Masonry Heater Association Of North America

MHA News

Volume 8 Number 1 Spring 1995

Sustainable Construction - Has it Reached Critical Mass?

FIRST INTERNATIONAL CONFERENCE

Introduction

The First International Conference on Sustainable Construction was held in Tampa, Florida, November 6 - 9, 1994. Sponsors included Environmental Building News (see MHA associate member list), Rocky Mountain Institute (home of soft energy paths advocate Amory Lovins), the University of Florida, and CIB - International Council for Building Research Studies.

An international group of researchers presented about 150 papers, and about 300 people participated in the conference. The Conference Proceedings are available from the University of Florida (885 pages, $100 US).(Continued on p. 3)

In This Issue

1995 MHA Annual Meeting Las Vegas March 22 - 24, 1995

This year's annual meeting will be held immediately prior to the Hearth & Home Expo sponsored by the Hearth Products Association (HPA).

There will be a new format this year, in order to attract more working stovemasons to the meetings.

The first full day (Thursday March 23) will be a Technical Session.

The morning session will be devoted to a discussion of bakeovens, and will feature noted baker and bakeoven builder Allan Scott, as well as longtime mason Dale Hisler. The afternoon will feature shop talk. Topics so far include: callback issues, heater design, fine tuning and combustion. Contact Pat Manley if you have suggestions for more topics.

Informal shop talk sessions after regular meetings have in the past been some of the most popular events. This year marks the first time that they have been moved front and centre on the agenda. Don't miss it! (see next page for more details)...

Masonry Heater Association Of North America MHA News

Volume 8 Number 1 ..... Spring 1995

Published by:

The Masonry Heater Association of North America

Elected Officers: 94/95

President	*Pat Manley*
Vice President	*Ron Pihl*
Secretary	*Christine Subasic, P.E.*
Treasurer	*Lucille Frisch*

Business Office:

Administrator: Christine Subasic, P. Eng.

The Masonry Heater Assoc. of N. America
11490 Commerce Park Drive
Reston, Virginia 22091

Telephone 703/620-3171
FAX 703/620-3928

Editorial Office:

Editor Norbert Senf
c/o
Masonry Stove Builders
RR 5, Shawville
Québec J0X 2Y0

Telephone 819/647-5092
Fax 613/722-6485

Membership Policy:

Membership is open to anyone with an interest in masonry heating .

Annual membership dues:

Voting	200.00 (US)
Associate	100.00 (US)

IMPORTANT NOTE: Please check the membership list in the current issue and notify us immediately of any errors in your address, phone numbers, or dues status. Voting members are entitled to a set of in print back issues of MHA News.

Contact the Editor if you haven't received your back issues or if the information published in this issue's membership list needs correction.

1995 MHA Meeting Agenda

Wed. , March 22, 1995 6:00 to 8:00 pm	Welcoming Reception at the Stardust Resort & Casino
Thurs. , March 23, 1995 8:00 am to 5:00 pm	MHA Annual Meeting at the Convention Center

A Heater Builder's "Bricks & Mud" Technical Session

8:00 am	Coffee and Welcome Hour
9:00 am	Bake Oven Construction and Operation by Allan Scott; additional comments from Dale Hisler
12:00 noon	Lunch on your own
1:30 pm	Shop Talk - • heater design • building for longevity and avoiding callbacks • fine tuning combustion • other topics
Fri. March 24 8:00 am to 5:00 pm	MHA Annual Meeting at the Convention Centre

Annual Business Session

8:00 am	Greetings and Introductions Minutes and Treasurer's Report
8:30 am	BIA Report Slide Program Update Colorado Review PR Program Update ASTM Update and other topics
12:00 noon	Lunch on your own
1:30 pm	Test Results from Lopez Labs Training Update Testing/Certification
7:00 pm	MHA Banquet
9:00 am to 5:00 pm	Expo Open
Sat. March 25 9:00 am to 12 noon	MHA Annual Meeting at the Convention Center Planning Session for Training Program
9:00 am to 12 noon	Expo Open

For hotel and additonal details, see back page of this newsletter

Keynote speaker Paul Hawken stated that in the year since the publication of The Ecology of Commerce, his most recent book, he has become convinced that the sustainability movement has reached critical mass.

See the separate report on Hawken's ideas elsewhere in this issue.

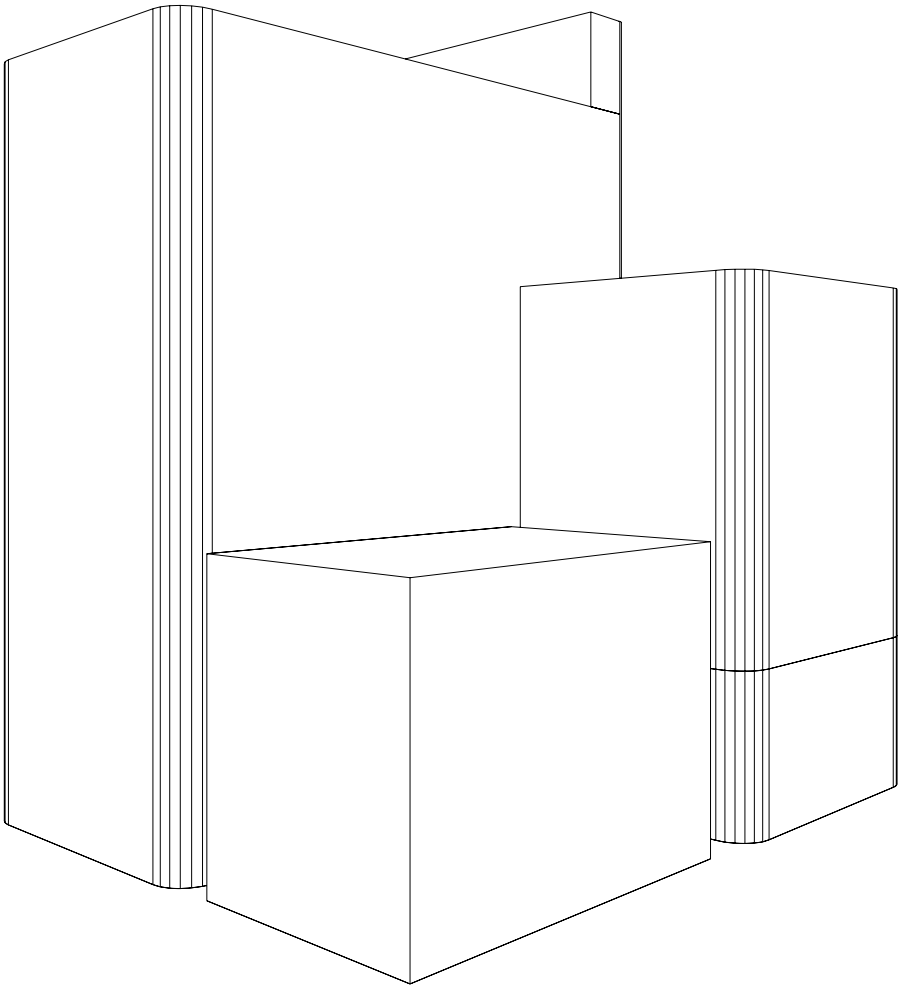
Keen Interest in Masonry Heaters at Trade Show

The conference included a small trade show with 30 booths. Masonry heaters were present with an MHA booth hosted by my wife Leila and myself. We had the generic photo display put together by Lou Frisch (contact Lou if you're a voting member and aren't yet represented). We had also sent a letter to MHA member manufacturers with details of the show and an offer to distribute their literature. Interest in masonry heaters was the highest of any show that we've seen. The attendees were well qualified and included a high proportion of architects, architecture professors and builders who were specifically looking for "green" products. We soon ran out of MHA brochures and newsletters. We brought plenty of MHA (voting) membership lists, and no doubt members can expect some calls. What seemed like a large supply of Biofire brochures that we brought from home lasted only thirty minutes.

Masonry heaters were in excellent company at the show. Our booth neighbour to one side was Collins Pine Company, owners of the first forest in the United States to be independently certified for its impact on the environment. Since sustainable forestry practice can yield large volumes of firewood, it is a perfect complement to environmentally responsible woodburning. Certified sustainably grown firewood is available in Germany, pushed by demand from educated consumers. Our neighbour to the other side, from Germany, was Hebel aerated concrete, "both environmentally and structurally sound", and now manufactured in the United States. We felt very much at home at this show - there were no fossil-fuelled fireplaces to be seen.

It is important for masonry heaters to become more visible in the sustainability arena. Very clean (as opposed to merely "EPA clean") biomass technology, such as ours, has an important contribution to make. Sustainable construction is only now approaching critical mass, and consensus is only starting to be approached on many of the concepts. Energy efficiency certainly is the key. Embodied energy is an idea just beginning to gain widespread popularity (see below). On the heating side, we don't really see much

> WE LIVE THE LIFESTYLE OF ADDICTS. RIDICULOUSLY CHEAP ENERGY IS OUR DRUG.



offered yet. This is probably because the recent cheap oil era has given us a sort of collective amnesia about heating. Heating is now automatically associated with fans, pumps and controllers - it has become the domain of the mechanical engineer. It is our job to start challenging some of those unconscious assumptions - we've got some good cards to play.

Defining Sustainability

The conference was split up into 13 sessions. Sessions 1 and 2 addressed "defining sustainability".

What does sustainability mean? The idea of trying to live a sustainable lifestyle and designing a sustainable economy means that we need to start behaving as if we would like to have great-grandchildren and beyond. To North Americans in particular, it is a wakeup call. It is becoming quite clear to increasing numbers of people, including a lot of masonry heater builders, that we are living in a fool's paradise if our only guiding principle is "business as usual", with perhaps the hope of a techno-fix or two. We need to redesign our economy and our businesses and figure out how to make a good, enjoyable living off annual solar income, instead spending our principal and compromising not just our own future, but also that of the global ecosystem. Viewed from the international perspective of a conference such as this, it soon becomes obvious that a majority of North America is asleep at the wheel. We live the lifestyle of addicts. Ridiculously cheap energy is our drug.

Conference organizer Charles Kibbert kicked off the discussion of defining sustainability at the conference and presented the following comparison:

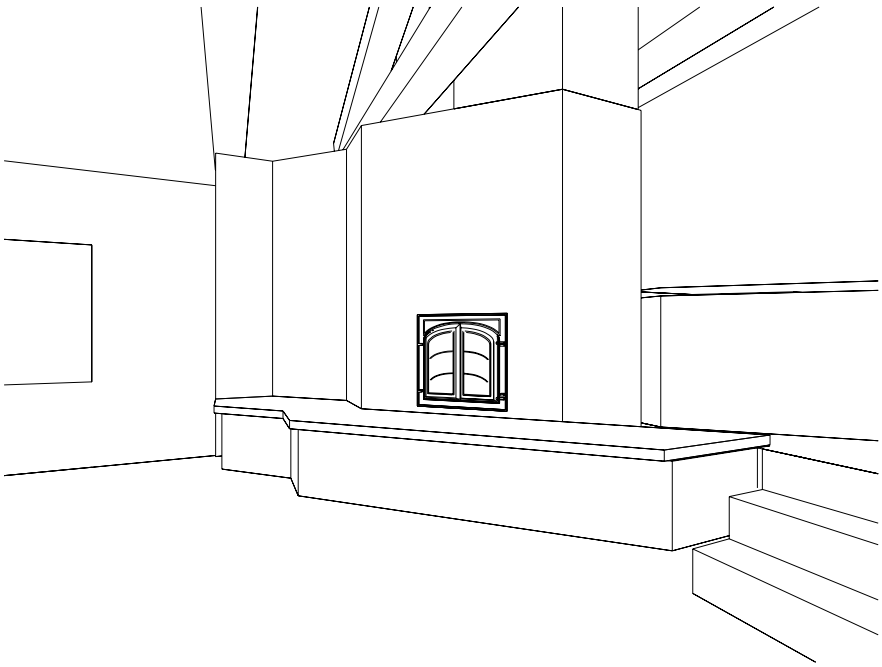
Traditonal Criteria	Sustainability Criteria
Performance	Resource depletion
Quality	Environmental degradation
Cost	Healthy environment

AN AUSTRIAN PAPER REPORTED THAT, IN SOME BUILDINGS STUDIED, THE EMBODIED ENERGY IN THE BUILDING WAS EQUIVALENT TO ABOUT 40 YEARS WORTH OF ANNUAL ENERGY CONSUMPTION.

Embodied Energy

One of the main threads to emerge at the conference was the concept of *embodied energy content*. Embodied energy includes the amount of energy used in the manufacture of the materials. For wood, it also includes the energy content of the wood itself, which is classed as renewable. An Austrian paper reported that, in some buildings studied, the embodied energy in the building was equivalent to about 40 years worth of annual energy consumption.

Embodied energy analysis is a new field. The flavour of some of the current research can perhaps best be illustrated by an example from a paper presented by Tarja Häkkinen, chief research scientist at VTT, the Finnish Building Technology Technical Research Centre. The paper is titled "Environmental Aspects of Building Materials"[1] and gives the following detailed analysis for some timber products:



[11] Häkkinen, T., Environmental Assessme Building Materials, VTT, P.O. Box 1805 (Kemistintie 3), FIN-02151 ESPOO, 1994.

EMBODIED ENERGY CONTENT ANALYSIS FOR THREE CONSTRUCTION MATERIALS			
Material or Energy	**Emissions or use of raw material per kg product (dry material)**		
	Structural timber	Roof truss	Cladding boards
EMISSIONS			
CO_2	95.7 g	98.4 g	94.1 g
CO	5.91 g	8.33 g	5.83 g
NO_x	3.39 g	4.02 g	3.34 g
SO_2	0.112 g	0.121 g	0.110 g
VOC total	1.16 g	1.56 g	1.14 g
CH_4	0.415 g	0.552 g	0.409 g
PAH	0.00123 g	0.00175 g	0.00121 g
Benzene	0.0341 g	0.0474 g	0.0336 g
Other VOCs	0.700 g	0.915 g	0.690 g
Heavy metals	0.000478 g	0.000679 g	0.000471 g
Dust into air (particulates)	0.773 g	1.06 g	0.761 g
BOUND CARBON (CO_2)	792 g	792 g	792 g
RAW MATERIALS			
Wooden raw material (wet/dry)	4900/2660 g	5400/2940 g	4830/2750 g
Phosphate fertilizers	0.300 g	0.331 g	0.295 g
Nitrogen fertilizers	1.71 g	1.88 g	1.68 g
Potassium fertilizers	0.300 g	0.331 g	0.295 g
Pesticides	0.0173 g	0.0191 g	0.0170 g
Saw blade chain oil, biol.	0.0628 g	0.0691 g	0.0617 g
Saw blade chain oil, miner.	0.128 g	0.141 g	0.126 g
Lubricants, biol.	0.246 g	0.271 g	0.242 g
Lubricants, miner.	0.917 g	1.01 g	0.902 g
Steel bands	0.790 g	0.870 g	0.780 g
Wrapping	2.11 g	2.32 g	2.08 g
Stamping colours (latex)	0.0135 g	0.0380 g	0.0133 g
Blue stain prevention	0.320 g	0.350 g	0.310 g
Nail and nail sheets	6.22 g	42.2 g	7.22 g
Paints	-	-	201 g
ENERGY			
Renewable energy (Higher Heating Value of logs)	54.6 MJ (=15.2 kWh = 14410 BTU)	60.2 MJ	56.5 MJ
Fossil fuels	1.40 MJ	1.38 MJ	1.38 MJ
Electricity	0.0140 MJ	0.0100 MJ	0.00695 MJ
Utilization of waste heat	0.208 MJ	1.21 MJ	0.205 MJ
Potential energy of products	17.1 MJ	17.1 MJ	17.1 MJ
of loss at building site	2.61 MJ	-	4.95 MJ

I asked Ms. Häkkinen whether a similar analysis has been done for masonry materials. She replied that it hasn't. The masonry industry in Finland is considering it, but hasn't yet decided to do it.

Other Factors:

Dr. Kibbert went on to suggest the following scheme as a starting point for assessing the sustainability aspects of the building process:

1. Embodied energy content
2. Greenhouse warming gases
3. Toxics generated/content

He warned that translating this from an academic discussion into the real world is fraught with complications. A repeated comment that I heard many times on this topic was that our current database is inadequate - the real homework is only starting to be done in this area, but research is growing rapidly. I learned, for example, that US-EPA is planning to put an online database on the Internet within two years that will give access to such things as embodied energy information for building materials and processes.

ANOTHER MAJOR SHIFT FOR EPA WILL BE A CHANGE IN THEIR MANDATE TO FOCUS ON POLLUTION AVOIDANCE RATHER THAN AN "END-OF-PIPE" APPROACH TO TOXICS AS IS NOW THE CASE.
HEATER BUILDERS SHOULD TAKE NOTE, BECAUSE POLLUTION AVOIDANCE IS SOMETHING WE ARE VERY GOOD AT

EPA IS PLANNING TO PUT AN ONLINE DATABASE ON THE INTERNET WITHIN TWO YEARS THAT WILL GIVE ACCESS TO EMBODIED ENERGY INFORMATION FOR BUILDING MATERIALS AND PROCESSES

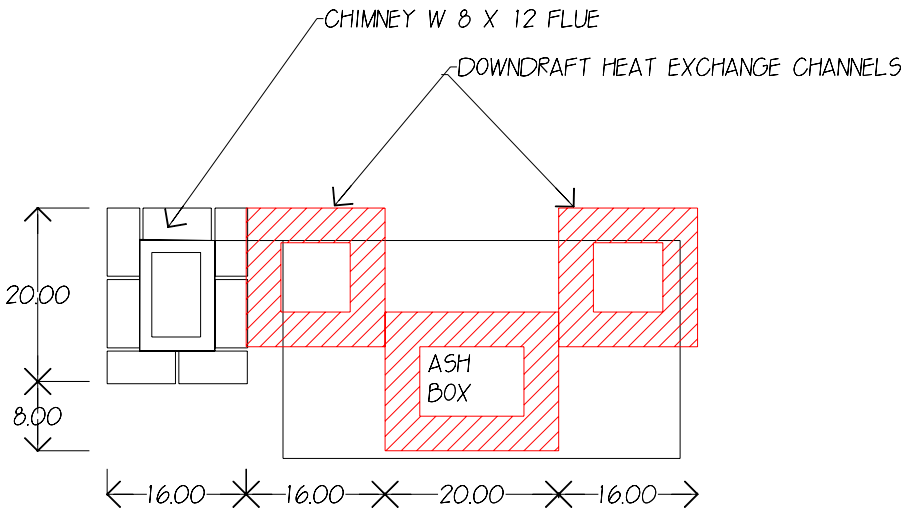
Masonry Heater Builders Take Note:

North American heater builders who can offer an analysis of their product will thus have an automatic edge on the Infobahn. Another major shift for EPA will be a change in their mandate to focus on pollution avoidance rather than an "end-of-pipe" approach to toxics as is now the case.

Heater builders should take note, because pollution avoidance is something we are very good at. So far, we've been getting smacked with the same stick as the woodsmoke culprits. We've been forced into a position of defending ourselves (reactive) rather than getting the credit for cleanburning that most of us can rightfully lay claim to (proactive). This hasn't been entirely bad, since it forced our industry to take a hard look at emissions issues and has in fact resulted in cleaner masonry heaters and in ongoing improvements.

If we want to be serious players in this arena, however, we've got to move beyond merely making claims that often are unsubstantiated and make a long-term commitment to educating ourselves in this field. Our clients are using more sophisticated criteria all the time in making their choices. Most of them are well educated and research their heater choice extensively. One manufacturer recently told me that purchasers are often more informed about heater issues than some of the dealers. The heater builder who builds up the most expertise will have a head start. This means education and training. It also means engaging in and supporting research. And it also includes networking with fellow builders and building our collective knowledge base.

When the EPA database and others come online on the Internet, where will masonry heaters be? Will manufacturers and builders be ready to make their case to the public? Can you formulate an environmental impact statement for your product and your business? We have an excellent product in many cases and can make a good



First Floor Heater with Downdraft Channels to Lower Level

case, and the playing field right now is fairly level inside the wood heating industry itself (although far from level when it comes to fossil fuel). More and more people are just beginning to consider these things in depth. The analogy with sports should probably stop here, because the winners will be co-operating with the other players, rather than trying to beat them into the ground. In many cases this will be a bottom-up process with smaller companies leading the way. A sizeable chunk of MHA members are doing this already, and have been for years - there are interesting, fun times ahead.

Other Events:

The list of papers presented at the conference was large, almost overwhelming. I'm still trying to digest much of it, but earning a living keeps interrupting. A presentation by Paul Hawken had the most impact on me,

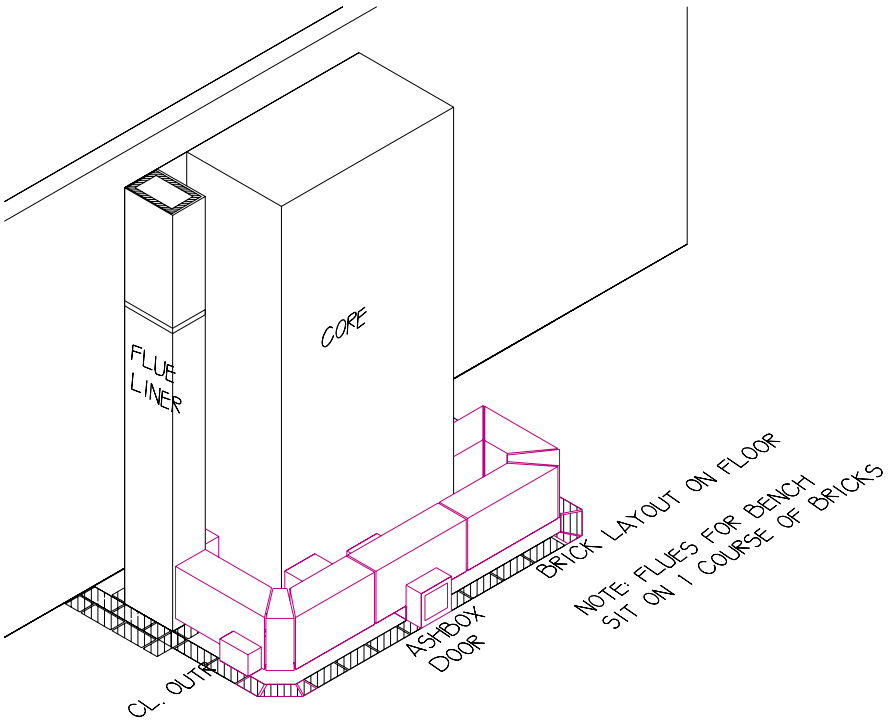
IN MANY CASES THIS WILL BE A BOTTOM-UP PROCESS WITH SMALLER COMPANIES LEADING THE WAY. A SIZEABLE CHUNK OF MHA MEMBERS ARE DOING THIS ALREADY

and is described in more detail below. Here's sampling of other presentations:

Environmental Building News: This 20 page bi-monthly newsletter seems to be one of the most influential publications in the field. MHA members will recognize the name from our Associate member list. Managing Editor Nadav Malin led a workshop on the pros and cons of various building materials that was extremely well received. Low key and articulate, he picked the audience's brains on their knowledge of various building materials with the help of a simple slide show. It was a fast education for everyone, and the knowledge of many of the audience members was astonishing. A number were leading edge builders who have to deal with toxicity of building materials and liability issues on a daily basis. Many of them are pioneering the use of new materials in the workaday construction world (a lot of parallels with heater builders here) and have to be on their toes continously. For example, one discussion centered on a new type of insulation consisting of batts made from cotton instead of glass fibre. Many people had had experience with it, knew particular details about manufacturer, availability and supply problems, as well as performance details. One builder had a house ignited by a plumber's torch because a faulty lot of the insulation didn't have adequate flame retardant chemicals. Others knew what the current status of the product was. This type of spontaneous networking and sharing of information was typical of much of the conference.

What became obvious here is that many of us in the "construction industry" are making the move into an information economy. Spending money to attend a conference is a good example. As Steward Brand has stated, the paradox of information is that it both wants to be expensive and free at the same time. Most of us have some expensive lessons under our belts, yet it is a thrill to share and swap them with colleagues. Information about the lesson, duplicated and given away, gains in value. In addition, we also have a new market out there of enlightened clients looking for efficient, non-toxic, low-environmental impact buildings. Often these buildings can be lower in cost, because it may involve leaving things out, such as carpeting and other surface finishes. Viewed from the right perspective, even a masonry heating system is low cost - perhaps even compellingly so. Price and cost are two different things. So are talking and doing.

Environmental Building News was one of the sponsors of the conference. The publication is respected,



Layout For Heated Bench - Contraflow Heater

often by parties on both sides of an issue, because of the thoroughness of its research and the even-handedness of its reporting. It is considered essential reading by many members of the sustainable building communinty in North America and elsewhere. They know about masonry heaters, for example. By the same token, we all need to know more about how masonry heaters fit into the larger picture of appropriate construction. Subscriptions are $60.00, available from EBN at RR 1, Box 161, Brattleboro, VT 05301; 802/257-7300; FAX 802/7304. They need your support so that they can continue and expand their valuable work.

Finland:

"**Design Method and Tools For Sustainable Construction**", presented by Pekka Huovila, VTT

SUSTAINABLE DEVELOPMENT HAS A LONG TRADITION IN FINLAND

Building Technology:

"Sustainable development has a long tradition in Finland. Our national epic poem, the Lakevala, published in its final form in 1849, based on material that goes back to the first millenium of our era, describes the felling of trees for growing of barley and oats as follows:

He cut down all the fine trees
but he left one birch
to the birds' resting place
and the cuckoo's calling tree

So were set the first written design guidelines for sustainable development 150 years ago. The challenge of sustainable development has also been taken as a starting point in the Finnish Building Law*:*

"An area to be planned or its use must be planned in such a way that the planning will support the sustainable development of the natural resources and of the environment".

Mr. Huovila described several projects at VTT, including a 5 yr, $20,000,000 program to develop new design tools. For one such tool, known as ECO-CAD,

"the objective of the project is to apply existing knowledge rapidly in use through developing a simple tool that gathers basic information of building parts from building designs, their corresponding environmental information for material, component and production databases, calculates their cumulative environmental impact and gives the ecological profile as output".

Also described is Design For Environment (DFE) in product development:

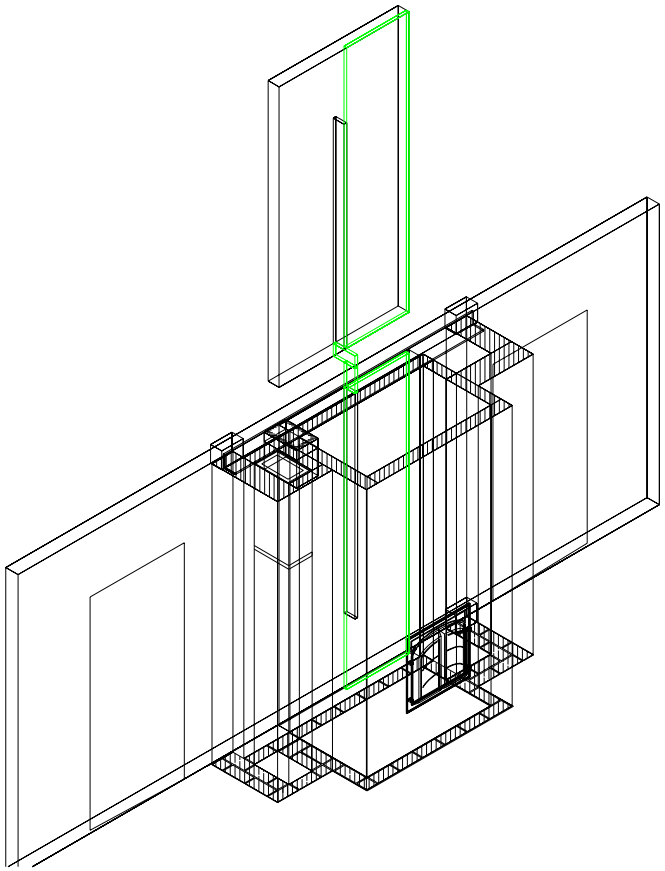
"Following the Dutch National Environmental Policy Plan, which is based on sustainable development (van der Horst et al, 1994) to obtain environmentally improved products one has to choose for higher quality and innovation first. Next, the least input of resources can be attained by closing the material cycle; reduction and selectivity of material use; preference for renewable and recyclable material; saving of energy as much as possible. Finally, minimization of hazardous waste, especially toxic emissions, has to be striven for."

Some of the other papers:

Ancient solutions for future sustainability: building with adobe, rammed earth, and mud - Michael Moquin (USA)

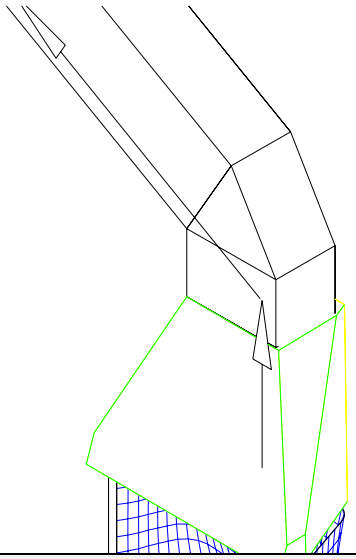
Site design and planning for sustainable construction - Kim Schaefer (USA)

Pressed soil-cement block: an alternative building material for masonry - B.V. Venhakatarama Reddy



Closed Air Loop Radiant Panel Driven by Lower Level Contraflow Heater

(India)



OFTEN THESE BUILDINGS CAN BE LOWER IN COST, BECAUSE IT MAY INVOLVE LEAVING THINGS OUT, SUCH AS CARPETING AND OTHER SURFACE FINISHES. VIEWED FROM THE RIGHT PERSPECTIVE, EVEN A MASONRY HEATING SYSTEM IS LOW COST - PERHAPS EVEN COMPELLINGLY SO.

Construction and demolition wood waste used in wood cement composites - Robert Frank (USA)

Plastered straw bale construction : A re-discovered vernacular building system - Maire E. O'Neill (USA)

An appraisal of the deciduous roof - J.S.C. Evans et al (UK)

The use of recycled high density polyethylene fibers as secondary reinforcement in Portland cement concrete - Flynn L. Auchey (USA)

Construction waste and a new design methodology - Richard C. Hill, et al (Australia)

Ekotecture: an integrated approach to sustainable construction - Lee P. Butler (USA)

Understanding ecological changes in the Danish building tradition - Kim H. Hansen (Denmark)

Quantification of construction and demolition waste - Robert L. Christensen (Canada)

The green material index - development of an environmental auditing system for building materials - David E. Shiers et al (UK)

Possibilities of reusing construction waste: a feasibility study for the city of Vienna 1993 - Peter Maydl (Austria)

Geonomics: fostering a market for sustainable building by reforming taxes and subsidies - Jeffrey J. Smith (USA)

Developments of new type of reinforced concrete composite using high flexural strength surface forming materials for solving environmental problems - Takaaki Ohkubo et al (Japan)

Using waste materials as an aggregate in low thermal conductivity mortars - John A. Tinker et al (UK)

Suggestive concepts and new developments of earth conscious methods for constructing reinforced concrete structures - Akio Baba et al (Japan)

Newly developed reinforced masonry structures suitable for global environmental requirements - Miho Makatayama et al (Japan)

PAUL HAWKEN AND THE ECOLOGY OF COMMERCE

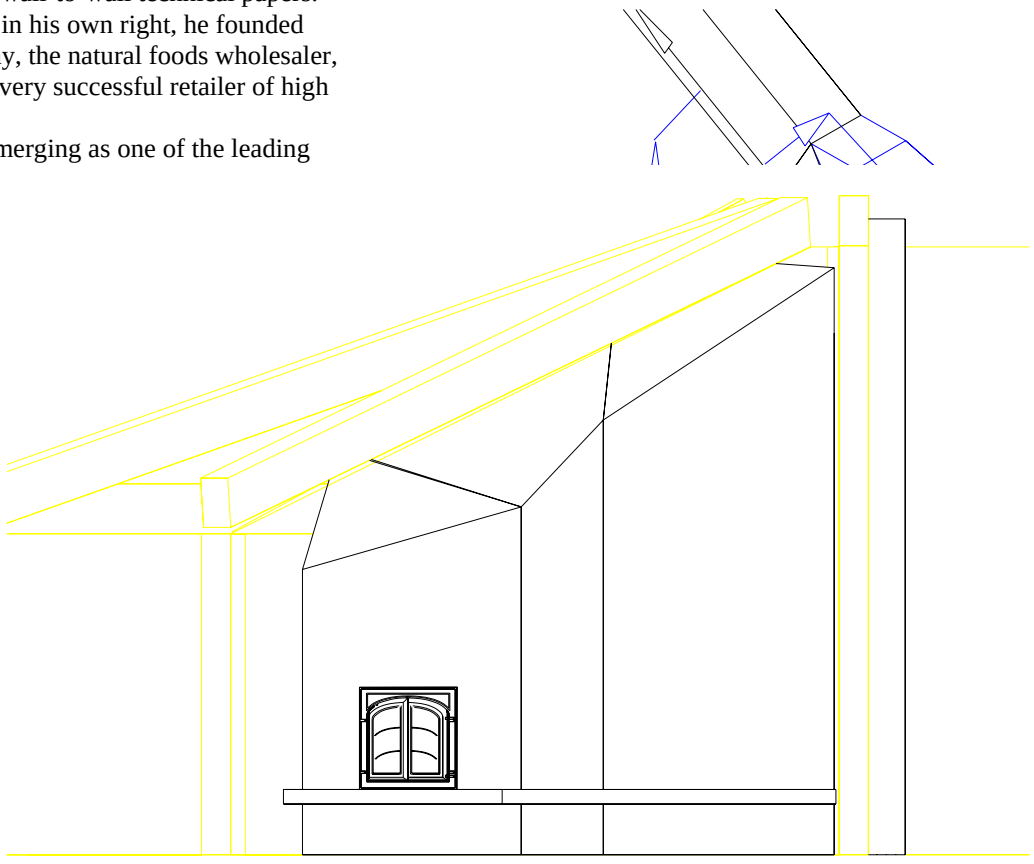
Day two of the conference concluded with a dinner that featured speaker Paul Hawken. It was easily the highlight of the conference, and recharged everyone's batteries after two days of wall-to-wall technical papers. A successful entrepreneur in his own right, he founded Erewhon Trading Company, the natural foods wholesaler, and Smith and Hawken, a very successful retailer of high quality tools.

Paul Hawken is also emerging as one of the leading philosophers of the sustainability movement. His third book, "The Ecology of Commerce" has been in print for about a year. It is a must-read. His previous books include "The Next Economy" and "Growing a Business." Our own business philosophy started to be influenced about ten years ago by articles of his that first appeared in CoEvolution Quarterly, and his insight has served us well.

Before undertaking the writing of his most recent book, Hawken's research included reading 200 books and 1000 papers, more than 20,000,000 words in all. He said that the more he read, the more depressed he became about the actual state of the world today. It is in a lot worse state than he had imagined.

Every natural system in the world today is in decline. The loss of habitat and of biodiversity is not only continuining, but is in fact accelerating.

Multinational corporations have become so large and so successful at exploiting the earth's natural resources that we are witnessing the physical limits being reached.



Custom Heater for YMCA Earth Residence, Kitchener, Ontario
Design output is 15 kW incl 5 kW hot water (2000 litres/day)
Room Fireplace Installation. Extra channels are 8x8 Rettratco flue liners.

A large array of toxic waste products are being released into the environment where they will never be broken down - chemical compounds such as chlorinated hydrocarbons have no counterparts in nature, and therefore there are no natural processes to assimilate them. They include the CFC's that are depleting the ozone layer, as well as the millions of gallons of herbicides that are applied annually to North American lawns.

The current method of increasing profits for corporations and their shareholders is to eliminate employees. In California, PacBell has told its telephone operators that they can no longer use the word "please". This will save enough time to allow them to lay off enough operators to save 5 million dollars per year. California is also currently building the world's largest penal colony and calling it "economic development".

SEVERAL YEARS AGO HE CALCULATED THAT IN ORDER TO REVERSE THE CURRENT TREND AND LIVE ON CURRENT SOLAR INCOME INSTEAD OF SPENDING OUR CAPITAL, WE NEED TO REDUCE THE THROUGHPUT OF ENERGY AND RESOURCES PER PERSON BY 80 PERCENT

Since the publication of his book a year ago, Hawken has given more than 120 talks worldwide. From what he has seen in the last year, he is convinced that the sustainability movement has reached critical mass. It will probably take another 50 or 60 years of hard work to get there however, so we need to be of good cheer and prepared to roll up our sleeves.

At the turn of the century, the total number of human beings that inhabited the planet was 1.5 billion. Today, when Hawken speaks to a university audience, he points out that 1.5 billion is the population increase since today's freshman was born. In the preface to his book, he states: "The problems to be faced are vast and complex, but come down to this: 5.5 billion people are breeding exponentially. The process of fulfilling their wants and needs is stripping the earth of its biotic capacity to produce life; a climactic bust of consumption by a single species is overwhelming the skies, earth, waters and fauna...Making matter worse, we are in the middle of a once-in-a-billion-year blowout sale of hydrocarbons. They are being combusted at a rate that will effectively double-glaze the planet within the next fifty years..."

Several years ago he calculated that in order to reverse the current trend and live on current solar income instead of spending our capital, we need to reduce the throughput of energy and resources per person by 80 percent. This was considered a radical idea at the time,

SINCE THE PUBLICATION OF HIS BOOK A YEAR AGO, HAWKEN HAS GIVEN MORE THAN 120 TALKS ALL OVER THE WORLD. FROM WHAT HE HAS SEEN IN THE LAST YEAR, HE IS CONVINCED THAT THE SUSTAINABILITY MOVEMENT HAS REACHED CRITICAL MASS. IT WILL PROBABLY TAKE ANOTHER 50 OR 60 YEARS OF HARD WORK TO GET THERE HOWEVER, SO WE NEED TO BE OF GOOD CHEER AND PREPARED TO ROLL UP OUR SLEEVES.

but recently a Swiss research group has come up with a figure that is closer to 90 per cent. We are all stressed out, in debt, and working long hours. This is it. This is as fast as it gets. We've reached the limit.

Despite the recent right wing shift in politics, Hawken believes that the growing movement towards sustainability is beyong right-left politics. The political right has appropriated the moral high ground when in fact they have no solutions to offer. The only solution offered by the right is to bring everyone in the world up to North American consumption levels through trickle down economics. Rather than reducing throughput by 80%, this would require a global increase of 20,000%, a clear physical impossibility. We have to stop being such political wimps. It is for the sustainability movement to reclaim the moral high ground.

This rings true for many heater masons that I've talked with over the years. As Paul Hawken told Leila: "Your products are beautiful. They are the right thing." He also told the audience: "You are real the low cost leaders". Many of us have believed for years that we are not a high-end product, but in fact the very opposite. Gas fireplaces and plastic patio furniture are the high cost products - it is time to stop pretending otherwise. On the way home, at a gas bar in Florida, we got a good illustration of the difference between cost and price: we paid 90 cents a gallon for diesel fuel, and 2.59 for a quart bottle of water. What's wrong with this picture?

Hawken feels that we essentially have a design problem. Businesses can buy all the recycled paper and recycle all the toner cartridges they want, but that won't make a sufficient difference. If every business in the world emulated environmental leaders such as 3M and Ben & Jerry's, it still will not be enough to reverse the environmental decline.

In order to solve the problem, we must first define it in real terms. The first half of Hawken's book does this with an in-depth look at today's envronmental problems - they must be understood before solutions can be designed. He states: "Although I think the problems are

actually more severe than we realize, embedded in each one of them is a realizable and crucial design solution."

He then proposes a set of eight design objectives. In his opinion, business is the only entity with the resources and skills to implement such a large undertaking. Briefly, the design solutions will:

1. Reduce absolute consumption of energy and natural resources in the North by 80 percent within the next half century.

2. Provide secure, stable, and meaningful employment for people everywhere.

3. Be self-actuating as opposed to regulated or morally mandated.

4. Honor market principles.

5. Lead to a way of life that is more rewarding than our present one.

6. Exceed sustainability be restoring degraded habitats and ecosystems to their fullest biological capacity.

7. Rely on current income.

8. Be fun and engaging, and strive for an aesthetic outcome.

Some examples of action towards these goals are already evident in several European countries, including Germany and Sweden. In Germany, there is now cradle-to-grave accountability in several industries, including the auto industry. When BMW sells you a car, their responsibility for its environmental impact doesn't stop when you drive it off the lot. When you are done with it, they have to take it back. Federal law puts all manufacturers on a level playing field, and strong economic signals encourage them to design for recyclability. The Japanese challenged this as an unfair trade practice. They lost. When you wrap your Toyota around a tree in Germany, Toyota either has to recycle it in Germany or ship it back to Japan.

An even more radical change is currently being discussed in Sweden, and is in fact agreed on by all political parties. It is known as the "tax shift". Hawken believes that this will eventually become the economic model here in North America. It involves a complete restructuring of the tax system. Taxes will be taken off of income and profits, and placed instead on emissions, energy, resources and pollution.

AN EVEN MORE RADICAL CHANGE IS CURRENTLY BEING DISCUSSED IN SWEDEN, AND IS IN FACT AGREED ON BY ALL POLITICAL PARTIES. IT IS KNOWN AS THE "TAX SHIFT". HAWKEN BELIEVES THAT THIS WILL EVENTUALLY BECOME THE ECONOMIC MODEL HERE IN NORTH AMERICA. IT INVOLVES A COMPLETE RESTRUCTURING OF THE TAX SYSTEM. TAXES WILL BE TAKEN OFF OF INCOME AND PROFITS, AND PLACED INSTEAD ON EMISSIONS, ENERGY, RESOURCES AND POLLUTION.

An example of how this would work in the United States is as follows: to minimize economic dislocation, the tax change is phased in over 20 years. This allows companies to write off existing investments in plant and equipment. The tax is made revenue neutral for low and middle income earners. So, for example, a 3 dollar per gallon carbon tax is added to gasoline to more accurately reflect the true costs associated with consuming it. This would mean an increase of 2,400 dollars per year in the gasoline bill for the average American. To make it revenue neutral, the average income tax is reduced by a corresponding 2,400 dollars. Therefore, it doesn't cost you one penny extra to run your car. However, you are now living in an economy that is giving you more accurate information about the impact of your actions on

the environment. You have a lot more incentive to buy an energy efficient car, and the auto industry has more incentive to design and build one. Right now, the tax on gasoline is about 2.50 per gallon in Germany. In the United States it is 38 cents, the lowest in the industrialized world. Which signal do you think places you in a better position to thrive in a future economy?

With a cost structure that is more in line with environmental costs, businesses will be able to lower their costs by lowering their environmental impacts, instead of achieving low prices by externalizing costs such as toxic waste production onto the public at large. Why should a coal fired power plant in the Ohio Valley be able to discharge sulphur into atmosphere that reduces the growth rate in my 60 acres of Québec hardwood forest? Am I not entitled to damages, and should these damages not be assessed against the electricity consumers of Ohio?

IN MATERIAL TERMS, IT AMOUNTS TO MAKING THINGS LAST TWICE AS LONG WITH ABOUT HALF THE RESOURCES. WE ALREADY HAVE THE TECHNOLOGY TO DO THIS IN MOST AREAS, INCLUDING ENERGY USAGE

If they are not getting this signal, then it needs to be designed into the economic system. 200,000 people in Bhopal, India, had their health seriously and permanently damaged by the Union Carbide Company. They haven't been paid. Why are corporate lawyers the only winners in this scenario?

A design-based economic restructuring as envisioned by Hawken and others could be a boon for the masonry heater industry. A truly level playing field would make biomass extremely competitive with non-renewable energy. Dirtier methods of woodburning could be directly penalized with taxes on their emissions, again a potential boost to our industry. And among masonry heaters, the cleanest systems would achieve a price advantage. This would stimulate clean-burn research. The marketplace would be restructured and would now deliver accurate information that includes the enviroment in the bottom line.

Reducing resource and energy consumption may sound to many people like a pipedream, but isn't really that difficult to achieve, according to Hawken: " In material terms, it amounts to making things last twice as long with about half the resources. We already have the technology to do this in most areas, including energy usage."

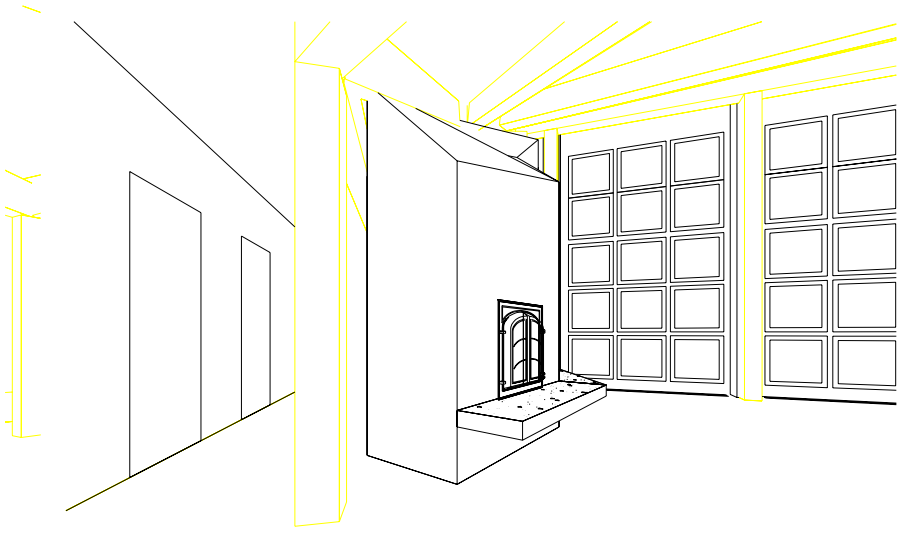
Here's a sampling of other quotes from "The Ecology of Commerce":

"Because the restorative economy inverts ingrained beliefs about how business functions, it may precipitate unusual changes in the economy...the restorative economy will be one in which some businesses get smaller but hire more people, where money can be made by selling the absence of a product or sevice, as is the case where public utilities sell efficiency rather than additional power, and where profits increase when productivity is lowered. Corporations can compete to conserve and increase resources rather than deplete them. Complex and onerous regulations will be replaced by motivating standards*." (This is exactly the situation where we are now at with R2000 and masonry heaters. We have the option of adopting an enlightened approach to change, favouring collaborative efforts to redesign codes and standards for everyone's benefit).*

"One statistic makes clear the demand placed on the earth by our economic system: every day the worldwide economy burns an amount of energy the planet required 10,000 days (27 years) to create."

"Biologic diversity, in the end, is the source of all wealth, and with a developed and practiced knowledge of nature, it could be even more so."

"...Germany, formerly the most wasteful nation in Europe, now (is) the leader in recycling. (But they still have a ways to go, still averaging yearly 824 pounds of waste per household. At 1900 pounds per household, we Americans have even farther to go; we're the world's worst wasters. With just 5 percent of the world's population, we produce 50 percent of its solid waste.)"



...“Markets are superb at setting prices, but incapable of recognizing costs...

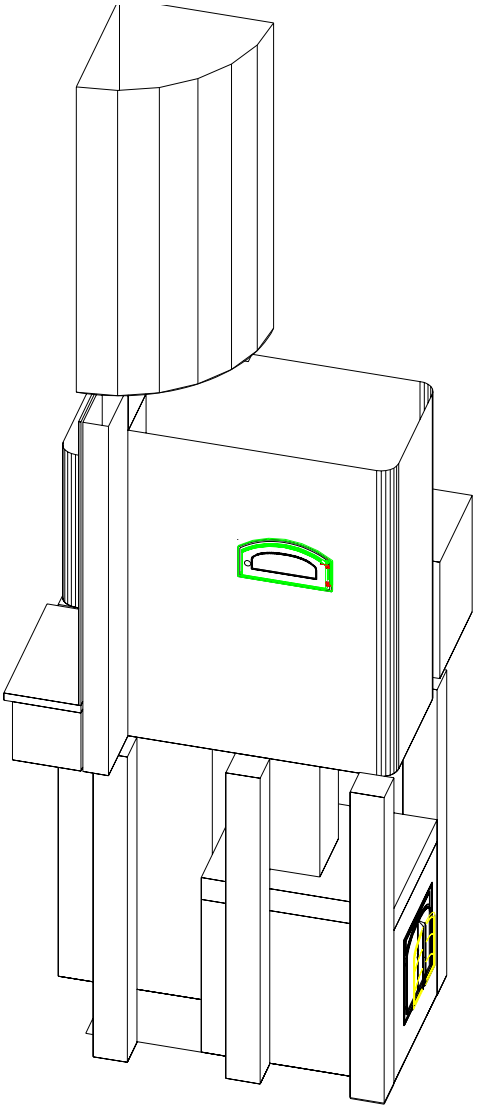
The answer cuts right through abstract political philosophy: We cannot return to the era of local markets, but we can regain control of the larger markets by enforcing the payment of costs--total costs...The incentive to lower costs is the same as the one that presently operates in all businesses, but in this case the producer’s most efficient means to lower them is not externalizing these costs onto society, but implementing better design.

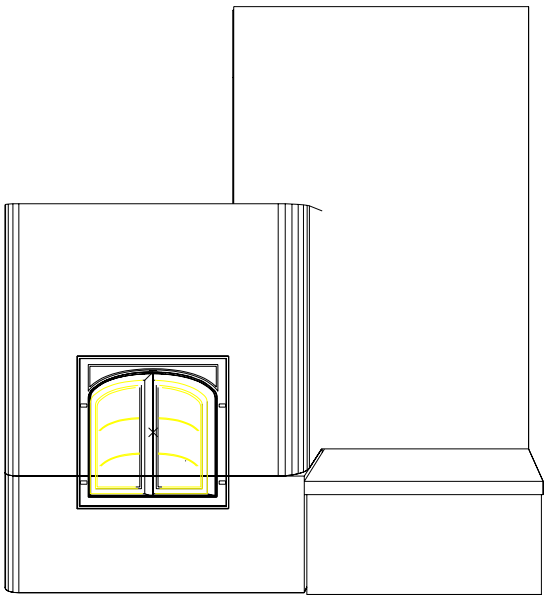
...none of the producers (of coal) are held accountable for the effect coal is having on the atmosphere--the prospect of global warming. The result? Planet Earth is having a once-in-a-billion-year carbon blow-out sale, all fossil fuels priced to move, no reasonable offer refused. And when this eon’s hydrocarbons are sold, they’re gone, never to be seen again.

NONE OF THE PRODUCERS (OF COAL) ARE HELD ACCOUNTABLE FOR THE EFFECT COAL IS HAVING ON THE ATMOSPHERE--THE PROSPECT OF GLOBAL WARMING. THE RESULT? PLANET EARTH IS HAVING A ONCE-IN-A-BILLION-YEAR CARBON BLOW-OUT SALE, ALL FOSSIL FUELS PRICED TO MOVE, NO REASONABLE OFFER REFUSED. AND WHEN THIS EON’S HYDROCARBONS ARE SOLD, THEY’RE GONE, NEVER TO BE SEEN AGAIN

Another way of imagining the scale of the carbon dioxide problem is by removing its two oxygen molecules. Looked at that way, every time you fill up... you are depositing into the atmosphere the equivalent of a 100-pound sack of pure carbon.

It stands to reason that coal should be the most expensive form of energy, not the least expensive. The only reason that it is now the cheapest is that the newer technologies (solar, biomass, etc), ...more accurately internalize their costs to the environment and future generations.”





Custom Heater: lower level firebox drives first floor heat battery, bakeoven and second floor bathroom heater. Design output: 10kW
Built by: Foyers Radiants DeBriel (Québec)

TOWARDS A SUSTAINABLE MASONRY HEATER

We can ask some interesting questions if we decide to take a look at masonry heaters from the standpoint of sustainabililty. There are many things that we are obviously already doing right - let's list some:

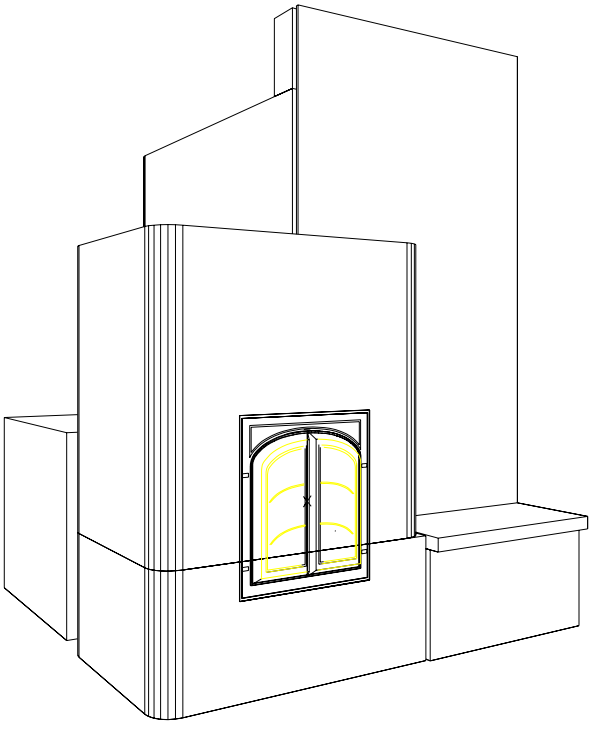
Sustainability Features of Masonry Heaters

- Use renewable energy (biomass) - zero net carbon impact if fuel is grown using sustainable practices
- Minimum processing of fuel (cordwood), fuel obtainable locally
- Low emissions under all operating conditions - excellent ability to target low average energy demand of efficient housing
- Contributes to good indoor climate (longwave radiant heating)
- Long lifecyle (therefore sustainable by definition)
- Low maintenance (requires good design, built properly, operated properly)
- Made from reusable/recyclable materials

(Brick could be the ultimate reusable building material if appropriate mortars are used. Instead of carting them off to the landfill site after demolition as is done now, they could be reused basically forever. How Buildings Learn, Stewart Brand's recent book, has an eloquent section on the inherent "rightness" of brick as a building material)

That's a pretty good start. A good excercise would be to expand the list, and to start analyzing some of the points. The goal is to get ourselves up on the learning curve.

A slightly more radical approach would be to ask the question "How can I increase the sustainability of the heaters that I build?" This list will be more personal, and more tailored to your own situation and locale. Here's a more or less random list of items, by no means exhaustive and hopefully getting longer as time goes by:

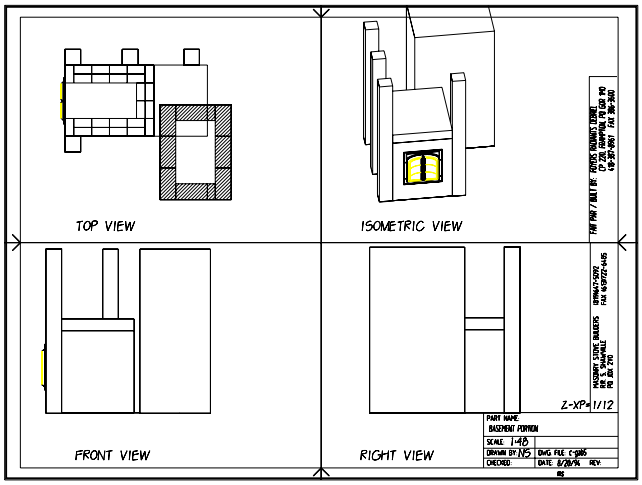


Making Masonry Heaters More Sustainable

•*Maximize lifecycle of heater* - improve design, invest in professional development, get feedback from previous clients, keep up with current developments in the field, network with other builders.

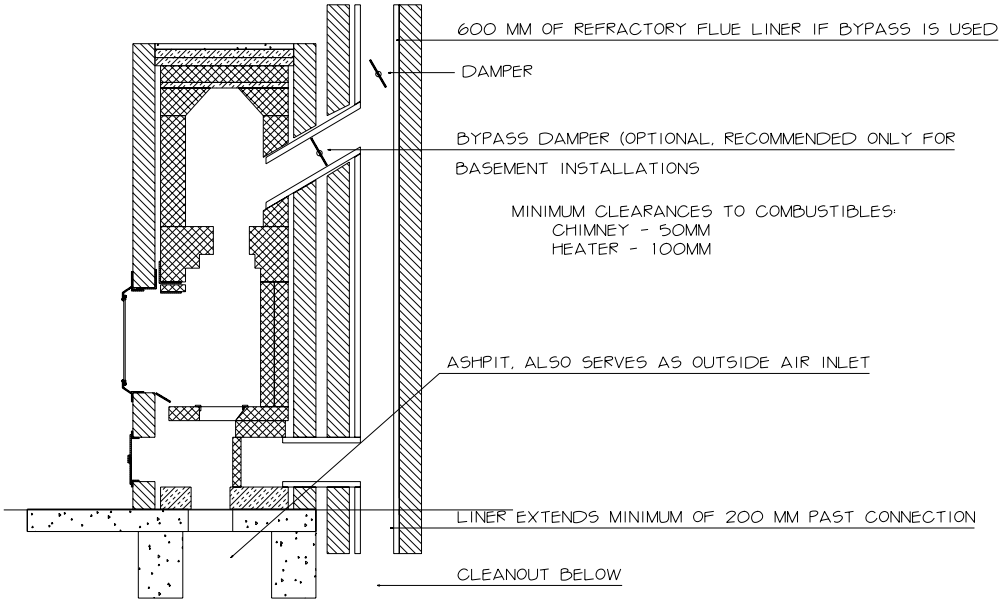
•*Maximize efficiency and clean-burning aspects of heater* - learn about and apply current research, educate clients in proper use

•*Maximize reusability/recyclability* - use clay mortar instead of cement; use modular units and a modular design (minimize cutting) - we test heaters at home, and are on the fourth one from the same reused firebricks and channel castings.



A SLIGHTLY MORE WOULD BE TO ASK CAN I INCREASE TI THE HEATERS THA

•*Reduce the embodied energy of the heater*
- demand environmental impact information from manufacturers
- use local materials (stone, unfired clay)
- use soft bricks instead of hard bricks
- get more organized (drive less)
- get a diesel truck



•*Add Sustainability Features* - a bakeoven operates for zero dollars. In the province of Ontario, a hot water coil can displace half of the 200,000 lethal doses of plutonium currently generated annually by an electric hot water heater, which is 60% nuclear fuelled[2].

The next step might be to start an environmental impact study/analysis of your business and the products and services that you sell and that you use. You are building the heater anyway, using a certain amount of natural resources and energy. When you implement better design, you are adding information with no increase in resource or energy use. This is the definition of value added. Eventually, if you can't provide an environmental impact assessment for your product or service, your competitor will. The demographic slice of aware consumers is growing daily.

North American drivers have, probably, the single largest environmental impact on the planet. Masons drive pickup trucks. Your pickup truck puts its own weight of carbon dioxide into the atmosphere every year. Drive less. Get better organized and make checklists for repetitive jobs (like heater core installations) so you don't forget something and have to make an extra trip - you'll boost profits at the same time. When the time comes to buy a new truck, consider a diesel. Many MHA masons are driving one already - the favorite seems to be the turbocharged Cummins from Dodge. It uses about 25% less fuel and has plenty of power. Invest in rustproofing and be scrupulous about maintenance so that you don't have to buy one as often - again, you'll reap more profits by being more organized. And it'll look good on your environmental impact statement.

[2] Source: William Shore, EnergyFutures, (1)3 p.1, Energy Probe, Toronto, 1990

New Members

Voting

David Cornell, Bob Liotta, Vince Zinglo
Kachelofen Corporation
2316 South Pacific Hwy.
Talen
OR 97540-9633
800-433 8128
503-535-2955
FAX 503-535-8020

Ken Johnston
Johnston Masonry
1529 Wildwood Road
Duluth
MN 55808
218-525-7278

Ben Sotero
Sotero Masonry and Construction
PO Box 804
Aptos
CA 95001
408-688-0509
FAX 684-1327

Associate

Carol Venolia
Carol Venolia Architect
P.O. Box 369
Gualala
CA 95445
(707) 884-4513
(reciprocal)

Richard Ellison
Master Builder Design and Construction
3626 Commonwealth Ave.
Charlotte
NC 28205
704-347-1380

Heikki Hyytiainen
Suomalaiset tulisijat/Finnish Fireplaces
Suonionkatu 1 C73
00530 Helsinki
Finland

Robert Herderhorst
6910 Navaho Trail N.E.
Bremerton
WA 98310-9408
(o) 206-396-1001
(H) 698-2366

THE USE OF MASONRY HEATERS AND OVENS IN BELARUS TODAY

By Marcus Flynn

The following observations were recorded during a brief visite to the village of Bolshiu Sliva in the Republic of Belarus

In Belarus all dwellings were traditionally heated by a large Masonry Oven “Pichka” located in the kitchen and a small to medium sized masonry heater “Grupka” usually situated in the living area. Today almost every rural home has a Pichka, but only about 40% still have and use their Grubka.

Though less efficient than the Grubka, it is the Pichka that are still built, probably due to the traditional sentimental attachment of the local population, and the multifunctional use as a heater, bed, and oven. Modern homes are now built in brick, and it is said that Grubka give out only enough heat to heat the old wooden houses. Consequently, even in some of the old wooden homes, briquette fired central heating systems have replaced the Grubka.

Figure 1. Front view of a Pichka built in 1976

Figure 2. Front view of Pichka built in 1978. Note the wooden step and opening to the hollow foundation behind it. The second opening to the foundation is directly below the opening in the smoke hood. The second damper is for a briquette burning central heating furnace seen at lower right. Damage to the tiled finish (middle right) was done when the furnace was planned into the Pichka.

Pichka consist of a 5 foot long arched brick oven built on top of a hollow rectangular masonry foundation. The oven has no door, just a tin shield which is placed over the firebox opening once the fire is out. A broad smoke hood covers the oven entrance (Figure 2), gradually tapering as it reaches the chimney connection just above the ceiling. On top of the oven (Figure 1) is a flat masonry sleeping platform about the size of a small double bed. This “Root” used to be reserved for the oldest female member of the family.

The fire is built directly in the oven, its smoke and gases leaving by the only opening, which is the firebox entrance. The smoke is then drawn up into the smoke hood, where it enters the chimney.

Pichka are built with clay bricks laid in clay mortar, the only other material being the iron lintels used over the oven and smoke hood openings, and 6” by 6” wooden beams used to span the hollow foundation.

Traditionally finished in white, lime based stucco, many Pichka are now given a more “up market” tile finish (Figure 3). The foundation is often divided into two sections, one used to store wood, and the other to keep piglets and chickens on cold nights.

The foundation is slightly larger on one side than the oven that it supports. This recess acts as a high step, which is often supplemented by a narrow wooden step closer to the floor.

Below the sleeping platform are two square openings horizontally as far as the oven’s inner wall. These drying niches are often fitted with cast iron doors.

Figure 3. Rear view of the same Pichka as figure 1. A sheet of pressed wood mounted on the end of the sleeping platform acts as a headboard for its 92 year old operator.

Figure 4. Grubka photographed in the same dwelling as the pichka in figure 1.

(Figure 7) The two floor level openings in the foundation and the opening in the smoke hood are closed off with simple curtains when the Pichka is not in use.

Due to the compact layout of rural dwellings, Pichka were always built against an interior wall or into an interior corner.

Traditionally in winter all cooking was done on the Pichka, though now most houses have a calor-gas stove in which “fast” cooking is done.

Pichka have a specific kind of cast iron cooking pot which have evolved with them. (Figure 5) These pots are placed in the oven using a long wooden pole with two wrought iron semi-circular prongs at one end. A small pile of sand, permanently kept in the oven, is raked around the pots to speed up cooking. A long-handled L-shaped rake is used to position the sand and remove the ashes.

Inside the smoke hood at either side of its opening, just above the path that the smoke takes as it leaves the oven are two cast iron shelf-like grills, used to smoke meat and keep a constantly warm pot of water.

Grubka are medium sized single skin Russian style masonry heaters. In rural areas they were usually built in brick with a whitewashed stucco finish. In cities, many were built with real stove tiles (Figure 4), as opposed to modern Pichka which are finished in regular flat bathrooom tiles.

Grubka are usually freestanding and located centrally in the living area. Today Grubka are rarely built.

Birch is by necessity the preferred fuel for both types of heater, with pine used as kindling. The local population is extremely conservative with their wood supply and still practice pollarding (coppicing). Fires are laid with great care and precision and damper adjustments during firing are frequent.

Figure 5. Three of the tools used to operate the Pichka. From left to right: long handled “ouchvat” used for removing the round cast iron cooking pots, right angled rake used to arrange the sand in the oven and remove ashes. Short handled ouchvat. Not shown here is a fourth pole-like tool used to open and close the dampers which are too high to reach.

Many heaters of both types have suffered severe cracking, which their operators eagerly told me results from over firing, or firing too soon after construction.

Each village or group of villages have their own stove builder, or pichnik. The stovebuilders work completely from memory using no plans and having no formal training, their knowledge being passed down from father to son or from master to apprentice.

Officially these pichnik are employees of the local collective farm and it is only at night or on days off that they can practice their alternative occupation. Traditionally it has been the local population themselves who have had to take care of their heating needs and with the central government being unable to offer a viable alternative, the individualistic behaviour of the pichnic has been reluctantly tolerated. Not only is this remarkable in such an authoritarian Marxist state, but it has meant that design and building techniques have remained virtually unchanged for the last 80 years. This is in stark comparison to the Northwest European democracies where design and development have advanced enormously in recent years with the aid of govenment and privately sponsored research and the advent of high-tech refractory materials.

In Belarus as in the rest of the cold areas of the former Soviet Union a heating system has evolved as a direct result of trial and error on the part of the local population over many generations.

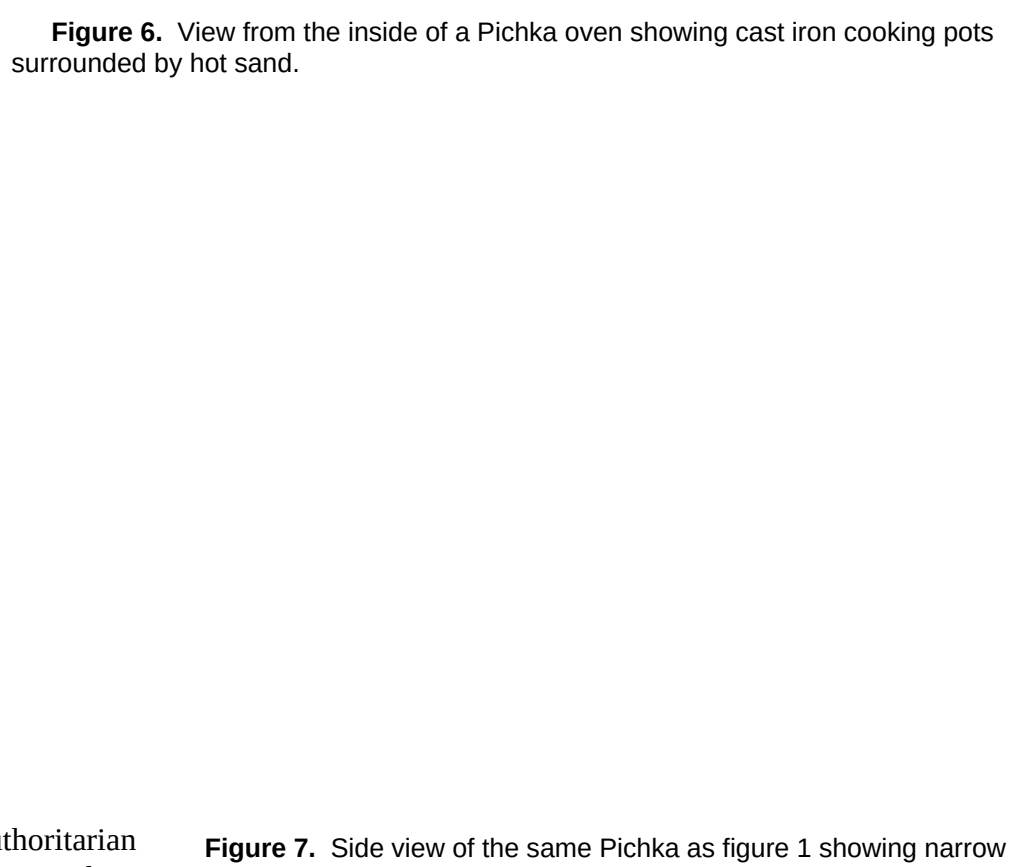


Figure 6. View from the inside of a Pichka oven showing cast iron cooking pots surrounded by hot sand.

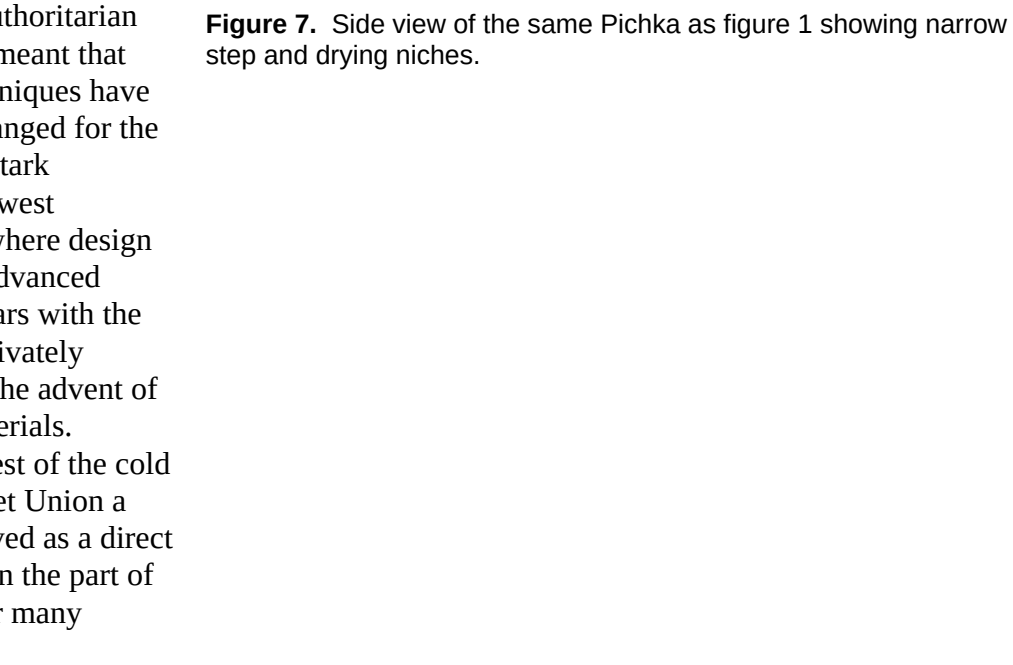


Figure 7. Side view of the same Pichka as figure 1 showing narrow step and drying niches.

HOW DO YOU SIZE A MASONRY HEATER?

Heat output for a masonry heater is calculated as follows:

Total Heat Output = Surface Area (number of sq. m) X Heat Output per sq m

Heat output per square metre is a function of the following variables:

- Overall Efficiency
- Weight of fuel charge (assuming constant moisture)
- Firing cycle (number of hours between firings)
- Construction (wall thickness, total surface area)

Construction

The thickness of the heater walls determines the outside surface temperature. With thin walls, the heater will heat up rapidly and reach a higher surface temperature. It will also cool down faster, because there is less thermal mass available for storage. With thicker walls, surface temperature drops and storage time increases. A heater of heavy construction therefore has to be physically larger in order to achieve the same output as one with lighter construction.

The following classification scheme is used in the German system of masonry heater sizing, which includes specifications for wall thicknesses for the different construction types:

Construction Type	Heat Ouput, W/m^2 (watts per sq. m. of surface)
light	1280 - 1100
medium-heavy	1100 - 850
heavy	850 - 700
over-heavy	< 700

For example, a contraflow heater with 7" thick sidewalls (2.5" firebrick liner plus 4" face) is classed as "over-heavy", and one with 5" sidewalls (1 inch liner plus 4" face) is "heavy".

Output can be calculated from surface temperature as follows:

Surface Temperature, C	Heat Output, W/m^2
58	465
65	580
85	930
90	1045

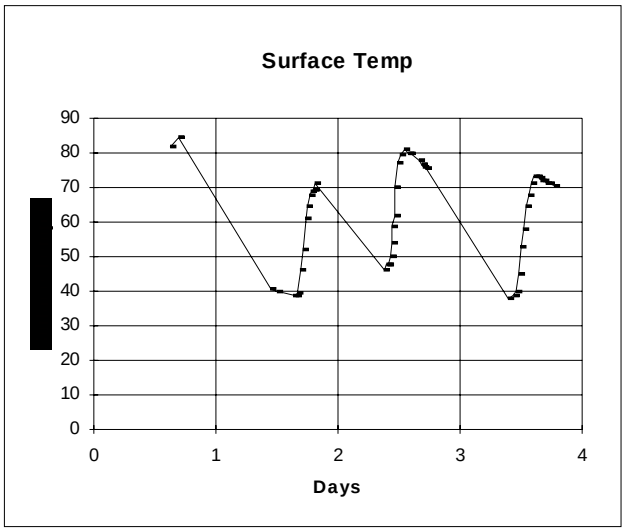
Thicker walls mean lower surface temperature and more heat storage and more thermal lag. Therefore a larger heater is required for a given output, but is fired less often. Cycles longer than 24 hours are impractical, and for very heavy heaters it is more usual to supply a base load and then use backup heat to fill in as needed.

Once the construction style is chosen, an appropriate formula is used to derive the firebox size from the surface area. A larger surface requires a larger firebox.

Below is data from some recent testing at Lopez Labs on an 18" contraflow heater with a surface area of 6.5 m^2 and a 1.5" granite face. The lab was unheated (10 C overnight).

This heater was fired from a warm start on a 24 hour cycle, and the fuel loads were as follows (in kg, 17% moisture Douglas Fir): 19.5, 15.2, 14.2 and 16.8. Overall efficiencies (combustion effic. x heat trans. effic., Condar stack loss method) were 75.7, 75.5, 70.9 and 76.1.

If you were to fire this heater on a 12 hour cycle, your average surface temps would be up in the 80 - 90 degree range required for a 1000 W/m^2 output.



WHAT IS THE HEAT OUPUT OF A MASONRY HEATER?

Example 1: Generic Calculation:

Calculations are based on Net Efficiency figures as measured by OMNI Environmental in EPA-audited in-home tests[3,4,5]

Efficiency is calculated using the Condar Method (Oregon Method M-41)[6]

Average Net Efficiency for all OMNI tests is as follows:

Underfire air masonry heaters (combustion air grate in firebox floor):	56.5%
Overfire air masonry heaters (no grate):	60.4%

For wood fuel at 20% moisture, the higher heating value (HHV) is (8600 x .8) BTU/lb

For a contraflow masonry heater with a standard 18" wide firebox, the average fuel load from 53 test runs at Lopez Labs with Douglas Fir was 39.8 lbs[7].

Therefore, for an average overfire contraflow heater, heat output is calculated as follows:

> Output = Efficiency x Fuel Weight x HHV / Heating cycle (hours)

Maximum output is achieved with the shortest heating cycle, which is 8 hours (ie., 3 firings per day):

Maximum Output = 60.4% x 39.8 x (8600 x .8) / 8 = **20,673 BTU/hr (= 6.05 kW)**

Example 2: Prototype contraflow heater - (27" Firebox w. bakeoven)

Calculations are based on Net Efficiency figures as measured at Lopez Labs[8].

Efficiency is calculated using the Condar Method (Oregon Method M-41)

Average Efficiency for 15 Lopez tests on this heater is as follows:

Combustion Efficiency:	96.7%
Heat Transfer Efficiency:	68.7%
Overall (Net) Efficiency = Comb. Effic. X Heat Transfer Effic.	66.5%

For wood fuel at 20% moisture, the higher heating value (HHV) is (8600 x .8) BTU/lb

For a prototype contraflow masonry heater with a 27" wide firebox, the average fuel load from 15 test runs at Lopez Labs with Douglas Fir was 42.4 lbs.

Heat output is calculated as follows:

> Output = Efficiency x Fuel Weight x HHV / Heating cycle (hours)

Maximum output is achieved with the shortest heating cycle, which is 8 hours (ie., 3 firings per day):

Maximum Output = 66.5% x 42.4 x (8600 x .8) / 8 = **24,250 BTU/hr (= 7.11 kW)**

REFERENCES:

[3] S. G. Barnett, Summary Report of the In-Home Performance of Five Commercially Available Masonry Heaters, OMNI 80132-01, prepared for the Masonry Heater Association of North America, Reston, (1992)

[4] S. G. Barnett, In-Home Evaluation of Emissions from a Mastercraft Swedish Heater Kit Masonry Heater, prepared for Mastercraft Masonry, Brush Prairie, (1993).

[5] R. Bighouse, S.G. Barnett, In-Home Evaluation of Emissions from a Temp-Cast 2001 Masonry Heater, prepared for Temp-Cast 2000 Masonry Heater Manufacturing, Inc., Port Colborne, (1992).

[6] S. G. Barnett, "Handbook for Measuring Woodstove Emissions and Efficiency Using the Condar (Oregon Method 41) Sampling System", Condar Co., (1985).

[7] N. Senf, "Recent Laboratory and Field Testing of Masonry Heater and Masonry Fireplace Emissions", presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, June 19-24, 1994.

[8] N. Senf, "Very Low Emissions Cordwood Combustion in High Burn Rate Appliances - Early Results with Possible Implications", to be presented at the 88th Annual Meeting of the Air and Waste Management Association, San Antonio, June 19-24, 1995