

GPG Outbrief 04

# Condensing Boilers

GPG Program | U.S. General Services Administration | July 13, 2017



# GPG-004 Condensing Boilers @ gsa.gov

- ❑ Infographic
- ❑ 4-page Findings
- ❑ Full Report
- ❑ Additional Resources

The screenshot shows a web browser window displaying the GSA website. The page title is "Condensing Boilers". The navigation bar includes links for TRAVEL, REAL ESTATE, ACQUISITION, TECHNOLOGY, POLICY & REGULATIONS, and ABOUT US. The breadcrumb trail is: Home > Governmentwide Initiatives > Sustainability > GPG Program > Published Findings > HVAC > GPG PROGRAM > 004. Condensing Boilers.

**GPG PROGRAM**

- Overview
- What is GPG?
- Published Findings
- Building Envelope
- Energy Management
- HVAC
  - 029. Smart Ceiling Fans
  - 020. Wireless Pneumatic Thermostats
  - 013. Indirect Evaporative Cooler
  - 012. Fan Belts
  - 009. Maglev Chiller
  - 006. Variable Refrigerant Flow
  - > 004. Condensing Boilers
    - Lighting
    - On-Site Power & Renewables
    - Water
    - Ongoing Assessments
    - Request for Information
    - Outbrief Webinars
    - Technology Deployments

## Condensing Boilers

**GPG-004, Updated July 2014**

Condensing boilers capture the heat that is lost through steam in conventional boilers and are therefore more efficient. Under the right conditions, they will outperform conventional boilers by a substantial margin. GSA tested condensing boilers at the Denver Federal Center and the Peachtree Summit Federal Building in Atlanta, Georgia and found energy savings greater than 14%. *Click on the infographic below to enlarge.*

**READ 4-PAGE FINDINGS**

Findings:  
Condensing Boilers >

**DOWNLOAD FULL REPORT**

Condensing Boilers Assessment PNNL 2012 >

**DOWNLOAD FULL REPORT**

Condensing Boilers Assessment NREL 2014 >

**ADDITIONAL RESOURCES**

- Tool: Energy Cost Savings Calculator for Commercial Boilers: Closed Loop, Space Heating Applications Only (DOE/EERE)

**OPPORTUNITY**

How much energy is used for heating in U.S. commercial buildings?

**35% OF ENERGY GOES TO HEATING!**

**32% OF COMMERCIAL BUILDINGS RELY ON BOILERS TO SUPPLY THIS HEAT?**

**TECHNOLOGY**

How do Condensing Boilers save energy?

**CAPTURE HEAT THAT IS LOST THROUGH STEAM IN CONVENTIONAL BOILERS**

**95% EFFICIENCY**  
15% more efficient than conventional boilers

**M&V**

# Upcoming GPG Outbriefs—Thursdays, 12 PM ET

---

August 10      Synchronous and Cogged Fan Belts

September 14      Next-Generation Chillers

October 12      Electrochromic Windows

## Webinar Recordings

Access all webinars on [GSA.gov](https://www.gsa.gov)

[GSA.gov/GPG](https://www.gsa.gov/GPG)

# Continuing Education Credits

---

GPG webinars offer 1 Continuing Education Learning Unit through the American Institute of Architects

To receive credit:

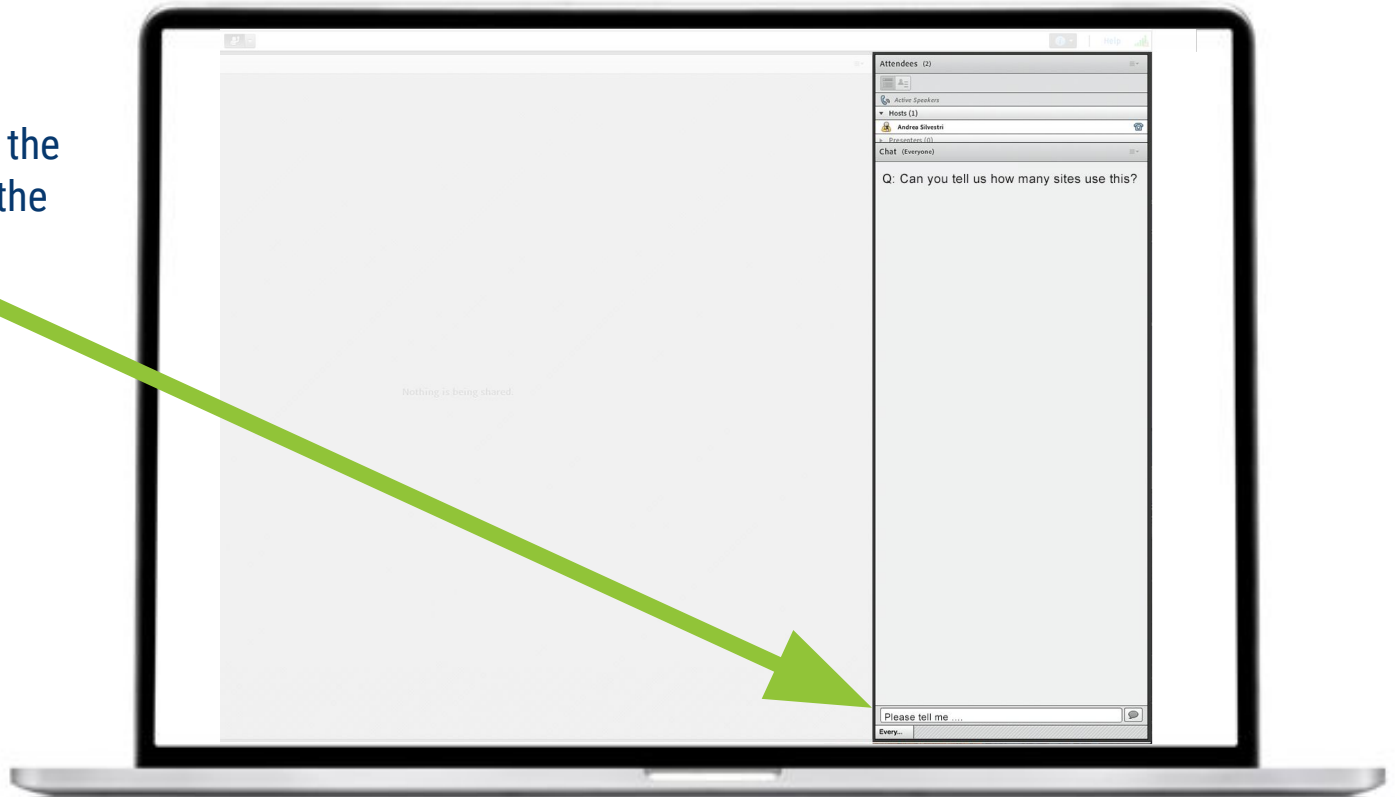
Complete the post-webinar survey, or contact Michael Hobson,  
[michael.hobson@gsa.gov](mailto:michael.hobson@gsa.gov)



# How to Chat Your Questions

---

Please chat your questions during the presentation for the Q&A segment



# Introduction

---



## **Michael Lowell**

Project Manager, GPG

[mike.lowell@gsa.gov](mailto:mike.lowell@gsa.gov)

720.641.8891

# Webinar Agenda

- ❑ **Overview of GPG (5 minutes)**  
Kevin Powell, Director, GSA Emerging Technologies
- ❑ **Condensing Boilers (15 minutes)**  
Dylan Cutler, National Renewable Energy Laboratory
- ❑ **On-the-ground Feedback (15 minutes)**  
Doug Baughman, GSA Region 8
- ❑ **Q & A (15 minutes)**

# Introduction

---




## **Kevin Powell**

Program Manager, Emerging Technologies

[kevin.powell@gsa.gov](mailto:kevin.powell@gsa.gov)

510.423.3384

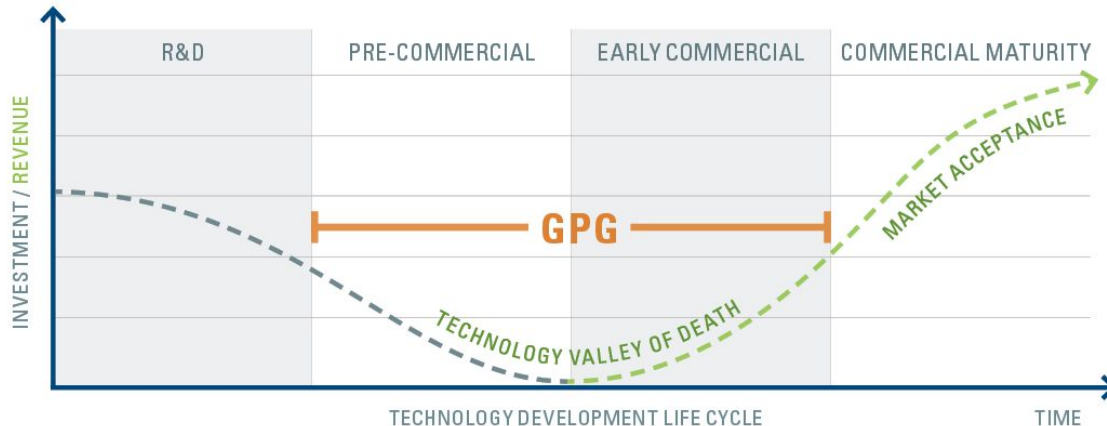




The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

# Leading by Example

GSA's Proving Ground accelerates market acceptance by objectively assessing innovative building technologies in real-world environments, and deploying those that deliver. To date, GSA has installed 9 technologies across more than 200 buildings. In aggregate, these technologies are delivering \$7.8 Million in annual O&M savings.



## GPG Process

---



Identify promising technologies at the edge of commercialization



Pilot technology installations within GSA's real estate portfolio



Partner with Department of Energy national laboratories to objectively evaluate real-world performance



Recommend technologies with broad deployment potential for GSA

# Measurement & Verification

---



**Dylan Cutler**

R&D Staff, National Renewable Energy Laboratory

GPG-004 | UPDATED JUNE 2014

# CONDENSING BOILERS

GPG-004

# Condensing Boilers



## Condensing Boilers Reduce Heating Energy Consumption

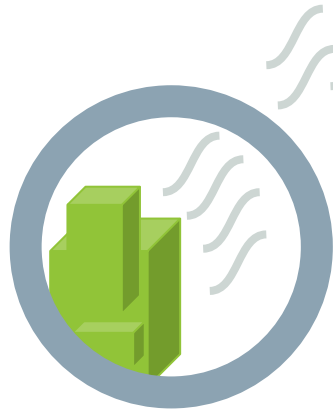
Heating accounts for roughly a third of total energy consumption in U.S. commercial buildings, with boilers supplying heat to 34.5% of total floor space.<sup>1</sup> Considering GSA's own reliance on boilers for heating, GSA's GPG program recently assessed the performance of condensing boilers at six federal facilities—one at the Peachtree Summit Federal Building, in Atlanta, Georgia, and five at the Denver Federal Center (DFC) in Lakewood, Colorado. Condensing boilers perform more efficiently than conventional boilers by extracting more of the heat energy released in the combustion process. For maximum efficiency condensing boilers must operate under the right conditions—the most important of which is return water temperature (RWT). For "condensing mode" to be achieved, RWT must be below 130°F. In the six facilities studied, only three were able to achieve condensing mode more than 30% of the time. Still, all facilities experienced significant reductions in natural gas consumption, with savings greater than 14% when compared

## GPG-004. Condensing Boilers

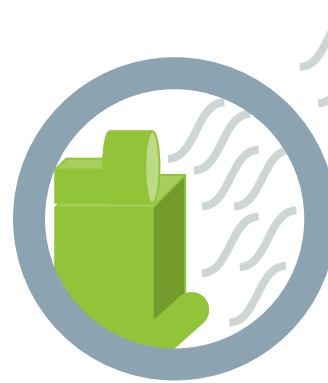
---

Captures heat that is lost through steam in conventional boilers

15% more efficient than conventional boilers



**80%**  
conventional  
boiler efficiency



**95%**  
condensing  
boiler efficiency

# Opportunity

---



**35%**  
of energy  
used for heat



**33%**  
commercial  
buildings rely  
on boilers

# Measurement & Verification

---

PNNL assessed 4 condensing boilers at Peachtree; NREL assessed 22 at DFC





# Measurement & Verification—Denver Federal Center

---

## Test Plan

- Pre-retrofit utility data normalized for outside air temperature from 10/2008 - 9/2011
- 15-minute trend data from the BAS from 2/2012 - 4/2012

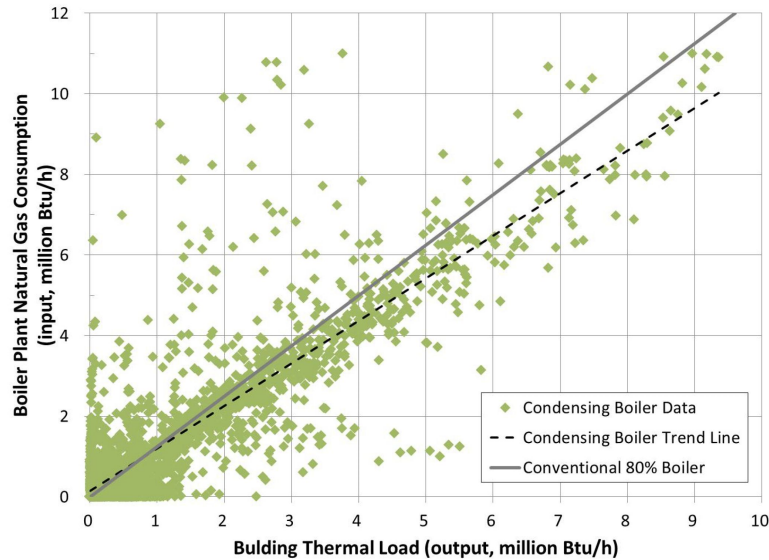
## Monitored points for Denver Federal Center

Building	OAT	SWT	RWT	Pump Enabled	Pump Speed	Coil Position
25	✓	✓	✓	✓	✓	✓
45	✓	✓	✓	✓	✓	✓
54	✓	✓	✓			
710A	✓	✓	✓	✓	✓	
810	✓	✓	✓	✓		✓

# Savings in Atlanta and Denver

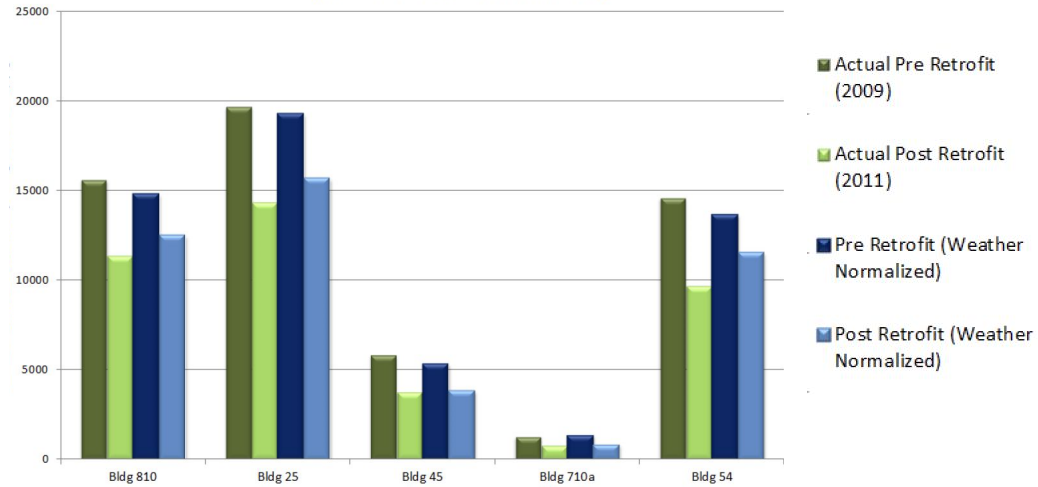
## Peachtree - Average Savings 14%

Condensing boiler plant thermal performance



## Denver - Average Savings 24%

Annual pre- and post-retrofit natural gas consumption (dekatherms/yr)



## 4–6 Year Payback with End-of-Life Replacement

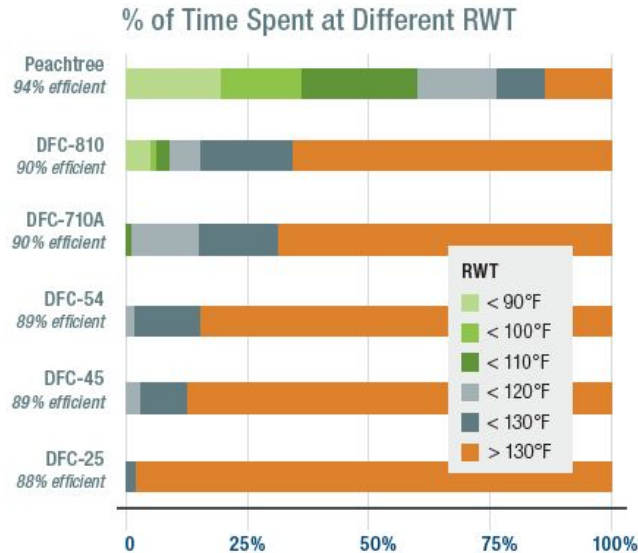
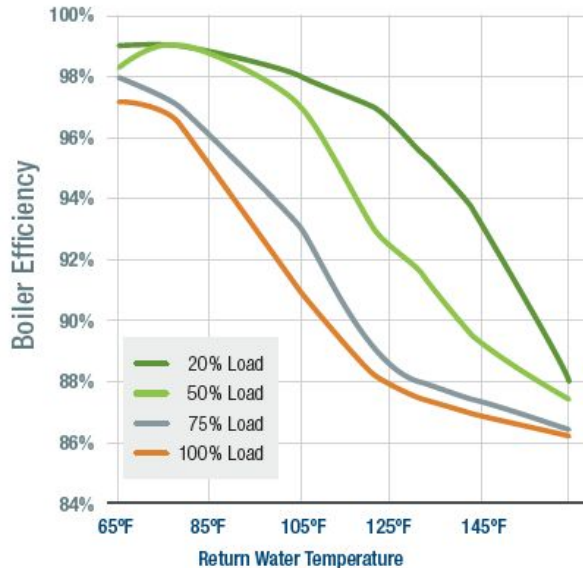
---

Life-cycle cost-effective when only 3-5% more efficient than a high-efficiency boiler

Building	Cost high-efficiency boiler 84%-86% efficiency	Cost condensing boiler 86%-98% efficiency	Energy Cost Savings	Projected Payback (yrs)
Peachtree (normalized)	\$384,800	\$426,100	\$11,425	3.7
DFC, 25	\$629,084	\$697,406	\$15,326	4.5
DFC, 45	\$183,836	\$203,801	\$6,361	3.1
DFC, 54	\$524,236	\$581,171	\$9,161	6.2
DFC, 710A	\$122,557	\$135,868	\$2,344	5.7
DFC, 810	\$629,084	\$697,406	\$16,368	42.6 <i>Boilers not due for replacement</i>

# Efficiency Hinges on Return Water Temperature Below 130°F

Lower RWT results in greater efficiencies



## Operating with RWT below 130°F

---



- ❑ Use an outdoor temperature reset on supply water
- ❑ Reduce hot water flow rate
- ❑ For new builds/deep retrofits
  - ❑ Install high Delta-T coils
  - ❑ Use 2-way valves with variable speed pumps
  - ❑ Use a primary piping system with 1 water loop

## Best Practices for Condensing Boilers

---



- ❑ Conduct a load calculation to meet max load without excess capacity
- ❑ Select boilers with low turndown ratio/minimum flow requirement
- ❑ Use stainless steel for vent stacks
- ❑ Operate multiple smaller boilers in parallel at low loads
- ❑ Consider using condensing boilers for 75% of building's heating load

# GSA Deployment Opportunity

---

**Best suited as end-of-life replacement**

For conventional boilers where return water temperature < 130F is possible



# On-The-Ground Feedback

---



**Doug Baughman, R8**  
Energy Program Specialist  
Denver Federal Center



# Condensing Boilers at the Denver Federal Center

---

## Between 2006–2007, 20 condensing boilers installed

- Existing non-condensing hot water boilers inefficient and expensive to maintain – \$100,000 over 2 years. Condensing boilers saved tens of thousands in refractory repairs.
- More compact—in 1 installation, 1 small boiler replaced 3 large boilers.
- New boilers saved 21% compared to campus data from previous winter and winter was much colder.
- 4 to 5 year payback.

# Installation Experience

---

## Boiler layout needs to work with flue vent and stack layout

- Breaching a common vent stack did not work for condensing boilers but worked fine for non-condensing boilers.
- Can a product be too new? R&D still working on operating program when boilers were installed but luckily boilers were installed in the summer.



# Galvanized Venting Didn't Work

---

One installation used improper materials for the venting

- Galvanized vent pipe experienced acidic condensation leaching within 5 years.



# Stainless Steel Replacement

---

Vent pipe replaced with proper venting installation in 2015

- Lesson learned: communicate, don't accept less than required, hire a good contractor.



# Building 25, Denver Federal Center

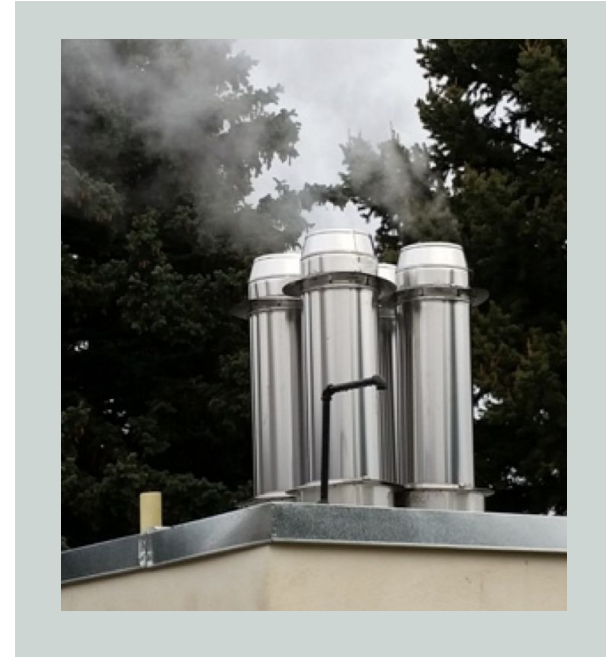
---



# Overall Feedback

---

- Current control strategy uses outside air to reset the supply temperature. Other strategies such as using the building load (return water temperature) could bring additional savings.
- Annual combustion tests show 90-93% efficiency.
- Annual maintenance less intensive but still time consuming.
- Condensing boilers heat water directly allowing faster response to changing conditions.
- 5 out of 5 stars.



# GSA Deployment of Condensing Boilers

---

## GSA deployment—127 Boilers

- Throughout the portfolio, largest number in Region 6
- BA54, BA55, ARRA and ESPC financing
- Wide range of manufacturers and models installed



Q & A



# Survey and Continuing Education Credit

GPG webinars offer 1 Continuing Education Learning Unit through the American Institute of Architects

To receive credit:

Complete the post-webinar survey, or contact Michael Hobson,  
[michael.hobson@gsa.gov](mailto:michael.hobson@gsa.gov)

### GPG Outbrief 04 Condensing Boilers – Follow-up Survey

Thank you for your participation in GPG Outbriefs.

**\* Required**

**Email address \***

Your email \_\_\_\_\_

**Continuing Education Credit**

Check here to request a certificate for 1 CE unit.

**How many people listened in on your phone line?**

Choose ▾

**The information presented in the Outbrief webinar was helpful.**

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

**I am interested in condensing boilers.**

Yes, in the next 2 years.

Yes, in the next 5 years.

Maybe

No

**Comments or questions about the webinar or condensing boilers:**

Your answer \_\_\_\_\_

**SUBMIT**

Never submit passwords through Google Forms.

Thank you!



For more information: [gsa.gov/GPG](https://gsa.gov/GPG)

Kevin Powell, Program Manager [kevin.powell@gsa.gov](mailto:kevin.powell@gsa.gov) 510.423.3384

Michael Lowell, Project Manager [mike.lowell@gsa.gov](mailto:mike.lowell@gsa.gov) 720.641.8891

