and UL Certified
- Compliant with Industry-Standard Cybersecurity Protections
- Harmonic filters
- Transformers & Breakers
- Cooling system
- Controls
- Communications

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Theoretical Underpinnings: Elinor Ostrom won the Nobel Prize in Economics for The Institutional Analysis and Development (IAD) framework that she developed based on empirical research of collective consumer management of resource systems as a common pool resource ("CPR"). The IAD has been used to optimize the institutional and engineering design of an ICES as a CPR

"Considerable theoretical and empirical research suggests that adaptive management of social-ecological systems requires networks that combine dense local informational flows with effective connections across groups and scales to foster the combination of local knowledge, cross-scale coordination, and social learning."

Ostrom, Elinor, "A general framework for analyzing sustainability of social-ecological systems", Science, 325(5939):419–422, 2009.

"Public policies based on the notion that all CPR consumers are helpless and must have rules imposed on them by either markets or the government can destroy institutional capital that has been accumulated during years of experience in particular locations. An in-depth analysis of their experience can deepen one's appreciation of human artisanship in shaping and reshaping the very situations within which individuals must make decisions and bear the consequences of CPR use on a day-to-day basis. Success in starting small-scale initial institutions enables a group of individuals to build on the social capital thus created to solve larger problems…"

Ostrom, Elinor, Governing the Commons: The Evolution of Institutions for Collective Action, New York: Cambridge University Press, p. 184.

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New Distributed Utility Business Model: Pareto Energy has also established a subsidiary, Pareto Electric, as a regulated utility holding company and developed state-by-state legal strategies to enable Pareto Electric to distribute power to multiple consumers within an existing utility franchise. A Consumer and Labor Stock Ownership plan enables collective management of an ICES as a Common Pool Resource

Key Partners

Engineering, procurement and construction contractors for designing and building power, thermal, telecoms and control networks

Local community, legal and labor relations consultants

Power & thermal generation owner-operator

Regional microgrid R&D enabling and apprenticeship centers in collaboration with local university think tanks and labor unions

Key Activities

30% design needed for construction loans, tax credits and grants

Application of non-wires alternative credits

Engineering, procurement & construction

Operations

Workforce development and supply chain surety

Key Resources

Off-the-Shelf power electronics hardware

Open-source optimal power flow software

Energy Improvement District legal documents

Value Propositions

Multi-sided platform business model optimizes the integration of microgrid assets & community outcomes with the following benefits:

Power guaranteed to be less than prevailing utility company rates with guaranteed of levels reliability and air emissions.

Lower costs to utility ratepayers to procure real power for frequency response and reactive power for voltage regulation and black starting.

Voting shares and dividends

Customer Relationships

Long term energy services agreement

Ancillary Services Auctions

Consumer-Labor Stock Ownership Plan

Channels

US Conference of Mayors

American Association of Port Authorities

Roosevelt Strategic Council

Local Chambers' of Commerce & community & regional organizations

Customer Segments

Critical Infrastructure

Regional Transmission Operator

Vulnerable Communities & Labor

Pareto Energy Cost Structure

$1.5 million fixed costs of customer acquisition and initial design + $2.50 to $3.00 per watt design-build costs

$1.00 per watt design-build costs for stand-by generation & distribution assets

Costs of workforce development & supply chain surety investments

Pareto Energy Revenue Streams

Tax credit, grant & non-wires alternative credits + sale of generation assets at $0.40 per KW profit margin + $0.03 per kwh of power distribution

$0.40 per watt per year for ancillary services capacity

Community-Labor Cost Structure

Labor wages lost due to elimination or delay of utility grid investments + community environmental and social impacts

Community-Labor Benefits

Increased income from Consumer-Labor stock ownership plan + lower costs of power due to less utility grid congestion + lower air emissions

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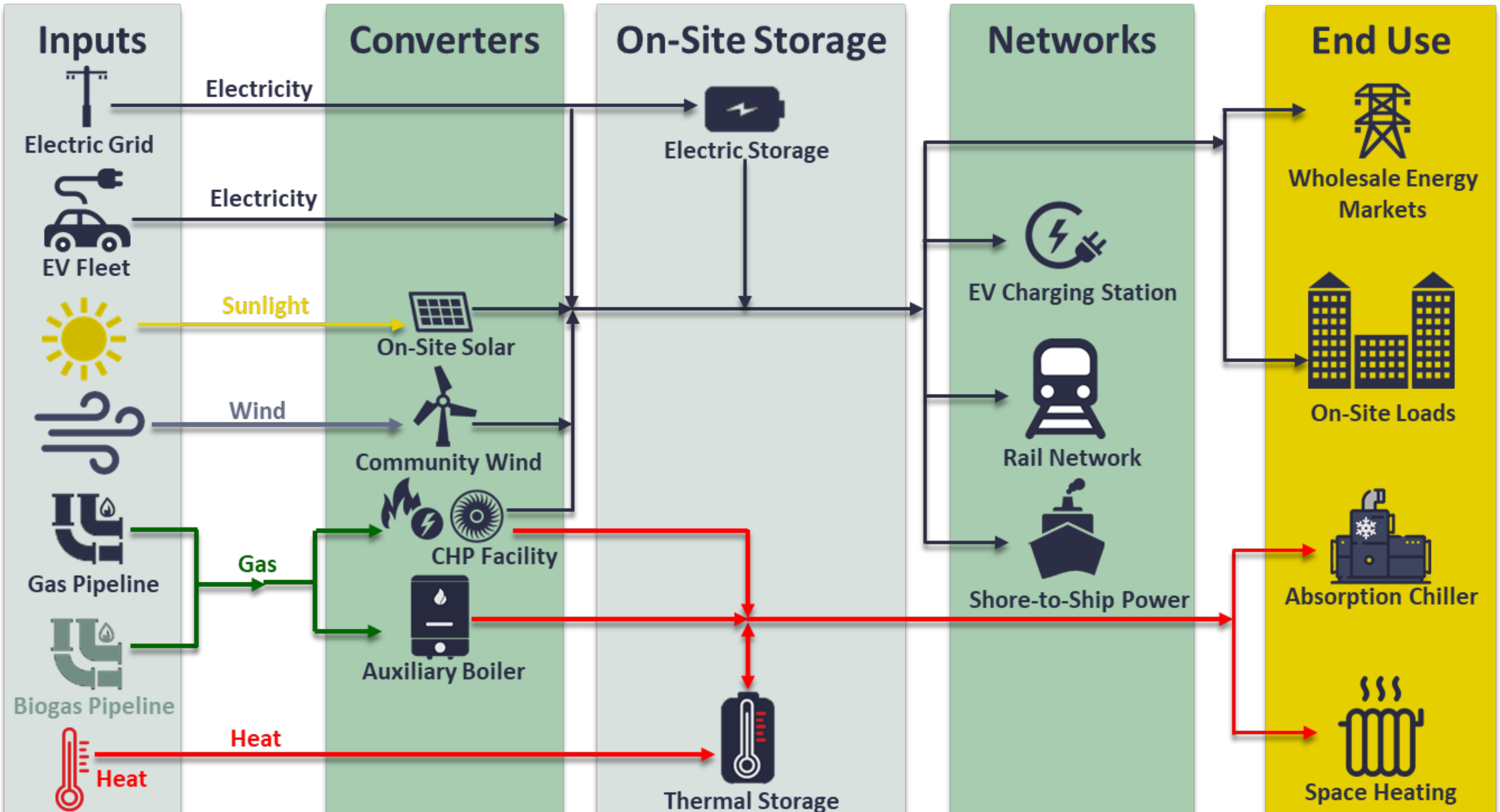
Engineering and Institutional Design: Unlike other microgrid platforms that only address engineering designs, GridLink includes four stages of simultaneous engineering and institutional design. Pareto Energy has developed a standard open-source framework of governance contracts, legal enabling and decision support software whereby an ICES of integrated local-area microgrids, collectively planned and governed by consumers as infrastructural commons, can enjoy fair competition and equitable profit sharing with the wide-area utility-owned grid.

GridLink Engineering and Institutional Design Methodology

Level		Engineering Design		Institutional Design	
Access	1A	Engineering Feasibility	Technology Availability & Feasibility	Institutional Feasibility	Customs, Traditions & Norms
			Permit & Regulation Requirements		Legal Feasibility & Government Support
			Utility Interconnection Requirements		Analysis of Utility Competition
			Electrical & Thermal Demand Forecast		Discounted Cash Flow Model
	1B	Systematic Environment	Basic System Architecture	Institutional Environment	Stakeholder Memorandum of Understanding
			Preliminary Design (30%)		Design-Build-Operate Supplier Subcontracts
			Conditional Interconnection Approval		Real Options Model
Responsibility	2	Design Principles	Complete IEEE Standard Design	Governance	Energy Purchase & Use Contracts
			Engineering Procurement & Construction		Construction Loan Agreement
			UL Certification		Dispute Resolution Procedures
			Final Interconnection Approval		Game Theoretic Profit Sharing Model
Control	3	Control Mechanisms	ISO Registration & Bidding Rules	Organization	ISO-ICES Agreements
			O&M Rules & Procedures		Permanent Financing Agreement
			Other Operational Decision Rules		Day-Ahead Optimal Power Flow Model
Operation	4	Operations	Monitoring & Control Systems	Administration	Accounting & Reporting System
			Information & Communications Systems		Membership Meetings & Support
			Asset Management Plan		Error-Corrected Optimal Power Flow Model

ICES Decision Framework: multiple energy sources and carriers would be included in an ICES. Each connection, conversion and end use indicates an option and/or decision point that could drive microgrid investment or operation. GridLink includes a software to optimize energy flows and the associated financial transactions



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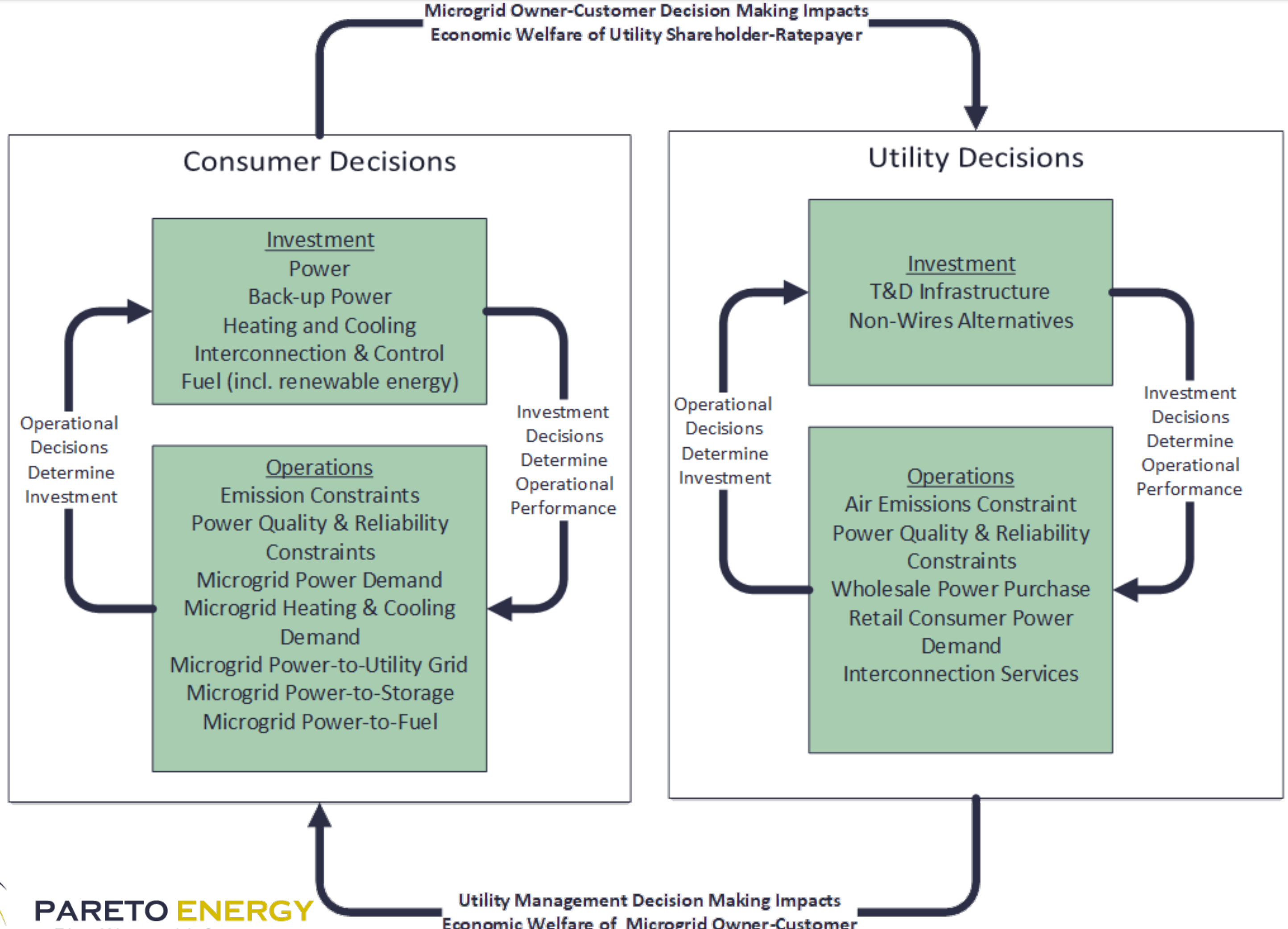
Optimization Model: Pareto Energy models the simultaneous consumer and utility decisions that drive microgrid projects. It also guides the intra- and interdependencies between operational and investment decisions. Though it adds complexity to the process, modeling typical results in a 40% higher rate of return as compared to heuristic planning methods.



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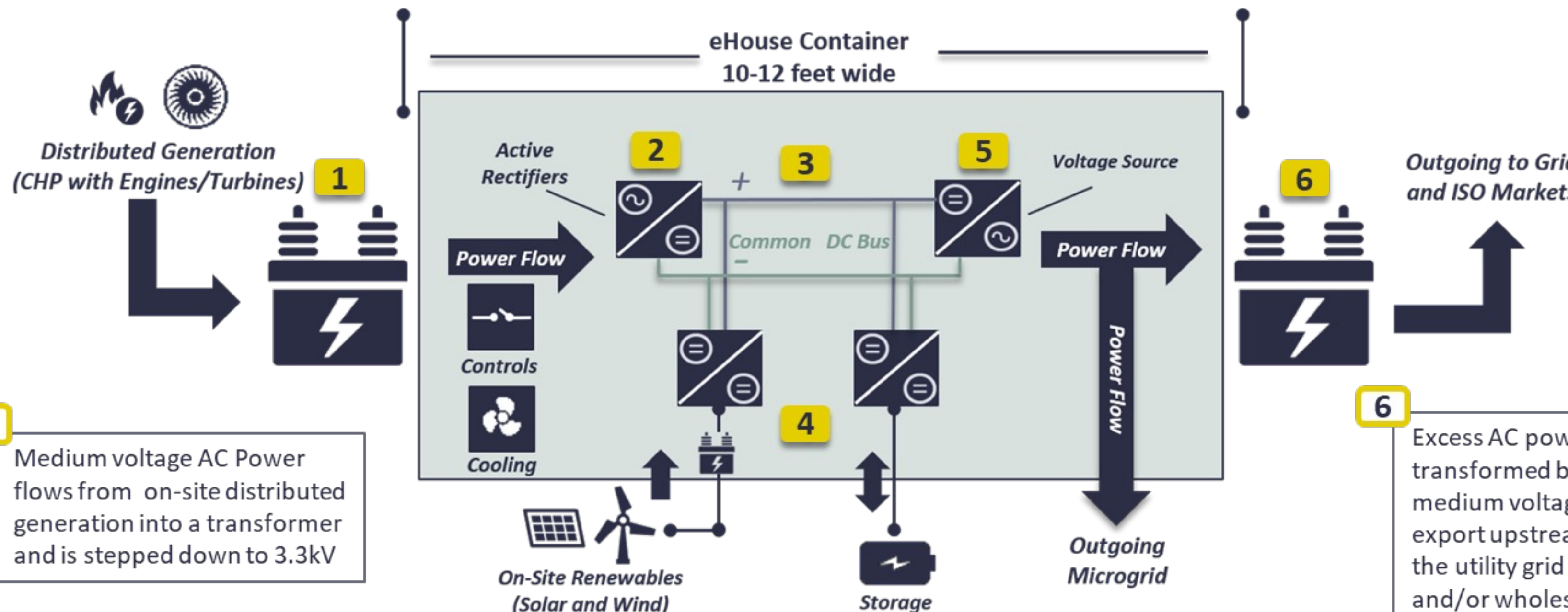
GridLink Electrical Networking

Product Description: GridLink enables control of both AC and DC powered on-site distributed resources without the need for additional protective equipment and enables sales of power to ISO markets to increase earnings



1 Medium voltage AC Power flows from on-site distributed generation into a transformer and is stepped down to 3.3kV

6 Excess AC power is transformed back to medium voltage for export upstream to the utility grid and/or wholesale markets

2 The stepped down AC power is converted from AC to DC through medium-voltage power converters

3 After the AC/DC conversion process, DC power from each source is combined on a common DC bus

4 Alternatively, power from on-site DC sources such as renewables and/or storage flows into the common DC bus where it is combined with other power sources

5 A second set of inverters draws power from the DC bus and converts it to AC, eliminating all power quality problems. Low voltage power flows downstream to serve on-site loads

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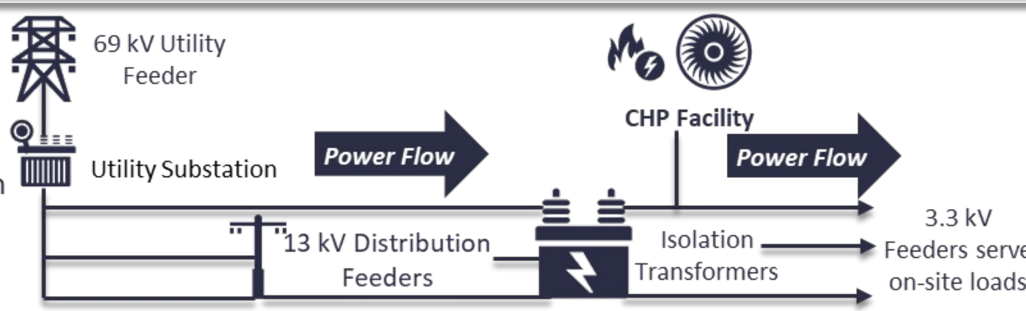
Comparison: Traditional Synchronous Interconnection vs. Non-Synchronous Interconnection with GridLink Platform for a CHP Facility

Example System 1

Synchronous Interconnection with Electro-Mechanical Switchgear

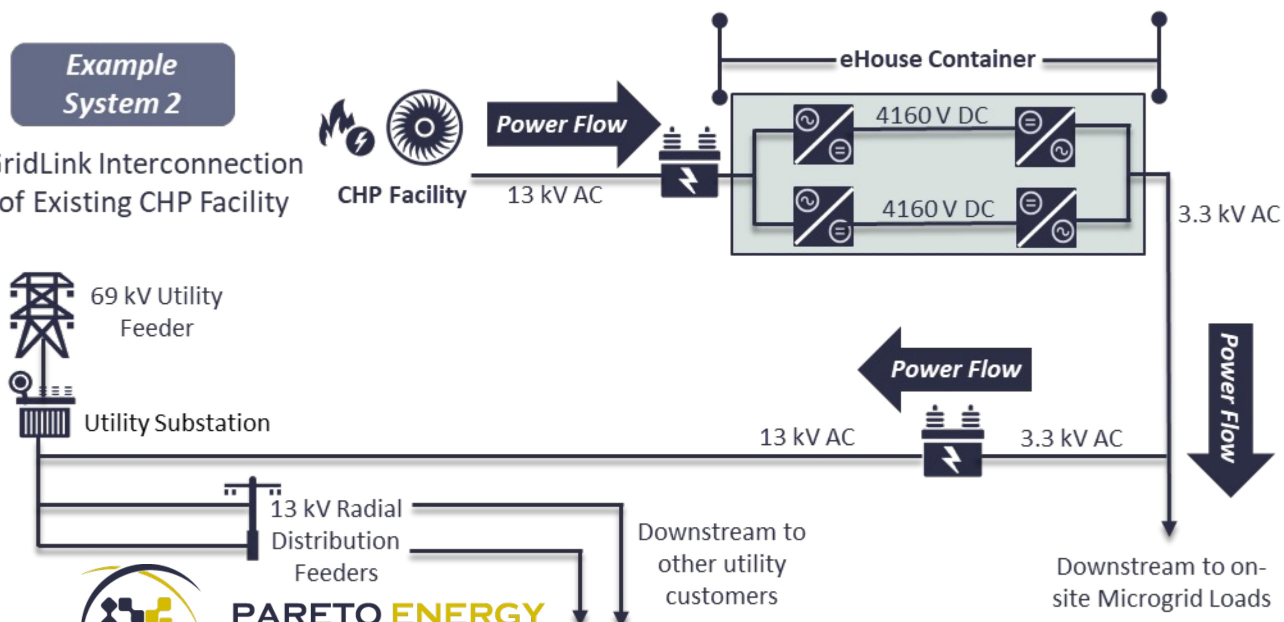


Enables connection to the grid while:

- Limiting functionality of Engines/Turbines
- Requires black start upon Utility outage
- No ability to export power upstream for sales to ISO Markets
- Usually subject to expensive standby tariffs for supplemental utility power

Example System 2

GridLink Interconnection of Existing CHP Facility



Enables connection to the grid while:

- Isolating the CHP generators from the grid
- Avoids cost of Utility standby charges by not importing power
- Continuous supply to the load in the event of a utility outage (i.e. no black start)
- Export of power upstream for Non-Wires Alternatives and sales to ISO Markets

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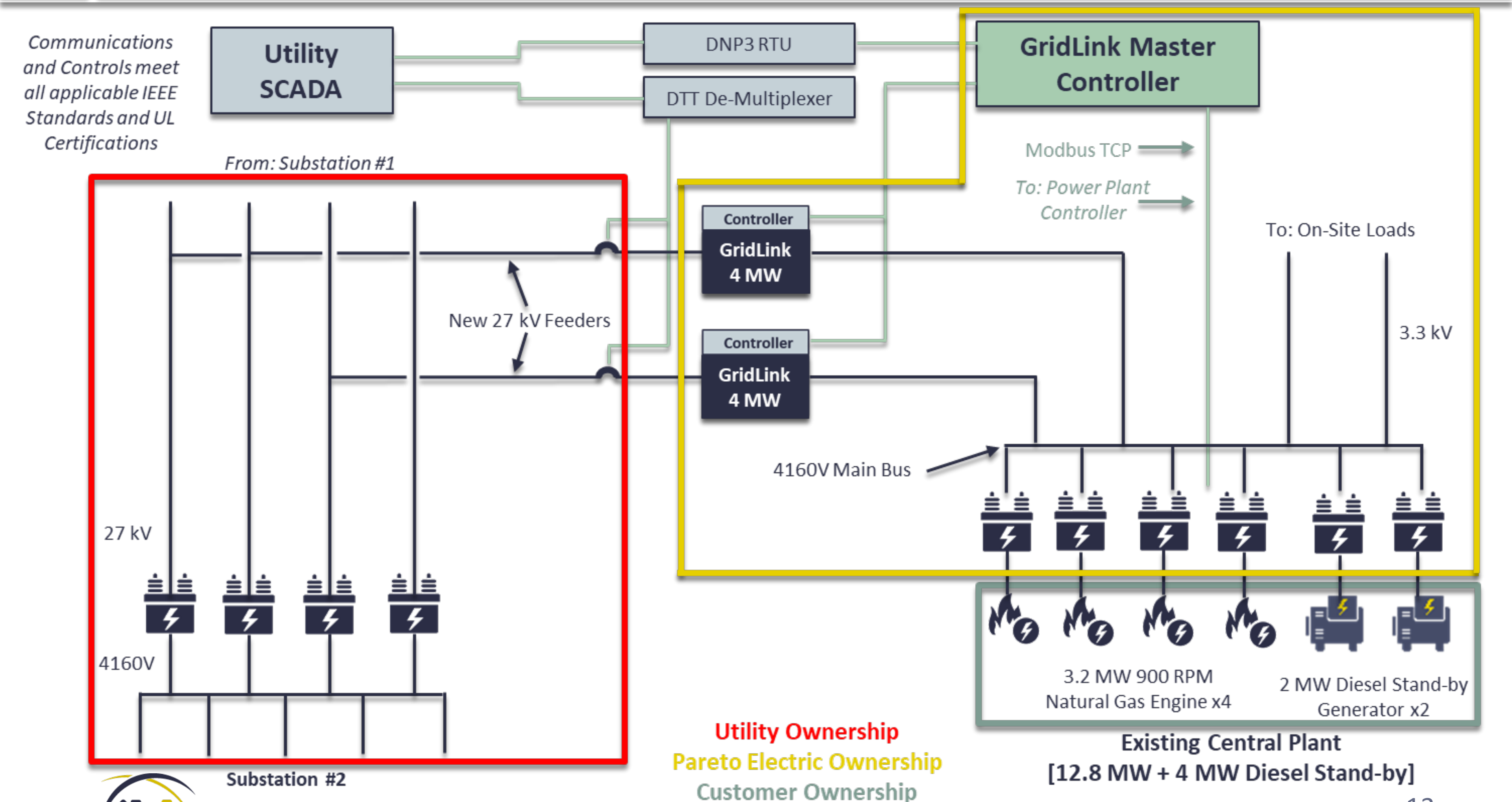
Project Proposal: An example New York City proof-of-market project for a single customer site with power export and sales of ancillary services to New York ISO from an existing CHP Facility in Brooklyn. The boxes depict the ownership arrangement as proposed in our DC filing.



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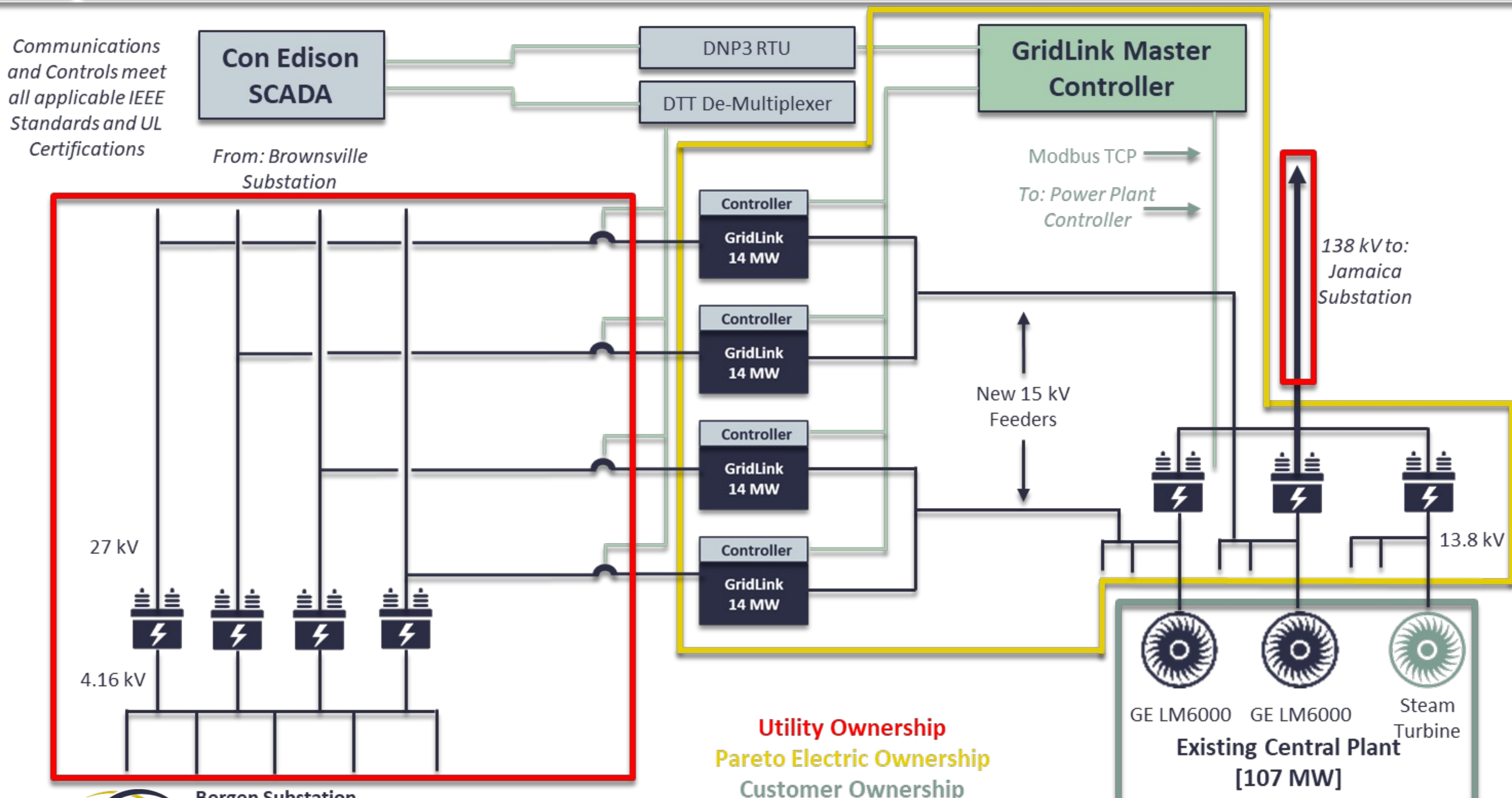
Project Proposal: An example New York City proof-of-market project where an existing, large CHP Facility is retrofitted to serve on-site loads, improve reliability and meet non-wires alternatives to avoid expensive infrastructure upgrades in the local grid at a critical facility in Queens. The site contains a single customer with a campus microgrid. The boxes depict the ownership structure as proposed in our DC filing.



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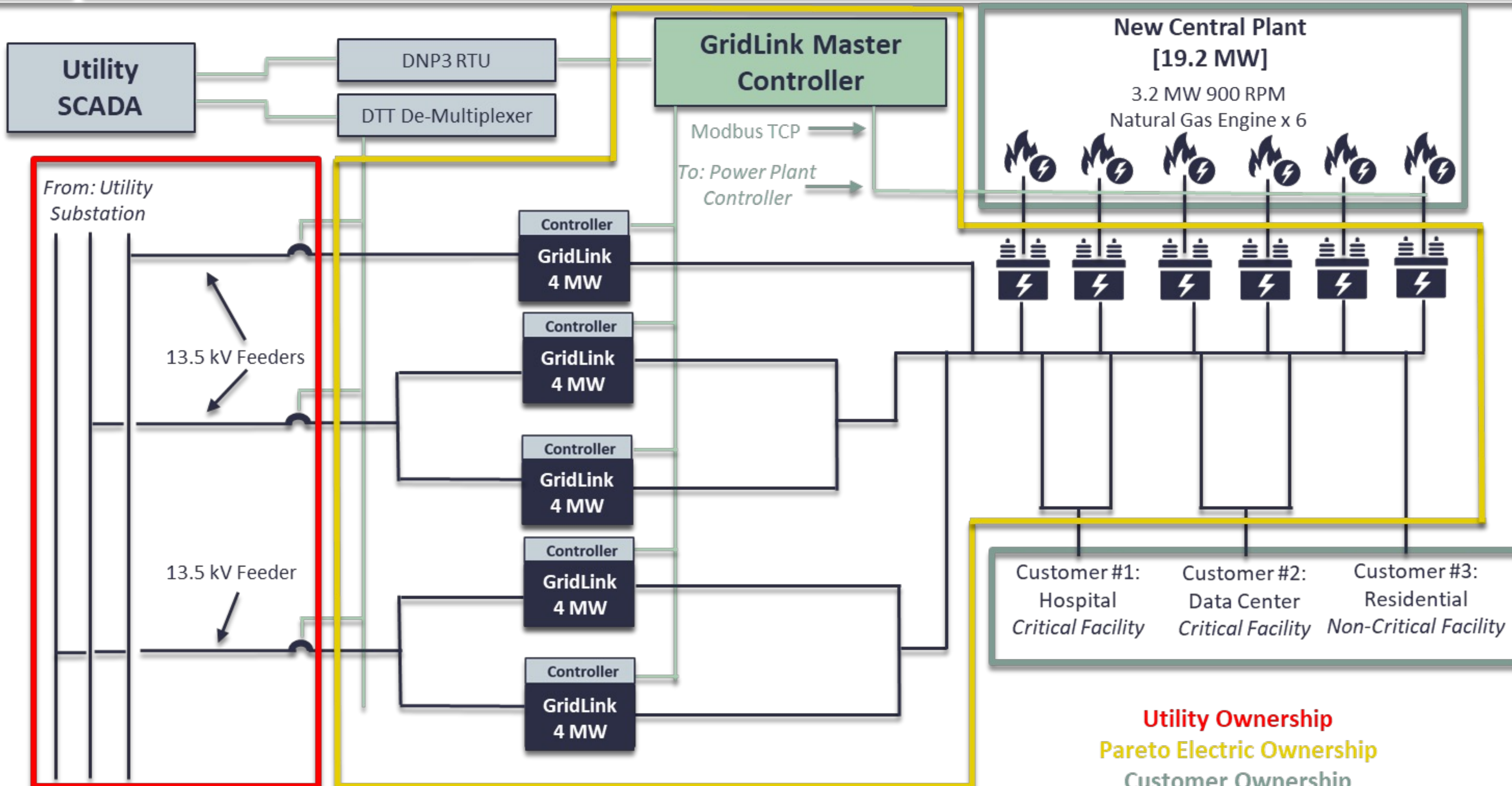
Project Proposal: An example proof-of-market project where a new, large CHP facility is constructed to meet on-site demand for two critical facilities. The project also includes distribution of electricity and thermal energy services to co-located residential units. The boxes depict the ownership rights as proposed in our DC filing.



Independent Research: Researchers at the University of Connecticut conducted a case study comparing Pareto Energy's GridLink Platform to a synchronous interconnection platform installed at New York University

Luh, Peter, et. al,"Real Case Based Comparative Study of MicroGrid Protections for Synchronous and Non-Synchronous Interconnections", Report of the University of Connecticut Department of Electrical and Electronic Engineering, September 15, 2015.

"Following a comprehensive overview of the technology challenges and solutions for protection scheme in microgrids, a comparative study of the protection solutions for MGs with synchronous and non-synchronous interconnections was conducted based on two real cases in New York City."

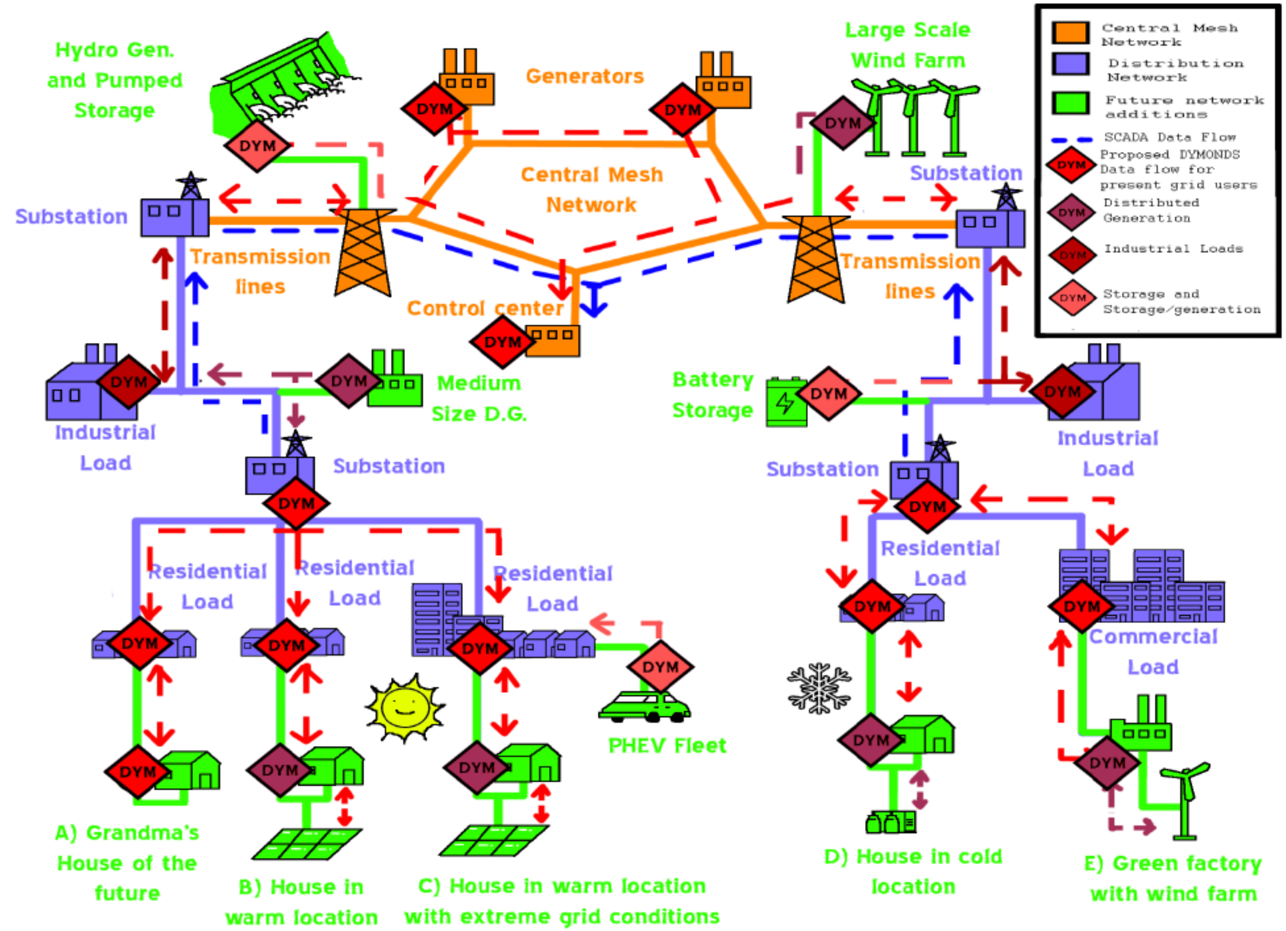
"NYU microgrid has one of the largest private CoGen plants in New York City. Current limiting fuse (CLiP) installed between old and new Cogen system provide protection for the under-rated old Cogen system at a substantial cost savings over replacement of the original circuit breakers ("CBs"). It is challenging for CBs to respond to various short circuit levels in both islanded and parallel mode. Numerical relays and selectable trip CBs is a solution at a substantially higher cost. Large fault current contribution from local CoGens from NYU push the short circuit capacity of substations to its limit. Moreover, solid state relays and circuit breakers (3 to 5 cycles) is not enough for interconnection protection."

"Kings Plaza microgrid utilizes non-synchronous interconnection with back-to-back inverters. Inverters provide much faster switching speeds along with advanced sensing and controls that can be used to eliminate fault current contributions, thus making DER coordination negligible. Steady state short circuit analysis shows that the back-to-back inverters isolate fault current contributions bi-directly, from the utility to the microgrid, and from the microgrid to the utility. Transient stability study shows that back-to-back inverters can also isolate transient fault disturbance, and support voltage stabilization."

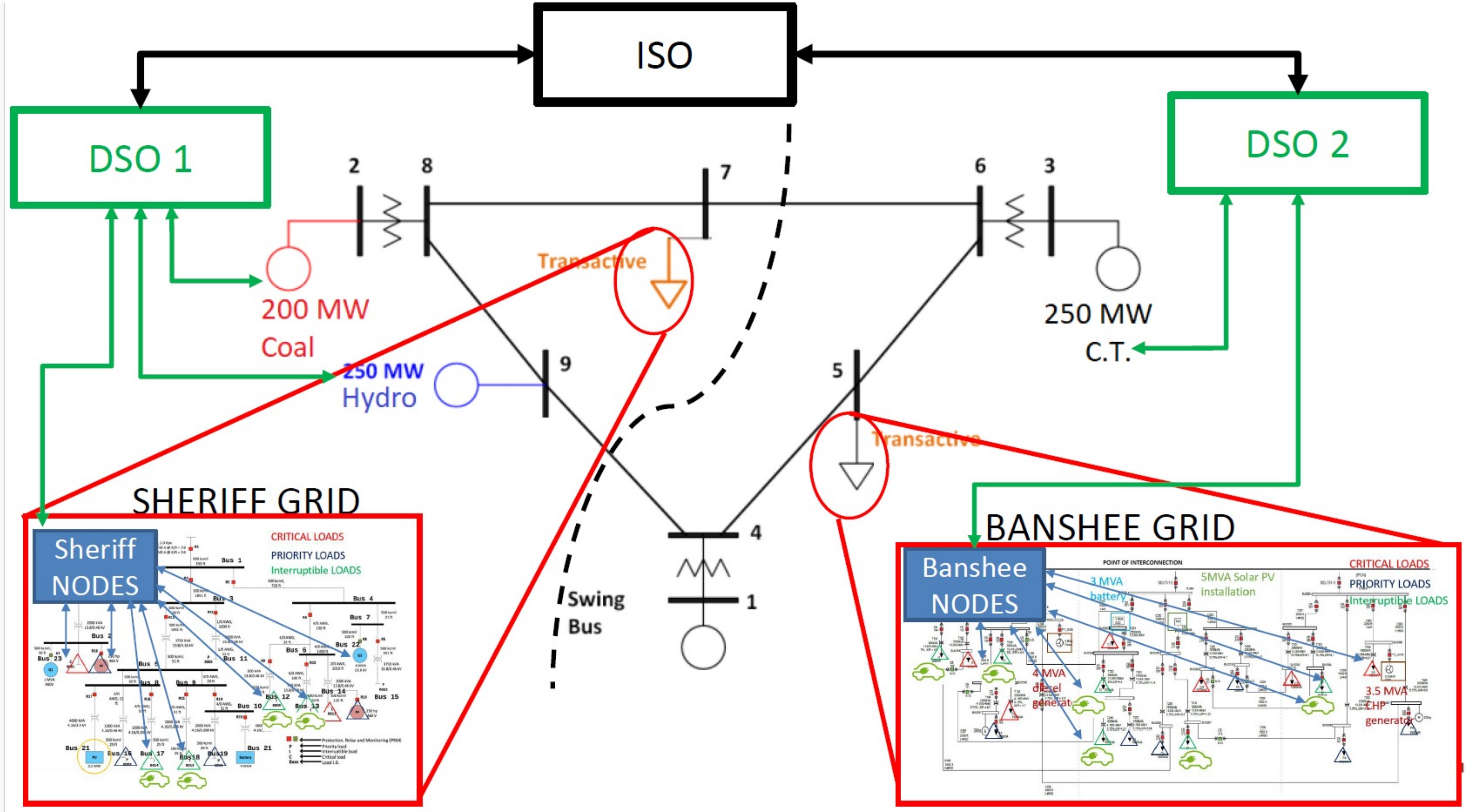
GridLink Optimization Modeling

DyMonDS Digital Twin Case Study for a Decentralized Modernization of the Puerto Rican Grid

DyMonDS: Basis for simple protocols that work*

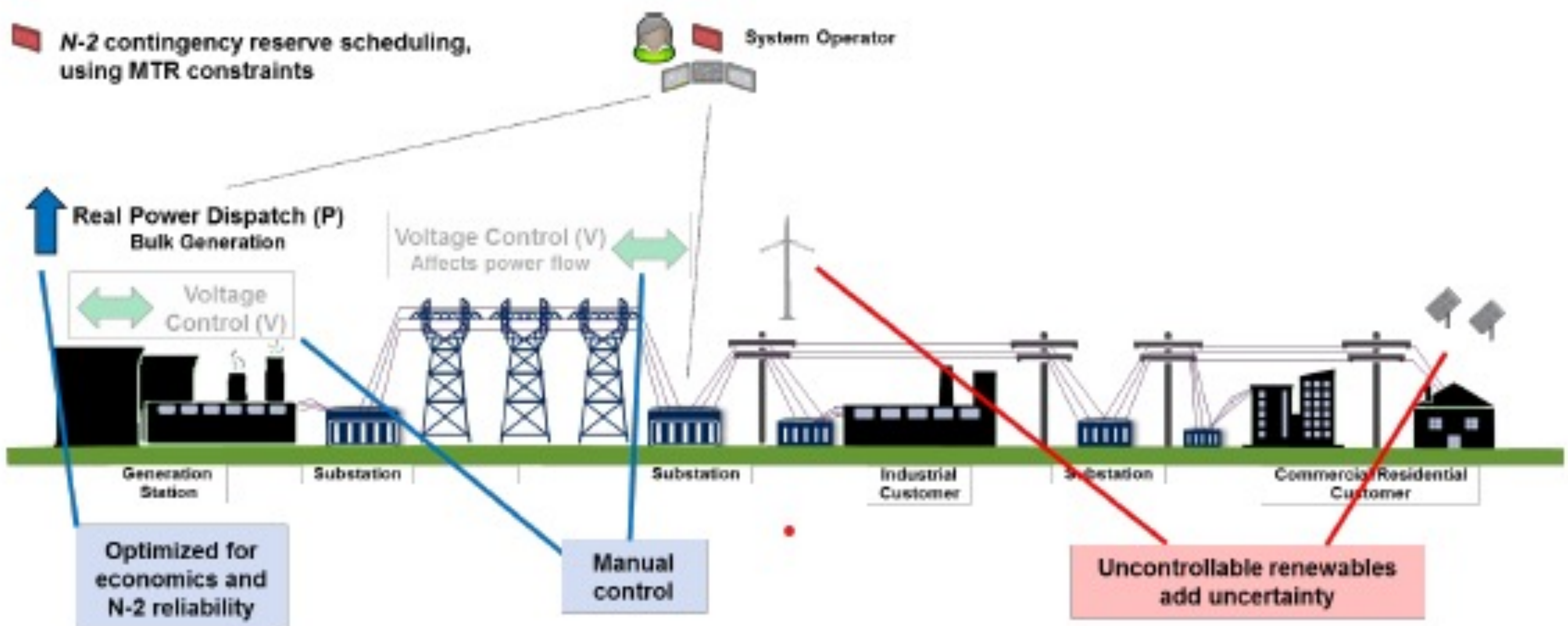


*Ilić, M. D. (2010). Dynamic monitoring and decision systems for enabling sustainable energy services. Proceedings of the IEEE, 99(1), 58-79.
Ilic, Marija D. "Toward a unified modeling and control for sustainable and resilient electric energy systems." Foundations and Trends in Electric Energy Systems 1.1-2 (2016): 1-141.

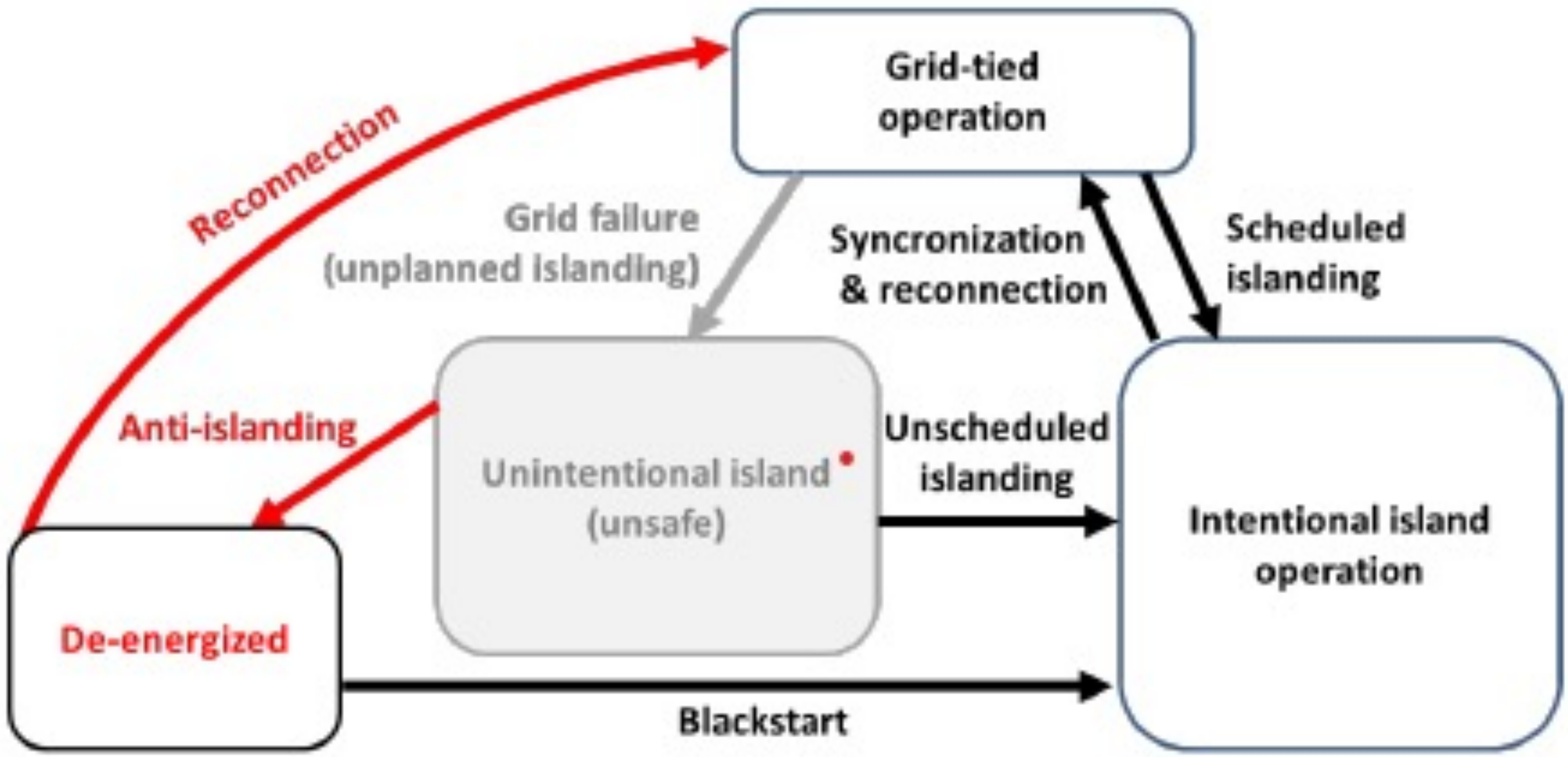


ISO
DSO 1
DSO 2
2
8
7
6
3
Transactive
200 MW
Coal
250 MW
C.T.
250 MW
Hydro
9
5
Transactive
4
1
Swing
Bus
SHERIFF GRID
Sheriff
NODES
CRITICAL LOADS
PRIORITY LOADS
Interruptible LOADS
BANSHEE GRID
Banshee
NODES
POINT OF INTERCONNECTION
3 MVA
battery
5MVA Solar PV
installation
CRITICAL LOADS
PRIORITY LOADS
Interruptible LOADS
4 MVA
diesel
generat
3.5 MVA
CHP
generator

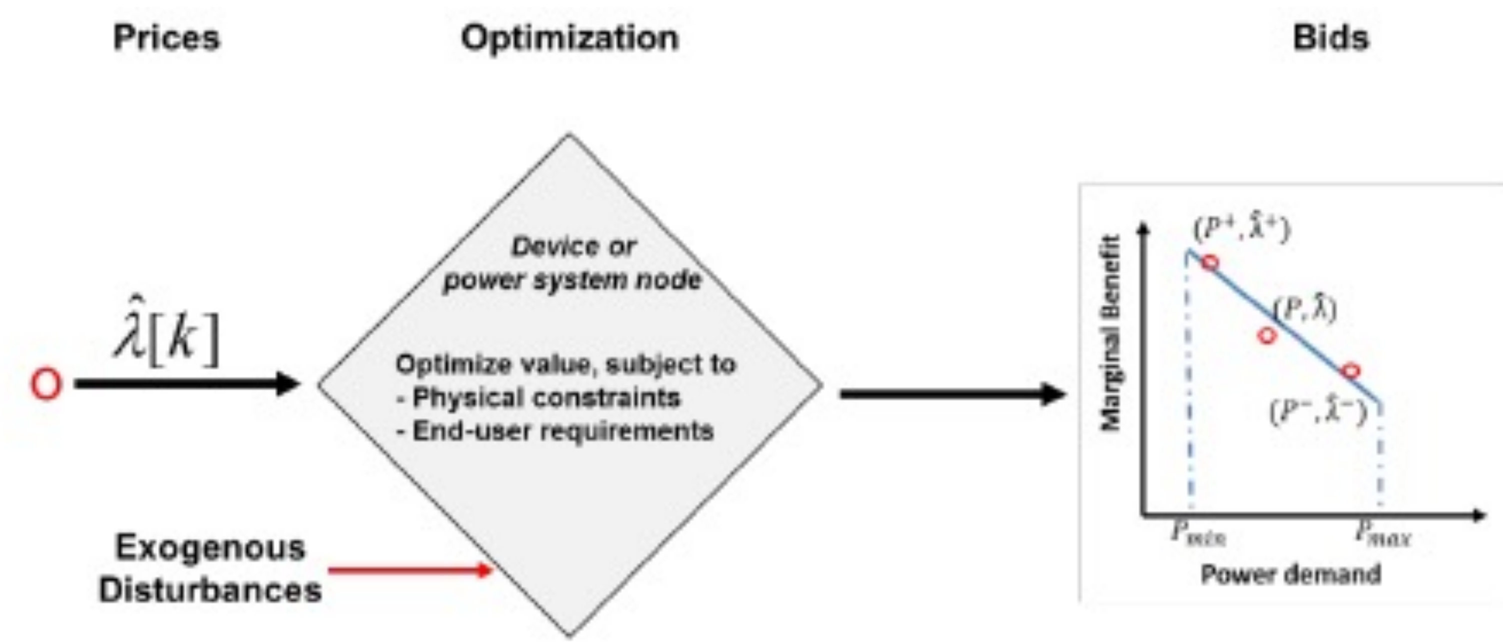
Pre-Hurricane Historical Centralized Optimization: Control levers and optimization objectives under today's preventive dispatch method



Proposed Post-Hurricane Resilient Inverter Control: Distributed generation can be increased with grid schemes that integrate generation at the distribution level, typically 38 kV and below, instead of at the transmission level, typically 230 kV or 115 kV. To provide resilience, one or more DERs must operate within a microgrid, which enables off-grid, “islanded” operation. When the grid fails, they can isolate local microgrids from the utility grid to safely provide continuous power to local loads.



Building block of DyMonDS framework: prices and bids are used to communicate control signals and allowable operating region



λ: price (as a control signal)
$\hat{\lambda}[k]$:predicted price at time *k*

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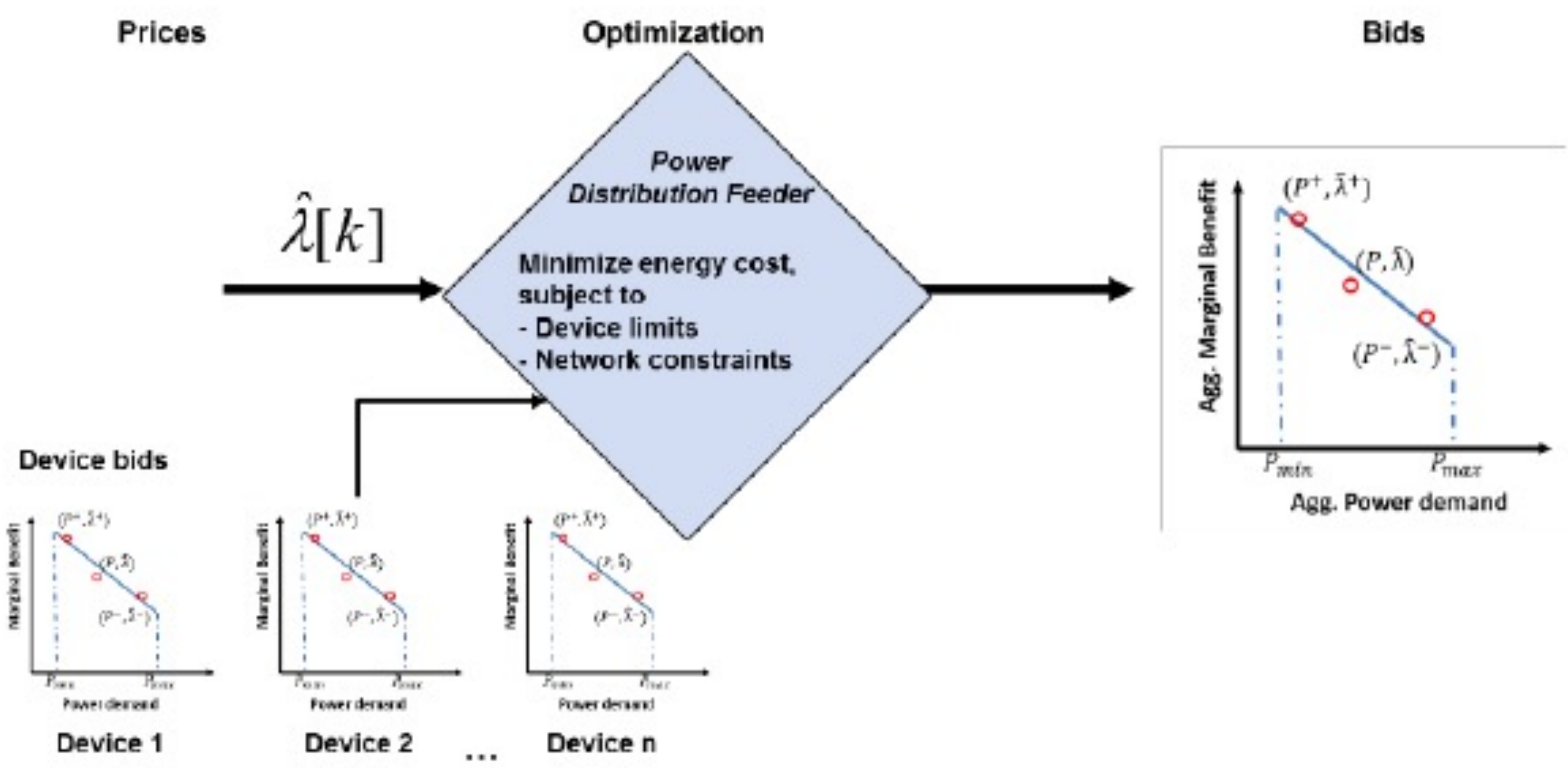
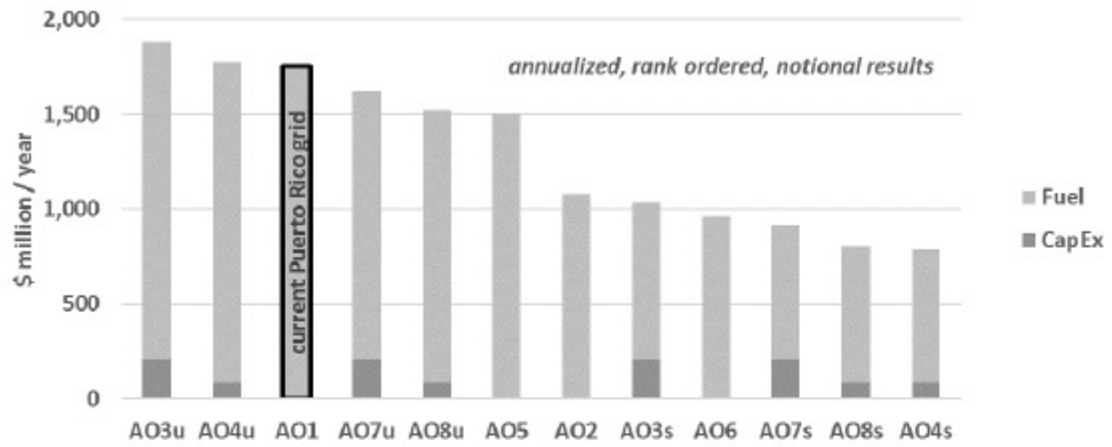
DyMonDS hierarchical communications: Power distribution and transmission nodes aggregate bids from lower-level devices, ensuring the system is balanced, efficient, and can be segmented



Results of DyMonDS Digital Twin Simulations: $1.04 billion per year of operational savings with 74 percent of Puerto Rico with power after a Hurricane Maria event



Problem	Recommendation	Impact	Cost
4. Today's top-down grid control cannot capture the value of DERs	(4a) Further research implementation of distributed MPC within Puerto Rico's bulk power plants and DERs	$80 million/year grid operational savings	< $2 million
	(4b) Organize a stakeholder workshop on implementing the DyMonDS framework (4c) Further research the DyMonDS interactive framework	$1.04 billion/year grid operational savings; 74% of Puerto Rico with power following Maria-scale damage	< $2 million

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