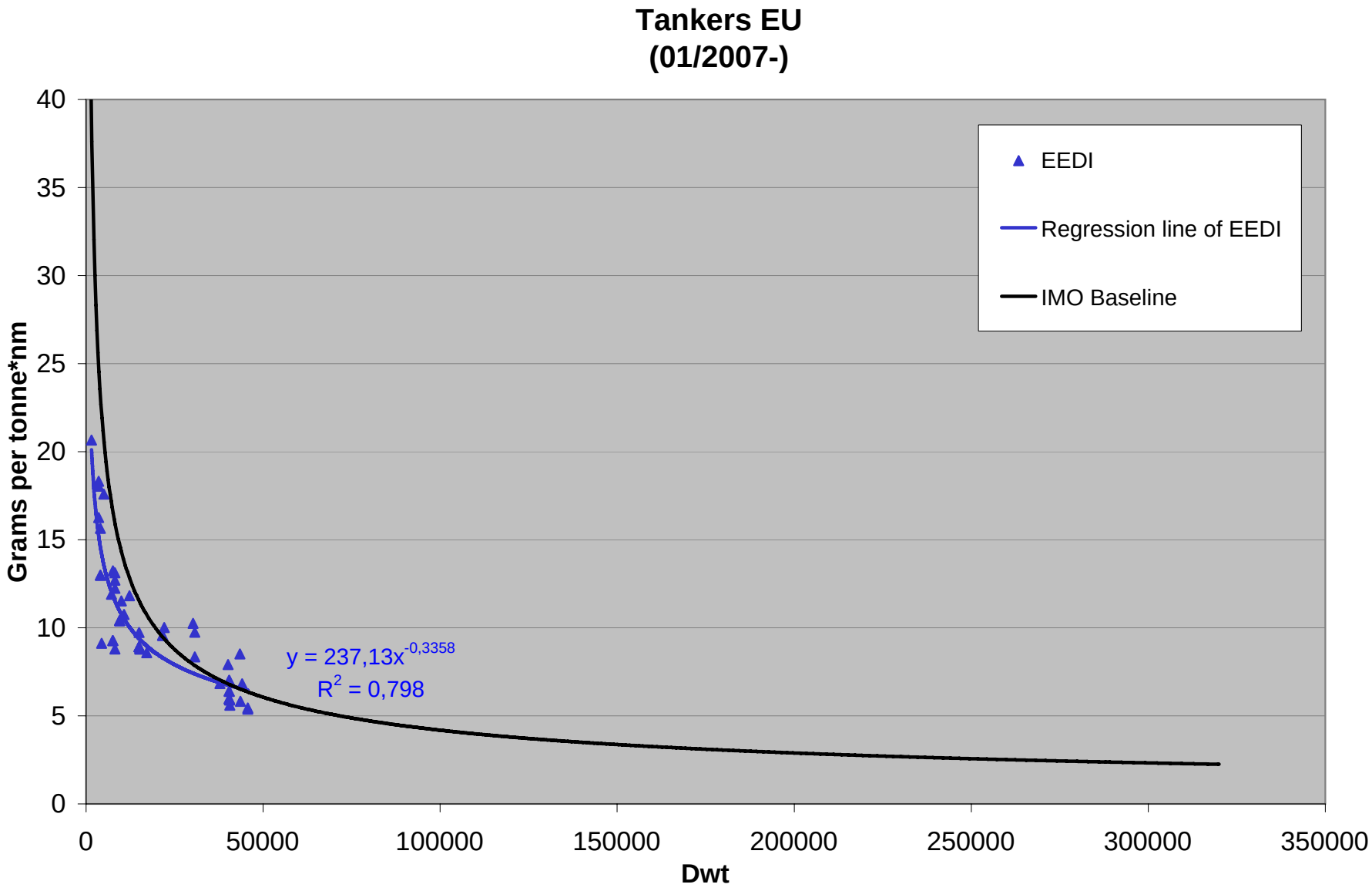
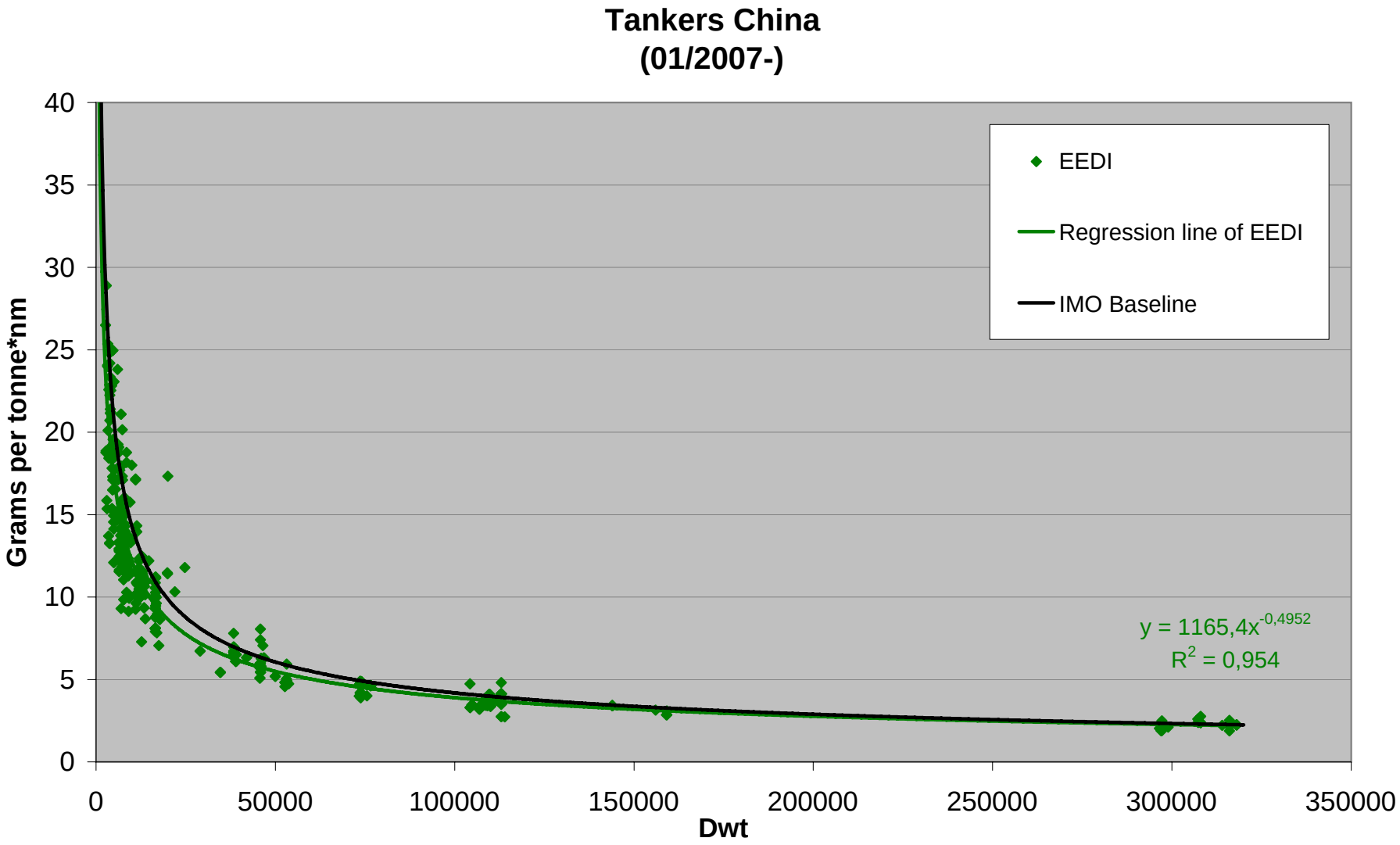
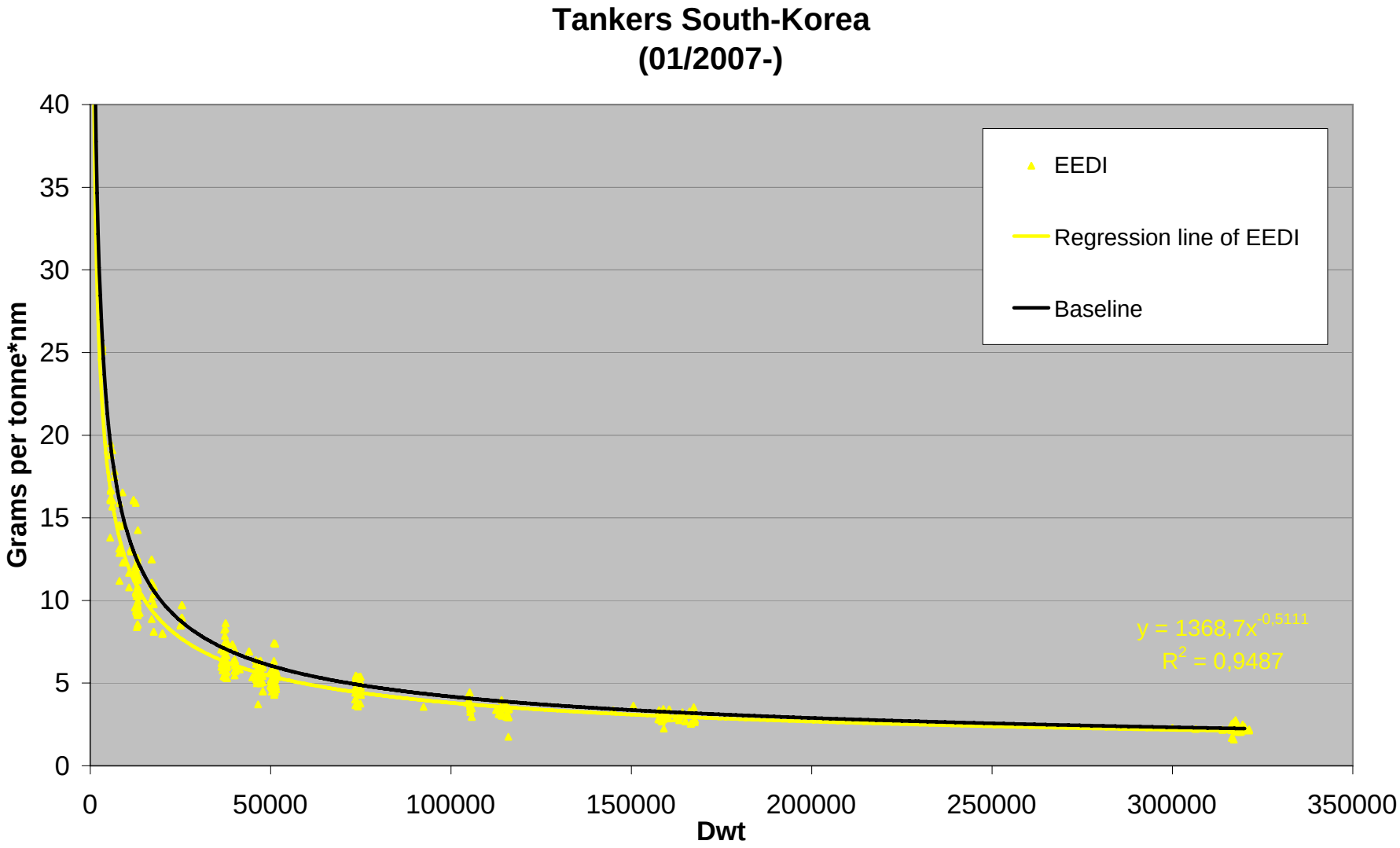
APPENDIX 1

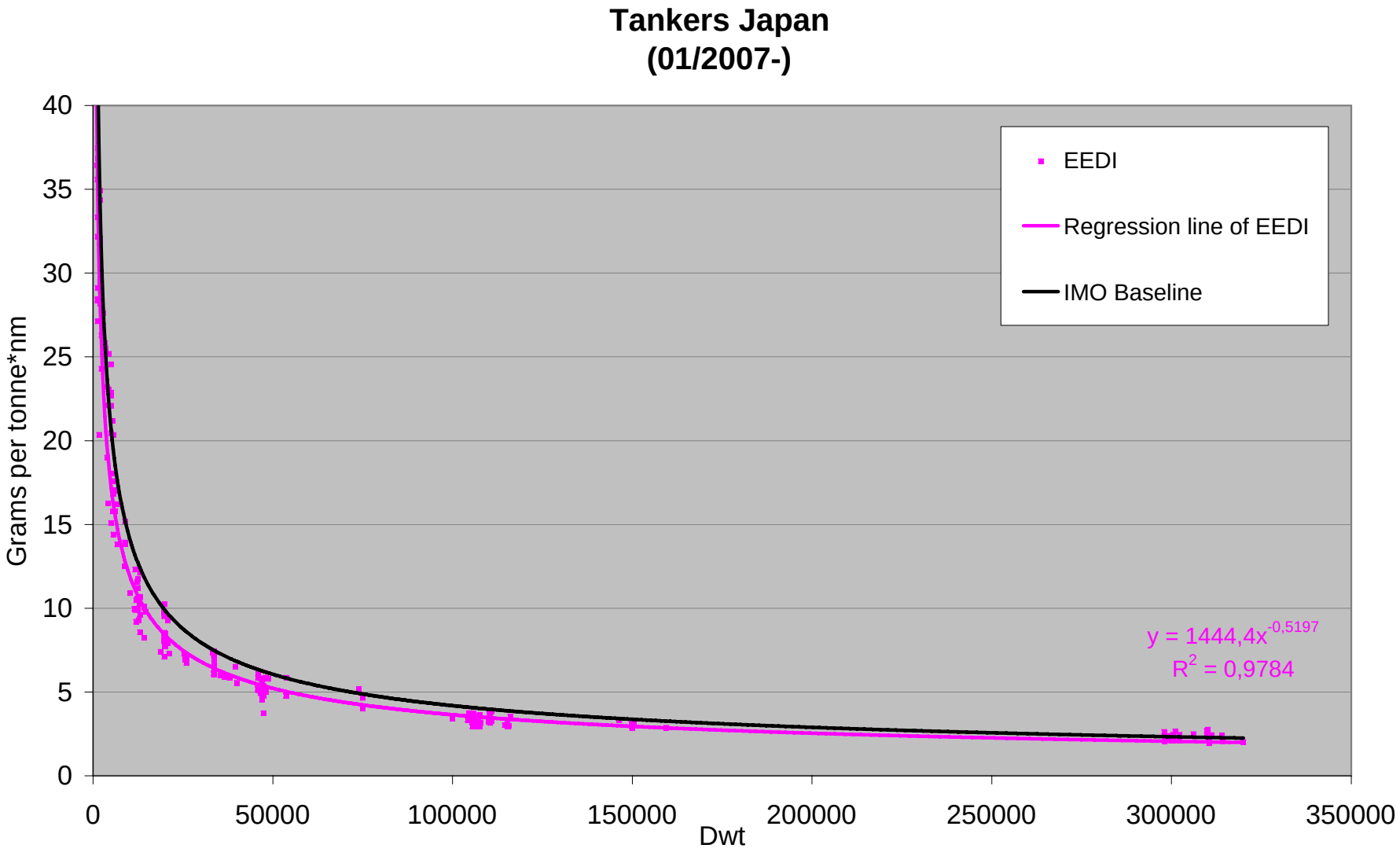
RESULTS OF EEDI CALCULATIONS FOR TANKERS

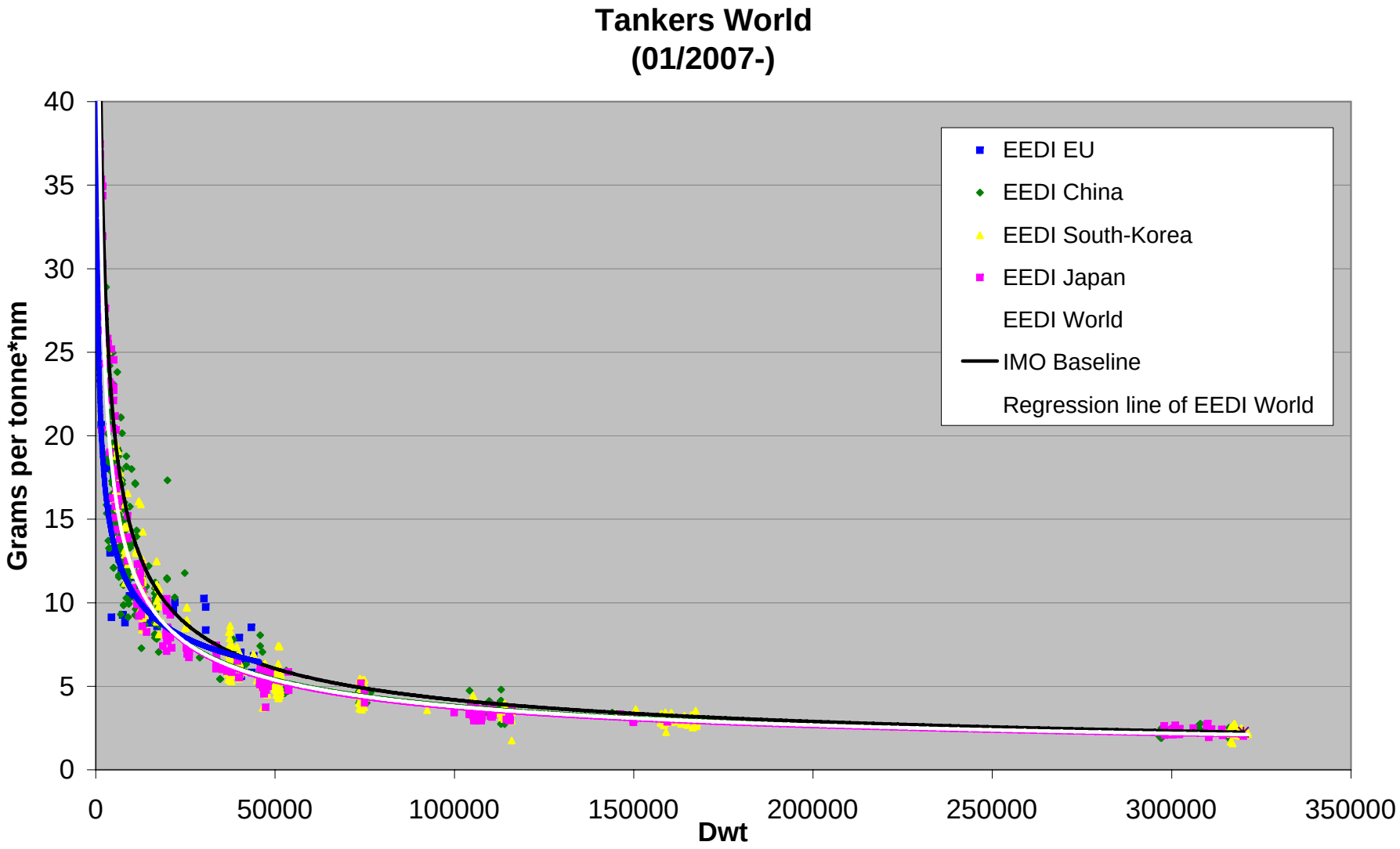
Tankers		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	53	445	826	401	1725
Avg. DWT	(t)	20783,98	57779,20	74099,74	66675,50	66525,54
Avg. ME MCR power	(kW)	5968,34	7826,42	10048,46	8785,33	9056,25
Avg. speed	(kn)	14,31	13,59	14,75	14,58	14,40
Avg. EEDI	(g/t*nm)	**9,99**	**9,986**	**6,56**	**8,848**	**8,08**
Avg. deviation from baseline		**-3,06**	**-1,55**	**-0,79**	**-1,60**	**-1,24**

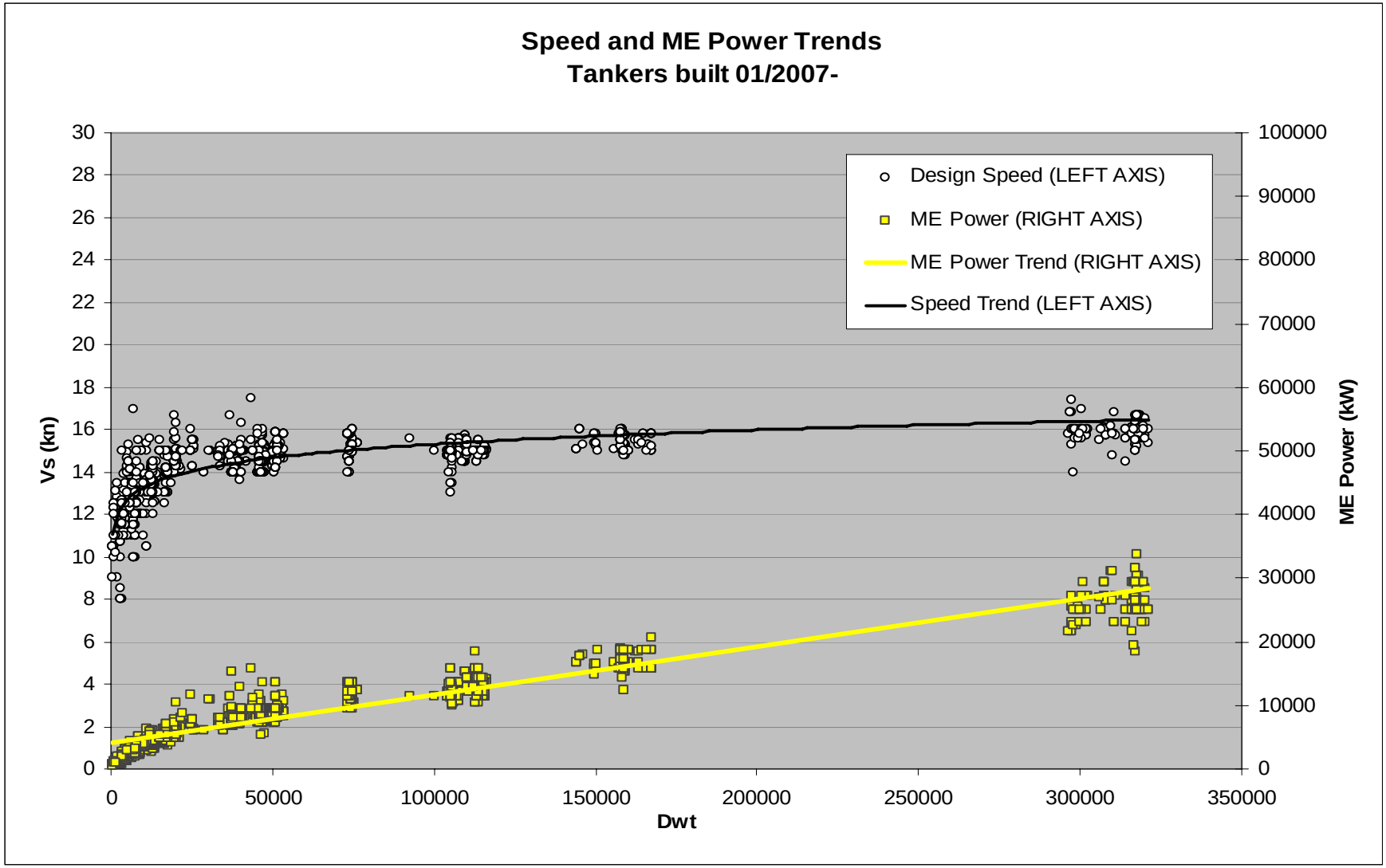

Tankers EU
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 237,13x-0,3358
R2 = 0,798
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000


Tankers China
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 1165,4x-0,4952
R2 = 0,954
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000


Tankers South-Korea
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
Baseline
y = 1368,7x-0,5111
R2 = 0,9487
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000


Tankers Japan
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 1444,4x-0,5197
R2 = 0,9784
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000

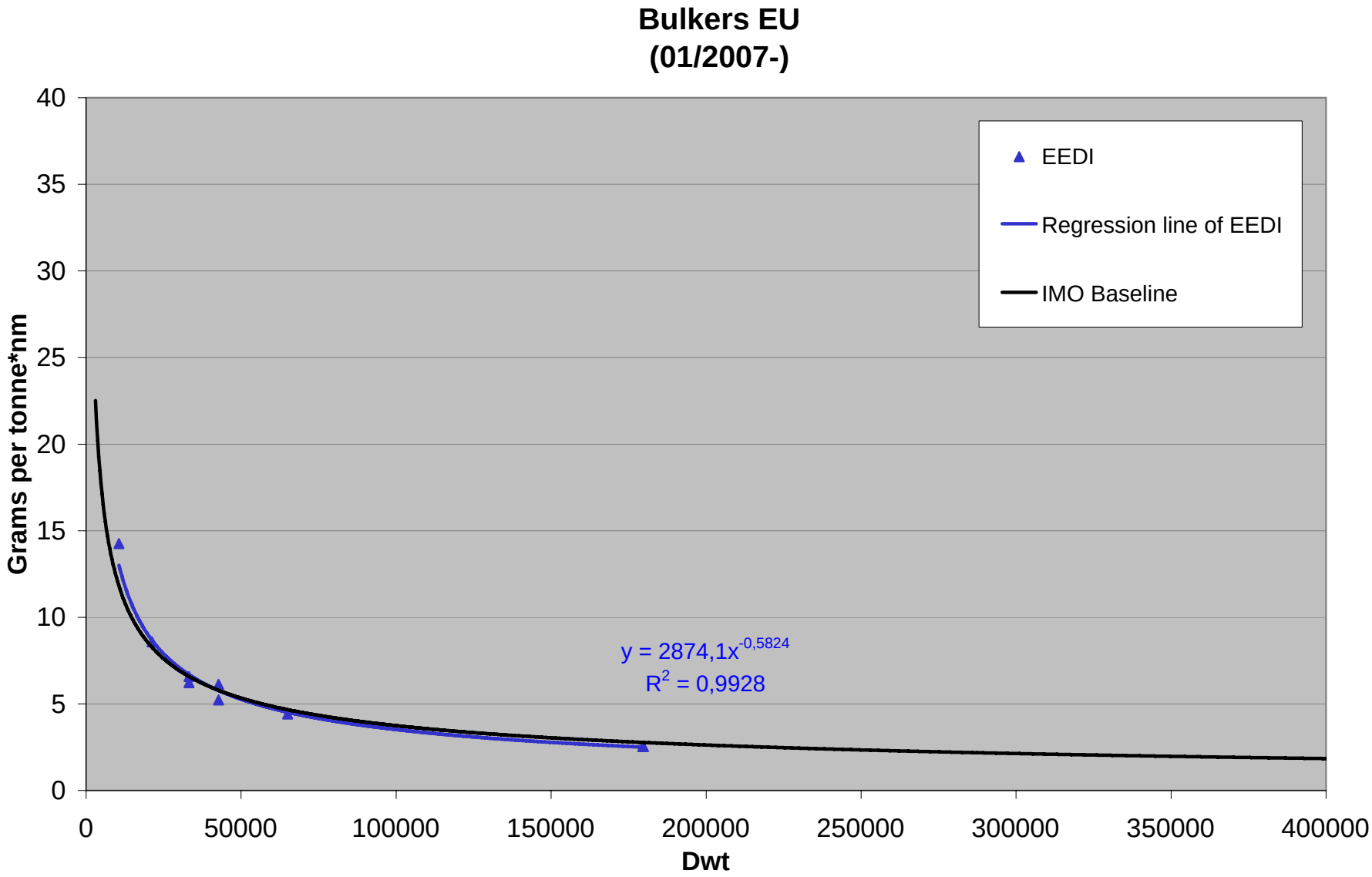

Tankers World
(01/2007-)
Grams per tonne*nm
40
35
30
25
20
15
10
5
0
0
50000
100000
150000
200000
250000
300000
350000
Dwt
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
EEDI World
IMO Baseline
Regression line of EEDI World

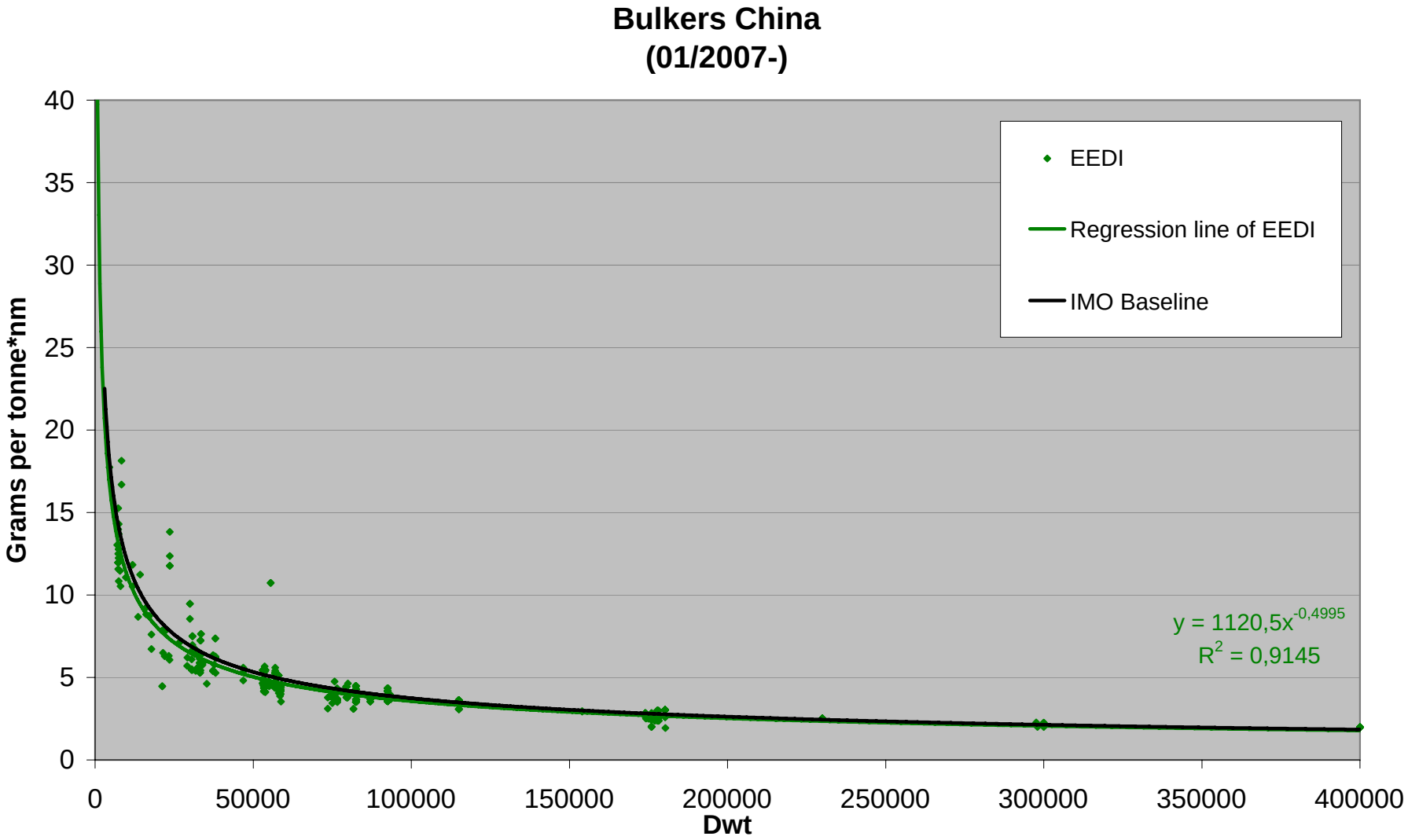

Speed and ME Power Trends
Tankers built 01/2007-
Design Speed (LEFT AXIS)
ME Power (RIGHT AXIS)
ME Power Trend (RIGHT AXIS)
Speed Trend (LEFT AXIS)
Vs (kn)
ME Power (kW)
Dwt
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
0
50000
100000
150000
200000
250000
300000
350000

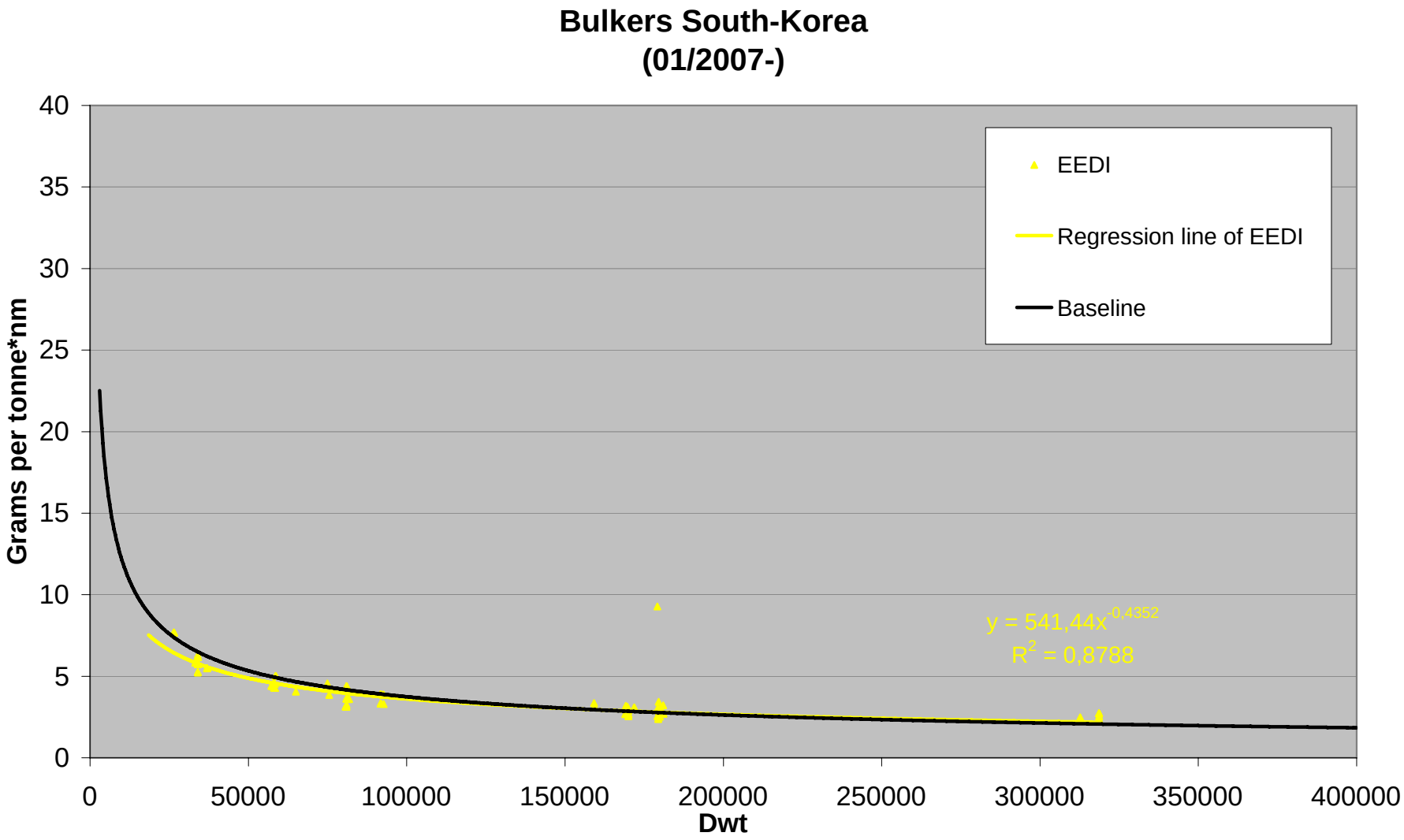
APPENDIX 2

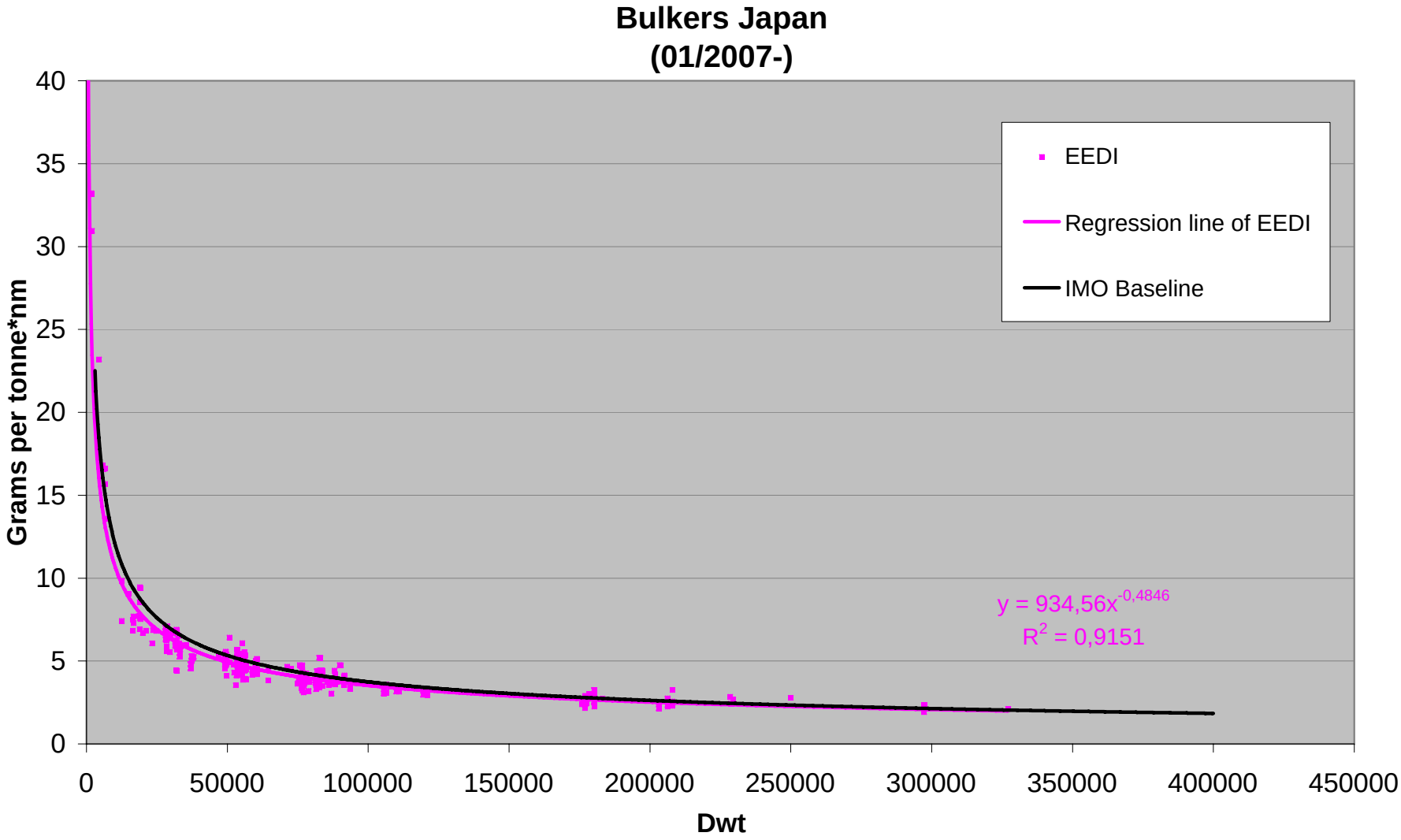
RESULTS OF EEDI CALCULATIONS FOR BULKERS

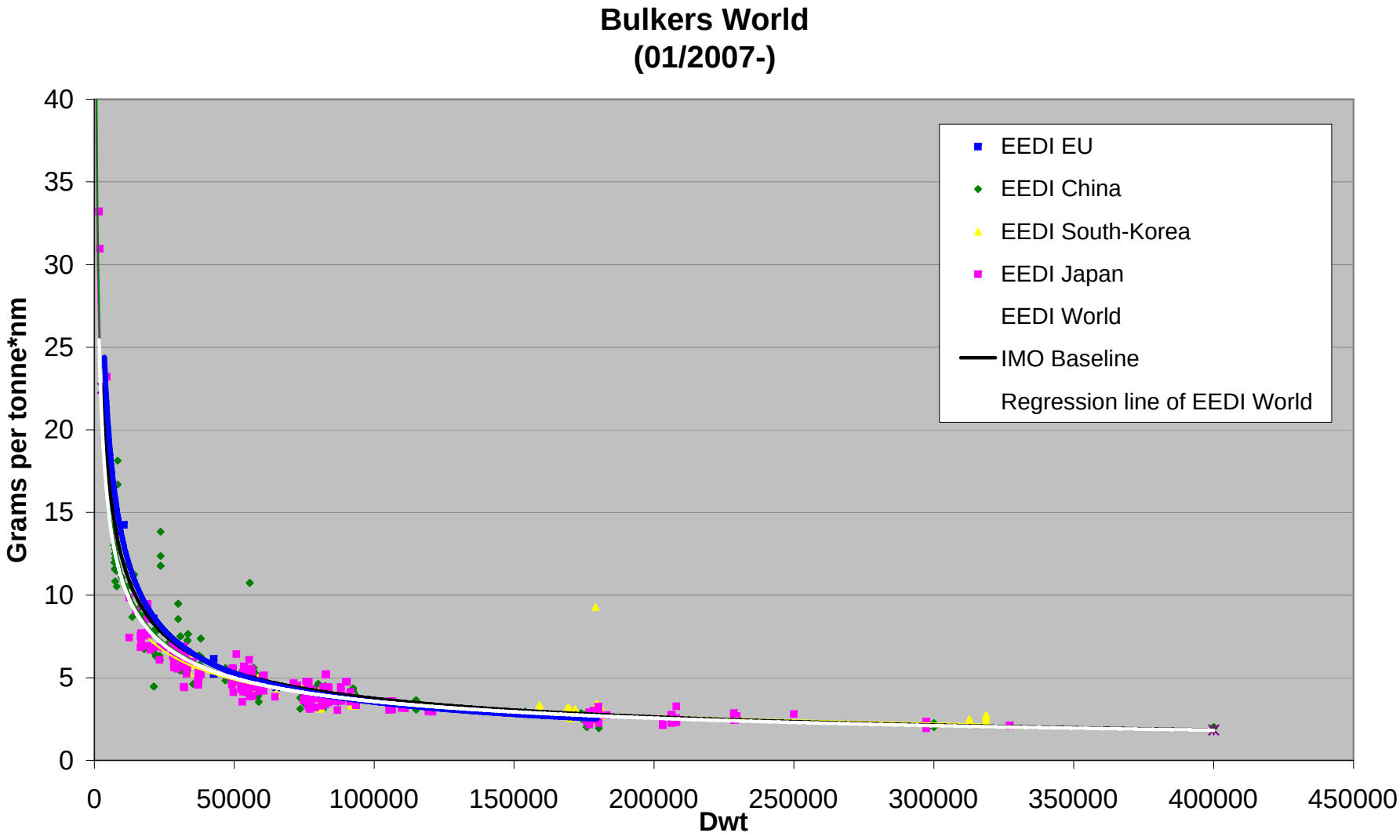
Bulk Carriers		**Europe**	**China**	**S-Korea**	**Japan**	**World**
Sample size	(pcs)	13	745	278	748	1784
Avg. DWT	(t)	102058,69	88721,80	127672,76	79872,82	91178,47
Avg. ME MCR power	(kW)	11210,69	10216,18	13256,49	9694,49	10478,46
Avg. speed	(kn)	14,80	14,20	14,52	14,45	14,36
Avg. EEDI	(g/t*nm)	**5,12**	**4,645**	**3,76**	**4,713**	**4,54**
Avg. deviation from baseline		**0,04**	**-0,23**	**-0,17**	**-0,33**	**-0,26**

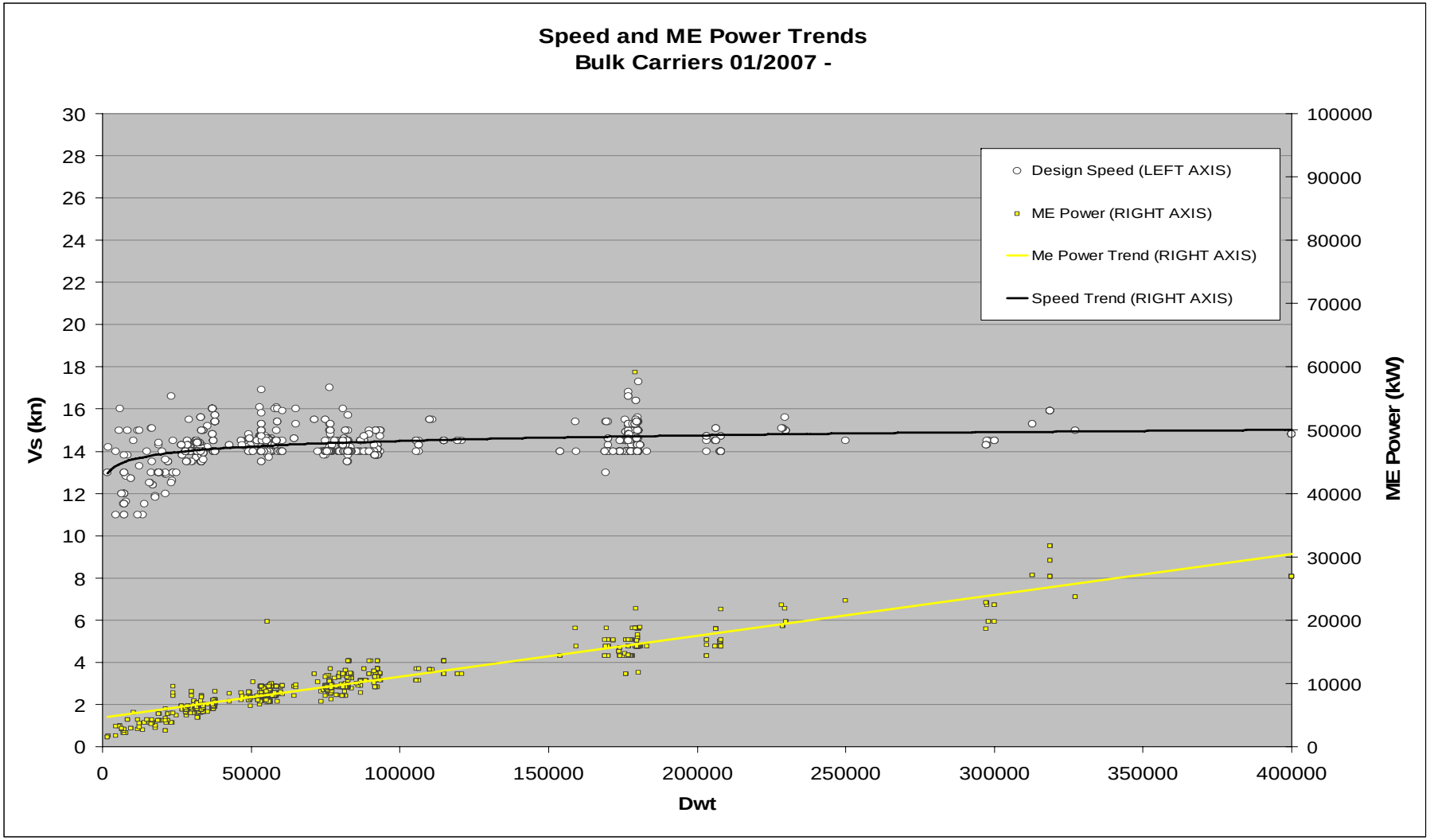

Bulkers EU
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 2874,1x-0,5824
R2 = 0,9928
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000
400000


Bulkers China
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 1120,5x^-0,4995
R^2 = 0,9145
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000
400000


Bulkers South-Korea
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
Baseline
y = 541,44x^-0,4352
R^2 = 0,8788
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000
400000


Bulkers Japan
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 934,56x-0,4846
R2 = 0,9151
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000
400000
450000

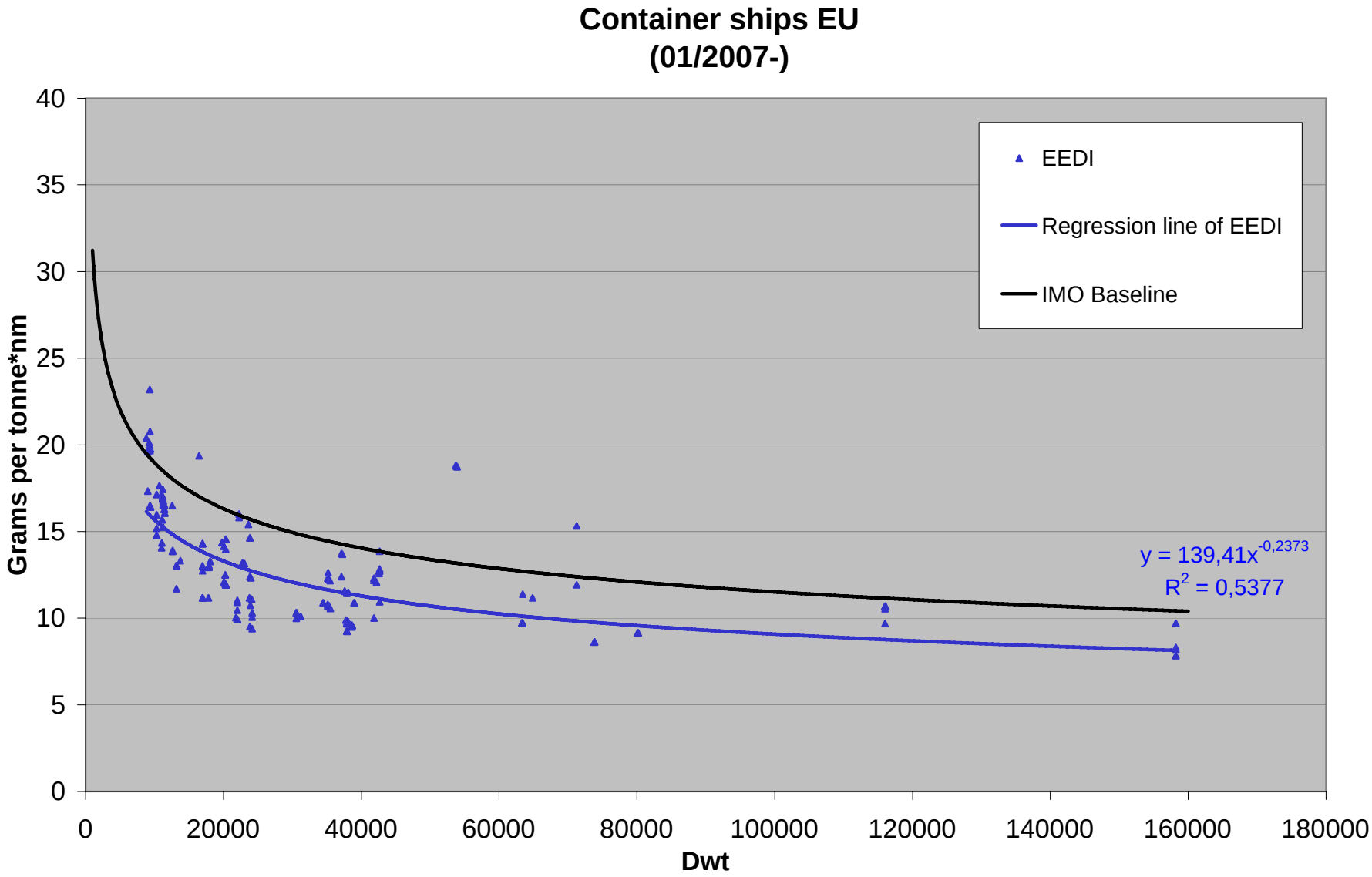

Bulkers World
(01/2007-)
Grams per tonne*nm
Dwt
0
5
10
15
20
25
30
35
40
0
50000
100000
150000
200000
250000
300000
350000
400000
450000
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
EEDI World
IMO Baseline
Regression line of EEDI World

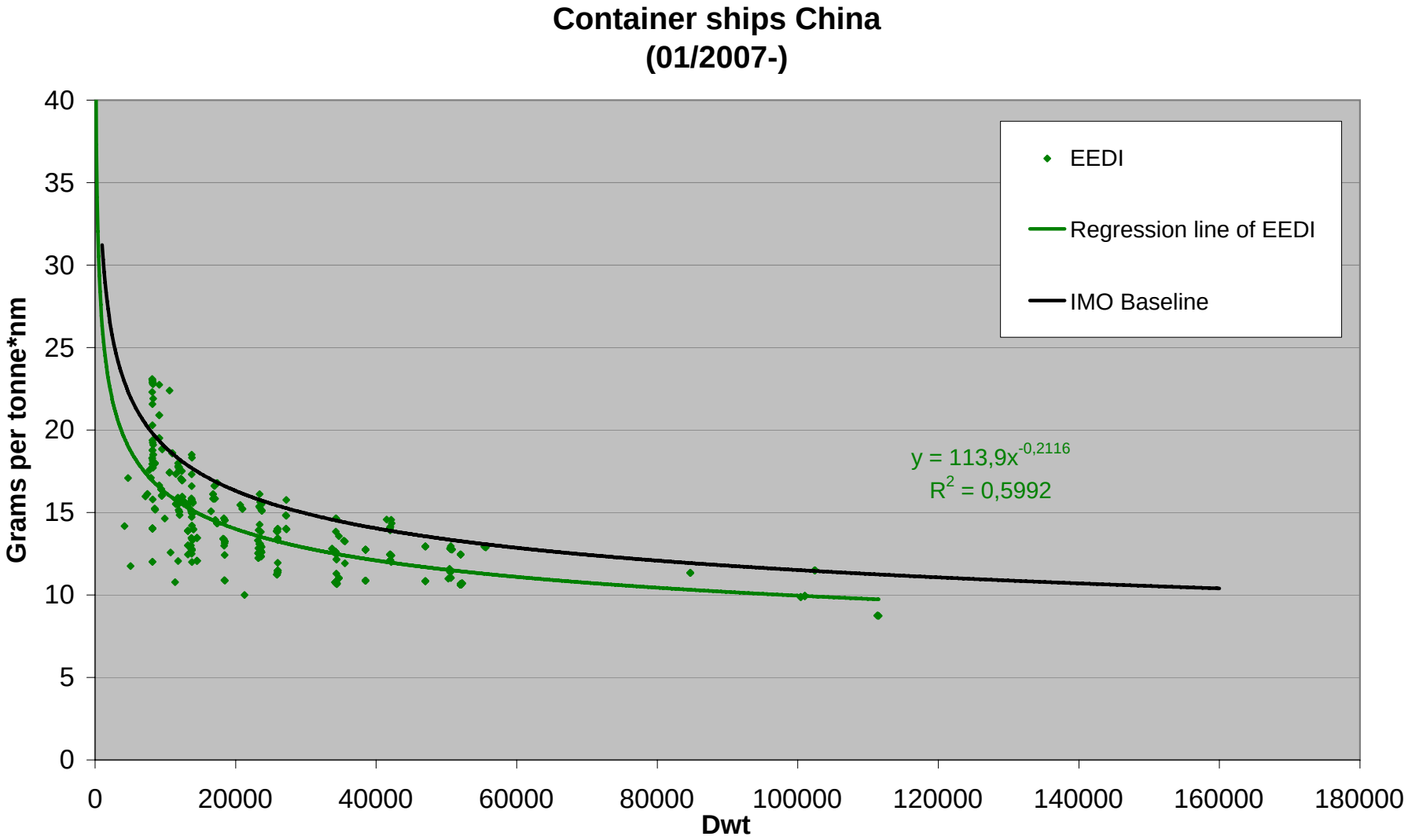

Speed and ME Power Trends
Bulk Carriers 01/2007 -
Vs (kn)
ME Power (kW)
Dwt
Design Speed (LEFT AXIS)
ME Power (RIGHT AXIS)
Me Power Trend (RIGHT AXIS)
Speed Trend (RIGHT AXIS)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
0
50000
100000
150000
200000
250000
300000
350000
400000

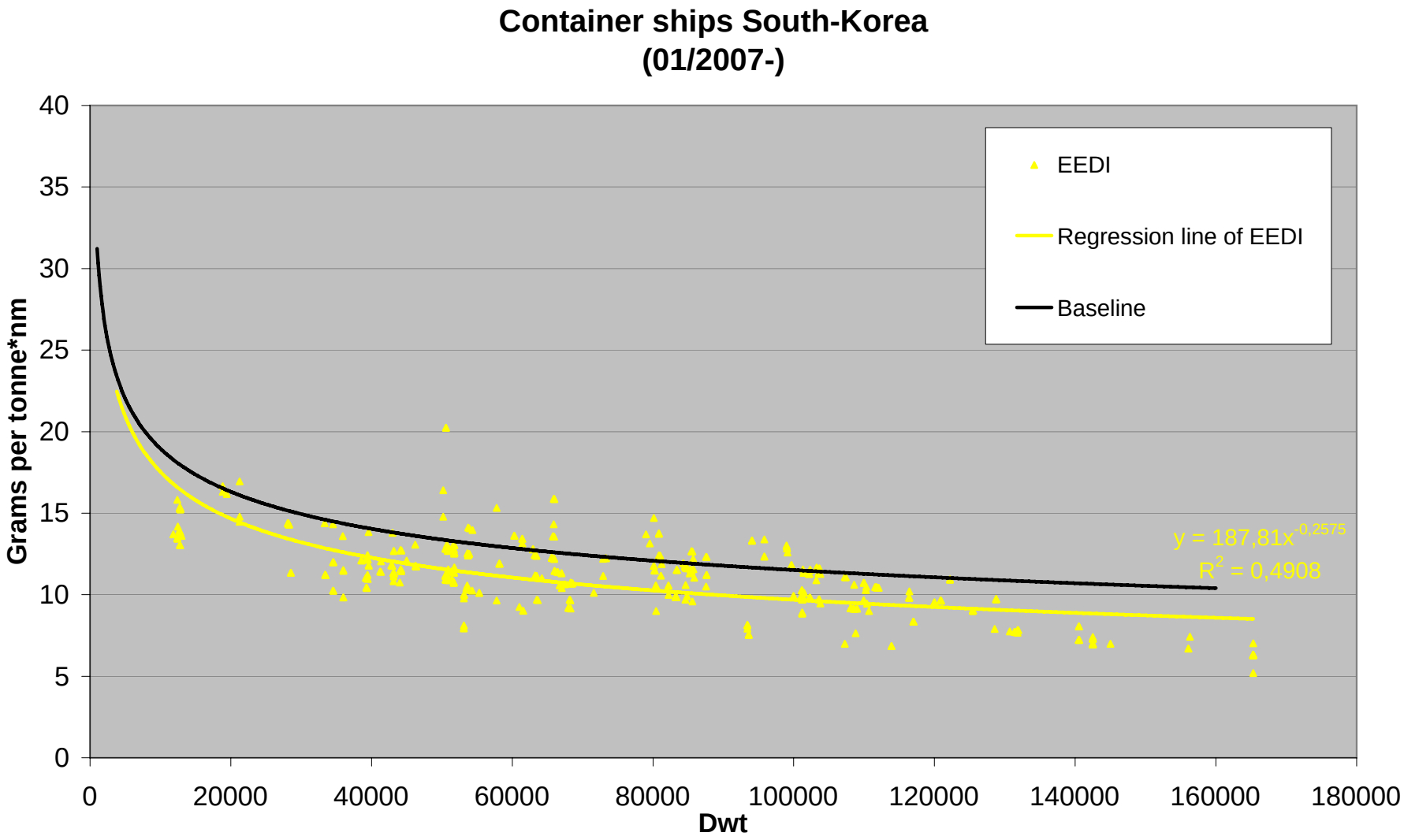
APPENDIX 3

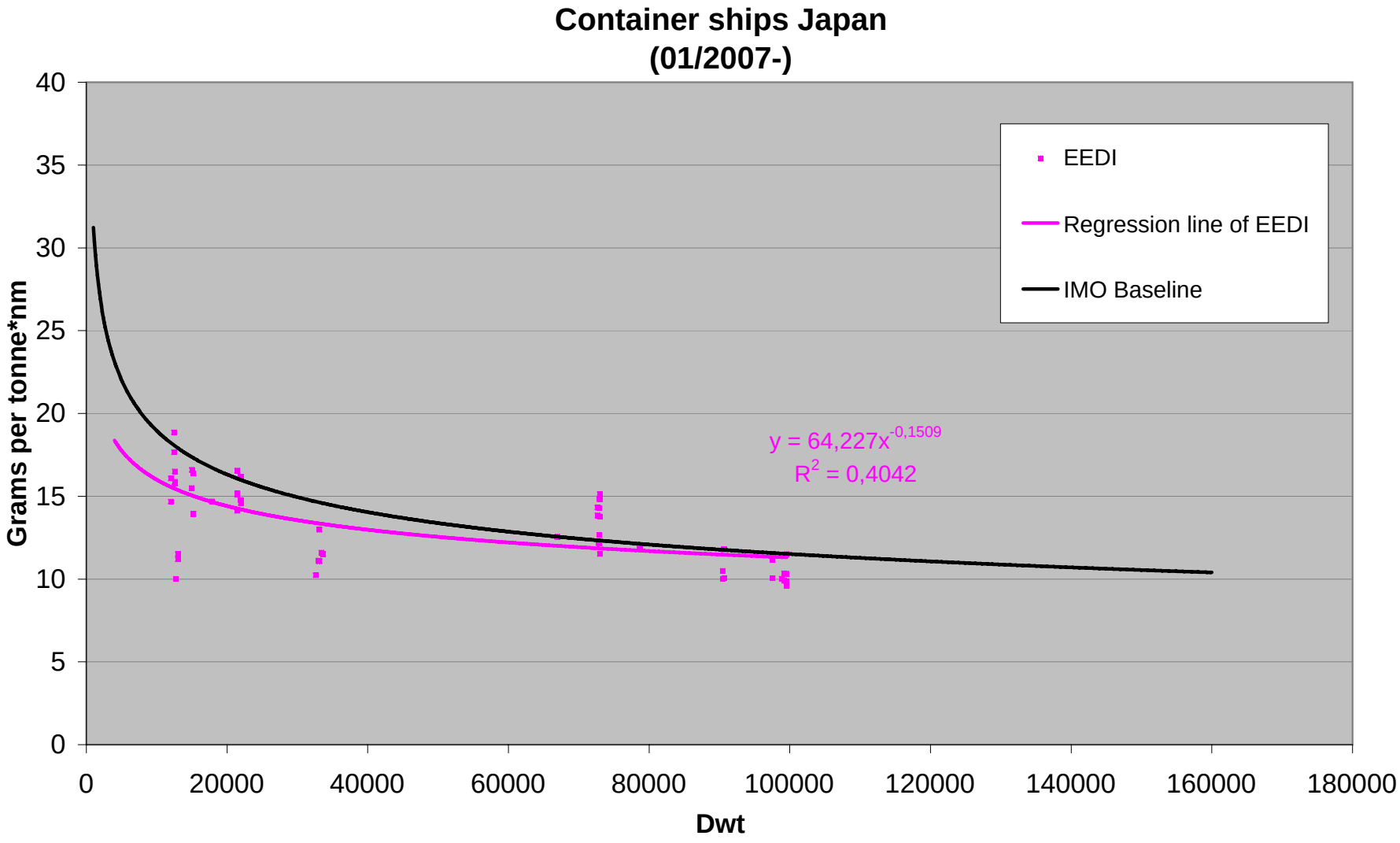
RESULTS OF EEDI CALCULATIONS FOR CONTAINER SHIPS

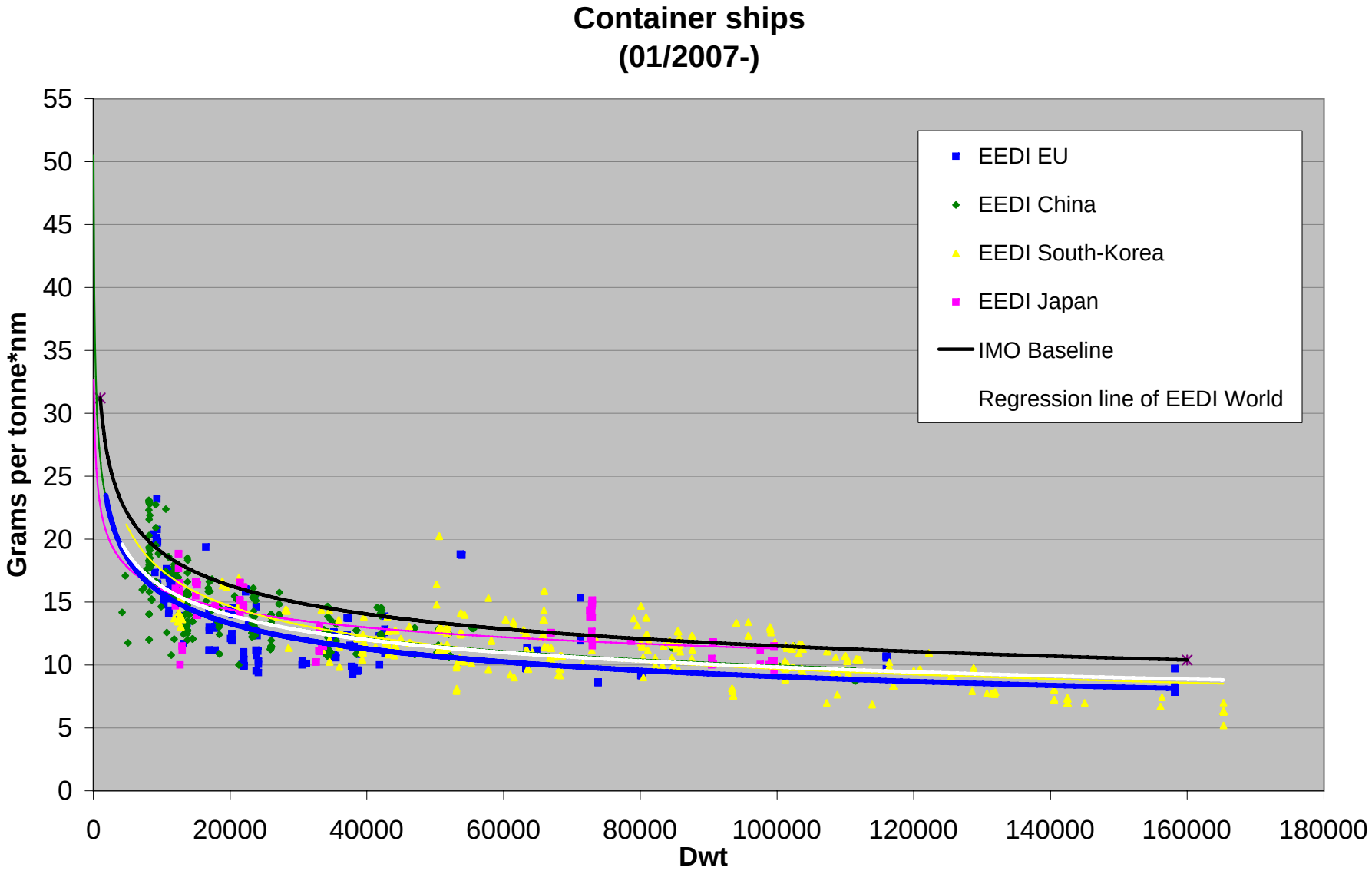
Container Ships		**Europe**	**China**	**S-Korea**	**Japan**	**World**
Sample size	(pcs)	212	479	590	119	1400
Avg. DWT	(t)	35068,17	29637,30	78061,16	51677,45	52740,30
Avg. ME MCR power	(kW)	20284,25	18713,98	44922,18	35011,04	31381,90
Avg. speed	(kn)	20,91	20,53	24,01	22,55	22,22
Avg. EEDI	(g/t*nm)	**12,79**	**13,816**	**10,94**	**13,162**	**12,39**
Avg. deviation from baseline		**-2,75**	**-2,15**	**-1,68**	**-1,03**	**-1,95**

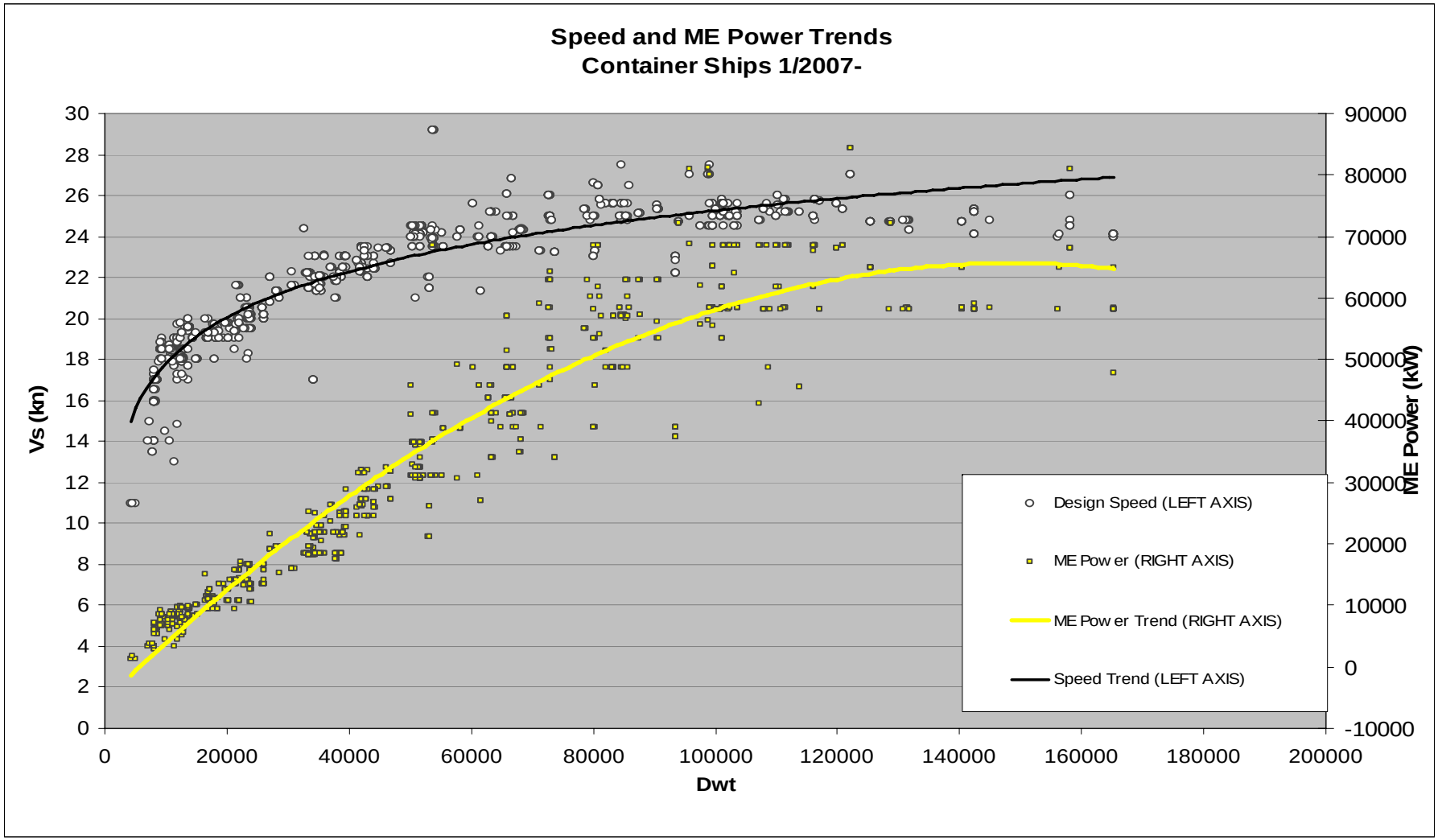

Container ships EU
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 139,41x-0,2373
R2 = 0,5377
0
5
10
15
20
25
30
35
40
0
20000
40000
60000
80000
100000
120000
140000
160000
180000


Container ships China
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 113,9x-0,2116
R2 = 0,5992
0
5
10
15
20
25
30
35
40
0
20000
40000
60000
80000
100000
120000
140000
160000
180000


Container ships South-Korea
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
Baseline
y = 187,81x-0,2575
R2 = 0,4908
0
5
10
15
20
25
30
35
40
0
20000
40000
60000
80000
100000
120000
140000
160000
180000


Container ships Japan
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 64,227x-0,1509
R2 = 0,4042
0
5
10
15
20
25
30
35
40
0
20000
40000
60000
80000
100000
120000
140000
160000
180000

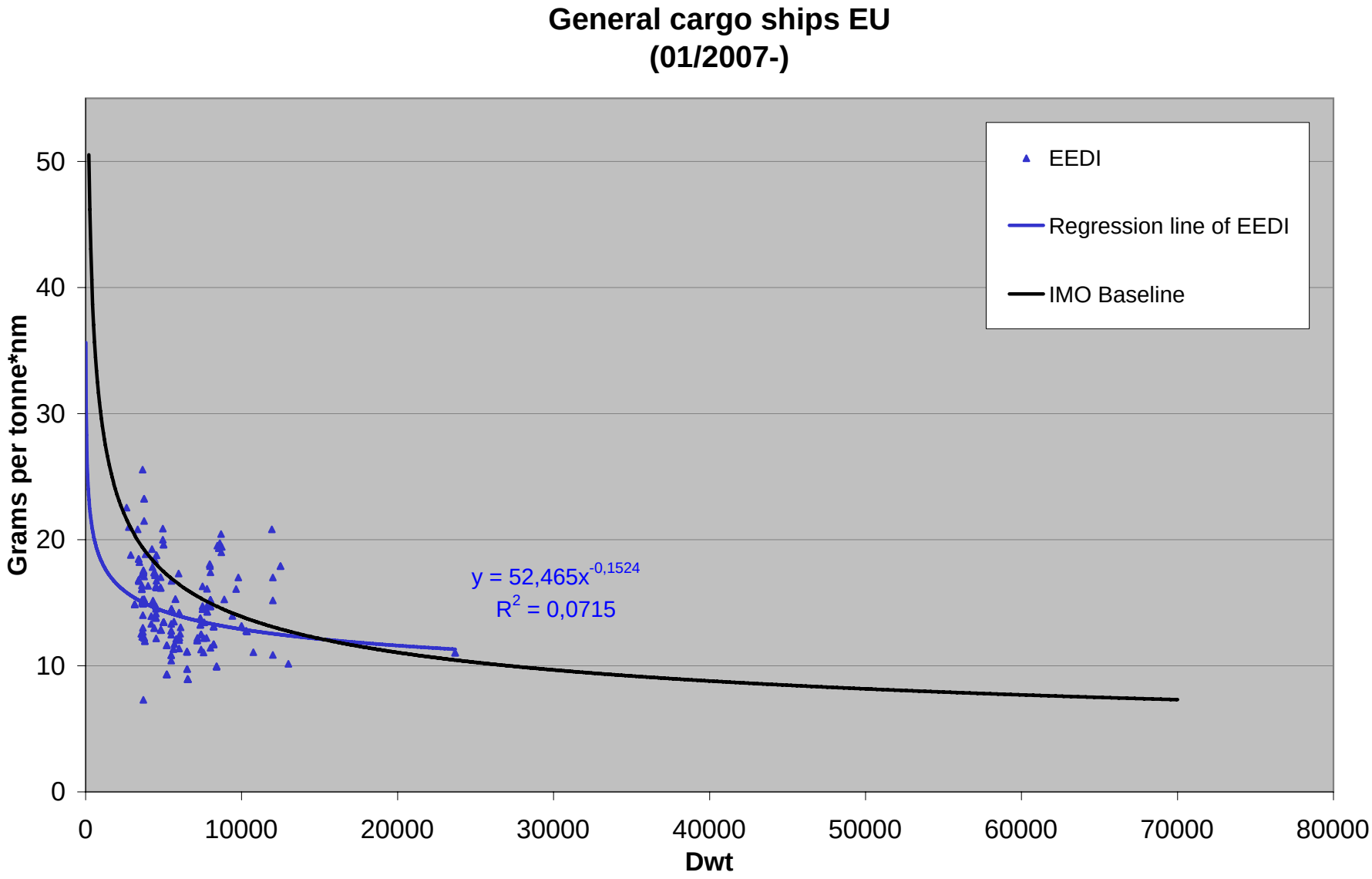

Container ships
(01/2007-)
Grams per tonne*nm
55
50
45
40
35
30
25
20
15
10
5
0
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
Dwt
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
IMO Baseline
Regression line of EEDI World

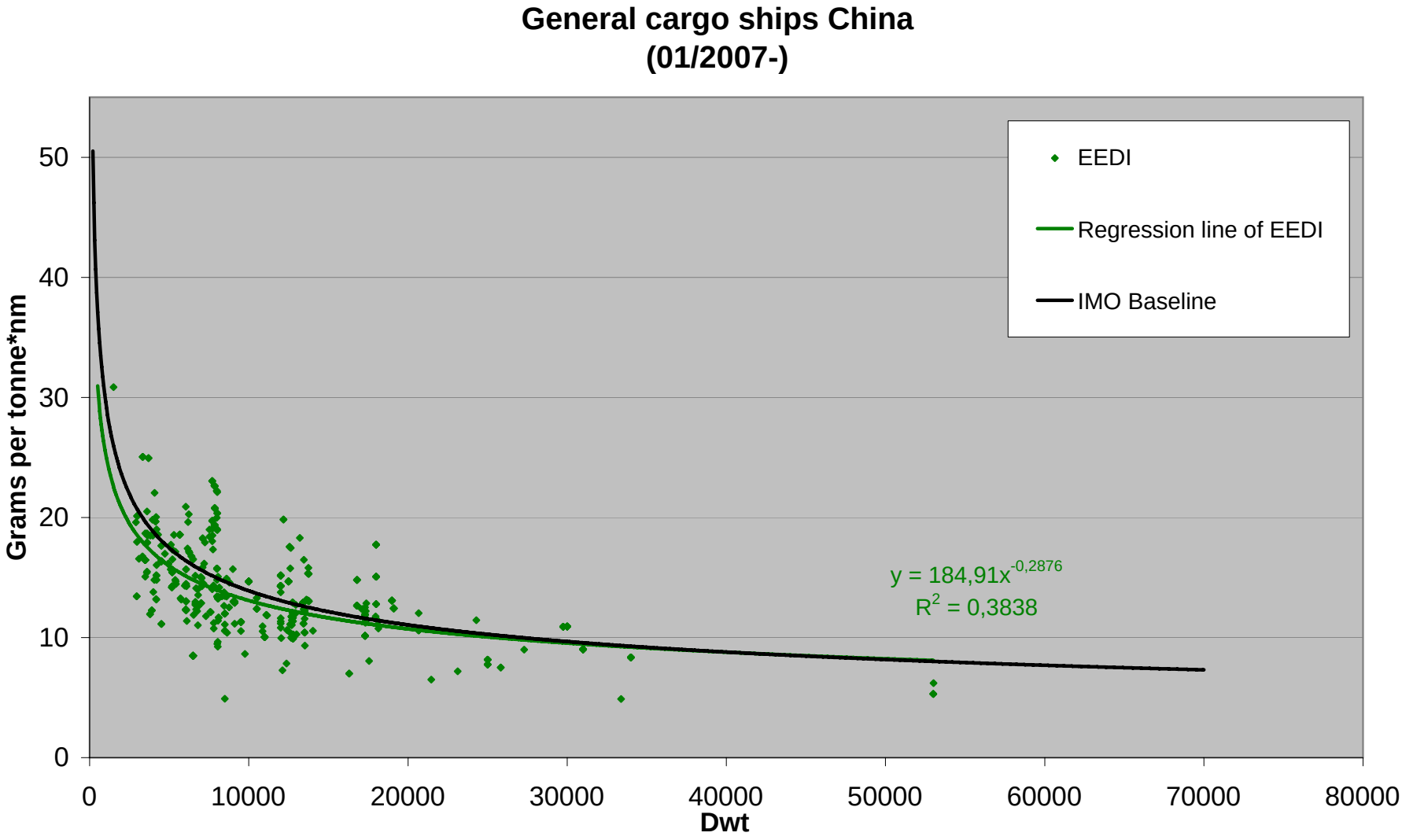

Speed and ME Power Trends
Container Ships 1/2007-
Vs (kn)
ME Power (kW)
Dwt
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
-10000
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
200000
Design Speed (LEFT AXIS)
ME Power (RIGHT AXIS)
ME Power Trend (RIGHT AXIS)
Speed Trend (LEFT AXIS)

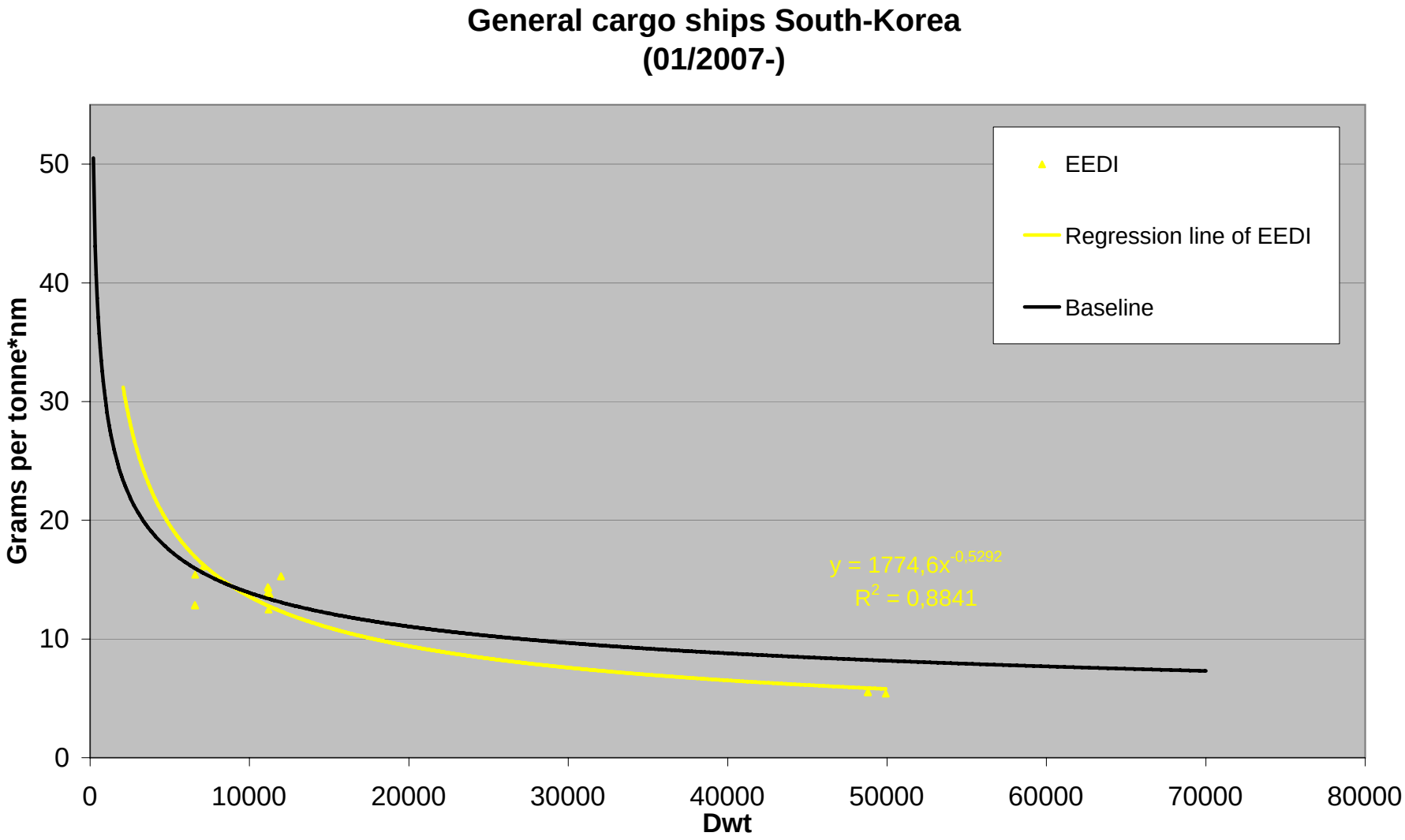
APPENDIX 4

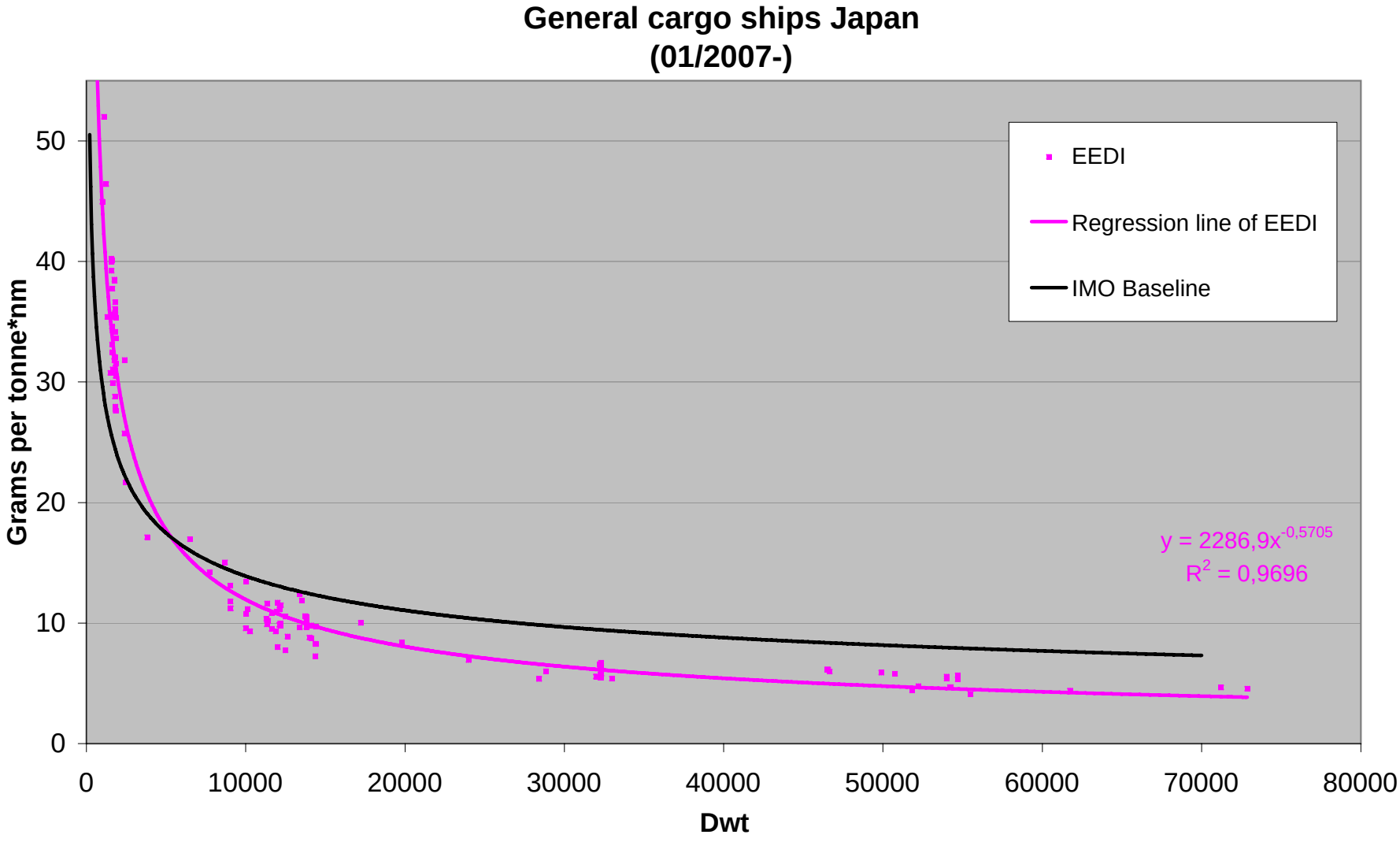
RESULTS OF EEDI CALCULATIONS FOR GENERAL CARGO SHIPS

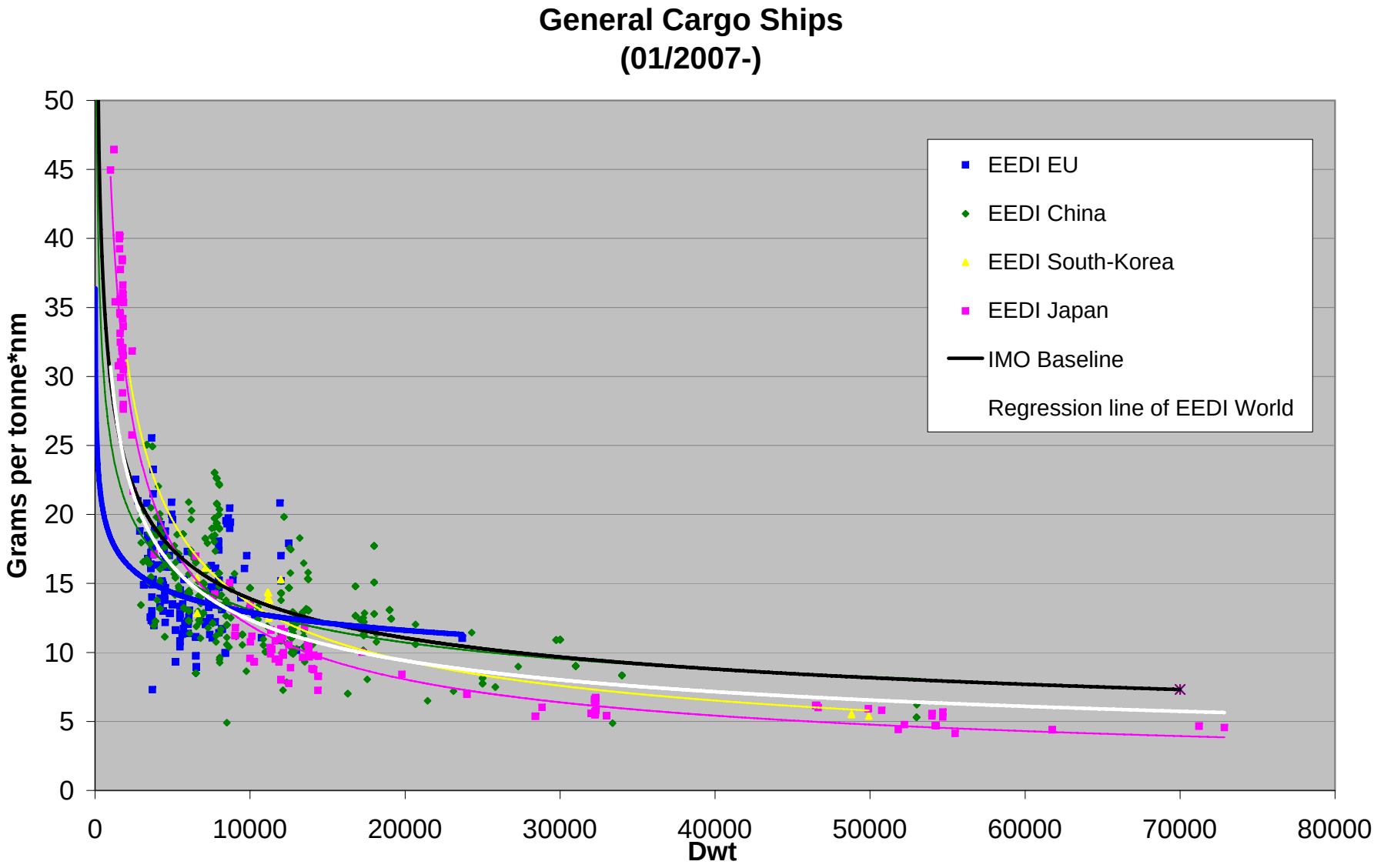
General Cargo Ships		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	249	553	16	147	965
Avg. DWT	(t)	5939,58	11811,37	19640,25	18191,87	11398,02
Avg. ME MCR power	(kW)	2661,46	4843,97	6104,00	4244,37	4210,37
Avg. speed	(kn)	12,98	14,22	15,56	13,61	13,83
Avg. EEDI	(g/t*nm)	**14,43**	**13,588**	**12,06**	**16,253**	**14,19**
Avg. deviation from baseline		**-2,60**	**-0,59**	**-0,62**	**0,83**	**-0,89**

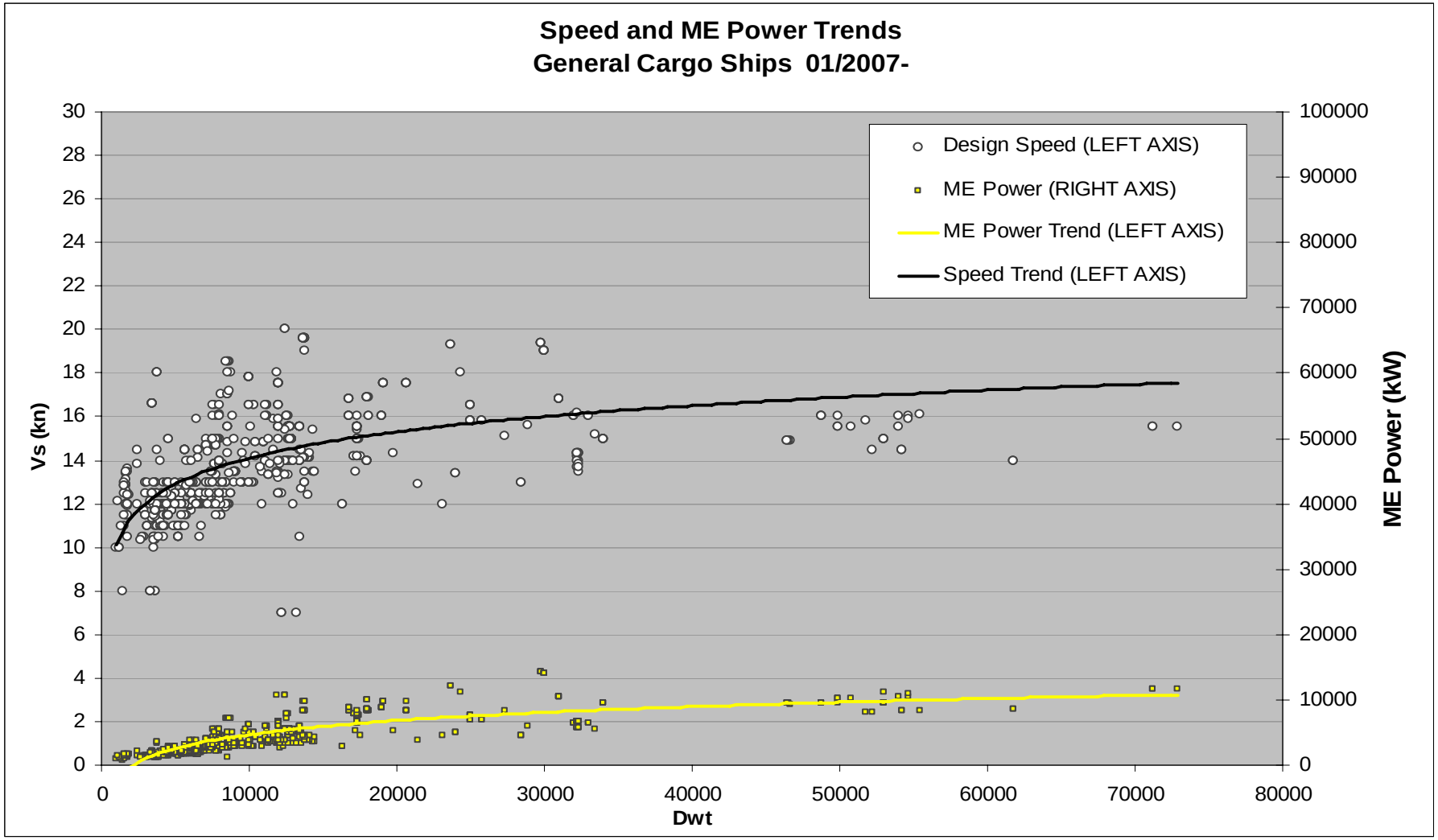

General cargo ships EU
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 52,465x-0,1524
R2 = 0,0715
0
10
20
30
40
50
0
10000
20000
30000
40000
50000
60000
70000
80000


General cargo ships China
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 184,91x-0,2876
R2 = 0,3838
0
10
20
30
40
50
0
10000
20000
30000
40000
50000
60000
70000
80000


General cargo ships South-Korea
(01/2007-)
Grams per tonne*nm
50
40
30
20
10
0
0
10000
20000
30000
40000
50000
60000
70000
80000
Dwt
EEDI
Regression line of EEDI
Baseline
y = 1774,6x-0,5292
R2 = 0,8841


General cargo ships Japan
(01/2007-)
Grams per tonne*nm
Dwt
0
10
20
30
40
50
0
10000
20000
30000
40000
50000
60000
70000
80000
EEDI
Regression line of EEDI
IMO Baseline
y = 2286,9x-0,5705
R2 = 0,9696

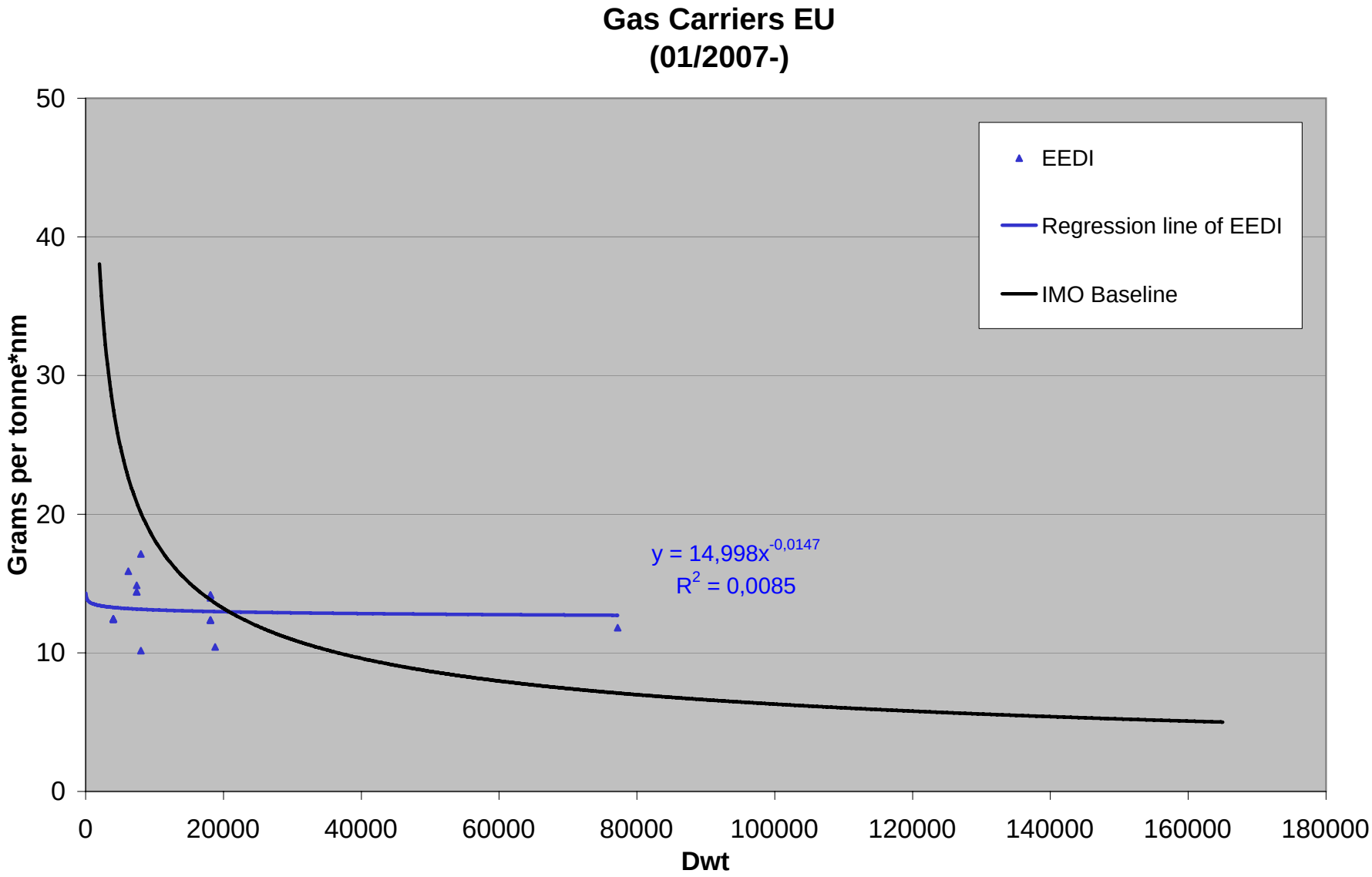

General Cargo Ships
(01/2007-)
Grams per tonne*nm
Dwt
0
5
10
15
20
25
30
35
40
45
50
0
10000
20000
30000
40000
50000
60000
70000
80000
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
IMO Baseline
Regression line of EEDI World

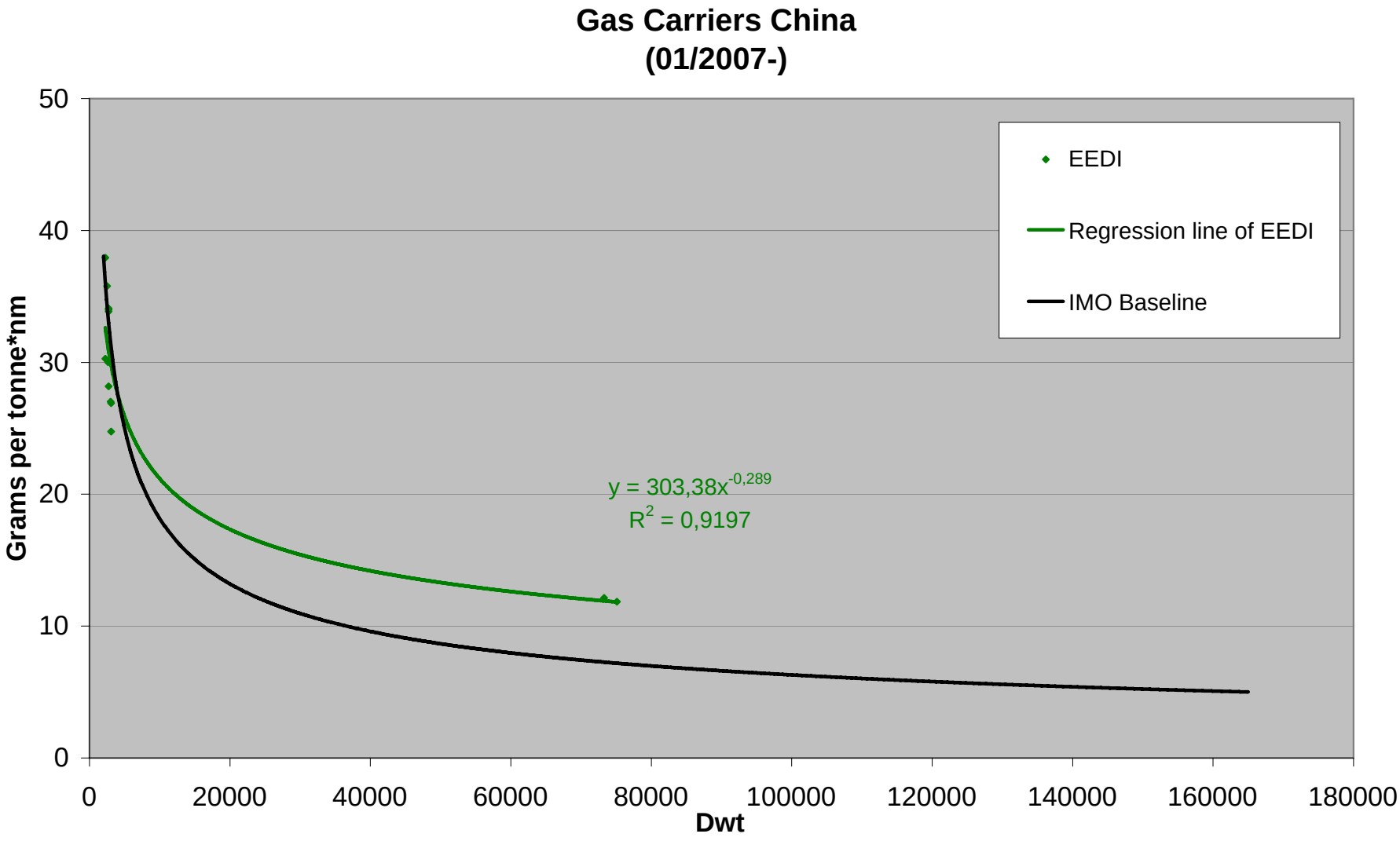

Speed and ME Power Trends
General Cargo Ships 01/2007-
Design Speed (LEFT AXIS)
ME Power (RIGHT AXIS)
ME Power Trend (LEFT AXIS)
Speed Trend (LEFT AXIS)
Vs (kn)
ME Power (kW)
Dwt
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000

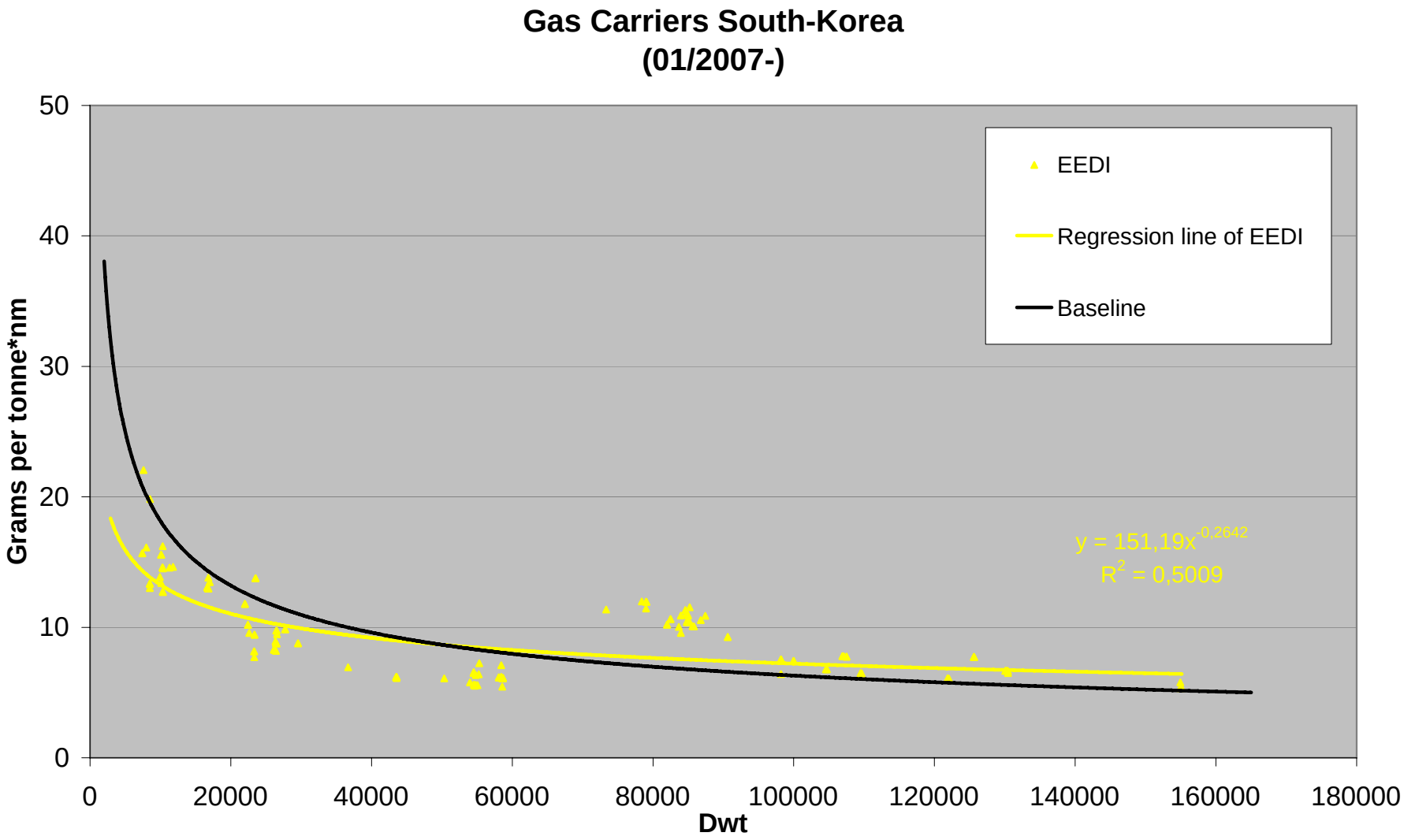
APPENDIX 5

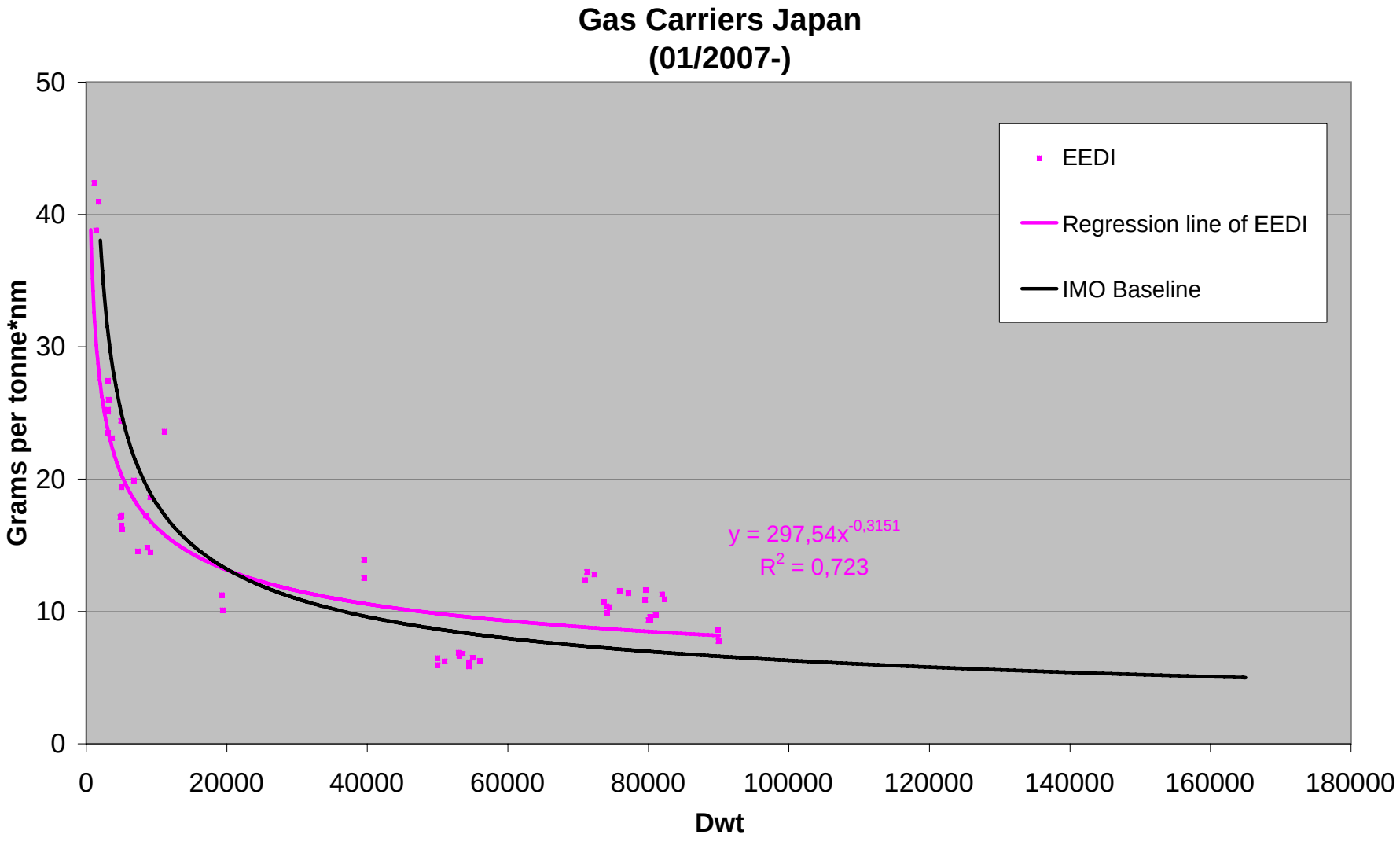
RESULTS OF EEDI CALCULATIONS FOR GAS CARRIERS

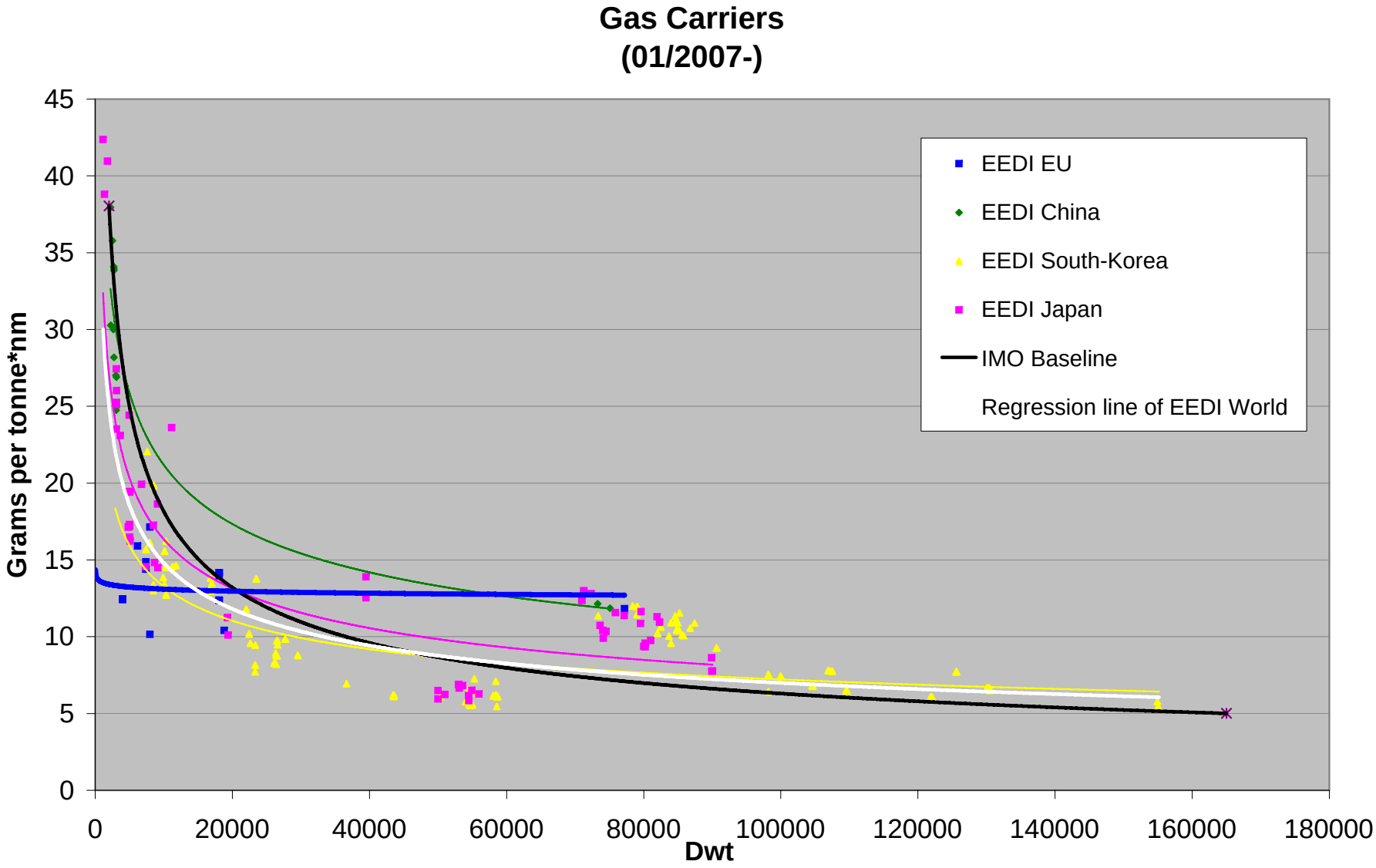
Gas Carriers		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	21	13	165	63	262
Avg. DWT	(t)	13873,14	13700,31	59324,99	41365,79	49099,65
Avg. ME MCR power	(kW)	6695,90	6122,92	18488,13	13316,75	15685,91
Avg. speed	(kn)	15,87	14,32	17,67	16,82	17,16
Avg. EEDI	(g/t*nm)	**13,20**	**28,216**	**9,55**	**14,598**	**11,98**
Avg. deviation from baseline		**-6,24**	**-1,03**	**-0,60**	**-1,00**	**-1,17**


Gas Carriers EU
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 14,998x-0,0147
R2 = 0,0085
0
10
20
30
40
50
0
20000
40000
60000
80000
100000
120000
140000
160000
180000


Gas Carriers China
(01/2007-)
Grams per tonne*nm
50
40
30
20
10
0
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 303,38x-0,289
R2 = 0,9197


Gas Carriers South-Korea
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
Baseline
y = 151,19x-0,2642
R2 = 0,5009
0
10
20
30
40
50
0
20000
40000
60000
80000
100000
120000
140000
160000
180000

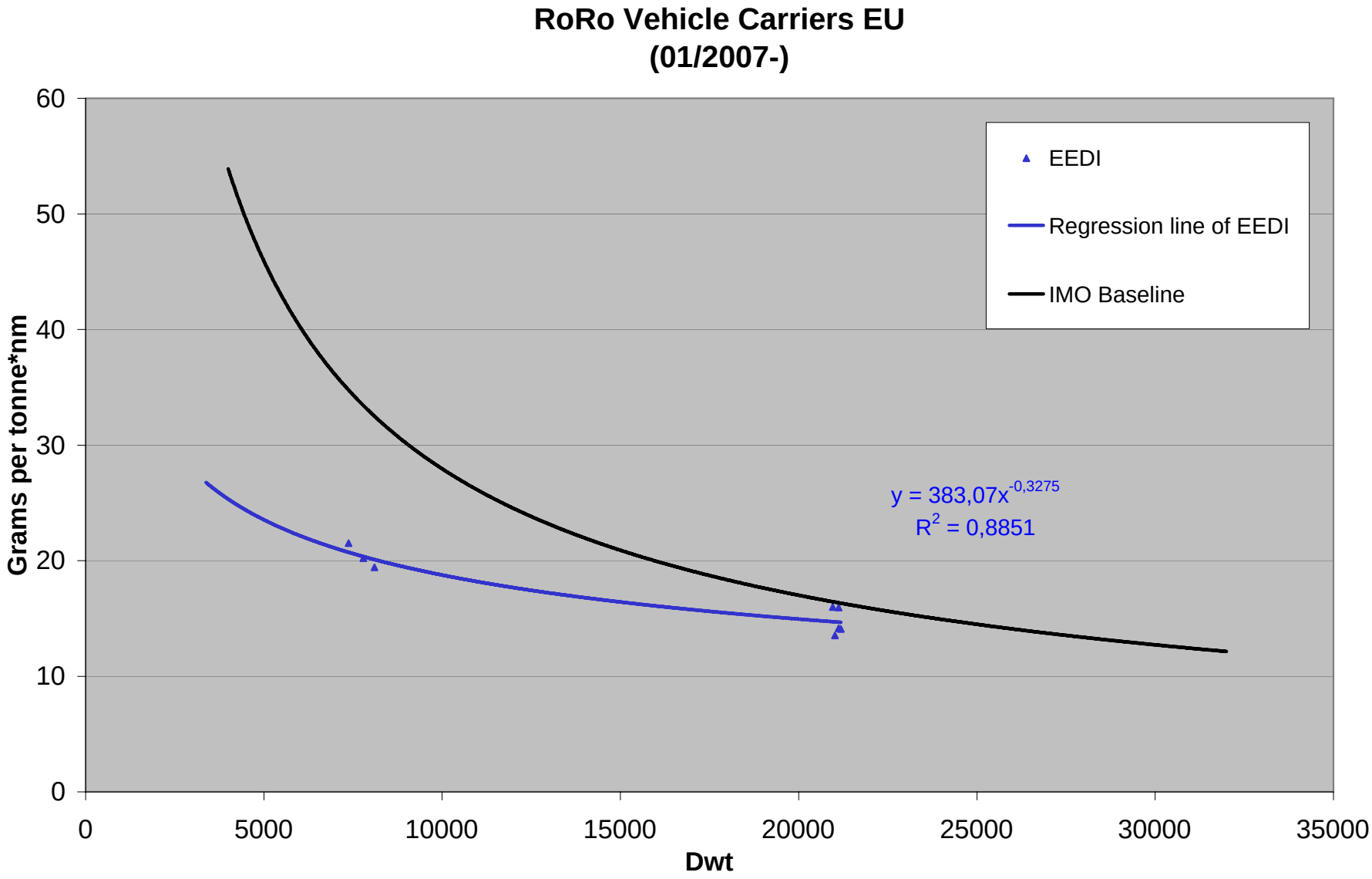

Gas Carriers Japan
(01/2007-)
Grams per tonne*nm
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 297,54x-0,3151
R2 = 0,723
0
10
20
30
40
50
0
20000
40000
60000
80000
100000
120000
140000
160000
180000

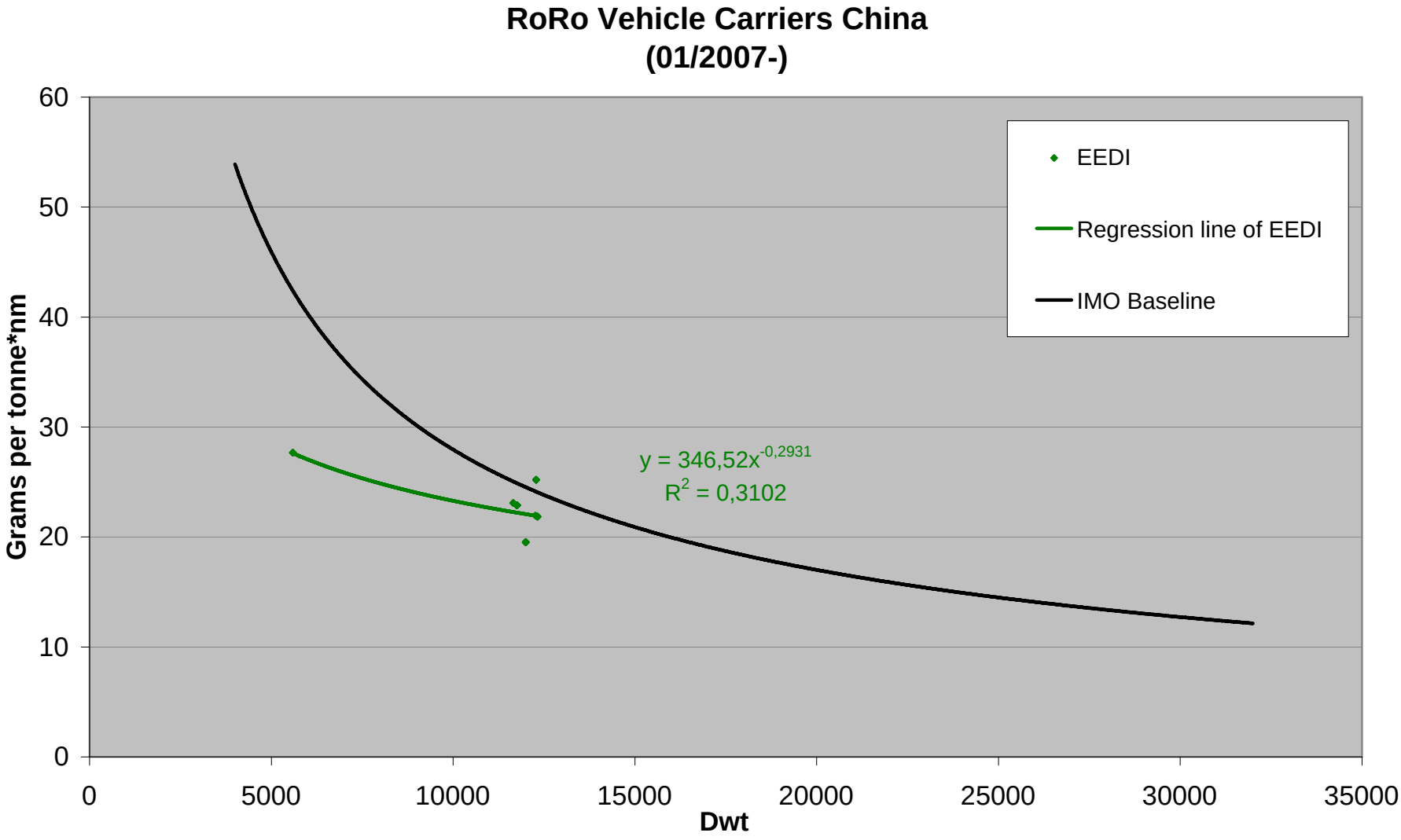

Gas Carriers
(01/2007-)
Grams per tonne*nm
45
40
35
30
25
20
15
10
5
0
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
Dwt
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
IMO Baseline
Regression line of EEDI World

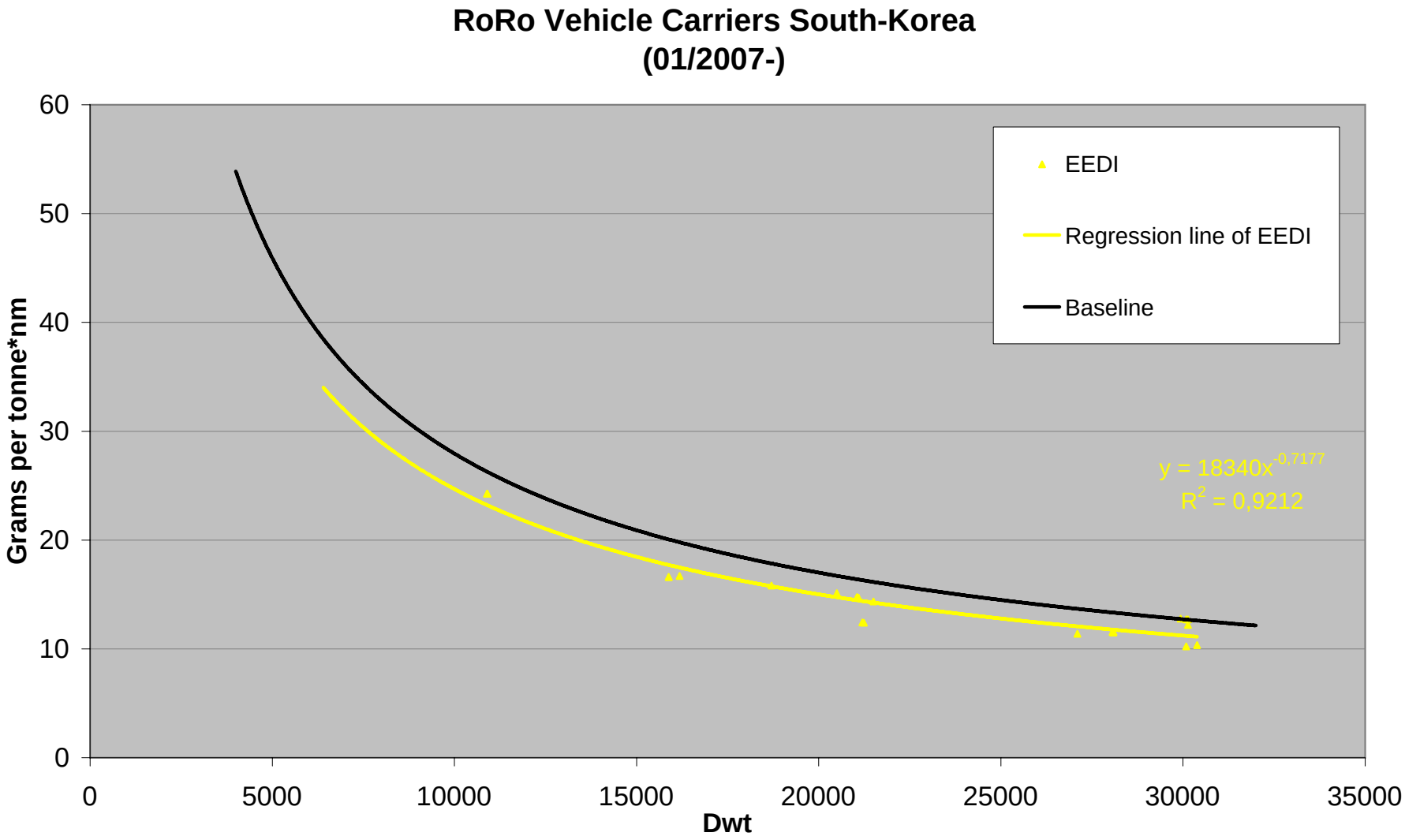
APPENDIX 6

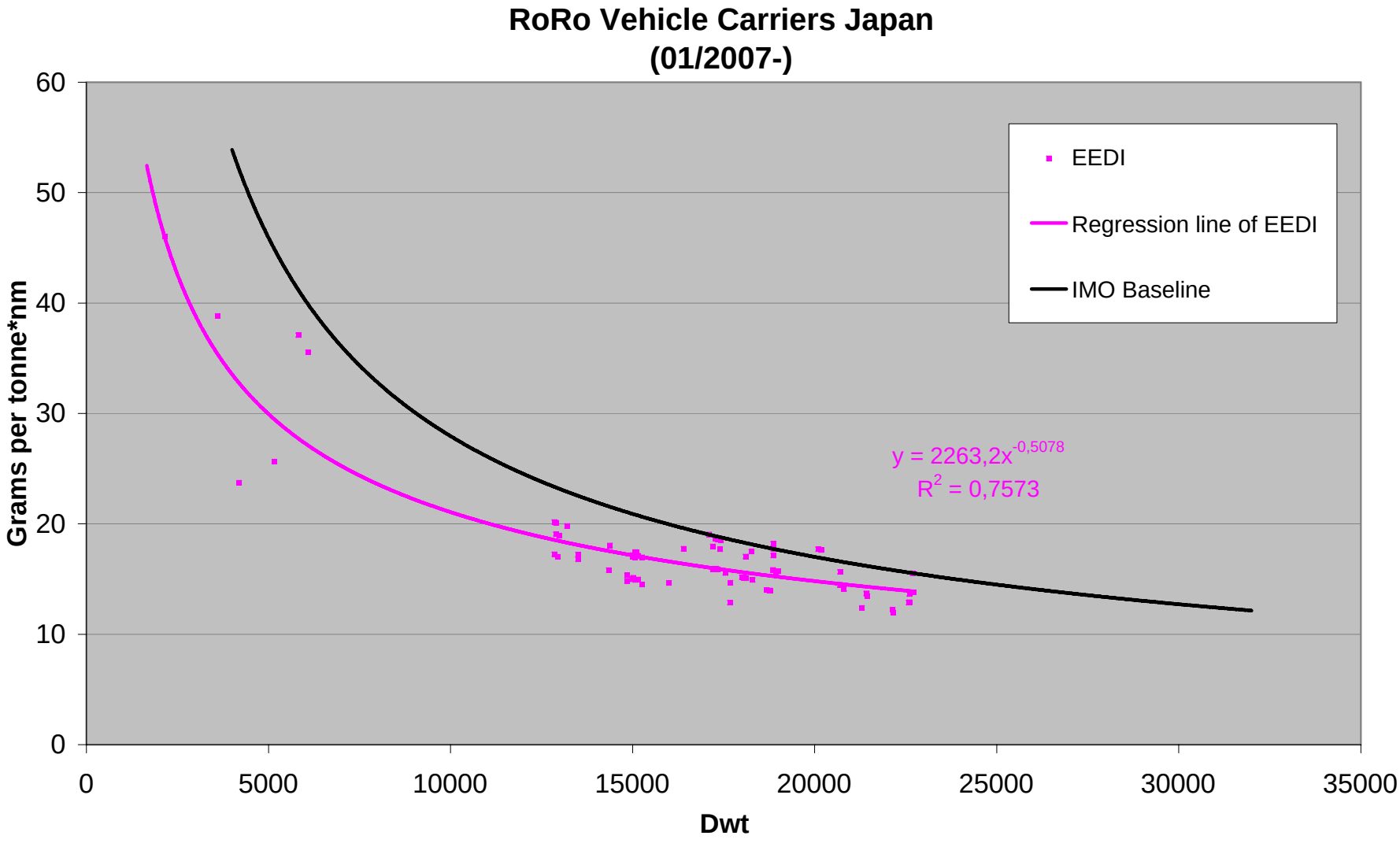
RESULTS OF EEDI CALCULATIONS FOR RORO VEHICLE CARRIERS

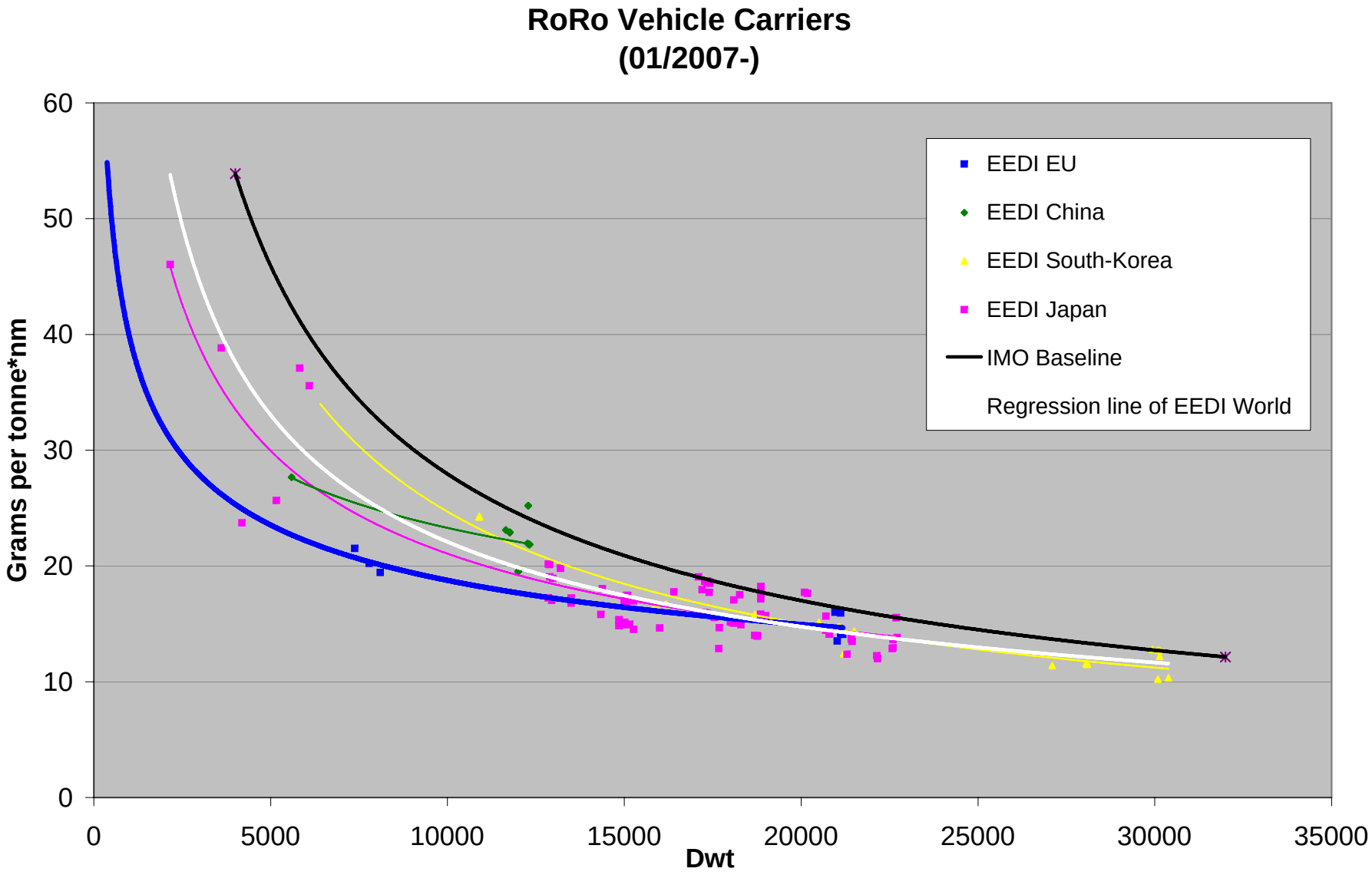
RoRo Vehicle Carriers		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	8	35	28	101	172
Avg. DWT	(t)	16083,38	11624,40	22148,68	16880,39	16631,41
Avg. ME MCR power	(kW)	11939,25	11343,63	13917,93	12197,49	12291,80
Avg. speed	(kn)	19,95	19,36	20,11	19,92	19,84
Avg. EEDI	(g/t*nm)	**16,86**	**22,467**	**14,97**	**17,061**	**17,81**
Avg. deviation from baseline		**-5,97**	**-3,10**	**-1,94**	**-3,86**	**-3,49**


RoRo Vehicle Carriers EU
(01/2007-)
Grams per tonne*nm
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 383,07x-0,3275
R2 = 0,8851


RoRo Vehicle Carriers China
(01/2007-)
Grams per tonne*nm
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 346,52x-0,2931
R2 = 0,3102


RoRo Vehicle Carriers South-Korea
(01/2007-)
Grams per tonne*nm
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
Dwt
EEDI
Regression line of EEDI
Baseline
y = 18340x-0,7177
R2 = 0,9212

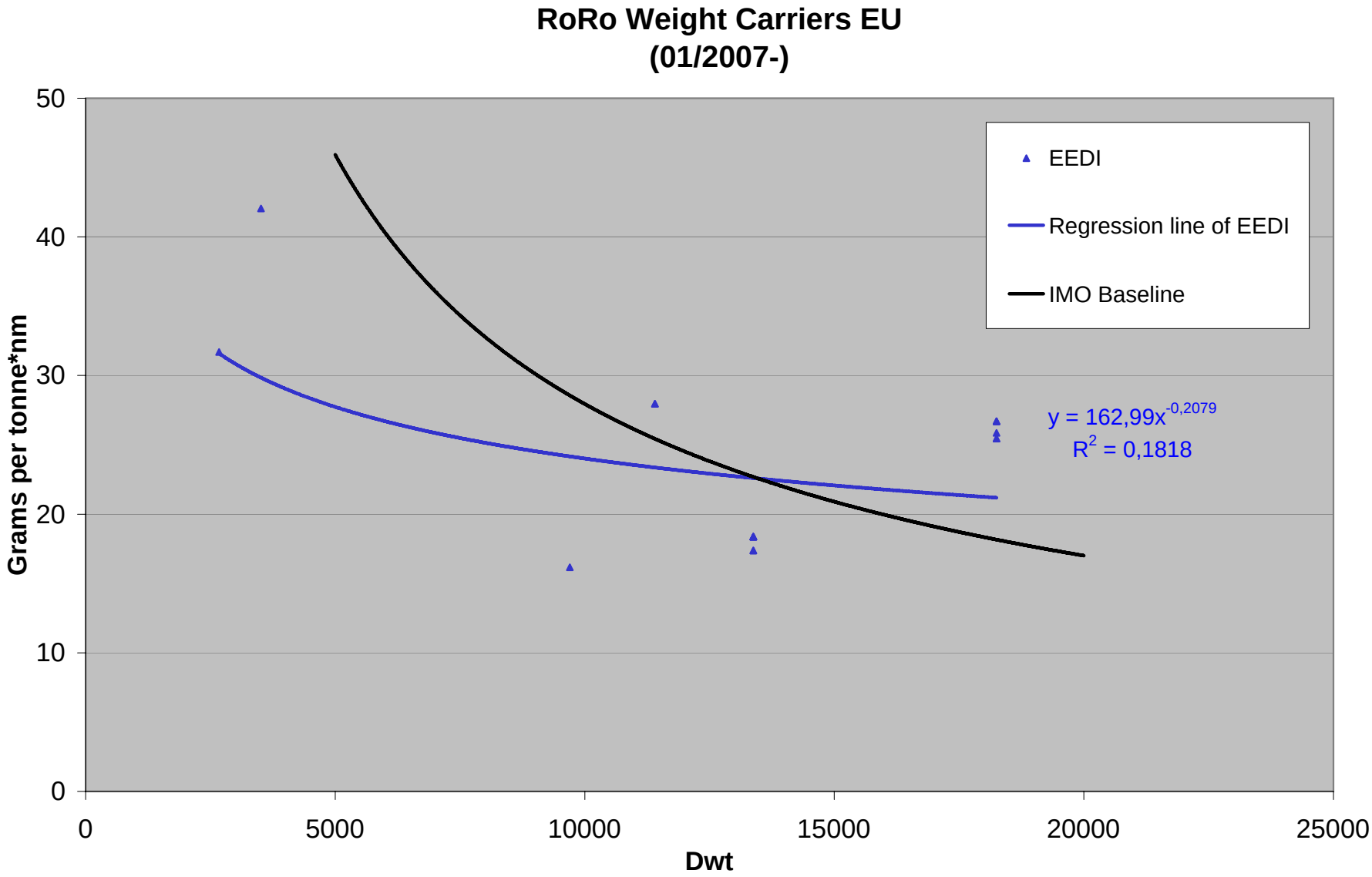

RoRo Vehicle Carriers Japan
(01/2007-)
Grams per tonne*nm
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
Dwt
EEDI
Regression line of EEDI
IMO Baseline
y = 2263,2x-0,5078
R2 = 0,7573

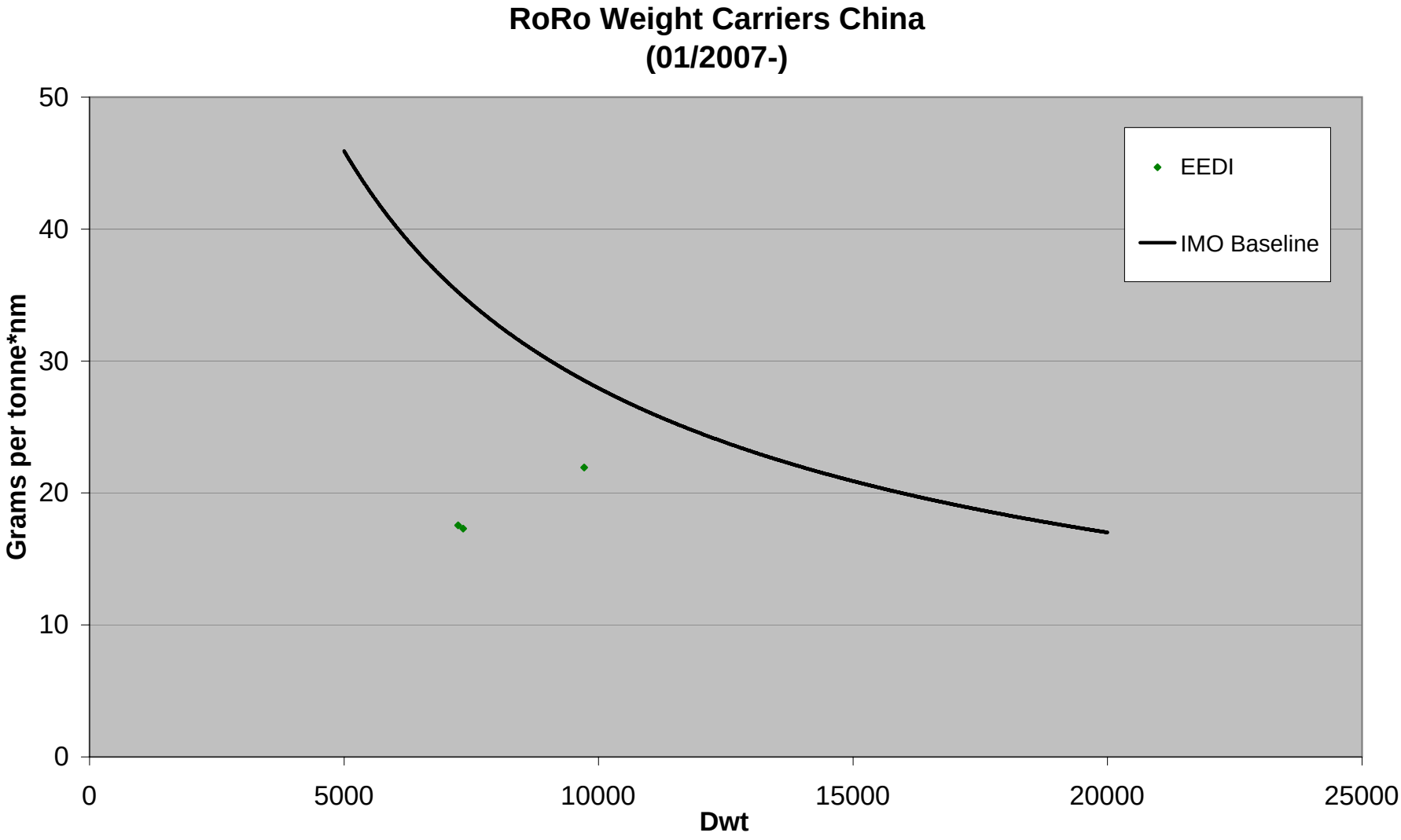

RoRo Vehicle Carriers
(01/2007-)
Grams per tonne*nm
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
Dwt
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
IMO Baseline
Regression line of EEDI World

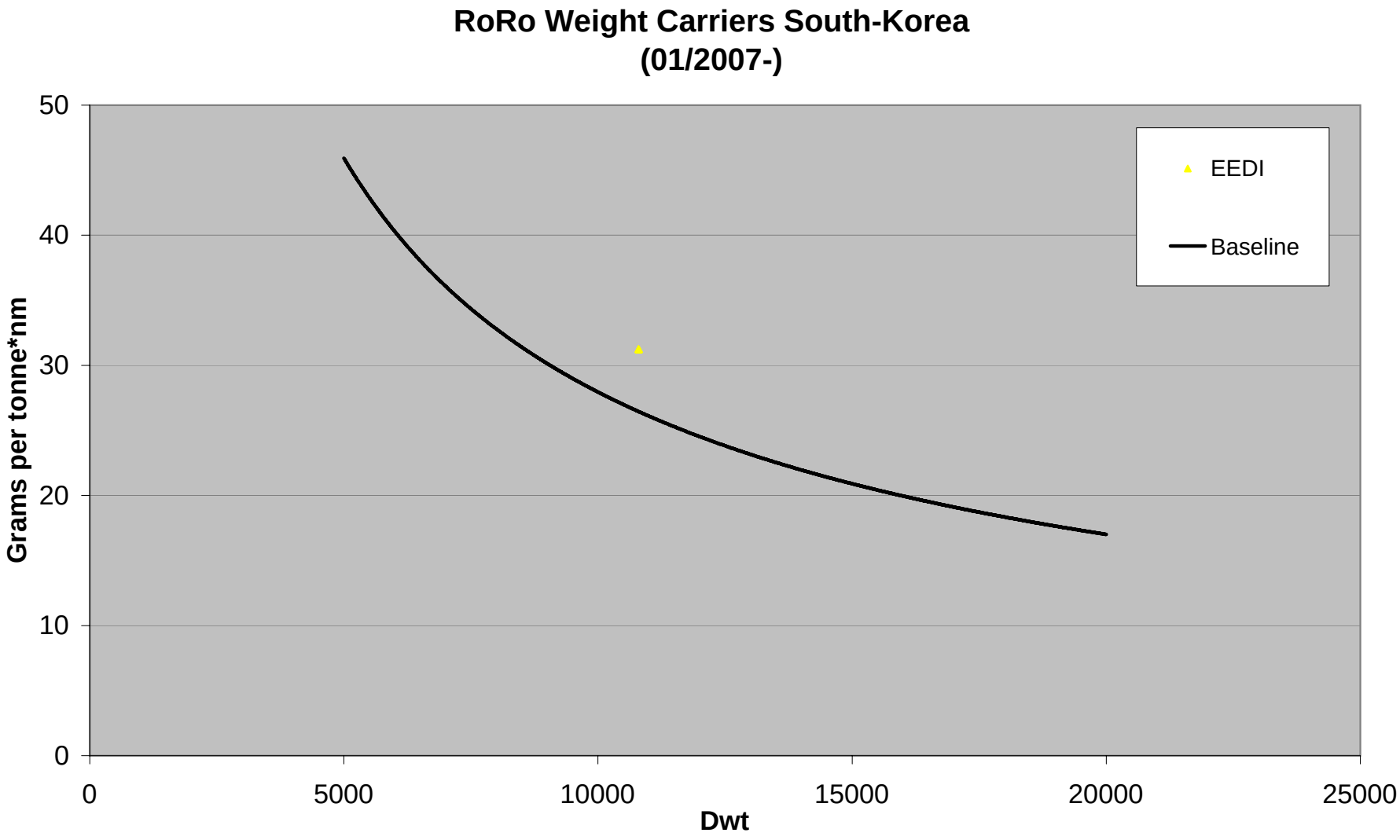
APPENDIX 7

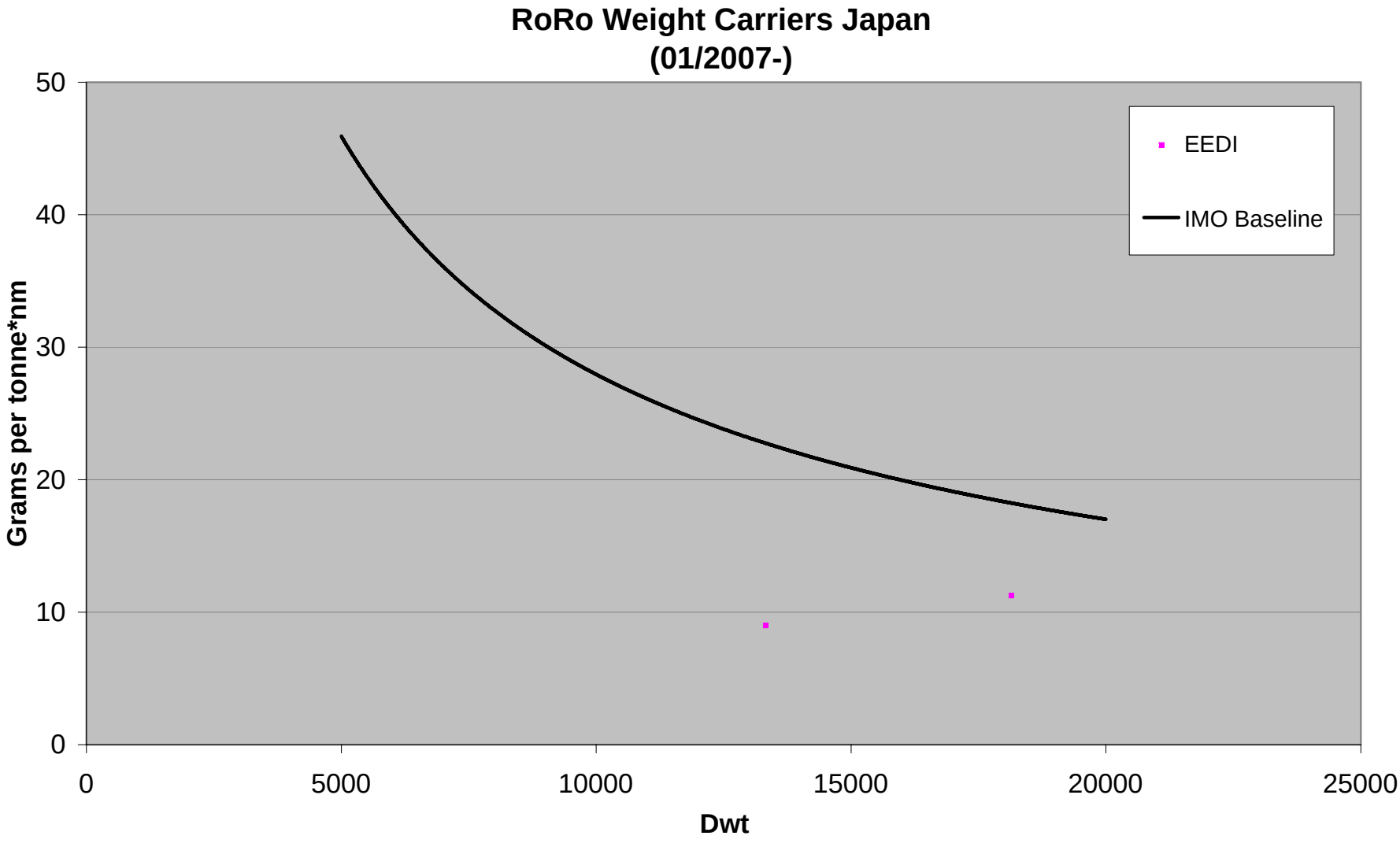
RESULTS OF EEDI CALCULATIONS FOR RORO WEIGHT CARRIERS

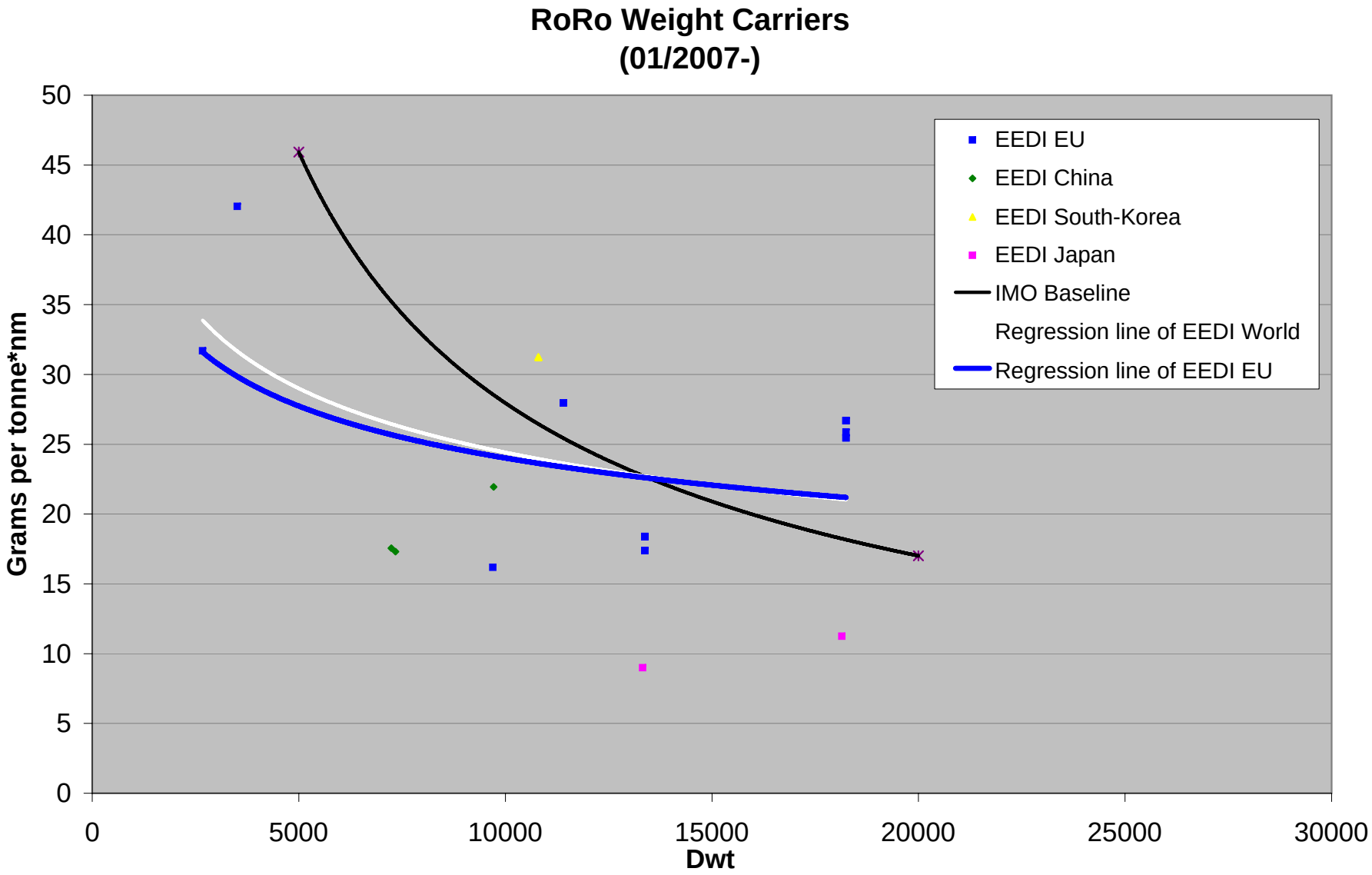
RoRo Weight Carriers		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	18	3	10	2	33
Avg. DWT	(t)	13434,78	8099,67	10800,00	15734,50	12290,73
Avg. ME MCR power	(kW)	14712,78	4946,67	17059,00	6083,50	14012,94
Avg. speed	(kn)	18,98	14,57	22,30	16,15	19,42
Avg. EEDI	(g/t*nm)	**23,85**	**18,932**	**31,24**	**10,121**	**24,81**
Avg. deviation from baseline		**-2,72**	**-13,94**	**4,79**	**-10,37**	**-1,93**


RoRo Weight Carriers EU
(01/2007-)
Grams per tonne*nm
Dwt
0
10
20
30
40
50
0
5000
10000
15000
20000
25000
EEDI
Regression line of EEDI
IMO Baseline
y = 162,99x-0,2079
R2 = 0,1818


RoRo Weight Carriers China
(01/2007-)
Grams per tonne*nm
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
Dwt
EEDI
IMO Baseline


RoRo Weight Carriers South-Korea
(01/2007-)
Grams per tonne*nm
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
Dwt
EEDI
Baseline

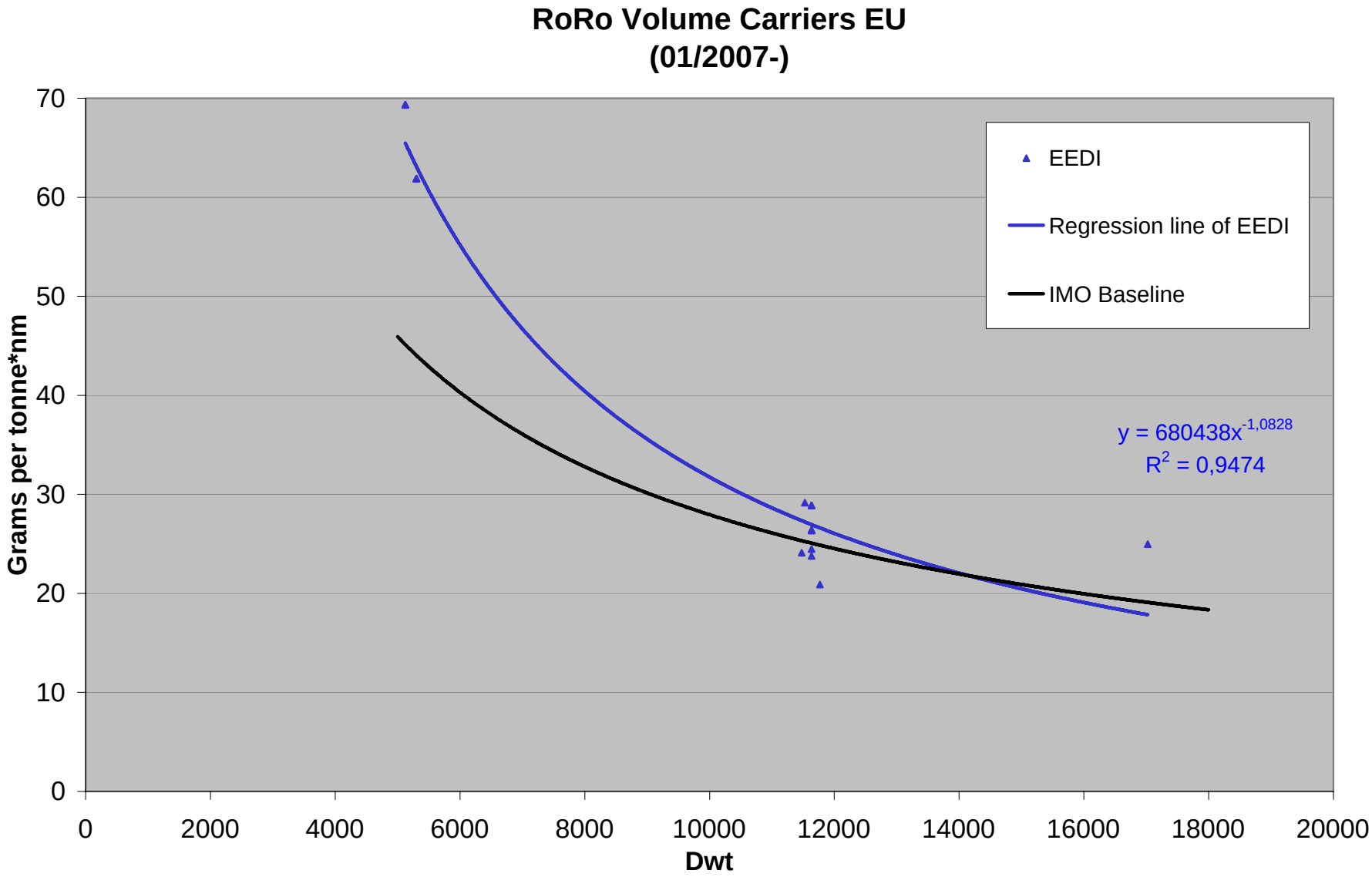

RoRo Weight Carriers Japan
(01/2007-)
Grams per tonne*nm
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
Dwt
EEDI
IMO Baseline

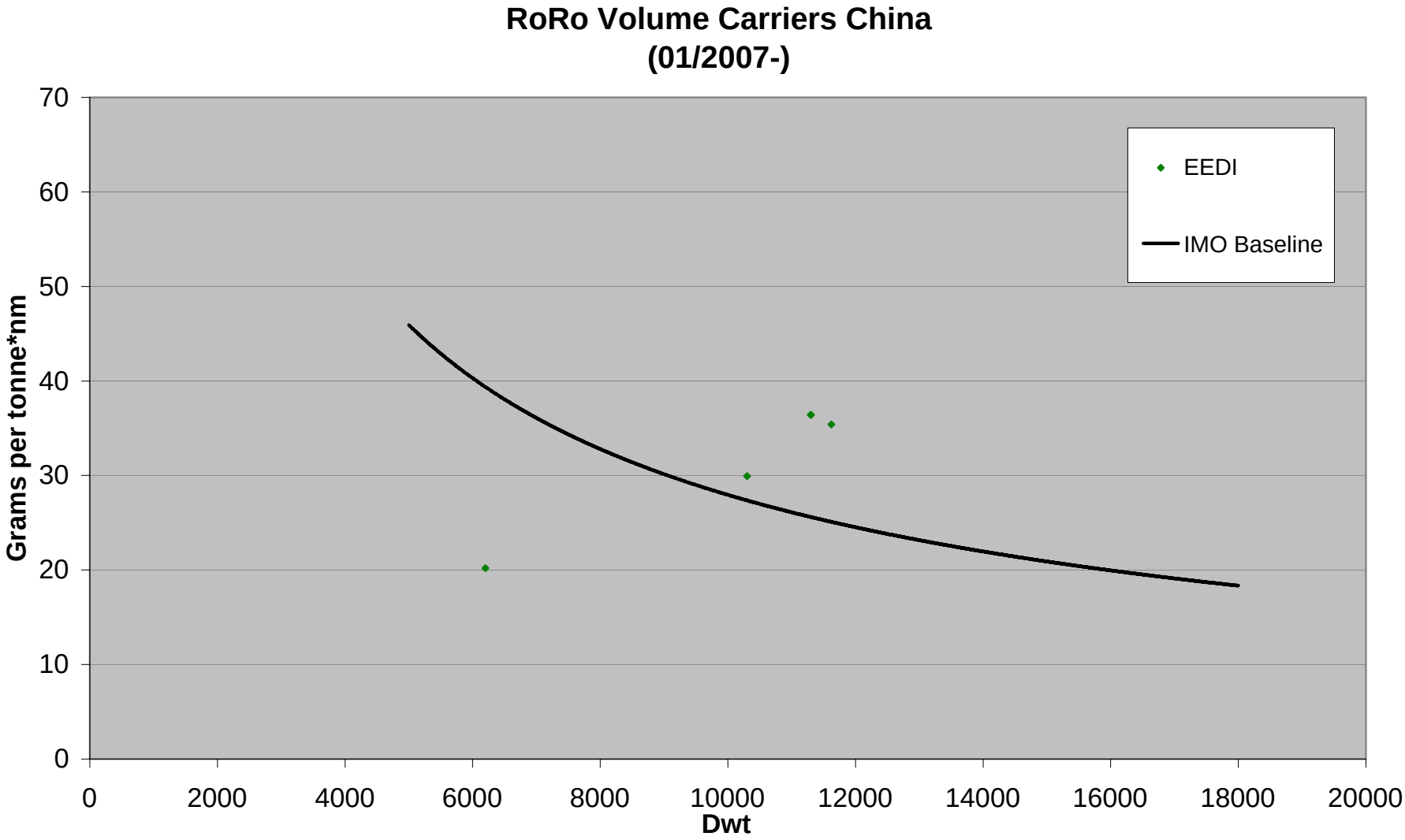

RoRo Weight Carriers
(01/2007-)
Grams per tonne*nm
Dwt
0
5
10
15
20
25
30
35
40
45
50
0
5000
10000
15000
20000
25000
30000
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
IMO Baseline
Regression line of EEDI World
Regression line of EEDI EU

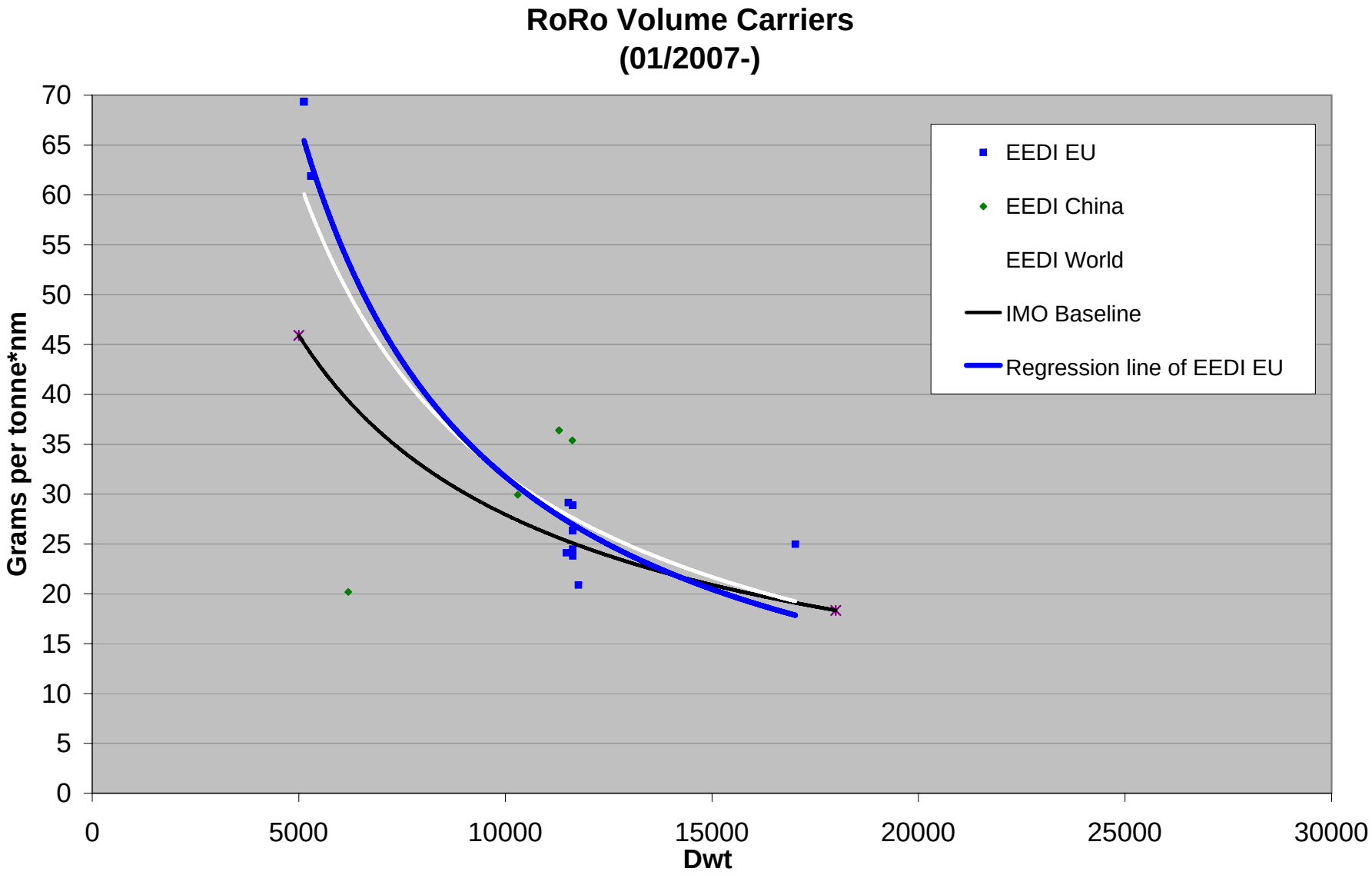
APPENDIX 8

RESULTS OF EEDI CALCULATIONS FOR RORO VOLUME CARRIERS

RoRo Volume Carriers		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	25	5	0	0	30
Avg. DWT	(t)	9790,60	10144,60	0,00	0,00	9849,60
Avg. ME MCR power	(kW)	16042,04	15001,20	0,00	0,00	15868,57
Avg. speed	(kn)	21,39	18,50	0,00	0,00	20,91
Avg. EEDI	(g/t*nm)	**38,79**	**31,664**	**0,00**	**0,000**	**37,60**
Avg. deviation from baseline		**7,71**	**3,06**	**0,00**	**0,00**	**6,93**


RoRo Volume Carriers EU
(01/2007-)
Grams per tonne*nm
Dwt
0
10
20
30
40
50
60
70
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
EEDI
Regression line of EEDI
IMO Baseline
y = 680438x-1,0828
R2 = 0,9474

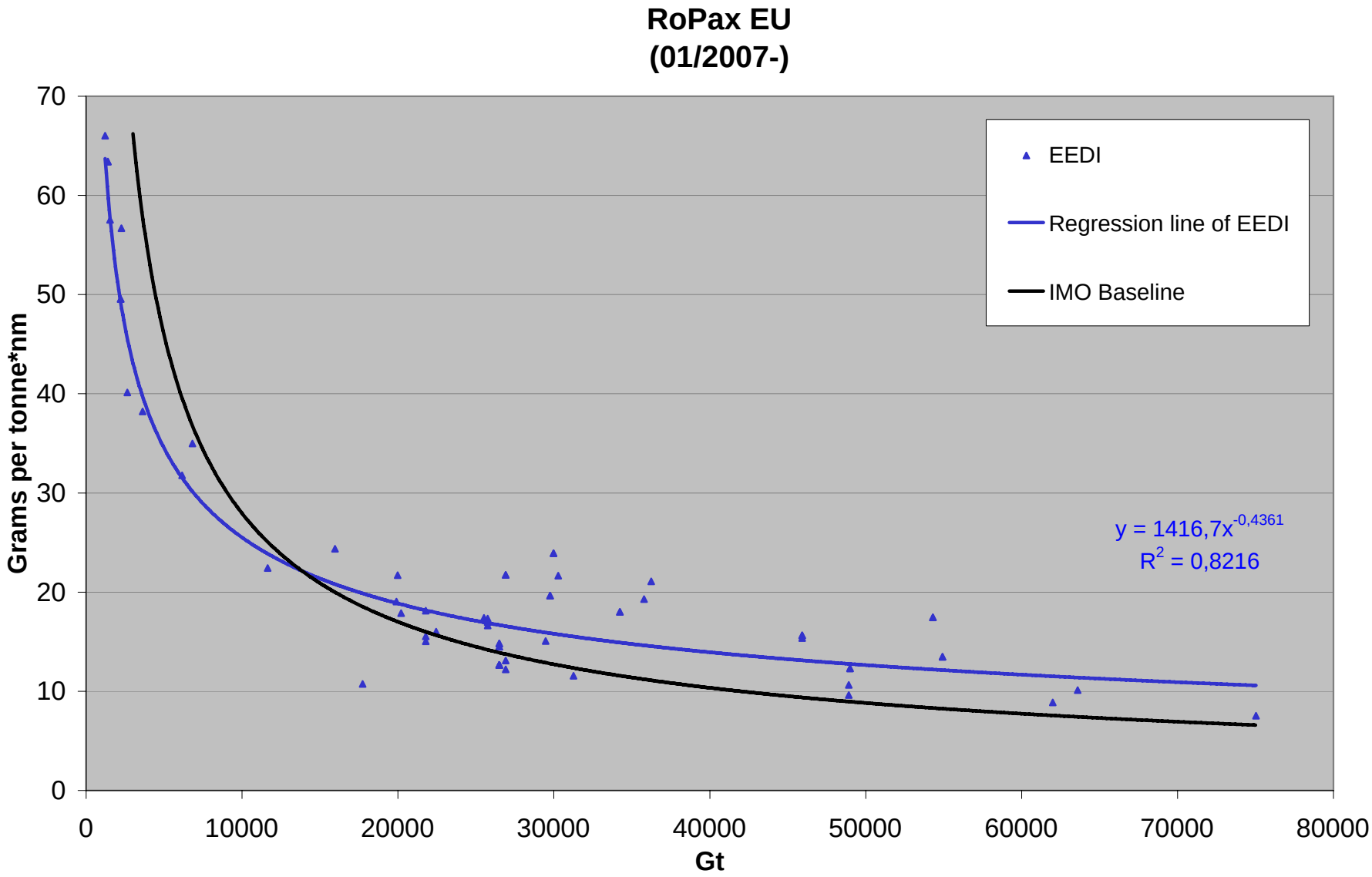

RoRo Volume Carriers China
(01/2007-)
Grams per tonne*nm
70
60
50
40
30
20
10
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
Dwt
EEDI
IMO Baseline

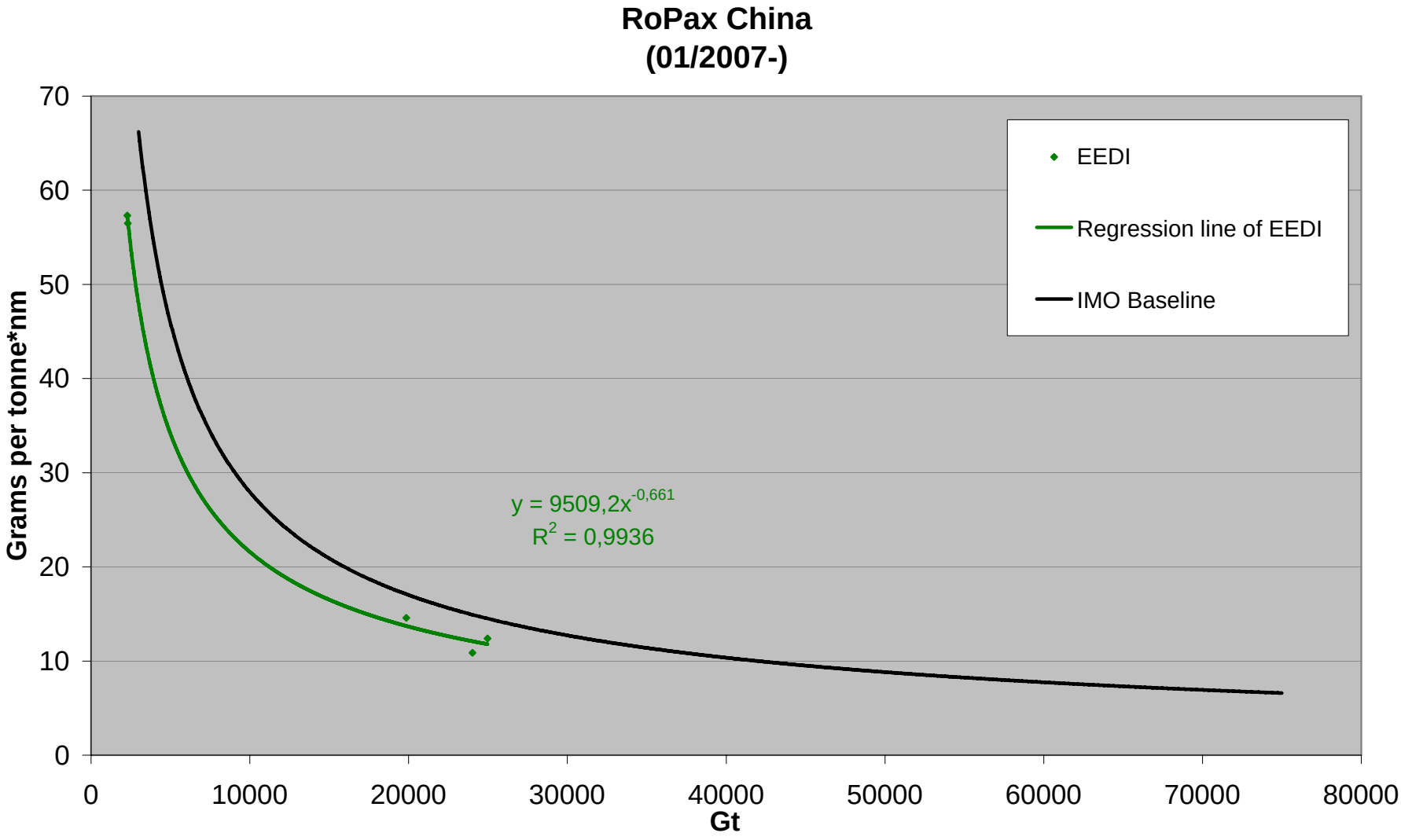

RoRo Volume Carriers
(01/2007-)
Grams per tonne*nm
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
5000
10000
15000
20000
25000
30000
Dwt
EEDI EU
EEDI China
EEDI World
IMO Baseline
Regression line of EEDI EU

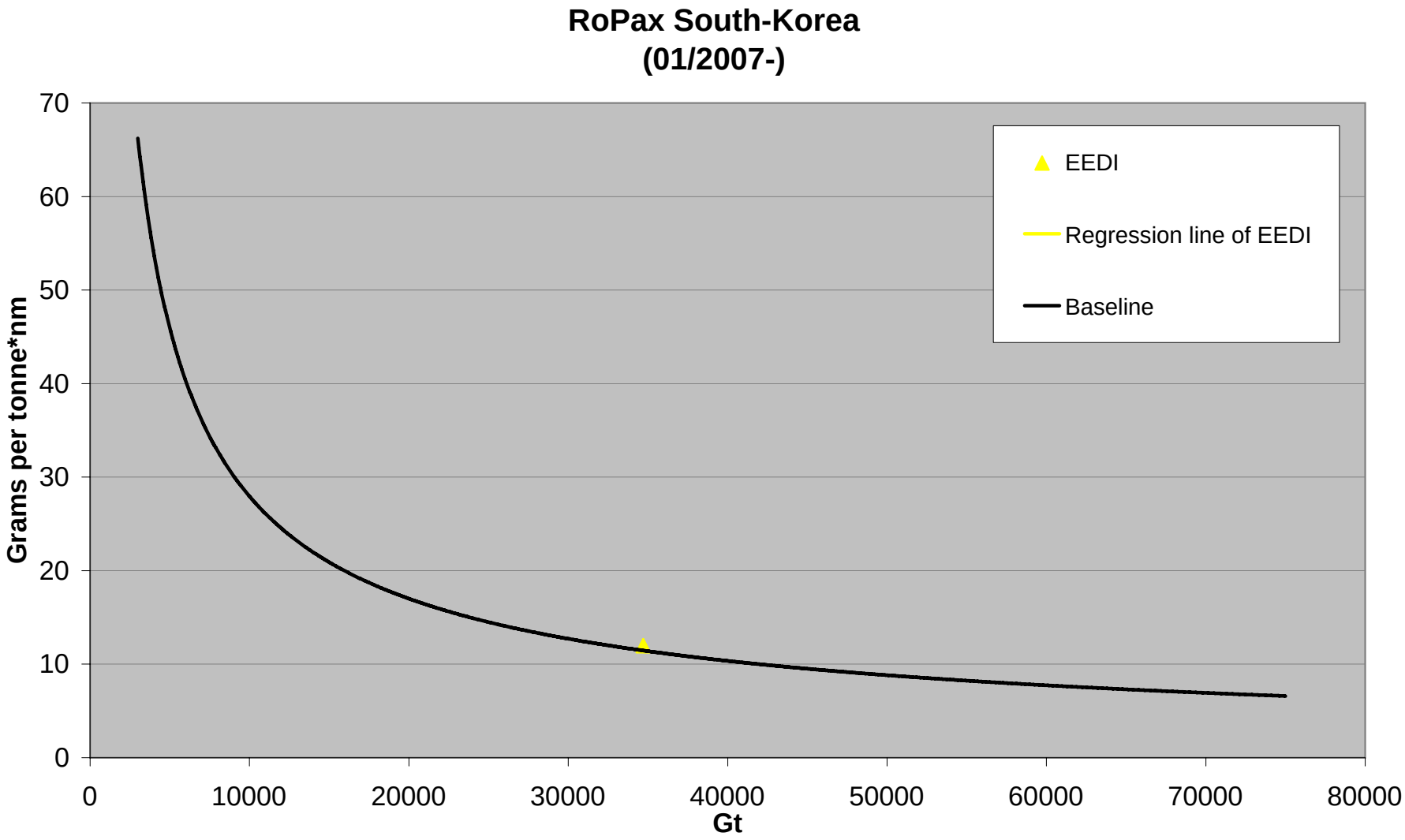
APPENDIX 9

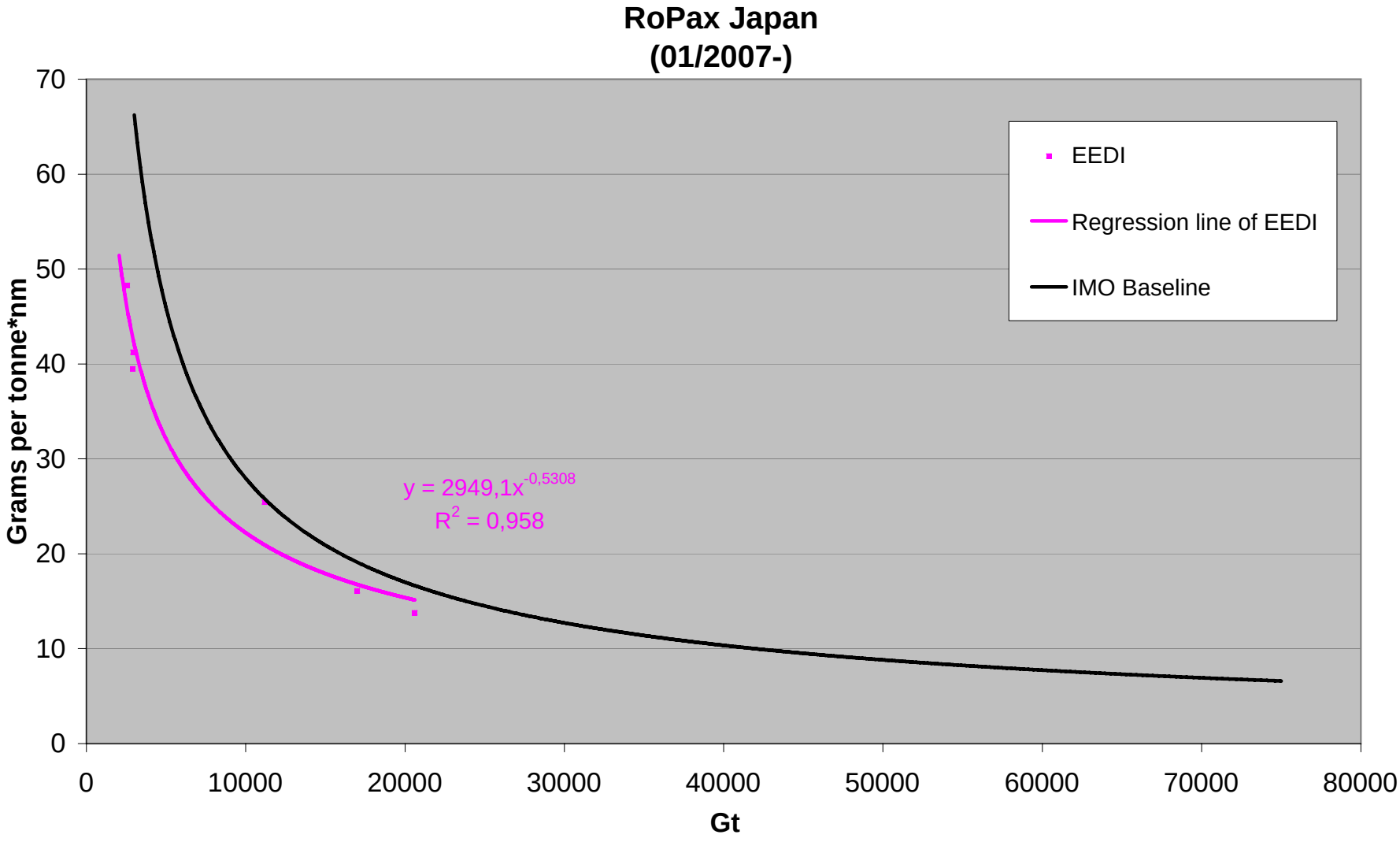
RESULTS OF EEDI CALCULATIONS FOR ROPAX SHIPS

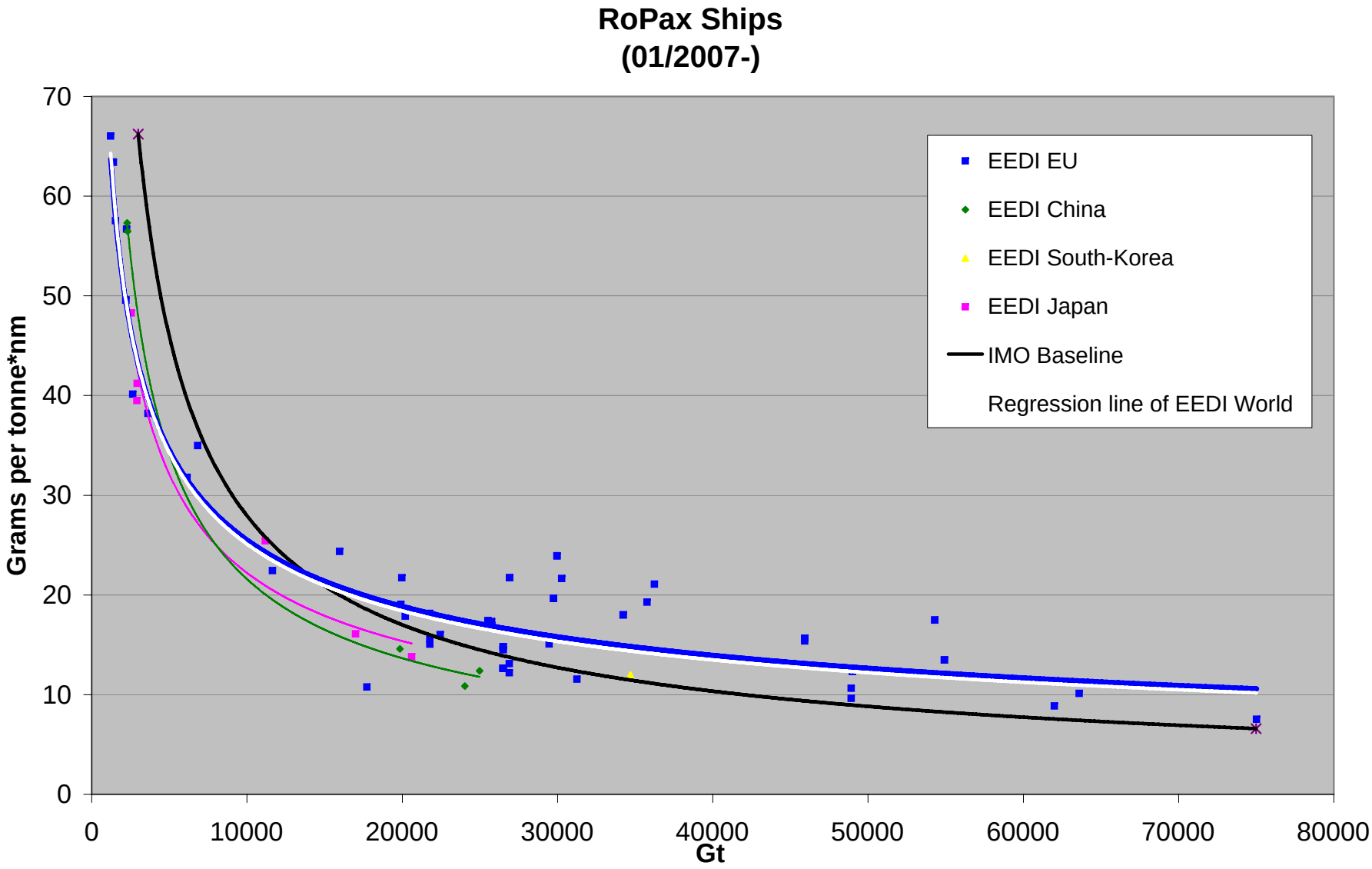
RoPax Ships		Europe	China	S-Korea	Japan	World
Sample size	(pcs)	64	5	2	6	77
Avg. Gt	(t)	28171,94	14689,60	34700,00	9529,50	26013,36
Avg. ME MCR power	(kW)	24150,72	8921,60	21600,00	9972,17	21990,74
Avg. speed	(kn)	21,93	19,80	22,20	20,87	21,71
Avg. EEDI	(g/t*nm)	**21,87**	**30,331**	**11,98**	**30,721**	**22,86**
Avg. deviation from baseline		**-3,07**	**-11,01**	**0,52**	**-14,42**	**-4,38**

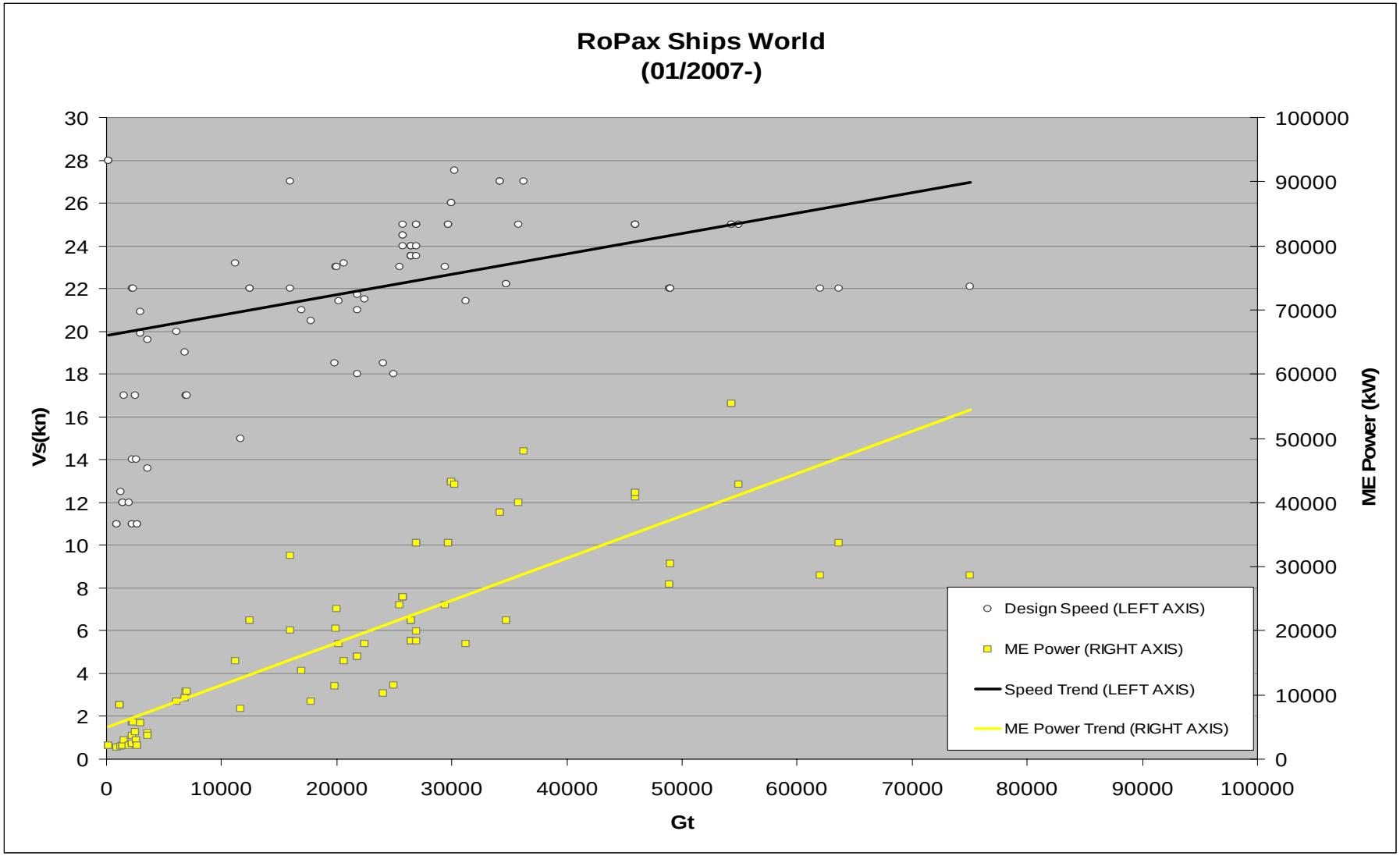

RoPax EU
(01/2007-)
Grams per tonne*nm
Gt
EEDI
Regression line of EEDI
IMO Baseline
y = 1416,7x-0,4361
R2 = 0,8216
0
10
20
30
40
50
60
70
0
10000
20000
30000
40000
50000
60000
70000
80000


RoPax China
(01/2007-)
Grams per tonne*nm
70
60
50
40
30
20
10
0
0
10000
20000
30000
40000
50000
60000
70000
80000
Gt
EEDI
Regression line of EEDI
IMO Baseline
y = 9509,2x-0,661
R2 = 0,9936


RoPax South-Korea
(01/2007-)
Grams per tonne*nm
70
60
50
40
30
20
10
0
0
10000
20000
30000
40000
50000
60000
70000
80000
Gt
EEDI
Regression line of EEDI
Baseline


RoPax Japan
(01/2007-)
Grams per tonne*nm
70
60
50
40
30
20
10
0
0
10000
20000
30000
40000
50000
60000
70000
80000
Gt
EEDI
Regression line of EEDI
IMO Baseline
y = 2949,1x-0,5308
R2 = 0,958


RoPax Ships
(01/2007-)
Grams per tonne*nm
Gt
0
10
20
30
40
50
60
70
0
10000
20000
30000
40000
50000
60000
70000
80000
EEDI EU
EEDI China
EEDI South-Korea
EEDI Japan
IMO Baseline
Regression line of EEDI World

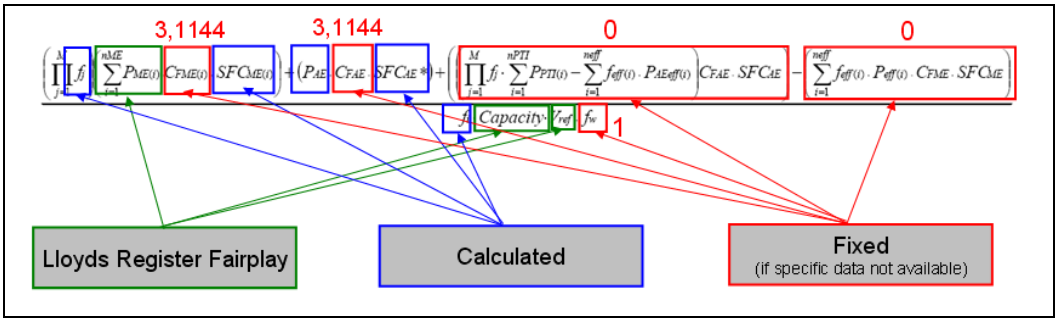

RoPax Ships World
(01/2007-)
Vs(kn)
ME Power (kW)
Gt
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
Design Speed (LEFT AXIS)
ME Power (RIGHT AXIS)
Speed Trend (LEFT AXIS)
ME Power Trend (RIGHT AXIS)

APPENDIX 10

BASIS OF EEDI CALCULATIONS WITHIN THIS STUDY

BASIS OF EEDI CALCULATIONS

Basis for selecting each parameter for EEDI calculation is illustrated in the following figure. Certain values are directly from Lloyds Register Fairplay database (green), some values are calculated based on database values and certain assumptions (blue), and certain values taken as fixed parameters (red).



For small number of ships accurate values have been available and in those cases the above principle has not been used.

LLOYDS REGISTER FAIRPLAY VALUES

Following EEDI parameters are taken directly from Lloyds Register Fairplay database:

V_{ref}
Capacity
$P_{ME(i)}$

Values are applied to the calculation exactly as they are in the database (power taken in 75%).

FIXED PARAMETERS

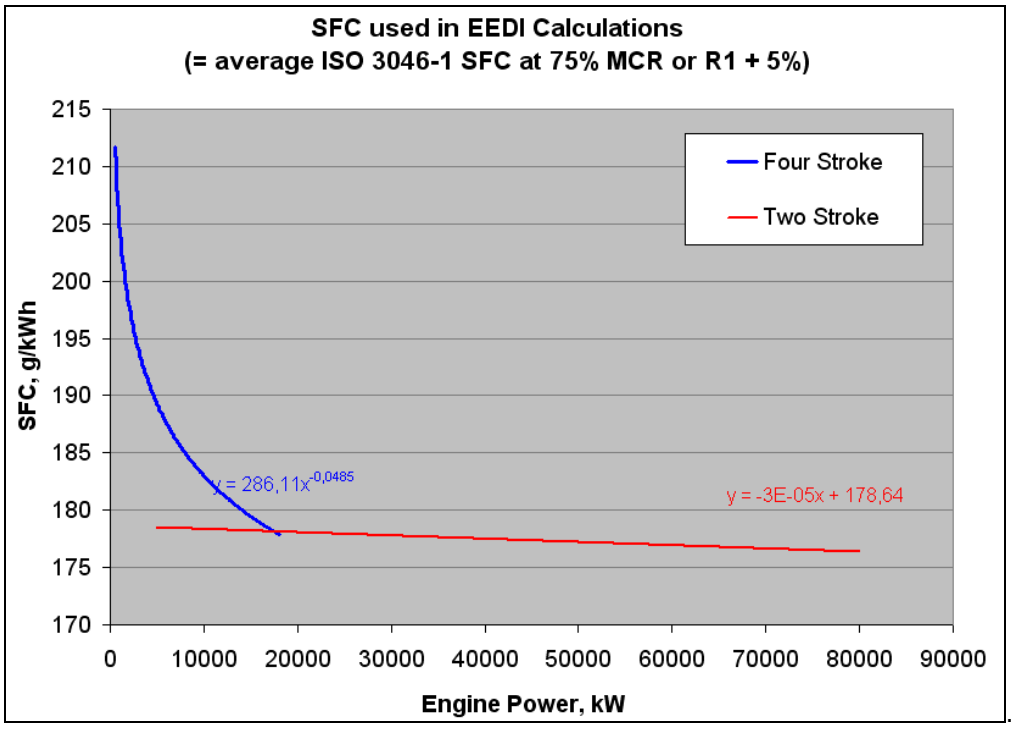
Following EEDI parameters are fixed if specific data or information has not been available for the vessel:

C_F	= 3,1144 (HFO)
$P_{PTI(i)}$	= 0
$P_{eff(i)}$	= 0
$P_{AEeff(i)}$	= 0
$f_{eff(i)}$	= 0
f_w	= 1

For certain vessels specific information has been available to calculate above factors In these cases accurate values have been used. For steam turbine driven LNG carriers C_F value of 2,932 has been used. This is based on 50% of LNG and 50% of HFO.

CALCULATED VALUES

SFC_{ME} is based on regression calculation. Size and type of main engine have been taken from Lloyds Register Fairplay database. Data of specific fuel consumption of Wärtsilä and MAN engines have been collected from engine project guides. As this SFC refers to standard ISO 3046-1 condition, a margin of +5% has been added on top of the guaranteed consumption. Finally, regression curves for four stroke medium speed and two stroke slow speed engines have been made as shown in the below image. For steam turbine driven LNG carriers, SFC value of 280 g/kWh has been used.



SFC_{AE} is calculated similarly according to the four stroke engine curve, however limiting the value to max 220 g/kWh.

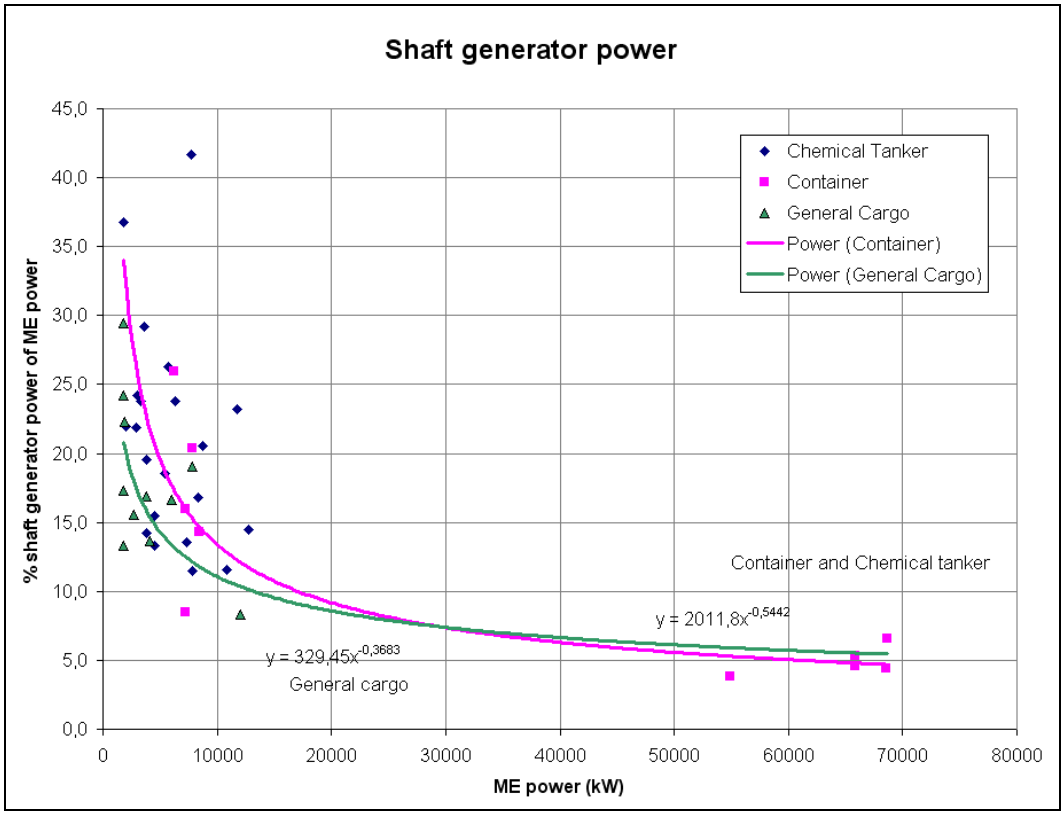
$P_{AE(i)}$ is calculated from engine power as described in IMO interim guidelines. For cargo ships with main engine power of 10000kW or above, P_{AE} is defined as:

$$P_{AE(MCRME>10000KW)} = \left(0.025 \times \sum_{i=1}^{nME} MCR_{MEi}\right) + 250$$

For cargo ships with main engine power below 10000kW, P_{AE} is defined as:

$$P_{AE(MCRME<10000KW)} = 0.05 \times \sum_{i=1}^{nME} MCR_{MEi}$$

$P_{PTO(i)}$ is calculated based on assumptions and regression data. If the vessel is equipped with controllable pitch propeller (CPP), it has been assumed that there is PTO device connected to the shaft line or reduction gearbox. Size of PTO has been estimated based ship type specific regression curves prepared for the purpose. If the vessel is equipped with fixed pitch propeller (FPP), it has been assumed that there is no PTO device. Below figure shows an example of PTO regression for general cargo ships, container ships and chemical carriers. Similar graphs have been prepared also for other ship types.



Correction factors f_j and f_i have been used as they are defined in EEDI calculation guidelines. For ice-classed ships power correction factor f_j has been determined as shown in following tables.

Ship type	f_j	Limits depending on the ice class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.516 L_{PP}^{1.87}}{\sum_{i=1}^{nME} P_{iME}}$	$\begin{cases} max\ 1.0 \\ min\ 0.72 L_{PP}^{0.06} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.61 L_{PP}^{0.08} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.50 L_{PP}^{0.10} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.40 L_{PP}^{0.12} \end{cases}$
Dry cargo carrier	$\frac{2.150 L_{PP}^{1.58}}{\sum_{i=1}^{nME} P_{iME}}$	$\begin{cases} max\ 1.0 \\ min\ 0.89 L_{PP}^{0.02} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.78 L_{PP}^{0.04} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.68 L_{PP}^{0.06} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.58 L_{PP}^{0.08} \end{cases}$
General cargo ship	$\frac{0.0450 \cdot L_{PP}^{2.37}}{\sum_{i=1}^{nME} P_{iME}}$	$\begin{cases} max\ 1.0 \\ min\ 0.85 L_{PP}^{0.03} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.70 L_{PP}^{0.06} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.54 L_{PP}^{0.10} \end{cases}$	$\begin{cases} max\ 1.0 \\ min\ 0.39 L_{PP}^{0.15} \end{cases}$

For other ship types, f_j should be taken as 1.0.

Ship type	f_i	Limits depending on the ice class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.00115 L_{PP}^{3.36}}{capacity}$	$\begin{cases} max\ 1.31 L_{PP}^{-0.05} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.54 L_{PP}^{-0.07} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.80 L_{PP}^{-0.09} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 L_{PP}^{-0.11} \\ min\ 1.0 \end{cases}$
Dry cargo carrier	$\frac{0{,}000665 \cdot L_{PP}^{3.44}}{capacity}$	$\begin{cases} max\ 1.31 L_{PP}^{-0.05} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.54 L_{PP}^{-0.07} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.80 L_{PP}^{-0.09} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 L_{PP}^{-0.11} \\ min\ 1.0 \end{cases}$
General cargo ship	$\frac{0{,}000676 \cdot L_{PP}^{3.44}}{capacity}$	1.0	$\begin{cases} max\ 1.08 \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.12 \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.25 \\ min\ 1.0 \end{cases}$
Containership	$\frac{0.1749 \cdot L_{PP}^{2.29}}{capacity}$	1.0	$\begin{cases} max\ 1.25 L_{PP}^{-0.04} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.60 L_{PP}^{-0.08} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 L_{PP}^{-0.12} \\ min\ 1.0 \end{cases}$
Gas tanker	$\frac{0.1749 \cdot L_{PP}^{2.33}}{capacity}$	$\begin{cases} max\ 1.25 L_{PP}^{-0.04} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 1.60 L_{PP}^{-0.08} \\ min\ 1.0 \end{cases}$	$\begin{cases} max\ 2.10 L_{PP}^{-0.12} \\ min\ 1.0 \end{cases}$	1.0

For other ship types, f_i should be taken as 1.0.

EXCLUSION OF CALCULATED INDEX VALUES

Lloyds Register Fairplay database obviously contains some erroneous ship data. In order to eliminate unrealistic EEDI values, ships deviating more than 10 index units from the trendline are excluded from the final calculations.

ACCURACY OF THE SELECTED APPROACH

In order to check the reliability of the used simplifications, a set of 19 ships where tested. For these vessels reliable and accurate information of EEDI parameters was available. The tested vessels were 1 container vessel, 2 bulkers, 5 tankers, 6 RoRo vessel and 5 Ferries.

Vessel type	number of ships	average error (% of EEDI)	Worst case error (% of EEDI)
Container	1	0,3	
Bulker	2	1,8	2,6
Tanker	5	3,3	5,8
Roro	6	2,8	7,5
Ferry 1	4	8,9	15,2
Ferry 2	5	2,2	3,0
Total	19	2,5	7,5

The general accuracy of the cargo vessels was rather good. The biggest source of inaccuracy is the speed value in the LRFP statistics. Accuracy of the EEDI value obtained with simplifications is about 5%. For the ferries the ships were calculated using shaft generators (Ferry 1) and without shaft generators (Ferry 2). The second approach gives clearly better values, indicating that speed values in the LR-Fairplay statistics are speed obtained without use of shaft generators. The difference in speed obtained is rather big in this type of vessels as the relative size of shaft generators is big. Accuracy of the EEDI value obtained with simplifications for RoPax ferries is about 10%.