



# **Technology for Development:**

## **An Adaptive Design Approach**

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**Where?**

**Who?**

**Why?**

**What?**

**How?**





**Where?**



*AFRICA*

*Malawi*

**Where?**

- 16,777,547 people
- Among the world's least-developed countries
- 85% of the population live in rural areas



**Where?**

- **Agricultural** (subsistence farming, tobacco, tea, sugar)
- 87% of energy from burning biomass
- 85%+ deforested
- All electricity hydroelectric
- 8.9% have access to electricity (<1% in rural areas)





**Who?**



Trinity  
College  
Dublin

The University of Dublin

# Who?



concern  
universal

Who?



Who?



Who?



**Why?**

# Fire is energy



# Why?



**deforestation**



**calories**



**lost income**



**health**

**Why?**

**Fire is light**



**Why?**



**unsafe**



**expensive**



**unavailable**

**poor quality**



**Why?**



**Why?**



**Why?**

# Electricity & Light



Why?

# Electricity & Phones



\$30-\$50 yearly



time, time, time

# Why?



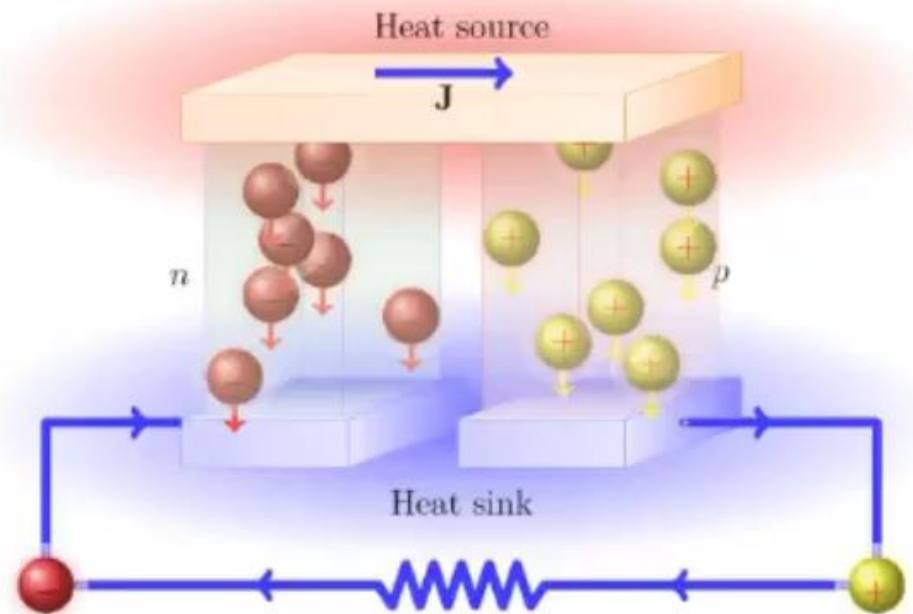
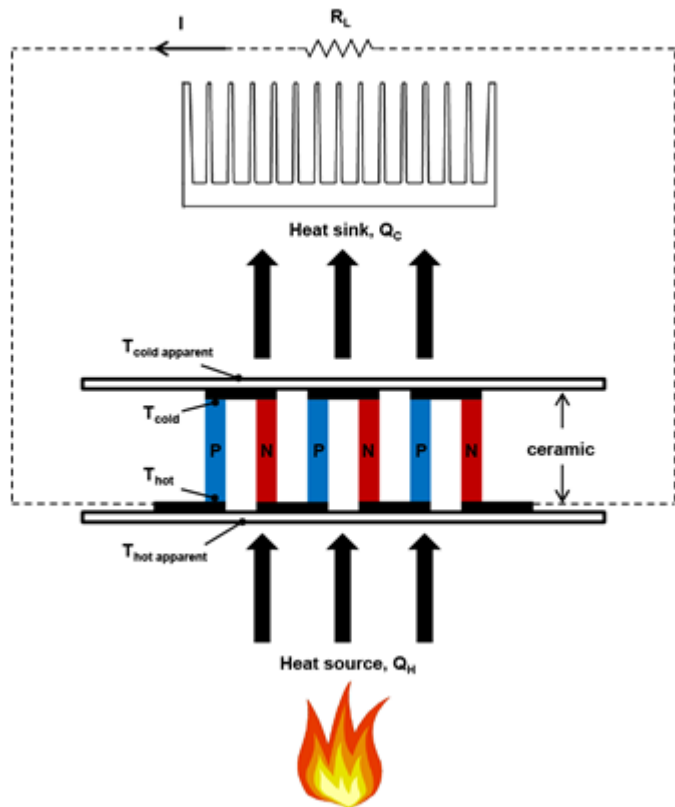
**What?**

**Scoping mission 2009**



**What?**

# Thermoelectricity



Thermoelectric (Seebeck) effect

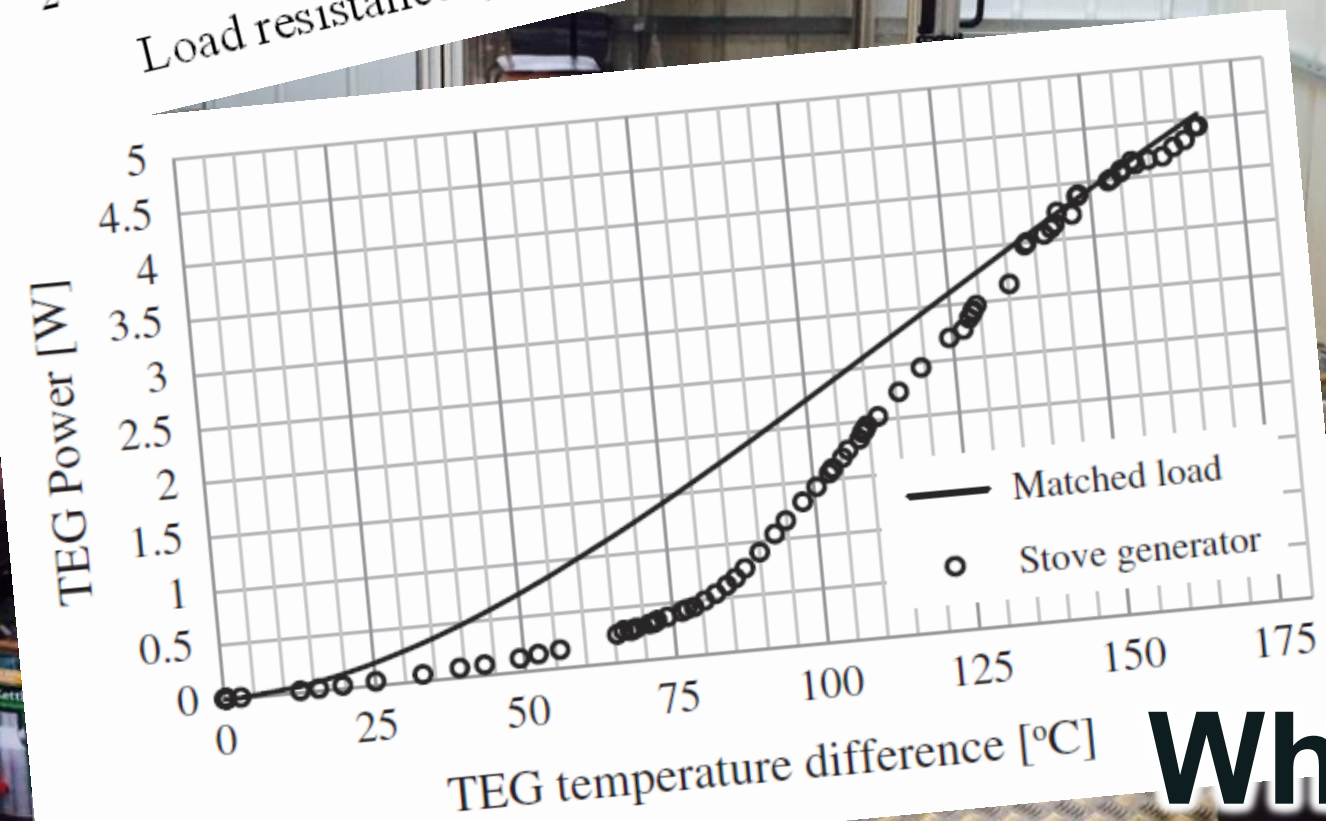
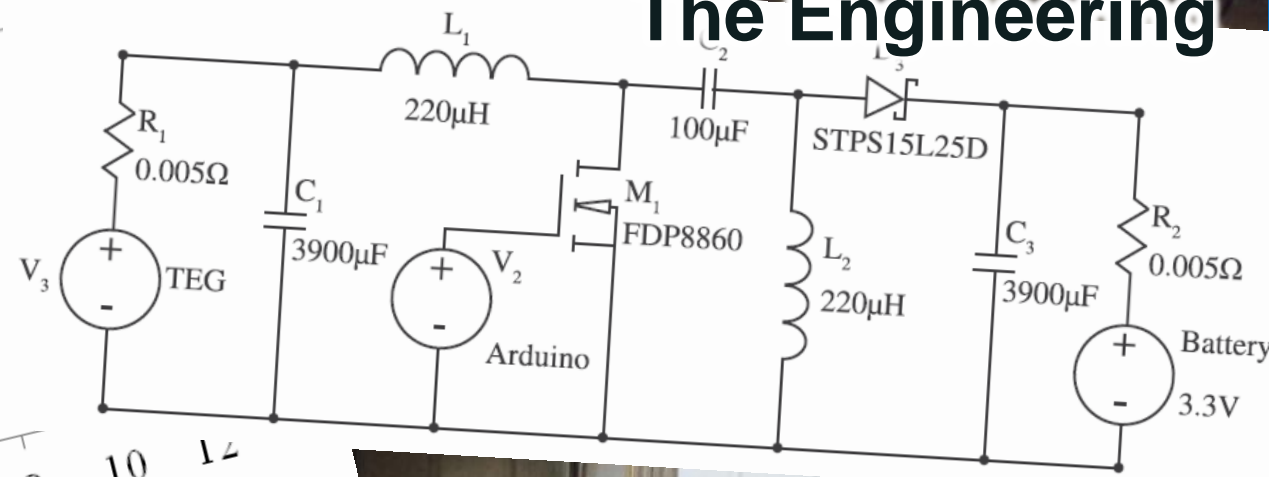
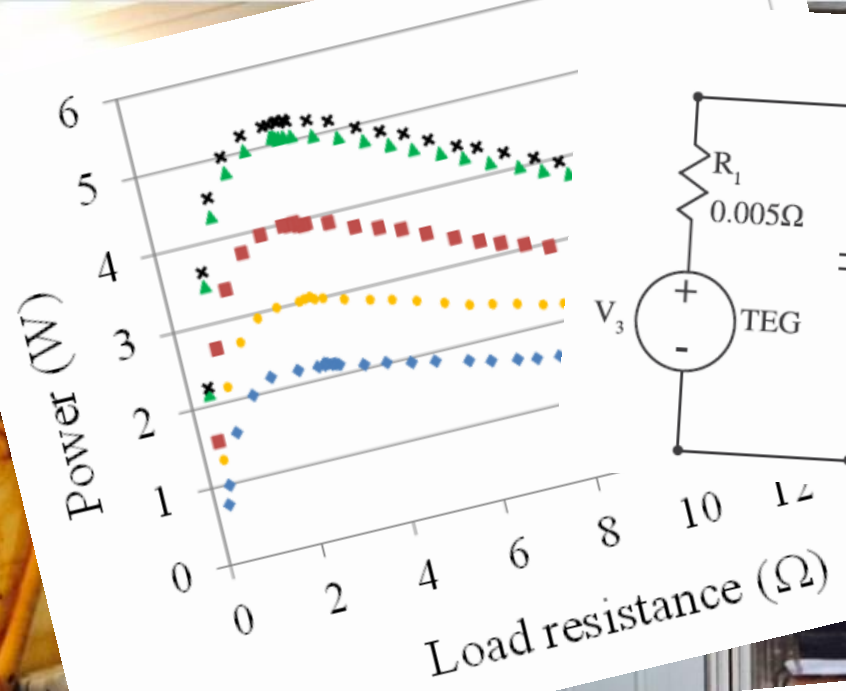
What?

# The burn lab at Trinity College Dublin



# What?

# The Engineering



# What?

# The Engineering

$$I^2 R_L = \left\{ -A_{\text{sub}} N I \left\{ A_{\text{sub}} H \times [A_e \alpha_{p,n} (T_{\infty,c} - T_{\infty,h}) + 4NI(2R_{\text{ec}-\rho} + H\rho)] + NI[-2NH I \alpha_{p,n} \times (R''_{c-\infty,c} - R''_{h-\infty,h})(2R_{\text{ec}-\rho} + H\rho) + A_e [H \alpha_{p,n}^2 (R''_{h-\infty,h} T_{\infty,c} + R''_{c-\infty,c} T_{\infty,h})] + 4k(R''_{c-\infty,c} + R''_{h-\infty,h})(2R_{\text{ec}-\rho} + H\rho)] \right\} \right\} \\ \left\{ A_e [A_{\text{sub}}^2 H + A_e A_{\text{sub}} k (R''_{c-\infty,c} + R''_{h-\infty,h}) + A_{\text{sub}} N H I \alpha_{p,n} (R''_{c-\infty,c} - R''_{h-\infty,h}) - N^2 H I^2 \alpha_{p,n}^2 R''_{c-\infty,c} R''_{h-\infty,h}] \right\}$$

$$Q_H = K(\Delta T) + (\alpha_{p,n}) I T_h - \frac{I^2 R_{\text{TEG}}}{2}$$

$$Q_H = K(\Delta T) + (\alpha_{p,n}) I T_c + \frac{I^2 R_{\text{TEG}}}{2}$$

$$P_{\text{elec}} = Q_H - Q_C = \alpha_{pn} I \Delta T - I^2 R_{\text{TEG}}$$

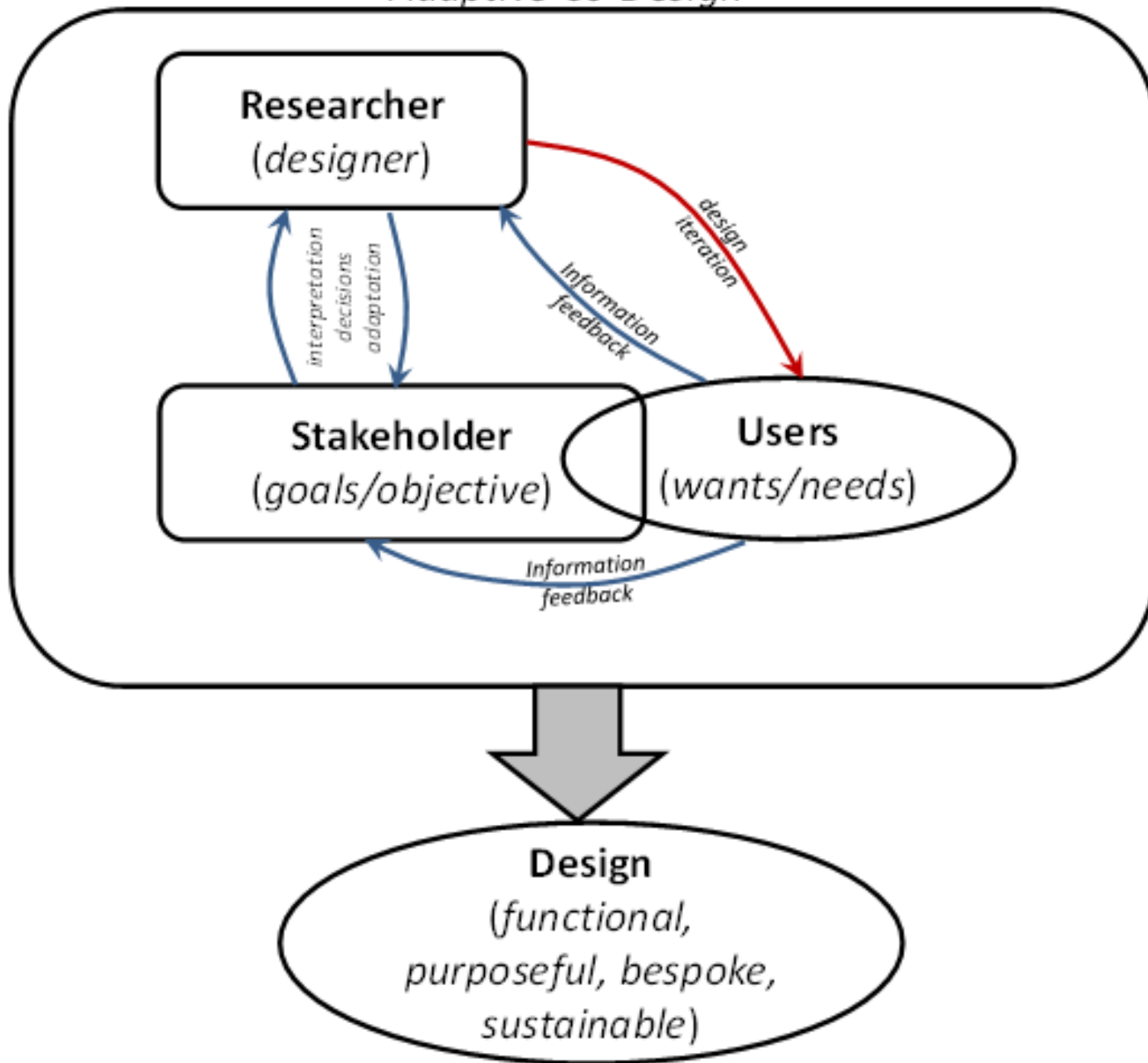
$$\eta = \frac{\dot{W}_g}{N [I \alpha_{p,n} T_h - K (T_h - T_c) - I^2 (R + R_{\text{ec}-R})/2]}$$

What?



**How?**

## Adaptive Co-Design



Thyolo

W?

# Field trials



2. Ntchue

3. Thyolo

1. Balaka

How?

**Data logging**



**Balaka: December 2011 Version 1  
technology demonstrator**

**How?**

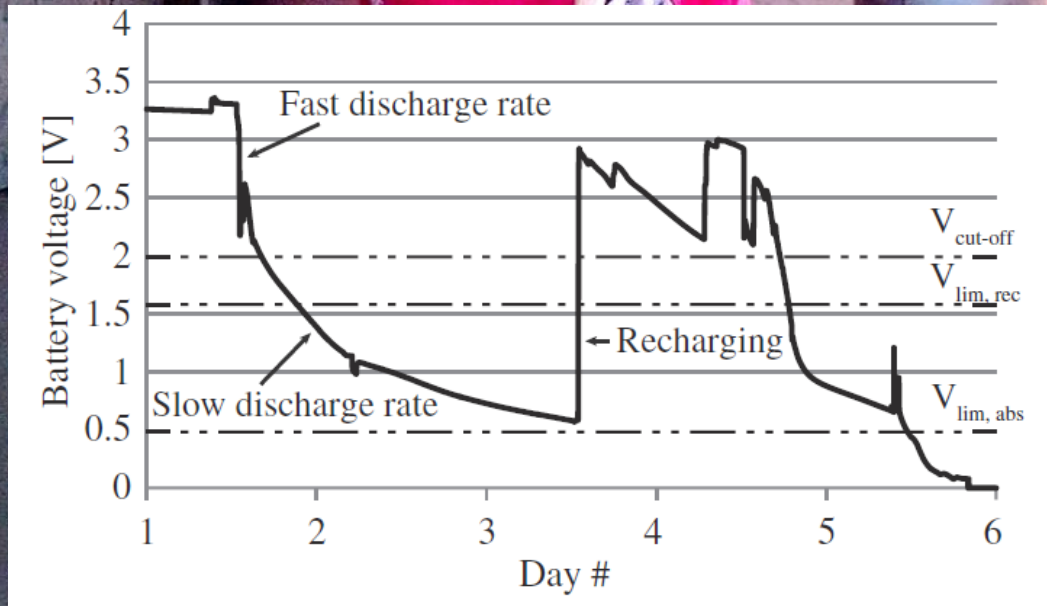
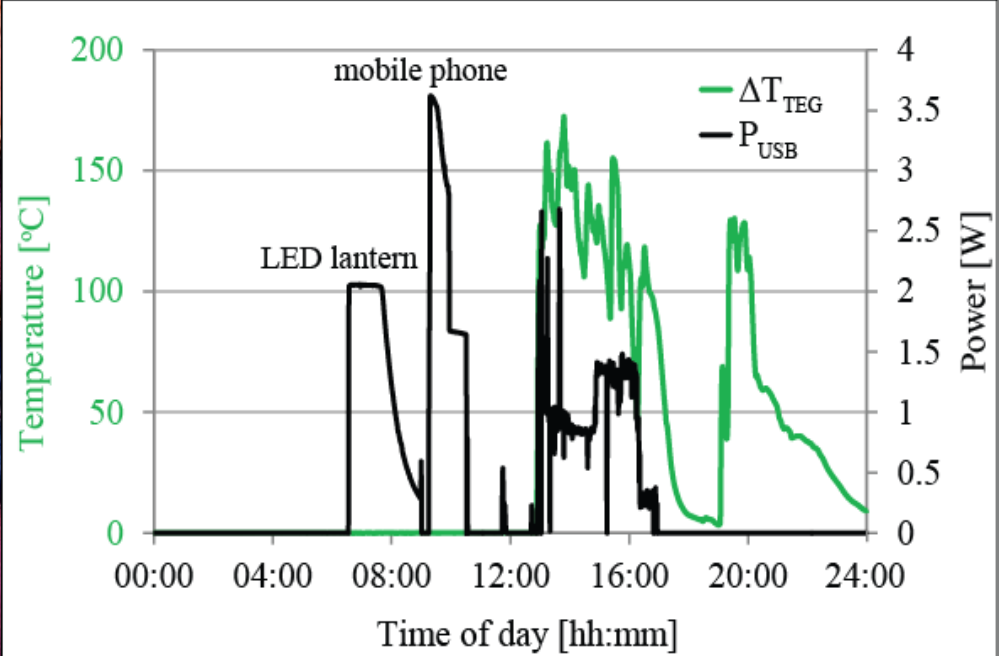
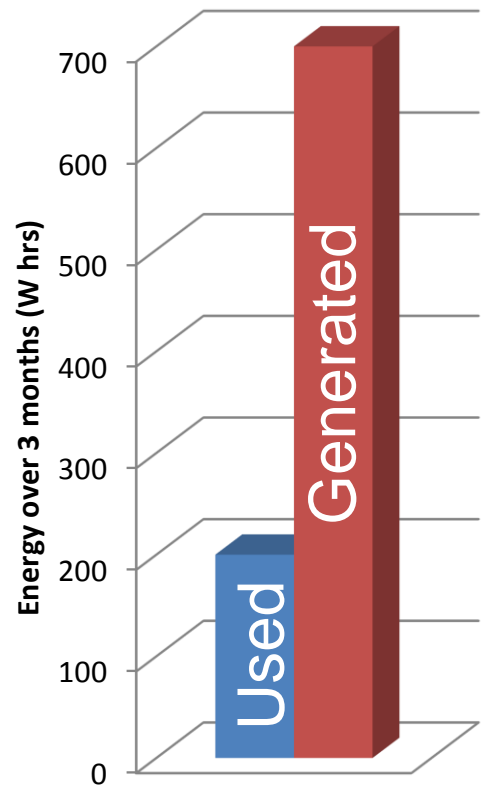


**Data logging**

**Ntchue: Fall 2012 Version 2 technology demonstrator**

**How?**

Data used to inform design based on performance and failure modes



How?



**How?**

Stoves with TEG port manufactured in Malawi



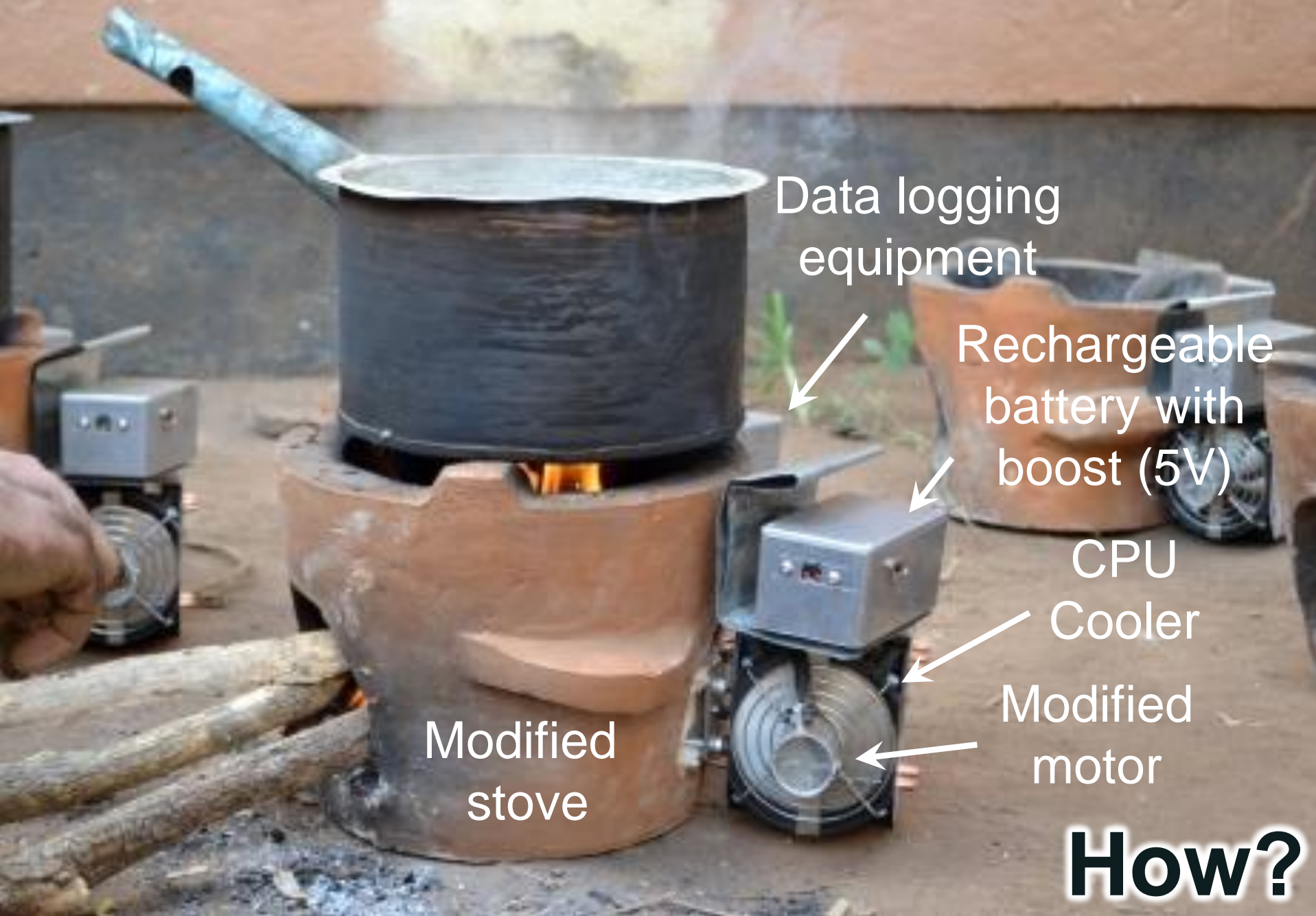
How?

Heat collector, dissipater and circuit housing manufactured in Malawi



How?

# Where we started: 5 Version 1 stoves







**Research output**



Applied Energy 102 (2013) 374–385

Contents lists available at [SciVerse ScienceDirect](#)

Applied Energy

journal homepage: [www.elsevier.com/locate/apenergy](http://www.elsevier.com/locate/apenergy)

## Small scale electricity generation from a portable biomass cookstove: Prototype design and preliminary results

S.M. O'Shaughnessy<sup>a,\*</sup>, M.J. Deasy<sup>a</sup>, C.E. Kinsella<sup>a</sup>, J.V. Doyle<sup>b</sup>, A.J. Robinson<sup>a,\*</sup>

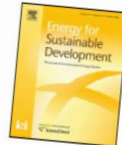
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Energy for Sustainable Development 20 (2014) 1–10

Contents lists available at [ScienceDirect](#)

Energy for Sustainable Development



## Field trial testing of an electricity-producing portable biomass cooking stove in rural Malawi

S.M. O'Shaughnessy<sup>a</sup>, M.J. Deasy<sup>a</sup>, J.V. Doyle<sup>b</sup>, A.J. Robinson<sup>a,\*</sup>

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Applied Energy 114 (2014) 80–90

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journal homepage: [www.elsevier.com/locate/apenergy](http://www.elsevier.com/locate/apenergy)

## Battery charging considerations in small scale electricity generation from a thermoelectric module

C.E. Kinsella<sup>a</sup>, S.M. O'Shaughnessy<sup>a</sup>, M.J. Deasy<sup>a</sup>, M. Duffy<sup>b</sup>, A.J. Robinson<sup>a,\*</sup>

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Contents lists available at [ScienceDirect](#)

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## Performance analysis of a prototype small scale electricity-producing biomass cooking stove

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# Research output



# Financial Support

