

Cordwood Technology Outlook- The 2020 Threshold and Emerging Technologies

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EPA “Hydronic Heaters” (aka. boilers or waterstoves that use wood fuel) overview as of early April 2017:

114 EPA Certified Hydronic Heaters

Of those:

- 3 Pellet or wood chip boilers don't meet 2020 thresholds.
- 71 Are pellet boilers now meeting 2020 thresholds**, however some will require re-testing with EPA methods rather than the EN303-5 certification. Most will still meet 2020 requirements, but most will also show higher emissions and lower efficiency.
- 15 Cordwood boilers meet 2020 thresholds. BUT, some were tested with methods that aren't approved after 2020. Some are virtual duplicates. So, only 12 are 2020 ready.**
- Of the 25 cordwood boilers that don't meet 2020 thresholds, most are 2 stage, down-drafting (gasification) models.
- Several of the appliances on the list of 114 are manufactured by companies that are already out of business or have been offered for sale. 8 appliances are represented by those companies.

What can be gleaned from the EPA list of boilers meeting 2020 thresholds?

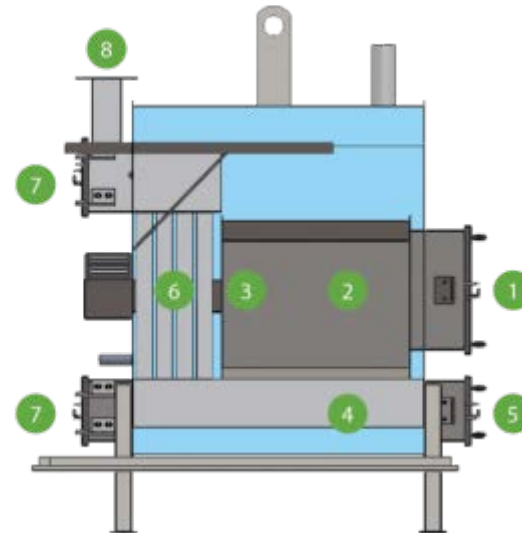
- 2 stage, down-drafting technology alone is usually not enough to satisfy 2020 regulations.
- Cordwood boilers rarely if ever pass the 2020 thresholds when cycled on and off.
- Active combustion air control (**Lambda**) is prevalent in 2020 boilers, **7 of 15**.
- **Thermal Storage** is utilized by **9 of 15** 2020 boilers.



Boiler	Thermal Storage – Gal.	In Vessel – Gal.
1	1830	1830
2	1830	1830 Duplicate
3	1420	1420
4	1420	1420 Duplicate
5	600	Minimal
6	190*	190
7	None	50 (Minimal)
8	250*	250
9	200*	200
10	195*	195
11	None	90 (Minimal)
12	600	Minimal
13	660	Minimal
14	595	Minimal
15	395	Minimal



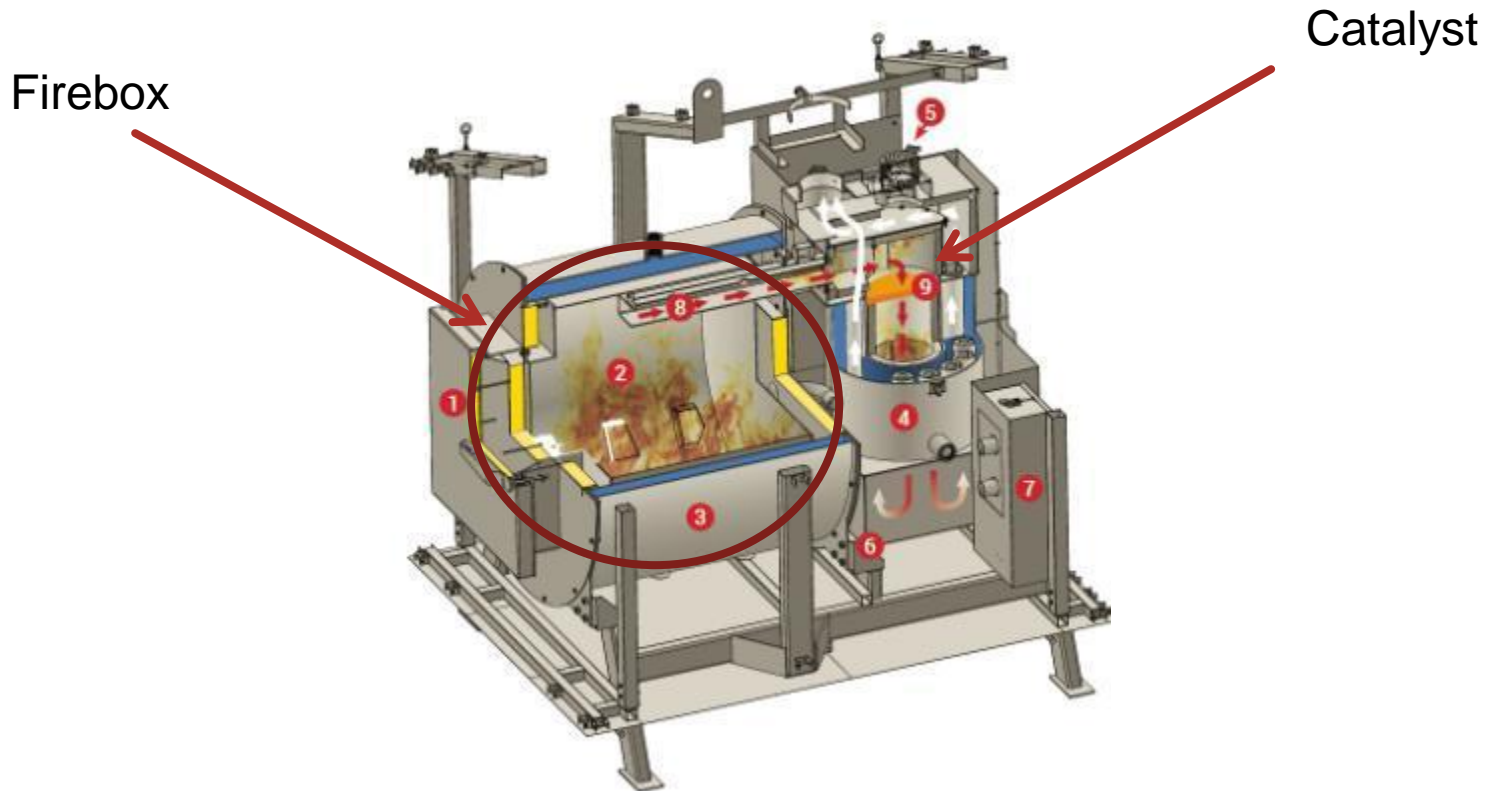
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*Not counted on prior page as thermal storage

Unique technology

One uses a dry firebox and feeds the resulting smoke into a catalyst



Another uses a long flame path, proper air/fuel mixing, and refractory that heats quickly to make a hot environment for burning smoke.

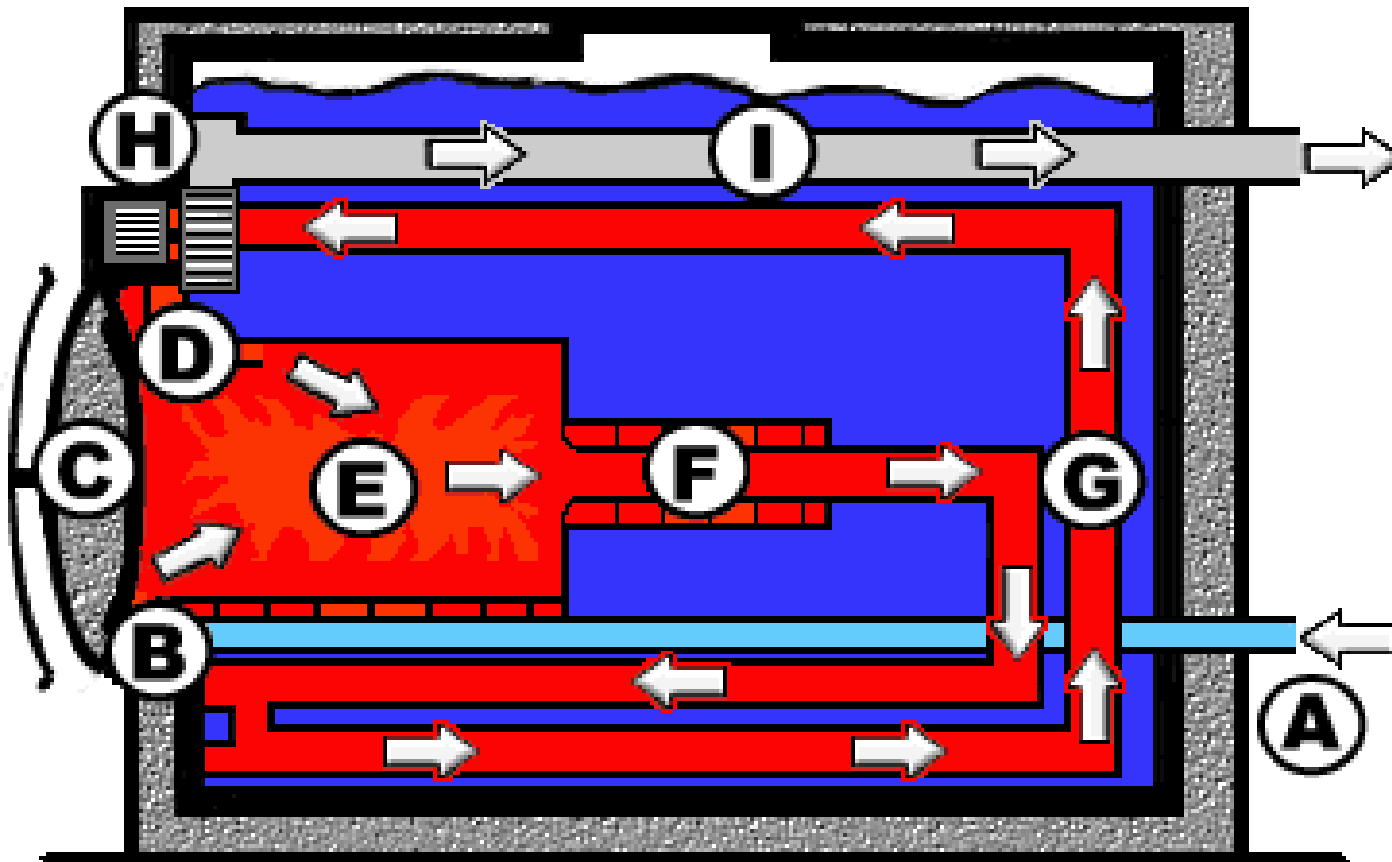


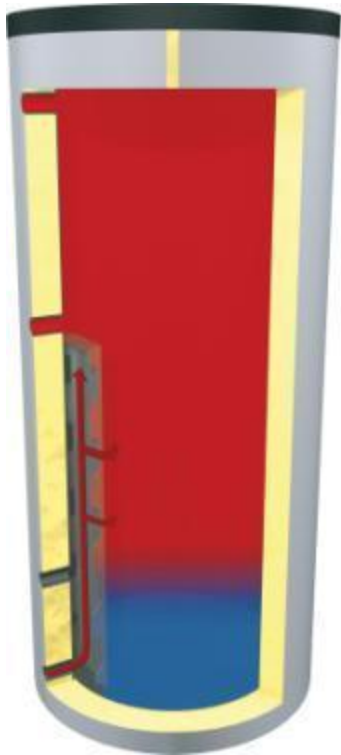
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“Thermal Storage” boilers are tested as cold start boilers, meaning there is no charcoal or ash in the firebox and boiler and storage tank water is 125°F or higher starting the test.

Non-thermal storage boilers are tested with a charcoal bed and 125°F or warmer water to start the test. Charcoal provides a major advantage for achieving temperatures high enough to burn particulates and for producing heat with very low particulate emissions.

There seems to be a sweet spot for some 2 stage, down drafting boilers testing with 12 pound or larger charcoal beds and substantial onboard water. At 12,900 Btu/pound., there are 154,800 Btu of low emission charcoal fuel on board at the start of the test. This charcoal counter-acts the placement of new wood fuel in the firebox.

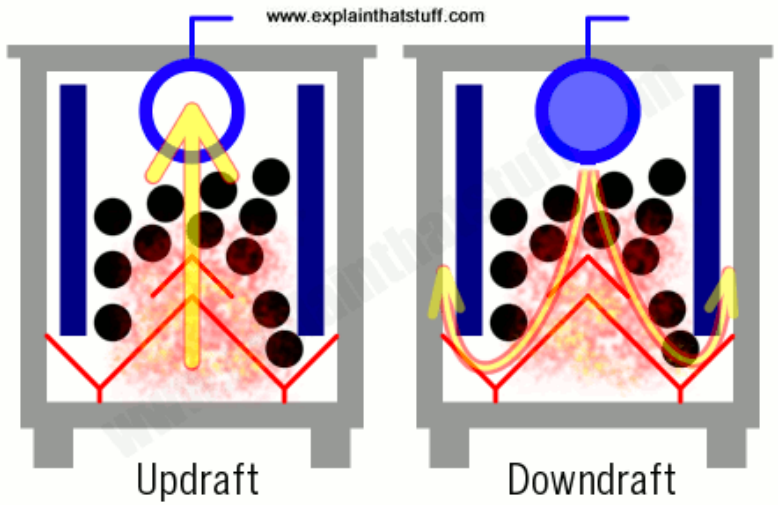
What is the consumer cost for wood boilers complying with 2020 thresholds?



Thermal storage
 \$5.00-\$10.00+/gallon



Lambda control
 ~\$1,000

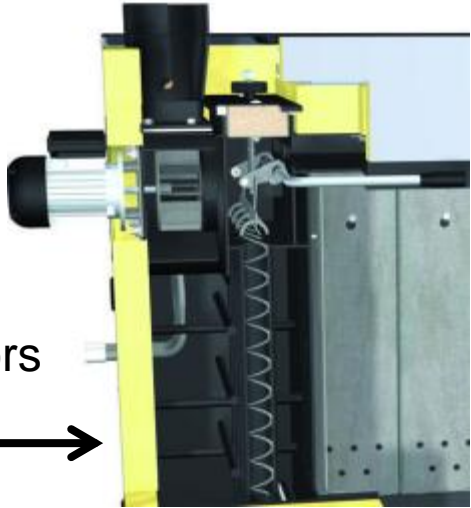


Updraft vs. downdraft technology
 \$ 2,000-\$6,000

The special sauce:



Firebox cladding and distributed primary air.



Firetube turbulators and lifting lever



Fill assistance based on thermal storage volume and temperature



Remote monitoring

Average Efficiency for 2015 boilers = **64%**

Average Efficiency for 2020 boilers = **70%**

Average lb/MM Btu 2015 = **.24**

Average lb/MM Btu 2020 = **.09**

Assume 20 MM Btu/cord.

Assume average of 5,000 boilers sold/year

Assume each boiler burns 8 cords/year in 2015

$20 \text{ MM Btu} \times 8 \times 5000 = 800,000 \text{ MM Btu}$

@ 2015 --- $800,000 \text{ MM Btu} \times .24 = \mathbf{192,000 \text{ lbs. particulates/year}}$

@ 2020 --- $800,000 \text{ MM Btu} \times .09 = \mathbf{72,000 \text{ lbs. particulates/year}}$

What about efficiency?

$800,000 \text{ MM Btu} \times .06 = 752,000 \text{ MM Btu}$

2020 efficiency gains reduce wood use 6% compared to 2015, thus **reducing particulates by another 11,520 lbs./ year.**

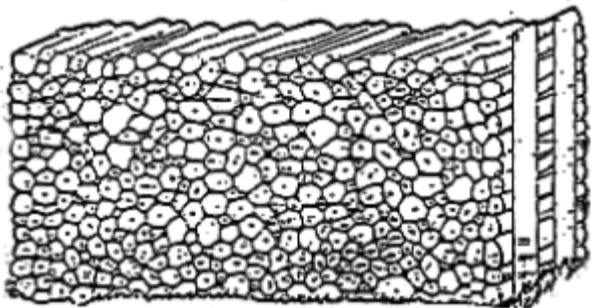
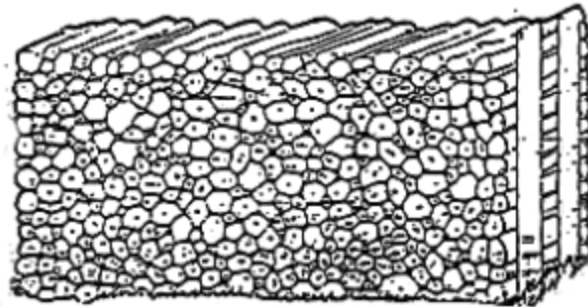
Total particulate reduction 2020 compared to 2015 = 317%



**Installed renewable energy with battery for about
\$1.00/Watt!**

= Nature's Solar Panel and Battery.

Two cords of wood...



...will make more energy
than a 5 kW solar array in
one year.

