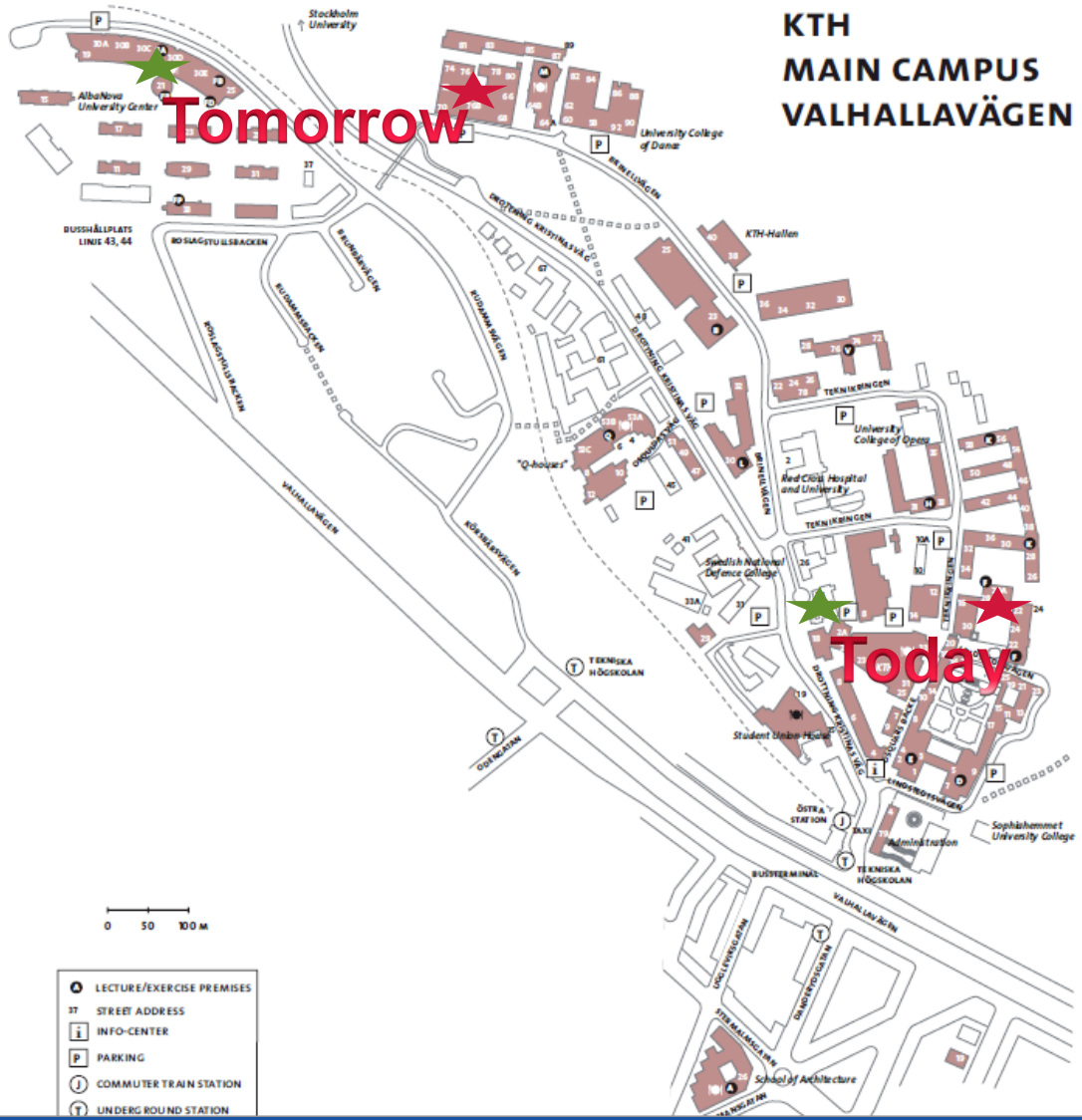
KTH ROYAL INSTITUTE
OF TECHNOLOGY

CCGEx Research Days Program

07-08.09.2017, CCGEx – Research Day

CCGEx Research Days
Sept 2017

Welcome to CCGEx and KTH!



Research day program
7th September, 2017

7th September - Lindstedtsvägen 26, KTH Campus, Room F3

11:00 Meet and Greet Registration

11:30 Conference Day Opening

11:40 Introduction - Research Directions for ICE/Gas Exchange Systems, Swedish/Global Perspective, ACE

12:00 High Efficiency and Gas Exchange, Jari Hyvönen, Wärtsilä Oy.

12:30 Lunch – In the common area

13:30 Research Area presentations: COLDSIDE, HOTSIDE, EAT, SYSINT by Mihai Mihaescu, Mikael Karlsson, ACE

14:00 Project presentations PhD students (15 minutes + 5 min questions / each)

Elias Sundström, KTH-Mek; *Large Eddy Simulations of Compressor Flows at Low Mass Flow Rates.*

Asuka Gabriele Pietroniro, KTH-Mek/MWL/Volvo Cars; *On the Aerodynamically generated Sound in Centrifugal Compressors.*

Valeriu Dragan KTH-Mek; *Analysis of non-axisymmetric Vaneless Diffuser Configurations – impact on range of Operability and Performance.*

Nicholas Anton, KTH-ICE/SCANIA; *Engine Optimized Turbine Design.*

15:30 Coffee Break

15:45 Project presentations PhD students

Marcus Winroth, KTH-Mek; *Gas Dynamics at Exhaust Valves and Ports.*

Ted Holmberg, KTH-ICE; *Valve Strategies and Exhaust Pulse Utilization.*

Shyang Maw Lim, KTH-Mek; *Flow and Heat Transfer in a Turbocharger Radial Turbine.*

Sandhya Thantla, KTH-ICE; *Low Temperature Waste Heat Recovery (WHR) in IC Engines*.

17:15 Lab visit CCGEx turbo/MWL & Refreshments All, Bengt guides

18:15 Dinner – Syster & Bror All

Research day program
8th September, 2017

Brinellvägen 68, Room M312

08:30 Project presentations PhD students

Zhe Zhang (Simulations), KTH-MWL; *Grouping of Particles in Gas Exhaust Systems by using Acoustics.*

Ghulam Majal (Simulations), KTH-MWL/Mek; *Control of Particle Agglomeration with relevance to After-Treatment Gas Processes.*

Arun Prasath (Exp), KTH-ICE; *Particulate characterization in the Gas Exchange Systems of DI/SI Engines.*

Senthil Mahendar, KTH – ICE; Heavy duty DISI Gas Exchange with Alternative Fuels

10:00 Coffee break

10:15 CCGEx targets & focus areas 2018-2021 – Proposed research questions - Anders C. Erlandsson, Mihai Mihaescu, Mats Åbom, Mikael Karlsson, Christophe Duwig

10:35 Workshop on research questions and feedback collection All

12:15 Conference summary & closing remarks by Anders C. Erlandsson

12:30 Lunch, Alba Nova All

13.45 ICE lab visit ALL, guided by Christer Spiegelberg

14:30 Conference close

Internal Combustion Engines!

Fascinating machines

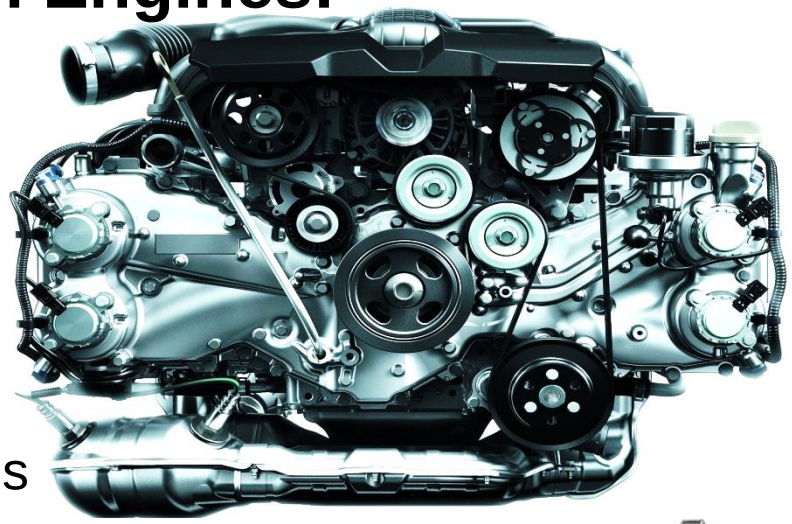
Cross function/discipline

Extremely complex

Extremely common

Very high impact on our lives

- Transport
- Power generation
- Fun ☺
- <u>Environment</u>




Why I am working with engines…

North America

The entire Atlantic seaboard would vanish, along with Florida and the Gulf Coast. In California, San Francisco's hills would become a cluster of islands and the Central Valley a giant bay. The Gulf of California would stretch north past the latitude of San Diego—not that there'd be a San Diego.

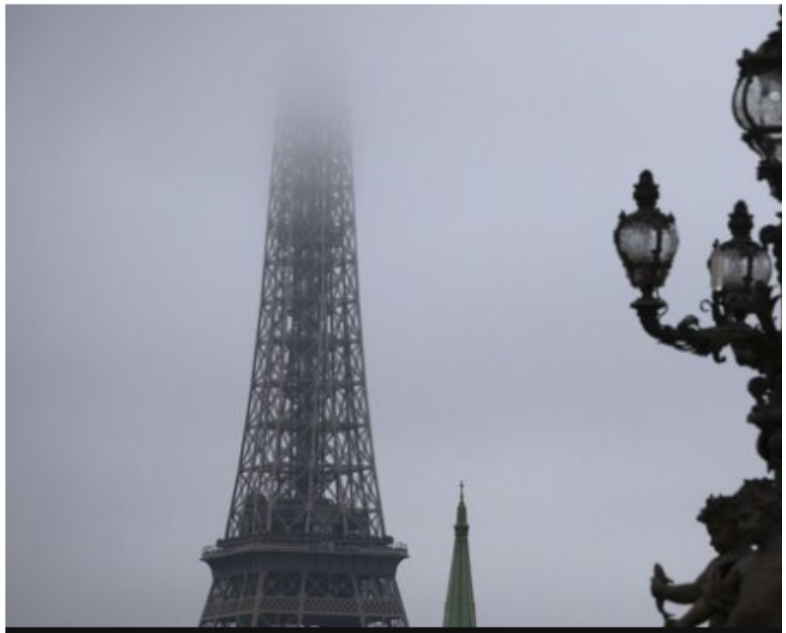

AURORA


GREENPEACE
MEET LISA. AN 8-YEAR-OLD EMISSIONS FILTER!

Four major cities move to ban vehicles by 2025

By Matt McGrath
Environment correspondent

2 December 2016 | Science & Environment



Air quality in Paris has forced political leaders to take a hard stance on the u

Petrol and diesel ban: How will it work?

26 July 2017 | UK

Share

All sales of new petrol and diesel cars will cease in the UK by 2040, under plans to tackle air pollution.

But with electric cars currently accounting for less than 1% of new sales, the switch will mean seismic changes, and gives rise to a host of pressing questions.

Why are petrol and diesel cars being banned?

Poor air quality is the "biggest environmental risk to public health in the UK" - thought to be **linked to about 40,000 premature deaths a year** - the government says. While air pollution has been mostly falling, in many cities nitrogen oxides- which form part of the discharge from car exhausts - regularly breach safe levels .

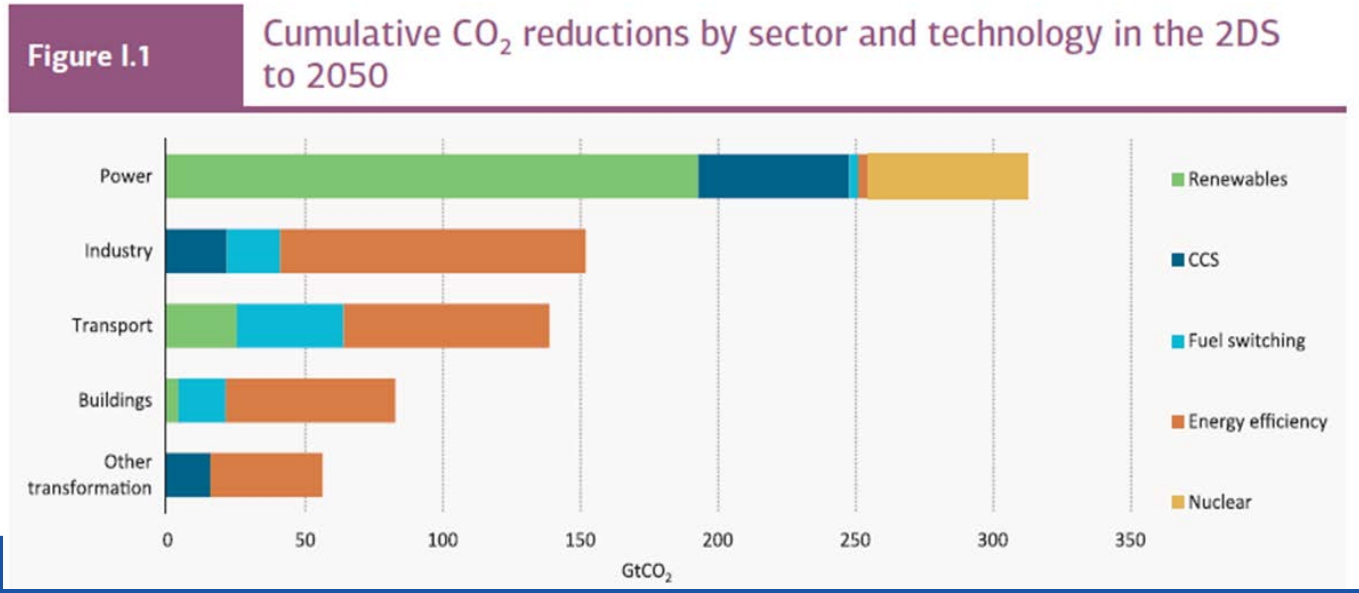
Diesel vehicles produce the overwhelming majority of nitrogen oxide gases coming from roadside sources.

The government was ordered by the courts to produce **a new plan** to tackle illegal levels of harmful pollutant nitrogen dioxide, a form of the nitrogen oxide pollutants emitted by vehicles.

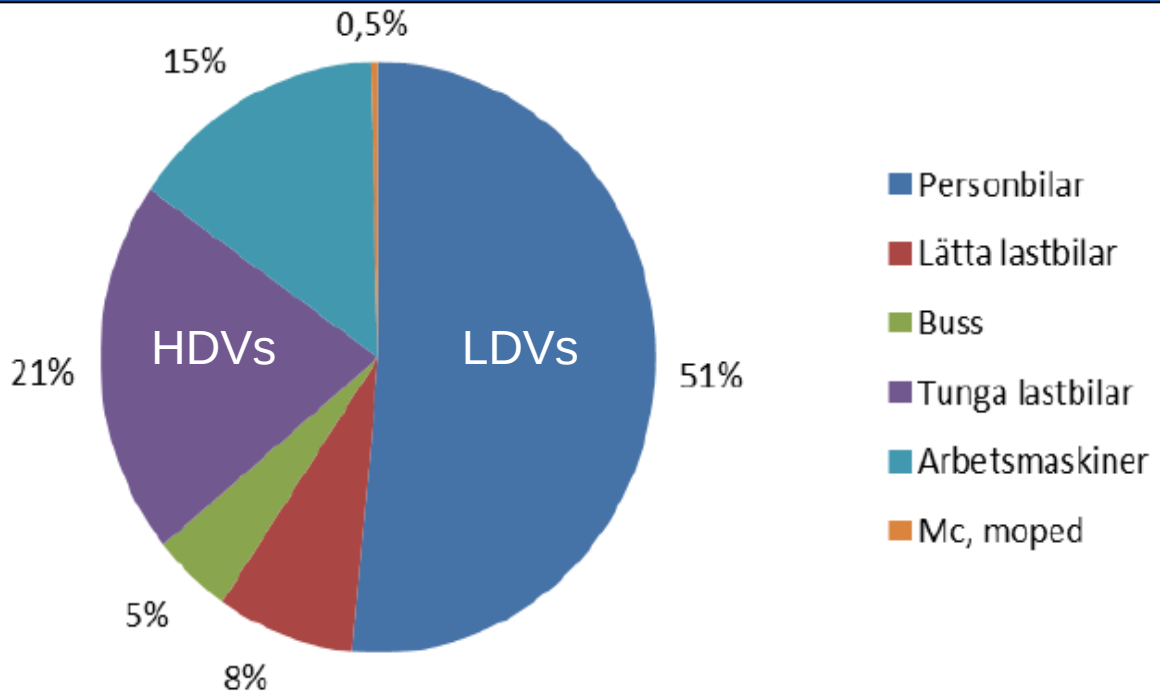
Local and global consequences of combustion for power and transport

Local emissions – “local” regulations…

“At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal.”

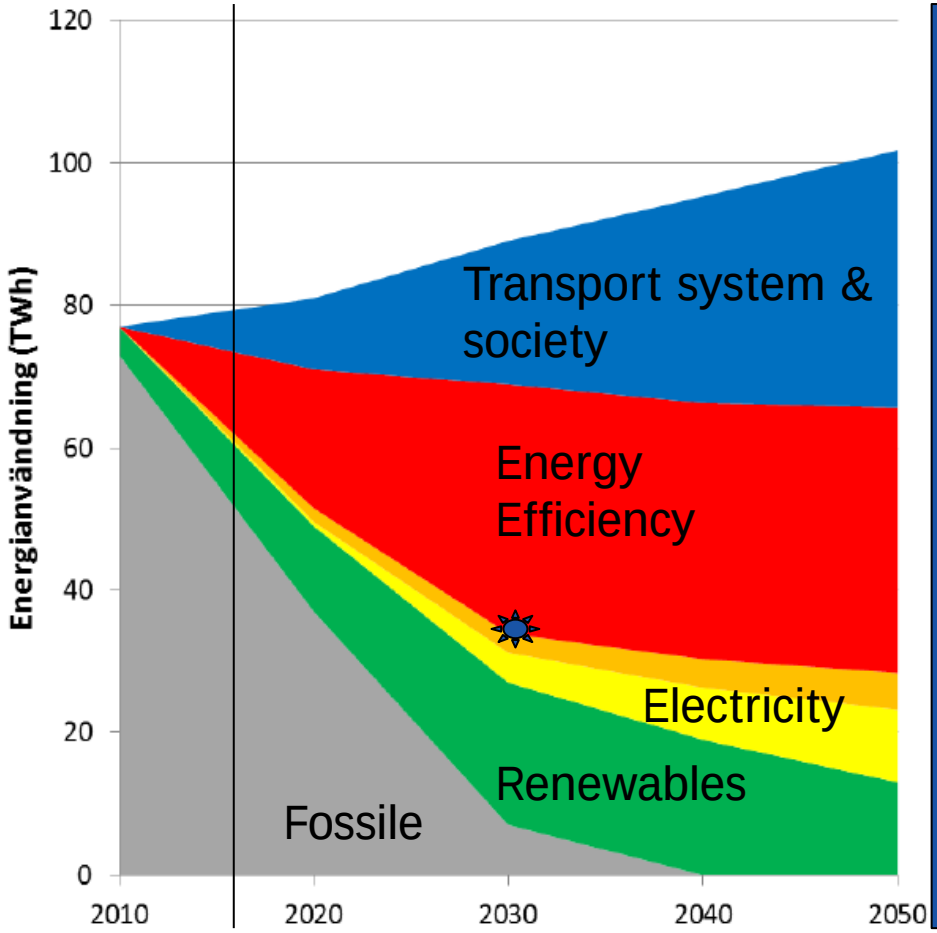


Energy usage for different vegicle types in Sweden 2013



HD share of energy usage is increasing due to increased transport needs and more efficient passenger car transport

Swedish reduction SCENARIO!
Towards fossile free transport in SWEDEN



Källa: SOU 2013:84, Fossilfrihet på väg (”FFF-utredningen”)

By 2030:

- Society & transports
- 50% higher efficiency
- 60% biofuels or renewables
- Squirt of fossile and electricity

By 2030: 50% less energy consumption – How the …..?

Less energy required for propulsion

- Drag & rolling resistance, weight, regeneration

Efficent energy production

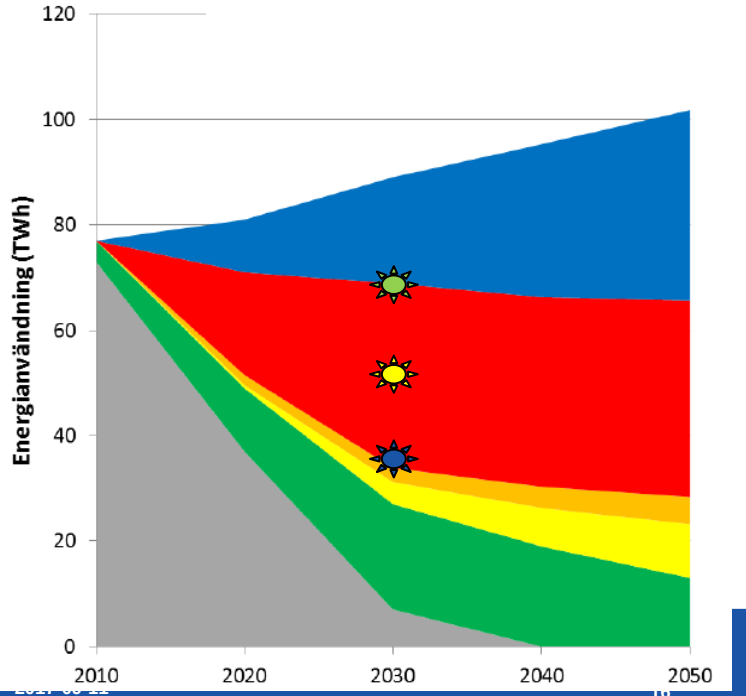
- Highly efficient power train

Split 50% energy reduction into

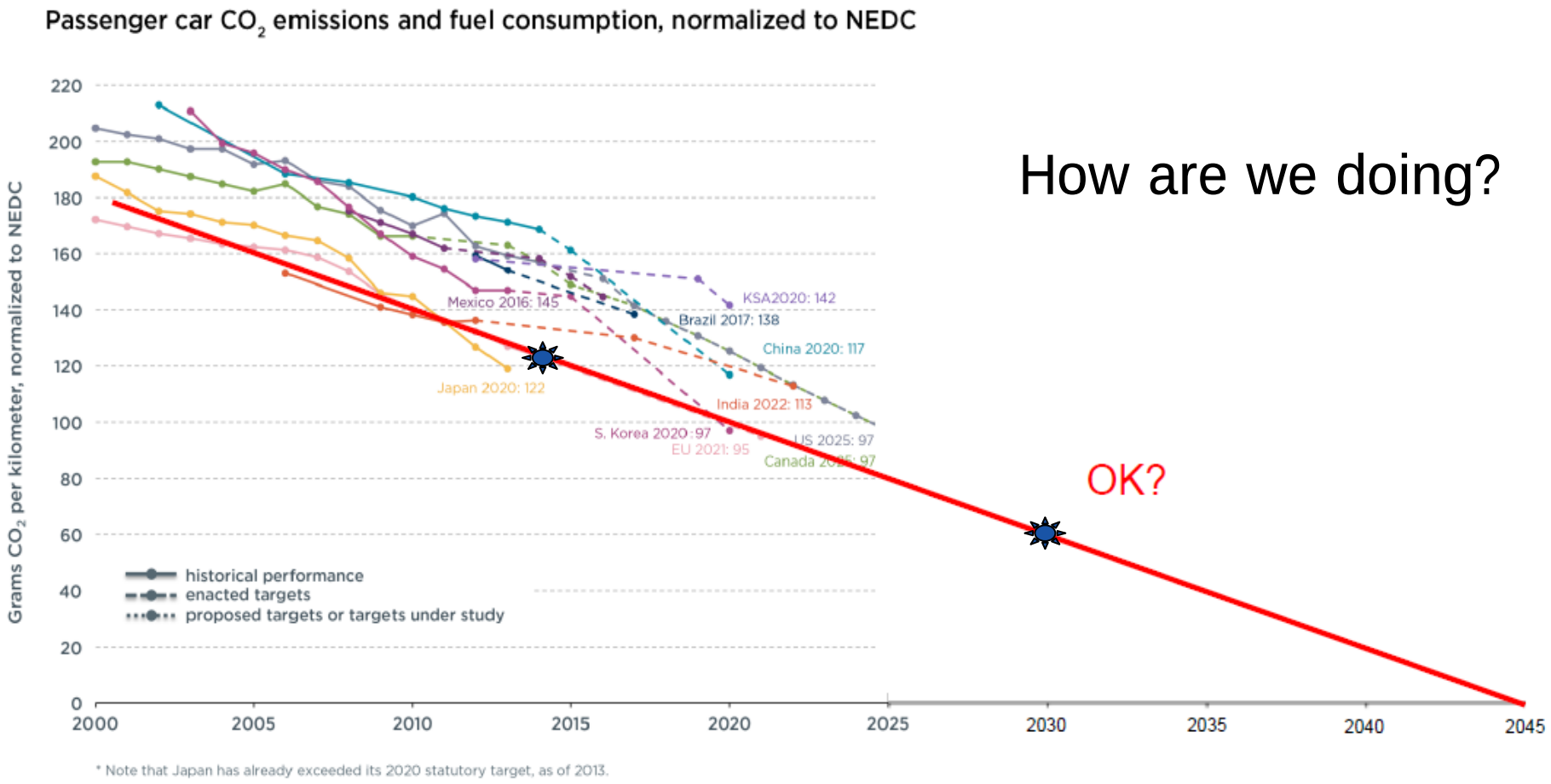
- 25% less for proulsion (yellow star)
- 33% less for production (blue star)

Propulsion effciency **40% to 60%** !!!

Add renewables & electricity



CO2 emissions passenger cars



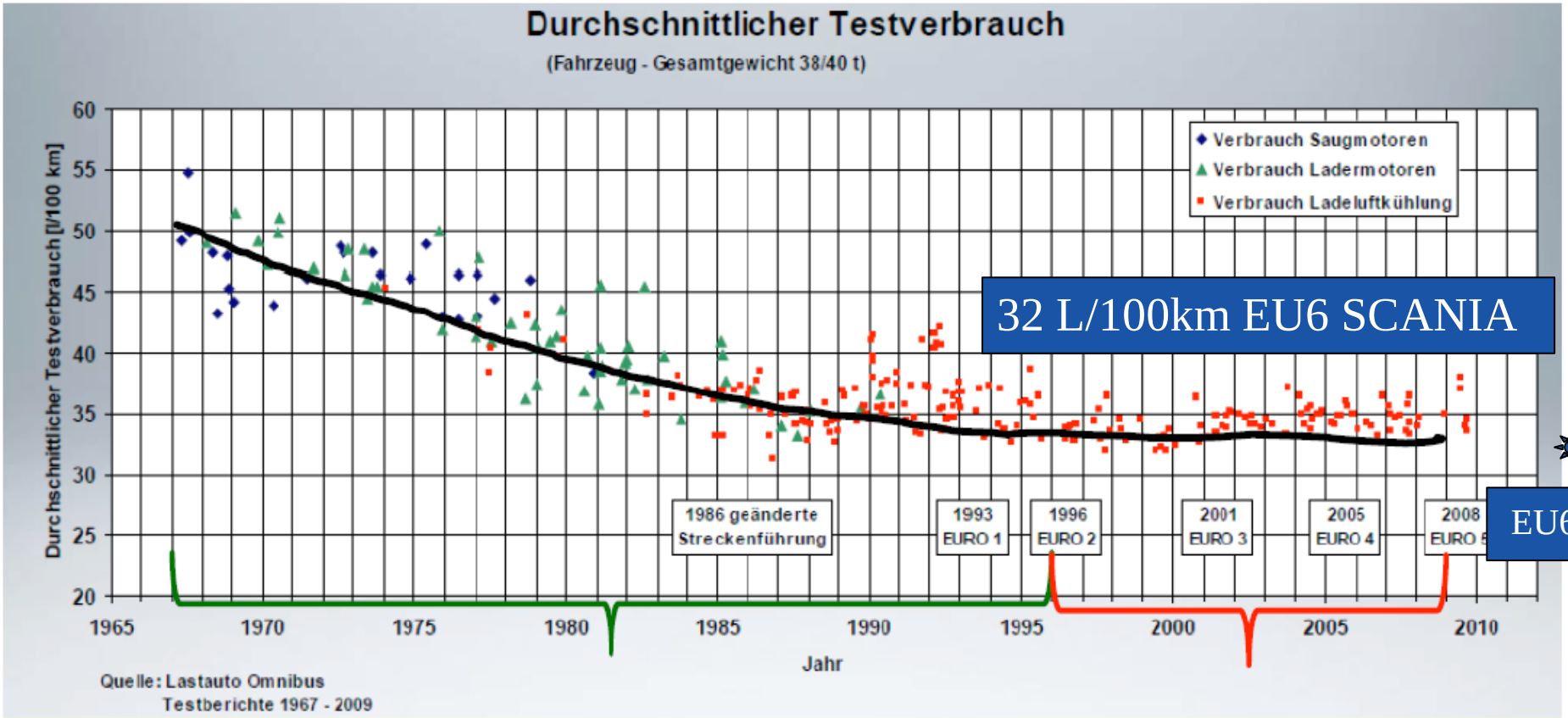
Hybridization

Elmotor i alla Volvos bilar 2019

Publicerad 5 juli

NYHETER Om två år kommer alla nya bilmodeller som rullar ut ur Volvos fabriker vara antingen laddhybrider, mildhybrider eller rena elbilar. Tillverkning med enbart förbränningsmotorer läggs ned.

Efficiency vs. Emissions



Continously reduced fuel consumption

No development in fuel consumption

What is the problem?

Fuel price

Legislation

Customer priorities

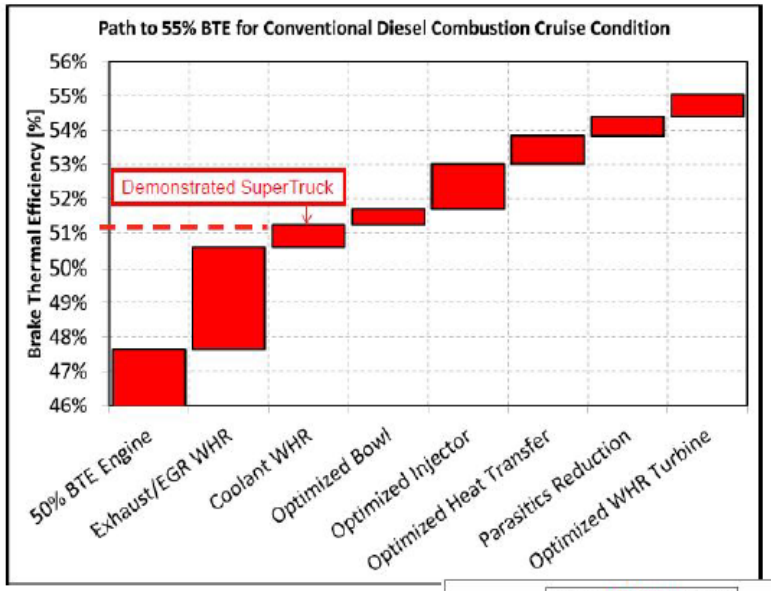
Lack of new ideas?

Physical laws?

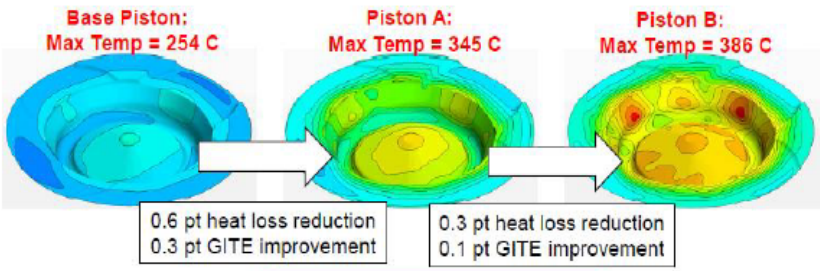
How are we doing???

Cummins

Pathways to 55% peak BTE proposed. Optimized WHR, injectors, bowl design, friction and parasitics, reduced heat loss. GPS engine control.

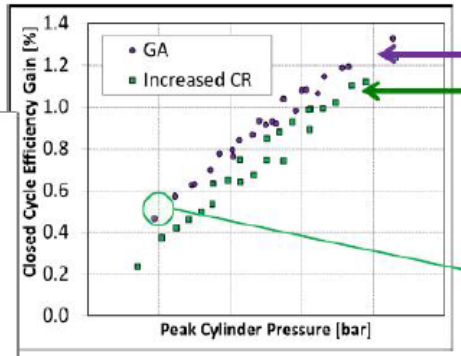


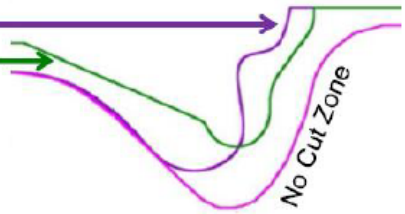
55% BTE technologies



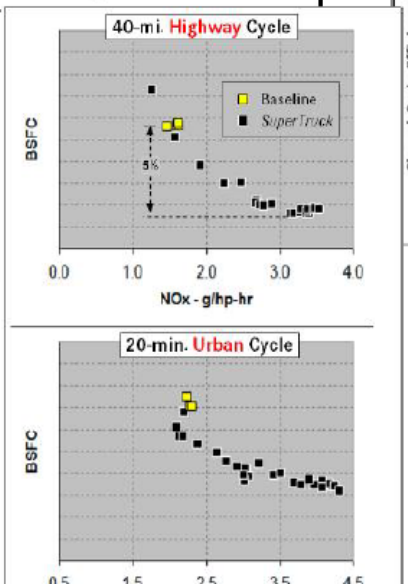
Cummins DOE AMR 6/14

BTE impact: + 0.8% BTE





BTE impact: + 0.5% BTE



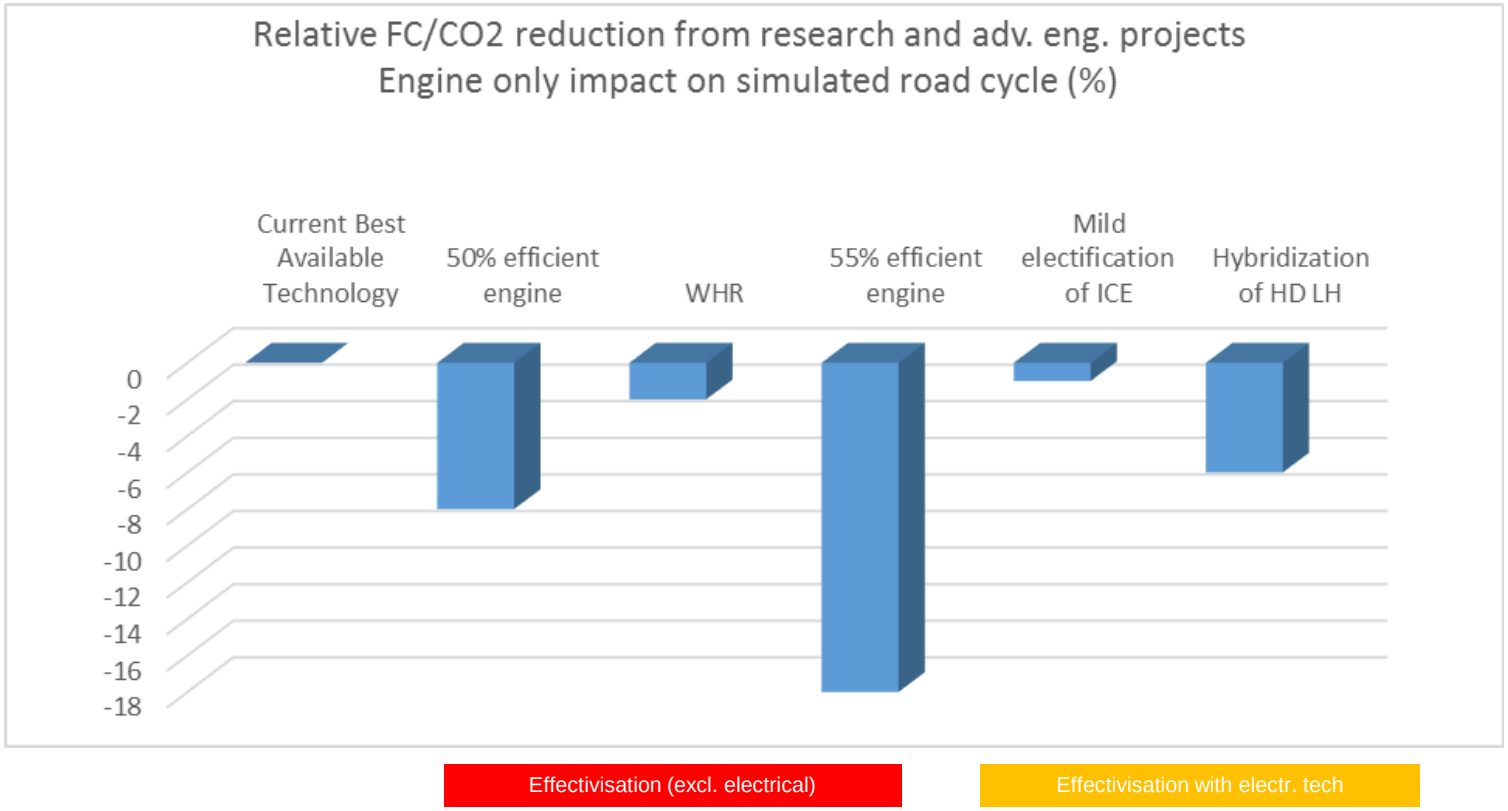
Predictive controls using GPS enables a highway vs. urban calibration.

DDC, DOE Peer Review May 2012

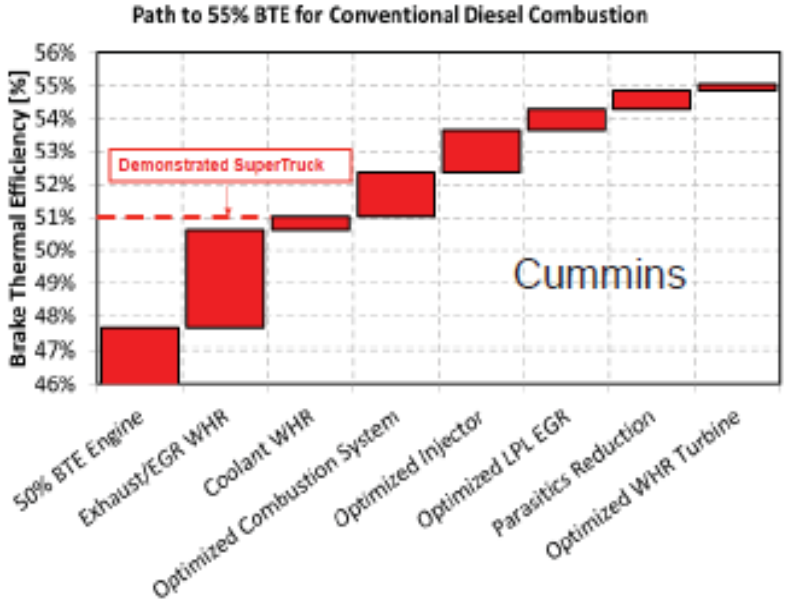
- Friction and Parasitic reduction
  - Piston/ring pack/liner changes
  - Piston cooling flow reduction
  - Main & rod bearing

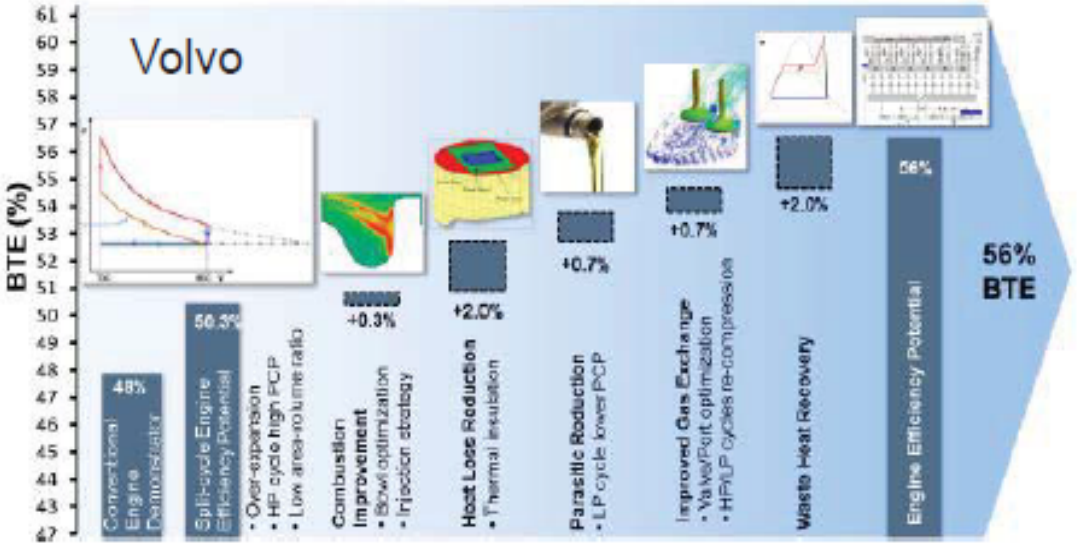
BTE impact: + 0.6% BTE

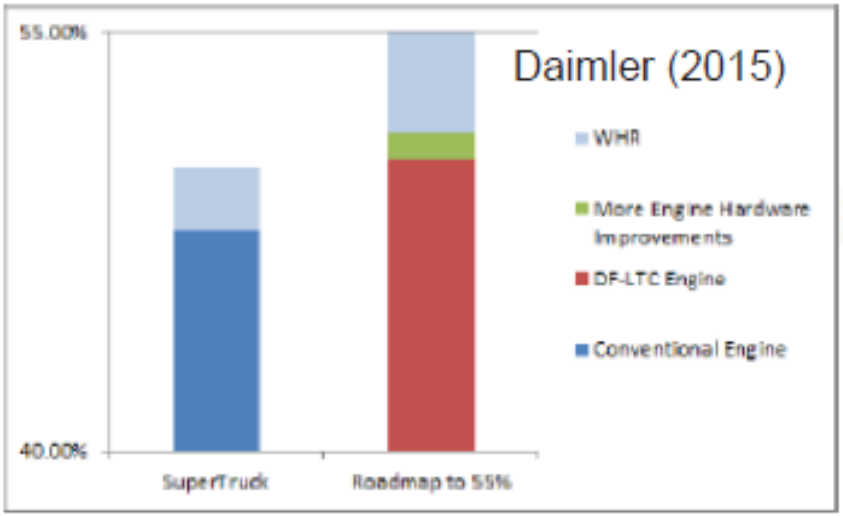
> 20% Energy saving with 55% ICE + Hybrid (Long haul)

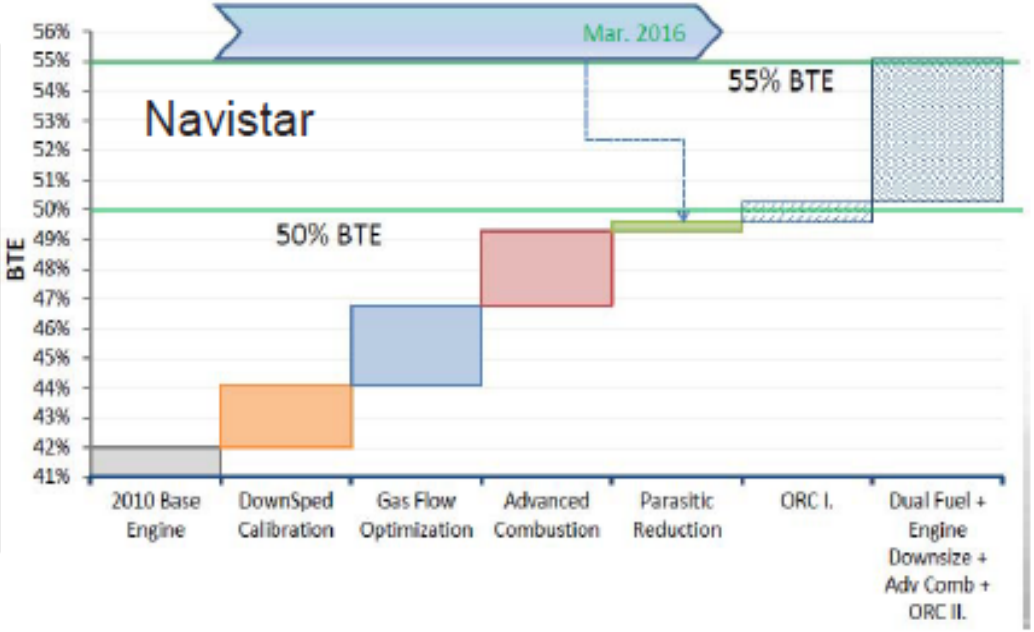


Roadmap approaches to 55% BTE are outlined.



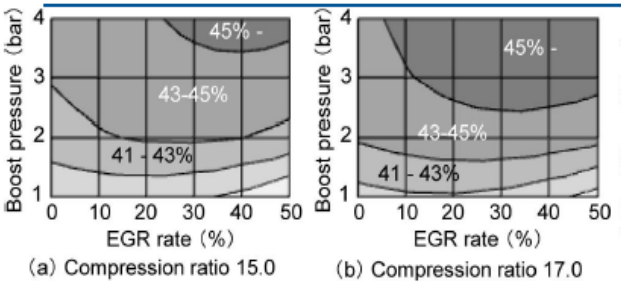




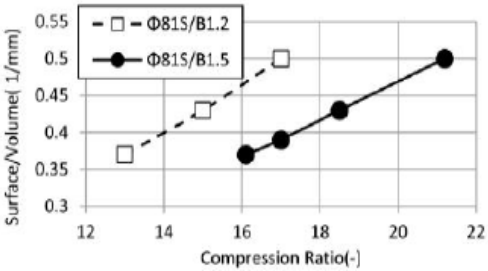


Honda - Light Duty

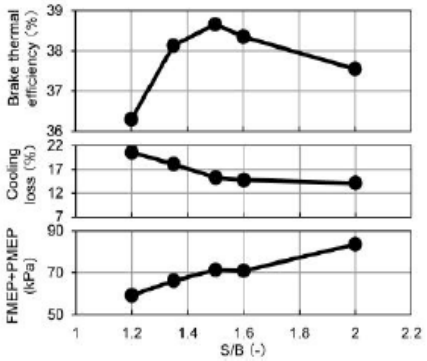
45% BTE on ~2.5 liter stoich gasoline engine. CR~17, S/B=1.5, MPI and DI, late IVC, 30% EGR, two-stage boost, strong ignition.



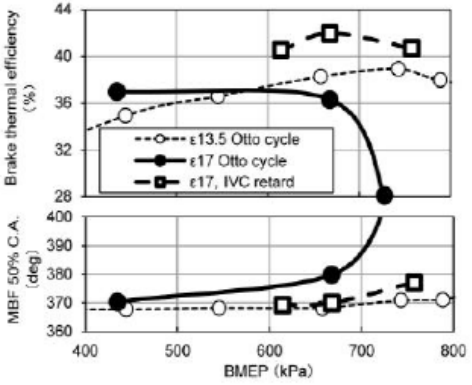
Model results. 45% BTE is possible at CR~17, 2.5 bar boost, and 30% EGR. Minimum-advance for Best Torque (MBT) used; 2000 RPM



S/B=1.5 gives CR=17 at same S/V ratio

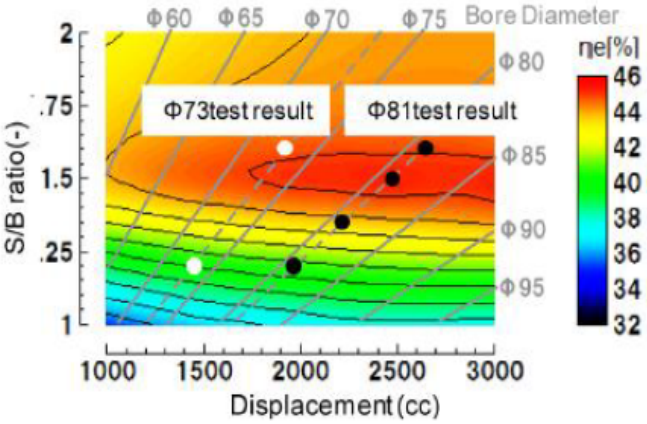


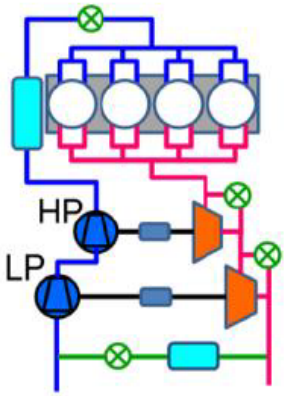
S/B=1.5 balances pumping and friction loss at CR=13.5. 2000 rpm, IMEP=720 kPa, MBT



Late IVC gives effective CR=12.5 with similar phasing as current engines but maintaining CR=17 expansion. 20% EGR, 2000 RPM

Multi-cylinder results

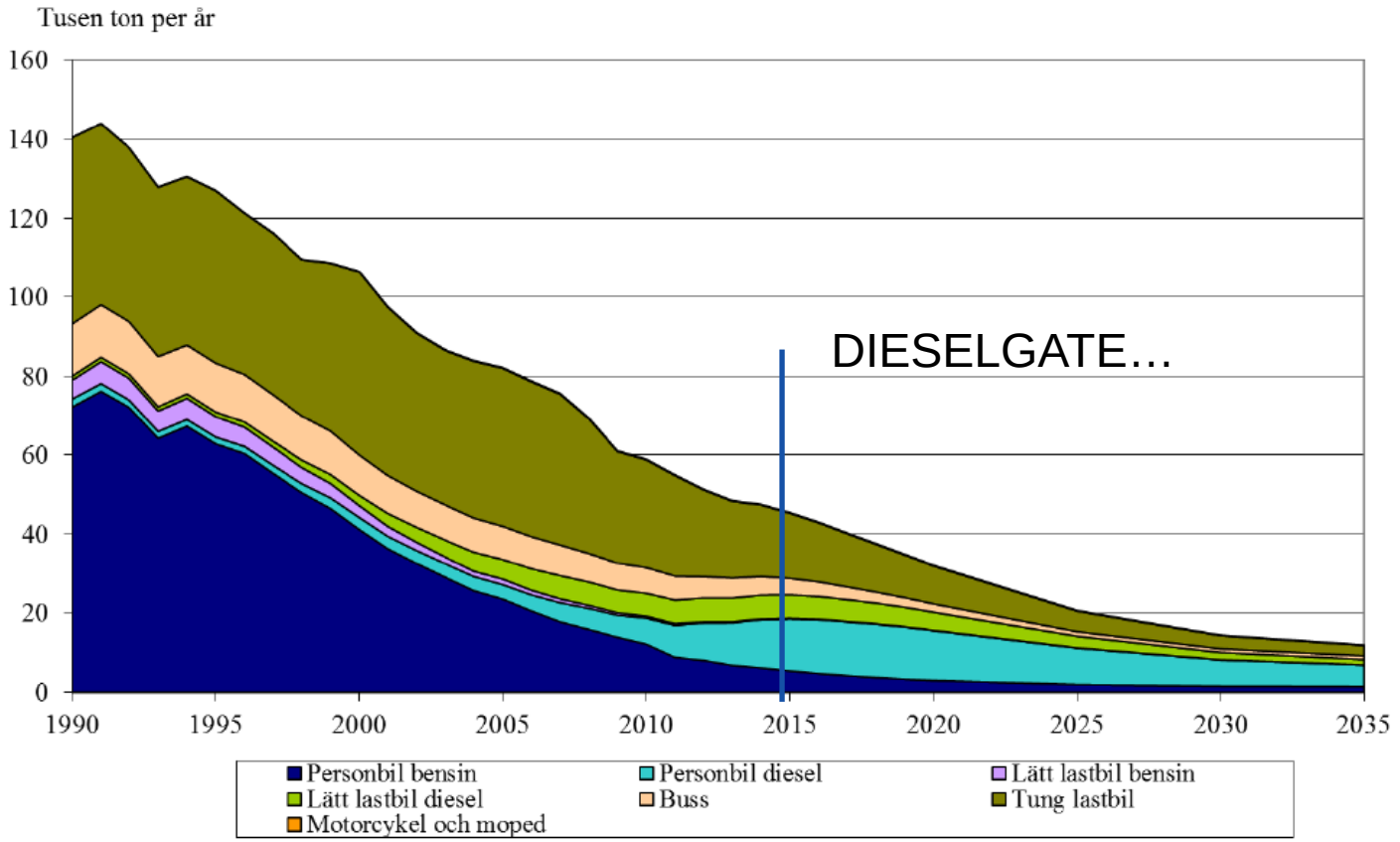




Combined boosting system

Honda, SAE 2015-01-1263

Emissions of NOx – Swedish total



Figur 6: Beräknade utsläpp av kväveoxider från vägtrafiken.

Dokumenttitel: Trafikverkets miljörapport 2014

Dokumentdatum: 2015-03-31

SICEC research focus

	City	Highway
Light Duty	**Prioritized properties:** • ”Zero emissions” • Silent drive **Technologies:** • Hybrid/ elektrified engine • Elektrification • PZEV ICE	**Prioritized properties:** • Energy efficiency • CO2/GHG **Technologies:** • Advanced ICE • Hybridization • Renewable fuels
Heavy Duty	**Prioritized properties:** • ”Zero emissions” • Silent drive **Technologies:** • Hybrid • Plug-in hybrid • Electrified road hybrid	**Prioritized properties:** • Energy efficiency • CO2/GHG/NOx/PM **Technologies:** • Advanced ICE • Hybridization • Renewable fuels • Electrified road hybrid

Summary - Is this enough?

Target 2030 - 33% less energy

Target 2050 – Fossile free

Identified paths to 20% less energy consumtion

Clear that the ICE itself need help from the surrounding systems

WHR, hybridisation, energy storage, traffic prediction, autonomous vehicles, platooning etc…

New ideas!!!

New technology!!

Science and research

Plenty of opportunities in the automotive/power industry

CCGEx future research focus

Zero Emissions

Sound, Gaseous, Particulates

Renewable Fuels

High ”well-to-wheel” efficiency, Low emissions, Intro

Higher Efficiency

Thermodynamic processes

Waste Heat Recovery, Heat transfer & energy flows

Hybridization an enabler

Competence Center for Gas Exchange

CC GEx

”Charging for the future”