

Polymer Electrolytes for Advanced Energy Storage Battery Systems: Potential Applications in ISRO and their Role in Achieving Viksit Bharat @2047

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Abstract-- Energy storage is a critical technology for India's future space exploration, renewable energy integration, electric mobility, and energy security. Polymer electrolytes have attracted significant research interest because of their potential to improve battery safety, flexibility, interfacial compatibility, and suitability for advanced solid-state battery architectures. This paper reviews the fundamental principles, types, materials, advantages, limitations, and potential applications of polymer electrolytes in advanced battery systems. Particular attention is given to their possible relevance to the Indian Space Research Organisation (ISRO), where batteries must operate reliably under demanding conditions involving temperature variations, vibration, vacuum exposure, and long-duration operation. The paper also examines the relevance of polymer-electrolyte research to Viksit Bharat @2047, especially through renewable energy storage, indigenous battery manufacturing, electric transportation, and technological self-reliance. Materials such as polyethylene oxide (PEO), polyvinylidene fluoride (PVDF), polyacrylonitrile (PAN), and polymer-ceramic composite electrolytes are discussed as candidate systems for further investigation. However, polymer electrolytes are not automatically superior to conventional liquid electrolytes, and their performance depends on ionic conductivity, electrochemical stability, mechanical strength, interface compatibility, and operating temperature. A proposed research framework is presented to evaluate these parameters experimentally. The paper concludes that developing locally manufactured, safe, durable, and application-specific polymer electrolytes could contribute to India's advanced energy-storage capabilities, provided that the technology undergoes rigorous laboratory, environmental, and system-level validation.

Keywords-- Polymer electrolyte; solid-state battery; lithium-ion battery; solid polymer electrolyte; composite polymer electrolyte; ISRO; space energy storage; renewable energy; battery safety; indigenous technology; Viksit Bharat @2047; energy security.

I. INTRODUCTION

Energy storage technologies are essential for modern scientific research, industrial development, and sustainable energy systems.

The increasing use of solar and wind power, electric vehicles, communication satellites, and space exploration systems has created a need for batteries that provide high energy density, long service life, reliable performance, and improved safety. Conventional lithium-ion batteries have become important because of their high specific energy and good cycling performance. However, many conventional lithium-ion batteries use flammable liquid electrolytes, making thermal management, cell protection, and failure prevention essential parts of battery design [1, 2].

Polymer electrolytes are promising alternatives or components for next-generation electrochemical energy-storage systems. They contain polymer chains and mobile ions that enable ionic conduction between the electrodes. Depending on their composition, they can be developed as solid films, gel-like materials, or polymer-ceramic composites. These systems offer opportunities to improve mechanical flexibility, control electrolyte leakage, simplify certain cell architectures, and establish intimate contact with electrode surfaces [1, 3].

The development of polymer electrolytes is particularly relevant to India because the country has growing requirements for reliable electricity storage, advanced transportation batteries, and indigenous electrochemical technologies. The Ministry of New and Renewable Energy reports that India's projected energy-storage requirement could reach 2,380 GWh by 2047, based on the Central Electricity Authority's National Electricity Plan 2023 projections [4]. This long-term requirement highlights the importance of research into diverse storage technologies rather than dependence on a single battery chemistry.

Another important application area is space technology. ISRO's satellites, spacecraft, scientific instruments, and exploration missions require dependable electrical power. Batteries are particularly important when solar generation is unavailable or insufficient. Space batteries must meet stringent requirements for mass, reliability, thermal behaviour, lifetime, and resistance to mission-specific environmental stresses [5].

Nevertheless, the potential relevance of polymer electrolytes to ISRO should be distinguished from confirmed operational use. Publicly available information does not establish that a particular polymer-electrolyte formulation is routinely used in ISRO's operational batteries. Therefore, this paper considers polymer electrolytes as a potential research and development pathway for future Indian space-energy systems, not as a claim about ISRO's existing battery technology.

The central objective of this paper is to examine how polymer-electrolyte research can support advanced battery development for space applications and terrestrial energy storage while contributing to the broader vision of Viksit Bharat @2047.

II. OBJECTIVES OF THE STUDY

The main objectives are:

1. To explain the scientific principles and classifications of polymer electrolytes.
2. To examine candidate polymer materials and their suitability for advanced batteries.
3. To identify the requirements of space-energy storage systems and potential research applications relevant to ISRO.
4. To investigate the potential contribution of polymer electrolytes to renewable energy storage, electric mobility, and indigenous battery manufacturing.
5. To identify technical challenges and propose an experimental framework for future research.
6. To develop a research roadmap aligned with India's long-term energy-security and technological self-reliance objectives.

III. FUNDAMENTALS OF POLYMER ELECTROLYTES

3.1 Definition

A polymer electrolyte is an ion-conducting material in which a polymer matrix supports the movement of mobile ions. In rechargeable lithium batteries, lithium salts supply lithium ions, while the polymer environment influences ion dissociation, mobility, and transport.

In a conventional liquid-electrolyte battery, ions move through a liquid solution held between the electrodes. In a solid polymer electrolyte, ion transport occurs through a polymer-based solid material. In a gel polymer electrolyte, a polymer network retains a liquid or plasticized electrolyte phase. Composite polymer electrolytes combine a polymer matrix with inorganic particles or other functional components.

The suitability of a polymer electrolyte depends on more than ionic conductivity. It must also provide sufficient mechanical integrity, electrochemical stability, electrode compatibility, and manufacturability [1, 3].

3.2 Working principle

During battery charging and discharging, ions move through the electrolyte while electrons travel through the external electrical circuit. In a lithium-ion battery, lithium ions move between the anode and cathode according to the direction of the electrochemical reaction.

A polymer electrolyte performs three principal functions:

- It transports mobile ions between the electrodes.
- It electronically separates the electrodes to prevent direct short-circuiting.
- It provides an environment in which electrode-electrolyte reactions and interfaces can be controlled.

In many polymer electrolytes, ionic transport depends on polymer-chain segmental motion, salt concentration, temperature, crystallinity, and the interactions between ions and polymer functional groups. For example, oxygen atoms in polyethylene oxide can coordinate lithium ions. Local movements of the polymer chains can help those ions move through the material [1, 3].

The overall battery performance is therefore governed by the interaction between the polymer structure, conducting salt, electrode materials, and operating conditions.

3.3 Types of polymer electrolytes

A. Solid polymer electrolytes (SPEs)

Solid polymer electrolytes contain a polymer matrix and a conducting salt without requiring a free-flowing liquid phase. They are attractive for solid-state batteries because they can reduce leakage risks and offer flexible film processing. However, some conventional formulations have low ionic conductivity at room temperature and insufficient mechanical resistance to electrode-related degradation.

B. Gel polymer electrolytes (GPEs)

Gel polymer electrolytes contain a polymer framework that holds a liquid electrolyte or plasticizing phase. They can provide relatively high ionic conductivity and good electrode contact. Their performance and safety depend on the retained liquid, its volatility and flammability, and the stability of the gel structure. Consequently, a gel polymer electrolyte should not automatically be described as a fully solid or non-flammable electrolyte.

C. Composite polymer electrolytes (CPEs)

Composite polymer electrolytes combine a polymer matrix with ceramic or other inorganic fillers. Candidate fillers include aluminium oxide (Al_2O_3), silicon dioxide (SiO_2), and selected lithium-ion-conducting ceramics. These fillers can modify polymer crystallinity, mechanical properties, interfacial behaviour, and ion transport. Their effectiveness depends on particle distribution, surface chemistry, filler concentration, and compatibility with the polymer.

D. Single-ion-conducting polymer electrolytes

These materials are designed to immobilize one type of ion, often the anion, so that the desired cation carries a greater fraction of the ionic current. They may reduce concentration polarization under suitable conditions. However, synthesizing such materials while retaining high conductivity and stability remains challenging [1, 3].

IV. CANDIDATE POLYMER MATERIALS FOR BATTERY RESEARCH

The following materials are research candidates, not a declaration of materials currently used in ISRO batteries.

4.1 Polyethylene oxide (PEO)

PEO is one of the most widely investigated polymer hosts for lithium-salt-based solid electrolytes. Its ether oxygen atoms interact with lithium ions, supporting ion coordination and transport.

Advantages:

- Established research base in solid polymer electrolytes.
- Good film-forming ability.
- Compatibility with several lithium salts.
- Potential for flexible, thin electrolyte layers.

Limitations:

- Crystallinity can reduce room-temperature ionic conductivity.
- Mechanical strength may be insufficient for some high-energy cell designs.
- Electrochemical stability and lithium-metal compatibility require careful engineering.

PEO-based electrolytes may be investigated for controlled-temperature solid-state battery applications, but their performance must be demonstrated over the complete operating-temperature range of the intended system [1, 3].

4.2 Polyvinylidene fluoride (PVDF)

PVDF is a fluorinated polymer known for chemical resistance and useful mechanical properties. It is frequently investigated in polymer electrolyte membranes and gel-electrolyte systems.

Advantages:

- Good film-forming characteristics.
- Useful chemical and mechanical stability in selected environments.
- Potential compatibility with composite electrolyte designs.

Limitations:

- PVDF alone does not guarantee high lithium-ion conductivity.
- Conductivity often depends on salt, solvent, plasticizer, and membrane structure.
- Processing, cost, and end-of-life environmental considerations require evaluation.

4.3 Polyacrylonitrile (PAN)

PAN contains nitrile groups that interact with ionic species. PAN-based membranes have been studied for gel and polymer-electrolyte applications.

Advantages:

- Good film-forming capability.
- Useful mechanical properties in selected formulations.
- Potential for incorporating conducting salts and liquid electrolyte components.

Limitations:

- Ionic conductivity depends strongly on formulation and processing.
- Electrode-interface stability must be evaluated.
- Thermal, electrochemical, and mechanical performance must be verified for each battery design.

4.4 Polymer–ceramic composite electrolytes

Composite electrolytes combine polymer processability with the properties of inorganic fillers or ion-conducting ceramics.

Potential benefits include:

- Improved mechanical reinforcement.
- Modified polymer crystallinity and ion-transport pathways.
- Better control over selected interfacial properties.
- Opportunities to develop thin and mechanically robust electrolyte membranes.

However, adding ceramic particles does not always increase conductivity. Agglomeration, poor interfacial contact, and unsuitable filler loading may decrease performance. The composition must therefore be optimized experimentally [1, 3].

V. POTENTIAL APPLICATIONS IN ISRO AND SPACE-ENERGY SYSTEMS

5.1 Power requirements in space missions

Spacecraft require electrical energy for communication, navigation, onboard computing, scientific instruments, thermal control, and mission operations. Solar panels can generate electricity when suitably illuminated, while batteries store energy for periods when solar power is unavailable or inadequate.

The selection of a space battery depends on mission duration, orbit, temperature, power demand, radiation exposure, launch vibration, reliability requirements, and mass constraints [5].

5.2 Potential role of polymer electrolytes

Polymer electrolytes could be investigated for future space battery designs in the following areas.

A. Reduced leakage risk

A properly designed solid polymer electrolyte does not rely on a free-flowing liquid electrolyte. This could reduce leakage-related risks, although solid-state cells can still fail through internal shorts, interface degradation, or other mechanisms.

B. Flexible and lightweight cell architectures

Polymer films can potentially support thin, compact, or mechanically compliant cell structures. Any reduction in total battery mass must be demonstrated at the complete cell and pack levels, including packaging, thermal control, and protective systems.

C. Interface engineering

Polymer electrolytes may be tailored to improve contact between the electrolyte and electrodes. Good interfacial contact can help reduce resistance, but chemical reactions and changes in contact during cycling can still cause degradation.

D. Long-duration energy storage

Future spacecraft may benefit from cells that combine stable ion transport with long cycle life and low self-discharge. These properties depend on the complete electrochemical system; they cannot be guaranteed by using a polymer electrolyte alone.

E. Future exploration systems

Potential research targets include batteries for satellites, planetary landers, rovers, and other space systems. Each application would require a separate qualification programme. In particular, a polymer electrolyte that works well in a terrestrial laboratory may not remain conductive or mechanically stable in the temperature extremes of a space mission.

5.3 Why space qualification is essential

Space applications require substantially more than an acceptable laboratory conductivity value. A candidate electrolyte and battery must be assessed for:

- Ionic conductivity over the mission temperature range.
- Electrochemical stability against the selected electrodes.
- Thermal cycling and dimensional stability.
- Resistance to vibration and mechanical shock.
- Vacuum compatibility and outgassing of cell materials.
- Radiation effects where relevant to the mission.
- Long-term cycling, calendar ageing, and storage behaviour.
- Abuse tolerance, fault response, and cell-level safety.

The qualification requirements must be defined for the intended mission. Polymer-electrolyte technology should therefore be considered a candidate for investigation rather than a drop-in replacement for qualified space batteries.

VI. RELEVANCE TO VIKSIT BHARAT @2047

Viksit Bharat @2047 represents India's long-term ambition to become a developed nation. Advanced battery research can contribute to this vision through clean energy, technological innovation, industrial development, and reduced dependence on imported critical technologies.

The Ministry of New and Renewable Energy reports a projected national energy-storage requirement of 2,380 GWh by 2047, comprising 540 GWh from pumped-storage projects and 1,840 GWh from battery energy-storage systems, according to the CEA's National Electricity Plan 2023 projections [4]. These are projections, not installed-capacity figures or guaranteed future outcomes.

6.1 Renewable energy integration

Solar and wind generation varies with weather, time of day, and season. Battery energy-storage systems can help shift electricity from periods of surplus generation to periods of higher demand.

Polymer-electrolyte batteries could potentially support some applications if they achieve competitive cost, cycle life, efficiency, safety, and scalability. They would compete with established lithium-ion systems and alternative storage technologies, including pumped hydro.

6.2 Electric vehicles and transportation

Electric vehicles require batteries that balance energy density, charging capability, power delivery, lifetime, cost, and safety.

Solid-state polymer electrolytes could contribute to future vehicle batteries if their conductivity, mechanical integrity, electrode compatibility, and manufacturing yield become suitable for commercial use. Gel polymer electrolytes may also have applications, but the presence of liquid components must be considered when evaluating their safety benefits.

6.3 Indigenous battery manufacturing

India can strengthen its battery ecosystem by developing domestic expertise in polymer synthesis, conducting salts, membrane fabrication, ceramic fillers, cell assembly, testing, and recycling.

An indigenous polymer-electrolyte research programme could help:

- Develop intellectual property and locally optimized materials.
- Train researchers in electrochemistry and polymer science.
- Build collaborations between universities, national laboratories, startups, and manufacturers.
- Reduce selected technology dependencies where domestic production becomes technically and economically competitive.

However, local manufacture alone does not guarantee lower costs. Raw-material availability, production yield, quality control, equipment, and recycling infrastructure must also be considered.

6.4 Energy security and environmental sustainability

Reliable energy storage can improve renewable-energy utilization and reduce dependence on fossil-fuel generation in suitable applications. Polymer electrolytes may offer advantages in particular battery chemistries, but their overall environmental benefit depends on raw-material sourcing, energy consumption during manufacture, battery lifetime, and end-of-life management.

A life-cycle assessment should therefore accompany any claim that polymer-electrolyte batteries are inherently greener than competing technologies.

6.5 Space technology and strategic self-reliance

Space batteries and terrestrial batteries have overlapping scientific foundations but different qualification requirements. Investment in polymer science, interfaces, electrochemical characterization, and manufacturing can create transferable research capabilities.

A coordinated research ecosystem involving universities, national laboratories, industry, and relevant space organizations could help develop advanced materials for both civilian energy storage and selected space applications. Such collaboration would support technological self-reliance without assuming that one battery design is suitable for every application.

VII. TECHNICAL CHALLENGES AND RESEARCH GAPS

Although polymer electrolytes have substantial potential, several obstacles limit their practical adoption.

7.1 Low room-temperature ionic conductivity

Some solid polymer electrolytes conduct ions less effectively at room temperature than conventional liquid electrolytes. Strategies such as polymer blending, controlled plasticization, salt optimization, nanofillers, and structural modification can be investigated to improve transport.

7.2 Mechanical strength versus ion mobility

Increasing polymer-chain mobility may improve conductivity but can reduce mechanical rigidity. Conversely, highly cross-linked or rigid materials may resist deformation but impede ion transport. The objective is to achieve a useful balance rather than maximize one property independently.

7.3 Electrode–electrolyte interface stability

Electrolytes must remain compatible with both electrodes during charging and discharging. Interfacial reactions can increase resistance, consume active lithium, and shorten battery life. Surface coatings, protective interlayers, and electrolyte formulation changes may help, but each requires testing.

7.4 Temperature sensitivity

Some polymer electrolytes perform well only within a restricted temperature range. Space systems require qualification across mission-specific thermal conditions, while terrestrial systems must tolerate local climate and operating conditions.

7.5 Manufacturing cost and scalability

Laboratory-scale membranes may not translate directly into economical mass production. Researchers must evaluate material availability, solvent recovery, coating uniformity, moisture sensitivity, production yield, quality control, and recycling.

7.6 Safety validation

Solid electrolytes can reduce certain liquid-electrolyte hazards, but they do not make a battery automatically safe. Lithium dendrites, internal short circuits, electrode instability, and mechanical defects remain possible. Safety claims must be supported by appropriate cell-level tests.

VIII. PROPOSED RESEARCH METHODOLOGY

This paper is a literature-based review and conceptual research proposal. No new experimental measurements are claimed. The following methodology could be used in a future laboratory investigation.

8.1 Research hypothesis

A properly optimized polymer–ceramic composite electrolyte may provide a useful balance of ionic conductivity, mechanical stability, and electrode compatibility for selected lithium-based battery systems. Its practical suitability for space or terrestrial energy storage must be demonstrated through comparative testing.

8.2 Proposed materials

Candidate formulations may include:

- PEO with a suitable lithium salt as a baseline solid polymer electrolyte.
- PVDF-based polymer electrolyte membranes.
- PAN-based polymer or gel electrolyte membranes.
- A polymer–ceramic composite using a selected inorganic filler.

The final salt, electrode chemistry, filler loading, and processing route should be selected based on a literature review, safety assessment, and laboratory capabilities.

8.3 Experimental procedure

Step 1: Preparation of polymer electrolyte membranes

Prepare candidate membranes using an appropriate method, such as solution casting or solvent-free processing, depending on the material chemistry. Control composition, film thickness, drying conditions, and moisture exposure.

Step 2: Structural and morphological characterization

Use suitable techniques to investigate polymer structure, crystallinity, chemical interactions, and surface morphology.

Possible methods include Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and scanning electron microscopy (SEM).

Step 3: Ionic conductivity measurement

Measure ionic conductivity using electrochemical impedance spectroscopy (EIS) with suitable blocking-electrode configurations and controlled temperature.

For a membrane of thickness L , electrode area A , and bulk resistance R_b , the conductivity is calculated as:

$$\sigma = LR_bA$$

where: σ is ionic conductivity.

- L is membrane thickness.
- R_b is the bulk resistance obtained from the impedance response.
- A is the electrode–membrane contact area.

If thickness is measured in centimetres and resistance in ohms, conductivity is obtained in $S\text{ cm}^{-1}$.

Step 4: Thermal and mechanical testing

Use differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), and appropriate tensile or mechanical tests to characterize thermal transitions, degradation behaviour, and membrane integrity.

Step 5: Electrochemical stability and interface testing

Assess electrochemical stability using an appropriate measurement protocol. Evaluate compatibility with the selected electrodes and, where justified, lithium transference number and interfacial impedance.

Step 6: Battery-cell testing

Assemble suitable laboratory cells using controlled procedures and compare their performance with an appropriate reference electrolyte. Measure discharge capacity, Coulombic efficiency, rate capability, cycle retention, impedance evolution, and temperature-dependent performance.

Step 7: Application-specific qualification

For terrestrial applications, assess cycling, thermal behaviour, cost, and safety at the intended operating conditions. For prospective space applications, establish a separate qualification plan that addresses vibration, vacuum compatibility, thermal cycling, radiation where relevant, and long-duration reliability.

All experiments should be conducted using appropriate laboratory safety procedures and qualified personnel.

**IX. PROPOSED PERFORMANCE EVALUATION
 FRAMEWORK**

They are proposed evaluation categories, not experimentally measured results.

The following parameters can be used to compare candidate electrolytes.

Parameter	Scientific importance	Relevance to application
Ionic conductivity	Determines resistance to ion transport	All battery systems
Electrochemical stability	Indicates compatibility with electrode potentials	High-energy and long-life cells
Thermal stability	Assesses material behaviour with temperature	Space and terrestrial batteries
Mechanical strength	Helps maintain membrane integrity	Thin-film and solid-state cells
Interfacial resistance	Influences power capability and efficiency	Fast operation and long cycle life
Cycle retention	Indicates capacity preservation over repeated cycling	Grid storage, EVs, and spacecraft
Manufacturing cost	Determines economic feasibility	Indian battery industry
Environmental impact	Evaluates sourcing, production, and end-of-life effects	Sustainable development

A meaningful comparison must use consistent measurement conditions, electrode configurations, temperature ranges, and cell designs. Results from different laboratories should not be compared without considering differences in test protocols.

X. EXPECTED OUTCOMES AND FUTURE SCOPE

The proposed research could identify candidate polymer compositions that offer an appropriate balance between conductivity, mechanical strength, and electrochemical compatibility. It could also clarify which formulations are better suited to terrestrial energy storage and which merit further investigation for specialized space applications.

Potential future research directions include:

1. Development of polymer-ceramic composite electrolytes with improved ion transport.
2. Exploration of polymer electrolytes compatible with high-voltage cathodes.
3. Design of mechanically stable interfaces for lithium-metal batteries.
4. Development of solvent-reduced or solvent-free manufacturing methods.
5. Evaluation of Indian-sourced raw materials and domestic manufacturing pathways.
6. Life-cycle assessment and recycling strategies for polymer-containing batteries.
7. Collaboration between electrochemistry laboratories, battery manufacturers, and space-technology researchers.

These outcomes remain prospective until supported by experimental data, independent verification, and application-specific qualification.

XI. CONCLUSION

Polymer electrolytes represent an important research direction for advanced electrochemical energy storage. Their tunable chemistry, film-forming capability, and potential for improved leakage control and interfacial engineering make them attractive candidates for selected solid-state and gel-polymer battery systems.

For ISRO-related applications, the key research challenge is to demonstrate reliable performance under demanding space conditions, including mission-specific temperature variations, mechanical stresses, vacuum exposure, and long-duration operation. Polymer electrolytes should not be considered a universal replacement for established space batteries until the complete battery system has passed appropriate qualification tests.

For Viksit Bharat @2047, polymer-electrolyte research could contribute to renewable-energy storage, electric mobility, domestic materials development, advanced manufacturing, and scientific capacity building. However, its contribution will depend on achieving competitive conductivity, safety, service life, production cost, and environmental performance.

The most practical strategy is to pursue application-specific research, establish reliable laboratory data, and develop collaborations between academic institutions, national laboratories, and industry.



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Through sustained research and rigorous testing, polymer electrolytes could become one of several technologies supporting India's long-term energy security, space capabilities, and technological self-reliance.

REFERENCES

- [1] Prasanth, R. S., Prasannavenkadesan, V., Katiyar, V., & Achalkumar, A. S. (2025). Polymer electrolytes: Evolution, challenges, and future directions for lithium-ion batteries. *RSC Applied Polymers*, 3, 499–531. <https://doi.org/10.1039/D4LP00325J>
- [2] Goodenough, J. B., & Kim, Y. (2010). Challenges for rechargeable Li batteries. *Chemistry of Materials*, 22(3), 587–603. <https://doi.org/10.1021/cm901452z>
- [3] Quartarone, E., & Mustarelli, P. (2011). Electrolytes for solid-state lithium rechargeable batteries: Recent advances and perspectives. *Chemical Society Reviews*, 40, 2525–2540. <https://doi.org/10.1039/C0CS00081G>
- [4] Ministry of New and Renewable Energy, Government of India. (n.d.). *Energy Storage Systems (ESS) Overview*. <https://mnre.gov.in/en/energy-storage-systemsess-overview/>
- [5] Pathak, A. D., Saha, S., Bharti, V. K., Gaikwad, M. M., & Sharma, C. S. (2023). A review on battery technology for space application. *Journal of Energy Storage*, 61, 106792. <https://doi.org/10.1016/j.est.2023.106792>
- [6] Ministry of Power, Government of India. (2023). *National Framework for Promoting Energy Storage Systems*. <https://mnre.gov.in/en/document/national-framework-for-promoting-energy-storage-systems-by-ministry-of-power/>
- [7] Ministry of Heavy Industries, Government of India. (2021). *Production Linked Incentive Scheme for Advanced Chemistry Cell Battery Storage*. Government of India. Scheme information is available through the Ministry of Heavy Industries and the Ministry of Power's energy-storage policy resources.
- [8] International Space Station and space-energy research literature should be consulted alongside the space-battery review in Reference 5 when defining mission-specific requirements for radiation tolerance, thermal cycling, vibration, and long-duration battery reliability.
- [9] Indian Space Research Organisation (ISRO). *ISRO Official Website*. Government of India. <https://www.isro.gov.in/>