Heat exchangers for Geothermal Systems

2023 Geothermal Energy and Machinery Systems Workshop

Renaud Le Pierres - Sales & Business Development Team

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Heatric

Parker MEGGITT

Heatric Market Segments

Serving the Energy Value Chain for over 35 years

Offshore

The compact nature of our heat exchangers enables significant reduction in the space and weight of the topside equipment; saving our customers significant capital costs.

Our experience of the offshore industry is unrivalled and our PCHEs are renowned for their performance and safe operation in high integrity gas processes.

Onshore

Our PCHE's deliver better thermal performance than other solutions and feature superior mechanical integrity. This results in improved plant efficiency and up-time for our customers.

Marine

Heatric PCHEs enable our customers to reduce footprint and overall system costs. We work in partnership with them to provide enabling technology in a variety of marine applications.

Power Generation

Our PCHEs are in systems that pre-heat the fuel into the Gas Turbines within Combine Cycle plants. This helps them run more efficiently; saving costs and emissions.

Green Technologies

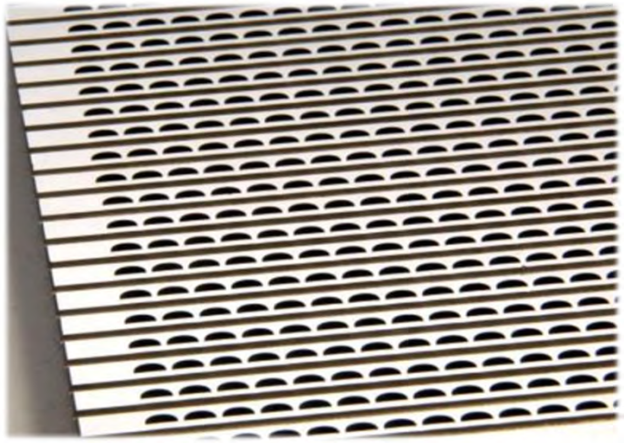
Being deployed or specified in a range of technologies and processes seeking to address the challenge of low carbon energy.

- Low Carbon Power Generation
- Energy Recovery Systems
- Energy Storage Systems
- Hydrogen Value Chain
- Renewable Generation Systems

Heatric Printed Circuit Heat Exchanger (PCHE) Benefits

A product suited for challenging applications

Superior Performance

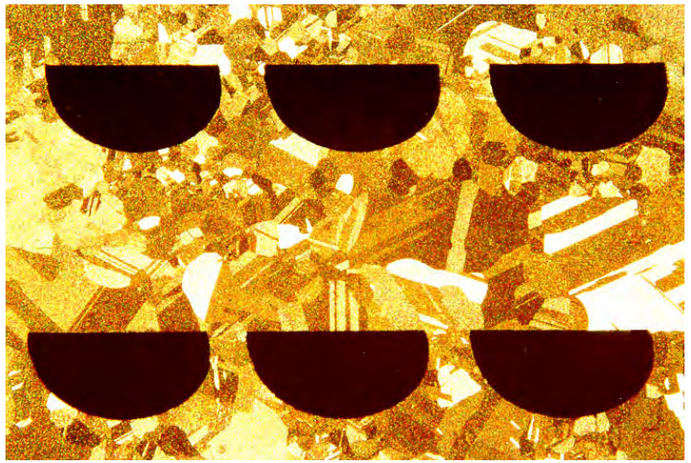


OPEX saving across wide range of processes

Heatric PCHEs are bespoke diffusion bonded compact heat exchangers providing:

- close temperature approaches (>2°C)
- very high thermal performance (i.e. 13.6MWth/m^3 sCO2 recuperator)
- high pressure capability (>1,000 Bar)
- widest range of temperatures (-196°C to 983°C)

Safe



Reduced operational risks

Using diffusion bonding with a fully welded construction, PCHEs:

- can operate at full differential pressure between streams
- are immune to flow induced vibrations and pressure fluctuations
- do not suffer from catastrophic failure mode
- have 30 years track record of safe operation and >3,000 exchangers supplied

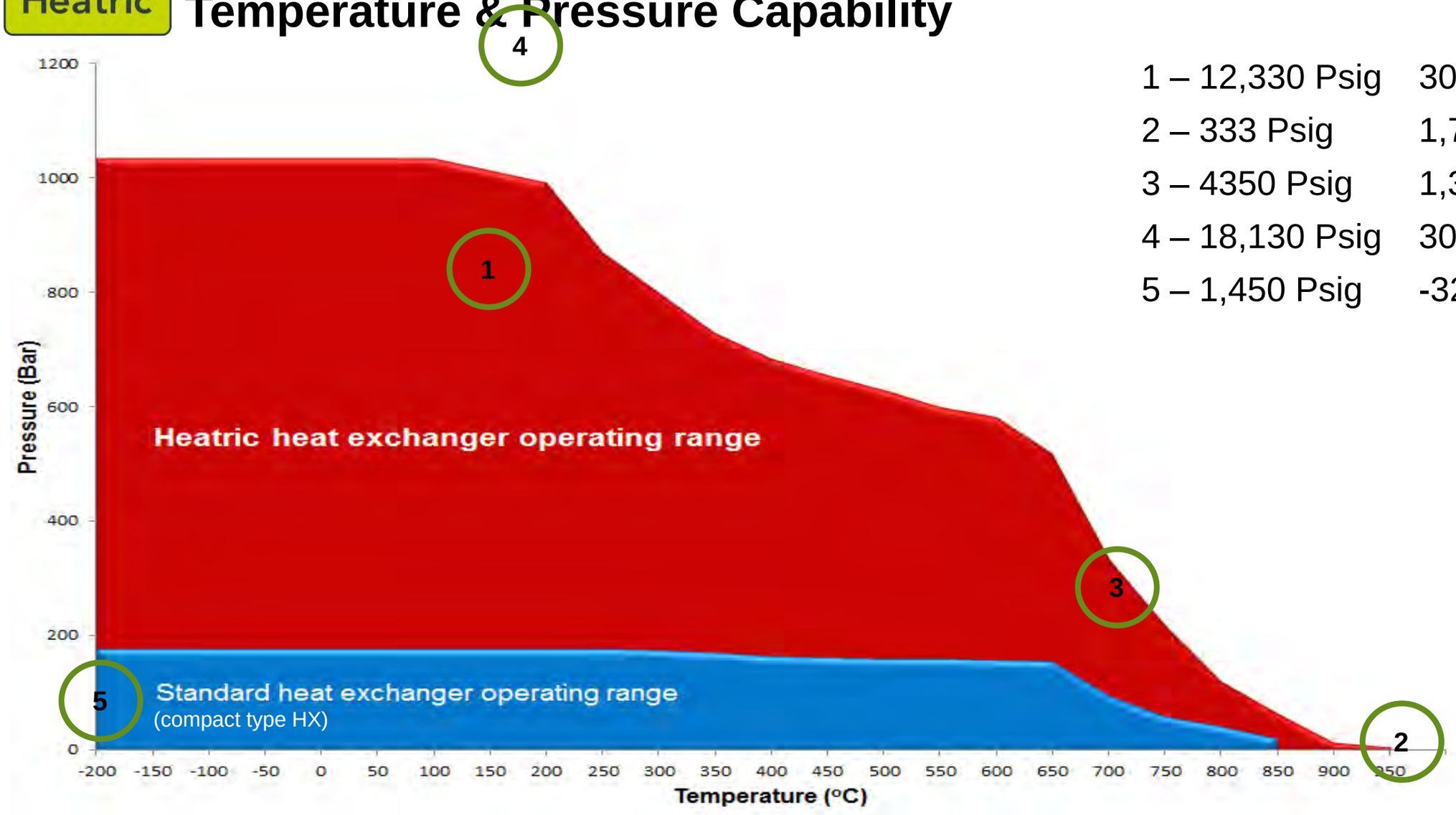
Compact and Modular

Overall Project CAPEX saving

Heatric PCHEs are up to 85% smaller than Shell and Tube exchangers, offering:

- modularisation for ease of transport, on-site installation
- reduced foundation structure
- reduced pipework and safety valves
- retrofit capability in-lieu of S&T

Temperature & Pressure Capability



1 – 12,330 Psig	302F	SS316
2 – 333 Psig	1,750F	617
3 – 4350 Psig	1,302F	617
4 – 18,130 Psig	302F	SS316
5 – 1,450 Psig	-320F	SS316

GEOTHERMAL PLANTS AND CYCLES

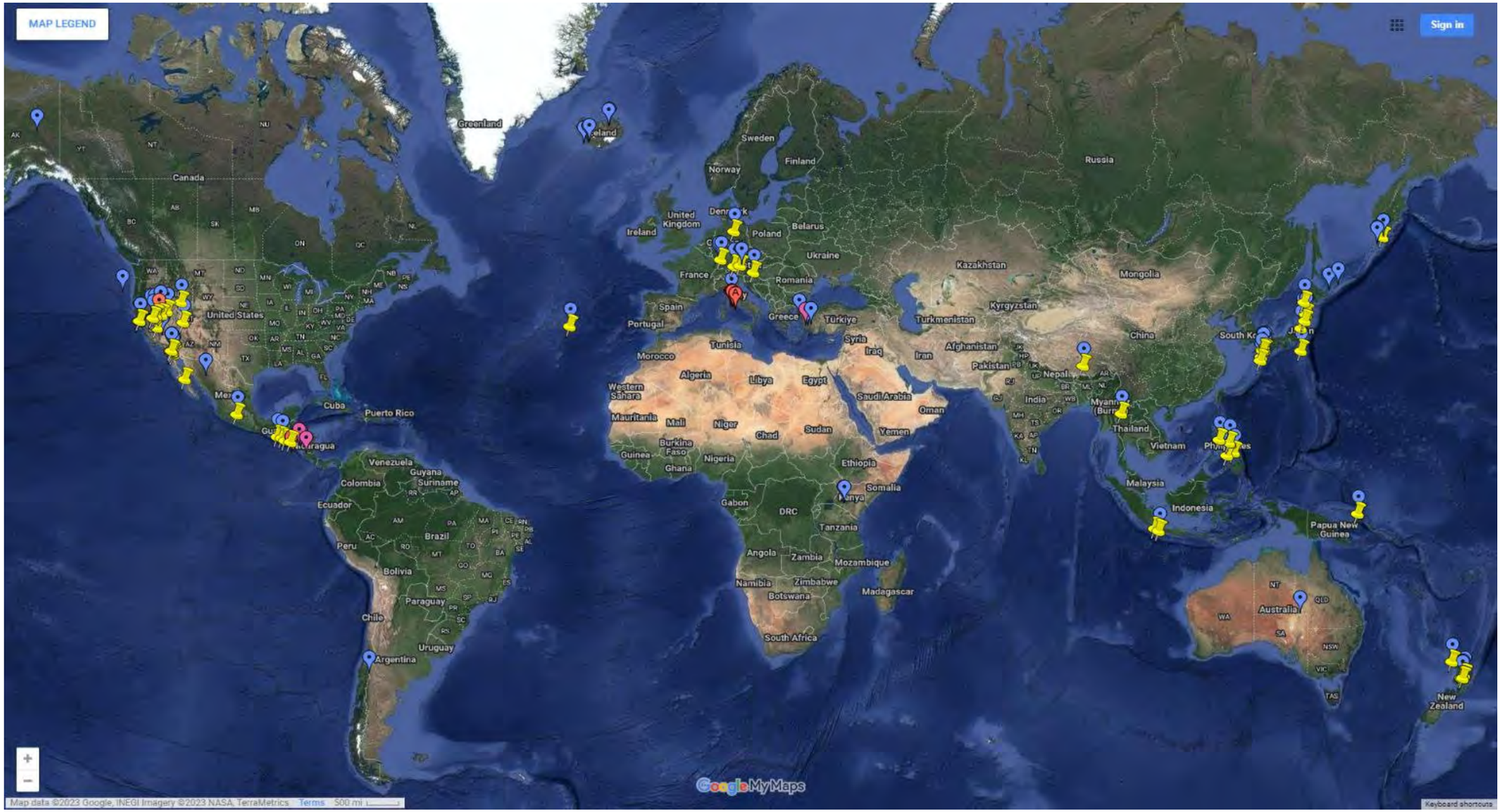
GEOTHERMAL PLANTS LOCATIONS

CYCLES

ASSOCIATED HEAT EXCHANGERS

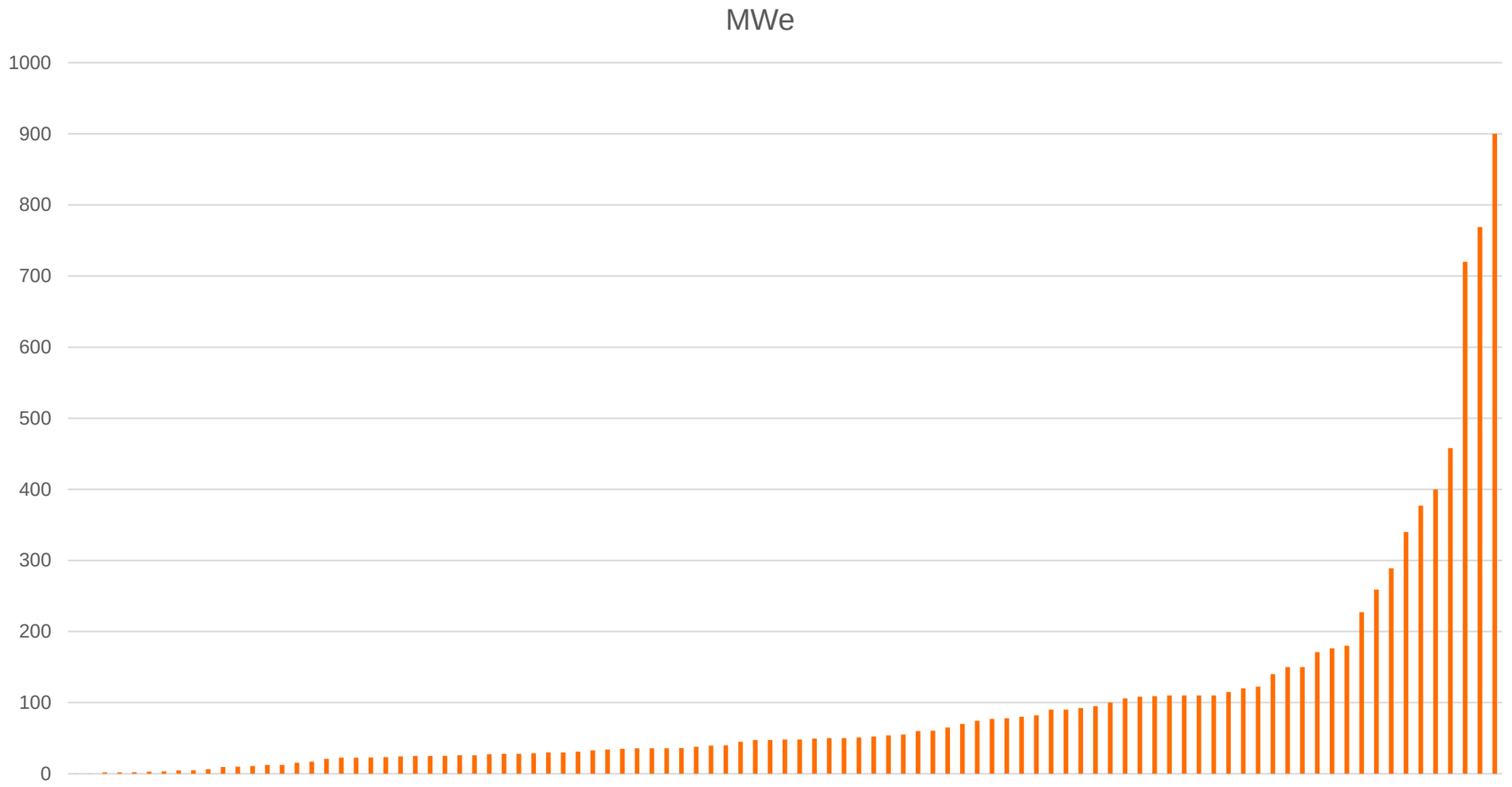
Heatric Geothermal power plants worldmap

Geothermal Power Plants - Google My Maps



Geothermal power plants duties

https://globalenergyobservatory.org/

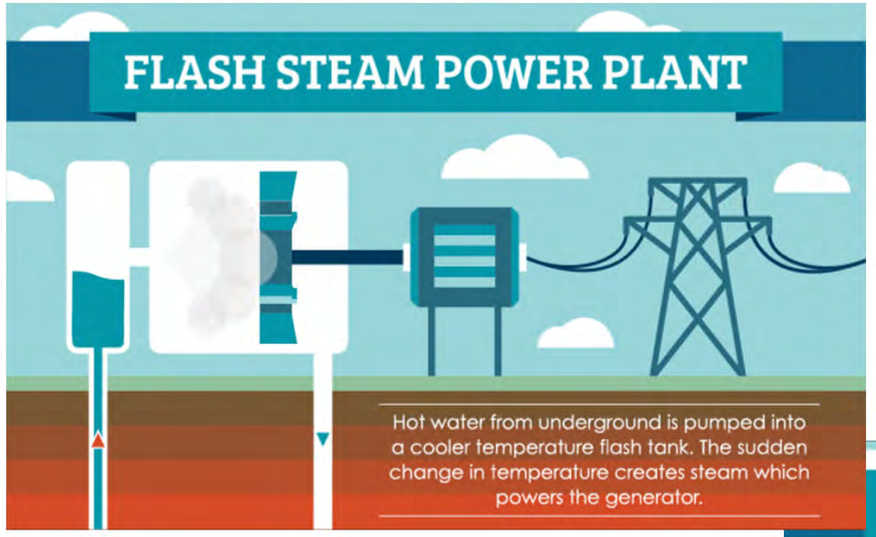


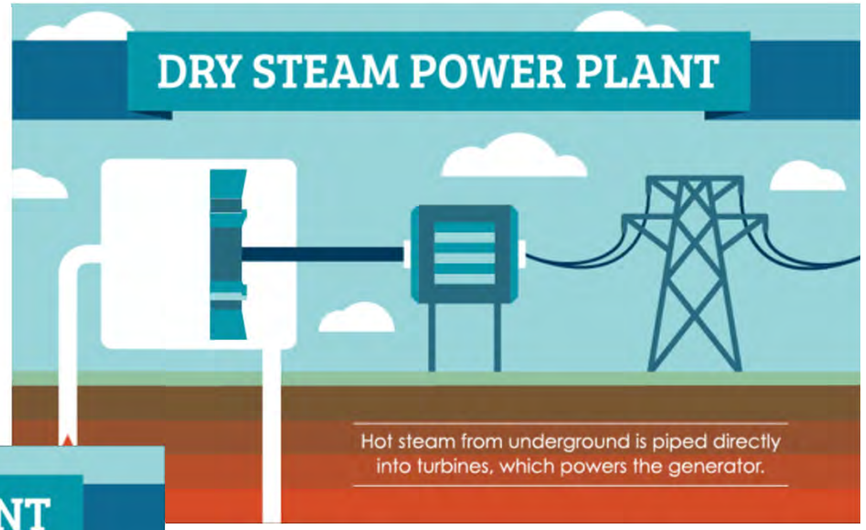
Country	>1MWe
Cost-Rica	5
El Salvador	2
Guatemala	2
Iceland	5
Italy	1
Japan	19
Kenya	3
Mexico	7
New-Zealand	10
Nicaragua	2
Philipine	7
Turkey	2
United-States	32

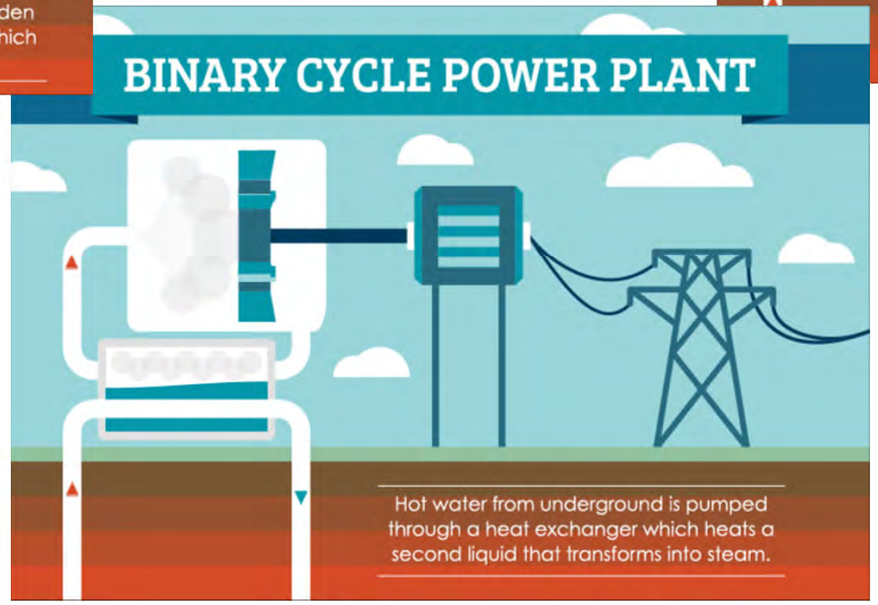
Heatric

Geothermal power plants cycles

Steam Rankine Cycles







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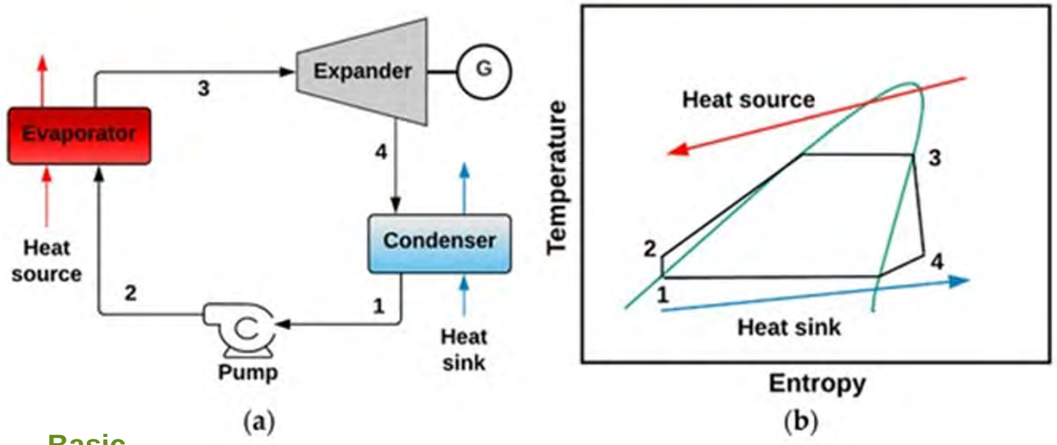
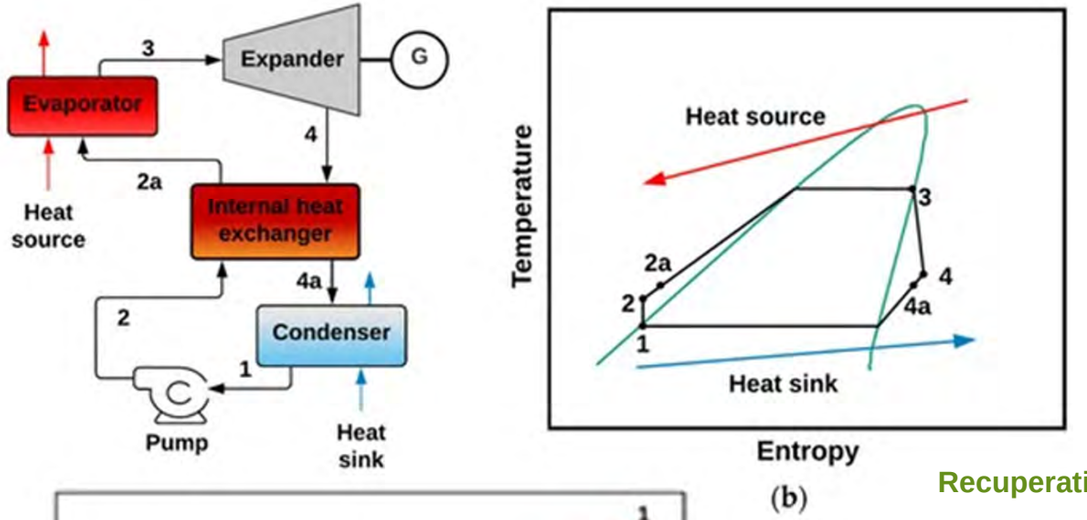
Geothermal power plants cycles

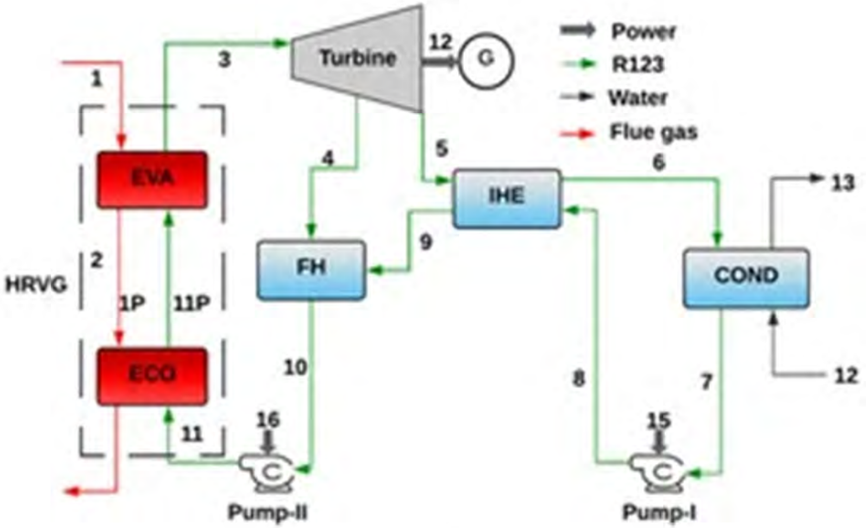
Organic Rankine Cycles (sCO2 excluded)

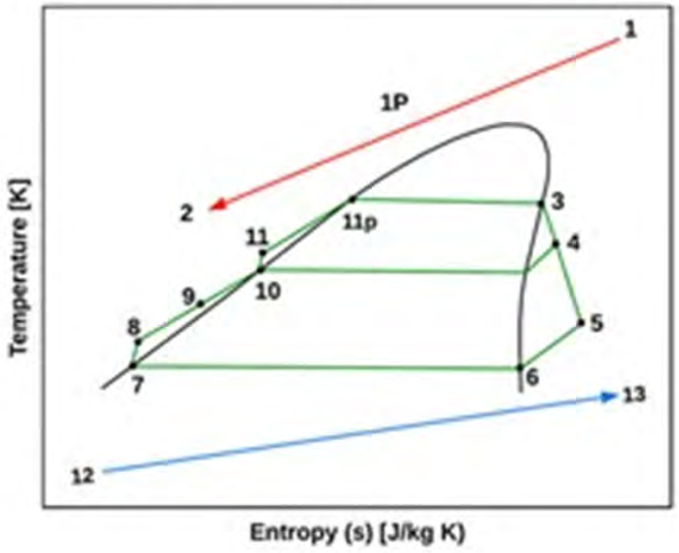


Basic



Recuperative

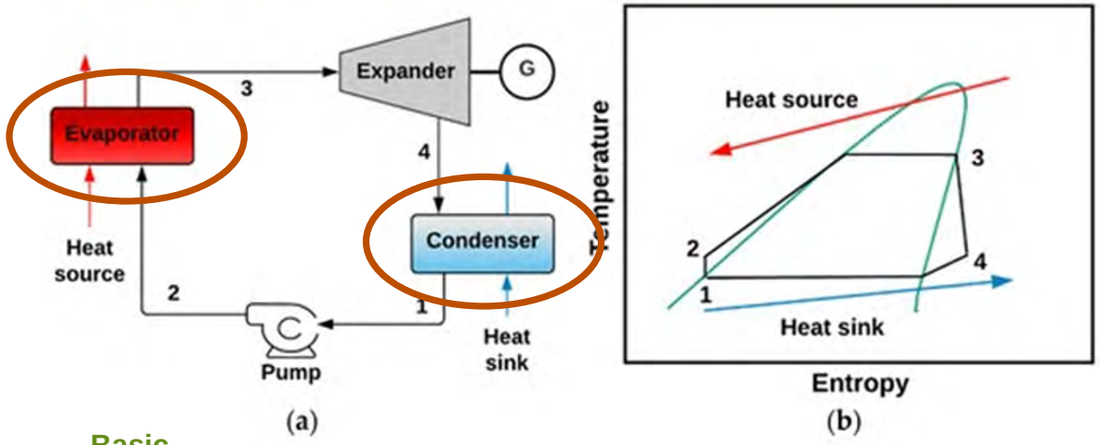




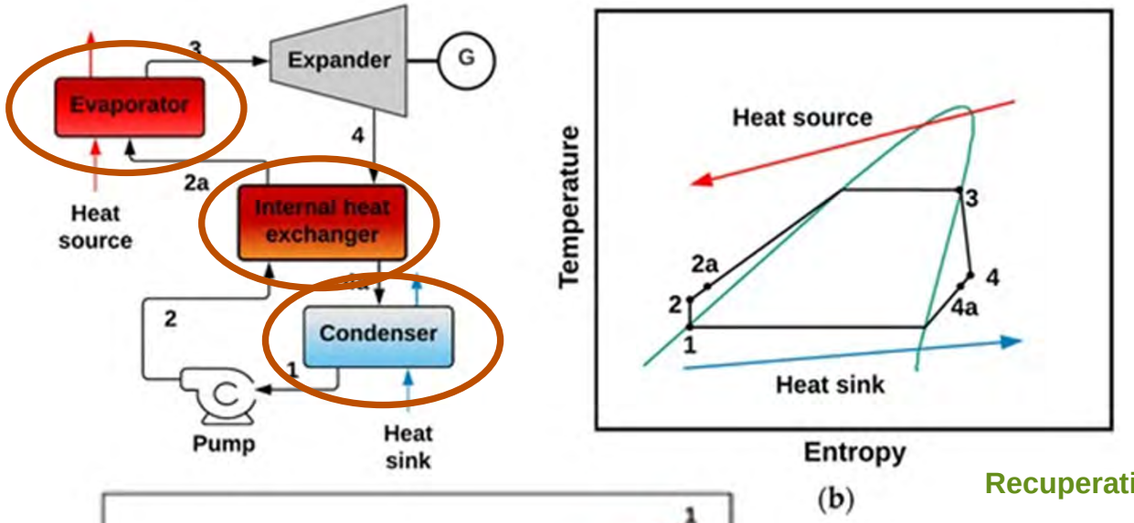
Regenerative - Recuperative

Geothermal power plants cycles

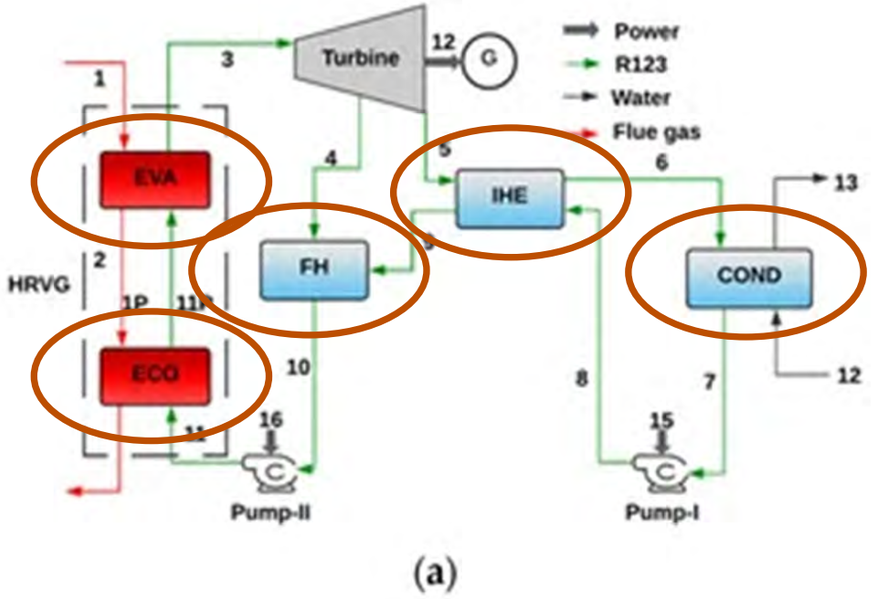
Organic Rankine Cycles (sCO2 excluded)

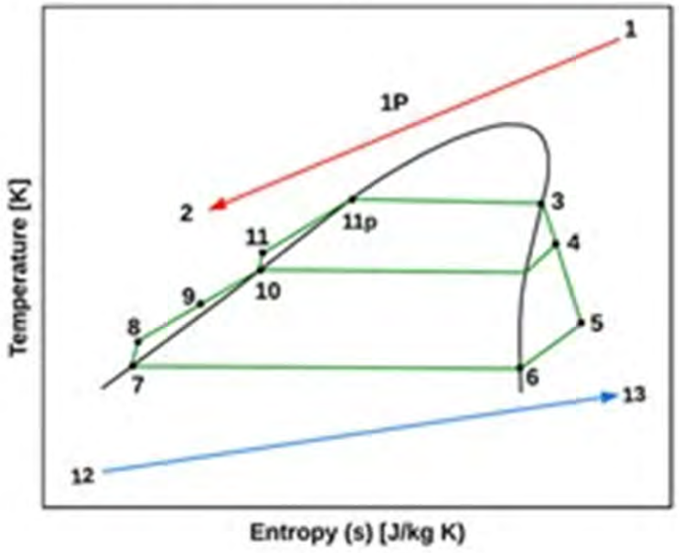


Basic



Recuperative





Regenerative - Recuperative

Heatric

Geothermal power plants cycles

Organic Rankine Cycles (sCO2 excluded)

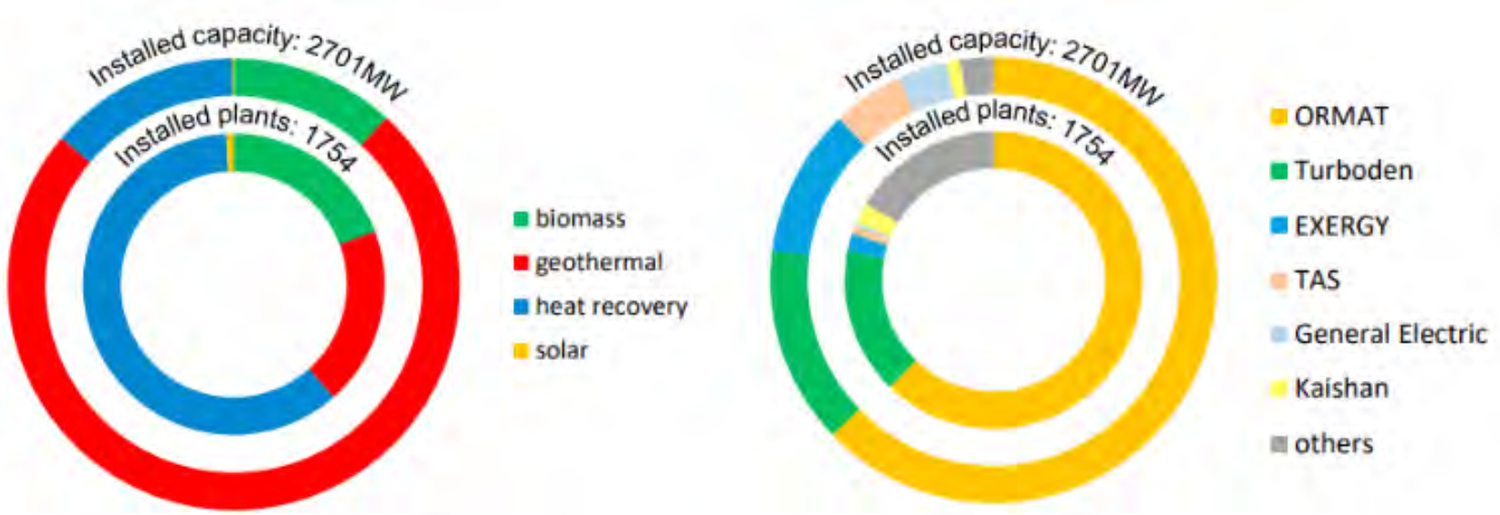
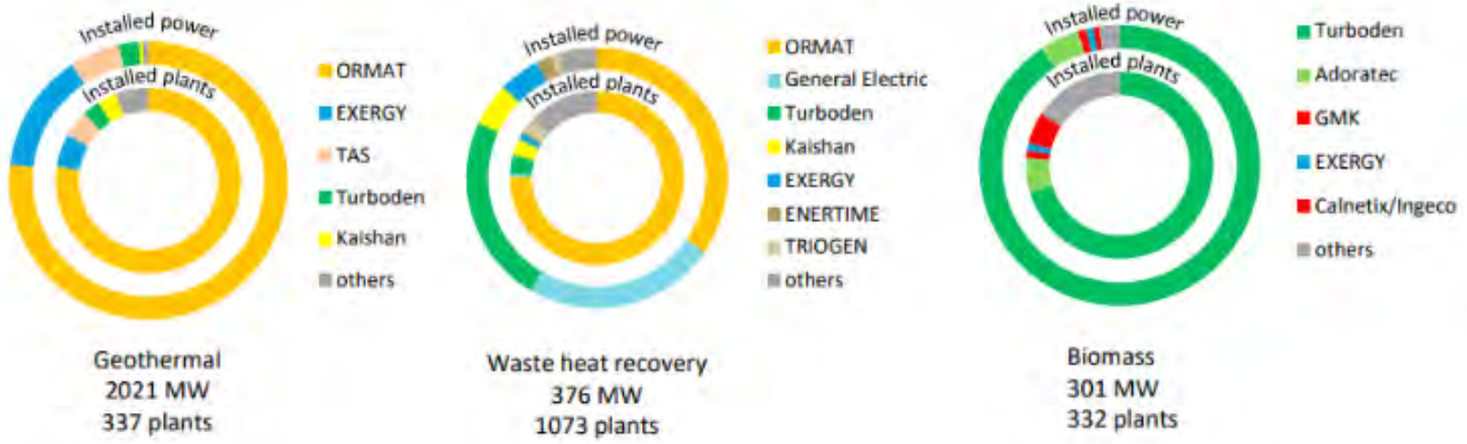


Fig. 1. Total installed capacity per application (a); per manufacturer (b).



A World Overview of the Organic Rankine Cycle Market

Thomas Tartiere - Marco Alstofi

https://orc-world-map.org/docs/WorldOverview2017.pdf

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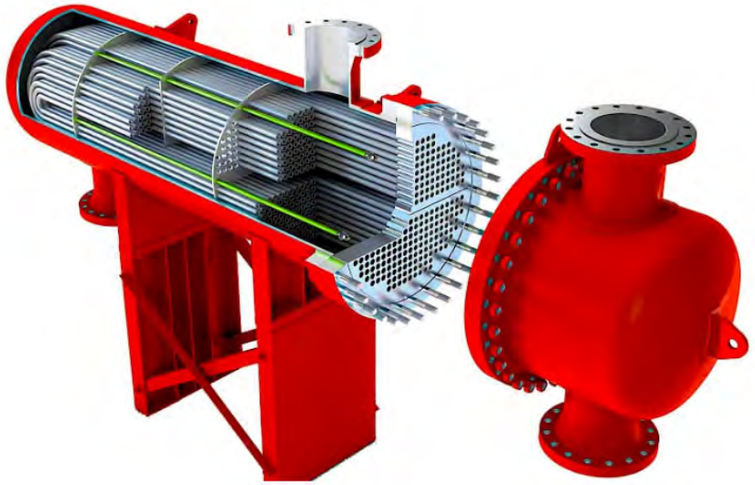
Heatric Geothermal power plants heat exchangers

Steam - Organic Rankine Cycles (sCO2 excluded)



Shell & Tube

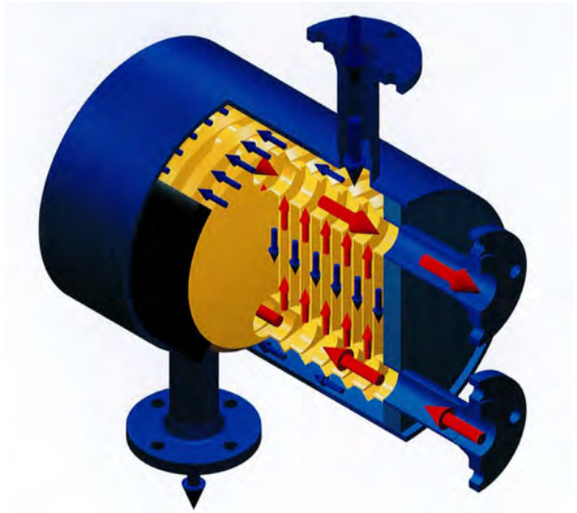
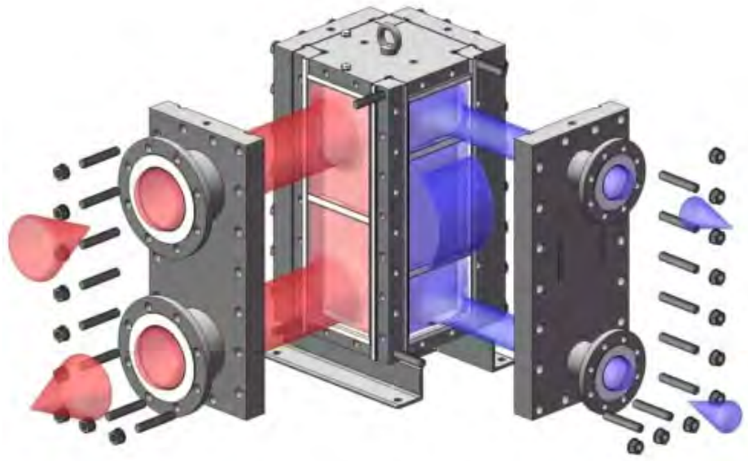
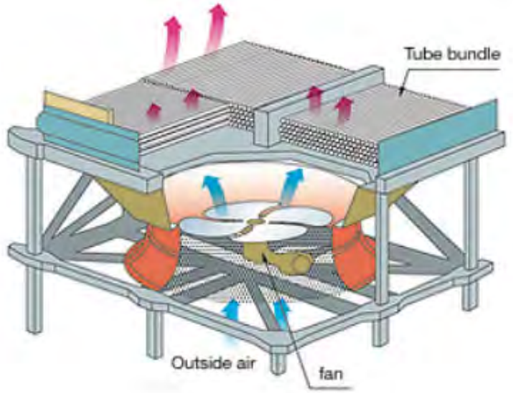


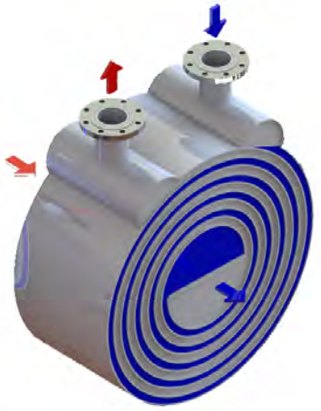
Plate and Shell



Welded Plate



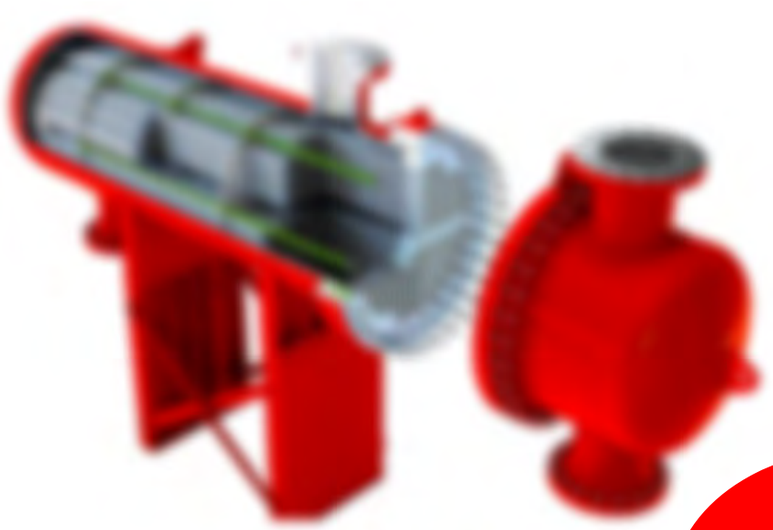
Air Cooler



Spiral Welded

Heatric Geothermal power plants heat exchangers

Steam - Organic Rankine Cycles (sCO2 excluded)



Shell & Tube

Welded Plate

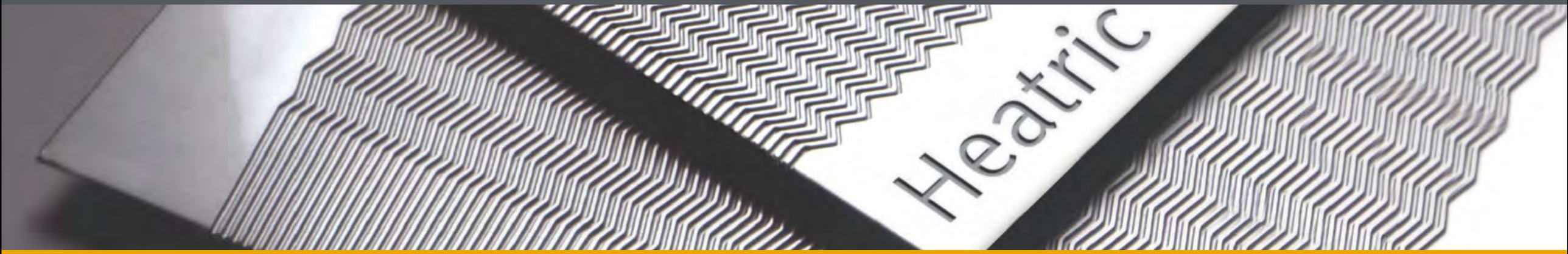
Air Cooler

Spiral Welded

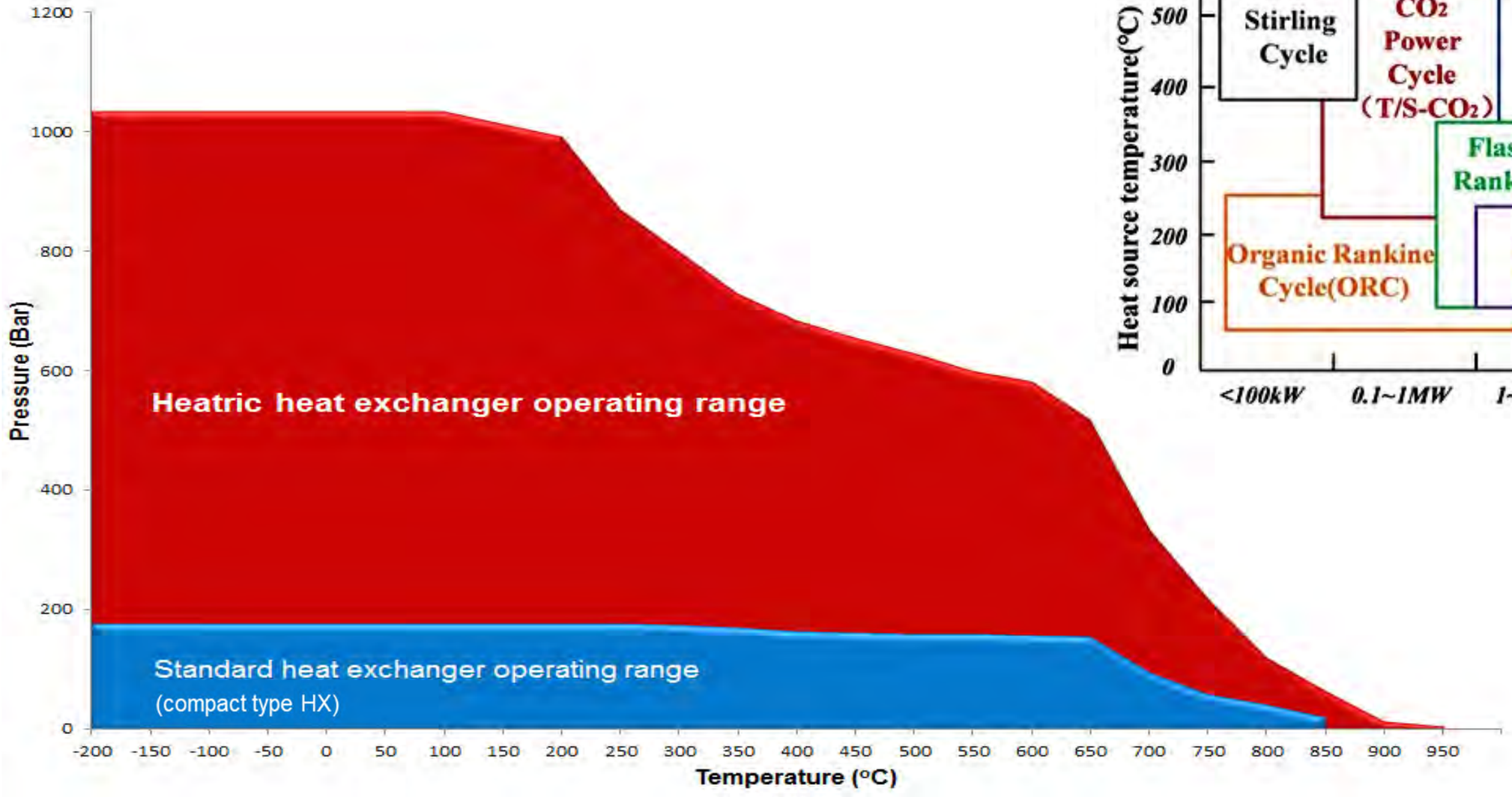
PCHE?

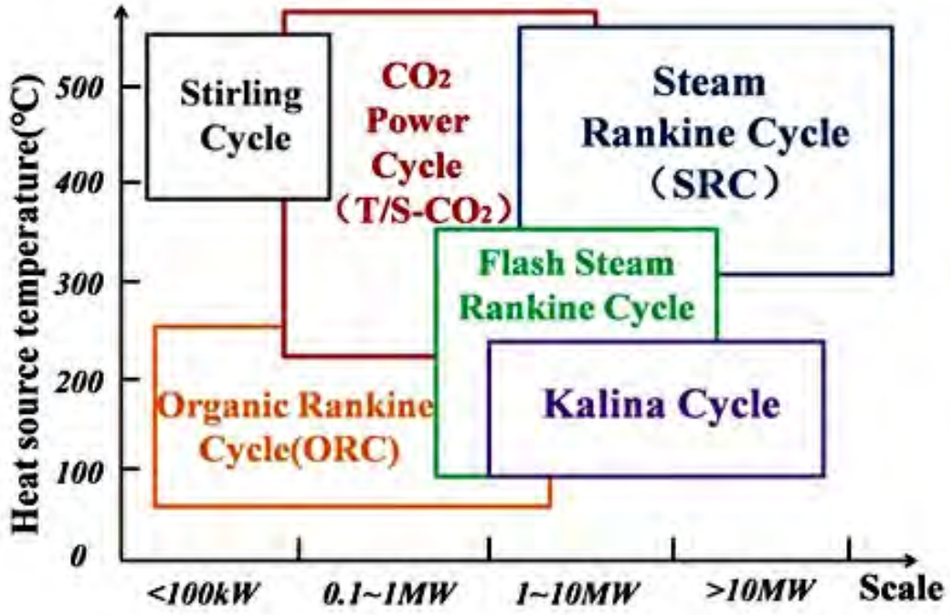
COST IMPACT

MATERIAL AND SUPPLY CHAIN



Temperature & Pressure Capability





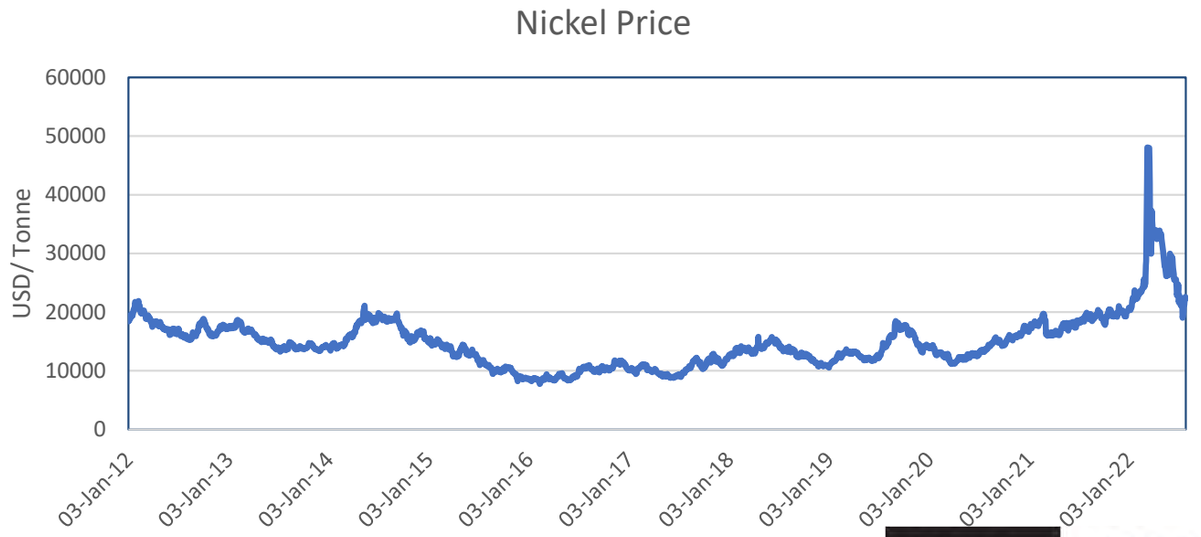
SUPPLY CHAIN

The reality and impact of costs (courtesy of PCC Metals Group)

	Ni %	Mo %	Co %	Cost Ratio 2012-21	Cost Ratio 2022 1H	ASME Allowable Stress ratio (550C)	Cost Factor (550C)	ASME Allowable Stress Ratio (700C)	Cost Factor (700C)
316L	11	2	0	1	1	0.95	0.95	N/A	N/A
347	10	2	0	1.2	1.2	1.0	1.2	1.0	1.2
617	52	9	12	5	6	0.70	4.2	0.66	2.77
740H	50	0.5	20	5.5	7	0.36	2.52	0.24	0.60

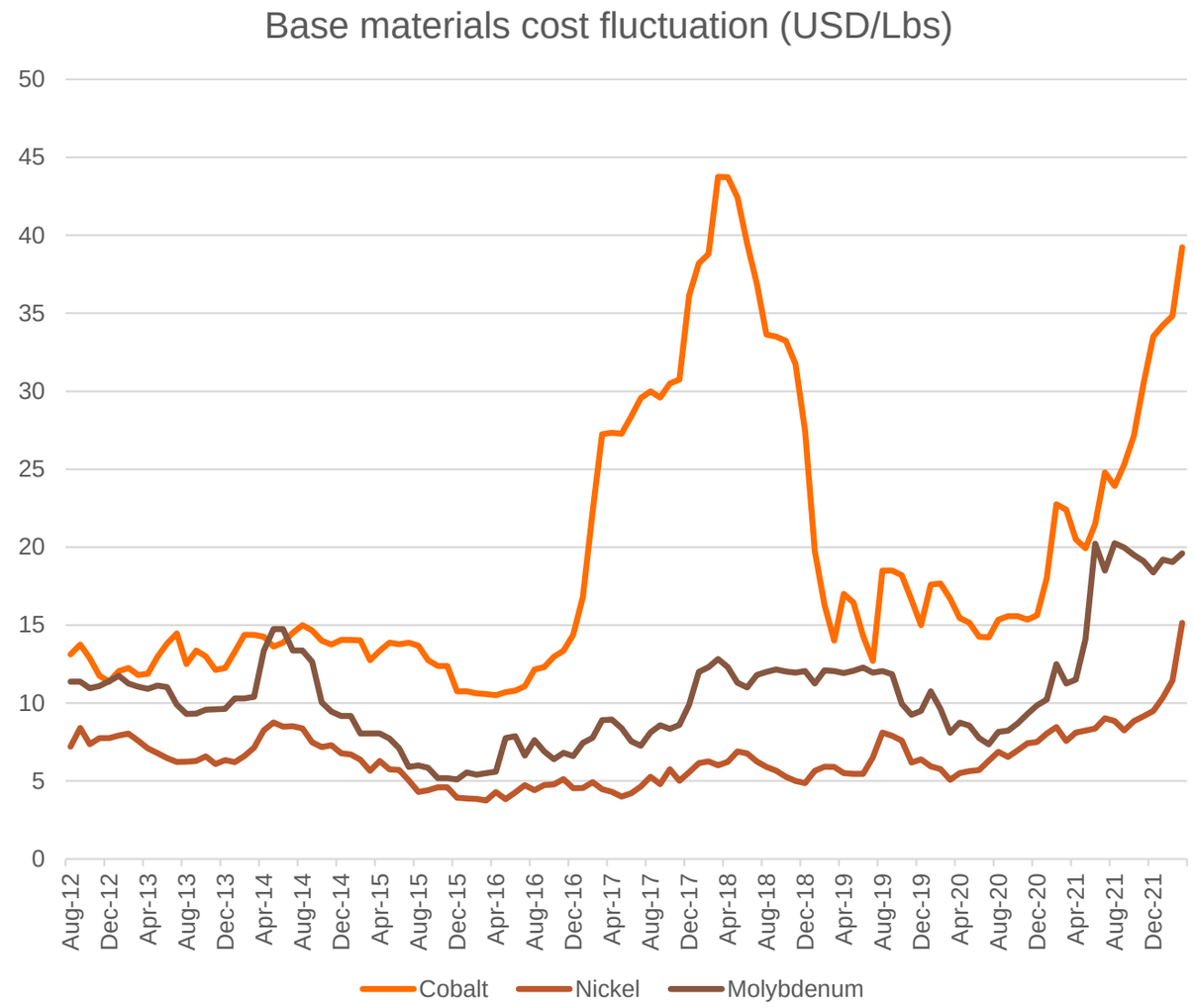
Nickel Historical average $14,100/T
Nickel Average price 2022 1H $28,500/T
Nickel Average price July 2022 $21,465/T

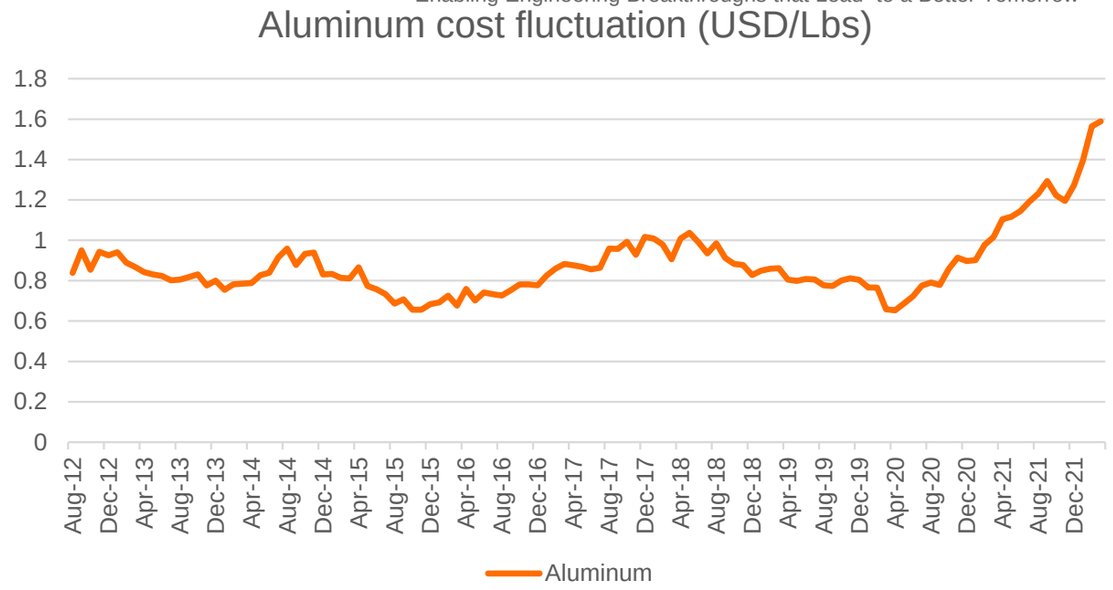
Quantity extras – Flat Products – Nickel alloys
2,000kgs – 20%
20,000kgs – 0%

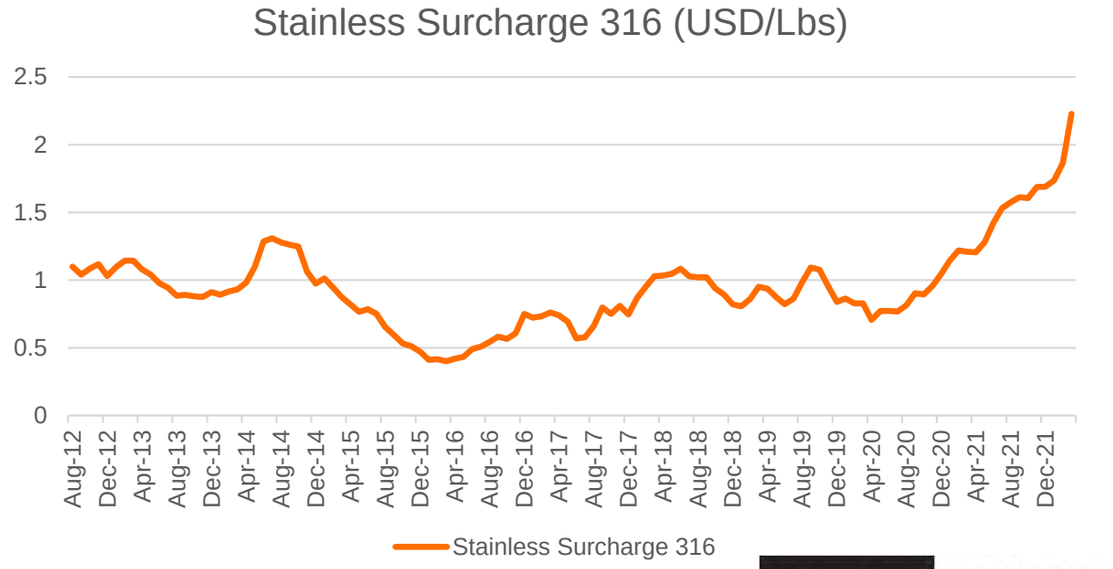


SUPPLY CHAIN

The reality and impact of costs

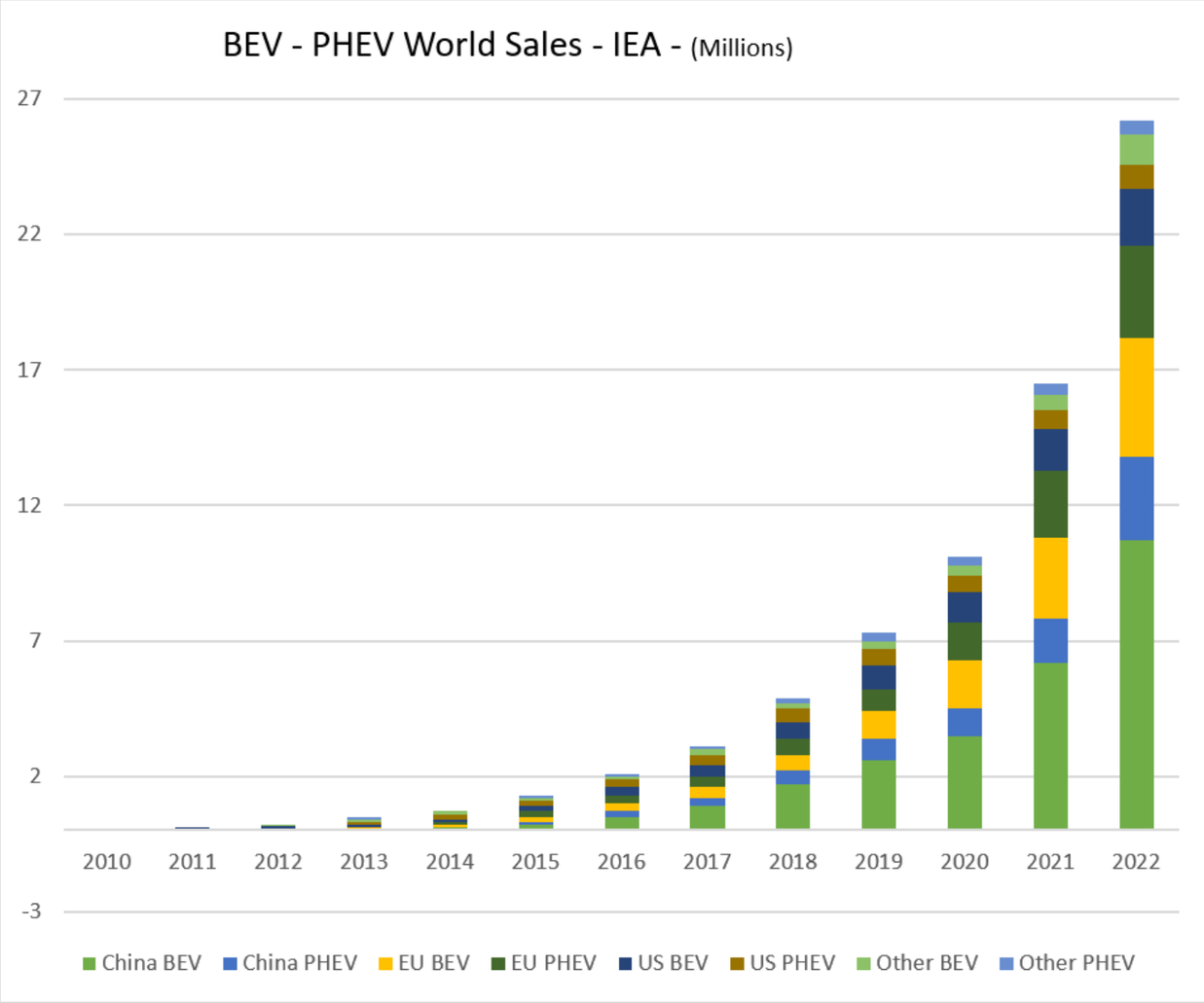






SUPPLY CHAIN

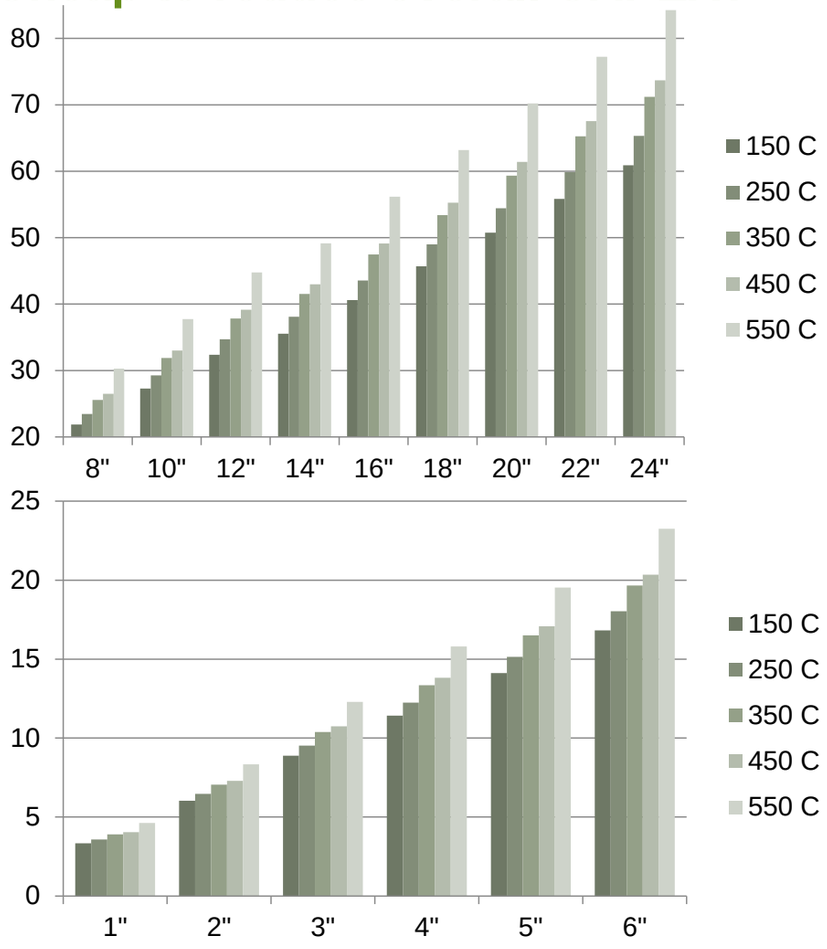
The reality and impact of costs



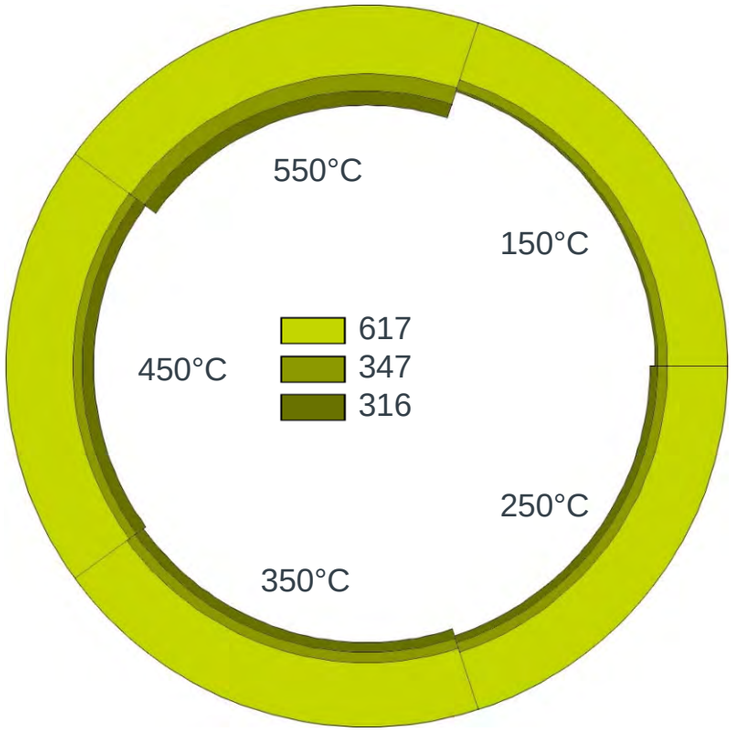
Mineral	Cell part	Average content in 66kWh battery [kg]	Content % of Total
Graphite	Anode	52	28,1 %
Aluminum	Cathode, case, current collectors	35	18,9 %
Nickel	Cathode	29	15,7 %
Copper	Current collectors	20	10,8 %
Steel	Case	20	10,8 %
Manganese	Cathode	10	5,4 %
Cobalt	Cathode	8	4,3 %
Lithium	Cathode	6	3,2 %
Iron	Cathode	5	2,7 %
Total		**185kg**	**100%**

SUPPLY CHAIN

Cheap to reduce overall CAPEX?

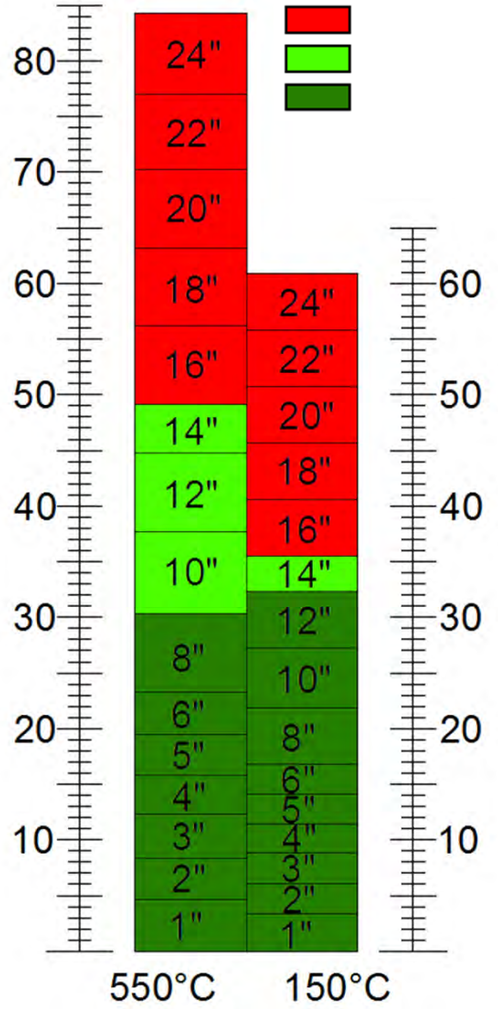


316 Pipe thicknesses vs. design temperature (250 Bar design pressure)



	150°C	250°C	350°C	450°C	550°C
316 vs 347	3%	9%	12%	13%	14%
316 vs 617	17%	22%	24%	23%	31%

316, 347, 617 Pipe thickness reduction vs. temperature (250 Bar pressure)



316 Pipe thickness vs. Std Pipe schedule (250 Bar pressure)

Enabling Engineering Breakthroughs that Lead to a Better Tomorrow

HEAT EXCHANGERS FOR GEOTHERMAL ENERGY

WHAT NEXT?

What next?

How to ensure Green Technologies deployment

Supply Chain

Cost reduction
Product availability

Even in stainless steel, material price and product form availability can be a challenge; Supply chain must be engaged with to providing competitive materials in suitable product forms.

Standardisation

Process | Products
Performance

Standardization of the various Energy Storage processes where possible will lead to cheaper products, potential for off-the shelf with mass production and guaranteed performance based on proven existing supplies.

Thermal Energy Storage

Modularisation

Flexibility | Footprint
Plant integration| Deployment

Modularisation brings benefits in flexible designs with minimum changes, defined footprints facilitating plant integration and facilitation deployment even in remote area (i.e. containerized).

Close Collaboration with suppliers

Faster Cycle Optimisation
Better planning and deployment

As for any system design, trade-off between cycles efficiencies and components designs are necessary; to guarantee success collaboration at the earliest is needed.

Heatric