The Score Stove.

For £20 it will cook and generate electricity
To help over 2 billion poor people
Powered by wood, dung or other fuel
Potential to save 10 Mt Carbon per year

DIE 15 April 2010

Paul H. Riley Score Project Director

Why Score?

- 2 billion people cook on an open fire with no electricity
  - Smoke bad for health
- Over-use of scarce wood supply
- Many stove designs
  - Insufficient impact
- Understanding social context is key
  - Poverty < $2 per day
  - Motivation, e.g. mobile phone
  - Inhibitors
  - Low power (20W) is enough to start
  - Familiarity with local culture

Photographs courtesy Practical Action

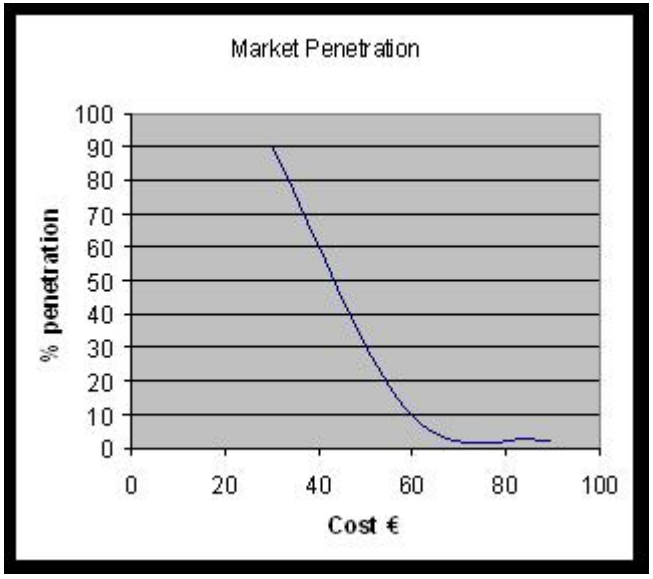
The Score Stove Project

The University of Nottingham

- The Charity Practical Action and the Universities of City, Manchester, Nottingham, Queen Mary
- £2M research
  - fuel burning Stove that can cook, generate electricity and provide cooling for use in Developing Countries.
- 5 years started in 2007
  - research to 2010 thereafter exploitation part funded until 2012
- Both High Technology and Social Science content
- Target of 100 Watts electrical for £20 in 1 million quantities
  - with half the wood and no smoke
- World-wide interest
  - GTZ (SA), GTZ (Bangladesh)
  - in 60 publications, over 10 different languages
  - Score Community Launched
    - » engaging with 10 developing countries and growing

Market Survey

- Nepal survey (results confirmed in Kenya)
  - Yangalot village in Hagam
  - Husband see chart on right
  - Wife
    - » better cooking position
    - » low smoke
    - » better education for children
- Business case
  - Household:
    - » €1 per month saved on kerosene for lighting,
    - » Score pays back in < 3 years
  - Village
    - » shop sells and maintains score to offset kerosene sales.
  - Country
    - » carbon credits
    - » cascade manufacturing.



Technology positioning

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- < 5 times cheaper per installed watt than PV
- Smoke free cooking
- Electricity generation
  - Provides real business case by displacing paraffin
  - Increases perceived value
  - Much bigger incentive to purchase than stove alone
- Rapid way to electrify remote regions
  - Local generation, no blackouts
  - Mass production
  - Self financing
  - Low bureaucracy overhead
  - Rapid disaster deployment when mains fails

Is Score wanted?

- Simulated Score Stove
  - 12 houses in Nepal
  - 10 – 20 W electrical
  - No smoke, less wood
  - Similar number in Kenya
- Satisfaction
  - 100% used electricity for lighting helping education, social
  - 80% used for radio
  - 32% mobile phone charging
    - » 16% sold electricity (i.e. promotes local commerce)

How does it work?

- Uses Thermo-Acoustics
  - Exciting new technology
  - No moving parts
    - » Stirling engine with no pistons
      Relies on acoustic waves
    - » Making it cheap and reliable
  - Difficult to design but low cost manufacture
  - Used in Space probe
    and a Natural Gas liquefying plant
- Wood or dung is burnt
  - A specially shaped pipe gets red hot
  - Another part of the pipe is cooled
  - This generates sound at 100 Hz
    - » very noisy inside >170 dBA
    - » Outside whisper quiet hum
  - Then a Linear Alternator turns the sound into electricity
- The waste heat is used for cooking

Key Features (v3.0)

- 100We electricity whilst cooking
- Uses half the wood of 3 stone stove
- 1.6kWth for cooking hob, or space heating
- 1.7kWth for water sanitation or space heating
  - No emissions into house
- Electricity can be used for:
  - Lighting
  - Mobile phone charging
  - Radio/ TV / Computer
  - Sale to neighbours

Product availability

	Available	Cost*	Elec.	Hob	Fuel	Volume	Comments
Score™ stove1	April 2009	€200	no	2	Wood	Market driven	Third generation smoke free stove with chimney
Score™ stove2	2010	€ 1200	>15W	2	Prop.	~10	As Stove 1 with 12V electrical output. For testing only
Score™ stove2.3	2011	€350	>30W	2	Wood Or Dung	~140	As Stove 1 with 12V electrical output. For testing only
Score™ stove2.5	2012	€100	>30W	2	Wood or Dung	1000's	First production units
Score™ stove3	>2012	~ €30*	100W	1 or 2	Wood Dung Or other	60Million – 2 Billion**	First very low cost units. Power is available to the load after the battery storage. Battery extra.

* Wholesale cost as delivered to capital city of country

** 2 billion at 30 Euros, 60 million at 90 Euros

Business Model Deployment

- Big aspirations
  - Benefit of large scale manufacture (10M – 100Million units PA)
  - Provide global solution, not piecemeal
  - Total solution, cradle to grave
- Sales and Marketing
  - Local chiefs
  - NGO's
  - Governments, local and development agencies
  - Energy Utilities
- Supply chain
  - Source parts from appropriate places
  - Training
  - Maintenance
  - Appropriate Manufacturing locations to minimise price
  - Reputation control
- Finance
  - Micro-finance
  - Payback at 3 levels
    - » Individual ~3 years due to paraffin displacement
    - » Village
    - » Country
  - Grant leverage for very poor

Acknowledgements

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    - » University of Manchester
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    - » City University London
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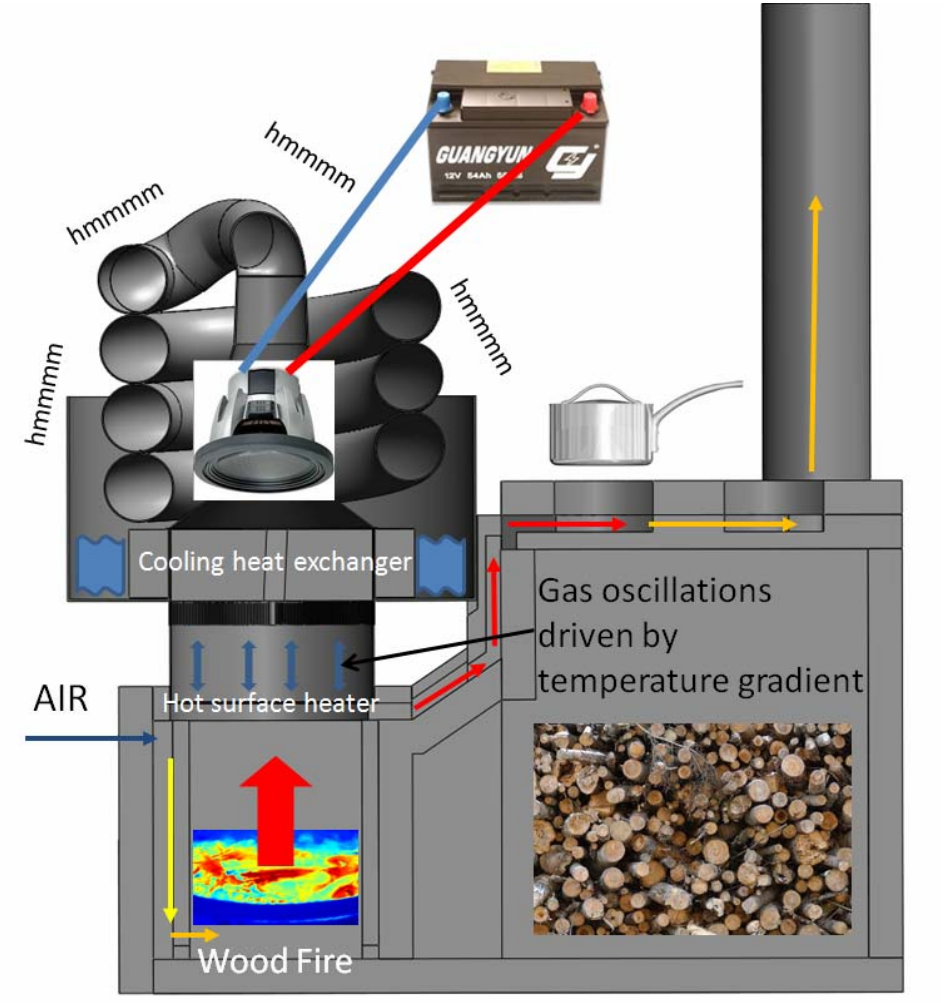
  - Professor Mark Johnson, and Dr Chitta Saha.
    - » My Nottingham colleagues

Current Stove and Thermo-acoustic Duct Design for a Travelling Wave



Early demonstrator, Nottingham

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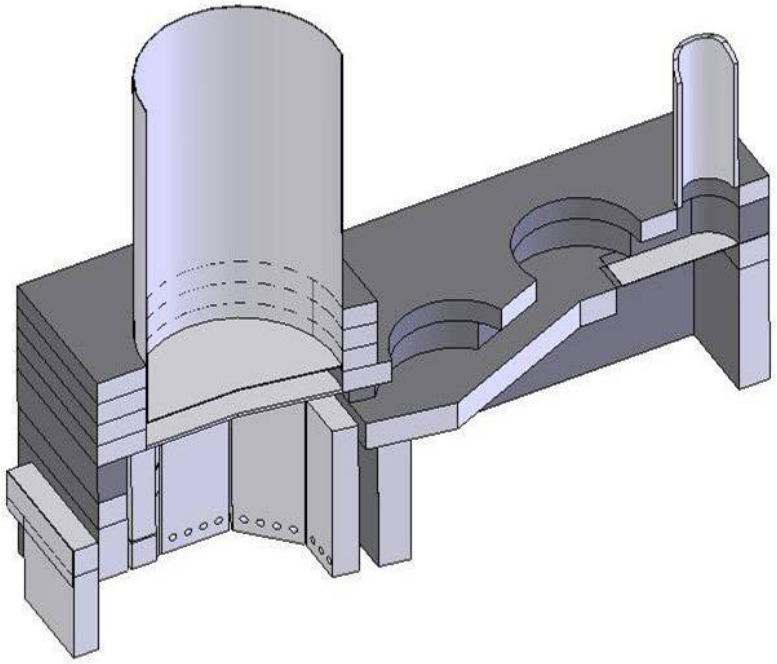
B & C speaker :

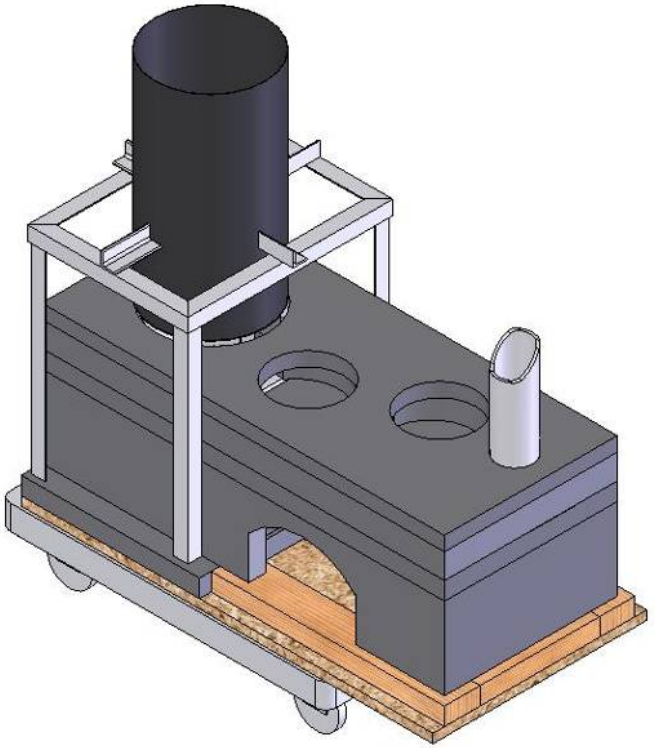
R_c = 5.5 Ω
F_n = 40 Hz
Q_{ms} = 4.5

Load	fn(Hz)	HHX (°C)	AHX (°C)	P_1 (mBar)	V_L (V)	I_L (A)	P_{out}
36 Ω	74	414	47	40	19.5	0.557	10.8 W
24 V battery	74	412	46	42	29.6	0.662	19.6 VA

SCORE Stove design
City University

The University of Nottingham





SCORE Stove manufacture City University

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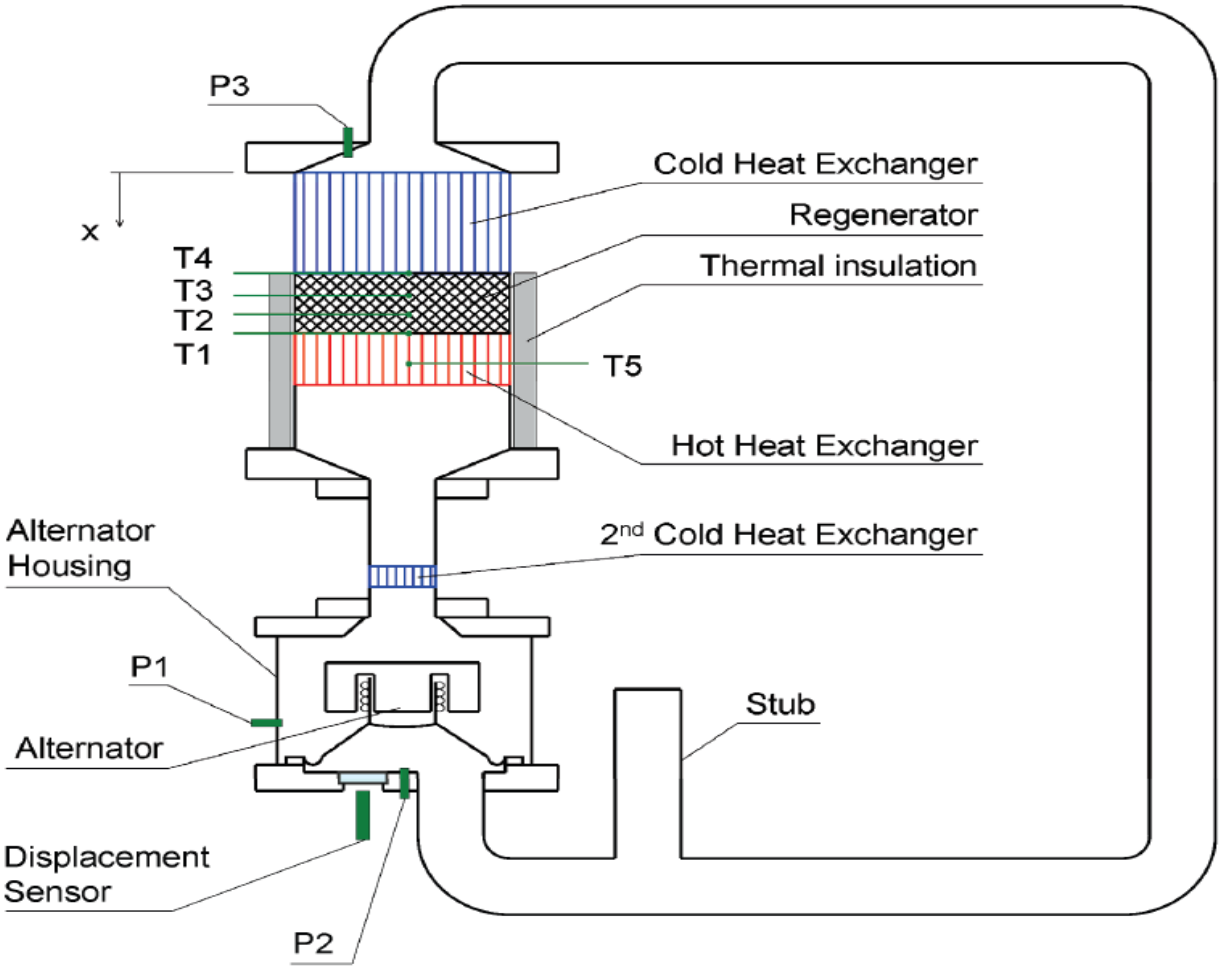
Travelling wave design, Manchester



The Principle of the 'Standing-Wave' Thermo-acoustic Engine (Yu and Jaworski, 2009)