



Loyola – ICAM College of Engineering & Technology (LICET)

Department of Electrical & Electronics Engineering

OPTIMIZATION IN PMSM FOR ELECTRIC VEHICLE

EE 8611 MINI PROJECT

BATCH NO: A6

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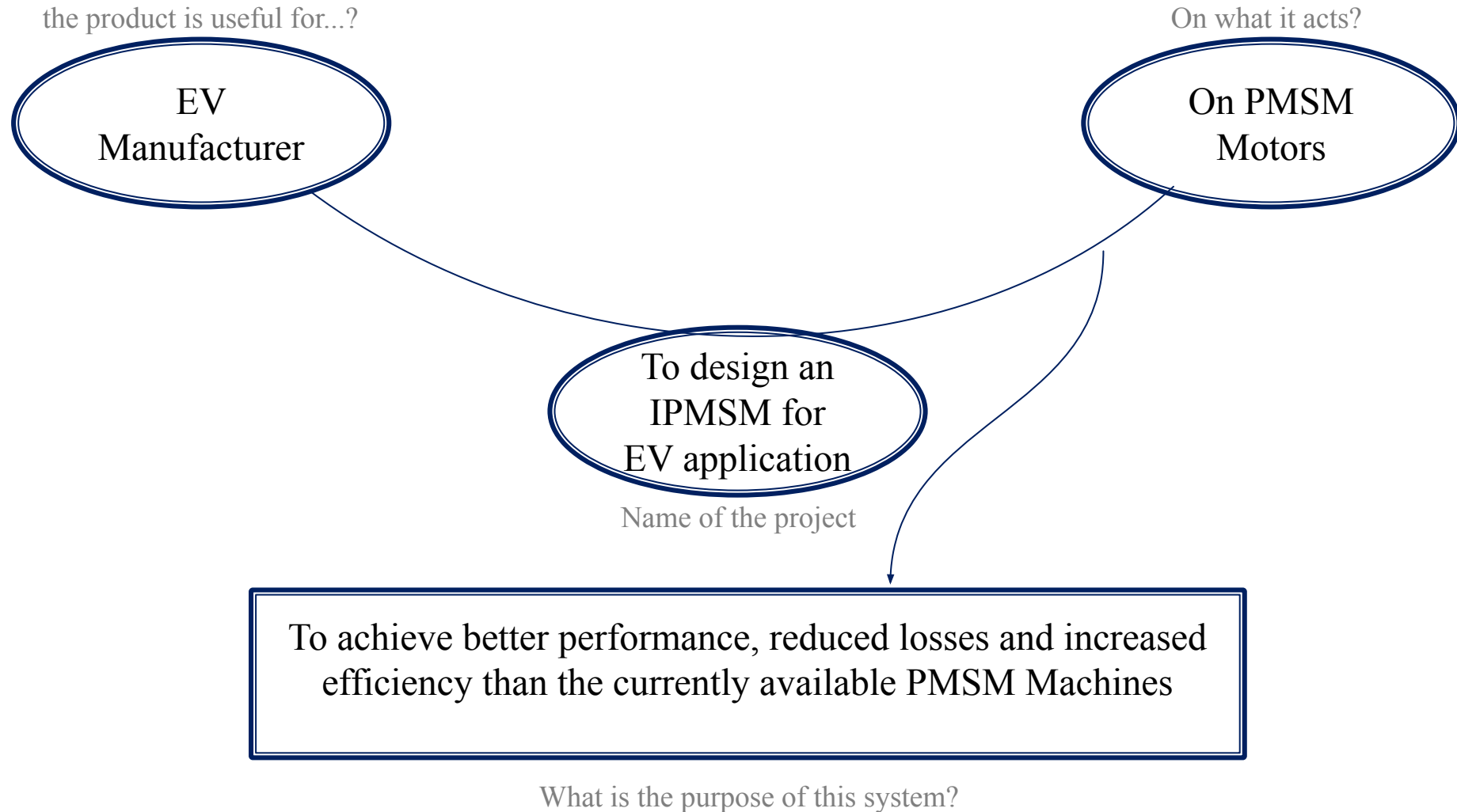
OBJECTIVE

- To design and simulate IPM PMSM using FEA for the specific EV Application.
- The power rating is fixed to 11KW as it is used in the existing EVs.
- To theoretically calculate the stator dimensions and slots based on the required design.
- To select the magnet shape and material of the Permanent magnet mounted on the Rotor
- Verify the design and simulate to estimate the losses in the PMSM.
- To consider the factors affecting the losses and use one of the methods to reduce the losses.
- Obtain the final output results of the PMSM motor using finite element analysis.
- To analyze the future scope in the design of the PMSM motor.

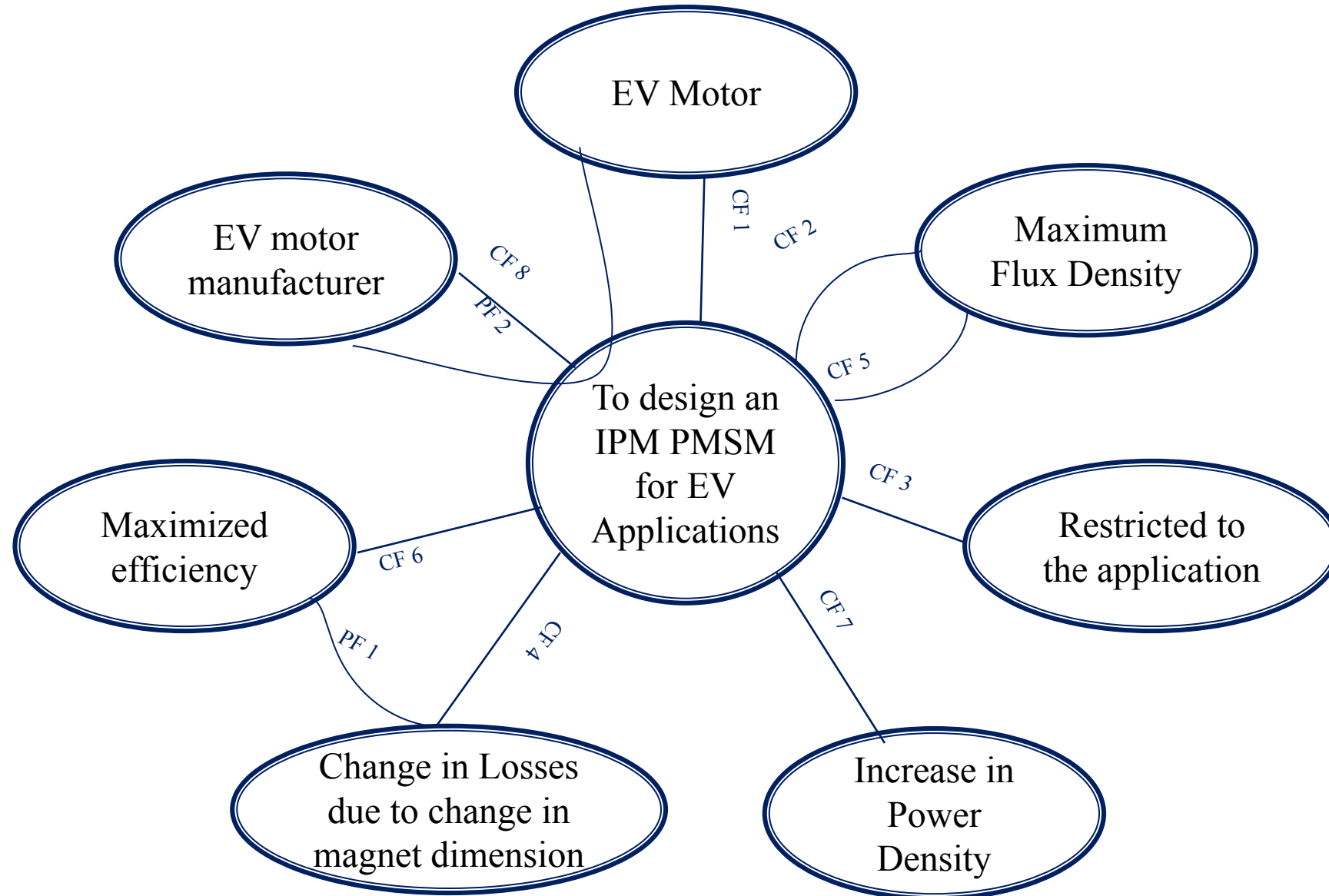
INTRODUCTION

The standard PMSM design used in electric vehicles as well as an improved version that uses magnet thickness modification are both investigated in this study. With the aid of sophisticated FEA simulations and analytical calculations, the ideal magnet thickness for the PMSM rotor may be determined. This research has the potential to increase the technical reliability of electric vehicles and make them more appealing to a wider consumer base.

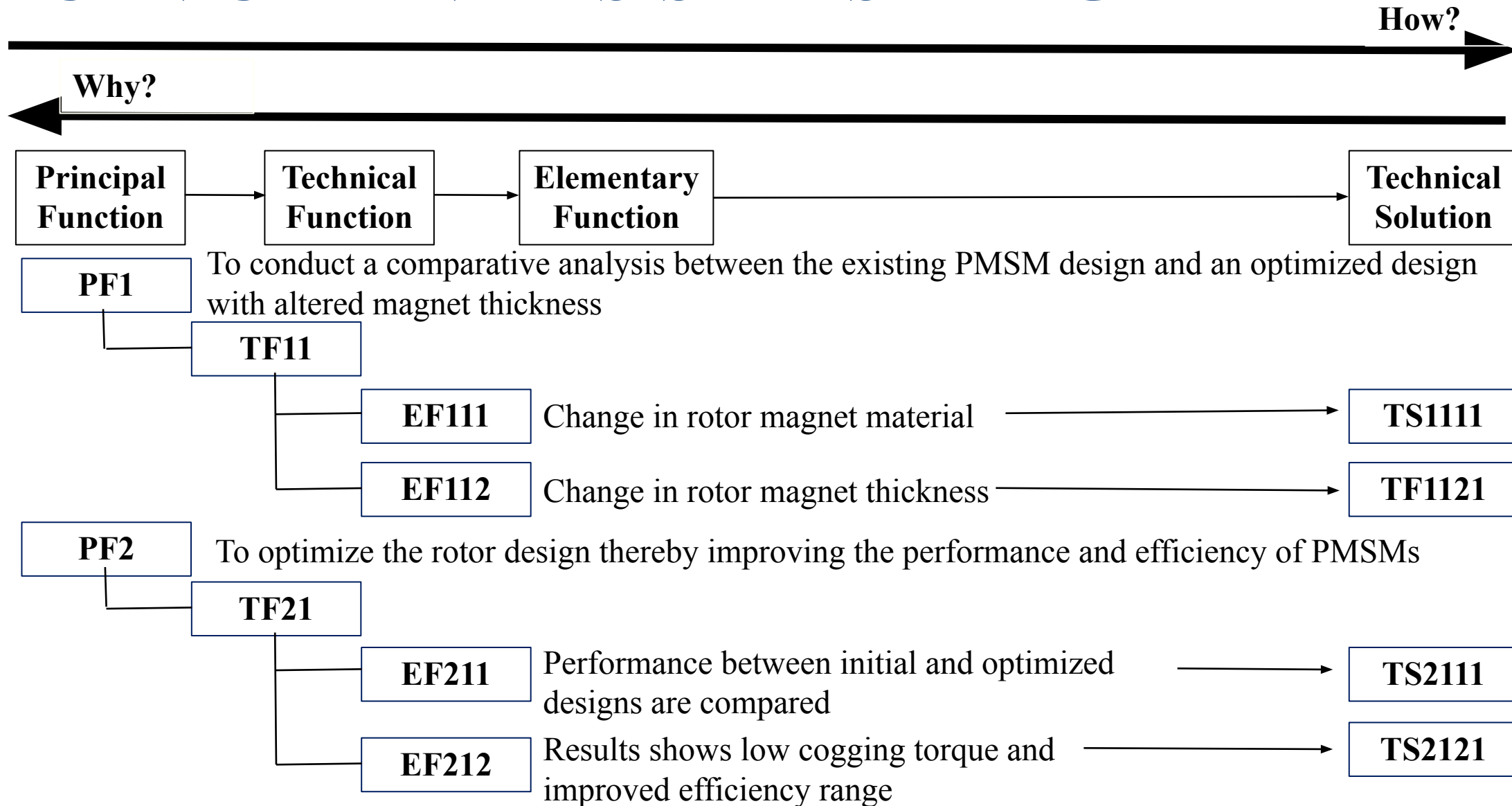
NEED ANALYSIS – BULL DIAGRAM



FUNCTIONAL ANALYSIS – OCTOPUS DIAGRAM



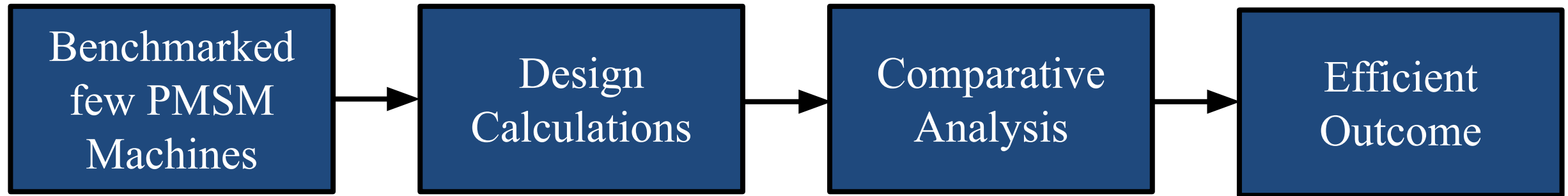
TECHNICAL ANALYSIS – FAST DIAGRAM



PROPOSED METHOD

Analytical calculations and FEA simulations are used in a comparative analysis to improve the rotor design of electric three-wheelers. High torque output, better efficiency, fewer losses, and enhanced flux distribution are all guaranteed by the optimised design with the changed magnet thickness. With this design, electric three-wheelers perform better and uses less energy which increases their use and appeal to consumers.

PROCESS DIAGRAM



DESIGN CALCULATION

The equation used to find the diameter and length

$$D2L = Q/C0Ns \text{ ----- (1)}$$

D - diameter of the inner stator

L - Length of the inner stator

Where Q is ;

$$Q = \text{power rating} / \text{efficiency} \times \text{Power factor} \text{ ----- (2)}$$

$$Ns = 120 f/P \text{ ----- (3)}$$

Stator slots;

$$S_{ss} = D/15 \text{ ----- (4)}$$

Where stator slot pitch can be in the range

$$Y_{ss} = 15 \text{ to } 25 \text{ mm}$$

$$S_{ss} = m \times p \times q$$

m - number of poles

p - number of phases

q - slots/ pole / phase

Rated Power	11 kW
Maximum Speed	1500 rpm
Peak Torque	90 Nm
Air Gap Length	0.5mm
Stator Slots	36
Rotor Poles	12
Supply Voltage	415 V
Magnetic Material	NdFeB
Magnet Thickness	4.25mm

Average flux density B_{avg}

$$B_{av} = P /DL \text{ ----- (5)}$$

$$T_{ph} = Es/ 4.44 f m K_{wm} \text{ ----- (6)}$$

Where;

T_{ph} - is the torque developed per phase.

SIMULATION MODEL

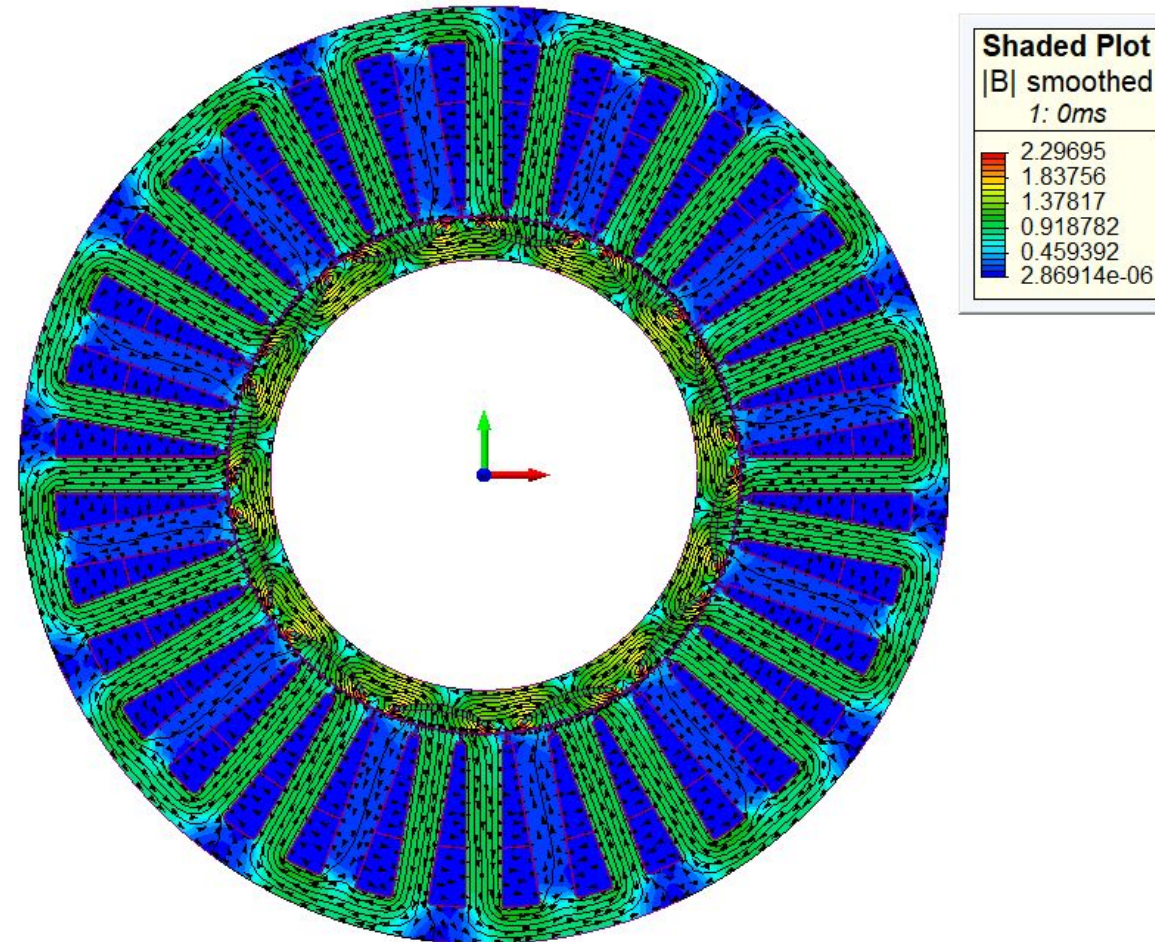


Image 1.1 Magnetic Flux Path

RESULT ANALYSIS AND DISCUSSION

For NdFeB type magnet having an air gap of thickness 4.25mm

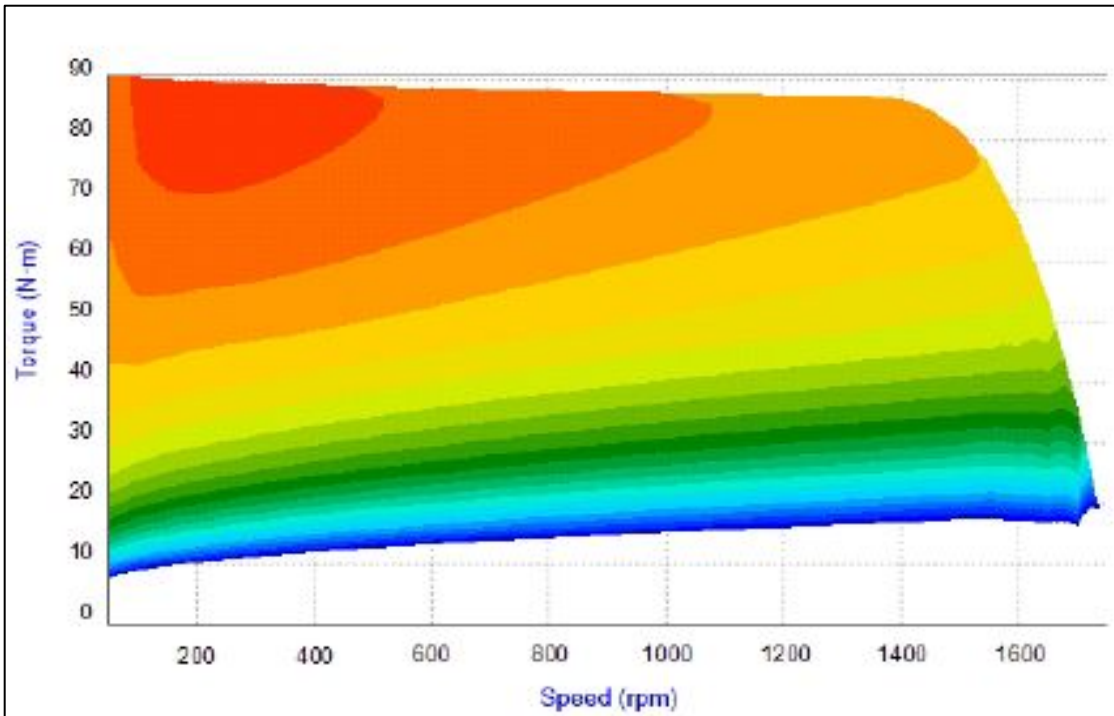


Image 1.2 Efficiency

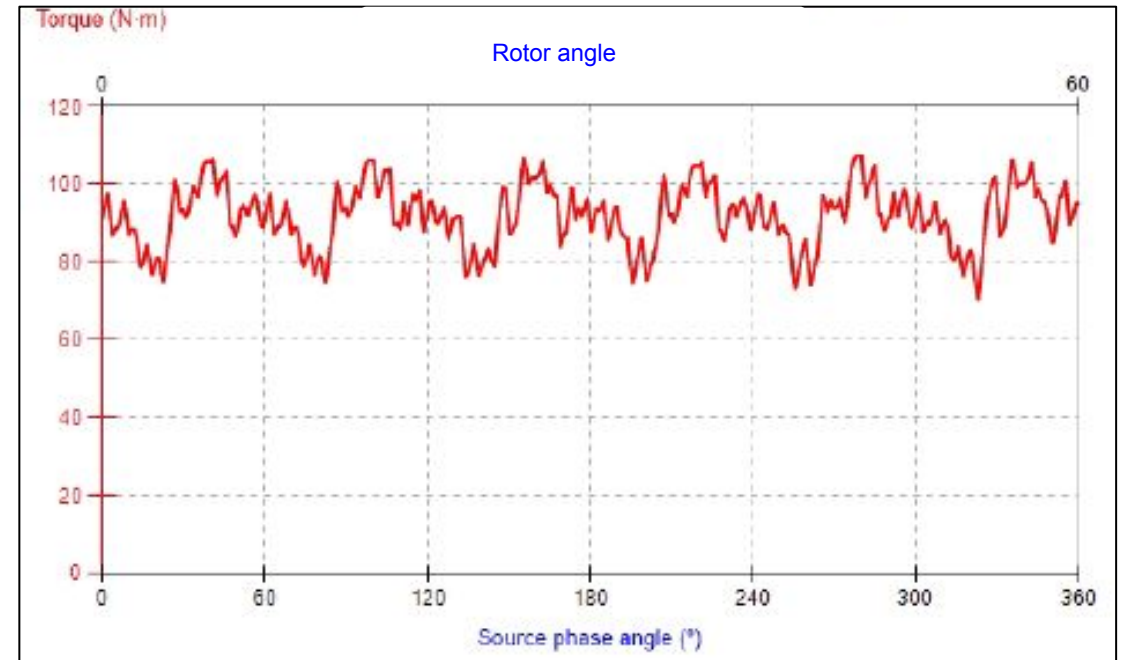


Image 1.3 Electromagnetic Torque

RESULT ANALYSIS AND DISCUSSION

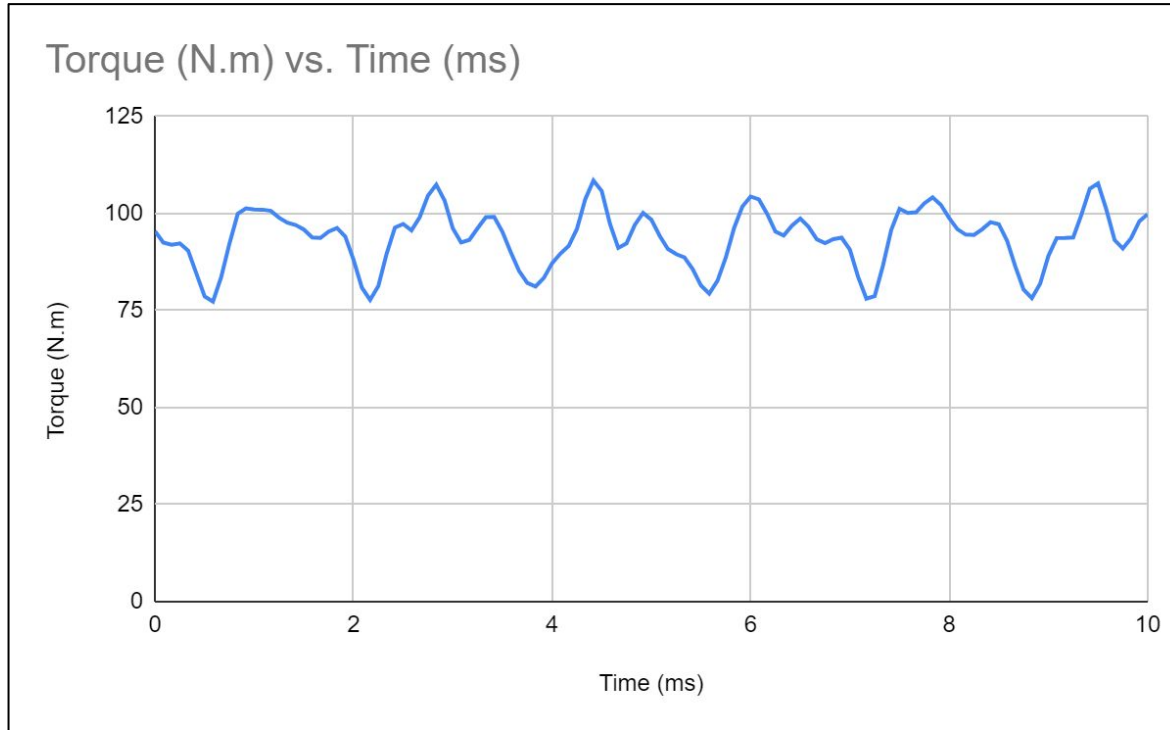


Image 1.4 Torque graph of magnetic thickness 4.25mm

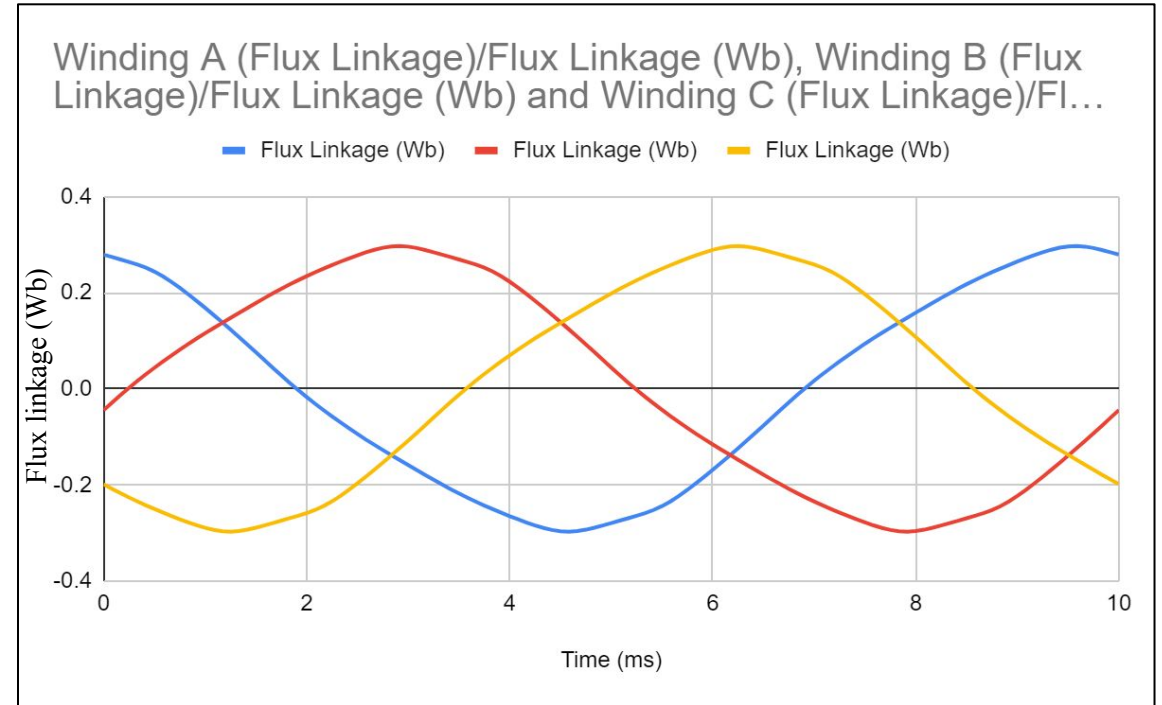


Image 1.5 Flux linkage graph of magnetic thickness 4.25mm

RESULT ANALYSIS AND DISCUSSION

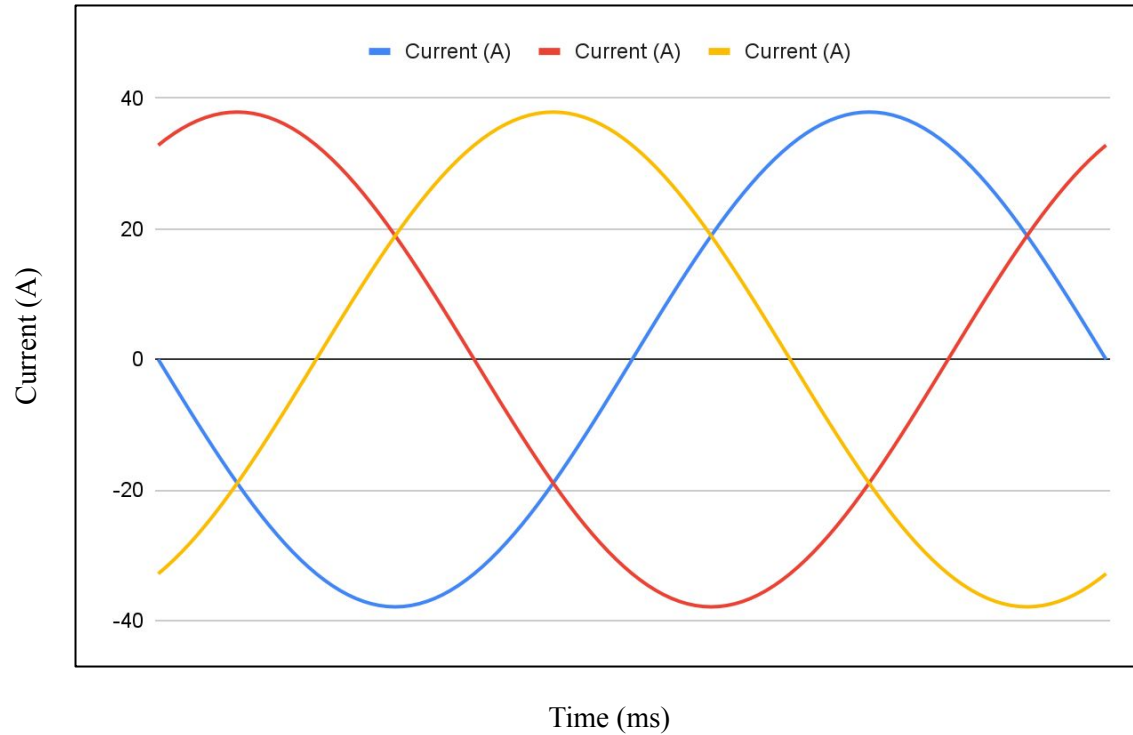


Image 1.6 Current

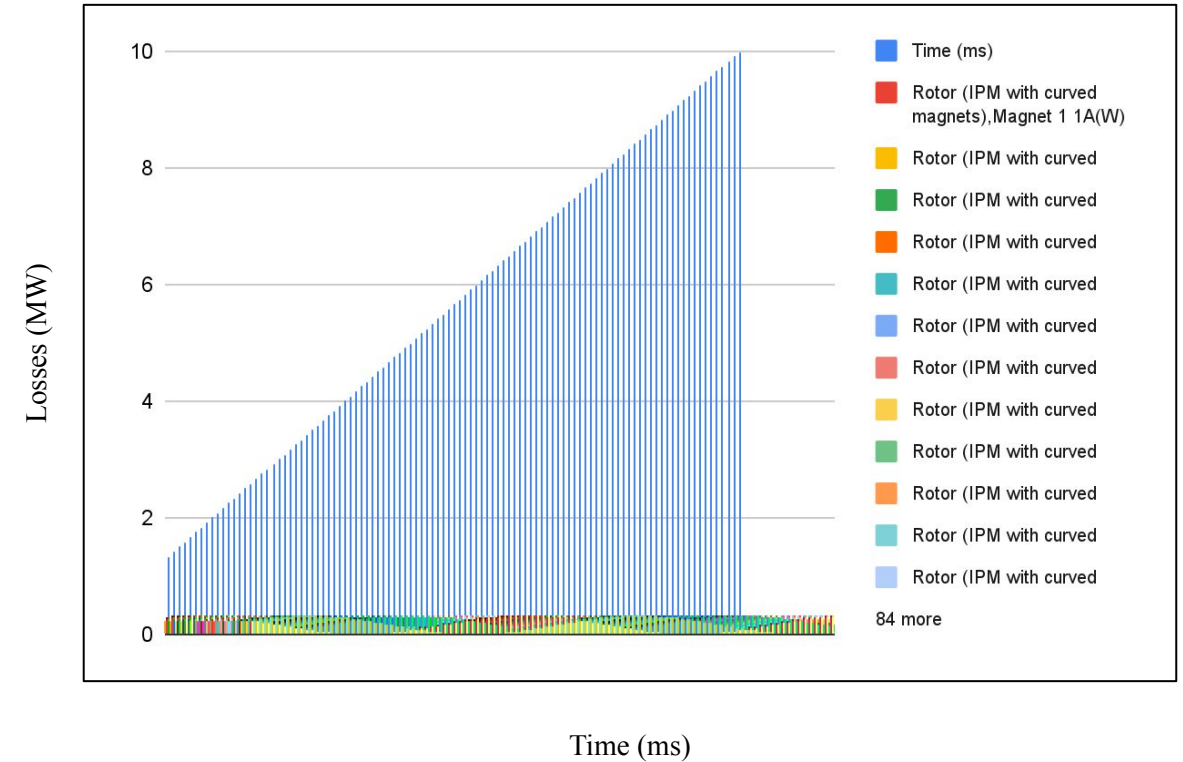


Image 1.7 Ohmic loss

RESULT ANALYSIS AND DISCUSSION

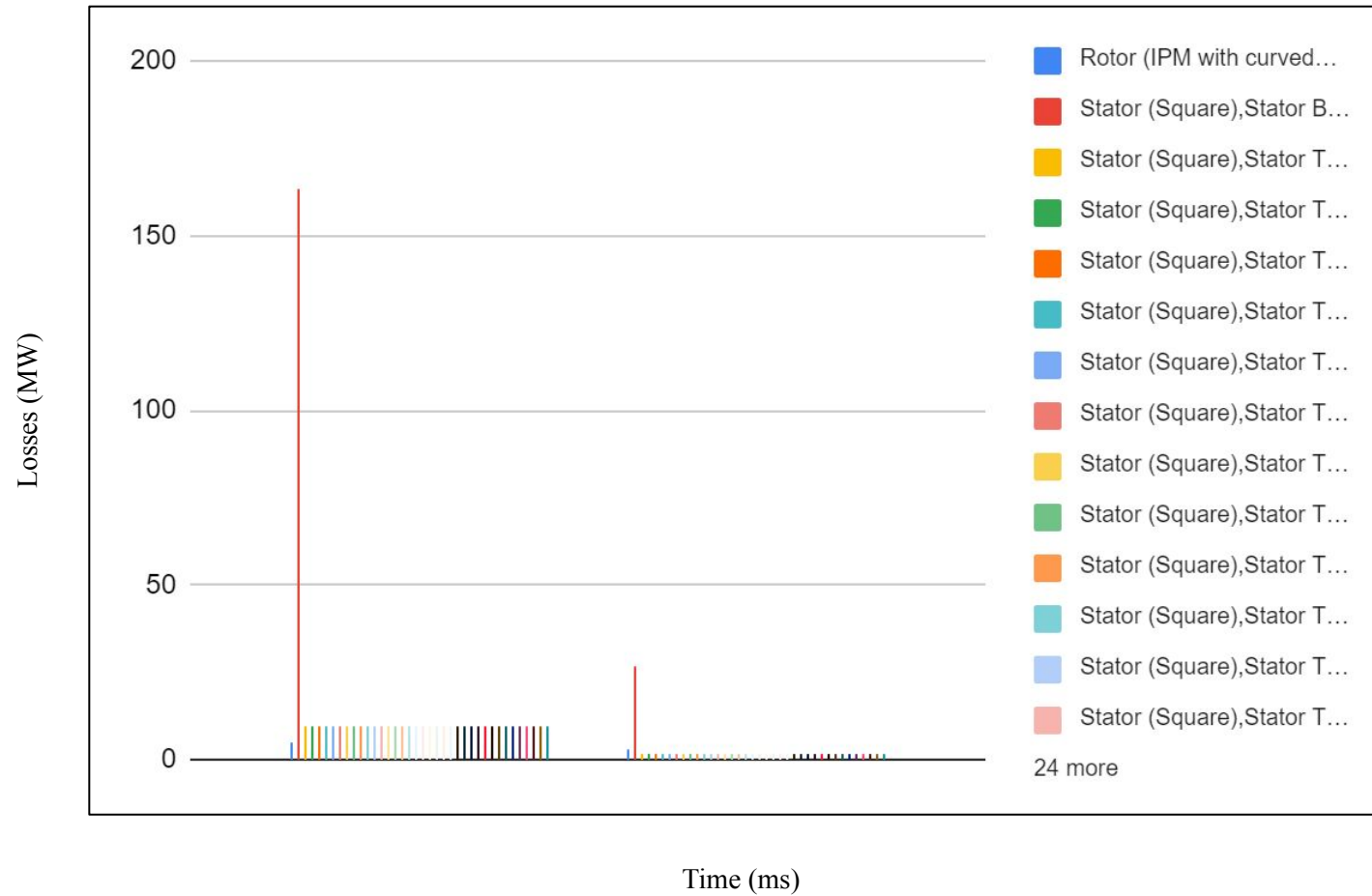


Image 1.8 Iron loss

RESULT ANALYSIS AND DISCUSSION

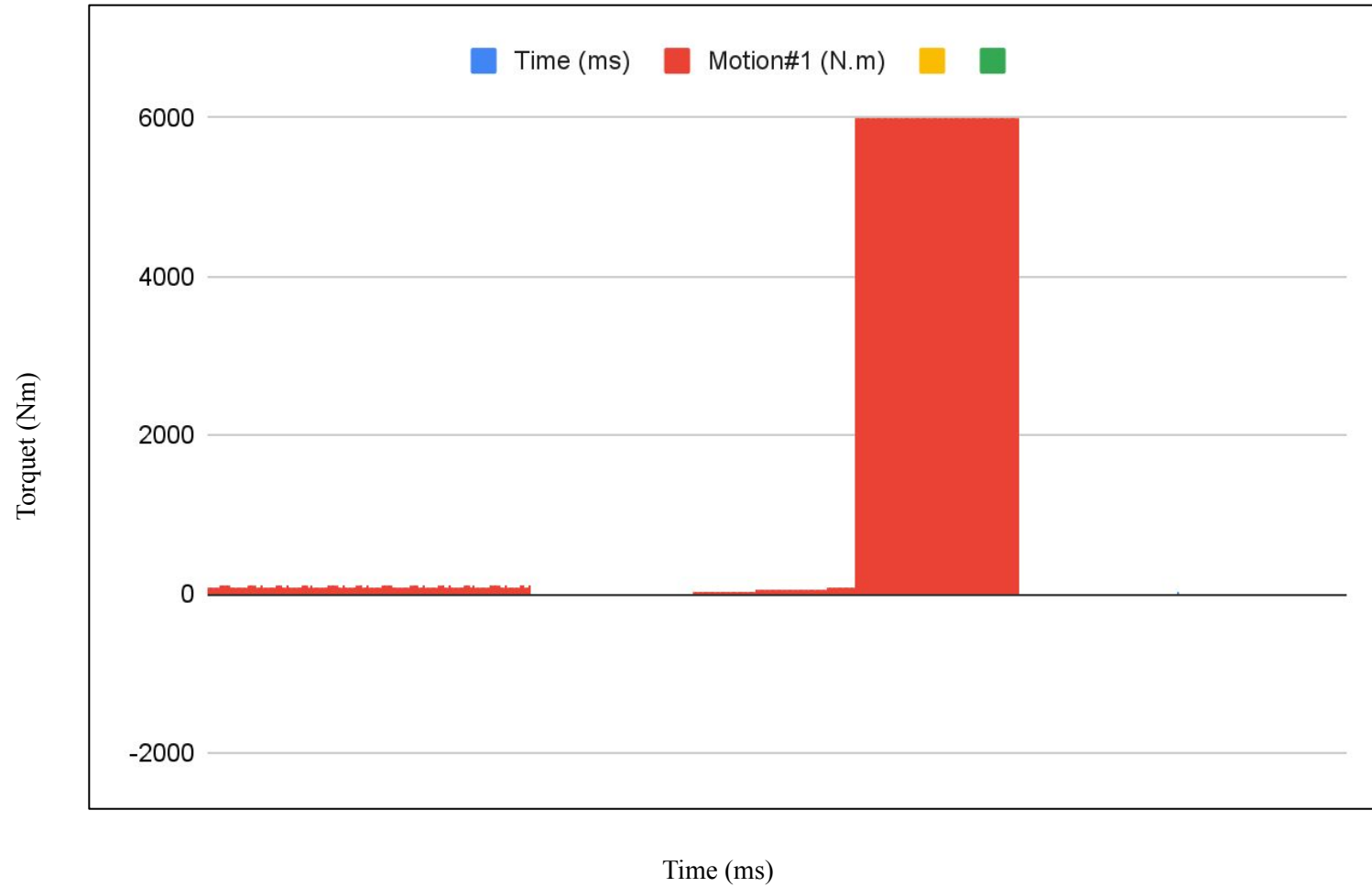


Image 1.9 Load torque

CONCLUSION

According to the study, increasing magnet thickness improved eddy current losses, efficiency, and motor torque output. Further increases, however, reached a point of diminishing returns and did not considerably boost torque output. The ideal thickness minimised the losses while increasing flux density and distribution. These discoveries have implications for the electric vehicle market, improving the performance and the effectiveness of electric three-wheelers while also increasing their customer appeal. mongoose aai

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