EU-MORE

EUropean MOtor REnovation initiative

Example of a specific action type

Early replacements of electric motors and how to calculate their energy saving potentials

17th December 2024, Dr. Robin Barkhausen (Fraunhofer ISI)

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Electric motors

Electric motors > 50% of EU electricity consumption

→ High impact in energy consumption & environmental impacts

Appr. 120M motors (industry & tertiary) in EU

Link to D2.1 European Motor Market Assessment
Fong, J. et al. (2024)

EU-MORE model for evaluating replacement policies

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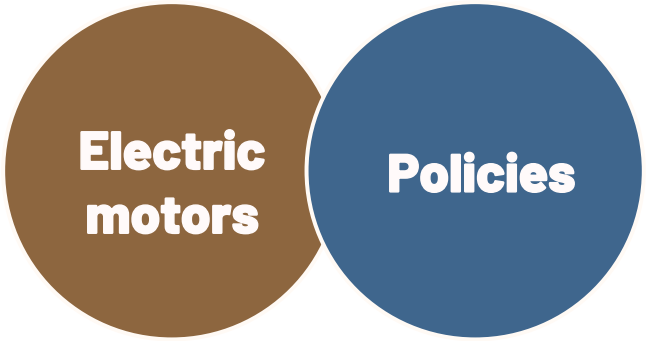

Ecodesign Directive
(Minimum Energy Performance Standards)

Financial policies
(subsidy schemes or tax rebates)

Non-financial policies
(information campaigns and capacity building)

- Motor policies with goal to reduce significant environmental impacts
- Focus on use phase, energy & CO_2

EU-MORE model for evaluating replacement policies

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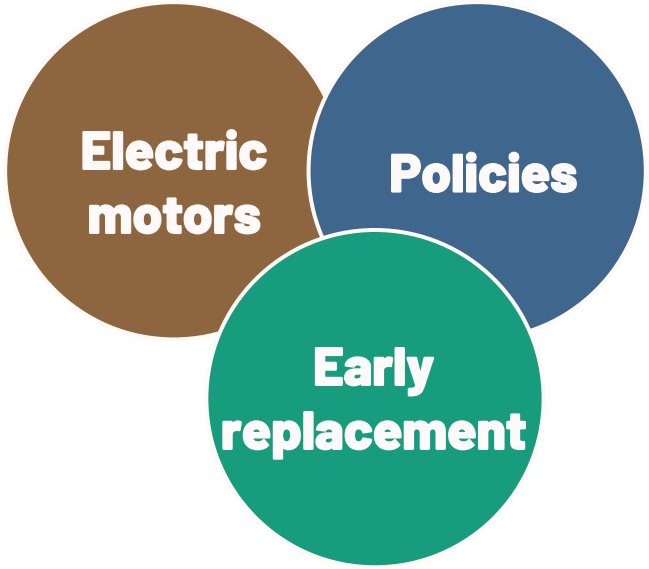

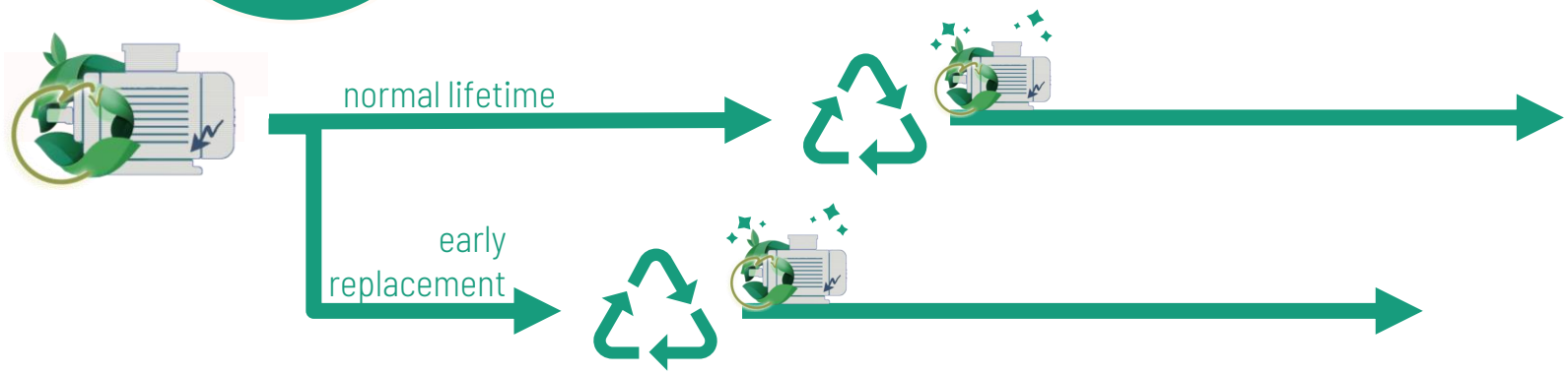

EU-MORE model for evaluating replacement policies

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EU-MORE Motor Model

Early replacements of electric motors and how to calculate their energy saving potentials

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EU-MORE Activities

Background

- Assessment of motor market
- Policy review
- Analysis of efficiency trends
- Analysis of end-of-life practice

New policy development

- Co-creation workshops at member-state level
- EU-MORE Knowledge Exchange Platform
- Tools for impact projection and monitoring
- Align policies with the circular economy

EU-MORE model for evaluating replacement policies

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EU-MORE Partners

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UNIVERSIDADE DE COIMBRA

International Copper Association Europe

Fraunhofer ISI

IEECP
INSTITUTE FOR EUROPEAN ENERGY AND CLIMATE POLICY

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Agenda

Genesis provides insight into the motivation and requirements behind the development of the model, elucidating its evolution and functionality.

Exploration serves as a guide to get started with and how to use the tool, outlining the calculation of policy impacts.

Application presents theoretical and practical country-specific case studies.

Reflection discusses prerequisites and limitations of the model and provides an outlook.

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1. Genesis

1.1 Motivation & scope

1.2 Covered policies

1.3 Policy impacts and monitoring

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1.1 Motivation & scope

- The EU-M^3 tool is designed to analyze the impact of existing and new policies on electric motor replacement
- The tool was created to help stakeholders and policy makers understand the implications of motor policy decisions

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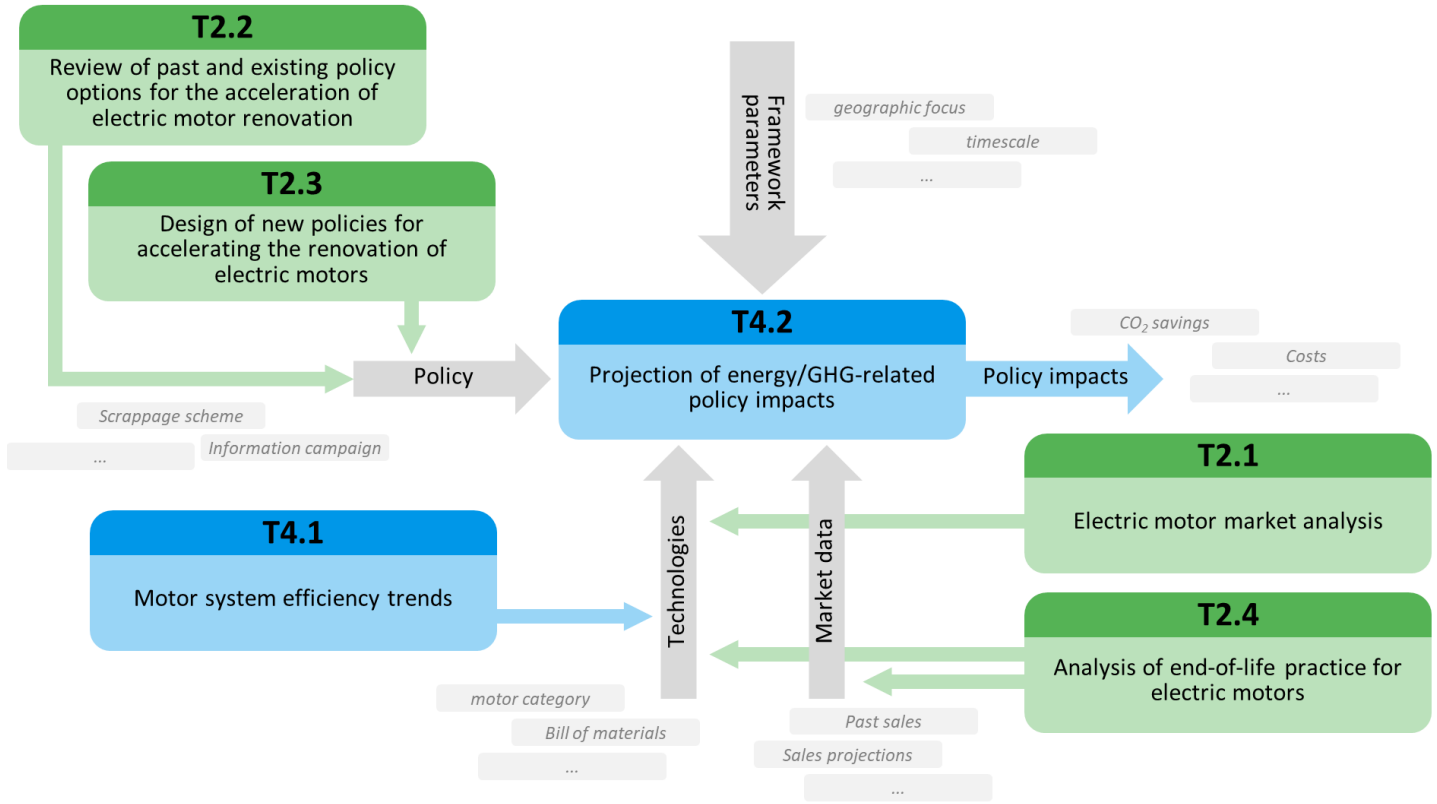
1.1 Motivation & scope

- Scope of tool largely determined by Task 4.2 of the EU-MORE project and preceding tasks including electric motor market analysis, end-of-life practices assessment, motor system efficiency trends review, past and existing policy options, and new policy designs



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1.1 Motivation & scope

- The EU-M^3 tool is applicable to the EU-27 market for industrial electric motors, providing data on motor sales by technology, power range, and efficiency class
- The tool categorizes motors into six efficiency classes (IE0 to IE5) and five power ranges (0.75-7.5 kW to >375 kW)
- Efficiency classes IE0 to IE4 represent squirrel cage induction motors (SCIM), while IE5 motors represent synchronous reluctance motors (SynRM).
- The EU-M^3 tool currently does not support the use of Variable Speed Drives (VSDs) due to a lack of reliable data on their effects

- Logic: multi-layer stock model, assessing energy consumption, materials and greenhouse gases
- Implementation: Microsoft Excel for easy accessibility

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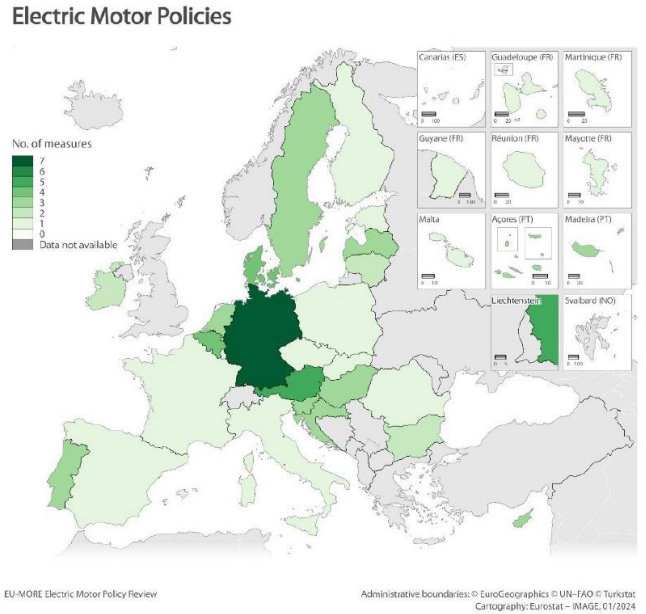
1.2 Covered policies

- Policies for EU-M^3 chosen based on comprehensive review of past and current electric motor policies in the EU (D2.2)
- Selected policies primarily financial, encouraging the replacement of old motors with more efficient ones, but non-financial policies are also considered



Subsidy Scheme

- financial policy incentivizing the replacement of old, inefficient motors with new, energy-efficient ones. For example:
  - Energy Efficiency Promotion Plan (PPEC) (Portugal),
  - ProkiloWatt (Switzerland),
  - National Motor Replacement Program (India)

Tax Incentive in combination with Voluntary Agreements

- financial policy offering tax rebates to companies that replace old motors with energy-efficient ones.

For example:

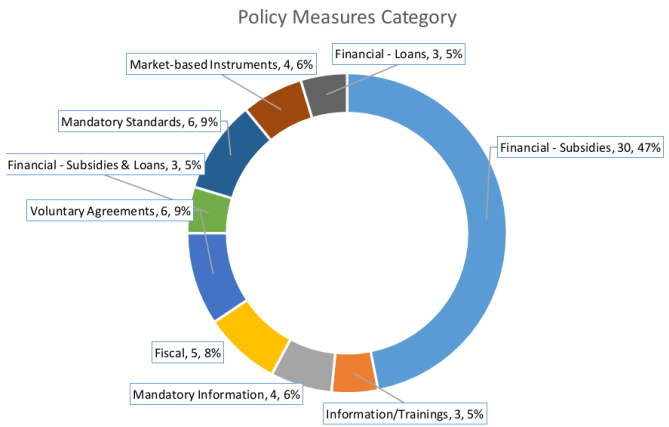
- e.g. Energy Investment Allowance (The Netherlands)
- Energy Investment Allowance (The Netherlands)
- PFE – Program for energy efficiency (Sweden)

Information Campaigns and Capacity Building

- non-financial policies aimed at overcoming informational and behavioral barriers to motor replacement and system optimization

For example:

- e.g. Klimaaktiv (Austria),
- OekoBusiness Vienna (Austria)



D2.2 Review of past and existing policies for the acceleration of electric motor renovation
Faassen, E.; Eichhammer, W.; Sangiorgio, I. (2024)

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1.2 Covered policies

- Financial policies like subsidy schemes and tax incentives are key for impact estimation, differing in the delivery of financial support
- Non-financial initiatives like informational campaigns enhance other policies or instigate behavioural changes, with their impact assessed indirectly through cost-effectiveness ratios from existing programs

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1.3 Policy impacts and monitoring

Additional information on how savings are calculated

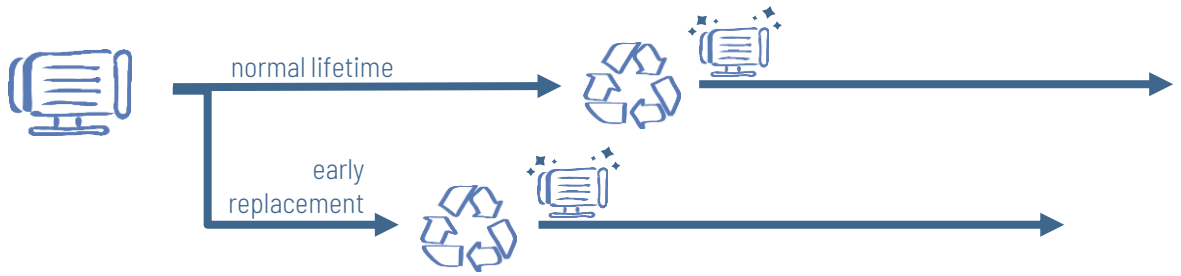
- The motor model calculates savings compared to a base case with no policy intervention.
- Savings are only counted for the years in which motors are removed from the market before their technical lifetime.
- A two-year reduction in lifetime in the policy scenario leads to a delay in replacing motors in the base case, with corresponding savings occurring for those two years.
- If the replacement motor is better than the market average at the end of the technical lifetime, then the savings are realized over the entire lifetime of the new motor.
- These savings apply to energy consumption, CO2 savings, and energy costs.

EU Energy Efficiency Directive 2023

Annex V COMMON METHODS AND PRINCIPLES FOR CALCULATING THE IMPACT OF ENERGY EFFICIENCY OBLIGATION SCHEMES OR OTHER POLICY MEASURES UNDER ARTICLES 8, 9 AND 10 AND ARTICLE 30(14)

1. Methods for calculating energy savings other than those arising from taxation measures for the purposes of Articles 8, 9 and 10 and Article 30(14).
Obligated, participating or entrusted parties, or implementing public authorities, may use the following methods for calculating energy savings: [...]
2. In determining the energy savings for an energy efficiency measure for the purposes of Articles 8, 9 and 10 and Article 30(14), the following principles apply: [...]

(m) for policies that accelerate the uptake of more efficient products and vehicles, except those newly implemented as from 1 January 2024 regarding the use of direct fossil fuel combustion, full credit may be claimed, provided that it is shown that such uptake takes place before the expiry of the average expected lifetime of the product or vehicle, or before the product or vehicle would usually be replaced, and the savings are claimed only for the period until the end of the average expected lifetime of the product or vehicle to be replaced; [...]



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1.3 Policy impacts and monitoring

Additional information on how savings are calculated

- The calculation of the Internal Rate of Return (IRR) at the individual motor level is an exception. This calculation is intended as a decision-making aid for policy design and represents a hypothetical company perspective.

- The current form of the tool does not directly allow for consideration of only savings beyond the minimum technical requirement.
  nevertheless possible to do it → the user must carry out two almost identical calculations, one with the old motor replaced with the minimum standard and one with the more efficient option. The difference between the two represents the savings.

- The user can model an exchange obligation by setting the funding rate to 0%.

EU Energy Efficiency Directive 2023

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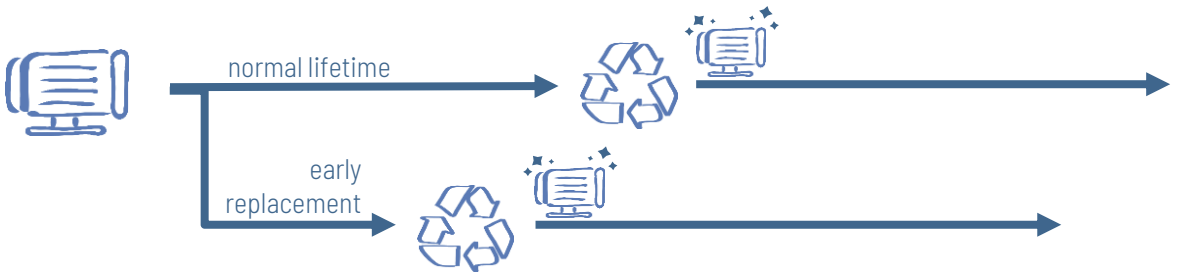

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2. Exploration

2.1 Getting started

2.2 Using the tool

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2.1 Getting started

Tour-through the model

- EU-M^3 can be downloaded directly from the EU-MORE website
- An online version of the model has been developed for direct access and interaction without any downloads.

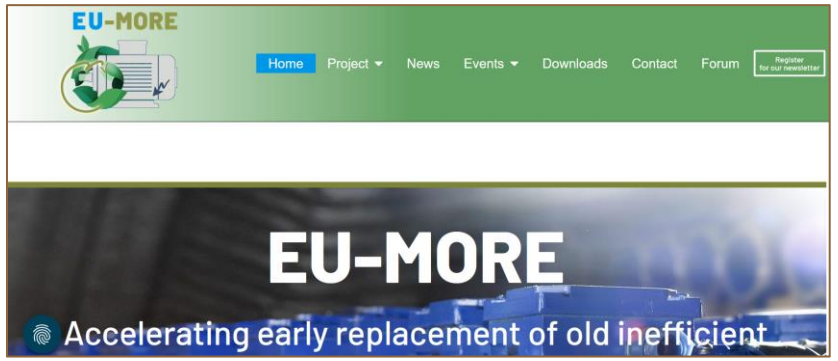
To get started, follow the steps below

1 Open the EU-MORE project website at https://eu-more.eu/

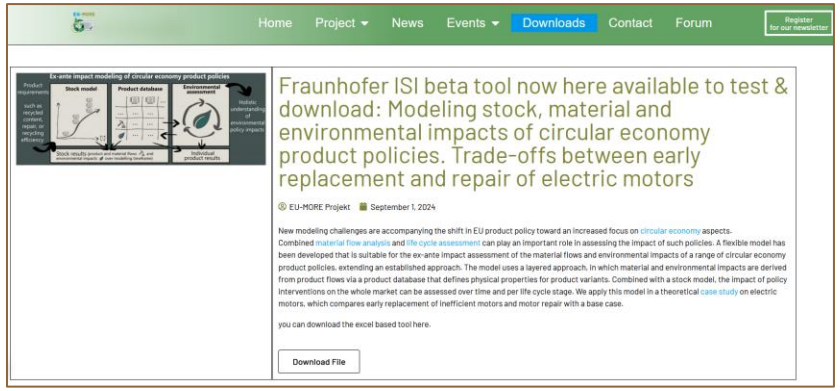
2 Navigate to the Downloads section

3a To download an Excel version on your computer for offline usage:
Look for D4.2 Stock-model to assess the policy impact of motor policies and select Download File

3b To use the web-based version for using or testing the tool online:
Look for D4.2 Stock-model to assess the policy impact of motor policies and select Web-based Excel



Landing page of the EU-MORE website



Download section of the EU-MORE website

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2.2 Using the tool

Info tab

The info tab serves as the landing page of the motor model. It contains information on version history, authors and means of providing feedback.

It provides an overview of the different sheets, including information on the sheets which are hidden by default to keep the tool lean. For interested users on the functioning of the tool, the hidden sheets can be displayed.

Links are provided to documents or scientific articles which provide further information on the model or its underlying logic.

Finally, information is provided on the EU-MORE project.

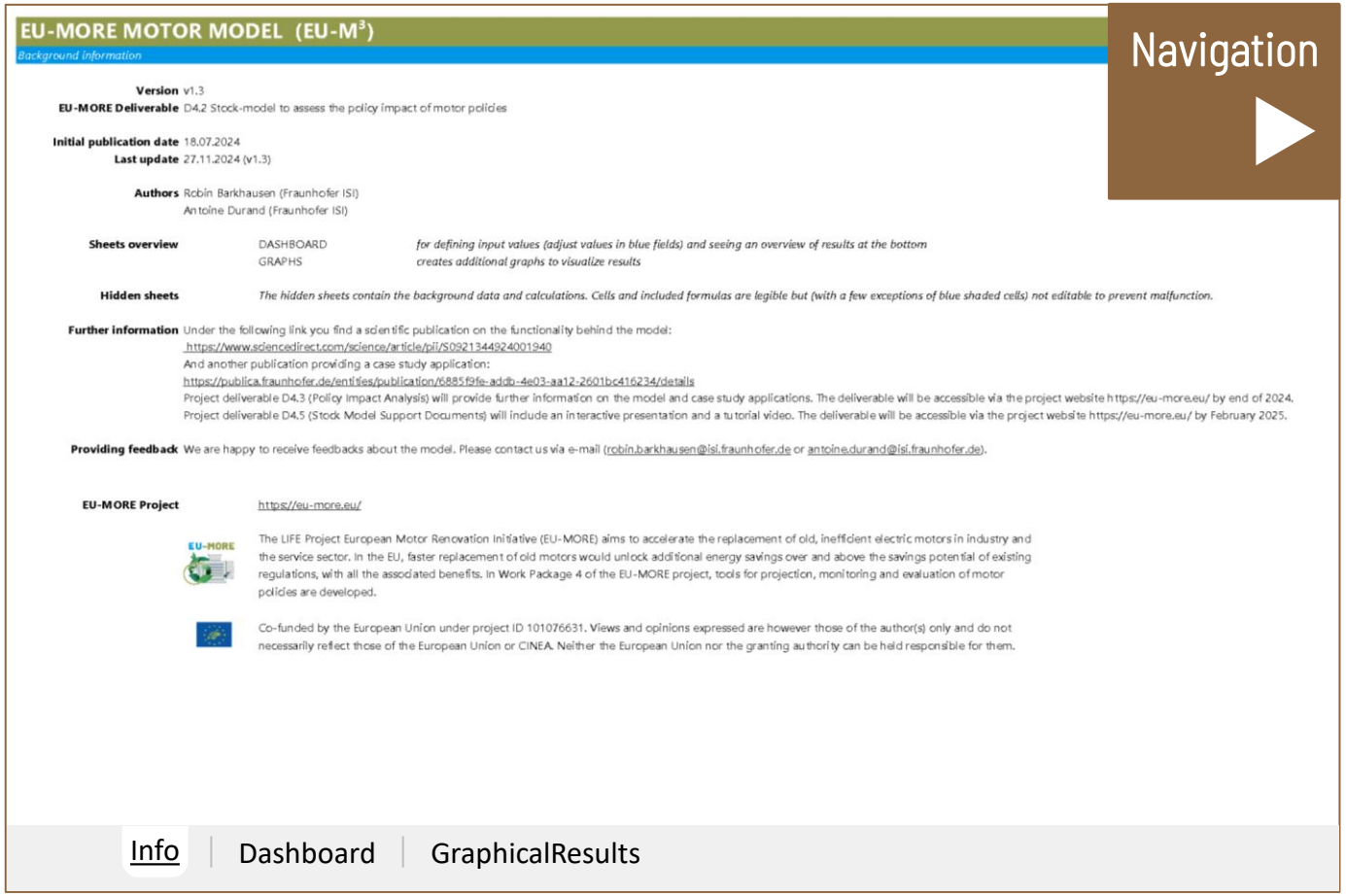

Figure: Click by click tour through the Excel file

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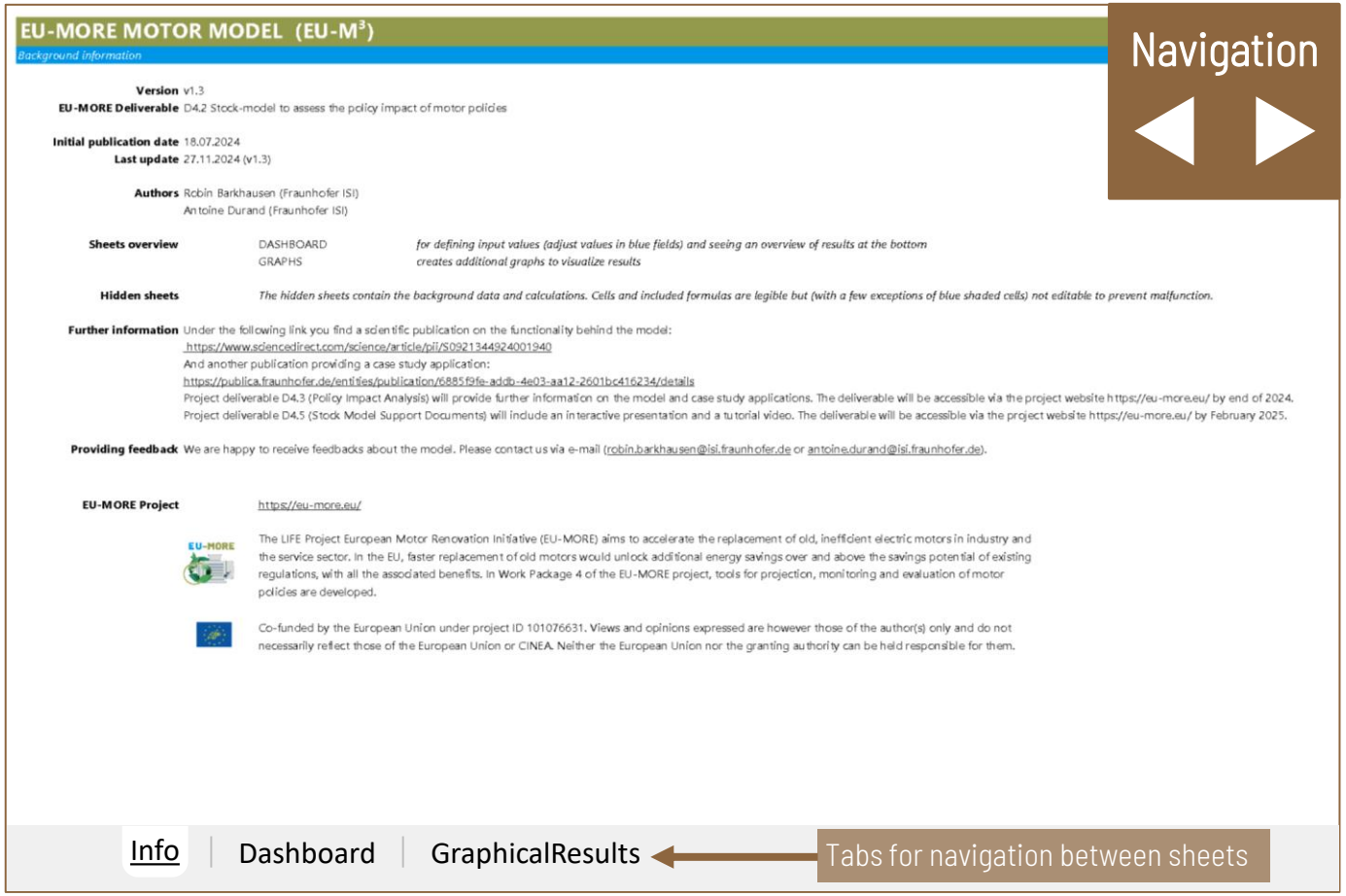
2.2 Using the tool

Navigation between sheets

To move to another sheet, click on one of the tabs at the bottom of the Excel.



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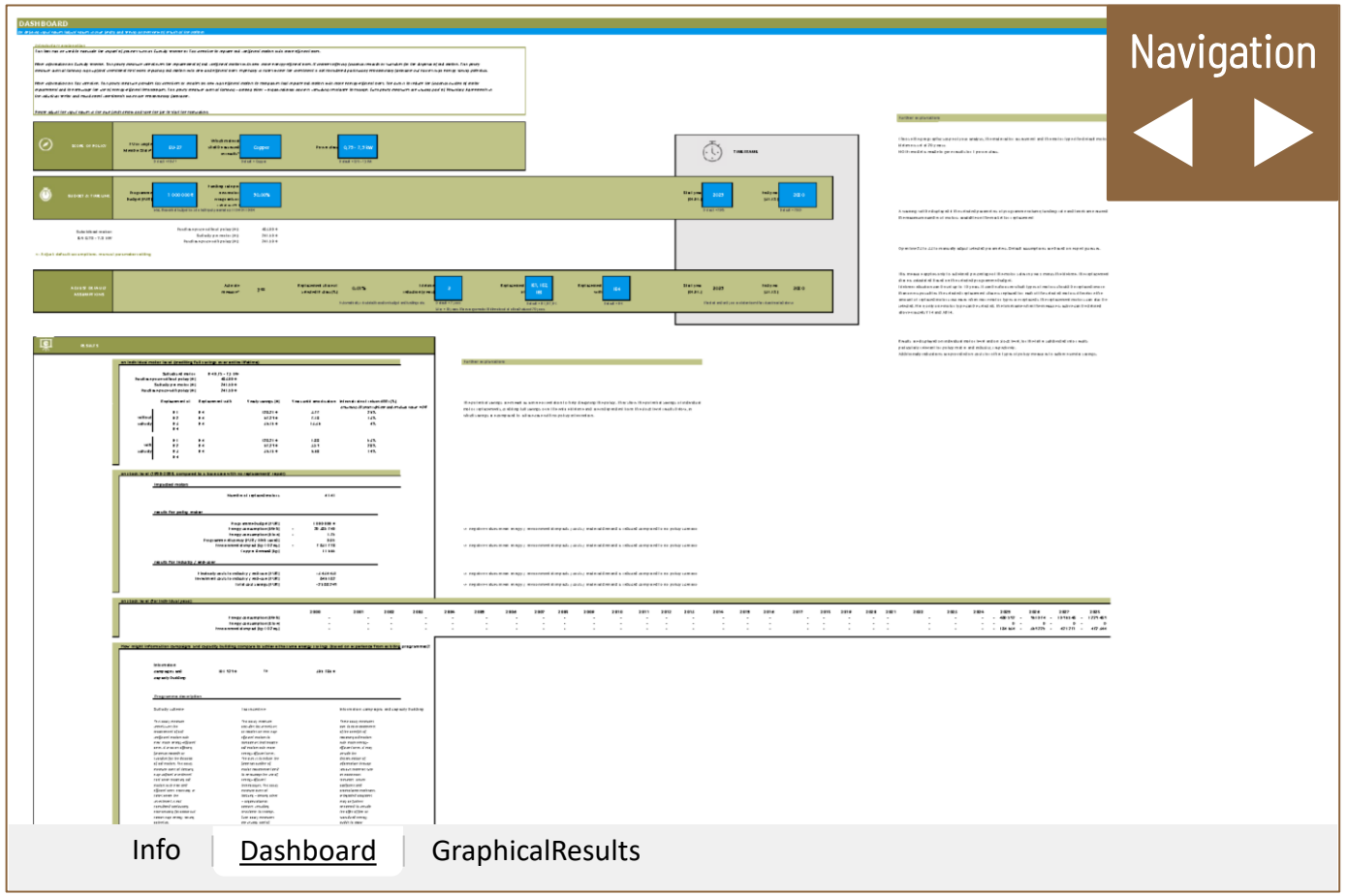
2.2 Using the tool

Dashboard

On the dashboard the user sees information on the policies and further explanation on how to use the tool.



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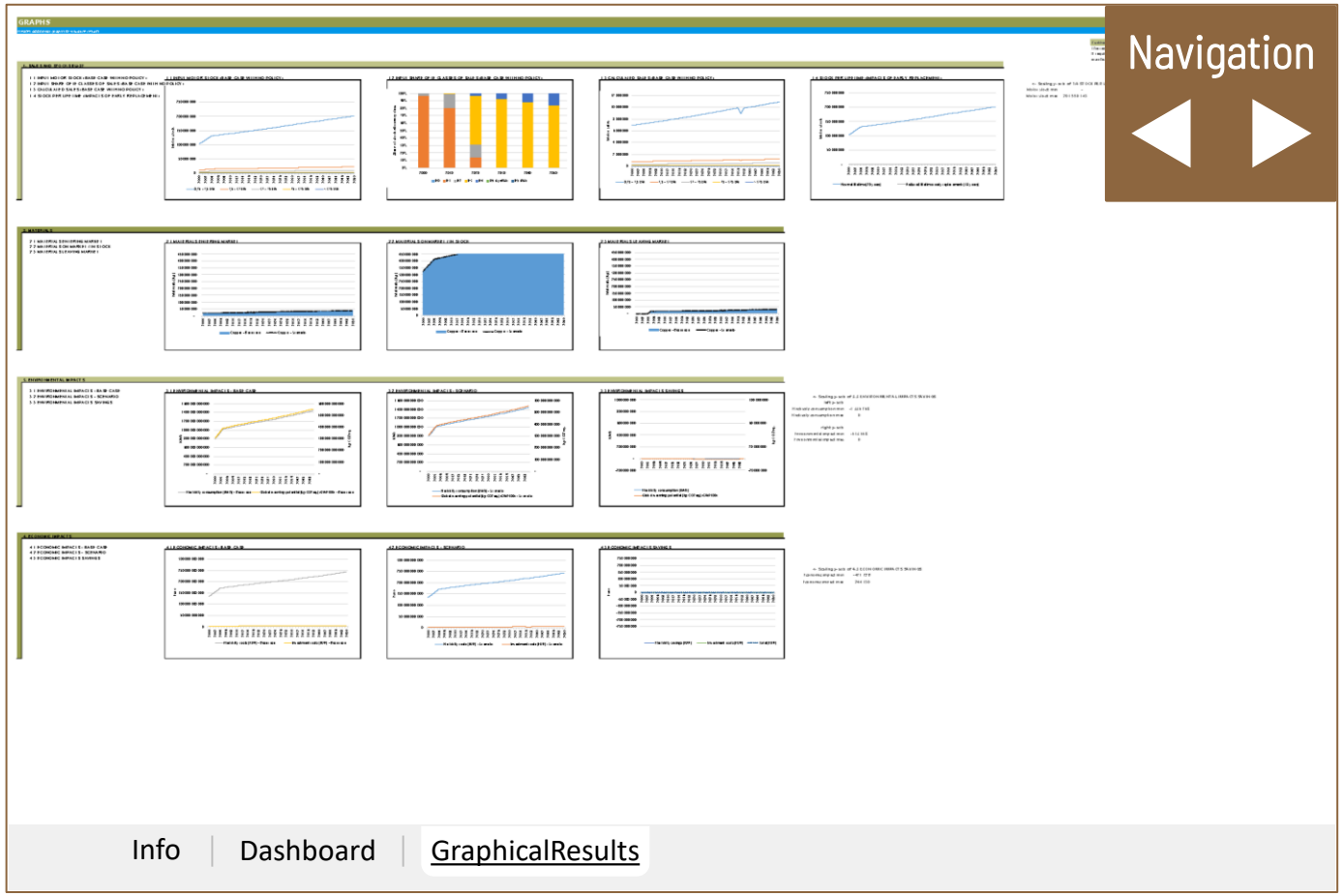
2.2 Using the tool

Graphical results

The Graphical results sheet extends the numerical values on the Dashboard.



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3. Application

3.1 Theoretical case study

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3.1 Theoretical case study

Introduction

- €2,000,000 subsidy program.
- Country similar to Belgium or Netherlands (in terms of electricity production).
- Program funds 50% of new motor costs (aligns with schemes like the Portuguese Energy Efficiency Promotion Plan)
- Policy for motors from 37 - 75 kW, active 2025 - 2030.
- Early replacement of IE1 and IE2 motors with IE4 motors.
- Example is theoretical, limitations discussed in section 4.
- All user inputs displayed on the right.

Geographical scope (EU or Member State)	EU average
One material for impact assessment	Copper
Power class of impacted motors	37 – 75 kW
Programme budget	€2,000,000
Funding rate per new motor	50%
Timeframe of policy (start and end year)	2025 – 2030
Lifetime reduction (how many years earlier do motors leave the market, respective to their assumed lifetime in the underlying motor market assessment)	2 years
Replacement of efficiency level (more than one class can be selected)	IE1, IE2
Replacement by efficiency level	IE4

Table: User input for theoretical case study

Link to D4.3 Policy impact analysis
Barkhausen, R.; Durand, A.; Ntaras, N.; Eichhammer, W. (2024)

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3.1 Theoretical case study

Results

- Key outcomes displayed on Dashboard tab after running calculation in Excel file.
- Shows motor and stock level results, industry and policy maker perspectives, economic, environmental, and material impacts.

Stock level results

- Program replaces 1,206 motors between 2025 and 2030.
- Total energy savings of 34.21 GWh until 2050
  - (10.35 GWh saved 2025-2030)
- Also yearly savings displayed
- €5,763,645 in electricity cost savings and €1,673,217 in additional investments for IE4 motors.

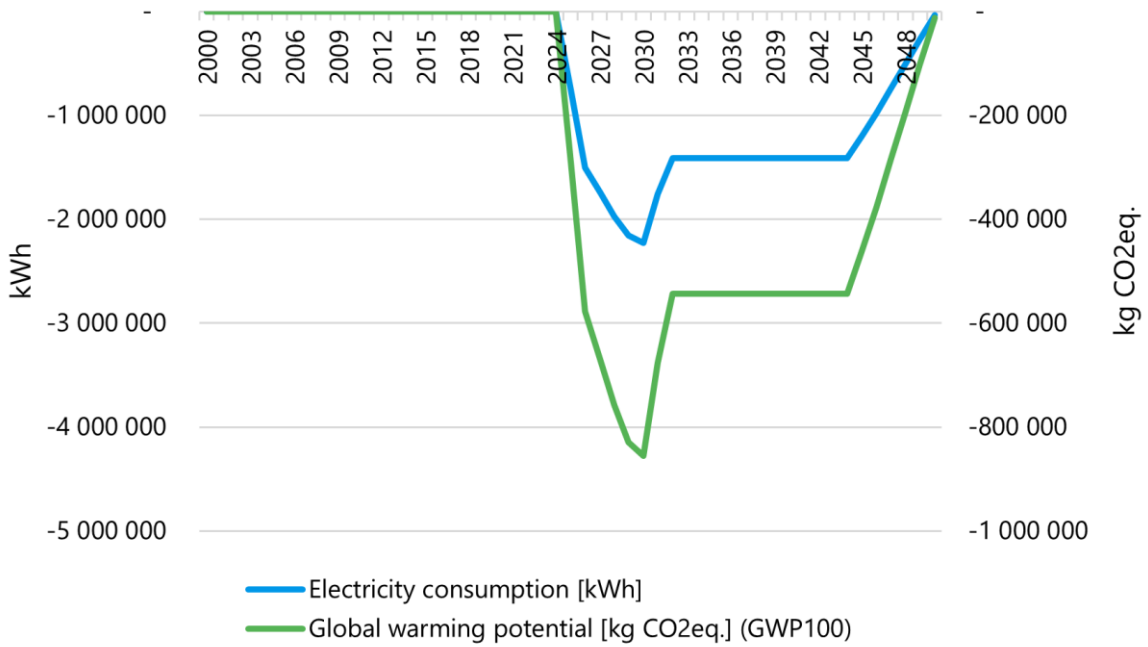

Figure: Example graphical results: environmental impact savings by early motor replacement

Link to D4.3 Policy impact analysis
Barkhausen, R.; Durand, A.; Ntaras, N.; Eichhammer, W. (2024)

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3.1 Theoretical case study

Results

Environmental impacts

- 34.21 GWh energy savings equals GHG savings of 12.14 thousand tonnes CO2eq.

Material impacts

- Early replacement with IE4 motors raises demand for copper by 26.02 tonnes → without considering recycling !

Maximum savings

- Maximum theoretical budget of €132,784,586.
- Maximum energy savings of 2,271.36 GWh and environmental savings of 872.61 thousand tonnes CO2eq.

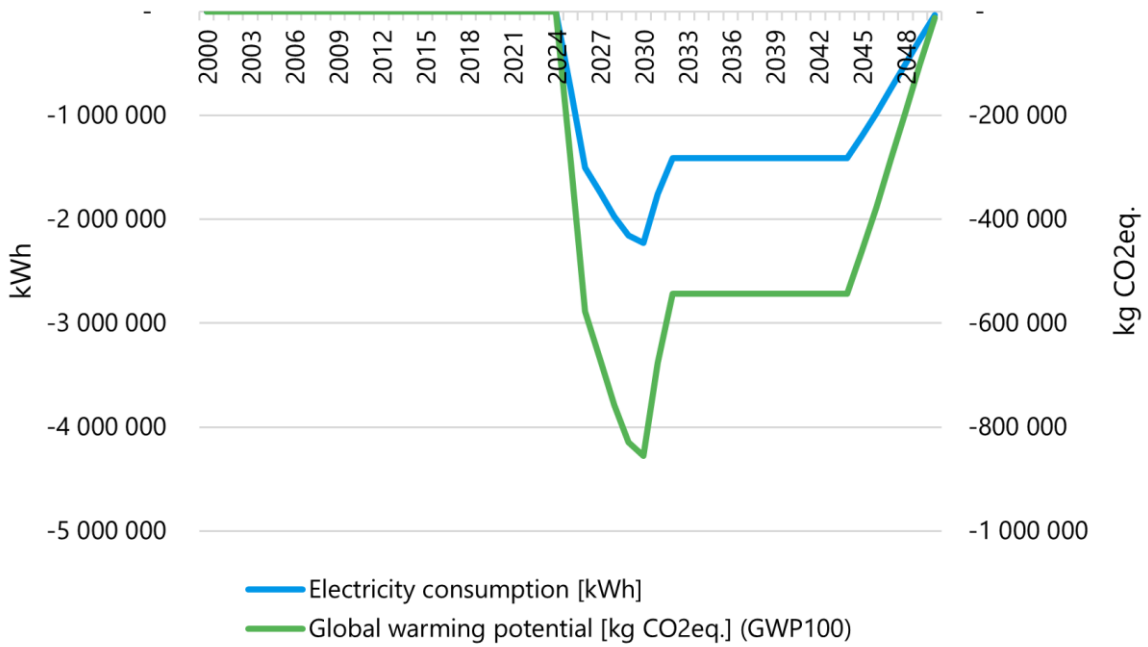

Figure: Example graphical results: environmental impact savings by early motor replacement

Link to D4.3 Policy impact analysis
Barkhausen, R.; Durand, A.; Ntaras, N.; Eichhammer, W. (2024)

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4. Reflection

3.1 Prerequisites

3.2 Limitations

3.3 Future

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4. Reflection

4.1 Prerequisites

- EU-M^3 model results depend on quality of user inputs and background data.
- Data sources come from previous tasks of EU-MORE project and literature.
- Reliability of data sources varies.
- Simplifications in background data necessary, such as setting a static lifetime for all motors. → In reality, motor lifetime follows a distribution function, potentially resulting in longer lifespan. Current model design works with a fixed lifetime representing the average lifetime of motors.

4.2 Limitations

- Model has necessary simplifactions that impact accuracy (e.g. country scaling based on gross electricity production as a proxy for industry size).
- Can apply policy to one selected power class per calculation.
- Requires significant computing time due to numerous background calculation steps.
- Calculated cost efficiencies can align with practical policy examples, but model's estimates should be interpreted with caution due to simplifications and assumptions

4.3 Future

- EU-M^3 model provides useful insights but results depend on quality of inputs and underlying data.
- Future improvements could include refining data inputs and assumptions for enhanced accuracy.
- More accurate data on motor lifetimes or refined country scaling method could yield more precise estimates.

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EU-MORE

EUropean MOtor REnovation initiative

Thank you

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Further materials can be found on the EU-MORE project website, including

- Deliverable D4.2 → EU-MORE Motor Model (EU-M^3)
- Deliverable D4.3 → report on policy impacts (soon available)

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