Assessing the Role of Energy Efficiency in Microgrids

March 22, 2016

Bill Moran, Senior Power Delivery Engineer
Mark Lorentzen, Vice President of Energy Services

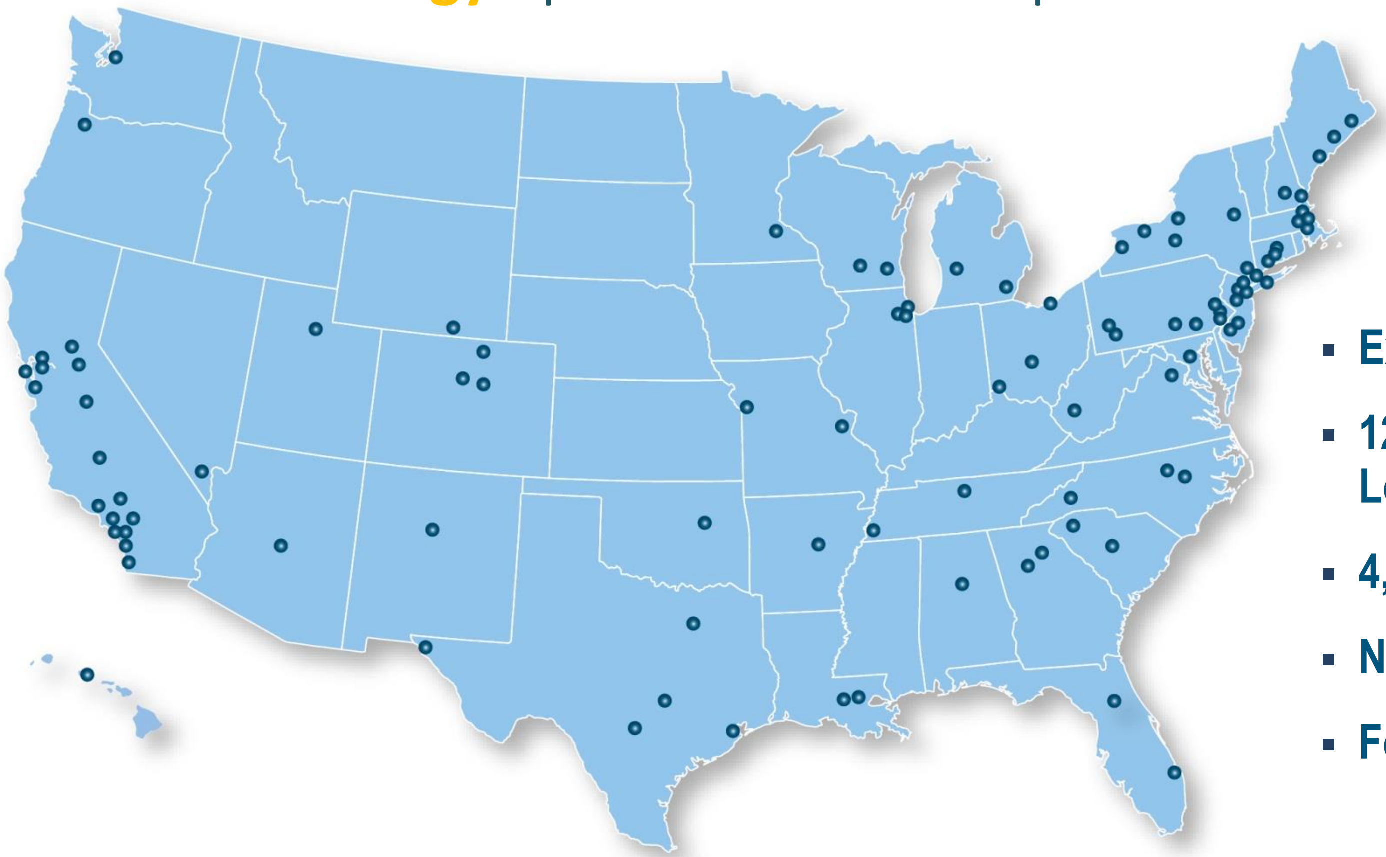
Learning Objectives

- Microgrid basics
- Microgrids as a force in Market Transformation
- Discuss the role of energy efficiency in the planning of a microgrid
- Share some key lessons learned while performing microgrid feasibility studies

About TRC

A pioneer in groundbreaking scientific and engineering developments since 1969, TRC is a national engineering, consulting and construction management firm that provides integrated services to three primary markets:

Energy | Environmental | Infrastructure



- Expert problem solvers
- 120+ U.S. offices
  London office
- 4,100+ employees
- NYSE: TRR
- Founded 1969

Energy

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Results you can rely on

- Electrical Transmission, Distribution & Substation Engineering
- Energy Efficiency, Demand Response, Renewable Energy, CHP
- Communications Engineering

Growth Drivers

Reliability | Power Supply | Aging Generation Assets | Regulatory Transformation

TRC Microgrid Team

TRC Multi-discipline team

Power Delivery

Power Delivery Systems Study
Jim Whittaker

PV, Wind, Hydro
Rob Jackson, Brent McCarthy, Steve Carl, Bob Golden

Combined Heat and Power (CHP)
John Lembo, Bill Moran

Interconnect Engineering
Charlie Pascale, Alex Groshev

Energy Storage
Bob Golden, Rob-ert Smith

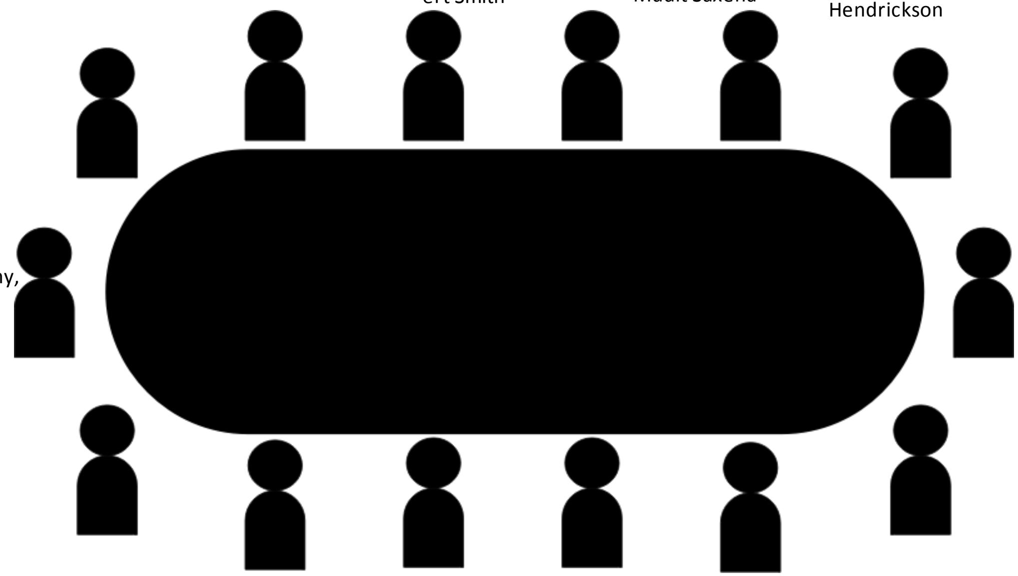
Emerging Technology
Abhijeet Pande, Mudit Saxena

Demand Re-sponse
Paul David, Carmen Hendrickson

Efficiency

Energy Efficiency
Mark Lorentzen,
Bob Callendar, John Lembo

Load Balancing
Bill Moran



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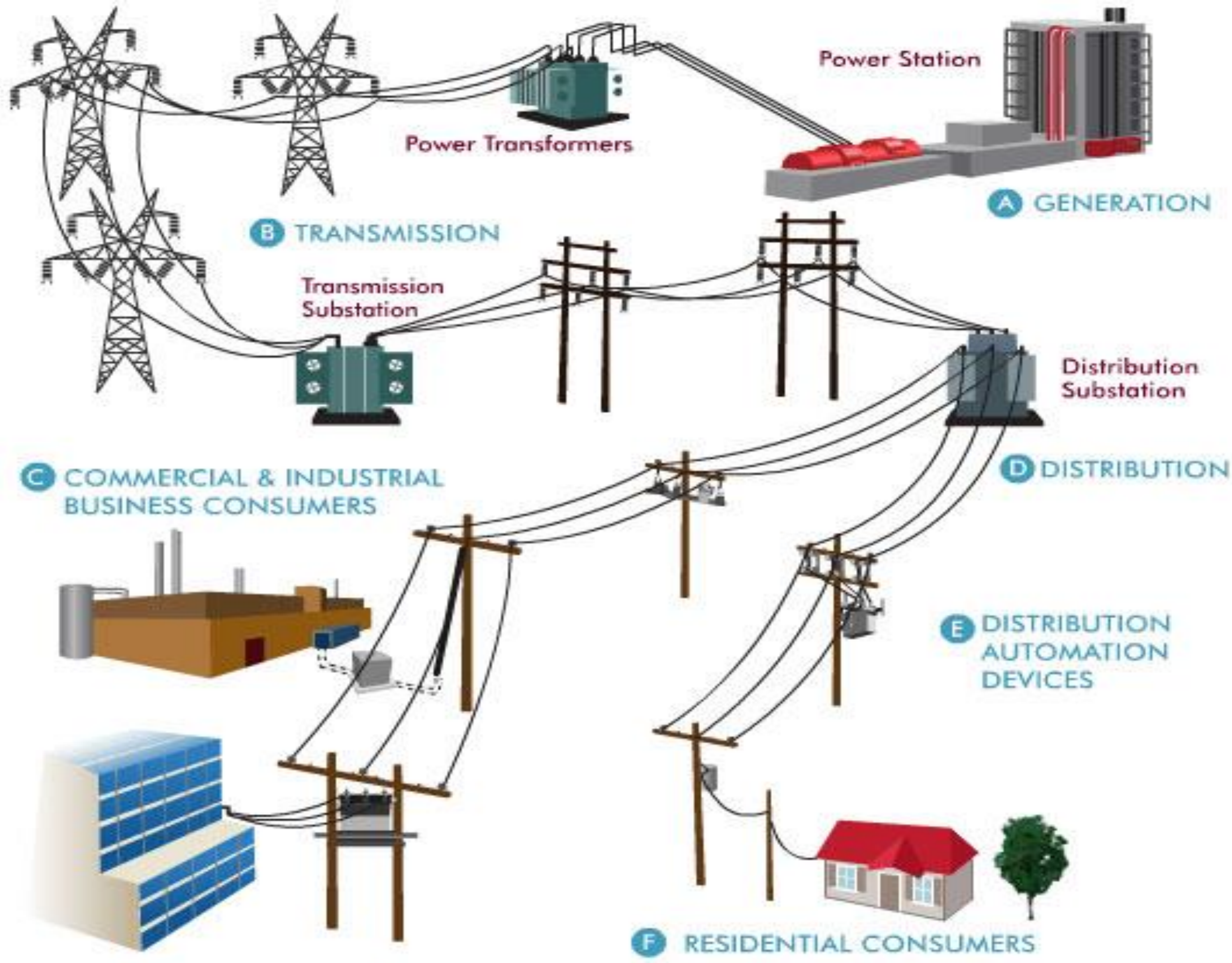
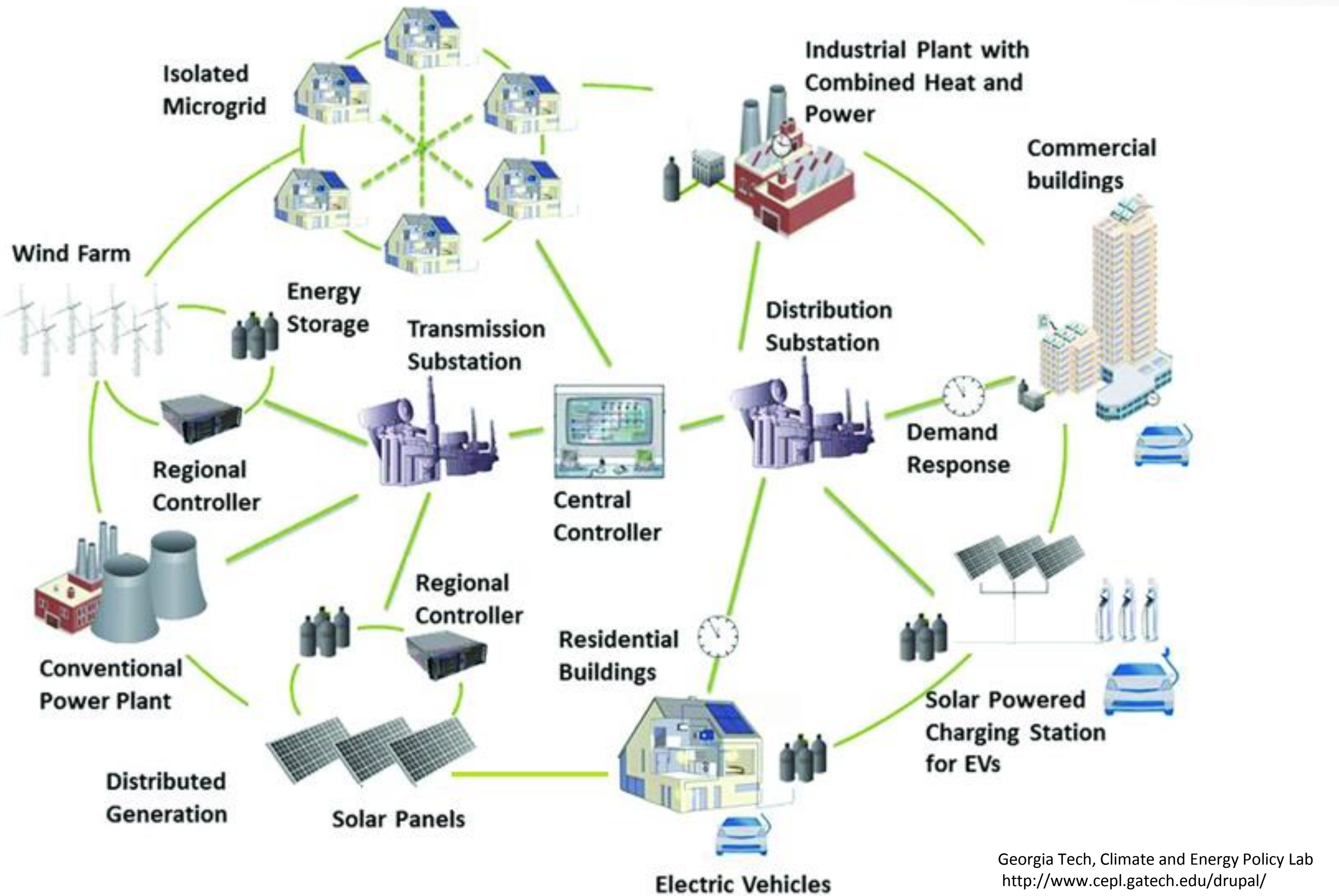
What is a Microgrid and why should I care?

Today's Grid



Source: http://peswiki.com/index.php/Directory:Smart_Grid

Tomorrow's Microgrids



Georgia Tech, Climate and Energy Policy Lab
http://www.cepl.gatech.edu/drupal/

Microgrid Basics

As defined by the US Department of Energy,

"Microgrids are localized grids that can disconnect from the traditional grid to operate autonomously and help mitigate grid disturbances to strengthen grid resilience."

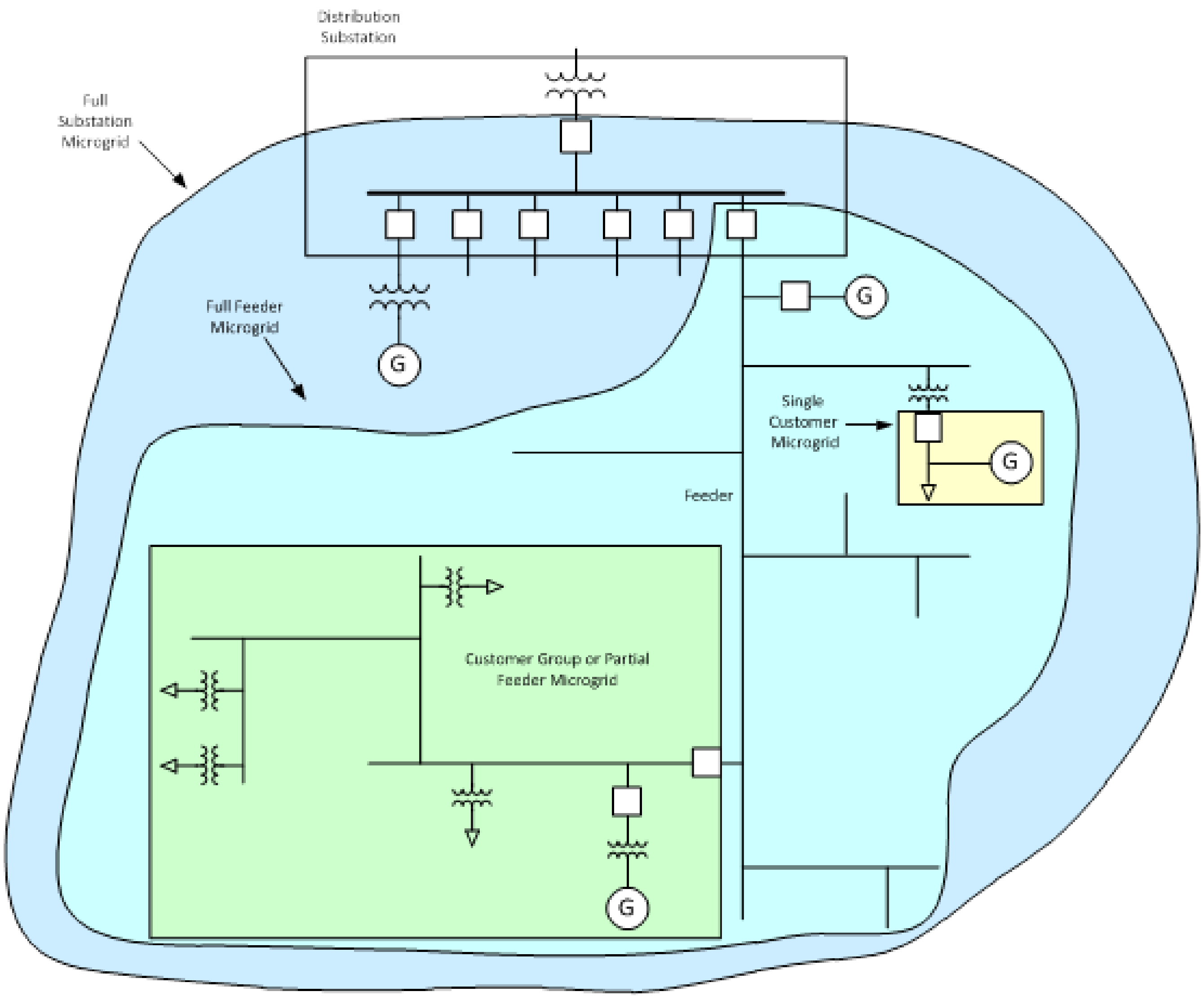
What is a Microgrid?

To put this another way,

"Microgrids are a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that connects and disconnects from such grid to enable it to operate in both grid connected or Island Mode."

- CT Public Act 12-148 § 7

Types of Microgrids



Microgrid Basics

Critical facilities kW demand = ***"The Load"***

Distributed Generation (DG) = Creates power to operate independent of utility grid.

"Island Mode" = separated from utility grid, all loads supplied with power from DG.

"Grid Paralleled Mode" = DG resources operating in parallel with utility grid.

Distributed Generation Technology

Energy Sources in a Microgrid

Microgrid Basics

Microgrids are all about kW – **Demand & Capacity**

Facility *demand* in peak kW required

DG *capacity* in maximum kW delivered

Demand reduction affects required DG capacity.

Kilowatt/hours kWh = energy cost, savings.

Affects operating cost, not DG capacity.

Distributed Generation for Microgrid

The power produced by DG must precisely match the demand of the combined loads -

"Coincident Load"

DG capacity must always exceed peak load -

"spinning reserve"

DG must be able to follow changing load.

- Base Load generation – Near steady output
- Peaking Generation – follows load/maintains frequency

DG operation in Grid Paralleled Mode

The DG required for Island mode will not be economically feasible without grid paralleled operation.

- DG operation in Grid Paralleled mode is all about efficiency.
- Reduces purchased electricity cost
- Time of day utility rate is advantageous
- Potential to provide Ancillary services. (Freq. regulation, volt/VAR support, Demand reduction resource.)
- May provide thermal energy, operation usually follows thermal load.

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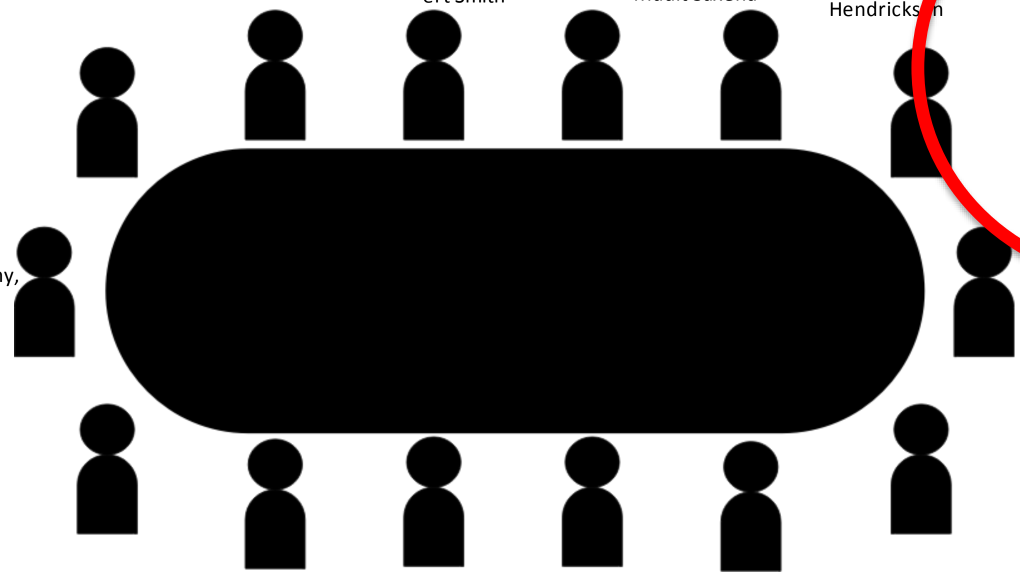

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Are Microgrids a potential force in market transformation?

Climate Change Adaption

Photo source: Nasa

Public Policies Promoting Microgrids

- CT DEEP Microgrid Program
- CA - "California Funds the Next Wave of Microgrids Paired With Renewables and Storage"
- Maryland Microgrid Task Force
- NY REV and NYSERDA NY Prize
- MA Microgrid Program

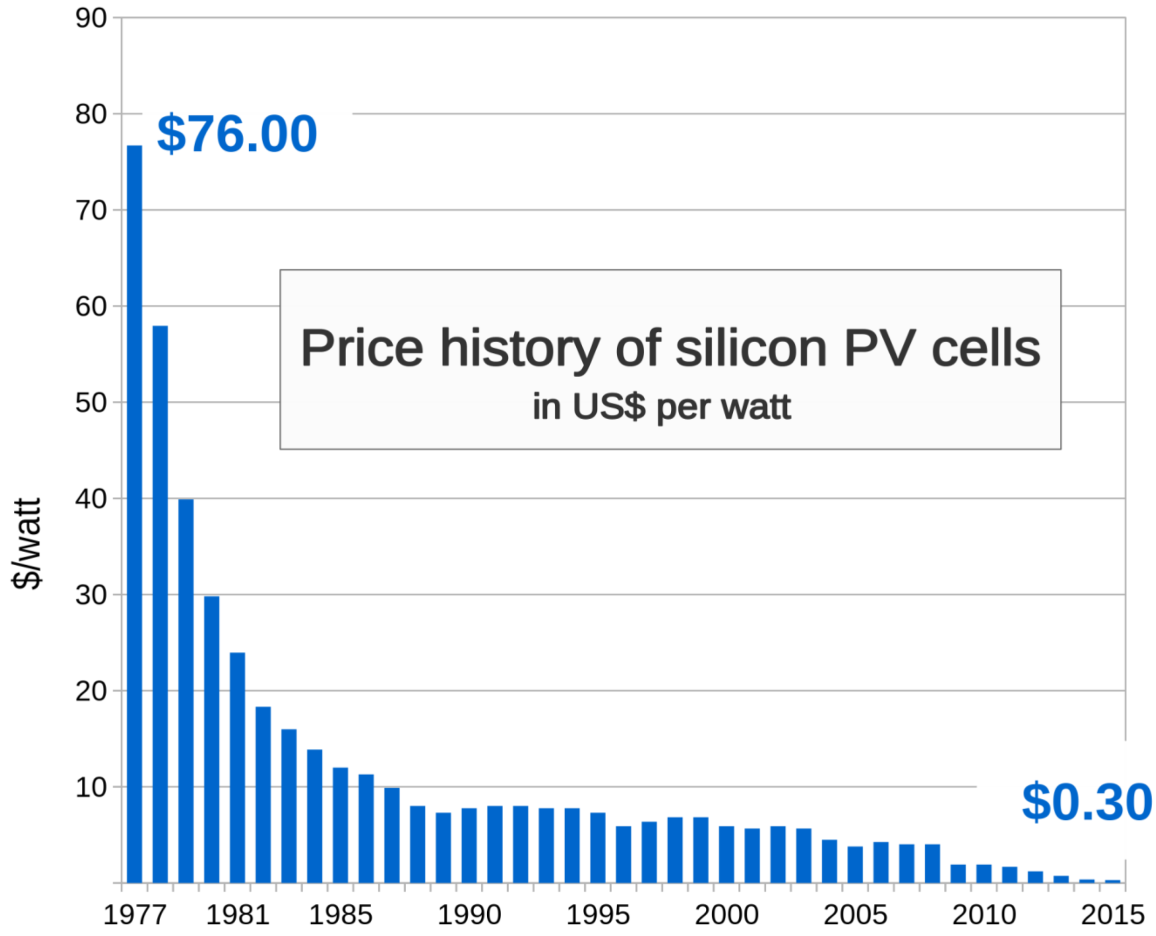
Innovators / early influencers in public policy

New York Reforming the Energy Vision (REV)

- “New York struggles with an aging electricity infrastructure, which will require an estimated $30 billion infusion of capital over the next decade”

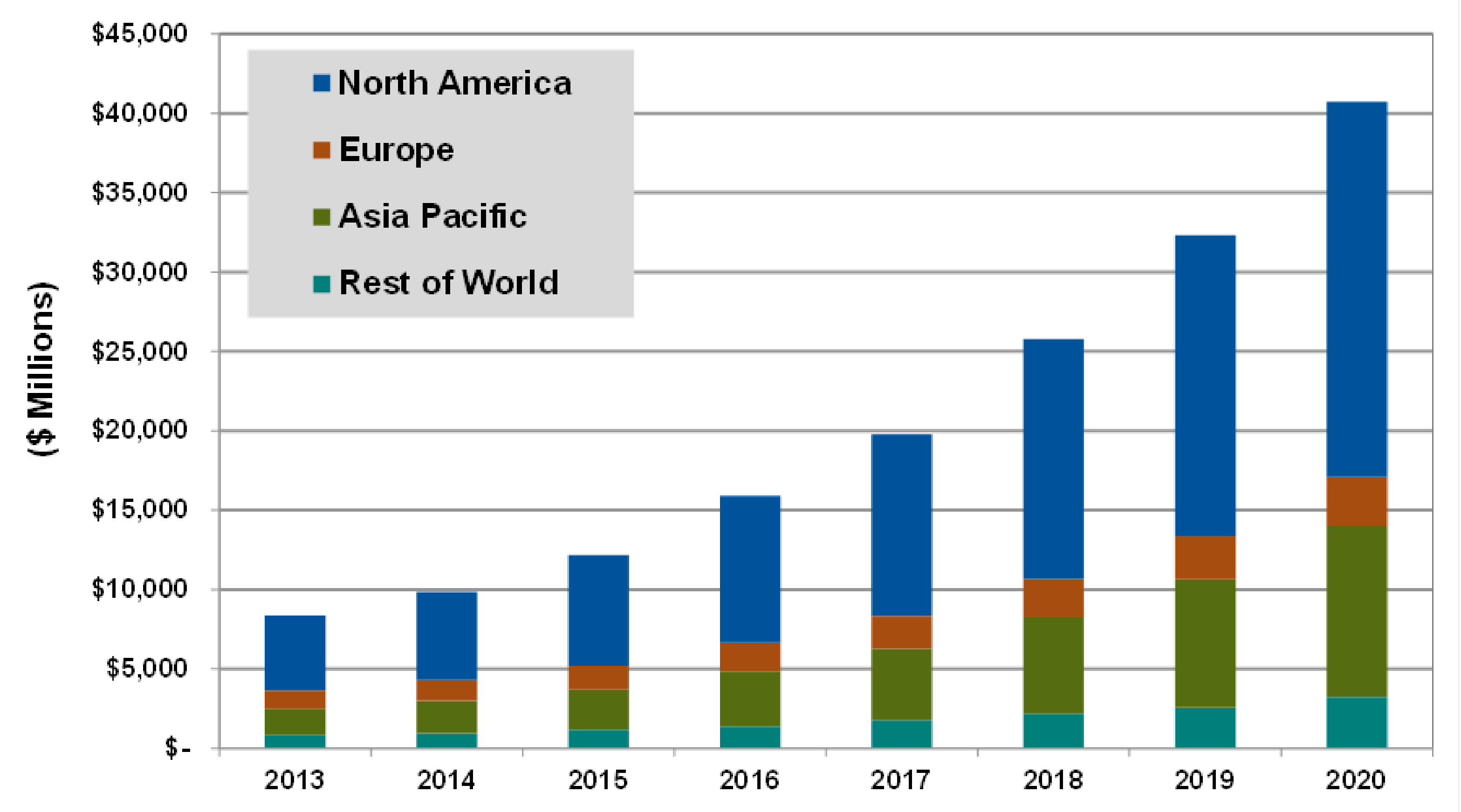
- “Half of New York's power will come from renewable sources in the next 15 years, under a new state energy plan”

Solar PV $/Watt



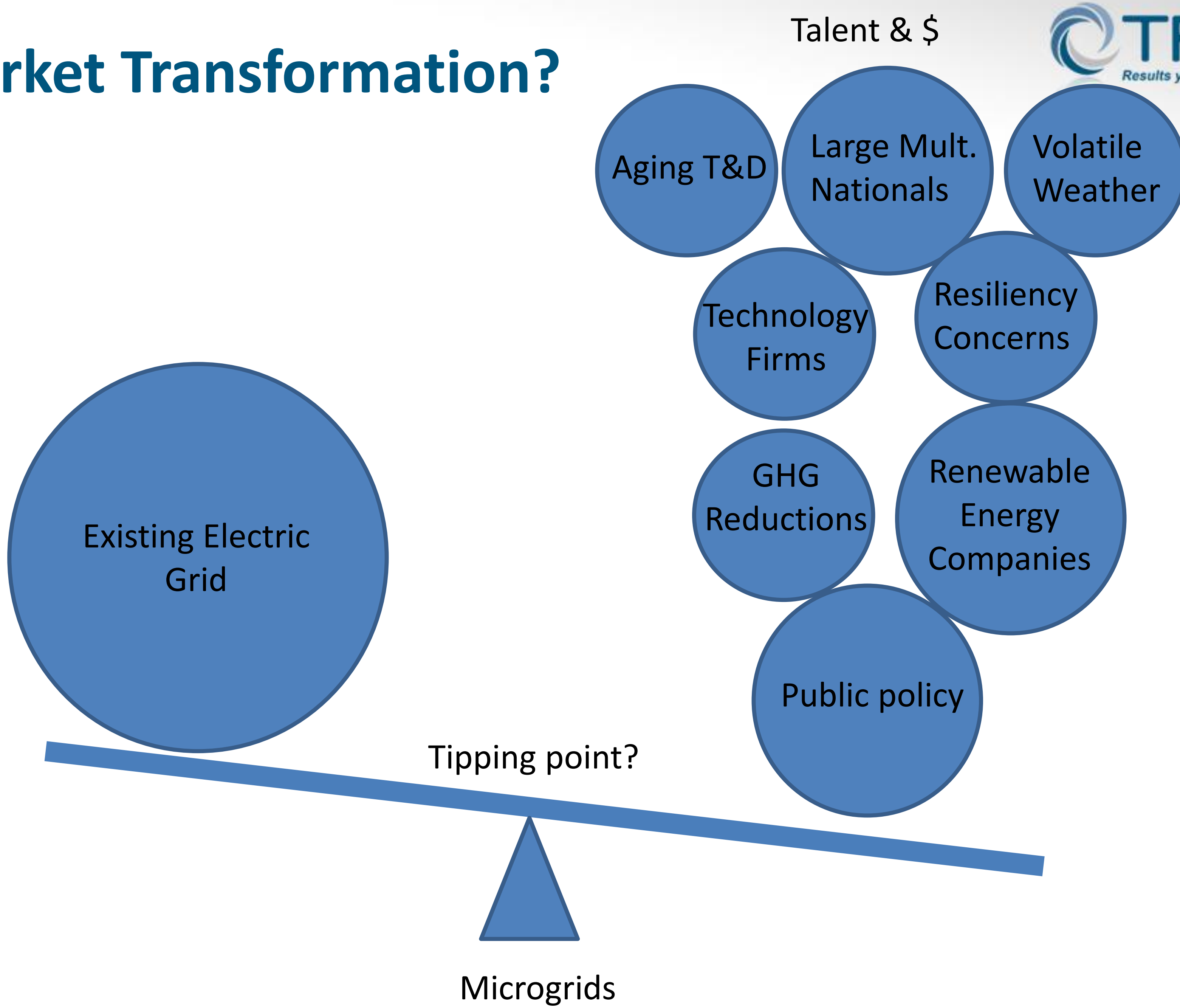
Source: Bloomberg New Energy Finance & pv.energytrend.com

Microgrid Market Size Projection



http://www.navigantresearch.com/blog/why-california-will-lead-the-world-on-microgrids - March 2013

Market Transformation?



What role does energy efficiency play in a microgrid?

A New Multidiscipline Approach

TRC Multi-discipline team

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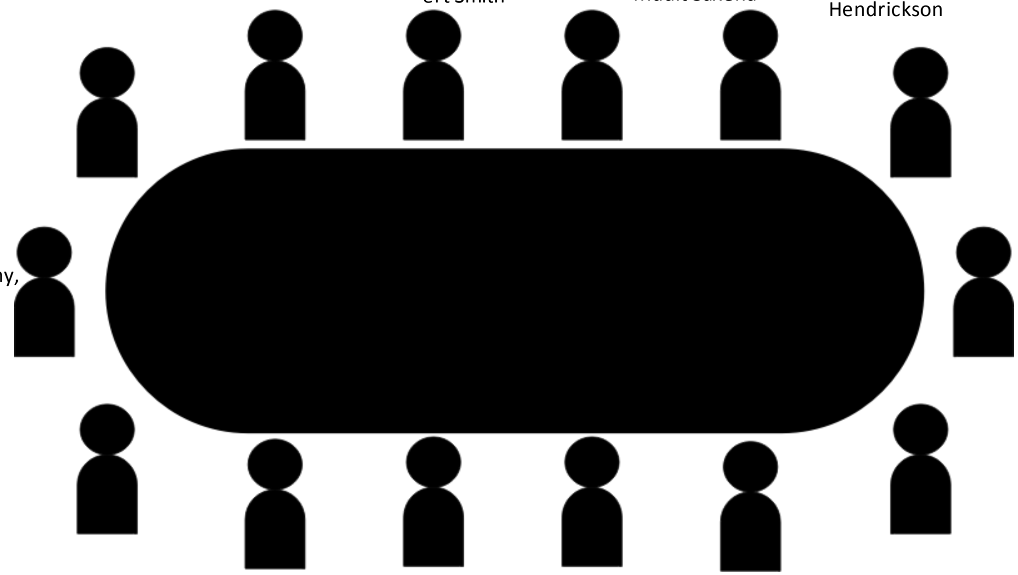

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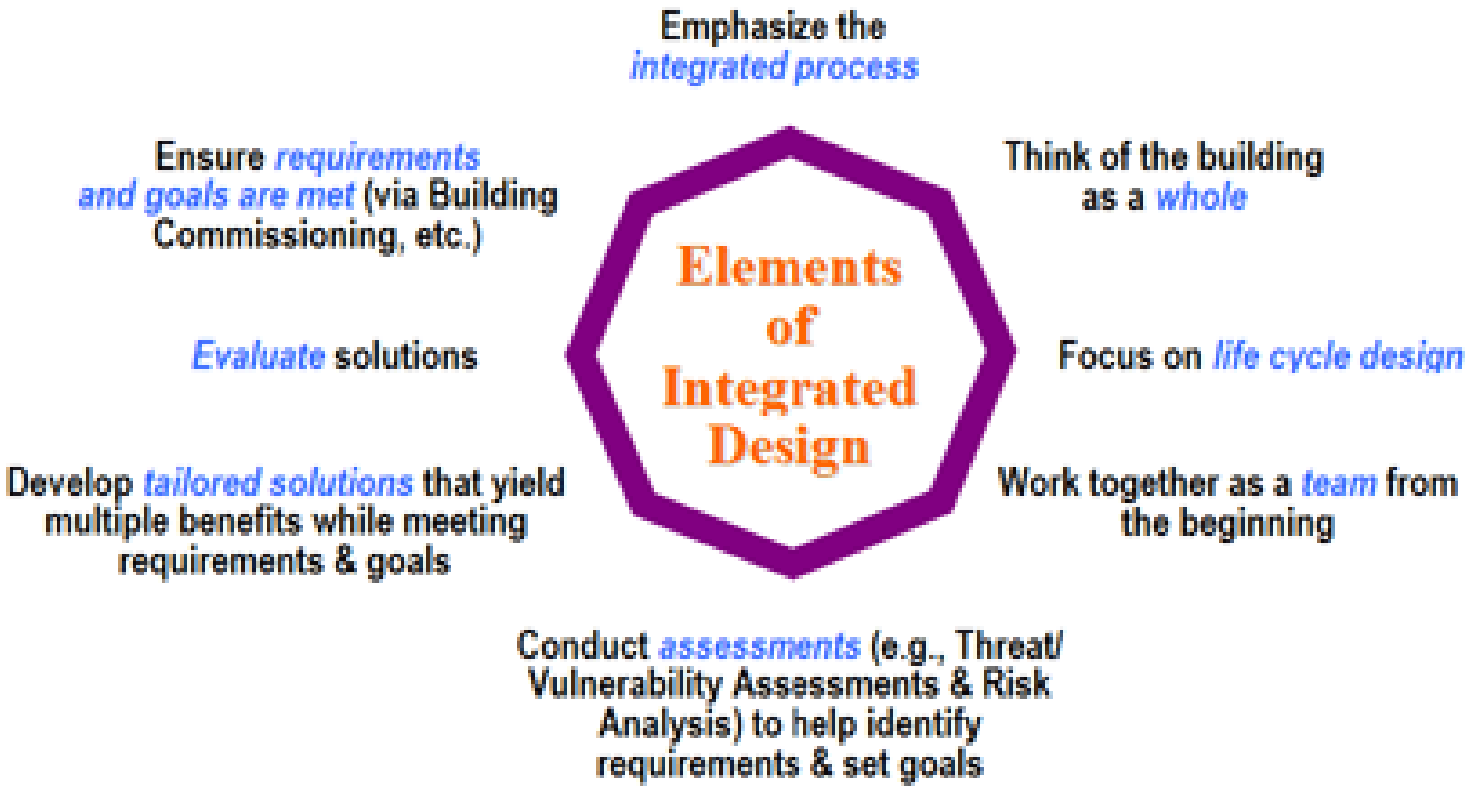
A New Multidiscipline Approach

	Power Delivery Engineer	Energy Efficiency Engineer
Traditional Grid	kW – demand peak and min. to develop load profiles – 15 minute interval data	Energy Cost ($) Savings, kWh/yr savings, MMBtu/yr savings, kW Savings (when applicable)
Microgrid	kW – demand peak and min to develop load profile – 5 minute interval data Existing or planning? PV, Emergency Power, EE upgrades, large motors, electric heat	Large kW demand peak savings Projected fuel costs within microgrid EE upgrades now and then overtime

The Meter is No Longer a Clear Divide

A New Multidiscipline Approach

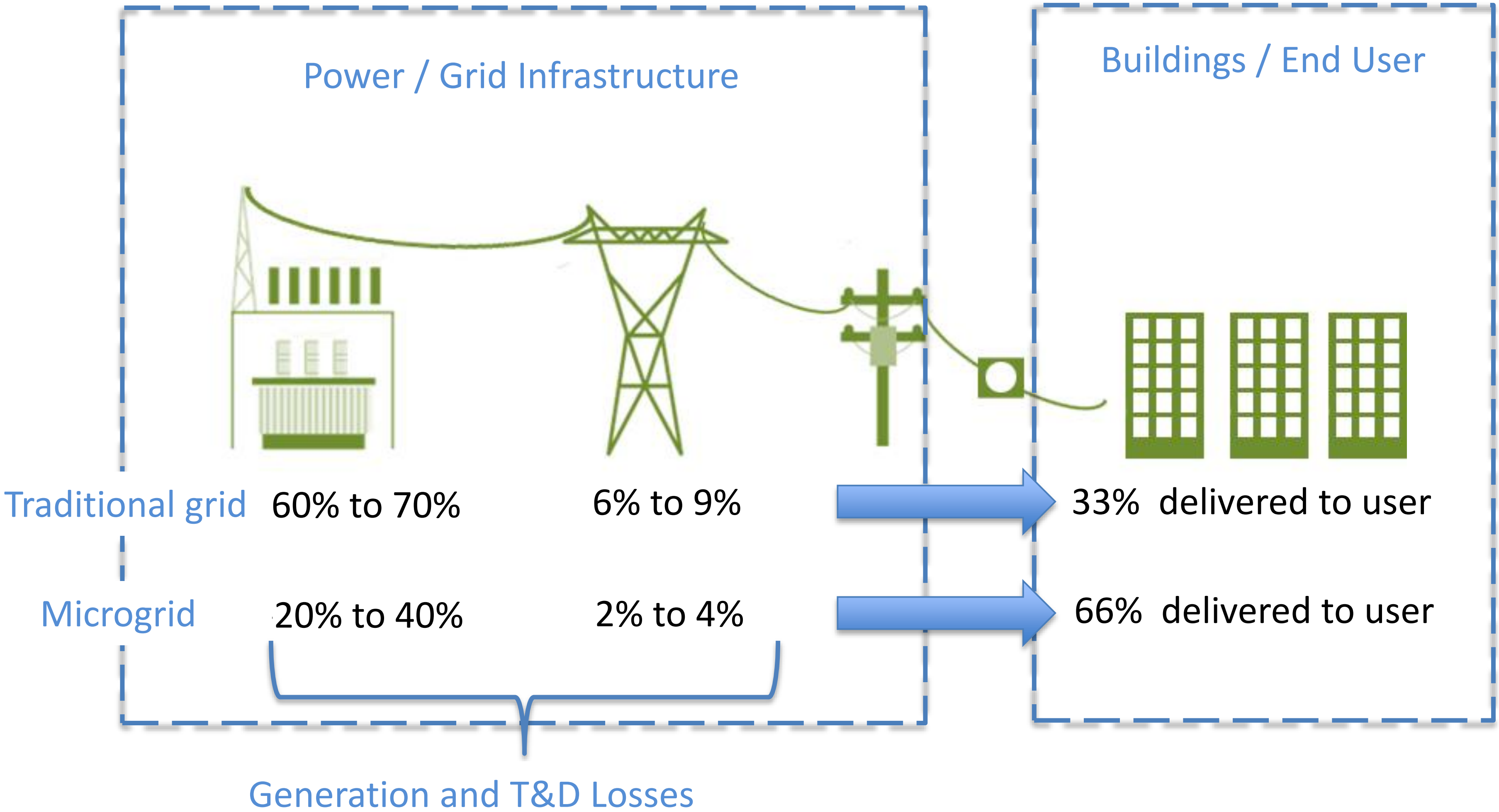


Microgrid Energy Efficiency

Energy efficiency within a microgrid may include upgrades on both sides of the meter.

"Customer-side" or the "utility-side" of the meter.

Microgrid Energy Efficiency



Microgrid Energy Efficiency

What is different from the current energy efficiency industry?

Building level "energy rates" may fundamentally change for "customers" located within microgrid

- **Not as simple as checking the historical average or published utility rate structure – business models are more complex**

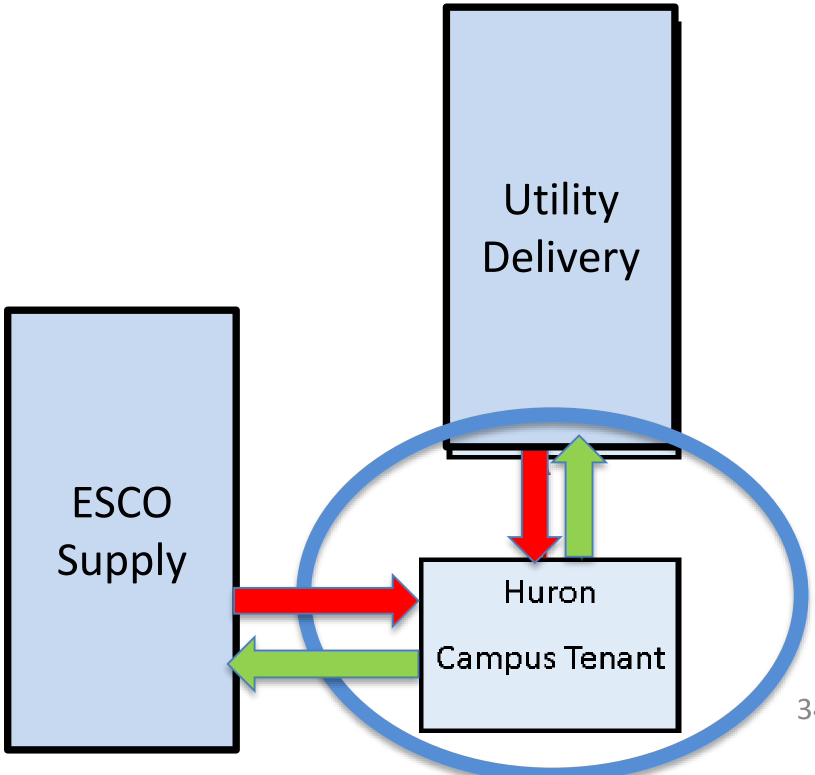
- **Efficiency gains "upstream" of the building may impact the delivered cost of energy. This may fundamentally change the cost structure and cost effectiveness of certain building level upgrades**

Traditional EE Project Revenue Model

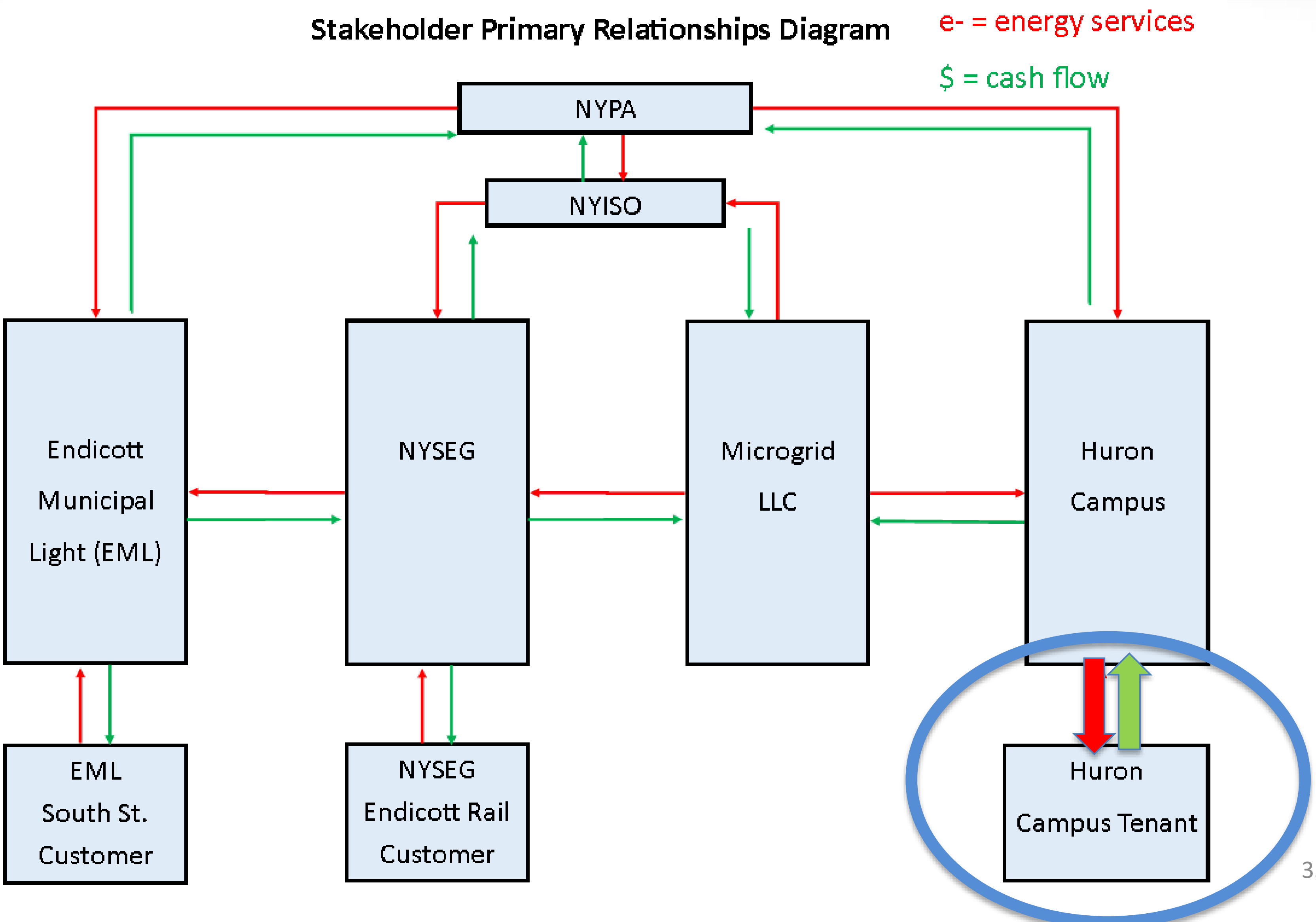
Stakeholder Primary Relationships Diagram

e- = energy services

$ = cash flow



Microgrid Business Model



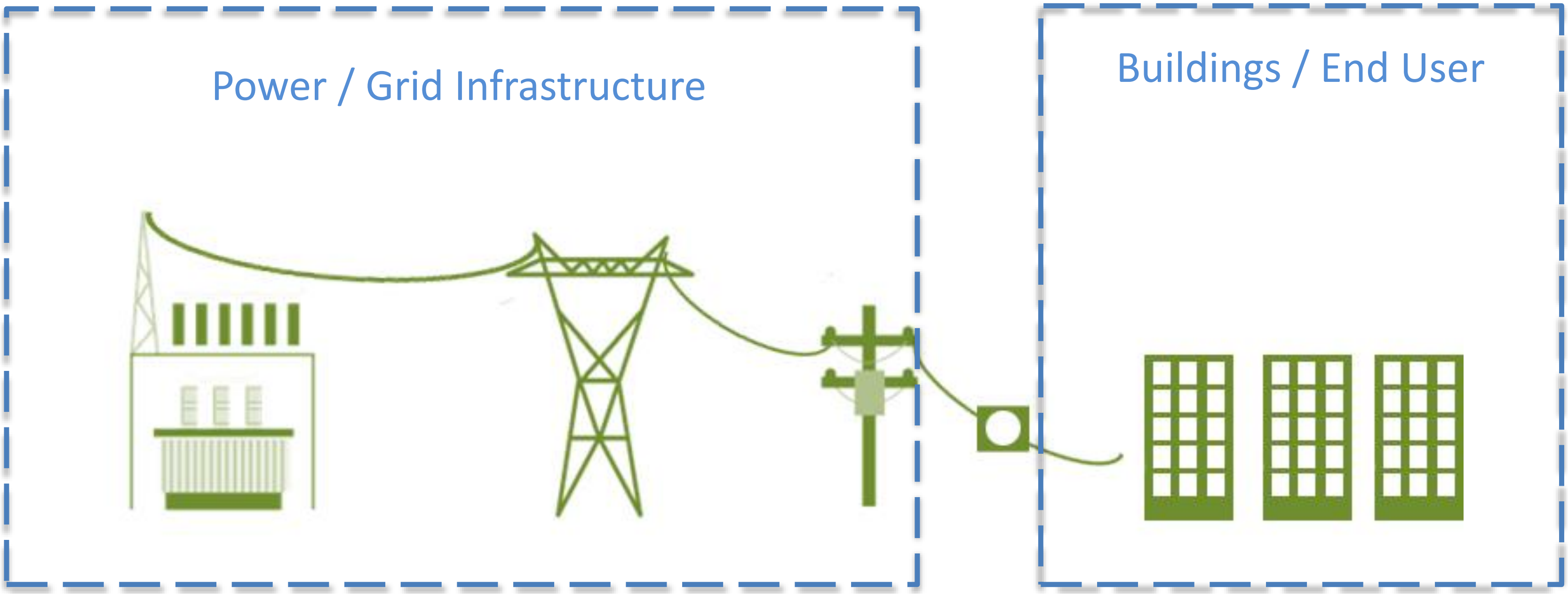
Core Microgrid: Revenue

- Scenario w/ 5 year NYPA rate

Item	Y1	Y25	Annual Average	25 Year Total
Traditional Revenue	-	-	-	-
Huron Campus Bilateral Contract: Electric	$ 10,130,462.99	$ 23,831,373.00	$ 17,874,891.67	$ 446,872,291.85
Huron Campus Bilateral Contract: Thermal	$ 1,985,364.87	$ 2,706,867.65	$ 2,328,283.25	$ 58,207,081.35
Total Traditional Revenue	**$ 12,115,827.86**	**$ 26,538,240.65**	**$ 20,203,174.93**	**$ 505,079,373.20**
Ancillary Service Revenue				
Community Emergency: Demand Charge	$ -	$ -	$ -	$ -
Community Emergency: Electricity	$ -	$ -	$ -	$ -
NYISO Generator w/ PTID#: Capacity	$ 420,000.00	$ 420,000.00	$ 420,000.00	$ 10,500,000.00
NYISO Wholesale Market: Electricity	$ 2,045,876.40	$ 2,045,876.40	$ 2,045,876.40	$ 51,146,910.00
NYISO Emergency Energy Support: Electricity	$ 72,000.00	$ 72,000.00	$ 72,000.00	$ 1,800,000.00
NYISO Voltage Support: VAR	$ 11,757.00	$ 11,757.00	$ 11,757.00	$ 293,925.00
Total Ancillary Service Revenue	**$ 2,549,633.40**	**$ 2,549,633.40**	**$ 2,549,633.40**	**$ 63,740,835.00**
Total Revenue	**$ 14,665,461.26**	**$ 29,087,874.05**	**$ 22,752,808.33**	**$ 568,820,208.20**

Photo Source: Jet.com

Building Energy Efficiency vs. Add. Generation



Should we add additional capacity?

Should we invest in efficiency?

E.G. Chiller vs CHP Capacity

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Results you can rely on

Total Peak Demand Reduction (F... ...ficiency)					C... ...t				
	Installed cost (M)				I... ...t (M)				
Chiller Replacement (9500 to...	$	21.85	4.54	MW		...00		**25**	MW
Lighting Improvement	$	4.8	0.30	MW					
Low-cost ECMs from Ben... ...king report	$	0.2	0.23	MW					
Total Estimated Peak Demand R... ...			**5.07**	**M...**					
Estimated Installed ... ...n Millions) per MW	$	5.30	M		$	4.00			
Estimated Installed ... for 5.07 MW (in Millions)	$	26.85	M		$	20.28	M...		
Estimated annual ... ...avings (in Million)		0.928	M...						
Incremental cost t... ...all energy efficiency vs CHP	$	6.5...							
Simple payback in ... ...s			...ears						

Notes

Does not take into a... ...nt value of thermal energy genera... ... additional CHP capacity

Based on .05 per kW... ...rrent rate. Microgrid rate per ... ...ill need to be used.

Does not value emiss... ...avings

Assumption of no dem... ...arges under migrogri...

Microgrid Phases & Role of EE

Feasibility – focus on large kW savings to reduce load. Compare investments in energy efficiency to generation.

Design – establish "delivered" costs of energy to the building based upon unique attributes of each microgrid. Identify EE opportunities and perform cost benefit analysis

Implementation – support installation of EE upgrades required for microgrid operation. Verify load reductions.

Operations – continued focus on EE to allow for growth

The World According to Bill…..

" The first thing we need to do is reduce the loads."
(Energy efficiency can play a major role)

"I need megawatts, don't bring me a 100kW."
(Permanent demand reductions are the primary concern during feasibility)

"We have grown accustomed to the notion that power is available in infinite supply."
(The kW savings better be real or the system could go down in island mode)

Conclusion

- Microgrids may be a significant force in market transformation
- Microgrids require and will promote a multidiscipline approach and a shift to systems thinking
- Energy efficiency has a key role but requires a different approach
  - Approach varies by phase of the project
  - Efficiency gains upstream can impact building level EE cost-effectiveness
  - The requirement to island raises the stakes for everyone



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