Solar Water Heating for the Residential, Commercial and Industrial Sectors

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January 24, 2018
Motivation

Aging Natural Gas Infrastructure

46% of transmission pipelines were built in the 50s and 60s
Some Facts

• Water heating accounts for almost 20% of energy consumption in households in the U.S.
• Almost 50% of California’s In-State Generation comes from Natural Gas

Aliso Canyon Gas Leak (2015)
Project Goals/Objectives

Goals:
• Demonstrate reduction in natural gas consumption for water heating
• Promote wider adoption of minichannel solar water heating technology.
• Overcome technological, economic and market challenges by identifying, targeting and demonstrating the minichannel technology

Objectives
• Demonstrate reliable performance through monitoring and verification.
• Develop and demonstrate aluminum and copper minichannel solar water heating technology
• Identify key implementation challenges and possible ways to overcome them.
Solar Collector Configurations
Minichannel tubes and Solar Energy

Diagram showing the flow of solar energy through a flat plate with round tubes and a flat tube with minichannels. Graphs illustrate temperature changes over distance for copper round-tube flat plate and aluminum minichannel tube.
Aluminum Minichannel Collector

Selective coating: Black chrome (EC series): $\alpha = .95$, $\varepsilon = .12$
Thermal Efficiency

Thermal Efficiency Improvement > 10%

Prototype Collector Cost

10 ft. by 4 ft. (3.7 m²) aluminum minichannel solar collector

- Aluminum minichannel tubes = $440
- Headers = $28
- Collector frame and glass = $500
- TIG welding = $1056
- Total = $2024, or $50.6/ft² (or $544.65/m²)
- Estimated cost for mass produced unit: $14.43/ft² (or $155.32/m²)

Average conventional collector $51.42/ft² (or $553.50/m²) *

* GTM Research and SEIA, 2011
UCSD – Solar/NG Resource

Prof. Carlos Coimbra’s group
Copper Extrusion

Copper minichannel tubes manufactured by Prof. Kraft, at Ohio University
Performance Optimization

![Graph showing heat transfer vs. pressure drop for different designs.](image)

- **Design #1**
- **Design #2**
- **Design #3**
Collector Manufacturing

Torch Brazing
Low-Grade Steam Generation

(a) Temperature [°C] / Flow rate [L/min]
- T Collector in
- T Collector out
- T Steam
- T Ambient
- Flowrate

(b) Solar Irradiance [W/m²]
- Solar Irradiance

Graph (a) shows the temperature and flow rate changes over time, while graph (b) displays the solar irradiance over time.
Changes in Incentives
CPUC approved Advice No. 4953 (April 29, 2016)

SoCalGas:

Step 1 incentive level of $70/therm for Single Family
$25/therm for Commercial/Multifamily applications.

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<th>Natural Gas-Displacing Single-Family System Incentive Steps</th>
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Acknowledgements