Universität Rostock
Traditio et Innovatio

EMship
Advanced Design

Sensitivity Analysis of Added Power of Ships in Seaway

EMship Master Thesis

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Thesis Motivation

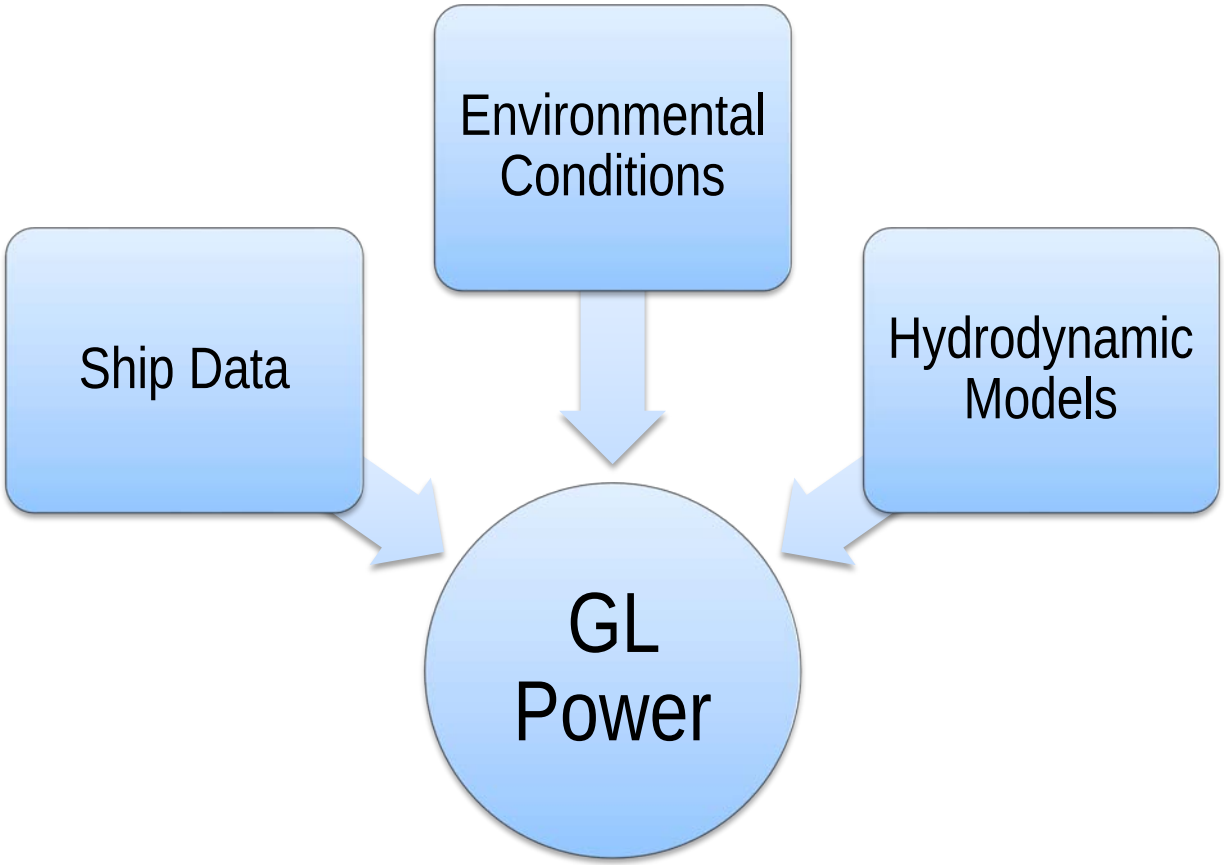
Discuss influence of wind, wave and current of added power of ships in seaways.

Thesis Ambition

Contribute to the scientific community research on added resistance and added power.

Contribute to ship operators on route optimization tools

Investigations Method



Ship Data

Series of 8 container ships (LOA ≈ 300 m)

Data recorded from 2009 to 2014

More than 295.000 Measurement

Table 1: Recorded Information

Date and time of record	Geographical Latitude
Speed over ground	Geographical Longitude
Course	Draft at aft perpendicular
Shaft RPM	Draft at forward perpendicular
Shaft power	Operational Status

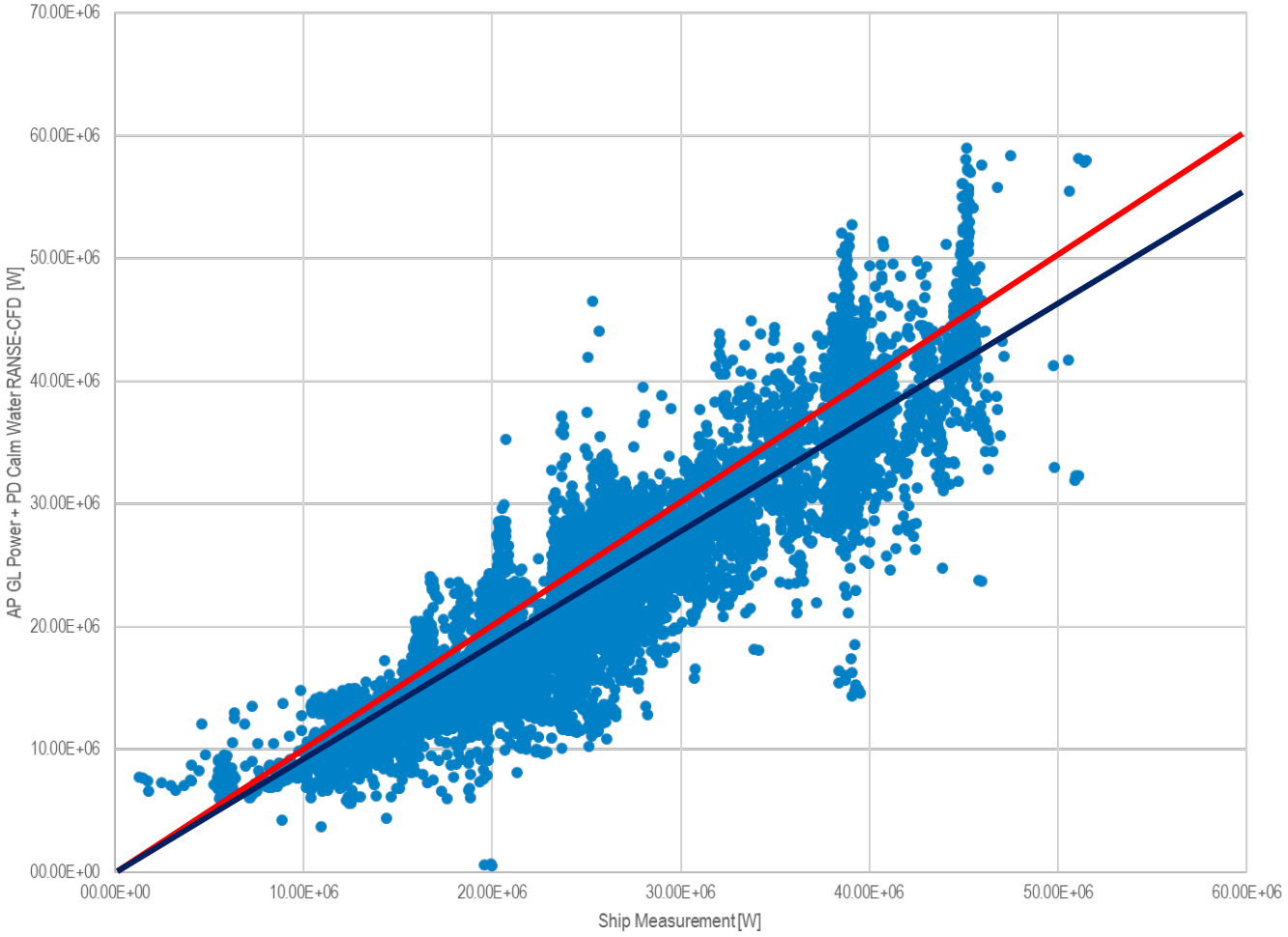
Environmental Conditions

Parameter	Grid	Time Interval	Source
Wind	0.75º x 0.75º	6 hours	ERA Interim
Wave	0.75º x 0.75º	6 hours	ERA Interim
Current	0.33º x 0.33º	5 days	OSCAR

Added Power Studied Cases

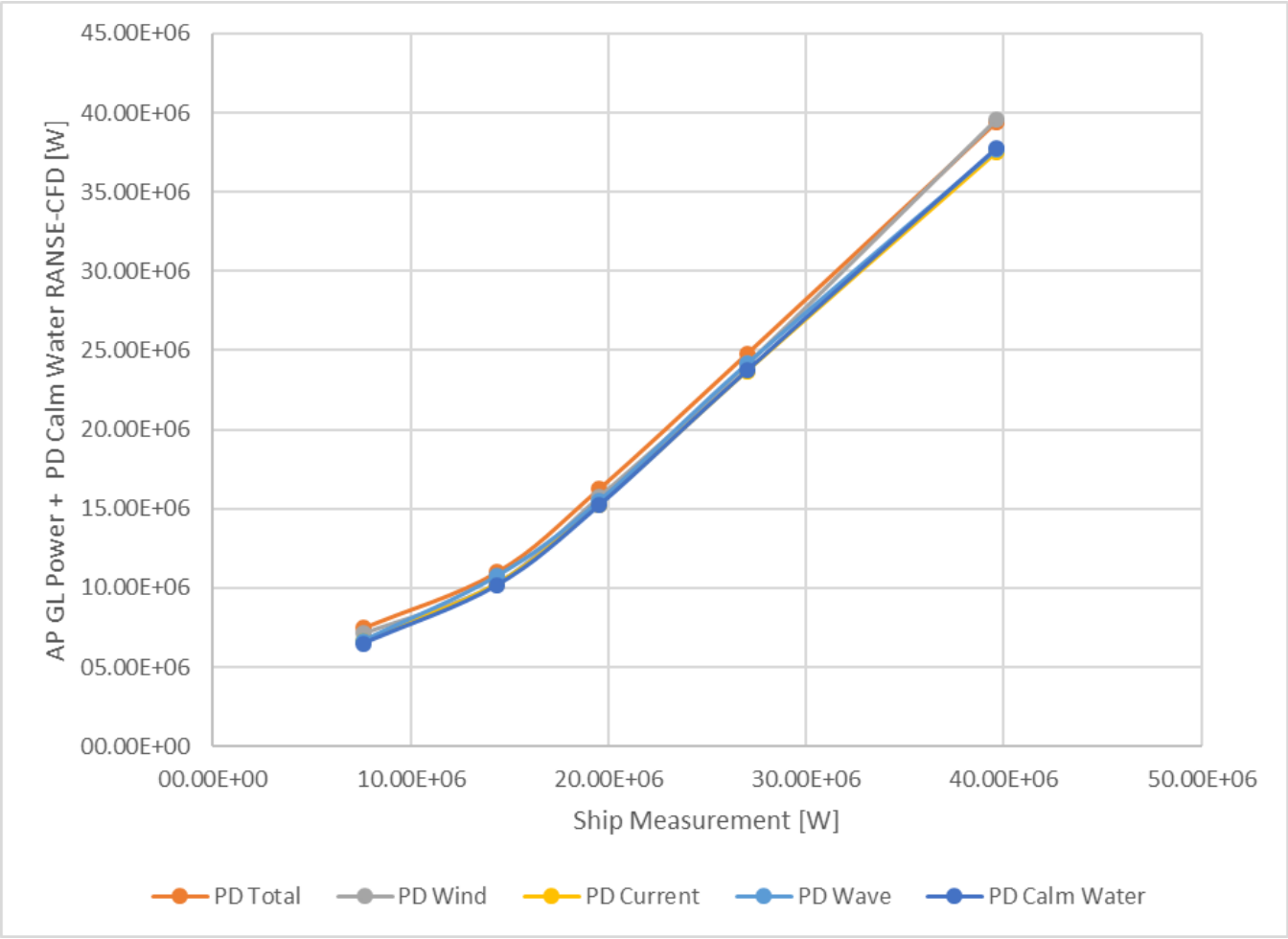
Case	Wind	Wave	Current
Case 1	-	-	-
Case 2	✓	-	-
Case 3	-	✓	-
Case 4	-	-	✓
Case 5	✓	✓	-
Case 6	✓	-	✓
Case 7	-	✓	✓
Case 8	✓	✓	✓

Total Delivered Power Estimation (Case 8)

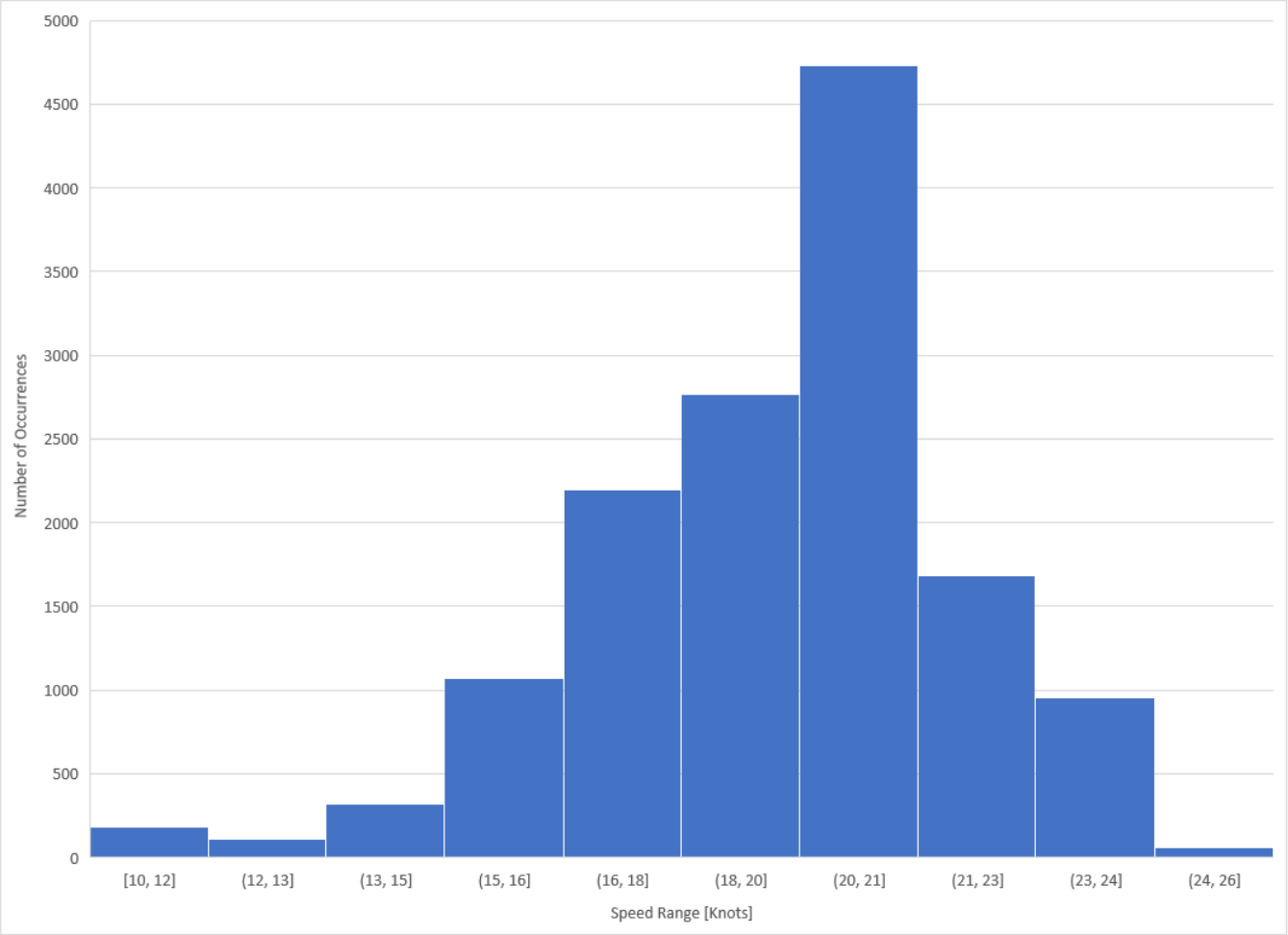


Fit	Slope Θ
—	1.0
—	0.915

Average – Ship Speed Range



Speed Histogram

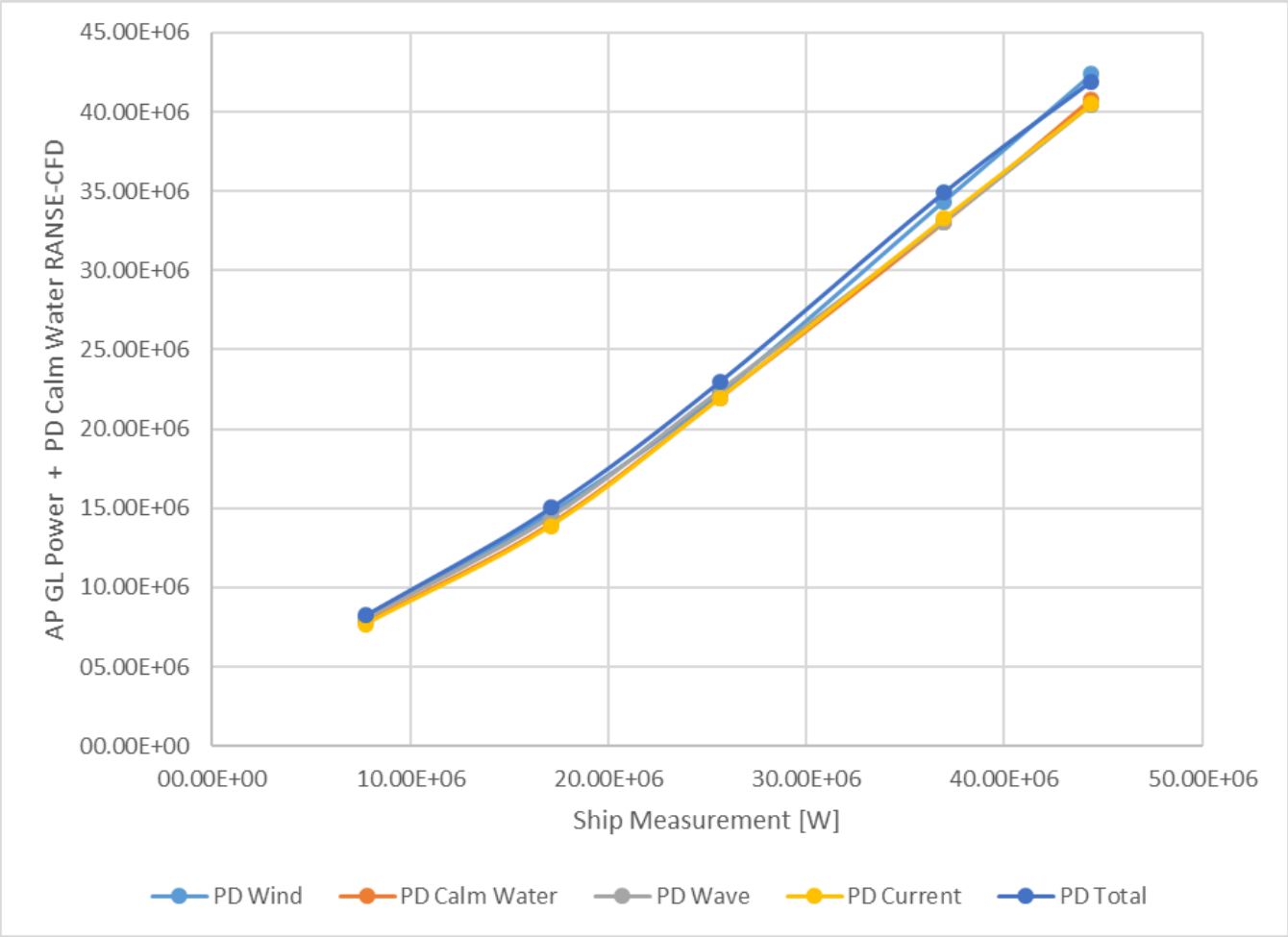


Speed [knots]	
min	13
13	16
16	19
19	22
22	Max

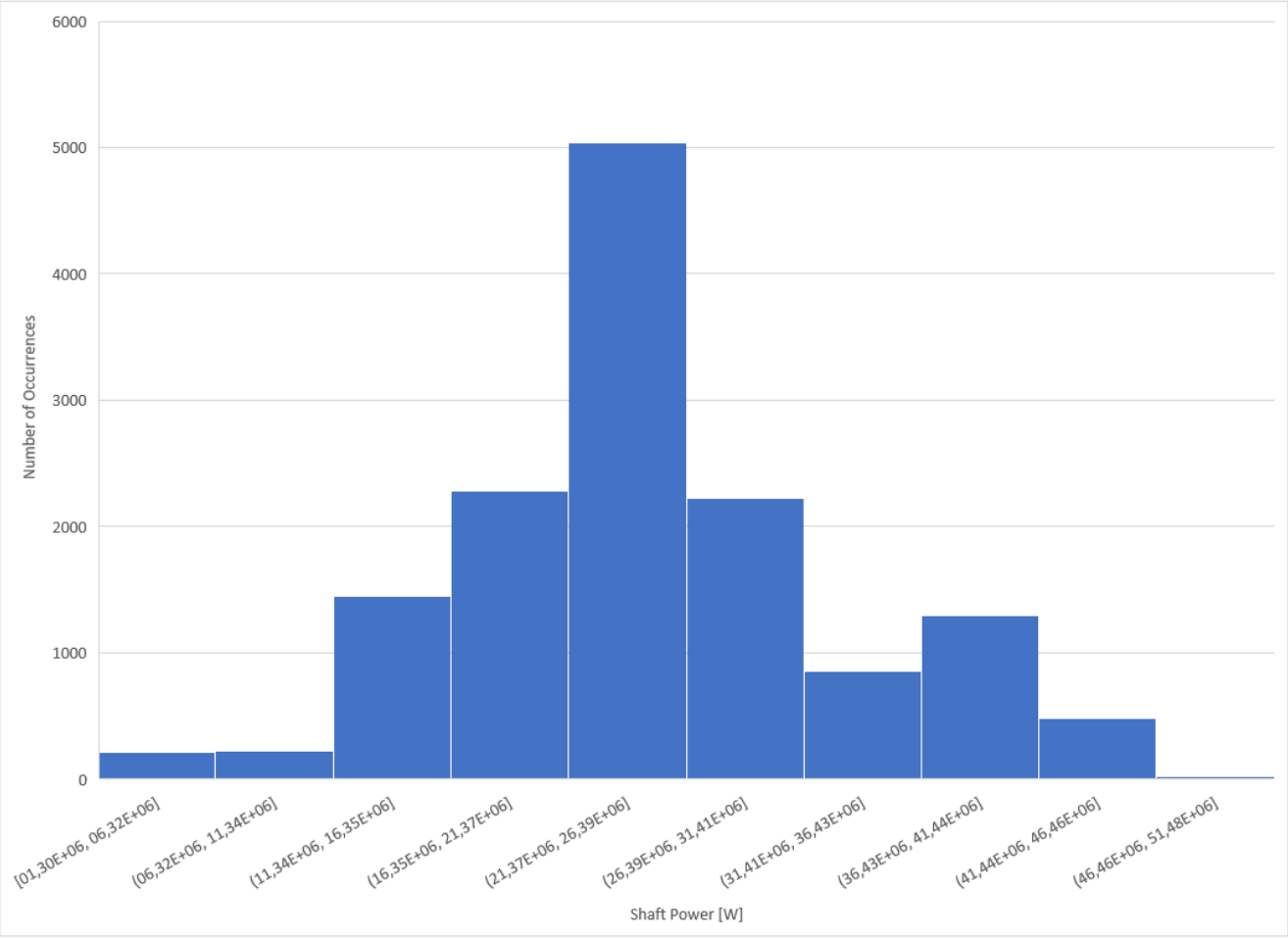
Average – Ship Speed Range

Range		Average per range				
Speed [Knots]		PD Calm Water (Case 1)	PD Wind (Case 2)	PD Wave (Case 3)	PD Current (Case 4)	PD Total Measured
min	13	06,50E+06	07,15E+06	06,66E+06	06,68E+06	07,62E+06
13	16	10,18E+06	10,34E+06	10,75E+06	10,28E+06	14,40E+06
16	19	15,21E+06	15,76E+06	15,48E+06	15,27E+06	19,54E+06
19	22	23,75E+06	24,17E+06	24,17E+06	23,71E+06	27,03E+06
22	max	37,80E+06	39,60E+06	37,71E+06	37,52E+06	39,64E+06

Average – Shaft Power Range



Shaft Power Histogram



Shaft Power [kW]	
min	11.337
11.337	21.372
21.372	31.408
31.408	41.443
41.443	Max

Average – Shaft Power Range

Range		Average per range				
Shaft Power [kW]		PD Calm Water (Case 1)	PD Wind (Case 2)	PD Wave (Case 3)	PD Current (Case 4)	PD Total Measured
min	11.337	07,82E+06	08,14E+06	08,02E+06	07,69E+06	07,75E+06
11.337	21.372	14,03E+06	14,71E+06	14,41E+06	13,89E+06	17,10E+06
21.372	31.408	21,98E+06	22,29E+06	22,40E+06	21,95E+06	25,63E+06
31.408	41.443	33,02E+06	34,37E+06	33,06E+06	33,26E+06	36,93E+06
41.443	max	40,79E+06	42,38E+06	40,45E+06	40,48E+06	44,39E+06

Conclusions

Relative Percentage Results

Range		Average per range			
Speed [Knots]		PD Calm Water (Case 1)	PD Wind (Case 2)	PD Wave (Case 3)	PD Current (Case 4)
19	22	-12,1%	-10,6%	-10,6%	-12,3%

Shaft Power [kW]		PD Calm Water (Case 1)	PD Wind (Case 2)	PD Wave (Case 3)	PD Current (Case 4)
21.372	31.408	-14,3%	-13,0%	-12,6%	-14,4%

- Wind & wave have the bigger influence on added power
- Waves has bigger influence than wind in some conditions
- Influence difference of each parameter are not so big