STEYR MOTORS' APPROACH FOR

TARGETING (FUTURE) CUSTOMER NEEDS

CONTENT

- About STEYR MOTORS
- Future market challenges for STEYR MOTORS
- Diversification of the product & development portfolio of STEYR MOTORS
- Challenges of established development life cycles in highly integrated complex hybrid powertrain systems
- Summary

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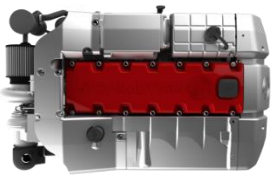
ABOUT STEYR MOTORS

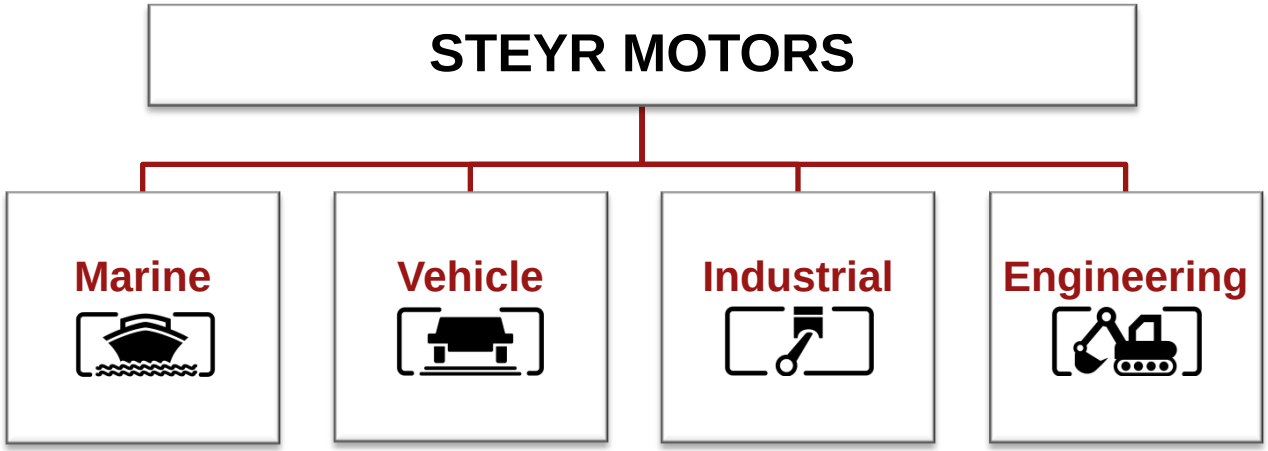
The specialist in **high-performance**

DIESEL ENGINES | **ELECTRIC SYSTEMS** | **HYBRID SOLUTIONS**

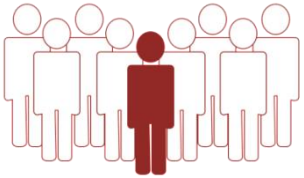
- Highly specialized engineering according to customer's demands including
  - Concepts & simulation
  - Prototyping
  - Extensive testing services
  - Serial production
  - Customer service and aftermarket



FIELDS OF BUSINESS



KEY FIGURES 2016/2017



Employees 2017

210

Export Ratio 2016

99 % of sales

Turnover 2016

36 million EUR

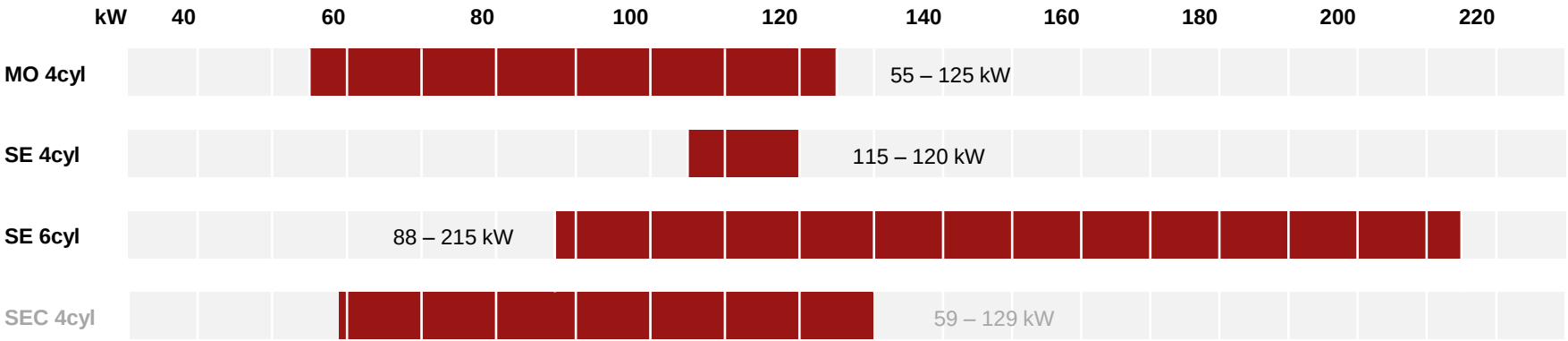
R&D quote 2016

9.4 % of turnover

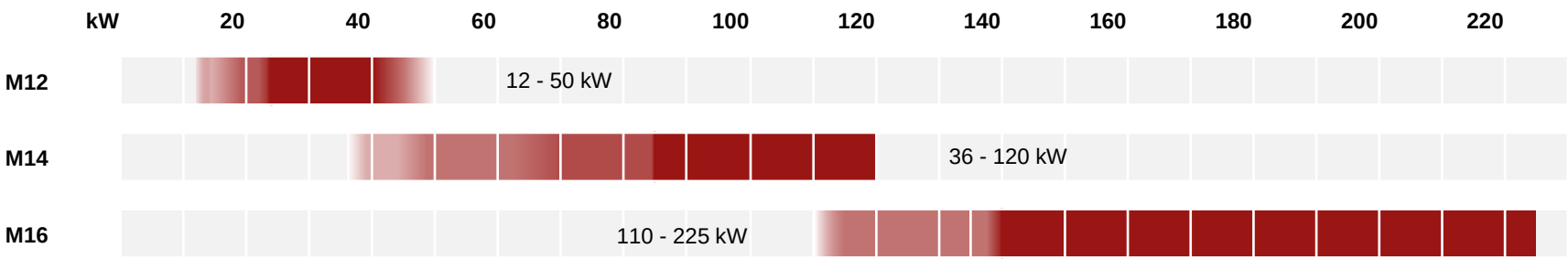
Partners worldwide

more than 350

STANDARD-PORTFOLIO MARINE



STANDARD-PORTFOLIO VEHICLE



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CHALLENGES FOR ZERO EMISSION FUTURE

Basically a lot of technologies are available but…

- **market readiness**
- **infrastructure for new technologies**
- **large scale production**
- **production costs**
- **customer expectations**

… have to be developed with corresponding investment.

MAIN DIRECT AND INDIRECT DRIVERS
OF FUTURE POWERTRAIN SOLUTIONS

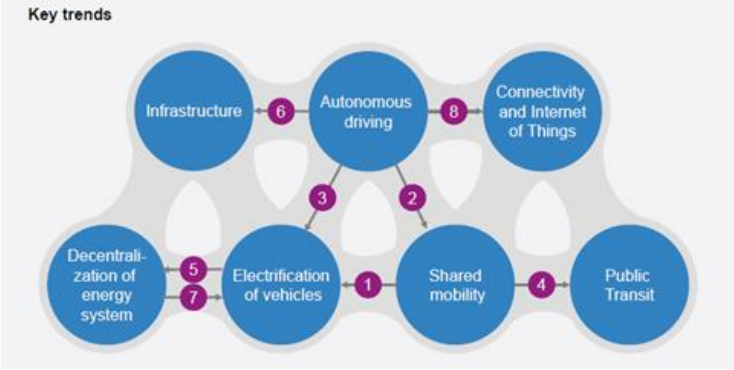
1) Emission legislation pushes *directly* the driveline development of vehicles worldwide

- Depends on the specific application and region
- CO_2 emissions are focused to avoid global warming and TCO
- Total emissions are focused to avoid emission problems in urban centers

MAIN DIRECT AND INDIRECT DRIVERS
OF FUTURE POWERTRAIN SOLUTIONS

2) Megatrends Digitalization/IoT & Autonomous Driving influence *indirectly* the driveline development

- Added value „moves“ to service provider („new dealer“ will be „service provider“)
- IoT / IT / data-driven topics mutually reinforce each other
- Only IoT compatible products will be accepted



Source: McKinsey/Bloomberg (2016)

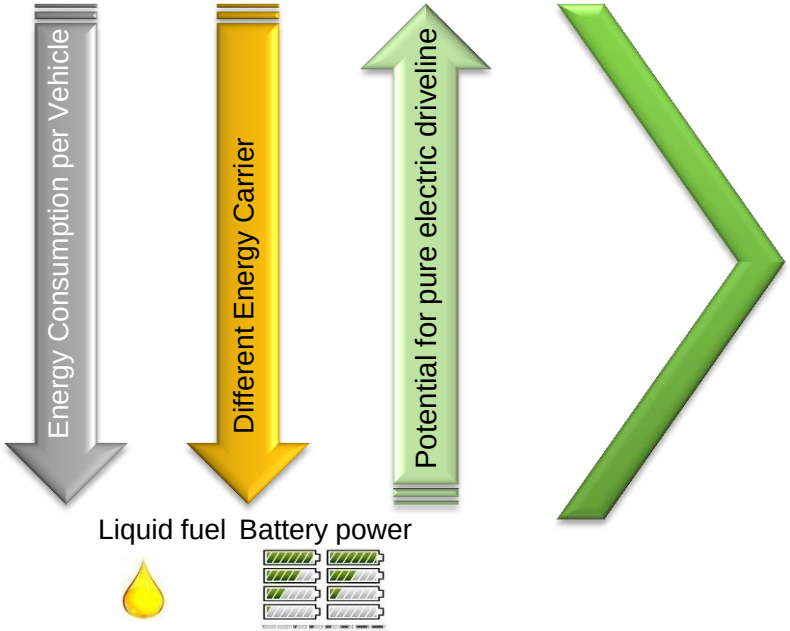
MARKET CHALLENGES

Different powertrain solutions for different energy consumers and legislation requirements

Personal Mobility

Mobile Machinery

Transportation



- ICE improvement “to the extreme”
- Development of new synthetic fuels
- Development of battery technology for higher safety and energy density
- Connected mobility

CHALLENGES FOR NICHE PLAYERS

- General upheaval in drivetrain development is reflected differently from niche to niche! Therefore, …

  - **Technological developments and changes**
  - **Increasing demands of customers (varying between applications, customers and region)**
  - **Powertrain diversification**
  - **Increasing complexity**

- … require a diversification of Steyr Motors´ product portfolio.

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DIVERSIFICATION OF PRODUCT PORTFOLIO ONGOING

MO 4-CYL

SE 4-CYL

SE 6-CYL

STEYR HDS

M12 UI

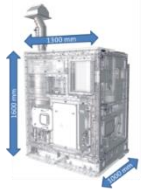
M12 CR

M14 UI

M14 CR

M16 UI

E1



DPM

IoT

REX

PRODUCT PORTFOLIO – EXCERPT

- Hybrid System for marine applications
- Electric Machine E1
- Diesel-electric Systems
  - Diesel Power Module for SIEMENS´ Vectron locomotive
  - Power Box/Range Extender
- Maintenance Dashboard/IoT

VAST EXPERIENCE WITH HYBRID AND DIESEL-ELECTRIC SYSTEMS

(EXCERPT OF RELEVANT DEVELOPMENTS)

2008
Diesel-electric systems for trolley busses (Switzerland, Venezuela)

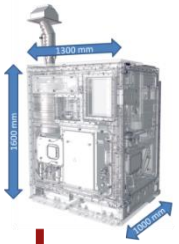
2008
World‘s first marine Hybrid Drive System (STEYR HDS)

2012
STEYR HDS (Stage II)

2013
CMO Range Extender Power Pack

2014
APU @ KMW Leopard II

2015/16
Diesel Power Module @ Siemens Vectron

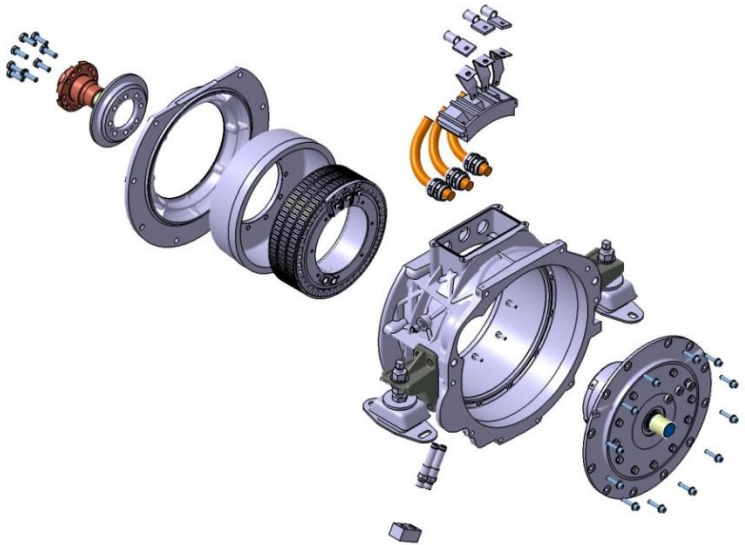


2017
STEYR Power Box

2018
STEYR HDS (Stage III)

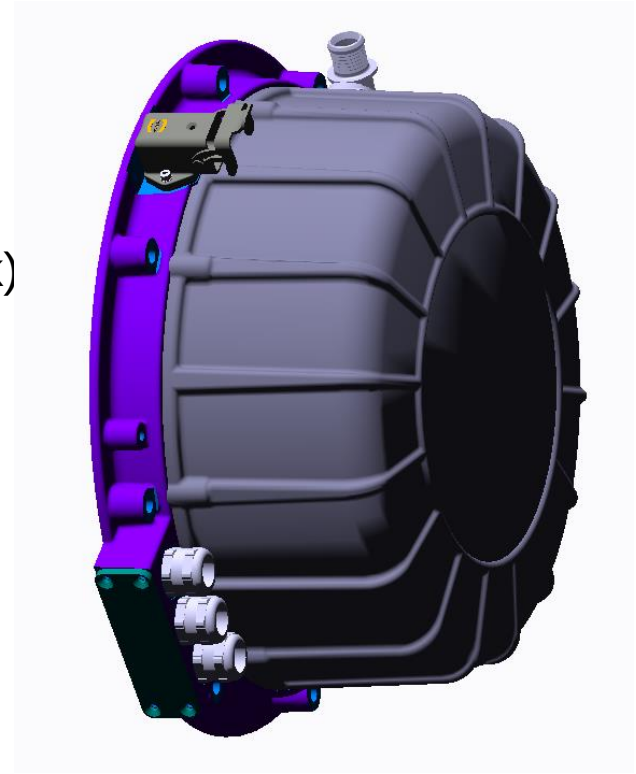
HYBRID STAGE III

- U_{DC}: 48 V
- Nominal / Peak power: 20 / 25 kW
- Speed range: 0 - 4500 rpm
- Water cooling
- Protection Class: IP67
- Diameter / Length : 400 / 250 mm
- Weight: 54 kg



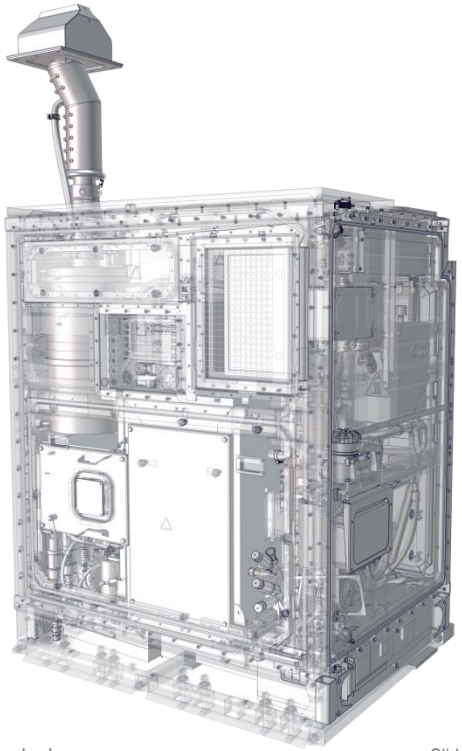
E1

- U_{DC}: 300-400 V
- Electrical nominal power: 40 kW (50 kW peak)
- Speed range: 0 - 3600 rpm
- Water cooling (8 l / min, 75°C)
- Protection class: IP67
- Diameter / Length : 400 / 250 mm
- Weight: 21 kg



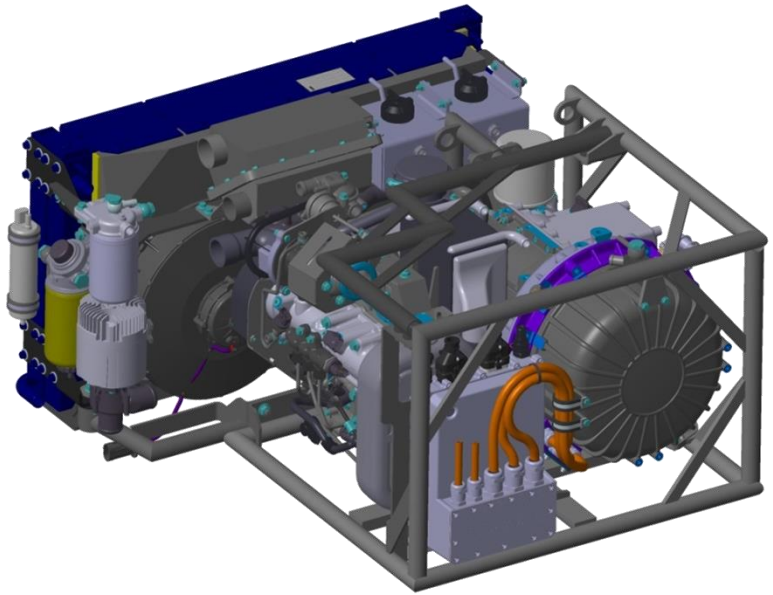
DPM

- U_{DC}: 1000-1800 V
- Electrical nominal power : 150 kW (160 kW peak)
- Speed range : 0 - 3550 rpm
- Diameter / Length : 400 / 250 mm
- Weight: 1400 kg
- Water cooling (8 l / min, 75°C)



POWER BOX/RANGE EXTENDER

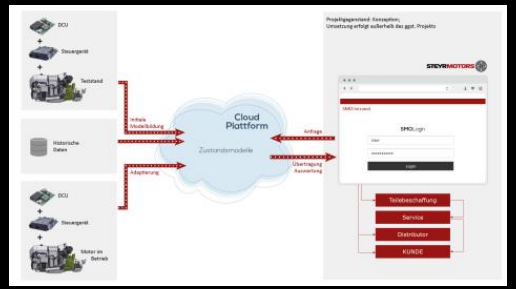
- U_{DC}: 400 V
- Electrical nominal power: 36 kW
- Speed range: 0-3.000 rpm
- Water cooling
- Length: 993 x 870 x 480 mm
- Weight: 250 kg

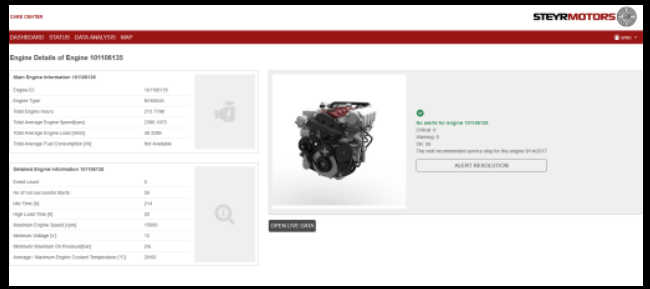


MAINTENANCE DASHBOARD & MODULE

- **Target**

  All available data will be transmitted and processed into the cloud infrastructure; allows the predictive maintenance of all powertrain components (engine, electric motor, transmission, battery, etc.); suppliers & service-partners will be fully integrated

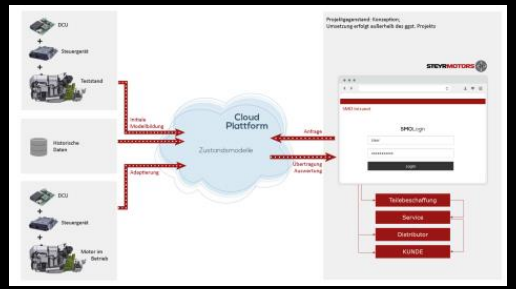


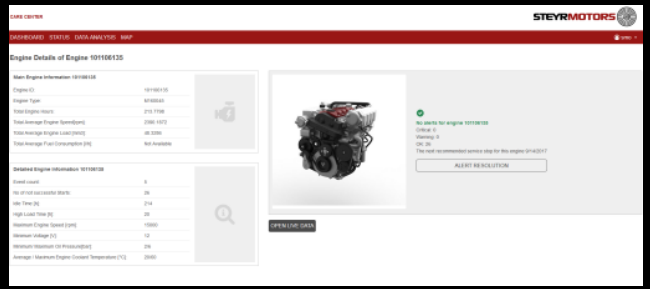


MAINTENANCE DASHBOARD & MODULE

- **Benefits for customers**

  Maintenance costs & time can be reduced to a minimum; optimized maintenance for fleet management; continuous emission monitoring





MAINTENANCE DASHBOARD & MODULE

- **Additional benefit for STEYR MOTORS**
  Extensive data on usage of system components will be integrated into the development process; data-based development makes our products more reliable and competitive
- **Technical approach**
  Data Communication Unit for data transmission in test phase; cloud infrastructure available; predictive maintenance algorithms in development

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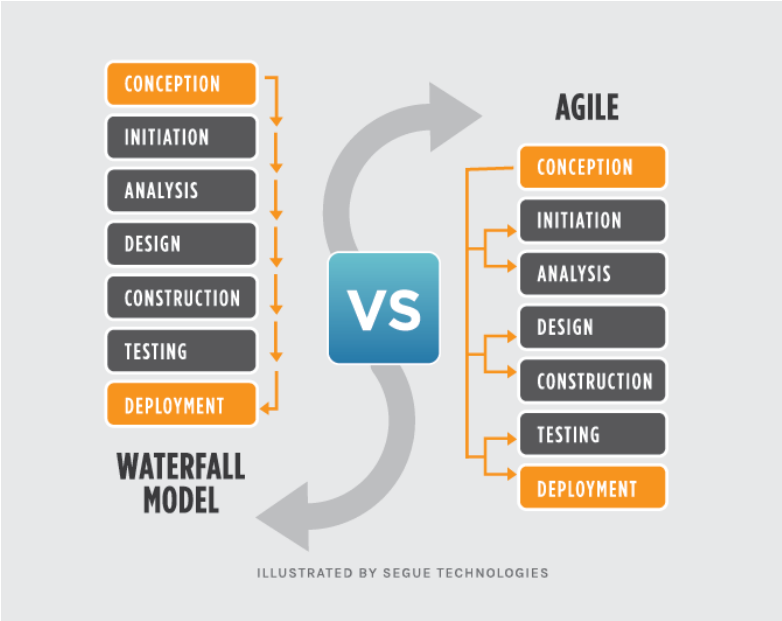
WHAT IS A COMPLEX SYSTEM

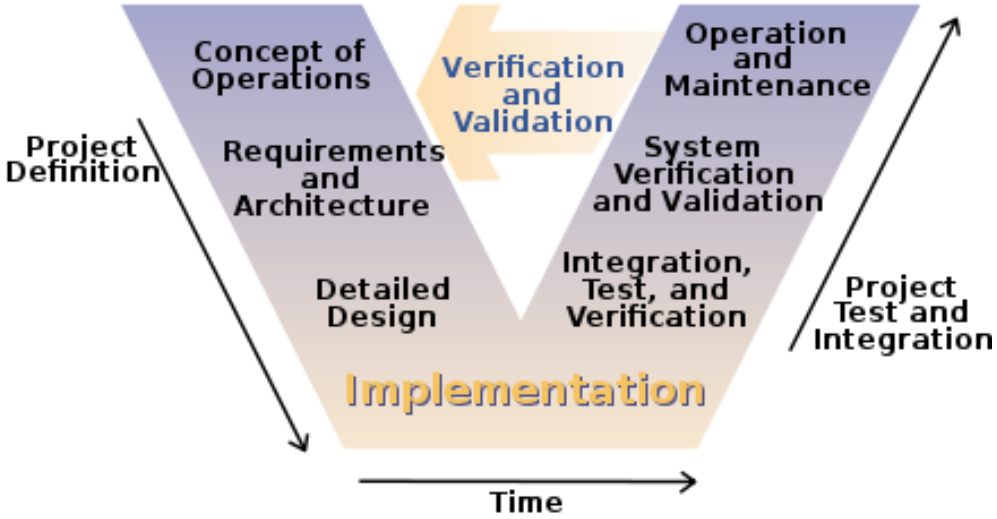
Simple System	Encompass some basic issues of techniques and terminology → once mastered, „following the recipe“ leads to a very high assurance of success (e.g. cooking recipe)
Complicate System	Complicated nature is related not only to the scale of the problem, but also to their increased requirements around coordination or specialized expertise. E.g. sending a rocket to the moon; However rockets are similar to each other and because of this following one success → relatively high degree of certainty of outcome repetition
Complex System	based on relationships, properties of self organization, interconnections and nonlinearity e.g. equation with multiple unknown variables; change to one variable may have disproportionate effects on the overall throughput

WATERFALL VS AGILE METHODS



- Which development methodology should we use ?
- Two most popular methodologies are waterfall (traditional) approach and Agile (specific type of Rapid Application Development) [2]

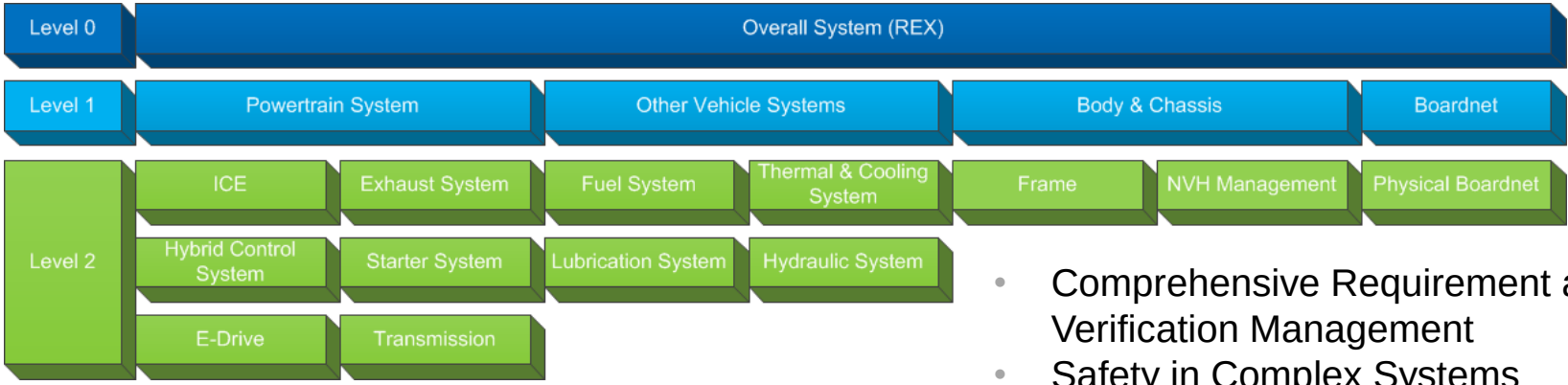
V-MODEL



- Considered as extension of the waterfall model
- Instead of moving down in a linear way, process steps are bent upwards after the coding phase to form the typical V shape
- Demonstrates relationships between each phase of development life cycle and its associated phase of testing

COMPREHENSIVE REQUIREMENT AND VERIFICATION MANAGEMENT

TECHNICAL AND QUALITY CHALLENGES



- Comprehensive Requirement and Verification Management
- Safety in Complex Systems
- Quality Aspects

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SUMMARY

- Emission legislations and megatrends like digitalization/IoT/etc. drive future powertrain development
- Diversification is a must – even for niche players!
- STEYR MOTORS - from diesel engine manufacturer to provider of innovative systems & solutions!
- Implementing development processes for highly integrated complex hybrid powertrain systems

REFERENCE LIST

- McKinsey & Company, Bloomberg New Energy Finance (2016): An integrated perspective on the future of mobility
- [1] Mary Lots, Waterfall vs. Agile: Which is the Right Development Methodology for Your Project, Web, 05.07.2013, http://www.seguetech.com/waterfall-vs-agile-methodology/

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