ICT instruments in multi-apartment buildings:
Efficiency and effects on energy consumption behaviour

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Overview

- Introduction of the BECA project
- Design of the field trials
- Evaluation approach
- Main Results of the field trials ➔ Effectiveness
  - Impact on energy/resources consumption
  - Impact on energy behaviour
- Conclusions and outlook

Introduction of the BECA project

- BECA – Balanced European Conservation Approach
- Funded by European Commission within ICT PSP Programme 2011-2014
- Core element: Development and implementation of ICT based services in social housing
- Objectives:
  - Reduce energy / water consumption in private households
  - Increase ecological awareness and knowledge of tenants
  - Encourage tenants to improve their everyday energy behaviour

➔ Filling research gap regarding effectiveness and efficiency of ICT feedback instruments related to energy behaviour

Design of the field trials

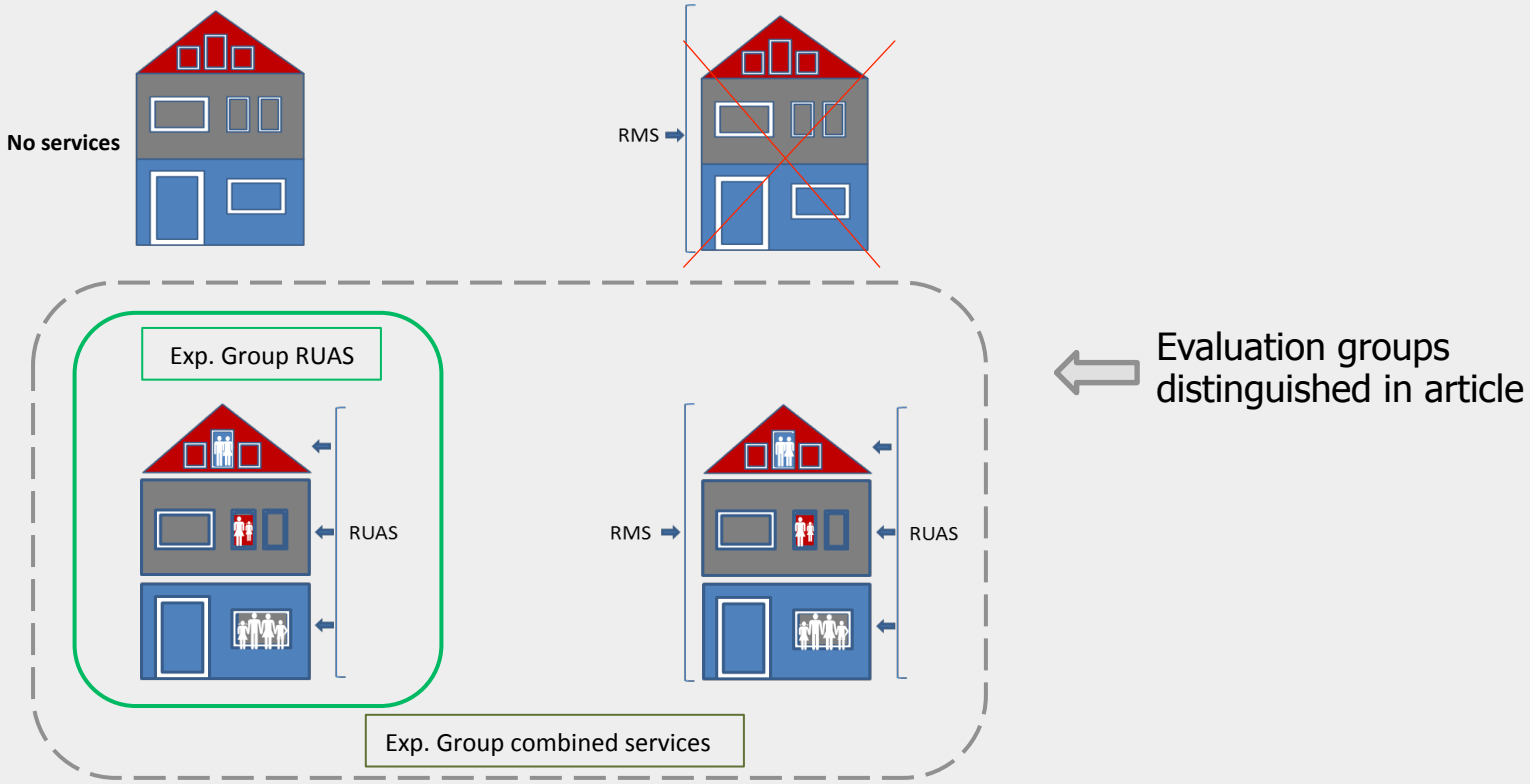
- Implementation of 2 kinds of services at 7 pilot sites in 7 European countries (in 1,500 dwellings in total)

- RMS: Resource Management Services
  - Monitoring system in order to ensure error-free operation of techn. infrastructure, optimise components, give maintenance warnings
  - At some pilot sites: automated features for optimising heating system

- RUAS: Resource Use Awareness Services
  - Feedback instruments (web, paper-based)
  - Monthly comparative/historic feedback, energy saving tips, additional educational material, workshops/trainings

Evaluation Approach

- Quasi-experimental design: pre-post comparisons and comparisons with control groups
- Pilot Sites either implemented both services in the same set of dwellings or implemented one of the services in a set of dwellings; buildings/dwellings without provision of services served as control group



Evaluation Approach

- Multivariate analyses carried out at 2 levels:
  Level 1: energy consumption based on metered data
  Level 2: energy behaviour based on panel survey data

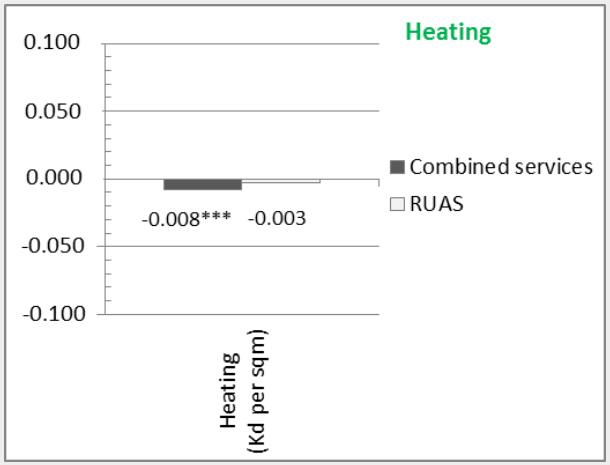
- Dependent variables:
  - Level 1: annual energy consumption savings (calculated based on adjusted values)
  - Level 2: individual change of behaviour for specific statements (surveyed at 2 stages, binary variables)

- Control variables:
  - User-related aspects
  - Local circumstances
  - Initial situation before service introduction

➔ Helps to identify the net impact of the services = influence solely caused by the services (and not by programme-external factors)

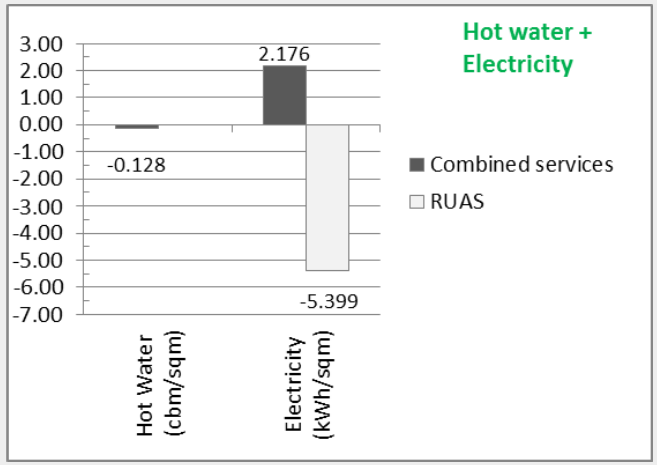
Results – Impact on energy consumption

Parameter estimates of OLS regressions (treatment variables)



N= 264 / 207
* indic. significance at p < 0.1, ** at p < 0.05 and *** at p < 0.01.

- Both service types lead to increased savings (against control group)
- Combined services show bigger and statistically significant impact
- Effects are rather small



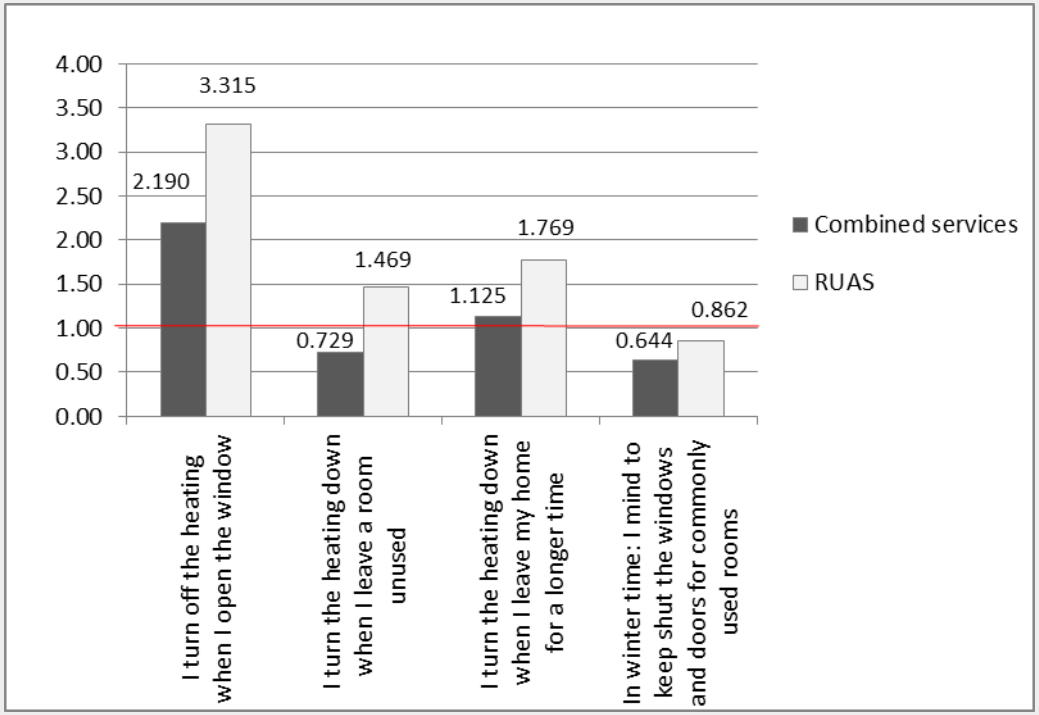
Hot water: N= 219; Electricity; N= 177 / 104

- Combined services lead to hot water savings
- RUAS leads to big electricity savings
- Combined services lead to increased electricity consumption
  ➔ one pilot using electr. for heating

➔ Services generally lead to higher savings against control group
➔ Results are mostly not statistically significant and modest values for R^2
➔ Effects are rather low for heating, but meaningful for hot water and electricity

Results – Impact on behaviour: Heating

Odds ratios for improved behaviour (Exp(b) by treatment type)



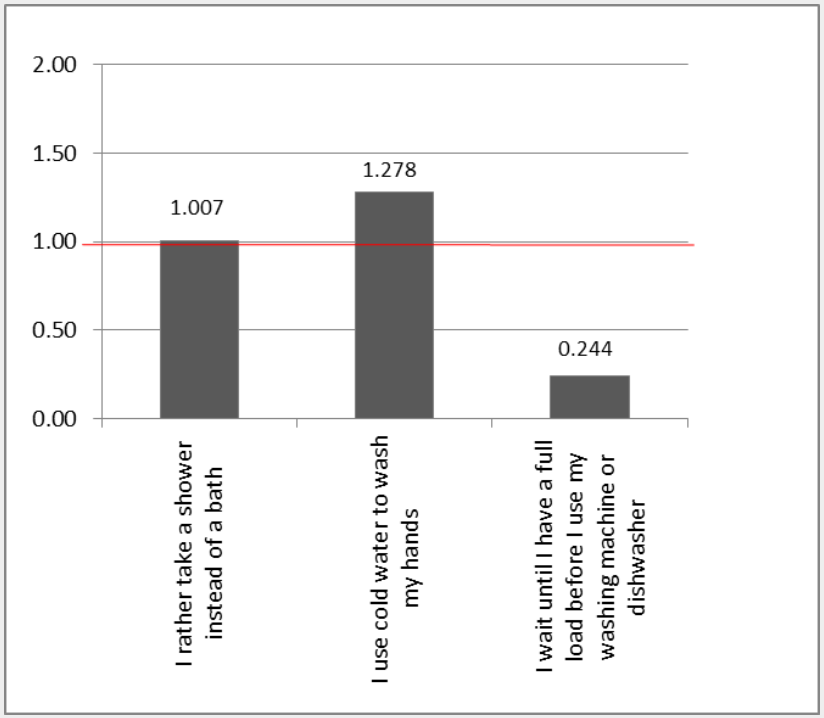
N= 112 / 95; 94 / 75; 61 / 53; 98 / 90

- Mostly positive influences of services
- RUAS is more succesful than combined services
  - more statements with improvement
  - Stronger effects
- Indication of rebound effects in combined services group
- Strongest RUAS effect for: „I turn off the heating when I open the window“
- Results not statistically significant, probably due to low sample sizes
- More than 40% explained variance for models with positive effects

➔ RUAS helps to optimise energy behaviour related to heating
➔ Results are not statistically significant, but good model fit
➔ Meaningful effects from RUAS, however effect sizes differ in kind of behaviour

Results – Impact on behaviour: Hot water

Odds ratios for improved behaviour (Exp(b) for combined services)



N= 59; 158; 72

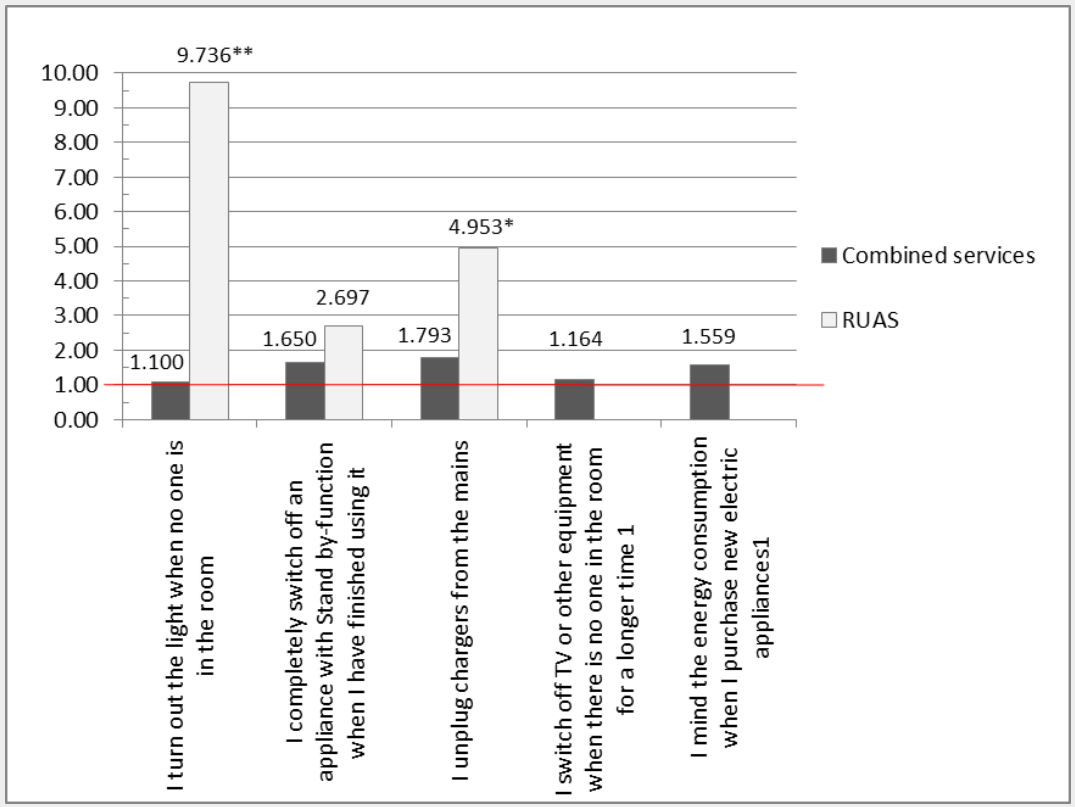
- Positive influence only for one behaviour statement
- Results not statistically significant, probably due to low sample sizes
- Explained variance varies between 34% and 63%

➔ No meaningful effects of combined services on behaviour related to hot water consumption

➔ Effects found for hot water consumption might be due to further kinds of behaviour

Results – Impact on behaviour: Electricity

Odds ratios for improved behaviour (Exp(b) for treatment types)



- Positive influence in all cases
- Stronger effects for RUAS than for combined services
- Effects vary largely in kinds of behaviour
- Strongest effect: by factor 10 increased chance to improve behaviour related to „turning out lights when no one is in the room“
- Two effects even statistically significant
- Explained variance between 35% and 65% in 7 cases

N= 80 / 62; 150 / 109; 91 / 69; 94; 119
[1] Impact for RUAS could not be investigated due to low sample sizes.
* indicates significance at $p < 0.1$, ** at $p < 0.05$ and *** at $p < 0.01$.

➔ RUAS helps to optimise behaviour related to electricity
➔ Although effects vary largely, striking and partly significant effects for RUAS

Conclusions and open questions

- Based on a sophisticated evaluation approach BECA results confirm positive influences of feedback instruments on energy consumption also found in previous studies
- BECA results suggest net impacts of feedback services for sets of behaviour related to heating and electricity; especially caused by RUAS
- Behaviour related to hot water was not considerably improved by services

- Open questions:
  - Do results also apply to a broader target group / differences for subgroups of users?
  - Related to kinds of behaviour which have not been optimised: would they have been optimised by a „better“ feedback tool or are they just not influenceable?
  - Does optimised behaviour result in visible energy savings?
    - ➔ Which kinds / sets of behaviour are most relevant?
    - ➔ Dependence from building types?

Thank you for your attention!

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Further information about BECA you can find at
http://beca-project.eu/home/