

# **Geothermal Heat Pumps: The “Killer Utility App” for the 21<sup>st</sup> Century**



Prepared by:

Dr. Katherine Johnson, President

Johnson Consulting Group and

Mr. Paul Bony, ClimateMaster

Ms. Marky Moore, LEED AP, CSBA, CEO,  
Capital Review Group

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### Introduction

As the 21<sup>st</sup> century moves into its second decade, utilities are facing an evolution from a traditional wires and poles operation focusing on electric transmission, generation, and delivery to an agile wireless organization that incorporates the newest Smart Grid technologies. To put it simply: *"This is not your father's electric utility."*

The most successful electric utilities will be those who position themselves aggressively in a new low-carbon world, according to a recently completed study conducted by Navigant Consulting on behalf of CERES<sup>1</sup> (2010). The changes that have been underway during the past two decades have led to deep and fundamental changes within the electric power sector. These changes have also led to increased complexity and uncertainty, especially regarding the traditional electric utility roles: of producing, generating, and delivering electricity in a distributed generation and net zero environment.

The Ceres report (2010) found that "new approaches to serving customers by using less energy, cleaner energy and emerging technologies are taking hold at the same time that business-as-usual approaches have become more expensive, complicated and risky." (p. i)

Today's electric utilities face daunting challenges extending far beyond the traditional goals of safety, efficiency and reliability. Now, the modern utility must also develop solutions to cope with environmental issues including climate change, the national security issues regarding the dependence on foreign oil, and the increased desire by customers to take a more proactive role in making energy decisions (Ceres 2010, p. i).

Therefore, the most successful electric utilities must look to incorporate a strategy that addresses all these needs, and energy efficiency is an essential piece of that long-term approach, (Ceres 2010, p. ii)

*"Energy efficiency – serving customers by helping to reduce electricity demand – is likely utilities' most important energy resource in the 21<sup>st</sup> century, as this report points out; but utilizing this resource requires a new business model that doesn't rely on electricity sales to drive profits."*

The cheapest kilowatt is the one that is not generated. Energy efficiency is a cheap and reliable source of energy. It can cost as little as 3 cents per kilowatt hour saved, while generated electricity costs 6 to 12 cents per kilowatt hour. Thus, energy efficiency measures reduce emissions, avoid unnecessary energy supply investments, lower customer bills and create jobs. But despite these obvious benefits, the utility industry has "historically grossly underinvested in energy efficiency" (Ceres 2010, p. iii).

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<sup>1</sup> Ceres is a national coalition of investors, environmental groups and other public interest organizations working with companies to address sustainability challenges such as global climate change. Ceres directs the Investor Network on Climate Risk, a group of more than 90 institutional investors and financial firms from the U.S. and Europe managing approximately \$10 trillion in assets. [www.ceres.org](http://www.ceres.org)

The energy efficiency focus by policy makers and utility regulators is also evolving. At its root, the original intent of energy efficiency programs was to reduce energy waste saving consumers money by reducing both their total energy consumption and by reducing the need for expensive new electric generation. The reduction of future electric generation was also seen as an opportunity to minimize environmental impacts, primarily green house gas emissions.

The electric utility industry was seen as an easy target to achieve these efficiency and environmental goals through both Demand Side Management (DSM) requirements and Renewable Portfolio Standards (RPS). Indeed, DSM and RPS policies have lessened the need for new electric generation over historic projections and provided a decreasing level of carbon per kWh generated. These policies have also stimulated the market for efficient buildings and appliances and have created a strong foundation for distributed and centralized renewable electric generation.

The success of these policies has provided a base to transition to the next evolution of energy policy, one in which efficiency and renewable generation converge into a total system view of energy use. This sharpening focus on total energy use including both electricity and fossil fuels is gaining momentum as climate change becomes more important in energy policy. The end game for total efficiency and renewable energy generation is the near or net zero building. The historic utility model does not work in a net zero energy market.

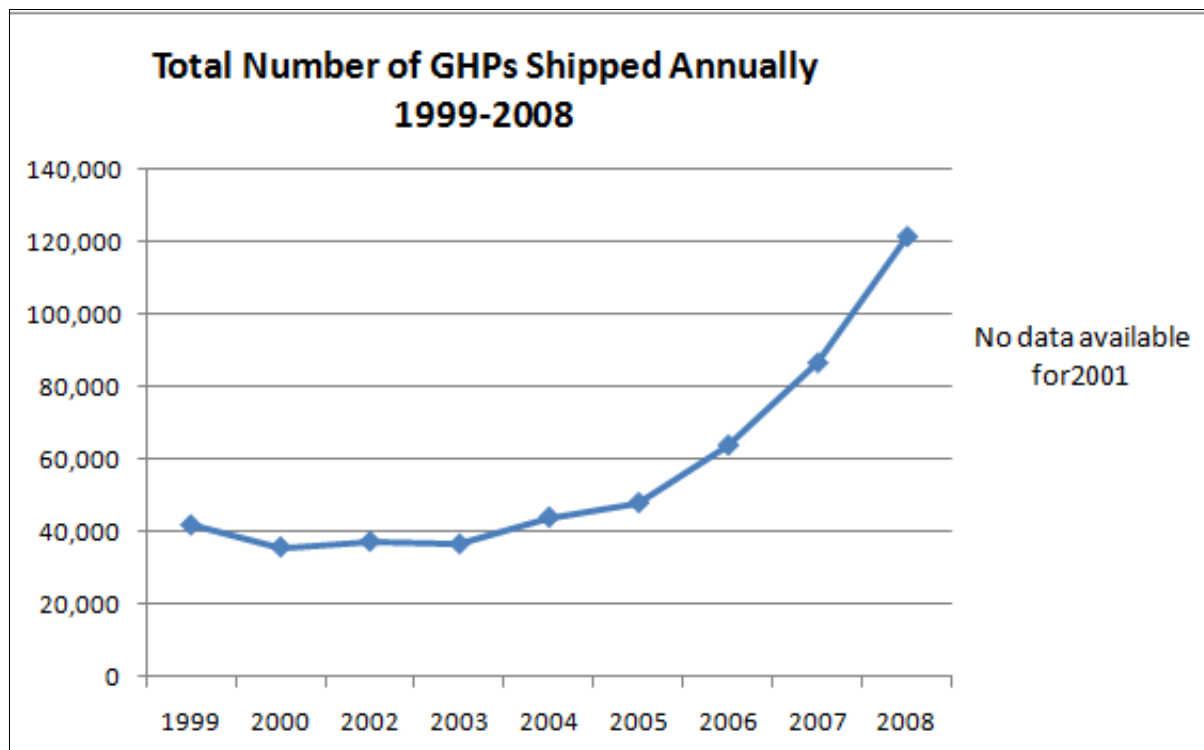
This paper describes an innovative new financing approach that utilities can use to successfully meet these challenges while also creating a viable and profitable clean energy strategy. However, the key to this new approach is not a new or unproven technology. The key is rather a technology that has a proven track record of long-term success dating back to the beginning of the last century. The next “killer app” for the electric utility industry is the geothermal heat pump (GHP).

First, we provide an overview of the ways in which GHPs offer customers, utilities, and investors a “win-win” solution. Then, we discuss an innovative new financing approach that electric utilities can use to position GHPs as an effective part of their long-term clean energy solution—profitably.

If traditional utilities do not take advantage of this opportunity, others will. Just as utilities have, for the most part, missed out on the Energy Services Company (ESCO) model and the market for leased solar photovoltaic (PV) systems.

### GHPs: Why it's the "Killer App" for Utilities

The geothermal heat pump industry (GHP) has experienced double-digit growth in the past few years, according to the most recent industry surveys from the Energy Information Administration (EIA) 2009 data as Figure 1 shows. This growth has been fueled by the soaring energy prices for traditional fuels as well as the desire for reliable and clean energy alternatives. In 2008, total geothermal heat pump shipments increased 28 percent to 121,243 units while the capacity shipped rose 29 percent to 416,105 tons. Despite the higher initial cost compared to traditional heating and cooling systems, the high efficiency and ongoing cost-saving potential have made GHPs the heating and cooling system of choice for many consumers. But even though GHPs offer energy efficiency, peak demand reduction and renewable energy benefits to utilities, their growth has not kept pace with solar PV systems, which now exceed the GHPs on an annual installation basis.



Source: Energy Information Administration, Form EIA-902, "Annual Geothermal Heat Pump Manufacturers Survey" October 2009. Note, the EIA did not collect data in 2001.

**Figure 1: Number of GHPs Shipped Annually**

Although the United States remains the world leader in GHP technology with the largest installed base of GHP systems—approximately 600,000 units in 2005 (Rybach 2005)—the overall GHP market share in the United States is much smaller than in some European countries. A 2005 review of the global market status of GHP systems estimated that Sweden, Denmark and Switzerland ranked higher on a per capita basis (Rybach 2005) than the United States regarding GHP installations.

Furthermore, supportive government policies in Asia have also lead to a rapidly growing market in both China and South Korea. Currently, the European and Asian markets have exceeded U.S. markets in the annual shipments of GHP units (Liu 2010, p. 8).

First cost remains an ongoing barrier to the installation of energy efficiency measures as it has since the advent of energy efficiency programs in the early 1980s. First cost is an especially difficult barrier to overcome for premium energy efficiency technologies, such as geothermal heat pumps (GHPs). Even though GHPs are a proven technology that offers significant savings in terms of carbon, energy and peak demand, first cost continues to be the major barrier to moving this technology to the main stream. This provides an excellent opportunity for progressive utilities to capture both revenue and efficiency.

Initial cost (even with short payback periods) clearly hinders GHP system acceptance in many markets. Currently in commercial markets, GHPs are primarily limited to institutional customers (e.g., federal, state, and local governments and K-12 schools) that take the lifecycle view. In residential markets, GHP installations are concentrated on a small subset of newly constructed premium homes and to home retrofits in which the owner plans to occupy the premises long enough to justify the investment. In all of these cases, the building owner must have the financial wherewithal to use self- finance the system. (Liu 2010, p. 11).

The potential of geothermal heat pumps has been recognized for over a decade. Current primary energy costs, costs of new energy facilities and concerns for the environment have created the “perfect storm” to promote GHPs as a viable energy efficiency technology across a broad range of applications (Brown 2008).

As a result, energy efficiency programs are using multiple strategies to reduce the first cost, or premium, associated with making investments in energy efficient technologies, including GHPs. These strategies range from simple rebates to more complex financing mechanisms including leases, loans, and bonds. An emerging trend is the development of other innovative strategies designed to encourage customers to make “deep” retrofits to their homes and businesses. These strategies include on-bill financing (OBF) and on-bill collection (OBC) as well as off-bill financing, e.g., using a line of credit, a home equity loan, or a similar type of credit arrangement.

Several innovative strategies include the Property Assessed Clean Energy (PACE) financing model, on-bill financing and GHP loop leases and tariffs. These utility-friendly financing models differ from other loans because they stay with the property, rather than the homeowner, if the property is sold. On-bill financing and loop tariffs tie the financing to the installation rather than the property owner, allowing it to be easily transferred from one customer to another. These approaches reduce the overall risk associated with the initial customer and has led to increased installations of premium efficient technologies such as GHPs.

Another major boon to promoting GHPs has been the availability of federal tax credits, which have helped to further lower the first cost premium. Federal tax credits through 2016 (Liu 2010; Liu 2011) include the following:

- Homes: 30% of the total GSHP system cost

- Businesses: 10% of GSHP system cost, 5 year depreciation, efficient building tax credit

Combining these tax credits with the following other options creates an attractive financing option for utilities to consider:

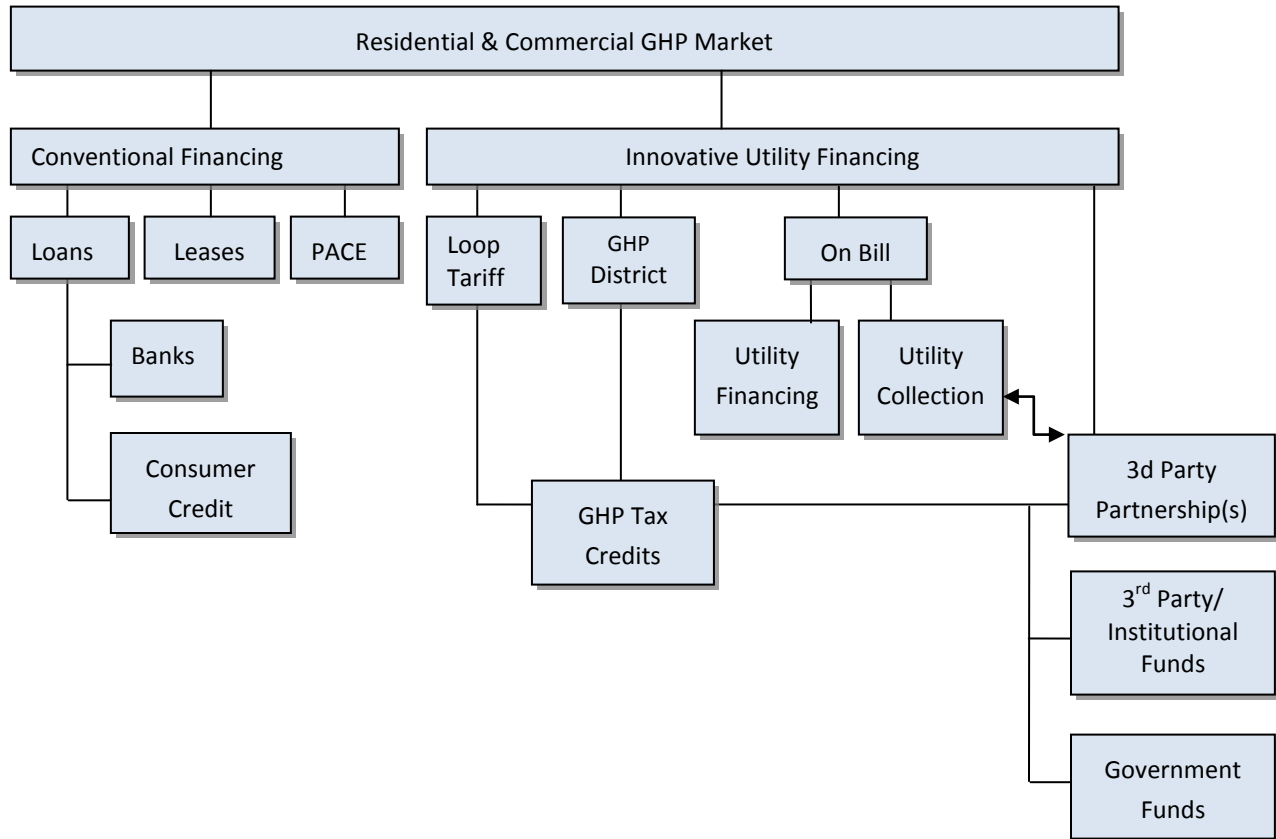
- Rural electric cooperatives have access to 35 year term loans at low government rates from the United States Department of Agriculture (USDA)
  - They can specifically use the funding to install 'GHP infrastructure'
  - They can recover the costs through a tariff on the utility bill

This white paper examines financing strategies that have been used previously to help reduce the first cost barrier, within the context of the GHP market. It also introduces a new financial model that can be utilities, non-profits, and municipal governments can use to encourage the installation of GHPs in both residential and commercial applications and make it a cornerstone of the utility's clean energy strategy.

### *Overview of Current Financing Programs for GHP Market*

Figure 2 illustrates financing mechanisms that have been used to reduce the "first-cost" associated with GHPs and encourage the installation of this equipment in both the residential and commercial markets. Utilities can play a key role in bringing innovative financing to the GHP market. While currently limited in number, utility efforts can be key to these new structures through both partnerships and GHP "utility" districts. Combining both mechanisms allows not-for-profit utilities to harvest GHP tax credits while using traditional utility, government, or institutional capital to finance projects.

## Overview of the GHP Financing Market



**Figure 2: Overview of the GHP Financing Market**



## White Paper

Financing is not a new strategy for the energy efficiency market place. Table 1 summarizes the variety of energy efficiency financing programs that have been offered to customers during the past two decades, including programs offering traditional secured and unsecured retail installment contracts (RIC), energy efficiency mortgages, and home equity lines of credit (Fuller, 2009). Table 1 summarizes ten financing programs and their key characteristics.

**Table 1: Summary of Financing Programs**

Sponsor Entity/ Start Date	Financing Mechanism	Sources of Capital	Collection Mechanism	Target Market	Eligible Measures	Application Processor	Credit Requirements	Security Interests	Interest Rate & Term	Enhancements	Average Loan Amount	Financing issued in 2007	% of Customers Served in 2007	Default Rate in 2007
AFC First Financial Corporate 2005	Retail Installment Contract or mortgage	PA Treasury, Housing Finance Agency & Energy Dev. Authority	Separate monthly bill from lender	Single family owner occupied	EE, solar, wind, geothermal	Sponsoring entity	FICA >640 ~65% approved	Loan loss reserve fund, some secured with mortgage	unsec 8.99% for 3, 5, or 10 yrs; sec 6.375-8.75% for 10/15/20 years	Below market rate interest	\$6,000 unsec \$10,000 max; sec. \$35,000 max	~1,500 loans \$9 million	<0.1% (1,500 loans/ 4.8 million homes)	<0.5%
City of Berkeley 2008	Special tax levied	Municipal bond	On property tax bill	Res & Com'l Property owners	EE, solar thermal, solar PV	TBA	Must own property & be current on property tax pmts.	Secured by lien on home	5-7% (tba) 20 years	Interest pmts are tax deductible	Tba	n/a	n/a	n/a
Efficiency Vermont 2006	Consumer loan or mortgage	Lender funds, plus public benefit charge	Separate monthly bill from lender	Single family owner occupied	Energy efficiency	Lender	Varies based on loan product 100% approved	Some loans secured with home equity or another asset	Buy down 3.5%; final interest varies, 2-6.5%, 5 years max	Interest buy down	\$8,000 \$15,000 max	34 loans \$257,000	<0.1% (34 loans/ 250,000 homes)	None so far
Hawaiian Electric Company 2007	Tariffed installation program	Public benefit charge	Separate bill within the utility bill envelope	Single & multi-family rented or owned	Solar hot water	Contractor	No set bar, review credit & bill pmt history	Disconnect for non-pmt	0% 8 yr. term avg	Zero percent interest	\$5,000 no max	16 loans \$80,000	<0.1% (16 loans/ 40,000 homes)	None so far, started last year
Manitoba Hydro 2001	Consumer loan	Utility's general revenue funds	On utility bill	Single family owner occupied	Energy efficiency	Utility	No set bar; review credit & bill pmt history, 94% approved	Unsecured	6% up to 5 yrs	Below market rate interest	\$4800 \$7500 max	8,100 loans \$39 million	<1.9% (8,100 loans/ 420,000 homes)	<0.2%
Midwest Energy 2007	Tariffed installation program	Utility's general revenue funds & state housing fund		Single & multi-family rented or owned			Good utility bill pmt history	Disconnect for non-pmt	4% 15 years		\$4,000 no max	47 loans closed \$188,000 since 8/2007	n/a	None so far, started last year

# White Paper

Sponsor Entity/ Start Date	Financing Mechanism	Sources of Capital	Collection Mechanism	Target Market	Eligible Measures	Application Processor	Credit Requirements	Security Interests	Interest Rate & Term	Enhancements	Average Loan Amount	Financing issued in 2007	% of Customers Served in 2007	Default Rate in 2007
Nebraska Energy Office 1990	Consumer loan	Lender funds, oil overcharge funds	Separate monthly bill from lender	Single & multi-family property owners	Energy efficiency, renewables	Lender	Lender does underwriting, Approval rate varies	Varies based on lender's requirements	Under 5% on average	Below market rate interest	SF max \$3,000 MF max \$75,000	784 loans \$7.1 million	0.1% (784 loans/ 700,000 homes)	<.01%
NYSERDA's Energy Smart Loan 1998		Lender funds, plus public benefit charge			EE, solar thermal, solar PV, wind			Loans over \$7500 must be secured	Buy down of 4% term varies	Interest buy down, Addl \$ for low income	SF \$11,000 \$20,000 max MF varies widely	SF 340 loans \$3.8 million MF 29 loans \$23.2 million	0.1% (369 loans/ 6 million homes)	<1%
NYSERDA's HPwES Loan 2003		Fannie Mae funds and public benefit charge subsidy		Single family owner occupied	Energy efficiency	Utility	FICA >640 ~65% approved	Unsecured	5.99% for 3, 5, 7, or 10 yrs	Below market rate interest, Addl \$ for low income	\$7,800 \$20,000 max	541 loans \$4.2 million	<0.1% (541 loans/ 6 million homes)	2-3%
Sacramento Municipal Utility District (SMUD) 1977		Utility's general revenue funds		Single family owner occupied	EE, solar thermal, solar PV		Std bank metrics used plus bill pmt history 73% approved	Secured with a fixture filing to property	7.5% up to 10 years	Below market rate interest	\$8,750 no max	3,200 loans \$28 million	0.6% (3,200 loans/ 520,000 homes)	1.8%

Source: Adapted from Fuller, 2009

### *Failure to Build on the ESCO Model*

One strategy that has never gained traction in the GHP financing market is the Energy Services Company (ESCO) model. The ESCO approach was established to provide manpower and systems to enable utilities to meet federal and state mandates and offer energy conservation services in the early 1980s. While early pioneers of the ESCO model, utility companies soon abandoned the business as de-regulation stalled, and the ESCO industry consolidated as many utilities folded or sold their ESCOs. Today, successful ESCO companies have broadened their offerings to an expanded customer base and have integrated renewables and “green” technologies into their product and service portfolios. Approximately 80% of the total ESCO business is now conducted by subsidiaries of large companies, primarily equipment manufacturers, not utility companies. The ESCO market was estimated to have annual revenues of \$5.2–\$5.5 billion in 2008. (This market was over one half the size of the retail electric distribution market’s total revenue of \$8.96 billion in 2008.) (EIA 2009).

Having lost the ESCO market, electric utilities now face losing market share to the distributed solar industry. While solar energy provides less than 1% of our nation’s electricity, over 300,000 homes boast a solar array. With the cost of solar power plunging and retail electric prices rising, the next ten years could see as many as 100 million Americans “go solar” for a lower price than grid electricity (Farrell, 2012).

A recent study completed by the National Renewable Energy Laboratory (NREL) reports that the new business model of solar leasing is expanding the solar market into lower income customers (Drury 2012). This approach repackages the value of PV into a simple savings on the monthly electric bill and is a much more attractive alternative to the pitch that a large up-front purchase will pay for itself in a decade (Drury 2012). Indeed the solar leasing model is accelerating the pace of solar adoption, and the Solar Electric Power Association (SEPA) reports that the majority of solar systems being installed today actually are not owned by the customer but rather by a solar services company. As this market matures, the invested leasing players will no doubt try to keep traditional utility companies out of the solar leasing market.

However, the solar leasing model can provide an attractive strategy that could be used by utilities to promote GHP installations and obtain long-term income streams from them.

### **Making the Case for GHPs**

GHPs offer customers significant total energy and peak demand savings, carbon reduction and a proven long-term wise energy efficient investment. GHPs offer utilities a way to improve load factor while lowering total energy consumption by promoting a viable and proven “green technology.” Even in the current environment of inexpensive natural gas, GHPs provide utilities and their customers a long-term hedge against fossil fuel prices and possible carbon caps or taxes. High propane and fuel oil prices offer an easy target for GHP systems today. This section explores each of these critical benefits.

## Significant Energy Savings

Table 2 illustrates the cost competitiveness of GHPS by comparing the rated efficiencies and installed-cost estimates for a range of residential space-conditioning technologies as of 2007 (Navigant 2009). Furthermore, GHPs are a cost-effective strategy even in today's low natural gas market, as Table 2 shows.

**Table 2: Comparison of Efficiencies and Installed Costs for Typical Residential HVAC Systems**

Technology	Rated Cooling Efficiencies	Rated Heating Efficiencies	Typical Installed Cost
Gas-Fired Furnace	--	<i>Typical:</i> 80% AFUE; 780 kWh/yr <i>ENERGY STAR®:</i> 90% AFUE; 500 kWh/yr <i>2007 Best Available:</i> 96% AFUE; 275 kWh/yr	\$24.00/kBtuh \$32.70/kBtuh \$44.00/kBtuh
Oil-Fired Furnace	--	<i>Typical:</i> 81% AFUE; 850 kWh/yr <i>ENERGY STAR®:</i> 83% AFUE; 800 kWh/yr <i>2007 Best Available:</i> 95% AFUE; 650 kWh/yr	\$23.80/kBtuh \$26.20/kBtuh \$50.50/kBtuh
Central A/C (Air Source)	<i>Typical:</i> 13 SEER <i>ENERGY STAR®:</i> 14 SEER <i>Best Available:</i> 21 SEER	--	\$814/ton \$886/ton \$1714/ton
Central Heat Pump (Air Source)	<i>Typical:</i> 13 SEER <i>ENERGY STAR®:</i> 14 SEER <i>Best Available:</i> 17 SEER	<i>Typical:</i> 7.7 HSPF <i>ENERGY STAR®:</i> 8.2 HSPF <i>2007 Best Available:</i> 10.6 HSPFb	\$1450/ton \$1570/ton \$2300/ton
Geothermal Heat Pump	<i>Typical:</i> 16 EER <i>ENERGY STAR®:</i> 14.1 EER <i>Best Available:</i> 30 EER	<i>Typical:</i> 3.4 COP <i>ENERGY STAR®:</i> 3.3 COP <i>Best Available:</i> 4.8 COP	\$3000/ton \$2830/ton \$5250/ton

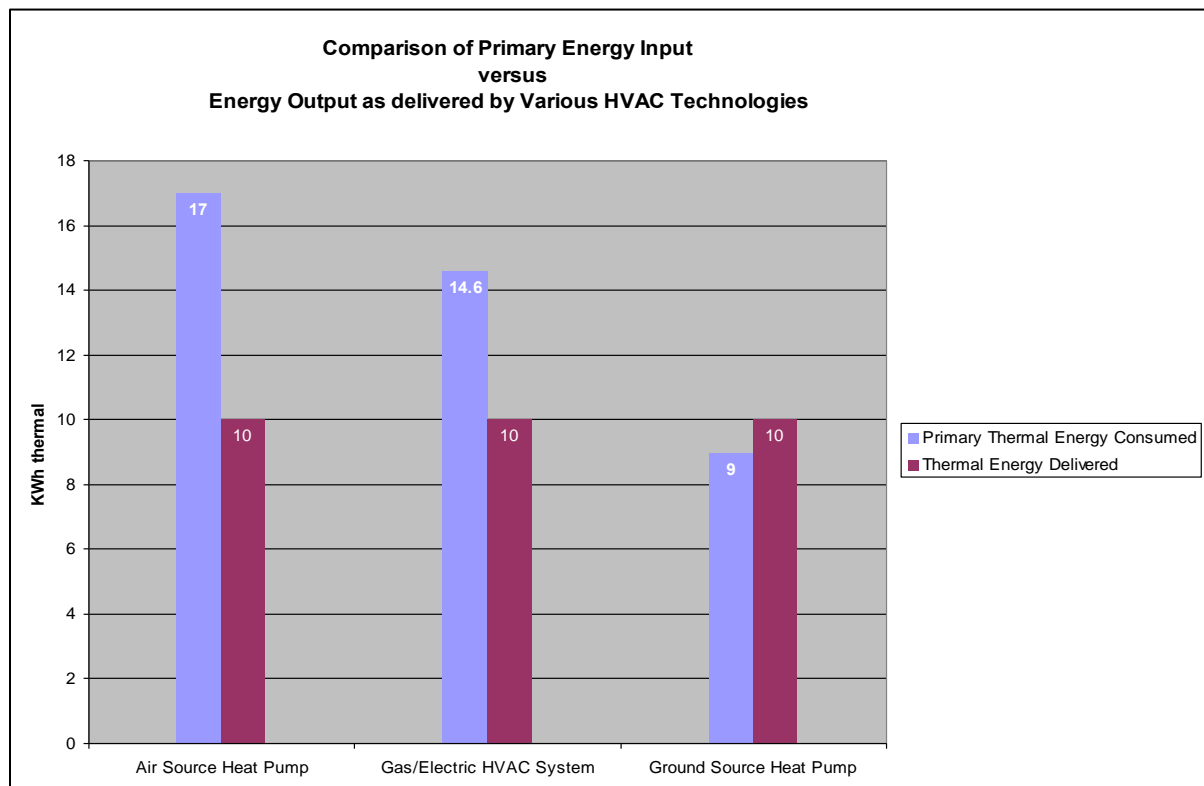
Source: GSHP Report, Navigant Consulting 2009, p. 33

## Lower Operating (and Energy) Costs

But while the upfront installation cost for a GHP system may be higher, the real benefit comes from the long-term or lifecycle cost of operating this equipment. Figure 2 shows that a GHP system is 60 percent more cost effective to operation compared to a standard natural gas furnace and central air conditioner. So the first critical benefit of GHPS is lower cost of operation.

For utilities, however, GHPs offer another critical benefit- the ability to be part of an overall peak reduction strategy, which means that this technology is just not applicable for energy efficiency programs, but for peak load reduction or Smart Grid programs as well. Each residential home using a geothermal system can reduce peak loads in:

- Summer by 1–2 KW
- Winter by 4–8 KW

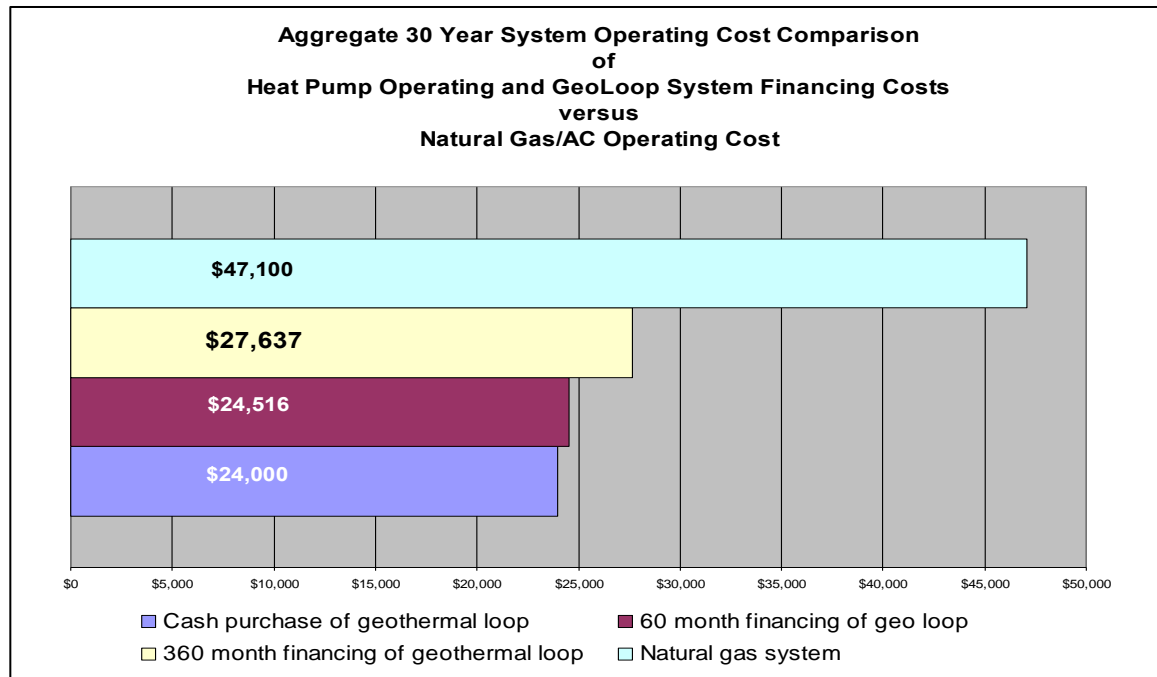


Analysis provided by DMEA, 2008<sup>2</sup>

**Figure 3: Comparison of Primary Energy Usage Across HVAC Technologies**

<sup>2</sup> A heat pump coupled with a GeoLoop with the 30 year financing option will cost 60% of the cost of a Natural Gas and AC system. Design parameters are: Montrose, CO; 2000 square foot house; 48,000 BTUH heating load, 20,000 BTUH; Energy cost assumptions are: 8.6 cents/KWH, \$2 gallon/propane, \$1.27 therm/ Natural Gas

Figure 4 further demonstrates the lower cost of ownership for a GHP system compared to a conventional HVAC system, regardless of the financing strategy used. This means even for owners who have to borrow the funds to purchase GHP system, they will still save significantly compared to customers purchasing a traditional system. This means that GHPs are no longer available only to a select group of customers, but rather are affordable option that should be considered for all customer groups.



Analysis provided by DMEA, 2008

**Figure 4: Comparison of Lifetime Operation Costs for GHPs to HVAC Systems**

### Viable “Green” Technology

A recent report by the Oak Ridge National Laboratory (Liu, 2010) identified the potential national benefits in terms of energy savings, reduced summer peak electrical demand, consumer energy cost savings, and reduced carbon dioxide emissions from retrofitting the space-heating, space-cooling, and water-heating systems in existing U.S. single-family homes with state-of-the-art GHP systems.

The analysis shows that replacing all Space Heating (SH), Space Cooling (SC), and Water Heating (WH) systems in existing U.S. single-family homes with properly designed, installed, and operated state-of-the-art GHP systems would yield the following benefits annually:

- A savings of **4.2 quadrillion (quad) British thermal units (Btu)** in primary energy, a 45.1 percent reduction in primary energy consumption associated with SH–SC–WH in existing U.S. single-family homes;
- A reduction of **271.9 million metric tons of CO<sub>2</sub> emissions**, a **45.3 percent** reduction in CO<sub>2</sub> emissions associated with SH–SC–WH in existing U.S. single-family homes;

- A savings of **\$52.2 billion in energy expenditures**, a **48.2 percent** reduction in energy costs for SH–SC–WH in these homes; and
- A reduction of **215.9 gigawatts (GW) in summer peak electrical demand**, a **56.1 percent** reduction in summer peak electrical demand for Space Cooling, in existing U.S. single family homes.

Increasing the installation rates of residential GHPS to 1 million units, which would effectively double the existing base in the US would lead to 32,860,000,000 Btu in primary energy savings, 2.1 million metric tons of CO2 emission savings and 1.7 Gigawatts of summer peak demand savings.

These savings would allow participating utilities to meet or exceed their carbon and demand savings requirements without penalizing annual kWh sales or putting pressure on rates. These carbon savings could offset the emissions from existing fossil fuel power plants used to serve the retrofitted homes. Studies conducted by the USDA Rural Utility Service (2010) show that GHPs that replace gas combustion furnaces and conventional air conditioning units result in net total system carbon emission savings, assuming modest GHP efficiency and average carbon loads per kWh.

But the Oak Ridge Report did not address another major benefit for utilities—the off-peak sales resulting from these installations. Unlike energy efficiency and on-site renewable generation, GHPs clip utility coincident peak (summer) while providing valley filling off-peak load. By improving load factor, GHPs reduce pressure on rates. Modest thermal storage strategies could easily capture off peak electric generation from wind farms to leverage the value of GHP operations.

Dr. Eric Wang of ClimateMaster has modeled the load impact of GHPs against conventional combustion furnaces and air conditioners using eQuest. eQuest is a useful GHP modeling tool as it can predict peak loads by month and time of day for HVAC and whole house loads.

Sample load impacts of converting a 4-ton load home with conventional gas/propane furnaces with 10 SEER air conditioners for 3 cities are provided in the following table for 3 sample cities in the U.S. These cities (Sacramento CA, Charlotte NC, and Denver CO) were chosen to demonstrate the impacts of GHP retrofits in various climate zones.

**Table 3: System Comparison GSHP with desuperheater vs. 10 SEER AC with 80% gas furnace**

<b>System Comparison GSHP with desuperheater vs. 10 SEER AC with 80% gas furnace</b>				
(both systems with natural gas standard water heater)				
	Annual Energy Usage Comparison		Annual Savings	
	GHP	Gas furnace with AC	GHP vs. Standard	CO2 in pounds (1) (2)
<b>Charlotte, NC</b>				
Annual kBtu of Gas	9,814.0	91,884.0	82,070.0	9,602.19
Annual kWh	17,976.0	16,717.0	(1,259.0)	(1,533.46)
CO2 load #/yr.	23,043.01	31,111.73	8,068.73	8,068.73
Peak kW (summer)	4.9	7.1	2.2	
Time of Peak	7/14/10 18:00	7/14/10 18:00		
<b>Denver, CO</b>				
Annual kBtu of Gas	8,729.0	156,684.0	147,955.0	17,310.74
Annual kWh	19,932.4	14,391.0	(5,541.4)	(11,005.23)
CO2 load #/yr.	40,607.03	46,912.54	6,305.5	6,305.51
Peak kW (summer)	3.3	6.1	2.7	
Time of Peak	7/26/10 18:00	7/26/10 18:00		
<b>Sacramento, CA</b>				
Annual kBtu of Gas	10,283.0	83,215.0	72,932.0	8,533.0
Annual kWh	17,038.2	15,745.7	(1,292.5)	(904.73)
CO2 load #/yr.	13,129.84	20,758.15	7,628.3	7,628.31
Peak kW (summer)	4.3	6.9	2.6	
Time of Peak	7/5/10 18:00	7/5/10 18:00		
1- kWh carbon load from US Environmental Protection Agency eGRID2006 Version 2.1, April 2007				
NC	1.218	#/kWh		
CO	1.986	#/kWh		
CA	0.7	#/kWh		
2- N gas carbon load =117 #/kBtu – U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009 (EPA 2011).				

In all cases, the GHP system saves peak summer demand and greatly reduces the use of fossil fuels for heating and water heating. An increase in annual kWh consumption is realized in all three cases, but this increase is due to off peak winter heating loads in excess of summer peak electric savings. It is this load factor improvement, combined with net energy savings from all sources on an annual basis that makes GHPs an excellent technology for electric utilities.



It is a little understood fact that utility efficiency programs based on SEER (seasonal energy efficiency rating) do not provide peak demand savings on hot summer days when high temperatures drive utility demand. The SEER rating was developed to provide a proxy for the expected average efficiency of an air conditioner or heat pump throughout an average cooling season in the U.S. It is a calculated value that uses the estimated Btus that will be provided for cooling over the year divided by the estimated watt-hours that will be used to provide this cooling (Btus/Watt-hours).

The formula for this calculation is based on measurements of a unit's performance at several different operating conditions/temperatures in a testing lab. The resulting data points are then used to calculate the SEER rating using an established Department of Energy (DOE) protocol (ARI 210/240). This calculation protocol was developed to represent the expected total cooling energy delivered by the unit during an average cooling season and the total electric energy that would be consumed to deliver the cooling over the course of the season. Because it is a calculated value based on a few measurement points, SEER does not measure peak load efficiency and it cannot be used to predict a unit's peak demand requirements on the hottest days of the year. It can only be used to estimate the unit's annual cost of operation against other units with different SEER ratings.

Consequently a utility using SEER as the basis for its efficiency programs may experience a lower annual usage of kWh without reducing the peak demand per unit than was generated from the equipment that was replaced. In a cost of service model where kWh sales generate net margins and summer peak demand cost are higher than average demand costs, this will increase the cost of service for the utility and their customers.

### *Summary of GHP Benefits*

Table 4 summarizes the benefits of calculated by Dr. Liu from retrofitting existing single family homes with state-of-the-art GHP systems at both a 20 and 40 percent market penetration rate. This table demonstrates that GHPs provide utilities an opportunity to meet both energy savings and peak reduction goals, while also offering customers an opportunity to install a "green technology" that reduces carbon emissions while saving energy. Dr. Liu's (2010) analysis of GHP systems retrofits using state-of-the-art technology found that the levelized cost determined that state-of-the-art GHP systems will yield a positive NPV for installed systems over a 20-year period at current market prices, and without any financial incentives, when the discount rate is lower than 8 percent. Furthermore, GHPs also offer significant value in the terms of reduced CO<sub>2</sub> emissions and reduced summer peak electrical demand.

**Table 4: Summary of Potential Benefits of Retrofitting Existing U.S. Single-Family Homes with State-of-the-Art GHP Systems At Various Market Penetration Rates**

Estimated National Benefits	Market Penetration Rate of GHP Retrofit	
	20%	40%
Primary energy savings (quad BTU)	0.8	1.7
Percentage savings	9.0%	18.0%
CO2 emissions reduction [MM Ton]	54.3	108.7
Percentage savings	9.1%	18.1%
Summer peak electrical demand reduction [GW]	43.2	86.4
Percentage savings	11.2%	22.4%
Energy expenditures savings [Billion \$]	10.4	20.9
Percentage savings	9.6%	19.3%

notes: MM ton, million metric ton; LIU 2010, p. 2

While these findings have clearly demonstrated the benefits of GHPs, for utilities the lack of convenient customer financing remains an on-going barrier. The next section introduces an innovative approach that utilities can use to make GHPs an affordable technology for residential and commercial customers and ultimately the centerpiece of an effective and profitable clean energy strategy.

Unlike the ESCO and roof top PV markets, the GHP market is ripe for joint ventures with electric utilities. Indeed, electric utilities played a key role in the early development of the GHP industry. Before the advent of DSM programs focused on reducing total electric consumption, GHPs provided electric utilities with cost effective high load factor growth. Today GHPs still provide peak load reduction and off peak electric sales while reducing the total energy foot print (and carbon emissions) of buildings. Like electric cars and solar thermal water heating, GHPs lever a small increase in electric use into large total energy savings and carbon emission reductions, by reducing fossil fuel consumption.

But, the ground loops that generate the energy, energy bill, and environmental savings derived from grounds source heat pumps generate a first cost barrier for consumers. They also create an installation barrier for HVAC contractors who are not willing or interested in adding complexity to the sale and installation of “conventional” HVAC systems.

However, the underground pipes that make GHPs the most cost effective and environmentally friendly HVAC (and water heating) technology available, look like traditional utility “poles, pipes and wires.” By converting the up-front cost of a GHP loop system into a utility owned or financed asset with a simple monthly payment, the utility company would capture a renewable rate-based asset, a new income source, lower overall costs of electricity from a higher load factor, and all of the environmental, financial, and customer relationships benefits currently being lost to other energy efficiency approaches. On bill financing or collection in partnership with other industry players can also generate a new utility income stream.

### An Innovative GHP Financing Solution

This new financial strategy combines resources and capabilities from the private sector, the utilities, and GHP manufacturers and their distribution channel partners. By partnering with GHP industry players, third-party financiers and GHP program implementation companies, non-taxed utilities (co-ops and munis) can participate in projects that capture tax credits and accelerated depreciation savings that would otherwise be lost in their stand-alone utility programs.

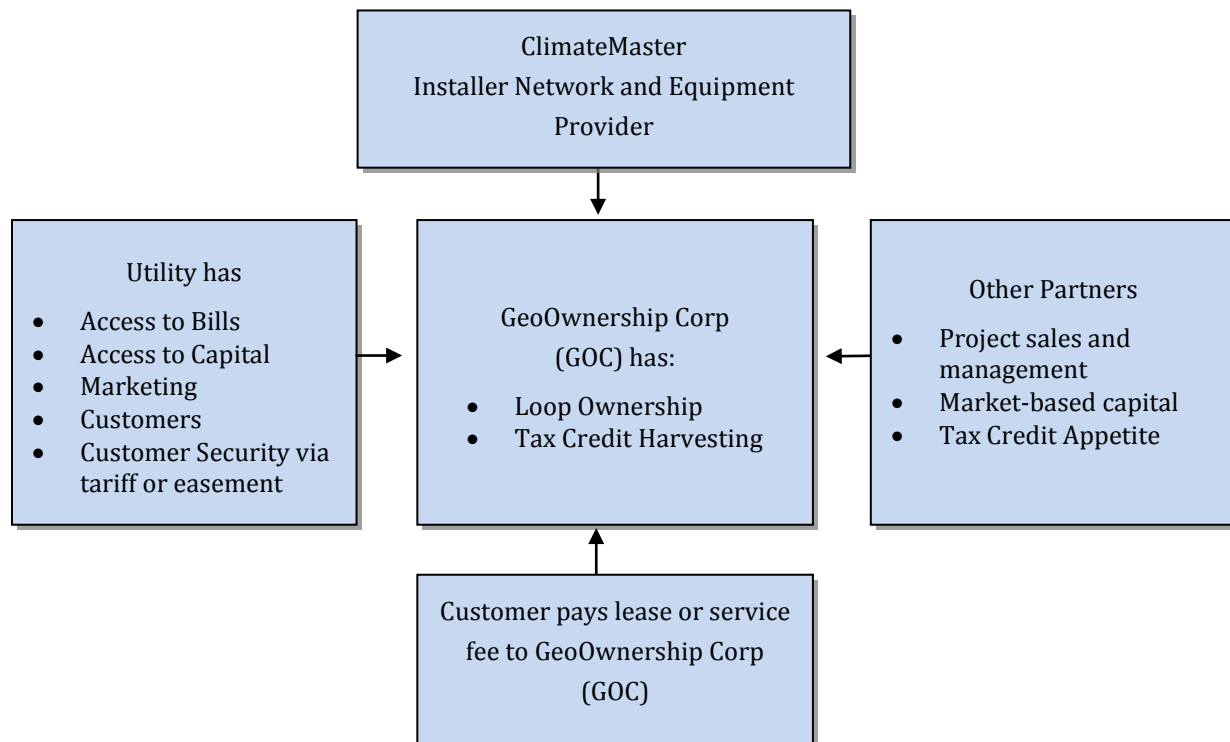
The utilities have access to consumer bills and capital, but they often do not have the internal resources and staffing capabilities necessary to implement large-scale energy efficiency programs cost-effectively. The GHP manufacturers' have the capital and/or a desire to capitalize on the tax advantages available through investing in clean energy technologies. Other private sector players can deliver project sales and management, and capital market financing, if needed. This mix of industry capabilities offers an opportunity is to form new partnerships with the goal of making GHPs an affordable option for residential and commercial customers:

- GHP manufacturers provide the implementation and installation infrastructure, marketing support, and direct-to-market pricing;
- The utilities provide the direct link to the customers; if desired, access to capital through loop loans or leases
- Third-party program managers provide the customer enrollment process and sales activities and offer financing solutions from governmental programs or institutional investors.
- Institutional investors or government programs can provide low-cost capital

Through the USDA, there is a funding mechanism through the Rural Utility Services (RUS) that can, in effect, operate as an energy efficiency bank. Through this mechanism, the utilities can offer financing strategies that reduce the upfront cost of installing GHPs through either loop leases or other types of long-term financing. Under a current pilot program, the USDA will grant loans for rural electric cooperatives to provide geothermal loop leases to their customers.

One GHP manufacturer, ClimateMaster, is currently exploring the opportunity to implement the following business model.

### Potential Funding Mechanism



**Figure 5: Potential Funding Mechanism**

This partnership model creates a strategy in which the for-profit partners harvest tax credits, the utilities get the long-term load factor improvement and a comprehensive clean energy strategy the investing partner(s) can receive a fixed return on investment capital, and customers have access to an affordable “green” technology. Furthermore, equipment manufacturers and their distribution channel partners can achieve greater market penetration.

### Commercial Financing Strategy

Many commercial property owners are considering implementing energy efficiency projects as the trend toward green building, sustainability, and environmental stewardship continues to strengthen and become part of an organization's business planning. The future rewards of improved building performance, including lowered operating costs and a measurable, positive impact on the environment are enticing; but sometimes the initial cost of the project can seem like an insurmountable obstacle when it comes to the actual implementation. In many cases, owners feel that their only options are to provide capital for the project by pulling from equity, taking out a bank loan, or to simply continue to face increased operating expenses. What they may not know is that incentives may be incorporated into a strategy to fund the energy efficiency projects by significantly lowering the organization's or owner's tax burden. There are many incentives for energy efficiencies available to facility owners from utility companies, as well as local, state and federal government programs. Understanding how to utilize these incentives as part of a project scope will assist the facility or property manager in gaining the support of building owners.

§179D of the Internal Revenue code supporting the Energy Policy Act of 2005 is one incentive that may provide major benefits to building owners. §179D includes full and partial tax deductions for investing in commercial building improvements that are designed to increase the efficiency of energy-consuming functions such as lighting and HVAC. The deduction available is up to \$.60 per square foot each for lighting, HVAC, and building envelope - a potential for \$1.80 per square foot if all three components/subsystems qualify. GHP systems may help attain the incentives available through §179D, if certain specifications are met. The following factors should be taken into consideration: plans and specifications for the building and the new system may be required, the building to be improved must be modeled by a qualified individual using IRS prescribed software, and third party certification is required in order for the system to qualify for §179D deductions. There are organizations across the country that are skilled and knowledgeable in both the §179D requirements and the assessment process. It should be noted as a reminder any incentive, i.e. investment tax credit, will reduce the basis of the GHP, but §179D may be applicable to the next costs. Source: Capital Review Group, 2012

### Conclusion

A utility that deals effectively with these trends, and receives sufficient support from regulators and legislators, will be better positioned to succeed in the 21st century. All else equal, such a utility is also more likely to attract lower cost capital, enabling it to earn stronger returns for investors. On the other hand, a utility that fails to effectively manage risk, including higher carbon exposure, may suffer greater financial impacts if climate legislation takes hold and fossil generation costs rise (Ceres 2010, pp. iv-v).

Non-utility players are taking a closer look at GHP loop ownerships system leasing so the window of opportunity for utility intervention may be closing, just as it did with ESCOS and roof-top solar installations.

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