

# Supplementary Materials: Heat Modeling and Materials Development of Mg-based Nanomaterials Combined with Solid Oxide Fuel Cell for Stationary Energy Storage

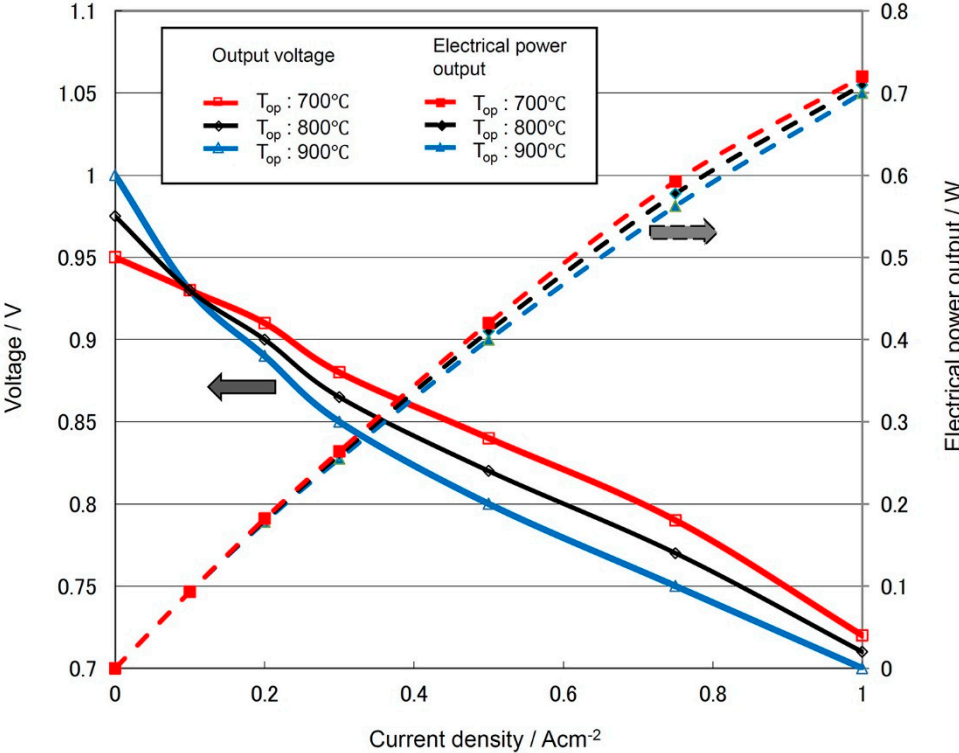
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**Table S1.** Operating conditions of MgH<sub>2</sub> storage and SOFC module.

Operating Condition	MgH <sub>2</sub> Storage	SOFC Module
Temperature (K)	643	1073
Pressure (Mpa)	1.0	0.1
Dehydration rate (kmol/h)	1.0	-
Fuel flow rate (kmol/h)	-	1.0
Air flow rate (kmol/h)	-	3.0

**Table S2.** Module domains and their functions.

Module Domain	Detailed Domain	Heat Source	Heat Supplied Line
SOFC	SOFC-a	SOFC anode	-
	SOFC-c	SOFC cathode	-
	HX-a	Anode gas pre-heater	SOFC waste heat
	HX-c	Cathode gas pre-heater	SOFC waste heat
MgH <sub>2</sub> Storage	ST	Gas storage	-
	SEP	Separator Mg <sub>sol</sub> & H <sub>2</sub>	-
Heat Exchanger	HX1	Heat exchanger to warm inlet air line	Cathode off-gas
	HX2		Anode off-gas
	HX3-a	Heat exchanger from off-gas to MgH <sub>2</sub> storage	Anode and cathode off-gas
	HX3-b		
	HX3-c		
	HX4-a	Heat exchanger from low temperature off-gas to HX4	Cathode off-gas
	HX4-b		Anode off-gas
			Heat recovery device



**Figure S1.** SOFC polarization curves. The solid and dashed lines correspond to the left and right axes, respectively.

**Table S3.** The required heat to maintain steady-state operating conditions.

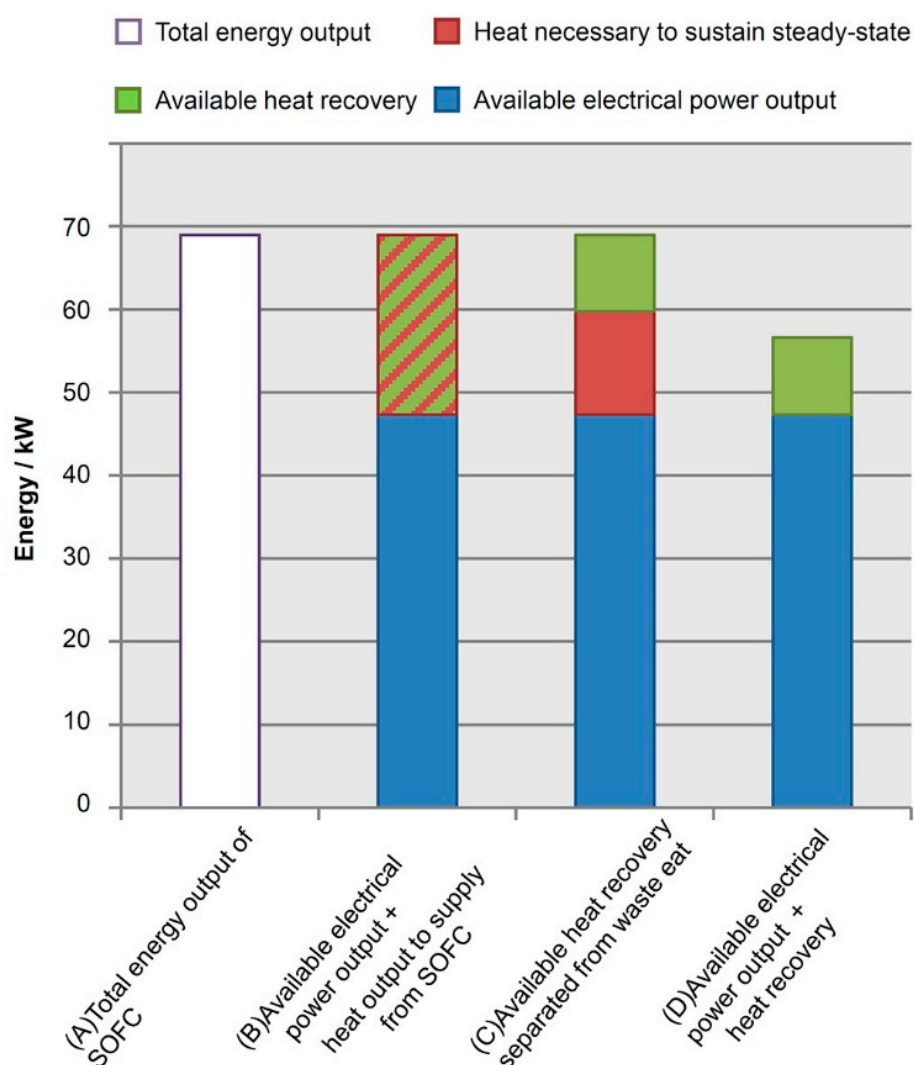
Required Heat	H <sub>2</sub> , anode gas flow	Air, cathode gas flow	MgH <sub>2</sub> storage, virtual flow	Total Heat
Temperature	Heating 643→1073 K	Heating 298→1073 K	Keep at 643 K	-
Heat Exchanger	HX-a	HX1, HX2, HX-c	HX3	-
Required Heat (W)	3554	20,141	22,013	45,708

**Table S4.** The available heat from waste heat of off-gas.

Usable waste heat from flowing gases	Off-gas, off-air, and unused off-air	Off-gas and off-air	Unused off-air	Total Heat
Temperature	Cooling 1073→643 K	Cooling 643→298 K	Cooling 643→298 K	-
Heat Exchanger	HX3	HX2	HX1	-
Usable Waste Heat (W)	14,459	11,601	7252	33,312

**Table S5.** Heat balance of the MgH<sub>2</sub> storage and SOFC module.

Item	MgH <sub>2</sub> storage	Fuel gas line	Air gas line	Total Heat
Required Heat to Maintain Steady-State (W)	-22,013	-3554	-9,616 (to 643 K) -10,525 (to 1073 K)	-45,708
Waste Heat from Exhaust Gas (W)	14,459	0	18,853 (to 643 K)	33,312
Heating by SOFC Resistive Losses (W)	7554	3554	10,525	21,633
Sum: remaining heat (recovered at HX4 and unused in system) (W)	0	0	9237	9237

**Figure S2.** Available electrical power output and heat recovery from SOFC and MgH<sub>2</sub> storage system.