New CHP & Microgrid Business Models Driven By a Changing Energy Market

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Siemens Energy Inc.

Agenda

- **Changing Market Landscape**
- Evolution of Solutions
- Evolution of Customers

Q&A

New Era of Energy Systems Through Decentralization & Digitalization

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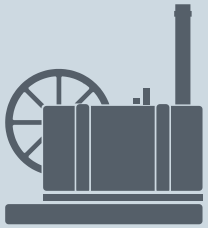
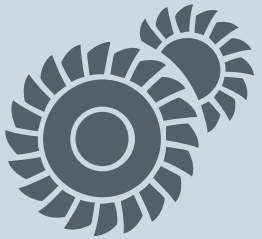
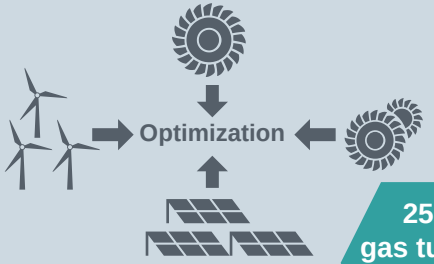
	1st Revolution	2nd Revolution	3rd Revolution	4th Revolution
Evolution of energy market	**Industrialization** of the steam turbine for local mechanical drive systems	**Electrification** by means of electric power plants for large-scale, centralized power generation	**Manufacturing costs and efficiency** by means of a high degree of efficiency with power plants >60% and DCS control	**Generation 4.0** Heterogeneous energy fleet with centralized and decentralized power generation and intelligent assets
Power & Gas				 25GB gas turbine data per day
Evolution of production	**Mechanical production plants** using water and steam power	**Mass production** with the aid of electric power	**Electronics and IT** for the ongoing automation of production	**Industry4.0** with the aid of highly digitalized and flexible value chains with small batch sizes
	1800	1900	2000	Today

The Transmission Grid and Markets Are Evolving…

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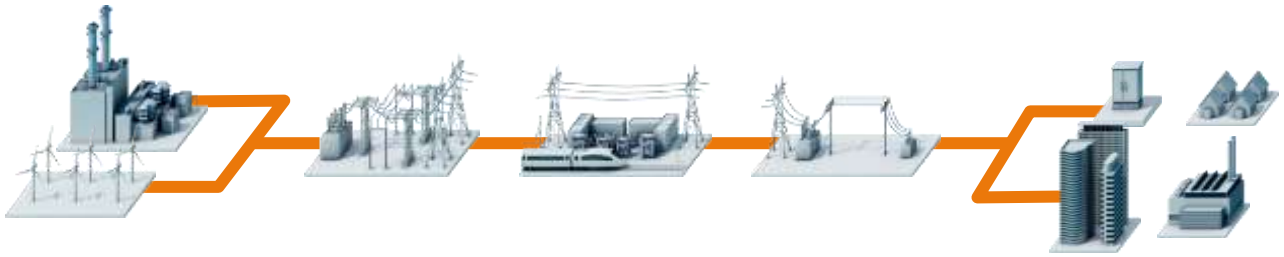
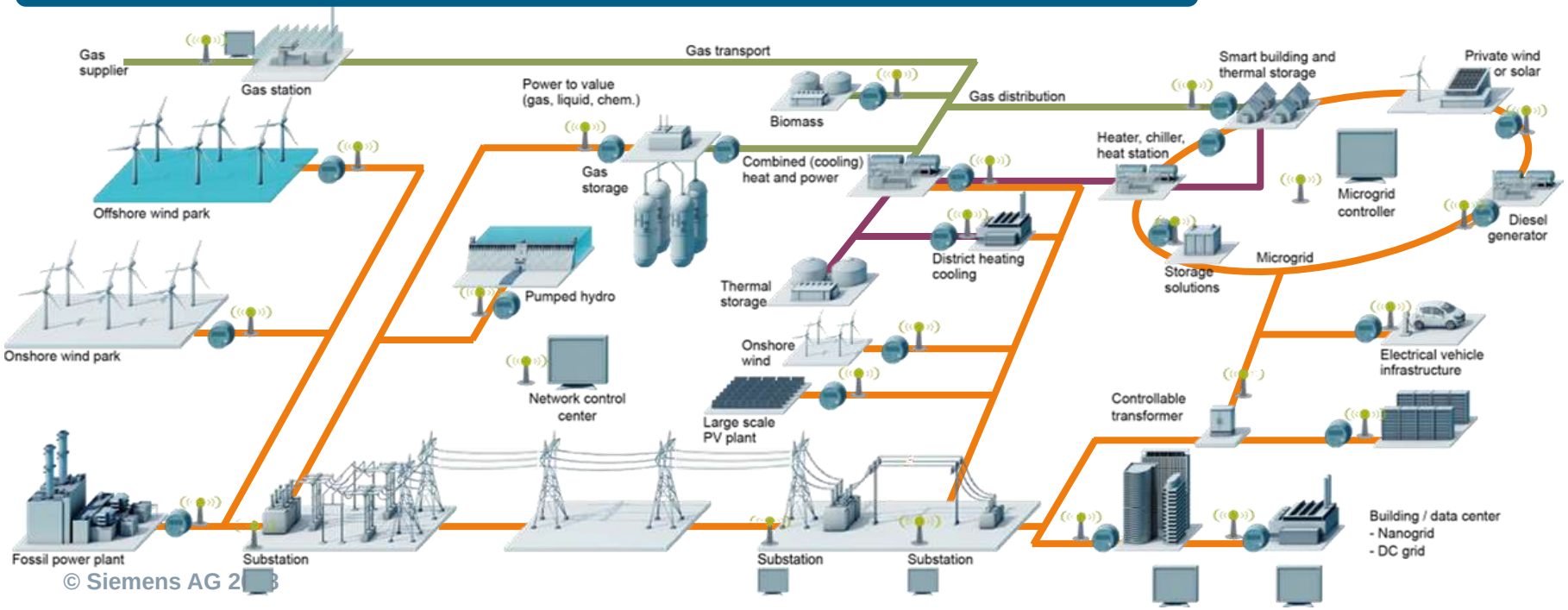
Traditional Grid – Centralized Generation



Multiple Generation Sources – Much More Decentralized



Key Drivers:

- Increased Reliability
- Reduced Costs
- Improve Grid Resiliency
- Reduced Emissions
- Enhanced Control

New installations shift to decentralized power generation

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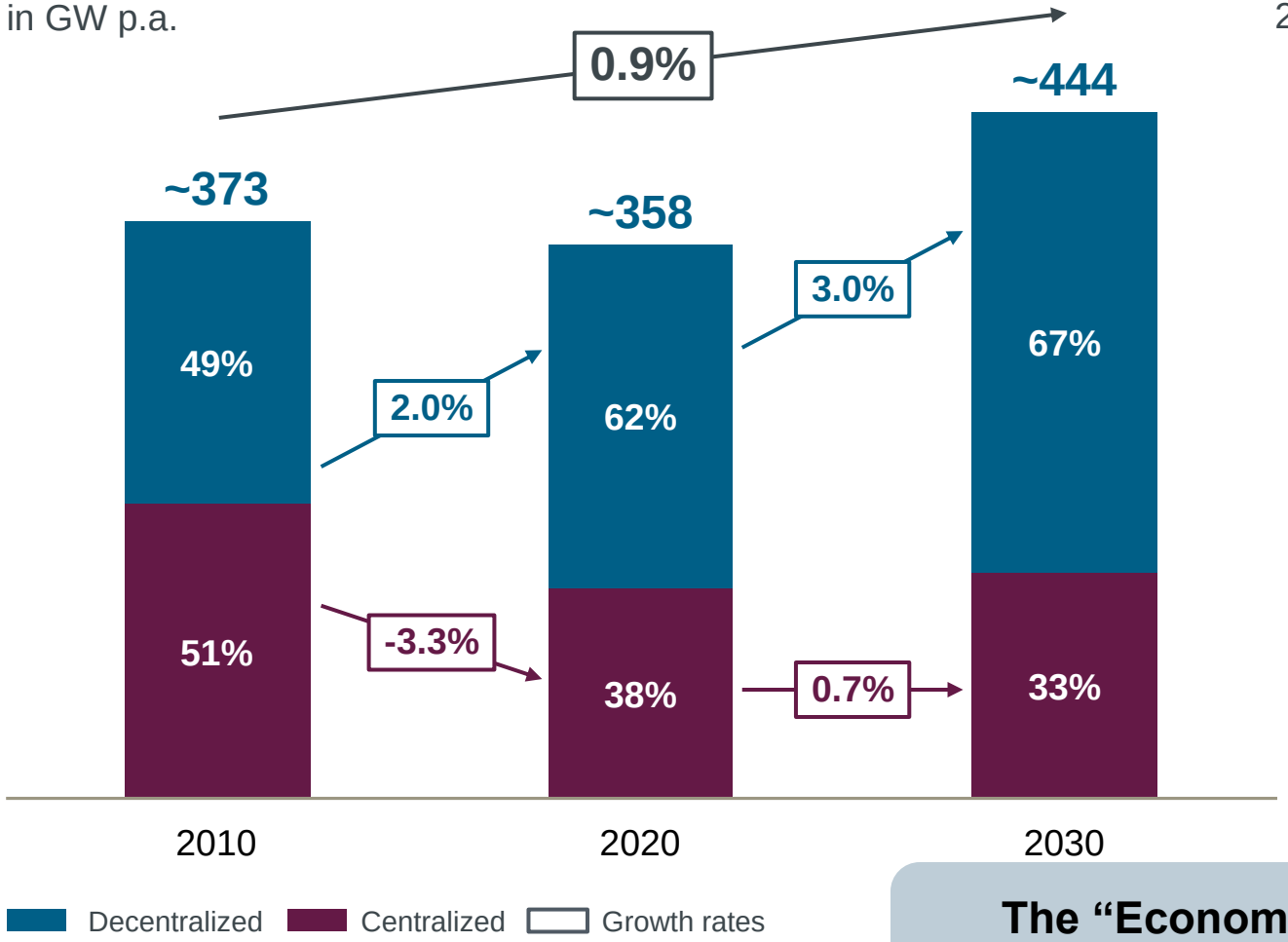
New installations worldwide
in GW p.a.



Growth rate
2010-2030

2.5%

Decentralized
Onshore wind, photovoltaic, small turbines, motors, storage

-1.3%

Centralized
Fossil, nuclear, offshore wind, large-scale hydropower plants

Sources: IHS (2016), Bloomberg (2016)

The "Economies of Scale" argument is no longer the decisive factor in power generation.

Evolving Grid Creates New Opportunities & Challenges

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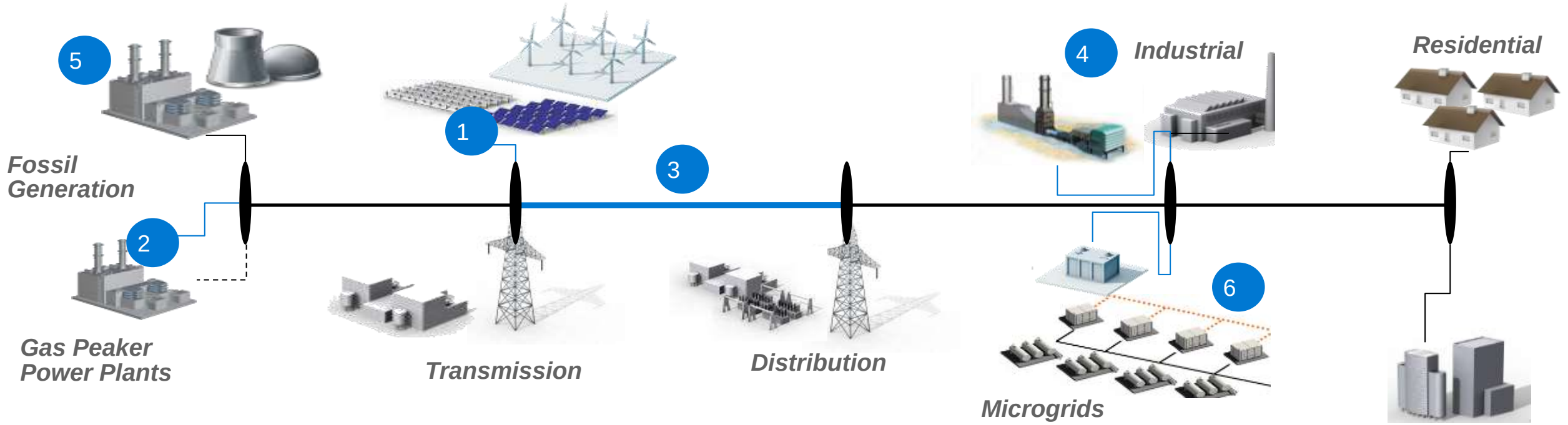

1. Penetration of Renewables
2. Change of Energy Mix
3. Saturation of Infrastructure
4. Increase of Grid complexity
5. Fuel Price Fluctuations
6. Deployment of Microgrids

Investment in Power Grid Gains Importance With Energy System Transformation

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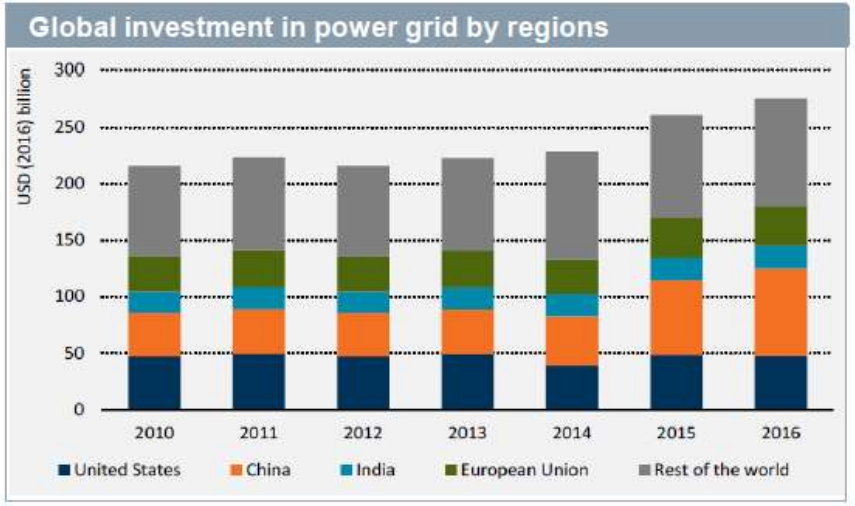

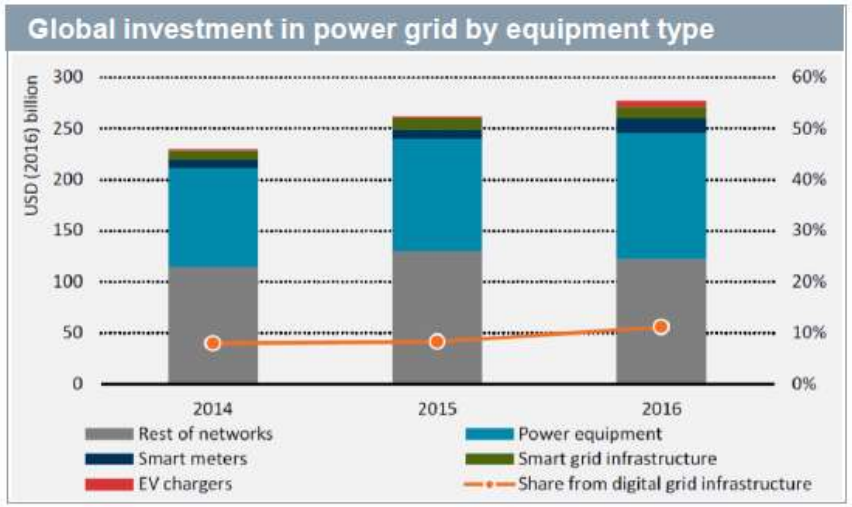

Source: IEA World Energy Investment Outlook 2017

- **Growing global investment in power grid** – especially in China, but increasingly strong in all established regional markets
- Overall **power grid investment surpassed $US 270 Billion in 2016**, with China accounting for ~$US 80 Billion
- Traditional power grid equipment remains largest sector, but investment in smart meters, smart grid and EV charger infrastructure is quickly catching up
- **Share of digital grid infrastructure covered about 12% of the total grid investment in 2016 Vs. only 8% in prior year**

All participants will have to support this additional power grid infrastructure investment.

Agenda

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- **Evolution of Solutions**
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Q&A

Changing Energy & Infrastructure Landscape

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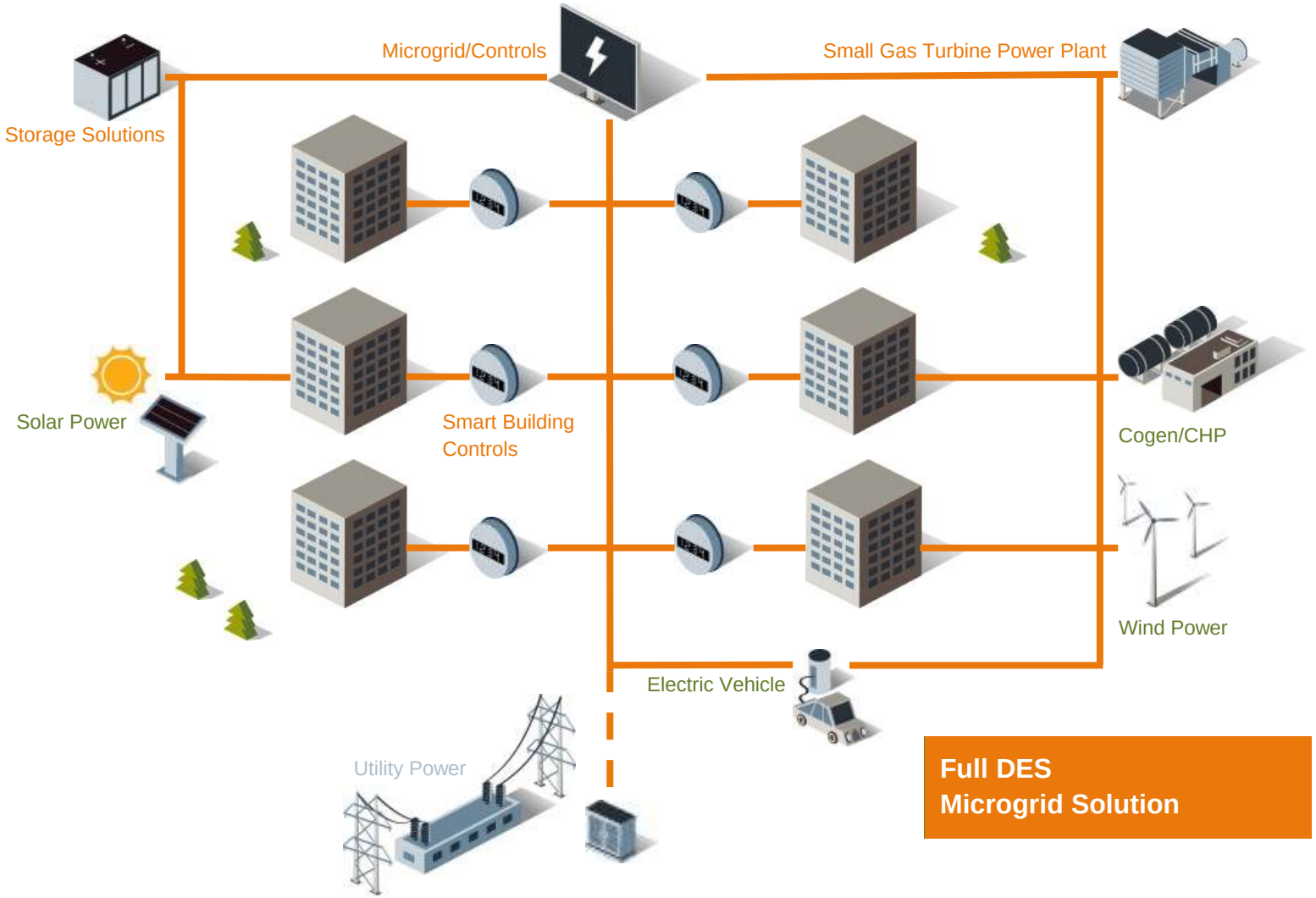
Objectives

- Enhanced Resiliency
- Lower Energy Costs
- Localized Control
- Enhanced Sustainability

Challenges

- Aging Infrastructure



Full DES Microgrid Solution

Algonquin College Benefits from Comprehensive Energy Services

Challenge	Solution
Fuel management and optimization, energy supply planning, utility bill management	Siemens Advantage Navigator
Achieve energy efficiency by optimizing and controlling integrated components	Siemens Spectrum Power Microgrid Management System
CHP project development: cogen, solar, power storage, EV charging and microgrid management	$52M in improvements

4MW
energy center (cogeneration)

48%
reduction in annual energy costs

$3.2M
annual operational savings through infrastructure upgrades

Source: http://www.algonquincollege.com/public-relations/algonquin-college-history/

Algonquin College CHP Microgrid
The value of advanced optimization

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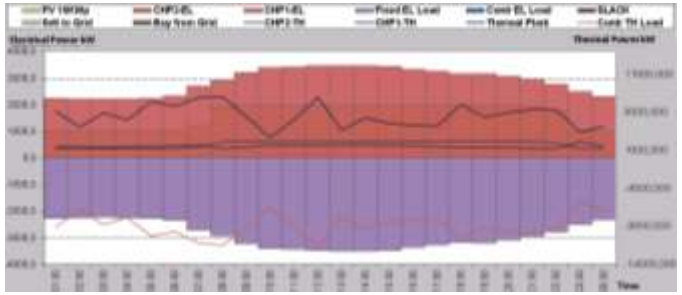

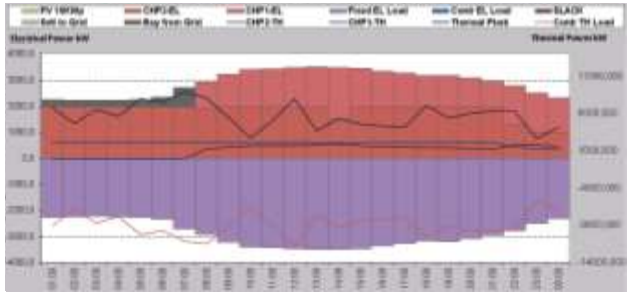

Scenario 1- Full CHP utilization

Savings are made through maximum CHP utilization and simple MG controller without optimization

TOTAL Energy COST ($/Yr): $2.2 Mil

Scenario 2 - Microgrid optimization

Additional savings are made through optimizing Energy intake from either CHPs or Grid with the MG manager

TOTAL COST ($/Yr)): $2.0 Mil

SAVINGS:$200K

Scope:

- CHP plant
- PV plant
- Li-ion storage
- EV charging
- Micro-grid control
- Financing

Optimization Parameters:

- Gas contract prices
- O&M costs of major generation assets
- Efficiency curves of major equipment
- Renewable generation capacity
- Controllable and uncontrollable/critical load (electricity & thermal) profile

Blue Lake Rancheria Deploys Low-Carbon Microgrid to Manage and Control Energy Sources

Challenge	Solution
Diverse renewable energy sources – • .5MW solar PV • 950 kWh battery storage system • Biomass fuel cell • Diesel generators **GOALS**: energy efficiency, cost savings and emission goals	Siemens SP MGMS software for managing numerous energy sources and balancing with energy loads
Operations need to be automated to allow limited staff to manage the system in event of a grid outage to ensure energy security for the on-site emergency shelter	Microgrid defined sequence of operations programmed to coordinate with the local utility

7 days

Duration of available on-site power independent from the utility

BLR Project Team

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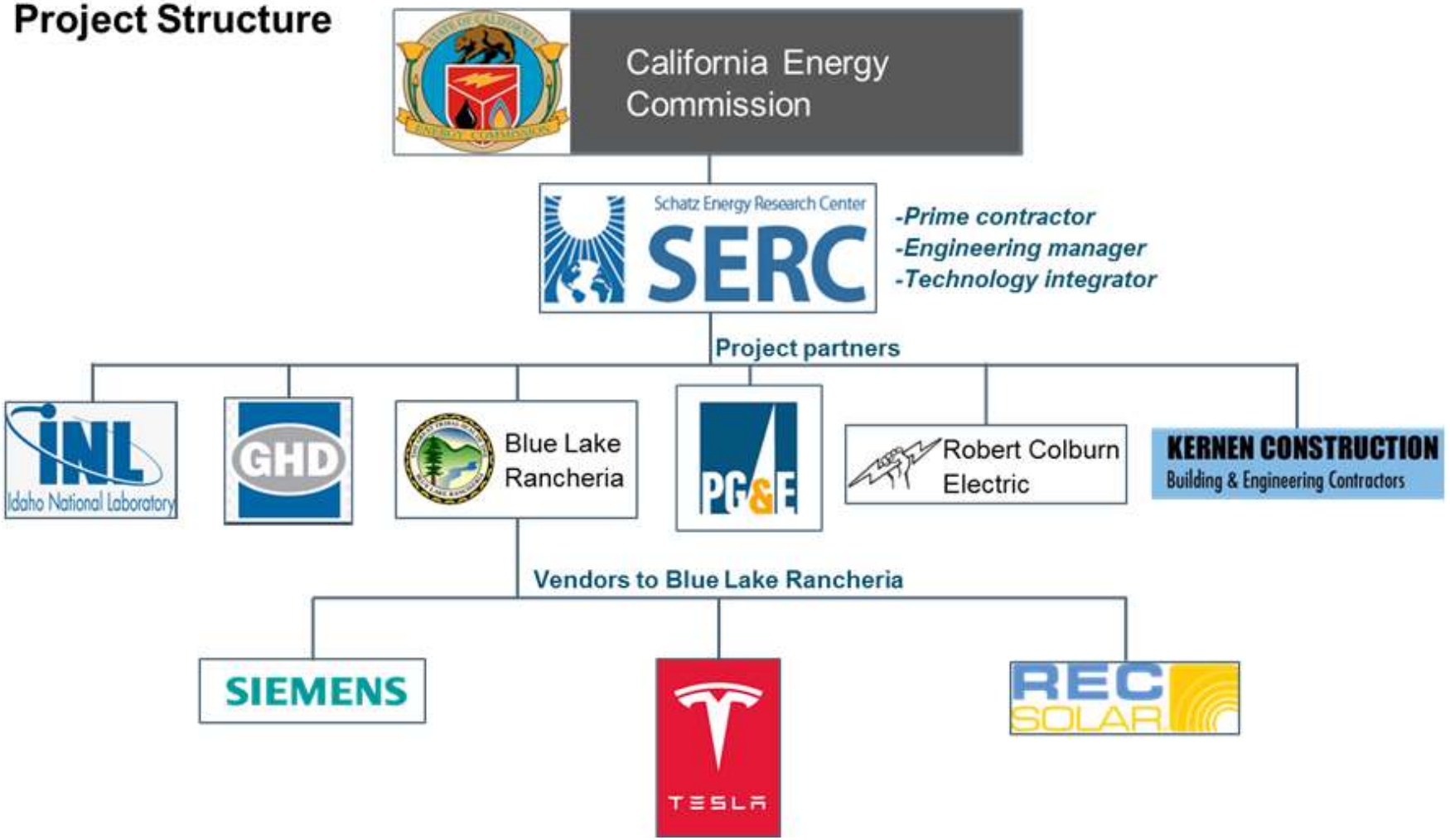
Project Structure



Hockey Fans Forecast

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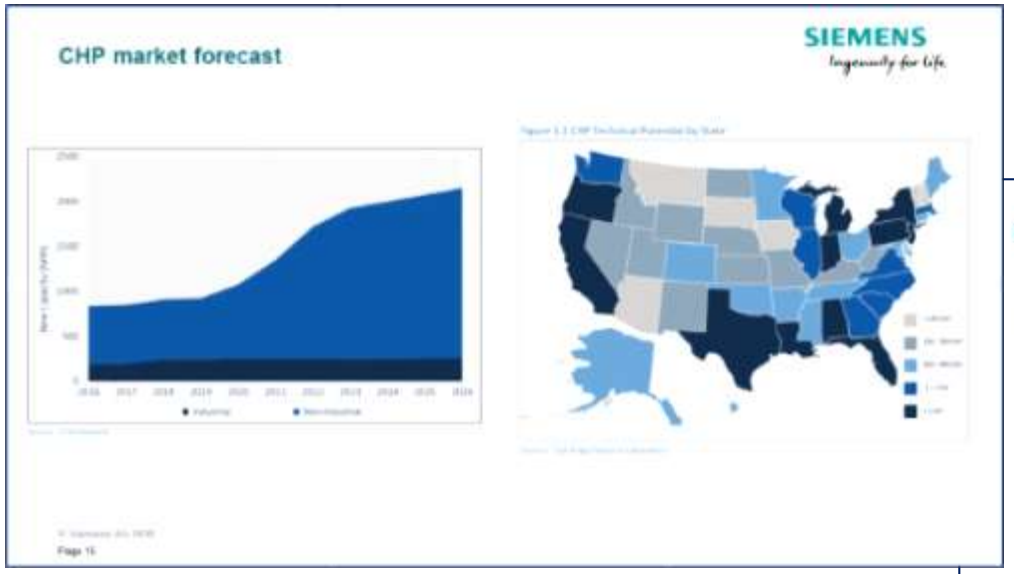

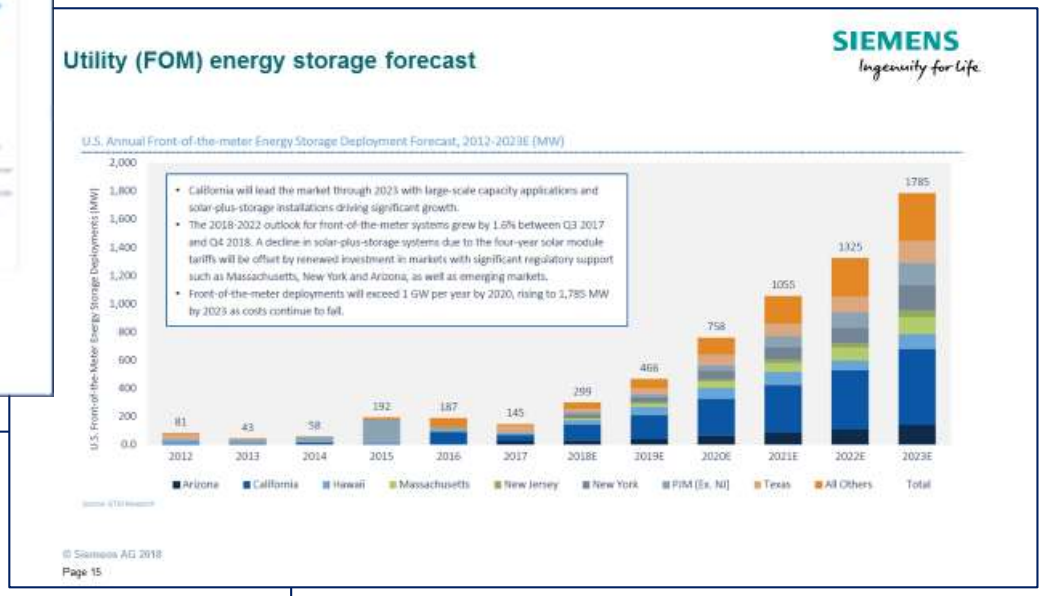

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- **Evolution of Customers**

Q&A

Utility integrates residential solar program and creates new business model for Arizona Public Service

Challenge	Solution
Design an advanced control solution to manage a significant amount of roof-top solar on geographically distributed residential houses	Microgrid controllers monitors controls and manages geographically distributed residential roof-top solar installations
Integrate seamlessly with APS' existing utility control architecture	Functionalities include data collection & storage, remote on/off, power curtailment (0% to 100%), reactive power control, frequency/Watt control
Ensure data reliability, quick reaction time, and system cyber security	Software solution supports UL 1741 SA and NERC CIP cyber security req.

10MW

Capacity of 1500 roof-top solar installations supported by microgrid

Source: https://www.aps.com/en/residential/renewableenergy/typesofsolar/Pages/home.aspx

Storage in utility RFPs

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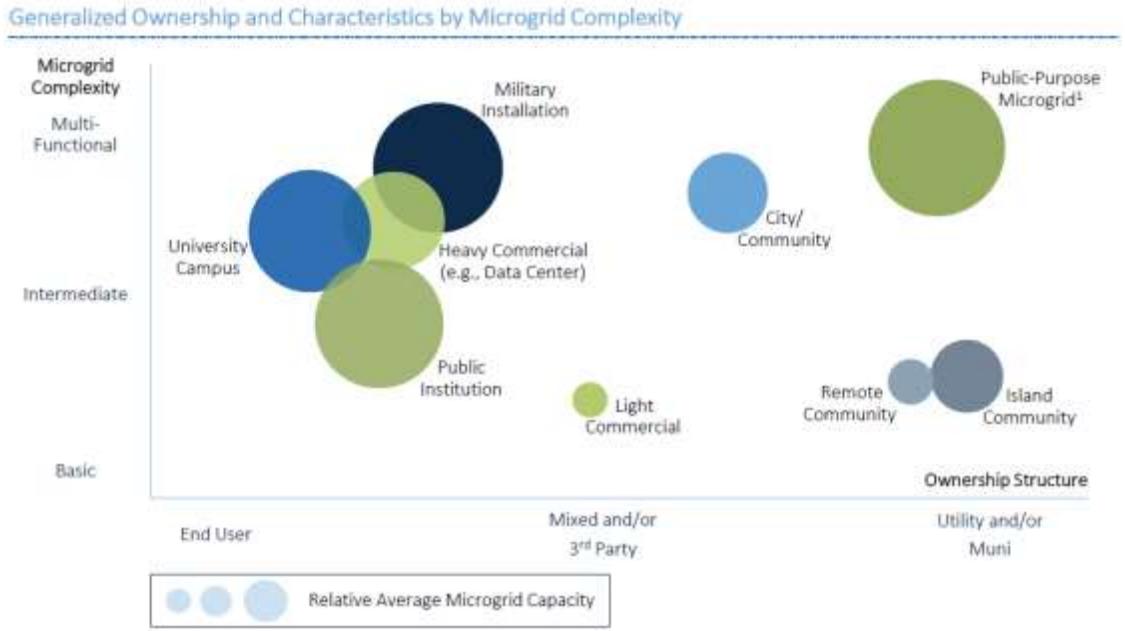
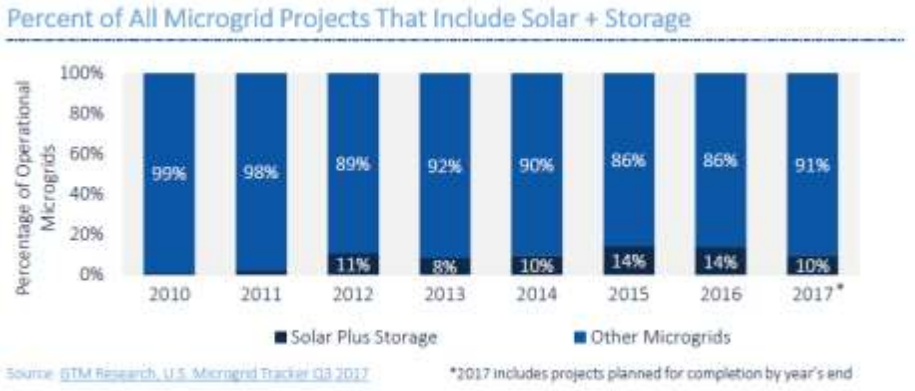
Utility	Procurement Amount	Resources Included	Bid Date Due	Commissioning Date	Notable Details
Great River Energy	10 MW storage, 10 MW solar	Solar and storage	February 23, 2018	End of 2019	Energy storage systems will be co-located with the solar systems and operate under what GRE describes as a Long Term Energy Storage Services Agreement with terms of at least 10 years.
Nevada Energy	330 MW of renewables, storage sized 25 MW or greater	Renewable energy and storage	February 2, 2018	2020 and 2021	The fact that energy storage is considered in a supplement to the primary RFP indicates that Nevada Energy does not want storage to displace other assets in the bidding process, or that the utility sees storage as a significantly different technology distinct from renewables.
Salt River Project	100 MW of renewables	Solar, wind, geothermal and biomass	March 9, 2018	End of 2020	Bidders are encouraged to include energy storage (for the purposes of meeting SRP peak needs) in their proposals, though complementary proposals without energy storage are required.
Orange and Rockland	Seven projects ranging from 1-15 MW	Multiple	Varies by project – through 2019	Varies by project – through 2022	Load relief and reliability were the drivers for all seven projects
Xcel Energy	454 MW to meet forecasted demand, and up to 1,114 MW	Multiple	November 2017	End of 2023	Median bid prices released show some of the lowest storage and renewable-paired storage prices to date

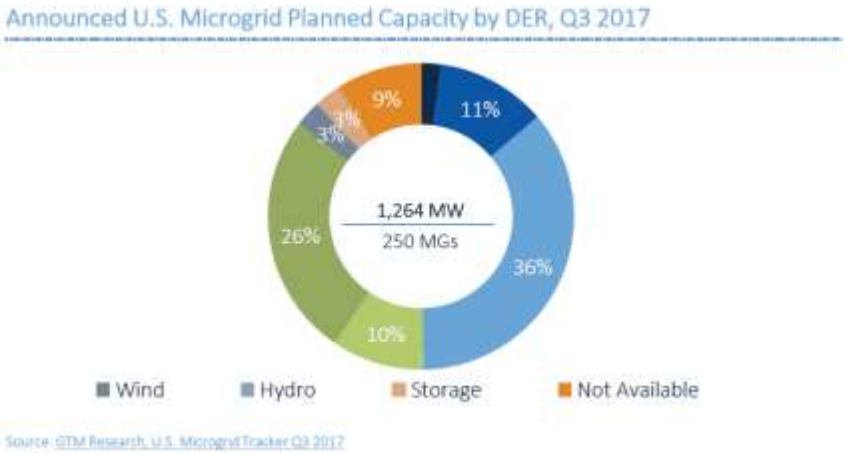
In three of the cases shown above, energy storage has been directly included or encouraged in RFPs otherwise focused on renewable energy, highlighting use cases from peak capacity, to solar integration, to capturing curtailed wind energy. Additionally, Xcel's all-source solicitation in Colorado, though closed, shows the remarkable potential for renewable-paired storage. The commission's phase II decision is due in July, but before then the median prices revealed showed that storage is increasingly competitive even when competing with traditional generation. While standalone renewables will continue to be the norm over the next two procurements happening now, representing installations two to five years out, they increasingly highlight storage. We are seeing an inflection point in utility planning where storage becomes the norm, rather than the exception, when considering procuring renewable energy.

Utility-DOD partnerships on microgrids

Operational microgrids by complexity & ownership







It Takes More Than Just Equipment

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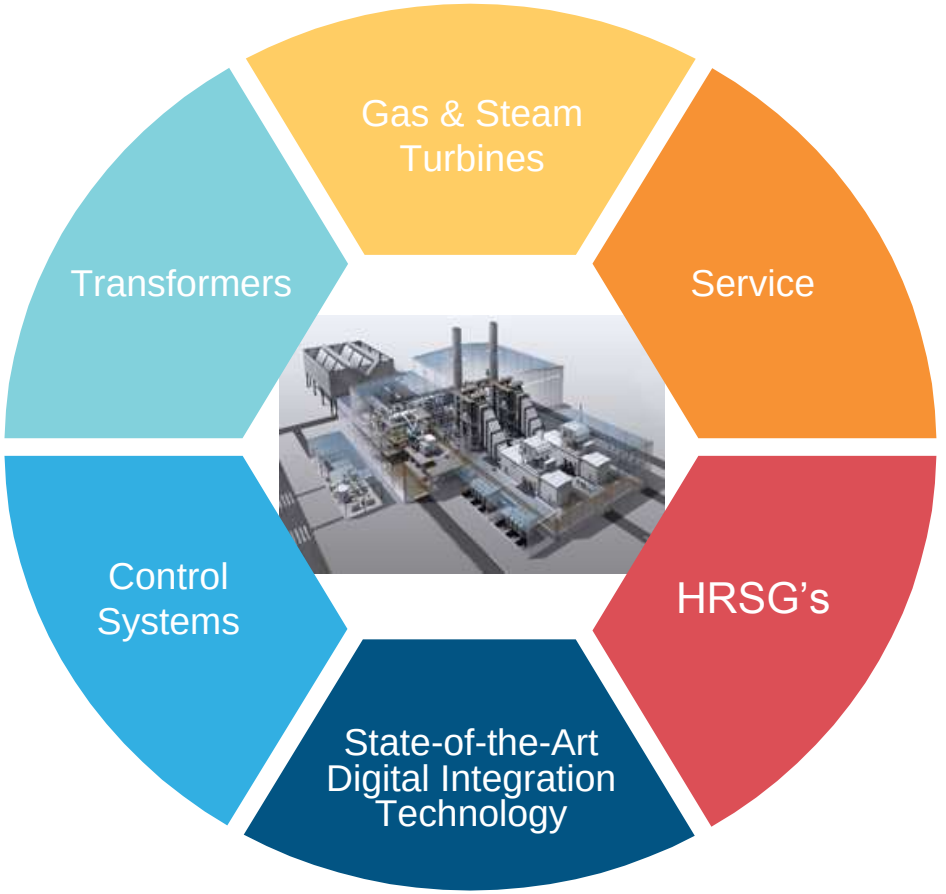
Integrated Solutions

- Situational Awareness
  - Energy audit experts with expertise to **analyze your energy requirements** and evaluate the **optimal solution**.
- Experienced Guidance
  - From **Design through Commissioning** and throughout the **Project Lifecycle**
  - **Deep understanding** of the market
  - Services to **ensure long-term reliability**
- Integration of **Multiple Types of Components**
- Financing Options
  - Comprehensive suite of financial solutions to help customers **meet objectives** and **overcome challenges**.
  - **Flexible** commercial structures to **maximize reliability**, **reduce risk** and **maximize customer value**



More Complex Solutions Demand a Deeper Understanding of the Markets

Questions?

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