Industrial Microgrids for Energy Savings

Using Distributed Generation Assets to Reduce Utility Spend

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HOMER International MICROGRID Conference | 8th Annual | #HIMC2020

02.September.2020

A Rolls-Royce solution

The Rolls-Royce vision

Rolls-Royce pioneers cutting-edge technologies that deliver the cleanest, safest and most competitive solutions to our planet's vital power needs.

Agenda

01 **Microgrid Design**

02 **Case for Microgrids**

03 **Industrial Case Study**

01

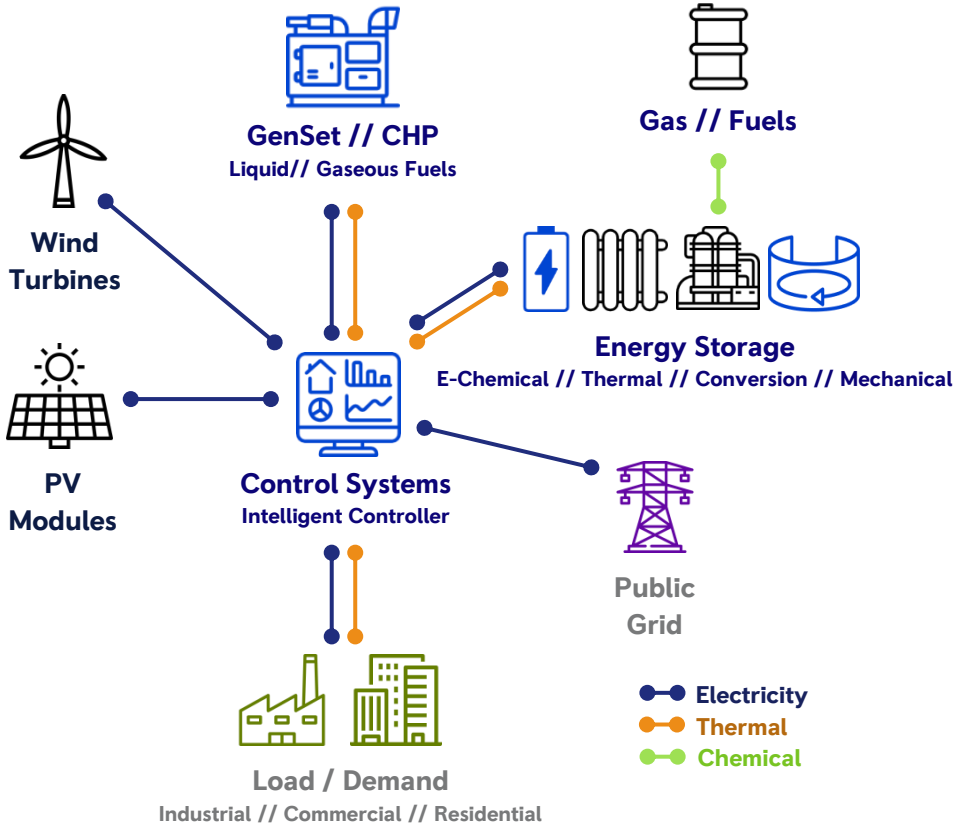
Microgrid Design

Components of a Microgrid

A Rolls-Royce solution

Microgrid Design

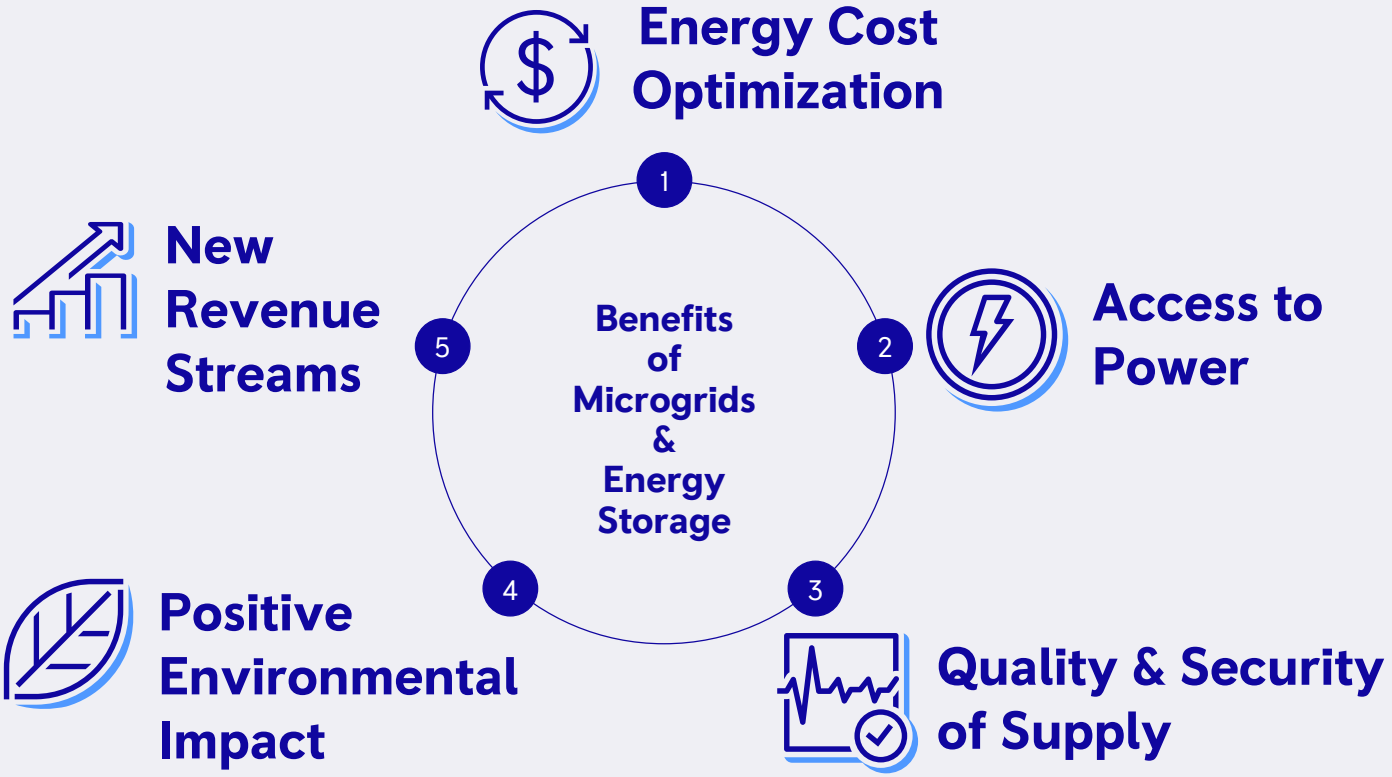
Key Components of a Microgrid



Is a Technical & Economical Solution ....

- **to satisfy an Energy Demand:**
  - Electrical, Thermal, or a Combination of both
  - Grid Connected or in Island Mode
- **w/ Distributed Energy Resources (DER):**
  - Conventional (i.e. Diesel / Gas GenSets)
  - Renewables (i.e. Wind Turbines & Solar PV)
- **w/ Energy Storage Systems**
  - Electrochemical (BESS)
  - Mechanical (Flywheels)
  - Thermal (i.e. Hot Water)
  - Energy Conversion (i.e. Power-to-X)
- **w/ Control Systems**
  - for Optimized and Intelligent Energy Dispatch
  - w/ or w/o Dynamic Control (Smart Grids)

Microgrids Design



Microgrids and Energy Storage can be one Answer

Energy Cost Optimization

- Electricity Cost Reduction
- Fuel and O&M Cost Reductions
- Independence from Electricity Price development

Benefits of Microgrids & Energy Storage

1. Access to Power
2. Quality & Security of Supply
3. Positive Environmental Impact
4. New Revenue Streams
5. Access to Power

Microgrids and Energy Storage can be one Answer

Energy Cost Optimization

Access to Power

- Access to Electricity in Remote Areas
- Increase of Industrial Load despite Grid Limitations
- EV Charging in Urban Areas

Quality & Security of Supply

Positive Environmental Impact

New Revenue Streams

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Microgrids and Energy Storage can be one Answer

Energy Cost Optimization

Access to Power

Quality & Security of Supply

- Backup during Power Outages
- Voltage & Frequency Stabilization
- Reduction of Fuel dependence

Positive Environmental Impact

New Revenue Streams

Benefits of Microgrids & Energy Storage

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A Rolls-Royce solution

Microgrids and Energy Storage can be one Answer

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4. Positive environmental Impact
5. New Revenue Streams

- Increased Energy Use from PV & Wind: reduced Carbon Footprint
- Incentives, Tax Benefits, Fines Avoidance
- Reputation

Microgrids and Energy Storage can be one Answer

New Revenue Streams

- Revenues from Grid services & Energy markets
- Improved Marketability of Renewable Energy

Benefits of Microgrids & Energy Storage

1. Energy Cost Optimization
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4. Positive Environmental Impact
5. New Revenue Streams

Strengths and weaknesses of key microgrid components

	Wind	Solar	Gas (CCHP)	Diesel	Energy Storage
+	• No Carbon emissions • Low operation & maintenance cost • No fuel requirement	• No Carbon emissions • Low operation & maintenance cost • No fuel requirement • Retrofittable, e.g. on buildings	• Power, Heat & Cooling • Efficient • Economic continuous operation • Opportunity to use bio gas • Dispatchable • Start-time (<100s)	• Fast start time (<20 seconds) • High load acceptance • Load operation capability, down to idle • Resilience • Dispatchable	• Charge & discharge capability • Enables integration of renewables • Instantaneous power • Flexible use for various applications • Low operation & maintenance cost
−	• Reliance on wind • Not dispatchable • Visual and noise pollution • Capital cost • Large space required	• Reliance on sun • Not dispatchable • Capital cost • Large space required (greenfield sites)	• CO_2 emissions (lower than diesel) • Gas pipeline or storage required	• High operating & maintenance costs • Transport/ storage of fuel • High CO_2 emissions • Noise level	• High capital cost • Efficiency losses • Battery capacity degrades over time

Flexibility

Response Time

02

Case for Microgrids

Market Conditions for Distributed Generation

Microgrids in the Headlines

California Regulators Approve Changes to Support Microgrids as State Braces for Wildfire Season

June 11, 2020 By Matt Roberts | Leave a Comment

Microgrids are getting a boost in California with an eye toward accelerating deployments in advance of the 2020 wildfire season thanks to actions voted on today by the California Public Utilities Commission.

The commission ordered a number of short-term modifications that large investor-owned utilities must implement immediately:

Source: Microgrid Knowledge

Britain goes two months without coal for first time

Lower demand during lockdown has meant no coal was needed

By Emma Gatten, ENVIRONMENT EDITOR
10 June 2020 • 12:01am

Source: Business Insider

Australian Government Awards $13.2 million for Microgrid Feasibility Studies

June 8, 2020 By Ethan Howland | 1 Comment

Share with your followers

The Australian government has awarded about $13.2 million (U.S.) for microgrid feasibility studies as part of a growing effort to bolster grid reliability and provide electricity in unserved areas across the continent.

Analysts: China's Energy Storage Market to "Skyrocket" by 2024

Wood Mackenzie forecasts a 25-fold increase in the total installed base.

ANGEL HANG | JULY 10, 2019

China is set to become the leading energy storage market in the Asia-Pacific region by 2024. That's according to new research from Wood Mackenzie Power & Renewables.

China's cumulative energy storage capacity is projected to skyrocket from 489 megawatts or 843 megawatt-hours in 2017 to 12.5 gigawatts or 32.1 gigawatt-hours in 2024. This represents a 25-fold increase in the installed base.

Source: Green Tech Media (Wood Mackenzie)

Solar-wind-battery microgrid completed and powering remote W.A. gold mine

Sophie Vorrath 18 May 2020 0 Comments Share

A groundbreaking 56MW solar, wind and battery project built to power a gold mine in remote Western Australia has been completed, marking the largest hybrid microgrid of its kind in Australia and the first in the country to use wind-generated electricity to power a mine.

Source: Renew Economy

01 Apr 2020, 15:11 Rachel Waldholz

Germany marks first ever quarter with more than 50 pct renewable electricity

#Climate & CO2 #Renewables

Source: Clean Energy Wire

UK Struggles With Sagging Power Demand and Surging Renewables

Curtailment of U.K. wind farms surged as COVID-19 lockdowns depressed power demand. More batteries on the grid would help, but how?

JOHN PARNELL | JUNE 10, 2020

The Pen y Cymoedd wind farm in Wales.

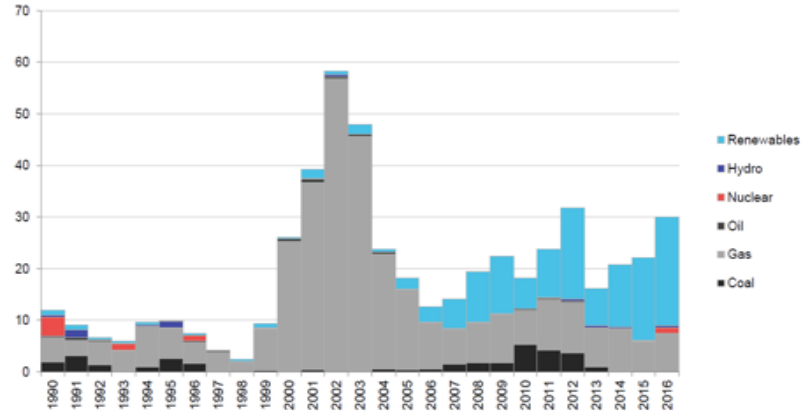
Source: Green Tech Media (Wood Mackenzie)

Canada's Prince Edward Island Plans $18.5M Microgrid to Ease Electricity Costs

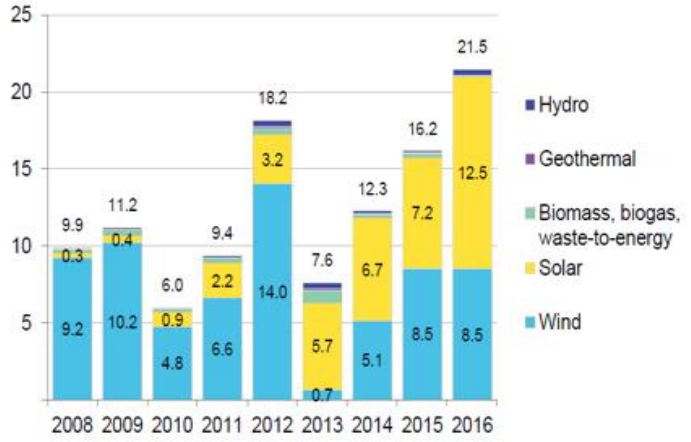
Source: Microgrid Knowledge

Case for Microgrids - Renewable Energy

Electric generating capacity build by fuel type (GW)

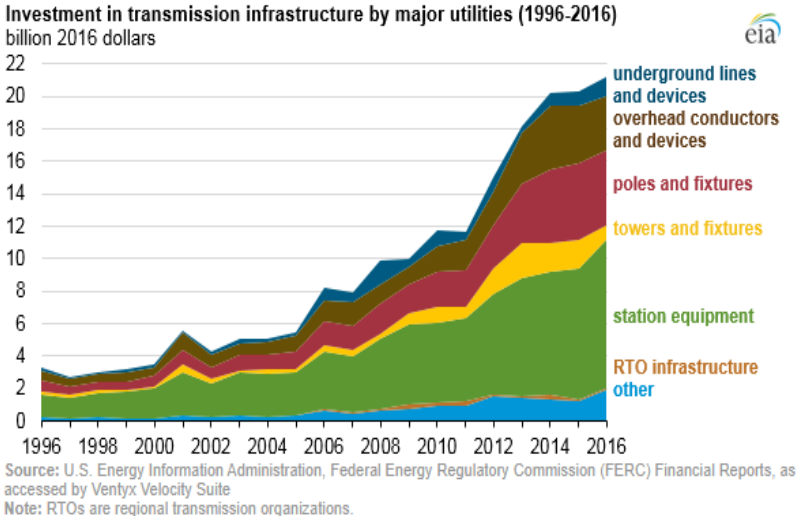


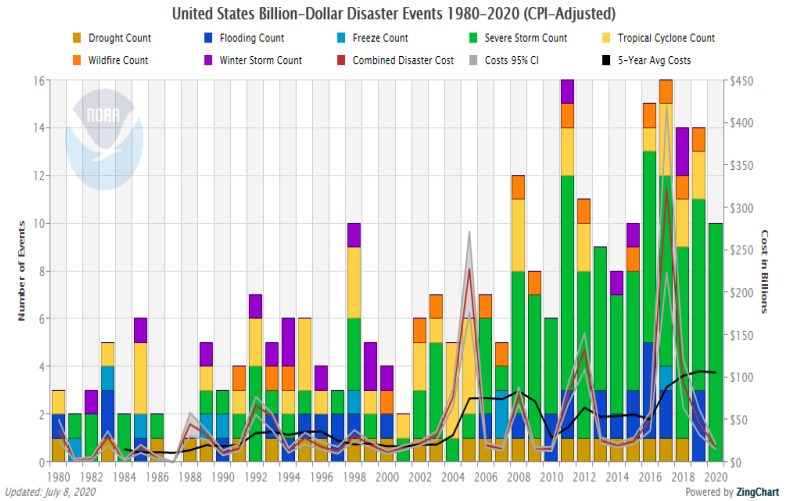
Renewable energy capacity build by technology (GW)



- 62% = New power plant construction is renewable energy
- 73% = One-year increase in solar
- 70% = Renewable capacity increase since 2008
- 244GW = Total renewable capacity
- Renewable Energy = Non-Dispatchable Power

Case for Microgrids - Aging Infrastructure + Natural Disasters





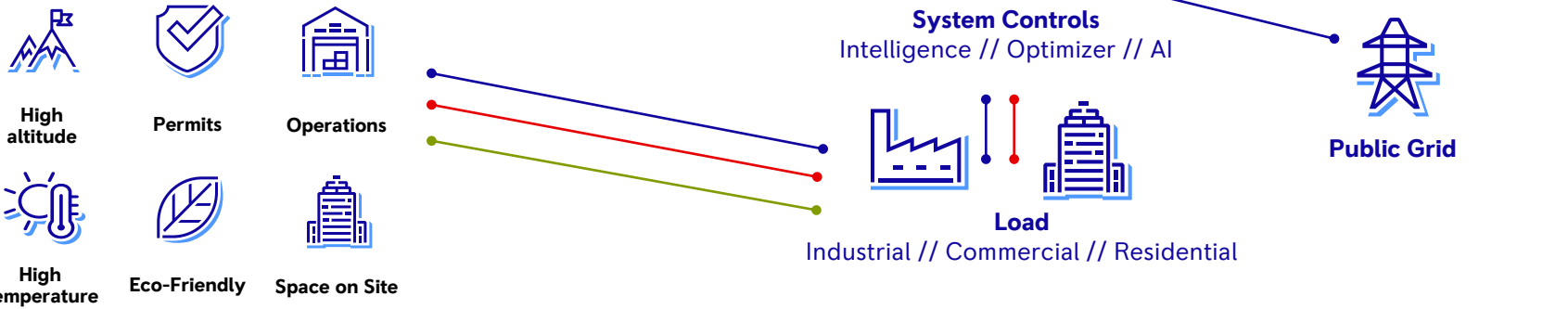
- 70% of power transformers are 25 years of age or older,
- 60% of circuit breakers are 30 years or older, and
- 70% of transmission lines are 25 years or older
- Average age of 52 yrs. 40,000 miles of transmission lines
- 2019 14 separate billion-dollar weather and climate events cost of $45B

03

Industrial Case Studies

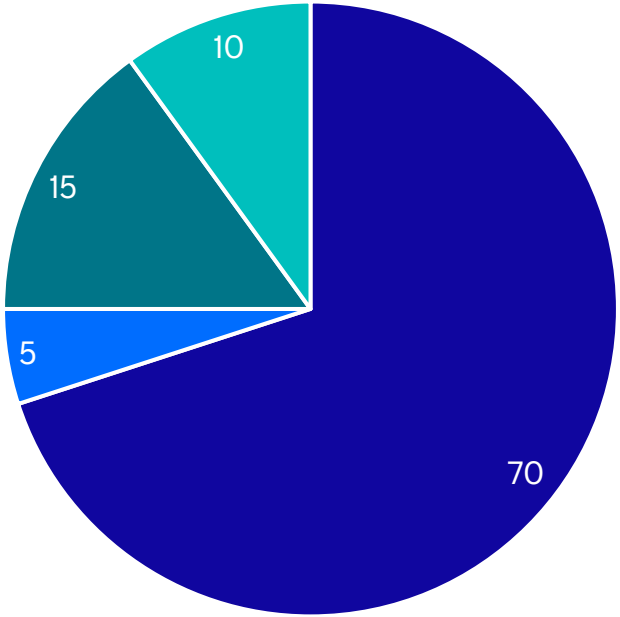
Design for Efficiency and Resiliency

- ✓ Microgrid = **Load Analysis is Key to the Design**
- ✓ Designing requires Balance between
  - ➢ Cost of Operation (OpEx / ManEx)
  - ➢ Space available
  - ➢ Fuel Resources
  - ➢ Government Regulations.



Design for Efficiency and Resiliency

Distributed Generation Project Lifecycle Costs 12 years



- Fuel
- Capital Cost
- Operation and Maintenance
- Consumables

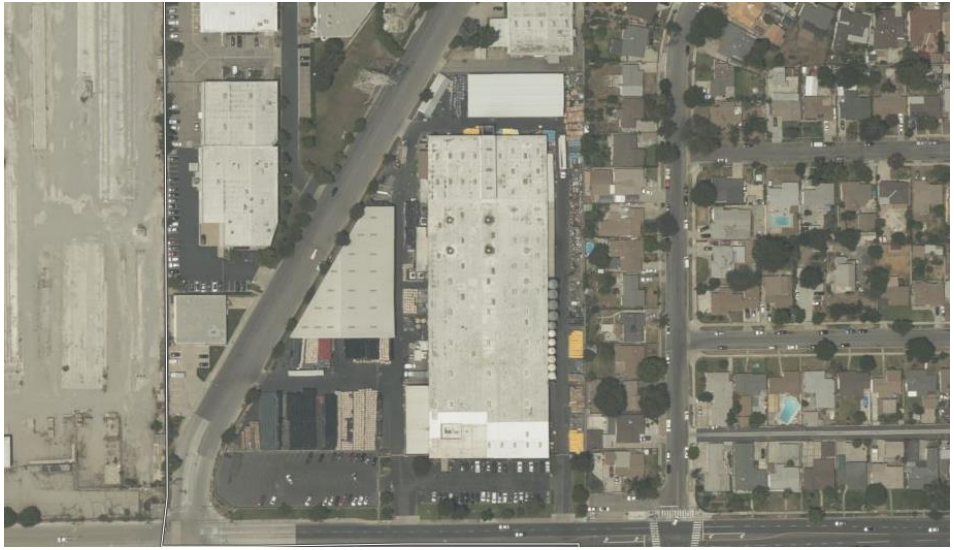
Largest Variable

Fixed Costs

Industrial Case Studies
Plastic Molding Company

Project Summary

- Industrial Client with a continuous process that requires large amounts of electricity
  - Electric loads for cooling using electric chillers
  - High constant energy usage in addition to cooling loads
- Evaluation = Managing cooling is the driver of the project opportunity



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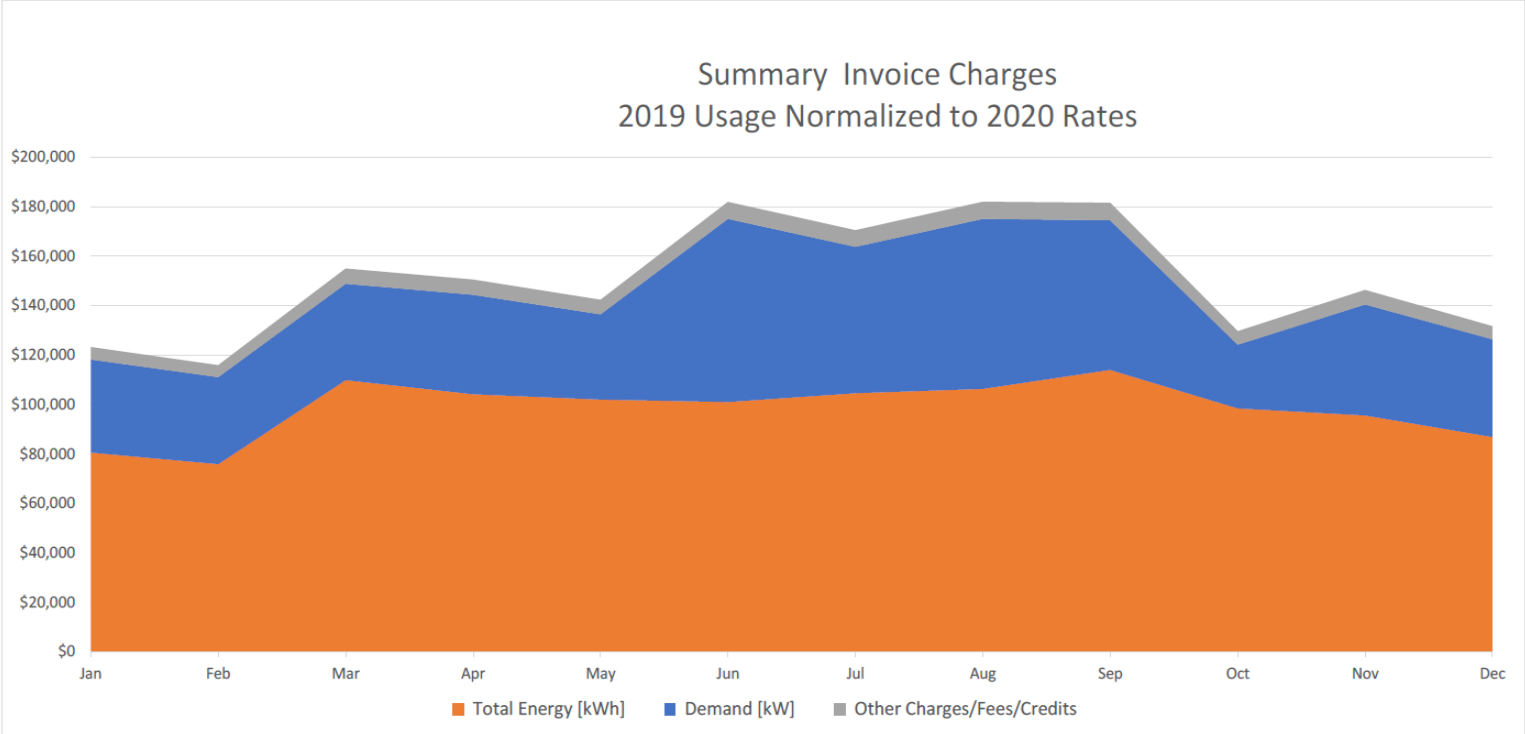

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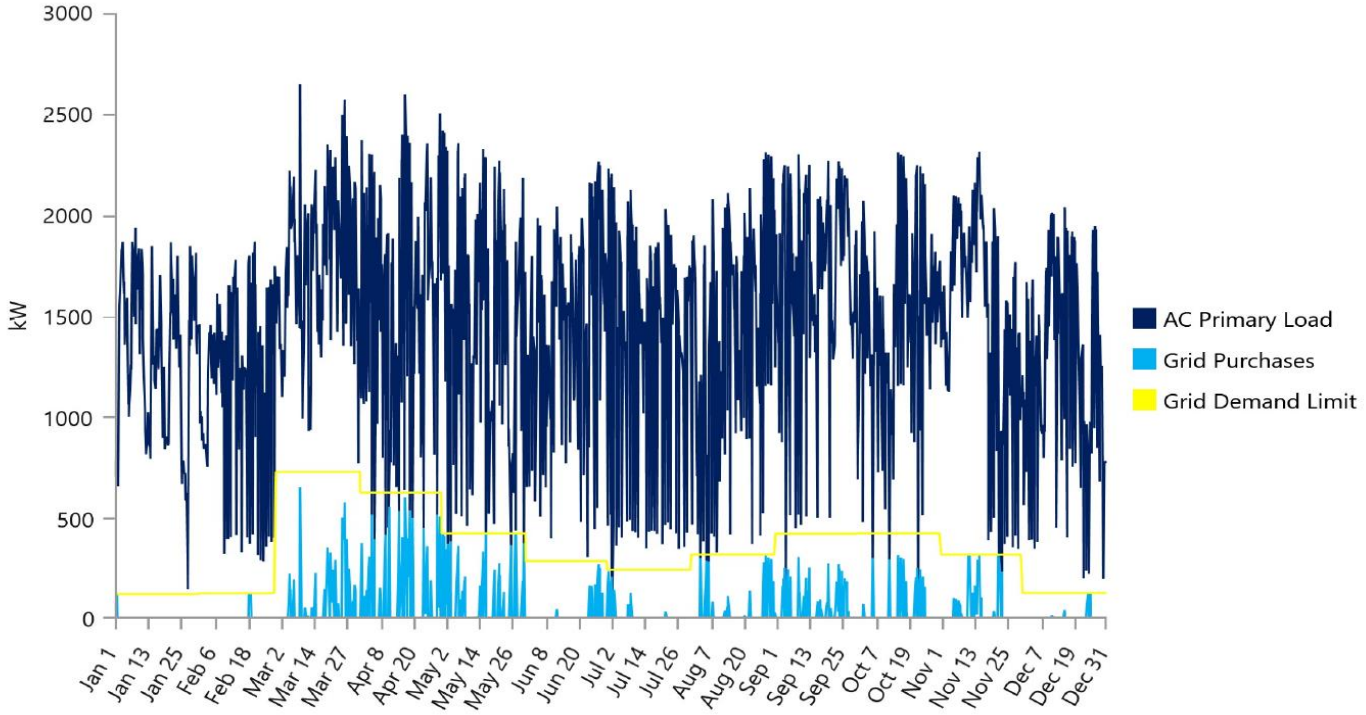
Time series charts:



Industrial Case Studies
Plastic Molding Company

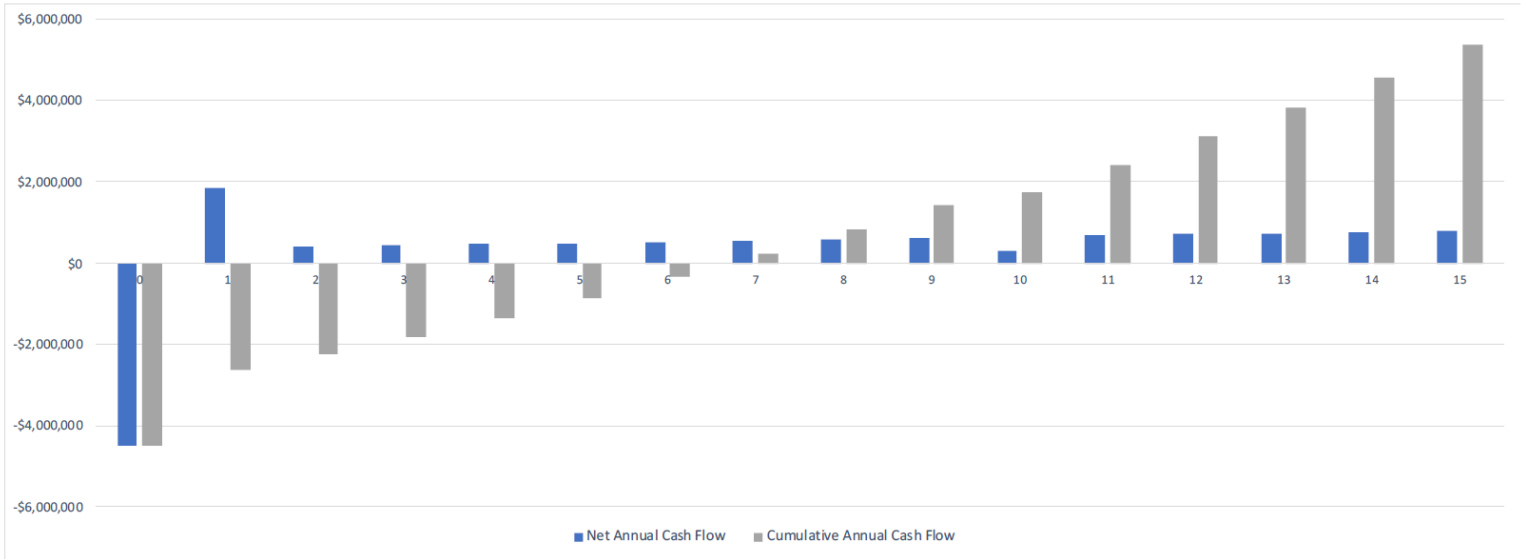
Project Summary

- 2 x 1MW CHP system was sized to offset approximately 97% of the facility's current electric load
- 400 tons of new chilling capacity allows for additional 120 tons of process cooling capacity beyond what is presently in place.
- CHP system will generate
  - 13,517,109 kWh of electricity per year
  - 2,072,597 ton-hrs. of chilled water annually.
- Additional cooling capacity is viewed as a key component of this project since it will allow production rates to increase during critical periods.

Description	Energy and Chiller Savings			Preliminary Project Financials					
	Cooling [Ton-hrs]	Electric Energy [kWh]	Electric Demand [kW]	Feasibility Budget	Tax Benefits	Net Feasibility Budget	20 Year Cash Flow	15 Year IRR	Simple Payback
Combined Heat & Power (CHP)	2,072,597	13,517,109	1,994	$4,871,475	$1,799,211	$3,072,264	$9,841,162	13.4%	6.72

Industrial Case Studies
Plastic Molding Company

. 15-year Cumulative Cash Flow Results



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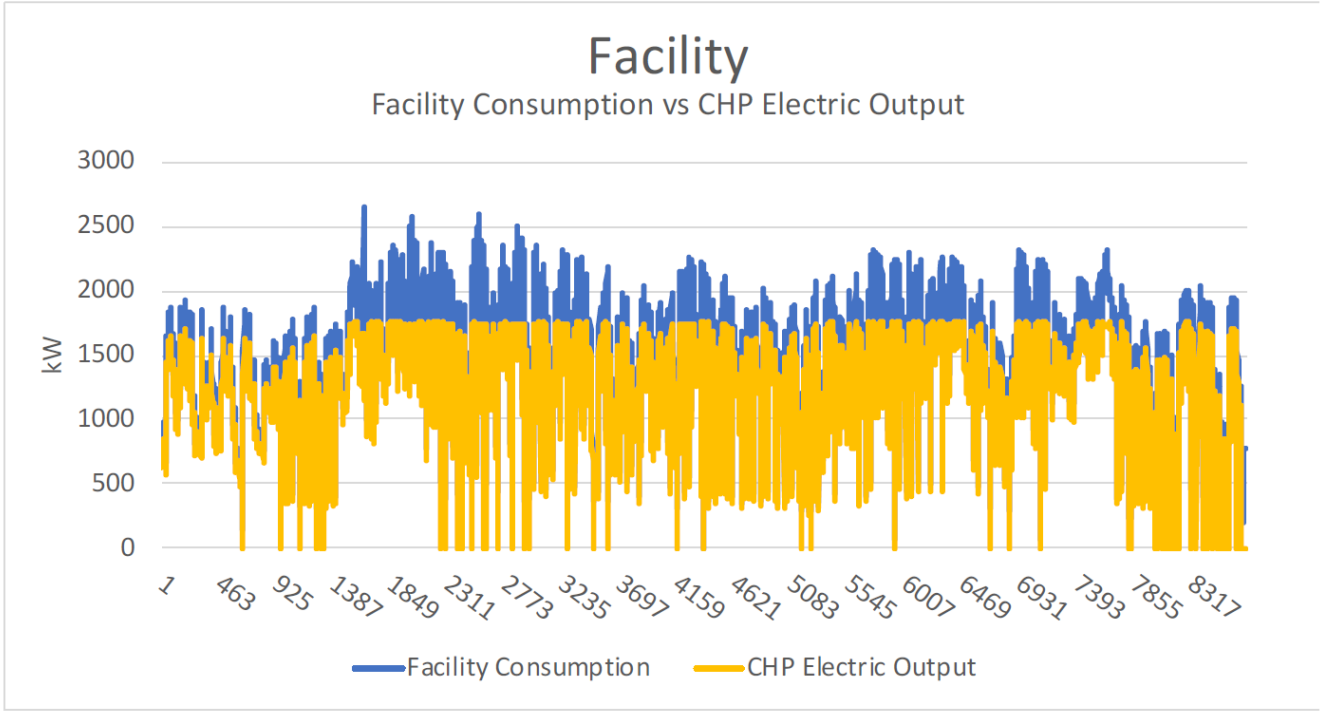

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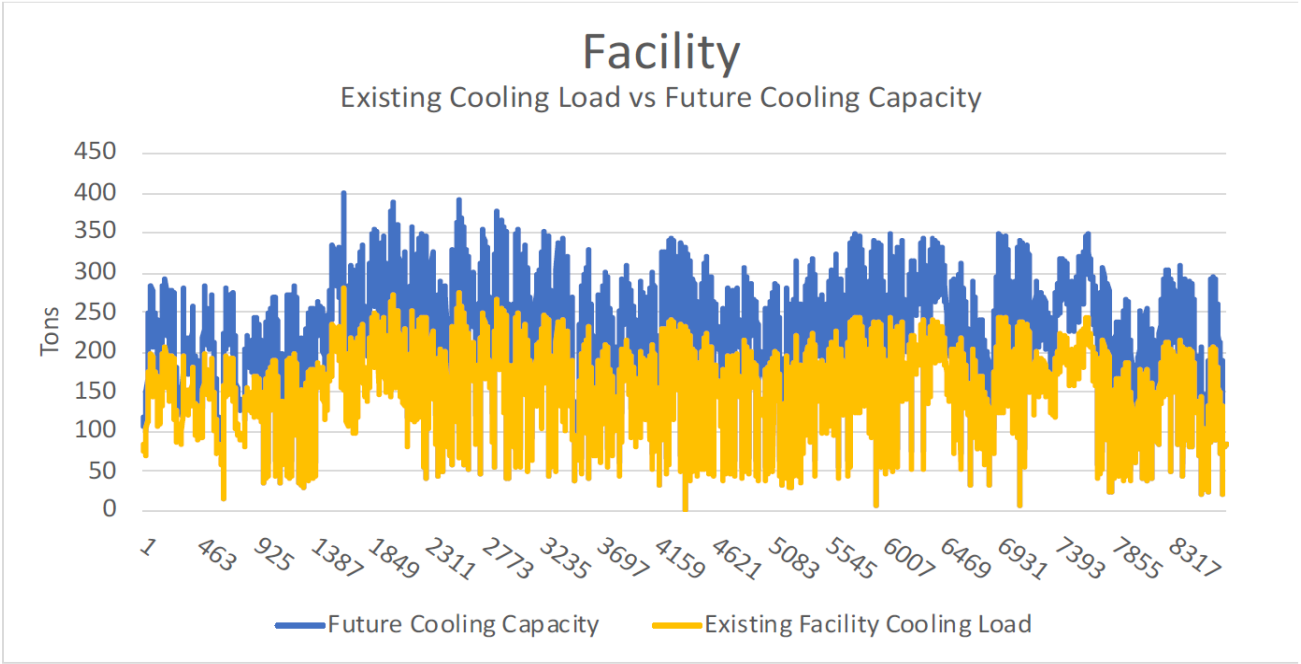

Industrial Case Studies
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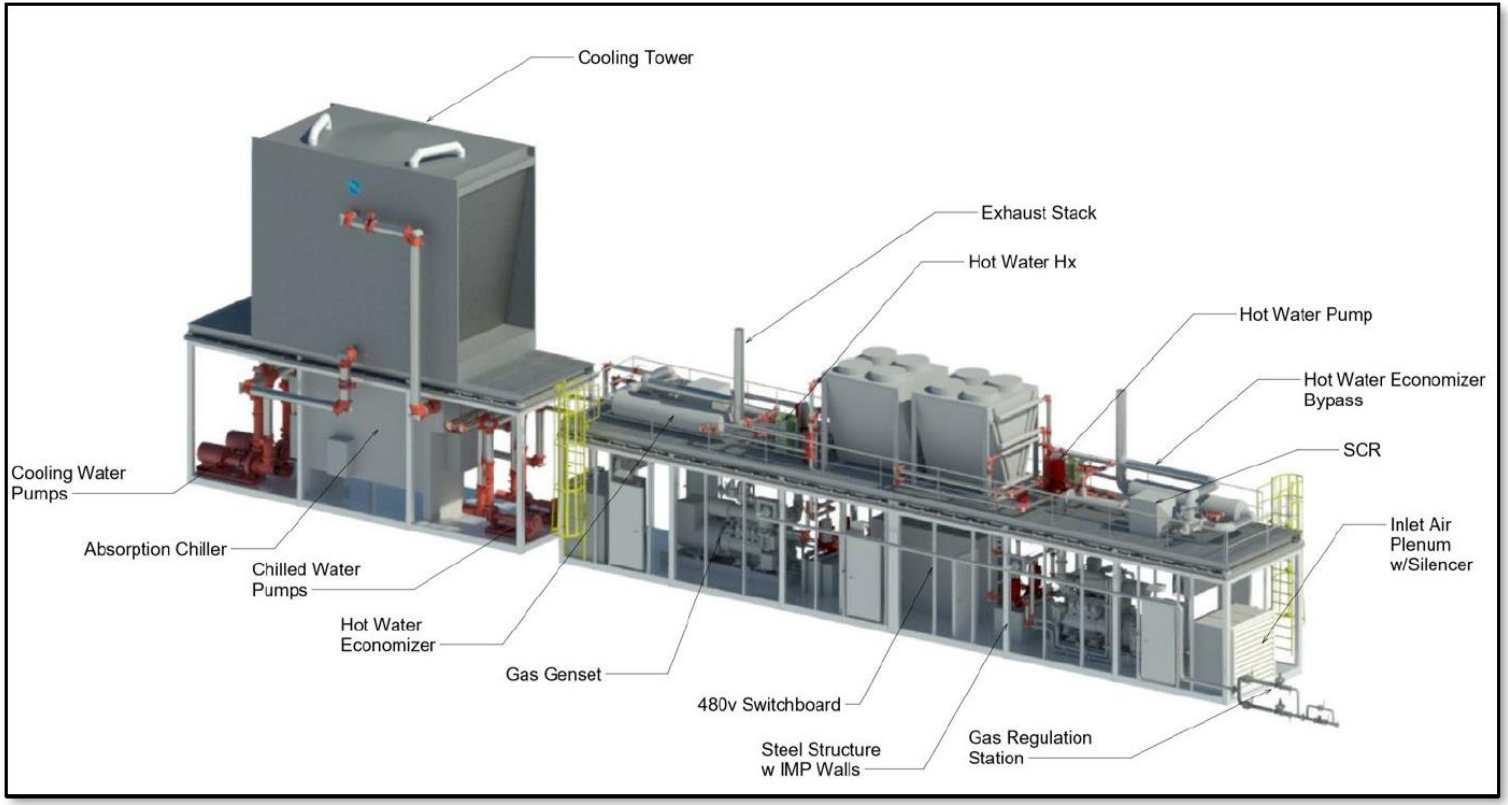

Summary of Savings

- Electric Savings – 13,517,109 kWh per year (includes generation + reduced run time of existing electric chillers).
- Process Cooling – 2,072,597 Ton-hrs per year (includes output of 400 ton absorption chiller).
- Absorption Chiller Value – $399,520 (equivalent to installed costs of added capacity of 120 ton chiller and cooling tower).
- CHP Maintenance Costs – $177,885 per year (includes CHP + absorption chiller, at a rate of $0.015 per kWh produced).
- Utility Standby Charges – $246,401 per year (represents utility reserve capacity charge in case generator goes offline).
- Tax Benefits – $1,799,211 (includes federal and state bonus depreciation and federal ITC).

Estimated 13.4% IRR, which could be higher if factoring in increased production revenue made possible by the added process cooling capacity. Also, future electric consumption of $0.13 average per kWh from the utility would be offset by incremental power generated at $0.035 per kWh.

Rolls-Royce at a Glance

A world-class technology company, built on three strong and complimentary business units

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Juan Matson

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mtu A Rolls-Royce solution

Civil Aerospace

35
types of commercial aircraft powered by us

13,000
engines in service around the world

25,600
of total employees

7,378m
underlying revenue

Defence

150
Customers in over 100 countries

16,000
engines in service around the world

10,400
of total employees

3,124m
underlying revenue

Power Systems

>40,000
customers in 13 different industries

20,000
Reciprocating engines sold per year

10,400
of total employees

3,484m
underlying revenue

Microgrid Validation Center

- Demonstration of our competence as a Solution Provider in the energy sector
- Development and validation of new algorithms and technologies
- Simulation of customer requirements in a real environment

A Rolls-Royce solution

Our first building block to becoming a global leader in Microgrids