at all times. Aoun, Kunz, and Ture [23] demonstrated a transportable high-efficiency dynamic DMFC structure. This setup doubled the effectiveness of the power transformation process by using a smart batteries as a reserve for buck-boost converters and the fuel cell.

As can be seen in **Fig 7**, hybrid sources integrate the high energy efficiency of battery with the higher power density of fueling cells with the goal to lengthen the lifespan of portable electronics. Synchronization boost converters are wired in series with fuel cells to enhance the voltage to DC standard (bus) (3V for electrical device). In practical implementations, fuel cells connected in series will provide input voltages of 2 to 4 V at full-load, with power regulation of the battery pack handled by an H-bridge buck-to-boost converters. H-bridge buck-to-boost converters are analogue in design, allowing them to switch between boost and buck modes reliant on the battery's state of charge.

IV. LIMITATIONS OF CURRENT DC CONVERTERS

The input current will increase until the boost converter's power lowers if the outputs power is too high. This will cause considerable losses and a decrease in efficiency. Because of this, the voltage across the diode drops significantly. If the diode is replaced with a switching element in low-voltage applications, as shown in **Fig. 8**, the resulting design is a synchronous DC-DC boost converter. During the transition from M1 off to M2 on, a shoot-through current may be generated; hence, a time delay is necessary in this circuit. This minimizes the power loss caused by the voltage drop across M2.

When PWM control was used for the higher-load situation and PFM controls were employed for low-load situation, significant efficiency gains were possible over the entire load range. To a certain extent, the load determines the amount of energy lost during conversions and switching. Boost converters have a big drawback in that they produce a lot of switching noise. As the fuel cell's voltage of the output is impacted by this noise, its performance suffers each time the switching element is activated and deactivated. A soft switching approach, which employs snubber circuit design at every switch, an extra electromechanical interface at the converter input and output, and so on, may all help to prevent this issue from occurring.

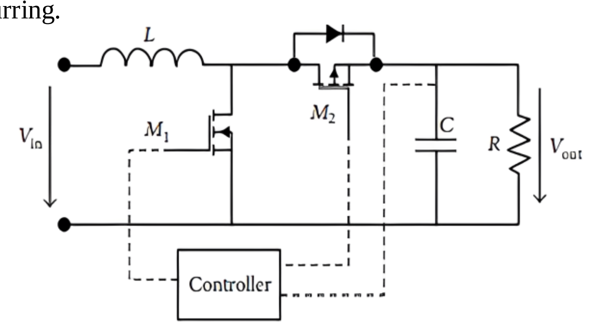

Fig 8. Synchronous DC-to-DC boost Converter Architecture

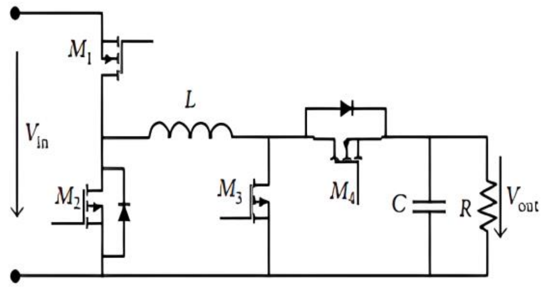

Fig 9. Non-inverting buck-to-boost Converter Architecture

To accomplish the same increment in output voltage, the converter of the buck-to-boost switching frequency must be greater than that of the power converter. However, the buck-boost converter is minimally economical compared to the power converters because higher duty periods enhance transmission and distribution losses in the frameworks. It's also not a good idea since the voltage level polarity is the opposite of the voltage at the source. One potential solution to this problem is a buck-to-boost converter with non-inverting input. It is indicated in **Fig 9** that the boost converter and the buck converter may be cascaded to form a non-inverting buck-boost design. Switches are more efficient than diodes for low-voltage applications. As with the boost multilevel inverters, this one is affected by the noise of switching. Employing the converter with higher switching frequencies improves efficiency without increasing the complexity or expense of the power cooling systems. Conventional hard-switched PWM has limitations including high transistor stress, high switching inefficiencies, and undesirable EMI. Soft-switching PWM technologies are being employed for the frequency of high-switching operation with high conversion effectiveness and larger volume-to-power percentages.

V. RECENT GROWTH IN DC-DC CONVERTERS AND LEVS

Concerns about the negative impacts of burning fossil fuels have prompted a global shift toward environmentally friendly technologies. The usage of electric cars is an area of green technology that shows promise (EVs). By the end of 2021, it is predicted that there will be around 16.5 million electric vehicles (EVs) on the roads worldwide. This includes both BEVs (battery electric vehicles) and PHEVs (plug-in hybrid electric vehicles). According to the Stated Policies contexts, the EVs number in the world is projected to reach about 200 million by 2030. Light electric vehicles (LEVs), such as scooters and mopeds, are on the rise. This is because they are convenient for public transportation and relatively small in size, both of which are important for nations working to decrease their carbon impact.

As an added bonus, such cars may be charged using a standard household AC power socket. Three-wheeled e-bikes in the Netherlands and e-rickshaws in India are two well-known applications of LEVs. Due to their slow pace, short daily travel, and huge volume, three-wheeled vehicles in India offer enormous potential for electrification. The result is an increase in the popularity of three-wheeled e-rickshaws in metropolitan areas, which were formerly dominated by autorickshaws powered by Compressed Natural Gas (CNG). **Fig 10** displays the percentage of LEV sales in different countries. This pattern makes it clear that nations like China and India have accounted for a disproportionately large number of sales of two- and three-wheeled LEVs.

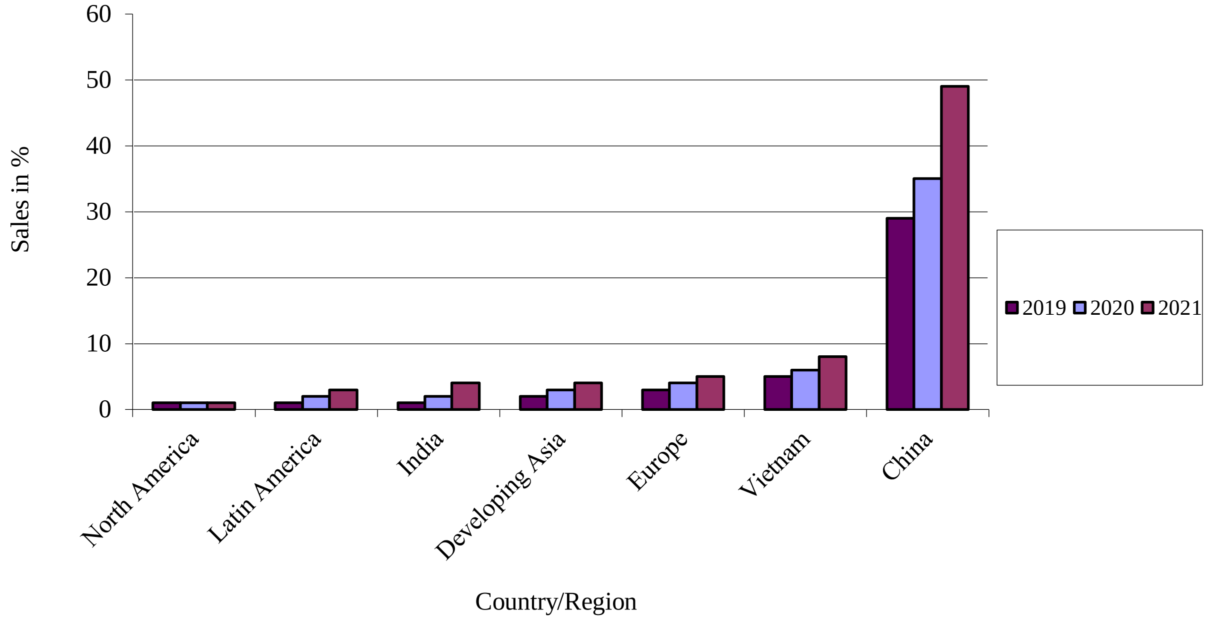

Fig 10. Trends of electric cars in Different Countries Development from 2019-2021

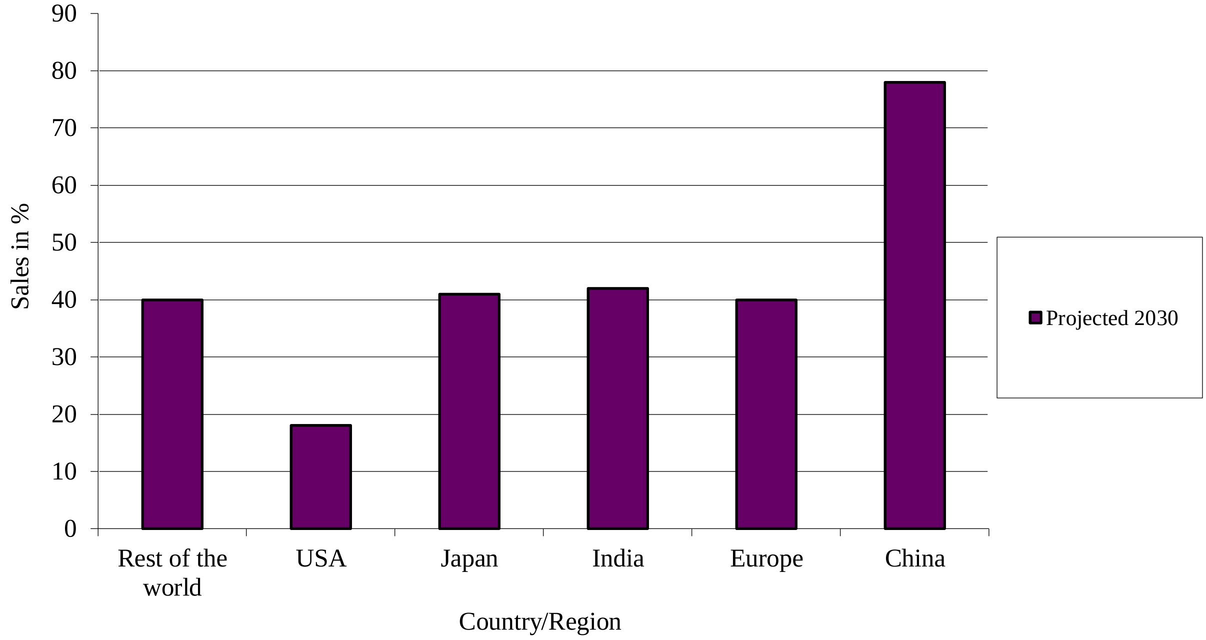

Fig. 11: Trends of electric cars in Different Countries Forecasted sales by 2030

Fig 10 shows the trends of electric cars in different countries illustrating the development from 2019-2021 **Fig. 11** shows forecasted sales by 2030. It is crucial to strengthen and expand the LEV charging infrastructure to keep up with the growing number of these vehicles. **Table 2** provides a selection of the LEVs now on the market. This table shows that the typical voltage for LEV batteries is between 48 and 72V, and the maximum available ampere-hours (Ah) is up to 180. So, unlike other types of EVs, LEVs just need a simple connection to a household's AC supply in order to be charged. As this is the case, LEVs have less complicated charging needs than conventional EVs. One other important lesson from this chart is that the majority of the cars listed have a regular charge time of 3 to 5 hours, with just a select handful able to use rapid charging. It follows that producers of two- and three-wheeled EVs need to make ready access to rapid charging a top goal. While recent publications have touched on LEV charging in some way, there is a dearth of effort that is categorically dedicated to the charging of LEV. In contrast to the extensive discussions of DC-DC converter architectures for the charging of EV seen in other papers, an overview of DC-DC converters is lacking for LEVs.

Table 2. Prevailing LEVs and Battery or Charging Specifications

Wheelers	Models	Batteries Type	Voltages	Capacities	Duration of Charge	Fast Charging
2-Wheeler	Athers 450-Plus	Li-ion	51V	3.7kWh	5 hours 50 Minutes	1 to 2 hours
	Okinawa PraisePro	Li-ion	72V	2kWh	2 to 5 hours	-
	Hero-Electrical Optima-CX	Li-ion	51V	30Ah	4 to 5 hours	-
3-Wheeler	Terra Motors Y4A	Lead Acid	48V	140Ah	6 to 8 hours	-
	Fixed Battery/Pioggio Ape E City	Li-ion	48V	8kWh	3 hours 45 minutes	-
	Mahindra Treo	Li-ion	48V	7kWh	3 hours 50 minutes	-

Fig 12 depicts a typical soft-switched boost converter consisting of a boost switch S1, a boost diode D2 and a boost inductor Ls. Nevertheless, Barote and Marinescu [24] suggested that the effectiveness of converters could be enhanced by adding an auxiliary network. A pair of inductors L1 and a diode D1 makes up the auxiliary network.

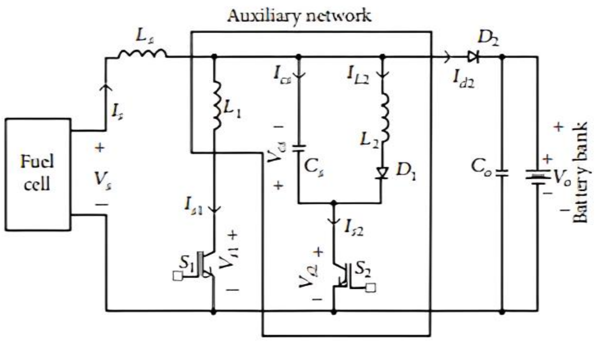

Fig 12. Novel soft-switched DC-to-DC boost converter

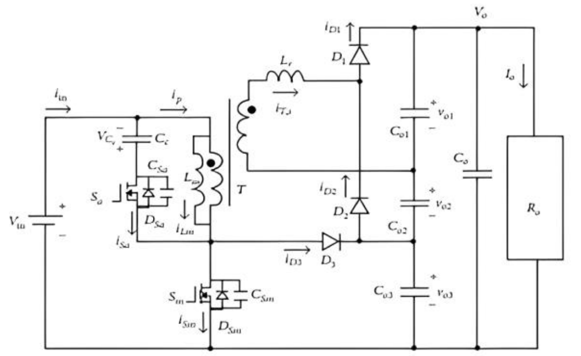

Fig 13. Novel zero-voltage switch DC-to-DC coverter

In addition to L2, a single snubber capacitor Cs is also required. This converter operates in seven different modes, with higher effectiveness (more than 95% full-load) being recorded. Adjusting the pulse width of switch S1 in the center of the converter permits users to effectively determine the voltage at its output. **Fig 13** shows a proposed unique zero-voltage switching DC-to-DC converters by Chen et al. [25] for renewable energy conversion systems, which makes use of a voltage source inverter and a doubler- voltage system composed of coupled inductor. When an active switch is employed, a voltage stress is created. An active snubber is employed to minimize this stress and emit energy that is stored in magnetizing and permeability inductances. In order to provide a high output voltage, the adopted converters in a conventional boost converter has a lengthy turn-off time. When active switches are modulated with an asymmetrical pulse-width, their inductances and output capacitance both have resonant frequencies during the transition interval. As both switchers activate at zero-voltage switching, the inefficient circuit and fast turn off time of a conventional boost converter are rendered unnecessary.

Recently, Shneen, Aziz, Abdullah, and Shaker [26] introduced a Pulse-Width Modulation (PWM) that is unique soft-switched quadratic boost converter, which operates with a DC input voltage of varying magnitude. Parasitic components in the unadventurous PWM DC-to-DC boost-converter limit the voltage gain even under extreme conditions of duty cycle, rendering it unusable in practical applications. To accommodate the broad DC input output voltages of fuel-cell systems, a novel soft-switched channel width-modulated exponential boost converter was developed. With a 92.3% efficiency rate, this converter is very effective. Vacheva, Genev, and Hinov [27] have introduced a brand new push-pull DC-DC converter that is fed by a zero-voltage switching current. Using this method, the voltage spike between the switches during the turn-off event is absorbed by an auxiliary circuit, resulting in a no-voltage switching state. With its size and weight reduced, the converter's efficiency has increased. Operating at high frequencies is needed to minimize the dimension of the inducement component and other reactive elements, which in turn reduces the converter's total size and weight. This converter is determined by the width of the pulse modulation and employs a simplified circuit. The maximum operating frequency of this converter exceeds that of a standard current-fed converter, allowing it to be used at higher frequencies. This converter employs a clamp circuit to smooth down the switching transition and eliminate [28] any harsh voltage changes that might damage the power semiconductor components. The converter's size and cost are decreased when compared to standard converters due to the use of a single input inductors and the absence of a clamp winding [29].

VI. CONCLUSION AND FUTURE RESEARCH

DC converters of different topologies have a significant contrition to the widespread application of renewable energy sources, especially in portable and self-contained applications. The review explains how DC converters might assist fuel cells more effectively transfer power to loads. A DC converter or group of DC converters may be used to remedy problems associated with unregulated voltage, poor current density, low voltage, and unstable power. When using fuel cells, it is recommended that you pair them with a composite DC converter that can steady the power conditioning from a battery, super-capacitors, or other external sources. According to this breakdown, the switching technique is what really makes a DC converter tick. By using a soft-switching technique, DC converters may increase their efficiency and density of power. The DC converter of PCU may use a single-stage design or a more complex multi-stage architecture. In single-phase topologies, DC converters are used without any further AC inverters or the DC converters, but in multi-stage topologies, they are used in conjunction with each other. In sum, the architecture of the DC converter design is crucial for fuel cell systems. Further study is needed to develop unique topologies for DC converters, which might also incorporate novel switching approaches, to accomplish a higher level of efficiency and enhance the present switching strategy. Fuel cell devices are widely sought after for certain mobile applications because to their small size and high energy density. Due to their ability to satisfy size and the standards of energy density, DMFCs (direct methanol fuel cells), DBFCs (direct borohydride fuel cells) are the focal domain of compacted fuel cell research. Fuel cells, such as DMFCs and DBFCs, are an alternative source of energy for portable electronics thanks to advances in power converter technology.

Data Availability

No data was used to support this study.

Conflicts of Interests

The author(s) declare(s) that they have no conflicts of interest.

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Ethics Approval and Consent to Participate

The research has consent for Ethical Approval and Consent to participate.

Competing Interests

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