
AUSTRALIA
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Salt Drying using Heat Pump technology

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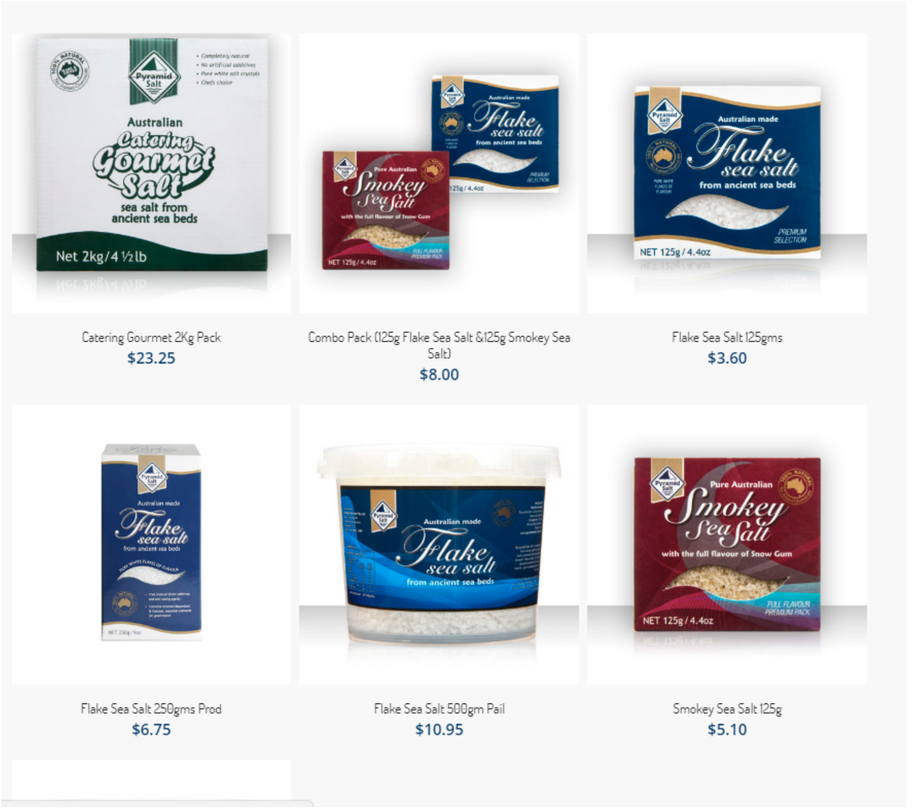
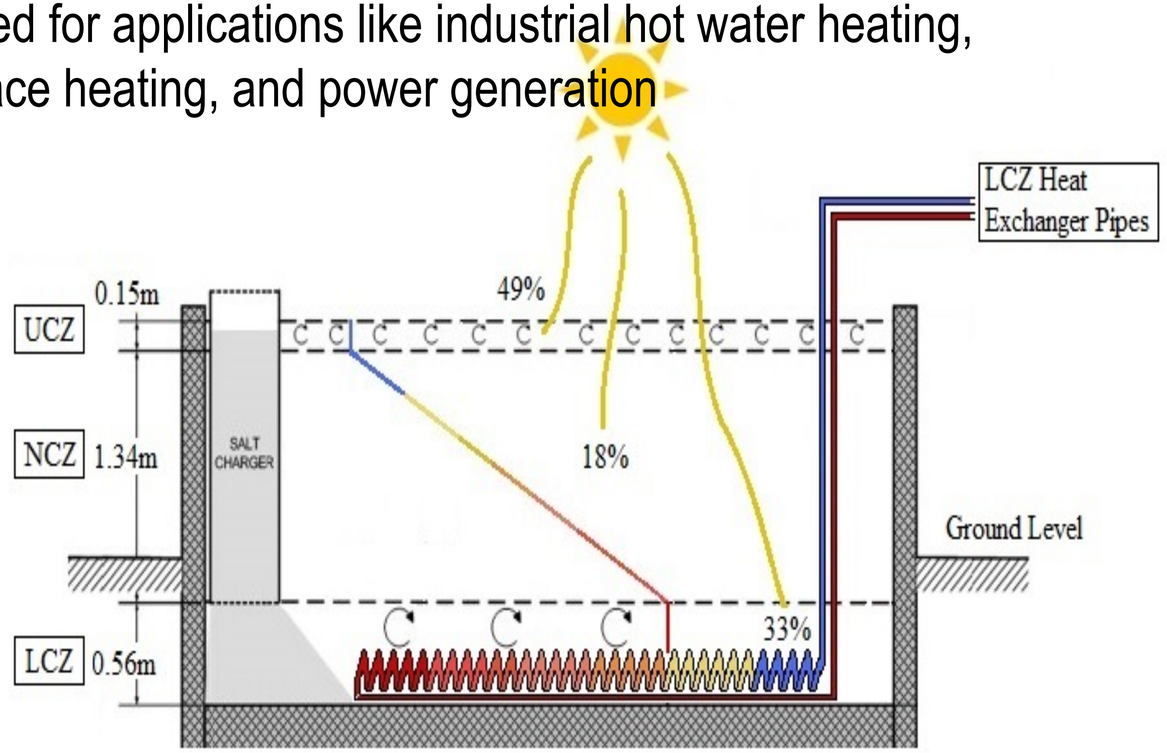
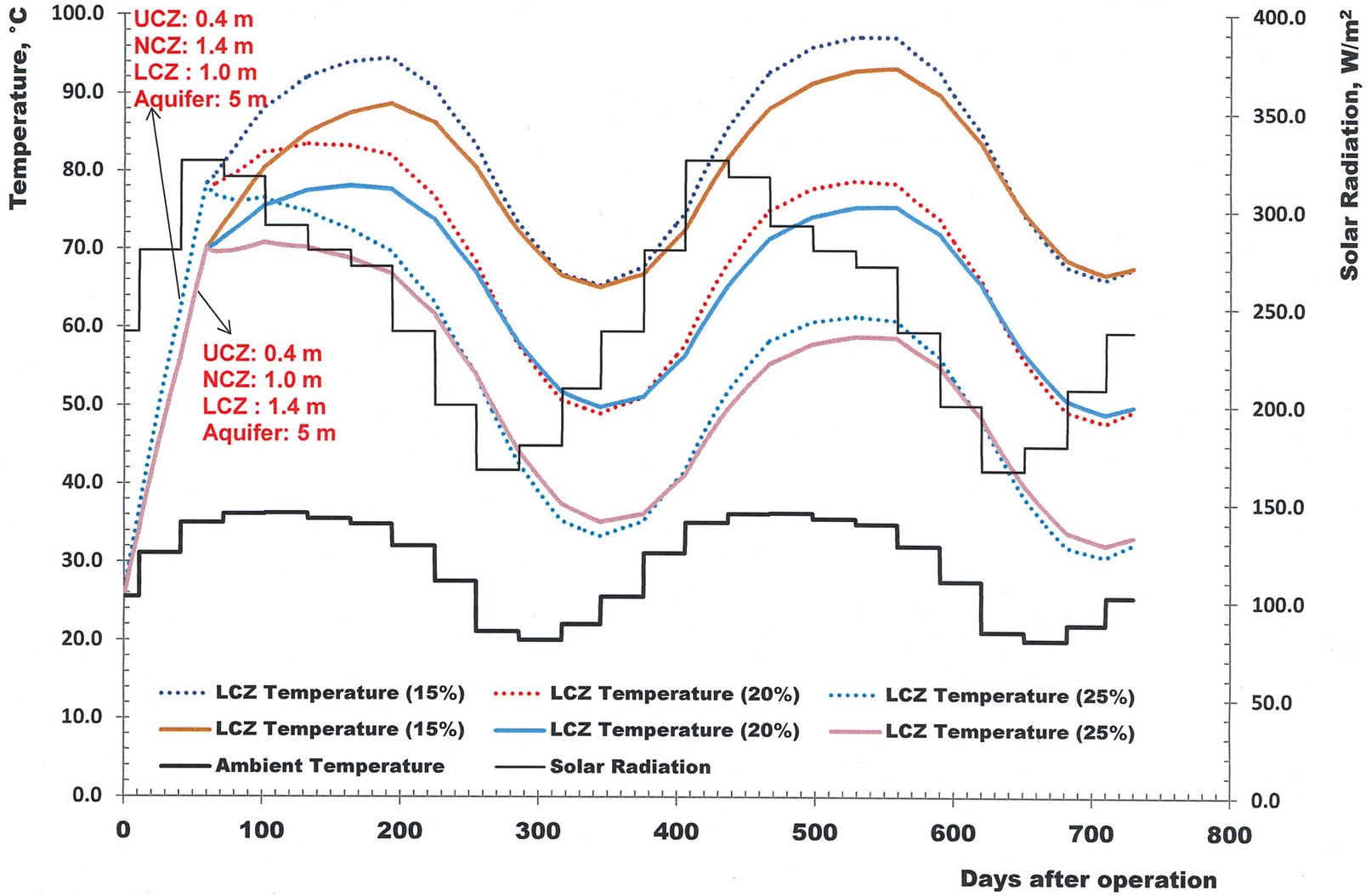
Pyramid salt



Solar Ponds

- A body of water that captures and stores solar radiation
- Increasing salinity at depth stratifies the pond and inhibits convection
- Without convective heat transfer, heat energy remains trapped in the lower layers of the pond
- Used for applications like industrial hot water heating, space heating, and power generation




UCZ: 0.4 m
NCZ: 1.4 m
LCZ : 1.0 m
Aquifer: 5 m
UCZ: 0.4 m
NCZ: 1.0 m
LCZ : 1.4 m
Aquifer: 5 m
Temperature, °C
Solar Radiation, W/m²
Days after operation
LCZ Temperature (15%)
LCZ Temperature (20%)
LCZ Temperature (25%)
LCZ Temperature (15%)
LCZ Temperature (20%)
LCZ Temperature (25%)
Ambient Temperature
Solar Radiation

Escúzar Mine Solar Pond

Escúzar Solar Pond

Escúzar Mine Solar Pond

- At the mine Celestite (Strontium Solfate) is extracted using a flotation process
- 5000 litres of water at 50 degrees Celsius is needed every 16 hours
- Solar pond designed to preheat water entering the process

Pyramid-Hill Solar Pond

- A collaborative project between RMIT University, Pyramid Salt Pty Ltd and Geo-Eng Australia Pty Ltd.
- Project made possible through a grant under the Renewable Energy Commercialisation program from the Australian Greenhouse Office.
- Constructed in 2000 at Pyramid Salt's facility at Pyramid Hill in northern Victoria, Australia.
- Surface area of ~ 3000 m2. Depth: 2.3 m, UCZ: 0.3 m, NCZ: 1.2 m, LCZ: 0.8 m.
- Solar pond integrated into the salinity scheme where the surface of the pond is flushed with saline groundwater (~ 3% salinity) and the overflow is used in the salt production process.

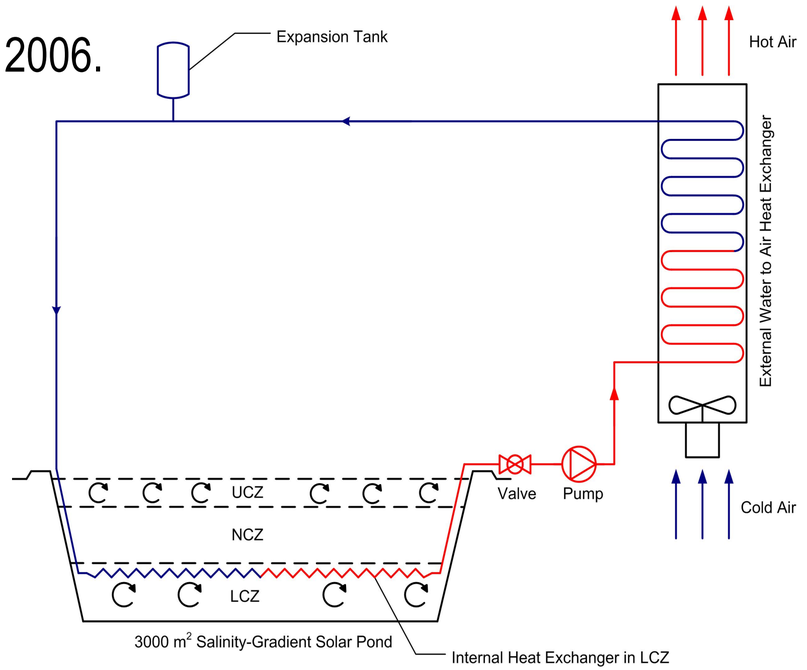
Pyramid-Hill Solar Pond

Applications during its ten years of operation:

- Industrial process heating, providing heat for use in high-grade salt production. The heat exchanger delivering hot air to the salt production process is a cross-flow liquid-to-air heat exchanger with copper tubes and aluminium fins. (Designed heat output: 60kW; Water flow: 174 LPM at 62^{o}C.

- Aquaculture (specially producing brine shrimps for stock feed).

- Thermal desalination trial in Dec 2006.



Pyramid Salt – Heat Pump proposal

- Replace electric heating with heat pump technology
- Use existing salt pond as water source for heat pump
- Keep existing system for back up
- Request funding for project through ARENA

Pyramid Salt – Eco Sirocco heat pump

Conditions:

1.Air flow

Air flow for each dryer : 665m3/h @ 65C to 70C
Number of dryers: 17 sets
Total air flow for 17 sets: 11,305m3/h @ 65C to 70C

Existing system: 3 sets of 91.8kW electrical element

2.Heat sources

Salt pond (Fresh water) 40C in summer for 12 hours, 35C in winter for 8 hours
Flow 300 to 600 L/min

3.Climate

Dec to Jan	28C, 40% humidity
Feb, Mar, Oct and Nov	25C, 40% humidity
Apr, May, Aug and Sep	15C, 50% humidity
Jun to Jul	10C, 50% humidity

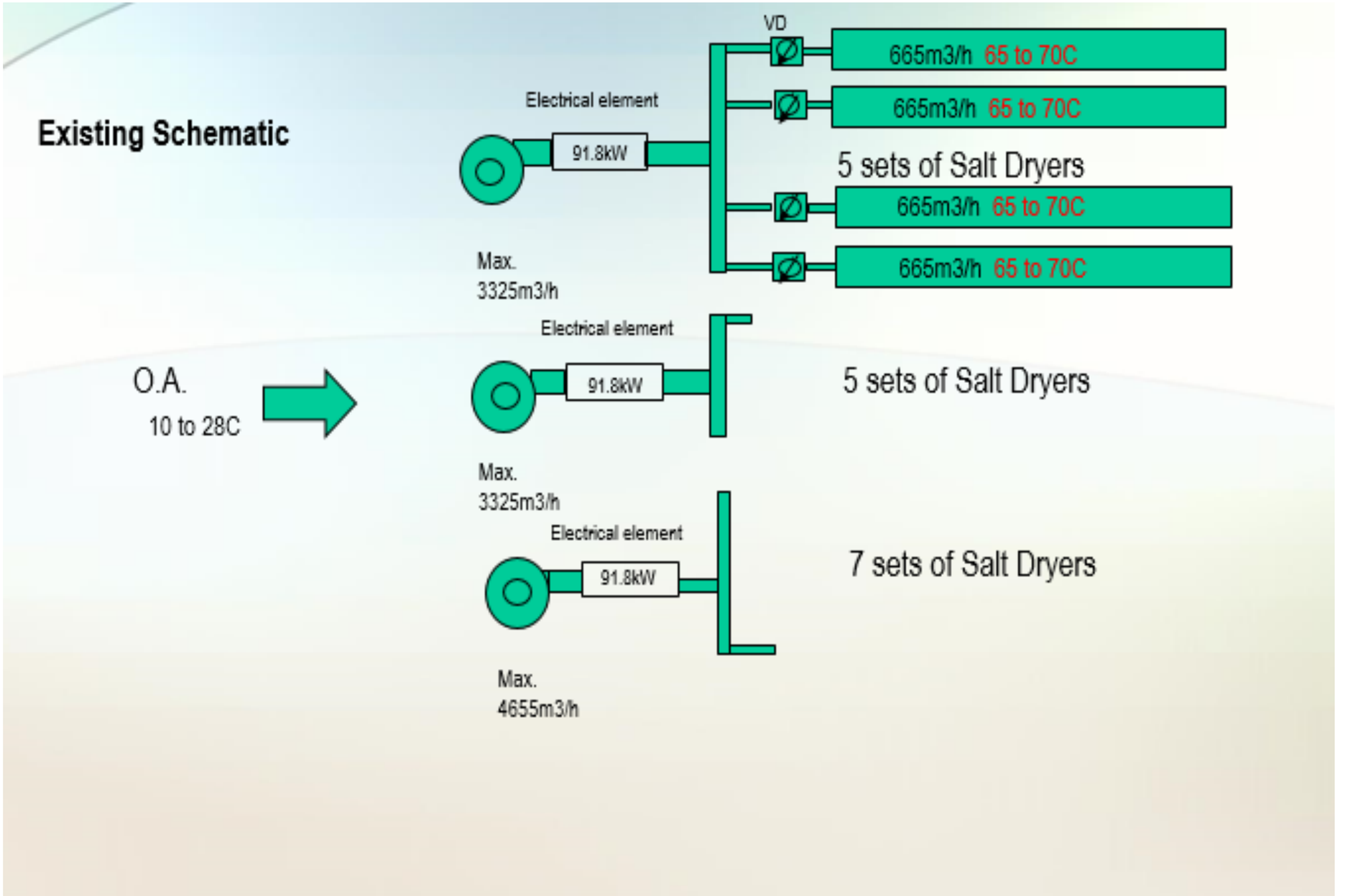
Salt pond heat source 35C in Winter, 40C in Summer

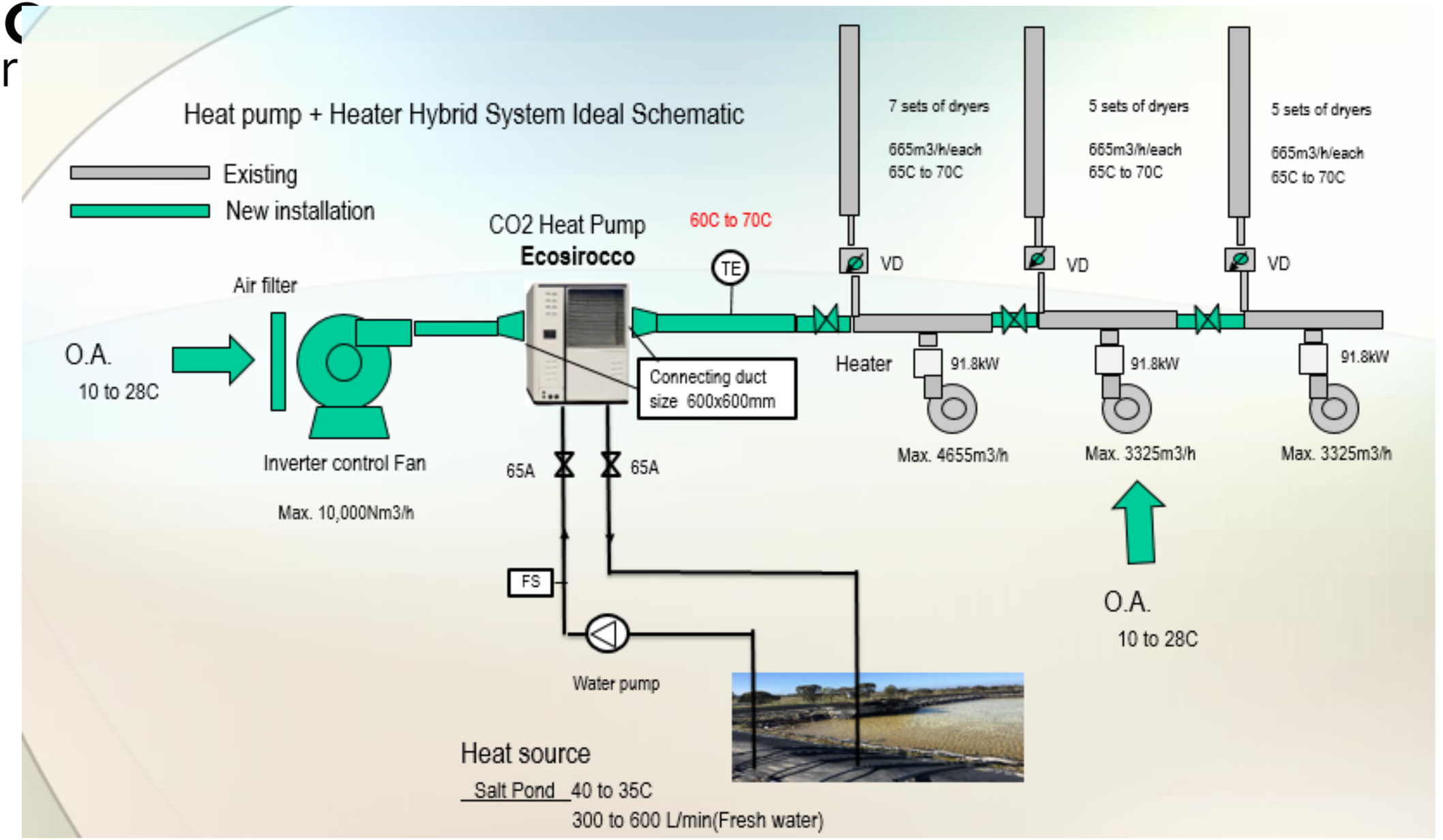
"Ecosirocco" performance table @ Max.speed 65Hz

Frequency	Air outlet temp.	Air inlet temp.	Heat source inlet water	Heat source outlet water	Air inlet air flow rate	Standard air flow rate	Heat source water flow rate	Heating capacity	Cooling capacity	Power consumption	COPh	COPt	Dryers
Hz	°C	°C	°C	°C	m^3/h	Nm^3/h	L/min	kW	kW	kW	-	-	
65.0	70.0	10.0	35.0	29.9	6092.0	5840.6	300.0	126.7	107.8	24.3	5.2	9.65	Set
65.0	70.0	15.0	35.0	29.9	6717.1	6313.0	300.0	125.6	106.1	24.8	5.1	9.35	8
65.0	70.0	25.0	40.0	35.0	8264.4	7475.7	287.8	121.7	100.4	25.1	4.8	8.83	9
65.0	70.0	28.0	40.0	35.0	8740.7	7808.5	277.4	118.6	96.8	25.4	4.7	8.49	11
													11
65.0	60.0	10.0	35.0	29.9	7138.1	6843.6	300.0	123.8	107.0	21.7	5.7	10.61	
65.0	60.0	15.0	35.0	30.0	7999.3	7518.1	300.0	122.4	104.9	22.2	5.5	10.24	
65.0	63.3	25.0	40.0	35.0	9426.7	8500.0	279.2	117.9	97.4	23.3	5.1	9.23	
65.0	65.8	28.0	40.0	35.0	9550.9	8500.0	271.4	116.3	94.7	24.2	4.8	8.71	

"Ecosirocco" performance table @ Min.speed 30Hz

Frequency	Air outlet temp.	Air inlet temp.	Heat source inlet water	Heat source outlet water	Air inlet air flow rate	Standard air flow rate	Heat source water flow rate	Heating capacity	Cooling capacity	Power consumption	COPh	COPt
Hz	°C	°C	°C	°C	m^3/h	Nm^3/h	L/min	kW	kW	kW	-	-
30.030.030.000	70.0	10.0	35.0	30.0	2812.7	2696.6	142.6	58.5	49.8	11.2	5.2	9.65
	70.0	15.0	35.0	30.0	3100.7	2914.2	140.3	58.0	49.0	11.4	5.1	9.36
	70.0	25.0	40.0	35.0	3814.3	3450.3	132.8	56.2	46.4	11.6	4.8	8.83
	70.0	28.0	40.0	35.0	4034.2	3603.9	128.0	54.7	44.7	11.7	4.7	8.49


Existing Schematic
VD
665m3/h 65 to 70C
665m3/h 65 to 70C
Electrical element
91.8kW
5 sets of Salt Dryers
665m3/h 65 to 70C
665m3/h 65 to 70C
Max.
3325m3/h
Electrical element
O.A.
10 to 28C
91.8kW
5 sets of Salt Dryers
Max.
3325m3/h
Electrical element
91.8kW
7 sets of Salt Dryers
Max.
4655m3/h


Heat pump + Heater Hybrid System Ideal Schematic
Existing
New installation
CO2 Heat Pump
Ecosirocco
60C to 70C
TE
7 sets of dryers
665m3/h/each
65C to 70C
5 sets of dryers
665m3/h/each
65C to 70C
5 sets of dryers
665m3/h/each
65C to 70C
VD
VD
VD
Air filter
O.A.
10 to 28C
Connecting duct
size 600x600mm
Heater
91.8kW
91.8kW
91.8kW
Max. 4655m3/h
Max. 3325m3/h
Max. 3325m3/h
Inverter control Fan
Max. 10,000Nm3/h
65A
65A
FS
Water pump
O.A.
10 to 28C
Heat source
Salt Pond 40 to 35C
300 to 600 L/min(Fresh water)

Recommended scheme for the project

Equipment conditions:

One off "Ecosirocco" will be installed.

The system will be hybrid Heat pump + Electrical heater

The collaboration: Pyramid Salt, RMIT and Mayekawa

The confirmation of existing system at Pyramid Salt	..... Pyramid Salt and RMIT
The material balance and simulation	..... RMIT and Mayekawa
The Installation	..... to be discussed
The energy audit	..... RMIT and Mayekawa
The technical paper	.....All parties

Pyramid Salt – Heat Pump proposal

Advantages – CO2

- Higher air temperatures achieved
- Better COP's than HFC's and electric heating
- Easier prospect for funding with natural refrigerants
- Based on $0.15/kWh, running 8 x dryers over 24 hrs, daily savings of $450.00 per day

Timeline for project

- Proposal for funding – June 2018
- PV solar to supply power to heat pump – September 2018

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Thank you very much!