

High Efficient 100kW_{el} R744 Compressor

November 2012

A. Hafner, P. Neksa – SINTEF Energy AS
C. Schmäzle, F. Obrist – Obrist Engineering

Content – 100 kW_e R744 Compressor

- Background / Motivation
- Compressor Concept and Ideas
- Test Facility
- Measurement Results
- Summary / Outlook

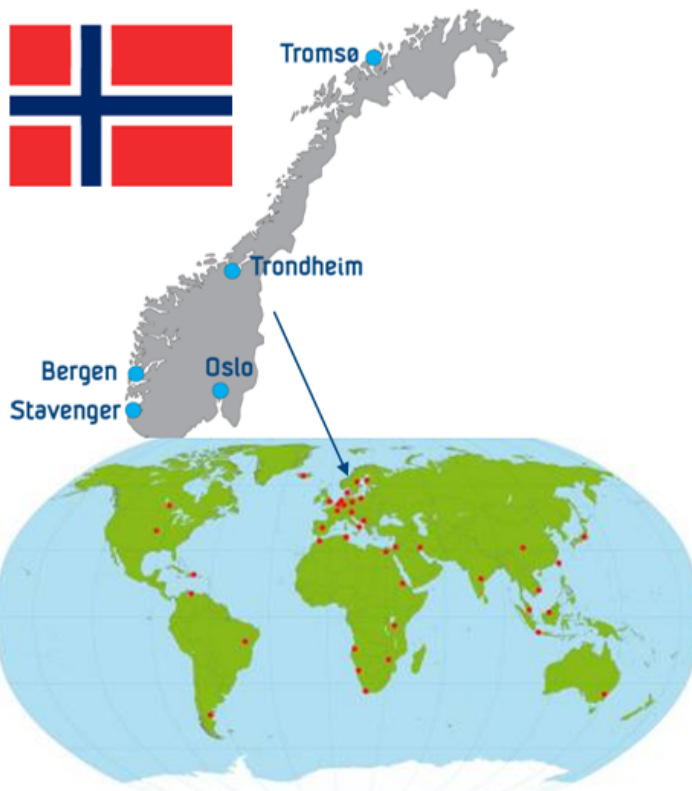
Background / Motivation

- Project initiated by SINTEF Energy AS in Norway
 - Target: 100kW_{el} , high efficient and low OCR compressor
 - High Efficient because of:
 - maximising R744 system COP
 - improving R744 performance under hot ambient
 - 100kW_{el} target because of:
 - no single R744 compressor unit available today, only parallel operation with complex piping and installation, customer requests on 100kW_{el} compressors
- SINTEF / OE common development on 1st prototype

SINTEF Energy Research

SINTEF - A contract research organization based in Trondheim, Oslo, Bergen, Stavanger and Tromsø

- SINTEF is one of the largest independent research organisations in Europe.



Social perspective

SINTEF wishes to contribute to the creation of value and to a society in healthy sustainable development

Business concept

SINTEF sell research-based knowledge and related services to Norwegian and international clients.

Fundamental values

Honesty, Generosity, Courage and Unity

SINTEF has 2145 employees,
1600 situated in Trondheim and 430 in Oslo

SINTEF receives only 3% basic grants

Gustav Lorentzens' Message

We have heard a great deal lately of the **harmful effects to the environment when halocarbon refrigerants are lost to the atmosphere.**

This should **not really** have come as **a surprise** since similar problems have happened over and over again. Numerous cases are on record where **new chemicals,** believed to be a benefit to man, **have turned out to be environmentally unacceptable,** sometimes even in quite small quantities (DDT, PCB, Pb etc.).

In the present situation, when the CFCs and in a little longer perspective the HCFCs are being banned by international agreement, it does not seem very logical to try to replace them by another family of related halocarbons, the HFCs, equally foreign to nature 1

Int. J. Refri 9. Vol. 18, No. 3, pp 190 197, 1995

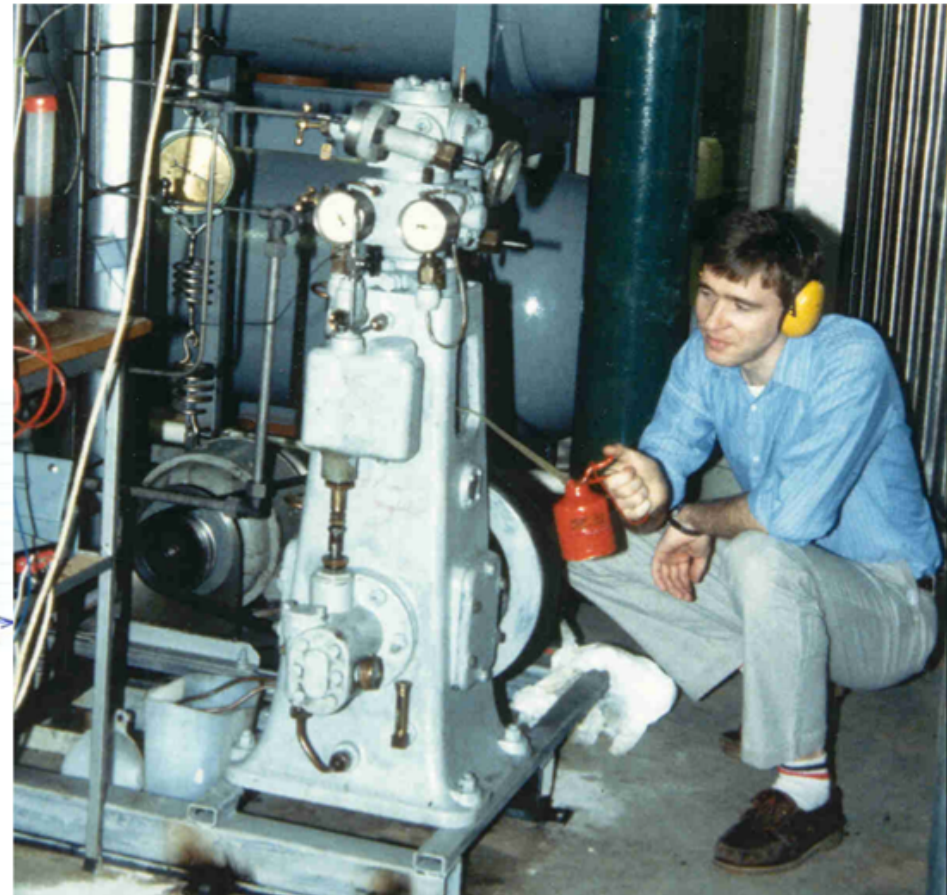
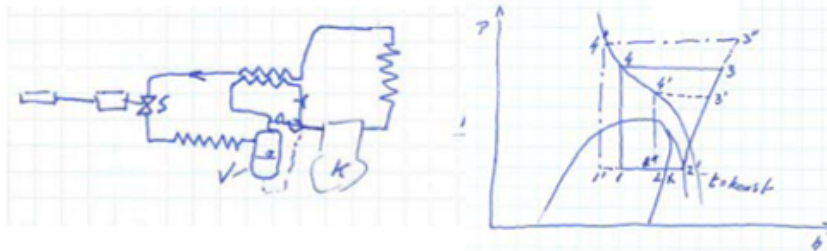


Prof. Gustav Lorentzen (1915-1995)

R744 Compressor History SINTEF



Professor Gustav Lorentzen (1915-1995)



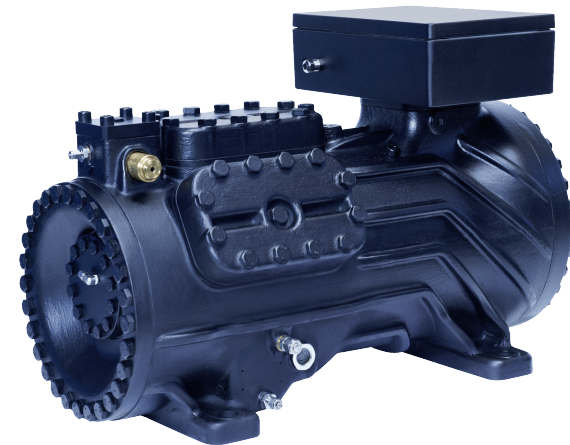
Picture: SINTEF, 1988

Sabroe CO₂ Compressor made in 1926

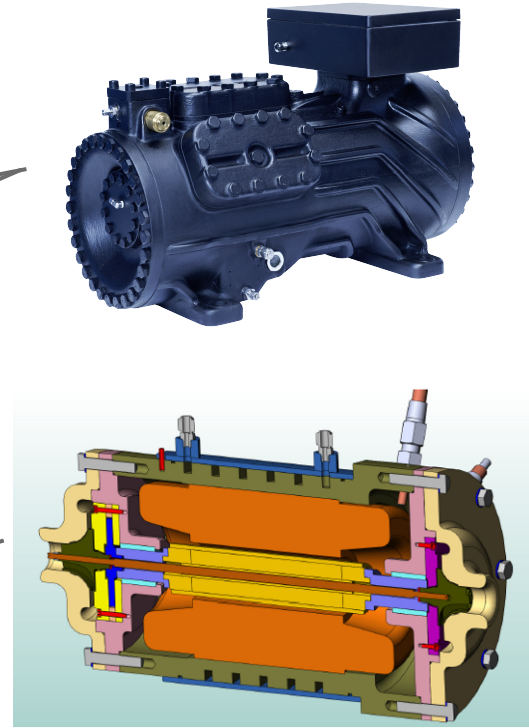
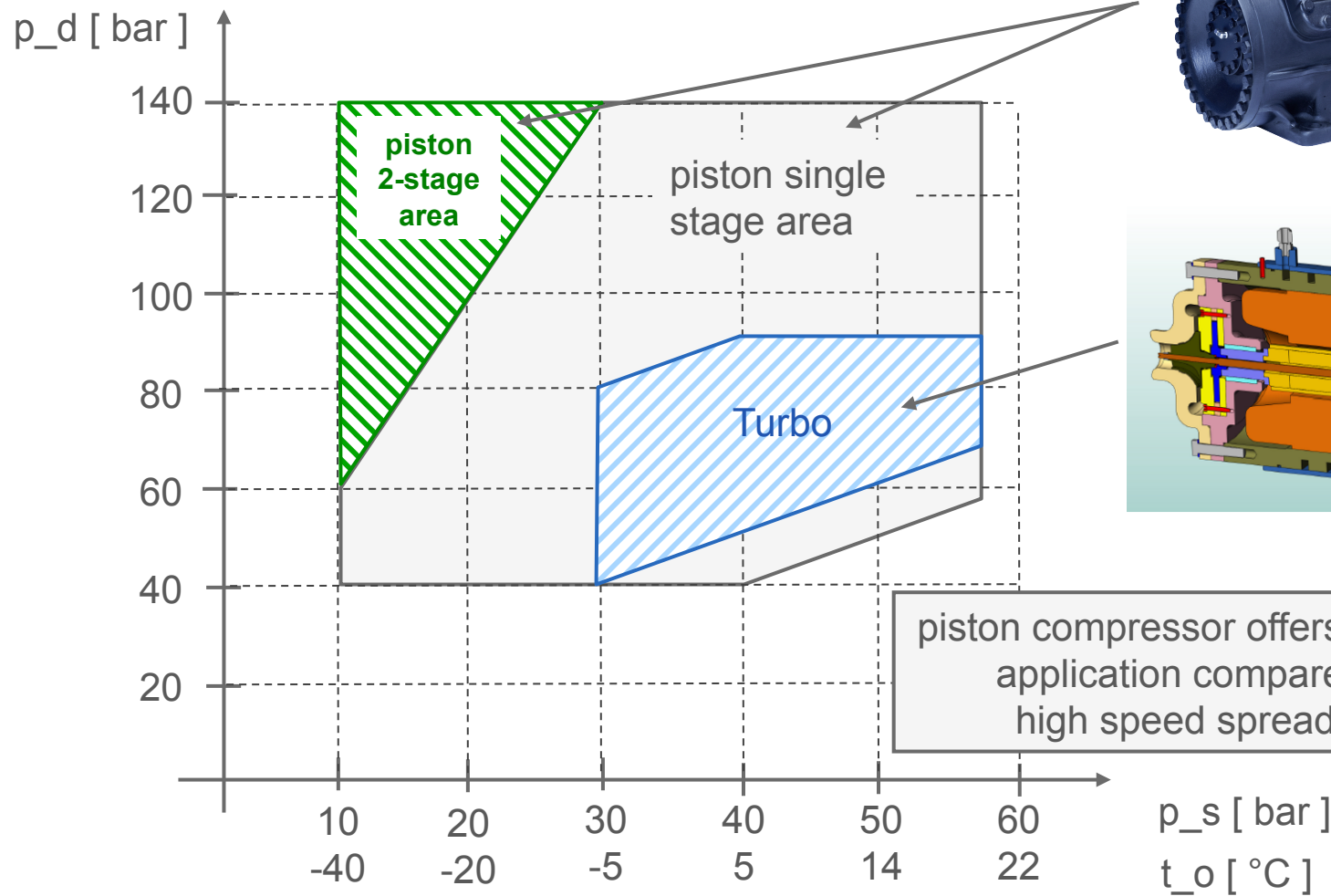
Is it possible to do a 100kW R744 compressor highly efficient ?

100kW_{eI} Piston Compressor Concept

- using compactness of R744 properties
- combining a high efficient, compact PM motor to it
- smart heat management for highest efficiencies
- improved valve system for high speed
- demonstrating high speed spread of 1:7
- active oil separation and intelligent oil management for lowest, external OCR



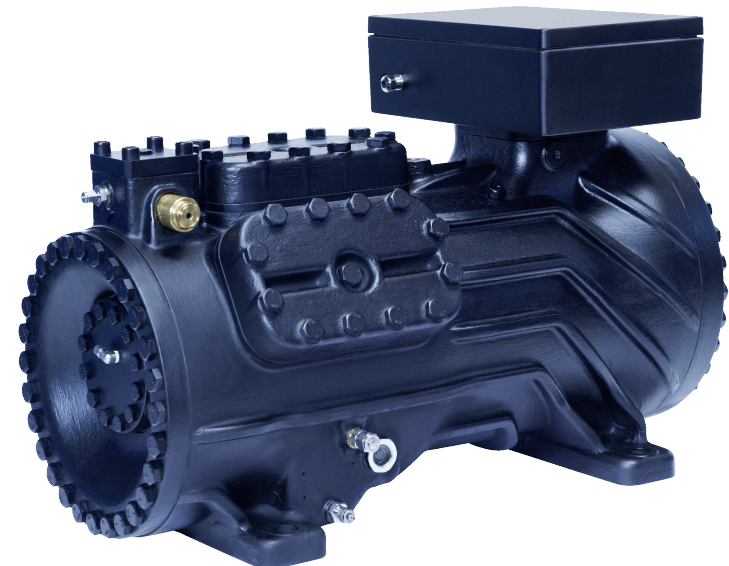
Application Envelope Comparison:



piston compressor offers wide range of application compared to turbo high speed spread possible

100kW_{el} Piston Compressor Main Data

- dimensions: 500 x 440 x 830 mm (H x W x L)
- weight: 286 kg
- volume flow rate: 13 to 95 m³/h (1:7)
- displacement: 380 cm³ per revolution
- 6 cylinder – 2 x 60° (Fan Arrangement / Y)
- max. el. power consumption: 100 kW_{el}
- AC and HP mechanism layout
- speed range: 600 to 4.200 rpm
- max. HP pressure 140 bar

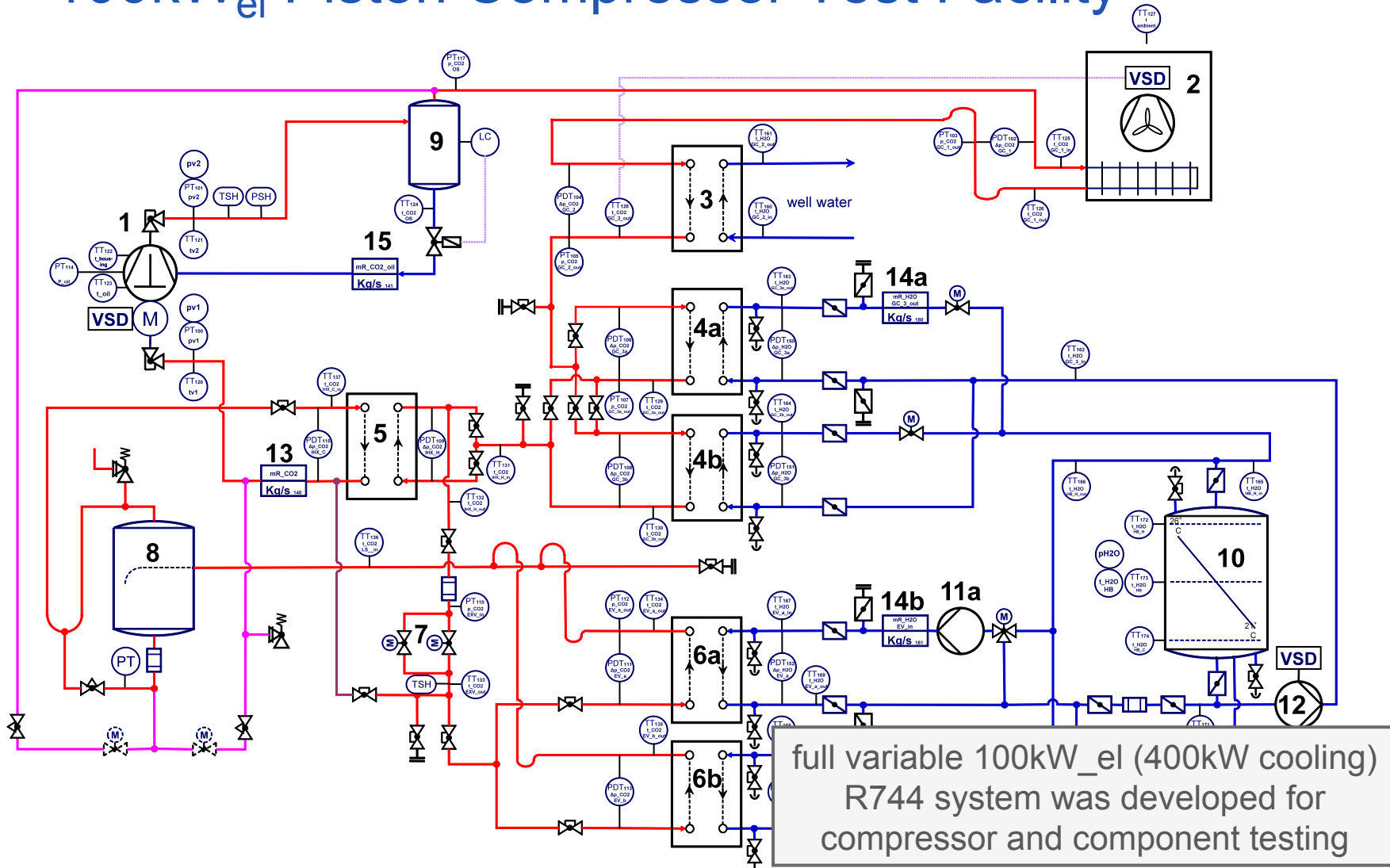


100kW_{eI} Piston Compressor - Dimensions

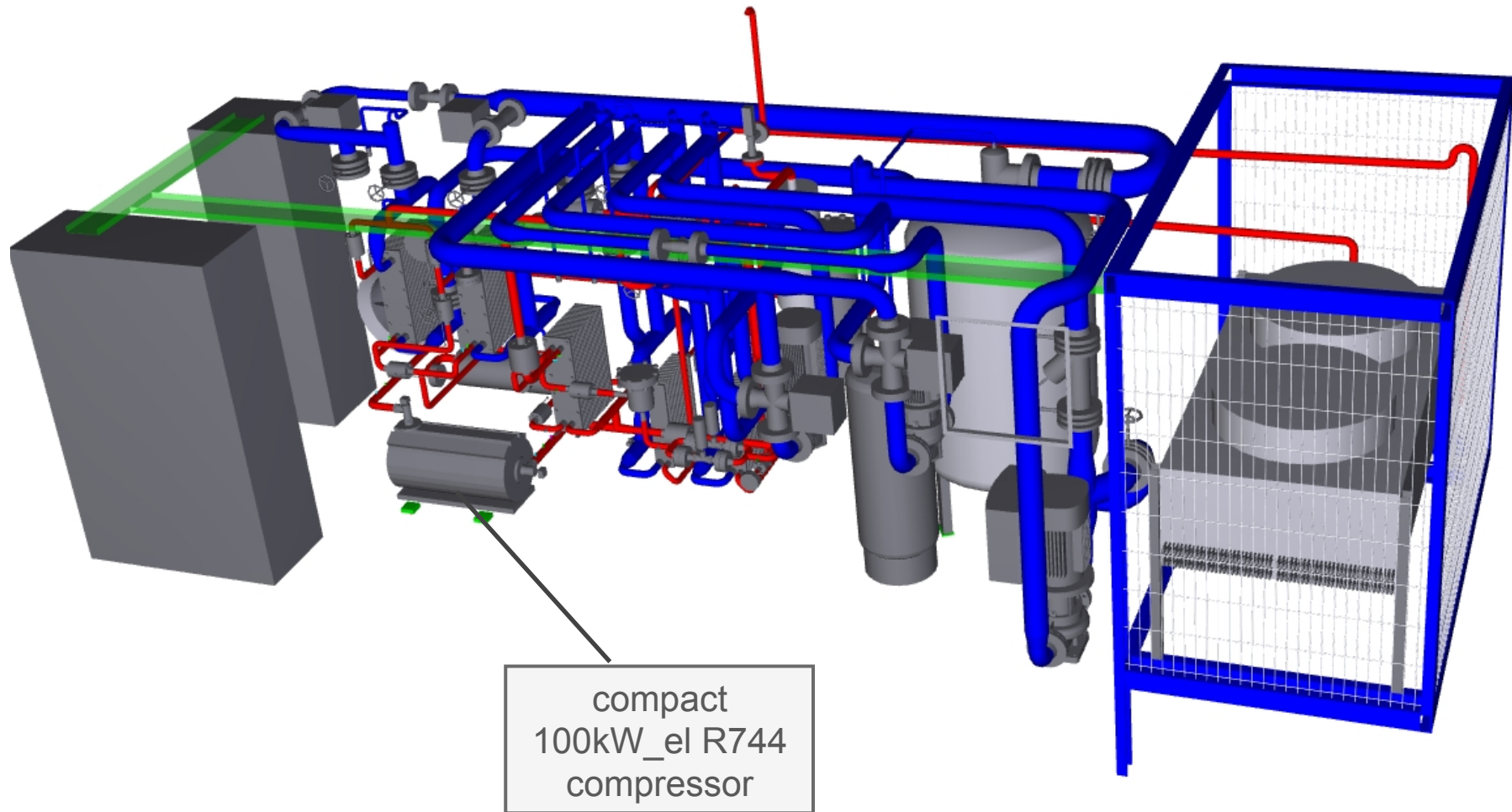


Dimensions
Length: 827 mm
Height: 498 mm
Depth: 434 mm
Weight: 280 kg

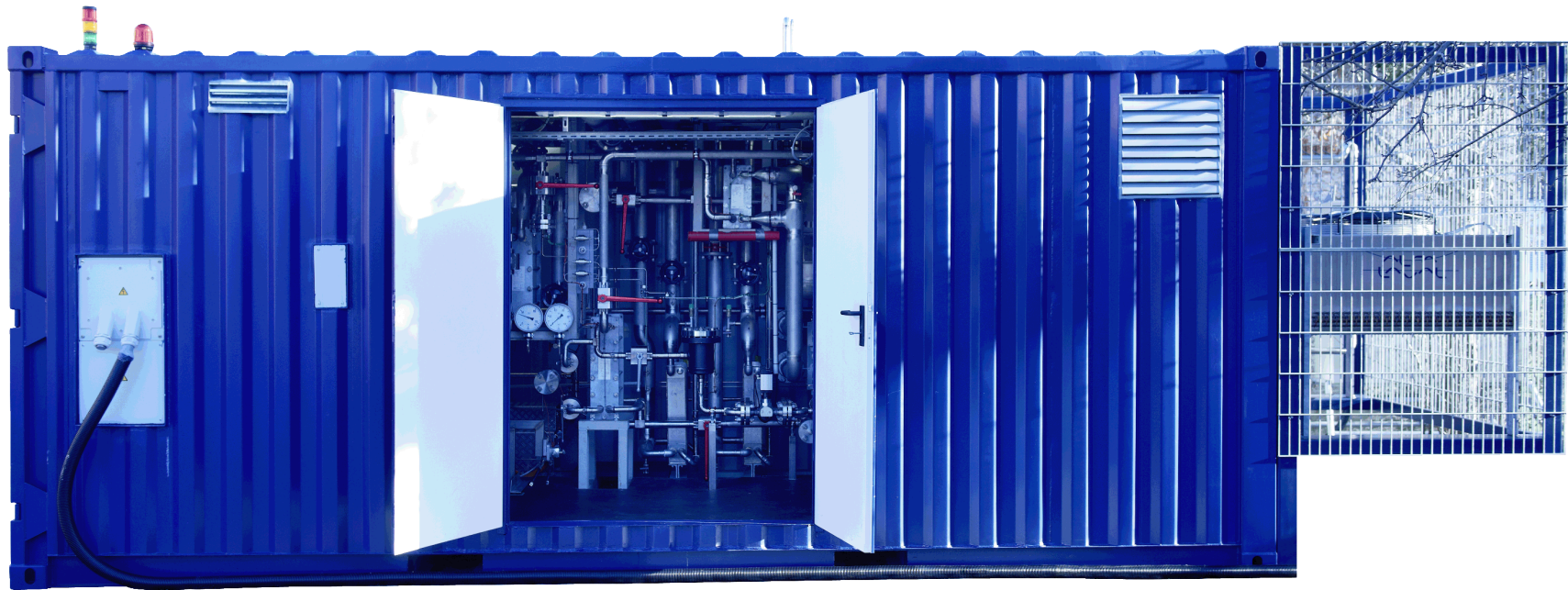
100kW_{el} Piston Compressor Test Facility



100kW_{eI} Piston Compressor Test Facility



100kW_{eI} Piston Compressor Test Facility



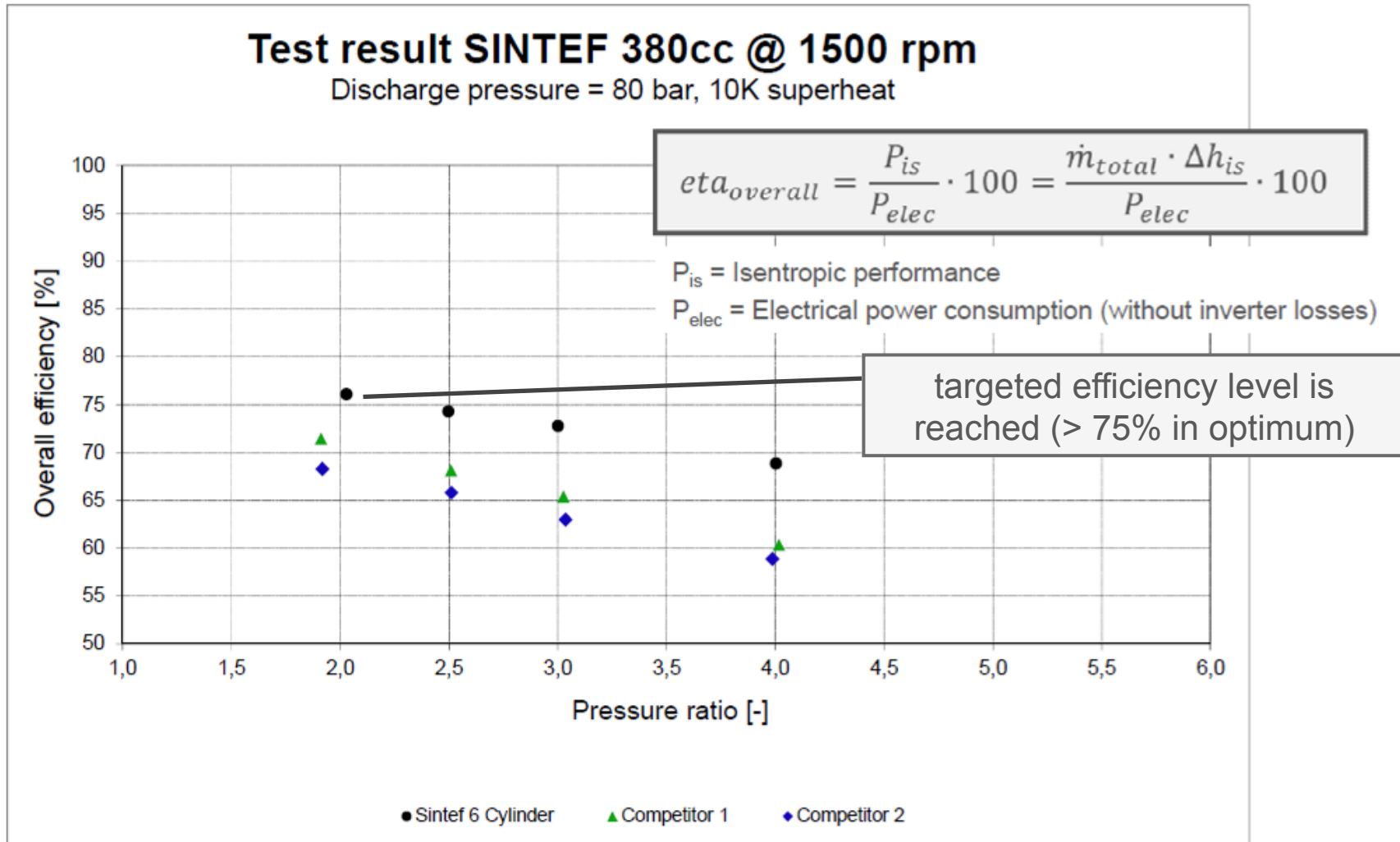
20ft container built in full system
Initial operation: Lustenau, Austria
Now: Trondheim, Norway

100kW_e Piston Compressor Test Facility

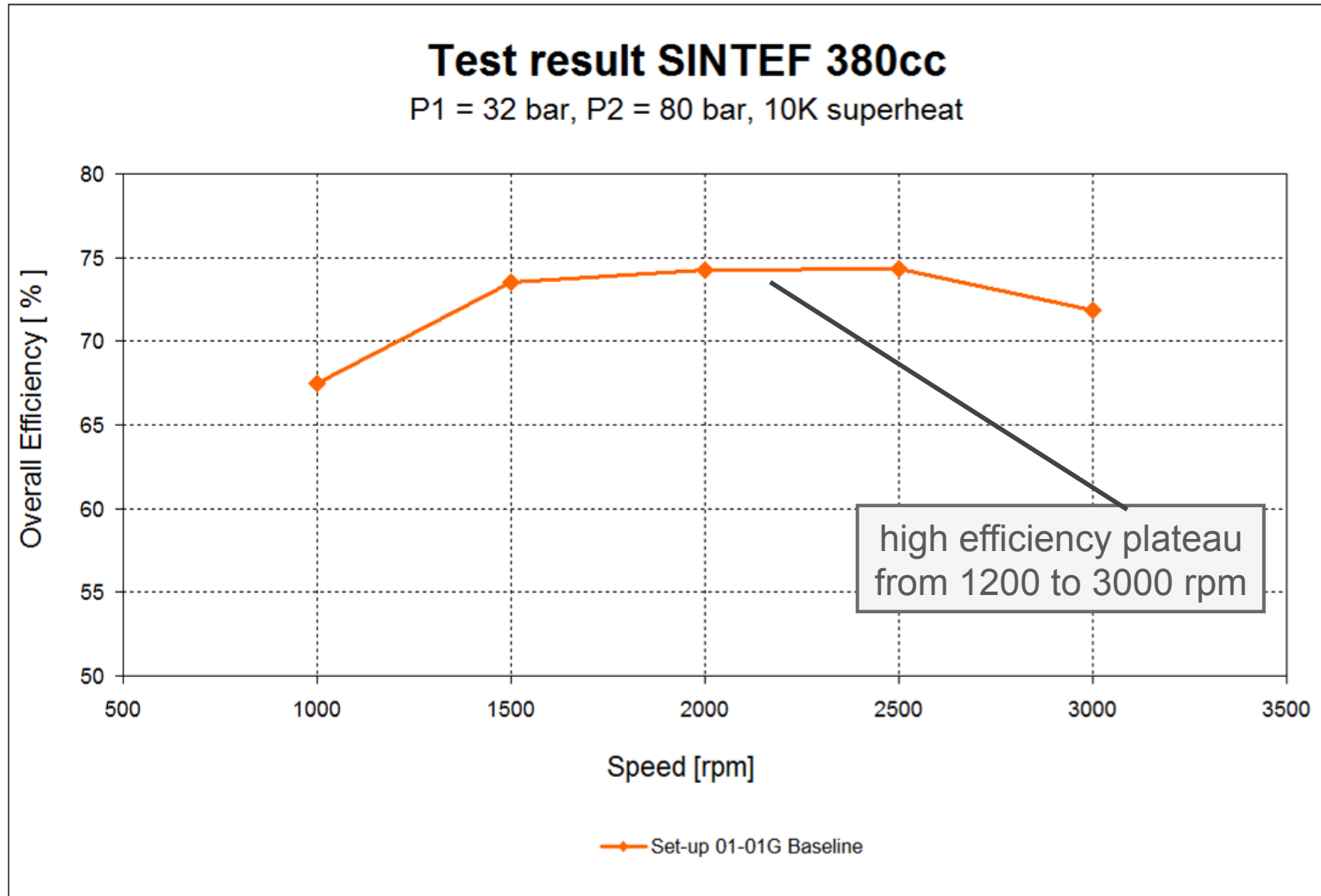


20ft container built in full system
Initial operation: Lustenau
Now: Trondheim, Norway

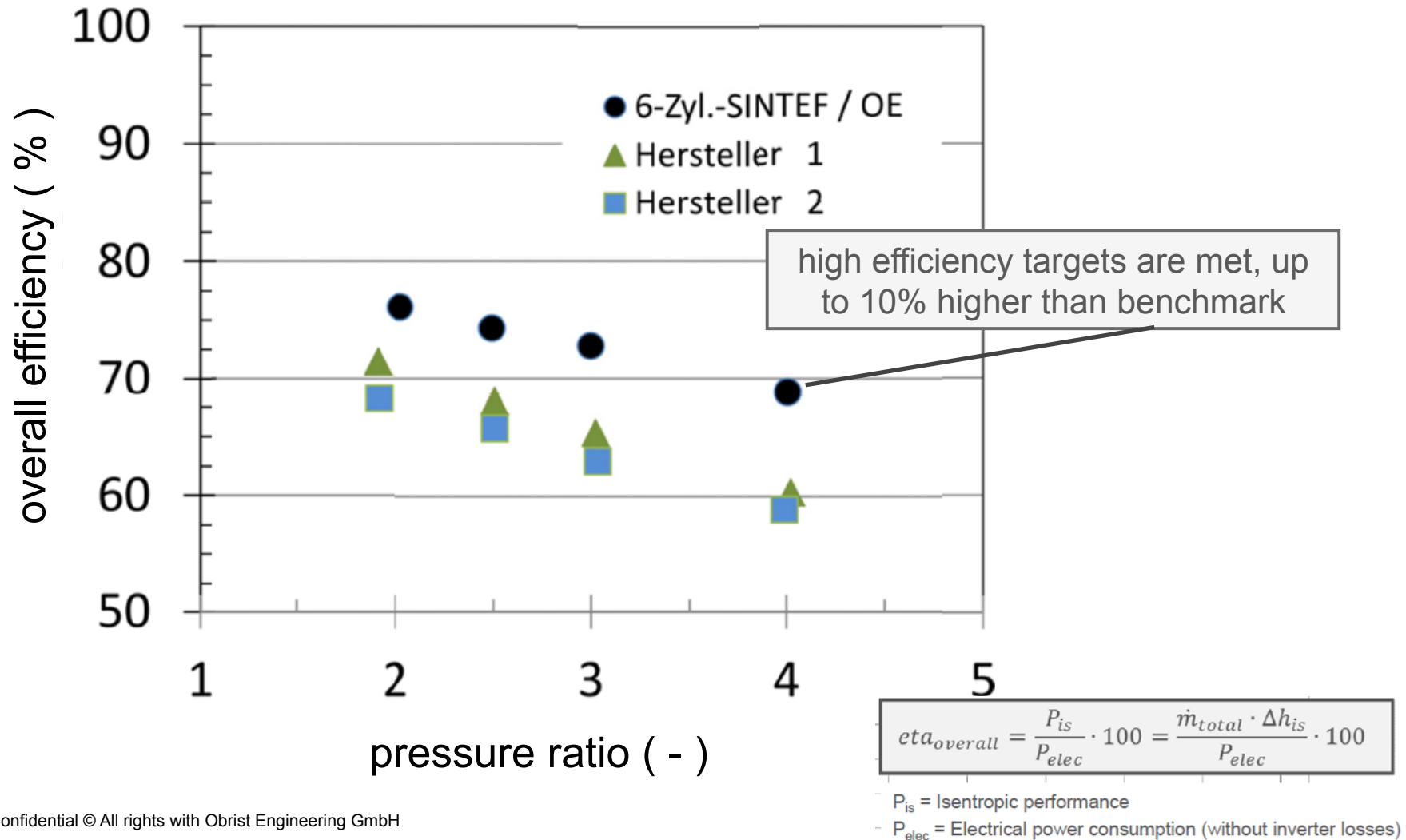
100kW_{el} Piston Compressor First Results



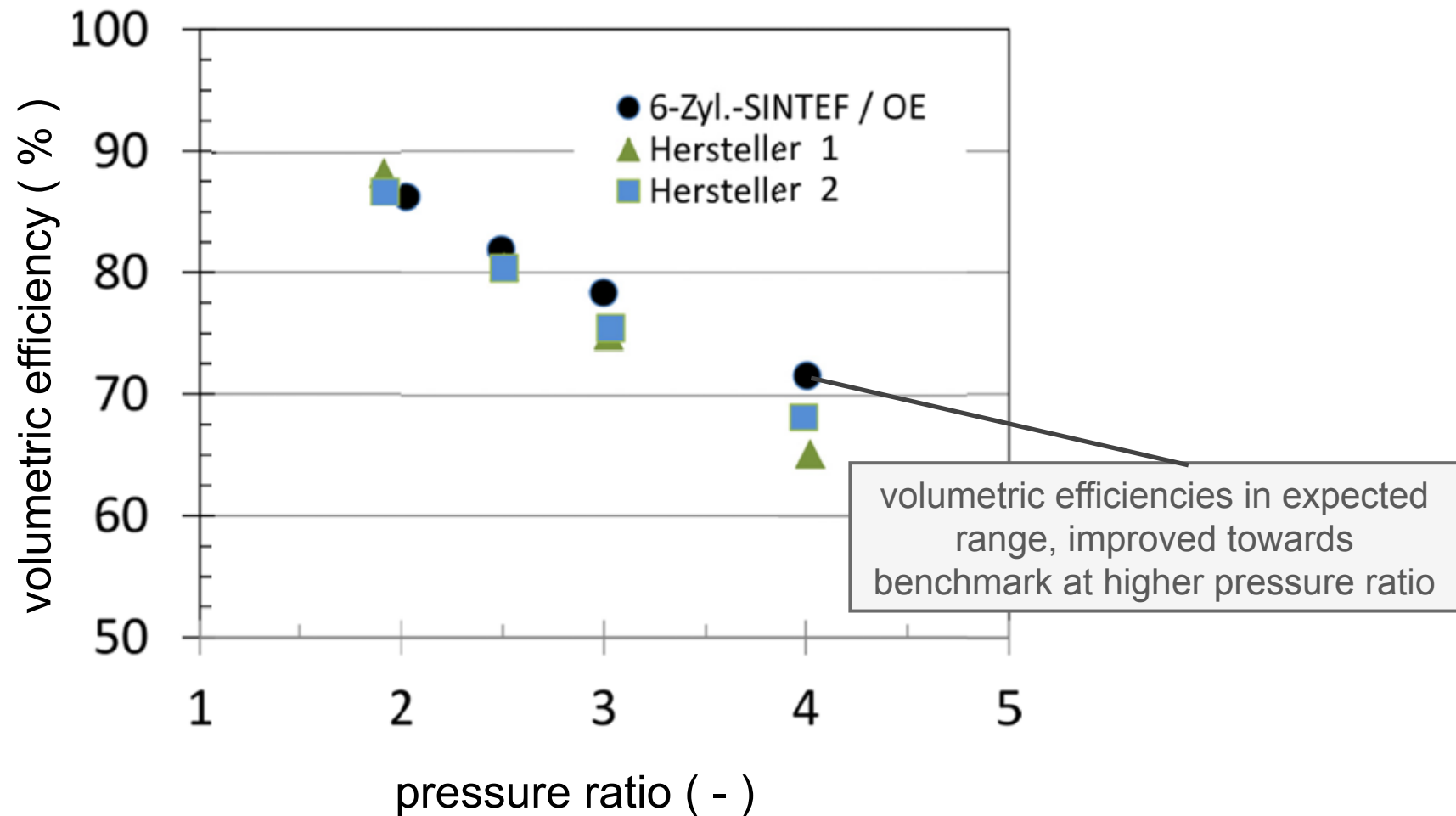
100kW_{el} Piston Compressor First Results



100kW_{eI} Piston Compressor Results

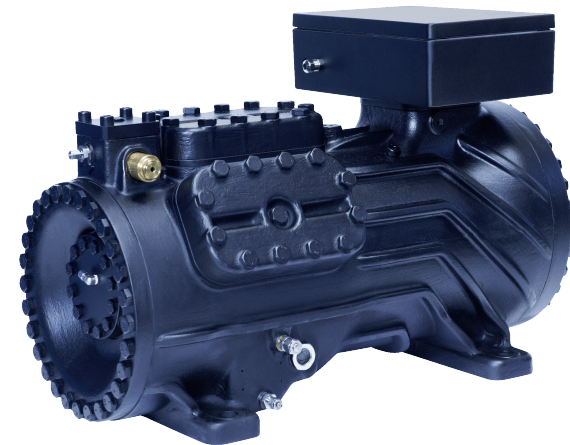


100kW_e Piston Compressor Results



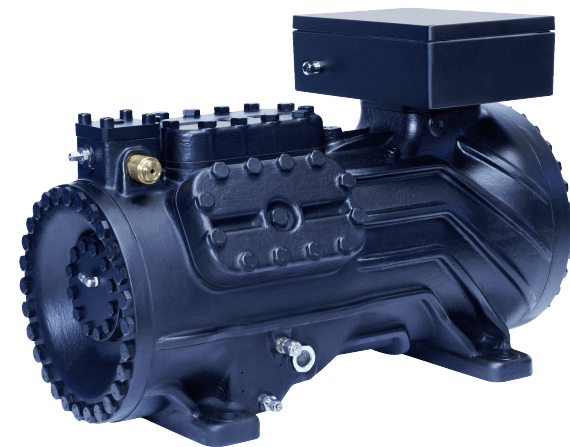
Outlook

- test unit and compressor at SINTEF from August 2012 on
- reliability testing ongoing – operation time approx. 500h so far
- further tests ongoing
 - noval valve system for further eff. Improve
 - alternative concepts heat / lubrication
- OE / SINTEF in contact with possible production companies



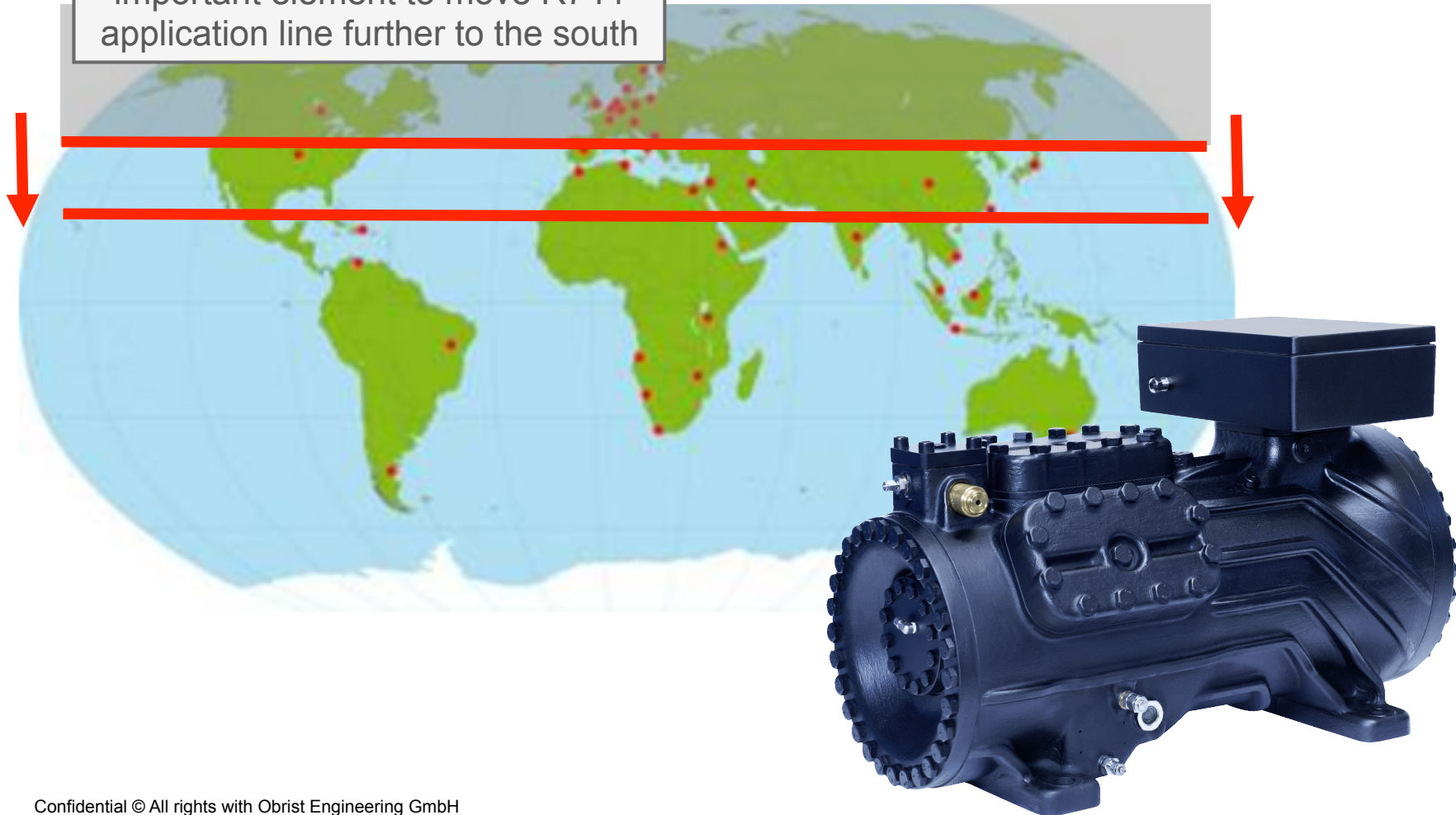
Summary:

- innovative, high efficient 6-cylinder compressor was developed and first – very encouraging - test results available
- high volume flow modulation possible 13 to 95 m³/h
- high performance and efficiency values are measured at low OCR
- fits perfect into
 - commercial refrigeration units
 - large capacity heat pumps
- design prepared for standard AC motors
- main design is validated

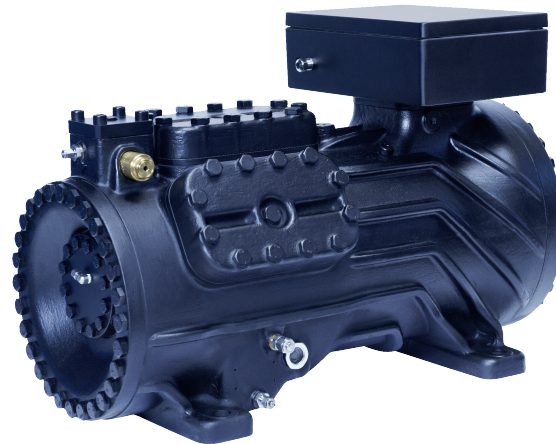


Summary: R744 Application Area Increase

a high efficient compressor is one important element to move R744 application line further to the south



Thank you for your attention !



For further information contact us:

Christian Schmaelzle

Obrist Engineering

c.schmaelzle@obrist.at

Dr. Armin Hafner

SINTEF Energy AS

armin.hafner@sintef.no