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

How to measure the overall energy savings linked to policies and energy services at the national level?

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IEPEC 2010

9 June 2010

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coordinated by

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Overview

- Background: the Energy Services Directive (ESD) and monitoring energy savings; the EMEEES project
- Bottom-up or top-down?
- The importance of monitoring for the effectiveness of the ESD: all, additional, and early energy savings
- How to ensure consistency between bottom-up and top-down calculation methods
- EMEEES methods tested in practice
- Conclusions on the selection of bottom-up and top-down methods
- How to achieve harmonisation?

ESD - the EU Directive on Energy End Use Efficiency and Energy Services

- The ESD sets an indicative target for EU Member States (MS) to achieve **9% annual energy savings by 2016** from energy services and other energy efficiency improvement (EEI) measures. First reports due in **2011**.
- But even until now, a ***common methodology on how to measure and evaluate these savings*** has not been agreed on.
- The set of common and harmonised evaluation methods developed by EMEEES would ***enable MS*** to ***report EEI activities and their impacts in a common way and with a harmonised accounting system***.
- Consequently, the methods designed by EMEEES would help the MS to prove to the European Commission the fulfilment of the indicative cumulative annual energy savings target of 9 percent by 2016.

Project Context: EMEEES (11/2006 to 04/2009)

- **21 partners** (agencies, science, energy industry)
- **support** the implementation of the EU Directive on energy end-use efficiency and energy services, ESD (2006/32/EC)
- developed harmonised **methods** for evaluation of energy savings (20 bottom-up and 14 top-down cases of methods)
- build trust in methods and hence in savings evaluated
- developed a **template** for national energy efficiency action plans
- provided **practical advice and support** for the European Commission
- provided **platform for exchange**: *www.evaluate-energy-savings.eu*

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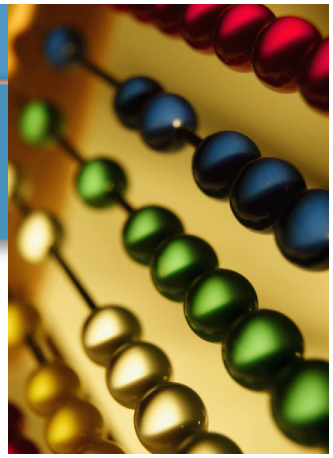
Bottom-up methods – formula and levels



- **General formula for energy savings:**

  total ESD additional annual energy savings =
  unitary gross annual energy savings per unit or participant
  * number of units or participants affected by the measure
  * (1 – double-counting coefficient)
  * (1 – *free-rider fraction* + multiplier (spill-over) coefficient)

level 1	If possible: deemed unitary energy savings = EU level default value
level 2	If possible: deemed unitary energy savings = national level default value, based on model or sales statistics, or samples of installations
level 3	Measure/Participant-specific data, e.g., on space or water heating systems, buildings, and number of inhabitants Sometimes: deemed or ex-post average unitary energy savings = measure-specific default or average value, based on model or sales statistics, or samples of participants

Example: Default values proposed for appliances

Case application	Default values for unitary annual energy savings				
Condensing boilers	For additional energy savings: 5.6 kWh/m^2/year For all energy savings or early replacement: 14.7 kWh/m^2/year Calculated for 3207 heating-degree days, to be modified by national value				
Cold appliances and washing machines	For A++ cold appliances: 61 kWh/year For washing machines below 0.17 kWh/kg: 0.06 kWh/standard cycle				
Office equipment: values in kWh/appliance/year, savings calculated vs. inefficient models of the same type	Type of office equipment	Active mode	Standby mode	Off mode	Standby incl. off mode
	Desktop PC	100.6	4.6	5.0	8.8
	Laptop PC	52.7	6.0	2.8	8.7
	Monitor CRT	36.8	17.3	2.5	19.4
	Monitor LCD	29.6	5.8	2.0	7.8

Top-Down (TD) methods

- Top-down methods rely on **energy efficiency indicators** calculated from national statistics
  (also called “top-down indicators”) (e.g. ODYSSEE indicators)
- For the top-down methods, **a regression analysis** can be done using the following equation to find the reference trend for ***additional*** energy savings:
- ln ES = a + b T + c ln P + K
- with :
  ln : logarithm; ES: energy saving indicator; b: trend; T: time; P : energy price;
  c : price elasticity (may be differentiated between upward and downward price elasticity); K: constant coefficient.

Additional or all energy savings?

- **ESD does not mention** that energy savings counting towards the 9 % target must be **in addition** to energy savings from autonomous changes
- But policy-makers and businesses usually want to know (but maybe not report) what is the additional impact of their measures
- **EU Action Plan for Energy Efficiency (2006)** obviously expects strong contribution from ESD (and other recent Directives): „new policy“ leading to **new and additional** energy savings compared to autonomous changes and even previous policy
  - EU Action plan requires 1.5 % per year of primary energy efficiency improvement; „new policy“ to bring 0.7 % per year (would be equivalent to ESD: average 1 % per year in non-ETS sectors)
  - autonomous changes: “brought about by natural replacement, energy price changes, etc.” (EU Action Plan)

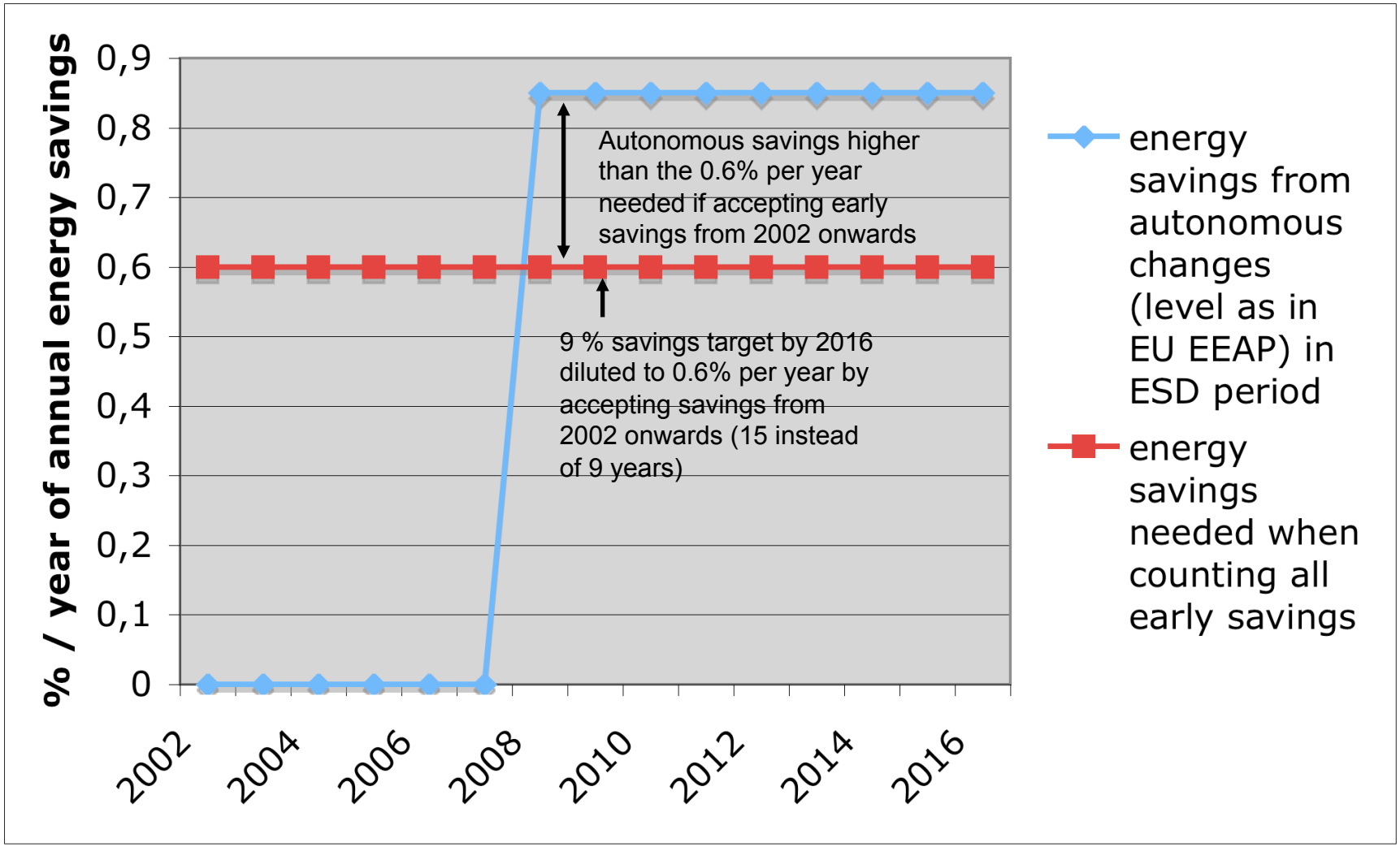
„Early Action“

- ESD Annex I: “**Energy savings** in a particular year following the entry into force of this Directive that result from energy efficiency improvement **measures** initiated in a previous year not earlier than 1995 and **that have a lasting effect** may be taken into account in the calculation of the annual energy savings.“
- “... that have a lasting effect”: Interpretation unclear!
  - **‘Early measures’?**
    (e.g., building code from 2005 and still in force in 2008 - 2016)

Or

  - **‚Early energy savings‘?**
    (e.g., from energy-efficient building constructed in 2005)

Potential consequences of admitting both autonomous and early energy savings: in the extreme case, no new additional energy savings needed at all

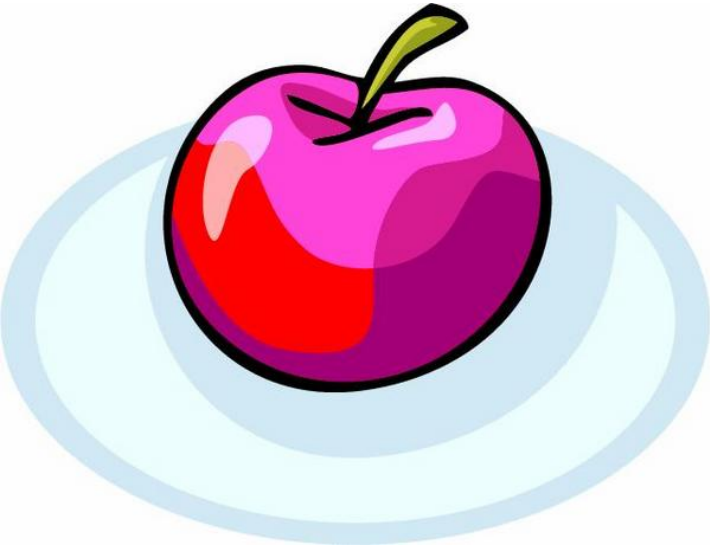


Conclusions on autonomous and early energy savings

- **Enable both** the evaluation of **all** energy savings (including autonomous savings) **and** energy savings additional to autonomous changes (**additional** energy savings)
- **Enable** the evaluation of **early energy savings**, if the Commission with the ESD Committee and/or a Member State decides to allow these to be counted towards achieving the ESD target

Consistency in integrating TD and BU results

Top-down



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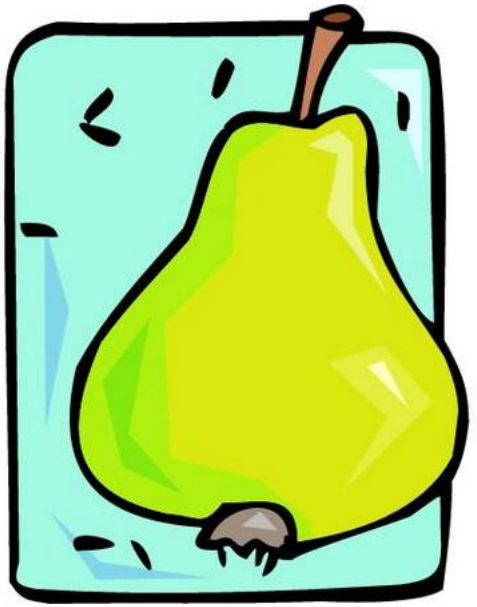
Bottom-up



=> ESD energy savings ?

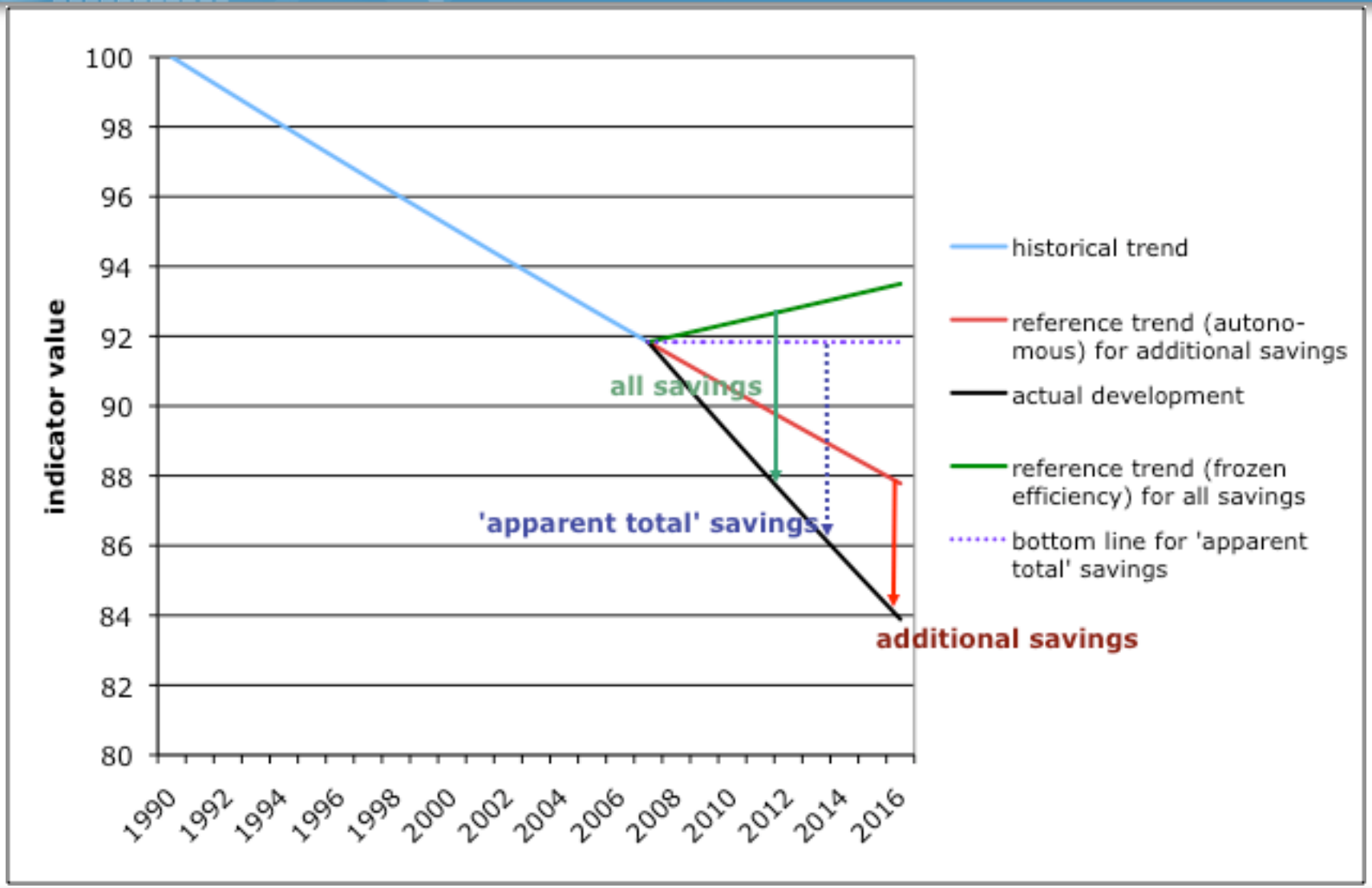
Baselines and reference trends

- Unlike energy, **energy savings** can usually **not directly be measured,** but **in relation to a reference situation** (‚counterfactual')
- ESD Annex IV: "*Energy savings shall be determined by measuring and/or estimating consumption,* ***before and after*** *the implementation of the measure,...*"
- For bottom-up methods, the reference situation 'before' the measure is called the **baseline**.
- For top-down methods, energy savings are calculated from the difference between the actual value of an indicator and the value for the same year that would have materialised in a **reference trend.**

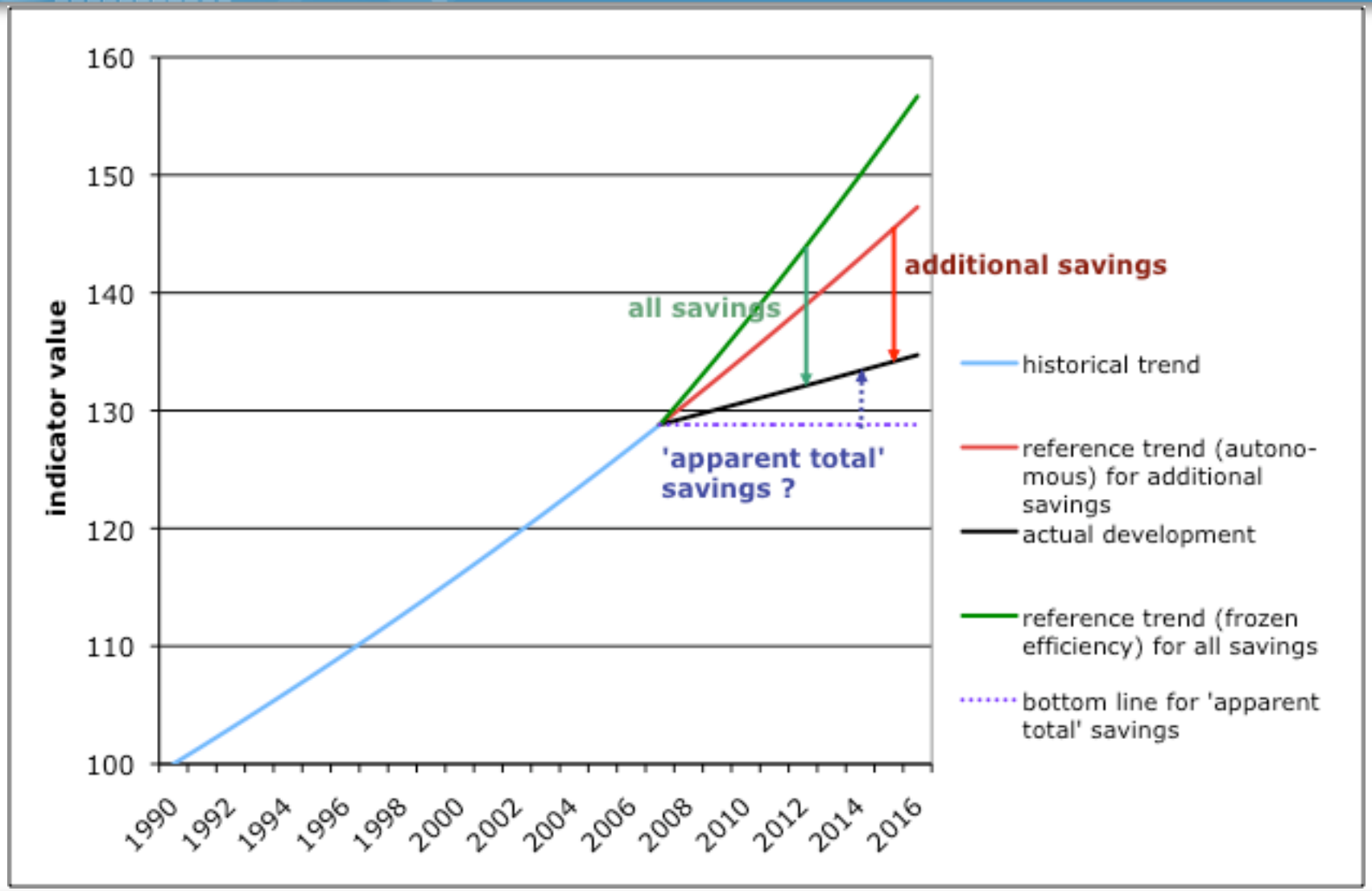
Consistency: Bottom-up

Element	All energy savings	Additional savings
Baseline case 1: replace existing equipment	Before action situation or stock average *e.g., refrigerator stock average consumption*	**Without measure situation or inefficient market average** *e.g., average consumption of new inefficient refrigerators*
Baseline case 2: add-on energy efficiency action	Before action situation or stock average *e.g., consumption of building before insulation*	Before action situation or stock average *e.g., consumption of building before insulation*
Baseline case 3: new building or equipment	A reference situation	A reference situation
Avoid double counting	yes	yes
Multiplier effects	yes	yes
Free-rider effects	no	**yes**

Top-down indicator with ‚right' trend

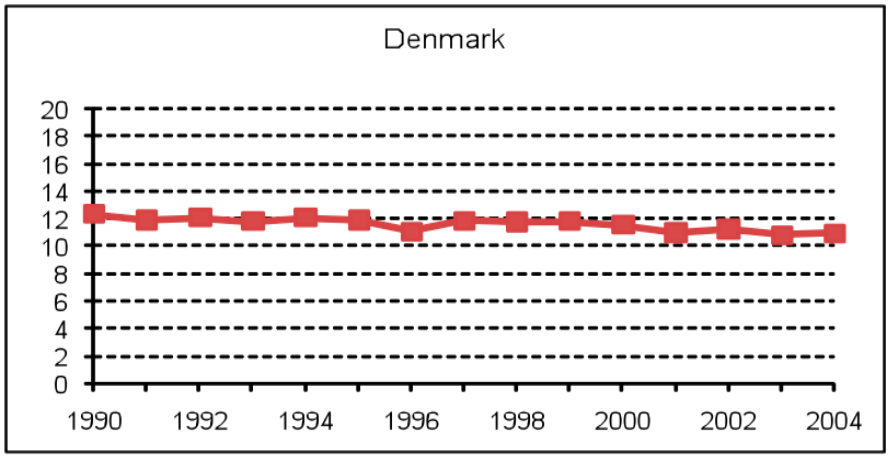


Top-down indicator with ‚wrong' trend

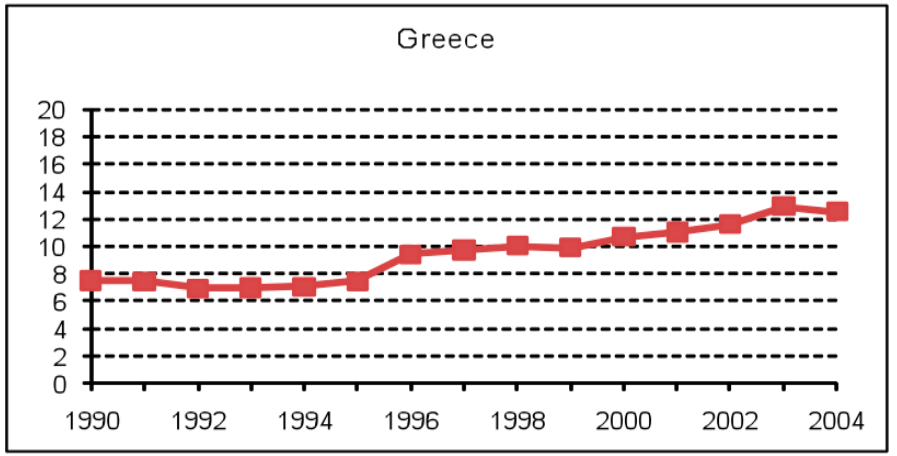


Some Top-down indicators can go in any direction

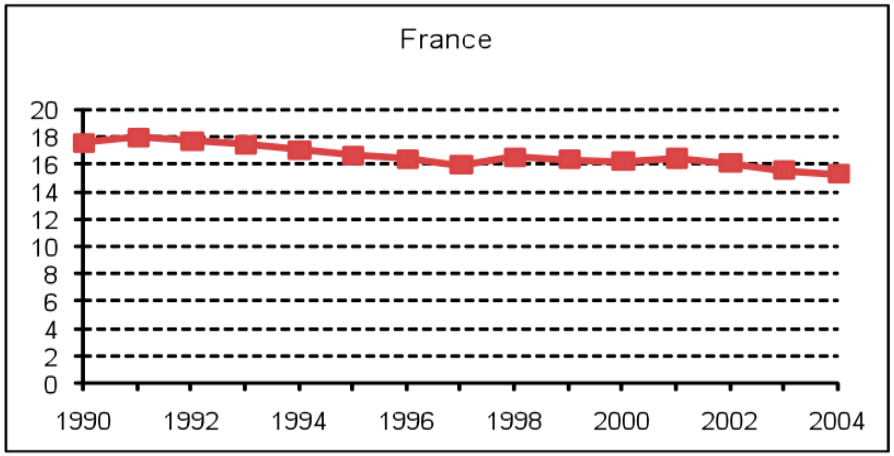
Case of a stabilisation



Case of an increase



Case of a reduction



Example: space heating consumption in kgoe / m2

Consistency: Top-down

Type of indicator	All energy savings	Additional savings
Specific energy consumption, solar water heaters	For new appliances and vehicles, solar water heaters, and vehicle stock: Reference trend = Zero change (‚apparent total' savings close to all savings)	Reference trend = EU default value based on 3 countries with ‚slowest' trend. Plus EU default value for price elasticity (rising price)
Unit energy consumption of sectors, other diffusion	No reference trend from statistics possible. Zero change not valid (‚apparent total' savings not the same as all savings). Calculate reference trend by bottom-up modelling with frozen efficiency??	No EU level reference trend possible. Use country-specific reference trend if possible. If not: Calculate reference trend by bottom-up modelling ?? Plus EU default value for price elasticity (rising price).

Tests of EMEEES methods

- 13 national workshops, an EU workshop (June 2007) and an EU Conference: general principles accepted, but comments on details => helpful to simplify approaches

- Pilot tests on real EEI measures in four MS:
  => EMEEES bottom-up methods and case applications tested can be applied in principle;
  improvements in the details proposed;
  e.g., some default values needed to be adapted

- Analysis: Which EMEEES cases can be applied for the measures mentioned in the NEEAPs?

Advantages of BU and TD methods

- Bottom-up able to cover 90% of ESD savings (result of analysis of Member States' planned measures)
- Bottom-up needs specific monitoring but provides info on (cost) effectiveness of measures, potential improvements, GHG emission reductions.
- Bottom-up has difficulties to measure multiplier *and free-rider* effects, impact of soft measures, mainly important for appliances and vehicles
- Top-down based on specific energy consumption indicator of equipment (e.g., kWh/unit of equipment/year or kWh/km) in principle includes multiplier *and free-rider* effects, impact of soft measures => well-suited to capture the effects of the whole package of measures

Applicability of top-down calculation methods in EU MS

Full title	Robust results?	Data MS	Applicable
Building shell and heating systems	**Some**	**EU-15**	**sometimes**
Household, all electricity for non-heating end-uses	**No**	**EU-15**	
Specific white goods (refrigerators)	**Yes**	**EU-15 (most)**	**yes**
Solar thermal collectors / solar heaters	**Yes**	**all**	**yes**
Building shell and heating systems	**Yes**	**few**	
Electricity end-uses in Services	**No**	**few**	
Thermal energy uses in Industry	**No**	**EU-15 (all)**	
Industrial electricity use	**No**	**EU-15 (all)**	
Industrial CHP	**No**	**all**	
New cars	**Yes**	**many**	**yes**
Improvement of car, bus and truck stock	**Yes**	**many**	**yes**
Modal shift in passenger transport	**Some**	**most**	sometimes
Modal shift in goods transport	**Some**	**most**	sometimes
General energy taxation	**Yes***	**all**	**yes***

Conclusion on selection of BU or TD methods (1)

- 1) Possible to use **top-down** calculation methods for **electric appliances and vehicles**, for which there is a well-defined indicator of the sales-weighted annual energy consumption per unit of appliance or per vehicle, and for solar water heaters. **Bottom-up** is possible, too.
- Reference trend for *additional* savings = average trend of the three countries with the slowest decrease;

  Reference trend for *all* savings = base year (2007) value of the indicator;

  for solar water heaters, zero m2 increase in each case
- Correct the reference trend for *additional* savings in case of energy market price increase, value of price elasticity: default +/- 0.1 or 0.2

Conclusion on selection of BU or TD methods (2)

- 2) use **top-down** methods to calculate the effects of **energy taxation** and add them to the effects of bottom-up calculations for a sector, if these bottom-up calculations exclude free-rider effects.
- The energy savings due to taxation must not be added to results of top-down calculations on sectors or end-use equipment, if the latter already include an analysis of price elasticities to separate the effects of energy taxation.

Conclusion on selection of BU or TD methods (3)

- 3) Use **bottom-up** calculation methods for **all other end-use sectors, end-uses, and energy efficiency improvement measures**. This is particularly the case for buildings, for the industry and tertiary sectors with their larger final consumers that are easier to monitor, and for modal shifts and eco-driving in transport.
- In these areas, structural effects can usually not be corrected for in top-down indicators. This will disable the use of top-down methods based on unit energy consumption and diffusion indicators. By contrast, bottom-up calculations are usually feasible.
- 4) At the end of the day, data availability in a Member State will determine the use of methods

Towards a harmonised calculation model

- ESD requires European Commission to propose a harmonised calculation model of BU and TD methods
- Harmonisation = as many **default values** as possible?
- Or **rather harmonised rules** for
  a) **definition** of formulas, parameters, monitoring methods, calculation procedures
  => EMEEES methods and case applications a source
  b) **reporting** of results? => EMEEES reporting checklist a start
- Quality of evaluations and level of harmonisation will improve through **learning by doing** and **exchanging experience**
- Evaluation needed to learn for **refinement** of energy efficiency improvement measures

Thank you!

„Will the European Commission and MS delegates to the Committee make life easy for ESD evaluators AND go for consistent results by using the EMEEES approaches as a start?“

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Objectives of evaluation - further considerations

- The ESD is directed towards the **Member States**
  => for one sector or type of end use, **only one aggregate figure** of energy savings from all EEI measures together (the ‚package') needs to be reported
- => No need to report savings for individual measures / measure operators (e.g., ESCOs, energy companies)
- ESD reporting needs **may differ** from national or other reporting needs
  => **synergies** possible (e.g., *additional* energy savings for ESD - *additional* greenhouse gas reductions from policies and measures for UNFCCC reporting),
  but **conversion** may be needed (e.g., *discounted* savings in white certificates schemes - *annual* energy savings for ESD reporting)
- Evaluation **entails a cost;** but particularly **bottom-up** evaluation allows insights in **why** an EEI measure is **effective** or not, and its **costs**
  => important data for **improving processes and (cost-)effectiveness**

The EMEEES Consortium

21 partners well-experienced in evaluation of energy savings

Project partner	Country
Wuppertal Institut for Climate, Environment, Energy (WI)	DE
Agence de l'Environnement et de la Maitrise de l'Energie (ADEME)	FR
SenterNovem	NL
Energy research Centre of the Netherlands (ECN)	NL
Enerdata	FR
Fraunhofer-Institut für System- und Innovationsforschung (FhG-ISI)	DE
SRC International A/S (SRCI)	DK
Politecnico di Milano, Dipartimento di Energetica, eERG	IT
AGH University of Science and Technology (AGH-UST)	PL
Österreichische Energieagentur – Austrian Energy Agency (A.E.A.)	AT
Ekodoma	LV
Istituto di Studi per l'Integrazione dei Sistemi (ISIS)	IT
Swedish Energy Agency (STEM)	SE
Association pour la Recherche et la Développement des Méthodes et Processus Industriels (ARMINES)	FR
Electricité de France (EdF)	FR
Enova SF	NO
Motiva Oy	FI
Department for Environment, Food and Rural Affairs (DEFRA)	UK
ISR – University of Coimbra (ISR-UC)	PT
Dong Energy	DK
Centre for Renewable Energy Sources (CRES)	GR