ATMOsphere AMERICA business case natural refrigerants

June 18-19, 2014 - San Francisco

Residential CO_2 Heat Pump Water Heater

Sanden International (USA), Inc.

Maho Ito

Washington State University

Ken Eklund

SANDEN Delivering Excellence

ATMOsphere business case
natural refrigerants

Sanden Profile

70th ANNIVERSARY

Founded in 1943 / Revenue: $2.8 billion / Employees: over 10,000 / Global network: 54 sites in 23 countries

Automotive

PEUGEOT CITROËN NISSAN BMW GM Audi DAIMLER FIAT CHRYSLER BUGATTI MINI Ford LAND ROVER JAGUAR VOLVO FREIGHTLINER IVECO Mack MITSUBISHI MOTORS

Food Storage

Heating
Core technology
Cooling

WAL*MART
DyDo PEPSI Asahi MARS Coca-Cola SUNTORY FOODS Nestlé FamilyMart CircleKSunkus POKKA KIRIN Belcraine

Household

MISAWA IMAGINENERGY Daiwa House SEKISUI HOUSE

Sanden Forest

SANDEN

経営方針
Management Policies

環境から企業価値を創造する

現有の強みを基礎に、
「環境」をコアにして次の成長を果たす

To create corporate values by the environment

We try to grow with the core of the environment
based on the strength we have now.

環　境
Environment

（技術開発・社会貢献）(R&D/Social Contribution)

品 質 力
Quality
（STQM）

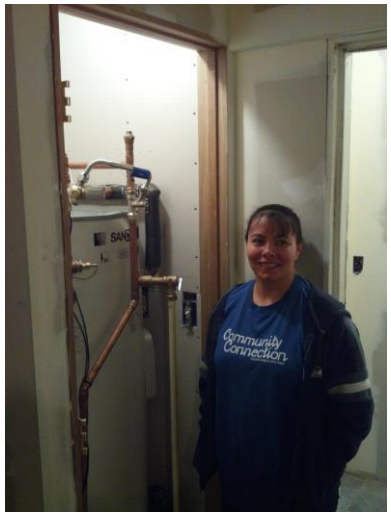
グローバル力
Global
（創造）(Creation)

Sanden Group

Environmentally Friendly Plant & Products

ATMOsphere AMERICA business case natural refrigerants

Lab and Field Test Sanden CO_2 Split System Water Heater



Ken Eklund

Washington State University Energy Program

Research Supported by Bonneville Power Administration

Partners include: Sanden, Northwest Energy Efficiency Alliance, Energy Trust of Oregon, Avista, Ravalli Electric and Tacoma Power

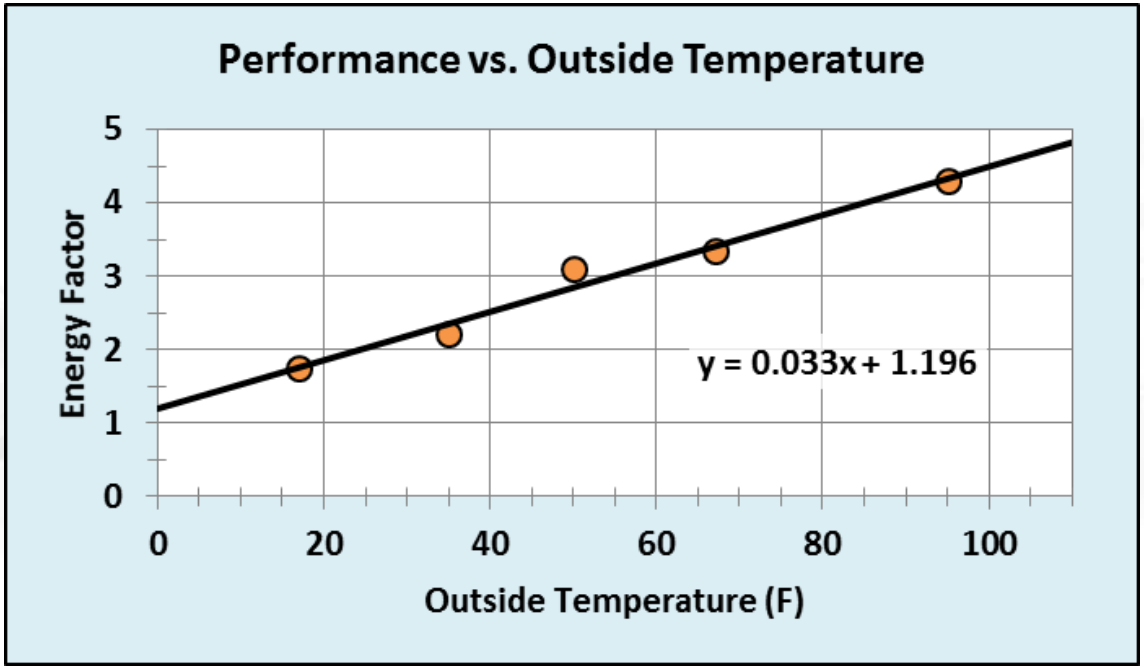
ATMOsphere AMERICA business case natural refrigerants

Energy Factor

SANDEN CO_2 Technology

- ***Energy Factor*** *is the Energy Contained in Total Useful Hot Water Divided by the Total Electricity.*
- *Lab Energy Factor includes* ***tank loss****.*

Lab Test



- *The system was tested at 5 outdoor air temperatures in the lab*
- *The graph shows energy factors plotted against air temperature*
- *As temperature increases from 17 F (-8 .3 C) to 95 F (35 C) the Energy Factor increases from 1.8 to 4.2*
- *Notice the plot is linear—we can predict performance*

ATMOsphere AMERICA business case natural refrigerants

Results

SANDEN CO_2 Technology

- *Electric Resistance Water Heater Energy Factor is .95.*
- *The annual Energy Factors for the Sanden split system are:*

Climate	Annual EF		Climate	Annual EF
Boise	2.9		Minneapolis	2.7
Kalispell	2.6		Raleigh	3.2
Portland	3.0		Boston	2.9
Seattle	2.9		Chicago	2.9
Spokane	2.8		Houston	3.5

ATMOsphere AMERICA business case natural refrigerants

Savings

SANDEN CO_2 Technology

- *The CO_2 split system is almost three time as efficient as an electric resistance tank water heater. This is about 68% annual average savings.*
- *This is without any impact on conditioned space.*
- *If electricity costs 10 cents per kilowatt hour and the average electricity use is 3,000 kilowatt hours, the average annual savings are $200.*
- *If the system is used as a combination space and water heater the savings increase to over $1,000 per year.*

ATMOsphere AMERICA business case natural refrigerants

Next Steps

SANDEN CO_2 Technology

- *Complete Field Performance Tests and Demand Response Potential Tests.*
- *Incorporate lessons learned into next generation design & installation training.*
- *Sanden introduces U.S product in 2015 that benefits from Washington State University research.*

AMERICA ATMOsphere

business case

natural refrigerants

June 18-19, 2014 - San Francisco

Thank you very much!

info@sanden.com