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Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services

# Top-down evaluation methods and example of applications: thermal uses in residential buildings

Bruno Lapillonne, Enerdata
Nathalie Desbrosses, Enerdata
Johanne Buba

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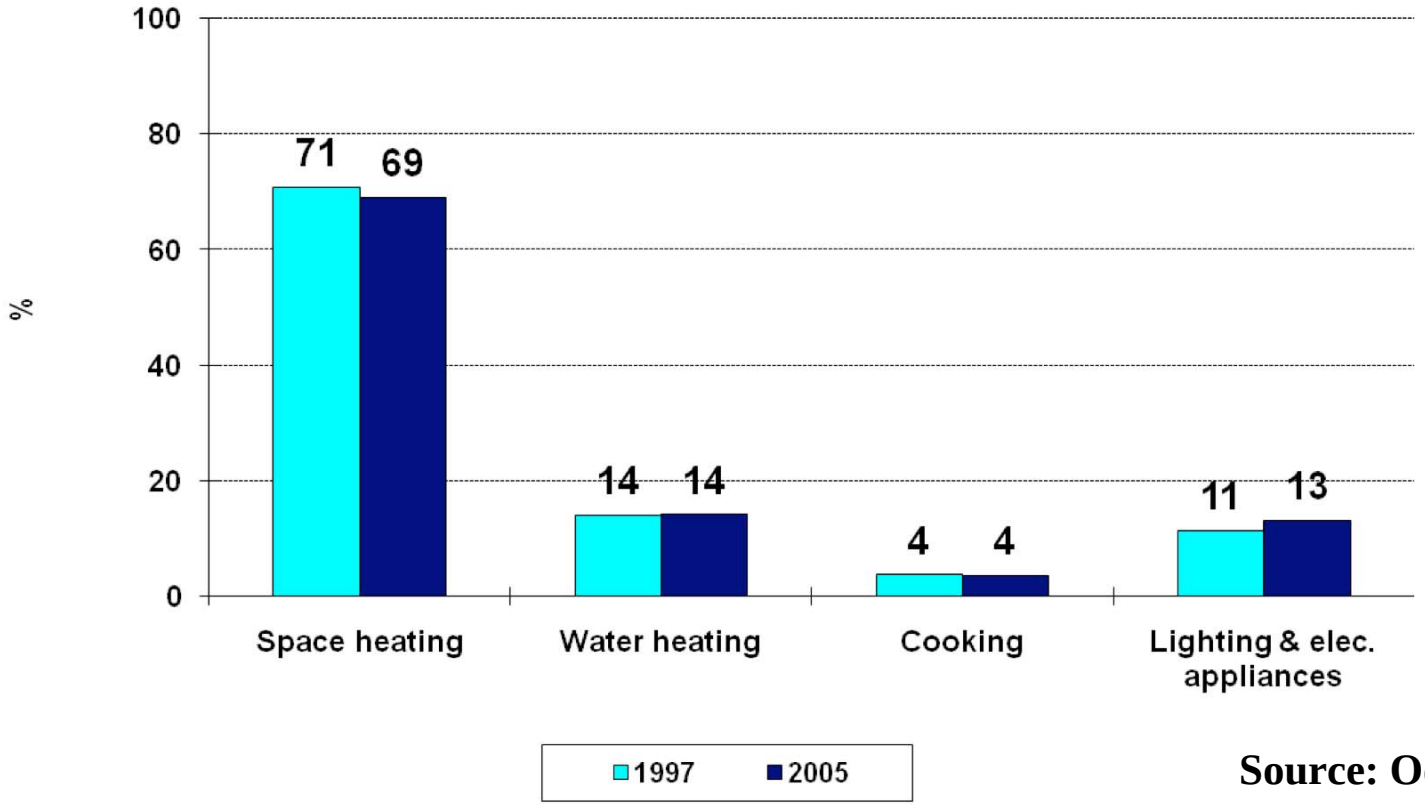
# EMEEES case studies with top-down methods: two main end-uses considered here: space heating and solar thermal

| | |
|---|---|
| 1 Building shell & heating (households) | Heat consumption per m2 |
| 2 Household electricity uses | Specific consumption (kWh/dwelling) |
| 3 Specific white goods (refrigerators) | Specific consumption (kWh/dwelling |
| 4 Solar thermal collectors | m2 installed |
| 5 Building shell & heating in tertiary sector | Energy use per employee/m2 |
| 6 Electricity end-uses in tertiary sector | Electricity use per employee/m2 |
| 7 Industrial thermal energy use | Energy use per output |
| 8 Industrial electricity consumption | Electricity use per output |
| 9 Industrial CHP | Share of electricity cogenerated |
| 10 New cars | Specific consumption (l/100 km) |
| 11 Car, bus and truck stock improvement | Specific consumption (l/100 km) |
| 11 Modal shift in passenger transport | Share of public transport |
| 13 Modal shift in goods transport | Share of rail & water transport |
| 14 Energy taxation | ODEX or final energy intensity |

# Thermal uses for household: more than 80% of the energy consumption in the EU, of which about 70% for heating and 14% for water heating ==> important end-uses for energy savings evaluation

**Distribution of household energy consumption by end-uses in the EU-27***




**Source: Odyssee**
**www.odyssee-indicators.org**

*** at normal climate**

# Estimation of energy savings for thermal uses for households

- Indicators used to measure 'total' energy savings:

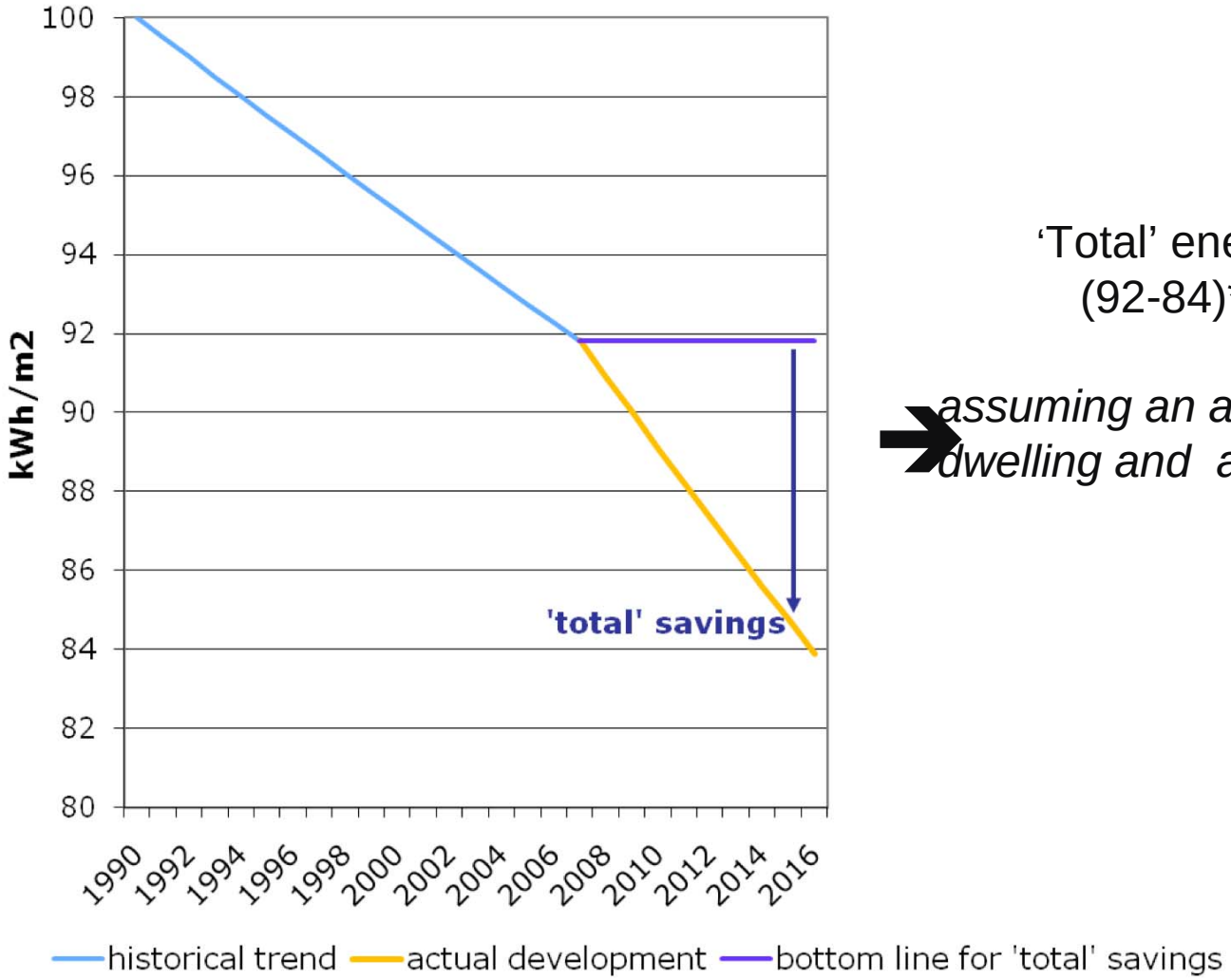
  - Space heating: heating consumption per m² with climatic correction* ➔ 'total' energy savings due to a reduction in heating consumption per m2 between 2007 and 2016

  - Water heating (solar water heaters) : diffusion of solar water heaters (in terms of installed stock in $m^2$) ➔ energy savings calculated from the variation in the number of $m^2$ between 2007 and 2016 multiplied by a coefficient kWh or toe/$m^2$

**Source of data: Odyssee for space heating, ObservEr for solar**
**www.odyssee-indicators.org**

***additional correction for shift from room to central heating also made in southern countries***

# Calculation of ‘total’ energy savings for space heating: example




‘Total’ energy savings in 2016 =
(92-84)*100*5 = 4000 GWh

➔ *assuming an average size of 100 m2 per dwelling and a stock of 5 M dwellings*

# Calculation of top-down energy savings

Simple calculation... but

- Additional refinement of methodology considered but not presented here for sake of simplicity (not accounting for negative behavioural savings for heating, use of 3 years moving average instead of yearly data)

- Are all these savings to be accounted for? .... It depends on the interpretation of the Energy Service Directive

# From ‘total’ energy savings to ESD additional savings

- Total energy savings are explained by different factors:
  - Facilitating measures (e.g. building regulations, economic and fiscal incentives)
  - But also:
    - ✓ Autonomous trend due to the fact that independently of any facilitating measures some dwellings are renovated and boilers replaced with new ones
    - ✓ Reactions of consumers to fuel price increases

- EMEEES has looked at the possibility of calculating the additional savings linked to facilitating measures and thus to correct the total energy savings for the effect of autonomous trend and market price increase (the energy savings linked to energy taxation are included in the additional savings)

- Method used: econometric modelling

# Modelling of heating consumption and solar water diffusion

- Modelling of heating consumption per $m^2$ through regression analysis with 2 main variables:
  - Time to capture an autonomous trend
  - Average fuel price

  (and possibly private household consumption to capture household income)

$$Ln(RBS) = T \times t + A \times \ln(P) + B \times \ln(I) + K$$

T: trend; A: price elasticity (>0 ) ; P: average fuel price; B : income elasticity; I : income

- Modelling of installed capacities of solar water heaters with 2 variables:
  - Time to capture an autonomous trend
  - Average energy price

$$Ln(IC) = T \times \ln(t) + A \times \ln(P) + K$$

IC : Installed capacities of solar collector (m2/1000 inhab); T : trend; A: price elasticity (>0 as price increase should increase penetration of solar water heaters); P: Average price for sanitary water heating

- The energy savings associated to price changes are then split into two components: energy savings linked to energy tax and savings linked to market price change

# Modelling of heating consumption and solar water diffusion: lessons from the correction for price effect and trend

- Econometric regressions did not give good results for the price elasticity:
  - Wrong sign or
  - Not statistically significant
- Why?
  - At the beginning of the period price often decreasing or stable➔ difficult to measure the reaction of indicators to price variation
  - Increase price at the end of the period often overlaps with policy facilitating measures ➔ price elasticity capture the effect of policies and are not relevant any more (case of solar)
- Use of default value for the price elasticities, for instance : 0.1

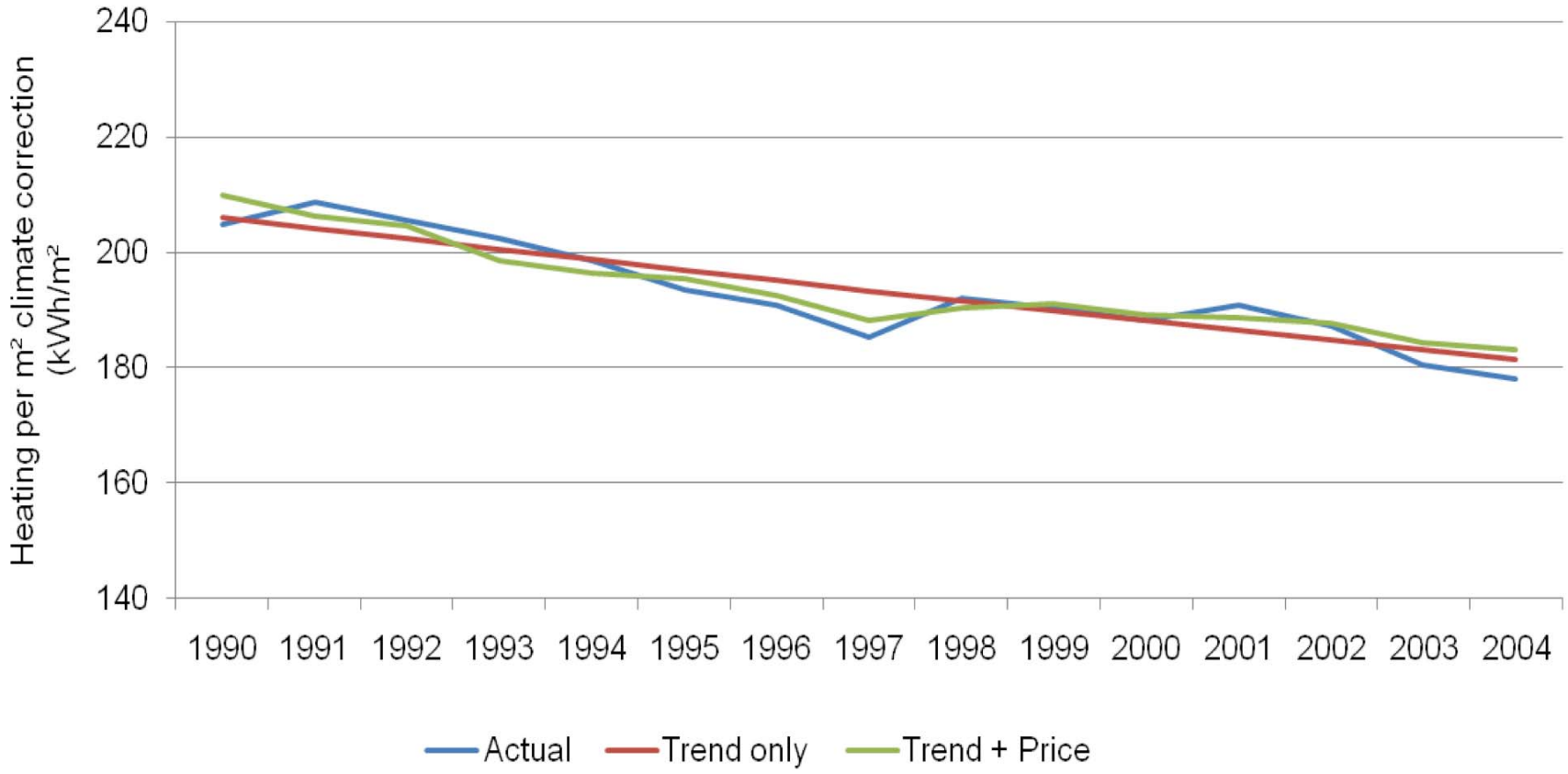
- Trend include true autonomous trend, but also the effect of previous policies ("early savings") ➔ separation not easy when continuous measures over time (case of heating and solar in some countries with mature markets (eg Cyprus, Germany or Austria)

# Modelling of heating consumption: how to measure the trend and price effect: example

- Example of regression (with a lag time of 2 years for the fuel price)**:**

  $\ln(RBS) = -0.025\ t - 0.086\ \ln(P) + 0.88\ \ln(I) - 8.5$

- Elasticity of around - 0.1 in this case; not always meaningful



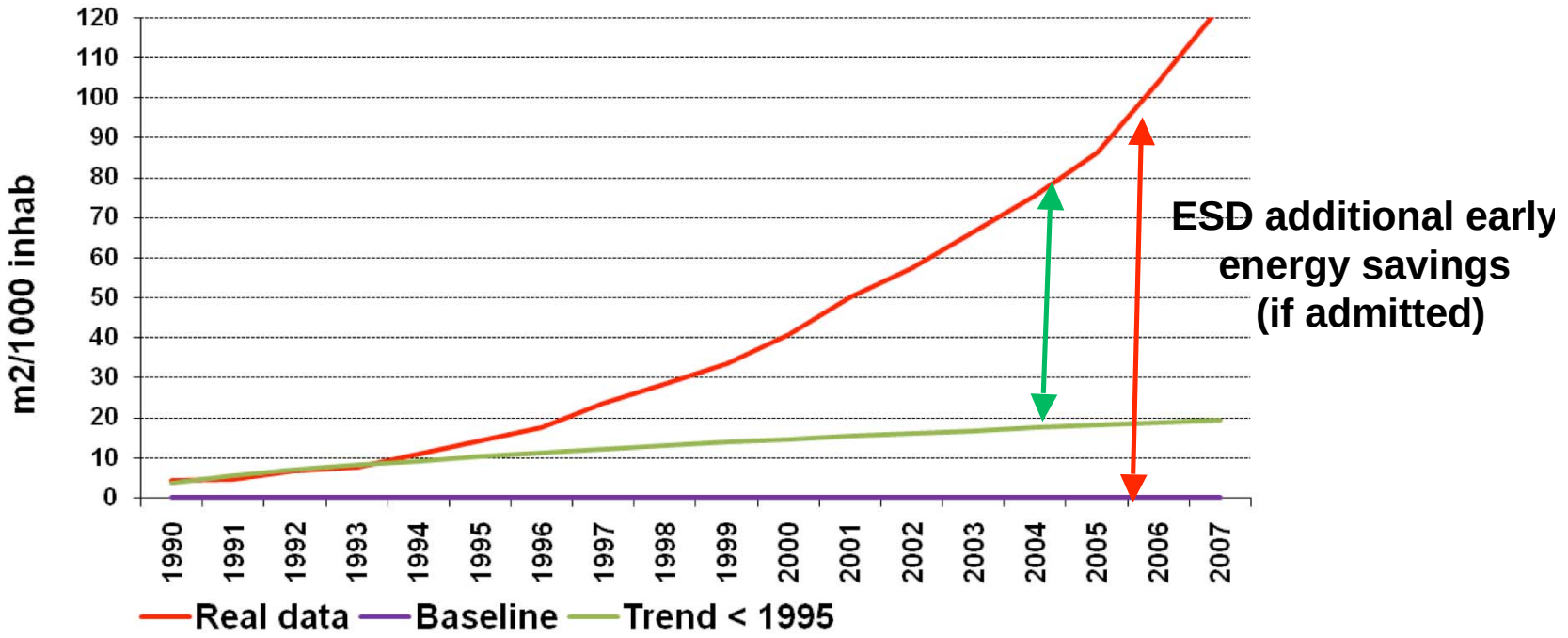
# Modelling of the diffusion of solar water heaters: example

➢If all the diffusion is assumed to be linked to policy measures (recent measures and “early measures”)

➔no autonomous trend considered (=> bottom line equal to zero)

➔ESD additional energy savings equal total energy savings (red line)

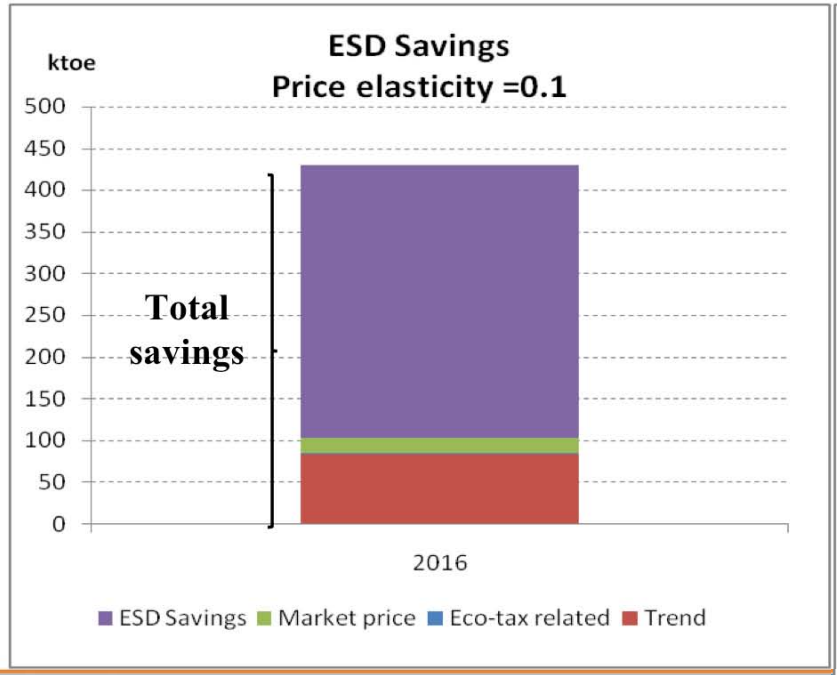
➢If an autonomous trend is considered (eg trend < 1995 ➔ESD additional energy savings will decrease (green line)

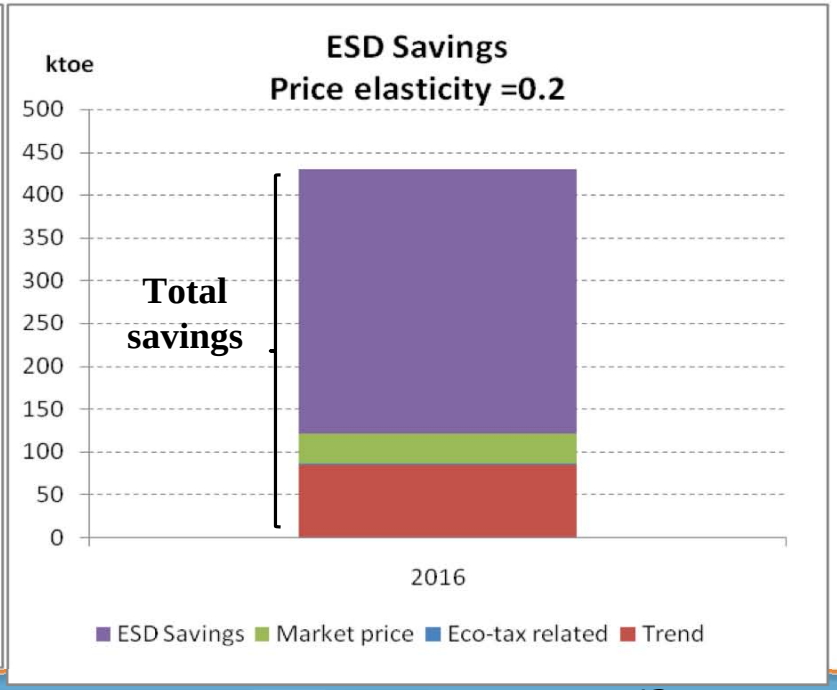


# From the indicator variation to ESD savings; sensitivity of the results to default price elasticity : case of solar

- Total energy savings are derived from m2 and ratio toe/m2 (430 ktoe)
- If autonomous trend considered (trend < 1995), ESD savings = 77% of total (330 ktoe )
- Market prices contribute for 5% of total energy savings with a price elasticity of 0.1 (of which 0.2% due to ecological tax); with a price elasticity of 0.2, decrease of ESD savings by 6%

**Total and ESD energy savings:**
**case of solar with correction for trend and market price**



# Conclusion

- Total savings can be calculated through top-down methods provided the statistical data are available: space heating consumption not yet available for all countries however this situation is improving.

- Econometric regressions did not give good results: assessment of autonomous trend and price effect not robust for most countries ➔ use of default value rather than national data

- Several options for correction are possible and have been tested in EMEEES, decision as to final correction of total savings to measure additional savings still to be decided

- Evaluation of savings are dependant on the quality of data➔ this should be reflected with a qualification of the uncertainty of the savings evaluation (e.g. qualitative assessment with 3 grades in Odyssee)

Thank you, for more information:

bruno.lapillonne@enerdata.fr

Enerdata, France

www.odyssee-indicators.org

For the assessment of energy efficiency trends and total energy savings by country

www.evaluate-energy-savings.eu

with a presentation of these two case studies in more detail and other top-down case studies, plus a description of the methodology and a 20 pages summary report