COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

Biomass Ready Guidebook

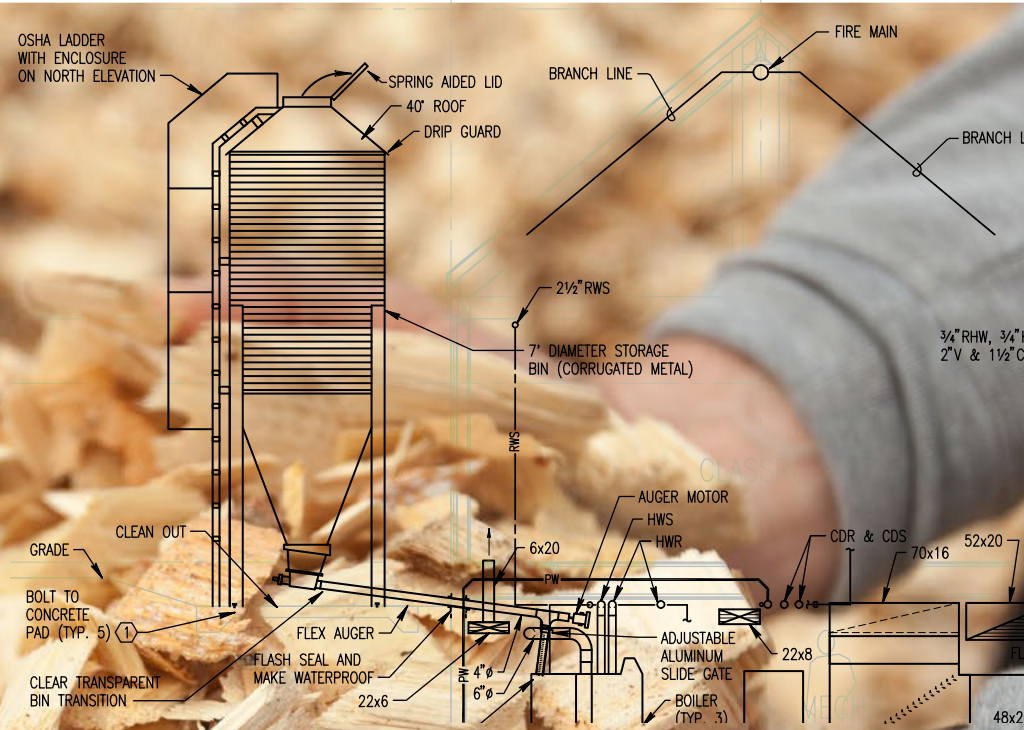
Delivery Path

Storage Area

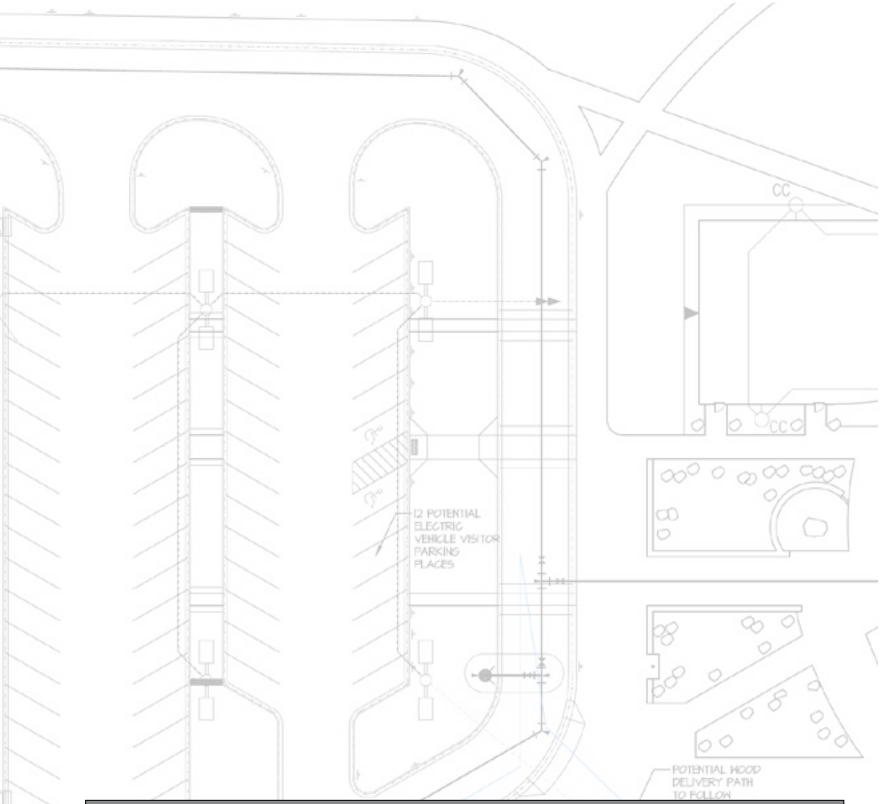
Boiler Room

Connection

HVAC Integration



The Biomass Ready Process



The Colorado State Forest Service has produced this planning guide under Cooperative Agreement 001807-00002, US Forest Service Research, Statewide Wood Energy Teams, Wood Education and Resource Center. No person in the United States shall, on the ground of race, color, national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance. 42 U.S.C. 2000d.

Biomass Ready is a quick and easy process to help teams design new community buildings that can better adapt to an uncertain energy future.

Today the economics of biomass may not be favorable, but your community will own and operate your new building for decades – perhaps even a century. Over the lifetime of your building, your community may decide to install a biomass boiler system. Will your building be ready?

Biomass Ready will help you avoid inadvertently creating barriers that make adding biomass in the future prohibitively expensive.

If you can add a biomass system to your building without extensive deconstruction or demolition, your building is

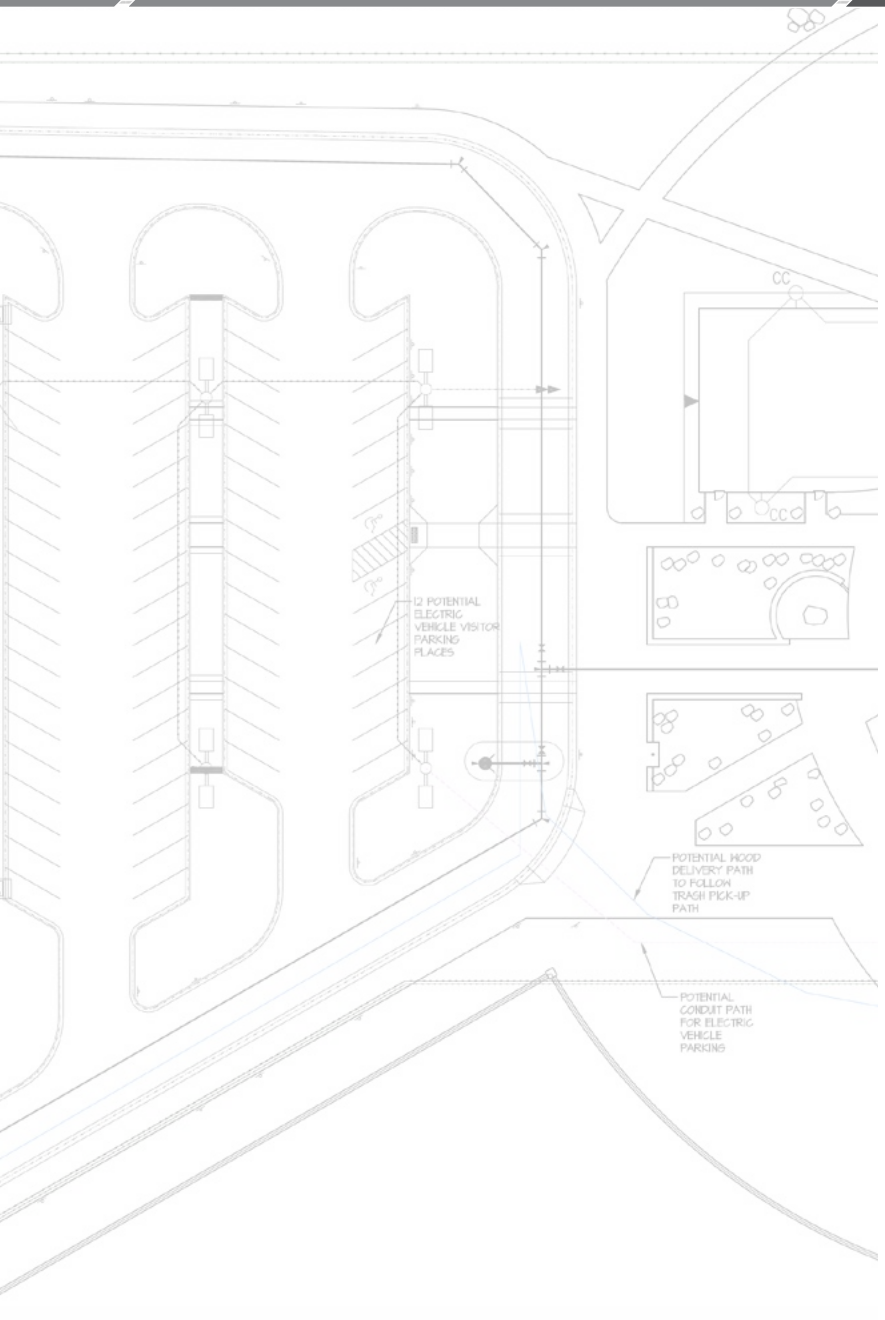
Biomass Ready!

And Biomass Ready *is simple enough that you can include it in your RFP process – encouraging your bidders to compete on designing a future-flexibility!*

For more information visit:

csfs.colostate.edu/cowood/wood-to-energy/

Model Projects



Tillamook Forest Center, OR

Space Heated: 12,100 sq. ft., **Boiler Size:** 0.410 MMBtu/h

Storage: 64 sq. ft. (8’ x 8’) **Boiler:** 280 sq. ft. (20’ x 14’)

South Park School, Fairplay, CO

Space Heated: 120,000 sq. ft., **Boiler Size:** 1.5 MMBtu/h

Storage: 720 sq. ft. (20’ x 36’) **Boiler:** 672 sq. ft. (28’ x 24’)

CSU Foothills Campus, Fort Collins, CO

Space Heated: 123,000 sq. ft., **Boiler Size:** 1.5 MMBtu/h

Storage: 800 sq. ft. (32’ x 25’) **Boiler:** 620 sq. ft. (25’ x 25’)

Harney Community Energy, Burns, OR

Space Heated: 95,000 sq. ft., **Boiler Size:** 2.1 MMBtu/h

Storage: 800 sq. ft. (32’ x 25’) **Boiler:** 620 sq. ft. (25’ x 25’)

Boulder County Jail, Boulder, CO

Space Heated: 103,400 sq. ft., **Boiler Size:** 3.4 MMBtu/h

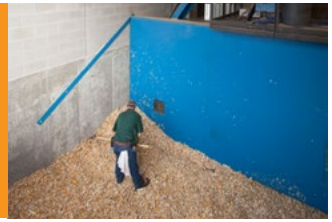
Storage: 748 sq. ft. (22’ x 34’) **Boiler:** 600 sq. ft. (20’ x 30’)

What Makes a Biomass System Retrofit Expensive?

Delivery

How will biomass fuel be delivered to your storage area? Biomass fuel for community-scale projects is delivered by truck of the size given in the Biomass Design Parameters. You'll need to know where you can add a paved driveway suitable for truck delivery during business hours. Add this driveway to your site layout diagram and label it something like "Future Biomass Delivery Driveway."

Storage



Where will you store the biomass fuel? Most biomass facilities store between a week of fuel and a whole heating season of fuel. That fuel is usually stored next to a biomass boiler to make supplying the fuel easy. Add a rectangle to your site diagram of the dimensions specified in the Biomass Design Parameters. Label this square something like "Future Biomass Storage Facility."

Boiler

Where will you put the biomass boiler? Biomass boilers are often used to supplement conventional heating systems, but can also be the primary source of heat. Biomass boilers are larger than conventional boilers and are often housed in a separate building or shipping container. These structures are usually located immediately adjacent to (or part of) the biomass storage facility. Add a rectangle to your site diagram of the dimensions specified in the Biomass Design Parameters. Label this square something like "Future Biomass Boiler Facility."

Connection

How will you connect your boiler to your building? Heat distribution piping is expensive – especially if it needs to be buried – so the closer the boiler building is to your new building, the better. Add a line or path to your site diagram connecting the biomass boiler facility to your building's mechanical room. Label this line something like "Future Biomass distribution pipe."

Integration

How will you integrate the biomass system with your HVAC system? This is often the biggest challenge. Biomass boilers deliver hot water. Many modern conventional heating systems work the same way. If you select one of those systems, adding biomass is simple. But if have a stand-alone heating appliances in each room, adding a central biomass system can be prohibitively expensive.

Tillamook Forest Center

Tillamook Forest Center

Facility

Name: Tillamook Forest Center

Location: Tillamook, Oregon (map)

Primary Use: Visitor and Interpretation Center

Total Square Footage: 1 building, 12,100 sf.

HVAC System: Hybrid forced-air and 180º F hydronic

Construction Date: 2004

Biomass System

Boiler Size: 409,500 Btu/h

Percentage heated with biomass: 100%

Biomass Fuel: Bulk wood pellets

Integration Approach: heating coil in the air handler for the large space, several hydronic loops for the offices and small spaces.

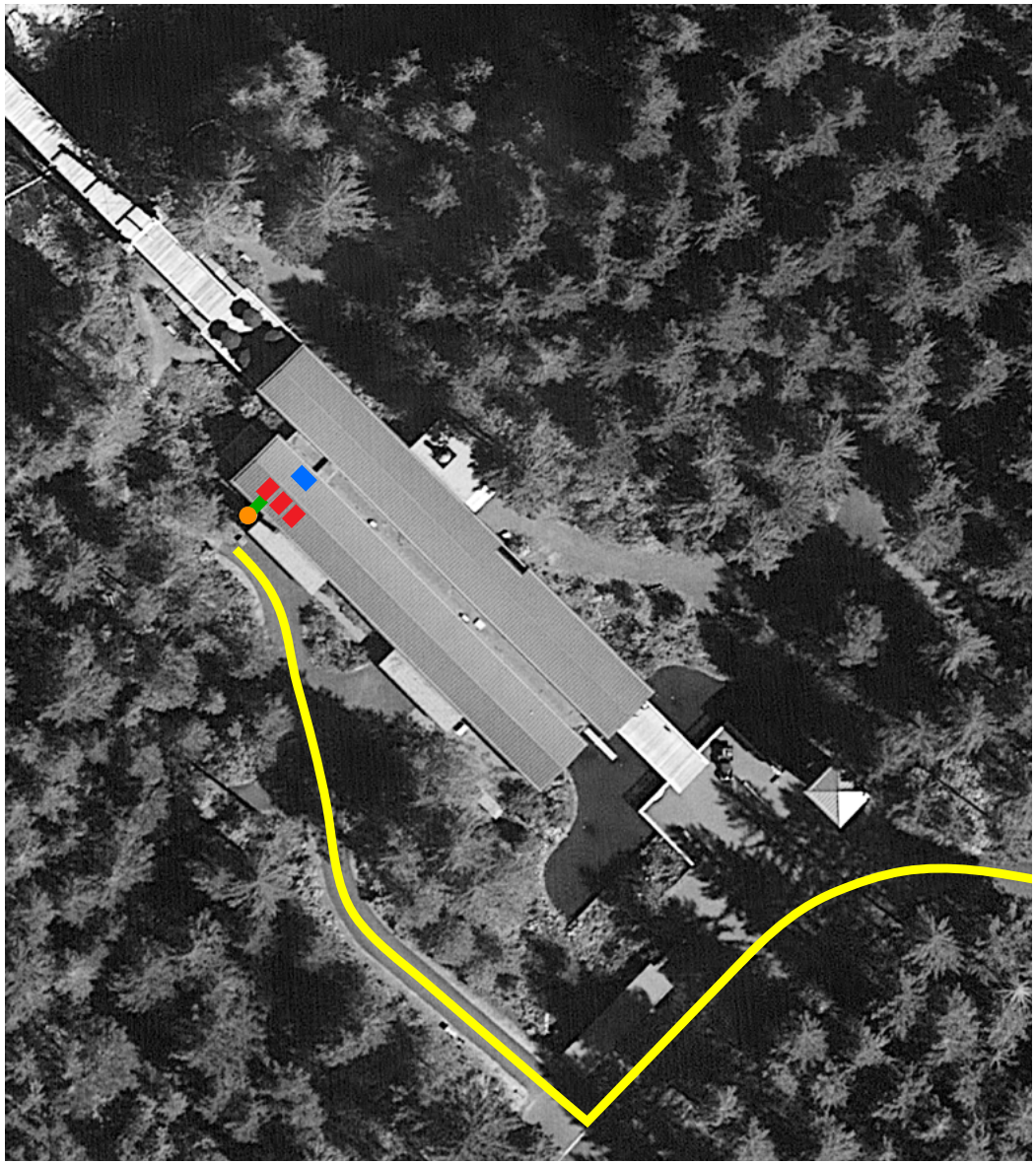
Completion Date: 2004

Project Goals & Features

One of the goals of the Forest Center was show how to harmonize with nature and with our forests. The Center is 100% heated by three wood pellet boilers – no conventional fuel back system.

The building is cooled in the summer by heat pump connected to the pond in front of the building. The water in the pond is treated and used by the fire prevention sprinkler system.

Tillamook Forest Center



Delivery

Grain Delivery Truck

Storage

64 sq. ft. (8’ x 8’)

(24’ tall)

Boiler

280 sq. ft. (20’ x 14’)

Connection

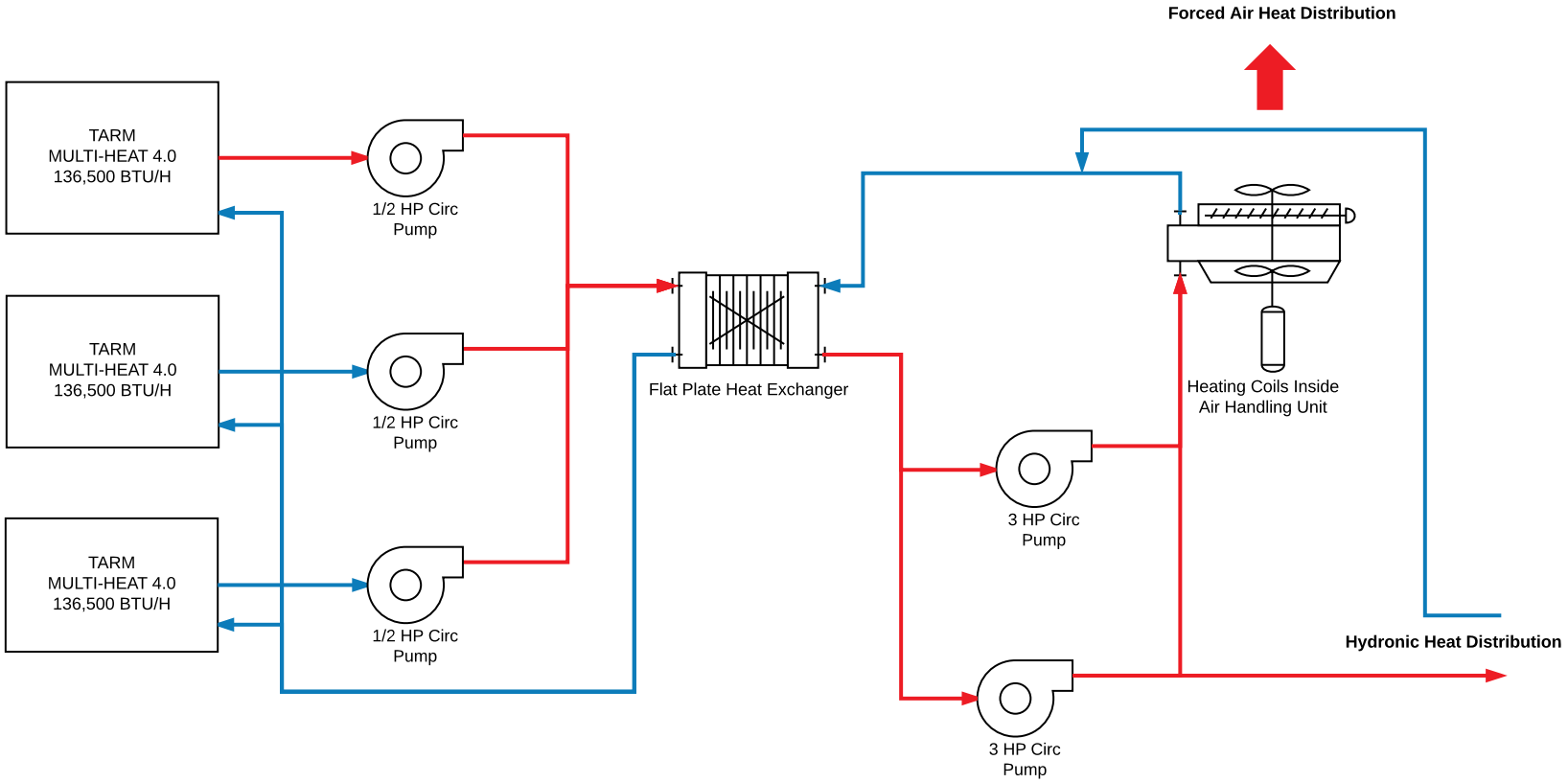
15’ of 3” insulated pipe in mechanical room

Integration

Heating Coil in Air Handler for main space (primary)

LOW RES

System Overview

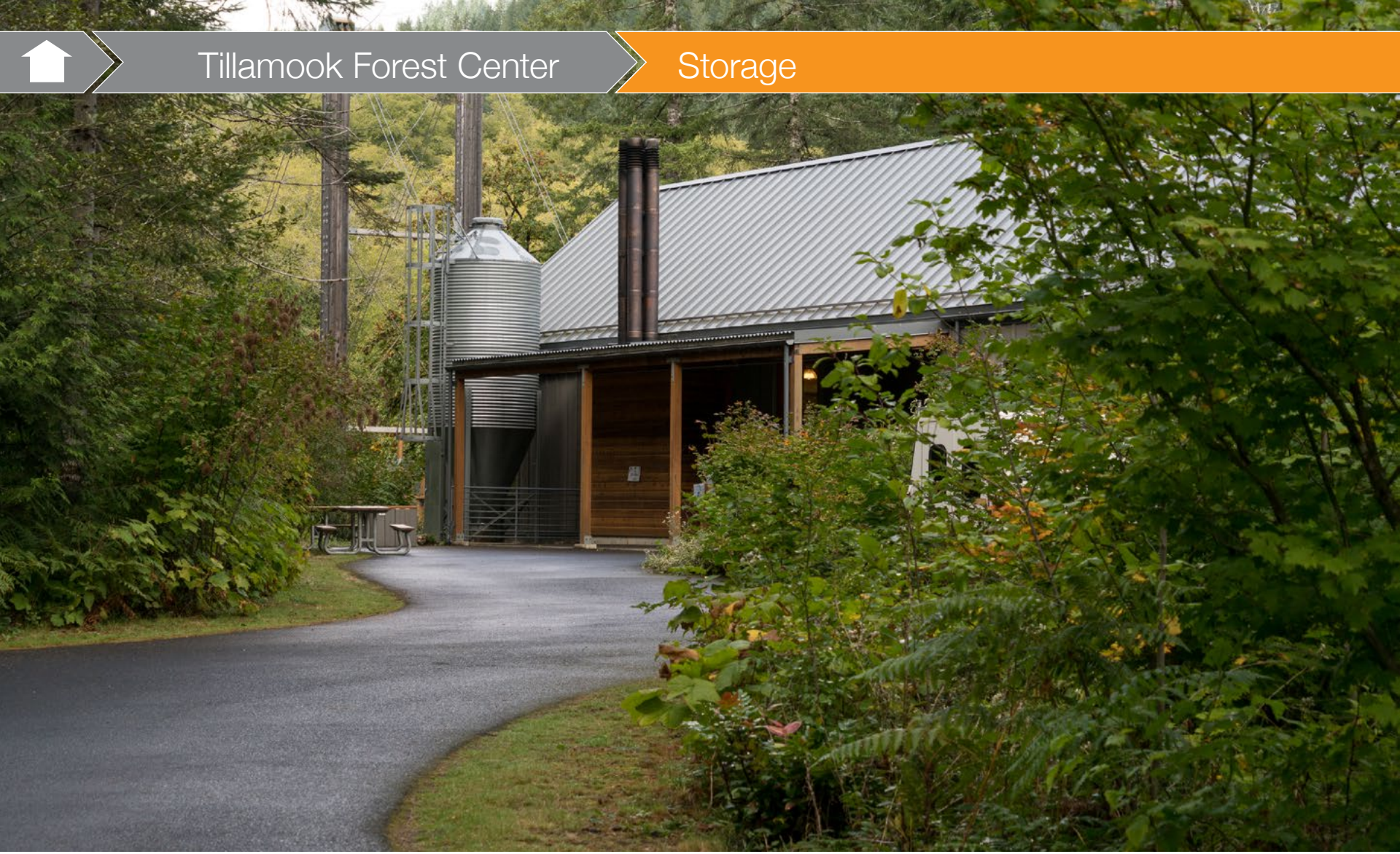


System Diagram: Heat is delivered from the boilers to the building using both forced-air (like a furnace in a typical home) and hydronic (hot water loop). A flat plate heat exchanger (center of diagram) is used to isolate the boiler water from the building's hydronic water loop. The three biomass boilers are the only source of heat in the building.

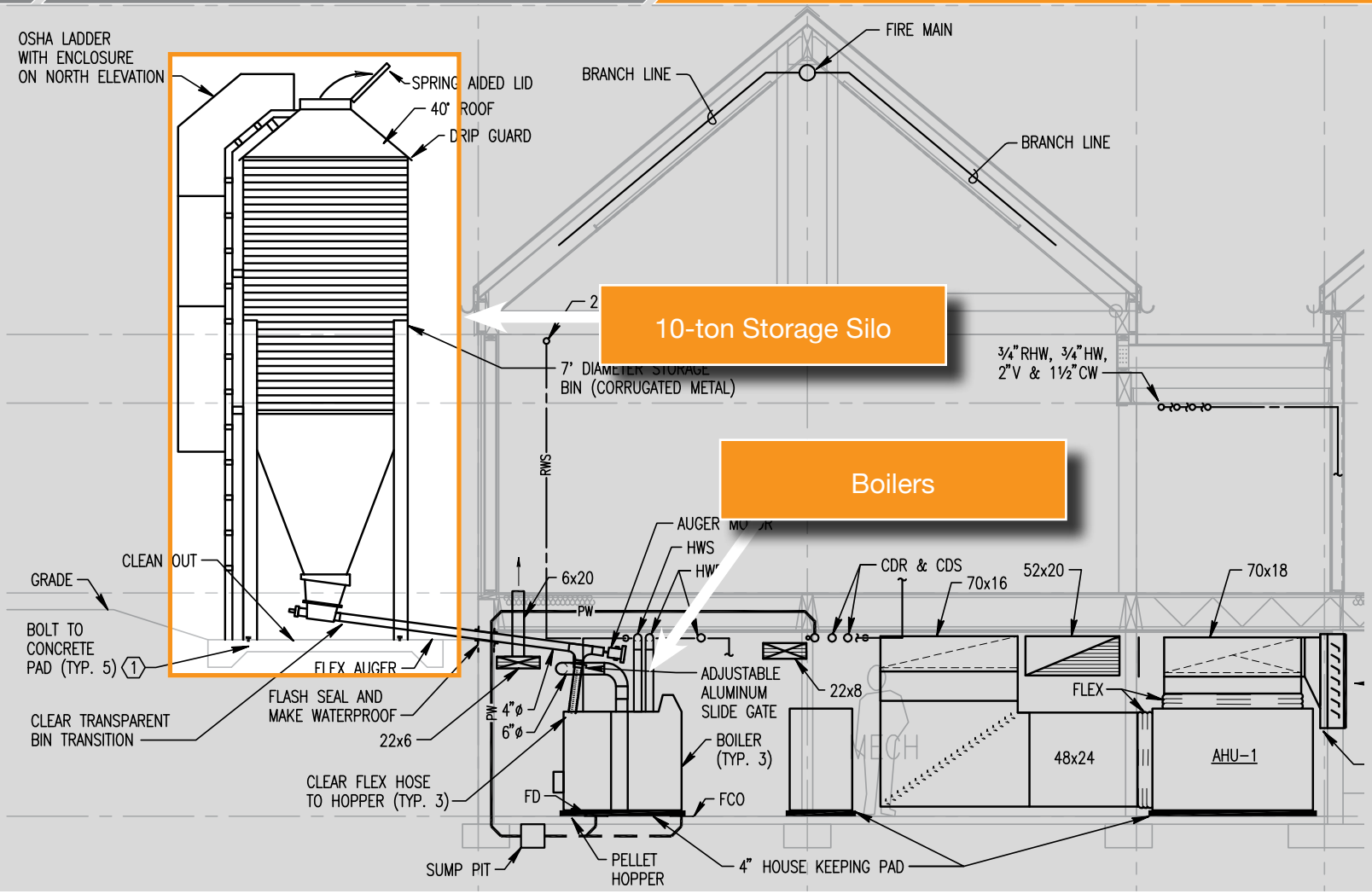
Delivery

Credit: Tillamook Forest Center

Delivery: Wood pellets are delivered in bulk using a grain delivery truck. The trailer is about 30 feet long with six 5-foot compartments, useful for measuring delivered quantity. Pellets are fed through a 9” trough auger, 12” vertical auger, and then a 9” boom auger (that’s the one feeding into the top of the silo). The closest pellet mill is about 70 miles away, not ideal, but workable.



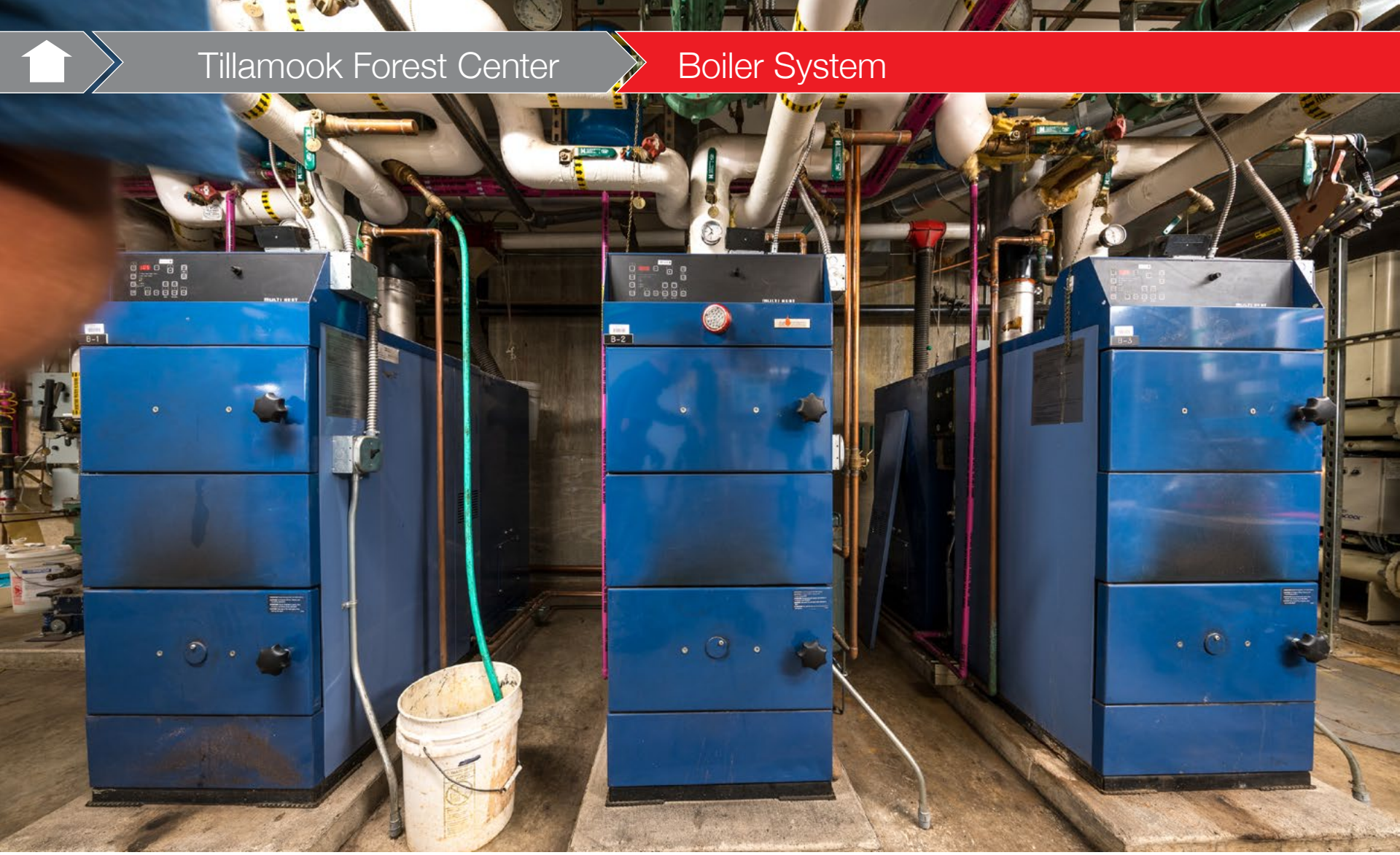
Storage: Approximately 64 sq. ft. (8’ x 8’) are needed for the 7’ diameter, 24’ tall, 10-ton grain silo used to store enough pellets to heat the building for a typical winter season. The architects incorporated the agricultural silo into the building’s design helping reinforce the theme of a working sawmill.



Storage: This elevation view shows the proximity of the pellet silo to the pellet boilers in the mechanical equipment room. The silo is 24' tall and 7' in diameter. *Having the mechanical equipment room (MER) on an appropriate exterior wall makes it easy to move the fuel (pellets in this case) from the storage silo or bin to the boiler.*

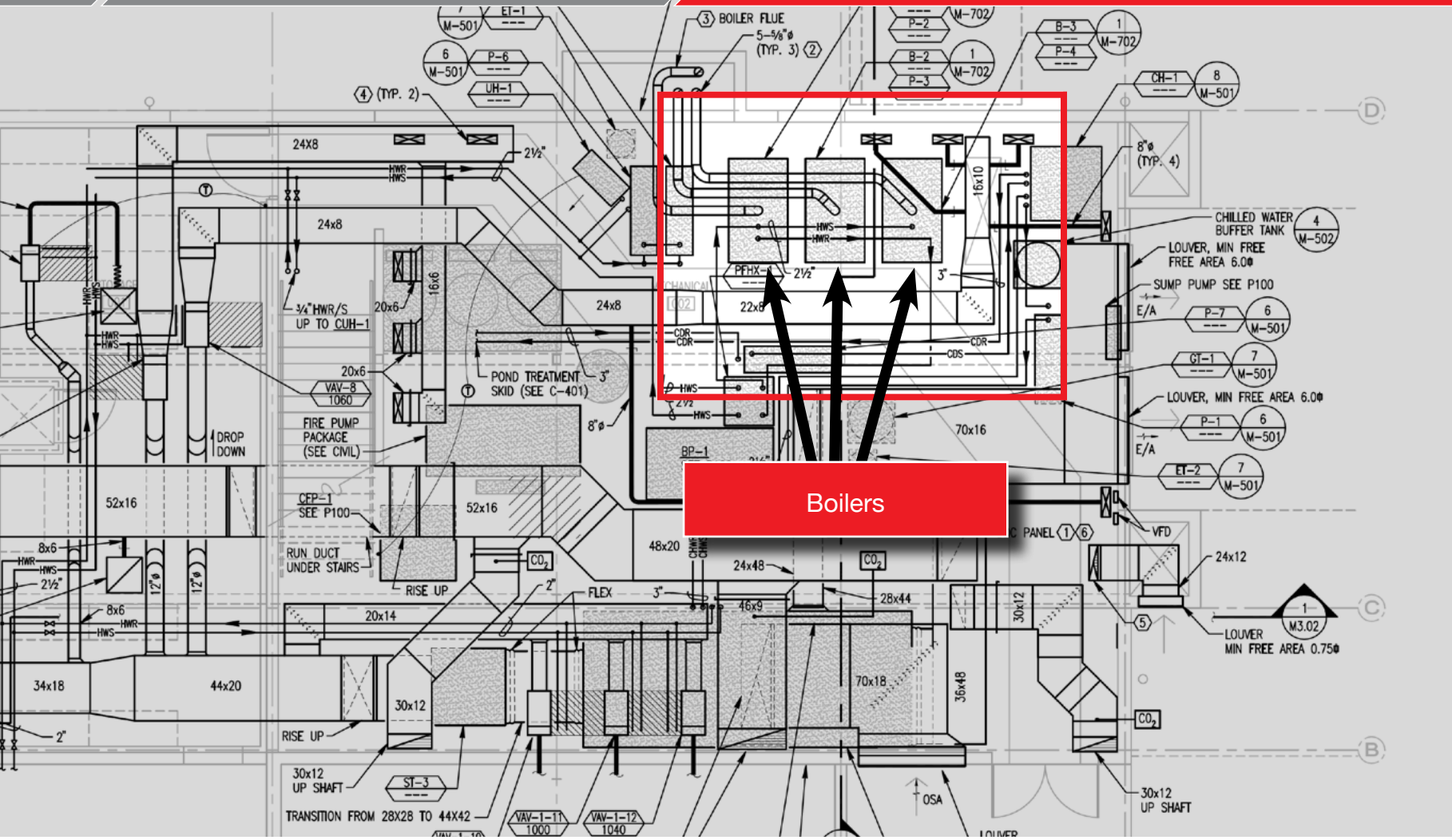
LOW RES

Boiler System



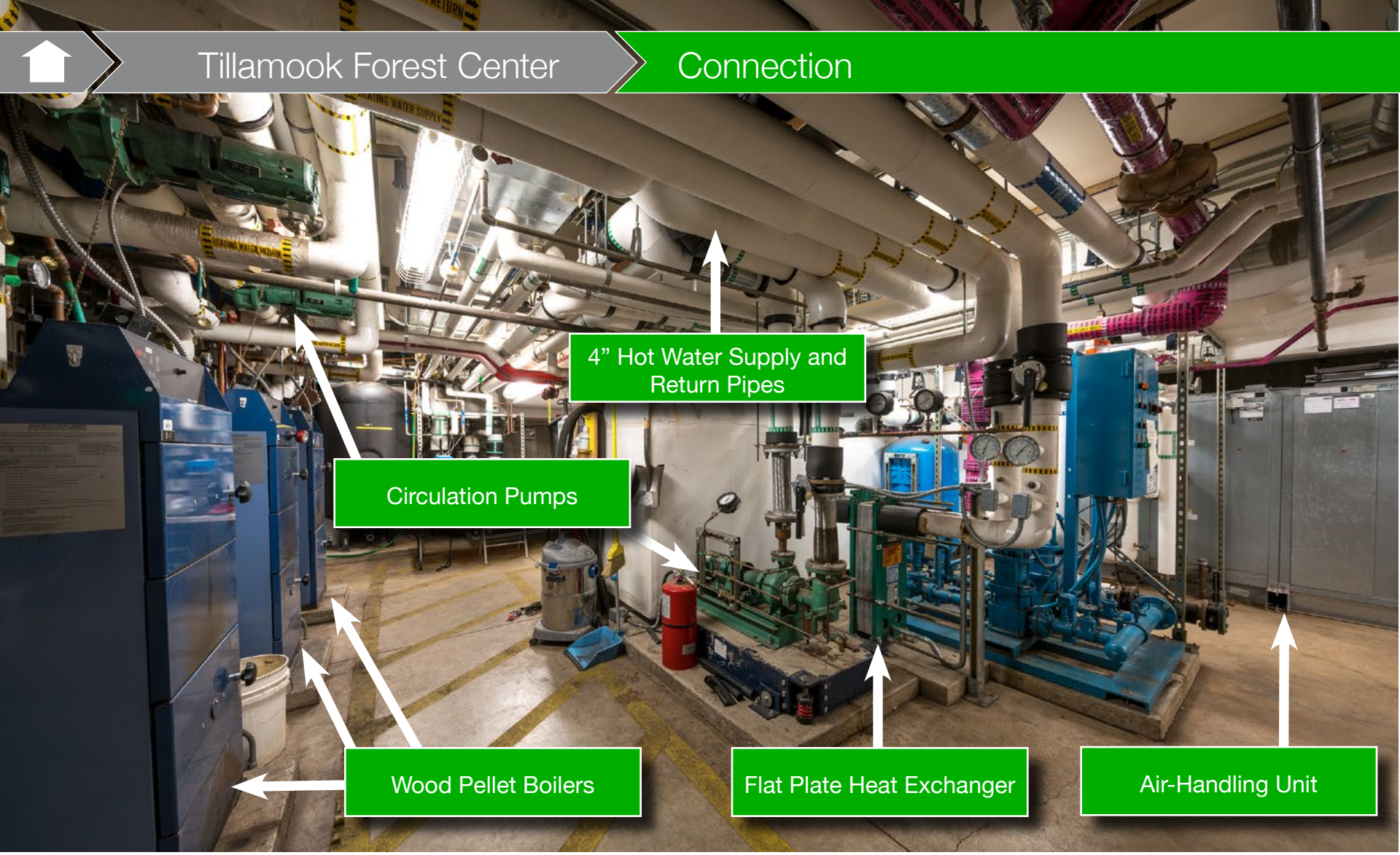
Boiler System: approximately 280 sq. ft. (20’ x 14’) of the 1,500-square foot mechanical equipment room is dedicated to the biomass boiler system. The system is made up of three TARM 136,500 Btu/h wood pellet boilers. Each boiler has an internal pellet storage bin that is semi-automatically filled from the large pellet silo outside.

Boiler System

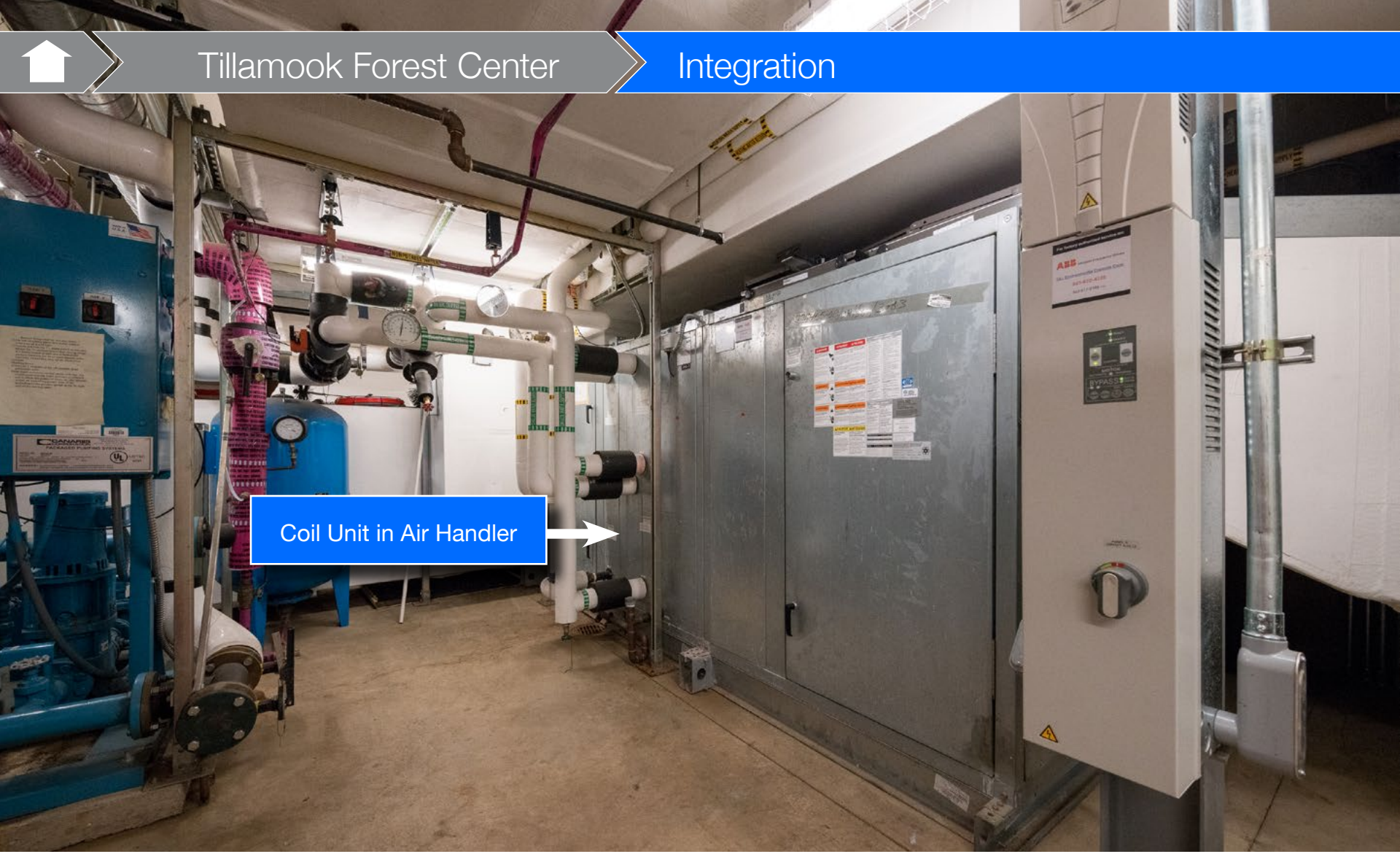


Boiler System: The three TARM 136,500 Btu/h wood pellet boilers and related equipment take up about one third of the mechanical equipment room. The rest of the space is used by the air handling system, an air conditioning chiller that uses cool water from a pond in the front of the building, and a fire suppression sprinkler system that also uses treated pond water.

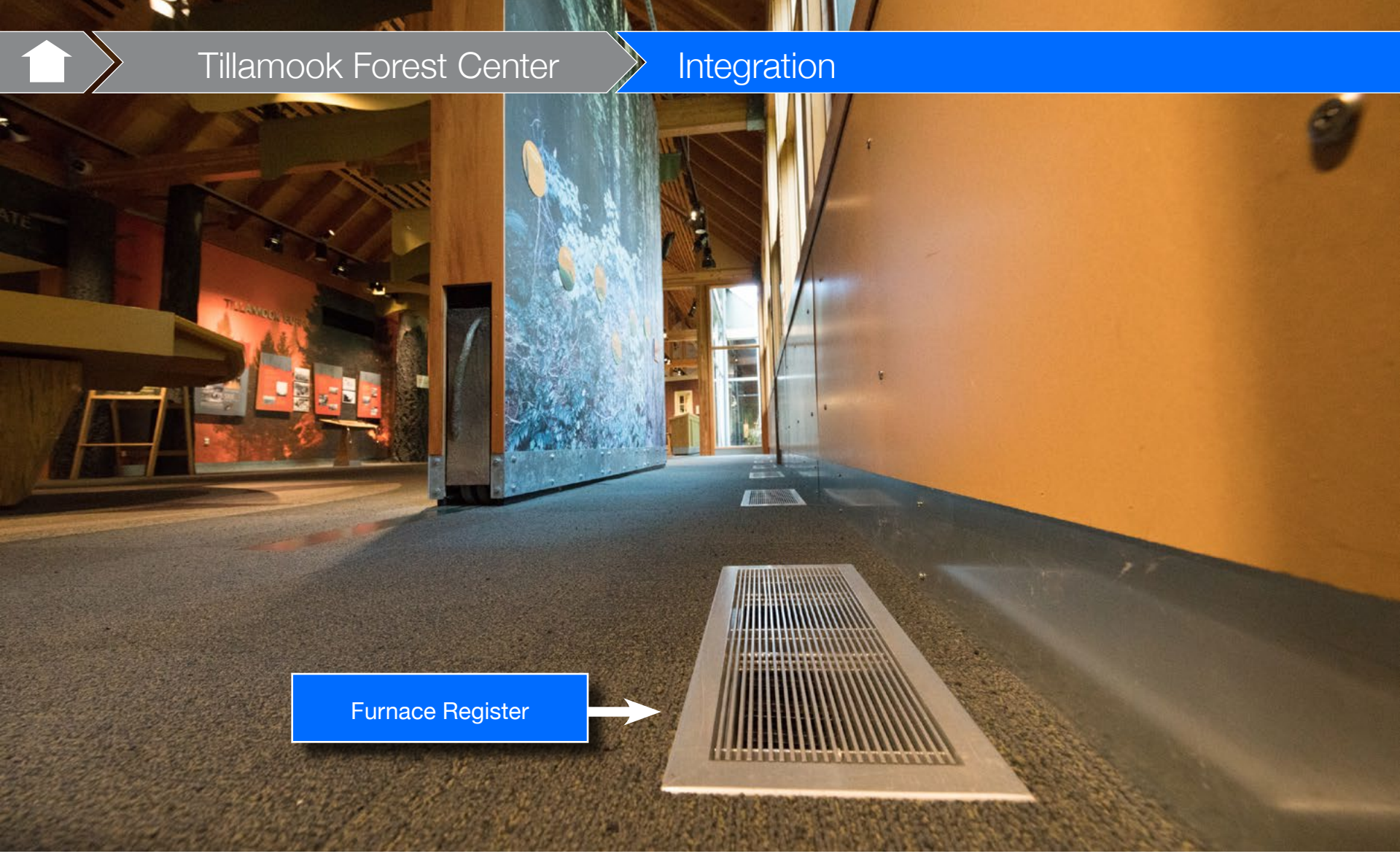
Connection



Connection: Heat is delivered to the building from the boilers using a combination of forced-air (like a furnace in a typical home) and hydronic (hot water loop) systems. A flat plate heat exchanger (center of diagram) is used to isolate the boiler water from the hydronic water loop that goes both to the fan coil unit inside the air handling unit. The three biomass boilers are the only source of heat in the building. There is no backup heat for the building.



Integration: The hot water distribution loop from the biomass boiler integrates with the building's domestic hot water (DWH) system through these two flat plate heat exchangers. If your building will have a forced-air heating system, be sure to have enough room for an additional heating coil that can connect to a future biomass system.



Integration: Heat for the main exhibit halls is delivered through forced air registers in the floor (like those found in many homes). Forced air heating systems do double-duty—delivering heat and fresh air.

Integration: Offices, rest rooms, and the entry area (above) are heated with hot water radiators like this one. The many independently controlled zones throughout the building provide flexibility to deliver heat only where it is needed. On days when the Center is closed to the public, individual offices can be heated without having to heat the entire building.


LOW
RES

Fairplay School

Facility

Name: Park County School District RE-2, Fairplay Campus

Location: Fairplay, Colorado (map)

Primary Use: K-12 School

Total Square Footage: 124,000 sq. ft.

HVAC System: 180º F hydronic

Construction Date: 2012

Biomass System

Boiler Size: Wood chip, 3.4 MMBtu/h, unpressurized hot water

Percentage heated with biomass: 100%

Biomass Fuel: Wood Chips

Integration Approach: direct, three-way mixing valve

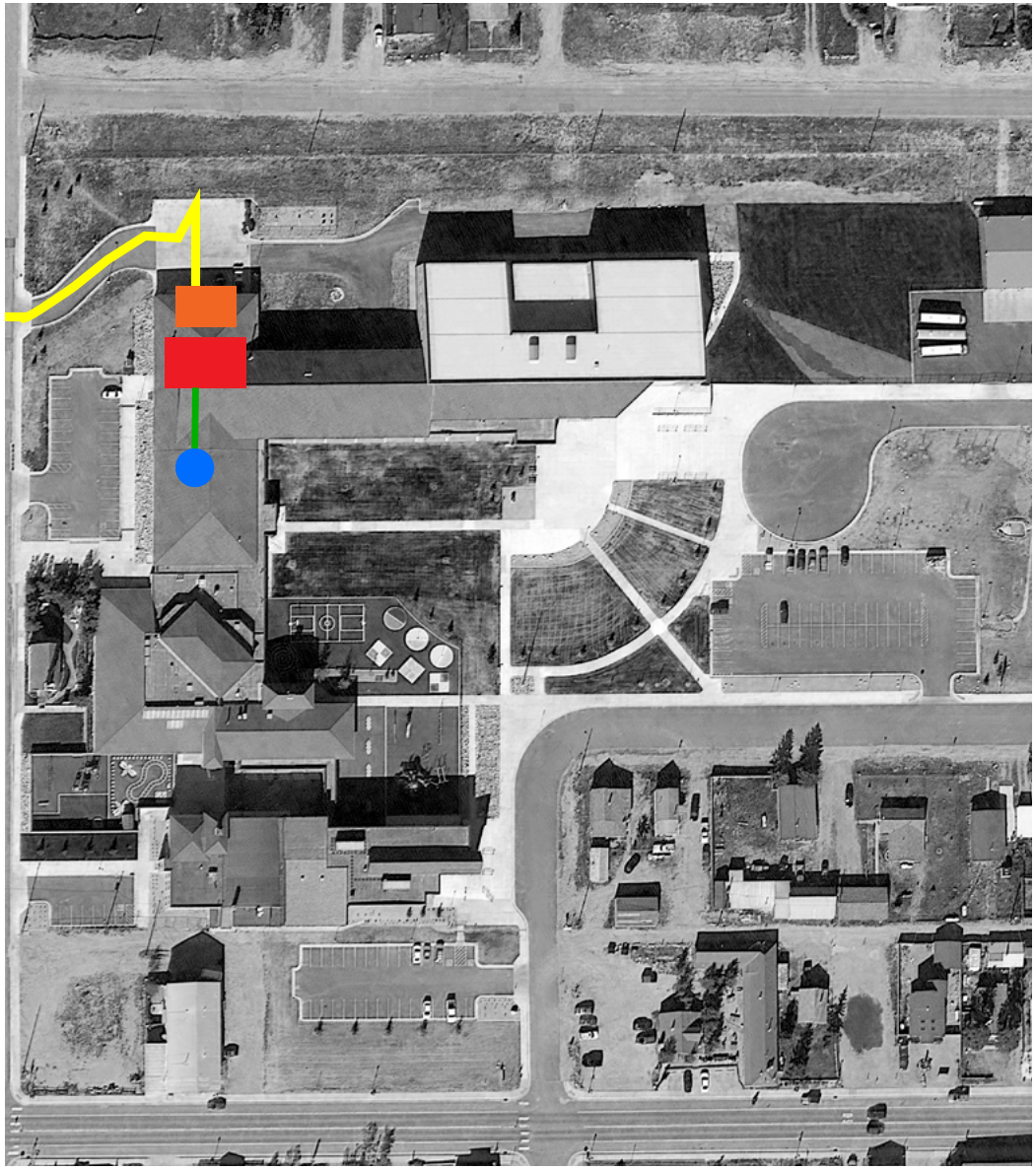
Completion Date: 2012

Project Goals & Features

Propane was the fuel of choice in Fairplay when the school board decided to construct a biomass heating system in 2010. Using locally sourced wood chips was expected not only to cut heating costs by half, but more of the school's energy dollars would remain in the community.

When natural gas costing half the cost of propane arrived in the area in 2014, the biomass system's economic value was seriously challenged. When the price of natural gas is low, the school doesn't always use the biomass system. However, the flexibility to switch fuels remains a key part of their operation.

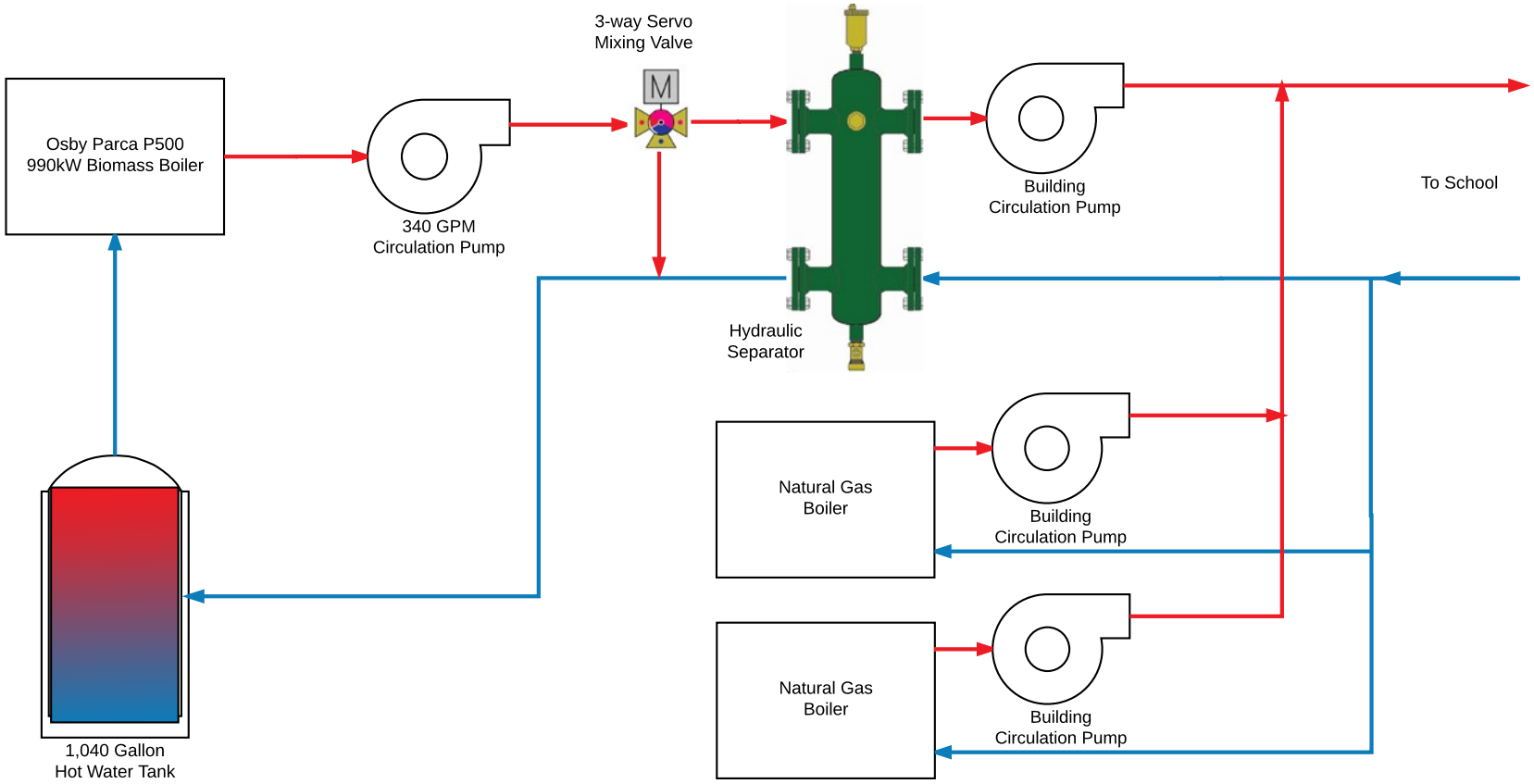
Fairplay School



Delivery		34’ Roll-off Truck
Storage		672 sq. ft. (28’ x 24’)
Boiler		720 sq. ft. (20’ x 36’)
Connection		10’ insulated 4” pipe
Integration		Hydraulic Separator

LOW RES

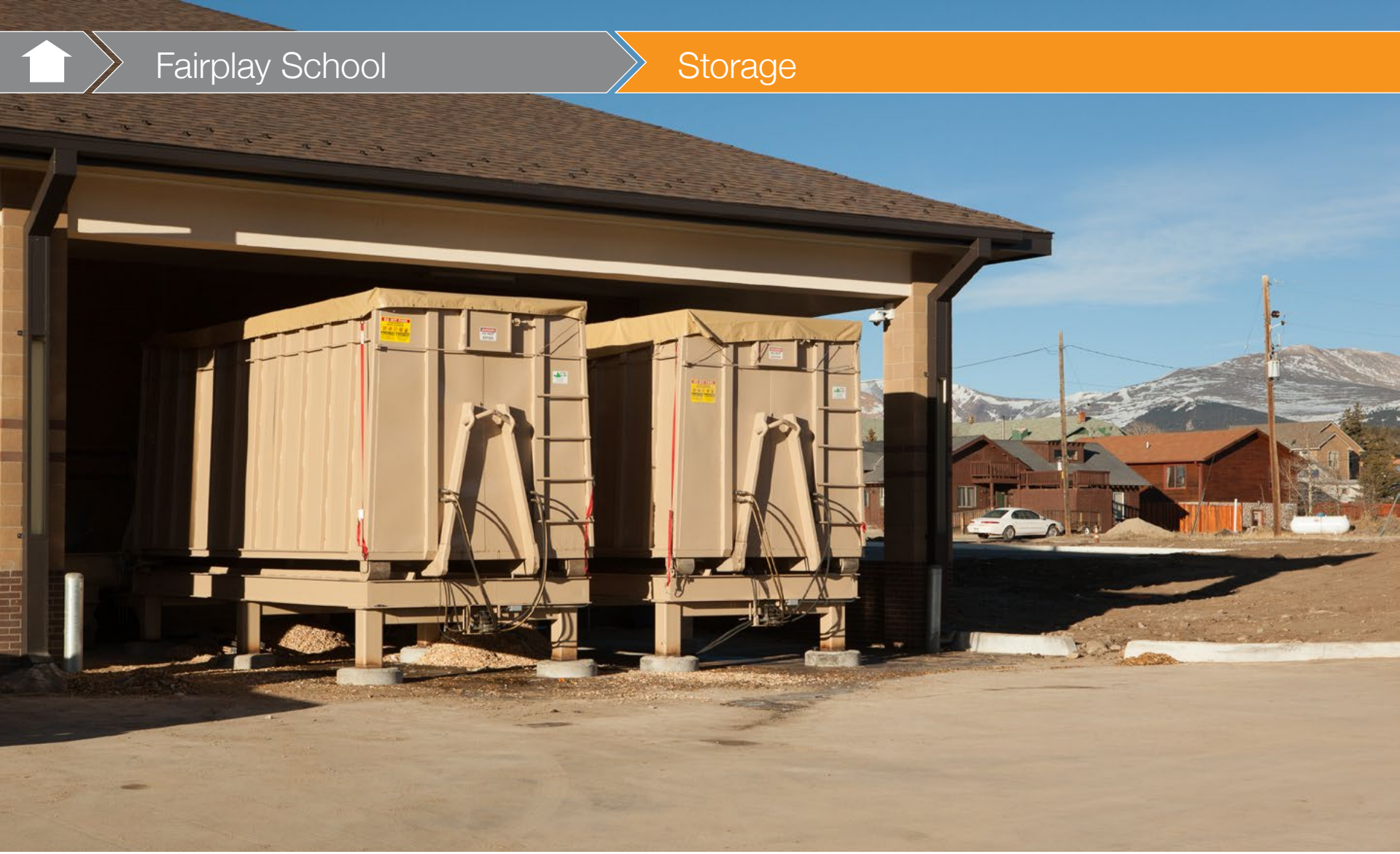
System Overview



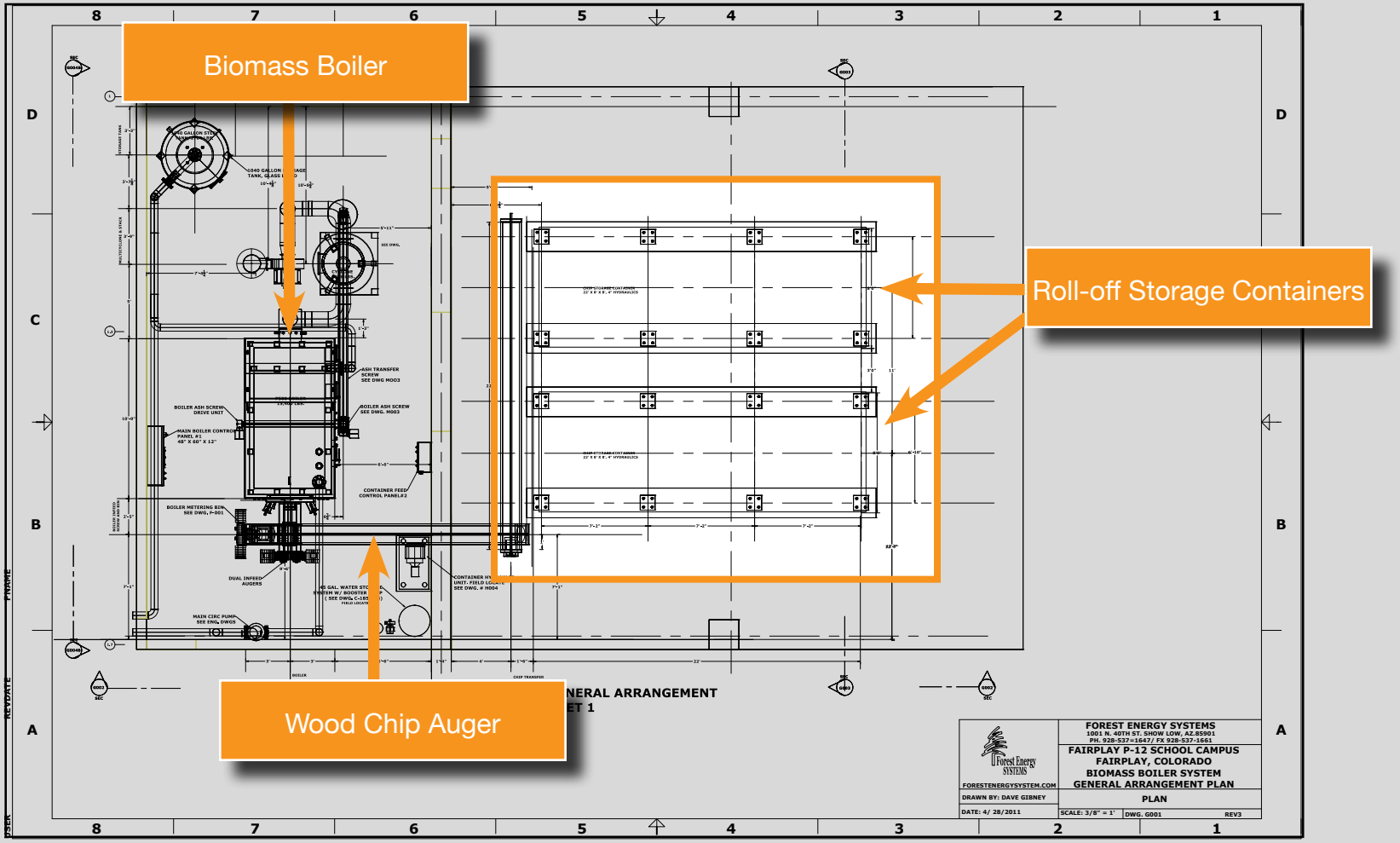
System Diagram: Biomass boilers work best when operated at near-maximum output levels and not cycled on and off frequently. Buildings are more comfortable when the temperature doesn't vary much, which typically means frequently adjusting the amount of heat from the boiler system. To solve these competing needs, an insulated 1,040-gallon hot water storage tank is used to store heat and act as a buffer. A 3-way servo mixing valve and independent "biomass boiler" circulation pump allows some or all the heat from the boiler to be automatically transferred to either the school or storage tank. Heat from the storage tank can also be transferred to the school without firing up the biomass boiler.

Credit: South Park High School Students

Delivery: This video shows the process of delivering and exchanging the custom roll-off containers, which serve as both delivery container and on-site storage. This roll-off truck has a turning radius of 40 feet. (This video was shot and produced by the photography class at South Park High School in 2016.)



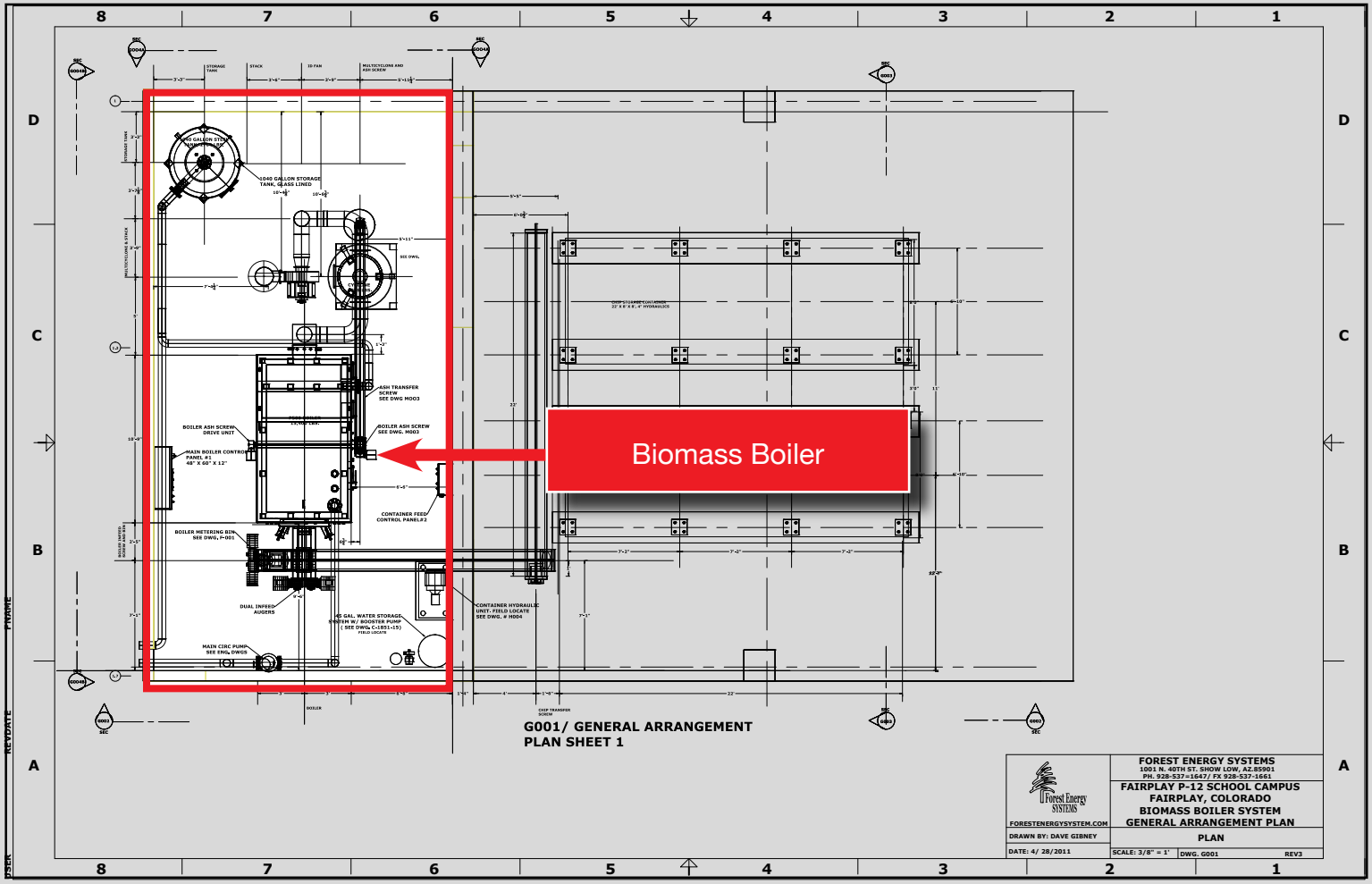
Storage: The two 22’ roll-off containers hold enough wood chips (about 10-tons of chips each) to feed the boiler at maximum heat output for one week. This covered outside storage area keeps the chips dry – but the low roof makes loading and unloading the containers difficult (see video on the previous page). Two-dimensional CAD software – and lack of experience with this pioneering approach are the source of the design problem.



Storage: The highlighted storage area easily holds the two roll-off storage containers – 672 sq. ft. (28' x 24'). The biomass boiler is in the nearby mechanical equipment room (MEC). This keeps to auger to a manageable and affordable length. It is a good idea to have the MEC on an exterior wall so it can be expanded, or easily modified in the future.

Boiler System

Boiler System: This state-of-the-art Osby-Parca 3.4 MMBtu/h wood chip boiler is from Sweden (in 2013, biomass accounted for 23% of Sweden's total energy supply). This boiler is almost fully automatic. However, because the auto-start option wasn't selected, an operator must manually light the fire. This isn't a problem in the winter because the boiler runs constantly. The challenge is during the fall and spring when temperatures fluctuate – this has proven to be a problem.

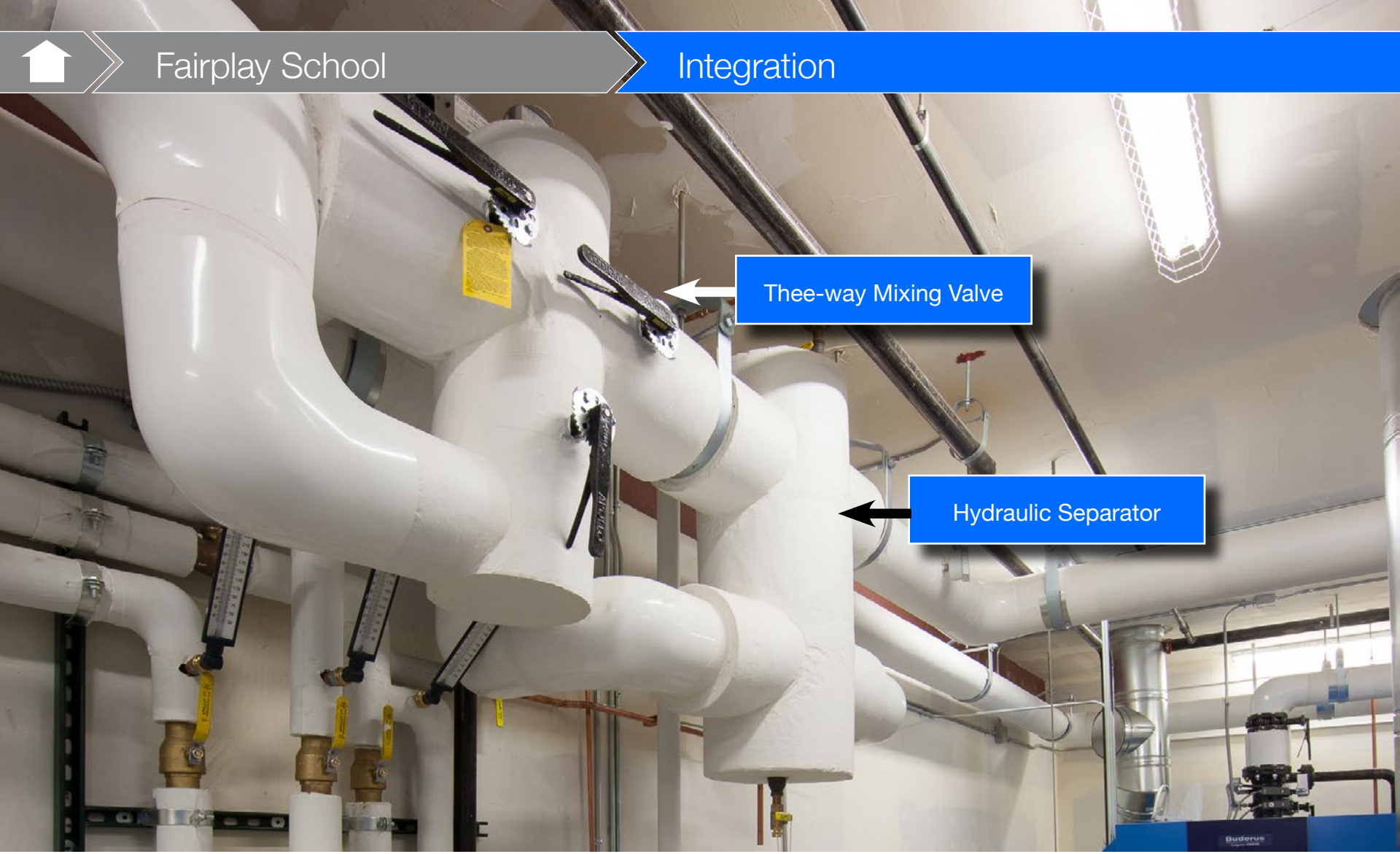


Boiler System: The biomass boiler, chip-delivery augers, 1,040-gallon hot water buffer tank, and all the piping are comfortably housed in this 20’ x 36’ (720 sq. ft.) boiler room.

LOW RES

Connection: The hot water from the boiler travels a few feet before being integrated into the building's conventional hot water heating system. The water storage tank (right) holds heated water to reduce cycling of the biomass boiler.

Integration



Integration: Hot water is used to distribute heat throughout the building. The water is heated by either the biomass boiler or a natural gas. On the coldest days, both boilers are needed. Biomass boilers operate best when they are run continuously. Starting and stopping solid fuel boilers takes time – and often leads to increased emissions. For best economic and operational performance, biomass boilers are often sized to meet about 80% of heat demand on a typical winter day.

CSU Foothills Campus

CSU Foothills Campus

Facility

Name: Judson M. Harper Research Complex

Location: Foothills Campus, Colorado State University, Fort Collins, Colorado (map)

Primary Use: Scientific Research

Total Square Footage: 2 buildings, 123,000 sq. ft.

HVAC: low-pressure steam

Construction Date: 2009

Biomass System

Boiler Size: Wood chip, 1.5MMBtu/hr unpressurized hot water

Reduction of Fossil Fuel Use: 4% of natural gas

Biomass Fuel: Wood chips

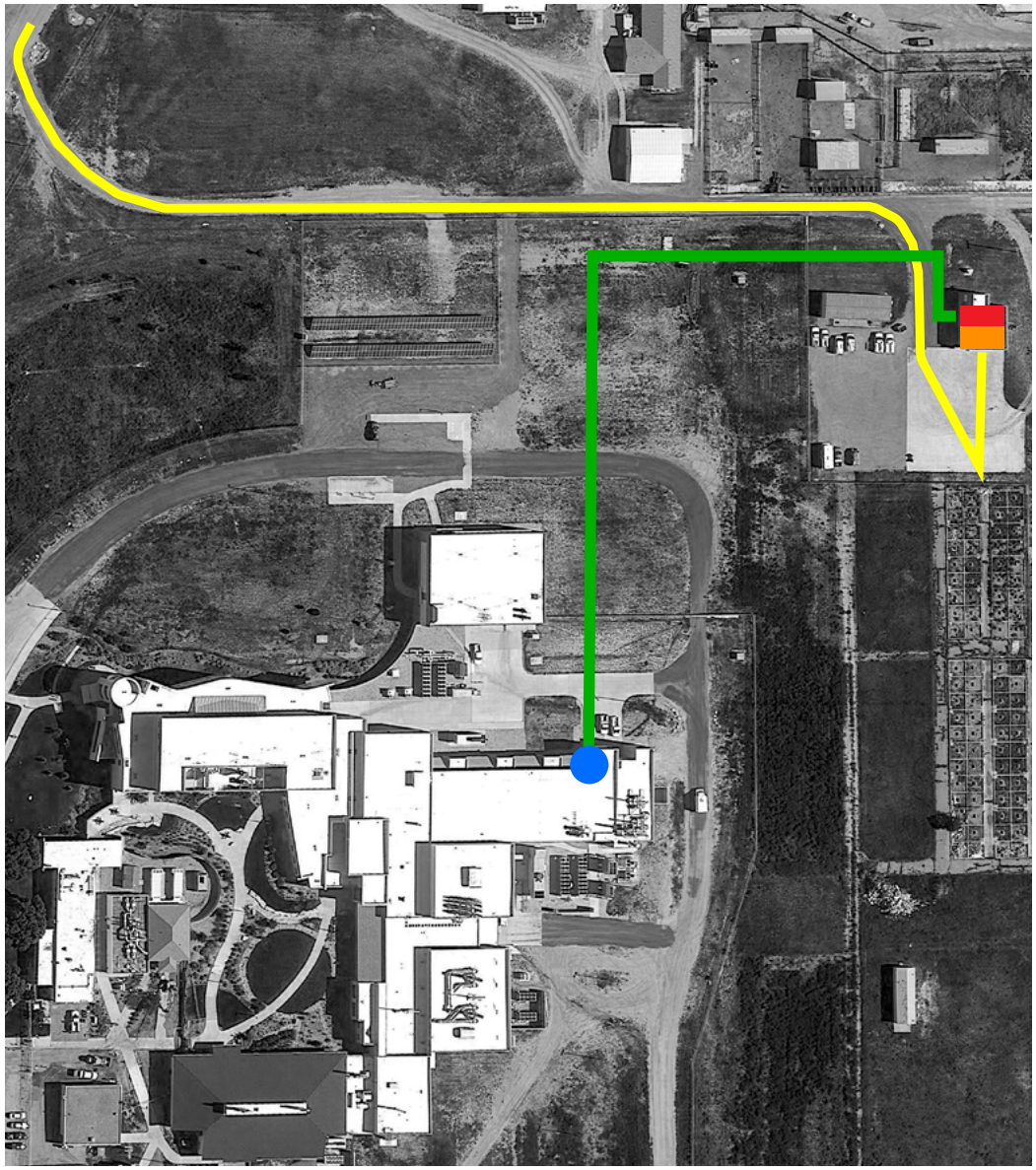
Integration Approach: heat exchanger with building's existing DHW system

Completion Date: 2009

Project Goals & Features

CSU wanted to gain experience using wood chip biomass systems for potential future expansion and to reduce their carbon footprint at the same time.

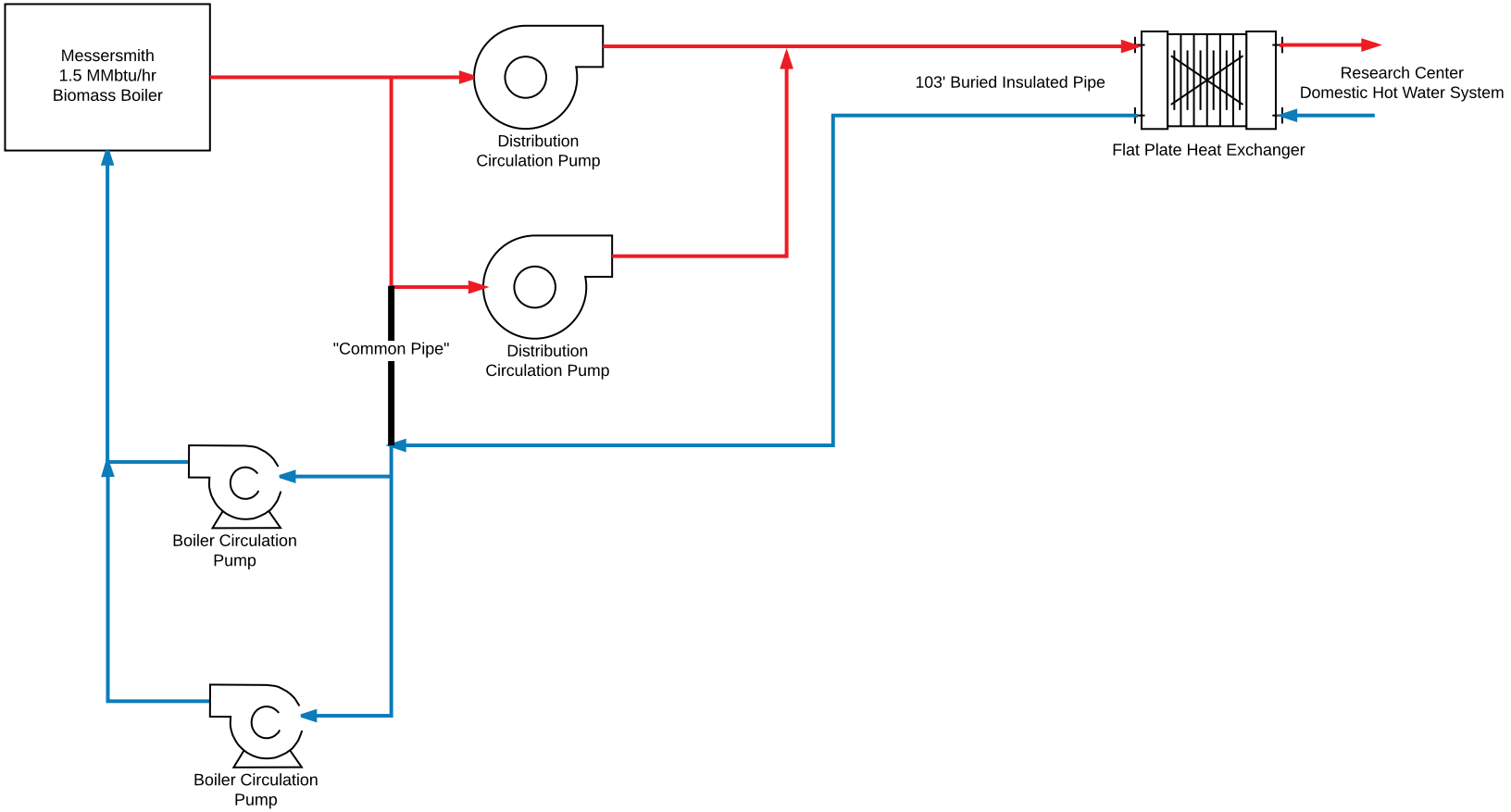
LOW RES



Delivery		WB-40 Semitrailer
Storage		800 sq. ft. (32’ x 25’)
Boiler		620 sq. ft. (25’ x 25’)
Connection		920’ of direct buried 4” insulated pipe
Integration		Heat Exchanger

LOW RES

System Overview



System Diagram: Heat from the biomass boiler is delivered to a heat exchanger in the research facility's domestic hot water system. The system uses a standard compound pumping design (also know as "primary-secondary" pumping) to flexibly deliver heat from the boiler to the distribution system.

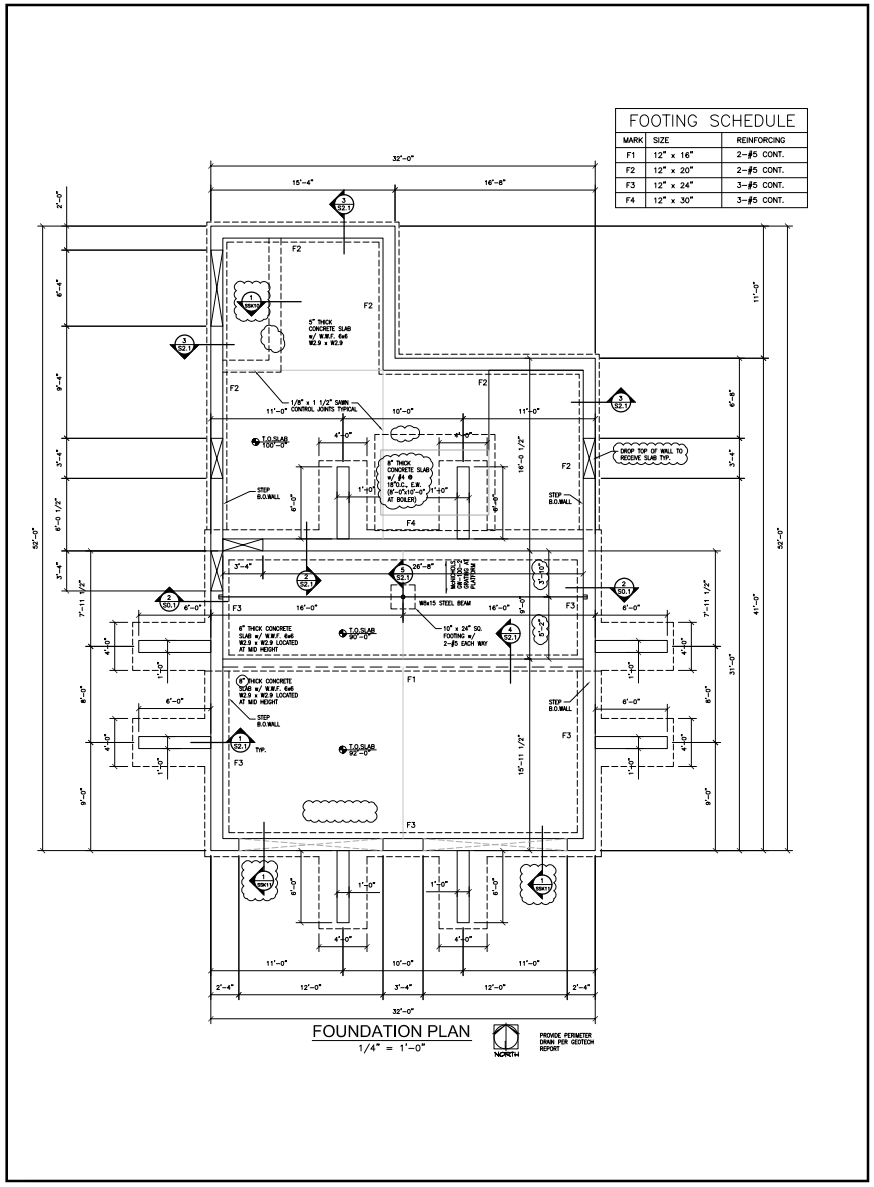
Delivery

Delivery: The larger the truck, the lower the delivery cost per ton. The above semitrailer can carry 20-tons of chips. To take advantage of the lower delivery cost, you'll need to design your project to someday accommodate a semitrailer like the one above, which can carry 20-tons of wood chips. The CSU facility uses about 300-tons of wood chips a year – 15 truckloads. In winter, that typically means one load a week.

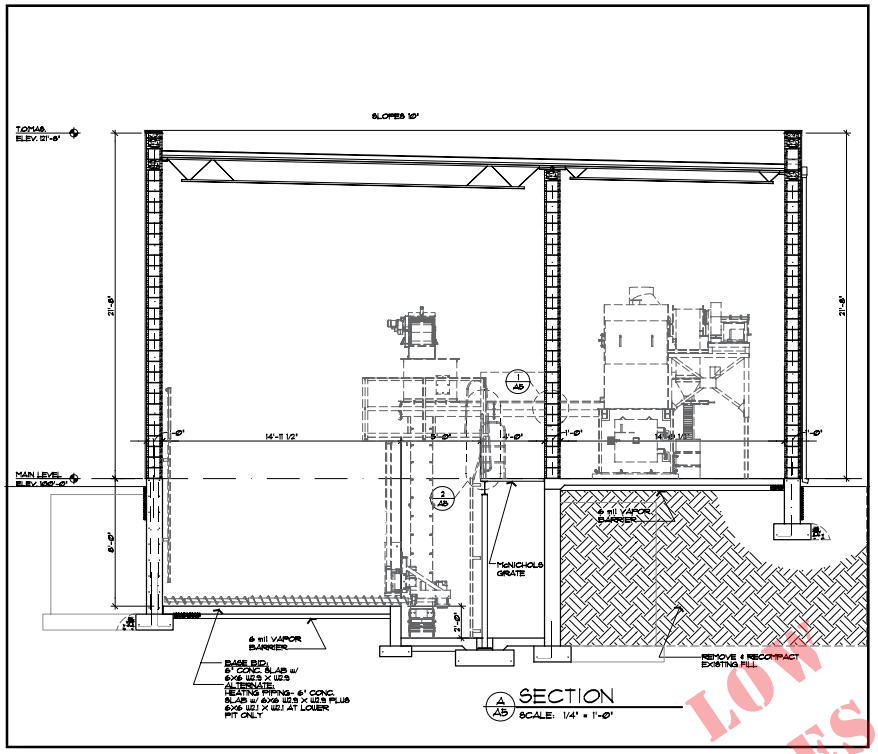
Delivery

Delivery: This video shows how a 45’ live floor (a.k.a. active or walking floor) trailer delivers wood chips to the CSU facility. If you haven’t designed your site to someday handle this size truck, you may need to use smaller, more costly delivery trucks. Or, worse yet, you may not be able to have any biomass fuel delivered.

Storage: The CSU storage facility is a concrete-lined pit 32’ x 15’ x 8’ deep (3840 cu. ft.). That’s big enough for 20-tons of chips, or one full semitrailer load of chips. In the peak of winter, this facility can burn through the entire amount in a week. The total footprint, including the chip handling system is 32’ x 25’.



Storage: Chips are stored in a concrete-lined pit 32' x 15' x 8' deep – less than 5% the volume of an Olympic sized swimming pool. The total footprint, including the chip handling system is 32' x 25'.



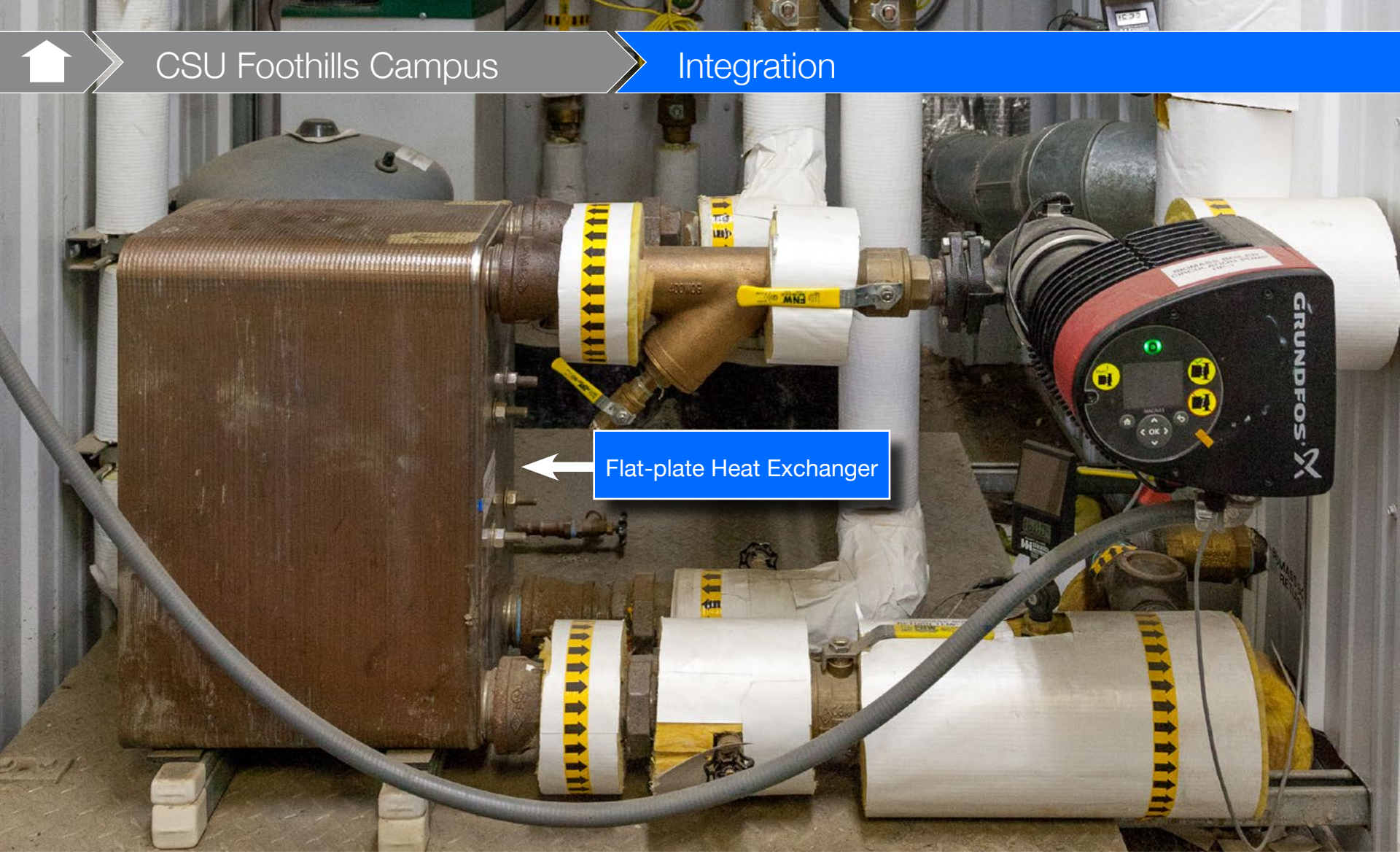
Boiler System

Boiler System: 25’ x 32’ (minus 11’ x 16.5’) = 620 sq. ft. = 25’ x 25’. The biomass boiler system is housed in half of the Biomass Facility Foothills Campus.

Connection: Hot water is circulated from the biomass boiler to the Animal Reproduction and Biotechnology Laboratory (ARBL) through 920’ of direct-buried insulated 4” pipes.

Connection

Connection: Most of the land between the biomass system and the Animal Reproduction and Biotechnology Laboratory was unpaved and unobstructed, which helped keep project costs down.



Integration: The hot water distribution loop from the biomass boiler integrates with the building's domestic hot water (DWH) system through two flat plate heat exchangers, like the one shown above.

Harney Community Energy

Credit: Wisewood Energy

Harney Community Energy

Credit: Wisewood Energy

Facility

Name: Harney Community Energy

Location: Burns, Harney County, Oregon (map)

Primary Use: Heating public buildings, including an elementary school, court house, and health care facility

Total Square Footage: 4 buildings, 95,000 sq. ft.

HVAC: Hybrid medium pressure steam (legacy school system) and hot water district heating

Construction Dates: 1917-1985

Biomass System

Boiler Size: hog fuel, 2.1 MMBtu/h biomass boiler (600 kW)

Reduction of Fossil Fuel Use: Displaces 17,000 gallons of fuel oil and 40,000 gallons of propane per year

Biomass Fuel: Hog fuel (see description on page 45)

Integration Approach: Hybrid steam-hot water district heating system.

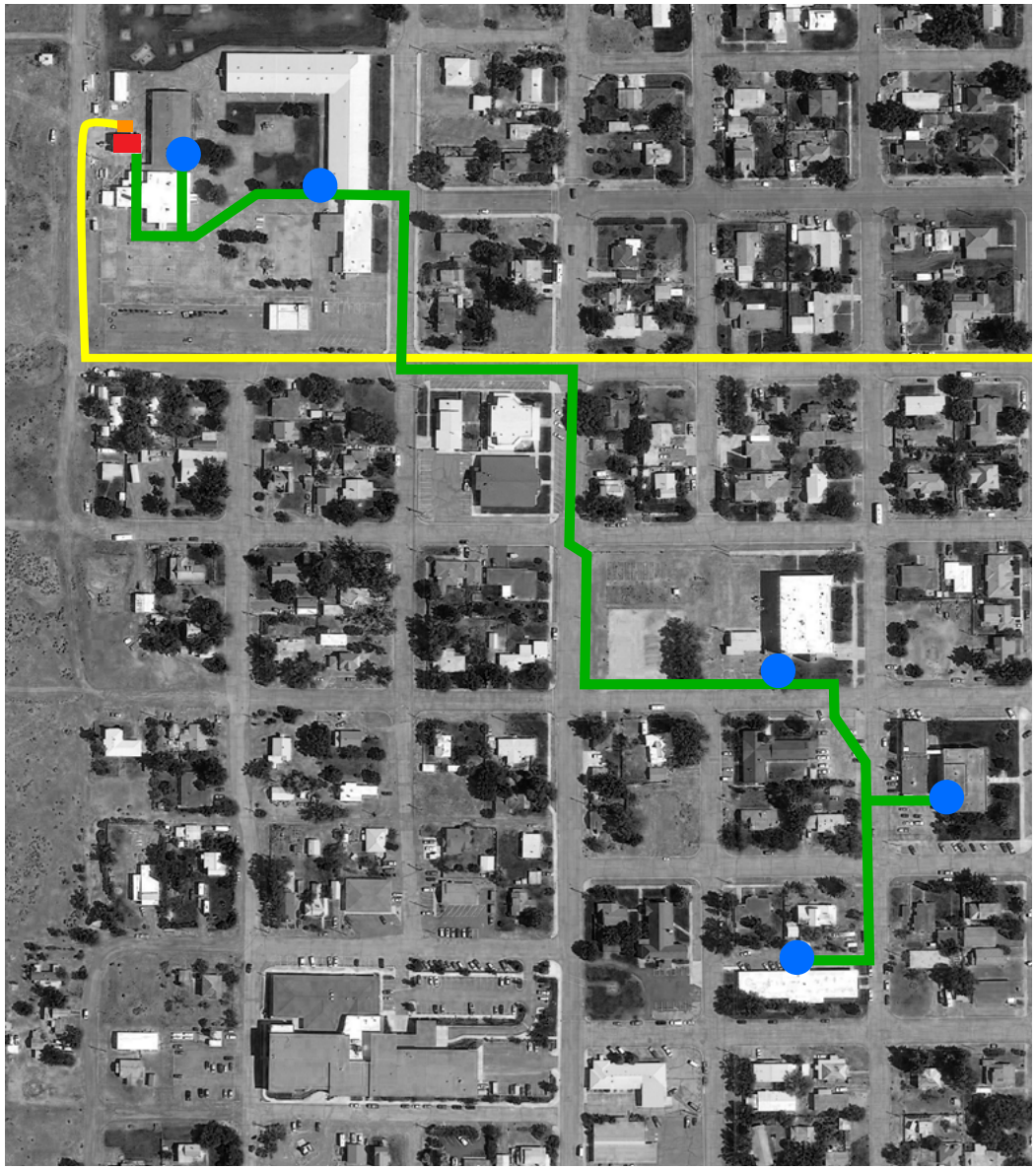
Completion Date: 2016

Project Goals & Features

Goal: Reduce the cost of heating public buildings by using wood fuel directly from the local forest.

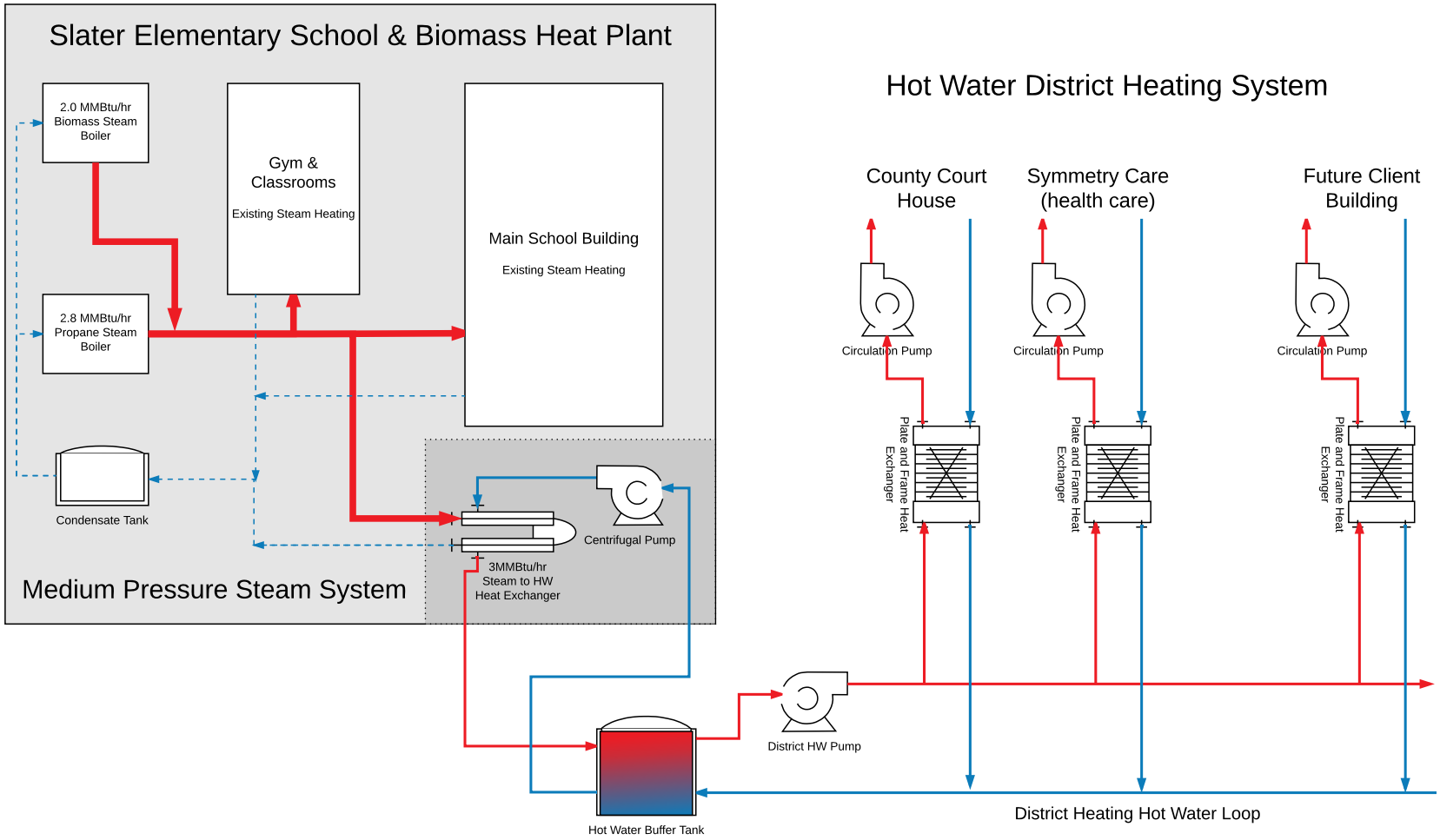
Challenge: The smallest biomass boilers capable of using minimally processed wood, produce several times more heat than the largest single building in this small rural town needs.

Solution: Connect several buildings together in a *district heating loop* that delivers heat from a central biomass heating plant to multiple buildings.



Delivery		34’ Roll-off Truck
Storage		832 sq. ft. (32’ x 26’)
Boiler		1,040 sq. ft. (26’ x 40’)
Connection		2,700’ of 4” direct buried PEX insulated flexible pipe
Integration		Heat Exchanger

LOW RES



System Diagram: Modern hot water district heating systems are cheaper and more efficient than steam systems. However, since the elementary school had a working steam heating system, a biomass boiler that produces steam was selected. The steam goes to the 2 school buildings and a steam-to-hot-water heat exchanger. The heat exchanger then heats the half-mile hot water district heating loop that currently serves 2 buildings. The system is designed to be expanded to handle many more buildings.

Hog Fuel

Credit: Wisewood Energy

Hog Fuel: The community wanted to directly use local forest material without expensive processing. That meant using minimally processed material made up of coarsely grade wood chunks and bark, called ‘hog fuel.’ Lumber mills and paper mills use it to generate process heat. The large number of suppliers and customers of hog fuel in the region insures a stable and competitive supply for the project.

The challenge with hog fuel is that even the smallest biomass boilers capable of using it produce more heat than is needed by any single building in town. One reason these systems are large is that high strength, heavy-duty equipment is needed to handle the odd sized pieces of wood (and the occasional rock) without jamming or being damaged.

Delivery

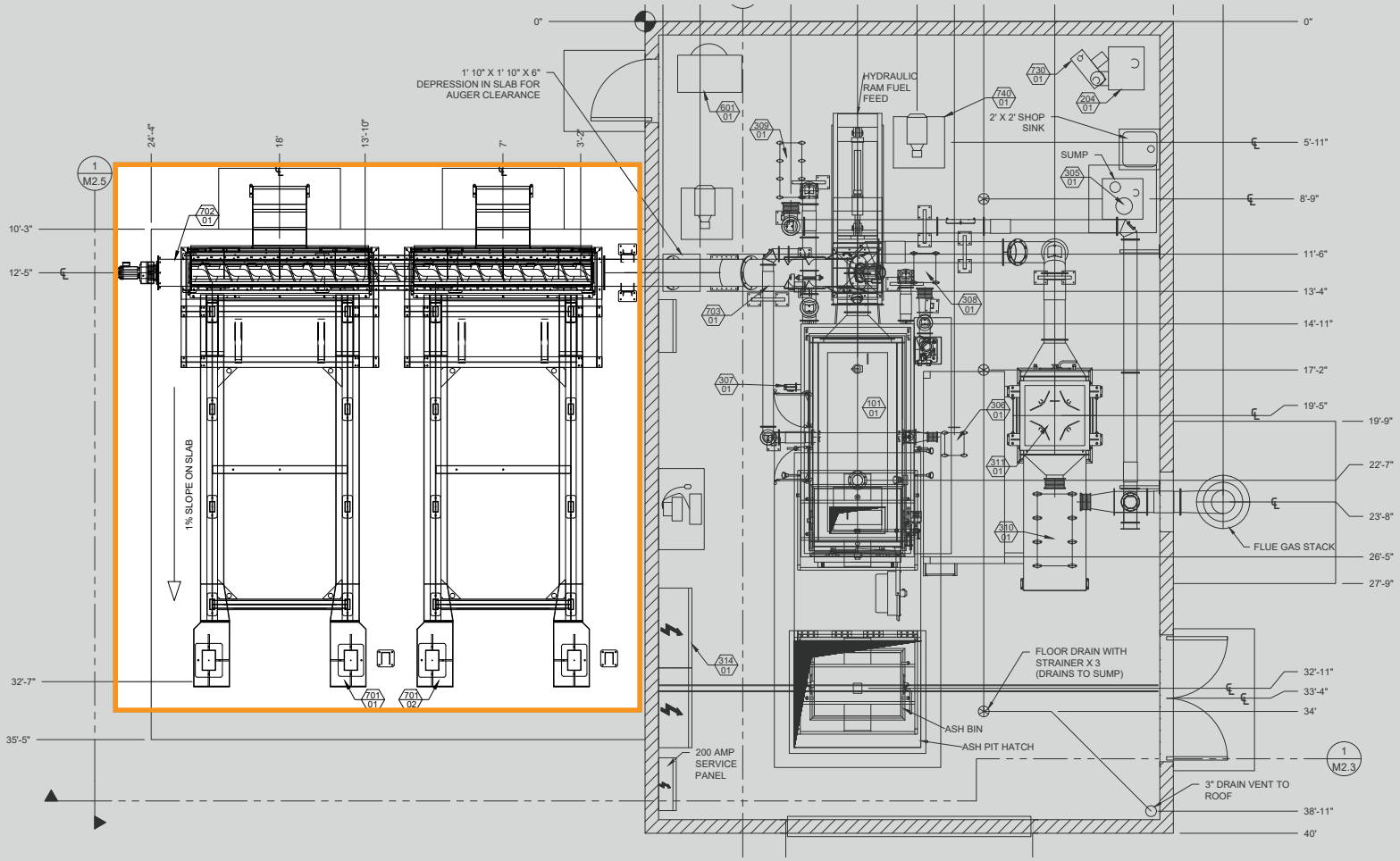
Credit: Wisewood Energy

Delivery: Hog fuel is first delivered to a biomass depot just outside of town. This depot can hold enough fuel for an entire season. Fuel can be bought and delivered when it is cheapest and most convenient, and then used when it is needed.

These modified containers work as both fuel storage container at the biomass heat plant and as a delivery container to pick up the fuel. When it is empty, a roll-off truck takes the container to the depot, loads it with hog fuel, and returns it to the heating plant. The truck operator reconnects the container to biomass boiler system. The whole process takes about 1 hour.

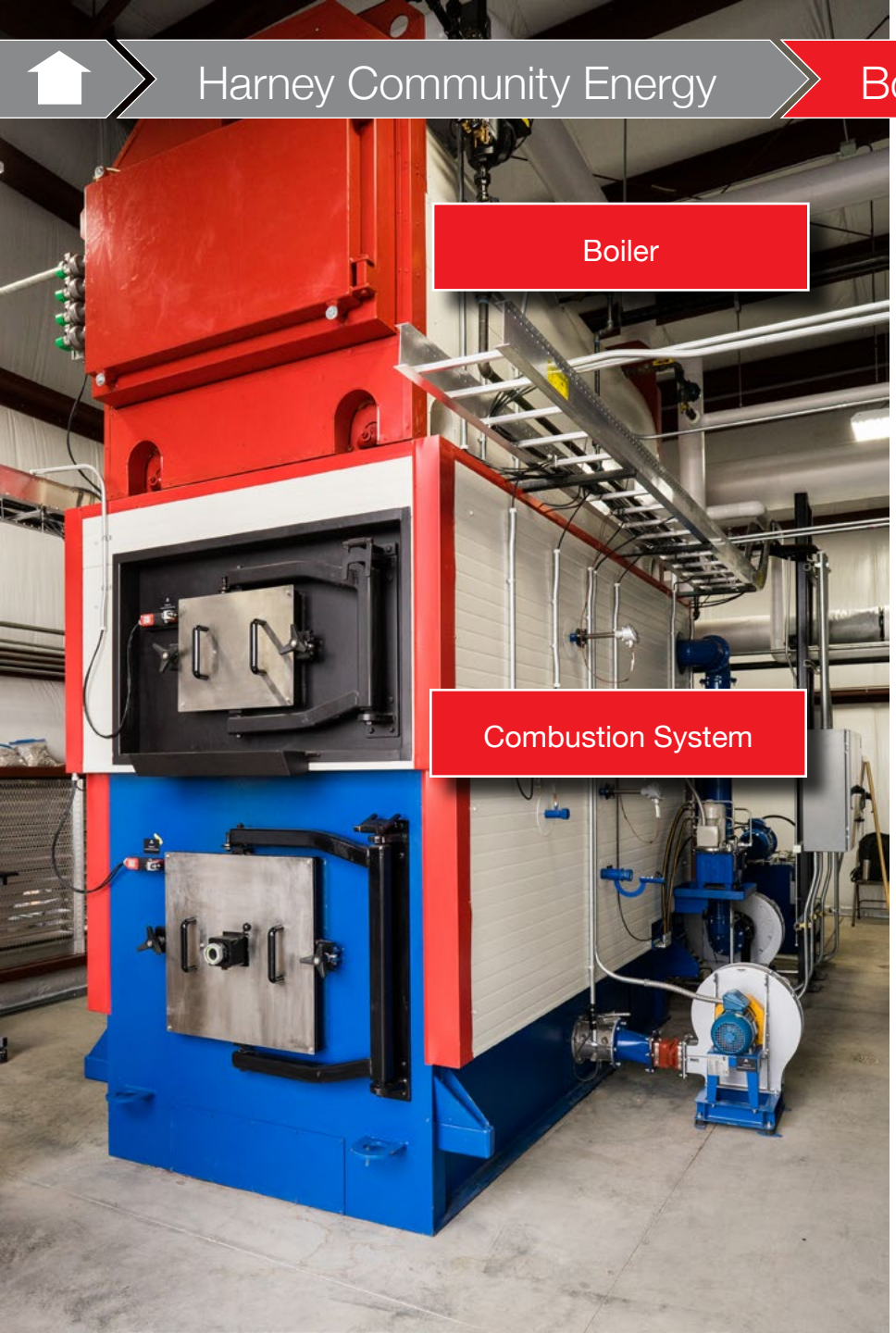
Credit: Wisewood Energy

Storage: When the container is returned from the biomass depot with fuel, the truck operator secures it to the storage docking platform, and reattaches the hydraulic hoses. The biomass boiler system controls the 'walking' floor to push the hog fuel into the auger that then feeds the boiler. Each container holds 8-tons of hog fuel, enough for about 3 days when the boiler is working at full power.



Storage: The 26’ x 32’ (832 sq. ft.) fuel container docking pad is immediately adjacent to the biomass boiler building – minimizing the length of the auger that moves the fuel from the containers to the boiler. Hog fuel is cheap and readily available in the region, but due to its irregular shape variable quality, requires heavy-duty augers. Keeping the auger length to a minimum not only reduces its cost, but reduces the chances for jamming and failure.

Boiler System



Boiler System: Boiler systems are made of two main parts, the combustion system and the boiler. The boiler is where the hot combustion gases heat water or, for steam boilers, produce steam. Frequently, the whole system is called a 'boiler,' but the distinction between the two parts is important for many biomass systems.

The combustion system is where fuel is burned to create the hot gases. For fuels like natural gas, the combustion system is simple and small – often an integral part of the boiler.

Handling and burning solid fuels like coal and biomass are much more complicated. This is particularly true when irregular and inconsistent material like hog fuel is involved.

It is difficult to reliably and cleanly burn hog fuel at the relatively small scale needed by this project. The best combustion technology for this size comes from Austria (a country where biomass provides more than 20% of all their energy).

Harney Community Energy combined a combustion system from Kohlbach in Austria with a boiler from Boilersmith in Canada.

Credit: Marcus Kauffman, Oregon Department of Forestry

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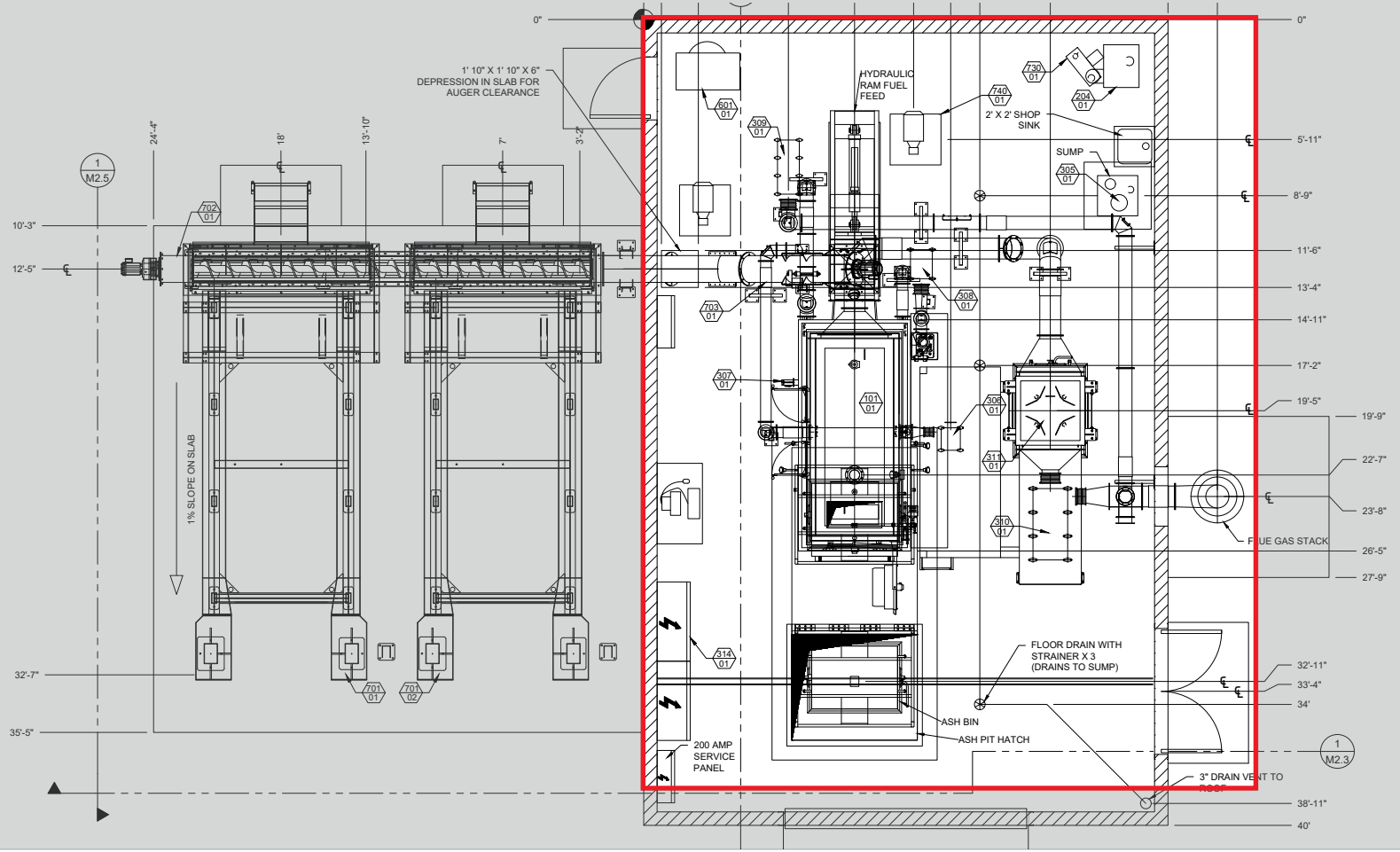
Boiler System



Boiler System: The boiler building (1,040 sq. ft.) houses the boiler, the equipment needed to automatically feed the boiler the hog fuel from the containers outside. Hog fuel has two characteristics that increase the size and complexity of the system. The fuel is irregular and inconsistent requiring larger fuel handling hardware. The fuel also includes a lot of bark and other tree parts that contain compounds like silicates that don't burn. Material that doesn't burn is turns into ash – often a lot of ash. That must be managed.

Connection

Connection: The steam from the biomass boiler is used to heat the hot water that circulates through the mile or so of buried insulated pipe that makes up the district heating system.

These two 5 kW pumps circulate the hot water and maintain a pressure difference between the supply (outbound) water and the return water. It is that pressure difference that drives the hot water through the individual heat exchangers in each customer's building.

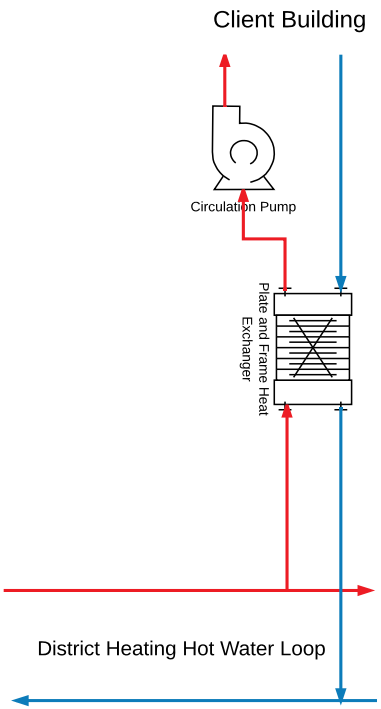
Credit: Wisewood Energy

Credit: Wisewood Energy

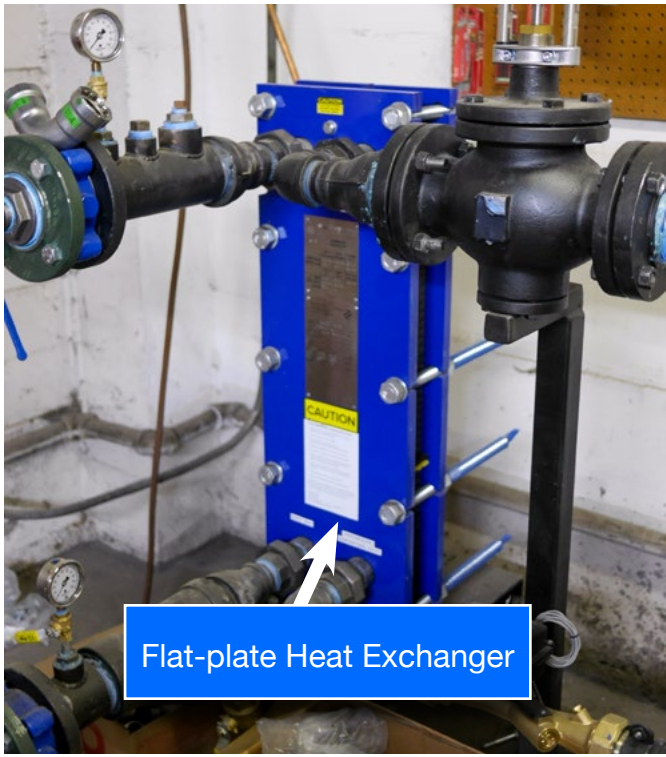
Connection: Hot water supply and return pre-insulated flexible pipes leave the Henry L. Slater Elementary School on their half-mile journey through the streets of Burns, Oregon. The school building is heated with steam. That steam is also used to heat the hot water in these district heating loop pipes.

Credit: Wisewood Energy

Connection: About 1 mile of pre-insulated flexible plastic pipe has been buried under the streets of Burns. One of the benefits of using a hot water instead of steam is that lower cost plastic piping can used.



Credit: Wisewood Energy



Credit: Wisewood Energy

Integration: Connecting a building to the district heating loop is straight forward. The pressure difference between the supply and return pipes causes the hot water to flow through each building's heat exchanger. The customer's heating system pumps water through the heat exchanger and uses that hot water to heat the building. If the building has a forced air furnace, the hot water can be circulated through a fan-coil unit (like a car radiator).

Boulder County Jail

Boulder County Jail

Facility

Name: Boulder County Jail

Location: Boulder, Colorado (map)

Primary Use: County jail with bed capacity of 536

Total square footage: 103,400 sq. ft.

HVAC System: hot water

Construction Dates: 1988–2005

Biomass System

Boiler Size: 3.4 MMBtu/h

Percentage heated with biomass: capable of providing 100% except for the coldest days of the year.

Biomass Fuel: wood chips

Integration Approach: three-way mixing valve

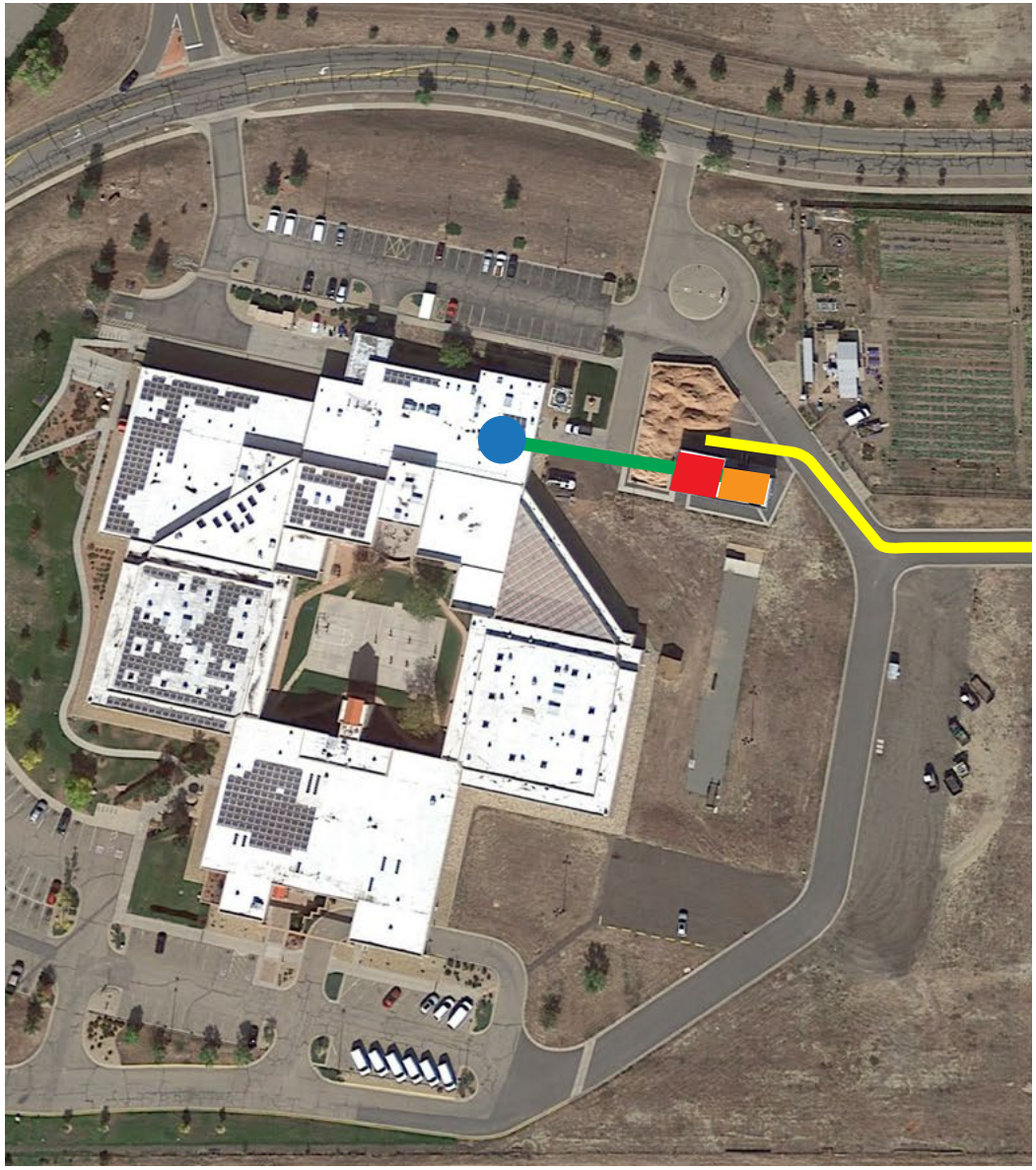
Completion Date: 2011

Project Goals & Features

Biomass heating is important to Boulder County for several reasons. The wood chips that fuel this biomass boiler come from forest restoration and treatment projects on land owned by Boulder County (parks and open space). Much of that wood would otherwise be burned in open slash piles, causing local air quality problems.

The biomass system offsets the use of natural gas, helping Boulder County meet their aggressive greenhouse gas (GHG) reduction goals.

Boulder County Jail



Delivery

WB-40 Semitrailer

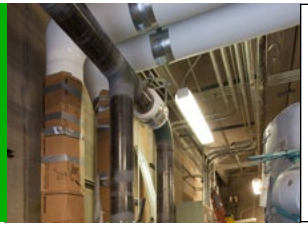
Storage

748 sq. ft. (22’ x 34’)

Boiler

600 sq. ft. (20’ x 30’)

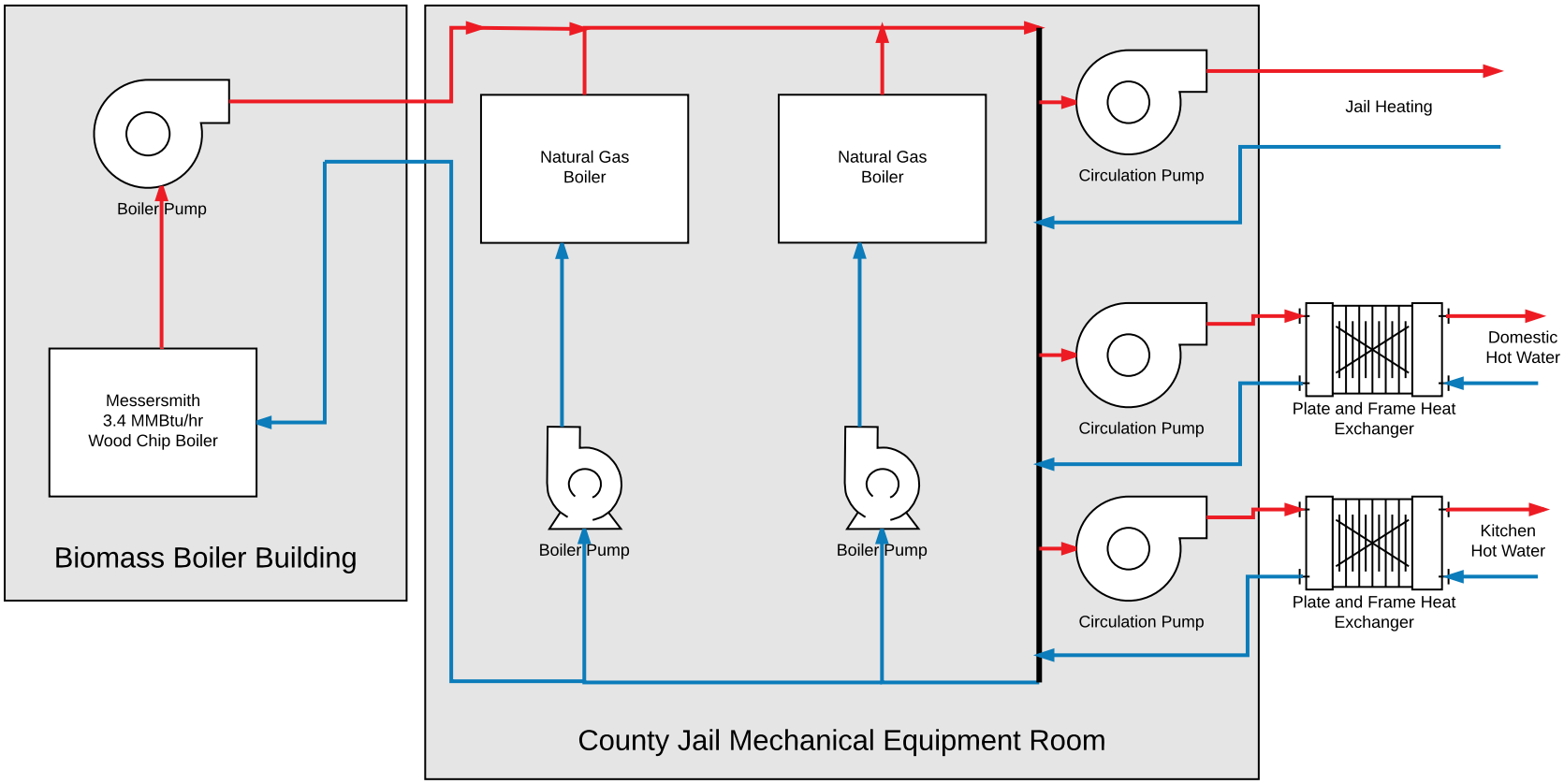
Connection



103’ of 4” insulated buried pipe in mechanical room

Integration

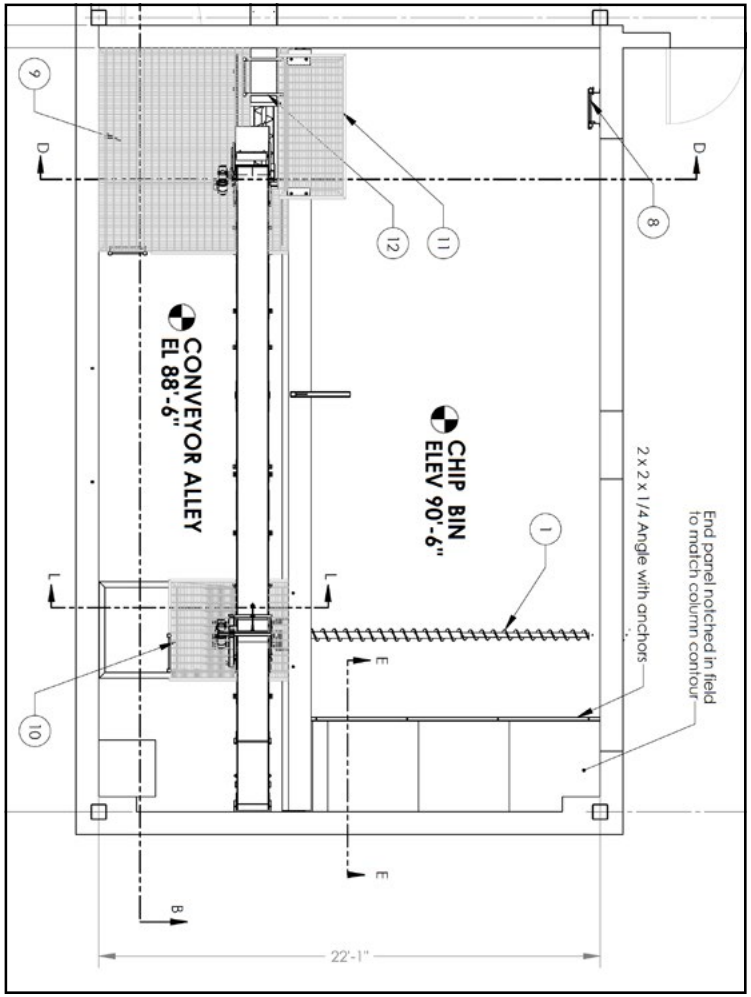
Hot water from the boiler directly connects to the heating system using a mixing valve.



System Diagram: The biomass boiler simple acts as a third boiler for the jails heating plant. Hot water from the biomass boiler mixes directly with the compound-pumping (primary-secondary pumping) system as is then used to heat the building, heat domestic hot water (showers, etc.), and the kitchen hot water.

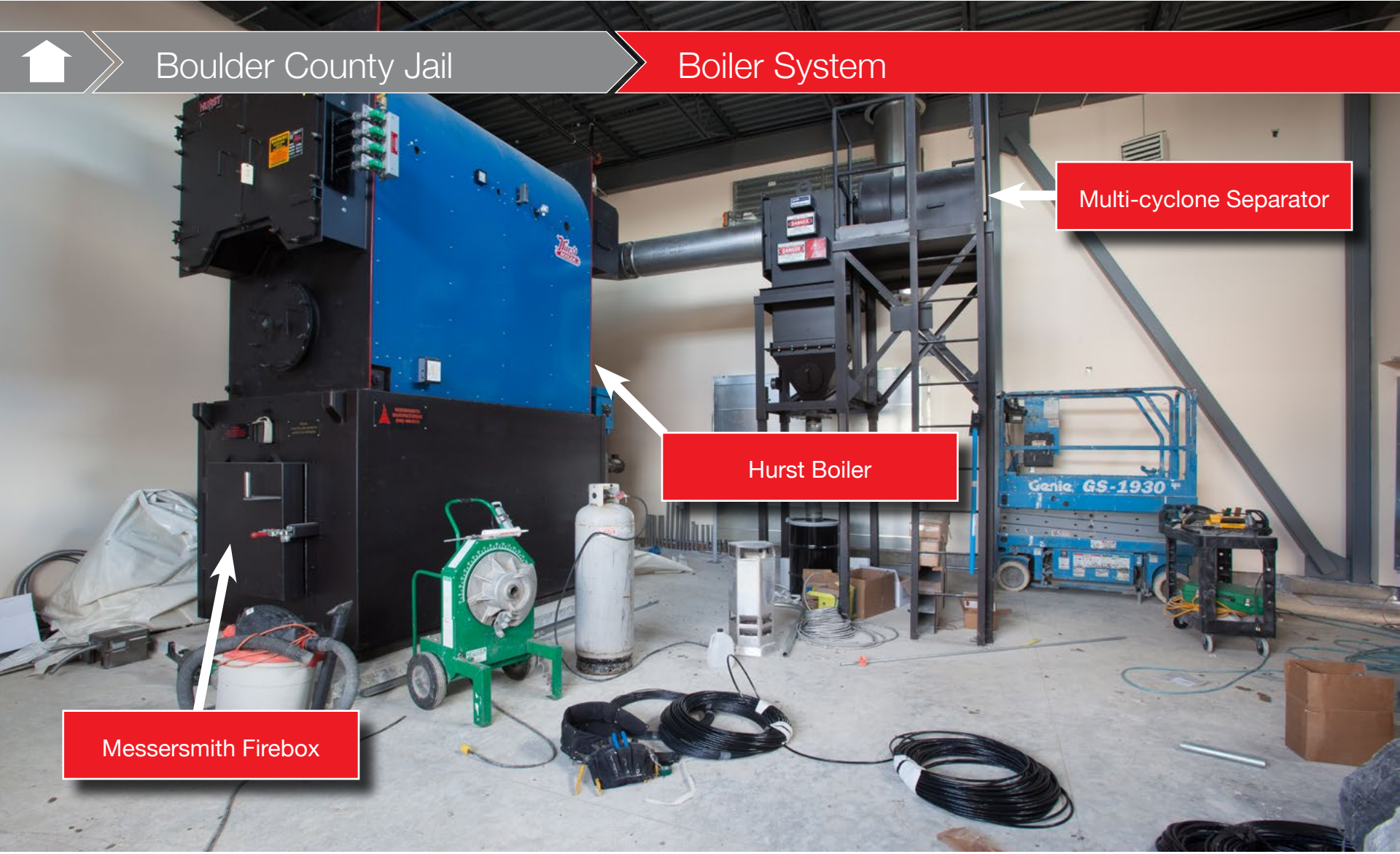
Delivery: As you can see, delivering chips by semitrailer isn't always easy – especially if the site wasn't designed to make it easy. Security concerns of the jail administrators prevented optimal orientation of the storage-boiler building preventing direct delivery of chips into the storage pit. Chips must first be delivered on the pavement outside then moved by small skid-steer loader into the enclosed storage pit. This example underscores the value and importance of proper site layout.

Storage: This time-lapse video shows 2 days of operation. An auger on the floor of the pit moves the chips to the conveyor belt on the right, and then to the boiler in the adjoining room. This concrete-lined pit 33.5’ x 13’ x 8.8’ deep (about 3,800 cu. ft.) – about a tenth the size of a short-course competition swimming pool. At the end of the video you can see the compact skid-steer loader delivering chips to the bin.



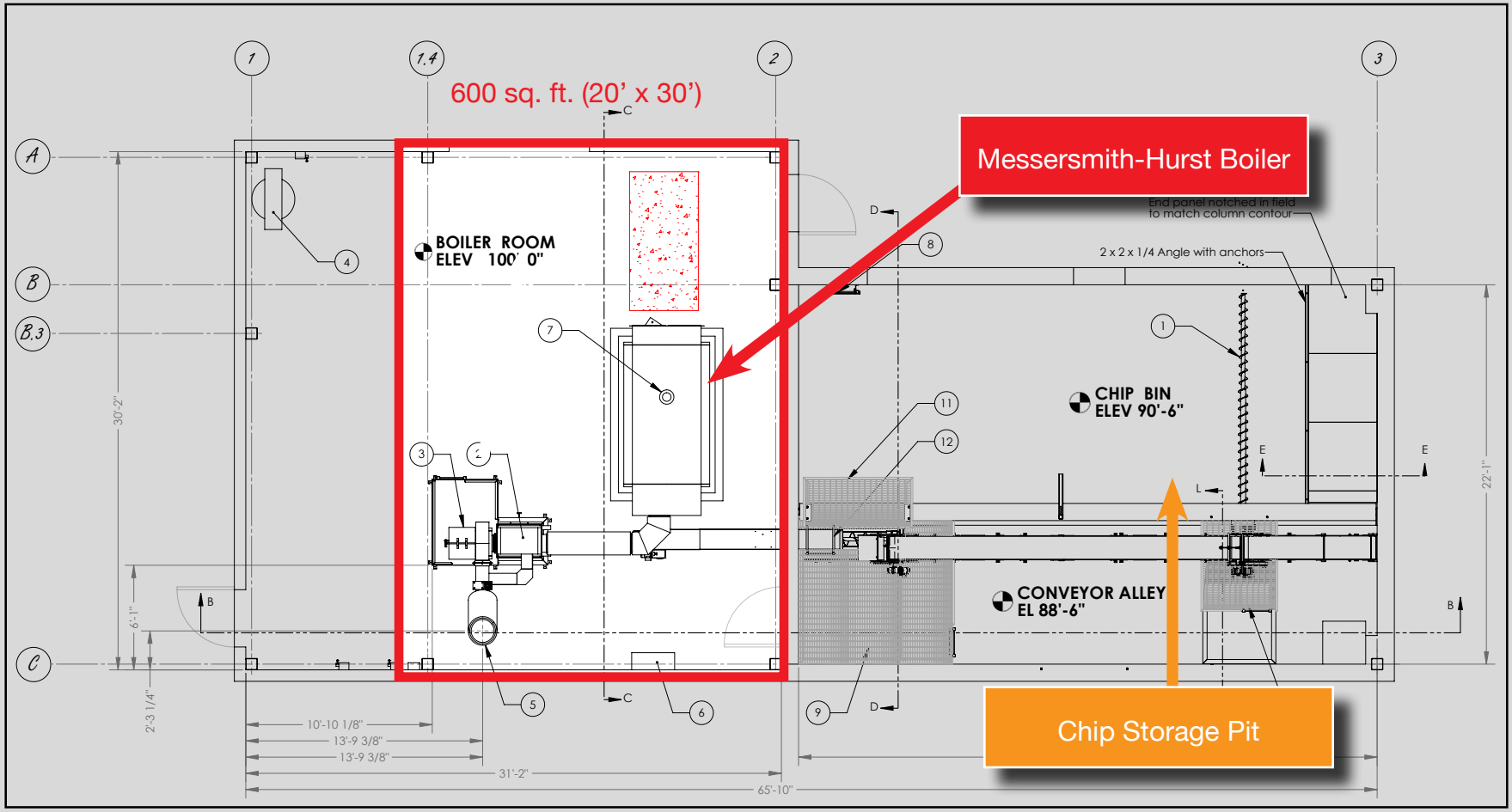
Storage: Getting the chips from the storage pit to the boiler automatically is done by a series of augers and conveyer belts. Here an augur traverses the bottom of the chip pit, moving chips through a narrow slot about 1' high. (The photo on the upper left was taken through that slot before the bin was initially filled.) The chips then fall on a conveyor belt that delivers them to the boiler's fuel feeding system (lower left photo).

Boiler System

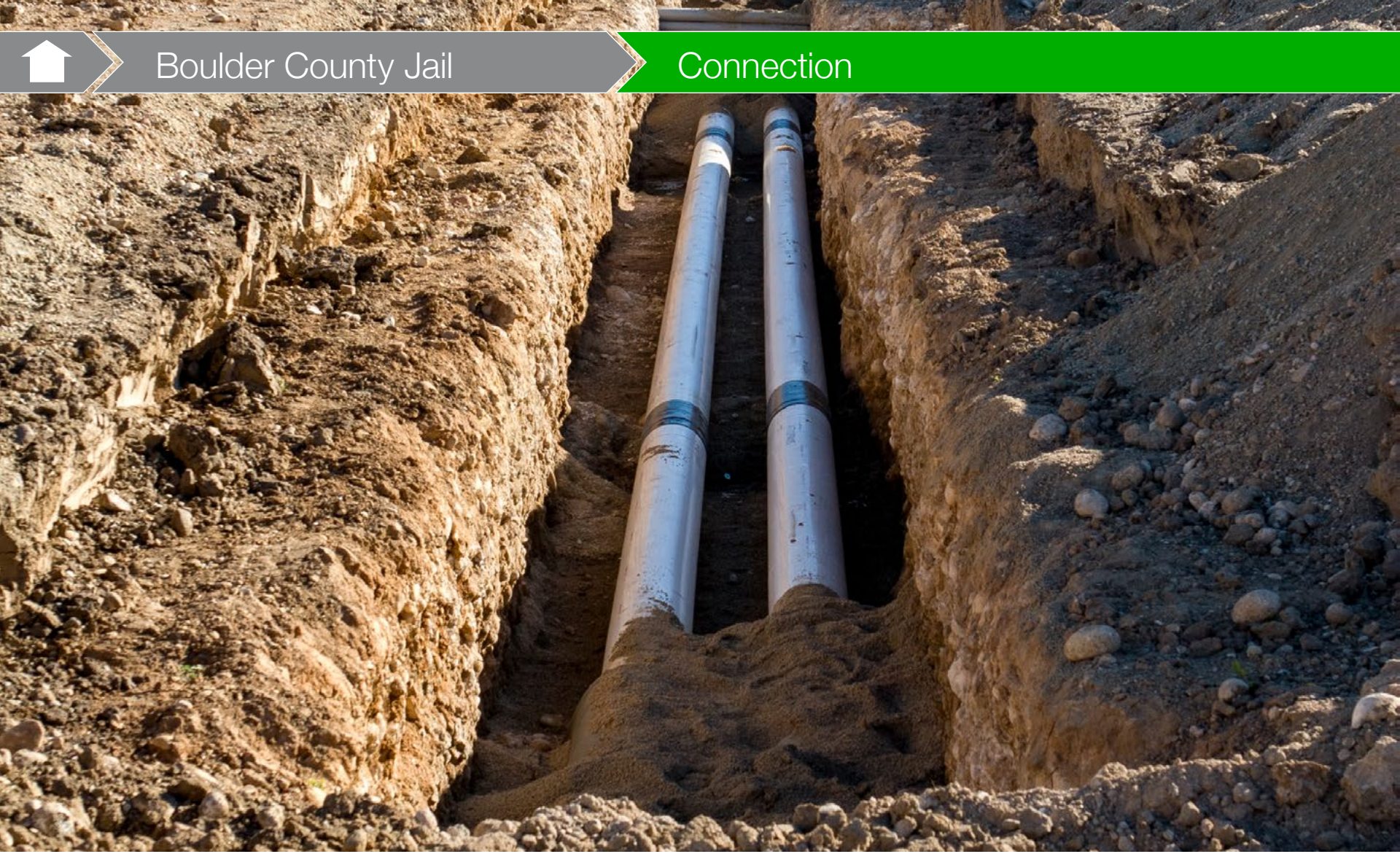


Boiler System: This photo, taken during construction, shows the 3.4 MMBtu/hr biomass boiler. The system has a guaranteed efficiency of at least 70% when burning chips with a moisture content of 45% or less (wet basis). A multi-cyclone separator removes most the large particulates in the exhaust stream. The system has been designed to accommodate a more expensive and more effective electrostatic precipitator (ESP) should that be needed in the future.

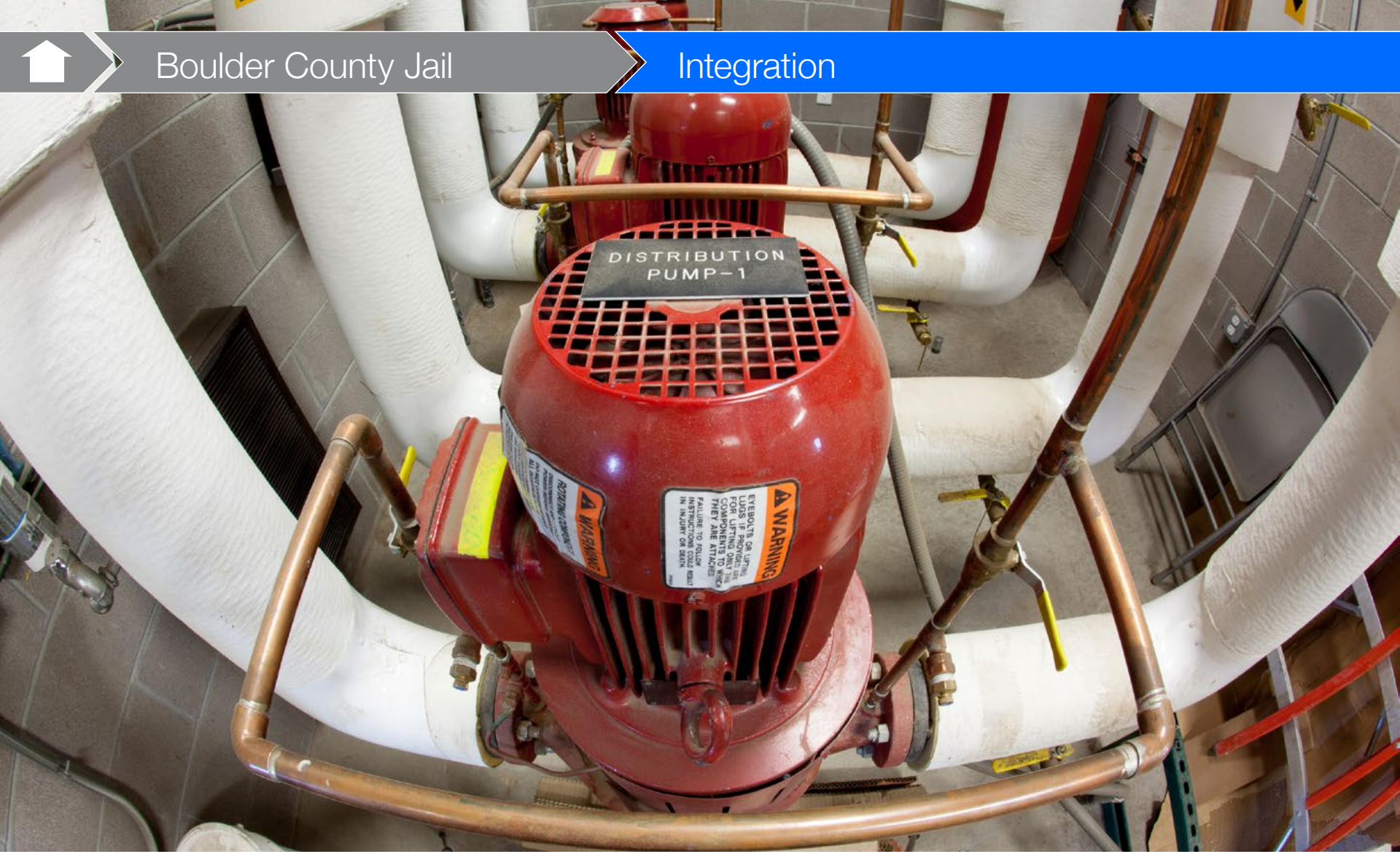
Boiler System



Boiler System: This floor plan diagram shows the footprint of the biomass boiler system (600 sq. ft.). The boiler itself is relatively compact, but the ample space around it makes the system easier to maintain and clean. Systems that use solid fuels like biomass are larger and require more frequent maintenance than gas or liquid fuels. Footprint dimensions in Biomass Ready include enough room to conveniently and affordably maintain equipment.



Connection: Climate conditions in Boulder, Colorado permit direct burial of insulated hot water supply and return pipes. The biomass boiler is about 100’ away from the jail’s existing mechanical equipment room (MEC) that houses the natural gas boilers. This piping often costs several hundred dollars per linear foot, so proximity is important. Choosing a site for your MEC and a future site for a biomass system that are as close as possible will help manage future costs.



Integration: The Boulder County Jail already had a hot water heat distribution system, so integrating the biomass boiler system was straightforward. A pump like the one in the photo above circulates hot water through the biomass boiler and then directly mixes with hot water of the jail's existing heat distribution system.

COLORADO STATE FOREST SERVICE
COLORADO STATE UNIVERSITY

csfs.colostate.edu/cowood/wood-to-energy/

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