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

Selected case studies on top-down methods

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Introduction to case studies

- Three case studies corresponding to each of the 3 types of indicators:
  - ✓ New cars (specific energy consumption of a well identified equipment) ➔ total energy savings calculated from reduction in specific energy consumption of the equipment (l/100 km, kWh/appliance)
  - ✓ Modal shift (market diffusion of energy efficient technology or practice) ➔ total energy savings calculated from increase in market share
  - ✓ Electricity uses in the service sector (unit energy consumption of a sub-sector) ➔ total energy savings calculated from change in the unit energy consumption trend of the sub-sector

New cars

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Relevant variables to estimate energy savings for new cars

- ➢Indicators used to measure energy savings: change in the test specific consumption of new cars sold every year in litres/100km

- ➢change in the test specific consumption of new cars can be explained by the following factors/variables :
  - Change in the average size of vehicles (in terms of weight, or horse power or engine size in cm3)
  - Autonomous trend (in technical efficiency)
  - Motor fuel price
  - EU policy (ACEA/JAMA/KAMA agreement) and national energy policy measures (tax on motor fuels, subsidies/ tax on vehicles): after 1995/ before 1995

➔Effect of change in the size of vehicles:

- "hidden structure effect" if trends towards larger or more powerful cars ➔ energy savings are underestimated);
- part of savings if trends towards smaller or less powerful cars as a result of policies

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Variables used to model energy savings for new cars

- Modelling of the specific consumption of new gasoline and diesel cars separately* (SC) (in litre/100km/cm^3* or litre/100km), with two variables :
  - Time to capture an autonomous trend
  - Average price of gasoline and diesel

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

  - ✓ SC: specific consumption of new cars in litre/100km/cm^3 or in litre/100km/kW
  - ✓ T: trend
  - ✓ A: price elasticity (<0)
  - ✓ P: motor fuel price

- The energy savings associated to price changes will then be split into two components: energy savings linked to tax increase (policy related) and savings linked to change in crude oil price (market related)

* To clean the effect of fuels substitution between gasoline and diesel on the average specific consumption

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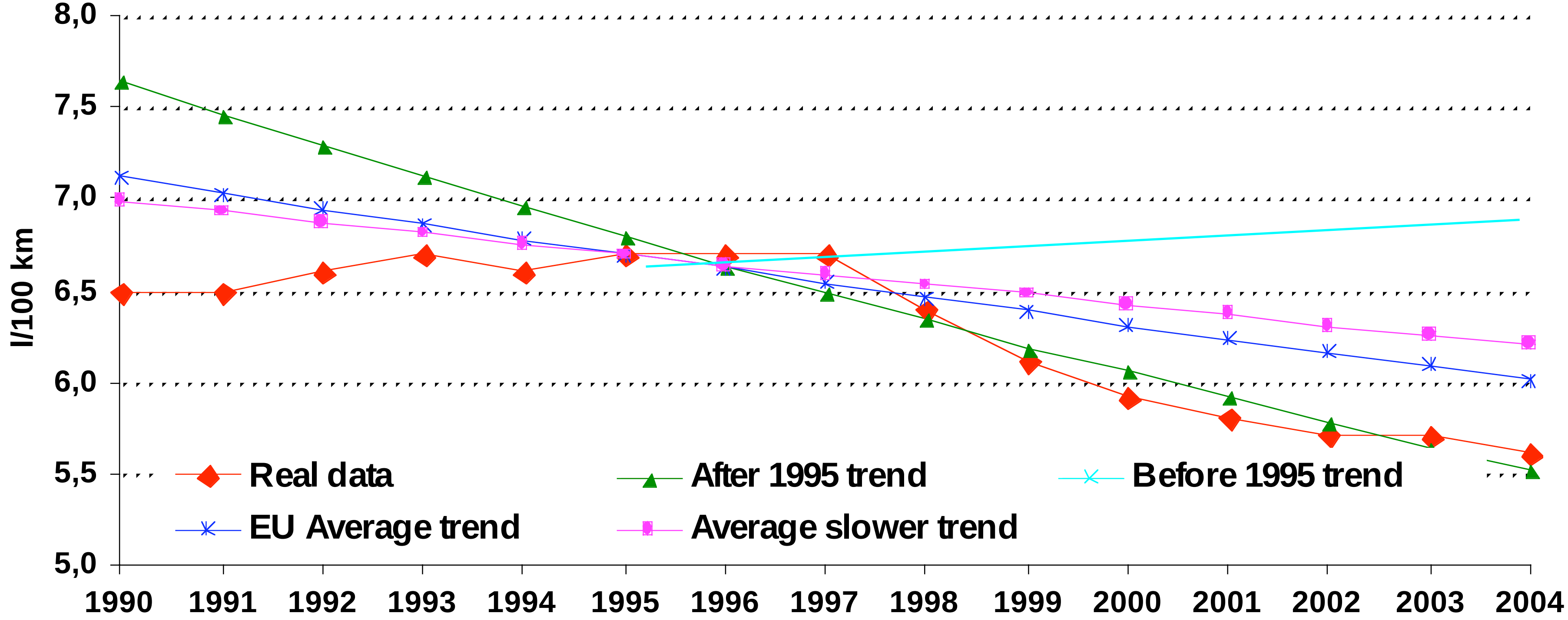
Econometric analysis (1/2)

Which autonomous trends to be considered as baseline?

- **Trend before 1995** (ie before the ACEA/JAMA/KAMA agreement) **("before 1995 trend")**
- **Trend since 1995 ("after 1995 trend")➔ reference used in the following case studies**
- **EU average trend =** > -1.1%/year for diesel
- **Trend of the average of the 3 countries with the lowest autonomous trend ("average slower trend")**

Specific consumption of new diesel cars (France)



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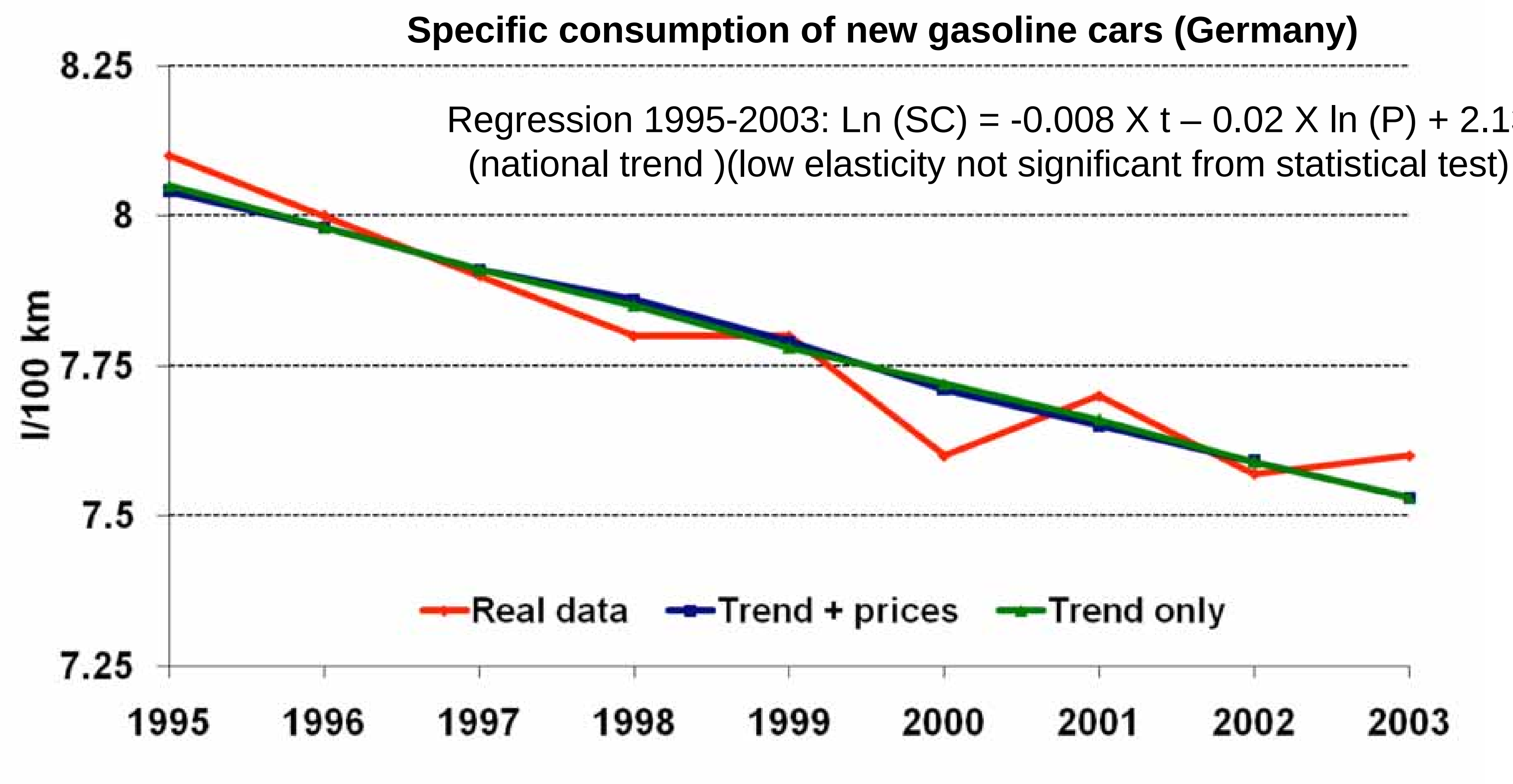
Econometric analysis (2/2)
Assessment of the impact of motor fuel prices

Prices elasticity are not significant for most countries : often positive value or value not validated by statistical test:

•too short period

•price not changing so much over the period of regression;



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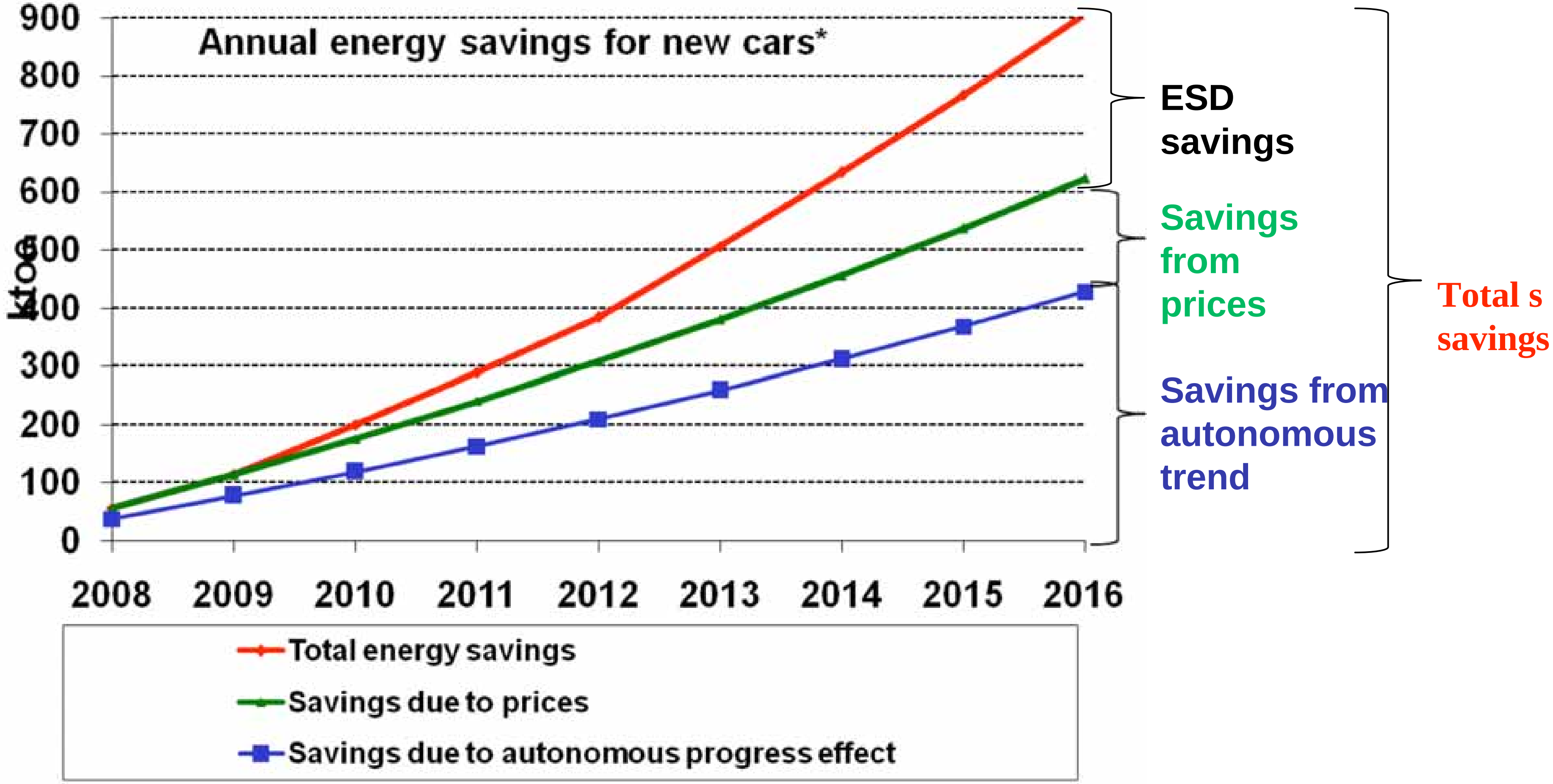
Calculation of ESD savings: example

ESD energy savings (about 400 **ktoe/year in 2016):** difference between total energy savings (about **1000 ktoe/year)** and energy savings induced by autonomous trend and price effect **(**-0.8%/year autonomous trend and price elasticity of -0.25)



Enerdata *calculated as sum of savings for new gasoline and diesel cars separately

Modal shift for transport of goods

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Top-down estimation of energy savings for modal shift

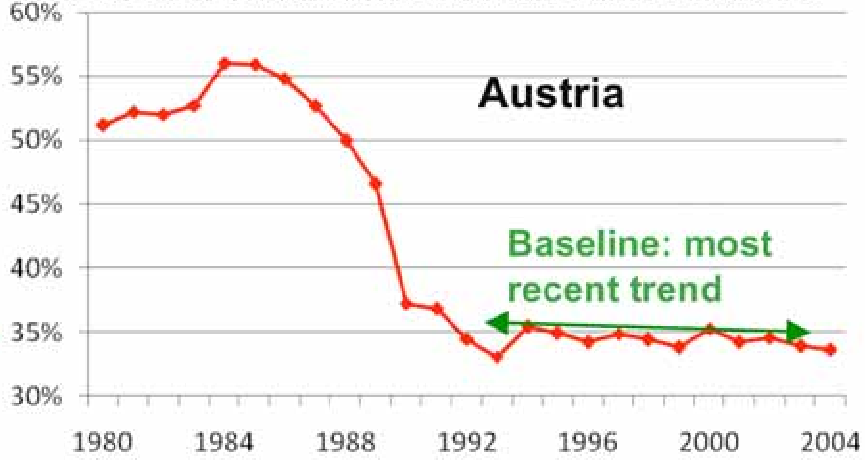
- Indicator used to measure energy savings: share of rail and water (non road transport).
- Change in modal shift can be generally explained by the following variables:
  - Autonomous trend
  - Cost difference by mode
  - Facilitating measures to promote modal shift (After / before 1995)
  - Other transport measures (relative investment in road/rail/water infrastructure)

  Defines the baseline (Autonomous trend; Cost difference by mode)
- In practice, taking into account the data usually available, modal shift in the absence of policy measures (baseline) can be modelled with two main variables :
  - Time to capture the autonomous trend
  - Average diesel price, as a proxy to measure change in relative costs
- Different situations among EU countries as to the trend in the share of rail and water transport for goods (see following typical cases)

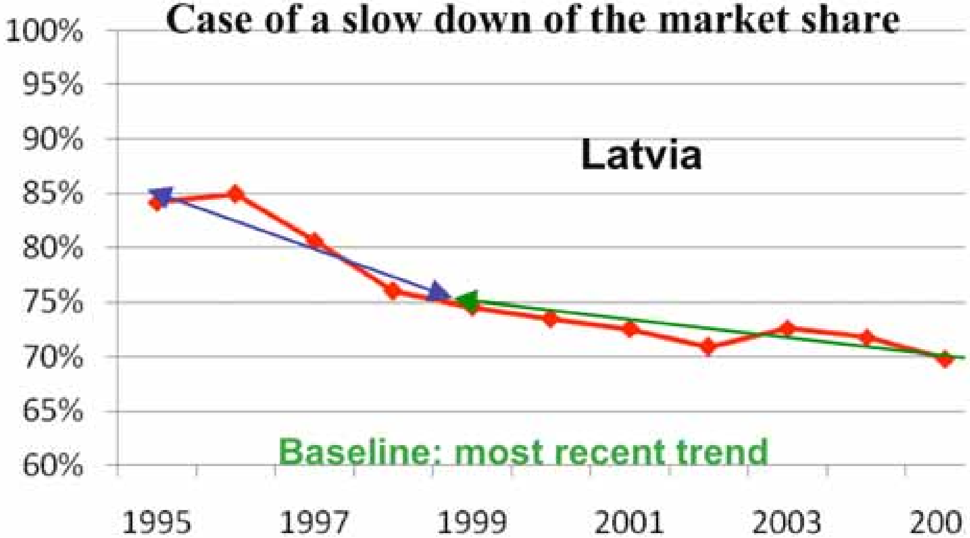
Trends in the market share of rail and water in total traffic of goods (%)

Case of a regular market share reduction

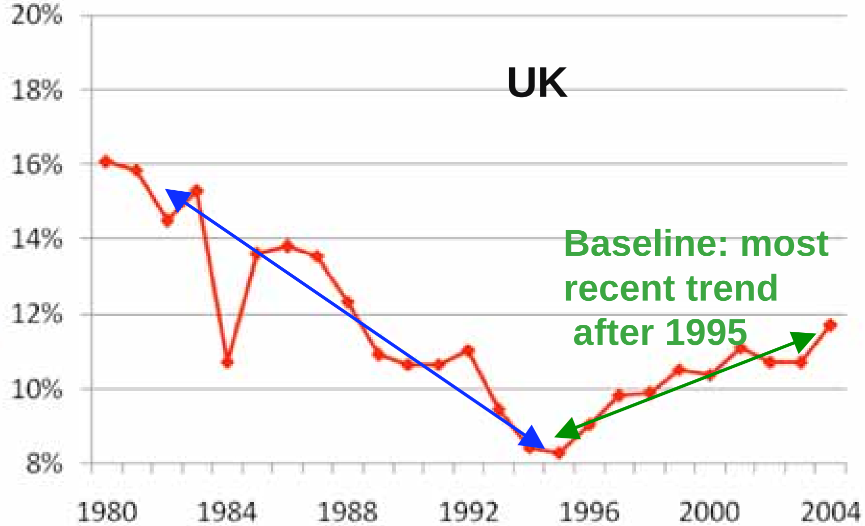
Case of a stabilisation of the market share



Case of a slow down of the market share



Case of an increase of the market share



Modelling of the baseline modal shift for transport of goods

➢ Modelling of the share of non road traffic through regression analysis with two variables:

- Time to capture an autonomous trend
- Average diesel price used to capture price differential

Ln (WRS) = T X t + A X ln (P) + K

- ✓ T: trend
- ✓ A: price elasticity (>0)
- ✓ P: diesel price

➢ Price elasticity calculated from regression not significant for most countries (e.g. <0 despite an important increase of diesel prices)

➢ It is proposed to use an exogenous and asymetric price elasticity, with a lag of 3 years to well capture the impact of price :

- ✓ 0.46 if prices increase (EU average between 2001 and 2005)
- ✓ and 0 if prices decrease

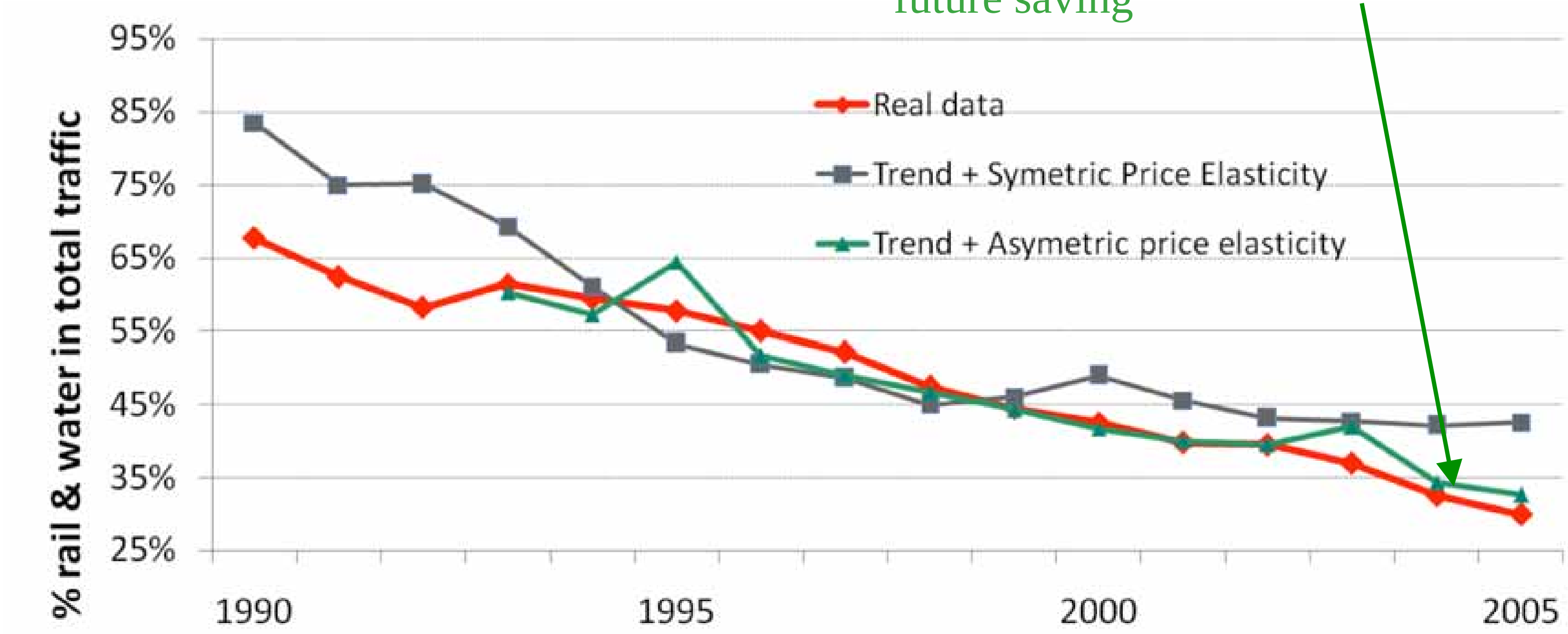
Modelling of baseline modal share Poland

➢ **Asymetric final regression :**

$$\ln (WRS) = -0.05 \times t + 0.46 \times \ln (P_{-3}) + 0.3 \quad \text{if prices increase}$$

$$\ln (WRS) = -0.05 \times t - 0.3 \quad \text{if prices decrease}$$

No energy saving in the past ➔ adjustment of a trend and price effect to get a reference from which to assess future saving



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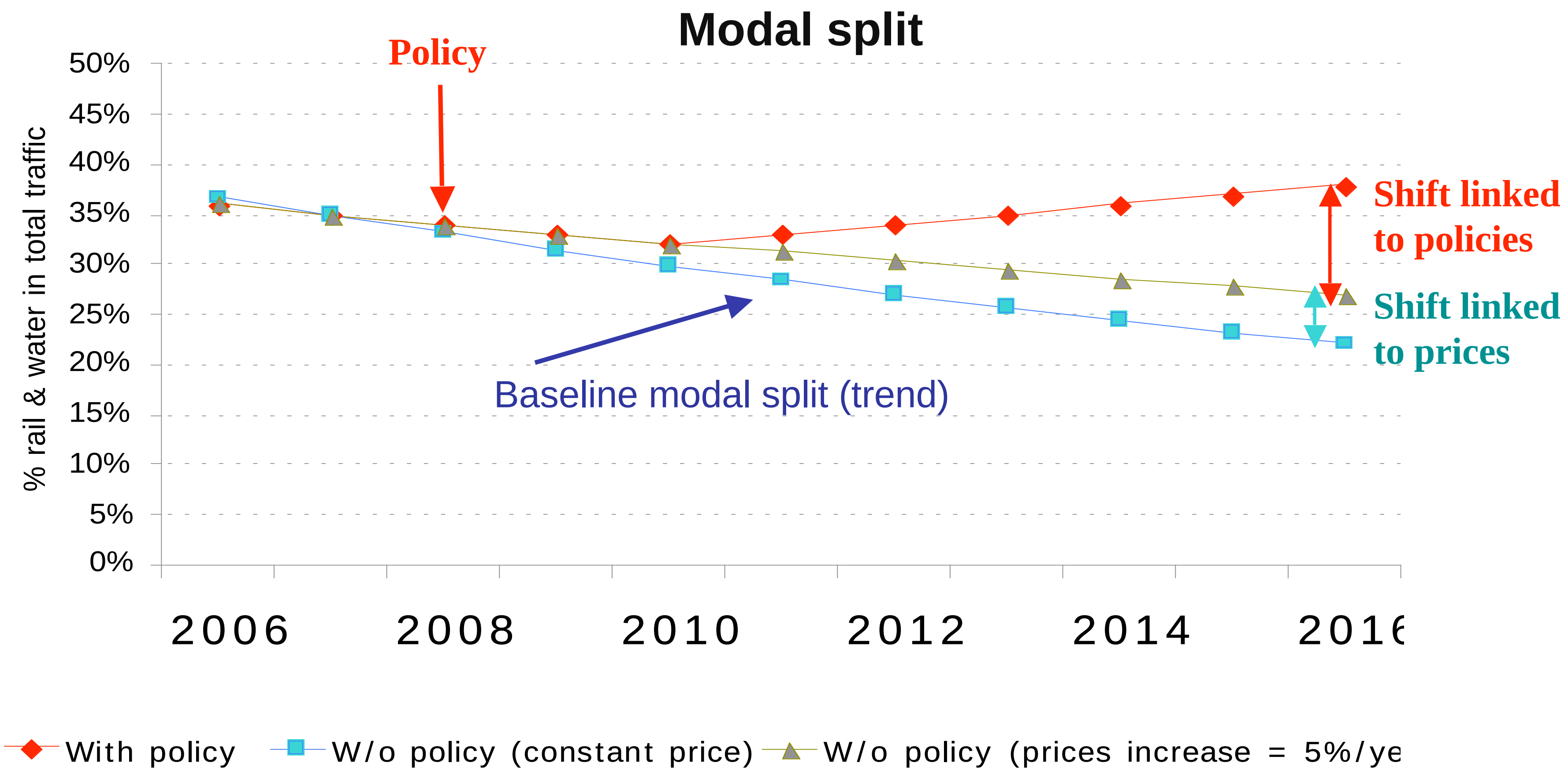
Calculation of ESD energy savings:
1 Calculation of modal split

➢Assumption of the implementation of a policy in 2008 with first impact in 2010 (rail and water traffic market share assumes to increase by 1% of each year)



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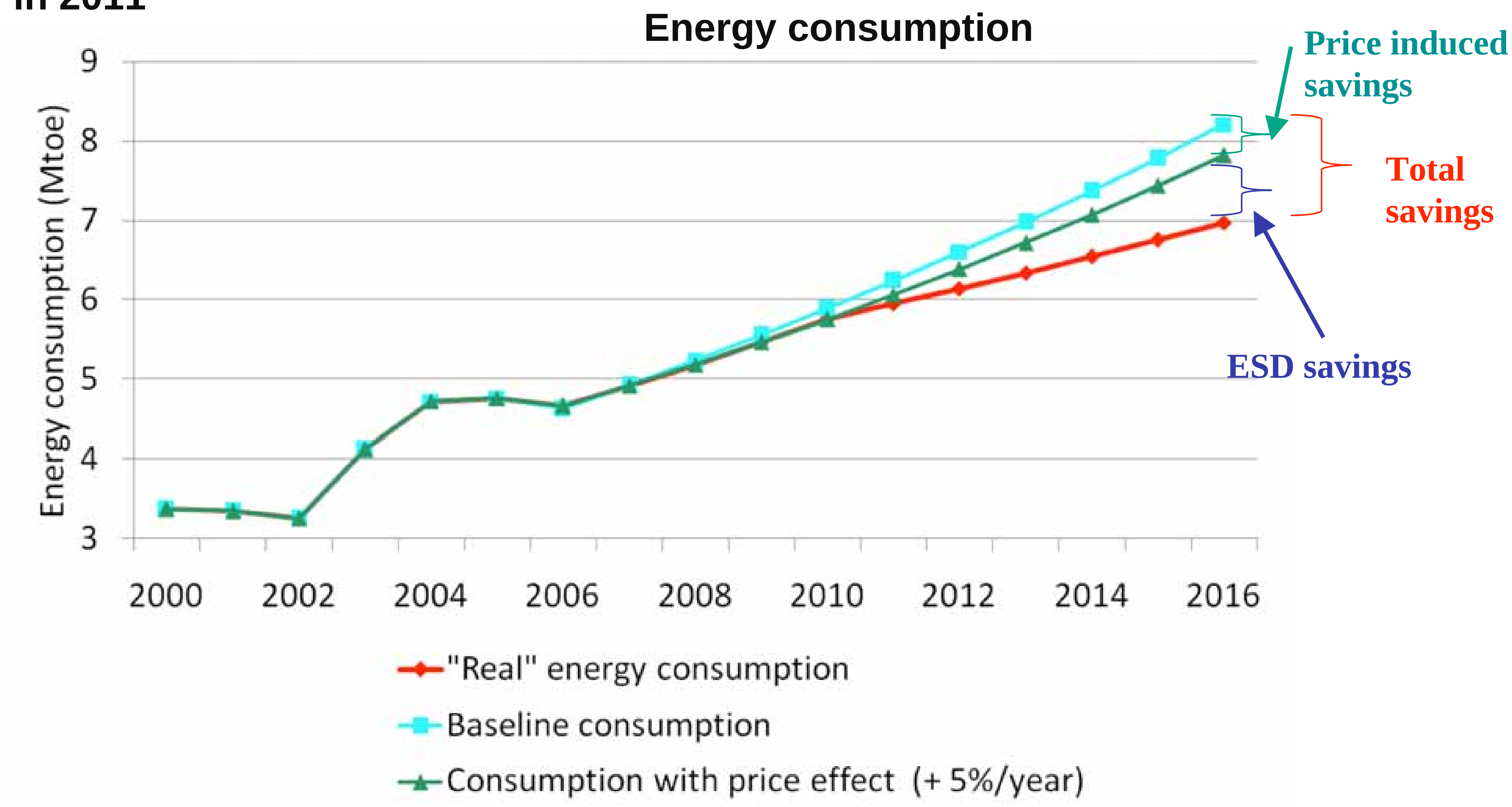
Calculation of ESD energy savings: 2 Calculation of baseline energy consumption and energy savings

➢ **Assumption implementation of a policy in 2008 and first impact of the policy in 2011**



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Electricity end uses in services

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Top-down estimation of energy savings for electricity end uses in services

- Indicators to measure savings : unit electricity consumption per employee (excluding electricity for thermal uses when data available) measured :

- from the sum of unit electricity consumption by activity branch (detailed approach) to clean the changes in the structure of service sector activities ("hidden structure effect") ➔ the best approach but data available only for few countries

- from the total unit electricity consumption for service sector (aggregative approach) if data by branch are unavailable.

- Use of unit electricity consumption per employee because
  - Physical indicators used and not economical indicators: energy needs related more to work conditions than to production
  - Employment data more robust than surface data

- Change in unit electricity consumption can generally be explained by the following variables:
  - Autonomous trend
  - Electricity price
  - Energy efficiency facilitating measures (subsidies, fiscal incentives, VA, taxes) (After / before 1995)

Defines the baseline (Autonomous trend, Electricity price)

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Modelling of the baseline unit electricity consumption of services

- Identification by country of a period over which policy measures either are negligible or have a limited impact ➔ over that period changes in unit electricity consumption mainly linked to autonomous trend, electricity prices

- Modelling over that period of the indicator through regression analysis with two variables:
  - Time to capture an autonomous trend
  - Electricity price

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

- ✓ T: trend
- ✓ A: price elasticity (<0)
- ✓ P: electricity price

- The price effect was generally not validated by statistics test as electricity prices did not change enough in the past

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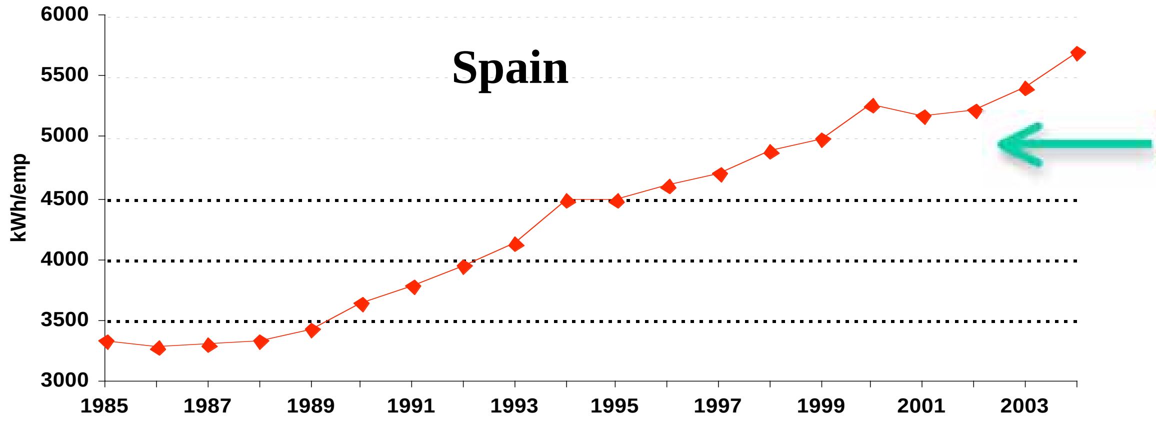
Classification of countries

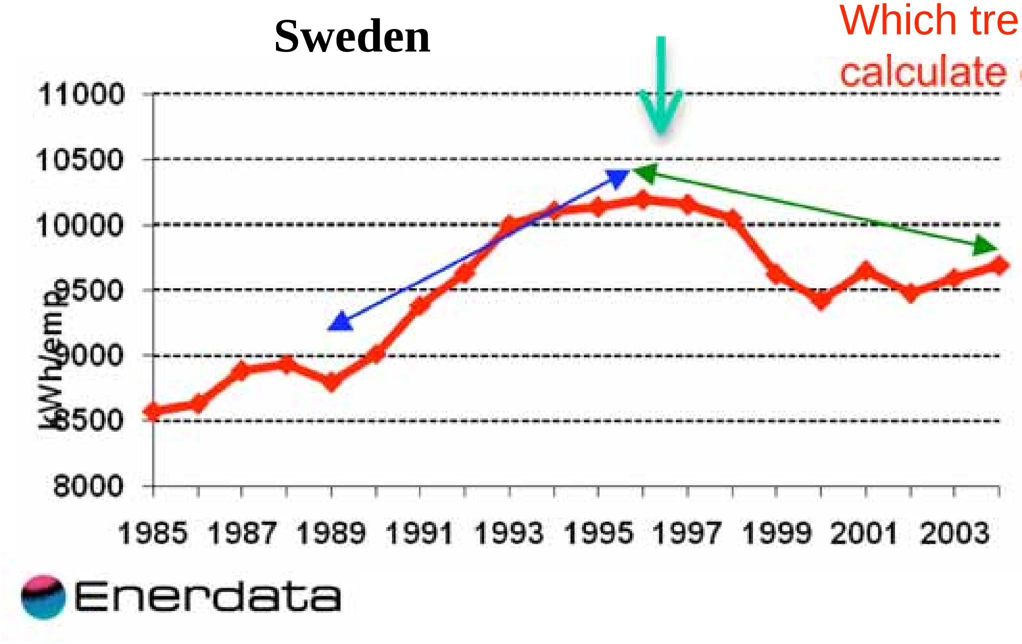
Countries with steady increase of the unit electricity consumption per employee

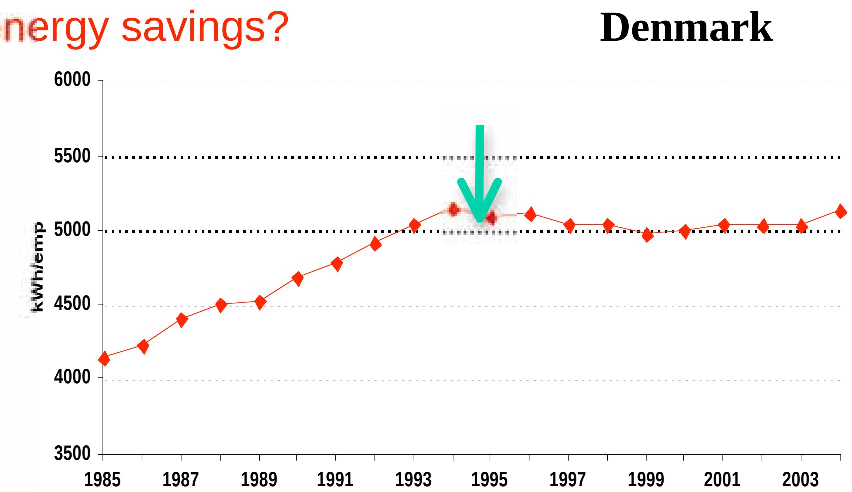


Trend easy to measure. Impact of measures not visible, if any (low impact ➔ any deviation in the future compared to the trend can be linked to measures

Countries with a break in the unit consumption trend (slower increase, stabilisation or decrease)

Which trend to be considered to calculate energy savings?

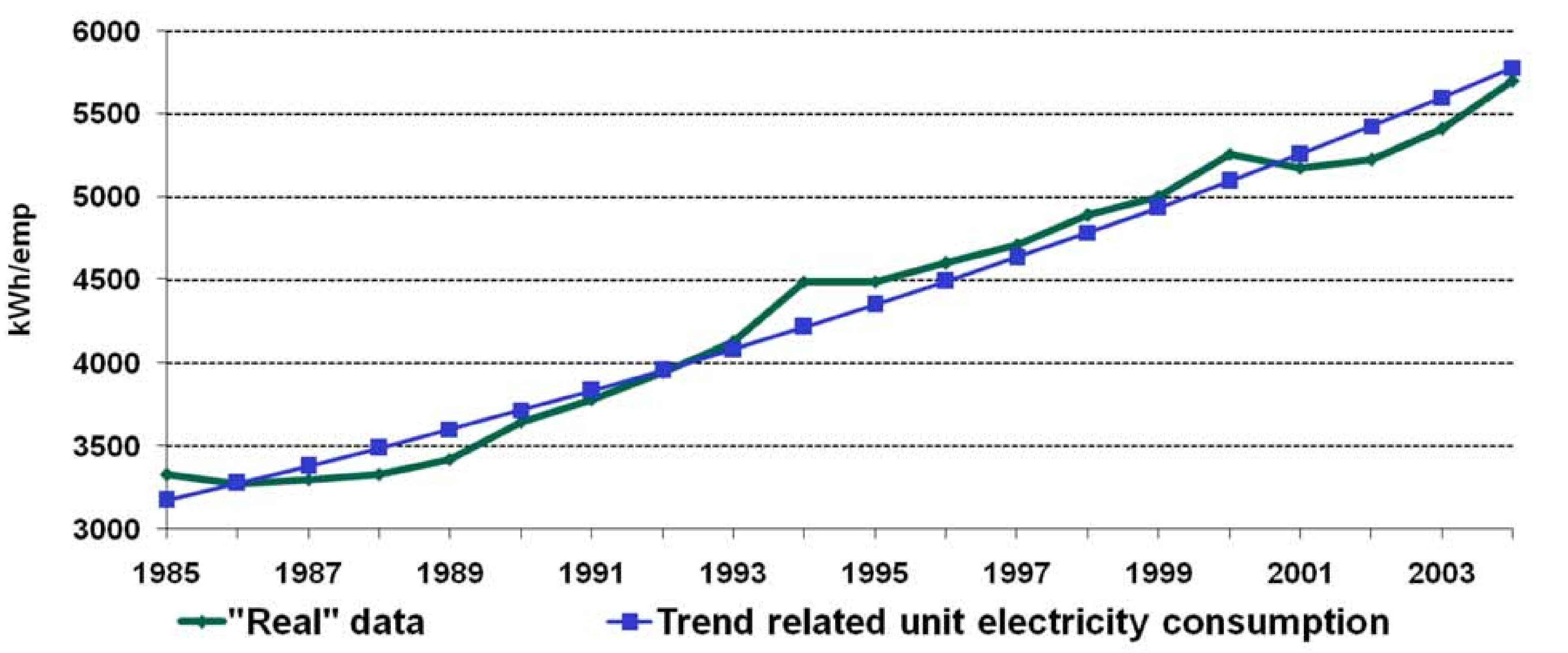




Modelling of the baseline unit electricity consumption of services : case of Spain

- ln (UC) = 0.03 X t + 8.06 (regression over the 1985-2004 period)
- Prices not validated by econometric tests

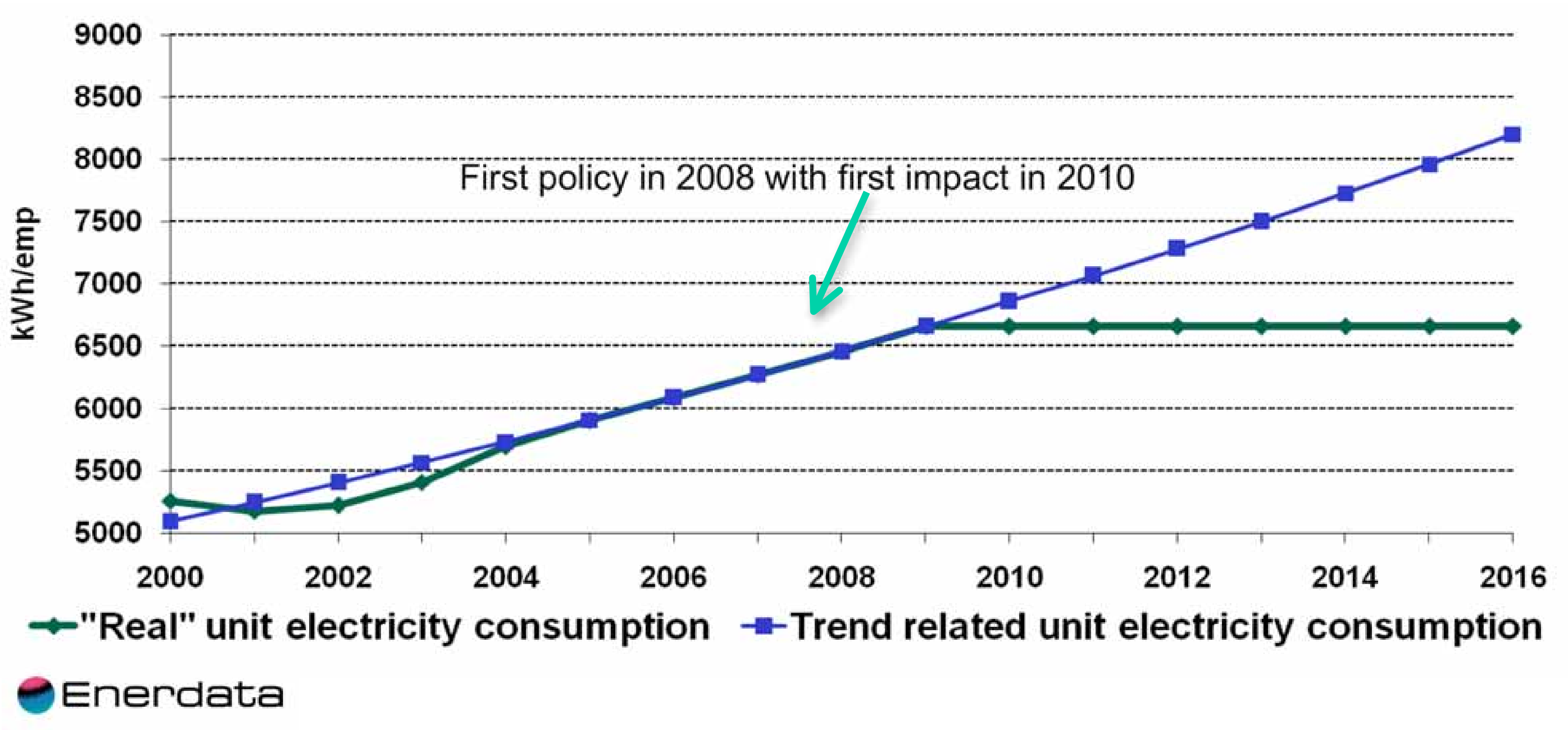
Unit electricity consumption per employee



Calculation of ESD savings

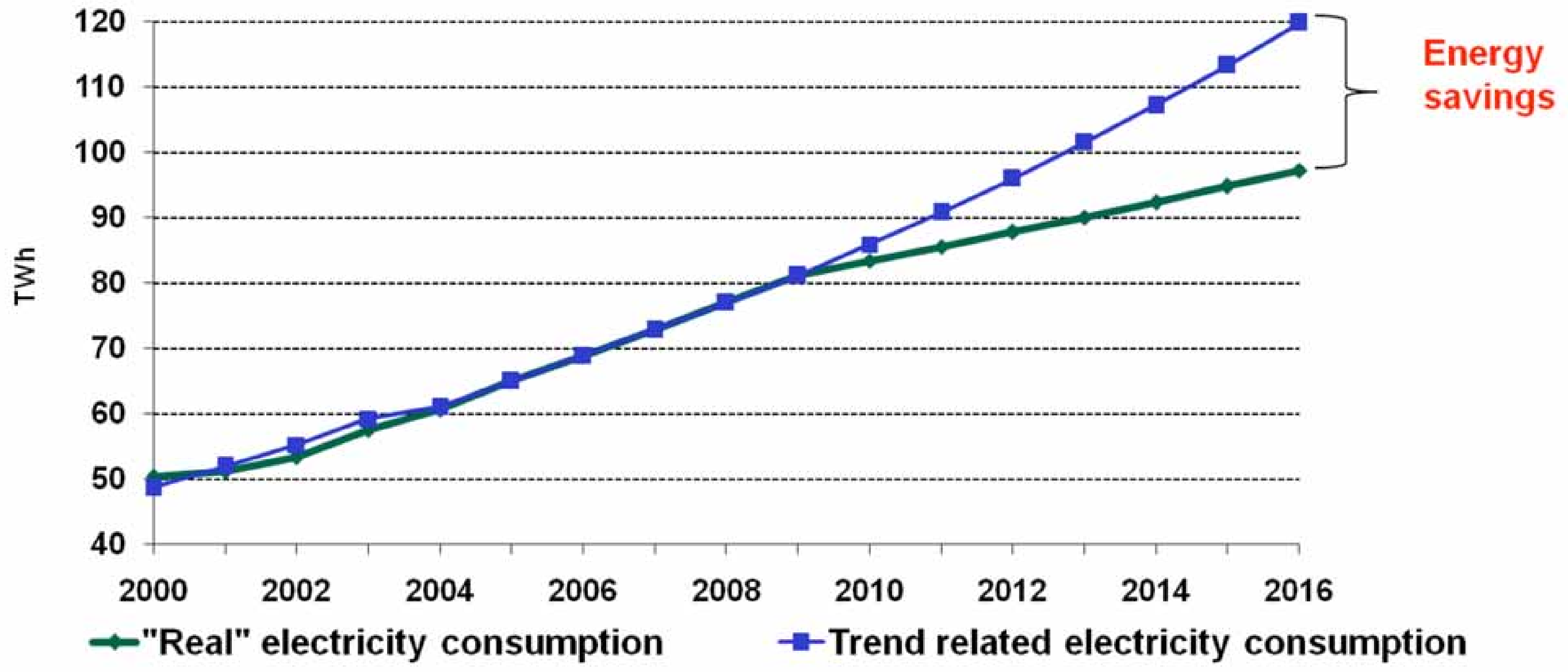
1. Calculation of the trend for the electricity consumption per employee

➢**Stage 1 : Calculation of the trend electricity consumption per employee**



Calculation of ESD savings

- **2 :** Calculation of the trend related electricity consumption
- **3 :** ESD energy savings calculated by difference between total electricity consumption and trend related electricity consumption



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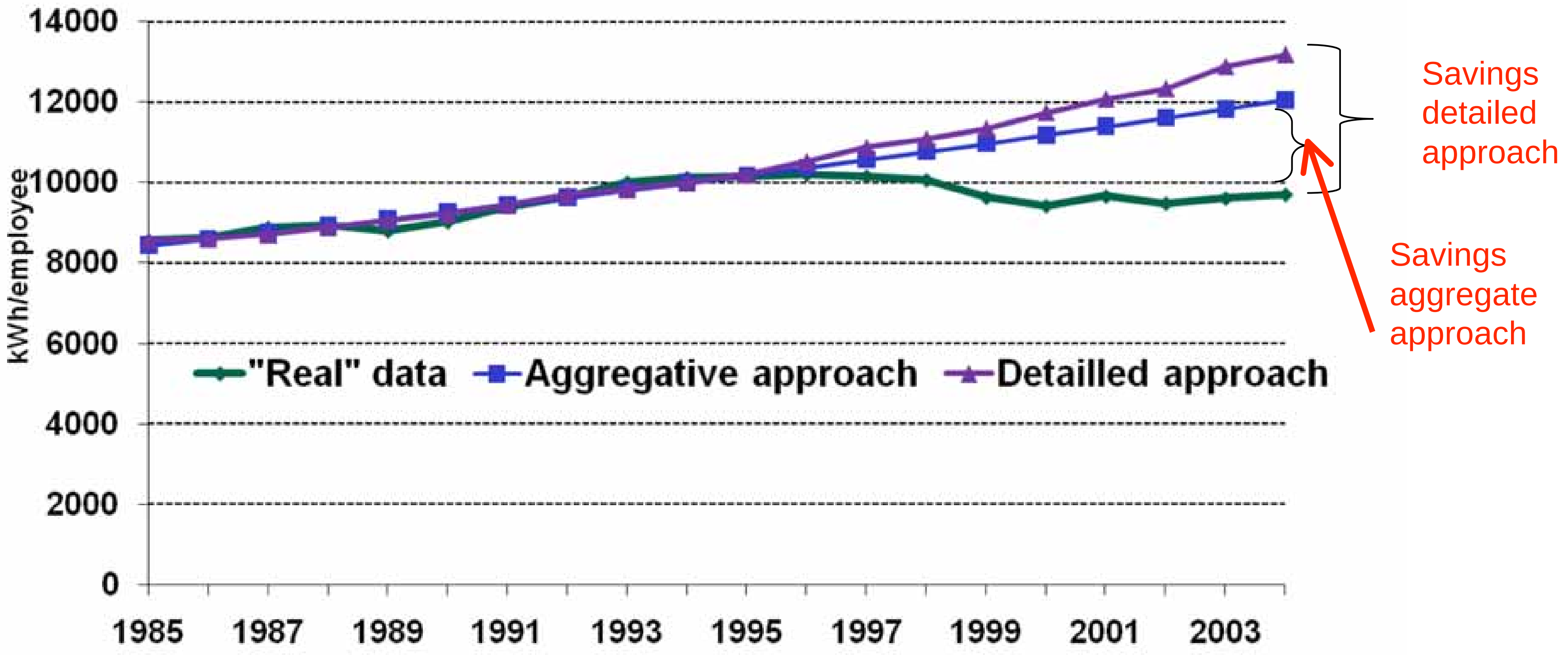
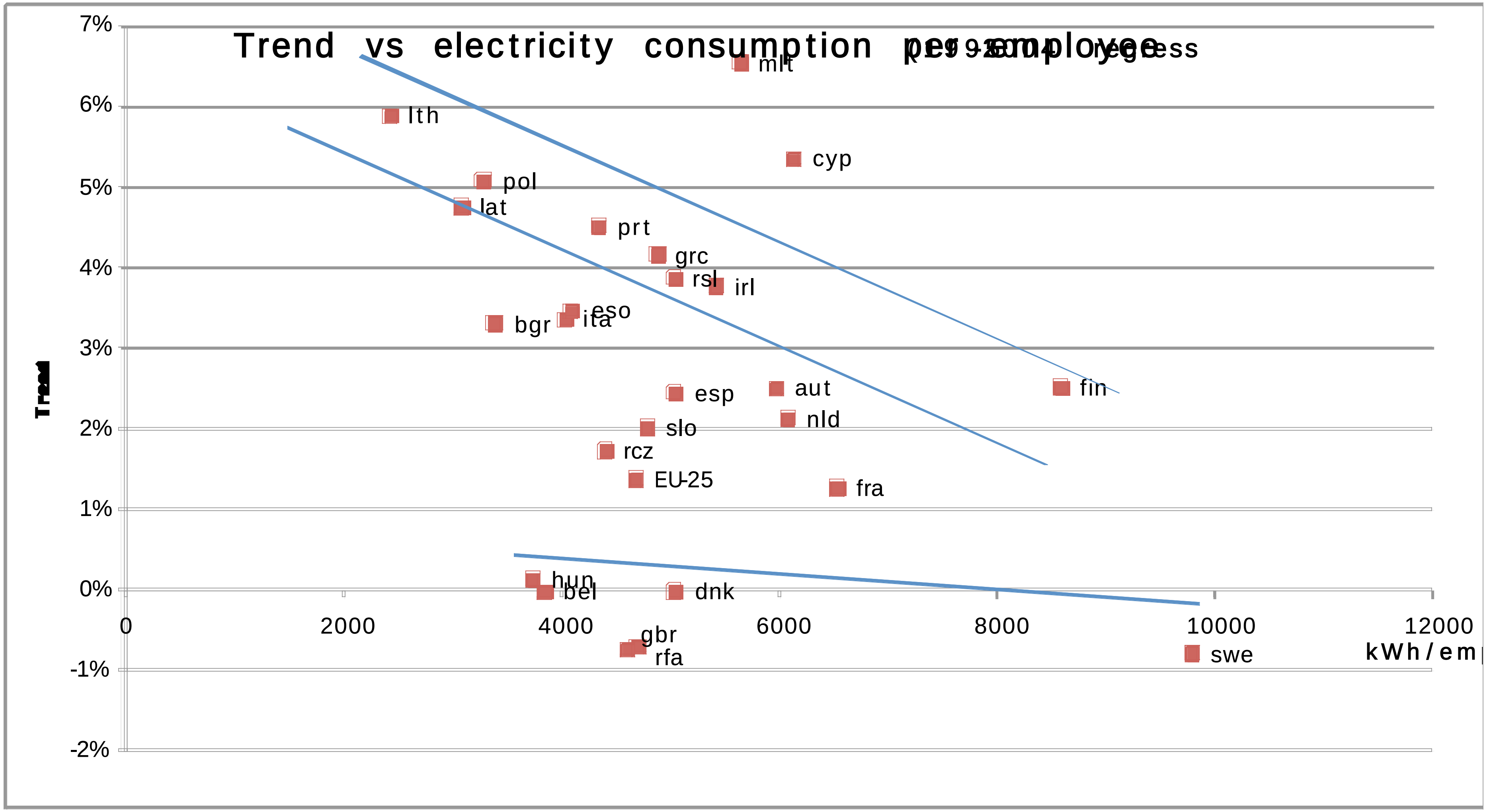
Use of different approaches according to countries (e.g. detailed versus aggregate): case of services (2)?

Trends calculated over the period 1985-1994 give different evolutions over 1995-2004 with aggregate approach or with the detailed approach by sub-sector ➔ the difference (about 1000 kWh in 2004 and about 3 TWh in terms of savings) is due to hidden structural effects (shift to branches with lower electricity consumption per employee)

Unit electricity consumption per employee in services in Sweden (excl. thermal uses)



Trends in electricity consumption per employee as a function of the electricity consumption per employee



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Conclusions on top-down case studies: issues needing decisions and possible solutions

Issues that need decisions for corrections of total savings

Following the case studies, the correction for autonomous trend and price effect has raised two main questions, for which decisions are needed:

1. For market prices:
   - Should we make the correction, i.e. the measure the part of the total energy saving that is due to market price increase;
   - If yes how to account for price effect?

2. For autonomous technological trend of specific equipment (transport modes, electrical appliances), how to define this historical autonomous trend?

Market price correction (1) : should it be made?

Pros	• Enable to remove energy savings that may be just linked to increase in the international oil price and thus not linked to policies • Enable to isolate the role of change in taxes, which is policy related •Even if present evaluations of price elasticities are disappointing, calculation could be more relevant if calculated including the most recent years with high prices (eg 1995-2007 or 2008)
Cons	•Corrections too difficult to make and too uncertain as price elasticities calculated over the past usually not statistically or economically significant (>o value whereas should be <0) and vary quite a lot depending on the period; • Leaving the effect of increase in market price on consumers without compensation may be considered as part of policies?

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Market prices (2):how to concretely account for price effects?

- **What value to be used for the price elasticity?**
  - ✓ National data if relevant (in most countries the values obtained from statistical regression have been found non significant)
  - ✓ Or harmonised values, the same for all countries

- **For harmonised values, what value to be used?**
  - ✓ The EU average if meaningful
    - Weighted average ➔ give a too high importance to EU large countries (e.g. Germany, France, UK, Italy) ?;
    - Arithmetic average of countries with relevant price elasticities (better but only if sample large enough with representative countries)
  - ✓ Expert judgement with a low and asymmetric price elasticity : the lower the elasticity the lower the correction, and the higher the ESD saving (i.e., if prices increase, baseline will be reduced; if prices decrease, no change in baseline);

Note: in red, our proposal

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Market price correction (3): example (new gasoline cars in France)

- **National price elasticity**
  - ✓ Equal to -0.10 1995-2005 period
  - ✓ Not validated by econometric tests over other periods (e.g. 1995-2004 or 1992-2005) ➔ evaluation very sensitive to period considered

- **Harmonised values for elasticities**
  - ✓ Average of countries with relevant elasticities : DK=-0.11, ES=-0.14 and FR=-0.10 => value of -0.12; sample representative?
  - ✓ EU average price elasticity = -0.25

Market price correction (4): use of national price elasticity vs harmonised values ?

Pros	• Better reflect the specificity of each country and the consumers price response •Account implicitly for the price level
Cons	• Lack of harmonisation among EU countries ➔ risk of having very different evaluations of savings associated to the same price

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Correction for autonomous technological trend for vehicles and electrical appliances (1). Which trend to take?

For energy savings, related to an equipment (e.g. refrigerators, cars), the autonomous energy efficiency progress is mainly an autonomous **technological** trend:

- How to define this autonomous **technological** trend ?
  - ✓ A “national trend” (i.e. a different trend for all countries) or,
  - ✓ the **same trend for a given equipment for each country,** as technical progress should be the same in Europe for a given equipement?

- If the same trend is assumed, what value to be taken?
  - EU average trend (weighted average)
  - **Average arithmetic trend of countries with the slowest trend** (non weighted), as reflecting countries with no effective national policies :
    - ✓ the half of countries below the EU average, or
    - ✓ the 3 countries with the lowest trend?

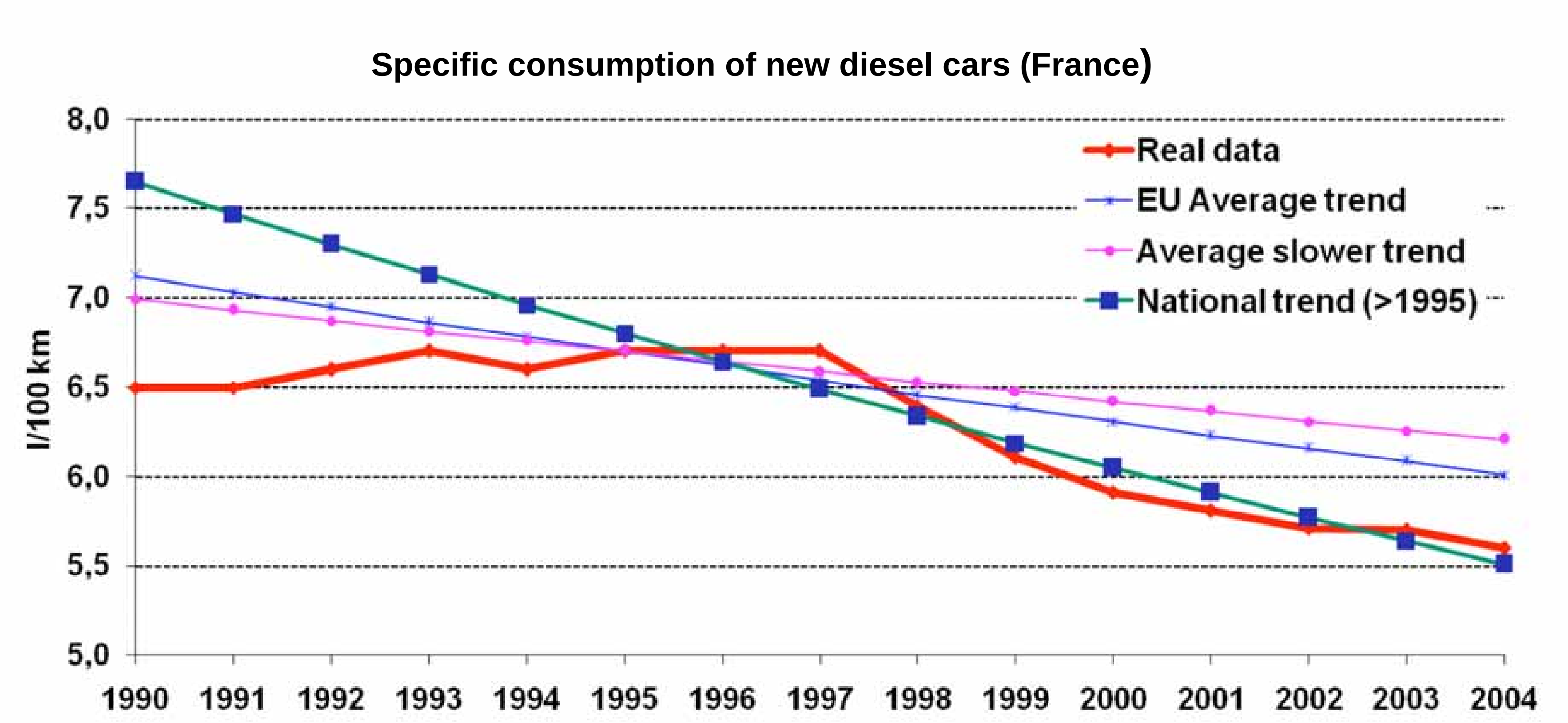
Note: in red, our proposal - this is not conservative, but assumed to be a proxy for the past autonomous trends

Correction for autonomous technological trend (2): pros and cons of EU harmonised value

Pros	• Harmonisation among countries • For countries with a trend more rapid than EU average this will account for past efforts (e.g. diesel cars in France next slide)
Cons	•Difficult to derive a reliable EU average •Need also to decide whether it is an arithmetic or weighted average (see above comment on prices) •ESD savings are lower for countries with a trend slower than EU harmonised value

Correction for autonomous technological trend (3): example

- National trend
- EU average trend = > -1.1%/year for diesel
- Average trend of countries with the lowest autonomous trend (“average slower trend”)



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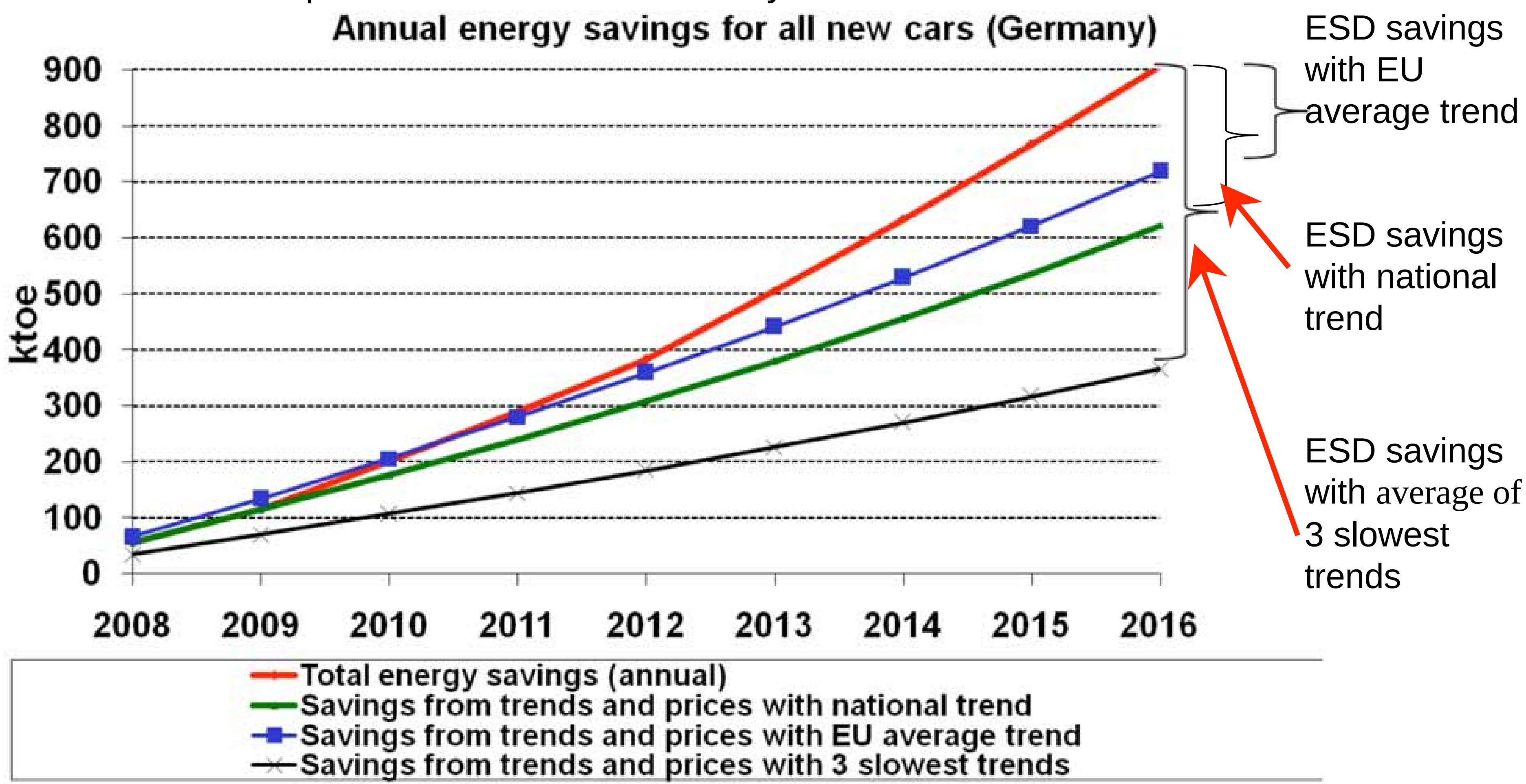
Correction for autonomous trend (4): sensitivity study

If baseline is EU average trend instead of national trend ➔ESD savings divided by 2
If baseline is average of 3 slowest trends ➔ESD savings multiplied by 2
This of course depends on the actual country's trend



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