Industrial Solar Hot Water for Dairy processing

Jeremy Osborne – Director
Enabling innovation for sustainable future

Research and Development

Consulting

Software sales and training

Project development & implementation

Expertise

Solar thermal / PV

Storage

Building energy

Heat pumps

Services

Numerical Modelling

System Design

Project Management

Technical advisory

Industrial Solar Hot Water for Dairy Processing J. Osborne Melbourne

23/02/2017
Our Team

Dr Fiona McClure    Jeremy Osborne    Alastair McDowell    Erika Degoute    Dr Mike Dennis

Australian Distributor for TRNSYS software  www.trnsys.com

Training in TRNSYS:  https://learn.trnsys.guru/

23/02/2017

Industrial Solar Hot Water for Dairy Processing  J. Osborne
Melbourne
Selection of clients

- Australian Government
- Rheem
- South East Water
- CSR
- TÜV SÜD
- Ingersoll Rand
Industrial Solar Hot Water
Why?

1. Lower energy costs
2. Secure a long term energy price
3. Demonstrate your commitment to environmental sustainability
Question for the audience?

What is the largest ‘new’ renewable by capacity in the world?

A) Solar Photovoltaic
B) Solar Hot Water
C) Wind Power
D) I care very little for silly quizzes
Solar Thermal

Source: IEA Solarheat worldwide 2015
Chile's advantage in Solar radiation was discovered by Charles Wilson in 1872. The Swedish Engineers built a 5,000 m² solar system to desalt brackish water. It delivered 20,000 liters / day and was in operation till 1912.

Source: Brunner, 2014, SHC Beijing
Solar Thermal - Chile Copper Mine 2013

27MW field

Source: ARCON SUNMARK
Solar Thermal

Flat plate

Evacuated Tube

Concentrating
Flat plate Solar Hot Water Dairy Study

Industrial Flat Plate Solar collectors to convert sunlight into hot water

- Ground mounted facing north tiled 26°
- Coupled with external HX
- stratified hot water tank
- pumps, pipes and control systems
- Well insulated tank and pipes
Large-profile collectors

1. Each up to 15m² each
2. Low cost
3. Easy Installation
4. Long project experience
Collector Manufacturer list

Ritter XL
GreenoneTec
Chromsun
NEP Solar
Rheem / Solahart
Greenland Systems
ErSol
Soltigua
Solimpeks
Solahart
Kingspan
Sunda

Rinnia
Tsinghua
Sunrain
Industrial Solar
Gasokol
Schuco
Hylodyne
TiSun
Arcon Sunmark
Apricus China
Zhejiang Jiadele
SonneCorp

Source: EnergyAE
Assumptions

Load

• A hot water supply system that heats potable town water from 15°C using 100kL of water at 60°C
• Load is ‘use and dump’. No return line to hot water set

Current systems:

• Cost of Gas $11 / GJ
• Back-up boiler efficiency 80%, Steam system 10% lost
Case study for the report

Solar field: 80 HT-SA 28-10 Arcon-sunmark collectors
Total collector area: 1000 m², 805 kW solar field
Land Space: 2000 m² – 50m by 50m
Heat Storage: 28 m³ for half day buffer
Heat exchanger to separate solar field from process

This is a small solar field
Case study for the report

Savings: 4,444 GJ, $48,000 p.a.

Turn-key cost: $600,000
Estimated STC: $378,000
Cost after STCs: $235,000

Payback: 5.3 years - including $5k per year O&M
(Less than 3 years on LPG, immediate payback with Energy Service Contracting)
PHASES IN INSTALLATION
PHASES IN INSTALLATION
PHASES IN INSTALLATION
FINAL INSTALLATION

23/02/2017

Industrial Solar Hot Water for Dairy Processing, J. Osborne
Melbourne

15,000 m² 12 MW
Case studies

1. Atacama Desert, Chile – Copper Processing with Solar Thermal
2. Paris Creek, South Australia – Dairy with Solar Thermal
3. Griffith, NSW – Winery with Solar Thermal
Chile - Copper Processing

Location: Minera Gabriela Mistral copper mine and processing site
100 km south of Calama, in the Atacama Desert

Source: ARCON SUNMARK, Google
Chile - Copper Processing

- Technology: Flat Plate Solar Thermal
- Turnkey supplier: Energia Llaima and Arcon-Sunmark
- Customer: Codelco mining company
- Size: 27MW, 39,000m² solar field
- Industry: Mineral processing, Copper, Electrowinning process
- Capital Cost: $0 to the customer
- Sales model: 10 year Energy Service Contract
- Start-up: August 2013.
4300m³ Storage Tank

Source: ARCON SUNMARK
2620 panels, 15m² each
Process Integration
Supply 50°C hot water for electrowinning
Performance

- Heat production: 51,800 MWh per year
- Solar fraction: 85%
- Fuel saving per year:
  - 6,500 tons of diesel
  - 250 truck travels per year

Source: ARCON SUNMARK
Paris Creek – Dairy

Location: Paris Ck Rd, Paris Ck, South Australia

Source: Google
Whole of site energy

Energy Efficiency
• Power Factor Correction
• Heat Recovery
• Soft-start

Clean Electricity
• Solar PV – 100kW

Clean Heat
• Solar thermal – 150kW

47% reduction in GHG emissions and financial saving $125,000 per year

Source: Clean Technology Food and Foundries Investment Program and Paris Creek Farm interview.
Paris Creek – Dairy
Paris Creek – Dairy

• Technology: Evacuated Tube Solar Thermal
• Supplier: Greenland Systems, LCi
• Customer: BD farm Paris Creek
• Size: 140 kW, 169 m² solar field
• Industry: Dairy Processing
• Capital Cost: $350,000 (not including grants)
• Sales model: Cash sale with government grants
• Start-up: August 2014

2014 : $2000/m² for complete project including collector, BOP, integration.

2016: $300-600/m² for ground-mount large field

Many opportunities for price reductions!

Source: BD farms, LCi, ARENA
Process integration

60 x Greenland Systems GL100-16
7m3 storage vessel
75° C
HX
Pump
Pump
Pump
Pasteurizer Heat
To the boiler
Return from process

Source: EnergyAE and LCi
De Bortoli Winery

Location: Griffith NSW
De Bortoli Winery

- Technology: Evacuated tube Solar Thermal
- Supplier: Apricus, The Solar Project, Fletchers Plumbing
- Customer: De Bortoli Winery
- Size: 200 kW Heating, 280 m² solar field
- Design concept: Provide pre-heating to a condensing gas boiler
- Industry: Winery
- Start-up: May 2013

Source: Apricus, ITPower 2015
De Bortoli Winery

100x AP30 Apricus Collectors
280m² solar field

12 m³ storage at 95°C

Source: Apricus Australia, ITPower 2015
More Case Studies

All


Solar thermal

http://ship-plants.info/
Process heating Project

Source:
IEA TASK 49
SHIP Database [3]
Where does it work best?

1. Space available required for collectors:
   1. 0.35 - 0.7 m² roof or ground space per GJ heat load / year **
2. For temperatures of less than 120°C use a good flat plate collector
3. Sites on expensive energy, LPG, wood chips, electricity
4. Where integration into existing hot water is simple

** Assumption update since talk: sun:1600kWh/m²/year, heat load, not purchased gas: multiply bill by efficiency to find heat load typically x0.8, assuming 60-100% solar fraction – 100% generally difficult, Ratio of collector to roof or ground space:2, 1.5 possible if flat on roof, 3 for trough collectors.
Steps?

1. Feasibility/concept design
2. Detailed Design / Finance / incentives
3. Installation / commissioning
4. Monitoring and operation
Conclusions

1. Industrial Solar Hot is cost effective now
2. Ground-mounting lowers the cost
3. Government support is available

However,
4. We must focus on the best opportunities (LPG
Reference

• ITPower, 2015 Renewable Energy Options For Australian Industrial Gas Users
• IEA, 2015 Solar Heat Worldwide 2015
Thank you!

Jeremy Osborne
jeremy.osborne@energyae.com
http://energyae.com
+61400063327
BUILDING A 62,000 M³ THERMAL PIT STORAGE
BUILDING A 62,000 M³ THERMAL PIT STORAGE
Balance of plant

• Storage – Dependent on load characteristics, for small solar fractions no storage is required.
  • Generally size for 0.5 – 1 day of average solar gains.
• Pipe and insulation: Careful balance between pump demand and heat loss. Don’t leave insulation on the roof.
• Heat rejection: Careful of fan power and water consumption.
• Pumps: System consideration – make sure you have pumps that an handle pressure and temperature.
• Control: Consider how the solar interacts with chiller and the building
Charlestown Square Shopping Center

Source: J Osborne
UTS Solar-driven Tri-generation

Source: J Osborne
Energyae.com/portfolio/uts
Wendouree Stockland Solar Desiccant

Source: CSIRO ARENA report
Solar Cooling Textbook

Earthscan Expert Series
Guide to Solar Cooling Systems

By Paul Kohlenbach and Uli Jakob