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LIBERTY ELECTRIC PRODUCTS

DECARBONIZATION OVERVIEW

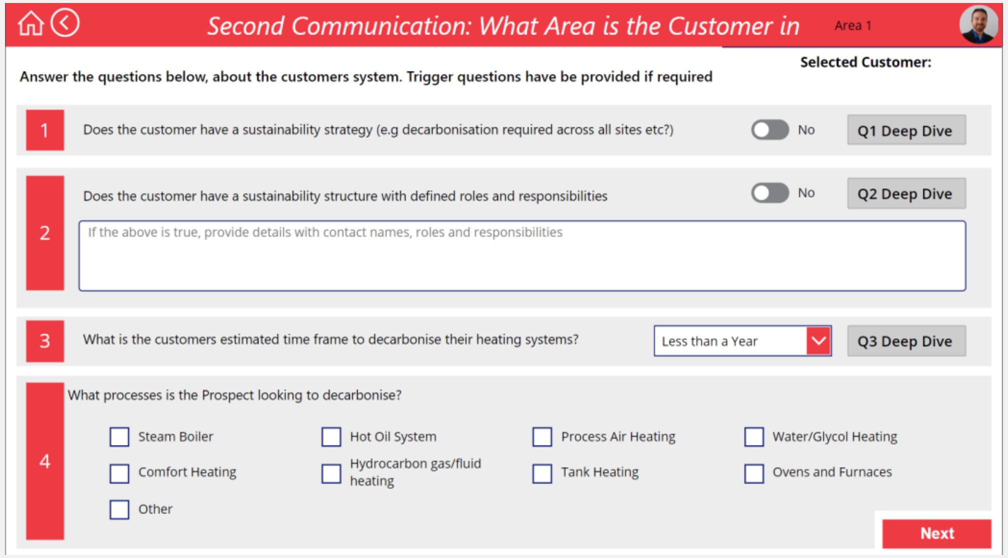
Industrial Decarbonization Solutions

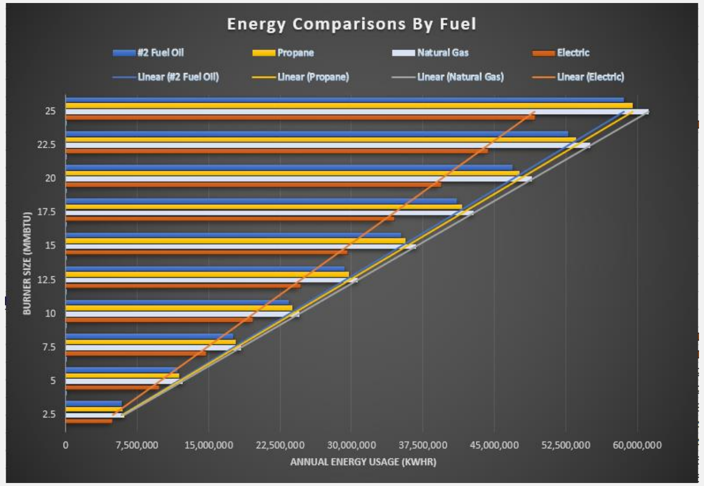
James Lewis| November 2022

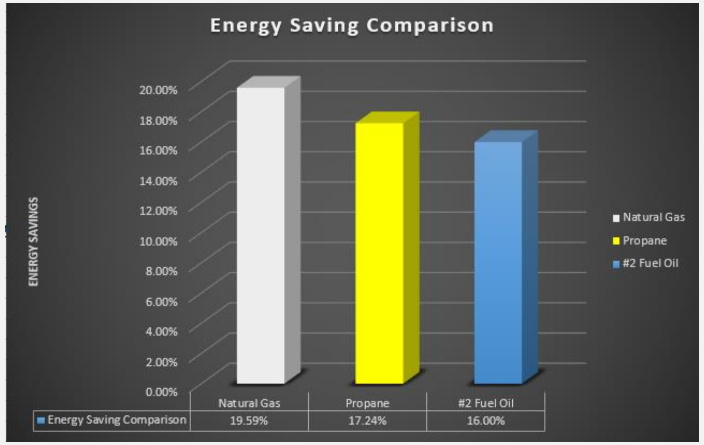
Decarbonization Strategy

Decarbonization Assessments

Chromalox can support evaluating your facility for energy efficiency improvement and emissions reduction







Takeaways:

- Chromalox personnel can walk the facility to perform a decarbonization assessment
  - Outline different options and alternatives to existing fossil fuel based heating systems
    - Evaluate whether existing equipment can be retrofit with electric heaters
    - Direct replacement may not be the best or even viable alternative

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Decarbonization Assessments (Continued)

Chromalox can bring value and support our customers on their sustainability journey's

Highlights

- Many customers have corporately set goals, but do not know where to begin or what options exist.
- Following a decarbonization assessment, Chromalox will provide a comprehensive sustainability report, solutions overview, and priced budgetary proposal
- The sustainability report will quantify carbon savings and energy reduction realized through our solutions

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OPPORTUNITY # - 003 / PRIMARY STEAM BOILERS

Application/Equipment Category: Steam Systems | Tables/Pictures/Graphics

Description of Equipment

- Two primary steam boilers were identified as decarbonization opportunities. These boilers were Apache and Mohawk model Superior Boilers designed for 14,000 lb/hr 125PSI steam loads. These boilers fed a number of processes throughout the facility. It was noted these boilers had some rework done due to some structural issues that occurred a few years ago.

Description of Solution

- A DirectConnect Medium Voltage MVSGI steam generator was identified as the ideal solution. The proposed MVSGI would be slightly larger than the cHP boilers, with rated capacity of 4600KW. Due to the prior damage to the primary boilers, alternate solution of boiler retrofit is not suggested.

Summary Impacts & Savings

- **Capital Budget Estimate:** $720K CapEx Ea
- **Timeframe To Implement:** 60 Weeks
- **GHG Reduction:**
  - Boiler 1 - 5,667 metric tons CO2 / year
  - Boiler 2 – 3,561 metric tons CO2 / year
- **Infrastructure Available:** No, 4160V Feed w/ 4600
  (4600KW) Required
- **Complexity To Implement:** High
- **Operational Risk To Implement:** Low

Calculations

- **Energy Savings:** *Constant Demand*
  - Boiler 1 - Estimated annual gas usage (KWhr) = 26,976,607

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PRICE SCHEDULE

			UNIT PRICE ($)	TOTAL PRICE ($)
Hot Oil System				
Item 1	Qty 2	MOS-500P-E4NPSTGVDBPDHWSGDT Hot Oil Heat Transfer System	$105,000	$210,000.00
Steam Systems				
Item 1	Qty 1	MVSGI-250P-3650K-E1 4160V 3650KW DirectConnect Steam Generator cHP Boiler	$650,000	$650,000.00
Item 2	Qty 2	MVSGI-250P-4600K-E1 4160V 4600KW DirectConnect Steam Generator Primary Boiler(s) 1 & 2	$720,000	$1,440,000.00
Tank Heaters				
Item 1	Qty 15	LTFXSS-2310-030E4XX 30KW 480V Tank ID: 73800, 74000, 73600, 73700, 72300, 72400, 72700, 72000, 71900, 73200, 72600, 72100, 73500, 72500, 73000	$25,000	$375,000.00
Item 2	Qty 15	484210739 - N4 Contactor Panel - 30KW	$6,000	$90,000.00
Item 3	Qty 7	LTFXSS-4310-070E4XX 70KW 480V Tank ID: 73100, 73400, 74200, 74300, 72200, 72900, 74400	$35,000	$245,000.00
Item 4	Qty 7	484210741 - N4 Contactor Panel - 70KW	$7,500	$52,500.00
Item 5	Qty 3	LTFXSS-6310-100E4XX 100KW 480V 3PH Tank ID: 73900, 74100 (QTY 2 Required)	$45,000	$135,000.00
Item 6	Qty 3	484210740 - N4 Contactor Panel - 100KW	$6,500	$19,500.00
Electric Heat Tracing				
Item 1	Qty -	Electric Heat Trace Package *Includes Self-Regulating Heating Cable, Pipe Straps, Fiberglass Tape, Caution Labels, End Seals	$79,802	$79,802.00
Item 2	Qty 1	IntelliTrace Heat Trace Panel	$48,800	$48,800.00
TOTAL PRICE (USD)..				**$3,345,602.00**

Price based on Ex Works: Factory

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SUSTAINABILITY REPORT

INTRODUCTION

Following the decarbonization assessment performed by Chromalox, a comprehensive proposal package is ready for your review. The solutions proposed by Chromalox are designed to support your sustainability journey through carbon emission reduction and improved energy efficiency. The following report looks at how our technology will get you closer to your sustainability goals

CUSTOMER INFORMATION

pany Name: Croda Chemical
act Name: Kevin Lucas
ity: Mill Hall, PA
pment Included:
m Generators: 3
Oil Heaters: 1
ess Air Heaters: 0
er/Glycol Heaters: 0
fort Heaters 0
rocarbon/Gas Heaters: 0
: Heaters: 24
: Trace: Yes

SUSTAINABILITY SUMMARY

Croda GHG Emission Reduction Target: 50% By 2030 / 100% By 2050

Chromalox Carbon Emission Savings: 12,852 tons of CO2 per year

Chromalox Energy Reduction: 16.54% Reduction in Energy Usage

MMARY TABLE

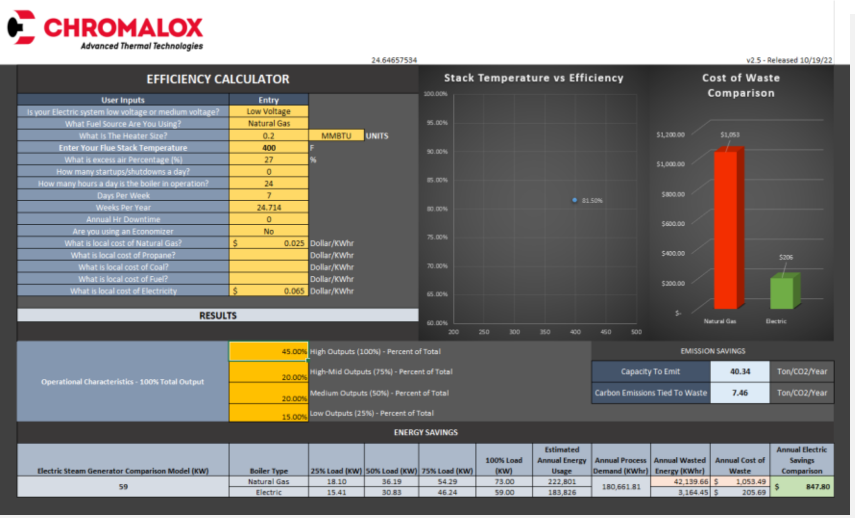
uipment	Total Steam System Impacts		Total Hot Oil System Impacts		Total Process Air System Impacts		Total Water/Glycol System Impacts		Total Comfort Heater Impacts		Total Hydrocarbon/ Gas System Impacts		Total Tank Heater Impacts		Heat Trace	
	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)	Carbon (tCO2/yr)	Energy (KWhr)
isting stem	12,587	69,519,757	265	1,463,150	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	794	4,387,311	42.4	234,199
omalox ution	0	58,003,979	0	1,237,314	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,093,470	0	183,826
ings/ uction	-12,587	16.57%	-265	15.43%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-794**	29.49%	-42.4**	21.51%

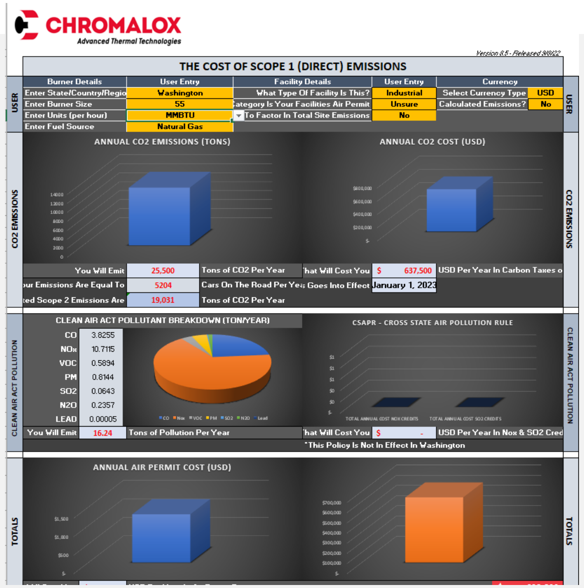
* All data is derived using emission factors from EPA and operational data based on combination of known usage and characteristics of similar equipment. Values are approximate and to be used as general reference only.
e** Tank farm and Heat Trace carbon savings are representative only, but not added into total savings as emissions are associated with cHP boiler savings already.

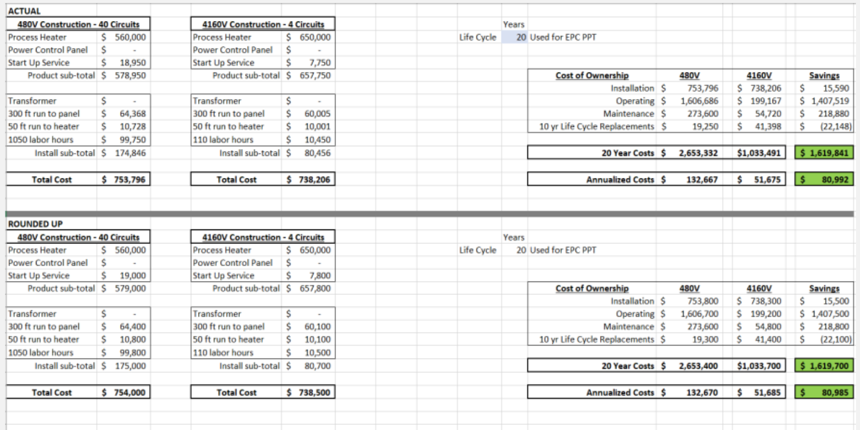
[1]Strategex | To Cut or Not to Cut Products

Decarbonization Value Calculators & Tools

The Business Development team has created numerous calculators to support the decarbonization discussion







Thermal Efficiency Calculator

- Quantifies rated efficiencies
- Looks at annual energy usage based on use case data
- Quantifies carbon emissions tied to annual energy usage
  - Additional quantifies cost of waste (utility cost & emissions)

Emission Calculator

- Evaluates emissions based on fuel source and burner size
- Looks at existing legislation to quantify cost of emissions
- Evaluates non-CO2 emissions and potential air permit impacts

MV vs LV

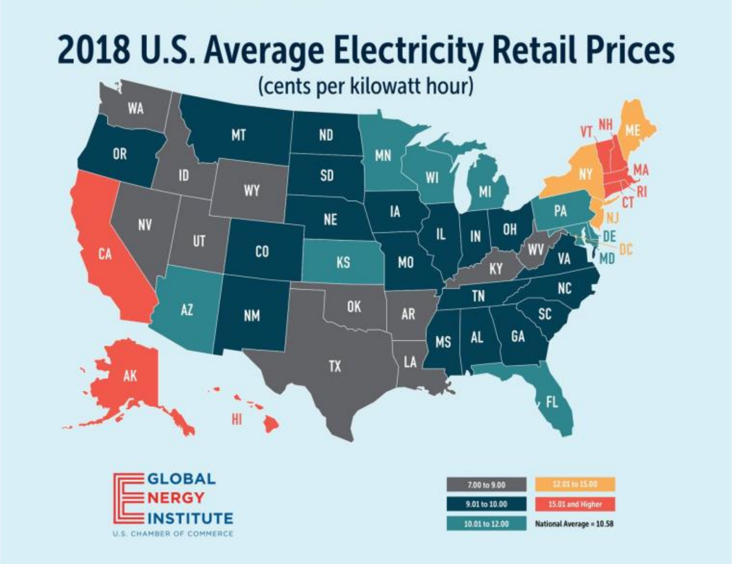
- Compares MV to LV total cost of ownership
- Looks at ROI of MV system
- Quantifies more specific operational efficiencies based on wire runs regarding I2R losses

Hurdles to Success

What challenges are we facing with large scale electrification?

- Cost of Electricity vs Fossil Fuels
  - Generally, the cost of electric utility is 2-4x more expensive than the comparable fossil-based fuel customers are sourcing. How we do address?
    - Total Cost of Ownership (TCO) – Maintenance reduction, emission cost avoidance (where applicable), air permitting avoidance, efficiency gains
    - Power Factor (PF) adjustments from utility provider
    - Incentive/Rebate programs from utility providers

- No Electrical Infrastructure
  - As much as customers may want to electrify, they may not have enough power on site to support large scale electrification
    - Incentive/Rebate programs or support from utility providers



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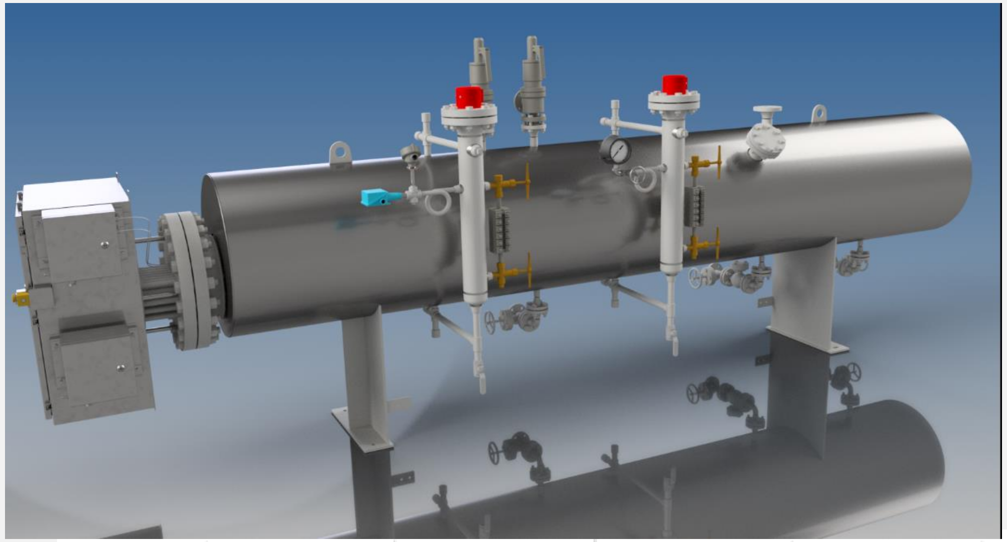
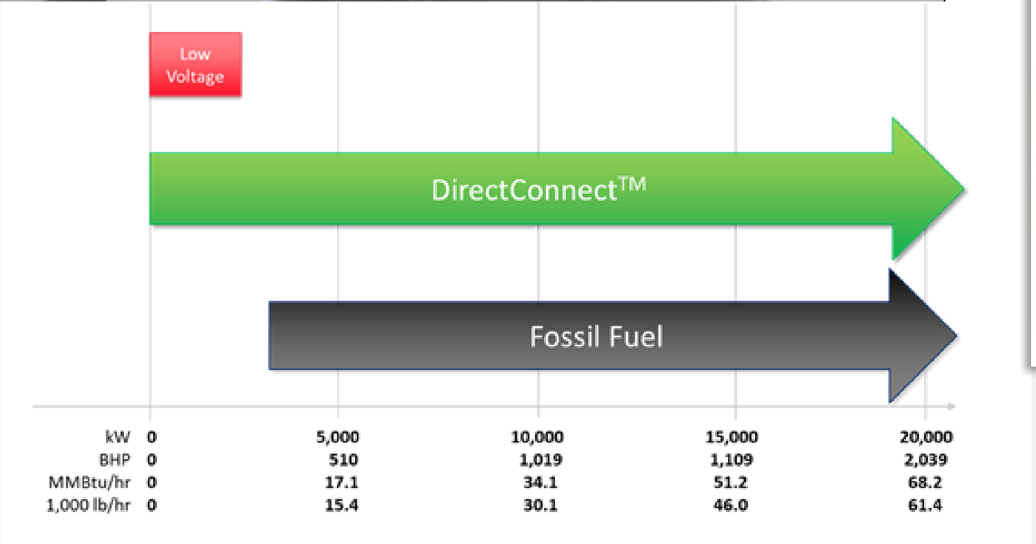
Steam & Process Heating Decarbonization Solutions

DirectConnect Medium Voltage Steam Generator

Bridge the gap between conventional electric steam generators and fossil fuel systems

- **Mechanical Codes**
  - ASME, Section 1 – 'S' Stamp
  - Up to 450 PSIG Standard, Option For 1000PSIG
- **Electrical Codes**
  - Heater Is IEC Certified
  - Indoor and Outdoor Installations
  - Steam Generator Components Carry Applicable Certifications
- **Control Panel**
  - IEC Rated To 7.2kV
  - UL Rated to 5kV



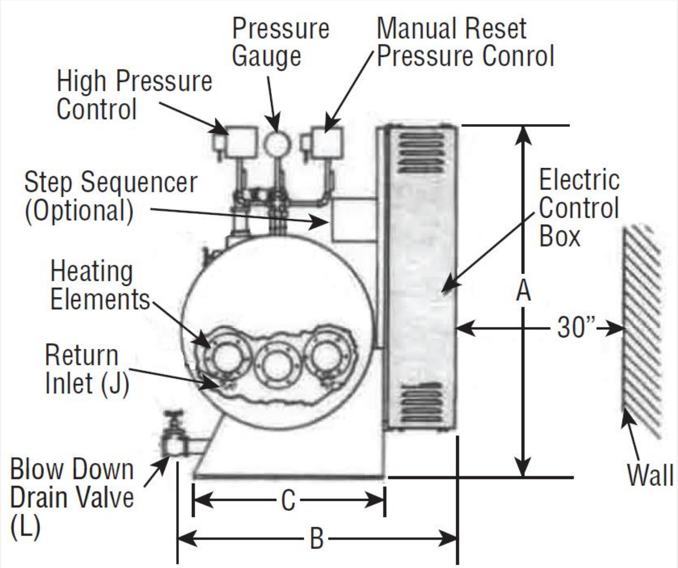


Steam and Hot Water Generation with Resistance Heating Technology

Additional benefits of electric resistance heating technology go beyond zero onsite emissions

Benefits of using resistance heaters vs electrode:

- Very little to zero water treatment required
- Able to utilize DI or de-min feedwater supply
- Electrical connections isolated from internal boiler vessel
- Simple control scheme based on outlet pressure sensor
- Corrosion resistant Incoloy sheathed heating elements
- Minimal maintenance due to zero moving parts required for operation
- 450 PSIG standard designs, up to 1000 PSIG custom designs available



Emission Reduction through Electrification

Electric resistance heating is a versatile and proven technology to replace, or supplement fired heating systems

Liquid Heating

- Steam & Hot Water Generation
- Water/Glycol Solutions
- Thermal Fluids and Oil Based Products
- Hydrocarbon Liquids
- Chemicals, Acids, and Corrosive Materials
- Liquid Storage Tanks

Gas Heating

- Air and Nitrogen
- Steam Superheating
- Fuel Gas and Hydrogen Blends
- Hydrocarbon Gas Superheating

Temperature Management

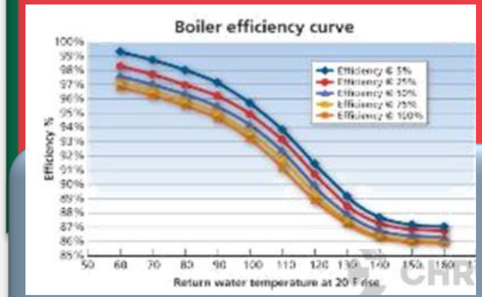
- Process Temperature Maintenance
- Freeze Protection
- Space and Comfort Heating
- Power Control & Communication

Electric Resistance vs Fossil Fuel Based Systems

Fossil Fuels vs Electric Total Cost of Ownership

A complete economic evaluation factors in more than just cost of energy

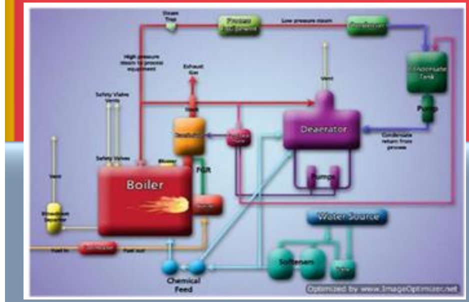
Thermal Conversion & Operational Efficiency



Parasitic Losses

Maintenance And Downtime Costs

Capital Expenditure



Emission & Carbon Costs

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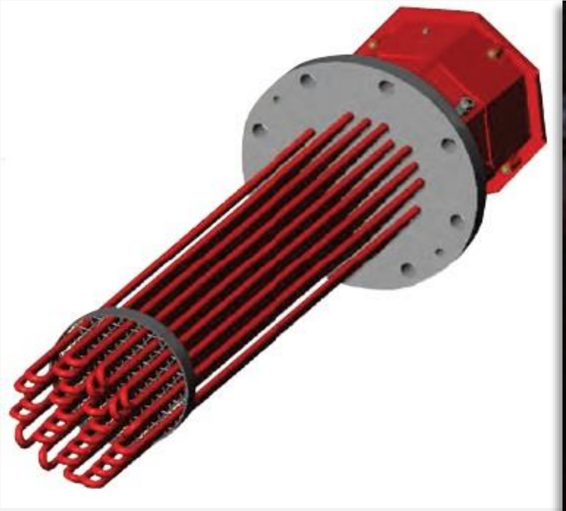
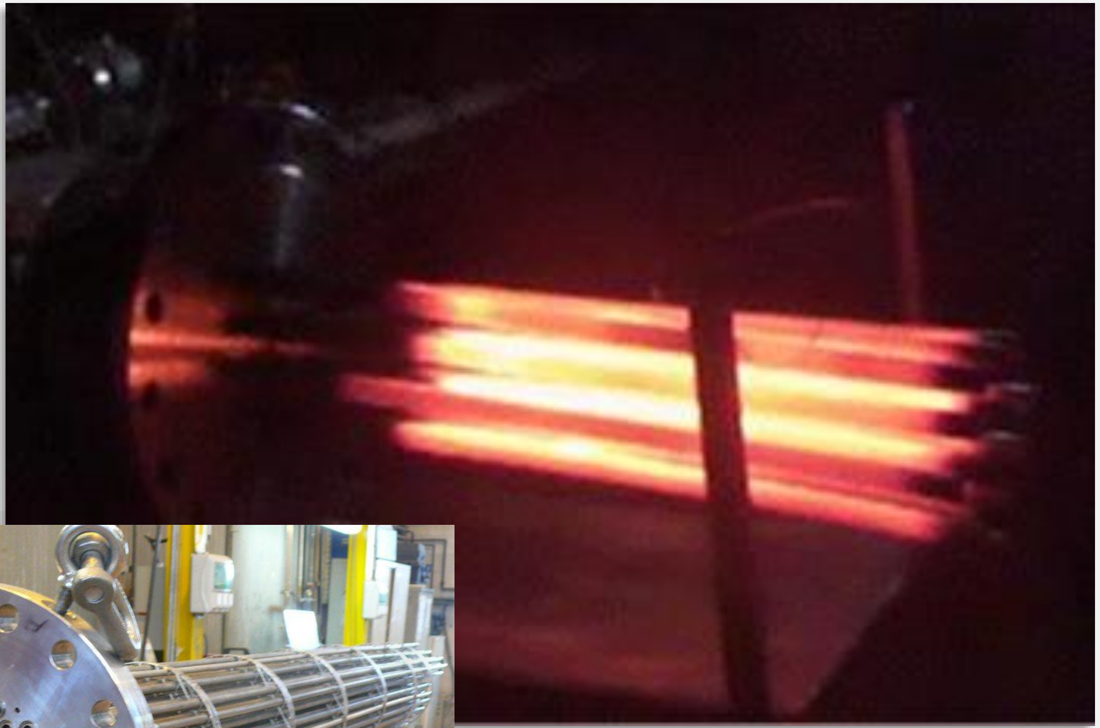
Efficiency of Electric Resistance Heating

Energy In = Energy Out

Thermal Conversion For Electric Systems Is 100%

- Losses occur upstream through I2R losses in power wiring and through heat dissipation of power switching components
- Electric power can be derived from renewable energy sources
- No combustion, open flame, or gas exhaust
- Power to heater can be trimmed based on demand, **so excessive energy is not wasted** to heat dynamic loads





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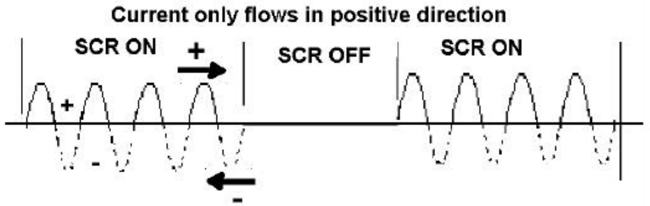
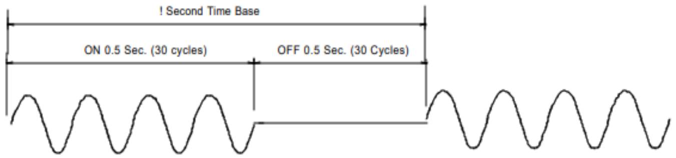
How Are Electric Heaters Controlled

High precision control allows efficient energy use

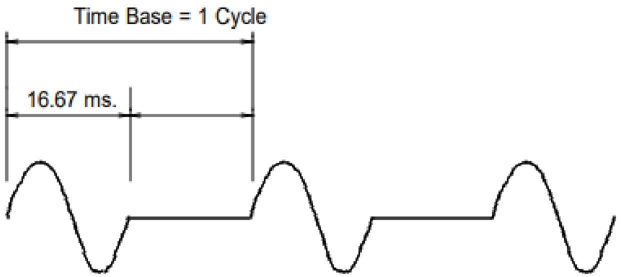
SCR CONTROL THEORY



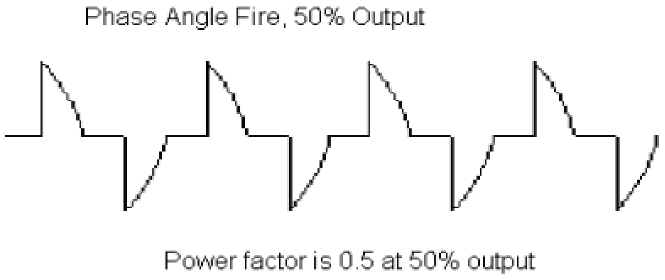
TIME PROPORTIONAL



DOT FIRING



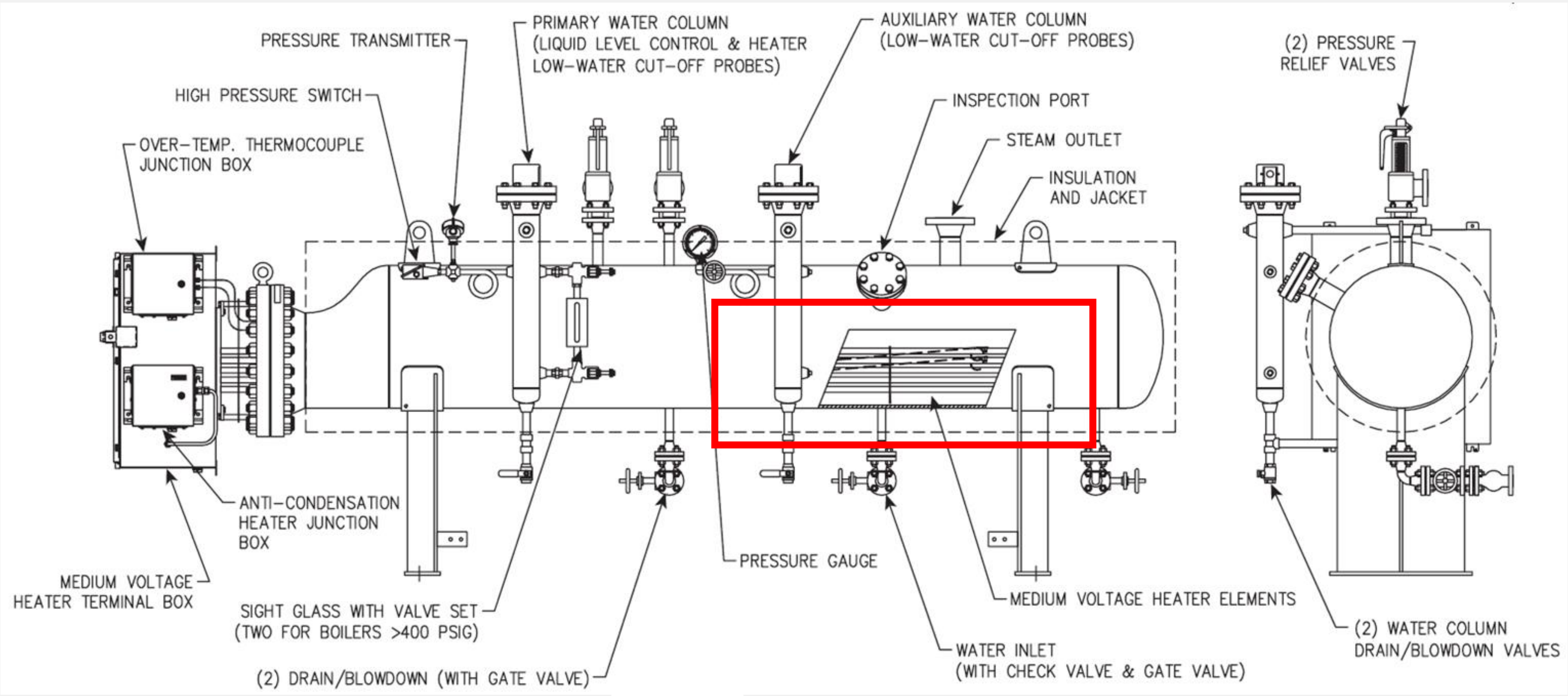
PHASE ANGLE FIRING



- Electric heaters can respond rapidly to dynamic loads by using Silicone controlled Rectifiers (SCR)
- And SCR's capability to respond to demand signals is extremely quick. With Demand-Oriented-Transfer (DOT) firing, the time scale is reduced to the minimum required to meet demand. This can be as short as a few milliseconds.
- Power is switched at the zero point (Zero Cross Firing) to prevent electrical noise, but other firing modes like Phase Angle are available for soft start or current limiting capabilities.
- Contactor control is possible as well, which offers ON/OFF switching. For stable processes this will work, or a hybrid SCR Trim control scheme allows switching on circuits with contactors and trimming a percentage of the load for dynamic response.

Electric Heaters Have No Parasitic Losses

99%+ of the energy is directly placed into the process



Natural Heat Loss

- Electric heating elements are submerged so heat has nowhere to go except into the process
- <1% of energy is lost through convection and radiation losses in shell and attachments
- Electric allows compact design and is insulated to minimize losses

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Simplicity With Electric Heating Systems

Fewer components and equipment means fewer parts to maintain and opportunities for failure

What is typical maintenance schedule for electric system?

Daily

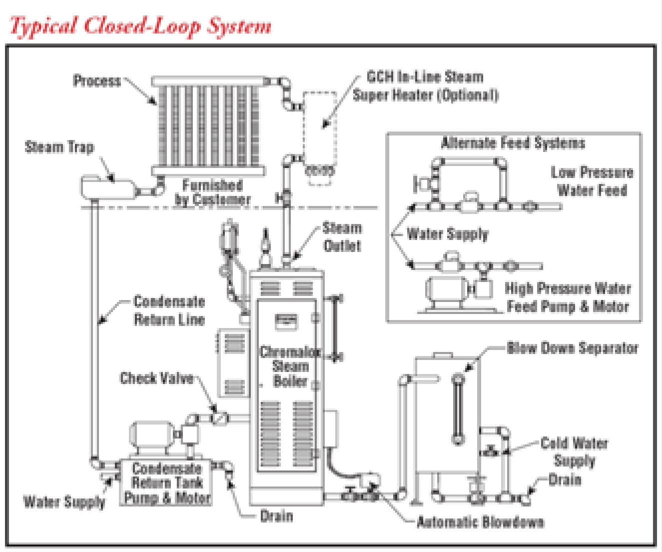
- Blowdown

Monthly

- Inspect electrical connections for tightness
- Check water and steam lines for leaks

Yearly

- Inspect bundle and remove/clean if necessary
  – *Can be achieved in hours!*



Production Downtime

Major boiler maintenance overhauls are not typically needed for electric compared to fuel-fired under the same conditions, which allows plant operations to continue running profitably for more hours per year

[1]Strategex | To Cut or Not to Cut Products

The Impact of Carbon Emissions

Governments globally are adopting cap-and-trade and carbon tax-based systems to incentivize decarbonization.

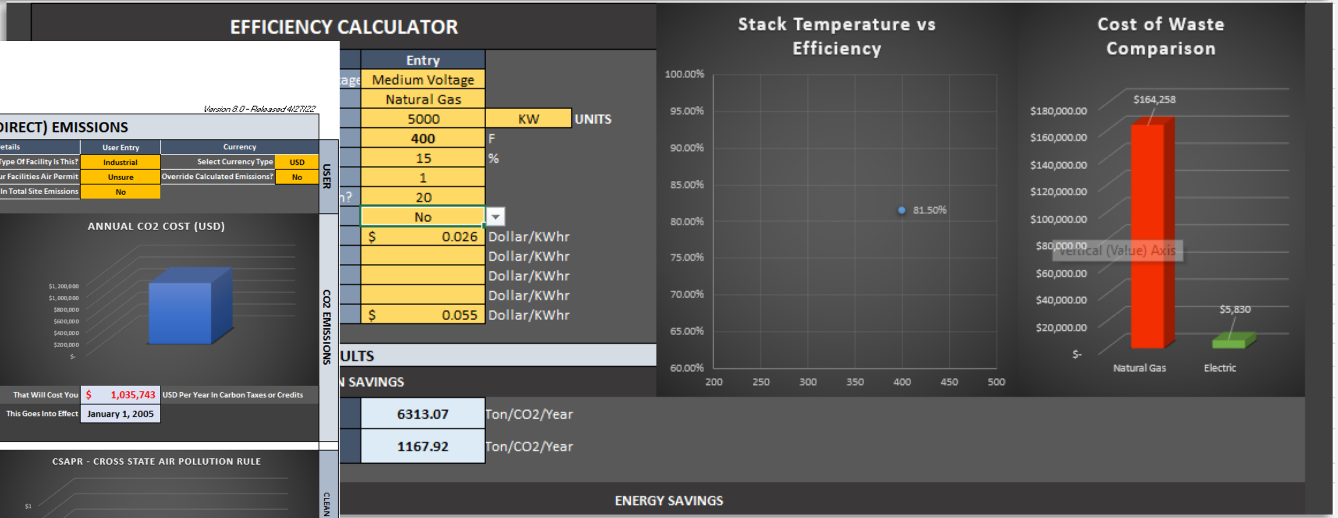
Decreasing Cap & Increasing Cost

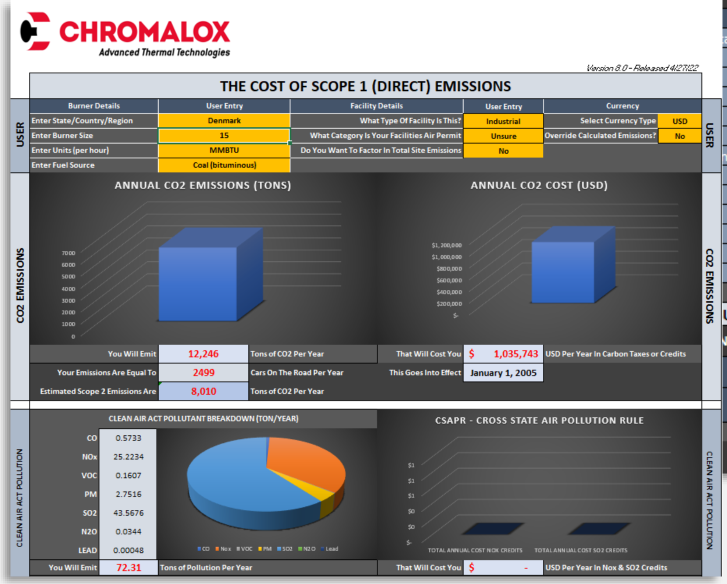
Electric Resistance Heating eliminates Scope 1 emissions. Depending on the comparative fuel types, this can equate to:

- Natural Gas = 465 tCO_2/yr per 1MMBTU
- Propane = 550 tCO_2/yr per 1MMBTU
- Fuel Oil = 650 tCO_2/yr per 1MMBTU

Carbon costs vary depending on applicable ETS clearing costs.

- RGGI (US) - ~$13.50 USD/ton
- British Columbia (Canada) - ~$50 USD/ton
- EU (Europe) - ~$85 USD/ton





[1]Strategex | To Cut or Not to Cut Products

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Zero Emission Electric Heating

- 1 megawatt of electric heating added = 1,600 tons/year of Scope 1 CO_2 emissions eliminated
- Ability to utilize renewable and off peak power supple to reduce Scope 2 CO_2 emissions
- Reduce maintenance cost by at least 50%
- Provides Energy Efficiency gains by 20% to 50%
- No emission permitting required

ZERO EMISSION STEAM GENERATION

By converting Fossil-Fuel Boilers to DirectConnect™ Electric Steam Generators, you can **eliminate carbon emissions** and enhance:

EFFICIENCY

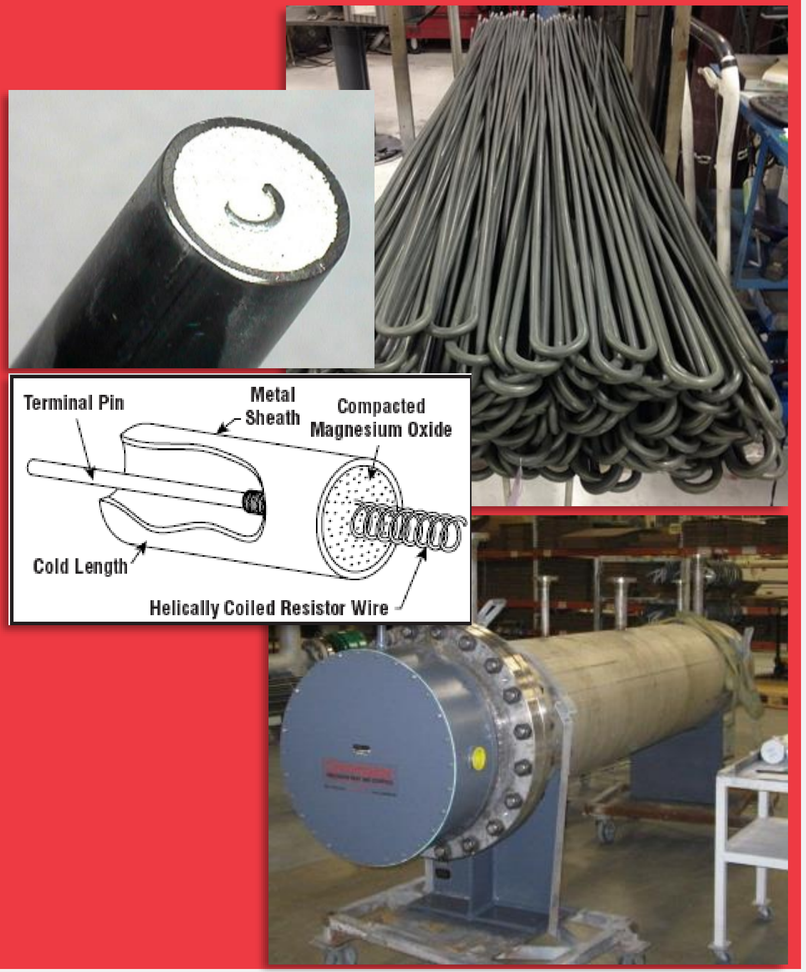
PRODUCTIVITY

RELIABILITY

DirectConnect
VS
Low Voltage

What Is Electric Resistance Heating

Core design can be vertically integrated into larger more complex systems



Simple Core Design Featuring Four Main Components

- Resistor (Ni Chrome Wire)
- Insulator (MgO)
- Container (Metal Sheath Tubing)
- Cold Pin and Termination

What Is Medium Voltage Electric Heating

- Same core concepts as low voltage but applies to voltages ranging from 1000V to 7200VAC without the use of a transformer
- Chromalox patented DirectConnect™ Technology

Reference 5 - Pages 27 & 28 ©2016 *Requirements Management: A Practice Guide*

Low Voltage vs Medium Voltage Elements

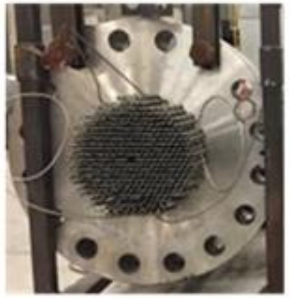
Medium voltage provides significant reduction in amperage and increase in efficiency

Low Voltage

- Up to 1000V (690V)
- Average Efficiency ~95.7%
- 0.475" Diameter Elements
- 0.028" Sheath Thickness
- 2,928V Hi Pot For 480V
- 3rd Party Certifications: UL, CSA, ATEX, IECex
- 1MW @ 415V = **1,493 Amps**
- 1.4MW SCR Control Panel = 112"W x 20"D x 90"H

Medium Voltage

- 1,000 to 7,200V
- Average Efficiency ~ 98.8%
- 0.994" Diameter elements
- 0.050" Sheath Thickness
- 15,400V Hi Pot For 6,600V
- 3rd Party Certifications: UL, ETL, ATEX, IECex
- 1MW @ 6.6kV = **88 Amps**
- 1.4MW SCR Control Panel = 90"W x 30"D x 93"H Control Panel



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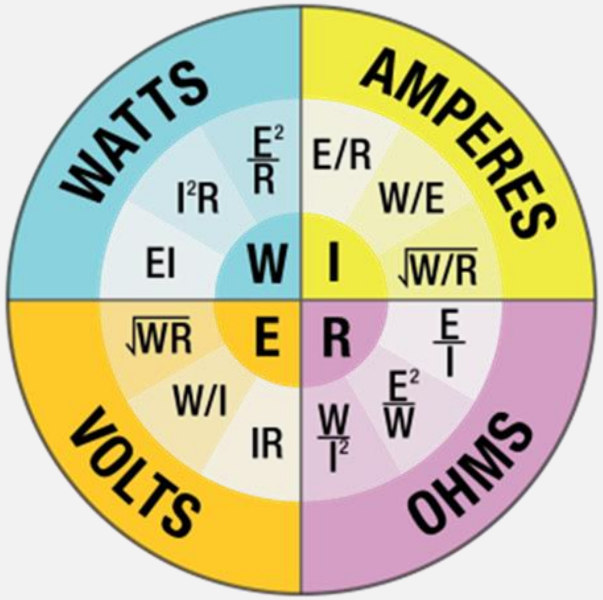
How Does MV Reduce Installation Costs

Using ohms law, we know an increase in voltage leads to decrease in amperage for fixed resistance



Case Study:

Typical Plant Service: 400-690V and 4160-6600V

Ohm's Law: kW / Voltage / 1.73 = Amperage

ex. 3,230kW at 380 V, ~4900 amps, 63 circuits

3,230kW at 6600V, ~280 amps, 3 circuits

*Using medium voltage eliminates 60 circuits worth of wire, contactors, fusing, and installation labor.

Utilizing MV reduces the amperage demand over 17X!

8

Takeaways:

- An increase in applied voltage leads to a significant drop in amperage
- Less amperage means fewer components and fewer wires
- Fewer wires leads to shorter installation labor
- A reduction in supporting components reduces maintenance and life cycle costs

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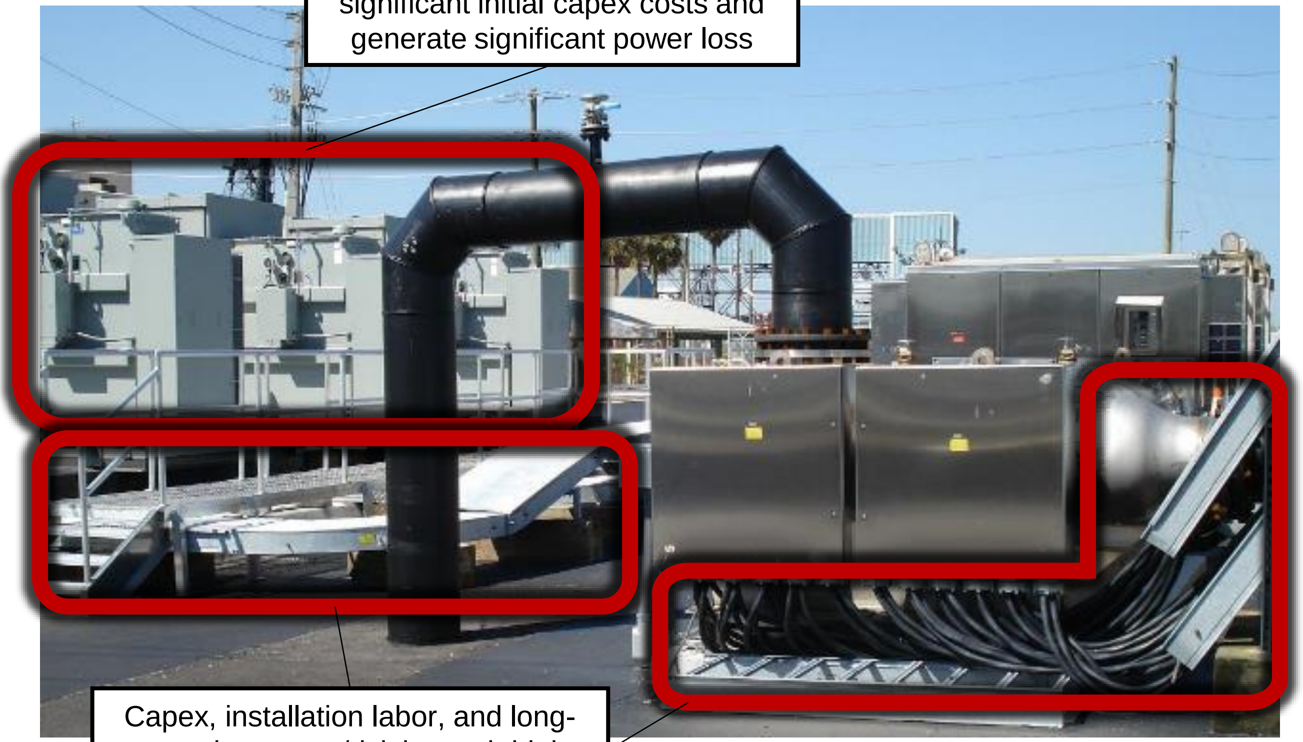
DirectConnect MV – Installation Savings Compared to Low Voltage

A look at how this translates in real world installation

Step-down transformers are a significant initial capex costs and generate significant power loss



Capex, installation labor, and long-term maintenance/risk is much higher for the transmission system

Traditional Low Voltage Solution

Significantly lower capex costs and increased energy efficiency through MV

Medium Voltage technology

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DirectConnect MV – Partial Experience List

End User Type	Install Location	Type of Facility	Product	Application	Voltage	Power Installed	Start-up	Fluid	Design Pressure (psig)	Design Temperature (°F)	Flowrate (lb/hr)
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Circulation Heater and Panel	Propane Superheater	4160 V	2.20 MW	Jun-2016	Natural Gas	1150	575	30,965
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Circulation Heater and Panel	NGL Preheater	4160 V	2.30 MW	Jun-2016	Natural Gas Liquid	1150	200	472,230
Confidential	USA	Crude Refinery	Circulation Heater and Panel	Light Cycle Oil for Heat Transfer Syste	4160 V	2.40 MW	May-2016	Light Cycle Oil	175	650	130,000
Major US Based Power Utility	USA	Power Plant	Circulation Heater/Panel Skid	Water Heater	4160 V	2.00 MW	Nov-2015	Water	300	385	35,500
Major Oil & Gas Company	USA	LPG Export Terminal	Vaporizer	Ethane/Propane vaporization	4160 V	1.65 MW	Oct-2016	Propane	350	200	18,514
Major Oil & Gas Company	Gulf of Mexico	Deepwater Offshore Platform	(2) Circulation Heaters and Panels	Oil and Produced Gas Heater	4160 V	2.60 MW	May-2016	Oil	450	250	120,536
Mexican Power Utility	Mexico	Combined Cycle Power Plant	(4) Circulation Heaters and Panels	Fuel Gas Heating & Steam	4160 V	15.50 MW	May-2016	Natural Gas / Steam	552 / 290	392 / 752	104,734 / 7,099
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Circulation Heater Skid and Panel	Butane Superheating	4160 V	4.70 MW	Jun-2017	Dry Regenerant Gas	785	600	119,111
Major Oil & Gas Company	USA	Power Plant	Circulation Heater and Panel	Steam Superheater	4160 V	1.10 MW	Jun-2017	Steam	250	600	29,500
Major US Based Power Utility	USA	Power Plant	Circulation Heater and Panel	Frazil Water Heating	4160 V	3.17 MW	Jan-2018	Water	100	54	597,600
Major Oil & Gas Company	Gulf of Mexico	Offshore Production Platform	Immersion Heater and Panel	Water/Glycol Heating	4160 V	1.32 MW	Apr-2018	Water/Glycol	150	295	731,170
Major Chemical Company	USA	HF Coolant Plant	Circulation Heater and Panel	Hot Oil Heat Transfer System	4160 V	2.03 MW	Dec-2018	Therminol 72	150	775	765,000
Major Chemical Company	Brazil	NGL Receiving Terminal	Circulation Heater and Panel	Liquid Ethane Heater	4160 V	3.30 MW	Nov-2017	Liquid Ethane	1075	86	79,380
Major Oil & Gas Company	Gulf of Mexico	Deepwater Offshore Platform	Circulation Heater and Panel	Crude Oil Heater	4160 V	0.65 MW	May-2018	Sweet Crude Oil	600	250	132,946
Major US Based Power Utility	USA	Power Plant	Circulation Heater and Panel	Natural Gas Heater	4160 V	3.23 MW	Mar-2018	Natural Gas	1250	135	200,000
Major Oil & Gas Company	USA	Ethylene Plant	Immersion Heater and Panel	Water Heating	4160 V	1.80 MW		Water	100	150	N/A
Major US Based Power Utility	USA	Combined Cycle Power Plant	Circulation Heater and Panel	Water/Glycol Heating	4160 V	5.00 MW	Feb-2019	Water/Glycol	150	150	1,384,358
Major Global Mining Company	Peru	Mineral Processing Plant	Heat Transfer System	Water/Glycol Heating	4160 V	1.80 MW	Apr-2019	Water/Glycol	100	350	132,635
Major US Based Power Utility	USA	Power Plant	Circulation Heater and Panel	Fuel Gas Heating	6900 V	1.65 MW	Oct-2019	Natural Gas	670	200	69,115
Major Chemical Company	USA	Chemical Plant	Circulation Heater and Panel	Hydrogen & Hydrocarbon Heating	4160 V	0.94 MW	Jan-2019	H2 & Hydrocarbons	800	950	4,680
Major US Based Power Utility	USA	Power Plant	(3) Circulation Heater/Panel Skids	Sea Water Heating	4160 V	7.33 MW	Jan-2019	Sea water	100	140	1,501,718
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	(2) Spare Immersion Heaters	Butane, Propane, NGL	4160 V	2.36 MW	SPARES	Butane, Propane, NG	1150	200	472,230
Major Oil & Gas Company	USA	Monoethylene Glycol & Polyethylene Pl	Vaporizer and Superheater	CO_2 Vaporizing and Superheating	4160 V	3.37 MW	Jun-2021	Carbon Dioxide	390	130	80,750
Major US Based Power Utility	USA	Power Plant	(2) Circulation Heaters and Panels	Fuel Gas Heating	4160 V	3.90 MW	Aug-2021	Natural Gas	670	495	135,000
Major Oil & Gas Company	Algeria	Gas Processing	Circulation Heater and Panel	Lift Gas Heating	5500 V	2.10 MW		Natural Gas	2872	315	68,564
Major US Based Power Utility	USA	Power Plant	(2) Circulation Heaters and Panels	Fuel Gas Heating	4160 V	0.99 MW		Natural Gas	550	150	90,000
Major Oil & Gas Company	CAN	Gas Processing	Circulation Heater and Panel	Regen Gas Heating	4160 V	1.25 MW	Oct-2020	Hydrocarbon Gas Mix	535	575	11,000
Major Oil & Gas Company	Gulf of Mexico	Floating Production System	Circulation Heater and Panel	Process Water Heating	4160 V	1.61 MW		Water	385	375	327,526
Major Oil & Gas Company	CAN	LNG Export Facility	(2) Circulation Heaters and Panels	Defrost Gas Heater	6600 V	9.50 MW		Natural Gas	942	177	222,446
Major Oil & Gas Company	CAN	LNG Export Facility	Circulation Heaters and Panels	Fuel Gas Heating	6600 V	2.44 MW		Fuel Gas	1100	136	98,731
Major Oil & Gas Company	CAN	LNG Export Facility	(2) Circulation Heaters and Panels	Cooling Water Heating	6600 V	7.60 MW		Water	232	111	198,416
International Chemical J-V	USA	High-Density Polyethylene Production	Circulation Heater and Panel	Regen Gas Heating	4160 V	1.21 MW	Sep-2021	Nitrogen	72.5	622	29,101
LNG Company	USA	LNG Export Facility	(2) Circulation Heaters and Panels	Fuel Gas Heating	4160 V	0.80 MW	Nov-2021	Natural Gas	1100	136	98,731
LNG Company	USA	LNG Export Facility	Circulation Heater and Panel	Defrost Gas Heating	4160 V	0.40 MW	Nov-2021	Nitrogen	100	130	40,000
LNG Company	USA	LNG Export Facility	(2) Circulation Heaters and Panels	Acid Gas Heating	4160 V	0.48 MW	Nov-2021	Acid Gas	13	130	159,252
Major Oil & Gas Company	Africa	FPSO	(2) Circulation Heaters and Panels	Process Water Heating	6600 V	5.50 MW		Process Water	345	195	288,805
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Spare Immersion Heater	Butane, Propane, NGL	4160 V	1.18 MW	Feb-2021	Butane, Propane, NG	1150	200	472,230
Major Global Mining Company	Peru	Mineral Processing Plant	Spare Flanged Heater Assembly	Water/Glycol Heating	4160 V	1.80 MW	SPARE	Water/Glycol	100	350	132,635
Major US Based Power Utility	USA	Power Plant	(5) Circulation Heaters and Panels	Fuel Gas Heating	4160 V	2.50 MW	Dec-2021	Natural Gas	450	225	53,640
Major Oil & Gas Company	USA	LNG Export Facility	Vaporizer and Control Panel	Ethylene Vaporizing	4160 V	1.93 MW		Ethylene	240	150	36,441
Major Oil & Gas Company	USA	LNG Export Facility	Circulation Heater and Panel	Fuel Gas Heating	4160 V	0.87 MW		Fuel Gas	1480	310	58,070
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Spare Immersion Heater	Butane, Propane, NGL	4160 V	1.18 MW	Apr-2021	Butane, Propane, NG	1150	200	472,230
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Spare Immersion Heater	Butane, Propane, NGL	4160 V	1.18 MW	SPARE	Butane, Propane, NG	1150	200	472,230
Major Oil & Gas Company	Saudi Arabia	Gas Reservoir Storage	(5) Immersion Heaters/Panels	TEG Reboiler Heaters	4160 V	3.80 MW		Triethylene Glycol	50	399	17,900
Major Oil & Gas Company	USA	NGL Processing & Export Terminal	Spare Immersion Heater	Butane, Propane, NGL	4160 V	1.18 MW	SPARE	Butane, Propane, NG	1150	200	472,230
Major US Based Power Utility	USA	Power Plant	Immersion Heater and Panel	Water/Glycol Heating	4160 V	4.00 MW		Water/Glycol	150	150	1,640,000
University	CAN	Steam Plant	(2) Steam Generators	Steam Generation	6600 V	20.00 MW		Water	150	336	30,000
Major Oil & Gas Company	USA	Renewable Fuels Facility	(4) Circulation Heaters and Panels	Feedstock Heating	2400 V	2.60 MW		Various Feedstock	30	140	395,000
Major Oil & Gas Company	USA	Renewable Fuels Facility	(2) Circulation Heaters and Panels	Feedstock Heating	4160 V	1.30 MW		Various Feedstock	30	140	395,000
Major US Based Power Utility	USA	Power Plant	Steam Generator	Steam Generation	4160 V	2.30 MW		Water	250	406	6,932
District Energy Provider	CAN	District Heating	(2) Hot Water Generators	Water Heating	4160 V	13.80 MW		Water	150	190	500,510
Major Oil & Gas Company	Sweden	Crude Refinery	Circulation Heaters and Panels	Feedstock Heating	6300 V	7.70 MW		Ethane / Hydrogen	943	664	490,750
Power Utility Company	USA	Combined Cycle Power Plant	(3) Circulation Heaters and Panels	Water/Glycol Heating	4160 V	3.50 MW		Water/Glycol	150	200	169,173

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Key Points From LV vs MV Cost Savings

Savings Are Realized In Multiple Areas

- Elimination of costly step-down transformers
- Reduced labor hours:
  - 1,270 hours for LV vs 70 hours for MV
- Conduit runs:
  - 380V = 50 vs 6.6kV = 9
- Wired circuits:
  - 380V = 63 vs 6.6kV = 3
- Increased Operational Efficiency
  - 380V = ~95.7% vs 6.6kV = ~98.8%
- Reduced Maintenance Costs:
  - LV = ~$238K vs MV = ~$40K

Cost of Ownership	380V	6,600V	Savings
Installation	$1,752,900	$907,500	**$845,400**
Operating	$4,070,400	$220,100	**$3,850,300**
Maintenance	$179,600	$17,100	**$162,500**
10 Yr Life Cycle Costs	$237,900	$39,900	**$198,000**
20 Year Costs	$6,240,800	$1,184,600	**$5,056,200**
Annualized Costs	$312,040	$59,230	**$252,810**

- We can see a decrease in amperage provides savings across multiple aspects of ownership, from initial installation to operating and life cycle costs.
- Chromalox DirectConnect Medium Voltage technology can provide significant annual savings

THANK YOU

Merci | Gracias | Obrigada

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