Advances in Machines and Drives for Industrial Energy Efficiency

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- Introduction: ABB, Energy Efficiency
- Highlighting the opportunity
  - Electric Motors
  - Variable Speed Drives
  - Full Industrial Systems
ABB
Let’s write the future. Together.

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Well positioned across global markets

- **Employees**: ~105,000
- **Countries**: >100
- **Revenues**: ~$29 bn
- **Europe**: ~$10.3 bn
- **Americas**: ~$9.6 bn
- **AMEA**: ~$9.6 bn

**ABB** is a technology leader in electrification and automation, enabling a more sustainable and resource-efficient future.

The company’s solutions connect engineering know-how and software to optimize how things are manufactured, moved, powered and operated.
**ABB purpose**

We enable a more sustainable and resource-efficient future with our technology leadership in electrification and automation.
Main sustainability ambitions

2030 targets

- **We enable a low-carbon society**
  - **Carbon neutrality** in own operations
  - Support our customers in reducing annual CO₂ emissions by >100 Mt¹
  - Work with most impactful suppliers to reduce their emissions by 50%

- **We preserve resources**
  - 80% of ABB products & solutions covered by circularity approach
  - **Zero waste** to landfill²
  - Supplier Sustainability Framework

- **We promote social progress**
  - **Zero harm** to our people and contractors
  - Comprehensive D&I framework³; **25% women** among ABB leaders
  - **Top-tier** employee engagement score in our industry
  - Impactful support for community-building initiatives

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1. Savings in the year 2030 from solutions provided to customers 2021-30
2. Wherever local conditions allow
3. Diversity & Inclusion framework
Our business areas

Electrification

Motion

Process Automation

Robotics & Discrete Automation
Exposure to strong long-term market trends

Well aligned to supportive mega-trends

- **Exposure to strong long-term market trends**
  - **Flexibility**: Reshoring, diversification, regionalization at forefront due to new technologies and policy environment
  - **Sustainability**: ESG in focus with strong drivers from regulations, financials and shareholder value
  - **Urbanization**: Globally increasing energy consumption drives development of smart cities
  - **Shift to electrification**: Electricity demand grows 2x faster than other energy sources
  - **Digitalization & e-commerce**: Focus on solutions, data analytics (incl. AI), connected factory data
  - **Labor shortage**: Aging population drives demand for automation. 25% of China’s population +60 years in 2030
  - **Automation & robotization**: Maximum productivity, quality, flexibility and simplicity
  - **Increased electricity consumption**: 1/3rd of world’s electricity consumed by electric motors
# ABB and R&D Drivers and Demands

## Motion
- Growing population, urbanization and digitalization
- Requires industrial processes, energy efficiency and electric mobility

## Electrifications
- Electricity demand grows 2x faster than other energy sources
- Digitalization accelerates demand for intelligent solutions

## Robotics & Discrete Manufacturing
- Individualized consumers, labor shortage, digitalization and uncertainty
- Automation solutions, increased productivity, highest flexibility, improved quality and maximum simplicity

## Process Automation
- Increasing demand for end-to-end integrated, connected solutions and advanced services
- Increasing demand for applications to drive autonomous operations
ABB has been pushing the boundaries of technology for +130 years.
R&D facts & figures

- 4.7% of revenues spent on R&D and digital
- 7000+ Scientists and Technologists which
  >60% focused on digitalization
- 11 countries with major R&D Centers
- >100 University collaborations
- >25,000 active patents to secure IP
- Start-up engagement direct or via our
  own ATV & Synerleap
  >15 strategic Partnership
Corporate Research
Fueling tomorrow’s innovation

Mission
• Develop/monitor technologies to de-risk future
• Pool of experts in common technologies
• Provide expert advice and support
• Actively link with academia
• Provide high quality talent to the organization
Technology Areas
of common interest within the ABB group

Sensing
We create solutions to transform real-world parameters into valuable information using competencies ranging from sensing technology and signal processing to information extraction and sensor system design.

Switching
We explore technologies for current interruption, from arc physics and gaseous insulation, to new interruption and breaker actuation principles, and up to the integration and coordination of protection and control devices at system level.

Software & Connectivity
We design next-gen software and communication systems, which involves areas of research such as software engineering and technologies, connectivity and communication architecture, system architecture and integration, cybersecurity, artificial intelligence & analytics technologies, and user experience.
Technology Areas of common interest within the ABB group

**Multiphysics**
We drive sustainability-oriented innovations in products and solutions. Multiphysics is the study of multiple interacting physical properties, and we improve productivity by merging physical properties with digital transformation.

**Mechatronics**
We develop intelligent products by integrating mechanical, electrical/electronics, software, control and sensing components into one system.

**Power Electronics**
We develop technologies for solid state power electronics (PE). PE enables conversion, control and protection of electrical power in applications like industrial drives, robotics, EV chargers, marine, mining, ultra-fast breakers and direct current (DC) distribution.

**Control & Optimization**
We research advanced modelling, control and optimization as well as its engineering in automation systems.
Global #1 in motion industries – leading from a strong foundation

Our key differentiators

01. Pioneering technology leader
02. Domain expertise
03. Global scale and coverage
ABB Motion
We keep the world turning while saving energy every day!

Key figures

Global #1
#1 in motors
#1 in drives

$80 bn
2018 market size

$6.9 bn
2021 revenues

17.1%
2021 Op. EBITA

>20 k
Employees worldwide

Business mix (by revenue)
We keep the world turning
Our motors and drives are an integral part in everyone’s lives

...opening a water tap, the water pressure is built by pumps powered by motors and drives.

...being in an airconditioned building: motors and drives are powering the compressors and fans to keep the air cool and flowing.

...your daily commute to work in case you go for public transportation: it will be motors and drives moving you reliably and safely to your destination.

...buying processed food in the supermarket, motors and drives run the machines and the conveyor belts.

...refueling your car: the oil and refinery process was powered by electrical motors and drives to get crude oil to gasoline suitable for your car.

This is only a small fraction of examples where our motors and drives keep the world turning – efficiently, reliably and safely.
The critical role of motors

• 45% of the world’s electricity is used to power electric motors in building and industrial applications

• Investing to upgrade the equipment used in these systems will yield significant rewards in terms of efficiency and sustainability
Motion offering

Drives
- Ability™ offering
- Low voltage drives
- Medium voltage drives

Electrical Motors
- Ability™ offering
- IEC Motors
- NEMA Motors
- Large Motors & Generators
**Insight.** It’s the power to see and understand how something works in a new way, to unravel complexity and take action. It comes from visibility, intelligence and experience. It’s what makes transformation possible.

ABB Ability solutions combine ABB’s deep domain expertise with connectivity and software innovation to empower real-time, data-driven decisions for safer, smarter operations that maximize resource efficiency and contribute to a low-carbon future.

Our large portfolio of digital solutions helps organizations automate, optimize and future-proof their business to achieve new heights of performance and drive sustainable progress.
Innovation, the way forward from ABB

One motor can make a big difference
Our Large Motor technologies provide the powerful solutions the world needs

99.05% efficiency

With such high-efficiency ratings, they are capable of producing massive energy savings
Product Group NEMA Motors : Baldor-Reliance®
Celebrating >100 years of motor experience

1920
Founded in St. Louis, MO “to build a better motor” by Edwin Ballman and Emil Doerr forming “Baldor”

1924
Baldor takes first jump into sales with Williams oil-o-Matic, building a plant in Bloomington

1956
Opened a new plant in Fort Smith, AR

1967
Moved to Fort Smith, AR

1976
Baldor became the first motor manufacturer to place energy ratings on nameplates of products

1976
Sales soar from $294m in 1990 to $503m in 1996

1996
Baldor is acquired by ABB Ltd of Switzerland

2007
Acquired Reliance Electric and Dodge from Rockwell Automation

2011
The Baldor name is dissolved into the ABB brand, becoming ABB across all locations

2018
Baldor is acquired by ABB of Switzerland

2020
Baldor celebrates its 100th year anniversary

https://www.referenceforbusiness.com/history2/24/Baldor-Electric-Company.html
Making the case for energy efficiency

- The global population is expected to rise to 9.7 billion by 2050.
- Urbanization, and the rise of living standards will increase the demand for energy.
- Critical processes can’t stop, but need to be energy efficient to reduce CO₂ emissions.
- The global economy is expected to double over the same period.
- The demand for the drive systems powered by electric motors will grow.
- With high-efficiency motors and variable speed drives, we can do just that.
Energy efficiency makes the difference

“..." It has been estimated that, if all of the more than 300 million industrial electric motor-driven systems currently in operation were replaced with optimized, high-efficiency equipment, global electricity consumption could be reduced by up to 10 percent.
Energy efficiency in electrical motors
Typically ~75% to 98%, increasing with larger power ratings

Approximate losses
- Stator Winding
- Core (Increases with rating)
- Rotor Cage (Induction Motors)
- Other

Efficiency $\eta$ = \frac{\text{Power Out}}{\text{Power In}} = \frac{\text{Power Out}}{\text{Power Out} + \text{Losses}}
Standard strategies to increase motor efficiency
For a given type of electric motor or generator

- Improve cooling
- Optimize trade-offs, tolerances
- Improve or substitute materials
- Increasing size and amount of materials

Improvements possible for each type of motor design
ABB IE5 synchronous reluctance motors
Elimination of rotor losses

IE3 Induction motor

Losses

100%

Losses

60%

IE5 SynRM motor

IE5 SynRM Motors
• Output: 5.5–315 kW
• Frame sizes: IEC 132–315

I^2R Rotor  Other  I^2R Stator
The new first choice for energy efficiency
ABB IE5 synchronous reluctance motors

ABB IE5 SynRM motors deliver a new level of efficiency: **Ultra-premium**

Significantly **more efficient** than IE3 motors

- Higher efficiency IE5
- Energy losses of 40% less
- Lowest energy consumption
- Reduce emissions
EC Titanium motor design
Variable speed motor with IE5 ultra-premium efficiency

- **End plate design**
  - Cast-in webbing around the bearing for less vibration and extended bearing life

- **IP54 Rated Motor**
  - Shaft lip seal standard

- **IE5+ Efficiency Guaranteed Magnet Assisted Synchronous Reluctance Rotor (FASR)**

- **Shaft grounding brush standard**
  - Eliminates bearing damage concerns

- **ACH4/580 Drive Firmware Support**
  - Designed for easy setup and operation

- **Low Noise Fan and Cover**
  - Designed for maximum cooling and quiet operation

- **QR Coded Nameplate**
  - Easy access motor and drive technical data

- **Class B Temperature Rise**
  - Longer component life & reliability for the product

- **Sealed Bearings**
  - No maintenance or re-greasing required
  - Resistance to water and dust ingress
Why adding a drive matters

It is estimated that **23%** of the world’s industrial motors are equipped with a drive.

That figure is expected to only increase to **26%** over the next five years.

While not every motor can use a drive, experts suggest that roughly **50%** of industrial motors would benefit from being paired with one.

When added to the existing motor of a pump, fan or compressor, a variable speed drive can typically reduce power consumption by **25%**.
Variable Speed Drive (VSD)
Typically ~90-98% efficient

Drive Itself
To minimize switching and conduction losses
- WBG devices, topologies
- Control and switching strategies

Enabled by the Drive
- Optimize system control of speed and torque
- Eliminate need for gearbox or pullies (in some cases)
- Reduced speed at partial loads
  - Avoid mechanical throttling, valves, dampers, vanes...
  - Regenerative breaking

Save money
Save energy
Reduce emissions
Overall System Efficiency
VSD + Motor + Load

• Total system efficiency, over typical load cycles

• Opportunity to minimize input power for desired output result

• Material usage and component lifetime

• Total lifecycle, from raw materials to disposal or recycling
Continual improvement:
- Materials: WBG, electrical steel, magnets, conductors...
- Alternative topologies

System Optimization:
- Loads not restricted by 50/60Hz induction motor speeds
- Scale with multiple motors and/or drives depending on application

Much higher than 10% electricity savings possible with load and total systems optimization
The way forward

All stakeholders have a critical role to play

• ABB, along with other global technology companies, need to always provide the most energy efficient solutions and to continue to innovate for more

• We also need to explain the value of these technologies and accelerate their adoption

• Public decision-makers and government regulators will need to incentivize the rapid adoption of the latest technology

• Businesses, countries and cities need to make the investment

• Investors need to reallocate capital towards companies better prepared to address the climate risk

It’s clear that deploying more high-efficiency motors and drives, and embracing digitalization represents a tremendous opportunity as the world seeks to achieve greater energy efficiency and cut CO₂ emissions
Discover how you can make a difference

www.energyefficiencymovement.com