
Advanced heat driven hybrid refrigeration and heat pump systems

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1. Introduction

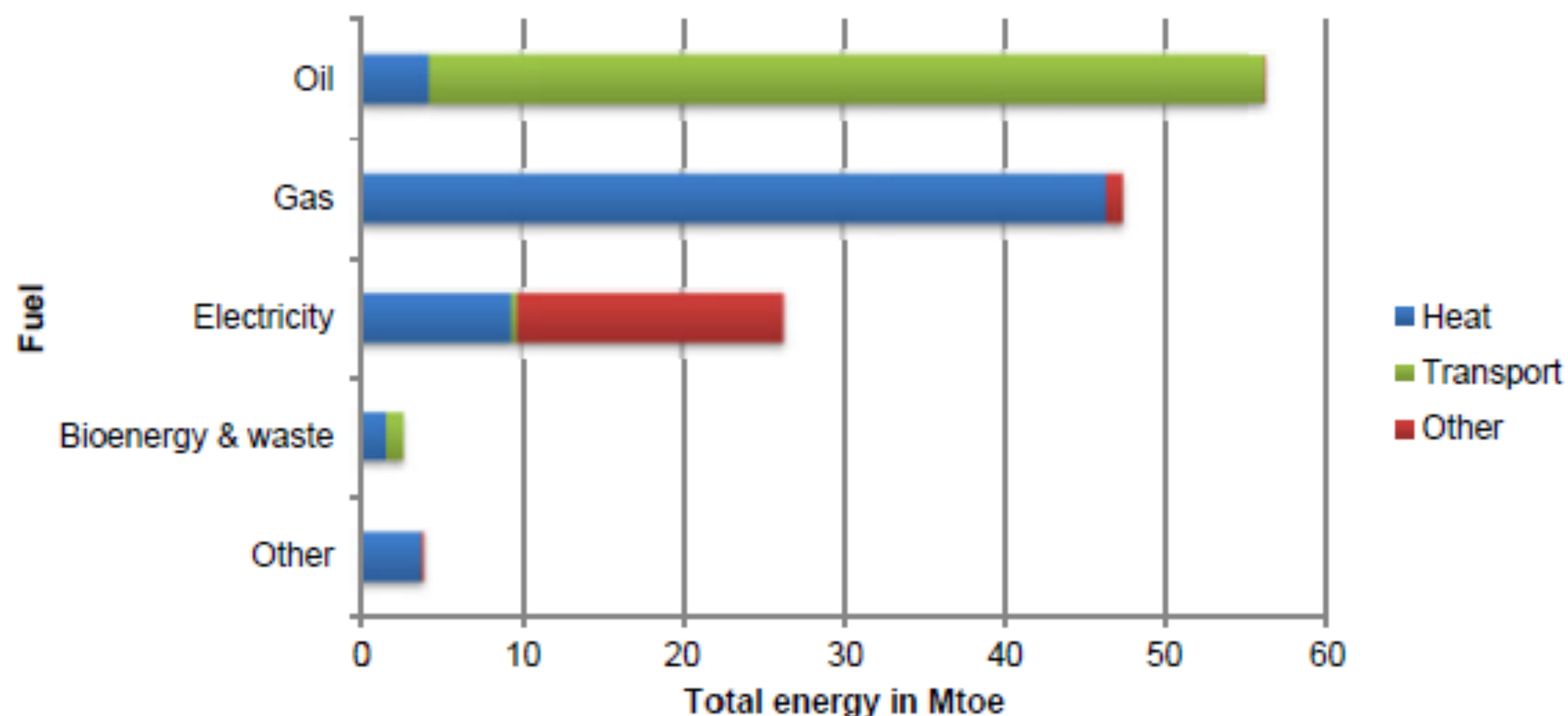
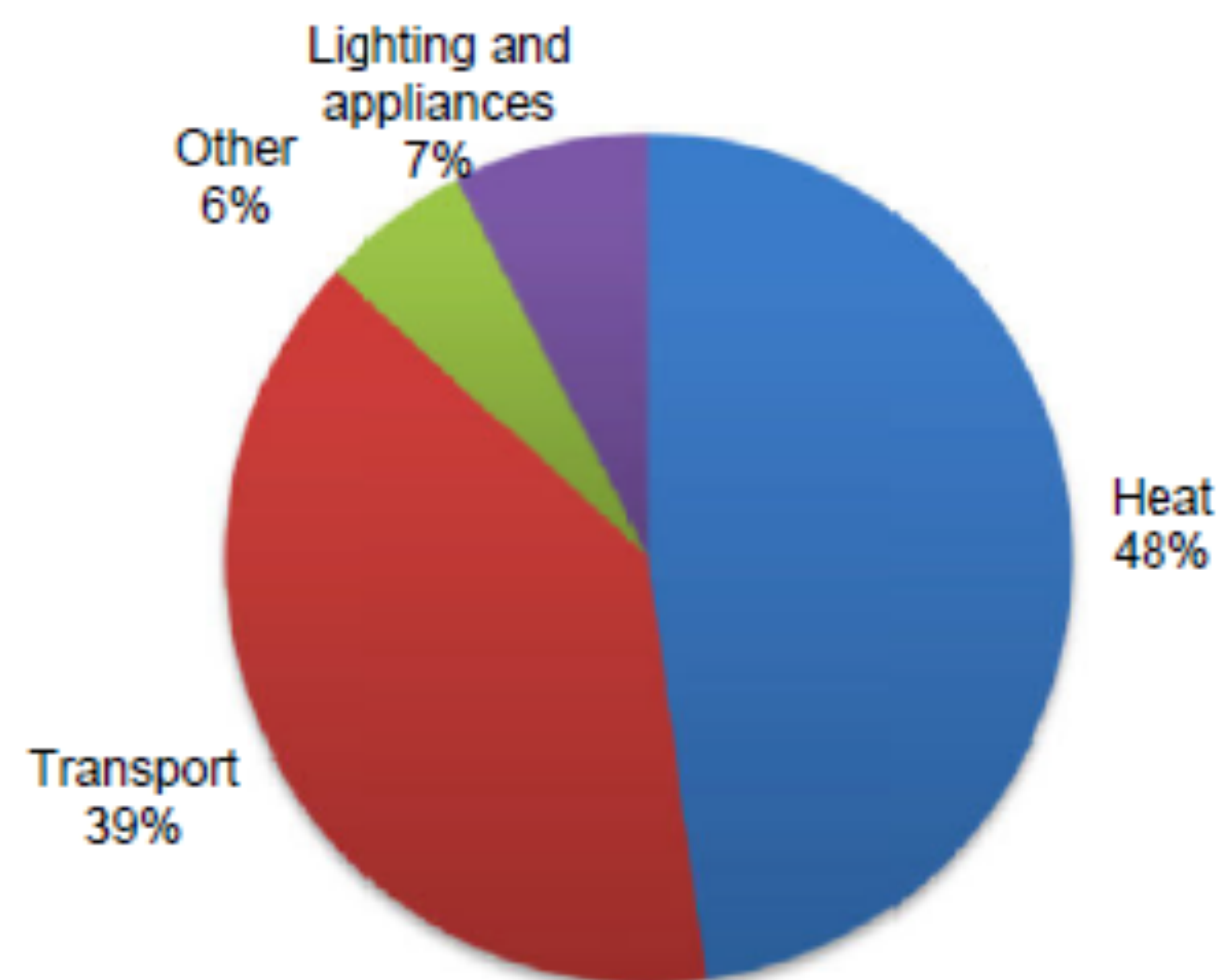
2. Conceptual Hybrid systems

- Configuration 1 (Description & Performance)
- Configuration 2 (Description & Performance)

3. Conclusions

1 - Introduction

- UK Energy landscape



Source: DECC Report 2014 (UK)

- Domestic heating

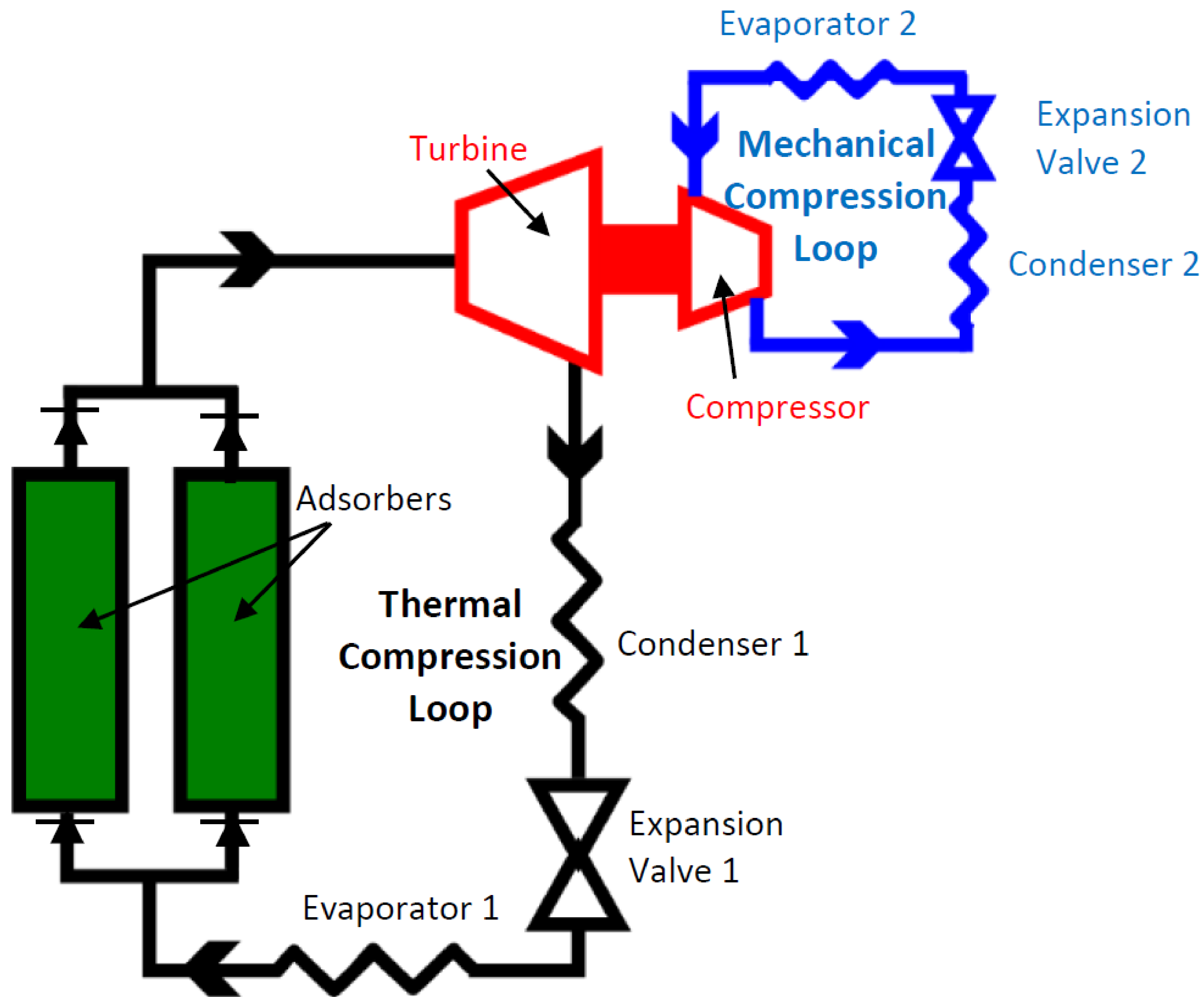
37% (Primary Energy)

& CO2 emission

25% Contribution

- Advanced Heat Pump (up to 40 kW): Prospect of CO2 emission reduction through better performance than condensing boiler (by factor of about 2 to 3).

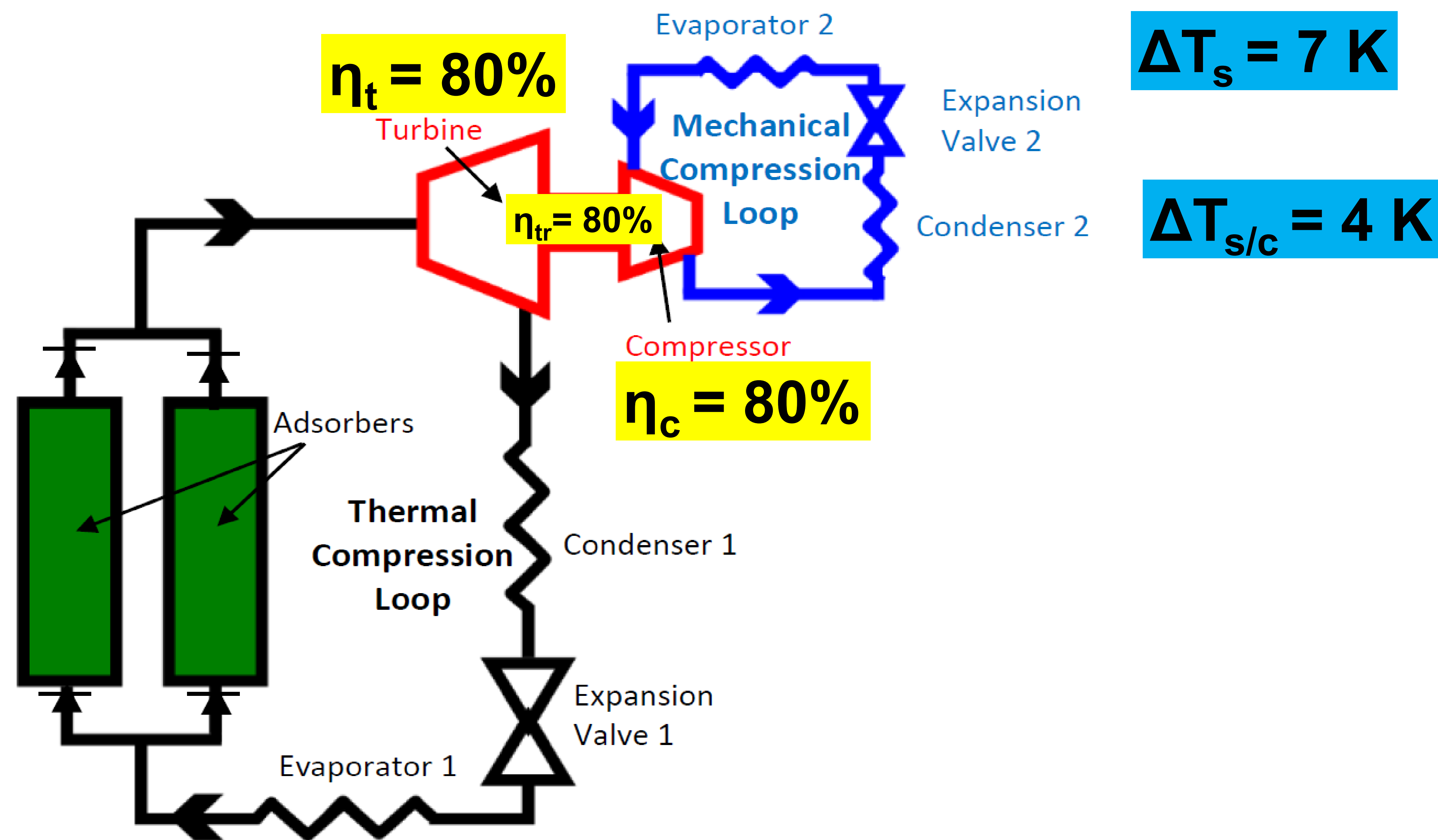
2. Conceptual Hybrid systems: Configuration 1



**ADSORPTION CYCLE WITH
TURBINE
(AdSC / AC-R717)**

**CONVENTIONAL
MECHANICAL VAPOUR
COMPRESSION CYCLE
(VCC / R717)**

2. Conceptual Hybrid systems: Configuration 1



ADSORPTION CYCLE WITH TURBINE
(AdSC / AC-R717)

CONVENTIONAL MECHANICAL
VAPOUR COMPRESSION CYCLE
(VCC / R717)

ADSORBER

AC 208C-R717

Shell-and-tube (40 off: 1m x 1"OD x 0.91mm Thickness) / SS

Packed density: 750 kg/m³

Thermal conductivity: 0.44 W/m K

Internal wall contact HTC: 750 W/m² K

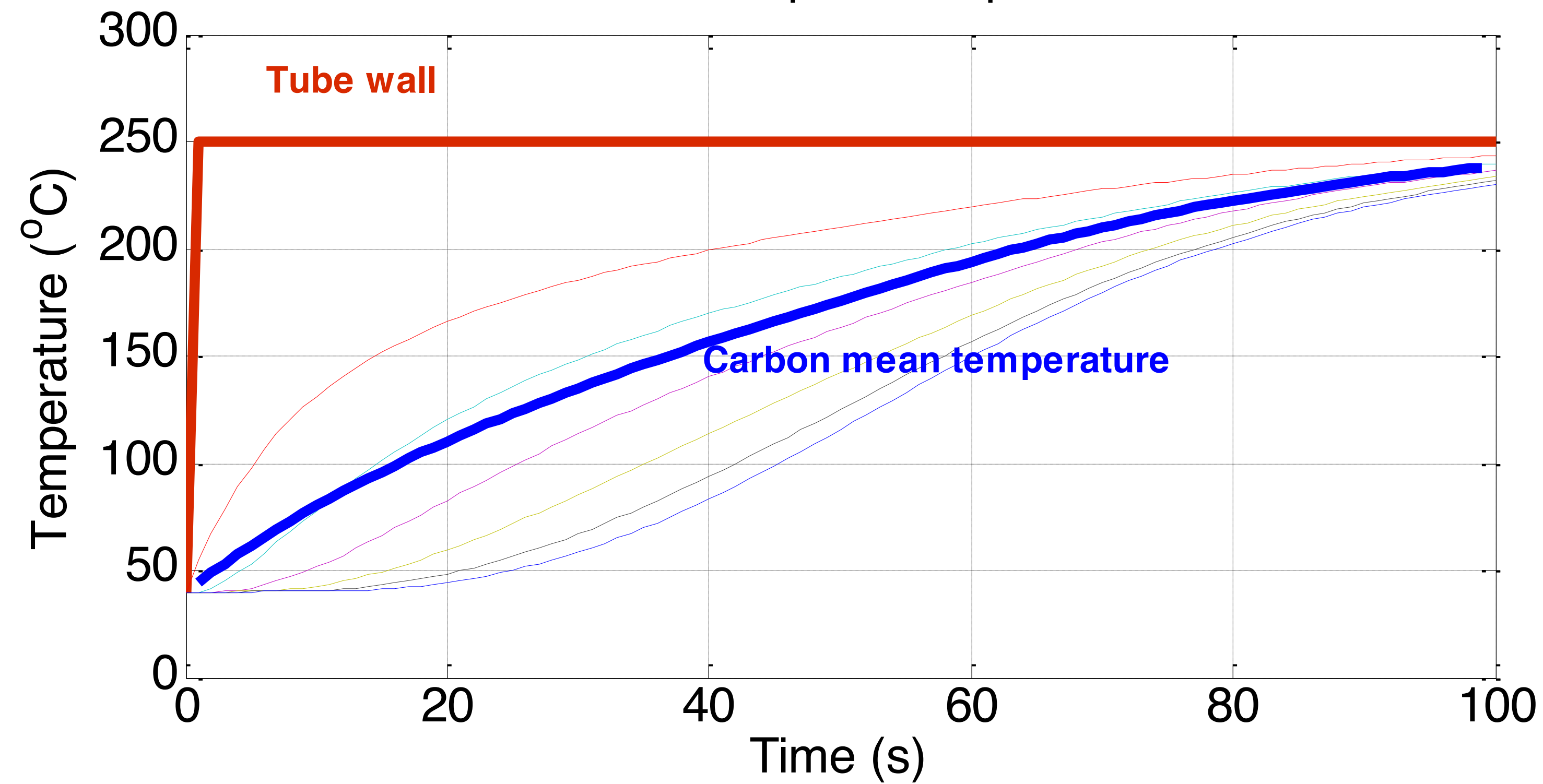
External wall convective HTC: Infinite

Bed operating pressure: 37 bar

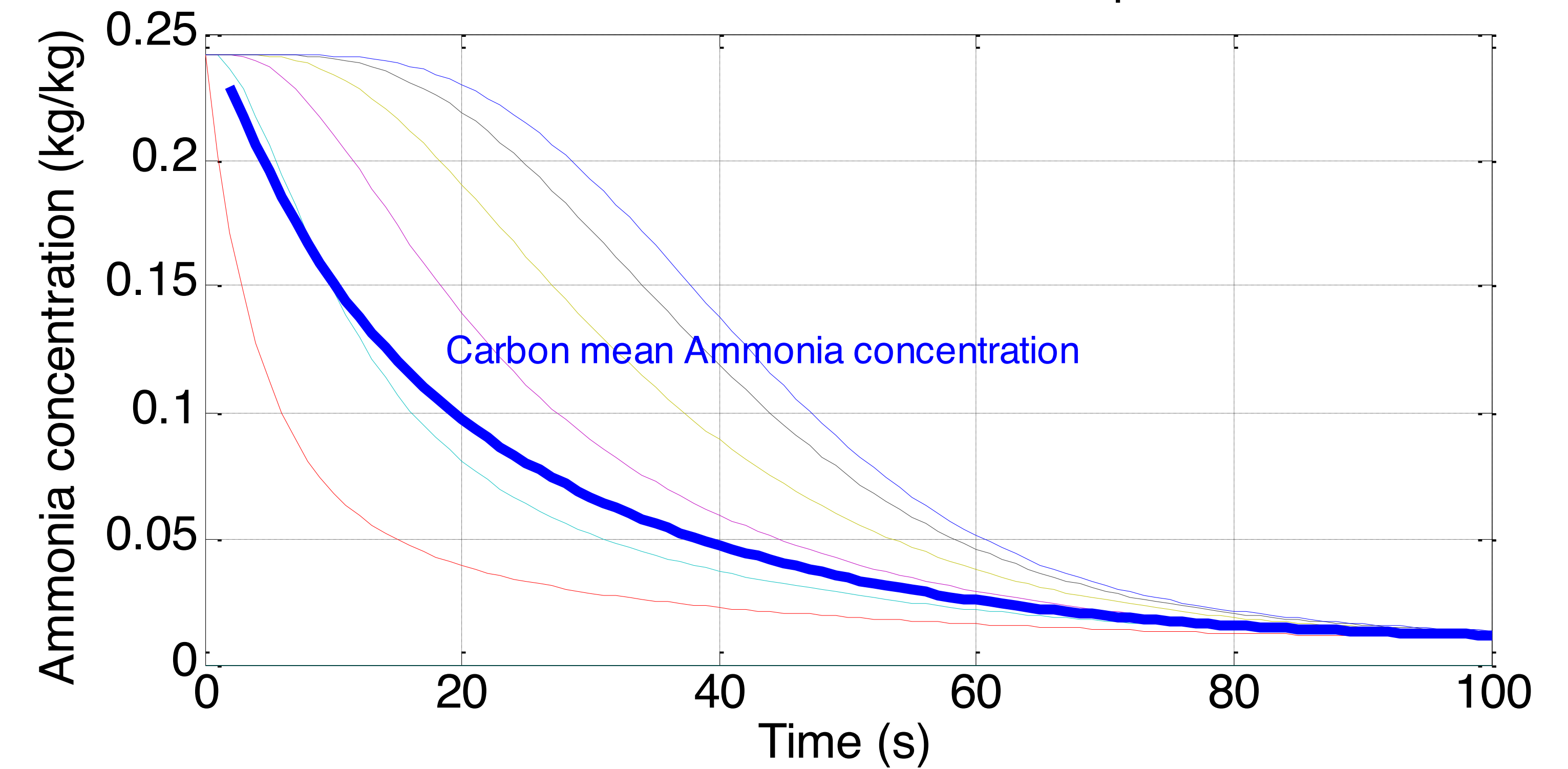
Maximum driving temperature: 250°C

2. Conceptual Hybrid systems: Configuration 1 Performance

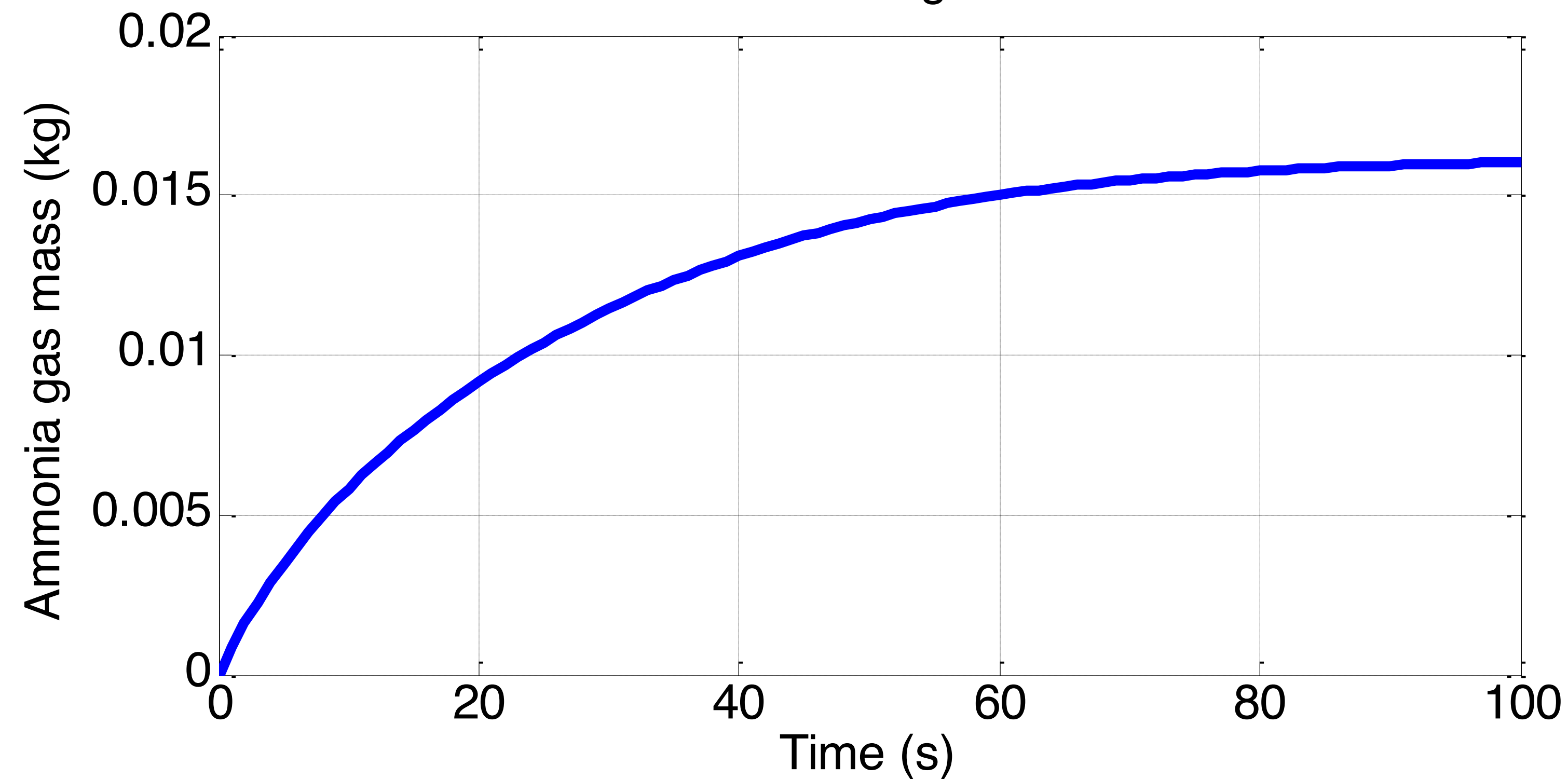
Module temperature profiles



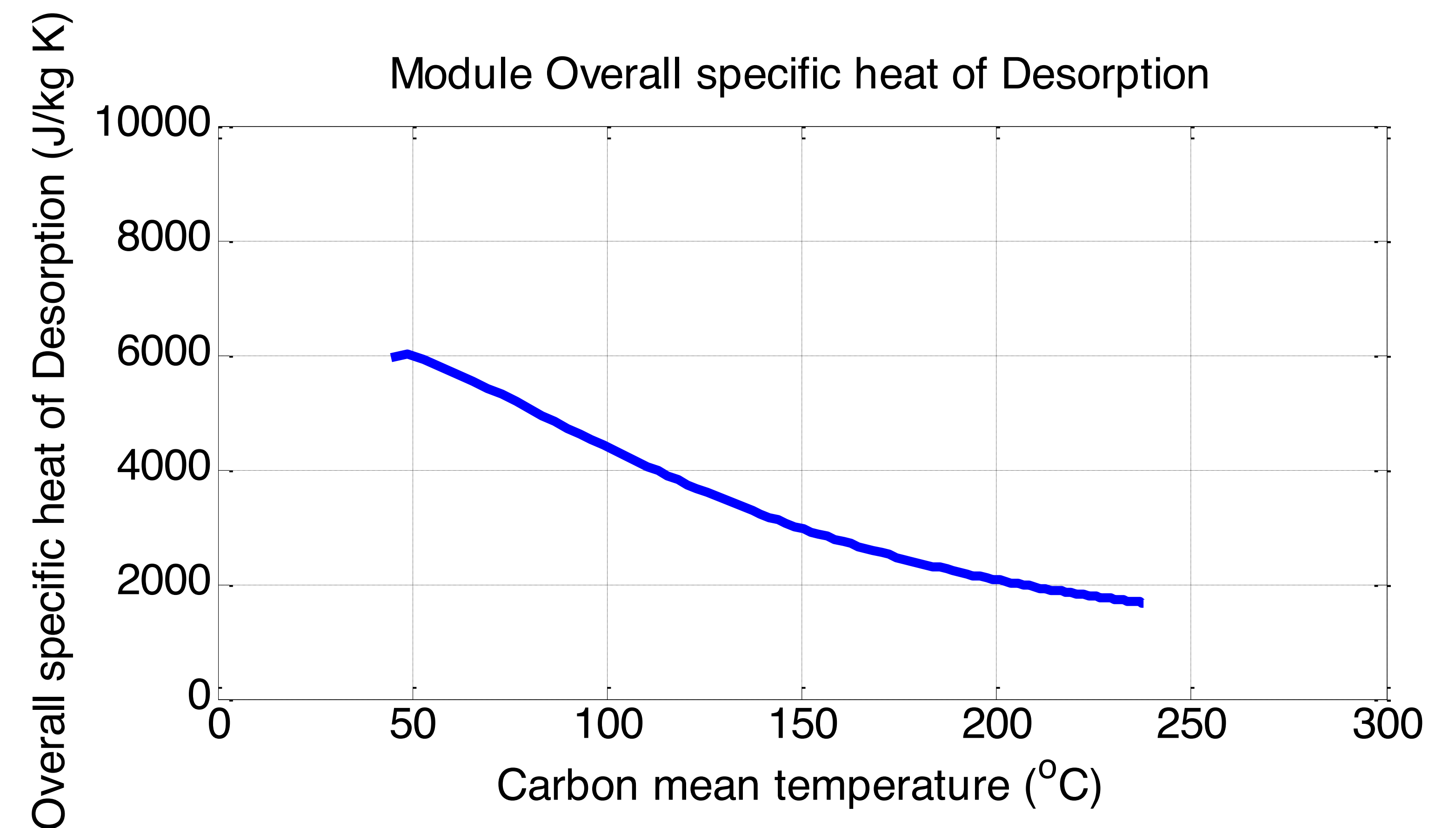
Module Ammonia concentration profiles



Ammonia mass flowing out of a Module

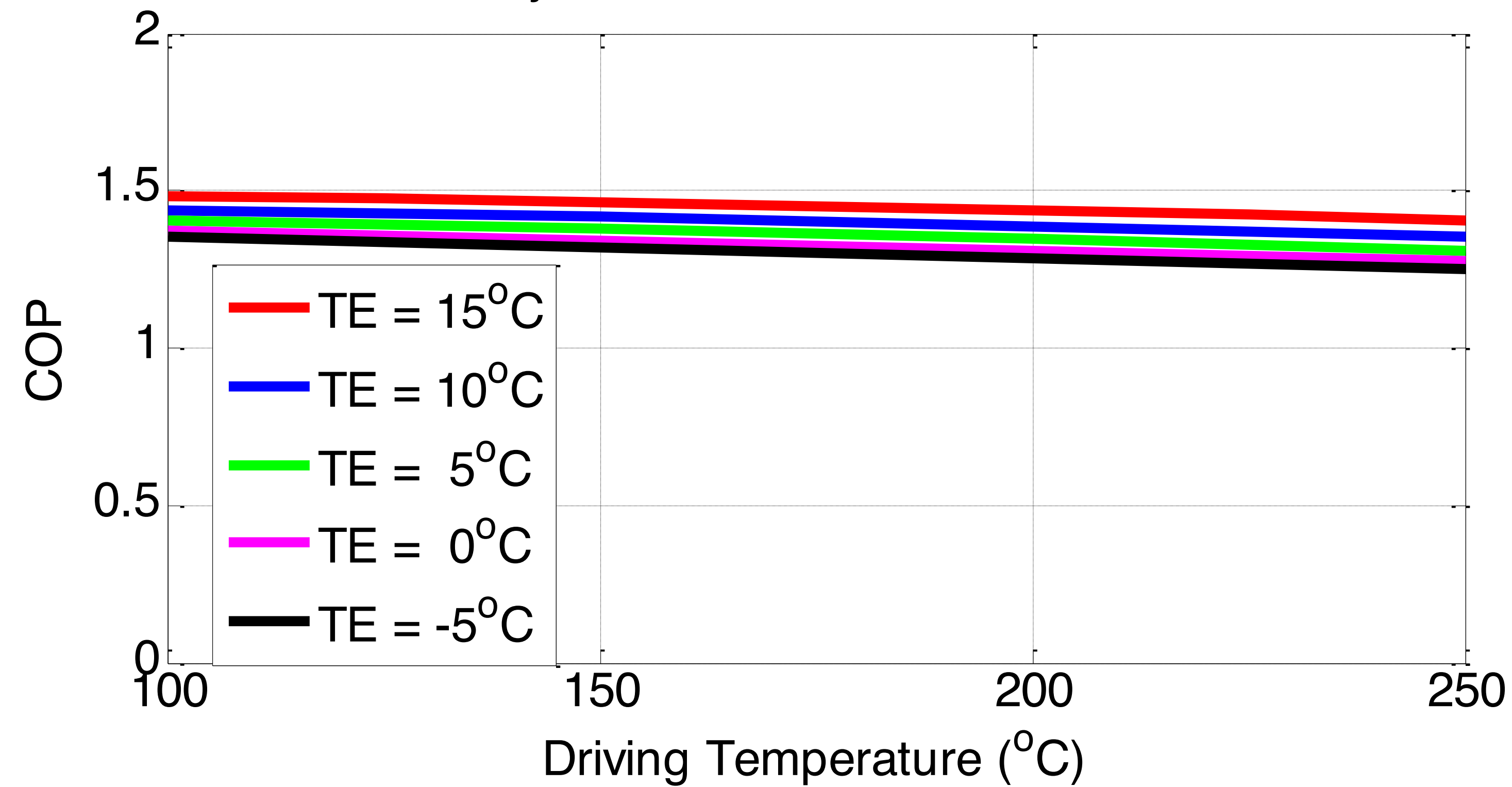


Module Overall specific heat of Desorption

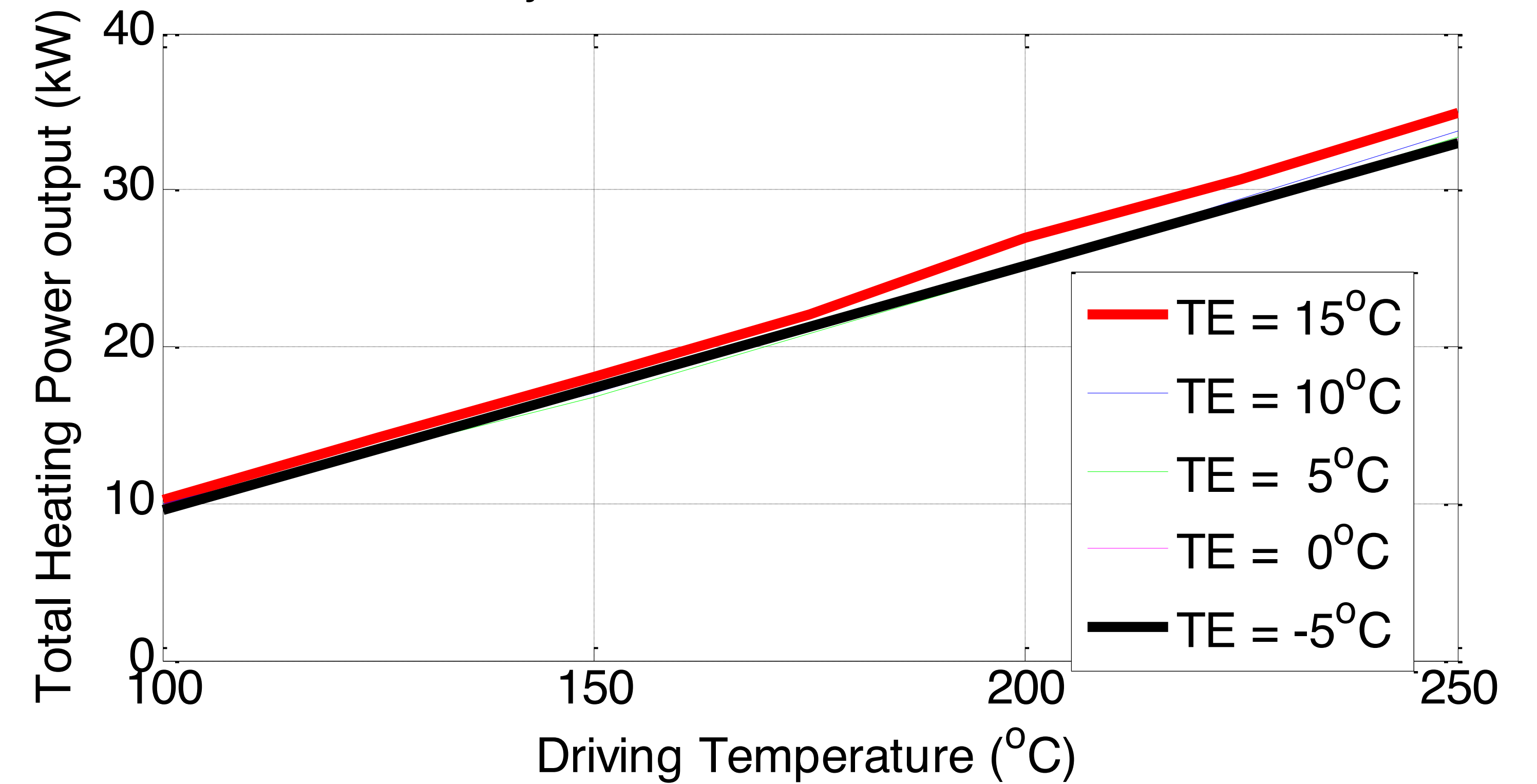


2. Conceptual Hybrid systems: Configuration 1 Performance

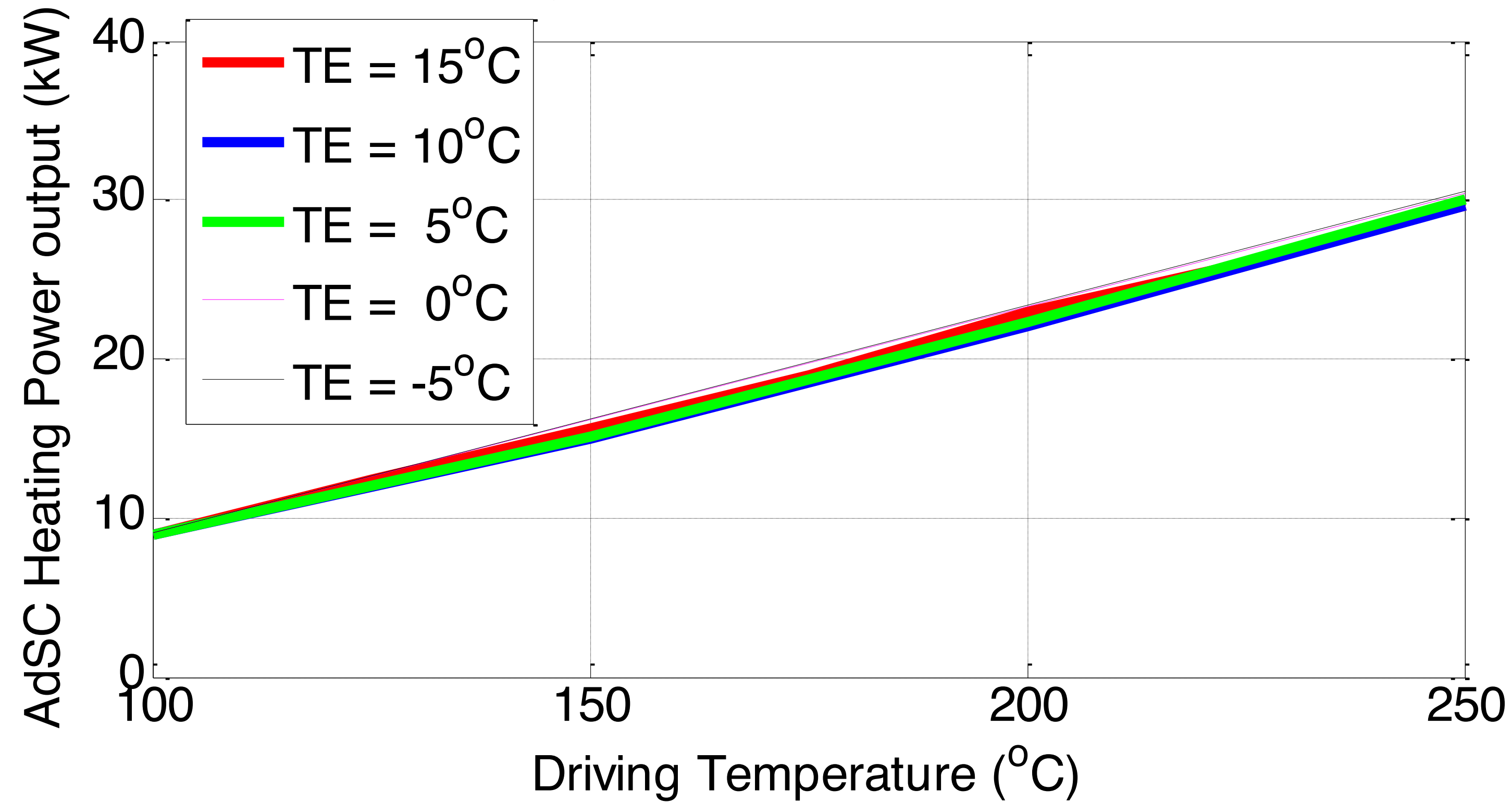
Hybrid AdSC-VCC: $T_c = 40^\circ\text{C}$



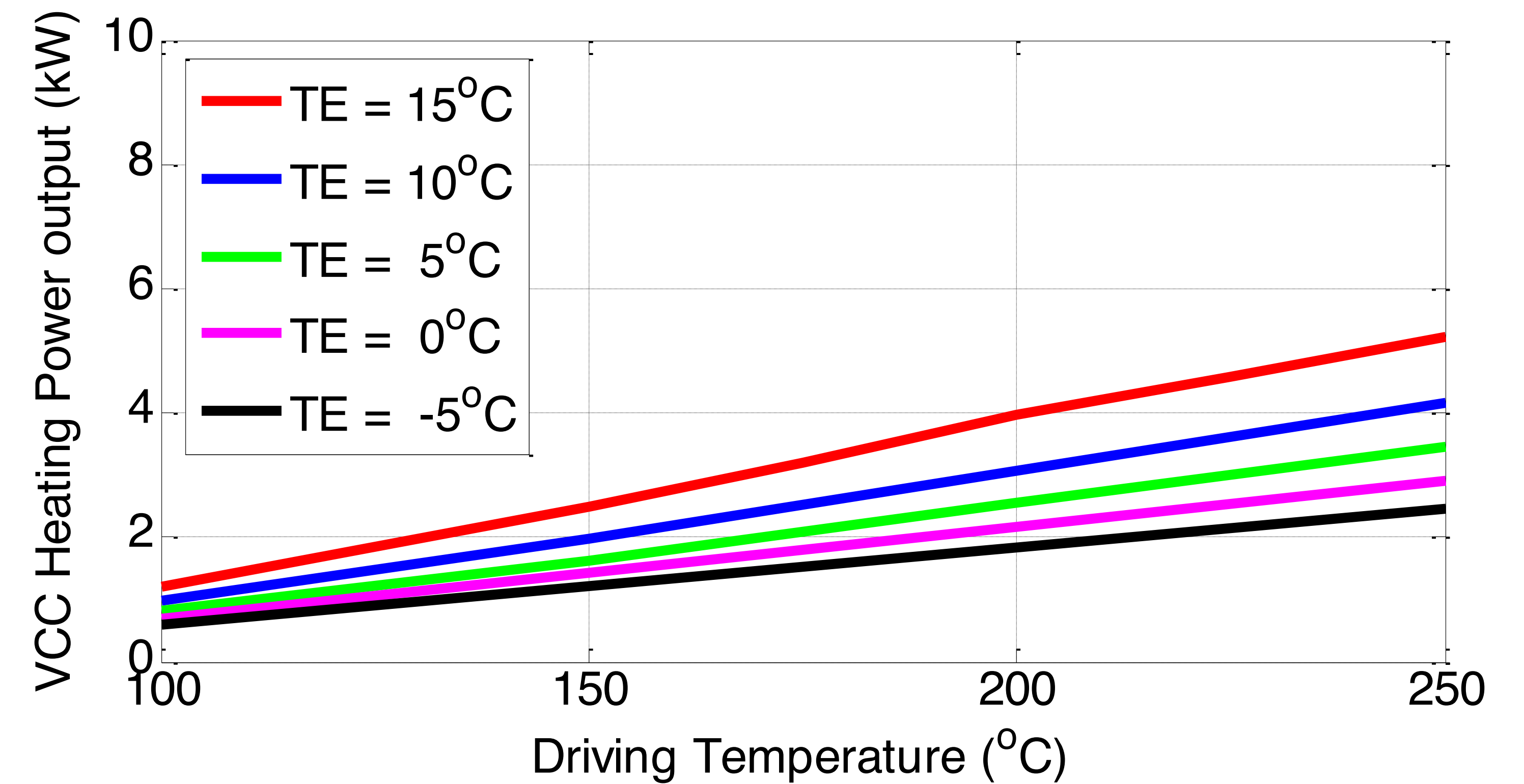
Hybrid AdSC-VCC: $T_c = 40^\circ\text{C}$



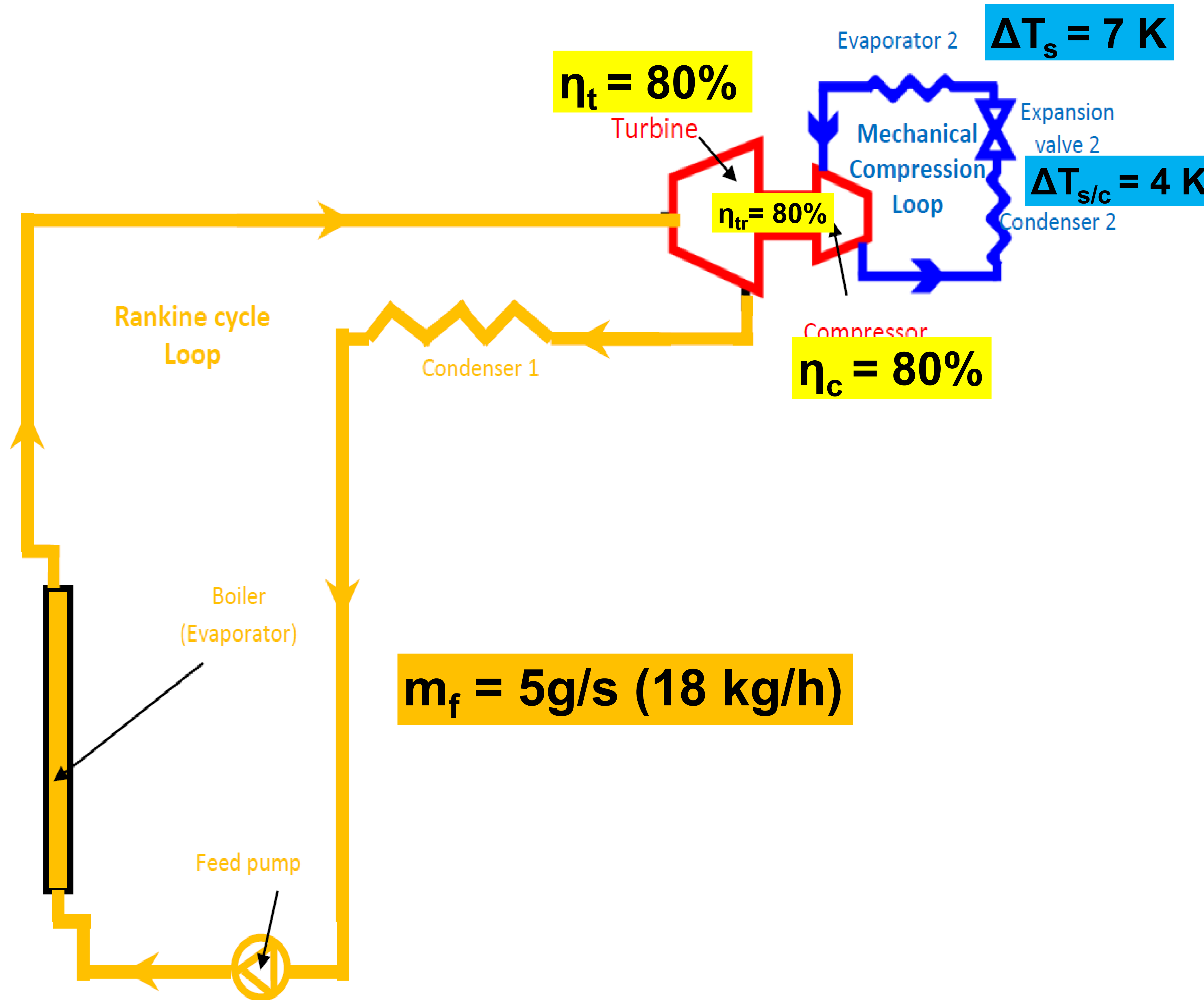
AdSC Contribution: $T_c = 40^\circ\text{C}$



VCC Contribution: $T_c = 40^\circ\text{C}$



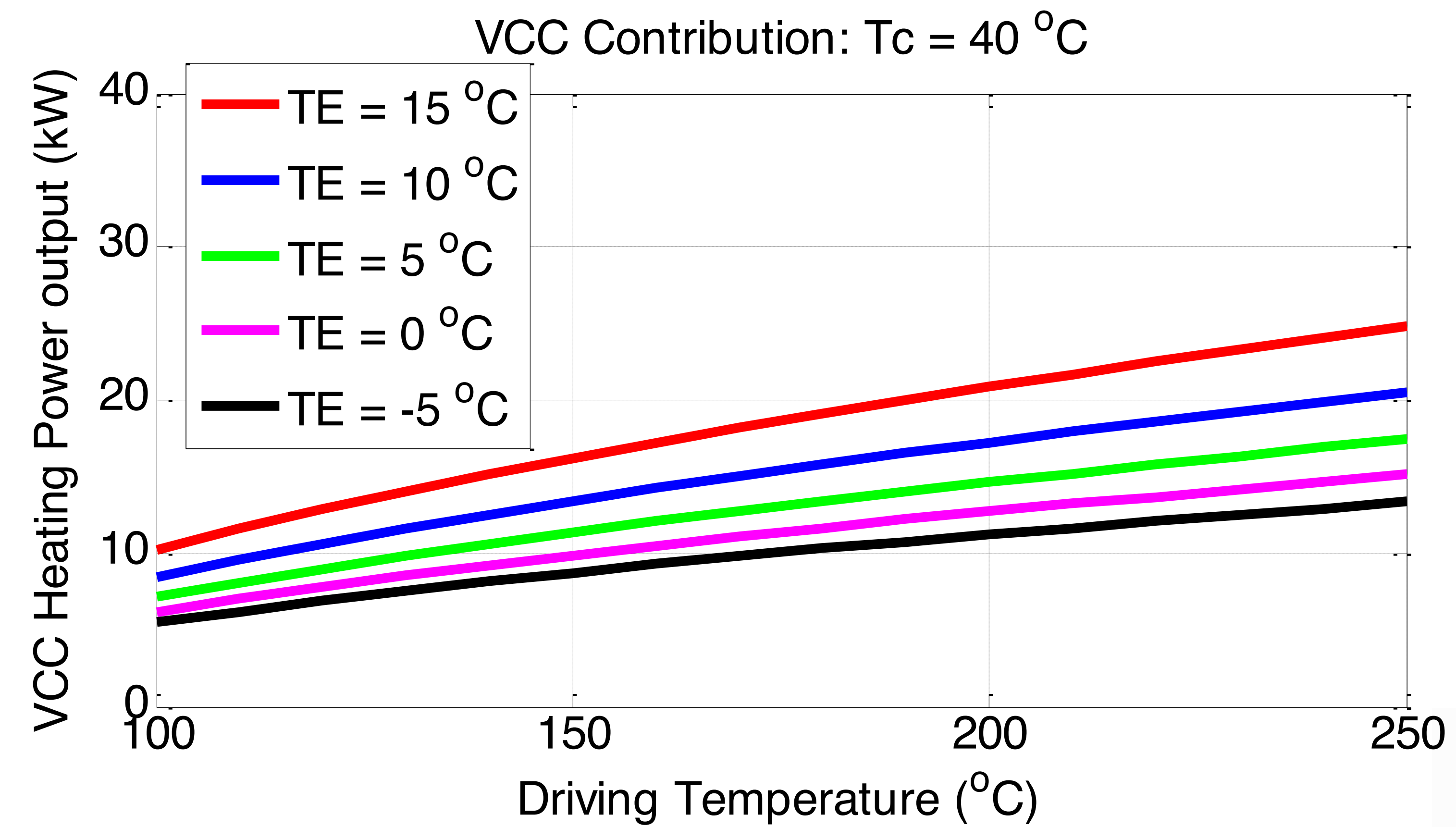
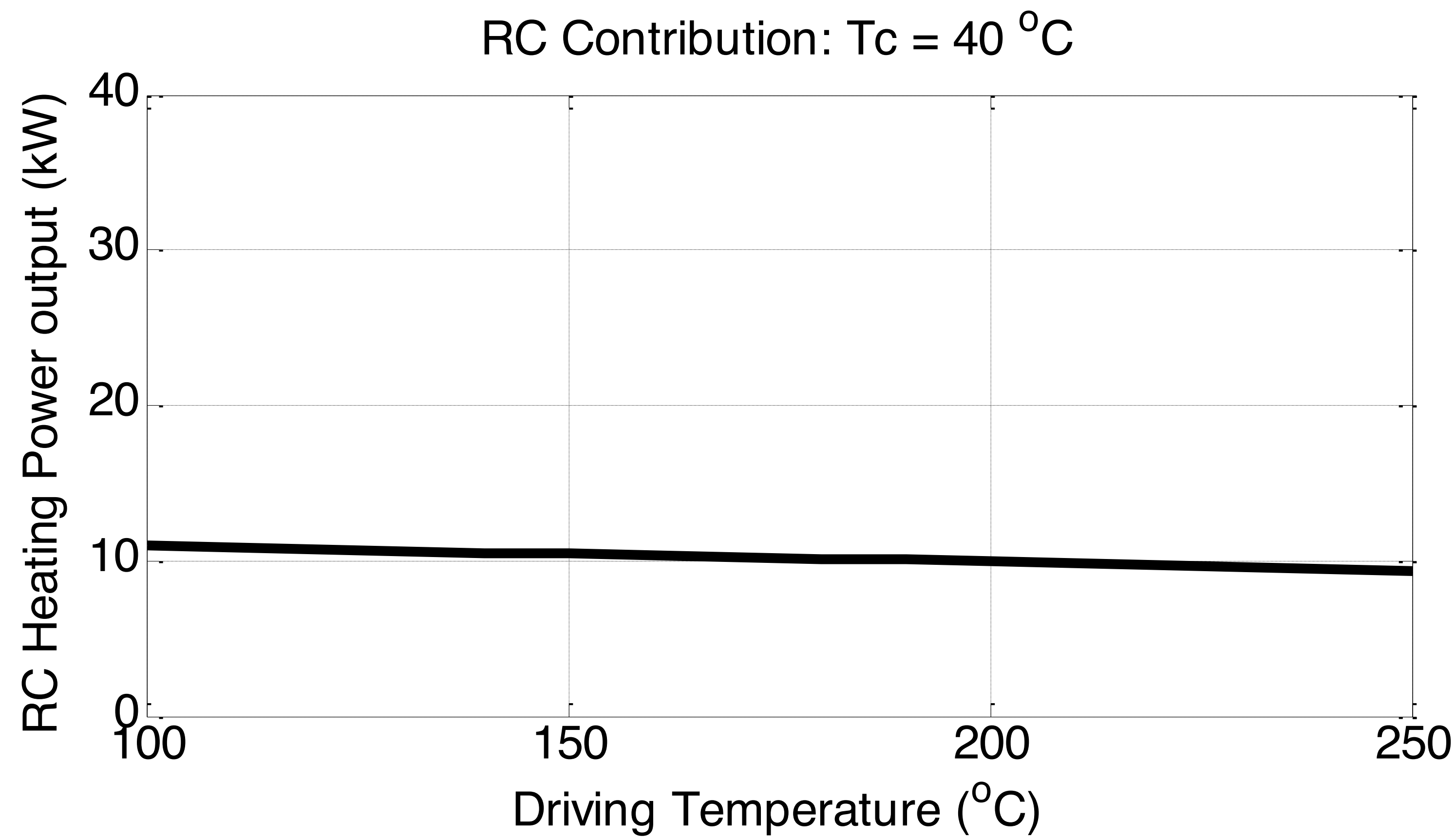
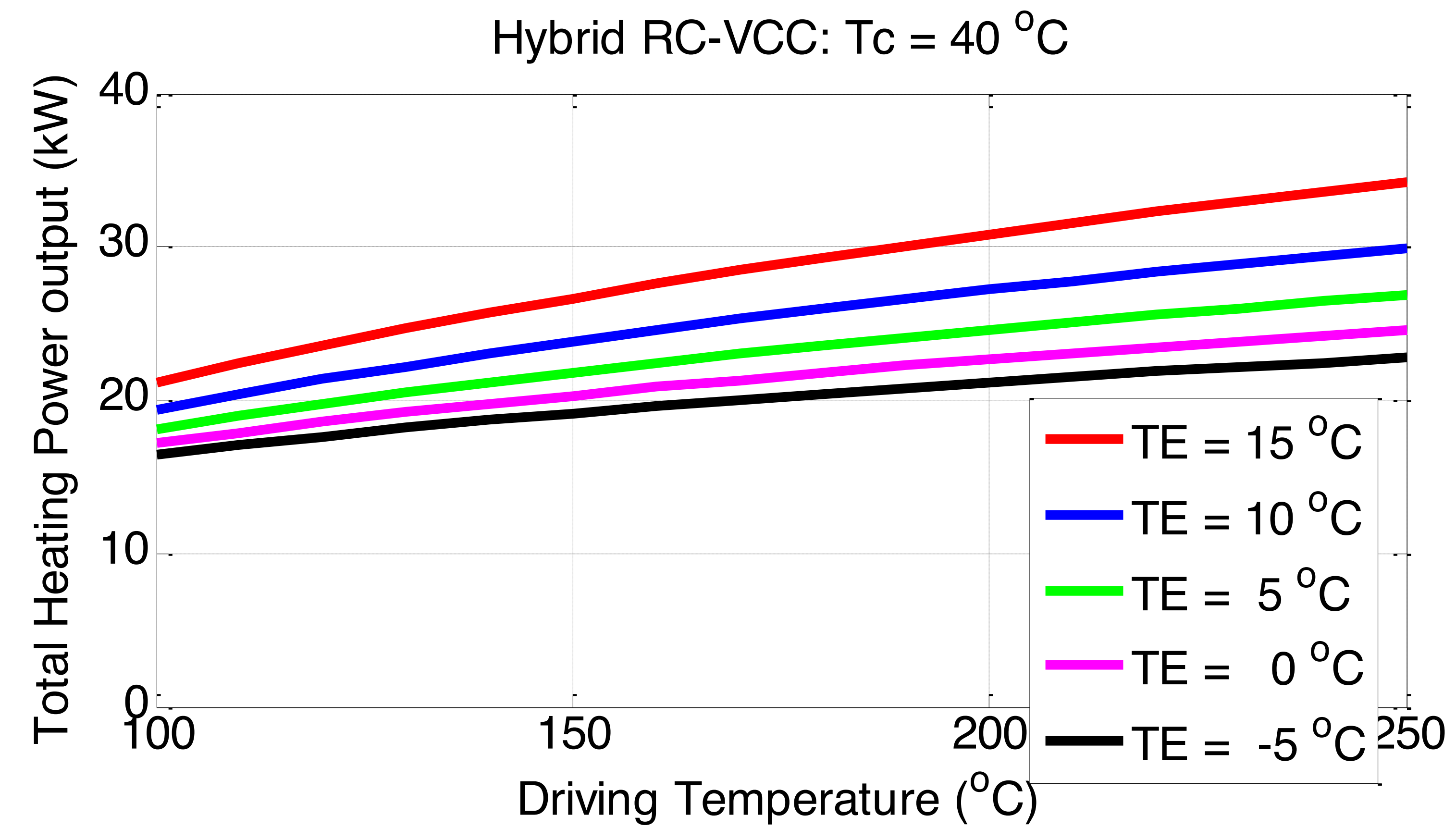
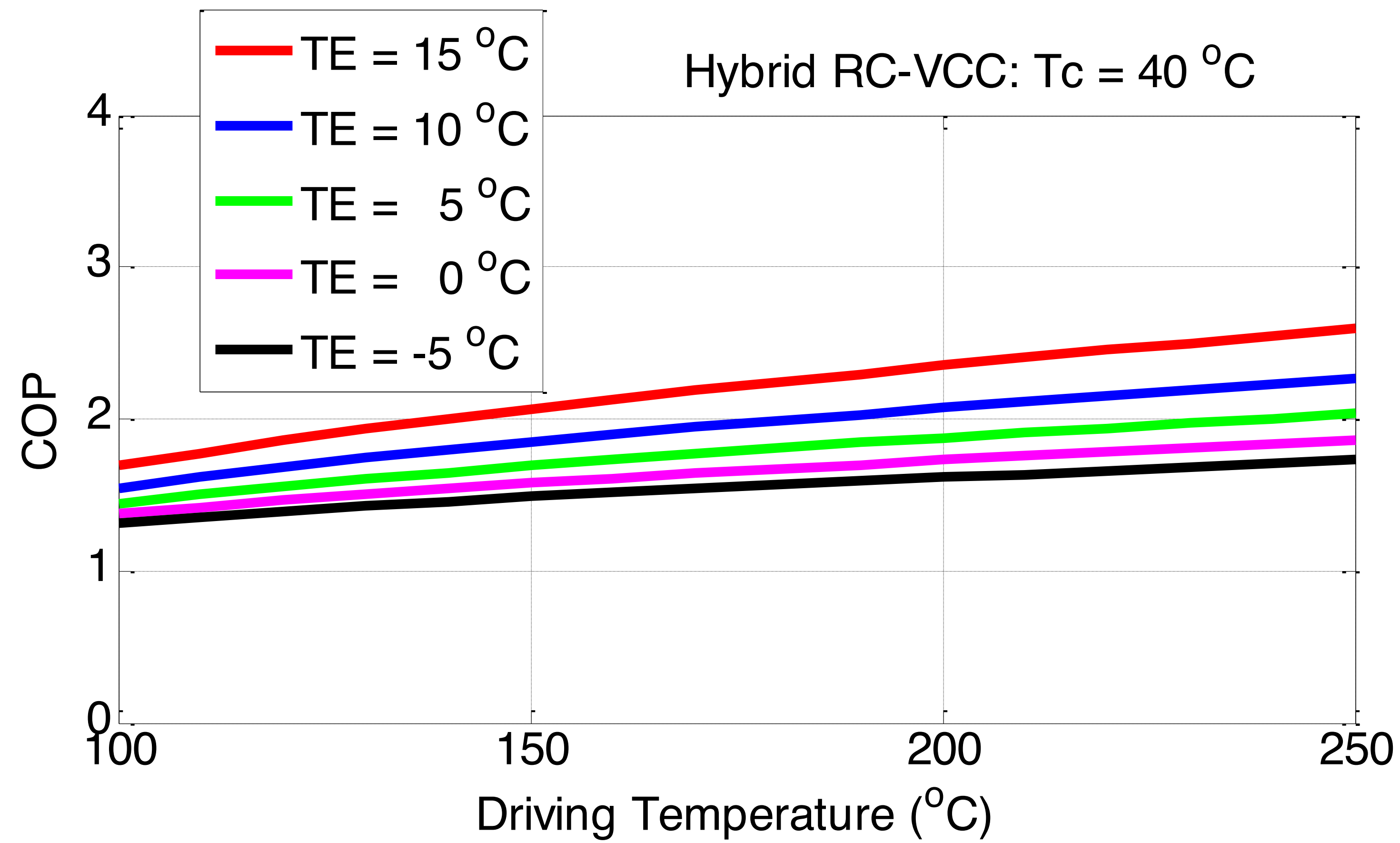
2. Conceptual Hybrid systems: Configuration 2



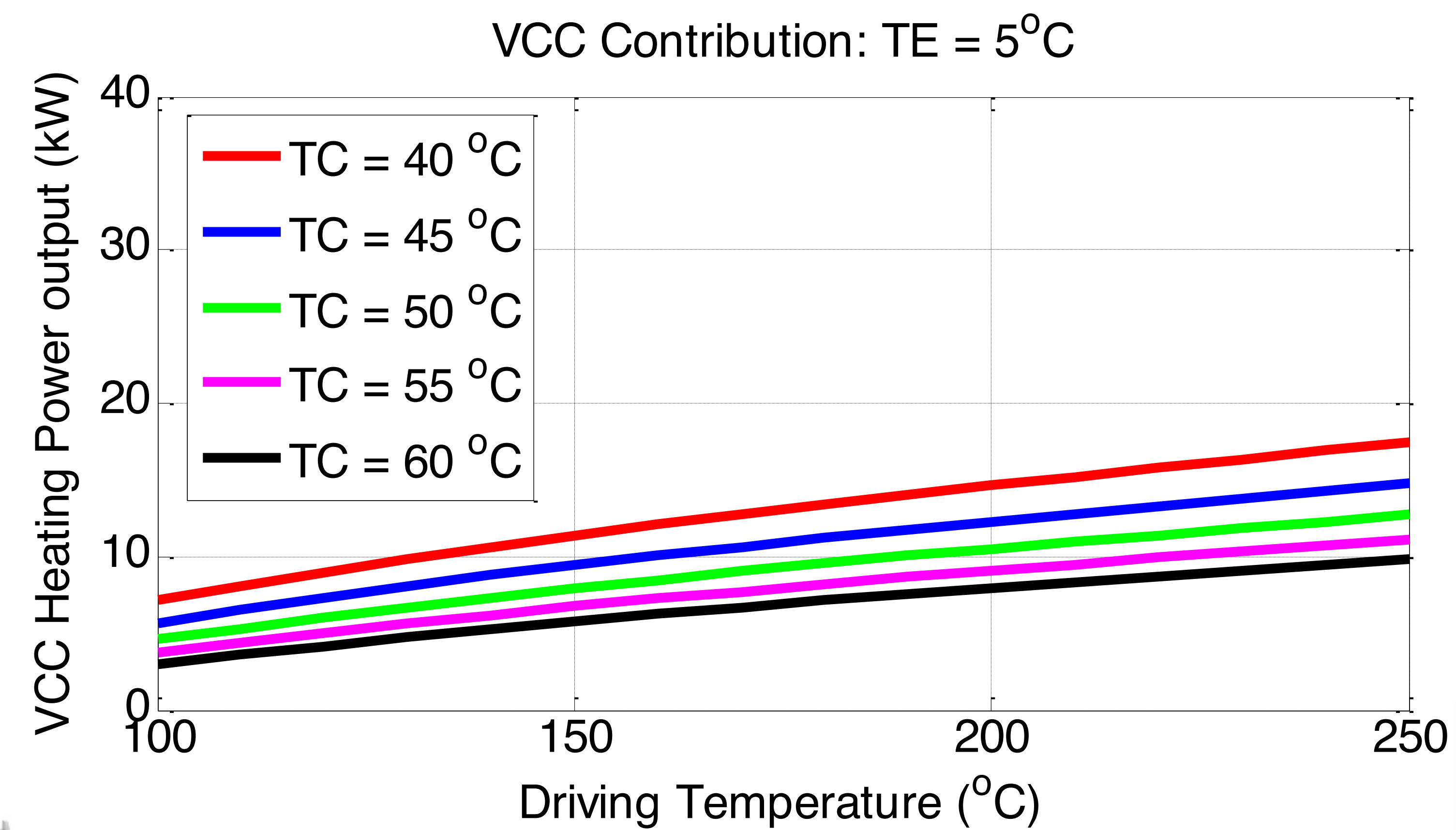
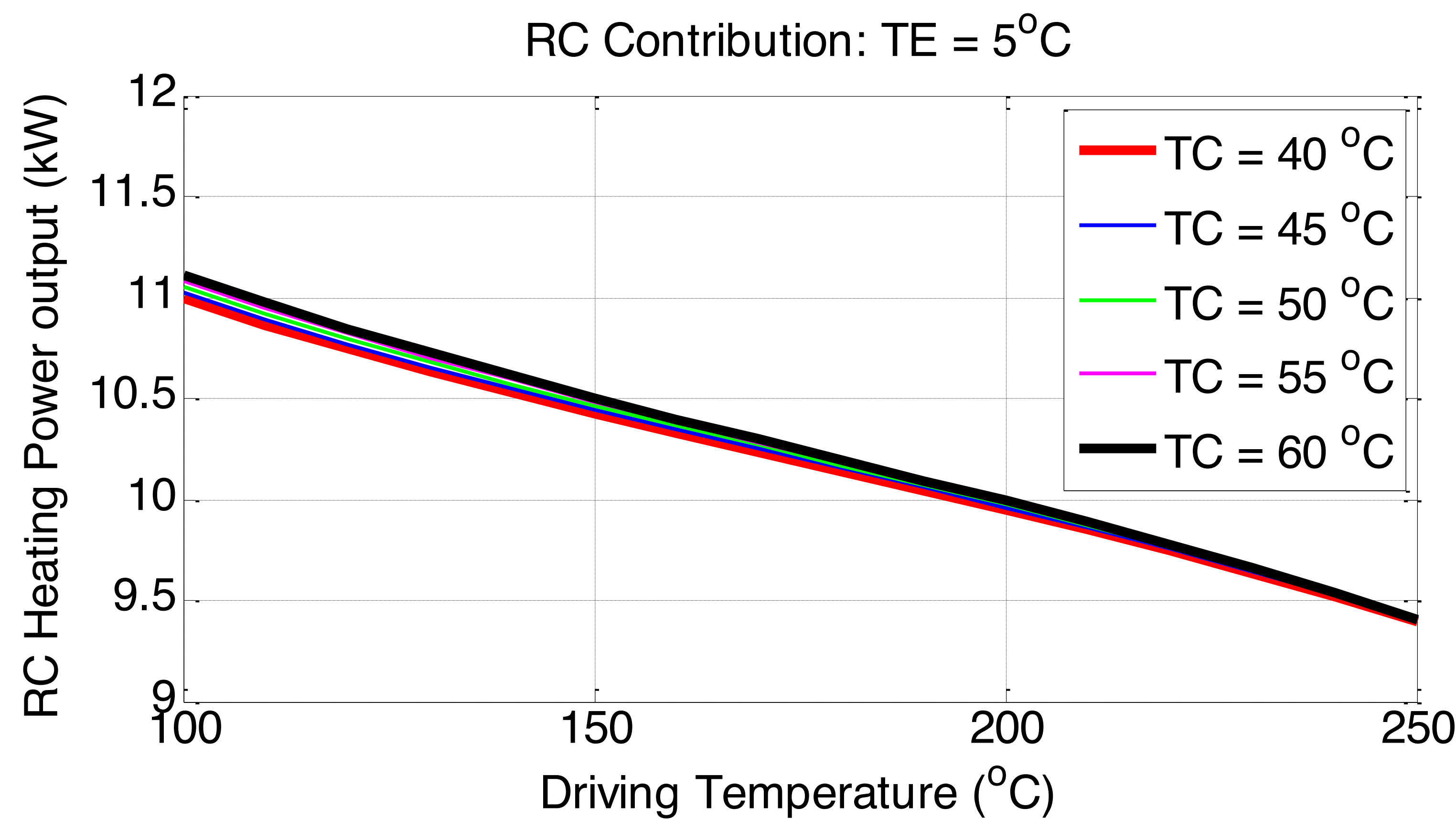
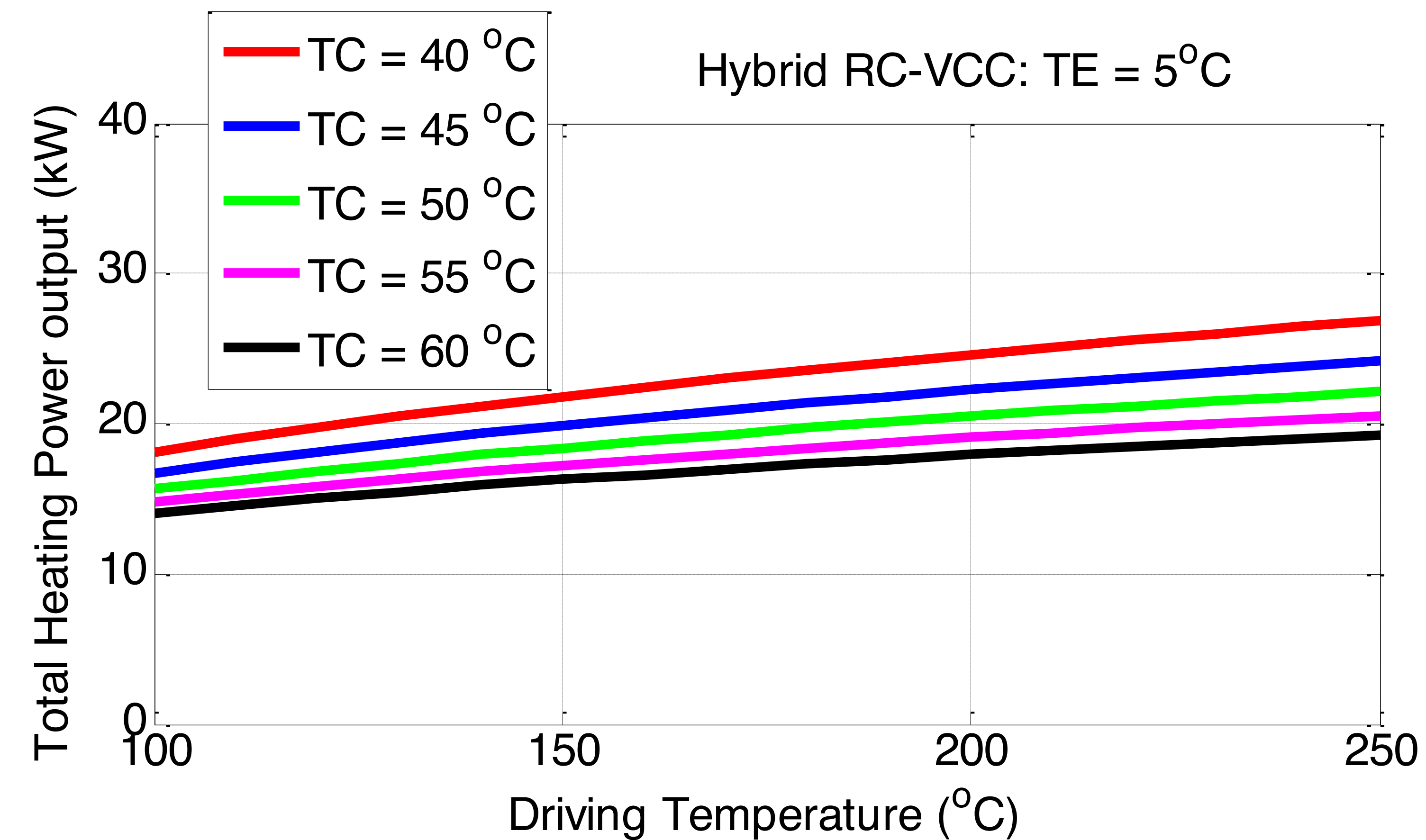
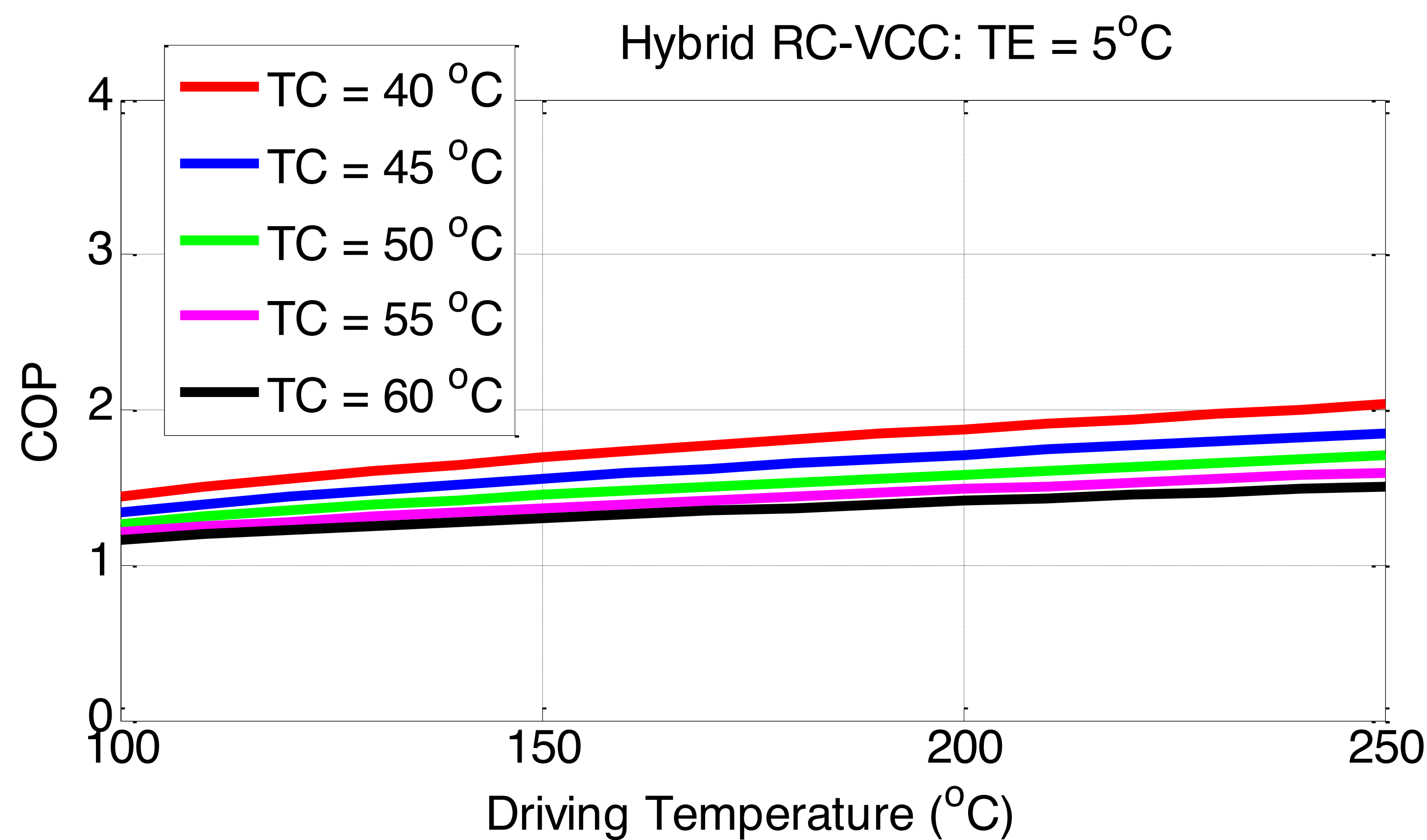
**RANKINE CYCLE
(RC / R718)**

**CONVENTIONAL
MECHANICAL VAPOUR
COMPRESSION CYCLE
(VCC / R717)**

2. Conceptual Hybrid systems: Configuration 2 Performance



2. Conceptual Hybrid systems: Configuration 2 Performance



3. Conclusions

Hybrid AdSC-VCC:

- Limited COP (1.2 to 1.4)
- Less cost effective
- Simple AdSC could be better instead

Hybrid RC-VCC:

- Good COP (1.5 to 2.6)
- Better than Hybrid AdSC-VCC
- Better than condensing boiler
- Could be cost effective
- Space heating and DHW

Thank you