Motor Replacement in the Energy Efficiency Directive: Practical solutions developed by the streamSAVE project

#MotorsAcademy

WEBINAR #1

November 28, 2023

15:00 – 16:00 CET

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The streamSAVE project (Horizon 2020) aimed at streamlining energy savings calculations under the Energy Efficiency Directive (EED). Accelerated replacement of old, inefficient electric motors was one of the ten technical energy saving actions in scope. The speakers will briefly discuss the overall project outcome and illustrate the streamSAVE guidance and its platform, focused on motors.

Leonardo ENERGY

An initiative by

European Copper Institute
Copper Alliance

MOTORS ACADEMY

stream SAVE

stream
SAVE

Untap saving potential under EED

High potential of energy savings under art.7 (now 8) of EED recognized

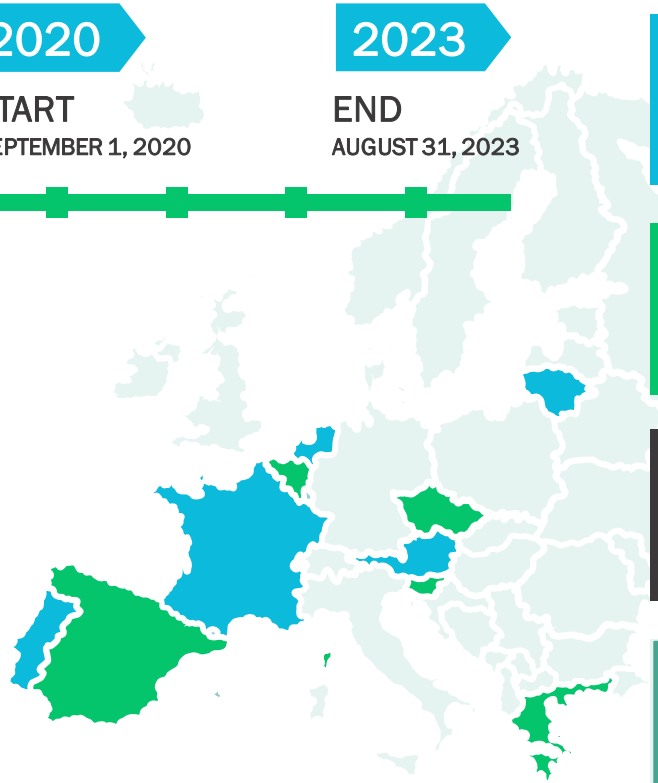
Some savings actions are lacking, despite documented savings potential

Lack of straightforward calculation methods, indicative values, parameters

streamSAVE: Horizon 2020

2020
START
SEPTEMBER 1, 2020

2023
END
AUGUST 31, 2023



COORDINATOR	vito, Energy Ville — 12 PARTNERS 10 COUNTRIES
RESEARCH & POLICY INSTITUTIONS	vito, IEECP (Institute for European Energy and Climate Policy), ISR, circe, Jožef Stefan Institute
ENERGY AGENCIES OR RELATED	Austrian Energy Agency, ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie), KAPE CRES, Lietuvos Energetikos Agentūra, SEVEn
CONNECTORS TO MARKET & TECHNOLOGY ACTORS	European Copper Institute (Copper Alliance), LGi (sustainable innovation)

What was the aim?

- *What?*
  Building capacity among public authorities on Article 3 & Article 7 *(now art.8)* of the Energy Efficiency Directive (EED)
- *Via?*
  Streamline calculation methodologies for bottom-up savings calculations
- *Result?*
  Address additional energy savings by 2030

10 actions: Member States' priorities

BUILDING AUTOMATION & CONTROL SYSTEMS

REFRIGERATION SYSTEMS

LIGHTING SYSTEMS

ELECTRIC VEHICLES

HEAT RECOVERY

SMALL-SCALE RENEWABLE CENTRAL HEATING

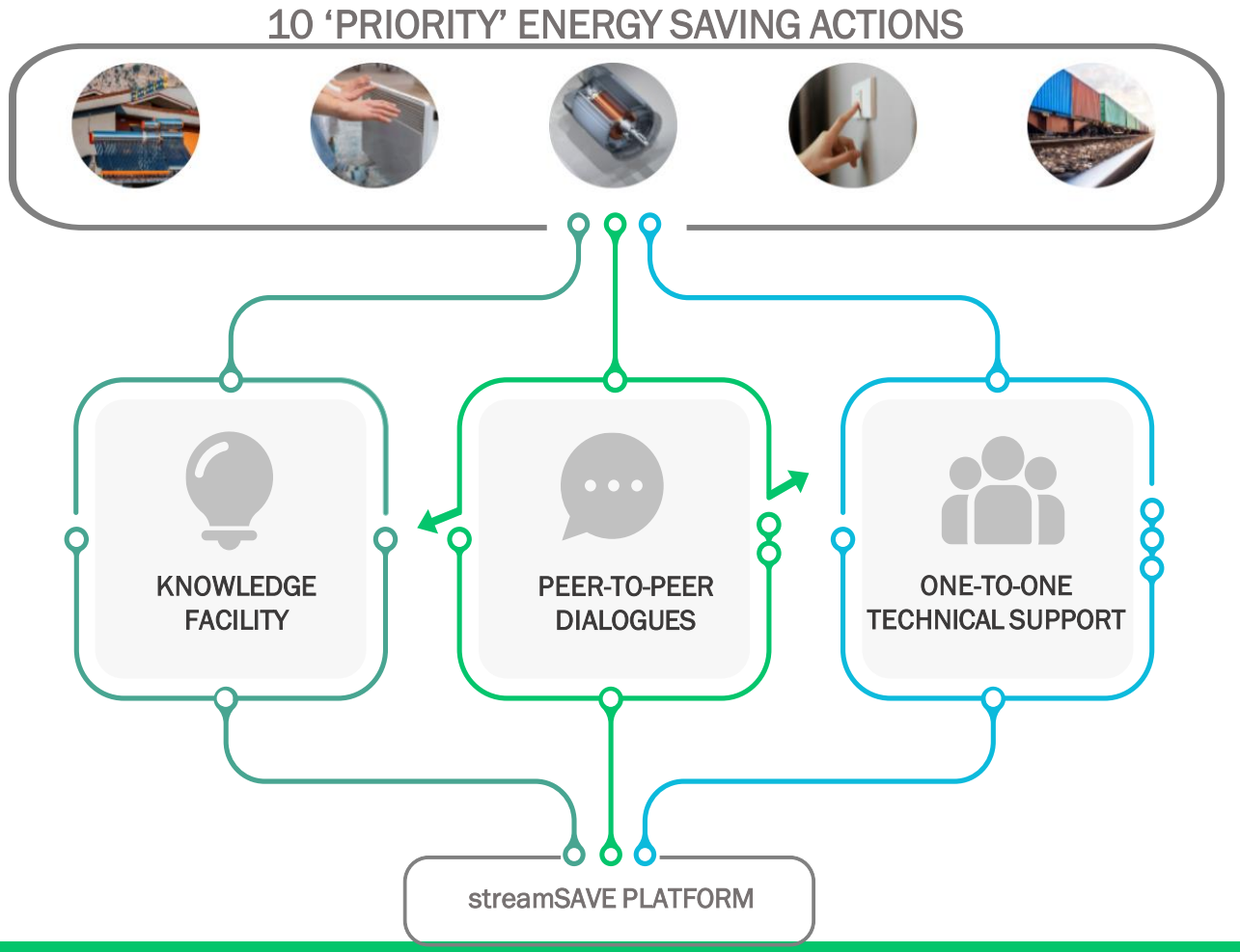
ACTIONS TO ALLEVIATE ENERGY POVERTY

REPLACEMENT OF ELECTRIC MOTORS

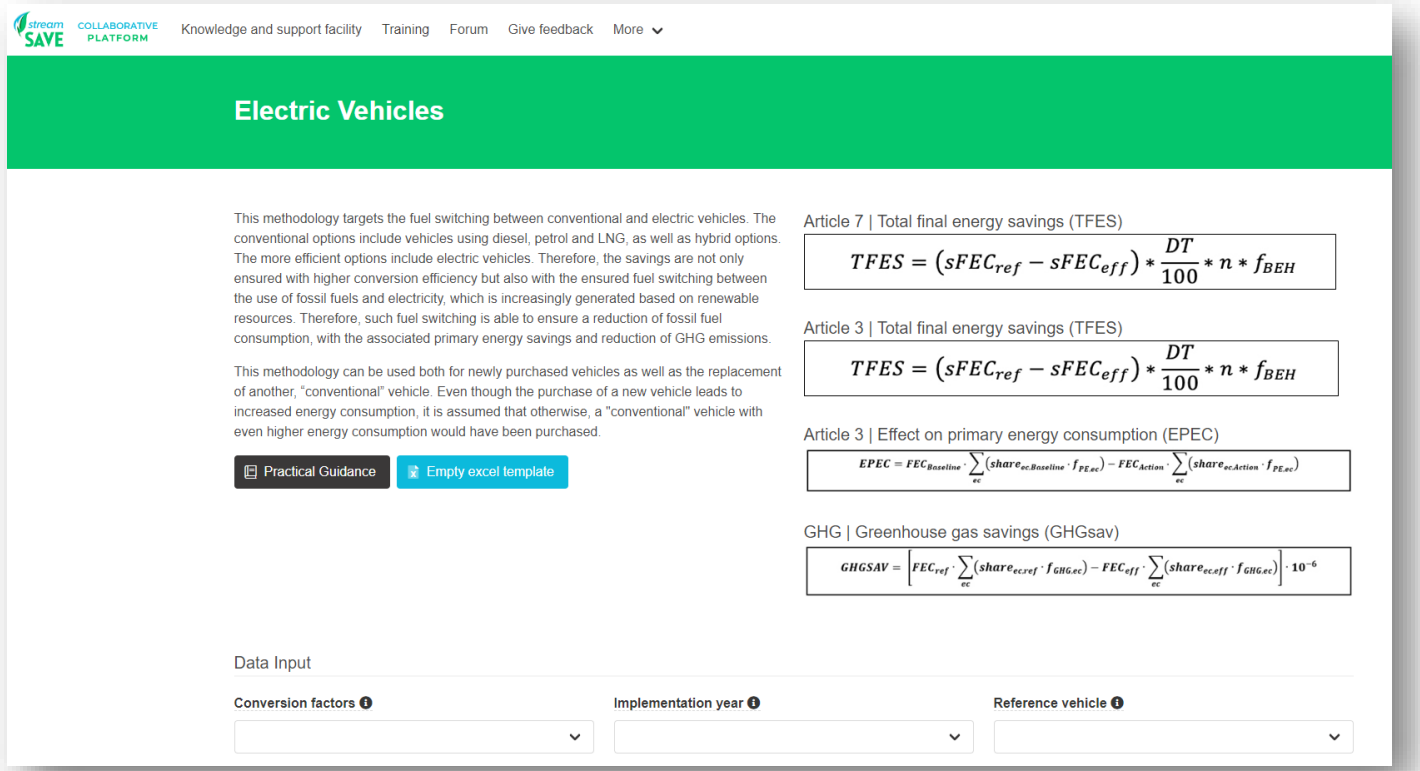
BEHAVIOURAL CHANGES

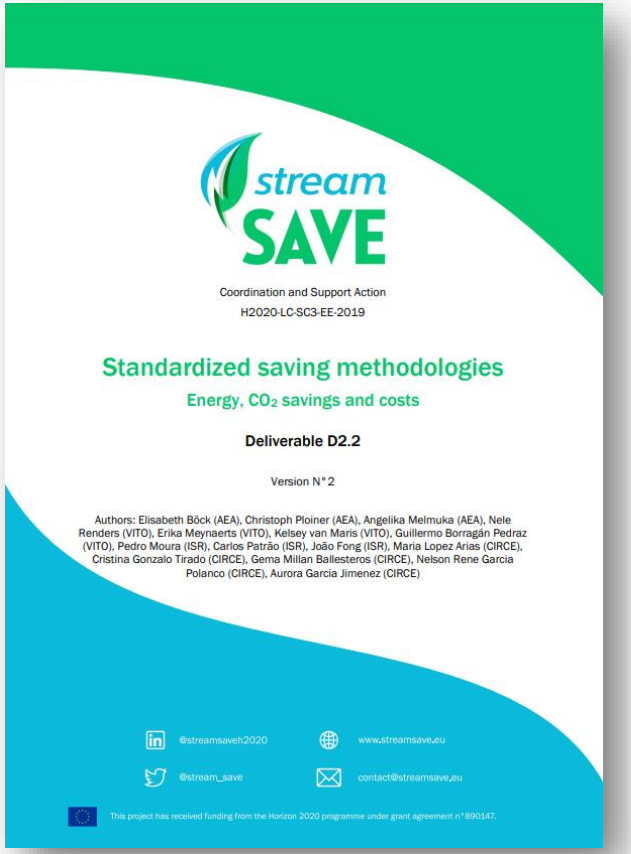
MODAL SHIFT FOR FREIGHT TRANSPORT

How did we realize these objectives?



streamSAVE guidance & platform



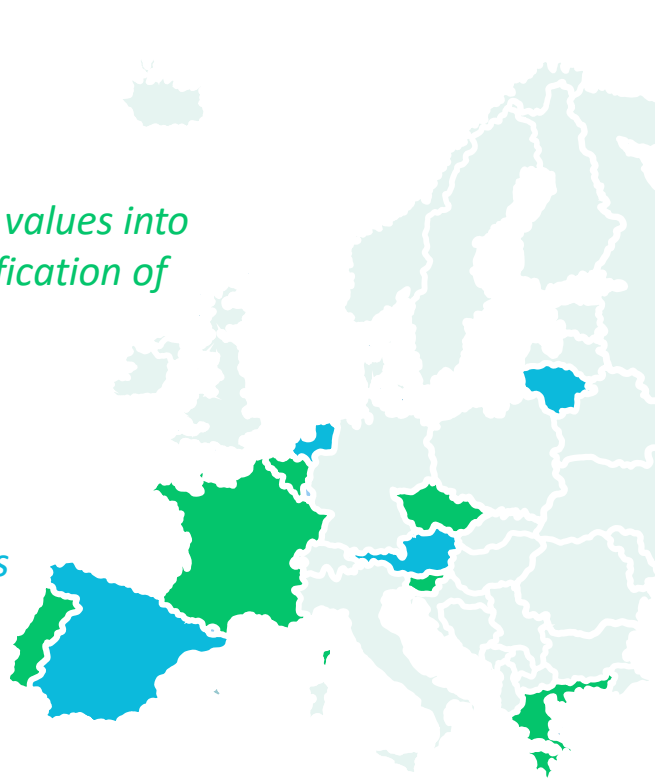


Register for methodologies in detail:
https://streamsave.flexx.camp/signup-0818ml

Result: policies improved in 13 countries

Belgium: *"publication deemed method & values into the revised Circular 307septies for electrification of federal car fleet"*

Spain: *"More realistic savings estimations for heat pumps in buildings"*



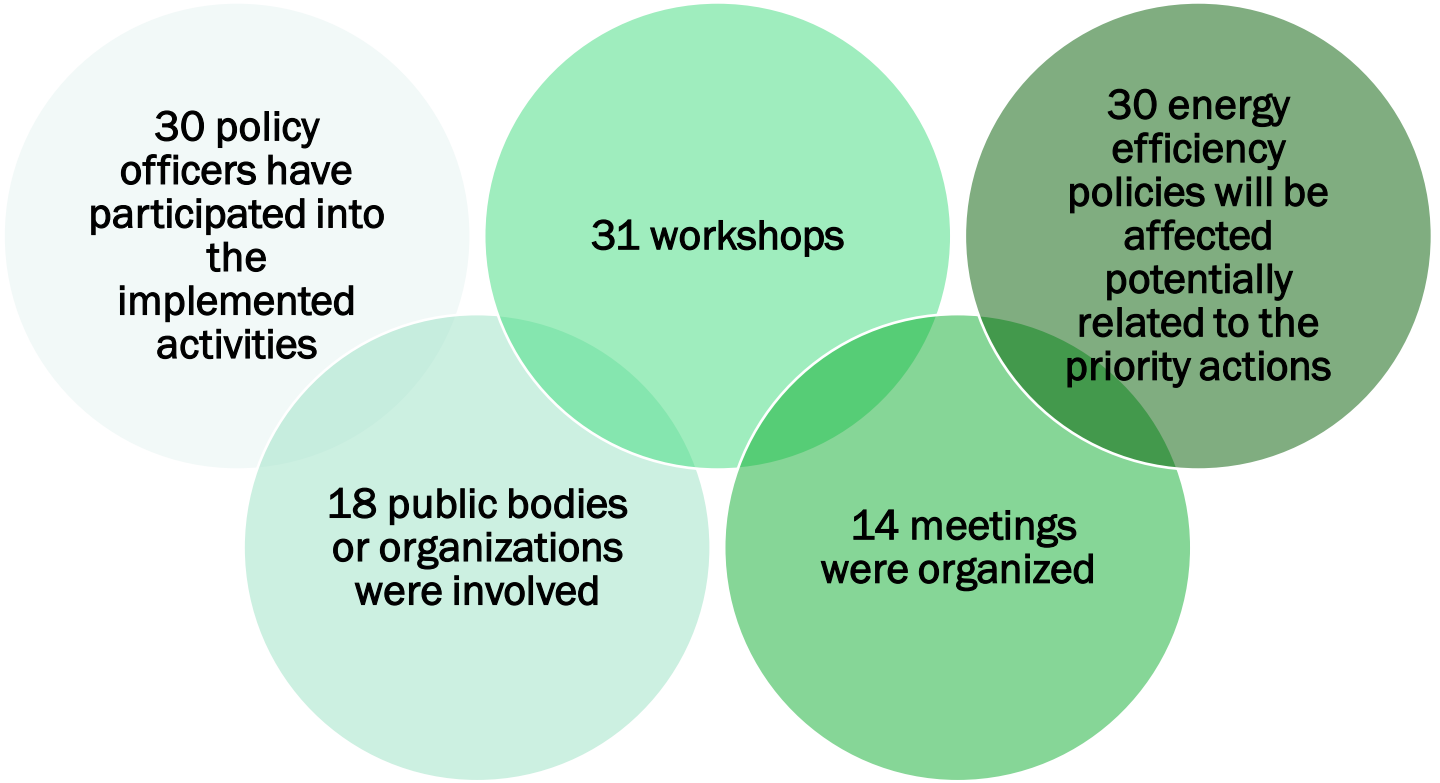
Austria: *"ready-to use methodology & indicative values for BACS, which was applied to a new subsidy program for BACS in non-residential buildings to estimate savings potential "*

Slovenia: *"integration of the developed BACS methodology in the Slovenian catalogue" "improving the existing awareness of the obligated parties on BACS"*

Greece*: "Improvement of the existing Greek catalogue of the EEO scheme for heat recovery from industry".*

"Bottom-up calculation methodologies support the coordination of monitoring, reporting and verification procedures between different bodies responsible for monitoring of the savings measures".

Impact achieved



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After the project end: still relevant!

- Energy Efficiency Directive 2023: recast

Energy Efficiency Directive *(recast)*

- New EU Energy Efficiency Directive
- Came into effect 10 October 2023
- Raises the EU-wide target and gradually **doubles the annual energy savings** target (Art.8, former Art.7) by 2028
- Pivotal article in achieving the energy efficiency targets of the EU

Energy Efficiency Directive *(recast)*

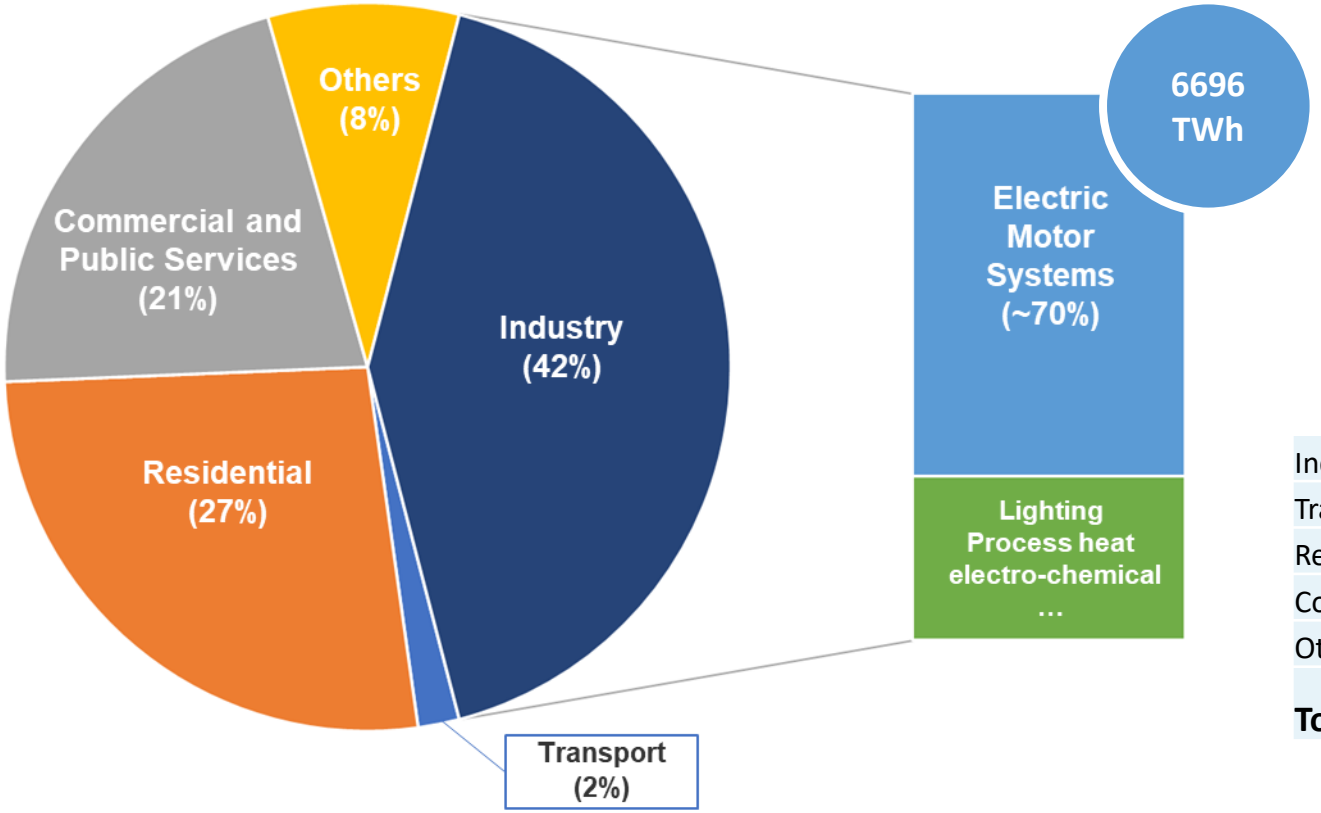
- Member states can claim full credit for policies that accelerate the uptake of more efficient products, provided
  - **proven additionality;**
  - that uptake takes place **before the expiry of the average expected lifetime** or before it would usually be replaced
- Accelerated motor replacement eligible
- streamSAVE methodology makes it easier for member states to integrate these actions into policy measures

Anticipated motor replacement
Contents

- Why is motor replacement relevant?
- Streamlined energy savings calculations for electric motor replacement

Anticipated motor replacement
Framing the problem / opportunity

Worldwide electricity use
2019 (IEA)



Industry: **9566 TWh**
Transport: **420 TWh**
Residential: **6072 TWh**
Commercial and public services: **4849 TWh**
Others (agriculture and fishing): **1940 TWh**

Total: 22847 TWh

Anticipated motor replacement

Framing the problem / opportunity

EC Ecodesign Regulations 640/2009 and 2019/1781

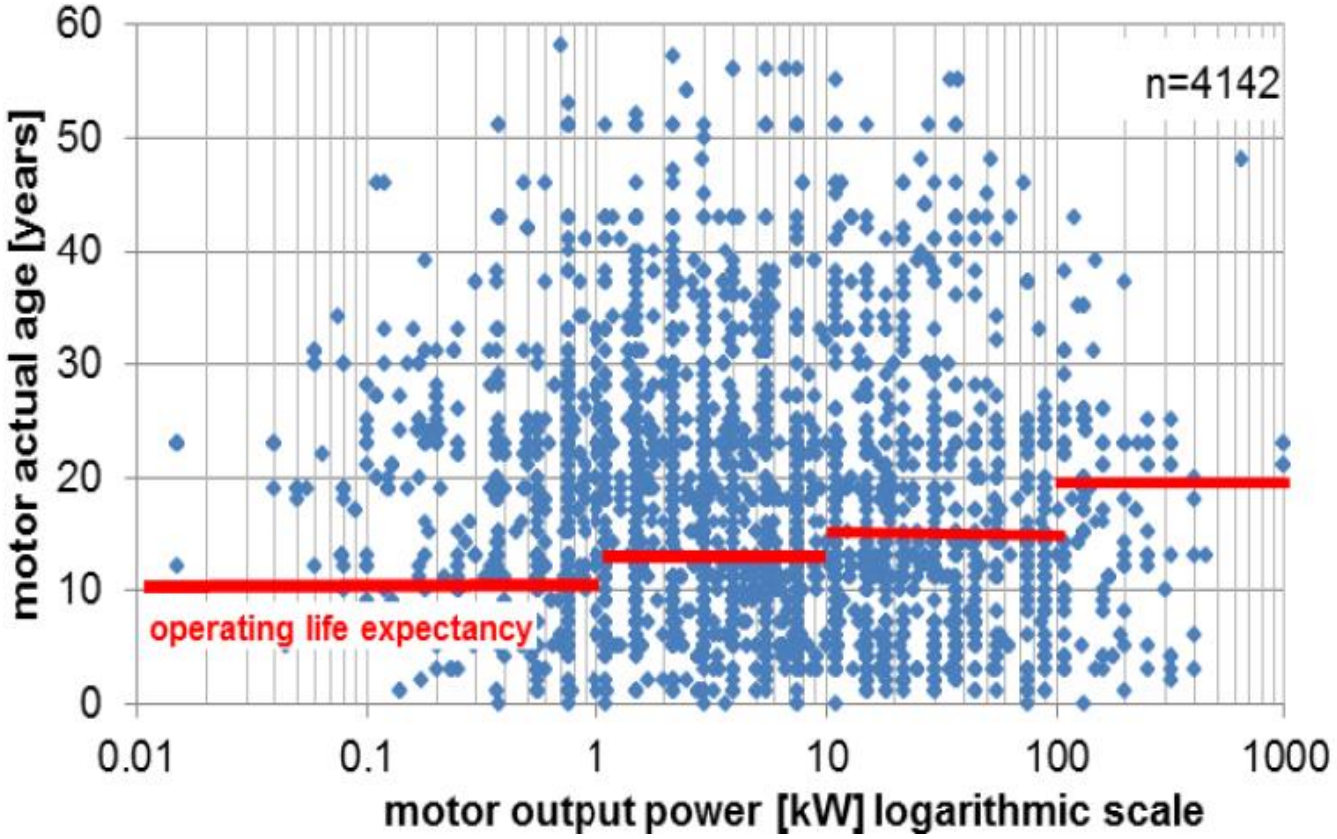
16 June 2011	• **Stage 1**: Motors with rated output 0,75 – 375 kW must meet **IE2** efficiency level
1 Jan 2015	• **Stage 2**: Motors with rated output 7,5 – 375 kW must meet **IE3** efficiency level or **IE2 + VSD**
1 Jan 2017	• **Stage 3**: Motors with rated output 0,75 – 375 kW must meet **IE3** efficiency level or **IE2 + VSD**
July 2021	• Motors (3-phase) with rated output 0,75 – 1.000 kW must meet IE3 efficiency level • Motors (3-phase) with rated output 0,12 – 0,75 kW must meet IE2 efficiency level
July 2023	• Single-phase motors with rated output equal or above 0,12 kW must meet IE2 efficiency level • Motors (3-phase) with rated output 75 – 200 kW must meet **IE4** efficiency level

Anticipated motor replacement

Average motor lifetime

1.0 – 7.5 kW:	12 years
7.5 – 75 kW:	15 years
75 – 250 kW:	20 years

Anticipated motor replacement
Average motor lifetime



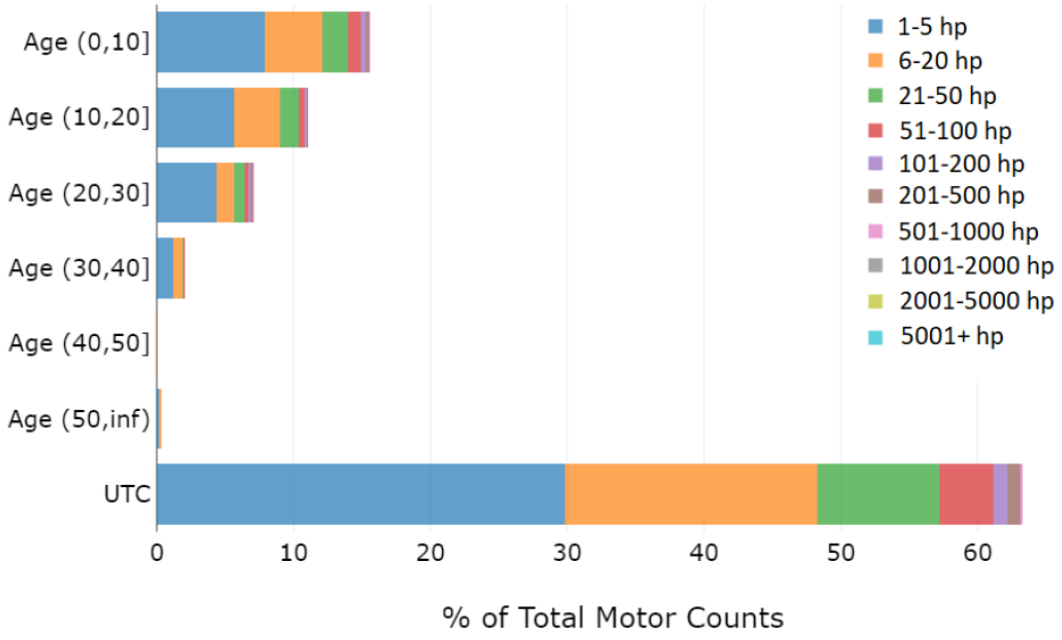
Source: Impact Energy, Switzerland, 2014

- In 2013 the Swiss Energy Agency S.A.F.E. assessed 4124 separate motor systems in 18 factories.
- The analysis shows that 56% of all motors and their respective systems were older than their expected operating life time (some were twice the expected age).

Anticipated motor replacement

Average motor lifetime

Age of industrial motor systems broken down by size



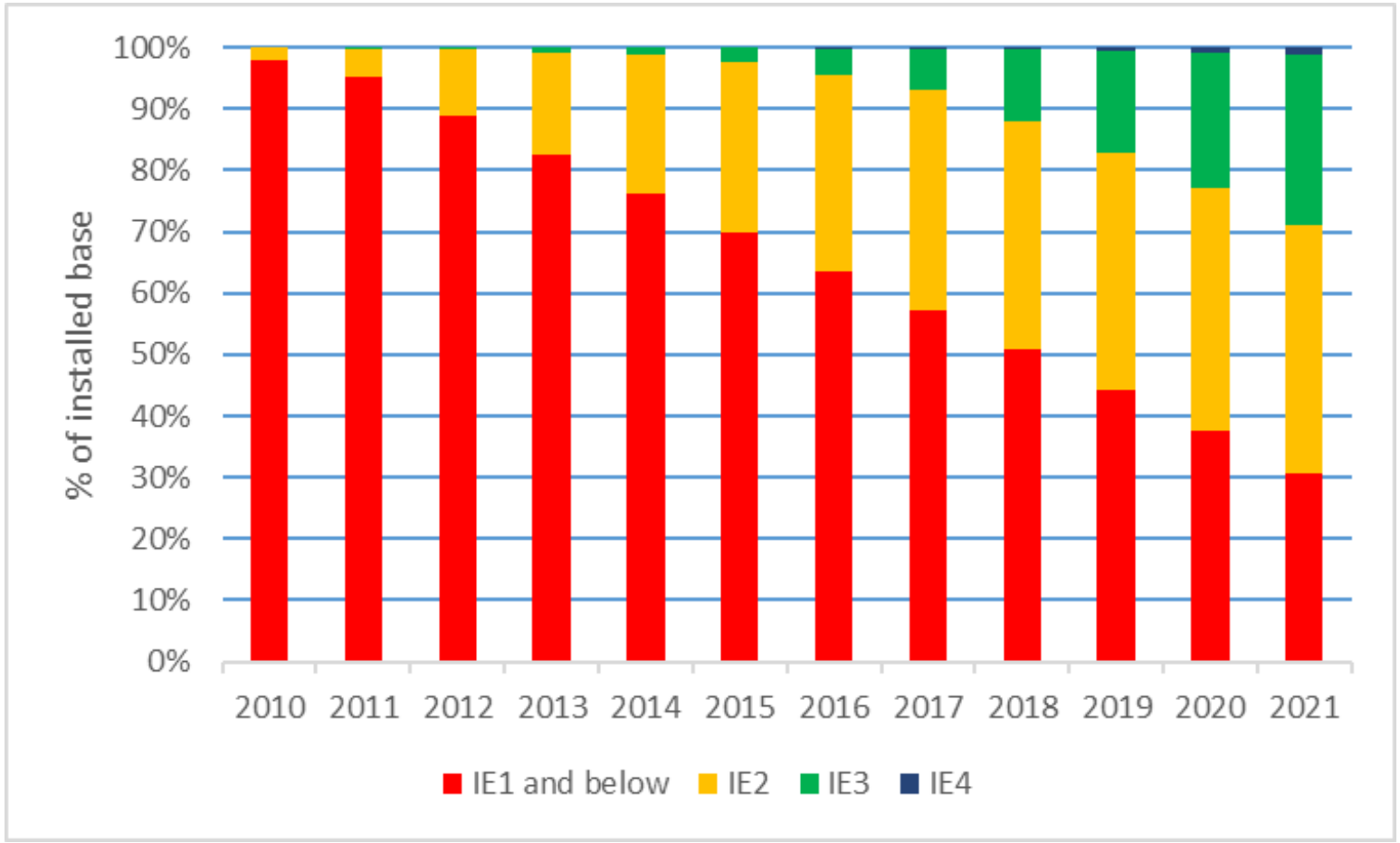
Source: (DoE, 2021) US Motor System Market Assessment

The 2021 US MS Market Assessment found that the majority of motors is over 10 years old, even for small motors under 20hp

* UTC - Unable to Collect

Anticipated motor replacement

Efficiency of installed base (EU-27)



Even when taking the values of 12, 15 and 20 years for the average lifetime, depending on motor power range, it can be seen that, despite the Ecodesign Regulation in place, over 70% of the motors installed in the EU-27 were still IE2 efficiency class or below in 2020

Anticipated motor replacement
The opportunity

- Replacing motors with IE2 Class or below.
- Assuming an average 4% gain in efficiency, equal to the average difference between IE1 and IE3

The savings triggered would equal **25 TWh/yr in the EU-27.**

The savings would be even larger if the replacement is made with:

- IE4 or IE5 motors
- correct sizing of the motor,
- equipping the motor with variable speed drive
- digitisation / sensorisation,
- removing unneeded transmissions,
- …

Total savings: 100TWh / year
= 55 average gas fired power plants (4)

= close to the electricity consumption of the Netherlands (2021) (5)

= 30% of natural gas import from Russia (08/2022) (6)

= 25 Mton CO2e (7)

Anticipated motor replacement
The StreamSave methodology

- Definition:
  - *This methodology deals with the replacement of existing motors (IE2 or below) to more energy efficient technologies (IE3 or above) before the end of their lifetime. It provides formulas for the calculation of energy savings of the implemented measures that account not only for the replacement of existing motors, but also for the installation of Variable Speed Drives (VSDs). The methodology can be applied in all Member States, following the provided indicative values and indications.*
- Scope:
  - **Sector:** Industry / Tertiary
  - 3-Phase Motors in the scope of The Ecodesign Regulation (EC Regulation 2019/1781)
    - Only between 0,75kW and 1000kW (exclude “small motors”)

Anticipated motor replacement

- Methodology:
  - *Article 7 =>*

$$\mathrm{TFES} = n \times P_n \times h \times \left(\frac{1}{\eta_c} - \frac{1}{\eta_{he}}\right) \times LF \times 100$$

$$\mathrm{TFES}_{VSD} = n \cdot \frac{P_n}{\eta_{he}} \cdot 100 \cdot h \cdot f_{VSD}$$

TFES	Total final energy savings [kWh/a]
$TFES_{vsd}$	Total final additional energy savings from VSD [kWh/a]
n	Number of motors replaced [dmnl]
P_n	Nominal power as indicated in the nameplate [kW]
h	Annual operating hours [h]
η_c	Efficiency of conventional motor [%]
η_{he}	Efficiency of high-efficiency motor [%]
LF	Load factor [dmnl]
f_{VSD}	Factor to account for additional savings generated by the installation of a variable speed control (VSD) [dmnl]

Anticipated motor replacement

Online Platform

Data Input

Conversion factors ⓘ
EU values

Power Range ⓘ
75 - 375

Effciency of the new motors ⓘ
IE3

Sector ⓘ
Industry, 2 shifts, 5 days/week

Variable Speed Drive (VSD) ⓘ
Yes

End-Use (VSD) ⓘ
Pumps

Anticipated motor replacement

Online Platform

Power range [kW]	Avg. Power	IE1-IE2 Avg	IE3	IE4
0,75 - 7,5	3.2	81.9	86.5	89.1
7,5 - 75	34.3	91.2	93.3	94.6
75 - 375	201.5	94.3	95.7	96.4
375 - 1000	587.5	94.5	95.9	96.6

Data Input

Conversion factors ⓘ
EU values

Power Range ⓘ
75 - 375

Effciency of the new motors ⓘ
IE3

Sector ⓘ
Industry, 2 shifts, 5 days/week

Variable Speed Drive (VSD) ⓘ
Yes

End-Use (VSD) ⓘ
Pumps

Type of activity	[h/a]
Industry, 1 shift, 5 days/week	1,920
Industry, 2 shifts, 5 days/week	3,840
Industry, 2 shifts, 6 days/week	4,608
Industry, 2 shifts, 7 days/week	5,376
Industry, 3 shifts, 5 days/week	5,760
Industry, 3 shifts, 6 days/week	6,912
Industry, 3 shifts, 7 days/week	8,064
Industry, 3 shift, continuously	8,760
Tertiary	1,480

End-Use	f_{VSD}
Pumps	0.28
Fans	0.28
Air Compressors	0.12
Cooling compressors	0.12
Conveyors	0.12
Other Motors	0.12

Anticipated motor replacement

Online Platform

Share of energy carriers

Before implementation	Share	After implementation	Share
Electricity	100	Electricity	100

Anticipated motor replacement

Online Platform

	National Data		Indicative Values	
n	1,00	dmnl	1.00	dmnl
Pn	90,00	kW	90.00	kW
h	3840,00	h	3840	h
nc	93,00	%	94.250625	%
nhe	95,20	%	95.68749999999999	%
LF	0,60	dmnl	0,60	dmnl
VSD Savings	0,28	dmnl	0,28	dmnl

Calculate

Anticipated motor replacement

Online Platform

Calculation results

	national values		indicative calculation values	
TFES Article 7	66,140.85	kWh/a	63,981.25	kWh/a
EFE Article 3	66,140.85	kWh/a	63,981.25	kWh/a
TPES Article 3	150,889.76	kWh/a	145,962.97	kWh/a
GHGsav	8.82	tCO2	8.53	tCO2

Anticipated motor replacement

Online Platform

- Download the empty excel file
- Download the results in an excel file

The EU-MORE Project

EUropean MOtor RENovation Initiative

GATHER INSIGHT	DEVELOP STRATEGIES FOR ACCELERATING THE MOTOR RENOVATION RATE	MAXIMIZE THE ENERGY EFFICIENCY BENEFIT OF MOTOR RENOVATION	MAXIMIZE THE CIRCULARITY OF MOTORS

What brings EU-MORE?

EU-MORE objective	**EU-MORE objective**	**EU-MORE objective**	**EU-MORE objective**
Gather data and develop a model. Use this for analysing different scenarios of policy implementations and their outcomes in terms of energy savings and GHG emission abatement.	Promote knowledge exchange. Propose appropriate policies aimed at improving the uptake of EE motors, coupled with motor system optimisation. These can assist Member States in achieving their EE targets.	Propose policies that stimulate system efficiency: proper motor sizing, variable speed drives, digital technology, …	Promote the use of recyclable, high value materials in motor manufacturing, and recover those materials at EoL, ensuring that motor renovation programs will contribute to the EU circular economy goals.

LIFE project co-funded under grant agreement N° 101076631

streamSAVE Training Module

The Training Module is available on the streamSAVE platform

It provides online calculation templates for all developed bottom-up calculation methodologies, including:

- indicative calculation values
- data on costs
- estimations of GHG emission reduction

Register here:

https://streamsave.flexx.camp/signup-0818ml