IDEA2016 *embracing change*

107TH ANNUAL CONFERENCE & TRADE SHOW • ST. PAUL, MN • JUNE 20 – 23

CITIES AND LOW CARBON SOLUTIONS

Innovative Seawater Heat Pump District Heating – Juneau, Alaska

Alan Simchick, Emerson Climate Technologies

Duff Mitchell, Juneau Hydropower and Juneau District Heating

Current Status: Diesel Heating Fuel-

High Carbon

Future Status: Hydro based Seawater Heat Pump District Heating-

Zero Carbon & Lower Cost

JUNEAU DISTRICT HEATING-ZERO CARBON SUSTAINABLE SOLUTION

EMERSON Climate Technologies

Juneau District Heating

PRESENTATION ROADMAP
JUNEAU, ALASKA - ZERO CARBON SOLUTION

- Why-WIFM
- Market Analysis & Demand
- Economic Analysis
- Environmental & Carbon Reduction Analysis
- Seawater Heat Pump Course of Action
- Sustainability and Implementation

WHY DISTRICT HEATING FOR JUNEAU?

- District Heating is a component of **"local"** community planning for over a decade:
  Comprehensive Plan, Climate Action Plan, Willoughby Plan, Sealaska/Federal study, etc.
- **High urban heat load density**
- **High space heating costs based on fossil fuels**
- ***Low conversion costs-redundancy of existing heating systems***
- **Available Local Renewable Energy Resources**

TEAM EFFORT-CBJ, JEDC, DBA, Emerson Juneau Hydropower, Ever-Green, Denmark-District Energy Alliance

Downtown Juneau, Alaska is well-suited for District Heating

EMERSON Climate Technologies

JUNEAU DISTRICT HEATING

- **78% OF JUNEAU IS HEATED BY FUEL OIL**
- **90% OF TARGET DOWNTOWN IS HEATED BY FUEL OIL**
- Current Fuel oil price is .50 cents a gallon above Seattle due to shipping and handling costs (891 miles)
- **FUEL OIL VOLATILITY** $5.00 a gallon vs. $2.50 a gallon
- **Alternative must provide High Heat (above 180°F)**
- Heating Costs are a large governmental and business property operating expense (7842 Heating Degree Days)

MARKET ANALYSIS & DEMAND

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JUNEAU DISTRICT HEATING

- **Pellets**-No local production, imported, high transport and handling costs. Long term price unknown.
- **Biomass**-Limited local production but not sustainable. High transport and handling costs that exceed biomass value.
- **Natural Gas-CHP**-No local supply chain, expensive transportation and handling. No infrastructure for converting LNG to natural gas and no distribution infrastructure.
- **Seawater Heat Pump** -Local resource, local expertise. High upfront costs. Innovative, but proven technology

ECONOMIC ANALYSIS

- **Pellets**-Carbon impact on production, importation and handling. Less emissions than fuel oil. Possibly sustainable. Ash residue.
- **Biomass**-Carbon impact on production, importation and handling. Less emissions than fuel oil. High transport and handling costs that exceed biomass value. Possibly sustainable. Ash residue.
- **Natural Gas-CHP** - Methane impact on NG production, carbon impact on importation, transportation and handling. Less emissions than fuel oil. Not sustainable. No Ash residue.
  - **Seawater Heat Pump** -Local resource and use of integrated renewable hydropower electricity. Creates a "value added" renewable energy resource. Zero emissions with a COP of 3 . Sustainable virtually… forever

ENVIRONMENTAL ANALYSIS

SEAWATER HEAT PUMP COURSE OF ACTION

JUNEAU HAS THE RESOURCES TO HEAT ITSELF SUSTAINABLY…FOREVER

SUSTAINABILITY AND IMPLEMENTATION

- Harvest heat from Gastineau Channel (Juneau)
- Convert Seawater Heat to produce 3 units of heat energy for every 1 unit of electrical energy input
- Circulate heat energy (180°F to 190°F) to heating district via pipe distribution network
- Juneau, Alaska is familiar with Heat Pump Technology

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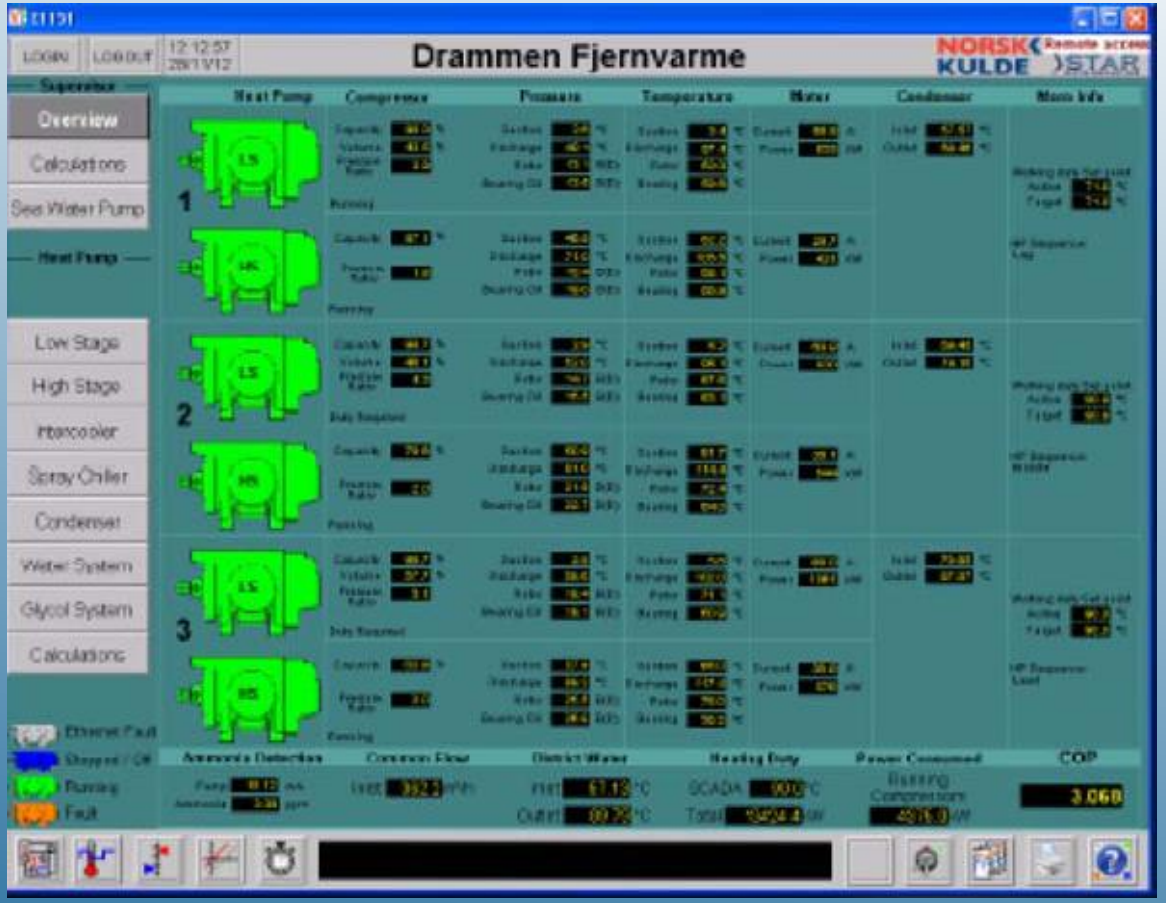
JUNEAU DISTRICT HEATING

HIGH COEFFICIENT OF PERFORMANCE (COP)

300% + Efficiency



A COP of 3 means that 3 units of heat is created for every unit of energy input.
Tripling the energy value.

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JUNEAU DISTRICT HEATING

HEAT PUMPS ARE SUPER 300% EFFICIENT = EFFECTIVE LOWER COST HEAT AND ZERO EMISSIONS

Type	Heat Demand (kWh) Output	Efficiency (%)	Input Energy (kWh)	Specific CO^2 emissions (kg CO^2/kWh)	Annual CO^2 emmissions (kg)
Oil-Fired boiler	15,000	80	18,750	0.274	5,138
Natural Gas fired boiler	15,000	95	15,790	0.202	3,189
Electric boiler (renewable source)	15,000	95	15,970	0	0
Electric Heat Pump (renewable source)	**15,000**	**300**	**5,000**	**0**	**0**
Source Heat Pump Centre, Boras, Sweden					

VALUE ADDED RENEWABLE ENERGY

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JUNEAU DISTRICT HEATING

14 MW, 90°C, District heating
3 x 2 stage 4.6 MW Systems

DRAMMEN FJERNVARME

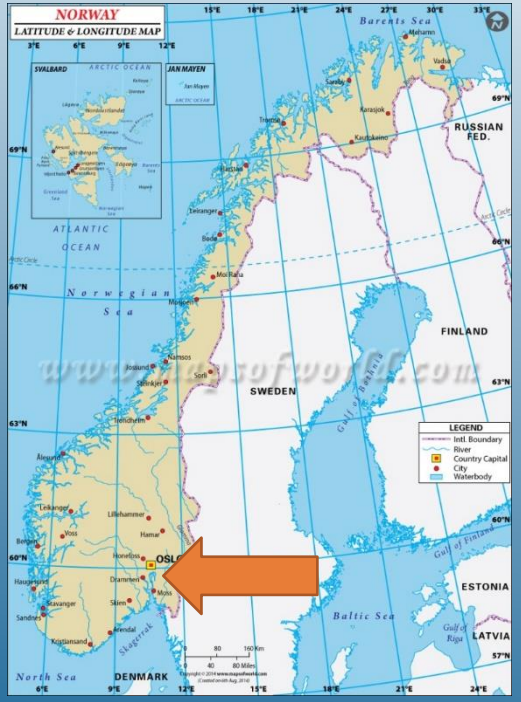
$COP_{heating}$ = 3.0

Evaporating temp. 2°C
Sea water 8 to 4°C

Condensing temp. 89°C
District heating water 60 – 90°C

TRIED AND PROVEN SEA WATER HEAT PUMP DISTRICT HEATING SYSTEM

Operating flawlessly since 2011



Drammen, Norway is 118 miles north of Juneau, Alaska

Drammen Latitude
59.74

Juneau Latitude
58.3

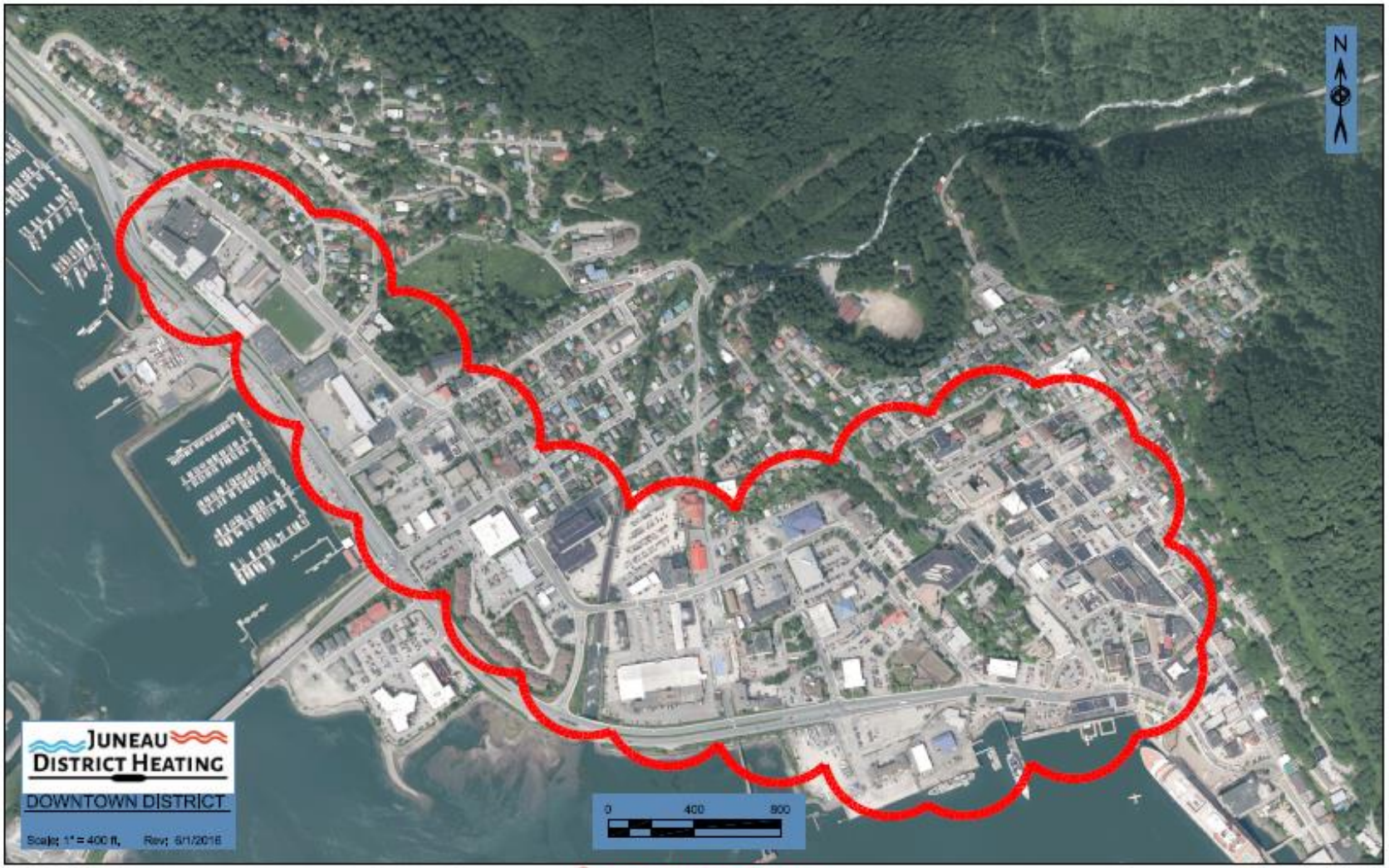
NOAA Sea Water Temperature Records show Gastineau Channel has similar or warmer water temperatures than Drammen, Norway

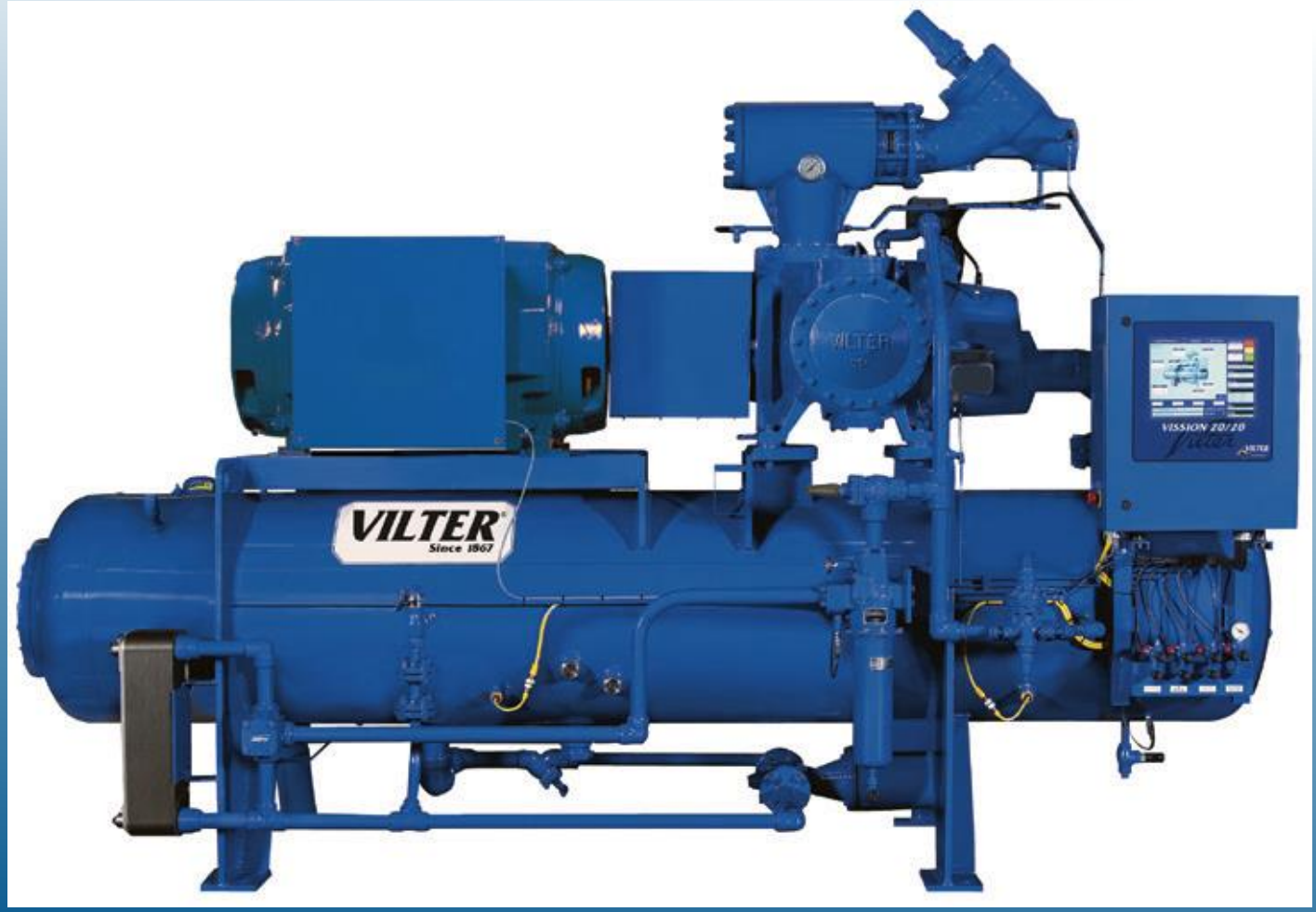
SEA WATER HEAT PUMPS IN OPERATION IN DRAMMEN NORWAY

EMERSON Climate Technologies

JUNEAU DISTRICT HEATING

JUNEAU DISTRICT HEATING INTAKE


N
JUNEAU
DISTRICT HEATING
DOWNTOWN DISTRICT
Scale: 1" = 400 ft.
Rev: 6/1/2016
0
400
800
© Juneau District Heating • CONFIDENTIAL



High Temperature Seawater Heat Pump 194° F

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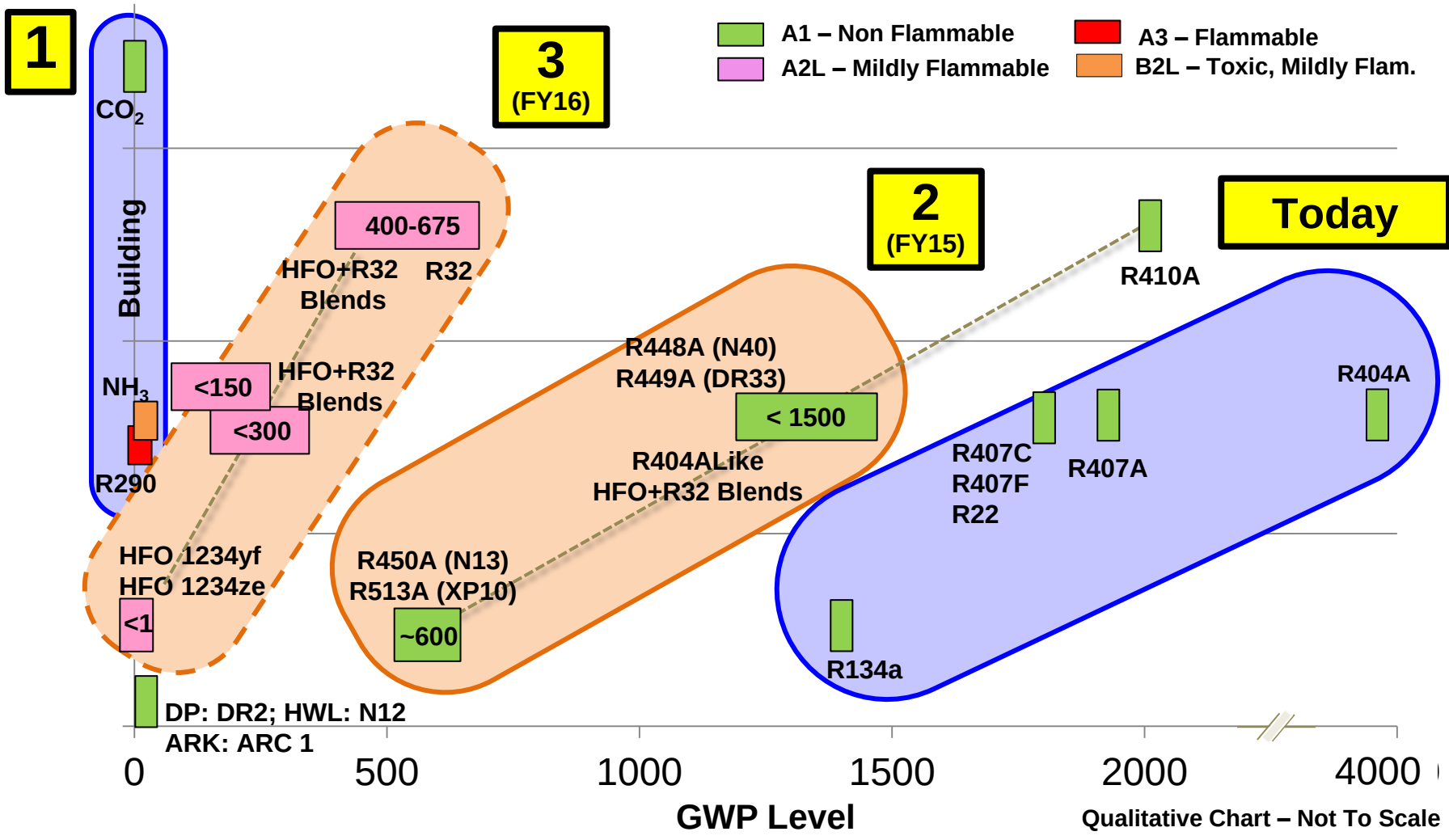
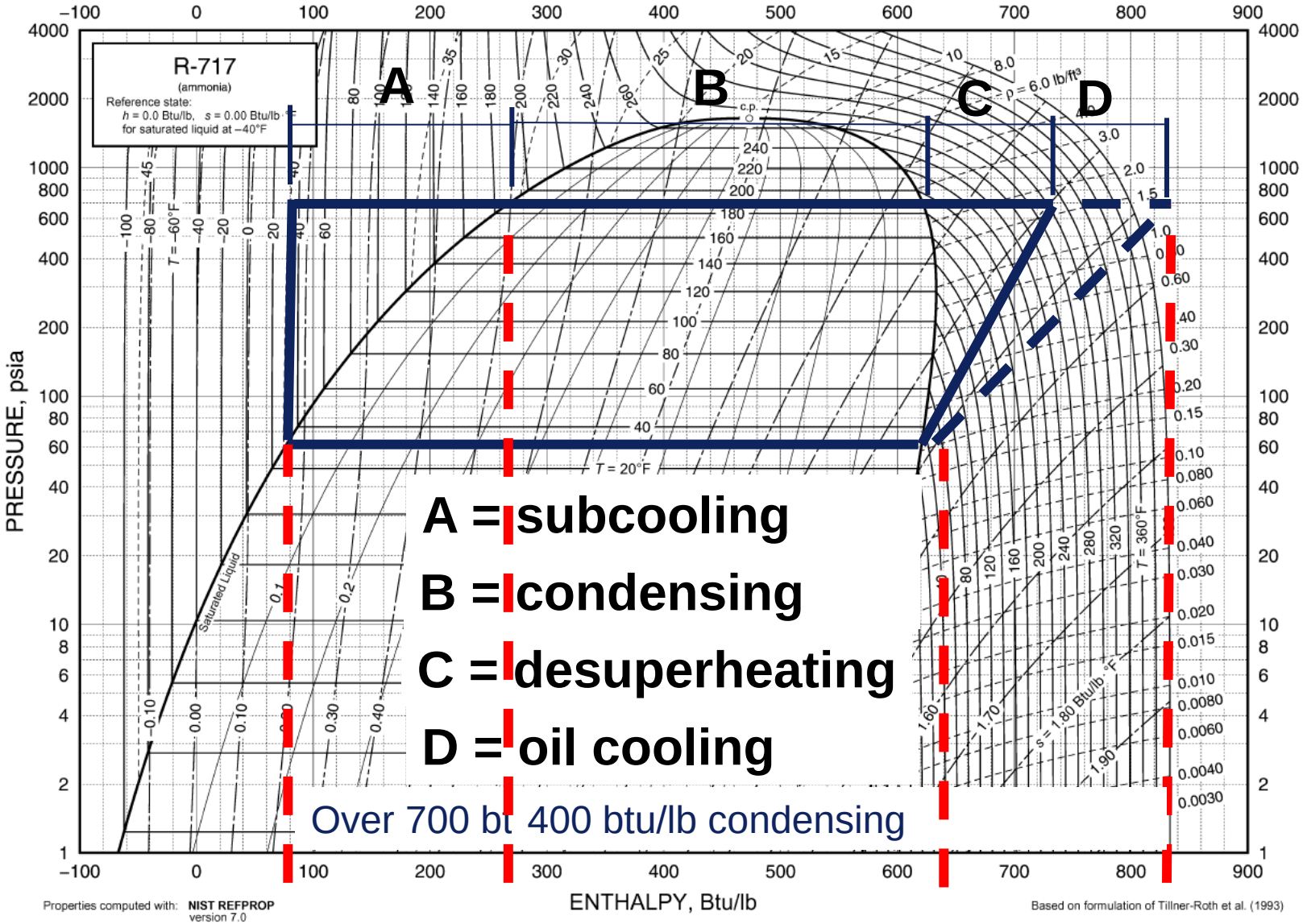
Juneau District Heating

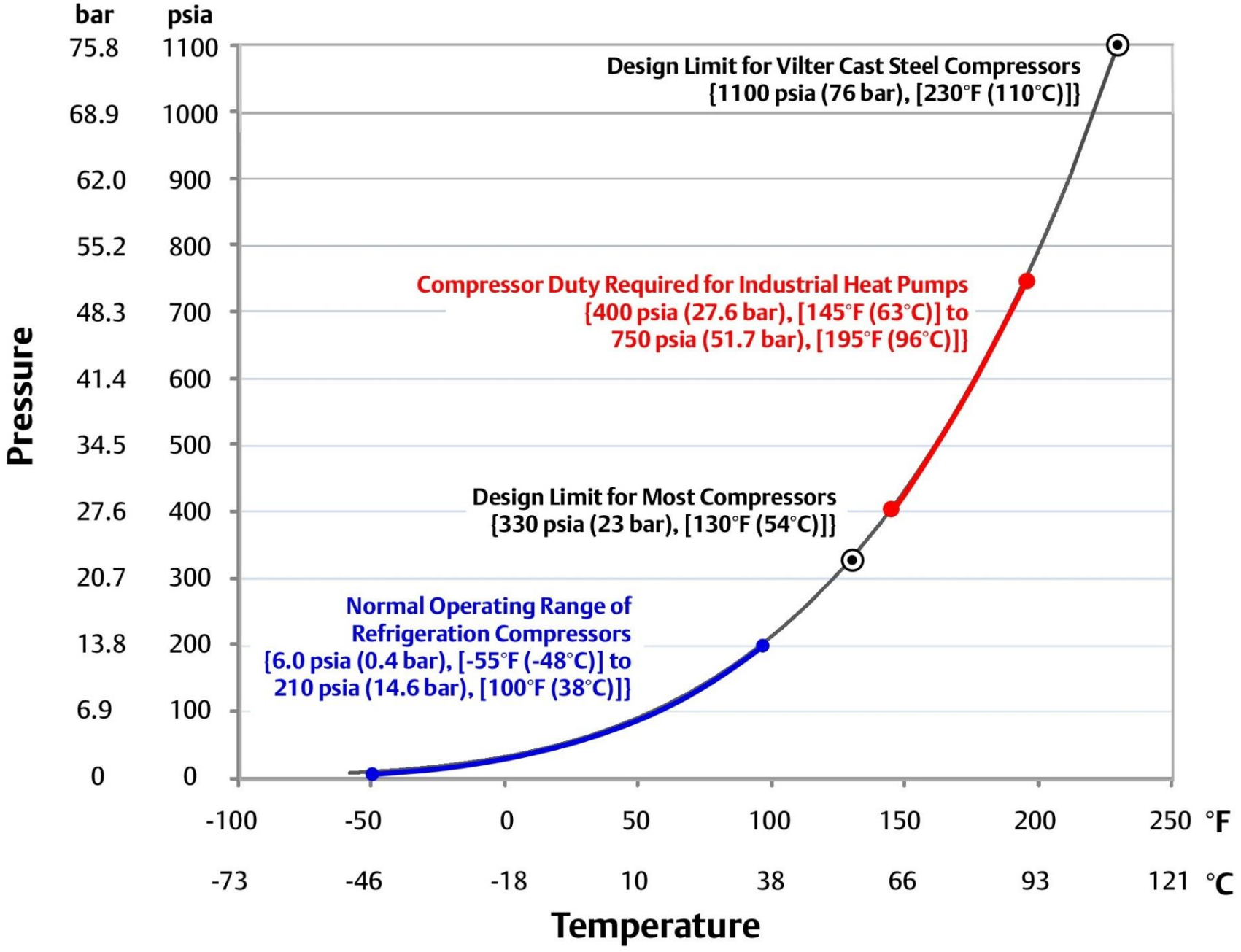
Reasons for wanting to use Ammonia (R-717)



Ammonia as a heat pump fluid

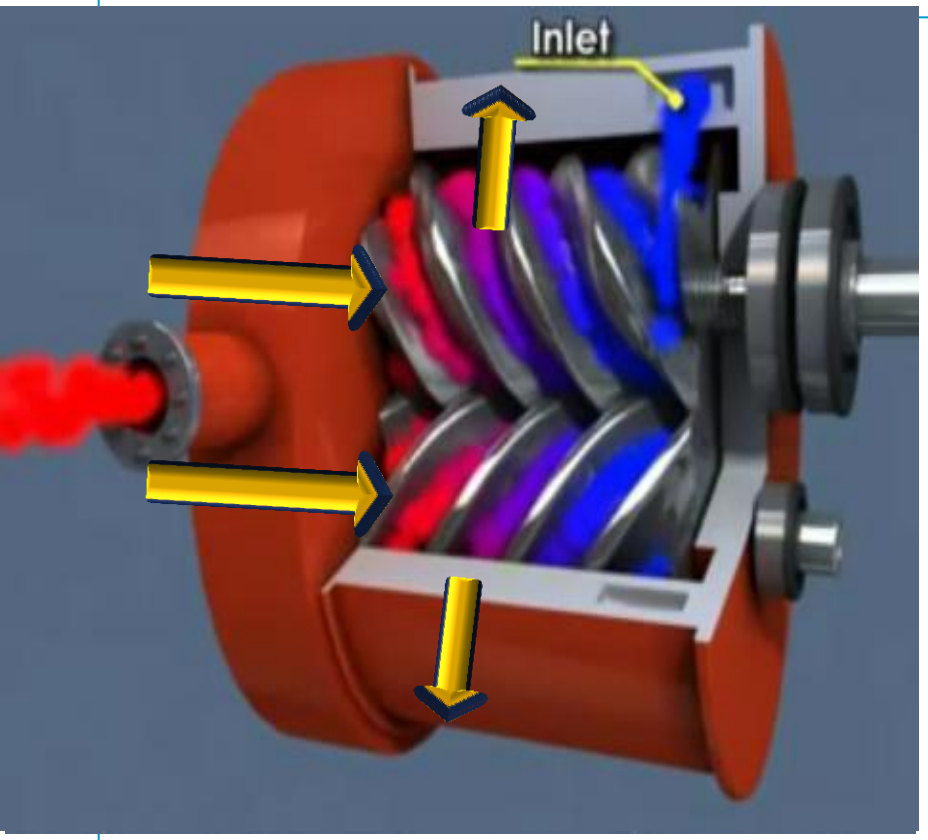


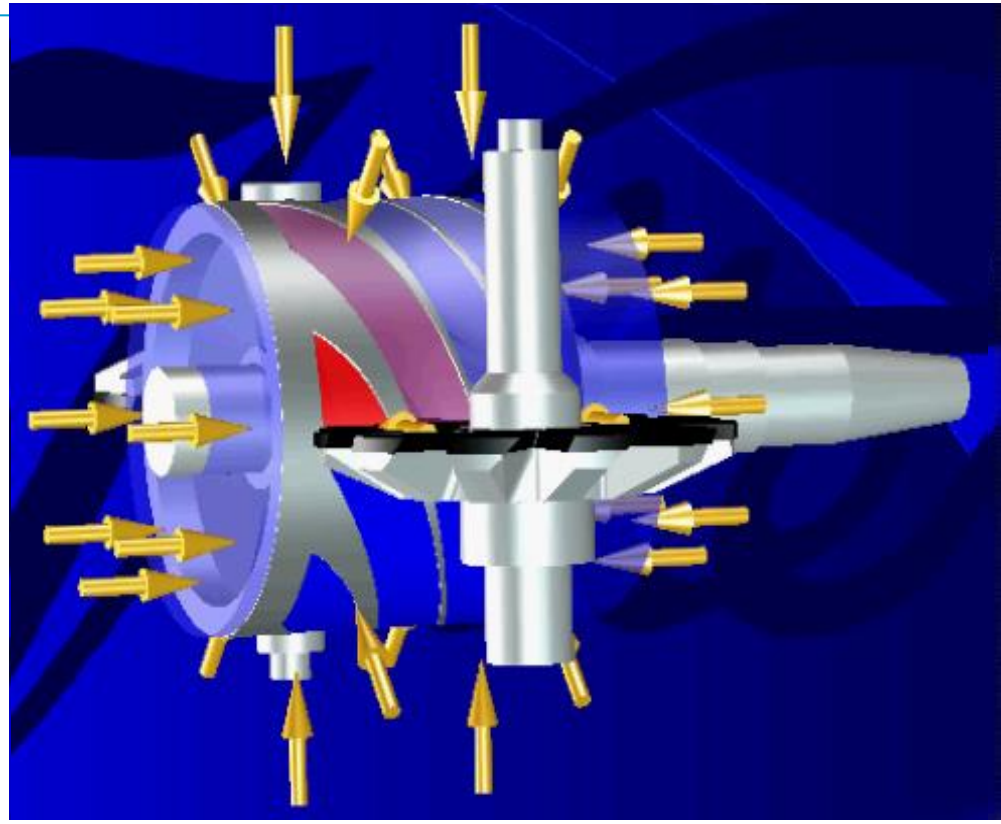
Ammonia (NH_3, R-717) Pressure-Temperature Relationship



Challenges: Ammonia Heat Pumps

Compressors are Limited by Pressure





Twin Screw

High Bearing Loads

Challenged at High Pressures

Single Screw

Balanced Loads

Suited for High Pressures

Heat Pump Equipment Skids

Factory packaged

- Single source solution
- Built in factory controlled environment
- In house expertise in engineering and manufacturing
- Control panels factory mounted and wired
- All components built to required standards as well as Vilter's manufacturing standards
- QC inspections throughout build and before shipment of unit from factory
- 100% manufactured in Cudahy, Wi

GO FORWARD PATHWAY

Bodø, Norway-Large Seawater District Energy-
Operating
Duindorp, the Netherlands-Large Seawater District Energy-
Operating
Drammen, Norway-Large Seawater District Energy-
Operating
Juneau, Alaska, Ted Stevens Marine Research Center Complex, -Small Seawater District Heating-
Operating
Seward, Alaska- Sealife Center, Small Seawater District Heating –
Operating

Juneau District Heating- Large Seawater District Energy-
Planned

Future Operating Systems?

Future Sustainable City Solutions

Success Indicators:

- Proper waterbody temperatures in close proximity to use: Sea, Lake, River
- 300% + efficiency is a game changer
- Reasonable cost electrical input and renewable energy availability
- Competitive and Compelling Cost Savings compared to Alternatives
- Willing and Accepting Market

Seawater Heat Pumps are to District Energy what LED lights are to lighting

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THANK YOU & QUESTIONS

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