



Forward. For all.

Applying the latest KULI features in
modern vehicle simulation

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2025-05-14



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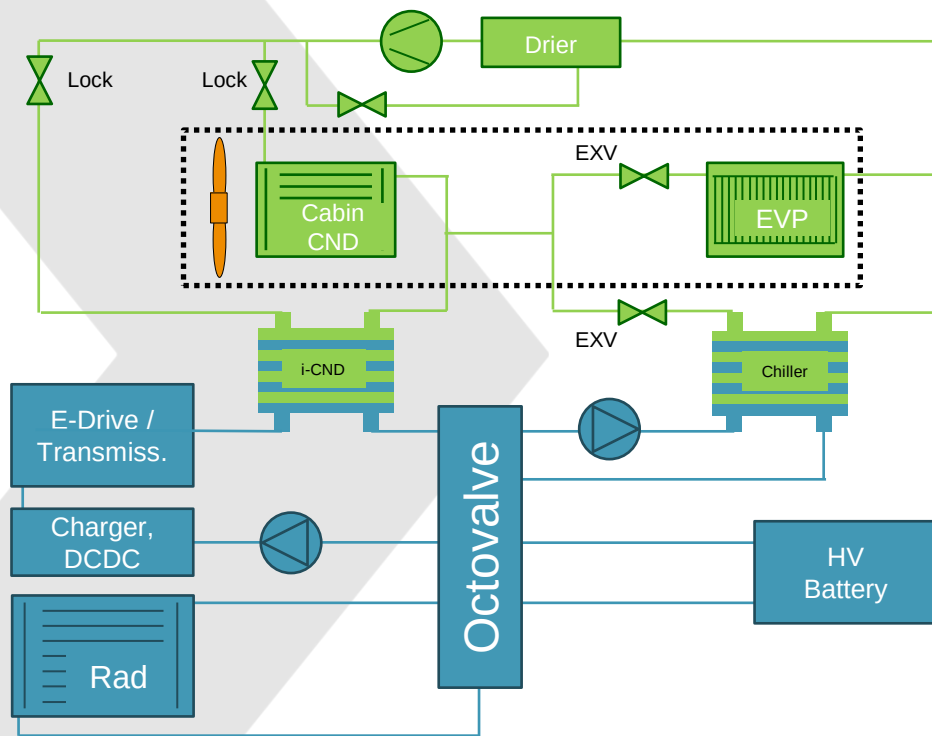
04 Refrigerant Mollier Chart

A woman in a black coat and white top stands next to a dark-colored Tesla Model Y in a misty, mountainous landscape. The car's rear lights are illuminated, and the scene is hazy with mountains in the background.

Tesla Model Y in KULI

(Available in the KULI online library)

Tesla Model Y



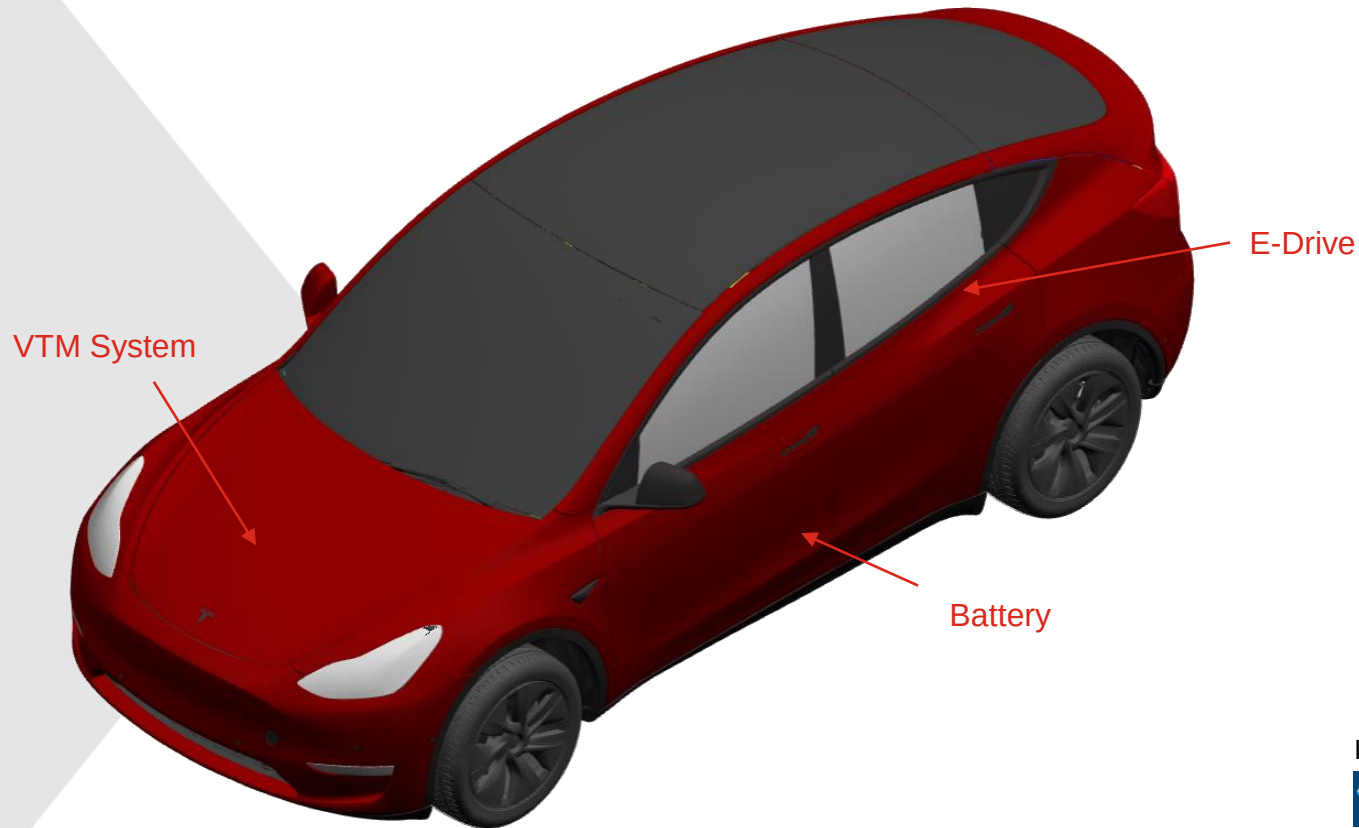
High level of **simplification** and **integration** without sacrificing efficiency...

Made possible through some key technologies and some clever engineering choices.



Source: Wikipedia

Tesla Model Y – Virtual Teardown



Images from...



Tesla Model Y VTM System

VTM Module:
Chiller, Liquid Cooled Condenser

HVAC Box Heat Exchangers:
Evaporator, Condenser

Note: **Very little tubing!**

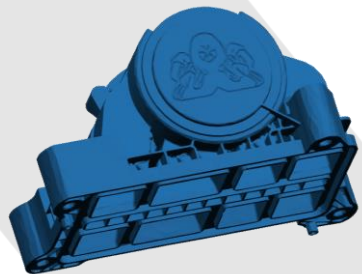
Compressor

Front End Heat Exchanger:
Main (and only) Radiator

Images from...

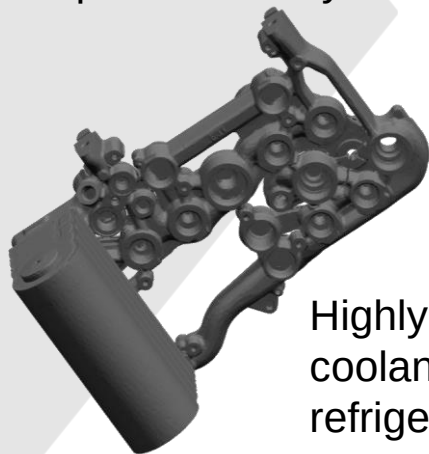
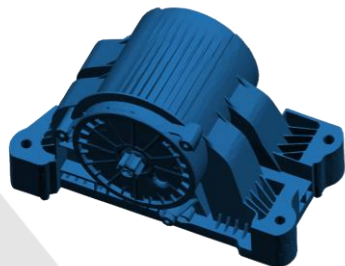


Some Tesla Model Y VTM Key Technologies...



„Octo valve“

= 8 port / 4 position rotary-valve

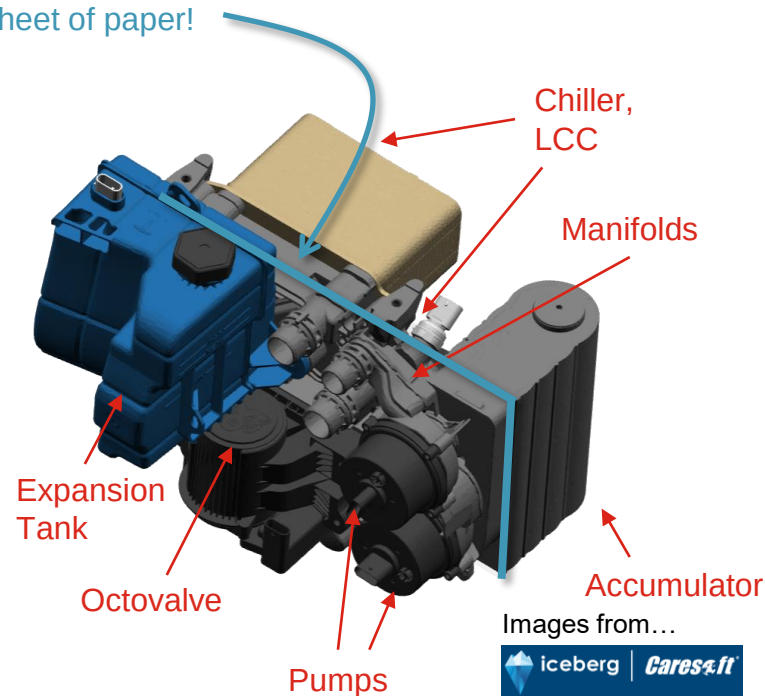


Highly integrated
coolant- and
refrigerant-manifolds



This cross section is
just a bit larger than an
A4 sheet of paper!

Ultra-compact design...

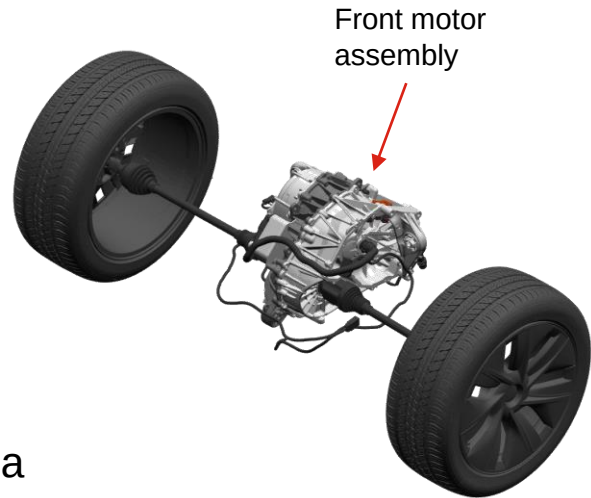


Images from...



Powertrain: “Lossy Mode”

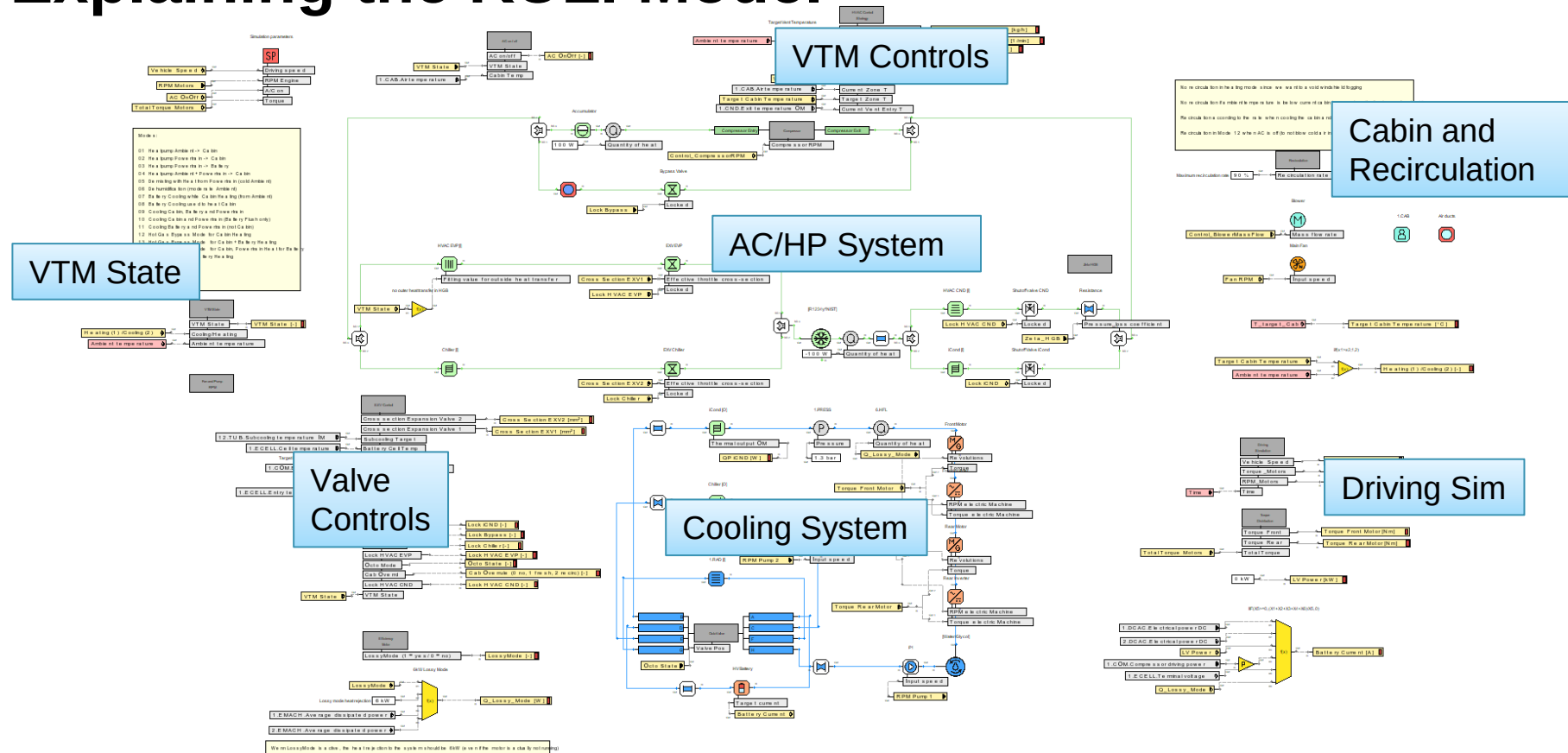
- One design principle of the Model Y is to **avoid PTC heaters**
- A strategy is to run the motors in deliberately inefficient operating points
→ **“Lossy Mode”**
- In extreme operating points this can even mean that the motor is standing and is only producing heat
- This heat can be used to warm-up powertrain, battery or provide a heat source for the heat pump.



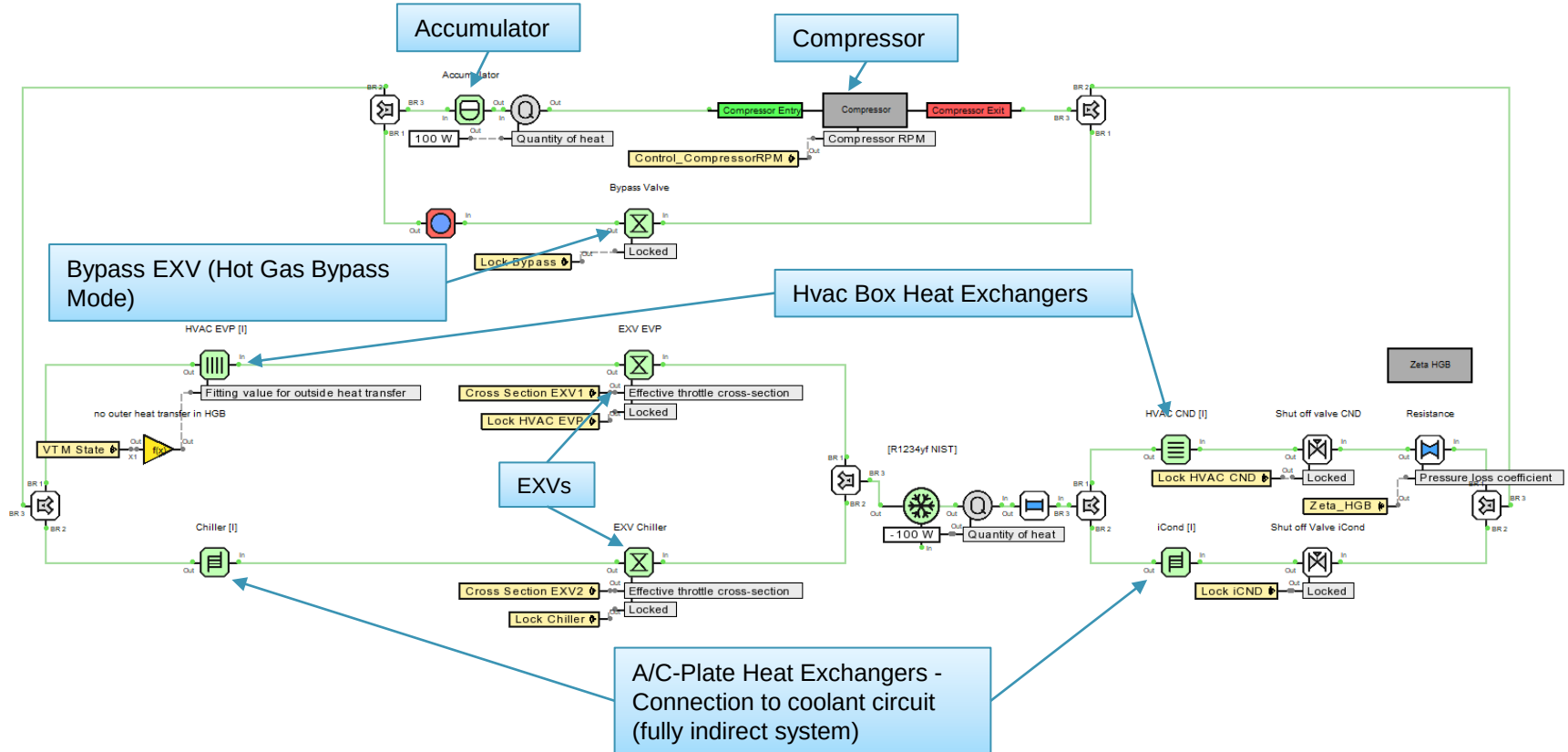
Images from...



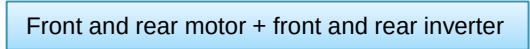
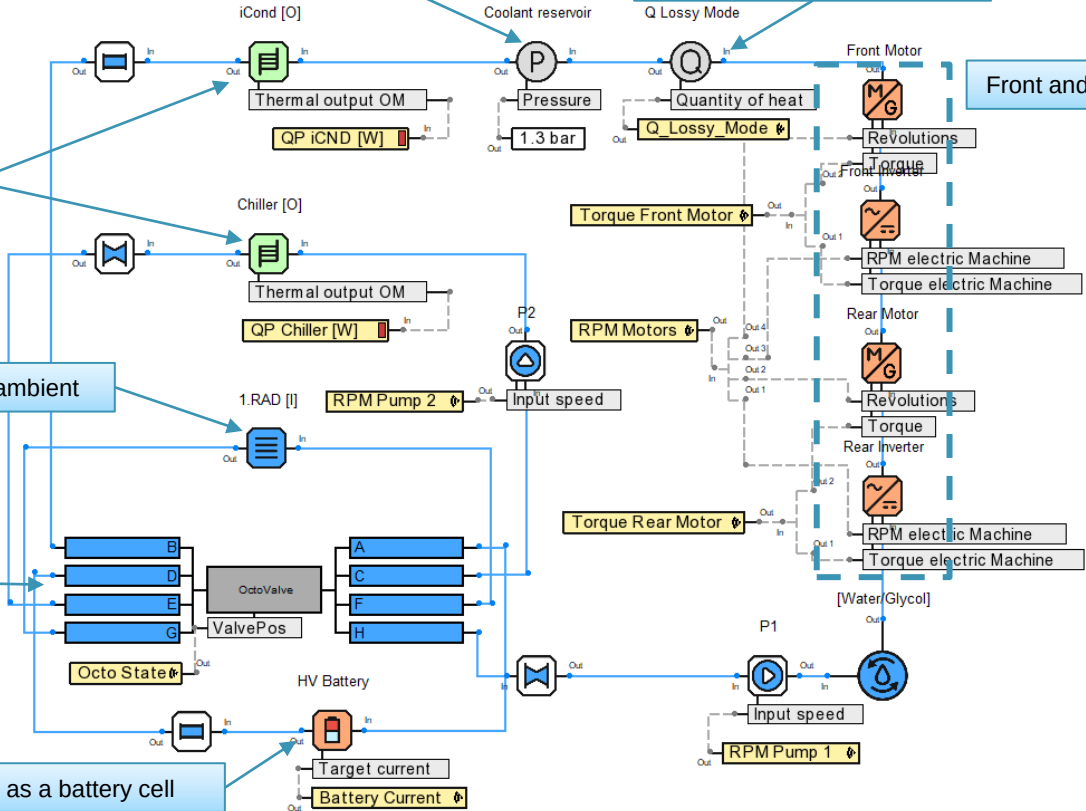
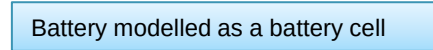
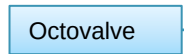
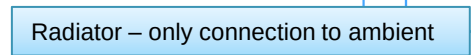
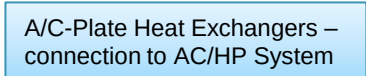
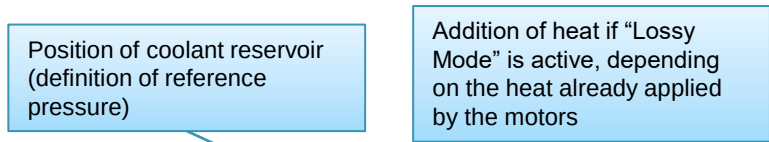
Explaining the KULI Model



AC/HP System



Coolant circuit

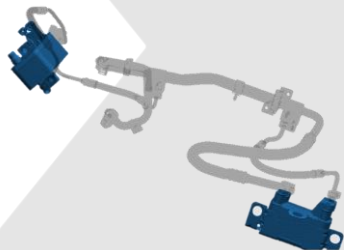
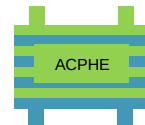


A woman in a black coat and white top stands next to a dark car in a misty, mountainous landscape. The car's rear lights are glowing red. The scene is hazy and atmospheric.

A/C-Plate Heat Exchanger Improvements

Why are A/C-Plate Heat Exchangers important in modern vehicles?

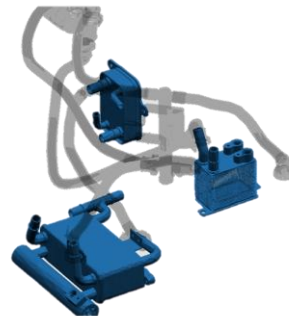
- The connection between refrigerant circuit and coolant circuit
- Also known as Chiller or indirect Evaporator / Liquid cooled condenser or indirect Condenser
- Compact, versatile in use and often a key component to enable complex VTM systems
- Used in almost every EV nowadays, since conditioning the traction battery is an important task of the VTM system



BMW iX xDrive 40 2022



Aito M9 Pure Electric 2024



Kia EV9 GT Line Launch Edition 2024

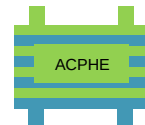


BYD Seal Long Endurance 2022

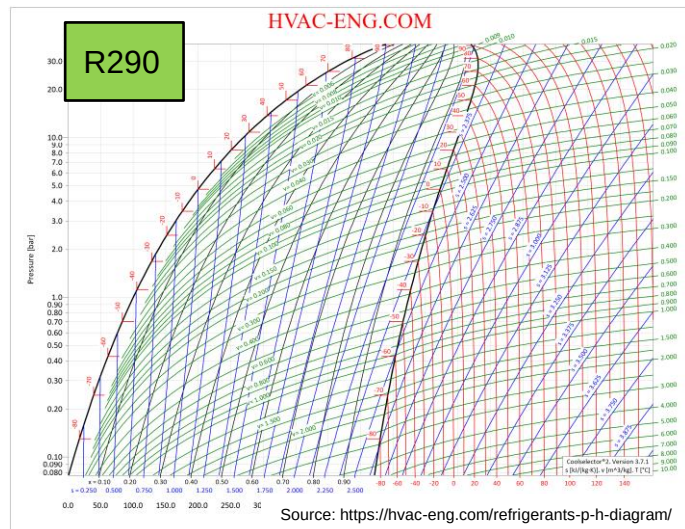
Images from...



Why are A/C-Plate Heat Exchangers important in modern vehicles?



- The connection between refrigerant circuit and coolant circuit
 - Also known as Chiller or indirect Evaporator / Liquid cooled condenser or indirect Condenser
 - Compact, versatile in use and often a key component to enable complex VTM systems
 - Used in almost every EV nowadays, since conditioning the traction battery is an important task of the VTM system
-
- Outlook: Especially interesting for R290-Systems



Source: <https://hvac-eng.com/refrigerants-p-h-diagram/>

What changes in KULI 19

for the A/C Plate Heat Exchanger:

- Improvement of adjustment
- Input data is validated for plausibility
- Supported by the Dynamic Solver

1.ACPHE [I]

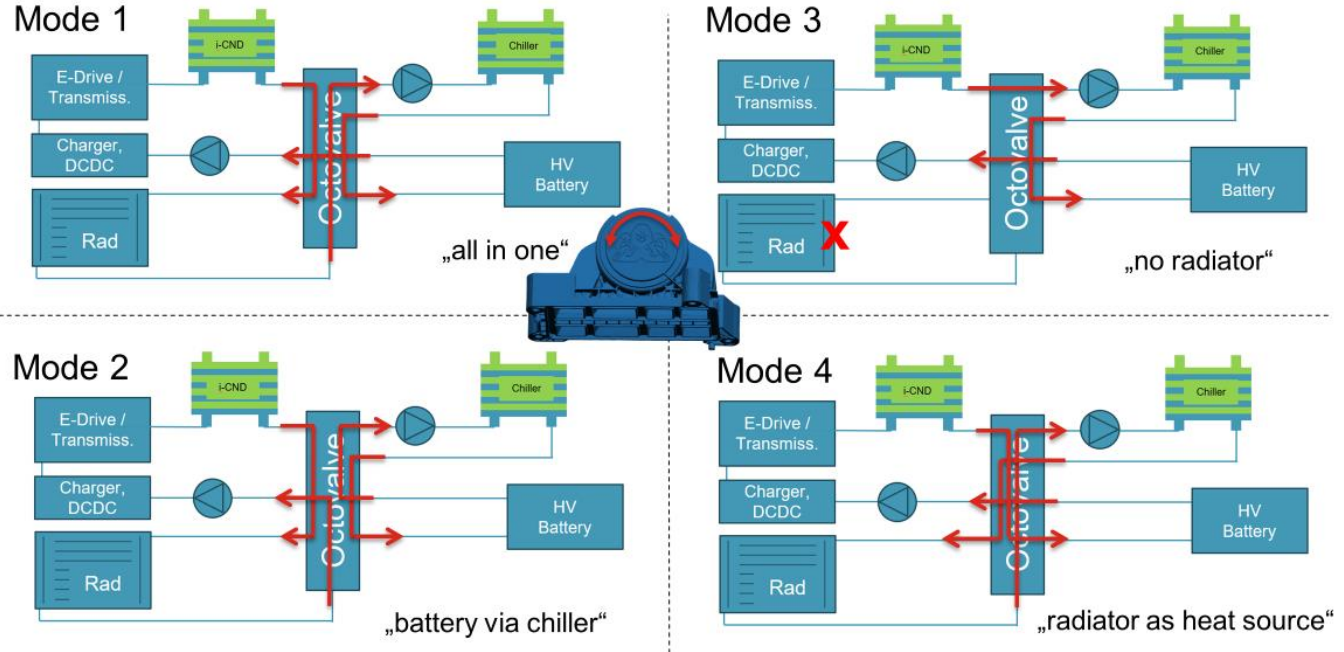


1.ACPHE [O]



Enabling the VTM System Design

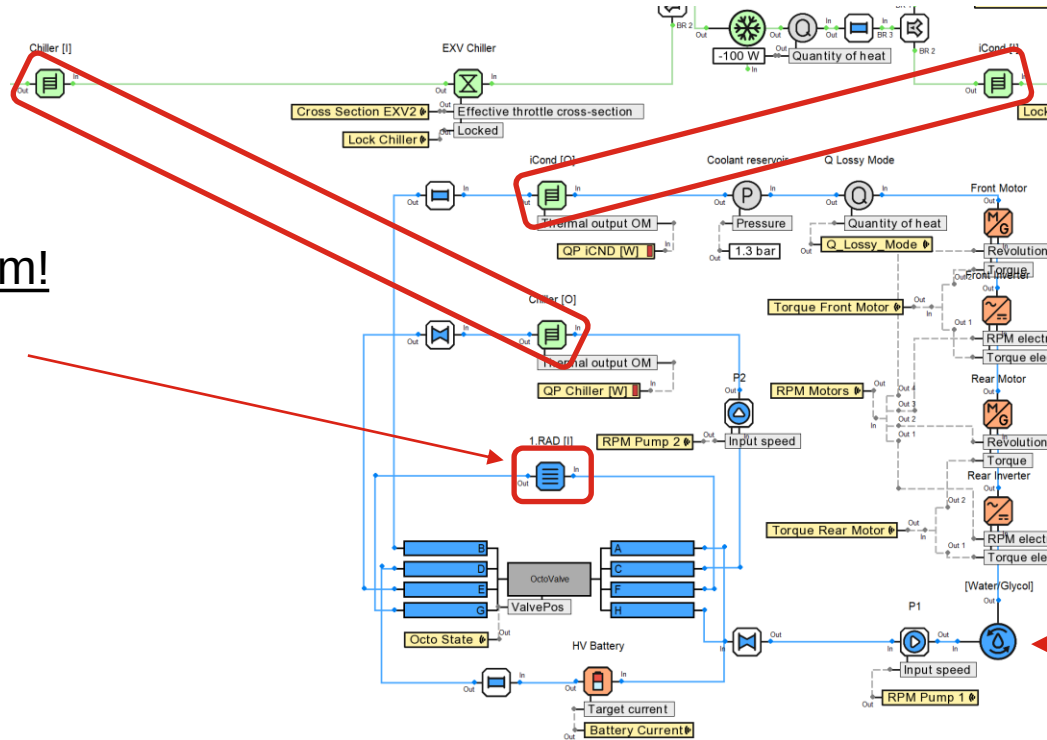
Fully indirect system!
(only a single radiator in the vehicle front)



Enabling the VTM System Design

Fully indirect system!

(only a single radiator in the vehicle front)



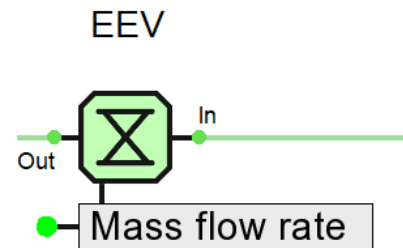
Integrated in the
Dynamic Solver
coolant circuit



Mass Flow Controlled Expansion Valve

Why do we need it?

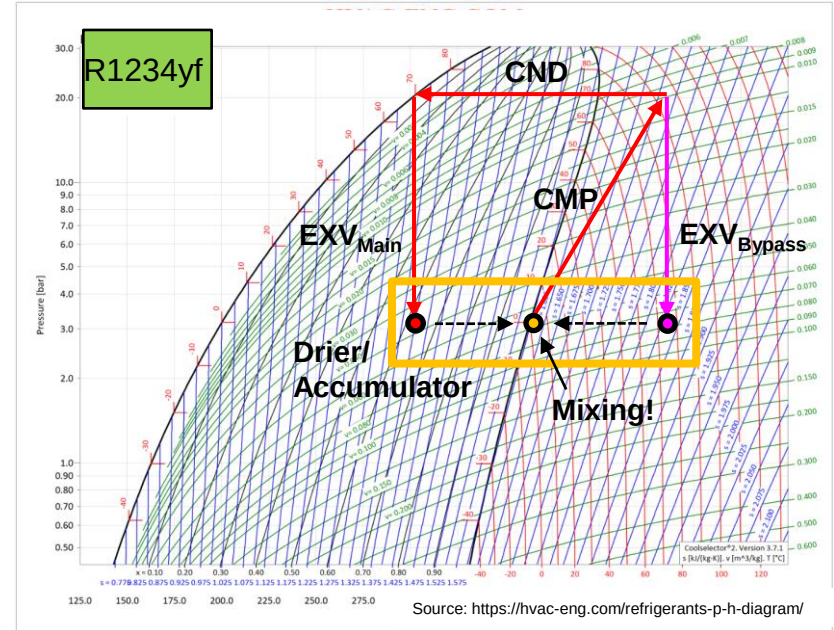
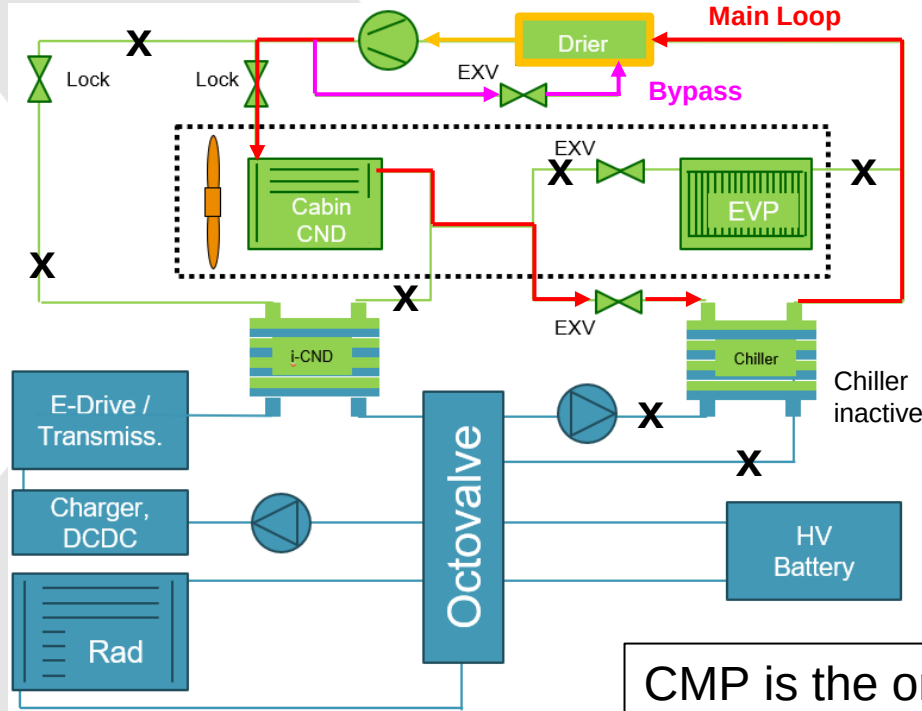
- EEVs (electrically controlled expansion valves) are way more flexible when it comes to control strategies
 - In the past: TXV (thermostatically controlled expansion valve) or FOT (fixed orifice tube)
- Several different control strategies necessary for a single VTM system
- From a simulation point of view being able to control the mass flow at the expansion valve is a big advantage
 - Running virtual compressor testbenches
 - Increasing stability for challenging topics such as the Hot Gas Bypass Mode



One Special Mode: The Hot Gas Bypass Mode

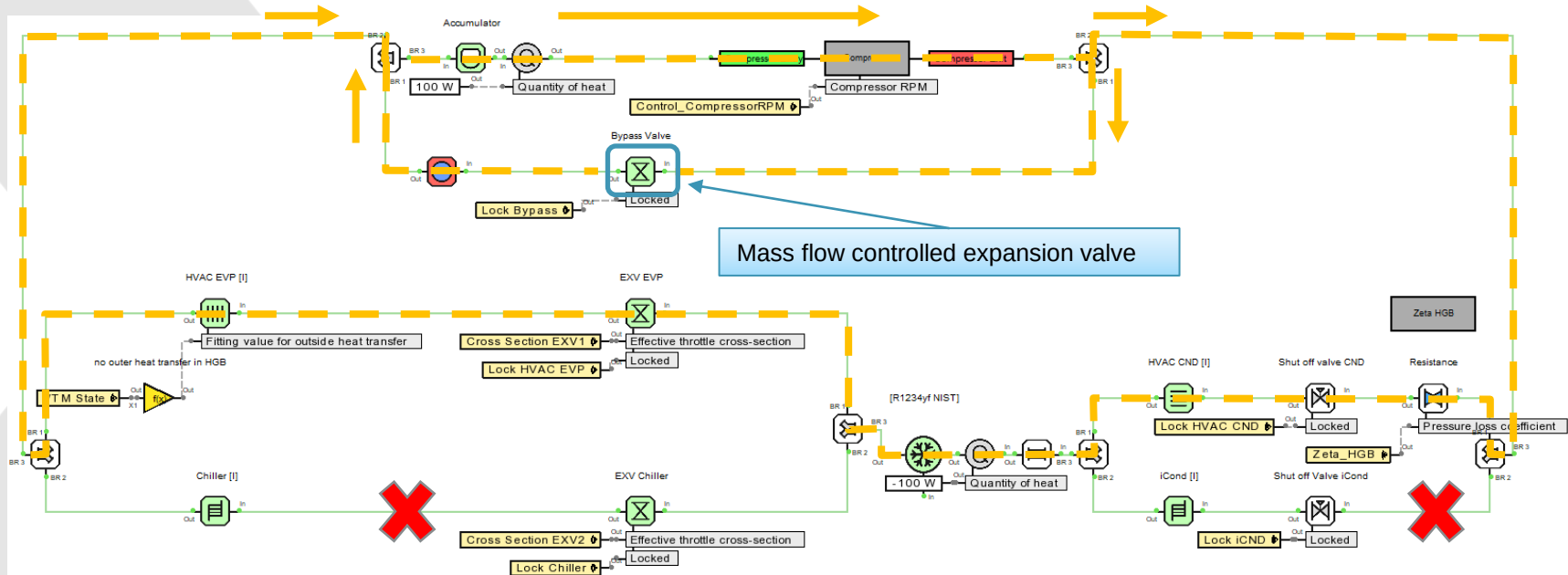
Prerequisite: Both powertrain and ambient are too cold for heat pump use

Example: Cabin Heating



CMP is the only heat source, CND the only heat sink!

AC/HP System – Hot Gas Bypass Mode



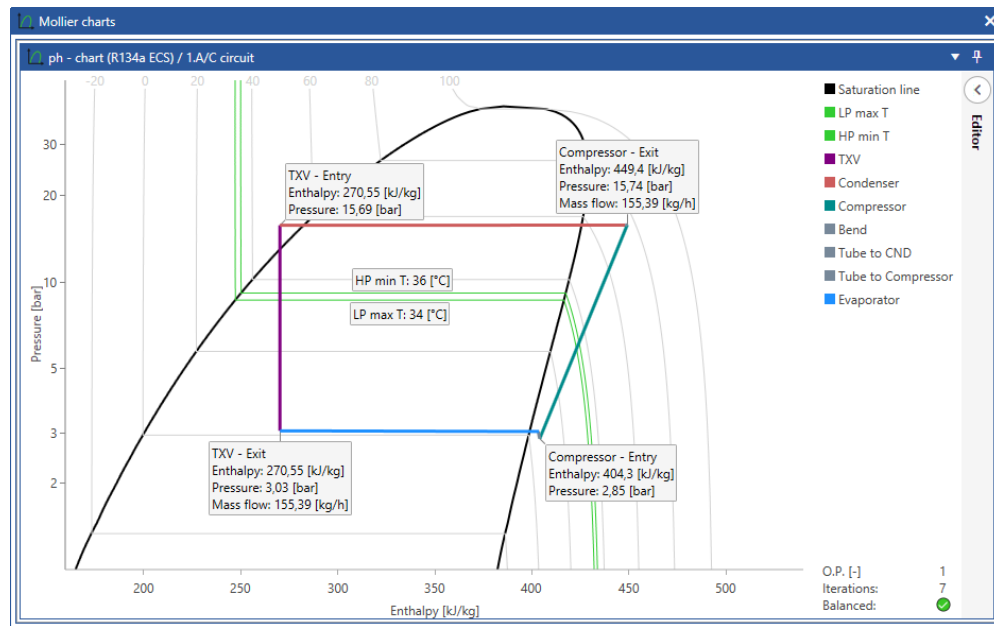


Refrigerant Mollier Chart

(in both **KULI** and **KULI lab**)

Why is it helpful?

- Comprehensive information at a glance
- Key parameters (pressure, superheating, subcooling, etc.) are easily accessible
- Identifying every component contributing to the active mode
- Facilitates quick decision-making and troubleshooting
- Course of simulation visible in post processing



Please check out our [KULI Online Library](#):

Tesla Model Y – Vehicle Thermal Management Model

<https://kulihelp.magna.com/wiki/spaces/KOL/pages/244580353/Tesla+Model+Y+-+Vehicle+Thermal+Management+Model>



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