Thermal management differences in Honda's transition from PHEV to BEV

HondaFrom Clarity PHEV（Clarity BEV It is an experimental BEV), and the time between the follow-up Honda e BEV is almost two years. The two cars have most of the inheritance in the vehicle thermal management and the heating and cooling of the battery system, and there are also many improvements. Note: Honda engineers like to publish technical articles on SAE. The two main content sources are "Integrated Cooling System for Underfloor High Voltage Devices in PHEV" in 2018 and "Powertrain Thermal System Development for Small BEV" in 2020.

01 Similarities in the overall thermal management of the two cars

As shown in the figure below, the layouts of the Clarity and Honda e vehicles are battery-floor layouts. The Clarity PHEV integrates DCDC into the battery system, OBC rear, PCU and front engine for integrated layout; and Honda e is a rear-wheel drive mode, OBC and DCDC are separated, placed in the front compartment; PCU/Motor part rear.

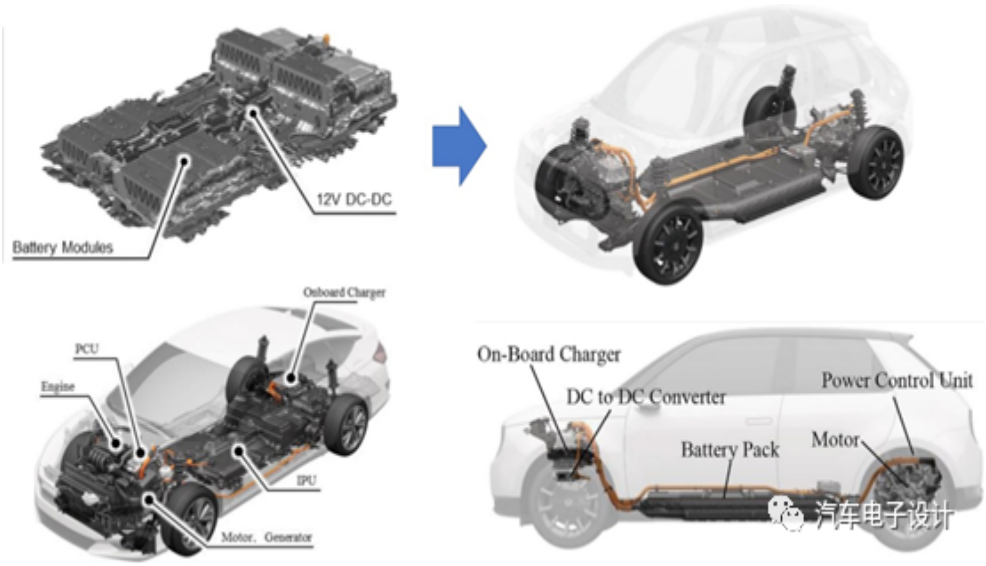

Figure 1 Arrangement of Clarity and Honda e

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From the overall requirements, there is no difference in the basic requirements of the two cars. The target temperature range of the battery is around 25-35°, and the target temperature of other power electronics is around 55°.

Table 1 Thermal management requirements for main components of PHEV and BEV

Specification		Target Temp.	Maximum rejected heat Driving	Maximum rejected heat AC Charging
Battery	Li-ion Capacity 17 kWh	25 °C to 35 °C	400 W	30 W
Charger	AC240 V 6.6 kW	55 °C or less	N/A	750 W
DC-DC	Output 2.3 kW	55 °C or less	150 W	80 W

	Target Temperature	Driving	Charging Normal	Charging Fast
Battery	Lo	✓	✓	✓
DC-DC Converter	Mid	✓	✓	✓
On-Board Charger	Mid	-	✓	-
Power Control Unit	High	✓	-	-
Motor	High	✓	-	-

The corresponding control intervals for battery temperature and coolant temperature can be divided into five intervals. In the high temperature zone, the two systems are completely similar. In the low temperature zone, PHEV has a great advantage, that is , the working mode of the battery cell can be adjusted according to the characteristics of the engine, so heating at low temperatures is not a very important discussion area. . In BEV, when the battery temperature is low and the coolant temperature is low at the same time, it is necessary to use battery heaters carefully, and control the heating loop within a minimum range to ensure the maximum use of limited energy.

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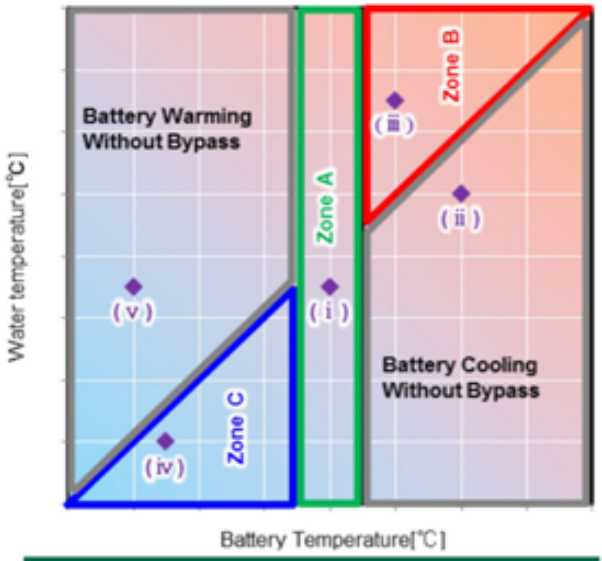

Vehicle Operation	Ambient Temperature	Battery vs. Water Temperature on Figure 6	Cooling Circuit
Low power	25 °C	(i) Zone A	Bypass
Driving	0 °C	(iv) Zone C	Bypass
High-load Driving	40 °C	(ii)	Battery Cooling
Park idle	40 °C	(iii) Zone B	Bypass
Charging	40 °C	(iii) Zone B	Bypass
	0 °C	(v)	Battery Warming

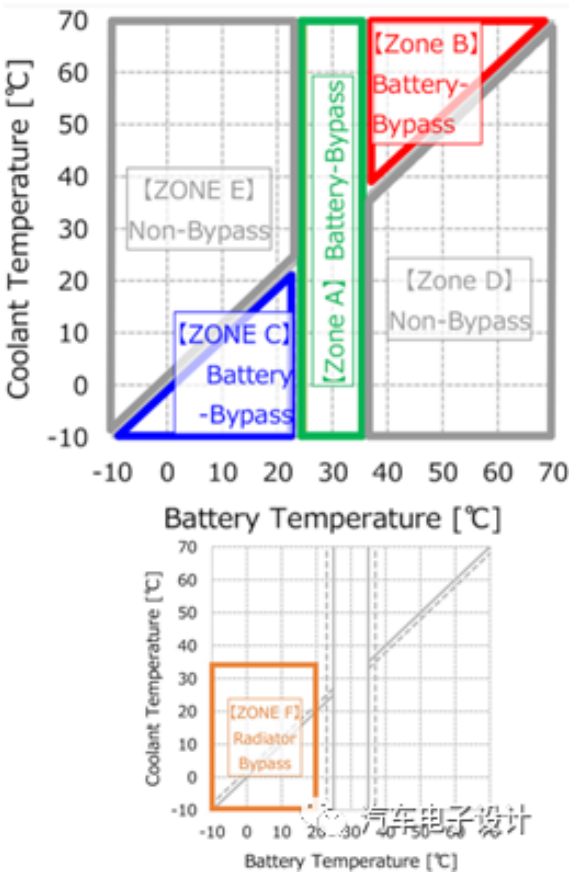

Figure 2 The temperature management area defined by Honda (battery temperature and coolant temperature are variables)

02 The model added by the overall thermal management

Therefore, in the design, as shown in the following figure, the overall difference is in these aspects:

1) In PHEV, since DCDC is arranged in the battery system, the pipelines of DCDC and OBC are connected in parallel, and then connected in series with the battery; while in BEV, the two upper and lower arrangements are directly connected in series;

2) BEV has one more cooling water valve than PHEV. The main purpose is to adjust the battery heating rate under different low temperature environments;

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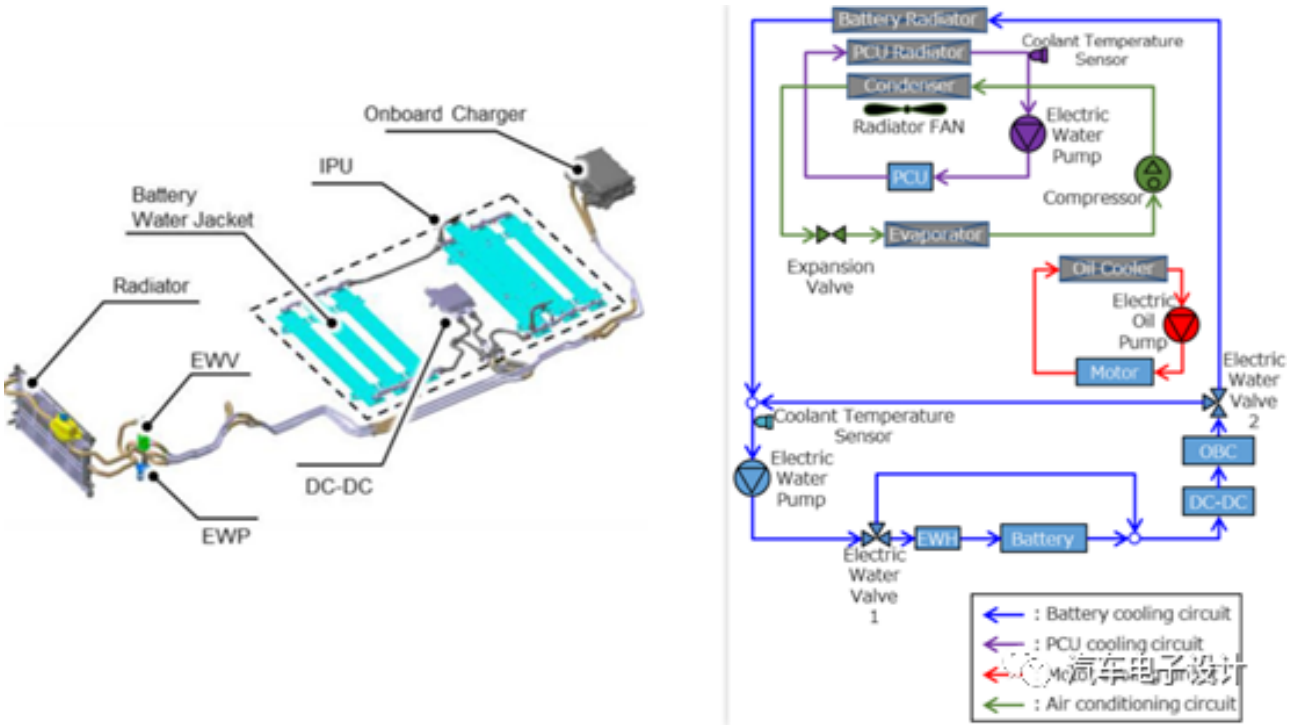

Figure 3 Differences in overall thermal management between PHEV and BEV

In the following two tables, we can see

1) The battery working mode of PHEV is relatively simple. The two worst modes are when the battery is high-power output and DCDC work, the overall power dissipation is only about 550W; in the slow-charge state, so skip the battery Just cool it, let the cell heat up naturally

2) The working mode of BEV is more complicated, and it also borrows the previous PHEV control mode. In charging and working mode, the battery bypass method is also adopted; because of the battery heating mode, through the control of EMW2 and EMW2, Minimize the entire heating circuit.

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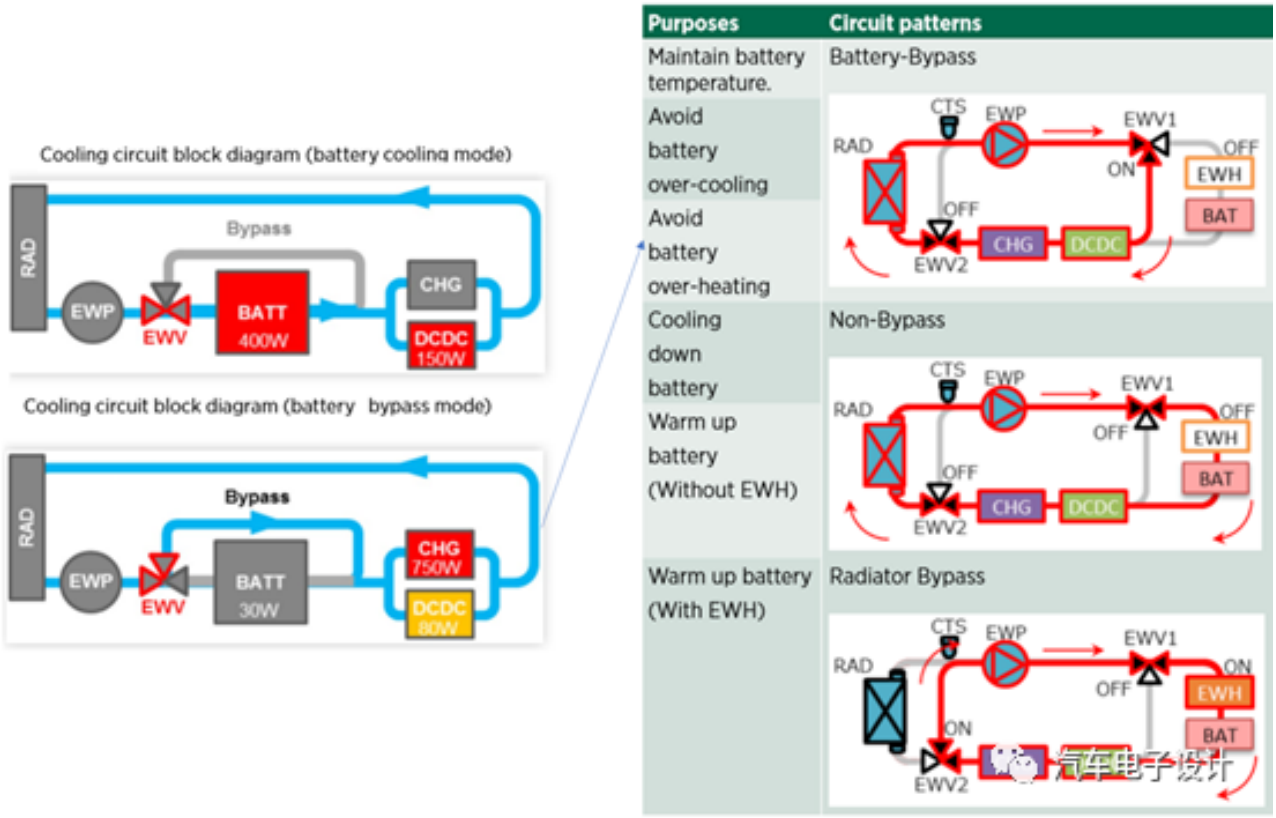

Figure 4 Different control modes of the two cars

Honda basically did not consider the heating of the battery in PHEV, but considered separately in BEV:

1) Warm-up: Before the car goes out, the battery temperature starts to heat up quickly. This is a design that is carried out immediately after the system is started with or without charging

2) Charging heating: rapid heating under low temperature charging

3) Parking heating: This is very special. If the car is parked in a cold area for a long time, the car can run the entire system by itself to keep the battery temperature within a certain range. This is a plug-in design. 4) Driving Heating: During driving, the battery is heated in two different modes, which are generally divided into fast heating and slow heating

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Table 2 Operational distinction of different modes

	Parking				
Charger	Plug-in		Unplug		
Pre A/C Before departure	Active	In Active	Active	In active	Driving
Prevent Overcooling	✓	✓	-	-	
Battery warm While Charging	✓	✓	-	-	
Battery warm Before departure	✓	-	✓	-	
Battery warm while driving					

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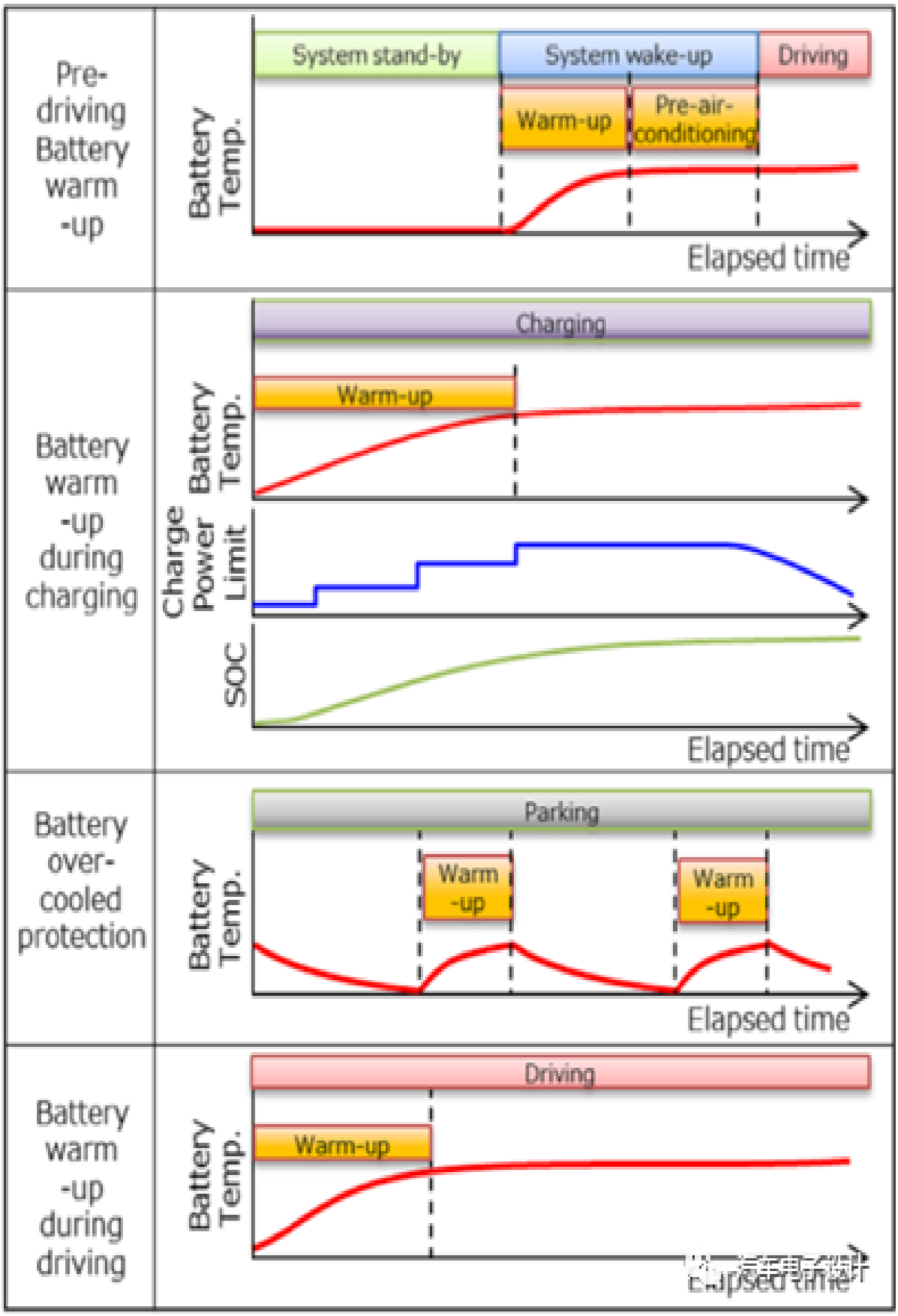

Figure 5 Battery heating in different modes

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Summary: In terms of vehicle thermal management, in fact, pure electric vehicles put forward higher requirements, especially under the conditions of low-temperature environmental adaptability and high-power charging. I think it must be the BEV platform and PHEV platform in the thermal management components Make some distinctions in the specifications and then make overall optimizations. It is difficult to be compatible with two things with large differences in requirements. Of course, some parts are compatible and similar. Tomorrow we will focus on the detailed design of the internal cooling of Honda's battery.

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