JONAS STRÖMBERG
SUSTAINABILITY DIRECTOR, BUSES AND COACHES

SUSTAINABLE BUSES AND TRUCKS

AGENDA

1. SCANIA BACKGROUND
2. SUSTAINABLE TRANSPORT SOLUTIONS HERE AND NOW
3. SUSTAINABLE TRANSPORT SOLUTIONS WHAT ABOUT THE FUTURE?
4. GOOD EXAMPLES FROM AROUND THE WORLD
5. DISCUSSION

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“Scania is a world leading provider of transport solutions. Together with our partners and customers we are driving the shift towards a sustainable transport system.”

Henrik Henriksson, CEO

OUR SOLUTIONS

Choosing from customised heavy trucks, buses, engines and services, our customers can build a variety of cost-efficient, low-carbon solutions.

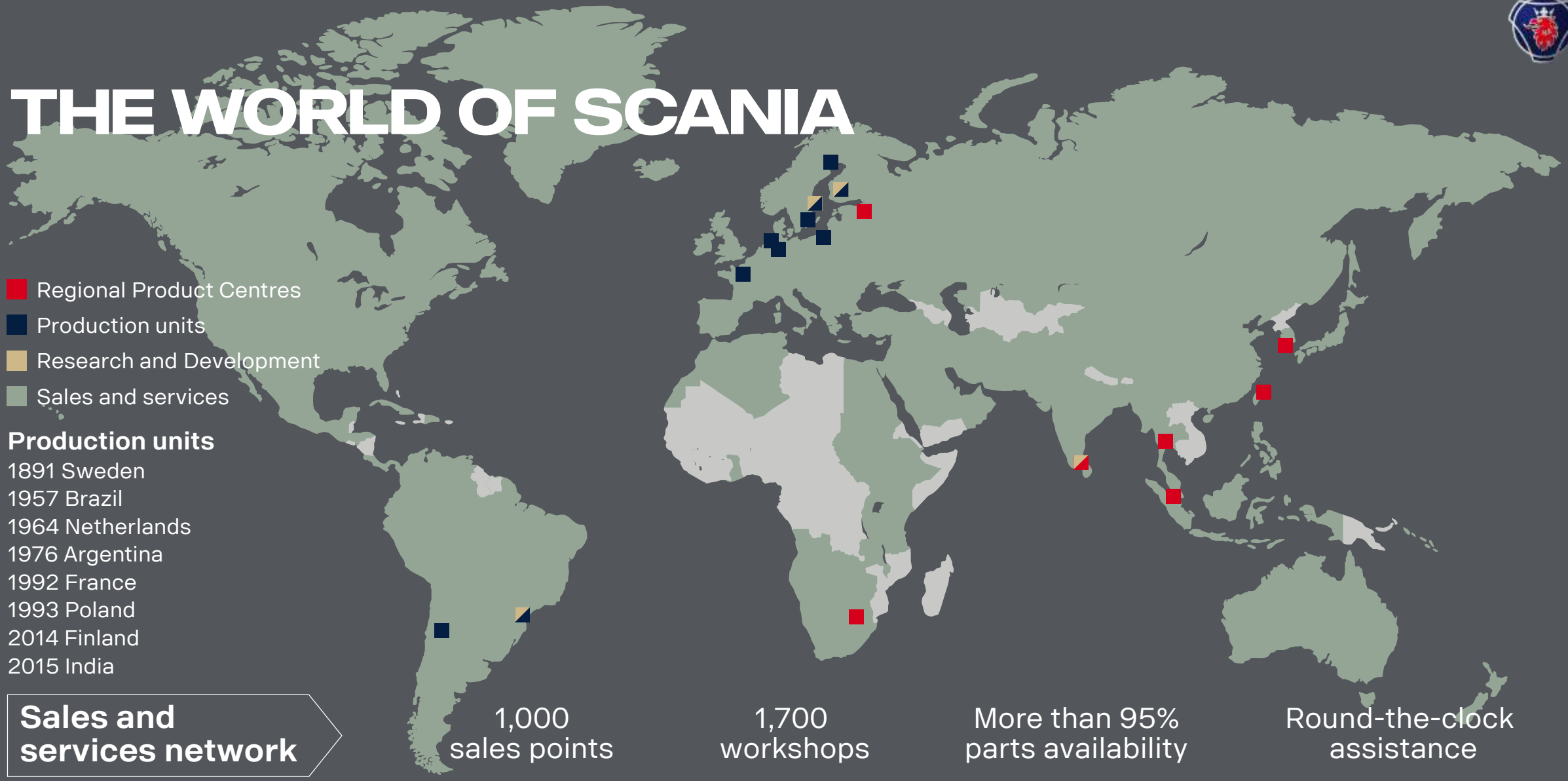
Trucks

Buses and coaches

Engines

Services

THE WORLD OF SCANIA



- Regional Product Centres
- Production units
- Research and Development
- Sales and services

Production units

1891 Sweden
1957 Brazil
1964 Netherlands
1976 Argentina
1992 France
1993 Poland
2014 Finland
2015 India

Sales and services network

1,000 sales points

1,700 workshops

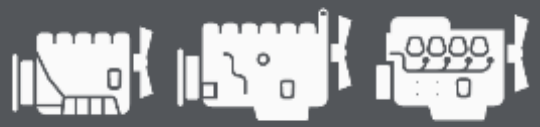
More than 95% parts availability

Round-the-clock assistance

Scania is part of Volkswagen Truck & Bus GmbH

MODULAR SYSTEM

Engines



Gearboxes

Frames

Axels

Trucks

Buses

Engines

SCANIA DELIVERIES, 2016

Trucks
73,093
(69,762)

Buses
8,253
(6,799)

Engines
7,800
(8,485)

SERVICES

- Scania Maintenance with Flexible Plans
- Driver services
- Finance and insurance
- Fleet management

Workshop services

Scania Assistance

Driver services

Finance and insurance

Fleet management

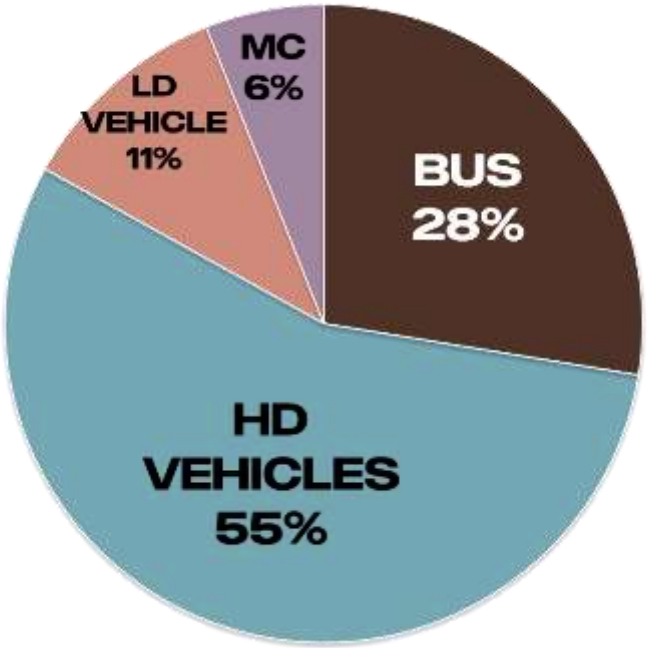
AN URBAN WORLD

70 % POPULATION	86 % GDP
80 % ENERGY USE	80 % CO_2

x3 MOBILITY DEMAND

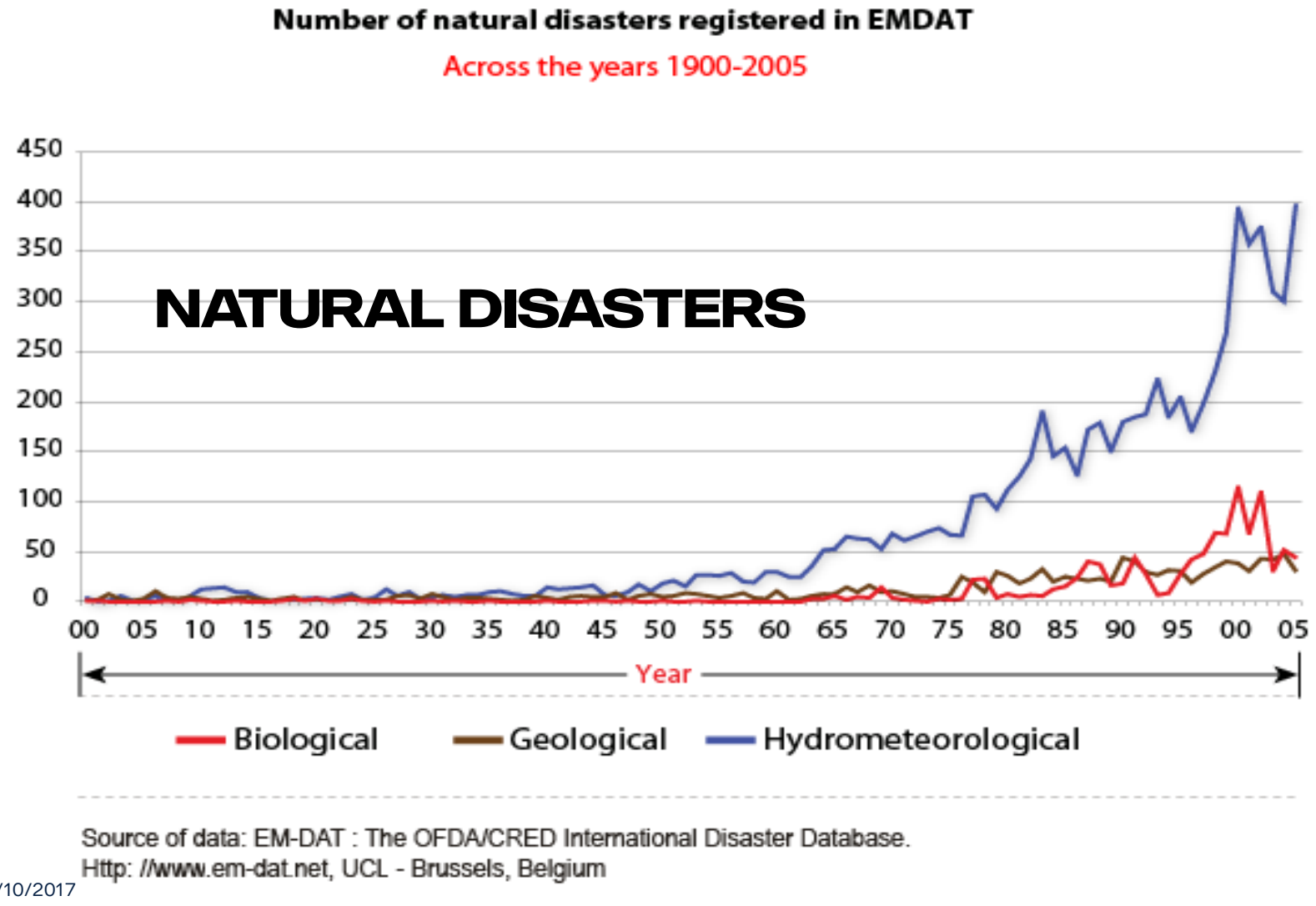
POOR AIR QUALITY: THE WORLD'S NO 1 KILLER

- Congestion and air quality problems threaten health and cities' economical growth
- Particle and soot emissions cause lung cancer and 1 out 8 deaths related to poor air quality (WHO)
- Black carbon/soot also is the 2nd worst climate change emission
- HD diesel → over 80% of particle emissions
- Scania participates in the Clean Soot Free Bus Partnership www.scania.com/cleanbus



PM 2.5 BY TRANSPORT MODE, 2010 (ICCT, 2013)

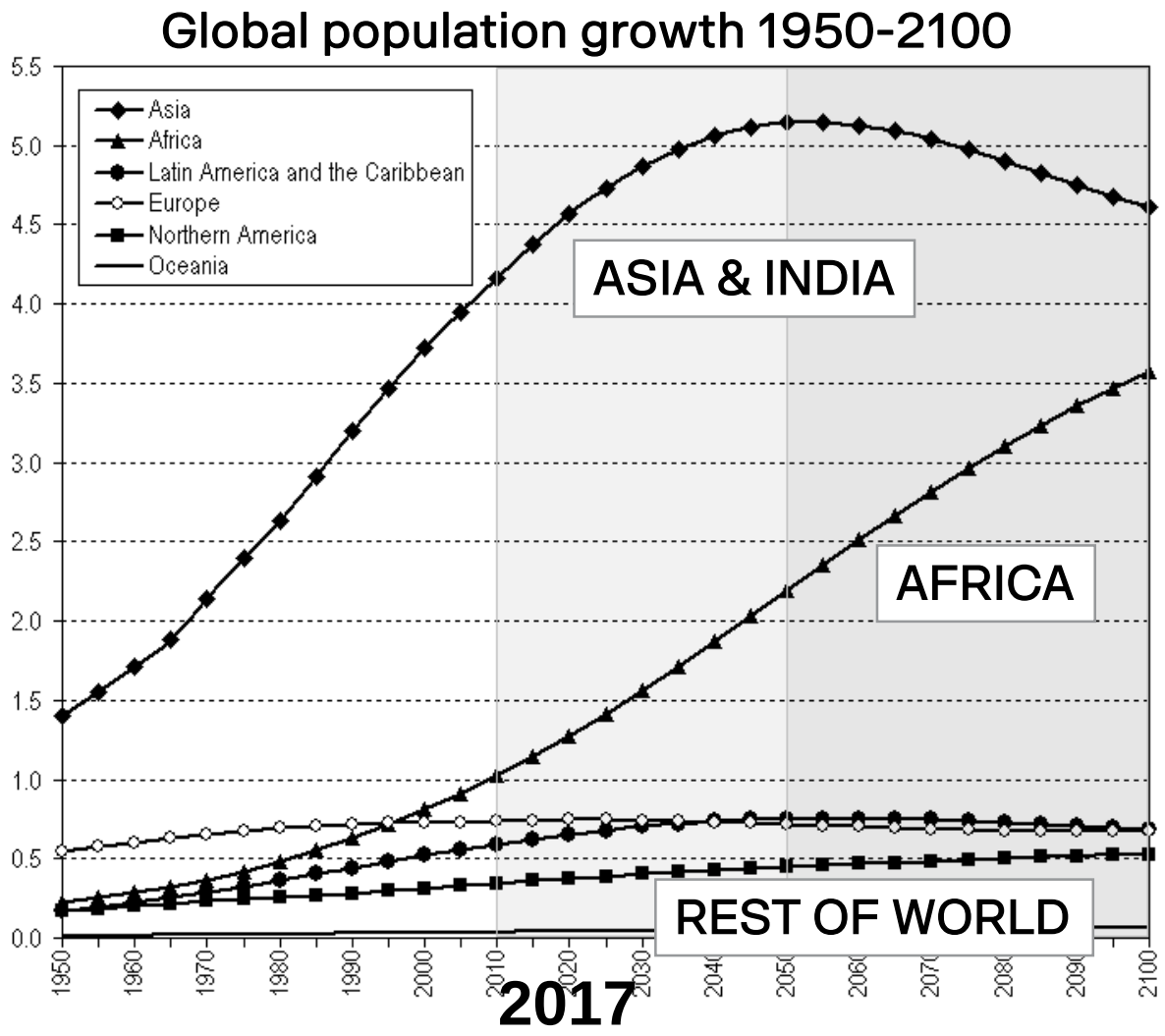
CLIMATE CHANGE
PRESSURE ON THE TRANSPORT SECTOR



Source of data: EM-DAT : The OFDA/CRED International Disaster Database.
Http: //www.em-dat.net, UCL - Brussels, Belgium

URBANIZATION AND POPULATION GROWTH

NO SUSTAINABILITY WITHOUT SOLUTIONS FOR ASIA, INDIA AND AFRICA



Source: United Nations, Department of Economic and Social Affairs The 2010 Revision. (Updated: 15 April 2011)

CLEAN

LOW CARBON

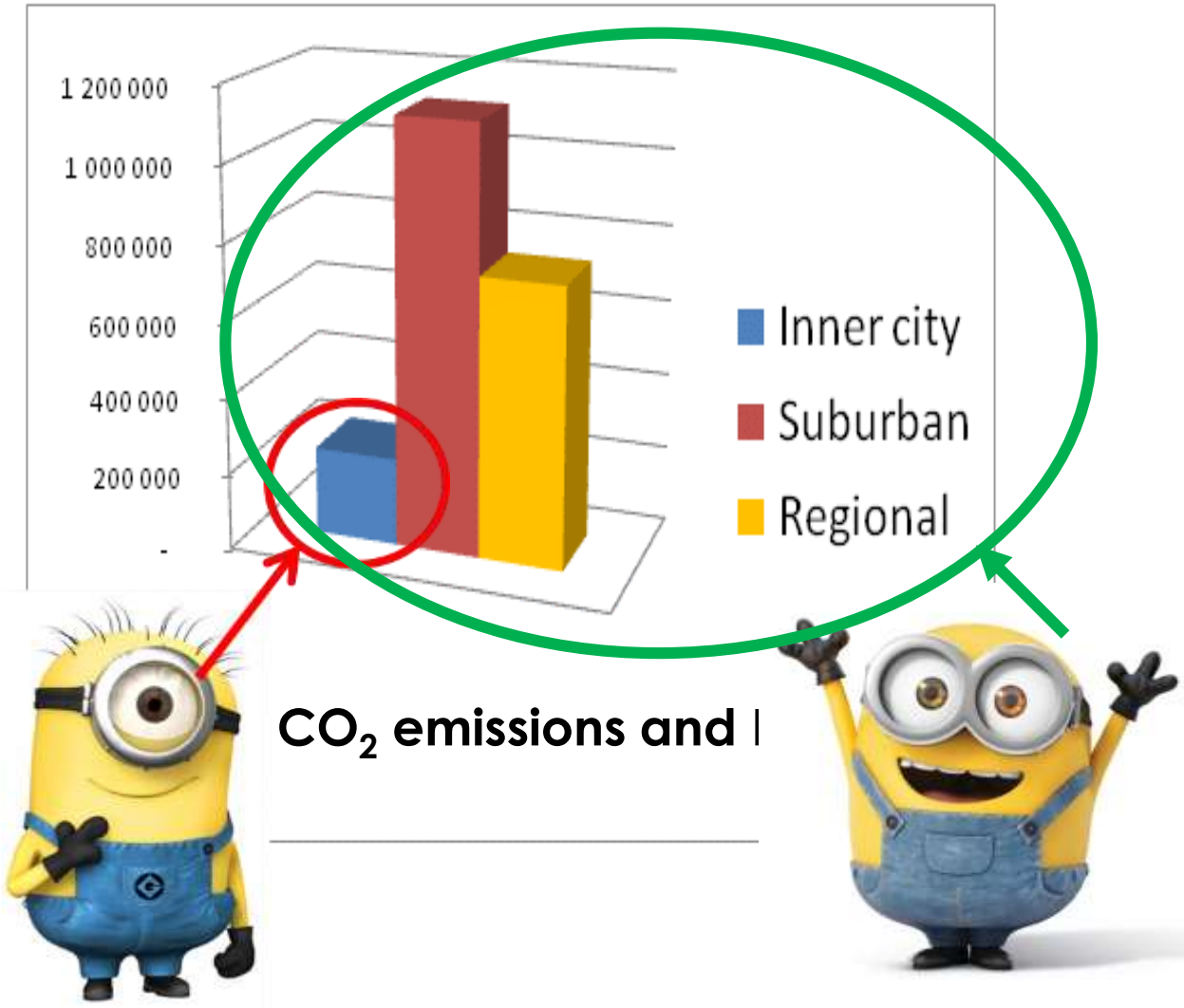
COMMERCIAL

OUTCOMPETE DIESEL

ROBUST

TRANSPORT'S FUEL USE AND EMISSIONS IN A TYPICAL CITY

- Example of a « million-citizen-city »
- Bulk of CO_2 emissions and fuel usage are outside city centres…
- Broader focus than only city centres necessary.
- Different solutions and technologies in the different areas
- Optimize whole regional transport systems, in order to achieve real and cost efficient decarbonization.



A SHIFT IS URGENT

GREEN TRANSPORT OFTEN DRIVEN BY THE BUS INDUSTRY

CONGESTION & URBANIZATION

MOBILITY x3

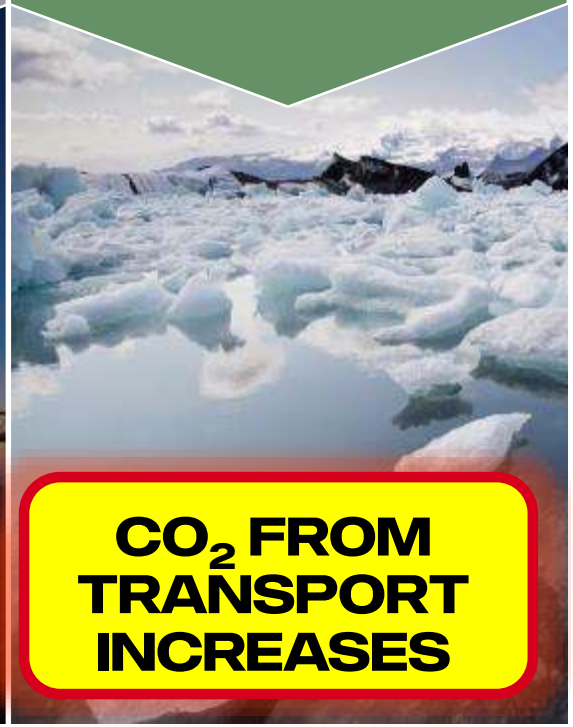
POLLUTION

THE NO 1 KILLER

ENERGY SECURITY

CURE THE OIL ADDICTION

CLIMATE CHANGE

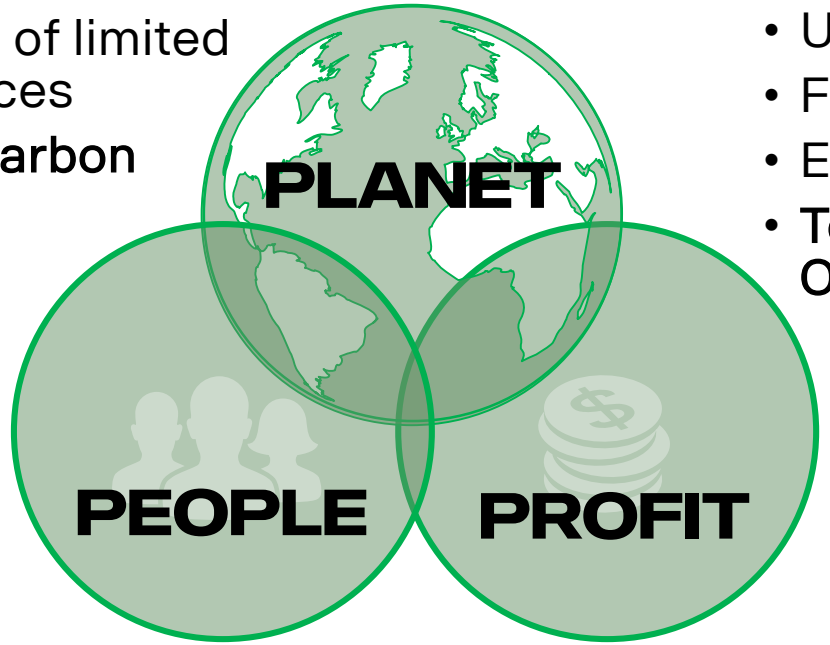


CO_2 FROM TRANSPORT INCREASES

WHAT IS SUSTAINABILITY?

AND WHAT IS SUSTAINABLE TRANSPORT?

- GHG emissions
- Usage of limited resources
- Low Carbon



- Attractive
- Uptime
- Flexibility
- Economy
- Total Cost of Operations

- Safety (driver & surrounding)
- NOx, PM, Noise, Ozone
- Supply chain responsibility
- Clean

CLEAN
LOW CARBON
COMMERCIAL
OUTCOMPETE DIESEL

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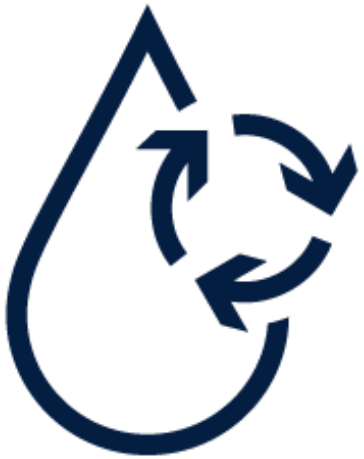
SOLUTIONS FOR SUSTAINABLE TRANSPORT

NO SILVER BULLETS - A BROAD, GREEN TOOLBOX

Energy efficiency



Alternative fuels and electrification

Smart and safe transport

HERE AND NOW SUSTAINABLE SOLUTIONS EURO 6

BIODIESEL & HVO

Low blends to B100
Diesel engine

Up to 60 %
CO_2 reduction

All types of applications, including long-haulage and coaches.

ETHANOL ED95

World's No. 1 biofuel
Diesel type engine

Up to 90 %
CO_2 reduction

Buses, coaches waste collectors, distribution trucks.

BIOGAS & CNG

Compressed or liquid
Otto engine

Up to 90 %
CO_2 reduction

City/Intercity buses, waste collectors, distribution trucks.

HYBRIDS & ELECTRIFICATION

Diesel hybrids
Biofuel hybrids
BEV Field tests

Up to 92 %
CO_2 reduction

City buses, waste collectors, distribution trucks.

BUS SYSTEMS

Bus System packages
Buses
Service and R&M
Workshops
Financing
ITS and FMS systems
Ticketing systems
Alternative Fuels

SCANIA ETHANOL ENGINE, EURO 6

THE COST AND ENERGY EFFICIENT WAY TO USE ETHANOL

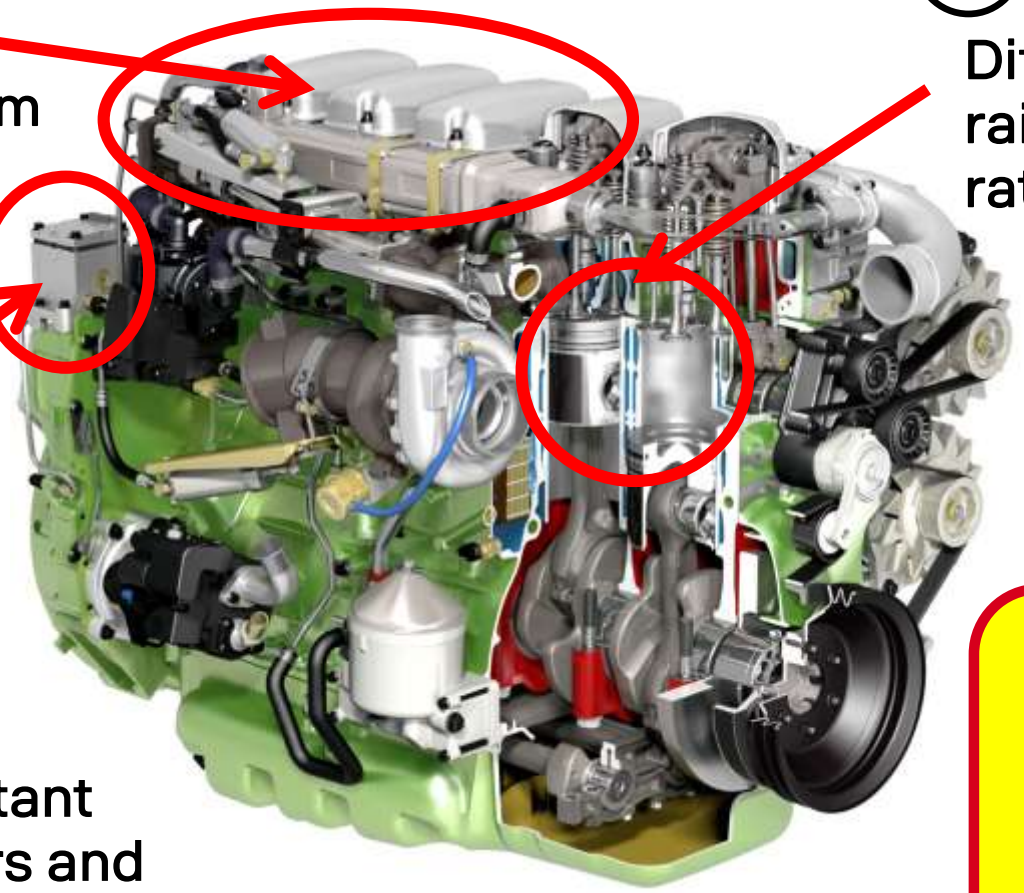
- Ethanol fuel ED95
  Hydrous ethanol (95%) with ignition improver (5%).
- 4th generation engine - Euro 6
  Diesel performance - 280 hp and 1250 Nm
  After treatment equipment; SCR and particulate filter.
- Highly efficient diesel combustion
  Ethanol: up to 43% efficiency
  Diesel : up to 44% efficiency
- Scania modular system
  Minor changes to the standard diesel engine.
  Very similar to diesel operation.
- Proven technology
  Fourth generation ethanol engine.
  In commercial traffic since 1986.

ETHANOL WITH DIESEL EFFICIENCY

GENERAL MODIFICATIONS ON A SCANIA ETHANOL-DIESEL ENGINE

3 Larger fuel injection system

4 Different pistons to raise compression ratio (28:1)



2 Different engine management programming

1 Ethanol resistant gaskets, filters and sealings

14

PARTS DIFFER FROM THE DIESEL ENGINE

SCANIA EURO 6 GAS ENGINES
THE MOST ENERGY EFFICIENT WAY TO USE YOUR GAS

Otto engine with outstanding efficiency
Gas 40% thermal peak efficiency
Diesel 43% thermal peak efficiency
Diesel torque levels

Scania modular system – Scania quality
Less than 40 parts differ from diesel engine
Excellent service and spare part availability

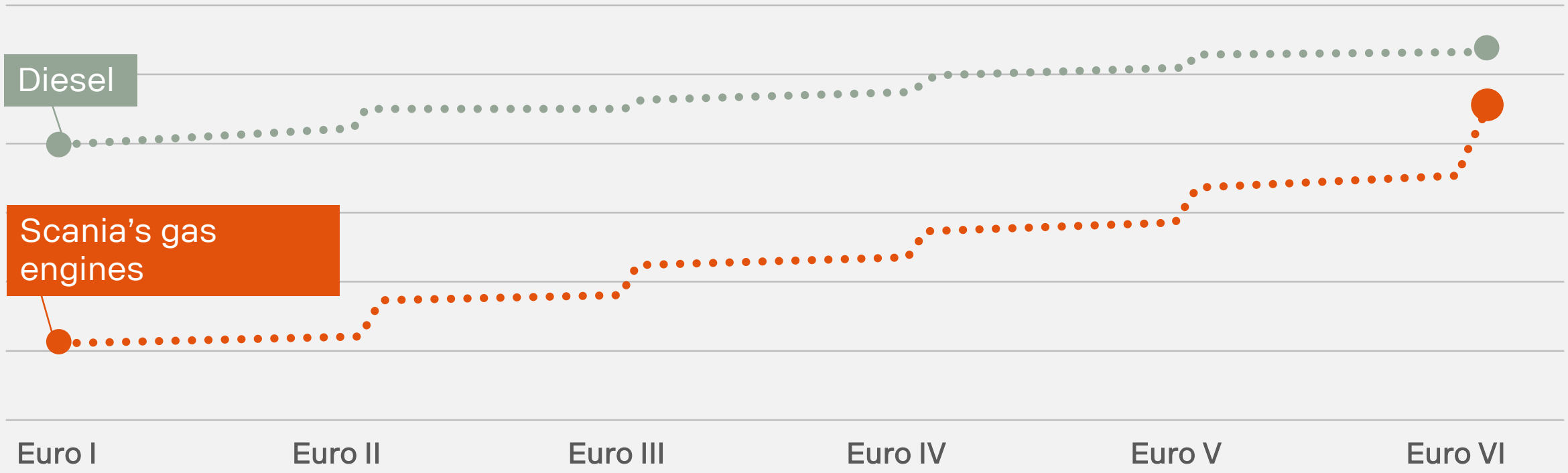
All city and regional purposes
280 hp (Bus, Truck, 1350 Nm)
320 hp (Bus, 1500 Nm)
340 hp (Truck, 1600 Nm)

THIS WEEKS NEWS:
410 hp (Truck, 13 l, 2000 Nm)
Range 1100-1600 km,
1-2 LNG tanks

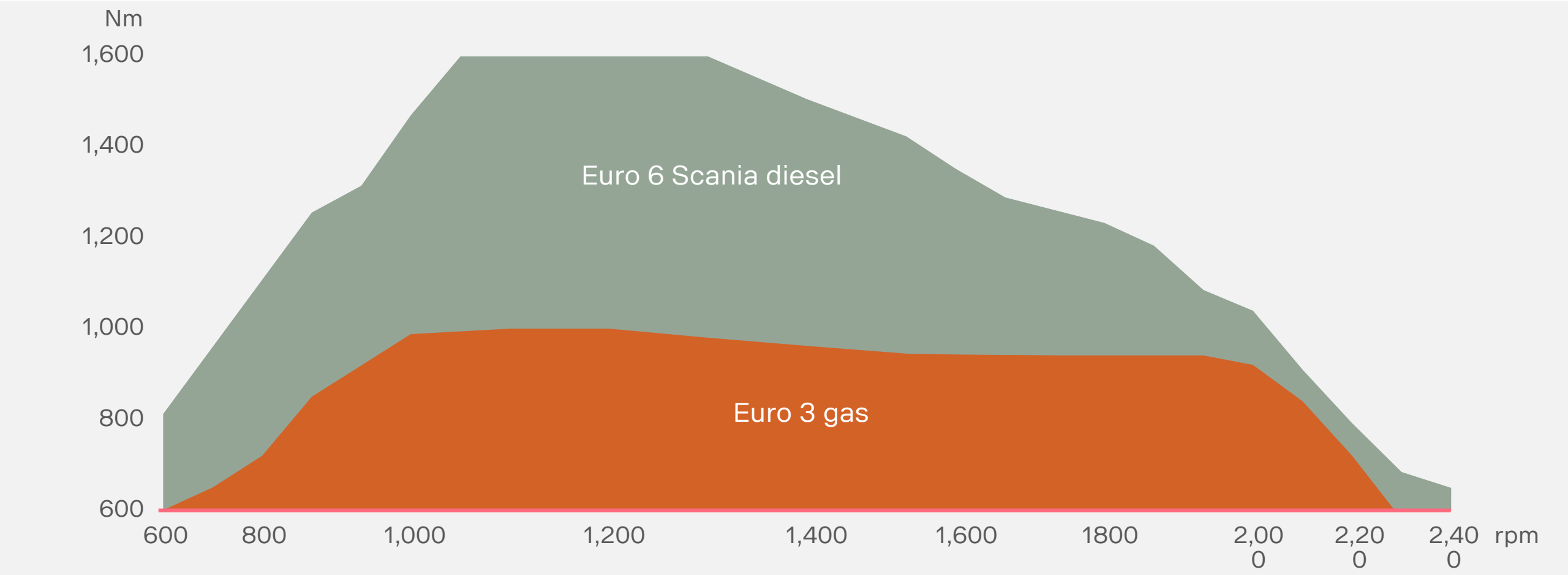
Other features
Less sensitive to gas quality
100% operability on 2 000 m+
Operates on both CNG and LNG
No complex after-treatment/SCR/AdBlue necessary
Only 3-way catalyst necessary to reach Euro 6
Up to 90% CO_2 cuts with biogas (~10-20% with CNG)

A PARADIGM SHIFT – THE NEW EURO 6 GAS ENGINE

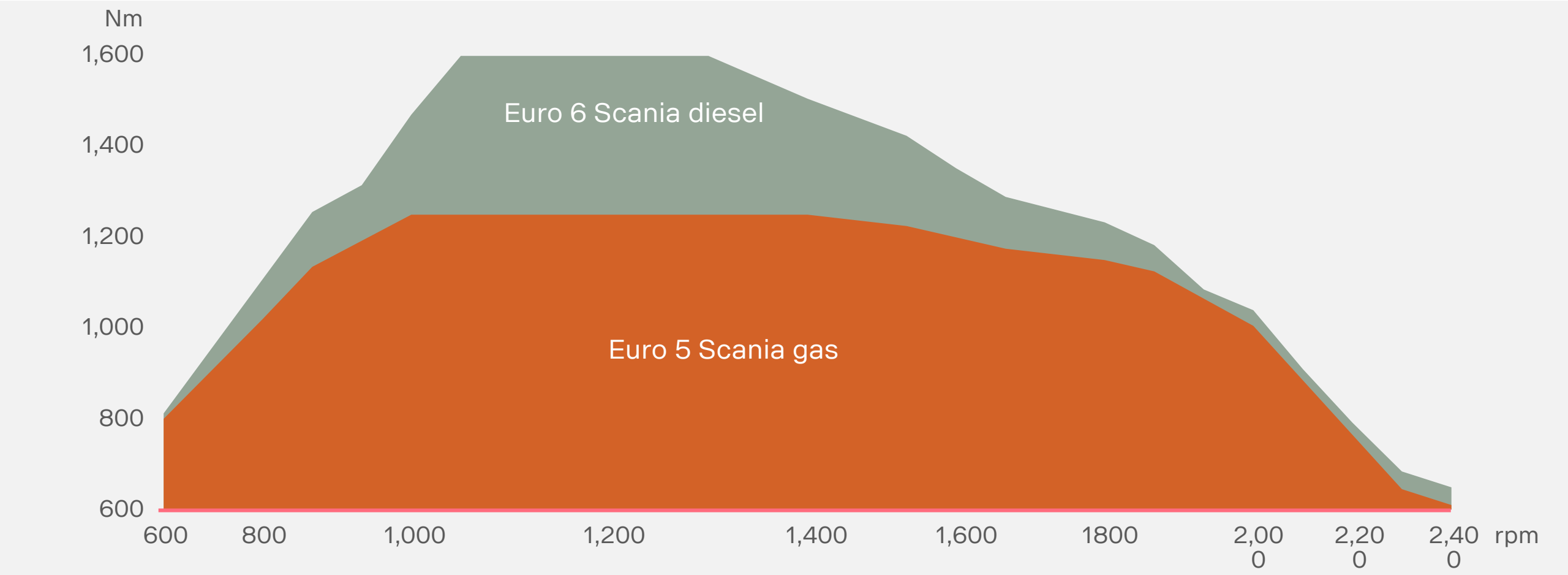
DIFFERENCE IN FUEL EFFICIENCY ALMOST ELIMINATED
FURTHER DEVELOPMENT ONGOING



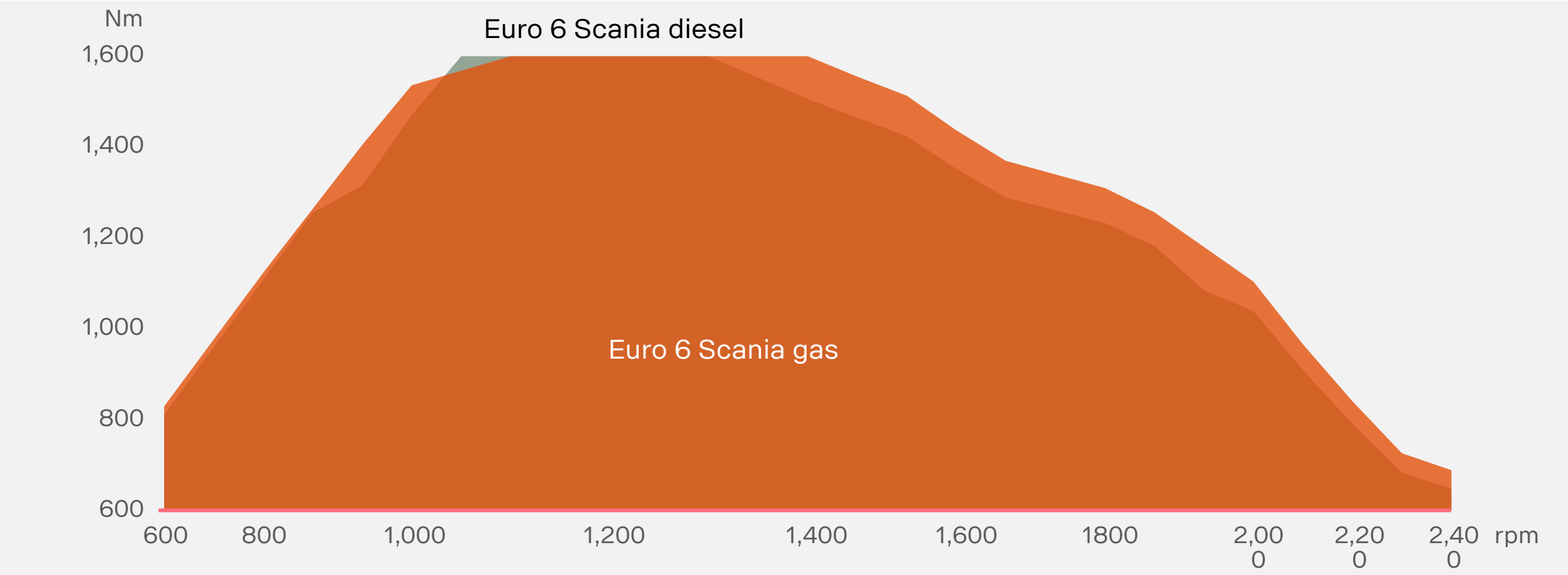
TORQUE DEVELOPMENT



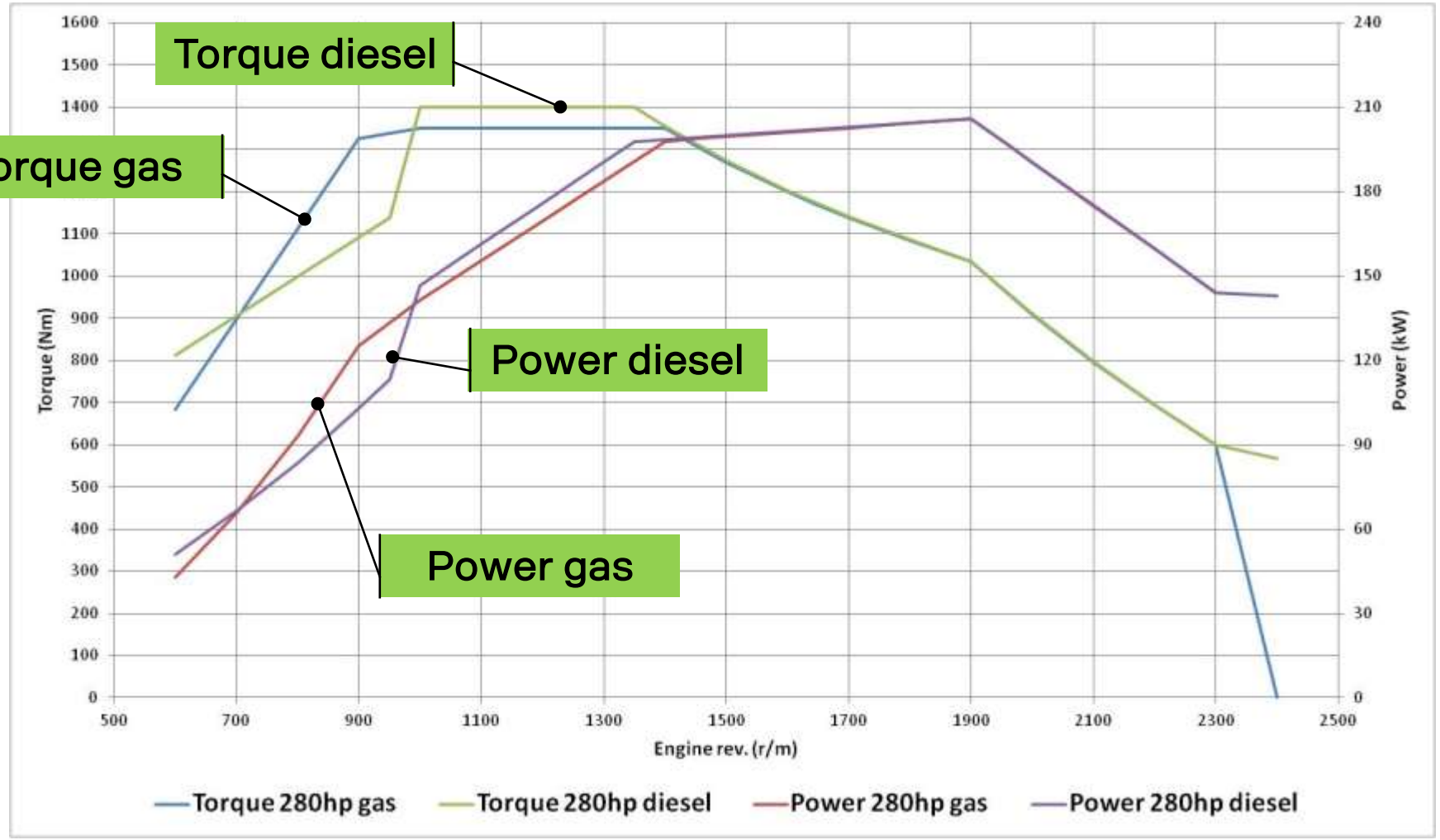
TORQUE DEVELOPMENT



TORQUE DEVELOPMENT



FIRST GAS ENGINE WITH DIESEL TORQUE



CERTIFIED FOR QUIET DELIVERIES

Scania's gas engines have been certified according to the Piek-Keur Quiet TRUCK standard.

The certification has been adopted by several European cities as a prerequisite for night time distribution.

GAS TANKS

CNG/CBG

LNG/LBG

EU infrastructure directive / Blue Corridors drive development

AIR QUALITY

Alternative Fuels...

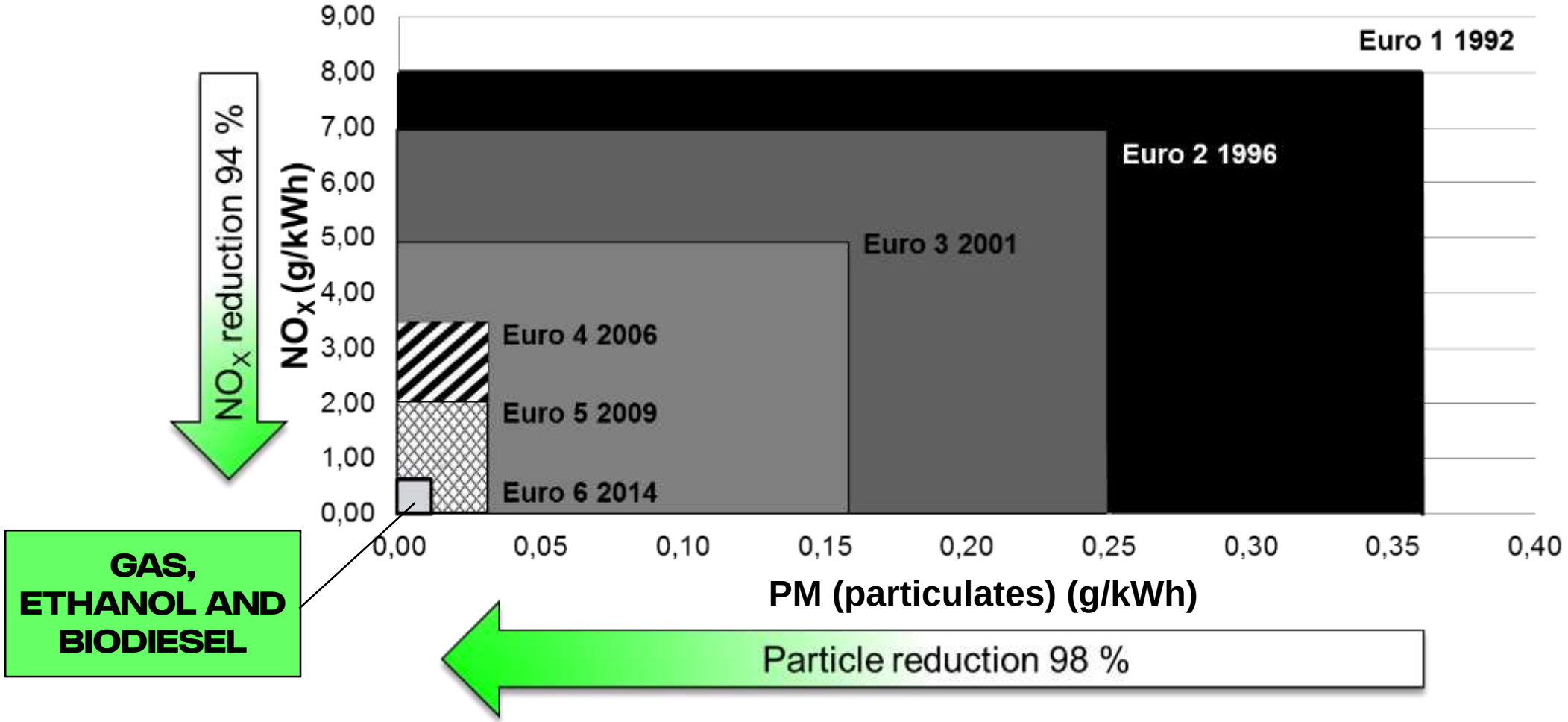
...CLEAN UP THE AIR AND SAVE LIVES

Heavy trucks and buses cause over 80% of particle emissions.

Leapfrog from poor diesel qualities straight to cleaner than Euro 6

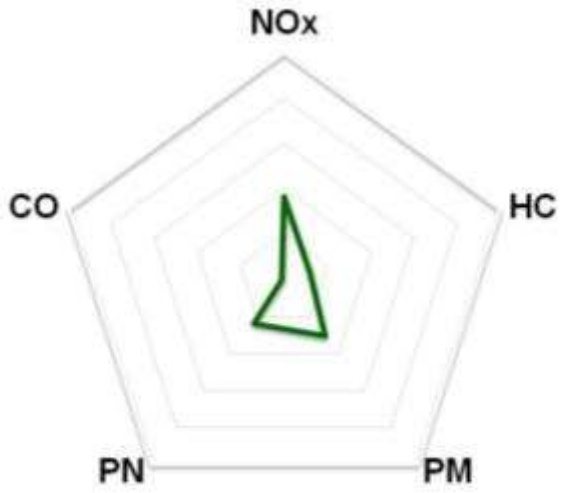
LOCAL EMISSIONS

ALTERNATIVE FUELS EVEN CLEANER THAN EURO 6



ULTRA-CLEAN OPERATION WITH BIOFUELS

Bioethanol engine emissions as compared to Euro 6 legislation



Gas engine emissions as compared to Euro 6 legislation

SCANIA A PROUD FOUNDING MEMBER OF THE SOOT-FREE CLEAN BUS FLEET PARTNERSHIP

CLEANING UP THE MEGACITIES OF THE WORLD TOGETHER

UNEP United Nations Environment Programme environment for development

C40CITIES CLIMATE LEADERSHIP GROUP

icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Centro Mario Molina Chile

CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

www.scania.com/cleanbus

www.ccacoalition.org/en/content/soot-free-urban-bus-fleets

www.theicct.org/news/soot-free-buses-commitment-20-megacities

CARBON FOOTPRINT

Alternative fuels...

...CUTS CO_2 EMISSIONS WITH UP TO 90%

Scania work with sustainability verified biofuel supply partners

JOB CREATION

Biofuel production
create up to...

...A 100 TIMES MORE JOBS

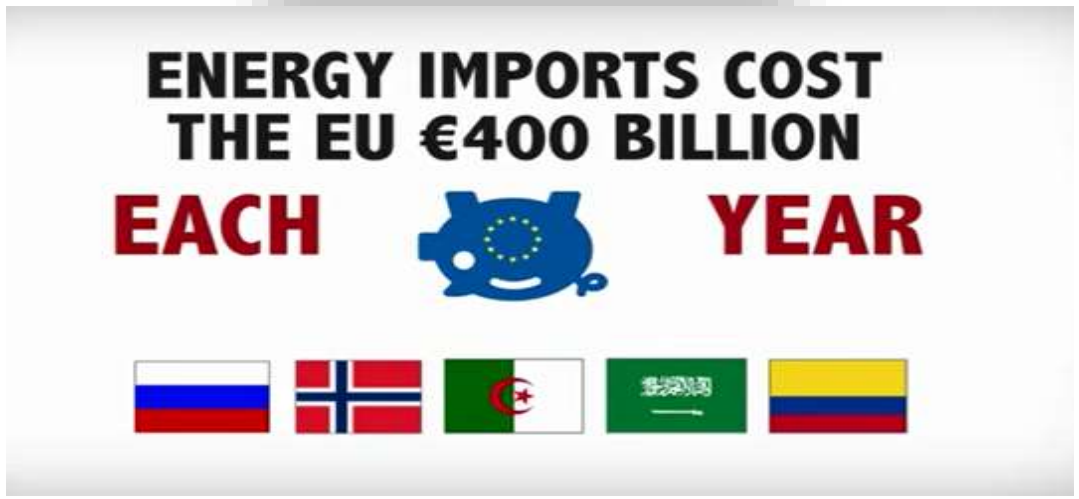
per unit of energy
produced, than the
traditional oil industry!

ENERGY SECURITY

Locally produced
Alternative Fuels..

...CREATES AN INDEPENDENT FUEL SUPPLY

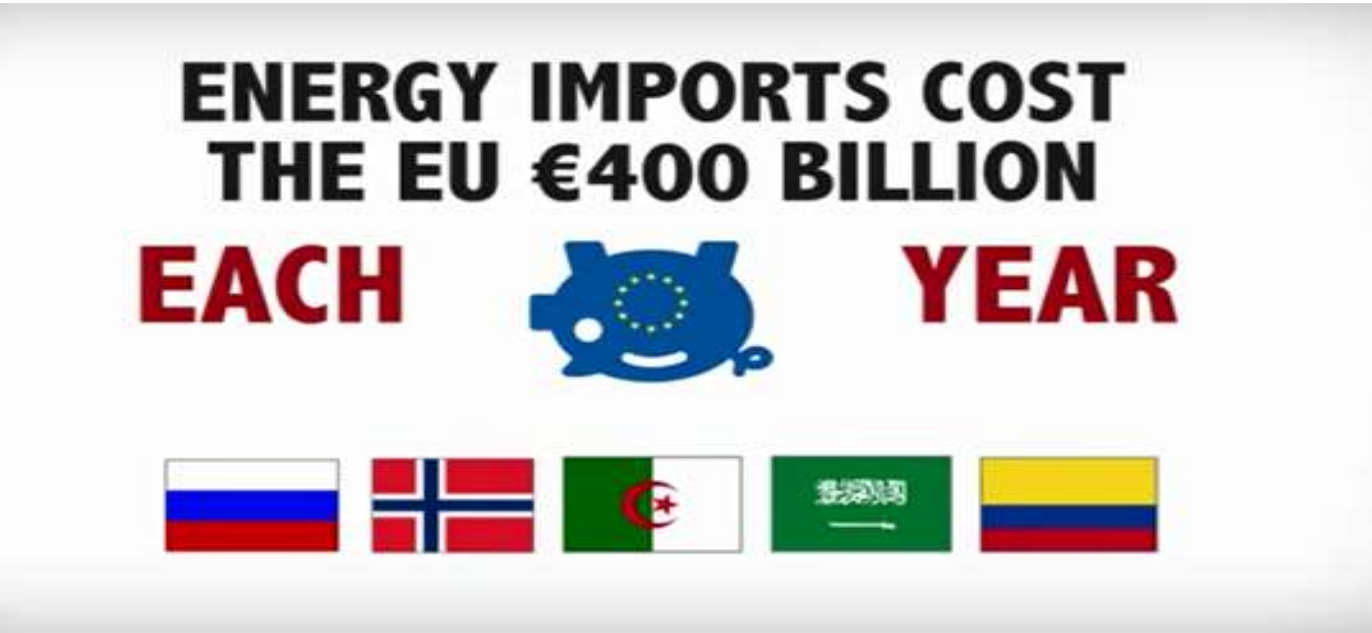
Strong oil dependency in the EU makes our economies vulnerable for fluctuations and political pressure.



EU'S ENERGY VULNERABILITY

- EU imports 90% of its oil at >1 billion € a day
- Energy insecurity and political pressure
- *"The oil dependency remains the EU's Achilles' heel, because of dependence on imports from unstable, authoritarian regimes."*

Anders Fogh Rasmussen,
former Prime Minister of Denmark and Secretary General of NATO



FROM WASTE TO CLEAN BIOFUEL FLEETS

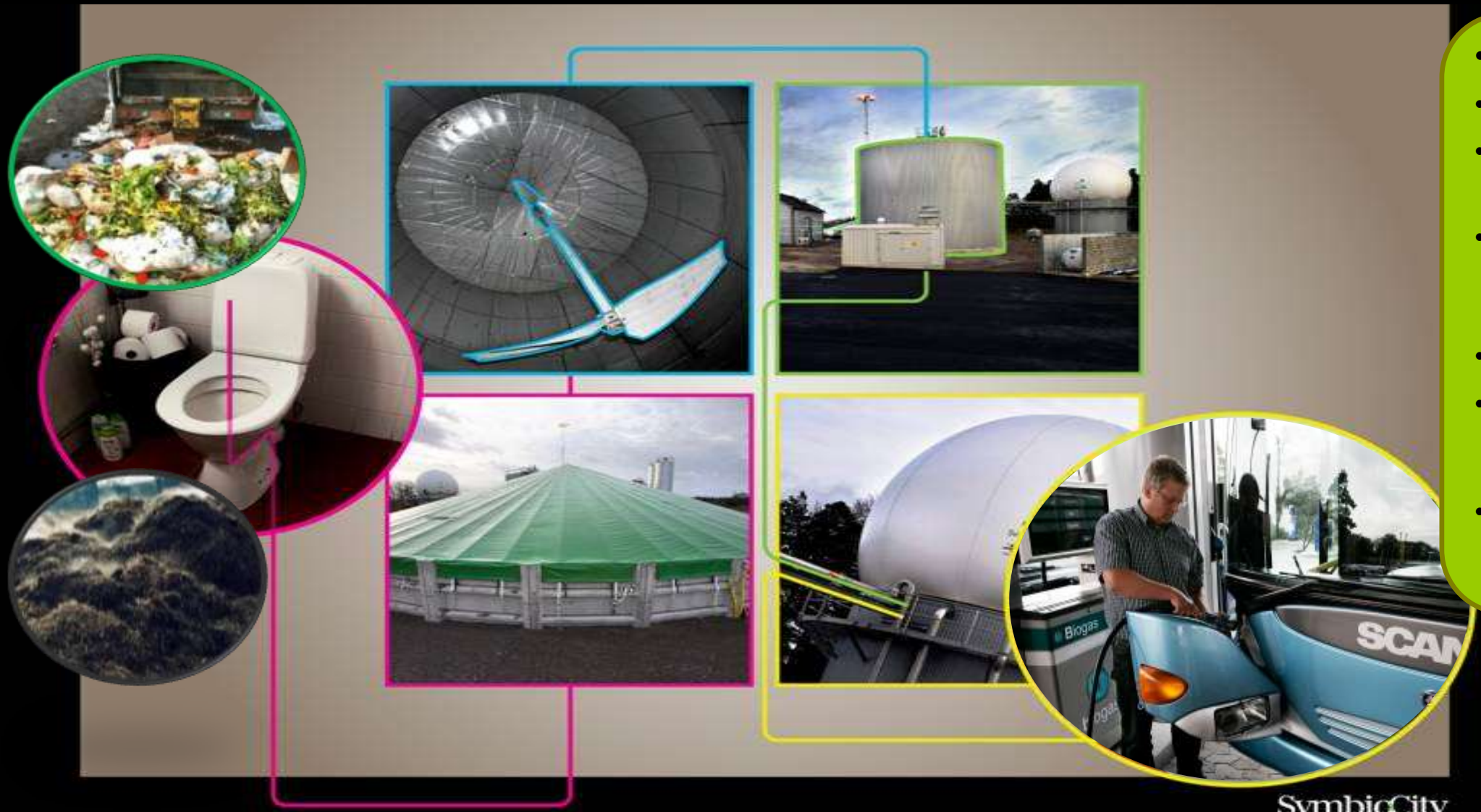
Alternative Fuels...

...HELPS ELIMINATE WASTE

Sewage and organic waste could commercially be turned into clean biogas, biodiesel and bioethanol fuels.

TURN-KEY PACKAGE SOLUTIONS

FROM ALL KINDS OF ORGANIC WASTE TO CLEAN BIOGAS FLEETS



- A low carbon fuel
- A clean fuel
- Sludge and landfill minimized
- By-product bio-fertilizer helps local agro business
- Clean water
- Biogas expertise – from waste to vehicle!
- Contact Scania and partners for a local feasibility study!

SymbioCity

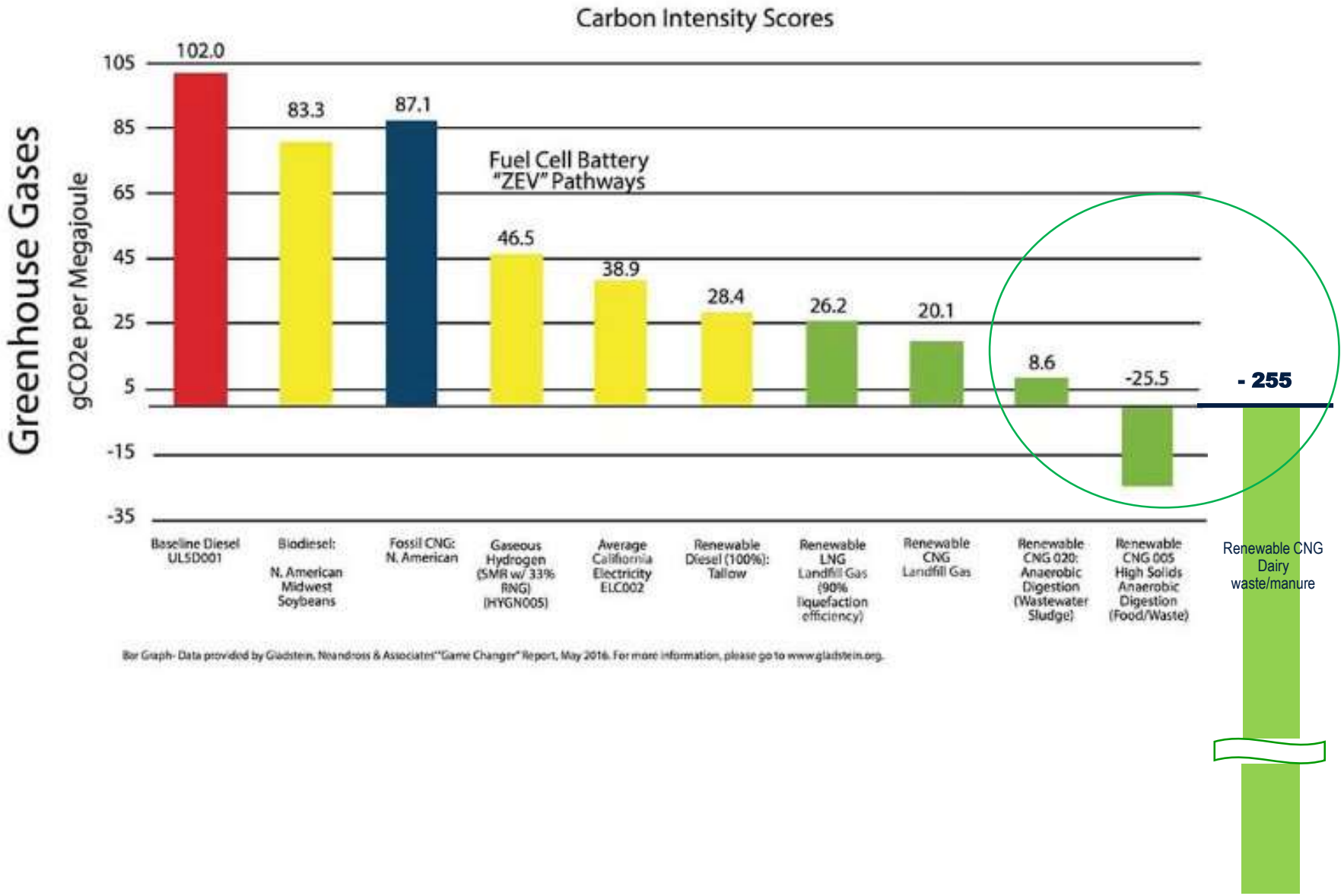
GHG PERFORMANCE - BIOGAS

- Biogas consistently shows outstanding GHG saving values.

- One of few fuels that actively could recycle GHG

- -73% (EU RED Directive)
- - 84 to -88% (LowCVP)
- - 97% (CONCAWE/EUCar)
- - 92% to -350% (CARB)

- The best biogas pathway (dairy waste/manure) could recycle 3x the corresponding diesel emissions.
(See latest CARB data)



BOTH FOOD AND FUEL

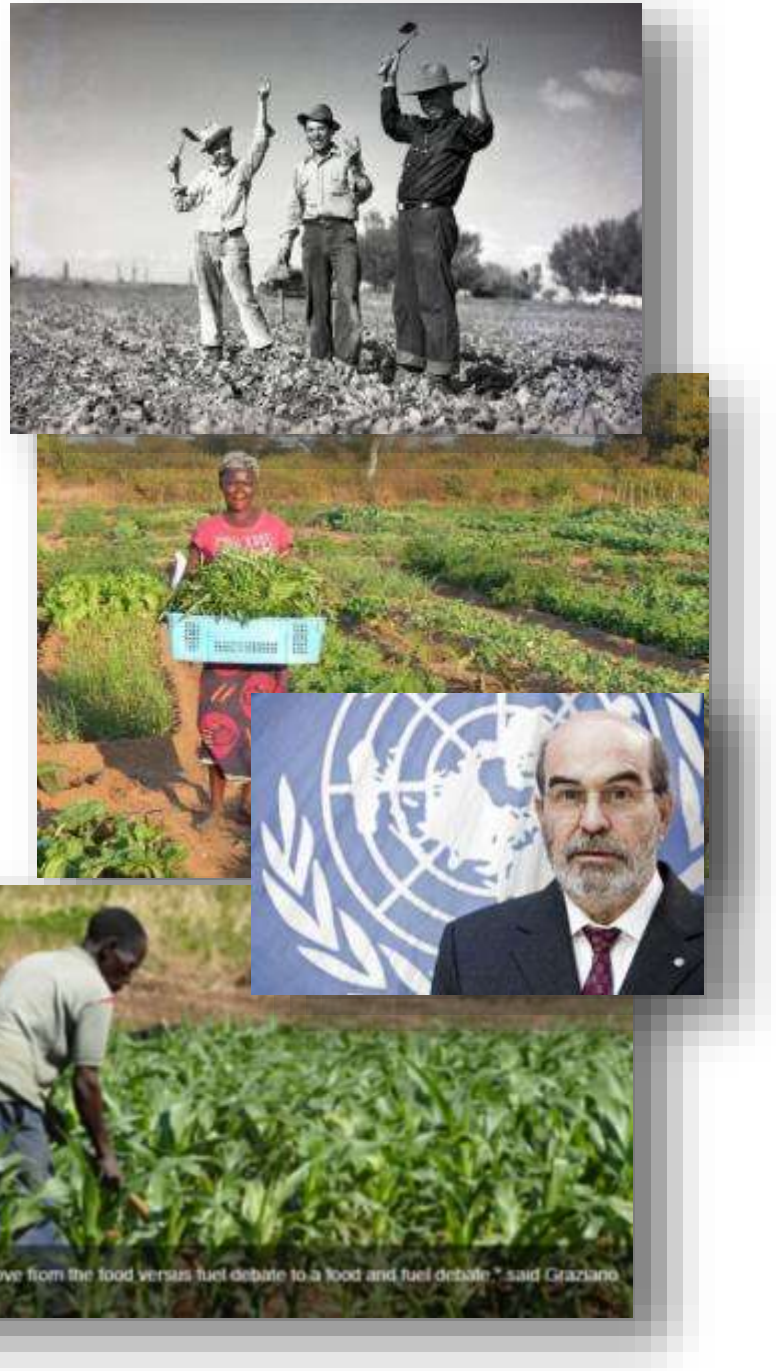
Alternative Fuels...

...HELPS FIGHT POVERTY

Majority of World's poor are small scale farmers that benefit from growing both food and fuel crops.

By-products like fertilizer and animal feed support local agricultural economies.

"We need to move from a food vs fuel debate to a food and fuel debate"
(FAO Director General da Silva)



PACKAGE SOLUTIONS FOR SUSTAINABLE CITIES - HERE AND NOW

GREEN TRANSPORT EXPERIENCE ON ALL CONTINENTS
BUSES, TRUCKS, ALTERNATIVE FUEL PRODUCTION AND FINANCE

Norway – bioethanol solution

SAMFERDSELSDEPARTEMENTET

transnova

Borregaard

SCANIA

UK – biogas solution

SCANIA

India – ethanol/biogas

SCANIA

IVL

PURTI GROUP

Finland - bioethanol

NEOT

st1

VTT

France – ethanol from waste

RAISINOR FRANCE

STAF

Carrefour

SCANIA

South Africa – ethanol and gas

MOLOPO
ENERGY LIMITED

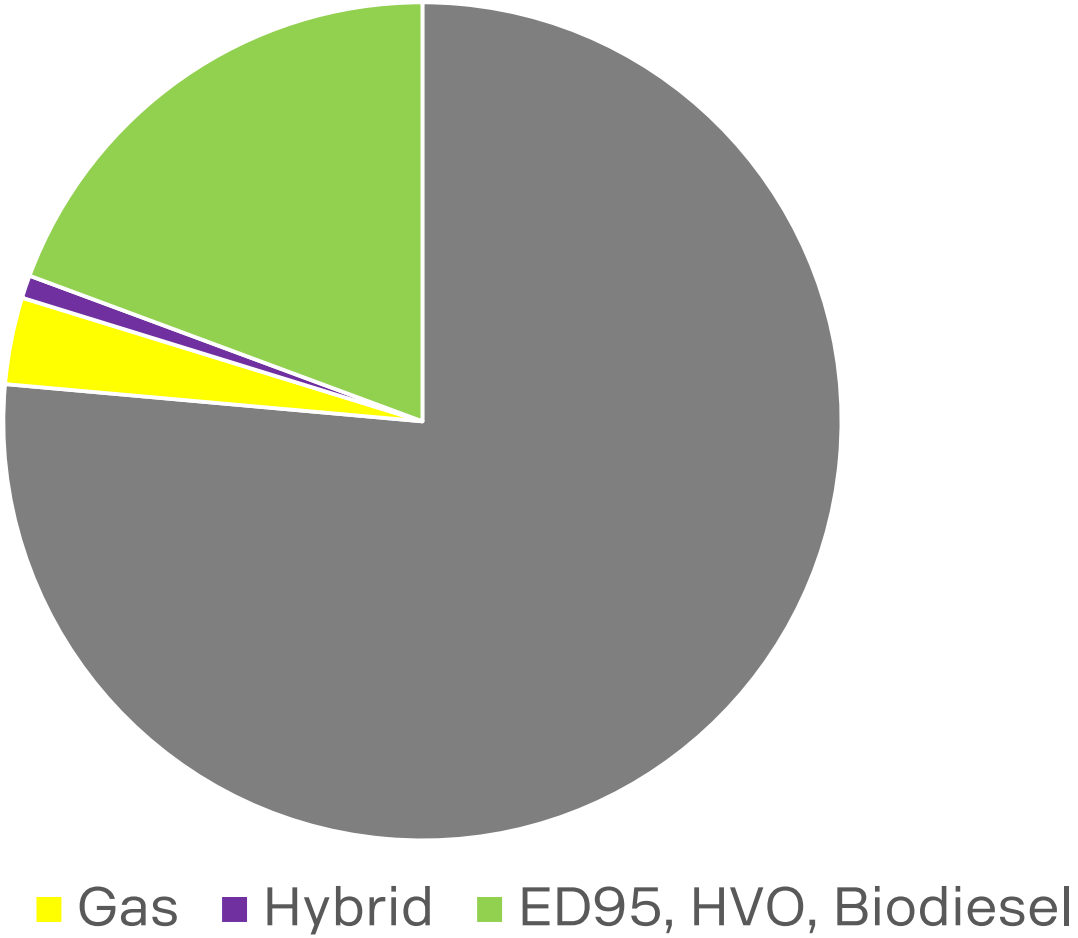
silversandsethanol

Colombia - gas

SCANIA

ALTERNATIVE → BUSINESS AS USUAL

SCANIA SALES OF SUSTAINABLE SOLUTIONS GROW (2016)



CITYS WALK, NATIONS TALK

DO YOUR MAYOR A FAVOUR!

ENERGY SECURITY,
PUBLIC TRANSPORT,
WASTE,
AIR QUALITY AND
CLIMATE CHANGE
MITIGATION
ARE THE TOP 5
PRIORITIES OF ALL
MAJOR CITIES

CONNECTED VEHICLES

Smart and safe transport

Currently

288,000

connected vehicles
(2/3 of rolling 5 year fleet)

Driving close to

50,000

laps around the world every month

Currently

288,000

connected vehicles
(2/3 of rolling 5 year fleet)

Real Time....
...Driver training/coaching
...Fleet Management
...Flexible Service
...Uptime Guarantee
→ Fuel, emission and cost savings

Driving close to

50,000

laps around the world every month

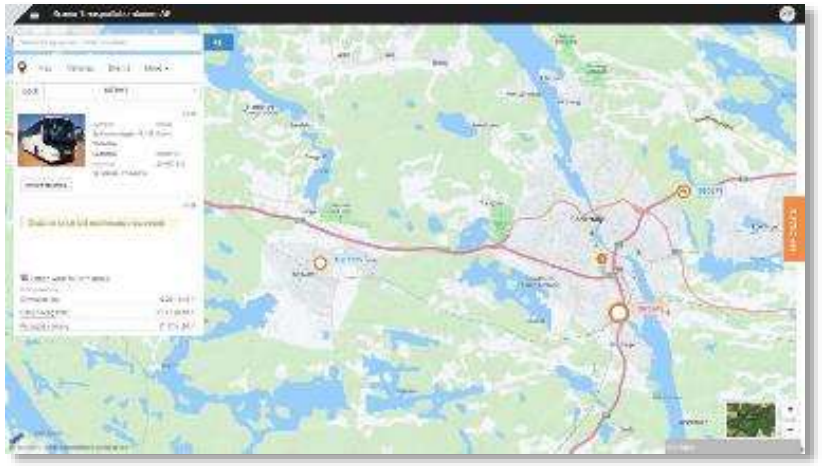
Autonomous vehicles
Platooning

SCANIA DRIVER SERVICES

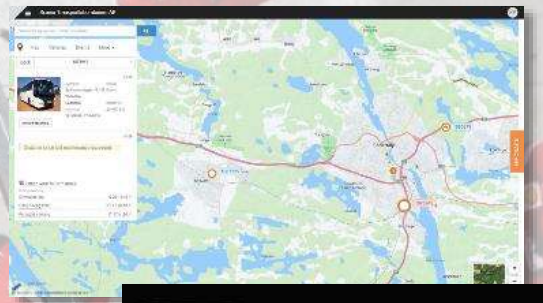
- Scania Application Based Driver Training
  Fuel Efficiency, Productivity, Safety and Security
- On average 11% fuel saving with Scania Driver Training and follow-up.

SCANIA FLEET MANAGEMENT

- Monitoring, Data Access and Control Package
- Fleet Management Portal
- Scania Fleet app

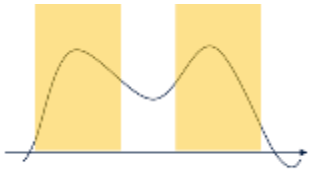


SCANIA FLEET MANAGEMENT AND FLEET CARE



- Fully serviced fleet
- Improved uptime
- Less spare capacity
- Focus on core business

TAILORED TO EACH FLEET'S OPERATION



Peak hours

Weekly schedules

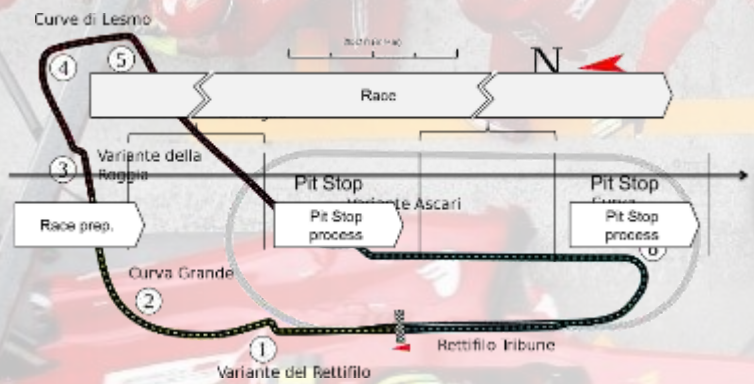
Seasonality

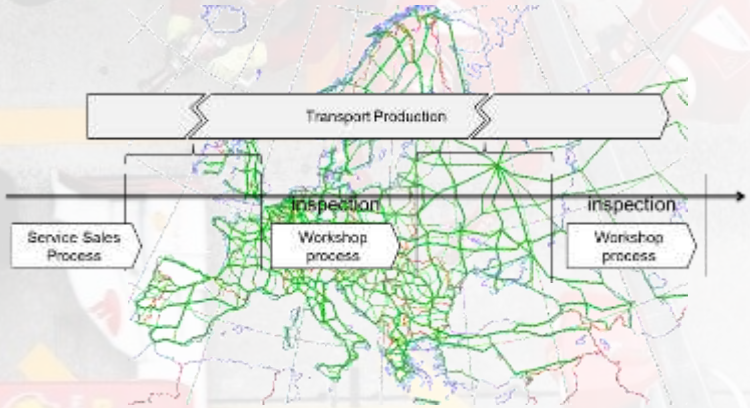
100% Uptime

Flexible service level

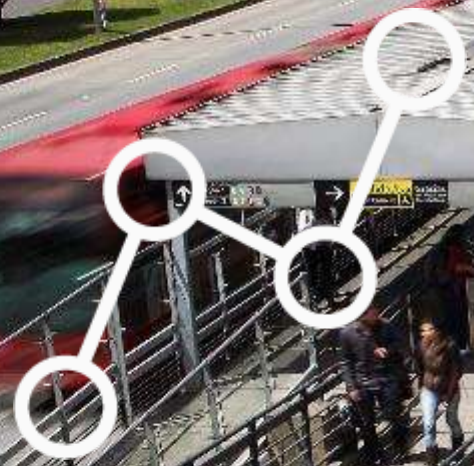
- ✓ Services on non-contracted hours
- ✓ Monthly reporting
- ✓ Automatic compensation

SCANIA FLEET CARE





BUS SYSTEMS BY SCANIA



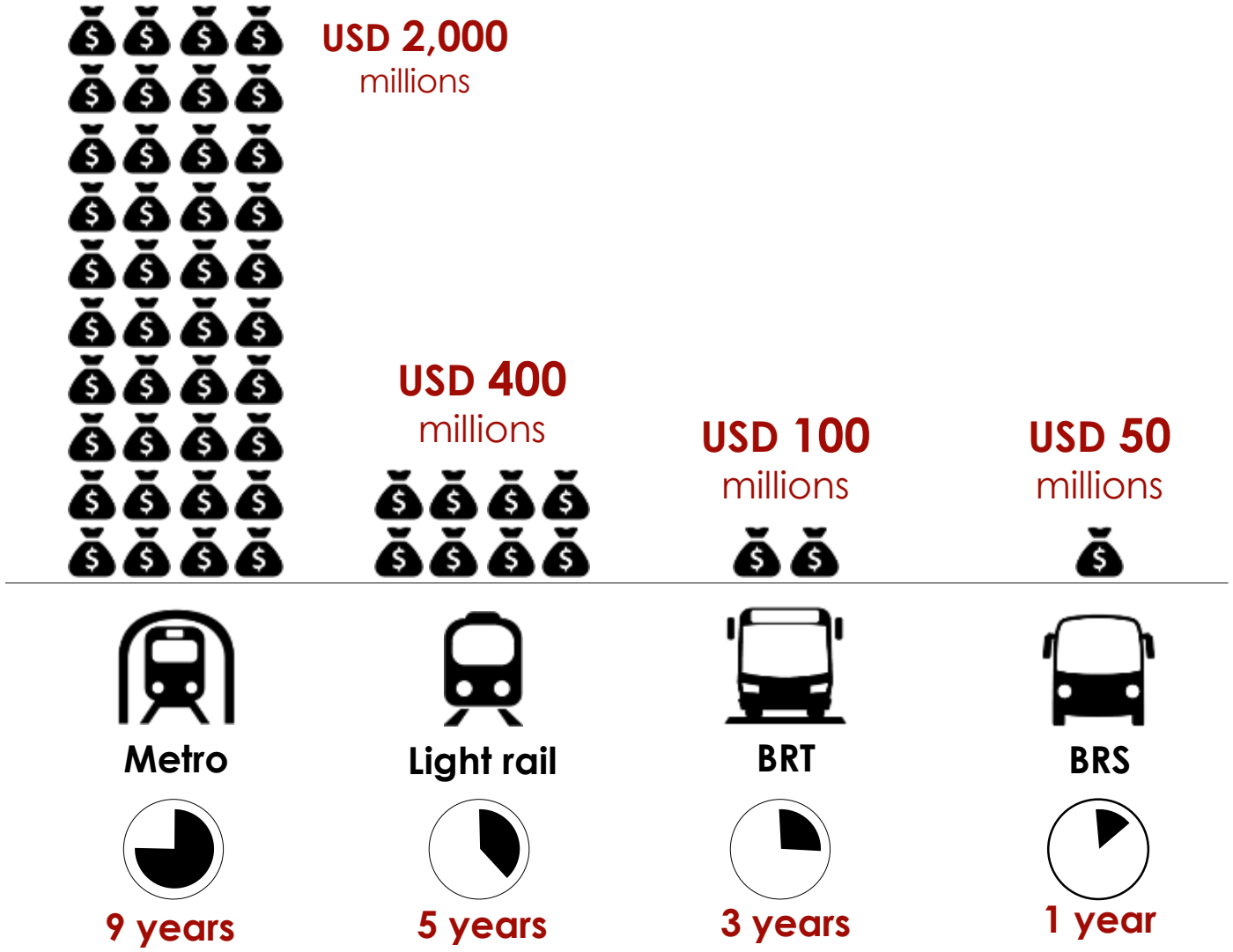
Smart and safe transport

SMARTER TRANSPORT – BUS RAPID TRANSIT/BRT

BUS SYSTEMS BY SCANIA

- DEDICATED BUS LANES
- HIGH FREQUENCY
- ATTRACTIVE AND EFFICIENT STATIONS
- BUS PRIORITY
- HIGH QUALITY CUSTOMER INFO
- MODAL INTEGRATION AT STATIONS
- FLEXIBLE TRAFFIC MANAGEMENT
- GREATLY IMPROVED ROAD SAFETY
- HIGH CAPACITY AT LOW COST - AND QUICK IMPLEMENTATION

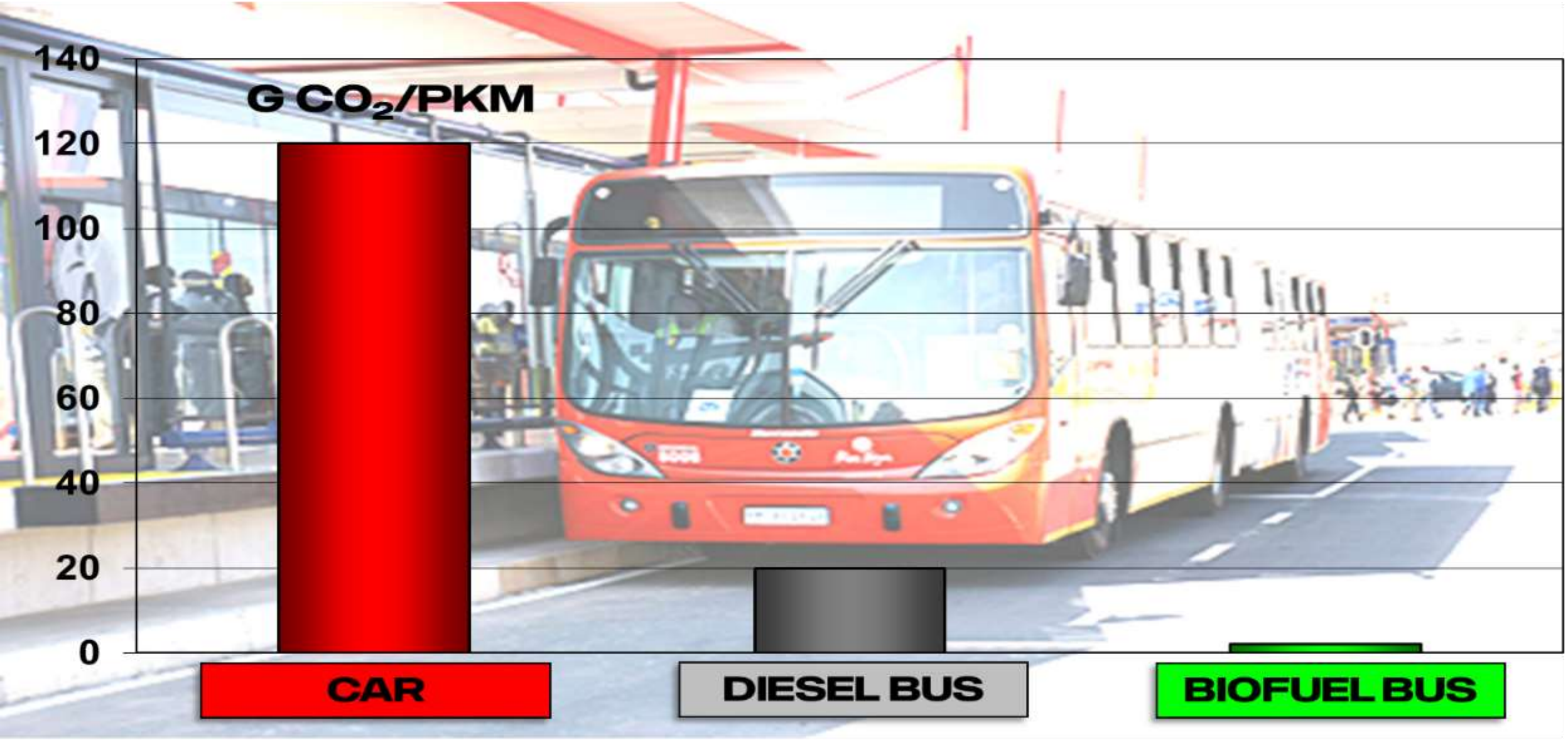
- BRT BOGOTA: 45 000 PASS/HOUR - $ 5 M/KM
- METRO MEXICO CITY : 39 000 PASS/HOUR - $ 41 M/KM



HOW MUCH DOES IT COST TO CONSTRUCT 10 KM OF PUBLIC TRANSPORT?

Source: Comparative evaluation of urban transport modals – NTU (2009)

BIOFUEL + BRT = SUSTAINABLE TRANSPORT



AGENDA

1. SCANIA BACKGROUND
2. SUSTAINABLE TRANSPORT SOLUTIONS HERE AND NOW
3. **SUSTAINABLE TRANSPORT SOLUTIONS WHAT ABOUT THE FUTURE?**
4. GOOD EXAMPLES FROM AROUND THE WORLD
5. DISCUSSION

WORLD'S FIRST ELECTRIC ROAD

Alternative fuels and electrification

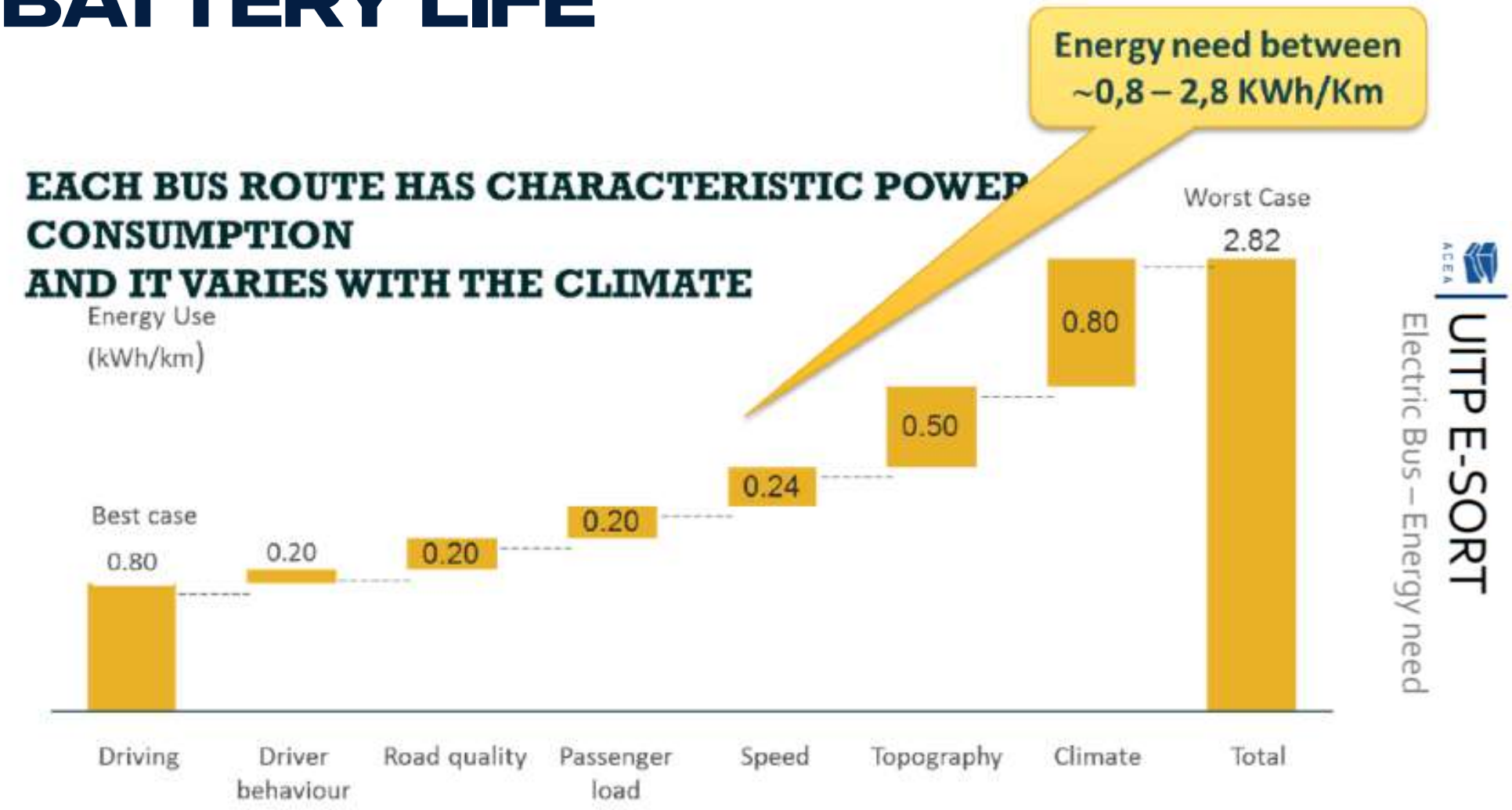
FIRST ELECTRIC ROAD

- First E-road in Gävle, Sweden, started in June 2016
- Scania G360, a field test vehicle with a range of 1,000km. It features a hybrid powertrain that's compliant with the Euro 6 emission standards, and has a pantograph that connects to the power lines above.
- The e-roads could support up to 10 trucks per kilometer
- More will be implemented over the next few years in different parts of Europe, including Germany.

INDUCTIVE CHARGING... OR PANTOGRAPH... OR PLUG-IN... OR BATTERY ELECTRIC... OR...?

Alternative fuels and electrification

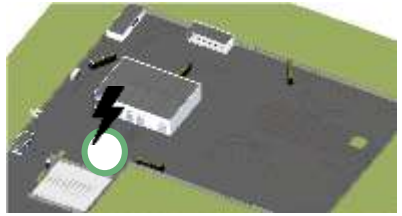
ENERGY CONSUMPTION AND BATTERY LIFE

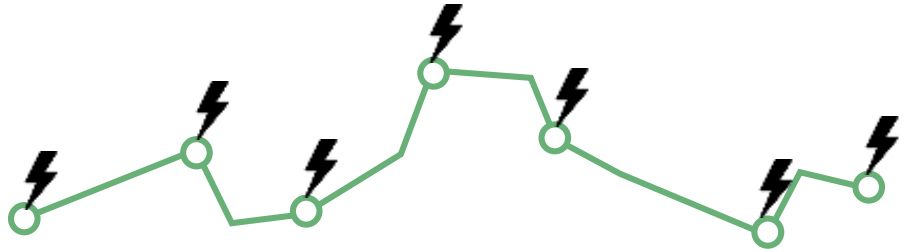


- The system design needs to handle different routes and climate.

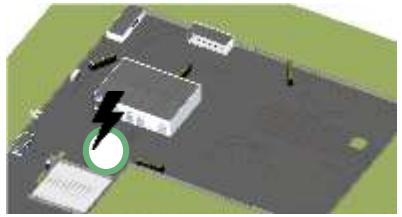
CHARGING ALTERNATIVES

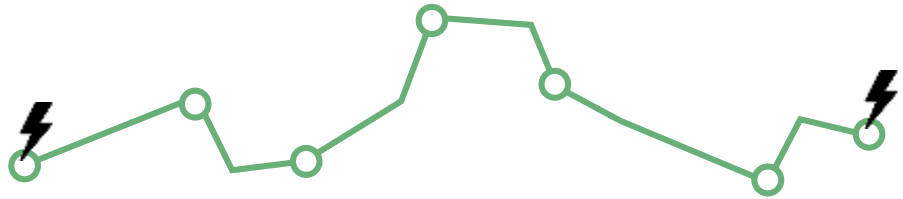
- Frequent charging (bus stops)



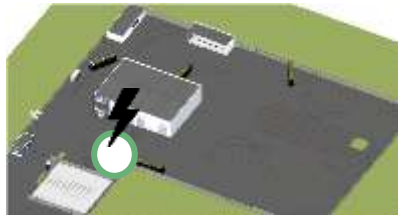


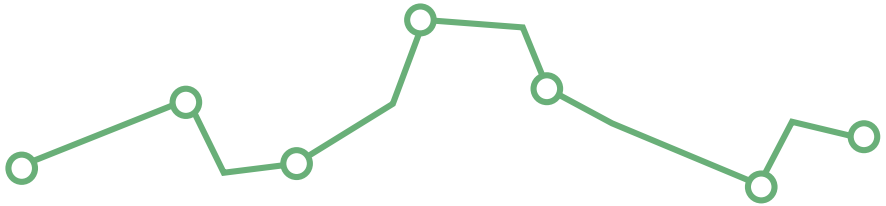
- Opportunity charging (Beginning/end)





- Overnight charging

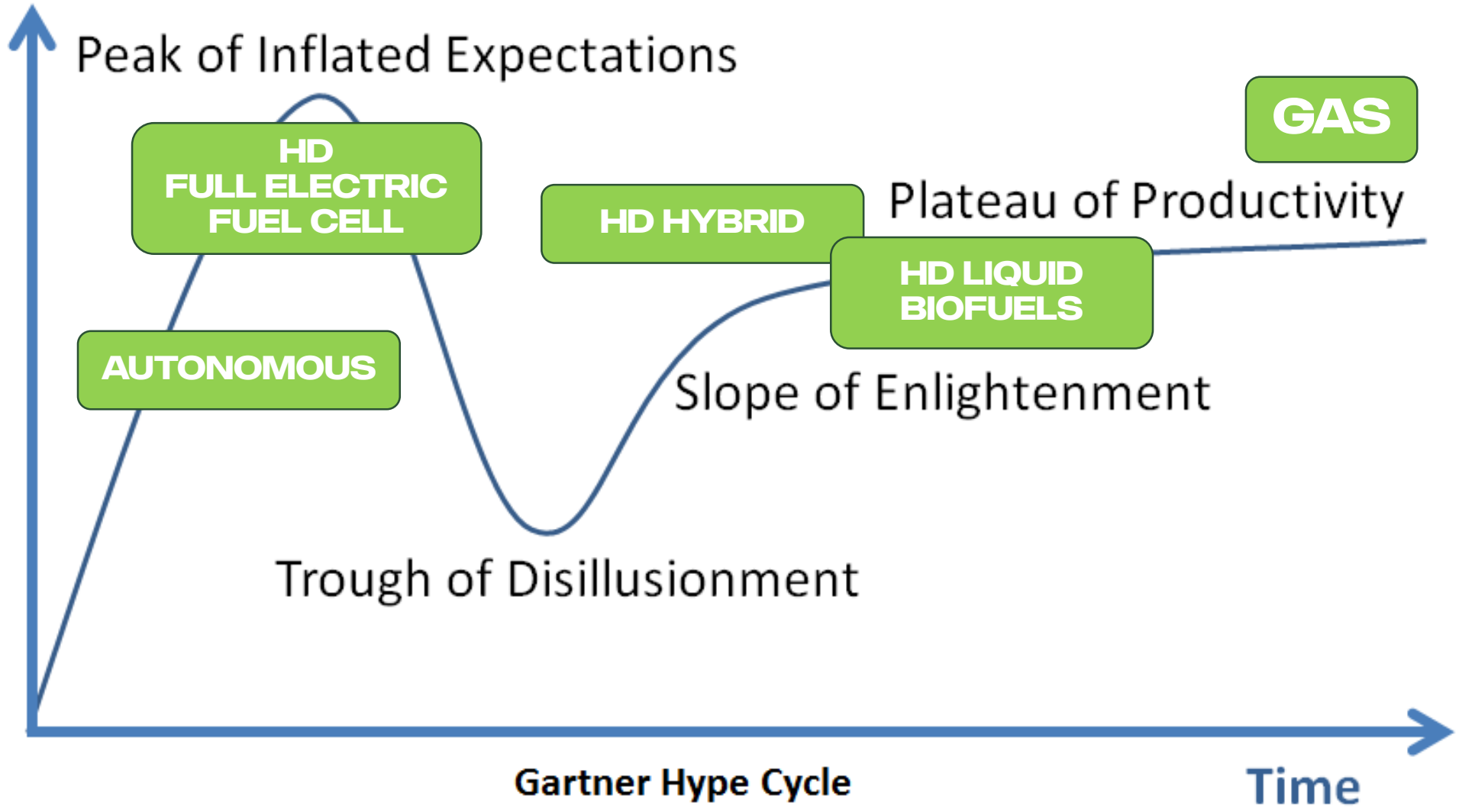




Charging point

NEED FOR STANDARDIZED ELECTRIC CHARGING SYSTEMS

2019?


Peak of Inflated Expectations
HD
FULL ELECTRIC
FUEL CELL
GAS
HD HYBRID
Plateau of Productivity
HD LIQUID
BIOFUELS
AUTONOMOUS
Slope of Enlightenment
Trough of Disillusionment
Gartner Hype Cycle
Time

THE SCANIA ELECTRIFICATION JOURNEY

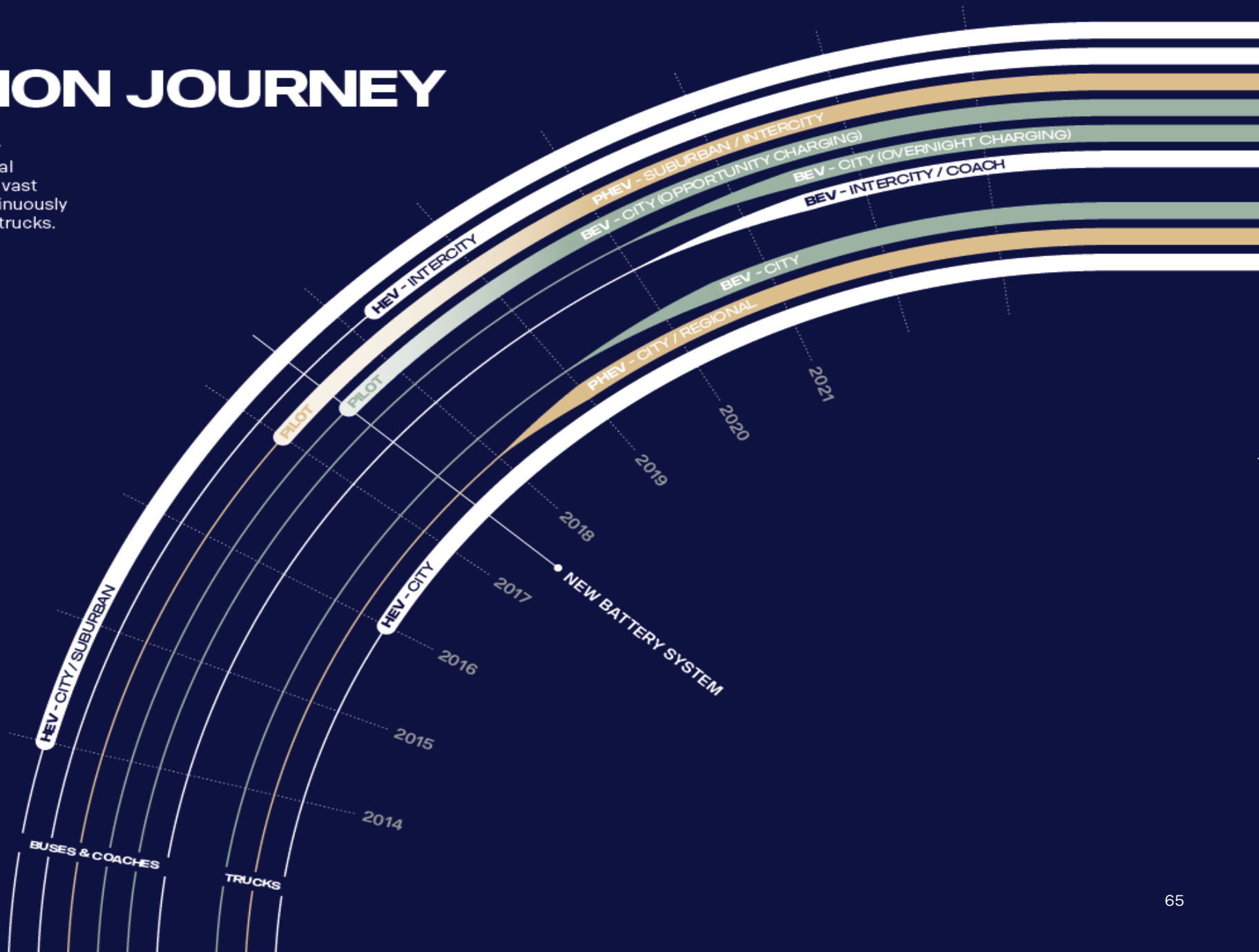
Minimised environmental footprint is at the heart of our operations, and we are determined to become the global leader in sustainable transport solutions. Based on our vast experience and comprehensive field tests, we are continuously expanding our offer of electrically operated buses and trucks.

ELECTRICALLY OPERATED VEHICLES

BEV
Battery Electric Vehicles use chemical energy in rechargeable batteries to power electric motors. Charging possibilities are conductive via pantograph or cable, or wireless via inductive charging.

PHEV
Plug-in Hybrid Electric Vehicles use rechargeable batteries in combination with an internal combustion engine, preferably running on alternative fuels. PHEV has the same charging opportunities as BEV.

HEV
Hybrid Electric Vehicles are powered by combining a conventional internal combustion engine, preferably running on alternative fuels, with an electric propulsion system. During braking, the vehicle's kinetic energy is converted into electric energy to charge the battery. HEV is not dependent on any charging infrastructure.



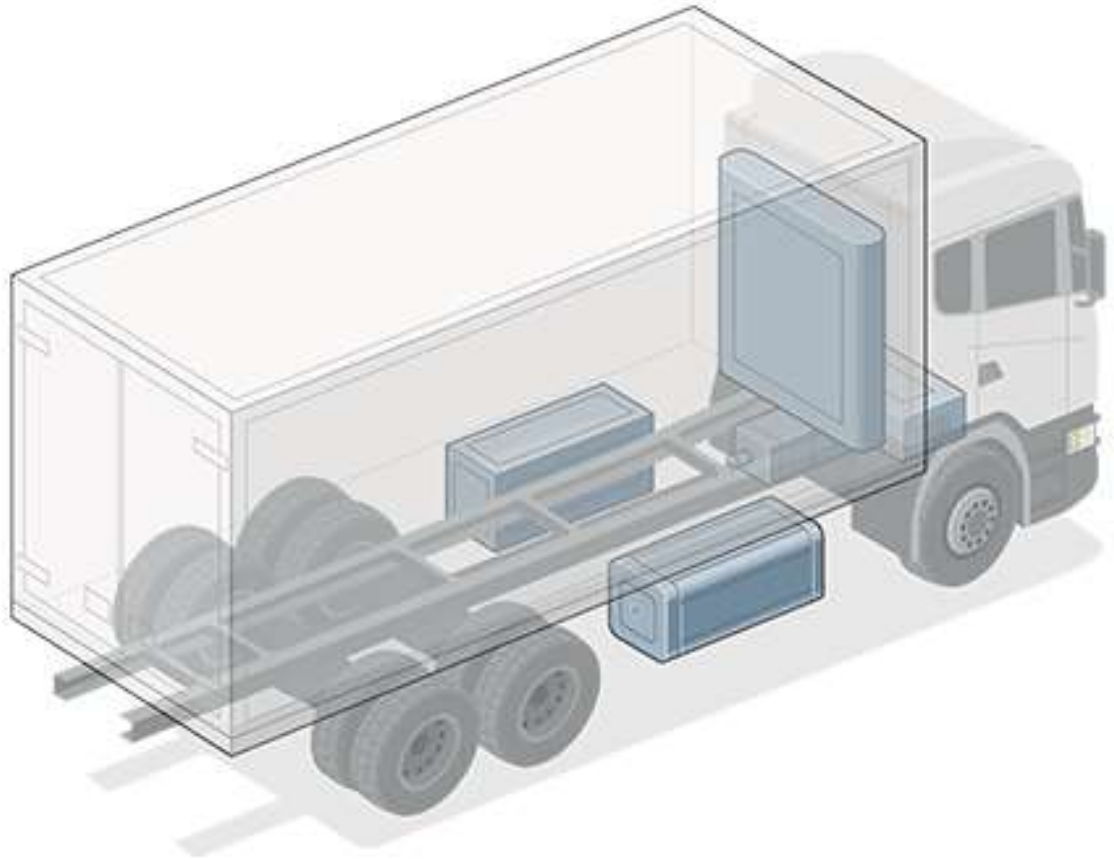
HYDROGEN FUEL CELL TEST

Ṣolar-cell produced hydrogen

Together with Asko, Norway’s largest convenience goods wholesaler, Scania will start testing trucks with an electric powertrain in which the electrical energy is converted from hydrogen gas in fuel cells on board the vehicles.

The hydrogen gas will be produced locally, using solar cells.

The three-axle 27 tonne trucks will run in distribution service with distances of almost 500 km.



FIRST FULL SCALE AUTONOMOUS TRUCK PLATOON

https://www.youtube.com/watch?v=XJgYyWn1svM

https://www.youtube.com/watch?v=C8SH-U5_p5Q

- Container transport between port terminals in Singapore
- Convoys of four trucks (three autonomous)
- Autonomous docking and undocking of cargo
- MoT, Port of Singapore, Scania and Toyota. ”Living lab”.
- Road Safety, fuel savings (3-7%), driver shortage.
- Scania lead in EU project Companion
- Scania and Ericsson co-op

SWEDEN4PLATOONING

- The aim is to explore the full potential of a technology that could reduce carbon emissions and make goods transport more efficient.
- Improve traffic flows on highways and to decrease the environmental impact of transport.
- The technology will only reach markets broadly if vehicles from more than one brand can find each other
- Improved fuel economy and increased transport efficiency.
    - reduction in drag. Drag accounts for 25% of a truck's fuel consumption, Early tests show that fuel savings potential at a one-second gap driving at 80km/h amounts to 3-7%, depending on where the vehicle is in the platoon
    - using wireless technology, the trucks in a platoon can drive with just a one-second gap between each vehicle
    - the trucks automatically match each other's speed and braking. This can reduce the reaction time for braking to zero."
    - improved traffic flows and the utilization of transport infrastructure.

Scania work with DB Schenker, Volvo, the Royal Institute of Technology, RISE (Research Institutes of Sweden) and the Swedish Transport Administration in multi-brand platoons on public roads.

AUTONOMOUS VEHICLES

Smart and safe transport

THE AUTOMATIC SOLUTION

GPS
The GPS gives the vehicle's position down to a few metres and allows the vehicle to plan its route. The manoeuvring required to follow the route is supported by the sensors and data fusion.

AUTOMATION CONTROL UNIT
Houses the vehicle's on-board intelligence and executes all automation and assistance functions. Collects data from the vehicle's numerous sensors and combines it to give a comprehensive view of the surrounding area. The control unit also receives transport missions from the off-board logistics system and translates them into instructions that the vehicle systems can understand.

MOBILE DATA LINK
The mobile data link is the vehicle's communication channel for receiving transport missions, reporting its status and performance, and sharing perception data with other autonomous vehicles.

POWERTRAIN SYSTEM
Scania's intelligent powertrain handles the truck's propulsion with the highest precision and energy efficiency. The central powertrain control system controls the engine, gearbox, clutch and auxiliary brakes.

SHORT RANGE RADAR
Mounted at each corner of the vehicle, the short-range radars provide 360-degree detection of other vehicles and pedestrians. They function in all weathers and light conditions.

INERTIAL SENSORS
The inertial sensors measure the rotation and acceleration of the vehicle to help the automation control unit calculate how it is moving.

WHEEL SPEED SENSORS
By measuring the rotation of each wheel, the automation control unit can calculate how the vehicle moves and turns.

LONG RANGE RADAR
With its range of up to 200 metres in front of the vehicle, the long-range radar enables high speed driving.

ELECTRONICALLY ASSISTED STEERING
EAS is an electrohydraulic system that enables the automation and assistance functions to safely steer the vehicle along roads and around obstacles.

MULTI-LENS CAMERA
Mounted behind the windscreen, the multi-lens camera monitors the area in front of the vehicle to detect objects, vehicles, pedestrians and lane markings. With stereoscopic vision, it can see the shape of the ground in much the same way a human can.

Sustainability is the key challenge facing global transport. We need to find new, more efficient and environmentally viable ways to move goods and people. Scania embraces this challenge.

Welcome to **Autonomous Transport Systems**
Scania's latest contribution to the future of sustainable transport.

SCANIA

AUTONOMOUS TRUCKS AND BUSES

Scania’s self-driving vehicles – how they work

Automation control unit

Houses the vehicle’s on-board intelligence and executes all automation and assistance functions. Collects data from the vehicle’s numerous sensors and combines it to give a comprehensive view of the surrounding area. The control unit also receives transport missions from the off-board logistics system and translates them into instructions that the vehicle systems can understand.

Powertrain system

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AUTONOMOUS TRUCKS AND BUSES

Multi-lens camera

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AUTONOMOUS TRUCKS AND BUSES

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Wheel speed sensors

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GPS

The GPS gives the vehicle’s position down to a few metres and allows the vehicle to plan its route. The manoeuvring required to follow the route is supported by the sensors and data fusion.

AUTONOMOUS TRUCKS AND BUSES

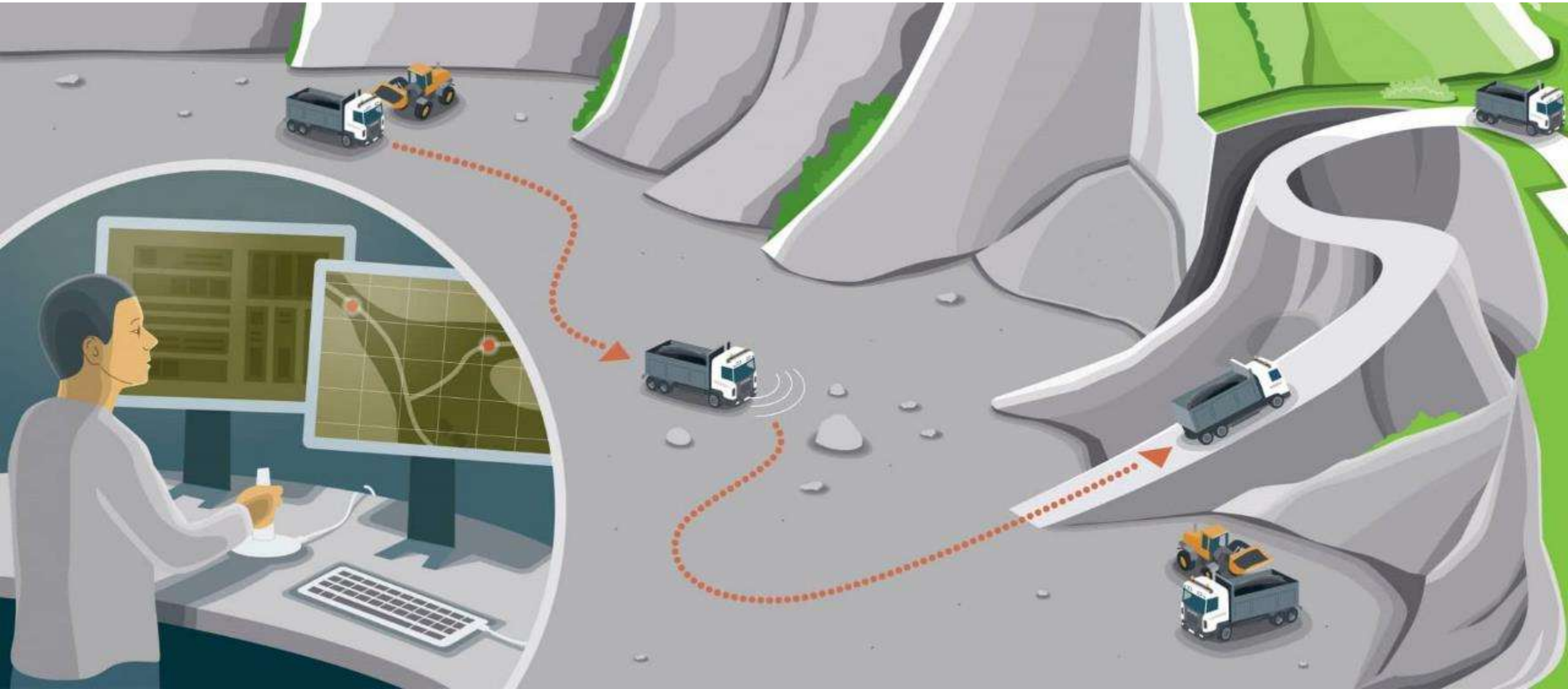
Mobile data link

The mobile data link is the vehicle’s communication channel for receiving transport missions, reporting its status and performance, and sharing perception data with other autonomous vehicles. New developments in LTE and 5G standardization have created opportunities for dedicated vehicle-to-vehicle communications using the mobile network while minimizing risks of unpredictability and latency.

TEST WITH SELF-DRIVING MINE TRUCKS, TRUCKS AND BUSES

- First tests successful
- Closed-off environments
- Mines, harbours, airports, etc
- Remote control development (Ericsson co-op)

TEST WITH SELF-DRIVING MINE TRUCKS



TEST - SELF-DRIVING MINE TRUCKS

MISSION POSSIBLE

AUTONOMOUS TRANSPORT SYSTEMS with people at their core, will provide the sustainable mobility of the future. With this system we can do the moving safely, efficiently and sustainably.

And this is not a pipe-dream 20 years away from being realised. This state-of-the-art system exists, it's already being tested. Scania is ready to roll it out for industrial applications in the near future. AUTONOMOUS TRANSPORT SYSTEMS will first see use in controlled environments like mines, terminals and container ports. As the technology evolves, highways and cities will follow. Scania will provide sustainable AUTONOMOUS TRANSPORT SYSTEMS to every transport segment where our customers and society can benefit.

When arriving at the designated unloading site, the autonomous vehicle accurately maneuvers into position and delivers its load. After unloading, the vehicle is again available for new missions.

An autonomous vehicle arrives at its destination – in this case, a loading site. The logistics system has already lined up an available loader, which duly loads the vehicle. When loading is complete, the system tasks the vehicle to make its way to the destination of this particular load.

An integral part of AUTONOMOUS TRANSPORT SYSTEMS is the control centre where the high level transport needs can be set, e.g. how much material needs to be transported and at what rate. The system interprets those needs and takes care of the details automatically, allocating missions to loaders and autonomous vehicles to efficiently coordinate the whole site.

The missions are sent to the autonomous vehicles via mobile data link. Their on board automation systems interpret the missions and set the vehicles on their way to their destinations.

The vehicles execute their missions, avoiding obstacles they detect with their sensors. In case they encounter a blockage that can't be circumnavigated they report it to the logistics system and ask for a mission adjustment. Only if the logistics system fails to solve the issue automatically, will an operator in the command centre be asked for guidance. Normal operation of the truck is completely automatic, without the need for any operator actions.

WHY AUTONOMOUS?

- Drivers
- Fuel & AdBlue
- Capex
- R&M
- Tyres
- Administration OH cost
- Daily cleaning
- Accidents & vandalism
- Dead head
- Penalties

WHY AUTONOMOUS?

Control rooms

Savings of over 40% possible

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3. SUSTAINABLE TRANSPORT SOLUTIONS WHAT ABOUT THE FUTURE?
4. **GOOD EXAMPLES FROM AROUND THE WORLD**
5. DISCUSSION

BIOGAS/NATURAL GAS TRUCKS

Finland

- LBG, liquid biogas truck operation for waste management.
- Scania G 340 hp tractor
- Range of approx. 1,000km
- Sewage sludge transport from a water treatment plant to the Topinoja biogas plant,
- Turku has set the target of becoming fossil-free by 2040.

Spain

- 20 LNG trucks for Alimerca
- Low noise delivery
- https://www.youtube.com/watch?v=WD184GlhQuc

HYBRID TRUCKS

- **Scania P320 hybrid**
  - Euro 6 hybrid powertrain, 320 hp.
  - Can be driven on electric power alone for up to 10km (up to 2 km on 10 min charge). Enabling silent deliveries and ZE drive in low emission zones.
  - Diesel, FAME or HVO biofuels.
  - Up to 90% CO_2 reduction.
  - Up to 18% lower fuel use.
  - Aimed at the distribution sector.
- **Swedish coffee roaster Löfbergs recently put a hybrid electric truck into operation.**

GAS AND HYBRID TRUCKS - HAVI

- 5 year roadmap to reduce CO_2 in McDonald's Supply Chain
- Goal – shift 70% of fleet into low-carbon alternatives.
- Real time monitoring
- Europe first, then Asia.
- Gas and hybrid-biofuel trucks.

ETHANOL ED95 TRUCKS

- **Finnish Post in good spirits**
  - Nearly carbon-free bioethanol from domestic waste and residue, such as food waste and animal by-products. (ST1)
- **Arla – green milk**
  - 17 trucks and World's best ethanol, reducing over 90% CO_2. Extra cost is 0,002 Euro/litre of milk.
- **ASKO – largest ethanol fleet**
  - **x trucks**
  - Test of 400 hp+ engine
- **France – ethanol from wine waste**
  - Marseille - Grape waste ethanol

EURO 6 GAS BUSES FOR ALL APPLICATIONS

CITY, SUBURBAN, INTERCITY & BRT

CLEAN AND LOW CARBON AROUND THE WORLD.

IT'S NOT DIFFICULT

Many cities around the world are showing leadership by long-term and strategic implementation of proven solutions for clean and low carbon public transport. By using cost effective Euro 6 engines and alternative fuels solutions, these cities dramatically reduce particulates, NO_x and CO_2 emissions – even in places where emission regulations are not yet in place.

We feel truly privileged and inspired to be part of their ongoing efforts.

Reading, United Kingdom – Fewer breakdowns and lower fuel costs
Showing a 7-15% year over year growth on routes running buses powered by biogas produced from local sewage, organic waste and manure, while also achieving 30% fuel cost savings.

Stockholm, Sweden – no fossil fuels!
A fully fossil free bus fleet and an increasing number of waste and distribution trucks running on clean Euro 6 bioethanol, biogas, biodiesel and biofuel hybrids.

Kalmar region, Sweden – Expanding a cleaner future further
Both city and regional buses operate clean Euro 6, reliable and modern buses, powered by biogas produced from local sewage, organic waste and manure.

Madrid, Spain – a champion in the pollution battle
Actively deploying clean Euro 6 gas buses – to contribute towards the Paris climate targets at the same time as providing substantially cleaner city air.

Cartagena, Colombia – a new, clean benchmark for Colombia
The first city in Colombia with a Bus Rapid Transit (BRT) system running on clean Euro 6 gas.

Virginia, South Africa – going clean without complex after-treatment
Gas buses allows the operation of clean Euro 6 technology without the hassle of complex after-treatment.

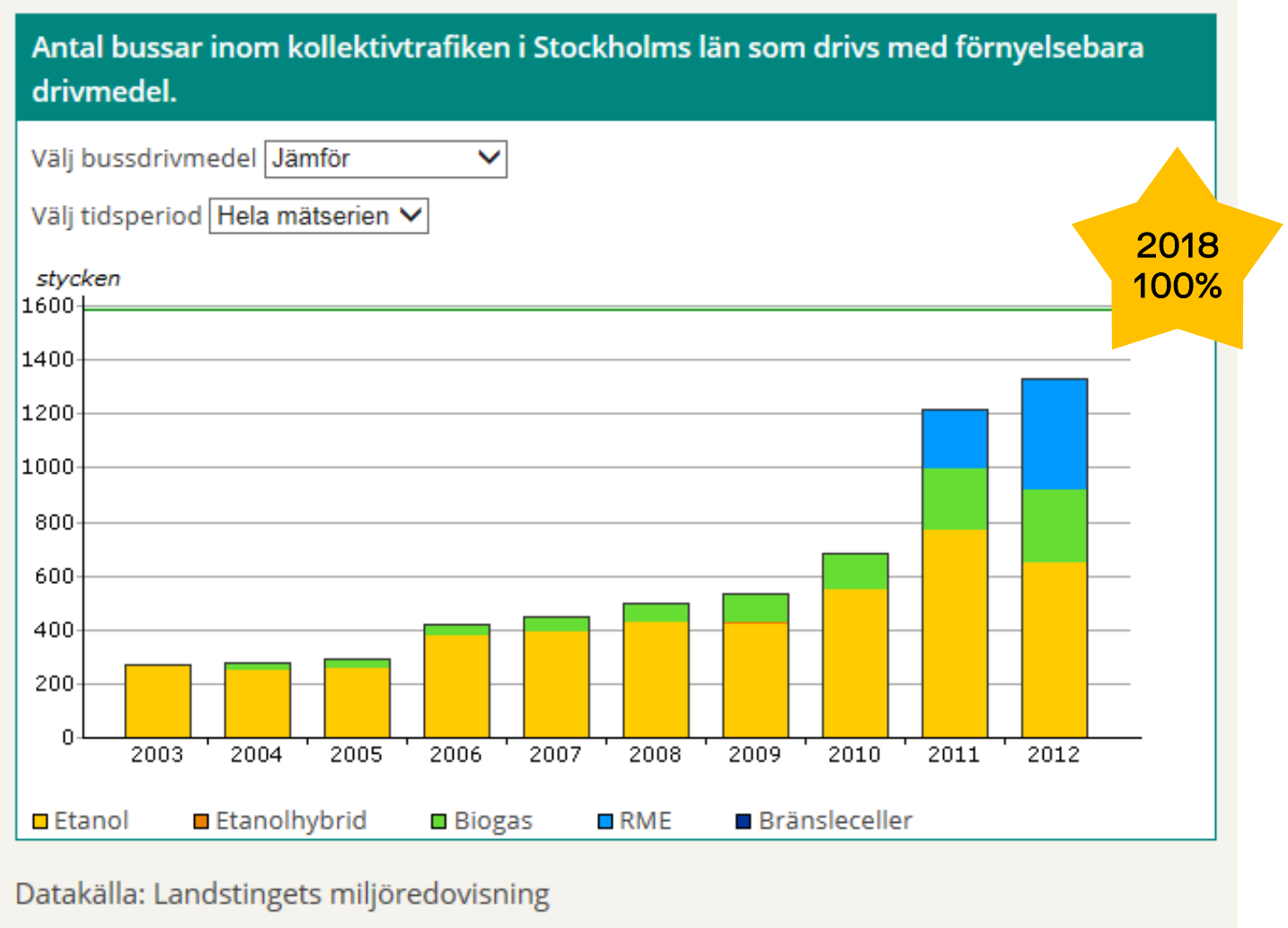
Nagpur, India – getting out of oil dependency
A large facility for Scania clean bioethanol and biogas buses powered by waste has been a crucial first step to help reduce India's environmental problems and costly dependence on imported oil and natural gas.

Jakarta, Indonesia – attractive and clean public transport
The introduction of clean and comfortable Euro 6 gas buses on the No. 1 bus system corridor has started a much needed transition towards cleaner air in the city.

STOCKHOLM →
100% FOSSIL FREE CITY TRANSPORT

THE STOCKHOLM EXAMPLE
IT IS NOT DIFFICULT

- Stockholm introduced functional demands for fossil free buses in transport procurement 2001.
- Long term goals was a 50% fossil free bus fleet in 2010 and a 100% in 2020.
- Swift, straightforward and cost efficient transformation, cleaning up the city and dramatically reducing GHG emissions.
- Biogas, biodiesel, HVO, ethanol and biodiesel hybrids – 2 300 buses.
- World's largest biogas bus fleet (~350 buses). Cost/km equal to diesel



BIOGAS IN THE UK

TRUE COMMERCIAL SUSTAINABILITY

"The gas fleet are less than 70% of the direct cost of running a diesel bus, or 80% including the infrastructure required. They're also much more reliable, which would be worth paying a premium!"

Reading Buses

THE LOWCVP LOW CARBON CHAMPIONS AWARDS 2016 WINNER

1

THE LOWCVP LOW CARBON CHAMPIONS AWARDS 2016 WINNER

LOCAL FUEL BY LOCAL PEOPLE

BIOGAS FROM ~1000 CITIZENS POWERS A BUS FOR A YEAR

http://www.bbc.com/news/uk-england-bristol-30115137

MADRID – A MAJOR GAS OPERATOR

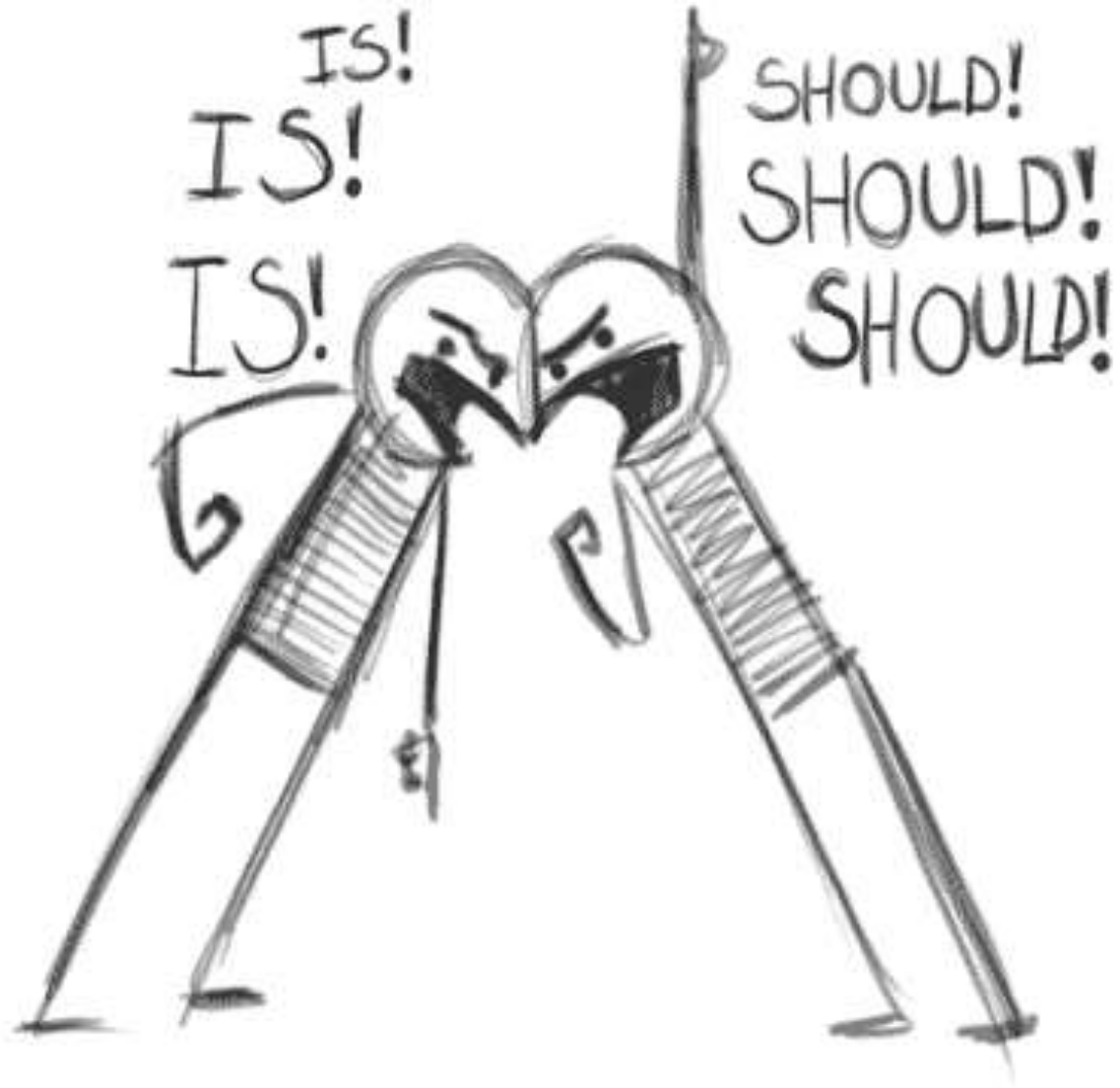
MADRID MOVES TO REPLACE ALL DIESEL BUSES

- 2017: 160 Scania new gas city buses for EMT Madrid
- This order is in addition to the 46 Scania gas buses ordered 2016.
- The City of Madrid has initiated an ambitious programme to improve air quality and reduce carbon emissions with the stated goal to ban diesel by 2025.

SUSTAINABLE TRANSPORT IS NOT DIFFICULT

IT IS HERE AND NOW!

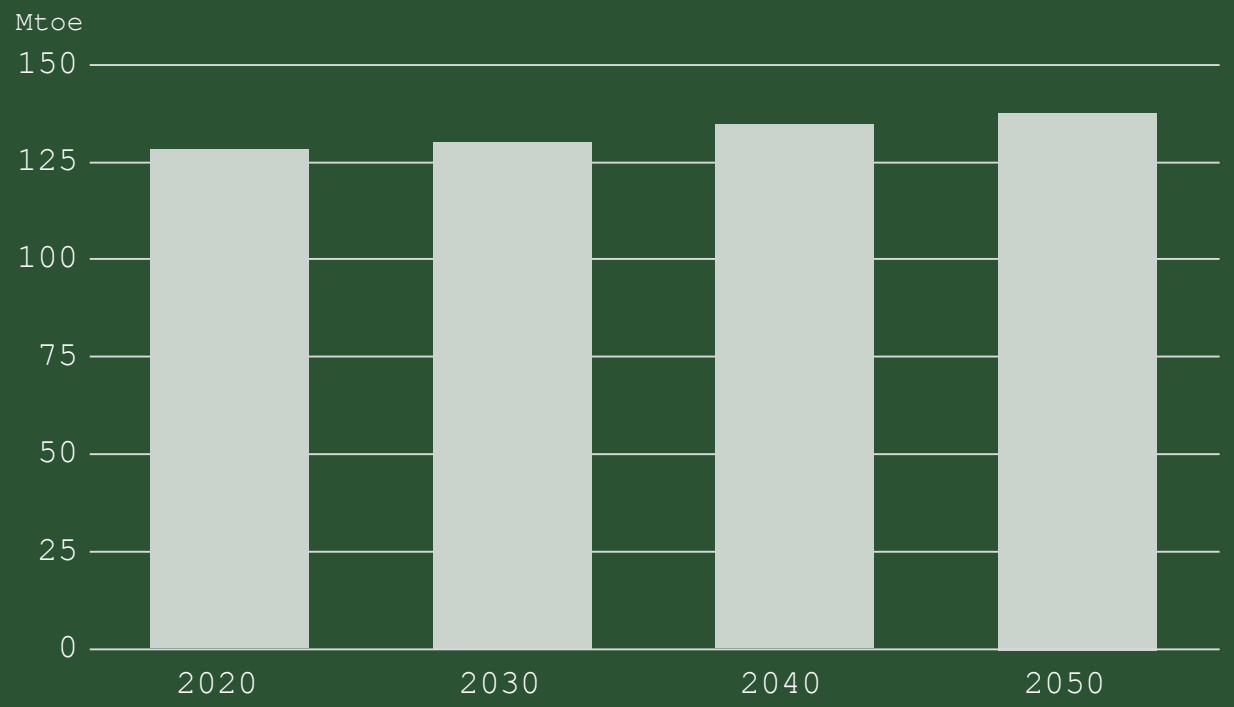
DISCUSSION




SCANIA

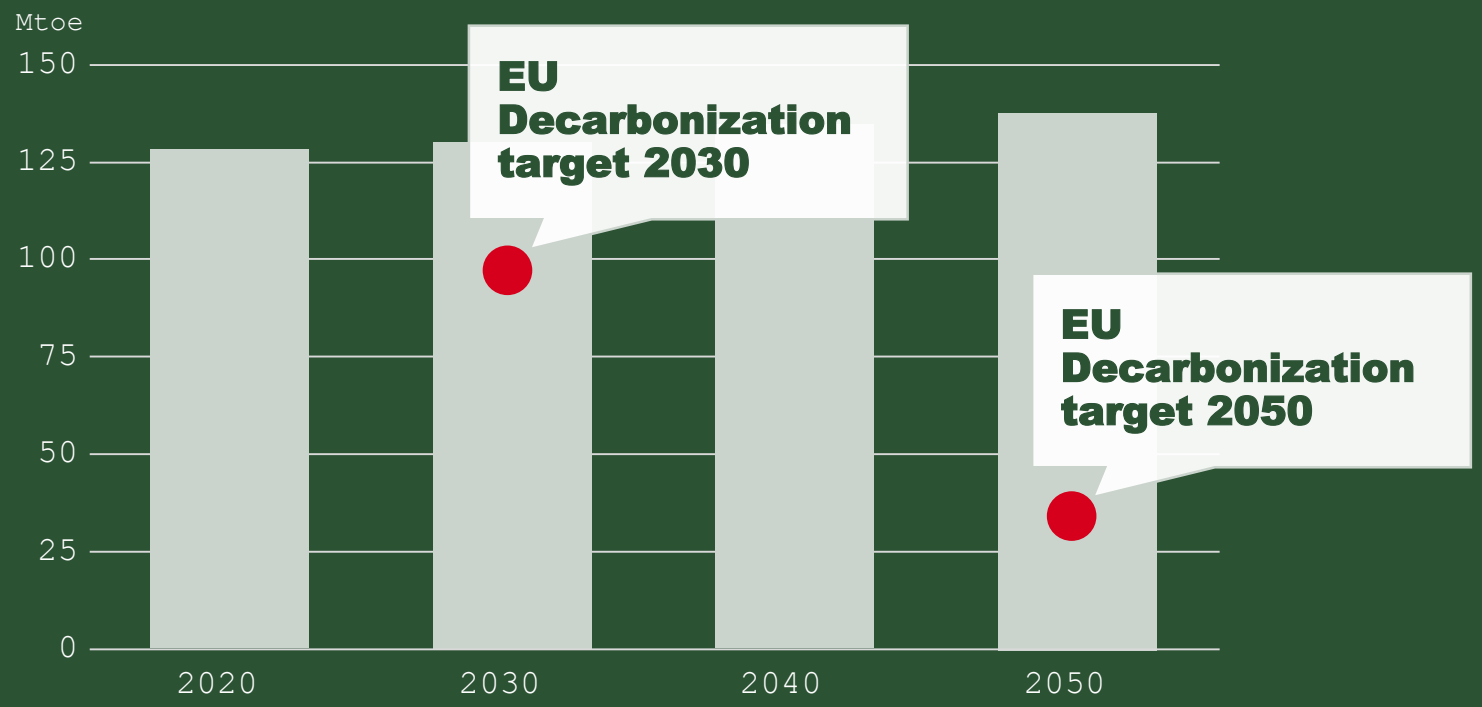
EXTRA MATERIAL

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU

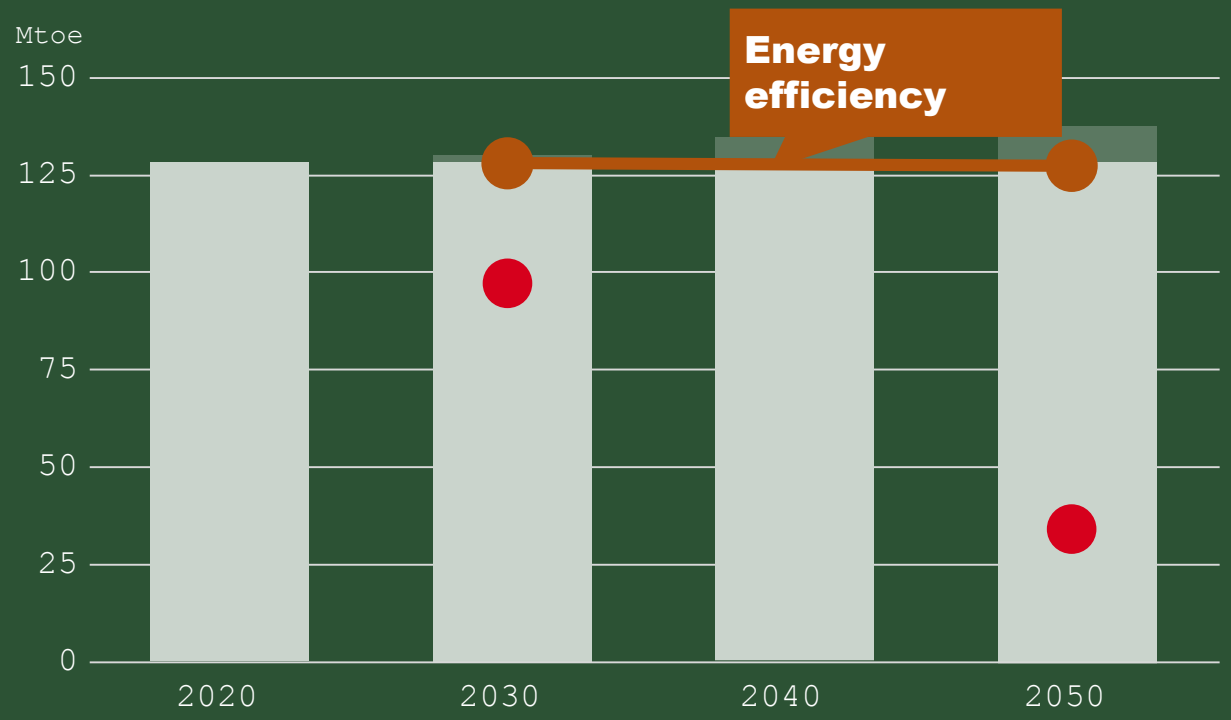


The projection assumes 20% energy efficiency improvment by 2050 in comparison to today's level

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU

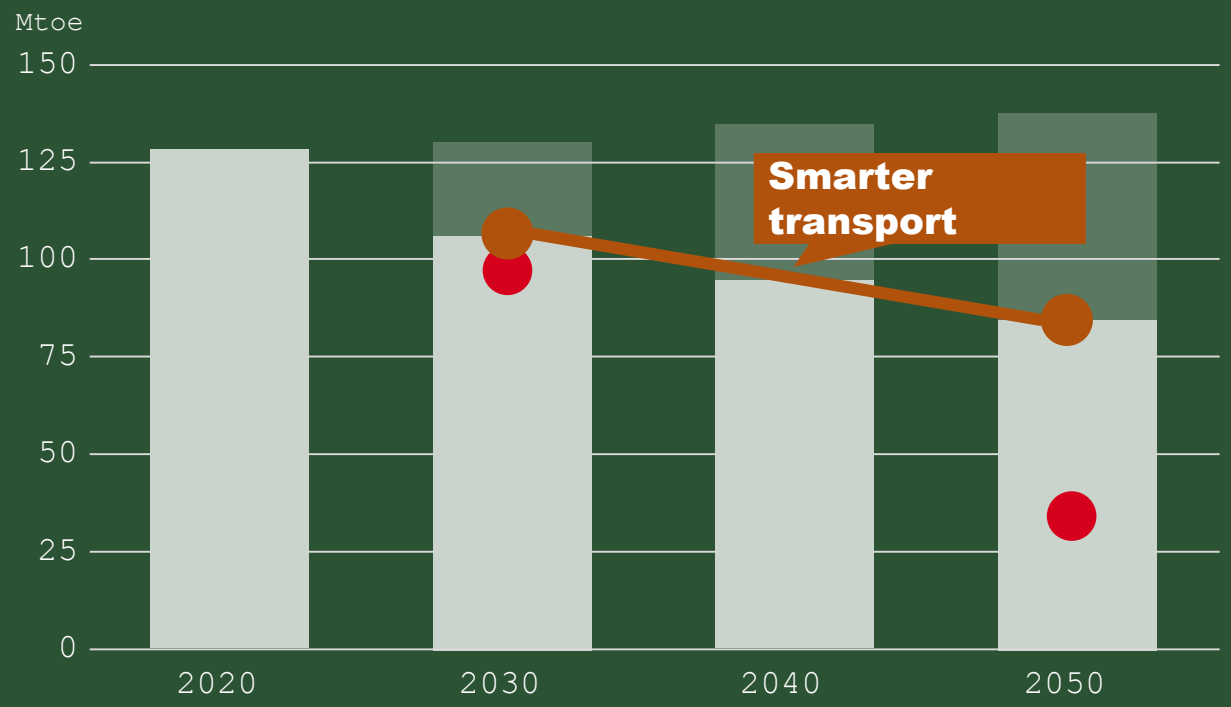


ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



Energy efficiency

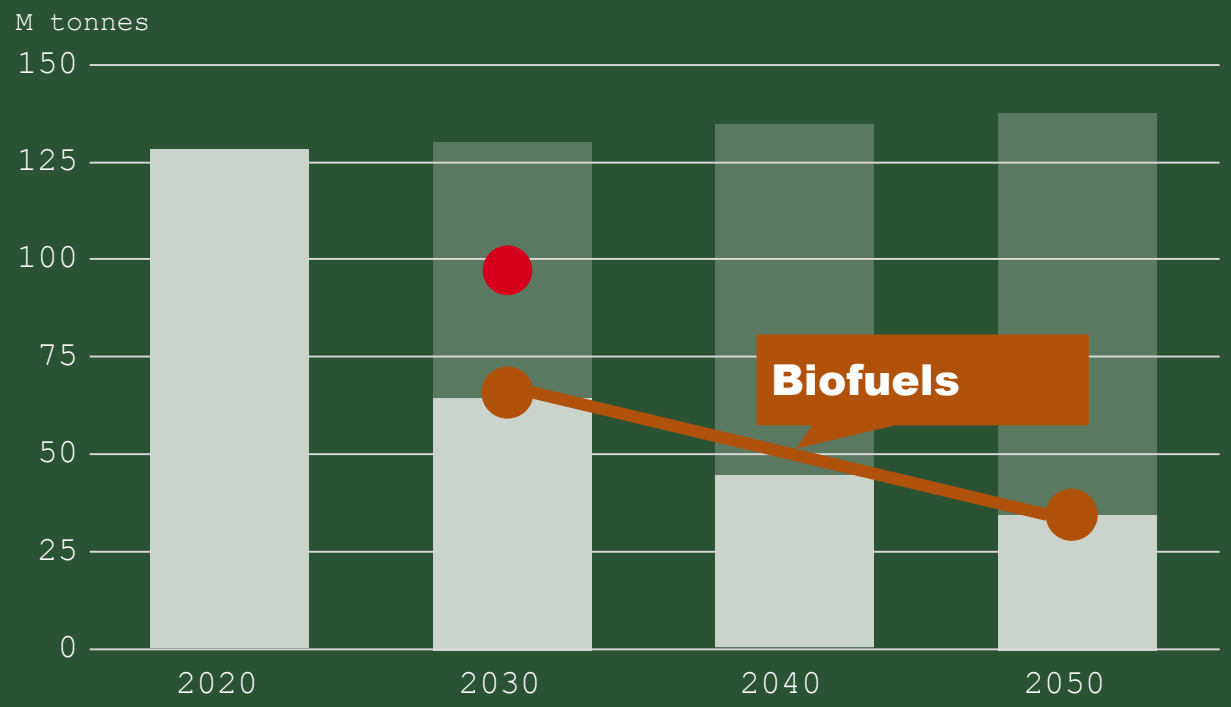
ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



Energy efficiency

Smarter transport

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU

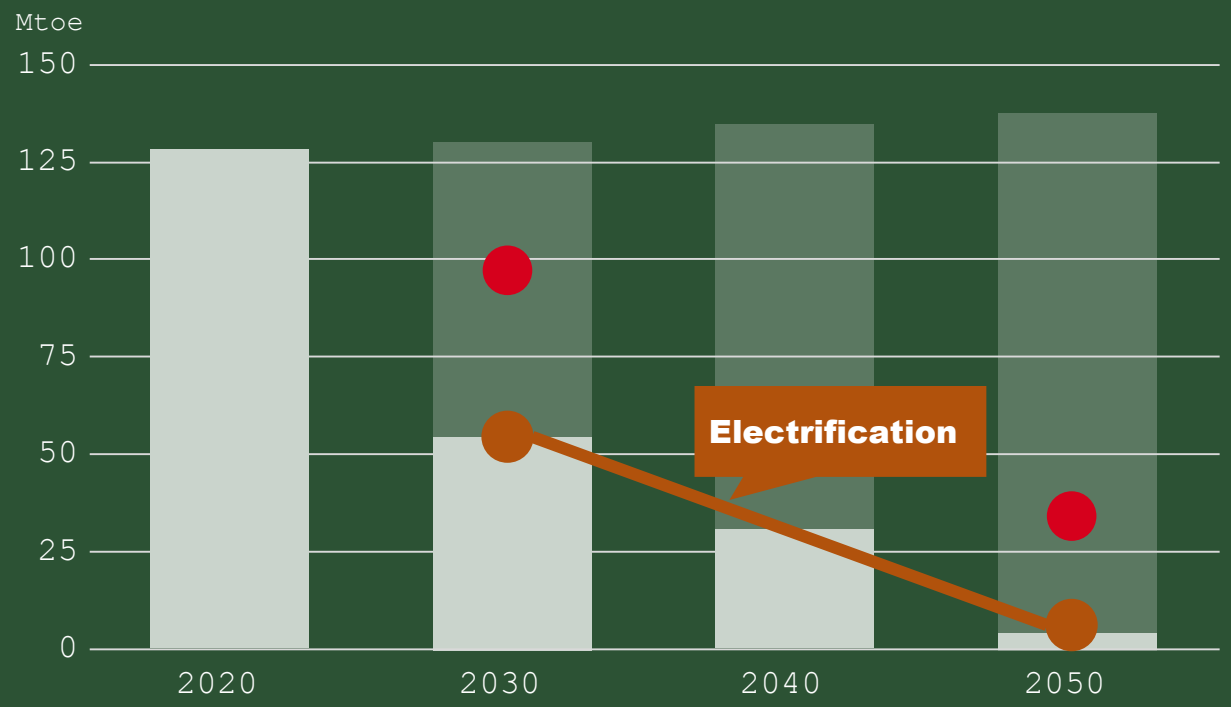


Energy efficiency

Smarter transport

Biofuels

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



Energy efficiency

Smarter transport

Biofuels

Electrification

Trends

Global trends

- Urbanisation
- Sustainability
- Digitalisation

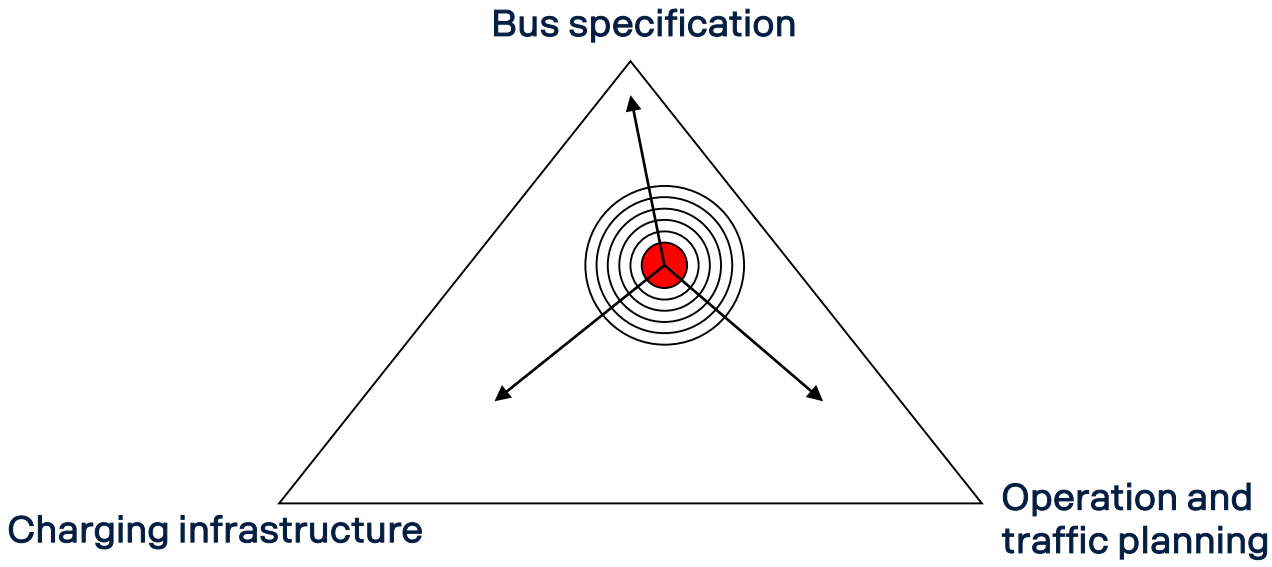
Industry trends

- Connected
- Electrified
- Autonomous

BATTERY BUS SYSTEMS
- NOT ONE SOLUTION THAT FITS ALL

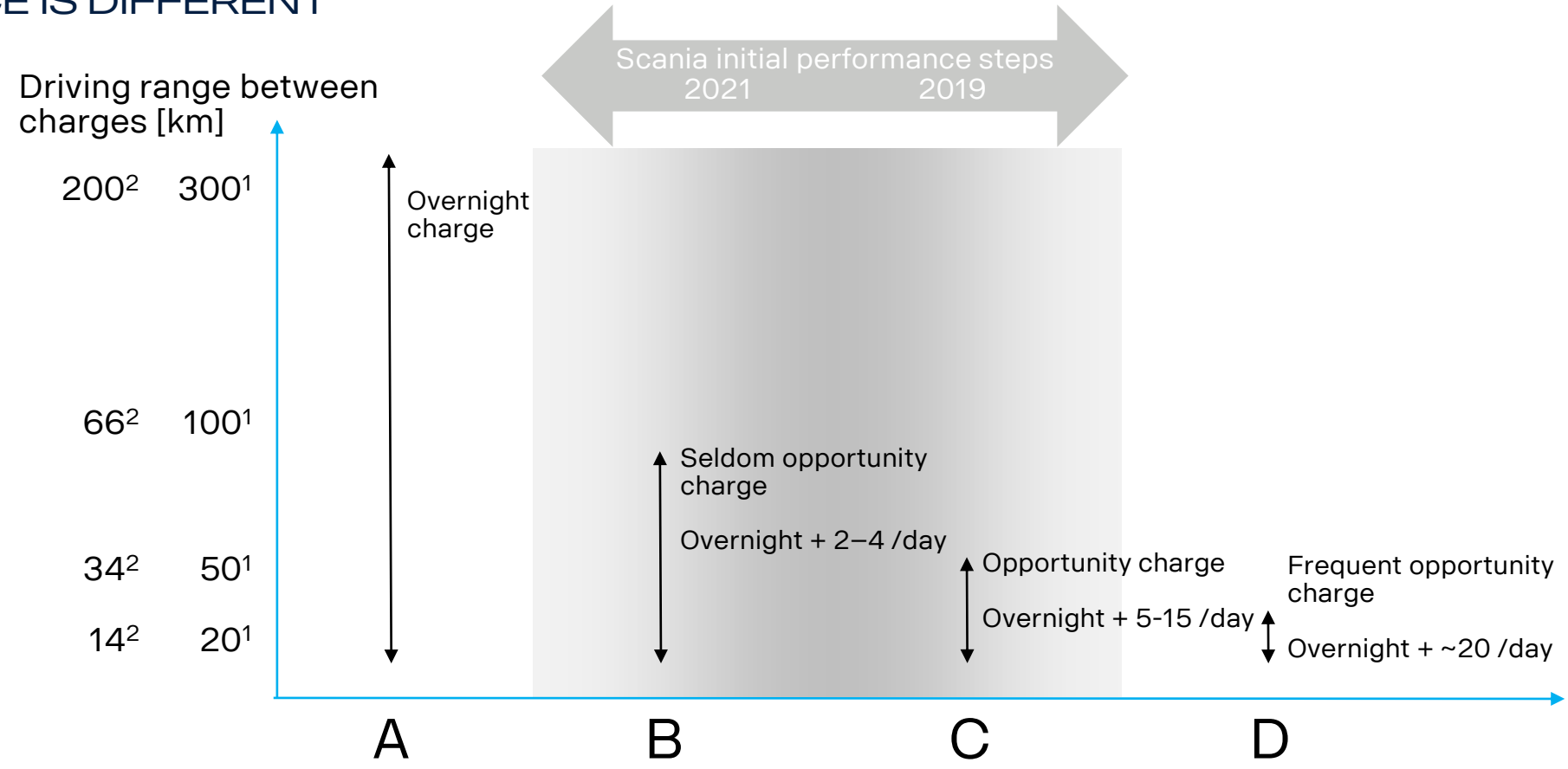
The whole system needs to be optimised regarding:

- vehicle cost
- uptime and quality,
- performance,
- lifetime,
- weight/passenger capacity,
- range,
- bus fleet size,
- infrastructure cost
- operational aspects



FOUR TYPES OF BATTERY BUSES

ALL THESE TYPES MAY RUN IN THE SAME CITY, DEPENDING ON BUS LINE THE CHOICE IS DIFFERENT



[1]@ average consumption (1.5 kWh/km)

[2]@ peak consumption, with AC and other auxiliaries

BIOGAS OPERATIONS IN THE UK

Buses (205)

- Sunderland
- Durham
- Runcorn
- Plymouth
- Reading
- Nottingham
- Bristol

Trucks (20)

- Waitrose
- DHL
- Argos

GAS OPERATION IN SOUTH AFRICA

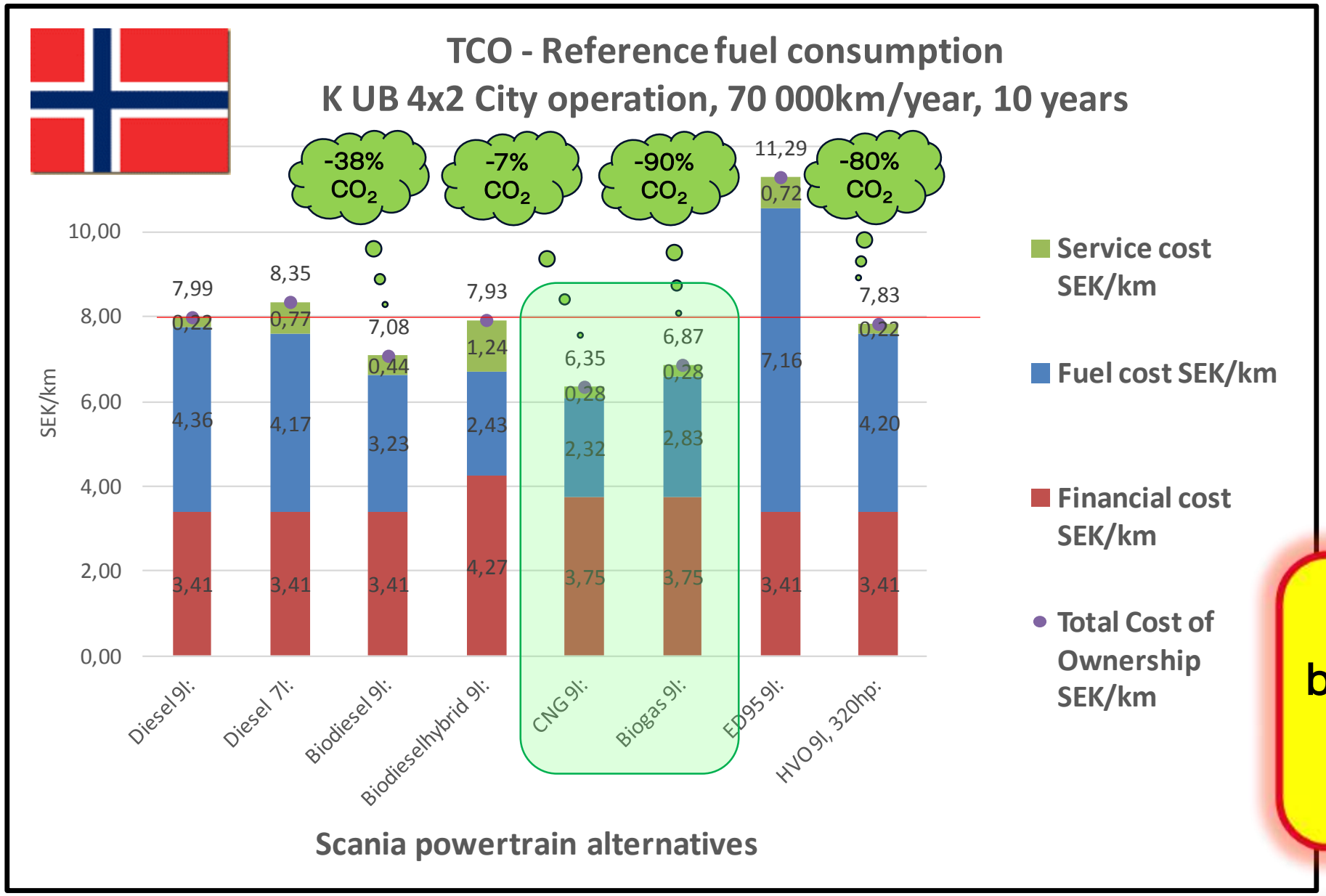
- First 10 Euro 6 gas buses in Africa. Free State, Virginia.
- Co-operation Scania, Unitrans/Megabus and Renergen.
- Complete solution with buses, fuelling infrastructure and fuel.
- Competetive fuel price and total TCO 10 – 25% below diesel.
- Service cost for Scania gas vehicles lower than for diesel operation.
- Cleaner than Euro 6 without AdBlue or other complicated after-treatment systems.

UNITRANS

RENERGEN

EURO 6 GAS BUSES IN NORWAY

RUNS MORE COST EFFICIENT THAN ANY OTHER OPTION



Gas and biogas give both the best cost and the best emission performance!

PARTNERING FOR CLEAN AND LOW CARBON PUBLIC TRANSPORT IN INDIA

Nagpur: Biogas buses - sewage
Test operation in Goa

BIOMETHANE FOR SUSTAINABLE URBAN MOBILITY IN BRAZIL

BIOMETHANE

PARANÁ
ITAIPU
CHICKEN MANURE

PTI
Parque Tecnológico
Itaipu

SCANIA

BIOMETHANE		DIESEL
1500	MILEAGE	1500
2,02 km/m³	AVERAGE CONSUMPTION	2,2 km/l
R$ 1,62	BIOMETHANE PRICE	R$ 2,45
743 m³	TOTAL CONSUMPTION	682 litros
R$ 1.203,66	TOTAL COST	R$ 1.670,90

EURO 6 GAS BUSES IN COLOMBIA

RUNS MORE COST EFFICIENT THAN DIESEL

ALTERNATIVE FUELS...

- ...clean up the air and saves lives.
- ...create local jobs and technology transfer...
- Replaces costly diesel and oil imports and creates independent local energy security...
- ...cuts CO_2 emissions with up to 90%...
- ...helps fight poverty and improves local agricultural economies...
- ...turn waste into clean local fuels!

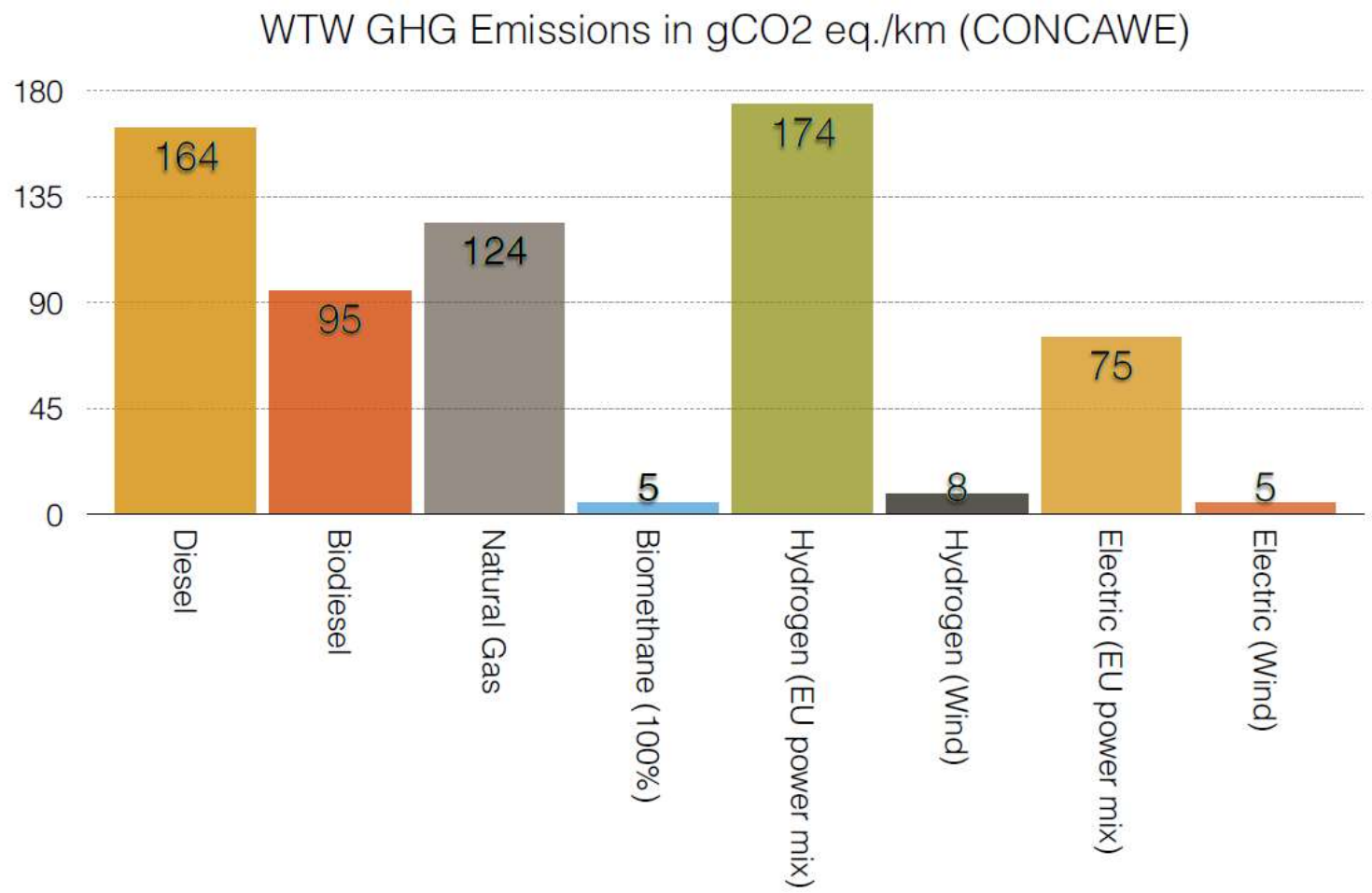
SCANIA AND PARTNERS COULD HELP WITH COMMERCIAL TURN-KEY SUSTAINABLE SOLUTIONS FOR CITY TRANSPORT

GHG PERFORMANCE - BIOGAS

- Biogas consistently shows good GHG saving values.
- One of few fuels that actively could recycle GHG
- The best biogas pathway (dairy waste/manure) could recycle almost 3x the corresponding diesel emissions. (See latest CARB data)

Biofuel production pathway		**Default GHG emission saving EU RED Directive Annex V**
Sugar beet ethanol		52%
Wheat ethanol, process not spec		16%
Wheat ethanol, NG as process fuel		47%
Wheat ethanol, straw as fuel		69%
Sugar cane ethanol		71%
RME from rape seed (Biodiesel)		38%
Waste oil FAME (Biodiesel)		83%
Biogas from organic waste		73%

GHG PERFORMANCE - BIOGAS



Big reductions possible – here and now!

from Annex V of the EU RED directive

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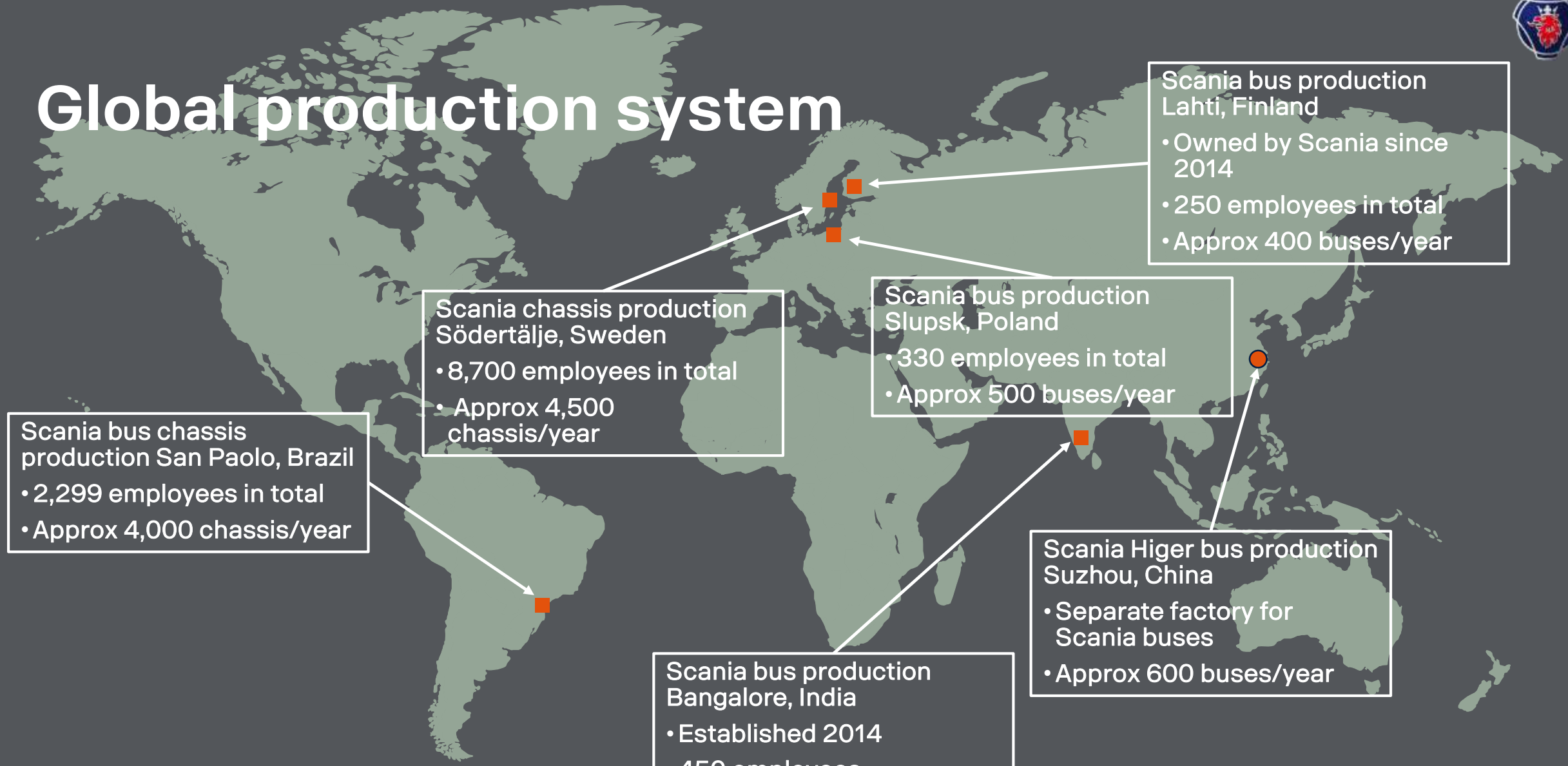
SCANIA

Global production system



Scania bus production
Lahti, Finland
- Owned by Scania since 2014
- 250 employees in total
- Approx 400 buses/year

Scania chassis production
Södertälje, Sweden
- 8,700 employees in total
- Approx 4,500 chassis/year

Scania bus production
Slupsk, Poland
- 330 employees in total
- Approx 500 buses/year

Scania bus chassis production San Paolo, Brazil
- 2,299 employees in total
- Approx 4,000 chassis/year

Scania bus production
Bangalore, India
- Established 2014
- 450 employees
- Capacity of 500 buses/day

Scania Higer bus production
Suzhou, China
- Separate factory for Scania buses
- Approx 600 buses/year

125 years of history

Company founded
1891

1897 First car

1900 Scania established in Malmö

1902
First truck

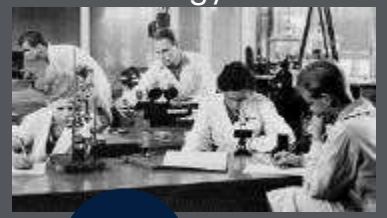

1905 First industrial engine

1911 First bus


1921 Bankruptcy

1930 Buses main product

1934 Last red figures

1940s
New Strategy


1950s
Export started


1957 Brazil
1964 Netherlands
1976 Argentina
1992 France
1993 Poland
1995 Mexico
Factory in

2000 Factory in St Petersburg

2007 Scania present in India

2009

2010 New R-series is “Truck of the year”

2011
Introduction of Euro 6 engines

100 years since the first bus delivery

2012
Launch Scania Citywide and Euro 6 engines


2015 Truck factory in India

2016
Bus factory in India
Launch Interlink


OUR BUSINESS MODEL

Customer profitability

+ Customer revenue

- Uptime
- Passenger capacity

– Customer cost*

- Tyres
- Drivers
- Fuel
- Vehicle
- Repair and maintenance
- Administration

= Customer operating income

Scania profitability

+ Scania revenue

- Vehicles and engines
- Repair and maintenance
- Financing and insurance
- Used vehicles

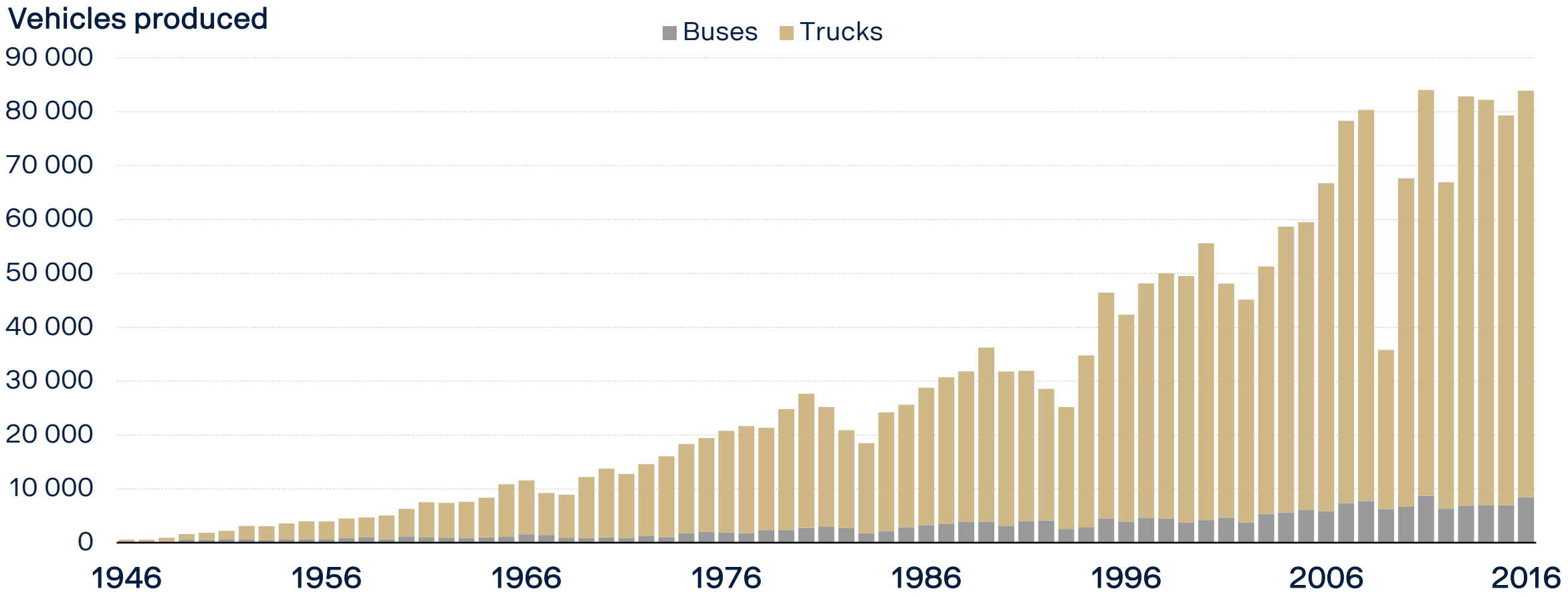
– Scania cost

- Production of vehicles, engines and services
- Research and development
- Selling and administration
- Financing

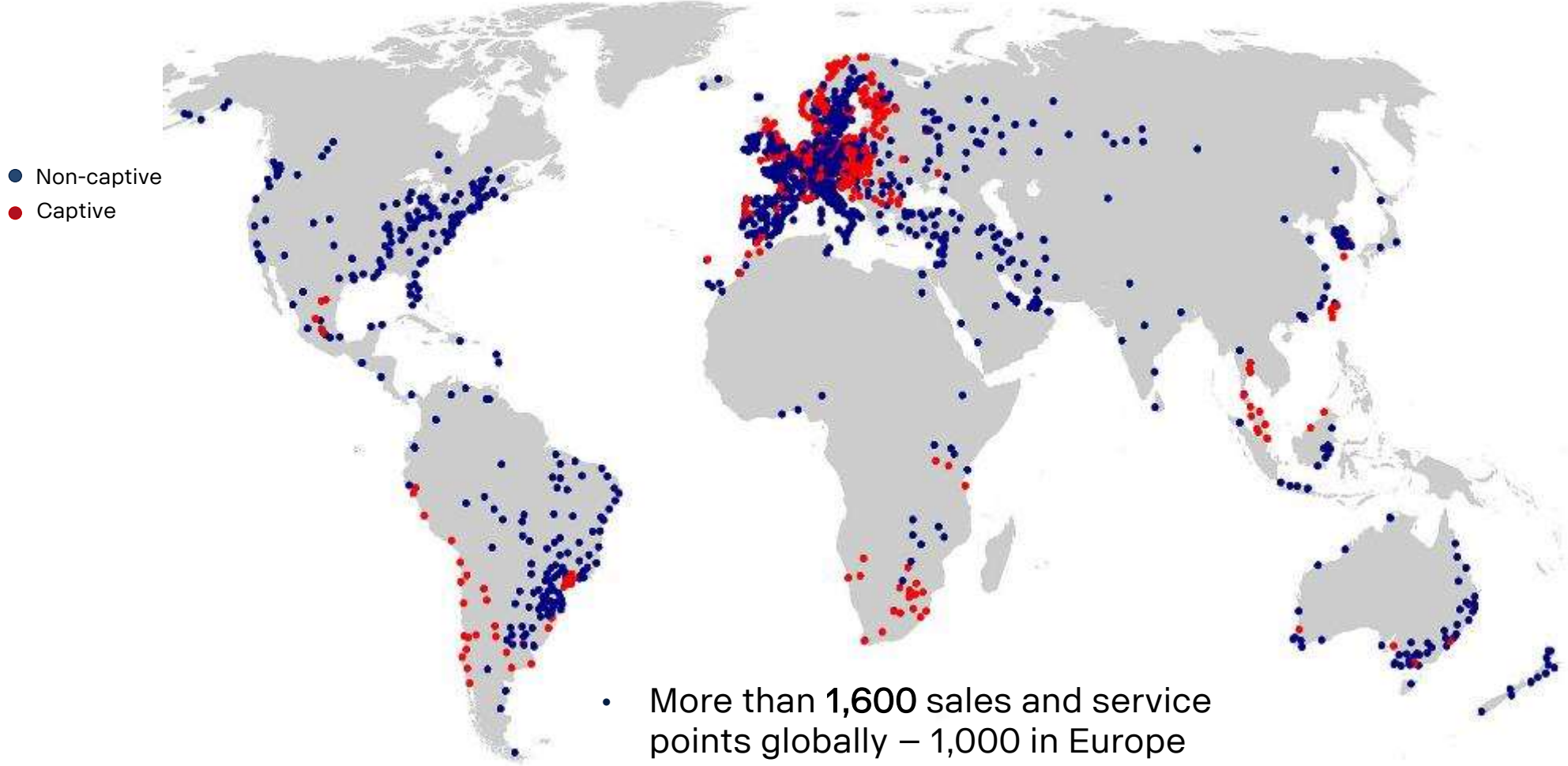
= Scania operating income

* European city bus operator

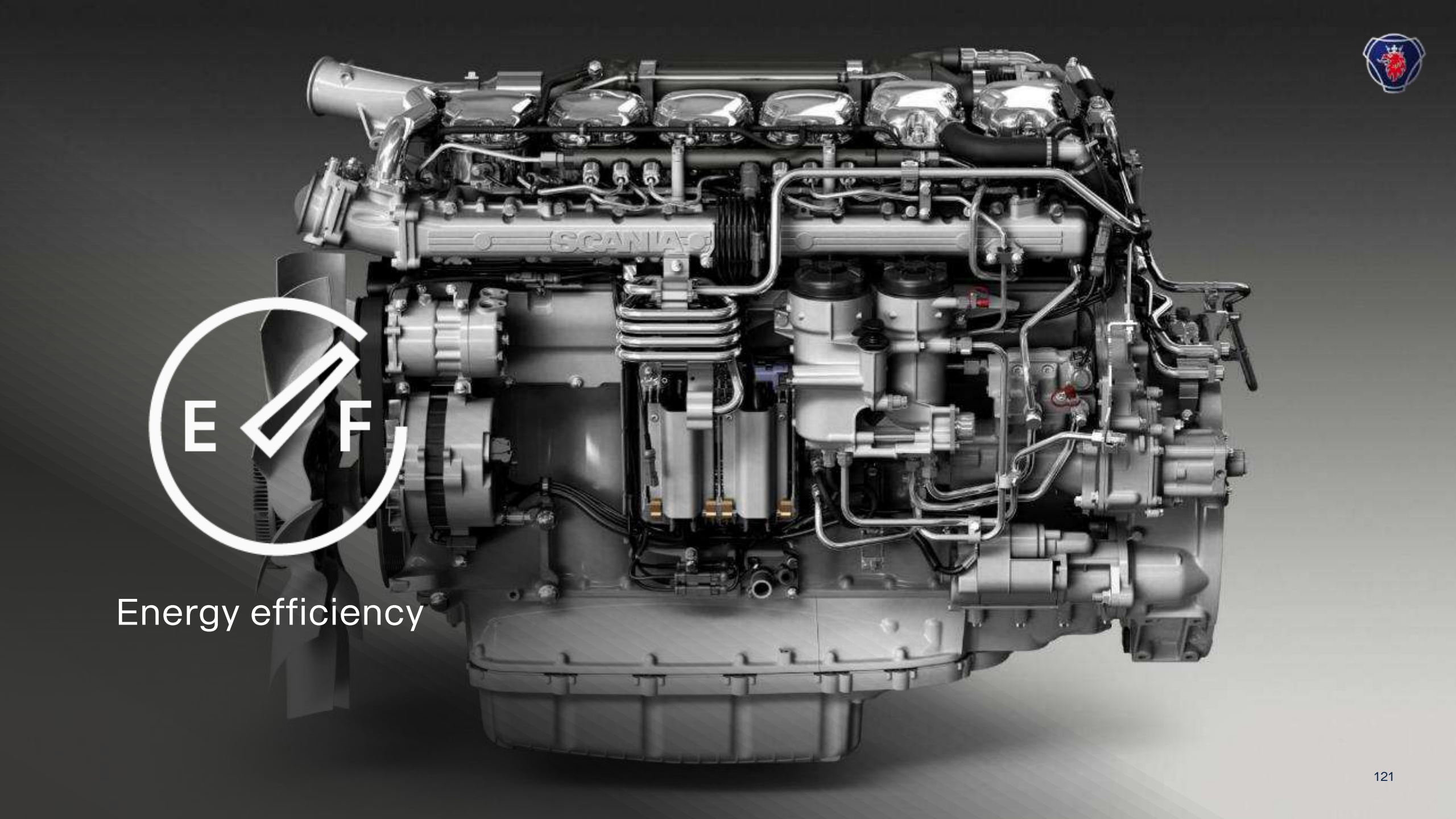
Historical growth



Scania Global Sales & Service network

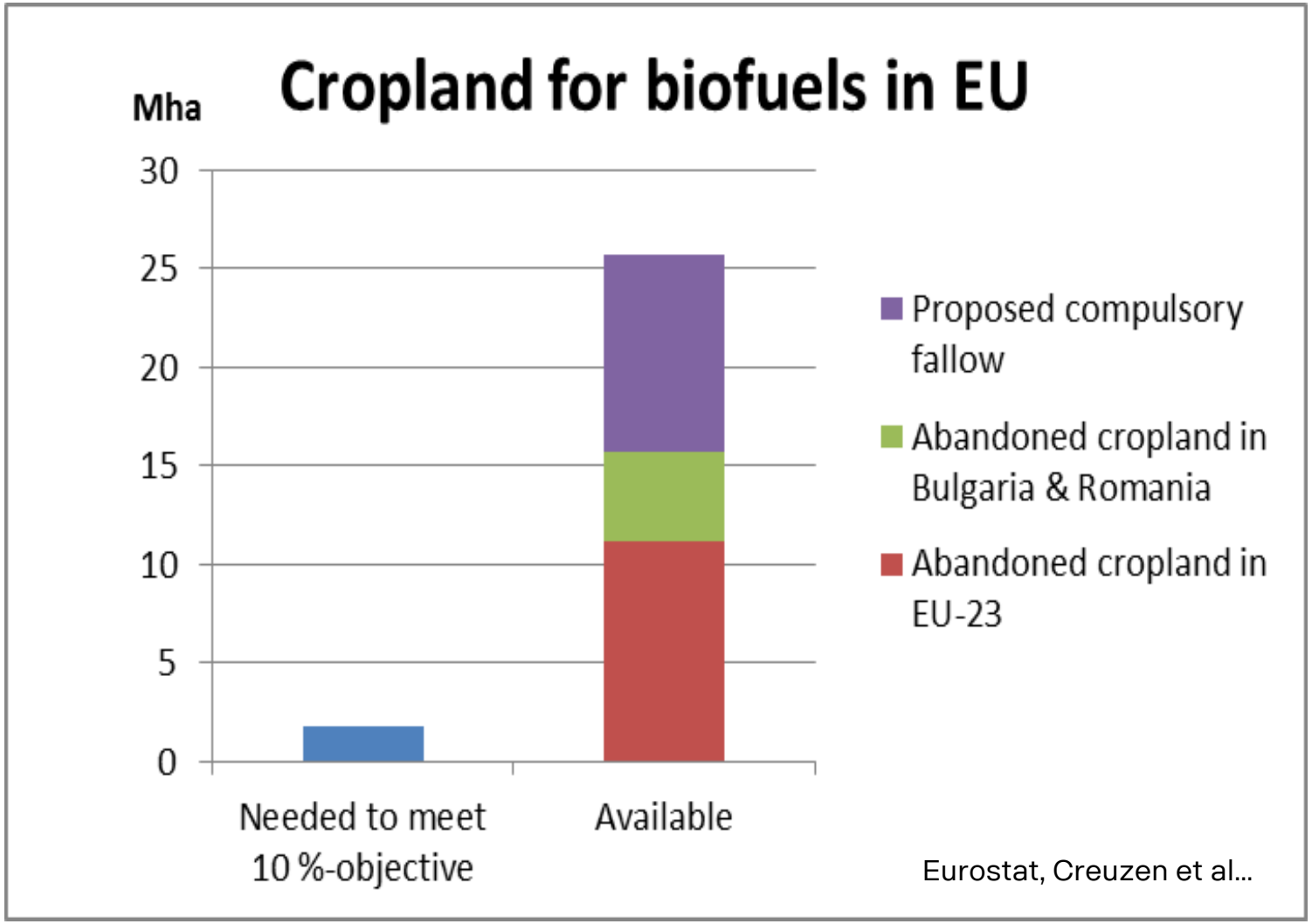


- More than **1,600** sales and service points globally – 1,000 in Europe
- **46 000** employees around the world



Energy efficiency

”FOOD VS FUEL” AND LAND USE MYTH



- EU has actively abandoned – and subsidized farmers to abandon – more farmland than is used for all global biofuel production (25 Mha).
- A fraction of this land would meet the 10% biofuel goal, save tax being spent on subsidizing farmers abandoning land and help EU energy security.

The widest portfolio of Low carbon vehicles

City	Ethanol	Biodiesel	Gas	Hybrid Electric
Suburban	Ethanol	Biodiesel	Gas	Hybrid Electric
Intercity	Ethanol	Biodiesel	Gas	Hybrid Electric
Coach	Ethanol	Biodiesel		

CITY CENTRE GREEN SOLUTIONS

- Frequent, defined routes, many stops, and short travel times → The best possibility for achieving a realistic cost for full electric solutions in the future.
- Opportunity charging – inductive and conductive BEV – tests ongoing in Södertälje and Östersund.
- City buses for all alternative fuels, hybrids or alternative fuel hybrids are commercial city solutions already today. 90-100% CO2 reduction.

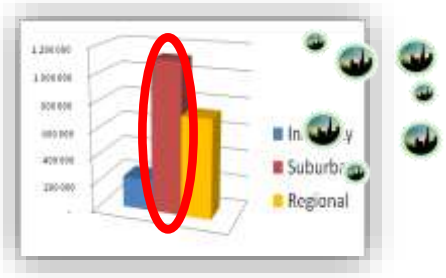
City type
Alternative Fuel
Hybrids

Full electric/BEV

Alternative Fuel
City Buses

SUBURBAN GREEN SOLUTIONS

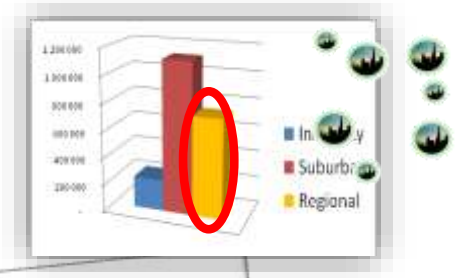
- Travel times of (15-30 min), higher comfort demands and higher average speeds.
- Longer, low entry type vehicles offer accessability capacity and comfort.
- Suburban type hybrids show high fuel savings.
- Dedicated Bus Systems/BRT type of operation strongly add to efficiency and attractivity.
- These solutions could reduce up to 90% of CO2 emissions at no or very low extra cost.



Suburban alternative fuel buses
(Biogas, Bioethanol, Biodiesel, HVO)

Biofuelled Suburban type Hybrid
(Best hybrid case!)

REGIONAL/IC GREEN SOLUTIONS



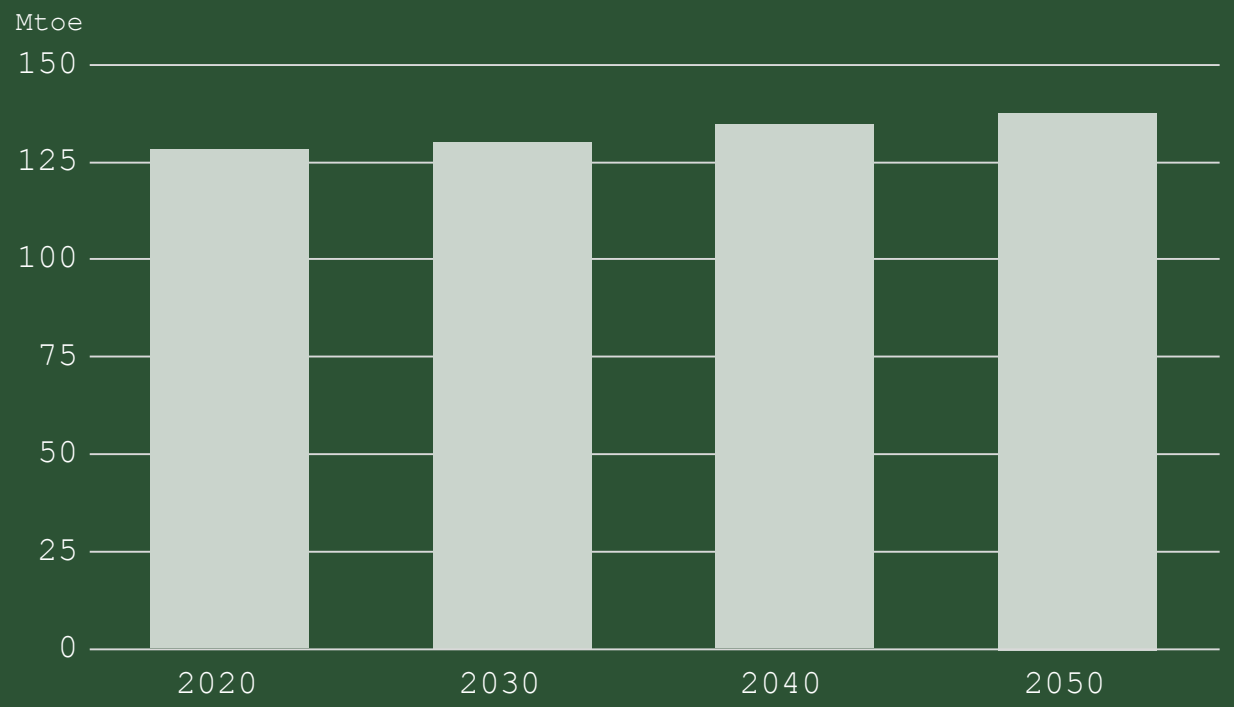
- Long travel times (30-60 min), high demands for comfort and time utilisation. Car → Public transport!
- These commercial green solutions could reduce up to 90% of CO2 emissions at no or very low extra cost.
- Bus Systems/BRT type of operation strongly add to attractivity and flexibility.
- Platooning increases capacity, flexibility and fuel efficiency even further.

High-comfort + alternative fuels

High-capacity BRT + alternative fuels

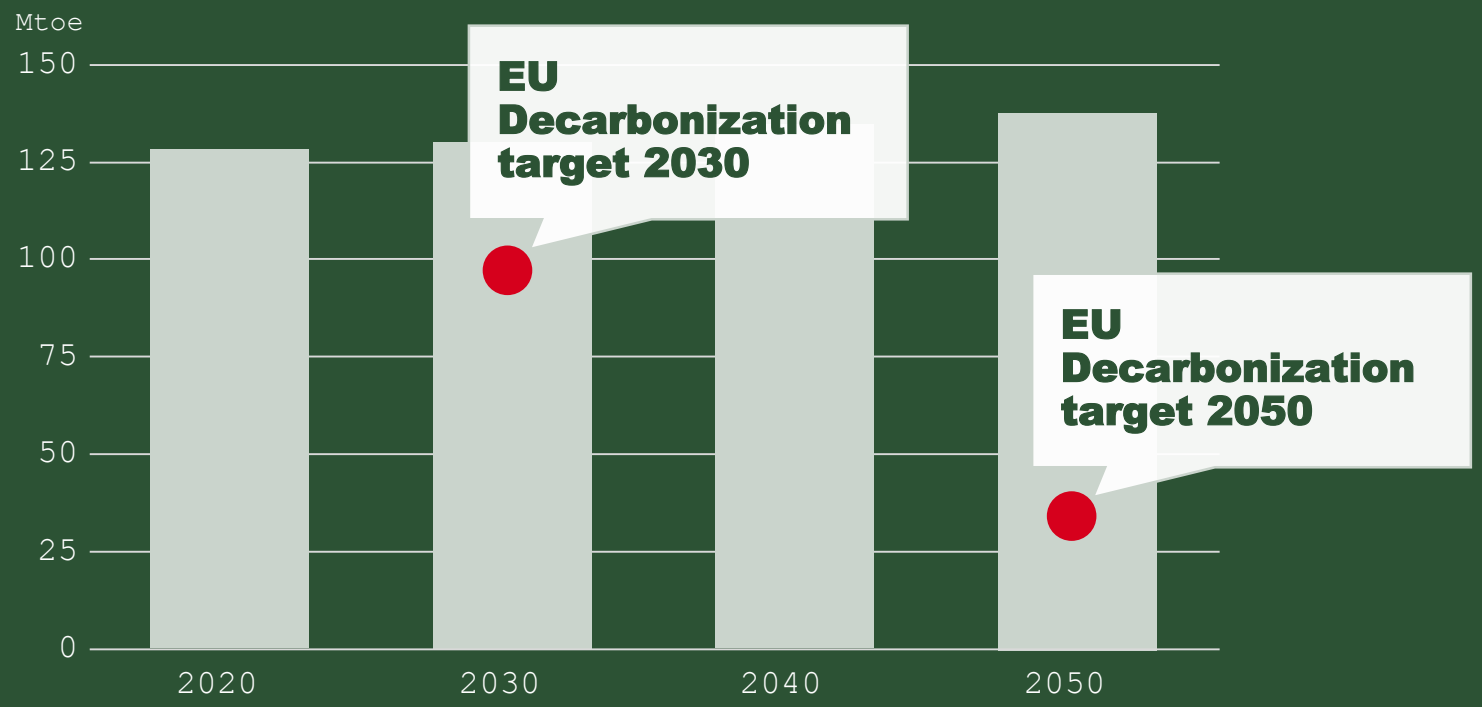
Platooning

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



The projection assumes 20% energy efficiency improvment by 2050 in comparison to today's level

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



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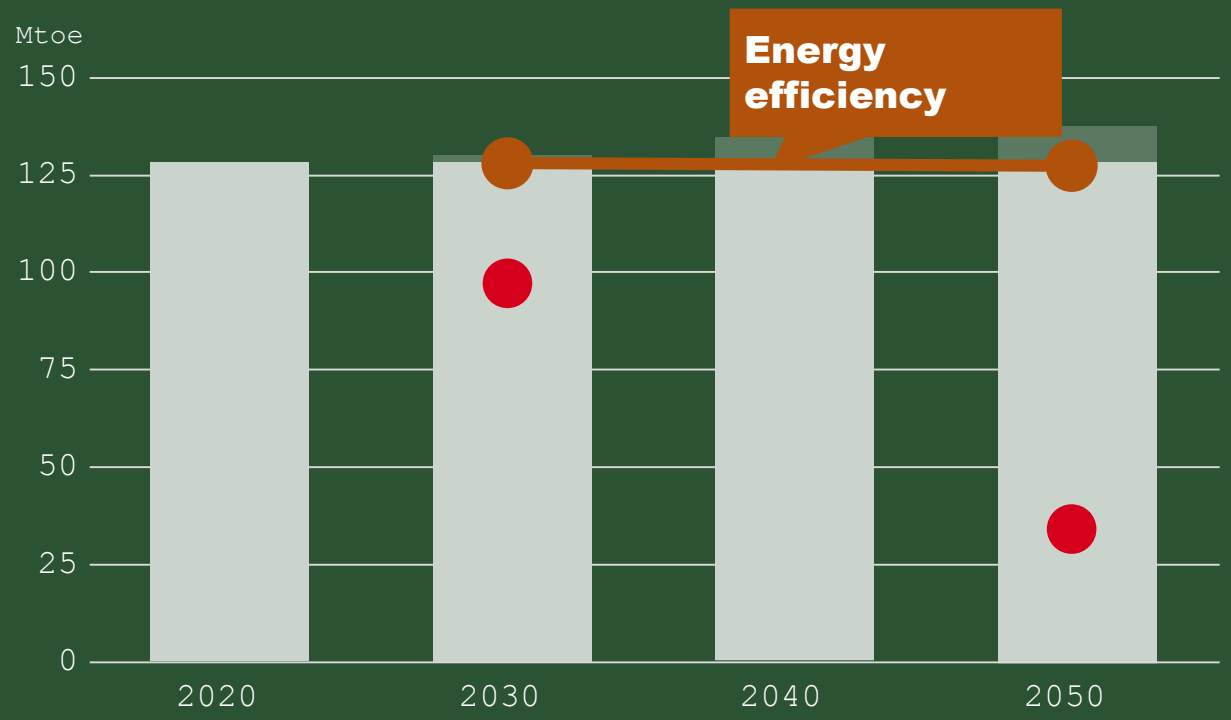
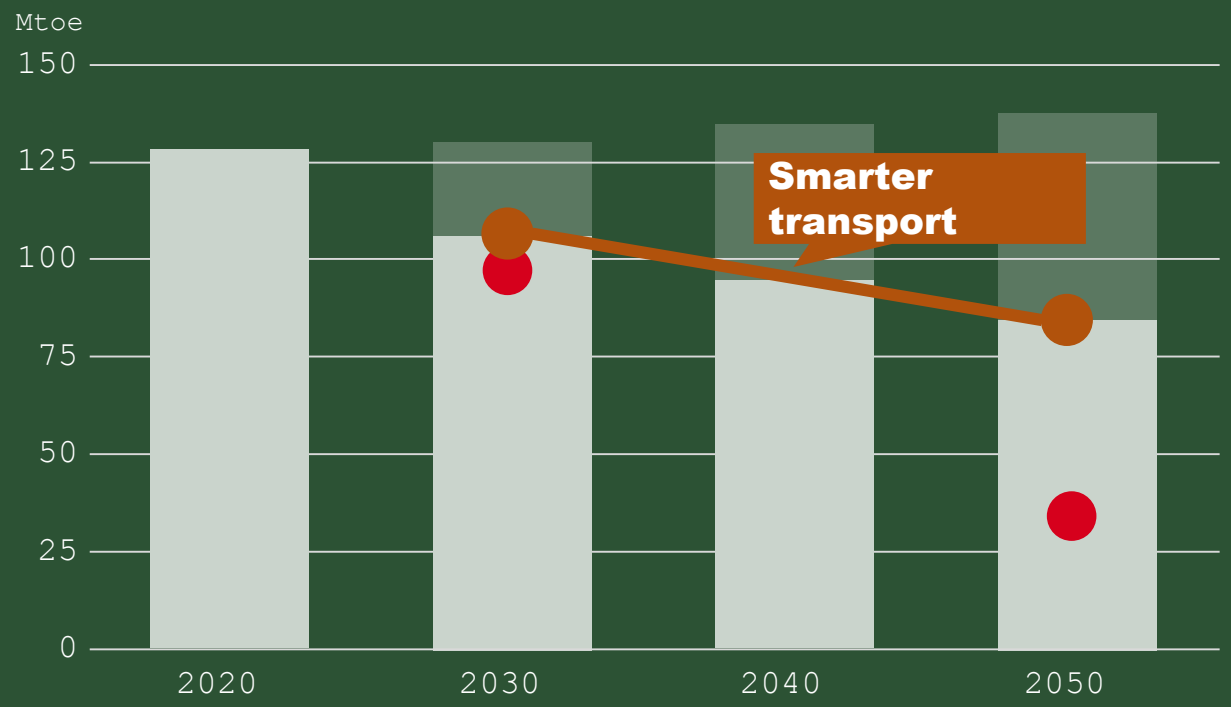


Energy efficiency

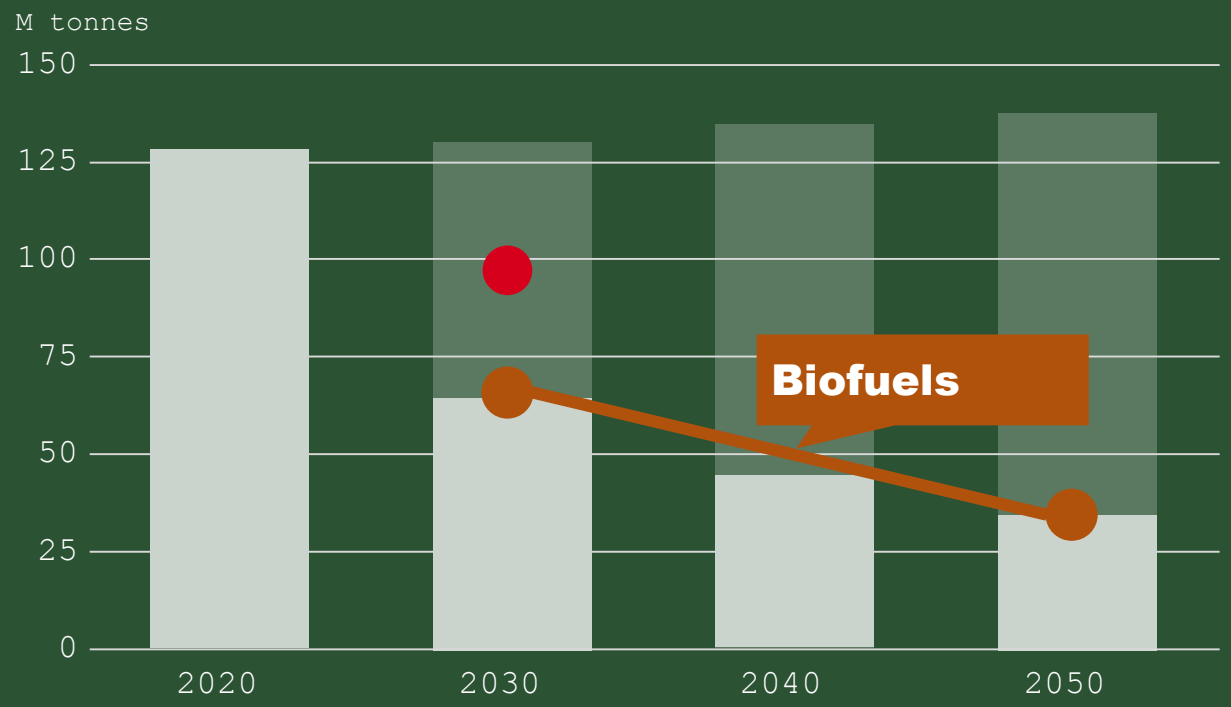
ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



Energy efficiency

Smarter transport

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU

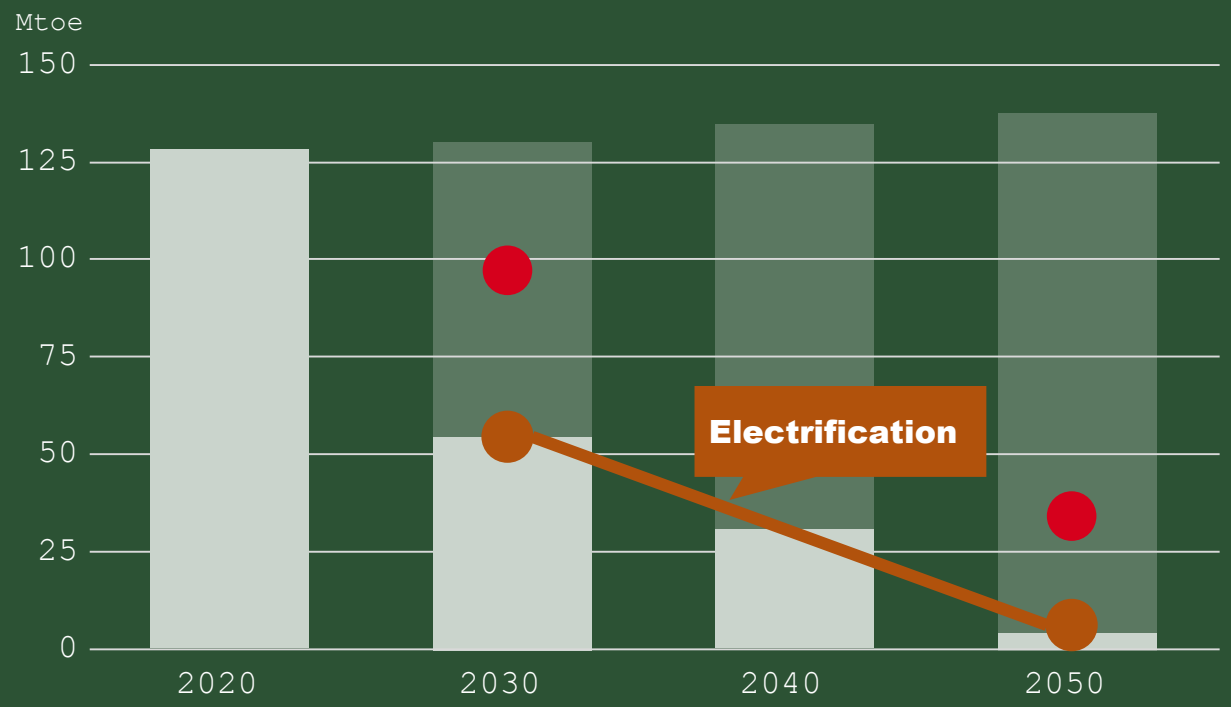


Energy efficiency

Smarter transport

Biofuels

ENERGY DEMAND PROJECTION HEAVY DUTY TRANSPORT IN EU



Energy efficiency

Smarter transport

Biofuels

Electrification