Welcome to streamSAVE Dialogue Group

- Today's topic: **Building Automation and Control Systems**
- Please rename yourself in zoom: **Name (organisation, country code)**
- Agenda (times are CEST):
  - **15:00** Introduction
  - **15:05** Calculation methodology for energy savings from BACS
  - **15:20** Q&A on key issues of the calculation methodology
  - **15:25** Insights on baseline components, indicative values and data sources
  - **15:40** Open discussions on data availability
  - **15:55** Conclusions and next steps

Building Automation and Control Systems

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BACS Dialogue web-meeting – 18th May 2021

This project has received funding from the Horizon 2020 programme under grant agreement n°890147. The content of this presentation reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

1. Calculation methodology BACS

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Building Automation and Control Systems (BACS)

Definition (Ecodesign preparatory study, 2020):

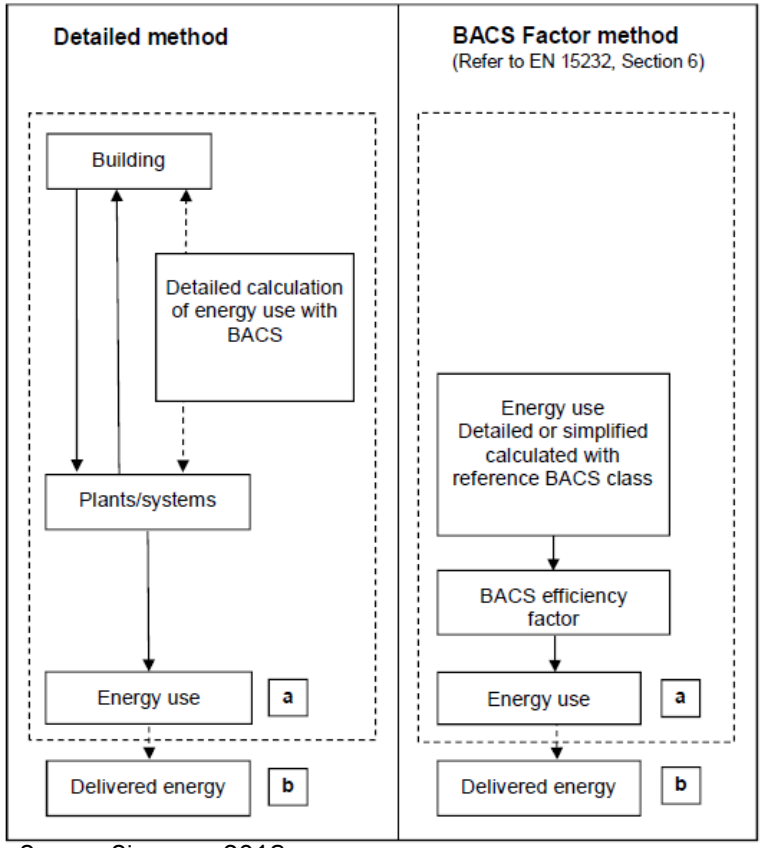
“All products and engineering services for automatic controls (including interlocks), monitoring, optimization, for operation, human intervention and management to achieve energy–efficient, economical and safe operation of building services. The term ‘controls’ also refers to ‘processing of data and information’.”

- Heating ventilation and Air Conditioning (HVAC)
- Domestic hot water (DHW)
- Lighting
- Metering
- Technical building management
- Access control
- Security
- Fire safety

BACS Factor Method

Two ways of calculating the impact of BACS on the energy demand of a building

- Detailed method vs. BACS factor method
- For BACS factor method, no information is needed about any specific control and automation function

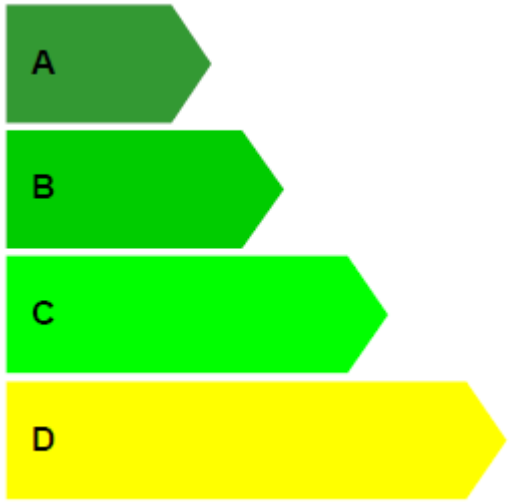


Source: Siemens, 2018

BAC Efficiency Classes

EN 15232 defines 4 different BAC efficiency classes (A, B, C, D) for building automation and control systems

- Assigned according to level of energy efficiency
  - A = high energy performance BACS and TBM
  - B = advanced BACS and some specific TBM functions
  - C = standard BACS
  - D = non-energy efficient BACS



Source: Siemens, 2018

BACS Factors

- Rough estimation of impact of BACS on thermal and electrical energy demand of the building according to the BACS efficiency classes A, B, C and D

- Combining the *BACS efficiency classes* with the *end use* and the *building type* → BACS efficiency factor
  - e.g.: heating BACS, efficiency class C, in an office building → BACS factor of 1

- BACS efficiency factor
  - different levels of control accuracy and control quality
  - for different building types characterized by user profile of occupancy and internal heat gains (due to people and equipment)

BACS Factors

- On an aggregated level of thermal and electrical energy use

Non-residential building types	BACS efficiency factors thermal $f_{BAC,th}$			
	D	C	B	A
	Non energy efficient	Standard (reference)	Advanced energy efficiency	High energy performance
Offices	1.51	1	0.80	0.70
Lecture halls	1.24	1	0.75	0.5 [a]
Educational buildings (schools)	1.20	1	0.88	0.80
Hospitals	1.31	1	0.91	0.86
Hotels	1.31	1	0.85	0.68
Restaurants	1.23	1	0.77	0.68
Wholesale and retail buildings	1.56	1	0.73	0.6 [a]
Other types: • Sport facilities • Storage • Industrial facilities • etc.		1		
[a] The values are highly dependent on heating/cooling demand for ventilation				

Residential building types	BACS efficiency factors thermal $f_{BAC,th}$			
	D	C	B	A
	Non energy efficient	Standard (reference)	Advanced energy efficiency	High energy performance
• Single family dwellings • Multi family houses • Apartment houses • Other residential or residential-like buildings	1.10	1	0.88	0.81

Source: Siemens, 2018

Non-residential building types	BACS efficiency factors electrical $f_{BAC,el}$			
	D	C	B	A
	Non energy efficient	Standard (reference)	Advanced energy efficiency	High energy performance
Offices	1.10	1	0.93	0.87
Lecture halls	1.06	1	0.94	0.89
Educational buildings (schools)	1.07	1	0.93	0.86
Hospitals	1.05	1	0.98	0.96
Hotels	1.07	1	0.95	0.90
Restaurants	1.04	1	0.96	0.92
Wholesale and retail buildings	1.08	1	0.95	0.91
Other types: • Sport facilities • Storage • Industrial facilities • etc.		1		

Residential building types	BACS efficiency factors electrical $f_{BAC,el}$			
	D	C	B	A
	Non energy efficient	Standard (reference)	Advanced energy efficiency	High energy performance
• Single family dwellings • Multi family houses • Apartment houses • Other residential or residential-like buildings	1.08	1	0.93	0.92

Source: Siemens, 2018

BACS Factors

- On a detailed level for
  - heating
  - cooling
  - DHW
  - lighting
  - ventilation

Non-residential building types	Detailed BACS efficiency factors $f_{BAC,H}$ and $f_{BAC,C}$							
	D		C		B		A	
	Non energy efficient		Standard (reference)		Advanced energy efficiency		High energy performance	
	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$
Offices	1.44	1.57	1	1	0.79	0.80	0.70	0.57
Lecture halls	1.22	1.32	1	1	0.73	0.94	0.3 [a]	0.64
Educational buildings (schools)	1.20	–	1	1	0.88	–	0.80	–
Hospitals	1.31	–	1	1	0.91	–	0.86	–
Hotels	1.17	1.76	1	1	0.85	0.79	0.61	0.76
Restaurants	1.21	1.39	1	1	0.76	0.94	0.69	0.6
Wholesale and retail buildings	1.56	1.59	1	1	0.71	0.85	0.46[a]	0.55
Other types: • Sport facilities • Storage • Industrial facilities • etc.	–	–	1	1	–	–	–	–
[a] The values are highly dependent on heating/cooling demand for ventilation								

Residential building types	Detailed BACS efficiency factors $f_{BAC,H}$ and $f_{BAC,C}$							
	D		C		B		A	
	Non energy efficient		Standard (reference)		Advanced energy efficiency		High energy performance	
	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$
• Single family dwellings • Multi family houses • Apartment houses • Other residential or residential-like buildings	1.09	–	1	–	0.88	–	0.81	–

Source: Siemens, 2018

Formula

- Using the BACS factor method, the formula we propose, is:

$$For\ end-use\ type\ x:\ \boldsymbol{EFE_x} = (\boldsymbol{FEC_{before,x}} - \boldsymbol{FEC_{after,x}}) * rb_x * so_x$$

$$FEC_{before\ ,x} = FEC_{floor\ ,before\ ,x} * A$$

$$FEC_{after\ ,x} = \frac{BAC_{after\ ,x}}{BAC_{before\ ,x}} * FEC_{floor\ ,before\ ,x} * A$$

EFE	Effect on the final energy consumption for end-use type x [kWh/a]
$FEC_{before,x}$	Final energy consumption for end-use x, before implementation of the action [kWh/a]
$FEC_{after,x}$	Final energy consumption for end-use x after implementation of the action [kWh/a]
rb_x	Factor to calculate a rebound effect for end-use type x [dmnl]
so_x	Factor to calculate a spill-over effect for end-sue type x[dmnl]
$FEC_{floor,before,x}$	Final energy consumption for end-use, before implementation of the action, per unit floor area [kWh/m²/a]
A	Total floor area of building [m²]
$BAC_{after,x}$	BAC energy efficiency factor after BACS upgrade for end-use type x [%], based on EN15232
$BAC_{before,x}$	BAC energy efficiency factor before BACS upgrade for end-use type x [%], based on EN15232

Formula

- Using the BACS factor method, the formula we propose, is:

$$For\ end-use\ type\ x:\ \boldsymbol{EFE_x} = (\boldsymbol{FEC_{before,x}} - \boldsymbol{FEC_{after,x}}) * rb_x * so_x$$

$$FEC_{before\ ,x} = FEC_{floor\ ,before\ ,x} * A$$

$$FEC_{after\ ,x} = \frac{BAC_{after\ ,x}}{BAC_{before\ ,x}} * FEC_{floor\ ,before\ ,x} * A$$

End-uses: heating, cooling, DHW, lighting, ventilation

BAC factor *before* versus *after*

EFE	Effect on the final energy consumption for end-use type x [kWh/a]
$FEC_{before,x}$	Final energy consumption for end-use x, before implementation of the action [kWh/a]
$FEC_{after,x}$	Final energy consumption for end-use x after implementation of the action [kWh/a]
rb_x	Factor to calculate a rebound effect for end-use type x [dmnl]
so_x	Factor to calculate a spill-over effect for end-sue type x[dmnl]
$FEC_{floor,before,x}$	Final energy consumption for end-use, before implementation of the action, per unit floor area [kWh/m²/a]
A	Total floor area of building [m²]
$BAC_{after,x}$	BAC energy efficiency factor after BACS upgrade for end-use type x [%], based on EN15232
$BAC_{before,x}$	BAC energy efficiency factor before BACS upgrade for end-use type x [%], based on EN15232

Formula: existing methodologies in EU countries

Bulgaria: heating residential

$$TFES = n * \lfloor FEC_{before} - FEC_{after} \rfloor$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{before}	Heat consumption of residential buildings before the installation of automation and heating control systems [kWh/m²]
FEC_{after}	Heat consumption of residential buildings after the installation of automation and heating control systems [kWh/m²]
n	Total heated area of the residential buildings where the automation and heating control systems will be installed

France: Heating & DHW (non-)residential

$$TFES = S * ES * G$$

TFES	Total final energy savings [kWh/a]
S	Surface [m²]
ES	Energy savings by sector by end use and energy [kWh/m²]
G	Geographical area

Q&A

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Questions

- What are your initial questions and remarks to the approach we suggest?
- Does this look feasible and easy to use?
- Are there existing practices we are not aware of?
- If there is further information or formulas, or …, always welcome to share via
  - Chat
  - Forum on platform

2. Baseline, indicative values and data sources

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BACS factors: baseline & indicative values

- Distribution of BACS factors in base year per end use per climate region
  - End uses: heating, cooling, DHW, ventilation and lighting
  - Building types: SFH, MFH, offices, retail outlets, education establishments, hospitality sector buildings, healthcare sector buildings, other
  - Climate regions: North, West and South

Table A-1 Estimated average stock BACS factors for 2020 by TBS and building type: North Region

TBS/system	SFH	MFH	Offices	Wholesale/ Retail	Education	Hospitals/ Healthcare	Hotels	Restaurants	Other
space heating	1.010	1.004	1.195	1.139	1.128	1.000	1.000	1.000	1.109
hot water	1.109	1.109	1.019	1.092	1.030	0.992	0.992	0.992	1.030
cooling	1.173	1.163	1.082	1.003	0.805	0.617	0.617	0.617	1.200
ventilation	1.091	1.084	1.138	1.071	0.966	1.000	1.000	1.000	1.154
lighting	1.079	1.079	0.989	0.991	0.991	1.000	1.000	1.000	1.000
space heating pumps	1.008	1.006	1.121	1.103	1.072	1.038	1.038	1.038	1.073
hot water pumps	1.109	1.109	1.018	1.092	1.029	0.991	0.991	0.991	1.029

Source: Ecodesign preparatory study for BACS, ongoing

- Expected impacts from EPBD on baseline
  - Non residential buildings with installed HVAC capacity > 290 kW : the BACS capabilities required under art. 14-15 EPBD could correspond to B-class BACS.

FEC_{before}: baseline

- Energy consumption per building type and end use per climate region
  - Possibilities
    - *Building specific* FEC per end-use, based on EPC score
    - *Average* FEC of building stock per end-use and building type, based on *average EPC scores* per climate region
    - *Average* FEC of building stock per end-use and building type, based on *energy statistics (e.g. national energy balances)*

FEC_{before}: baseline & indicative values

- We will propose indicative values on EU level per climate region, based on energy statistics

Average final energy use of building types per unit floor area before BACS upgrade

EU averages of existing building stock per Climate Region (North, West and South)							
$FEC_{floor,before,x}$ [kWh/m²/a]	Residential		Non-Residential				
	SFH	MFH	Offices	Retail	School	Hospital	Other
Space heating	[kWh/m²/a]						
Hot Water							
Cooling							
Ventilation							
Lighting							

TO BE COMPLETED BASED ON BUILDING STOCK OBSERVATORY & ODYSSEE DATABASE

complemented with estimations from EU-wide Impact Assessments

- Development SRI for buildings (DG ENER, 2020);
- Impact of the revision of EPBD on energy savings from BACS (eu.bac, 2019);
- Ecodesign preparatory study for BACS (ongoing, DG ENER)

Indicative values in EU countries

- Bulgaria
  - Uses the energy class of the buildings (EPC) to calculate specific final energy savings for heating.
- France
  - Uses average values to calculate the energy savings for categories ‘heating’ and ‘hot water and heating’, per type of building.

Energy savings by sector by end used and energy type [kWh/m²]				
Sector	Heating only		Hot water and heating	
	Fossil energy	Electricity	Fossil energy	Electricity
Office	28	16	29	16
Education	10	6	12	8
Retail	29	16	31	18
Hotel and restaurants	27	9	31	13
Health	11	7	15	11
Other	10	6	12	8

$$TFES = S * ES * G$$

TFES	Total final energy savings [kWh/a]
S	Surface [m²]
ES	Energy savings by sector by end use and energy [kWh/m²]
G	Geographical area

Geographical area	G
H1	1,1
H2	0,9
H3	0,6

Data sources for streamSAVE indicative values

- Building Stock Observatory
- ODYSSEE database

Complemented with:

- Development SRI for buildings (DG ENER, 2020)
- Impact of the revision of EPBD on energy savings from BACS (eu.bac, 2019)
- Ecodesign preparatory study for BACS (ongoing, DG ENER)

- Possibility to use national values ?

Discussion

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Conclusions

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Next steps BACS

- Meeting minutes
  - please feel free to send us your suggestions
- All information will be included on the platform
  - in case not registered yet, we will show you how
- Next round: late autumn 2021
- Suggestions for topic or want to share policy practices?

Next Dialogues Group

- Dates for the next Dialogue Groups web meetings

18.05.2021	Changed date 29.06.2021	01.06.2021	15.06.2021	22.06.2021
				
BUILDING AUTOMATION & CONTROL SYSTEMS	REFRIGERATION SYSTEMS	LIGHTING SYSTEMS	ELECTRIC VEHICLES	HEAT RECOVERY

All web-meetings will be from **3.00 to 4.00 pm CEST**.

- Subscribe via: **REGISTRATION LINK** or send an email to dialogues@streamsave.eu

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- You may also leave us a longer message
  - Via forum on the streamSAVE platform
  - Via the anonymous form (link in the chat)
  - Via dialogues@streamsave.eu
    - Please accept as sender

- To receive more info → register on the streamSAVE platform: https://streamsave.flexx.camp/signup-0818ml

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Thank you

Get in touch for more information!

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