PARETO ENERGY

COMBINED HEAT AND POWER MICROGRIDS FOR NEW YORK CITY

Presented to:

NYSERDA CHP Conference

"CHP in New York State: The Next Generation"

June 22, 2012

Summary of the Presentation

- **Consolidated Edison's Plans for the City's Goal of 800 MW of Customer-Owned Distributed Generation**
  Con Edison has committed to work with customers and stakeholders to help meet PlanNYC's goal of 800MW of DG in NYC

- **Known Technical Barriers to Interconnection**
  Existing interconnection methods will likely keep the goal out of reach

- **Pareto's Microgrid Business Model Using the GridLink Non-Synchronous Microgrid Solution**
  "Non-synchronous" microgrids eliminate the interconnection limitations with zero impact on utility equipment

- **A Pilot Test at the NYU Polytechnic Institute to Clear the Way for Rapid Scale-Up**
  Microgrids can compress expected timelines for widespread DG deployment and fast-track the emissions reductions goals. Microgrids with GridLink also improve reliability and help the utility defer costly upgrades to transmission and distribution systems

Consolidated Edison's Plans for Implementing the City's Goal of 800 MW of Customer-Owned Distributed Generation

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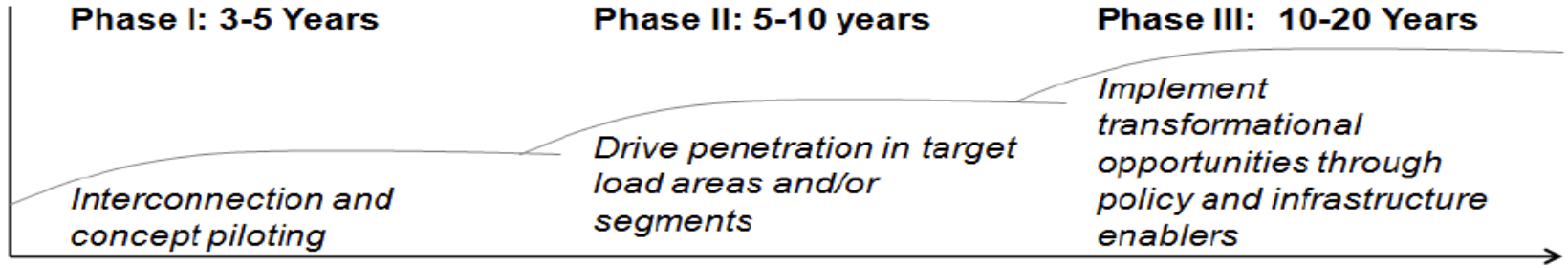
Mayor's PLAN NYC Results in Initiative for 800 MW's of Customer-Owned Distributed Generation. Consolidated Edison's Long Range Plan Sets Time Line.

CONSOLIDATED EDISON COMPANY OF NEW YORK

Electric System Long Range Plan: Assessment Documents

Assessment Document 2: Distributed Generation

Figure 3-1: Implementation Plan: Distributed Generation



"Continue partnering with customers and other stakeholders … and distributed generation advocates to facilitate the interconnection of distributed generation facilities and examine the opportunity to pilot new projects and concepts."

"Promote adoption of distributed generation in areas of the service territory where it can be the most beneficial to meet customer and Company objectives, including: reducing cost, increasing reliability, improving air quality and lowering greenhouse gas emissions. Results … will shape the subsequent strategy of the Company."

"Focus on more transformational opportunities through new policy and infrastructure enablers. By this time, technology standards should begin to emerge among the multitude of technologies being tested today. These standards will allow for simplified interconnection and management of disparate devices in the network"

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Interconnection Technologies are Found Wanting: November 2010 Consolidated Edison Report from DG Collaborative

Case 09-E-0428 – Proceeding on Motion of the Commission as to the Rates, Charges, Rules, and Regulations of Consolidated Edison Company of New York, Inc. for Electric Service

2010 DISTRIBUTED GENERATION COLLABORATIVE REPORT

November 2, 2010

"The City proposed a conceptual CHP installation with an electric power generator supplying a portion of the energy requirements at a municipal hospital campus. After its review, Con Edison noted that all the technical interconnection requirements, e.g., transfer trip, short circuit study and fault current mitigation, voltage and stability studies, telemetry, would have to be met, that the customer would be responsible for interconnection costs, including studies and system reinforcement, and that a primary connection for the generator would require that the customer employ personnel trained in high tension switching on site 24 hours a day, seven days a week. Based on those case-specific assumptions, Con Edison advised that it considers this site to be a reasonable candidate for this type of connection. Despite positive qualities of this particular City proposal, and Con Edison's agreement to investigate ways to interconnect DG in this fashion, as a general matter, this type of approach is not the preferred interconnection method for Con Edison and may be cost prohibitive for the customer. Con Edison's concerns are: … both planned and unplanned feeder outages require customer interaction with the Company for communications and breaker operations … if a feeder is planned to be removed from service, when the customer opens the breaker, Con Edison personnel would need to lock-out and tag the breaker so that outage work may be performed. When the feeder is ready to be returned to service, all of these steps must be repeated by the customer and Con Edison personnel in reverse order. Feeder testing coordination could be required, which may require actions by customer personnel."

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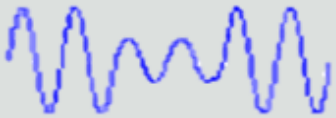
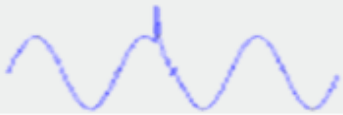
Known Technical Barriers to Interconnection

Synchronous Interconnection Requires Control of Multiple Disturbances. Lengthy Interconnection Permitting with Complex Requirements for Control Measures Results in Microgrids that Cannot Readily Island without Large Capital Costs

Disturbance	Waveform	Origin	Consequences
Voltage Sag / Undervoltage		Short circuits in the network grid or on another radial Startup of large motors	Disconnection of sensitive loads Fail functions.
Voltage Swell/ Overvoltage		Earth fault on another phase Shut down of large load Lightning strike on network structure Incorrect substation settings	Ageing of insulation Disconnection of Equipment May harm equipment with inadequate design margins
Harmonic Distortion		Non-linear loads Resonance phenomena Transformer saturation Notches	Extended heating Fail function of electronic equipment
Transients		Lightning strike Switching event	Insulation Failure Reduced lifetime of equipment: transformers, motors, etc.
Voltage Flicker		Welding Wind turbines Arc furnaces Sawmill, crushing mill, Startup of large motors	Flicker Fail functions Ageing of insulation
Short-duration Interruptions		Direct short current Disconnection False Tripping Load Shedding	Disconnection
Unbalanced Phases		One phase loads Weak connections in the network	Voltage quality for overloaded phase Overload and noise from 3 phase equipment

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The Consequences of Delayed Islanding of On-Site Power: Bradley International Airport October 2011 Outage, On-Site CHP Took Many Hours to Island

FAA Report on Bradley Outage:

…20 inches of snow fell at Bradley International. It caused a widespread commercial power failure, which caused communications problems in the airport. Luggage belts and cargo belts and elevators stopped working. There was difficulty refueling airplanes. There was difficulty de-icing aircraft. We all know that when you can't de-ice your aircraft in those conditions, you might as well weld your plane to the ramp. You're not going anywhere.

Source: http://www.faa.gov/news/speeches/news_story.cfm?newsId=13252

Not the only recent outage at Bradley:

"A power outage occurred on March 6 on 8:15 p.m. that was caused by a blip on the C L & P grid and a switch that did not operate as it should have at the Airport's cogeneration plant."

(Bradley Airport Minutes, March 2011)

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The Consequences of Delayed Islanding of On-Site Power: September 2011 San Diego Outage, UC San Diego Took Many Hours to Island

Last year, an unanticipated power outage of most of San Diego was caused by a utility worker's switching error in Arizona.

The University of California San Diego's Microgrid:

- Could not island instantaneously,
- Required 6 hours for black start, and
- After utility power was restored, required a second campus black out to resynchronize.

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Columbia University Study Suggests an Inverter Approach

"The fault current margin will always be linked to the total amount of electricity-generating capacity connected to the grid. As demand continues to increase each year around the city, requiring additional generation to be connected to the grid, the technological 'fixes' called for by the Public Service Commission will work for some time. At some point, however, the upgraded circuit breakers may also reach their higher-rated capacity limit, requiring yet another round of system upgrades. A second technical solution external to the grid involves the use of power electronics, which are a mix of devices used to convert, control, and improve power quality. Some manufacturers use two complementary forms of power electronics – a rectifier and an inverter – to switch from AC to DC and back to AC power in order to produce higher quality power and facilitate interconnection. The duration and complexity of the review is likely to be substantially less than for synchronous interconnection."

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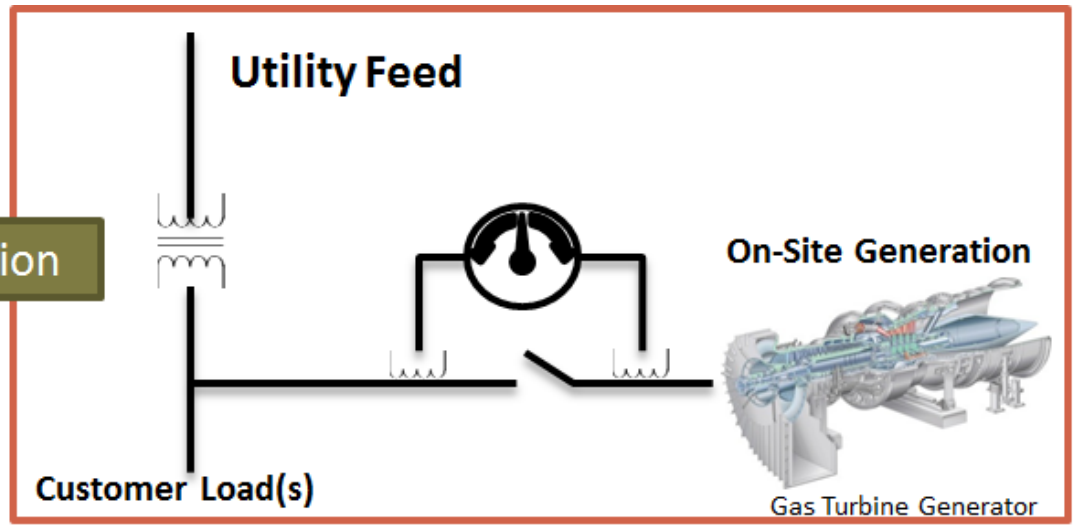
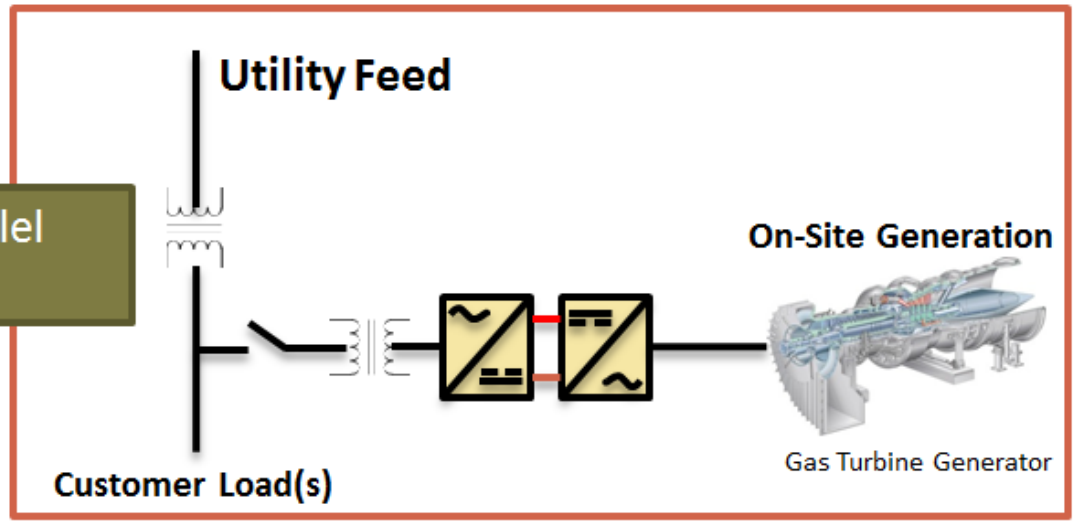
Overview of the Two Interconnection Approaches

Synchronous Interconnection

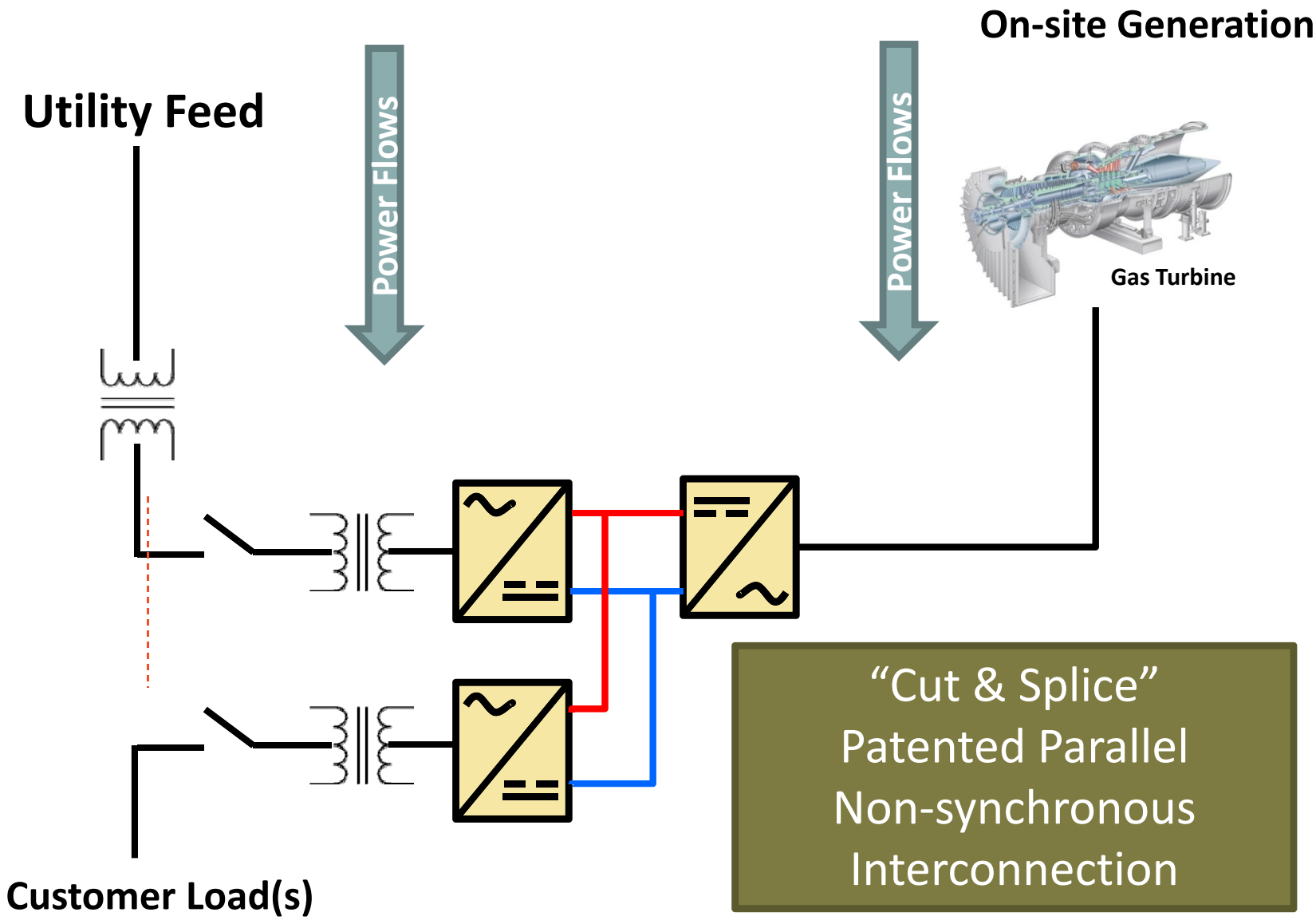


Non-synchronous Parallel Interconnection



The Non-Synchronous Microgrid Solution

Non-Synchronous Microgrid Solution
Overview of Pareto Energy's Patented GridLink Technology



"Cut & Splice"
Patented Parallel
Non-synchronous
Interconnection

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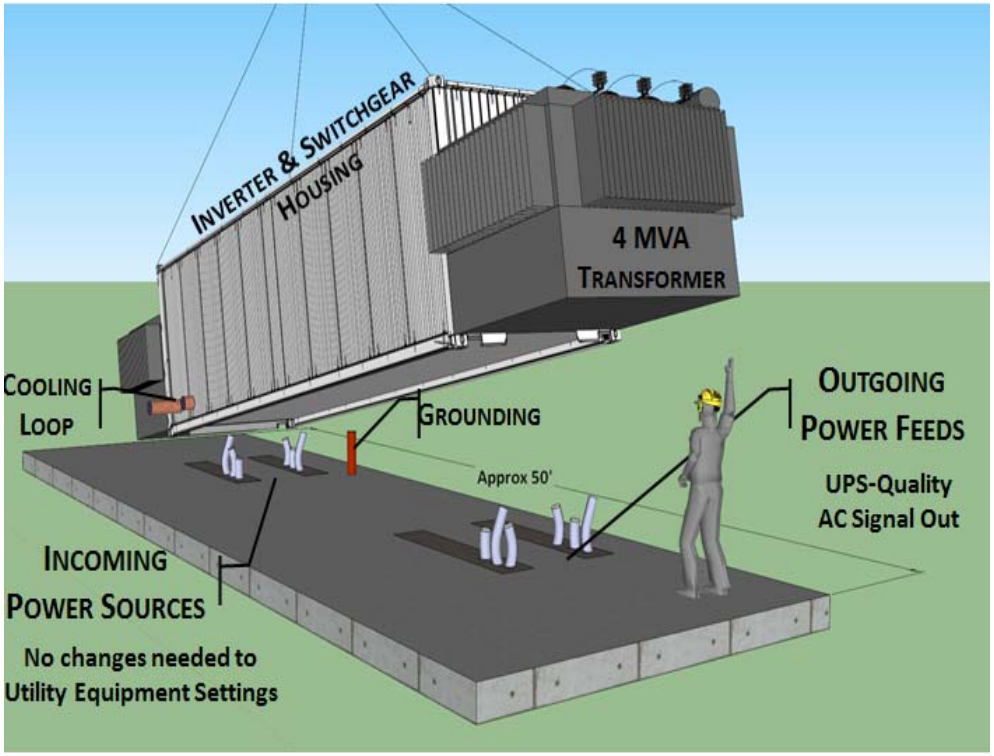
Benefits of GridLink Non-Synchronous Microgrids



- No impact on distribution system: insert any amount of generation anywhere on the network
- Fully packaged systems: ready to install, modular for easy expansion
- Quick build-deliver timeline for implementation
- UPS-quality reliability: no interruption during grid outage, ride-through for grid disturbances.
- UPS-quality power signal: Fully conditioned AC power to loads
- All the benefits of UPS without the costs, equipment or maintenance
- Tie microgrids together for Peer-to-Peer systems to share power

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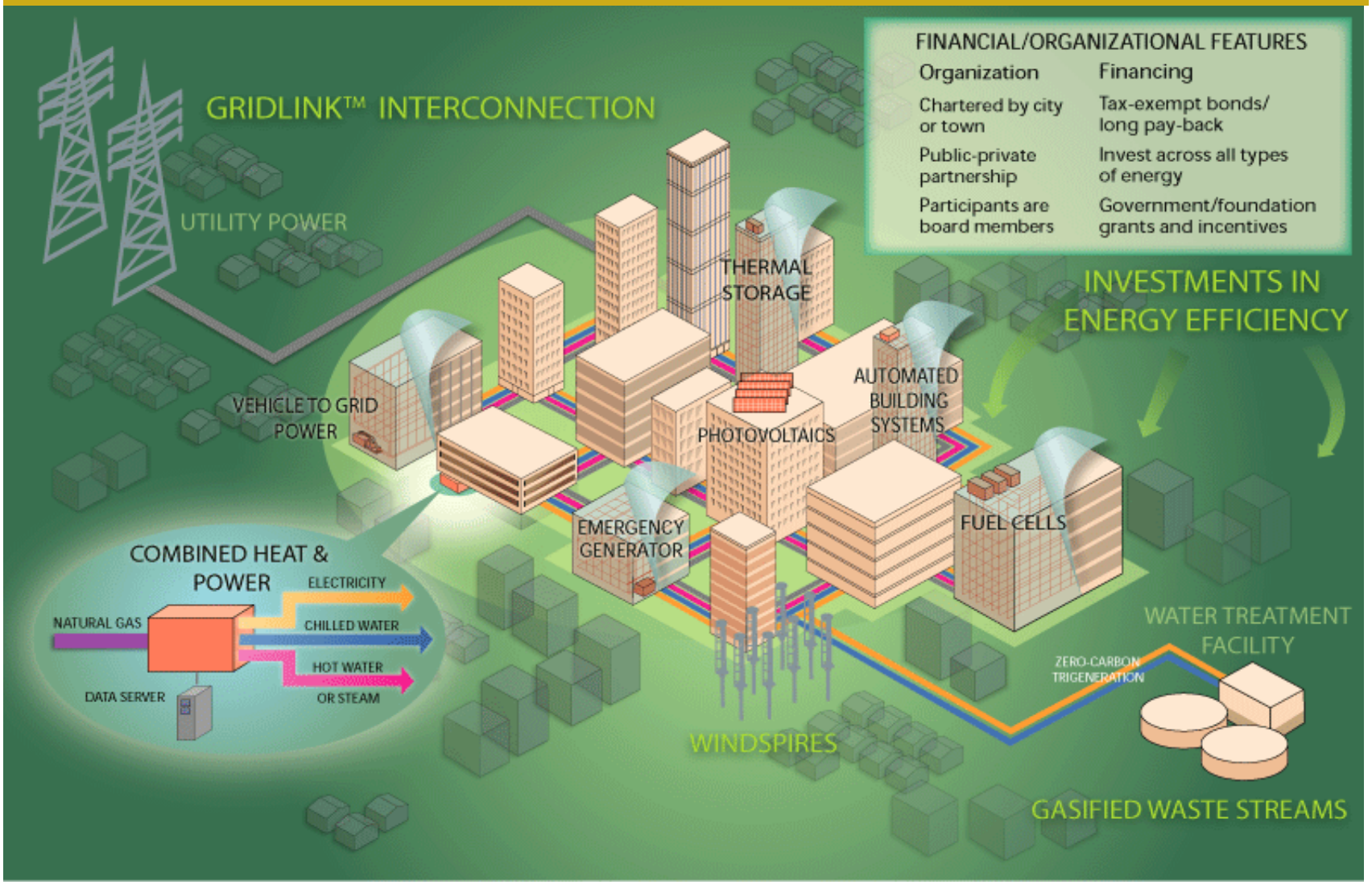
The Pareto Energy Microgrid Business Model: Patented Non-Synchronous Interconnection Technology Enables An Always Islanded Microgrid with the Ability to Plug and Play Multiple Distributed Energy Resources and to Provide Continuous Power During Utility Grid Power Outages at Below Grid Rates with Governance by the Microgrid Energy Users



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Pareto Energy has Developed Utility Company Support For its Business Model

Edison Electric
Institute

May 6, 2011

Dear Mr. Warner:

I am writing to invite you to participate in an EEI project to assess the implications of smart grid-enabled distributed resource development. As I'm sure you realize, the marriage of smart grid (SG) technologies with distributed energy resources (DER) has the potential to change fundamentally traditional utility operating paradigms, and the utility business. This has become more pressing as public policy encourages the development of DER owned by customers and third parties.

We think it is vital, therefore, to understand the implications of these new technologies and policies. We have identified your project work as among the cutting-edge demonstrations in this area.

We believe your perspectives and experience can contribute significantly to building a knowledge base about pilots that demonstrate the integration and interoperability of multiple types of DER at multiple levels and establish frameworks for stakeholder collaboration and participation by new market players.

Of particular interest to EEI are your innovative governance structure and your "GridLink" technology that enables a safe connection between a microgrid and a traditional grid. These innovations represent significant sustainable economic development assets.

History of GridLink Engineering Reviews and Approvals

URS

URS Washington Group:
GridLink will "preclude any potential detrimental effects on the power delivery system [and] eliminate the potential of voltage, frequency, and phase-angle mismatching between the facilities and the utility grid."

11/08

Connecticut Light & Power

2/09

"the proposed generator will not have an impact on the CL&P distribution system."

5/11

"…cutting-edge GridLink technology enables a safe connection between a microgrid and a traditional grid"

Edison Electric Institute

pepco

6/11

" The proposed generators will not operate in parallel with the Pepco electric distribution system."

8/11

Silicon Valley Power
CITY OF SANTA CLARA

" Master Interconnection Agreement"
- One application for microgrid, covers all future generation.

conEdison

12/11

No interconnection application
Microgrid looks like a load to the Utility grid

Meeting with BGE to discuss GridLink for projects in BG&E service territory

BGE

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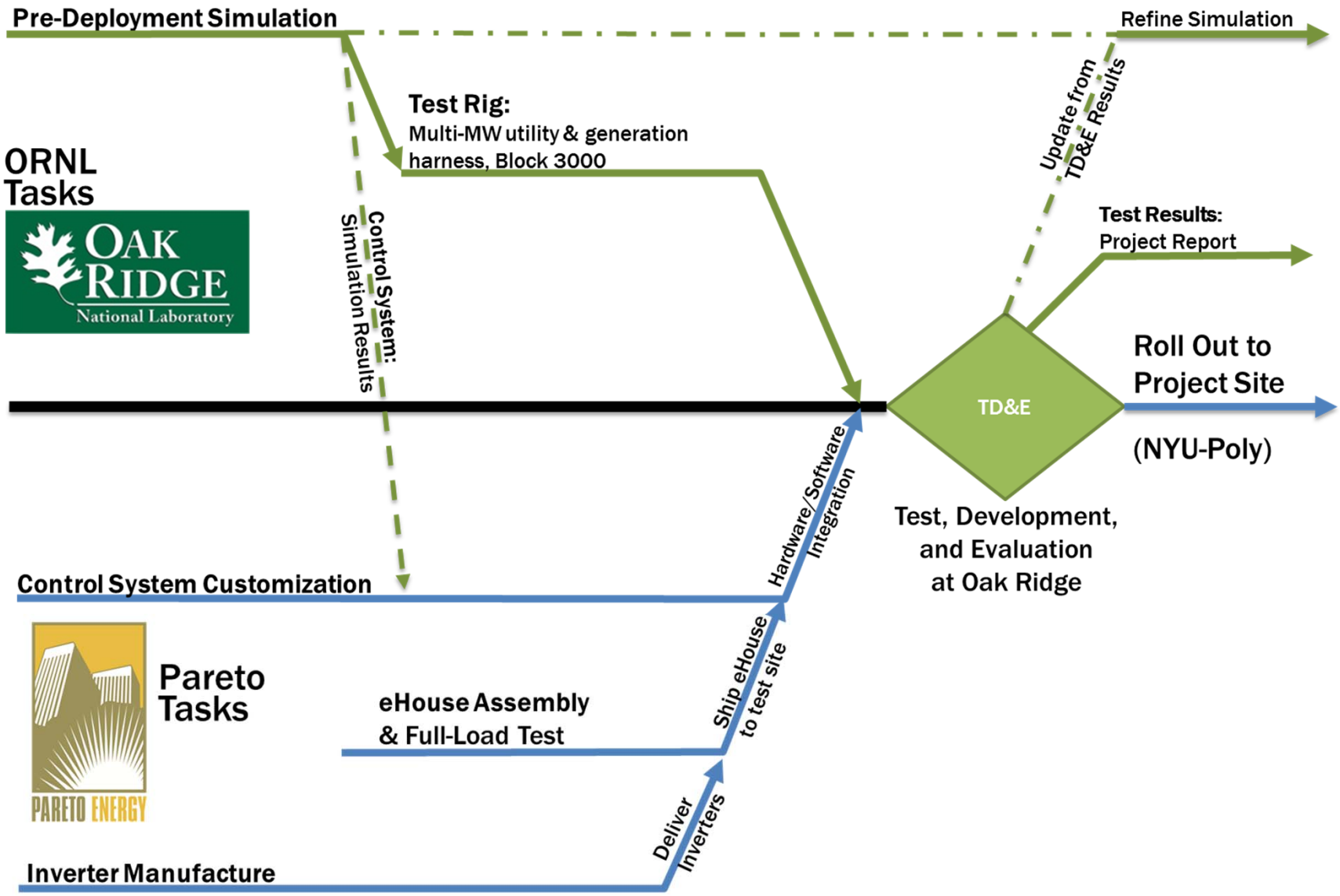
GridLink One-Year Development and Testing Plan



The Pilot Project at NYU Poly

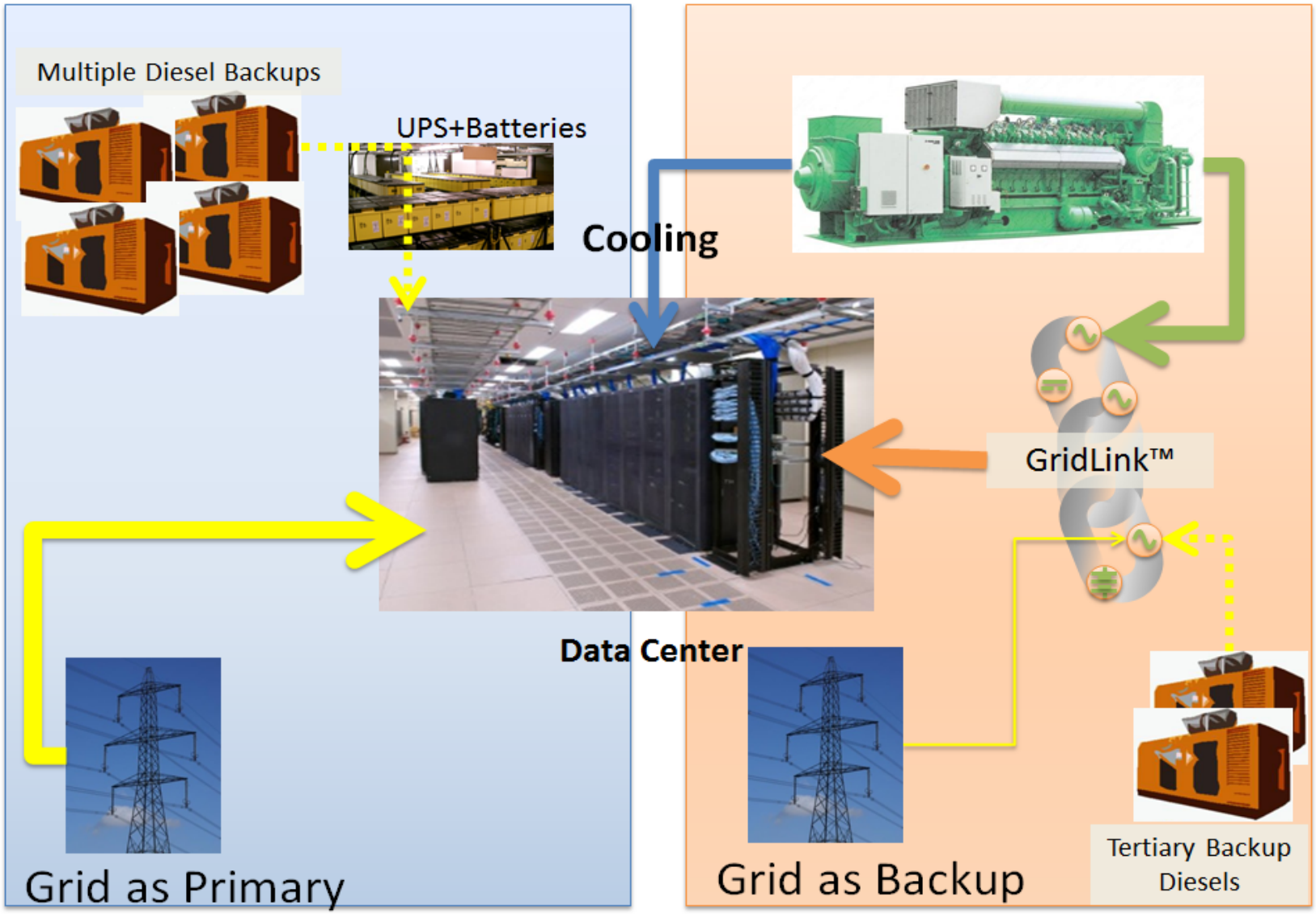
The "Campus Greenup" Student Group tasked with:

- Greening-up the campus, delivering on the Mayor's Climate Action Plan;
- Satisfying the power needs of a growing, world-class engineering school;
- Addressing deferred maintenance issues;
- Implementing flexible solutions that accommodate utility constraints;
- Working with a constrained budget;
- Partnering with industry pioneers;
- Securing benefits for all project stakeholders.

NYU Poly Project Anticipates Providing Power for Data Centers
Traditional Backup Systems versus a GridLink Non-Synchronous Microgrid

Traditional Data Center Power System

GridLink Non-Synchronous Microgrid



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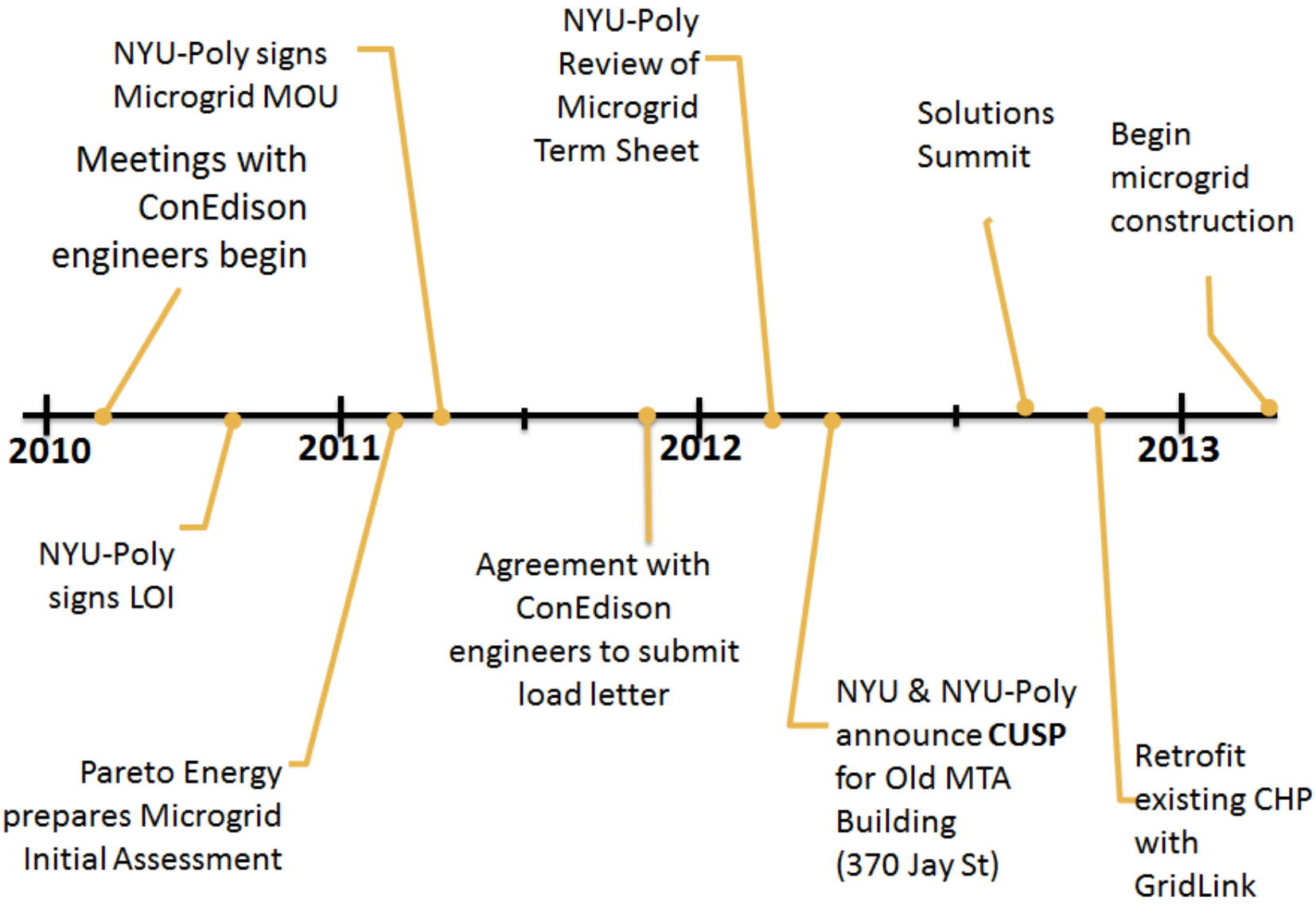
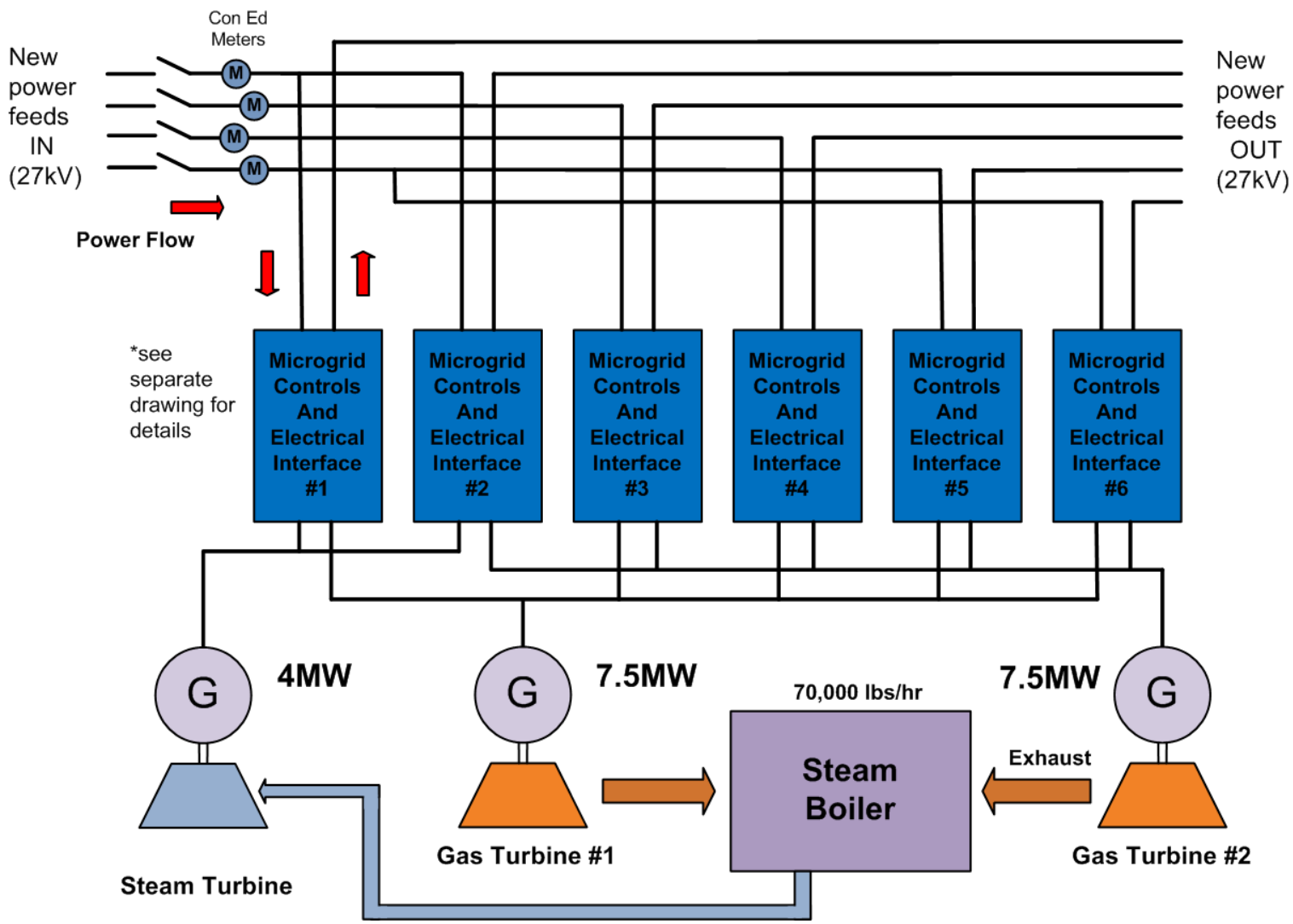
NYU Poly Anticipated Development Plan



General Arrangement for a 19 MW Microgrid where Con Edison's Engineers have Decided that the Microgrid is Not Connected Directly to their Grid and Therefore Does Not Require a Complex Interconnection Application



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Notes Regarding the Use of the Microgrid in a Networked Utility Grid

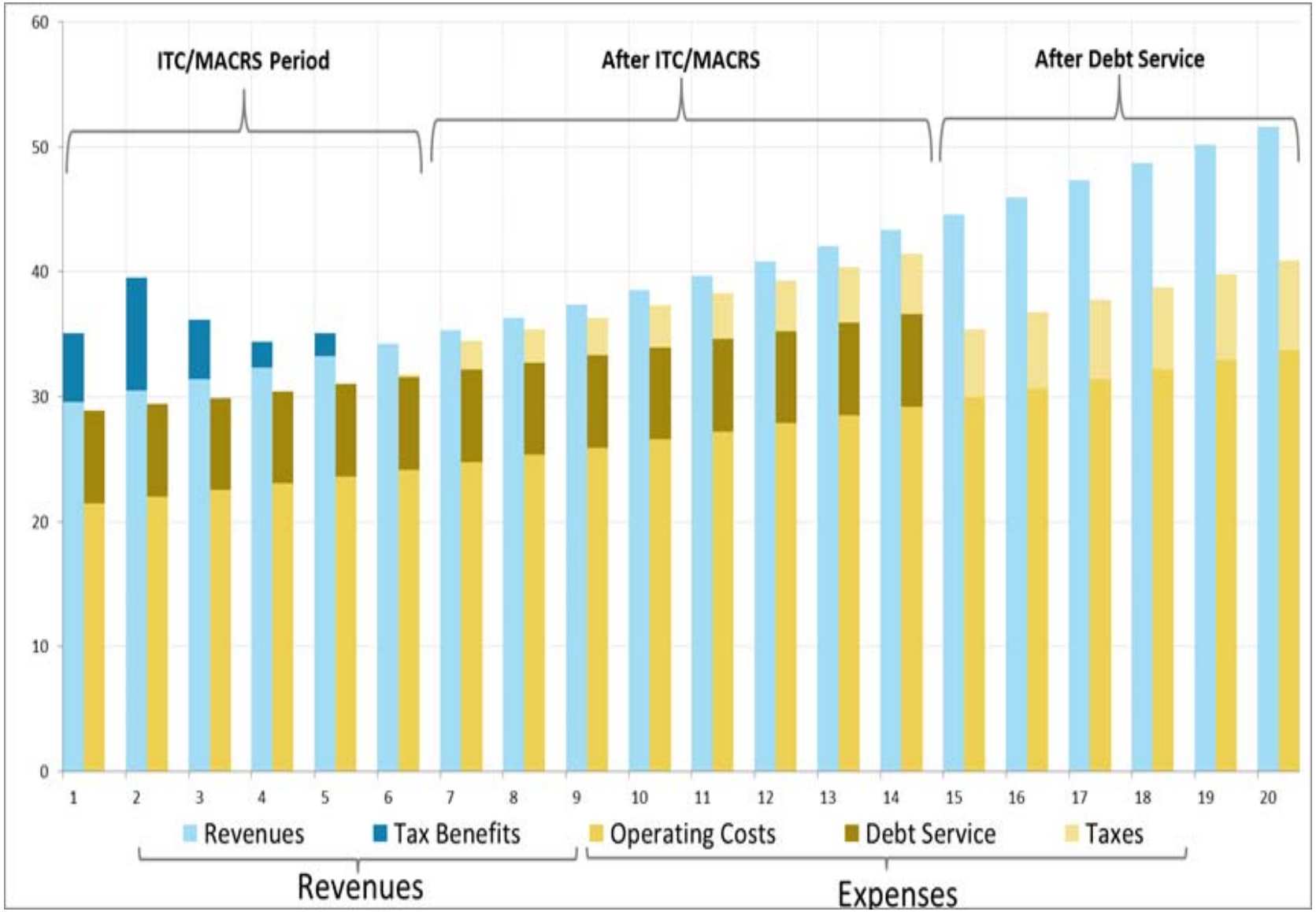
The new microgrid uses power electronics to create a new grid just like the Con Edison network it is replacing. Each "blue box" is synchronized with the others, such that the outputs can be connected in the manner now used in the buildings.

The "cut & splice" method needs to take place on the medium voltage side of the grid in order to accommodate the amount of power required and to transport to other buildings in a cost efficient manner.

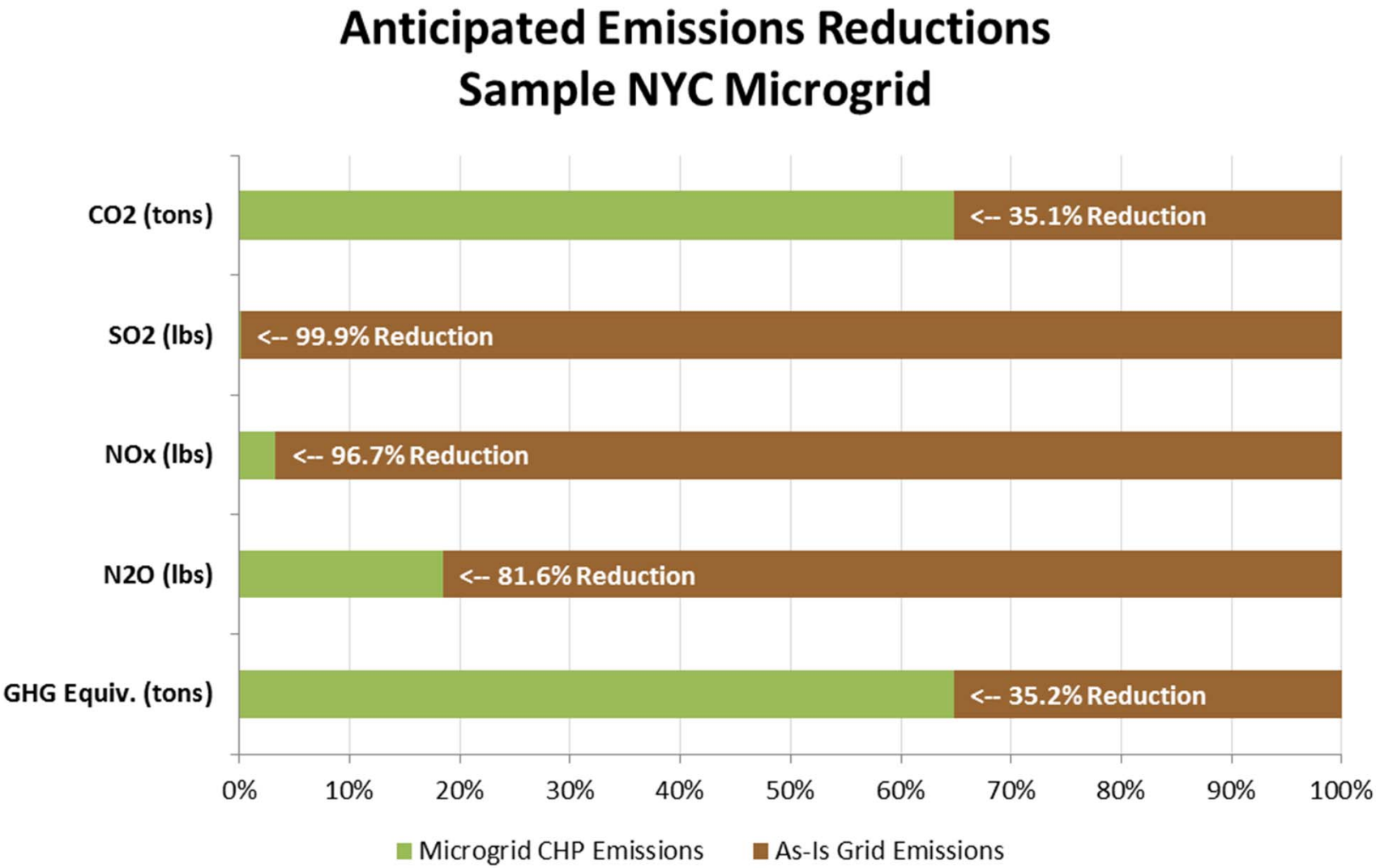
This requires feeding the step down transformers in the buildings from the microgrid feeds.

The microgrid will take power from the new Con Edison feeds to make up peak requirements above what the generators can provide, and provide back up service for generator down time. All the power to the buildings will come through the microgrid.

Summary of Anticipated Economic Benefits



Summary of Anticipated Environmental Benefits



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