Objectives / Expected results

To develop **engines able to switch between fuels**, whilst operating in the most cost effective way and complying with the regulations in all sailing regions.

- **Development** of a **fuel injection system** for multi fuel purposes
- **Demonstration** of **fuel flexible** engine **operation**
- **Feasibility study** on rapid compression/expansion machine (**RCEM**)

1.1 Fuel flexible engine
Identify, design, manufacture, test, and validate systems for flexible engine operation

→ 2-Stroke: Winterthur Gas & Diesel Ltd.

→ 4-Stroke: Wärtsilä Finland Oy

1.2 Feasibility study (RCEM)
Assessment, identification and reporting of existing systems

WP Leader: Andreas Schmid
DWP leader: Kaj Portin

Status:

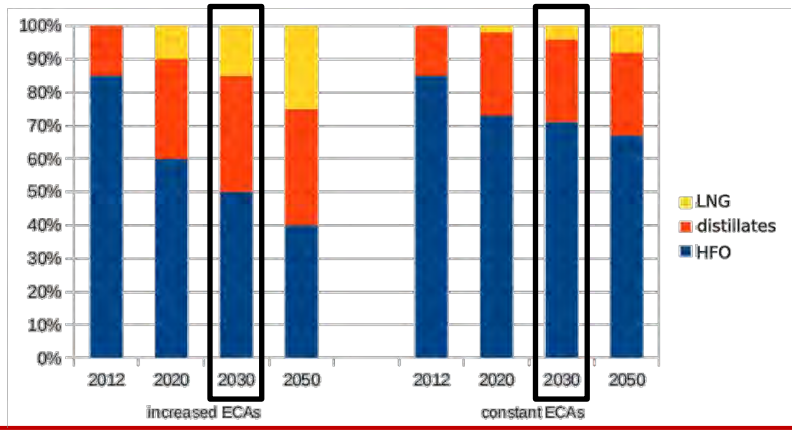
Literature study in review process:

Studies from
Lloyd's Register, DNV GL, Maersk, ICS, BIMCO, Lloyd's List, BP, Exxon, Shell, Concawe, IMO, IEA, WWF, Chalmers, BC, MEC
have been taken into account

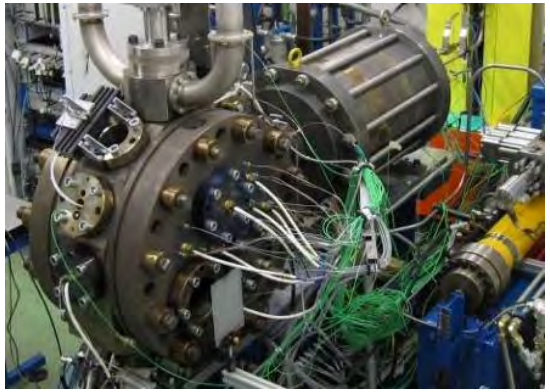
Due to the uncertainty of the global sulphur cap and the low crude oil price, studies on future fuels are very difficult.

The fuel consumption in shipping will be doubled until 2030 (LR)

Most of the studies expect an HFO share between 50% and 70% by 2030, depending on the global sulphur cap.
The rest is mostly MDO/MGO, and between 5%-15% LNG



WP1: Sub project 1.2 *Feasibility study RCEM (2-stroke)*



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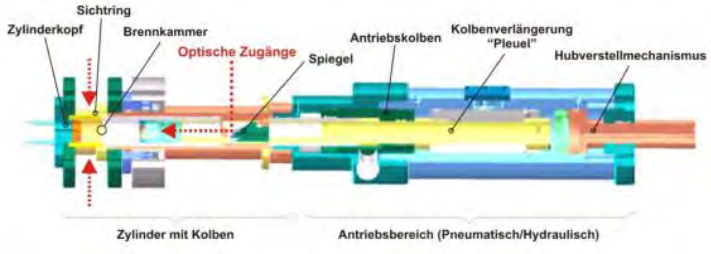


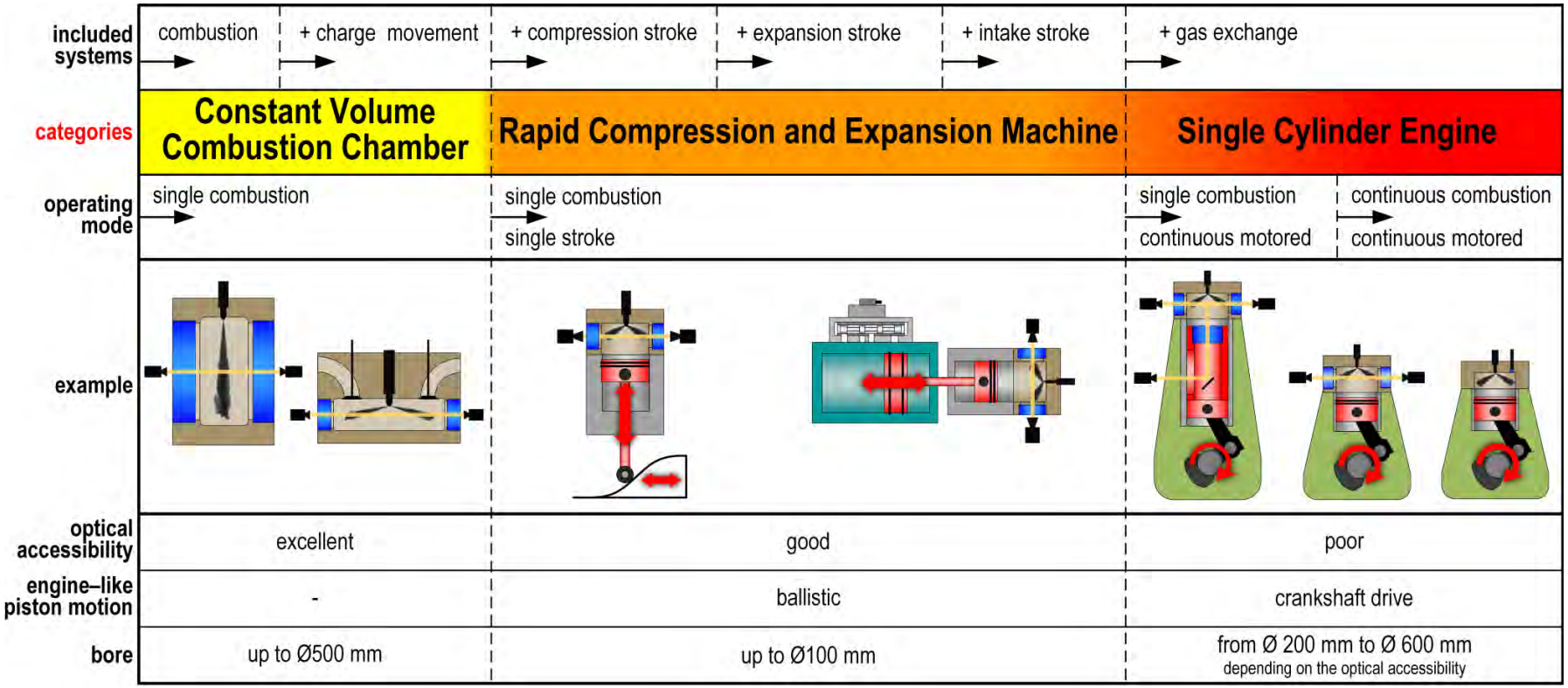
Constant volume chamber

- Real engine dimensions
- No piston => no mechanical compression
- Very good optical accessibility
- No vibration
- No oil mist
- Negligible fuel consumption

Test engine (e.g. RTX-6)

- Limited optical accessibility
- High fuel consumption
- Vibration, noise, emissions
- Non ideal conditions for quantitative optical measurements

WP1: Sub project 1.2 *Feasibility study RCEM (2-stroke)*



Completed activities

- Literature review accomplished (database)
- Characterization and classification
- Requirement specifications (close to be defined)

Assessment applicability features

- Flexibility combustion process
- Variation operation conditions
- Fuels (HFO, blends, gas, mixtures)
- Design options (optical accessibility)
- Reproducibility, repeatability
- Various, etc. …

Elaboration of two concepts

→ crank mechanism driven

→ alternative (e.g. hydraulic) driven

DWP Leader: Kaj Portin

How

Measurement technology for intermediate combustion products formed inside the combustion chamber will be developed and tested.
The impact of switching between different fuels on possible after-treatment devices and engine components will be part of the investigations.

Partners: Aalto-yliopisto, Vaasan yliopisto UNIVERSITY OF VAASA, WÄRTSILÄ

Expected Results

A fully fuel flexible optical injection and ignition test platform for low-speed Diesel engines will also be produced. A fully optical medium-speed multi-fuel engine will be developed and tested for the first time.

Activities Plan Year 1 (Status and progress October 2015)

- Flex fuel pre-study (Identify requirements for flexible injection system)
  - →Investigation started on injection system requirements for fuels C3 to C20
- Numerical modeling studies for liquid bio-fuels, methanol, or DME
  - →On-going master thesis on 1-D simulation of the effect of the methane and methanol on pre-combustion in-cylinder conditions.
- Spray chamber studies for various new fuels and for different DF pilot setups
  - →Planning and development of research environment is started.
- Ignition studies for non-auto-igniting fuels
  - →Background material is being collected
- Development of new in-cylinder measurement and diagnostics sensors
  - →Online gas quality sensor ordered and testing starts in November.
  - →Master´s Thesis work started 1.10.0215

WÄRTSILÄ Vaasan yliopisto UNIVERSITY OF VAASA Aalto-yliopisto