New Water Heater Technology

CAMERON CHANEL

Technology Solutions Case Study ESCO Press
"Standard sets out a method for evaluating the annual energy performance of water heaters using a combination of test results for component performance and mathematical models to determine the standardized annual supplementary energy use. Keywords: water heater; water heater energy evaluation; energy saving; energy performance; water heating technology; thermal collector; heat pump; photovoltaic array; thermal storage tank; solar water heater; heat pump water heater" - Standards NZ website

Performance and Economic Evaluation of the Seahorse Natural Gas Hot Water Heater Conversion at Fort Stewart. Final Report Springer Science & Business Media
This paper presents a case study of the residential heat pump water heater (HPWH) market. Its principal purpose is to evaluate the extent to which the HPWH will penetrate the residential market sector, given current market trends, producer and consumer attributes, and technical parameters. The report's secondary purpose is to gather background information leading to a generic framework for conducting market analyses of technologies. This framework can be used to compare readiness and to factor attributes of market demand back into product design. This study is a rapid prototype analysis rather than a detailed case analysis. For this reason, primary data collection was limited and reliance on secondary sources was extensive. Despite having met its technical goals and having been on the market for twenty years, the HPWH has had virtually no impact on contributing to the nation's water heating. In some cases, HPWH reliability and quality control are well below market expectations, and early units developed a reputation for unreliability, especially when measured against conventional water heaters. In addition to reliability problems, first costs of HPWH units can be three to five times higher than conventional units. Without a solid, well-managed business plan, most consumers will not be drawn to this product. This is unfortunate. Despite its higher first costs, efficiency of an HPWH is double that of a conventional water heater. The HPWH also offers an attractive payback period of two to five years, depending on hot water usage. On a strict life-cycle basis it supplies hot water very cost effectively. Water heating accounts for 17% of the nation's residential consumption of electricity (see chart at left)--water heating is second only to space heating in total residential energy use. Simple arithmetic suggests that this figure could be reduced to the extent HPWH technology displaces conventional water heating. In addition, the HPWH offers other benefits. Because it produces hot water by extracting heat from the air it tends to dehumidify and cool the room in which it is placed. Moreover, it tends to spread the water heating load across utility non-peak periods. Thus, electric utilities with peak load issues could justify internal programs to promote this technology to residential and commercial customers. For practical purposes, consumers are indifferent to the manner in which water is heated but are very interested in product attributes such as initial first cost, operating cost, performance, serviceability, product size, and installation costs. Thus, the principal drivers for penetrating markets are demonstrating reliability, leveraging the dehumidification attributes of the HPWH, and creating programs that embrace life-cycle cost principles. To supplement this, a product warranty with scrupulous quality control should be implemented; first-price reduction through engineering, perhaps by reducing level of energy efficiency, should be pursued; and niche markets should be courted. The first step toward market penetration is to address the HPWH's performance reliability. Next, the manufacturers could engage select utilities to aggressively market the HPWH. A good approach would be to target distinct segments of the market with the potential for the highest benefits from the technology. Communications media that address performance issues should be developed. When marketing to new home builders, the HPWH could be introduced as part of an energy-efficient package offered as a standard feature by builders of new homes within a community. Conducting focus groups across the United States to gather input on HPWH consumer values will feed useful data back to the manufacturers. ''Renaming'' and ''repackaging'' the HPWH to improve consumer perception, appliance aesthetics, and name recognition should be considered. Once an increased sales volume is achieved, the manufacturers should reinvest in R & D to lower the price of the units. The manufacturers should work with ''do-it-yourself'' (DIY) stores to facilitate introduction of the technology to these sales venues. The HPWH is an excellent example of a technology that would have benefited from the implementation of a market research program run in parallel with the technology R & D program. Understanding consumer values and ''willingness to pay'' for product attributes and recognizing the corresponding influences those values have on purchase decisions are crucial. This knowledge should be incorporated into the R & D process with continuous dialogue between the market research and the R & D programs. Partnerships among stakeholders to gather consumer feedback and market analysis during R & D will facilitate a strong framework for successful market penetration of energy-efficient technologies.

Electrification of Domestic Hot Water to Aid the Integration of Renewable Energy in the California Grid Life Level Up
H.P. Garg Centre of Energy Studies Indian Institute of Technology Hauz Khas, New Delhi 110 016 India Heating of water using solar energy is not new and by using a little science and technology in it, the solar energy can be utilized more effectively and economically for heating the water both for domestic and industrial applications. Solar Water Heaters are popular for the last three decades in countries like USA, Australia, Israel, Japan, India. This is the only solar energy application which is commercially, technic ally and economically viable and has been studied for more than 30 years in many countries. Technical advances in solar water heating have been very rapid in the last 30 years. These are becoming popular not only for domestic use but for large establishments like hostels, hotels, hospitals, industries such as Textile, Paper and Food Processing and even in heating of swimming pools in winter. In few instances the cost of solar water heating systems may be higher than those operated by electricity, gas or other fuel but over a period of time this is more than recovered by the savings in the cost of operations and maintenance.

Heated Water Systems Springer Science & Business Media
Solar Domestic Water Heating is a comprehensive introduction to all aspects of solar domestic water heating systems. As fossil fuel prices continue to rise and awareness of climate change grows, interest in domestic solar water heating is expanding.Solar water heating technology is the most environmentally-friendly way to heat water. This fully-illustrated and easy-to-follow guide shows how domestic solar water heating systems work, the different types of systems, types of collectors, both flat plate and evacuated tube, types of storage tanks and other accessories. It also shows how systems are installed and explains how solar water heating can be integrated into existing water heating systems. Numerous examples from around the world have been included. The ideal guide for plumbers, heating engineers, builders and architects, housing and property developers, home owners and DIY enthusiasts, and anyone who needs a clear introduction to solar water heating technology.

Sustainable Environment and Transportation New Society Publishers
Gas instantaneous water heaters are increasingly used as auxiliary energy sources for renewable energy domestic hot water systems. Currently the gas used by these systems is measured and modelled only very approximately. Accurately assessing consumption is important as gas can supply up to 50% of the energy. Gas auxiliaries used in these arrangements are also predominantly designed as stand-alone devices and typically integrated into renewable systems in a very basic manner. This research seeks to fill two important gaps. First, how does the gas instantaneous water heater actually perform as part of a renewable water heater? Second, once performance can be measured and modelled accurately, what improvements in

energy use might be made through novel ways of integrating the gas auxiliary with the renewable energy water heater? This study adopts a broad approach in examining these gaps. A number of existing test methods for gas instantaneous, air source heat pump, solar and electric storage water heaters are reviewed in detail. A number of different gas instantaneous water heater test standards are compared experimentally. The effect of water use patterns on the energy use of various water heating technologies is investigated both experimentally and with modelling. The carbon emissions of a number of different types of water heater is calculated after a detailed review of CO2 emissions of the New Zealand electricity generating system during both dry and wet years. A new experimental test method is developed to characterise the steady state performance of a gas instantaneous water heater. This performance characterisation is then used in a TRNSYS model together with established models of renewable energy water heaters to predict energy consumption. Integrated systems using novel control and hydraulic connection arrangements are then compared to other water heating systems. The current methods of determining the gas consumption of auxiliary water heaters may understate energy use by as much as 15%. Improved control system integration saves an average of 17% in energy and 11% in carbon dioxide emissions compared to other high efficiency water heating systems. Improved hydraulic arrangements result in 4.5% savings. The change in energy conversion ratio with differing water use patterns of some water heaters can exceed the differences exhibited between technology types and competing models of similar technology. If consumers are to choose their water heaters based on comparable running costs or emissions, accurate measurement and modelling of gas auxiliaries is required. Current test methods do not appear to provide the required accuracy. There are also opportunities for significant improvement in energy use through better integration of gas auxiliaries with renewable energy residential water heating systems.

University to Industry Technology Transfer Trans Tech Publications Ltd

Current federal and provincial efficiency standards for residential water heating are based solely on the tested efficiency of individual water heating devices. Additional energy expended or saved as the water cycles through the home is not taken into account. This research, co-funded by British Columbia's Ministry of Energy, Mines and Petroleum Resources (MEMPR), is a first step toward the Province's goal of developing a new energy efficiency standard for water heating systems in new construction. This groundbreaking new standard would employ a?systems? approach, establishing guidelines for new construction based on the total energy used for water heating within the building envelopeThe research team has developed a Simulink computer model which, using a one-minute time-step, simulates 24-hour cycles of water heating in a single-family home. The objectives of this thesis are to use that model to simulate a variety of water heating technology combinations, and to devise methods of utilizing the resulting data to evaluate water heating systems as a whole and to quantify each system's relative energy impact. A metric has been developed to evaluate the efficiency of the system: the system energy factor (SEF) is the ratio of energy used directly to heat water over the amount of energy drawn from conventional fuel sources. The CO2 impact of that energy draw is also considered. Data is generated for cities in three different climates around BC: Kamloops, Victoria and Williams Lake. Electric and gas-fired tank water heaters of various sizes and efficiencies are simulated, along with less traditional energy-saving technologies such as solar-assisted pre-heat and waste water heat recovery components. A total of 7,488 six-day simulations are run, each representing a unique combination of technology, load size, location and season. The resulting data is presented from a variety of angles, including the relative impacts of water heater rating, additional technology type, location and season on the SEF of the system. The interplay between SEF and carbon dioxide production is also examined. These two factors are proposed as the basis for devising performance tiers by which to rank water heating systems. Two proposals are made regarding how these tiers might be organized based on the data presented here, though any tiers will have to be re-evaluated pending data on a wider range of technology combinations. A brief financial analysis is also offered, exploring the potential payback period for various technology combinations in each location. Given current equipment and energy costs, the financial savings garnered by the increase in energy efficiency are not, in most cases, found to be sufficient to justify the expense to the homeowner from a purely fiscal perspective. Additional changes would need to take place to ensure the financial viability of these technologies before large-scale adoption of systems-based standards could be employed.

Solar Water Heating Earthscan

Water heating in residential buildings, also known as domestic hot water (DHW), is the third largest use of energy after appliances and space conditioning. About 90% of the residential buildings in the state use natural gas fueled water heaters, 6% use electricity, and a small percent use liquefied petroleum gas (LPG) or solar water heaters. The current energy use associated with residential water heating is small relative to the total amount of energy consumption in the residential building sector, but it is still a contributor of greenhouse gas (GHG) emissions. Improving hot water systems can be beneficial for bill customer savings, energy use, and water savings. Heat pump water heaters (HPWH) can function as grid batteries by using the water tank capability of thermal storage. The use of aggregated electrical DHW systems to store extra electricity during peak generation times or during low utility time of use (TOU) rates has the potential to alleviate some of the curtailed renewable energy power generation sources in the California grid while reducing carbon emissions and customer cost. Water heating technology was simulated using the Building Energy Modeling software California Building Energy for Code Compliance (CBECC-Res) and the California Simulation Engine (CSE). Different climate zones were explored to compare the electricity needed for a water heater operation given the same input parameters of water draw profiles and building envelope. The results show the feasibility of using HPWH and ERWH technology to participate in demand response management programs. The demand response capability of HPWH and ERWH show that they could be useful tools to accommodate surplus energy from solar generation during the solar peak hours. Whether the demand response is implemented using traditional HPWH or ERWH units, the capability of the technology to act on control signals is a necessary condition for a successful program.

Solar-assisted Gas Hot Water Heating Systems for Small Food Processors New Society Publishers

Residential Water Heating ProgramHeated Water Systems

Selecting a New Water Heater Cengage Learning

The following document is the final report for DE-FC26-05NT42327: Development of an Accurate Feed-Forward Temperature Control Tankless Water Heater. This work was carried out under a cooperative agreement from the Department of Energy's National Energy Technology Laboratory, with additional funding from Keltech, Inc. The objective of the project was to improve the temperature control performance of an electric tankless water heater (TWH). The reason for doing this is to minimize or eliminate one of the barriers to wider adoption of the TWH. TWH use less energy than typical (storage) water heaters because of the elimination of standby losses, so wider adoption will lead to reduced energy consumption. The project was carried out by Building Solutions, Inc. (BSI), a small business based in Omaha, Nebraska. BSI partnered with Keltech, Inc., a manufacturer of electric tankless water heaters based in Delton, Michigan. Additional work was carried out by the University of Nebraska and Mike Coward. A background study revealed several advantages and disadvantages to TWH. Besides using less energy than storage heaters, TWH provide an endless supply of hot water, have a longer life, use less floor space, can be used at point-of-use, and are suitable as boosters to enable alternative water heating technologies, such as solar or heat-pump water heaters. Their disadvantages are their higher cost, large instantaneous power requirement, and poor temperature control. A test method was developed to quantify performance under a representative range of disturbances to flow rate and inlet temperature. A device capable of conducting this test was designed and built. Some heaters currently on the market were tested, and were found to perform quite poorly. A new controller was designed using model predictive control (MPC). This control method required an accurate dynamic model to be created and required significant tuning to the controller before good control was achieved. The MPC design was then implemented on a prototype heater that was being developed simultaneously with the controller development. (The prototype's geometry and components are based on a currently marketed heater, but several improvements have been made.) The MPC's temperature control performance was a vast improvement over the existing controller. With a benchmark for superior control performance established, five additional control methods were tested. One problem with MPC control is that it was found to be extremely difficult to implement in a TWH, so that it is unlikely to be widely adopted by manufacturers. Therefore the five additional control methods were selected based on their simplicity; each could be implemented by a typical manufacturer. It was found that one of these methods performed as well as MPC, or even better under many circumstances. This method uses a Feedback-Compensated Feed-Forward algorithm that was developed for this project. Due to its simplicity and excellent performance this method was selected as the controller of choice. A final higher-capacity prototype heater that uses Feedback-Compensated Feed-Forward control was constructed. This prototype has many improvements over the currently marketed heaters: (1) excellent control; (2) a modular design that allows for different capacity heaters to be built easily; (3) built-in fault detection and diagnosis; (4) a secondary remote user-interface; and (5) a TRIAC switching algorithm that will minimize 'flicker factor'. The design and engineering of this prototype unit will allow it to be built without an increase in cost, compared with the currently marketed heater. A design rendering of the new product is shown below. It will be launched with a new marketing campaign by Keltech in early 2009.

Energy and Water Development Appropriations for 2013: Dept. of Energy FY 2013 justifications Trans Tech Publications Ltd

A large majority of homes in the US have a storage-type water heater that provides domestic hot water. These water heaters can be electric or gas-fired and require regular maintenance and servicing. This training module covers the installation, maintenance, and service of residential and light commercial gas and electric storage water heaters. This manual provides students and practicing technicians with the information and knowledge necessary to understand typical operation of both gas and electric water heaters. It is full of color illustrations and includes end of lesson review questions that provide students and practicing technicians with the information and knowledge necessary to accurately and safely install, service, and maintain storage-type water heaters. Main topics include: safety and hazard awareness, sizing, components and controls, installation, maintenance and troubleshooting. The end of the booklet contains fill-in-the-blank worksheets that review the content of the entire manual.

Heat Pump Water Heater Technology Assessment Based on Laboratory Research and Energy Simulation Models Residential Water Heating ProgramHeated Water Systems"Standard sets out a method for evaluating the annual energy performance of water heaters using a combination of test results for component performance and mathematical models to determine the standardized annual supplementary energy use. Keywords: water heater; water heater energy evaluation; energy saving; energy performance; water heating technology; thermal collector; heat pump; photovoltaic array; thermal storage tank; solar water heater; heat pump water heater" - Standards NZ websiteWater Heaters

Over recent years, heat pump water heaters (HPWHs) have become more readily available and more widely adopted in the marketplace. For a 6-month period, the Building America team Consortium for Advanced Residential Buildings monitored the performance of a GE Geospring HPWH in Windermere, Florida. The study found that the HPWH performed 144% more efficiently than a traditional electric resistance water heater, saving approximately 64% on water heating annually. The monitoring showed that the domestic hot water draw was a primary factor affecting the system's operating efficiency.

New Engine Technology for California's Combined Heat and Power Market Nordic Council of Ministers

Find out about: Heat pump, solar hot water & PV optionsMaking the switch to efficient electric systems Sizing, installation & maintenanceRebates, retrofits & moreWhat we consider to be an efficient hot water system has changed a lot in the last ten years. Modern electric appliances can perform better than gas appliances, are cheaper to operate and can run entirely on renewable energy. And more Australian households have rooftop solar PV installations with at least some excess electricity available to help run the hot water system.Water heating can account for around 21% of total energy use at a considerable financial cost each year, so efficiency is important when choosing a system.Replacing a conventional water heater with a heat pump, solar thermal (commonly referred to as solar hot water) or solar electric system will help save the most energy.

Solar Domestic Water Heating Springer

Heating water with the sun is a practice almost as old as humankind itself. Solar Water Heating , now completely revised and expanded, is the definitive guide to this clean and cost-effective technology. Beginning with a review of the history of solar water and space heating systems from prehistory to the present, Solar Water Heating presents an introduction to modern solar energy systems, energy conservation and energy economics. Drawing on the authors' experiences as designers and installers of these systems, the book goes on to cover: Types of solar collectors, solar water and space heating systems and solar pool heating systems, including their advantages and disadvantages System components, their installation, operation, and maintenance System sizing and siting Choosing the appropriate system. This book focuses on the financial aspects of solar water or space heating systems, clearly showing that such systems generate significant savings in the long run. With many diagrams and illustrations to complement the clearly-written text, this book is designed for a wide readership ranging from the curious homeowner to the serious student or professional.

Real Goods Solar Living Sourcebook

DOE has supported efforts for many years with the objective of getting a water heater that uses heat pump technology (aka a heat pump water heater or HPWH) successfully on the residential equipment market. The most recent previous effort (1999-2002) produced a product that performed very well in ORNL-led accelerated durability and field tests. The commercial partner for this effort, Enviromaster International (EMI), introduced the product to the market under the trade name Watter$aver in 2002 but ceased production in 2005 due to low sales. A combination of high sales price and lack of any significant infrastructure for service after the sale were the principal reasons for the failure of this effort. What was needed for market success was a commercial partner with the manufacturing and market distribution capability necessary to allow economies of scale to lead to a viable unit price together with a strong customer service infrastructure. General Electric certainly meets these requirements, and knowing of ORNL s expertise in this area, approached ORNL with the proposal to partner in a CRADA to produce a high efficiency electric water heater. A CRADA with GE was initiated early in Fiscal Year, 2008. GE initially named its product the Hybrid Electric Water Heater (HEWH).

Plumbing Technology

The main advantages of solar energy are inexhaustibility and wide accessibility, as well as the relative environmental friendliness of its transformation into other forms of energy. The widespread use of solar energy requires the creation of functionally complete systems which convert solar energy into an element of a given technological process. The collection Engineering of Solar Energy Systems consists of papers published by Trans Tech Publications Inc. from 2010 to 2014 inclusive and covers a wide range of advanced achievements in the field of creating and designing systems for technological use of solar energy. The compiled scientific papers are presented in eight chapters: Chapter 1: Solar Systems for Heating, Cooling and Ventilation Chapter 2: Solar Energy in Environmental Treatment and Water Desalination Chapter 3: Solar Hydrogen Production Chapter 4: Systems for Electricity Supply Based on Solar Energy Chapter 5: Design of Components and Equipment for Solar Systems Chapter 6: Mechatronics, Control and Automation in Solar Energetics Chapter 7: Integration of Solar Technologies in the Architecture of Buildings Chapter 8: Engineering Management in Solar Energetics, which cover many aspects of scientific and engineering activities.

High Efficiency Water Heating Technology Development

In this project, Pacific Northwest National Laboratory studied heat pump water heaters, an efficient, cost-effective alternative to traditional electric resistance water heaters that can improve energy efficiency by up to 62%.

Research and Development Management

This paper explores the laboratory performance of five integrated Heat Pump Water Heaters (HPWHs) across a wide range of operating conditions representative of US climate regions. Laboratory results demonstrate the efficiency of this technology under most of the conditions tested and show that differences in control schemes and design features impact the performance of the individual units. These results were used to understand current model limitations, and then to bracket the energy savings potential for HPWH technology in various US climate regions. Simulation results show that HPWHs are expected to provide significant energy savings in many climate zones when compared to other types of water heaters (up to 64%, including impact on HVAC systems).

Solar Energy Update

This book introduces readers to essential technology assessment and forecasting tools, demonstrating their use on the basis of multiple cases. As organizations in the high-tech industry need to be able to assess emerging technologies, the book presents cases in which formal decision-making models are developed, providing a framework for decision-making in the context of technology acquisition and development. Applications of different technology forecasting tools are also discussed for a range of technologies and sectors, providing a guide to keep R&D organizations abreast of technological trends that affect their business. As such, the book offers a valuable the theoretical and practical reference guide for R&D managers responsible for emerging and future technologies.

Reliable, Economic, Efficient CO2 Heat Pump Water Heater for North America

Although heat pump water heaters (HPWHs) have gained significant attention in recent years as a high efficiency electric water heating solution for single family homes, central HPWHs for commercial or multi-family applications are not as well documented in terms of measured performance and cost effectiveness. To evaluate this technology, the Alliance for Residential Building Innovation team monitored the performance of a 10.5 ton central HPWH installed on a student apartment building at the West Village Zero Net Energy Community in Davis, California. Monitoring data collected over a 16 month period were then used to validate a TRNSYS simulation model. The TRNSYS model was then used to project performance in different climates using local electric rates. Results of the study indicate that after some initial commissioning issues, the HPWH operated reliably with an annual average efficiency of 2.12 (Coefficient of Performance). The observed efficiency was lower than the unit's rated efficiency, primarily due to the fact that the system rarely operated under steady-state conditions. Changes in the system configuration, storage tank sizing, and control settings would likely improve the observed field efficiency. Modeling results suggest significant energy savings relative to electric storage water heating systems (typical annual efficiencies around 0.90) providing for typical simple paybacks of six to ten years without any incentives. The economics versus gas water heating are currently much more challenging given the current low natural gas prices in much of the country. Increased market size for this technology would benefit cost effectiveness and spur greater technology innovation

Residential Water Heating Program

Adoption of heat pump water heating technology for commercial hot water could save up to 0.4 quads of energy and 5 million metric tons of CO2 production annually in North America, but industry perception is that this technology does not offer adequate performance or reliability and comes at too high of a cost. Development and demonstration of a CO2 heat pump water heater is proposed to reduce these barriers to adoption. Three major themes are addressed: market analysis to understand barriers to adoption, use of advanced reliability models to design optimum qualification test plans, and field testing of two phases of water heater prototypes. Market experts claim that beyond good performance, market adoption requires 'drop and forget' system reliability and a six month payback of first costs. Performance, reliability and cost targets are determined and reliability models are developed to evaluate the minimum testing required to meet reliability targets. Three phase 1 prototypes are designed and installed in the field. Based on results from these trials a product specification is developed and a second phase of five field trial units are built and installed. These eight units accumulate 11 unit-years of service including 15,650 hours and 25,242 cycles of compressor operation. Performance targets can be met. An availability of 60% is achieved and the capability to achieve>90% is demonstrated, but overall reliability is below target, with an average of 3.6 failures/unit-year on the phase 2 demonstration. Most reliability issues are shown to be common to new HVAC products, giving high confidence in mature product reliability, but the need for further work to minimize leaks and ensure reliability of the electronic expansion valve is clear. First cost is projected to be above target, leading to an expectation of 8-24 month payback when substituted for an electric water heater. Despite not meeting all targets, arguments are made that an industry leader could sufficiently develop this technology to impact the water heater market in the near term.