The Role of Microgrids in Distributed Generation on University Campuses

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Power and Energy Industry Leader
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ROCKWELL AUTOMATION IN POWER AND ENERGY

*World's **largest** company focused on industrial automation.*

Point Technology Solutions for ACIS, SCR, TIAC	CHP Microgrid Hospital	50 MW CSP	Large Scale Hydro Globally	Remote Monitoring & Control of Wind and Solar	20 MW CHP *(2016 CHP Plant of the Year)*	Simple Cycle	2 6x1 CCGT 840 MW

SMALL / SUBSYSTEMS → **SCALABLE** → **LARGE SYSTEM**

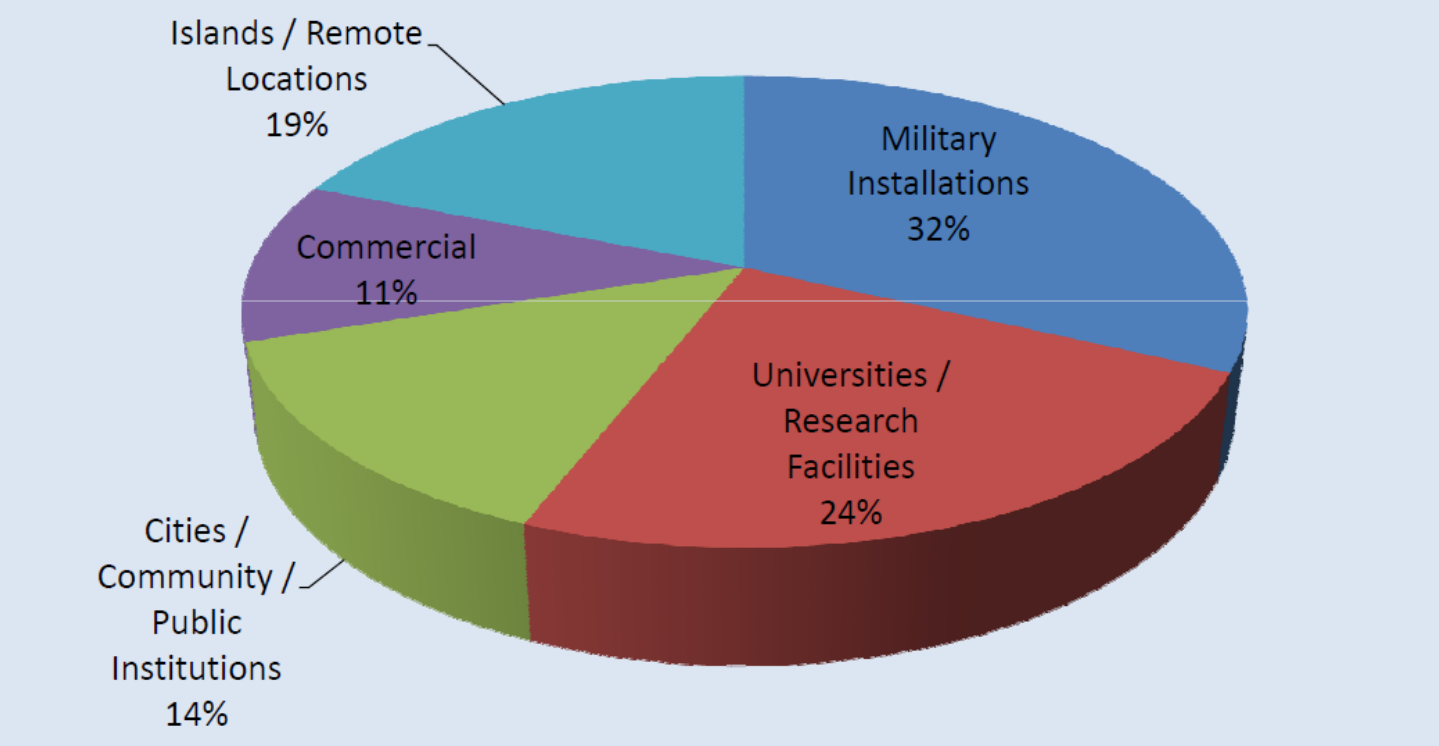
Rockwell Automation supplies technology and services in all phases of Power Generation and Industrial / Institutional Energy

Microgrid Definition

- Department of Energy definition of Microgrid:
  - A group of interconnected loads and distributed energy resources (DER) with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid [and can] connect and disconnect from the grid to enable it to operate in both grid-connected or island mode."
- Can be described as Mini grids that serve a small geographic area, maybe a college campus, or downtown area where there might be a hospital, a police station and a grocery store, or industrial applications
- A microgrid is typically made up of:
  - Renewable energy sources (solar, wind or biomass)
  - Fossil fuel energy sources to ensure grid stability
  - Energy storage solutions (batteries, hydrogen storage, mechanical storage, etc.)
  - A low-voltage supply grid regulated by a smart control system
  - Microgrids have become properly competitive as a result of technological progress and falling prices of certain key components, including photovoltaic panels, batteries and control systems.

Who is Building Microgrids?

- Universities/Research
- Military
- Cities
- Industry – light and heavy

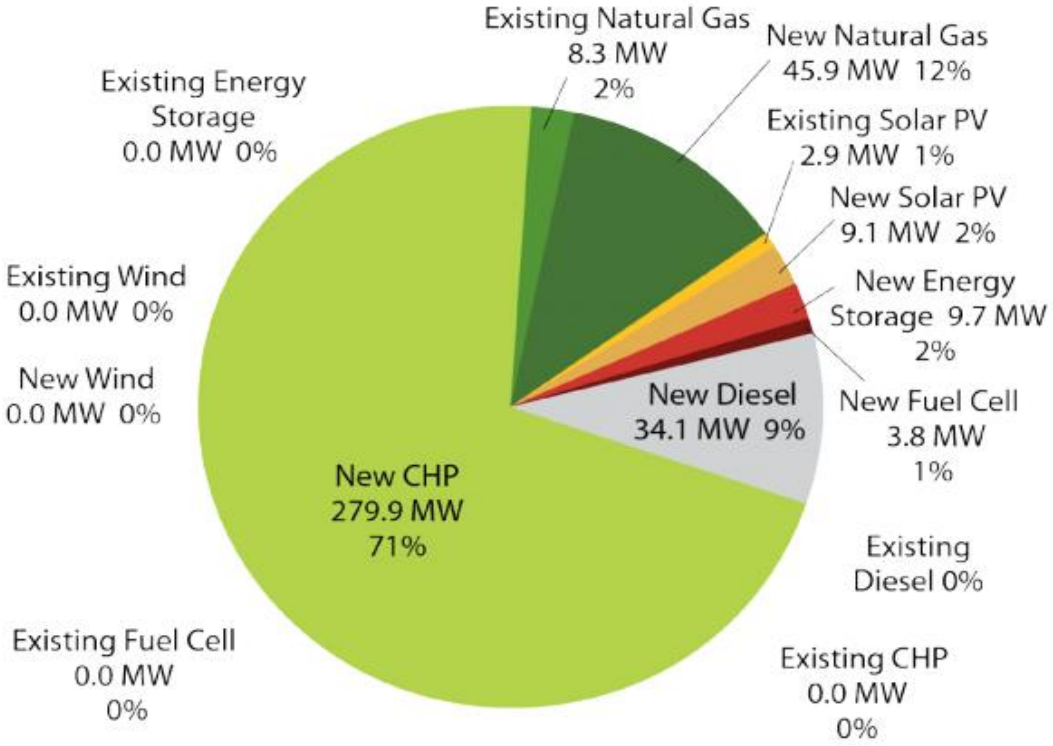


GTM Research

Campus / Institutional – New and Existing Generation by Technology

Mix of Distributed generation resources in Institutional Microgrids

- Dash to gas
- Inclusion of green generation technologies



New and existing distributed generation by technology for campus and institutional microgrids
NREL NREL/TP-5D00-67821 October 2018

Why Now?

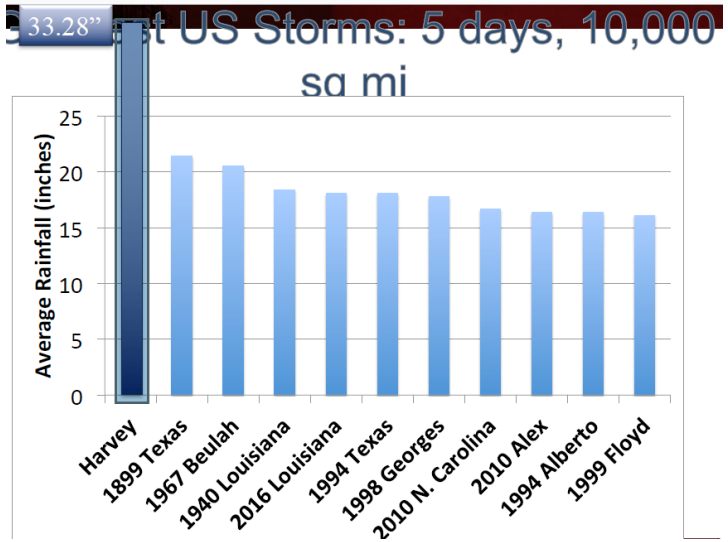
- Why the interest now in Microgrids?
  - Ability to sustain critical loads
  - Efficiency when combined with Central Heat and Power (CHP) as byproduct of generation
  - Fluctuating energy rates
  - New revenue streams – generating capacity, frequency and voltage support, blackstart capabilities

- Multi-stakeholder ownership models are lifting microgrid growth expectations / outsourcing

Why Now?

- Resiliency is another huge draw for universities, especially in the wake of Hurricane Sandy in 2012, and most recently, the devastation from Harvey, Irma, and Maria.
  - Princeton University's microgrid kept the lights on when Hurricane Sandy slammed into the East Coast in 2012 even as much of New Jersey remained in the dark.
- During the first weekend of December 2018, 29 tornadoes ripped across Illinois, leaving thousands without power. A week before, 340,000 people in northern Illinois lost power during a punishing blizzard, which set single-day snowfall accumulation records
- One of the biggest microgrids in the country is at the University of Texas at Austin. It includes a 135-MW CHP plant that produces electricity and steam, as well as a chilled water plant, a 36,000 ton-hour thermal energy storage tank, and six miles of pipes to distribute hot water and steam. It can provide all of the university's power, heating and cooling needs.

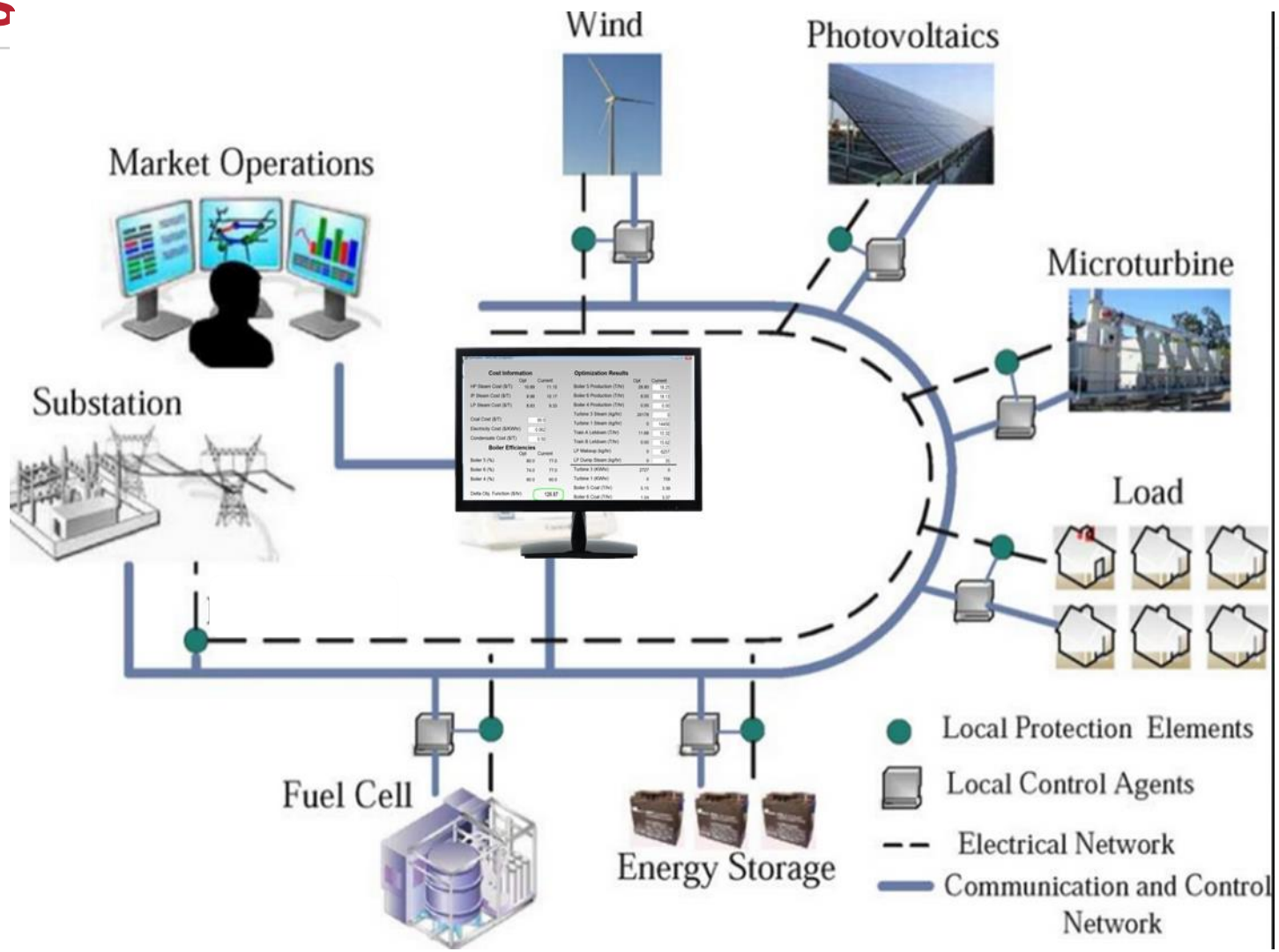
Greatest US Storms 5 Days, 10000 Sq. miles



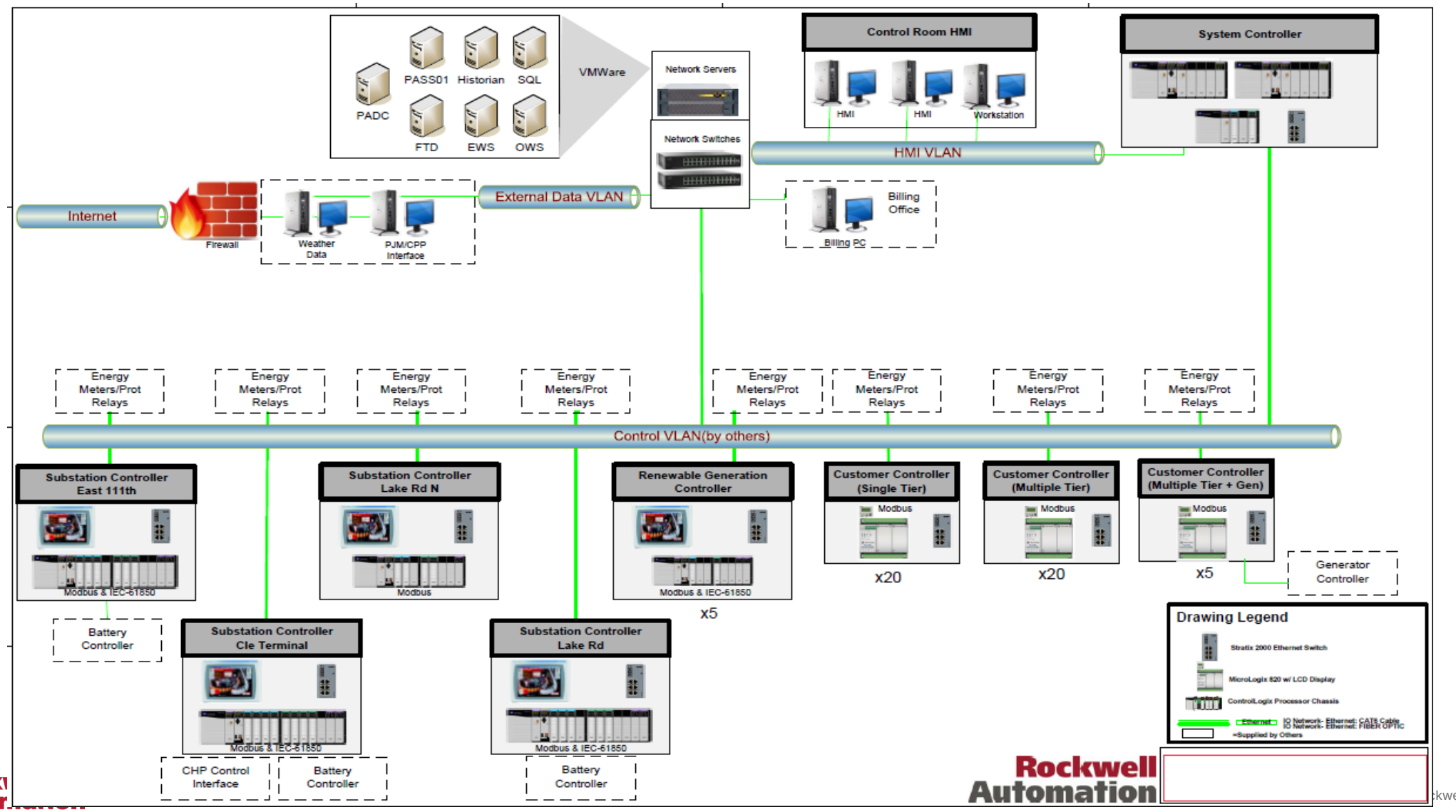
Texas A&M 2017

Microgrid Components

- Sources of Energy
- Protective Devices
- Energy Consumers
- Distribution System
- Communications
- Energy Control
- Energy Dispatch



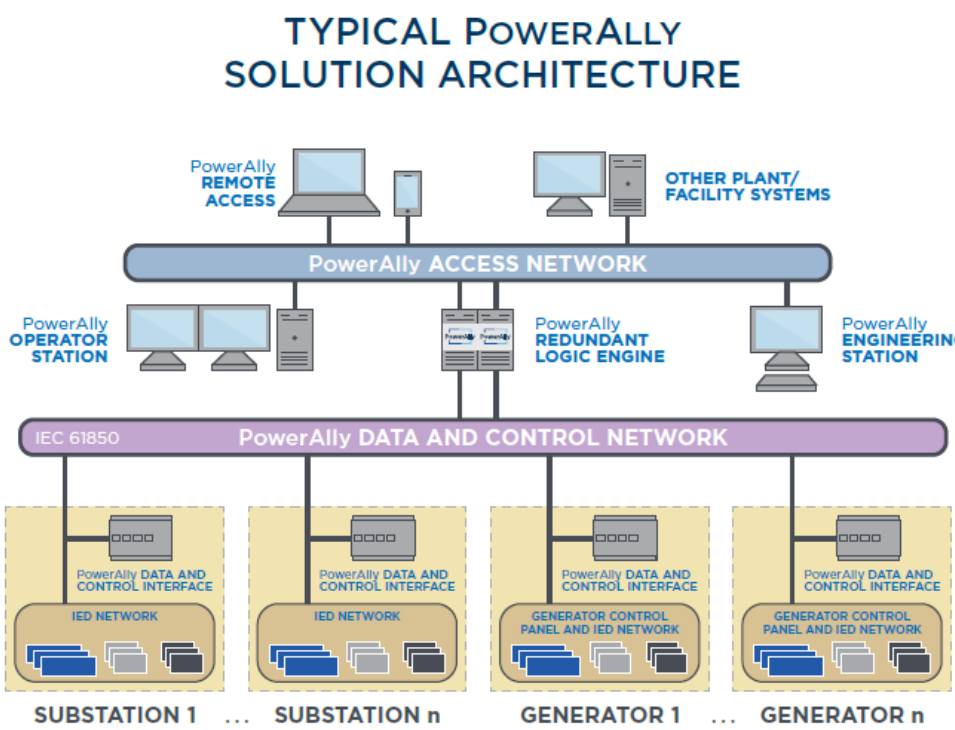
Scoping the Typical Architecture



Automation

The key to success for any microgrid project is the **controls platform**. Whether intentionally islanding from the utility grid or responding to a signal from a grid operator to provide ancillary services, the **automation** can be viewed as the heart of the microgrid. It is vital to the success of microgrid projects whether focused on resilience, renewable energy integration, or economic optimization.

- Technology Changes are driving innovations at breakneck speeds.
- Disruptive forces of change are everywhere
- Productivity demands and the speed of business continues to increase
- Automation that unlocks new business models and fosters
  - Increased visibility and Optimized Operations
  - Increased Safety
  - Asset/equipment Optimization and Reliability
  - Increased financial demands / profitability.



BURNS McDONNELL

GENERATION ASSET

REAL-TIME DATA

Voltage, Kwh, Running Time, Temperature, Vibration

INFORMATION

Contextualization

Energy/Product

SCALABLE COMPUTING

Control, Edge, Cloud

KNOWLEDGE

Analytics

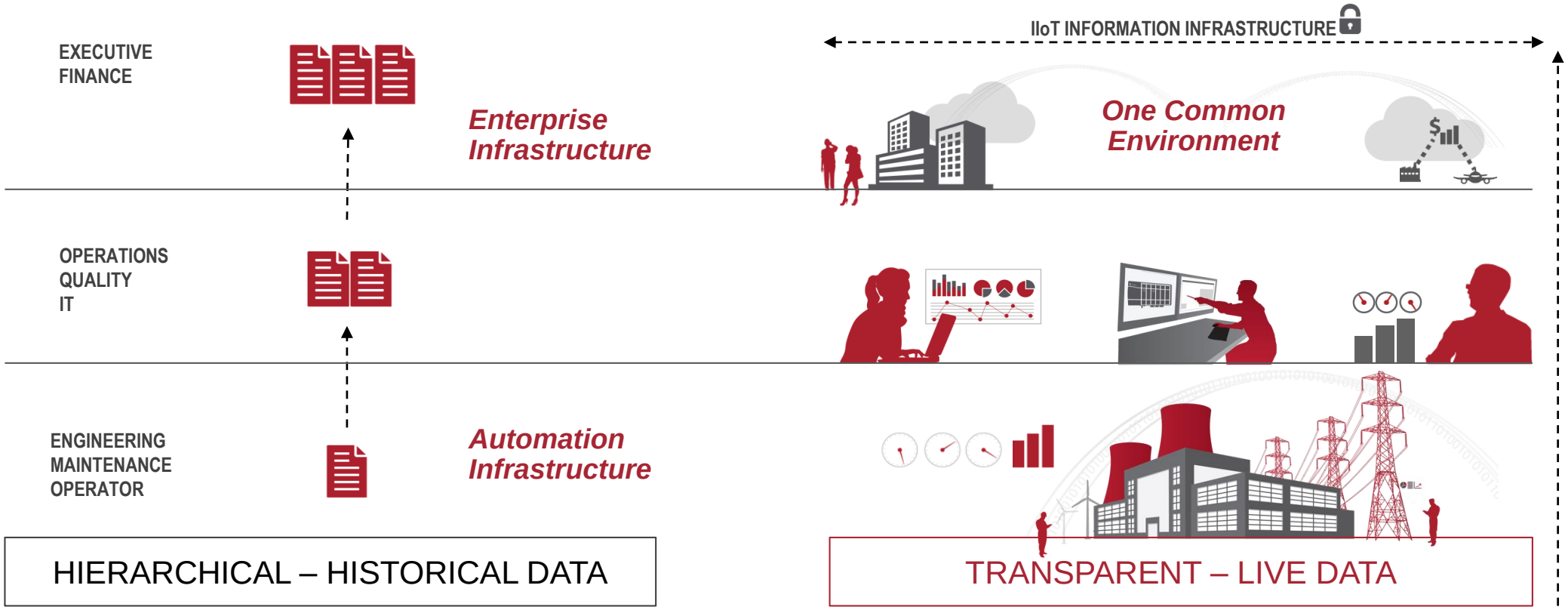
Predict Bearing will Fail in 10 Hours

OPTIMIZE

TECHNOLOGY + PROCESS + PEOPLE

All within a Secure Network Infrastructure

DIGITAL TRANSFORMATION



SMART

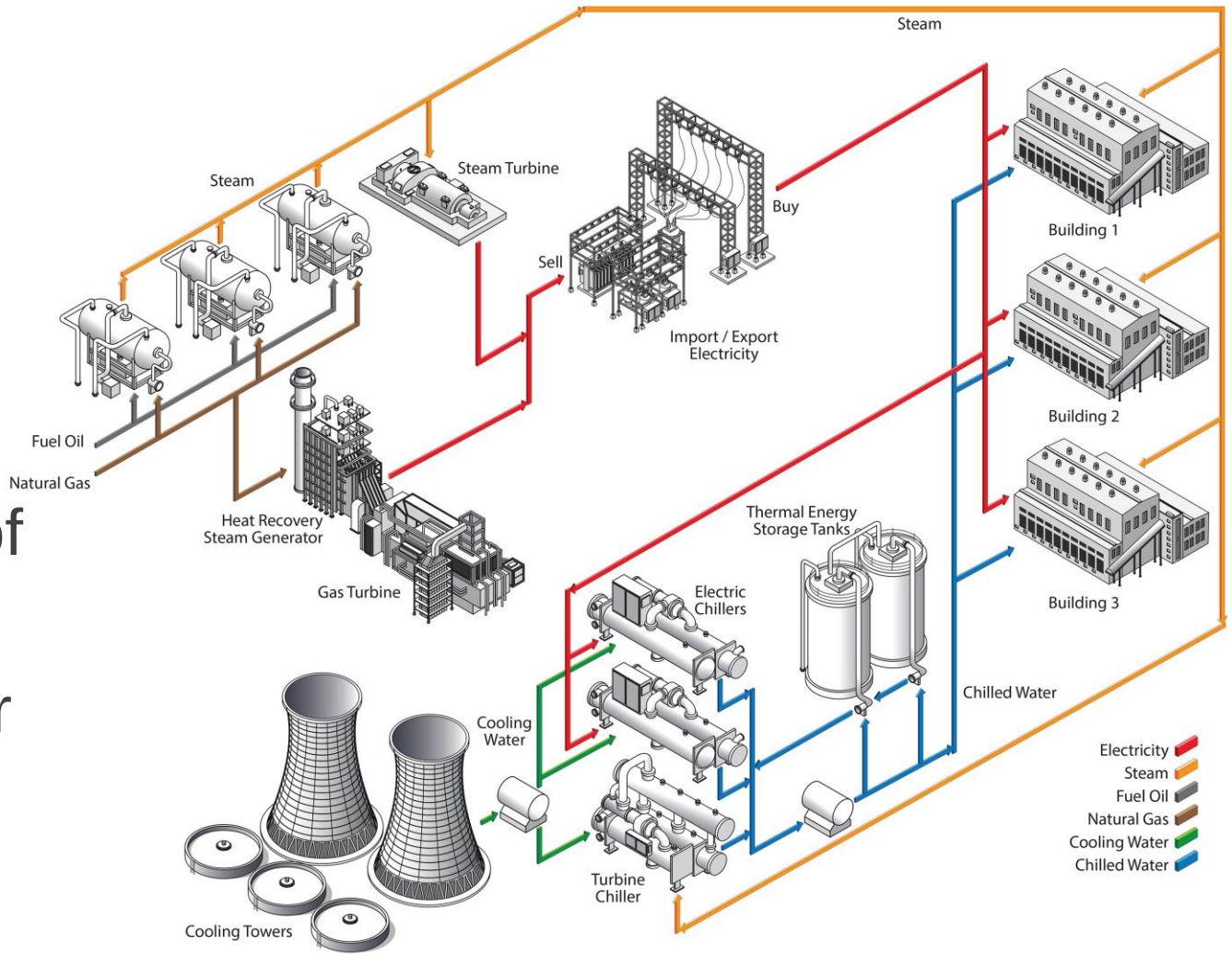
GENERATION

- Highly Responsive to Market Demand
- Improve Plant Availability & Reliability
- Compliance to Regulations
- Enable Secure Access
- Reduce Operational Costs

Analytics
Energy information for making intelligent decisions

Optimization of Plant Energy Systems

- Graphically drive to Economic Optimization of overall utilities
- Consider System Holistically
  - Electricity, steam, chilled water, refrigeration, fuel
- Optimize against current and forecast operating conditions of the plant
- Automated model retraining for simplified maintenance and accuracy.



Real-Time Dispatch Optimization

Real-Time Optimization™ sits above control

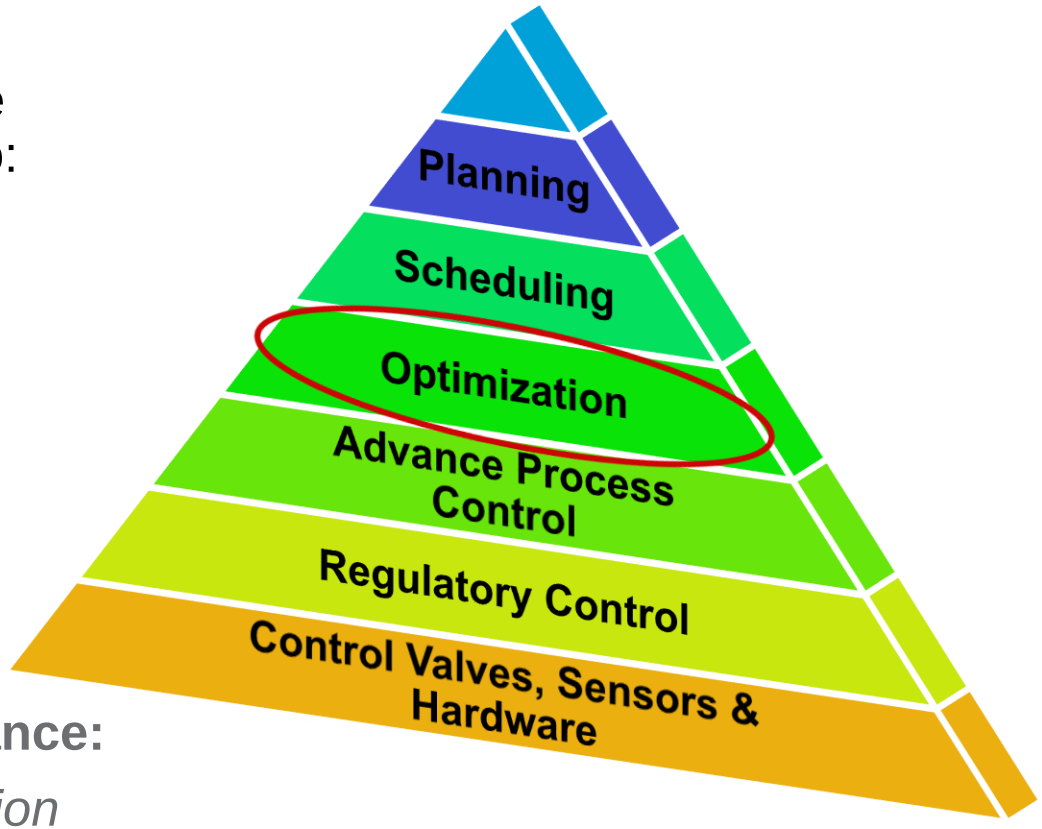
- Calculates optimization at the plant level
- Uses equipment models, business requirements, plant-wide operating conditions, forecast and scheduling information to:
  - Predict optimal products (energy) to make in a plant
  - When to make them
  - What are the best operating conditions to maximize profitability

Reads real-time data and sends targets to a control system

- **Where control maintains operations at targets:**
- *Optimization determines best targets*

Where advanced control provides best operator performance:

- *Optimization calculates best performance and only optimization identifies new ways to operate*



Real-Time Dispatch Optimization

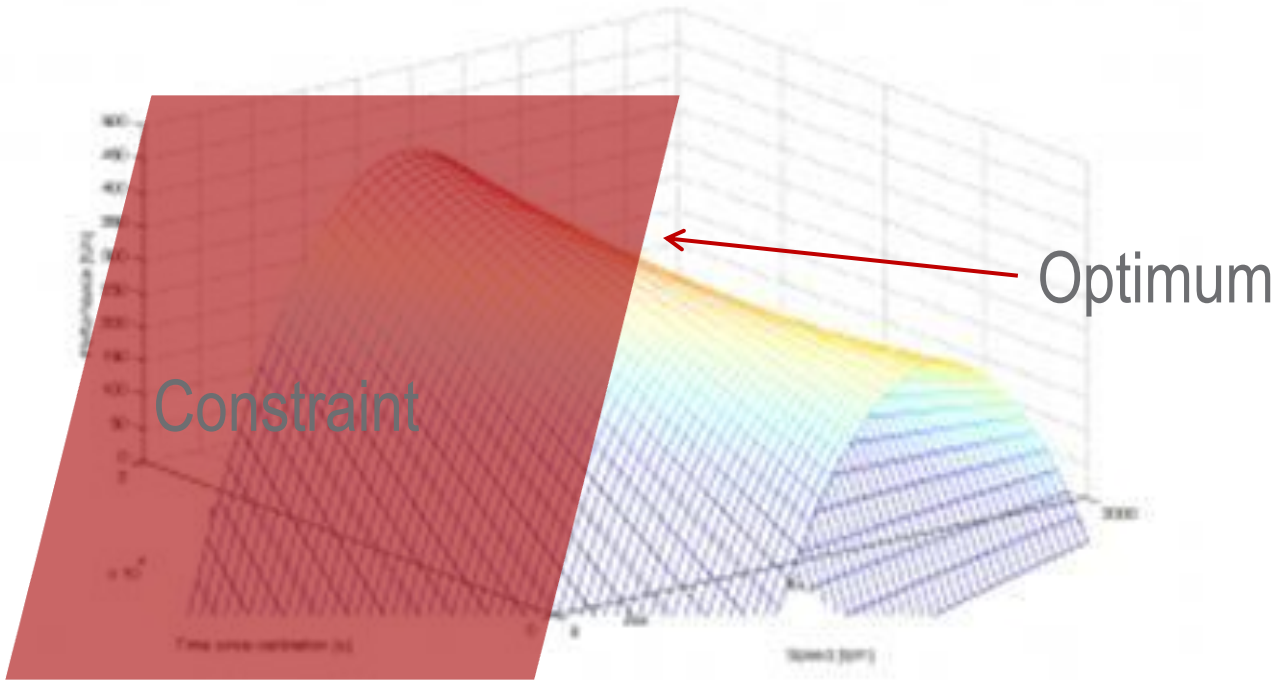
Necessary components:

- A Steady-state process model
- Economic information (e.g., prices, costs
- A performance Index to be maximized (e

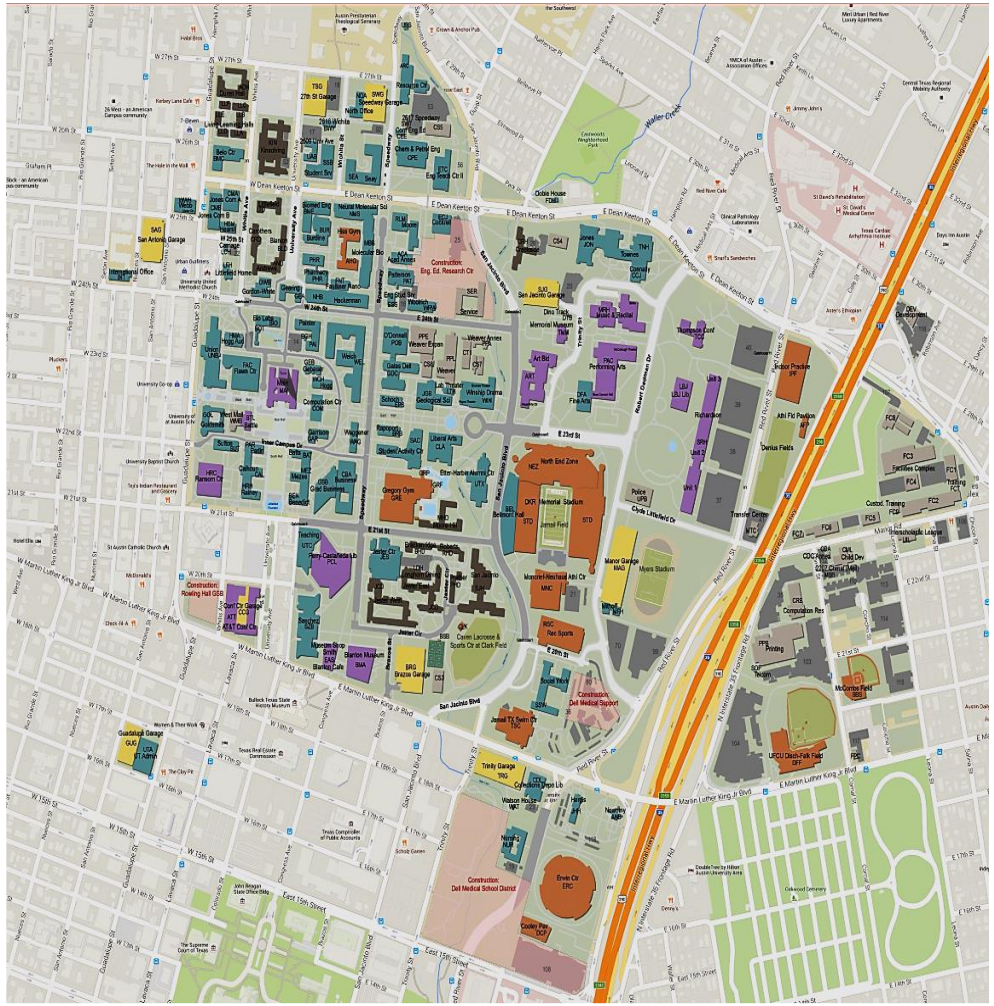
Common Types of Optimization Probler

- Operating Conditions – equipment load, storage usage and recycle
- Allocation – equipment dispatch
- Scheduling – equipment start-up and shu

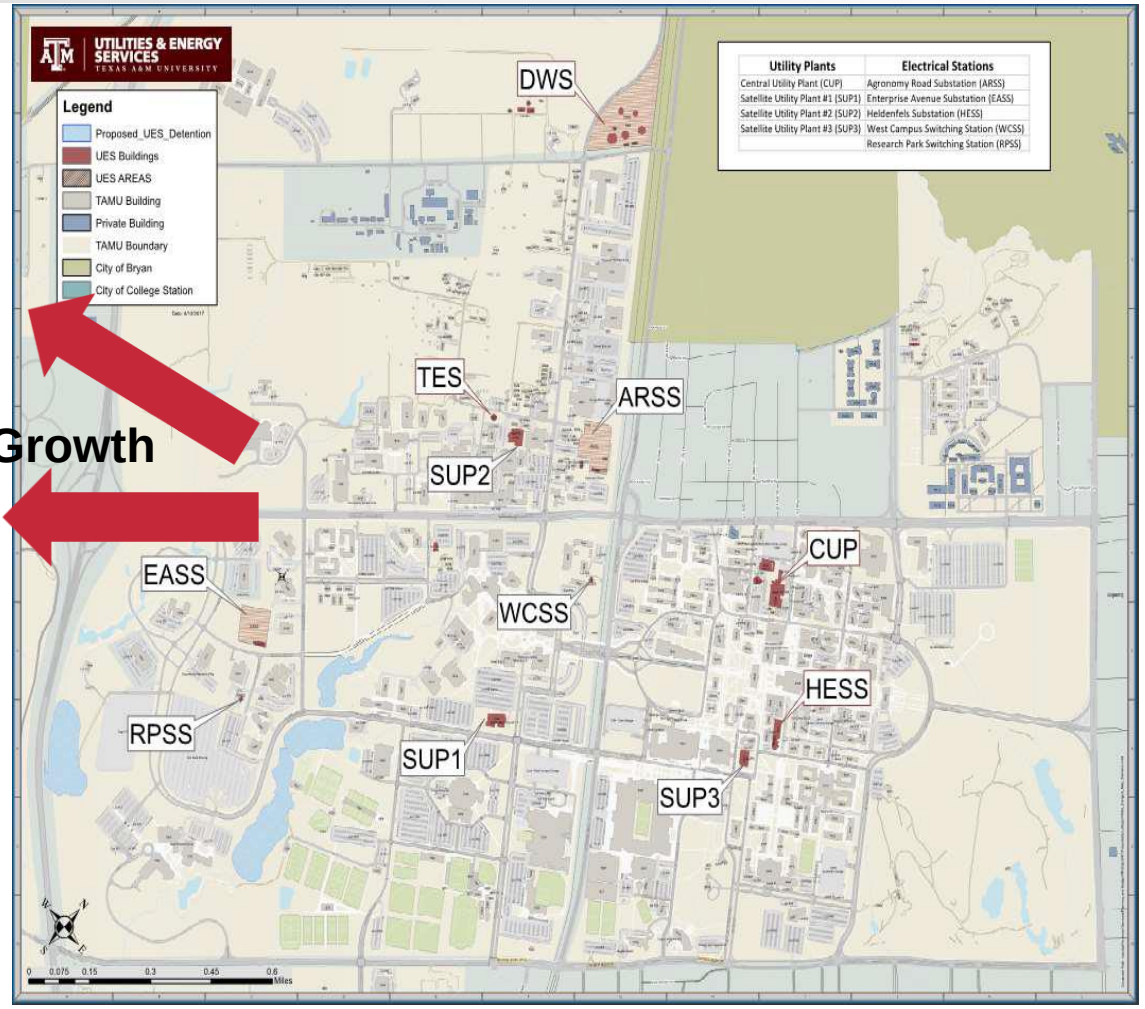
Plant Economic Model



Expansion of Universities



Growth



25 x 25 Engineering
Over 68,500 students with 11,000 faculty and staff
Future 100K?

GRU South Energy Center: Existing Facilities

- Power Generation
  - 4.6 MW Solar Turbine
  - 2250 KW Cat Emergency DG
  - 500 KW Cat Black Start DG
- Steam Generation
  - 45,000 lb./hr. HRSG (CT Exhaust)
  - 30,000 lb/hr Rentech Aux Boiler
- Chilled Water Generation
  - 2 1500 Ton Trane Electric Chillers
  - 1 1200 Ton York Steam Driven Chiller
- Electrical Distribution
  - Two Utility Connections
  - 12.47 KV Medium Voltage Switchgear
  - 480 V Low Voltage Switchgear
  - 480 V Motor Control Centers

GRU South Energy Center: Phase 2 Expansion

- Power Generation
  - 1 New 7.4 MW Wartsila Reciprocating Engine
  - 1 New 3 MW Caterpillar Emergency Diesel Generator
- Steam Generation
  - 1 New 8,600 lb./hr. HRSG (Recip Exhaust)
- Chilled Water Generation
  - 1 New 3000 Ton Trane Electric Chiller
- Hot Water Generation
  - 1 New Plate & Frame Recip Engine Heat Exchanger
  - 1 New Shell & U-Tube Steam Heat Exchanger

Case Study – Hudson Yards

Hudson Yards' Microgrid Details:

- Energy producers – CHP Plant, Four natural gas reciprocating engine generators ~ 3MW each coupled with four absorption chillers to maximize efficiency
- Energy consumers – Residential, office and commercial space at Hudson Yards
- Controls
  - Balance of Plant (BOP) controller (thermal) - chilled water, hot water, condenser water, fuel gas, etc..
  - Power Management System (PMS) controller (electric) – electrical breaker control, generator speed, etc..
- Microgrid breakers, collector bus, power distribution

Providing Critical Infrastructure

Academy of Advance Manufacturing

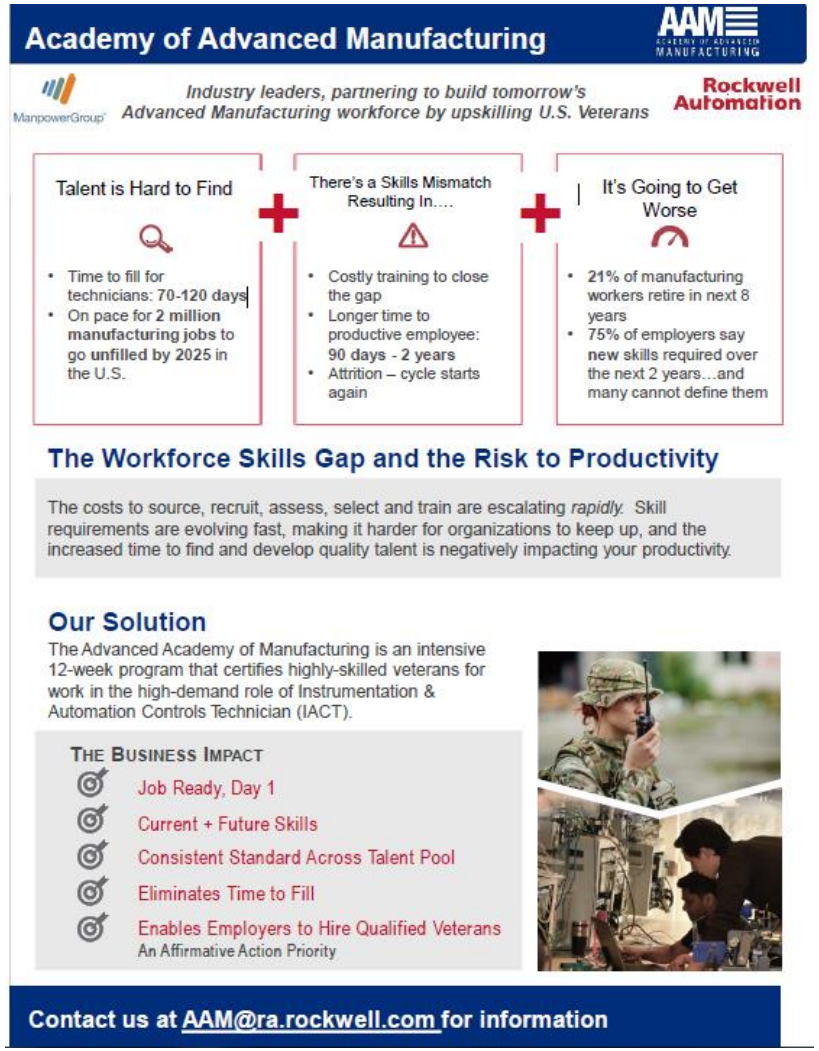
The Skills Gap is Widening Bringing Unique Challenges to the Owners/Operators

*Every job in manufacturing creates another 2.5 jobs in local goods and services.**

*78% of manufacturing leaders believe the talent gap will hurt their ability to adopt new technologies and increase productivity.**

More than 1M new engineers are needed globally in the next 5 years.⁺

*Over the next decade, more than 3.5M US manufacturing jobs will be needed. 2M are expected to go unfilled.**



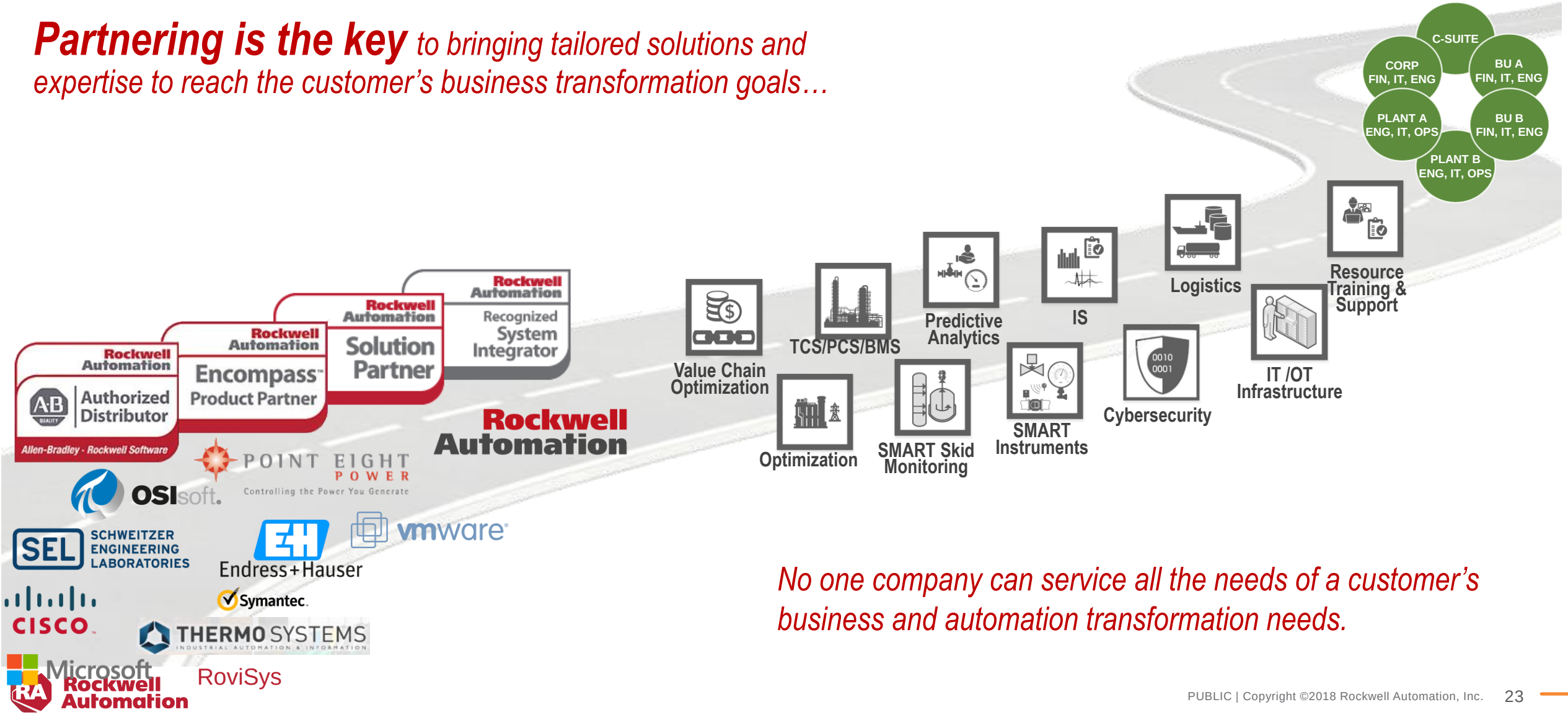
The Way People Work and Interact with the Process Has Changed.

⁺World Bank

*Deloitte Analysis on BLS Data

Partnering and Best in Class

Partnering is the key *to bringing tailored solutions and expertise to reach the customer's business transformation goals…*



No one company can service all the needs of a customer's business and automation transformation needs.

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Thank you

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