Growth, Managing Costs and Reducing Carbon at Mayo Clinic by Leveraging DERs

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CampusEnergy2020
THE POWER TO CHANGE
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Purpose

- **Why did Mayo Clinic pursue this DER Evaluation?**
  - **Cost Reduction**
  - **Growth**
  - **Sustainability**
  - **Resiliency**

Process

- **Established Priorities**
  - Cost Savings
  - Carbon Reduction
  - Reliability & Resilience

- **Established Financial Assumptions**
  - ***As a Non-Profit, Mayo Clinic can NOT take advantage of Federal Tax-based Incentives; i.e.***
    - *Investment Tax Credit (ITC)*
    - *Modified Accelerated Cost Recovery System (MACRS) with Bonus Depreciation*
  - Discount Rate = 7.5%
  - Utility Cost Escalator = 2.0% annually
  - Project Life = 20 years

Process

- **Data Gathering**
  - Rates, Invoices, Contracts for *Electricity, Natural Gas, Steam*
  - Utility Supplied Electric Interval Data
  - Hourly Onsite Generated Power
  - Daily Nat Gas Consumption
  - Hourly Steam Production for Downtown Campus
  - Daily Steam Production for St. Mary's Hospital Campus

Process

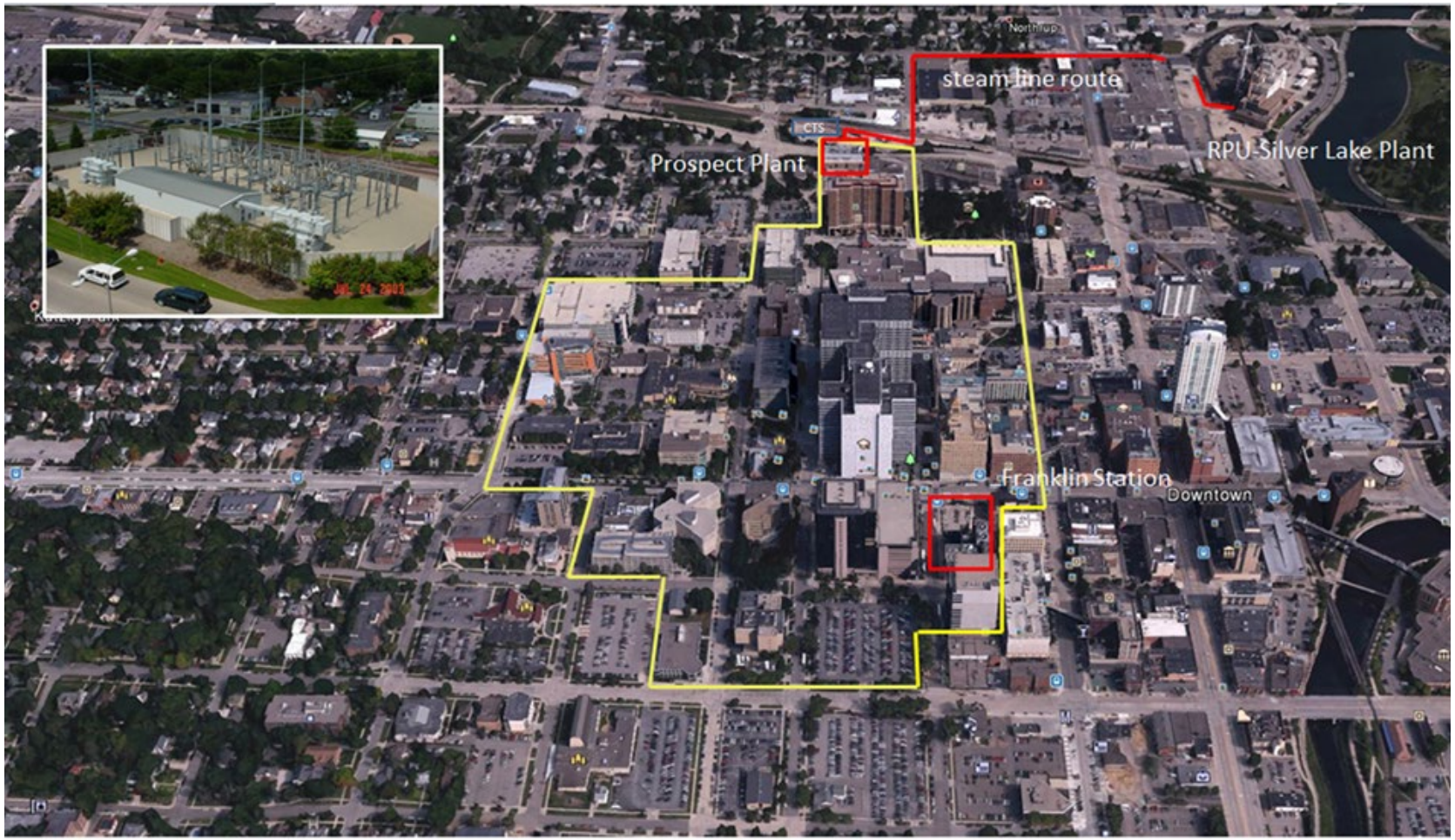
- **Dealing with Complexities**
  - **Data Integrity**
    - Some data provided hourly
    - Some data provided daily
    - Matching Metered data (hourly and daily) to Invoice data (electric, natural gas, steam)
  - **Current System Understanding**
    - Boilers, HRSG, Purchased Steam
    - Gas Turbines, Steam Turbines
    - Only Evaluate Current Boiler Steam & Associated NG for Displacing with new CHP
      - *Do **NOT** use Current **GT Gas** and **HRSG Steam***
  - **Downtown & St. Mary's Campuses tied electrically but separate thermally**
  - **Satellite Campuses**
    - Scope Creep – Identifying and Limiting which facilities to include
  - **Limited Rooftop or Land for BTM Solar**
  - **Check for Nat Gas Supply Constraints** – *Found no concerns for these facilities*

Process

- **Establish Current State**
  - **Electric Loop Connects Downtown and St. Mary's Campuses**
  - **Downtown Campus** *(includes Franklin Heating Station & Prospect Utility Plant)*:
    - Four (4) Steam Boilers with Steam Turbine-Generators
    - Emergency Diesel Backup Generators (7 x 2.4 MW)
  - **St. Mary's Campus**:
    - One (1) Combustion Turbine with HRSG
    - One (1) Steam Turbine-Generator
    - Three (3) Boilers for additional steam
    - Emergency Diesel Backup Generators (3 x 2.5 MW)

Process

- **Establish Current State: Downtown Campus Aerial View**



Process

- **Establish Current State: St. Mary's Hospital Campus Aerial View**

Process

- **Established Current State: Electric Supply**

	Downtown Campus		St. Mary's Campus		COMBINED			
	ENERGY (MWh)	MAX (MW)	ENERGY (MWh)	MAX (MW)	ENERGY (MWh)	Sum of MAX (MW)	Coincident MAX (MW)	Diversity Factor
TOTAL CAMPUS LOAD								
Annual Total:	**163,440**	**31.7**	**67,630**	**14.6**	**231,070**	**46.2**	**44.2**	**96%**
Mo/Hrly Avg:	*13,620*	*18.7*	*5,640*	*7.7*	*19,260*	*26.4*		
PURCHASED POWER								
Annual Total:	**96,420**	**23.4**	**9,990**	**8.4**	**106,410**	**29.0**	**26.6**	**92%**
Mo/Hrly Avg:	*8,040*	*11.0*	*830*	*1.1*	*8,870*	*12.1*		
	59.0%		*14.8%*		*46.1%*			
GENERATED POWER								
Annual Total:	**67,020**	**13.4**	**57,640**	**11.3**	**124,660**	**24.1**	**22.4**	**93%**
Mo/Hrly Avg:	*5,590*	*7.7*	*4,800*	*6.6*	*10,390*	*14.2*		
	41.0%		*85.2%*		*53.9%*			

Process

- **Established Current State: Steam Supply**

	Downtown Campus		St. Mary's Campus		COMBINED	
	STEAM (kp)	MAX (kpph)	STEAM (kp)	MAX (kpph)	STEAM (kp)	MAX (kpph)
TOTAL CAMPUS STEAM						
Annual Total:	1,402,280	280	517,760	100	1,920,040	350
Mo/Hrly Avg:	*116,900*	*160*	*43,100*	*60*	*160,000*	*220*
PURCHASED STEAM						
Annual Total:	291,870	120	-	-	291,870	120
Mo/Hrly Avg:	*24,300*	*30*	*-*	*0*	*24,300*	*30*
	20.8%		*0.0%*		*15.2%*	
GENERATED STEAM						
Annual Total:	1,110,400	210	517,760	100	1,628,160	300
Mo/Hrly Avg:	*92,500*	*130*	*43,100*	*60*	*135,700*	*190*
	79.2%		*100.0%*		*84.8%*	

Process

- **Established Current State: Satellite Facilities**
  - **Which to include in Evaluation – No Existing DERs**
    - Mayo Support Center
    - Mayo Inventory Center
    - Superior Drive Support Center
    - 41st St. NW
    - Marvin Building
    - 3939 Warehouse
  - ***Numerous additional facilities were not included in this evaluation***

Process

- **Modeled Energy Rates**
  - **Electric** Distribution and Supply from Rochester Public Utilities (**RPU**)
  - **Natural Gas Distribution** from Minnesota Energy Resources Corp (**MERC**)
  - **Natural Gas Transportation** from Northern Natural Gas (**NNG**)
  - **Natural Gas Supply** from multiple vendors
  - **Steam Supply** *(partial)* from **RPU** *(through 2025)*

- **Utilized HOMER Grid software**
  - 100's of iterative scenarios run
  - Optimized Results based on Net Present Cost (NPC)
    - Combined DERs
    - Individual DERs

Process

- **Potential DER Solutions Evaluated**
  - **Solar Generation**
    - Solar Photovoltaic (PV) System
  - **Peak Shaving Generator**
    - Reciprocating Engine System
  - **Combined Heat and Power (CHP)**
    - Combustion Turbine System
  - **Battery Storage System**
    - Lithium Ion Battery considered as at present that is the most widely used solution to provide energy storage
  - **Wind Generation**
    - Wind Turbine System

Results

- **Findings & Recommendations: Downtown & St. Mary's Campuses**
  - New DERs Optimized on Net Present Cost (NPC)
    - 11 MW of additional Combined Heat & Power (CHP)
    - 2 MW of Solar Photovoltaic (Solar PV)
    - 3 MWh of Battery Storage
  - Projected Financial Performance
    - 20 Year NPC Reduction = $22 million
    - Annual Operating Cost Savings = $4.5 million
    - Annual CO2e Emissions Reduction = 31,460 metric tons
    - Capital Investment = $32 million
    - Simple Payback = 5.3 years
    - 20 Year ROI = 9.1%
    - 20 Year IRR = 13.4%

Recall: *These results assume Mayo Clinic, as a Non-Profit, can NOT take advantage of Tax-based incentives; i.e. ITC, MACRS with Bonus Depreciation*

Results

- **Alternative Findings & Recommendations: Downtown & St. Mary's Campuses**

Case	Solar PV (kW)	CHP (kW)	Battery Storage (kWh)	Net Present Cost ($)	Operating Cost ($/yr)	Initial Capital Cost ($)	Fuel cost ($/yr)	CO^2e Emissions (tonne/yr)	CO^2e Emissions Reduction (tonne/yr)	CO^2e Emissions Reduction (%)	Return on Investment (%)	Internal Rate of Return (%)	Simple Payback (yr)	Utility Bill Savings ($/yr)
Base Case	**-**	**-**	**-**	**$ 232,370,200**	**$19,270,970**	**$ -**	**$ 7,360,062**	**169,123**	**-**	**-**	**-**	**-**	**-**	**-**
Top 3 NPC	**2,000**	**11,000**	**3,000**	**$ 210,265,200**	**$14,783,930**	**$32,000,000**	**$ 8,567,900**	**137,661**	**31,462**	**18.6%**	**9.1%**	**13.4%**	**5.26**	**$ 8,283,308**
	-	11,000	3,000	$ 211,393,200	$15,126,280	$29,000,000	$ 8,576,406	138,969	30,153	17.8%	9.3%	13.9%	5.04	$ 7,963,876
	2,000	11,000	-	$ 211,762,700	$15,032,520	$30,500,000	$ 8,568,386	137,644	31,479	18.6%	8.9%	13.3%	5.26	$ 7,978,001
Solar PV Only	**2,000**	**-**	**-**	**$ 231,092,600**	**$18,916,220**	**$ 3,000,000**	**$ 7,360,062**	**167,587**	**1,535**	**0.9%**	**7.2%**	**9.8%**	**8.89**	**$ 340,346**
	1,500	-	-	$ 231,362,600	$19,000,820	$ 2,250,000	$ 7,360,062	167,971	1,152	0.7%	7.4%	10.0%	8.75	$ 259,354
	500	-	-	$ 232,003,100	$19,178,330	$ 750,000	$ 7,360,062	168,738	384	0.2%	7.8%	10.4%	8.49	$ 89,041
CHP Only	**-**	**11,000**	**-**	**$ 212,730,800**	**$15,361,600**	**$27,500,000**	**$ 8,576,841**	**138,954**	**30,169**	**17.8%**	**9.2%**	**13.8%**	**5.01**	**$ 7,671,415**
	-	10,000	-	$ 212,872,600	$15,580,690	$25,000,000	$ 8,504,064	140,684	28,439	16.8%	9.8%	14.5%	4.87	$ 7,148,822
	-	12,000	-	$ 213,000,500	$15,176,640	$30,000,000	$ 8,640,925	137,492	31,631	18.7%	8.6%	13.1%	5.15	$ 8,151,848
Battery Storage Only	**-**	**-**	**3,000**	**$ 231,044,700**	**$19,036,650**	**$ 1,500,000**	**$ 7,360,062**	**169,127**	**(5)**	**0.0%**	**10.8%**	**15.2%**	**5.73**	**$ 291,896**
	-	-	4,000	$ 231,124,900	$19,001,840	$ 2,000,000	$ 7,360,062	169,130	(7)	0.0%	8.6%	12.5%	6.54	$ 345,899
	-	-	5,000	$ 231,316,700	$18,976,270	$ 2,500,000	$ 7,360,062	169,132	(9)	0.0%	7.0%	10.3%	7.34	$ 390,655

Results

- **Findings & Recommendations: Satellite Facilities**
  - New DERs Optimized on Net Present Cost (NPC)
    - 2.1 MW of Solar Photovoltaic (Solar PV)
    - 1.0 MW NG Recip Engine
    - 2.0 MWh of Battery Storage
  - Projected Financial Performance
    - 20 Year NPC Reduction = $1.8 million
    - Annual Operating Cost Savings = $500,000
    - Annual CO2e Emissions Reduction = 1,640 metric tons
    - Capital Investment = $4.25 million
    - Simple Payback = 8.9 years
    - 20 Year ROI = 7.2%
    - 20 Year IRR = 9.8%

Recall: *These results assume Mayo Clinic, as a Non-Profit, can NOT take advantage of Tax-based incentives; i.e. ITC, MACRS with Bonus Depreciation*

Results

- **Alternative Findings & Recommendations: Satellite Facilities**

Case	Solar PV (kW)	Wind Turbine (kW)	NG Recip (kW)	Battery Storage (kWh)	Net Present Cost ($)	Operating Cost ($/yr)	Initial Capital Cost ($)	Fuel cost ($/yr)	CO^2e Emissions (tonne/yr)	CO^2e Emissions Reduction (tonne/yr)	CO^2e Emissions Reduction (%)	Return on Investment (%)	Internal Rate of Return (%)	Simple Payback (yr)	Utility Bill Savings ($/yr)
Base Case	-	-	-	-	**$42,237,770**	**$ 3,502,872**	-	-	**19,152**	-	-	-	-	-	-
Top 3 NPC	2,100	-	1,000	2,000	$40,457,460	$ 3,002,765	$ 4,250,000	$ 37,083	17,513	**1,639**	**8.6%**	7.2%	9.8%	**8.9**	$ 528,879
	2,100	-	1,000	-	$40,556,220	$ 3,019,249	$ 4,150,000	$ 47,267	17,496	**1,656**	**8.6%**	7.0%	9.6%	**9.0**	$ 520,778
	-	-	1,500	2,000	$41,000,750	$ 3,267,592	$ 1,600,000	$ 55,092	19,106	**45**	**0.2%**	10.1%	13.2%	**7.0**	$ 295,992
Solar PV Only	2,100	-	-	-	$41,552,280	$ 3,184,786	$ 3,150,000	$ -	17,540	**1,612**	**8.4%**	5.5%	7.7%	**10.5**	$ 302,960
	2,000	-	-	-	$41,553,180	$ 3,197,301	$ 3,000,000	$ -	17,617	**1,535**	**8.0%**	5.6%	7.8%	**10.4**	$ 291,165
	1,800	-	-	-	$41,554,990	$ 3,222,330	$ 2,700,000	$ -	17,770	**1,381**	**7.2%**	5.8%	8.1%	**10.2**	$ 267,576
Wind Turbine Only	-	750	-	-	$42,926,640	$ 3,435,604	$ 1,500,000	$ -	18,626	**526**	**2.7%**	-0.5%	-	-	$ 82,269
	-	1,000	-	-	$43,179,830	$ 3,415,134	$ 2,000,000	$ -	18,451	**701**	**3.7%**	-0.6%	-	-	$ 107,738
	-	1,250	-	-	$43,447,380	$ 3,395,857	$ 2,500,000	$ -	18,276	**876**	**4.6%**	-0.7%	-	-	$ 132,015
NG Recip Only	-	-	1,500	-	$41,092,910	$ 3,283,528	$ 1,500,000	$ 63,752	19,092	**60**	**0.3%**	10.0%	13.1%	**7.1**	$ 286,568
	-	-	1,250	-	$41,115,650	$ 3,306,147	$ 1,250,000	$ 40,020	19,114	**37**	**0.2%**	11.4%	14.1%	**6.8**	$ 232,215
	-	-	1,750	-	$41,201,680	$ 3,271,815	$ 1,750,000	$ 84,483	19,073	**79**	**0.4%**	8.4%	11.6%	**7.8**	$ 325,315
Battery Storage Only	-	-	-	200	$42,131,540	$ 3,485,769	$ 100,000	$ -	19,152	**(0)**	**0.0%**	12.3%	17.0%	**5.3**	$ 20,942
	-	-	-	300	$42,135,690	$ 3,481,967	$ 150,000	$ -	19,152	**(0)**	**0.0%**	9.1%	13.1%	**6.3**	$ 26,663
	-	-	-	400	$42,154,660	$ 3,479,393	$ 200,000	$ -	19,152	**(1)**	**0.0%**	6.9%	10.2%	**7.4**	$ 31,156

Satisfaction

- **What did Mayo Clinic get from the Evaluation?**
  - Confirmation?
  - Direction?
  - Alternatives?

Satisfaction

- **Lessons Learned**
  - **Data Gathering**
    - The most time consuming part of the process
    - Introduces the most inaccuracies and errors – ***must correlate to invoiced cost and usage***
    - Different data sources often come in different formats – ***must translate to a single format for modeling***
      - *e.g., utility electric interval data typically 15 or 30 minute; other metered data may be hourly or daily, etc.*
  - **Modeling**
    - HOMER Grid has advantages but any “off the shelf” tool requires some customization or “trickery”
    - I still like to run my own Excel based templates to confirm some data and results, and to present as I like
  - **Clarifications**
    - Iterative communication with your client to ensure accuracies
      - *Current System*
      - *Data*
      - *Future Planning*

Satisfaction

- **Follow-up / Next Steps**
  - ***What Does Mayo Clinic plan to do with these results?***
    - Short-term
    - Long-term

Satisfaction

- **The Future – Changing World Creating New Opportunities & Risks**
  - **RPU Renewable Energy Goals**
    - 100% Renewable by 2030
  - **Changing Market Cost of Power and Nat Gas**
  - **Technology Changes**
    - Declining Costs for Solar, Battery Storage, Other Storage
  - **Regulatory Changes**
  - **Potential Price on Carbon**

Thank you!!

For further discussion, please contact:

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