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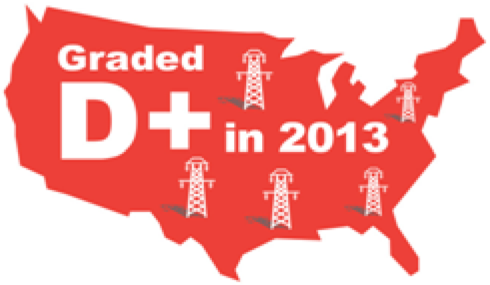
Honeywell Microgrid and Enabling Technologies

Date: Sept 27, 2013

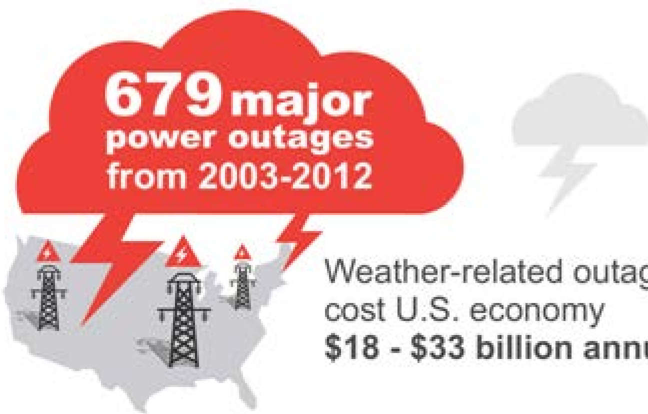
The Case For Micro-Grids

Heavily burdened, aging electrical grid



Some of the country's existing electrical infrastructure **dates back to late 1800s**

The toll of power disruptions



Weather-related outages cost U.S. economy **$18 - $33 billion annually**

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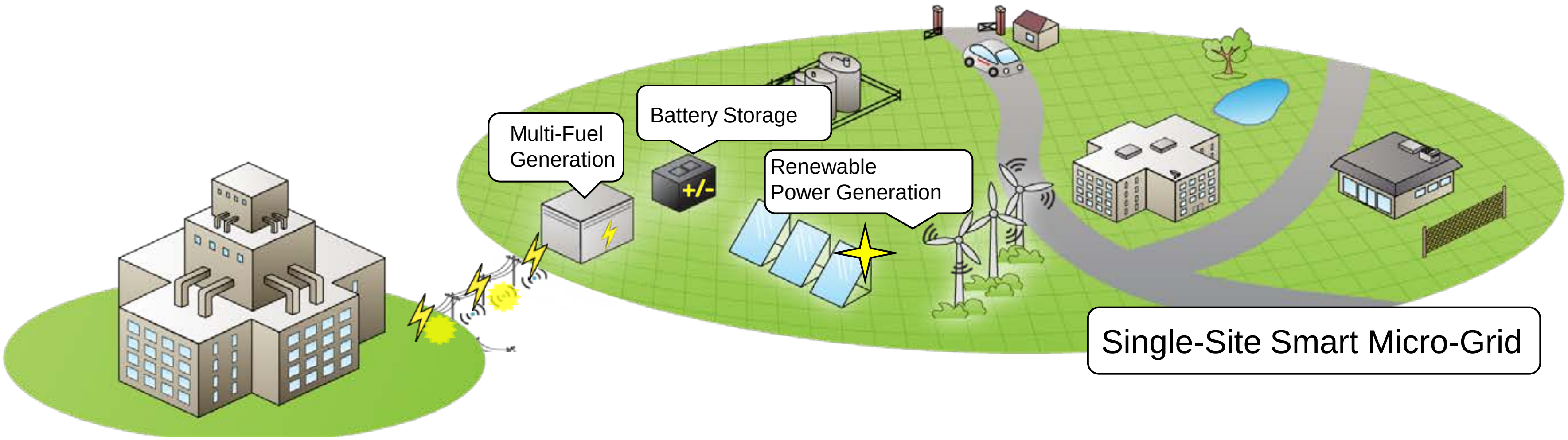
Definition Of MicroGrid



"Intelligent management of local (electric) power generation supplying local (electric) loads"

- Local Power Generation
- Co-exist with the utility
- Can operate totally independent of utility grid (islanding capability)
- Ability to manage and control your local load

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What Makes a Good Candidate

- Need for energy reliability, security and economy
- Customers who primarily need to interface with a utility grid and have islanding capability to support critical functions when necessary
  - *University & College Campuses*
  - *Fixed Military Installations/Bases*
  - *Commercial Building Complexes (e.g., Industrial parks, Corporate Headquarters)*
  - *Data Centers*
  - *Hospitals*
  - *Communities With a Utility Infrastructure But Experience Power Shortages*

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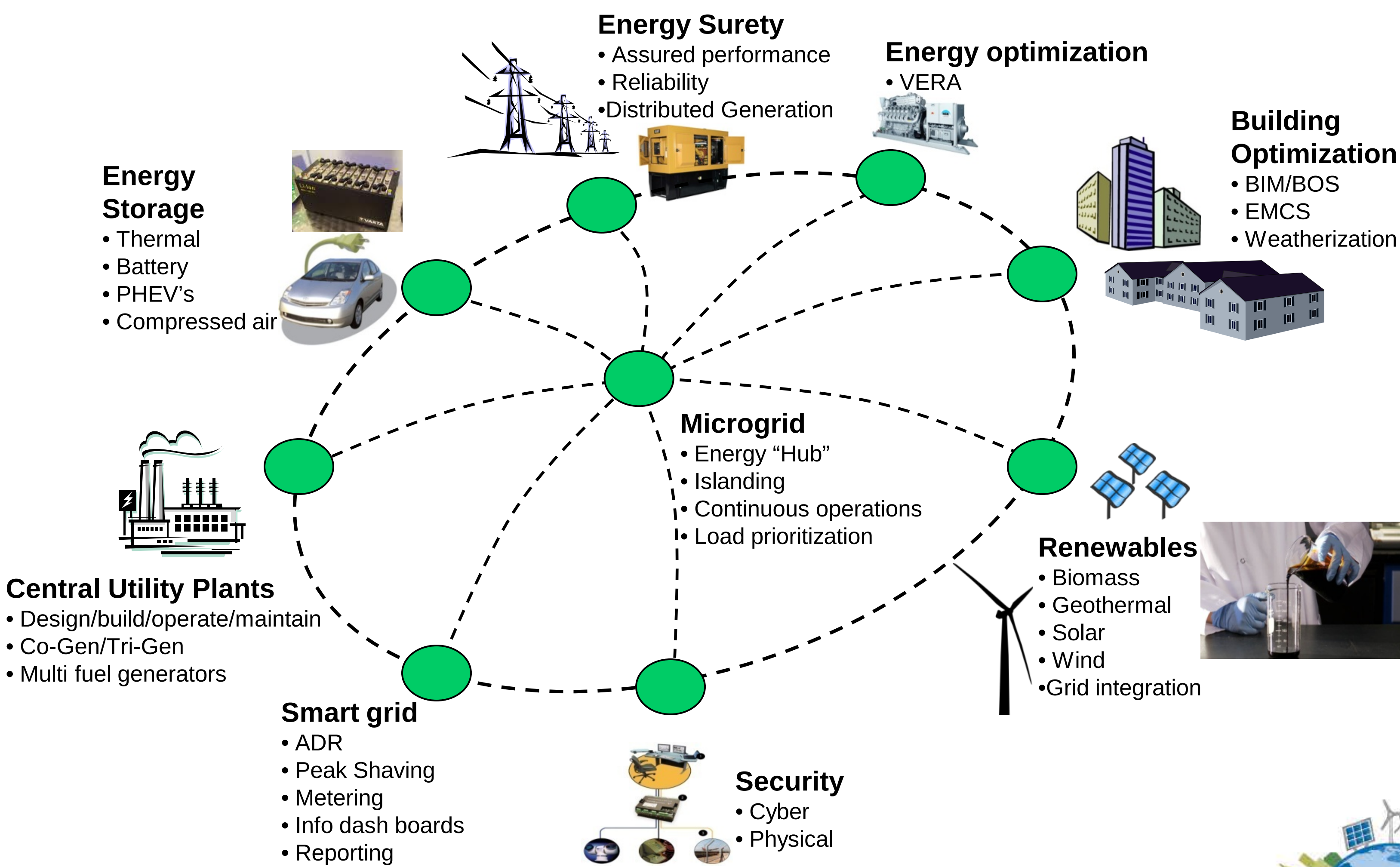
Key Micro Grid Capabilities



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Case Study - White Oak Microgrid

The Federal Research Center at White Oak, MD, is a state-of-the-art 3 million square foot, $900 million Food and Drug Administration office and lab compound built by the General Services Administration.

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Federal Research Center at White Oak Microgrid

The project involves the design, construction, & on-going operation of a 55MW Central Utility Plant Microgrid.

The White Oak microgrid provides a high level of energy surety enabling the GSA/FDA to fulfill their mission while also benefitting from the energy efficiency measures incorporated to satisfy the required electrical and thermal loads of the campus regardless of what happens to the external utility grid.

- **Construction of An Onsite Utility (CHP: Combined Heat and Power) To Produce Energy**
  - The current system operational capacity is 26 megawatts, with phase 3 (2013) taking it to 55 megawatts.
  - The existing utility infrastructure is a net exporter of electricity. It supplies more power to the utility grid than is used from the grid on an annual basis.
  - The utility infrastructure has adapted to the changing mission and changing needs of the Campus. The facility was designed to incorporate future growth with no impact to on-going operations. Programmed square footage for the White Oak campus has nearly doubled since the original master plan was developed.
- **Microgrid Provides Energy Surety**
  - GSA White Oak has operated in island mode more than 70 times between 2010-2013.
  - In the last two years the critical infrastructure has remained online 100%.
  - While buildings near the campus went dark, White Oak avoided interruption during the 2011 earthquake, the 2012 Derecho, and Hurricane's Irene & Sandy and numerous other storms…

- **Energy Efficiency Measures Provide Savings and Benefits**

Expected Annual Energy Savings:	Expected Annual Pollution Prevention:
640,000 MBtu (Current)	50,000 metric tons CO_2 equivalent (Current)
275,000 MBtu (In Construction)	22,000 metric tons CO_2 equivalent (In Construction)

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FRC White Oak Microgrid Requirements

- **Fast dependable separation from Utility instability**
  - Reliable detection of Utility deviations
  - Instantaneous separation to Island mode
  - Operation with adequate spinning reserve
  - Smooth generator transition to load sharing Island mode control
- **Fast load management for generator demand control, when required**
  - Accurate real-time generator capacity and spinning reserve assessment
  - Fast updated load measurement
  - Fast load shed of prioritized demands
  - Coordinated load restoration process
- **Synchronized transfer from island mode back to utility parallel operation**
- **Coordinated Black Start capability to Island mode operation, if required**

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White Oak Micro Grid

Definition	White Oak FDA Micro Grid
Local Power Generation	▪ 26MW power supply (currently being expanded to 55MW-65MW's to handle the installation's peak load) ▪ Leverage waste heat (CHP) to condition buildings ▪ Puts more power on the grid than it takes off
Co-exist with the utility	▪ Works in parallel with Pepco under a three-party Interconnect Agreement. ▪ Participate in demand response events ▪ Utilize spinning reserve to maintain energy surety
Can operate totally independent of utility grid (islanding capability)	Operate mission critical functions independent of Pepco, enabling FDA to continue operations regardless of what happens outside the campus
Ability to manage and control your local load	▪ Match load to supply ▪ Ability to make power purchase decisions

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ESPC I & II Major Physical Features

- 27,000 Square Foot Central Plant
- Electrical Generation
  - One – 5.8 MW reciprocating engine (dual fuel)
  - Four - 4.5 MW turbine-generators (nat. gas only)
  - One - 2.0 MW diesel black-start generator
- Chilled Water
  - Two – 1,100 Ton Absorption Chillers
  - Centrifugals (2 @ 1,100 tons + 3 @ 2,000 tons)
- Hot water
  - Three – 14 MMBtu/Hr Waste Heat Boilers
  - Three - 10 MMBtu/Hr Dual-fuel Back-up Boilers
- 25KW Fixed & 5KW Tracking PV Array

Master Plan	Square Footage	Campus Population
1997	2,100,000	6,000
2006	3,200,000	7,500

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ESPC III – Major Physical Features

- 57,000 Square Foot Central Plant
- Electrical Generation
  - Two - 7.5 MW turbine-generators (dual fuel)
  - One - 4.5 MW turbine-generator (natural gas only)
  - One - 5 MW steam turbine-generator
  - Two - 2.25 MW diesel black-start generators
- Chilled Water (3 @ 2,500 tons + 1 relocated)
- Thermal Energy Storage (2 million gal)
- Heat Recovery Steam Generators (132,000 lbh)
- Dual-fuel Steam Back-up Boiler (one 25 KPPH)
- Heating Hot Water Converters (112 MMBTUH)

Master Plan	Square Footage	Campus Population
2009	3,900,000	9,000

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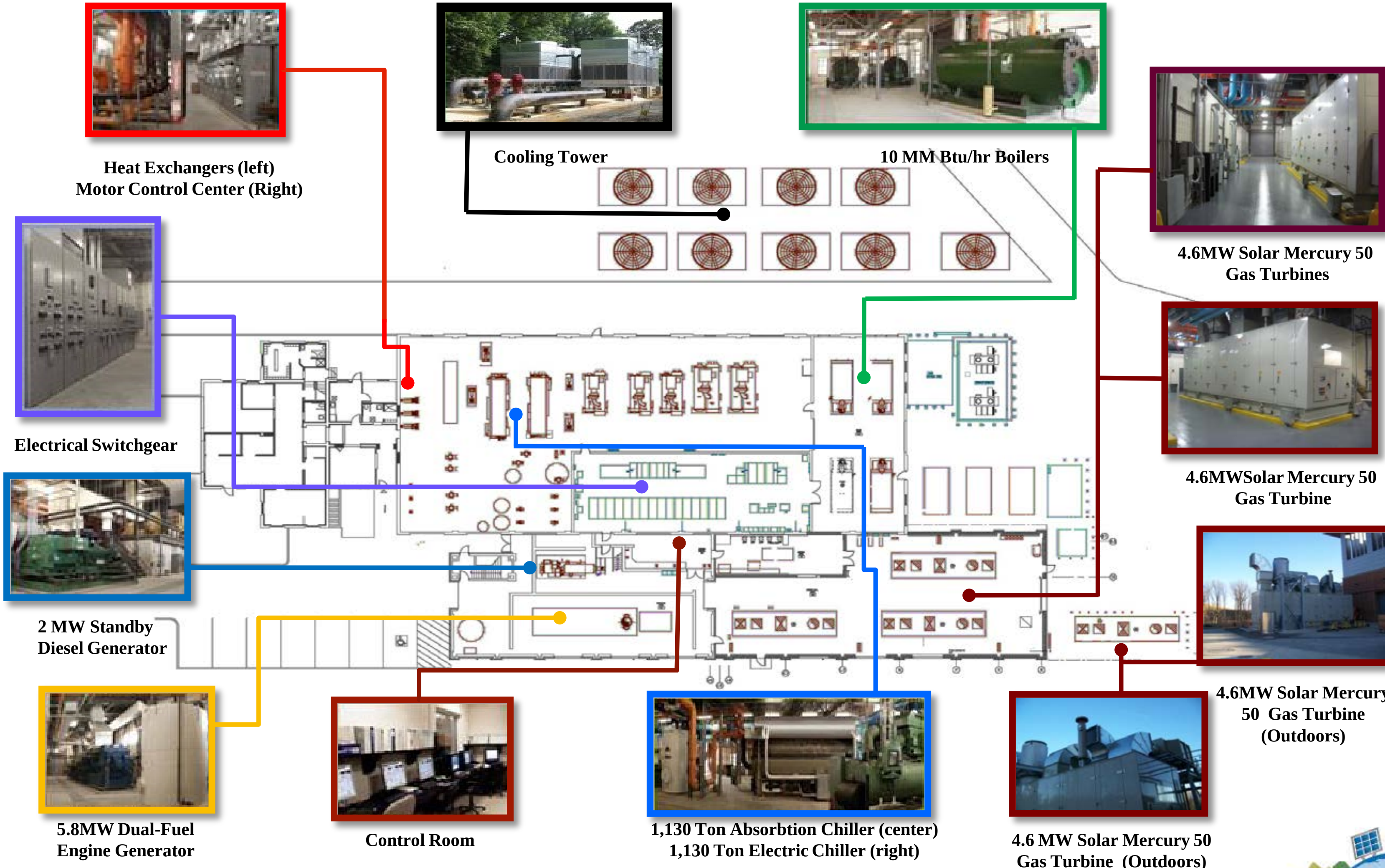
White Oak CUP 1



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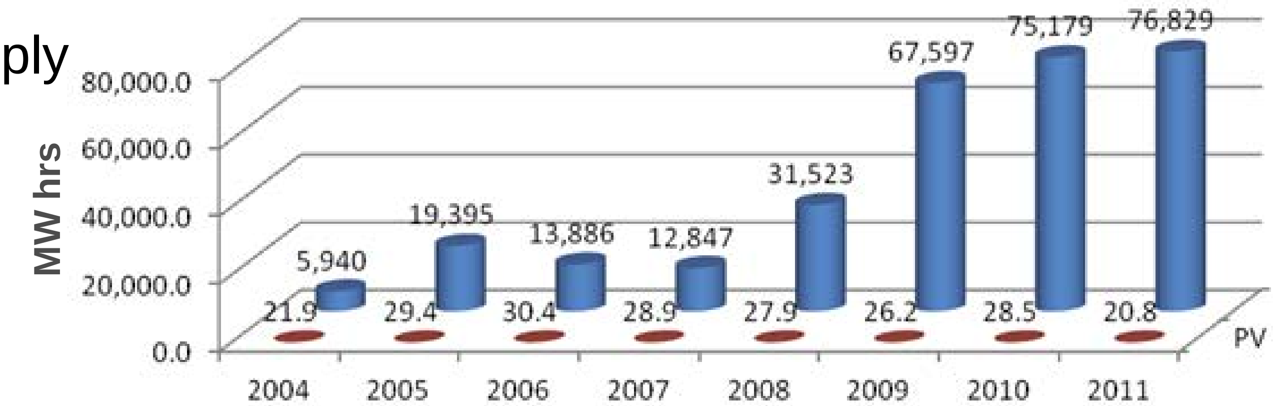
Reliability Enhancements

- Utility Service Enhancements
  - Physical and Functional Separation of Utility Generation Systems
  - Electrical Bus Ties between Central Utility Plants (CUP) 1 and 2
  - Dual Distribution Loop for redundancy
- Two additional Black Start Generators
- CUP and Building Level Load Shed
- Thermal Energy Storage
  - Electrical load shed of chillers
  - Backup water supply

Electricity Produced
Blue -CUP generators
Red - photovoltaic arrays



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Reliability Metrics

Uptime	Uptime over the last 12 months is > 99.999%.
Redundancy	Redundancy provided for all critical systems.
Island Mode	Islanded, either automatically or manually, 70 times over the past 36 months. Operations have not been interrupted for any weather
Power Generation	On a yearly basis more power is supplied to Pepco than Pepco supplies to the White Oak Campus.

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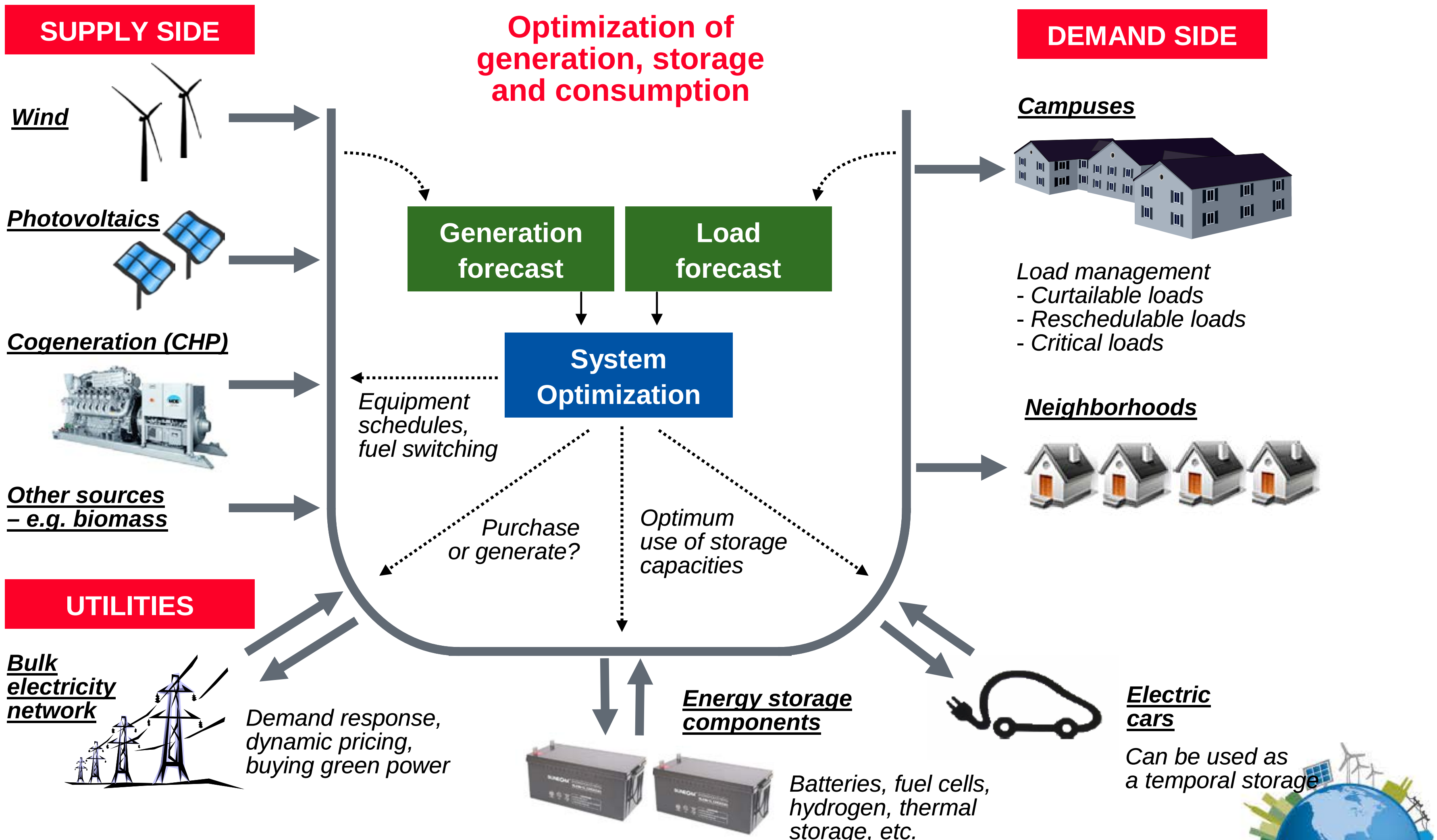
Microgrid Optimization

Microgrids with more than just reactive approach



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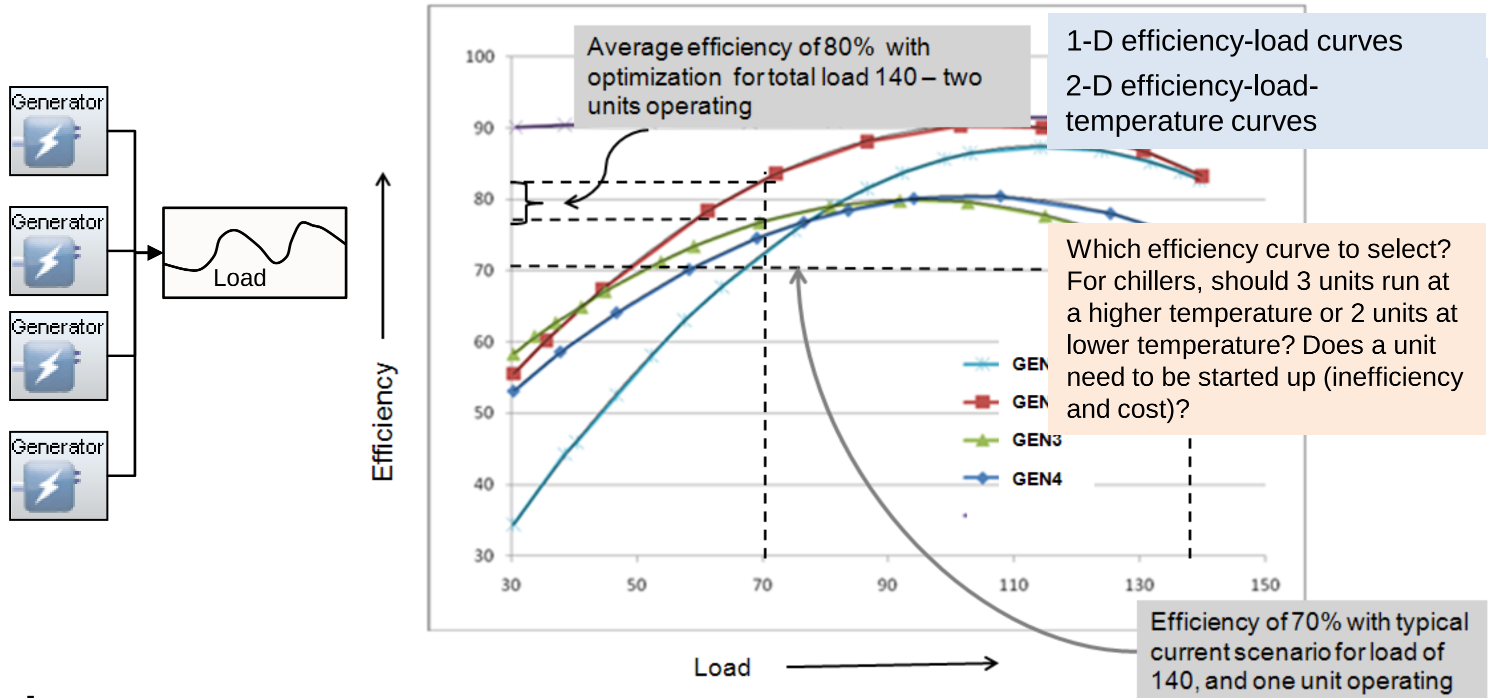
Why Automated Optimization?



Motivation

- Maximize ***economy*** of energy usage (energy composition costs, energy market buy/make/sell dynamics)
- Minimize total emissions and energy usage
- Minimize fuel usage (e.g., diesel in remote locations)

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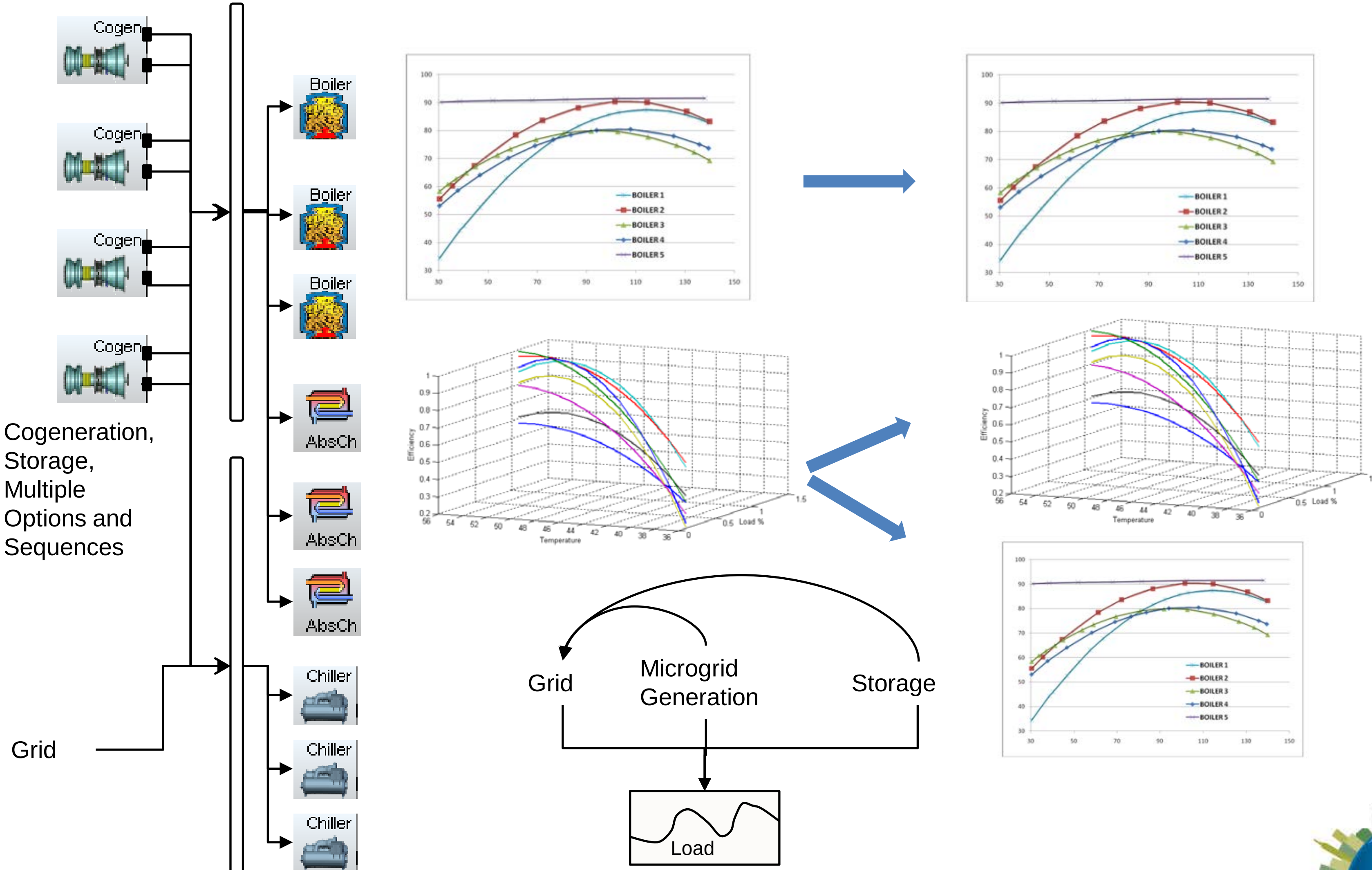
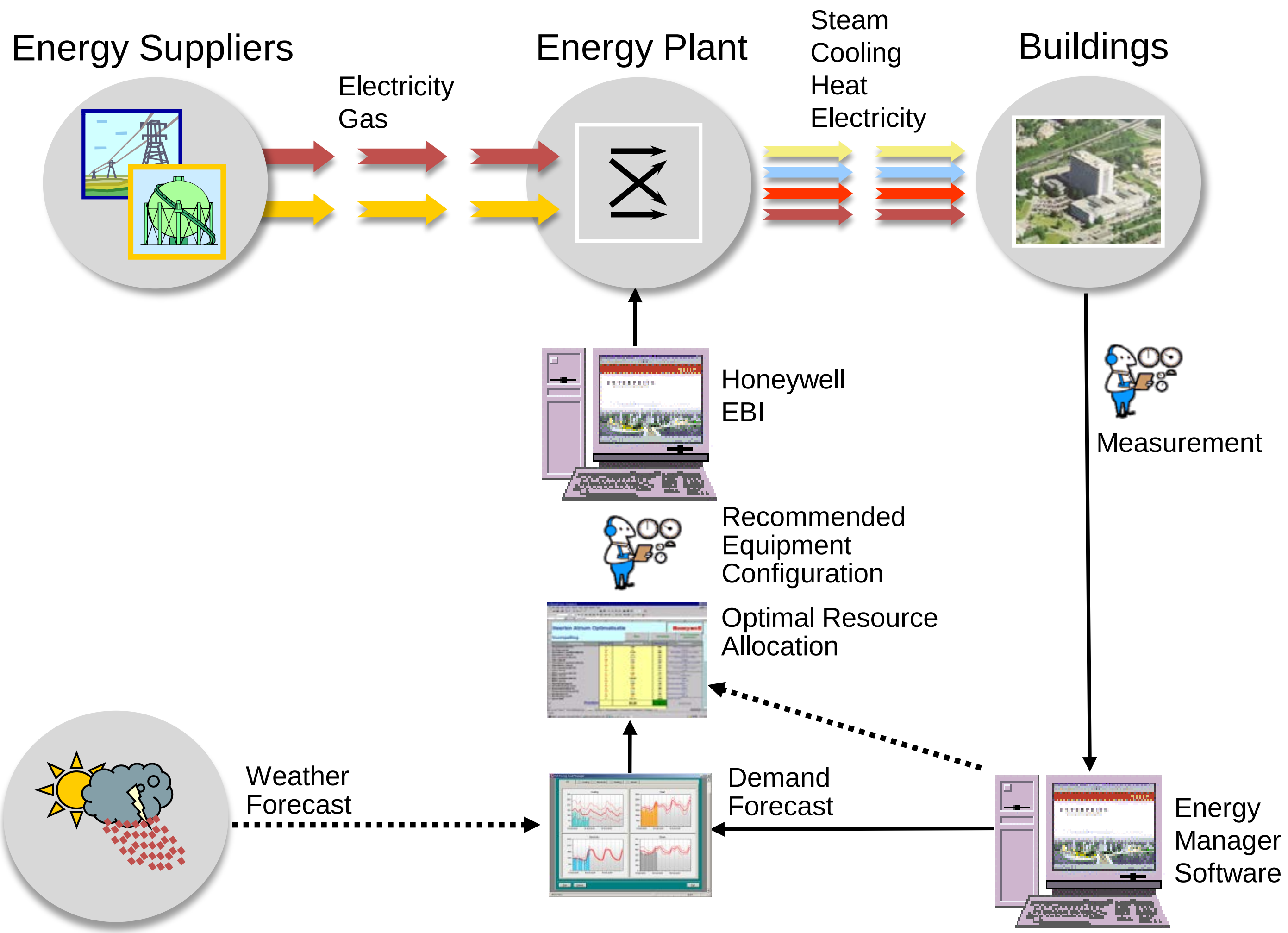
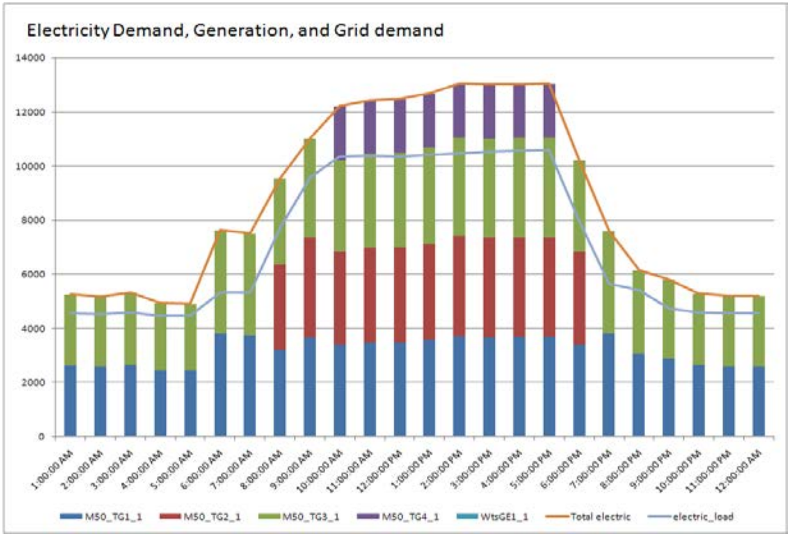
Optimization–Additional Complexity

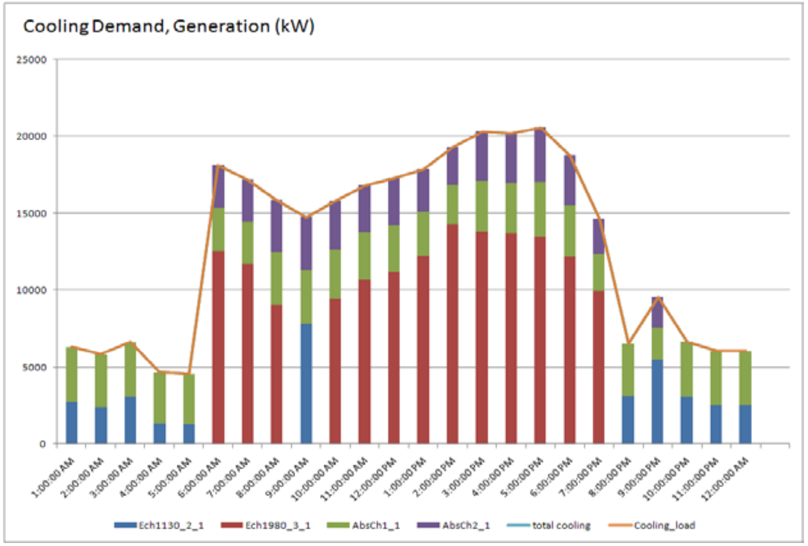


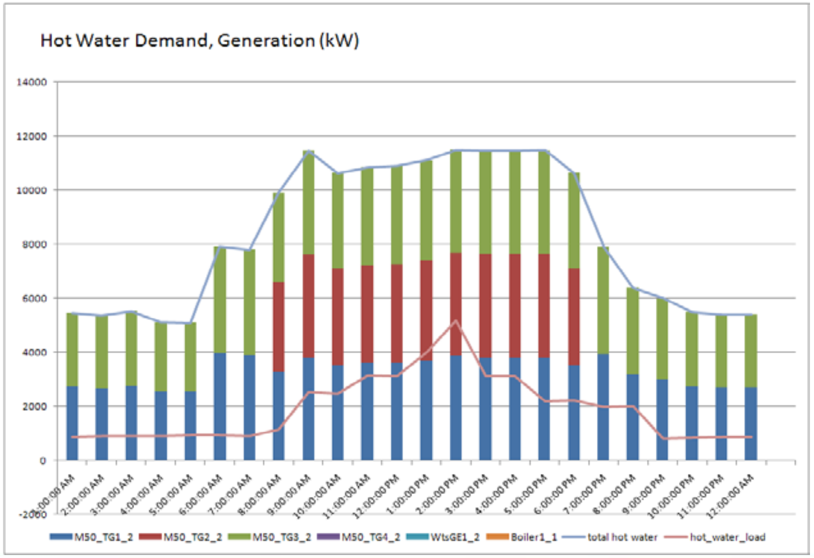
Microgrid Optimization and Control



Schedules for Electricity, Cooling and Hot Water







Scenario: Islanded mode of operation; grid sell and buy disabled

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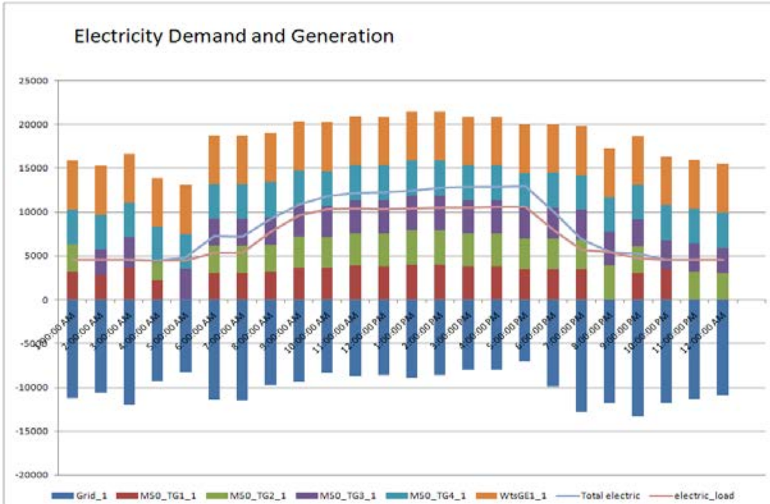
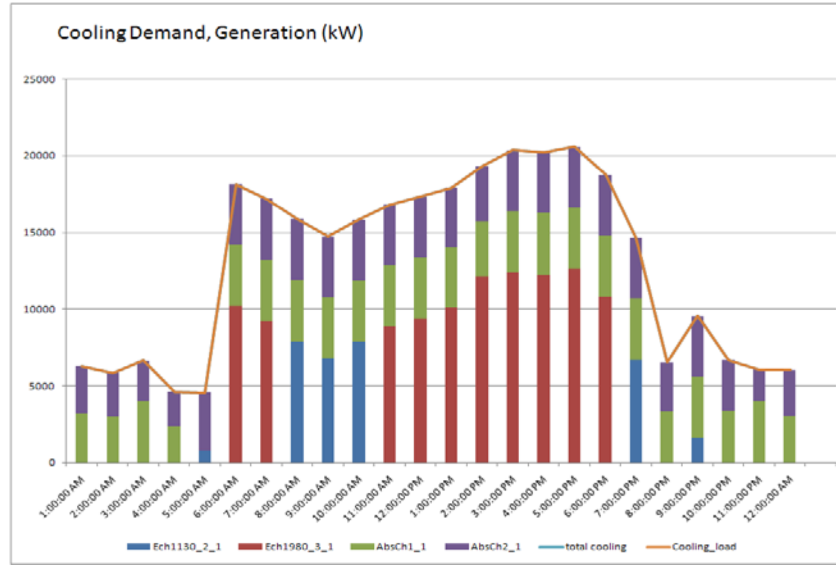
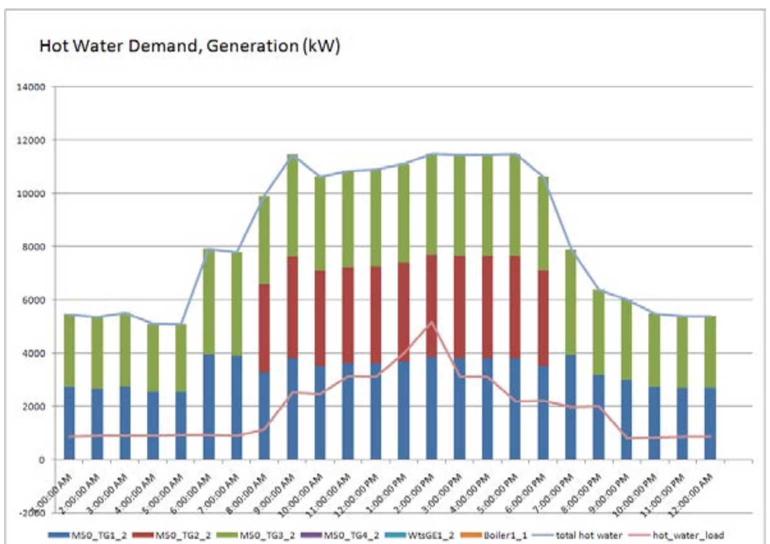
Schedules for Electricity, Cooling and Hot Water







Scenario: Grid connected; grid sell and buy enabled

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Key Elements for Successful Micro Grids

- **Micro Grids are a key element forming part of an overall energy strategy**
  - Advanced Controls and Optimization – consider all energy flows
  - Distributed Generation
  - Enable Alternative Generation – CHP, Renewables
  - Energy Efficiency
- **Micro Grid technology is available now and is maturing rapidly**
  - Can be built up in stages at any specific site
- **Three questions will define the pace of deploying micro grids**
  - Is the current power generation and distribution system adequate for future growth?
  - Financial – does it make financial sense to build, operate and maintain a microgrid?
  - What are the impacts of not implementing a microgrid solution?

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EXTRA

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The Benefits

- **Annual Energy Savings**
  - Current: 640,000 MMBtu
  - Under Construction: 275,000 MMBtu

30% Reduction from Baseline

- **Pollution Prevention (annual)**
  - Current: 50,000 metric tons CO_2-equivalent
  - Under Construction: 22,000 metric tons CO_2-equivalent

15,000 Cars Removed from Road

- **Co-Generation reduces GSA NCR Demand**
  - Response during “Gold Days” (approximately 22 MW currently; nearly 33 MW post-ESPC III Base)

$3M in Demand Savings and Program Participation

- **Rainwater Harvesting**
  - Makeup water for cooling towers

Good water stewardship

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Four Steps Of A “Smart Micro Grid” Approach

Traditional Efficiency Improvements	• Building Management System • HVAC Upgrades • Building Envelope Improvements • Usage transparency through (advanced metering) • Lighting retrofits
On-site Generation and Storage Capacity	• Gas turbines • Diesel generators • Power storage (thermal, electric) • Renewable energy (PV, wind turbines) • Electric vehicle infrastructure
Implement Advanced Controls	• Demand response programs • Balance system supply and demand • Optimization of power system based on performance metrics • Interconnection with the BMS system to balance loads and generation
Operate with Utility Grid or in Island Mode	• Automatic connect and disconnect from main grid to meet specific performance outcomes

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