Table 4
Statistics on authors, powertrains, algorithms, and contributions of journal papers (Powertrain Innovation).

Author (Year)	Powertrain	Algorithm	Contribution
Zhou[247] (2019)	Serial HEV	Q Learning	Electrified off-highway vehicle; three multi-step learning strategies (sum-to-terminal, average-to-neighbor recurrent-to-terminal); hardware-in-the-loop;
Lahyani[248] (2020)	PEV	Q Learning	Hybrid energy storage systems (battery and supercapacitor); electro-thermal battery model; an RL-based power-sharing configuration and a rule-based frequency power-sharing control;
Sun[249] (2020)	FCV	Q Learning	Fuel cell, battery, and supercapacitor; shrink state-action space based on an adaptive fuzzy filter; speedy Q-Learning; ECMS-based multi-objective optimization considering lifespan and fuel efficiency of fuel cell; RL-based splitting strategy for battery and fuel cell;
Zhou[250] (2020)	FCV	DDPG	The health status of the proton electrolyte membrane fuel cell and Li-ion battery decreases; The RL optimizes the boundary of SOC that changes with power source attenuation, and the thermostat controller controls the fuel cell current according to the SOC boundary;
Li[251] (2021)	PEV	DQN	Hybrid battery systems (high-energy and a high-power battery pack); energy loss minimization and electrical and thermal safety enhancement;
Wu[252] (2021)	HE Bus	SAC	Thermal safety and degradation of onboard lithium-ion battery; the over-temperature penalty and multi-stress-driven degradation cost of battery are introduced in the existing indicators;
Xu[253] (2021)	PEV	Q Learning	Battery and supercapacitor; optimizing the energy and battery degradation; validating the battery aging model with experimental data;
Yang[254] (2021)	Rail transit	DQN	considering the energy-saving and voltage-stabilizing effects of supercapacitor; a traction power system simulator;
Zhang[255] (2021)	PHEV	DQN	The dual-mode engine with homogeneous charge compression ignition (HCCI) and spark ignition (SI); DP obtains optimal combustion mode and SOC reference trajectories at the cloud. DRL-based EMS and combustion mode with prioritized experience replay at the powertrain; makes full use of HCCI combustion mode and avoids frequent switching of combustion modes;
Cheng[256] (2022)	PEV	Q Learning	Supercapacitor and battery; reduce the loss, reduce the change of current, and prolong the life; Pearson similarity judges the update of the TPM;
Deng[257] (2022)	FC railway vehicle	TD3	Minimizing hydrogen consumption and fuel cell aging costs; an online fuel cell aging estimation model; a stochastic training environment;
Fu[258] (2022)	FCV	DQN	Fuel cell, battery, and supercapacitor; supercapacitor supplies peak power and recovers braking energy by the fuzzy control-based adaptive filter; DRL-based allocation and ECMS-based reward optimize the control process; the action trimming restrains the adverse effect of sudden peak power of fuel cell;
Guo[259] (2022)	FCV	Dueling-double DQN	Fuel cell degradation; an evaluation mechanism of allowable approach punishment to mitigate system degradation; heavy-duty FCVs; hardware-in-the-loop;
Han[260] (2022)	Serial HEV	Eligibility Trace	Fuel economy and battery degradation; online recursive Markov chain from statistical features from actual driving cycles; induced matrix norm is employed to measure the difference between TPMs and decide when to update the environment model;
Haskara[261] (2022)	PEV	Q Learning	Energy consumption and battery degradation; Heating Ventilation Air Conditioning (HVAC); RL-based EV traction with driver demand and HVAC control with cabin comfort; empirical battery aging model;
Hu[262] (2022)	FCV	DDPG	Fuel cell, battery, and supercapacitor; adaptive fuzzy control filter to separate the low-frequency and high-frequency demand power; learning guidance mechanism that rewards the reasonable action and penalizes the bad action guides the agent in a rational learning direction;
Li[263] (2022)	FCV	DQN	The optimal size of batteries with the lowest cost, minimizing the summation of hydrogen consumption, fuel cell degradation, and battery degradation;
Shi[264] (2022)	FCV	IQL	Multi-agent reinforcement learning; fuel cell fault for a multi-stack fuel cell; hardware-in-the-loop; considering the safe working when the multi-stack fuel cell system fails;

Author (Year)	Powertrain	Algorithm	Contribution
Tang[265] (2022)	FCV	DQN	Prioritized experience replay; the fuel cell system degradation;
Wang[266] (2022)	Parallel PHEV	DQN	The HEV model is equipped with the waste heat recovery system of the organic Rankine cycle;
Xiao[267] (2022)	Serial HEV	SAC	An auxiliary power unit charging strategy achieves high fuel conversion efficiency while maintaining battery health for charging protection; the reward: fuel, SOC, and charging rate;
Xu[268] (2022)	PEV	Q Learning	Hybrid power system (battery and supercapacitor); maximizing energy efficiency and battery life; the baseline power-split layer and an upper layer to trigger the engagement of the supercapacitor;
Xu[269] (2022)	PEV	SAC	Battery and supercapacitor; slower convergence rate, brittle training stability, and dissatisfactory optimization; parallel computing; DP-based expert knowledge is embedded;
Zhang[270] (2022)	PHEV	TD3	Dual-mode engine with the lean burn spark-induced compression ignition and the stoichiometric spark ignition; hybrid action space (combustion mode, engine power); spatiotemporal data processing incorporating the multivariate traffic and terrain information, clipped double DQN mechanism, target policy smoothing technique, and delayed policy updates;
Zhang[271] (2022)	Serial HEV	Model-based RL	hybrid construction vehicles; the generalized design: 1) long-term stability, 2) self-learning ability, and 3) state transition model reuse; a reward function with a trend term for avoiding the cumulative errors; Gaussian process regression for approximating the value function; Gaussian mixture-based modeling method;
Zhang[272] (2022)	FCV	TD3	The transient lifespan degradation information of proton exchange membrane fuel cell stack and lithium-ion battery; limiting the overestimation;
Zheng[273] (2022)	FC Bus	DQN	Fuel cell degradation model; prioritized experience replay; The action space is limited based on the efficiency characteristic of the fuel cell;
Zheng[274] (2022)	FCV	DDPG DQN	three typical RL algorithms are compared; prioritized experience replay; fuel cell degradation model; the action space is limited based on the characteristic of the fuel cell; pre-initialization; the Ornstein-Uhlenbeck noise is adopted;
Saeid[275] (2023)	HEV	Q Learning	Serial parallel powertrain; fuel consumption and battery life cycle; expert knowledge (battery characteristics);
Chen[276] (2023)	FCV	SAC	SAC algorithm with Beta policy; health degradation of both fuel cell system and power battery; the ablation experiment for health performance;
Cui[277] (2023)	PEV	DDPG	Dual-motor four-wheel-drive vehicle; particle swarm optimization-based parameters matching method for the dual-motor front and rear axle four-wheel drive power system; DRL-based EMS facing uncertain demands;
Deng[278] (2023)	PFCV	SAC	Battery thermal- and cabin comfort awareness; thermal management model and an air conditioning system with cooling and heating mode;
Han[279] (2023)	HETV	DDPG	The lateral dynamics; steering resistance on the energy distribution is considered; the multidimensional matrix framework; the pyramid-like network; hardware-in-the-loop;
Hong[280] (2023)	Electric Hydraulic HEV	TD3	A self-adaptive electric-hydraulic ratio under different driving cycles; a DRL-based EMS with a rule-based mode switching strategy;
Hu[281] (2023)	FCV	DDPG	Analyzing the main degradation factors of the fuel cell and battery; a DDPG agent is trained to adjust the adjustment parameters of the Hamiltonian function; hardware-in-the-loop;
Huang[282] (2023)	FC Bus	A3C	A distributed DRL-based EMS considering the fuel cell degradation and battery aging; a comprehensive driving cycle for training reconstructed from real-world driving data;
Huang[283] (2023)	FC Bus	DPPO	A distributed DRL-based EMS considering the multi-objective optimization in hydrogen conservation and fuel cell degradation suppression;
Jia[284] (2023)	FC Bus	TD3	The air-conditioning system; cabin comfort and fuel cell/battery durability;
Lu[285] (2023)	FCV	DDPG	Fuel cell, battery, and supercapacitor; an adaptive fuzzy filter is employed to complete frequency-based decoupling of power demand; the semi-empirical

Author (Year)	Powertrain	Algorithm	Contribution
			degradation model of battery; heuristic experience replay;
Tao[286] (2023)	FCV	DDPG	Fuel cell, battery, and supercapacitor; an action-value-based adaptive noise and an action screening-mechanism-based priority experience replay; an adaptive fuzzy filter is employed; terrain-information-considered TPM;
Wang[287] (2023)	PEV	Q Learning	Battery and supercapacitor; its robustness of RL-based EMSs is verified at different temperatures; the dynamic experiments are used to obtain mechanism characteristics and the genetic algorithm is selected to identify the parameters of the battery and supercapacitor model;
Wei[288] (2023)	HEPS	Q Learning	Hybrid electric power system with turboshaft engine; the economic rotational speed of turboshaft engine and safety constraints-based variable action space;
Ye[289] (2023)	PHEV	Q Learning	energy consumption and battery deterioration; lithium-sulfur battery with bilateral solid electrolyte interphases considering the power performance and degradation characteristics;
Zhang[290] (2023)	PHE Bus	PPO	the PPO-Clip and Penalty-based EMSs considering the battery thermal characteristic;
Zhang[291] (2023)	Power split HEV	DDPG	Lithium-Plating Suppressed effect; single particle model with electrolyte and lithium-plating model; hybrid particle swarm optimization grey wolf optimizer algorithm is applied to the parameter identification; Multi-objective Optimal based on DDPG-based EMS;
Zhang[292] (2023)	Electric Hydraulic HEV	PPO	Integrating the LSTM network to the proximal policy optimization for switching optimal working mode; local sample Shannon entropy and Z-score to realize dynamic evaluation for performance parameters;
Zhang[293] (2023)	Electric Hydraulic HEV	Double DQN	Battery and hydraulic motor; Double DQN avoids overestimation; DRL-based working mode switching; a period of actual velocity data as the off-line training driving cycle;

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