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The use of a Generic Energy Systems model for fishing vessels

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Contents

- Explanation of GES-principles
- Examples of GES-models for
  - Beam trawler - propulsion system
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- Results of fishing vessel studies using GES
- Concluding remarks

GES-principles

- domain-independent graphical description of dynamic behaviour of physical systems
- system is split in components
- component characteristics put in libraries
- interaction between components based on ‘Bond Graph’ notation
- power = effort * flow
- effort & flow -> input or output for any component

Effort & flow

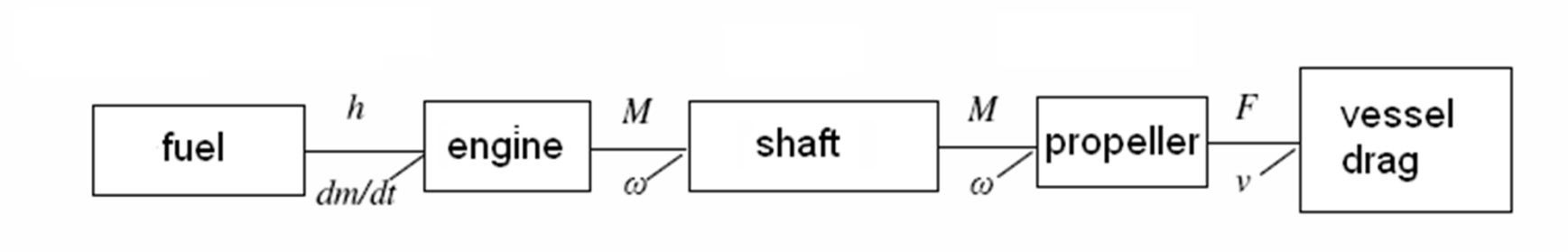
Domain	**Effort**		**Flow**	
Mechanical translation	Force *F*	[N]	Velocity *v*	[m/s]
Mechanical rotation	Torque *M*	[Nm]	Angular velocity ω	[rad/s]
Hydraulic	Total pressure *p*	[N/m2]	Volume flow rate *Q*	[m3/s]
Electric	Voltage *U*	[V]	Current *I*	[A]
Chemical	Chemical potential μ	[J/mol]	Molar flow *dN/dt*	[mol/s]
Thermodynamic	Temperature *T*	[K]	Entropy flow *dS/dt*	[W/K]
Thermodynamic (stationary)	Specific enthalpy *h*	[J/kg]	Mass flow *dm/dt*	[kg/s]

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Bond graphs

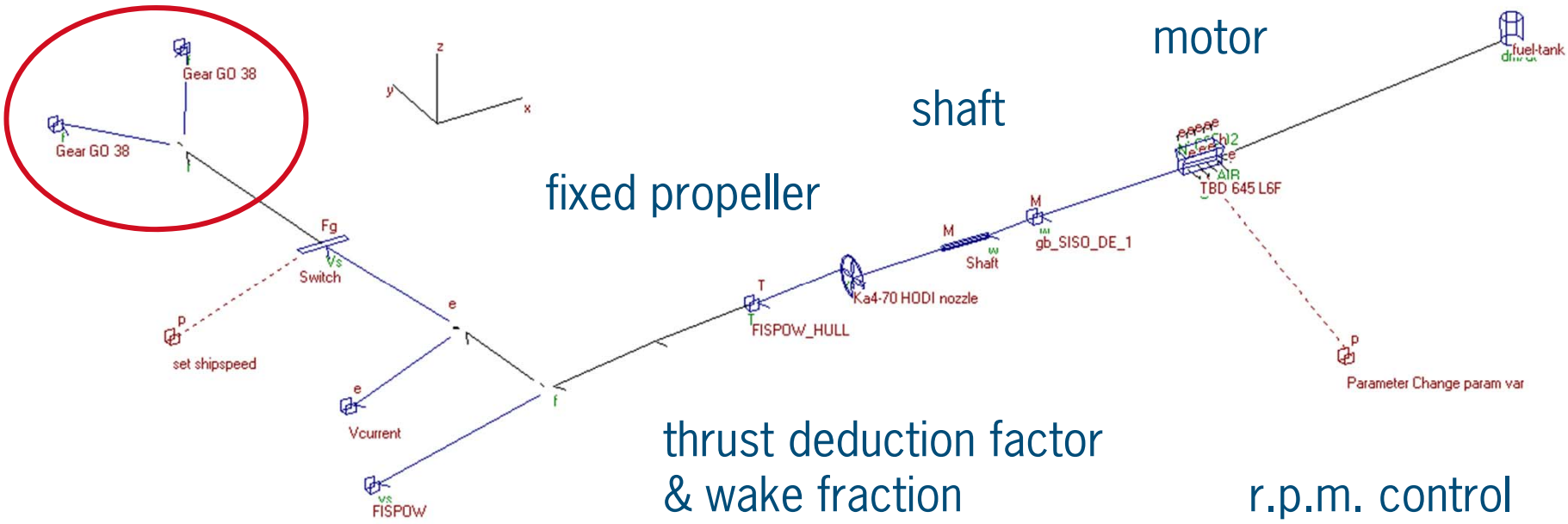
Example: Propulsion system of a vessel



GES-model of beam trawler propulsion system

gear drag vs. speed

fuel tank



thrust deduction factor
& wake fraction

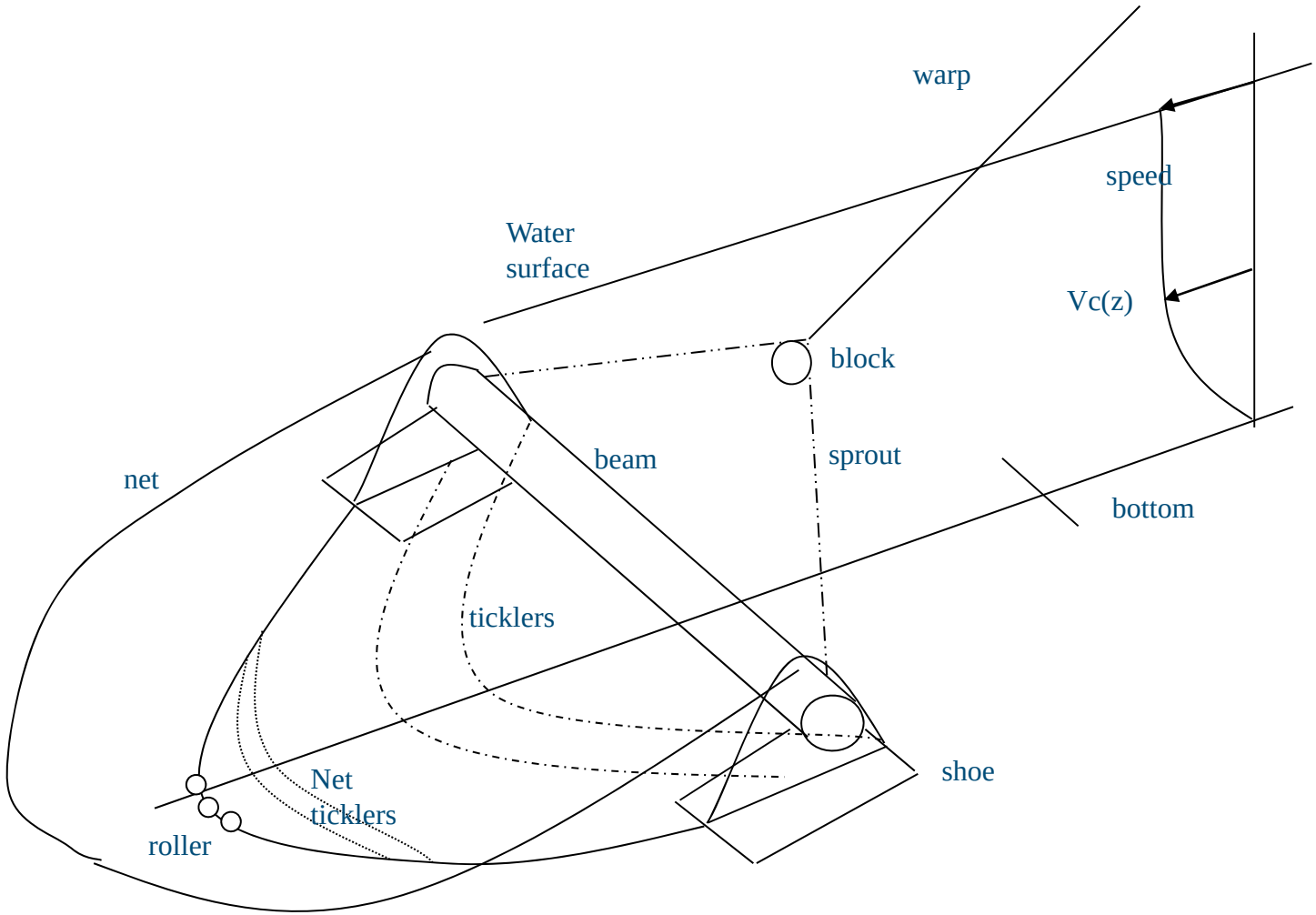
r.p.m. control

hull resistance vs. speed

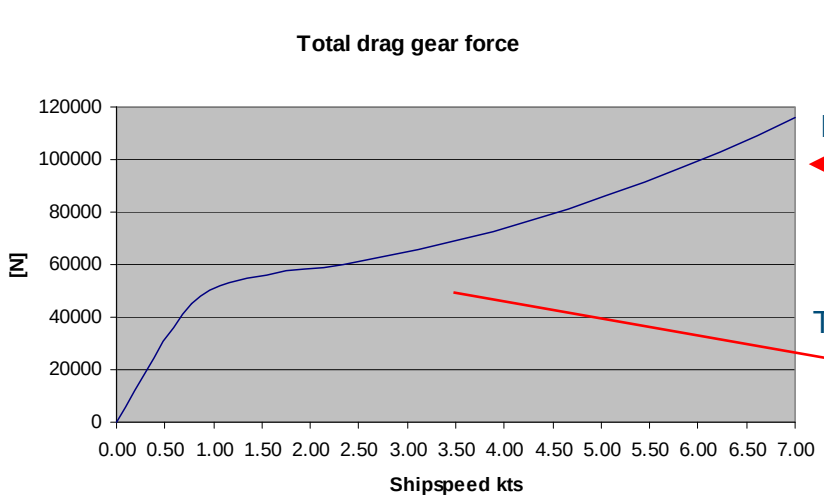
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Beam trawl diagram



GES-model of a beam trawl



Derived curve

Tabled curve

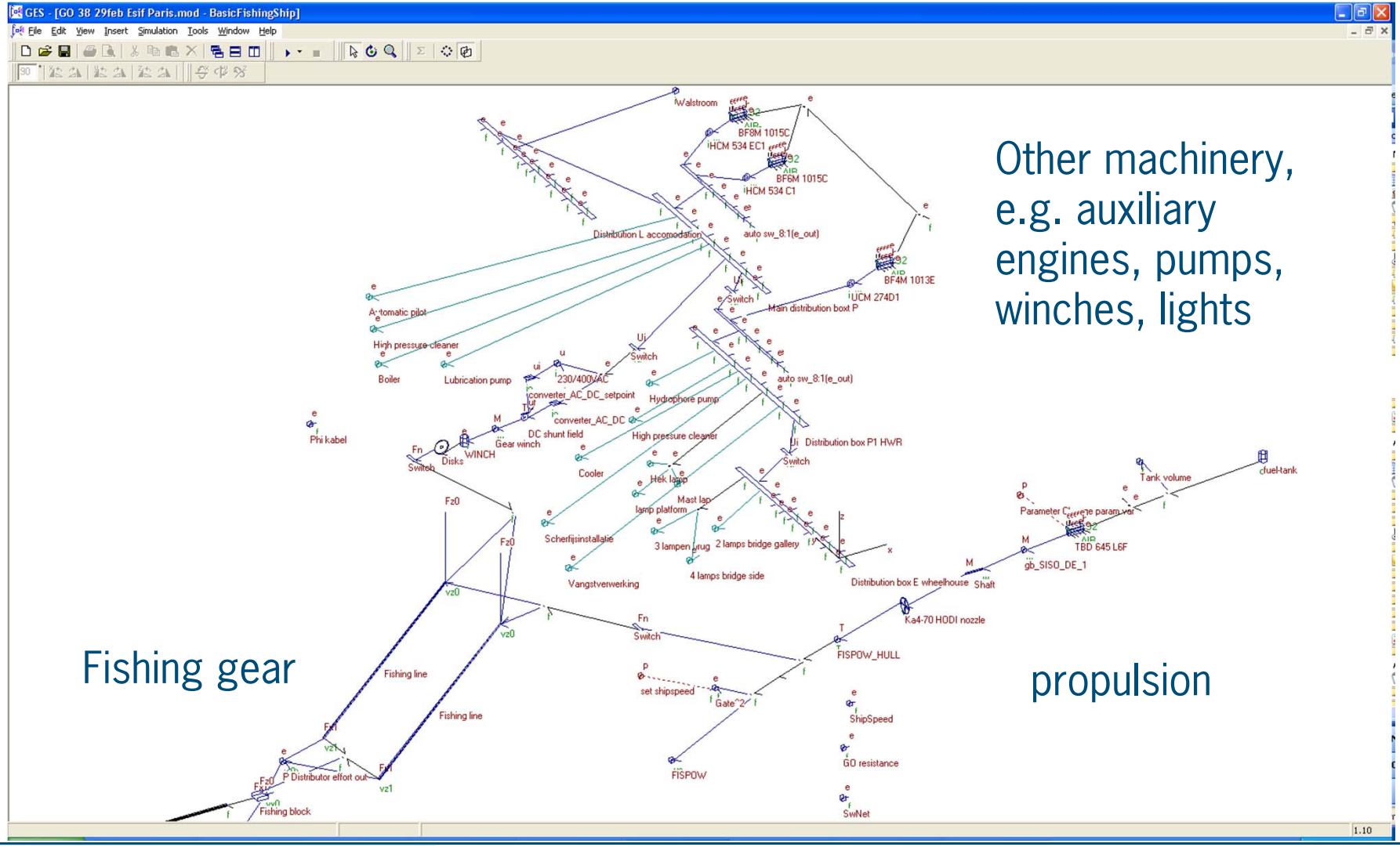
Cable force

Gear drag force

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Model of complete beam trawler machinery installation

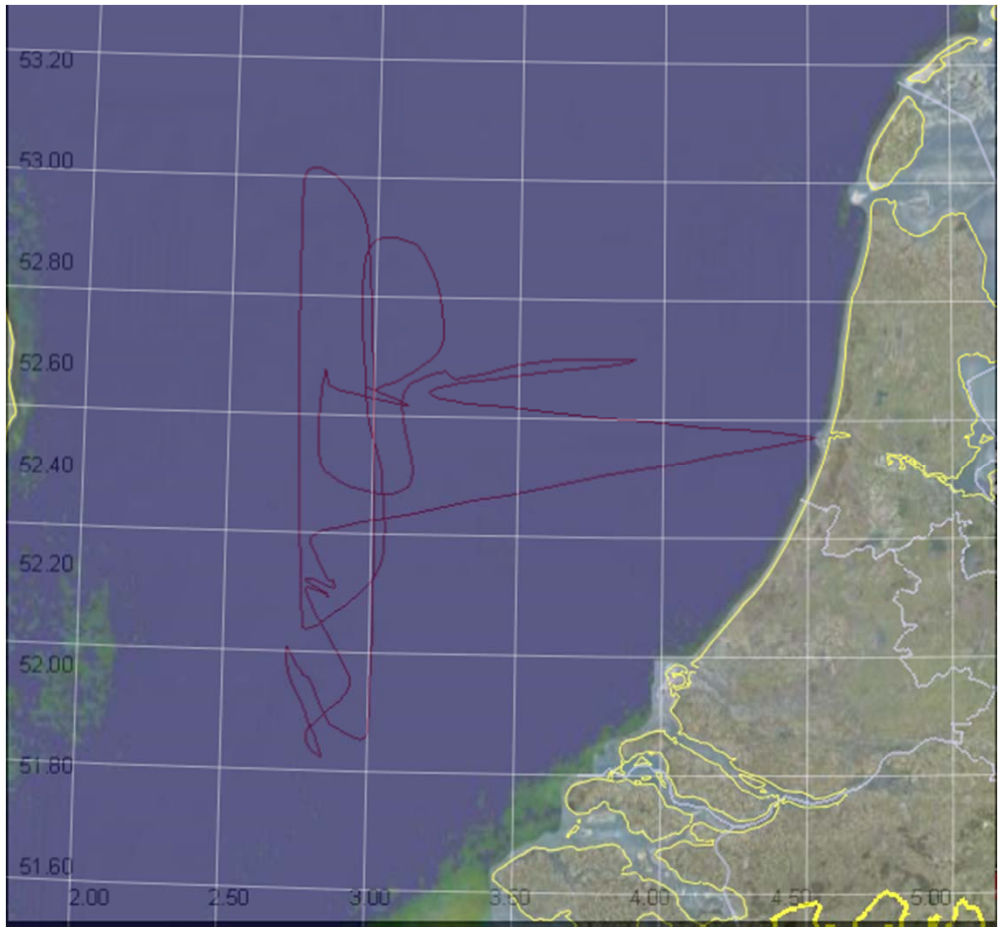


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Fishing trip – operational profile (weekly)

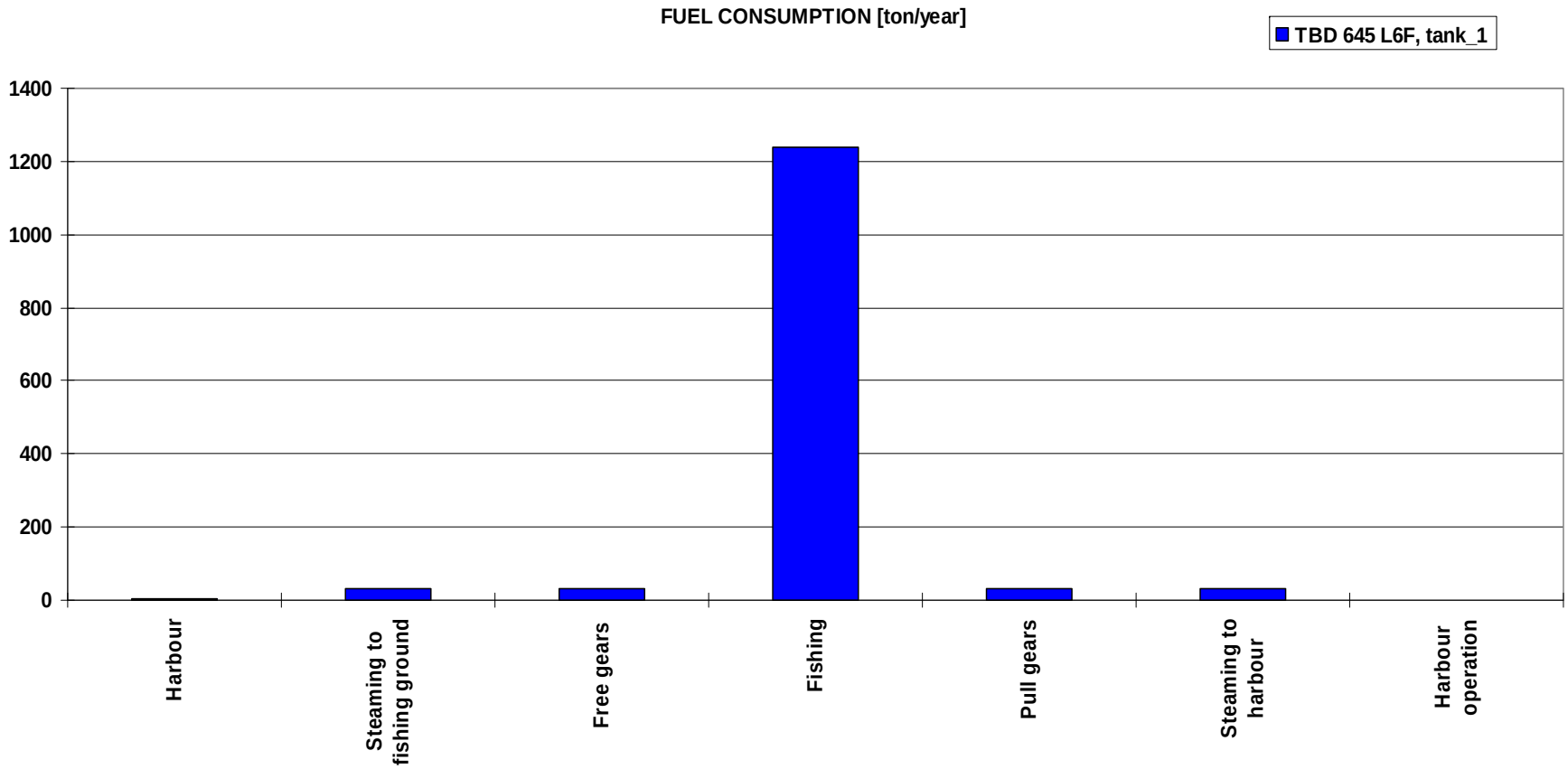
Operational condition	hours
Port	1
Steaming	9.00
Shooting gears	4.50
Towing gears	76.50
Hauling gears	4.50
Process catch	4.50



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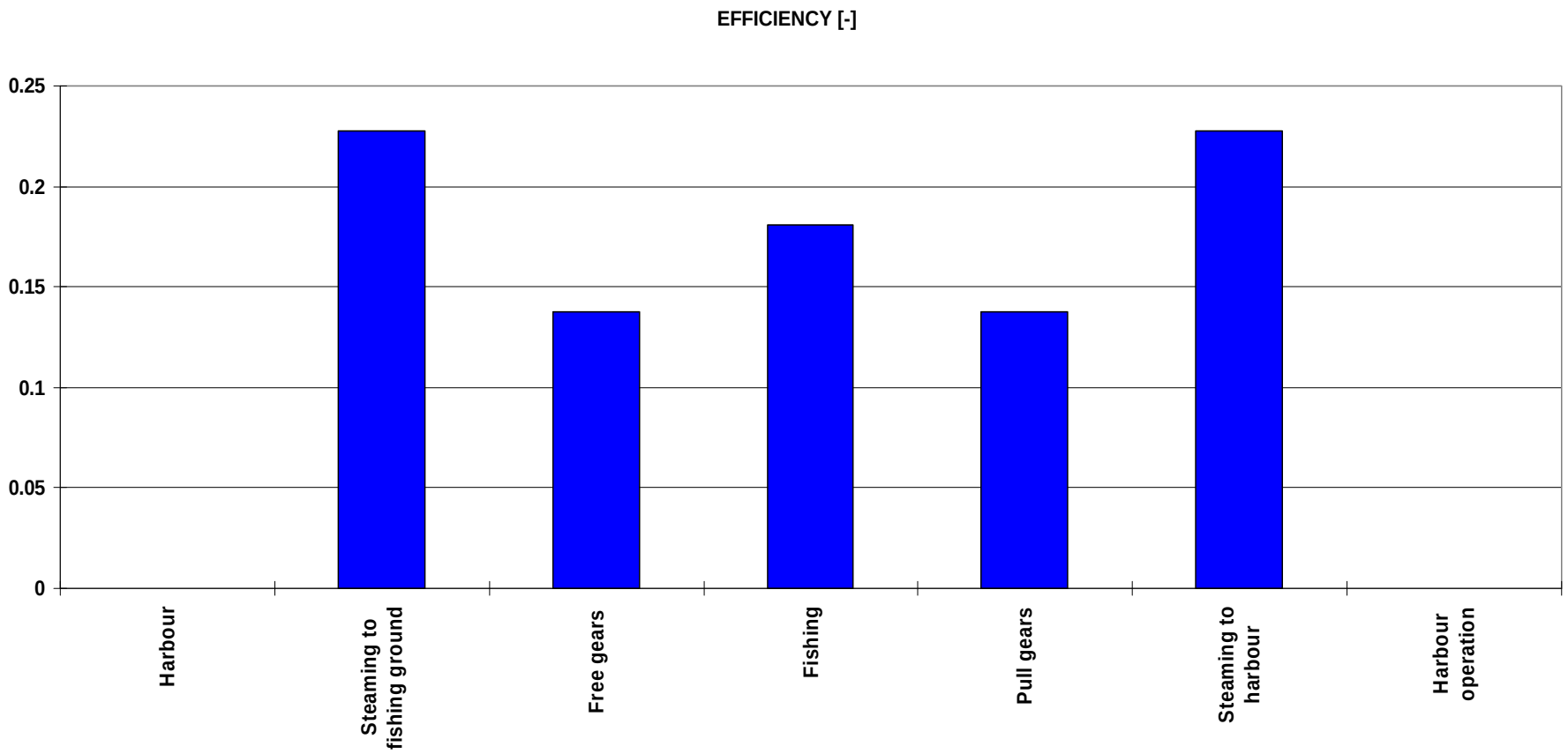
Examples of GES-output 1



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Examples of GES-output 2

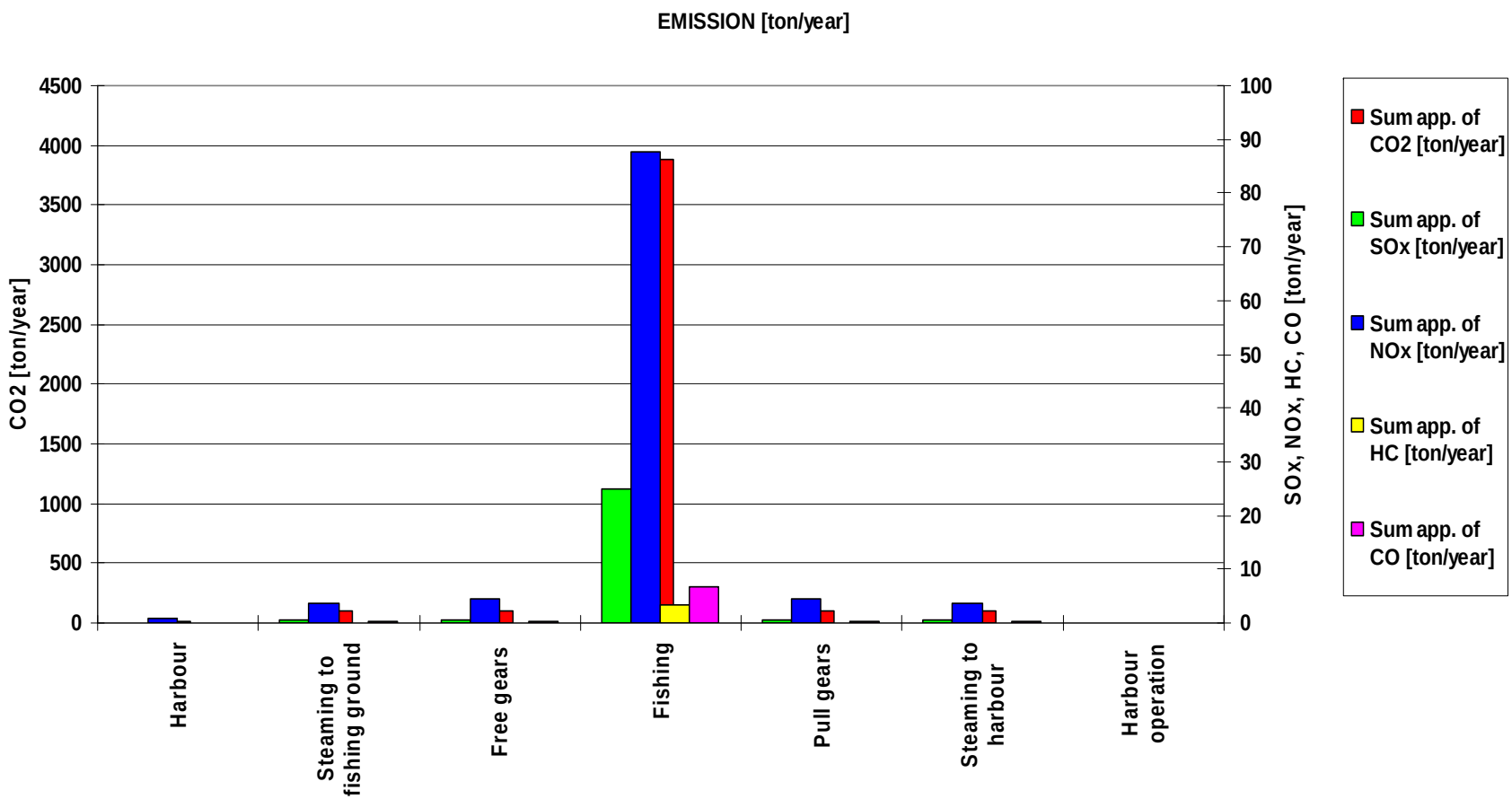


Efficiency = (total power to tow gears and move vessel)/power delivered by fuel

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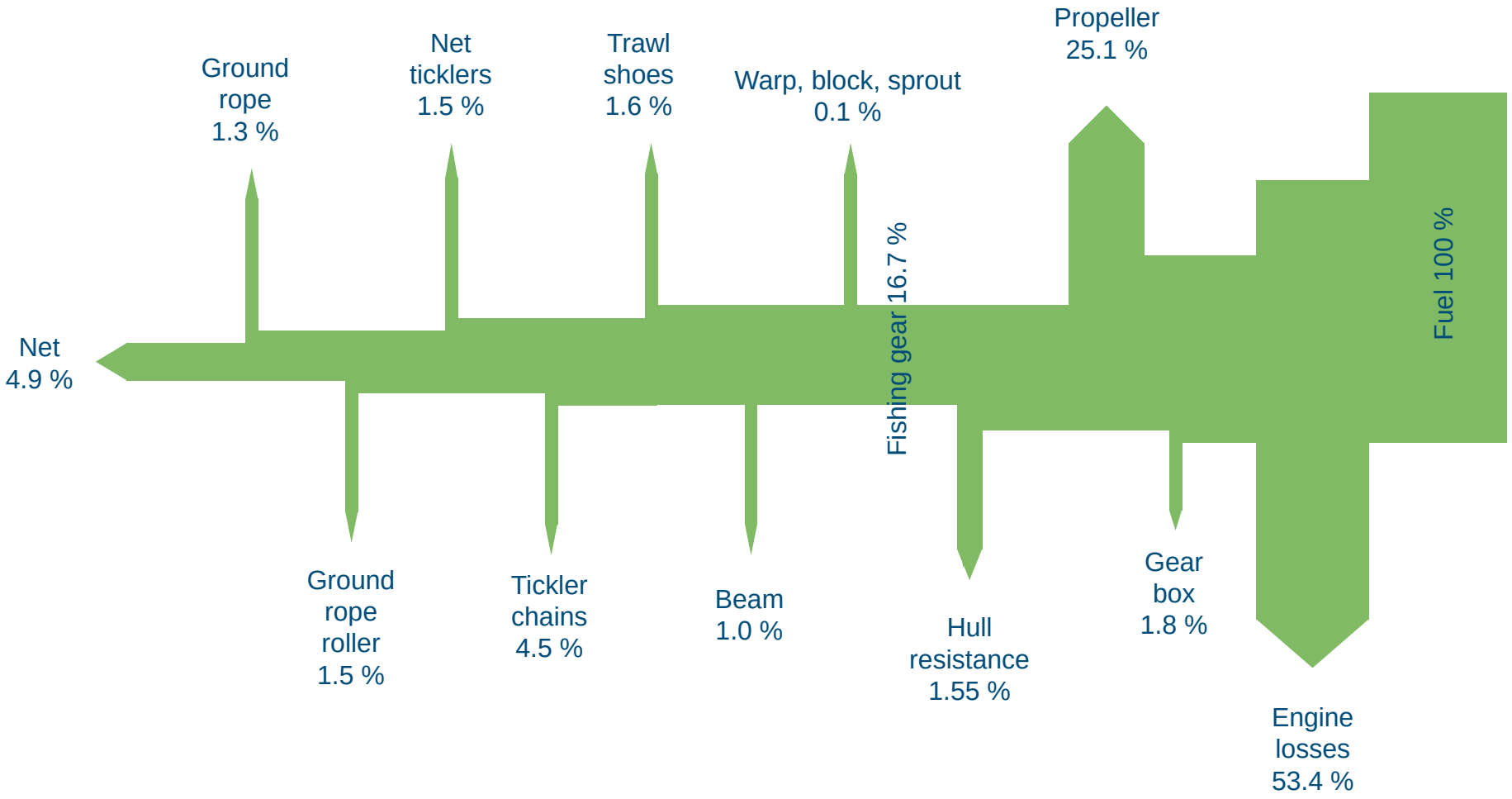
Examples of GES-output 3



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GES-results 1: energy dissipation by component

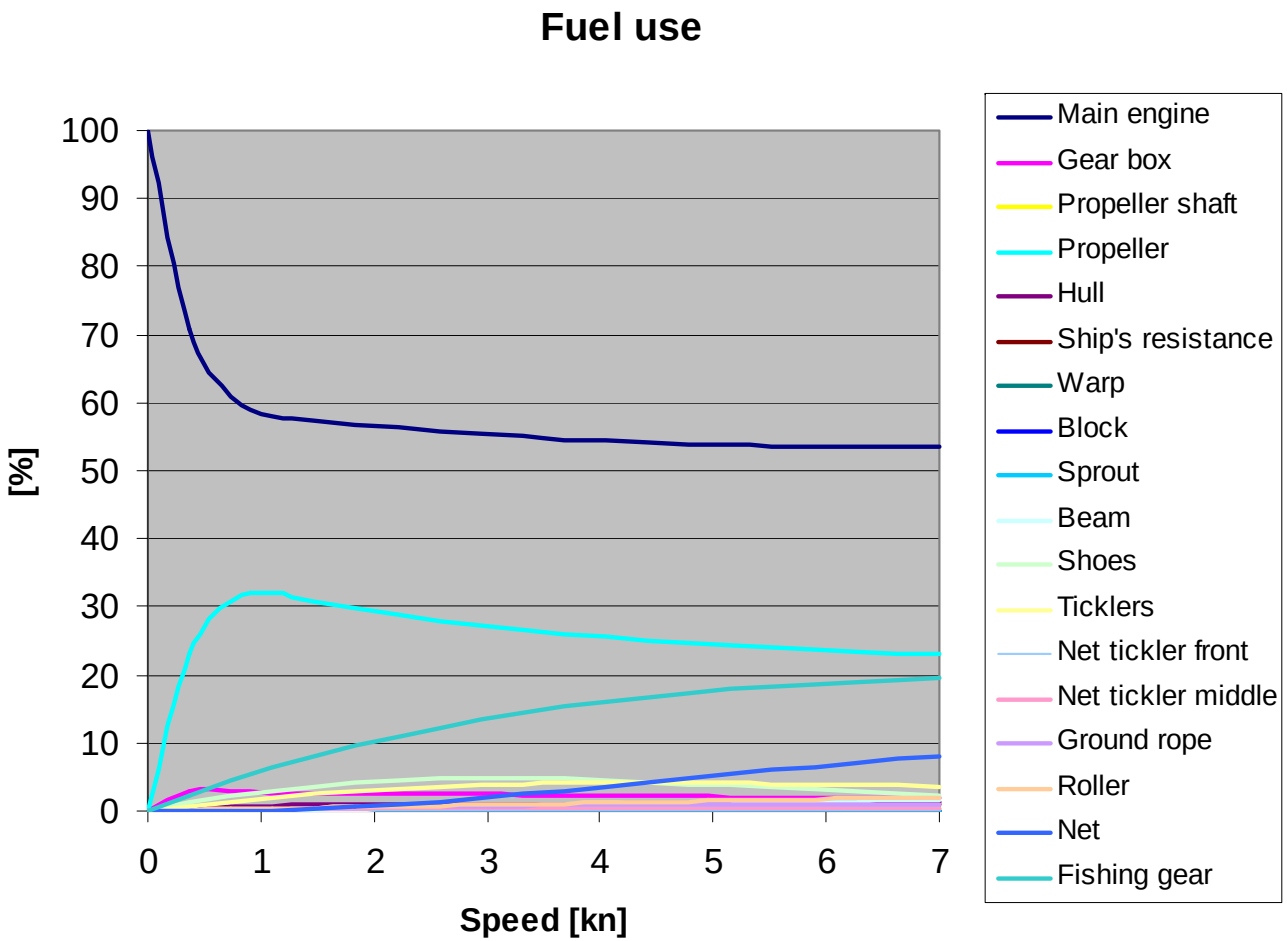


Fishing at 6 knots

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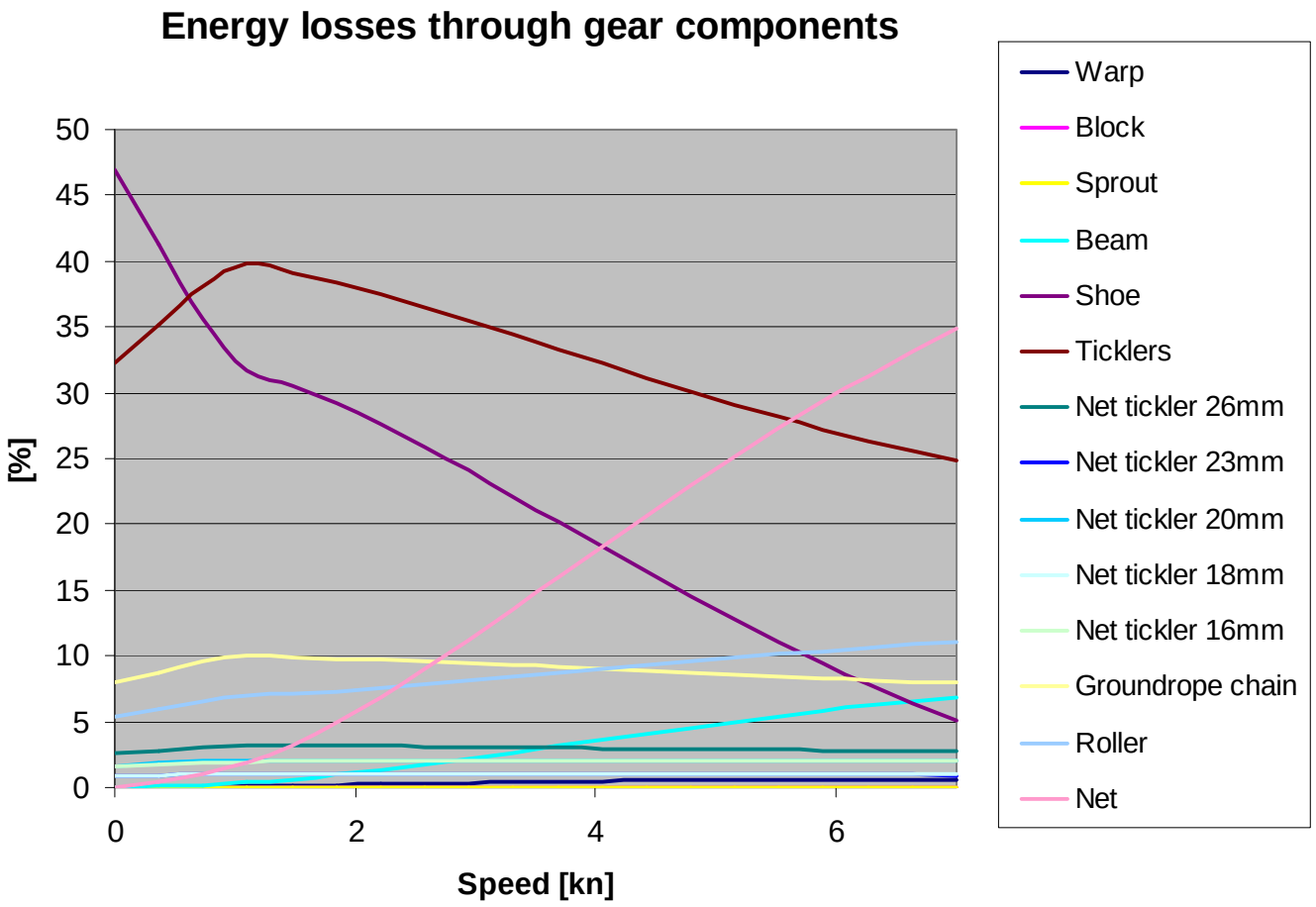
GES-results 2: Fuel use vs. speed



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GES-results 3: Energy losses vs. speed



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GES-results 4: Potential energy savings

MS / gear	Length (m)	Range of potential savings (%)
Belgium		
Beam trawl	24-40	5-50%
Denmark		
Demersal trawl	12-24	5-30%
Demersal trawl	24-40	5-30%
France		
Demersal trawl	12-24	15%

GES-results 5: Potential energy savings

MS / gear	Length (m)	Range of potential savings (%)
Ireland		
Demersal trawl	12-24	8-21%
Demersal trawl	24-40	5-20%
Pelagic trawl	24-40	5-25%
Italy		
Demersal trawl	24-40	8.5%

GES-results 6: Potential energy savings

MS / gear	Length (m)	Range of potential savings (%)
Netherlands		
Beam trawl	24-40	7-40%
United Kingdom		
Demersal trawl/seine	12-24	5-15%
Demersal trawl/seine	24-40	10%

Conclusions

- GES-model
  - very versatile and flexible tool
  - gives insight in energy flows through components
  - tool to identify ways for saving energy and reducing greenhouse gas emissions
- Potential energy savings: 5% - 50%
- Study new fishing vessel and gear technology using GES in order to appraise their energy saving potential
- Also possible to appraise economic effects
  - using a special library

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That's it, Thanks



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