









# Technology Day 19.04.2023

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# Agenda

-  Transition Drivers in Mobility
-  TIFS Transition in Mobility
-  Thermal Management & TIFS Roadmap
-  TIFS Portfolio
-  TIFS USPs in Thermal Management
-  E-Mobility Innovation Center
-  Summary



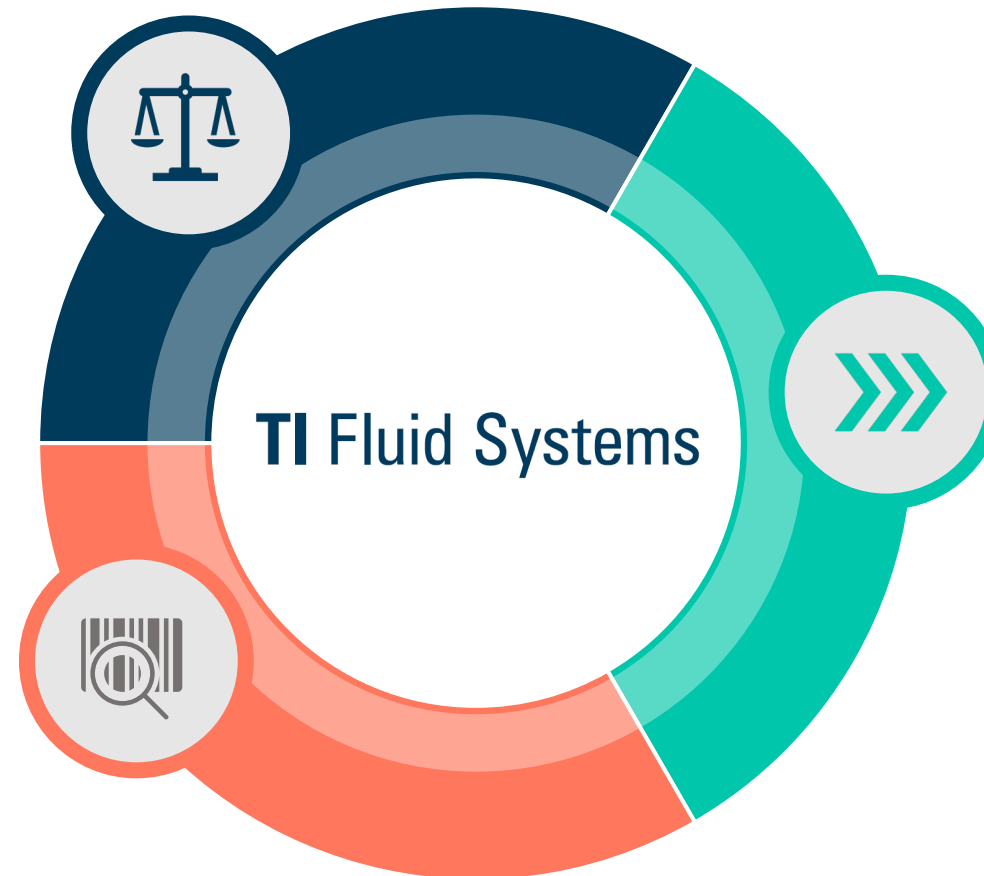
# Transition Drivers in Mobility

## Legislation

- Global CO<sub>2</sub> restrictions
- EU7, China7

## Market Trends

- Global ICE expiration
- Conversion from ICE into NEV
- Some OEMs provide charging infrastructure



## Technology Trends

- X by Wire
- Centralized E/E architecture
- New vehicle architectures replacing classical ICE (e.g. Skateboard / Rolling Chassis)
- Autonomous driving
- Electrification enforces significant improvement in efficiency
  - driving range
  - charging time
  - reduce energy losses

**Modularisation & compactness to improve efficiency and reduce cost  
Technology transition generates additional opportunities for TI Fluid Systems**



# Transition Drivers in Mobility

## Global Emission Legislation



### US CARB LEV VIII (released 2015)

350mg hydro carbon/day (vehicle) + ORVR

### California 2030 Goal

68% NEV of total Auto sales

### US 2035 Goal

50% NEV of total Auto sales

### California 2035 Goal

80% BEV / 20% PHEV of total Auto sales



### EU7 approach (target effective 2025)

Targeting CARB LEV VIII requirement

### EU 2030 Goal

55% CO<sub>2</sub> g/km reduction vs 2023

### EU 2035 Goal

100% CO<sub>2</sub> g/km reduction vs 2023

CO<sub>2</sub> neutral e-fuel powered ICE vehicles under investigation



### China 7 approach (target effective 2026)

Targeting CARB LEV VIII requirement

### China 2030 Goal

40% NEV of total Auto Sales

### China 2035 Goal

>50% NEV of total Auto Sales

## Consequences

Zero emission requirements strongly boosts NEV, especially BEV

Hydrogen & e-fuels as potential future alternative sources, despite hurdles as:

Technological complexity

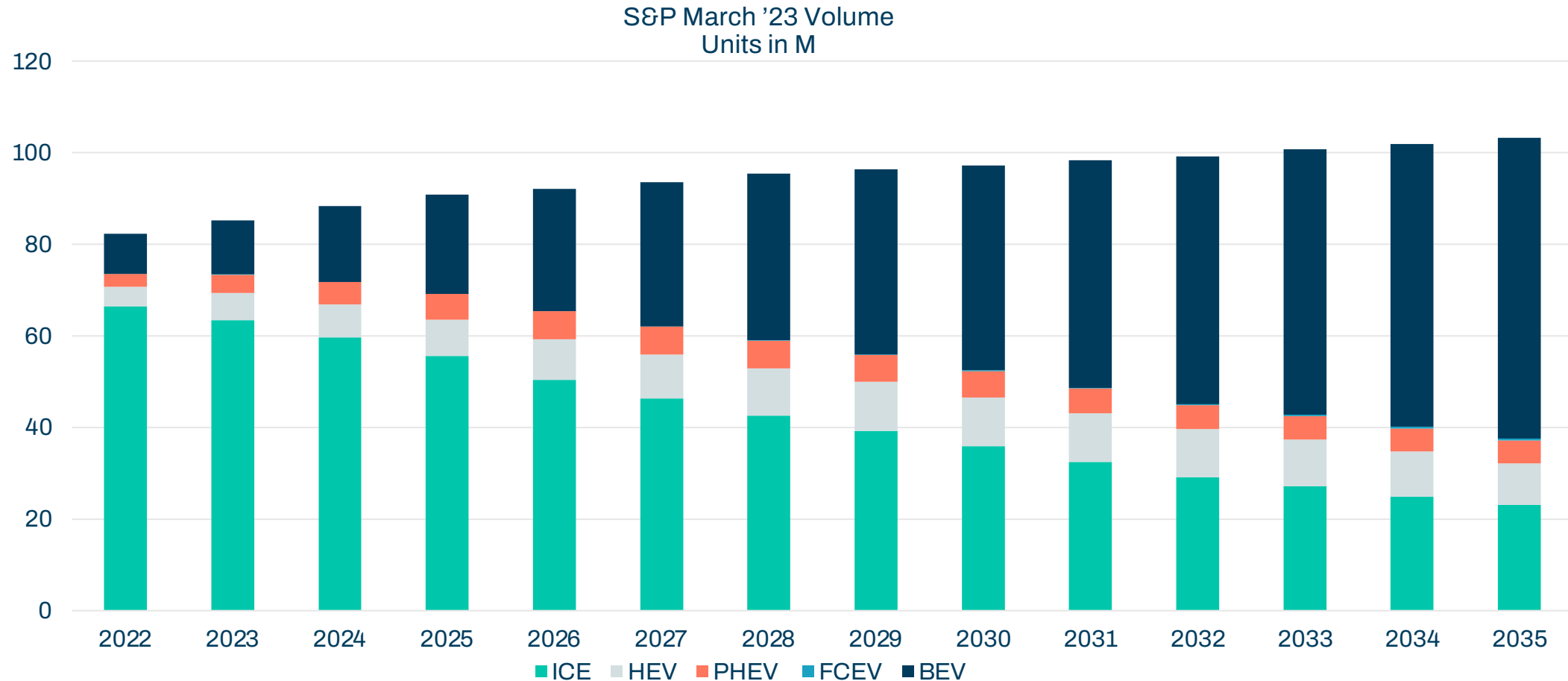
Commercial unattractiveness

Infrastructure



# Transition Drivers in Mobility

## Market: Global Light Vehicle Production Volume Forecast

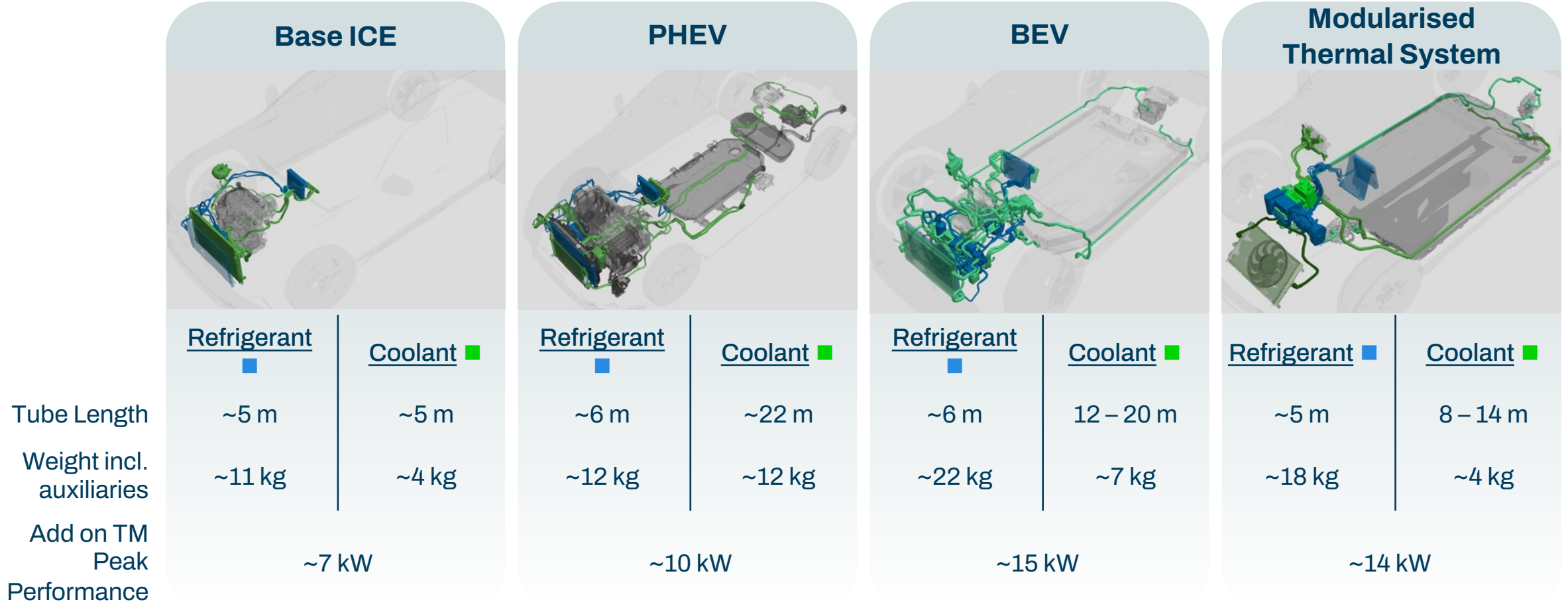


**Strong conversion from ICE into BEV**



# Thermal Management Walk from ICE to BEV

Average content range on global light vehicle volume by powertrain



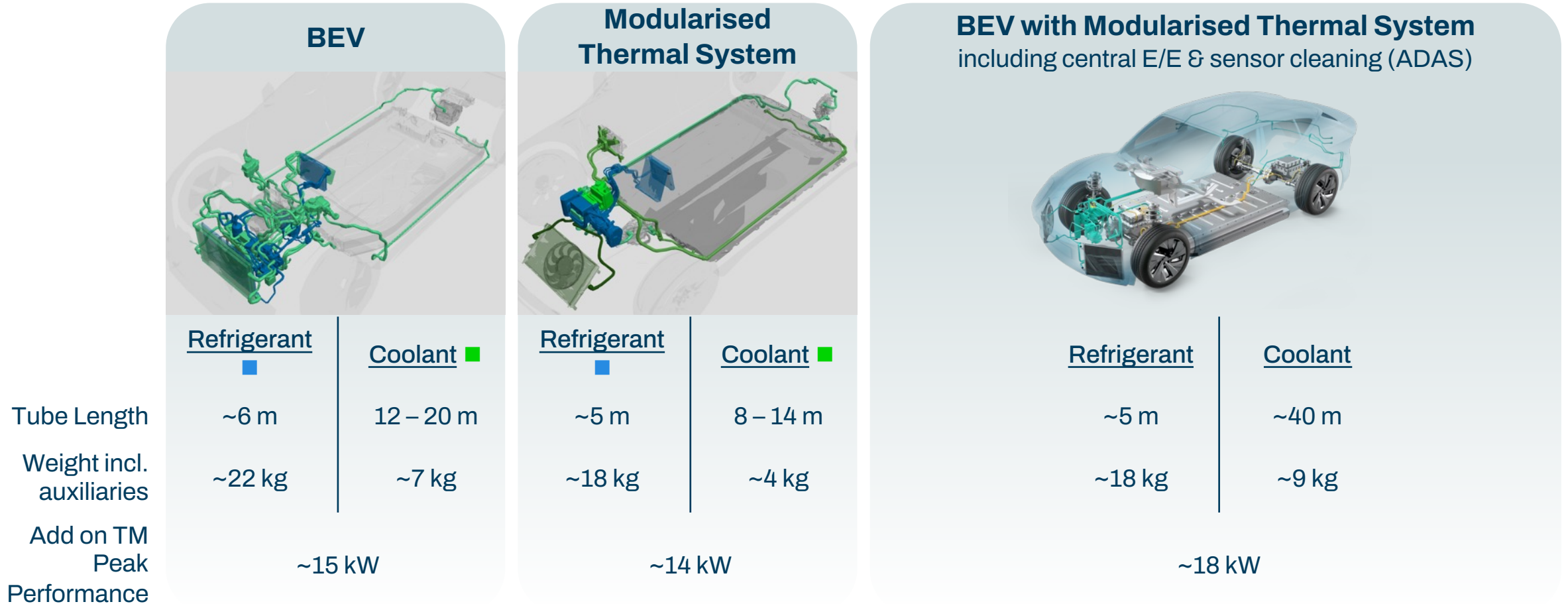
**Shift from ICE to BEV requires significant increase in thermal management performance & product content  
Modularisation simplifies TM architecture and improves efficiency & costs**





# Thermal Management Walk from ICE to BEV

Average content range on global light vehicle volume by powertrain



**Autonomous driving & centralised electronics require additional coolant performance, tremendous increase in coolant product content**

# Transition Drivers in Mobility

Market: Representative regional BEV players



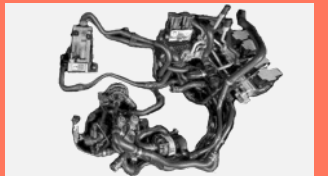
- **Battery** Cell to Body / Liquid Cooling
- **Refrigerant** Valve Module
- **Coolant** Individual Components



- **Battery** Cell to Pack / Liquid Cooling
- **Refrigerant** } Thermal Module
- **Coolant** }



- **Battery** Cell to Module to Pack / Liquid Cooling
- **Refrigerant** Valve Module
- **Coolant** Individual Components



Modularisation expected to increase significantly, driven by efficiency & costs





# TIFS Transition in Mobility

## Benchmarking: Representative Thermal Management Architectures

**Complete Overview**  
(Refrigerant & Coolant Loop)

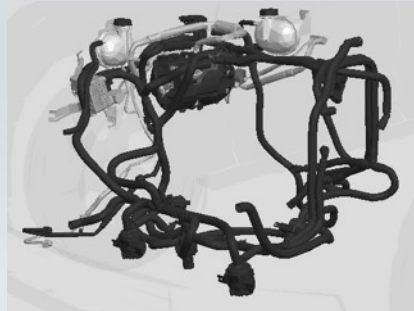
**Coolant**

**Refrigerant**

**Thermal Management System**

**Main Differentiator**

**Thermal Management System  
ICE/BEV hybrid Architecture**



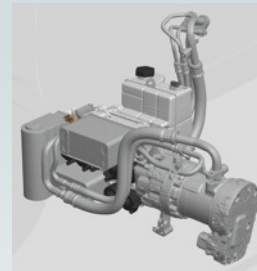
Assembly of scattered coolant components

Assembly of scattered refrigerant components

Hybrid ICE/BEV based scattered architecture

**Scattered architecture  
minor leverage on efficiency**

**Thermal Management System  
on BEV Architecture**



Compact coolant module

Compact refrigerant module

Thermal management module

**Energy losses driven by intersect  
needs dedicated installation  
space**

 **TI Fluid Systems**  
ITMS



Compact coolant module

Compact refrigerant module

Thermal management module

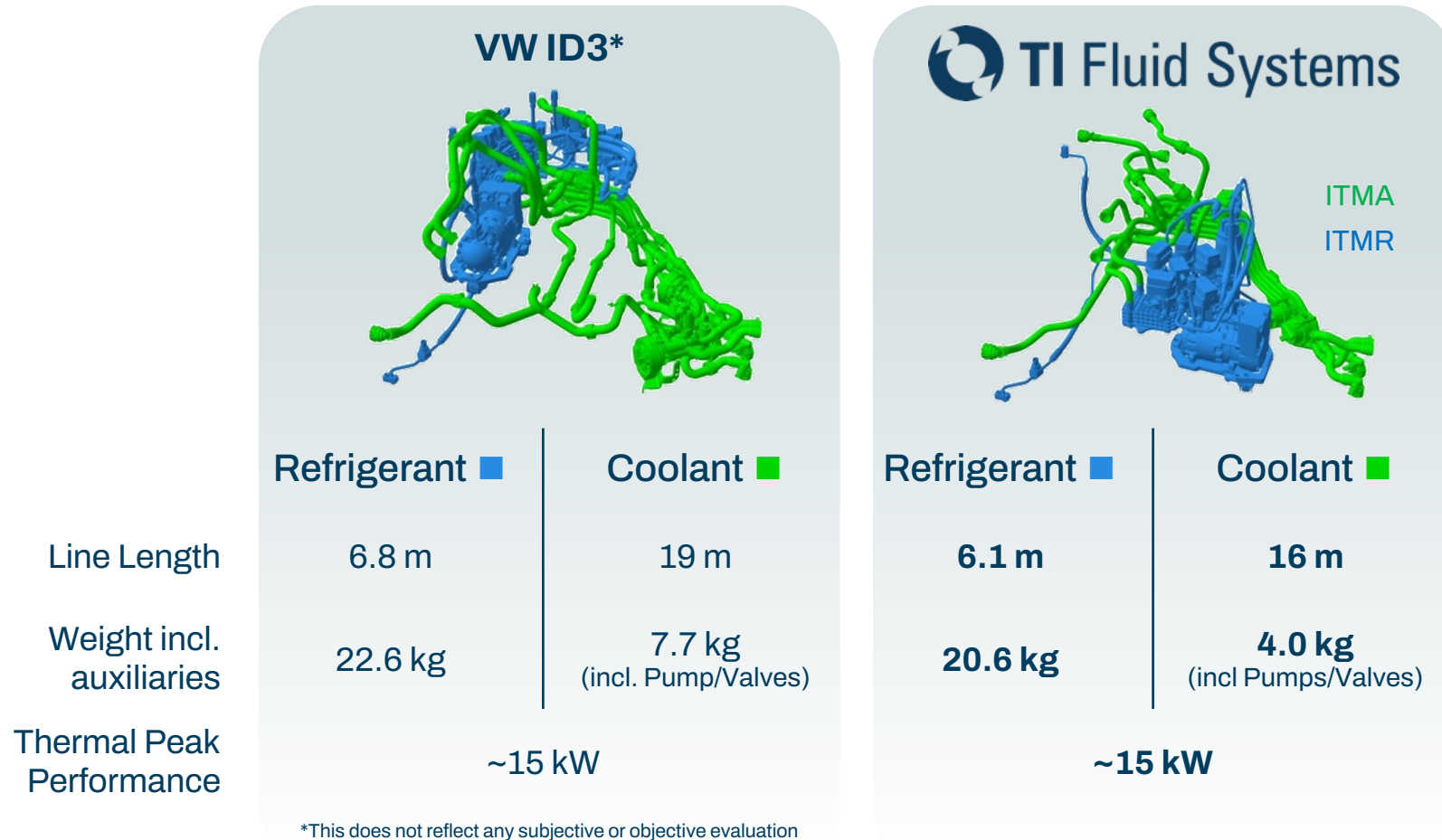
**Energy efficient  
flexible on installation space**



# TIFS Transition in Mobility

ITMA = Integrated Thermal Module Coolant  
ITMR = Integrated Thermal Module Refrigerant

## Benchmark Volkswagen ID3 vs. TIFS retrofit, thermal management architecture

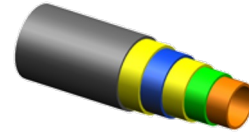
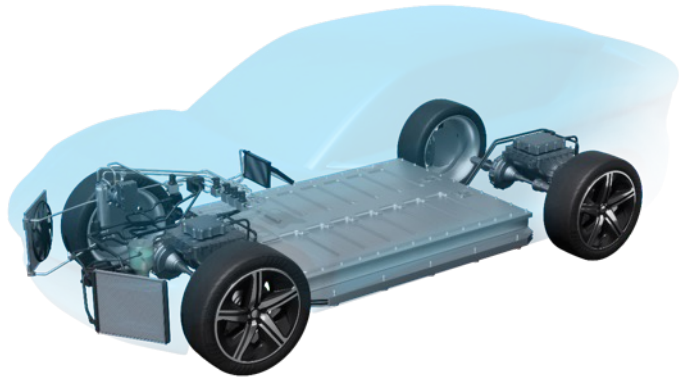


TI made ITMA & ITMR modules achieve less weight, less complexity → improved competitiveness



# Transition in Mobility

## TI Fluid Systems Technology Strategy



### 1 Market Requirements

- Electrification, Digitalisation & Autonomous future mobility
- Modularity across vehicle “functions”
- Zero Emission / CO<sub>2</sub> neutrality
- OEMs seeking system development partners in Thermal Management
- Efficiency as “The New Currency”

### 2 TIFS Technology Strategy

**Core Business:**  
Lightweight lines, connectors & assembly

**Refrigerant:** Convert rubber aluminum into lightweight TPRL.

**Coolant:** Convert rubber into multi layer plastic tubes. Extend Portfolio on higher performance needs.

#### New generation Portfolio: modularisation

System competence in simulation, from vehicle to component level

Efficient & flexible modules with high level in scalability, creating value added

Benefit from our traditional FTDS & FCS product and process technology

Position TIFS as global Technology Partner

### 3 TIFS Execution & Status

Regional installation of the TI unique e-Mobility Innovation Centers by Q1 2024

- ✓ Next Openings of Korea and Japan in June 2023, China by September 2023

Consequent execution according TIFS product Technology Roadmap



- **Business awards in Coolant Modules received globally**
- **Joint developments with global respective OEMs in execution**
- **Growing with the leading global BEV Manufacturers**



# Thermal Management & TIFS Roadmap

## Secondary cabin comfort loop - representative circuit for cabin cooling

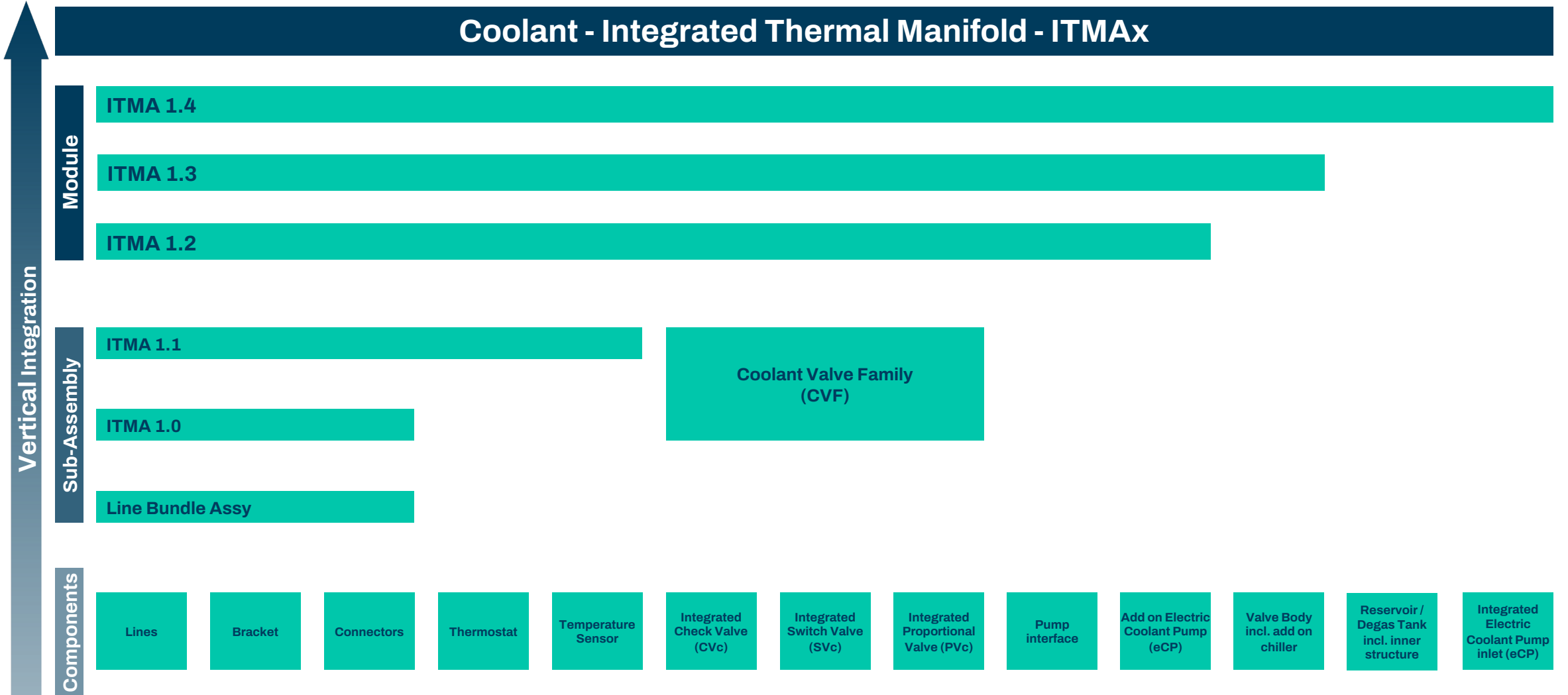
### Application: Cabin Cooling

- |                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. Compressor</li> <li>2. Switch Valve</li> <li>3. Condenser</li> <li>4. Expansion Valve</li> <li>5. Chiller (Heat Exchanger)</li> <li>6. Switch Valve</li> <li>7. Accumulator</li> <li>8. Refrigerant Lines</li> </ol> | <ol style="list-style-type: none"> <li>9. Electrical Coolant Pump (eCP)</li> <li>10. Chiller</li> <li>11. Switch Valve</li> <li>12. Evaporator</li> <li>13. Switch Valve</li> <li>14. Coolant Manifold / Lines</li> </ol> |
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# Thermal Management & TIFS Roadmap

## Coolant Products – Technology Roadmap

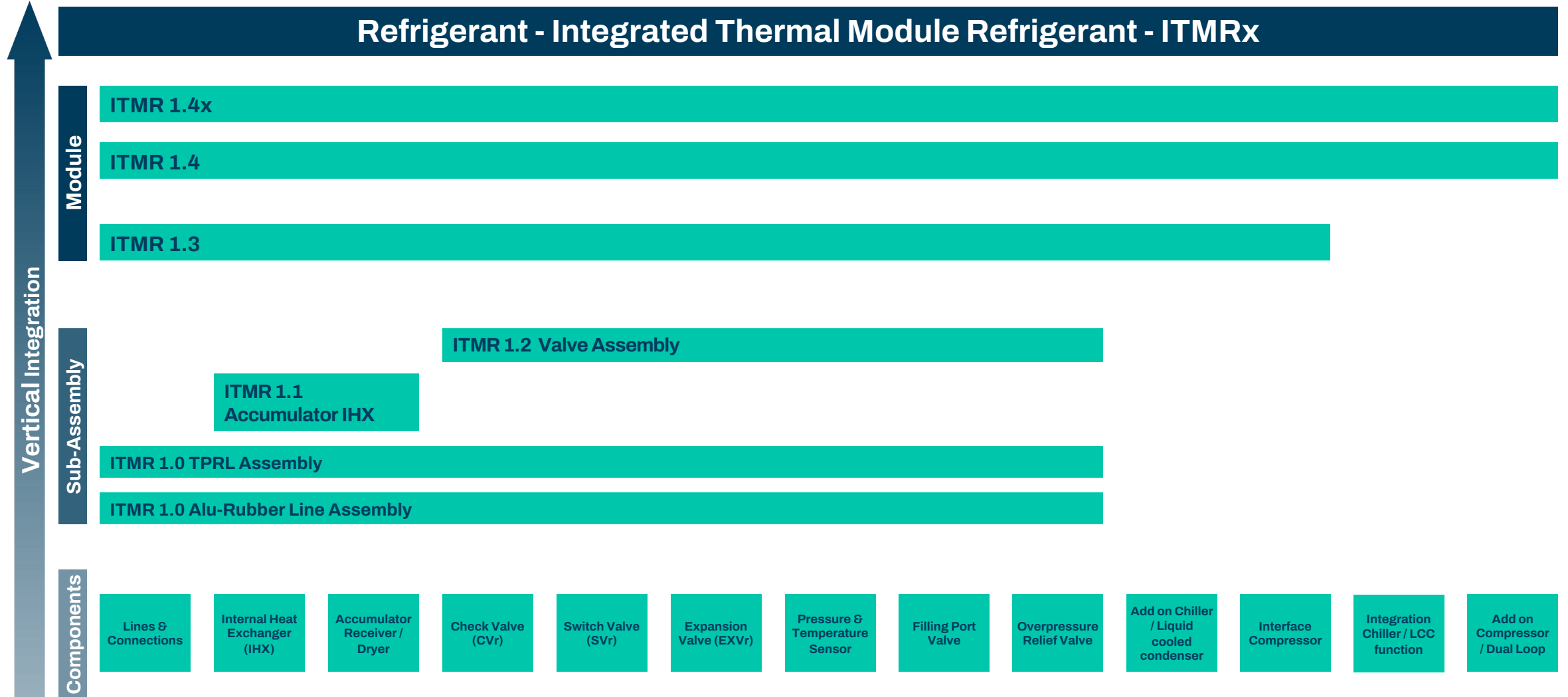
### Coolant - Integrated Thermal Manifold - ITMAx





# Thermal Management & TIFS Roadmap

Refrigerant – Technology Roadmap for R744, R134a, R1234yf and R290



# TIFS Portfolio

## New Generation for BEV & FCEV

### THERMAL MANAGEMENT



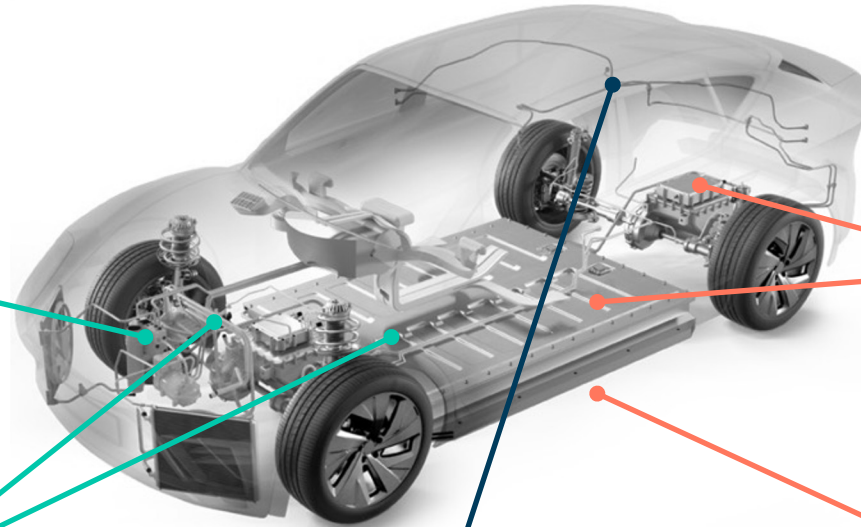
### Refrigerant



### Coolant



### AUTONOMOUS MANAGEMENT



### ADAS Cleaning



### NEW ENERGY STORAGE

*New Energy incl. Battery, Hydrogen, E-Fuels*



### Power Electronics Housing



### H2 distribution



# TIFS Portfolio

## Classical coolant architecture vs. TIFS coolant module (ITMA 1.4)



### Save weight

From rubber to plastic  
Integrated functionalities



### Improved efficiency by reduced pressure losses

From lines into module  
Compact module with less connections & fixations



### Improved space utilisation

Compact design  
Easy-to-assemble, Plug & Play



### Reduced Cost

Reduced complexity  
Less components, less interfaces & less assembly

**Fundamental increase in value added across all levels, from component through module up to vehicle level**



# TIFS Portfolio

Traditional for ICE & HEV

## FLUID CARRYING SYSTEMS (FCS)

### Powertrain



### Refrigerant



### Coolant



### Brake & Fuel



## FUEL TANK & DELIVERY SYSTEMS (FTDS)

### Fuel Tank



### Fuel Delivery



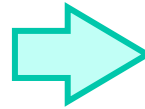
# TIFS Portfolio

Line & Connector evolution supporting specifically the BEV efficiency demand

## Refrigerant



Rubber & Aluminum



Thermoplastic (TPRL)



Weight reduction  
up to 60%

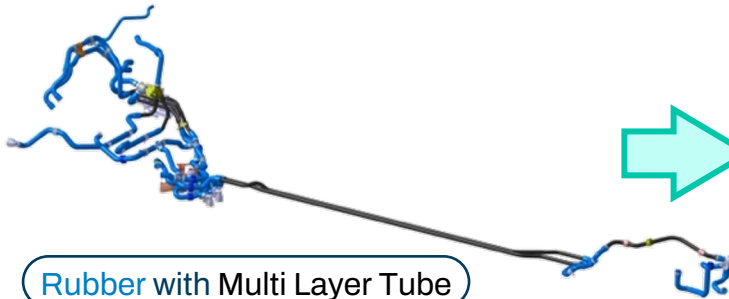


Pressure loss reduction  
up to 60%

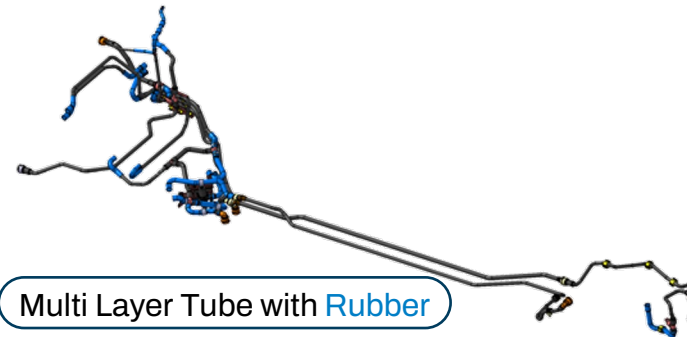
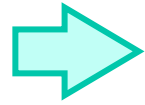


Reduced Interfaces &  
simplified assembly

## Coolant



Rubber with Multi Layer Tube



Multi Layer Tube with Rubber



weight reduction  
up to 30%



Connection reduction &  
improved assembly

## Connectors\*

\*extract of Connector Portfolio

### Thermal



SAE SAE Safe Lock VDA DMC VDA Dry Break

### Fuel



SAE TI Lock SAE RFID SAE Compact

### Hydrogen



Stuffer Pin High Pressure QC

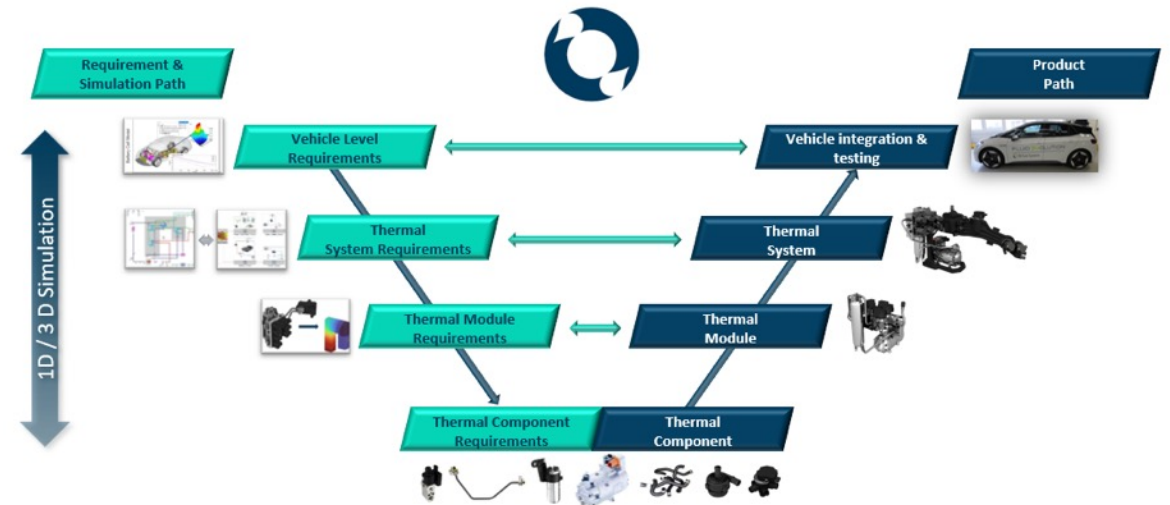
Traditional rubber aluminum lines converted into TIFS unique Thermoplastic Multilayer constructs  
Strong Portfolio in connectors by benefiting from the different fields of applications





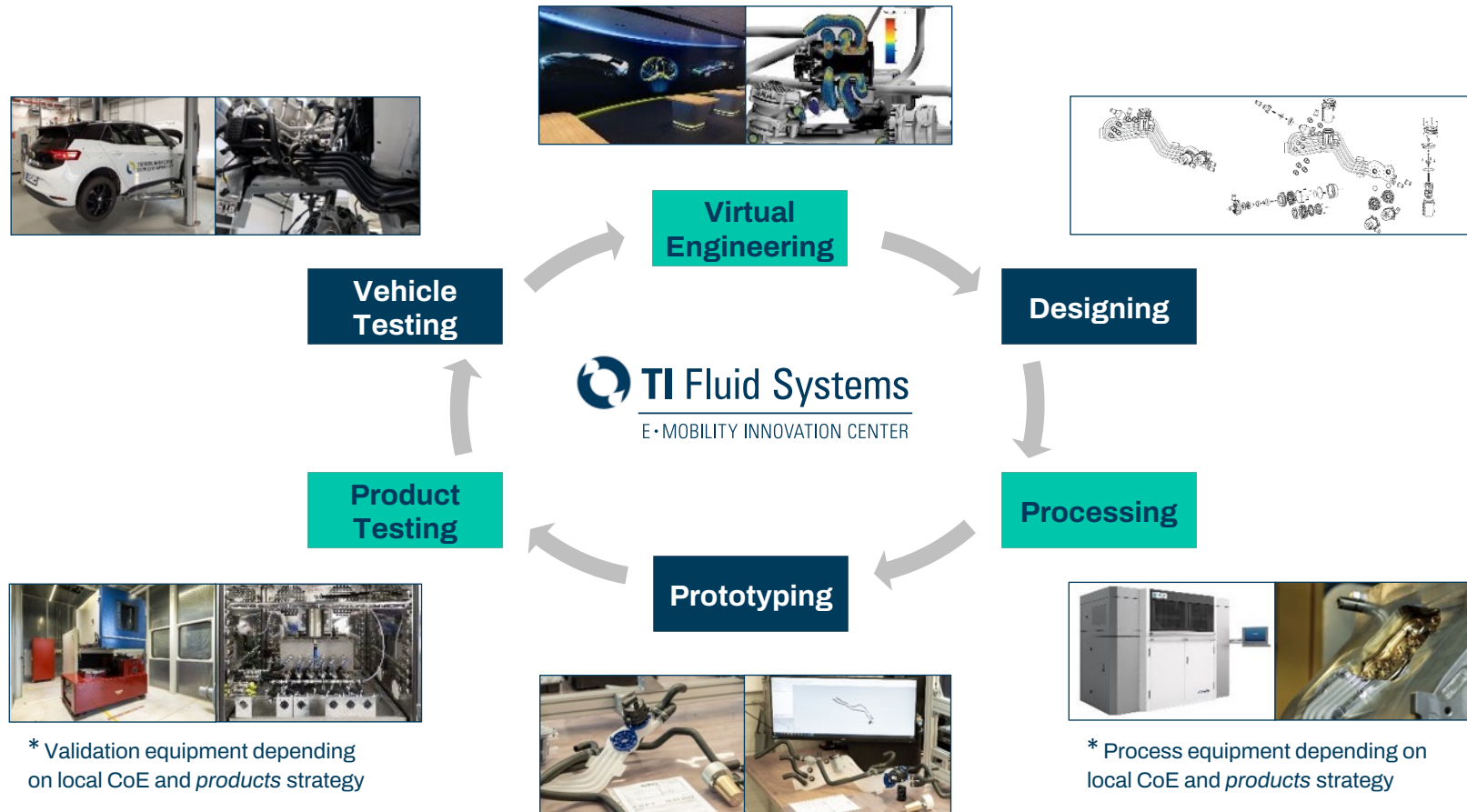
# TIFS USPs in Thermal Management

- **System competence** from vehicle to component level
- Unique **simulation competence** providing efficient solutions at an early development stage
- **E-MICs** and its **unique set of skills** reduces development time up to 6 months
- **Preferred** joint development **partner** on OEM Level, present in each region
- **Synergies** through core FTDS and FCS product & process technologies  
→ blow molding & multilayer tube extrusion
- Global **innovative & motivated team** with 100% **commitment**



# e-Mobility Innovation Center

Six Core Competencies – Installed at each location



**“From fluid system simulation to production readiness, under one roof”**

# e-Mobility Innovation Center

## Global Locations

China – Jiading



South Korea – Incheon



Germany – Rastatt



USA – Auburn Hills



Japan – Nagoya



# Summary



**Localise core competencies for local development**



**Joint developments with customers**



**Completion of scalable and flexible thermal module kit**



**Global thermal management business expansion**

***Efficiency as “The New Currency”***



Thank You!