Journal of
Marine Science and Engineering

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Correction

Correction: Jung, W.; Chang, D. Deep Reinforcement Learning-Based Energy Management for Liquid Hydrogen-Fueled Hybrid Electric Ship Propulsion System. *J. Mar. Sci. Eng.* 2023, *11*, 2007

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In the original publication [1], there was a mistake in Table 2 as published. There was an error in the value of k_p written in Table 2, and the unit of β has been revised to a clear unit to aid the readers' understanding. The corrected Table 2 appears below.

Item	Unit	Value	Definition
k_p	-	1.72	Accelerating coefficient
k_1	%/h	0.00126	Output power < 2% of max. power
k_2	%/cycle	0.00196	Full start-stop operation
k_3	%/h	0.0000593	Output variation rate > 5% of max. power per second
k_4	%/h	0.00147	Output power > 90% of max. power
β	%/operation	0.01	Natural decay rate

In the original publication [1], there was a mistake in Table 6 as published. There were some errors in the result values written in Table 6, and the results calculated through each algorithm have been revised and presented. The corrected Table 6 appears below.

	$C_{H_2,total}$	$C_{FC,deg,total}$	$C_{bat,deg,total}$	Total Cost	Ratio to DP
DRL-EMS	36,588	2650	1245	40,483 USD	1.002
DP-EMS	36,159	2743	1491	40,393 USD	1.000
SQP-EMS	36,834	7575	390	44,799 USD	1.109

In the original publication [1], there was a mistake in Figures 8–11 as published since the results in Table 6 should be partially revised. For Figure 8, the used data remains unchanged, but some numbers previously indicated in the existing figure were inaccurately represented and have been removed. Additionally, due to certain alterations in the total cost of DRL-EMS as presented in Table 6, the original values (40,689 USD) used in Figures 9–11 have been updated to the revised value (40,483 USD). The corrected Figures 8–11 appears below.

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Received: 31 January 2024
Accepted: 7 February 2024
Published: 14 March 2024

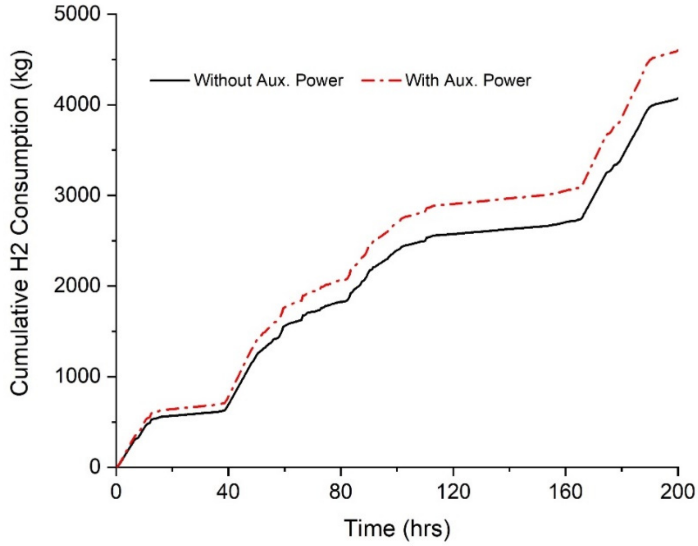

Figure 8. Cumulative hydrogen consumption with and without consideration of BOP power for the liquid hydrogen fuel gas supply system and PEMFC system.

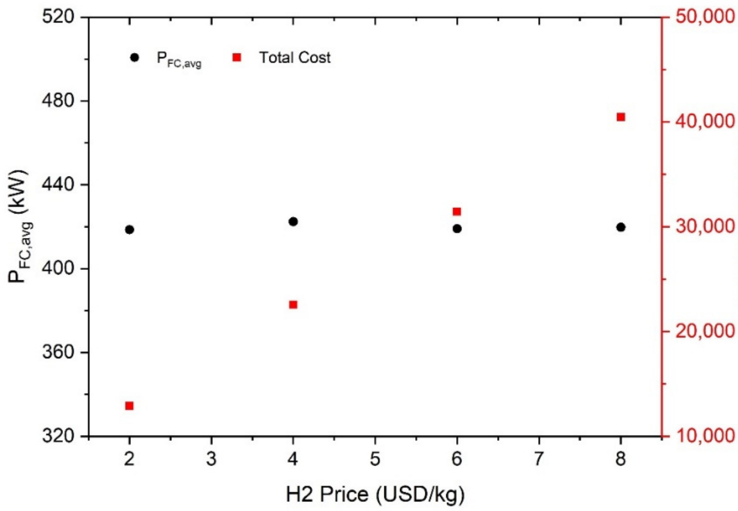

Figure 9. Energy management results with different hydrogen fuel costs for reference case.

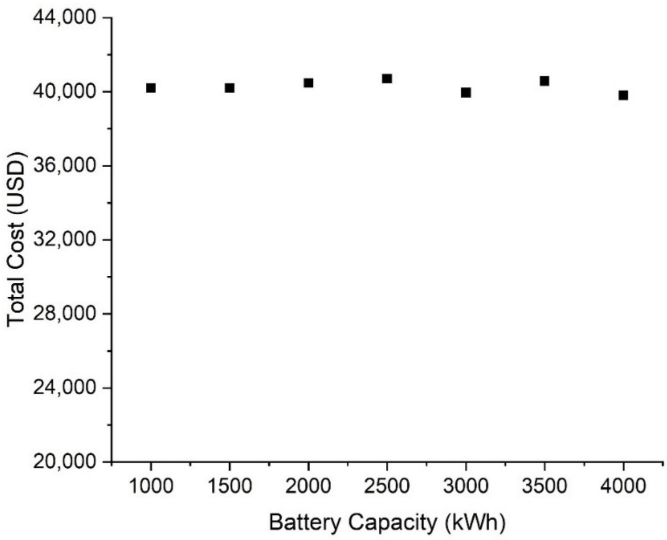

Figure 10. Energy management results with different capacities of the battery system for reference case.

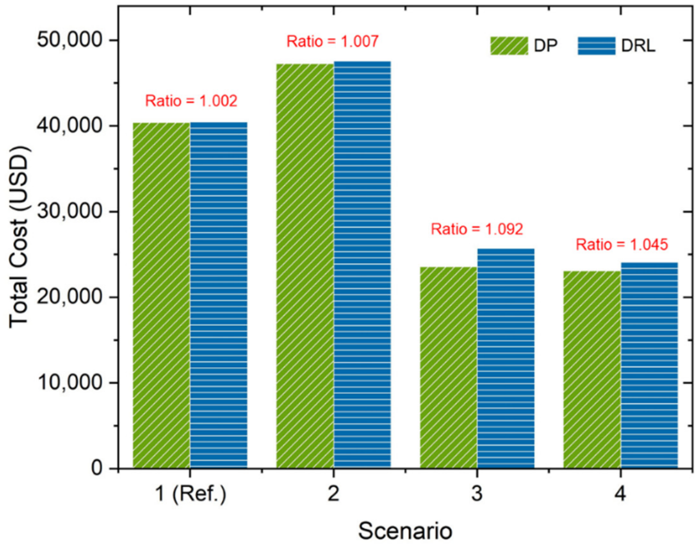

Figure 11. Energy management results for Cases 1 to 4 with dynamic programming and deep reinforcement learning algorithms.

There was an insufficient explanation in the original publication [1]. To enhance readers' accurate understanding of the operation of the target system, some sentences have been modified. A correction has been made to Section 2. Model Description, 2.4. System Efficiency, first paragraph. The corrected paragraph appears below.

"Using the models for LH_2 FGSS and the PEMFC system, the efficiency of the target system is approximated based on the power of the PEMFC system using Equation (19), which includes hydrogen consumption with BOP power. Additionally, the calculated system efficiency is used to estimate hydrogen consumption in the energy management problem. Since the BOP power from the battery system is not significantly high compared to the LH_2 FGSS and PEMFC system, we assumed the battery system can generate all auxiliary power during operation of the PSV".

There was a minor error in the original publication [1]. There were typos related to the signs of some variables in Equations (4) and (5), and they have been corrected. A correction has been made to Section 2. Model Description, 2.2. Liquid Hydrogen Fuel Gas Supply System. The corrected equations appear below.

$$\frac{d\left(m_{f,shell} h_{f,shell,out}\right)}{dt} = \dot{m}_{f,shell}\left(h_{f,shell,in} - h_{f,shell,out}\right) - \dot{Q}_{HX} \tag{4}$$

$$\frac{d\left(m_{f,tube} h_{f,tube,out}\right)}{dt} = \dot{m}_{f,tube}\left(h_{f,tube,in} - h_{f,tube,out}\right) + \dot{Q}_{HX} \tag{5}$$

There was an error in the original publication [1]. Some variables were omitted in Equations (22)–(24), and they have been corrected. A correction has been made to Section 3. Methodology of Energy Management. The corrected equations appear below.

$$C_{FC,deg}(t) = Cost_{FC} \cdot P_{FC,max} \cdot \frac{\Delta V_{loss,FC}(P_{FC}(t))}{EOL_{FC}} \cdot \Delta t \tag{22}$$

$$C_{bat,deg}(t) = Cost_{bat} \cdot E_{bat} \cdot \frac{\Delta E_{loss,bat}(P_{FC}(t), P_{req}(t))}{EOL_{bat}} \tag{23}$$

$$C_{bat,eq}(t) = Cost_{H_2} \cdot \frac{s}{LHV_{H_2}} \cdot P_{bat}(t) \cdot \left\{1 - \frac{SOC(t) - SOC_{ref}}{0.5(SOC_{max} - SOC_{min})}\right\}^{p} \Delta t \tag{24}$$

There was an error for explanation of results in Table 6 the original publication [1]. Based on some modified values in Table 6, we have made some adjustments to the content described in the main text. A correction has been made to Section 4. Results and Discussion, first paragraph. The corrected paragraph appears below.

"Before analyzing the optimal operational strategy applied to LH2-HSPS by DRL-EMS, the optimization results with DP-EMS and SQP-EMS algorithms are compared to evaluate the performance of these algorithms, as shown in Table 6. It is observed that both DRL-EMS and SQP-EMS resulted in 0.2% and 10.9% higher OPEX, respectively, compared to DP-EMS. The significant impact on the performance of these two algorithms was attributed to the equivalent degradation cost of the PEMFC system. The degradation rate calculated through the model exhibited discontinuities at low-load operations (<40 kW) and high-load operations (>1800 kW), which SQP-EMS, based on gradient descent, failed to sufficiently consider. Additionally, DRL-EMS yielded OPEX values nearly identical to DP-EMS, indicating that the effective utilization of the battery system allowed DP-EMS to calculate slightly lower OPEX. Meanwhile, Figure 6 shows the changes in the calculated PEMFC system output and SOC when each EMS is applied. As mentioned earlier, it can be observed that DP-EMS is most effectively utilizing the battery system based on the SOC changes, while SQP-EMS appears to underutilize the installed battery system in situations where future required power is uncertain".

There was an inaccurate explanation in the original publication [1]. Based on some modified values in Table 6 and Figure 8, we have made some adjustments to the content described in the main text. A correction has been made to Section 4. Results and Discussion, third paragraph. The corrected paragraph appears below.

"In the previous results, it is confirmed that approximately 90% of OPEX was incurred through hydrogen fuel consumption, indicating the necessity of saving hydrogen consumption for the efficient operation of LH_2-HSPS. Figure 8 represents cumulative hydrogen consumption when using the same DRL-EMS but distributing power based on PEMFC stack efficiency instead of system efficiency. Without considering of auxiliary power, a total of 4074 kg of fuel was consumed, which is approximately 11% lower compared to the system efficiency-based calculation. Since ships have limited space for equipment relative to their capacity, the appropriate sizing of each piece of equipment should be determined in the design phase. When using LH_2 as fuel without a separate external power plant to supply BOP power required for ship propulsion, power must be supplied through the PEMFC system for propulsion. In this case, as explained earlier, there is a significant difference of about 11% in fuel consumption per operation, affecting the volume of the fuel tank. Therefore, the volume of the LH_2-powered ship's fuel tank to be built in the future should be determined by thoroughly reviewing the system efficiency of LH_2-HSPS".

The authors state that the scientific conclusions are unaffected. This correction was approved by the Academic Editor. The original publication has also been updated.

Reference

1. Jung, W.; Chang, D. Deep Reinforcement Learning-Based Energy Management for Liquid Hydrogen-Fueled Hybrid Electric Ship Propulsion System. *J. Mar. Sci. Eng.* **2023**, *11*, 2007. [CrossRef]