

CRAFTING THE FUTURE

Optimization of BTMS Cooling for Electric Vehicle utilizing KULI Software

13th May 2025

Presenter –Ms. Trupti Jadhav



TTR Portfolio

TTR Methodology for Heat Exchanger Design

1D Simulation Methodology Using KULI

Case Study

Results & Discussion

Conclusion

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TTR Portfolio



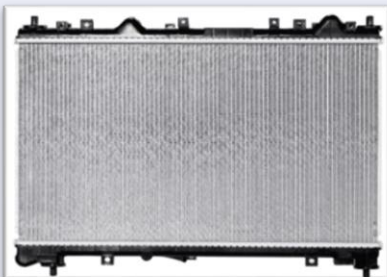
-
- Plant**
R&D center
Warehouse
- Jammu - Kashmir
Himachal Pradesh
Punjab
Uttarakhand
Haryana
Delhi
Uttar Pradesh
Rajasthan
Gujarat
Madhya Pradesh
Bihar
Jharkhand
West Bengal
Orissa
Chhattisgarh
Tamil Nadu
Kerala
Lakshadweep
Goa
Karnataka
Andhra Pradesh
Telangana
Maharashtra
Daman and Diu
Dadra and Nagar Haveli
Sikkim
Arunachal Pradesh
Assam
Nagaland
Manipur
Mizoram
Tripura
Meghalaya
Puducherry
Andaman and Nicobar Islands
- Pantnagar
Lucknow
Sanand
Jamshedpur
Pithampur
Sricity
Hosur
Chakan
R&D Centre

Strictly Confidential

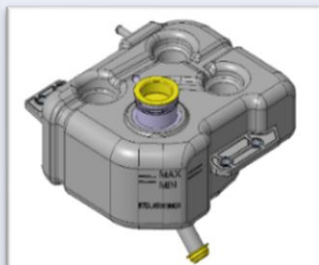
TTR Portfolio

Product Portfolio for ICEV

ICE Application



Radiator



DAT



Engine Cooling System



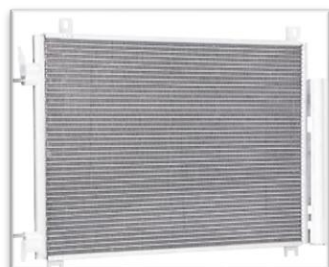
Heater Core



Intercooler



EGR Cooler



Condenser



CRFM



Radiator for 2W



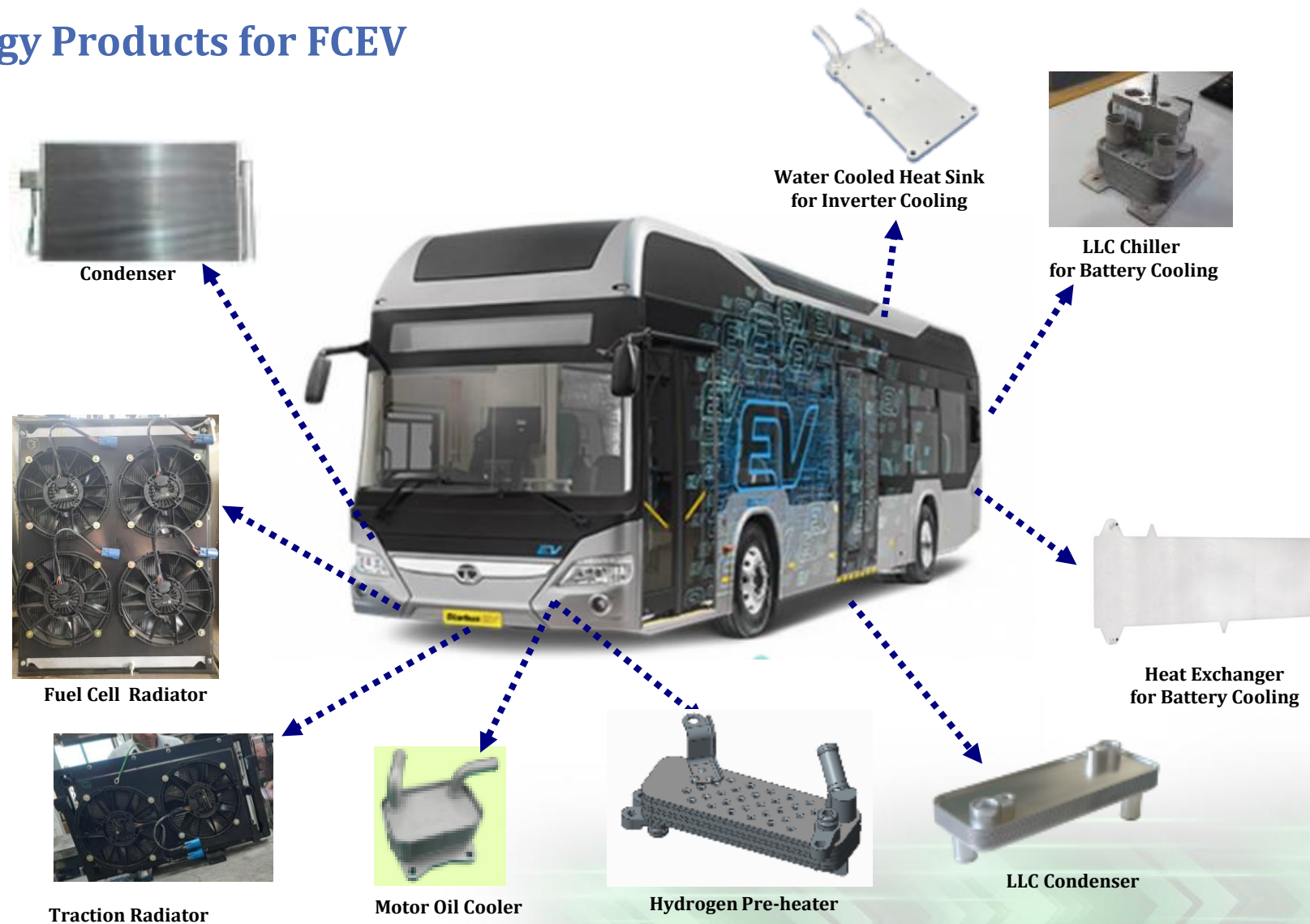
Oil cooler



Transmission Oil cooler

TTR Portfolio

New Technology Products for FCEV



TTR Portfolio

New Technology BEV Products



TTR Portfolio

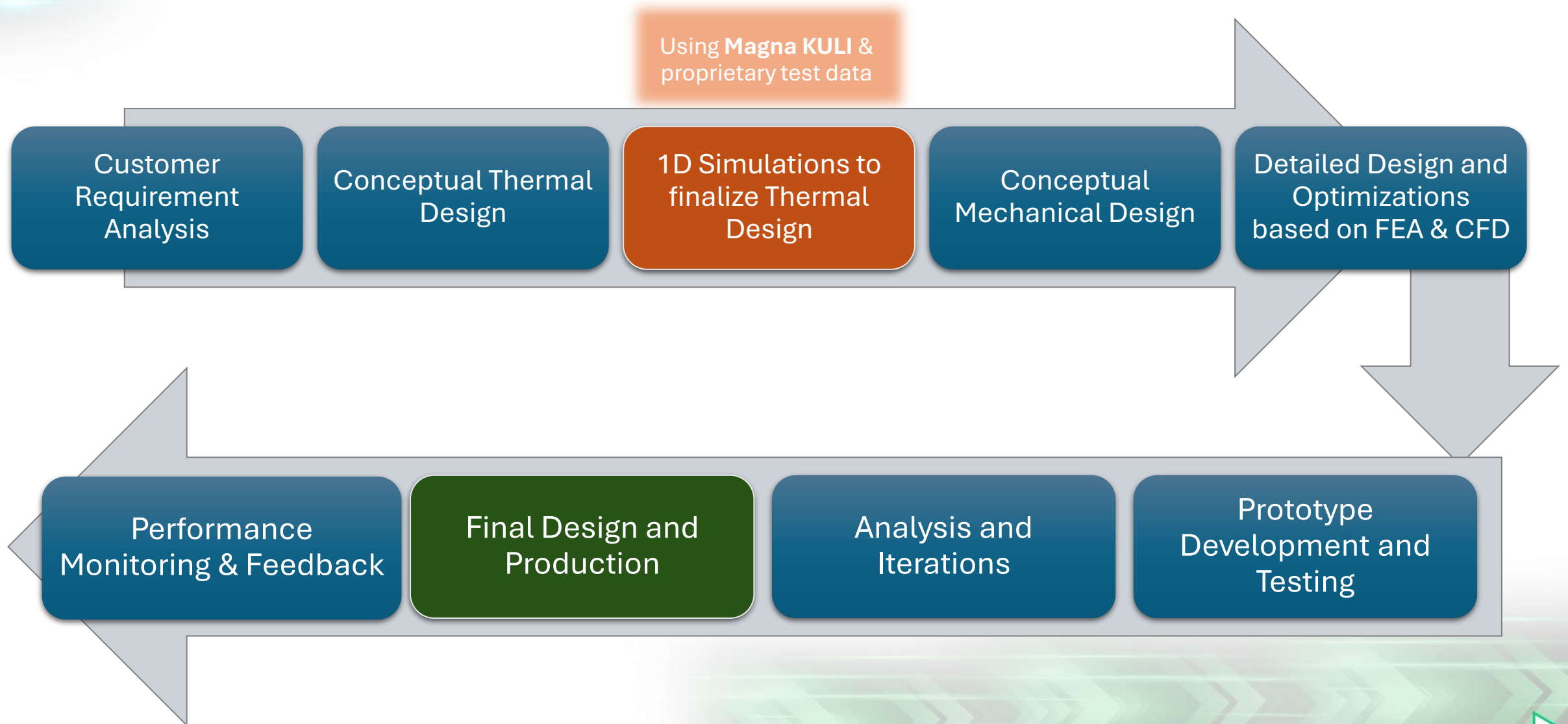
Market Segment	Customers
Passenger Vehicle (PV)	
Medium & Heavy Commercial Vehicle (M&HCV)	
Light Commercial Vehicle (LCV)	
Small Commercial Vehicle (SCV)	
Tractors	
Diesel Genset (DG)	
Two/Three Wheeler (2/3W)	
Aftermarket	75+ Distributors Across India
Export	
Construction Equipment (CE)	

Three blue chevrons pointing left, composed of multiple parallel lines.

TTR Methodology for Heat Exchanger Design

Three green chevrons pointing right, composed of multiple parallel lines.

TTR Methodology for Heat Exchanger Design



1D Simulation Methodology Using KULI

Simulation Overview

Introduction

- Simulation methodology is a technique used to model case study using software to analyze its behavior.
- It helps to experiment with different inputs conditions.
- By simulating iterations, we can optimize solution for better outcomes.

Steps

- Define the problem.
- Model the system
- Validate and verify

Benefits

- Time Saving
- Cost-Effective
- Decision Support



1D Simulation Methodology Using KULI

KULI Graphical User Interface (GUI)

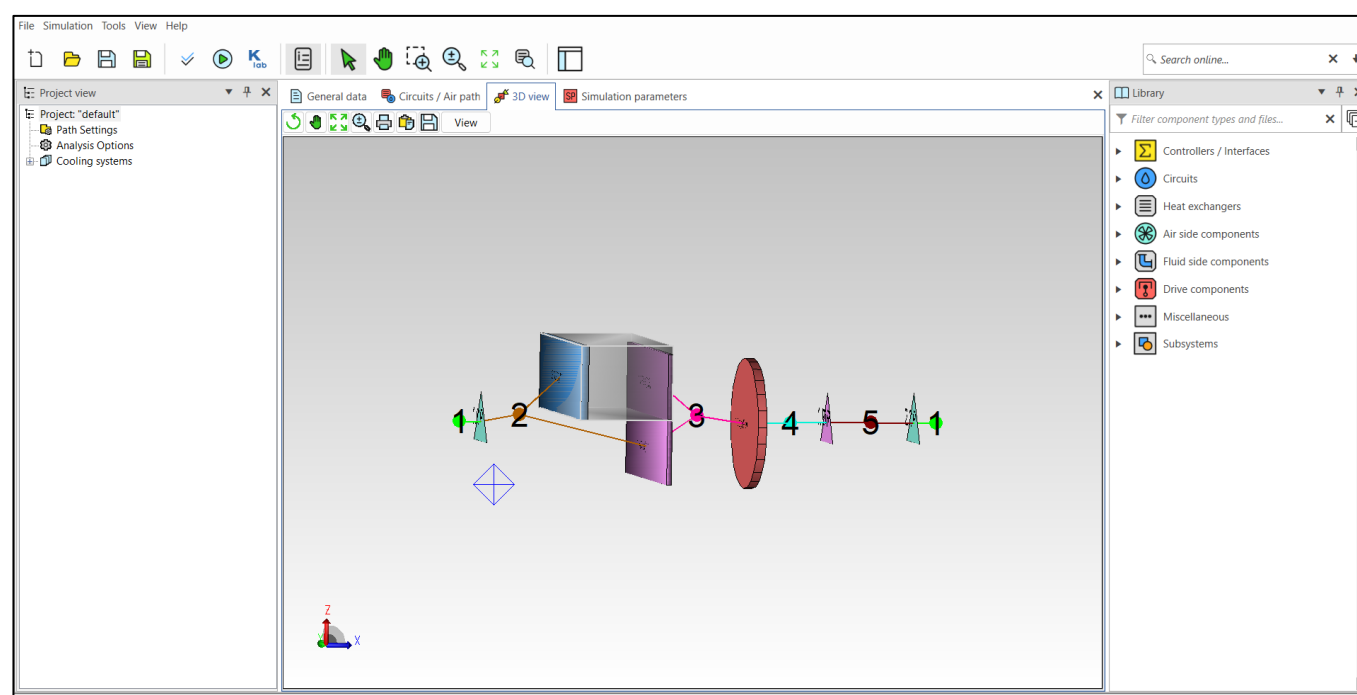


Image : KULI GUI

General Data

All components are displayed here and the dimension, position of all the component can be defined.

Circuit/ Air path

The inner circuit is defined on this tab.

Air side

All components are arranged on this tab according to the direction of airflow.

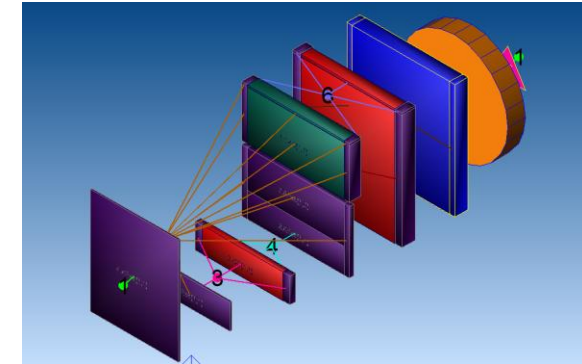
Simulation Parameters

Simulation parameters as per given input conditions can be defined in this section.

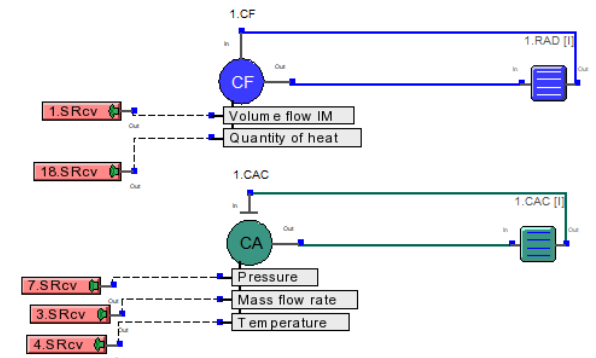
1D Simulation Methodology Using KULI

Step by Step Procedure for KULI Modelling

- Prepare component files (radiator, intercooler, oil cooler, fans, etc.) required for the cooling system.
- Use tested or validated simulation data when creating these component files.
- Store the prepared component data files in the library for universal project use.
- Define the inner circuits (water, oil, and charge air).
- Insert all cooling system components and display them in the component table of the general data section.
- Insert radiators and pipes and connect components in the Circuits/Air path section.
- Connect all components node by node in the Air side section to complete the setup.
- View the configured components in 3D for visualization.
- Set simulation parameters in the simulation parameter section.
- Ensure correctness using characteristics curves and 3D maps for interpolation and extrapolation.
- Start KULI's Simulation to automatically save the latest updates on the cooling system model in the .scs file.
- After simulation, export results to Kuli Lab to view and extract all component results into Excel.



KULI 3D View



IM Fluid Circuit

Case Study



Case Study

Optimization of BTMS Cooling System for EV Application

Need of Eco-friendly electric vehicle

- Reduction in Air Pollution
- Combatting Climate Change
- Less Dependence on Fossil Fuels
- Energy Efficiency
- Supports Renewable Energy
- Lower Operating Costs
- Noise Pollution Reduction & Health Benefits
- Government Support and Incentives
- Sustainable Urban Development

Why BTMS

- Prevents overheating
- Improves efficiency
- Extends Battery Life Span
- Ensures Safety

Cooling system types in BTMS

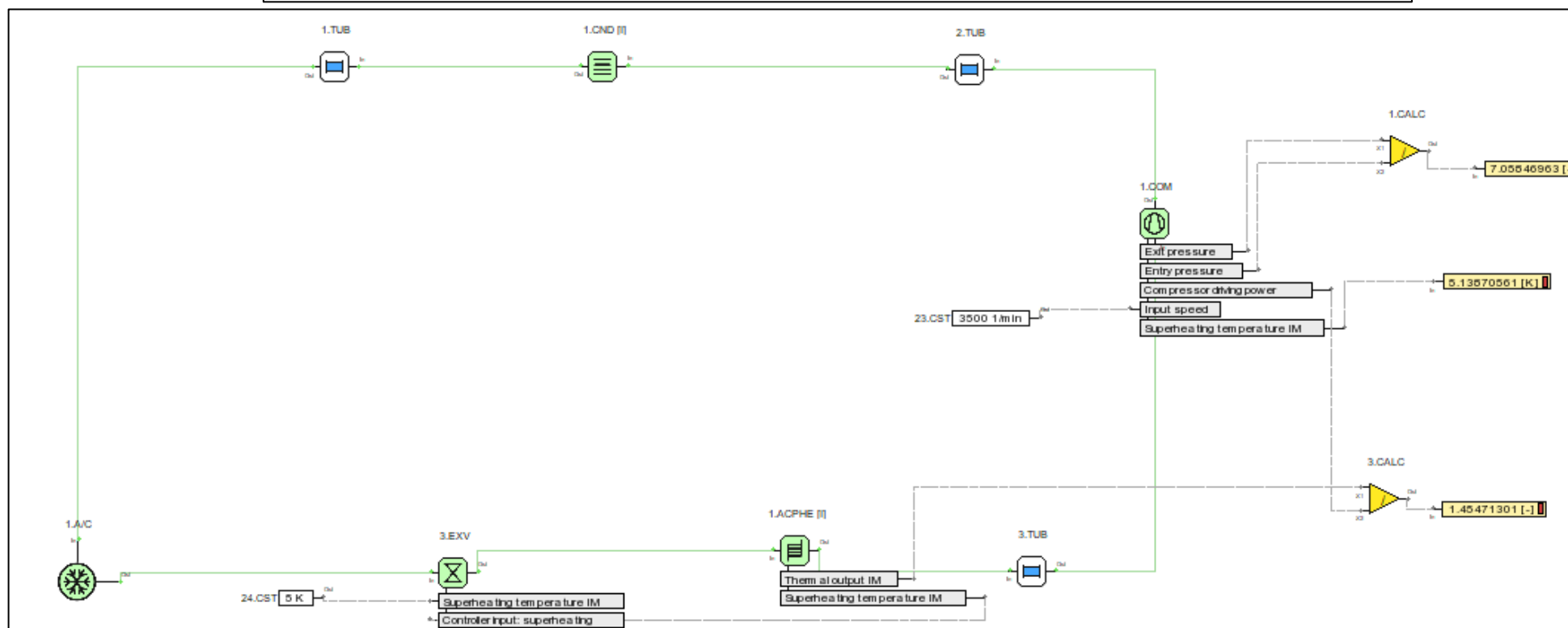
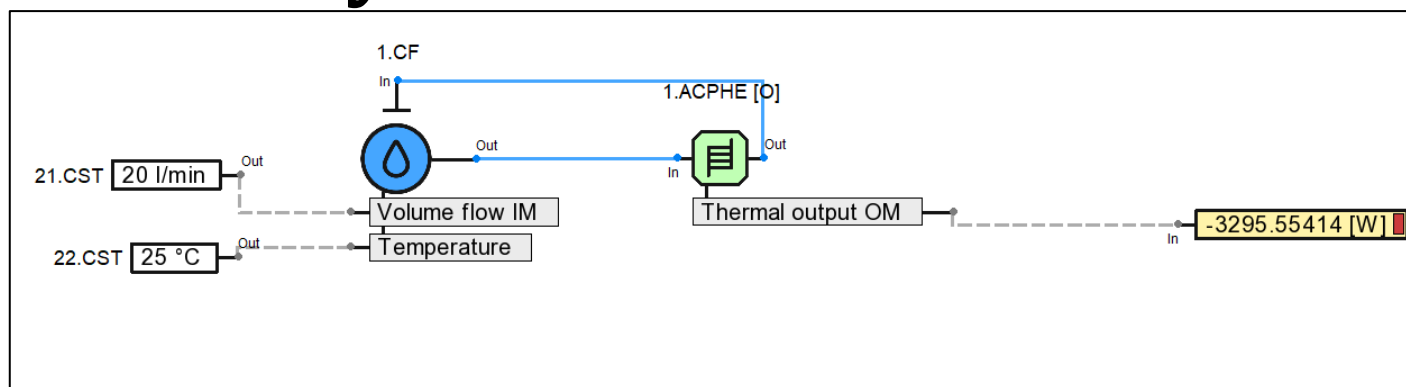
- Air Cooling
- Liquid Cooling
- Immersion Cooling
- Phase Change Materials
- Refrigerant Based Cooling

Software Capability

- Real-World Modelling
- Accuracy and Precision
- Real-Time Simulation
- Scalability
- Customization and Flexibility
- Data Handling and Analysis
- User-Friendly Interface



KULI Simulation Layout



The background features a light blue and white geometric pattern with large, stylized arrows pointing left and right. The left arrow is blue and the right arrow is green.

Results & Discussion



Results & Discussion

Inputs

- Ambient Temperature : 40 ,45, 50 , 55, 60 , 65 Degree Celsius
- Cooling Air flows by Mass flow target
- Components in AC circuit and Water circuit:
 1. Condenser
 2. MFL
 3. AC Plate heat exchanger
 4. Compressor
 5. Expansion valve
- 36 Operating points are simulated at different ambient temperatures and cooling air mass flow rates to optimise the AC Circuit.
- Heat Exchange between water and refrigerant is calculated.



Results & Discussion

Results

✓ Components Load

- Condenser Heat Rejection : 5.3 kW
- Compressor driving Power : 2.3 kW (3.5 – 25 bar) at 3500 RPM
- A/C Plate Heat Exchanger: 3.3 kW

✓ Components Sizing

- Condenser size : 225 x 539 x 20 mm.
- AC Plate heat exchanger size : 42 x 76 x 154 mm.



Three blue chevrons pointing left, composed of multiple parallel lines.

Conclusion & References

Three green chevrons pointing right, composed of multiple parallel lines.

Conclusion

- Utilized MAGNA KULI software for detailed 1D HVAC simulations of BTMS for EV application.
- Analyzed heat transfer.
- Optimization is done for all AC circuit components while simulating no. of iterations.





Enabling Mobility Solutions

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