• Inside: Universities Moving to CHP Systems •

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Natural Gas is Moving More Fleets

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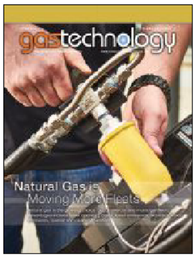

on the cover

Natural gas is the growing choice for commercial and municipal fleets. Advantages include lower operating costs, lower emissions, reduced carbon emissions, quieter and cleaner operation. Cover photo courtesy: Agility Fuel Solutions

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inside

FLEETS SWITCHING TO NATURAL GAS FUELING

UPS, A GLOBAL LEADER IN TRANSPORTATION AND LOGISTICS, recently announced plans to build an additional 12 compressed natural gas (CNG) fueling stations and to add 380 new CNG tractors to its alternate fuel and advanced technology truck fleet in the US. The expansion involves purchases totaling $100 million. This announcement is indicative of a growing trend in North America toward long-term commitments to CNG as a major fleet motor fuel. The range of vehicles, the development of fueling infrastructure, and the awareness of the benefits of this technology continue to be on the upswing.

UPS Has History with CNG

UPS operates a motor fleet of 100,000 vehicles worldwide, including local delivery vans and large intercity truck-trailer combinations. The company has evaluated the use of CNG as a motor fuel since 1989, and beginning in 1999 participated in a detailed study by the U.S. DOE on CNG vs. diesel motor fuel at two Connecticut UPS locations. The results of that study were published by DOE in 2002 and included documentation on fuel economy, vehicle maintenance, emissions, and vehicle performance. Since that time, UPS has periodically expanded its natural gas fleet.

As part of its corporate commitment to sustainable energy use, the company also uses hybrid electric, propane, and composite light-weight body vehicles. UPS had set a goal of achieving one billion miles on its alternate fuel and advanced technology fleet. It met that goal in 2016, one year earlier than initially expected.

Commitment Based on Long-Term Value

In a 2016 statement, Mark Wallace, UPS Senior Vice President Global Engineering and Sustainability stated, "At UPS, we own our fleet and our infrastructure. This allows us to invest for the long term, rather than planning around near-term fluctuations in fuel pricing." In addition to the 380 new CNG road tractors, in 2015 the company also announced the purchase of 64 liquefied natural gas (LNG) tractors for its fleet of more than 3,000 natural gas vehicles.

Worldwide Trend

The UPS commitment to natural gas as a primary fleet fuel is part of a growing worldwide trend toward this preferred energy source. According to the organization Natural Gas Vehicles for America (NGVAmerica), there are currently about 153,000 natural gas vehicles on U.S. roads. This includes

Kenworth road tractor with CNG storage tanks behind the cab.
Photo courtesy: Agility Fuel Solutions

Many new CNG and LNG fueling stations have been built near major interstate highway locations with ample facilities for fleet fueling. Photo courtesy: Agility Fuel Solutions

39,500 heavy duty vehicles – transit buses, school buses, refuse trucks, regional haul trucks, and municipal vehicles. It also includes 25,800 vehicles classified as medium duty – delivery trucks, government vehicles, utility trucks, and airport, university and miscellaneous vehicles.

For all these fleet vehicles, various fueling strategies are used, depending on the daily use pattern and proximity to public or private rapid fueling facilities. For vehicles that normally return to a central site and are not in use in a predictable pattern, many owners choose to install a timed-fill fueling station. For other vehicles that may not be on a predictable daily use pattern, the choice is often to use a public or private fast-fill facility. Such fueling stations are being installed in many urban and interstate highway locations.

Fueling Systems Fit the Customer

Agility Fuel Solutions is a leading provider of natural gas fueling systems for heavy-duty and medium-duty vehicles. A spokesperson for Agility, Steve Whaley, was recently a presenter at a Technology & Market Assessment Forum sponsored by the Energy Solutions Center. His presentation focused on the growing opportunity for vehicle providers to reduce operating costs, reduce emissions and offer a positive public presentation by selecting natural gas vehicles.

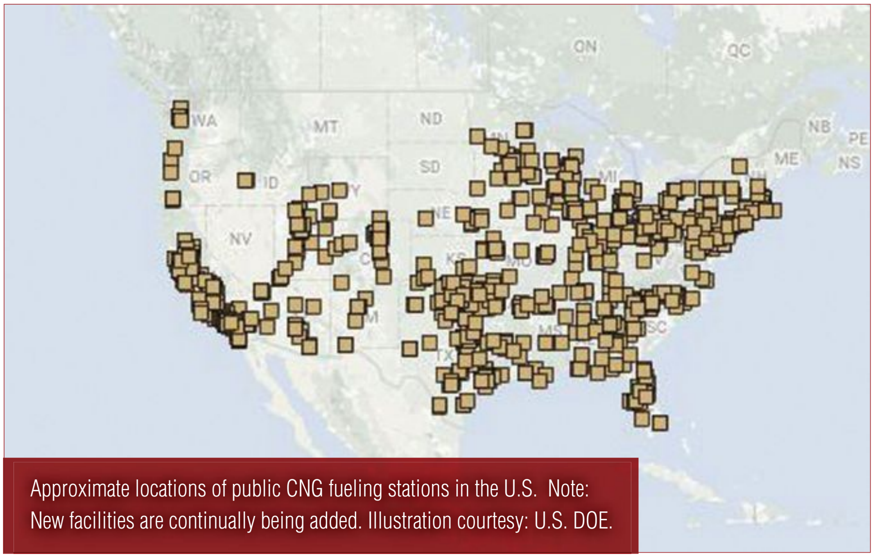
Whaley points outs obvious first candidates for natural gas fleet use. “The common characteristics are a defined area of travel and overnight refueling at a central location.” A very visible example is transit buses. “Years ago, natural gas adoption in the transit bus market became very popular. They commonly have a central location that the entire fleet can use.” Today, about 30% of the transit buses in the U.S. are fueled with natural gas.

Local-Use Vehicles an Attractive Opportunity

He notes that a similar characteristic is seen in the refuse truck market, and today that is a growing area of adoption of natural gas fueling. Similar opportunities exist for ready-mix concrete and parcel delivery trucks. For these types of vehicles, Agility and other companies provide CNG vehicle tank configurations in a wide variety of types to meet the gallonage requirement of the owner, with a choice of the most practical placement of the fuel tanks.

Over-the-Road Requires More Storage

In addition to the local transit and delivery vehicle markets, there is growing interest in CNG fueling for over-the-road tractors. Whaley points out, “Now that CNG fuel stations are becoming much more common with strategic placement along major highway routes, the heavy-duty trucking industry is the next emerging market for natural gas adoption. These vehicles have much larger fuel storage requirements than buses



Approximate locations of public CNG fueling stations in the U.S. Note: New facilities are continually being added. Illustration courtesy: U.S. DOE.

Behind-the-cab systems can be installed with capacities from 30 to 175 DGE. With the addition of side tanks, capacity increases to 280 DGE. Systems include an integrated fuel management module. Photo courtesy: Agility Fuel Solutions

and refuse collectors, which average 60 to 80 diesel gallon equivalents (DGE)."

He notes that Agility has developed system configurations to meet the range requirements of much longer haul routes. "Side mount systems range from 17 to 120 DGE and behind the cab systems range from 30 to 170 DGE (and sometimes combinations of both) are being implemented to achieve the necessary amount of fuel needed for the route application."

For the applications such as the UPS purchase of CNG road tractors, companies like Agility help owners evaluate the economic benefits of the purchase. Whaley indicates that the incremental cost of adopting natural gas fueling is proportional to the capacity of the system purchased. "The most popular for this market segment has been the 160 DGE behind-the-cab system that provides over 600 miles of range and costs on average an additional $45,000."

Higher Vehicle Cost Offset by Fuel Savings

He notes, "If the life cycle of this vehicle is specified as 750,000 miles, with the disparity of diesel to natural gas fuel cost at $.80/gallon, the total savings over the life of the truck is over $10,000. When diesel prices are above natural gas by $1.00/gallon, the savings become well over $30,000. If diesel prices were to get past $2.00 per gallon more (as they have done in the past), the net lifetime fuel savings would climb to $150,000 per truck. "

Lower Maintenance Costs

Regarding maintenance costs, Whaley points out that because natural gas engines require spark plugs, maintenance costs are slightly higher in the first one to two years. "There is a dramatic reduction after year three, however, due to the expensive diesel exhaust treatment systems needed to comply with emission standards." Whaley explains that natural gas engines meet EPA and CARB emission standards without the expense of diesel exhaust fluid (DEF), particulate filters, or the need for regeneration.

Environmentally Sustainable Solution

Whaley adds that companies are increasingly requiring environmentally sustainable measures, both as truck buyers and as customers of transportation services. "They are finding that the natural gas transportation solution is not only environmentally sustainable; it is also economically sustainable." He adds, "Natural gas provides less expensive and cleaner energy than diesel, and by utilizing our domestically produced energy, we can reduce our dependency on foreign oil." **GT**

MORE info

AGILITY FUEL SOLUTIONS
www.agilityfuelsolutions.com

DOE ALTERNATE FUELS DATA CENTER
www.afdc.energy.gov/vehicles/natural_gas.html

CANADIAN NATURAL GAS VEHICLE ALLIANCE
www.cngva.org

NATURAL GAS VEHICLES FOR AMERICA
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View of the 25 MWe General Electric gas turbine installed at the University of Minnesota CHP facility. Photo courtesy: University of Minnesota

CHP MAKES SENSE FOR UNIVERSITIES

Reducing Energy Costs, Cutting Carbon Emissions

COMBINED HEAT AND POWER (CHP) USES BYPRODUCT HEAT FROM ELECTRIC GENERATION AS THE ENERGY SOURCE for other applications such as steam for space heating, domestic hot water and/or absorption cooling. CHP, sometimes called co-generation, represents an opportunity to dramatically increase total system efficiency. These applications often use natural gas as the primary energy source. When systems replace coal-fired electric power plants or coal-fired heating plants, they also reduce total emissions and virtually eliminate sulfur oxide and particulate emissions.

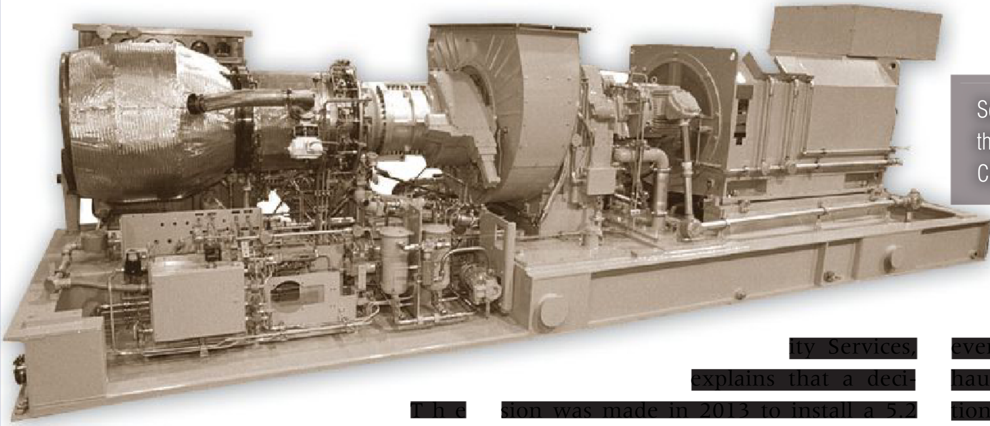
Makes Sense for Universities

Many universities supply energy to dozens or even hundreds of buildings from central power and heating plants. This is an exceptional opportunity for CHP. The central heating plant usually supplies medium- and high-pressure steam for space heating, laundry and sometimes food service and laboratory operations. In some cases, the university is also affiliated with healthcare facilities, which have additional requirements for steam and hot water. The university often also supplies chilled water for comfort conditioning and other purposes.

In most cases, the demand for electric power, heat and chilled water is year-round, 24 hours a day. Thus, the heat captured from power generation can be fully utilized. A supplementary steam system may sometimes be used for peak winter heating periods.

DOE Report Indicates Potential

According to a March 2016 report by the U.S. DOE titled "Combined Heat and Power (CHP) Technical Potential in the United States," there currently are 272 applications of CHP by colleges and universities in the U.S. These facilities have a total capacity of 2,674 MWe. Thus, the average university system is about 10 MWe. Most of these systems are natural gas-fired steam turbines, gas turbines and engines. The report notes that for many educational institutions, the demand for electric power and for steam is often coincident, thus making these systems especially attractive.



Solar Turbines Model Taurus 60 gas turbine of the type installed at the University of Arkansas CHP facility. Photo courtesy: Solar Turbines

[redacted] cates that the national potential for these systems is 13,932 MWe. Thus, to date we have achieved 20% of the potential in this area. In many cases, adoption of CHP is being considered in conjunction with decommissioning or mothballing of coal-fired generation and heat plant units.

University of Arkansas

A recent example of an institution that has taken this route is the University of Arkansas at Fayetteville. Scott Turley, Executive Director of Campus Util[redacted] ply campus electric energy. This unit was sized to the school's base steam demand, and uses a heat recovery steam generator (HRSG).

Turley explains, "The CHP system can satisfy the full campus requirement for steam for five months of the year. Under winter-load conditions, the HRSG system can furnish approximately 35% of the campus steam requirement." This installation was an important element in the university's Climate Action Plan, which is based on reducing source air emissions. Because the central station electric power it replaced was 75% coal-fired, the contribution was significant.

Photo illustrates the inlet side of the heat recovery gas generator at the University of Arkansas. Photo courtesy: Cleaver Brooks

Solar Turbines Taurus Unit

The gas turbine and HRSG are located in the existing 1956 heating plant building. The building currently also houses ten Miura high pressure steam boilers. The CHP system went into operation in February of 2016. The turbine used is manufactured by Solar Turbines. According to Chris Lyons from Solar Turbines, the unit is a Taurus 60-7301 with an ISO-rated output of 5.2 MWe.

Lyons indicates that these tur[redacted]ines have very long major main[redacted]enance intervals. "Approximately [redacted] 30,000 hours the engine is over[redacted] to bring it back to new condi[redacted] In addition, Solar Turbines does [redacted]annual inspections to assure the units do not have any issues."

According to Lyons, this unit used alone has an efficiency of 30%, but when used with an appropriately sized HRSG, the system efficiency jumps to 77.8%, and when used with supplemental firing of the exhaust heat, can increase to 88.8%. The HRSG is manufactured by Cleaver-Brooks, and can produce up to 29,500 pph of 250 psig saturated steam.

Fuel Efficiency Soars

Because of this high system efficiency, it is estimated that the project will divert 35,000 metric tons of carbon dioxide equivalent emissions from the atmosphere. The University cites this as a major step to its goal of complete carbon neutrality, while also saving money for the school. According to Turley, based on the first six months of operation, the CHP system is projected to reduce utility bills for the University by $420,000.

A recent speaker at a Technology & Market Assessment Forum, sponsored by the Energy Solutions Center, was Dalia El Tawy from Siemens Energy. She presented information on a variety of CHP applications, several of which were university campus projects. One was the University of New Hampshire, where a recent installation includes a 7.8 MWe Siemens gas turbine, which can operate on natural gas or landfill biogas collected at a nearby site.

Cuts Emissions from Power Plants and Landfills

Through use of a HRSG, the facility also supplies up to 12 MW of heat for campus heating and cooling. Again, this facilit[redacted] contributes to carbon emission goa[redacted] not only by reducing campus and utilit[redacted] emissions, but also by reducing landfi[redacted] gas atmospheric emissions. According t[redacted] Tawy, the facility has achieved 99.02[redacted] average availability.

Engine Generation CHP

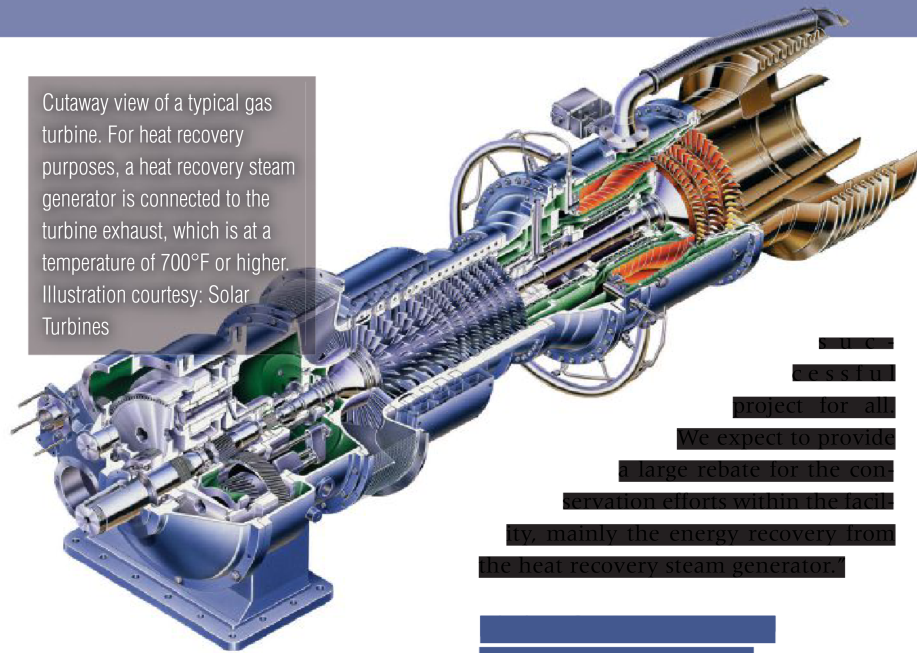
Smaller campuses can also benefit fro[redacted] CHP. Another example cited by Taw[redacted] is Wesleyan University in Middletow[redacted] Connecticut, where a 676 kWe Guasco[redacted] engine-generator at an athletic facilit[redacted] also feeds into the campus microgri[redacted] and the byproduct heat is used for hea[redacted] ing and domestic hot water application[redacted] It is estimated that this project provides savings of $1,000 per day.

Another large-scale example is the recent completion by the University of Minnesota of a CHP facility on the Mississippi River in St. Paul. The facility serves the sprawling university campus and uses a 25 MWe GE gas turbine with a waste heat boiler, plus supplementary duct heaters to also supply steam for campus heat and domestic hot water.

According to University Director of Energy Jerome Malmquist, the guiding principles of the University's utility operations are reliability, sustainability and cost management. He adds, "The campus has a goal to reduce carbon emissions 50% by the year 2020, and to zero by 2050. Modeling predicts that this project will reduce the carbon footprint by 60,000 tons or 10% to 13%. The same models show annual operations savings of $2 million. With regard to reliability, this system has the capacity to power all critical loads on this research and medical campus."

Major Portion of Campus Steam Needs Met

University Vice President for Facilities Management Mike Berthelsen notes that the plant will supply approximately 85% of the campus steam needs, and will annually generate 166 million kilowatt-hours of energy. A specific need for the high-pressure steam is for sterilization and other research purposes at large campus medical and laboratory facilities.



Cutaway view of a typical gas turbine. For heat recovery purposes, a heat recovery steam generator is connected to the turbine exhaust, which is at a temperature of 700°F or higher. Illustration courtesy: Solar Turbines

The University recently completed an electric energy interconnection agreement with electric power supplier Xcel Energy. The natural gas supplier to the University, CenterPoint Energy, recently gave its "Most Innovative Project of the Year" award to the University for the project.

CenterPoint Energy Worked with University

Paul Albinson, key account manager for CenterPoint, worked closely with the university on this project. He notes, "To ensure financial sustainability and reliability, the University worked with CenterPoint Energy to put into place a new service line to the CHP plant to provide natural gas, and also negotiated long term delivery contracts for this to be a [redacted]

[redacted]

With states and governing bodies looking for ways to cut operating costs at educational institutions, CHP is a major opportunity. With these projects, the sponsoring institutions may be motivated not only by energy and dollar savings, but also by the potential of CHP projects to contribute to lowering atmospheric carbon emissions and other air pollutants. It is an investment that can pay dollar and environmental dividends for decades. **GT**

MORE info

DOE CHP DATABASE
https://doe.icfwebservices.com/chpdb/state/WI

GENERAL ELECTRIC POWER GENERATION
https://powergen.gepower.com

GUASCOR ENGINES
www.dresser-rand.com/products-solutions/guascor-gas-diesel-engines

MUIRA
www.miuraboiler.com/solutions

SIEMENS ENERGY
www.energy.siemens.com/us/en/fossil-power-generation

SOLAR TURBINES
https://mysolar.cat.com/en_US/about-us.html

COMBINED HEAT AND POWER AND...FROZEN VEGETABLES

Ammonia Absorption Cycle Creates Opportunities

LARGE-SCALE ENERGY USERS AROUND THE WORLD HAVE BECOME AWARE OF THE BENEFITS OF COMBINED HEAT AND POWER (CHP) SYSTEMS. These use a high-quality energy source – often natural gas – to generate electric power using an engine, gas turbine, or fuel cell. The heat byproduct from this electric generation is then used beneficially for process purposes, for space heating or domestic hot water, or to power an absorption chiller for process or comfort cooling.

CHP can increase overall system efficiency from 30-40% for electric generation alone up to 75-80% or even higher for total energy utilization. This approach can dramatically reduce total site energy costs and cut down drastically on total carbon and other emissions.

Getting More for the Energy Dollar

For many industrial and institutional energy users, absorption cooling may be the key method to derive year-round efficiency through CHP. The many different types of absorption chillers all work on the same principle. In a partial vacuum environment, an absorption fluid is evaporated, removing heat from the fluid which is then used to chill water. An external thermal source such as steam, exhaust gas or hot water is introduced to regenerate the absorption solution, allowing the fluid to continue the chilling cycle.

Where Absorption Works

The most frequently used system with absorption chillers uses a bromine-water refrigerant. This chiller method is ideal for comfort cooling where there is a low-cost thermal source, such as byproduct engine or turbine exhaust heat. The limitation is that it is impractical to use this cycle to generate chilled water much lower than 40°F (4.4°C) because of the risk of freezing up the machine. This temperature level is adequate for perishable product pre-refrigeration. Fortunately, another absorption system is available that offers true refrigeration into the low 30s, and far beyond into sub-freezing temperatures. That system is absorption refrigeration and freezing using ammonia-cycle chillers.

Ammonia Cycle for Lower Temperatures

Ammonia-based absorption is not new. Many home and commercial refrigerators in the early twentieth century used this system. More recently, refrigerators for campers and remote scientific sites use this technology, employing a propane or kerosene flame as a thermal source.

Ammonia based systems have come a long way in efficiency, especially for situations where there is an abundant source of byproduct heat. They are ideally suited for a wide range of industrial applications.

The ammonia absorption system can easily produce temperatures in the range just above the freezing point of water, and can even generate refrigeration suitable for freezing product down to 0°F (-18°C) or even lower. With an adequate source of high temperature byproduct heat, it is an ideal method for using this energy productively.

This ammonia absorption chiller can use hot water from a solar collector, supplemented by a natural gas boiler, to provide both hot water and chilled water at a hotel complex. Photo courtesy: Energy Concepts Company

Ammonia Chiller Packages Available

Energy Concepts Company is one of the leading providers of ammonia cycle absorption chillers and related heat exchange equipment. Ellen Makar from

MORE info

DOE ABSORPTION COOLING BASICS
www.energy.gov/eere/energybasics/articles/absorption-cooling-basics

ENERGY CONCEPTS COMPANY
www.energy-concepts.com

OSHA AMMONIA USE SAFETY GUIDELINES
www.osha.gov/SLTC/etools/ammonia_refrigeration/index.html

This skid-mounted 125-ton ammonia absorption chiller provides chilled water at a nominal 32°F for a vegetable processing plant. The heat source is a gas fired engine generator. Photo courtesy: Energy Concepts Company

Energy Concepts was a recent presenter at a Technology & Market Assessment Forum sponsored by the Energy Solutions Center, providing information about these applications.

Makar explains, "The colder refrigeration you want, the hotter the driving heat is required. For +10°F refrigeration, we need a heat source around 260° F that we can take down to 230° F. For -10° F we need around 280° F to take down to 250° F." She notes that engines or gas turbines can provide ample thermal energy. "Gas turbines are great sources of waste heat because of the hot exhaust." She notes that the Capstone microturbine, with an exhaust temperature of 535°F, can be a very valuable source of heat for refrigeration using an ammonia-cycle chiller.

An 80-ton ammonia absorption chiller provides -25° F refrigeration for a public cold storage warehouse in the Philippines. The heat source is a boiler that burns rice husks. Photo courtesy: Energy Concepts Company

Efficiency Penalty at Lower Temperatures

Makar points out that with compression refrigeration, the cycle efficiency goes down as the target temperatures are lowered. "Compressor efficiency for an output at air conditioning temperatures (45°F) is about 0.6 kW per ton. For temperatures of 10°F, you need 2.0 kW per ton. With waste heat-powered refrigeration, you do not need to burn extra fuel or buy additional electric energy." She adds that the heat-source water, after it leaves the absorption chiller, can further be reused for space heating or domestic hot water.

Variety of Industries Use Ammonia Systems

Makar indicates that a variety of industries with refrigeration or freezing requirements have chosen this solution for their processes, using byproduct heat from electric generation as the source. Examples include potato processing, fruit and vegetable freezing, dairy products and meat processing. Other candidates might include cold storage warehouses, breweries, wineries, poultry processing plants and cheese plants.

Energy Concepts Company has units successfully operating at a wide range of sites, including a vegetable processor and a cheese plant in California, a fish storage warehouse in Alaska, and a public cold storage warehouse in Manilla, Philippines.

Existing Generation Becomes an Asset

Are you a candidate for ammonia cycle refrigeration using CHP byproduct heat? If you are an industry that uses large scale refrigeration and already have on-site electric generation and are not using the byproduct heat, it's definitely a promising option. As Makar points out, it is practical to use refrigeration for the first stage in using heat. The chiller outlet water still contains much thermal energy that can be used for other applications.

If you are contemplating CHP, remember to include potential absorption cooling or refrigeration applications as very effective ways to use that heat and avoid the cost of compression refrigeration. Absorption is a tool to make CHP pay. **GT**

TAKE BACK YOUR STEAM ENERGY

It's Out There to Capture

IN DISCUSSIONS ON HOW TO MAKE TODAY'S STEAM AND HOT WATER SYSTEMS MORE EFFICIENT, first thoughts often turn to replacing or upgrading boilers or boiler burners, or to reducing the demand for steam or hot water at the point of use. But great opportunities also exist in making major improvements in steam and hot water distribution systems.

Rapid Paybacks Possible

Often the paybacks from improvements come within weeks or a few months at a cost much lower than replacing or upgrading a boiler or burner. After making these improvements, you may find yourself asking, "Why didn't I do this sooner." The first step is evaluating your system and finding those opportunities.

Savings can come from incremental reductions in energy losses by completely insulating hot pipes and devices, improving condensate return systems, assuring correct operation of steam traps, and recovering heat from boiler blowdown water. Individual steps may make only small improvements, but taken together they can make for improvements in steam system efficiency ranging from 10% to 20%. Where do we find these savings?

Insulate to Reduce Heat Losses

Whether it's an eight-inch main steam line, or a one-inch hot condensate return line, insulation is critical. In an example cited by the U.S. DOE, at a plant where the fuel cost was $8.00/MMBtu, a survey identified 1,120 feet of bare 1-inch steam line, and 175 feet of bare 2-inch line, both operating at 150 psig. An additional 250 ft of bare 4-inch-line operating at 15 psig was found. Taken together, these resulted in a heat loss of 5,069 MMBtu/hour at an annual energy cost of $45,620. These energy losses could be reduced by 90% by the appropriate use of pipe insulation. In a case like this, the payback is very short – a matter of weeks.

Missing Insulation Common

Reasons for inadequate or missing insulation are numerous. Sometimes in the rush to start up a new system, the final step of pipe insulation is never completed. Sometimes devices such as steam traps and valves are initially wrapped with insulation but during periodic inspection or maintenance, the insulation is removed and not replaced.

Often older insulation is damaged or saturated with water and loses its effectiveness. Sometimes asbestos insulation was removed as part of a plant-wide abatement program, but was never adequately replaced. With today's higher energy costs and an increased emphasis on system efficiency, it's time to correct these problems.

Heat Loss Per 100 Feet of Uninsulated Steam Line

Distribution Line Diameter, inches	Heat Loss Per 100 Feet of Uninsulated Steam Line, MMBtu/yr			
	Steam Pressure, psig			
	15	150	300	600
1	140	285	375	495
2	235	480	630	840
4	415	850	1,120	1,500
8	740	1,540	2,030	2,725
12	1,055	2,200	2,910	3,920

Based on horizontal steel pipe, 75°F ambient air, no wind velocity, and 8,760 operating hours per year.

Designs for Easy Removal and Replacement

One very useful solution is advanced insulation systems that are highly effective yet allow easy removal and replacement for periodic inspection or service. One provider of these systems is Shannon Enterprises, manufacturers of INSULTECH™ blanket thermal and acoustic insulation systems. Shannon manufactures a wide range of custom insulation products, including insulation packages for steam and hot water pipes and devices of all type. Commonly insulation for each steam device is custom-fitted to allow for piping, sensors, valve stems, etc. This fitted insulation is designed for quick removal and replacement to allow for inspection or service, and fits around data links such as steam trap monitoring systems. Three additional benefits of quality insulation are more comfortable working conditions, less pipe noise, and reduced risk of personnel burns.

Complete Condensate Return a Target

Another major area for system efficiency improvement is improving hot condensate return. Too often condensate return piping has not been extended to the full extent of the steam system and hot liquid simply drips away into floor drains. Nevana Iordanova discussed the importance of condensate return at a recent Technology & Market Assessment Forum sponsored by the Energy Solutions Center. Iordanova noted, "Condensate is a tangible item which can be measured in the form of a savings analysis."

She pointed out that 13% to 45% of the total heat in a steam system is represented by hot condensate, most of which can be retained by proper condensate return. Further, this hot condensate is already treated so it does not require additional chemicals. In some locations collection of condensate also significantly reduces the cost of water. Thus, the payback for extension and maintenance of these return lines is often short and should be considered. Another aspect of collecting full value from condensate return improvement is

Uninsulated fittings, such as this bare six-inch steam valve, represent a major heat loss, and thus a loss in plant efficiency. Situations like this can be easily corrected with modern removable insulation tools. Photo courtesy: Shannon Insultech

adequate insulation at the steam trap and along the return piping.

Steam Traps a Major Target

Most steam distribution systems have dozens, sometimes hundreds of steam valves and traps of various designs. Iordanova pointed out, “Steam leaks, water hammer, plugged valves and traps lead to process loss, large equipment damage, safety issues, energy loss, and environmental issues.” These are often in locations where inspection is challenging or at least time-consuming. Thus, it is important to verify that these devices are operating as intended, without loss of steam or condensate. Often the best solution is remote steam system device monitoring, with alarming features that indicate malfunctions as soon as they occur, rather than waiting for the next inspection.

Iordanova notes that Armstrong recently introduced SAGE™, a cutting-edge innovation in smart utility monitoring, measuring and reporting. It is a powerful software tool to analyze data and track trap’s behavior and performance. A fully integrated solution, it works seamlessly with Armstrong’s real-time monitoring devices, ensuring that it always has access to the most current data on your critical system steam traps.

Many owners have chosen to include steam trap monitoring in initial system designs, or to retrofit existing systems with remote monitoring capabilities.

Recover Heat from Blowdown

One more opportunity for major energy savings in the steam system is boiler blowdown water heat recovery. According to a Steam Tip Sheet of the U.S. DOE, in a plant where the fuel cost is $8/MMBtu and the blowdown ratio is 6% of the hourly steam flow of 50,000 lbs at 150 psi, the potential is for recovery of 90% of the heat, with an annual value of $68,000. Several manufacturers offer these heat recovery devices which can be installed during initial system construction or in retrofits. This is heat energy that has already been paid for, and should be recovered.

These are some of the potential energy conserving steps that can be taken to improve system efficiency. All are worthwhile targets for most applications. In today’s era of increased emphasis on conserving energy and reducing carbon emissions, they are worth acting on. Many older steam systems were designed without the full complement of these tools, but can be upgraded. Major system efficiency improvements are out there, often for a very moderate investment. **GT**

By insulating valves, steam traps and other fittings, plant efficiency is significantly increased, plant temperatures are lower, and risks of burns to personnel are reduced. Photo courtesy: Shannon Insultech

The steam system efficiency monitoring plus malfunction alarming can detect departures from established standards in real time. Photo of Sage™ monitoring system courtesy: Armstrong International

MORE info

ARMSTRONG INTERNATIONAL
www.armstronginternational.com/products-systems

DOE BOILER BLOWDOWN HEAT RECOVERY
https://energy.gov/sites/prod/files/2014/05/f16/steam10_boiler_blowdown.pdf

DOE PIPE INSULATION BENEFITS AND CALCULATOR
https://energy.gov/sites/prod/files/2014/05/f16/steam2_insulate.pdf

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Rich North American Gas Resources

FEW OF US SAW THIS COMING. WE DIDN'T FORESEE THE IMPORTANT ROLE that would be played by tight natural gas extraction technology on the volume and location of natural gas recovered. Final production figures for 2016 are not yet tabulated, but it is expected that for the first time, more than half the natural gas that comes to market in the U.S. comes from gas wells in shale and other tight rock formations. This was a resource that in previous decades was considered "not economically recoverable."

The term "tight" refers to rock formations which hold gas and oil so closely that it cannot be recovered economically without fracturing the rock. In large part, because of shale and other tight rock-sourced natural gas and oil, the energy picture has dramatically changed. Areas in the Eastern United States and Eastern Canada are producing large volumes of natural gas where it was not previously produced. Western regions that had been in a production decline are now on an upswing.

Map illustrates the diversity of natural gas plays in North America. Illustration courtesy: U.S. Energy Information Administration.

New Sources, New Technology

The convergence of three technologies made energy recovery from tight rock formations practical. These were sophisticated horizontal drilling tools and techniques, "smart" drill feedback communications, and hydraulic fracturing – "fracking." Beginning in the early 2000s, use of these tools began contributing to North American energy production capabilities.

Interestingly, although oil and natural gas are associated in many production fields, currently the largest producing tight oil fields and the largest tight gas fields are not in the same areas. According to the U.S. Energy Information Administration (USEIA), of the top ten tight gas-producing fields in the US, only one, the Eagle Ford formation in Texas, is also among the top ten oil fields.

Sources in Varied Locations

The largest-producing natural gas formation in the U.S. is the Marcellus formation in Pennsylvania and West Virginia. In 2013, this formation accounted for 2,836 billion cubic feet of natural gas. Other important formations include the Newark East Barnett Shale in Texas, and the Haynesville Shale in Texas and Louisiana. Other regions that have major shale gas production include Arkansas, New Mexico, Colorado and Wyoming.

In Canada, a much lower percentage of the country's gas production currently comes from shale and other tight rock formations. Prominent producing areas in Canada include northeastern British Columbia and to a lesser extent, Alberta. In Quebec, Nova Scotia and New Brunswick, promising formations have been identified, but production is still quite low. Canada is a net exporter of natural gas, most of it to the U.S.

Decline of Utility Carbon Emissions

In a related significant development, electric utility carbon emissions in the U.S., for the first time in decades, fell to a level below that of transportation carbon emissions. This follows a steady drop in these utility emissions since 2003. This decline can be attributed to three factors: The retirement of older coal-fired generating stations, the increasing installation of lower-emission natural gas-fired facilities, and the growing role of renewable electric generation from solar and wind sources.

Where the gas turbine alone is used to operate a generator, it is called a simple-cycle plant. These have been widely used in the past, but the growing trend is toward what is called a combined-cycle plant. Here, the exhaust from gas turbines is directed to a heat recovery device for steam generation. The steam is used to turn a steam turbine for additional generation.

Strong Trend Toward Combined-Cycle

According to the USEIA, in 2018 about 75% of new natural gas-fired generating plants will be of the combined-cycle type. This trend is one of the reasons that emissions from utility natural gas-fired generations are significantly lower. Combined-cycle technology increases the generation efficiency of the plant and thereby reduces carbon emissions per kWh generated.

An example of implementation of this technology was recently given by Siemens

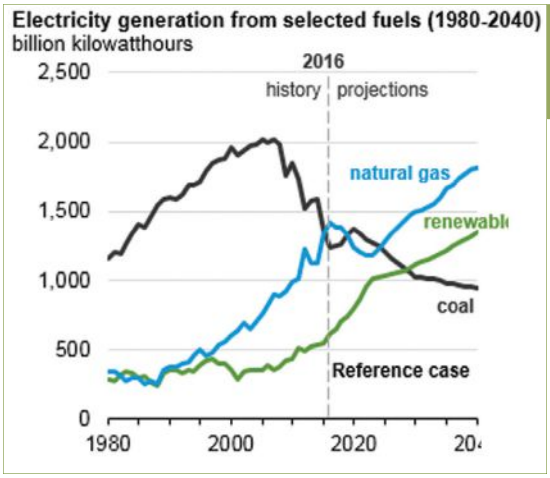

Chart shows one EIA projection of the energy sources for future electric generation. This illustrates the probable growing role of natural gas as a replacement for coal-fired generation. Illustration courtesy: U.S. Energy Information Administration

spokesperson Dalia El Tawy of Siemens Energy at a Technology & Market Assessment Forum, sponsored by the Energy Solutions Center. She described a decision by the City of Holland, Michigan to replace a coal-fired generating station with a natural gas-fired combined-cycle plant. This plant has two Siemens gas turbines rated at about 50 MWe each, and a steam turbine rated at about 40 MWe.

The byproduct heat from the plant, in addition to feeding the steam turbine, is used to supply an expanded snowmelt system covering over 11.5 acres of city streets and sidewalks. This is the largest snowmelt system in the U.S., serving a city in the lake-effect snow area of western Michigan.

This is typical of hundreds of decisions being taken by public and investor-owned utilities in the U.S. and Canada. In a recent USEIA forecast, in 2018 for the first time ever, electric generation from natural gas will exceed that from coal combustion. The world changes.

Export and Import in Balance

Taken together, the United States and Canada consume a very high percentage of the natural gas produced by the two countries. The U.S. is a significant importer of natural gas from Canada in the west – in Idaho, Montana, and Minnesota. On a somewhat smaller scale, the U.S. is an exporter of natural gas in the east – in Michigan and New York into Ontario and Quebec. Changing production volumes in both countries will cause these balances to continually change in the future. The U.S. is also a major net exporter of natural gas into Mexico. In the case of these three countries, gas movement is almost entirely by pipeline.

Because of the growing production of natural gas in North America, the trend of natural gas importing into the U.S. by liquid natural gas shipment has remained steady or declined slightly. Of the imported liquid natural gas, in 2015 about 80% came from Trinidad/Tobago. Other sources include Norway, Yemen and other countries. However, on a broad level, imports of liquid natural gas currently represent a small proportion of gas used.

Gas Storage Trends

Natural gas is produced at a fairly even rate through the year, but traditionally, the usage pattern is much higher in the winter. For this reason, storage facilities have been developed in the U.S. and Canada to allow withdrawals during times of peak usage, and replenishment during other times of the year. These storage sites include depleted oil and gas production fields, below impenetrable aquifers, and in empty salt caverns.

Storage Remains Steady

Although the usage of natural gas has increased dramatically in recent years, the available storage capacity has shown few changes. This has not been a problem to date, because much of the increase in usage has been by electric generation and manufacturing applications. Electric generation nationwide peaks during summer air-conditioning months, thus tending to even out annual demand patterns. Therefore, the unevenness between summer and winter usage has not increased.

Future for Natural Gas is Bright

Natural gas is the fuel that is driving many changes. It is supporting the transition from coal and oil to other methods of electric production. It is making it possible for North America to hold onto many of its traditional industries, and in fact is drawing some companies that have offshored to return home. And it is a lead force in a world that is demanding higher efficiency, lower emissions, and energy to maintain our life style. **GT**

MORE info

CANADA NATIONAL ENERGY BOARD/NATURAL GAS
www.neb-one.gc.ca/nrg/sttstc/ntrlgs/index-eng.html

U.S. ENERGY INFORMATION ADMINISTRATION/NATURAL GAS
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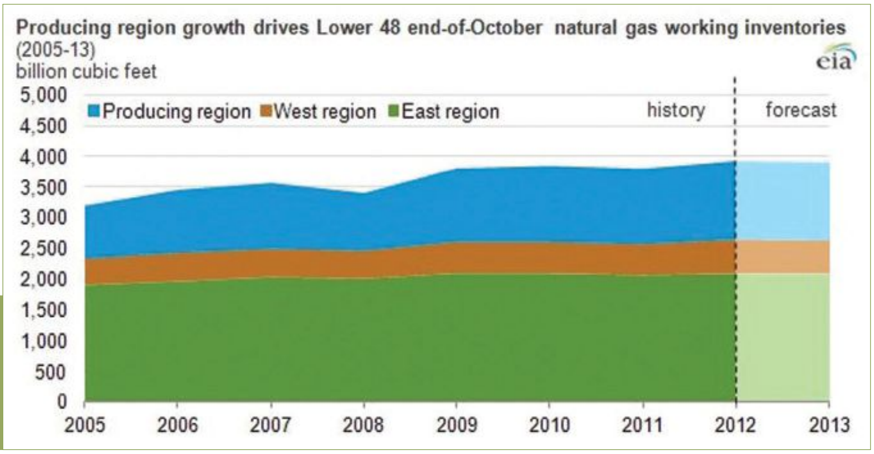
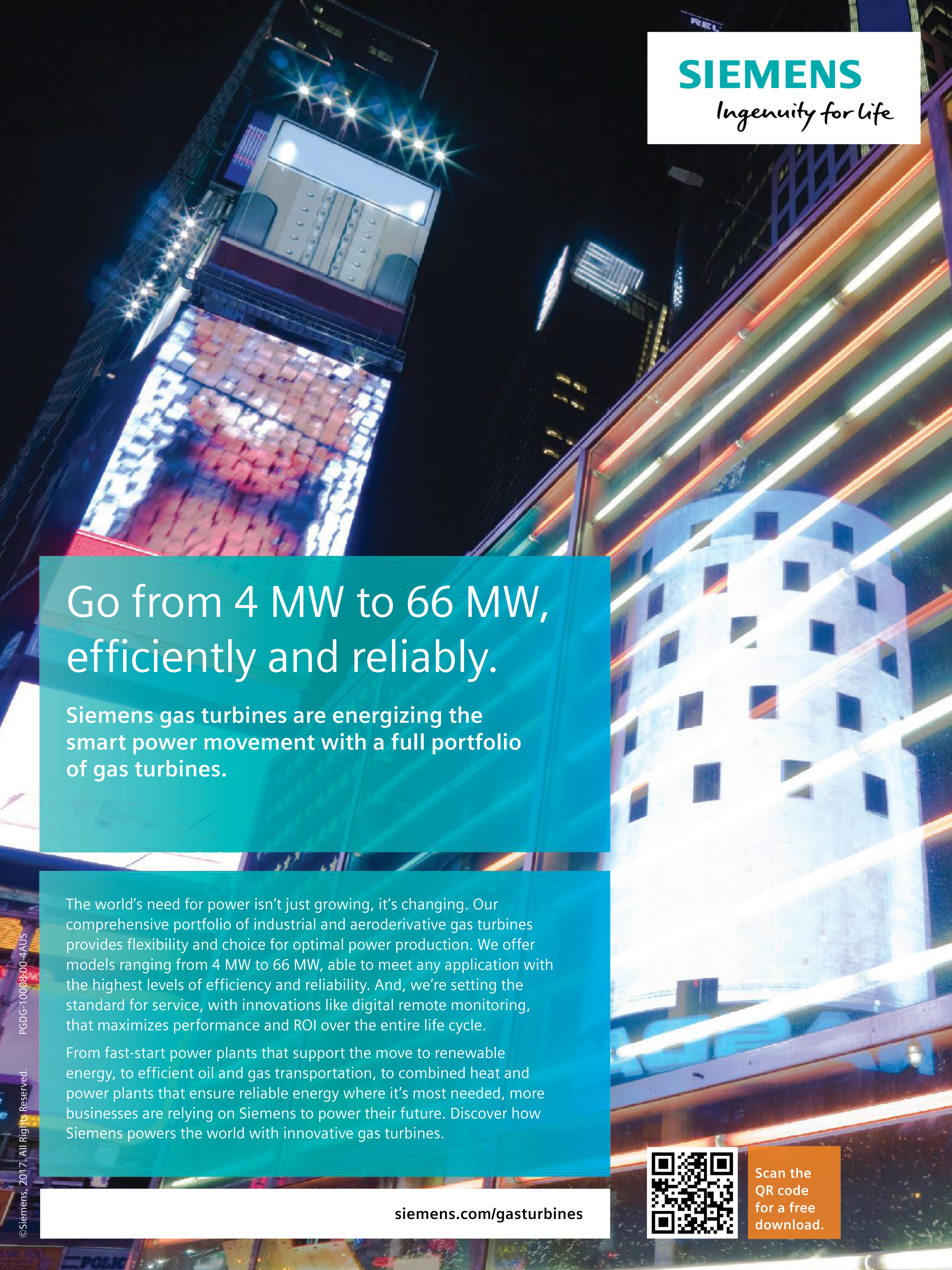


Graph shows recent trends in gas storage in the U.S. Note: increase has been gradual because of the growing seasonal diversity of gas usage. Illustration courtesy: U.S. Energy Information Administration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