

## Go green, gas gas – the answer to all (emission) problems?


**5<sup>th</sup> CIMAC Cascades 2014 Busan**  
**“GAS ENGINES - THE VIABLE ALTERNATIVE FOR ECAs?”**  
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## (Marine) engines market drivers




**Emissions**  
 Demand for reduced NOx, CO2, SOx and PM

- Exhaust after-treatment for diesel engines
- Gas engine concepts




**Economy**

- Lower fuel consumption
- Lower OPEX (e.g. EHM Initiatives)
- Low energy loss concepts



**Technology**


- Trends toward more specialised vessels with more flexible propulsion systems (e.g. diesel-/gas-electric, hybrid drive)
- Move to deeper waters and more harsh environment operation



**Regulations**

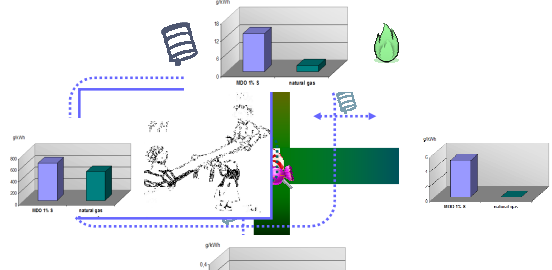
- Stronger environmental focus through IMO Tier III and EPA
- Stronger safety focus (e.g. SOLAS, NORSOK and others)

**Kleiner's law(s)**  
*"Make sure the dog wants to eat the dog food. No matter how ground-breaking a new technology, how large a potential market, make certain customers actually want it."*  
 (Eugene Kleiner)



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## The diesel dilemma → “Go Gas”

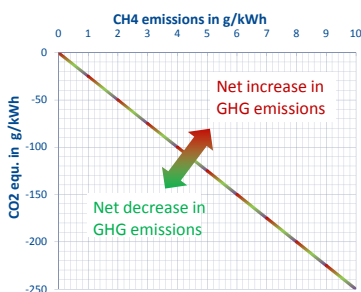


**IMO** INTERNATIONAL MARITIME ORGANIZATION

**EPA** United States Environmental Protection Agency

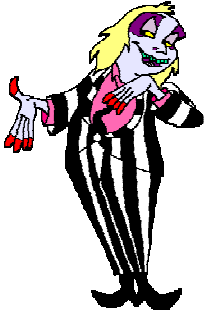
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## Methane, methane, meth... → GWP\*

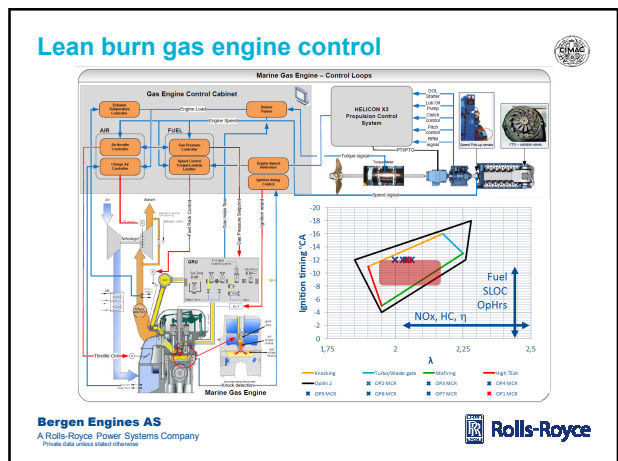
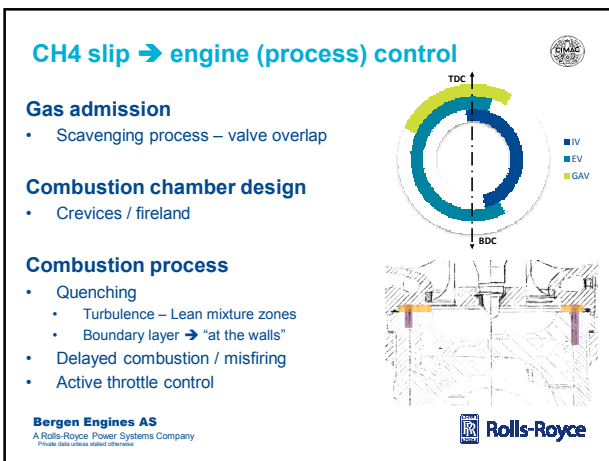
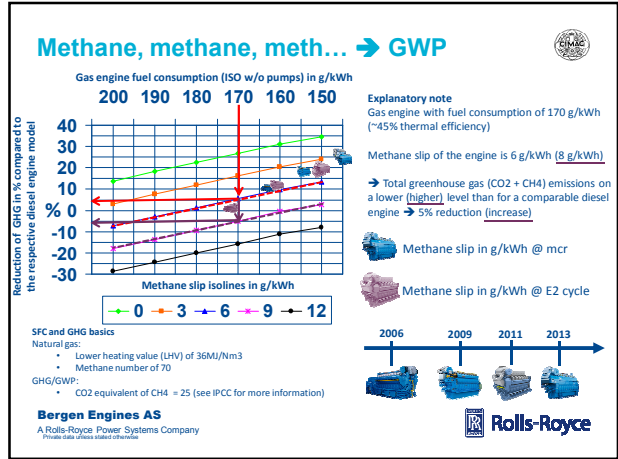
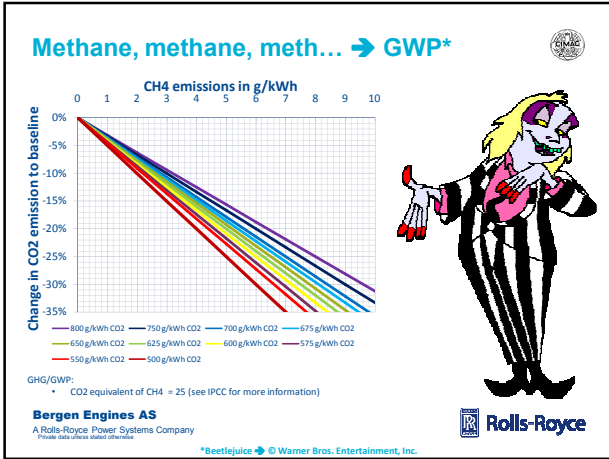


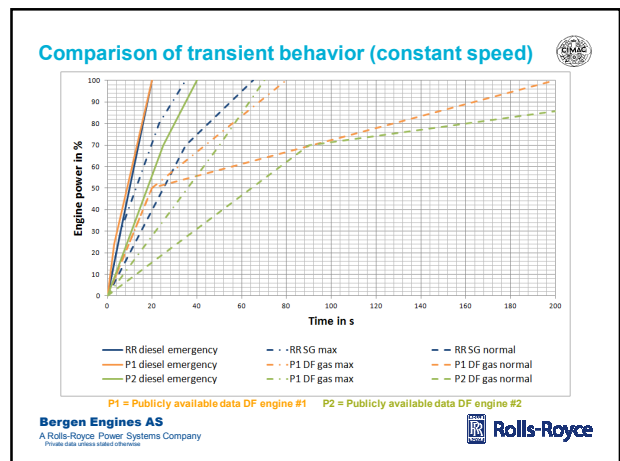
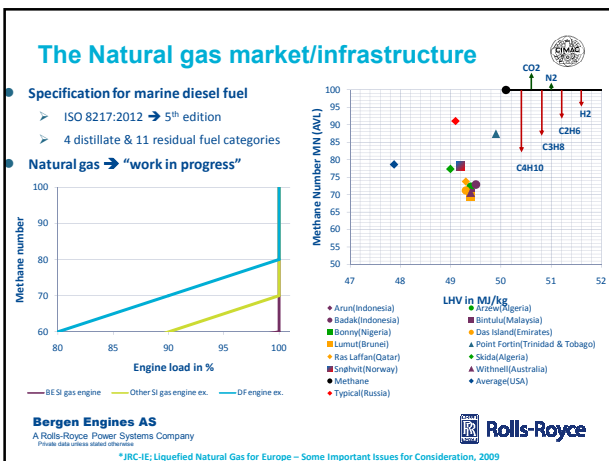
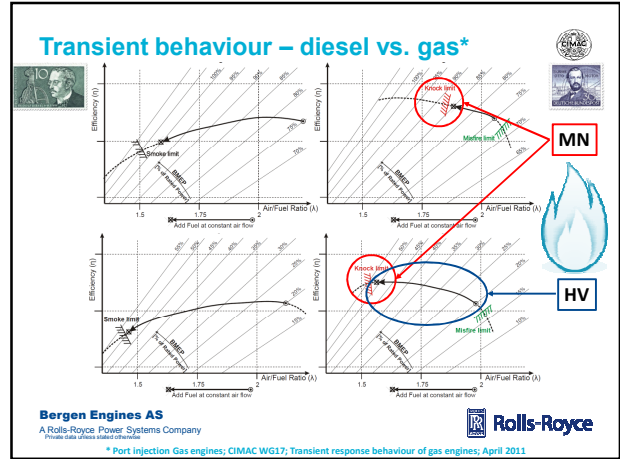
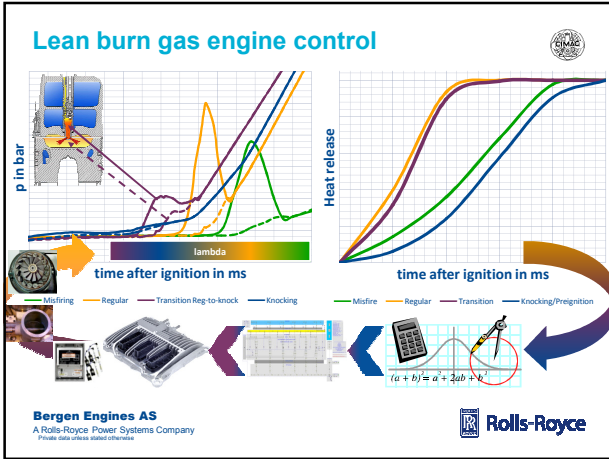
GHG/GWP: CO2 equivalent of CH4 = 25 (see IPCC for more information)

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\*Beetlejuice © Warner Bros. Entertainment, Inc.





### Marine mechanical drive key enablers

**Variable speed and dynamic load capability**

Example of variable speed up-loading and subsequent pitch reversal at rated speed 750 rpm

Engine speed in rpm on the 1<sup>st</sup> axis    Engine power in % on the 2<sup>nd</sup> axis

PSV in rough weather DP operation  
→ 30 knots wind and 3m wave height

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### Marine mechanical drive\*

**"... first tugboat in the world to run purely on natural gas"**

M/T Borgøy

35 m long  
14,5 m wide  
13,5 knots  
68 tons Bollard pull  
1 x 80 m3 Gas tanks and ancillaries  
Acon gas monitoring safety system  
2 x RRM US35 CP azimuth thrusters  
2 x C26:33L6PG @ 1705kW = 2286 bhp

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### Marine mechanical drive

**... and the "Oscars" go to M/S "Stavangerfjord" – M/S "Bergensfjord"**

170 m long  
27,5 m wide  
25 000 GT  
600 cars  
1500 passengers  
25 knots  
2x RRM Promas system  
4 x B3540V13PG @ 5.600kW = 7.616 bhp  
Over 4500 operating hours (17.03.14)  
Overall true efficiency based upon thermal energy input at 47% (~50% with WHR)

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### The LNG "argument clinic"\*

**No, it isn't.**

- Costs
- Emissions
- Operation
- Reliability

**Yes, it is.**

- Bunkering / Infrastructure
- Installation
- Safety
- Conversion ...

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\*Monty Python's Flying Circus © BBC & Python Pictures / The Ten Commandments © Paramount Pictures & Motion Picture Associates, Inc.

