Energy CARE Group

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Renewable-energy hydrogen systems
Solar thermal desalination

Other areas:
- Solar ponds
- Heat pipes
- Industrial waste heat recovery
- Low-head hydroelectric systems
Renewable-energy hydrogen systems

- **Solar-hydrogen system**
  - Developing a computer simulation code on solar-hydrogen system
  - PV/aerogenerator direct coupling to PEM electrolysers
  - Low-cost hydrogen storage as compressed gas and in metal hydrides
  - PEM fuel cell combined power and heat
  - Solar-hydrogen system economic optimisation
  - Unitised regenerative fuel cells
  - Control system for solar-hydrogen RAPS

- **Hydrogen ICE racing car**
- **Sustainable hydrogen fuelling station**
- **Wave/tidal power hydrogen energy systems**
Solar/Wind Hydrogen Systems

Improving performance and system development

Funded by CSIRO under National Hydrogen Materials Alliance

RMIT University
Computer simulation code on solar-hydrogen system

20000 lines of Pascal programming
Took about 1.5 years for being developed
SOLAR-HYDROGEN ENERGY SYSTEMS FOR REMOTE APPLICATION

Direct Coupling of PV-Proton Exchange Membrane (PEM) Electrolyser Without MPPT/DC-DC Converter
PEM fuel cell combined power and heat

Potential of about 10% saving in the cost of solar-hydrogen system
Solar-hydrogen system economic optimisation

Case study: 5 kWh daily demand peaked at 0.3 kW, remote household in south east Australia
Single module of BP275 PV module, Single cells of 500 W BCS fuel cell and sat XX7 electrolyser
Economic perspective of solar-hydrogen system against IC generator

Case study: 5 kWh daily demand peaked at 0.3 kW, remote household in south east Australia
Investigation of zero-emission systems for desalinating salty groundwater or sea water under National Action Plan for Salinity and Water Quality Grant 2004-2007

Systems investigated:
- Combined desalination and power (CDP)
- Single/multi-stage flash (SSF/MSF)
- **Multi-effect evaporation (MEE)**

Solar thermal MEE system current priority area for R&D and commercialisation
A single-stage flash unit for use with solar heat at temperatures in the 60-85°C range.

- Distillate production: 500 litres/day
- Specific thermal energy: 4,900 kJ/kg
- Recovery ratio: ~ 5.5% (with preheating).
Field trial of Single-Stage Flash System conducted using the existing demonstration solar pond at Pyramid Hill, northern Victoria, Australia in December 2006.
Experimental Multi-Effect Evaporation Solar-Thermal Desalination unit

- Max daily distillate production: ~ 2,300 litres (~ 0.84 ML / year)
- Recovery ratio: ~ 55%
- Specific thermal energy: ~ 960 kJ/kg
- Requires ~ 1,020 m² solar pond (Melbourne insolation).
Solar Pond Multi-Effect Evaporation Desalination System
Preliminary water costs comparative analysis

- Water costs based on present value of all costs over the lifetime of the unit (25 years), at 5% real discount rate, divided by the total production of fresh water over that time.
- Water costs does not include distribution costs.
- Technical and Economic analysis based on Melbourne weather conditions (insolation and wind speed) for desalination units with a distillate production of 15 ML/day.

SGSP: Salinity-gradient solar pond
ETSC: Evacuated tubular solar collectors
MEE: Multi-effect evaporation
RO: Reverse osmosis
PV: Photovoltaic
Critical conditions:
- High solar radiation (relatively low wind speed)
- Sea water or saline ground water

Prospective areas:
- Northern and northwestern Vic where there is saline groundwater – for local water supply
- Coastal WA and SA where there is high insolation
- Central Australia (WA, SA, southern NT, W NSW, where there is saline groundwater)
- Overseas – high insolation, next to sea, or saline ground water.
Combined Desalination and Power (CDP) experimental unit

CDP Stage I

CDP Stage II

Distillate production: ~ 1,728 litres/day
Recovery ratio: ~ 8.5%
Specific energy: ~ 2,765 kJ/kg
Power output: ~ 370 W.
Combined Desalination and Power (CDP) experimental unit
Geothermal CDP project

- Australian Research Council Linkage grant with Greenearth (awarded round 2 2008)
- Use of CDP system with geothermal hot saline water
3000 m² solar pond (Pyramid Hill)

Demonstration solar industrial process heating system developed

Low-temperature Multi-Effect Evaporation Desalination Systems coupled with SGSP
Sustainable energy education

- Master of Engineering (Sustainable Energy) program
- PhD and Master of Engineering by research
- Greenhouse Challenge program - industry projects on emission reduction for B Eng and M Eng (SE) students