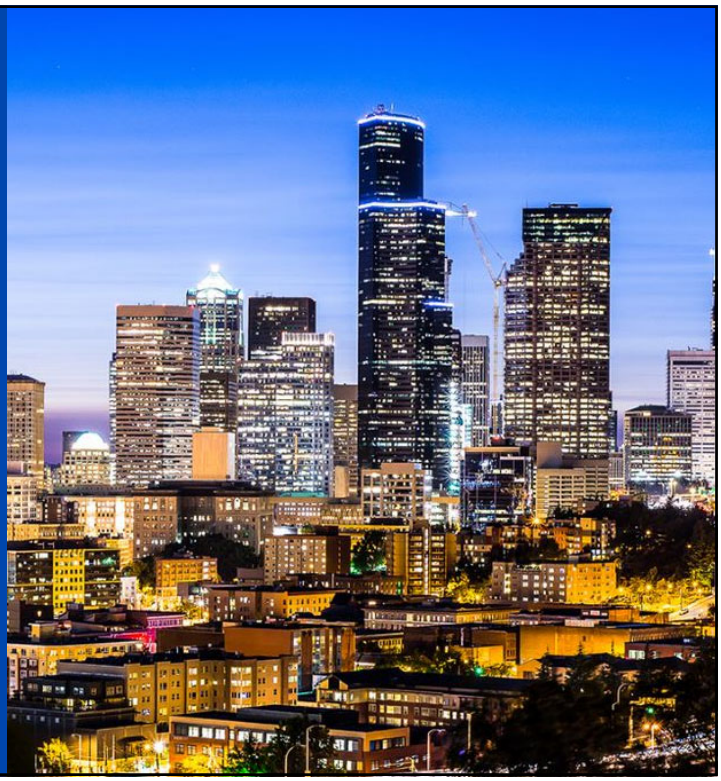
lighting design lab

Save On Refrigeration – How to Optimize Commercial and Industrial Refrigeration

Presented by
Todd Toburen, Energy Smart Industrial Partner | Cascade Energy
Theo Frey, Energy Management Analyst | Seattle City Light

January 28, 2025

Seattle City Light



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What Is This "Lighting Design Lab"?

- Seattle City Light's go-to resource for lighting and lighting controls since 1989 – 30+ years
- Formed by BPA and NW utilities to fill education needs for the transforming market
- Now expanded to include resources that support whole buildings
- Being rebranded!

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Upcoming Events

Course	Day	Time
Lighting & Electrical Issues in 2021 WA & Seattle Commercial Energy Codes	Thu Feb 20	10:00-11:30 a.m.
Lessons Learned on Commercial Hot Water Heat Pump Installations	Thu Feb 27	10:00-11:00 a.m.
Our Friends: Smart Buildings Center, UW IDL, Comfort Ready Home	Thu Mar 11	10:00-11:30 a.m.
HVAC Issues in 2021 WA & Seattle Commercial Energy Codes	Thu Mar 20	10:00-11:30 a.m.
Water Heating Issues in 2021 WA & Seattle Commercial Energy Codes	Thu April 17	10:00-11:30 a.m.
Alternations Issues in 2021 WA & Seattle Commercial Energy Codes	Thu May 15	10:00-11:30 a.m.

Registration Open Soon

Event	Day	Time
Seattle City Light Trade Ally Office Hours	Fri Feb 21	9:00 a.m.

Stay up-to-date at LightingDesignLab.com and by subscribing to our newsletter.

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AGENDA

- Introductions
- City Light Incentive Overview
- Refrigeration System Optimization Opportunities
  - Compressors
  - Evaporative Condensers
  - Control Optimization
- Q&A
- Note:
  - *The session will break at approximately 9:30 for 10 minutes*

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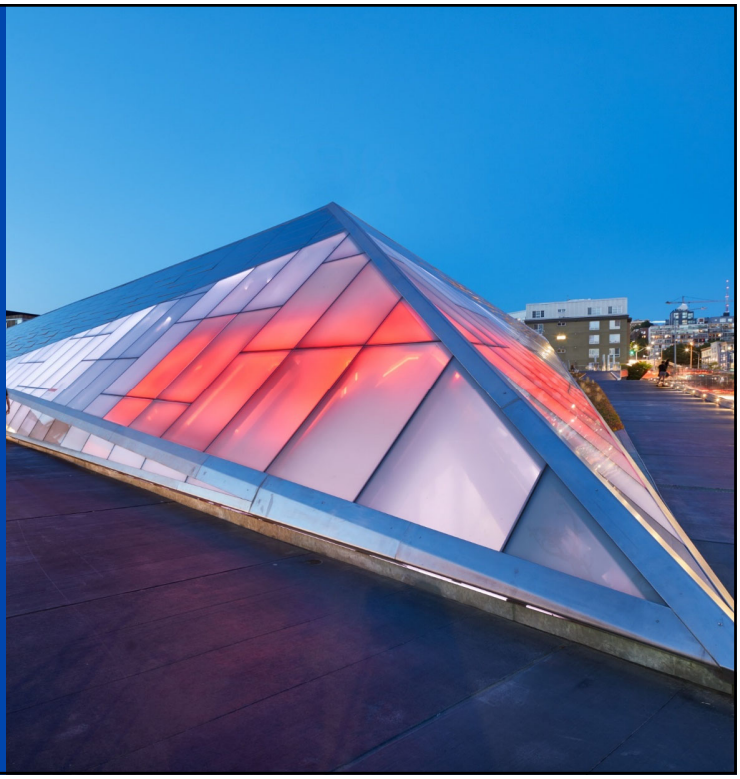
Presented By

Theo Frey
Energy Management Analyst

Seattle City Light



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Incentive Offerings

Capital Improvements	Fast Acting Door New Compressor	$0.33 per kWh
New Controls	Floating Head & Suction On Demand Defrost	
Durable Operation & Maintenance	Adjust set points Clean Equipment	

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Even More Incentive Offerings

Seattle City Light

SEATTLE CITY LIGHT 2025 ENERGY CONSERVATION INCENTIVES Effective January 1, 2025

COMMERCIAL, INDUSTRIAL, AND MULTIFAMILY[1] RETROFIT PROJECTS

CONSERVATION ACTION	INCENTIVE ($/kWh)	MEASURE NOTES
RETROFIT LIGHTING* **		
LED fixtures (outdoor, indoor, high-bay, display case), integrated retrofit kits, downlights**	$0.25	Retrofit kits limited to DLC defined integrated-style retrofit kits All fixtures and retrofit kits must be certified by DesignLights Consortium (DLC) except downlights which must be ENERGY STAR
Other retrofit kits	$0.17	For any DLC retrofit kit category other than integrated-style
Standard controls (including non-QPL networked lighting controls)	$0.25	Standard controls include daylighting and occupancy sensors
QPL networked lighting controls (LLLC and non-LLLC)	LLLC: $75 per fixture Non-LLLC: $50 per fixture	In addition to $/kWh incentive for fixture efficiency and controls See DLC's Networked Lighting Controls Qualified Product List (QPL) for eligible systems
*For multifamily projects, only common areas are eligible for incentives. ** Downlights must be hardwired (e.g., no pigtail screw-in) and can be any lumen output.		
Looking for LED lamps? Get instant discounts on qualified LED lamps at participating distributors. Visit Lighting to Go for more information.		
HEATING, VENTILATION AND AIR CONDITIONING (HVAC)		
Chiller Plant Upgrades	$0.33	1 for 1 replacements of chillers not eligible
Variable speed drives on AHU Fans	$300 per HP	For constant speed fans serving VAV systems, replacing the function of inlet guide vanes or other throttling devices
Economizer controls	$0.33	
Multi-Measure HVAC Equipment Projects	$0.33	For interactive HVAC System improvements
Building automation system upgrades	$0.33	Includes Major HVAC control system upgrades
Heat recovery improvements	$0.33	Must generate kWh savings
Dedicated outdoor air systems (DOAS), or very high efficiency (VHE) DOAS	$0.27	Must meet NEEA's VHE DOAS requirements
Packaged terminal heat pumps (PTHPs) for lodging (hotel/ motel) and residential care	$600 per unit	Existing equipment must be electric resistance, proposed equipment must be AHRI Certified® and exceed WA State Energy Code by minimum 10%.
Looking for heat pumps, hybrid heat pump water heaters, variable refrigerant flow, chillers, pumps, fans, and more? Get high-efficiency equipment at participating distributors. Visit Mindstream HVAC+ for more information.		
DATA CENTER AND IT EQUIPMENT		
Computer room air conditioners (CRAC)	$0.27	For new equipment or variable speed drive/ECM retrofits
Efficient uninterruptible power supply (UPS) systems, <10kVA	$0.33	Serving data centers, Commercial only
Efficient uninterruptible power supply (UPS) systems, >=10kVA	$0.33	Serving data centers, Commercial only
Server virtualization	$150	For each server removed; Max. 100; Commercial only
Plug load reduction	$0.33	Data Center or IT plug load, Commercial only
Data center air flow management	$0.07	Commercial only
OTHER RETROFIT MEASURES		
Compressor equipment	$0.33	
Process loads	$0.27	Primarily for industrial customers
Generator block heaters	$200 each <3kW $1,500 each if >= 3 kW	
Vehicle engine heater controls	$200 each	
Durable Operations & Maintenance Improvements	$0.33	
Variable speed drives	$0.33	For constant speed equipment with remaining service life

CONSERVATION ACTION	INCENTIVE ($/kWh)	MEASURE NOTES
WATER HEATING MEASURES		
Heat pump water heater systems	$0.33	Must meet NEEA's Advanced Water Heating Specification 8.0, commercial only Systems <=120 gallons not eligible.
Electrically commutated motors	$0.27-$0.33	Clean water circulator pumps <3.5 HP not eligible
REFRIGERATION MEASURES		
New refrigeration equipment/ new doors	$0.18	Must be above federal code
Refrigeration system improvements	$0.33	Includes a variety of measures including insulation, fast-acting doors, heat recovery, compressors, and condenser efficiency.
Refrigeration controls	$0.33	
MULTIFAMILY WEATHERIZATION		
1-3 FLOORS		
Replace single-pane, or metal double-pane window with a window between > 22 and <= .30 U-factor	$12 per square foot	U value calculation is an average value. Also available for patio doors.
Replace single-pane, or metal double-pane window with <= 22 U-factor	$16 per square foot	
Upgrade existing attic, floor, or wall insulation	$0.30-$2 per square foot	Contact City Light for details on qualifying existing insulation conditions
Exterior door, ENERGY STAR certified	$40 per door	Replacing substandard exterior door, contact City Light for details on qualifying existing conditions
4+ FLOORS		
Replace single-pane, or metal double-pane window with a window between > 22 and <= 30 U-factor	$6 per square foot	U value calculation is an average value. Also available for patio doors.
Replace single-pane, or metal double-pane window with <= 22 U-factor	$6 per square foot	
Upgrade existing attic, floor, or wall insulation	$0.75-$1.80 per square foot	Contact City Light for details on qualifying existing insulation conditions
To receive funding for the above weatherization measures, the building must be an apartment building, condominium, retirement community, and/or cooperative with 5 or more units and have permanently installed electric heat (baseboard, wall unit, furnace, heat pump) as its primary heat source. If 50% or more of your building tenants are income-qualified, your project may be eligible to participate in City of Seattle Office of Housing Homewise program which offers incentives up to 90% of project cost.		

Incentives may not exceed 70% of project costs. Incentives are subject to availability of funds and eligibility. **This list is not comprehensive**, work directly with an Energy Management Analyst to understand all available measures and provide the necessary project details. Funding levels are finalized only when a Participation Agreement is signed between Seattle City Light and the customer. **In order to receive an incentive, equipment installation cannot begin and products/equipment shall not be purchased until the project has been reviewed and approved by City Light.**

The Commercial Retrofit and Multifamily Weatherization Applications are available online. Once your application is received, all project applicants will work directly with an Energy Management Analyst to provide the necessary project details.

Questions or want to initiate an application?

Contact Seattle City Light Energy Advisors at SCLEnergyAdvisor@seattle.gov or (206) 684-3800.
More information, including full program requirements, and application form online at: seattle.gov/city-light/business-solutions

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But Wait There's More (Supplemental Incentives)

Project Development Incentive

Must be completed by June 15th, 2025

$0.025 per kWh

Energy Program Manager

Multiple Projects

One non-lighting

Minimum estimate 200,000 kWh

2-year contract

Caps out at $150,000

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Cost Cap

Base Incentive ($0.33/kWh) capped at 70% of project cost

Supplemental Incentives capped at 100% of project cost

Durable O&M are the most likely to Cap

Bundling with a capital measure can help

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How to Participate

- Contact a City Light Energy Management Analyst (EMA) or Energy Smart Industrial Partner (ESIP)
- Review opportunity with EMA or ESIP
  - Site visit / or baseline data collection may be needed
- Incentive and Energy saving estimate made by City Light EMA
- **Participation agreement** executed between City Light & customer

  BEFORE Completion of project !!
- Project completed & verified
- Incentive paid

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Energy Smart Industrial Program

- Funded by the Bonneville Power Administration
- Todd is an active participant in our projects
  - Site Visits
  - Identify opportunities
  - Measurement & Verification
- Energy Studies for large projects
  - Identify savings estimates
  - Estimate project costs

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Thank you!

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Seattle City Light

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Efficiencies in Refrigeration

Todd Toburen
Energy Smart Industrial

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Presented by Todd Toburen, Cascade Energy

Overview

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- Refrigeration Basics
- Compressors
- Condensers
- Evaporators
- Control Systems
- Opportunity Tool Belt

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Facts and Figures Sheet

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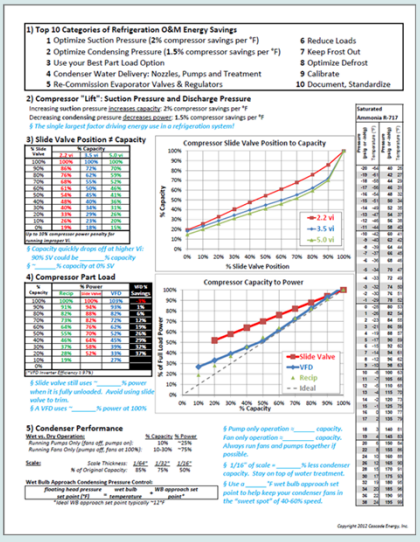

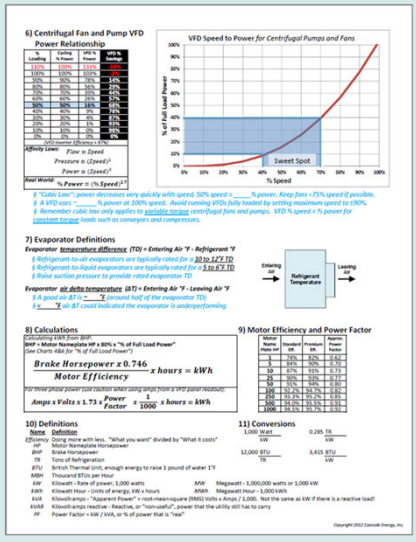

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Industrial Refrigeration Best Practices

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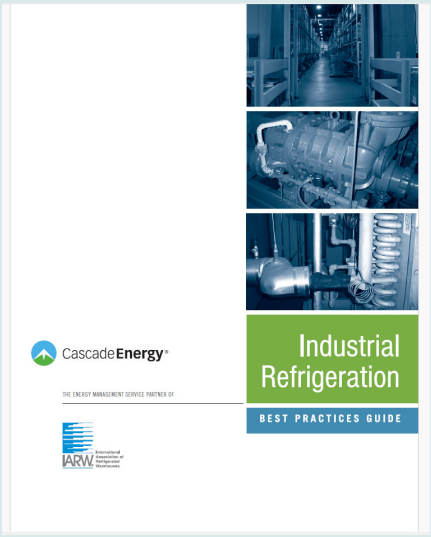

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FOUR MAJOR PROCESSES

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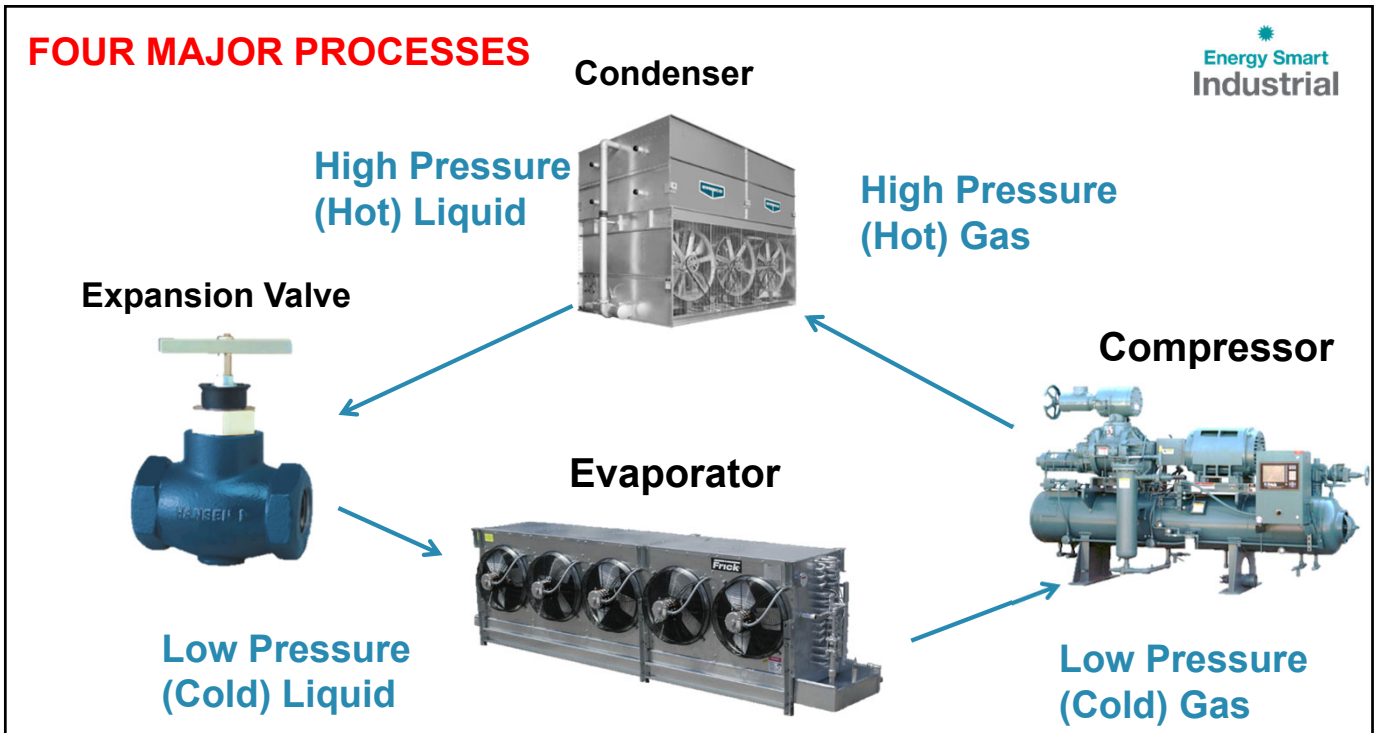

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Compressors

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Twin Screw Compressor

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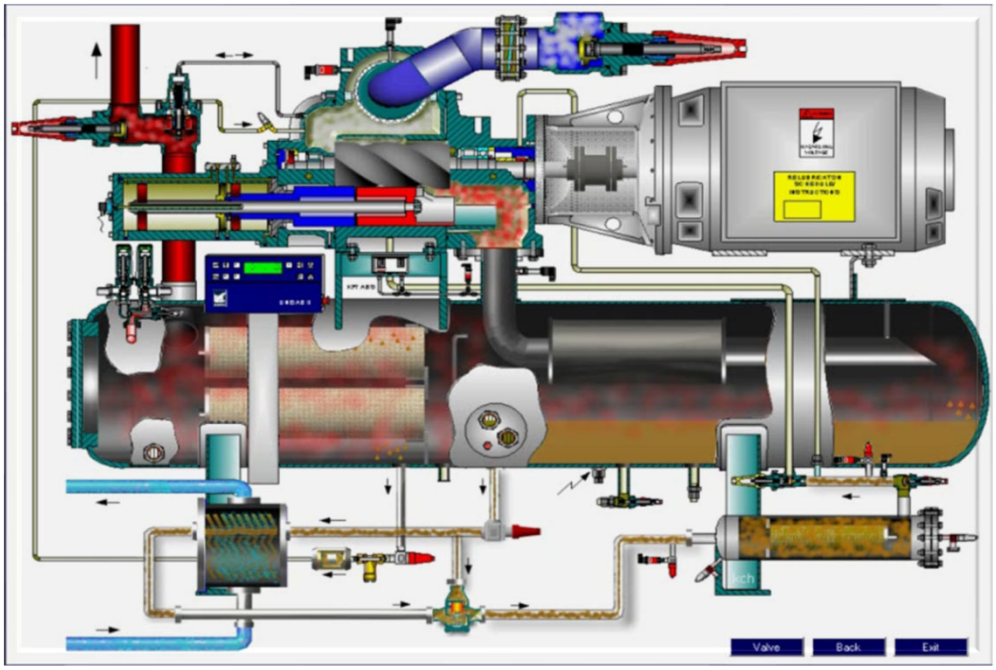

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Compressor Energy Opportunities

1. Discharge Pressure Reduction
2. Suction Pressure Optimization
3. Part Load Control
4. Oil Cooling
5. Coalescent Filters

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Reduce “Lift” Gain Higher Performance

Raise Suction: More Capacity (TR)

Lower Discharge: Less Power (BHP)

Compressor performance = BHP/TR

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Rules of Thumb

2% compressor savings per °F of increase in **suction** temperature

1.5% compressor savings per °F of decrease in **condensing** temperature

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Compressor Part Load

Two absolute rules:

1. Compressor efficiency is worse as compressors unload
2. Speed control is the most efficient part-load control for screw compressors

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Compressor Part-Load Performance

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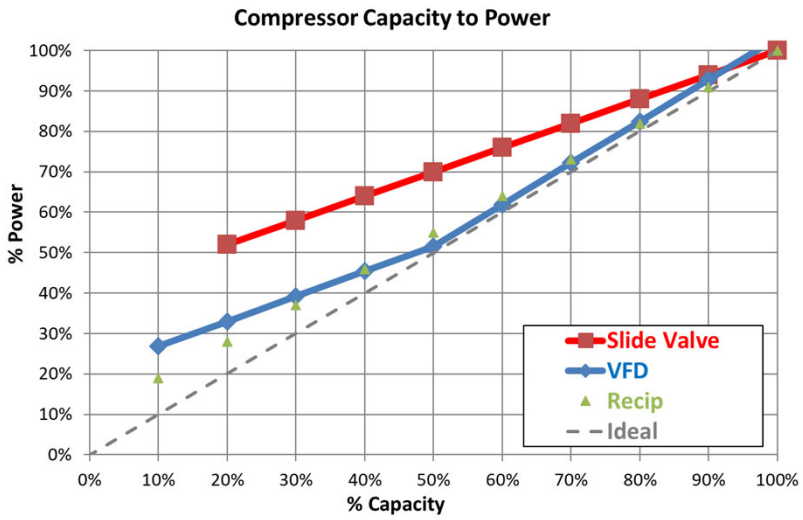

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VFD's vs. Slide Valves

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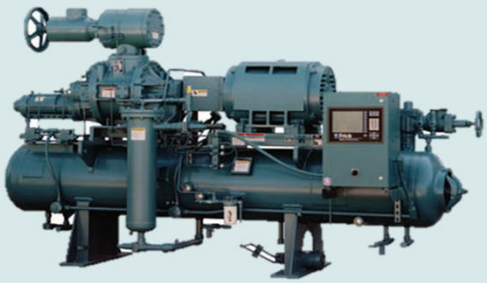
Given: Two same-model, screw compressors, but one has a VFD. What is the power at **60% capacity**?



Slide Valve

76%

VFD

62%

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VFD's vs. Slide Valves

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Given: Two same-model, screw compressors, but one has a VFD. Which one is more efficient at full load?

Slide Valve

100%

VFD

103%

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Oil Cooling / Filters

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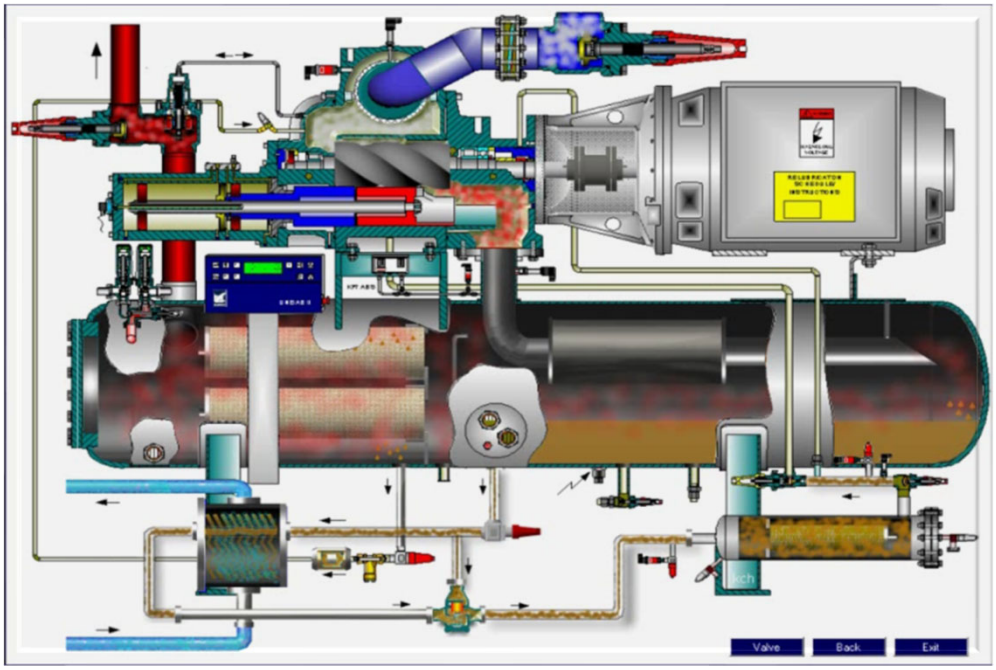

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Condensers

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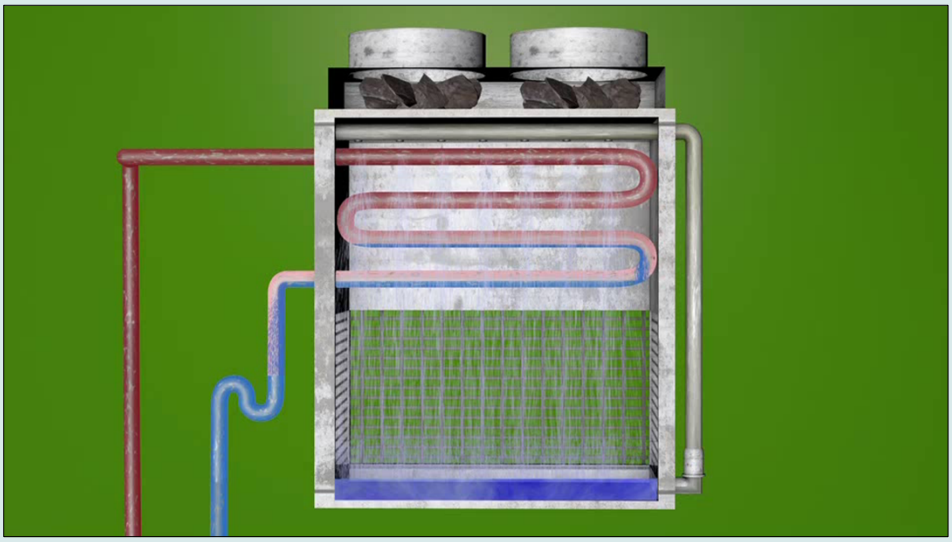

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Evaporative Condensers

1. Evaporative condensers drive towards wet bulb temperature
   Wet bulb temperature is lower (or occasionally the same) as dry bulb
2. Lower lift = lower compressor power
3. Condenser Fan VFD's
4. On Packaged condensing systems, VFD's or ECM's
5. Condenser water pumps are usually NOT a good energy project, but worth looking at on remote sump systems
6. Look at sump heater settings

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Throttled Pumps

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Nozzle Types

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Older design 180° nozzle

Newer "clog free" nozzles

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Impact on Performance

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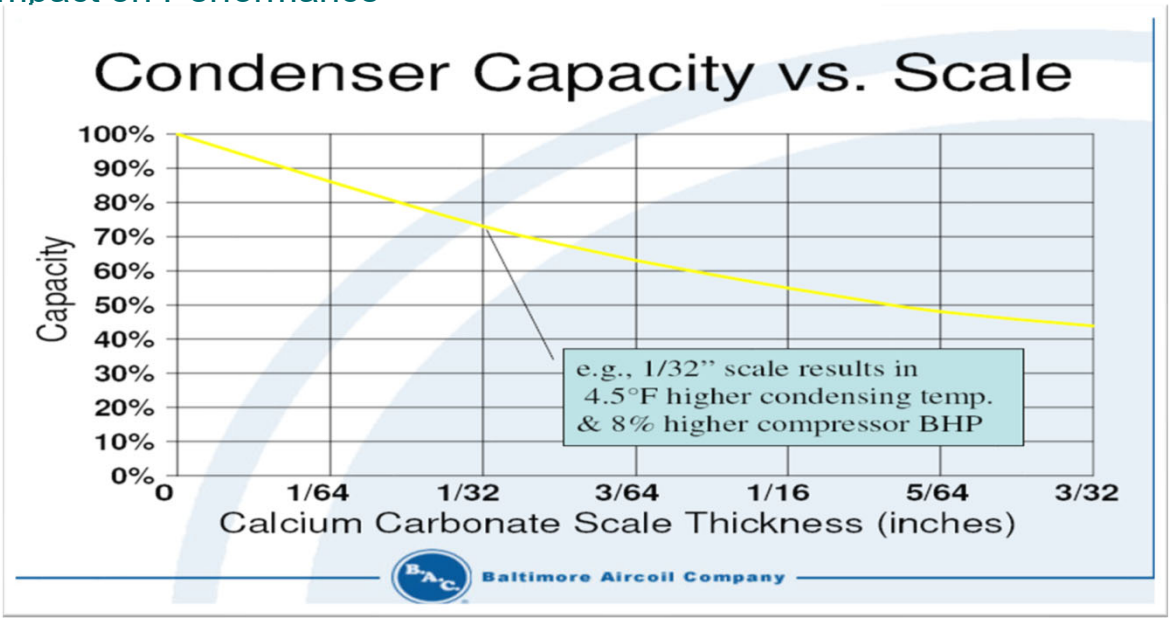

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Purgers—What Can Go Wrong?

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Evaporators

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Evaporator Capacity Control

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Capacity Control

- Fan cycling
- Constant fan operation (cycle liquid solenoid)
- Variable speed - VFDs

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Fans—Variable Torque Loads

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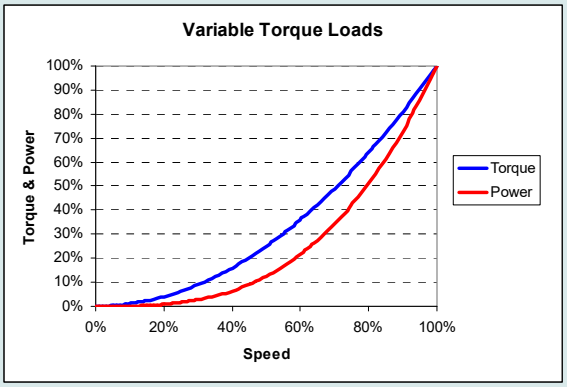
Fans follow “affinity” or “cubic” law

- Capacity ~ speed, power ~ speed^3 !!!!!
- Example at 50% speed: capacity is 50%, power is 12.5%



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SYSTEMATIC DEFROST OPTIMIZATION

Defrost Types

1. Hot gas defrost
2. Electric defrost
3. Air defrost
4. Water defrost

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The Reality of Defrost

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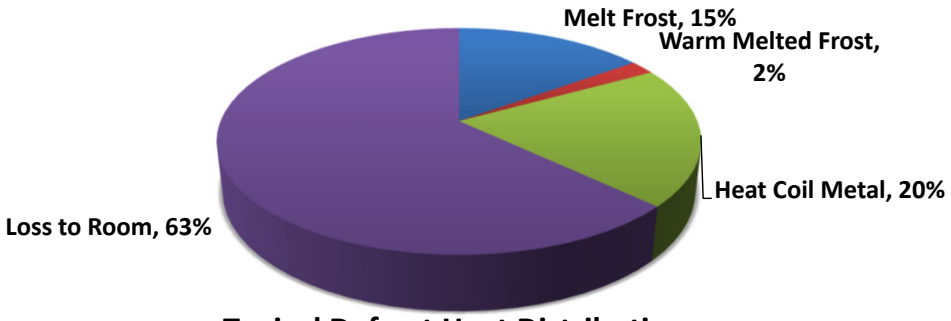
- **What % of heat is actually used to melt frost?**



Typical Defrost Heat Distribution

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Implementing Defrost Changes

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- **Approach a defrost management plan systematically**
- **Start with clean coils; address problem evaporators**
- **Address the source of infiltration; keep frost out**
- **Make changes gradually and check evaporators and pans *daily* for signs of frost build-up**

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Where Does Your Frost Come From?

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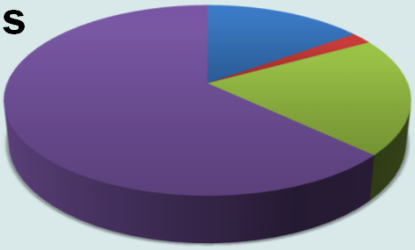
- **Dock Doors**
- **Freezer Doors**
- **Product**
- **Wall or Ceiling Penetrations**
- **Water Defrost**
- **People**
- **Other**



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Control Systems

- Central Control Systems
- Individual Unit Control

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Controls

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Compressors

- Sequencing
- Floating Setpoints
- Proper VI Settings

Condensers

- Floating Head pressure
- Group fan control
- Defrost bumps

Evaporators

- Group fan control
- Fan cycling
- Floating temp setpoints
- Runtime defrost
- Cap maximum speed on VFD's

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Controls

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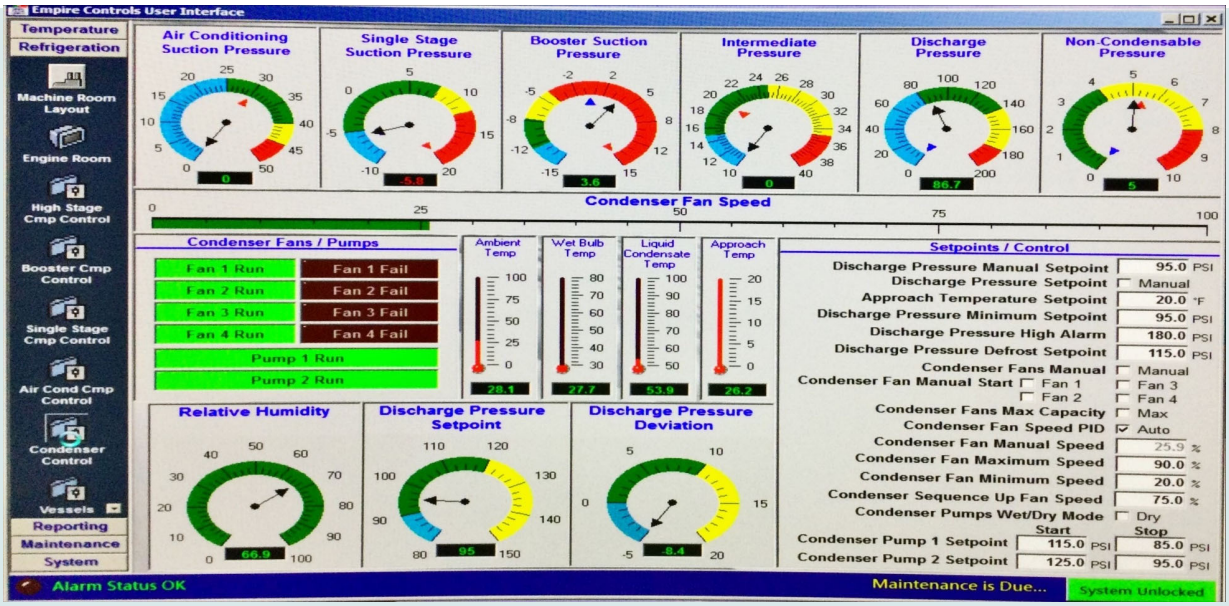

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Controls

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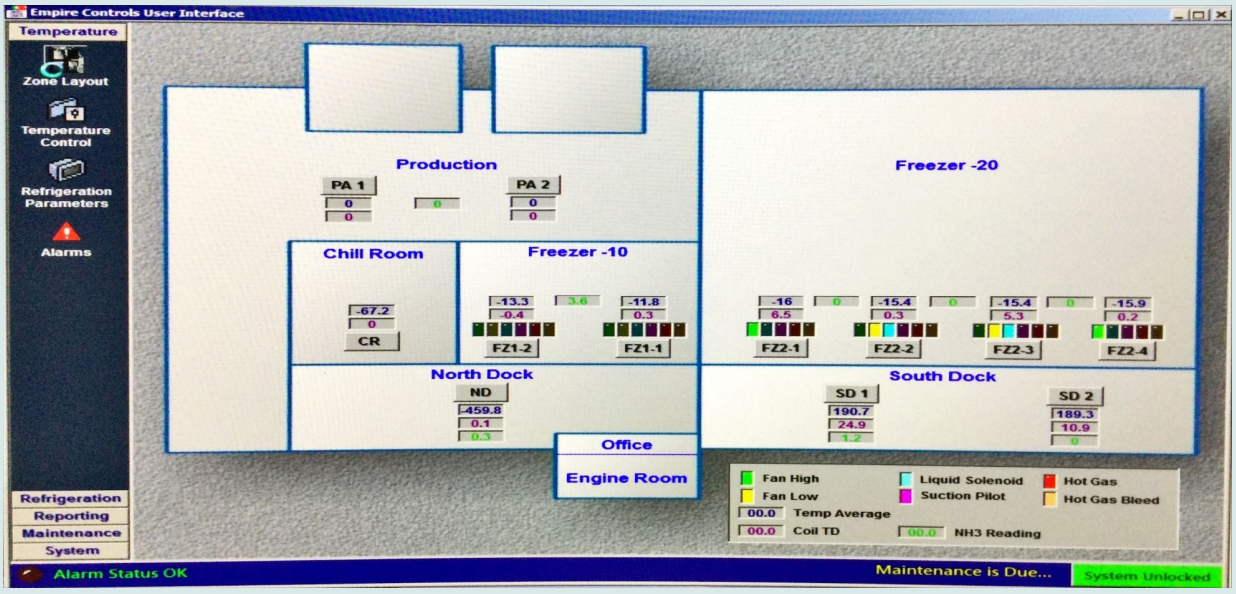

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Controls

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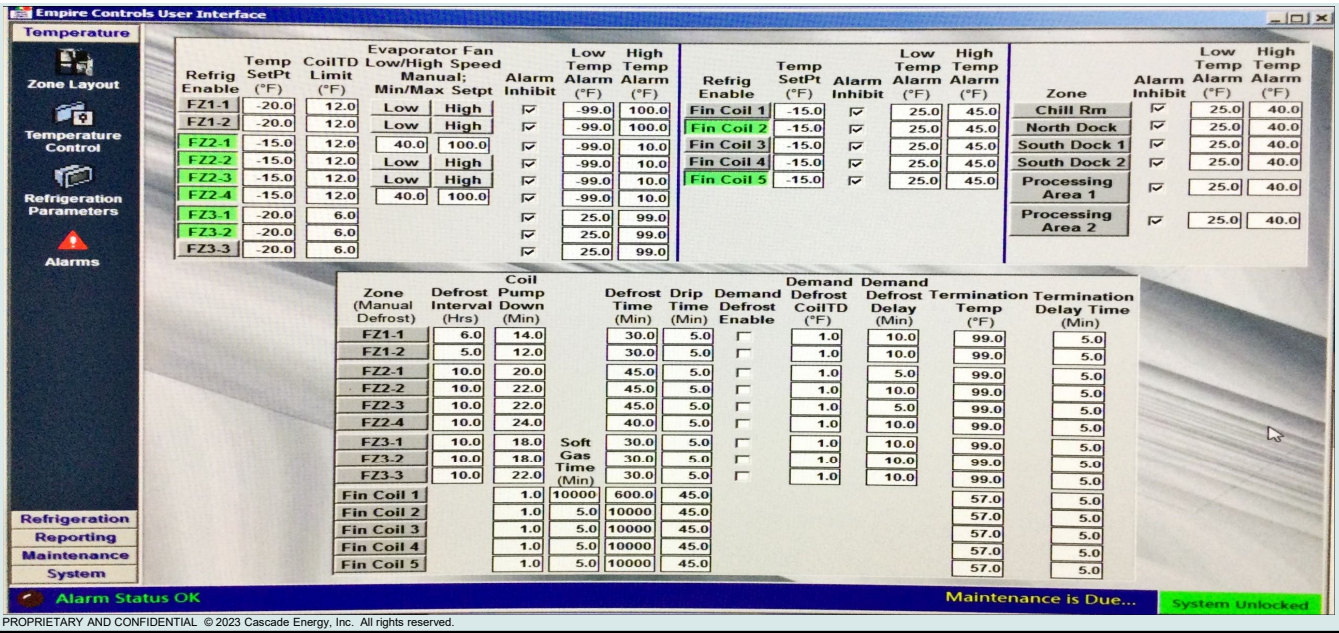

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Tool Belt Compressors

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- **Suction Pressure**
  - What are the temp requirements?
  - What is the coil TD
- **Discharge Pressure**
  - Can they use wet bulb control
  - Minimum condensing pressure (NW 100 psi is standard)
  - Is there a defrost bump

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Tool Belt Condensers

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- **Do the fans have VFD's (Max speed 90%)**
- **Good water distribution**
- **Clean coils**
- **Throttled valves on pumps**

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Tool Belt Evaporators

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- **Fan Cycling**
- **Group Control**
- **Clean Coils**
- **Standardize Temps**

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Tool Belt Controls

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- **SCREEN SHOTS!!!!**
- **Control system is where you can find many of the opportunities.**

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How To Get Started

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- **Contact a City Light EMA or ESI Representative**
- **Call a City Light Energy Advisor : 206-684-3800**
- **Email: SCLEnergyAdvisor@seattle.gov**

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QUESTIONS

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