Solar + CHP
Increased Resilience, Sustainability & Productivity

Mark Feasel
VP, Smart Grid
Schneider Electric
More ELECTRIC

2x faster growth of electricity demand compared to energy demand by 2040

Source: IEA WEO

More DIGITIZED

10X more connected devices than connected people by 2020

Source: Internet World Statistics, McKinsey

More DECARBONIZED

86% of investments in power generation through 2040 will be in zero-carbon fuels

Source: BNEF 2017

More DECENTRALIZED

12% of generating capacity from distributed generation in 2025 of which solar will be 65%

Source: Frost & Sullivan
New Energy Landscape
Data demystifies energy, unlocking new ways to optimize energy and meet business objectives

- Consumer-Centric
- Load-Centric
- Flexible, Modular, and Scalable

Microgrid is about making wise choices at the intersection between energy smartly acquired, locally produced and efficiently consumed
Integrated Energy Outcomes
Historically passive consumers are thinking about energy in new ways

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**Cost**
- Lower / More Predictable Energy Costs
- Energy / Fuel Source Arbitrage
- Flexibility drives savings / incremental revenue

**Resilience**
- Serve loads during times of grid stability
- Oasis for employees / customers – shelter in place
- Protect power sensitive / critical assets from poor power quality

**Sustainability**
- Reduce carbon footprint
- Improve brand image
- Attract / Service carbon sensitive customers
## Integrated Energy Outcomes

Supply mix considerations

<table>
<thead>
<tr>
<th>Technology</th>
<th>Electrical Output</th>
<th>Emissions</th>
<th>Load Following Ability</th>
<th>Technology Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas Reciprocating Engine</td>
<td>Synchronous</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>Inverter</td>
<td>Low</td>
<td>Low-Medium</td>
<td>Medium-High</td>
</tr>
<tr>
<td>Microturbine</td>
<td>Inverter</td>
<td>Low</td>
<td>Medium-High</td>
<td>Medium-High</td>
</tr>
<tr>
<td>Gas Turbine</td>
<td>Synchronous</td>
<td>Low</td>
<td>Medium-High</td>
<td>High</td>
</tr>
<tr>
<td>Diesel Reciprocating Engine</td>
<td>Synchronous</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Battery Energy Storage</td>
<td>Inverter</td>
<td>Zero</td>
<td>High</td>
<td>Low-Medium</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Inverter</td>
<td>Zero</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Wind Turbine</td>
<td>Inverter</td>
<td>Zero</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
Orchestrating a Diverse Supply Mix

Get used to it!

Diverse DER are complementary

PV and storage rightly make headlines

- Combined, they represent 30% of new annual microgrid capacity today, forecast to grow to 54% in 2026

However, fossil incumbents play key roles

- Long duration dispatchable power for windless winter stretches; see Hurricanes Sandy (2012) and Harvey (2017).
- Energy density: gensets can deliver 4,500 times more energy per square foot than PV.
- Fuel price volatility and carbon emissions are significant risks/barriers, but both can be mitigated.
Catalysts for a New Energy Landscape in the US

1. Levelized Cost of Energy at or below Grid Parity (Deutsche Bank)
2. Credits for Net Excess Generation – Net Metering (DSIREUSA)
3. Aggregated, Virtual, or Community Net Metering (NCSL.org)
4. Prone to Power Outages / Severe Weather (US Blackout Tracker)
5. High MWs per Net Meter (EIA-826)
6. Forecasted Growth in non-Resi Solar PV systems (GTM)
7. Potential for Self-Supply (ScottMadden Mgmt Consultants)
Case Study: Montgomery County, Maryland

Approximately **1M people**

**High-tech, knowledge-based economy**

400+ facilities, 9M sq ft of real estate, 3k vehicles, 9k employees

**Leader in Advanced Energy**

- 11 megawatts of solar across 18 sites
- One of the largest green power purchasers in the US, acquiring more than 430,000,000 kWh of clean energy annually
- Procure 100% clean energy for County facilities
- Inaugural Partner in the U.S. DOE’s Combined Heat and Power for Resiliency Accelerator
Challenges

- **Better Resilience**
  - February 6, 2010 – snowstorm 108,000 without power in Montgomery County. Almost 10,000 in Montgomery County still without power after three days.
  - June 29, 2012 – Derecho, ¼ million without power in Montgomery County, Over half a million regionally. 71 County facilities without power, 550 traffic signals out, over 8 days for some residents.

- **Higher Sustainability**
  - Valued by constituents: Jobs, taxes, quality of life

- **More Predictable Energy Costs**
  - Capital Procurement not an option
  - Variable energy costs difficult to budget

- **Without exposing County to new risks**
  - Technology risk
  - Rebate, Tax Credit & Incentive uncertainty
  - Approach new to utilities and permitting officials
  - Difficulty in constructing “in situ”
The Solution

- Improve the resilience of county operations with majority of energy local produced and ability to island > 7 days without grid support
- Upgrade existing aging electrical infrastructure without capex
- Control energy cost exposure
- Reduce greenhouse gases and other emissions
- Provide a contract vehicle to peer jurisdictions
- Structured as a P3 built upon an enhanced Power Purchase Agreement
- Competitively solicited as energy supply + other tech
  - Schneider Electric selected as the energy performance contractor/prime.
  - Duke Energy Commercial Renewables provides capital and owns the system for 25 years
  - REC Solar Canopy construction

Public Safety Headquarters

- Large electrical upgrades
- New 2 MW Solar
- Load management with BAS
- New Cogen
- Integrate Existing gas generator
- DC fast charging
- Improved HVAC

Montgomery County Correctional Facility

- Minor Electrical Upgrades
- New 250 kW Cogen
- Integrate existing Diesel
- Potential future canopy installation over parking
Energy as a Service
Delivering integrated energy outcomes in an off balance sheet – performance driven model

- With energy technology, regulation, and business model in flux, a solution for delivering energy outcomes is much more than a question of finance.

- Energy as a Service not only addresses financial aspects but efficiently transfers the risks associated with new technology, shifting regulation and incentives, and asset operation and optimization to others whose business models are setup to mitigate them – without sacrificing governance.

- It provides a single point of accountability for project delivery across design, financing, construction, operations & maintenance.

- Inherent is the ability to enforce standards for construction quality and service performance.

Clear risk transfer and alignment of objectives
How Do we Quantify the Value?

USGBC PEER Standard

- Independent assessment of performance
- Certified Sustainability Rating from USGBC
- Independent assessment of project value
- Basis for case studies and marketing materials
- Recognition by GBCI and USGBC and candidate for **Annual Galvin Award**
## Overall PEER Score — 97%

<table>
<thead>
<tr>
<th>Performance Categories</th>
<th>Max Points</th>
<th>Estimated Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEER Estimated Total Score</td>
<td>300</td>
<td>292.2</td>
</tr>
<tr>
<td>Energy Efficiency and Environment</td>
<td>100*</td>
<td>100</td>
</tr>
<tr>
<td>Reliability and Resiliency</td>
<td>100*</td>
<td>98.7</td>
</tr>
<tr>
<td>Operational Effectiveness</td>
<td>100*</td>
<td>93.5</td>
</tr>
</tbody>
</table>

* Able to achieve 100 leveraging bonus points

### Additional Value Streams
- Water savings of $5 million
- Reliability and resiliency
- Reduction in power quality events – low voltage, voltage imbalance – that damage equipment
- Insurance cost reduction

### Finding Additional Savings or Profits
- Leverage external service for economic dispatch
- 2MW plus solar of excess generation
- Capacity avoidance and sales- ~$140K
- Export power - ~$150K
## Reliability and Resiliency

**PEER Score 98.7 out of 100**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Benchmark</th>
<th>Project Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAIDI, min</td>
<td>181</td>
<td>2</td>
</tr>
<tr>
<td>SAIFI</td>
<td>1.2</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**Protected Equipment**
- Exposed overhead lines
- Electrical system is underground and enclosed, sump pumps protect equipment in basement

**Redundant Supply**
- Two overhead feeds from same substation
- Local generation 2x peak demand, redundant site substations with a cross tie

**Redundant Site Distribution**
- Four of the six site distribution panels have redundant distribution feeds and auto-transfer from the redundant on-site generation bus
- No change to site distribution

**Islanding Capability**
- None
- Black start, auto-restoration

## Energy Efficiency & Environment

**PEER Score 100 out of 100**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Benchmark</th>
<th>Project</th>
<th>Benefits</th>
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</thead>
<tbody>
<tr>
<td>Power Efficiency (MMBtu/MWh)</td>
<td>10.5</td>
<td>4.2</td>
<td>Saved 64,000 MMBtu, equivalent to 560 Net Zero Homes</td>
</tr>
<tr>
<td>CO₂ (lbs./MWh)</td>
<td>1,330</td>
<td>460</td>
<td>Saved 4,500 tons, equivalent to removing 850 passenger vehicles</td>
</tr>
<tr>
<td>NOₓ (lbs./MWh)</td>
<td>1.4</td>
<td>1.7</td>
<td>None</td>
</tr>
<tr>
<td>SO₂ (lbs./MWh)</td>
<td>2.5</td>
<td>0.07</td>
<td>Saved 13 tons</td>
</tr>
<tr>
<td>Water (gal/MWh)</td>
<td>540</td>
<td>73</td>
<td>Saved 5 million gallons</td>
</tr>
<tr>
<td>Waste (% recycled)</td>
<td>38%</td>
<td>99%</td>
<td>58% reduction in solid waste to landfills, specifically coal ash</td>
</tr>
</tbody>
</table>
## Operational Effectiveness

PEER Score 93.5 out of 100

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<tr>
<th>Metric</th>
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<th>Project</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Savings</td>
<td>NA</td>
<td>$66/MWh</td>
<td>$680,000 in annual savings</td>
</tr>
<tr>
<td>System Energy Efficiency (SEE)*</td>
<td>47%</td>
<td>117%</td>
<td>Saved 100,000 MMBtu or 875 net-zero homes</td>
</tr>
<tr>
<td>Demand Response Capability</td>
<td>15%</td>
<td>160%</td>
<td>Reduce demand on electricity systems</td>
</tr>
<tr>
<td>Load Duration Curve</td>
<td>40%</td>
<td>67%</td>
<td>Increased asset utilization</td>
</tr>
<tr>
<td>Waste Identification &amp; Failure Analysis</td>
<td>NA</td>
<td>Process for Both</td>
<td>Process for minimizing waste and addressing failures</td>
</tr>
</tbody>
</table>

*SEE = \( \frac{Total \ energy \ delivered \ (electric, \ cooling \ & \ heating)}{Total \ fossil \ fuel \ consumed} \)