

# KSS-III Lithium-Ion Battery System



KSS-III Program Group  
Defense Acquisition Program Administration  
Republic of Korea

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# 1 About ROKN Submarine

## ○ Introduction



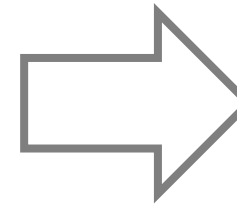
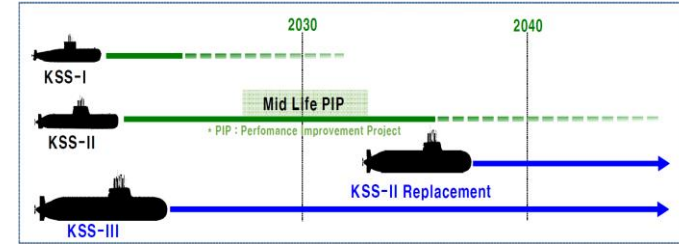
### <Type KSS-I(= Type 209)>

- 1992 - 2001
- Appx. 1,200ton
- Lead-Acid Battery(LAB)
- Torpedo, Mine, Anti-ship Missile



### <Type KSS-II(= Type 214)>

- 2007 - 2019
- Appx. 1,800ton
- LAB + **Air Independent Propulsion(AIP)**
- Torpedo, Mine, Anti-ship Missile



**OEM Production**  
\* Designed by TKMS

**Independent Development**



### <Type KSS-III Batch-I>

- 2007 - 2024
- Appx. 3,000ton
- LAB + AIP
- Torpedo, Mine, Anti-ship Missile + **SLBM**



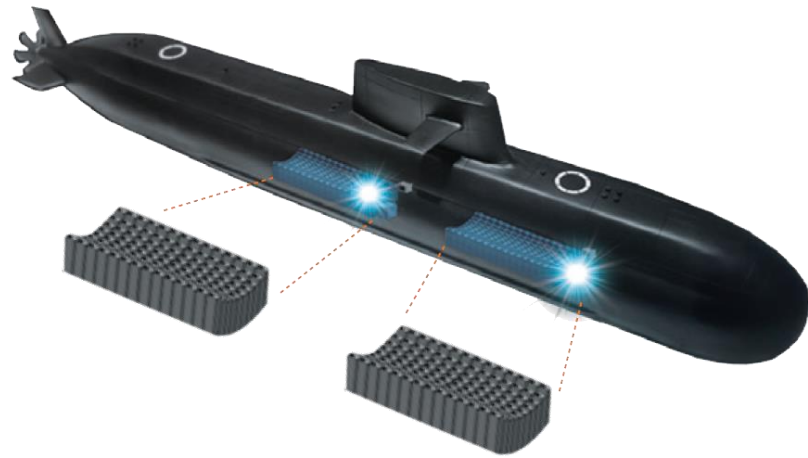
### <Type KSS-III Batch-II>

- 2016 - WIP
- Appx. 3,600ton
- **Lithium-Ion Battery(LIB)** + AIP
- Torpedo, Mine, Anti-ship Missile + **SLBM**

# 2 Lithium-Ion Battery System of KSS-III Batch-II

## ○ Configuration

- ✓ Layered Structure : Cell – Cell Tray – Module – String – Group – System
- ✓ The submarine has devices that monitor its condition and detects faults



Li. Bat. Group#1

Li. Bat. Group#2

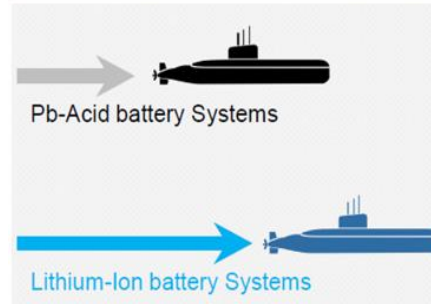


Devices	Cell Trays	Module	String	Group
<b>Product Appearance</b>				
<b>Configuration</b>	Series of Cells	Series of Cell Trays	Parallel of 10 Modules	Parallels of 14 Strings
<b>Main Components</b>	<ul style="list-style-type: none"> <li>• CMD (Cell Monitoring Device)</li> <li>• Hybrid Busbar</li> </ul>	<ul style="list-style-type: none"> <li>• MPMD (Module Power Management Device)</li> <li>• Fusing Busbar and Cables</li> <li>• Cell Trays</li> </ul>	<ul style="list-style-type: none"> <li>• SMD (String Management Device)</li> <li>• Current Limiter</li> <li>• Busbar and Cables</li> </ul>	<ul style="list-style-type: none"> <li>• BGMP (Battery Group Management Panel)</li> <li>• FCL (Fault Current Limiter)</li> </ul>

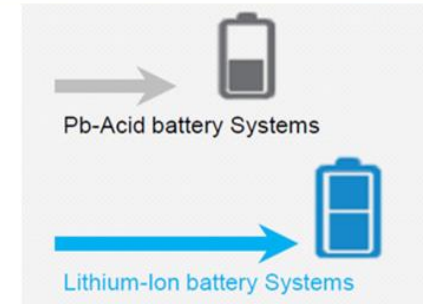
# 2 Lithium-Ion Battery System of KSS-III Batch-II

## ○ Advantages over lead-acid batteries

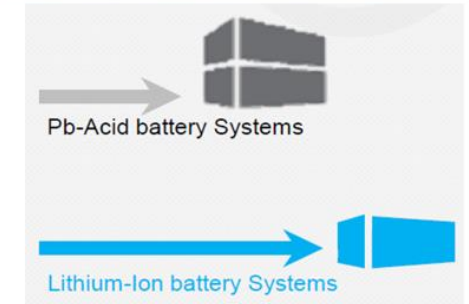
- ✓ Longer submerged operation
- ✓ Enhanced Capacity
  - Can run for more than 2h at max speed
- ✓ Longer life cycle : 4,000 cycle
- ✓ No H<sub>2</sub> generation (charging/discharging)
- ✓ No electrolyte (H<sub>2</sub>SO<sub>4</sub>) overflow
- ✓ No need for (compared to lead-acid battery) :
  - regular check of electrolyte level/refilling
  - 1 ~ 3 step full charging every 4 weeks : 12h
  - equalizing charging every 4~6 months : 30h



✓ **Longer Operation Range**  
 Distance at Cruising Speed(160% ↑)  
 Distance at Max. Speed(300% ↑)



✓ **Less Maintenance**  
 Battery Life(200% ↑)



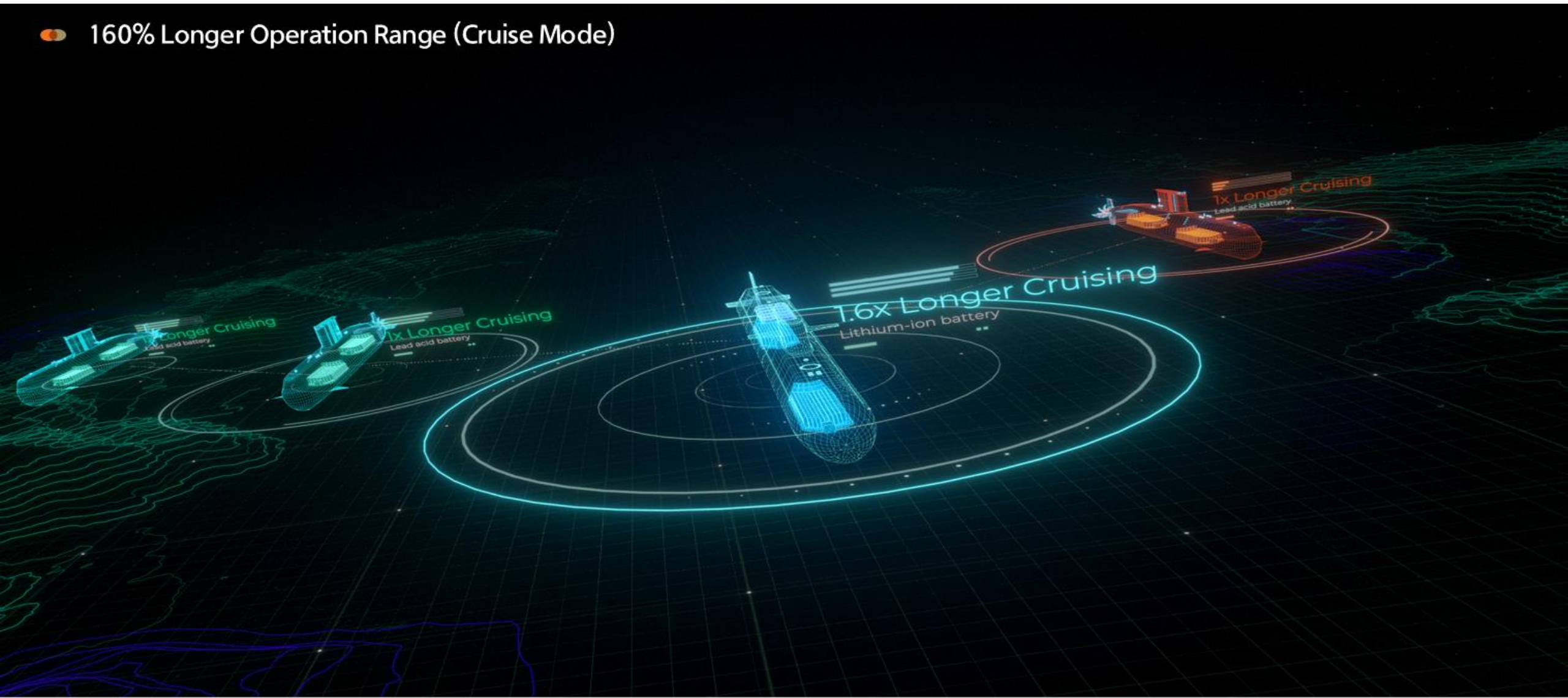
✓ **Less Space**  
 Energy Density(200% ↑)

Category	lead-acid battery	Lithium-ion Battery	Note
Structure			① Longer Operation time (Cruise Mode) ② Longer Operation time (Full Ahead) ③ longer lifecycle : ≥ 200% ④ Simple Maintenance
life cycle	2,000 cycle (DOD 50%)	≥ 4,000 cycle (DOD 50%)	Vantage
Gas generation	(charging/discharging) H <sub>2</sub> emission	(charging/discharging) No H <sub>2</sub> emission	Vantage
Maintenance	regular check of electrolyte level/refilling	N/A	Vantage
Performance at low temperature	Bad	Very	Vantage
Fault module	No remotely shut off	Remotely shut off	Vantage

## 2 Lithium-Ion Battery System of KSS-III Batch-II

### ○ Advantages over lead-acid batteries

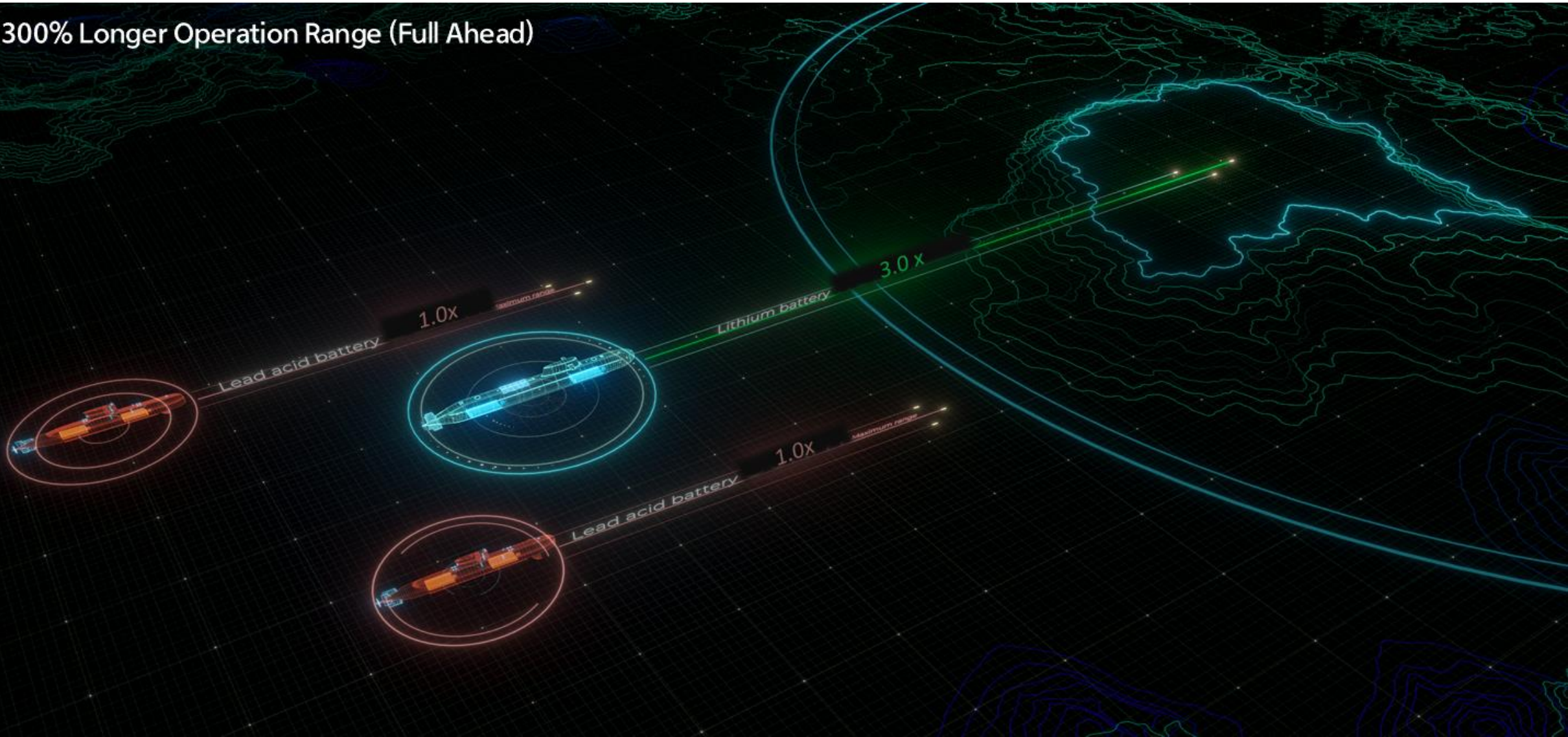
- 160% Longer Operation Range (Cruise Mode)



## 2 Lithium-Ion Battery System of KSS-III Batch-II

### ○ Advantages over lead-acid batteries

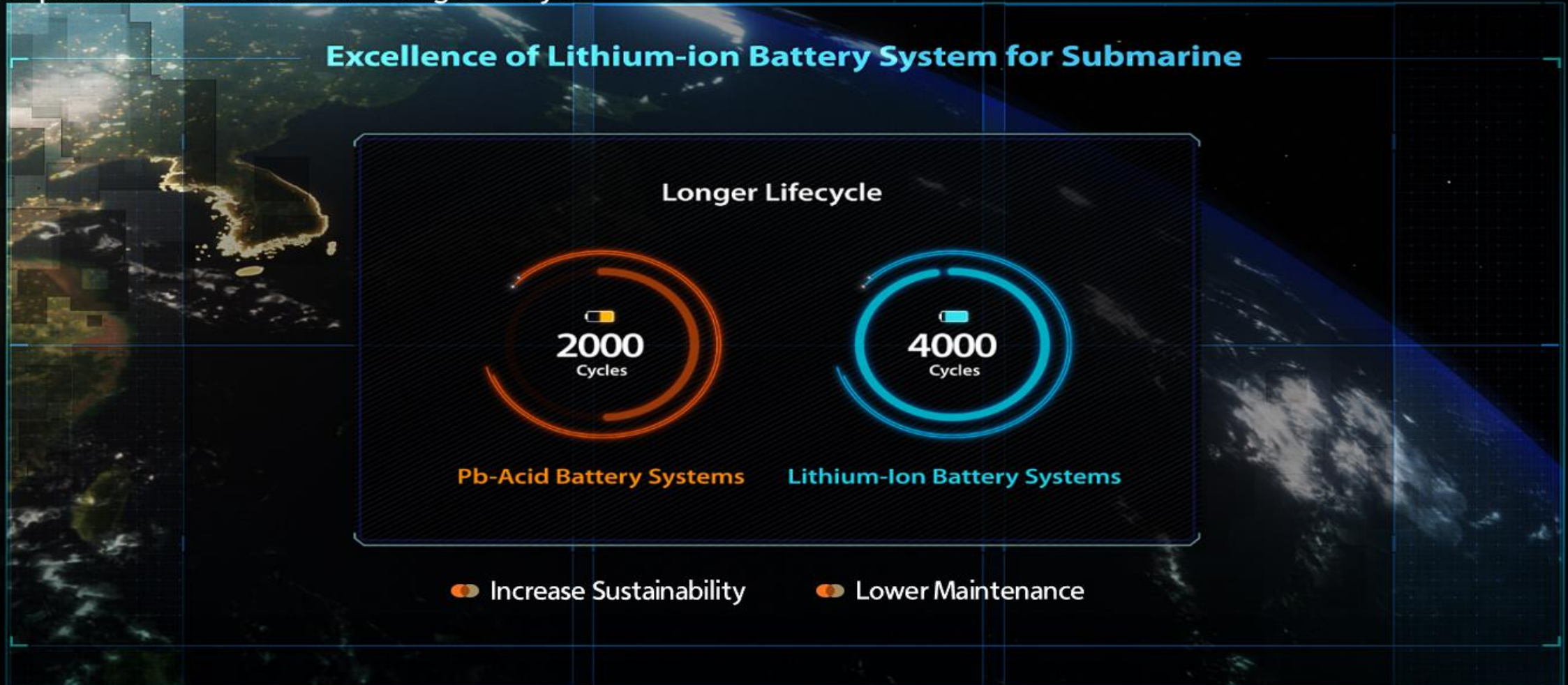
- 300% Longer Operation Range (Full Ahead)



# 2 Lithium-Ion Battery System of KSS-III Batch-II

## ○ Advantages over lead-acid batteries

- Require less maintenance and longer lifecycle

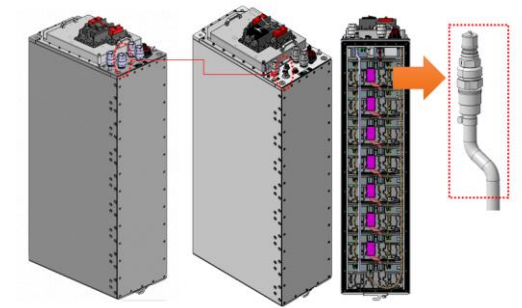
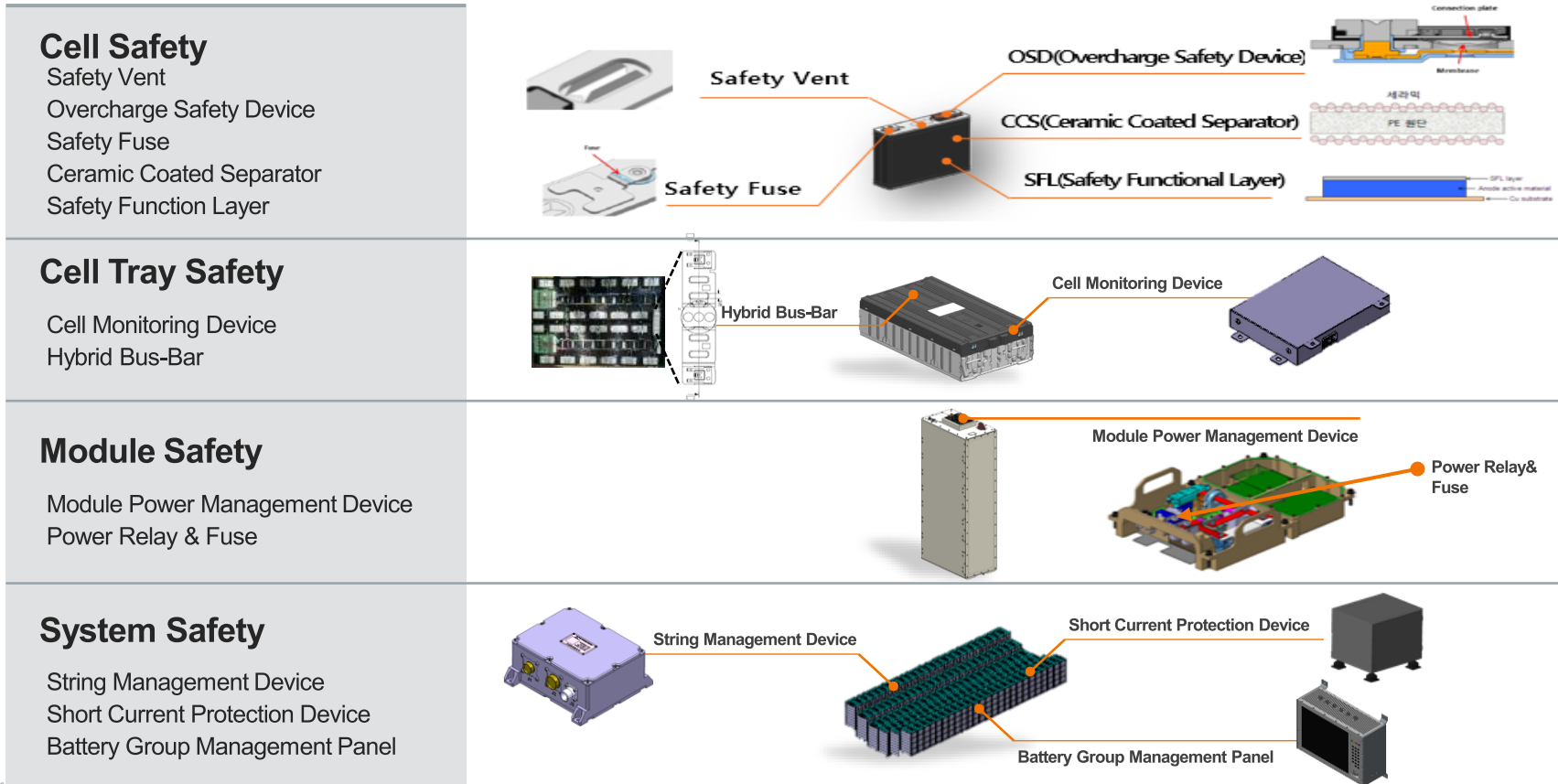




# 3 Safety Design & Test

## ○ Safety Design

- ✓ Layered safety systems with built-in mechanical safety devices that enable data monitoring, fault diagnosis and corrective action from cell to Lithium-Ion Battery System
- ✓ Qualified by Korean government agencies



<Water extinguishing material sealing>

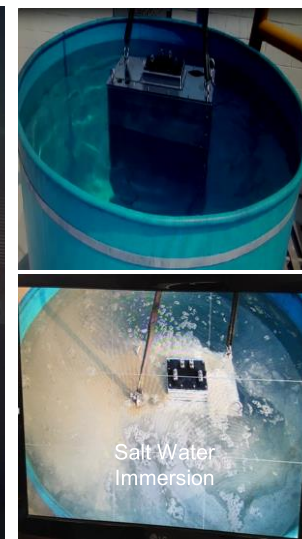
# 3 Safety Design & Test

## ○ Safety Test(1/2)

✓ Tested under the most severe conditions and approved by the Korean government agencies

### ✓ Battery Module Safety Test

- Overcharging, Over discharging, Short Circuit Current, Heat Exposure, Pressure, External Fire Exposure, Salt Water Immersion, etc.

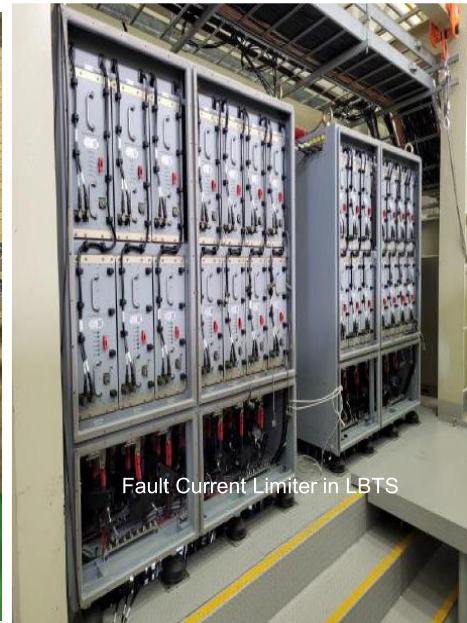


# 3 Safety Design & Test

## ○ Safety Test(2/2)

### ✓ Battery Module Reliability and Performance Test & LBTS(Land Based Test System/Site) Test

- Electrical Performance, Shock, Temperature, Humidity, EMI/EMC etc.
- Batteries placed in parallel and Safety Function Test etc.



# 4 Lithium-Ion battery under development

## ○ Development status

Development complete

Under development

Category	SIB	Lithium-ion		ASB	Li-S	LMB	Li-O <sub>2</sub>	
		LFP	NCM					
Energy density	40~50%	70~80%	100%	≥ 200% (in theory)	≥ 200~500% (in theory)	≥ 500~1000% (in theory)	≥ 500~1000% (in theory)	
Cost	40~50%	70~80%	100%	Pricey	Pricey	Pricey	Undecided	
Materials	Cathode	Na	LFP	Li, Ni, Co, Mn	Li, Ni, Co, Mn	S <sup>2-</sup> (sulfide)	Li, Ni, Co, Mn	Air
	Anode	C, Si	C, Si	C	C, Si, Li	Li	Li	Metal
	Electrolyte	Liquid	Liquid	Liquid	Solid	Liquid or Solid	Liquid or Solid	Liquid or Solid
	Separator	Film	Film	Film	N/A	Film or N/A	Film or N/A	Film or N/A
Advantage	<ul style="list-style-type: none"> <li>Low Cost</li> <li>Low temperature</li> <li>Long Lifecycle</li> </ul>	<ul style="list-style-type: none"> <li>Low Cost</li> <li>High Safety</li> </ul>	<ul style="list-style-type: none"> <li>High Energy density</li> <li>Mature Technical</li> </ul>	<ul style="list-style-type: none"> <li>High Energy density</li> <li>High Safety</li> <li>Short Charging time</li> </ul>	<ul style="list-style-type: none"> <li>Low Cost</li> <li>High Energy density</li> </ul>	<ul style="list-style-type: none"> <li>High Energy density</li> <li>Short Charging time</li> </ul>	<ul style="list-style-type: none"> <li>High Energy density</li> </ul>	
Disadvantage	<ul style="list-style-type: none"> <li>Low Energy density</li> </ul>	<ul style="list-style-type: none"> <li>Medium Cost</li> </ul>	<ul style="list-style-type: none"> <li>High cost</li> </ul>	<ul style="list-style-type: none"> <li>Ionic conductivity</li> </ul>	<ul style="list-style-type: none"> <li>Short Lifecycle</li> <li>Shuttle effect</li> </ul>	<ul style="list-style-type: none"> <li>Dendrite</li> </ul>	<ul style="list-style-type: none"> <li>Beginning research</li> </ul>	
Expected serial production in	Late 2023	Under serial Production	Under serial Production	2027 ~ 2030	2030	2025	2030s	

QA &



Defense Acquisition  
Program Administration



# Thank you



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