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Task 4: Technology

First stakeholder meeting

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Brussels, Centre Albert Borschette
3rd of March 2020

Agenda

- 10h00-10h05: Welcome and introduction to study (DG ENER)
- 10h05-10h15: Tour de table +agenda(VITO)
- 10h15-10h30: Overview of draft Task 1 work (VITO)
- 10h30-10h45: Task 1 Q&A on functional unit and scope
- 10h45-11h00: Overview of initial draft Task 2 work (Waide)
- 11h00-11h20: Overview of initial draft Task 3 work (VITO)
- 11h20-11h30: coffee break
- **11h30-11h50: Overview of initial draft Task 4 work (Ricardo)**
- 11h50-12h00: Overview of initial draft Task 5 work (VITO))
- 12h00-12h20: Discussion on the base case selections (VITO)

Agenda

- 12h20-13h30: Lunch Break
- 13h30-14h00: Discussion of approach and applicable market data to scale-up the base cases to derive the EU27 impact (Waide/VITO)
- 14h30-14h50: Discussion of selected improvement options for Task 4/6 (Ricardo/VITO
- 14h50-15h20: Discussion of approach and data sources to model improvement options for Task 4/6 including life time and self-consumption(Ricardo/VITO)
- 15h20-15h30: coffee break
- 15h30-16h00: AOB (all)
- 16h00-16h15: conclusions and next steps (VITO/DG ENER)

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Objectives:

- Analyse **technical aspects** of BACS products/systems on the EU market.
- Provide descriptions of typical BACS products and systems and the main alternatives to BACS including those which will be used as the base case.
- Analyse energy savings realised by BACS, costs & self energy consumption.
- Define:
  - **Best Available Technologies** (BAT)
  - **Best Not yet Available technologies** (BNAT)
- Assess the barriers to the introduction of BNAT, including cost factors and current levels of technical and commercial readiness.

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Challenges:

- The market for building automation and control systems (BACS) is rapidly evolving as manufacturers adopt Internet of Things (IOT) technology.
- Wide variety of different BACS products on the EU market including:
  - Single package, pre-programmed building management systems.
  - Flexible, modular distributed systems - programmed after installation.
- The diversity of BACS architectures, functionality and delivery channels, makes it is difficult for building owners and facility managers to:
  - Determine which BACS specification is likely to provide the energy saving features needed to optimise a building's operation and
  - Ensure that the specified functionality is installed and commissioned.
- Self-energy consumption varies with number of control zones and data gateways needed to control HVAC equipment and additional functionality.

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Work plan:

- Define BACS in terms of core automation and control functionality
- Produce definitions of BACS energy saving functions based on EN15232.
- Identify a small set of reference buildings for use as base cases (BC)
- Gather data on the typical level of energy savings by EN15232 functions.
- Modelling of up to 16 cases that best demonstrate energy saving potential
- Research to establish key influencing factors for self energy consumption
- Define BAT in terms of functions and features that facilitate building energy management, demand response and use of renewables.
- Identify BNAT through a review of the literature, including technologies at demonstration stage such as model based predictive control and artificial intelligence based optimization.

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Definition of core automation and control functionality:

- BACS products and systems defined in terms of EN15232 BAC functions:
  - Class A: High energy performance BACS and TBM functions
  - Class B: Advanced BACS with some TBM functions
  - Class C: Standard BACS
  - Class D: Non-energy efficient BACS
- This allows us to define:
  - The base case as Class C - the reference design under EN15232
  - Best Available Technology (BAT) as Class A
- Question: Is Class C the correct base case for residential/non-residential?

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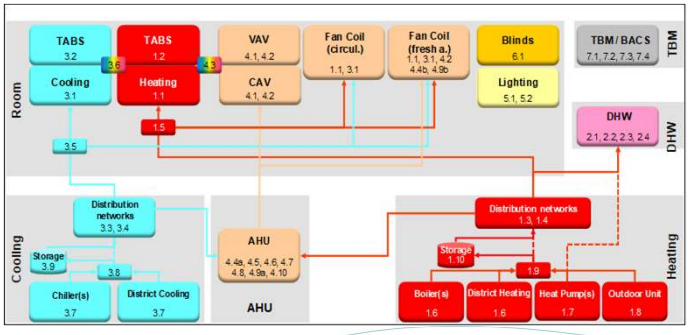
Definitions of BACS energy saving functions:

- EN15232 defines **7 Groups with 43 functions with to 5 levels of control functionality each** that impact on the energy performance of buildings, including variations to cover control of thermally activated building systems (TABS), different sources of heating and cooling, and different types of heating, ventilation and air conditioning (HVAC) system.



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Definitions of BACS energy saving functions (2):

- For each BAC function, up to 5 levels of control functionality are defined:
  - The lowest level (Level 0) corresponds to a Class D BACS
  - The highest level corresponds to a Class A BACS
- Notes:
  - No requirements for technical and home building management (TBM) systems for Class D, as TBM systems are not expected to be fitted.
  - A Class A BACS must implement the functionality of a Class B and Class C BACS in addition to those specified for a Class A BACS.
  - Class A BACS will generally include facilities to manually override automatic control, and to disable higher levels of control functionality.

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Example of levels of control functionality 1.1

Table 4 — BAC and TBM functions having an impact on the energy performance of buildings

Automatic control			
1	Heating control		
1.1	Emission control	HEAT_EMIS_CTRL_DEF	M3-5
		The control function is applied to the heat emitter (radiators, underfloor heating, fan-coil unit, indoor unit) at room level; for type 1 one function can control several rooms	
	0	No automatic control of the room temperature	
	1	Central automatic control: There is only central automatic control acting either on the distribution or on the generation. This can be achieved for example by an outside temperature controller conforming to EN 12098-1 or EN 12098-3; one system can control several rooms	
	2	Individual room control: By thermostatic valves or electronic controller	
	3	Individual room control with communication: Between controllers and BACS (e.g. scheduler, room temperature setpoint)	
	4	Individual room control with communication and occupancy detection: Between controllers and BACS; Demand control/occupancy detection (this function level is usually not applied to any slow reacting heat emission systems with relevant thermal mass, e.g. floor heating, wall heating)	

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Example of minimum requirements Class A-D

Table 5 — Function list and assignment to BAC efficiency classes

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
Automatic control										
1	Heating control									
1.1	Emission control									
	The control function is applied to the heat emitter (radiators, underfloor heating, fan-coil unit, indoor unit) at room level; for type 1 one function can control several rooms									
	0	No automatic control	x				x			
	1	Central automatic control	x				x			
	2	Individual room control	x	x			x	x		
	3	Individual room control with communication	x	x	x	x[a]	x	x	x	x[a]
	4	Individual room control with communication and occupancy detection (not applied to slow reacting heating emission systems, e.g. floor heating)	x	x	x	x	x	x	x	x

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Definitions of BACS energy saving functions (3):

- The Task 4 report identifies a number of basic **methods** used by the control functionality specified in EN15232 to realise energy savings:
  - Improved control accuracy
  - Individual room control
  - Adaptive room set point scheduling
  - Demand orientated control
  - Adaptive generation sequencing
  - Energy management and optimisation measures
- It also identifies a number of other plant specific functions, and some other energy saving measures that are not specified in EN15232, but are commonly implemented by BACS systems, as a result of other standards.
- Lighting control not described, but Lot 37 results factored into modelling.

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Typical level of energy savings by EN15232 functions:

Energy saving method	Control Improvement	Typical Savings (Literature)
Improved control accuracy	Operates 1°C closer to ideal set point	?
Individual room control	Occupation based zone/room control	8 - 43%
Adaptive room set point scheduling	3 to 4 hour reduction in operating hours	?
Demand orientated control	Reduction in pump/fan energy	25-50%
Adaptive generation sequencing	Reduced cycling, load point optimisation	2 - 40%
Energy management and optimisation measures	Resets set points so 1°C closer to ideal, automatic fault detection /diagnosis (FDD)	?
Other plant specific functions	e.g. Automatic shading / blind control	3 - 11%
All Class A BAC functions	**Combination of control improvements**	**30-80%**

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Reference buildings used as base cases (BC):

No	Building	Climate Zone	BAC methods / functions examined
1	Existing House	Average	Improved control accuracy (Emission control)
2	New House	Average	Demand orientated control of ventilation and AC
3	Existing Flat	Warm	Demand orientated control of distribution pumps
4	New Flat	Warm	Other plant specific measures (Blind control)
5	Existing Shop	Cold	Lighting control functions
6	New Shop	Cold	Individual room control with weather and load compensation functions
7	Existing Office	Average	Energy management & optimisation functions
8	New Office	Average	Individual room control with different occupancy patterns in each room (combination of functions).

- Details of reference buildings, base cases, control setup and modelling tools used will be defined in Technical Annex. This is a work in progress.
- Stakeholders are invited to provide supporting modelling evidence.

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Preliminary results of modelling BACS energy saving potential

No	Building	BAT			Data Source
		$f_{BAC,th,H}$	$f_{BAC,th,C}$	$f_{BAC,el}$	
1	Existing House	0.87	NM	0.95	PHPP
2	New House	0.91	NM	0.81	PHPP
3	Existing Flat	0.91	1.00	0.95	PPHP & Literature
4	New Flat	1.06	0.23	NM	EnergyPlus
5	Existing Shop	1.02	NM	0.80	Enercalc & Lot 37
6	New Shop	0.83	NM	1.00	Literature
7	Existing Office	TBD	TBD	TBD	Literature
8	New Office	0.79	0.98	NM	EnergyPlus

- There are some gaps in the modelling results that have yet to be resolved.
- Stakeholders are invited to provide the results of simulations and case studies that confirm the energy savings identified for each base case.

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Definition of Best Available Technology

- The study approach defines a EN51232 Class A BACS as BAT
  - This defines functions and features that facilitate building energy management, demand response and use of renewables.
- However need to confirm:
  - Cost effectiveness of Class A relative to Class C
    - Need Life Cycle Costs for Task 6
  - Whether Class B is more appropriate for some applications
- Identify cost effective improvements that would optimise savings:
  - e.g. Dynamic hydronic balancing
- Stakeholders are invited to provide data on:
  - additional costs of upgrading existing BACS to classes A, B & C
  - actual and potential useful lifetime of BACS products. O&M costs

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Identification of BNAT through literature review:

- improvements adopted by other standards, regulations and codes
  - e.g. multiple temperature and presence sensors per room
- technologies under research
  - model based predictive control
  - artificial intelligence based optimization (fuzzy logic, Neural Networks)
  - automatic fault detection and diagnosis
  - automatic reporting of faults and energy waste.
- barriers:
  - cost – extra sensors, wiring, processing power & installation time
  - complexity & reliability – limitations of installer skill base
- Stakeholders are invited to identify BNAT functionality in own product range that could form the basis of additional EN15232 classifications.

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Establish key influencing factors for self energy consumption (1):

- Establish boundaries of BACS system
  - include electricity consumption of all components required to:
    - automate processes in the building
    - control energy conversion e.g. burners
  - exclude:
    - energy flow through energy converters
    - components that are an essential part of TBS operation
      - blind motors
      - electronic ballasts
      - local plant controls e.g. boiler / combustion controls
  - will need rules for when the self-consumption of variable speed drives (VSDs) should be included and basis for calculating self-consumption.

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Establish key influencing factors for self energy consumption (2):

- Key influencing factors for self consumption:
  - number and types of sensors and actuators required to:
    - implement room control as change from Class C to Class A BACS
    - control different types of TBS plant and distribution networks
  - location of room controllers
    - individual controllers in or near individual rooms
    - multiroom controllers in central or local plant rooms
    - Integral to TBS plant or building management system (BMS)
  - other factors:
    - signalling standards, e.g. 4-20mA, 0-10 Vdc
    - communication ports, field buses, expansion buses
    - losses in power supplies, transformers and signal cables

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Establish key influencing factors for self energy consumption (3):

- Options for energy budgets:
  1. end-use metrics in kWh/m^2/year for each EN15232 Class A-C, for each building use e.g. Offices, and for the common configuration of TBS.
  2. simple design metrics for maximum power consumption in W per controller output for each type/category of equipment controlled.
  3. detailed design metrics with allowances (in W) per control unit for:
     - different types/number of inputs, outputs and comms ports
     - different types of sensors, actuators and user interface units
     - signal processing requirements (per data point and BACS class)
     - common add-ons e.g. wireless transceivers, webservers etc.
     - electrical losses in transformers, power supplies and cables.
  - Stakeholders are invited to provide data that would support the development of best in class energy budgets and worked examples.

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Discussion of selected improvement options for Tasks 4/6

First stakeholder meeting

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3rd of March 2020

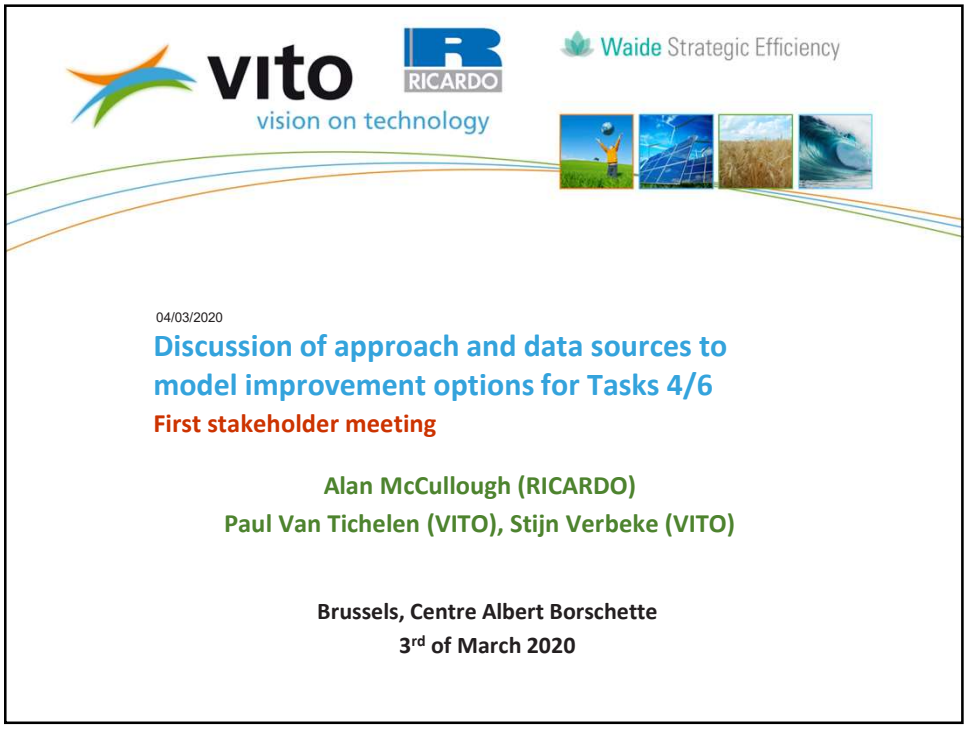
Task 4/6 Selected improvement options

Discussion Topics:

- Modelling approach
  - Base case = Class C BACS
  - BAT = Class A BACS
- Improvement options
  - Class D to Class C
  - Class C to Class B
  - Class B to Class A

Questions to stakeholders:

- **Are there other improvement options that should be modelled?**
  - **Intermediate solutions e.g. Class A/B**
  - **Class A + ….?**
  - **Can any other improvements be modelled within the 8 base cases?**



Task 4/6 Model improvement options

Discussion Topics:

- Modelling approach
  - Results of simulations of base cases in different tools
  - Additional evidence to fill gaps in modelling results.
- Data requirements
  - additional capex costs per m2 (relative to Class D)
    - Class A and Class C for each base case
    - average for residential and non-residential
  - Annual opex costs as % of capex.
  - Typical useful technical lifetime, now and in future with IOT
  - Self-consumption
    - in kWh/m2/year for each base
    - Supporting calculations (technical basis)

Task 4/6 Model improvement options

Data collection template:

	Parameter	BACS Class	Existing House	New House	Existing Flat	New Flat	Existing Shop	New Shop	Existing Office	New Office
1	minimum price (euro/m²)	Class C								
		Class A								
2	maximum price (euro/m²)	Class C								
		Class A								
3	typical technical life time (years)	Class C								
		Class A								
4	typical self-consumption (kWh/m2/year)	Class C								
		Class A								

Task 4/6 Model improvement options

Other requirements for each base case:

- List of major cause of failure for Class C and Class A solutions
- Reference block diagram for Class C and Class A solutions
- Bill of materials with costs for Class C and Class A solutions
- Self-consumption calculations for Class C and Class A solutions

Questions to stakeholders:

- **Is there other information that could be added to the Task 4 technical annex that would enhance understanding of BACS solutions? e.g.**
  - **Hard wired / non wired networked solutions?**
  - **Design / application considerations?**