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SIMULATION-BASED POWER STRATEGY OPTIMIZATION IN A DIESEL HYBRID VEHICLE

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Abstract
This study includes comparing fuel-energy consumption, consumption cost, and vehicle dynamic performance of a diesel hybrid electric vehicle created by combining virtual diesel and electric vehicle models in MATLAB/Simulink and correlated with real-world driving data. In the diesel hybrid vehicle model, electric power initiates the acceleration until the hybrid mode transition threshold speed, and after, the diesel traction system maintains the motion. The hybrid mode transition threshold speeds were determined as 10 km/h, 15 km/h, 20 km/h, and 25 km/h. The virtual tests were repeated according to different vehicle masses as 3500 kg, 4000 kg, 4500 kg, and 5000 kg. As a result, this study achieved the best dynamic performance and the lowest total energy consumption with the hybrid mode transition threshold of 10 km/h. Also, diesel hybrid combinations mostly showed better dynamic performance than pure diesel and battery electric vehicles.
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Key Words: Electric Vehicle, Diesel Hybrid Vehicle, Simulink, Power Strategy, 1D Simulation

1. INTRODUCTION

The rising global energy demand has pushed the automotive industry toward solutions like electric vehicles [1, 2], which include battery, hybrid, and fuel cell systems. Unlike internal combustion engines, electric vehicles are powered by electric motors, offering benefits such as zero emissions [3], quiet operation, and lower maintenance costs. Regenerative braking also reduces energy consumption by returning kinetic energy to the batteries. However, challenges remain, including high battery costs, limited range, and insufficient charging infrastructure, which cause range anxiety. While fast-charging technologies are improving, charging still takes longer than traditional refuelling. Therefore, energy-efficient vehicle design and driving are important [4]. For this purpose, researchers mainly focus on energy-optimal transportation regarding traffic jams, energy consumption, and driver behaviour habits [5] and comprehensively analyse the impact on charging strategies and potential technical developments [6].

Diesel hybrid vehicles hold significant potential for heavy-duty applications due to growing global energy demand and environmental concerns. By combining the durability of diesel engines with the eco-friendly benefits of electric motors, these vehicles improve energy efficiency and reduce carbon emissions [7]. Hybrid vehicles leverage both power sources and employ regenerative braking to recover energy, minimizing fuel consumption and emissions through advanced energy management systems. In addition, this architecture includes the infrastructure to support promising studies aimed at emission management and performance increase of diesel vehicles [8, 9]. Research has demonstrated that energy management models and simulations, particularly in platforms like MATLAB/Simulink, improve fuel efficiency across different driving cycles and vehicle loads [10, 11]. These optimizations are essential for enhancing driving performance and lowering energy use. Diesel hybrid technology, especially in freight and commercial vehicles, offers notable benefits in energy efficiency and cost savings. Additionally, studies on energy and carbon loss management in electric bus production facilities reveal that sustainable practices can significantly reduce energy consumption and emissions, contributing to greener manufacturing processes.

Hybrid vehicles have more components than conventional ones, requiring more control and management systems. A diesel hybrid vehicle includes a diesel engine, an electric motor, a battery, a transmission, a differential, a power electronics, and energy management systems [12]. The diesel engine delivers high performance for long-distance and high-torque driving, while the electric motor provides low emissions and quiet operation at low speeds in urban settings. The battery powers the electric motor and stores energy from regenerative braking. Power electronics and energy management systems [13] efficiently regulate energy flow between these components, optimizing performance, reducing fuel consumption, and lowering emissions.

Simulations enable different driving conditions and scenarios to be modelled in a digital environment, significantly reducing the cost and time of physical tests. These studies allow for detailed analysis of the performance of vehicle components and systems using advanced software platforms [14, 15]. It also plays a major role in optimizing energy management systems, as it is possible to evaluate fuel consumption and emission performance under different driving cycles and vehicle loads. In this way, the most appropriate strategies can be developed for critical components such as the vehicle's powertrain, battery management systems, and regenerative braking. Simulations also allow examining the effects of variables such as different tire diameters, vehicle weights, and driving habits on vehicle performance. This makes it possible to prepare for various scenarios that may be encountered in real-world conditions and to develop solutions best suited to these scenarios. In this way, potential problems can be identified and resolved before prototype production, reducing research and development costs and accelerating time to market.

Various successful studies have been conducted on various optimization topics in diesel hybrid systems. These studies mostly include diesel hybrid electric buses [16], optimization of energy management strategy compatible with traffic conditions [17], anomaly detection in fuel consumption [18], diesel generator and hydrogen fuel cell [19], adaptive energy management in parallel diesel hybrid electric buses, control of buses based on driver behaviour [20].

This study aimed to determine an optimal transition strategy by addressing the question of how different hybrid mode transition threshold speeds (the hybrid mode transition threshold is the vehicle speed value, e.g., 10–25 km/h, that determines when the propulsion switches from electric to diesel drive during acceleration) and vehicle mass affect the energy consumption, cost, and dynamic performance of diesel-electric hybrid vehicles. While previous research has largely focused on energy management algorithms and control strategies such as ECMS and MPC, very little has examined the impact of transition thresholds, particularly using real-world driving data. To address this gap, we developed diesel, electric, and hybrid vehicle models in MATLAB/Simulink and validated them against real-world driving profiles. By isolating the vehicle powertrain variable, the effects of various transition speeds (10–25 km/h) and vehicle masses (3500–5000 kg) were systematically analysed. The findings demonstrate that utilizing electric power at low speeds significantly improves acceleration and reduces energy consumption, demonstrating the suitability of such hybrid strategies for frequent stop-and-go driving behaviour. The study also presents a practical and validated simulation approach that reduces testing costs and contributes to a new methodology for hybrid system optimization.

2. MATERIALS AND METHODS

The methodology used in the study includes creating and correlating diesel and electric virtual vehicle models, creating diesel hybrid vehicle models with correlated models, and examining consumed energy, consumption costs, and dynamic performance. During this process, technical information about real vehicle models used in creating virtual models was shared. Details about the preferred approach in the energy consumption and consumption costs analysis were explained, and information about reference driving was provided. Fig. 1 summarizes the general flow of the study.

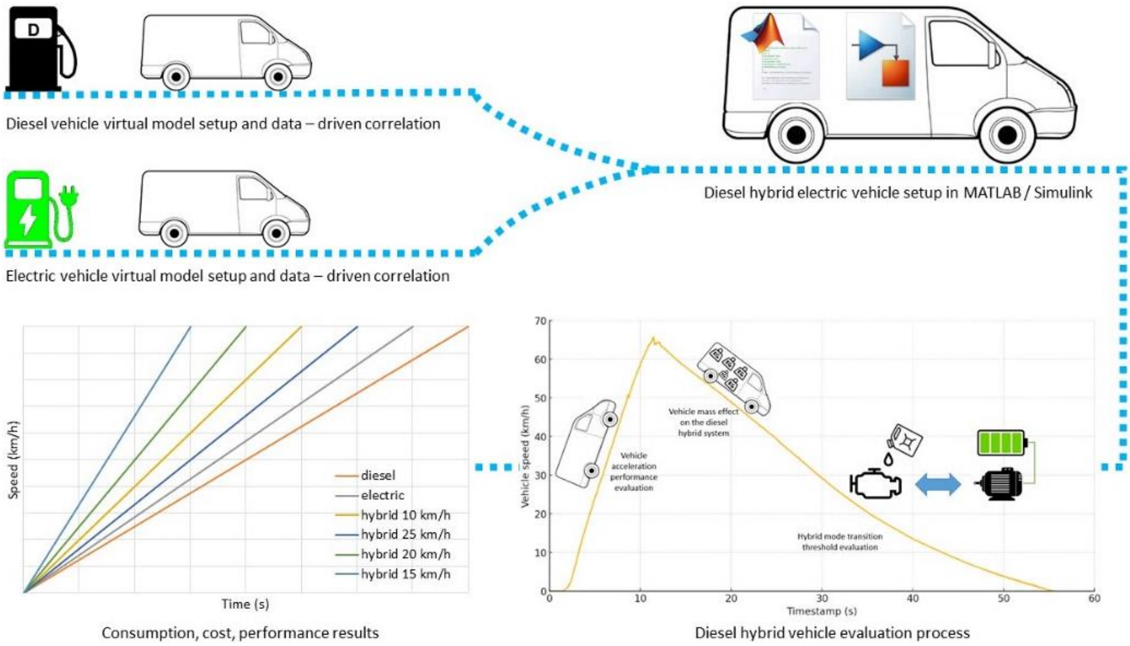

Figure 1: The flow of the study.

2.1 Diesel vehicle

The real diesel vehicle is suitable for urban use, its length is between 6 and 7 meters, gross vehicle weight is 5000 kg, frontal area is 5–6 m^2, drag coefficient is 0.5-0.6, and rolling resistance coefficient is 0.0057. The engine volume is 3000 cm^3, maximum engine power is 129 kW, and maximum engine speed is 4200 rpm. The diesel engine transfers the torque to the wheels with the help of a 6-speed automatic transmission. The fuel consumption map of the vehicle in real-world driving is given in Fig. 2. The vehicle consumed 0.2128 litres of fuel in a real-world driving test with this technical equipment, on a flat, windless, and asphalt road, at a distance of 1880 m in 293 seconds.

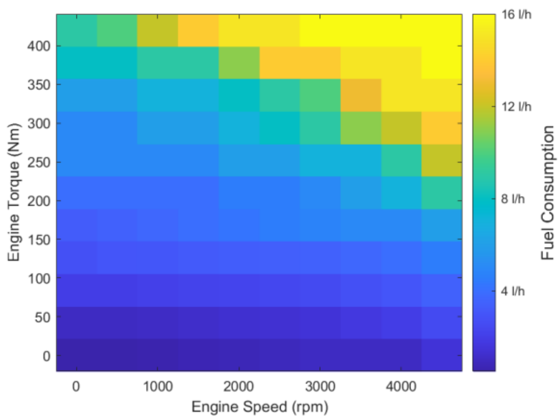

Figure 2: Fuel consumption map of diesel engine.

A virtual diesel vehicle traction system has been created in MATLAB/Simulink by adhering to the technical specifications of the real diesel vehicle. In the virtual diesel vehicle model presented in Fig. 3, the performance and fuel consumption information to be obtained from the vehicle can be output in response to the acceleration demand input. When the time-speed-slope data obtained from real-world driving is given as input to the virtual diesel vehicle model, the driver controller, that means the controller that creates torque demand based on the difference between target speed and current speed was prepared with appropriate coefficients defines a torque demand between 0 and 1 for the generic engine to reach the target speed on time. The engine block shares the torque, power value, and the fuel consumption information according to the torque and speed from the predefined map with the user while transmitting the incoming torque demand to the line where the torque converter and transmission are connected in series. The torque converter transmits the torque from the engine to the transmission by increasing it by a certain ratio according to the instantaneous speed value. In addition, the torque converter contains coefficients for the drive and sail moments. In the torque converter, a certain amount of increased torque is transferred to the 6-speed transmission. The input is given to the transmission block, where gear information is expected from outside, with numerical values between 1 and 6.

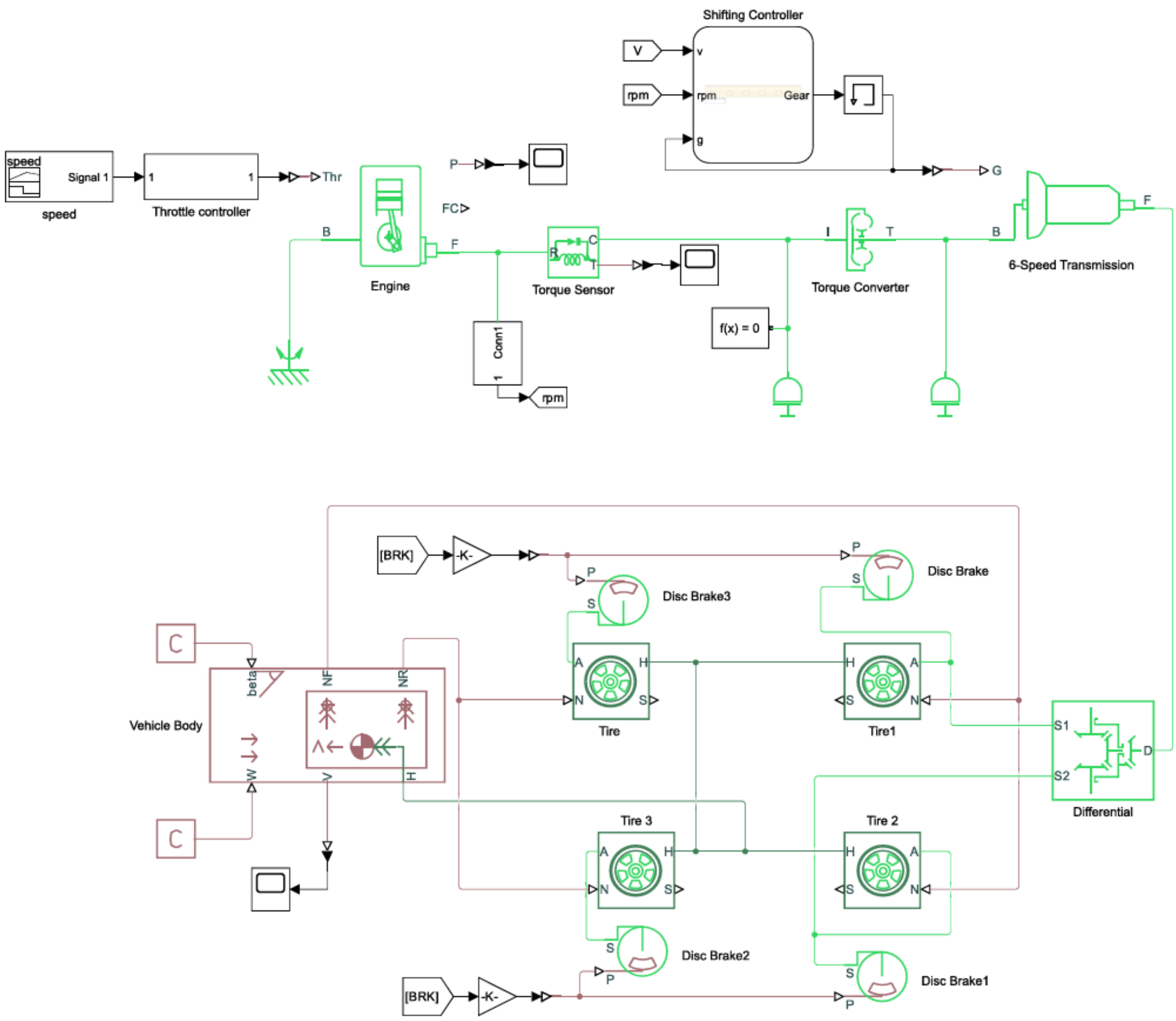

Figure 3: Pure diesel vehicle virtual model.

The gear-shifting behaviour is created based on the gear-shift map of the vehicle that emerged during 5236 seconds of real-world urban driving. The gear-shifting model includes a rule-based management strategy and outputs the appropriate number of gears in response to vehicle speed and pedal ratio inputs. The gear-shifting data that emerged during real-world driving is given in Fig. 4.

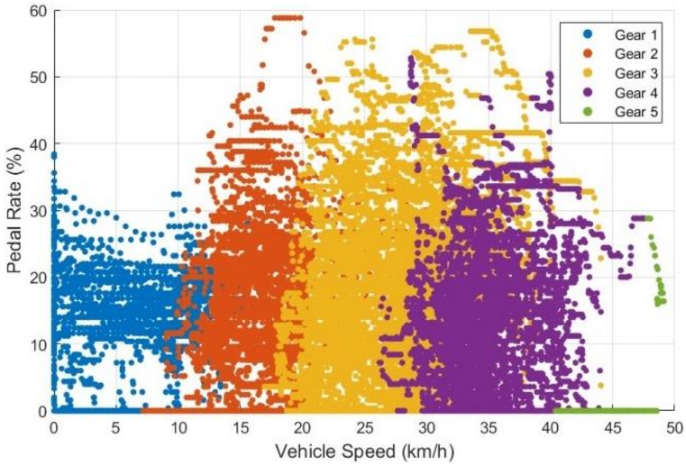

Figure 4: Gear shifting data.

The torque, which is also increased by the transmission ratio, is transferred to the differential and then to the wheels. The torque transferred from the differential to the two wheels allows the virtual vehicle to gain speed. The disc brake blocks connected to the four wheels help with the deceleration request. The four wheels are connected to the vehicle body. In the vehicle body block, values such as vehicle mass, centre of gravity position, drag coefficient, air density, and frontal area, which are fundamental vehicle parameters, are entered. When the time-speed-slope profile obtained in real-world driving is defined as input to this model, a fuel consumption value of 0.2114 litres is formed. The vehicle speed, gear, engine speed, and fuel consumption graphs belonging to the virtual model correlation are shared in Fig. 5.

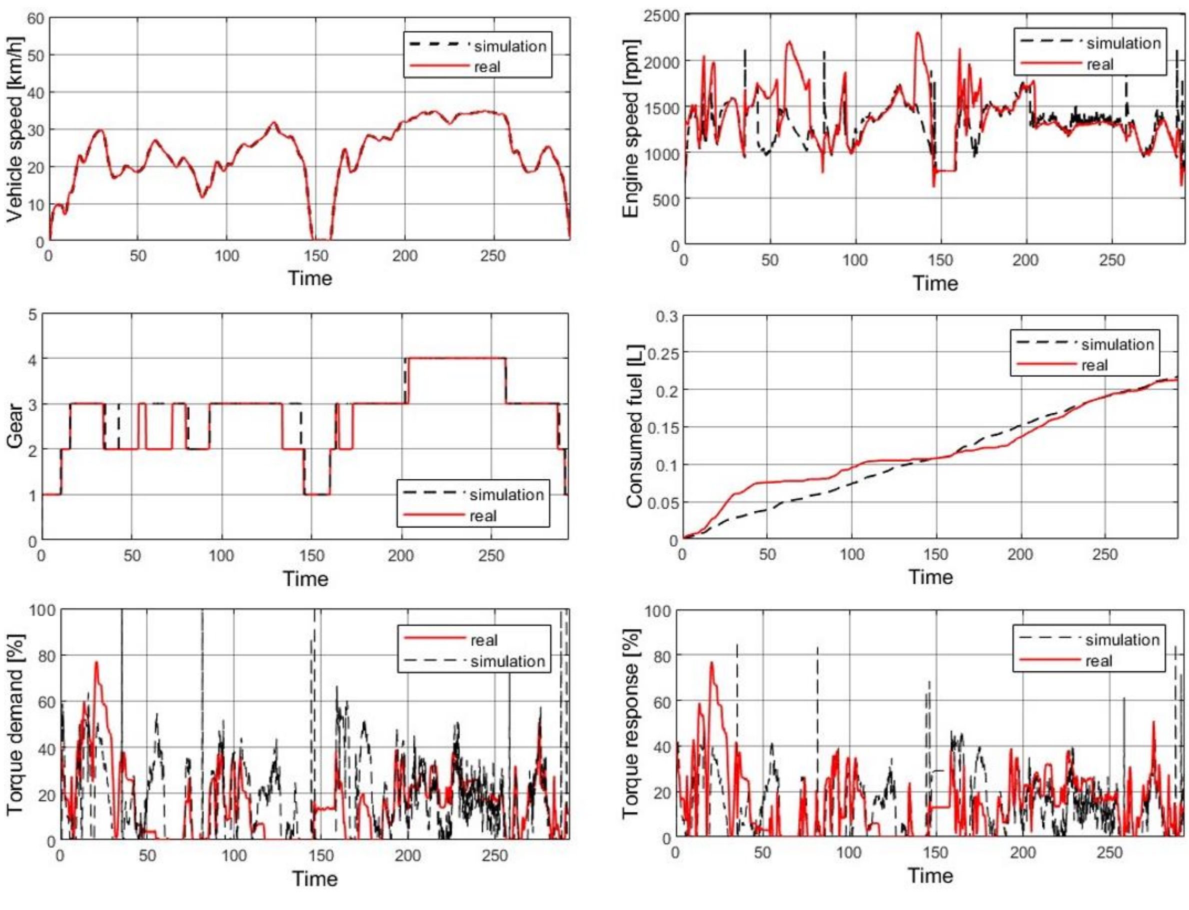

Figure 5: Virtual diesel vehicle correlation.

2.2 Electric vehicle

The battery electric vehicle is a version of the diesel vehicle with an electric drive system. Unlike diesel vehicles, there is an electric motor and a battery as energy source in the drive system. The maximum motor power is between 130 and 140 kW, and battery capacity is between 80 and 90 kWh. The electric motor transmits the torque it produces to the wheels via a 12.4 fixed transmission ratio. This vehicle configuration was driven 75.2 m in 30 seconds on a flat, windless, and concrete ground in a windless environment and consumed 0.03172 kWh of energy.

A virtual electric vehicle traction system model created in MATLAB/Simulink was prepared to include the technical specifications of a real battery electric vehicle. Similar to the virtual diesel afterburner model, vehicle performance and energy consumption outputs can be obtained with time-speed-slope data input in the electric vehicle model. In an electric virtual traction system, the driver controller produces an output signal that minimizes the error by comparing the current speed of the system and the target speed. This signal is transmitted to the Pulse Width Modulation (PWM) generator, and PWM signals are generated that control the speed and torque of the motor. The motor moves according to the PWM signal and performs braking or reverse gear functions when the operating modes are required. It converts electrical power into mechanical motion and transmits it to the transmission, differential, and wheels, respectively. Torque and motion sensors are added to the motor output line to monitor the performance of the motion transmission. With the time-speed-slope dataset input that occurs in real-world driving to the virtual electric vehicle traction system, 0.03230 kWh energy consumption occurred. These results show a sufficient correlation between the real and virtual vehicle modes. The virtual electric vehicle model is shared in Fig. 6; correlation graphs are in Fig. 7.

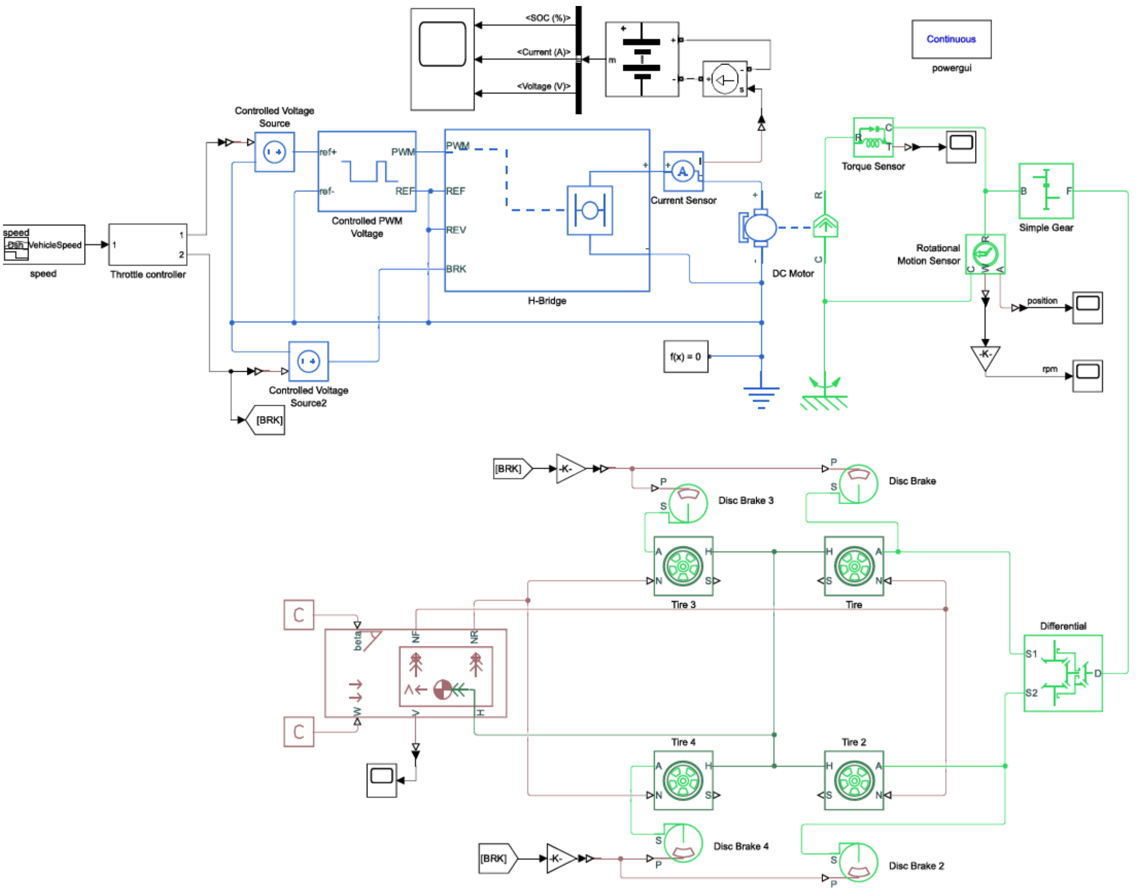

Figure 6: Battery electric vehicle virtual model.

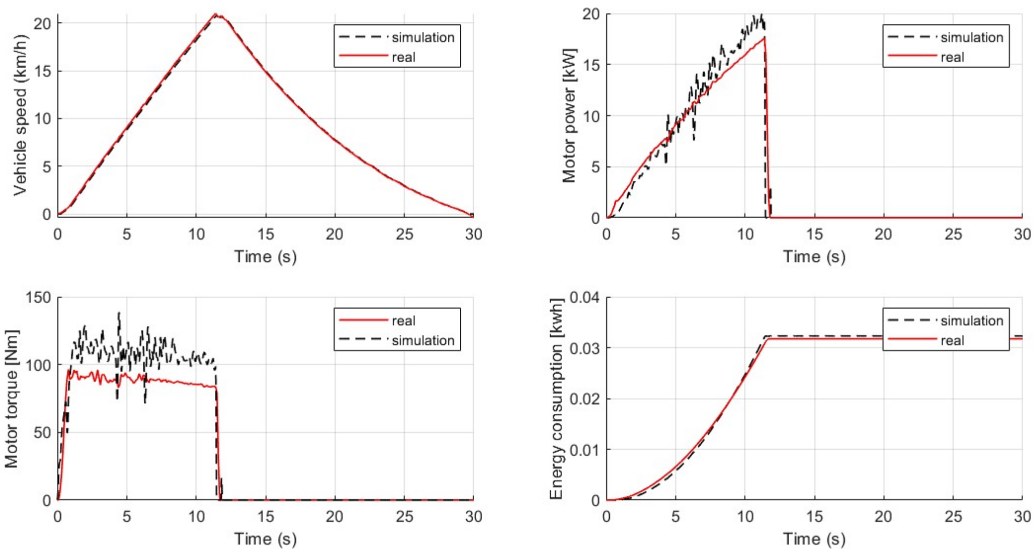

Figure 7: Virtual electric vehicle correlation.

2.3 Diesel hybrid vehicle

The diesel hybrid vehicle model is a virtual model integrated with virtual traction systems correlated with real-world driving test data. Hybrid system can be seen in Fig. 8. Diesel and electric traction systems are combined in a common torque demand (traction demand) input and motion output system. There is a driver controller that generates acceleration or deceleration demand to the time-speed-slope target. Since the study aims to investigate the effect of diesel-electric transition behaviour on consumption, 10 km/h, 15 km/h, 20 km/h, and 25 km/h vehicle speed thresholds are determined as the transition value between systems. In the acceleration condition from a standstill, the torque demand (traction demand) of the driver controller is transmitted to the electric traction system up to the threshold speed value, and the diesel traction system at speeds greater than the threshold speed. Since the reference driving cycle includes acceleration from a standstill to approximately 64 km/h (seen in Fig. 9), then deceleration and stopping conditions, only the brake system is active during the deceleration and stopping phases without any demand being transmitted to any drive system. In addition to hybrid mode transition speeds, the vehicle mass, which is a highly effective parameter in vehicle energy and fuel consumption, is also examined in the study. The virtual hybrid vehicle model was run at each speed threshold value with masses of 3500 kg, 4000 kg, 4500 kg, and 5000 kg, and the energy and fuel consumption values were recorded. The total energy consumption was calculated as the sum of diesel fuel (converted to kWh) and electric energy, referred to as equivalent energy consumption. This conversion enables the direct comparison and aggregation of energy consumed from different sources – electric and diesel – in a unified metric. In order to calculate the total equivalent energy consumption, diesel fuel was converted to kilowatt-hours using a standard energy content of 3.8 kWh per litre, representing the lower heating value (LHV) commonly used in automotive energy analyses [21]. To evaluate the consumption cost, energy amounts were multiplied by average market prices: 1.18 USD/l for diesel fuel and 0.154 USD/kWh for electricity [22, 23]. The consumption cost is the current market prices of diesel fuel and electricity, calculated by multiplying the respective energy quantities by their unit prices. The obtained values were compared with the energy consumption and consumption costs of pure diesel, pure electric, and diesel hybrid vehicles.

The acceleration performance of pure diesel, battery electric vehicle, and diesel hybrid vehicles was evaluated in addition to consumption and cost analysis. Three vehicle combinations were accelerated from rest to 50 km/h with full mass, and the acceleration time to 50 km/h was marked on the speed graphs. The diesel hybrid vehicle model was accelerated separately with 10 km/h, 15 km/h, 20 km/h, and 25 km/h hybrid transition thresholds.

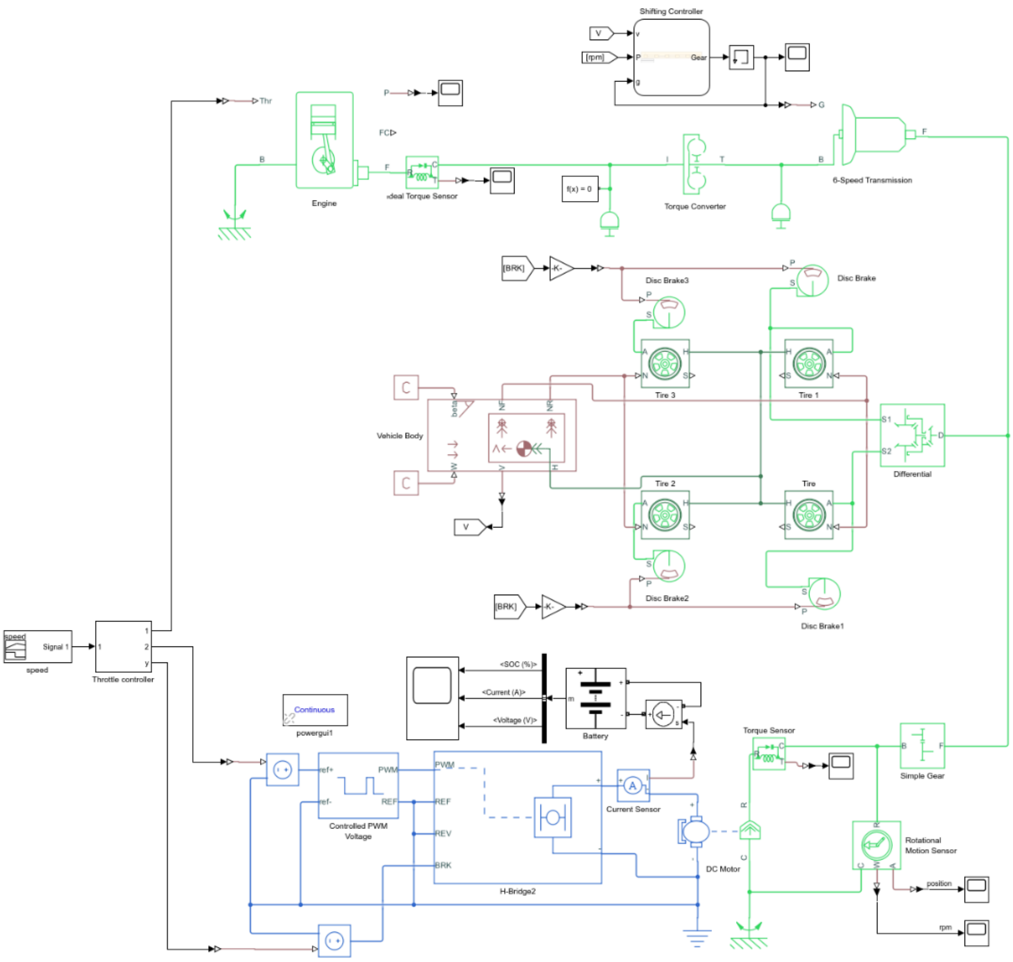

Figure 8: Diesel hybrid vehicle model.

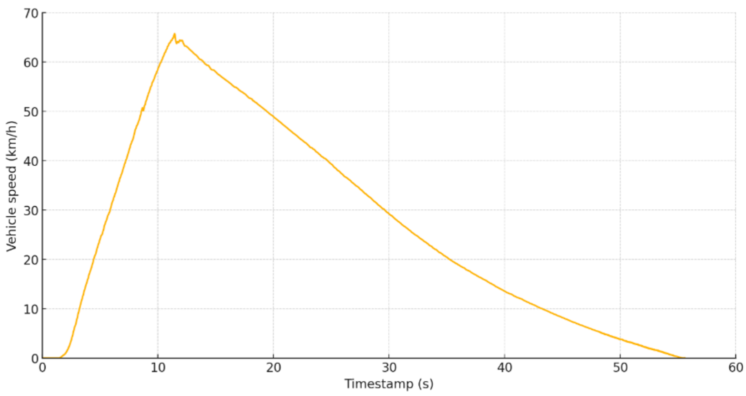

Figure 9: Reference speed profile for diesel hybrid electric vehicle.

3. RESULTS

Energy and fuel consumption, consumption cost, and vehicle performance evaluation were performed in the diesel hybrid virtual vehicle model created from diesel and electric vehicle traction systems correlated with real-world driving tests. In the study, the optimal transition speed was determined from the consumption and dynamic outputs that emerged when the diesel hybrid vehicle model, which started moving with the electric drive system from a standstill, transitioned to the diesel traction system at speeds of 10 km/h, 15 km/h, 20 km/h, and 25 km/h. The obtained results are explained with tables and visuals.

Table I includes the diesel fuel consumption in litres and energy consumption in kWh obtained by running the reference time-speed dataset by pure diesel and battery electric vehicle models. The consumption values increased in parallel with the increase in mass. Tables II, III, IV, and V include the consumptions that emerged at hybrid mode transition speeds of 10 km/h, 15 km/h, 20 km/h, and 25 km/h, respectively. In addition to the independent consumption of diesel and electric systems, the theoretical equivalent energy amount of diesel fuel consumption was calculated in kWh by using the diesel energy content, and the total energy amount in driving was obtained in kWh. As expected, the total energy consumption increased in parallel with the increase in mass in the resulting values. In addition, while diesel consumption decreased with the increase in hybrid mode transition threshold speed, electric energy consumption increased. The increase in total equivalent energy consumption with the increase in hybrid mode transition threshold speed is remarkable. Table VI shows the consumption costs by taking into account the current prices for diesel fuel and electric energy. The energy consumption resulting from the increase in mass also created a similar result in terms of cost. The result that should be noted is that the consumption cost values showed a slight decrease in the increase in hybrid mode transition threshold speed.

Table I: Consumption results of pure diesel and pure electric vehicle.

Vehicle mass (kg)	**Pure diesel consumption** (l)	**Pure electric consumption** (kWh)
3500	0.07791	0.2943
4000	0.0899	0.3307
4500	0.09841	0.3652
5000	0.106	0.3885

Table II: Consumption results with hybrid mode transition threshold 10 km/h.

Vehicle mass (kg)	**Hybrid diesel consumption** (l)	**Hybrid electric consumption** (kWh)	**Hybrid total equivalent consumption** (kWh)
3500	0.0685	0.0072	0.2675
4000	0.0810	0.0080	0.3157
4500	0.0899	0.0088	0.3504
5000	0.0971	0.0096	0.3786

Table III: Consumption results with hybrid mode transition threshold 15 km/h.

Vehicle mass (kg)	**Hybrid diesel consumption** (l)	**Hybrid electric consumption** (kWh)	**Hybrid total equivalent consumption** (kWh)
3500	0.0670	0.0148	0.2695
4000	0.0794	0.0168	0.3211
4500	0.0880	0.0187	0.3530
5000	0.0955	0.0207	0.3835

Table IV: Consumption results with hybrid mode transition threshold 20 km/h.

Vehicle mass (kg)	**Hybrid diesel consumption** (l)	**Hybrid electric consumption** (kWh)	**Hybrid total equivalent consumption** (kWh)
3500	0.0653	0.0268	0.2750
4000	0.0776	0.0303	0.3253
4500	0.0865	0.0338	0.3624
5000	0.0934	0.0374	0.3922

Table V: Consumption results with hybrid mode transition threshold 25 km/h.

Vehicle mass (kg)	**Hybrid diesel consumption** (l)	**Hybrid electric consumption** (kWh)	**Hybrid total equivalent consumption** (kWh)
3500	0.0632	0.0433	0.2855
4000	0.0754	0.0485	0.3370
4500	0.0840	0.0537	0.3730
5000	0.0905	0.0592	0.4030

Table VI: Vehicle consumption costs.

Vehicle mass (kg)	**Pure Diesel** ($)	**Pure Electric** ($)	**Hybrid mode threshold 10 km/h** ($)	**Hybrid mode threshold 15 km/h** ($)	**Hybrid mode threshold 20 km/h** ($)	**Hybrid mode threshold 25 km/h** ($)
3500	0.09193	0.04532	0.0819	0.0814	0.0812	0.0812
4000	0.10608	0.05093	0.0968	0.0963	0.0963	0.0964
4500	0.11612	0.05624	0.1074	0.1067	0.1072	0.1074
5000	0.12508	0.05983	0.1161	0.1159	0.1159	0.1159

Vehicle performance results were measured by measuring the acceleration time at a speed of 50 km/h. According to virtual measurement, diesel vehicle reached 50 km/h in 7.138 seconds, battery electric vehicle in 7.700 seconds, diesel hybrid vehicle with 10 km/h transition threshold in 6.747 seconds, diesel hybrid vehicle with 15 km/h transition threshold in 6.875 seconds, diesel hybrid vehicle with 20 km/h transition threshold in 7.158 seconds, and diesel hybrid vehicle with 25 km/h transition threshold in 7.539 seconds. According to this result, the diesel hybrid vehicle with a transition threshold of 10 km/h showed the best acceleration performance. Acceleration performance graphs of the vehicles are given in Fig. 10.

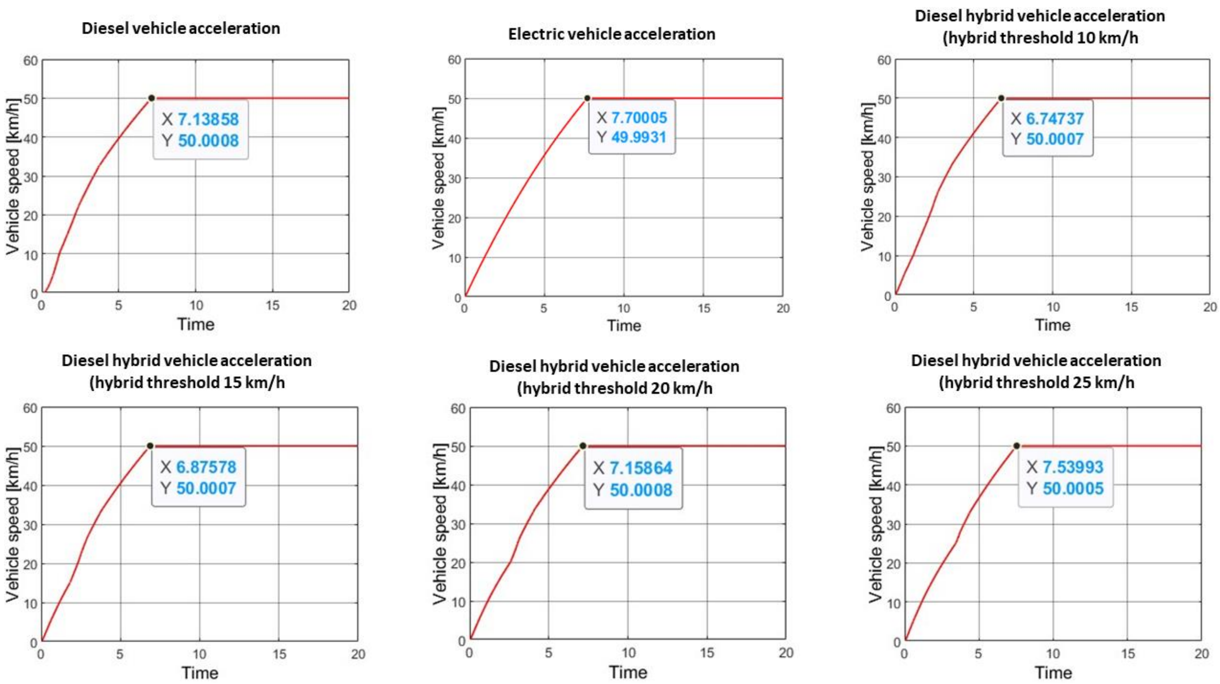

Figure 10: Vehicle acceleration performance.

4. CONCLUSION

This study investigates the energy consumption, consumption costs, and vehicle dynamic performance of diesel hybrid vehicles, positioned as cleaner alternatives to conventional diesel engines. Several key findings were revealed using virtual models created in MATLAB/Simulink and validated with real-world driving data. The findings of this study revealed clear trends that inform hybrid power strategy design. Total energy consumption and cost increased with vehicle mass across all configurations. Increasing the hybrid mode transition threshold from 10 km/h to 25 km/h resulted in a reduction in diesel consumption but a disproportionately higher increase in electric energy use and a higher total equivalent energy consumption. Among the tested strategies, the 10 km/h threshold yielded the best results in terms of energy efficiency and acceleration performance. This finding demonstrates that activating electric traction, particularly at low speeds, effectively compensates for the low-end performance limitations of diesel engines and enhances their suitability for urban stop-and-go traffic conditions. Compared to pure diesel and electric systems, diesel hybrid configurations offer significant advantages in terms of energy consumption and operating costs, while their dynamic performance is clearly superior. These results highlight the importance of transition speed calibration in hybrid power strategy design and demonstrate the value of simulation-based validation in reducing real-world prototyping requirements.

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REFERENCES

[1] Yavaş, Ö.; Savran, E.; Nalbur, B. E.; Karpat, F. (2022). Energy and carbon loss management in an electric bus factory for energy sustainability, *Transdisciplinary Journal of Engineering & Science*, Vol. 13, Spec. Issue: Current and Future Challenges in Energy Issues, 97-110, doi:10.22545/2022/00207

[2] Savran, E.; Yavaş, Ö.; Günaslan, S.; Nalbur, B. E.; Karpat, F. (2025). Comparison of energy consumption and global warming potential of electric and hydrogen-fueled vehicles across different product size, *Environmental Monitoring and Assessment*, Vol. 197, Paper 609, 13 pages, doi:10.1007/s10661-025-14060-z

[3] Alanazi, F. (2023). Electric vehicles : benefits, challenges, and potential solutions for widespread adaptation, *Applied Sciences*, Vol. 13, No. 10, Paper 6016, 23 pages, doi:10.3390/app13106016

[4] Savran, E.; Karpat, E.; Karpat, F. (2024). Energy-efficient anomaly detection and chaoticity in electric vehicle driving behavior, *Sensors*, Vol. 24, No. 17, Paper 5628, 27 pages, doi:10.3390/s24175628

[5] Salman, S.; Alaswad, S. (2020). Mitigating the impact of congestion minimization on vehicles' emissions in a transportation road network, *International Journal of Industrial Engineering and Management*, Vol. 11, No. 1, 40-49, doi:10.24867/IJIEM-2020-1-251

[6] Shrivastava, H.; Reddy, S.; Singh, U. K.; Chauhan, U.; Gupta, P. K.; Verma, S. (2023). Large-scale power transmission systems' integrated electric vehicle load modelling, *Proceedings on Engineering Sciences*, Vol. 5, No. S1, 127-136, doi:10.24874/PES.SI.01.016

[7] Altun, Y. E.; Kutlar, O. A. (2024). Energy management systems' modeling and optimization in hybrid electric vehicles, *Energies*, Vol. 17, No. 7, Paper 1696, 39 pages, doi:10.3390/en17071696

[8] Trabajovsky, P.; Puskar, M.; Sabadka, D. (2023). Simulation model of vehicle emission reduction exhaust system, *International Journal of Simulation Modeling*, Vol. 22, No. 4, 679-689, doi:10.2507/IJSIMM22-4-675

[9] Biswas, S.; Mukhopadhyay, A. (2022). Assessment of the quadruple injection strategy over triple injections to improve emissions, performance and noise of the automotive diesel engine, *Facta*

Universitatis, Series: Mechanical Engineering, Vol. 20, No. 2, 321-339, doi:10.22190/FUME210329049B
[10] Savran, E.; Karpat, E.; Karpat, F. (2024). GA and WOA-based optimization for electric powertrain efficiency, *International Journal of Simulation Modelling*, Vol. 23, No. 4, 599-610, doi:10.2507/IJSIMM23-4-699
[11] Savran, E.; Karpat, E.; Karpat, F. (2024). Fuel cell electric vehicle hydrogen consumption and battery cycle optimization using Bald Eagle Search Algorithm, *Applied Sciences*, Vol. 14, No. 17, Paper 7744, 19 pages, doi:10.3390/app14177744
[12] Minh, V. T.; Moezzi, R.; Cyrus, J.; Hlava, J. (2022). Optimal fuel consumption modelling, simulation, and analysis for hybrid electric vehicles, *Applied System Innovation*, Vol. 5, No. 2, Paper 36, 16 pages, doi:10.3390/asi5020036
[13] Khadhraoui, A.; Selmi, T.; Cherif, A. (2022). Energy management of a hybrid electric vehicle, *Engineering, Technology & Applied Science Research*, Vol. 12, No. 4, 8916-8921, doi:10.48084/etasr.5058
[14] Niu, Y.; Abdullayev, V. (2023). Design and performance analysis of hybrid electric vehicles using Matlab / Simulink, *Wasit Journal of Computer and Mathematics Science*, Vol. 2, No. 2, 60-71, doi:10.31185/wjcms.149
[15] Savran, E.; Karpat, E.; Karpat, F. (2025). Sustainable energy management in electric vehicles through a fuzzy logic-based strategy, *Sustainability*, Vol. 17, No. 1, Paper 89, 17 pages, doi:10.3390/su17010089
[16] Tian, X.; Cai, Y.; Sun, X.; Zhu, Z. (2024). Collaborative optimization of fuel economy and battery life for plug-in hybrid electric buses considering traffic condition, *Journal of Energy Storage*, Vol. 90, Part B, Paper 111928, 13 pages, doi:10.1016/j.est.2024.111928
[17] Tian, X.; Cai, Y.; Sun, X.; Zhu, Z.; Wang, Y.; Xu, Y. (2023). Incorporating driving style recognition into MPC for energy management of plug-in hybrid electric buses, *IEEE Transactions on Transportation Electrification*, Vol. 9, No. 1, 169-181, doi:10.1109/TTE.2022.3181201
[18] Li, J. (2022). Key technologies for abnormal fuel consumption monitoring of hybrid diesel engine, *Journal of Applied Science and Engineering*, Vol. 26, No. 9, 1285-1292, doi:10.6180/jase.202309_26(9).0009
[19] Dar'enkov, A.; Kralin, A.; Kryukov, E.; Petukhov, Y. (2024). Research into the operating modes of a stand-alone dual-channel hybrid power system, *AIMS Energy*, Vol. 12, No. 3, 706-726, doi:10.3934/energy.2024033
[20] Tian, X.; Cai, Y.; Sun, X.; Zhu, Z.; Xu, Y. (2019). An adaptive ECMS with driving style recognition for energy optimization of parallel hybrid electric buses, *Energy*, Vol. 189, Paper 116151, 14 pages, doi:10.1016/j.energy.2019.116151
[21] Paul, U.; Hasan, M. M.; Labib, L.; Roy, N. K. (2017). Optimal design of hybrid microgrids for readymade garments industry of Bangladesh: a case study, *3rd International Conference on Electrical Information and Communication Technology (EICT 2017)*, Paper 61383, 6 pages, doi:10.1109/EICT.2017.8275208
[22] GlobalPetrolPrices. Learning resources and data on the world economy – Diesel prices, from *https://www.globalpetrolprices.com/diesel_prices/*, accessed on 01-02-2025
[23] GlobalPetrolPrices. Learning resources and data on the world economy – Electricity prices, from *https://www.globalpetrolprices.com/electricity_prices/*, accessed on 01-02-2025