

Alternative fuels for commercial vehicles

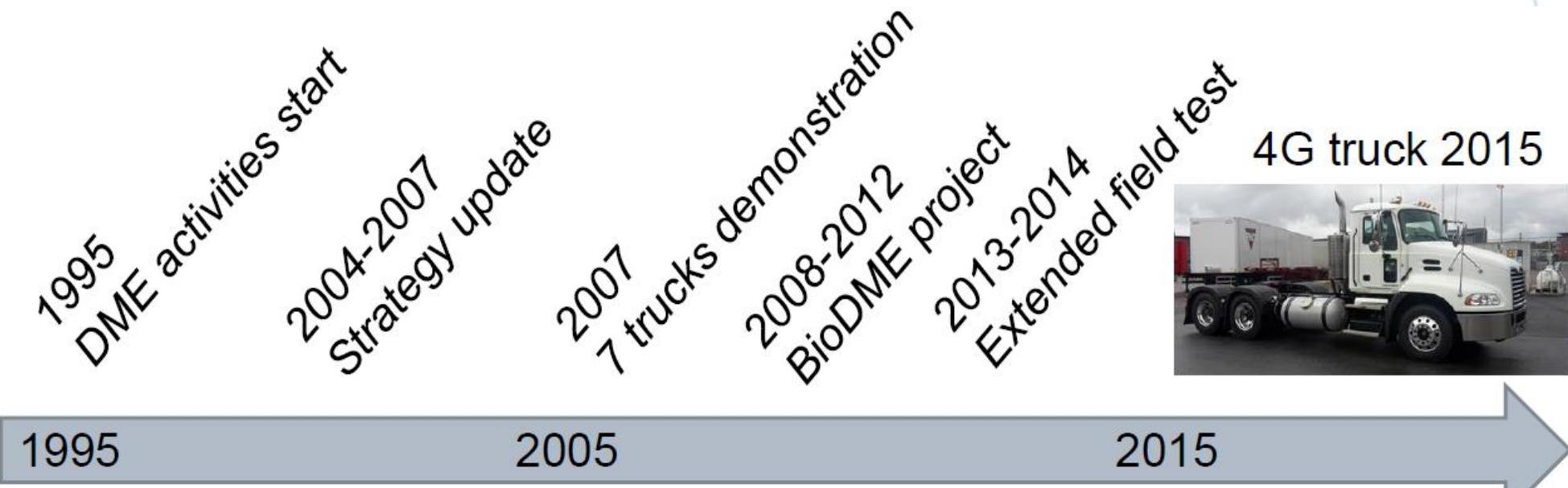


Video

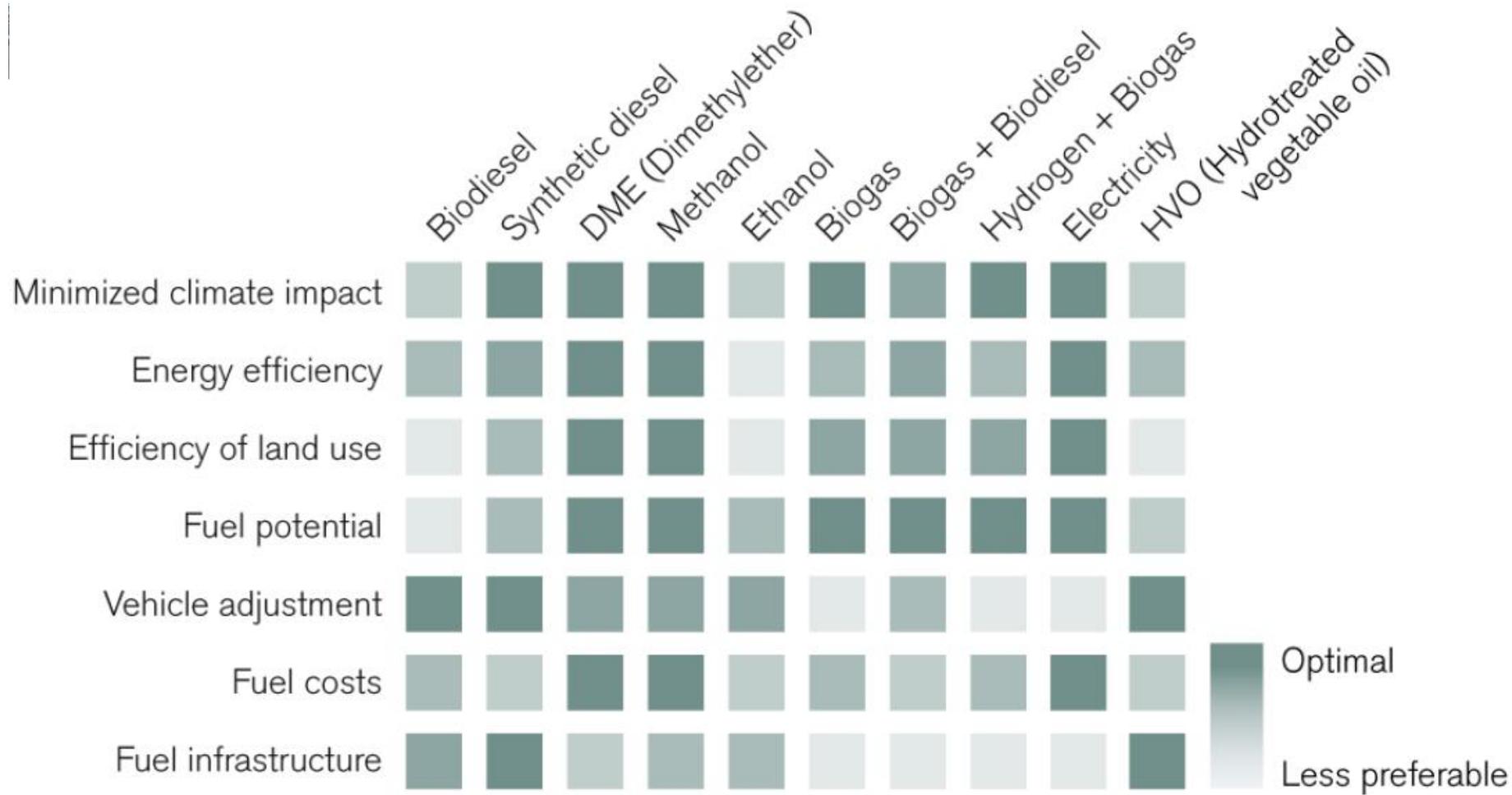
<https://www.youtube.com/watch?v=6wGb5260c58>



Timeline for research and testing

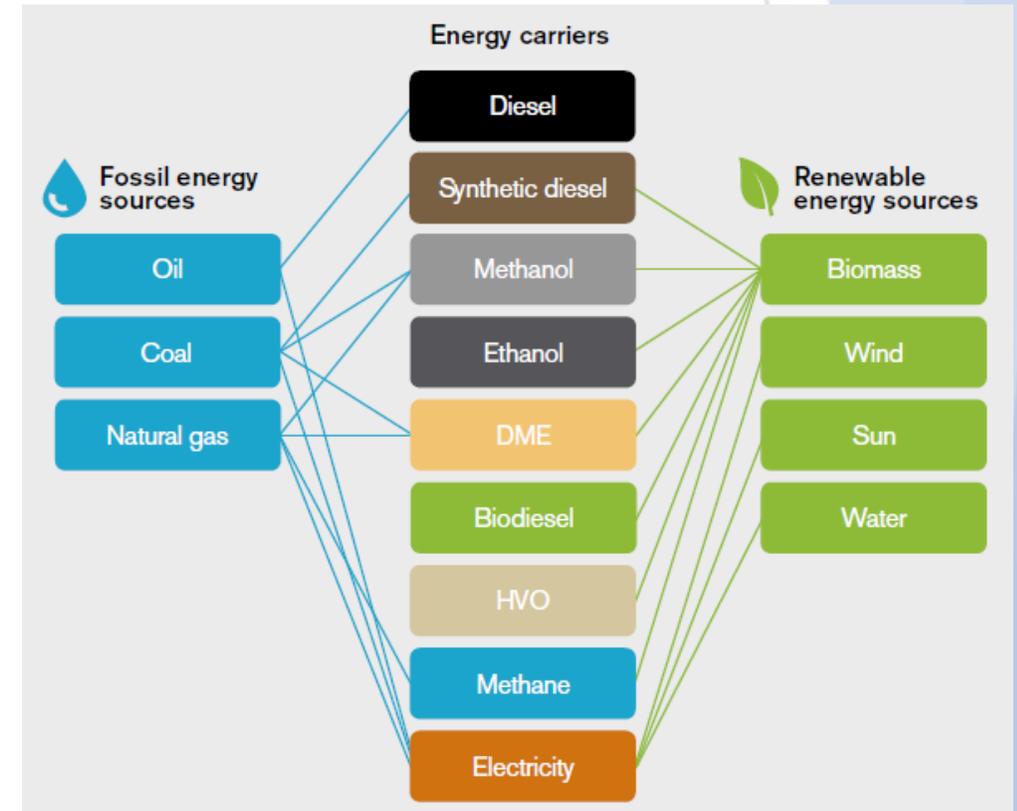


Evaluation of fuel pathways



Sustainable transport solutions

- The Volvo Group's vision is to become the world's leading provider of sustainable transport solutions
- Volvo Group welcomes developments that allow our vehicles to run on non-fossil fuels
- Volvo Group is studying and evaluating all alternative fuels with potential for use in our products, including but not limited to:
 - Biodiesel, HVO (hydro-treated vegetable oils), synthetic diesel, ethanol, methanol, DME (dimethyl ether), methane, electricity

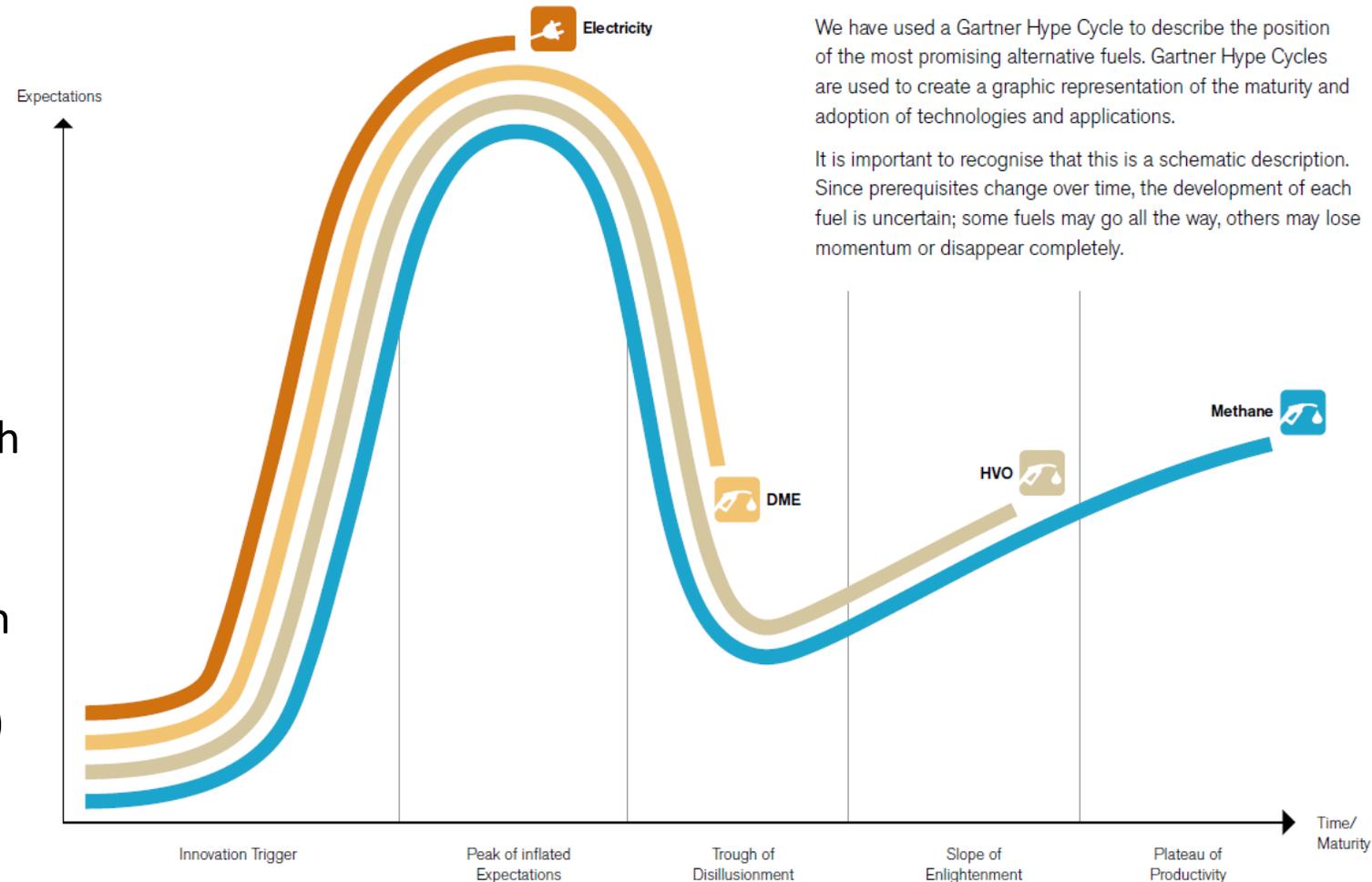


An overview of the relationship between different energy sources and the production of fuels



The four most promising fuels

- **HVO** is easy to use in current infrastructure and engines. With animal fat as feedstock, HVO has good climate potential
- **Electricity** has high efficiency and a low climate impact. It is most suitable for urban applications. Dynamic charging is needed for long distance transport
- **DME** is a strong long-term candidate with low impact and efficiency benefits
- **Methane, natural gas** and preferable **biogas**, is widely available and already an established alternative for urban applications. **Liquefied natural gas (LNG)** is suitable for long distance transports



Volvo's position on alternative fuels – trucks and buses

- For long distance transport, crude-oil-based diesel fuel with increasing renewable and synthetic components will remain the dominant fuel
 - Liquid methane and DME are prioritised complements
- For regional transport, compressed and liquid methane will grow due to price and security of supply
- Short distance transport will lead the shift to electricity, especially in urban areas
 - City buses with plug-in or fully electric drives
 - Compressed methane, later followed by DME, will also be important alternatives



Operational efficiency

- Alternatives must be compatible with HD truck applications
 - Clear back of Cab
 - Fast fill
 - Same maintenance intervals as Diesel
- Truck efficiency in operations
 - No significant weight increase
 - Engine efficiency, DME today on par with diesel
 - Short wheelbase
- On-truck fuel stability and venting management to limit GHG impact (no venting preferred)



HDPI on FH – Europe



DME on VNL – US



How Volvo's gas truck with methane diesel technology works

Volvo's efficient diesel engines

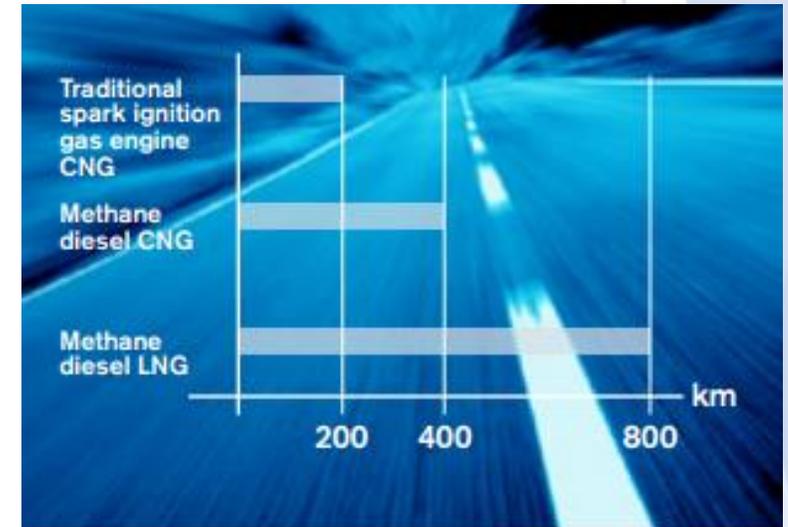
The solution is based on Volvo's proven and reliable Euro 5 diesel engines. When the engines are converted for gas operation, special tanks are added for either liquid methane gas (LNG/LBG) or pressurised methane gas (CNG/CBG). In addition, a separate fuel system is added with gas injectors in the inlet manifold.

Same driveability as conventional diesel trucks

A small amount of diesel is injected into the cylinders and ignited by the compression, which in turn ignites the methane gas/air mixture. As a result, there is no need to use a spark plug and Volvo can make full use of the efficient diesel technology. The power output and driveability are equivalent to that of a conventional diesel truck. Processors continuously calculate the ratio of methane gas to diesel according to the driver's current driving pattern. The optimum – i.e. the highest – proportion of gas is achieved during smooth, stable driving. The amount of diesel required during operation varies. The aim is to be able to run on up to 80% methane gas once the technology has been refined and tested. The field tests carried out in 2010 will start with a mixture containing up to 70% methane gas. The remainder will consist of fossil diesel mixed with diesel produced from renewable raw materials.

Realistic alternative

A unique feature of Volvo's technology is that the truck can continue to operate on diesel alone if the gas runs out. This makes it a realistic alternative for many customers in areas where gas distribution networks are not yet fully developed.



Estimated operational range for different gas trucks

Up to four times greater operational range with methane diesel technology

Previously it has been problematic to use methane gas for long-haul transportation. The operational range of a truck with a spark ignition internal combustion engine is usually restricted to 150–200 km. Volvo Trucks' solution is to use methane gas combined with a small amount of diesel in a diesel engine. This enables the truck to drive twice as far between refuelling stops. If liquefied energy-dense gas (LNG) is used, the truck can drive twice as far again compared with pressurised methane gas (CNG). Apart from the technology chosen, other factors that affect the maximum driving distance are tank size, driving style and gross weight.



Gas technologies

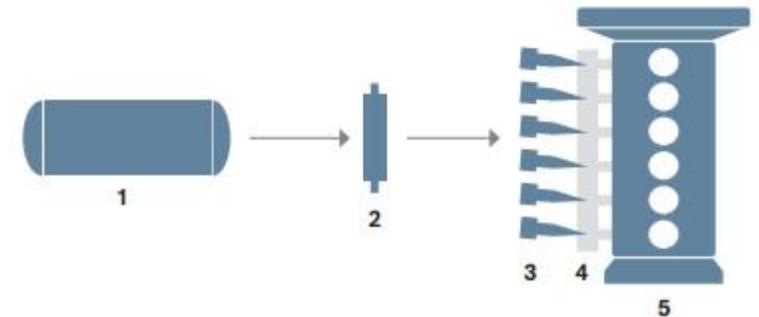
1. Methane gas tank in two different versions
 - Contains CNG at a pressure of approx. 200 bar
 - Contains LNG which is liquefied and kept at a temperature of -130°C
2. Pressure reduction valve or gas converter
 - For CNG, pressure reduction valve, reduces pressure to approx. 4 bar
 - For LNG, gas converter, transforms liquefied gas from liquid into gaseous form with a pressure of approx. 4 bar
3. Injectors
 - The injectors inject biogas into the inlet manifold
4. Inlet manifold
 - The injectors are installed so that the gas is injected through the opening of the inlet valve
5. Engine
 - The methane gas/air mixture is ignited by a small amount of diesel injected by the normal diesel injectors



13-litre engine with LNG fuel system



7-litre engine with CNG fuel system



Gas tank



Strong interest in gas powered trucks

Several factors driving demand

Methane gas is currently a relatively low cost fuel. Already today, Volvo Trucks technology offers a profitable fuel alternative for trucks carrying out short transports during the day and then returning to the same fuel station. Apart from the economic factor, another driving force is the strict environmental regulations in many towns and cities, which play a crucial role in purchasing decisions, particularly in municipal companies. In addition, there is a strong demand from hauliers and transport buyers wishing to reduce their CO₂ emissions. They have discovered that methane diesel technology is both an economical and practical way towards this objective.

Volvo Trucks drives development

A broader market introduction will only become possible once the gas distribution network has been extended and the necessary laws are in force. Volvo Trucks maintains a dialogue with several fuel companies to ensure that fuel stations are built at the same pace as the increasing number of gas powered vehicles on the roads. Volvo Trucks also collaborates with the authorities in charge of drawing up the necessary rules and regulations covering the new technology.



“Besides reducing fuel consumption, methane diesel technology also offers improved reliability and lower maintenance costs compared to today’s gas trucks. Moreover, the truck can continue to run on diesel alone, making this a realistic alternative for our customers.”

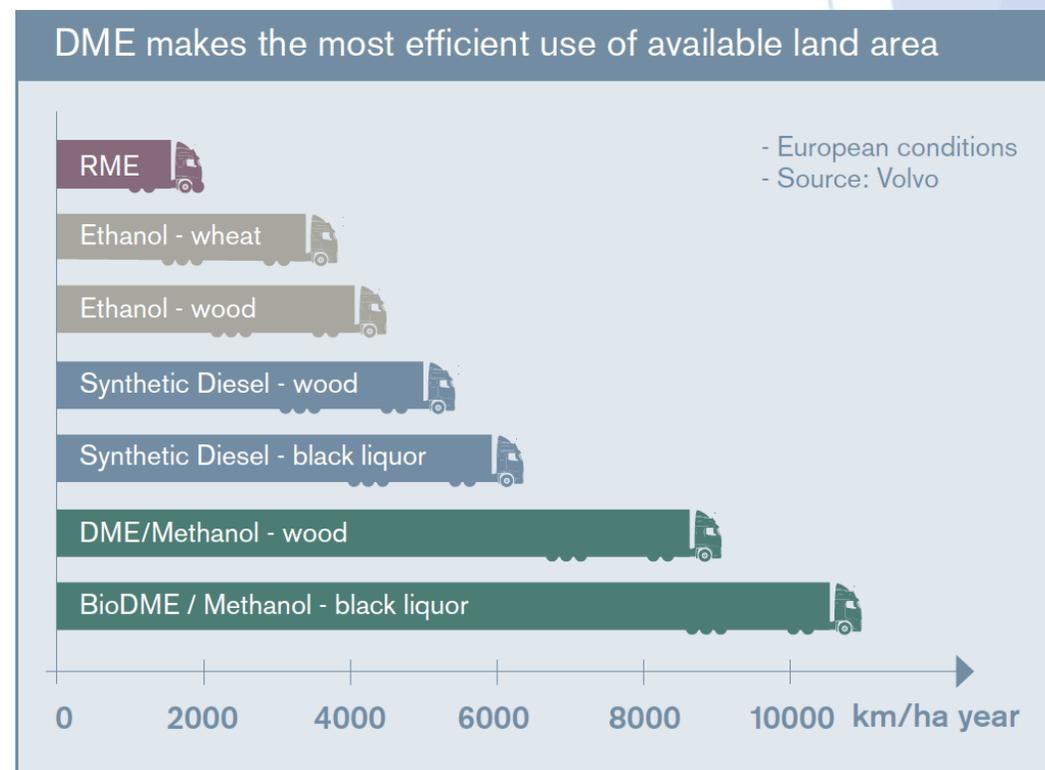
Gunnar Ekwall, Product Manager, Volvo Trucks Nordic



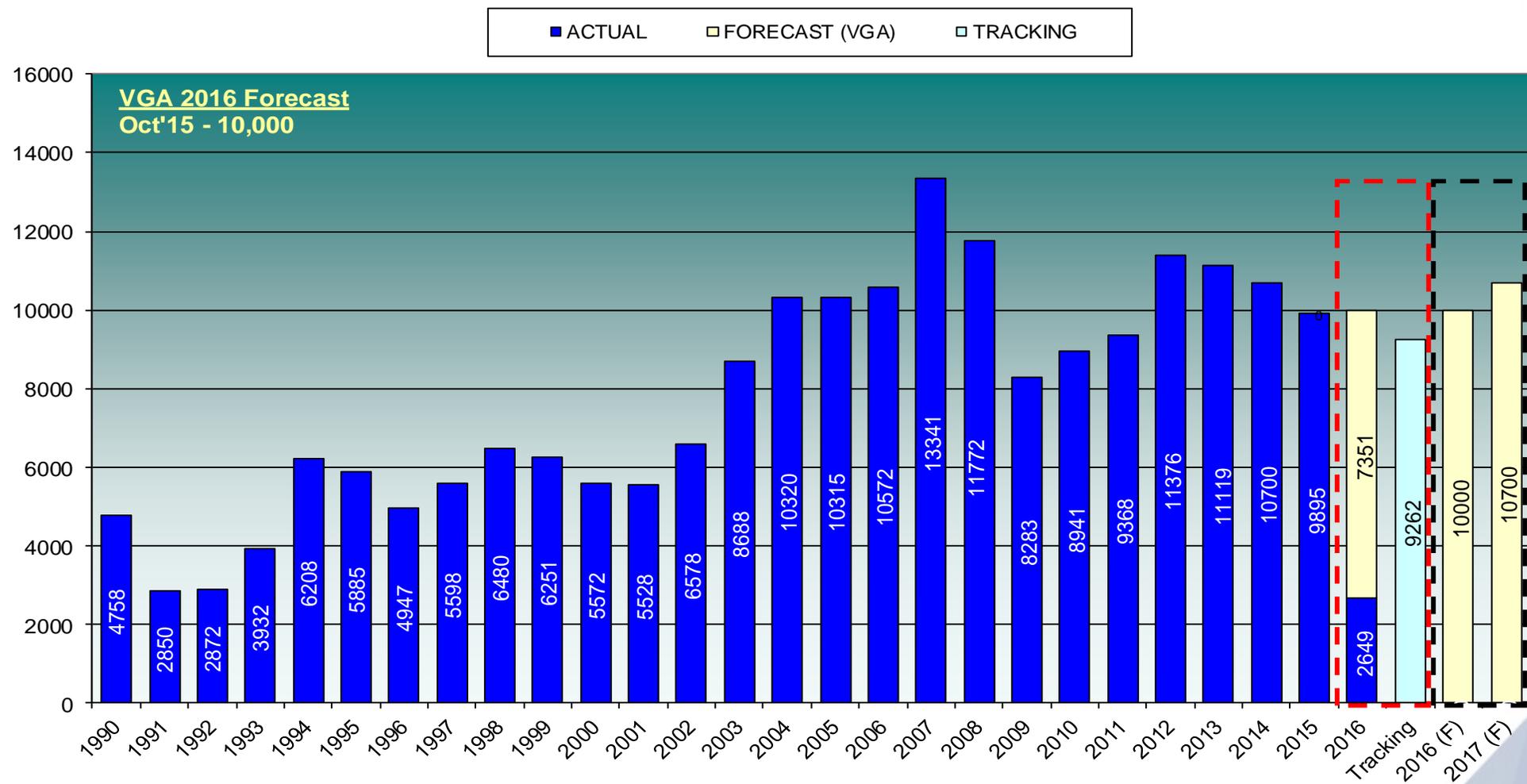
Dimethyl ether – DME

- DME (Di-Methyl-Ether) is a gas but is converted into liquid form at low pressure
- Simple to handle in a process similar to that required for liquefied petroleum gas (LPG)
- Today the most common use is as a propellant in spray-cans. DME can be produced from any organic source including various forms of biomass
- From an EU perspective, by 2030 Bio-DME has the potential for replacing more than 50%* of today's diesel usage in heavy road transport

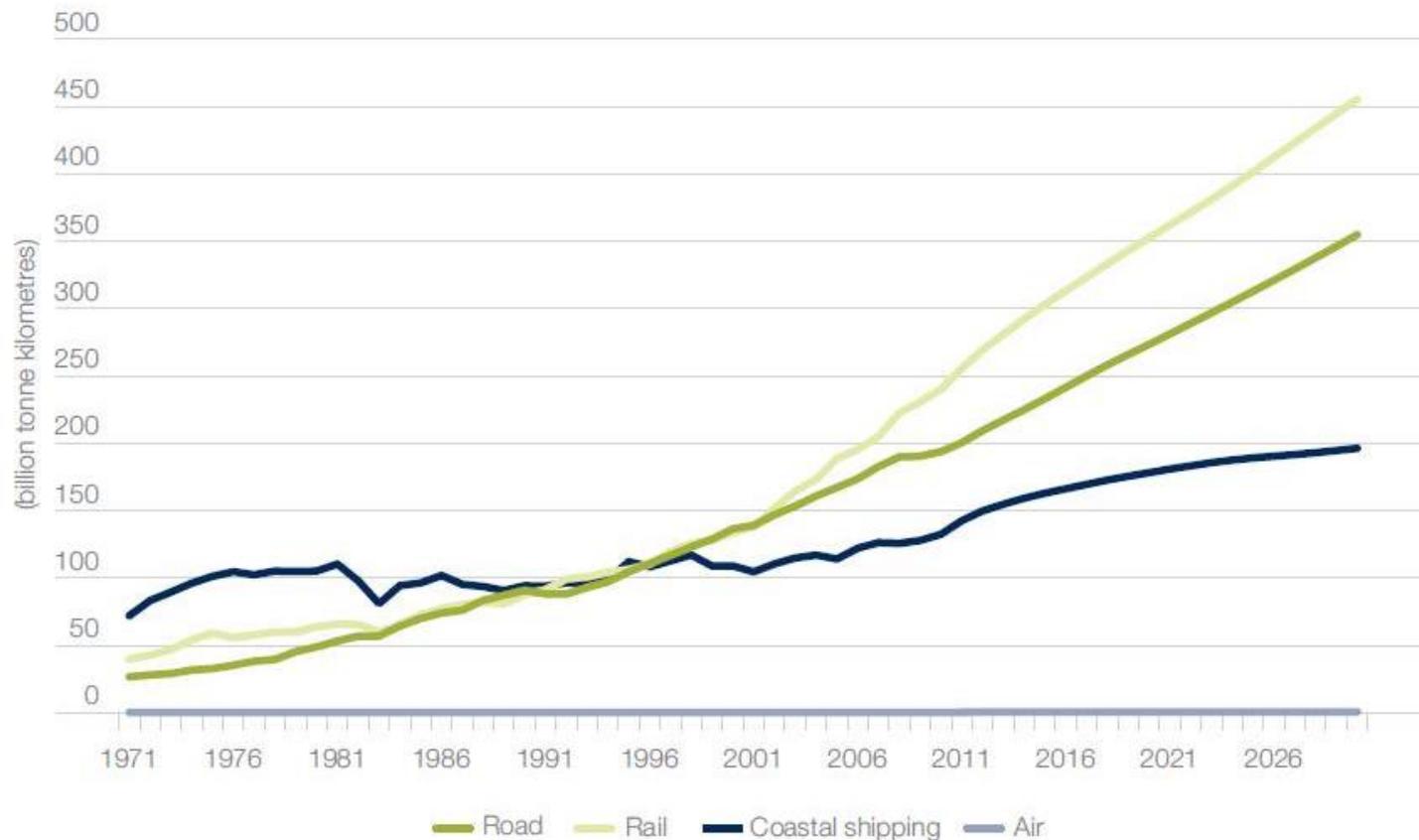
*Source: EUCAR/CONCAWE/JRC 2005, European Commission



Australian HD market overview



Australian freight task



Source: BITRE 2010, *Long term projections of Australian Transport Emissions: Base Case 2010*, Report prepared for Department of Climate Change and Energy Efficiency, BITRE, Canberra.



