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Introduction

- Program evaluation is an outcome of the PhD project: „**Cost-benefit analysis of energy efficiency programs in liberalized electricity and gas markets**“
- Collaboration between **Wuppertal Institute** and **EDF R&D**

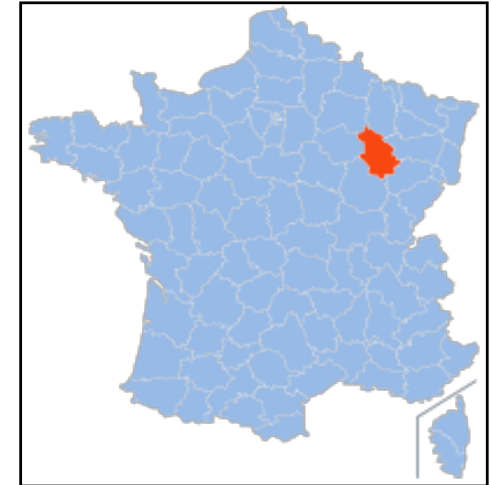


European Centre and Laboratories for Energy Efficiency Research

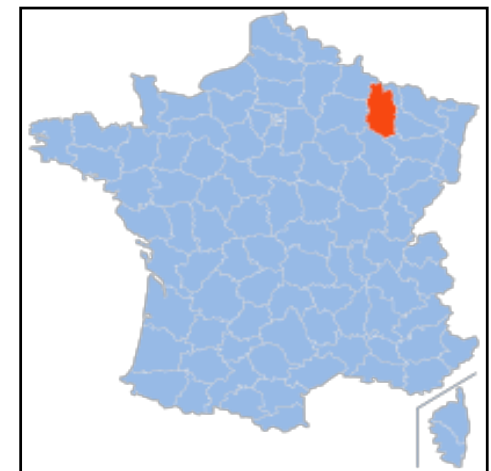
- **Objective:** Analysing the cost-effectiveness of the „MDE 52-55“ program from 3 perspectives
 - a) the program participant
 - b) the society
 - c) the energy company (EDF)

The MDE 52-55 program

- MDE 52-55 energy efficiency program promoted by EDF in the residential sector of Haute-Marne and Meuse
- Total MDE 52-55 program budget: 20 Mio € over 5 years
- Background:
 - Large energy savings potential in rural regions in the east of France (dwelling stock is comparably old, often not refurbished yet and mainly oil and wood heated)
 - EDF obliged by the French White Certificate scheme



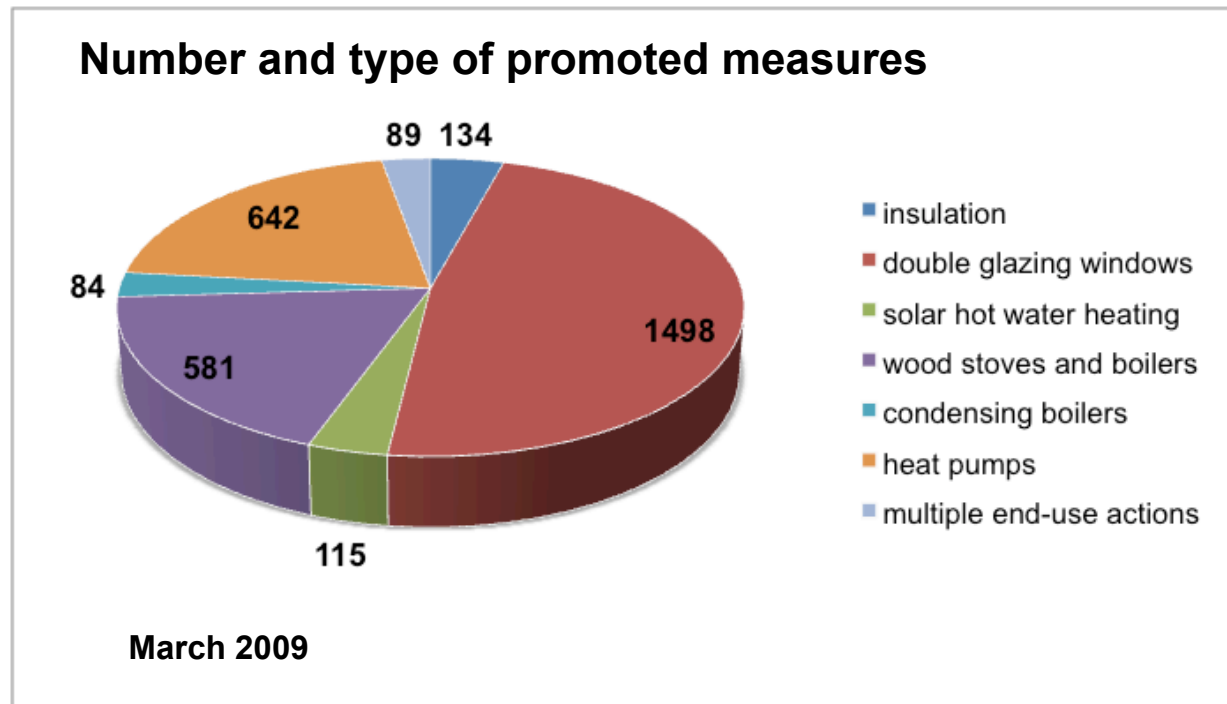
Haute-Marne 52



Meuse 55

The MDE 52-55 program

- EDF promotes several energy efficiency improvement measures by providing
 - information about energy saving opportunities and refurbishment advices to households
 - training courses and certification for local installation contractors and building firms
 - financial incentives for households, i.e.
 - a) interest free loans
 - b) bonus payments



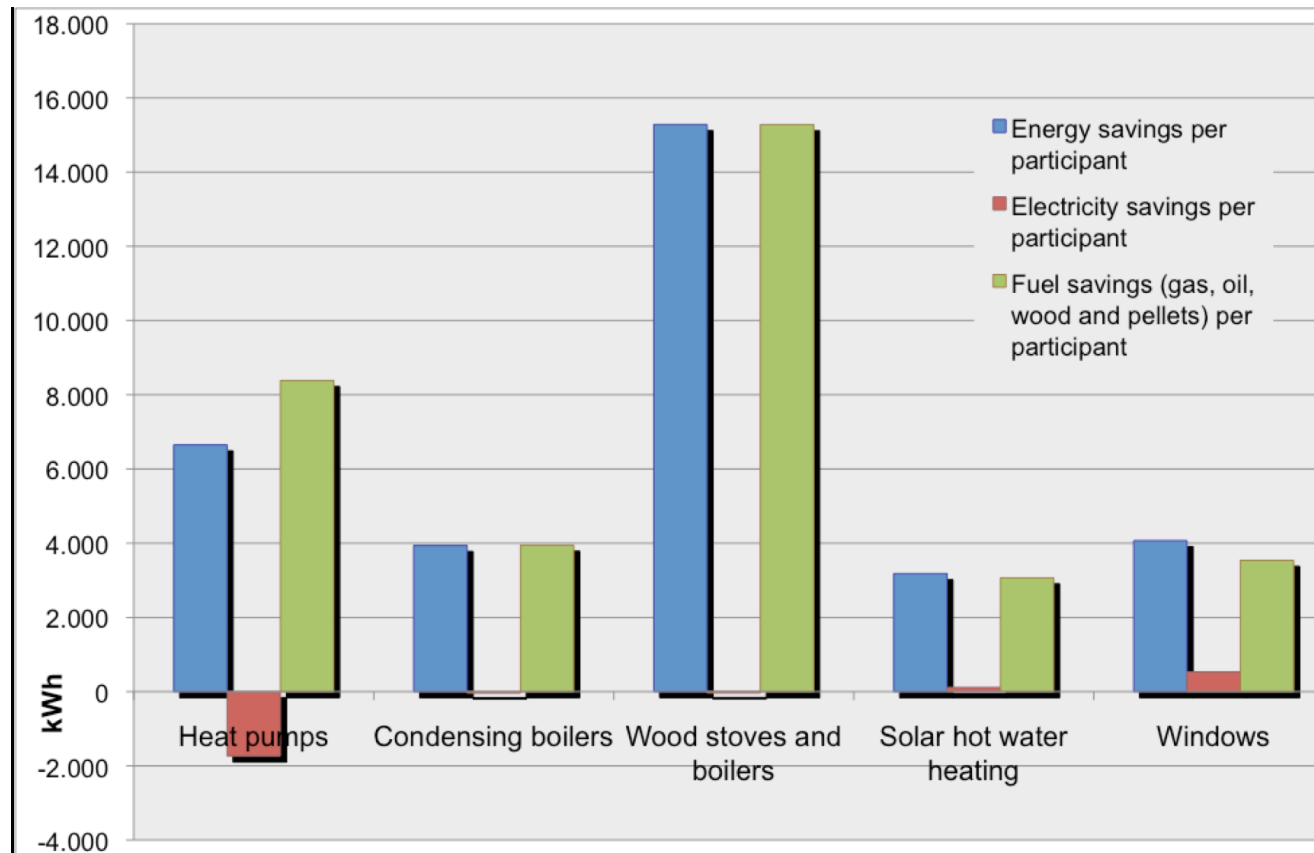
Energy savings – calculation

Billing analysis based on a survey that covers around 10% of all participants at the time of evaluation

Calculation steps:

1. Estimating the share of electricity and fuel consumption that is used in Haute-Marne and Meuse for space heating
2. Temperature normalization (using département specific heating degree days) of the pre-retrofit and post-retrofit energy consumption
3. Comparing pre-retrofit/normal retrofit to post-retrofit energy consumption

Energy savings – results (1)



- Heat pumps & condensing boiler: incremental savings
baseline: low temperature boiler
- All other measures: full savings

Energy savings – results (2)

- Significant **rebound effect**:
 - average indoor temperature increase of $\approx +1.5^{\circ}\text{C}$ after retrofitting
→ Rebound effect included in the results of the billing analysis
- **Uncertainty** about the level of the savings:
 - Moderate sample size
 - No control group available of similar customers who did not participate in the program
- **Gross annual program savings**:
 - 20.000 MWh of annual program savings taking into account the 3.143 participants in March 2009 (End of 2009 > 8.000 participants)
 - Wood stoves and boiler: 8.879 MWh annual savings
 - Windows: > 6.000 MWh annual savings
 - Heat pumps: > 4.000 MWh annual incremental savings
- **Gross-to-net correction factors** not taken into account due to lack of data

Benefit and cost components

Perspective	Benefits	Costs
EDF - integrated electricity generation and retail supply company	<p>Avoided energy supply system costs (wholesale prices, T&D tariffs)</p> <p>Additional energy sales revenue (in case of increased energy sales; net of taxes and T&D tariffs)</p> <p>Avoided penalties of the FWC scheme</p>	<p>Additional energy supply system costs (in case of increased energy sales; wholesale prices, T&D tariffs)</p> <p>Lost marginal revenue (net of taxes and T&D tariffs)</p> <p>Incentive payments to program participants (bonus payments and capital costs of interest free loans)</p> <p>Program overhead costs</p>
Program participant	<p>Energy bill savings (incl. taxes)</p> <p>Incentive payments (received bonus payments and avoided capital costs of interest free loans)</p> <p>Tax credits</p>	<p>(Incremental) costs of the energy efficiency improvement measure (incl. VAT)</p>
Society	<p>Avoided energy supply system costs (wholesale prices, T&D grid losses)</p> <p>Avoided external environmental costs</p>	<p>Additional energy supply system costs (in case of increased energy sales; wholesale prices, T&D grid losses)</p> <p>Additional external environmental costs (in case of increased energy sales)</p> <p>(Incremental) costs of the energy efficiency improvement measure (excl. VAT)</p> <p>Program overhead costs</p>

Cost-effectiveness analysis

- Levelized costs of conserved energy (LCCE) in cent/kWh allow a direct comparison with the avoidable costs of the energy supply system

$$LCCE = \frac{(NPV \times CRF)}{\text{annual savings}}, \text{ with } CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

NPV = net present value
CRF = capital recovery factor
i = real discount rate
n = useful measure life (years)

- Discount rate assumption:
 - Program participant: 8 %
 - Energy company: 8 %
 - Society: 3%
- Results are expressed in benefit-cost ratios (BCR)
BCR > 1 → program cost-effective!

Results from the program participant perspective

Measure type	Heat pumps	Condensing boilers	Wood stoves and boilers	Solar hot water heating	Windows
Lifetime	16	16	15	15	35
(Incremental) costs of efficient end-use action [Euro/kWh incl. VAT]	0.1302	0.0561	0.0727	0.2825	0.1454
<i>Bill savings</i> [Euro/kWh]	0.0579	0.0640	0.0495	0.0668	0.0640
<i>Incentive payments</i> [Euro/kWh]	0.0683	0.0877	0.0215	0.0745	0.0190
<i>Tax credits</i> [Euro/kWh]	0.0647	0.0469	0.0247	0.1130	0.0309
Total benefits [Euro/kWh]	0.1909	0.1985	0.0957	0.2542	0.1139
Benefit-cost ratio	1.47	3.54	1.32	0.9	0.78

- Potential increases of the property value and comfort gains for customers not considered
→ calculations assume that the refurbishment is only done for the sake of energy efficiency
- Assumption of full costs and savings is critical
- Without the governmental tax credits, all measures except from condensing boilers not cost-effective!

Results from the societal perspective

Measure type	Heat pumps	Condensing boilers	Wood stoves and boilers	Solar hot water heating	Windows
Lifetime	16	16	15	15	35
<i>(Incremental) costs of efficient end-use action [Euro/kWh excl. VAT]</i>	0.0762	0.0330	0.0436	0.1693	0.0659
<i>Overhead program costs [Euro/kWh]</i>	0.0043	0.0055	0.0058	0.0058	0.0032
Total costs [Euro/kWh]	0.0806	0.0385	0.0494	0.1751	0.0692
<i>Avoided system costs electricity and fuels [Euro/kWh]</i>	0.0223	0.0381	0.0347	0.0385	0.0390
<i>Avoided environmental costs from fuel emissions [Euro/kWh]</i>	0.0036	0.0044	0.0025	0.0044	0.0030
Total benefits [Euro/kWh]	0.0260	0.0425	0.0372	0.0429	0.0420
Benefit-cost ratio	0.32	1.10	0.75	0.24	0.61

- Avoided energy supply system costs and avoided external environmental costs are determined by assuming constant future energy and carbon prices
- For windows, incremental costs and savings may be more appropriate than full costs and savings, and may lead to cost-effective savings; however, evaluation was not possible

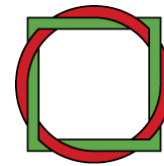
Results from the perspective of EDF

Measure type	Heat pumps	Condensing boilers	Wood stoves and boilers	Solar hot water heating	Windows
Lifetime	16	16	15	15	35
Incentive payments [Euro/kWh]	0.0683	0.0877	0.0215	0.0745	0.0190
Overhead program costs [Euro/kWh]	0.0062	0.0078	0.0080	0.0080	0.0059
Lost marginal revenue electricity [Euro/kWh]	-0.01534	-0.00018	0.00002	0.00263	0.00969
Avoided system costs electricity [Euro/kWh]	-0.01385	-0.00016	0.00001	0.00237	0.00875
Avoided penalties of the FWC scheme [Euro/kWh]	0.0178	0.0554	0.0122	0.0111	0.0148
Benefit-cost ratio	0.38	0.58	0.41	0.16	0.68

- Promotion of all MDE 52-55 energy efficiency improvement measures is not cost-effective for EDF to fulfill its saving obligations, as no cost-recovery mechanism for program costs exists in France
- But non-energy benefits for EDF neglected in the calculation
 - Customer retention
 - Image improvement

Conclusions

- **It will be possible** to calculate cost-effectiveness and benefit/cost ratios in liberalised markets for different types of energy companies, society, and the customers ...
- ... **if the data are available!**
- **Critical data factors:**
 - Incremental costs and savings of technical measures: do joint research for all government and energy company programs?
 - Program overhead costs (in principle, easy to track if done right from the start)
 - Free-rider and spill-over effects (costly surveys?)
 - In case of billing analysis: control group of similar customers who did not participate in the program
 - Avoided system costs – even easier in liberalised markets due to the existence of a power exchange!



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and Energy

Many thanks for your attention!

Your comments and suggestions are
very welcome:

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Further information on energy efficiency
services and programmes at:

www.wupperinst.org/energy-efficiency