# Seminar 'Monitoren, rapporteren, verifiëren en terugdringen van CO2-emissies'

*17 juni 2015*

PLATFORM SCHONE SCHEEPVAART

KVNR NETHERLANDS MARITIME TECHNOLOGY Port of Amsterdam Port of Rotterdam MARIN TNO innovation for life Stichting De Noordzee

# Programma

| | | |
|---|---|---|
| *14.00 uur* | *Ontvangst* | |
| 14.20 uur | Openingswoord en introductie door dagvoorzitter | Johan de Jong<br>*MARIN* |
| 14.25 uur | Ontwikkelingen in regelgeving rondom monitoring, rapportage en verificatie (MRV) van CO2-emissies van zeescheepvaart | Henk-Erik Sierink<br>*Senior Policy Advisor,*<br>*Ministerie van Infrastructuur & Milieu*<br><br>Thijs Hasselaar<br>*Senior Project Manager, MARIN* |
| 14.50 uur | Zijn ambitieuze EEDI doelen haalbaar? Ontwikkeling van de efficiëntie van nieuwe schepen 1960 – 2014 | Jasper Faber<br>*Aviation and maritime specialist,*<br>*CE Delft* |
| 15.15 uur | Perspectief van een verlader: Duurzaamheid en verminderen van emissies | Kim van Neer<br>*Category Manager Global Distribution,*<br>*DSM Sourcing* |
| *15.40 uur* | *Pauze* | |
| 16.00 uur | EU Project Retrofit: Een aanpak van CO2-reductie voor bestaande schepen | Gerco Hagesteijn<br>*Senior Project Manager, MARIN* |
| 16.25 uur | Groene sleepoperaties met een hybride E-KOTUG | Koos Smoor<br>*Innovation Manager, KOTUG* |
| 16.50 uur | CO2-besparing in de praktijk: Oplossingen voor coasters | Gaby Steentjes<br>*Fleet Director, Rederij Flinter* |
| 17.15 uur | Vragen en discussie | Onder leiding van dagvoorzitter |
| *17.30 uur* | *Netwerkgelegenheid* | |

# Seminar Monitoren, rapporteren, verifiëren en reduceren van $CO_2$ emissies. 17 juni 2015.

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# Platform Schone Scheepvaart

Milieu en economie samen laten opgaan in de bestrijding van ongewenst emissies.

www.schonescheepvaart.nl

# Waarom dit seminar?

- EEDI is nu ruim 2 jaar ingevoerd.
- Ontwerpen voor afname ≡ ontwerpen voor operaties?
- Invoering MRV -> EEOI
- Wat kunnen we doen?

Operatie kan gedomineerd worden door :

- Regelmatig extreem weer.
- Regelmatig afwijkende snelheden of zelfs low power operaties (stand by).
- Sterk afwijkende belading waardoor afwijkende diepgang en trim.
- Varierende ondiepwater operaties.

Invoering MRV wrschl opgevolgd door IMO.

Complex materie omdat eenvoudige verbanden ontbreken dus met eerste invoering vooral awareness kweken en ervaring op doen.

Big Data.

Ministerie van Infrastructuur en Milieu

# Platform Schone Scheepvaart 17 juni 2015

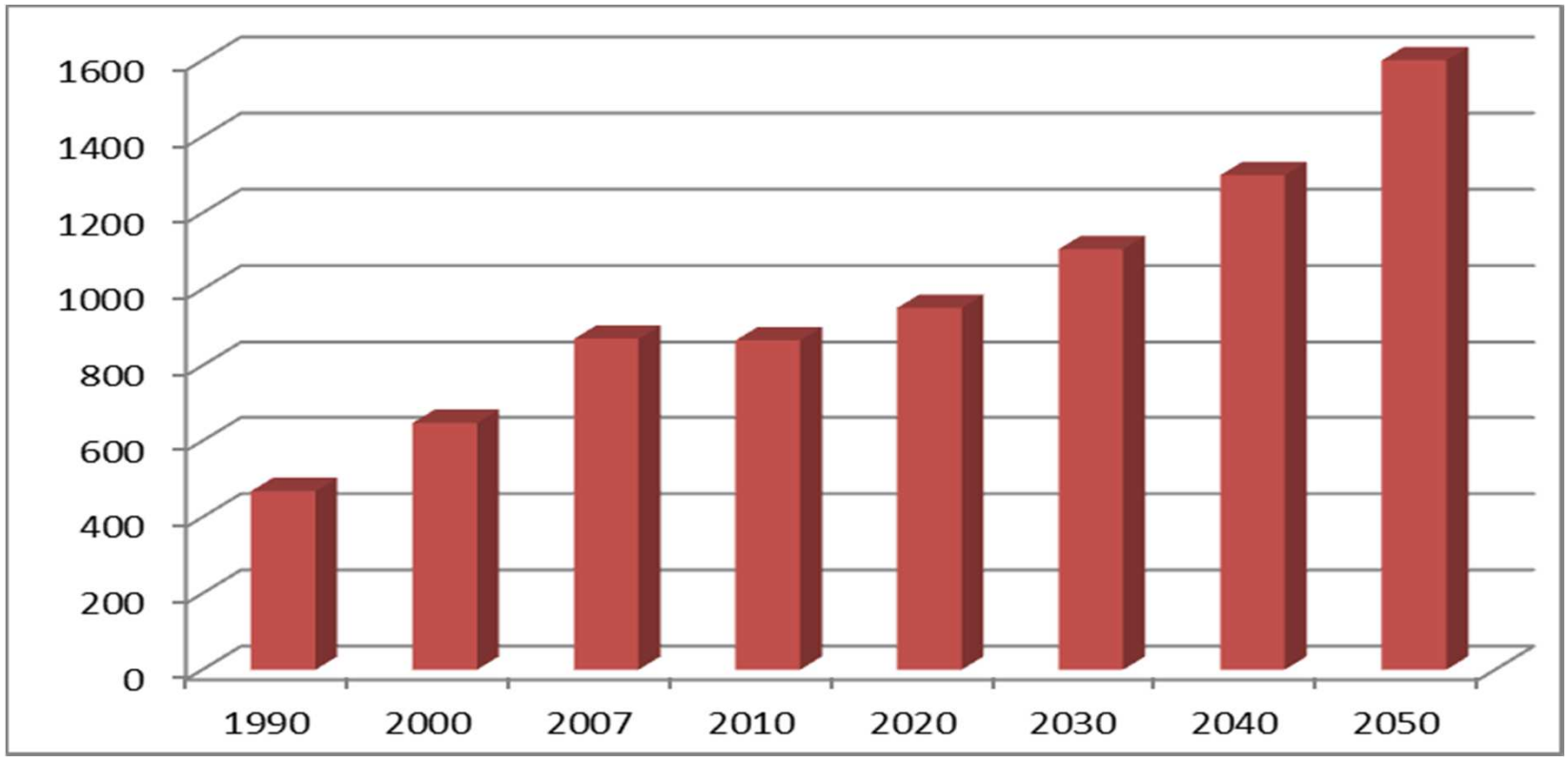
1. EU Verordening 2015/757 Monitoring, Rapportage en Verificatie van maritieme $CO_2$ emissies (EU MRV)

2. IMO - mondiaal data collectie systeem

19 juni 2015

# Studies laten zien: groeiende uitstoot $CO_2$

## Verwachte groei van maritieme $CO_2$ emissies (mln ton)



# Aanvullende maatregelen nodig

- Juli 2011 IMO (Internationale Maritieme Organisatie) besluit over:
  - Energy Efficiency Design Index (EEDI; nieuwe schepen)
  - Ship Energy Efficiency Management Plan (SEEMP; alle schepen)

- Aanvullende maatregelen nodig
- Groot potentieel technische en operationele maatregelen
- Maar: belemmeringen voor implementatie, zoals 'split incentives'
- Transparante informatie moet dit overwinnen

- Bovendien: debat over marktgerichte maatregelen zit vast
- US voorstel gericht op data collectie en verbeteren Energy Efficiency

# 1. EU MRV – achtergrond / aanpak

- In licht ervaringen luchtvaart ETS debat
  - Geen maritiem ETS
  - voorkeur mondiale maatregelen

- Aansluiten bij IMO; data collectie en energy efficiency
- Europese Commissie: gefaseerde aanpak
- 1e stap MRV; dan doelstelling bepalen en marktgerichte maatregelen

- EU MRV moet debat IMO voeden
- Aansluiten bij bestaande methodes
- Administratieve lasten beperkt houden
- Robuuste data ook ivm vaststellen reductiedoelstelling

# EU MRV - Scope

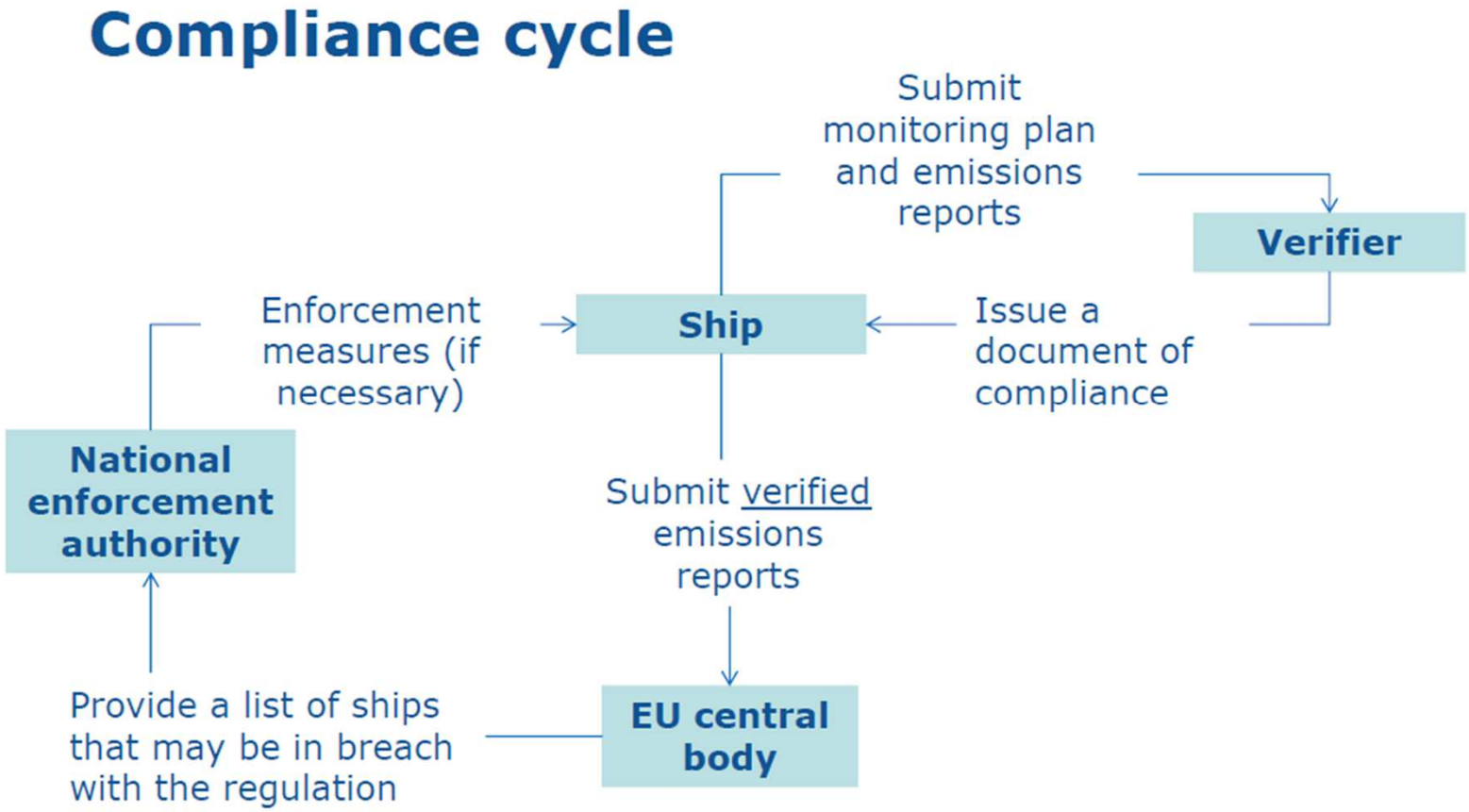
- Scope
  - Reizen van en naar EU havens (geen baggerschepen)
  - Alleen 5000gt en meer
  - Alleen $CO_2$
  - Moet inzicht bieden in Energy efficiency
  - Bijzondere schepen uitgezonderd (Defensie, Visserij)

- Keuze tussen bestaande monitoring methodes, bijv.
  - BDN
  - fuel tank monitoring
  - flow meters
  - meten emissies

# EU MRV – Rol private verificateurs

- Private verificateurs:
  - Controleren monitoring plan reders
    - Uiterlijk augustus 2017
  - Beoordeling emissieplan reders
    - Uiterlijk april 2019
  - Afgifte Document of Compliance door verificateur
    - Verplicht aan boord vanaf 1 juli 2019
    - 18 maanden geldig (na afloop rapportage periode)

# EU MRV – Naleving (1)



# EU MRV – Naleving (2)

- EU lidstaten
  - controleren op basis Document of Compliance
  - stellen een effectief, proportioneel en afschrikkend sanctiesysteem in
  - implementeren per 1 juli 2017
- Implementatietraject in NL gestart
  - Bespreking met ILT en NEa over taakverdeling (inspectie & handhaving)
  - Bespreking met sector wordt gepland

# EU MRV - Monitoring

- Vanaf 1 januari 2018: Monitoren van iedere voyage[1] van, naar en binnen EU havens
  - Afgelegde afstand
  - De tijd benodigd per voyage
  - Vervoerde vracht of aantal passagiers
  - Transport work (afstand x vracht)
- plus de totalen hiervan per jaar
  - Aangevuld met de gemiddelde energy efficiency

1. *Uitzondering: schepen die alleen en volgens planning 100x of vaker EU havens aandoen*

# EU MRV – Rapportage en publicatie

- Vanaf 1 april 2019: jaarlijkse rapportage van de bovengenoemde gegevens, inclusief:
  - identificatiegegevens van schip en bedrijf
  - technische efficiency (EEDI of EIV)

- Vanaf 30 juni 2019 publiceert de Europese Commissie jaarlijks de geaggregeerde gegevens
  - Ook de energy efficiency van de schepen.
  - Wel mogelijkheid vermelden aanvullende informatie (over lading, operatie, type schip, etc)

# EU MRV - Energy Efficiency

- Tweede deel presentatie door Thijs Hasselaar / Marin over efficiency

- Verder van belang dat EU MRV voorziet in:
  - Uitvoeringshandeling inzake definitie vracht
  - Gedelegeerde handelingen inzake monitoring en berekening efficiency

- EC organiseert ESSF (European Sustainable Shipping Forum)
  - Werkgroep monitoring (*8 juli*)
  - Werkgroep verificatie en accreditatie (*7 juli*)

# 2. IMO milieucomité (MEPC)

- Klimaatmaatregelen IMO
  - Technische maatregelen
  - Operationele maatregelen
  - Marktgerichte maatregelen

- Huidige maatregelen (EEDI en SEEMP) onvoldoende
- Marktgerichte maatregelen (MBM) nodig, maar debat stokt …

- Voorstel VS voor gefaseerde aanpak:
  - data collectie (zo breed mogelijk)
  - analyse
  - energy efficiency standaard ter stimulering technische en operationele maatregelen

# IMO - onderhandelingen over data collectie

- Steun voor VS voorstel gefaseerde aanpak en start met data collectie

- Onderhandelingen over mondiaal data collectiesysteem vorderen
- Doel: inhoudelijk debat over reductiemaatregelen gebaseerd op energy efficiency

- Openstaande issues oa:
  - Vrijwillig / verplicht
  - Wel / niet Transport Work (ergo: energy efficiency)

- Werkgroep bespreekt die punten in september dit jaar
- Volgende MEPC: mrt / apr 2016

– Vragen?


# TOWARDS A REALISTIC $CO_2$-MRV MODEL FOR MERCHANT SHIPPING

Thijs Hasselaar

June 2015

# MRV OBJECTIVES

- Aim; more competition and reduced emissions
- Problem: Market barriers
  - Reliable information on fuel efficiency of ships or ESDs?
  - Access to finance investments into ship efficiency?
  - Split incentives

- EU wishes a public database so that freighters can choose most efficient ship to transport their goods
  - Insight into performance of individual ships, operational costs, resale value

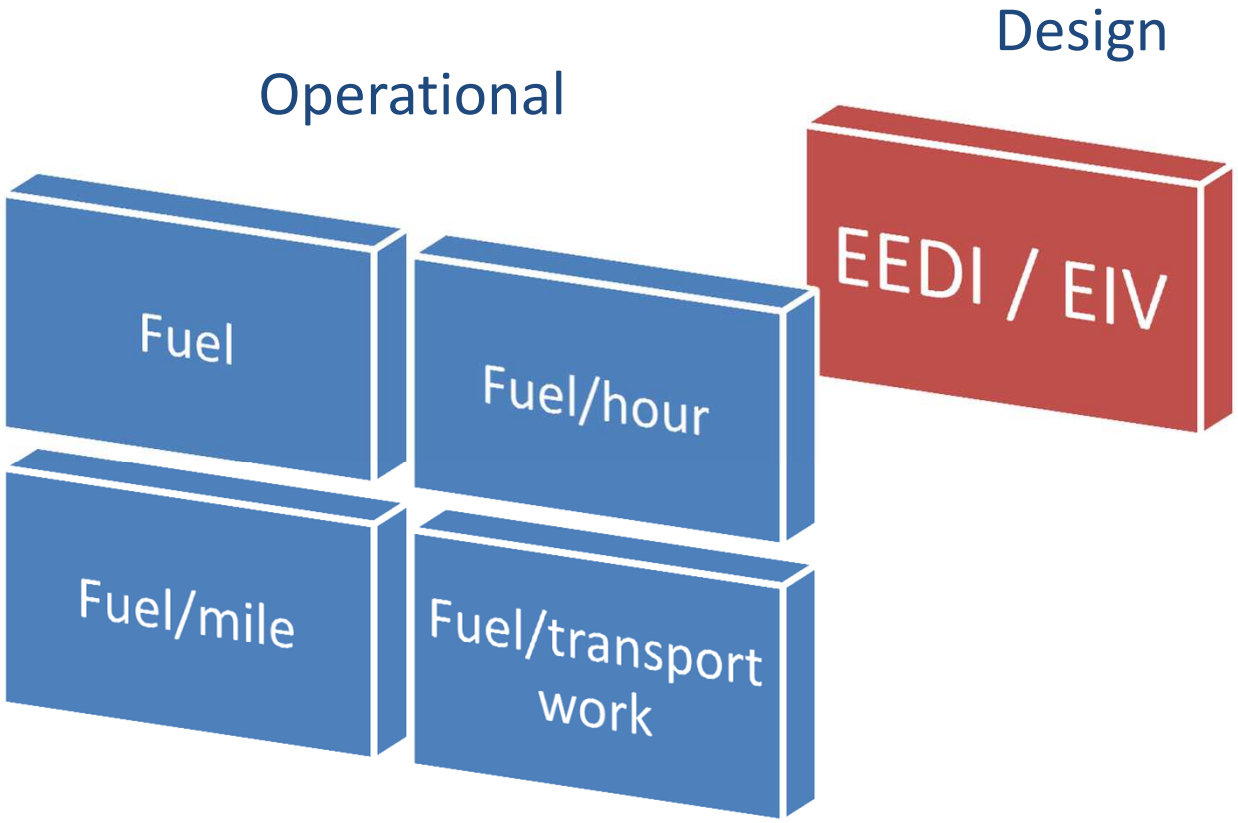
Source: EUROPEAN COMMISSION PRESS RELEASE Brussels, 28 June 2013

# FUEL EFFICIENCY

- Ship efficiency: influenced by
  - Design (hull, propeller, engine, energy management, ESD)
  - Draft / Trim
  - Fouling, roughness

- Operational efficiency: influenced by
  - displacement (loading, ballast water)
  - ship speed
  - environmental conditions
  - type of cargo (hotel load, cargo density)
  - ship efficiency

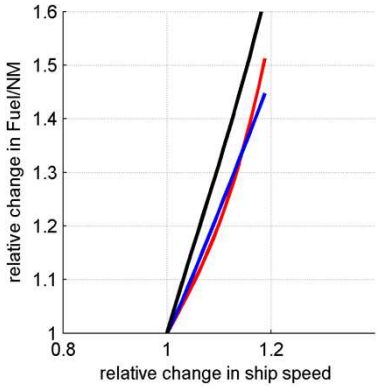
# FUEL EFFICIENCY INDICATORS

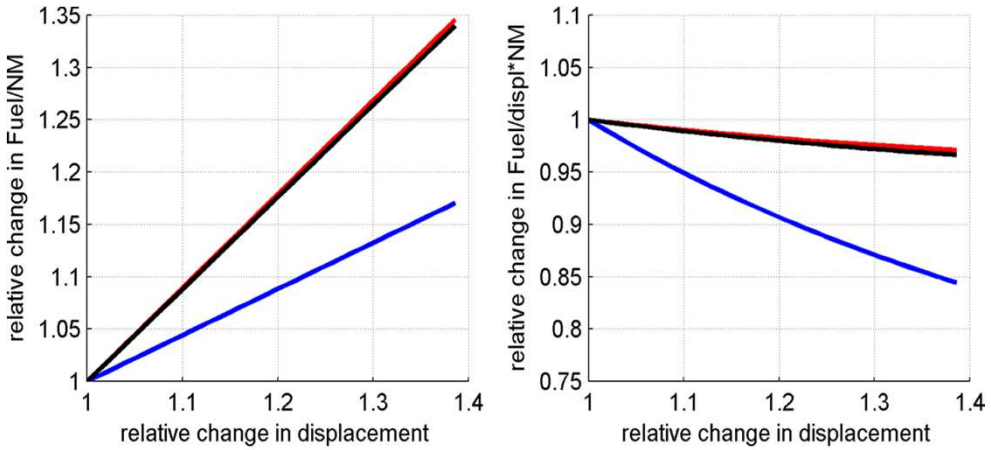


# FACTORS AFFECTING OPERATIONAL PERFORMANCE

- Objective : *'Reliable information on fuel efficiency of ships or ESD's*
- Fluctuations due to changes in
  - Speed: FC = const x $Vs^{3.5}$
  - Cargo:

$$Efficiency \approx \frac{Fuel\ consumption}{cargo\ carried}$$

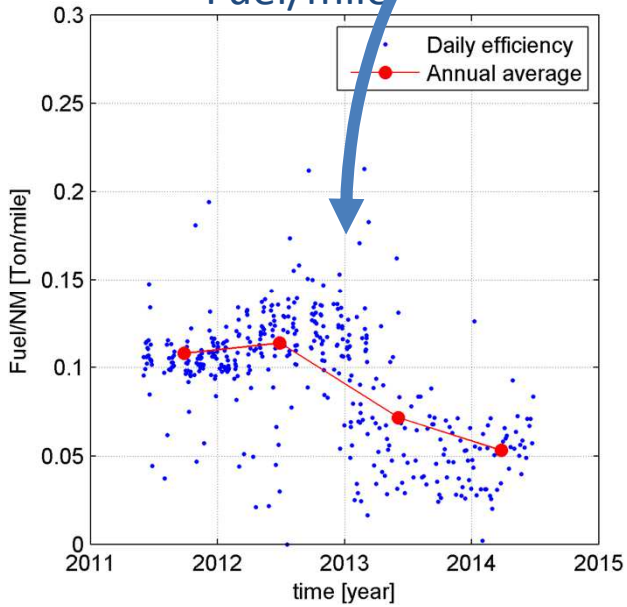


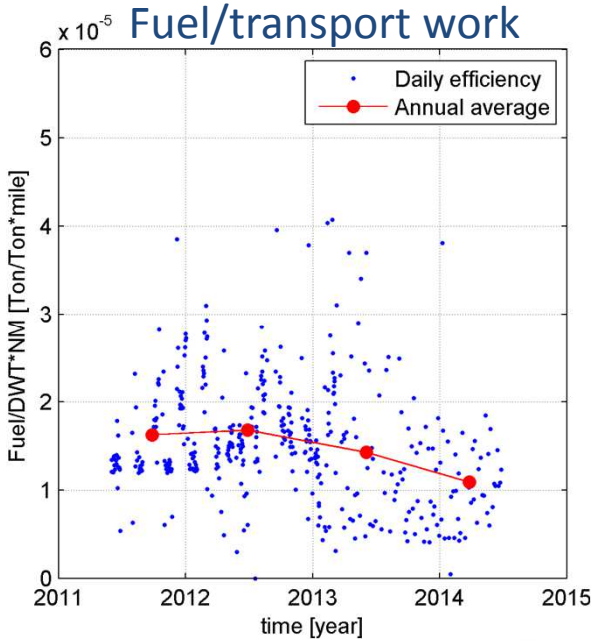
# FACTORS AFFECTING OPERATIONAL PERFORMANCE

- Speed drop
- Decrease in cargo

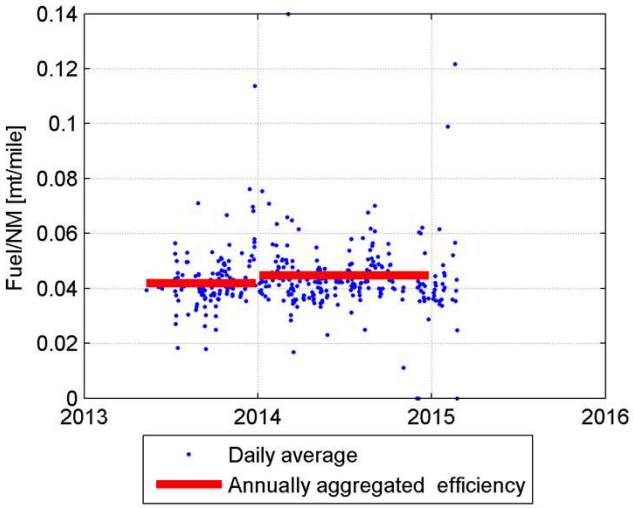
Fuel/mile

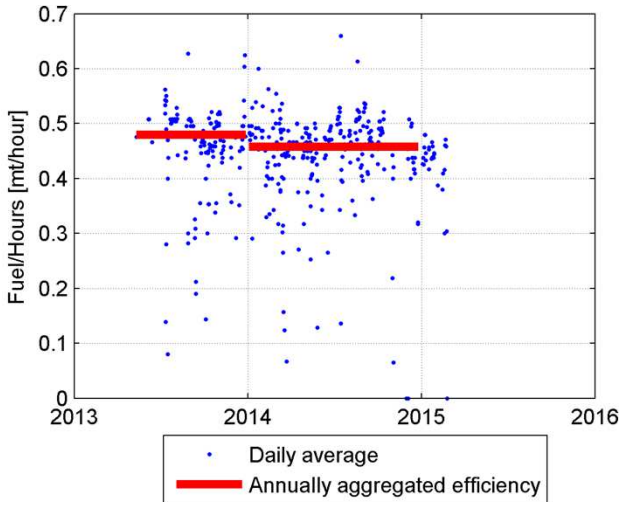


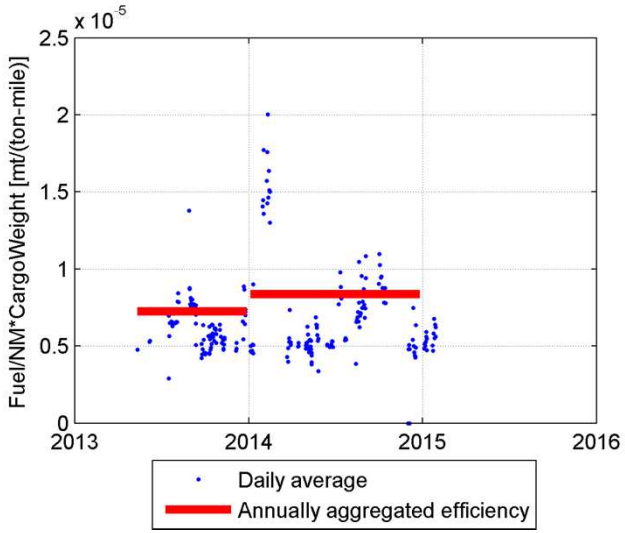

Fuel/transport work



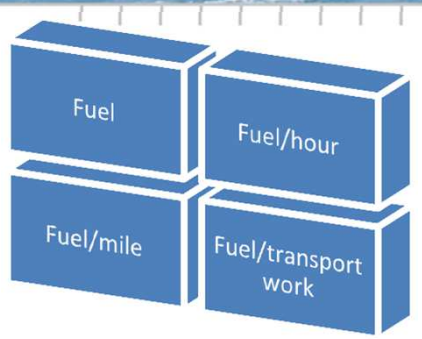
# FACTORS AFFECTING OPERATIONAL PERFORMANCE




# TRANSPORT WORK DEFINITION




- Transport work per voyage :
  - *'distance travelled x amount of cargo carried'*
- *Annual transport work:*
  - *Total transport work*

Transport work
Ballast voyages = 0!

- Highest Operational efficiency → maximum transport work
  = maximum amount of cargo onboard

- Cargo carrying capacity depends on:
  - Cargo density
  - Ballast requirements
  - Special handling requirements

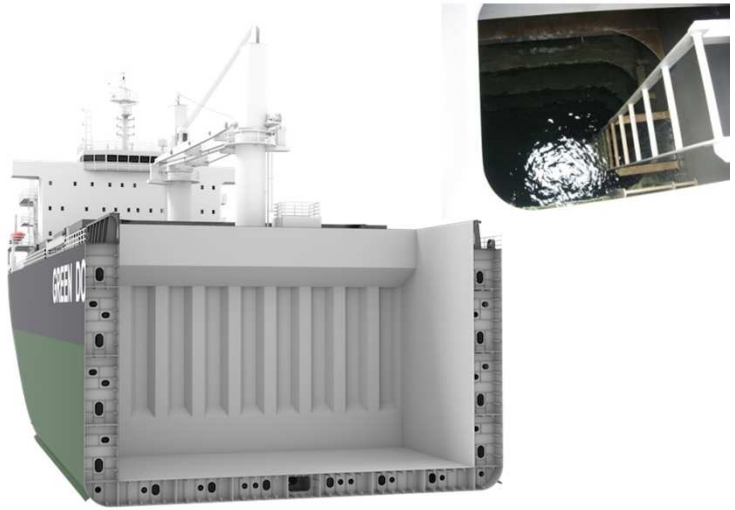
# TRANSPORT WORK DEFINITION

- How to quantify cargo?
  - Volume [m3, TEU, lane-meters]
  - Mass [mt]
  - Quantity [people, …]

- How to deal with different cargo types?
  - DWT cargo
  - Volume cargo
  - Project cargo
  - Grain cargo


# BALLAST WATER REQUIREMENT

- Most cargo requires ballast water
  - Necessary for stability & safe navigation
  - Smoothens out density differences
  - Easier to interpret annual averages
    - Includes ballast voyages

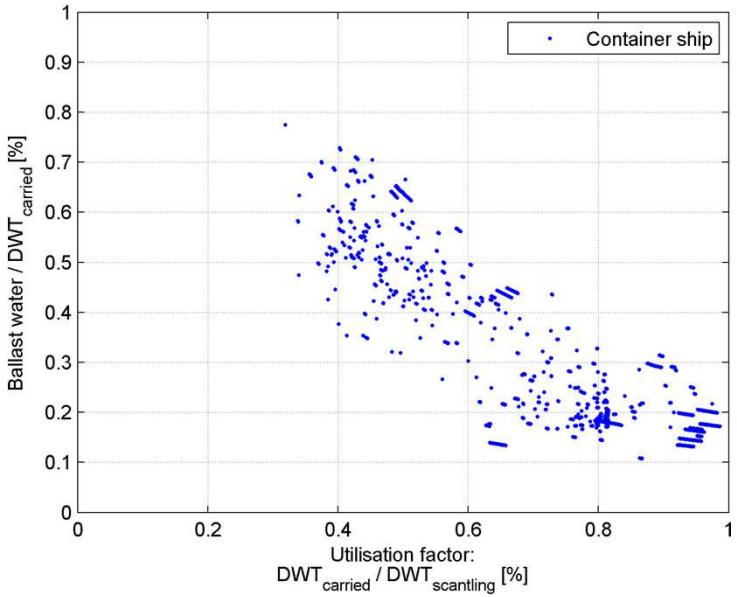


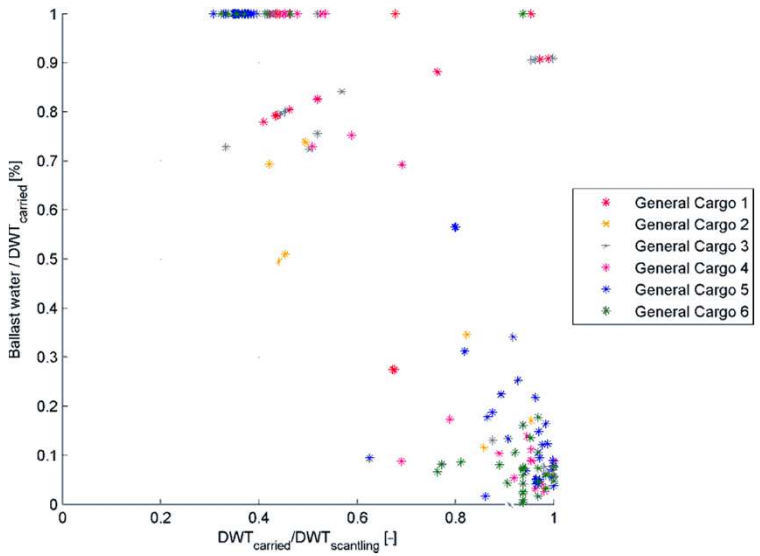
# SENSITIVITY ANALYSIS; DISPLACEMENT

- Fuel consumption = F(Δ, Vs)

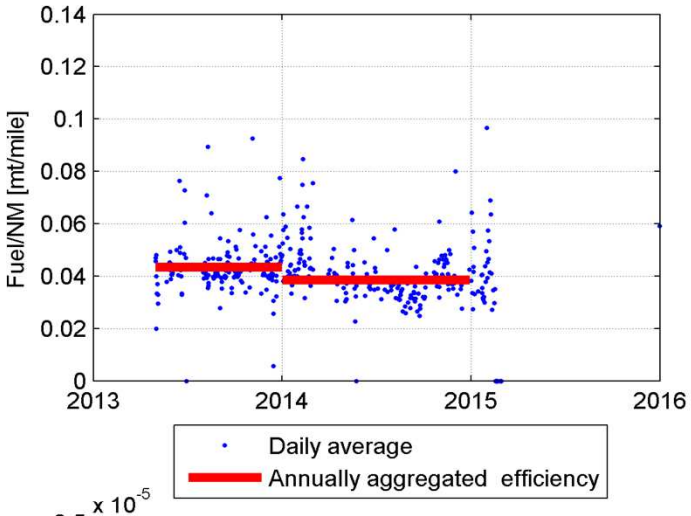
Light ship + cargo + ballast water + consumables

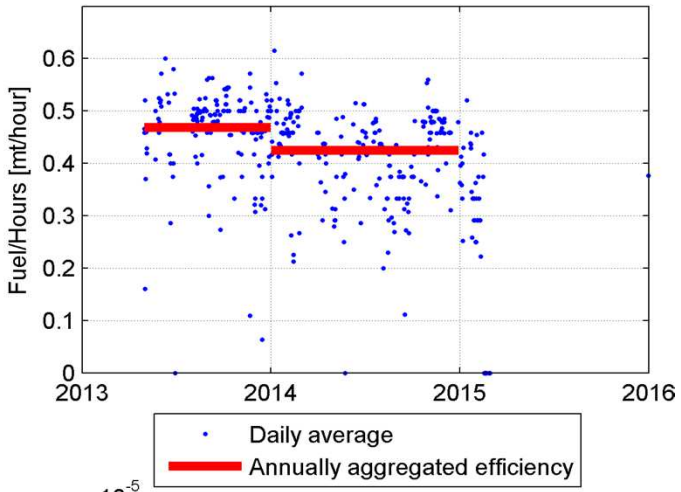
Deadweight (DWT)

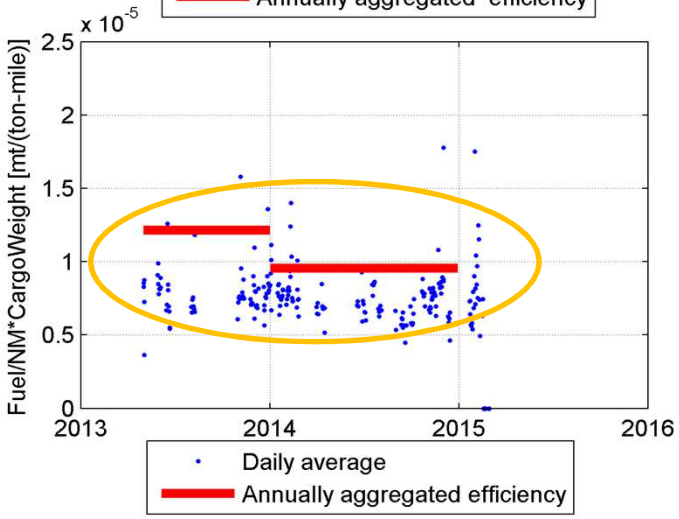


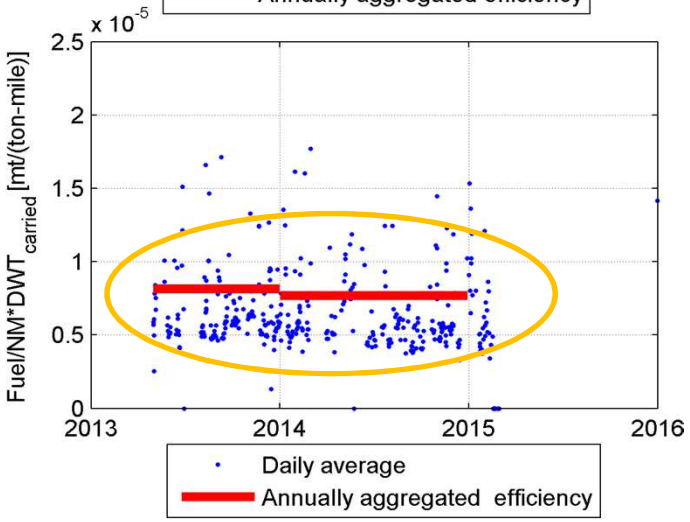



# INTERPRETATION OF ANNUAL AVERAGES



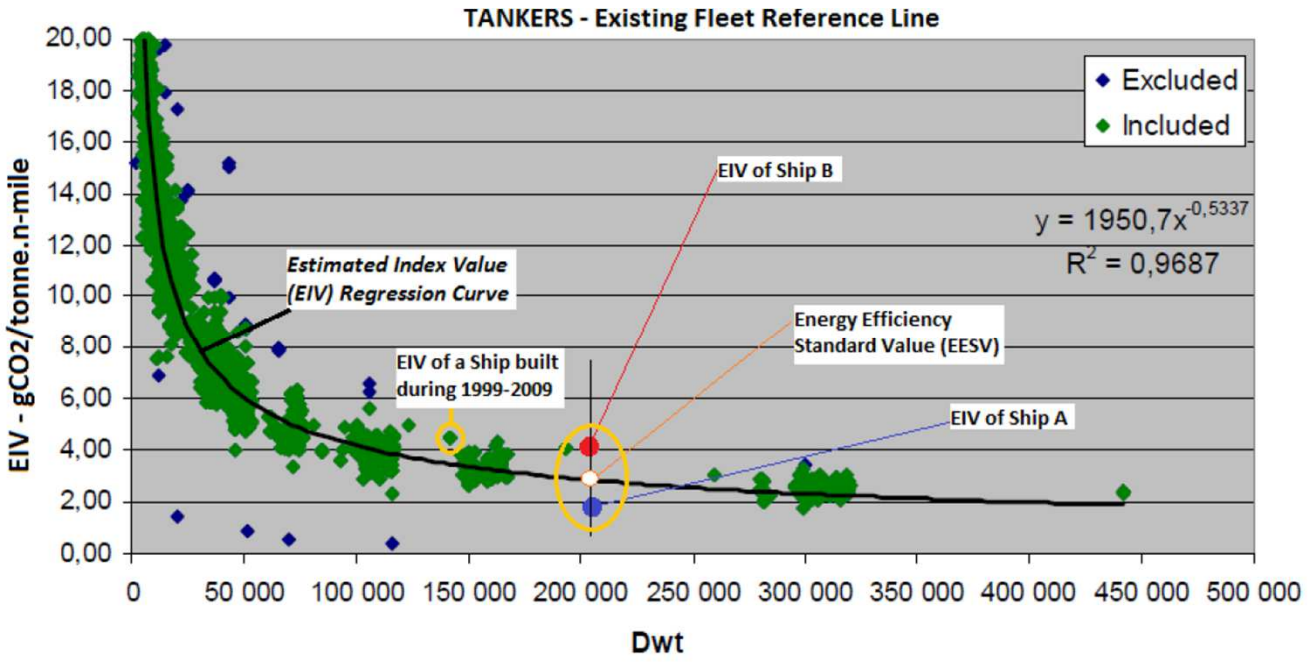



# DIFFERENTIATED FUEL SAVING TARGETS

- MRV requires reporting of EIV / EEDI
  - Not a measure of efficiency, more about vessel capacities!

- Can be used for differentiated improvement measures
  - % improvement * design efficiency factor



# CONCLUSIONS

- MRV focuses on *operational* performance
- KPI not decided, yet large differences
- KPI with transport work → more meaningful KPI
  - Suggest DWT-carried to quantify cargo
  - Include ballast
  - More meaningful than cargo weight, more reliable data

- Individual ship performance difficult to evaluate
- Suggest: individual efficiency target, based on design EIV

# THANK YOU!

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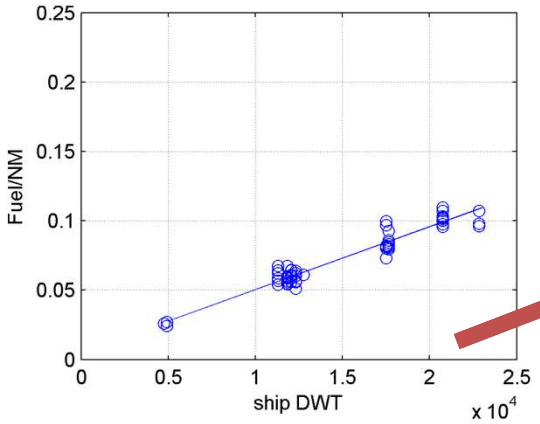
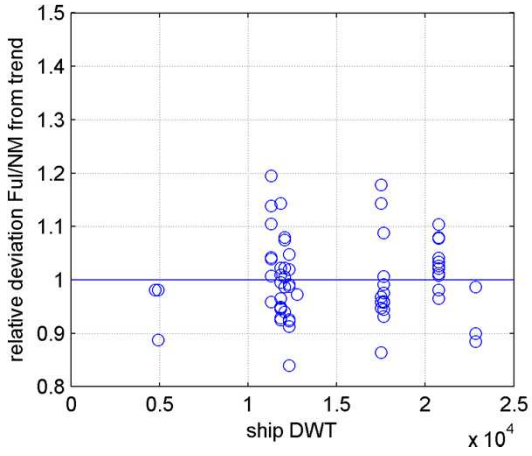
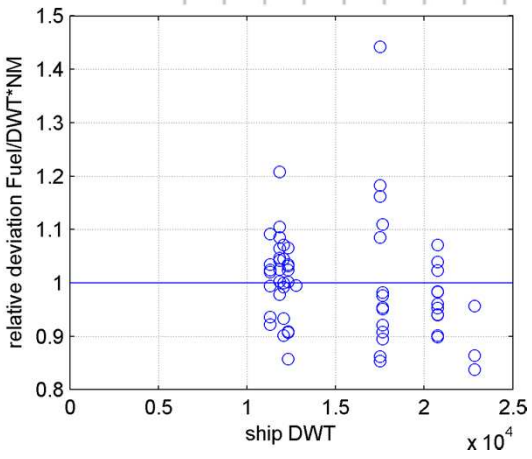
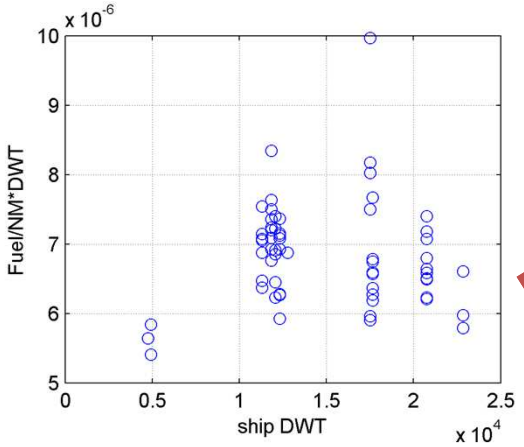
# CASE STUDIES

- General cargo vessels



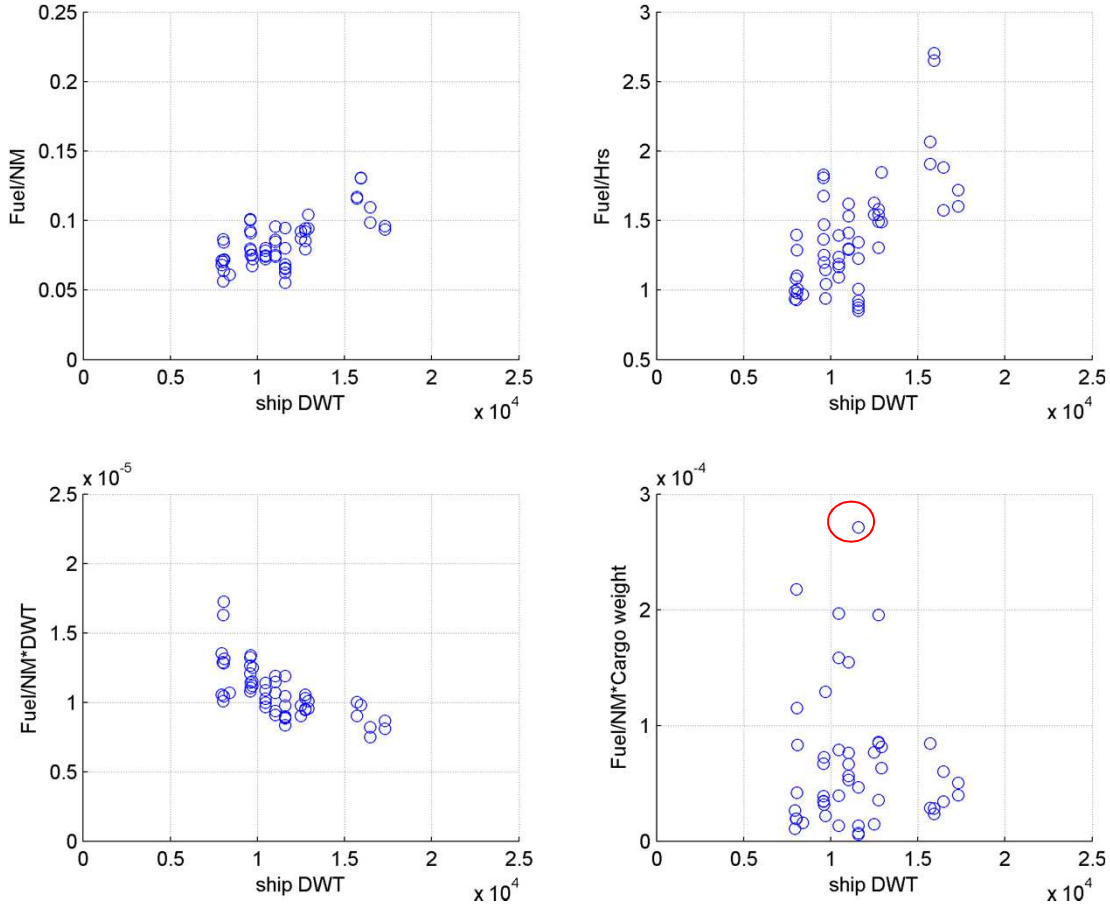



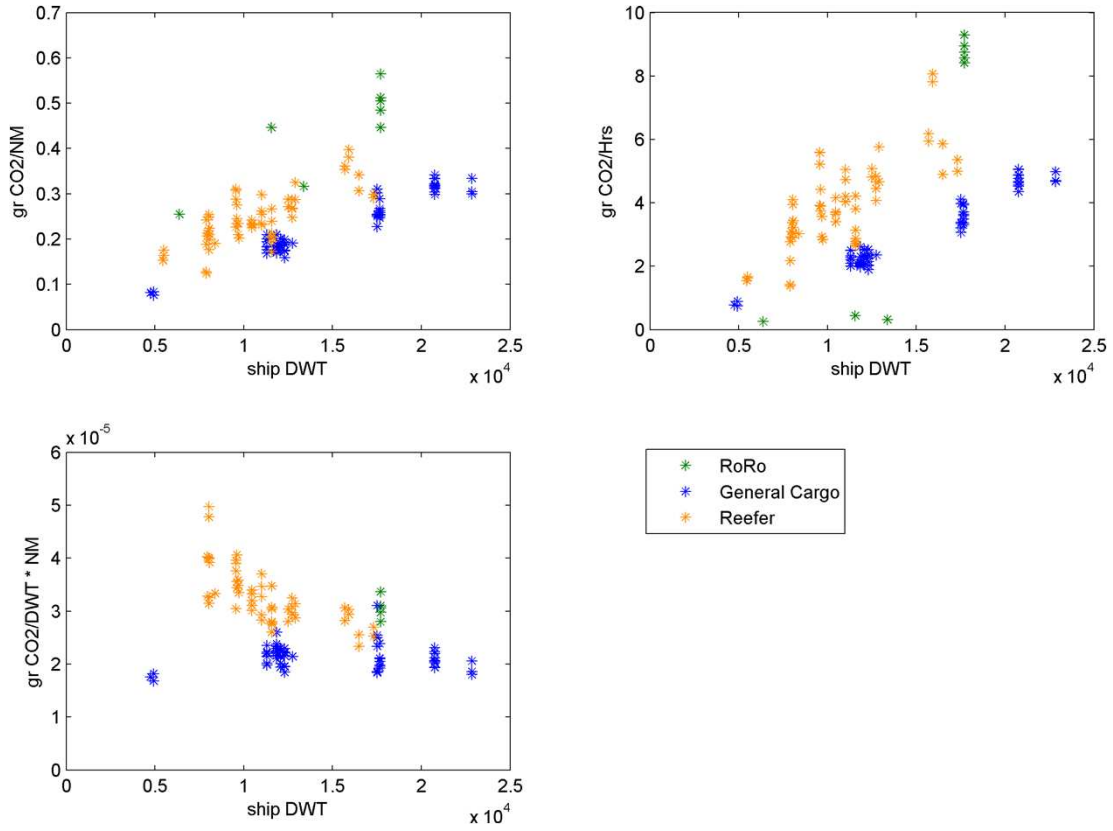
# CASE STUDIES

- Reefer vessels



# CASE STUDIES

- CO2 emissions for all analysed ships



# Design efficiency of ships - historical developments and impact of the EEDI

Platform Schone Scheepvaart, 17 juni 2015

CE Delft

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# Outline

- Policy relevance of this study
- Methods for assessing design efficiency of ships
- Historical development of design efficiency of ships
- Recent developments in design efficiency
- Conclusions

# Policy relevance

- Design efficiency of ships is regulated since 2013.
- New ships need to have an Energy Efficiency Design Index (EEDI) that is better than a reference line.
- In the next years, the minimum required distance to the reference line will increase by 10% (2015), 20% (2020) and 30% (2025).
- A review of the 20% target is being conducted.

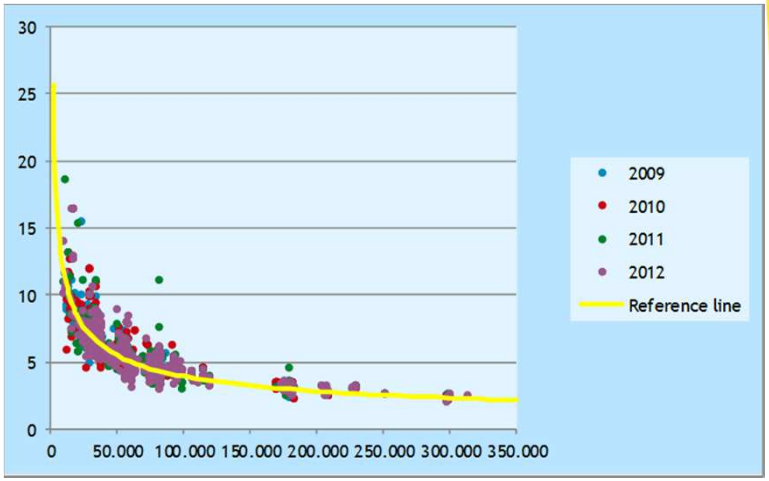
- The reference line has been defined as the best fit power curve through the Estimated Index Values (EIVs) of ships that have entered the fleet between 1999 and 2008.
- The EIV is a simplified form of the EEDI.

# Methods for assessing design efficiency of ships

- Estimated Index Value (EIV) (tonne $CO_2$/tonne.nm)

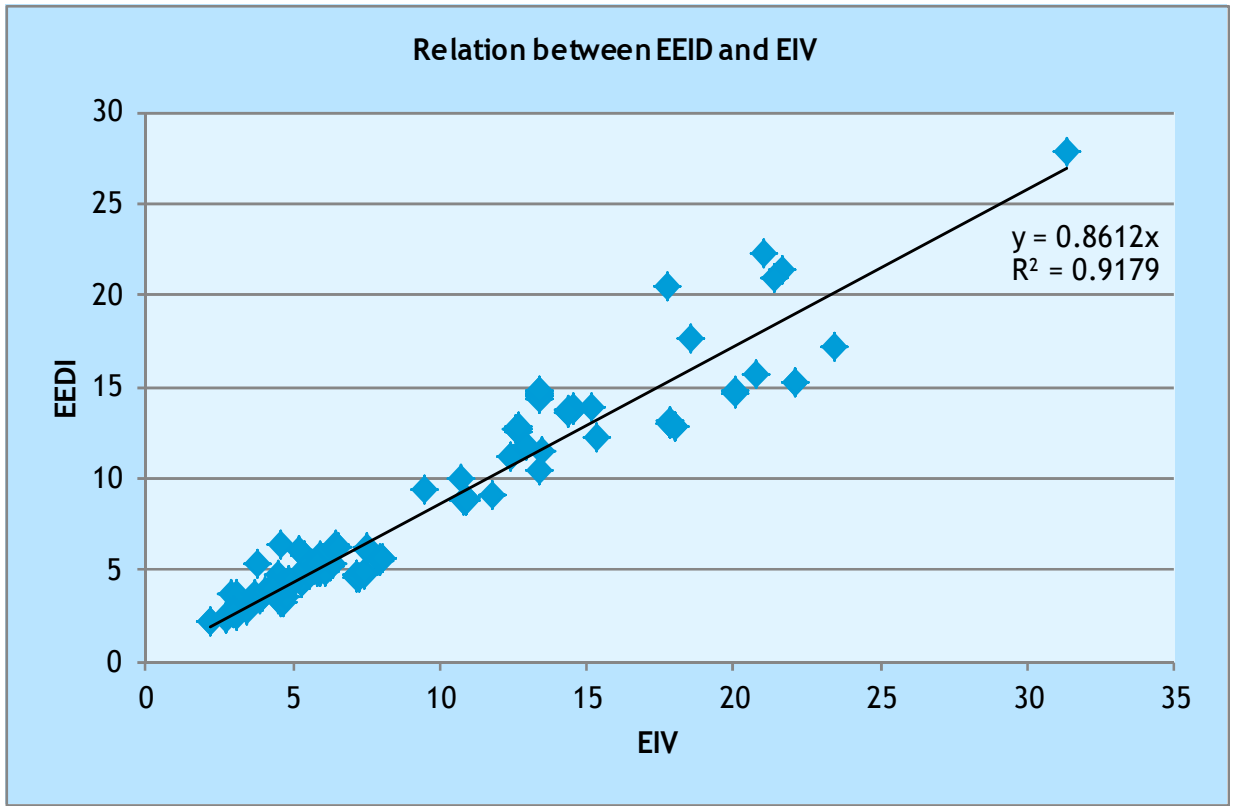
$$Estimated\ Index\ Value = 3.1144 \cdot \frac{190 \cdot \sum_{i=1}^{NME} P_{MEi} + 215 \cdot P_{AE}}{Capacity \cdot V_{ref}}$$

- EIV declines with size of the ship
- Therefore, we use the average relative difference between the EIV and the EEDI reference line as the indicator of the design efficiency of ships



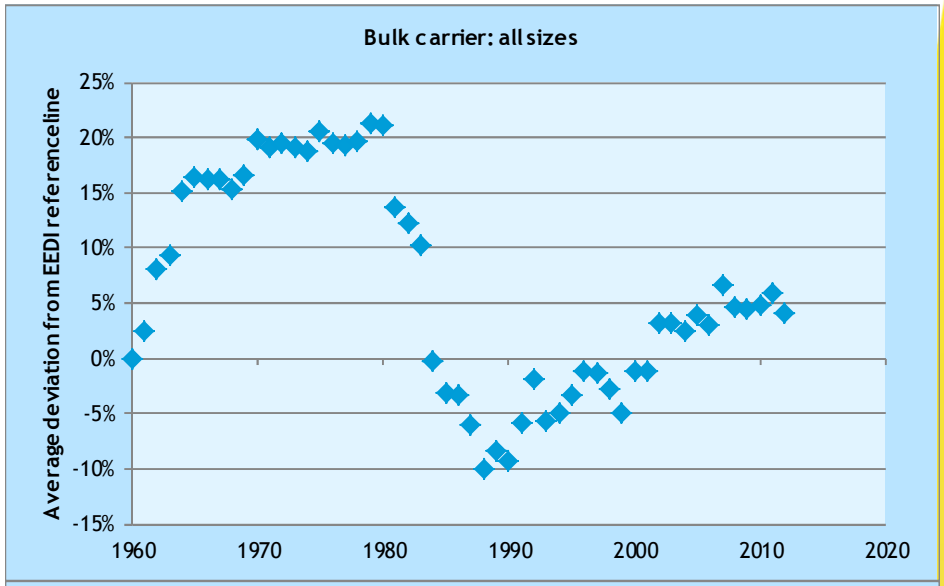
# Methods for assessing design efficiency of ships

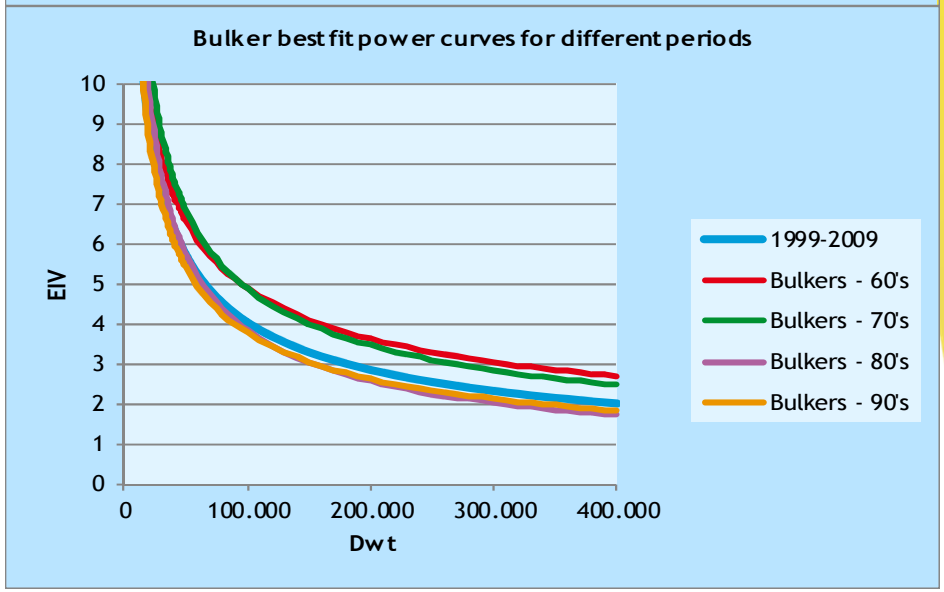
- Strong correlation between EEDI and EIV



# Historical development of design efficiency

Bulk carriers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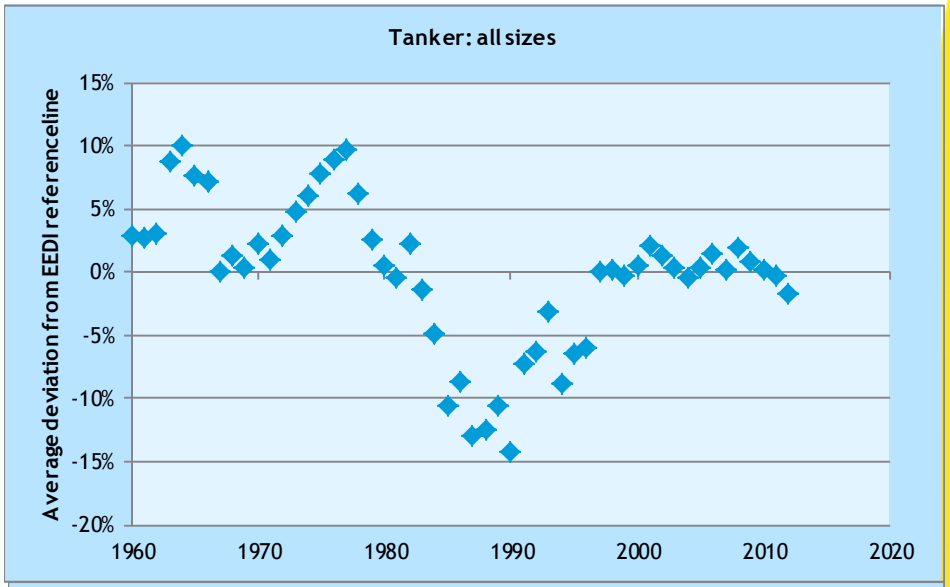
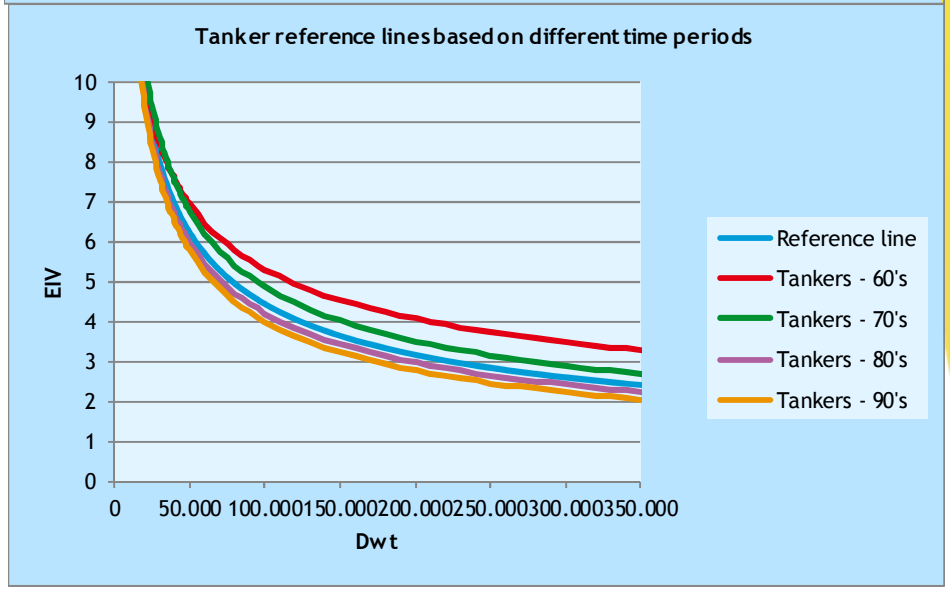
# Historical development of design efficiency

Tankers

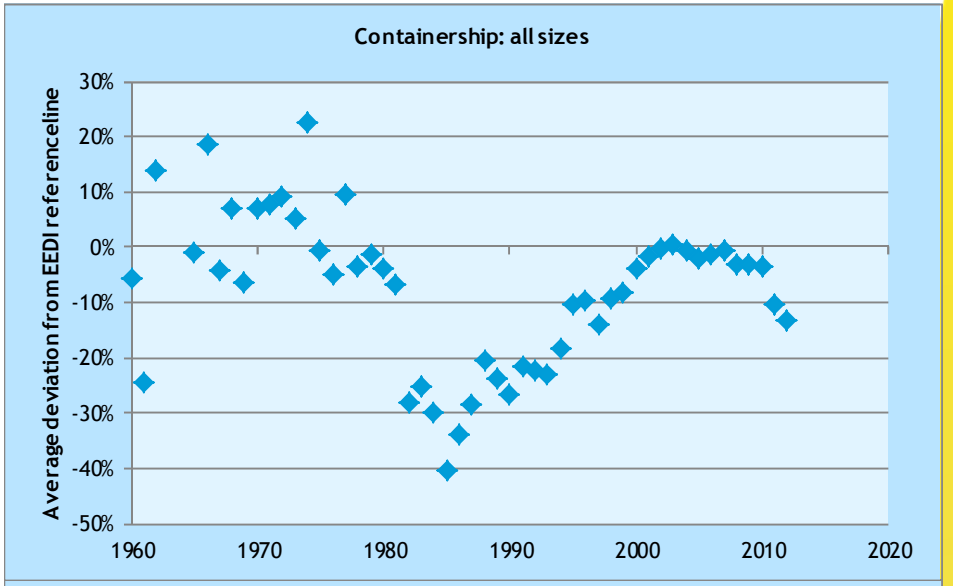


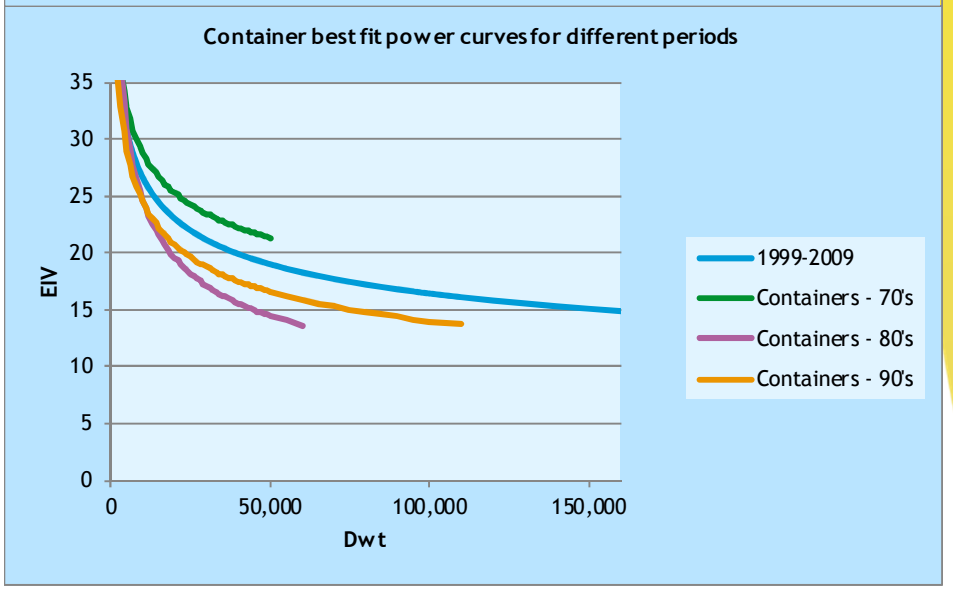




CE Delft
Committed to the Environment

# Historical development of design efficiency

Container ships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# Historical development of design efficiency

Example: tankers 60-100k dwt

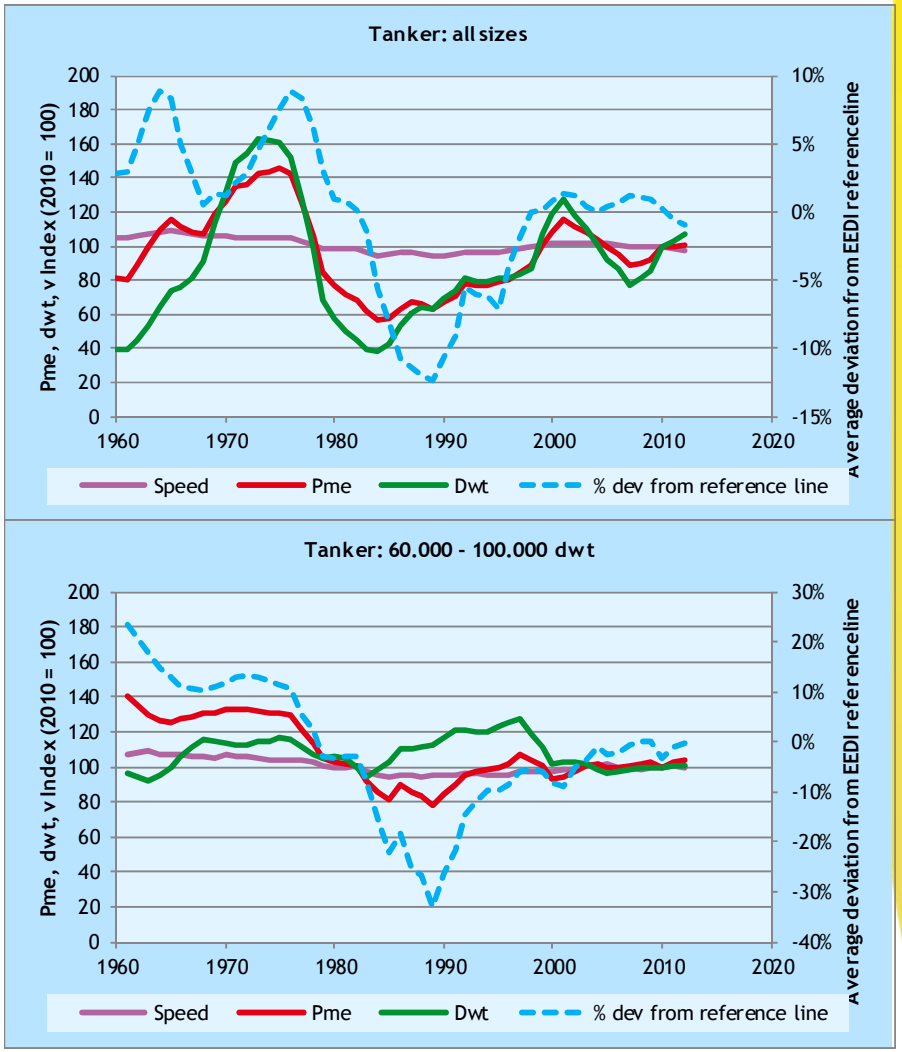
1980-1990 improvement

- Size increase
- $P_{ME}$ decrease
- Speed slight decrease

1990 – 2000 deterioration

- Size increase
- PME increases more
- Speed constant

Hull shape, propeller, and speed can explain differences

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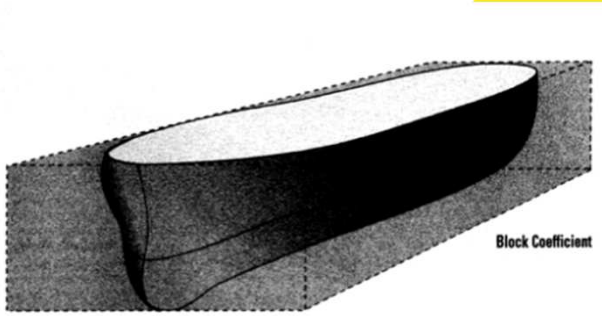
# Historical development of design efficiency

Hull shape

- Slimmer, more efficient designs (higher length/displacement ratio, lower $C_b$) in the 1980s
- Fuller designs (lower length/displacement ratio, higher $C_b$) post 1990




Propeller

- Anecdotal evidence of sub-optimal propellers in the 1990s and 2000s

Lightweight of the ship

- Heavier ships have a higher wetted surface and higher water and wave resistance

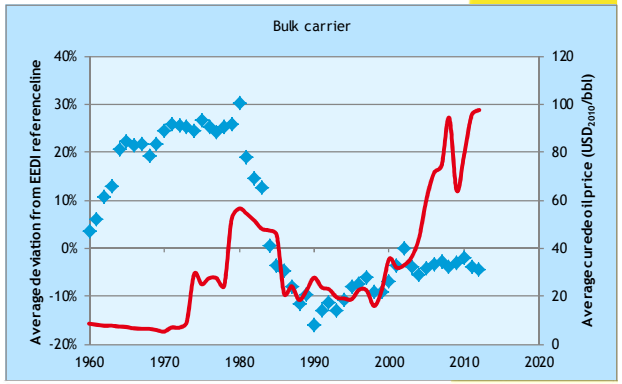
# Historical development of design efficiency

Design choices driven by:

- Fuel price (higher fuel price: more efficient ship)
- Freight rate (high freight rate: higher $C_b$)

- Opportunity costs of building time (high opportunity costs: simpler designs: fuller ships)
- Steel prices, labour costs, …

- Regulation that have had an impact on lightweight (double hull tankers, structural rules, et cetera)



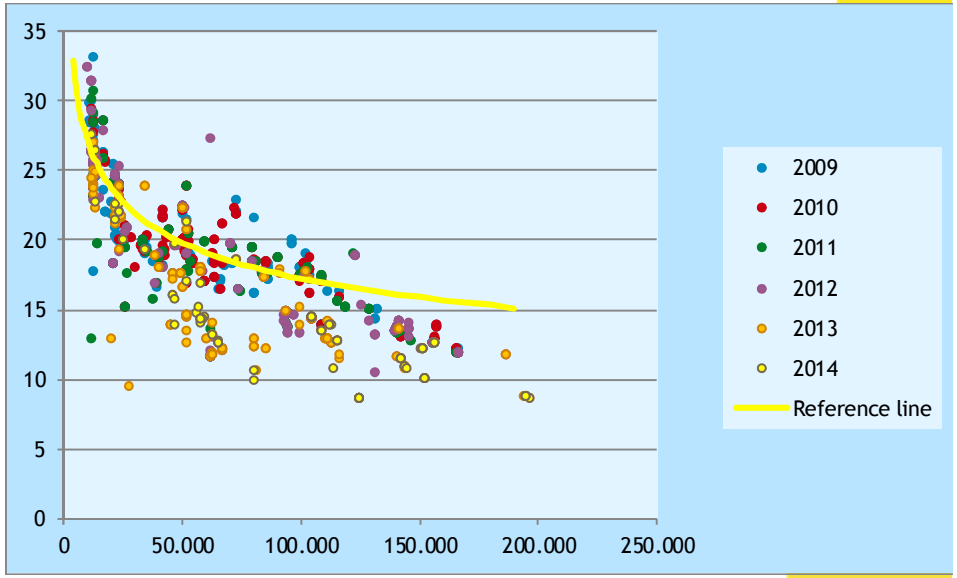

# Recent developments in design efficiency

Several developments may have had an impact on the design efficiency of new ships:

- Decrease in freight rates in 2008
- Fast recovery of fuel prices after 2008
- EEDI requirements for ships built since 2013

# Containers

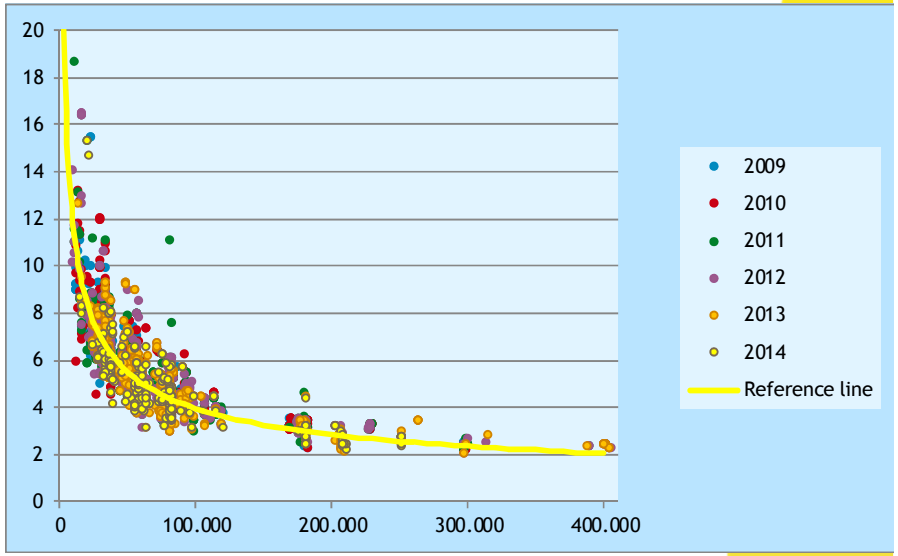
- Strong improvement in design efficiency
- Especially for large container ships
- More than 50% of new ships in 2013 and 2014 meet 2020 standards
- Lower speed, lower $P_{ME}$, larger ships




| EIV | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| %deviation from reference line | Mean | -2% | -2% | -8% | -9% | -21% | -29% |
| Number of ships | Total number | 259 | 255 | 181 | 195 | 192 | 80 |
| EIV under reference line | >0 % | 64% | 57% | 63% | 73% | 87% | 95% |
| | > 10% | 16% | 21% | 43% | 52% | 72% | 84% |
| | > 20% | 5% | 5% | 14% | 20% | 51% | 61% |
| | > 30% | 2% | 1% | 6% | 9% | 26% | 34% |

# Bulk carriers

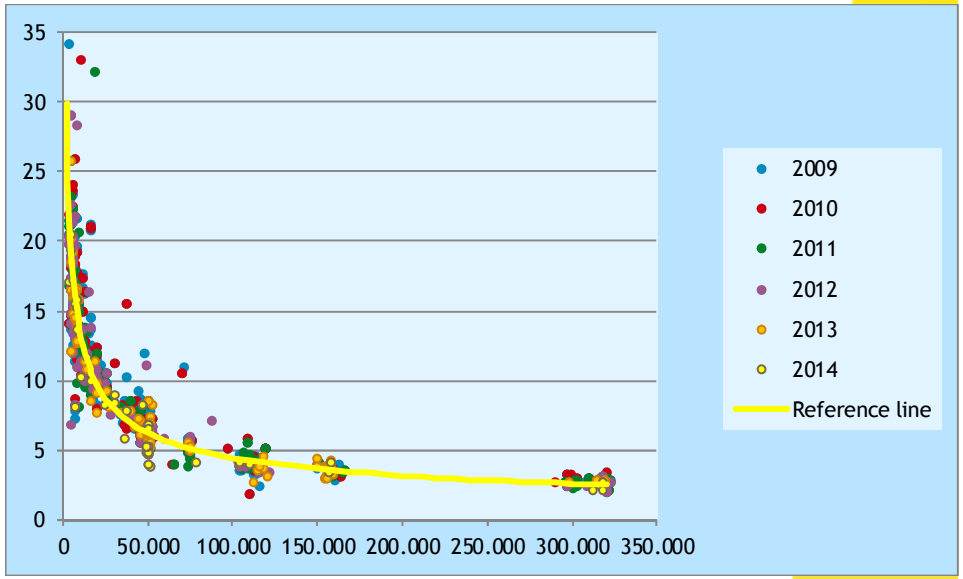
- Improvements in design efficiency since 2013
- About a third of new ships meet 2015 standards
- *Higher* speed, lower $P_{ME}$, *smaller* ships




| EIV | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| %deviation from reference line | Mean | 5% | 6% | 7% | 6% | 2% | -3% |
| Number of ships | Total number | 545 | 960 | 1,105 | 1,023 | 614 | 235 |
| EIV under reference line | >0 % | 30% | 29% | 23% | 35% | 53% | 68% |
| | > 10% | 9% | 8% | 8% | 11% | 25% | 36% |
| | > 20% | 1% | 1% | 1% | 2% | 3% | 8% |
| | > 30% | 0% | 0% | 0% | 0% | 0% | 1% |

# Tankers

- Improvements in design efficiency since 2013
- About half of new ships meet 2015 standards
- *Equal* speed, *equal* $P_{ME}$, *equal* size




| EIV | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| %deviation from reference line | Mean | 2% | 2% | 2% | -1% | -1% | -10% |
| Number of ships | Total number | 696 | 513 | 345 | 224 | 151 | 54 |
| EIV under reference line | >0 % | 43% | 47% | 45% | 49% | 48% | 63% |
| | > 10% | 14% | 15% | 15% | 18% | 16% | 46% |
| | > 20% | 3% | 2% | 2% | 6% | 5% | 26% |
| | > 30% | 1% | 1% | 1% | 2% | 1% | 11% |

# Conclusions

- Historical efficiency of bulk carriers and tankers has improved in the 1980s, was best in the 1990, deteriorated in the 1990s and 2000s
- Similar pattern for container ships, but efficiency deteriorations have been offset by increases in size

- Efficiency of current ships 10% - 20% worse than best historical value
  - Probably higher when taking into account engine improvements, propeller improvements, energy saving devices, etc.
- Large improvements are possible in relatively short time periods

- Recent developments show that designs have improved considerably

- EEDI: reference line -20% is not a problem

Thank you for your attention

Jasper Faber faber@ce.nl

All reports are available at www.cedelft.eu

# Sources

CE Delft, 2015, Historical trends in ship design efficiency, Delft

CE Delft, 2015, Estimated Index Values of New Ships: Analysis of EIVs of Ships That Have Entered The Fleet Since 2009, MEPC 68/INF.25


# EU PROJECT RETROFIT: EEN AANPAK VAN CO2-REDUCTIE VOOR BESTAANDE SCHEPEN

Gerco Hagesteijn

# INTRODUCTIE

- **Huidige situatie**
  - Wereldwijde opwarming/CO2/regelgeving
  - Lokale luchtkwaliteit/SOx, Nox/PM/SECA/Havens
  - EEDI

- Noodzaak voor reductie van brandstof verbruik en emissies
- Vraag naar energie besparende maatregelen
- En.. Ontwerpen voor operationele condities

# BESTAANDE SCHEPEN

- Veranderd operationeel profiel
- Schroef niet meer optimaal
- Vervanging/revisie van motoren

- →RETROFITTING

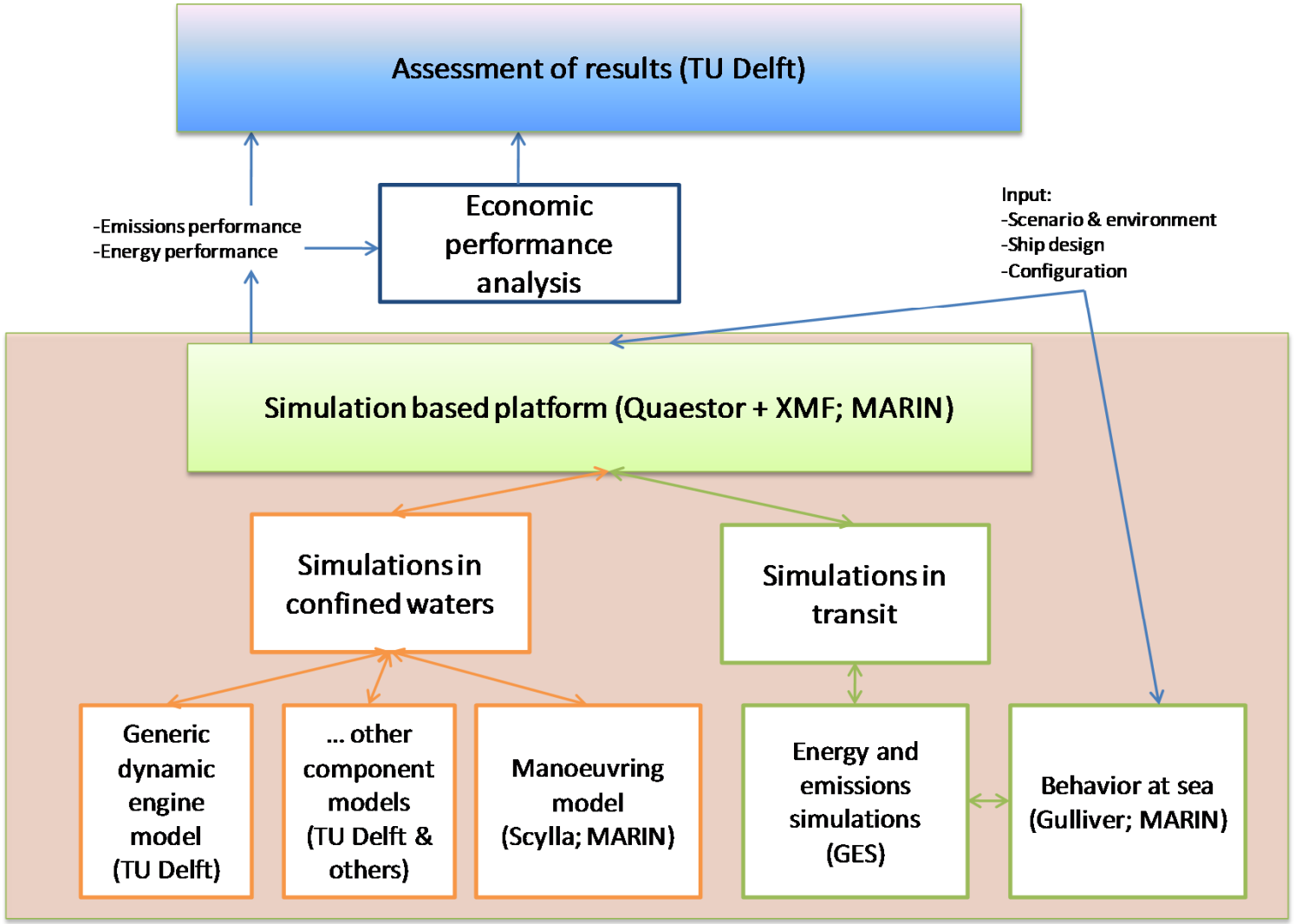



# BESTAANDE SCHEPEN

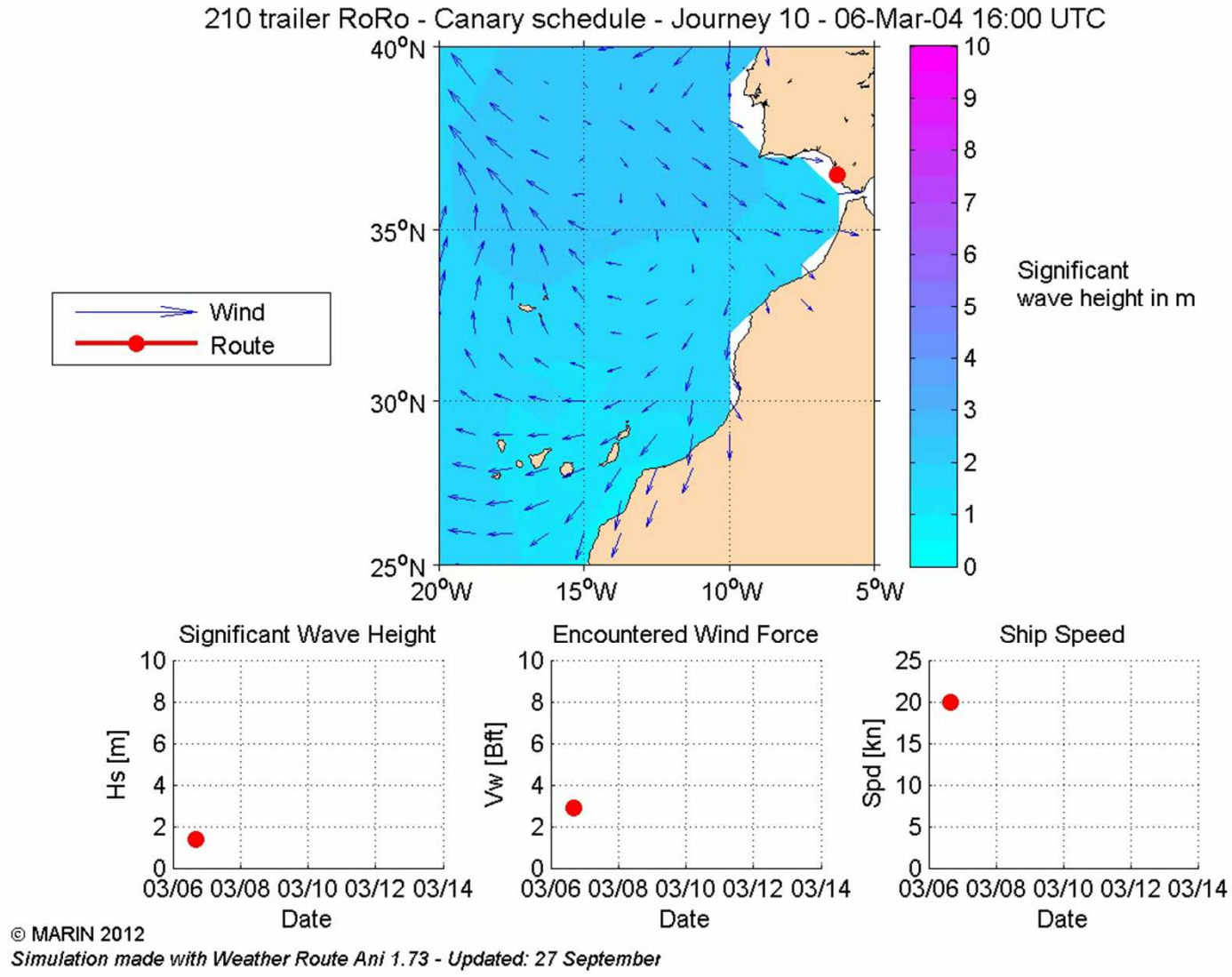
- Hoe en wat?
  - Wat levert het op?
  - Wat kost het?
  - En hoelang voordat het is terug verdiend?

→Simulaties binnen het EU-project Retrofit uitgevoerd i.s.m. TNO (motor model) en TU Delft (financieel model en motor model)

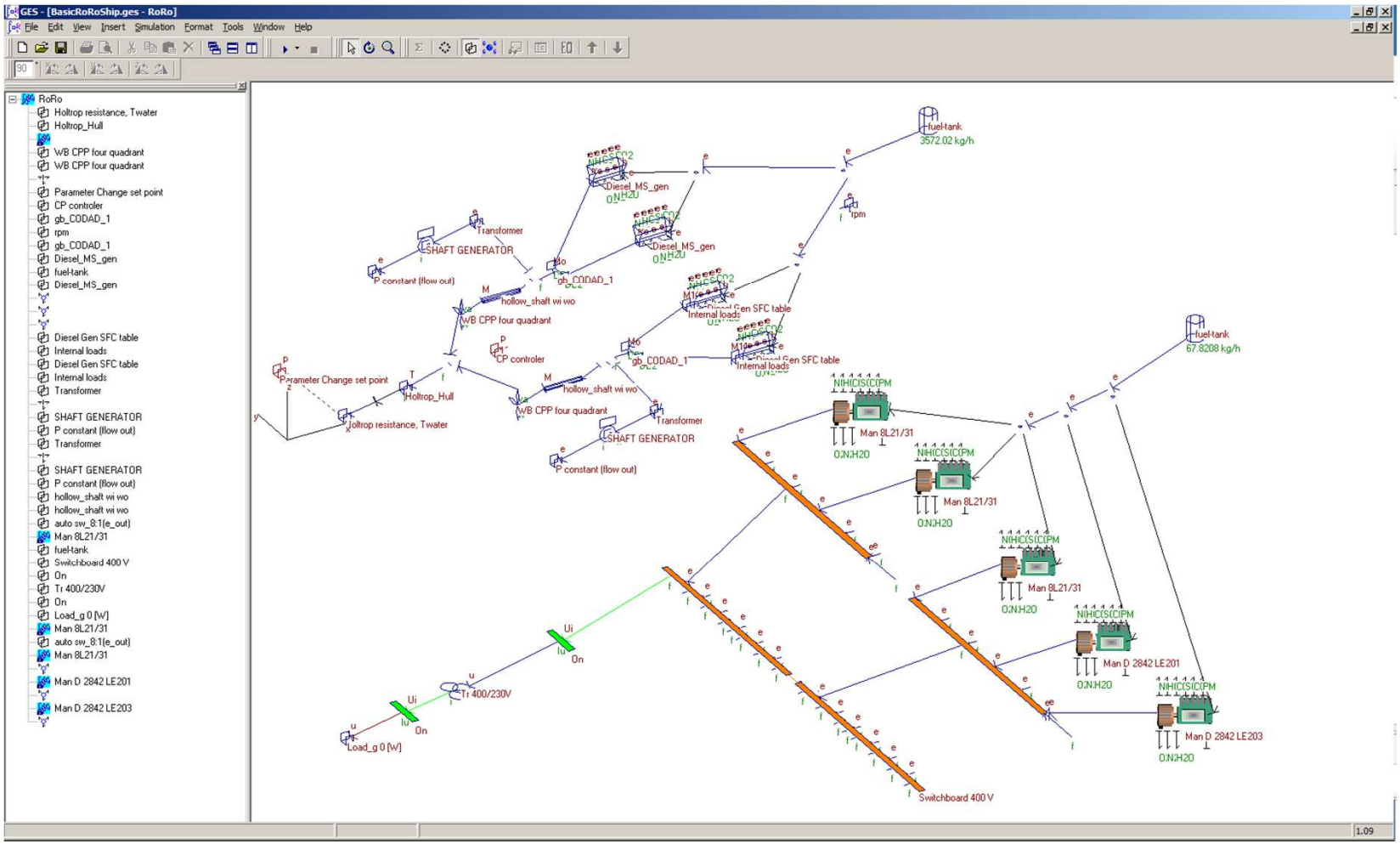
# SIMULATIE MODEL



# REIS SIMULATIE



# MOTOR MODEL


GES - [BasicRoRoShip.ges - RoRo]
File Edit View Insert Simulation Format Tools Window Help
RoRo
Holtrop resistance, Twater
Holtrop_Hull
WB CPP four quadrant
WB CPP four quadrant
Parameter Change set point
CP controler
gb_CODAD_1
rpm
gb_CODAD_1
Diesel_MS_gen
fuel-tank
Diesel_MS_gen
Diesel Gen SFC table
Internal loads
Diesel Gen SFC table
Internal loads
Transformer
SHAFT GENERATOR
P constant (flow out)
Transformer
SHAFT GENERATOR
P constant (flow out)
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hollow_shaft wi wo
auto sw_8:1(e_out)
Man 8L21/31
fuel-tank
Switchboard 400 V
On
Tr 400/230V
On
Load_g 0 [W]
Man 8L21/31
auto sw_8:1(e_out)
Man 8L21/31
Man D 2842 LE201
Man D 2842 LE203
fuel-tank
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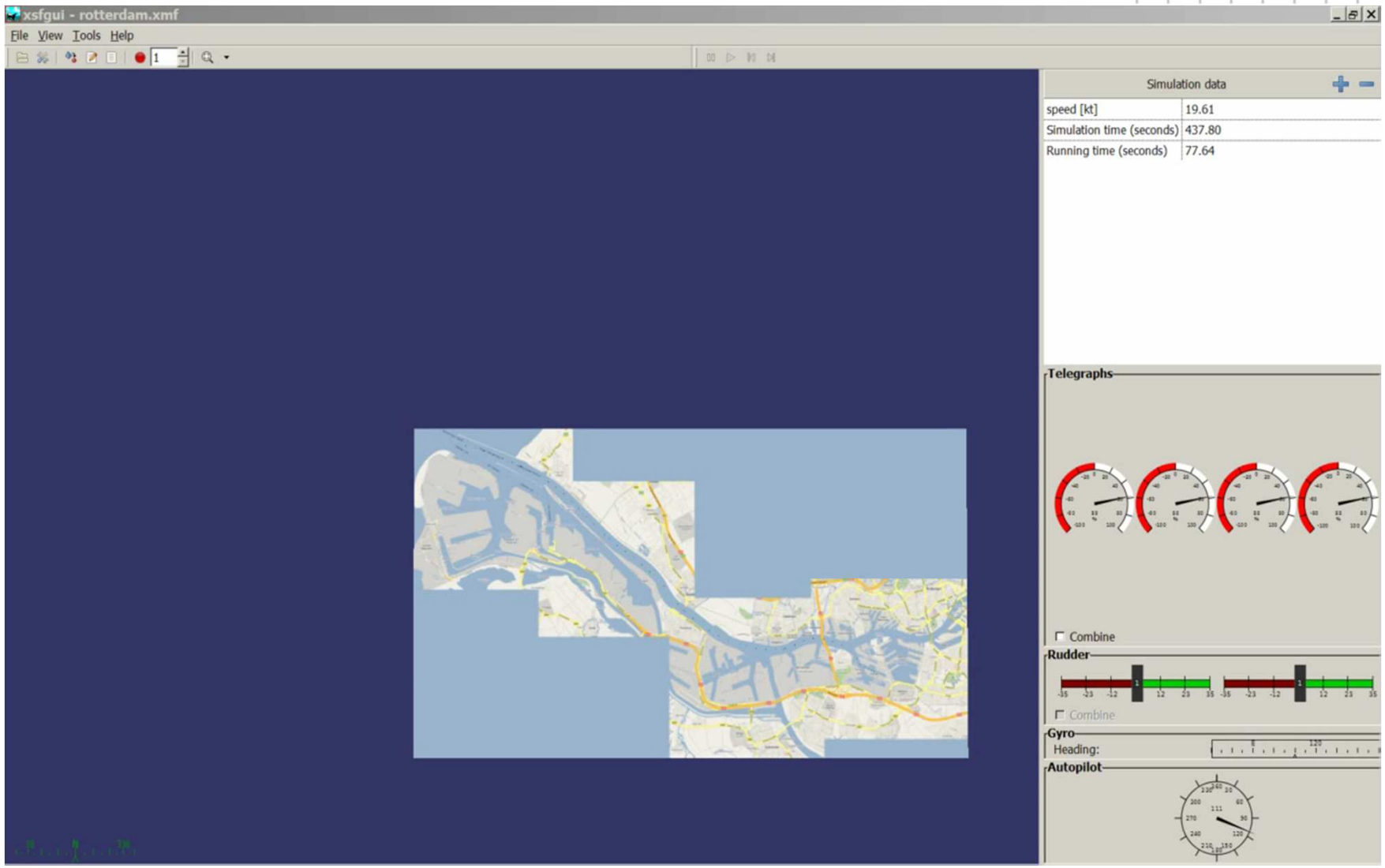
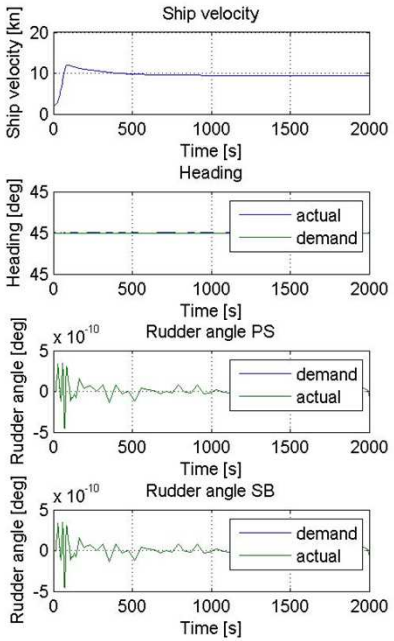
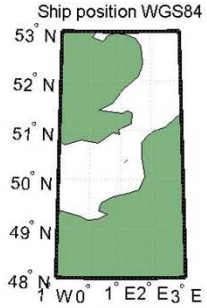
Diesel_MS_gen
Transformer
SHAFT GENERATOR
P constant (flow out)
gb_CODAD_1
hollow_shaft wi wo
WB CPP four quadrant
CP controler
Internal loads
Diesel Gen SFC table
rpm
Parameter Change set point
Holtrop_Hull
Holtrop resistance, Twater
fuel-tank
67.8208 kg/h
Man 8L21/31
Man 8L21/31
Man 8L21/31
Man D 2842 LE201
Man D 2842 LE203
Tr 400/230V
Load_g 0 [W]
Switchboard 400 V

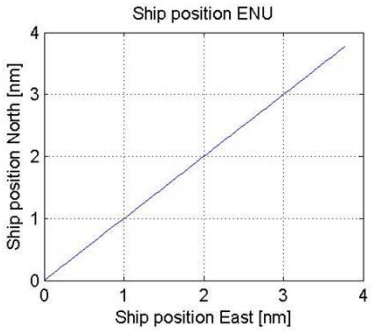
# HAVEN SIMULATIE

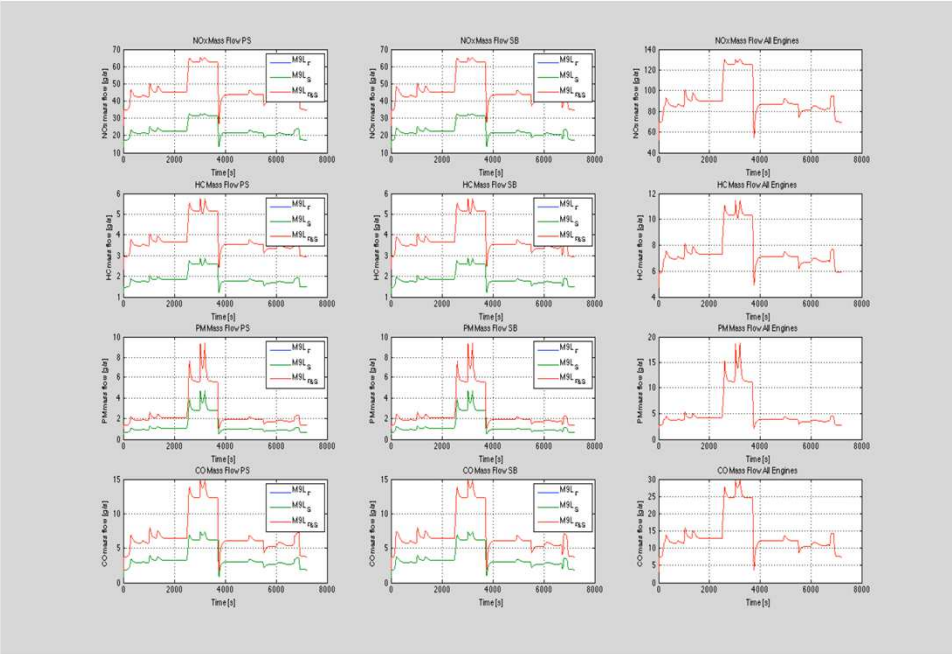


# HAVEN SIMULATIE



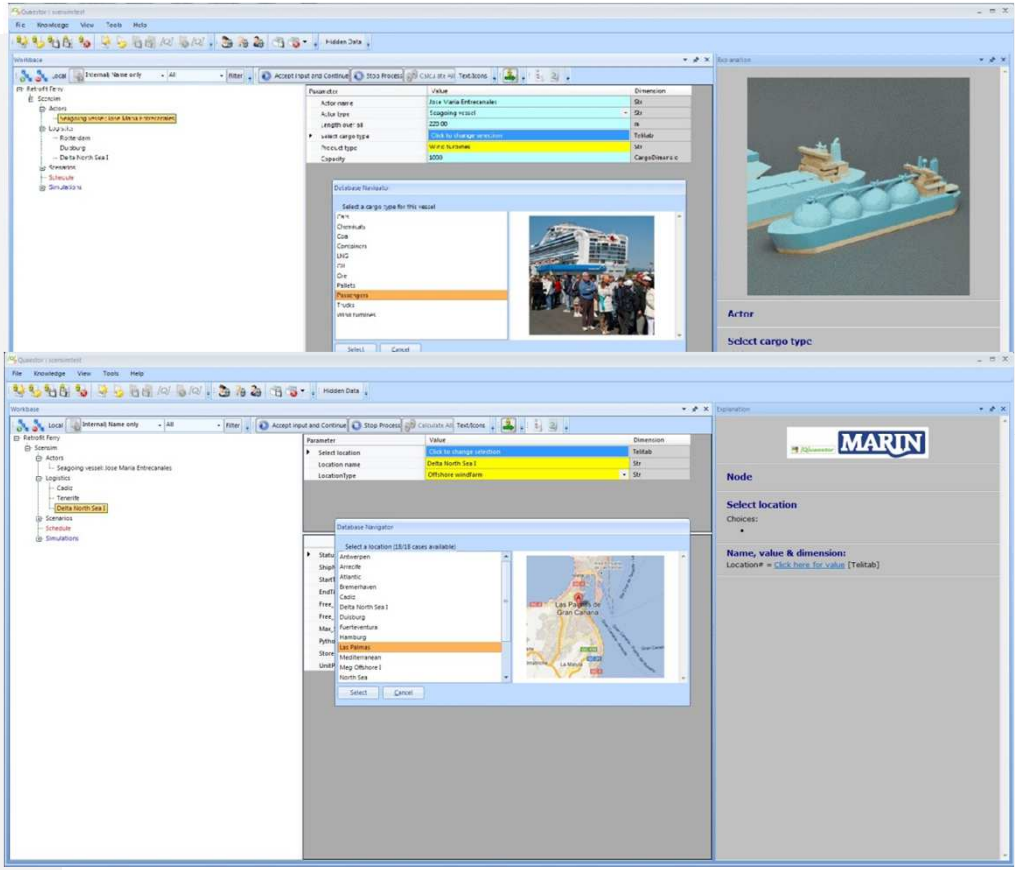



# SCENARIO SCRIPTING

- Define ship type
- Upload hull lines
- Define route and harbours
- Select equipment
- Run transit and harbour simulation
- Assess before and after refitting vessel in terms of
  - Emmissions
  - Fuel consumption
  - Investment costs
  - Return of investment

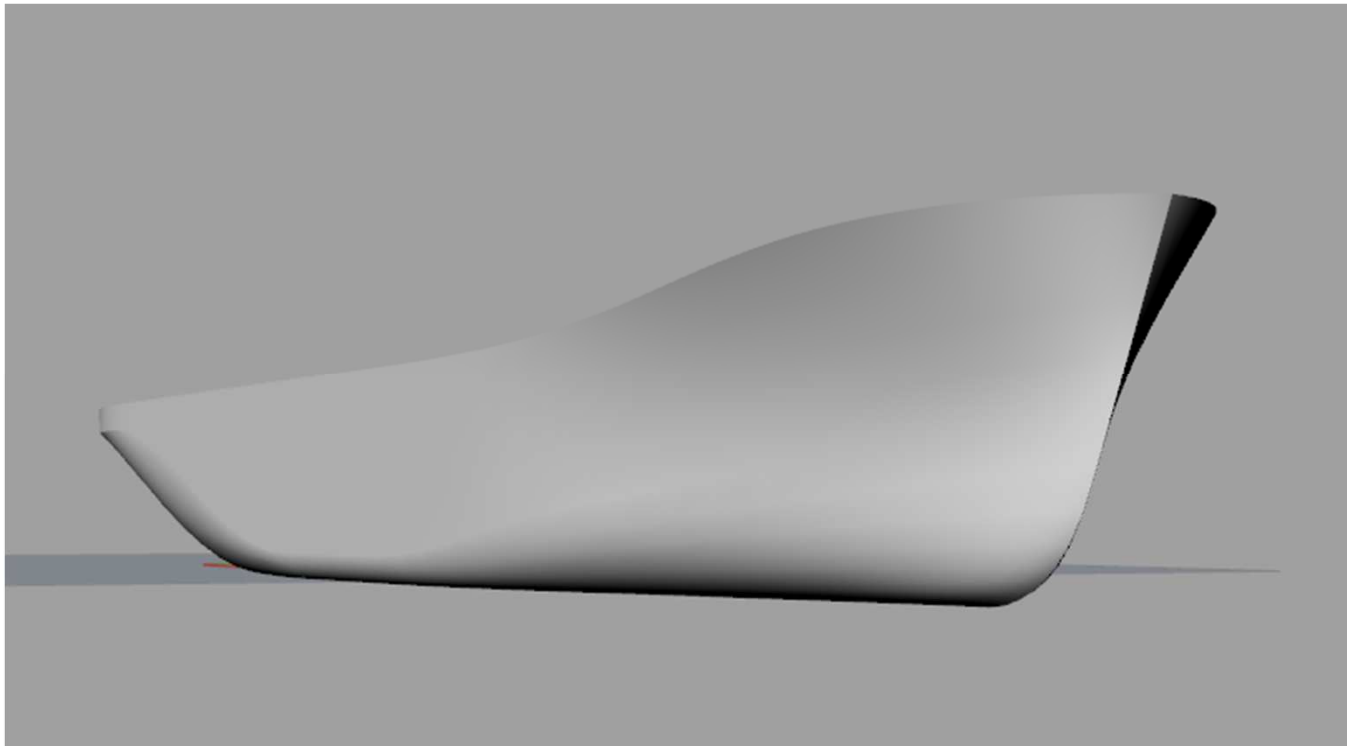


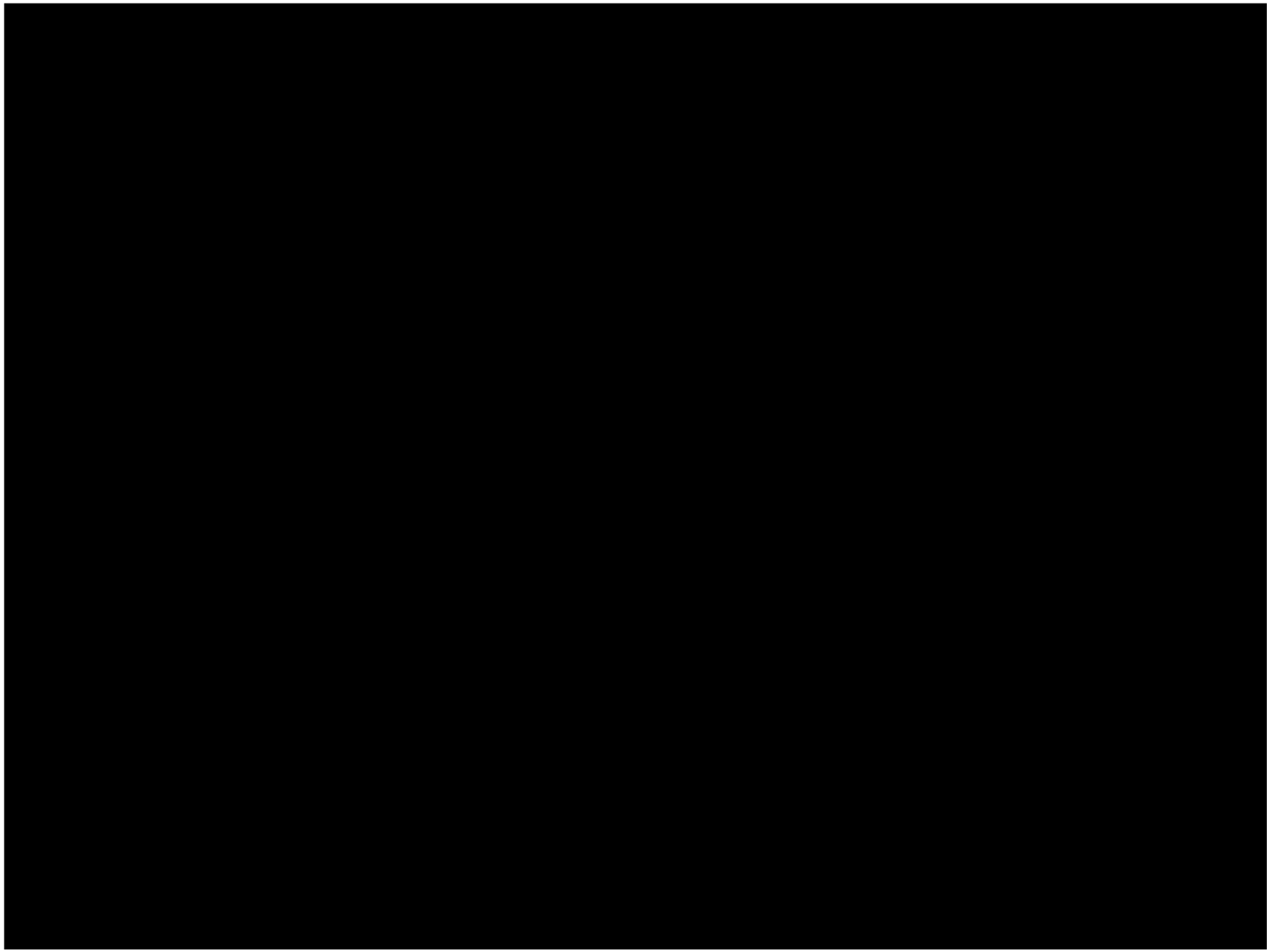
# TEST CASE

- 2 SSS reders gevonden als test case

# RESULTATEN

- Eerst romp in 3D





# SIMULATIE RESULTATEN

| ID | HFO | LNG | SO2 | CO2 | NOx | SO2-aux | CO2-aux | NOx-aux |
|---|---|---|---|---|---|---|---|---|
| | ton | ton | ton | ton | ton | ton | ton | ton |
| As built | 100.0 | - | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Pre-duct | 97.0 | - | 96.7 | 96.8 | 96.6 | 100.0 | 100.0 | 100.0 |
| DF engine | 3.3 | 86.9 | 2.1 | 79.7 | 23.5 | 69.5 | 69.6 | 74.4 |
| PSS | 96.1 | - | 96.0 | 96.0 | 95.8 | 100.0 | 100.0 | 100.0 |
| Rudder bulb | 98.9 | - | 98.7 | 98.7 | 98.7 | 100.0 | 100.0 | 100.0 |
| Scrubber | 102.6 | - | 10.3 | 102.5 | 100.0 | 100.0 | 100.0 | 100.0 |
| var PTO | 100.2 | - | 101.2 | 101.1 | 101.1 | 57.9 | 57.9 | 0.0 |

# ESD’S


# CONCLUSIE

- Reissimulaties kunnen helpen bij de keuze voor groene technologieen.
- Per scheepstype en afhankelijk van het operationele profiel.
- Groene technologieen niet alleen voor nieuwe schepen, ook voor bestaande schepen rendabel.

# THANK YOU!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# Presentatie KOTUG

https://prezi.com/wxovc9gglm9t/clean-shipping-june-17-wageningen/?utm_campaign=share&utm_medium=copy

PLATFORM SCHONE SCHEEPVAART


# Schone short sea

Gaby Steentjes
Fleet Director Flinter Management

# SECA

?

Controlling the driver, not the equipment


Verbruik in Seca; 150 ton per dag



Verbruik in Seca; 8 ton per dag,
dat moet beter kunnen

# TechnologieCluster Efficiente Schepen

**Reden voor project: SECA per 1/1/15**

Rederij Flinter:
Als ik over moet op MGO,
Dan maar zo zuinig mogelijk !

<u>Kennis vraag aan TNO:</u>

Kunnen jullie met simulatie-technieken
Bepalen welke retrofit optie het beste
Is, gegeven vaarsnelheid en route?

Alewijnse

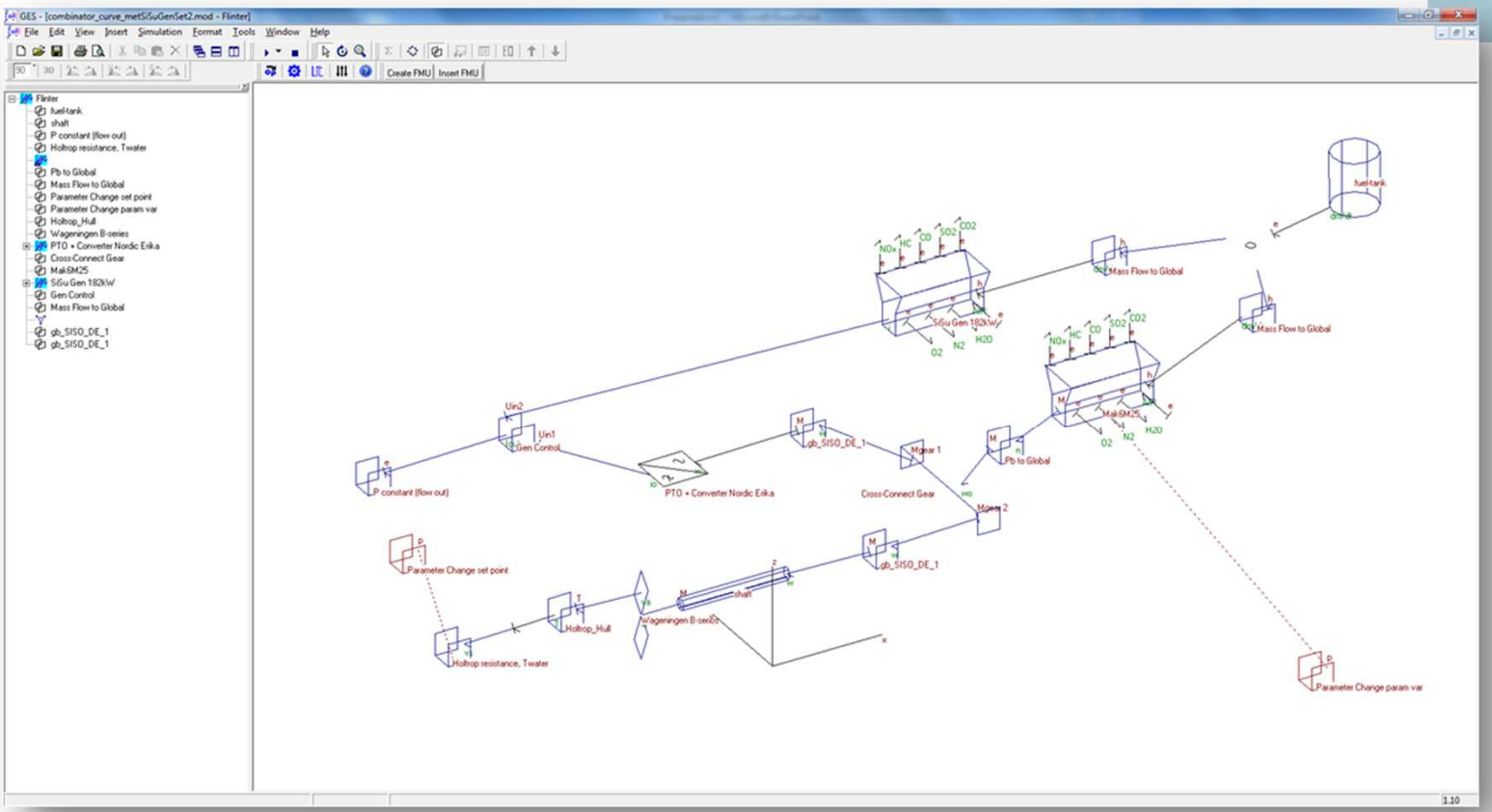
BOLIER | MaK

Wolfard & Wessels Werktuigbouw bv

Flinter

# Model energie stromen

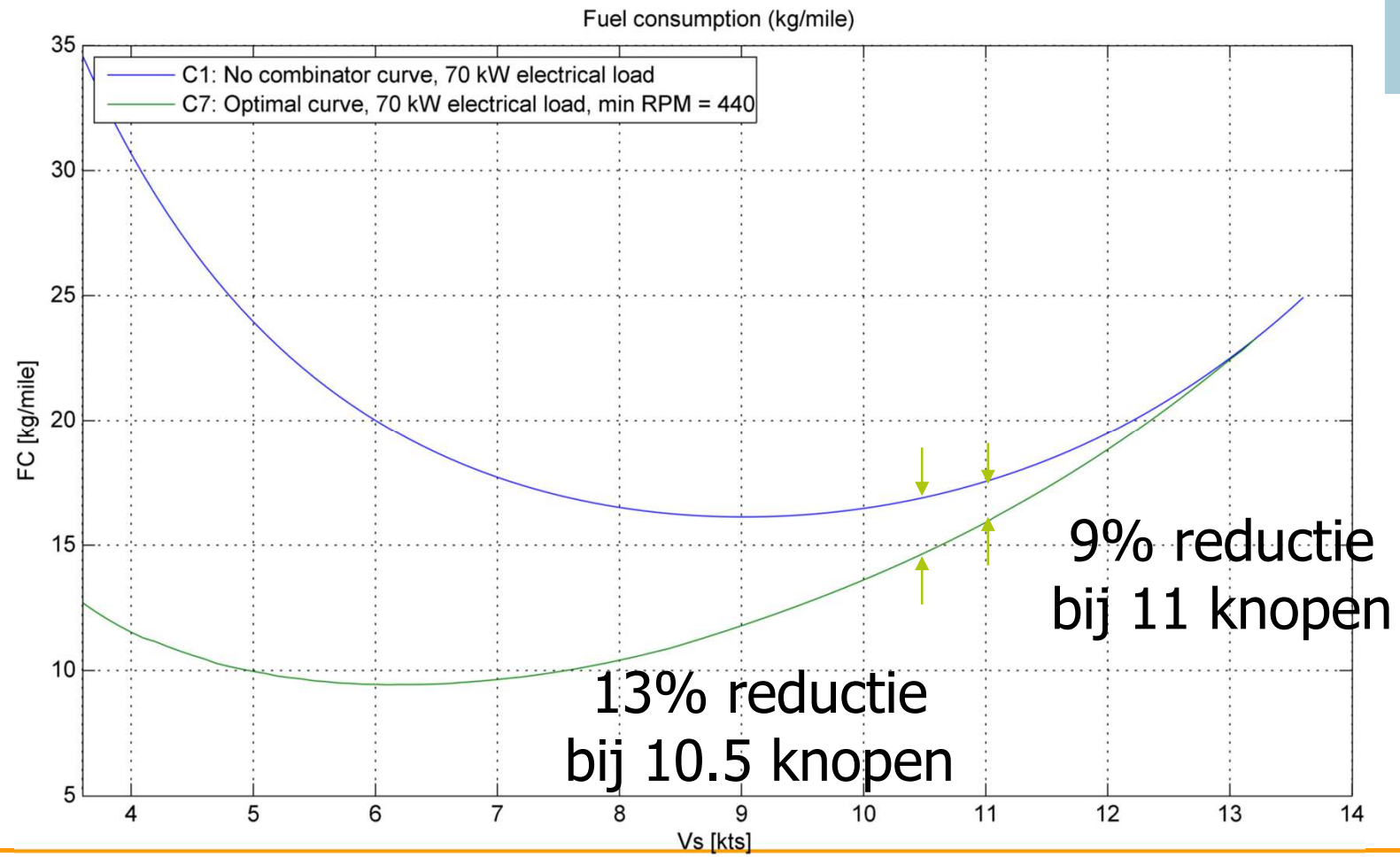
## Nordic Erika in een energie model



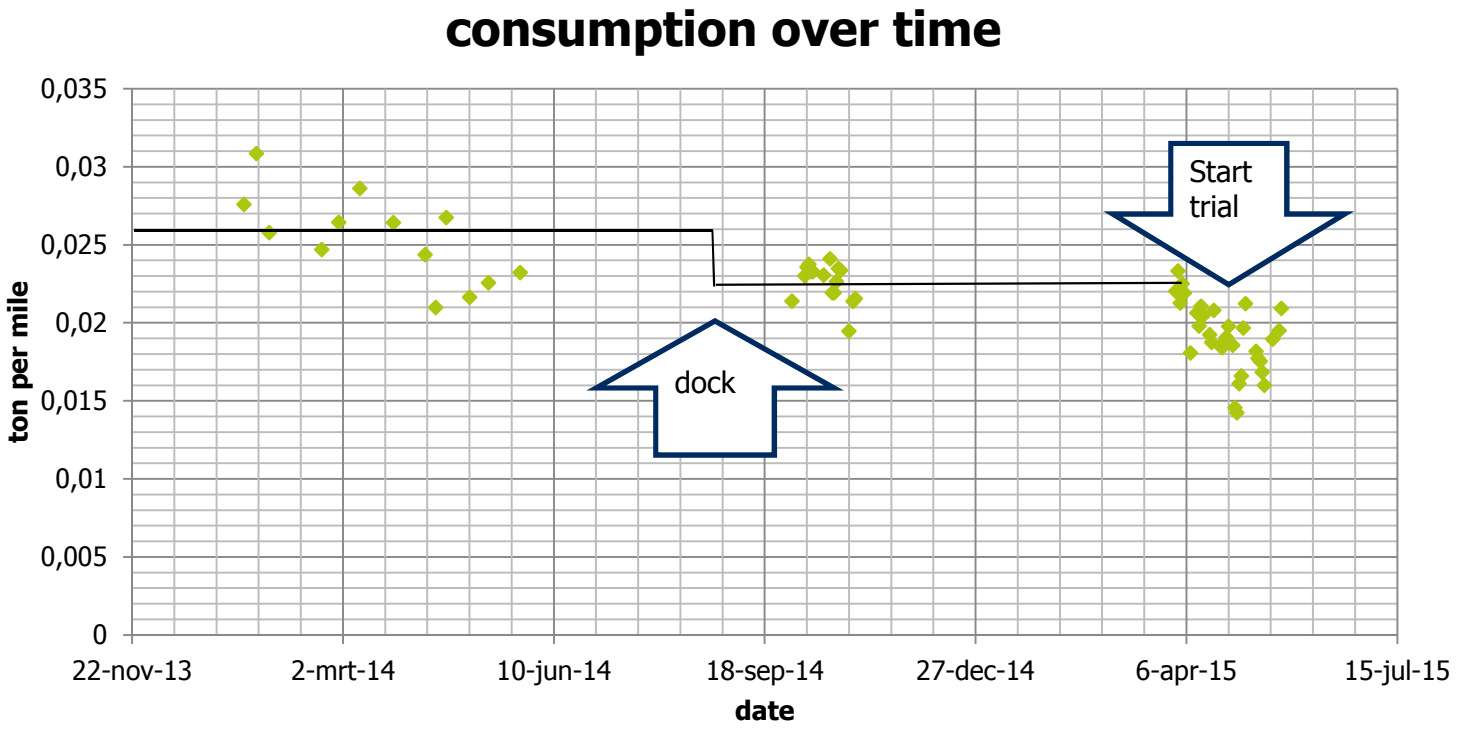
# Combinator curve - strategie

- Specific Fuel Consumption (SFC) is voor een bepaalde motor afhankelijk van toerental en gevraagd vermogen
- Voor een opgegeven scheepssnelheid en spoedhoek van de schroef worden het benodigd vermogen en toerental berekend door TNO tool (GES)
- De spoedhoek (en bijbehorende toerental) waarbij het brandstofverbruik per mijl het laagst is wordt gekozen als optimum (binnen voor het configuratie gestelde grenzen)
- Acht verschillende configuraties voor de combinator curve zijn geanalyseerd, ieder met eigen limieten (bv. minimum RPM, maximaal vermogen

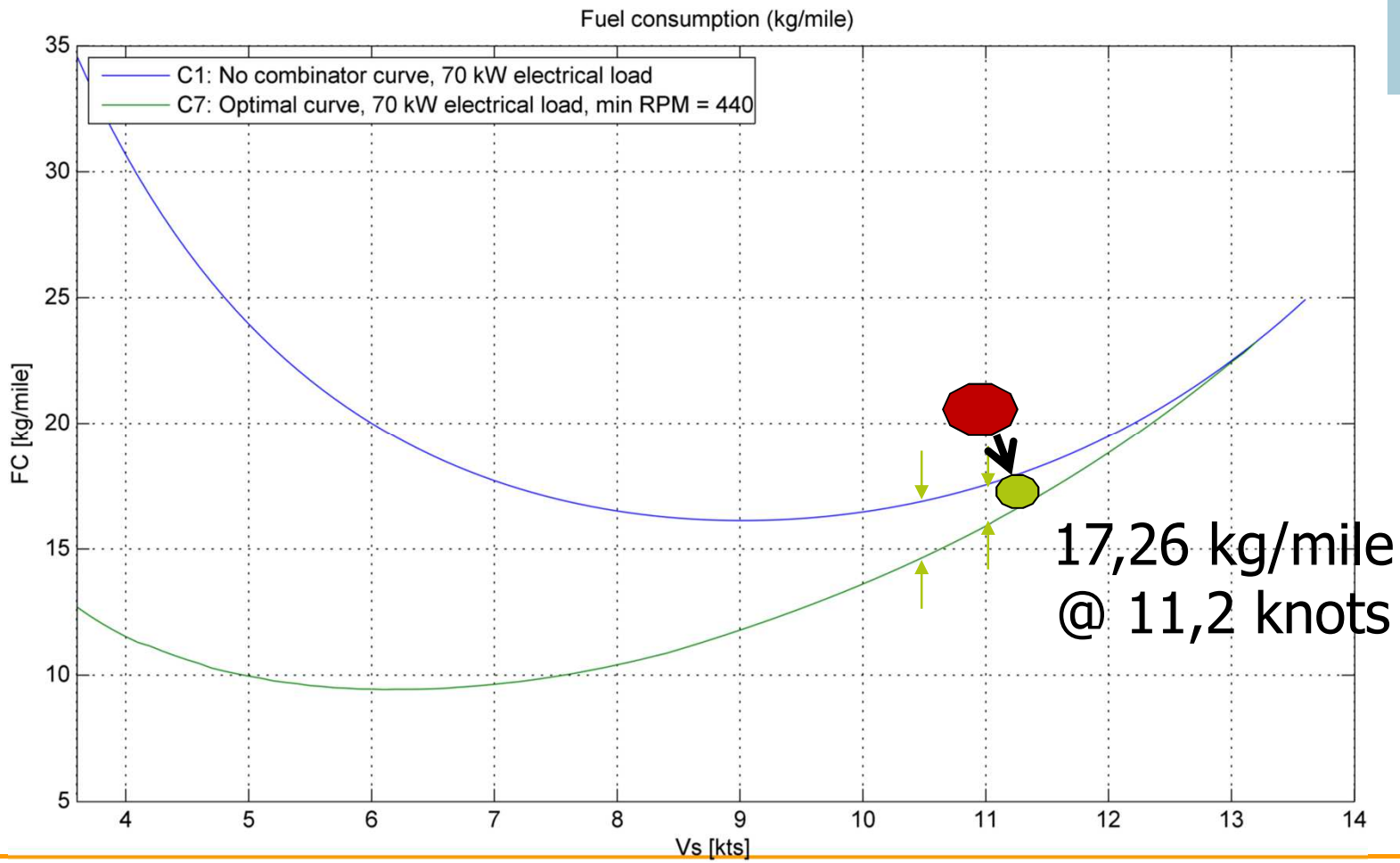
# Reductie brandstofverbruik



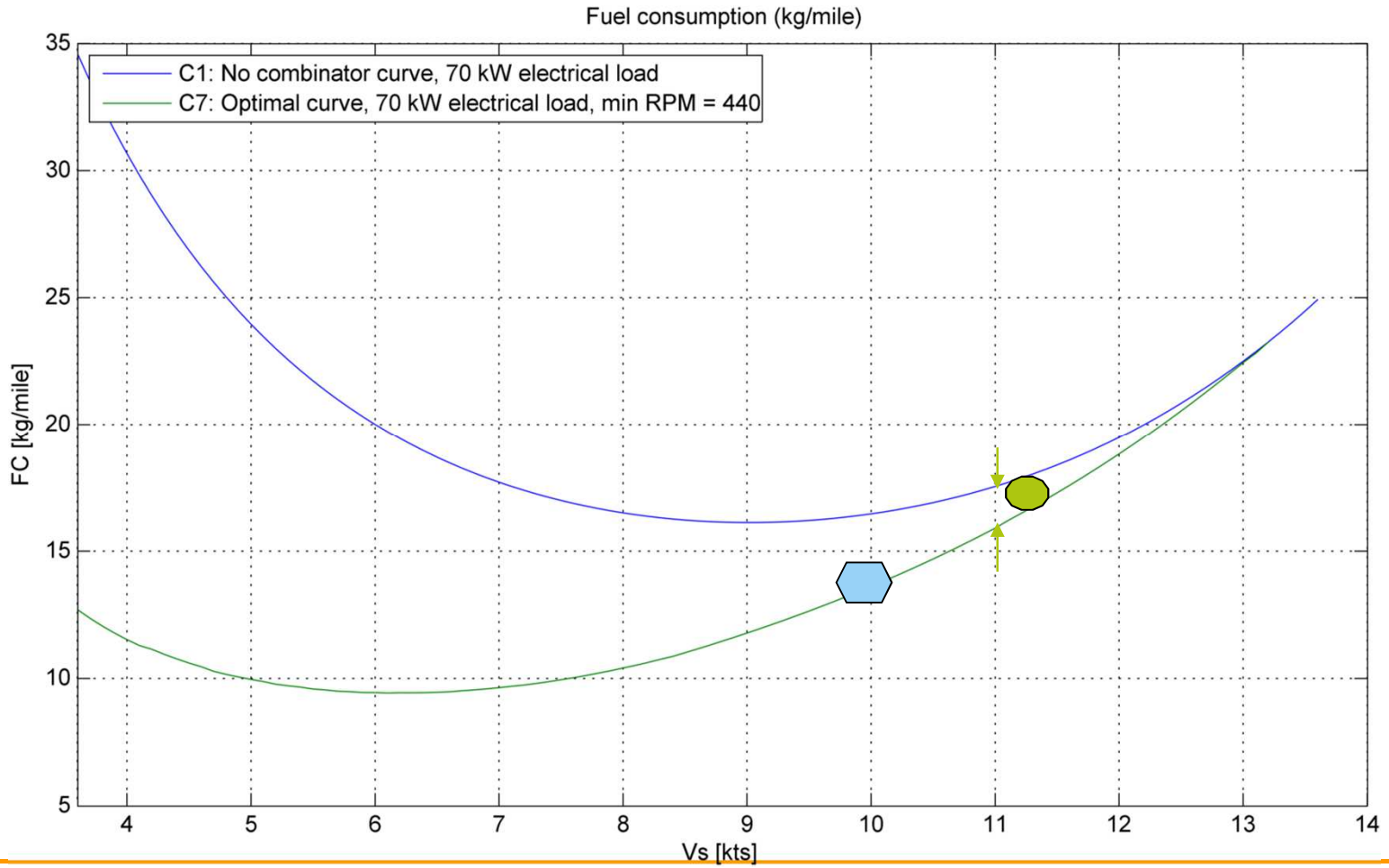
# Gemeten brandstof verbruik



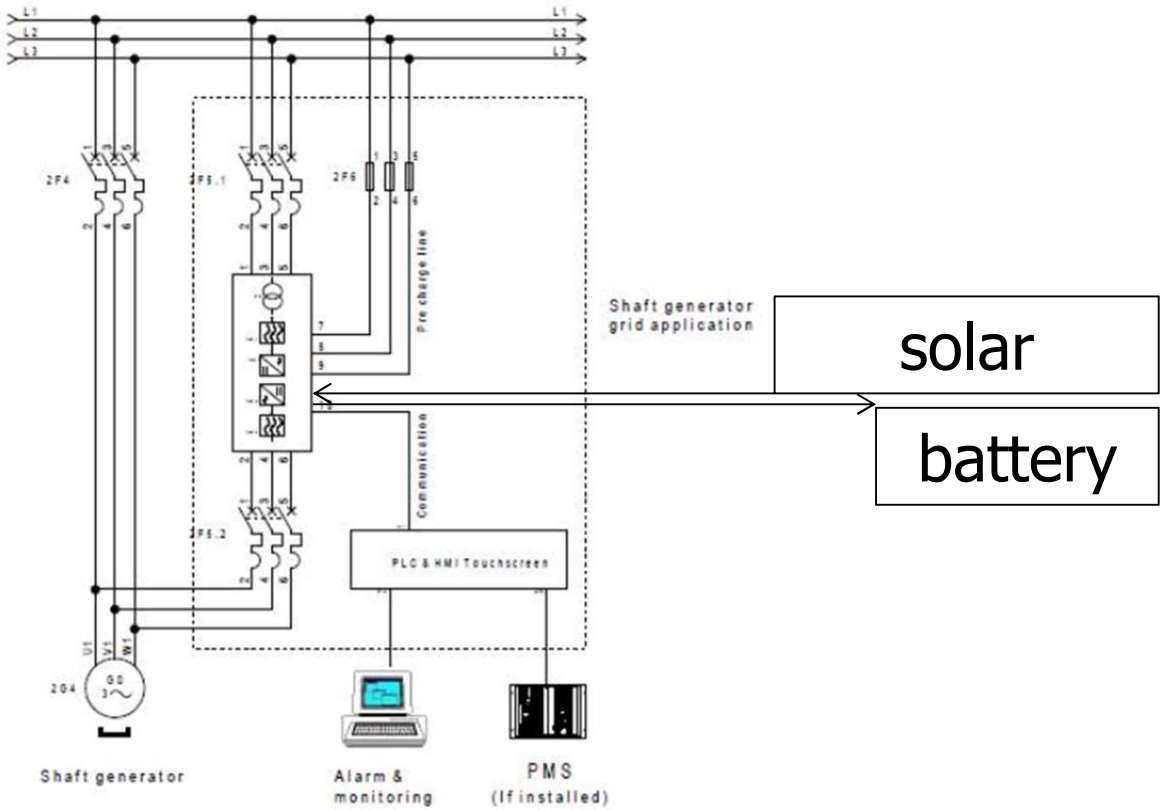
# Reductie brandstofverbruik



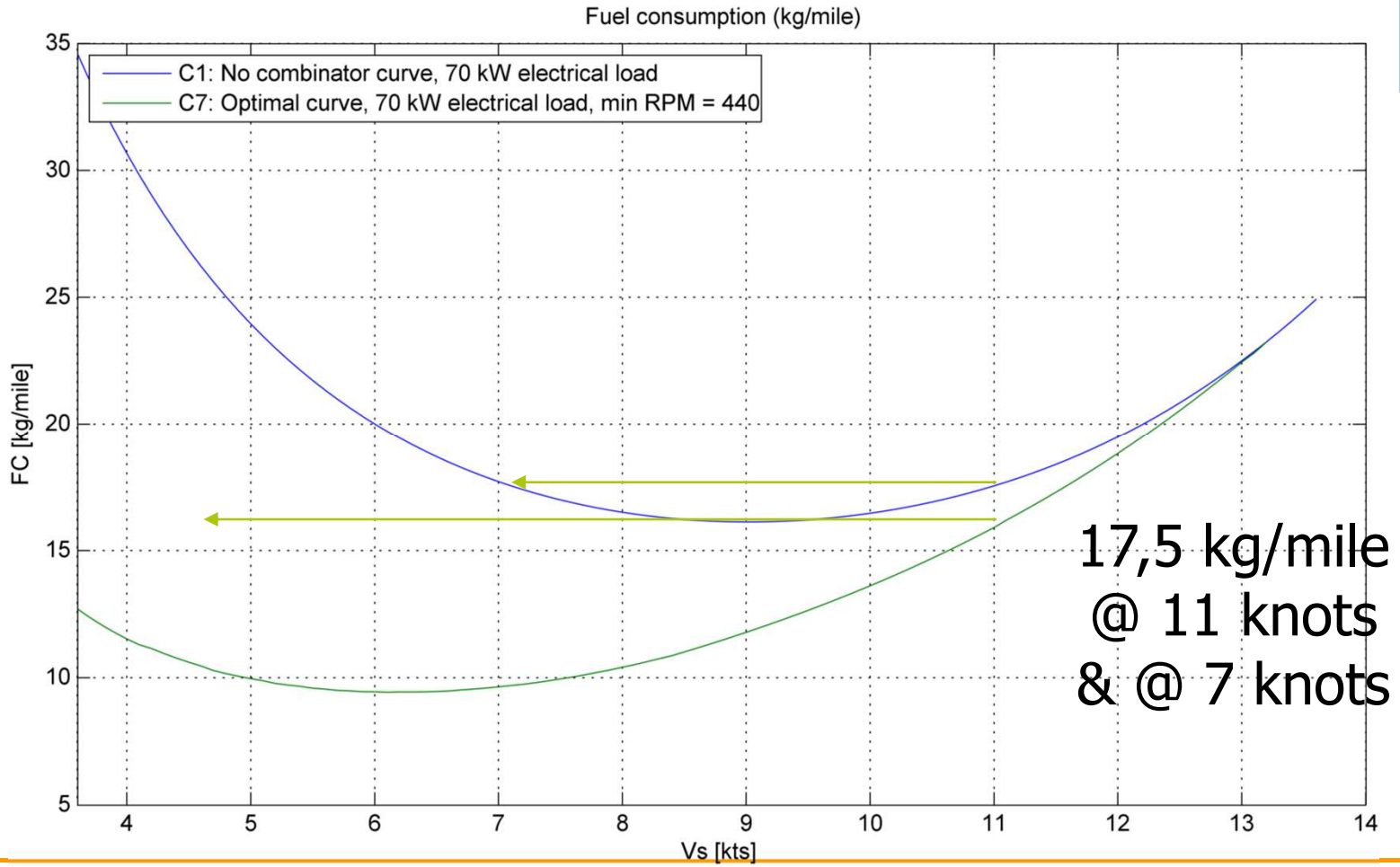
# Ter vergelijk ; een 3000 tonner met conoduct en 749kW motor



# De gelijkrichter biedt nieuwe mogelijkheden



# …en kunnen we nu slowsteamen?




17,5 kg/mile
@ 11 knots
& @ 7 knots

# Slow steaming in short sea


# Effect op emissie

- Voor een rondreis van 4447 mijl varen 3 3000 tonners achter elkaar in 3 weken tussen aantal havens. De rondreis duurt 3 weken.
- Door nu een schip toe te voegen, kunnen alle schepen langzamer varen; In plaats van 11 knopen voldoet 8. De rondreis duurt nu weliswaar 4 weken maar in 3 weken tijd wordt er nog steeds evenveel vracht vervoert. Er is immers iedere week een afvaart.

| | snelheid | Totaal afstand | verbruik | Totaal verbruik | besparing |
|---|---|---|---|---|---|
| 3 schepen | 11 kn | 13341 | 17,5kg/m | 233 mT | - |
| 3 schepen in combinator | 11 kn | 13341 | 16 kg/m | 213 mT | 20mT |
| 4 schepen in combinator | 8 kn | 17788 | 10 kg/m | 178 mT | 55mT |

# Vragen?