Technische Universiteit
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University of Technology

# Enabling true green transport

## Commercial vehicles

de emissie-loze(!?) verbrandingsmotor


Where innovation starts


- **Biofuels and bioenergy**
- Bioenergy is seen as an important contributor to meeting the targets set by the Renewable Energy Directive (20% share of renewable energy over total EU consumption by 2020), and therefore complementary to other low carbon energy alternatives. The European Commission has also proposed that 10% of the transport sector's final energy consumption in 2020 should come from renewable energy sources. Biofuels are expected to play an important role to achieve this target

https://ec.europa.eu/jrc/en/research-topic/sustainable-transport-and-fuels

# Commercial vehicles: the Dilemma

## Direct Use of Electricity not foreseen for all modes

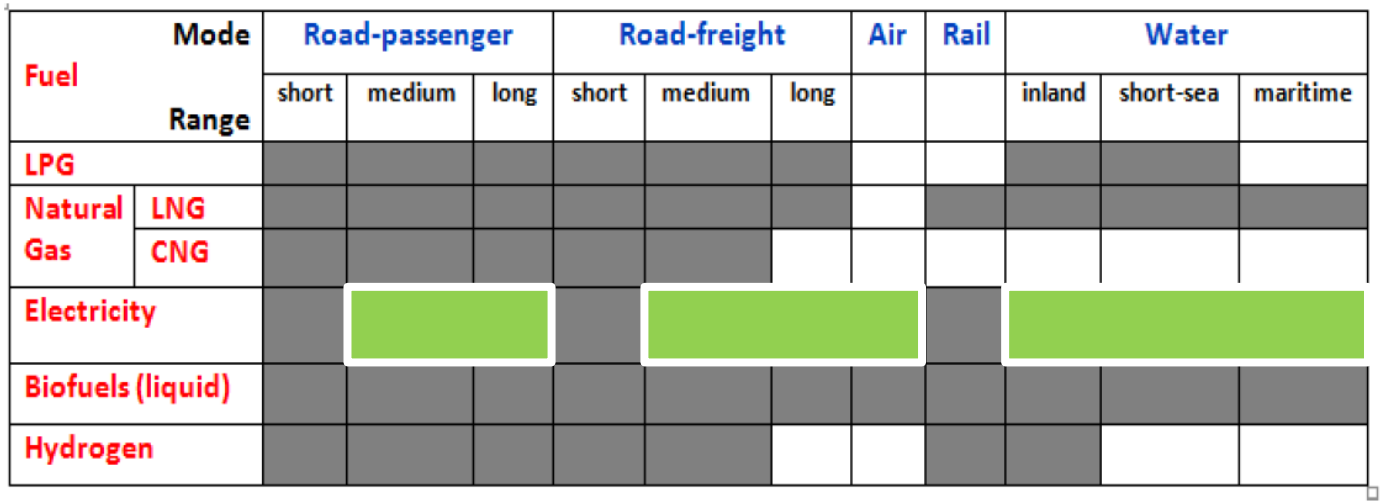
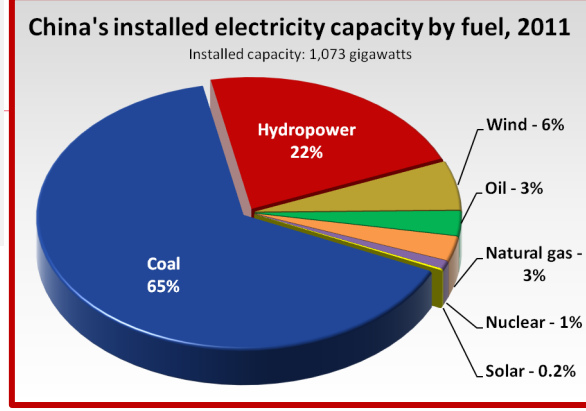



Figure 2.2 Coverage of transport modes and travel range by the main alternative fuels [Clean Power for Transport: A European alternative fuels strategy, 2013]

According to Hans-Dieter Schilling (Energie-Fakten), **the average efficiency** of all coal power stations in the world currently stand at **around 31%,** leaving a vast potential to reduce coal consumption and CO2 emissions.




# Commercial vehicles an '*inconvenient truth*'

## Electric transport is not green perse

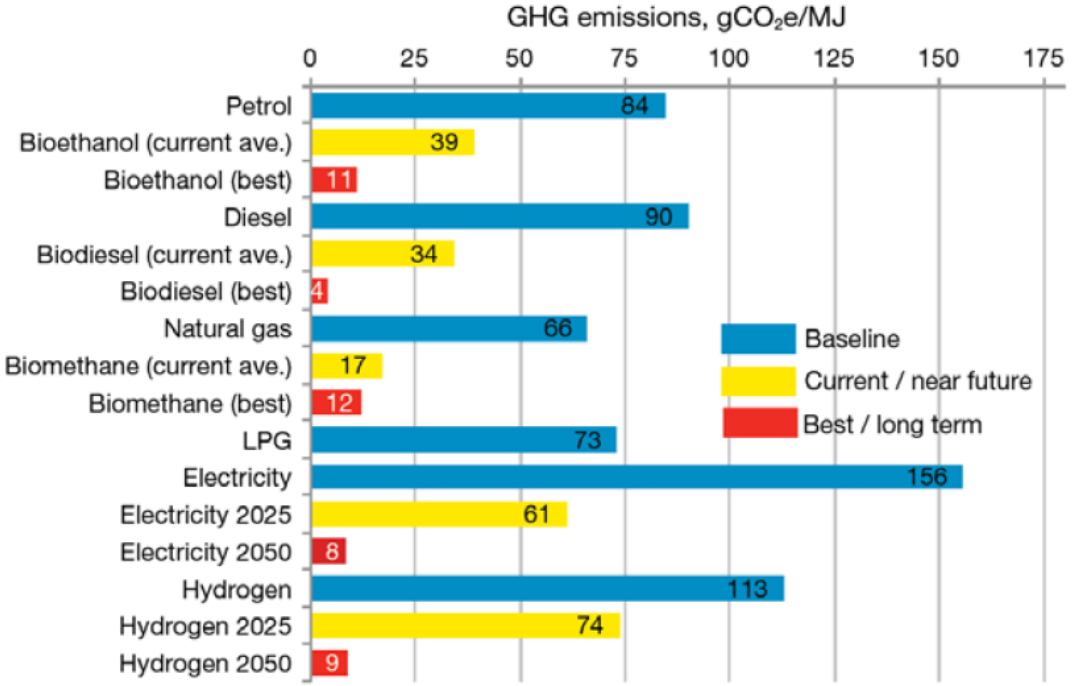
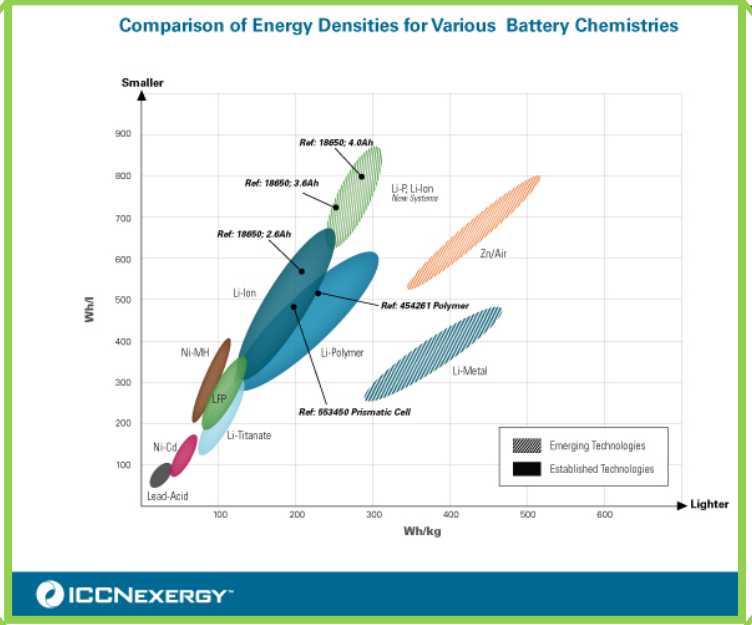



Figure 4.43 Well-to-Wheel assessment of different production pathways and powertrain systems [Ricardo-AEA analysis]

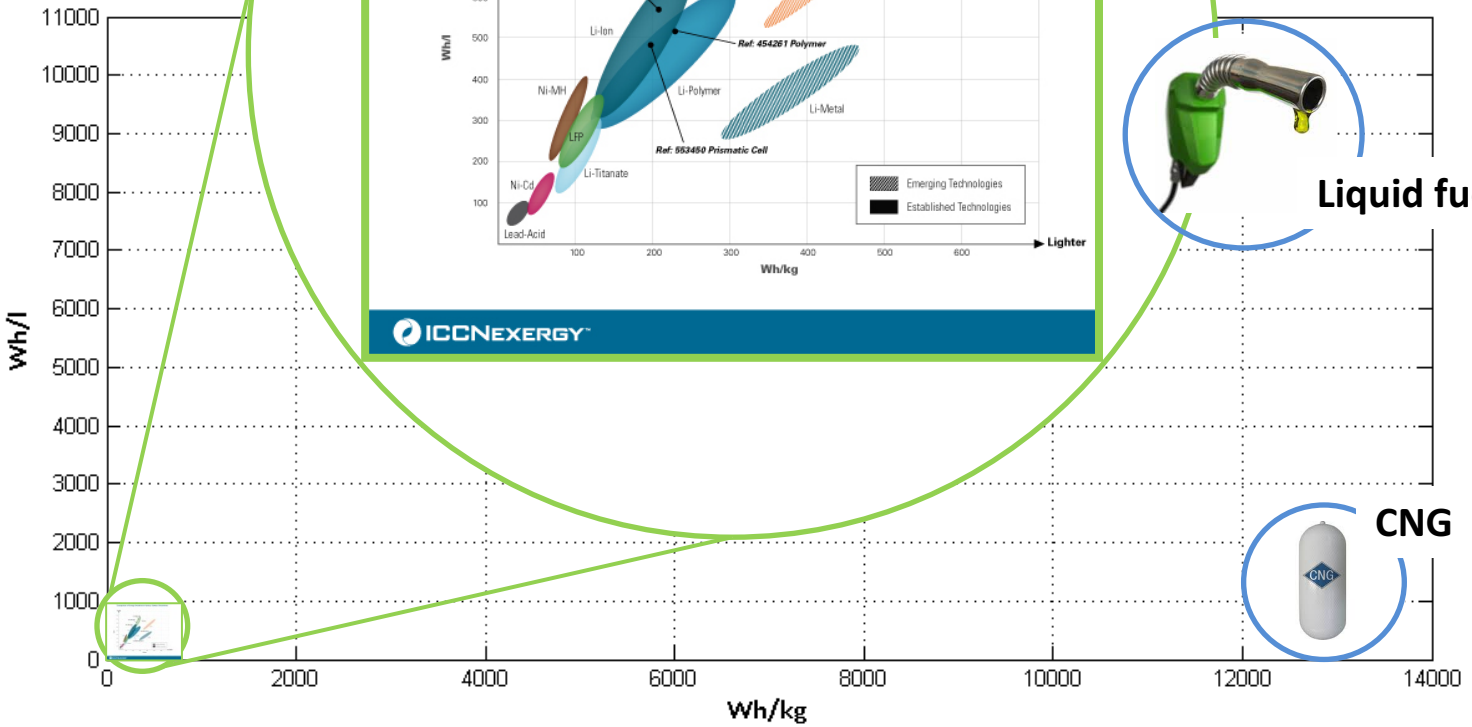
# Energy density of liqui

## Energy Density of batteries




| Mode | Road-passenger | | | Road-freight | | | Air | Rail | Water | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | short | medium | long | short | medium | long | | | inland | short-sea | maritime |

transport modes and travel range by the main



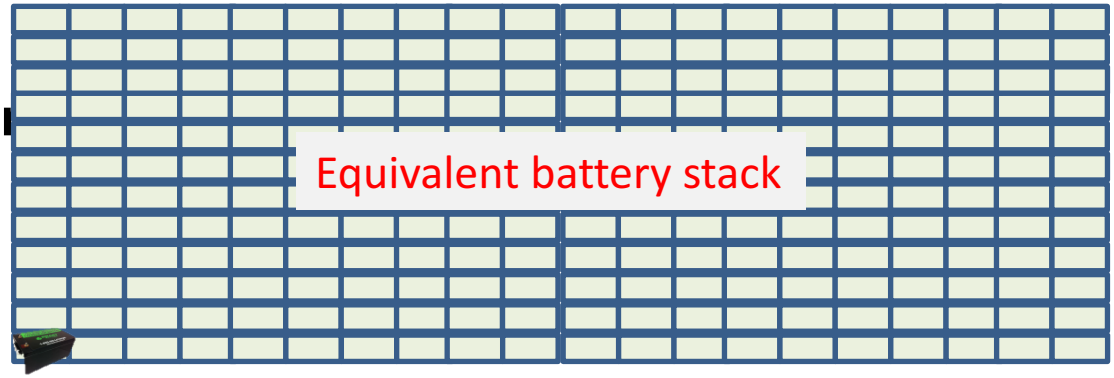



Liquid fuels

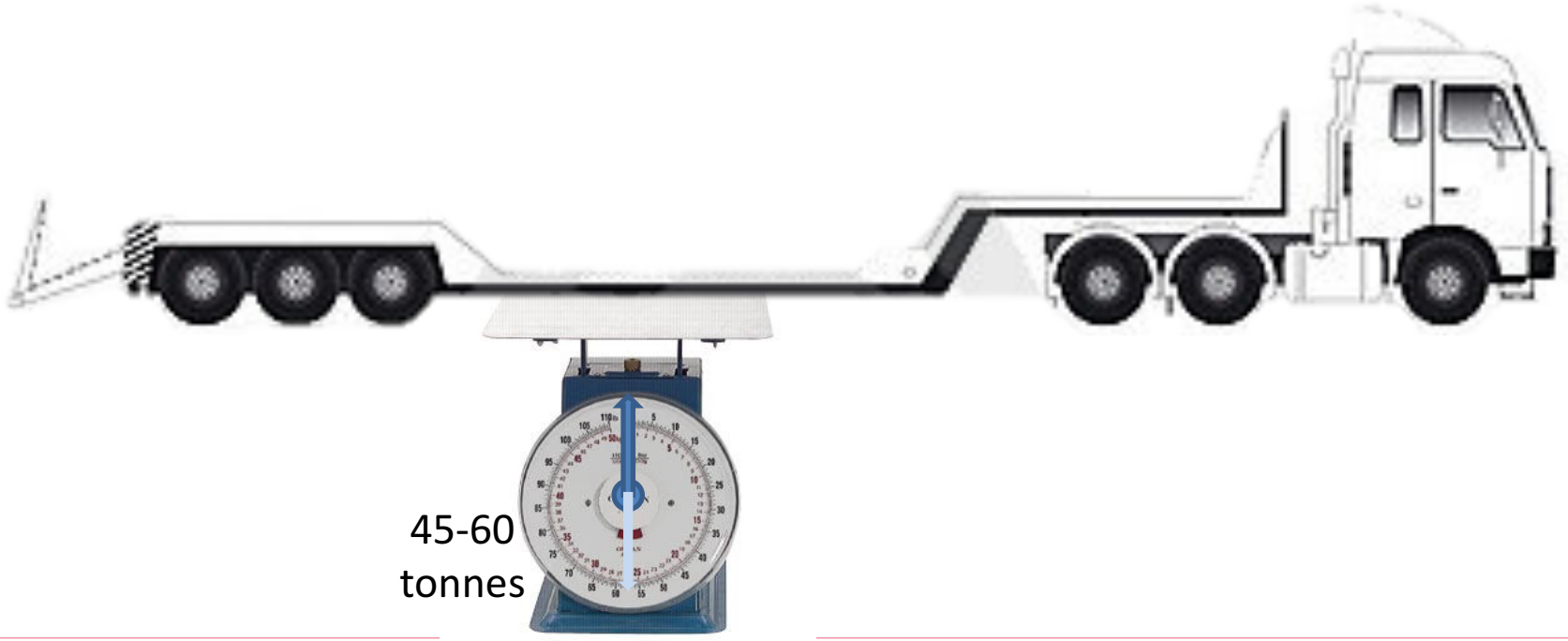



CNG

## Energy den




15-25 $m^3$



45-60 tonnes

# The road to green transport

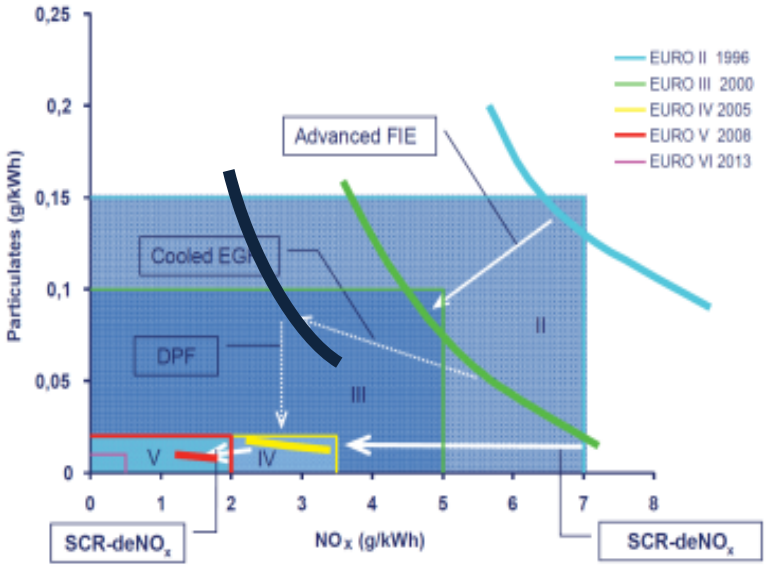
## Ultra-Clean and Ultra–Efficient Engines prepared for Low-Carbon Liquid Fuels

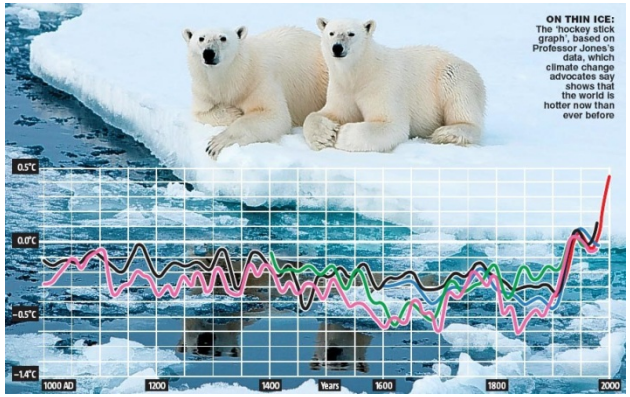
### Local, (NOx/Soot)

- Clean Concepts
- Aftertreatment

### Global ($CO_2$/$CH_4$)

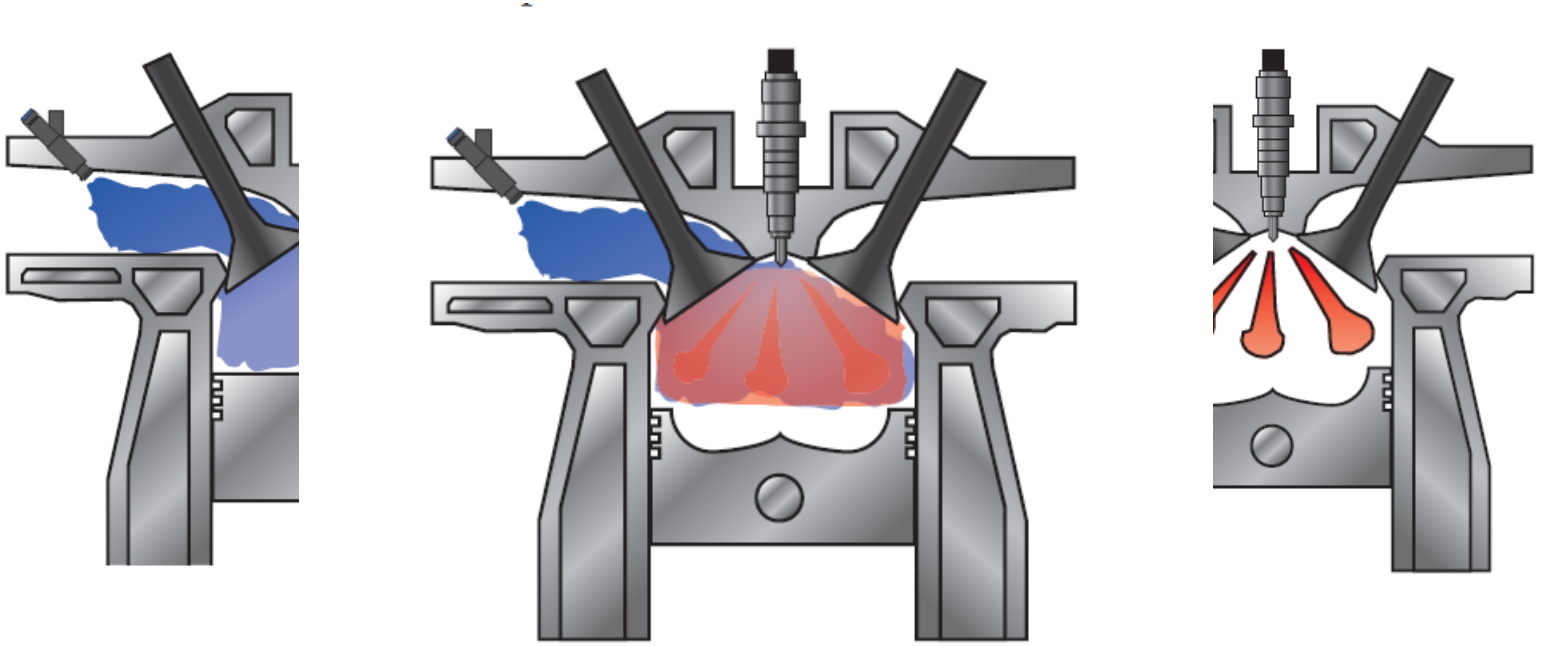
- Efficient
- Low-Carbon Fuels



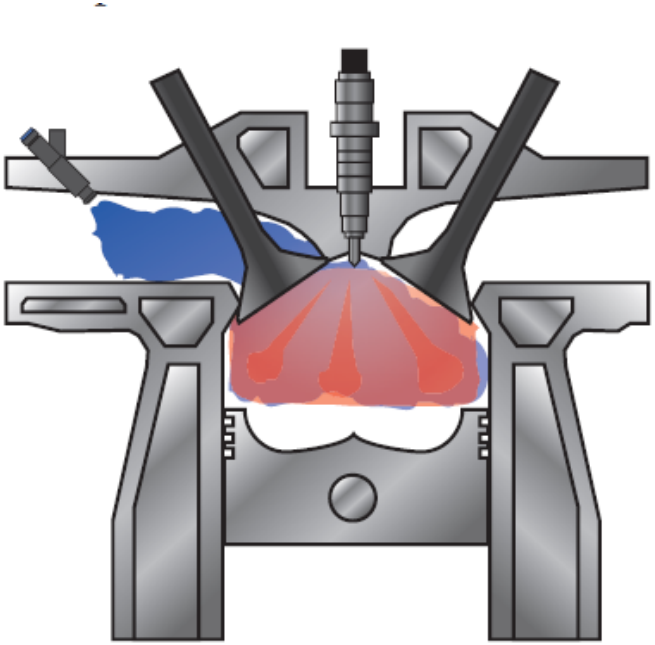
# The road to green transport

## Clean Engines (game changer)



# The road to green transport

## Clean Engines (game changer)



Hamburg, 01. July, 2015

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Dr.-Ing. Andreas Janssen
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21107 Hamburg, Germany

dr.ir. L.M.T. Somers
Eindhoven University of Technology
Materials Technology
PO Box 513 ,GEM-N 1.42
5600 MB Eindhoven
The Netherlands

**Support to project "Towards a HiEff engine"**

Dear Bart,

We were interested to hear about the initiative to start a research project on advanced combustion concepts leading towards a highly efficient engine. We believe that proposed idea is very innovative and could become a gamechanger for future engine technology. The fundamental and applied components of the project will contribute valuable and essential understanding, and will also be very useful for industrial applications.

The proposed research as written down in the abstract is of great interest to us and it will help us increase our understanding of advanced diesel combustion and the impact of different fuels. Therefore, we will support the final project with an amount of 50 thousand euro as in-kind contribution. Key deliverables from Shell include:

1.) Shell will provide special and reference fuels including detailed fuel analyses using our in-house blending and laboratory facilities

2.) Shell commits to assist in defining fuel specifications and to support in interpretation of the fuel chemistry effects.

We hope that your proposal is successful, and we are looking forward to a fruitful collaboration.

Yours sincerely,

Dr.-Ing. Andreas Janssen
Fuels Technology

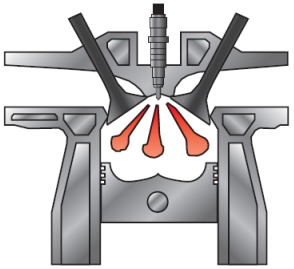
JV 2150 06.14

Shell Global Solutions (Deutschland) GmbH
Geschäftsführung: Dr. Dominik Schröder, Dr. Wolfgang Warnecke
Sitz: Hamburg · Registergericht: Amtsgericht Hamburg · HRB 91485
Bankverbindung: The Royal Bank of Scotland plc, Niederlassung Frankfurt,
IBAN DE77 5023 0400 1668 3150 09, Swift Code: ABNADEFFFRA

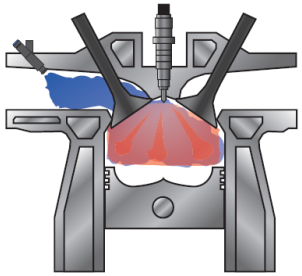
# The road to green transport

## Clean Engines (visualization)

### Classical Concept



### New Concept



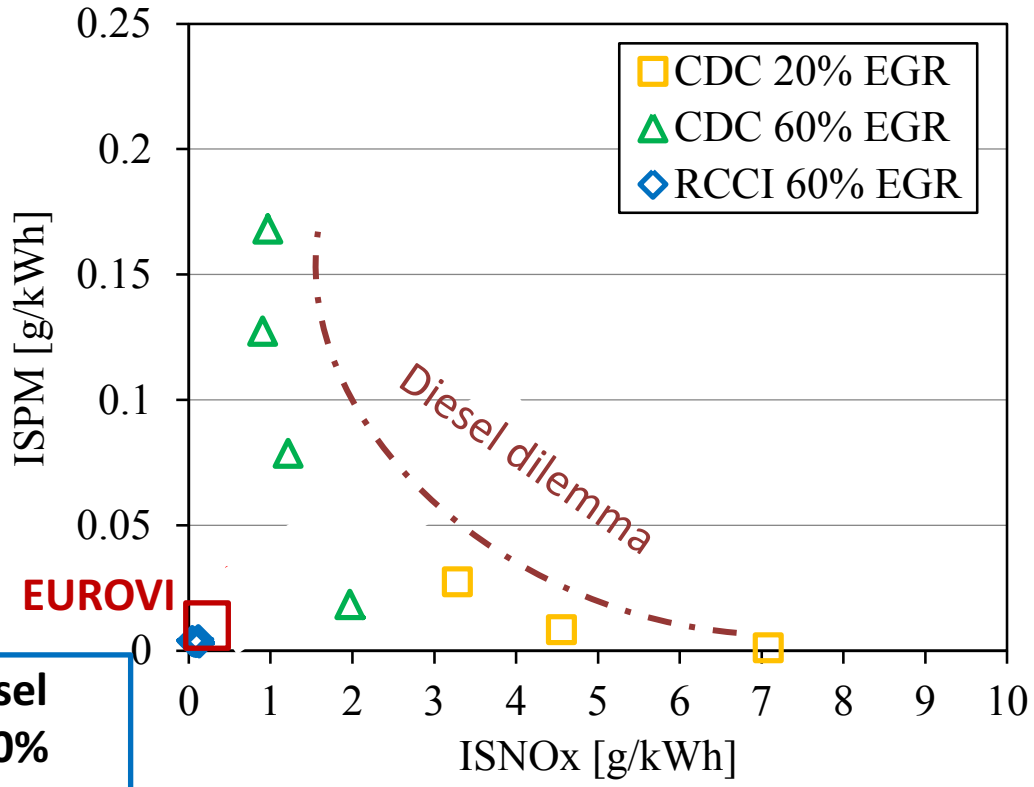
Hot burning soot



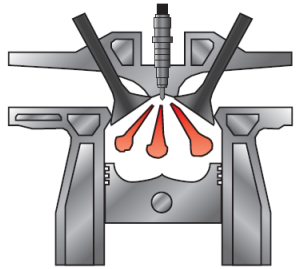
Cheminumilescence

# The road to green transport

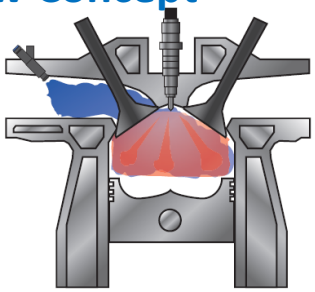
## *Ultra*-Clean Engines (a paradigm shift)




Classical Concept



New Concept

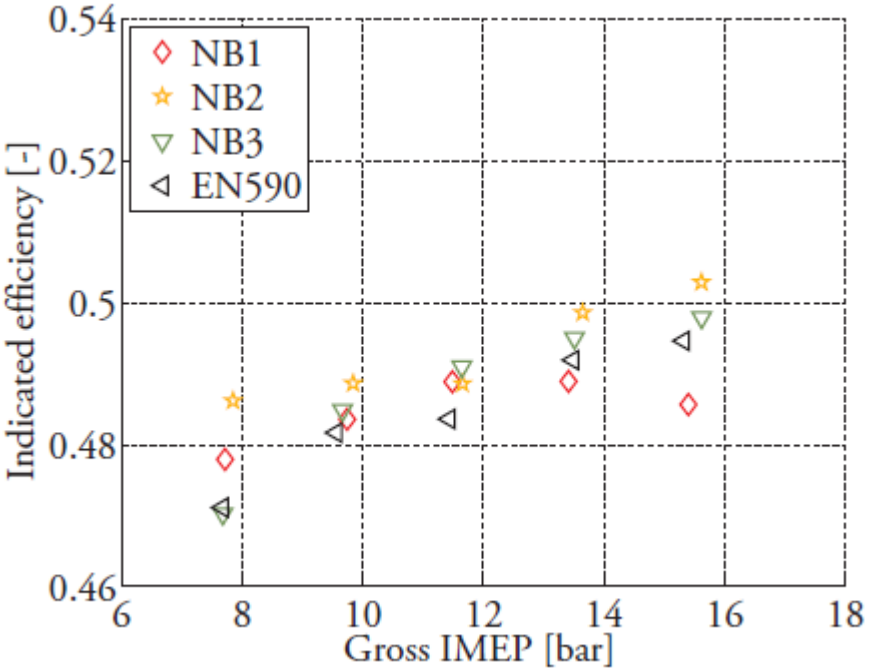


Gasoline/Diesel
70-90%/30-10%
No Aftertreatment!

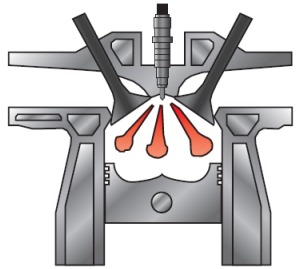
# The road to green transport

## *Ultra*-Efficient Engines (a paradigm shift)

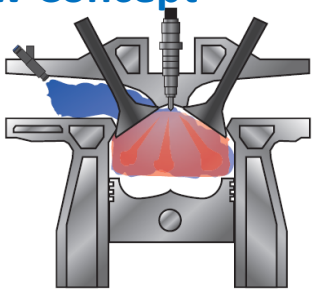
**59% reported in literature!**




**Classical Concept**



**New Concept**



**New Concept, Naphta blends**

**Vs**

**Classical Diesel**

nm = 0.000000001m
= $10^{-9}$ m
100nm = 0.1 micrometer

# The road to green transport

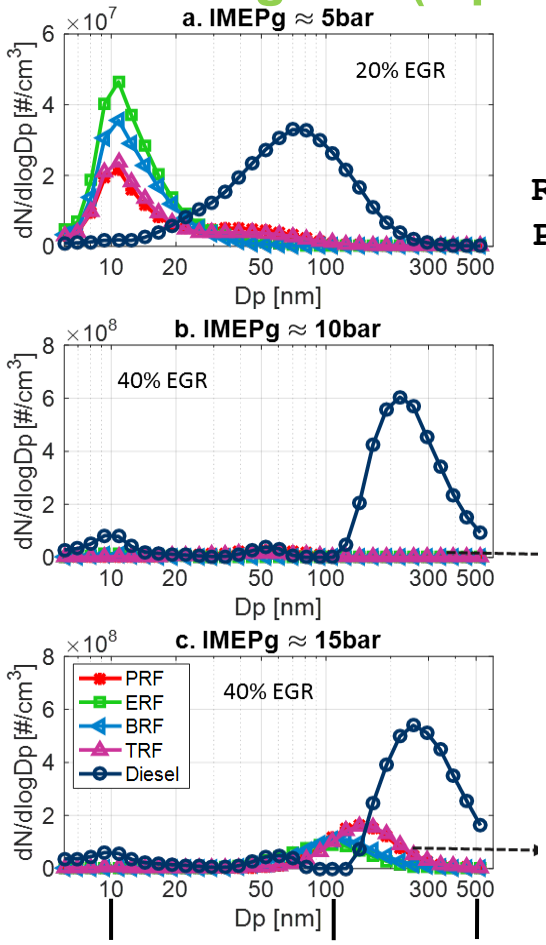
## *Ultra*-Fuel flexible Engines (a paradigm shift)

**Fuel appetite**

Low load

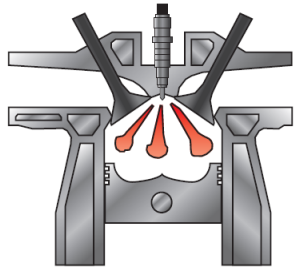
Medium load

High load

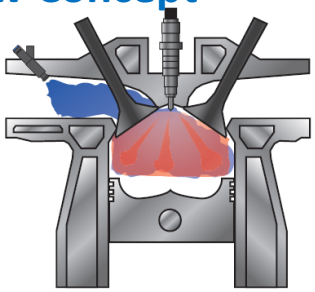



RON70 fuels
Primary Reference Fuels

Classical Concept



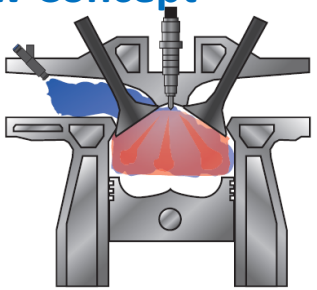
New Concept



# The road to green transport

## Clean Engines: its fuel appetite

New Concept



**Any gasoline-like fuel**

### Candidates

- **Gasoline**
- **Less refined fuels (naphta)**
- **CNG/LNG (20% $CO_2$ benefit)**
- **Alcohols**
- **Lignin based fuels (waste from paper industry)**
- **Solar Fuels ($H_2$, $H_2O/CO_2$ to liquid), liquid electricity!**

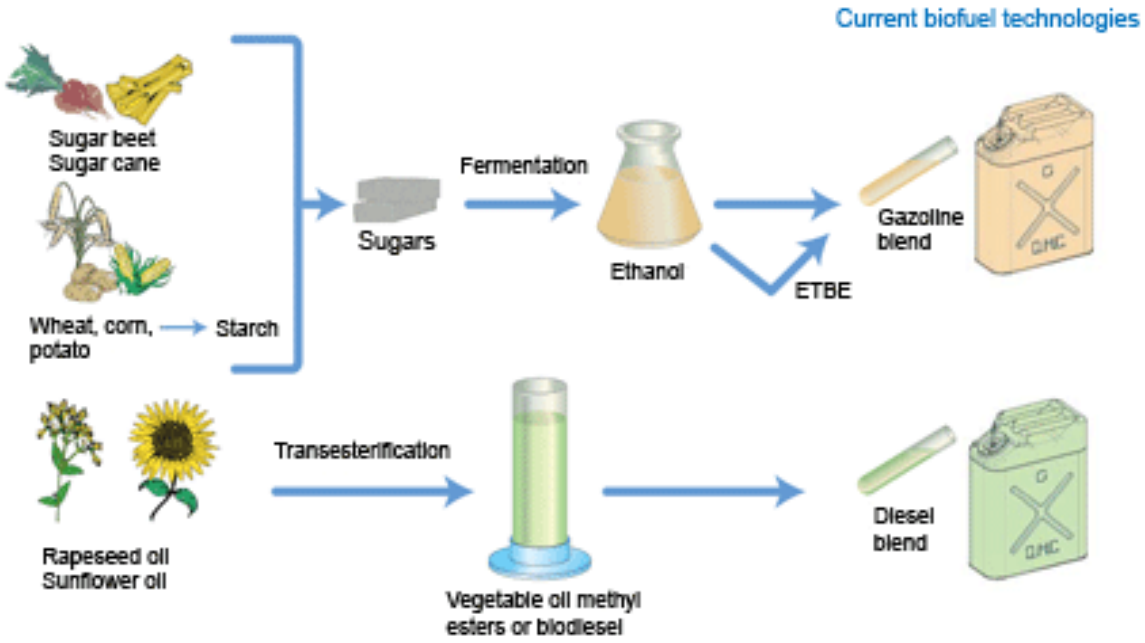
+

- **5-20% diesel or bio-diesel, DME/FAME/FAEE/HVO**

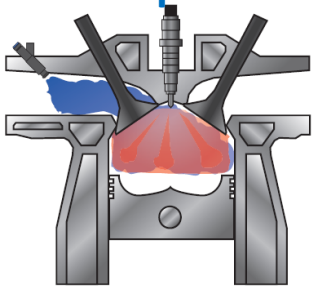
# Sustainable Liquid Fuels Future

## Bio-fuels

- Alcohols
- Lignin based fuels (waste from paper industry)
- Bio-diesel




**New Concept**



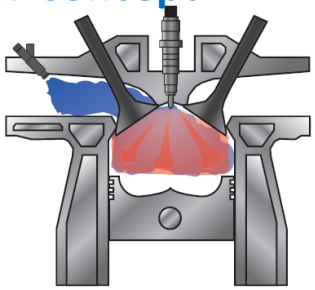
# Sustainable Liquid Fuels

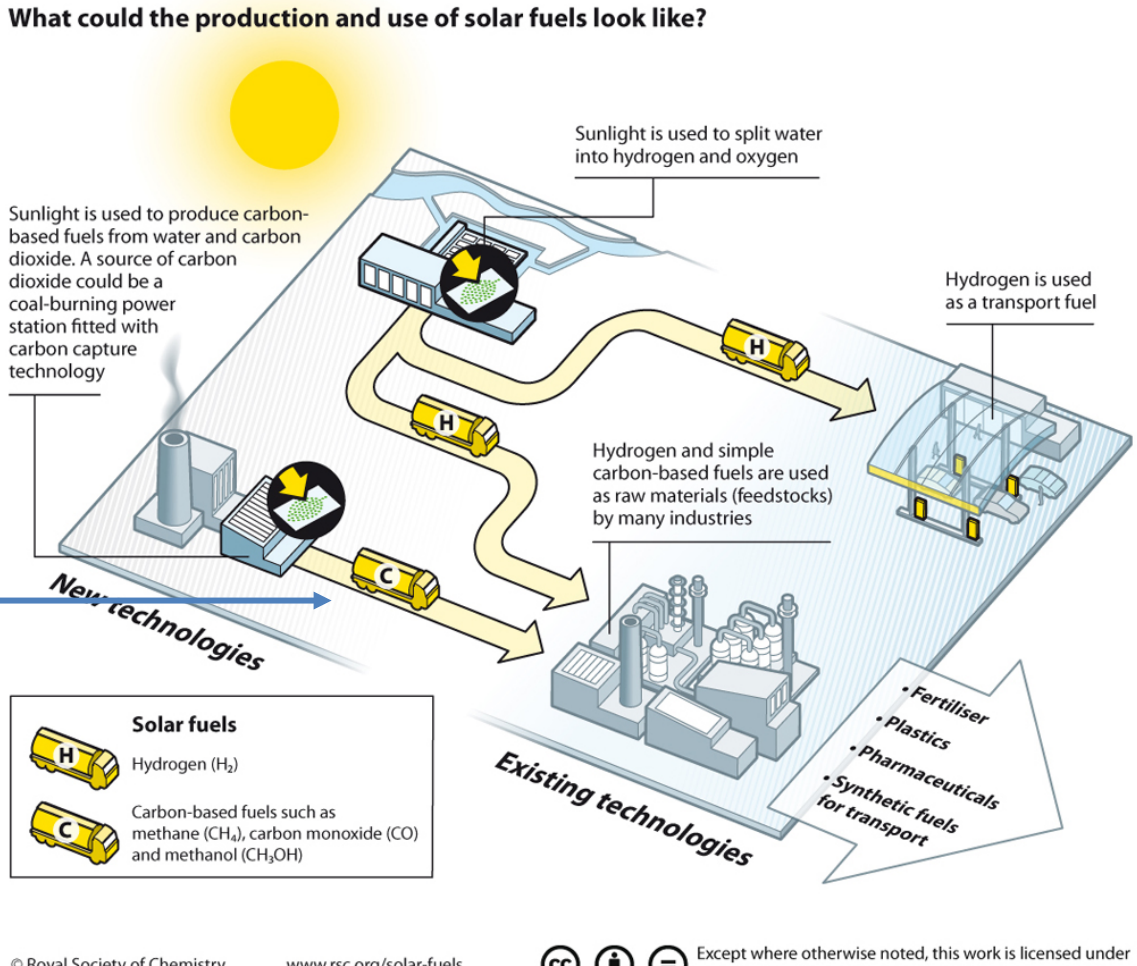
## Solar-fuels

### Differ (TU/e)
### ST/TN (TU/e)

Fischer-Tropsch fuels
as
Carbon Capture
solution

### New Concept





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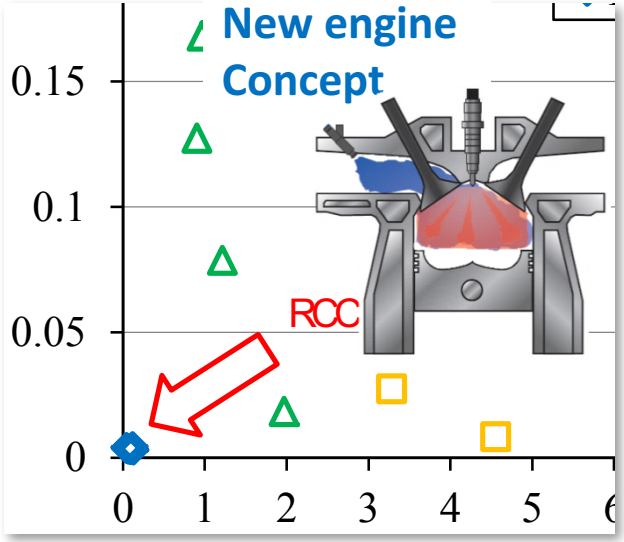
# Enabling true green transport

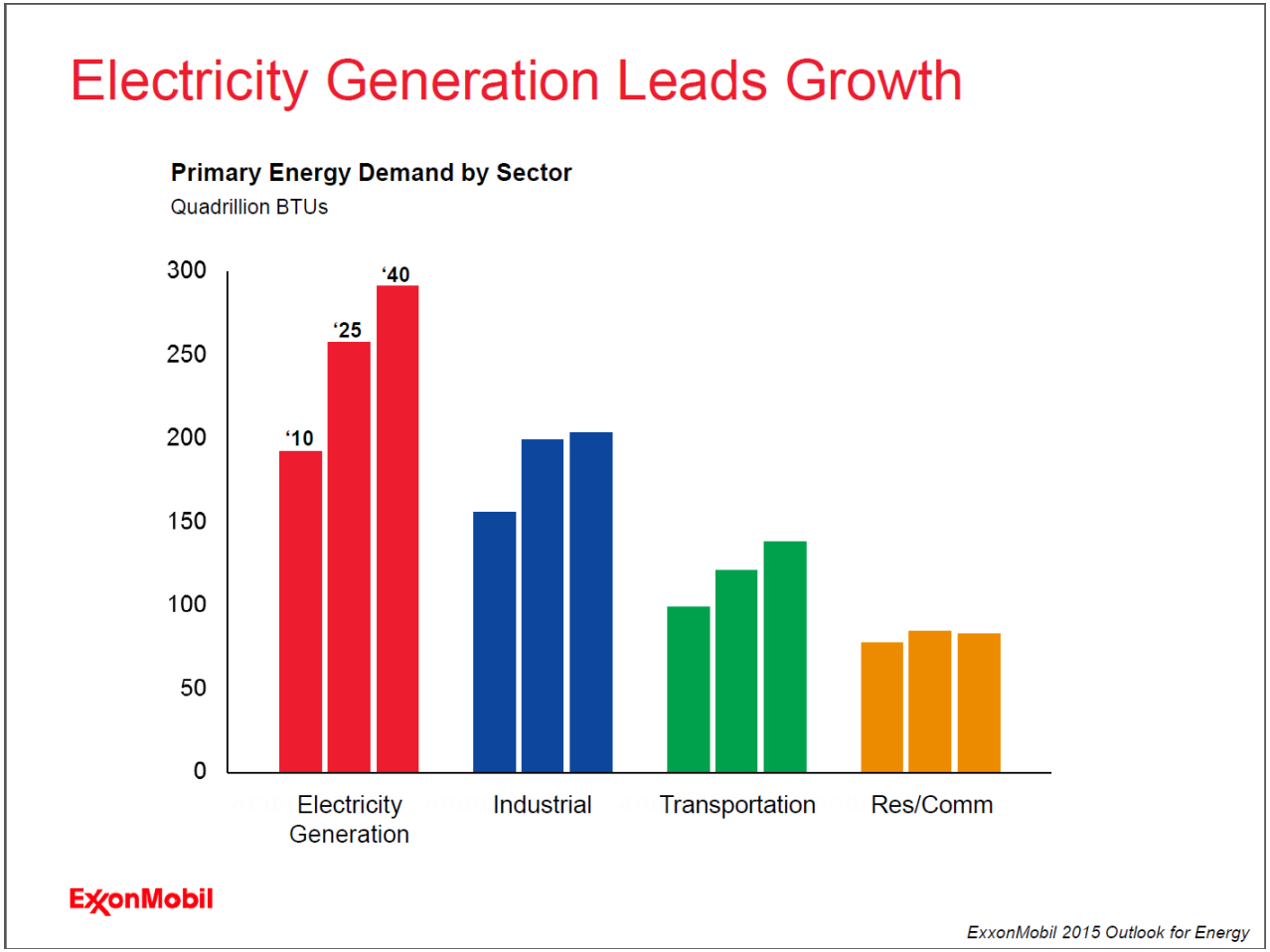
## Commercial vehicles

*Locally*




*Globally*

# Some comments on CO2 neutrality of EV?




1000 BTU~1MJ

Quadrillion=$10^{15}$.
$10^{15}$ J = Peta Joule

# Some comments on CO2 neutrality of EV?

6% growth scenario

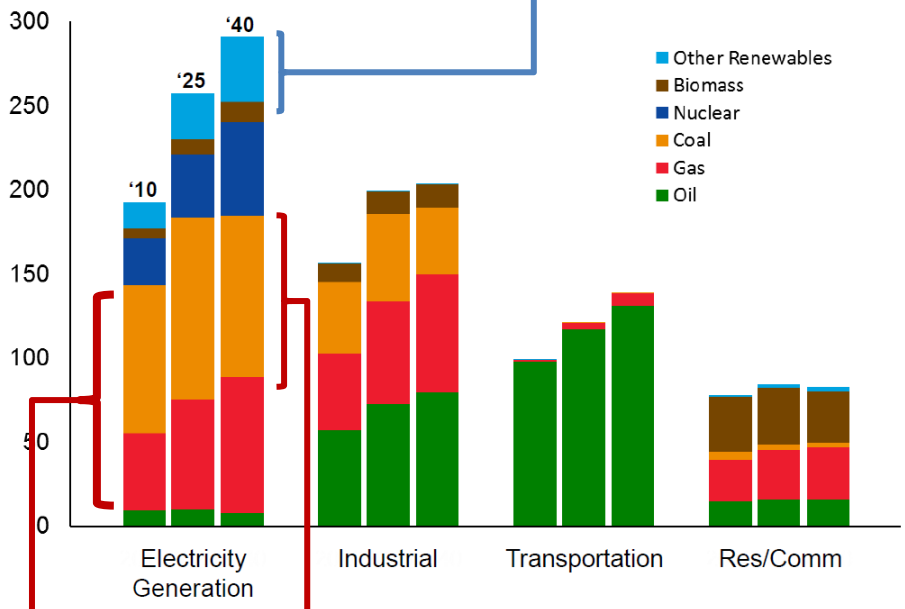
Which is why electric vehicles are NOT zero emission nor will they be in the near future

Especially this guy

## Electricity Generation Leads Growth

**Primary Energy Demand by Sector**

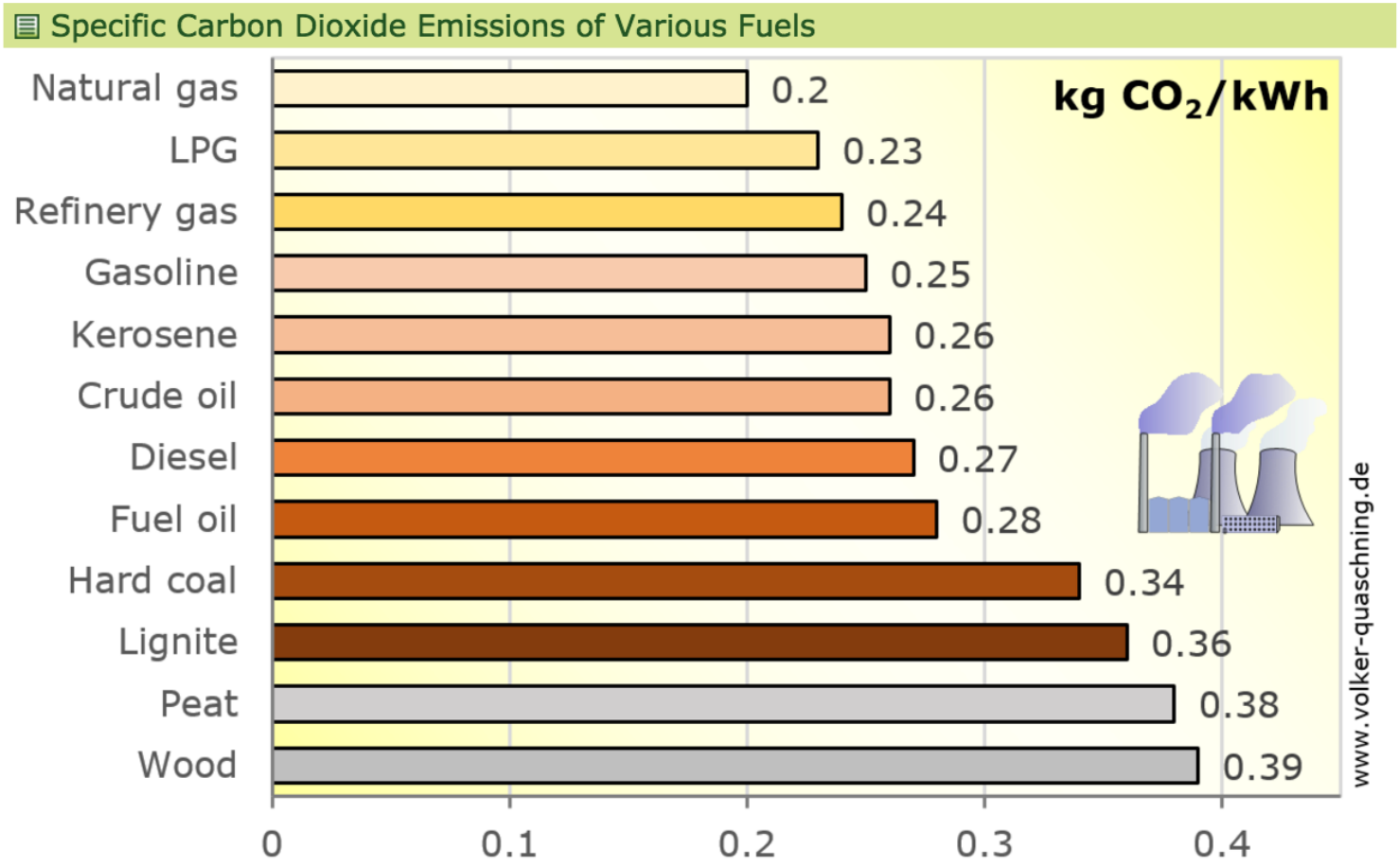
Quadrillion BTUs




ExxonMobil

*ExxonMobil 2015 Outlook for Energy*

# Some comments on CO2 neutrality of EV?



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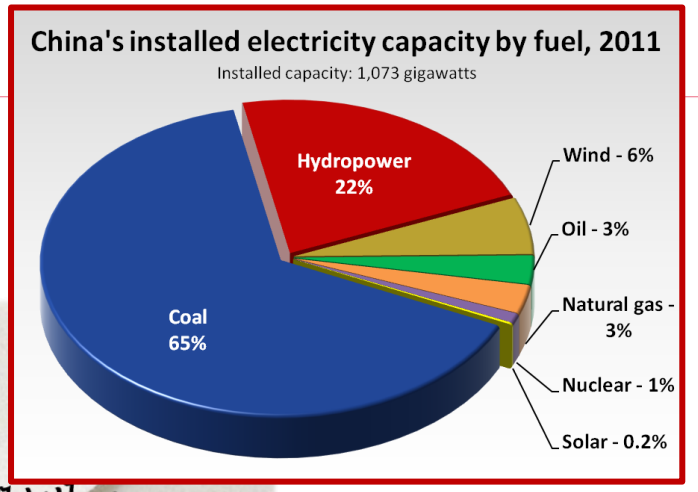
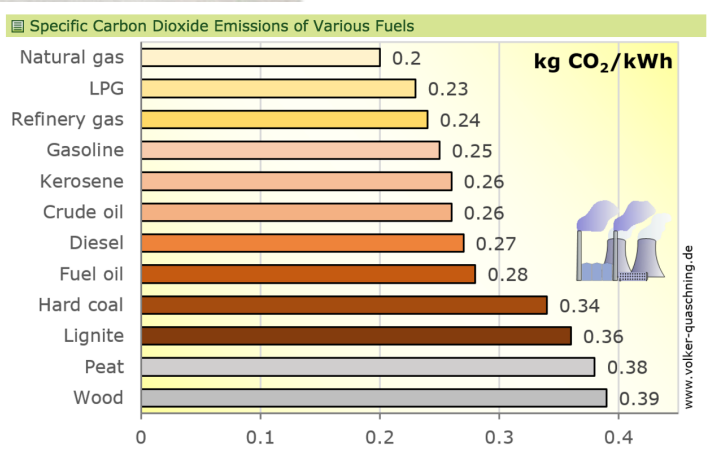
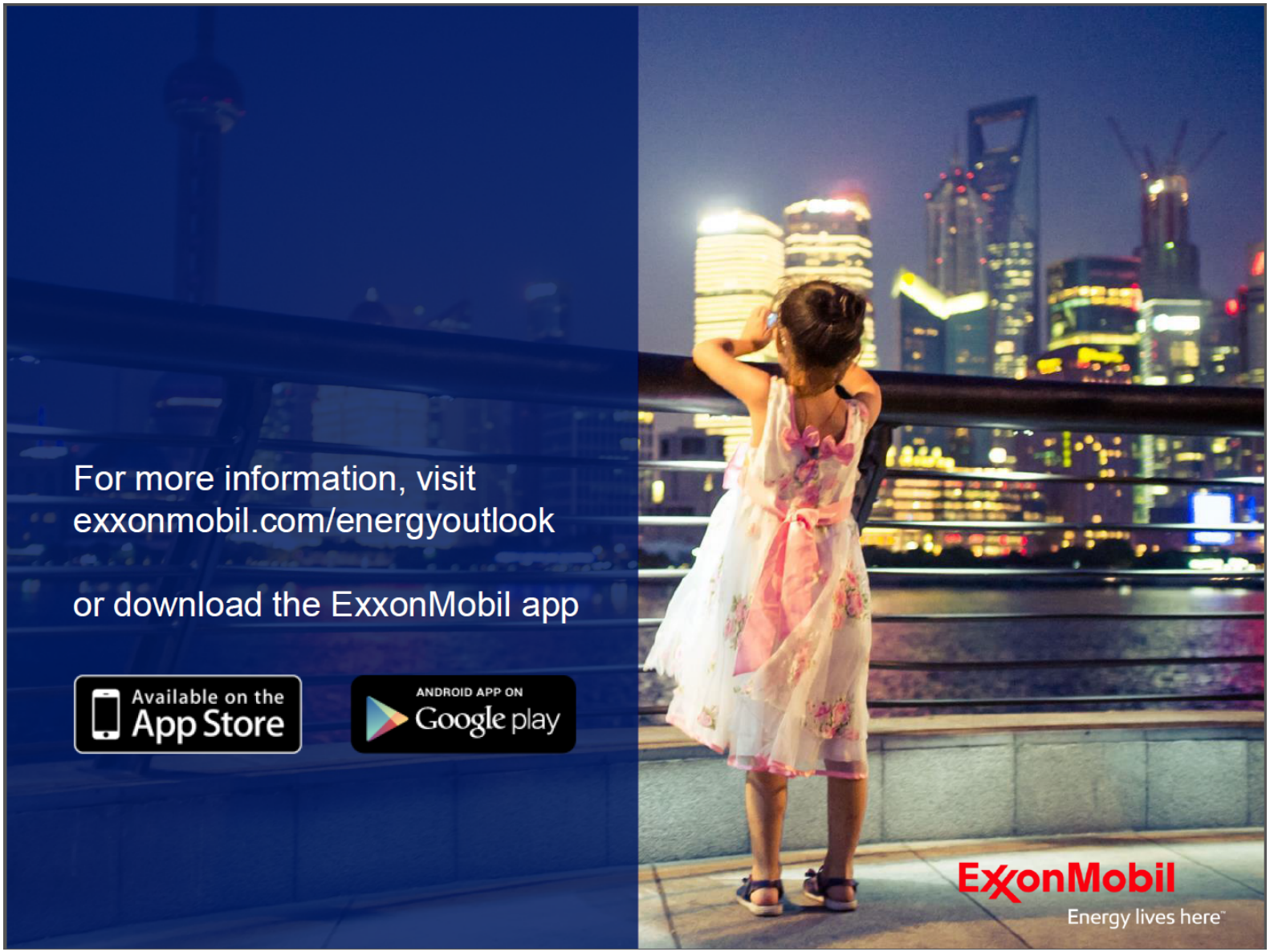



Electricity from a coal plant
380 /0.32 = 1004 gCO2/kWhr
from a gas plant
240 /0.36 = 660 gCO2/kWhr

Direct use of HD engine
270/0.44 = 617 gCO2/kWhr
270/0.55 = 490 gCO2/kWhr

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