SANDEN SHS-33
New ELECTRIC COMPRESSOR

EAAC Frankfurt

September 17th 2012

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Structure of this presentation

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- Sanden Business Overview
- Summary of vehicle trends
- Development History of electric compressors at Sanden
- Explanation of the electrical compressor
- Impact on Safety & Service Notes
- Conclusion and Outlook

Business Structure of Sanden

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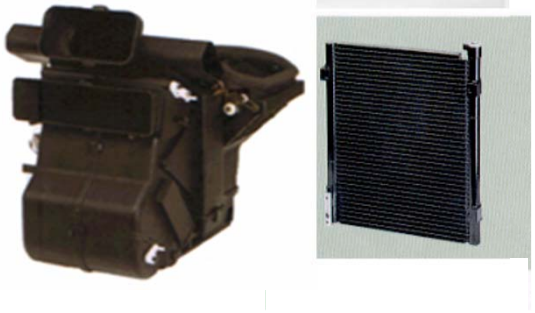
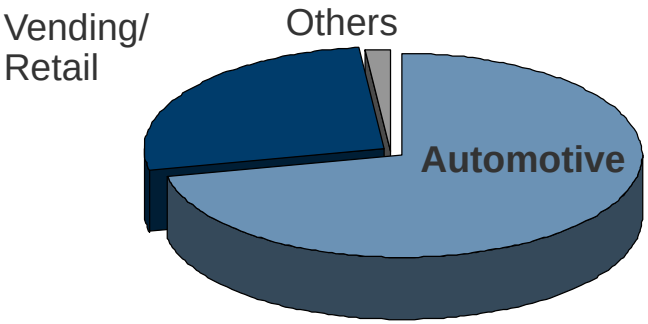


Automotive Equipment Systems

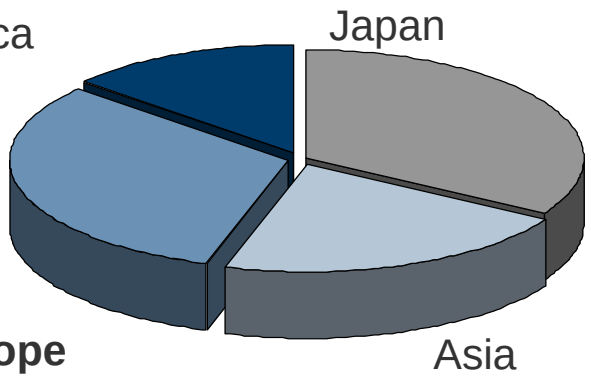
Vending/ Retail Systems

Household Environmental Systems

Sales by Business Segment



Sales by Geographic Area



Summary of vehicle trend in Europe

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2009 2012 2015 2020

Euro 5 Euro 6

Legislation

CO2:130 g/km

95 g/km

Exhaust gas emission
&
CO2 emission

A/C considered in regulation of CO2 emission from 2017 in US

HEV / EV

- *Introduction of Mild Hybrid Vehicle*
- *Full hybrid vehicle ⇒*

Electric

- *Electric vehicle / Range Extender*
- *FC vehicle*

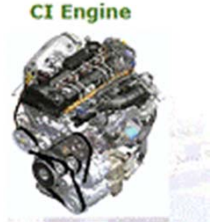
ICE

- *Start & Stop function*
- *Smaller displacement + Turbo*
- *CI (Compression Ignition) engine*
- *Bio fuel*

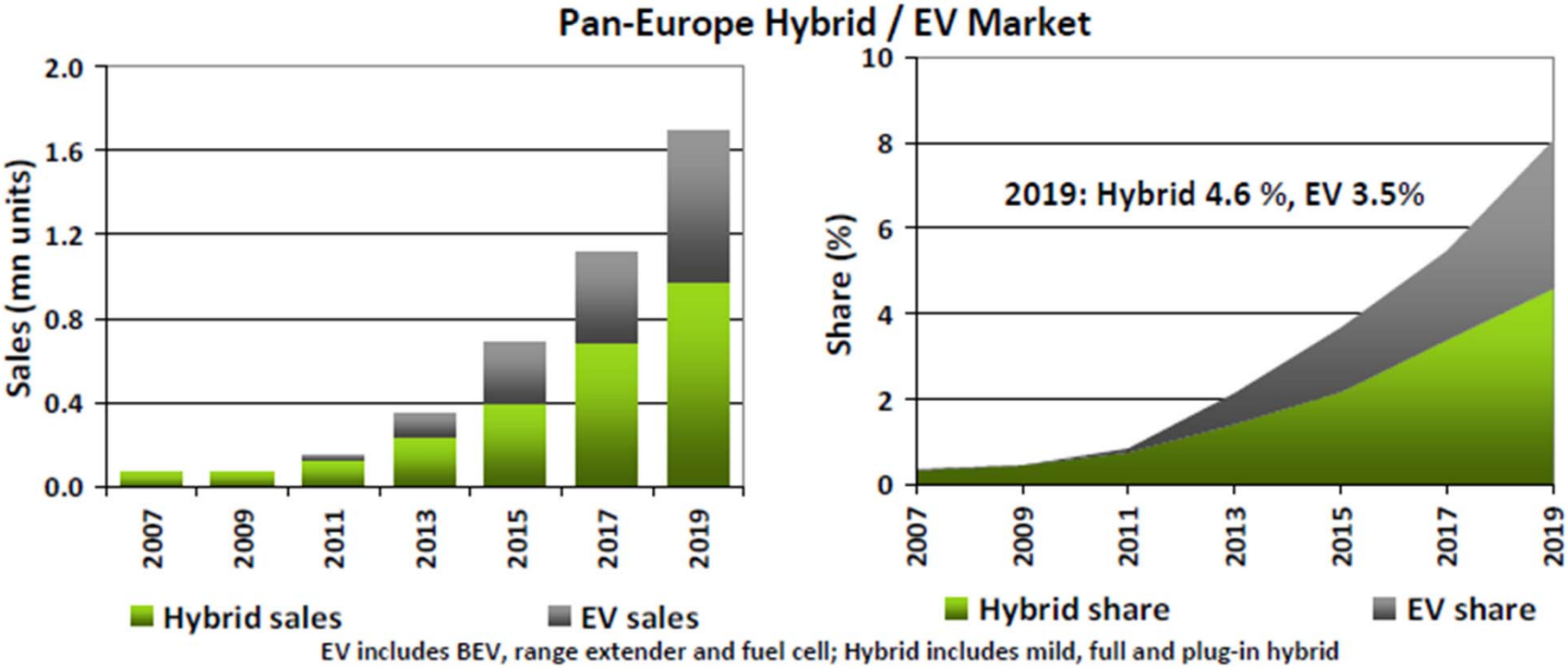
- *SI (Spark ignition) engine*
- *48V application*

High efficiency Downsizing

Penetration of small segment increase



Hybrid and EV Market Outlook



Market Research shows market volume between 3% and 8% around 2020 for Hybrid and Electric vehicles → 500k and 1.400k for Europe

Example Source: LMC Automotive Global Hybrid & EV Forecast

SHS-33 Development History

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1985 → 1990 → 1995 → 2000 → 2005 → 2010 → 2015

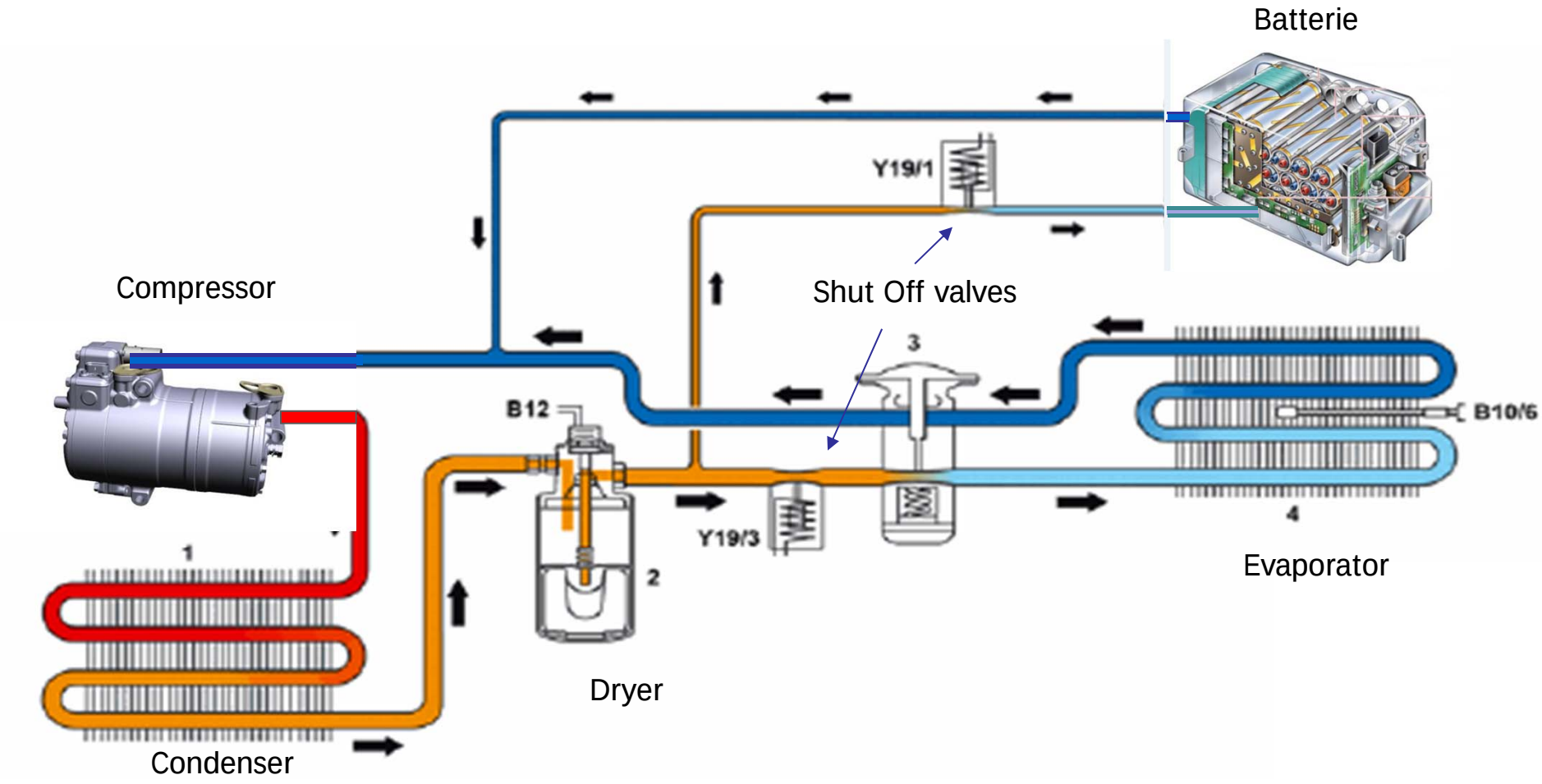
- Scroll Comp. Production start
- EC Development Start('86)
- SAE Presentation('89)
- EVS-10 Presentation('90)
- EC production('97-'99)
- SAE Presentation('02)
- F6xx series
- Hybrid Comp('01). Dev.start (Launched on '04)
- CO2 EC('02). Dev start
- GEN1 – 120V start dev ('07)
- GEN1 SOP ('09)
- GEN2 start dev 120/280V ('08)
- GEN2 SOP ('Sep 11)
- GEN3 start dev ('End 10)
- GEN3 SOP ('13)








A/C System Layout



Example of A/C system with integrated battery cooling system

Gen2 Key Data

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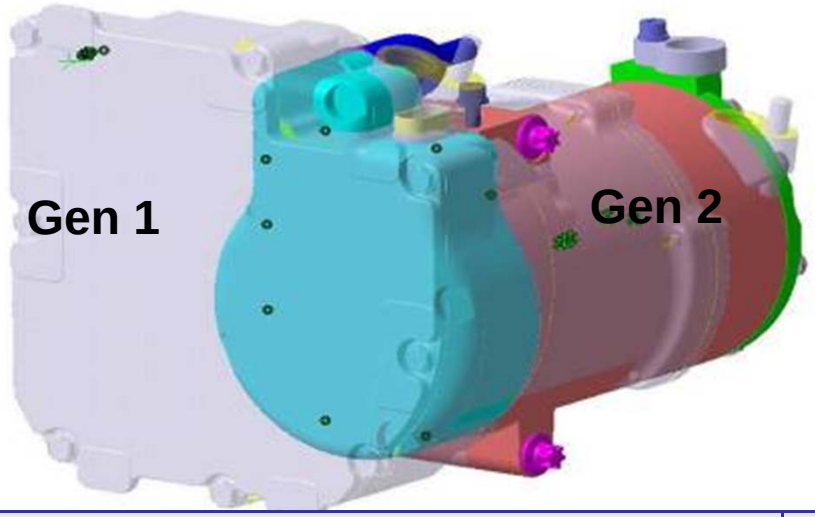
Gen 1 vs Gen 2 Package comparison



Gen2 Key Features:

- Global standard based on VDA spec
- High and Low Voltage (HV)
- LIN 2.0/ 2.1 & CAN 2.0 Communication
- Modular Concept from Hybrid to EV, L-VDA
- uC low voltage power supply for crash safety
- Refrigerant type R134a and R1234yf
- Durable for passenger car applications

Voltage Range / Insulation Resistance		110V to 432V / 5MOhm EOL	
NVH values		1000rpm <50 dB(A) 3000rpm <57 dB(A) 5000rpm <62 dB(A)	
Performance (33cc)		15/3bar / Pel < 4kW / n_max > 8.2kW (COP:2.0) 25/3bar / Pel < 5,2kW / n_max > 6,0kW (COP:1.4)	
Operating Speed range		800 to 9000 rpm	
Weight and Oil		Less than 6.8kg incl. oil 120g	PAG Oil compatible with 1234yf (SP-A2)
Temperature Specification		Operating -15 degC to + 125 degC Storage -40 degC to + 150 degC	
High Voltage:	Min.: 60V Max: 430 V	Low Voltage:	Rated: 12V

What makes the EC different to the products you know...

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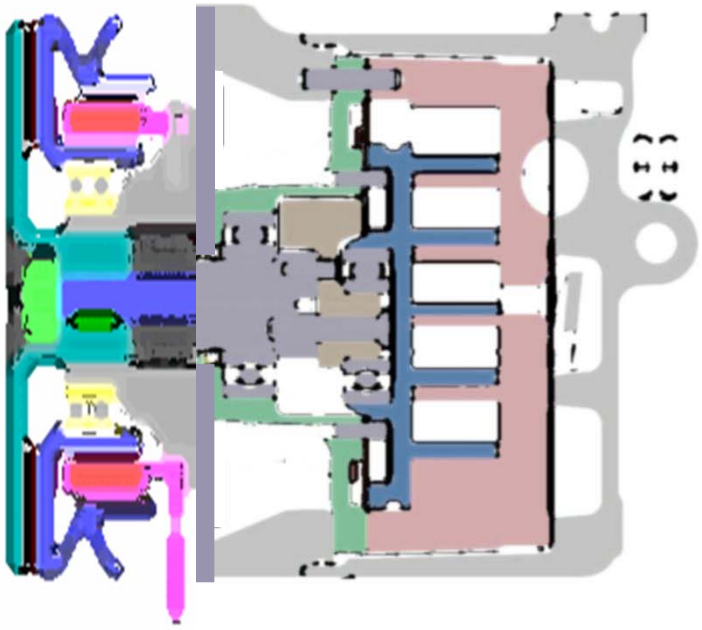
...Remove Pulley – Add Inverter & Motor = EC



Pulley Compressor

Function Principle

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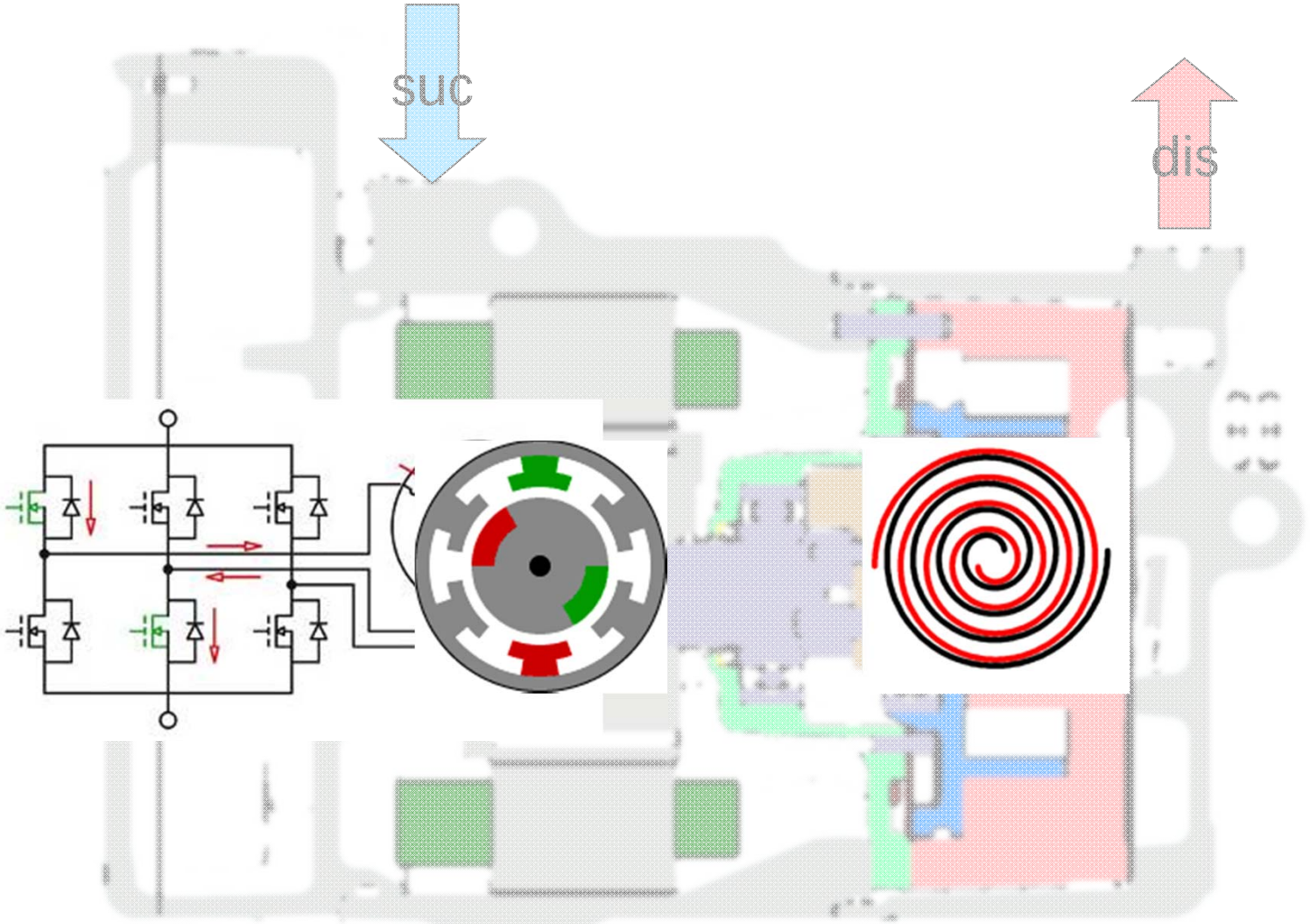

Inverter Motor Compressor

SHS33- Electrical Compressor

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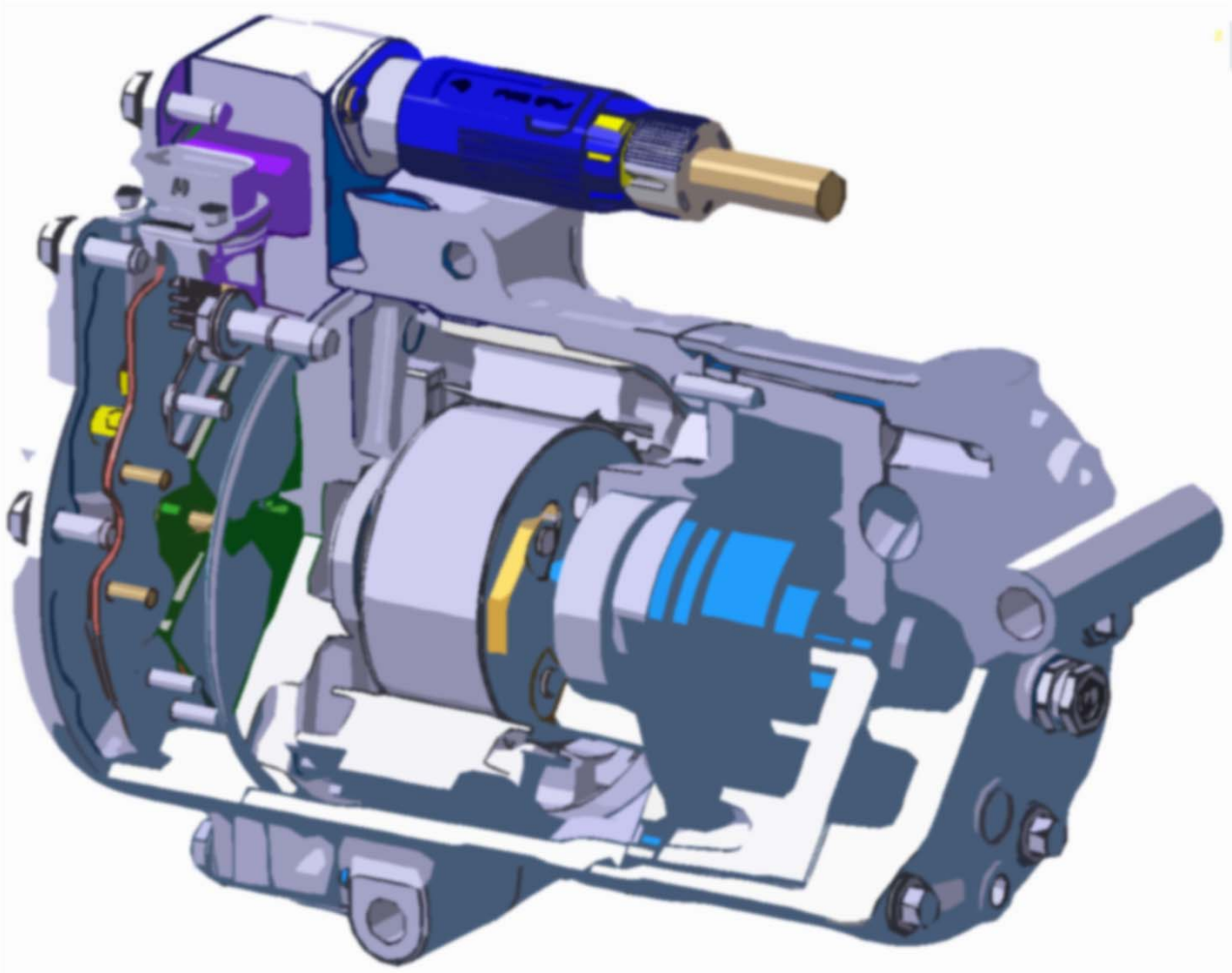

New Requirements for the Electrical compressor:

- New severe specification requirements for NVH
- Durability: Double or Triple Lifetime for Heatpump applications and pre conditioning
- Oil: Refinement of new PAG oil SP-A2 for 1234yf and EC
- HV Safety: New HV crash safety concept developed
- Modular concept for smaller vehicles and low cost markets

Important Handling Issues for Service

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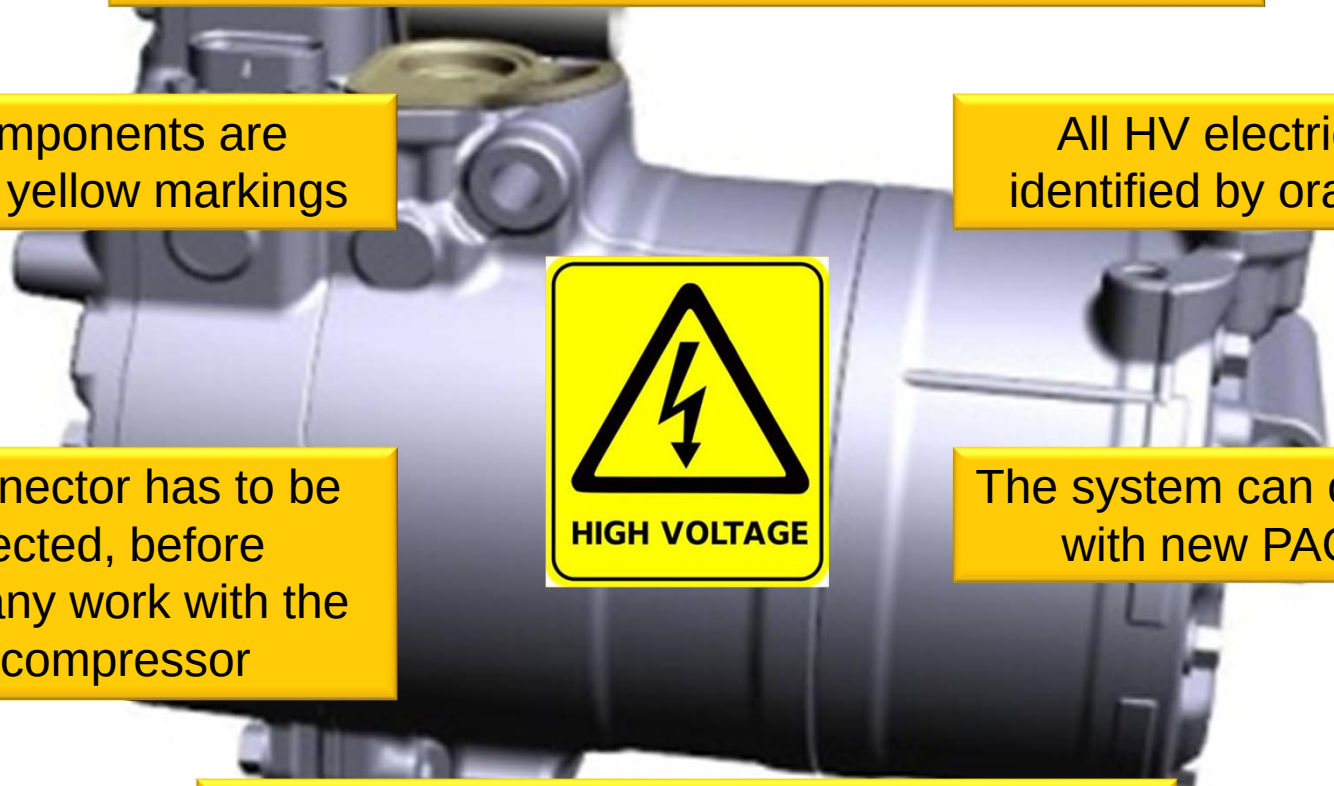
Work on any HV or Hybrid components must only be performed by trained and certified personnel under consideration of HV safety requirements

All HV components are identified by yellow markings

All HV electrical lines are identified by orange markings

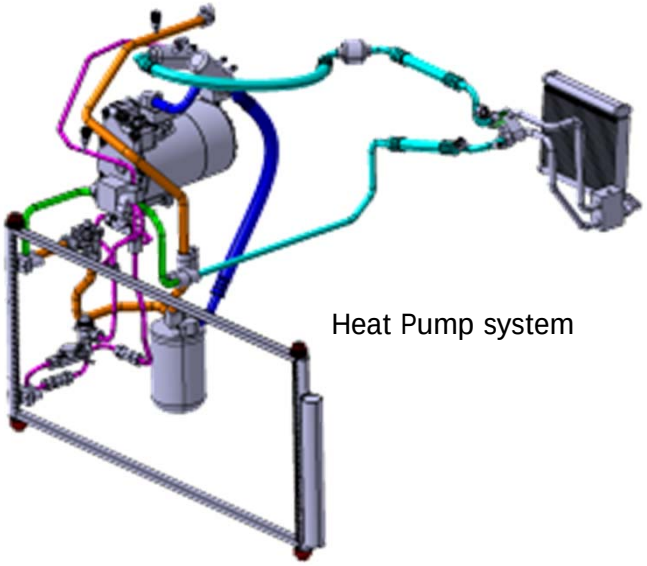


The HV connector has to be disconnected, before performing any work with the electric compressor

The system can only be charged with new PAG Oil SP-A2

The compressor can not be opened or repaired, it has to be sent back to Sanden

Conclusion / Outlook



Heat Pump system

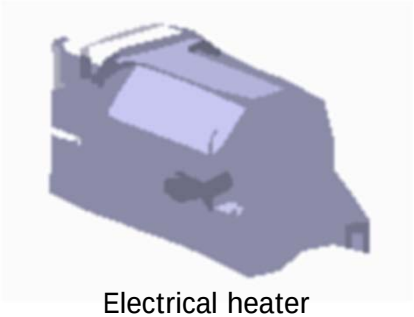
Basis for new technologies like

Heat Pump systems,

Waste heat recovery systems,

electrical heaters

Rankine System with Expander



Electrical heater

New products have to be developed in shortened development times, with increased technology levels and new requirements to environment, safety and service.

The demand for Co^2 reduction and limited availability of natural resources is a trend that grows slowly, but consistently.

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Thank you for your attention

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