



HOW GREEN CAN YOU MAKE A TUG?

FFCA-East Coast, New York, 8&9 July 2008



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Introduction

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Project Partners:

- WorldWise Marine Engineering BV
- Iskes Towage & Salvage BV
- Smit Nederland BV





How to achieve:

- Limiting emissions (CO_2 , SO_x , NO_x , Smut) especially in urban areas
- More efficient energy use



Diesel Engines:

- Run engines always as close as possible to optimal load condition.
- Use clean fuel reducing SO_x .
- Installation of catalyst systems reducing NO_x .
- Installation of smut filters to reduce particle emission.



The Concept

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HYDROGEN HYBRID HARBOUR TUG (HHHT)

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All Electric Tug powered by:

- Fuel cells on hydrogen
- Batteries
- Diesel generator sets



Power Supply:

- Diesel – Electric when substantial Bollard Pull is required for berthing & unberthing (15-40%)
- Fuel Cells Stacks feed by Gaseous Hydrogen for mobilisation purpose and electricity supply during inactive condition (60-85%)



Operational Profile Power Supply

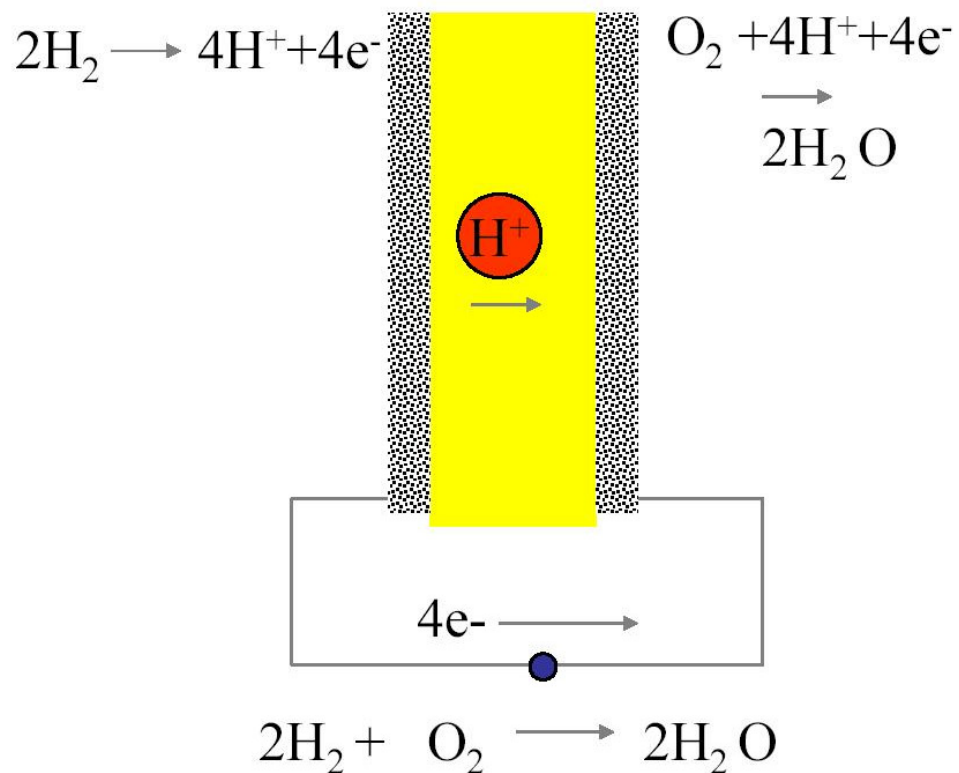
	Towing & Escorting 2900 kW	Mobilisation & Demobilisation 300 kW	Stand - By 30 kW
Fuel Cells	(X)	X	X
Batteries	(X)	X	
Generator Sets	X		



Fuel Cell Technology

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Basics of the PEM fuel cell technology





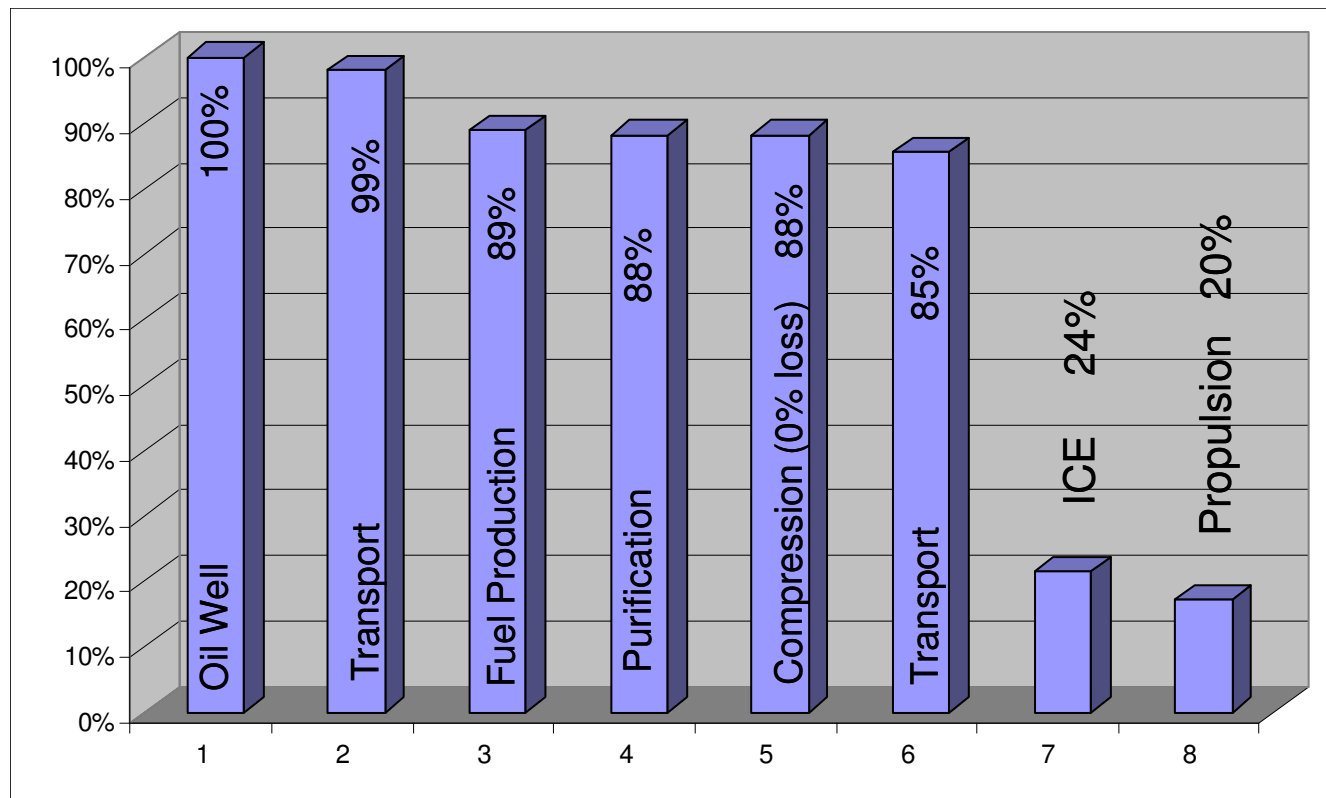
Advantage Hydrogen:

- Zero emissions
- Well to Propulsion efficiency: 34%
(in relation to conventional diesel
20%)
- Lower noise levels



Well to Propulsion Efficiency

The Petrol and ICE Chain



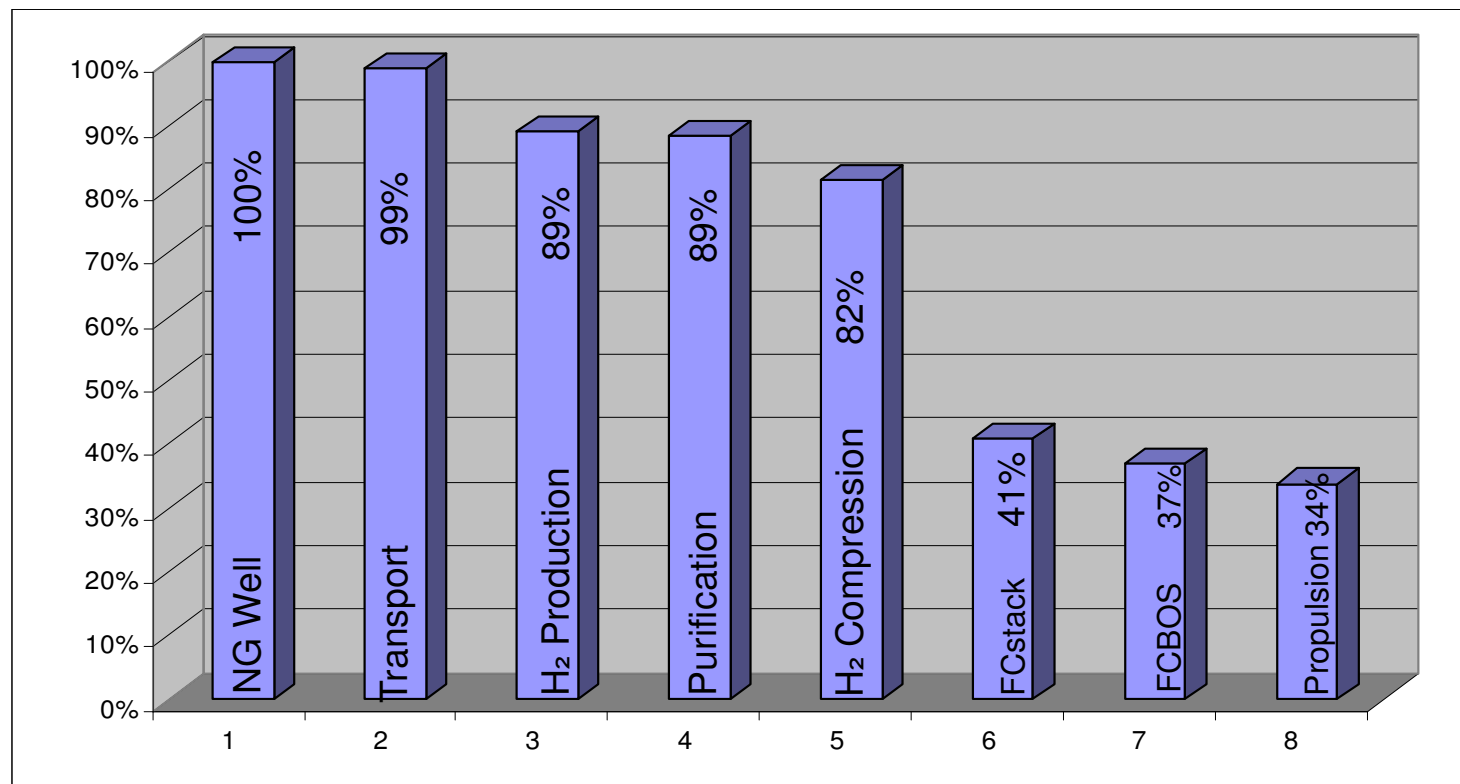
* In accordance with JRC WTW report 2007

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Well to Propulsion Efficiency

The Hydrogen and Fuel Cell Chain



* In accordance with JRC WTW report 2007

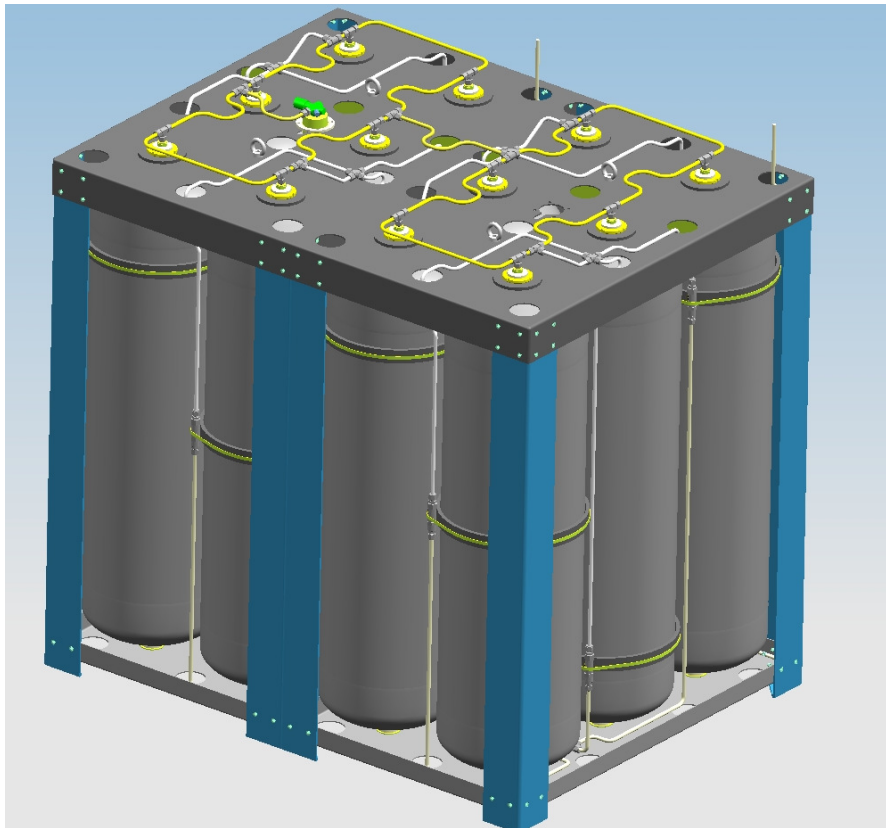
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Hydrogen Tanks

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Storage Hydrogen:



- 12 cylinder modules
- 2700 L
- 430 bar



Raufoss
FUEL SYSTEMS



Endurance Calculation

$$24 / (200 * 0.65 / 430) = 79.4 \text{ hours}$$

- 06 – 07m³ hydrogen at atmospheric pressure to generate 1 kW
- Storage at 430 bar pressure
- 9 modules of 12 cylinders total 24m³



Achievable Results

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Possible reductions total concept:

- CO₂: 15-40% (dependent on operational profile)
- SO_x: ≥ 90%
- NO_x: ≥ 90%
- Smut: ≥ 90%



The Design

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Design Features:

- VOITH inline retractable bow thruster for mobilisation/demobilisation
- Four diesel generator sets to achieve optimal load factors
- Electro motors directly on top stern main propulsion units



Concept Design 50 tBP HHHT:

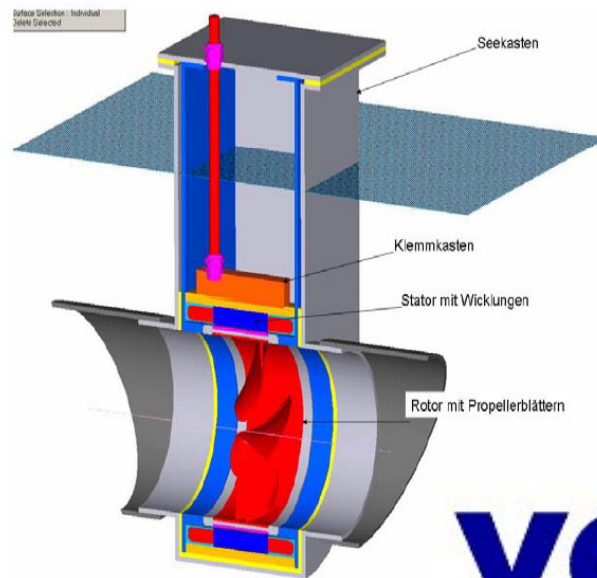
- Loa: 30,20 mtr.
- B: 10,70 mtr.
- T: 4,20 mtr.
- D: 5,30 mtr.
- Fuel Oil: 75m³
- Hydrogen: 24m³
- Water Ballast: 40m³
- Fresh Water: 30m³



Design 50 tBP HHHT:

- Main Propulsion units: 2x1300 kW
- Bow Unit: 1x Voith Inline Thruster
ILT 850-300, 300 kW
- Generator sets: 4x650 kW
- Fuel Cells: 2x Nedstack PS100, 100kW

VOITH Inline Thruster:

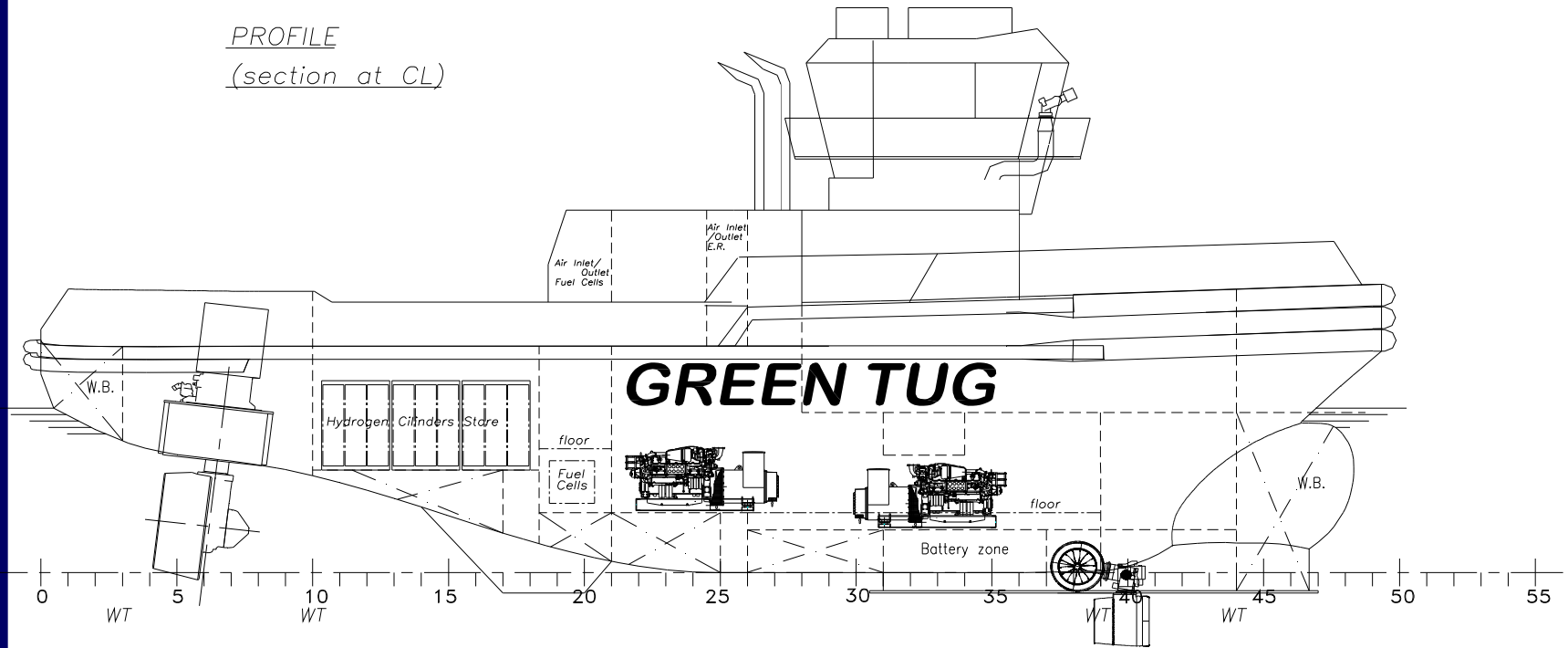


- Stator & Rotor integrated in nozzle
- No Gearing = more efficiency
- Water cooled

VOITH
Engineered reliability.[®]

Design 50 tBP HHHT:

PROFILE
(section at CL)

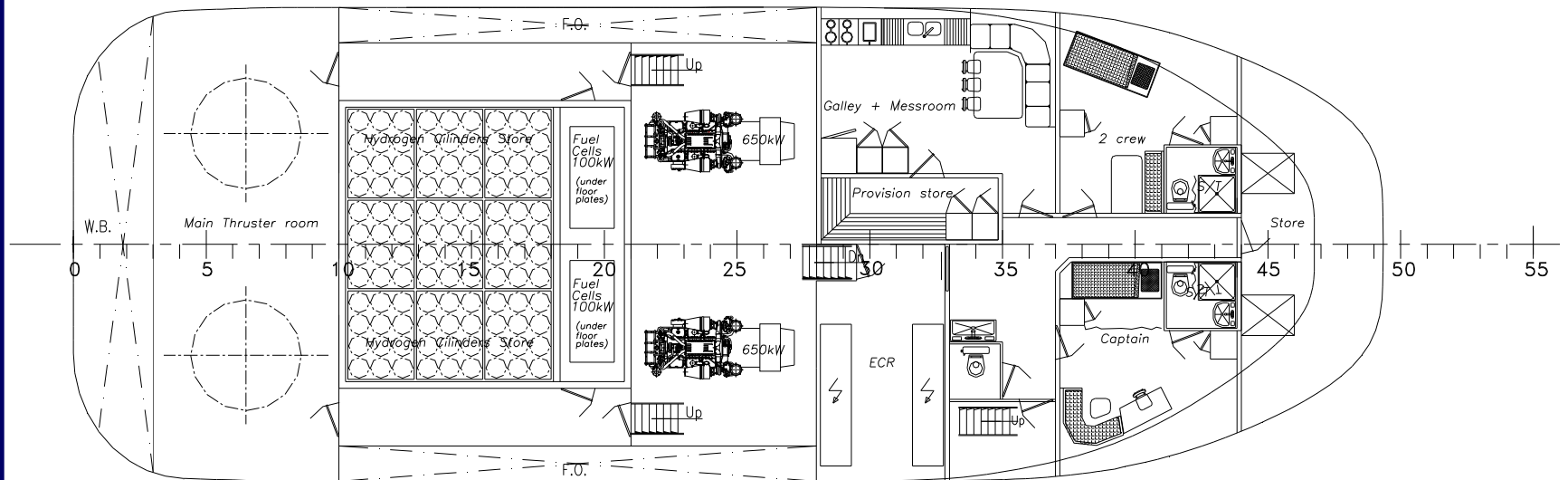




Design 50 tBP HHHT:

VIEW BELOW MAINDECK

VIEW AT TWEEN-DECK



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Further Development

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- In depth analysis operational profiles
- Development Electronic Power Management System
- Development power regenerating features winch and propellers
- Manoeuvrability on bow unit only
- Development full basic and detailed design
- Selection electrical deck equipment, etc.
- Investment operational cost



Project Supported by:

