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**The High Efficiency Heating System
at
Haverstick Homes, Trenton, N.J.
for the ACEEE Summer Study, Santa Cruz, Ca.**

Disclaimer: The Hydropulse modular boiler discussed in this report is a product of Hydrotherm, Inc., Northvale, New Jersey. This paper is a review of one particular installation of this equipment and is not intended be construed in any way as a recommendation or endorsement of this product. Furthermore, there is no assurance that the same or similar products, in a different installation. will provide the results detailed herein. The author has no interest, financial or otherwise, in Hydrotherm Corp.

Author's Note: This project was not undertaken as research; it was a standard modernization replacement of an existing public housing heating plant. It is notable because new technology was employed and fuel consumption was significantly reduced. The careful reader may note that this paper raises almost as many questions as it answers. The author recognizes this fact, apologizes for it, and can only hope that further research can be conducted which will attempt to answer some of those questions in greater depth, and on a wider scale.

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The High Efficiency Heating System at Haverstick Homes, Trenton, N.J.

Haverstick Homes is a 112-unit family-type public housing project operated by the Trenton Housing Authority. Fourteen buildings are connected by underground piping carrying heating hot water and domestic hot water. In the summer, 1984, the existing conventional heating plant (two large industrial boilers, 175 BHP each, burning #4 oil, with tankless DHW heaters) was replaced by 32 Hydropulse modules (150,000 BTU each). New outdoor reset controls were installed (although tests of the old controls indicated that they appeared to be working properly). No changes were made to the building envelopes.

Actual fuel consumption for the last three winters (October 1 to April 30) was as follows:

1982-83	104,930 gal./	4591 dd =	22.9 gal/dd
1983-84	118,025 gal./	5066 dd =	23.3 gal/dd
1984-85	78,089 therms/	4617 =	16.9 th/dd or 11.3 OEG/dd

One OEG (oil-equivalent-gallon)=145,000 BTU = 1.45 Therms

The reduction was approximately 50%.

The Housing Authority obtained formal bids for the replacement of the boiler room. A conventional boiler room replacement was bid at \$135,000. The Hydropulse system cost \$195,000. The dollar saving in fuel in the first year was approximately \$40,000, giving a simple payback of about 1.5 years.

In the months of June through September, in which no heat was provided, the saving on domestic hot water was approximately 35%.

These systems are not installed without some study. Different designs are required to maximize operation of the equipment; there are problems associated with the installations, including noise and acid condensate discharge. They continue to be expensive. Nevertheless they have an obvious benefit in energy efficiency.

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at
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July 1, 1986

The environment: Multi-family public housing is among the most energy-wasteful building stock in the entire country. Data collected over the years from more than one hundred properties, varying in size from 50 to over 1000 units, in Northeastern cities from Boston to Baltimore, gives a picture of unrelenting waste of oil and gas used to provide heat and domestic hot water (DHW) in these properties.(1) Most of these properties are old, the family housing was constructed between 1937 and 1955; with senior citizen properties typically dating from 1958 to the mid-1970's. They were never designed to be energy-efficient. There is only a single building temperature controller, usually activated by the outside temperature; heating control has customarily been by opening and closing windows. Some public housing authorities have made significant progress in controlling their energy requirements (most notably New York City, Jersey City, and Trenton in particular)(2), but for most of the others, successes have been limited.

All buildings consume, or waste, energy in three ways:

- 1) In the losses of thermal energy through the building shell;
- 2) In the effectiveness by which this thermal energy is controlled;
- 3) In the efficiency of conversion of raw fuel to thermal energy.

The first item, which has been most exhaustively studied in single-family homes, is actually the least significant in multi-family buildings. The losses in the building shell in multi-family public housing, while high relative to new energy-efficient construction, do not generally represent

the largest, or even a large, concern relative to the losses in other areas.

Item #2 is the major loss of energy in large multi-family housing: The inability to control indoor temperatures consistently, over a period of hours or months, given wide fluctuations in outside temperature. This is because in large part these buildings have either no controls beyond an on-off switch; or because the temperature controllers regulate boilers and valves based upon outdoor, rather than indoor, temperatures. A paper presented before this group four years ago (3) described an indoor temperature control system in which a microcomputer controlled pumps and boilers based upon temperature sensors which had been installed in a selected sample of apartments. While this particular installation reduced fuel consumption by 50% in the first full year of operation, it may have been in retrospect an unusually successful project; the only subsequent project to obtain such dramatic savings was the Princeton University effort (4). Other projects have produced savings ranging from 15% to 35% (5).

Beyond the large savings to be obtained by improving control systems, comes the third issue, the efficiency of mechanical equipment itself. Large industrial boilers capable of combustion efficiencies greater than 80% have been common for more than 50 years. We have routinely coaxed combustion efficiencies of 82% out of multi-family boilers and burners installed in 1939. While it would appear that there would be only limited room for improvement, this has not been the case for at least two reasons:

- 1) The combustion efficiency is a measure of performance only while the boiler is firing; there are substantial losses in the off-cycle. In other words, "seasonal efficiency", the total ratio of useful energy output to total energy input, can be low, even when combustion efficiency is high. In the summertime, where the boiler is used only to provide DHW, these standby

losses frequently exceed the consumption used to furnish the DHW. In an extreme case, we measured summertime thermal losses in a large underground piping network at 80% of total fuel consumption- the seasonal efficiency was only 20% (6).

2) The problem of low seasonal efficiency problem is compounded by the fact that tremendous excess capacity exists in many of these boiler plants as originally installed. Years ago, boiler plants were sized to maintain relatively high indoor temperatures (75F typical) under the most adverse weather conditions; and then frequently an extra boiler was thrown in for backup. The entire institutional bias over the years has been to provide too much heat, rather than not enough heat:

A) "No engineer ever got sued for sending up too much heat."

B) Boiler operators only hear from tenants who are cold; rarely from those who are warm.

C) Housing authority boards are sensitive to tenant complaints, even if those complaining represent only one or two percent of the total tenancy.

D) HUD regulations have established fuel costs as being pretty much of a pass-through. Correspondingly, energy savings become pretty much of a pass-through too. The result is that there is little incentive to save energy, and little penalty for squandering it (7).

The high-efficiency pulse combustion boiler room at Haverstick Homes addresses some of these problems, institutional as well as technical, and has resulted in a heating plant which reduces energy consumption dramatically. For those who are unfamiliar with the operation of the high-efficiency pulse combustion boiler, a detailed description of its operation may be found in the Appendix.

Because of its tight combustion control and condensing exhaust, a pulse

combustion boiler achieves energy efficiencies of typically over 90%, compared to more common efficiencies of 60-80% in residential-type equipment and a maximum of 85% in large industrial boilers (when they are run near full output continuously, and assuming careful maintenance.) While this saving is significant, it doesn't tell the whole story; especially, it doesn't explain how an overall savings of 50% was achieved at the Haverstick Homes project.

The improvement in combustion efficiency is significant but modest, typically on the order of 10% to 15%. The improvement in seasonal efficiency, on the other hand, is considerably greater. In large installations using multiple boilers, the greatest improvement in fuel consumption comes from improved seasonal efficiency coupled with reduction of excess capacity.

THE CASE STUDY: HAVERSTICK HOMES

Haverstick Homes is a 112-unit family-type public housing project operated by the Trenton Housing Authority. The layout of each building, which consists of from four to twelve apartments, is locally known as "duplex", with a living room and kitchen downstairs, and two bedrooms plus a bath upstairs. The total size of the property is 92,000 square feet (exterior measurements), making the average apartment about 820 square feet. The property was constructed in 1955. The heating plant is located in a separate building at least 70 feet away from any residential building. Fourteen apartment buildings are connected by underground piping carrying heating hot water and domestic hot water. While much of public housing has flat roofs, Haverstick has "A" roofs, which are not insulated. The original casement windows were replaced in the summer of 1983 by conventional double-hung

aluminum double-pane windows.

The tenancy at Haverstick Homes consists primarily of single-parent (usually female) households with children, although there are some two-parent families.

Why replace the boilers? Public housing-- those properties constructed under the original Public Housing Act of 1935-- was generally built between 1937 and roughly 1965. Therefore, original heating plants are never newer than 20 years and may be almost a half-century old. The life expectancy of the equipment varies greatly, but may be as little as 20 years, and is almost never reliably more than 40 years. Public housing managers who are concerned about the reliable and safe provision of heat rarely like to operate boilers more than 30 years old. The Trenton Housing Authority, for the last decade, has had a policy of replacing heating and hot water equipment before its 30th anniversary.

Replacement options: THA could have replaced the existing hardware with new equipment of similar design. Two options were bid: A straight replacement, and a high-efficiency (Hydropulse) installation. THA had already done four straight replacements over the previous five years. The straight replacement bid was \$135,000; the high-efficiency replacement bid was \$195,000, almost half again as great. (The difference really was not quite that much, since under the straight-replacement scenario, the existing 5-year-old burners and DHW heat exchangers would have been rehabilitated rather than being replaced). The decision to spend the extra money was based upon two factors: 1) Perceived greater reliability and ease of maintenance by going to multiple, modular, gas-fired units; and, 2) Anticipated fuel savings, which had failed to materialize in any of the previous four straight replacements.

The original heating and hot water plant consisted of two Fitzgibbon brickset steel firetube boilers of approximately 175 boiler horsepower (BHP) each, firing #4 oil. The original burners were replaced in 1979 with Preferred Utilities Horizontal Rotary burners rated at a maximum of 35 gallons per hour each (about 125 BHP). The original DHW system consisted of a storage tank with internal coil, but this too was replaced in 1979 with a pair of Patterson water-to-water heat exchangers, each rated at approximately 1,000,000 BTU/hour maximum output. Heating control was via a 30-year-old Sarcotherm hydrostatic (non-electric) outdoor reset controller (8), which, despite its age, appeared to be in reasonable working order.

In the summer, 1984, the existing conventional heating plant was replaced by 32 Hydropulse modules (150,000 BTU each). One bank of eight modules was set up to feed a 500-gallon DHW tank-with-coil arrangement on a DHW-priority basis; an electric control valve allows for the use of these eight modules for space heating, 1) once the DHW requirements have been satisfied; and 2) if more than 24 modules' worth of heating hot water are required.

New outdoor reset controls were installed at this time. The new controller is a step controller, compared to the old controller, which was a water mixing valve. The actual result is the same- HHW temperature varies inversely with outside temperature, according to predetermined settings which can be selected by switches on the front of the controller. There are eight steps, each step controlling the firing of four heating boilers, allowing HHW temperatures to vary from below 100 degrees to more than 180 degrees.

Downsizing: One significant question is whether appreciable savings might have been obtained simply by replacing the existing boilers with smaller units, thereby reducing capacity and therefore the ability to waste heat. To a certain extent this has already been done in the past; the design temperature, formerly zero degrees in Trenton, has been raised to about 15 degrees.

Front End Boilers: This question has been raised in light of recent successful experience with so-called "front end" boilers in Minneapolis and St. Paul, in which new high-efficiency units were installed as baseload units, leaving existing hardware to handle the peaks. For example, it might be argued that in lieu of replacing both large industrial boilers with 32 modules, perhaps 16 modules could have replaced one boiler, leaving the second boiler to pick up the peak heating requirement on especially cold days. This is an altogether reasonable and cost-effective approach; but in New Jersey, and in fact in much of public housing, it is generally the practice to rebuild the entire boiler room with new equipment at one time. However, as will be discussed later, a mix of expensive high-efficiency and less expensive regular-efficiency equipment is likely to be more cost-effective.

Results: Actual fuel consumption for the last three winters (October 1 to April 30) was as follows (9):

1982-83	104,930 gal./	4591 dd =	22.9 gal/dd
1983-84	118,025 gal./	5066 dd =	23.3 gal/dd
1984-85	78,089 therms/	4617 =	16.9 th/dd or 11.3 OEG/dd

One OEG (oil-equivalent-gallon) = 145,000 BTU = 1.45 Therms

The degree day system used is based upon no heat being supplied at 65F outside temperature, with linear heat being supplied at lower temperatures--in other words, twice as much heat is supplied at 35F as at 50F. This is not

precisely correct because we have found that the approximate temperature at which heat balance with internal apartment sources exists is closer to 58F than 65F. In addition, "hot water degree days" are added according to a formula which allocates boiler fuel for domestic hot water on days where little or no heating is required. (10)

The reduction in fuel consumption from 1983-84 heating season to the 1984-85 heating season was approximately 50%.

The Housing Authority obtained formal bids: A conventional boiler room replacement was \$135,000; the Hydropulse system cost \$195,000. The Hydropulse system had a cost differential of \$60,000, due to a combination of more expensive equipment and higher installation costs. The dollar saving in fuel in the first year, over and above a straight replacement which had historically yielded no saving, was approximately \$40,000, giving a simple payback of about 1.5 years. Note specifically that the simple payback is not $\$195,000/\$40,000$, or 4.9 years, because the boilers were going to be replaced in any case due to their age and condition.

In the months of June through September, in which no heat was provided, the saving on domestic hot water was approximately 35%.

One interesting aside is that new double-hung double-pane windows were installed at Haverstick Homes over the summer of 1983. As can be seen from the above data, it doesn't appear to have had any effect on fuel consumption, although they certainly improved the appearance of the property. One reason, purely speculative, which would account for the lack of savings, would involve the amount of heat delivered to the apartments. If heating levels were too high, then windows would be kept open (quite common in public housing), negating the improved performance of the new windows.

Characteristics of Pulse Combustion Boilers: These units are not without their quirks. Specific attention must be paid to the following:

- Noise (intakes and exhaust)
- Vibration (through base and piping)
- Exhaust
- Piping Requirements
- Condensate disposal
- Maintaining the condensing mode

Pulse combustion boilers are noisy. They have a characteristic 60-hertz hum which comes from the fact that there are approximately 60 combustion pulses per second. With the sound-deadening cover removed from the unit, the noise is unpleasant at close range; with the cover in place, the noise is still quite noticeable. These units are really not suitable for use in occupied rooms unless special attention is paid to soundproofing.

Where multiple units are used in a large central installation, the noise can be very annoying. Obviously a separate boiler room would be employed; the noise comes from the exhaust tubes (each unit is required to have its own through-the-wall exhaust vent). The manufacturer has designed exhaust and intake mufflers to reduce the noise to the point where it is possible to locate modules in a basement boiler room without noise complaints from tenants living upstairs from the heating plant. At Haverstick, where a separate boiler room was employed, noise has not been a problem.

The internal combustion process also produces a good deal of vibration. This is easily dealt with by mounting the units on non-yielding pads (poured concrete) with neoprene vibration mats if required, and using vibration-isolating couplings to the piping system.

Exhaust can be a problem for several reasons:

- 1) The noise problem, which has been discussed above.
- 2) There is an exhaust plume of water vapor; if a number of exhausts are clustered, this plume can be quite pronounced. In very cold climates where proper precautions have not been taken, ice formation can occur.
- 3) There will be some condensate drip from the exhaust. It is acidic and will damage concrete or ferrous metals (screens, window grates) located underneath it.

Piping Requirements: Currently, a 32-module installation requires 32 air intakes and 32 exhausts, with consequent high material and labor costs of installation. At Haverstick Homes there was sufficient room to install 64 runs of plastic pipe; but more recently, at the Miller Homes project with 64 Hydropulses, the 128 pipes represents a veritable forest- an expensive forest which is difficult to work with. Manufacturers must develop manifolding systems for large installations. A simple variable-speed induced-draft exhaust manifold, and a forced-draft air supply, with electronic pressure regulation, would vastly simplify installation, and might even be designed to take advantage of existing chimneys (lined with plastic pipe to prevent corrosion) in retrofit applications, reducing the noise problem still further.

Condensate disposal: The bulk of the condensate comes, not from the exhaust, but from the condensate drain at the base of the boiler. Each 150,000 BTU module will produce about one pint per hour. In rural areas this might have an effect on the septic system; it may be better just to route it into a dry well in the ground. In urban areas there may be code provisions dealing with the disposal of moderately acidic liquids; dilution, or even treatment with a neutralizer, may be required. At Haverstick, where the normal flow to the

interceptor sewer is always at least 20,000 gallons per day, condensate is piped into the floor drains leading to the sewer.

Maintaining the condensing mode is primarily a matter of proper design. These boilers can act as condensing or non-condensing boilers; which condition occurs is purely a function of the temperature of the water returning to the boiler. This intake water must come back at no more than 135F in order to maintain condensation, which produces a significant increase in combustion efficiency. Depending upon the amount of installed radiation, or the amount of heat exchanger surface in a DHW heater, outgoing water temperatures must be limited to between 150 and 170 degrees. When the return water temperature increases to beyond 135 degrees, "conversion" to the non-condensing mode is automatic; the condensate will simply not form. Which mode of operation is occurring is easily determined by observing the condensate drain at the bottom of the boiler; when condensing, there will be a regular drip of condensate. As the return water temperature increases, the drip will suddenly start to slacken, finally to disappear altogether.

Now look at what happens in a retrofit heating plant, such as Haverstick Homes. When this property was constructed in 1955, engineering practice of the day was to provide for boiler hot water temperatures of 200F, and heating hot water temperatures of 200F on a zero-degree day [today's "design maximum" hot water temperature would likely be 160F-180F.] On more moderate days, a three-way mixing valve mixed this hot boiler water with the cooler return water, reducing this heating water temperature, so that 140F was a more typical temperature.

At Haverstick Homes, the boilers are controlled by an outdoor step controller. As the temperature drops, more and more modules are enabled

(allowed to operate), increasing the temperature of the heating hot water. Assume that the following linear relationship exists between modules:

$$\# \text{ of modules} = 60F - (\text{Outside Temp.}) / 3$$

In other words, for each 3F drop in outside temperature below the setpoint of 60 degrees, one more module will be allowed to fire (actually, because the controller has only 8 steps, not 20, each 8 degree drop enables four more modules). Now it becomes immediately apparent that when it is 40F outside and only 8 modules are firing, the plant cannot maintain heating hot water of more than, say, 130F, with return water of 120F, well within the condensing range. When the outside temperature drops below a certain point, say 30F, the heating hot water temperature rises to the point (roughly 150F) where the boilers stop condensing and the benefits of the improved efficiency are lost.

In designing a Domestic Hot Water system, however, the benefits of boiler condensation can be maintained at all times through proper design. It is simply necessary to provide significantly more heat exchanger area than is normally the case, in order to assure that return water temperature stays below 135F under all conditions. For example, the following design conditions are typical in a non-condensing boiler/heat exchanger DHW system:

Boiler Hot Water leaving:	200F
Boiler Hot Water returning:	160F
Cold water entering temperature:	35F-75F*
Maximum DHW tank temperature:	140F
DHW system temperature rise:	65F-105F

* dependent upon time of year

To maintain a condensing system, it is desirable to set up a system wherein

boiler hot water was 160F and return hot water 120F. This would require, roughly speaking, at least twice as much heat exchanger surface area; and while it certainly increases the costs, the savings over a period of years would more than make up for it. Efficiency of the system would rise from roughly 85% non-condensing to about 91% condensing.

Haverstick was not designed with sufficient heat exchanger area. High hot water temperatures are maintained, just as with the old system. The benefits of condensing operation are not obtained on the DHW side, which probably accounts for the relatively poor 35% saving on DHW. It is unlikely that the authority will take steps to correct it; because the costs would have to come out of funds which are already very tight; and the savings would largely be returned to HUD.

Conclusions and Implications for Future Use:

1) This retrofit has wide applicability for properties which have large, functionally obsolete, central boiler hot water systems. This includes private as well as public housing. This system was probably more expensive than it needed to be because, in retrospect, a system consisting of 16 high-efficiency units and 16 regular-efficiency units probably would have yielded 90% of the savings, at significantly lower initial cost.

2) Condensing boiler systems should employ series hot water converters to keep them condensing under normal DHW situations. Currently, most designs do not provide for sufficient heat exchanger area. As a result, boilers must be run at temperatures of up to 200F output; and these boilers will not condense with return water temperatures of 160F. More desirable would be a design with two heat exchangers in series, with boiler hot water entering at one end and cold water through the other end. Under these conditions, the

boiler can be run as low as 140F (more likely, 160F) and return water temperatures can be on the order of 100F-120F, allowing for condensing operation.

3) In a large multi-unit installation, running large quantities of plastic pipe becomes difficult and expensive. Better methods need to be made available to reduce complexity and installation costs, while at the same time utilizing existing chimneys where available (this is much more important in high-rises which may not have heating plants in separate buildings).

4) Building operators will need improved maintenance management procedures to assure that individual failures don't add up. One hazard of multiple boilers is that the failure of the first few modules does not affect the provision of heat, because the majority of modules work fine. Over a period of time the failures add up; then suddenly, with the advent of a cold wave, there is insufficient heating capacity available. This shouldn't happen- but it does.

5) Hybrid systems, sometimes known as "front-end boilers" (using condensing boilers to handle the baseload, plus regular [and much less expensive] boilers for intermediate and peak loads) are much more cost-effective and will have much wider applicability. In a typical hybrid application in multi-family housing, the base-loaded units can run up to 6000 hours a year, supplying 2000-3000 hours of domestic hot water, with the balance being low-temperature hot water for heating. The base-loaded units would run up to eight hours a day to make DHW in May-early October, then run virtually full time from mid-October to May.

FOOTNOTES:

(1) PHA/HUD annual fuel reports obtained from individual PHA's (Boston, Hartford, Philadelphia, Newark, Trenton, New Brunswick, Baltimore, and others, unpublished.

(2) Review of fuel reports, as above.

(3) Gold, Chaim S., Computerized Energy Management System at George W. Page Homes. 1982 Summer Study Proceedings.

(4) Dutt, Gautam, and others, Lumley Homes Computerized Monitoring System, Princeton University. 1984 Summer Study Proceedings.

(5) Computerized energy management systems installed by Bumblebee Energy Systems, Trenton, N.J., as follows:

Property	City	Operation	Savings
Seth Boyden Court	Newark	1982	14%
Liddonfield Homes	Philadelphia	1983	20%
Jack Pincus Apts.	New Brunswick	1983	15%
Glen Cairn Arms	Trenton	1983	20%

Computerized energy management system installed by Trenton Housing Authority, Chaim S. Gold, Consultant:

Wilson Homes	Trenton	1986	35%
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(6) Hill Creek Homes of the Philadelphia Housing Authority, unpublished report to management. Bumblebee Energy Systems, Inc., Trenton, N.J., 1983.

(7) HUD Performance Funding System Handbook, Public Housing Administration, Department of Housing and Urban Development. In theory, savings are split 50-50 between HUD and the local authority; in practice, from discussions with housing authority accountants, the authority rarely retains more than 20% of the savings, and this amount may disappear entirely after three years.

(8) Note: Outdoor reset control is a technique of heating control used in large buildings, in which the temperature of the heating hot water is automatically increased as the outside temperature drops, usually following the formula $y=mx+b$, where both b (outside temperature at which the system turns on) and m (rate of change between outside temperature and heating hot water temperature) are adjustable at the controller.

(9) Actual fuel consumption was determined as follows:

For fuel oil, the tank oil level was measured with a dipstick at least weekly during the heating season.

For natural gas, a new digital gas meter serving only the boiler room was installed. It was read and recorded daily, excluding weekends, holidays, and some days when the boiler operator was not available.

Trenton Housing Authority fuel data has been found over the last five years to be consistent and accurate.

(10) The relationship between additional "hot water degree days" and heating degree days" is as follows:

If heating DD are:	Then add for DHW:
0-3	6
4-7	5
8-11	4
12-15	3
16-19	2
20-22	1
23 up	0

APPENDIX: PULSE COMBUSTION

The concept of pulse combustion is simple and was developed in Canada over thirty years ago, although there was little use for it as an energy-saving device until the second oil crisis in 1979. It is an internal combustion thermal engine in which a small quantity of air and natural gas is admitted into a small combustion chamber and exploded. The amount of gas contained in each explosion is tiny- less than one British Thermal Unit- but sixty such explosions occur each second, making the input of such a unit

$$0.69 \text{ BTU} \times 60 \text{ CPS} \times 60 \text{ seconds/minute} \times 60 \text{ minutes} = 150,000 \text{ BTUh}$$

which is sufficient to heat a typical large house. The manufacturer also produces smaller versions of 50,000 BTUh and 100,000 BTUh input.

When the boiler is cold, combustion is started by igniting the gas/air mixture with a spark plug, but the reaction becomes self-sustaining after the first few pulses. The advantage of internal combustion is that higher efficiency comes from very tight control over the air/fuel mixture.

The other exceptional characteristic of the pulse combustion boiler is that it condenses the water vapor in the exhaust, releasing the latent heat of vaporization in the flue gas. This requires a much larger heat exchanger surface area, in order to provide for extra cooling of the flue gas; and it also requires the heat exchanger to be made of stainless steel, since the condensate is fairly corrosive (pH about 4.5). The resulting exhaust need not be sent up a chimney (not a good idea in any case, since the corrosive gasses would quickly destroy the mortar in the chimney) but can be vented through the wall like a clothes dryer, using plastic pipe. In normal use this plastic vent pipe becomes hot to the touch, but not uncomfortably so- perhaps 130F, compared with typical flue gas temperatures of 500F.