Simulation of Electric Vehicle Using MATLAB

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Abstract-*The aim of this thesis work 'Design of electrical vehicle together with different gear train elements' is to style an energy model of electrical vehicle together with different gear train components with the appliance of a design and simulation tool, that during this thesis work would be MATLAB Simulink software system. With this style and simulation, we have a tendency to search out the energy consumption by a vehicle by virtue of different forms of forces engaged on vehicle once subjected to different standard driving cycles. This work conjointly includes a survey of various vehicles that runs on electrical propulsion either solely or in assisted mode within the present market. As electrical vehicles become promising alternatives for sustainable and cleaner energy emissions in transportation, the modeling and simulation of electrical vehicles has attracted increasing attention from researchers. This paper presents a simulation model of a full electrical vehicle on the Matlab- Simulink platform to look at power flow throughout motoring and regeneration. The drive train elements contains a motor, a battery, a motor controller and electric battery controller; shapely in keeping with their mathematical equations. All simulation results are mentioned and discuss. The torque and speed conditions throughout driving and regeneration were used to verify the energy flow, and performance of the drive. This study forms the base for further analysis and development.*

Key Words:- Electric vehicle, Vehicle Body Subsystem, Motor Circuit and Controller Subsystem, Driver Input Subsystem, Battery Pack Subsystem, State of charge(SOC), Simulation

1. INTRODUCTION

These coming years, electrical vehicles were hugely created for the first time in history, and it should include more learning thoughts and experiments that are associated with that topic. Today, electrical Vehicles (EVs) are one of the technological progress results that have contributed and still contribute so as to form our lives easier and safer. As EVs don't solely consume energy but they also produce, store, and transport electricity. That's what makes them different from other fuel vehicles. Moreover, they are economical and ecofriendly compared with the standard cars that use gasoline or diesel oil .As they have a reversible energy storage device.

Electric cars on the opposite hand, were quiet, easy to drive and didn't emit unpleasant pollutants just like the alternative cars of the time. Electrical cars quickly became fashionable urban residents - especially women. As a lot of gained access to electricity within the 1910s, it became easier to charge electrical cars, also adding to their popularity.

This popularity caught the attention of many innovators. Porsche developed an electrical automotive and created the world's 1st hybrid electric car; a automotive that was power by electricity and a gas engine.. Thomas Edison believed that electrical vehicles were superior and worked to make an improved electrical vehicle battery.

With a continued increase within the adoption of electrical vehicles across the planet, charging infrastructure has become a pressing issue.

In addition to the innovation in new technology, the planning method in most of the industries has also noteworthy modify in trendy years. A style that is model-based is currently employed in aeronautic, automotive and alternative industries for compound embedded systems [12-15].Ancient style progress follows a consecutive path that involves: a) Requirements, b) Design, c) Implementation and d) check and justification or validation.

The projected Model-Based design uses models early within the feasible specifications that permit engineers to instantly justify and verify specifications against the requirements. The Engineer then shares the model that show the performance of the subsystems and parts, and so engineer uses the automated code generation capability of Simulink/Real Time and Embedded coder to help Hardware in the Loop (HIL) testing..
Simulation is a key tool that facilitates design by decreasing the cost of product progress. As the design method develops the engineer can perform Model-In-The-Loop (MIL), Software-InThe-Loop (SIL), and Hardware-In-The-Loop(HIL) development modeling to model the planning. By integration of simulation within the design process engineers can lower both design costs and design time thus aiding the companies to complete and test designed items.

2. LITERATURE REVIEW

Author Emma Grunditz, Emma Jansson Describe The Matlab/Simulink Modelling And Simulation Of The Series Hybrid Car. It is published In Chalmers University Of Technology In 2009.[1]

Paper by National Research Council 2015 U.S. Overcoming barriers to the deployment of plug-in electric vehicles. A comprehensive report addressing different aspects of EVs, including technologies, customer purchase & market development, incentives, infrastructure, and implications for the electricity sector.

Williams & Johnson 2016 California EV Consumer Characteristics, Awareness, Information Channels & Motivations tell us about Analyzes the results of a consumer survey from California electric vehicle purchase rebate recipients. Based on electric vehicle consumer data, the researchers identify who is adopting the technology, what their main sources of information are, and the motivations influencing their decision to select an electric vehicle.

3. METHODOLOGY

3.1 Block Diagram of the System

This area unit consist of many elements and a colossal network of connecting wires within the electrical vehicle. Within the case of an electrical vehicle, the standard IC engine is replaced by the motor. The operating fuel that's the battery pack is transferred to motor. The below diagram can show vital elements of the electrical Vehicle system.

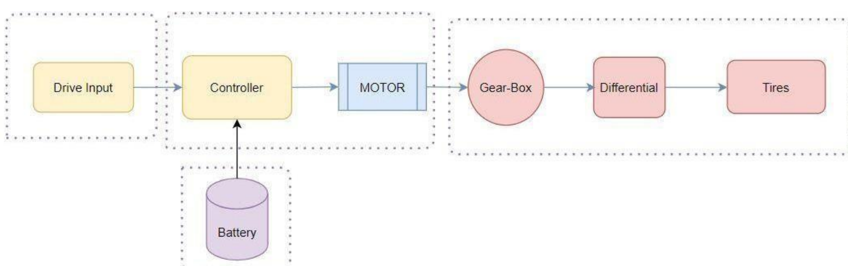

Figure 3.1: Block Diagram of the System

The key elements of electrical vehicles are the motor, vehicle body, controller, and battery pack. There are many kinds of motors utilized in electrical Vehicles. BLDC motors, Brushed DC motors, and AC Induction Motors are ordinarily used electrical motors. The vehicle body includes a case, differentials, and tires. Earlier, we have a tendency to used the battery simply to start out the engine. However currently we have a tendency to use the battery as a operating power. Mixtures of cells can produce a module, and lots of modules will form electric battery pack. The motor desires an influence offer from the battery to perform operations. Suppose we have a tendency to connect the battery pack directly to the motor. In this case, the motor can run at a rated speed, and speed management is not possible. We are able to control the speed of the motor with the help of the controller. The controller can operate by taking input from the driver.

3.2 Simulink Model

We have divided the whole simulation system into four subsystems. The primary scheme contains the vehicle body. The second scheme contains the motor and controller circuit. The third scheme contains driver input, and the fourth scheme contains the battery pack.

3.2.1 Vehicle Body Subsystem

First, we have developed a vehicle body subsystem. We have included tires, differential, gearbox, and vehicle body blocks from the Simscape library within the vehicle body subsystem. We can modify the block parameters as per our necessities. Connect tires, differential, gearbox, and vehicle body blocks to each other to form the primary subsystem.

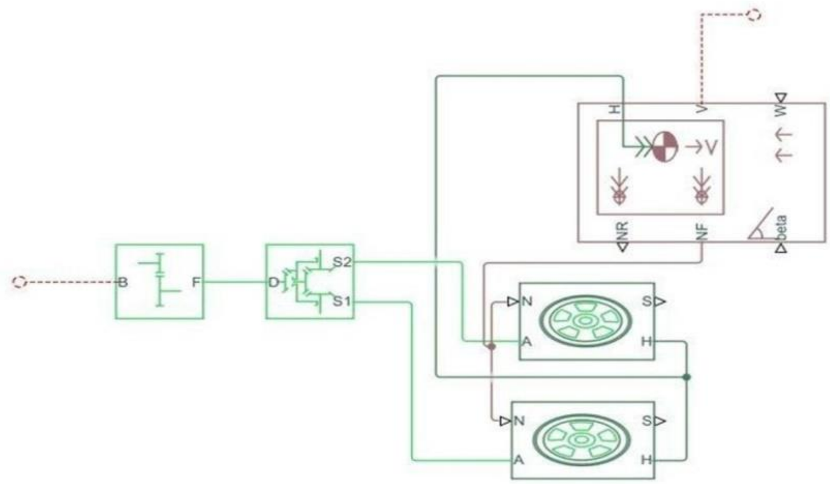

Figure 3.3: Vehicle Body Subsystem

3.2.2 Motor Circuit and Controller Subsystem

The motor will take controlled power from the battery and convert electrical power to mechanical power. The energy created is provided to the gearbox and mechanical rotational frame. To create the subsystem, we have added the motor circuit and controller block from the Simscape library. We have used an easy DC motor, and to regulate the DC motor, we have used an H-bridge controller. With the assistance of H-bridge controller bridge, We can apply acceleration, slowing, and breaking. To regulate the PMW wave, we have added a controlled PWM voltage block. we can modify the block parameters as per our necessities. The below diagram will show connections between each block to create a subsystem.

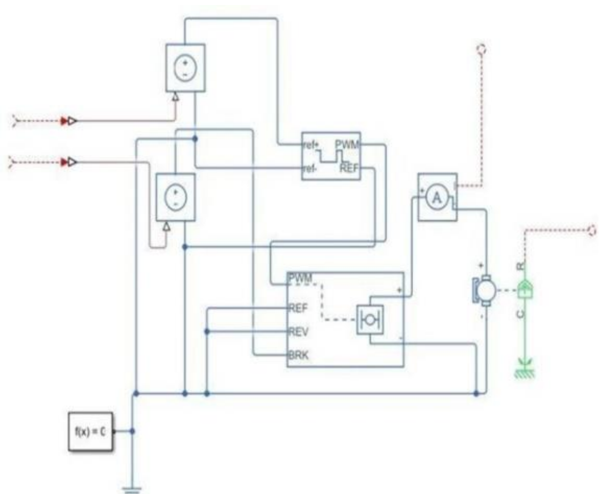

Figure 3.4: Motor Circuit and Controller Subsystem

3.2.3 Driver Input Subsystem

Longitudinal driver block from the powertrain block library produces normalized acceleration and braking commands depend on reference and feedback speeds. Reference rate are given by the inbuilt drive cycle or we can generate our own signal by making use of the signal builder block. Feedback speed is taken from actual vehicle speed. Based on the distinction between the reference signal and also the actual speed error will be generated. The error made will end in acceleration or retardation so the vehicle's actual speed will attempt to match the reference speed. We have used the longitudinal block and Signal Builder block to make the Drive Input subsystem. The diagram below displays the connection between the blocks.

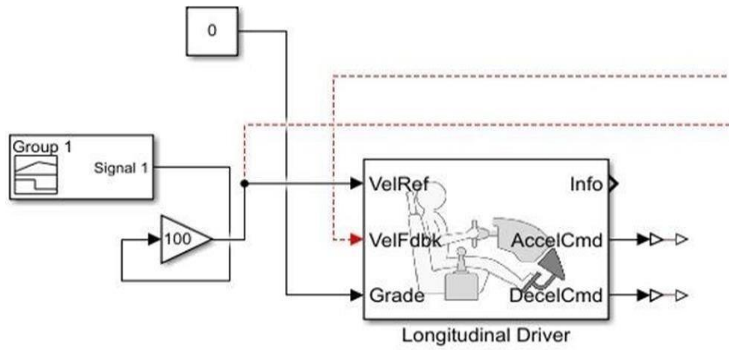

Figure 3.5: Driver Input Subsystem

3.2.4 Battery Pack Subsystem

The battery pack will offer power to the motor. Calculation of State of Charge (SOC) would provide information regarding how much we can drive before recharging and how much time we are able to use an existing battery. We have used a lithium-ion battery to see the SOC percentage directly. Battery charging and discharging can examine with the help of SOC. The below diagram can show connections between each block to create a subsystem.

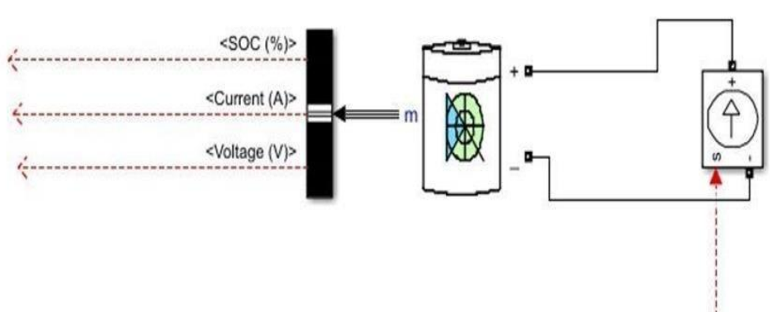

Figure 3.6: Battery Pack subsystem

3.2.5 Overall model

Add power interface block to Simulation. Add scope and display block to look at outputs and behavior of the electrical Vehicle model. With the assistance of the signal builder block, we have created a reference signal. The reference signal and actual speed on identical graph will justify how the feedback loop is functioning. we can additionally calculate the average speed of the electrical vehicle. With the SOC graph's help, we can analyze battery charging and discharging throughout deacceleration and acceleration command, respectively. The software model in below fig. will show the overall electrical Model that we have used to examine the vehicle's SOC percentage and average speed.

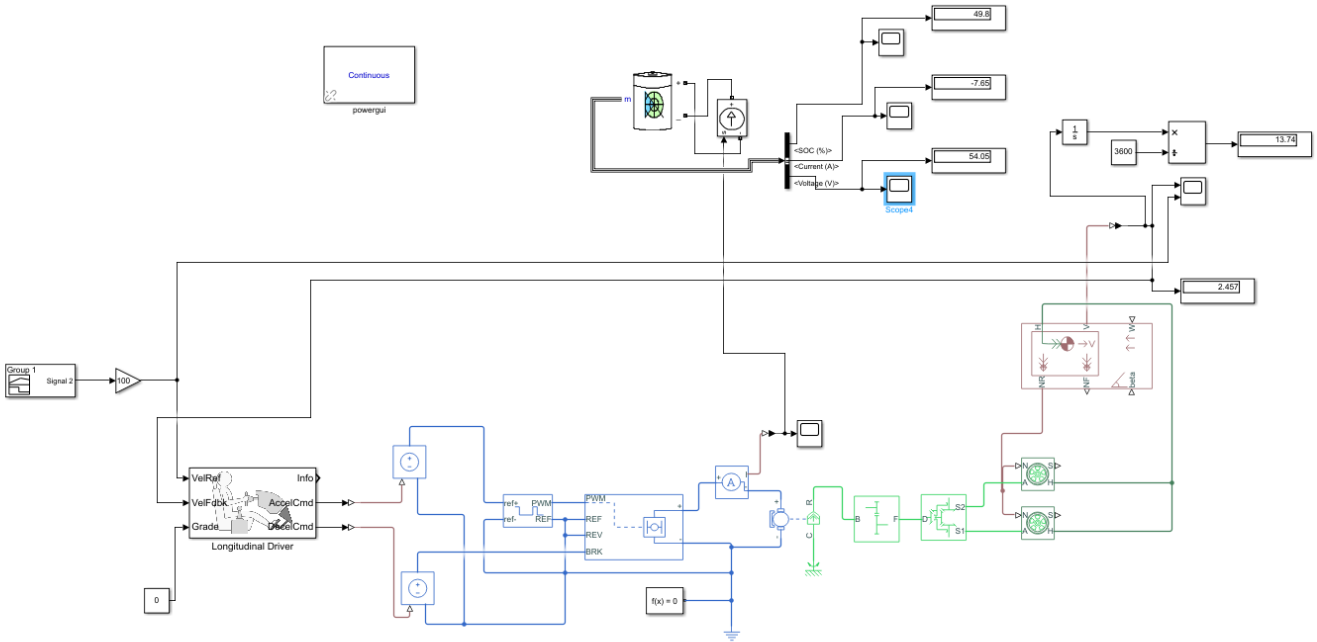

Fig. Software Model

4. RESULT

First, with the help of the signal builder block, we have created reference speed. We have elect a high speed of hundred kilometers per hour. We have been simulating the model for one thousand seconds. The speed will increase for the first four hundred seconds. The speed remains constant for next two hundred seconds, and the speed decreases for the remaining four hundred seconds. The below Image will show the reference signal that we generated with the signal builder block's help.

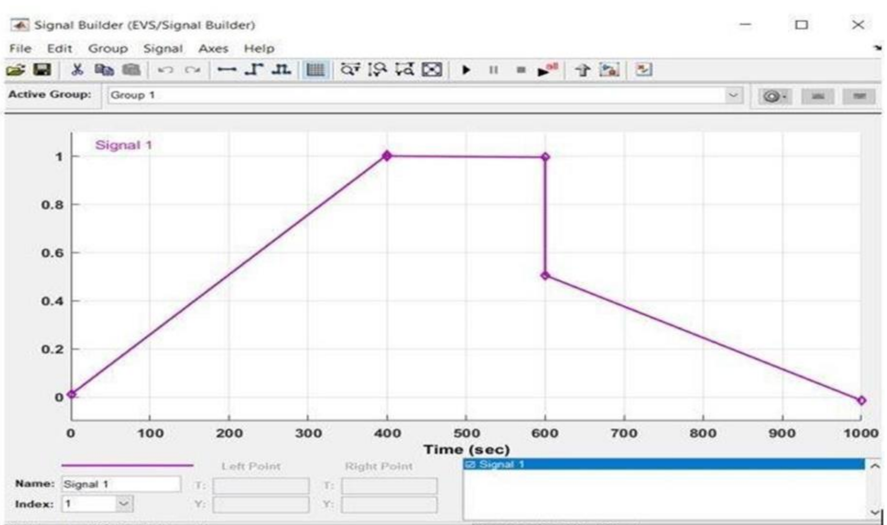

Fig. Generated Input Signal

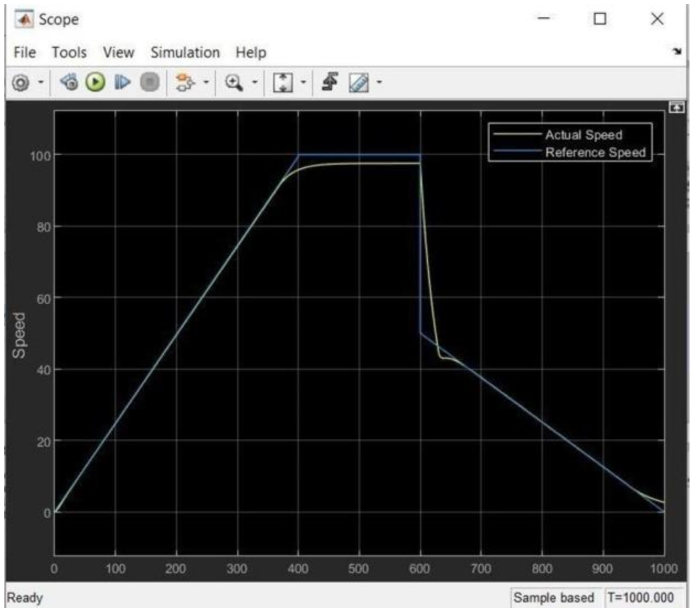

Figure 4.2: Graph of SOC %

The below graph will show how the vehicle's actual speed is following the reference speed ofthe input drive cycle

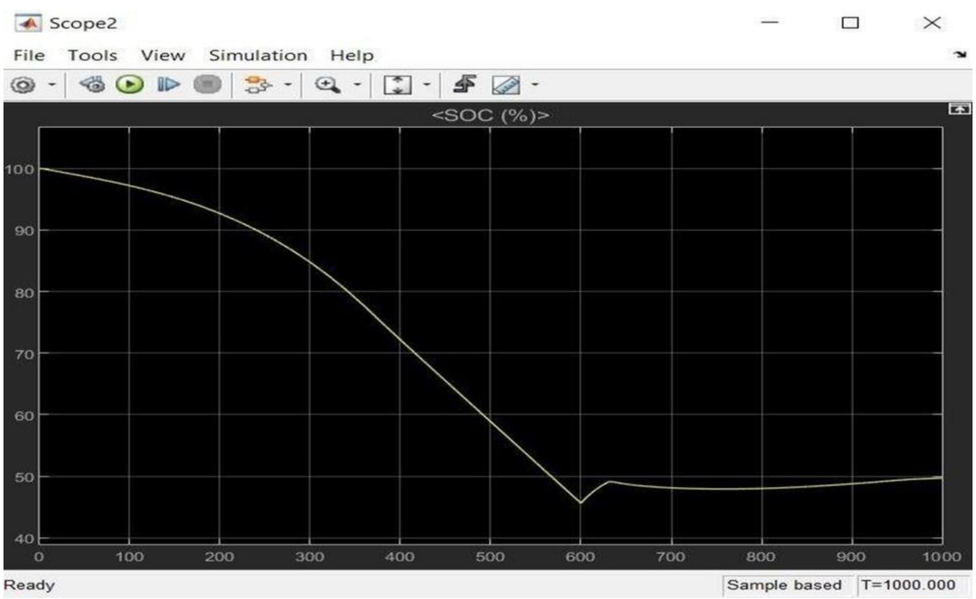

Figure 4.3: Actual Speed and Reference speed on the same graph

Suppose we calculate the average speed for 1,000 seconds. In that case, it is approximately equal to the average speed that we got in the graph.

5. CONCLUSION

Modeling and simulation in Matlab-Simulink has been shown to be of nice worth in investigation the energy flow, performance and efficiency of the electric vehicle drive train. During this study, the simulation was performed and analyzed in both motoring and regeneration mode. The operation mode of the motor is determined either by the road speed and torque needs or by the polarity of the motor current and voltage. The energy flows from the battery to the load during motoring however in the opposite direction

during regeneration. The EV's performance depends on the performance of the controller in removing error from the system. This work utilized an easy controller to maintain the identical input–output power of battery and also the P-I controller to catch up on the voltage error. The design of the electric vehicle shown in this paper is a basic model. Modeling and simulation are vital for automotive designers in order to find out the simplest energy control strategy and actual part size, and to minimize the employment of energy, because prototyping and testing are costly and sophisticated operations.
We have determined the SOC percentage and speed graph. The SOC percentage graph indicates that the battery is discharged once there is an acceleration command. The battery is charged once there is a deacceleration command. The Speed graph indicates that the actual speed tries to meet the reference speed by considering feedback. The model shows that the electrical vehicle has traveled around fourteen kilometers in one thousand seconds. If we calculate the average speed, the vehicle will travel around fifty kilometers per hour. This determined average speed is approximately equal to the average speed found on the graph.
In the future, we are able to build electrical vehicles hopped-up by alternative energy like solar energy.
Conventional fuel features a high calorific value than batteries. Still, the battery conversion efficiency is more than fuel. If we use hybrid technology, it would have lot of potential and efficiency. If we are able to replace current fuel-based transport with electrified transport, this would create an enormous advantage for the ecosystem.

REFERENCES

[1] W. Kempton and J. Tomić, "Vehicle-to-grid power fundamentals: determinative capability and internet revenue," Journal of Power Sources, vol. 144, no. 1, pp. 268-279, 2005.
[2] R. Gadh, S. Mal, S. Prabhu, C.-C. Chu, J. Panchal, O. Sheikh, C.-Y. Chung, L. He,B. Xiao and Y. Shi, sensible electrical vehicle (ev) charging and grid integration equipment and ways, 2012.
[3] S. Deilami, A. S. Masoum, P. S. Moses and M. A. S. Masoum, "Real-Time Coordination of Plug-In electrical Vehicle Charging in sensible Grids to cut back Power Losses and Improve Voltage Profile," IEEE Transactions on sensible Grid, vol. 2, no. 3, pp. 456-467, 2011.
[4] F. Musavi and W. Eberle, 'Overview of wireless power transmit technologies for electrical vehicle battery charging,'Iet Power physical science, vol. 7, no. 1, pp. 60-66, 2014.
[5] K. Chau, C. Chan and C. Liu, 'outline of Permanent-Magnet Brushless Drives for electrical and Hybrid electrical Vehicles," IEEE Transactions on Industrial physical science, vol. 55, no. 6, pp. 2246-2257, 2008.
[6] C. C. Chan and K. T. Chau, trendy electrical Vehicle Technology, 2001.
[7] K. Qian, C. Zhou, M. Allan and Y. Yuan, "designing of Load Demand thanks to electrical vehicle Battery Charging in Distribution Systems," IEEE Transactions on Power
[8] J. A. P. Lopes, F. J. Soares and P. M. R. Almeida, "Integration of electrical Vehicles within the electric power System," Proceedings of the IEEE, vol. 99, no. 1, pp. 168- 183, 2011.
[9] O. Tremblay and L. A. Dessaint, "Experimental confirmation of battery dynamic model for electrical vehicle applications,' World electrical Vehicle Journal, vol. 3, no. 2, pp. 289-298, 2009.
[10] O. Khitirosai and that i. Tetsukhiro, ELECTRICALLY DRIVEN VEHICLE AND electrical power FEEDER FOR aforementioned VEHICLE, 2013.
[11] Z. Zhu and D. How,Electrical Machines and Drives for electrical, Hybrid, and electric cell Vehicles," continuing of the IEEE, vol. 95, no. 4, pp. 746-765, 2007.
[12] D. B. Richardson, "Electric vehicles and also the electrical grid: Analysis of modelling approaches, Impacts, and renewable energy integration," Renewable & property Energy Reviews, vol. 19, pp. 247-254, 2013.