

GPG Outbrief 07

# Wood-Pellet-Fired Biomass Boilers

GPG Program | U.S. General Services Administration | October 12, 2017

The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white on a dark blue square background.

GSA

# GPG-014 Wood-Pellet-Fired Biomass 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 "Biomass Boilers". The URL is "https://www.gsa.gov/governmentwide-initiatives/sustainability/gpg-program/published-findings/014-wood-pellet-fired-biomass-boilers". The page features a navigation menu with categories: TRAVEL, REAL ESTATE, ACQUISITION, TECHNOLOGY, POLICY & REGULATIONS, and ABOUT US. The main content area is titled "Biomass Boilers" and includes a sub-header "GPG-014, June 2014". The text describes biomass boiler systems as an efficient alternative to oil and natural gas. A sidebar on the left lists various GPG programs, with "014. Biomass Boilers" selected. On the right, there are links to "Read 4-Page Findings [PDF - 505 KB]" and "Download Full Report [PDF - 1 MB]". Below the main text, there are sections for "OPPORTUNITY" and "TECHNOLOGY". The "OPPORTUNITY" section highlights the benefits of locally sourced renewable energy and the advantage of waste wood, noting that pine-beetle infestation has killed 177 million acres of U.S. forest. The "TECHNOLOGY" section states that biomass hot-water-heating systems with solid wood fuel have an efficiency rating of 85%-90%.

**Biomass Boilers**

**GPG-014, June 2014**

Biomass boiler systems that burn solid wood fuel instead of oil are an efficient alternative for hot-water heated facilities where natural gas is unavailable. GSA's GPG program found biomass boilers to be most cost-effective for buildings in cold northern climates within 50 miles of a wood pellet mill. *Click on the infographic below to enlarge.*

**OPPORTUNITY**

*What are the benefits to using Biomass Boilers?*

**DRIVE USE OF LOCALLY SOURCED RENEWABLE ENERGY**

**TAKE ADVANTAGE OF WASTE WOOD**

PINE-BEETLE INFESTATION HAS KILLED 177 MILLION ACRES OF U.S. FOREST<sup>1</sup>

**TECHNOLOGY**

*How do Biomass Boilers work?*

**POWER HOT-WATER-HEATING SYSTEMS**

WITH SOLID WOOD FUEL

**85%-90% EFFICIENCY RATING**

**M&V**

**ADDITIONAL RESOURCES**

- Guidance: Wood Pellet Heating - A Reference on Wood Pellet Fuels & Technology for Small Commercial & Institutional Systems (MA Division of Energy Resources, 06-2007)
- Guidance: Three Ways to Optimize Solid Fuel Combustion (Hurst Boiler & Welding Company, Inc., undated)

# Upcoming GPG Outbriefs—Thursdays, 12 PM ET

---

- |             |  |
|-------------|--|
| November 16 | 2018 RFI<br>Behind-the-Meter Load Optimization<br>Improving Overall Building O&M<br><b>Note: start time of 3 pm ET</b> |
| December 7  | Next-Generation Chillers   |
| January 18  | Socially-Driven HVAC Optimization  |
| February 8  | Plug Load Control  |

## 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)
- ❑ Wood-Pellet-Fired Biomass Boilers (15 minutes)  
Gregg Tomberlin, National Renewable Energy Laboratory
- ❑ On-the-ground Feedback (15 minutes)  
Marty Novini and Michelle Jones, GSA Region 10
- ❑ Q & A (15 minutes)

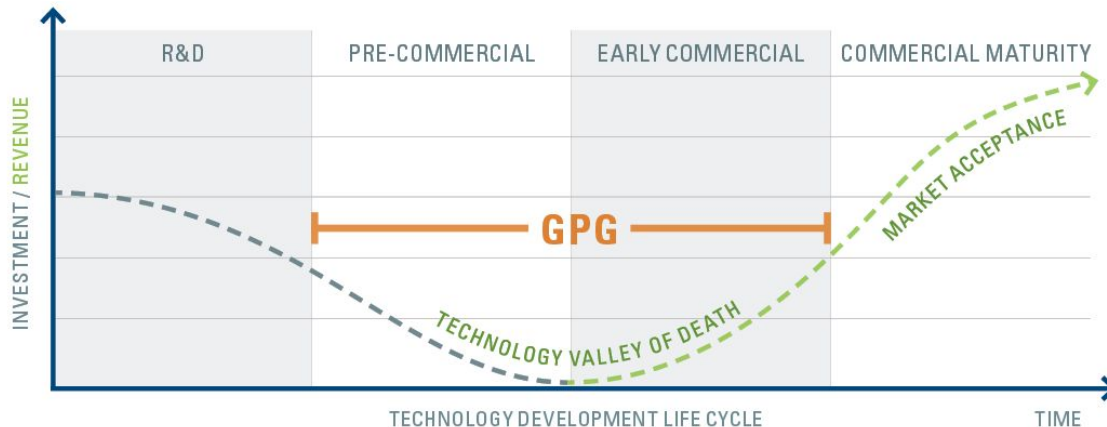


The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.



# 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 \$7.4 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

---



**Gregg Tomberlin**

R&D Staff, National Renewable Energy Laboratory

GPG-014

# Wood-Pellet-Fired Biomass Boilers

General Services Administration  
Public Buildings Service



GPG-014 | JUNE 2014

## WOOD-PELLET-FIRED BIOMASS BOILERS



### Biomass Boilers Offer Cost-Effective Alternative to Fuel-Oil-Heated Facilities

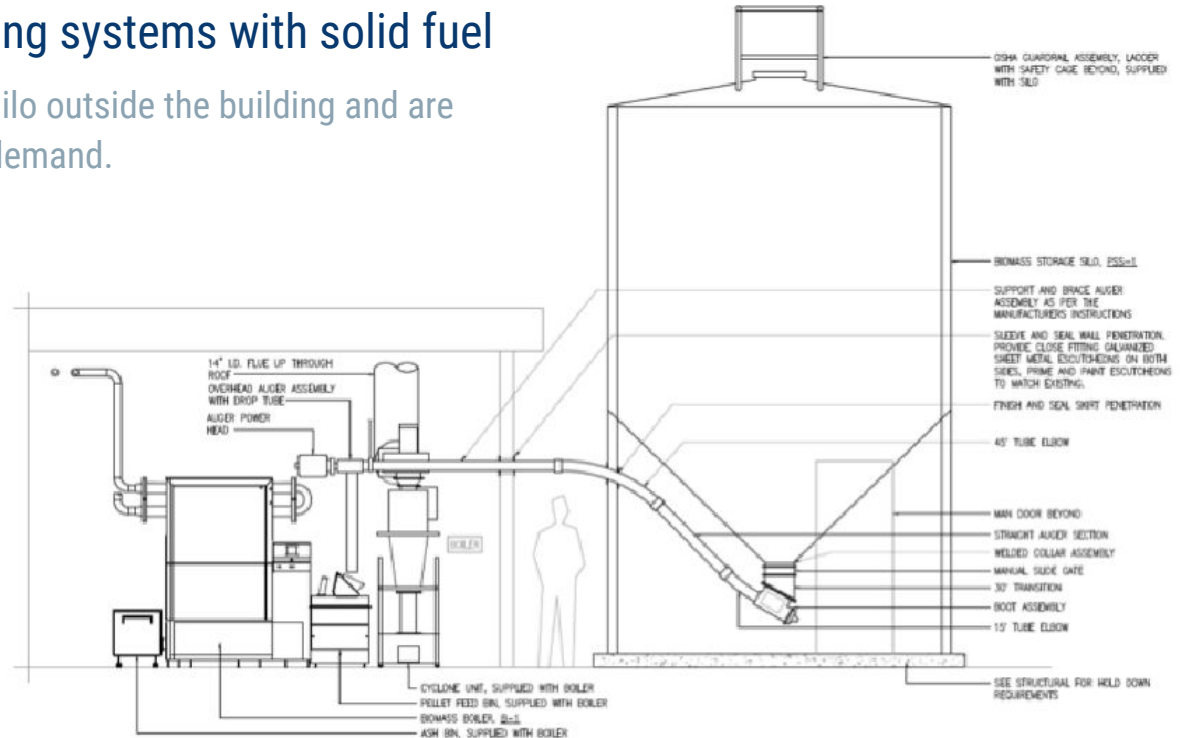
Advances in pellet combustion and control automation have recently positioned wood-pellet-fired biomass boilers as economical alternatives to traditional boilers. Their targeted use promises distinct benefits to GSA, foremost among them the ability to bring cost-effective heat to facilities that lack access to natural gas. The technology also has the potential to redirect some regional energy economies from fossil fuels to locally sourced renewable energy such as waste wood, which has been accumulating in the nation's forests. This is particularly relevant throughout the western United States where waste wood has been accumulating because of a pine beetle infestation that has killed over seventeen million acres of lodgepole and ponderosa pine.<sup>1</sup>

In 2012, GSA's GPG program leveraged the replacement of an entire legacy heating system at the Ketchikan Federal Building in Ketchikan, Alaska, to evaluate a state-of-the-art wood-pellet-fired biomass boiler. The project demonstrated that wood-pellet-fired

# GPG-014. Wood-Pellet-Fired Biomass Boilers

## Powers hot-water heating systems with solid fuel

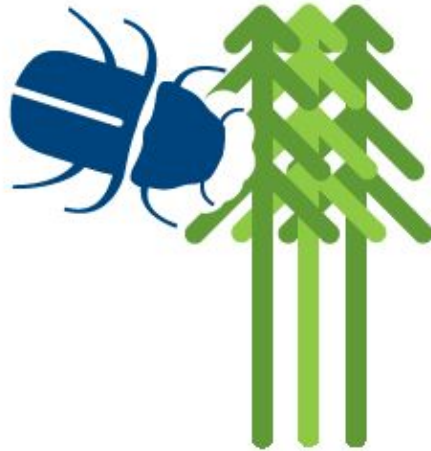
Wood pellets are stored in a silo outside the building and are augered into the building on demand.



## Opportunity

---

**DRIVE USE  
OF LOCALLY  
SOURCED  
RENEWABLE  
ENERGY**



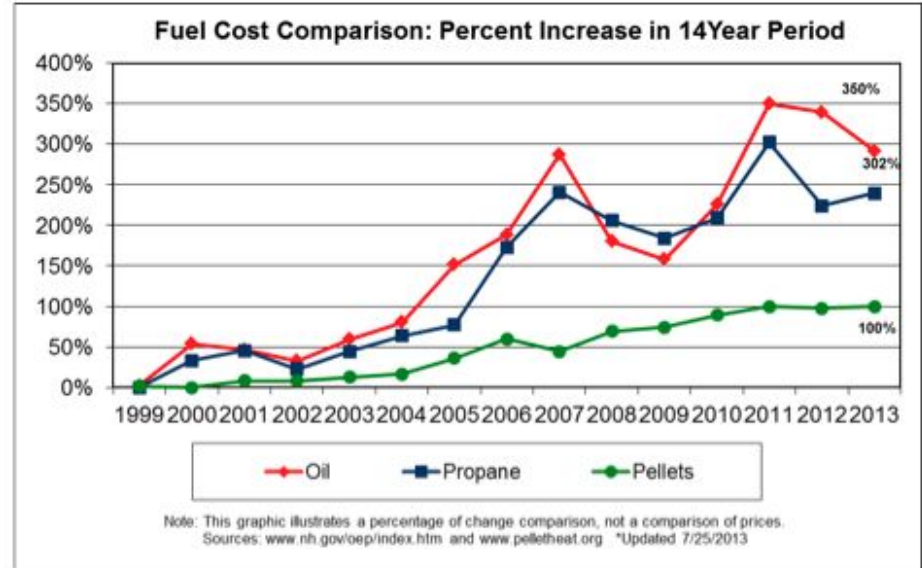
**TAKE ADVANTAGE  
OF WASTE WOOD**

PINE-BEETLE INFESTATION  
HAS KILLED 17.7 MILLION  
ACRES OF U.S. FOREST<sup>1</sup>

# Biomass Fuel

## Locally sourced biomass fuel:

- Has lower price volatility.
- Diversifies the energy supply of the region.
- Reduces waste in landfills.
- Is carbon neutral.



# Measurement & Verification, Ketchikan, Alaska

---



NREL assessed a biomass boiler at the Federal Building, Ketchikan, AK

Hydronic heating system—one biomass boiler (1,000,000 BTUs/hr) and one high-efficiency oil-fired boiler (as backup)



# M&V Results

---

## Test Results

Description	Value	Units
Full load output	1,000,000	BTUs/hour
Test length	8.25	Hours
Heat to water	3,711,968	BTUs during test
Average heat to water	449,935	BTUs/hour
Pellet feed	537	Pounds during test
Pellet higher heating value (HHV)	8,147	BTUs/pound
Pellet heat input	4,335,574	BTUs during test
Average pellet heat input	525,524	BTUs/hour
Average boiler load	45%	of Full load
Efficiency	85.6%	

Ketchikan boiler can generate 8,760 million BTUs.  
In 2011, used 1,150 million BTUs or 13% of full capacity.

# 85.6%

## BOILER EFFICIENCY

AT 45% PARTIAL LOAD

Boiler had efficiency  
rating of 85-90%

# Operations & Maintenance

---

## Minimal labor during normal operations

- Automated monitoring and control systems run all aspects of the boiler including feed, load reduction and tube cleaning.
- Continuously adapt as system conditions change.
- Uniform pellet size makes fuel handling straightforward.
- Operational stability allows small-scale operations with small maintenance teams.

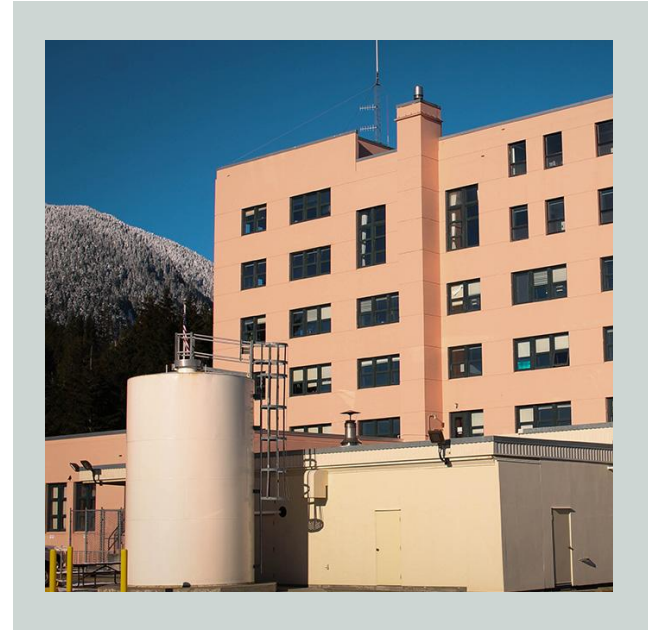


Photo Credit: Schmolck Mechanical Contractors

# Payback Varies by System Size and Pellet Cost

Savings are greatest with larger systems and lower biomass fuel costs

System Size (BTUs/hr)	Pellet Cost (\$/ton)				
	\$400	\$350	\$300	\$250	\$200
<b>PAYBACK IN YEARS</b>					
500,000	30.7	10.7	6.5	4.7	3.6
1,000,000	24.1	8.4	5.1	3.6	2.8
1,500,000	20.9	7.3	4.4	3.2	2.5
2,000,000	18.9	6.6	4.0	2.9	2.2
2,500,000	17.5	6.1	3.7	2.6	2.1
3,000,000	16.4	5.7	3.5	2.5	1.9
3,500,000	15.6	5.4	3.3	2.4	1.8
4,000,000	14.8	5.2	3.1	2.2	1.8

- < 2
- < 3
- < 5
- < 10
- 10+

**<5  
YEARS**

PAYBACK  
OPERATING AT  
75% CAPACITY  
WITH AVERAGE  
PELLET COSTS

**Diesel Price \$3.63/gallon; 75% capacity factor**

(At a 50% capacity factor, the payback period increases 30%)

# Variables Impacting Payback

---

- **Biomass fuel cost:** Pellet prices vary across the U.S. by region. In 2012, highest costs were in the northeast, and lowest costs were in the south, with a nationwide average of \$169/ton.
- **Biomass fuel delivery costs:** Delivered fuel cost is a function of local diesel fuel prices and proximity to a pellet manufacturer. Being within a 50 mile radius is recommended. Transportation costs average \$0.15 per ton-mile.
- **Heating oil costs:** Fuel oil is more volatile in pricing. (GSA payed \$3.50/gal in 2014, \$1.86/gal in 2017 in Ketchikan). Remote locations pay more for fuel. On average, the fuel content of one ton of wood pellets is equal to 120 gallons of heating oil.
- **Heating oil consumption:** Greater efficiencies are realized in cold climates where the biomass boiler is operating at a full heating load with high annual hours of operation.
- **Economies of scale:** Because of economies of scale, larger systems have better payback. Mechanical engineers use the “six-tenths rule” to estimate boiler costs, such that as size increases, cost increases by an exponent of six-tenths:  $cost_1/cost_2 = (size_1/size_2)^{0.6}$ .
- **Proper boiler sizing:** As a rule of thumb, systems should be designed to meet 60% of peak load.

## GSA Deployment Opportunity

---



Best suited to hot-water heated facilities using fuel oil and where natural gas is not an option.

- Most cost-effective for facilities with an extended heating season and where pellet fuel is available within 50 miles.

# On-The-Ground Feedback

---



**Marty Novini, R10**  
Energy Manager

# Ketchikan Federal Building, Alaska

---

## Installation & Design

- Sizing of the boiler is critical
  - Design engineers like to size for maximum heating load, however, buildings don't generally operate that many hours at the maximum.
  - Size the boiler at ½ capacity, and use secondary-fuel boiler for the gap.

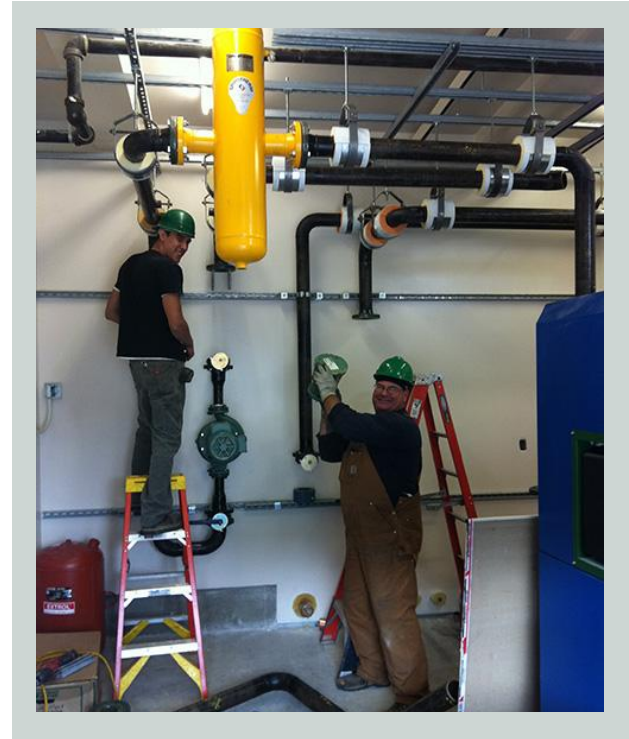


Photo Credit: Schmolck Mechanical Contractors

# Ketchikan Federal Building, Alaska

---

## Installation & Design

- Biomass load control differences
  - Unlike other boilers, biomass cannot be turned off quickly—similar to a fireplace.
  - Once fuel is fed, you have to use it.
  - Oversizing is more of a problem with biomass because it doesn't have a good turn-down ratio.
  - Consider a cover on the pellet storage tank to shield from rain water





# On-The-Ground Feedback

---



**Michelle Jones, R10**

Facility Manager, Ketchikan Alaska

# Regional Goal to Use Local Resources and Grow the Economy

---

## Ketchikan leads the state in wood-byproduct energy adoption

- Woody biomass is found in abundance in Southeast Alaska and represents a significant energy resource for local communities.
- The Ketchikan airport, high school, and the library all use biomass boilers.
- The Forest Service has a stated goal to transition 30% of oil heating to wood-pellets in the next decade.



# Ketchikan Federal Building, Alaska

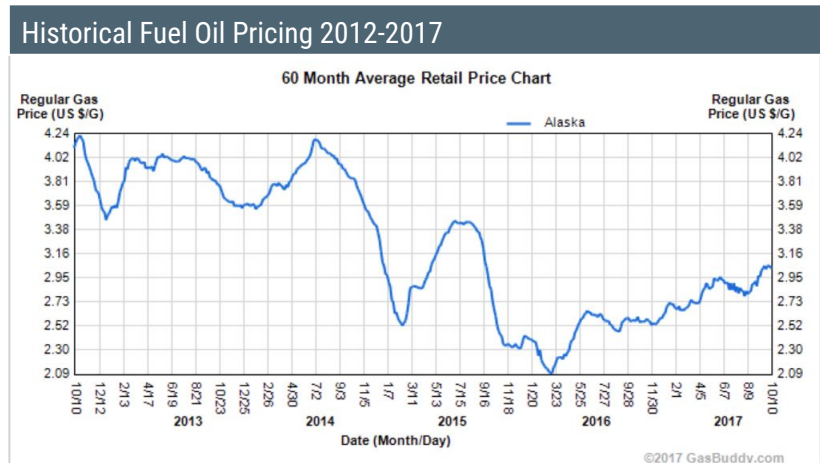
## Fuel Cost Volatility

- 2017 fuel oil is less expensive than pellets.
- The more remote the location, the higher the price of fuel.

## Resiliency

- Pellet mill is close to our facility so the fuel source is local.
- Local source of fuel doesn't need to be shipped.

Ketchikan Fuel Costs	2014	2017
Wood Pellets	\$250/ton	\$285/ton
Fuel Oil	\$3.50/gal	\$1.86/gal



# Ketchikan Federal Building, Alaska

---

## Operations

- Biomass boiler does not run in the shoulder season (runs from approximately October to April/May).
- Need to understand warm-up and cool-down periods—the difference between driving a boat and a car.
- Takes time to fine-tune settings.

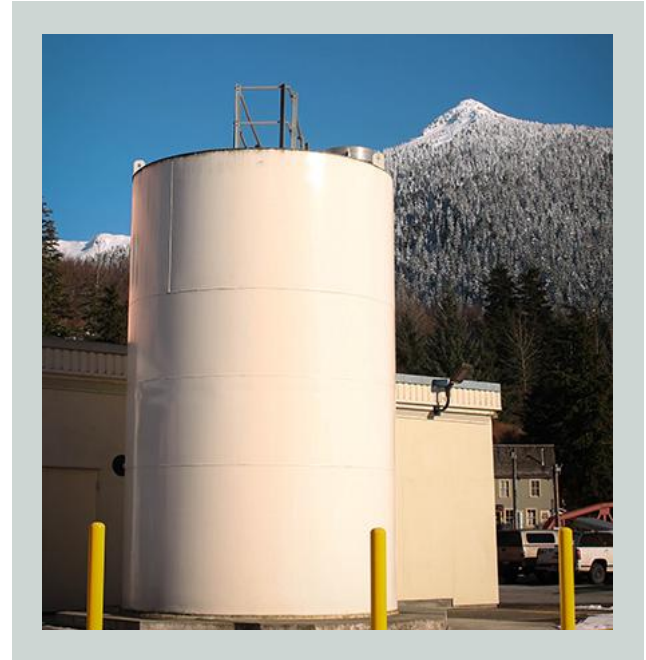


Photo Credit: Schmolck Mechanical Contractors

# Ketchikan Federal Building, Alaska

---

## Maintenance

- Technicians have a learning curve to understand boiler differences.
- Hand-off knowledge from one technician to the next.
- To minimize any down time, it's important to have spares on hand of any vital parts.



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 07: Wood-Pellet-Fired Biomass Boilers**

---

Thank you for your participation in GPG Outbriefs.

---

**Email address \***

Valid email address

This form is collecting email addresses. [Change settings](#)

**Continuing Education Credit**

Check here to request a certificate for 1 CE unit.

**AIA Number**

Short answer text

**First Name and Last Name**

Short answer text

The information presented in the Outbrief webinar was helpful.

1 2 3 4 5

Strongly Disagree      Strongly Agree

I am interested in installing wood-pellet-fired biomass boilers.

Yes, in the next 2 years.

Yes, in the next 5 years.

Maybe

No

Comments or questions about the webinar or wood-pellet-fired biomass boilers.

Long answer text

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

