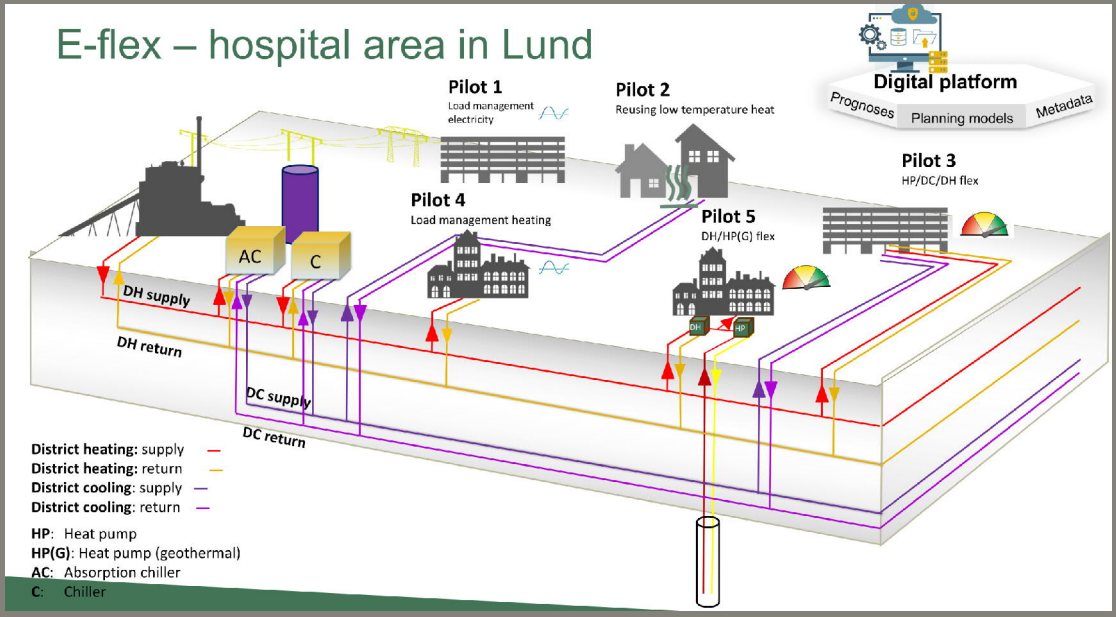
Dual Fuel Engines

MARCUS LUNDGREN, 2025 LOCAGAS MEETING

LUND UNIVERSITY

LTH
FACULTY OF ENGINEERING

Division of Sustainable Energy Systems



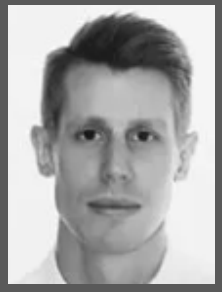
Lund

In the region of Scania, Sweden

“Senior team”

Energy systems

Diagnostics



Engine experiments

Controls

Modeling

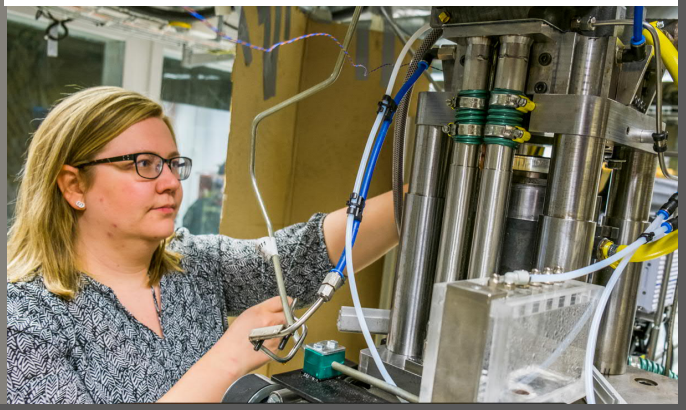
Aerosols

Fuels

Strategic priorities 2025-2030

- Consolidate the engine team
  - Maintain the strong international reputation
  - Maintain the academic staff and a postdoc
  - Coach our associate professor to become full professor and the future team leader
  - Expand the number of PhD-student projects to at least 12
  - Safeguard the laboratory
  - Get the fuel-cell laboratory operational
- Revive a strong energy systems team
  - Maintain the strong reputation on education and external engagement
  - Coach our assistant professor to become full professor and team leader
  - Recruit key academic staff
  - Expand the number of PhD-student projects by strategic application work
  - Recruit two postdocs

Forskare ser in i framtiden



Experimental engine projects

Finished recently

BioRen (finished), André Olsen

FastWater (finished), Magnus Svensson

KCFP (finished), Ola Björnsson

On-going

Eco-Force Fuels Brian Gainey

Locagas,ML

GasWave, Miaoxin Gong

HYVET, Anupam Saha

HYDICE, Peter Hallstadius

ASMEF, Beyza Dursun

FutuRe, Christoffer Ahrling

Volvo iPhD (new), Yannick Rousseeuw

HYMN (new), Frank Nation

VAHDI (new), PI Öivind Andersson

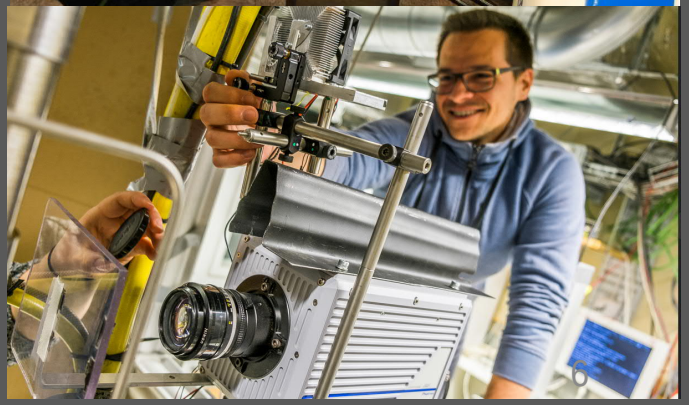
Hectic (new), Martin, Per & Brian

HyLAI (new) - Hydrogen engine Leveraged by Artificial Intelligence, PI Per Tunestål

H2

Applications waiting for decision

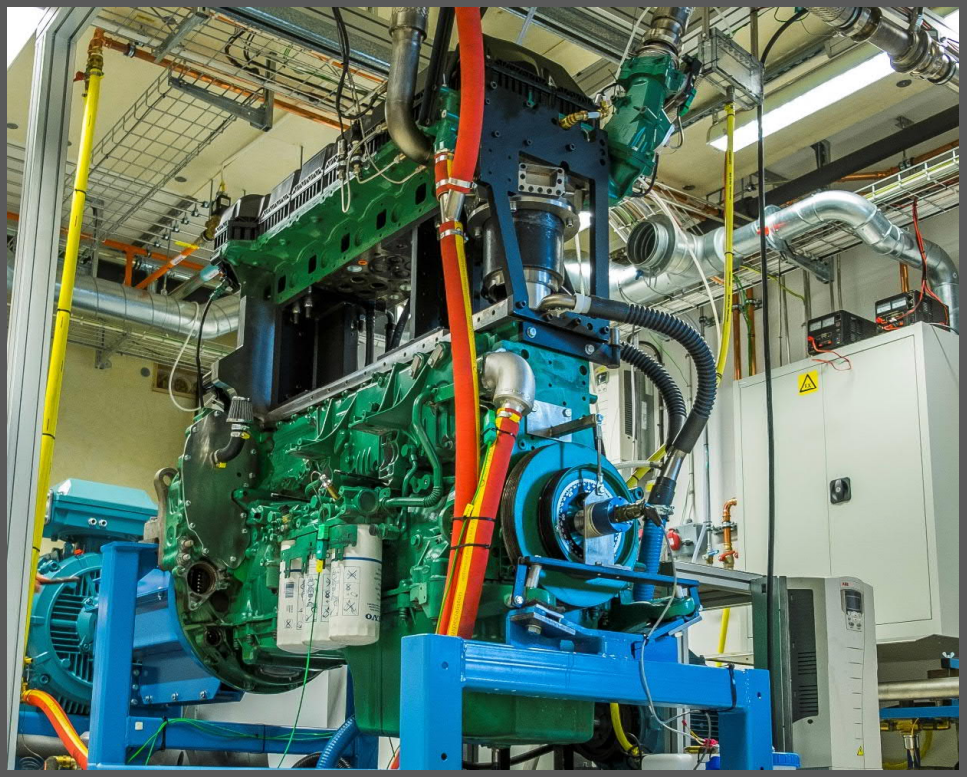
MESILIENT- Methanol engines for sustainable shipping and resilient electricity generation, PI Martin Tunér

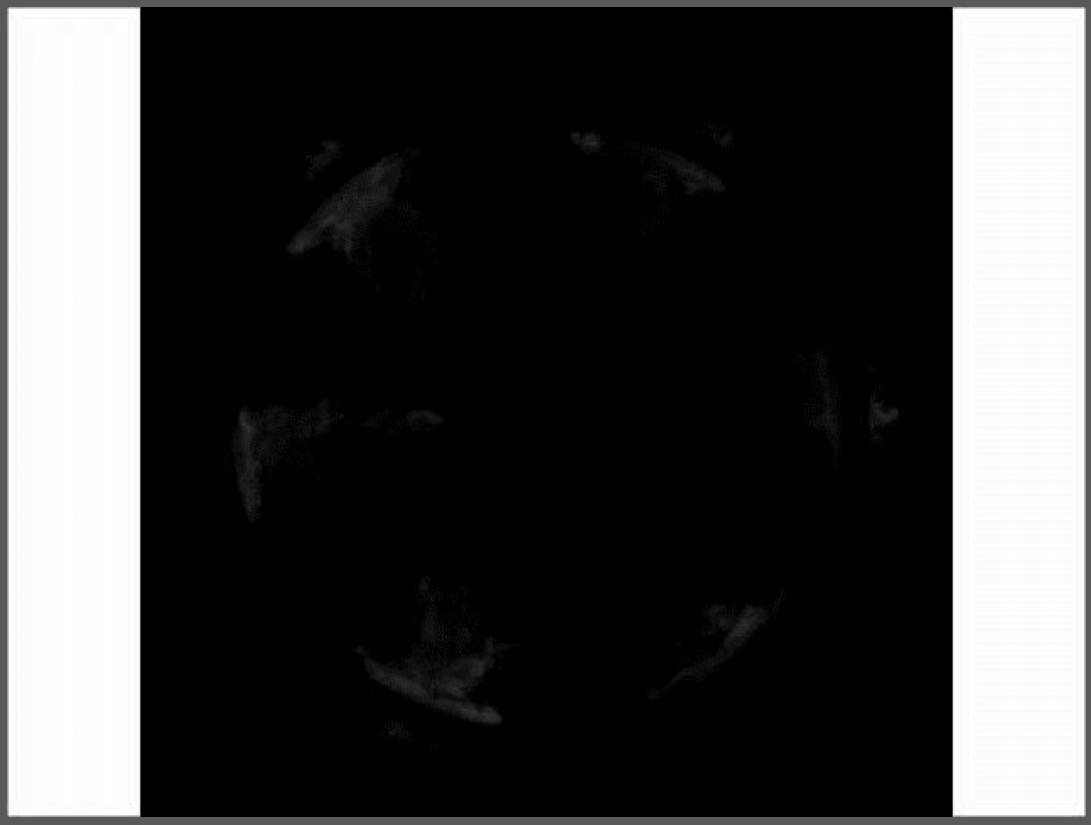


Infrastructures

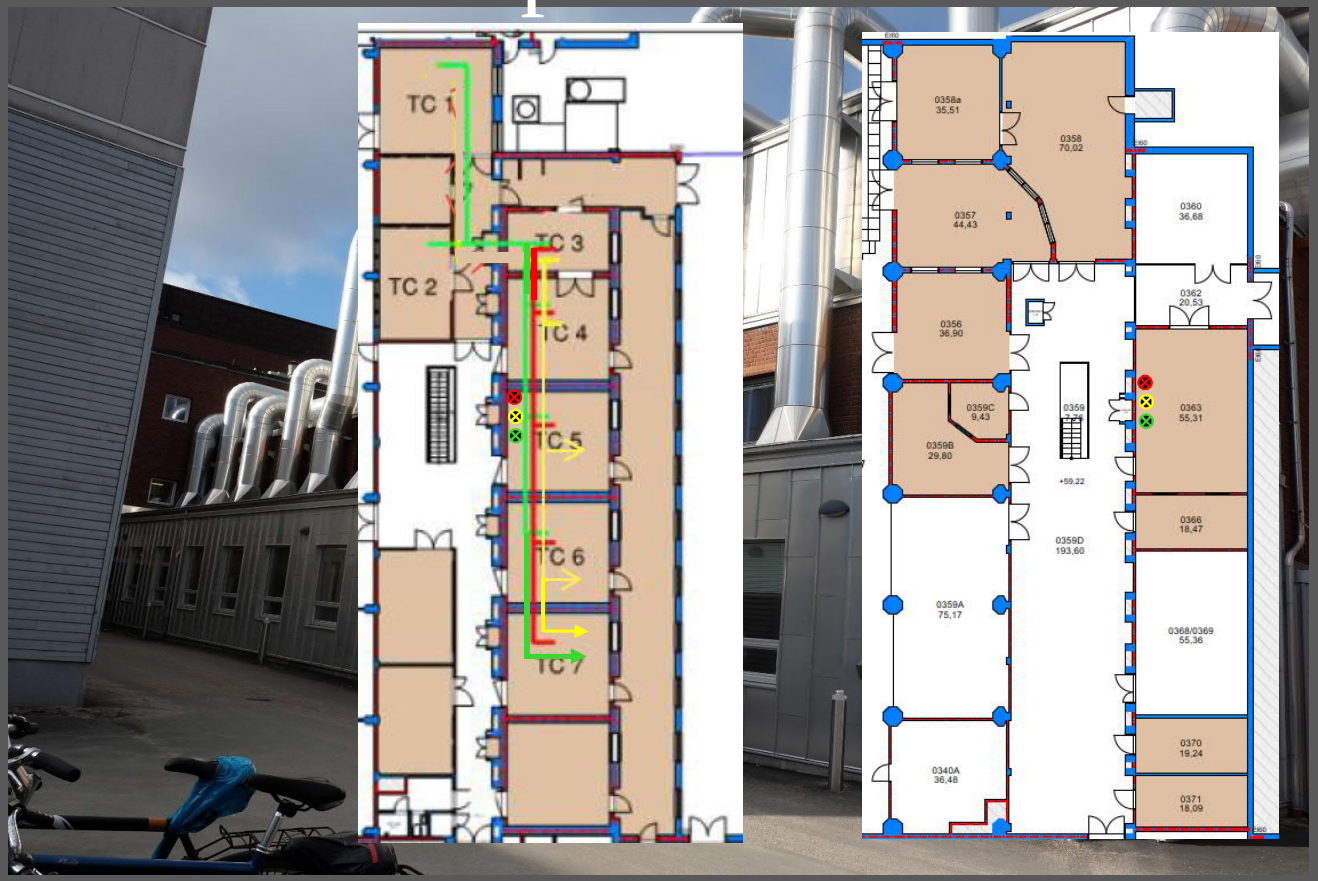
- 7 HD & 2 LD engines (SC, multi-cylinder, optical)
- Medium-speed marine engine (SC, optical, Lund)
- CFR engine
- Fuel cell
- BG/NG/H2 (high pressure installations finished 2025)
- Various CFD tools
- Broad range of lasers and other diagnostic tools
- NI / Labview control systems
- AVL emissions analysers
- AVL FTIR & Protea FTIR & IAG FTIR
- MSS + various equipment for PM
- EATS on building
- And more…

Core expertise – Optical diagnostics





New Infrastructure and right sizing lab – new research capabilities

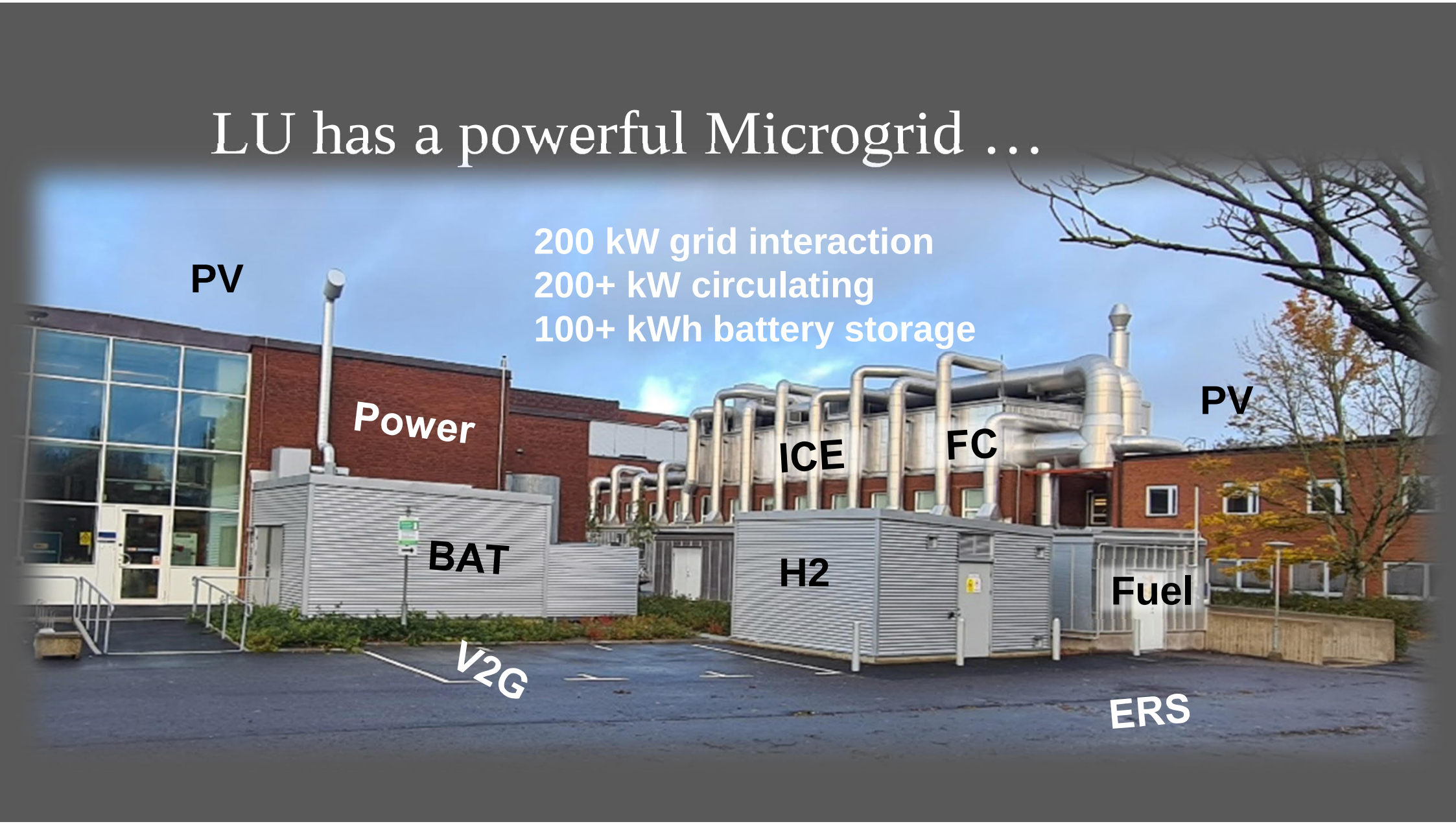


H2 High pressure (10-500bar)

H2 Low pressure (1-12bar)

CH4 High pressure (10-500bar)

LU has a powerful Microgrid …



Dual Fuel Engines?

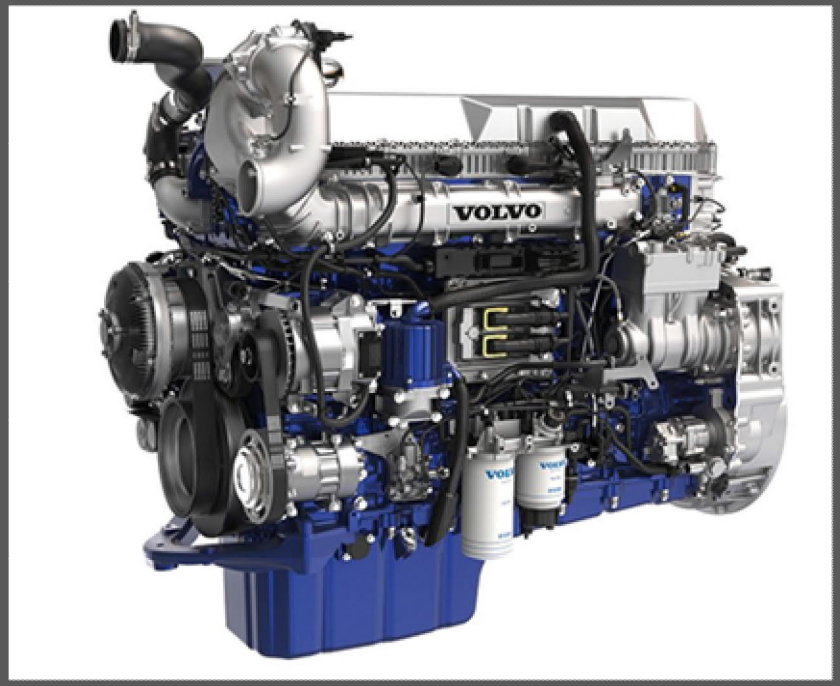
”...It follows from the foregoing that if a given mixture is compressed to a degree below its igniting-point, but higher than the igniting-point of a second or auxiliary combustible, then injecting this later into the first compressed mixture will induce immediate ignition of the secondary fuel and gradual combustion of the first mixture, the combustion after ignition depending on the injection of the igniting or secondary combustible...”

Rudolf Diesel, U.S patent, 1901

Dual Fuel Engines

What?

Dual fuel engine
Primary fuel: Natural gas/ Biogas
Pilot fuel: Diesel/ HVO/ RME



Why?

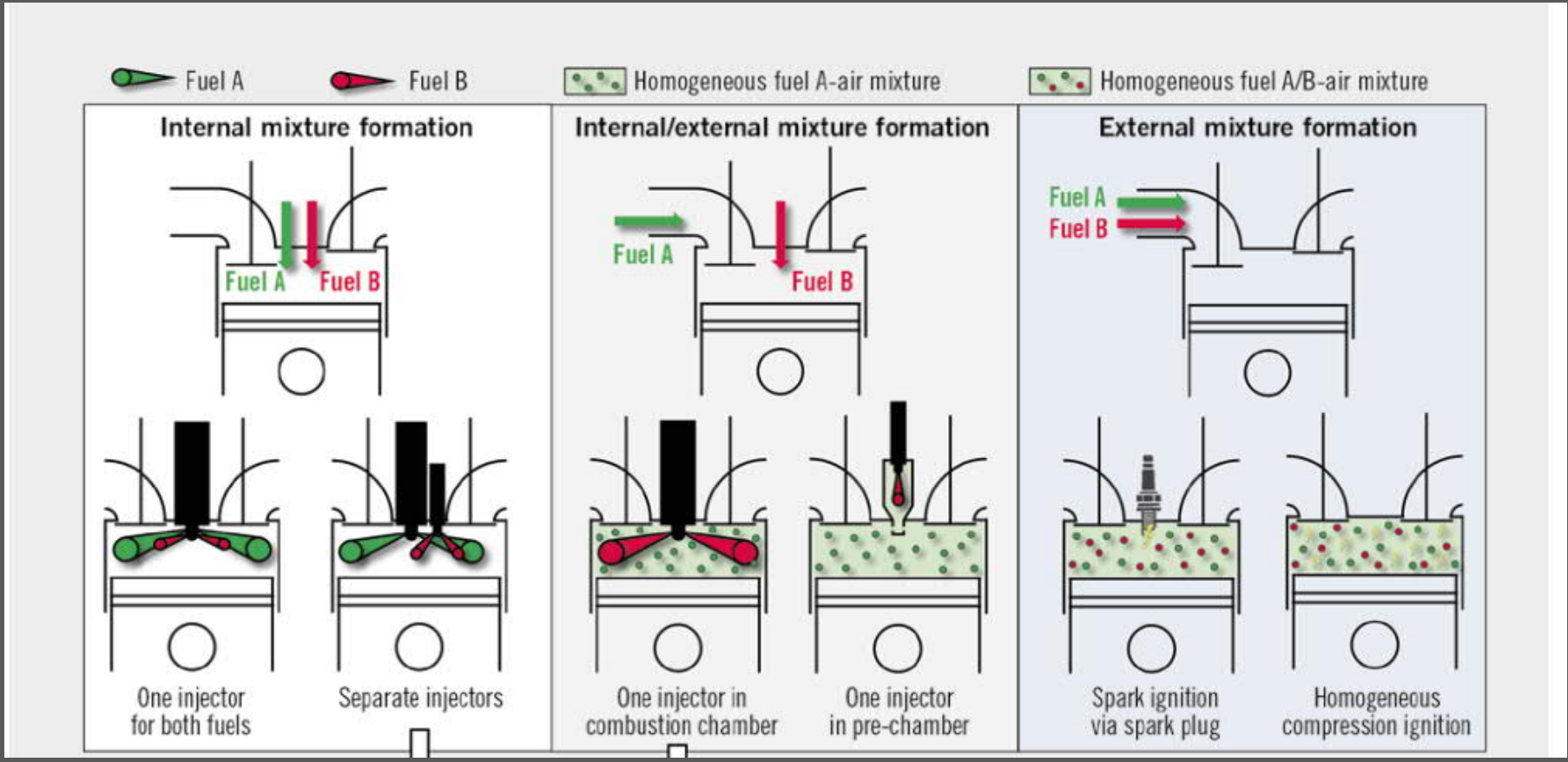
- Lower operational costs
- Improved efficiency (compared to SI engines)
- Reduced carbon emissions
- Fuel Flexibility

Why not?

- Methane emissions (compared to)
- “Higher” investment costs


GASOLINE ENGINE
AIR
FUEL
INTAKE
COMPRESSION
COMBUSTION
EXHAUST
GASOLINE ENGINE
DIESEL ENGINE
AIR
FUEL
DIESEL ENGINE

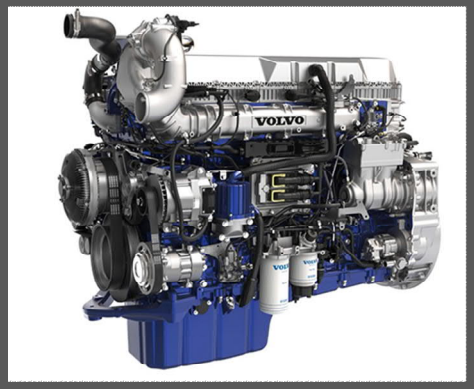
How?



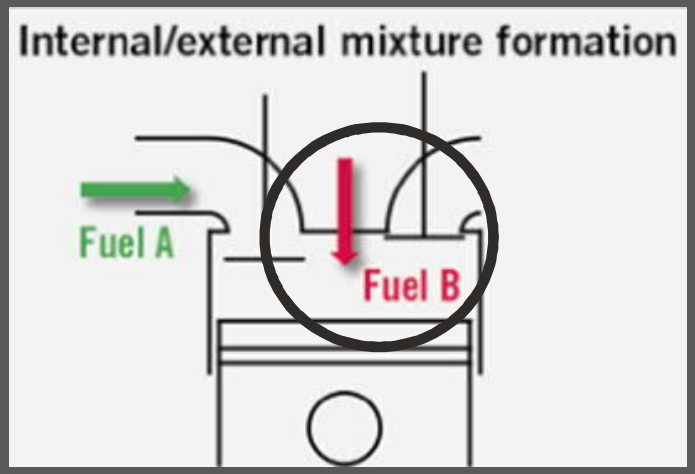
Sprenger, F., Fasching, P., Granitz, C. *et al.* New Dual-fuel Combustion Process for Passenger Car Engines. *MTZ Worldw* **79**, 60–67 (2018). https://doi.org/10.1007/s38313-018-0037-1

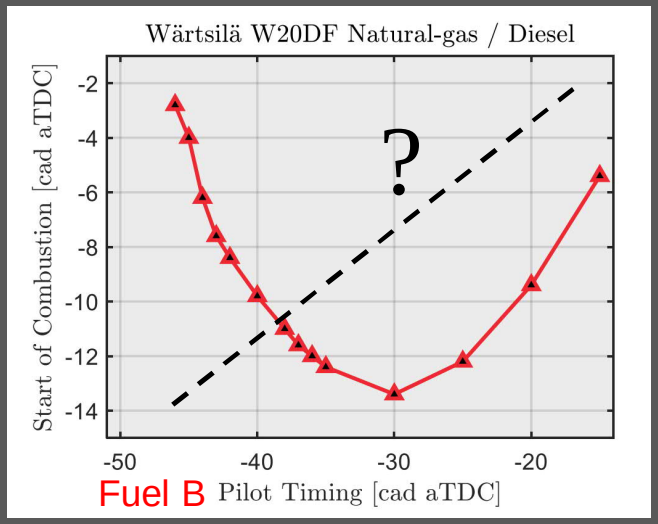
Dual Fuel Research at Lund University

- High pressure hydrogen injection using diesel/HVO as pilot fuel
  - PhD-student Yannick Rousseeuw (2024-ongoing)
- Experimental Investigations on Natural Gas-Diesel Dual Fuel Combustion
  - Dr. Menno Merts (2022)
- Advancing the understanding of pilot ignition in dual fuel engines
  - Dr. Pablo Garcia (2018)



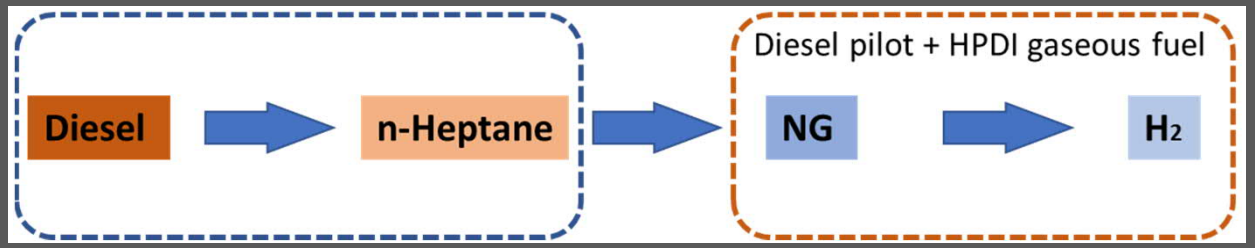
Dual Fuel Research at Lund University

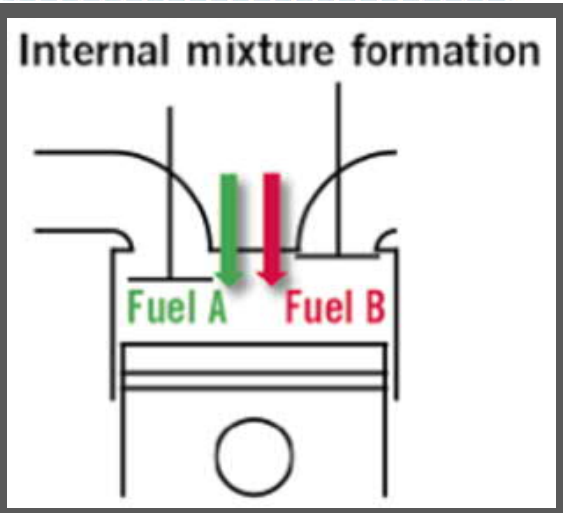


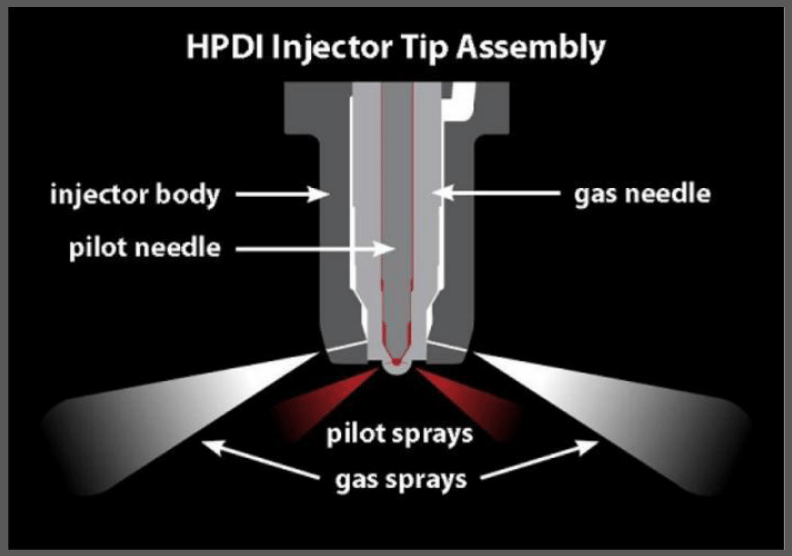


DI Dual Fuel

(PhD-student Miaoxing Gong and Yannick Rousseuw)



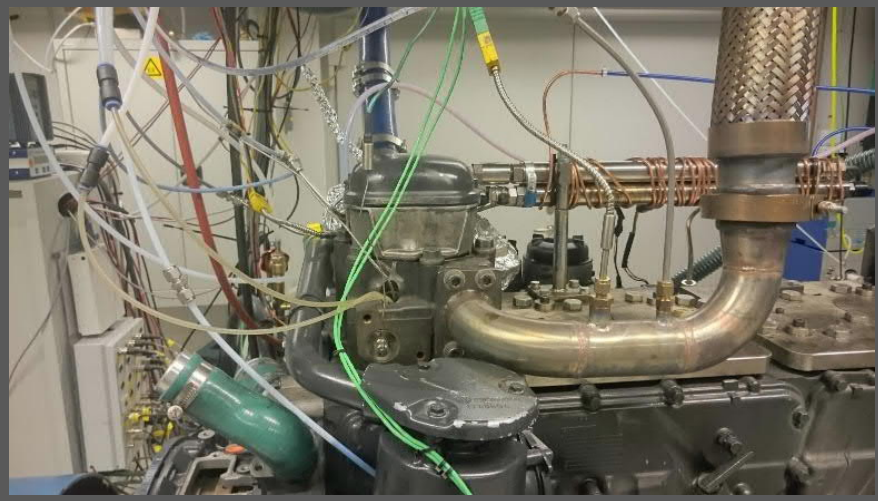




*Pilot and primary fuel timings

*Gas sprays to be tested: NG, H2 and H2/NG

Experimental activities in LocaGas



Experiments:

- Reference case with HVO as pilot fuel
- Model gas composition:
  - **20% methane (CH_4) and 80% carbon dioxide (CO_2)**

- **TEST WITH PYROLYSIS OIL AS PILOT FUEL**
  - Try running the same case as the reference case but replace the renewable pilot fuel (HVO100 or RME) with a blend of pyrolysis oil in RME/HVO100.
  - For example: 5%, 10%, 25%, 50%, 100% pyrolysis oil.
  - Preheating of the pilot fuel may be necessary at a high proportion of pyrolysis oil.

Pyrolysis oil mixes		Diesel	HVO	RME
A	Oil trap I 530c,35min, Trä, test 241202cb	A.Diesel	A.HVO	A.RME
B	Oil trap II 550c, 35min. Trä test 241202 cb	B.Diesel	B.Diesel	B.RME
C	Condensate 550C, 35 min, trä 2441202 cb	C.Diesel	C.HVO	C.RME

Before mixing

A.Diesel B.Diesel C.Diesel A.HVO B.HVO C.HVO A.RME B.RME C.RME

After mixing

A.Diesel B.Diesel C.Diesel A.HVO B.HVO C.HVO A.RME B.RME C.RME

Tack!

- Questions?
- Marcus.lundgren@energy.lth.se
- Tel: +46-702923941