ALLIANCE FOR GREEN HEAT
low carbon, renewable and local

BTEC
Biomass Thermal Energy Council

Automated Wood Stoves

Thursday, June 29, 2017

10:00 AM ET

In support of the Alliance for Green Heat's 4th Wood Stove Competition in November 2018

NEXT GENERATION WoodStove DesignChallenge

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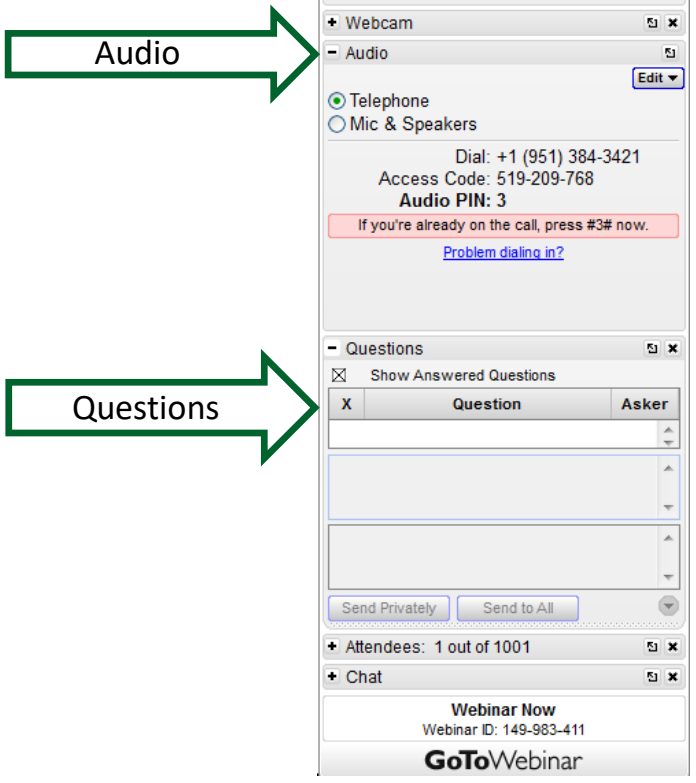
Quick Notes

- Two Audio Options: Streaming Audio and Dial-In.
  1. Streaming Audio/Computer Speakers (Default)
  2. 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.



BTEC
Biomass Thermal Energy Council

About BTEC

The national trade association for the modern wood heating industry

Develop technical codes and standards, advocate for wood heating policies, and communicate the benefits of modern wood heating.

100+ members and associates across the US and Canada:

- Fuel Producers
- Manufacturers
- Sellers
- Installers
- Service Providers
- Universities
- Non-profits & NGOs
- Government agencies

Bear Mountain Forest Products SINCE 1988

CENTRAL BOILER

Forest Energy Corporation

NEW ENGLAND WOOD PELLET, LLC

BTEC
Biomass Thermal Energy Council

For More Information:

http://www.biomassthermal.org

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ALLIANCE
FOR GREEN HEAT
low carbon, renewable and local

- ✓Independent 501c3 nonprofit
- ✓Promotes clean & efficient biomass heaters
- ✓National voice for wood heat consumers
- ✓Hosts design competitions
- ✓Encourages transparency from manufacturers and regulators

NEXT GENERATION WoodStove DesignChallenge

November 10 – 14, 2018
National Mall in Wash. DC

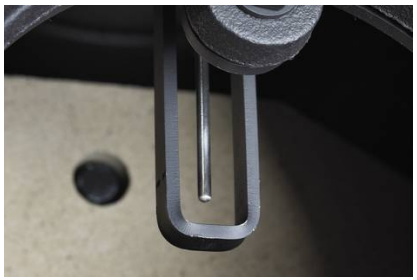
Two Competition Categories:

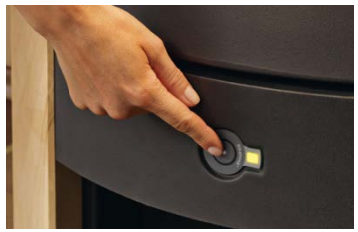
- Automated stoves
- Thermoelectric stoves

Please register at
www.forgreenheat.org!

Automated Stoves: policies, barriers & potential

- These stoves may not excel in the lab – indeed they may not even appear at the top – but they are designed to excel in homes, which is the goal.
- Automated stove development is progressing far faster in Europe – and ironically, in $50 cook stoves, thanks to Global Alliance of Clean Cookstoves and their partners (including the EPA).
- We want to commend these companies and many more not pictured here for undertaking the R&D to bring cleaner stoves to market: MF Fire, Hwam, Aduro, Biolite, Rika, Quadrafire, Luuma, Hark, the VcV, etc.
- We are looking for speakers and related topics for future webinars so please let us know your ideas!





Thank you!

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(for thermoelectric issues)

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NEXT GENERATION
WoodStove
DesignChallenge

TARM BIOMASS
Innovative Leaders in Alternative Heating Solutions

HS TARM froling

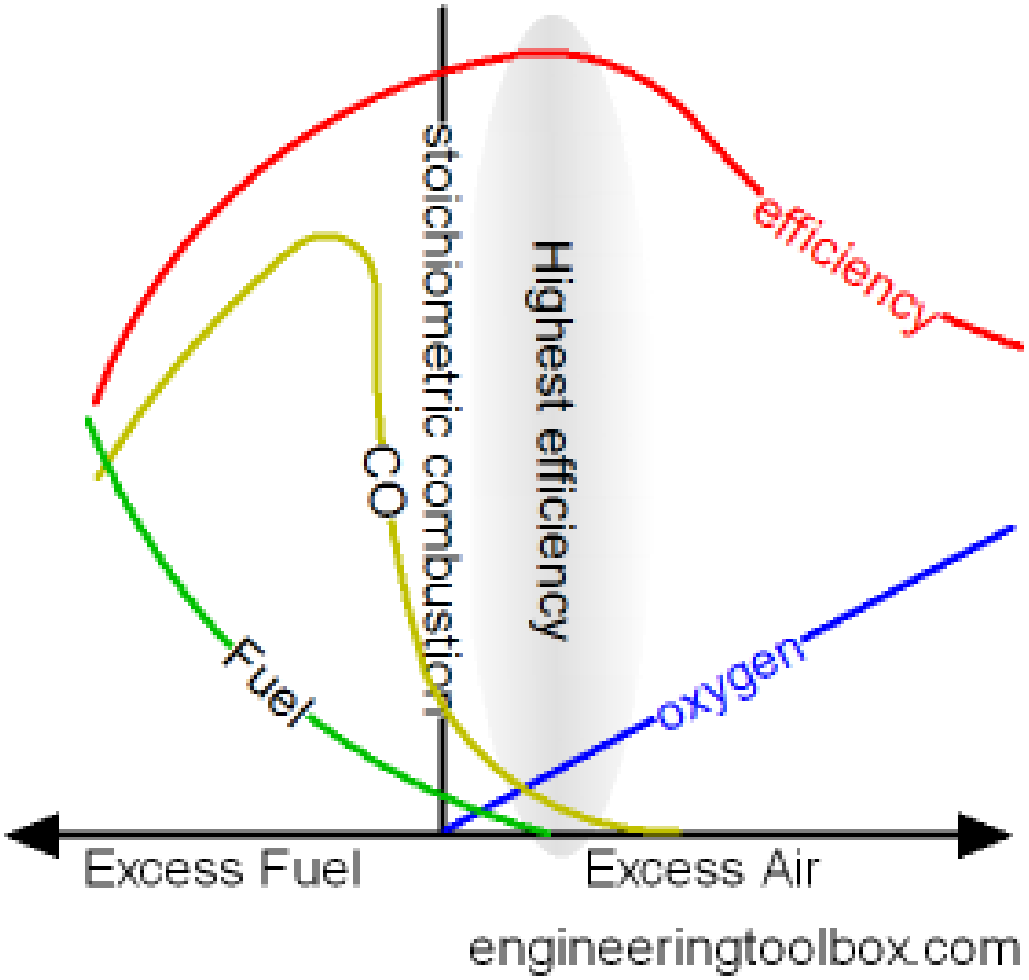
Automated Wood Stove: Technology Policies and Barriers

Scott Nichols for BTEC and The Alliance for Green Heat
June 2017

Firewood is not like oil or gas.

Firewood:

1) Contains varying amounts of water
2) Is derived from as many as 40 common tree species in the United States
3) Changes chemically as it burns
4) Every piece is different
5) Is placed by human hand into the appliance
6) Combustion is often subject to natural chimney draft, which varies from day to day and house to house.
7) Cannot be turned on and off with a nearly instantaneous ignition
8) Ignition is subject to various human lighting techniques



Controlling combustion based on exhaust temperature alone can't ensure high performance. There is a fine line between dirty combustion and low efficiency.

By controlling combustion using excess oxygen and stack temperature, the highest efficiency and lowest emissions can be achieved.

How can a hot box with air moving through it and
highly variable fuel
meet operator, policy, and regulatory demands?

Automation

What is automation?

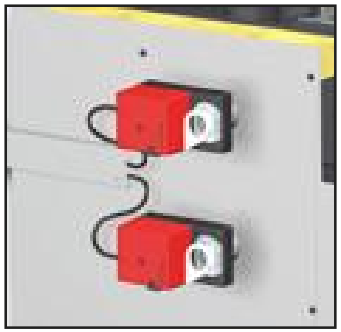
(A common example)

Start with regular firewood

1

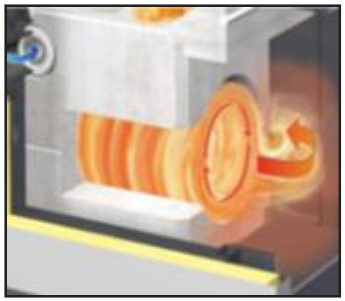
Smoke temperature and residual oxygen content are sensed at the flue collar. A fan controls entering combustion air.

2



Often primary and secondary actuators react to smoke conditions.

3



…resulting in ideal combustion

Manufacturer's perspective: Wood heat is under pressure.

1) Low oil and gas prices
2) New homes often are built without chimneys and are so tight and well insulated that wood stoves are often not an attractive heating option
3) Regulators continue to recognize wood smoke as a major winter pollutant
4) Gas stoves that imitate wood stoves do not require line power to operate
5) Heat pumps are taking market share as "renewable energy sources" even though they mostly use line power from non-renewable sources.
6) Wood pellet stoves are usually cleaner and provide more even heat.
7) Old stove stock produces a high percentage of emissions.

Should manufacturers continue to hold onto an existing niche or double down on technology to make stoves that burn reliably cleaner while providing more of the features owners demand from other common appliances? Both?

Tough Questions.

Stove Manufacturers can play defense:

A primary regulatory goal: Making appliances operate as well in the field as they do in the test laboratory.

Evidence: EPA wood boiler partial thermal storage (PTS) test captures all emissions (cold to cold test) and categorizes emissions based on “start up”, “steady state”, and “end” conditions.

Low burn rates during testing are highly weighted in calculations

Cordwood is being allowed and encouraged

Single burn rate cordwood boilers- those used with thermal storage predominantly make up the list of boilers approved for 2020 emissions thresholds. (Many are also “automated”)

Can regulators diminish old and dirty stock if new replacement technology is too expensive? Tough Question.

2015- NYSERDA Program Opportunity Notice (PON) # 3027

$1,000,000 available for "Product Development and Evaluation of High-Efficiency Biomass-Fired Boilers, Furnaces, Stoves, Thermal Storage, Emission Control Technologies, Sensors, Controls, and Other Non-Fuel Components for Residential or Commercial Applications."

"There is a need for innovation toward higher-efficiency, lower-emissions biomass heating technologies including boilers, furnaces and stoves. For example, low thermal mass wood boilers that have staged combustion and sensors to optimize combustion performance are capable of greatly improved performance compared to conventional technologies. Examples of innovative strategies are oxygen and temperature sensors and variable primary and secondary air controls. **Automation of wood or pellet stoves**, boilers and furnaces for combustion and thermal efficiency optimization is also needed."

Why not automation?

•Adds cost, about $1,000 more at retail for automated boilers. Economy of scale (# of units sold) is a factor. One automated stove is $5,000!

•Risk of raising prices so high that other technologies will fill the gap

•Adds complexity- more parts to fail

•Requires electric power, which fundamentally alters an ideal capability of woodstoves. It is hard to imagine a cabin in the woods without a chimney. Could self-powered stoves solve this problem?

•The fear of regulatory no return / a slippery slope due to Best Demonstrated Technology (BDT) or Best Systems of Emission Reduction (BSER).

Other Possibilities for woodstove emissions reduction exist:

•Single burn rate operation works- the operator cannot adjust the firing rate. Similar to operating a wood boiler with a thermal storage tank to achieve continuous firing at high output.

•Better operator training about wood fuel preparation and stove operation (EPA Burn Wise) epa.gov/burnwise

•Broader use of existing Best Systems of Emission Reduction

•Reducing stock of existing dirty wood heating equipment.

Stove manufacturers can play offense:

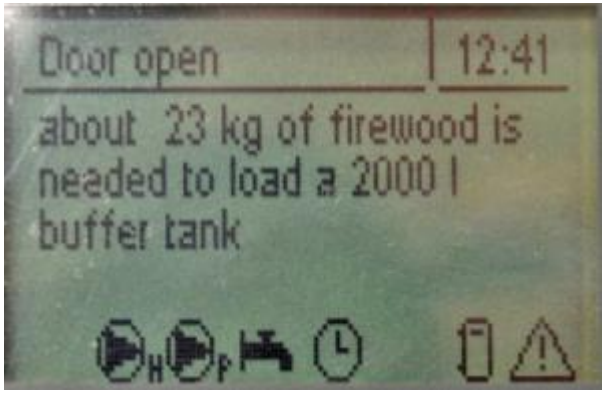
Apart from Regulation, Why Automation?

There is a chance that many people like less work and more comfort!

- Easier for operators to use (fewer steps to think about)
- Stabilizes heat output (more comfortable)
- Enables longer burn times at lower, but clean burn rates
- Stabilizes emissions
- Safer (less chance of runaway fire and chimney fires)
- Prevents thermal damage to stoves
- Reduces wasted heat up the chimney during and after a burn, which means higher efficiency
- Can provide user feedback about stove condition including indicating the presence of leaks, damaged components, or cleaning required

Why Automation? (cont.)

Typically once combustion automation is added, there is some form of microprocessor involved, which opens doors to better “real time” information both through on-the-stove displays and through internet applications. Operators like these features.



Should manufacturers continue to hold onto an existing niche or double down on technology to provide more of the features owners demand from other common appliances? Both?

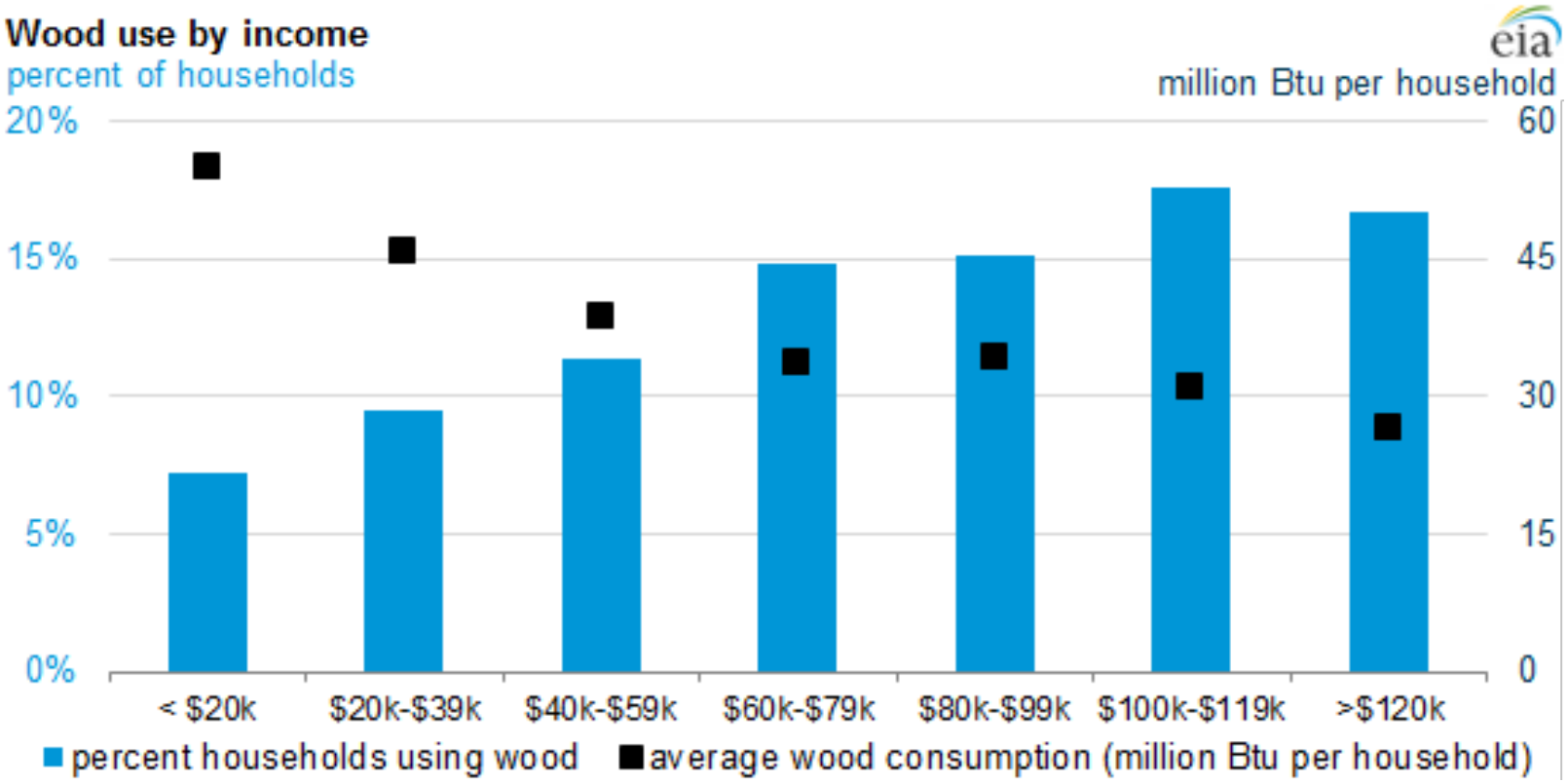
Can regulators diminish old and dirty stock if new replacement technology is too expensive?

Wood fuel use is increasing faster than any other heating fuel use according to the 2010 U.S. Census, increasing 34% between 2000 and 2010.

U.S. Energy Information Administration March 17, 2014:

1) 2.5 million households (2.1%) use wood as the main home heating fuel + 9 million households (7.7%) use wood as a secondary heating fuel.
2) Total wood fuel consumption for heating these households is approximately equal to U.S. propane use for heating by BTU and slightly less than fuel oil use.
3) "And while Households in higher income brackets are more likely to use wood, those at lower income levels who burn wood consume more on average."

Graph on next page.



So yes, there are tough questions, but questions that need to be answered.

AUTOMATED WOOD STOVE WEBMINAR

BTEC AND THE ALLIANCE FOR GREEN HEAT, 29th JUNE 2017

PhD. Ricardo L. Carvalho

Thermochemical Energy Conversion Laboratory (TEC-Lab)
Department of Applied Physics and Electronics
Umeå University, Sweden

Previous work
SBi, Aalborg University Copenhagen, Denmark
+CESAM, University of Aveiro, Portugal

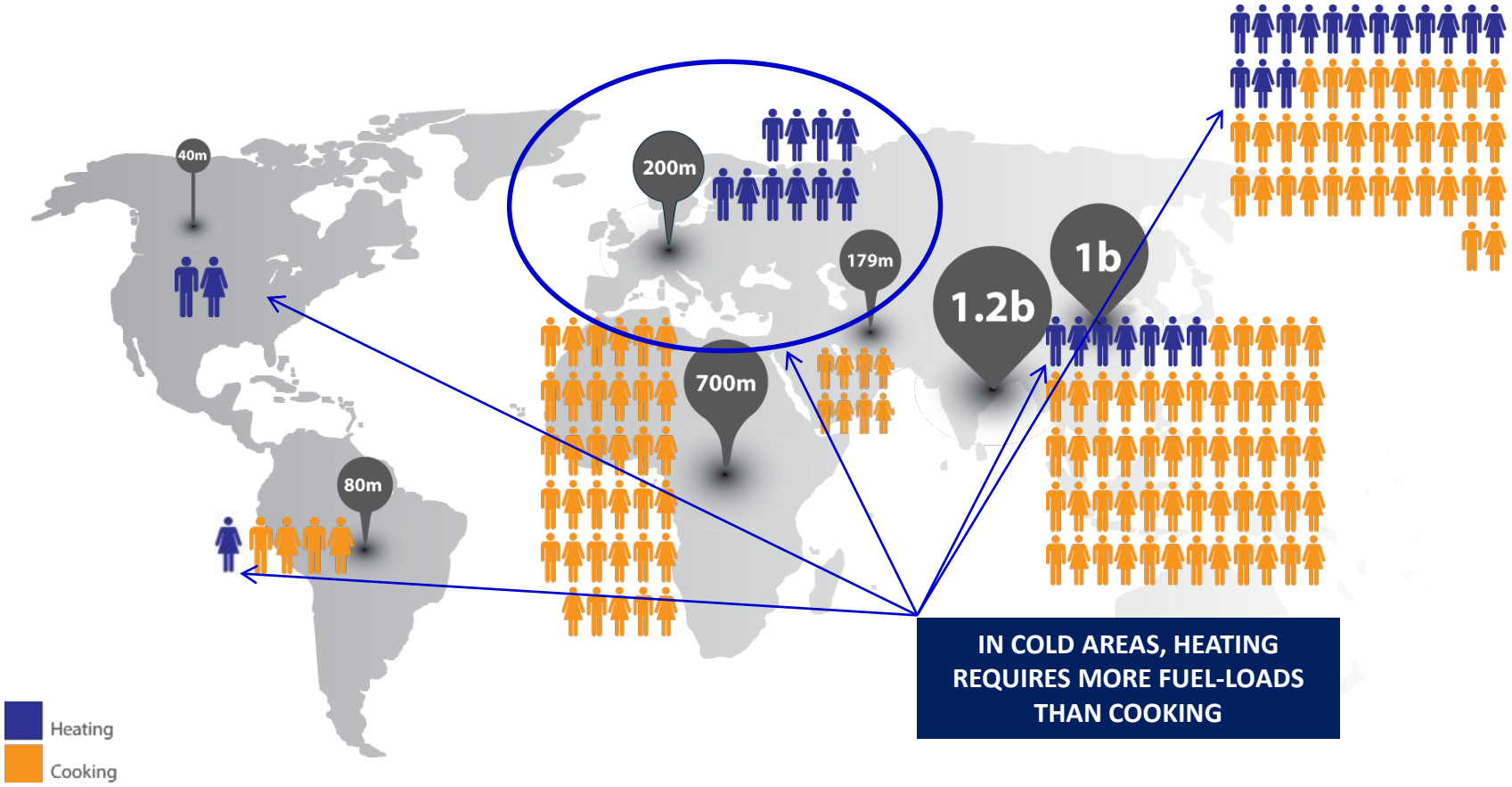
SR&DT IN EUROPE

1. SOLID-FUELS AND STOVES: EUROPE (AND OVERSEAS)
2. SOURCE CONTROL: ECODESIGN 2022 (AND WHO)
3. CASE STUDIES: REPRESENTATIVE TESTING
4. EMERGING INNOVATIONS
5. POLICY AND INTELLIGENT STOVES

1

SOLID-FUEL USE & CLIMATE

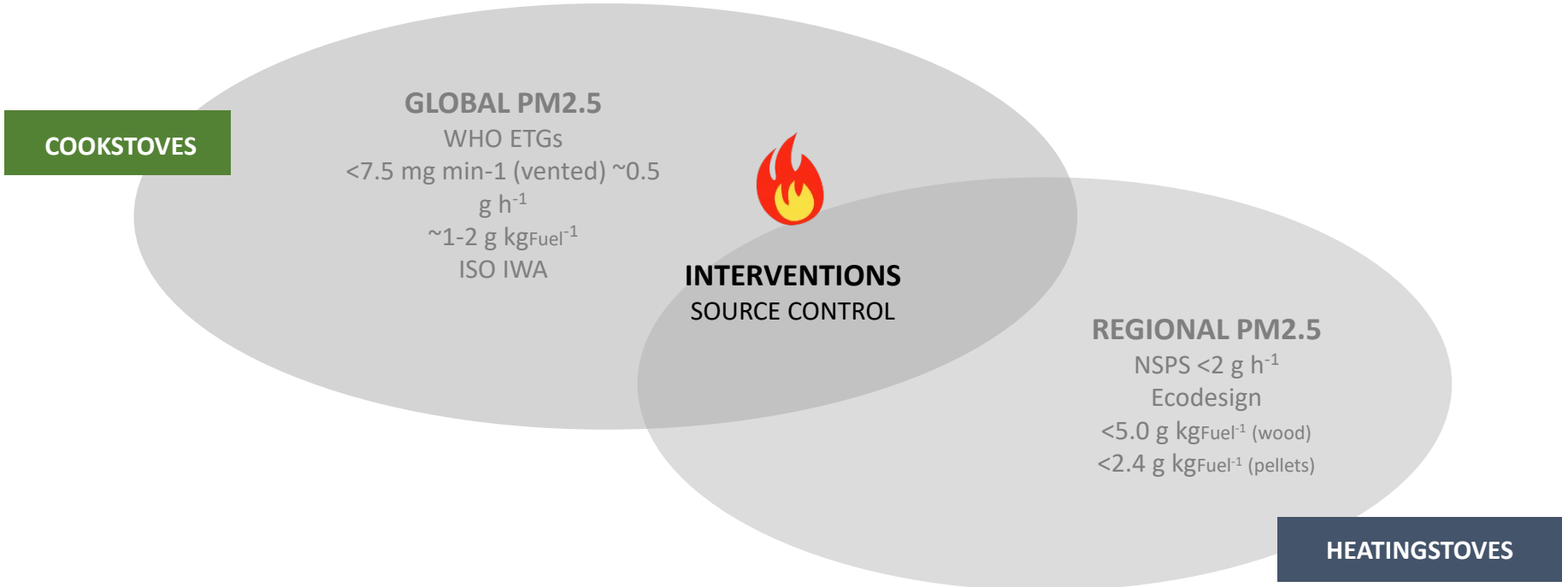
HEATING AND COOKING



1 STOVES AND OPERATION
INSTALLATIONS AND EFFECTS

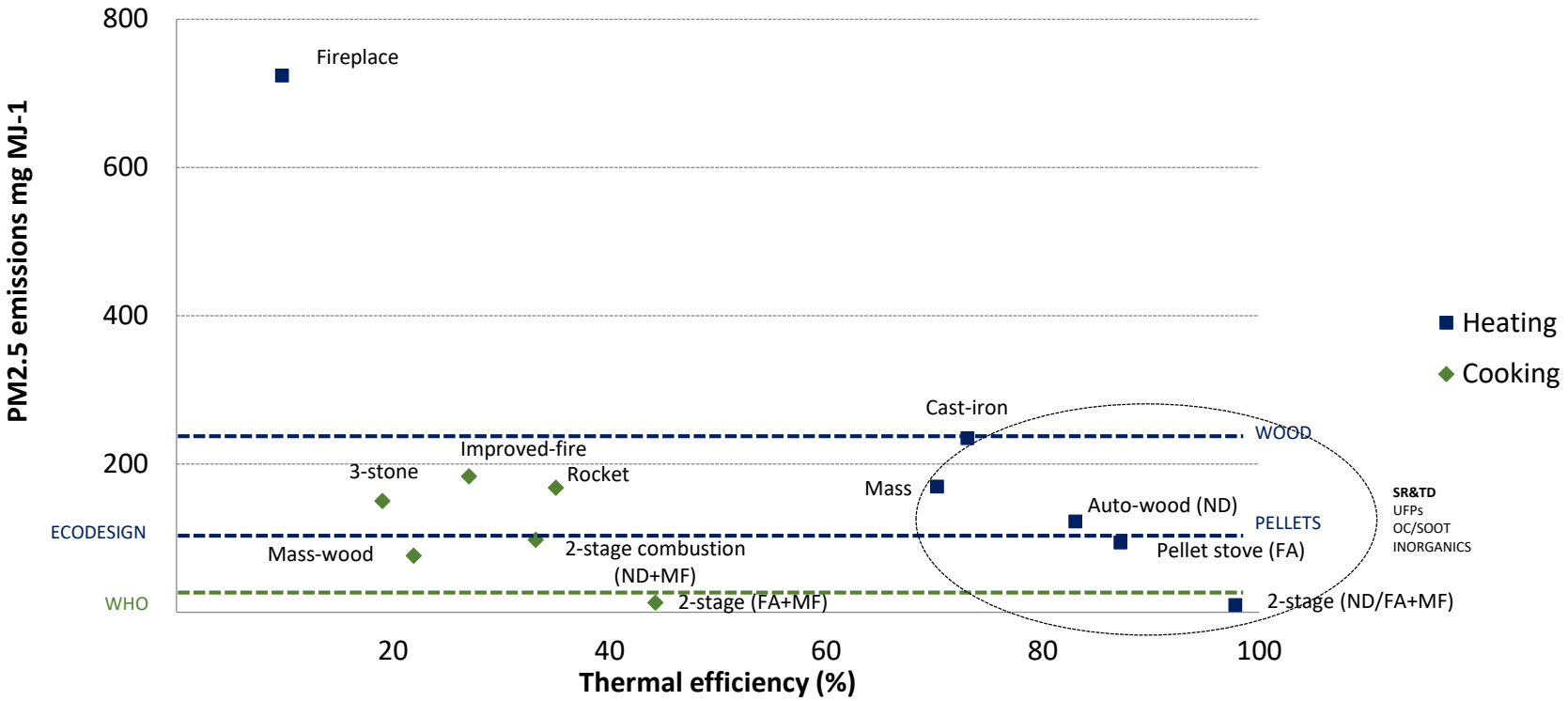
Stoves	Categories	Fuel and air-flow	Health and particles	Climate issues
	Traditional	Uncontrolled conditions	High direct exposure (PM)	Deforestation and particles (OC/EC)
	Improved	Moderate conditions (fuel savings)	Moderate indirect exposure (PM1)	Energy losses and particles (soot)
	Advanced	Controlled conditions (+fuel savings)	Low exposure (UFPs)	Ultra-fine particles (salts)

2 SOURCE CONTROL
GUIDELINES AND METRICS



2 SOURCE CONTROL: +ENERGY EFFICIENCY

ECODESIGN 2022+WHO GUIDELINES



In "Mapping the performance of wood-burning stoves by installations worldwide, Energy and Buildings 2016"

3 CASE STUDIES
PRACTICES IN EUROPE (AND OVERSEAS)

RELYING ON WOOD HEAT

TRADTIONAL HEATSTOVE
Spain

PELLET STOVE
Portugal

PRIMARY HEATING

RECREATIONAL WOOD HEAT

ROOMHEATER STOVE
Denmark

HYDRONIC STOVE
Norway

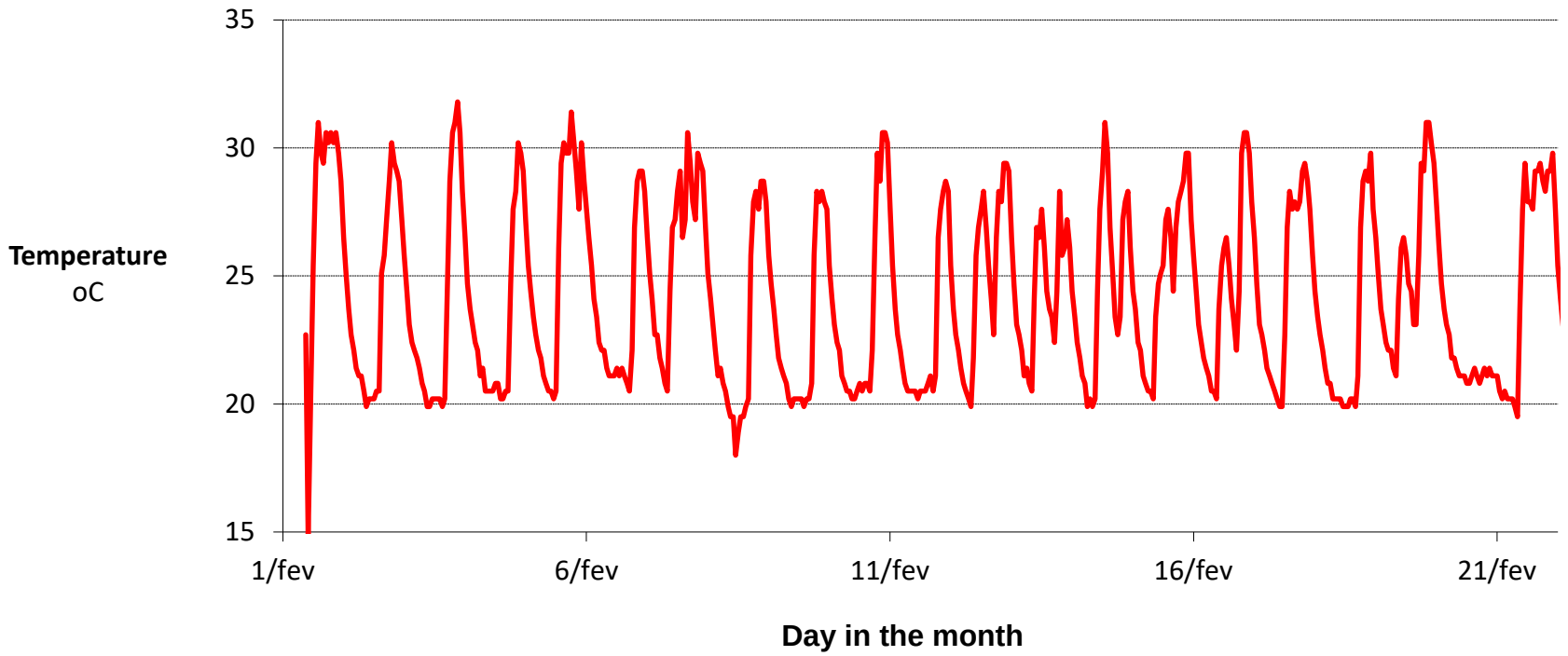
SECONDARY HEATING

3 FIELD STUDIES
STOVES IN SCANDINAVIA

MODERN STOVE
DANISH HOUSE

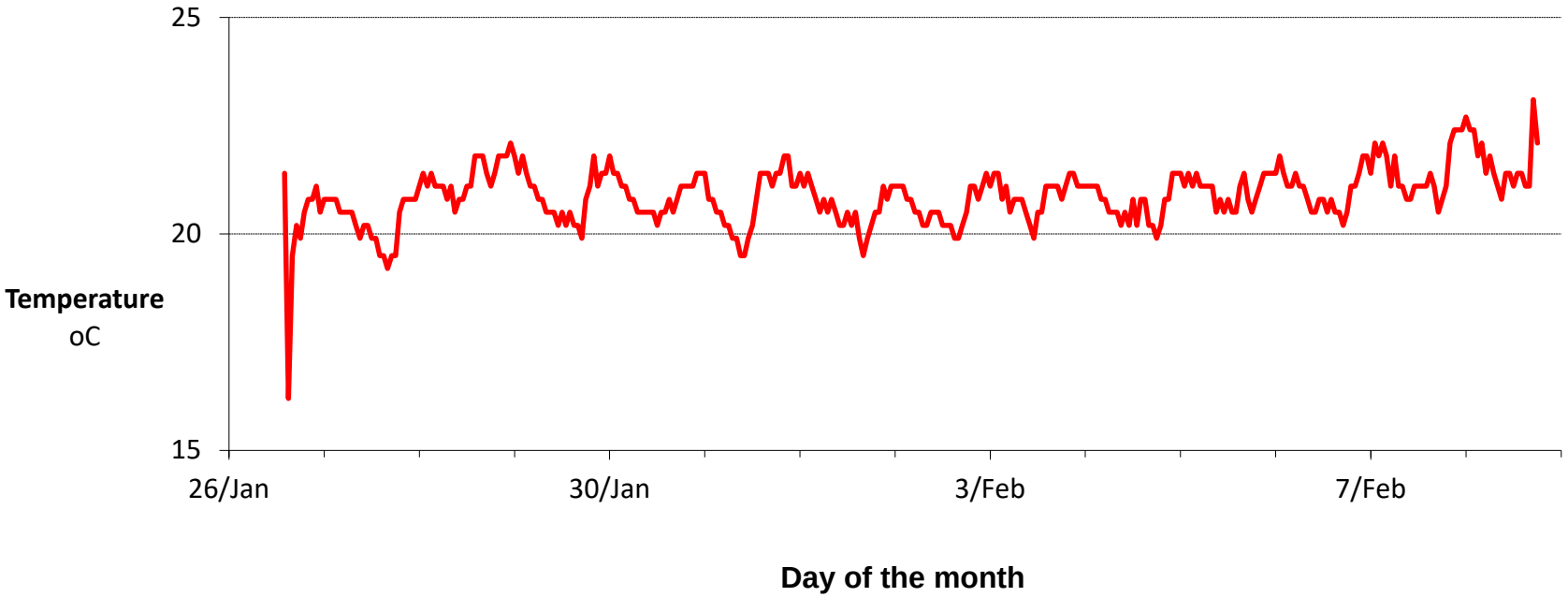
INSTRUMENTATION
NORWEGIAN HOUSE

3 FIELD STUDIES
HEATSTOVES AND INTERMITENT TRANSFER IN EUROPE



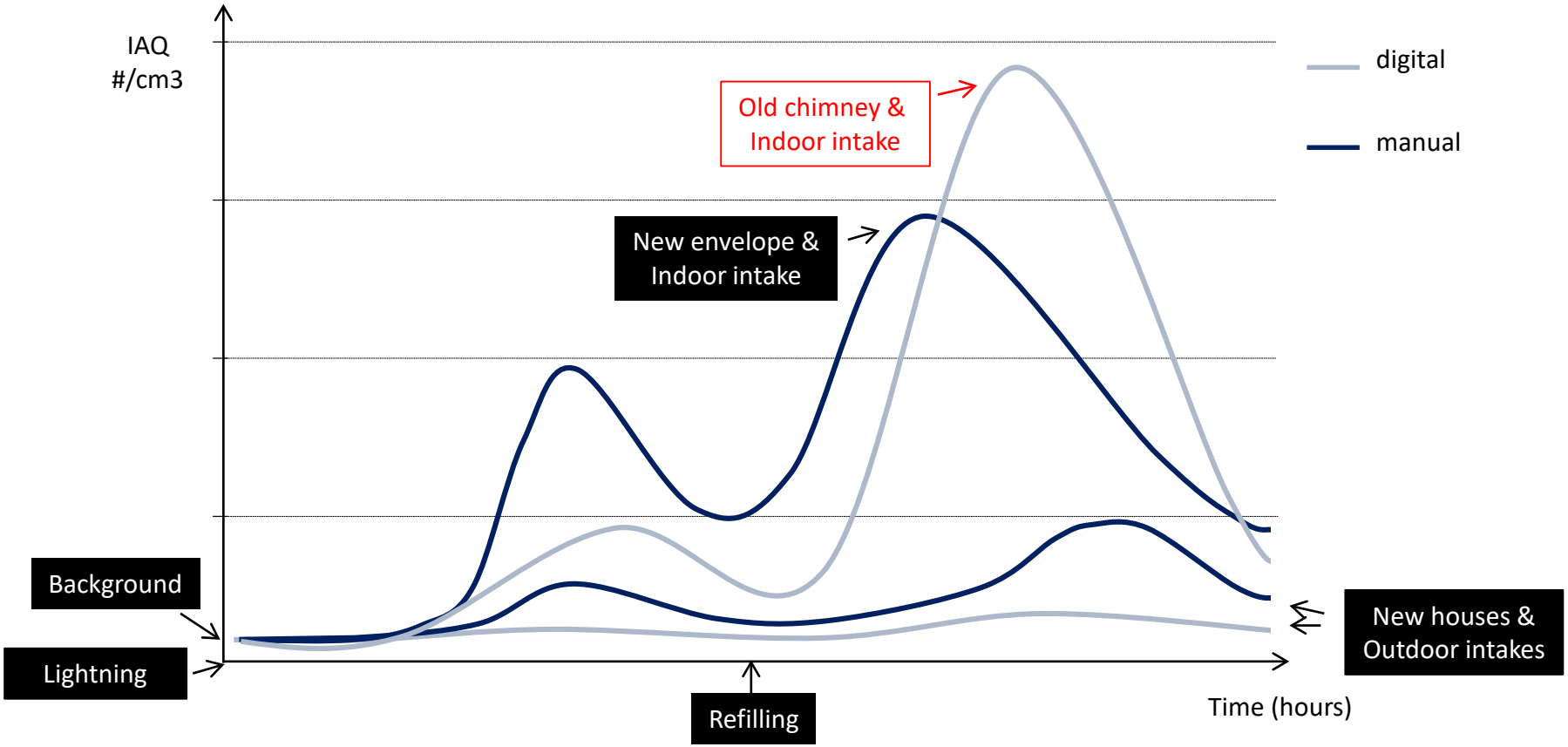
In "Wood-burning stoves in low-carbon dwellings, Energy and Buildings 2013"

3 FIELD STUDIES
STOVES AND STABLE HEATING IN DENMARK



In "Wood-burning stoves in low-carbon dwellings, Energy and Buildings 2013"

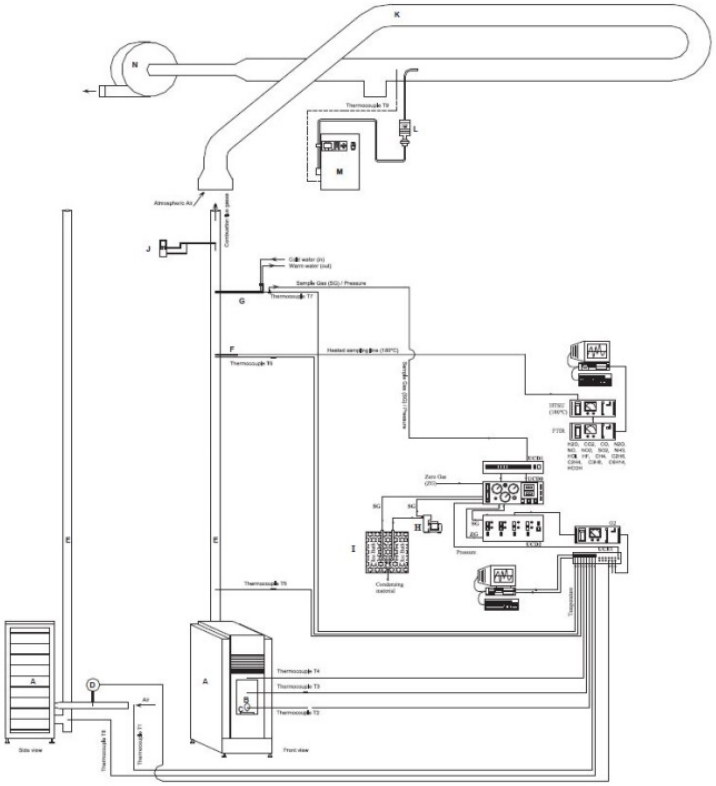
3 FIELD STUDIES
STOVE INTERPLAY AND PARTICLES IN SCANDINAVIA



3 FIELD AND LABORATORY WORK

ADDRESSING THE REAL-WORLD OPERATION (BASED ON NS-3058)

FIELD TESTING IN DENMARK
Glausius, Ole Schleicher et al.



LAB TESTING IN PORTUGAL
Credits to Tarelho, Vicente et al.

3

LABORATORY WORK
STOVES IN EUROPE

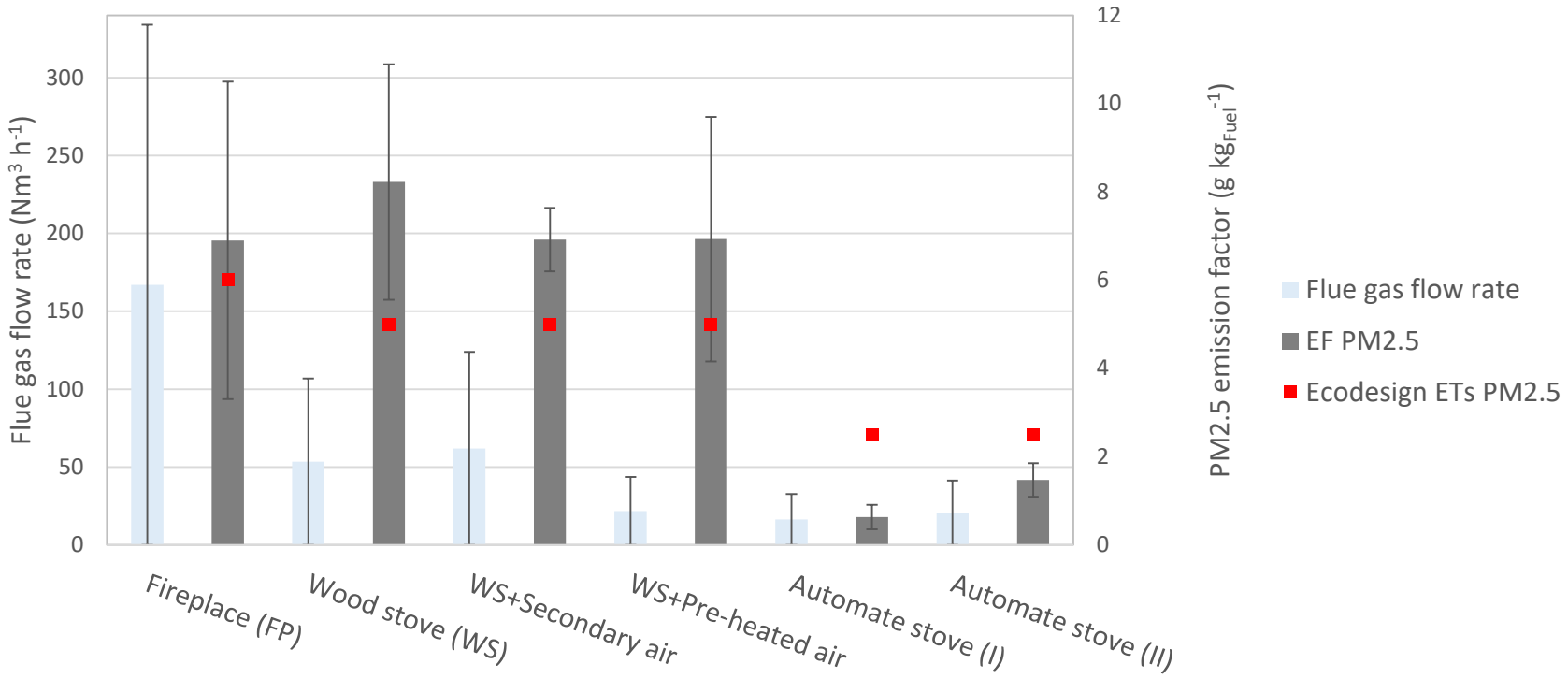
FIREPLACE

WOOD STOVE

PELLET STOVE

3 LABORATORY WORK

THE ECODESIGN AND ACESSIBLE AUTOMATED STOVES+BIOFUELS



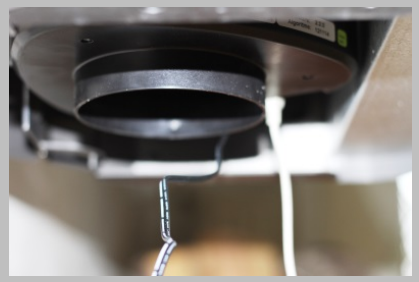
4 EMERGING INNOVATIONS
AUTOMATE AIR REGULATION CONTROL

MECHANICAL SYSTEMS

Two-stage (bimetal coils/flaps)
(e.g. DBFZ, cred. RAIS)

Mechanical springe-type "lightning" timer
(e.g. Cred. ADURO)

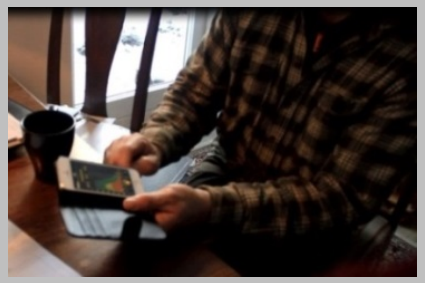
ELECTRONIC COMPONENTS



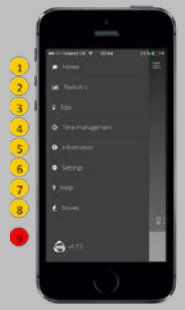
Comb+indoor temp/gas sensors
(e.g. HWAM; RIKA, DBFZ/ETE, ATECH)

Pellets/hybrids & catalysts
(e.g. SOLZAIMA, ADURO, TFZ)

DIGITAL APPS



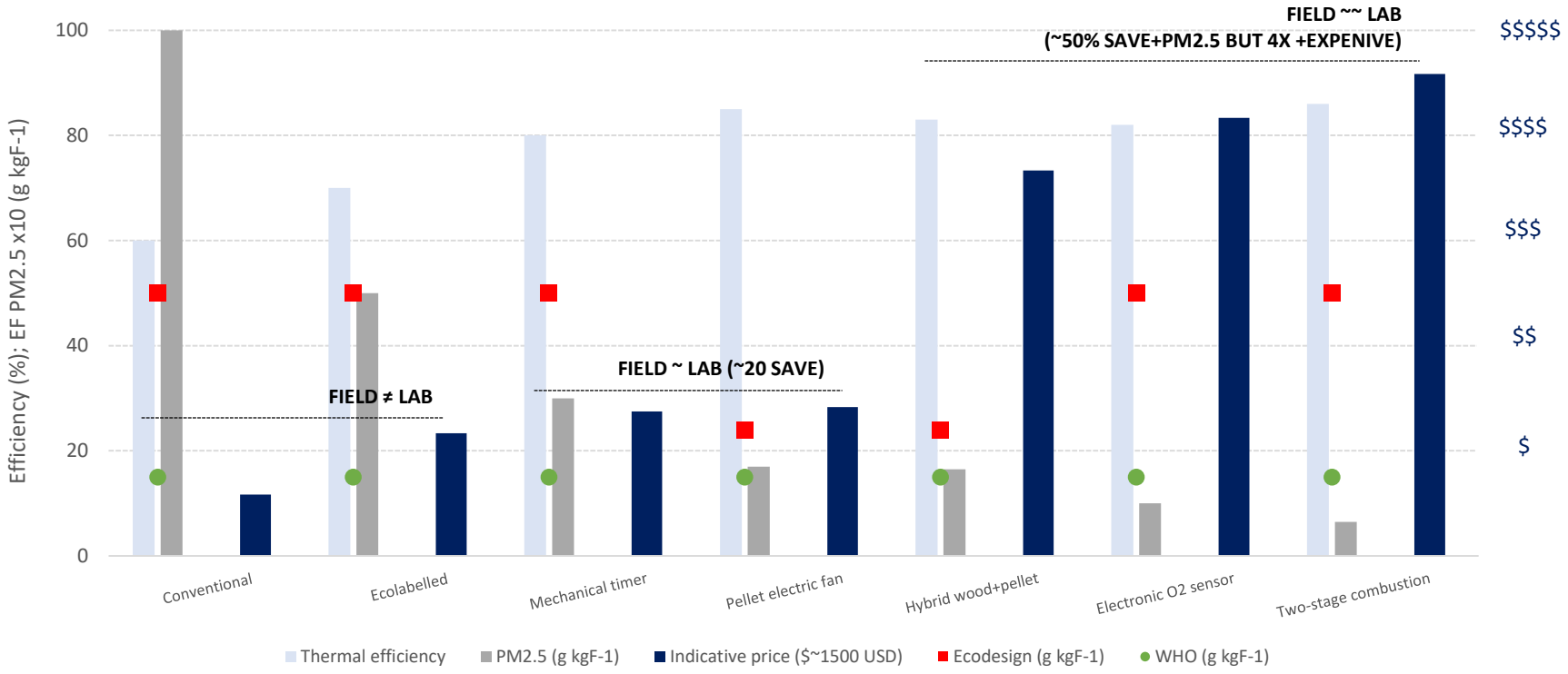
Smart response for cleaner use
(e.g. ADURO)



WIFI auto, tips & cleaver-vent.
(e.g. Cred. HWAM, RIKA, ATECH)

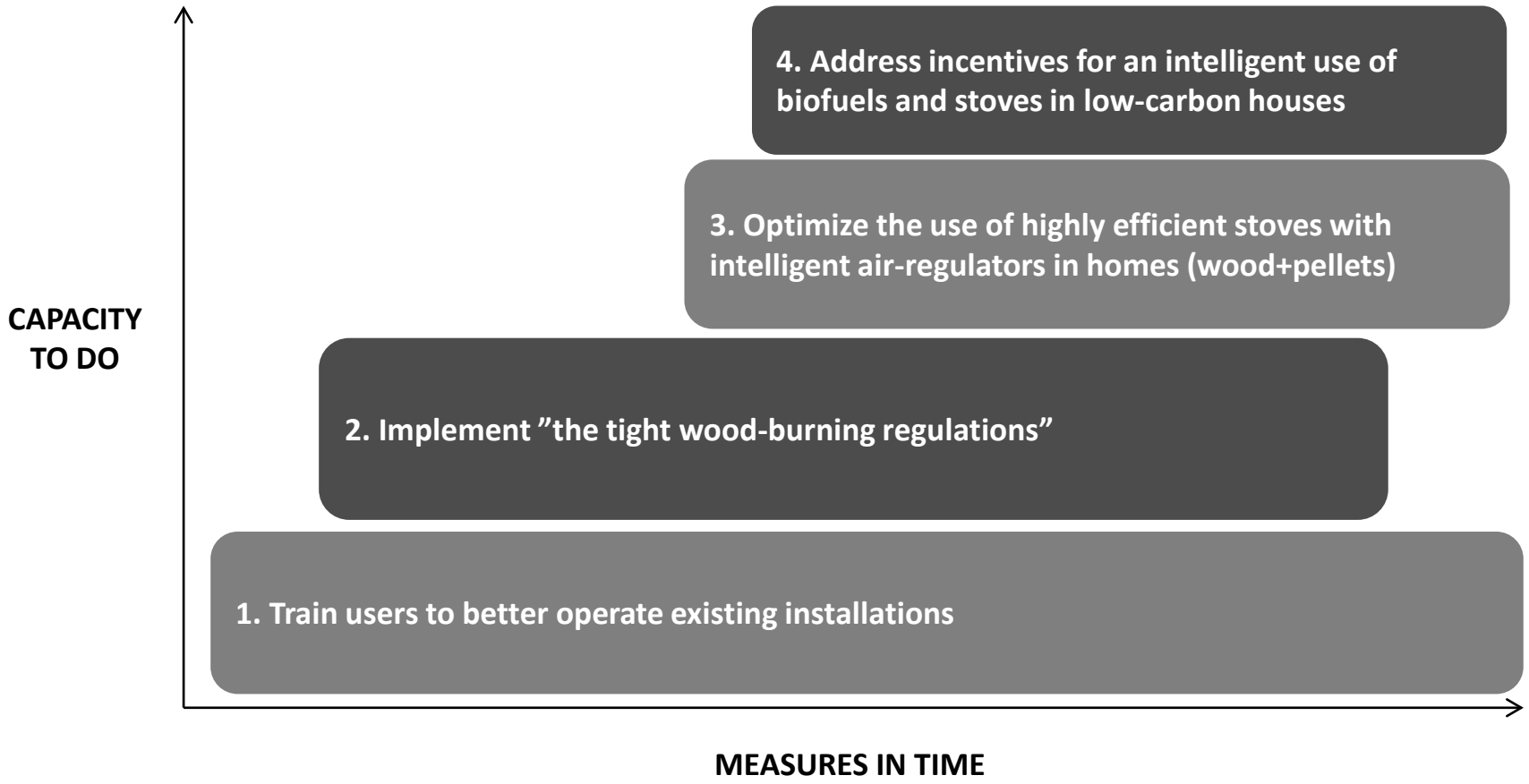
4 EMERGING INNOVATIONS: DIVERSE SEGMENTS

ECODESIGN 2022 AND AUTOMATED STOVES (INDICATORS)



5 POLICY AND INTELLIGENT STOVES

HOUSEHOLD ENERGY AND SOURCE CONTROL



THANKS FOR LISTENING

Further work

Address proper interventions to enhance optimal and intelligent interplays between fuel use, heatstoves and low-carbon dwellings.

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POPH QUALIFICAR É CRESCER.
QREN QUADRO DE REFERÊNCIA ESTRATÉGICO NACIONAL PORTUGAL 2007.2013
GOVERNO DA REPÚBLICA PORTUGUESA
UNIÃO EUROPEIA Fundo Social Europeu
FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA