Supplementary Materials

The modelling of the electric-hydrogen coupling AC-DC hybrid microgrid together with the control method proposed in the paper "Flexible on-grid and off-grid control for electric-hydrogen coupling microgrids" were implemented in Matlab/Simulink.

The microgrid model is mainly comprised of five parts. **Figure S1** shows simulation modules of photovoltaic (PV) panels and battery energy storage system (BESS) connected to DC bus of the microgrid. PV panels are regulated by the maximum power point tracking (MPPT) or constant voltage control under normal circumstances or in the case of insufficient electricity supply, respectively. The BESS adopts voltage and current (U-I) double closed-loop control to stabilise DC bus voltage.

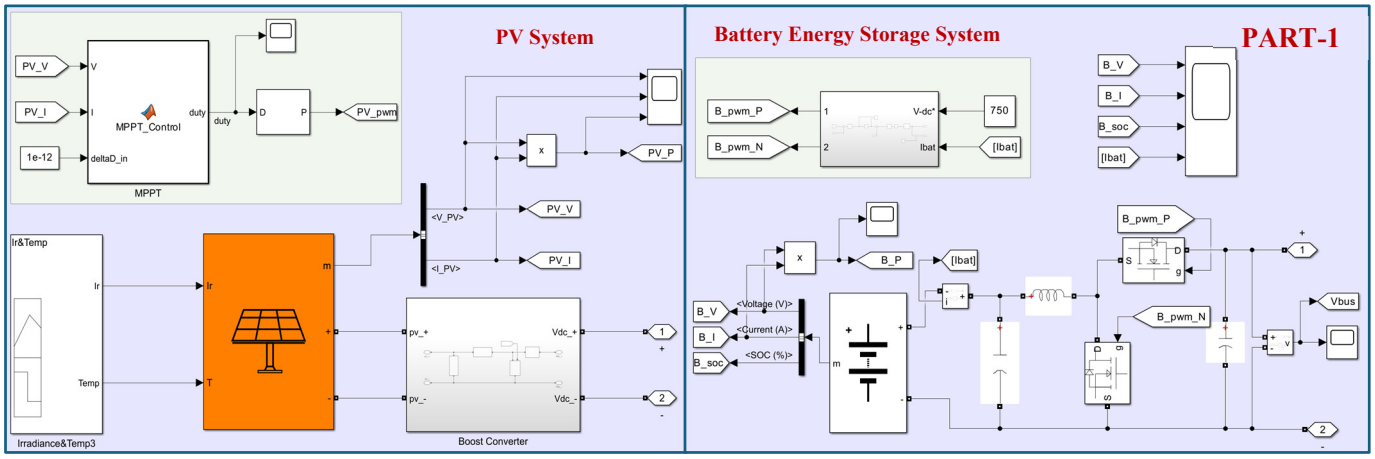


Figure S1. Simulation modules of PV panels and BESS within microgrid.

Figure S2 shows simulation modules of electrolyser (EL) and hydrogen storage tank (HST), mainly including the U-I characteristic curve, hydrogen production rate and constant power control of EL, as well as HST pressure calculation. The modeling is completely in accordance with theoretical introductions in Section 2.2.3 of the paper.

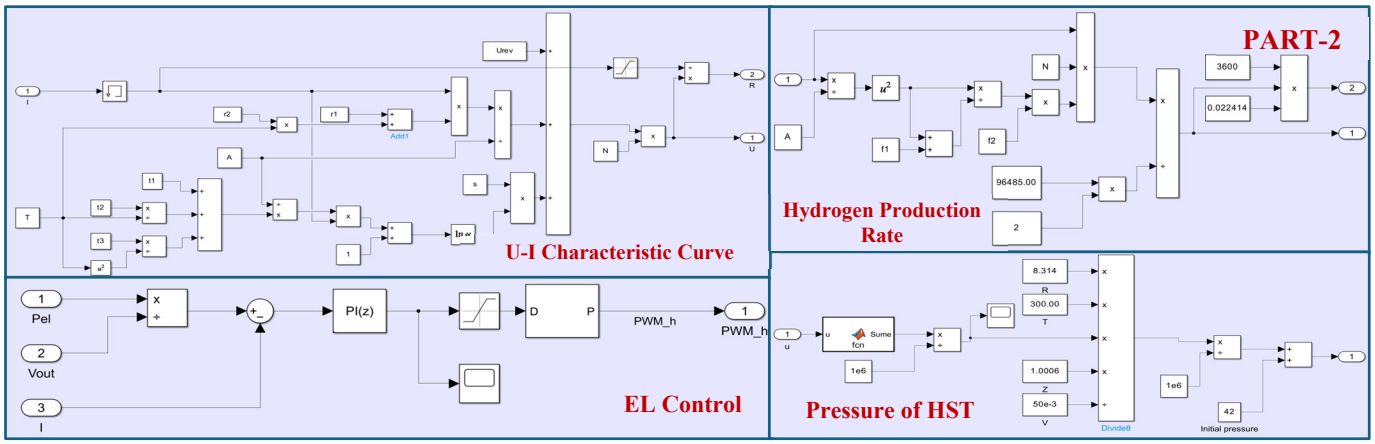


Figure S2. Simulation modules of EL and HST within microgrid.

Figure S3 shows simulation modules of proton exchange membrane (PEM) fuel cells (FCs), including multiple PEMFC stacks formed based on structure and control of a single-stack PEMFC, and a slave converter and related active and reactive power (PQ) control.

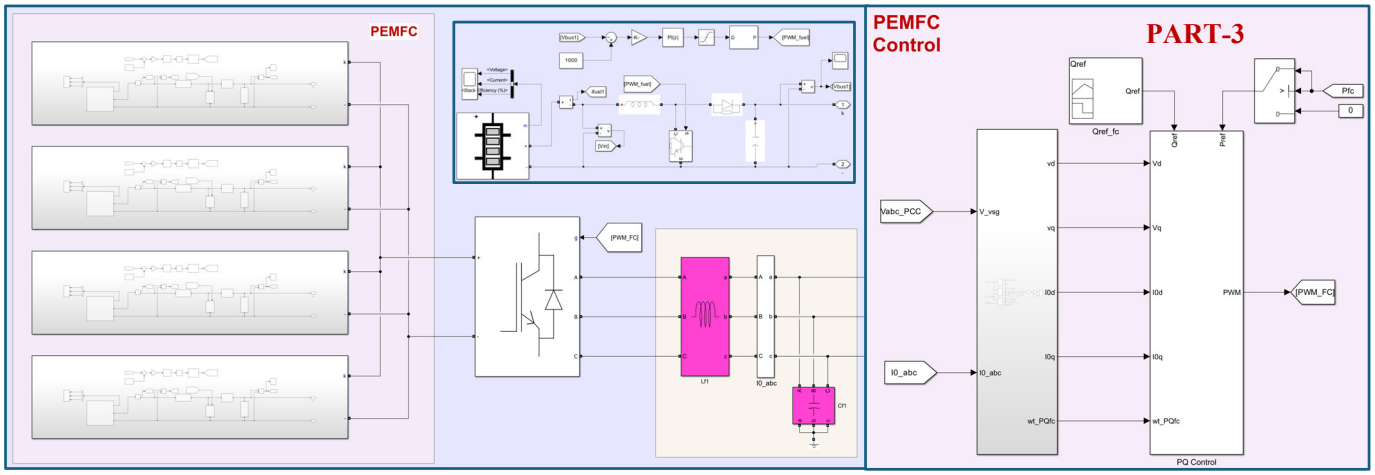


Figure S3. Simulation modules of PEMFCs and PQ control of slave converter.

Figure S4 shows simulation modules of virtual synchronous generator (VSG) control applied to a master converter linking microgrid and upstream grid and pre-synchronisation control. The VSG control comprises active power-frequency (P-f) control, reactive power-voltage (Q-V) control and virtual impedance control. The pre-synchronisation control together with grid-connection condition determination ensure smooth transition from off-grid mode to on-grid mode.

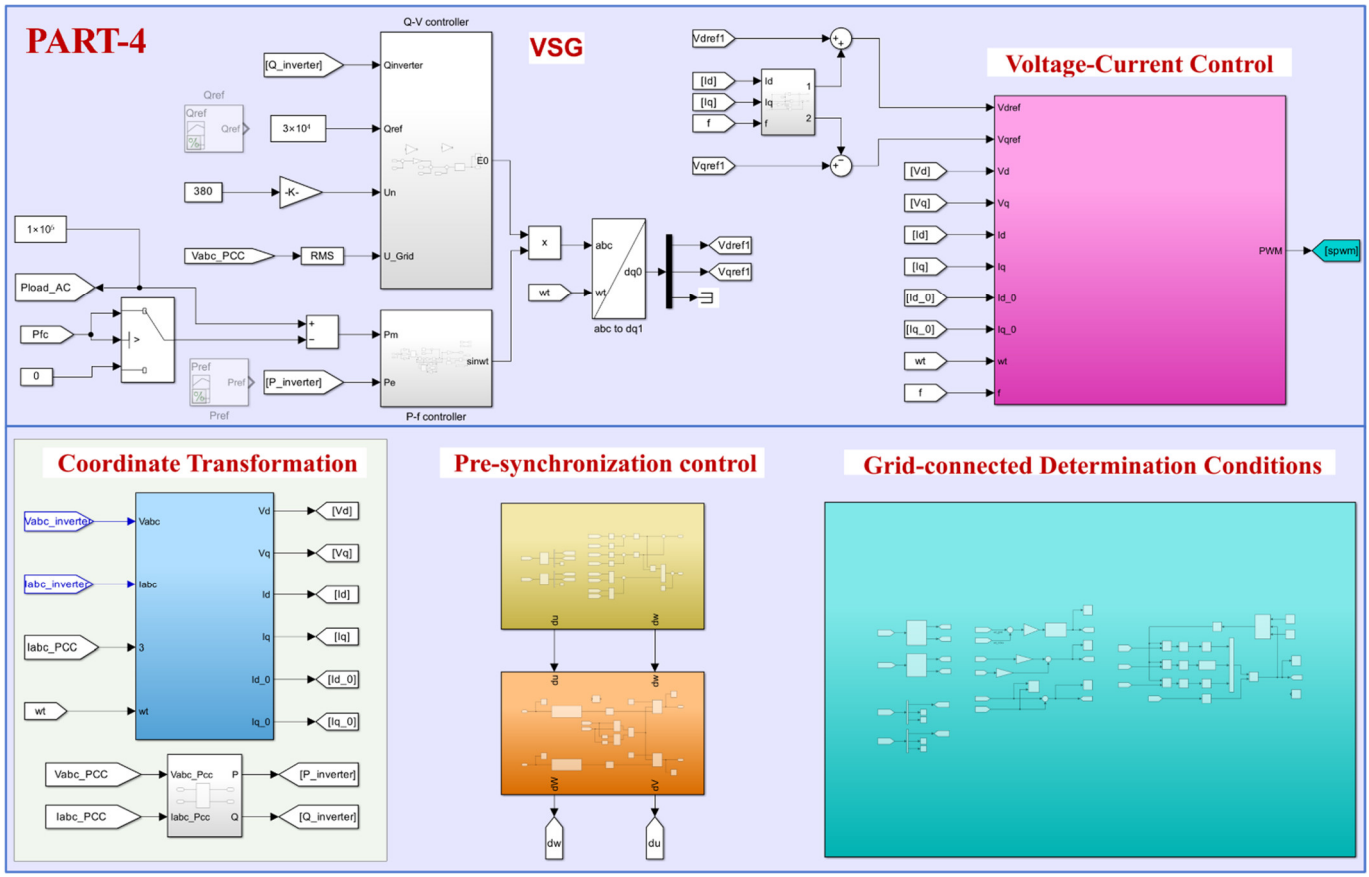


Figure S4. Simulation modules of VSG control of master converter and pre-synchronisation.

Figure S5 shows the simulation module of power management strategy (PMS) proposed for the electric-hydrogen AC-DC microgrid, which allocates power among multiple components within the microgrid based on the state of charge of BESS, state of hydrogen charge (SOHC) of SHT and source-load imbalance.

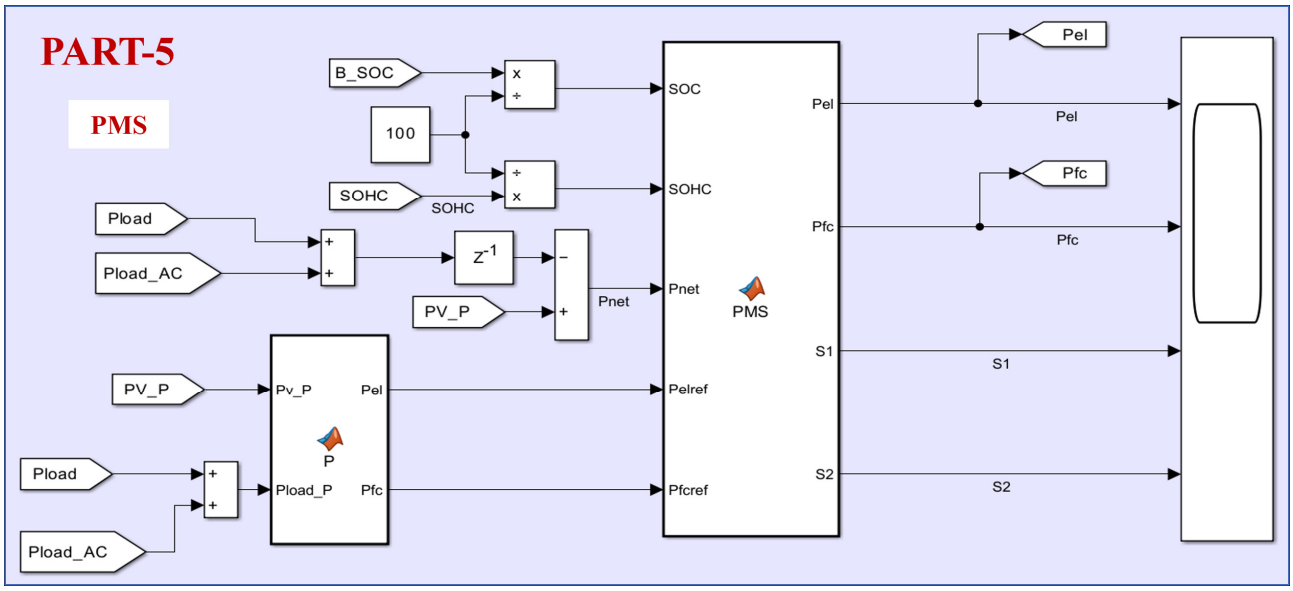


Figure S5. Simulation module of the PMS for the electric-hydrogen microgrid.