# Comparison of proposed solutions for applying cold start tests to HILS

It is desired that HILS respond to cold start tests, but the HEV models currently used for HILS don't suppose temperature changes. So we can't simulate vehicles that change their power-train control as temperature changes. As a solution for temperature changes, the TU Graz have proposed 1) detailed temperature change models. Other possible solutions include 2) adding a temperature change map to the components of the HEV model or 3) combining a commercial temperature change model with it.

Whatever solution may be used, it seems difficult make it a common solution on an HEV model. So we considered 4) adding a predicted temperature profile to the interface (I/F) model.

**Comparison of proposed solutions to temperature change for HILS**

| No. | Solution | Advantages | Disadvantages |
|---|---|---|---|
| 1 | Replace the component model with a detailed temperature model. | ●If we could create a model that can perfectly simulate temperature change in components and performance change due to temperature change, the accuracy of simulation will improve. | ●It is very difficult to create a model that responds to all vehicles, because temperature change differs vehicle from vehicle.<br>●Parameter testing methods may require very many testing man-hours. |
| 2 | Add a temperature change map to the component t model. | ●Can deal with the problem by only improving the current model | ●Depending on how the temperature change map is given to HEV model and how the map is tested, the accuracy of simulation significantly changes<br>●Some map testing methods may require very many testing man-hours. |
| 3 | Combine the component model with a commercial simulation model. | ●Doesn't need many man-hours for development. | ●Isn't suited as gtr, because part of the HEV model is made a black box. |
| 4 | Add a predicted temperature profile to the I/F model. | ●Doesn't need any modification for current model. | ●Can't use for temperature change of battery or motor/generator from the aspect of accuracy verification. |

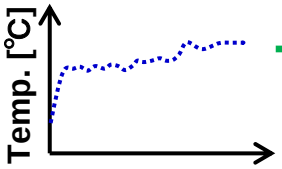
# Japanese proposal: "Temperature prediction method" for cold start tests

**For vehicles whose power-train control strategy changes with the temperatures of components such as exhaust-gas aftertreatment device, input the predicted temperature profile in time series into an interface (I/F) model so that the HILS respond to cold start tests as shown below:**

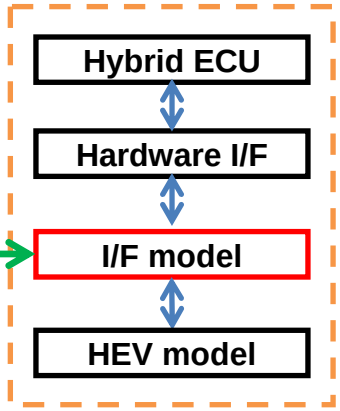
## (1) Calculation of engine testing cycle by HILS

**Run an HILS with the predicted temperature profile based on data such as actual measuring input into the I/F model, and calculate the engine testing cycle.**

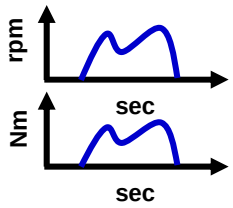
**Into the interface model, input the predicted temperature profile of each component that is necessary to control the power-train.**




**Predicted temp.**



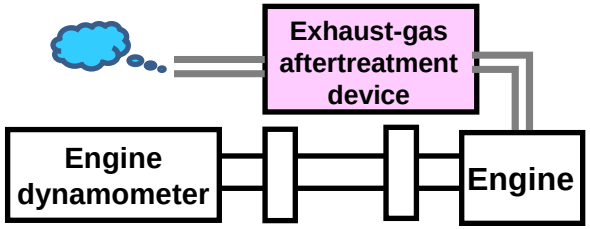

**HILS system**

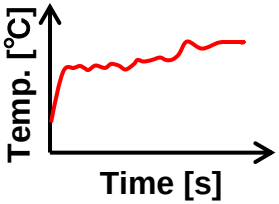



**Calculated engine testing cycle**

## (2) Exhaust gas test

**Run an exhaust gas test using the engine testing cycle calculated by HILS and measure the temperature of each component.**




**Measured temp.**

## (3) Consider the validity of predicted temperature profile

**Check the validity of predicted temperature profile by comparison with measured temperature.**