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

# Case studies on top-down methods: case of solar water heaters and new cars

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# List of selected case studies (1/2)

## ➢ Residential sector

(i) Building shell and heating systems (energy consumption indicator)

(ii) Household electricity use excluding thermal uses (ie electric appliances as a whole including lighting) (energy consumption indicator)

(iii) Specific white goods (e.g. cold appliances, dryers) (market diffusion indicator)

(iv) Solar thermal collectors (market diffusion indicator)

## ➢ Transport sector

(i) New cars (energy consumption indicator)

(ii) Improvement of the car, bus and truck stock (energy consumption indicator)

(iii) Modal shift in passenger transport (energy consumption indicator/ modal split indicator)

(iv) Modal shift in goods transport (energy consumption indicator/ modal split indicator)

# List of selected case studies(2/2)

## ➢ Industry sector

(i) Industrial thermal energy use (excluding electricity) (energy consumption indicator)

(ii) Industrial electricity consumption (energy consumption indicator)

(iii) Industrial CHP (market diffusion indicator)

## ➢ Tertiary sector

**(i)** Building shell and heating systems (energy consumption indicator)

(ii) Electricity end- uses excluding thermal uses

## ➢ General policy instruments

**(i)** Energy taxation

(ii) Focused information campaigns with high impact

# Pilot case studies to test the methodology

- Pilot case studies selected so as to have one based on a market diffusion indicator and one based on an energy consumption indicator

- Select end use with a good data coverage：
  - Solar thermal collectors (market diffusion indicator)
  - New cars (energy consumption indicator)

- Comparison of approaches:
  - With market diffusion indicators, need to express them in terms of energy savings whereas with energy consumption indicators energy savings obtained directly
  - Market diffusion indicators more rapidly updated (e.g. 2006 available for solar compared to 2004 for new cars)

# Estimation of energy savings linked to policy measures: why a top down evaluation

- Energy savings linked to the development of solar water heaters can be both assessed with bottom-up and top-down methods. Why consider it with top down methods?

- With bottom-up approach, assessment from a given policy measure (e.g. if grant available, installed capacity derived from the amount of grants given)

- However in most countries several measures are often available at the same time (e.g. In France tax credit on the cost of the equipment + subsidies from regional/local organisations + soft loans+ reduced VAT on the cost of installation

→ risk of double counting if looking at policy measures individually

→ ex post evaluation of measures not always available (e.g. tax credit)

→ it may be easier to look at the overall market development (e.g. sales of water heaters or installed capacity)

# Solar water heaters

# Estimation of energy savings linked to policy measures: methodology for solar heaters (1/2)

➢Development of solar water heaters will be measured from the installed stock in m2

➢The diffusion of solar water heaters and hence the related energy savings will be explained by the following factors/ variables:

- Autonomous trend
- Energy price
- Energy policy measures (subsidies, tax credit) (After / before 1995)

➔ residual hidden structure effects and direct rebound effects neglected

➢Total energy savings are calculated by multiplying the number of m2 by an amount of energy saving per m2 depending on the country

➢ESD energy savings calculated by difference: totals savings minus trend and price related savings

# Estimation of energy savings linked to policy measures: methodology for solar heaters (2/2)

➢Identification by country of a first period over which policy measures either are negligible or have a limited impact (graphic, plus analysis of policy measures) by country ➔over that period diffusion mainly linked to autonomous trend and possibly energy prices

➢ Modelling over that period of the diffusion of solar water heaters through regression analysis with two variables:

- Time to capture an autonomous trend
- Average price of energies used for water heating to measure the impact of prices

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

- ✓ T: trend
- ✓ A: price elasticity (>0 as price increase should increase penetration of solar water heaters)
- ✓ P: energy price

# Source of data and information on energy policy measures for solar heaters

- **Solar heaters installed stock (m2):** Odyssee from
  - ✓ Observ'er, plus:
    - European Solar Thermal Industry Federation
    - IEA Solar Heating and Cooling Programme

- **Energy price:** Odyssee+ Enerdata database (based on IEA, Eurostat, national data
  - ✓ Average price of energies used for water heating
  - ✓ or average household price
  - ✓ or price of the dominant source for water heating

- **Energy policy measures**
  - ✓ MURE database, plus:
    - IEA global renewable energy policies and measures database
    - National sources as transversal sources are not always exhaustive (in particular for new member countries)

# Classification of countries

Three groups of countries:

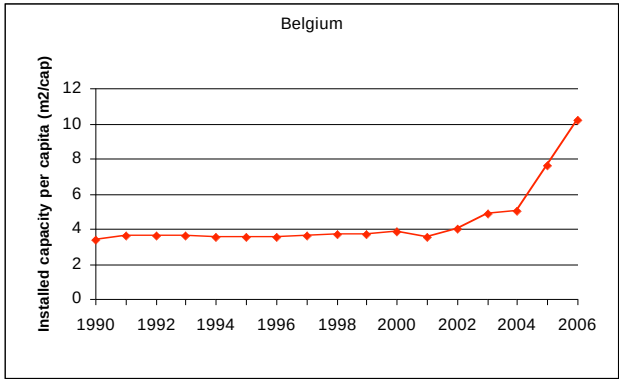
- "Policy pushed markets": countries for which a policy was implemented after the mid –nineties ➔ period with autonomous trend clearly visible (net and rapid take off from one year):
  - ✓ Case of France, Belgium, Italy, Finland, Ireland, Netherlands, Spain, UK, Hungary, Sweden, Portugal

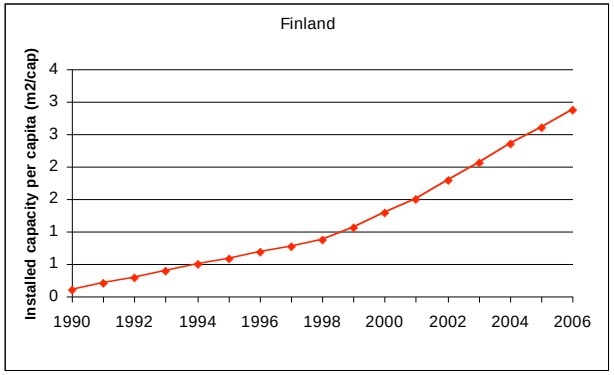
- "New markets": recent policies (same as above but diffusion starting from a very low level close to zero➔ no autonomous trend ):
  - ✓ Case of most new EU member countries

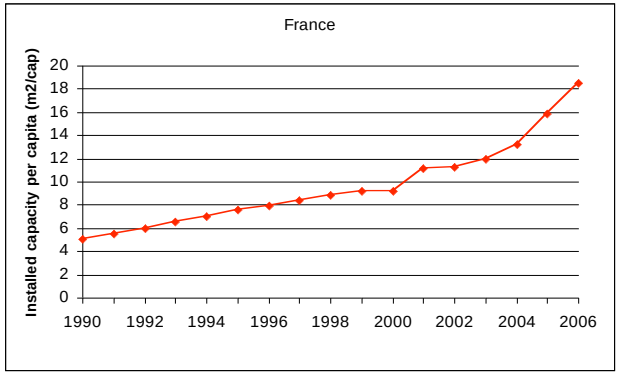
- "Mature markets" with already a high penetration of solar water heaters resulting from policies implemented before 1995 ➔ most difficult case:
  - ✓ what is eligible with respect to ESD?
  - ✓ what is part of the trend and what is linked to policies
  - ✓ Case of Germany, Austria, Cyprus, Greece, Slovenia and Denmark

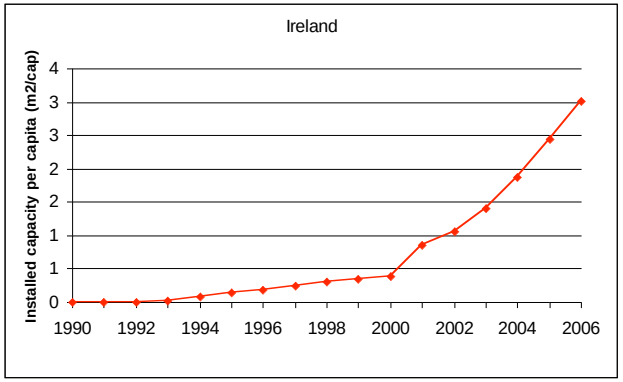
# Policy pushed markets (1/2):

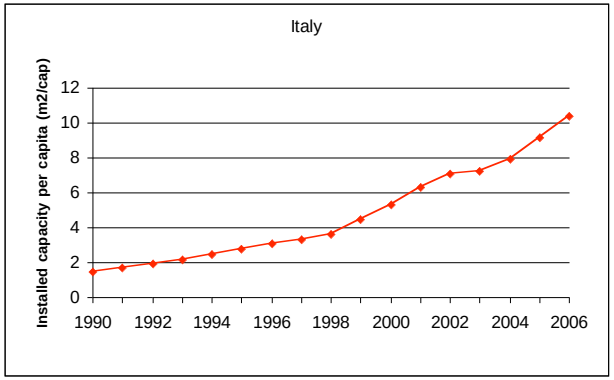
## Acceleration of the diffusion when a policy measure is implemented

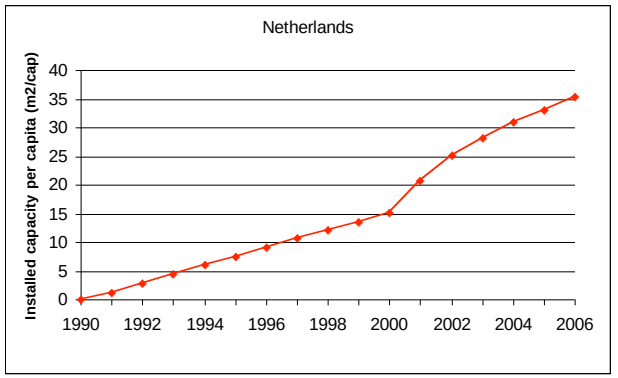


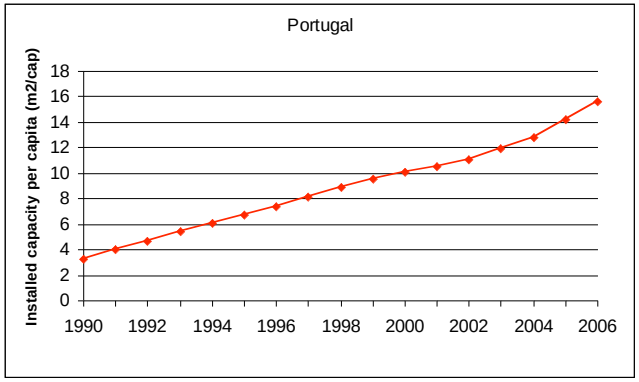



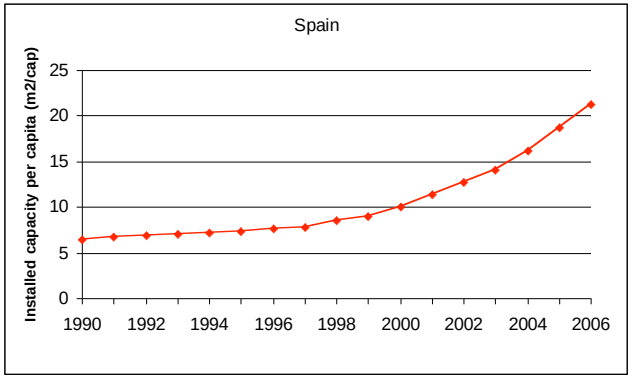



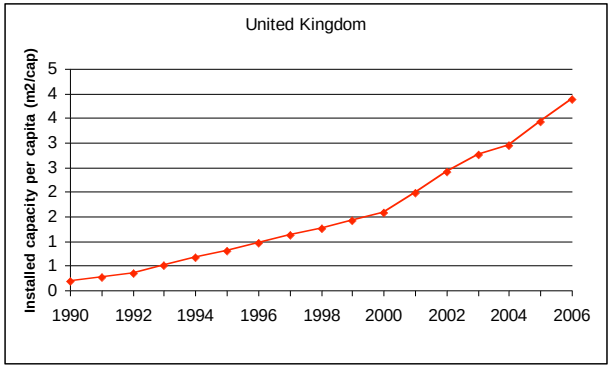

**For sake of comparison all graphs are shown in terms of installed area in m2 per 1000 capita**

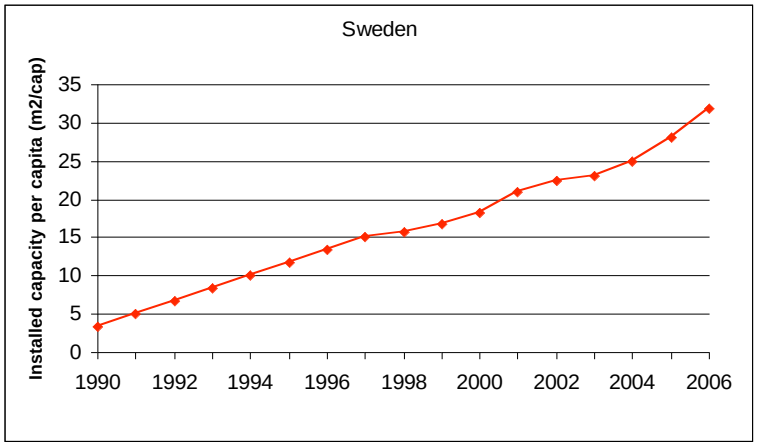
# Policy pushed markets (2/2):

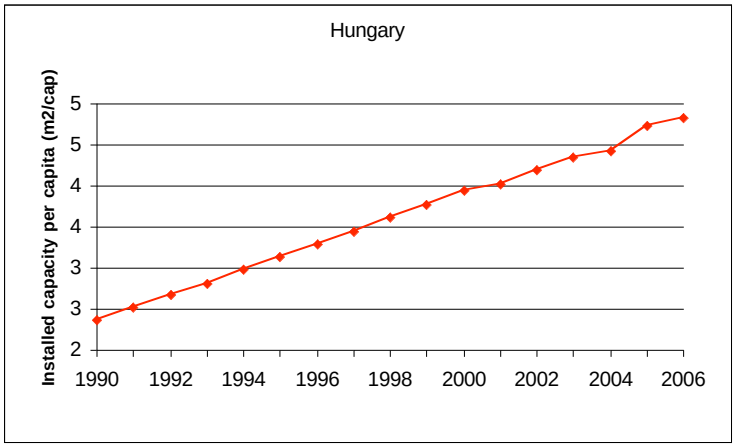
## Acceleration of the diffusion when a policy measure is implemented



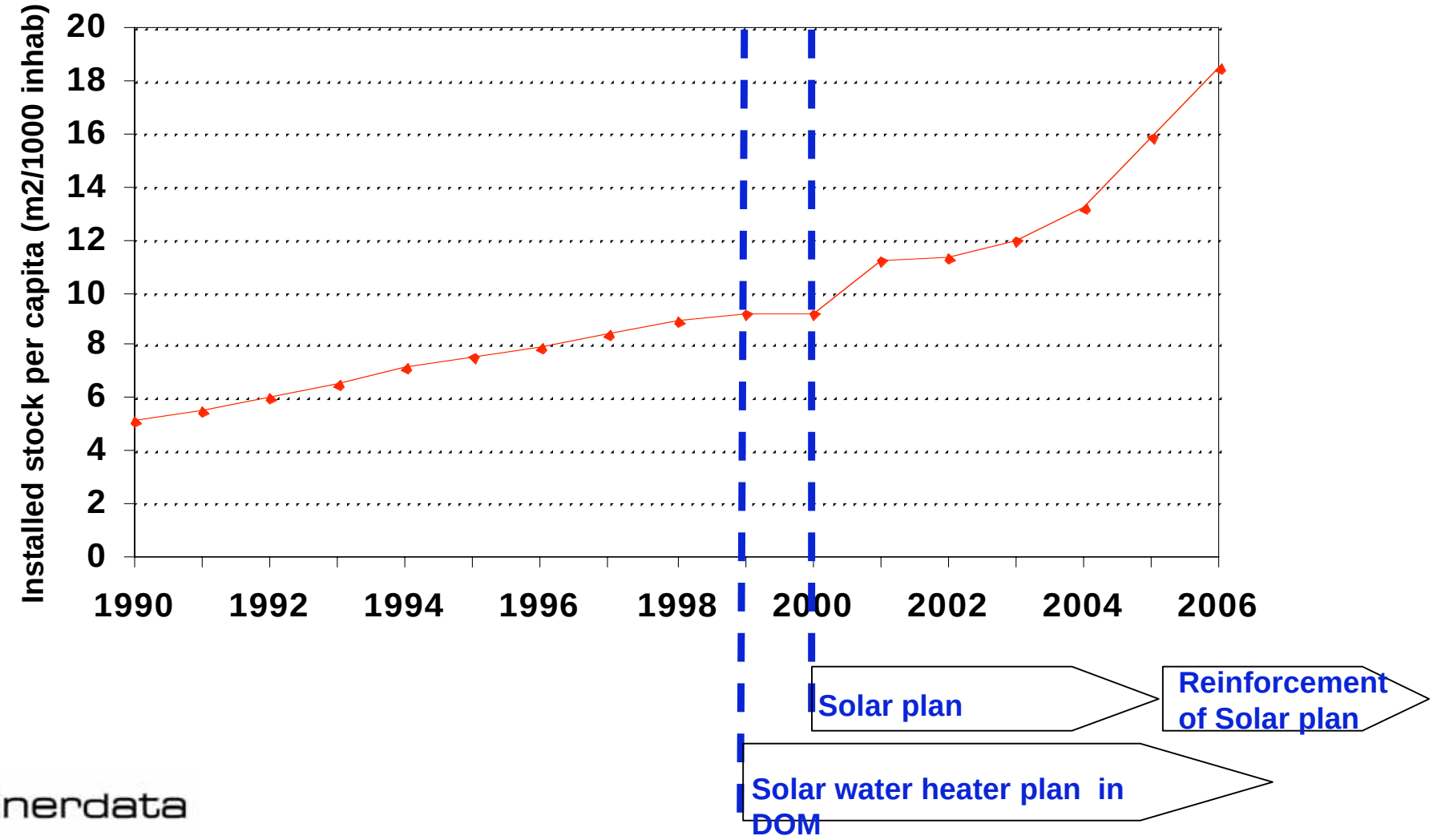




**For sake of comparison all graphs are shown in terms of installed area in m2 per capita**

# Policy pushed markets: case of France
# Historical development (1/4)



# Policy pushed markets: case of France
## Modelling (2/4)

➢ **Regression with autonomous trend and average price of energies used for water heating between 1990 and 2000**

Ln (**IC**) = 0.27 X ln (**t**) – 0.07 X ln (**P**) + 1.96 + $\mathbf{e_t}$

t-stat (6.6) (0.2)

$R^2$ = 0.96 => Good correlation ($R^2$ near 1)

F-stat = 104 => regression is globally significant (F-statistic is > 4.5 )

T-stat > 1.9 for time but <1.9 for prices and negative elasticity=> price effect not significant

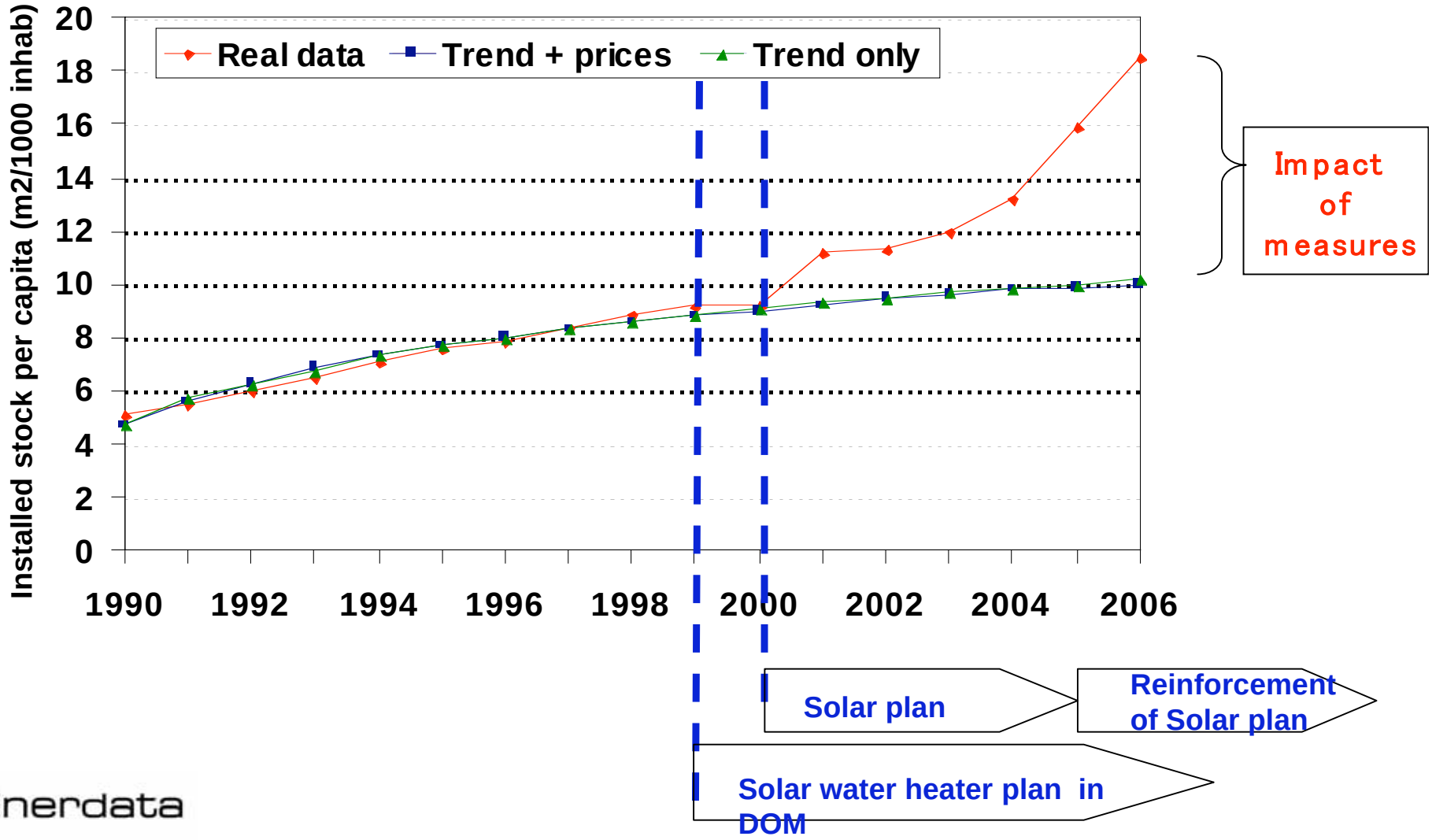
➢ **Regression with autonomous trend only between 1990 and 2000**

Ln(**IC**) = 0.28 X ln(**t**) + 1.54 + $\mathbf{e_t}$

t-stat (15.2) , $R^2$ = 0.96, F-stat = 232

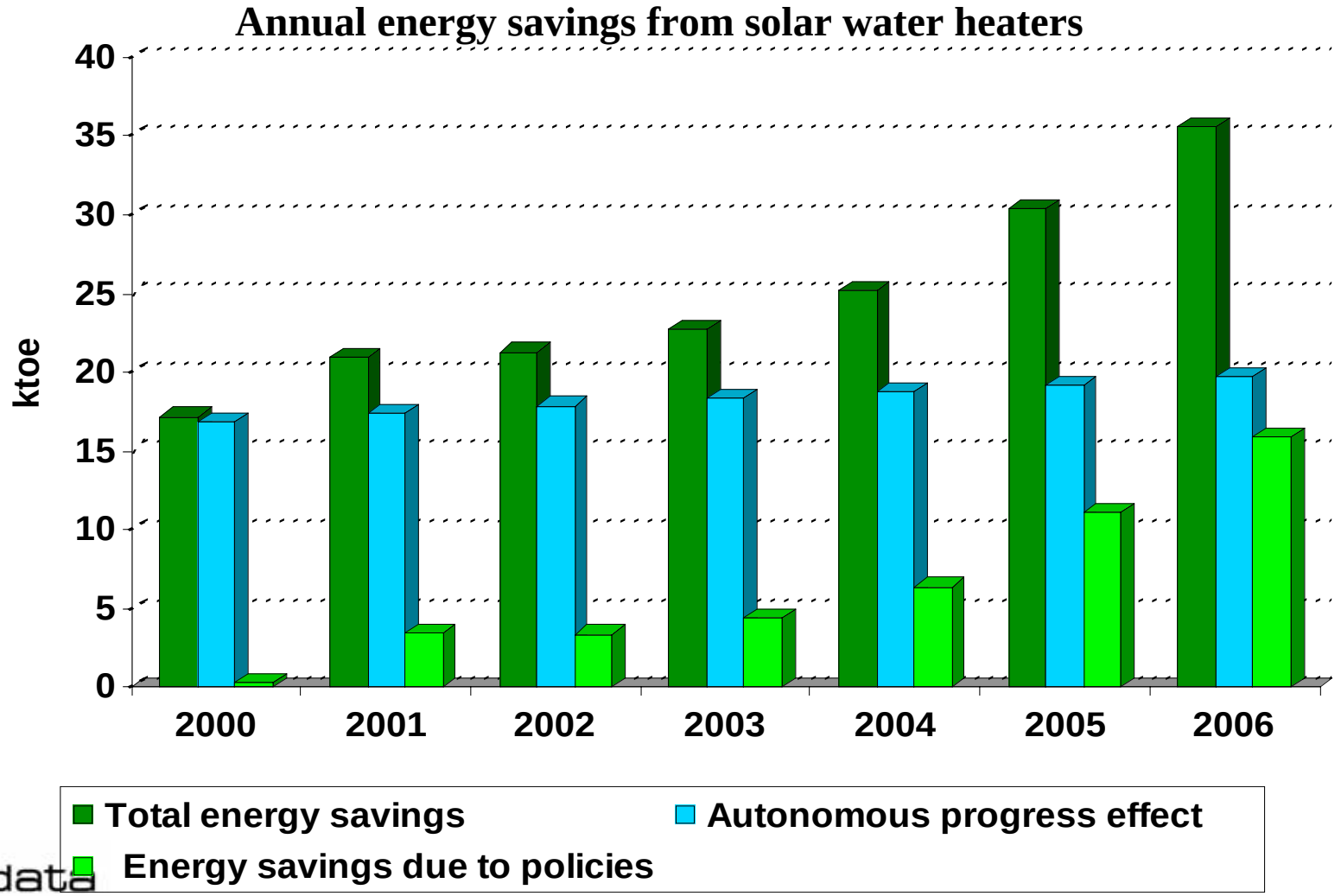
Good correlation, regression globally significant

# Policy pushed markets: case of France (3/4)
## Modelling of installed capacities in m2



# Policy pushed markets: case of France
## Energy savings (4/4)

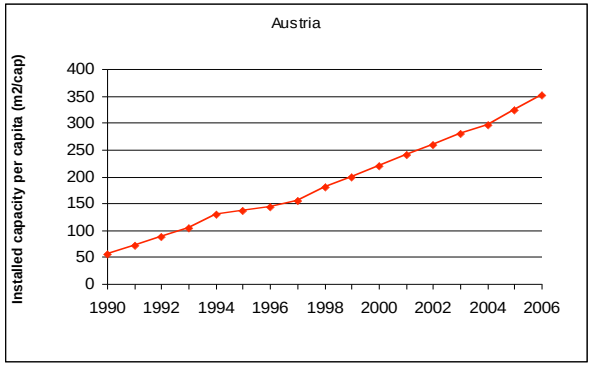
**Annual energy savings calculated from installed area of solar collectors and a coefficient in toe/m2 (useful energy provided by the solar energy); could be also calculated in terms of final energy replaced (e.g. electricity or gas)**

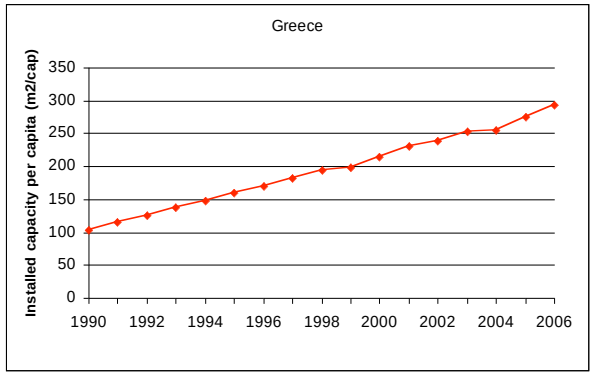


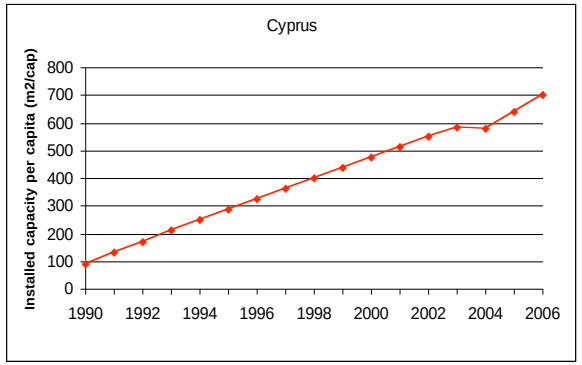

Enerdata

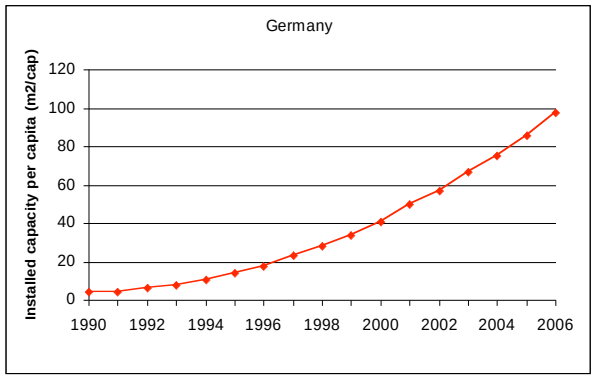
# Mature markets:
# Old policies and/or continuous policies

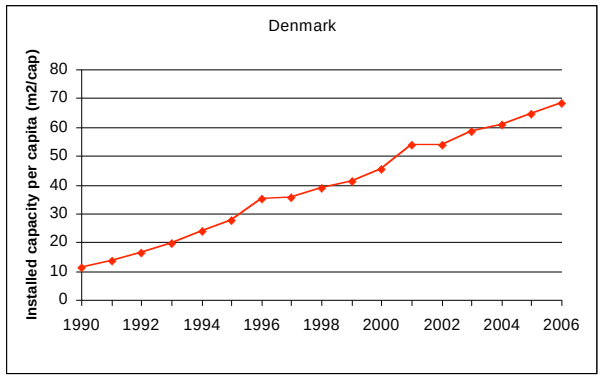
**What is the autonomous trend? When does the regression end? What is eligible policy according to ESD?**

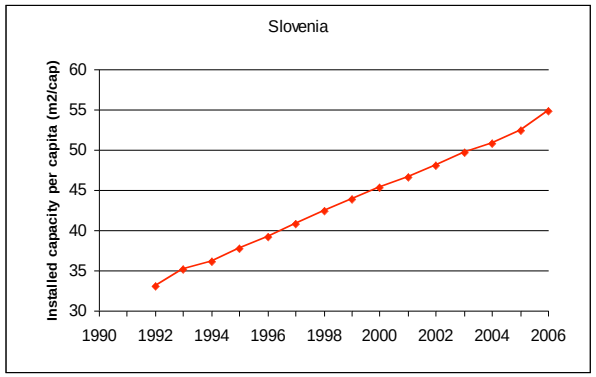


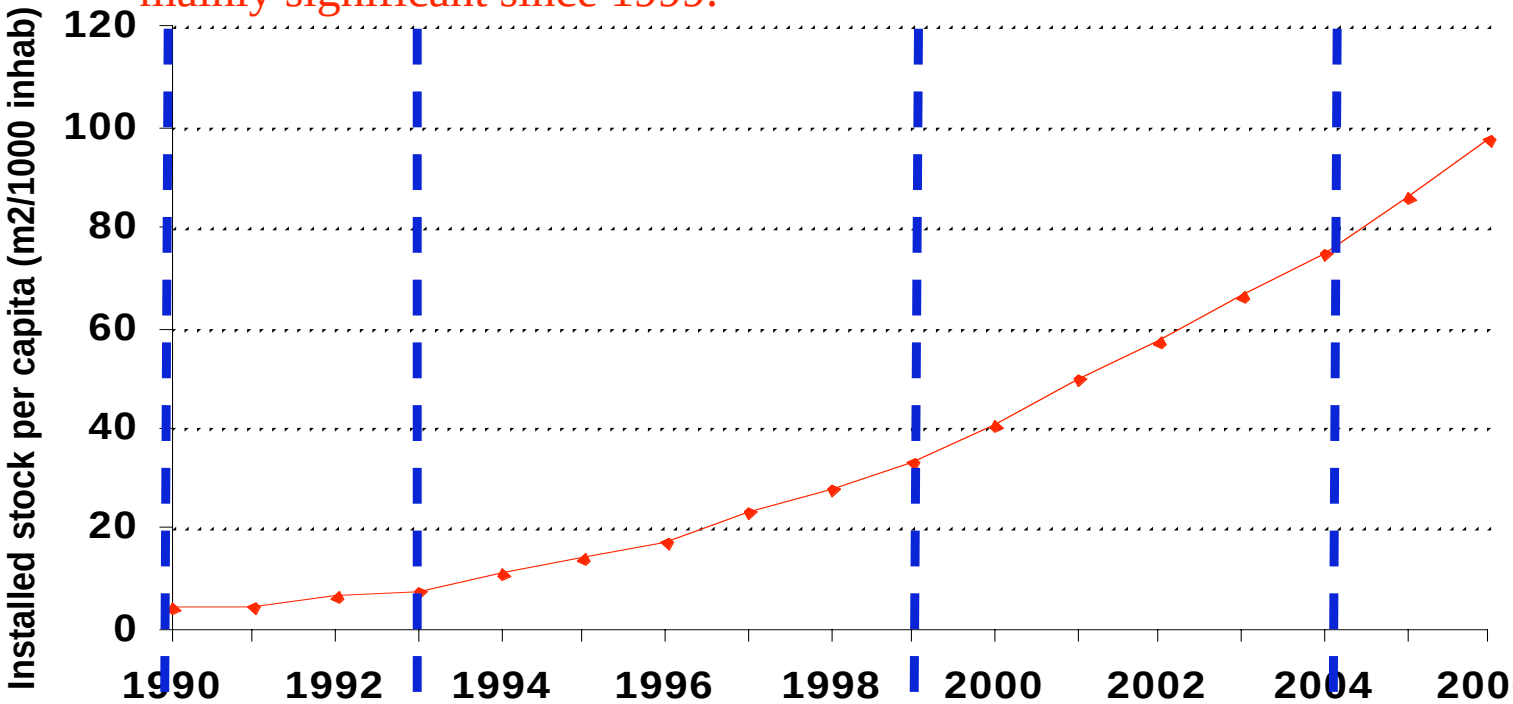




**For sake of comparison all graphs are shown in terms of installed area in m2 per capita**

# Mature markets: case of Germany
# Historical development (1/4)

Several policies implemented for solar water heaters ( 1993, 1995, 1999), plus ecological tax in 1999. Over which period do we do the regression? The diffusion mainly significant since 1999.




Old policies

Solarthermie 2000Plus

Solarthermie 2000

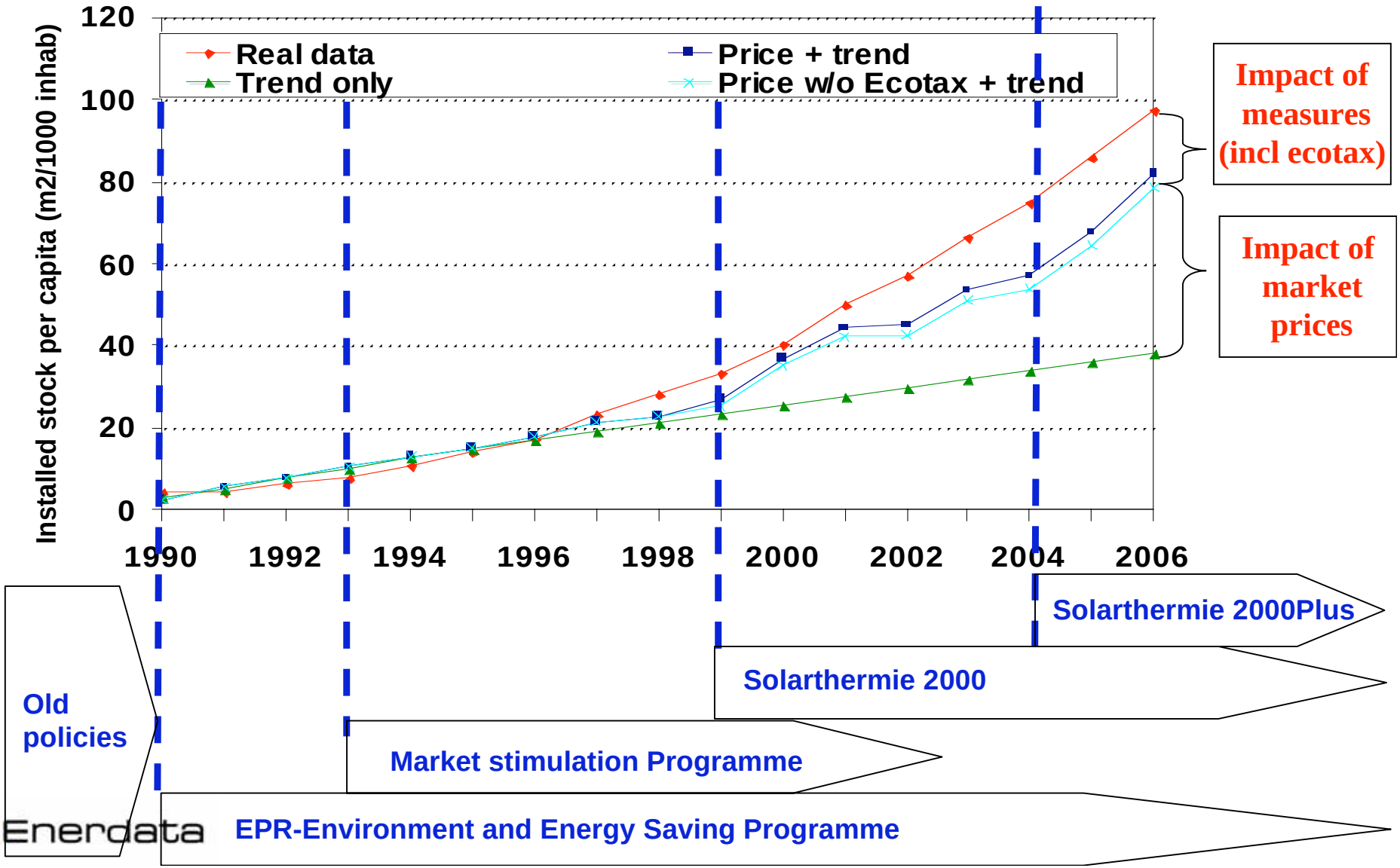
Market stimulation Programme

EPR-Environment and Energy Saving Programme

Enerdata

# Mature markets: case of Germany
## (2/4): installed capacities

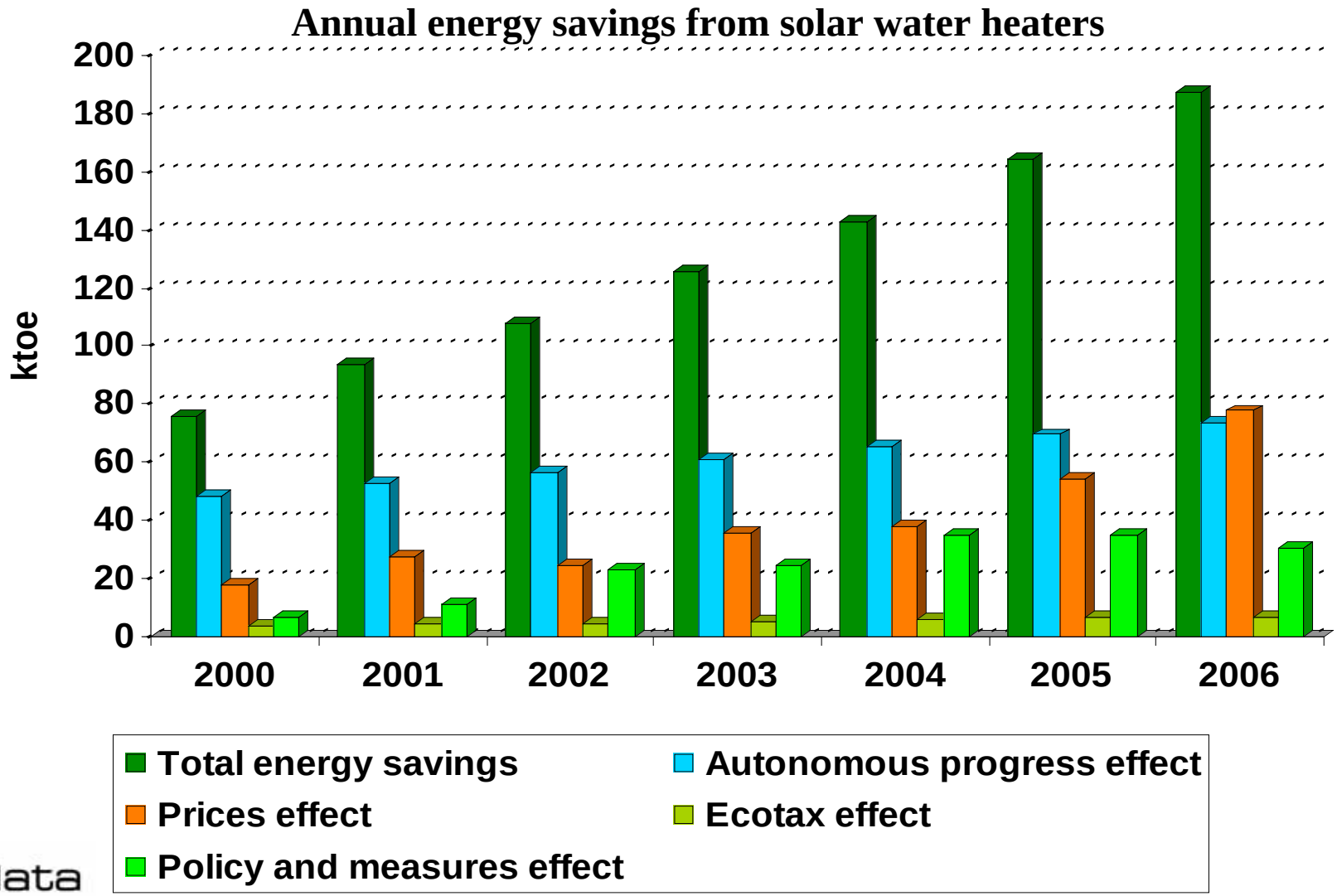
**Regression until 1999:** Ln (**IC**) = 1.08 X ln (**t**) + 1.03 X ln (**P**) - 4.96 + $\varepsilon_t$



# Mature markets: case of Germany

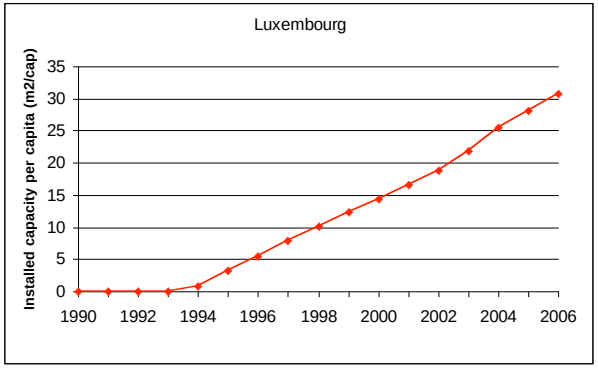
## Energy savings (4/4)

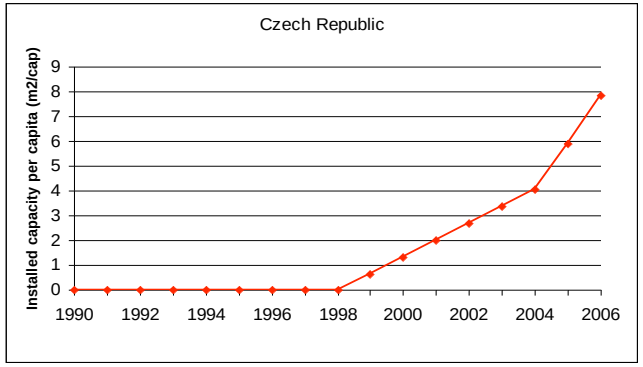
Energy savings linked to policies include ecotax (around 20% of total savings) ; limited impact of ecotax (equal around 5% of average energy price since 1999)

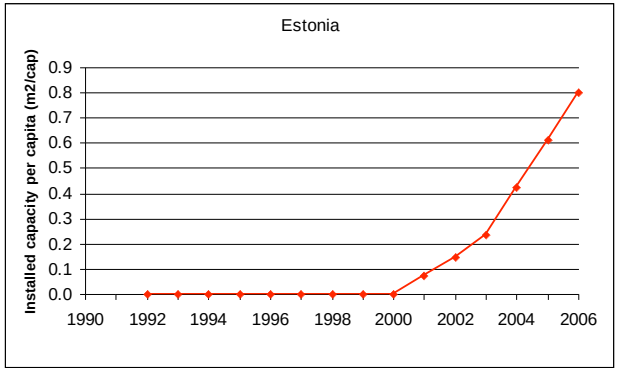


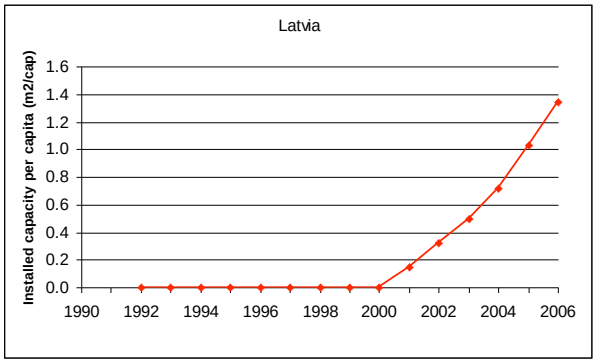
ADEME

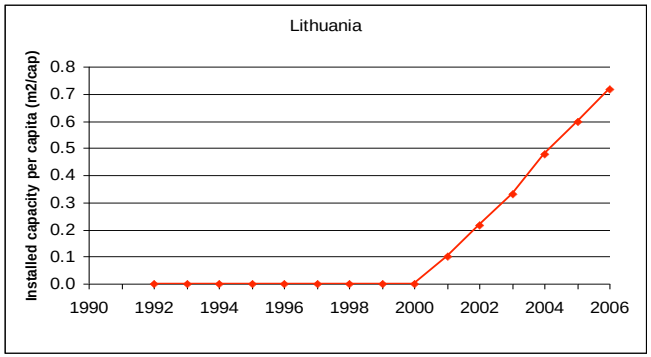
# New markets:
Recent policies

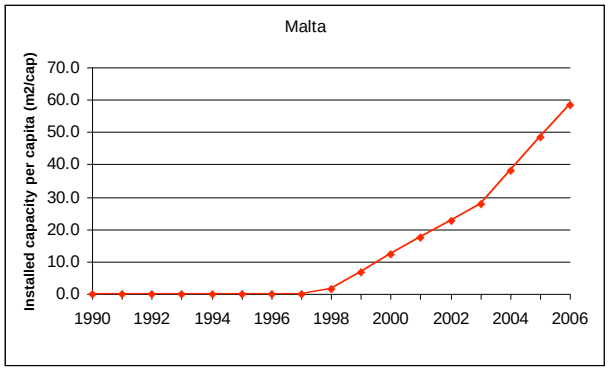


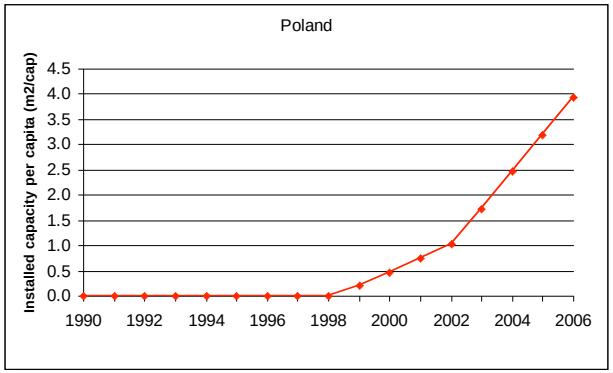



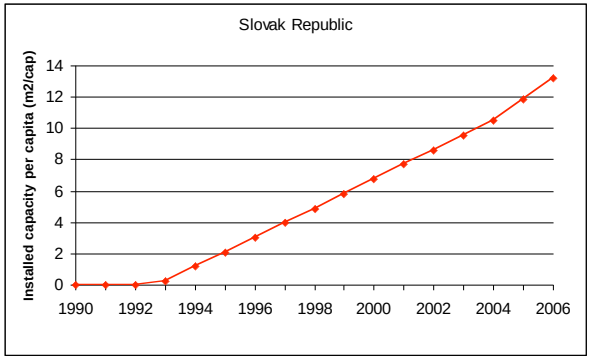



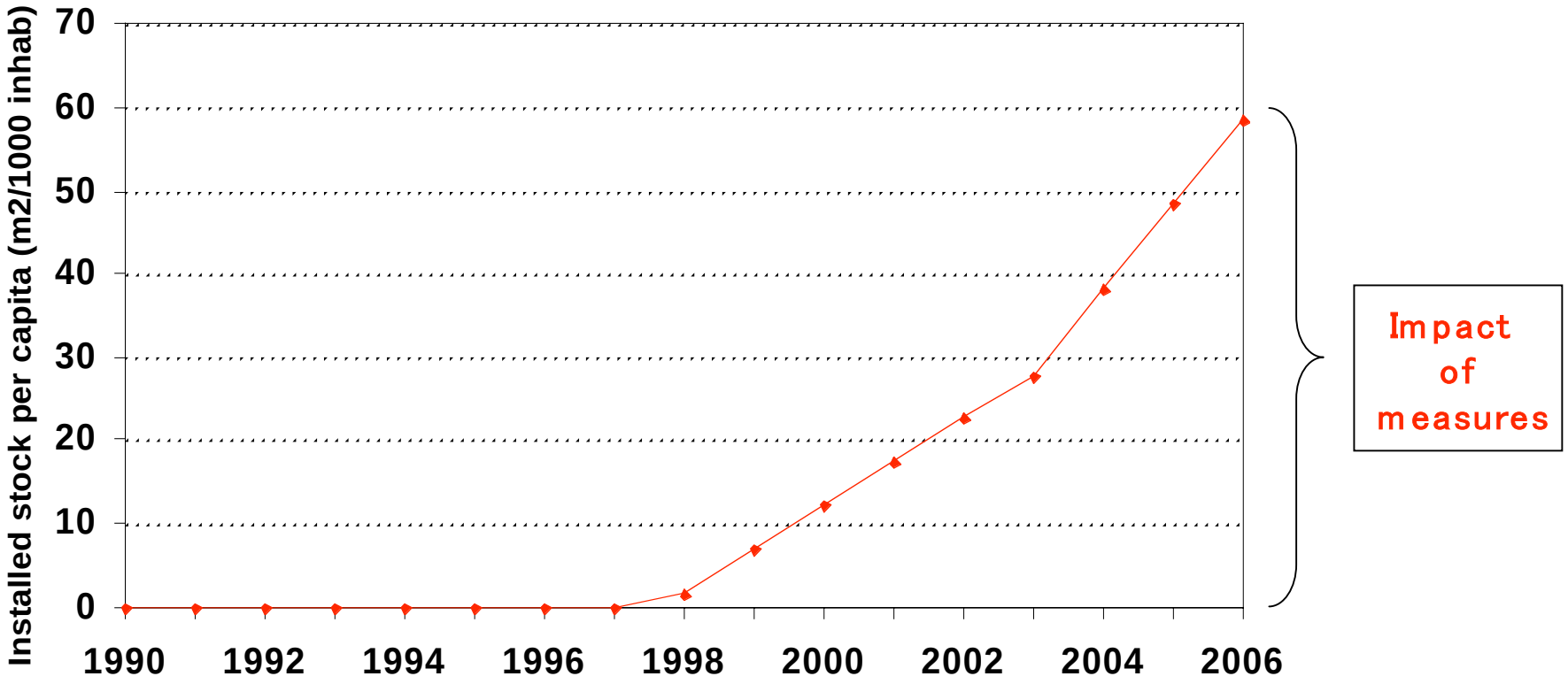




Enerdata

Is the beginning of the diffusion due to a policy or is there a data problem?

# New markets :
Malta Case Study



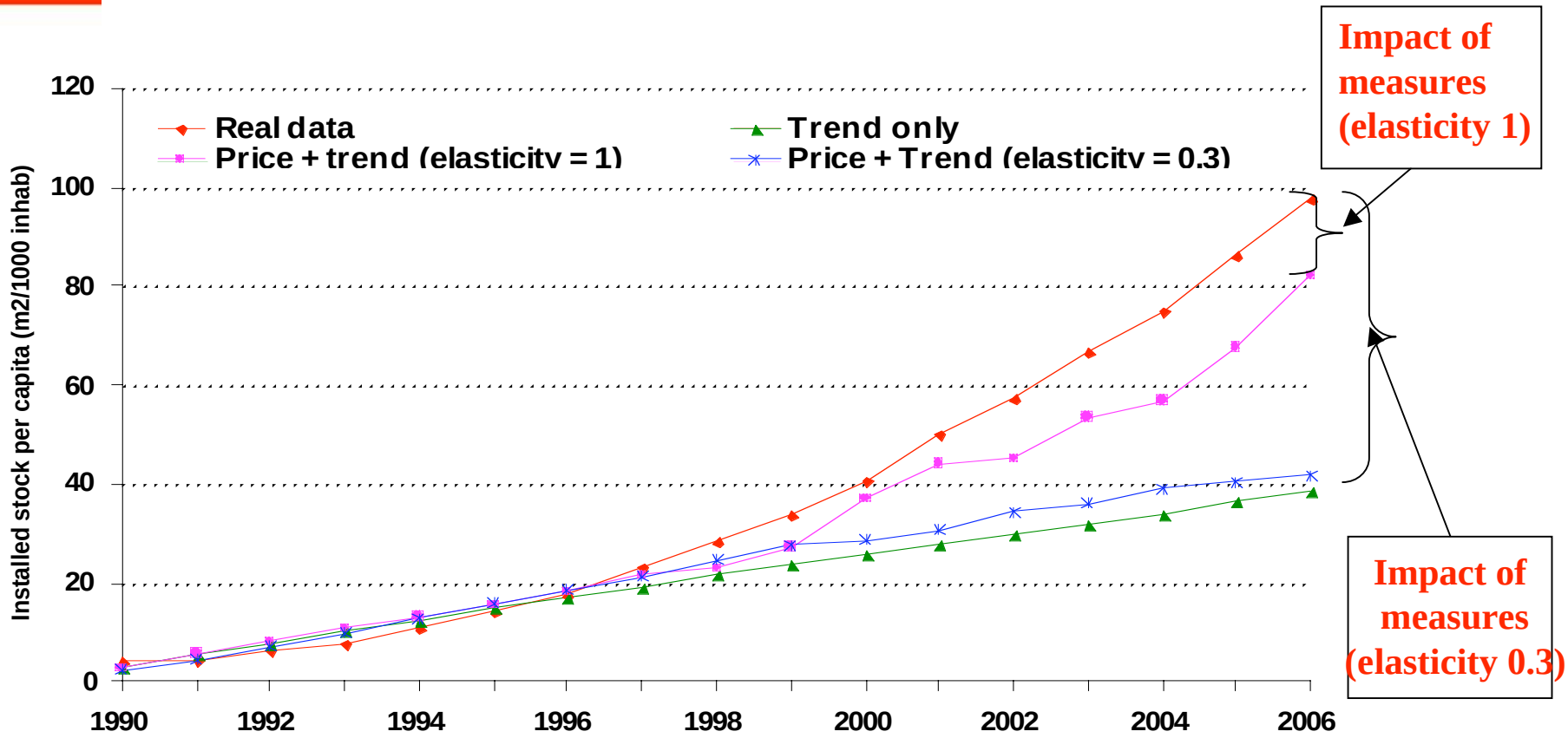
# Top down assessment of energy savings for solar heaters: first conclusions (1/2)

- No data limitations: all countries are covered even if for most EU New Member Countries data start in the late nineties

- Definition of trends or baseline difficult for countries with mature markets

- Role of energy price variable: negligible for France, very high in Germany:
  - ✓ quality of the estimate of price elasticity questionable as short period ;
  - ✓ use of same price elasticity for all countries? (default value calibrated on a longer period and all countries)

# Impact of price elasticity (case of Germany)




**Price elasticity of 0.3 about EU average**

# Top down assessment of energy savings for solar heaters: first conclusions (2/2)

- Need of country specific coefficient of energy saving to account for difference in solar flows; however decision has to be taken on the way to measure the savings; in terms of energy displaced? In terms of solar inputs?

- No need to account for the lifetime of energy savings: removal/ replacement of solar heaters at the end of their lifetime implicitly taken into account in the measurement of the installed solar area

- Similar approach seems applicable for other case studies with market diffusion indicators

# New cars

# Estimation of energy savings linked to policy measures: methodology for new cars (1/3)

➢Change in new car efficiency measured from the test specific consumption of new cars sold every year in litres/100km

➢Trends in the specific consumption of new cars and hence the related energy savings can be explained by the following factors:

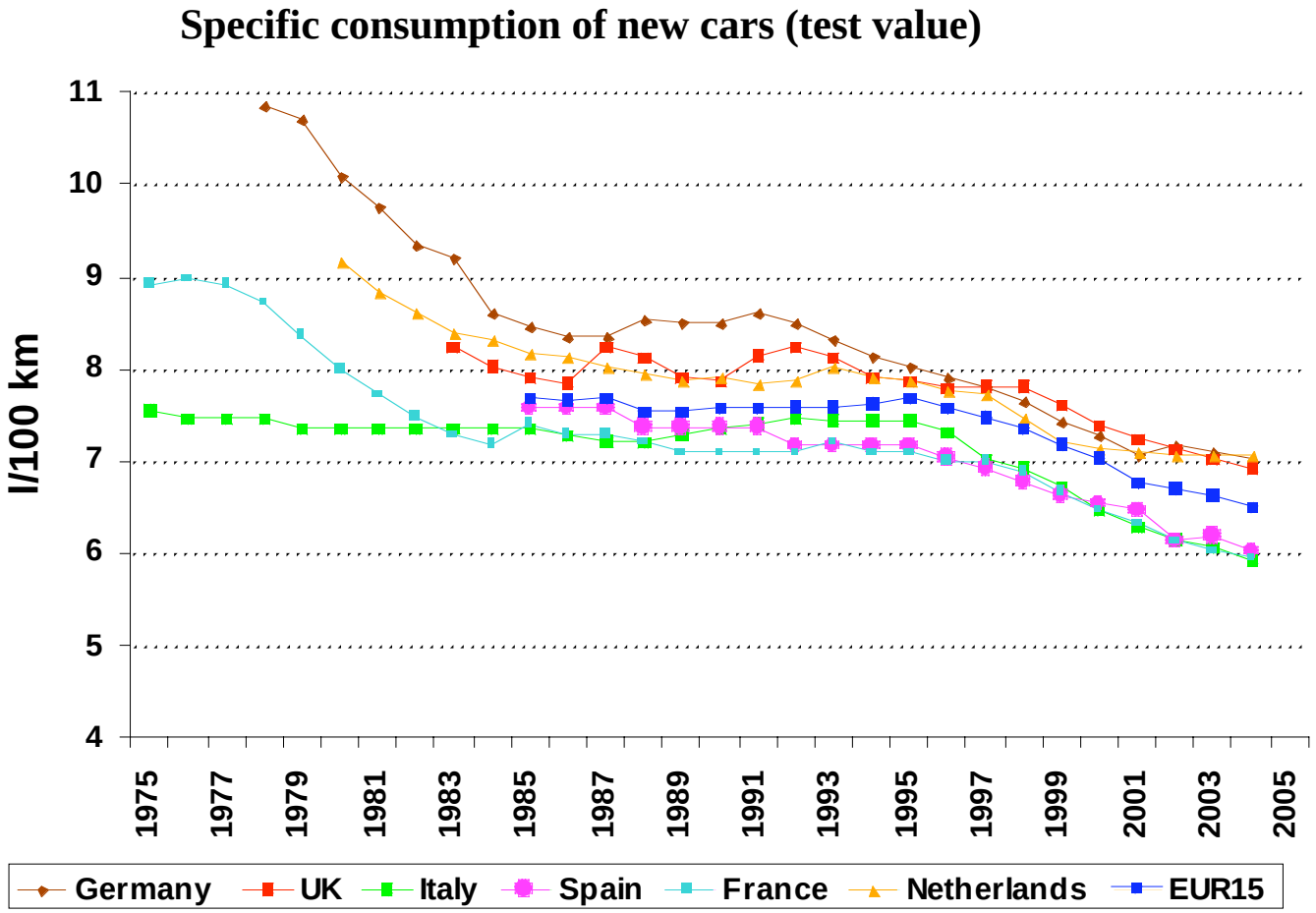
- Change in the average size of vehicles (in terms of weight, or horse power or engine size in cm3) ("hidden structure effect") ( towards larger or more powerful cars, ➔ energy savings are underestimated
- Autonomous trend (in technical efficiency)
- Motor fuel price
- EU policy (ACEA/JAMA/KAMA agreement) 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 interesting to consider but limited in practice due to data availability ; only tested for one or two countries

➢ ➔Direct rebound effect not taken into account at this stage (may be introduced later through the annual distance travelled by new car)

# Estimation of energy savings linked to policy measures: methodology for solar heaters (2/3)

➢Identification of the period over which policy measures either are negligible or have a limited impact so as to get the autonomous trend




➢Very different trends before and after 1995, mainly as result of the ACEA/JAMA/KAMA agreement

➢What is the autonomous trend: before or after 1995?

Enerdata

# Estimation of energy savings linked to policy measures: methodology for solar heaters (3/3)

➢ Modelling over that period of the trend in the specific consumption of cars (SC) (by country) (in litre/100km)* :

- Time to capture an autonomous trend
- Average price of gasoline and diesel

➢To clean the impact of fuels substitution between gasoline and diesel, total energy savings will be calculated separately for gasoline and diesel vehicles as well for alternative fuels vehicles and then added together.

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

- ✓ 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 (>0 or <0 savings depending on the variation) linked to change in crude oil price (market related)

* or litre/100km/kW if car size taken into account

# Source of data and information on new cars
**(1/2)**

- Data on the specific consumption of new cars (test value):
  - ✓ assessed in the annual monitoring of the ACEA/JAMA/KAMA agreement for **all EU-15** countries **since 1995** (available in ODYSSEE)
  - ✓ **not available for new EU members**.
  - ✓ for a few countries, available as **long time series** (e.g. since 1980 for France, Denmark, Austria, and since 1990 for Italy, UK and Germany) with a break due to a change in the way to measure the test consumption
  - ✓ Data by car size available for a few countries from national sources (e.g. France, Ireland); from international sources, only available for ACEA, which represent a decreasing market share of cars sales in the EU

- Gasoline and diesel price:
  - ✓ from Enerdata database*

- Number of new cars registered
  - ✓ from ODYSSEE

*Source IEA, Eurostat

# Source of data and information on new cars
**(2/2)**

- Annual distance driven by new cars:
  - ✓ not available
  - ✓ only available for the average for all cars ➔ underestimation of energy savings as new cars travel more than the stock average

- Technical coefficient accounting for the difference between the test value and the actual value for the specific consumption:
  - ✓ only estimate ➔ will be calibrated from actual data available (e.g. estimated in a range of 15-20% from Secodip survey in France) and/ or by comparison between the simulated gasoline or diesel consumption of cars and the actual gasoline or diesel consumption of cars.

- Energy policy measures:
  - ✓ MURE database
  - ✓ IEA energy efficiency database
  - ✓ WEC data base on energy efficiency policies

# Classification of countries

Two group of countries:

- "Countries with national measures: e.g. Germany, UK, Finland, Sweden, Austria, Denmark, France
  - ✓ Tax on motor fuels (increased or new) : Germany, UK, Finland, Sweden
  - ✓ Tax on car purchase linked to energy efficiency and/or CO2 emissions*: Austria, Denmark, UK
  - ✓ Annual registration tax linked to energy efficiency and/or CO2 emissions*: Germany, Denmark, UK, Sweden

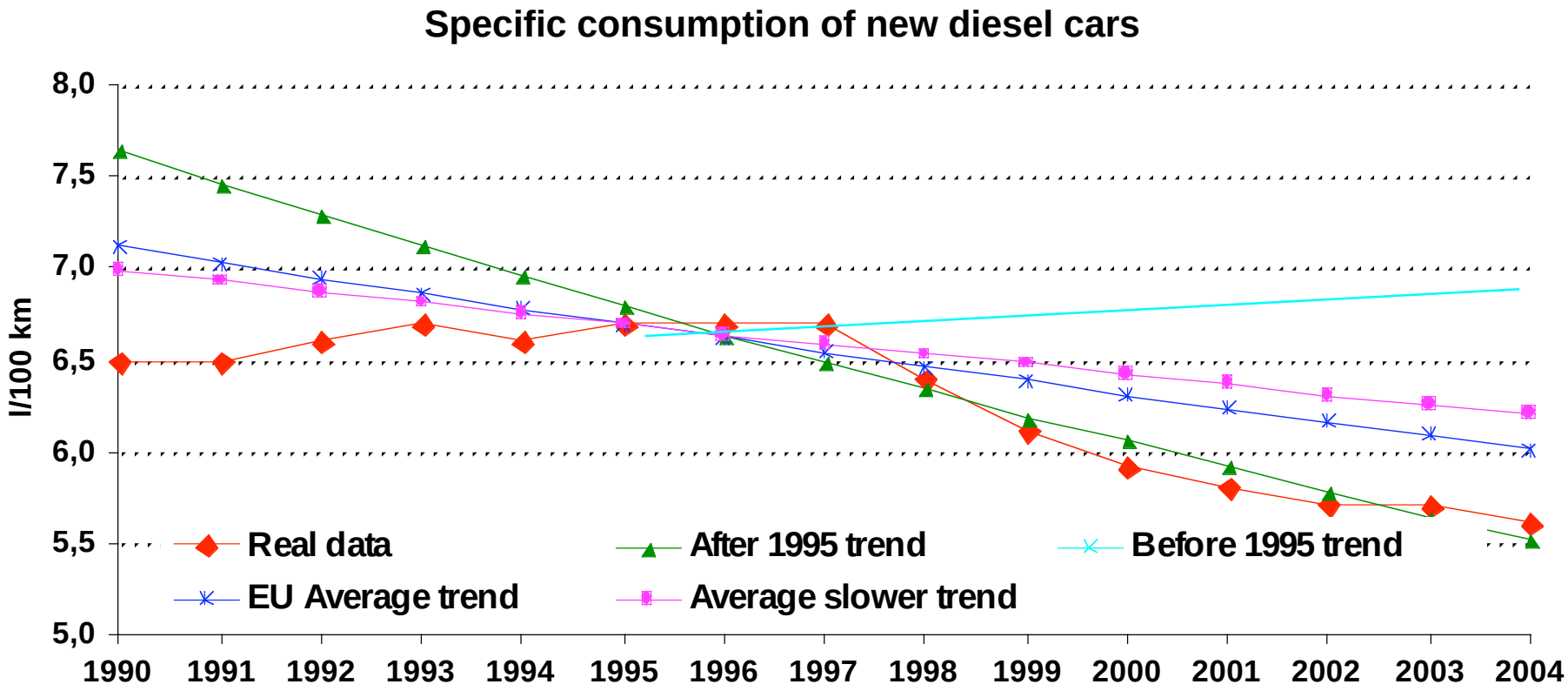
- "Countries without national measures ➔ trends mainly influenced by ACEA/JAMA/KAMA agreement, market price and autonomous trend

* France: exist measures since 2006 on commercial cars only

# Countries without national measures: case of France: diesel cars

## What autonomous trends to be considered?

- 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
- Trend of the average of the 3 countries with the lowest autonomous trend (“average slower trend”)

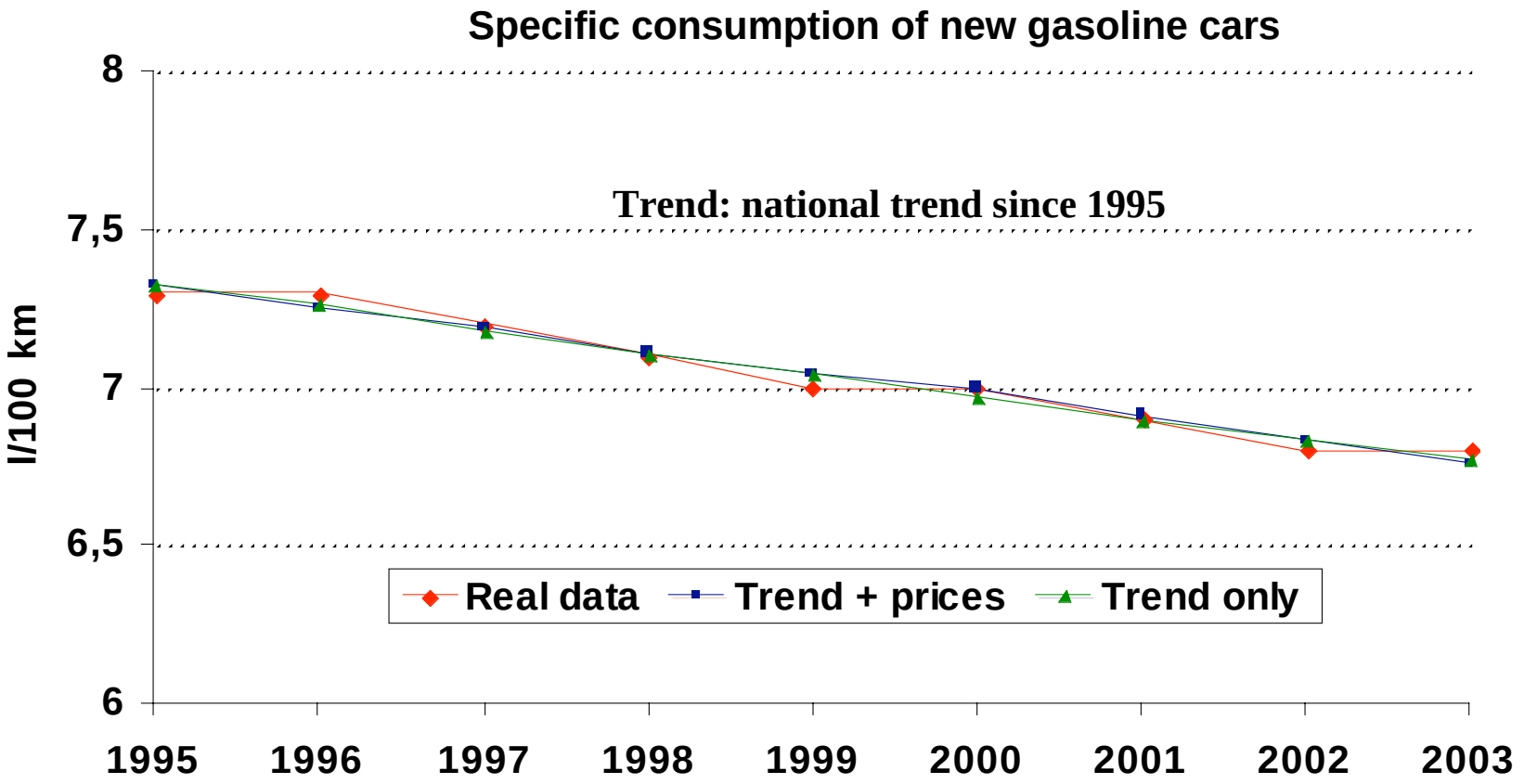



Enerdata

# Countries without national measures: case of France: gasoline cars

**Prices effect not significant**

**Trend: national since 1995 (regression 1995-2003: Ln (IC) = -0.010 X ln (t) + 2.05 + $\varepsilon_t$**

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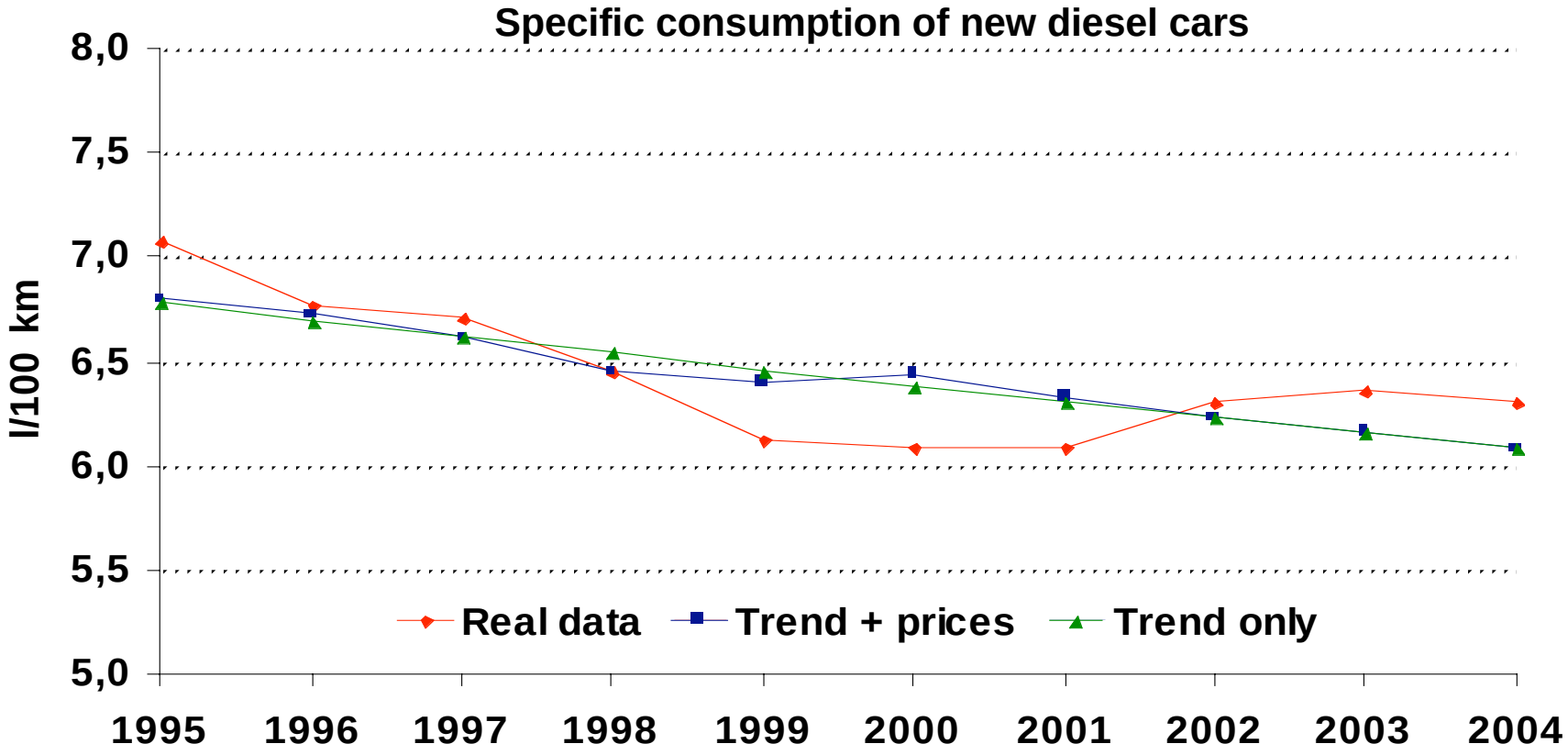
# Countries with national measures: case of Germany Diesel cars

**Price effect not significant**

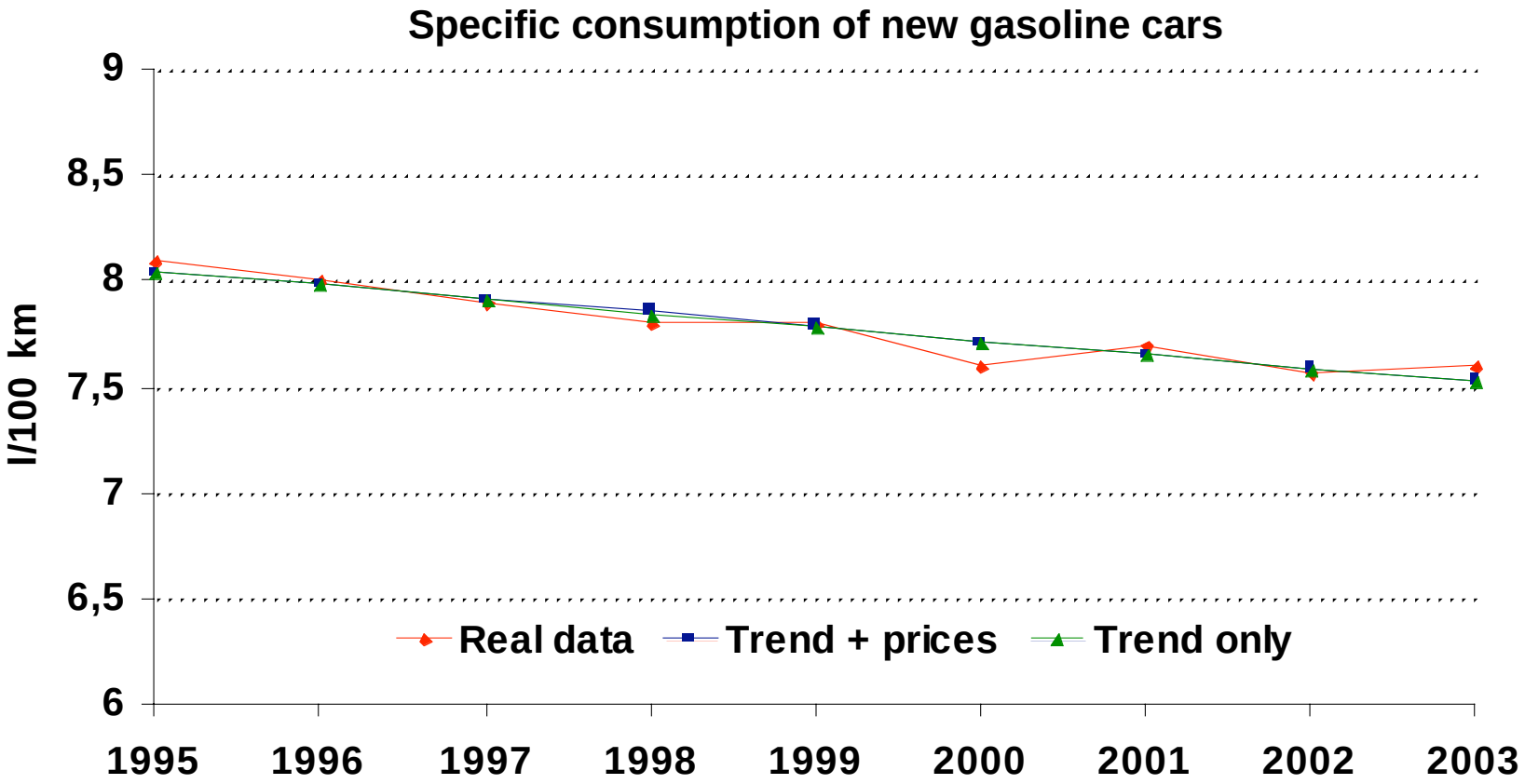
**Trend: national since 1995; regression 1995-2004:** Ln (**IC**) = -0.012 X ln (**t**) + 1.99 + $\varepsilon_t$



# Countries with national measures: case of Germany: gasoline cars

**Prices effect not significant**

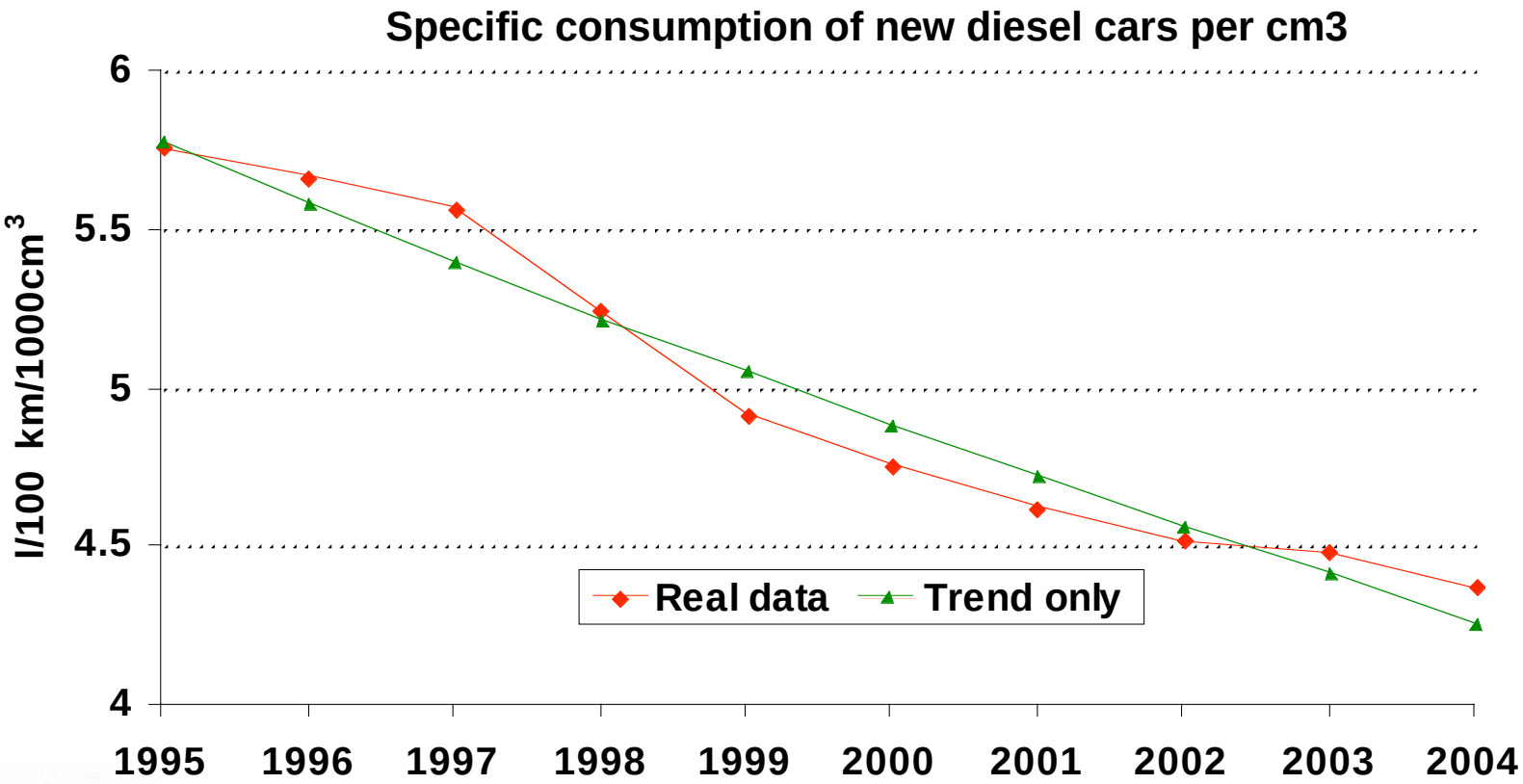
**Trend: national since 1995; rRegression 1995-2003:** Ln (**IC**) = -0.008 X ln (**t**) + 2.13 + $\varepsilon_t$



# Countries with data on engine size: case of diesel cars in France

The impact of change in average car size can be done if data are available ➔ engine size in cm3 seems to be the most relevant indicator

- **Trend of –3,4% (close to technical trend) instead of –2.3% (technical and non technical trend)**
- **Better estimate of energy savings ( underestimated if no correction of size)**
- **Engine size data available ONLY for ACEA members**

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# Energy savings of new cars: preliminary conclusions

- Data limitations: no data for most EU New Member Countries (data not covered yet by the EU monitoring)
- Definition of trends or baseline to be decided
- Role of energy price negligible so far, which is not surprising
- Need of define coefficient to account for difference between test values and actual values
- Similar approach seems applicable for other case study with energy consumption indicators, although this case study may be simpler as other end-uses