A global motor replacement success story: Insights from a steel wire company

#MotorsAcademy

WEBINAR #17

March 4, 2025

15:00 – 16:00 CET

Prof.
Kurt Stockman
Ghent University

This webinar outlines the process of implementing a successful worldwide motor replacement programme at a large steel wire company. To meet its sustainability goals, the company decided to evaluate the potential benefits of upgrading to high-efficiency motors (IE4 or IE5) in its wire drawing machinery. The installed base consists of over 1,000 machines, which originally used frequency-controlled IE2 and IE3 induction motors.

MOTORS ACADEMY

International Copper Association Europe

FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ELECTROMECHANICAL, SYSTEMS AND METALS ENGINEERING
ENERGY EFFICIENT DRIVE TRAINS RESEARCH GROUP

A GLOBAL MOTOR REPLACEMENT SUCCESS STORY: INSIGHTS FROM A STEEL WIRE COMPANY

Kurt Stockman, Jasper De Viaene, Steve Dereyne, Valentijn Kuijken and Bart Vanlandeghem

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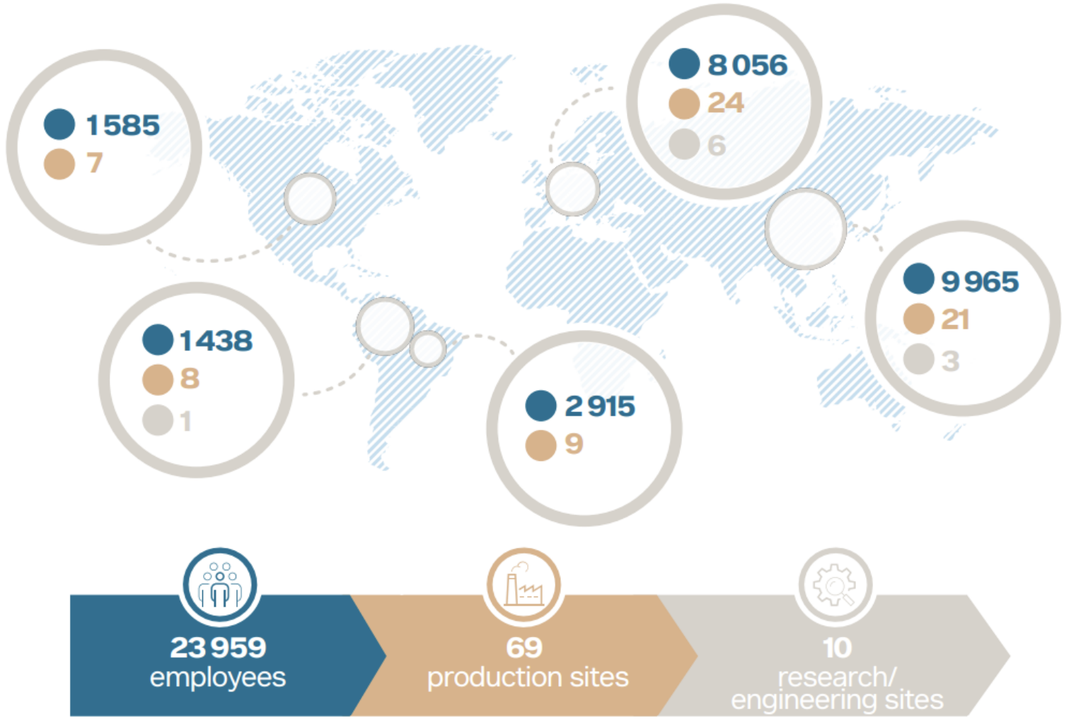
Bekaert

BEKAERT: STEEL WIRE, COATINGS, APPLICATIONS

– A global company with a clear focus on sustainability

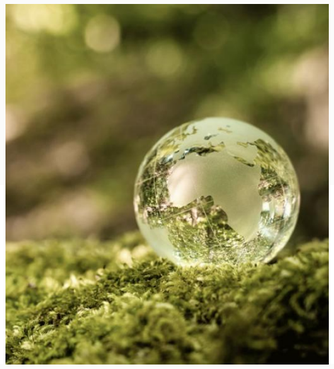


46.2%

Reduction of Scope 1 & 2 greenhouse gas emissions, in line with Science Based Targets by 2030

Zero

Reach Carbon Net Zero by 2050



15%

Less freshwater intake in water stressed areas by 2030

65%

Of sales to be from sustainable solutions by 2030

19.7%

Reduction of Scope 3 greenhouse gas emissions, from purchased goods and services by 2035

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Bekaert

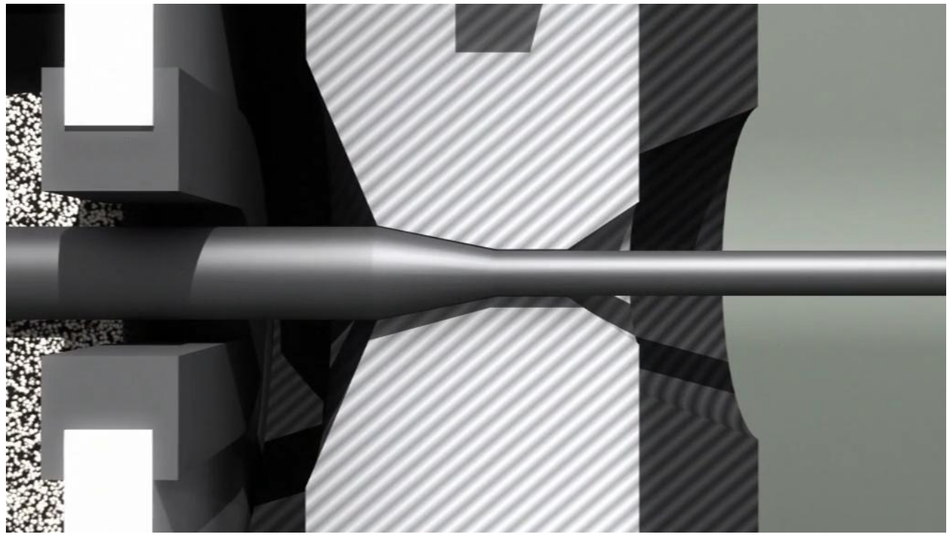
Focus on reducing our energy use and investing in renewable energy

As part of our strategy to make Bekaert a more sustainable company, we focus on using energy more efficiently and ultimately use energy from renewable sources only.

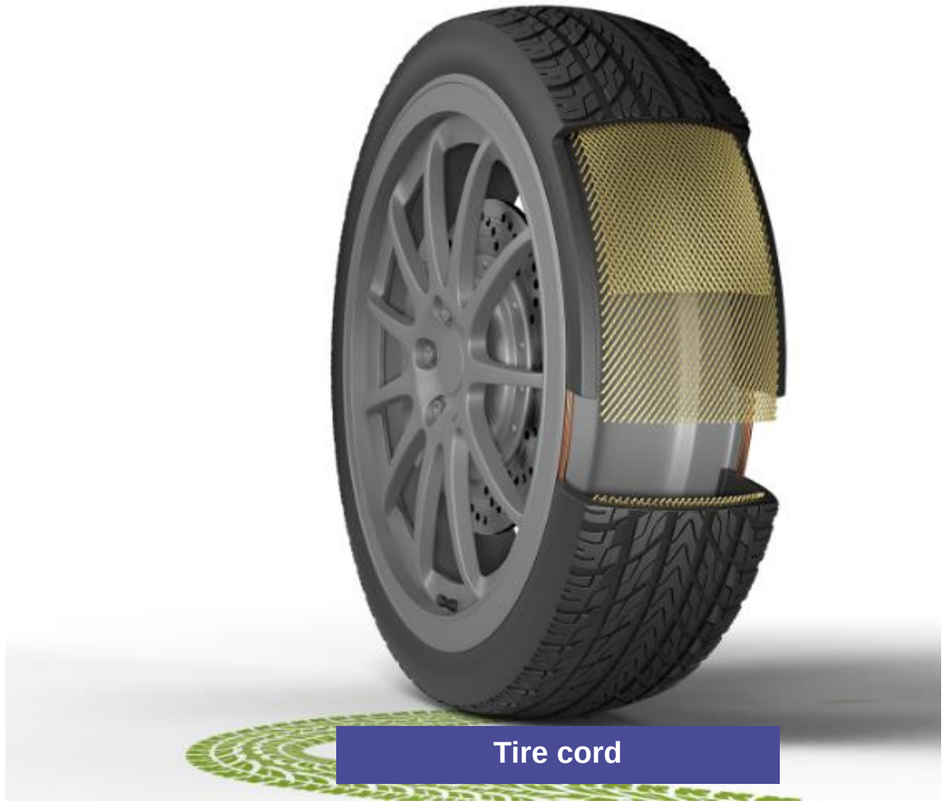
With our You Know Watt energy efficiency program, we are counting every “Watt” in our plants.

BEKAERT

- Core competences
  - Steel wire transformation
  - Coating technologies
  - Electricity intensity: ± 1650 kWh/ton



- Products in scope: 1 Mio ton tire cord per year
  - First drawing steps: 500 machines
  - Second drawing step: 10 000 machines
  - Cable making step: 10 000 machines



- State of use: IE1, IE2 and IE3 induction motors with VSD, sensorless

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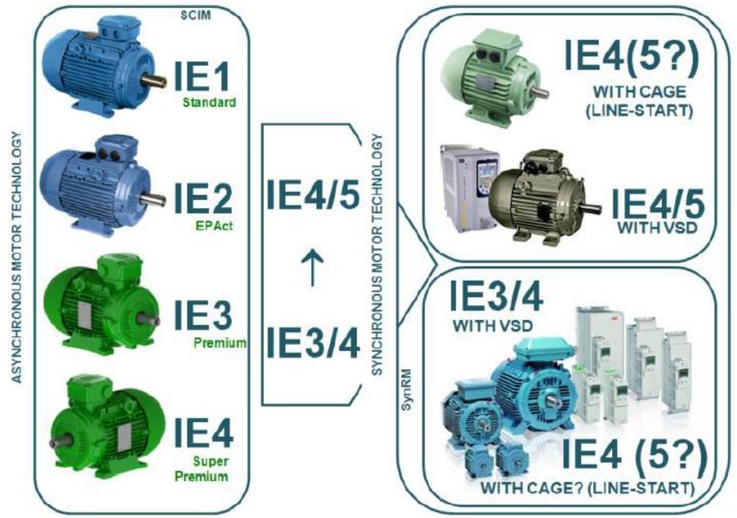
RESEARCH GOAL & APPROACH

- Yearly investments on ‘Energy Efficient Operations’
- High amount of electric motors: benefits of motor replacement ?
  - In competition with other energy saving potentials (thermal, mechanical)
- Research goal:

  Payback period and CO_2 impact for/of motor replacement with IE4 motor technology
- Ghent University (Flanders Make) acts as expert partner

- Approach
  1. Bekaert load profile analysis worldwide
  2. Benchmark data based on current machines
  3. Market screening IE4 and beyond
  4. Motor and drive compatibility check
  5. Payback calculation
  6. Convince board of directors
  7. Roll-out plan



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BEKAERT LOAD PROFILE ANALYSIS

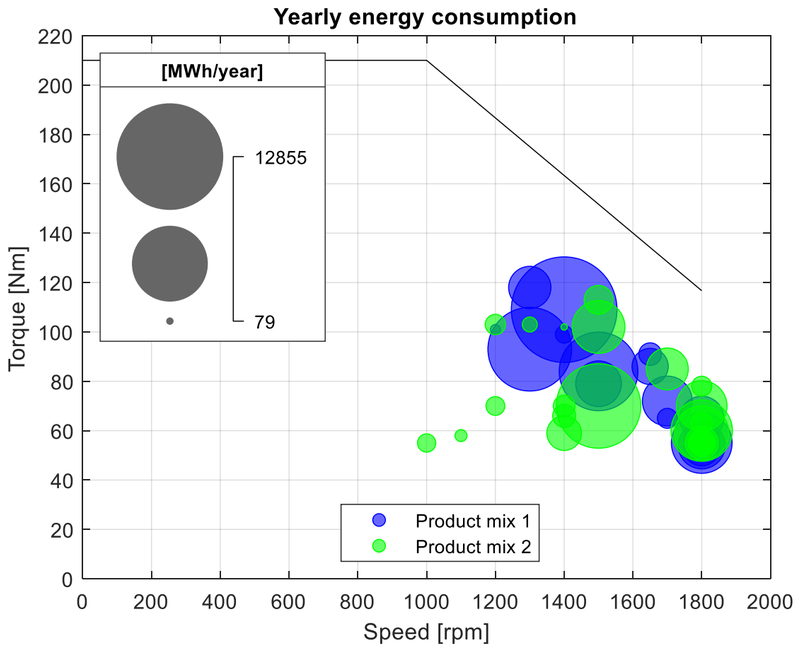
– Motor quantities

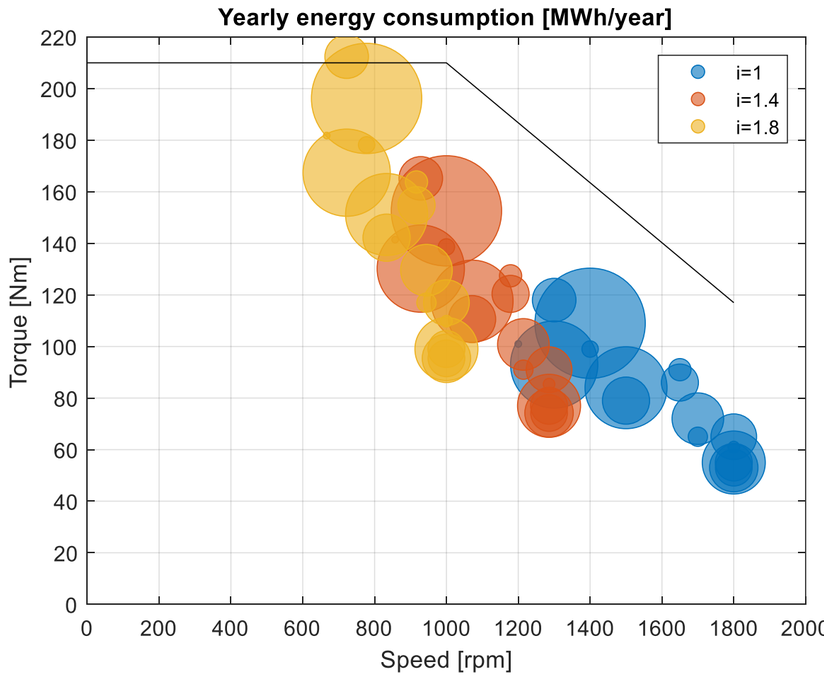
motor type	quantity
0.75 KW - 750 rpm	8000
0.75 KW - 1500 rpm	600
1.5 kW - 1500 rpm	8600
2.2 kW - 1500 rpm	500
4 kW - 1500 rpm	4800
4 kW - 3000 rpm	600
7.5 kW - 1500 rpm	4000
11 kW - 1000 rpm	2700
11 kW - 1500 rpm	9600
11 kW - 3000 rpm	3100
15 kW - 1000 rpm	1000
15 kW - 1500 rpm	1800
18.5 kW - 1500 rpm	800
22 kW - 1000 rpm	3500
22 kW - 1500 rpm	2400
30 kW - 1000 rpm	8200
30 kW - 1500 rpm	900
37 kW - 1500 rpm	100
45kW - 1500 rpm	1900

estimated as highest potential applications

Input product mix

- Products: volume / year
- Required motor speed and torque
- Focus on **22 kW/1000 rpm machines**
- Uptime 85%, 13,3 kW on average





– Field weakening region operation !

– Impact of transmission ratio

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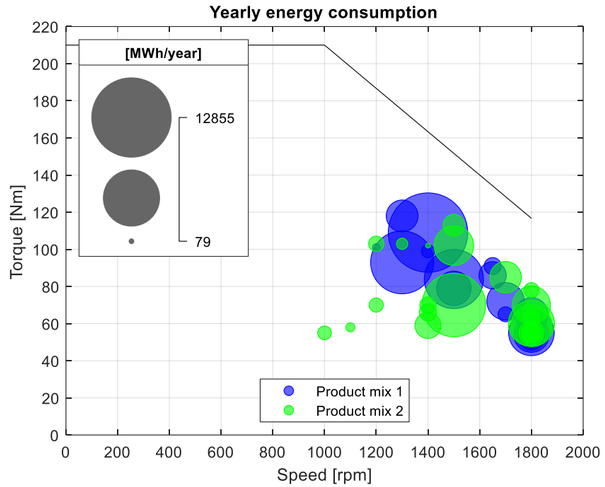
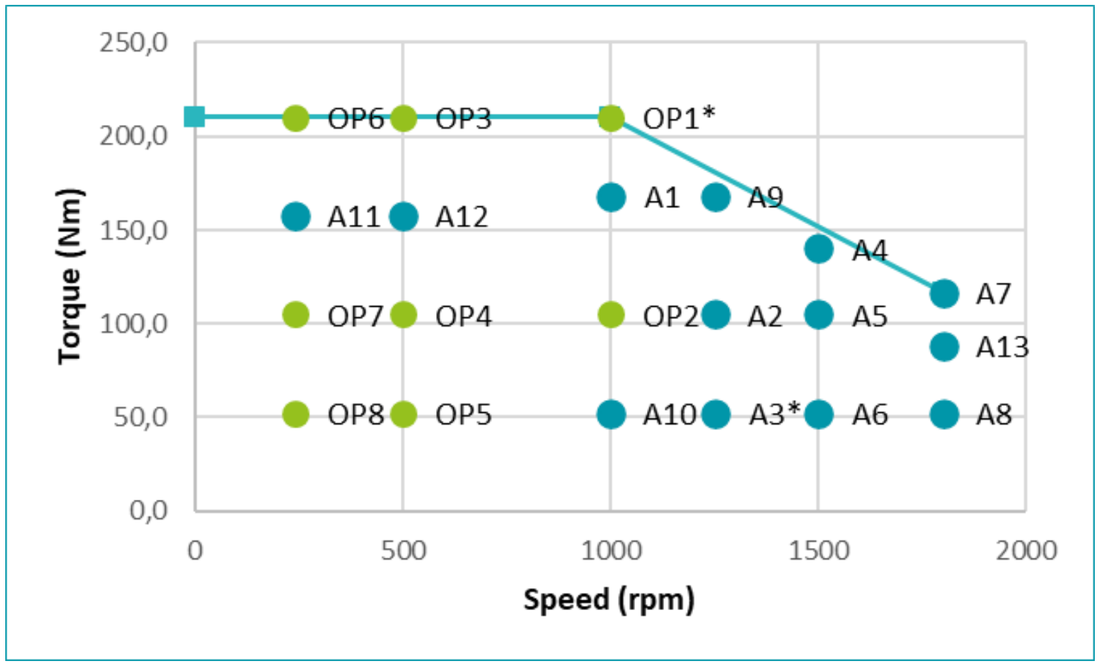
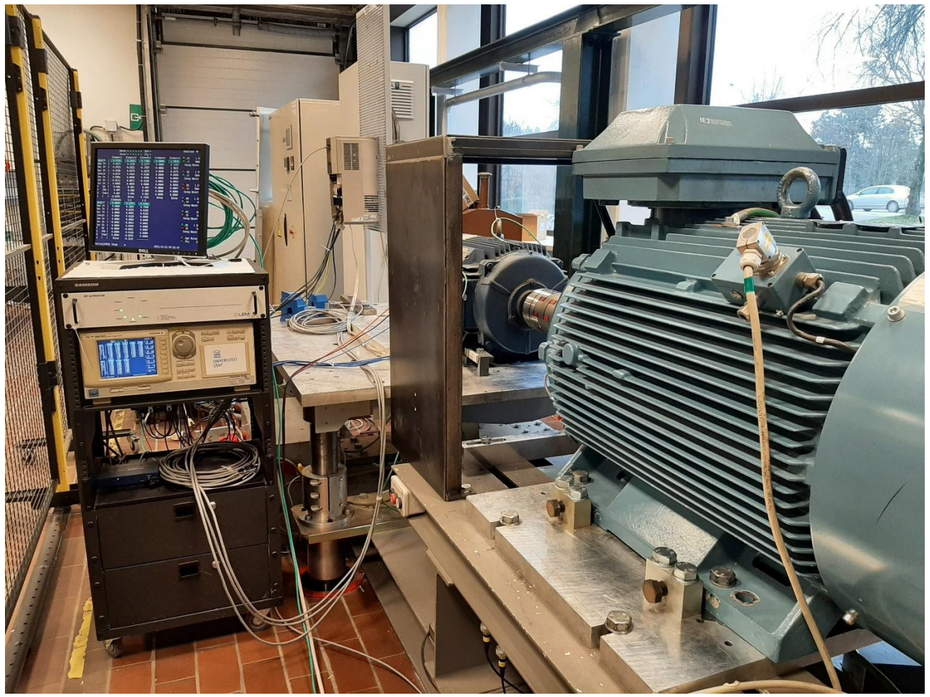
BENCHMARK DATA: MEASUREMENTS

- Focus on 22 kW, 1000 rpm (± 3500 machines)
  - Specific test points (A)
  - IEC test points (OP)
- Benchmark motor technology
  - IE1, IE2 standard Induction Motors (IM)
  - IE3 in most recent drawing machines
  - With and without VSD







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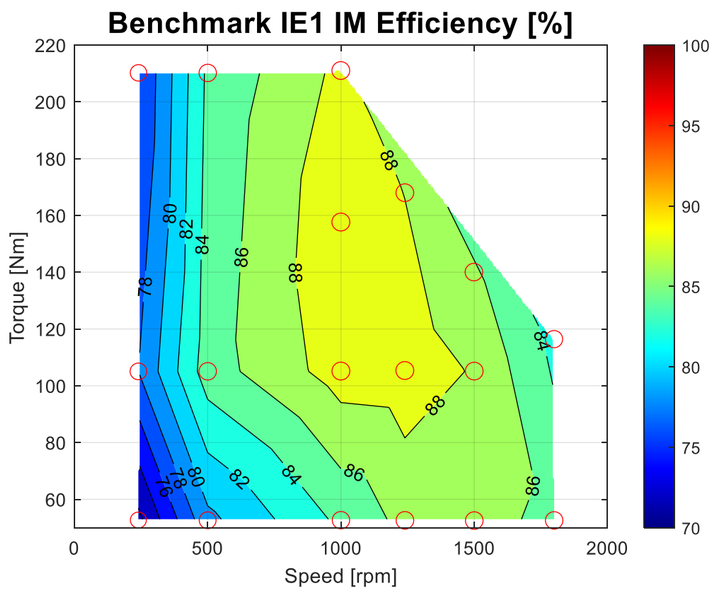
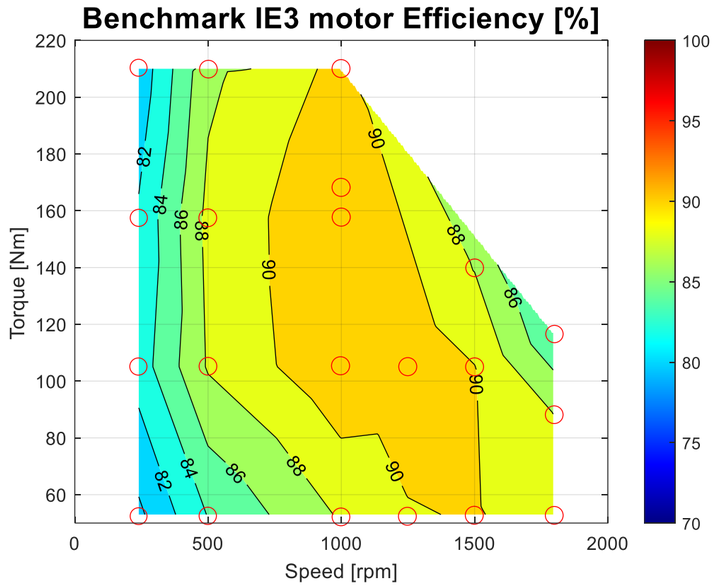
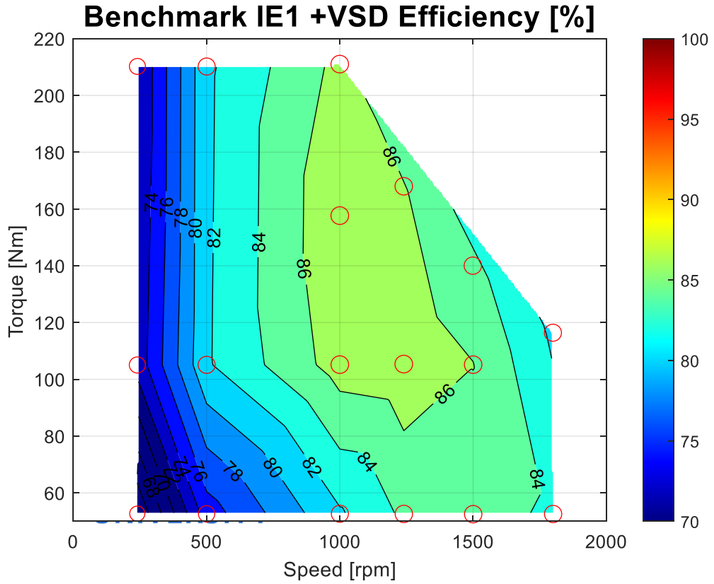
BENCHMARK DATA: MEASUREMENTS

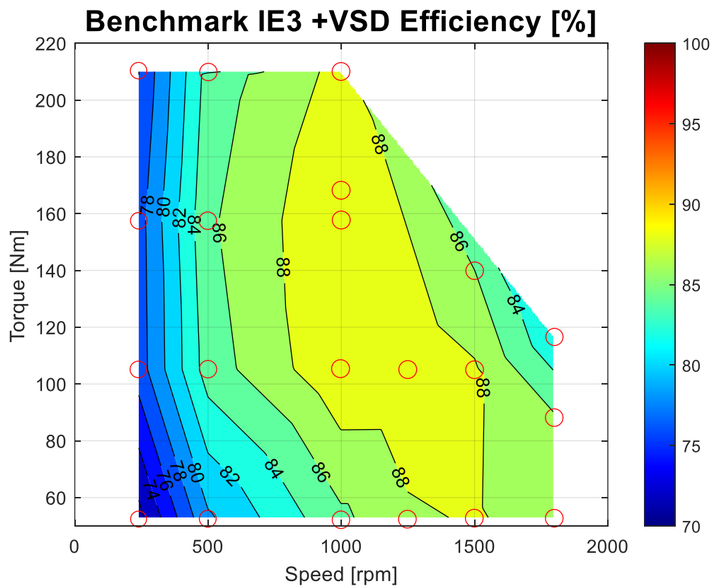


IE1



IE3



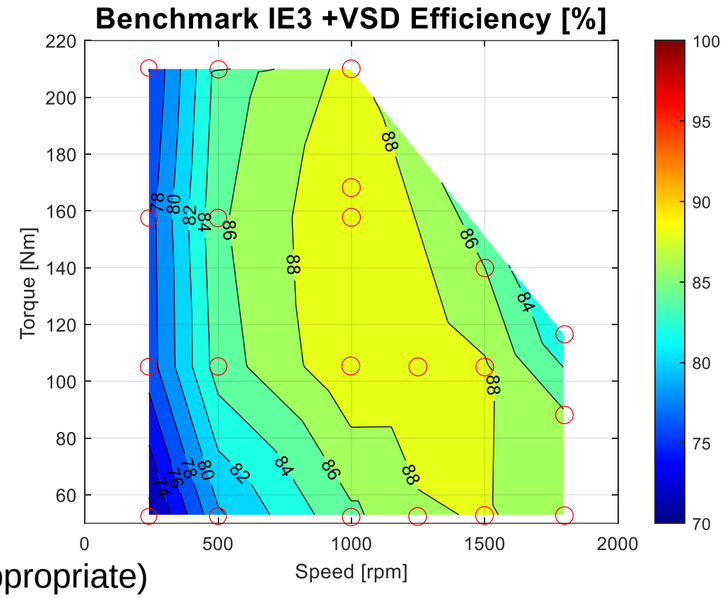


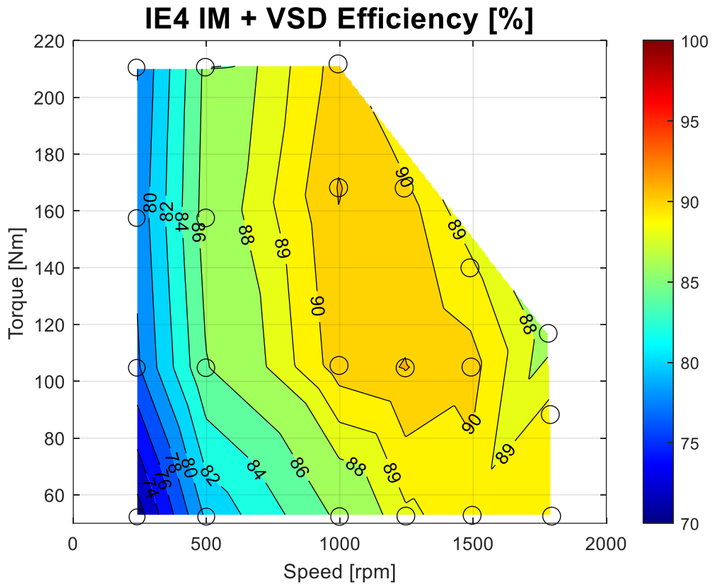
All motors tested (DOL) fullfil the respective IE class

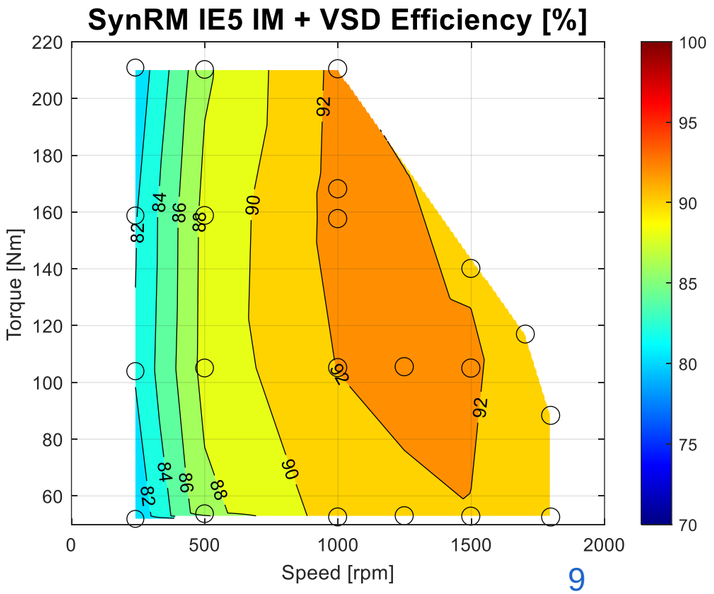
As expected, highest efficiency in field weakening region

IE4 AND IE5 MOTOR ASSESSMENT

- Motor technologies
  - IM IE4
  - SynRM
  - PM assisted SynRM
  - PM
- Standard motors
  - All meet specified IE class (if appropriate)
  - Not optimal for the specific profile …
- Check drive compatibility
  - Sensorless operation
  - Older drives not always able to drive motors in field weakening region (3 out of 5 brands not OK, after checking possible software update)







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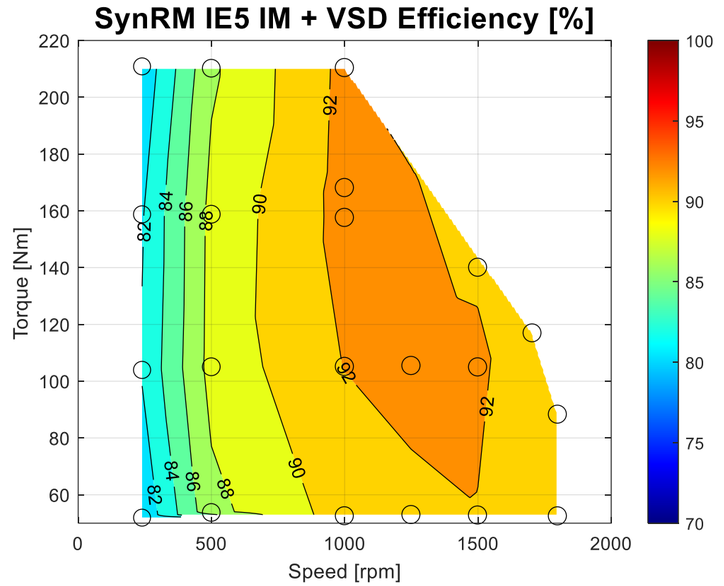
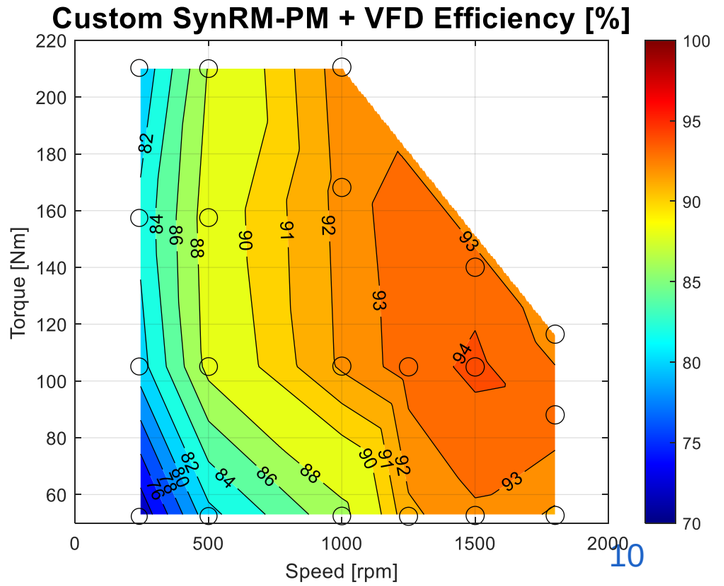
IE4 AND IE5 MOTOR ASSESSMENT

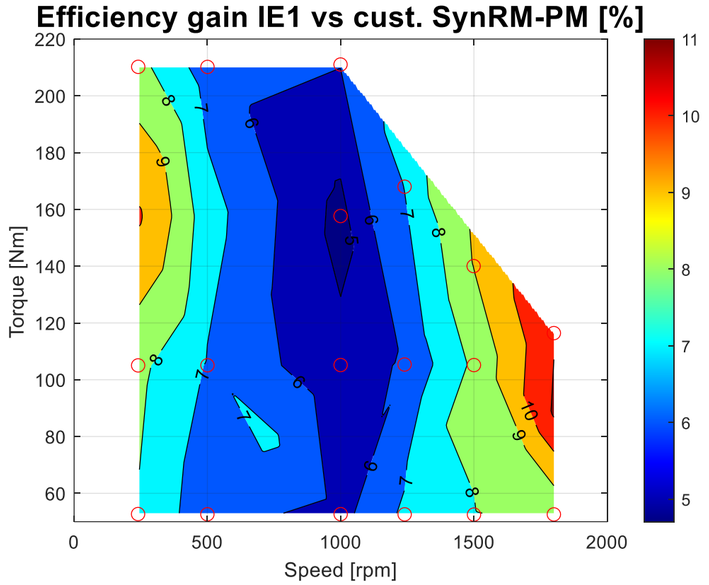
- Custom made IE4/IE5 motors ?
  - Over 3000 machines
  - Field weakening region
- Several manufacturers open for this option
  - And price competitive …
- Sample measurements to confirm promised efficiency
- PM assisted SynRM best option

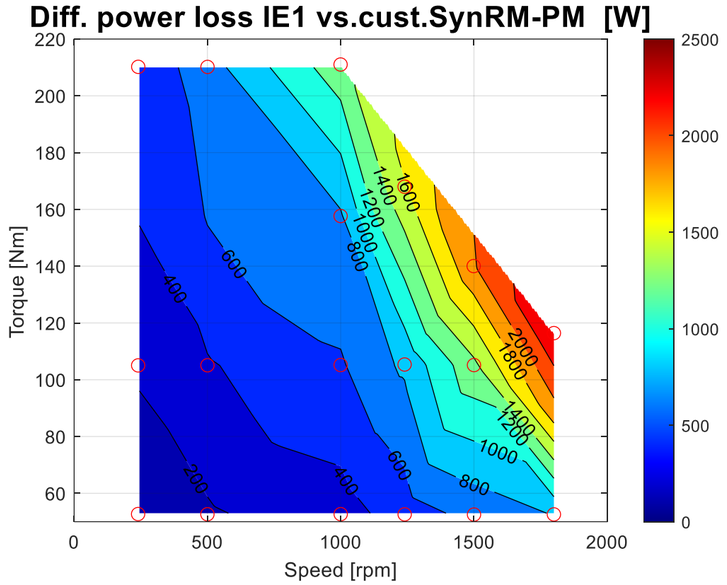


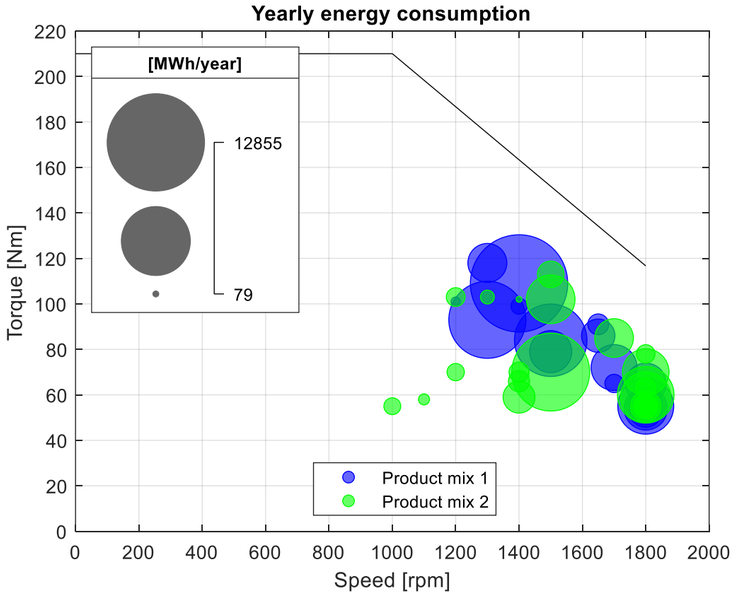


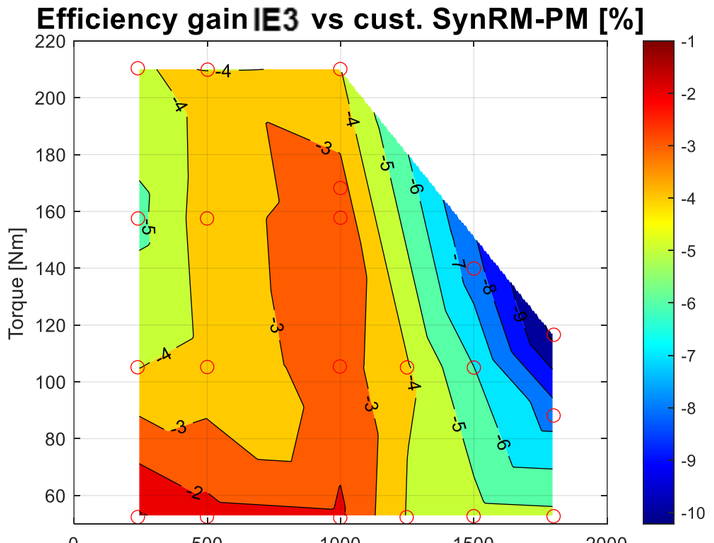
IE4 AND IE5 MOTOR ASSESSMENT

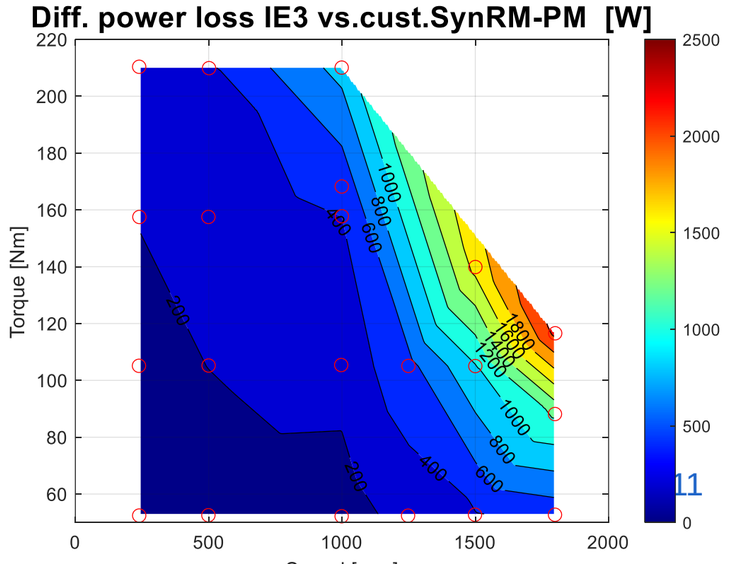
Benchmark versus custom PM assisted SynRM











Yearly energy savings/product mix:

NDE, 22 kW, 1000 rpm

- IE1: 8.95%
- IE3: 5.75%

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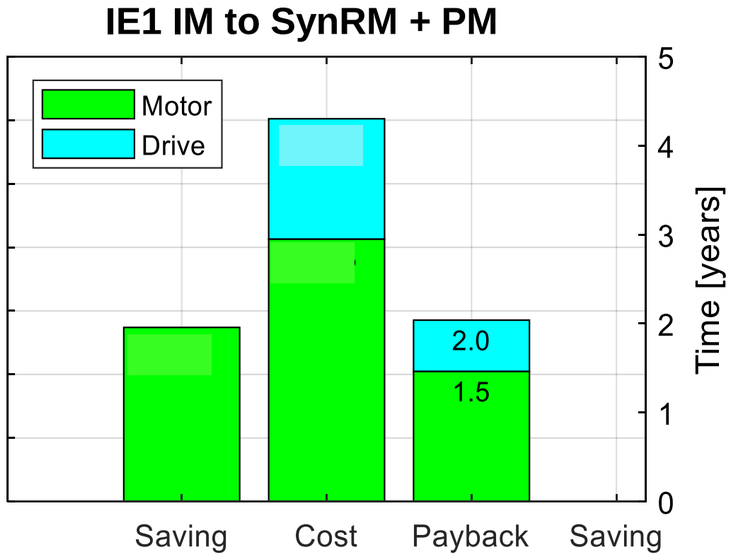
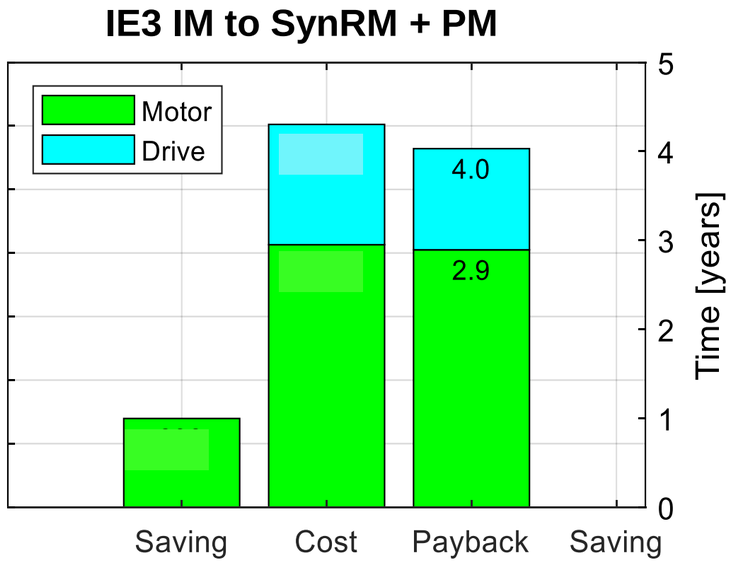
PAYBACK TIME (IRR)

Parameters involved:

- Original motor type
- New motor type
- VFD replacement required?
- Electricity price / country
- Type of electricity production facilities / country (CO_2/MWh)
- Replacement cost (labour/parts/transport)





Mid 2023: GO from management for roll-out NDE machines

+ assessment of other machinery

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ROLL-OUT ON 22KW 1000 RPM MACHINES

- Roll-out time frame: 3 years
- Taking into account plants with best IRR
  - Payback: 3,1 years
    (IE1 & IE2, plant dependant)
  - 3,6 kton CO_2 reduction
- 1250 machines replaced in 2023
  - IE1 and IE2 machines + new VFD if required
- End of 2024: no more IE1 & IE2 (± 2150 replacements)
- Also for new installations (replacing IE3 IM)

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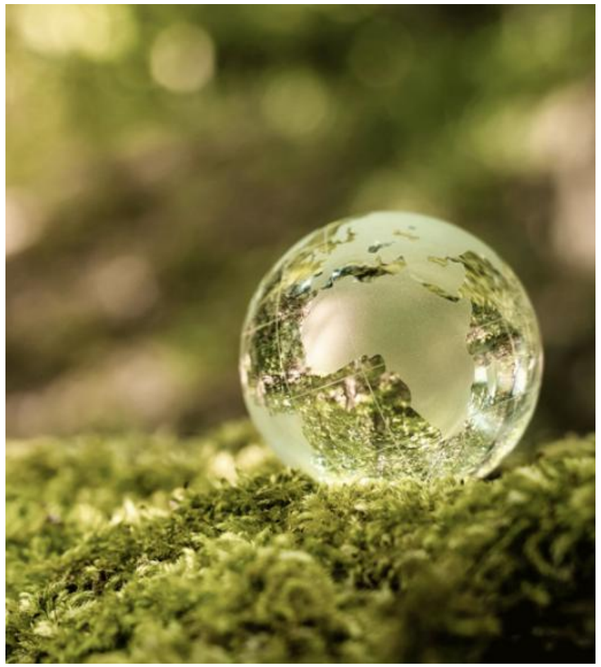
CONCLUSION

- Large number of identical motors to replace
  - Custom made motor for specific load profile
  - Drive compatibility not guaranteed: extra cost
- Operation in field weakening region
  - Need for efficiency data
    - Measurements, but standards follow ☺ …
- Payback time and/or CO_2 reduction: acceptable !
- Implementation ongoing @ Bekaert (15kW & 45 kW)
  - Savings seem confirmed from field measurements



From Bekaert annual report 2023, online

Furthermore, the key energy efficiency levers identified through You Know Watt are summarized in the table below.

Key energy efficiency levers	Description
Motor replacement	(1) Replacing old and inefficient motors with new high-efficiency motors (2) Rightsizing motors and drives to match the required duty and load
Heat recovery and recuperation	Recovery and reuse of waste heat from different

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AND ARCHITECTURE

Prof. Kurt Stockman

DEPARTMENT OF ELECTROMECHANICAL SYSTEMS AND METAL ENGINEERING
Flanders Make @ UGent – MIRO core lab

E Kurt.Stockman@ugent.be
T +32 499 14 05 89

www.ugent.be
www.eedt.ugent.be

Universiteit Gent
@ugent
@ugent
Ghent University

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