Clean Energy in Manufacturing

Jeremy Osborne – Director
Our Mission

Enable Innovation for a sustainable future
Stationary energy consumption (PJ) in Australia 2012 (IEA, BREE 2012)

Industry, 991, 49%
Residential, 438, 22%
Commercial, 292, 14%
Agriculture, 93, 5%
Other, 201, 10%

Electricity 30%
Heat 70%

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Heat use in Manufacturing process (PJ) (BREE, IEA, UNIDO)

- Food, Beverage, Tabacco
- Textiles
- Paper and printing
- Chemical, Polymer and Rubber
- Glass
- Ceramics, Cement, lime, plaster and concrete

Heat categories:
- Heat less than 60C
- Heat Between 60-100C
- Heat Above 100C
Current technology to meet generate heat

Natural gas

Liquid petroleum gas

Coal

Electricity (Bioenergy)

?
Cost of Energy ($/GJ) Electricity, Natural Gas, Coal

- Residential Elec: 20c/kWh, $25/GJ
- Residential Gas: 30c/kWh, $68/GJ
- Light Comm. Elec: 10c/kWh, $22/GJ
- Light Comm. Gas: 20c/kWh, $41/GJ
- Industrial Elec: 12c/kWh, $25/GJ
- Industrial Gas: 8c/kWh
- Coal Briquetts: $7/GJ, $5/GJ

THE CHALLENGE.
Options for new energy
Energy Efficiency

Industrial Solar Hot Water

Heat Pumps (+re)

Bioenergy

Photovoltaics

Electric Boilers (+re)

www.huffingtonpost.ca

http://publictabs.com/

www.greensolarsolutions.com.au
Industrial Solar Hot Water

SUNLIGHT ➔ [Solar Panel] ➔ Hot Water ➔ HEAT

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Industrial Solar Hot Water

Source: ARCON SUNMARK
Industrial Solar Hot Water

Flat plate
Evacuated Tube
Concentrating
Industrial Heat Pumps

Electricity

Compressor Energy

Motor Inefficiency

Useable Heat

Waste Heat

HEAT

Source: Emerson
Industrial Heat Pumps

Source: GEA
Industrial Heat Pumps

1. Currently: Up to 90°C heat
2. Near Future: 120-150°C heat
3. Provides Heating and Refrigeration
4. Efficient ‘300%-500%’, COP 3-5
5. Can be powered by renewable electricity

Source: GEA
Solar photovoltaics

SUNLIGHT → Electricity

Electricity
Industrial Photovoltaics

1. Re-deployable
2. Prefabricated
3. Minimal site preparation
4. Autonomous Drone Flyover
5. Robot Mower

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Our vision

- **Phase 1**: Industrial Solar, Hot Water (<100°C)
- **Phase 2**: Heat Pumps, with PV (<200°C)
- **Phase 3**: Electric Elements, with PV (>200°C)

Temperature vs. Time & Market size
Case studies

1. Atacama Desert, Chile – Copper Processing with Solar Thermal
2. UK - Chocolate factory with a Heat Pump
3. Paris Creek, South Australia – Dairy with Solar Thermal
Chile - Copper Processing

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

Source: ARCON SUNMARK
Process Integration
Supply 50°C hot water for electrowinning

FLAT PLATE SOLAR COLLECTORS
1. The thermal solar plant consists of 2,620 flat plate collectors and covers a total area of 39,300 m², becoming the largest of its kind in the world. The plant receives the solar radiation and heats a water-antioxidant mix, transforming the radiation into thermal energy (heat).

STORAGE TANK
1. The tank is 17 meters high and 17 meters in diameter, having a total storage capacity of 4,000 m³. It is thermally insulated and its design allows to stratify the water at different temperatures. Additionally, an automatic control system allows the plant to steadily supply heat 24 hours per day.

HEAT EXCHANGERS
2. The heat exchangers transfer the heat to the different stages of the system.

BACK UP SYSTEM (HEATERS)
3. The existing boiler system serves as a back-up system.

COPPER CATHODES

ELECTRO WINNING PROCESS
4. The process to obtain copper requires heat at different demand points: keeping the electrolyte at a steady temperature of 50°C as well as for the washing of the copper cathodes, among others.

Through the thermal solar plant we are able to provide the necessary heat at the right temperature to allow our client to get high purity copper cathodes.

Source: ARCON SUNMARK
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
UK- Chocolate factory with HP

Location: Halifax, UK
Replaces an old Coal Boiler
UK- Chocolate factory with HP

- Technology: Ammonia Heat Pump
- Supplier: Star refrigeration, Vilter/Emerson, Cool Partners
- Customer: Nestle
- Size: 1.25MW Heating, 3.2MW Cooling
- Design concept: Provide cooling or heating and cooling at the same time.
  - Heat Pump supply 60°C, + 90°C boost with gas
  - Refrigeration from 5°C to 0°C simultaneously. Industry: Chocolate factory
- Capital Cost: £4,200,000
- Start-up: 2010

Source: Star Refrigeration Ltd.
Paris Creek – Dairy

Location: Paris Ck Rd, Paris Ck, South Australia

Source: Google
Whole of site energy

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

- 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
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!
Process integration

Source: EnergyAE and LCi
More Case Studies

All

Solar thermal
http://ship-plants.info/

Heat Pumps
More Case Studies

Bioenergy

http://www.bioenergyaustralia.org/pages/case-studies.html
Where does each technology work?

Solar thermal:

1. Space required for collectors:
   1. 0.35 - 0.7 m\(^2\) roof or ground space per GJ heat load / year **
2. For temperatures of less than 120°C use a good flat plate
3. For less than 160°C, use a good evacuated tube
4. For greater than 160°C, use concentrating collectors

** Assumption update since talk: sun:1600kWh/m\(^2\)/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.
Where does each technology work?

Heat Pumps:
1. Where little roof or ground space is available for solar
2. Where grid connection can support extra demand
3. Where temperature is less than 95°C (high temperature on the way)
4. Where a refrigeration is also required for process integration

Add PV and thermal/battery storage to remove electricity grid reliance
Government Support

- Australian Renewable Energy Agency’s Advancing Renewables Program
- Large-scale Renewable Energy Target (LRET, LGCs)
- Small-scale Renewable Energy Scheme (SRES, STCs)
- Victorian Government New Energy Jobs Grants
- NSW Government Energy Saving Scheme
- Clean Energy Finance Corporation (for finance)
Clean Energy Regulator’s STCs

Small-scale Technology Certificates for Large-scale Solar Hot Water

The program uses AS/NZS 4234 to calculate the energy savings of solar hot water using the program TRNSYS over a 10 year period.

Each MWh saved is worth about $35-40 with 10 years paid up-front.

Call us for help!
Conclusions

1. Renewable energy options market ready
2. We are developing our Australian experience
3. There is a bright future for renewables in process energy

However,
4. We must show leadership to make it happen!
5. Government support is available to make it happen!
Reference


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• UNIDO, 2010 Renewable Energy in Industrial Applications An assessment of the 2050 potential. 2010


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• ITPower, 2015 Renewable Energy Options For Australian Industrial Gas Users

• Star Refrigeration, 2010, Case Study No 66: Nestle Halifax

• Apricus, 2016, Personal Communication
Thank you!

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