Energy behaviours as promoters of energy efficiency: An integrative modelling approach

Marta Lopes

Supervisors:

Carlos Henggeler Antunes, University of Coimbra

Nelson Martins, University of Aveiro

EfS Meeting, December 9, 2015

MIT Portugal

FCT Fundação para a Ciência e a Tecnologia

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

· U C ·

Energia para a Sustentabilidade
Energy *for* Sustainability

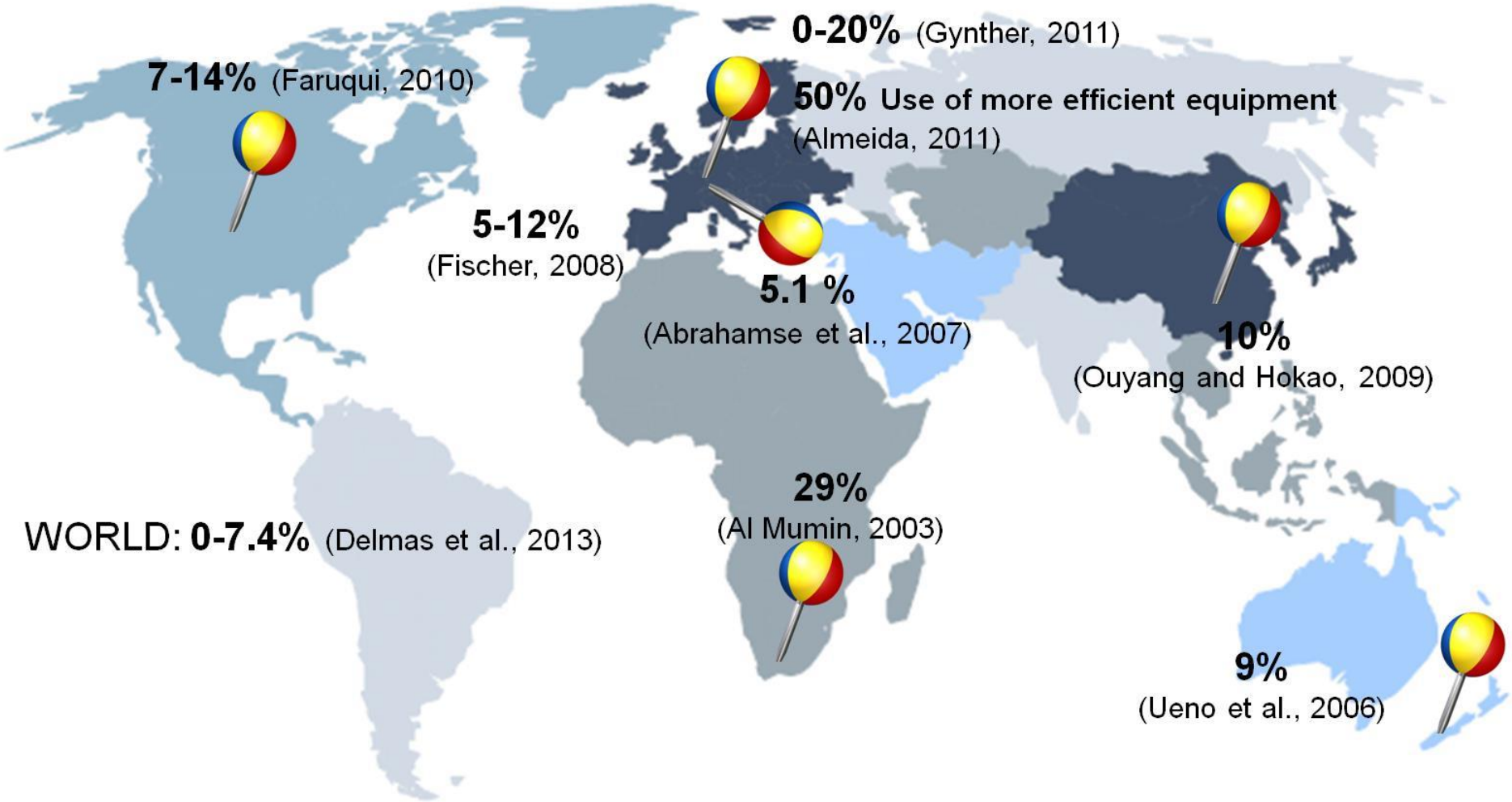
INESC Coimbra

Objectives

Energy behaviours are explored as an important resource in the context of **promoting end-use energy efficiency in the residential sector:**

1. Establishing the **influence of energy behaviours on energy consumption** through a multidisciplinary approach
2. **Estimating energy behavioural savings** potential using BEPS tools
3. Foreseeing energy **behaviour adaptations during the transition to smart(er) grids** and characterisation of end-users' preferences regarding a residential demand responsive energy management system
4. Supporting the **design of more effective behaviour change interventions and energy efficiency policies**

Potential Savings of Energy Behaviours



Equivalent or superior to the replacement of equipment or the improvement of buildings, but results can not be generalised

Research Plan

Real case studies

Residential sector

Case study 1: N=128

Case study 2: N=1,084

MULTIDISCIPLINARY APPROACH

Engineering & Social sciences

Infrastructure

Web-based questionnaires

Smart electricity sensing
(www.cloogy.com/en/)

Building energy performance simulations

Variables

Results: (1) Energy behaviours influence on energy consumption

Energy Behaviours:

- Use
- Investment
- Maintenance
- Self-control and monitoring
- Provision and management of energy resources

- **Influenced by multiple variables:**

  Personal, contextual, technological, environmental

- **Different energy stakeholders are interested:**

  Regulators, governmental and energy agencies, utilities, energy service companies, consumer associations, scientific community

Results: (2) Behavioural impact on energy consumption

Real case study

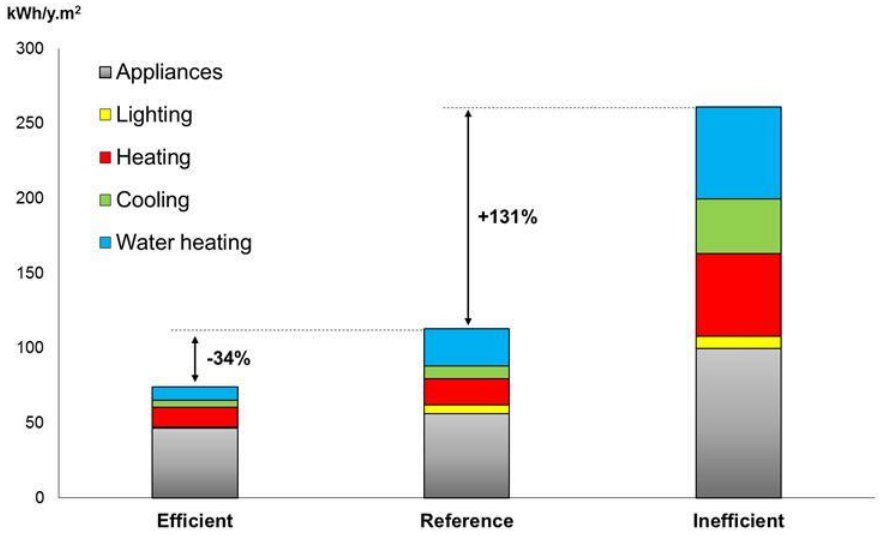
Behaviour & energy monitoring

A **multiple regression analysis** yielded a solution accounting for **60% of the variance of electricity consumption**:

1% Behaviour based on technical know-how

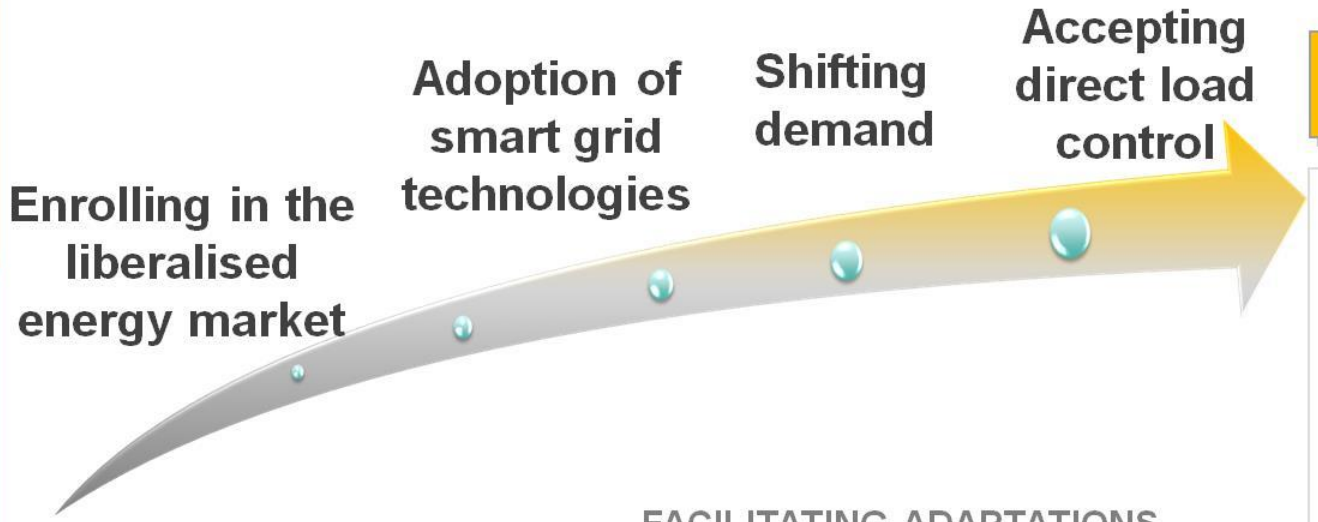
1.8% kWh/day

Building energy performance simulations



- **Wasteful** practices almost as **4 X more energy intensive than efficient** practices
- **Higher savings potential** associated with behavioural **investment practices**
- Potential of **usage practices is not negligible**

Results: (3) Behavioural changes to Smart(er) Grids



CURRENT CHANGES

34% Enrolled the liberalised energy market

7% Use energy monitoring devices

29% Control TOU

3% Prosumers and 3% own EV

FACILITATING ADAPTATIONS

71% Willing to adopt an "Energy Box"

68% Willing to shift energy demand

35% Accept direct load control

Key-Factors

- Financial incentives, value added and personalised services, and environmental protection
- Detailed feedback
- Not interfering with the household activities and override option
- Trust in the utility
- Regulation role
- Influence of the socio-economic context

Results: (4) Designing more effective behaviour change interventions

1. Previously understand each situation
2. Specify which energy behaviours to address
3. Involve the different energy stakeholders and reconcile their perspectives
4. Build a multidisciplinary team
5. Tailor the intervention using methods from different fields and keep it flexible and adaptive
6. Ensure adequate material, human and financial resources

Publications

2 Papers in peer-review journals
8 Full papers in conference proceedings
9 Abstracts in conference proceedings
2 Organisation of technical seminars
1 Organisation of International Conference

2016 ?

Lopes, M.A.R., Antunes, C. H., Reis, A., & Martins, N. **Estimating behavioural savings in dwellings using Building Energy Performance Simulations**. *Under revision*

Lopes, M.A.R., Antunes, C. H., Janda, K. B., Peixoto, P., & Martins, N. **The potential of energy behaviours in a smart(er) grid: Policy implications from a Portuguese exploratory study**. *Under revision*

2015

Lopes, M.; Antunes, C. H.; Martins, N. (2015). **Towards more effective behavioural interventions: an integrative modelling approach to residential energy consumption**. Energy Research and Social Science, 7 (0), 84-98. doi: 10.1016/j.erss.2015.03.004

Lopes, M.A.R.; Antunes, C. H.; Reis, A.; Martins, N. (2015). **Quantifying the savings potential associated with energy behaviours**. In: ENERGY FOR SUSTAINABILITY 2015 - SUSTAINABLE CITIES: DESIGNING FOR PEOPLE AND THE PLANET, Coimbra

Reis, A.; Lopes, M.A.R.; Martins, N. (2015). **Estimating the impact of occupant behaviour on energy consumption of small commercial and services buildings**. In: ENERGY FOR SUSTAINABILITY 2015 - SUSTAINABLE CITIES: DESIGNING FOR PEOPLE AND THE PLANET, Coimbra

2014

Lopes, M.; Peixoto, P.; Antunes, C. H.; Martins, N. (2014). **Facilitating energy behaviours transition to more sustainable patterns: findings from a case study**. In: BEHAVE 2014 – 3rd EUROPEAN CONFERENCE ON BEHAVIOUR AND ENERGY EFFICIENCY, Oxford, UK

Breda, M. & Lopes M. (2014). **Acceptation of a Demand-response Enabling Technology for using Electricity at Home upon a Simulated Marketing Campaign - Role of Sociodemographic Variables and Prior Energy Behaviours, in Tandem with Expectations and Attitudes Formed to the Message Target**. In: 3rd INTERNATIONAL CONFERENCE ON SMART GRIDS AND GREEN IT SYSTEMS, Barcelona, Spain. doi: 10.5220/0004941902960304

2013

Lopes, M.; Antunes, C. H.; Peixoto, P.; Martins, N.; Breda, M.S.J. (2013). **Energy behaviour changes during the transition to smart(er) grids: a key to foster higher levels of energy efficiency**. In: 1st ENERGY FOR SUSTAINABILITY MULTIDISCIPLINARY CONFERENCE - SUSTAINABLE CITIES: DESIGNING FOR PEOPLE AND THE PLANET, Coimbra

Breda, M.S.J. & Lopes, M. (2013). **Features of the measured attitude to accepting a demand-response enabling technology in using electricity at home and its role in forecasting intention and willingness to try**. In: 1st ENERGY FOR SUSTAINABILITY CONFERENCE 2013 - SUSTAINABLE CITIES: DESIGNING FOR PEOPLE AND THE PLANET, Coimbra

Lopes, M.; Antunes, C. H.; Martins, N.; Breda, M.S.J.; Peixoto, P. (2013). **Characterisation and modelling of energy behaviours**. In: 1st INTERNATIONAL CONGRESS ON ENERGY & ENVIRONMENT: BRINGING TOGETHER ECONOMICS AND ENGINEERING, Porto

Soares, A.; Lopes, M.; Gomes, A.; Antunes, C. H.; Martins, N. (2012). **Smart(er) Energy Management Systems in Smart(er) Grids**. In: INTERNATIONAL WORKSHOP ON ENERGY EFFICIENCY FOR A MORE SUSTAINABLE WORLD, Ponta Delgada

2012

Lopes, M. A. R.; Antunes, C. H.; Martins, N. (2012). **Energy behaviours as promoters of energy efficiency: A 21st century review**. Renewable and Sustainable Energy Reviews, 16(6), 4095-4104. doi: 10.1016/j.rser.2012.03.034



Behave 2016 - 4th European Conference on Behaviour and Energy Efficiency

8 - 9 September 2016

University of Coimbra, Portugal

Behave 2016 aims to bring researchers and practitioners involved in end-use energy efficiency to share recent research, new technological developments and best practices on understanding and influencing behaviour related to energy efficiency. Research on behaviours associated with energy use plays a fundamental role to achieve a more sustainable energy system, in face of challenges such as security of supply, climate change and evolution to the smart grids.

Contributions to Behave 2016 are expected to cover a wide range of topics related with energy efficiency and behaviours, namely:

- promoting sustainable energy behaviours: instruments, interventions and evaluation of behaviour change
- adoption and use of low carbon technologies
- behavioural potential to facilitate the smart grid and demand response
- end-use energy efficiency in buildings and organisations
- behaviour in transport and mobility
- behaviour integration into energy modelling
- multidisciplinary approaches to energy behaviours
- energy policies for promoting behaviour change

www.inescc.pt/behave2016

Thank you for your attention!

Contact Details

Marta Lopes (mlopes@esac.pt)
IPC-ESAC, INESC Coimbra

ACKNOWLEDGMENT

Energy for Sustainability Initiative of the University of Coimbra

Fundação para a Ciência e a Tecnologia (FCT) for the doctoral grant SFRH/BD/51104/2010, and projects grants MIT/SET/0018/2009 and UID/MULTI/00308/2013

Energy and Mobility for Sustainable Regions Project (CENTRO-07-0224-FEDER-002004

Energy Box R&D team

INESC Coimbra

CES Centre for Social Studies

ISA Intelligent Sensing Anywhere

AMES Sintra Municipal Energy Agency

Lisboa E-Nova Lisbon Municipal Energy and Environmental Agency

IPC-ESAC Agriculture College of Coimbra