Contract ENER/C3/2018-447/05

Feasibility study EPBD article 19a

2nd stakeholder meeting

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EPBD
Feasibility study 19a

Analysis of potential impacts of policy options for inspections of stand-alone ventilation systems

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Impact analysis specifications

- Analysis of the potential impacts of each policy option until 2030, 2040 and 2050
- Account for different scenarios based on:
  - the evolution of the building stock,
  - the evolution of the use of ventilation systems in buildings,
  - possible additional supporting measures
- Quantify benefits or effects along these criteria:
  - Energy
  - CO_2 emissions
  - Wider benefits including comfort, indoor air quality, well-being and health

Methodology of impact analysis

BUILDING STOCK DATA
(5 regions and EU)

MARKET SHARE OF
VENTILATION SYSTEMS
(5 regions and EU)

2020
2025 - … with estimation
of impact of options

IMPACT OF OPTIONS ON
VARIOUS PERFORMANCES

Energy and IAQ INDICATORS
(results per m²)

ESTIMATION OF
FAN AND HEATING ENERGY USE,
TOTAL PRIMARY ENERGY USE,
CO_2-EMISSIONS,
IAQ-INDICATOR

Chosen scope of impact analysis

- Focusing on residential buildings
  - 93% of stand-alone ventilation systems are residential
- Options for inspection only have impact on new systems installed in new or renovated buildings
  - Existing regulations and guidelines mainly relate to initial inspection of stand-alone ventilation systems

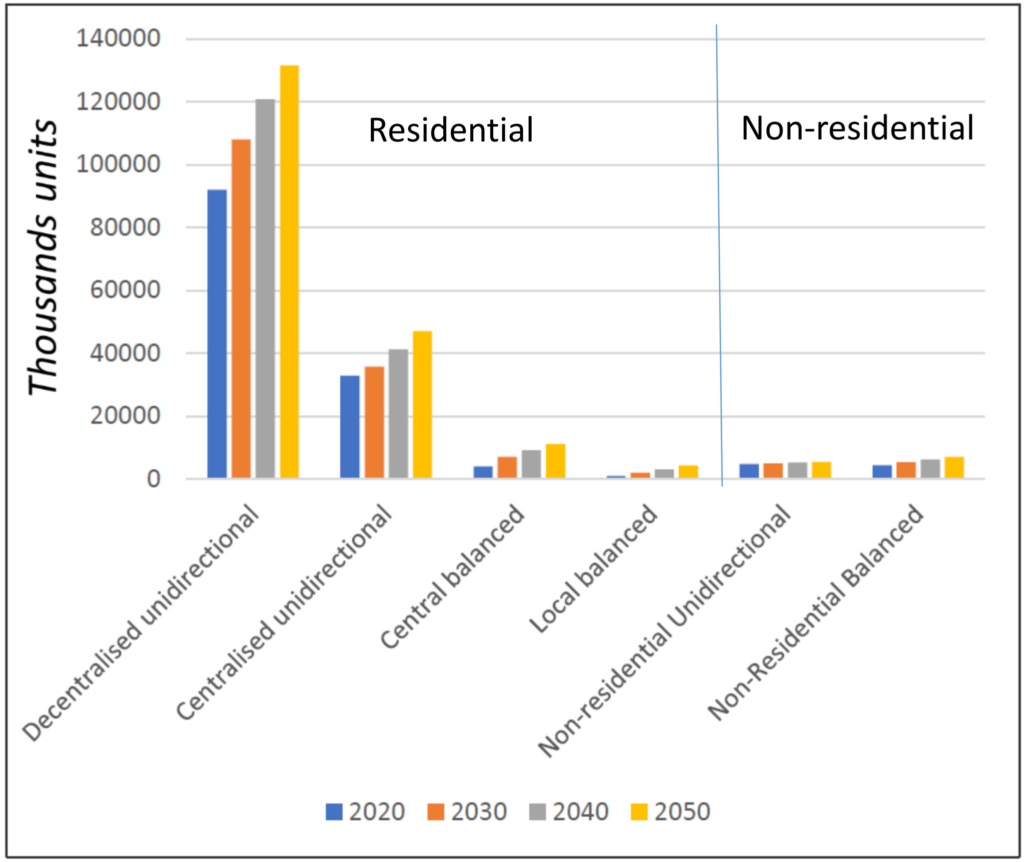


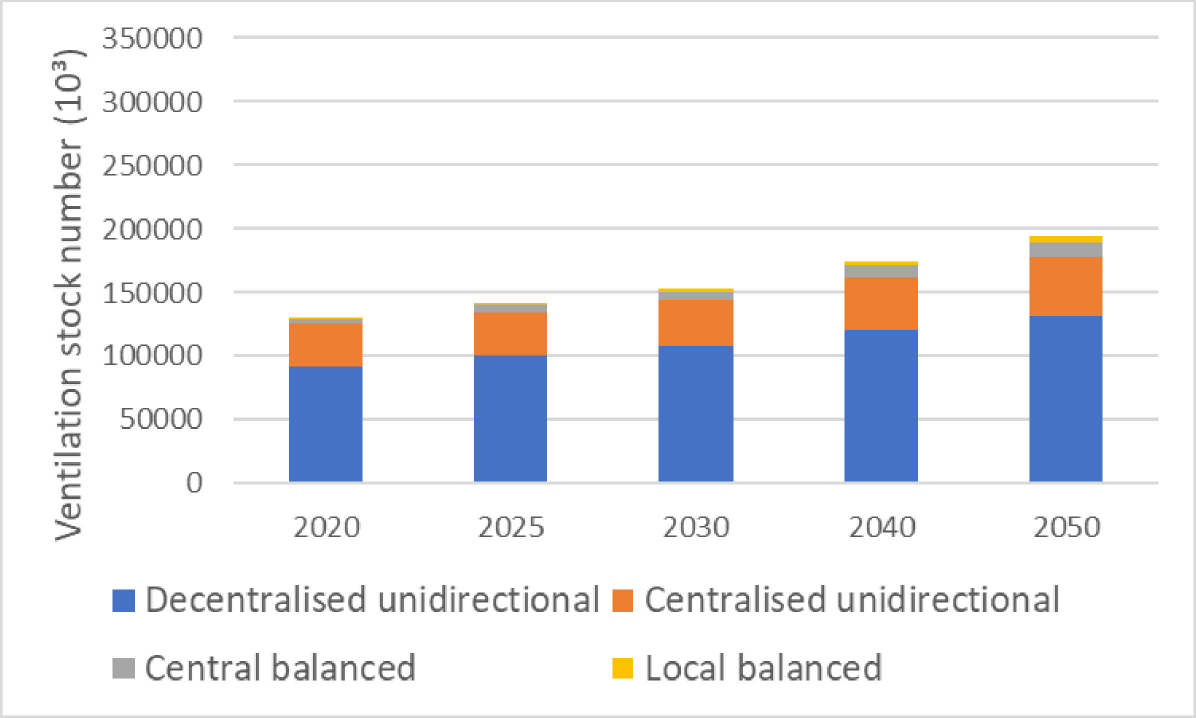
Figure 4: Evolution of the stock for mechanical ventilation systems

[Feasibility study EPBD art. 19a, Final report Task 1.1 & 1.2]

Available data to estimate market share evolution of different types of ventilation systems

- Evolution of dwelling stock
  - SRI-study (BEAM-model)
  - 'agreed amendments pathway'

- Evolution of residential ventilation stock
  - Final report task 1.2

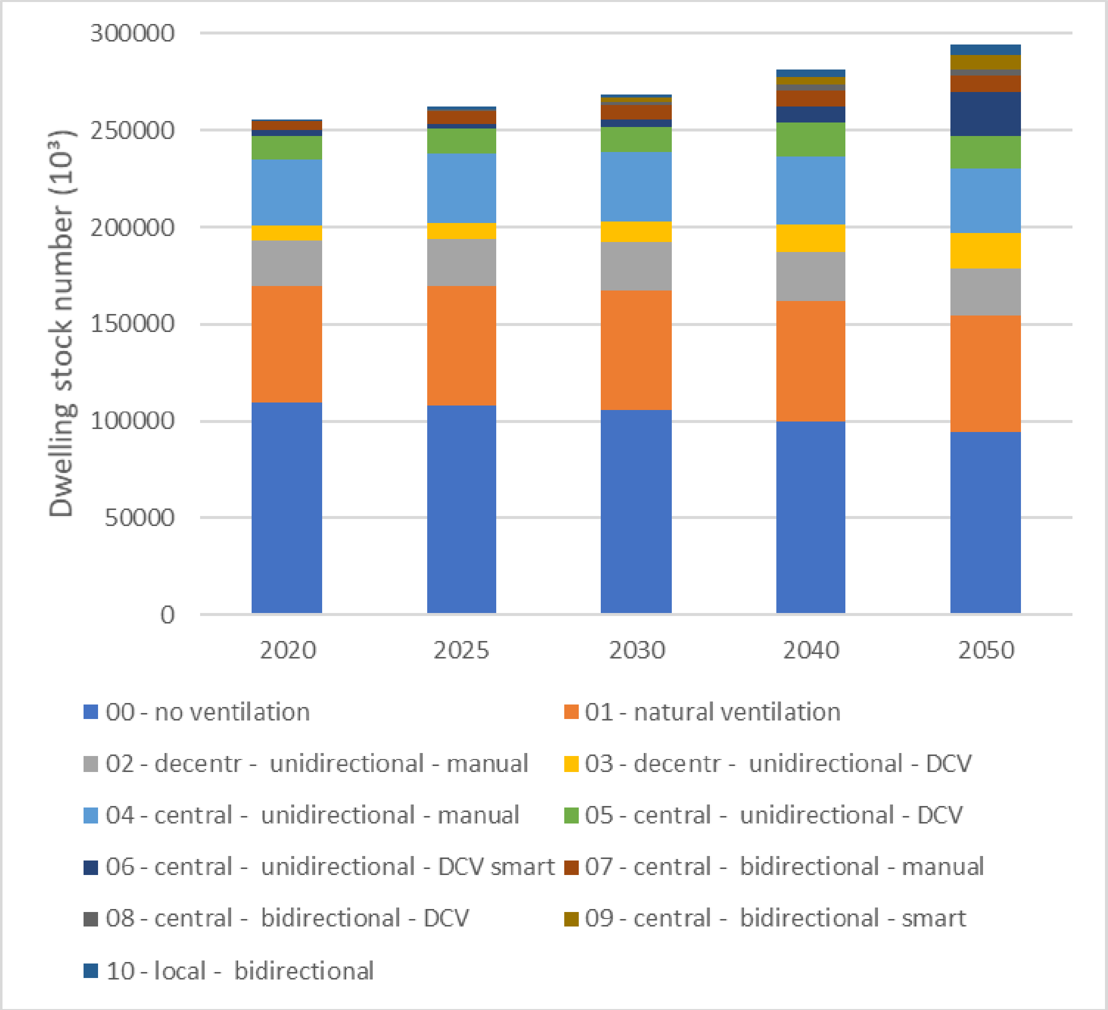


Considered types of stand-alone ventilation systems

00 -	no	ventilation	
01 -	natural	ventilation	
02 -	decentr -	unidirectional -	manual
03 -	decentr -	unidirectional -	DCV
04 -	central -	unidirectional -	manual
05 -	central -	unidirectional -	DCV
06 -	central -	unidirectional -	DCV smart
07 -	central -	bidirectional -	manual
08 -	central -	bidirectional -	DCV
09 -	central -	bidirectional -	smart
10 -	local -	bidirectional	

- Main categories subdivided in subcategories with different controls:
  - Manual control
  - Demand control ventilation (in reponse to contaminant sensors)
  - DCV with additional smart features (self-calibration, fault detection, flow balancing,…)
- Impact of policy options may be different for different types of controls

Assumed market share evolution of different types of ventilation systems (EU-28)



Number of dwellings with specific ventilation system

Mechanical ventilation systems

Natural ventilation systems (supply inlets and exhaust stacks)

Dwellings without ventilation system

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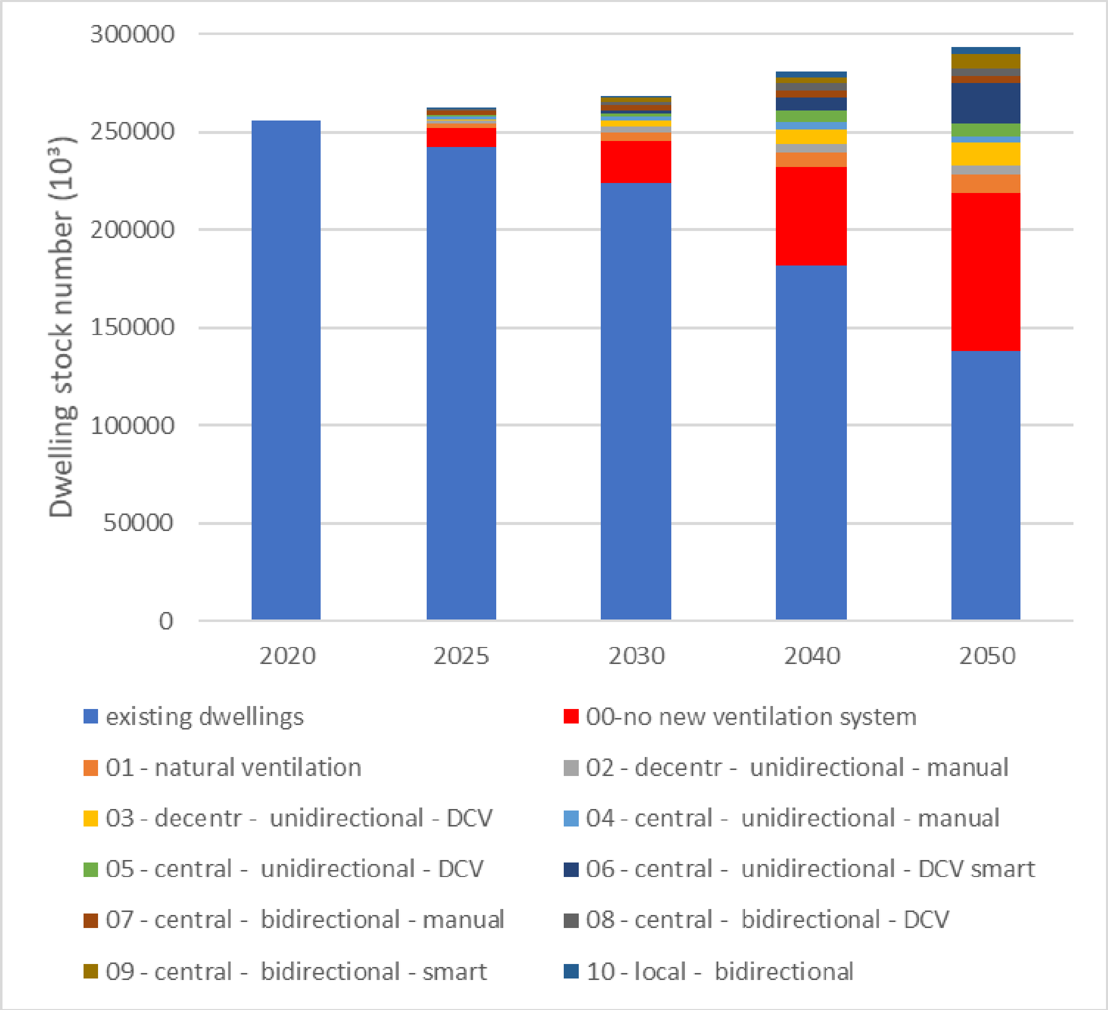
Assumed market share evolution of different types of ventilation systems (EU-28)



Number of new and retrofitted dwellings with specific ventilation system

New and retrofitted dwellings with new ventilation systems, impacted by policy options

New and retrofitted dwellings with no (new) ventilation system

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Assumed impact of policy options on market share evolution of ventilation systems

- Baseline evolution:
  - Gradual evolution towards **more mechanical systems**
  - Within each system type, it is assumed systems will **shift** from manually controlled systems **to DC and smart systems**, towards 2050
  - ±50% of new and retrofitted dwellings don't have (new) ventilation systems, e.g. in countries without ventilation regulation, façade renovation projects,…
- Impact of 6 policy options are reflected in 6 variations of the assumed evolution, considering e.g.:
  - With **increased awareness raising**, more builders might decide to **install ventilation** when building or renovating their house, even in countries where it is not mandatory.
  - With **visual inspection** or inspection with measurements, builders who don't install a system even though it is mandatory, might be **forced to do so**
  - With **inspection with measurements**, the **shift towards smart systems** might be faster, because in these systems it is easier for installers to perform or obtain the required measuring results

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Calculation of ventilation related energy indicators

- Based on eco-design SEC calculation (Directive 2009/125/EC)
- Primary fan energy use (kWh/m²/a)

$$P_{f,p} = t_a . pef . q_{net} . f_{qual} . f_{ctr} . f_{use} . SFP$$

- Ventilation and infiltration related heating energy use (kWh/m²/a)

$$Q_{h,p} = t_h . \Delta T_h . \eta_h^{-1} . c_{air} . \left(q_{net} . f_{qual} . f_{ctr} . f_{use} . (1 - \eta_t) + n_{50} . H . 0.04 \right)$$

- Quality factor of design and installation f_{qual}
- Control factor of ventilation system f_{ctr}
- User impact on the air flow rate f_{use}
- Specific fan power SFP
- Thermal efficiency of heat recovery η_t

Performance parameters influenced by policy options

Assumptions on performance parameters (baseline scenario)

- In a vast majority of European countries the quality of ventilation systems is very poor (Final report Task 1.2, Qualicheck platform,…):
  - A large proportion of systems (20%-55% depending on system type) have significantly **lower installed flow rates** than the required values;
  - In a large proportion of systems (50%-75% depending on system type) users **operate** the systems at **lower flow rates** than installed, e.g. because of noise or draft problems, or concerns about energy bills;
  - A large proportion of mechanical ventilation systems (25%-70% depending on system type) have a **higher specific fan power** than the default values defined in ventilation standards (500-750 W/(m^3/s) per fan);
  - A large proportion (50%) of balanced mechanical systems with heat recovery have **imbalanced supply and extract air flows**, decreasing the heat recovery performance.

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Example of assumed variation of values for performance parameters:

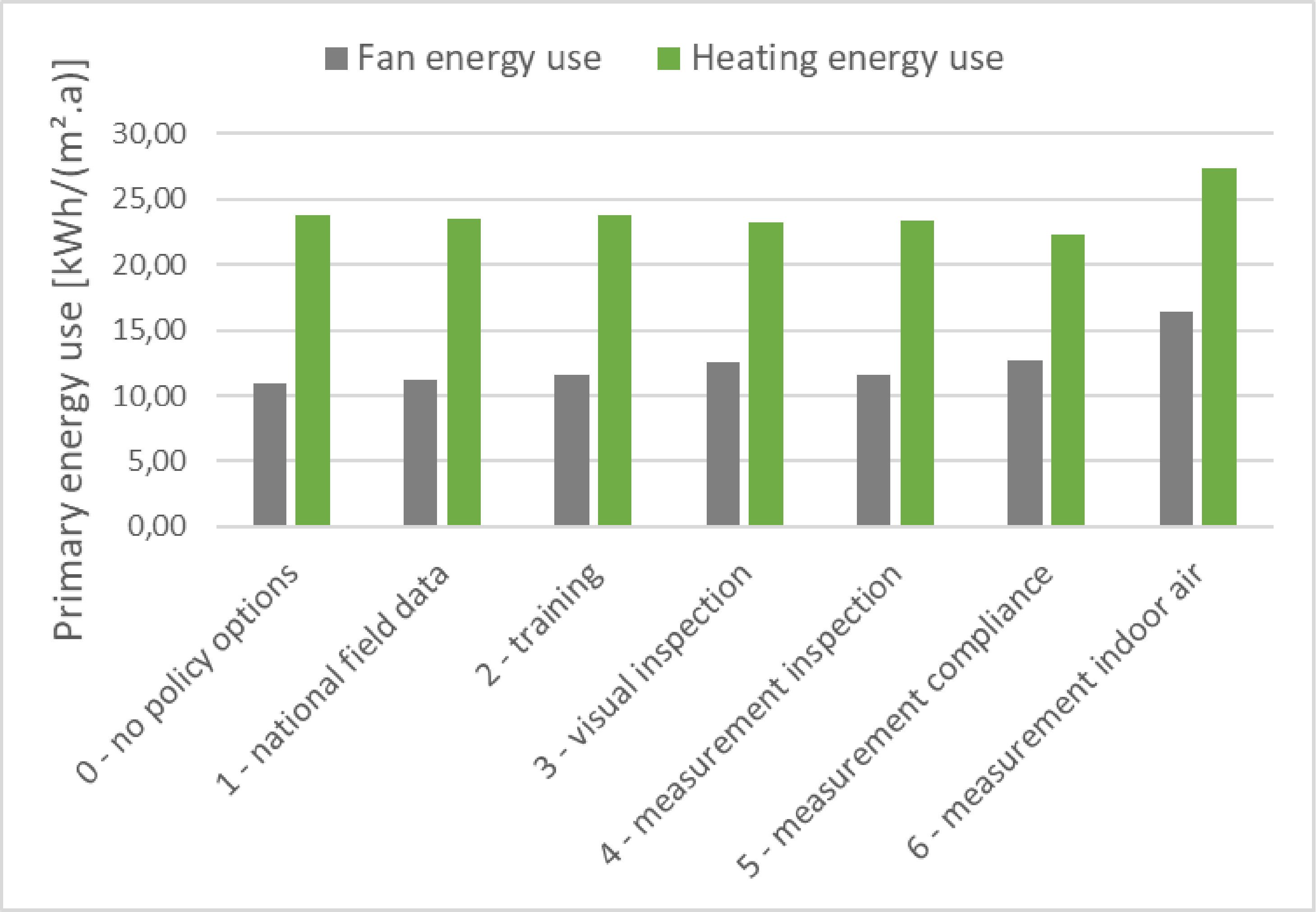
- Quality factor f_{qual}

	07 - central - bidirectional - manual						
	0 - no policy options	1 - national field data	2 - training	3 - visual inspection	4 - measurement inspection	5 - measurement compliance	6 - measurement indoor air
high air flow rate	5%	5%	10%	5%	10%	20%	25%
nominal air flow rate	40%	40%	45%	45%	70%	80%	60%
low air flow rate	35%	40%	35%	40%	20%	0%	15%
very low air flow rate	20%	15%	10%	10%	0%	0%	0%
CHECK	100%	100%	100%	100%	100%	100%	100%
	77%	79%	86%	82%	98%	110%	107%

- Heat recovery efficiency η_t

	0 - no policy options	1 - national field data	2 - training	3 - visual inspection	4 - measurement inspection	5 - measurement compliance	6 - measurement indoor air
very high thermal efficiency	5%	5%	10%	10%	10%	30%	10%
high thermal efficiency	40%	40%	40%	40%	60%	60%	40%
medium thermal efficiency	30%	40%	40%	40%	30%	10%	30%
low thermal efficiency	20%	10%	10%	10%	0%	0%	20%
no thermal efficiency	5%	5%	0%	0%	0%	0%	0%
CHECK	100%	100%	100%	100%	100%	100%	100%
	61%	63%	67%	67%	72%	78%	65%

Example calculated energy indicators Central-bidirectional-manual control



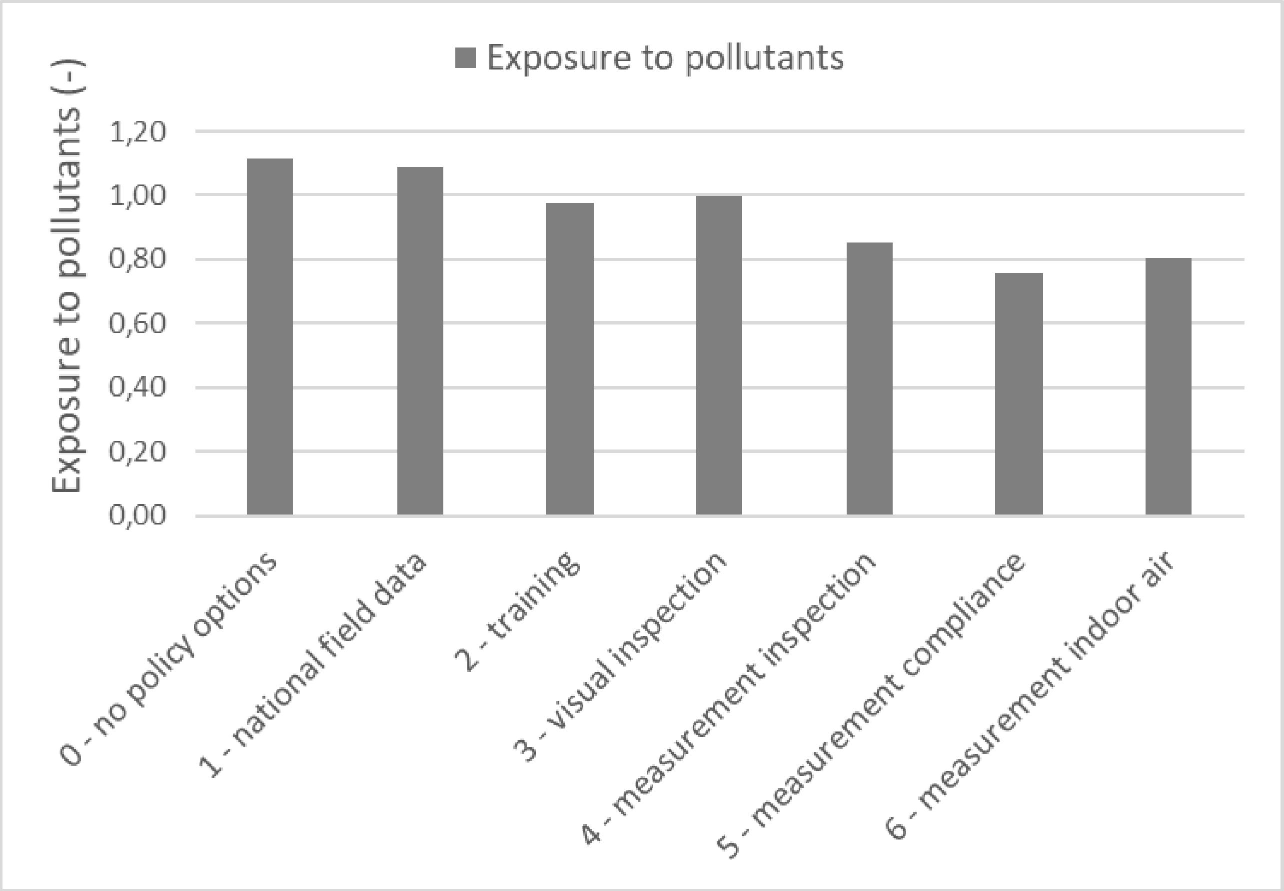
Calculation of health indicator

- Generic pollutant dose
  - Effective flow rate q_j
  - Probability of occurrence p

$$Dose_j \sim \frac{p_{qual} \cdot p_{use} \cdot p_{clim}}{q_j}$$

$$exposure\ indicator = \frac{Dose_{total}}{1/q_{net}}$$

Example calculated health indicator
Central-bidirectional-manual control



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Assuming each policy option is introduced in 2020 and has immediate effect

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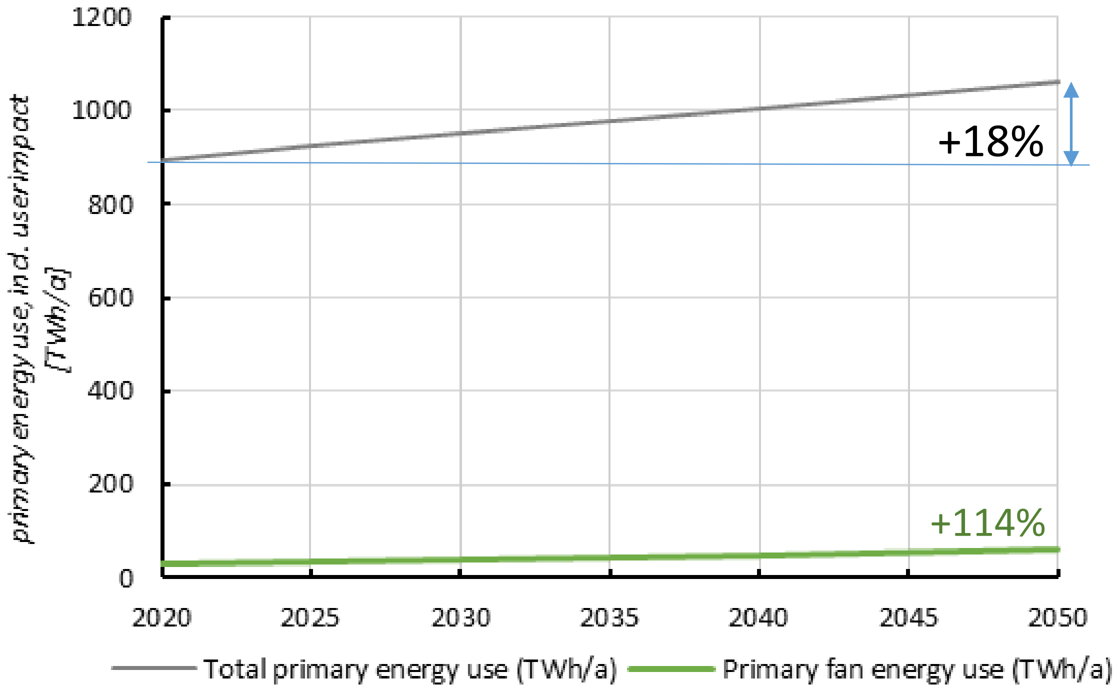
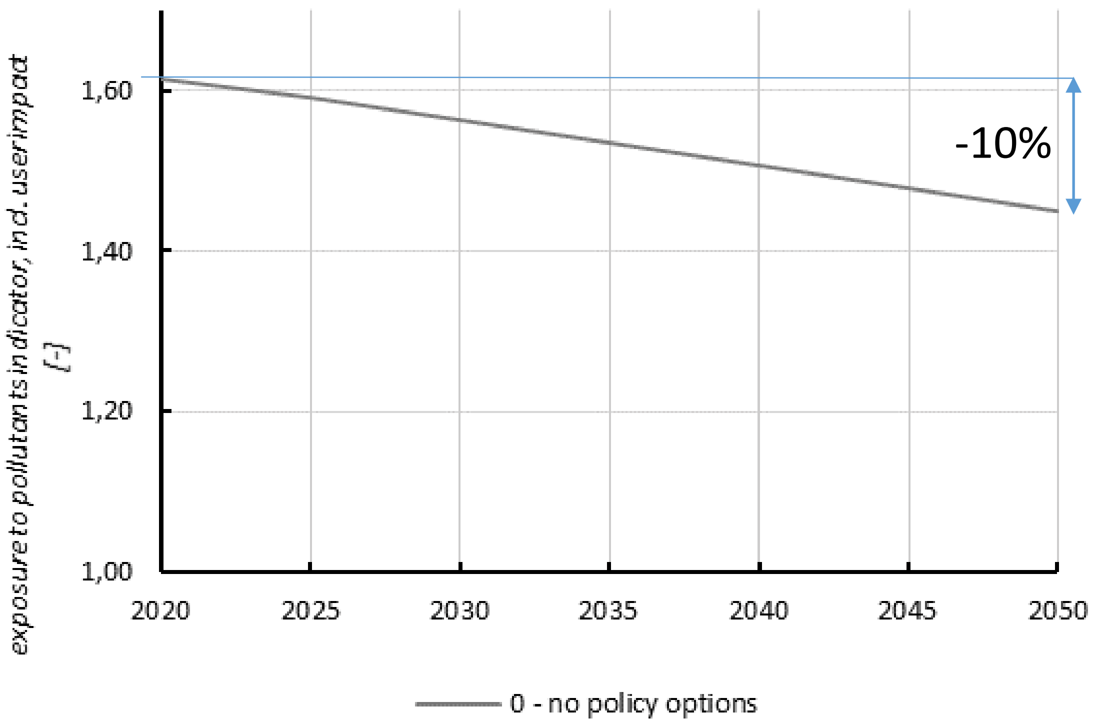
Results for baseline scenario with no policy actions

Evolution of the primary energy use as a result of the ventilation of the dwelling stock

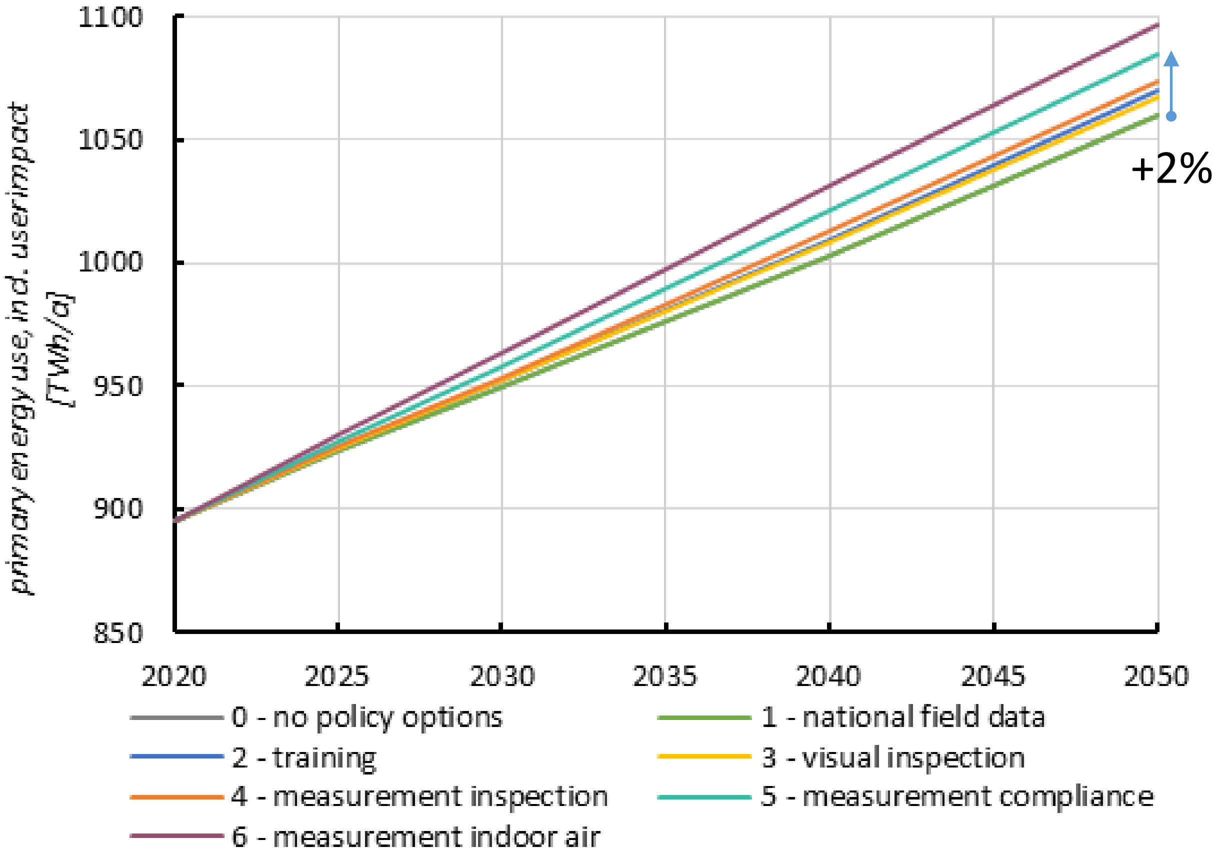


Evolution of the average exposure to pollutants over the dwelling stock

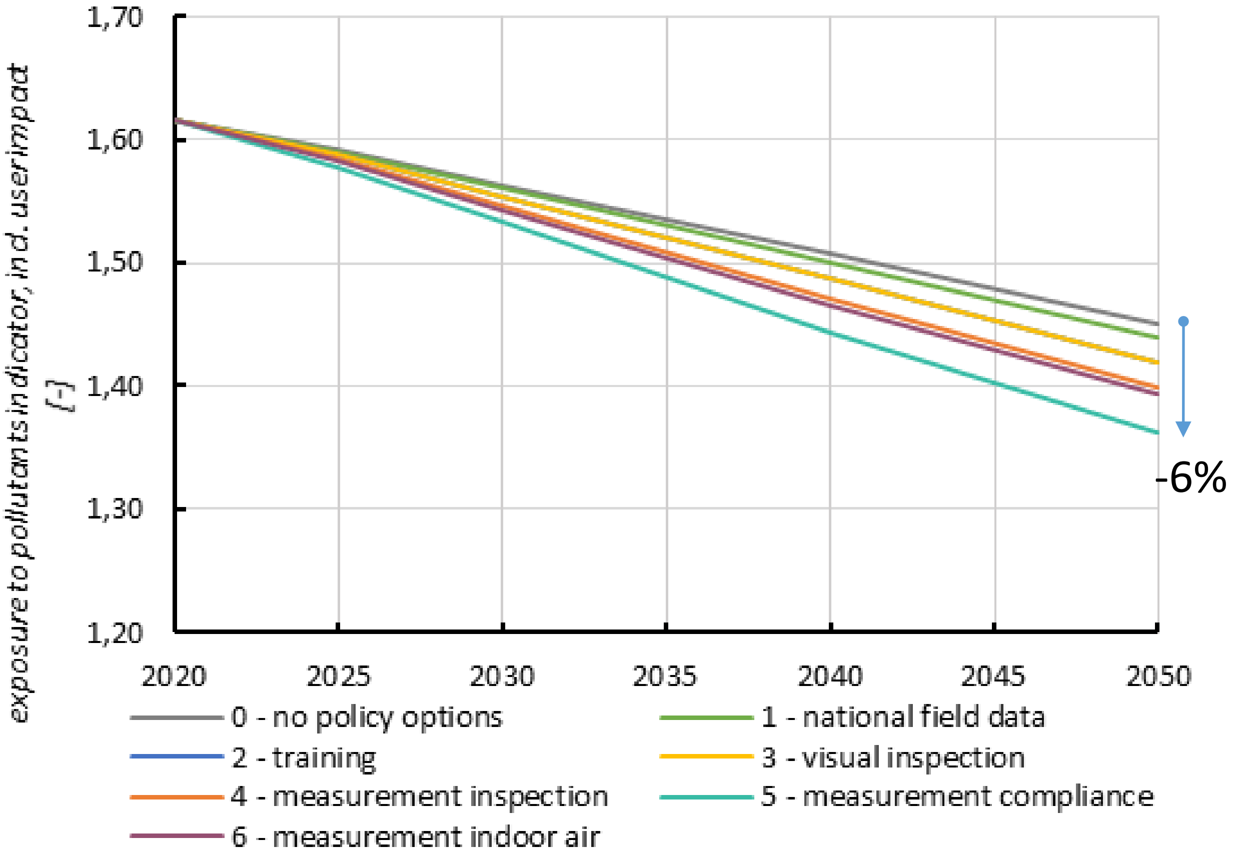


Impact of policy options at level of dwelling stock (EU-28)

- Primary energy use as a result of the ventilation of the dwelling stock



- Average exposure to pollutants



Impact of policy options

- All policy options result in a better indoor air quality but also in a higher energy consumption compared to the baseline scenario with no policy actions
  - Policy options result in better designed and executed ventilation systems and therefore higher ventilation rates, compared to current practice.
  - Policy options directly or indirectly result in ventilation systems with higher quality and in a more effective operation of such systems
  - In policy option 4 and 5, the energy efficiency of mechanical systems is expected to improve because of availability of measurements
- Impact of policy options depends on type of ventilation system, e.g.
  - In bi-directional systems with heat recovery, inspection contributes to an improved IAQ with limited or no increase of primary energy use
  - In mechanical ventilation systems with smart features (DCV-smart), the impact of policy options is smaller than with other systems

Conclusions

- Analysis of potential future impacts of policy options for inspections of stand-alone ventilation systems
  - Chosen scope of impact analysis: newly installed residential systems
- Impact is sensitive to:
  - Assumed evolution of the use of ventilation systems in buildings
  - Assumptions on input data for calculation of energy and health indicators
- Baseline situation: in a vast majority of European countries the quality of ventilation systems is very poor
- Results indicate that all policy options reduce exposure to pollutants, but increase ventilation related energy use
  - Impact of policy options depends on ventilation type

This study is a service contract with the European Commission’s Directorate General for Energy and has received funding under contract ENER/C3/2018-447/05.