CO_2 reduction
due to
"topography orientated" voyage-planning and navigation

-Prerequisites of ship handling simulators as training tool-

DST – Development Centre for
Ship Technology and Transport Systems

CO_2 reduction IWT - TopoNav – Training with ship handling simulators

What matters ?

CO_2 emitted per cargo-ton / km transported

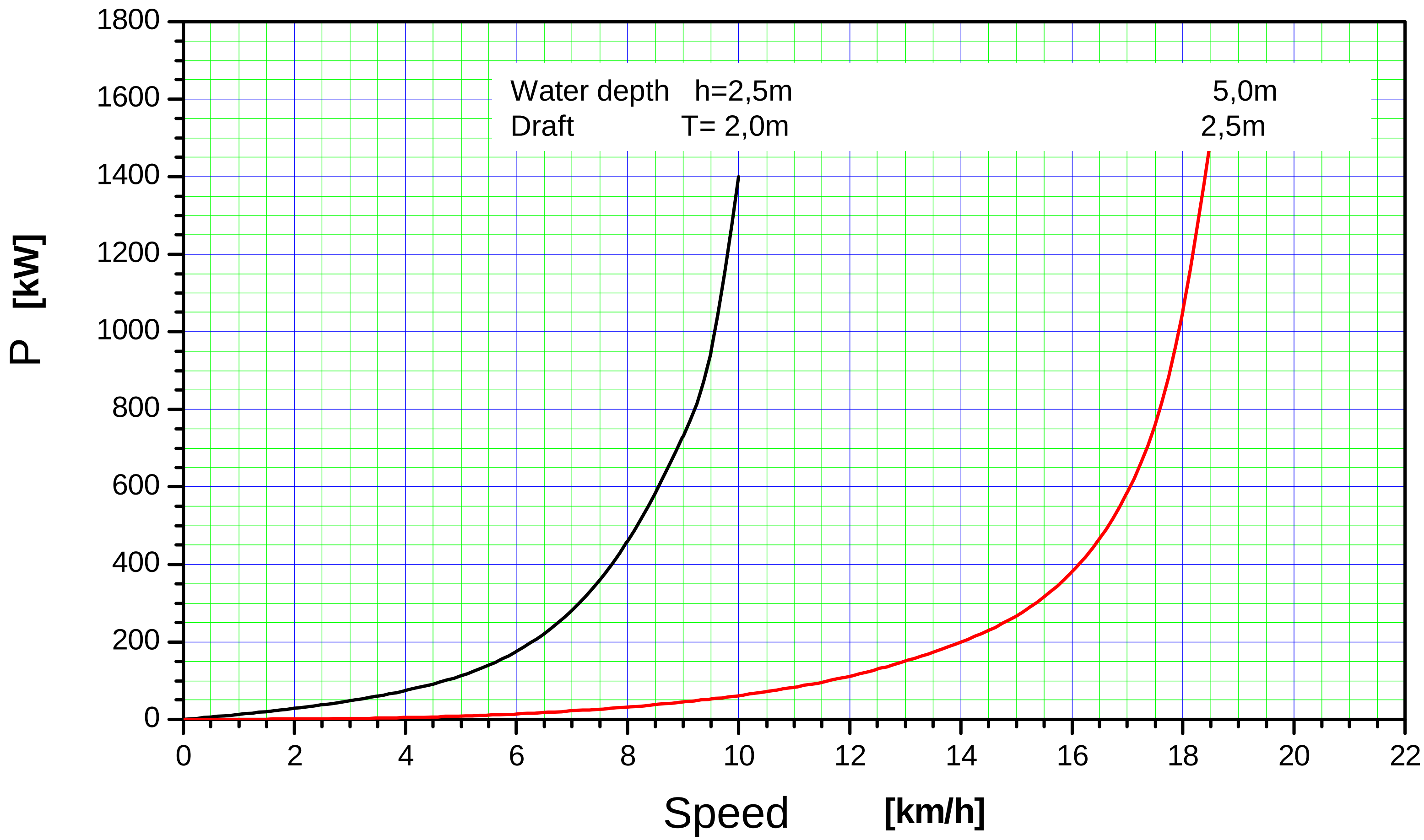
Areas of concern

- ***technical***
  waterways & ships

- ***business – company level***
  selection of ships, fleet-management, service design

- ***nautical – onboard level***
  navigation, handling of ships

CO_2 reduction IWT - nautical aspects



- Speed is a well known predominant driving factor for consumption (all kind of vehicles)
- Design speed can be achieved only with sufficient keel – clearance
- Consumption of ships is largely driven not only by speed but rather by the overriding factor keel - clearance

Variability of water depth (soundings) during a voyage generally occurs due to:

- topographical variance – along a river or along a route (river and / or canal)
- positions in the cross section according to individual navigation
- water-level variance

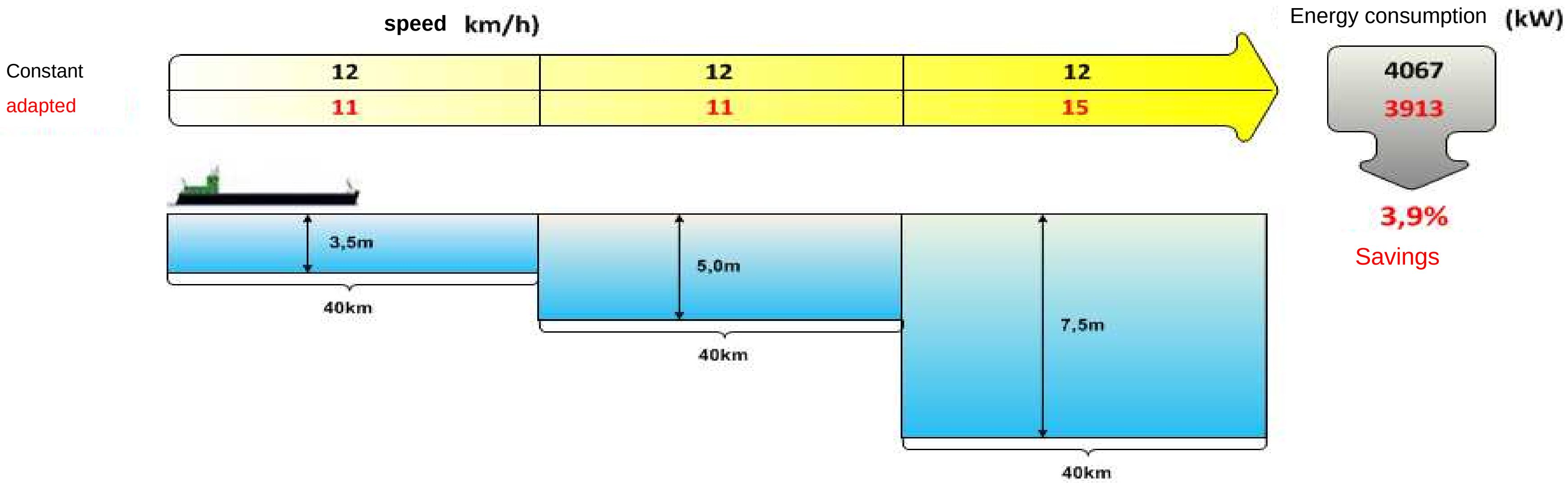
Objective:

Reduction of CO_2-emission & fuel consumption

How to deal with expected water depths ?

Example 2*

length of route: 120 km, duration target: 10 hours



*Ship: L=110mxB=11,4, draft 2,5m

CO_2 reduction IWT - nautical aspects

List of examples*

			speed			consumption	
Case N°	distance [km]	duration [hour]	segment 1 [km/h]	segment 2 [km/h]	segment 3 [km/h]	basic / optimum [kw]	savings [%]
1	24	2	11	12	14	854 / 800	6,8
2	120	10	11	11	15	4067 / 3913	3,9
3	20	2	9	10	12	506 / 501	1,0
4	28	2	12	15	16	1472/1282	14,8
5	26	2	11	13	17	1280 / 1035	19,1
6	36	12	11	12	13	1179 / 1114	5,8

*Ship: L=110mxB=11,4, draft 2,5m

Basic approach to the simulated optimization process

- 3 segments differ in length and water depth
- per segment only one speed
- discretisation – speed interval 1 km/h
- specific & complex mathematical model for optimization

Findings

➢ **optimum speed** per segment largely depends on
  - water depth and
  - its length relative to the total distance

➢ **high saving potential**
  - especially if high average speed is needed and
  - segments differ in water depth and length

How to deal with these findings in practice (real life)

?

- A solution can be found using numerical methods for tabulated functions

$$P_D = f(Fr_h; T)$$

- By assuming simplified approximation functions such as

$$P_{Di} = P_{D0i} + k_i \cdot (Fr_h - Fr_{hi})$$

or

$$P_D = k(T) \cdot Fr_h^{\ 3}$$

an analytical solution can be found, but the approximation error has to be evaluated ?!

Common practical situation : ***fixed voyage order***:

- ✓ route (port of departure >>> port of destination)
- ✓ sailing duration-time (time of departure >>> target ETA)
- ✓ ship's draft

Target-setting: fuel consumption / CO_2 reduction ?

Basic awareness probably ok

? but how to deal with it ?

Enhancing awareness and experience
by
Simulator based training for concerned persons

Types of simulation scenarios (examples)

1. Simple scenarios >>> to show effects and to develop general approach to “topography oriented navigation”
2. Close to “real” routing scenarios >>> to show specific “CO_2 – saving potential” along selected routes
3. Close to “real” driving scenarios >>> to develop specific navigation tactics for “topography oriented navigation”

CO_2 reduction IWT - training aspects

Prerequisites of ship handling simulators for close to “real” routing scenarios

- a minimum of different types of inland-ships
- correctly implemented shallow water effects and other ship-related effects
- correctly implemented topography (ECDIS is not enough)
- correctly implemented river current, wind and other external effects

Prerequisites of ship handling simulators for close to “real” routing scenarios

- possibility to record continuously & sum up speed, positions, keel clearance, rpm or energy or consumption

- possibility to replay

- possibility to generate “stand alone / automatic simulations”

Learning targets for specific training with simulators

- basic understanding concerning shallow water effects related to CO_2 emission
- use of a simplified mathematical model for speed optimization
- rough cascading of ship's energy profile according to speed and keel clearance
- rough segmentation of route into stretches with averaged water depths
- translation of simplified calculation into voyage planning

  - envisaged speed per segment -

Topography orientated voyage planning and navigation appears to be

a possible approach to CO_2 -reduction

- Suitable simulators are useful tools to develop and train appropriate methods
- Suitable training is – amongst others - a solution to enhance awareness, i.e.

to make CO_2 –reduction happen!

Thanks for your attention !

CO_2 reduction IWT - simulation aspects