

# NOVEL / GREEN ENERGY SOLUTIONS FOR TACTICAL SOLDIER APPLICATIONS

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## AIM

To investigate energy-dense, lightweight, safe and sustainable emerging battery technologies for tactical soldier applications.

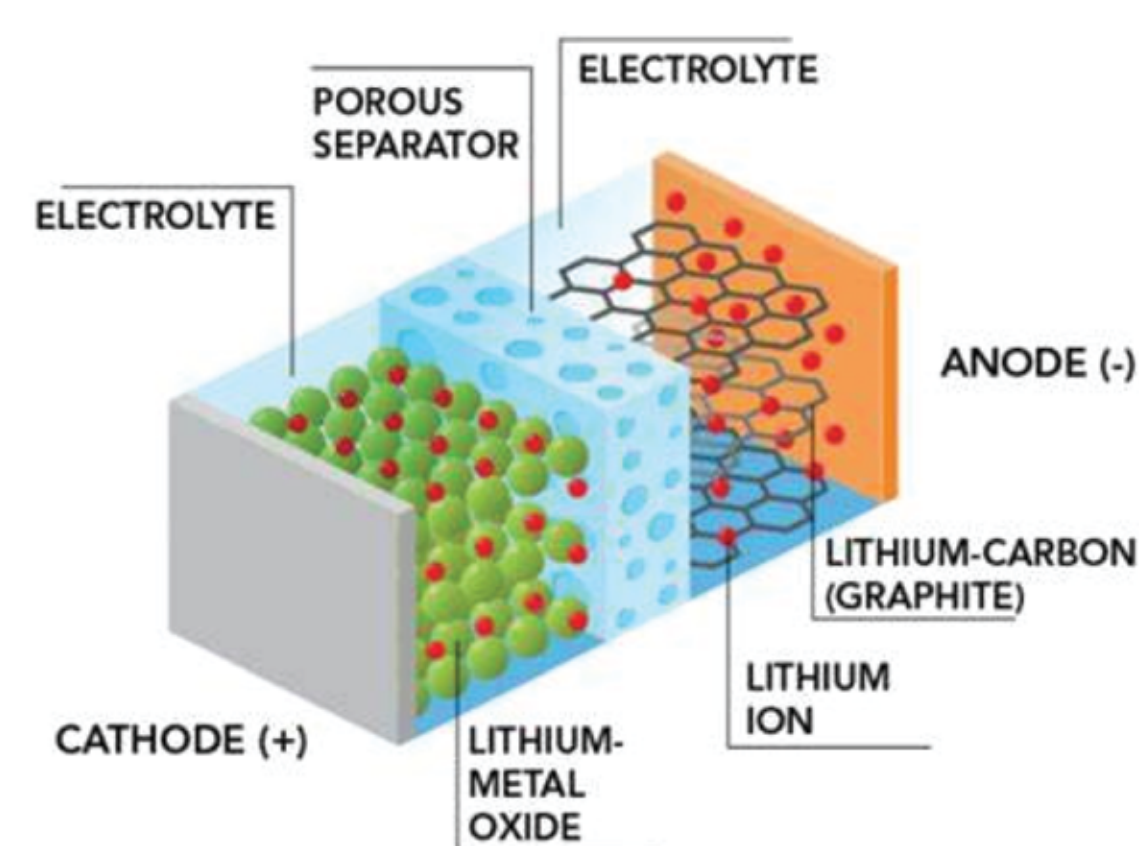


## LITHIUM-ION BATTERY

- Uses reversible intercalation of  $\text{Li}^+$  ions into electronically conducting solids
- **Advantages:**
  - High energy density
  - Higher voltage than counterparts; able to store more energy
- **Disadvantages:**
  - High cost
  - Limited lifespan
  - Environmentally unfriendly

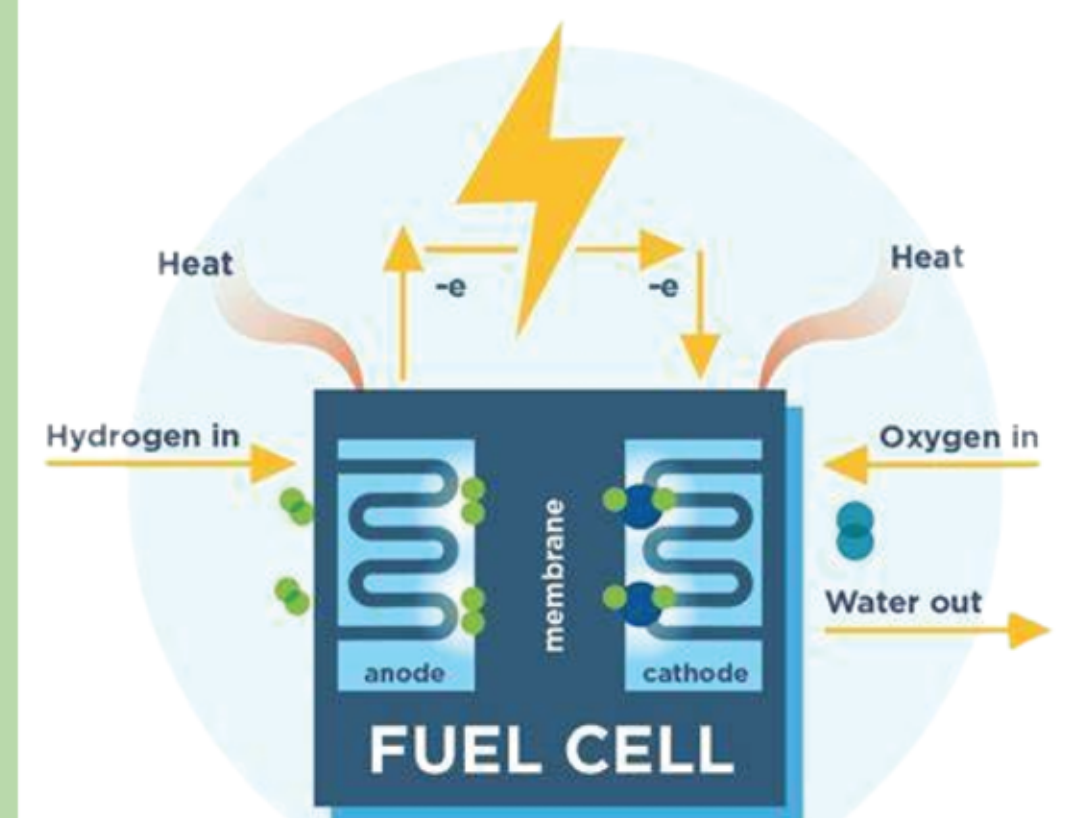


### PARTS OF A LITHIUM-ION BATTERY



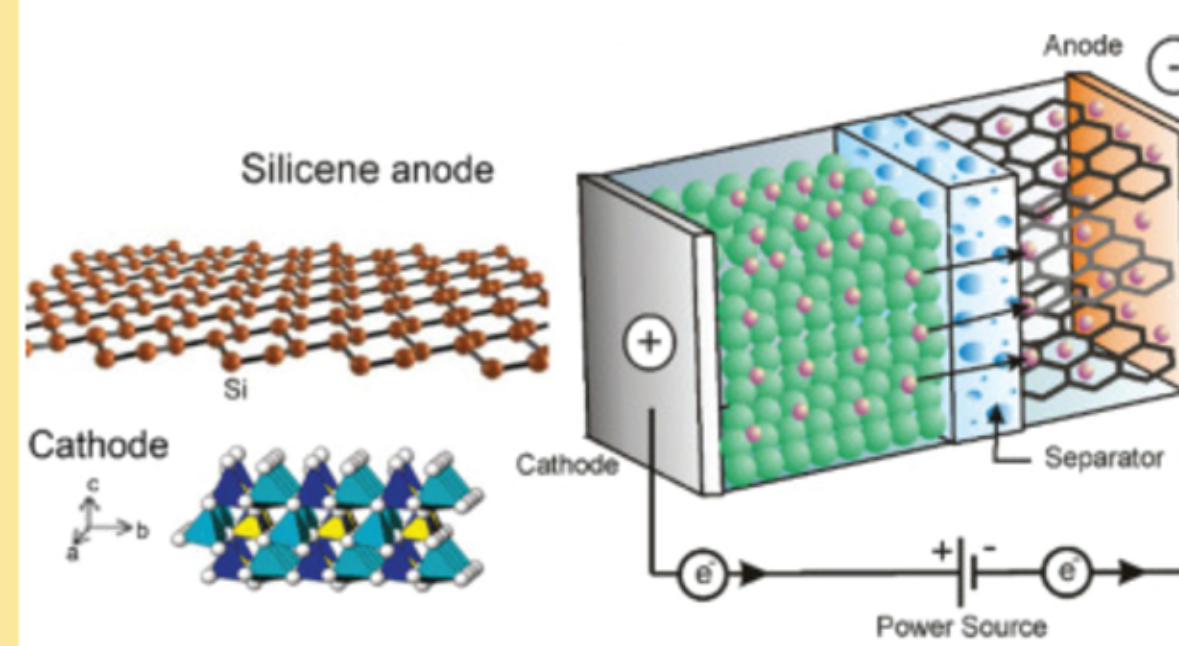
## HYDROGEN FUEL CELL

- Converts energy into electricity through an electrochemical reaction
- **Advantages:**
  - High energy efficiency
  - Long driving range
  - Fast refuelling time
  - Quiet operation
  - Environmentally friendly
- **Disadvantages:**
  - Lack of hydrogen refuelling infrastructure
  - Expensive
  - Dangerous



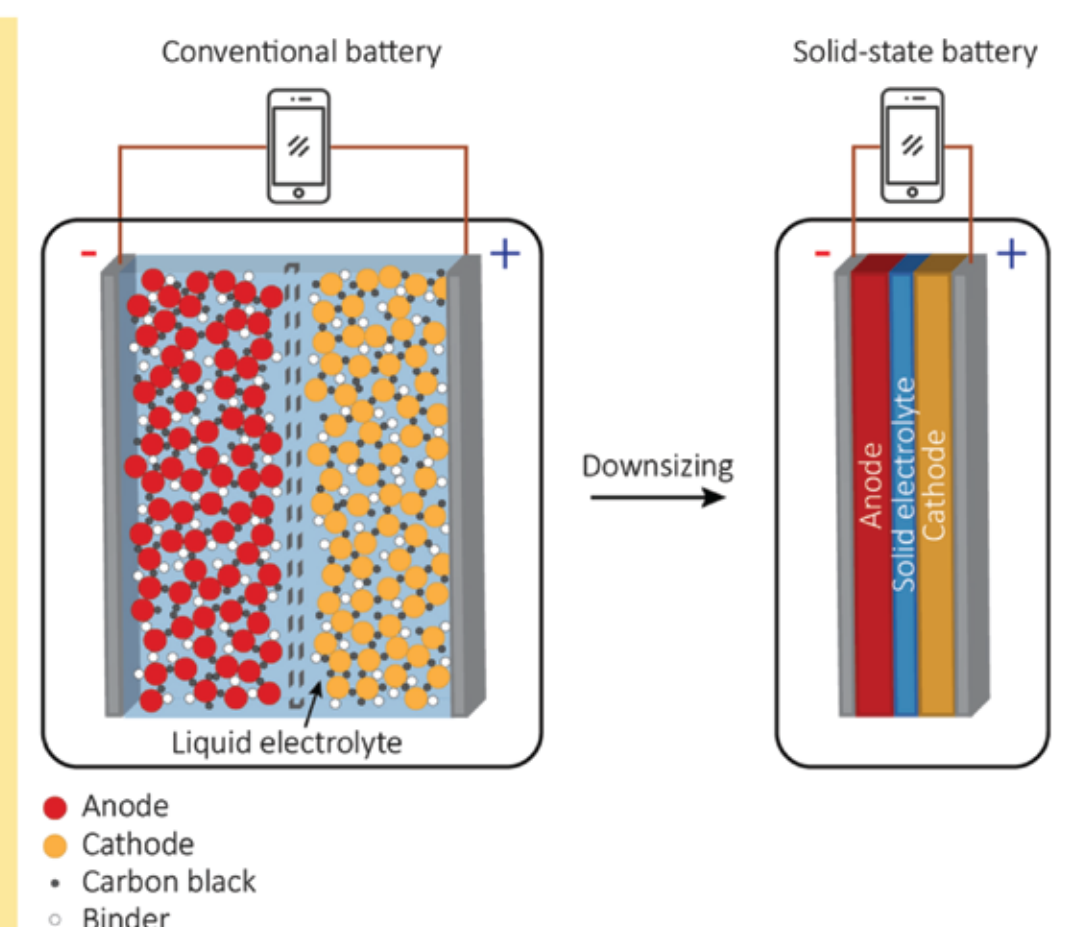
## LITHIUM-SILICON BATTERY

- Silicon-based anode with Li-ions as charge carriers
- **Advantages:**
  - Higher storage capacity
  - Low discharge potential
- **Disadvantages:**
  - Expands and contracts significantly, leading to swelling
  - Faces serious performance degradation



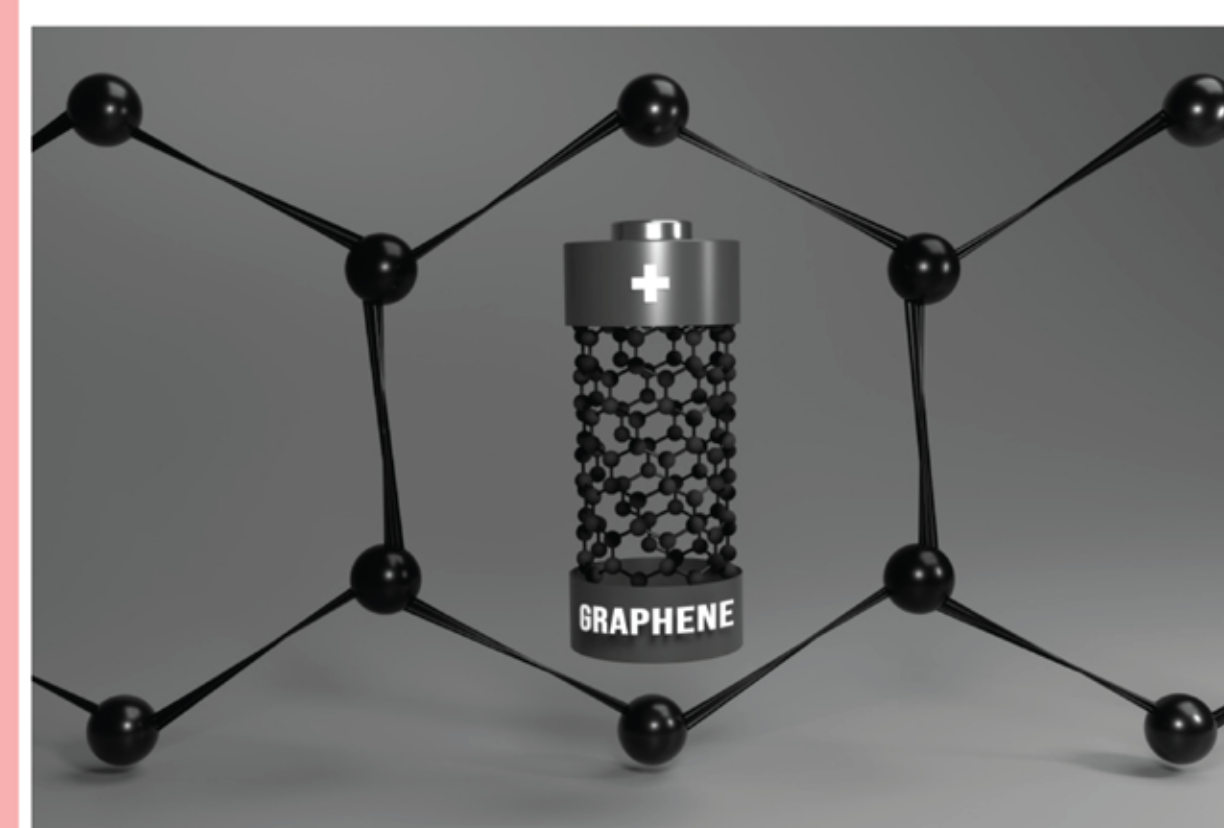
## SOLID-STATE BATTERY

- Uses solid electrolytes
- **Advantages:**
  - High energy density
  - Compact for soldiers
  - Non-flammable
- **Disadvantages:**
  - Expensive
  - Requires high pressure & temperature
  - Mechanical failure during discharge



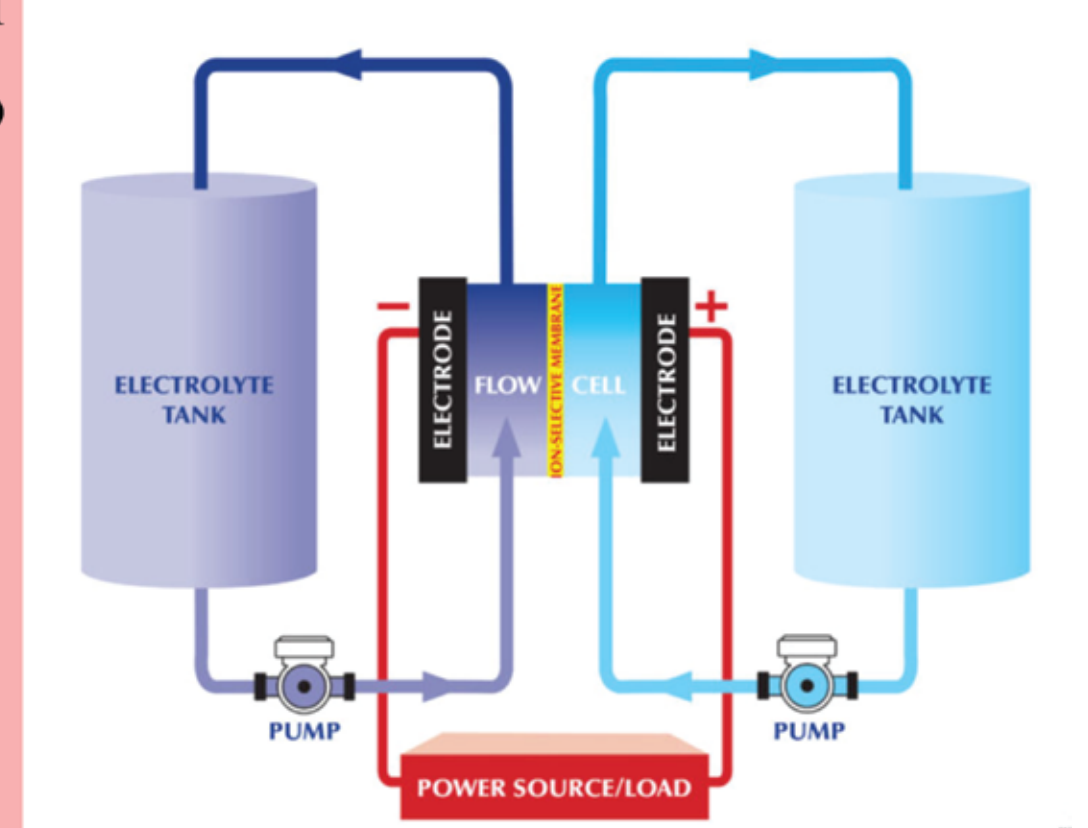
## GRAPHENE

- Single layer of carbon atoms that is regarded as a 2D structure
- **Advantages:**
  - Increases battery's conductivity
  - Increases energy density
- **Disadvantages:**
  - Expensive
  - Poor capacity retention
  - Cannot be switched off



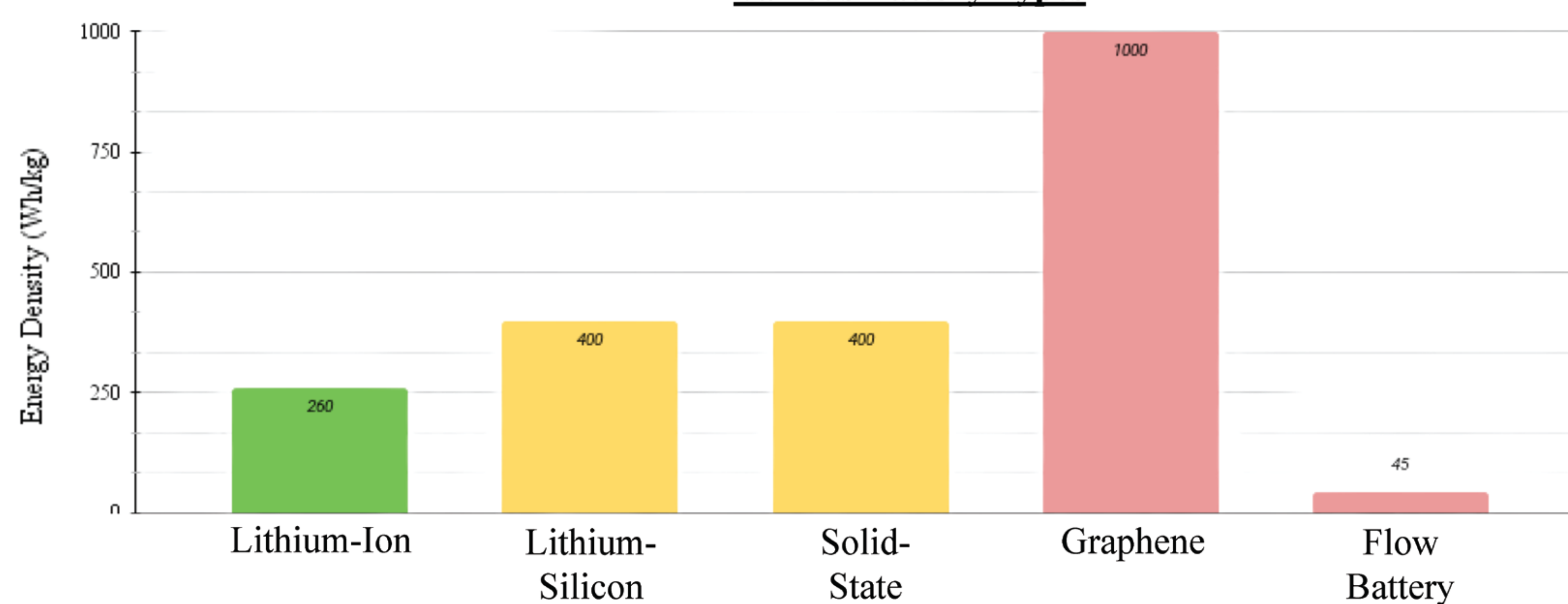
## FLOW BATTERY

- Electrolyte flows through an electrochemical cell that reversibly converts chemical energy to electrical energy
- **Advantages:**
  - Decoupling of energy and power rating
  - Longer lifespan
- **Disadvantages:**
  - Expensive
  - Less dense and compact



## ENERGY DENSITIES

**Various Battery Types**



**Hydrogen Fuel Cell**

