

ASME ORC 2017

4TH INTERNATIONAL SEMINAR ON ORC POWER SYSTEMS

SWEP International AB
Kristian Ekstrand

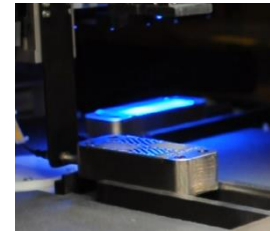
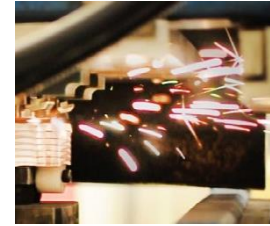
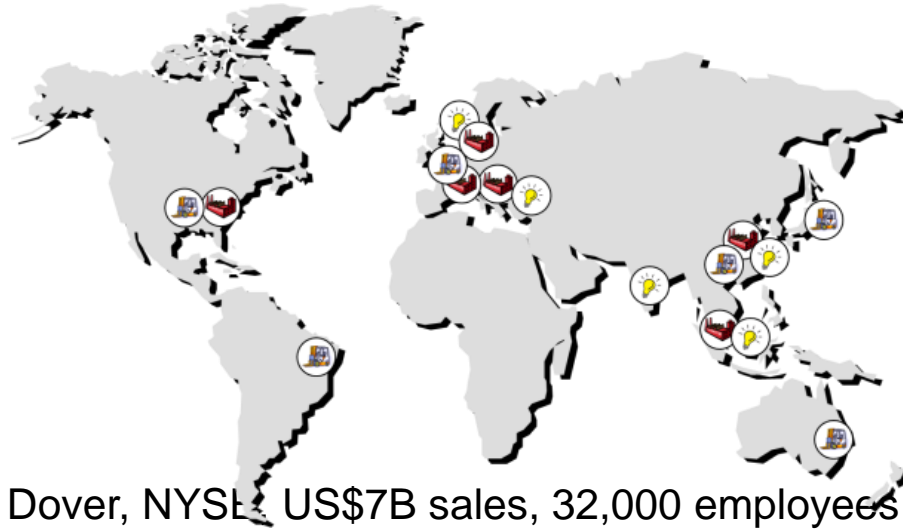
Lead Application Engineer



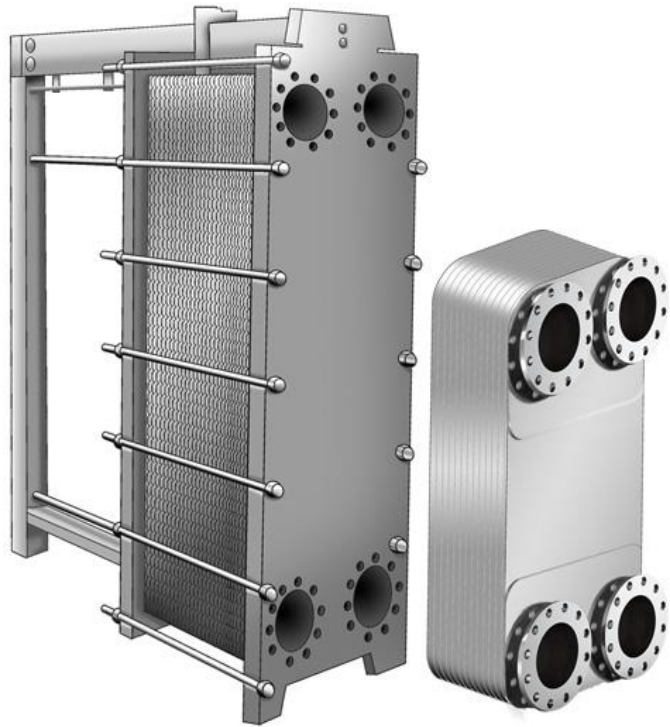
About SWEP and BPHE

- Facts, Figures and Global Footprint

- Brazed plate heat exchangers (BPHEs)
- 900 employees
- 3,000,000+ BPHEs per year
- Own sales force in 30+ countries
- 6 plants in 6 countries
- Warehouses in 8+ locations
- Founded in 1983 and since 1994 a part of Dover, NYSE, US\$7B sales, 32,000 employees
- SWEP is number one in the BPHE segment in Europe (Frost & Sullivan)



The Brazed Plate Heat Exchanger (BPHE)



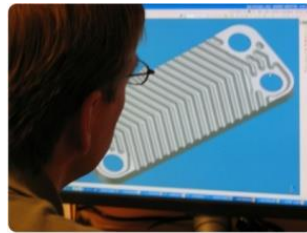
- Totally flexible and scalable
- Modular construction
- Optimized for modular design
- Minimal footprint
- Available in various material combinations
- Now also in 100% stainless steel material!

SWEP – The BPHE specialist

- SWEP have all know-how in-house



Simulation



Design



Tooling



Laboratory



Material



Pressing



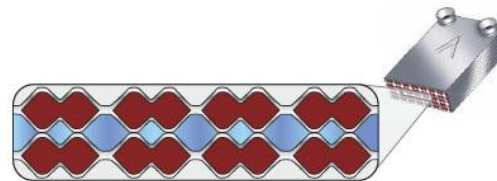
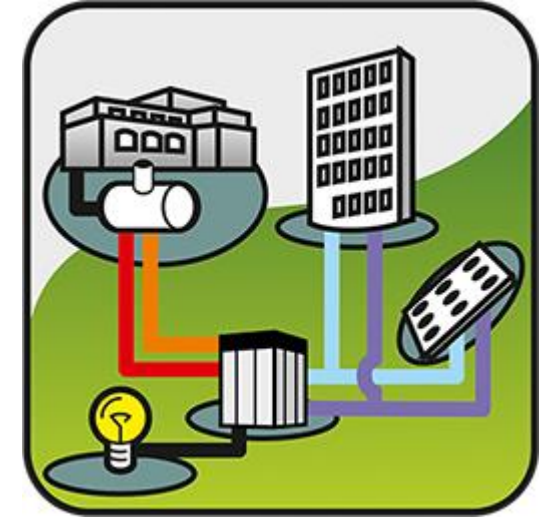
Brazing



Testing

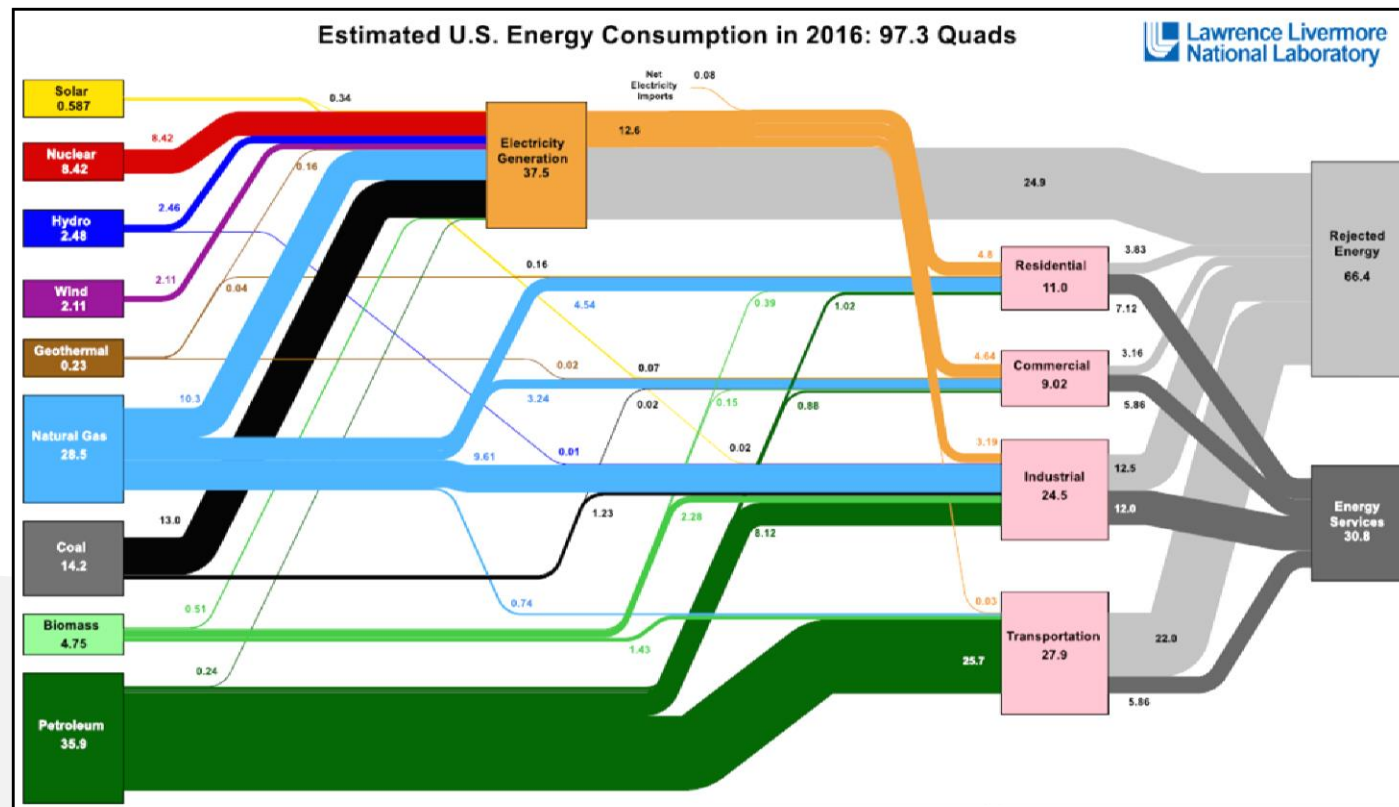
ORC and SWEP BPHE

- Long experience and a wide variety of references within ORC
- A range of low pressure drop compact BPHE's
- Capability
 - 16-45 bar pressure rating
 - Up to 350 m³/h water capacity, DN150, 6"
- Modularity
 - Capacity and performance
 - Different plate patterns
 - Asymmetric plate patterns
- Maximal material efficiency – 95% usage of material
 - Extremely compact
 - Small hold-up volumes
- Availability
 - The most advanced SWEP BPHE is never more than 3 weeks away



ORC + SWEP BPHE

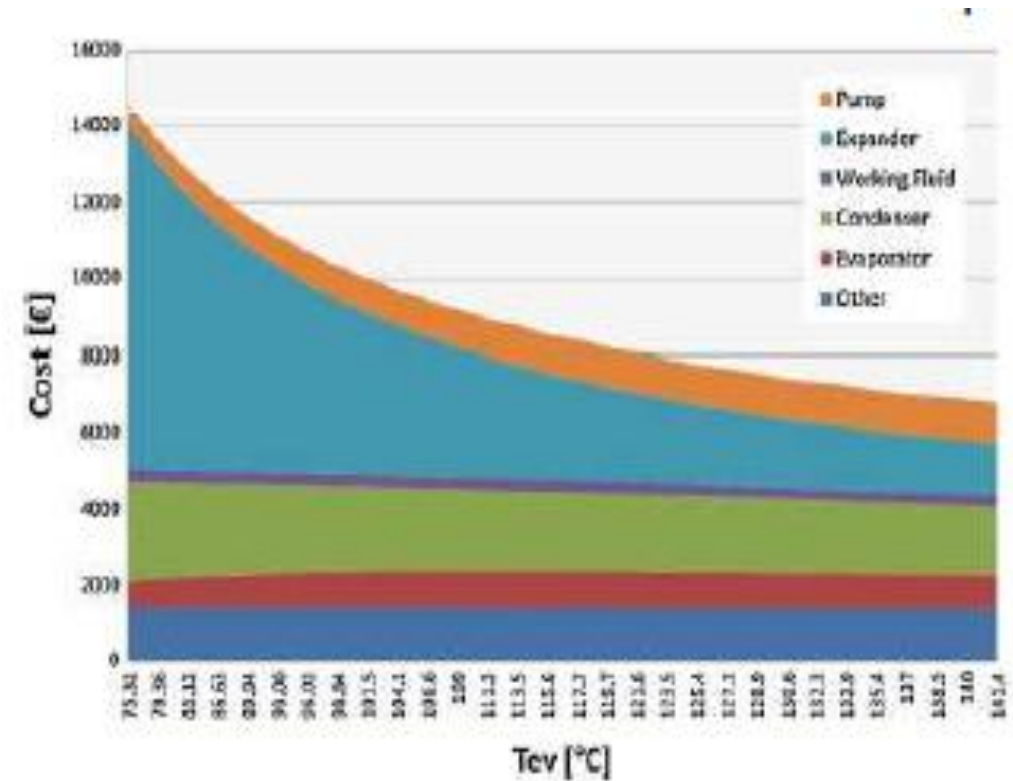
- A good opportunity to recover waste energy
 - Lower total CO2 emissions
 - Breakthroughs is the payback of the systems.



Picture LLNL

Payback time <4 years

- System cost
 - €0,2/kWh Average European tariff 2016
 - AOH: 8000
 - $32000\text{h} \times €0,2/\text{kWh} = \mathbf{€6400/\text{kW}}$
- 100kW
 - $100\text{kW} \times €6.400/\text{kW} = €640.000$
 - Heat exchangers 50% reduction with BPHE
 - Real system cost is lower → **Payback <3 years**
- 40kW
 - $40\text{kW} \times € 6.400 /\text{kW} = €256.000$
 - Real cost is in line → **Payback 4 years**
- 10kW
 - $10\text{kW} \times € 6.400 /\text{kW} = €64.000$
 - Real cost is higher → **Payback >4 years**
 - Need for cheaper system, €2500/kW



Picture S. Quoilin

SWEP SSP G7

- SWEP has a proven, easy to use, calculation software
- Necessary fluids available (UDF)
- Liquid Evaporator (preheater + evaporator)
 - sensible + latent + sensible

Calculations

- Single Phase
- Single Phase Dual
- Single Phase Two Stacks
- Cascade
- Applications
 - Condenser Heat Pump
 - Evaporator Heat Pump
 - AHRI Selection
 - Two Stage
 - Air Dryer
 - District Energy

Liquid Evaporator ...

File Tools Printout Table

Design Performance

Fluid Side 1: R245fa
Fluid Side 2: Water

CoCurrent:

Exchangers: B649

Side 1: Side 2:

Heat load: 2000 kW

Subcooled liq. temp.: 50,00 °C

Inlet vapor quality:

Outlet vapor quality: 1,000

Inlet temperature: 120,00 °C

Evap. temp. (dew): 90,00 °C

Superheating: 5,00 K

Outlet temperature: 100,00 °C

Flow rate: kg/s kg/s

Max pressure drop: 20,0 kPa 50,0 kPa

Number of plates:

Oversurface: %

Fouling factor: m²·°C/kW

AutoPerformance:

Calculate

Heat Exchanger : B649Lx162

Side 1 : Inner circuit
Side 2 : Outer circuit

DUTY REQUIREMENTS

Unit	Side 1	Side 2
Heat load		2000
Inlet vapor quality	0,000	
Outlet vapor quality	1,000	
Inlet temperature	49,99	120,00
Evaporation temperature (dew)	90,00	
Superheating	5,00	
Outlet temperature	95,00	100,00
Flow rate	9,615	23,70
- inlet vapor	kg/s	0,0000
Fluid vaporized	kg/s	9,615
Max. pressure drop	kPa	20,0

PLATE HEAT EXCHANGER

Unit	Side 1	Side 2
Total heat transfer area	m ²	105
Heat flux	kW/m ²	19,1

Very high heat flux not experimentally certified (19 kW/m²).

Technical Data Dimensional Data Totals

SWEP SSP ORC Simulation Program

SSP Organic Rankine Cycle Simulation
⊖ ⊕ ⊗

Condenser Pump Efficiency (%)

Evaporator

Select Secondary Fluid

BPHE: B400T;B439M
Fluid: Water

Heat Load (kW)

SuperHeat (K)

Dew Temperature (°C)

Secondary Inlet Temperature (°C)

Secondary Outlet Temperature (°C)

Max Pressure Drop Ref Side (kPa)

Max Pressure Drop Secondary (kPa)

Co Current Arrangement?

Condenser

Select Secondary Fluid

BPHE: B400T;B439M
Fluid: Water

SubCooling (K)

Dew Temperature (°C)

Secondary Inlet Temperature (°C)

Secondary Outlet Temperature (°C)

Max Pressure Drop Ref Side (kPa)

Max Pressure Drop Secondary (kPa)

Co Current Arrangement?

Efficiency (%)	Turbine Load [kW]	Total Heat Transfer Area [m ²]	Ref Flow Rate [kg/s]	Evap Model	Evap Load [kW]	Evap HTA [m ²]	Evap In Temp [°C]	Evap Temp [°C]	Evap Flow Rate Sec [kg/s]	Evap DP1 [kPa]	Evap DP2 [kPa]	Evap OS [%]	Cond Mo
11.27	58.69	31.68	2.17	B400Tx50	500.00	10.42	45.88	117.25	5.93	117.25	50.04	0.0	B400Tx10
11.22	58.32	33.82	2.18	B439Mx44	500.00	12.56	45.73	116.42	5.93	116.42	40.87	0.0	B400Tx10
11.29	58.76	35.53	2.18	B400Tx50	500.00	10.42	46.38	117.20	5.93	117.20	50.04	0.0	B439Mx8
11.21	58.30	37.67	2.18	B439Mx44	500.00	12.56	46.18	116.22	5.93	116.22	40.87	0.0	B439Mx8

Evaporator Design

Heat Exchanger: B439Mx44

Refrigerant: R245fa
Secondary Fluid: Water

	Unit	Side 1	Side 2
THERMAL DUTY			
Heat Load	kW		500.0
Inlet Vapor Quality		0.000	
Outlet Vapor Quality		1.000	
Inlet Temperature	°C	45.73	140.00
Dew Temperature	°C	116.42	
SuperHeating	K	5.00	
Outlet Temperature	°C	121.42	120.00
Total Flow Rate	kg/s	2.177	5.925

R245fa (500.0 kW)

Evap: B400T;B439M
Cond: B400T;B439M
Max Efficiency (%): 11.3
Total HTA (m²): 31.7

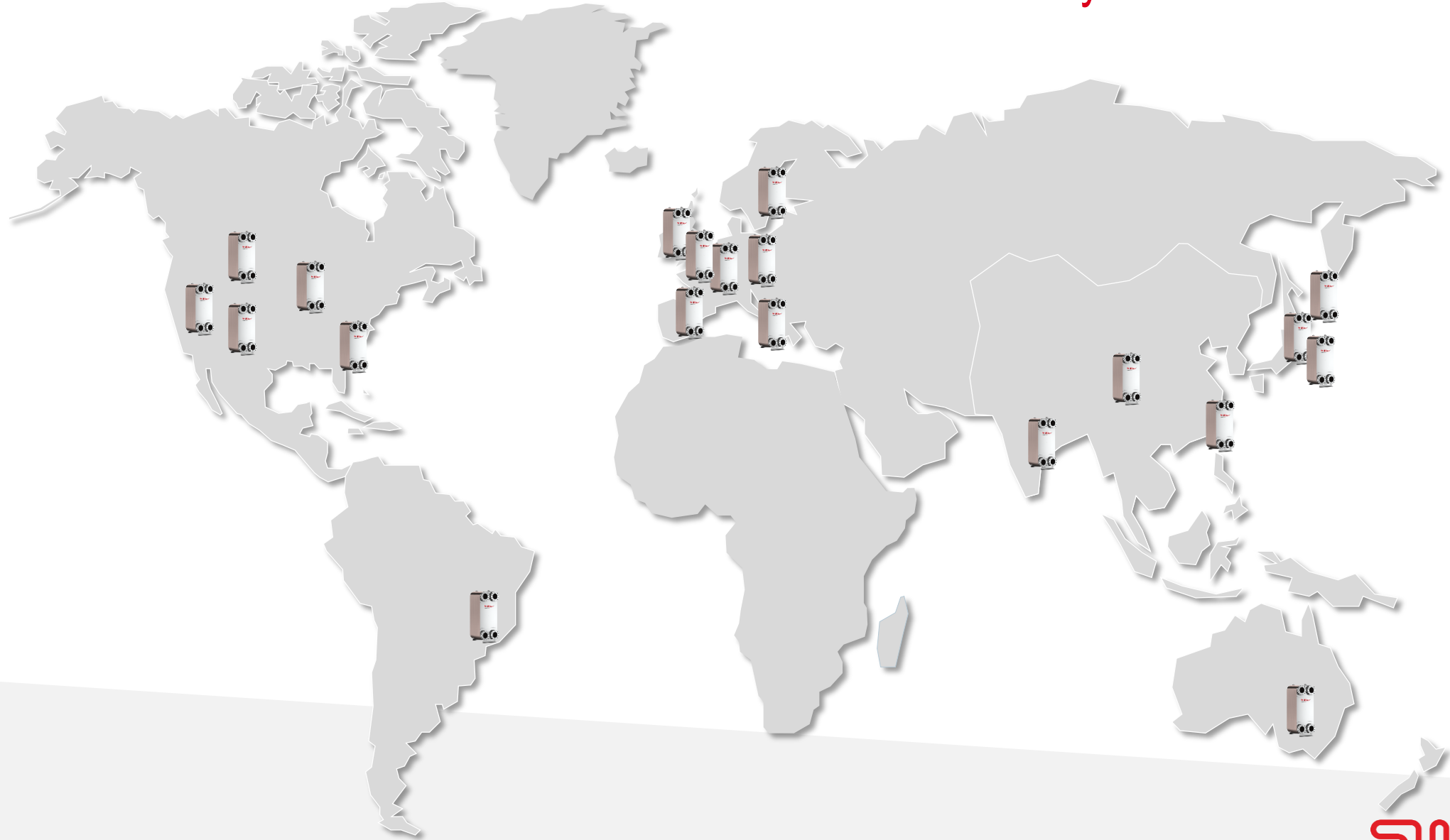
PENTANE (500.0 kW)

Evap: B400T;B439M
Cond: B400T;B439M
Max Efficiency (%): 11.1
Total HTA (m²): 31.2

MM Siloxane (100.0 kW)

Evap: B427L
Cond: B427L
Max Efficiency (%): 8.8
Total HTA (m²): 25.3

+50 customer used SWEP BPHE in commercialized ORC systems



Factories and Global logistics



Distribution centre:

- Customized products stocked
- Contracted commitments on both parties
- 48-72 hour lead time from call-off to arrival



TURN WASTE HEAT INTO ENERGY THE SMART WAY

ORC systems put high demands on heat transfer equipment. SWEP brazed plate heat exchangers handle the challenges. Our long experience and passion for energy-efficient technology have resulted in the highest capacity range on the market.

The brazed technology offers unparalleled performance at lowest life-cycle cost, all in a compact and robust unit. A modular design concept matched to your needs by an experienced team ensures an optimized solution.



SWEP
Box 105, SE-261 22 Landskrona, Sweden
Tel: +46 418 40 04 00, Fax: +46 418 292 95
info@swep.net www.swep.net

SWEP
A DOVER COMPANY