The Rise of the Automated Wood Stove:
An inside look at the Collaborative Stove Design Workshop

An AFGH & BTEC Webinar
November 5, 2014
Quick notes

- Two Audio Options: Streaming Audio and Dial-In.
  - Streaming Audio/Computer Speakers (Default)
  - Dial-In: Use the Audio Panel (right side of screen) to see dial-in instructions. Call-in separately from your telephone.

- Ask questions using the Questions Panel on the right side of your screen.

- The recording of the webinar and the slides will be available after the event. Registrants will be notified by email.
Webinar Speakers & Outline

- Introduction – Joe Seymour
- Contest Background – John Ackerly
- Stove Presentations – 5 Team Representatives
- Technology Reflection – Dr. Tom Butcher
- Q & A Session – Joe Seymour
About BTEC

The Biomass Thermal Energy Council (BTEC) is the industry trade association dedicated to advancing the use of biomass for heat and other thermal energy applications.

Why was BTEC established?

• To **advocate for and promote** the biomass thermal industry in the national energy policy debate

• To **reach out to and educate** the public and decision makers on the benefits and advantages of using biomass for heat and CHP

• To **develop biomass energy research** and analysis that enables sound investment and policy decisions
Notable Program Activities

Policy and Governmental Affairs
• Level the playing field for thermal (e.g. BTU Act of 2013)
• EPA recognition of biomass as carbon beneficial

Technical and Regulatory Affairs
• Bulk pellet storage and delivery guidance and standards
• Creating a universal efficiency test method for commercial biomass heaters

Education and Marketing
• Installation and design training for HVAC professionals
• Northeast Biomass Heating Expo, April 16-18, Portland, ME
New State Policy Map Available
Visit biomassthermal.org/legislation/stateincentives.asp
Collaborative Stove Design Workshop
Brookhaven National Lab, Upton, NY
Nov. 3 - 7
Alliance for Green Heat Goals

✓ 501c3 nonprofit funded by foundations & grants
✓ Voice for wood heat consumers in Wash. DC
✓ Work for more incentives for the cleanest & most efficient biomass heaters
✓ Work for more government R&D funding for ultra-clean “next generation” stoves
Primary wood heating in NY is double the national growth rate
Wood & pellet stove are leaders in reducing fossil fuels in the US

- Over 10 million homes heat with wood
- Less than 500,000 have solar panels
Wood Smoke in the US
Competition.
Healthy competition to fairly assess performance of one stove vs another.

Credibility.
Stoves will be professional tested and evaluated by a panel of expert judges.

Transparency.
Protocols, judging criteria, etc. up for scrutiny.

Collaboration.
Teams, experts, agency officials

Visit [www.forgreenheat.org/stovedesign](http://www.forgreenheat.org/stovedesign) for more
The Wood Stove Decathlon

• 13 teams competing for $35,000 prize money
• Open to the public
• Extensive media coverage
• Exhibits of innovative stoves, components and software
• VIP tours for agency officials, members of congress and staff
Inspired by the Solar Decathlon

- DOE’s Solar Decathlon helped solar energy gain significant attention from policy makers and the public.
- The Wood Stove Design Challenge will bring attention and exposure to the potential of wood heat.
Judging criteria

- Emissions
- Efficiency
- Affordability
- Market appeal
- Innovation.
- Safety & CO
John Ackerly
Alliance for Green Heat
6930 Carroll Ave, Suite 407
Takoma Park, MD 20912
(301) 841-7755
Jeff Hallowell

Catalus Ventus
Company: ClearStak from Connecticut, United States
Catalus Ventus

*Patent pending*

Side view

Rear view
Catalus Ventus: Science

Catalyst: CO, VOCs, PM

Cyclone: PM$_{2.5}$, PM$_{10}$

Baghouse: PM$_{2.5}$, PM$_{10}$
Catalus Ventus: Technology

- ClearStak controls
- Fire box, stack, catalyst temps
- O2 sensor
- Maximize air-to-fuel ratio
- More heat, less fuel

http://www.clearstak.com/
http://managemyfurnace.com/csdesign/
Jack Kleiss

The Kleiss Company: Kleiss Engineering LLC from Indiana, United States
Wood Stove Heaters – Ideal World

“IDEAL” WOOD STOVE PHYSICAL DESIGN + “IDEAL” AND CONSISTENT WOOD FUEL + “IDEAL” STOVE OPERATION = OPTIMAL HEAT

Safe
Clean
Aesthetically Pleasing

Warm
Efficient

+To be marketable needs to be a good overall value (cost/benefit tradeoff for consumer), efficiently utilizing a renewable resource with minimal environmental impact.

+Examples of current state of the art are well-designed and continuously monitored, high-efficiency stoves using uniform, dry pellets or hardwoods.

Kleiss Engineering, LLC
Wood Stove Heaters – Real World

1. Ideal physical designs are rarely effective over a wide range of:
   + Heat Output
   + Fuel Type and Quality
   + Fuel Moisture Content

2. Manual controls (even with continuous monitoring and input) are not always optimal controls
   + The “Batch” Fuel is Constantly Changing Over Burn Duration
   + Some Variables Require Delicate Controls Balancing Act

3. End users rarely choose or are able to use wood fuel with consistent characteristics and moisture content
   + Availability
   + Cost Considerations
Wood Stove Heaters - Solution


- Warm, Efficient, Environmentally Friendly, Aesthetically Pleasing & Safe

Regenerative Heat Exchanger with Heated Primary & Secondary Air

Ability to Burn Wood of All Types - Variable Volatiles, Density, Moisture Content, BTU, etc.

Microprocessor Control of Stepper Motor Actuated Primary and Secondary Flow Control Valves, Stainless Steel Critical Components, Emergency Stop Valve on Over-temperature, Control Power Loss or Manual E-Stop

Kleiss Engineering, LLC
Ryan Fisher

The Mulciber

Company: MF Fire from Maryland, United States
Inefficiencies → Money Lost
High Emissions → Public Health Damage
No Controls → Fewer Users
The Mulciber Stove

Automation lets us:
• Minimize emissions
• Maximize efficiency
• Provide a better user experience

Woodstove Decathlon: 0.2 g/hr

Since then:
TEDCO MII
NSF I-Corps
MIT Clean Energy Prize
ACC Clean Energy Challenge
RECESS Pitch Competition
MD Innovator of the Year

Woodstove Workshop: ???

Future: ???

Visit us at mffire.com!
Niels Wittus

Twinfire
Company: Wittus Inc & ETE
EmTechEngineering from New York/Germany
Webinar Collaborative Stove Design Workshop 2014
Stove: NEKO (Team Wittus)
Niels Wittus, Ingo Hartmann, Frank Werner, Tobias Ulbricht, Sebastian Günther
Starting point for the development

**xeoos „TwinFire“ wood log stove from German company Specht:**

Recent Developments - Catalyst

- **spinel-type mixed metal oxides promising to meet the requirements** → Catalyst screening
- **Synthesis of mixed metal oxides on surface of monolithic structures via RSSA-Synthesis [1]**

<table>
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<th>Reference no cat.</th>
<th>New cat.</th>
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<th>Aged 2</th>
<th>Aged 3</th>
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<td>mg/m³ with 13 % O₂</td>
<td>0 h</td>
<td>185 h</td>
<td>338 h</td>
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<td>654 h</td>
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<td>CO / ppm</td>
<td>1718</td>
<td>725</td>
<td>833</td>
<td>222</td>
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<td>677</td>
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<td>16.6</td>
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</table>

→ CO and CₓHᵧ conversion of > 50 %

References
[1] DE 102013020398 A1, 12.06.2014, Assignee: DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Germany; Specht Modulare Ofensysteme GmbH & Co. KG, Germany; Universität Leipzig, Germany; By: Specht, Bodo et al.
Down draft wood log stove NEKO

Project partner: Specht Modulare Ofensysteme GmbH and Co. KG, Universität Leipzig, DBFZ

- **Integration of catalyst: $\alpha$-$\text{Al}_2\text{O}_3$ support with spinel-type catalyst**
  - Chamber integration of catalyst, stable under high temperature conditions
  - Without use of noble metals: RSSA synthesis of metal oxide catalysts
  - Without use of wash coat, catalyst coating by solid-state reaction route

- **Redesign of the furnace on the basis of xeoos X8**
  - Lengthening of lower chamber: Higher residence time and avoidance of contact
  - New development of double plate
  - Spliting of stove door and use of IR reflecting ceramic glass

- **Development of cost-effective control system**
  - Operation with natural draft!
  - Only one flapper valve (possible because use of down draft combustion)
  - Thermocouple for flame temperature („$\text{O}_2$-Sensor“)
  - Electronic control unit with display for refueling
  - Optional: Mass flow sensor for combustion air and lambda sensor
Down draft wood log stove NEKO

Emissionen at 13 % O₂, standard conditions

- Particulate matter: < 10 mg/m³
- CO < 200 mg/m³
- VOC (Org.-C) < 20 mg/m³
- 2 Prototypes (of identical construction!)
  - Prototype 1 will be presented in USA at „Wood Stove Design Challenge“ (4.-7. Nov. at BNL: http://www.forgreenheat.org/)
  - Prototype 2 will be operated and demonstrated in field test at Coswig/Dresden by private user (Nov. 2014 - Mrz. 2015)

- Spin-off: Engineering office:
  ETE EmTechEngineering GmbH
  Homepage: www.ete-ing.de

Flyer for Download:
http://www.ete-ing.de/sites/default/files/ETE_Flyer_English.pdf
Working Group Small scale furnace systems, Department Thermo-chemical Conversion
„Small scale furnaces and catalytic emission reduction“

Contact
Dr. rer. nat. Ingo Hartmann
Tel. +49 (0)341 2434 - 541
E-Mail: Ingo.Hartmann@dbfz.de
E-Mail: Ingo.Hartmann@ete-ing.de

DBFZ Deutsches Biomasseforschungszentrum
gemeinnützige GmbH
Torgauer Straße 116
D-04347 Leipzig
Tel.: +49 (0)341 2434 - 112
E-Mail: info@dbfz.de
www.dbfz.de

www.ete-ing.com
Brian Gauld

The VcV/Kiwi Valve

Company: Flamekeeper LLC
From Auckland,
New Zealand
WHAT IS THE VcV?

• A clever device - a short tube with a disk inside
• The disk floats up and down on a shaft in the center of the tube
• Normally two VcV’s are installed on a stove - one on the primary air inlet and one on the secondary air inlet
• VcV is a mechanical device - **no power is required**
HOW DOES THE P VcV WORK?

• The disk on the primary VcV will be down when the fire is lit and will stay down until the static pressure reaches a set predetermined amount, enough to sustain a Low burn fire when the P disc “pops” up.
• As the static pressure increases, the fire draws in more air and this air flow makes the disk “pop” up.
• As static pressure drops the disk in the P VcV will eventually drop down.
• The primary VcV can be bypassed for high and medium burns by opening the primary air control.
VcV’s - BENEFITS

Test results from an EPA accredited laboratory with crib fuel and cord wood show that:

- Low burn emissions from VcV non cat stoves are well below EPA proposed new Phase 1 requirements (4.5 g/h) and very close to the proposed Phase 2 limit
- Efficiency for both crib and cord wood increases about 7%. In a VcV controlled non cat stove, low burn overall efficiency (HHV) is increased to over 76%  [82% LHV]
- Fire consumes less fuel, requires less stoking, gives more even heat

Nov 2014
Dr. Tom Butcher

Technology Reflection
Company: Brookhaven National Lab
Upton, NY
Question and Answer Session

Ask questions using the **Questions Panel** on the right side of your screen.

The webinar slides and recording will be made available after today. Please fill out survey upon leaving.
Upcoming Thermal Events
View all at biomassthermal.org/events

- **Annual BTEC Membership Meeting**
  - Two Locations: DC and online
  - December 2, 2014

- **World Sustainable Energy Days / European Pellet Conference**
  - Wels, Austria
  - Feb. 25 – 27, 2015

- **Northeast Biomass Heating Expo 2015**
  - Portland, ME
  - April 16 – 18, 2015
  - More info at nebiomassheat.com

- **International Biomass Conference and Expo**
  - Minneapolis, MN
  - April 20-22, 2015
  - More info at biomassconference.com
We Are Helping Grow the Biomass Heating Market

Who BTEC Is
- Non-profit advocacy group with 130 members from U.S., Canada, Europe
- All sectors represented, from landowners to end users

Why Consider Joining
- Promote the use of biomass thermal fuels and technology to all industries
- Achieve policy parity at the national and state levels
- Share best practices and drive innovation and research
- Recognition of our company’s leadership and achievements

Join Us!
Membership levels tailored to a company’s size. Ask me about how to join, email info@biomassthermal.org, or visit www.biomassthermal.org
Thank you for attending today’s webinar and remember to fill out attendee survey.

For more information, contact:
Joseph Seymour
BTEC Executive Director
Joseph.seymour@biomassthermal.org
202-596-3974 x302