Efficient Motors in Pakistan – Industry Accelerator
2023 – 2026

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Efficient Appliances for People & the Planet

Introduction & Background –

Muhammad Salman Zaffar

Introduction

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Sama Verte Pvt Ltd

- We are a Lahore based environmental consulting firm founded in 2012 working on the environment.
- Developing MEPS and Labels for National and Regional Governments
- Industry Accelerator Program
- Other Environment related consulting projects

- Web: www.samaverte.com

CLASP

- Work with governments on policy related work focused on enhancing appliance energy efficiency levels – for past 26 years
- Standards and Labels for Appliances
- Testing and quality assurance
- SAMA^Verte and CLASP have been working together since 2016 in Pakistan.
- Web: www.clasp.ngo

Electric Motor

An Electric Motor is a type of appliance that simply converts Electric Power to Mechanical Power by rotating its shaft by applying force known as torque

Electric motor is a common appliance found in our everyday life in areas including but not limited to:

- **Household and Commercially used applications**
  - Fans
  - Pumps used for displacement of water
  - Washing Machine
  - Kitchen appliances (Juice / blending machines, exhaust systems etc.)
  - Refrigerators
  - Air Conditioners
  - Small appliances (electric shavers, hair dyers etc.)
- **Industrial Applications**
  - Industrial equipment (for production and manufacturing goods)
  - Power generation and distribution
- **Specialized applications**
  - Electric Vehicles
  - Waste management (waste water & storm water pumping)
  - Elevators

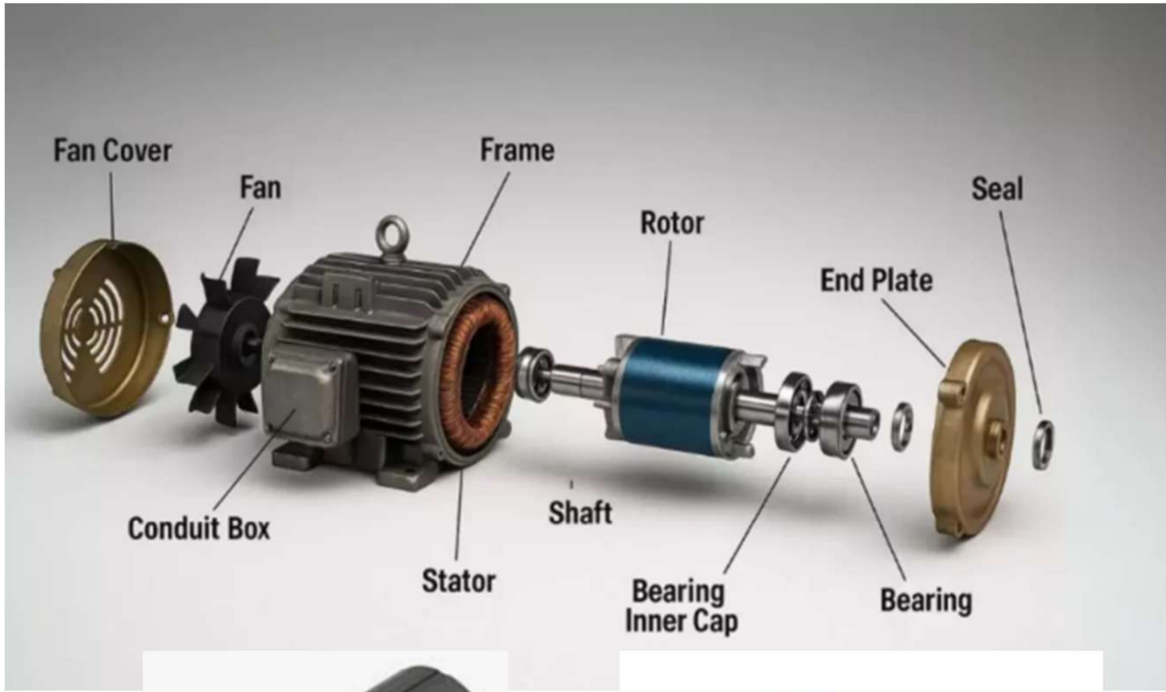
Electric Motor Construction

Generally, Each motors has following common components:

- *Stator (stationary part)*
- *Rotor (rotating part)*
- *Shaft (which delivers mechanical power)*

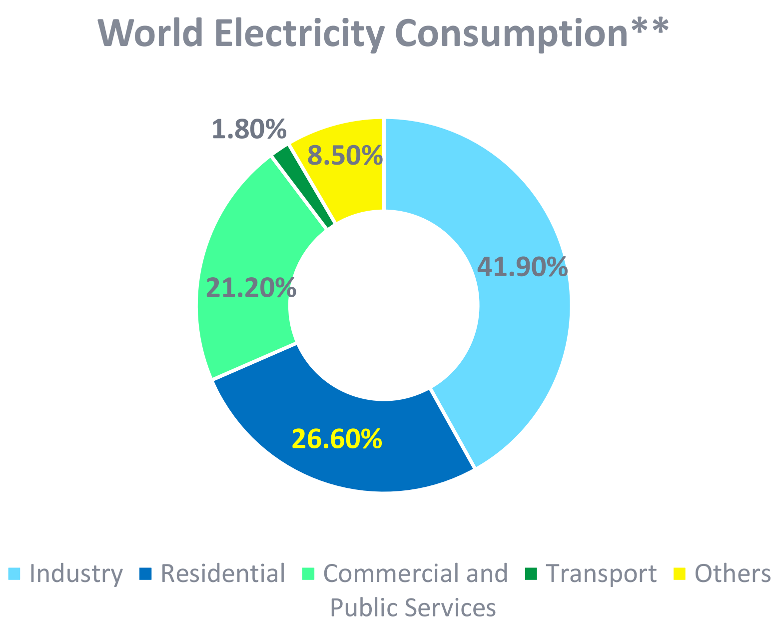
Other important parts include:

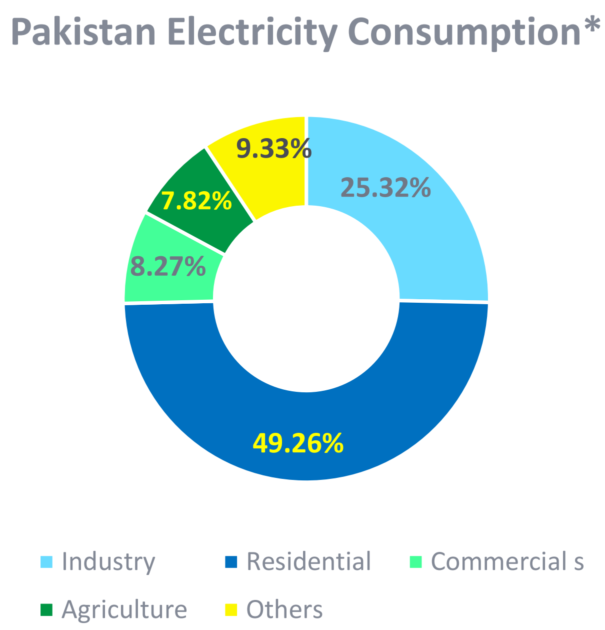
- Winding
- Bearings
- Frame
- Cooling Fan
- Terminal Box



Electric Motors & Global Energy Consumption

- *As per IEA & Electric Motor Systems Platform (IEA – EMSA), Electric motors and motor systems in industrial and infrastructure applications are responsible for 53% of the world's total electricity consumption.*
- *Below are some electric motors consumption patterns by sector*



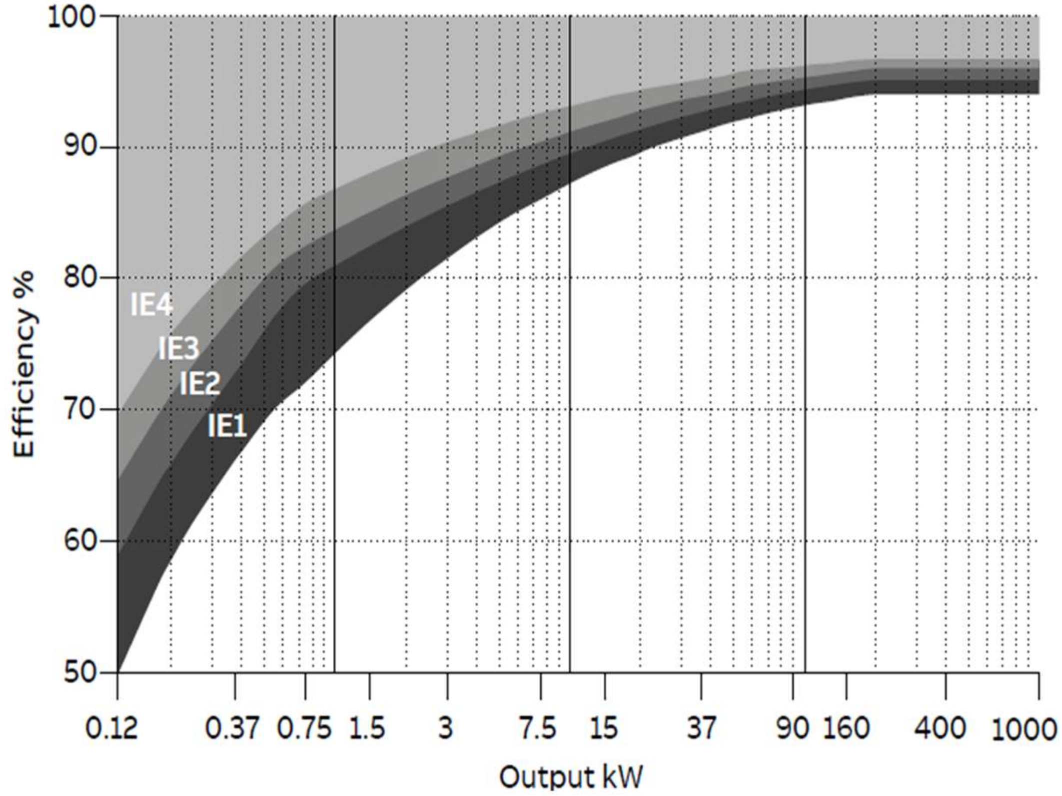


Source:
* State of Industry Report 2024
** IEA Website

Motor Efficiency Standards

- ***As per IEC 60034-30 standard, Electric Motors are classified into following categories according to their respective efficiencies***

- **IE – 1: International Efficiency class 1**
  - Also known as "**Standard Efficiency**"
- **IE – 2: International Efficiency class 2**
  - Also known as "**High Efficiency**"
- **IE – 3: International Efficiency class 3**
  - Also known as "**Premium Efficiency**"
- **IE – 4: International Efficiency class 4**
  - Also known as "**Super Premium Efficiency**"
- **IE – 5: International Efficiency class 5**
  - Also known as "**Ultra Premium Efficiency**"



IE efficiency classes for 4 pole motors at 50 Hz

Current established MEPS worldwide

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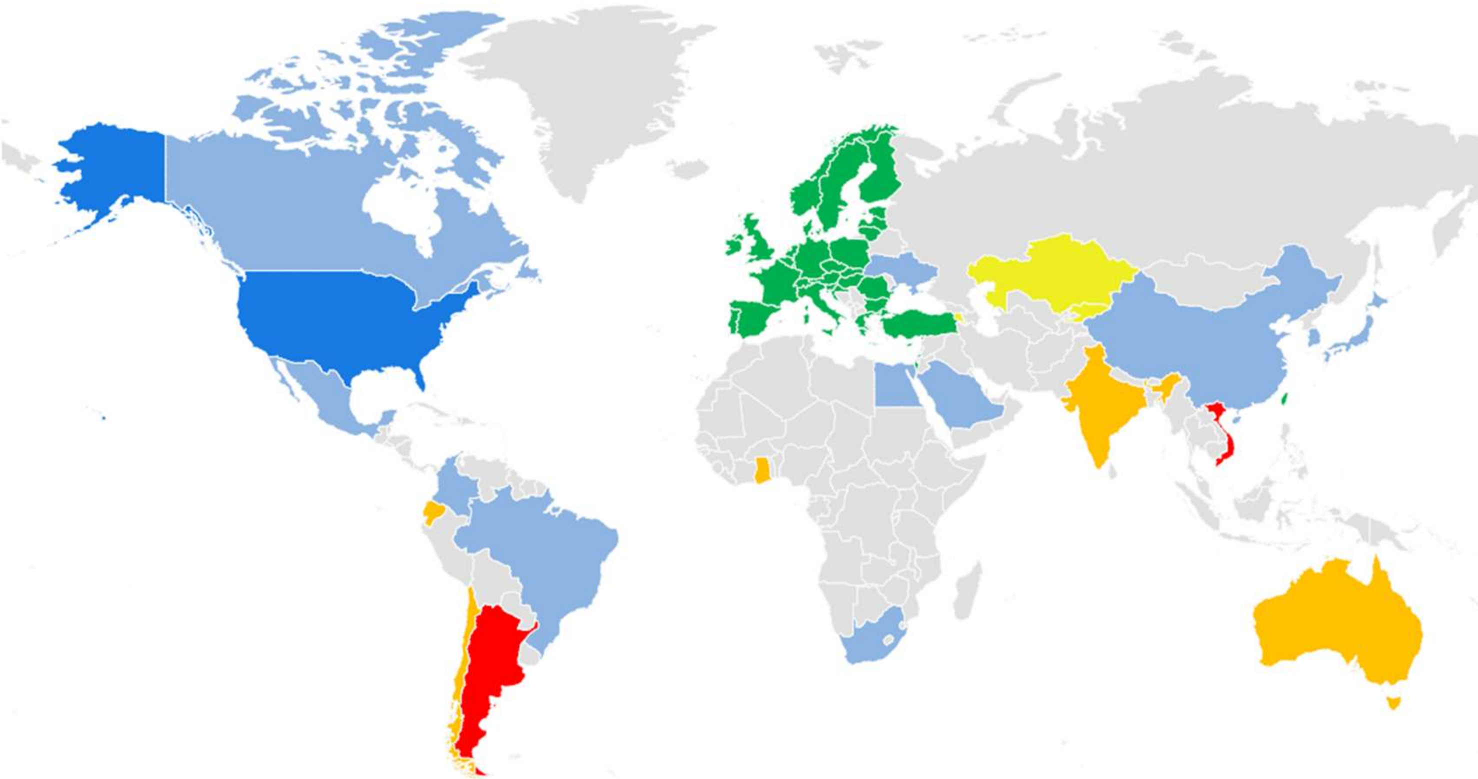

- Colors on map show level of MEPS implemented (Motors)
- RED – IE-1
- Yellow – IE-2
- Blue – IE-3
- Green – IE-3 (IE-4 in higher sizes)

Region / Country	MEPS (0.75kW to 75kW)
Europe	IE-3
Türkiye	IE-3
Canada	IE-3
North America	IE-3
Brazil	IE-3
China	IE-3
Saudia Arabia	IE-3
Egypt	IE-3
South Africa	IE-3
Australia	IE-2
India	IE-2
Kazakhstan	IE-2
Argentina	IE-1

Pakistan Market

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In Pakistan motor market, 4 major motor supply sectors are:

1. **Global companies importing their own branded motors either themselves or through distributors**
   - ABB – importing directly and supplying through distributorship model
   - Siemens – importing directly and supplying through distributorship model
   - WEG – imported and distributed by Avanceon Limited
   - KSB pumps – importing motors coupled with their own pumps
2. **Local Motor manufacturers (members of PPEMMA)**
   - Golden Dynamics
   - Al Khas Industries
   - Asli Diamond
   - Chishtia Pumps

   And several others

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3. Chinese motors supplied through independent importers

4. 2nd Hand motor market (located in Faisalabad, Karachi & Lahore)

- Huge market containing thousands of used motors which have in most cases already achieved their end of life

- Motors are available in:
  - Single Phase (0.37kW up to 5kW)
  - Three Phase (1.5kW up to 1 MW)

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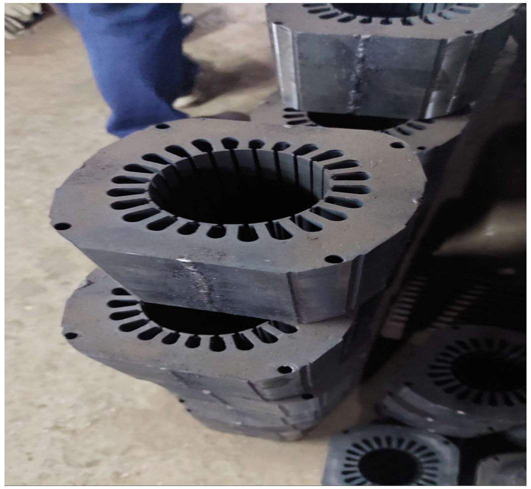
Pakistan's SME motor manufacturing industry

Industry Context

- Pakistan's electric motor manufacturing sector is dominated by small and medium family-owned enterprises (SMEs)
- Most factories rely on workshop-based experience, with limited exposure to scientific design methods, testing, and R&D
- Many manufacturers were still using motor designs developed 30–40 years ago, resulting in low efficiency and outdated performance
- *In 2022, no one could produce up to IE1 standard in Pakistan and no one could test reliably.*



Industry Accelerator Program - MOTORS

Industrial Accelerator Programme

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Objective behind Industrial Accelerator Programme

- To accelerate the development of industry towards sustainable production of energy efficient appliances
- Uplift the local industry to international efficiency standards
- Remove trade barriers / ease restrictions to exports and reduction in import bill

Target industry

- **Motors**
- Water Heaters

Key Goals – set at the outset

- Overarching goal: Carbon emission reductions
- **MOTORS: Develop local motor manufacturing industry to build IE-1 / IE-2 motor**
- Water Heaters: to increase efficiency of local manufactured water heaters learning from best international practices

The IAP

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- Industry Accelerator Program so far has been executed in two phases
- **Industry Accelerator Programme – 1 (IAP – 1)**
  - Spanned for 18 months from January 2023 to June 2024
  - Worked on locally made three phase motors in 5.5kW to 15kW range
  - Engaged with test labs to identify gaps in testing and implemented steps to improve them
  - Engaged the wider local motor manufacturing industry through **stakeholder workshops** and engagements to adopt standardization in production and end products
- **Industry Accelerator Programme – 2 (IAP – 2)**
  - Currently ongoing and scheduled to end in 18 months (January 2025 – June 2026)
  - Working to consolidate the gains made in IAP – 1 on three phase motors [Prototypes, Testing, Workshops]
  - Building single phase motors from 0.75kW to 1.5kW range for standardization and improvement
  - Support for motor manufactures to include their motors in NEECA's Standards & Labels scheme and PEECA's Endorsement label
  - Encouragement of test labs to register themselves for NEECA Enlisted Labs certification and also preparation for PNAC accreditation
  - Support to motor manufacturers to adopt workplace optimization & production efficiency
- **Industry Accelerator Programme – 3 (IAP – 3)**
  - Still in planning stage
  - Will focus our work on creating demand for these locally made efficient motors in the market

Industrial Accelerator Programme - 1

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Key Achievements - MOTORS:

- Local motor industry built an IE-1 / IE-2, 5.5kW motor with support from EMOSAD and TSE.
- Key linkages were established with EMOSAD and TSE and experts made several trips to Pakistan
- The program was able to enhance production capability and quality of finished product.
- TSE helped at least two labs improve their testing capability and equipment.
  - Motors tested in local labs were sent to TSE for testing in order to corroborate results
- 21 manufacturers / SMEs came on board and made investments – [showing commitment to improving quality and energy efficiency]

2025 – 2026 program - Accelerator 2 (ending June 2026)

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- This 18-month program started from January 2025
- Program comprises of three main activities:
  1. Consolidating wins from IAP 1
  2. Working on developing IE1 + motors in a size category of 0.75kW (2P) and 1.5kW (4P)
  3. Helping develop laboratories further (A third lab has been added to the program)
- Similar approach was applied. EMOSAD experts visited motor manufacturers and test labs in order to give suggestions for their improvement.

Key Achievements – production side

- Over 10 Prototypes from single phase constructed. Results show high efficiency prototype clocking high IE1 and close to IE2.
- Considered a big achievement in single phase category of motors for common 1hp and 2 hp sizes.
- Three phase larger motors on the cusp of IE2 !

Motor Test Labs – Current Status / Achievements

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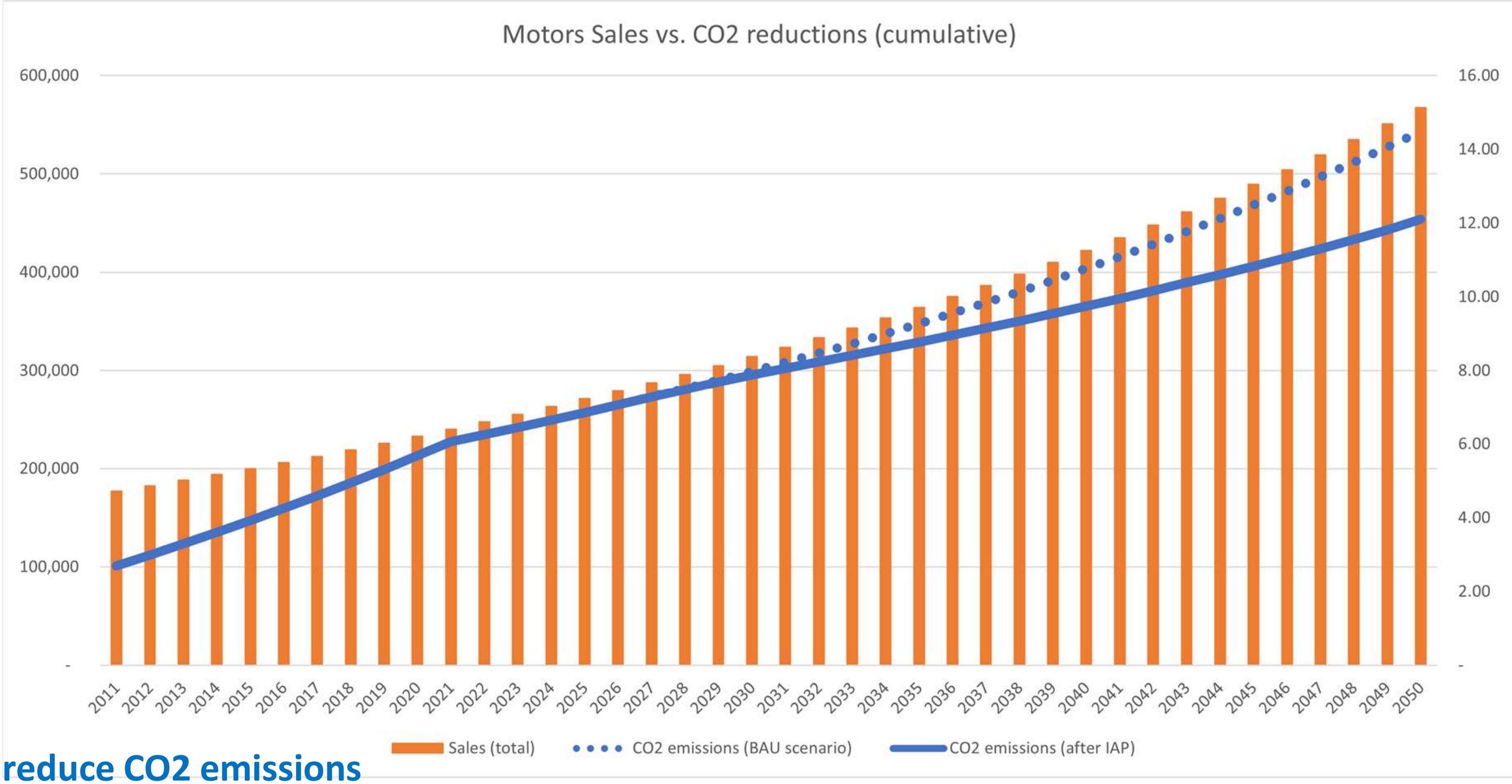
- There are currently four different Test Labs present in Pakistan
- **PCSIR Karachi Motor Test Lab**
  - Located at SUPARCO Road Karachi (in the middle of city)
  - State of the art Lab built by LANMEC China & commissioned in February 2025
  - Capacity to test Motors from 0.5HP / 0.37kW up to 30HP / 25kW (single and three phase)
  - Tests are repeatable and result comparable to TSE Türkiye
  - **Can perform Compliance & Development testing reliably – Results have been verified by TSE - Istanbul**
- **ITU Motor Test Lab**
  - Previously was located at Arfa Tower but now shifted to their new campus at Burki Road Lahore
  - Capacity to test Motors from 2.2kW to 5.5kW (single and three phase)
  - Planning to add small test bench to test motors from 0.5kW to 2.2kW
  - **Can perform Development testing**
- **GIFT University Motor Test Lab**
  - Located at GIFT University in Gujranwala
  - Capacity to test Motors from 0.75kW to 3.7kW (single and three phase)
  - Planning to increase testing capacity up to 15kW
  - **Can perform Development testing**
- **UET CERAD Motor Test Lab**
  - Still under development
  - Planned to perform compliance testing once commissioned

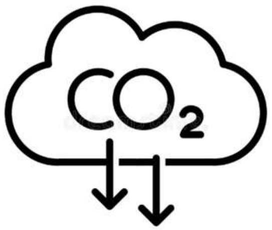
IMPACTS - Summary

- **EFFICIENCY**:
  - Seven manufacturers can now produce IE1 class motors and two are expected to achieve IE2 class soon.
- **MODERNIZATION:**
  - 20 manufacturers have made collaborative and individual investments in motor production tooling, facilities and quality control
- **MOTOR TESTING:**
  - PCSIR, the government test lab in Karachi, is fully capable to test motors to the international standard.
- **SUPPLY CHAINS:**
  - Have been established for high quality copper, special steel and other components.
- **EQUITY:**
  - Protecting the livelihoods of over 24,000 people in local communities.
  - Securing about 4,000 jobs and 300 businesses involved in motor manufacturing and supply chains against future market challenges.
- **COMPLIANCE:**
  - Manufacturers have the capacity and resources to meet future regulatory requirements.
  - Local motors will qualify for the SAVE UP endorsement label in Punjab province and meet NEECA and federal government procurement requirements.
- **INVESTMENT:**
  - Attracting foreign direct investment to build motors competitive in export markets.

IMPACTS - Summary



- **CLIMATE ACTION**



Potential to reduce CO_2 emissions cumulatively up to 13.55 Million Tons by 2050

IMPACTS - Summary

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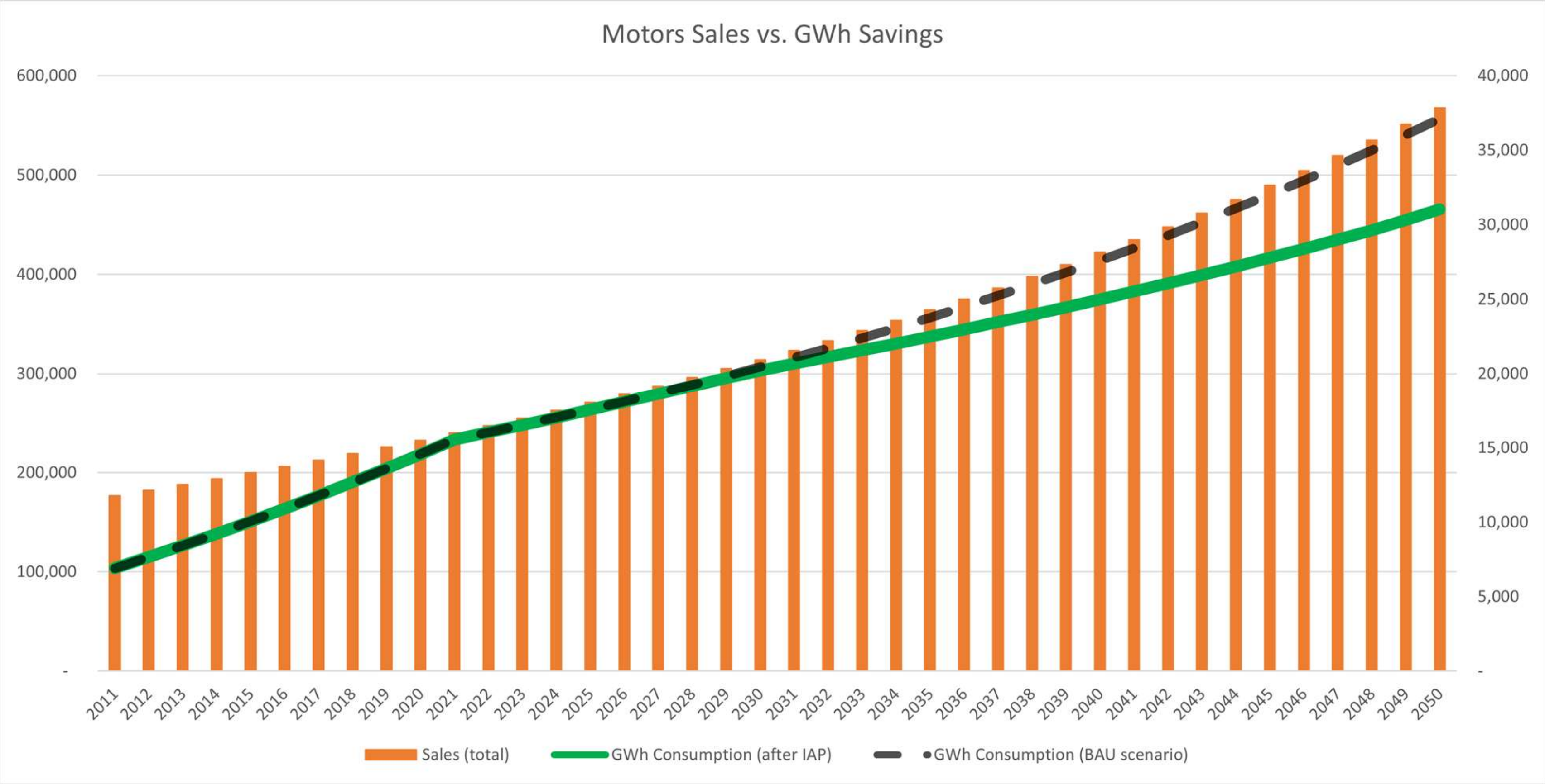

- **ENERGY SAVINGS**

Potential to cumulatively save Energy by 34,745 GWh till 2050

Design, Production & Testing

Fraz Siddiqui

SCOPE

There are many types of Electric Motors available in the market today classified by their supply parameters as:

- DC Motors
  - Brushless DC motor (also known as BLDC motor)
  - Brushed DC motor (which may include series, parallel, compound windings or use permanent magnets)
- AC Motors
  - Synchronous motors
  - **Induction Motors (the most common type of motors available worldwide)**
- Motors for special applications
  - Stepper motors
  - Servo motors
  - Universal motors

OUR SCOPE:

- **Induction Motors (squirrel cage type)**
- **Widely used for Household, commercial, Agricultural pumping & equipment & Industrial machinery**

Motor Design Capability

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- Since motors can be of different types even in the same category and output power, therefore each model requires special attention to design elements
  - For example, a motor with 5.5kW output can either
  - be Single or three phase
  - Can either be 2 poles, 4 poles, 6 poles or 8 poles (difference in output speed)

- ***Any changes in the above mentioned (or other parameters) will change the design completely!***
- **This is why having knowledge about designing of motor to meet particular parameters is paramount!**

- Currently many manufacturers still use motor designs developed 30–40 years ago, resulting in low efficiency and outdated performance all due to lack of design knowledge and capability
- In order for local motor manufacturing to improve their products, we need to have an ecosystem where:
  - Designing capabilities can be effectively managed through collaboration between Academia (NUST, LUMS, ITU and others) with Local Motor Industry
  - There is a steady pipeline of design professionals coming out of universities (either through short courses or integration with engineering curriculums)

Design Capability

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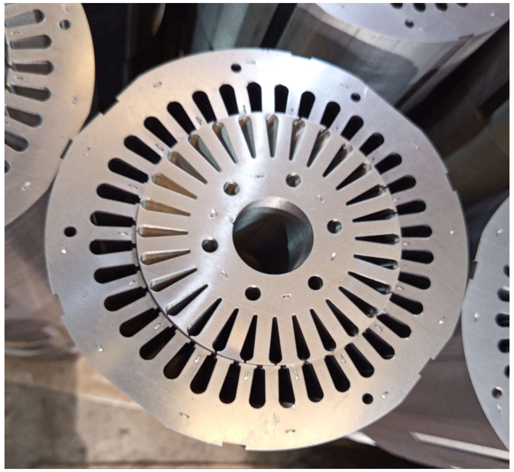
How This Was Initially Addressed

Through a structured capacity-building program, this gap was systematically closed:

- Hands-on and virtual trainings delivered by EMOSAD international motor design experts
- National-level workshops covering:
  - Motor design fundamentals
  - Efficiency optimization
  - Loss reduction techniques
- Introduction of new, high-efficiency motor designs, proven to outperform traditional local designs
- Development and distribution of a practical "**Making Efficient Motors**" handbook, giving manufacturers a step-by-step guide to improving motor efficiency through design

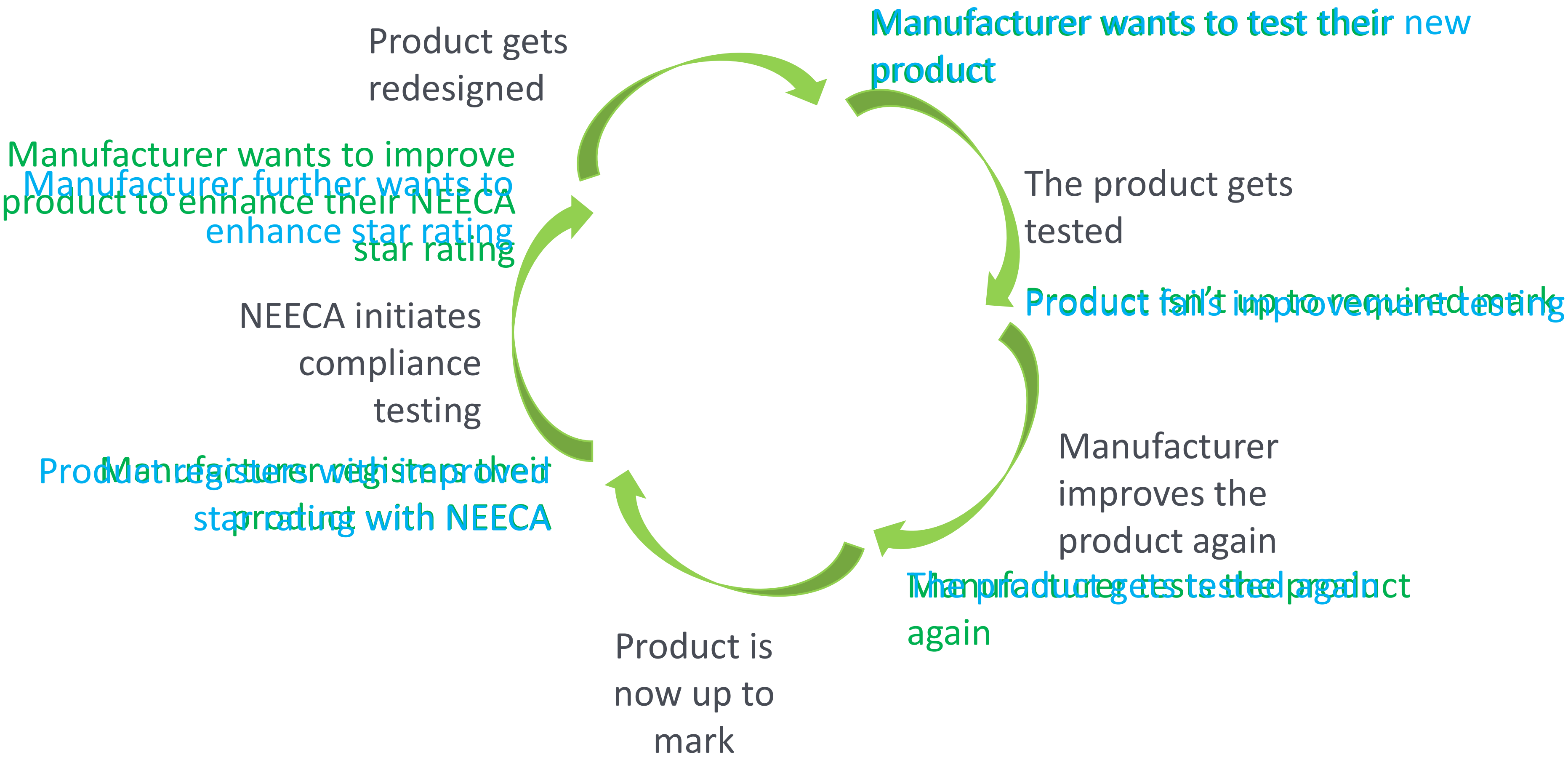


Impact

- Manufacturers gained the ability to understand, modify, and improve motor designs
- Shift from trial-and-error manufacturing to engineering-based design
- A foundation created for MEPS-compliant and high-efficiency motor production

Motor Testing

Significance of Improvement via TESTING



Motor Testing Ecosystem

Test Labs Situation

- **Test labs were not aligned with IEC motor testing standards:**
  - Test labs previously used IEEE 112 standard
  - Only measured current, voltage, torque and speed.
  - No measurement of losses, no thermal equilibrium
  - Therefore, true efficiency and losses were not being measured, meaning motor was not being tested as per its actual operational conditions.

- **How this barrier was addressed:**
  - Hands on and virtual training on IEC-60034-2-1 standard based testing by EMOSAD experts
  - Testing literature also shared with test labs
  - Technical support in equipment upgradation to meet IEC standards.

- **Impact: Test Labs adopted IEC standard for testing which made them compatible with compliance for NEECA's standards**

Motor Testing

Test Labs Situation

Poor Repeatability & Reproducibility

- In order for a test lab to have credibility in its test reports, it needs to have two capabilities
  - **Repeatability** – testing a motor in same lab multiple times with same result.
  - **Reproducibility** – testing the same motor in another lab with same results.

- **Test Labs lacked repeatability & reproducibility**
  - A particular motor being tested in same lab may had **variation in results of up to +/- 7.4%**
  - This hurts test lab's credibility and commercial attractiveness and also undermines compliance for NEECA's Standards and Labels regime.

How Repeatability & Reproducibility was issue was addressed

- Multiple round robin test were conducted among test labs
- Inter lab coordination was enhanced and results were analysed, mistakes in measurement rectified
- International level round robin also performed with the help of TSE lab in Türkiye and results were compared.

Impact of these interventions:

- **Repeatability improved with now only 0.04% margin of error.**
- **Test Labs reproducibility improved with only 0.31% variation compared with TSE, results attached in the next slide. (efforts underway to further improve this)**

Motor Testing Ecosystem

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DENEY VE KALIBRASYON MERKEZİ BAŞKANLIĞI ELEKTROTEKNK LABORATUVARI GEBZE
HEADSHIP OF TEST AND CALIBRATION CENTER ELECTROTECHNICAL LABORATORY GEBZE
MUAYENE - DENEY SONUÇLARI/ *TEST RESULTS*

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4. ANNEX

Motor description		
Rated output power	kW	5,50
Rated voltage	V	400
Rated current	A	11,80
Rated speed	min^{-1}	1465
Supply frequency	Hz	50
Number of Phases	-	3
IEC 60034-30-1 (rated)	IE-Kodu	0

Manufacturer	CLASP_SV
Model Nr.	BENCHMARK
Serial Nr.	MOTOR_06
Duty type IEC 60034-1	S1
Design	0
Insulation class IEC 60085	0
Max. ambient temperature	0

Initial motor conditions			
Test resistance	R_I	Ω	1,44667
Winding temperature	ϑ_0	°C	23,60
Ambient temperature	ϑ_a	°C	23,60

6.1.3.2.1 Rated load test			
Test resistance	R_N	Ω	2,32587
Winding temperature	ϑ_N	°C	180,76
Ambient temperature	ϑ_a	°C	24,80

6.1.3.2.3 Load curve test					*Before test*	R	Ω	1,72333
Rated output power		%	125%	115%	100%	75%	50%	25%
Torque	T	Nm	45,69	41,85	36,18	26,88	17,77	8,81
Input power	P_1	kW	8,150	7,456	6,322	4,736	3,170	1,716
Line current	I	A	14,38	13,26	11,54	9,25	7,35	5,94
Operating speed	n	min^{-1}	1437	1443	1453	1466	1479	1490
Terminal voltage	U	V	400,0	400,3	400,4	400,1	400,3	400,4
Frequency	f	Hz	50,0	50,0	50,0	50,0	50,0	50,0
Winding temperature	ϑ_w	°C	73,2	73,8	74,4	74,3	73,6	72,3
					After test	R	Ω	1,76347

6.1.3.2.4 No-load test						*Before test*	R	Ω	1,64767
Rated voltage		%	110%	100%	95%	90%	60%	50%	40%	30%
Input power	P_0	W	419,365	285,543	238,073	205,151	107,218	86,072	69,985	57,312
Line current	I_0	A	6,84	5,44	4,87	4,42	2,58	2,11	1,69	1,30
Terminal voltage	U_0	V	440,3	400,4	380,4	360,3	240,2	200,3	160,3	120,3
Frequency	f_0	Hz	50,00	50,00	50,00	50,00	0,00	0,00	0,00	0,00
W. temperature	ϑ_w	°C	63,69	63,32	63,05	62,70	62,33	62,03	61,55	61,12
						After test	R	Ω	1,53181

6.1.3.3 Efficiency determination								
Rated output power corr.	$P_{2,\theta}$	%	125%	115%	100%	75%	50%	25%
Output power corrected	P_2	W	6,875	6,325	5,503	4,127	2,752	1,374
Slip corrected	$s_{,\theta}$	p.u	0,042	0,038	0,032	0,022	0,014	0,007
Input power corrected	$P_{1,\theta}$	W	8,151	7,457	6,322	4,736	3,170	1,716
Iron losses	P_{fe}	W	148,415	148,415	148,415	148,415	148,415	148,415
Frict. and wind. losses corr.	$P_{fw,\theta}$	W	36,408	36,815	37,411	38,306	39,122	39,854
Additional-load losses	P_{LL}	W	222,049	186,302	139,176	76,829	33,591	8,247
Stator losses corrected	$P_{s,\theta}$	W	534,839	455,045	344,238	222,654	141,388	92,839
Rotor losses corrected	$P_{r,\theta}$	W	314,759	259,622	184,681	98,106	40,914	10,129
Power factor	$\cos\varphi$	%	0,818	0,811	0,790	0,739	0,622	0,416
Efficiency	η	%	84,6%	85,4%	86,5%	87,7%	87,3%	82,5%

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TEST REPORT

Page 2

Test Report No. ILD/ATR-2025-40361

6.1.3.2.4 No-load test					Test resistance before no-load			R	Ω	1.8381
Rated voltage		%	110%	100%	95%	90%	60%	50%	40%	30%
Input power	P0	W	432.3	283.4	239	206.9	107.1	86.7	70.2	56.6
Line current	I0	A	6.949	5.45	4.918	4.473	2.692	2.262	1.865	1.507
Terminal voltage	U0	V	440.25	400.72	380.42	360.48	240.67	200.57	160.31	120.1
Frequency	f0	Hz	50.05	50.05	50.05	50.05	50.05	50.04	50.05	50.04
W. Temperature	θw	°C	68	68.9	69.4	69.7	70.1	70.2	70.2	70.1
					Test resistance after no-load test			R	Ω	1.9431

6.1.3.3 Efficiency determination								
Rated output power corr.	P2,θ	%	125%	115%	100%	75%	50%	25%
Output power corrected	P2,θ	W	6921.5	6429.4	5660.9	4284	2920.6	1525.8
Slip corrected	S,θ	p.u.	0.0417	0.0376	0.0318	0.023	0.015	0.0075
Input power corrected	P1,θ	W	8140.4	7494	6521.3	4876.8	3337.2	1841.6
Iron losses	P fe	W	133.1	134.9	136.8	142.1	148.3	153.8
Frict. and wind. losses corr.	P fw,θ	W	34.6	35	35.5	36.3	37.1	37.8
Additional-load losses	P LL	W	147.4	124.9	94.9	53.4	23.5	6
Stator losses corrected	P s,θ	W	594.3	512.1	402.8	258	162.3	106.3
Rotor losses corrected	P r,θ	W	309.5	257.7	190.4	103	45.4	11.9
Power factor	COS φ	%	0.817	0.812	0.799	0.747	0.643	0.438
Efficiency	η	%	85.03	85.79	86.81	87.84	87.52	82.85
			Test resistance after load test			R	Ω	2.0259

Locked Rotor Test			
Voltage	V	Volt	106.84
Torque	T	Nm	1.996
Current	I	Amp	11.82

Motor Testing Ecosystem

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Test labs Sustainability

No test lab can sustain itself without testing and not treating itself as a commercial entity

- The test labs (ITU, GIFT) initially were more focused on Research work by students
- Their testing fees of PKR 12,000 to PKR 17,000 barely covered the electricity consumption during testing
- Motor Manufacturers were not interested in sending their motors to Test labs either due to
    - Lack of awareness about benefits of testing
    - Limited knowledge about test reports and how to study them for improvement
    - Lack of credibility of local test labs
    - Cost

Industry Accelerator Program addressed this by:

- Stakeholder meeting with Lab management regarding adopting a sustainable and business minded approach towards motor testing
- Conducting industry wide workshops to encourage Motor Manufacturers about the value of testing their motors

Impacts:

- **GIFT university motor test lab performed 30+ hours of testing of motors**
- **ITU performed about 64 hours of testing**
- **PCSIR performed about 80 hours of testing different motors**

Manufacturing Processes

Production Challenges

Outdated production equipment:

- The local motor manufacturing industry in Pakistan is primarily SME-based and family owned
- Many manufacturers still use machinery originally decommissioned from factories in developed countries in the **1960s**
- Motor manufacturers relied on outdated and inefficient production methods, which increased manufacturing time and reduced product quality:
  - Manual / low-precision **stamping of electrical steel sheets** for stator and rotor laminations
  - **Machining and reworking** of stator and rotor laminations to achieve acceptable tolerances

Lack of Facility organization:

- Most motor manufacturers had limited knowledge about proper organization and handling of material
- Equipment is not arranged in a production-based sequence which limits productivity

Improving Production Capabilities

Interventions during IAP:

- *Due to efforts during the Industry Accelerator, 21 Motor manufacturers pooled capital in partnership with Multi Alloy, a key components manufacturer to purchase new Stamping mould according to IEC standard capable of producing even IE-3 motors.*
- *In addition to new stamping mould, the local motor manufacturing industry cumulatively has invested $300,000.00 in new equipment and machinery*
- This shows confidence of motor manufacturers in promoting energy efficiency in their motors.

Apart from investment in new machinery and equipment, several consultations were taken with Motor manufacturers to modify their production layout according to better flow of materials and better organization

Improving Production Capabilities

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Material & Production quality control:

- **Before the Industry Accelerator**
  - Motor Manufacturers did not inspect quality of their finished parts
  - All of the incoming material (enamel wire, iron frame, bearings, varnish etc.) were not inspected thoroughly for quality control
  - *In short, there was no quality control mechanism in place either in production or incoming material*
- **Interventions during IAP:**
  - Standard SOPs of quality control of different materials prepared and distributed
  - Business case for use of better quality material leading to cost savings in motor production was elaborated
- **Impact:**
  - Motor manufacturers now use M800 & M470 compared to Mild Steel in motors
  - High quality precision bearings are now being used instead of used ones
  - Quality control departments or quality personnels were deputed at production and incoming materials store to maintain quality control

clasp — **Instruction For Quality control of Incoming Enamel Wire** — SAMA^Verte

فیکٹری میں آنے والی اینمل وائر کی کوالٹی چیک کرنے کے لیے ہدایات

1	2
1. Each spool of enamel wire should have uniform diameter of wire a. excluding enamel coating b. Including enamel coating 2. For this take 10 meters of enamel wire and check both ends diameter before & after removing the enamel. وائنڈنگ وائر کے ہر گوٹ میں تار اور اُس کی اینمل کا ڈایا یکساں ہونا چاہیے۔ اس کے لیے دس (10) میٹر کی تار کا سیمپل لے کے اُس کے دونوں سروں کا ڈایا اینمل اُتارنے سے پہلے اور بعد میں لینا چاہئے۔	3. To check the resistance, first check the ambient temperature of the room for picking correct resistance values from the table تار کی ریزسٹنس کو چیک کرنے سے پہلے کمرے کا ٹمپریچر ضرور چیک کرلیں تاکہ ٹیبل میں دی گئ صحیح ویلیو کا انتخاب کیا جا سکے۔
3	**4**
4. An enamel wire should have uniform resistance throughout the length of its spool. For this, check the resistance between both ends of the sample obtained in step 1 اِس کے بعد تار کے نمونے کے دونوں سروں کو اینمل اُتار کر اُس کی ریزسٹنس کو چیک کریں	5. Compare the measured resistance with standard values against its diameter and ambient temperature given in table for the given sample. آخر میں معلوم کردہ ویلو کو دیے گئے ٹیبل میں سے ٹمپریچر اور تار کے ڈایا کے مطابق میچ کریں۔ اگر ویلو میچ نہ کرتی ہو تو تار کو ریجکٹ کر دیں۔

Enamel wire size in SWG	Enamel wire diameter in mm	Resistance of 10-meter wire at 25 °C	Resistance of 10-meter wire at 30 °C	Resistance of 10-meter wire at 35 °C
16	1.626	0.083944	0.085562	0.087179
17	1.422	0.109757	0.111872	0.113987
18	1.219	0.149356	0.152234	0.155113
19	1.016	0.215024	0.219168	0.223311
20	0.914	0.265720	0.270841	0.275962
21	0.813	0.335876	0.342349	0.348822
22	0.711	0.439203	0.447667	0.456131
23	0.61	0.596744	0.608244	0.619744
24	0.559	0.710669	0.724364	0.738060
25	0.508	0.860611	0.877196	0.893781
26	0.457	1.063519	1.084014	1.104510
27	0.417	1.277465	1.302083	1.326702
28	0.376	1.571407	1.601690	1.631973
29	0.345	1.866679	1.902652	1.938626
30	0.315	2.239392	2.282548	2.325704
31	0.295	2.553586	2.602797	2.725417
32	0.274	2.960307	3.017356	3.166174
33	0.254	3.445195	3.511589	3.693394
34	0.234	4.059691	4.137926	4.364086

Demand Creation

Commercial Challenges

Demand Side interventions have not officially been in scope for IAP 1 and IAP 2. However demand side focus is or utmost importance !

- **Seasonal Demand of Local Motors**
  - Local motor manufacturers supply most of their production to agricultural water pumping solutions followed by household water pumping
  - This distorts the entire annual production cycle into periods of high production and low production
  - *This also puts the local motor industry prone to external and force majeure events like demand suppression due to Floods or Policy reversal*
- **2nd Hand Motor market**
  - There is a huge 2nd hand motor market in Pakistan which caters to most of the local small industrial demand but being low cost while being unreliable and less efficient, this hurts local motors demand
- **Lack of General consumer awareness about local motors:**
  - General consumer in Pakistan is relatively unaware of local motor manufacturing capable of now producing better quality efficient motors

From Technical Breakthroughs to Market Readiness

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IAP has demonstrated that

- Domestic manufacturers can design and produce high-efficiency motors according to the international benchmarks
- Technical barriers related to design optimization, materials, and testing were systematically addressed
- Local lab and testing constraints were resolved through iterative testing and debugging
- Early commercial challenges highlighted cost, scale, and buyer confidence gaps

What is still required for long-term impact

- Consistent market demand for efficient motors
- Buyer awareness and confidence beyond early adopters
- Policy, procurement, and institutional signals that reward efficiency
- Commercial viability is now critical to support technical advancements

Sustaining and Scaling the Gains from IAP

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Extending IAP learnings

- Building on validated motor designs, materials, and testing protocols
- Supporting manufacturers to move from pilot to repeatable production
- Strengthening quality assurance, consistency, and compliance confidence with NEECA regulations
- Demonstration exercises in industries

Enabling conditions to sustain supply-side investments

Building on IAP experience, SAMA^Verte is advancing complementary actions to strengthen the enabling environment through

- Supporting NEECA in Advancing policy and standards alignment that rewards efficient products among manufacturers, and industry associations etc.
- Raising market awareness of improved local motor performance and reliability among buyers, distributors, and relevant stakeholders. **IAP 3 and similar projects envisioned / kicking off**
- Engaging buyers and institutions to highlight demand confidence and continuity

EMOSAD's Role in the Industry Accelerator Programme

Jeremy Tait

What is EMOSAD

EMOSAD
Elektrik Motorları Sanayicileri Derneği

The Electric Motor Manufacturers' Association of Turkey:

"To develop the electric motor industry in Turkey, increasing quality to national and international standards … working on technical, energy efficiency, environmental compliance..."

18 motor manufacturer members

EMOSAD members cover more than 70% of Europe's motor demand

Experts supporting the programme

- **Mr. Tunç İşcan – EMOSAD**
  - Business Owner – Marketing, WAT Motors
  - Head of International Relations – EMOSAD Türkiye
- **Mr. Onur UZER – EMOSAD**
  - Design & Testing Expert – Promote, Türkiye
- **Mr. Halil Gündüz – EMOSAD**
  - Production & Quality Expert – WAT Motors, Türkiye
- **Mr. Ahmet GÜL – TSE**
  - Motor Testing Expert – Turkish Standards Institute, Türkiye

Experts supporting the programme

- **Mr. Serhat AKŞUN - EMOSAD**
  - Motor Design & Testing Expert – Volt WEG Group, Türkiye
- **Mr. Ali Han ÖZCAN - EMOSAD**
  - Motor Production & Quality Expert – OMEGA Motors, Türkiye
- **Mr. Stuart Jeffcott – CLASP**
  - CLASP International Team Lead during IAP – 1
- **Mr. Jeremy Tait – CLASP**
  - CLASP International Team Lead during IAP - 2

Excellent support to motor manufacturing in Pakistan

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- Experts from Türkiye have completed:
  - **16 individual visits**
  - **Spent 123 days of their time in Pakistan (combined)**
  - **More than 950 man-hours for improvement of the motor manufacturing industry**

Future collaboration

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EMOSAD has indicated their interest for further collaboration:

- **To further the gains from the Industry Accelerator Programme**
- **To support Pakistani regulators on MEPS compliance and future upgrade of requirements**
- **On possible strategic collaboration in commercial terms with Pakistani Businesses**

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Some comments from our EMOSAD experts

QUESTIONS & DISCUSSION

Sustainable progress in Energy Efficiency – An international perspective

Jeremy Tait

Motor Minimum Standards around the world

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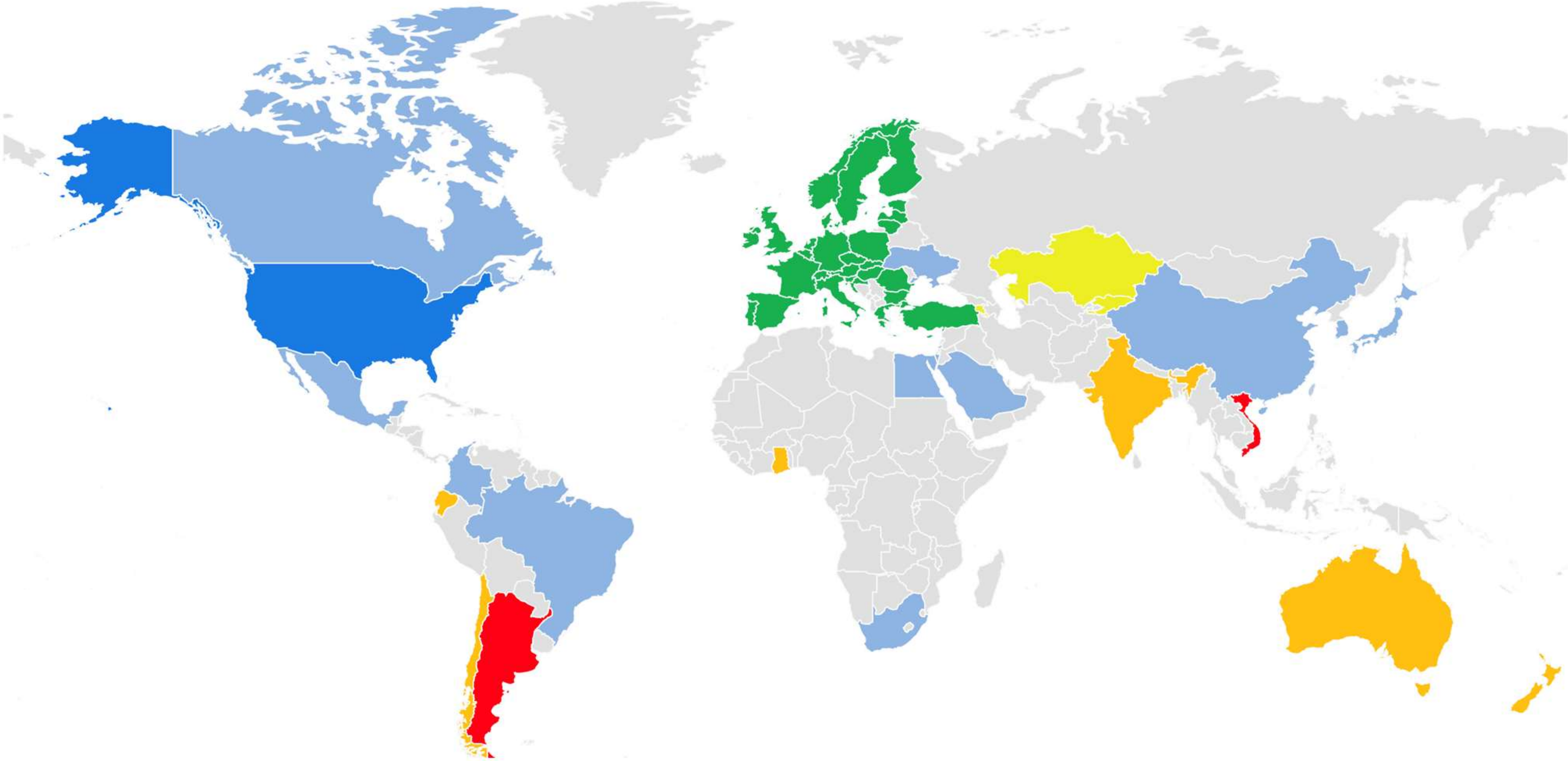

IE1 | IE2 decided | IE2 | IE3 | IE4 decided | IE4

Motor Minimum Standards around the world

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Efficiency classification	Mandatory Minimum Energy Performance Standard			
IEC 60034-30-1:2014	Testing standard IEC 60034-2-1		Phases	
IE efficiency class [1]	Country / Economy/ Region	Range (kW)	1	3
IE2	*AM, KZ, KG [5] from Sep 2025*	*0.75 - 375*		x
IE2	Australia	0.73 - 185		x
IE2	Chile	0.75 - 7.5		x
IE2	Colombia	0.18 - 0.55		x
IE2	Ecuador	0.18 - 1.5	x	
IE2	Ecuador	0.75 - 373		x
IE2	EU 27, CH, NO, TR, GB[6]	0.12 - 1 000	x	
IE2	EU 27, CH, NO, TR, GB[6]	0.12 - 0.75		x
IE2	Ghana	0.12 - 1 000		x
IE2	India	0.12 - 1 000		x
IE2	Israel	0.75 - 5.5		x
IE2	New Zealand	0.73 - 185		x
IE2	United States	0.18 - 2.2	x	
IE1	Argentina	0.12 - 7.5	x	
IE1	Argentina	0.75 - 30		x
IE1	China	0.12 - 3.7	x	
IE1	Ghana	0.12 - 1 000	x	
IE1	Viet Nam	0.75 - 150		x

3-phase:

Pakistan 5kW-1000kW, IE2

Pakistan 0.12kW-5kW, IE1

Motor Minimum Standards around the world

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Efficiency classification	Mandatory Minimum Energy Performance Standard			
IEC 60034-30-1:2014	Testing standard IEC 60034-2-1		Phases	
IE efficiency class [1]	**Country / Economy/ Region**	**Range (kW)**	**1**	**3**
IE4	European Union (27 countries)	75 - 200		x
	Norway, Switzerland, Türkiye, United Kingdom	75 - 200		x
	United States from Jun 2027	*75 - 186*		x
IE3	Brazil	0.12 - 370		x
	Canada	0.75 - 375		x
	China	0.12 - 1 000		x
	Colombia	0.75 - 373		x
	Egypt	0.75 - 375		x
	European Union (27 countries)	0.75 - 75; 200 -1 000		x
	Israel	0.75 - 185		x
	Japan	0.75 - 375		x
	Mexico	0.75 - 375		x
	Norway, Switzerland, Türkiye, United Kingdom	0.75 - 75; 200 - 1 000		x
	Saudi Arabia	0.75 - 375		x
	Singapore	0.75 - 375		x
	South Africa	0.75 - 375		x
	South Korea	0.75 - 375		x
	Chinese Taipei	0.75 - 200		x
	Ukraine	0.75 - 375		x
	United States	0.18 - 2.2		x
	United States	0.75 - 375		x
	United States from Jun 2027	*0.75 - 75; 186 - 563*		*x*

A longer journey - further savings from motors

- Increasing stringency: IE2 -> IE3 … -> … IE4
- Regulating second-hand motors (Pakistan is onto this already)
- Encouraging use of Variable Speed Drives
- Focus on Motor Systems - an ‘expanded product approach’
- Improve rewinding and repair
  - IEC 60034-23 Repair, overhaul and reclamation
  - IEEE 1068 Repair and Rewinding of AC Electric Motors

What makes the progress SUSTAINABLE?

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- Bring stakeholders on the journey and establish trust
- Protect livelihoods
  - ‘Signal’ years in advance and explain
  - Help companies adapt
- Make goals achievable:
  - Affordable (price of materials / components / end-product)
  - Help establish supply chains
  - Requirements suitable to local market conditions, regulatory frameworks and institutional remits
- Enforceable *and seen to be enforced*
  - Registration scheme
  - Labelling
  - Test labs
  - Inspectors
  - Publicise serious non-compliance