Innovative Power Solutions for Autonomous Systems

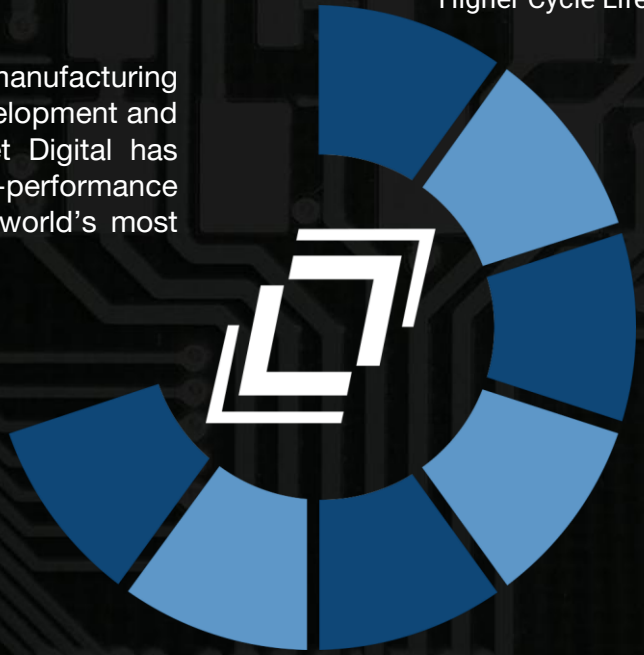
Terri Zimmerman
CEO

PacketDigital


Our Mission
Empowering Autonomous Systems
Our Vision
Limitless Flight
PacketDigital

Technical Capabilities

Packet Digital is an engineering and manufacturing company focused on UAS battery development and production. Founded in 2003, Packet Digital has experience developing reliable, high-performance batteries and power systems for the world's most demanding UAS applications.



Battery Design

Research & Development
High Energy Density
Higher Cycle Life

Mechanical Design

Rugged Construction
Thermal Analysis
Wire Harness Design

Circuit Boards

SMT Line for Production Runs
High Component Density
Scalable Board Sizing

Power Management

Maximum Power Point Tracker
Power Distribution Board
Fast Tracking & High Efficiency

Solar Integration

Charge Diverse Range of Products
Connect in Parallel
Portable & Compact

Software Design

Battery Fleet Management
Embedded Programming
Data Analysis

Battery Pack Assembly

Laser & Automated Spot Welding
Prototype & Volume Production
Testing & Quality Control

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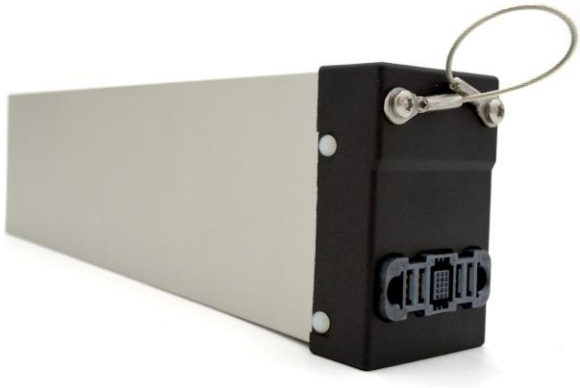
Smart Batteries

- Highest Performance
- Longest Lasting
- Safest
- Made in the USA



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Long Lasting Batteries for Lockheed Martin

"We have been cycling Packet Digital's battery for 6 months. It is now at 1000 cycles that's 10X better than anything we have ever seen, and it only shows 11% degradation"

- **Lockheed Martin, Chief Engineer**

LOCKHEED MARTIN | PacketDigital

Smart Charging

4 Port Charger

- Field charger for up to 4 batteries with data collection
- Charge or discharge 2 batteries simultaneously at up to 22A each
- Supports LiPo, LiHV, LiFe, and Li-Ion chemistries

Rack Mounted Chargers

- Batteries slide into rack systems
- No user interface, battery fleet software tracks the batteries
- Heavy duty steel construction built to withstand a battery failure event
- Notifies user when battery should be replaced

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Battery Fleet Management Software

- See latest status, notifications of faults and end-of-life
- Battery profile inventory
- Smart battery creates its own profile
- Data is synced to the cloud during charger operations
- Automated reporting
- Summary of healthy and unhealthy batteries
- Proactive battery replacement notification

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Manufacturing and Assembly Facility

- Facility opened in December 2023
- SMT line capable of 25,000 components per hour
  - High accuracy screen printer
  - Solder paste inspection machine
  - Pick and place machine
  - Automated optical inspection machine
  - Reflow oven
  - Selective soldering machine
- Programmable laser welder
- Automated resistance welder
- Laser engraver
- State-of-the-art testing lab
- Assembly/quality control

Increased Flight Time from 1.5 to 18 Hours

- Fast tracking (>1 kHZ)
- 200W peak capacity delivered in a 0.5m^2 array area
- High efficiency (>98%)
- Partnership with Naval Research Laboratory
- Test flights at Aberdeen Proving Ground and Cape Canaveral resulted in successful sunrise to sunset flights

U.S. NAVAL RESEARCH LABORATORY | PacketDigital

Enabled Multi-Day Flight

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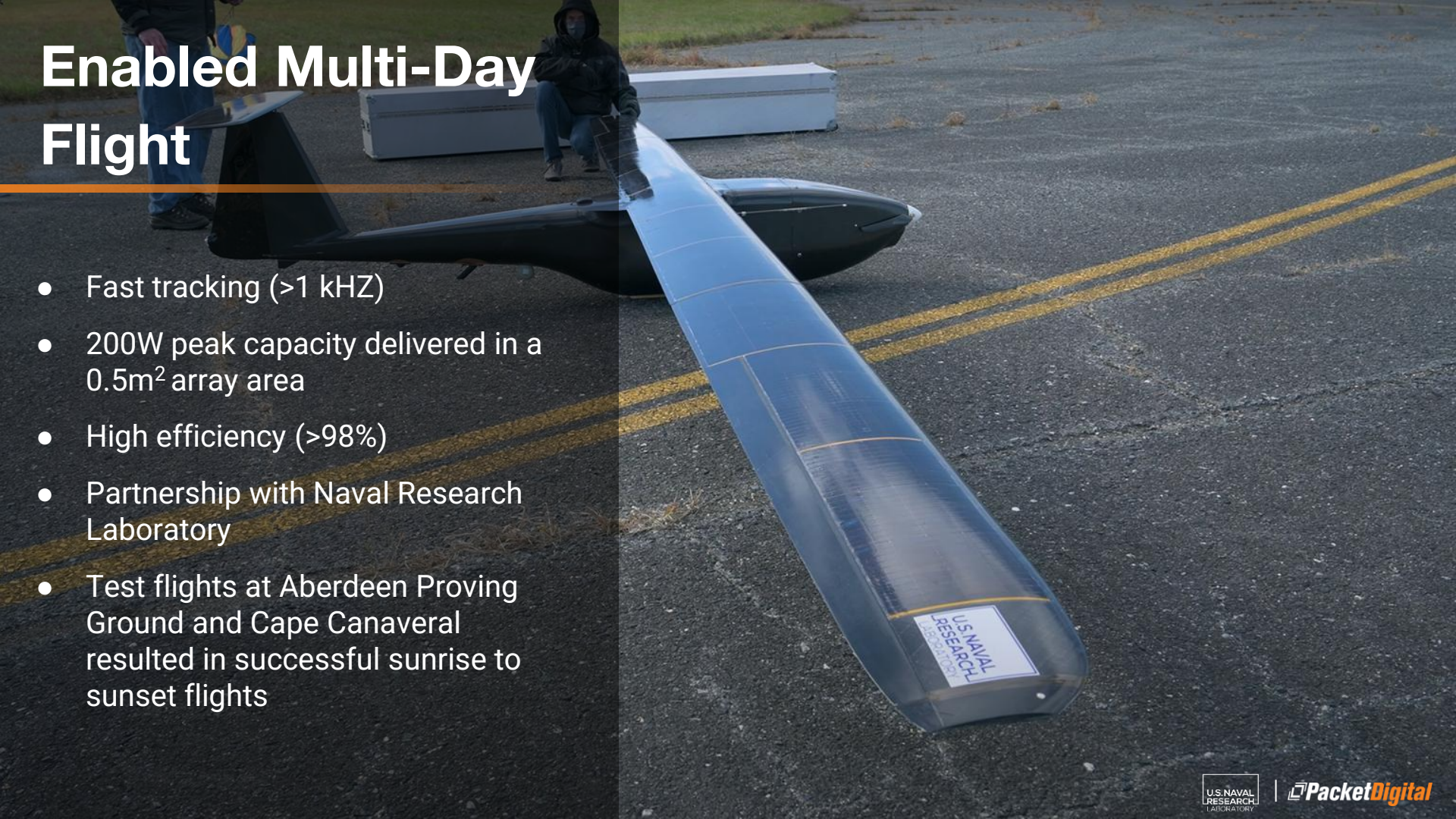

U.S. NAVAL RESEARCH LABORATORY | PacketDigital

Kraus Hamdani Endurance Record

- Smart battery packs with built-in battery management system
- MPPT with fast-tracking algorithms
- K1000 broke the endurance record for class 2 unmanned aerial systems by flying for 76 hours

KRAUS HAMDANI AEROSPACE | PacketDigital

Batteries & Chargers for the Navy Fleet

- Navy contract: Design batteries around companies designing drones
- Fleet battery management software
- Smart batteries
- Safe handling, charging & storage
- Drone companies:
  - L3 Harris
  - Shield AI
  - Skyways
  - Pterodynamics

Standardized Battery Family

- Scalable design to support multiple airframes
- Automatic self discharge
- Safe handling, charging and storage
  - Battery containers slide into rack systems
  - Heavy duty steel construction built to withstand battery failure event
- Battery fleet management software
  - View full fleet of batteries
  - Predictive analysis of battery health is based on measured activity

Safety & Security

Battery transport regulations

UN38.3 testing & certification

- Electrical Testing
- Shock & Vibe
- Environmental

Inconsistent battery manufacturing standards

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MPPT

Packet Digital's MPPT hardware and embedded algorithms take precise power measurements and adjust settings quickly to maintain maximum power transfer from solar panels to battery storage, pushing the limits on solar UAS operations.

Thin size fits inside most wing panels to simplify integration

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Addressing Areas of Need

Improving gravimetric and volumetric power densities

Maximizing power conversion efficiency

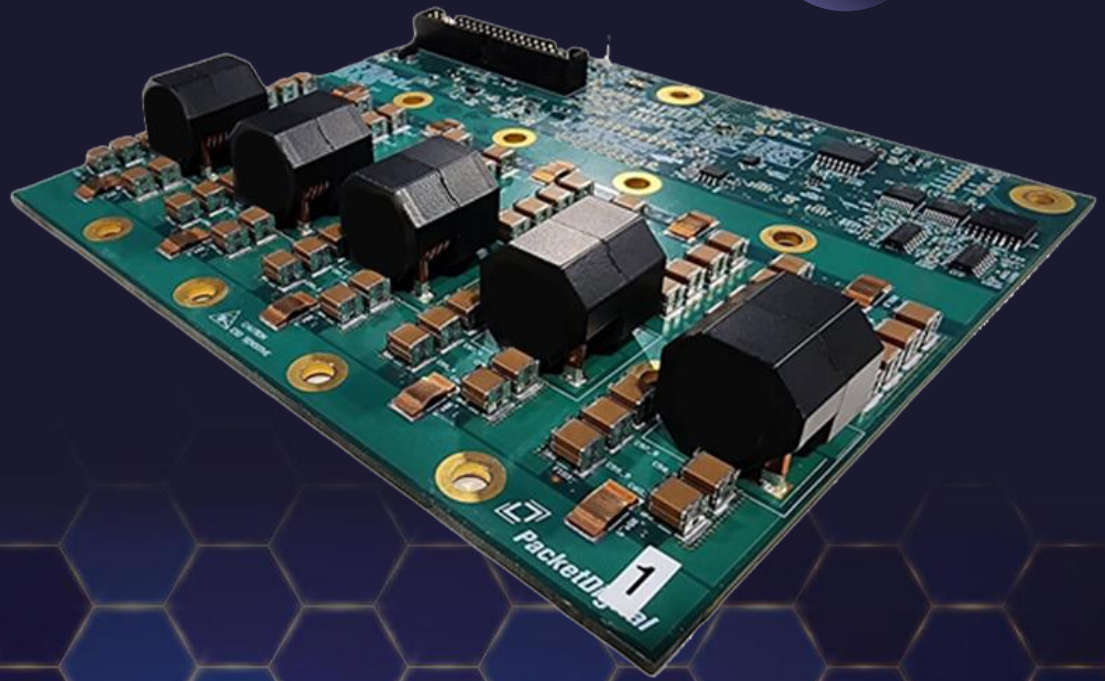
Reduce need for complex thermal management systems

Enabling scalability to fit platform needs

AFRL | PacketDigital

GaNFET Based Maximum Power Point Tracker (MPPT) Card

Packet Digital's GaN based MPPT hardware and embedded algorithms take precise power measurements and adjust settings quickly to maintain maximum power transfer from solar panels to the spacecraft bus.



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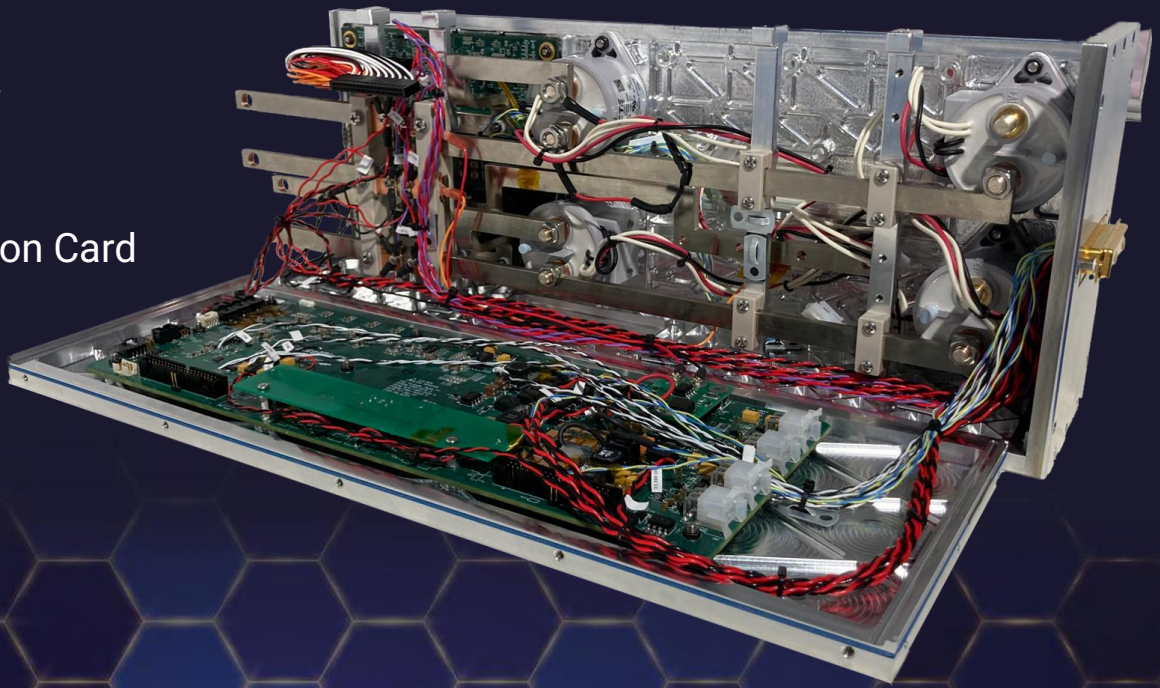
SmallSat Power Supply Unit

- Power: 3kW Nominal, 4kW Peak
- 98% Peak Conversion Efficiency
- GaNFET based MPPT
- Power Management & Distribution Card
- N+1 Redundancy
- System Safety Features
  - Overvoltage
  - Overcurrent
  - Thermal



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Future Plans

- Explore scalability of MPPT design architecture
- Software driven, paralleled and phased design allows for support at multiple power levels
- Incorporate MPPT technology into a highly integrated systems with full power management
- Actively seeking opportunities for spaceflight heritage

Power Module	Power Targets	Efficiency Targets
Cubesat EPS	80W - 400W	93% - 95%
Smallsat PMAD	600W - 3000W	97%

Product Development is a Team Effort

National Security Corridor at UND

- Impressive labs and programs that provide a unique opportunity for space research in the region.

SmallSat Payload Vacuum Testing

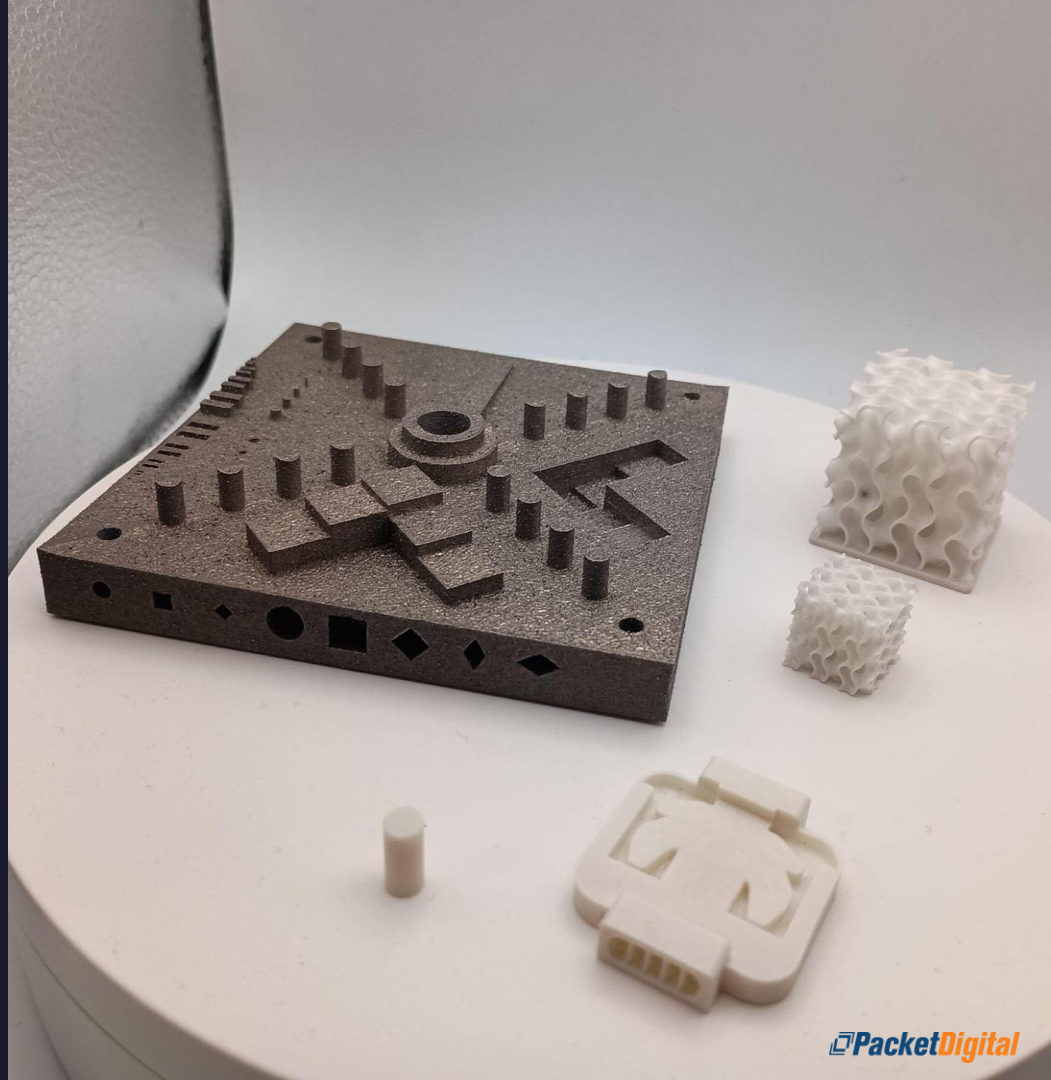
- Paving the way for future space technology development, testing, and delivery from North Dakota.

Technology Development

- Research and development of future space technology through our collaborative efforts will bolster the growing space sector of North Dakota.

Innovative Additive Manufacturing Silicon Carbide Electronic Packaging with ARPA-E

- High Performance Integrated Cooling
- Reduction in Volume
- Improved Power Density
- Improved Thermal Resistance
- Integrate a variety of working fluid, including phase change materials



Power Beaming with DARPA at White Sands Missile Range

Global Battery Manufacturing

- China accounts for 90% of the drone battery manufacturing market
- 70% of overall global battery supply originates from Asia

90%

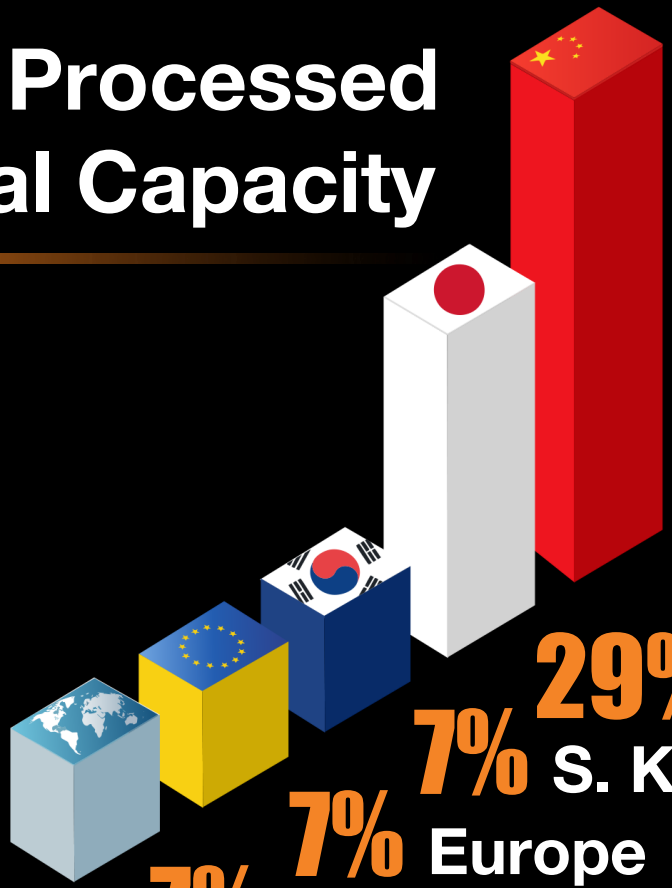
Reliance on Chinese UAS batteries

10%

UAS batteries from the rest of the world

Global Processed Material Capacity

- Cathode materials such as NCA, NMC and LCO
- Anode materials such as processed natural graphite and artificial graphite
- Over 85% of critical components originate from Asia



48% China

29% Japan

7% S. Korea

7% Europe

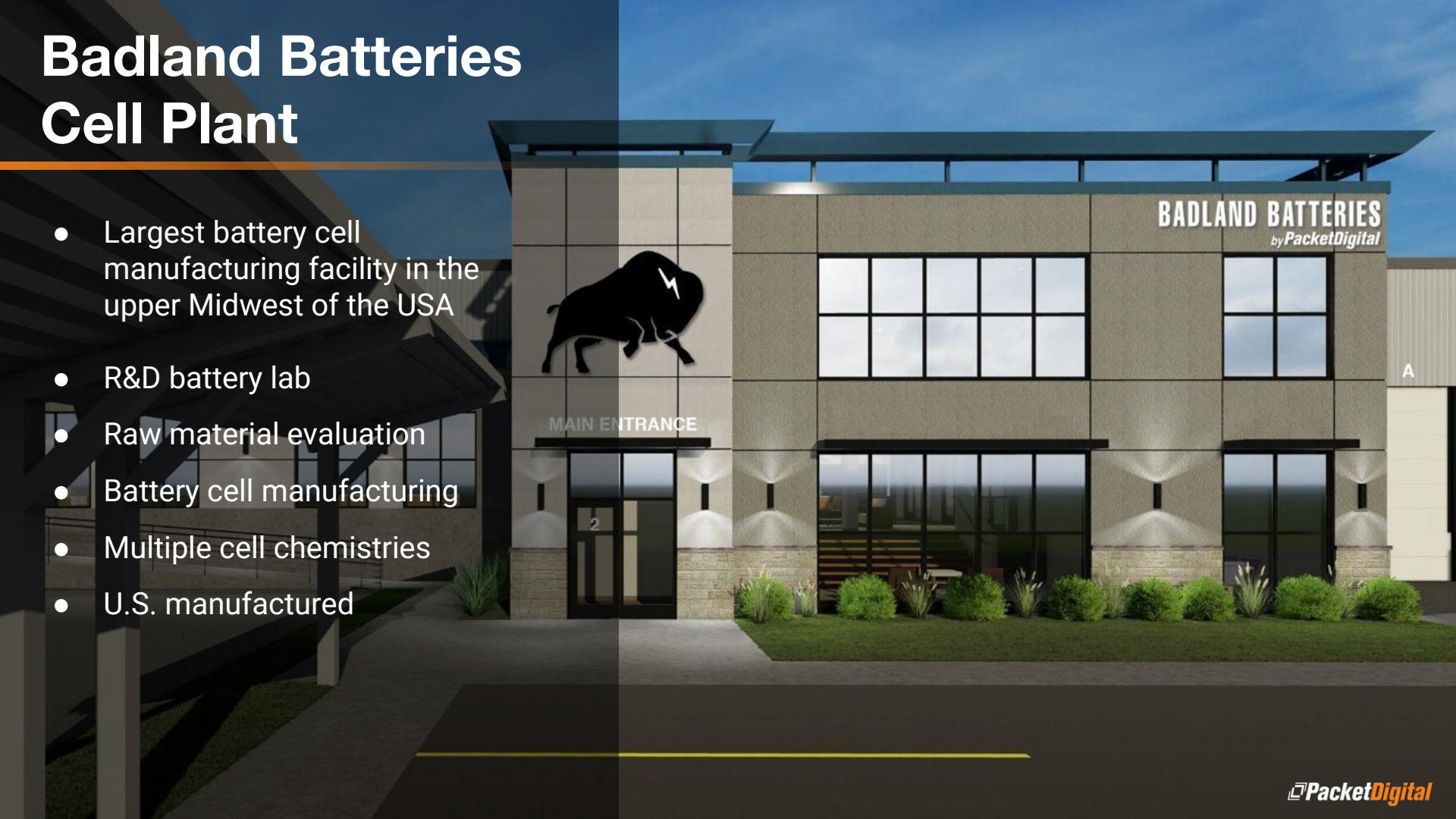
7% Others

Courtesy of the Center for Strategic & International Studies


BADLAND
BATTERIES
by PacketDigital
12S
BADLAND BATTERIES

Badland Batteries Cell Plant

- Largest battery cell manufacturing facility in the upper Midwest of the USA
- R&D battery lab
- Raw material evaluation
- Battery cell manufacturing
- Multiple cell chemistries
- U.S. manufactured



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