FROST & SULLIVAN

Market Engineering

Strategic Analysis of the Medium- to Heavy-duty Natural Gas Commercial Vehicle Market in Europe

lastauto omnibus zukunfts kongress
DAS CO_2-ARME NUTZFAHRZEUG

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Agenda

European Natural Gas MCV and HCV Market - Key Influencing Trends

Key Influencing Trends, Europe, 2011–2018

Volatile Global fuel prices and **Energy Security** driving the market towards alternate fuel powered vehicles

Regulatory environment, incentives, and tax credits from European Union paving way for green vehicles

Emergence of **carbon neutral Biomethane** hubs across Europe

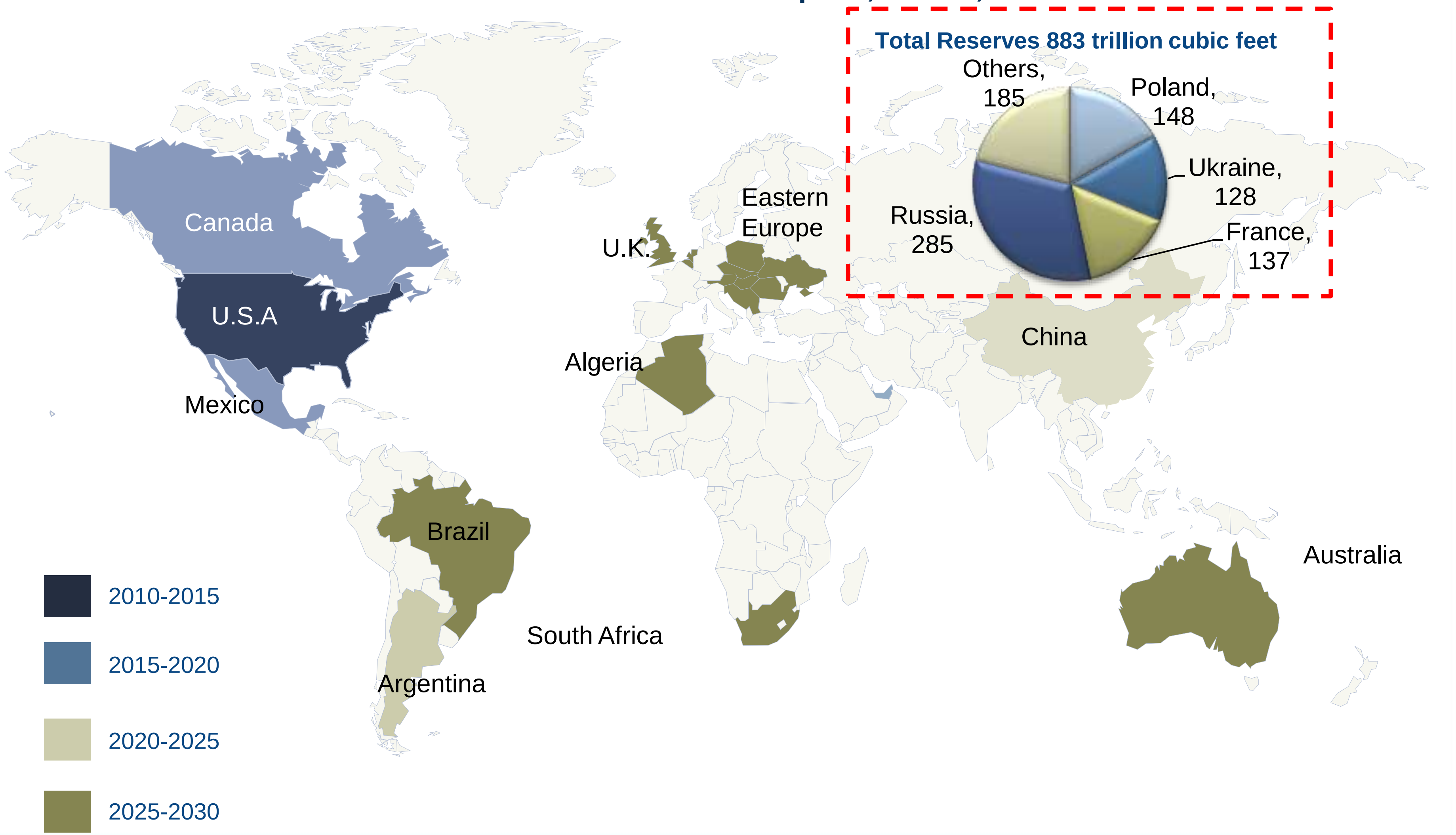
Potential imports and exploration of natural gas including shale will lead to delinking gas prices from oil prices

Growing concerns regarding environmental sustainability around Europe have made **consumers and enterprises** opt for green vehicles.

Source: Frost & Sullivan analysis.

Global Shale Production Impact - Western Europe to realize Shale Gas Impacts on Supply Trends by 2025-2030

Shale Gas Production Timeline Impact , Global, 2010-2030



Comparative Analysis by Markets - Germany, Italy, and France are leading natural gas fuel retailing in Europe. The Netherlands is set to emerge as a potential hub for LNG; bio-methane will be featured in Sweden

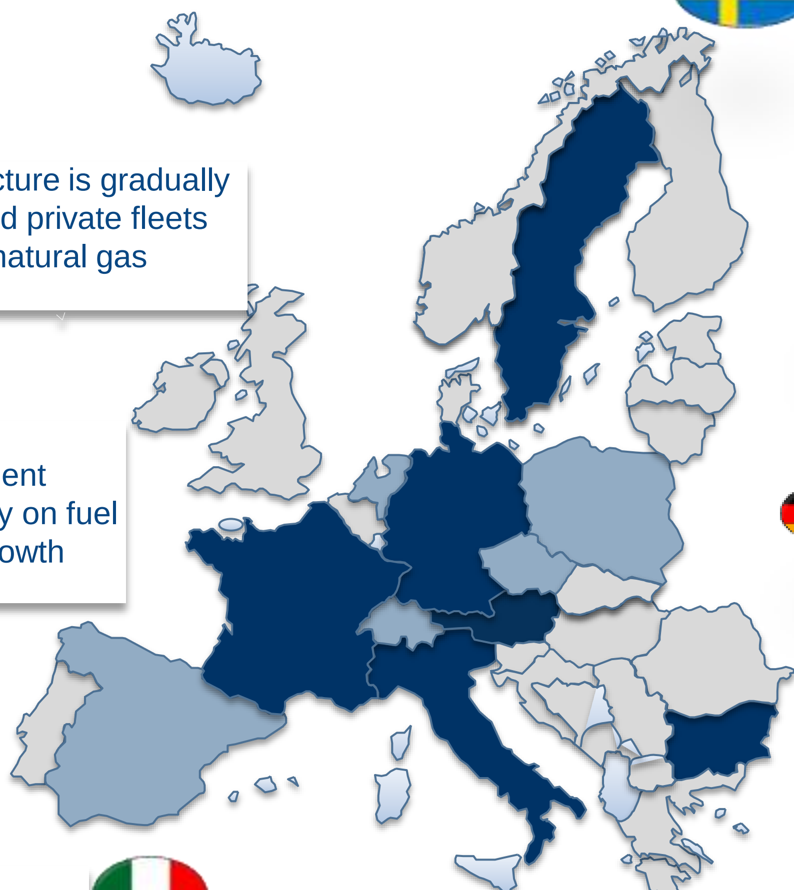
Potential hub for bio-methane, and bio-methane contributes 58% of total natural gas demand in Sweden

Fuel infrastructure is gradually building up and private fleets lead in using natural gas vehicles

Developing as a potential hub for LNG with private fleet using LNG for long haul applications

Proactive government policies carbon levy on fuel tax will aid NGV growth

Clearly defined roadmap in creating infrastructure and strong policies will ensure rapid growth of natural gas vehicles



Developing as a potential hub for LNG with large availability through ports

Well poised for growth due to established CNG infrastructure and active retrofit conversion industry

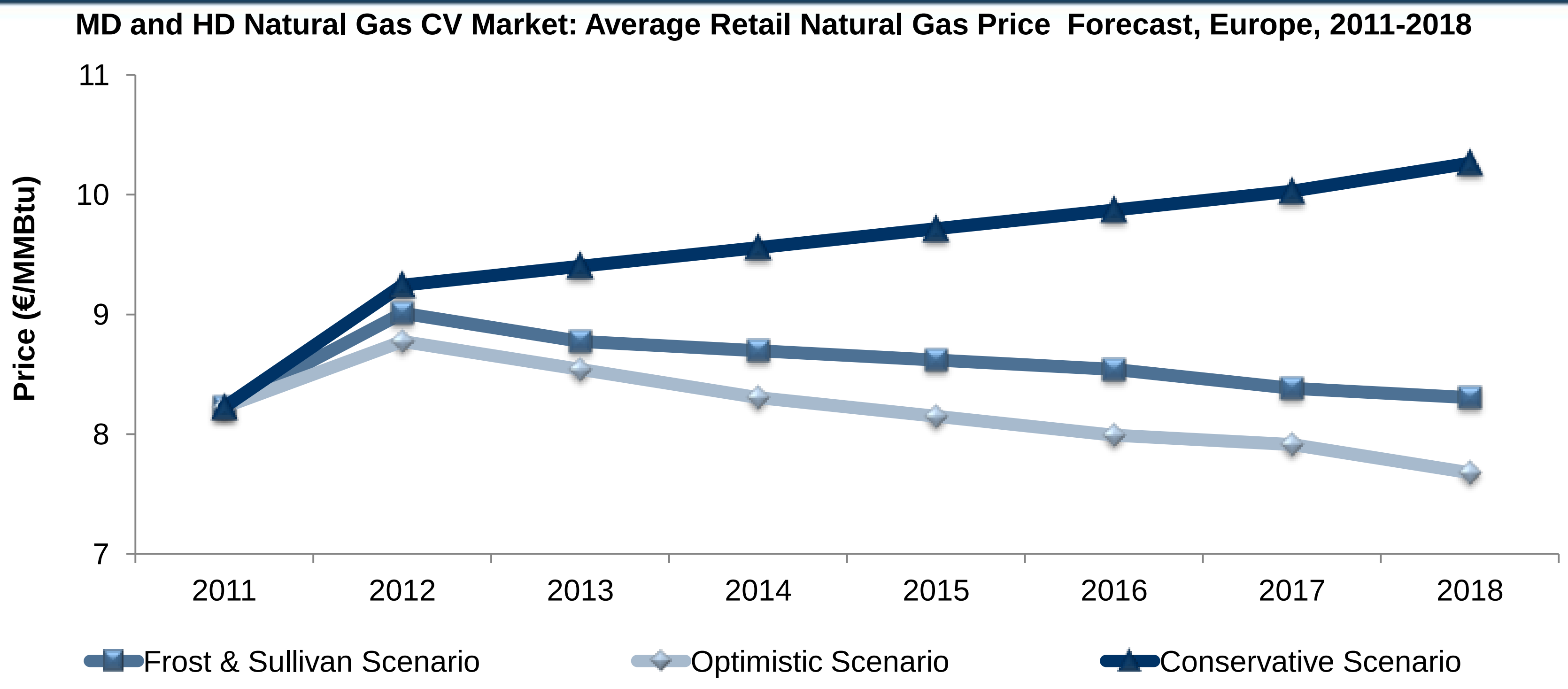
Number of Stations: 100 and above

Number of Stations: 40 to 100

Number of Stations: 1 to 40

No natural gas infrastructure in 2011

Natural Gas Price Overview - The price advantage of natural gas over diesel is expected to remain considerable even at an expected natural gas price of €8.3 per MMBtu in 2018.

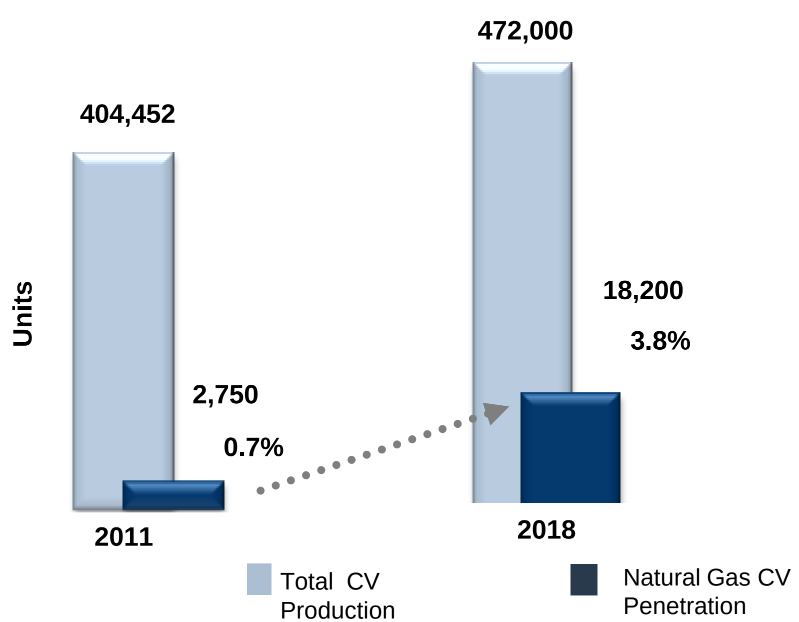


Optimistic Scenario	Frost and Sullivan Scenario	Conservative Scenario
• The average prices of CNG will be around €7.7 per MMBtu by 2018.	The average price of CNG to be around €8.3 per MMBtu by 2018.	• The average price of CNG will be around €10.3 per MMBtu by 2018.

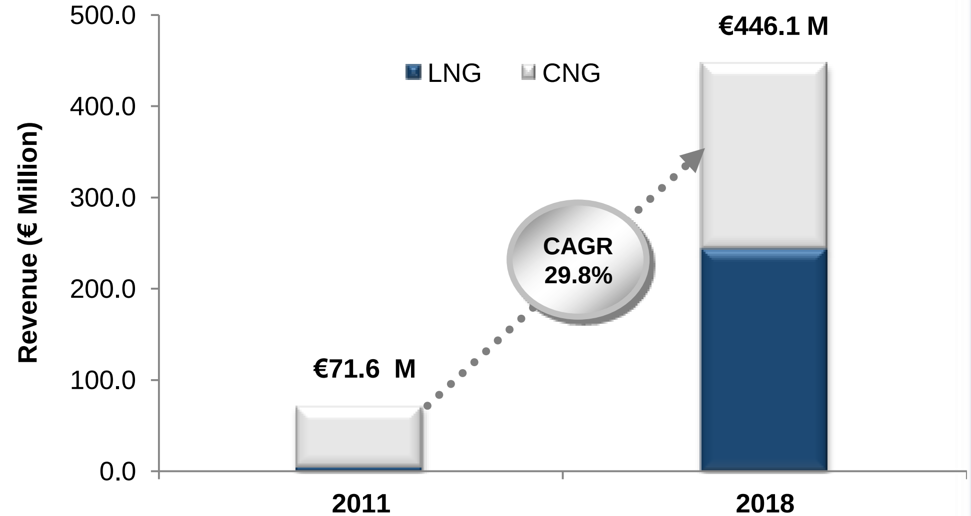
Note: All figures are rounded. The base year is 2011. Source: World Bank, Frost & Sullivan

Strategic Fact Sheet - Natural gas penetration in the European MD and HD natural gas CV market will reach 3.8%, and component revenue is expected to grow at a 29.8% CAGR.

Natural Gas CV Penetration Forecast, Europe, 2011 and 2018



MD and HD Natural Gas CV Market: Component Revenue, Forecast, Europe, 2011 and 2018



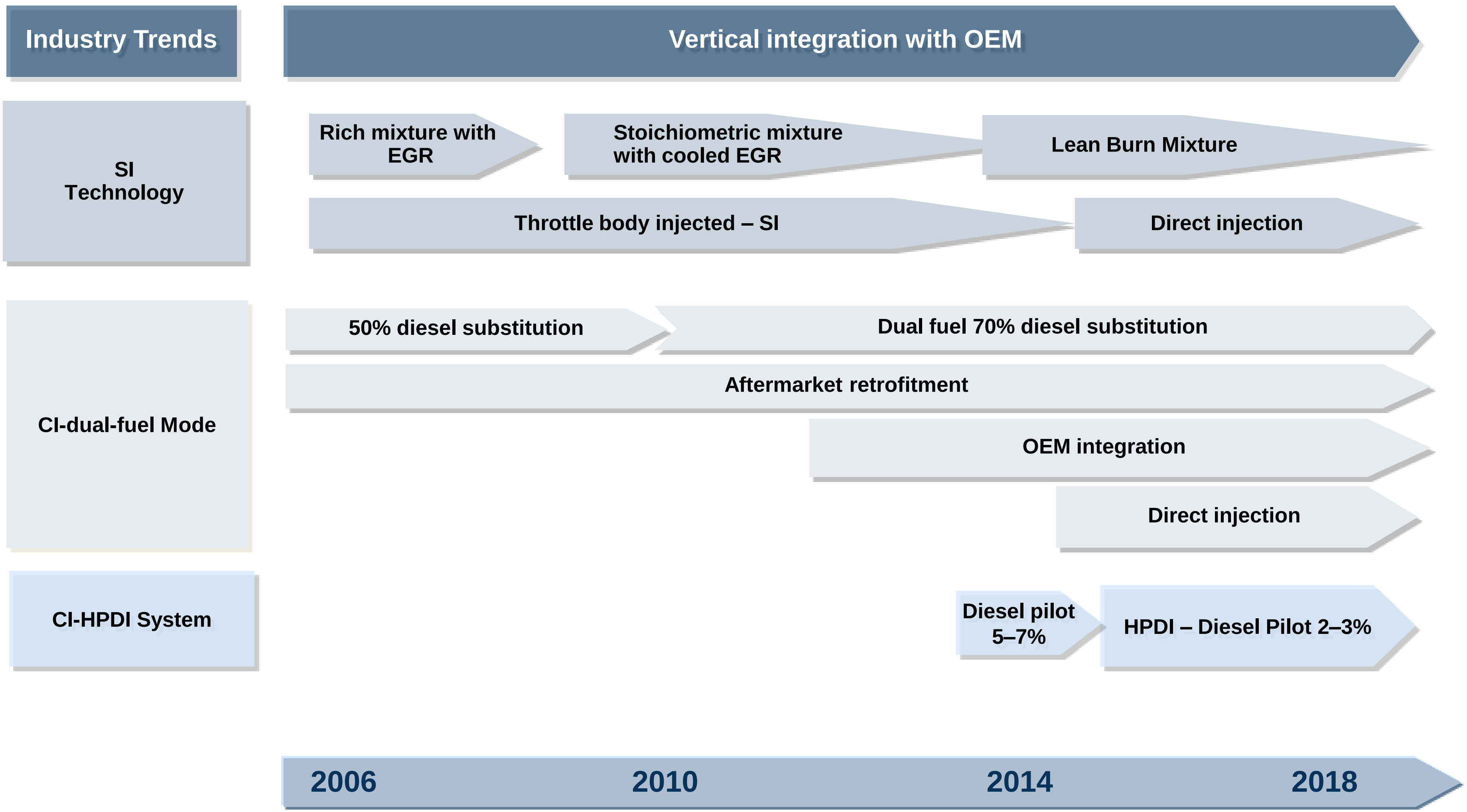
CNG and LNG tanks constitute 67% of the total system costs. LNG penetration in long haul segment to drive the component revenue from € 4.7 million to € 242.2 million in 2018

Note: Component revenues include price of components like fuel injectors, after treatment systems, LNG/CNG tanks and fuel control modules.
CV Production includes medium and heavy duty trucks and buses
All figures are rounded. The base year is 2011

Technology Roadmap

On-board natural gas tanks are experiencing new compositions of materials and designs, and new CI engine architectures are now in focus among OEMs.

MD and HD Natural Gas CV Market: Technology and Product Roadmap, Europe, 2006-2018



Source: Frost & Sullivan

Natural Gas Trucks Price Premium versus Conventional Diesel Trucks -

The price premium on natural gas trucks is the highest for LNG CI technology because of the high cost of the high-pressure direct-injector (HPDI), LNG tank and emissions after treatment.

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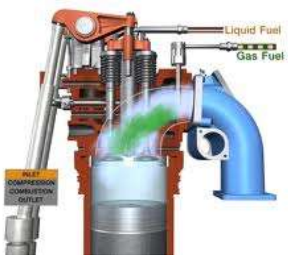
Ignition Technology

Spark Ignited

Dual fuel



HPDI

Fuel Technology

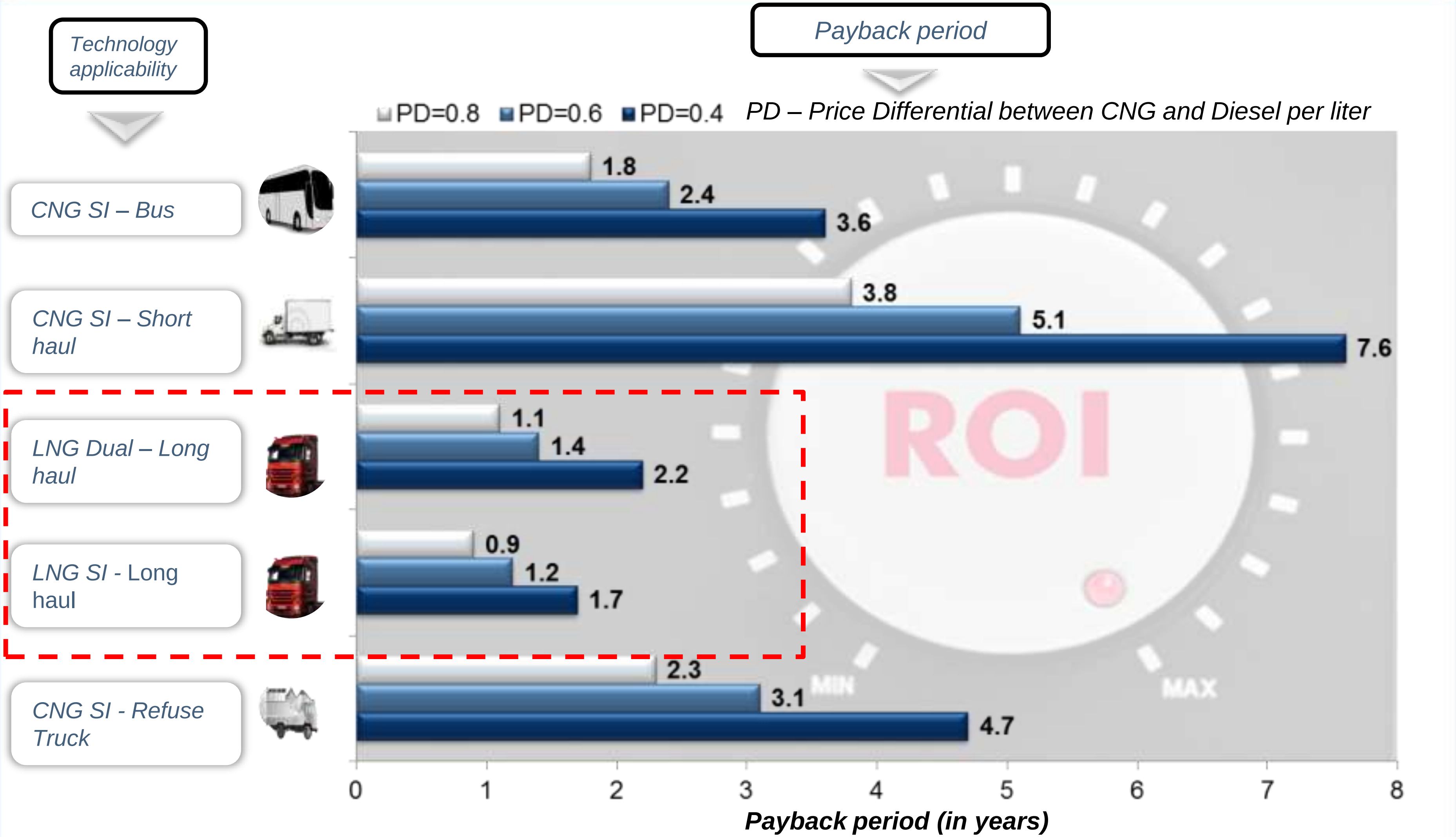
CNG

LNG

Ignition Technology	**Spark Ignited**	**Dual Fuel**	**HPDI**
Price range	€25,450 *	€ 35,000**	$72,450***

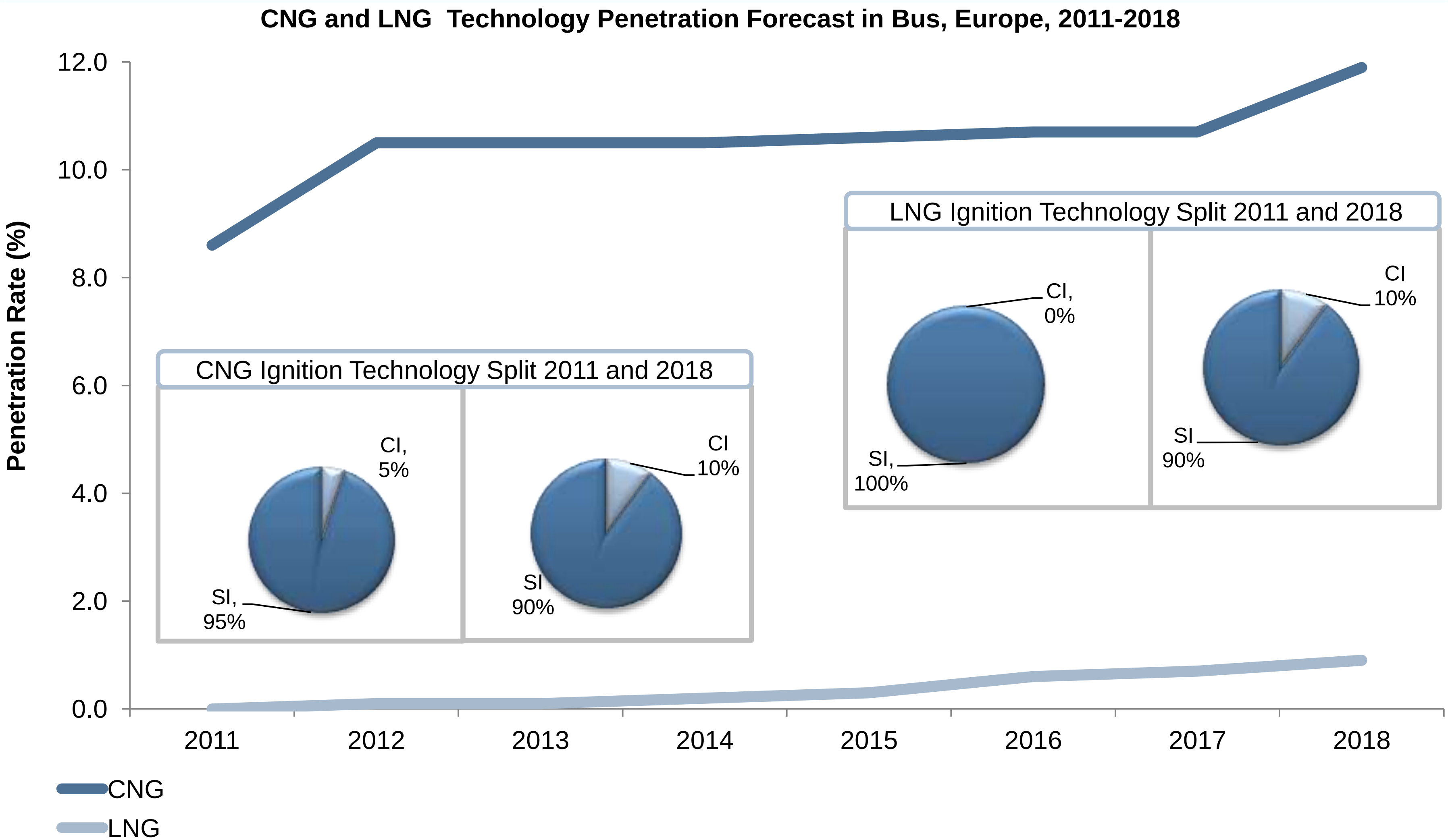
** SI engine with CNG as fuel , **CI engine with CNG as dual fuel, *** CI engine with LNG as fuel. Currently not available in Europe*

Payback Period Analysis-Western Europe - Payback Period is Approximately 2 years for Most Appropriate Duty Cycle Applications When the Price Differential Between Diesel and CNG is 0.8 Euros



Source: Frost & Sullivan analysis.

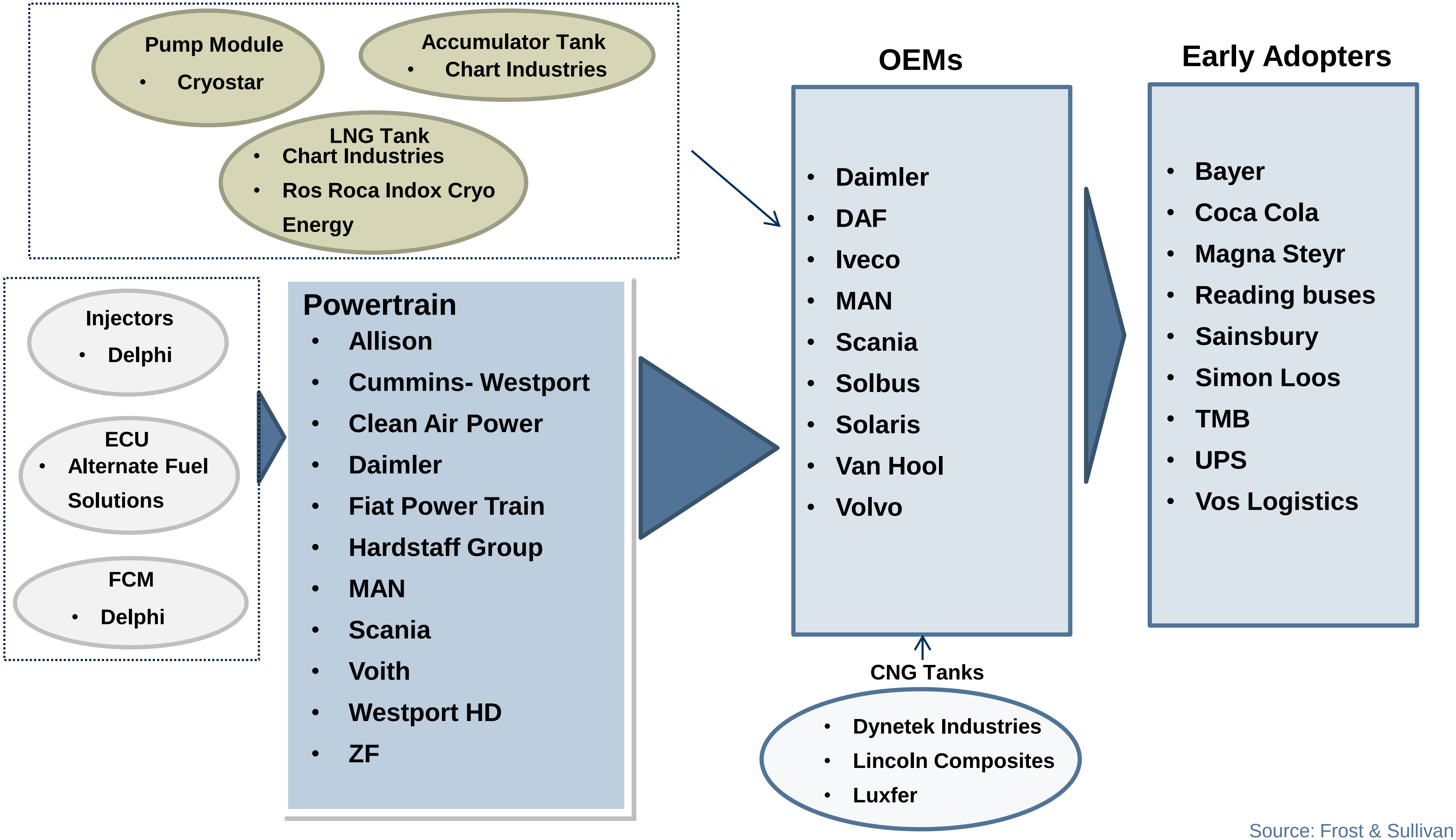
Bus Penetration Forecast - SI technology is expected to remain dominant in the CNG bus space as the duty cycle requirements of the transit bus segment is a perfect match for CNG technology



Note: CI mentioned here refers to Dual Fuel Vehicle. All figures are rounded. The base year is 2011. Source: Frost & Sullivan

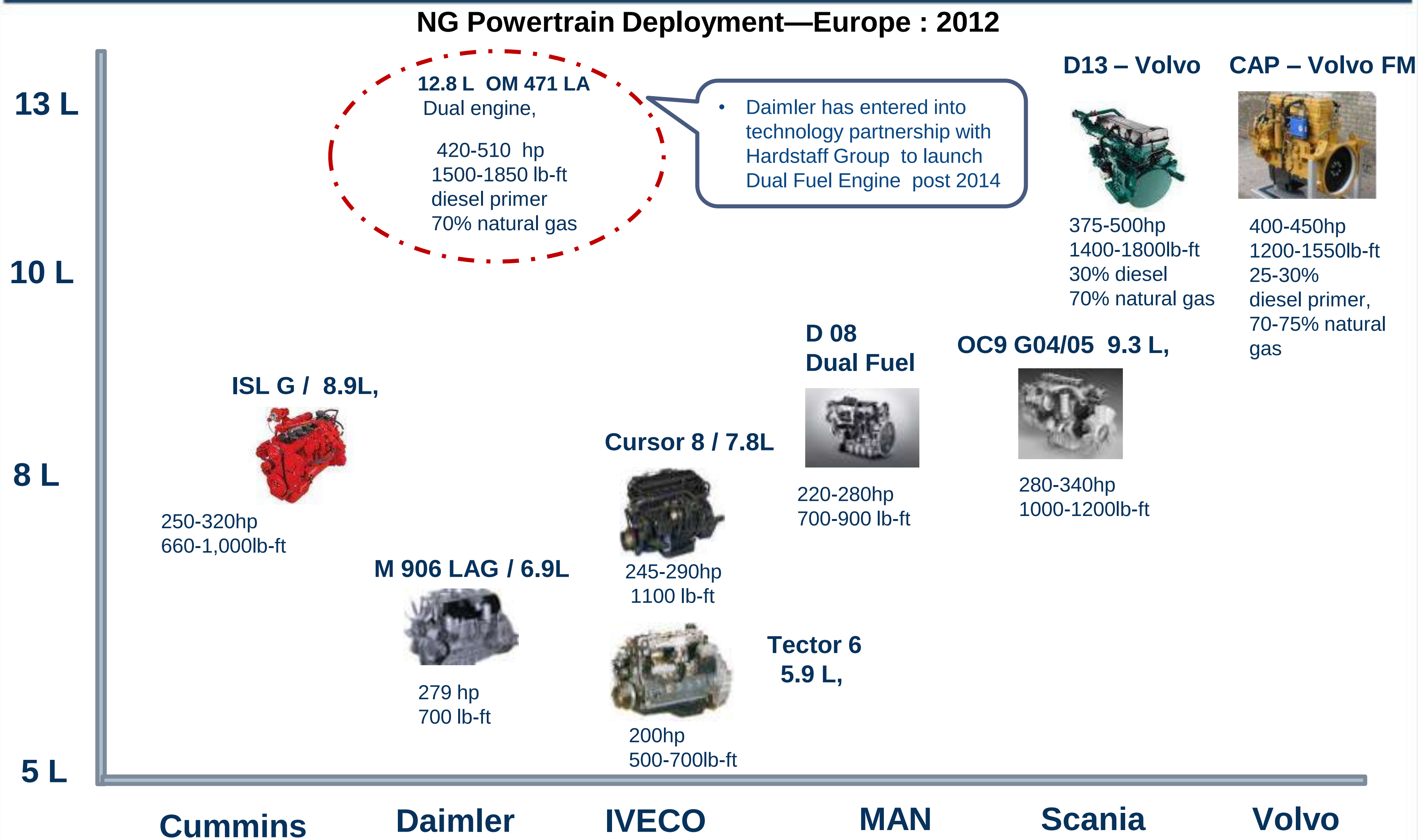
MD and HD Natural Gas CV Market - Key Supply Chain Participants

Partial List of Supply Chain Participants, Europe, 2012



Source: Frost & Sullivan

Case Study: European NG Truck Powertrain Roadmap - OEMs are concentrating on developing a Dual Fuel platform in addition to the already existing spark ignition engine platform



Global NG CV OEM Strategies: EU - Most European OEMs currently have SI engine platform while Daimler , Volvo and MAN have started focussing on Dual Fuel Platform

Region	Brand	Ignition Technology			Powertrain Partners
		SI	Dual fuel	HPDI	
Europe	Daimler Group	✔ (current portfolio)	✓ (in-development)	—	Hardstaff Group
	DAF	—	—	—	CAP, (only aftermarket)
	IVECO	✔ (current portfolio)	—	—	FPT
	MAN	✔ (current portfolio)	✔ (current portfolio)	—	PrinsAuto Gas
	Scania	✔ (current portfolio)	—	—	Scania
	Volvo Group	✔ (current portfolio)	✔ (current portfolio)	✓ (in-development)	CAP, Hardstaff, Westport HD

✔ **Current portfolio** ✓ **In-development** — **NA**

Conclusion - Favorable government policies, strong OEM product portfolio, extensive network of fuel suppliers have created the successful ecosystem for adoption of NG in major European countries

France, Germany, Italy, Spain, and Sweden are the key markets in CNG transit bus segment. Estonia, Slovenia, Ireland, and Poland have shown inclination towards CNG transit buses

Biomethane is emerging as favored fuel for NG vehicles. “BioWALK4Biofuels” and “Green Gas Grids” are projects focused on biomethane development in Europe.

Spark ignited engines to dominate the bus segment. CNG to feature in over 90% of all natural gas buses by 2018. MAN and FPT engines to feature in majority of the natural gas buses in Europe

Source: Frost & Sullivan

Questions & Answers

Thank you !

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