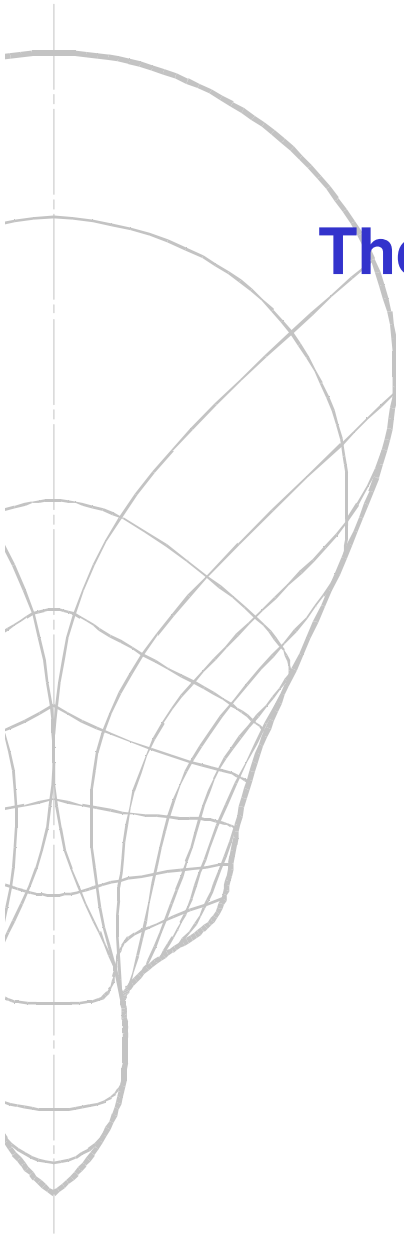

The Energy Efficiency Design Index (EEDI)

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Motivation for EEDI

- CO_2-Output from shipping is expected to increase – not tolerated by society
- CO_2-Output is proportional to fuel consumption (matter of fact)
- All measures to decrease fuel consumption also decrease CO2-footprint.
- Fuel efficient ships are accepted by the market if fuel price is high enough (was not the case in the past)
- CO_2- problem could most efficiently be solved by adjusting the fuel price accordingly (MBI).
- IMO is responsible for CO_2-reduction in shipping.
- IMO does not favour MBIs, but creates an index (EEDI)

Principles of EEDI (1)

The EEDI expresses the impact to environment from shipping versus the benefit to society from shipping

$$EEDI = \frac{\text{Impact to environment}}{\text{Benefit to society}} = \frac{\text{Power*SFOC*} f_{co2}}{\text{Deadweight *speed}}$$

EEDI is measured in gCO_2 per ton mile.

Concept is roughly reasonable, if deadweight would be replaced by payload.

How much EEDI is acceptable ?
Now, political aspects enter the playing field.

Principles of EEDI (2)

The acceptable EEDI (base line definition) depends solely on the deadweight of the ship and the ship type.

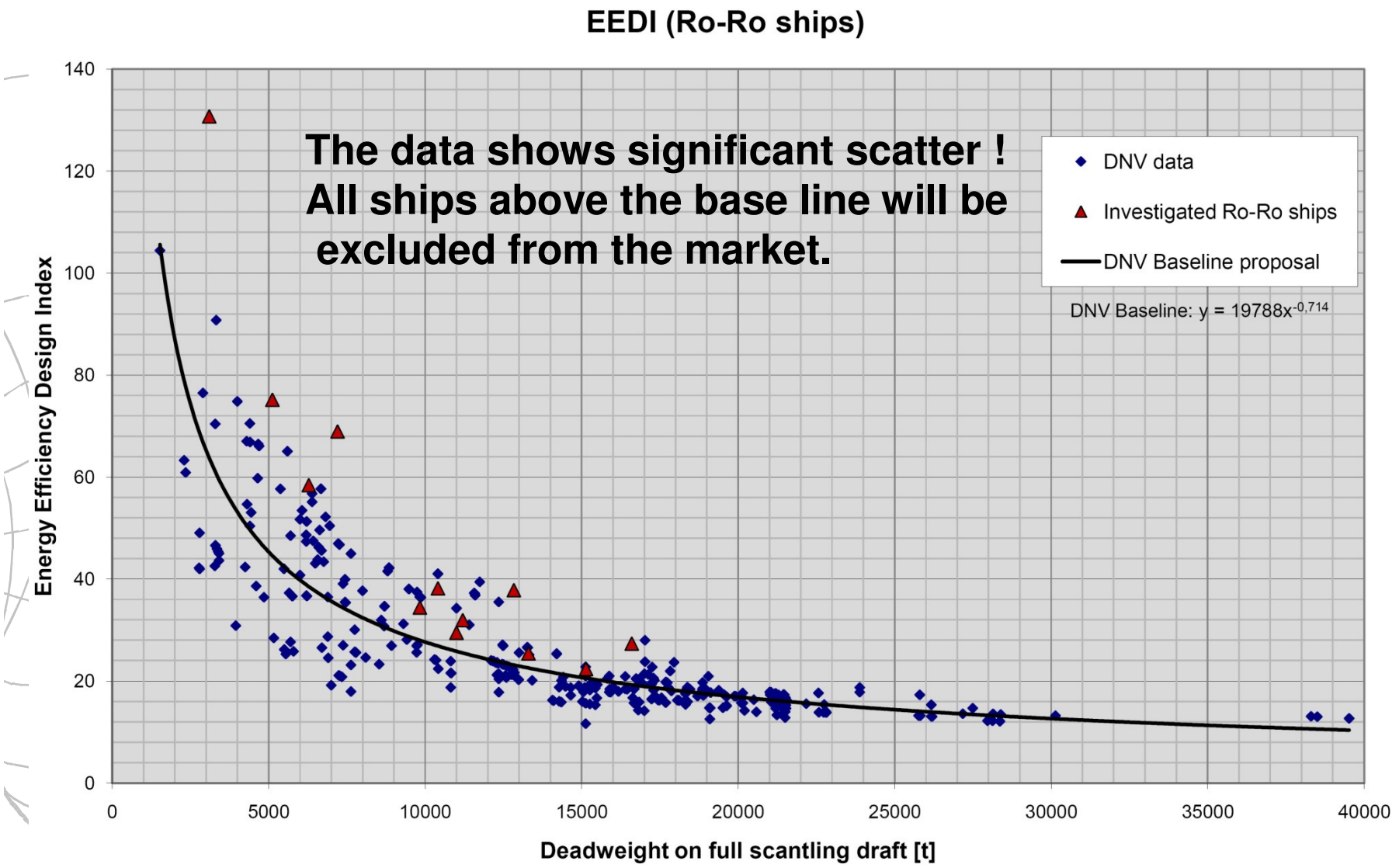
Baseline = F(DW).

A ship is seen as “efficient” if it is slow and big. (Engineers have a different view on this).

The base lines are devloped from regressions over existing data bases (FAIRPLAY).

A newbuilding then must have an EEDI below the prescribed baseline.

Baseline Example for RoRo-Ships



Data Problems

Ship Description in Data-Bases:
(LR, ShipPax, etc.)

Deadweight: from 9050 t to 14260 t
Speed : from 21.20 kn to 21.60 kn
Power : 16200 kW (2 MaK 9 M 43)

Correct data from model test report:

Power	**:**	**12500 kW**	**12500 kW**
Speed	**:**	**21.72 kn**	**20.20 kn**
Deadweight	**:**	**7663 t**	**14191 t**
Draft	**:**	**5.70 m (Design)**	**7.40 m (Full Scantling)**

Conclusion: Only consistent data should be used for EEDI-trials !!
(Extremely important for smaller ships !!)

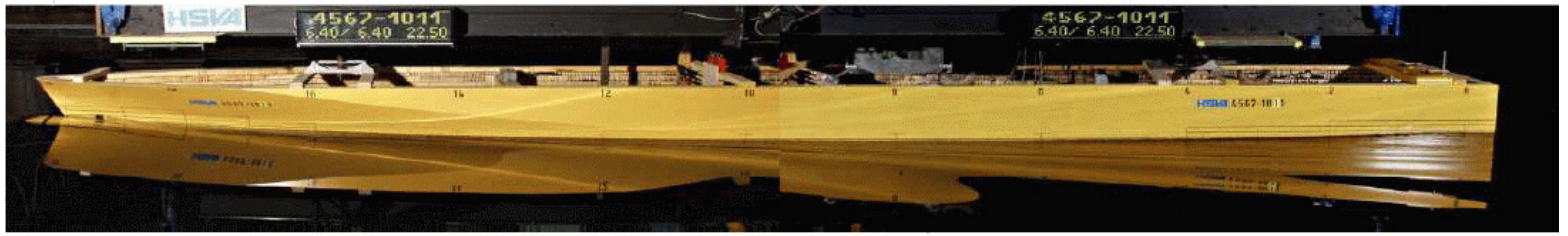
TUHH- Evaluation Procedure

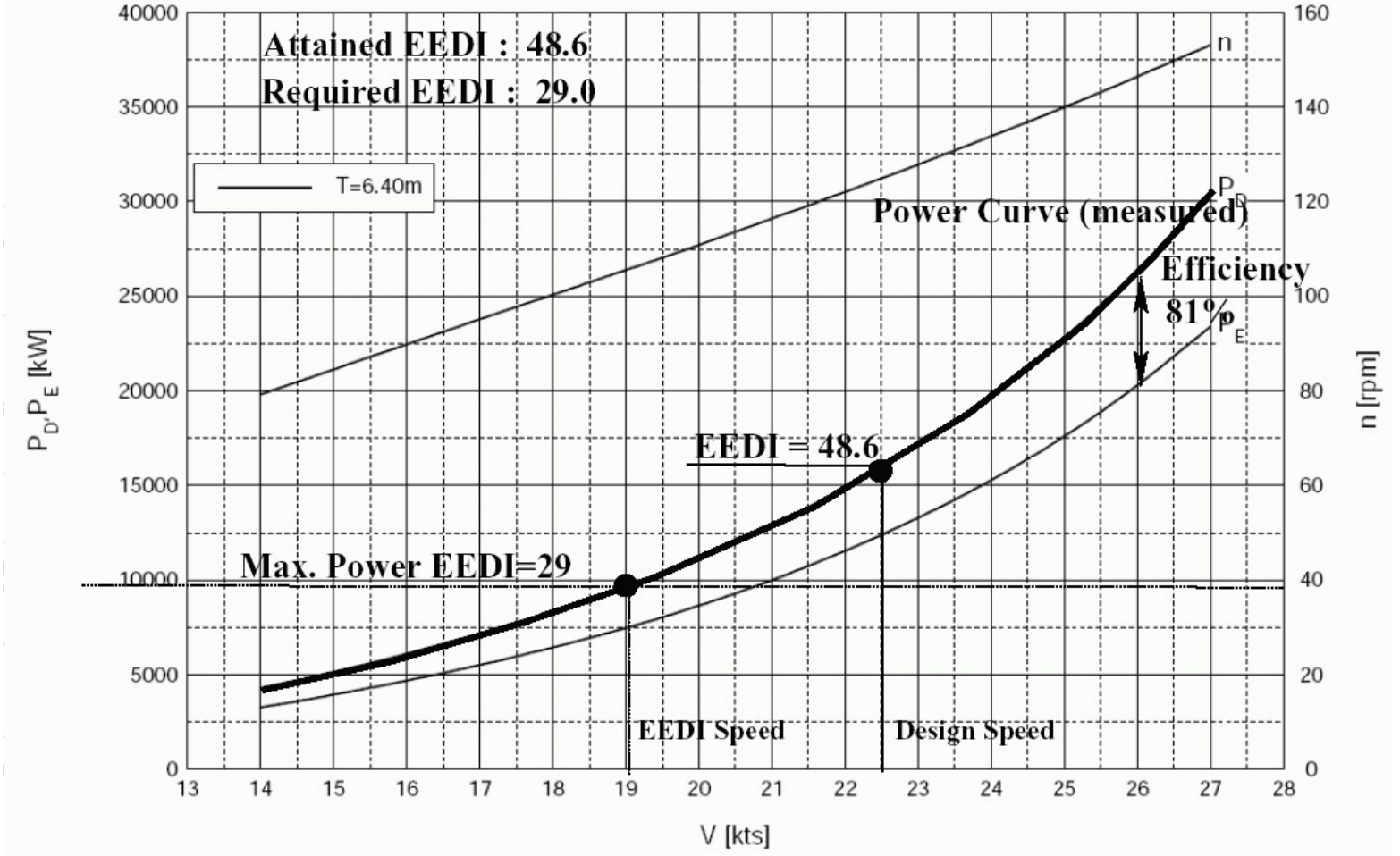
- The EEDI was calculated according to the proposal using only correct model test data, hull form, light ship weights and auxiliary machinery data.

- The EEDI results then in a permissible maximum engine power which can be installed into the ship.

- On design draft including sea and engine margin, this results in the permissible ship speed.

Application: Most efficient RoRo in TUHH DB





Consequence: Speed loss of 3.5 knots or design optimization !

Optimization Potential

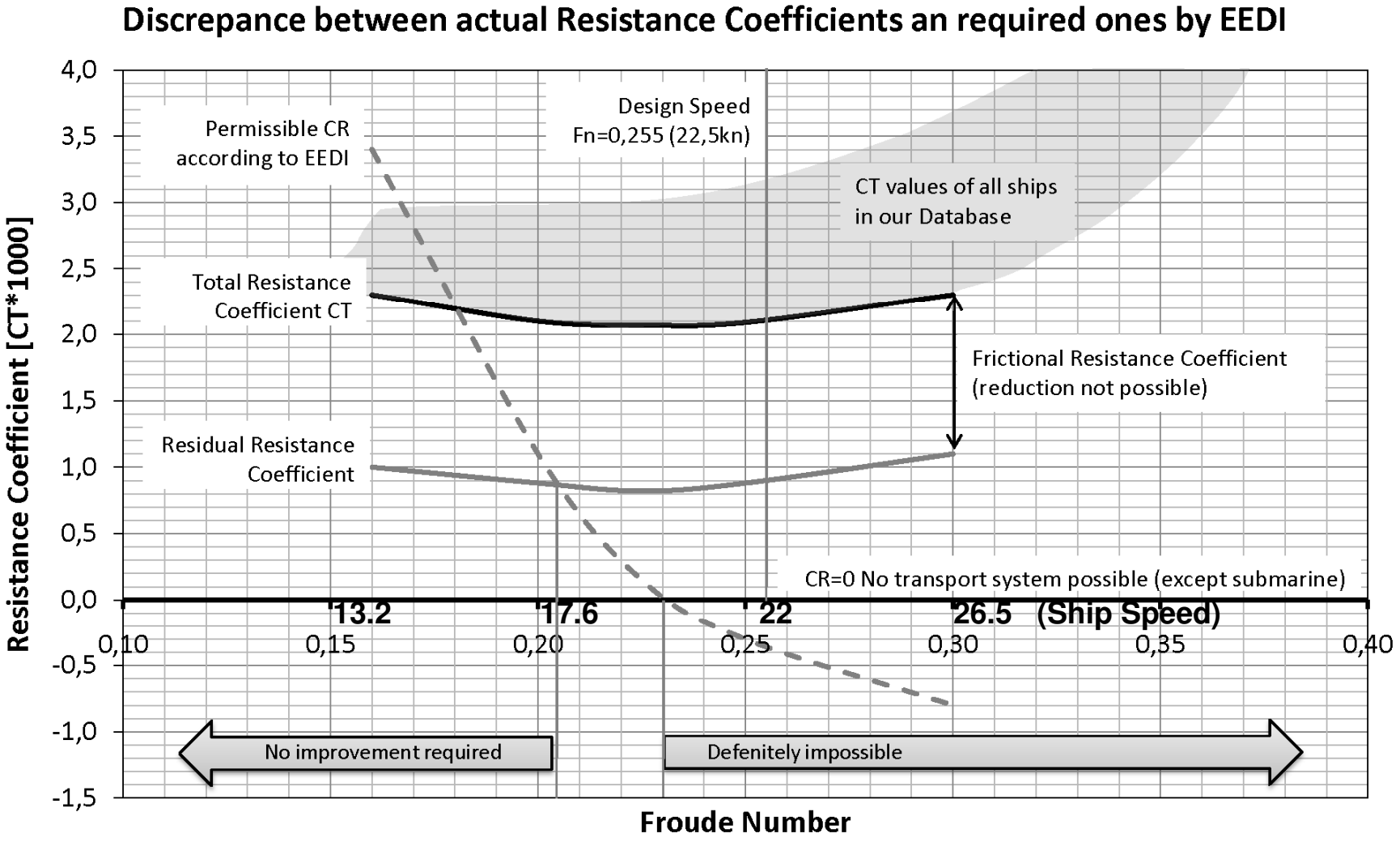
- The EEDI results in a permissible maximum engine power which can be installed into the ship.

- If the ship shall operate at a given speed, this permissible power can not be exceeded.

- This results in a permissible resistance of the ship at that speed.

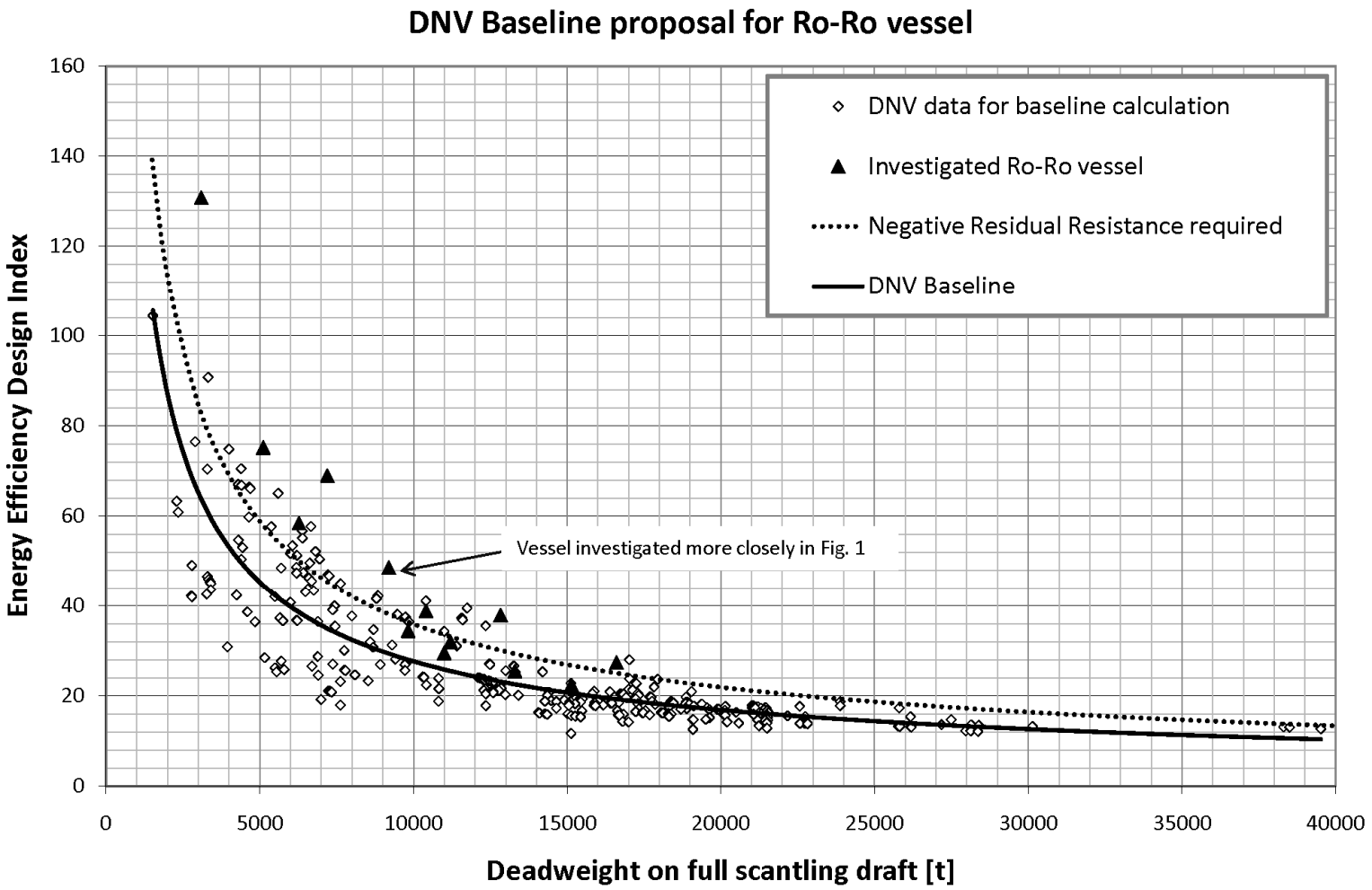
- As the frictional resistance can hardly be influenced by the ship design, this results in a permissible wave resistance.

Best performing ship in our DB



Resistance for a 210m Ro-Ro vessel, v=22,5kn, lane meters= 4800, MCR=23200kW
Best ship in database concerning residual resistance

Consequences

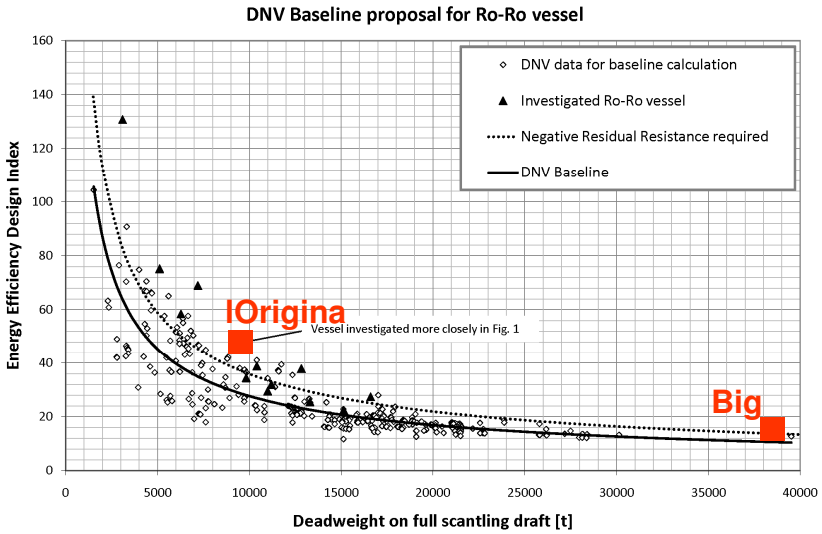


Many ships require negative wave resistances to fulfill the EEDI !
(The ship needs to gain energy from the waves)

Is big really beautiful?

	Original Design	"Big" New design
Length	215.00 m	322.50 m
Beam	28.40 m	44.10 m
Draft	6.40 m	9.60 m
DWT	9200 t	43500 t
Speed	22.50 kn	22.50 kn
MCR	23200 kW	37500 kW
EEDI att.	48.6	16.9
EEDI req .	29.0	9.2
Excess Power	10100 kW	17500 kW
Speed attained	19.1 kn	17.70

The "scatter" is reduced from 19.6 to 7.7.
Speed loss increases from 3.4 kn to 4.8 kn.



Other means of Transport

Example: Airbus A 380 (freight version)

Light Aircraft Weight : 286 t
Max. Take Off Weight : 590 t (including 235t of fuel)
Speed : 491 kn
Consumption : 21.7 t/h

Calculated EEDI for A 380: 342
Permissible EEDI for A 380: 333

???

Obviously, there is something fundamentally wrong with the EEDI.

Some Basic Mathematics

Attained EEDI **Required EEDI**

$$EEDI = \frac{Power \cdot SFOC \cdot f_{CO2}}{DW \cdot v} = Const \cdot DW^{-x} = Baseline(DW)$$

As

$$DW^{-x} = \frac{1}{DW^{x}}$$

If x equals 1 (RoRo: 0.78) this results in:

$$EEDI = \frac{Power \cdot Factor}{v} = Const.$$

(Violates basic principles of ship hydrodynamics!)

Final Conclusions

The EEDI trial applications show the following results:

- **Both EEDI and baseline in combination violate basic physical principles.**
- **Technical possibilities of optimizing the ship design are extremely limited (except significant speed reduction).**
- **The worst problems can be healed if the relevant variables are used for a revised baseline definition.**
- **The baseline concept can be improved, further work is necessary !**
- **The EEDI will then be a powerful instrument to reduce CO_2 Emissions !**