Unlocking
potential
that leads
innovation

INDUSTRY UPDATE

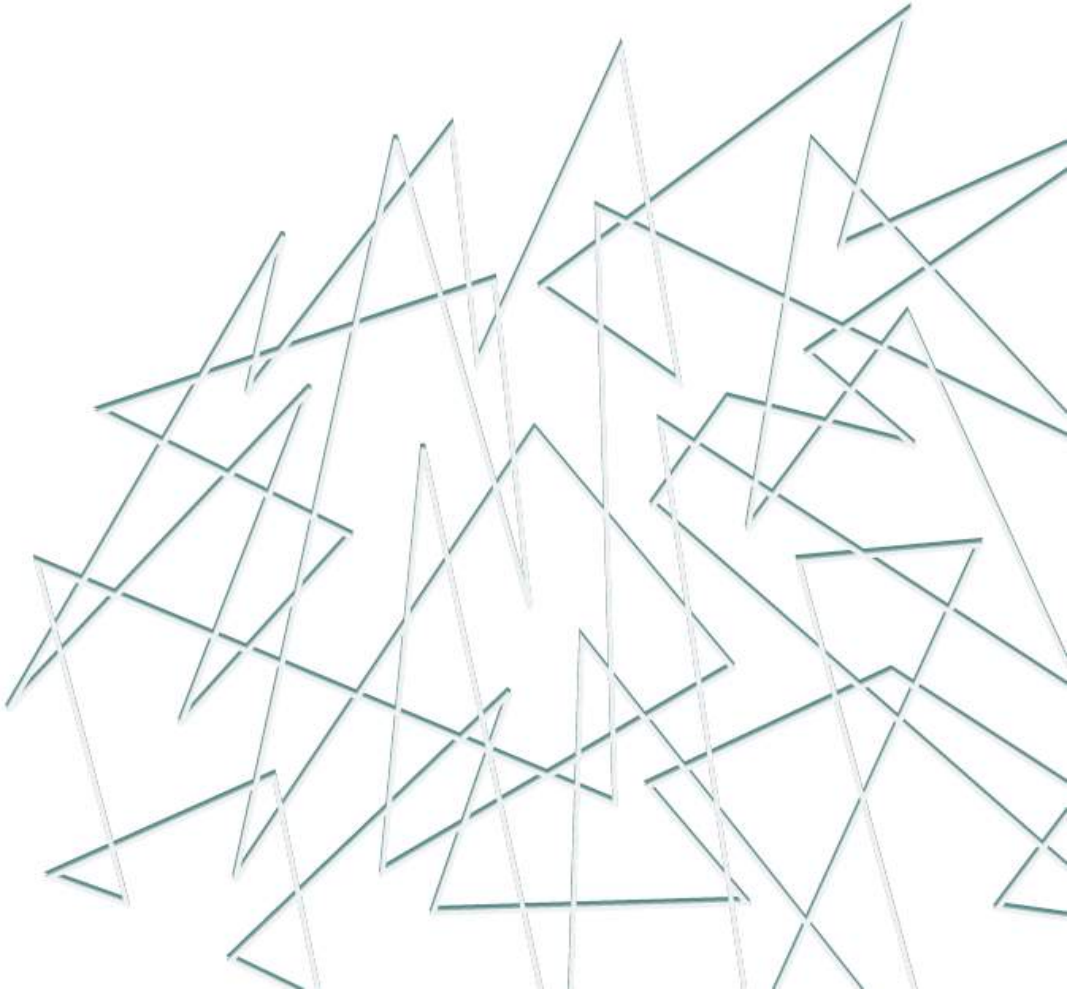
NZGW 2016

NZGW
New Zealand
Geothermal Workshop

AGGAT, a HERA program:
Now and beyond

Boaz Habib
AGGAT Programme Manager
November 2016

AGGAT | HERA Innovation in Metals



Heavy Engineering Research Association

AGGAT

- Industry owned and governed
- 600+ NZ wide membership
- Not-for profit organisation
- Established in 1978
- Structural, Welding, Industry Development Divisions
- Metal based industries but also… LG, SS, light alloys, metal based composites
- Industry elected executive

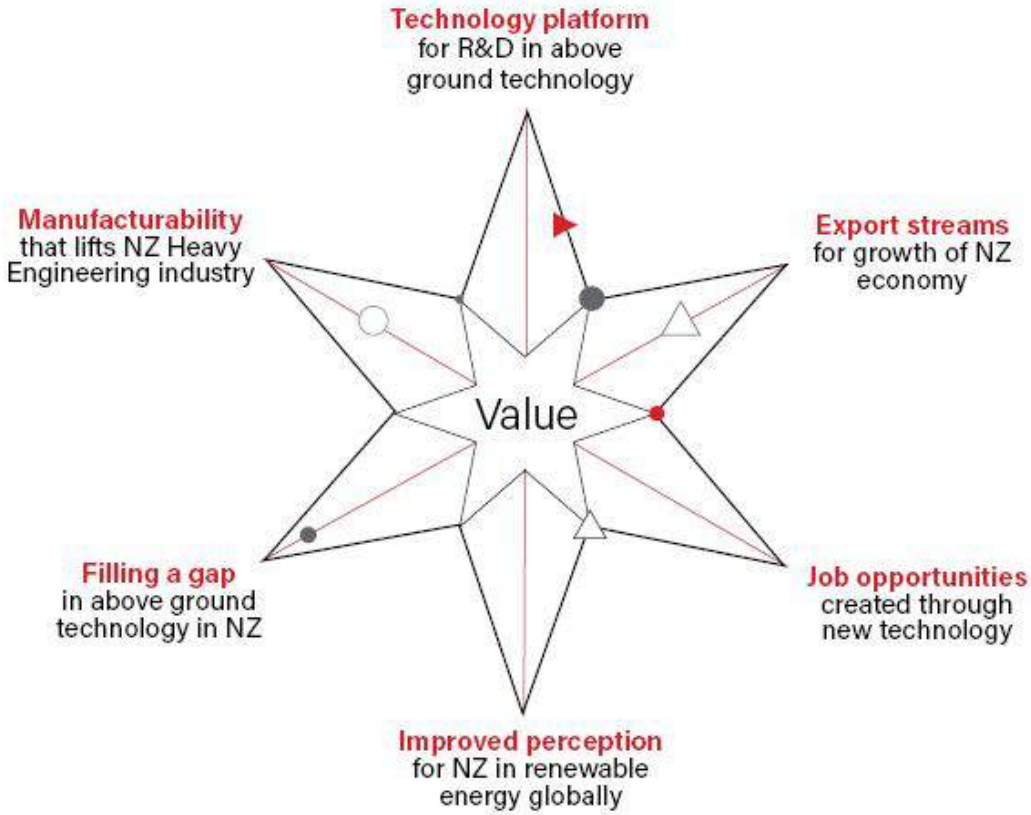
HERA

Industry development

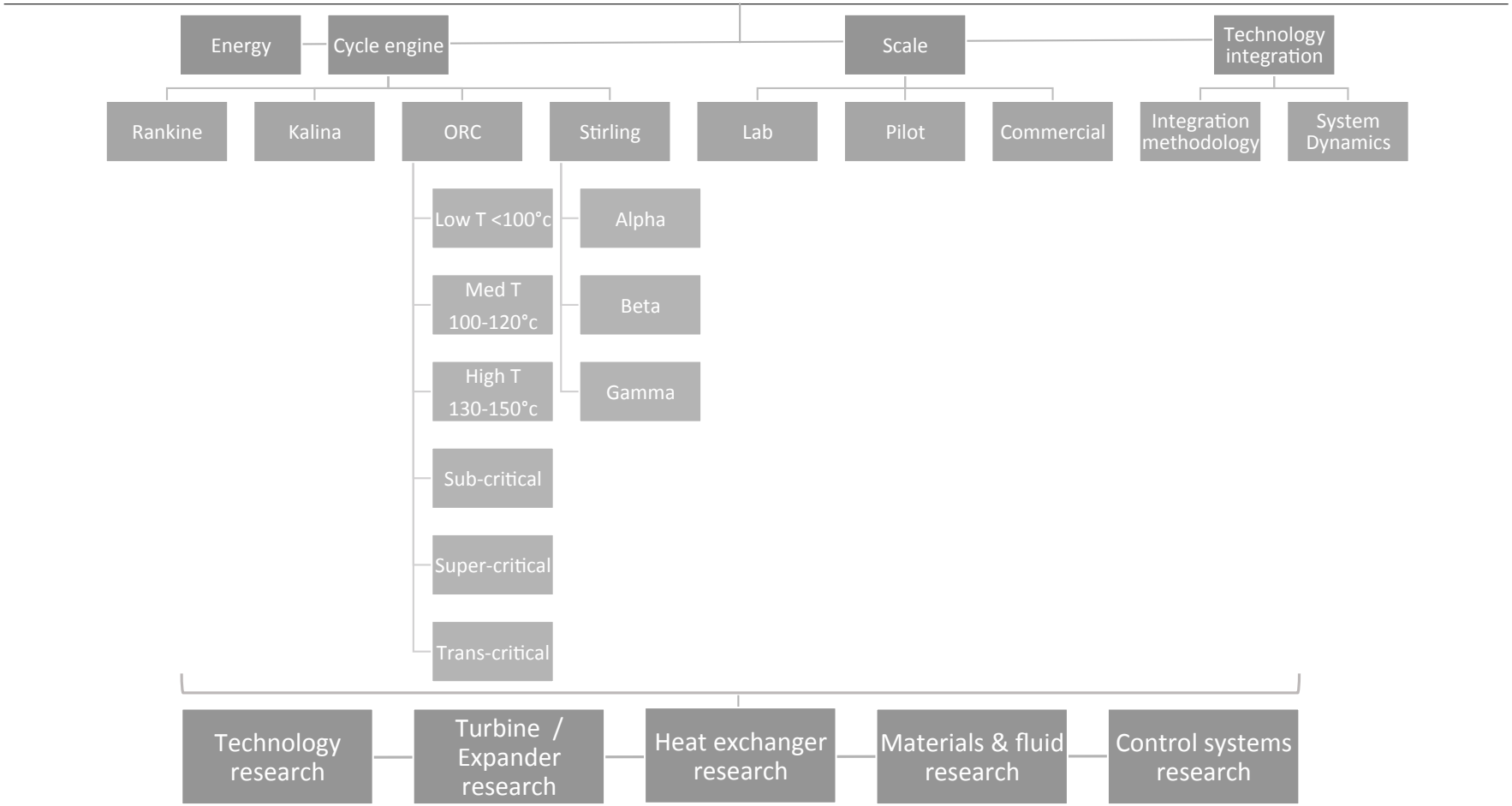
Structural

Welding Centre

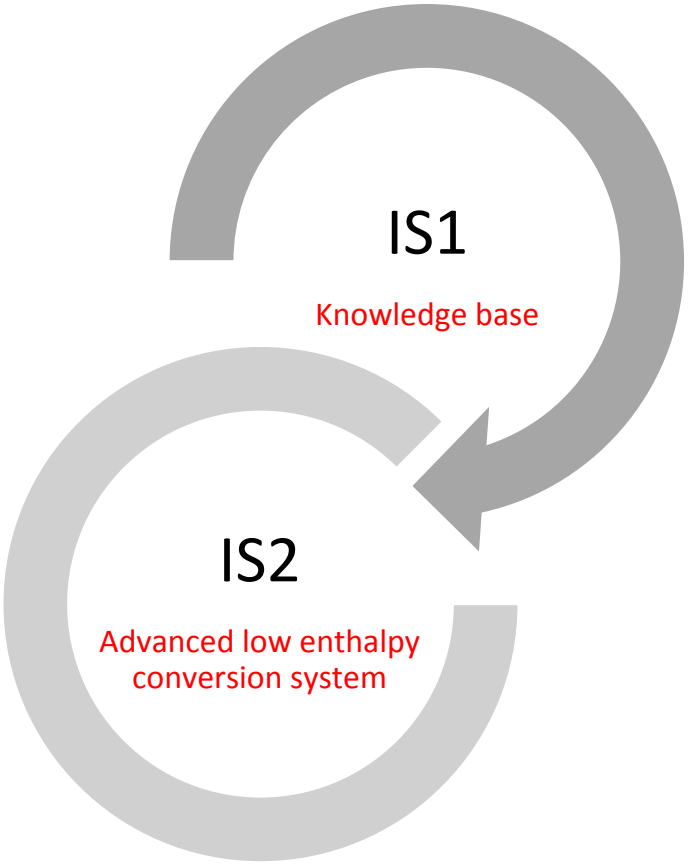
Our value proposition



Our research framework



Our program



IS1-1 Expert Design Tool
IS1-2 Materials Knowledge Base
IS1-3 Scaling Mechanisms
IS1-4 Heat Transfer Data
IS1-5 Expander Research
IS1-6 Control Research

IS2-1 Systems and Modules
IS2-2 Heat Exchanger Concepts
IS2-3 Turbo Machinery Development
IS2-4 Control Systems Development

Our research and industry Leaders

AG GAT

Our research theme leaders

Technology Concepts
Boaz Habib

Control Systems
Brent Young

Materials and Fluids
Michail Karpenko

Materials and Fluids
Sadiq Zarrouk

Heat Exchangers
Mohammed Farid

Turbines
Lei Chen

Our key deliverables

AGGAT

Expert design tool
to better inform our members

Two ORC pilot plants
close to testing phase

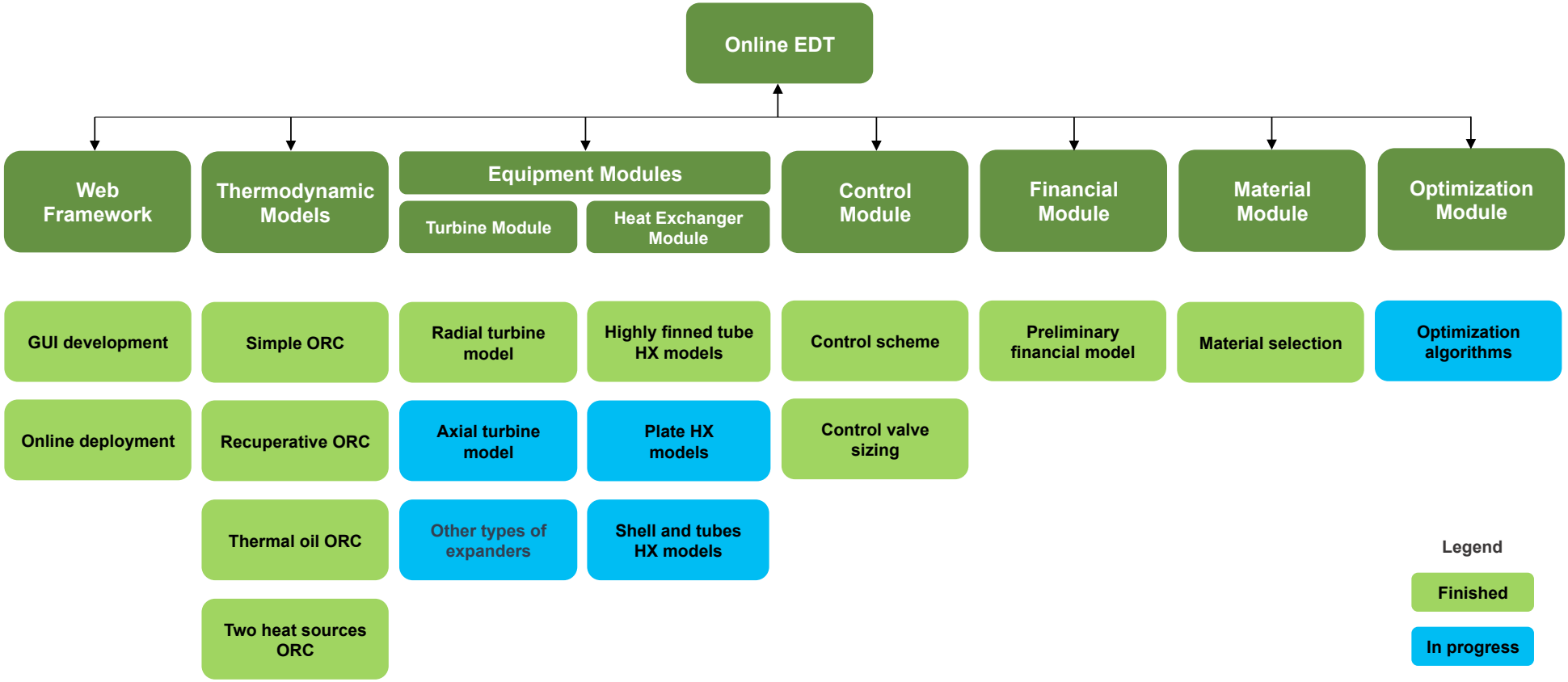
Turbine design concept
specifically for AGGAT

Heat exchanger
design concepts

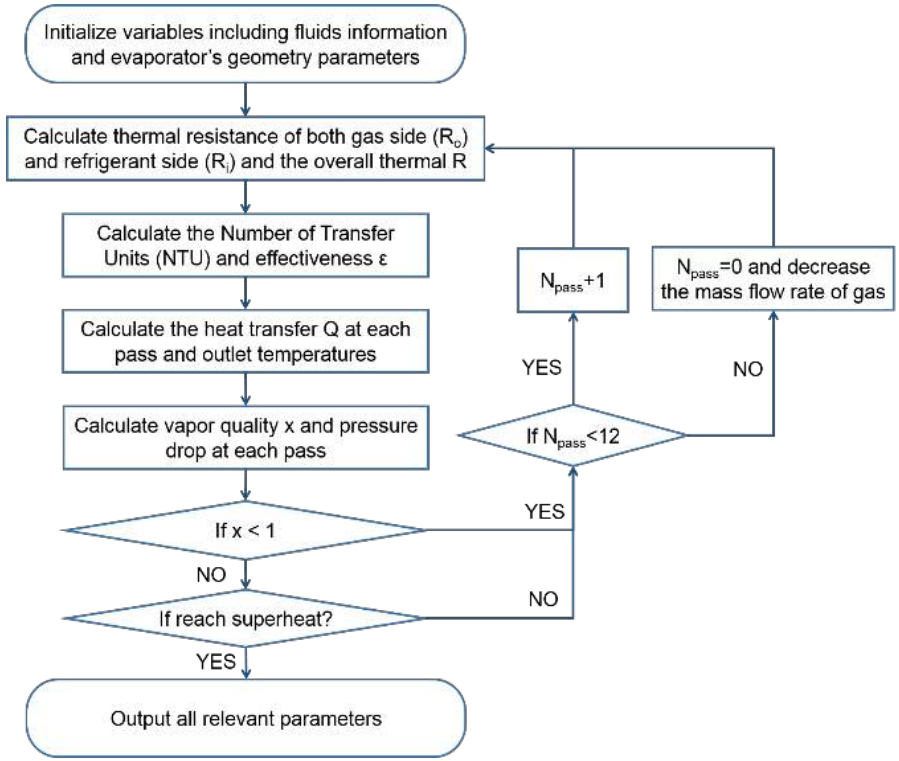
Control systems
modelling packages

Materials test rig
for geothermal scaling research

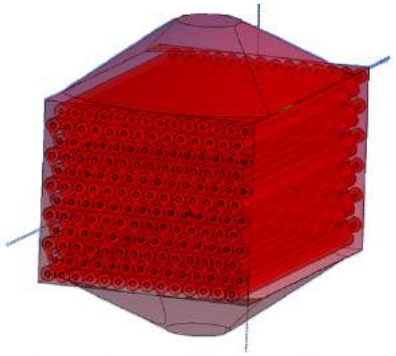
EDT


Online EDT
Web Framework
Thermodynamic Models
Equipment Modules
Turbine Module
Heat Exchanger Module
Control Module
Financial Module
Material Module
Optimization Module
GUI development
Online deployment
Simple ORC
Recuperative ORC
Thermal oil ORC
Two heat sources ORC
Radial turbine model
Axial turbine model
Other types of expanders
Highly finned tube HX models
Plate HX models
Shell and tubes HX models
Control scheme
Control valve sizing
Preliminary financial model
Material selection
Optimization algorithms
Legend
Finished
In progress

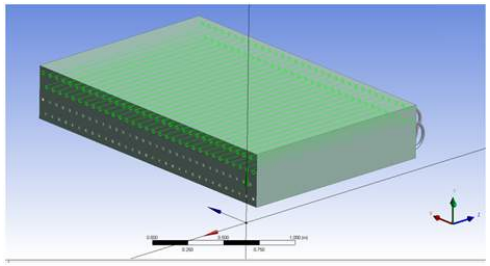
EDT



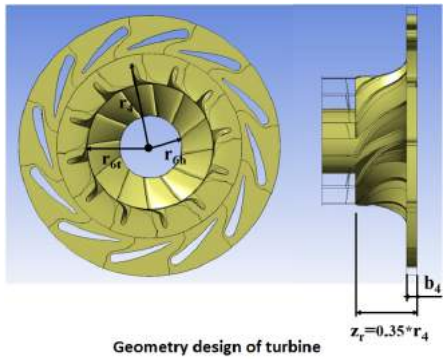
The flowchart for highly finned tube co-current evaporator



3D schematic diagram for whole evaporator



3D Schematic diagram for whole condenser

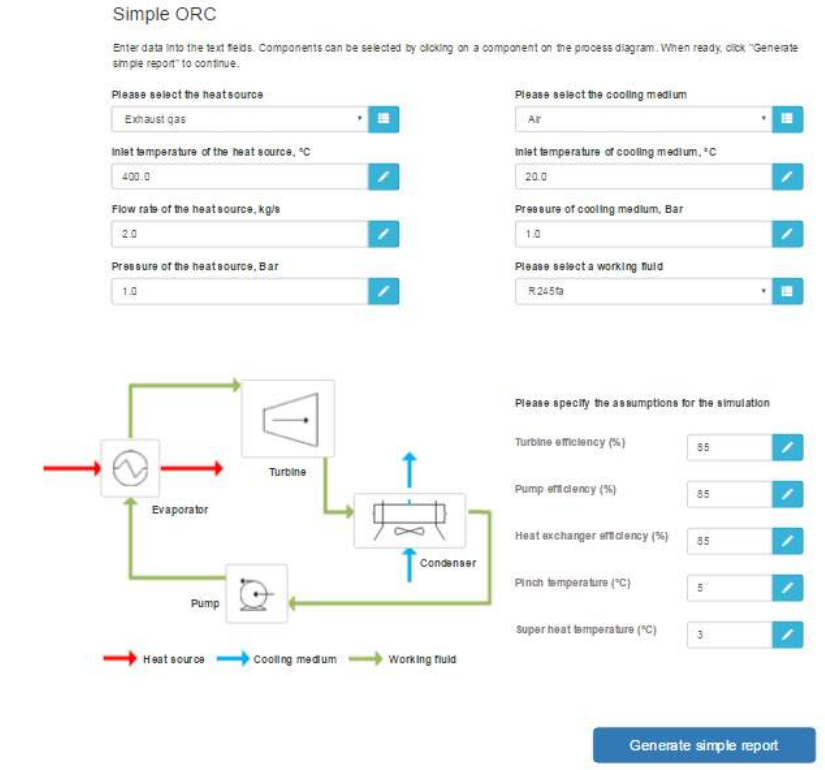


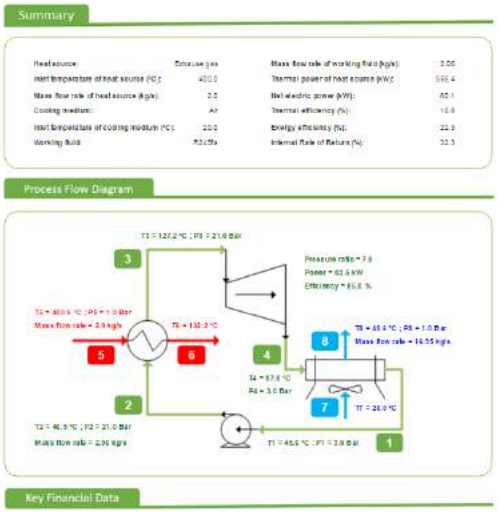
Geometry design of turbine

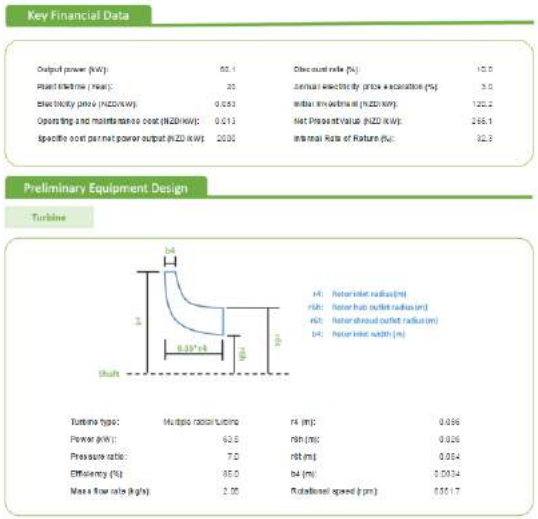
EDT

AGGAT

Input screen → Results pages





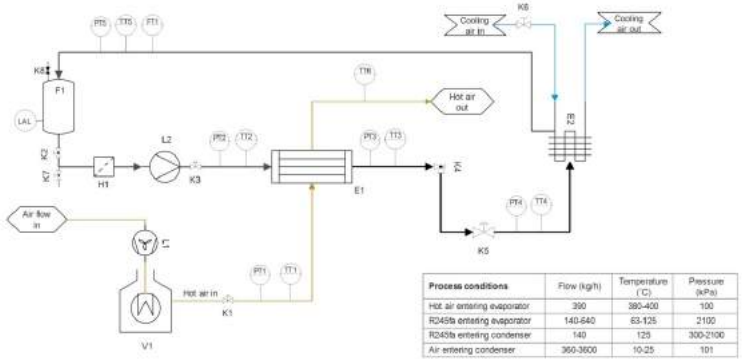


Geothermal ORC pilot plant

- Built at workshop
- Cooling system installation
- Torque measurement
- Busy times for industry!

AGGAT Test Rig

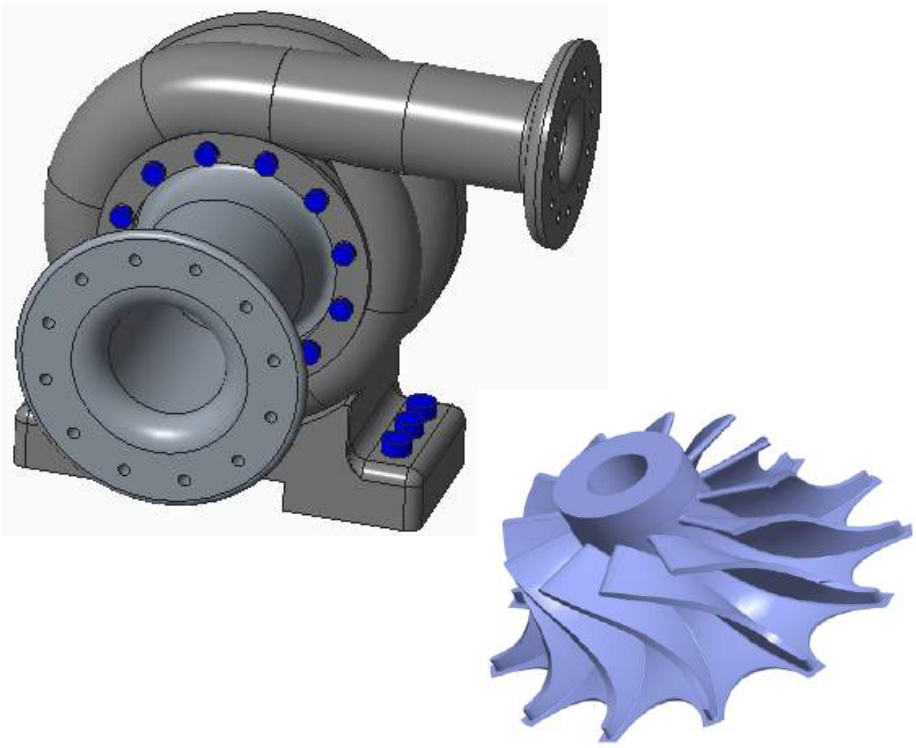
- Above Ground systems and equipment testing capability
- Heat exchanger innovations
- AGGAT Turbine
- Basic control logic
- Thermodynamic limitations

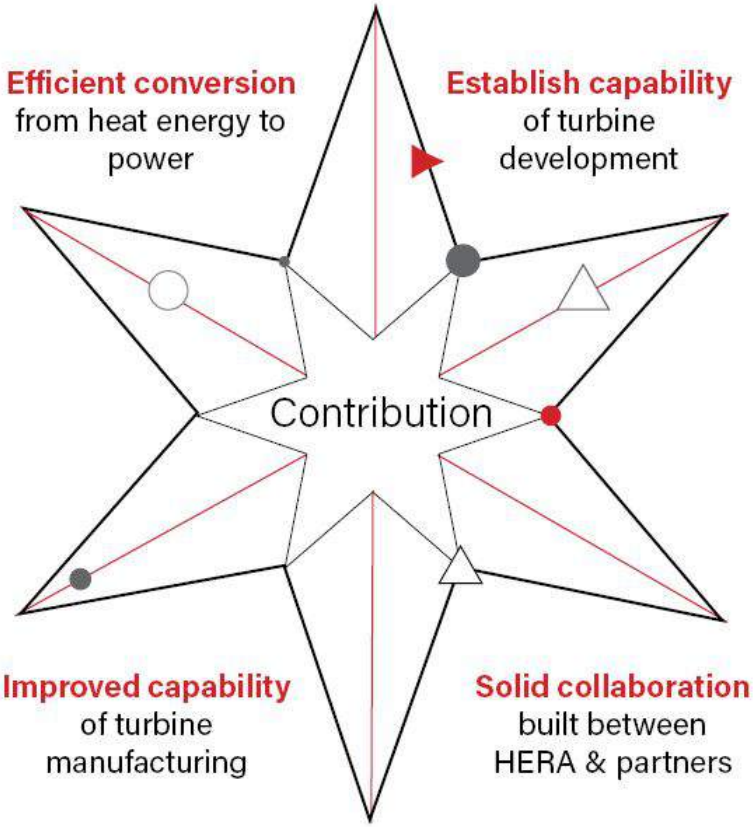


Process conditions	Flow (kg/h)	Temperature (C)	Pressure (kPa)
Hot air entering evaporator	390	380-400	100
R245fa entering evaporator	140-640	63-125	2100
R245fa entering condenser	140	125	300-2100
Air entering condenser	360-3600	10-25	101

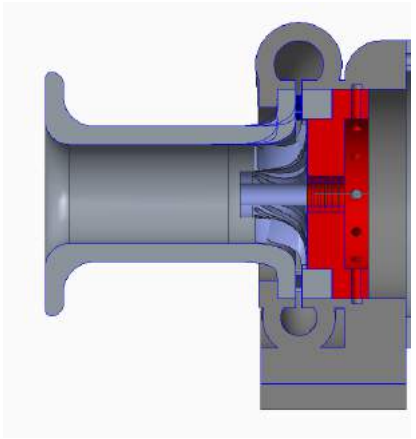
Turbo-generator research

AG GAT

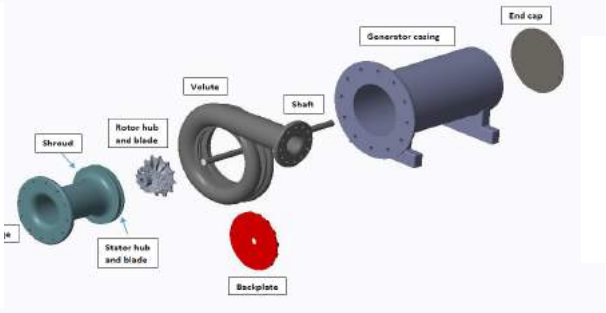


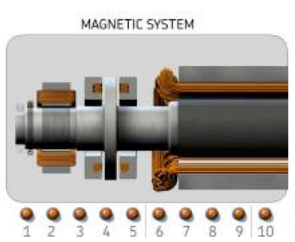


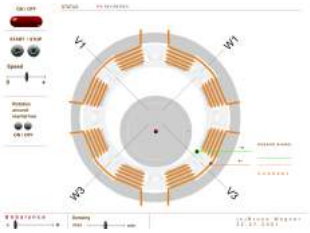
Our research work –turbine design system



Turbo-generator partnerships



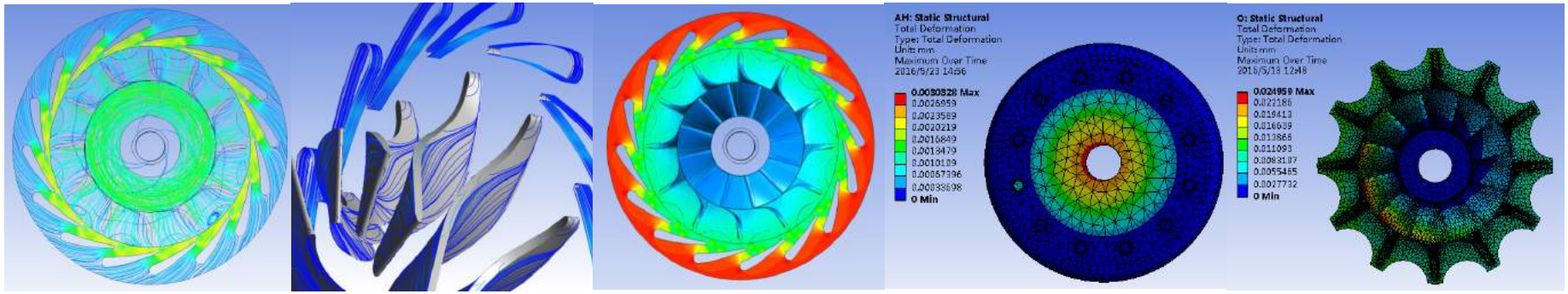




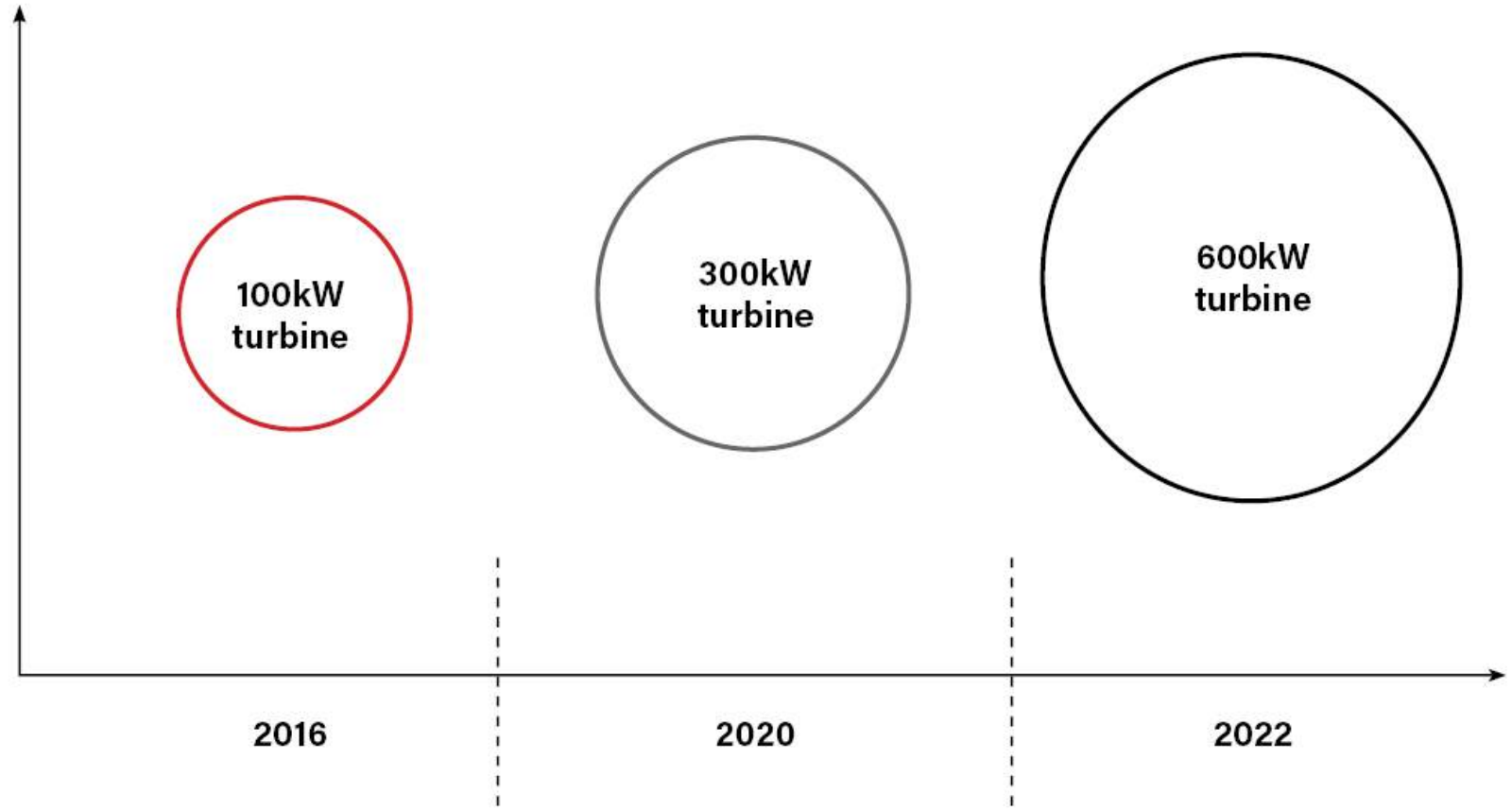
Our research work – turbine performance

3D numerical simulation results of turbine performance

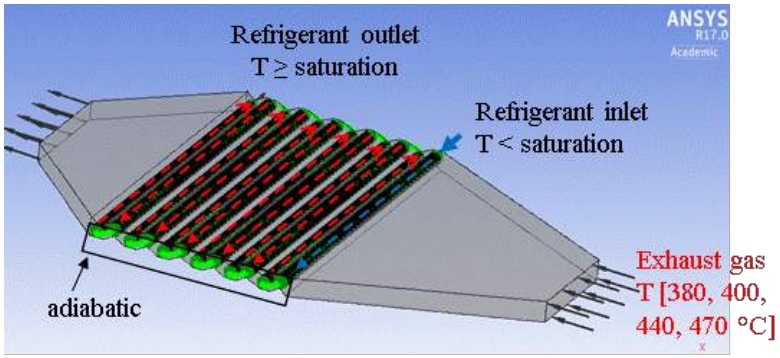
Power (kW)	Efficiency	Pressure ratio	Rotational speed (rpm)
103	0.86	5.1	29000



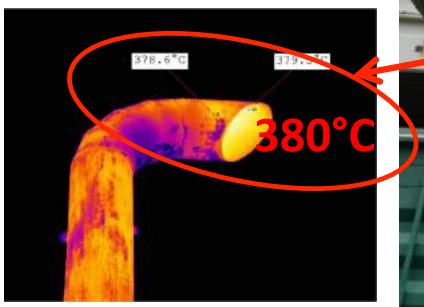
Our research plan

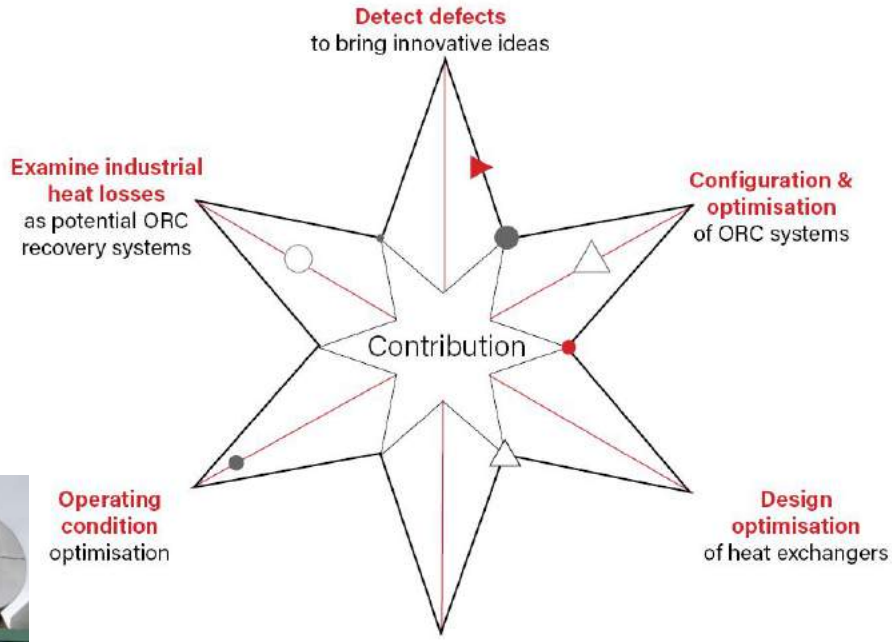


Heat transfer research



CFD model replicating one tubes rows of highly finned tube evaporator with 12 passes





Our design optimisation and innovation

Collaborating and leveraging our expertise in thermal analysis and modelling to validate, design and optimise.

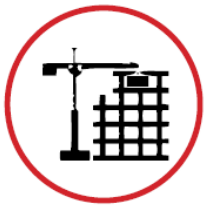
Increase of quality of heat source
100°c higher

Refrigerant decomposition threshold simulated
to give confidence in temperature range

Fluctuations mitigated
in heat source temperatures according to refrigerant requirements

Thermal effectiveness & heat duty of evaporator
increased up to 90% & 34%

Regions with defects detected
& innovative solutions found



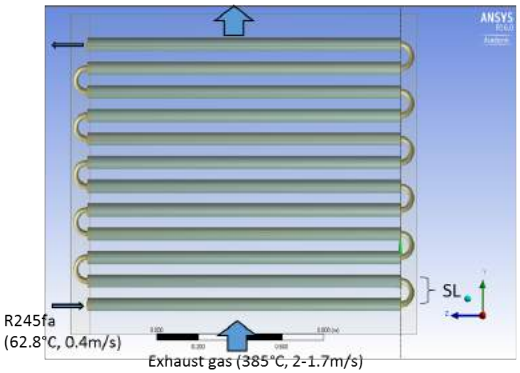
Heat exchanger size decreased by 50%
saving costs & space needs

Delivering:

- A viable way for our members technology to run by detecting and solving errors that originally caused failure.
- Optimum operating conditions with areas of risk failure highlighted.
- Member confidence through increased levels of understanding in the design optimisation process

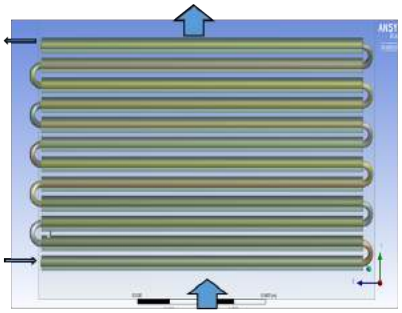
Our goal

Size and cost reduction with higher heat extraction



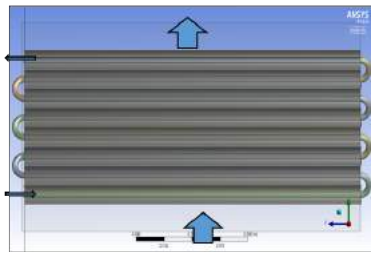
Evaporator highly finned tubes
(Fin length 1.55 cm, and SL 0.1m), height 1.2m
ABS design (basecase)

Reference design
2015



Enhanced design by increasing fin length to 2.18 cm and decreasing SL to 0.07 m
Height 0.84 m

Concept-1
2015



With porous media a potential to decrease the total passes from 12 to 8

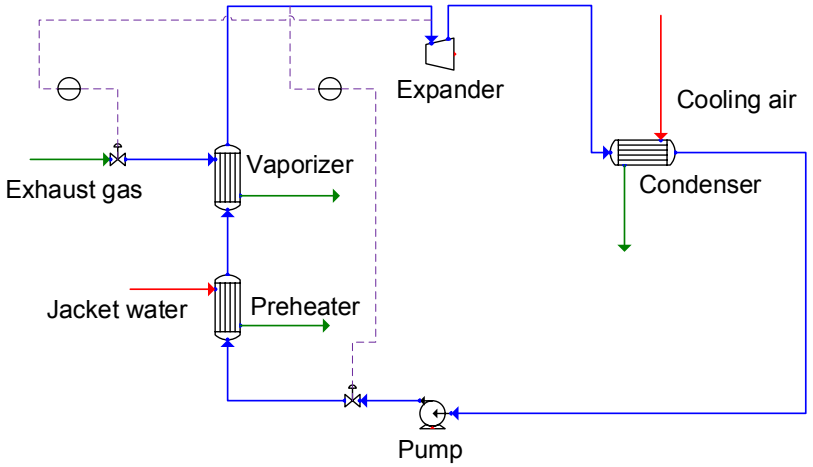
Concept-1, and 2
2016

New concepts

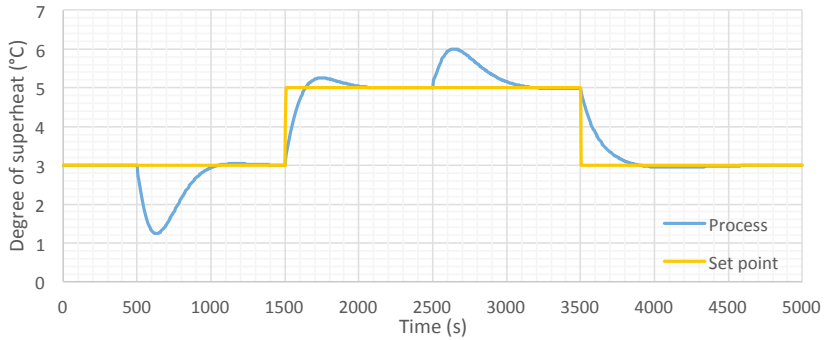
Concept-1, 2, and 3
2016-2020

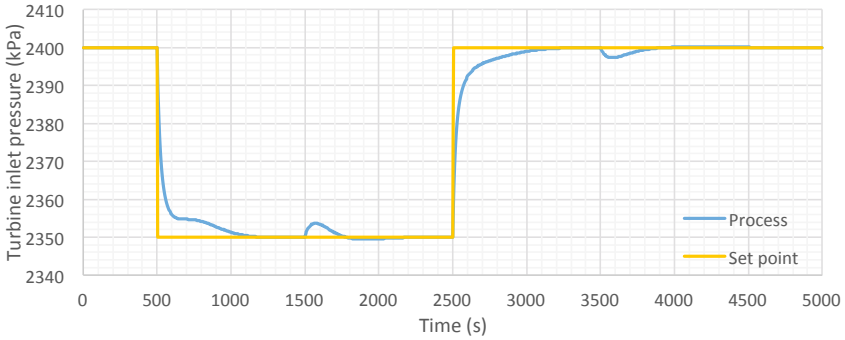
*Innovative concepts in heat exchanger design (evaporator & condenser) currently under study

Control systems research @ UoA

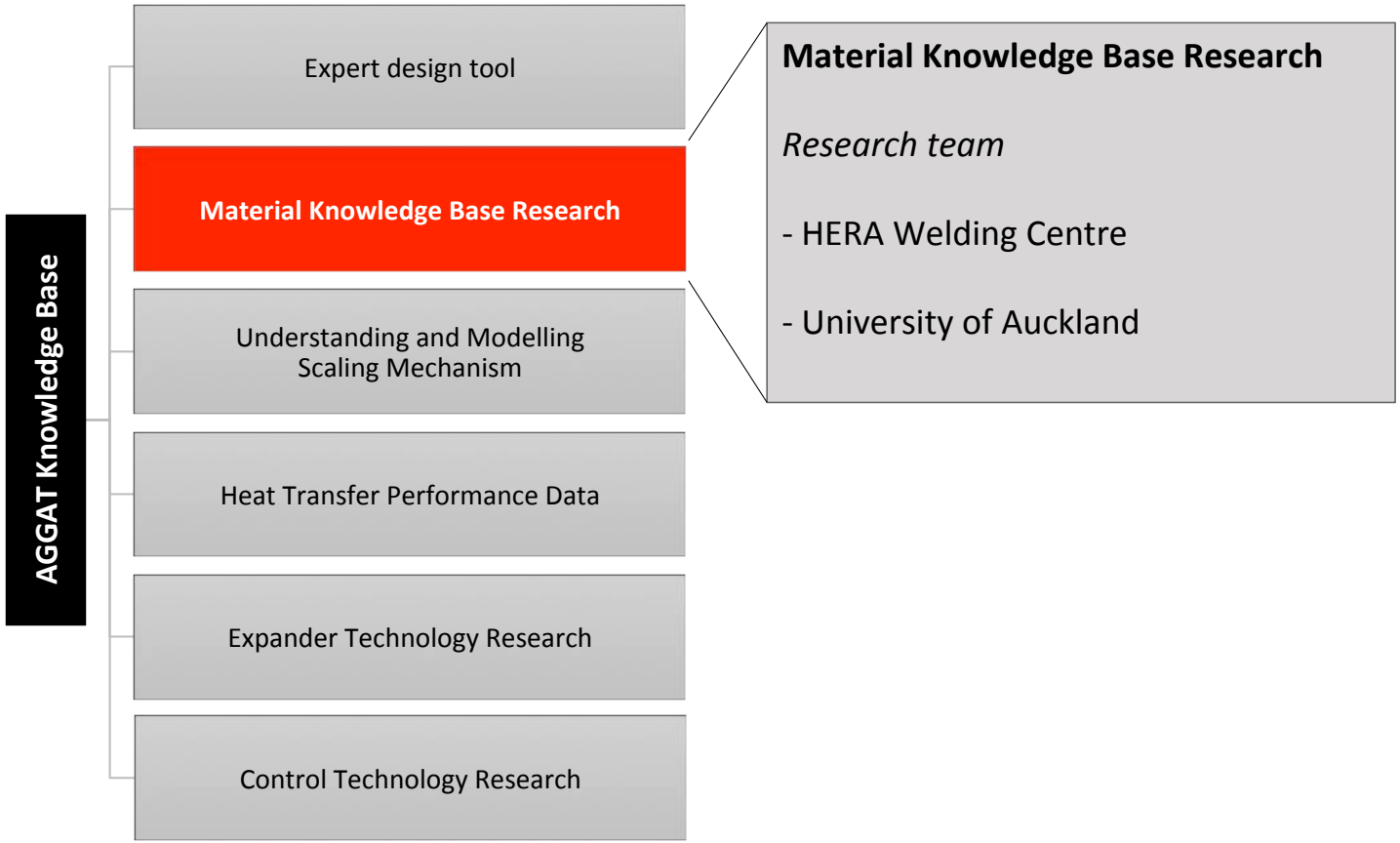


Pressure step down → Superheat step up → Pressure step up → Superheat step down





Materials and fluids research



What materials perform best?

AG GAT

Overall objectives

Identification & characterisation
for components within an ORC plant

- Standards and novel materials
- Surface modifications

Built up industry capability
for the research and consulting services

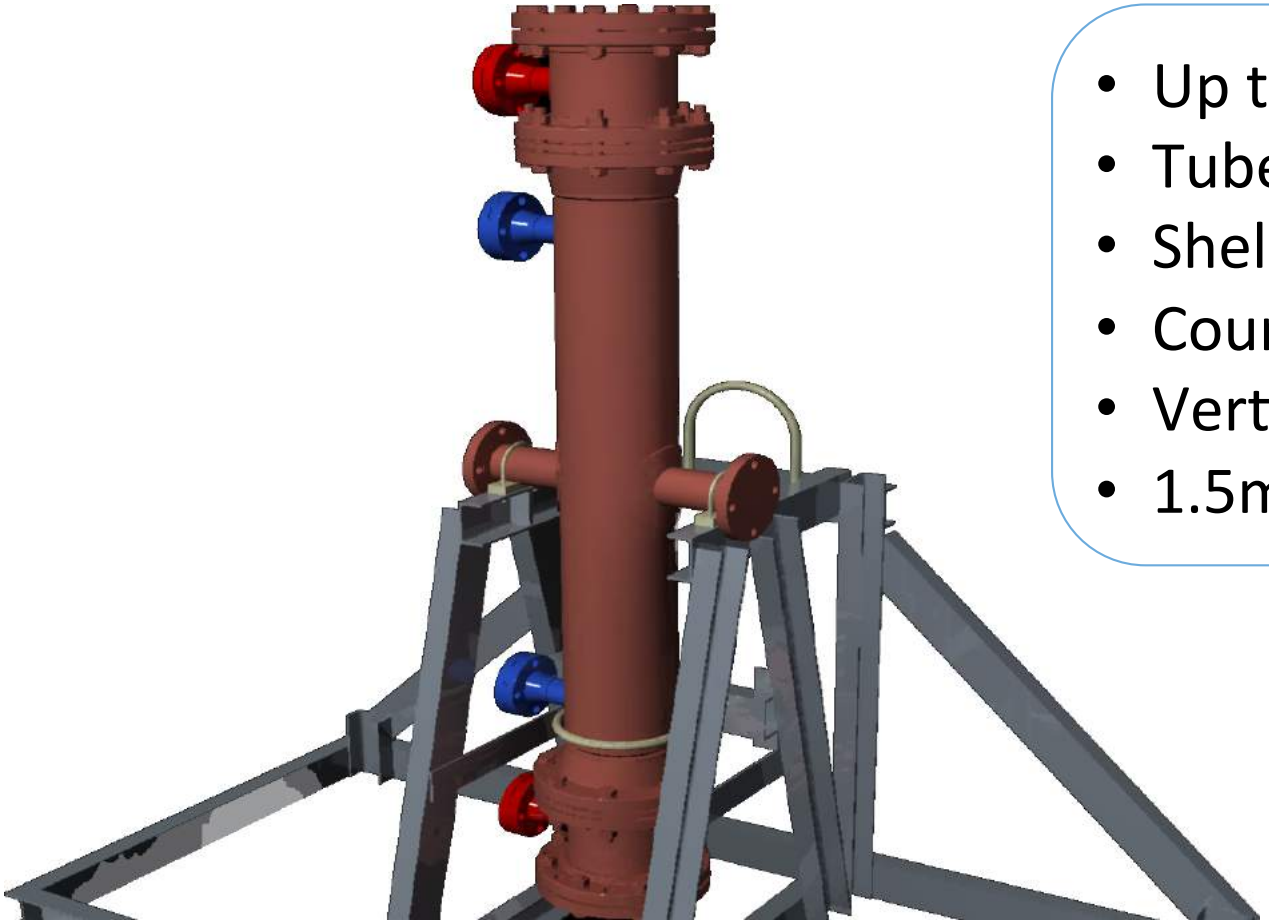
- Manufacture and deliver equipment and samples required

Scaling

Corrosion

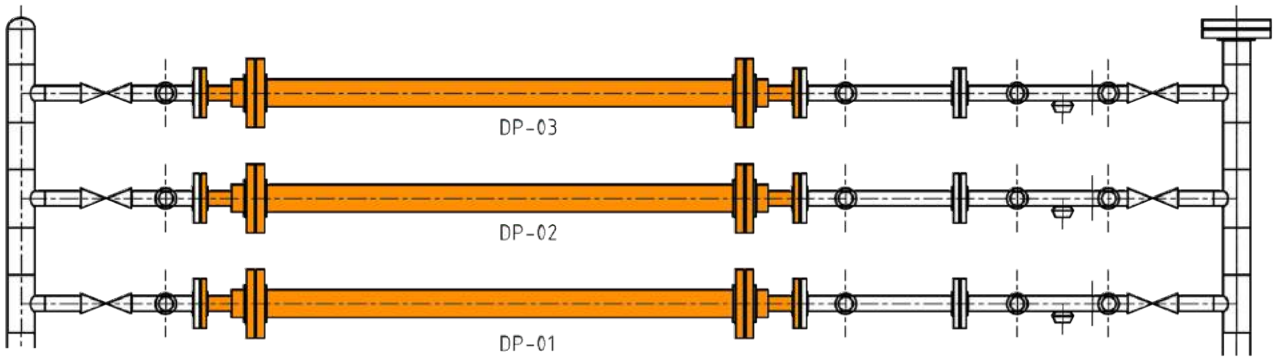
Fabrication

Shell & tube rig



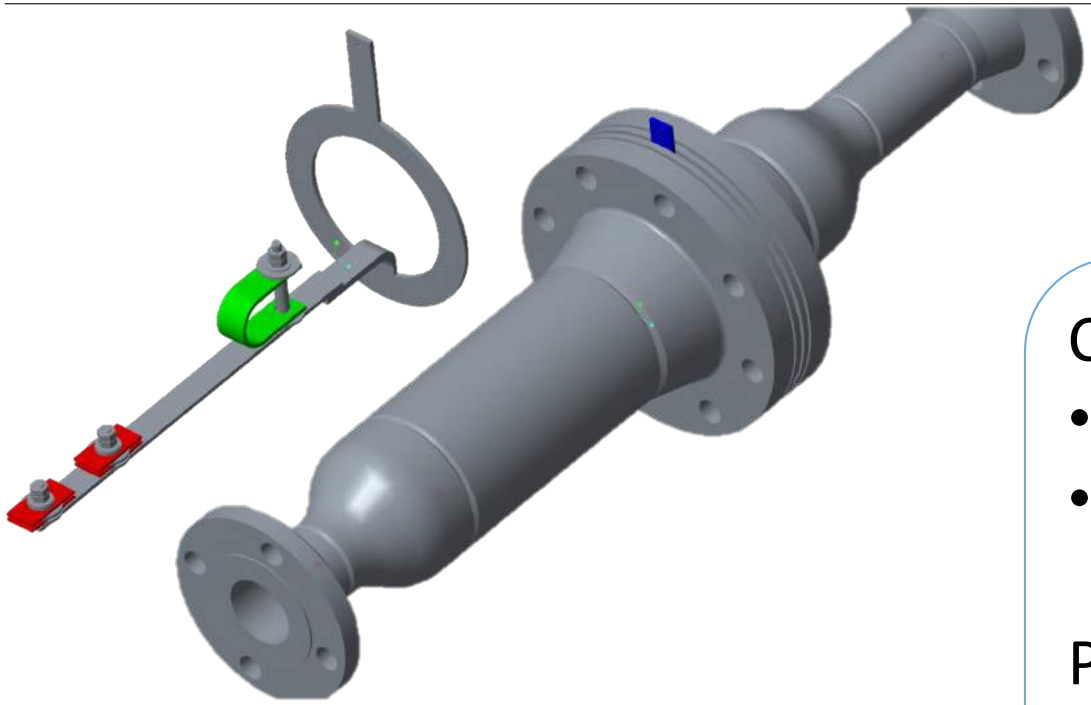
- Up to 19 tubes, 1” OD
- Tubeside: SGW
- Shellside: CW
- Counter-current
- Vertical arrangement
- 1.5m tube length

Double pipe complex rig



- Three DP units
- Individually adjustable flow rates (CW, SGW)
- Ability to test anti scaling and scale mitigation technologies

Corrosion rig

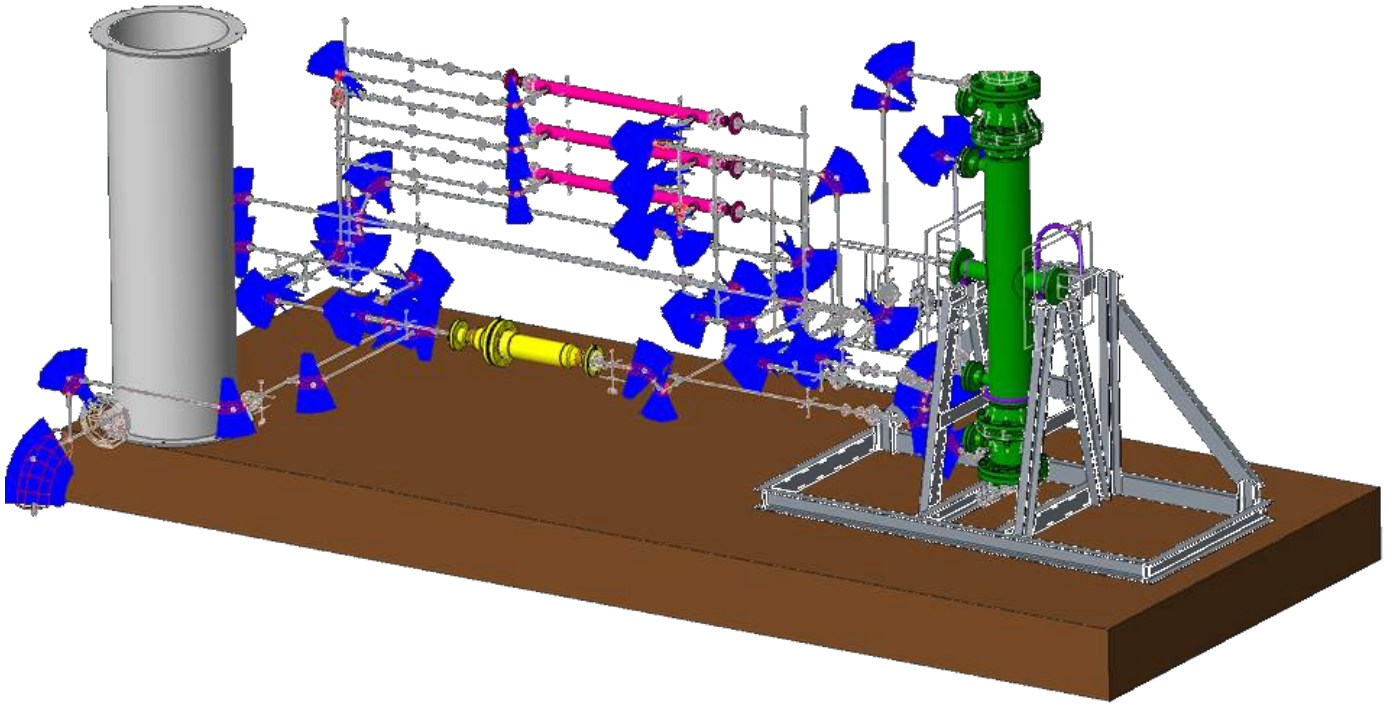


Corrosion coupon holder

- Straight specimen
- Stressed specimen

Piping to fit coupon holder

Materials test rig design



Based on 20ft flat rack container
50 m of piping, 28 valves, 40 flange pairs

Materials test rig

AGA GAT

- Awaiting final connections to mainline and discharge end
- Building experimental programme via partnerships and collaboration
- Inauguration planned for January 2017

AGGAT
ABOVE GROUND GEOTHERMAL & ALLIED TECHNOLOGIES

GEOTHERMAL TEST FACILITY

HERA
Innovation in Metals

Made possible thanks to the generous sponsorship of

VULCAN STEEL

steel&tube
STRONGER IN EVERYWAY

DE
DOBBIE
CONSULTING MECHANICAL ENGINEERS

Ohaaki Heat
ThermalDry
Firewood

SANDVIK

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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Te Whare Wānanga o Tāmaki Makaurau

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ASMUSS

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B.O.P. Gear Cutters

index
ENGINEERING LTD

Our achievements to date

AGGAT

2016

Expert Design Tool

- Models
- Algorithms
- Presentation

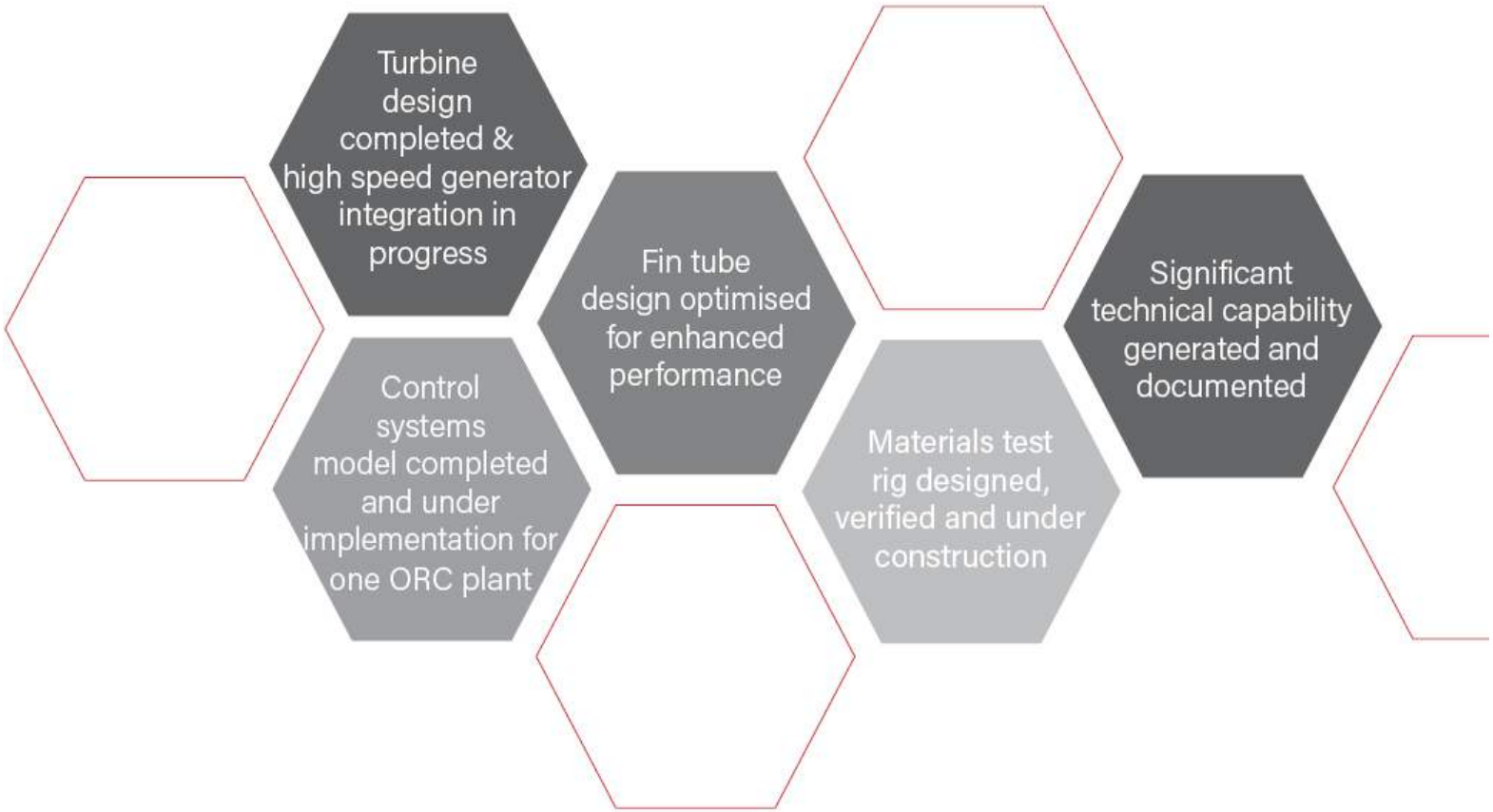
ORC Pilot Plants

- Design
- Cost
- Installation
- Commissioning
- International partnerships
- Company Investments
- Research value to stakeholders
- AGGAT Brand

Our achievements to date

AG GAT

2016



Beyond

EDT EDAT

- Include analysis component in EDT
- Greater sophistication in ORC modelling

ORC

- Application sites biomass, hybrid source
- Cycle super-critical
- Scale above 100-250kW
- 2nd generation ORC Plant
- Growth in Allied Technologies space

AGGAT @ NZGW New Zealand Geothermal Workshop

Innovation

Paper nos.

1. Abbas et al., no. 30
2. Heinzel et al., no. 124
3. Chen et al., no. 25
4. Dong et al., no. 147
5. Jamero et al., no. 26
6. Dacillo et al., no. 27
7. Lie et al., no. 148
8. Habib et al., Industry update

Acknowledgements

- ✓ Ministry of Business, Innovation and Employment
- ✓ AGGAT research team
- ✓ University of Auckland
- ✓ Industry partners
- ✓ Callaghan Innovation