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Beyond Energy Savings:
Quantifying the Additional Benefits from Energy Efficiency

Tuesday, January 12, 2020

11:00 AM – 12:00 PM EDT

Bruce Lung

U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY

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Polls 1-2

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Multiple Benefits of Energy Efficiency

- The concept of multiple or non-energy benefits is known
- Research has shown that including multiple benefits improves ROI calculations. Example:
  - Worrel, Laitner, Finman & Hodaya
    - Simple payback without multiple benefits = 4.2 years
    - Simple payback with multiple benefits = 1.9 years
- Problem is that most studies come AFTER projects were implemented
- Can we identify & quantify multiple benefits BEFORE projects are implemented?
- Yes!!!

Today’s Presenters

Catherine Cooremans
Université de Lausanne

Alex Zhang
Lineage Logistics

Catherine Cooremans

Université de Lausanne

Better Buildings Webinar Series

Beyond Energy Savings: Quantifying the Additional Benefits from Energy Efficiency

The MBenefits approach to investment projects

Catherine Cooremans, PhD, MBA

Université de Lausanne – Eco'Diagnostic Genève

January 12, 2021

Outline:

- Introduction
- Context
- The Mbenefits method
- The Toolkit
- Pilot projects examples
- Conclusion

Introduction

The MBenefits project & team

Fraunhofer ISI

Graz ENERGYAgency

BORGOCO

IREES Institute for Resource Efficiency and Energy Strategies

KAPE

Environmental Change Institute

eci

UNIVERSITY OF OXFORD

Lucerne University of Applied Sciences and Arts

HOCHSCHULE LUZERN

FH Zentralschweiz

ceeee european council for an energy efficient economy

FIRE FEDERAZIONE ITALIANA PER L'USO RAZIONALE DELL'ENERGIA

Utrecht University

Unil UNIL | Université de Lausanne

BPIE

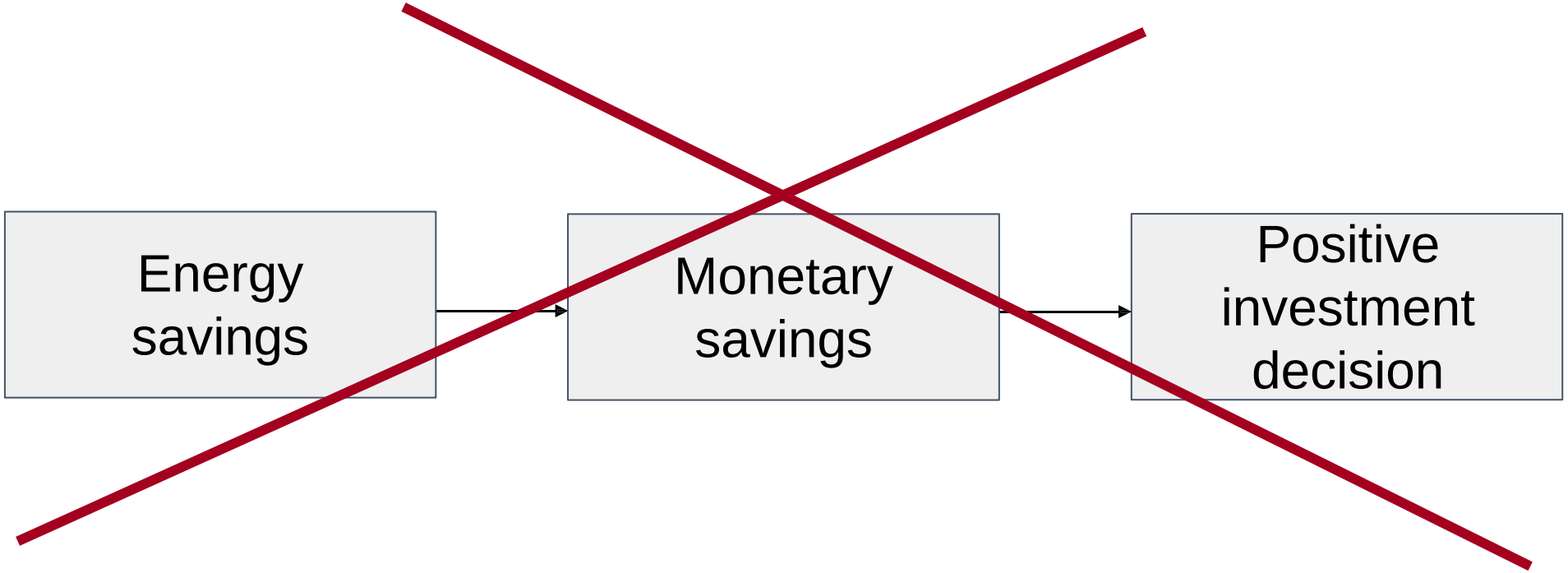
Hes·so Haute Ecole Spécialisée de Suisse occidentale Fachhochschule Westschweiz University of Applied Sciences and Arts Western Switzerland

ISR - University of Coimbra

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 785131. This document only reflects the authors' views and EASME is not responsible for any use that may be made of the information it contains.

Context

The conventional approach to energy-efficiency projects:



Does not work (well enough)

- Energy is not a priority for companies, which often waste energy.
- There is a very **tough internal competition** between projects.
- Decision-makers select investment projects contributing to core business and benefitting the whole company.

"As a CEO, there is only so much time and so many projects and initiatives we can focus on and execute at one time. What is important to me is what is important to helping us grow our business an retain our customers."

CEO Insurance brokerage company

The MBenefits method

The MBenefits method

A decision-support tool for investment projects:

- Includes complimentary analyses.
- Takes into account the interests of all company departments.
- Does not provide default values for non-energy benefits.
- Applies to any type of project, activity, or organization.
- Is clear and simple to apply.

The MBenefits method increases the attractiveness of an investment project and thus its chances of being approved.

The MBenefits method of analysis

www.mbenefits.eu

www.mbenefits.eu

STEP 1 – Company's analysis

- What is the energy-efficiency project's contribution to the company's business model?
- What are the decision-making drivers?

www.mbenefits.eu

STEP 2.1 – Energy analysis

- Level of analysis: the project
- What is the impact of the project on energy consumption?

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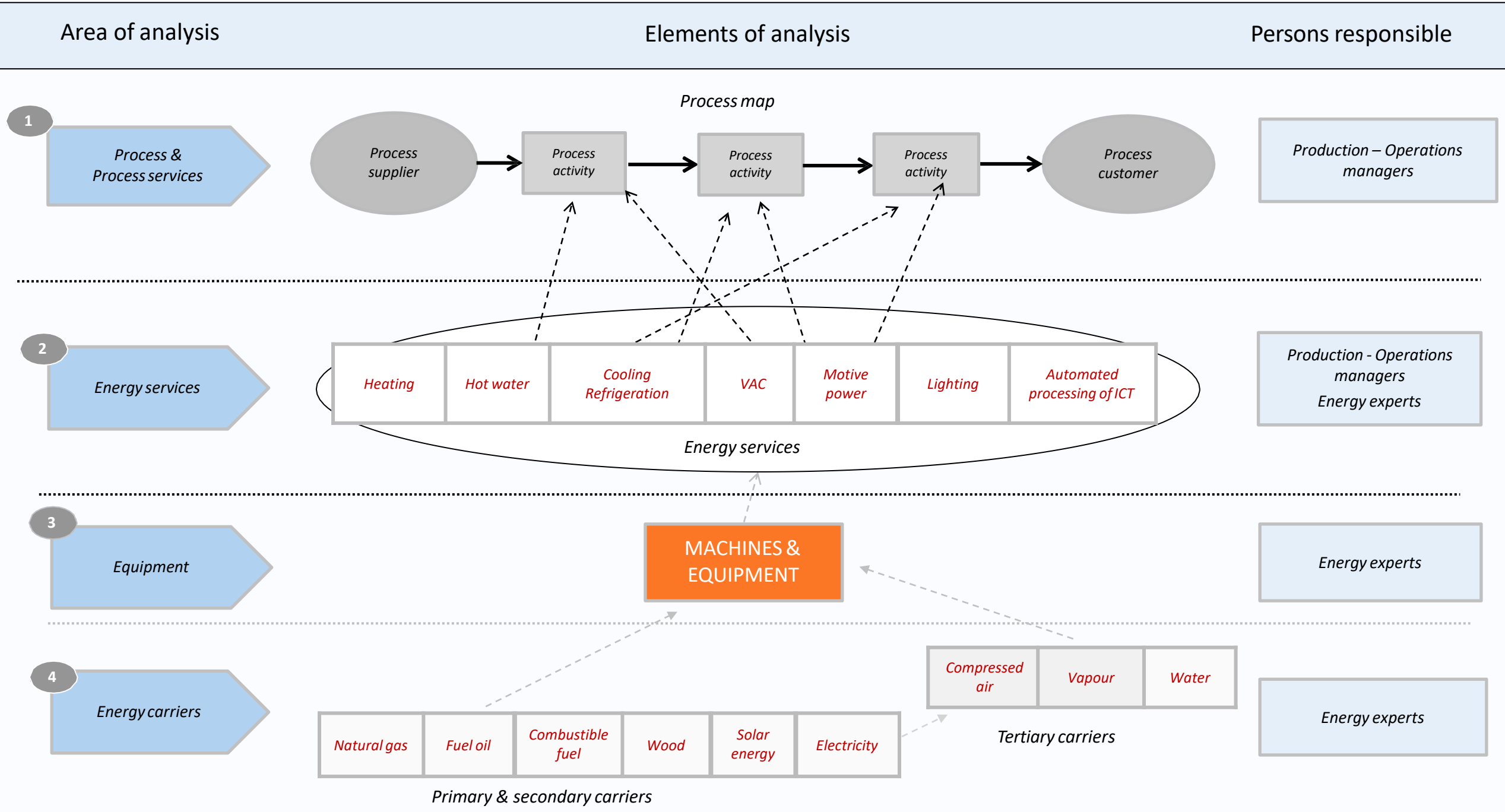
STEP 2.2 Operational Analysis

- What is the project's contribution to operational excellence?

Safety | Quality | Costs | Time


Area of analysis
Elements of analysis
Persons responsible
1
Process & Process services
Process map
Process supplier
Process activity
Process activity
Process activity
Process customer
Production – Operations managers
2
Energy services
Heating
Hot water
Cooling Refrigeration
VAC
Motive power
Lighting
Automated processing of ICT
Energy services
Production - Operations managers
Energy experts
3
Equipment
MACHINES & EQUIPMENT
Energy experts
4
Energy carriers
Natural gas
Fuel oil
Combustible fuel
Wood
Solar energy
Electricity
Primary & secondary carriers
Compressed air
Vapour
Water
Tertiary carriers
Energy experts

Example: Industrial bakery

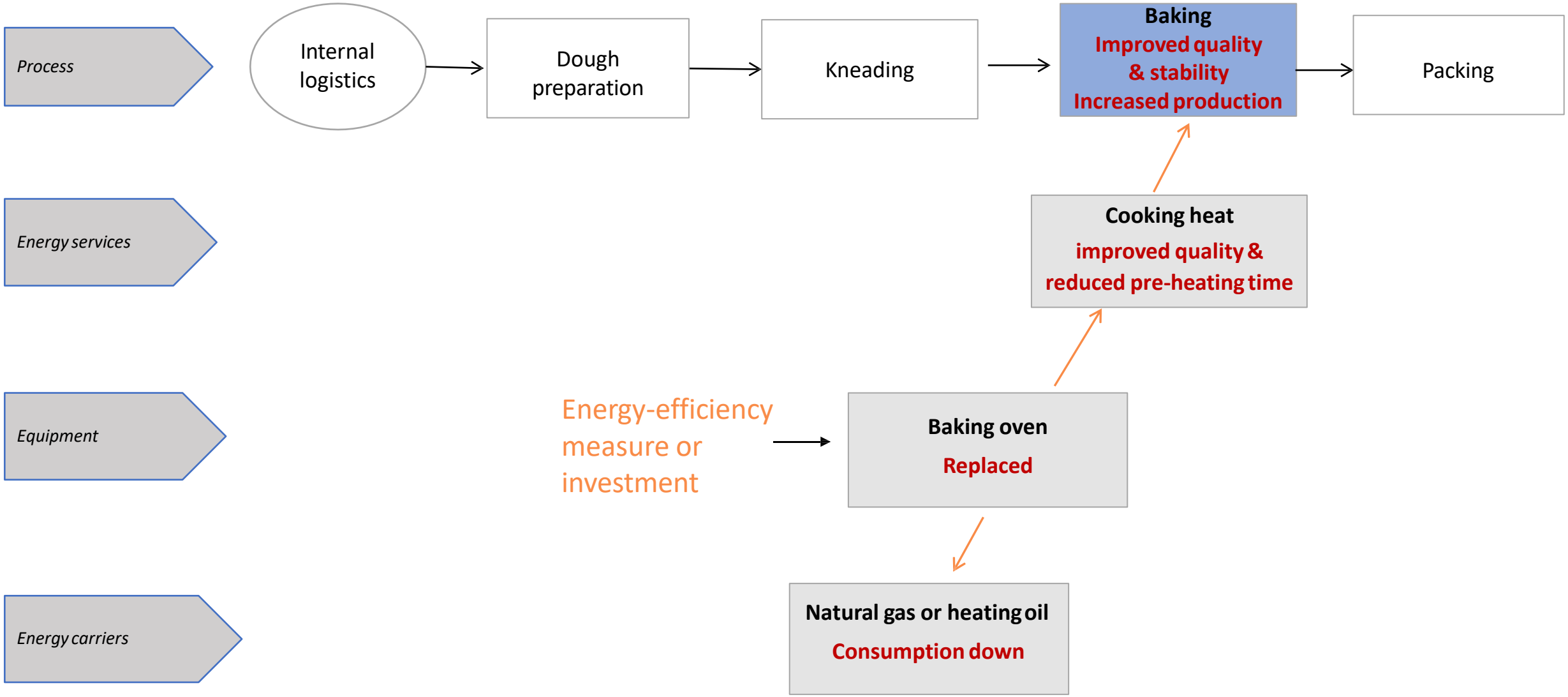
- Swiss Precision: a well-proven manufacturing process.

  Our production runs 24 hours a day, seven days a week, in shifts. More than 30,000 rolls per hour, ten per second, are produced in our factory. But speed isn't everything. Every product meets its specifications exactly - millimeter precision guaranteed.
- Quality: our top priority
- Always on the lookout: We are constantly developing new products.

https://www.fortisa.ch/fr/Production

Example: replacement of baking ovens in an industrial bakery

Step 2 – Energy & operations analysis



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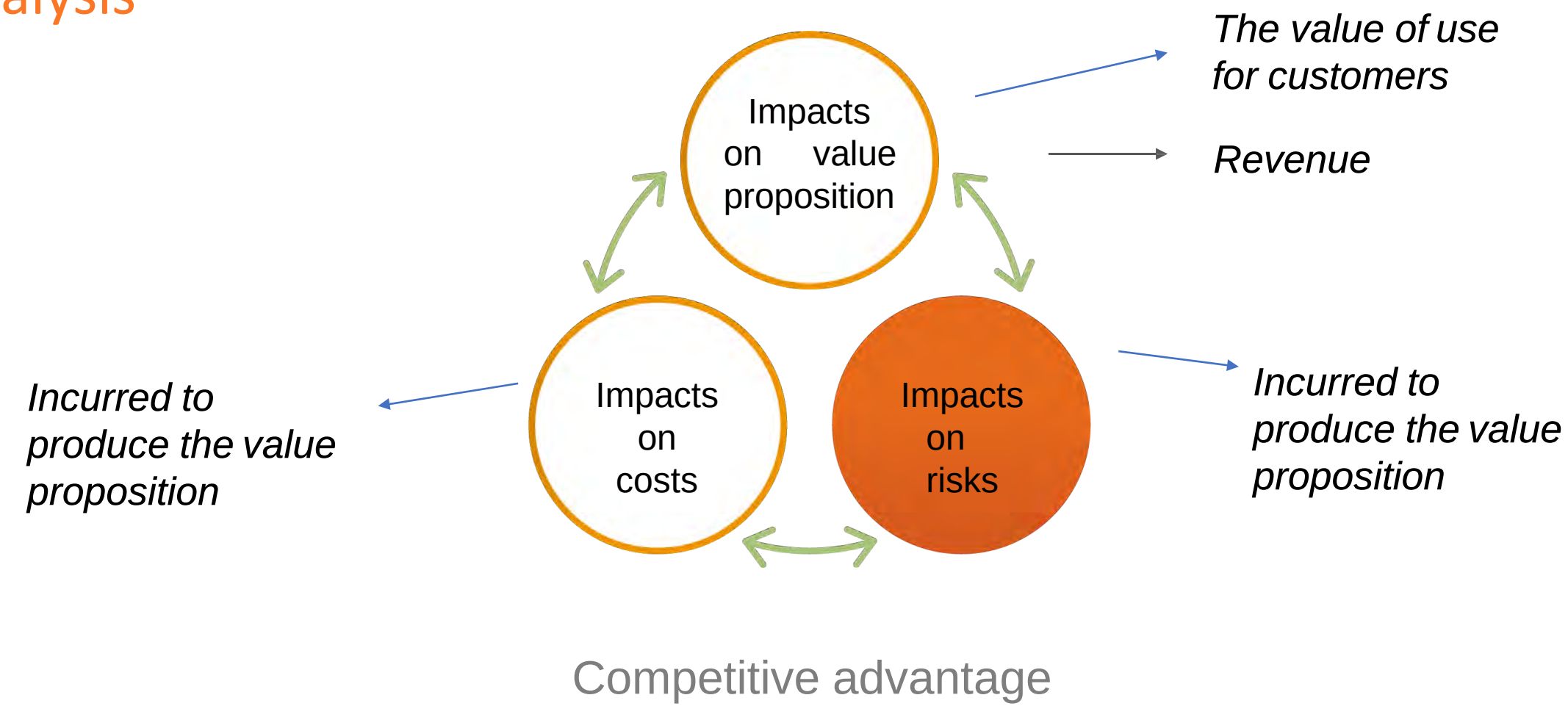
STEP 3 – Strategic analysis

- What is the project's contribution to the company's competitive advantage?

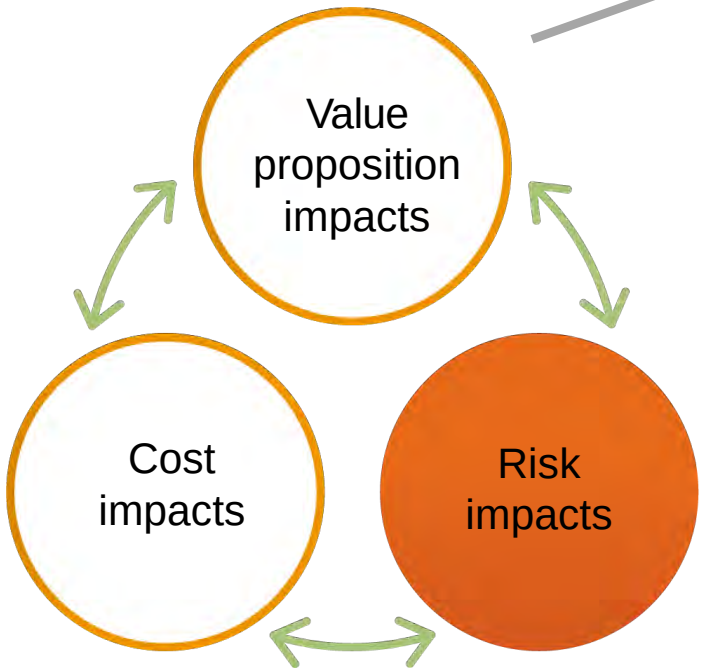
Strategic analysis

Value-Cost-Risk analysis



Strategic analysis example:

replacement of baking ovens in an industrial bakery



- Increased product quality
- Improved product stability
- Increased staff satisfaction and loyalty

- Increased workforce productivity
- Increased equipment productivity
- Lower costs of products not conforming to specifications
- Lower maintenance costs
- Lower energy & carbon costs

- Lower workplace accident risk
- Lower legal risk
- Lower breakdown & production disorganization risks
- Lower commercial risk
- Lower CO2 risk

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STEP 4 – Financial Analysis

- What is the financial attractiveness of the project?
- i.e. profitability (NPV-IRR) & payback

Financial analysis example: complete renovation of an office building

Energy benefits only:

- CAPEX: 24’000’000 CHF (approx. = 27’000’000 US$)
- Investment income before taxes: 380’000 CHF
- NPV: - 20’170’000 CHF
- IRR: -11.69 %
- Simple payback: 49 years

Energy + non-energy benefits:

- CAPEX: 24’000’000 CHF (approx. = 27’000’000 US$)
- Investment income before taxes: 3’390’000 CHF
- NPV: 4’840’000 CHF
- IRR: 11.04 %
- Simple payback: 8 years

Discount rate: 8 %
Investment duration: 15 years (= number of years used to calculate NPV and IRR).

NB: In this example, non-energy benefits figures do not take into account an **increased value of the real estate asset** or possible increases in energy and CO2 prices.

Step 4 – Financial analysis

NON-ENERGY BENEFITS (NEBs)

NON-ENERGY BENEFITS	Amount in CHF	Start period	Duration	Year 0	Year 1
Better space use	1 385 200	Year 1	Recurrent	0	1 385 200
Maintenance cost reduction	270 000	Year 1	Recurrent	0	270 000
Maintenance cost reduction	30 000	Year 1	Recurrent	0	30 000
C02 cost reduction	144 000	Year 1	Recurrent	0	144 000
Reduction of wear & tear of machinery & equipment	45 000	Year 1	Recurrent	0	45 000
Reduced cost of complaint management and adjustments	12 000	Year 1	Recurrent	0	12 000
Improved employee productivity (hyp. 1.25% improvement)	1 312 500	Year 1	Recurrent	0	1 312 500
Reduced turn-over cost (hyp. 0.5% improvement)	192 500	Year 1	Recurrent	0	192 500
TOTAL NON-ENERGY COST REDUCTION IN CHF				0	3 391 200

Total non-energy benefits income before taxes

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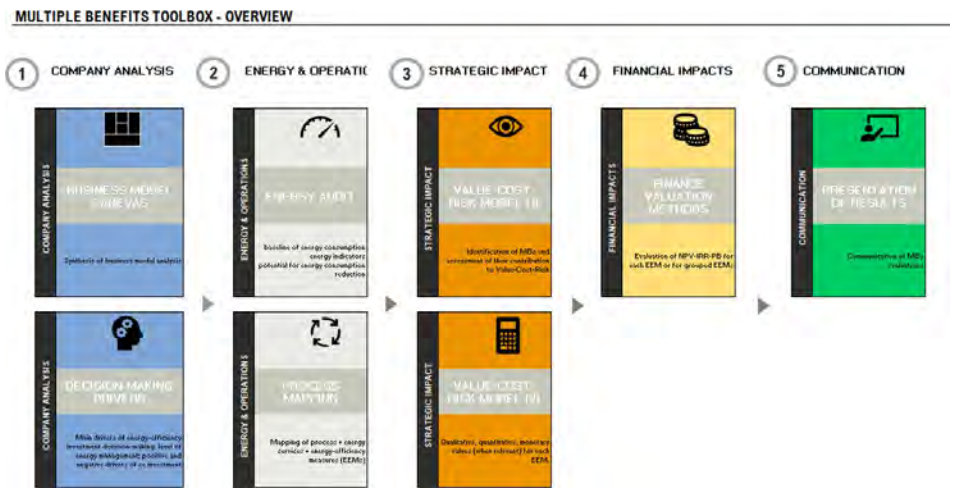
STEP 5

- Communication to top management decision-makers:

  why this project is worthwhile.

The MBenefits toolkit

- Method
  - 4 analysis steps + communication
- Software including
  - Information-help section
  - Energy services description
  - Non-energy benefits check-list (60)
  - Template for result presentation
- Training workshops
  - Concepts
  - Serious game
- Learning base
  - Pilot projects results



Mark your agenda:

M-BENEFITS conference (virtual), May 11th, 2021, where all pilot project results will be presented.

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MBenefits pilots
Examples

Pilot project example 1: Renovation and optimization of the chromium plating workshop facilities (ventilation, rectifier cooling, chromium plating baths)

1. COMPANY ANALYSIS

Activity:
X is a company active in the coating of metal parts.

Customer segment & value proposition:
B2B - Customized work, on demand (parts are supplied by the customer); quality and flexibility; respect of deadlines.

2. ENERGY & OPERATIONS ANALYSIS

- Reduction of the **energy consumption** of the equipment concerned: 23.7%
- **Employee safety:** improved working conditions
- **Quality:** reduction of non-quality and unplanned production stoppages.
- **Costs:** reduction of non-quality & customer problems costs; energy costs.
- **Time:** time saved on re-do.

WHY THIS PROJECT IS WORTHWHILE:

- Employee and process safety: improved employee comfort & health.
- Operational efficiency: increased labor productivity; reduction of non-quality.
- Lower costs: labor costs, non-quality costs, energy costs.
- Financial attractiveness of the investment.
- Strategic impacts on competitiveness: improved customer service; employee satisfaction and loyalty; reduced health & legal risks, commercial risks.

3. STRATEGIC ANALYSIS

Better value proposition:
- Increased reliability of production & quality of products
- Reduction of malfunctions/delays
- Improvement of customer service
- Employee satisfaction and loyalty

Cost reduction:
- Costs of non-quality
- Improved productivity
- Energy costs

Risk reduction:
- Health/legal risks
- Commercial risk
- Risk of production disorganization

4. FINANCIAL ANALYSIS

Discount rate: 8%
Investment duration: 10 years
Corporate tax rate: 13.84%

ENERGY BENEFITS ONLY:
- Initial investment: 25’500 CHF
- Investment income before taxes: 31’740 CHF
- NPV : 160’370 CHF - IRR: 108,56 %
- Payback: 9 months.

NON-ENERGY BENEFITS INCLUDED:
- Investment income before taxes: 43’330 CHF
- NPV : 227’376 CHF - IRR: 147,77 %
- Payback: 7 months.

Pilot project example 2: Renovation of the windows (electrochromic glazing) and lighting system in the headquarter building of a multinational company

1. COMPANY ANALYSIS

Activity:
Maintain an optimal and environmentally-friendly building portfolio.

Customer segment & value proposition:

- The General Management – Swiss plants (Building envelope) R&D employees - Pension fund - All employees on administrative sites.
- A healthy and environmentally-friendly working environment for all employees in Switzerland. Quality services at a competitive cost.

2. ENERGY & OPERATIONS ANALYSIS

- Reduction of the **energy consumption** of the building concerned: 29%.
- Better **quality** of building and working conditions.
- **Safety**: better employee health and comfort.
- **Costs:** reduced maintenance and energy costs.

WHY THIS PROJECT IS WORTHWHILE:

- Employee safety: better employee comfort and health.
- Operational efficiency: increased labor productivity.
- Lower operational costs: maintenance, equipment, CO2 and energy costs.
- Financial attractiveness of the investment.
- Strategic impacts on competitiveness: employee satisfaction and loyalty; customer satisfaction (environmentally-friendly building); contribution to company's vision and strategy.

3. STRATEGIC ANALYSIS

Better value proposition:

- More environmentally-friendly building.
- Employee satisfaction and loyalty.
- Contribution of the renovated building to the company's strategy and vision.

Cost reduction:

- Improved productivity due to better visual quality.
- Maintenance & equipment costs.
- Cost of complaint management.
- Energy and CO2 costs.

Risk reduction:

- Reduced risk of occupational illnesses.
- Risk of loosing talent.

4. FINANCIAL ANALYSIS

Discount rate: 8%
Investment duration: 10 years
Corporate tax rate: 13.84%

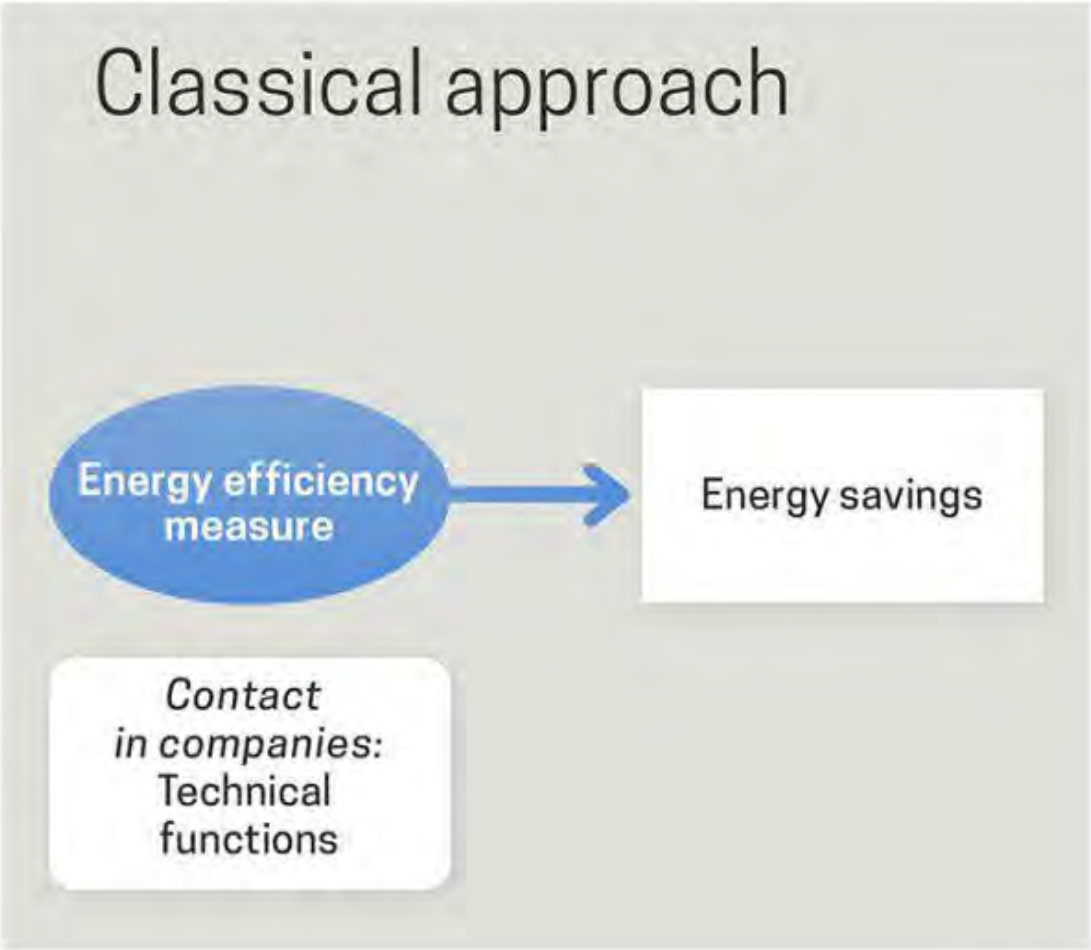
ENERGY BENEFITS ONLY:

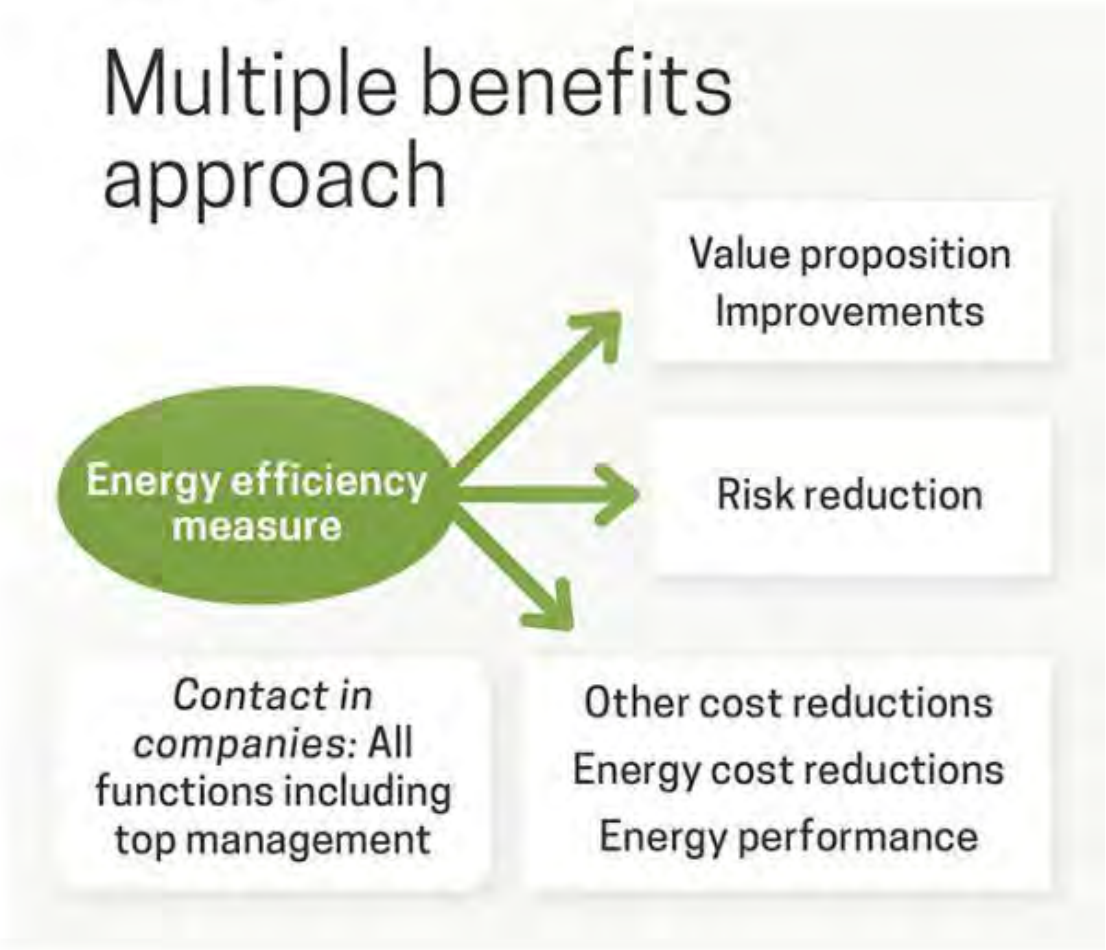
- Initial investment: 5'300'000 CHF
- Investment income before taxes: 115'500 CHF
- NPV : - 4'084'795 CHF - IRR: -10.17%
- Simple payback: 41 years

NON-ENERGY BENEFITS INCLUDED:

- Investment income before taxes: 562'500 CHF
- NPV : 63'557 CHF - IRR: 8.2 %
- Simple payback: 9 years

Conclusion





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The MBenefits approach increases the attractiveness of projects for decision-makers because it:

- Takes into account all main corporate interests: operations, logistics, production, marketing & sales, strategy, finance.
- Beyond energy savings!
- Makes energy efficiency strategic.
- Makes energy efficiency more profitable.
- Bridges the gap between the “energy people” and the “non-energy people”.

Thank you for your attention

catherine.cooremans@unil.ch
cooremans@ecodiagnostic.ch

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Alex Zhang

Lineage Logistics

Energy Benefits and Beyond in Cold Storage

Alex Zhang, Lineage Logistics Data Science Team

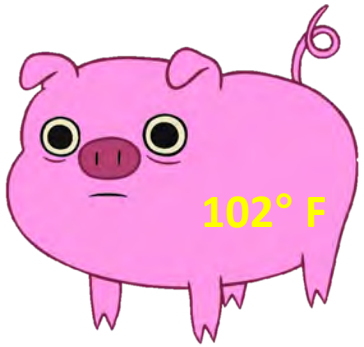
Lineage

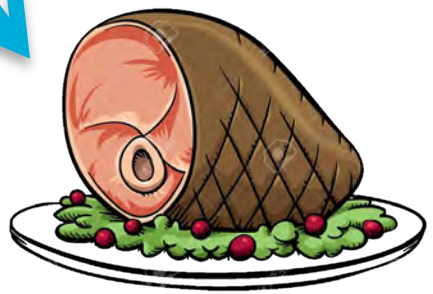
Outline

- What is Lineage Logistics?
- Case Study 1: Increasing Blast Throughput
- Case Study 2: Energy Scheduling

COLD STORAGE WAREHOUSING

- Perishable products need to be stored at 0F or below to maintain quality and safety
- Lineage Logistics operates a global network of over 120 cold storage facilities to store and distribute such products





CUSTOMER SNAPSHOT

Lineage
Lineage Headquarters
Lineage Facilities (New)
Lineage Facilities
Port Facilities
Major Logistics Market
SEATTLE
TACOMA
NORCAL
LOS ANGELES
INLAND EMPIRE
CHICAGO
NOVI
KANSAS CITY
FORT WORTH
DALLAS
HOUSTON
NEW ORLEANS
ATLANTA
ALLENTOWN
NY/NJ
BOSTON
NORFOLK
CHARLESTON
SAVANNAH
JACKSONVILLE
MIAMI
UK
NETHERLANDS
BELGIUM
AUSTRALIA
NEW ZEALAND
CHINA
VIETNAM
SRI LANKA

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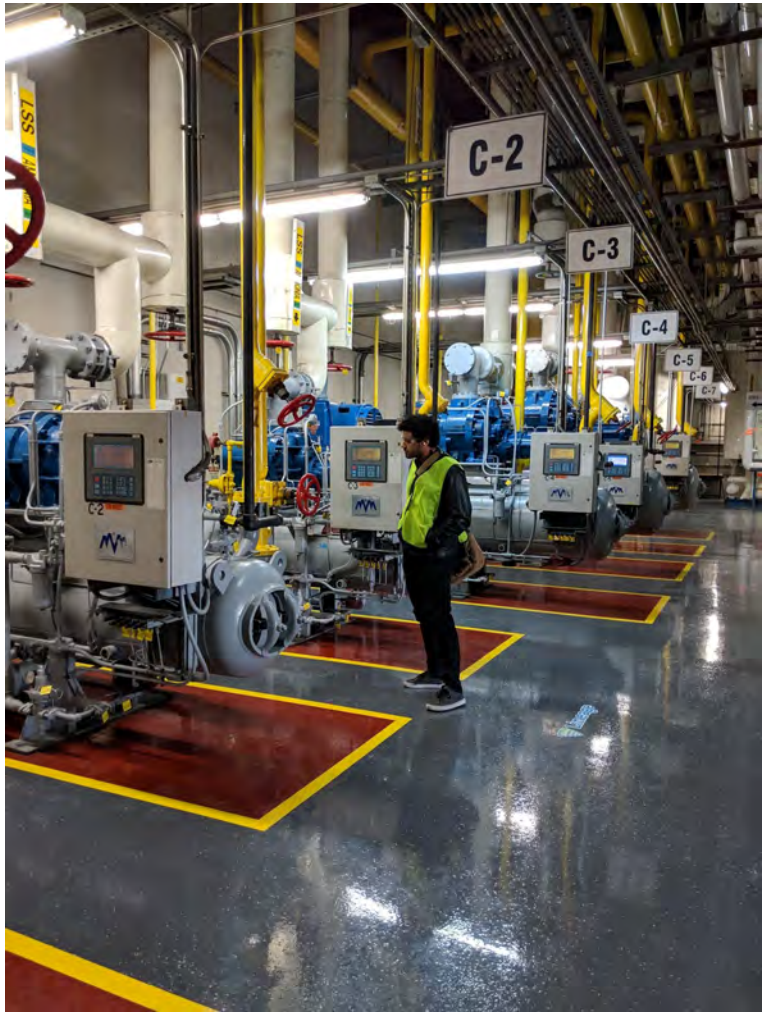
10-7
10-6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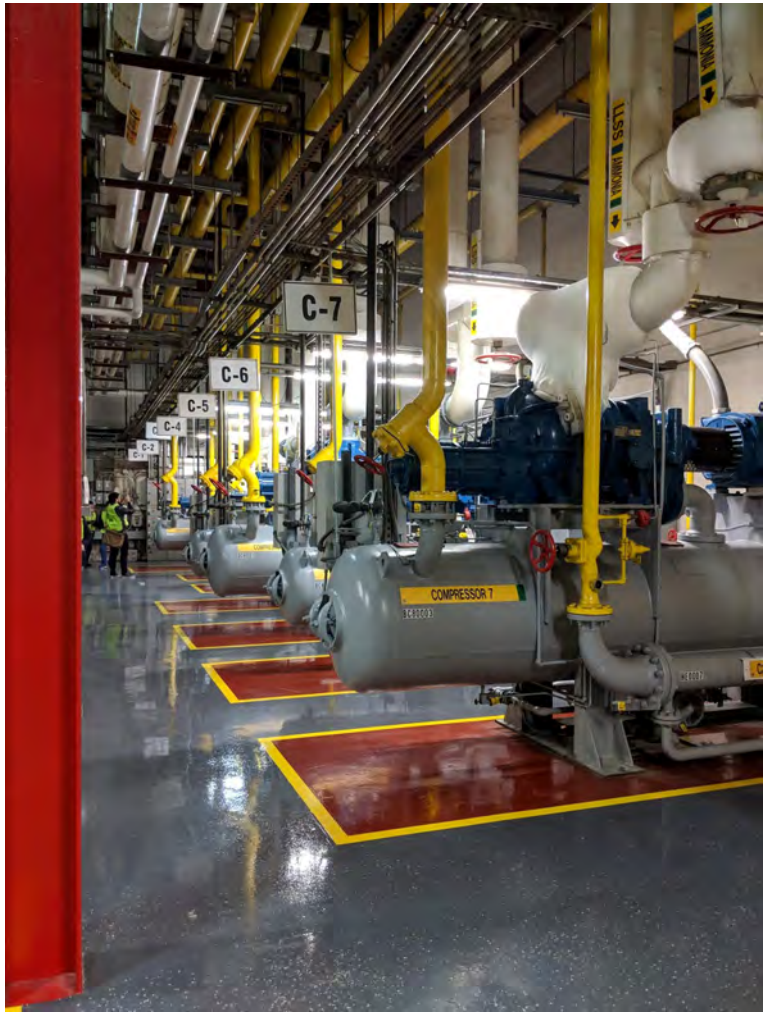
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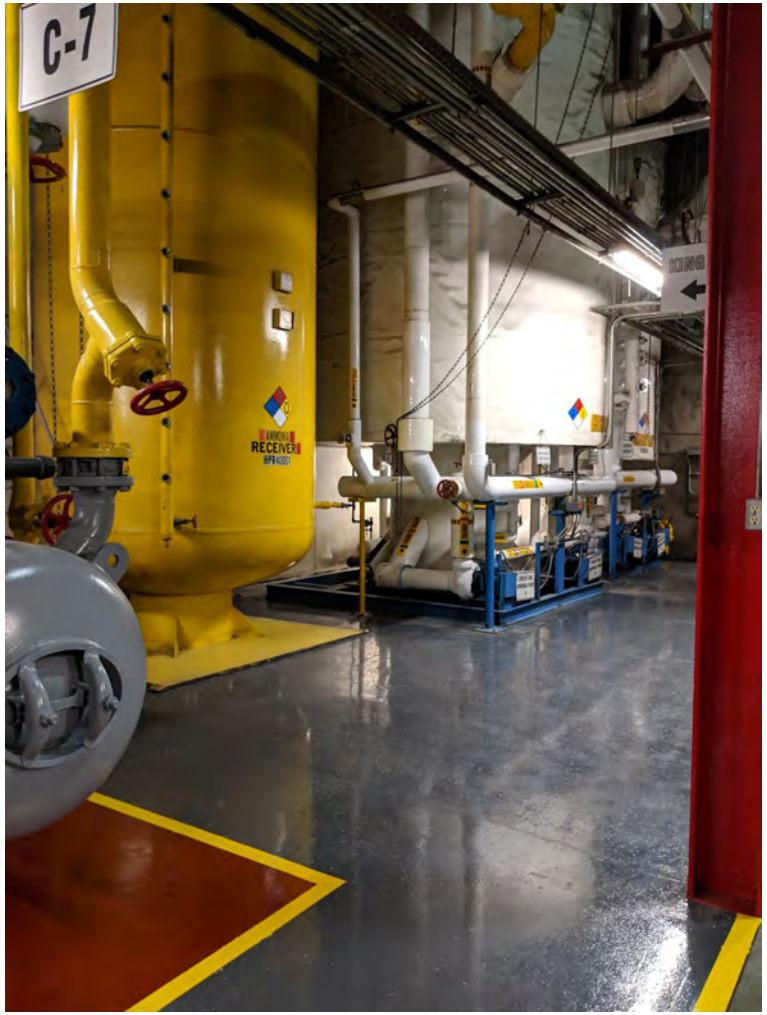
COMPRESSOR 7


C-7
RECEIVER

Outline

- What is Lineage Logistics?
- **Case Study 1: Increasing Blast Throughput**
- Case Study 2: Energy Scheduling

APPROACH

EBITDA = PRICE * QTY - POWER - LABOR

		Thermal Work		Efficiency		Price / kW
Power Cost	=	KW_T	*	$\frac{kW_E}{kW_T}$	*	$\frac{\$}{kW_E}$

Goal: Reduce total facility power costs

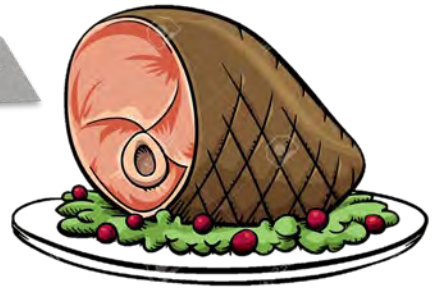
Step 1: Evaluate current blast cell designs to identify areas of improvement

Step 2: Design a modernized blast solution that is more thermodynamically robust and energy efficient than older designs

Lineage

BLAST FREEZING

Blast Cell
T = -20 °F



Lineage

WHAT MAKES A GOOD BLAST CELL?

1. Blast Temperature and Refrigeration

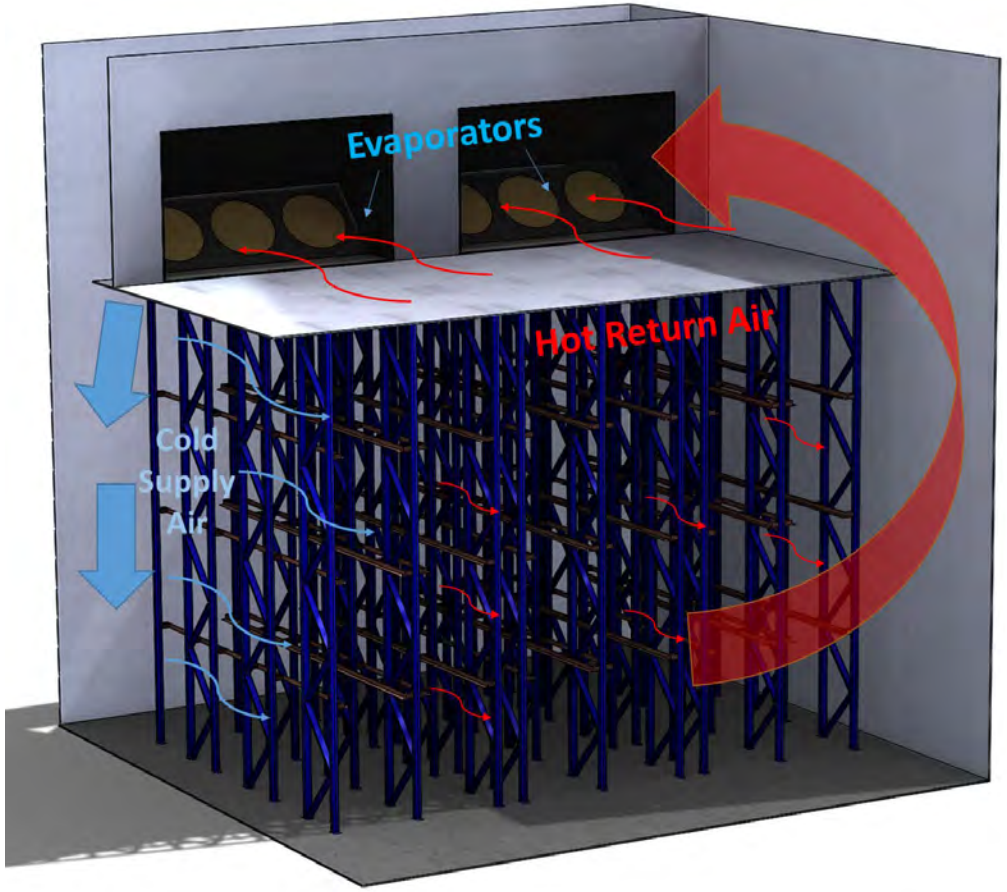
- Cells need appropriate refrigeration capacity to remove product heat load

2. Blast Airflow

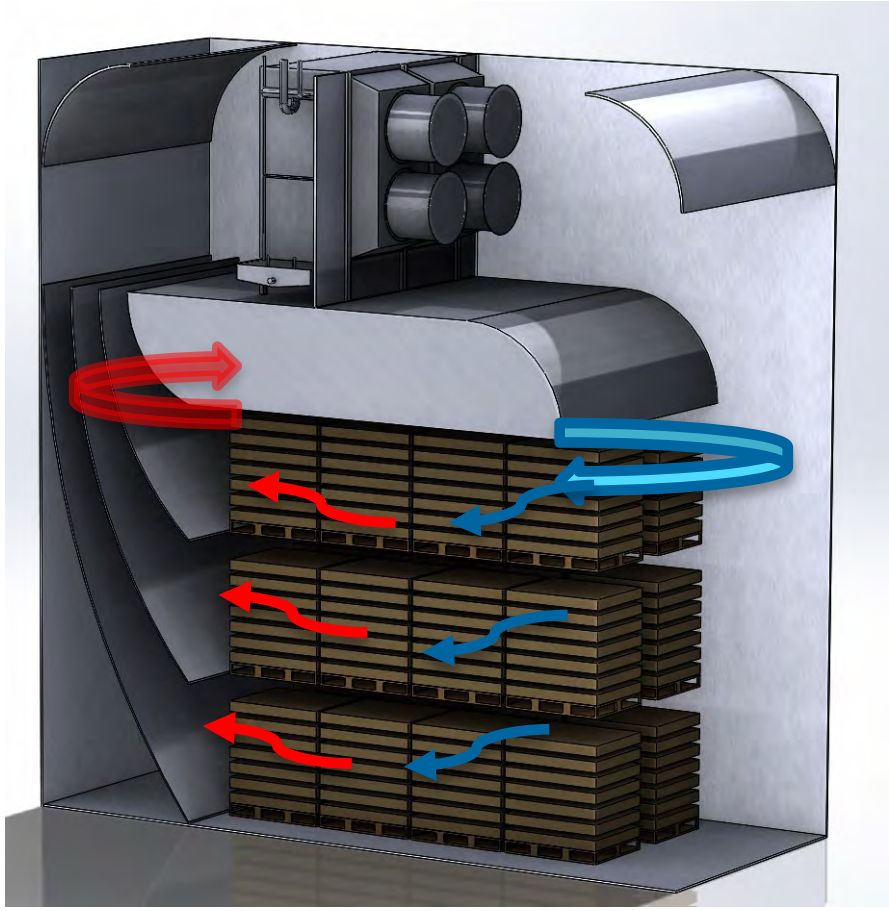
- Cells need appropriate structural design for consistent, evenly-distributed airflow to cool all product within a cell

DESIGN IMPROVEMENT

Standard Backthrow Blast Cell



ZFD Guided Airflow Blast Cell



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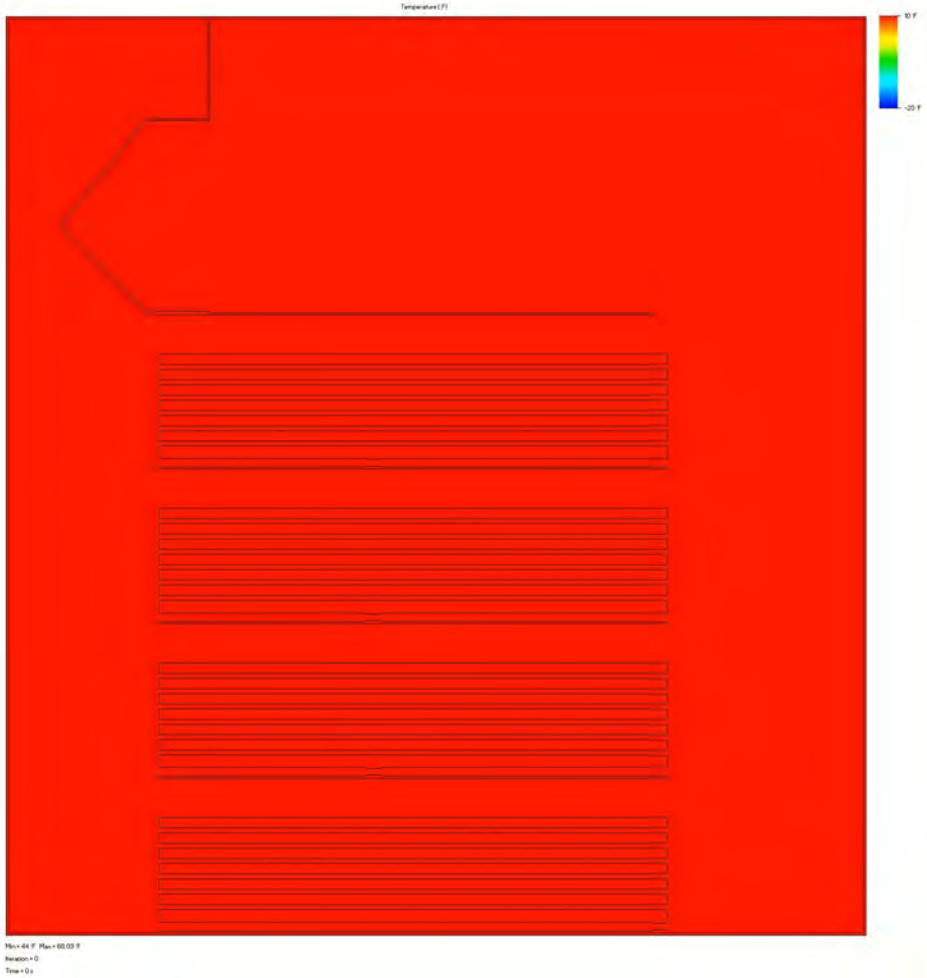
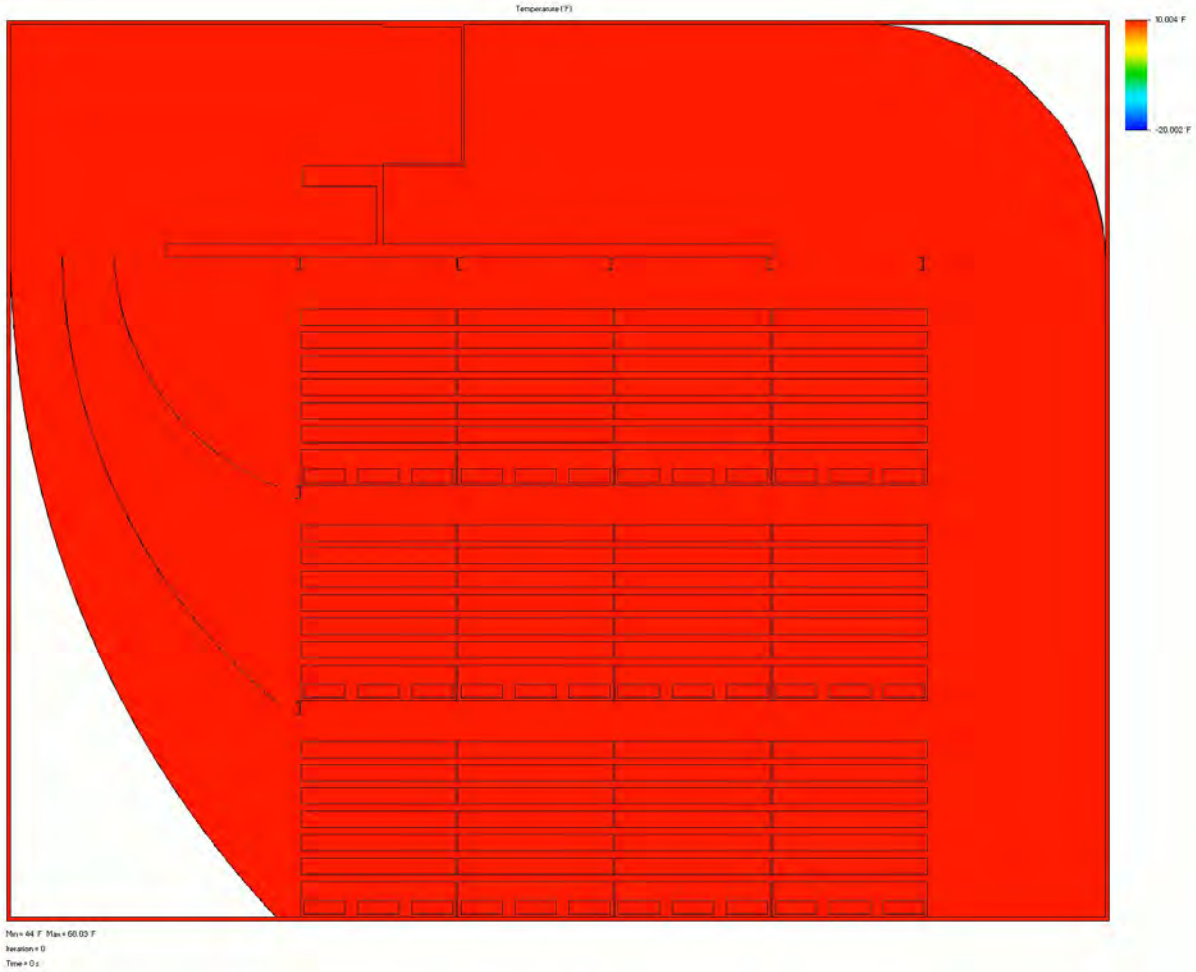
TEMPERATURE COMPARISON

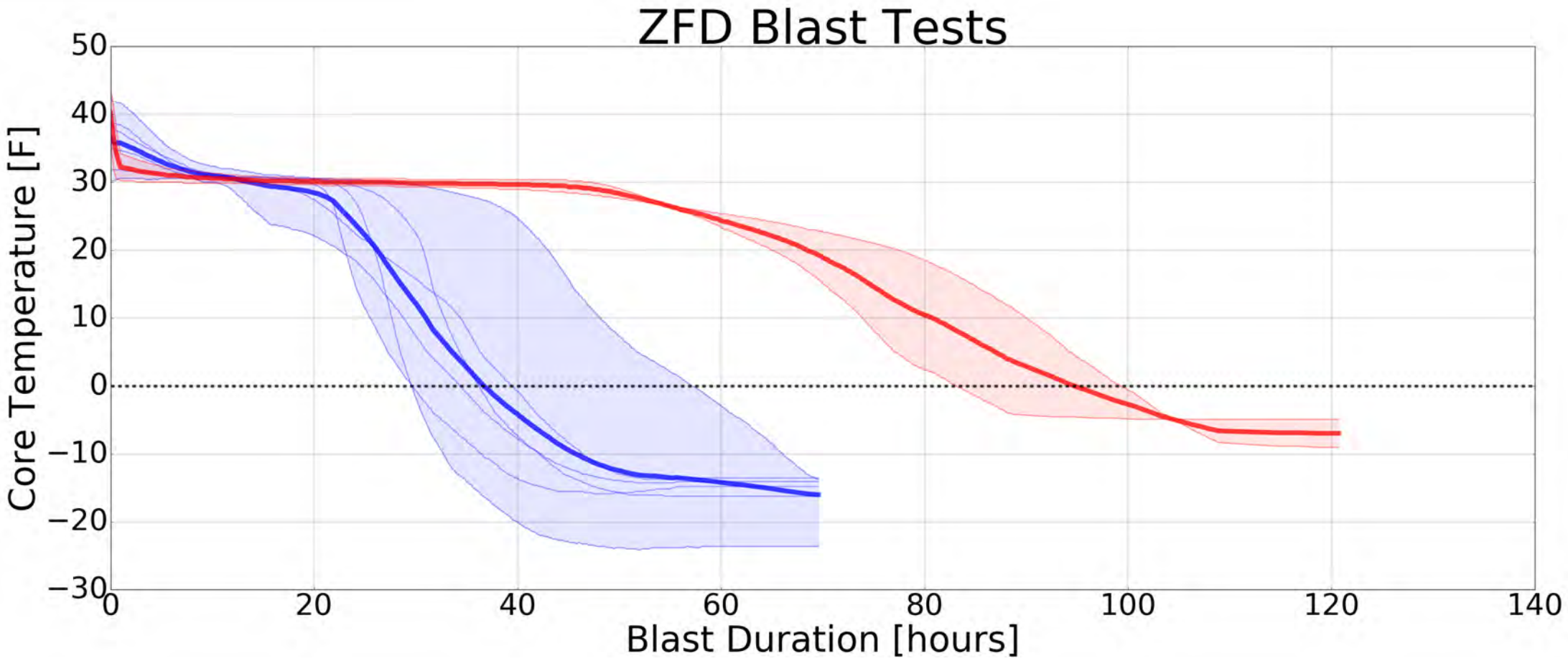
Standard Backthrow Blast Cell



ZFD Guided Airflow Blast Cell



TEMPERATURE EXPERIMENT RESULTS



Lineage

Table 1 Time and Energy Savings of ZFD Design

Annual Projection	Standard Blast	ZFD
Blast Runtime, hours	7,514	3,653
# of Blast Cells	5	5
Product Blasted, lbs.	56,356,802	56,356,802
Total Power Consumption, kWh	3,844,273	3,215,860
Energy Efficiency, kWh/pallet	122.8	102.7

Outline

- What is Lineage Logistics?
- Case Study 1: Increasing Blast Throughput
- Case Study 2: Energy Scheduling

APPROACH

EBITDA = PRICE * QTY - POWER - LABOR

		Thermal Work		Efficiency		Price / kW
Power Cost	=	KW_T	*	$\frac{kW_E}{kW_T}$	*	$\frac{\$}{kW_E}$

Goal: Reduce facility storage power costs

Step 1: Upgrade facility hardware and controls to accept and accurately follow scheduled setpoints

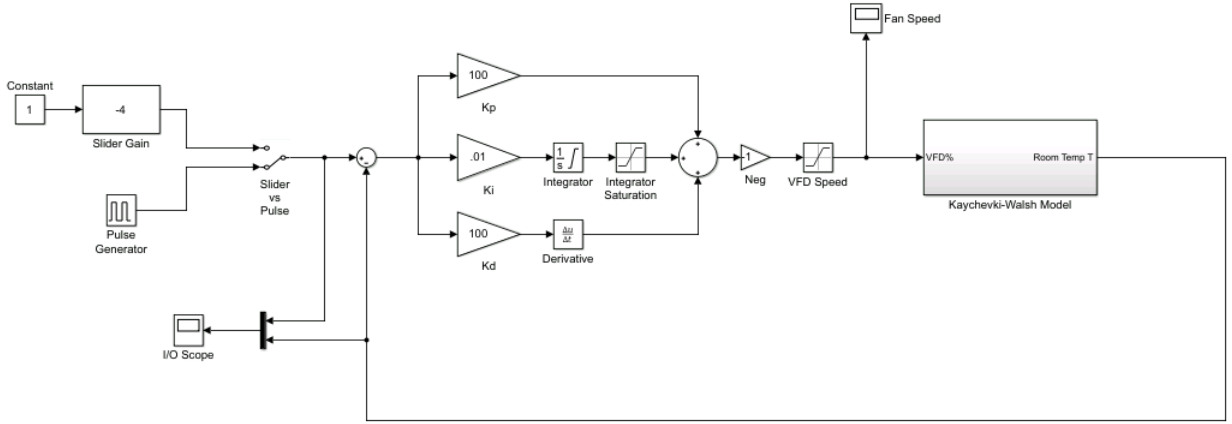
Step 2: Push scheduled setpoints to the facility that optimize energy usage around power prices and equipment capabilities/efficiencies

Lineage

EVAPORATOR CONTROL

- Installed VFDs on all evaporator fans

- Improved controls algorithms to better follow room temperature setpoints



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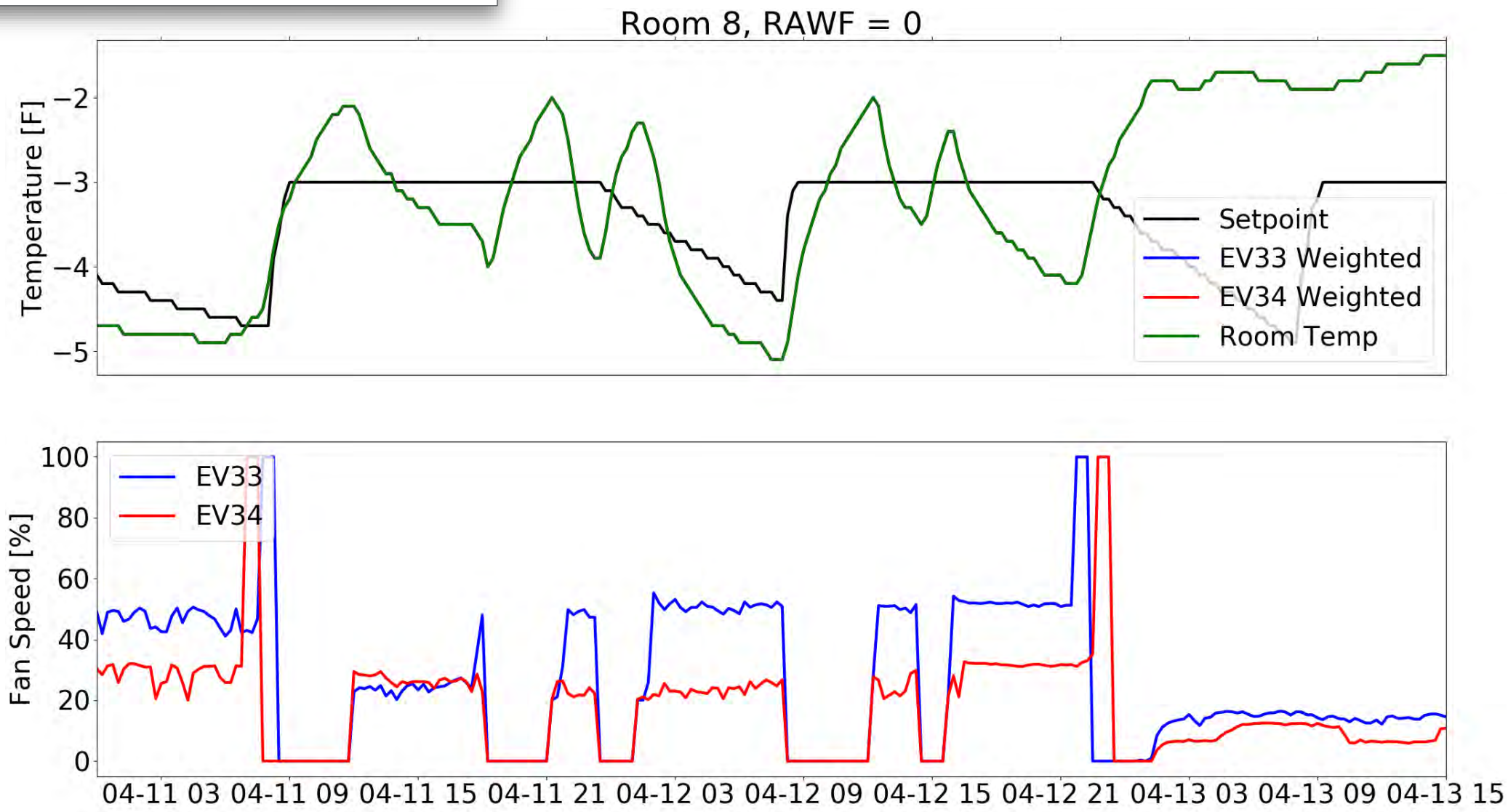
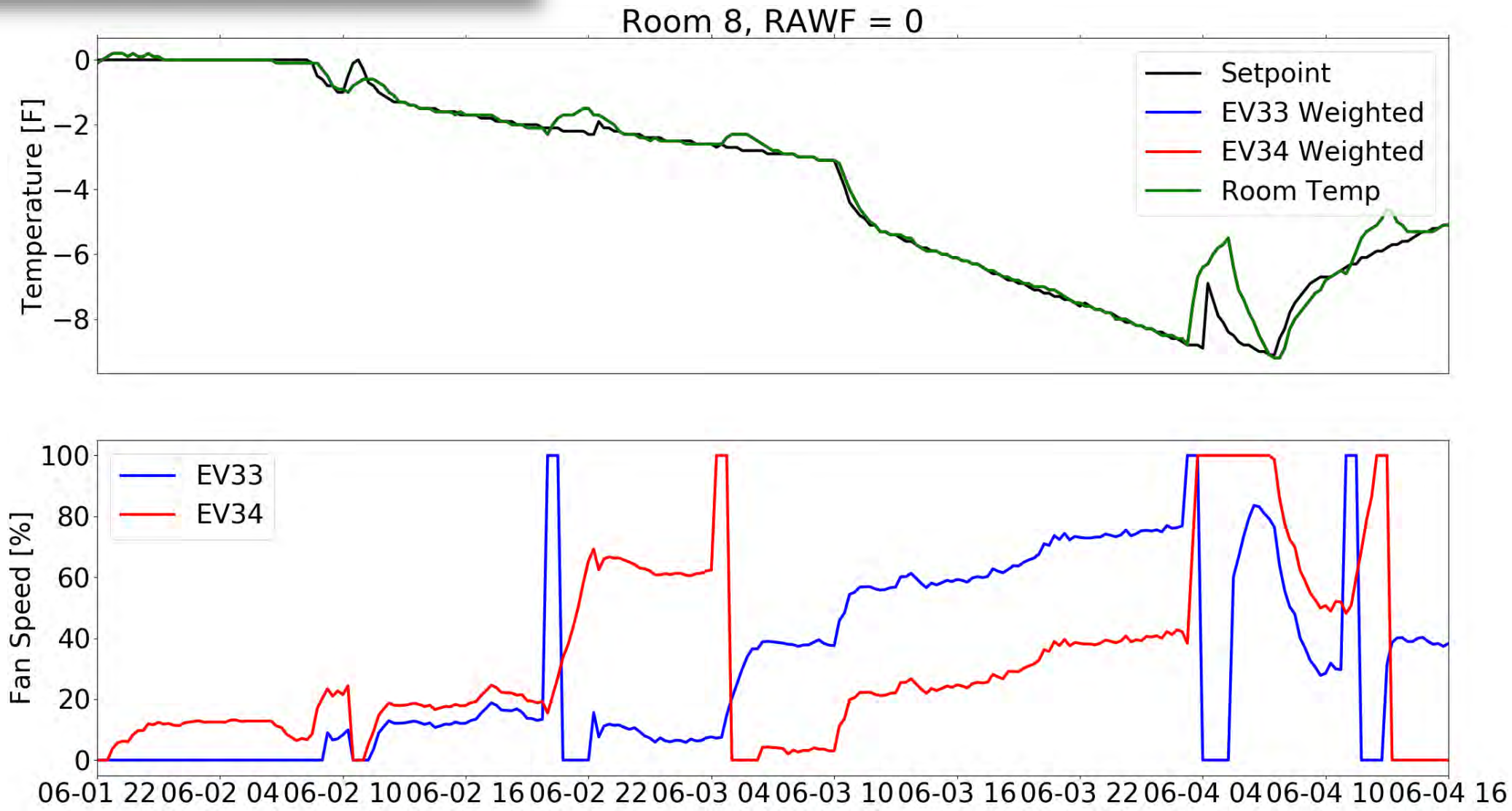
EVAPORATOR CONTROL - OLD



Lineage

EVAPORATOR CONTROL - NEW



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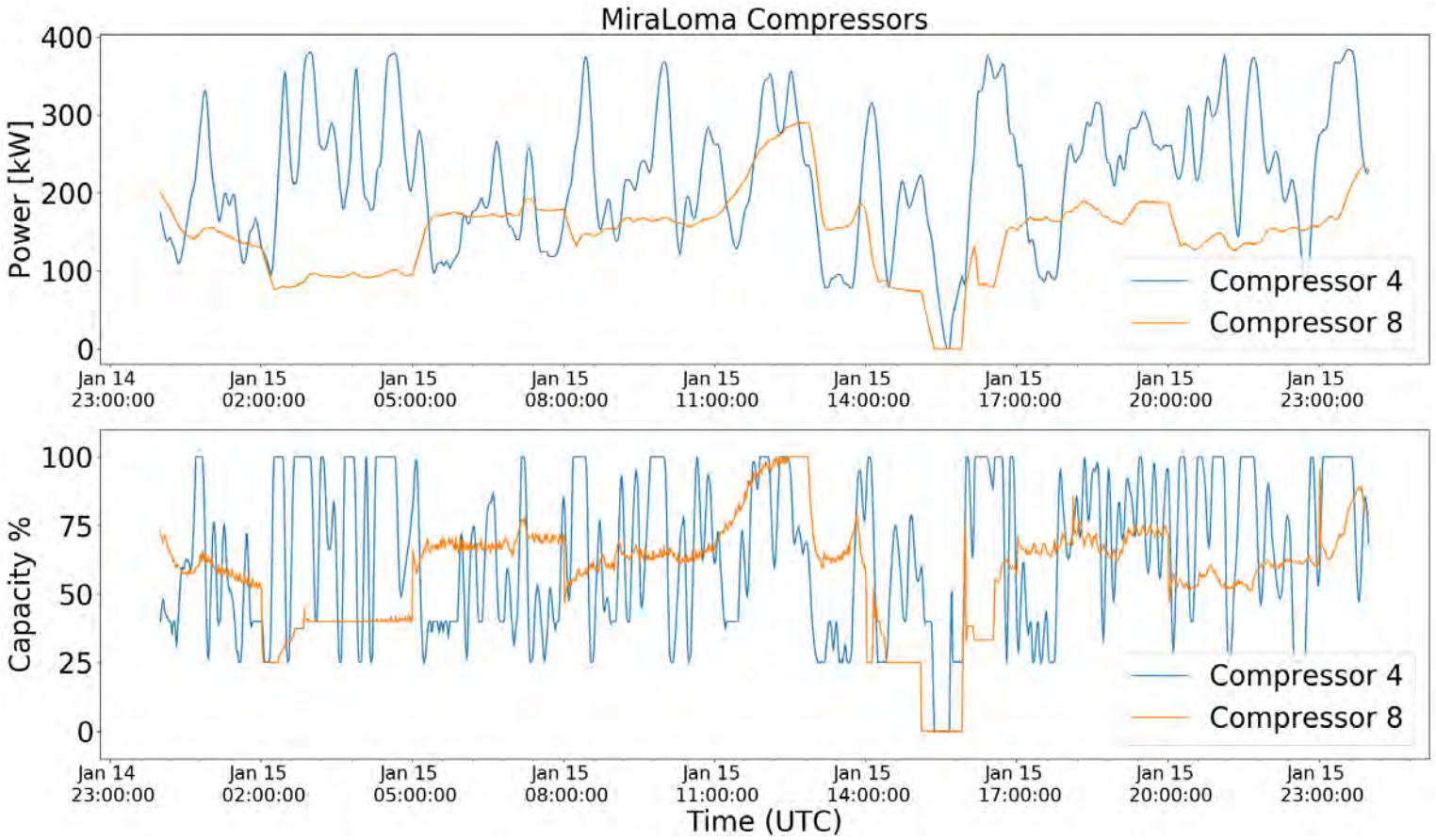
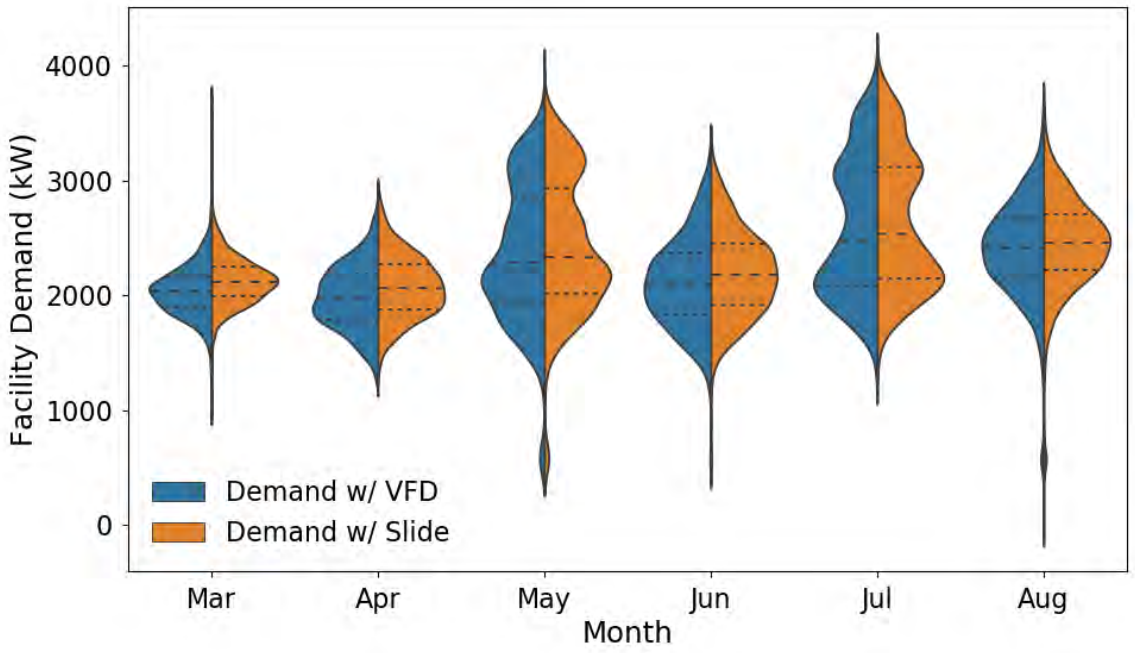
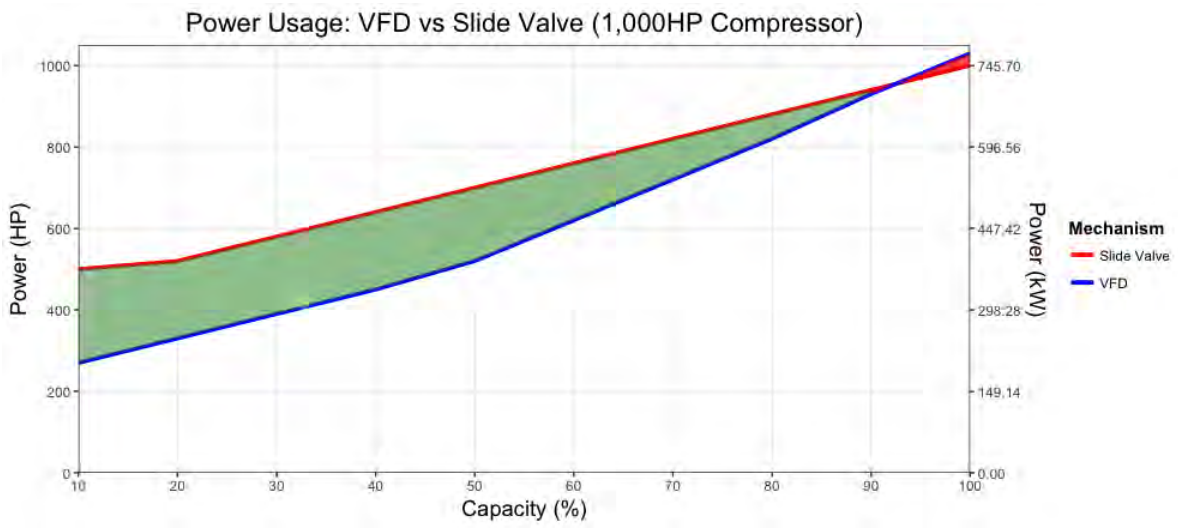
COMPRESSOR VFDS

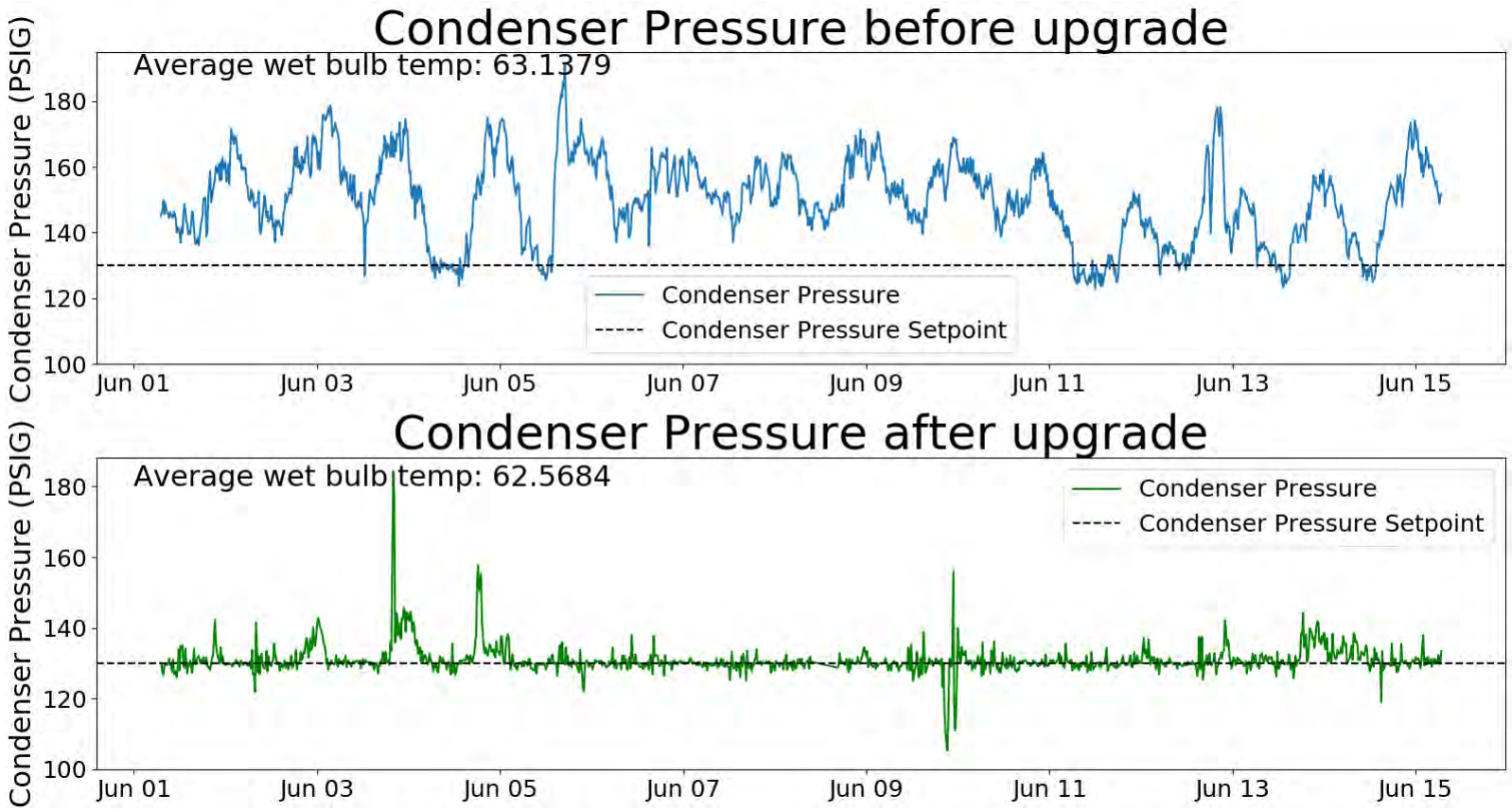


COMPRESSOR VFDS

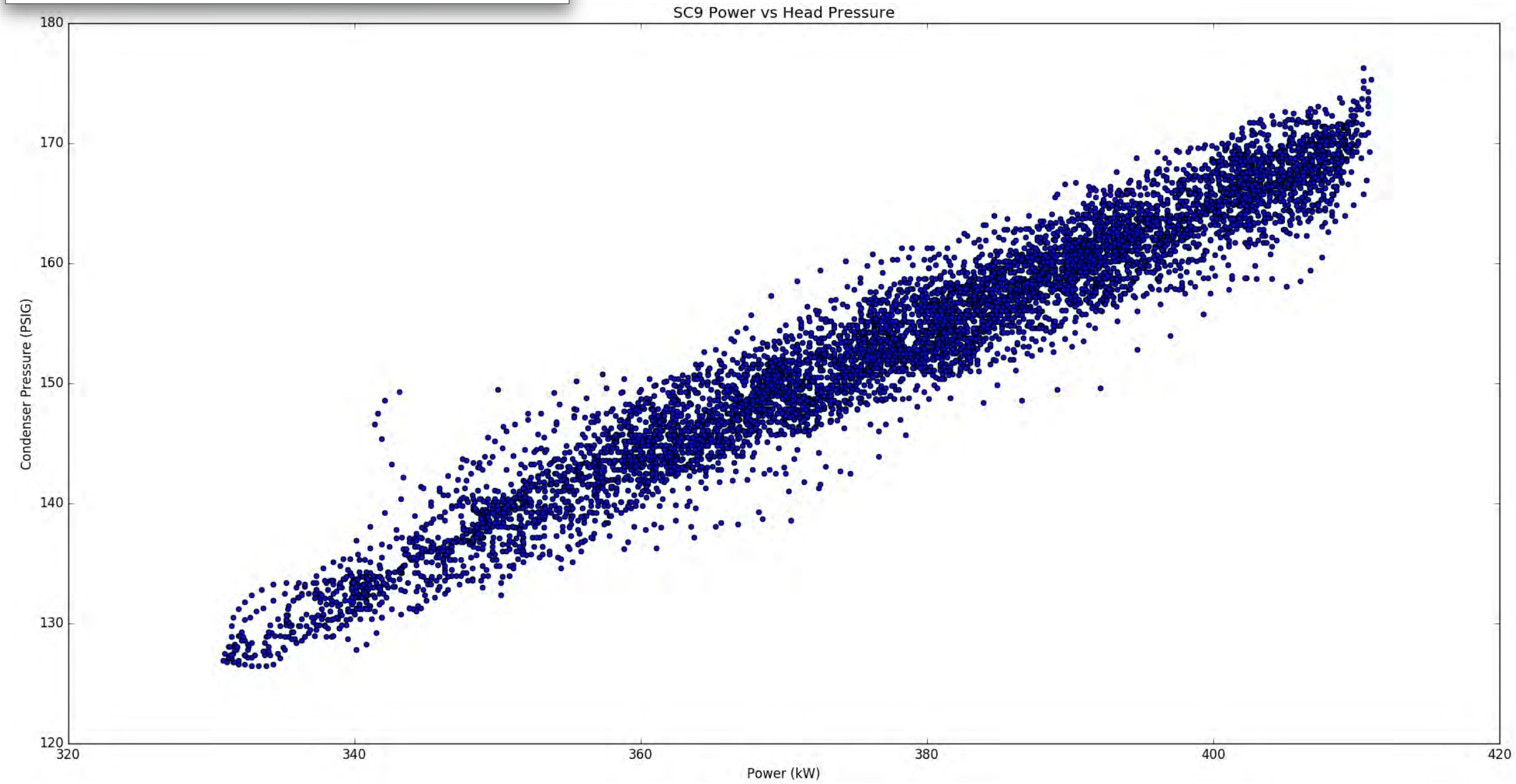




CONDENSER UPGRADE

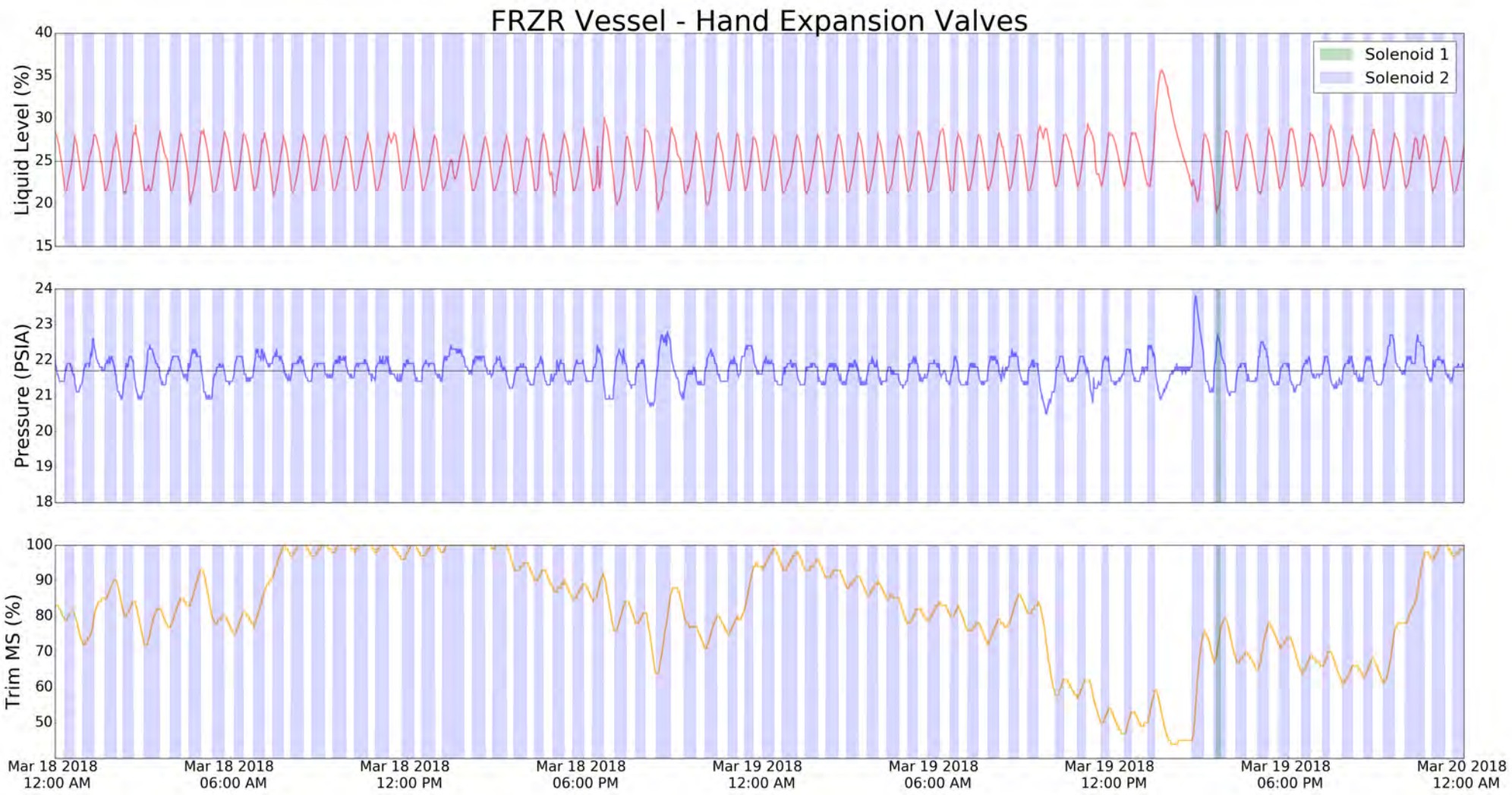


CONDENSER UPGRADE

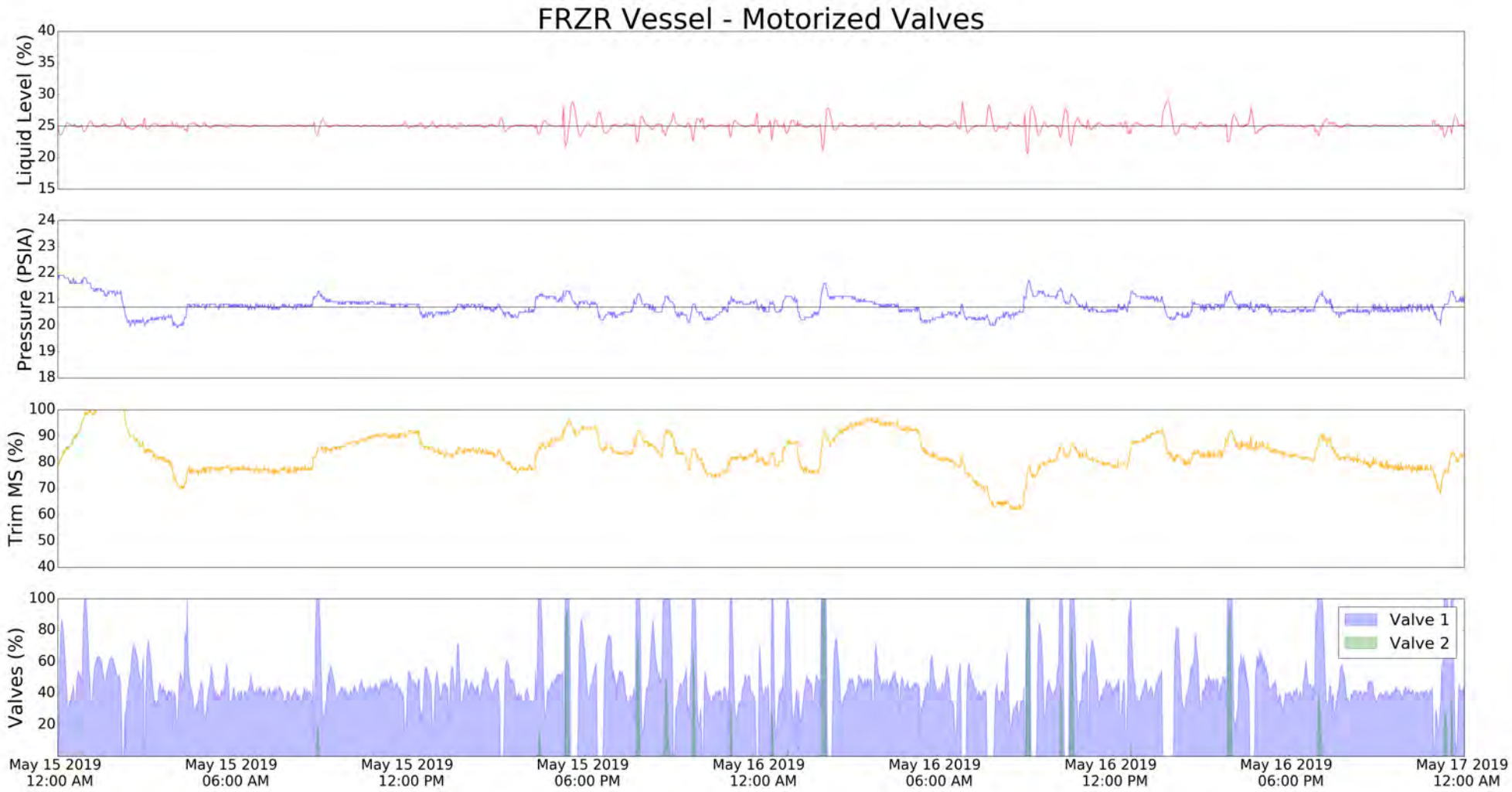


VESSEL VALVES UPGRADE

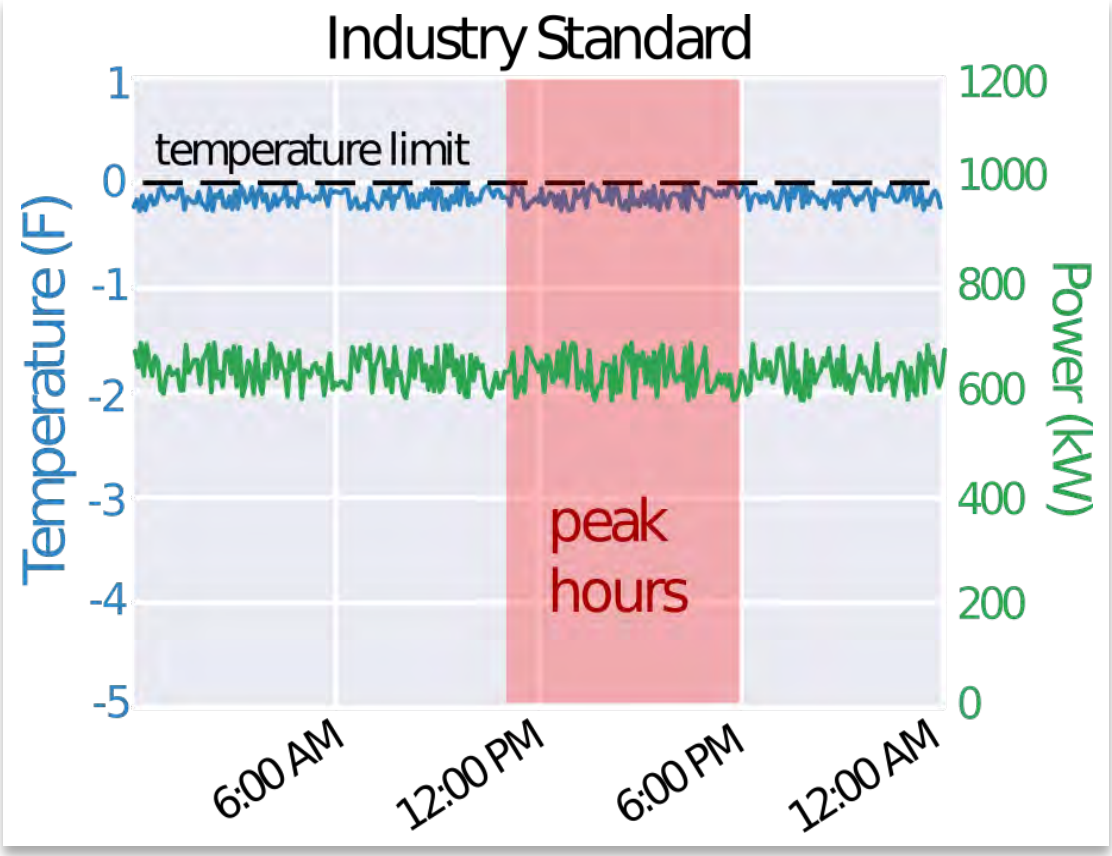
VESSEL VALVES - OLD

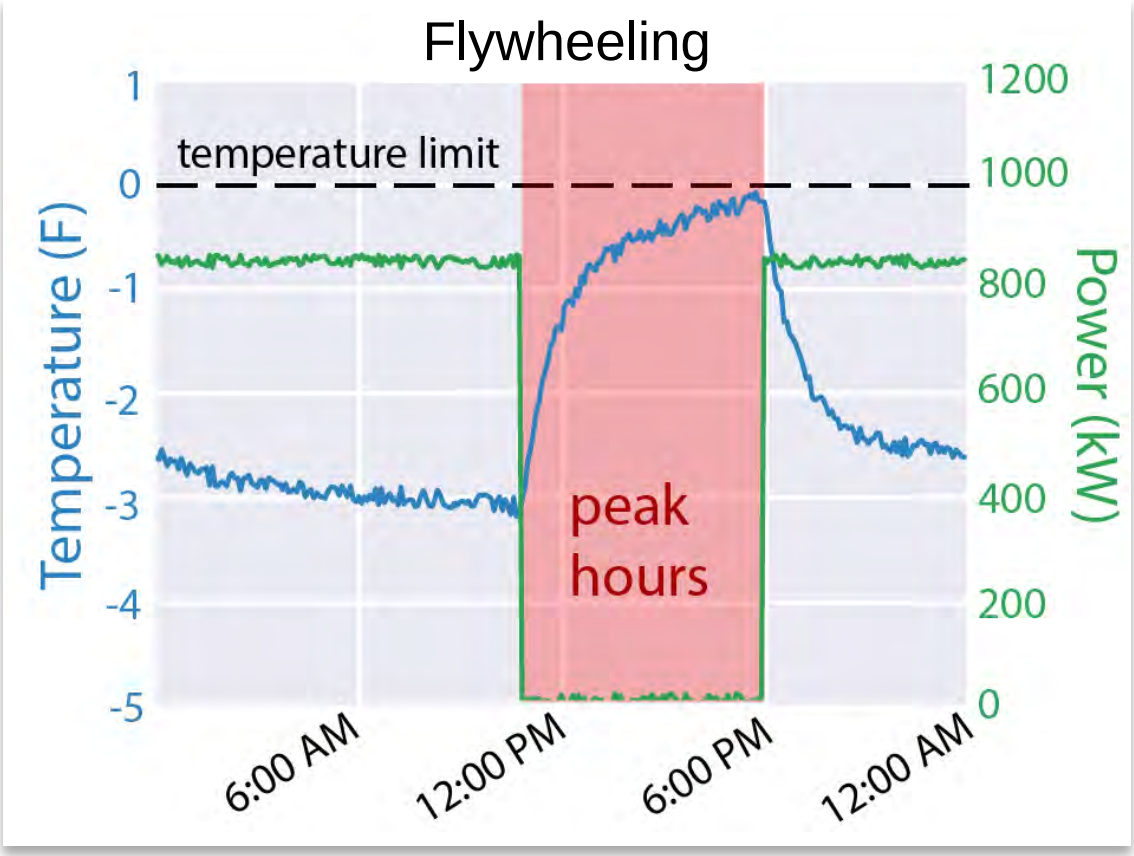


VESSEL VALVES - NEW



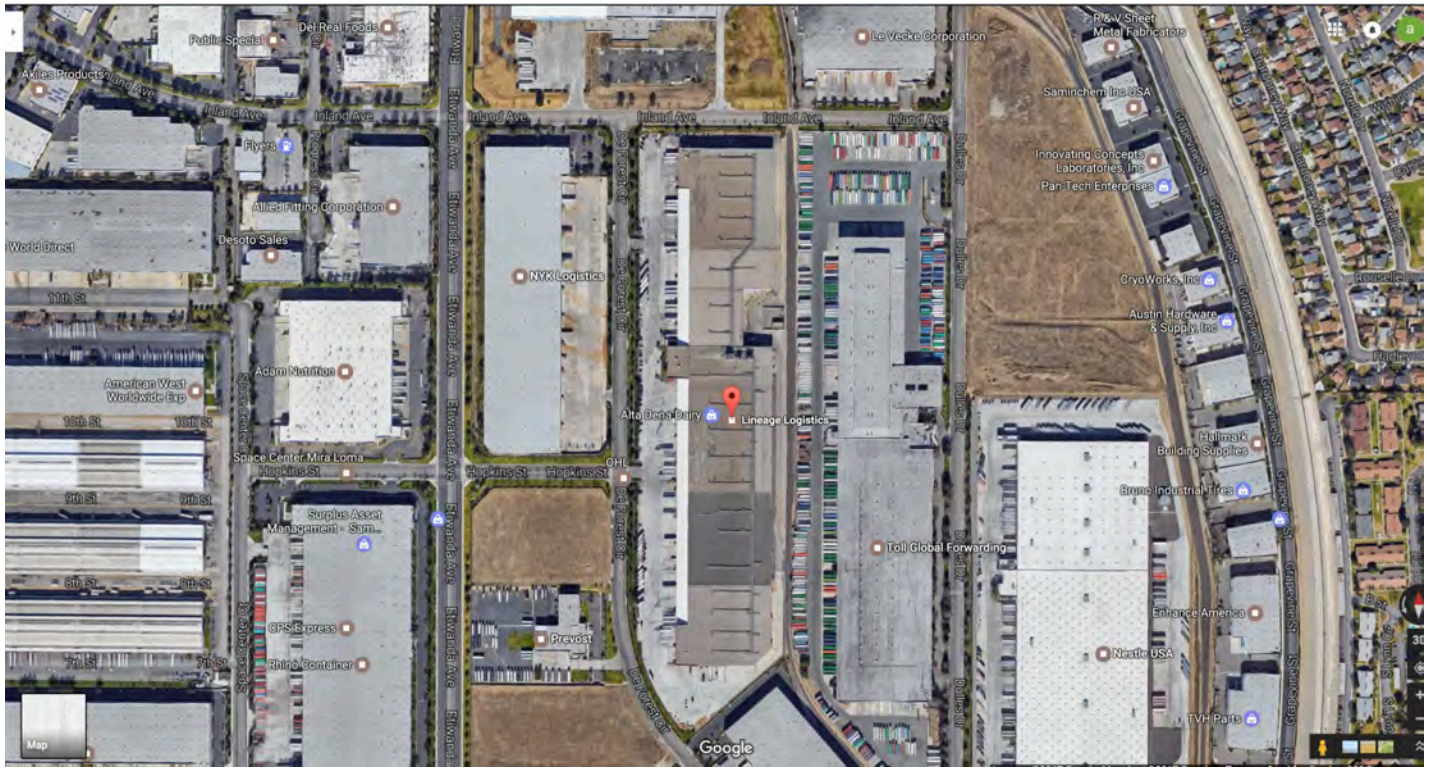
FLYWHEELING



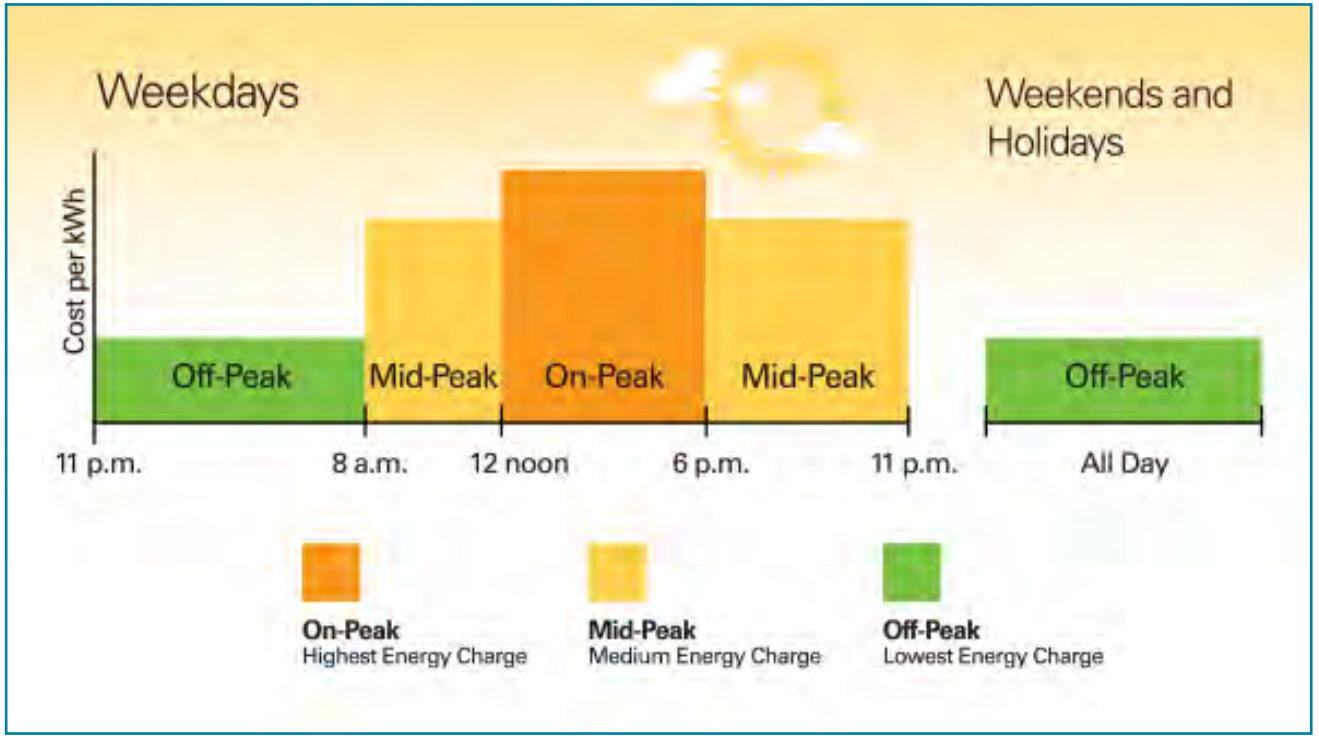


Lineage - Mira Loma, CA

- ~700k sq ft
- Up to 4MW
- $2.2M Power Bill
- TOU + Demand Rate



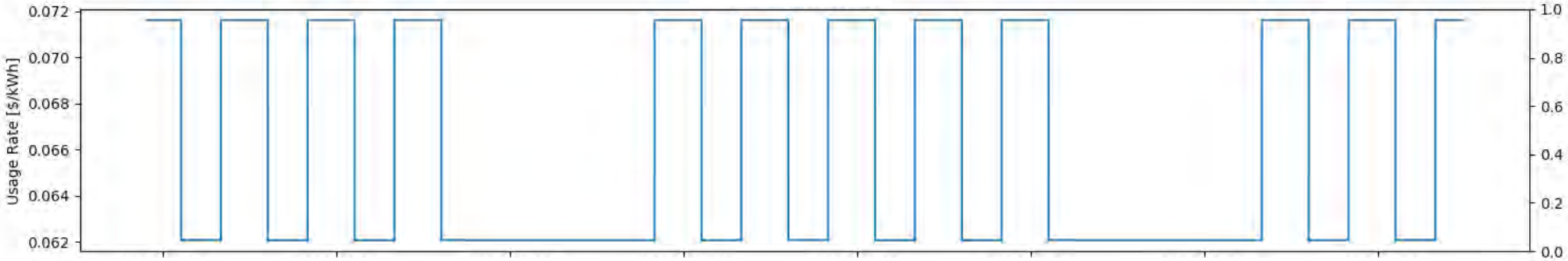
TOU + DEMAND CHARGE



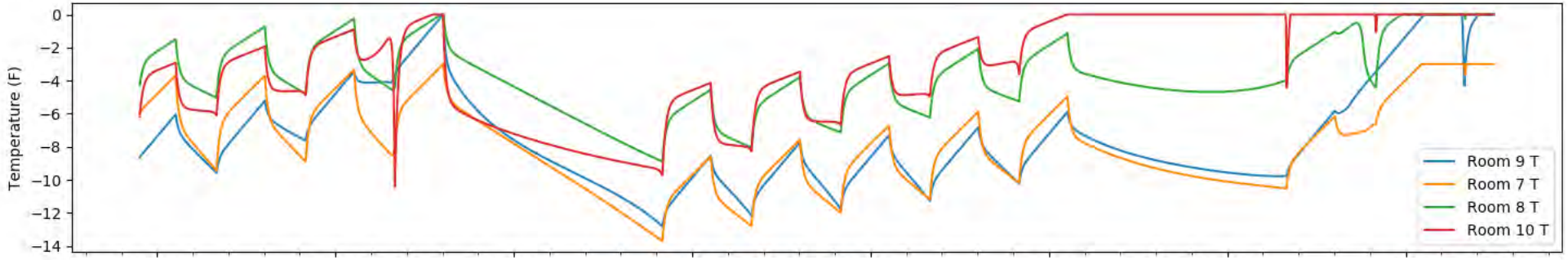
Example Demand Charges

Flat	$18,550 / MW
On-Peak	$18,920 / MW
Mid-Peak	$3,630 / MW

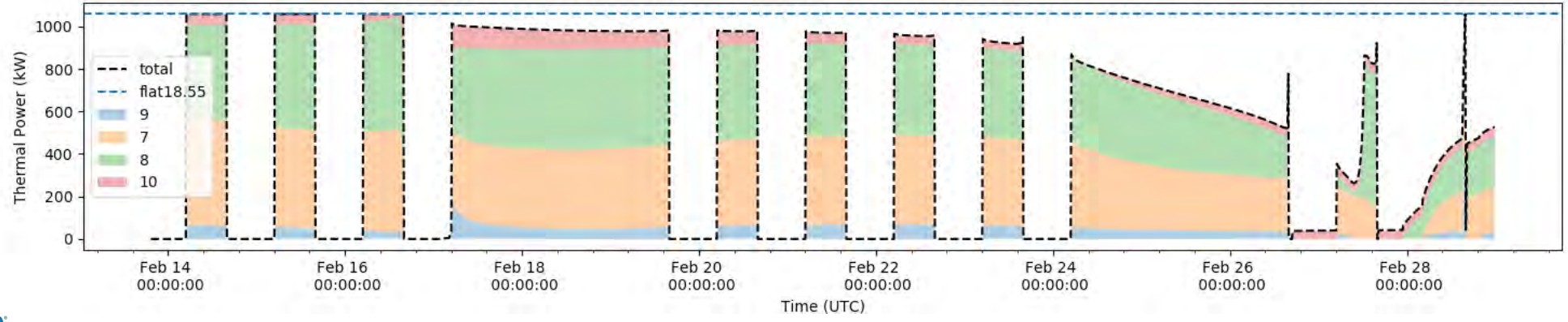
Energy Rate



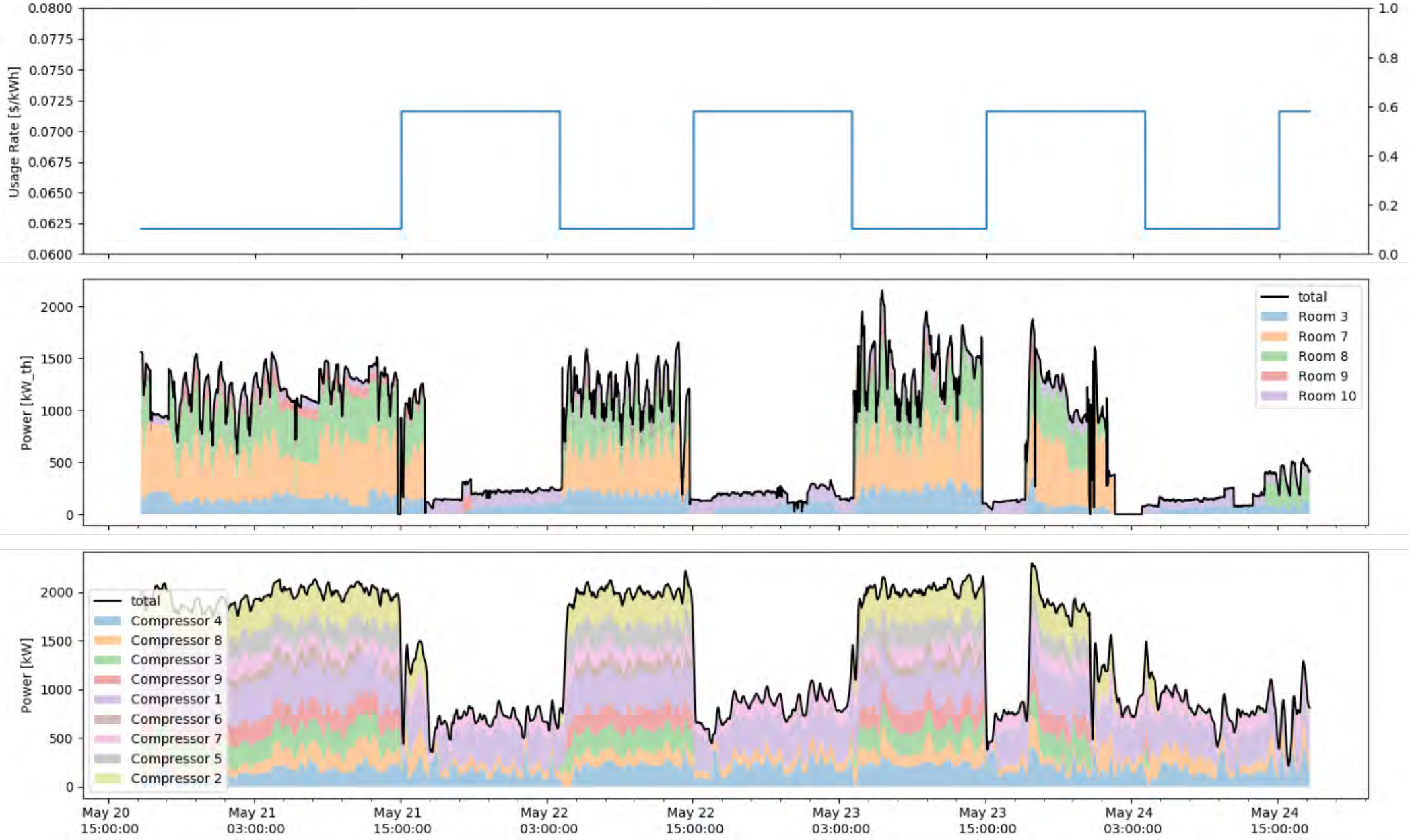
Temperature Setpoints



Resulting Power Draw



Lineage

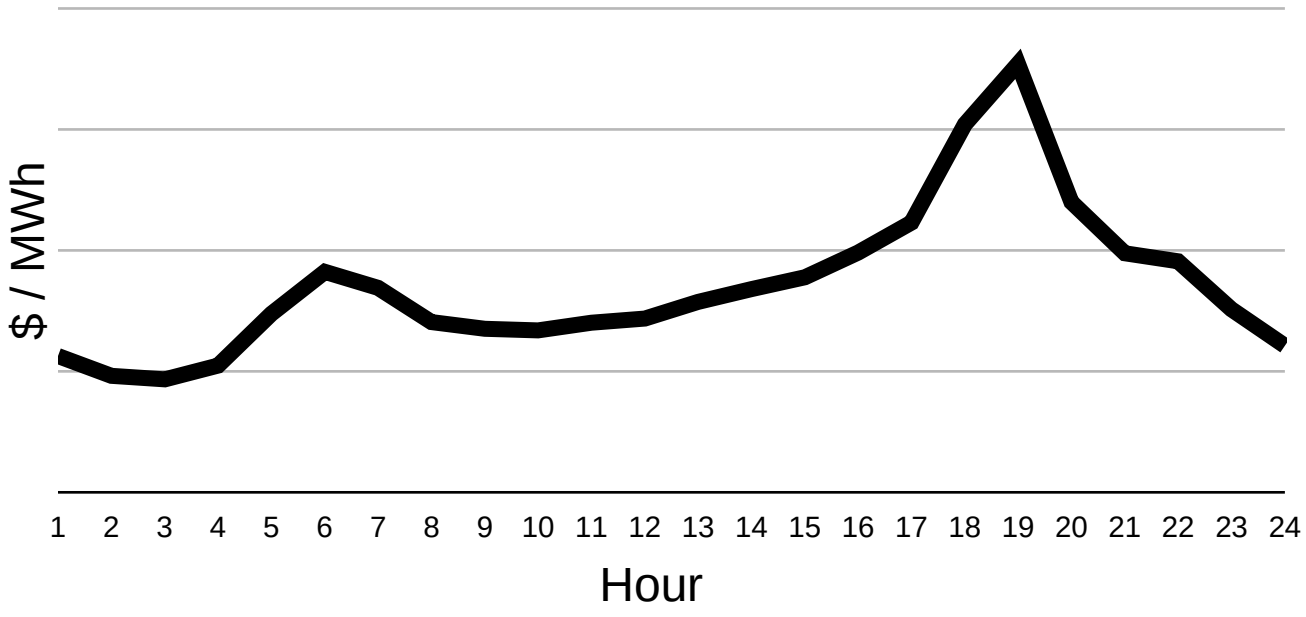

Usage Rate [$/kWh]
0.0800
0.0775
0.0750
0.0725
0.0700
0.0675
0.0650
0.0625
0.0600
1.0
0.8
0.6
0.4
0.2
0.0
Power [kW_th]
2000
1500
1000
500
0
total
Room 3
Room 7
Room 8
Room 9
Room 10
Power [kW]
2000
1500
1000
500
0
total
Compressor 4
Compressor 8
Compressor 3
Compressor 9
Compressor 1
Compressor 6
Compressor 7
Compressor 5
Compressor 2
May 20 15:00:00
May 21 03:00:00
May 21 15:00:00
May 22 03:00:00
May 22 15:00:00
May 23 03:00:00
May 23 15:00:00
May 24 03:00:00
May 24 15:00:00

Lineage

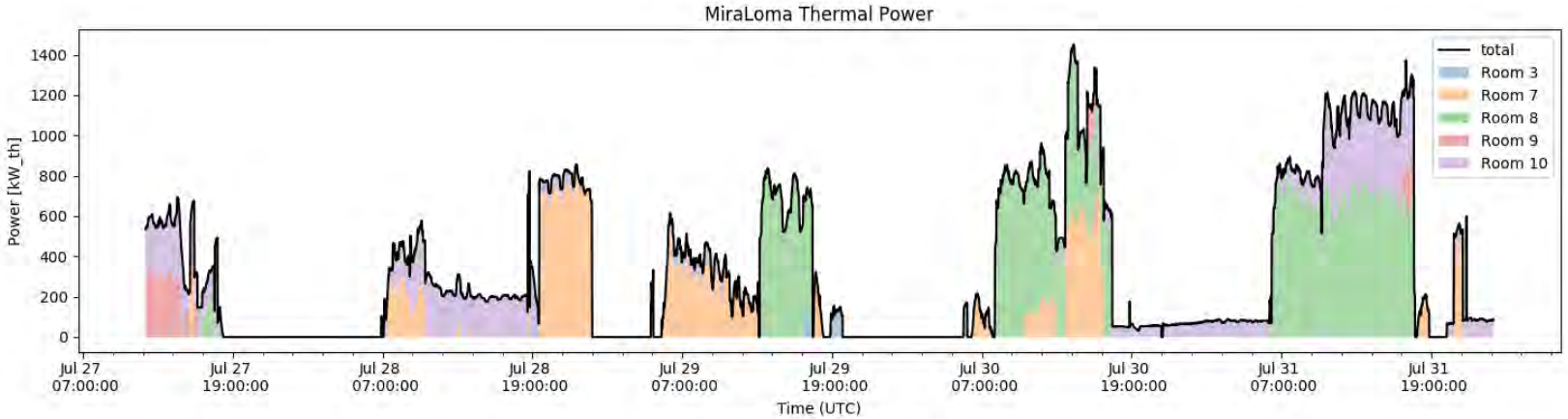
DIRECT ACCESS

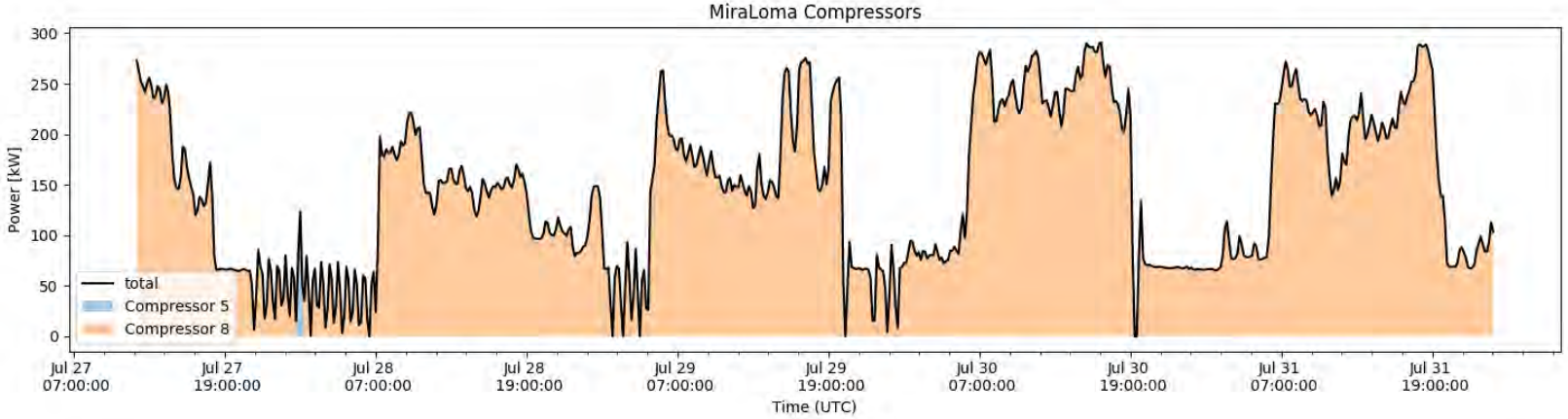
Direct Access Demand and Energy Charges

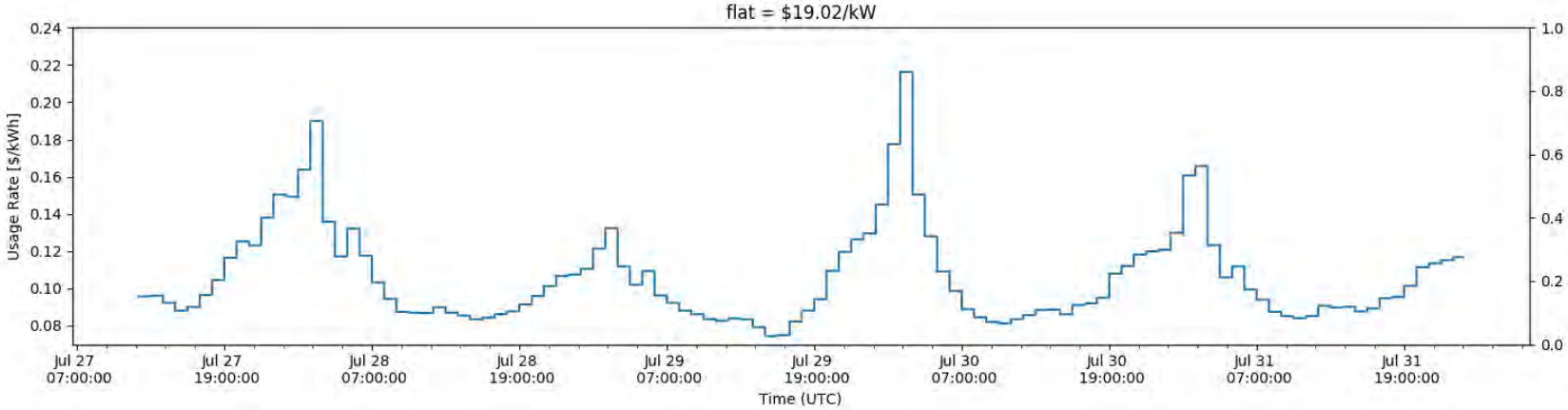
Flat	$19,020 / MW
Energy Charges	Variable / Market-Based



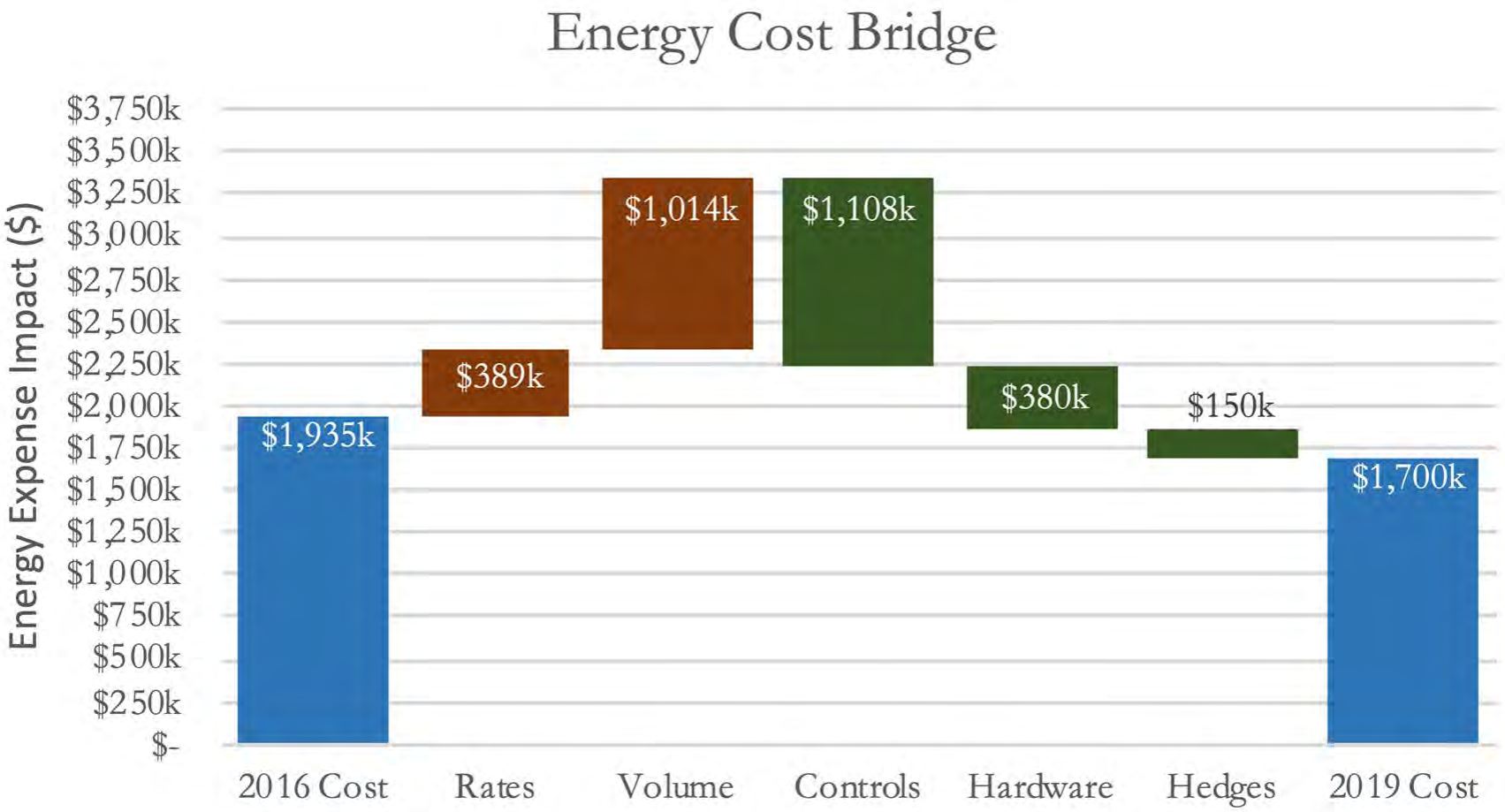
Lineage


MiraLoma Thermal Power
Power [kW_th]
total
Room 3
Room 7
Room 8
Room 9
Room 10
Time (UTC)


MiraLoma Compressors
Power [kW]
total
Compressor 5
Compressor 8
Time (UTC)


flat = $19.02/kW
Usage Rate [$/kWh]
Time (UTC)

Lineage


Energy Cost Bridge
Energy Expense Impact ($)
$3,750k
$3,500k
$3,250k
$3,000k
$2,750k
$2,500k
$2,250k
$2,000k
$1,750k
$1,500k
$1,250k
$1,000k
$750k
$500k
$250k
$-
$1,935k
$389k
$1,014k
$1,108k
$380k
$150k
$1,700k
2016 Cost
Rates
Volume
Controls
Hardware
Hedges
2019 Cost

Lineage

CLOSING STATEMENTS

Energy improvements go hand-in-hand with additional benefits such as:

- Increased productivity and throughput
- Modernization of old hardware and software
- Increased longevity and stability of motorized equipment
- Grid benefits with utility companies

Thank You!

Q & A

Submit Questions
www.slido.com event code **#DOE**

U.S. DEPARTMENT OF ENERGY

MAY
17-20
2021

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STATE AND LOCAL PERSPECTIVES

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IMPACTS, CHALLENGES, AND WHAT COMES NEXT

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WASTEWATER TREATMENT 2.0:
THE NEXT PHASE OF ENERGY EFFICIENCY AND RECOVERY

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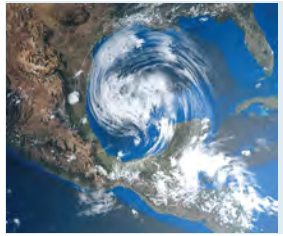
WATCH RECORDING



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A PORTFOLIO-WIDE APPROACH

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WATCH RECORDING

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QUANTIFYING THE ADDITIONAL BENEFITS FROM ENERGY EFFICIENCY

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ONE SIZE DOES NOT FIT ALL:
LESSONS LEARNED FROM FINANCING LARGE AND SMALL ENERGY RETROFITS

Tue, Jan 19, 2021 | 3:00 - 4:00 PM ET

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INSUARANCE AND CREDIT UNDERWRITING

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Indicates the session was a part of the 2020 Virtual Summit. To view a full list of the Summit Sessions, click here.

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A building's envelope (walls, windows, roof, and foundation) accounts for approximately 30% of the primary energy consumed in residential and commercial buildings. Explore all previously recorded webinars on this topic by pressing MORE.

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- Sneak Peek of the Building Envelope Campaign (2020)
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- Innovative Wall Technologies for Commercial Buildings (2019)
- Energy Savings Impact of Airtightness in U.S. Commercial Buildings (2019)
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General Inquiries
BetterPlants@ee.doe.gov

Program Support
ksanderson@retechadvisors.com

Catherine Cooremans
Université de Lausanne
catherine.cooremans@unil.ch

Alex Zhang
Lineage Logistics
AZhang@lineagelogistics.com

Bruce Lung
U.S. Department of Energy
robert.lung@ee.doe.gov