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

Application of Calculation Methods: Session 1 – Residential buildings

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Introduction

Context

- Action Plan for Energy Efficiency of the European Commission (COM(2006)545): "*Energy efficiency in the building sector was identified as a* ***top priority***" + "***largest cost-effective savings potential***"
- Implementation of the **EPBD** → measures targeting residential buildings in all the NEEAPs
- 5 BU and 2 TD case applications in EMEEES deal with residential buildings

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Introduction

EMEEES Bottom-Up Case Applications for Residential Buildings
1 Energy performance of new buildings
2 Building envelope improvement
3a: Biomass boilers
3b: Condensing boilers
5 Hot water: solar water heaters, heat pumps

EMEEES Top-Down Case Applications for Residential Buildings
Solar thermal collectors (market diffusion indicator)
Building shell and heating (unit energy consumption indicator)

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a) Building regulation for new buildings

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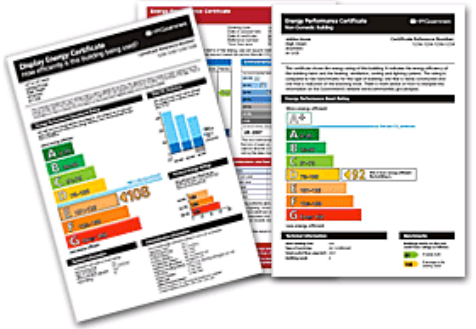
Building regulation for new buildings

- **authors of the method:** Cees Maas, Tom Monné SenterNovem

- **subject**
  - sector: residential (new buildings)
  - end-use: heating, cooling, hot water, ventilation
  - instruments: building codes → minimum energy efficiency requirement

- **context**

  → implementation of the **EPBD**: a frame for the regulations and the calculation methodology



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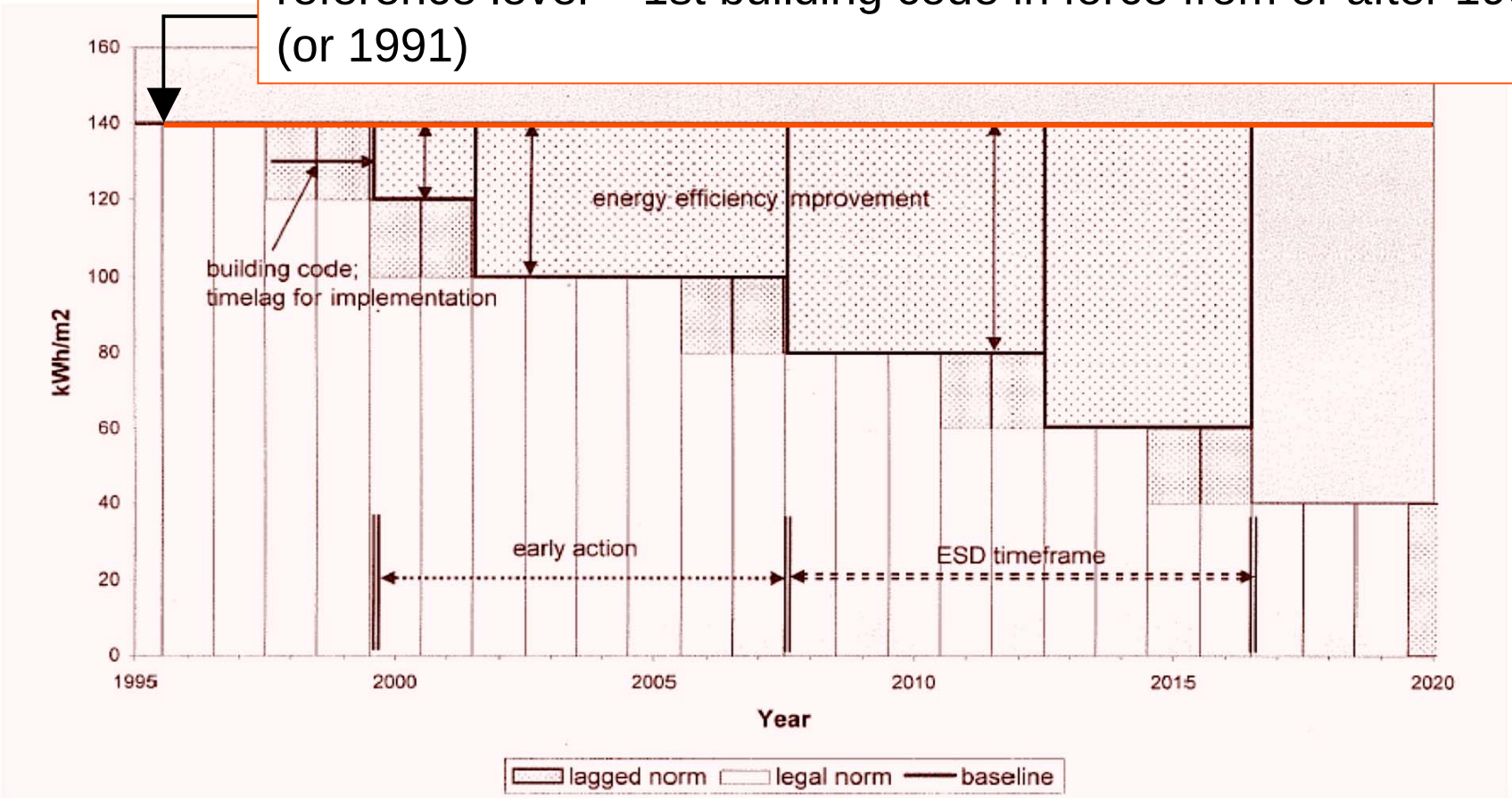
Building regulation for new buildings

- **baseline → assumption: no autonomous development = static baseline**

reference level = 1st building code in force from or after 1995 (or 1991)



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Building regulation for new buildings

STEP 1				STEP 2
Unitary Energy Demand ***(baseline)***	-	Unitary Energy Demand ***(year of action)***	x	Number of actions
kWh/m²(or dwelling)/year				*m²(or dwelling)*

L2	normalised average energy demand per building type	summation per building type and regulation period
L3	specific calculation or measurements for each building (e.g. EPCert)	direct summation per regulation period

Level 3: in practice, for samples / verifications (and maybe for single large buildings)

possible data sources: building statistics (e.g. permits)

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Building regulation for new buildings

- **special issues**
  - **non compliance**:
    - ✓ effective energy demand may be higher than required
    - ✓ proposed default value: 10%

➔ { Unitary Energy Demand ***(baseline)*** - [**(1 + 0,1) x** Unitary Energy Demand ***(year of action)***] }

  - **time lag**:
    - ✓ delay between regulation entry into force and 1st buildings delivery
    - ✓ proposed default value: 2 years
  - **double counting**:
    - ✓ splitting savings between the minimum requirements and beyond
  - **no free riders** (from assumption: no autonomous development)
  - **multiplier effects automatically included** (through static baseline)

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b) Condensing boilers

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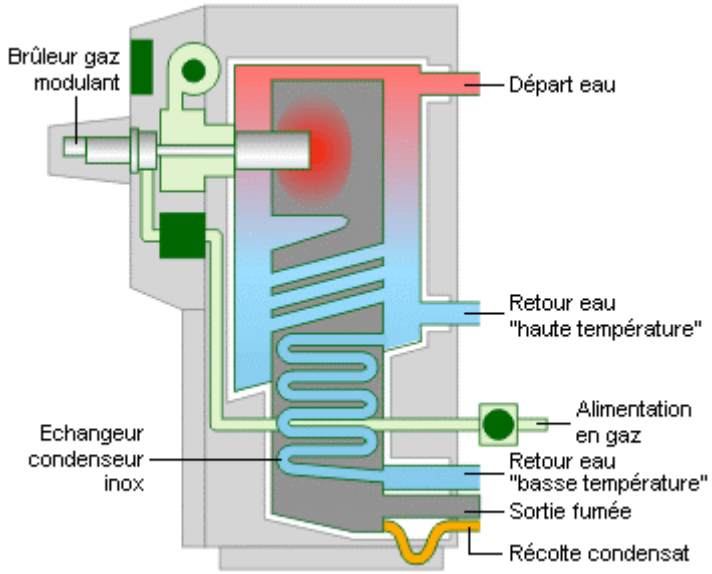
Application of Calculation Methods: Session 1 - Residential buildings
Condensing boilers

- **authors of the method:** Jérôme Adnot, ARMINES Nicola Labanca eERG



- **subject**
  - sector: residential (existing buildings)
  - end-use: heating
  - instruments: information, incentives, etc.
  - efficient solution: **condensing boilers**

- **context**

➔ implementation of the **EuP Directive**:
update of the Boiler Efficiency Directive (92/42/CE)
EuP preparatory study (EcoBoiler)

CE

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Condensing boilers

STEP 1

$$\left[\left(\frac{1}{\eta_{old}} - \frac{1}{\eta_{new}}\right) \times \text{Heating need (normalised)}\right] \times \text{Number of actions}$$

- η_{old}: Replaced boiler
- η_{new}: Condensing boiler
- $\%_{NCV}$
- Heating need (normalised): $kWh/m^2(or\ dwelling)/year$
- Number of actions: $m^2(or\ dwelling)$

STEP 2

L1	European default values based on the EcoBoiler study (and German field data)	no level 1 for the number of actions
L2	National statistics (heating demand) and sales data (boiler efficiency)	summation per building type and climatic zone
L3	Participant-specific data	direct summation

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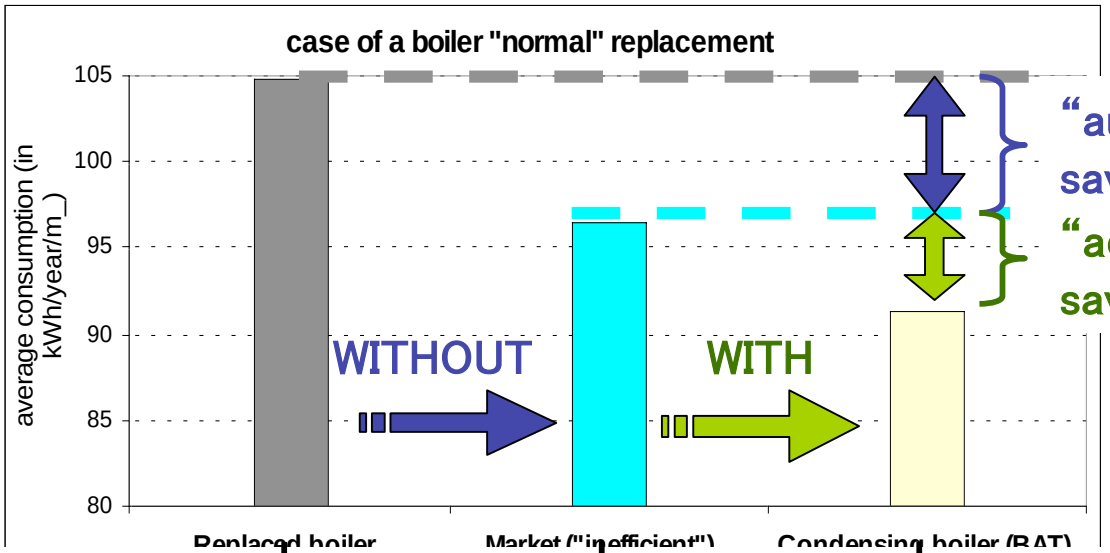
Condensing boilers

- baseline: two cases ("all" and "additional" savings)



L1	*European default values based on the EcoBoiler study and German field data*			
L2	national stock average	"inefficient" market average	"efficient" market average	average per building type and climatic zone
L3	replaced boiler	"inefficient" market average	installed boiler	metered consumption

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Condensing boilers

- **details of the data used**

Efficiencies	"Non efficient" stock values	"Non efficient" market values	"Efficient" values (condensing boilers, radiant panels, etc.)
Boiler	82%	89%	94%
Emitter	92.5%	92.5%	97%
Distribution	93%	93%	97%
Controller	84.8%	84.8%	96.7%

	ΔE in kWh/m2/a for "additional" savings	*ΔE in kWh/m2/a for "all" savings*
E = 86 kWh/m^2/year *	5.6	14.7
Based on the following default values for seasonal average boiler efficiency:		
Efficient condensing boiler	94%	94%
Replaced boiler	89%	82%

** EU average; national data are provided to modify results: heating degree days or national average for E?*

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Condensing boilers

- **other specific issues**
  - **conversion factor**:
    - ✓ ESD requires to use the NCV but GCV commonly used by practitioners
    - → $\eta_{NCV} = 1{,}11 \times \eta_{GCV}$
  - **normalisation factors**:
    - ✓ Heating Degree Days: significant differences between sources
  - **technical interactions**:
    - ✓ possible interaction with thermal insulation of buildings
  - **multiplier and free-rider effects**:
    - ✓ evidences of multiplier effects (UK, NL)
    - ✓ high risk of free-riders (particularly relevant in case of financial incentives *and* already high market shares and/or few participants)

Condensing boilers

- **pilot test: case of the French White Certificates**

➔ **formula:** $$\textit{unitary energy savings} = \textit{annual consumption} \times \underbrace{\left(1 - \frac{\eta_{before}}{\eta_{after}}\right)}_{\textit{efficiency gain}}$$

➔ **data used**

Level 2 (national statistics)	· average efficiency gain ≪ before/after ≫: 40% · average annual heating consumption per building type and period · correction factors (for climatic zones, and dwelling size)
Level 3 (registered participants data)	· building type and period · climatic zone · dwelling size

Condensing boilers

- **pilot test: case of the French White Certificates**

➔ **different possible scenarios** (or mix of values)

	Energy consumption	Efficiency gain
Level 1 (EMEEES based on EcoBoiler)	*EcoBoiler for France* 10.253 kWh/year/dwelling	– "all" (vs. stock): 12,8% – "additional" (vs. "inefficient" market): 5,3%
Level 2 "rough" (national statistics on heating)	*"non-weighted" average* 15.931 kWh/year/dwelling	40% (reference = stock ; national study on boilers in the building stock)
Level 2 "improved" (+ national statistics on building stock)	*"weighted" average* 18.837 kWh/year/dwelling	
Level 3 (based on participants data)	*participants average* 24.310 kWh/year/dwelling	unknown (→ level 2: 40%)

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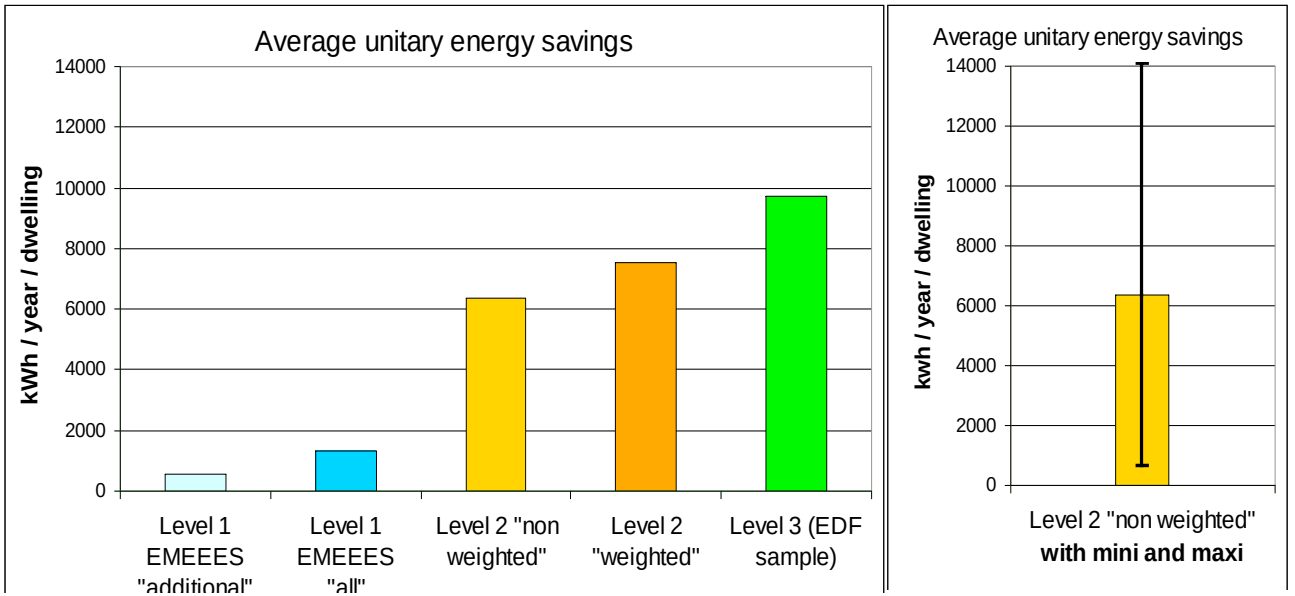
Condensing boilers

- **pilot test: case of the French White Certificates**



➔ it is worth to get level 2 and level 3 data (higher results)

➔ large difference between level 1 and 2 for efficiencies: justifications needed on the national values provided

➔ White Certificates target the actions that bring more energy savings

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c) Improvement of the envelope of existing buildings

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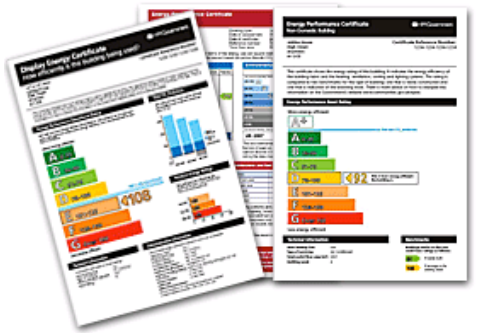
Application of Calculation Methods: Session 1 - Residential buildings

Building regulation for existing buildings

▪ authors: Christof Amman, Susanne Geissler, Leonardo Barreto (Austrian Energy Agency)



▪ Subject

- sector: residential (existing buildings)
- end-use: heating, cooling, hot water, ventilation

· Facilitating measures

- Regulations: e.g. building codes and enforcement, standards
- Financial instruments: e.g. subsidies
- Information: e.g. energy consulting, energy audits, motivation, focused information campaigns

· Context: Implementation of the EPBD

Approach

- Level 1: No default values at EU level possible
- Level 2: Two approaches at the national level
  - Level 2a: Model of the building stock with correction factors
  - Level 2b: Method counting participants;
    estimates for unitary gross annual energy savings based on evaluation of samples:
    - Energy Performance Certificates (EPCerts): whole building
    - Standardised estimates of energy savings: components
- Level 3: The method at level 2b can be used at level 3 as well (regional samples or all buildings).

Calculation of Energy Savings

- Step 1: Unitary Energy Savings
- The basis for the calculation is the specific heat demand (SHD) of a building (kWh/m²/a)

$$\left(\frac{SHD_{baseline}}{\eta_{baseline}} - \frac{SHD_{action}}{\eta_{action}}\right)$$

- Step 2: Number of actions
  - Level 2: energy savings are added across heating systems, building age classes and building types
  - Level 3: actual energy savings are added across all buildings within a given efficiency program

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Unitary Energy Savings

- „Systems“ approach (whole building):
  - Level 2: Average gain (kWh/m^2) per categories (building types and construction periods) based on a sample and a difference between „before“ and „after“ Energy Performance Certificates
  - Level 3: Actual difference between the „before“ and „after“ Energy Perfomance Certificates for each registered building
- „Components“ approach:
  - Level 2: Average gain per standardised action (in kWh/m²) per categories (building types and construction periods) based on physical considerations, national statistics, etc. (e.g. white certificate schemes)
  - Level 3: Actual gain = measured/metered difference between “before” and “after” energy consumption, taking account of climatic conditions

Other Issues

- Technical interactions with heating systems
- Avoiding double counting
  - measuring the combined effect of the whole package of measures
  - database tracking participants and the end-use actions they take
- Free-rider effects

General conclusions

From the bottom-up side

- Bottom-up approach can be used for most of measures targeting residential buildings
- Harmonised rules for baselines are crucial
- National values should be documented
- EPBD implementation may be a solution for harmonisation between MS (but not yet)
- EcoDesign studies may provide benchmarks (but they should be used with caution)