Protonex™

High Performance Portable and Remote Power Systems

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Hydrogen and Fuel Cell Technical Advisory Committee

June 15th, 2011

THE NEXT GENERATION OF PORTABLE POWER.™

COMPANY OVERVIEW

Organization

- Founded in 2000; headquartered in Southborough, MA with 45 employees
- Private Company
  - Listed on the AIM in July 2006; proactively delisted in June 2010

Solution Overview

- Focused on 100 - 1000 watt high-performance power solutions
- Only fuel cell manufacturer to specialize in both PEM and SOFC designs
- Over 100 granted and pending patents on key technology and processes

Value Proposition

- Clean, quiet, efficient and lightweight advanced fuel cell power solutions
- High-performance and reliable fuel cells for military applications
- Enable a range of fuels focused on specific markets and value propositions

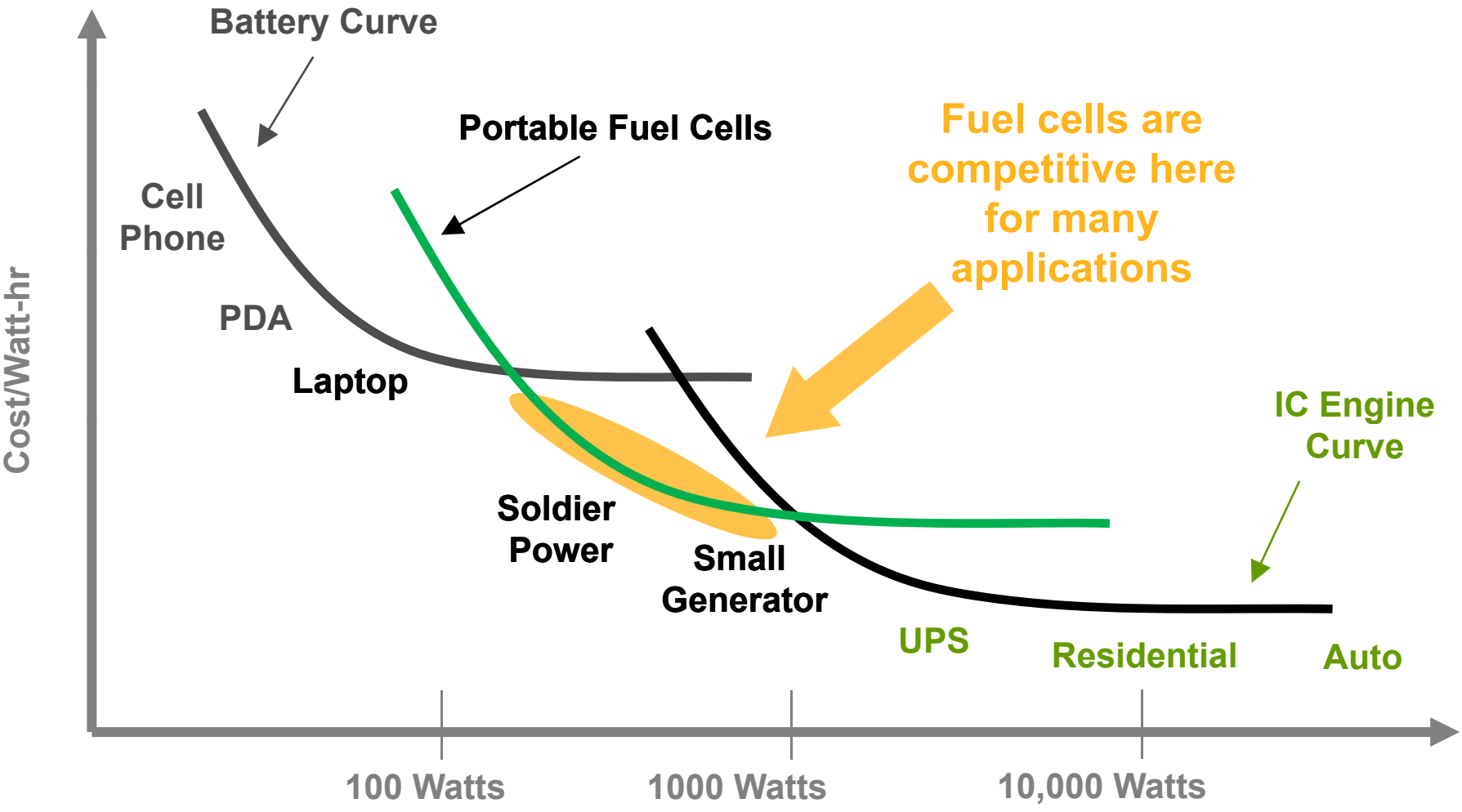
Customer and Partner Traction

- Targeted applications include: military battery charging, UAV power, APU, general portable, and others
- Key strategic partnerships with both military and commercial leaders

Financial Profile

- Accelerating product revenue as products transition from trial to deployment
- 2011 product revenue projected growth at over 90%
- Major shareholders include Parker Hannifin, Goldman and Conduit Ventures

POWER RANGE FOCUS: 100 - 1000W



COMPELLING FUEL CELL BENEFITS

vs. existing GENERATORS

- **Provides attractive alternative to operating conventional generators or main engines**
  - **Quieter** - near silent operation
    - 100X quieter than a Honda generator
    - Virtually no vibration
  - **Lighter**
    - Hybridization allows lower power fuel cell
  - **More Efficient** – Less fuel, less waste heat
  - **Cleaner** – low emission profile, low odor
    - Zero SOx and NOx; less CO

vs. existing BATTERIES

- **Rechargeables** - Fuel cell systems complement and extend functionality
  - **Hybridizes** installed battery systems
    - Clean, quiet duration extension
  - **Portable charging** method for off-grid batteries
  - **Reduces** number of batteries required in many applications

- **Non-Rechargeables** will be replaced by fuel cells in certain military applications
  - **Duration**: 2 to 4x longer
  - **Mission Weight**: 2 to 4x lighter
  - **Energy Density**: superior
  - **Lower Cost** of ownership
  - **Less Caustic** chemistries

SUB-KILOWATT PORTABLE FUEL CELLS ARE AN EXCELLENT FIT WITH MANY APPLICATIONS AND ARE WIDELY EXPECTED TO DEPLOY FIRST

POTENTIAL APPLICATIONS ARE VAST

Recreation
- RV Power
- Marine Power
- Campsite/Cabins
- General Portable

Military
- Battery Chargers
- Generators/APUs
- UAV/UGV Power
- Power Managers

Renewable
- Small Solar Systems
- Small Wind Systems
- Remote Monitoring

Transport
- Truck Idling APU
- Personal Mobility
- Small EVs

Emergency
- Homeowners
- Battery Chargers
- Comm. Equipment
- Security Systems

Protonex™

Professional
- Generators/APUs
- Battery Charging
- Scientific Equipment
- Video Surveillance

Backup Power
- Broadband / CATV
- Telecom Networks
- Critical Systems
- Traffic Systems

Government
- First Responders
- Surveillance
- Command Centers
- Remote Power

Initial Targets

MILITARY PORTABLE POWER FOCUS - 100 TO 1000W

- **Wearable (1–2 kg, ~20-50 W)**
  - Individual soldiers
  - Direct power of soldier loads, single battery charging

- **Packable (4–8 kg, 100–200 W)**
  - Squad level
  - Battery charging for soldier batteries
  - Direct power of field gear
- **Portable (10–20 kg, 200–1,000 W)**
  - Platoon+ level
  - Forward base battery charging
  - Tent power, silent watch

- **Truckable (30–60 kg, 1,000–5,000 W)**
  - Current tactical generators
  - High power equipment
  - Fixed APU for vehicles

CURRENT MILITARY PRODUCTS & PLATFORMS

M300-CX Battery Charger & APU

- 300W methanol-fueled PEM
- Fully functional 6-bay battery charger or APU
- Rapid Equipping Force / PEO soldier fielding in Afghanistan
- Demonstrating Silent watch missions with led users

S150-CX Packable Battery Charger & APU

- Enables use of logistics fuels
- Demonstrated unattended operation
- Moving from to TRL7
- Currently OSD QRF sponsored development

SPM and BPM Power Managers

- Provides soldiers with on-board power management of multiple devices
- High efficiency to reduce heat loads. Lightweight, compact and rugged
- Automatic and flexible for a wide range of applications
- Field trials ongoing in Iraq and Afghanistan

UAV, UGV and UUV Propulsion

- Demonstrated 26 hours on UAV vs. 3 on battery
- Commercializing in UAV platforms with OEMs
- Hand launchable and Tier 1 UAVs demonstrated
- Demonstrated over 3x range on FMI Talon Robot

MULTIPLE PRODUCTS IN THEATER NOW
PORTFOLIO OF SOLUTIONS FOR MILITARY POWER AND ENERGY

DEVELOPING BOTH PEM AND SOFC BASED SYSTEMS

- **Focused on 100 - 1000 watt fuel cell power solutions**
  - Focused on a broad range of applications under-served by batteries and generators
  - Fully integrated, high performance power solutions
  - Fueling solution is key to success (in the absence of a hydrogen infrastructure)

Proton Exchange Membrane (PEM)

- Fuels
  - Methanol
  - Chemical Hydride
  - Hydrogen
- Operating temperature: 50˚C – 75˚C

Solid Oxide Fuel Cell (SOFC)

- Fuels
  - Diesel, JP-8 and Gasoline
  - Propane
  - Bio and renewable fuels
- Operating temperature: 650˚C - 750˚C

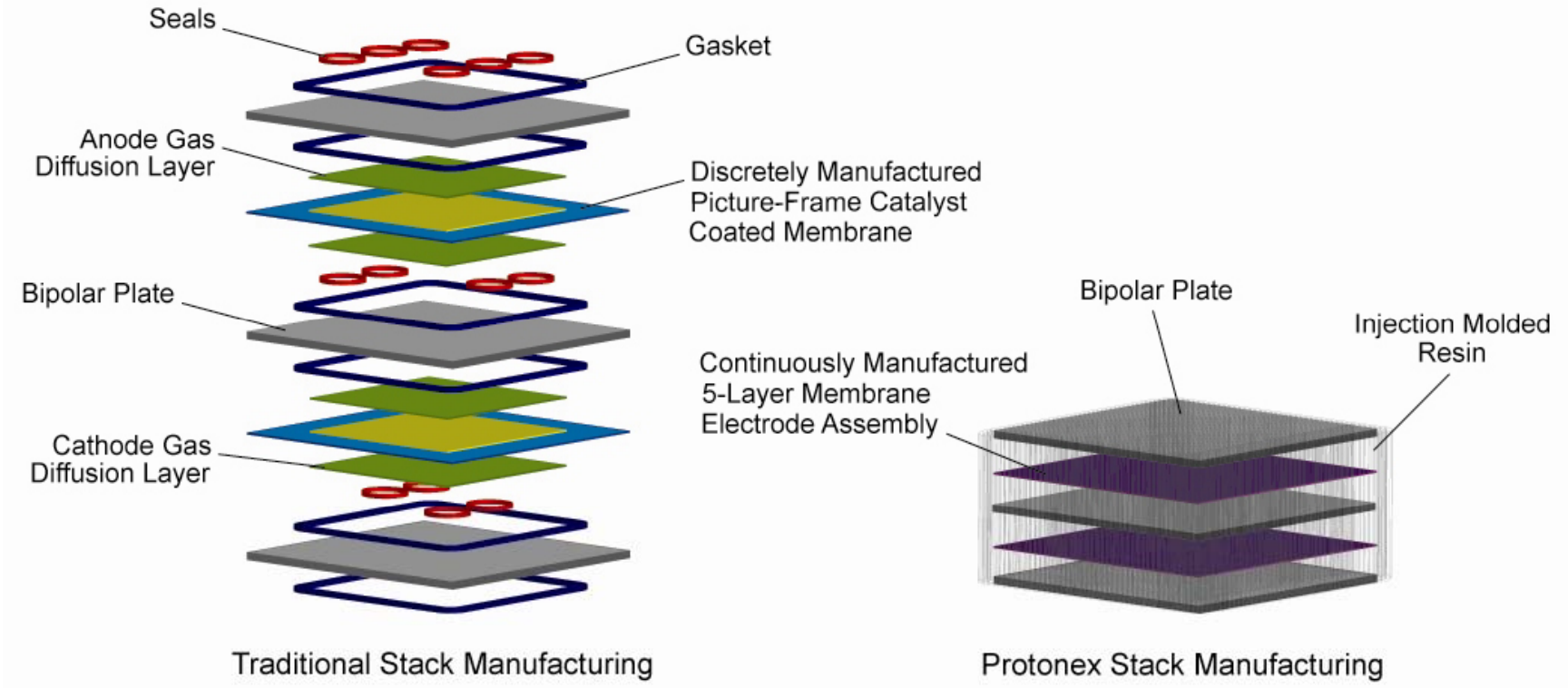
PROVIDING FULLY INTEGRATED SYSTEMS INCLUDING FUELING SOLUTIONS FOCUSED ON SPECIFIC APPLICATIONS AND MARKETS

PROTONEX ADHESIVE BONDED STACK TECHNOLOGY

- **Cost-effective, high performance design**
  - Simple construction enables fast build cycles and automation
  - Low part count
  - Membrane supplier independent
  - Compatible with both high temperature and low temperature membrane assemblies
- **Rugged and highly durable**
  - No gasket compression set
  - No exterior leakage paths
- **Liquid cooled design provides**
  - Long life
  - Stable performance
- **Scalable**

ADHESIVE BONDED STACK MANUFACTURING IS EASILY AUTOMATED FOR LOW COST IN VOLUMES

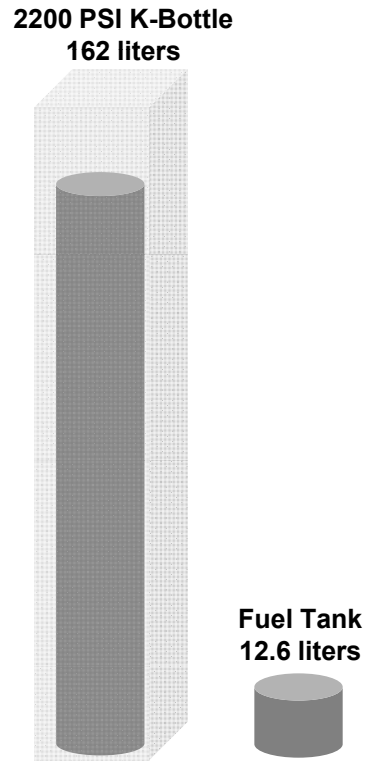
PROTONEX ADHESION BONDED FUEL CELL STACK



REDUCED PART COUNT, SIMPLE COMPONENTS AND HIGH MANUFACTURING YIELDS RESULT IN A SIGNIFICANTLY LOWER COST

METHANOL FUEL VS. COMPRESSED HYDROGEN

- **Ease of Refueling**
  - Methanol fuel is easily handled in the field
  - No high pressure connections
  - No partial bottle problem
  - No need for gas supplier – can be internalized
- **Availability**
  - Methanol is one of the most commonly used and transported chemicals
  - Easily stored by system operator
- **Long Shelf Life**
  - Does not degrade in storage like liquid hydrocarbon fuels
- **High Energy Density**
  - 1 Gallon provides > 8 hours of back-up power (250 watts)
- **Low Flammability**
  - Flashpoint significantly higher than common hydrocarbon fuels
  - Dilution with water makes non-flammable



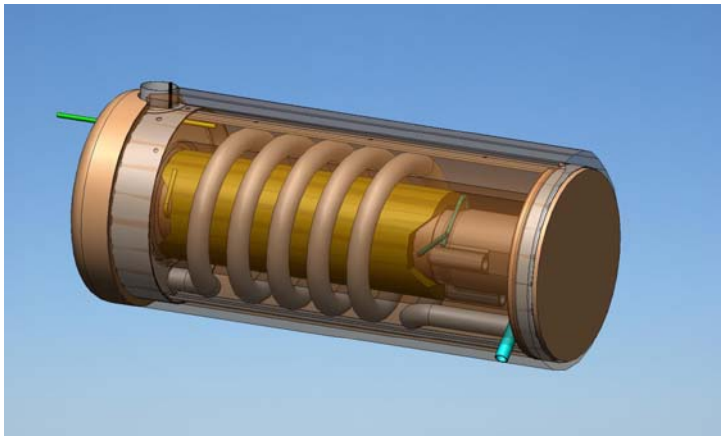
Hydrogen vs. Methanol
30 hour Back-up Volume

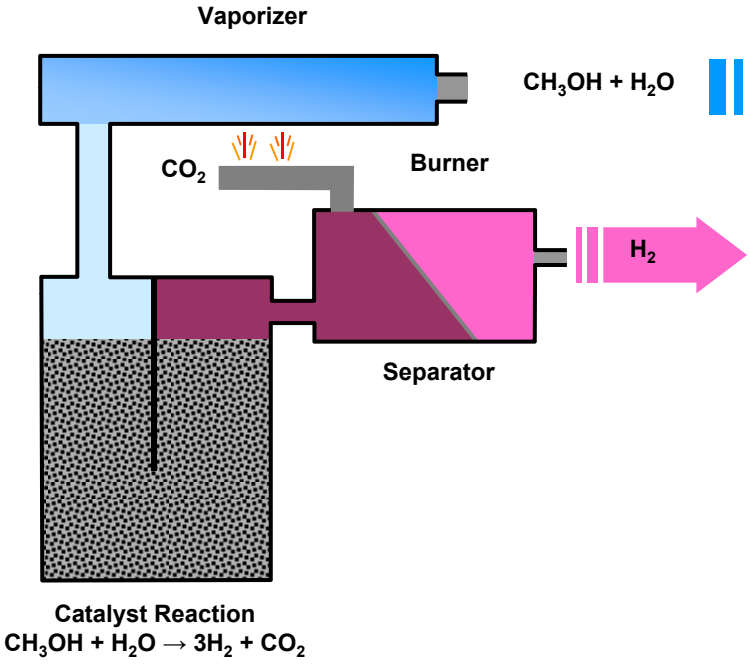
METHANOL IS A PRACTICAL FUEL FOR MANY APPLICATIONS

METHANOL REFORMER SUBSYSTEM

- Hydrogen is generated from methanol using steam reformation process
- Pre-mixed fuel significantly reduces system complexity
- Well proved components / materials of construction
- Small, relatively low temperature hot zone

- Requires pressure to drive separation process

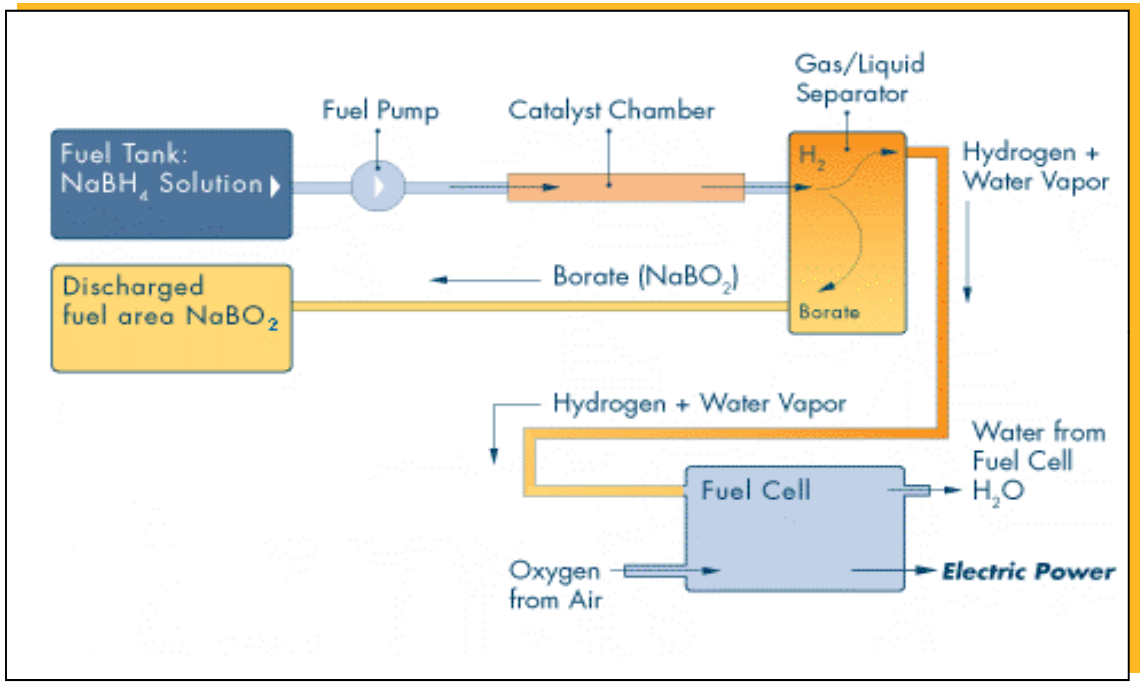




STEAM REFORMATION IS A WELL PROVEN AND ECONOMICAL PROCESS FOR PRODUCING HYDROGEN

CHEMICAL HYDRIDE FUEL CARTRIDGE
SODIUM BOROHYDRIDE [$NaBH_4$]

- Simple design
- High storage metrics
- Cartridge system
- Hydrogen as needed
- **Non-flammable**
- Non-toxic
- **Wide temperature range**
- Low cost materials



Protonex™

M300 – CX Field Battery Charger / APU

OSD - QUICK REACTION FUNDS

AMERICAN RECOVERY AND REINVESTMENT PROGRAM FOR 300 WATT SQUAD LEVEL FUEL CELL SYSTEM

THE NEXT GENERATION OF PORTABLE POWER.™

M300 PLATFORM – DETACHED BATTLEFIELD POWER

M300-CX Military Battery Charger / APU

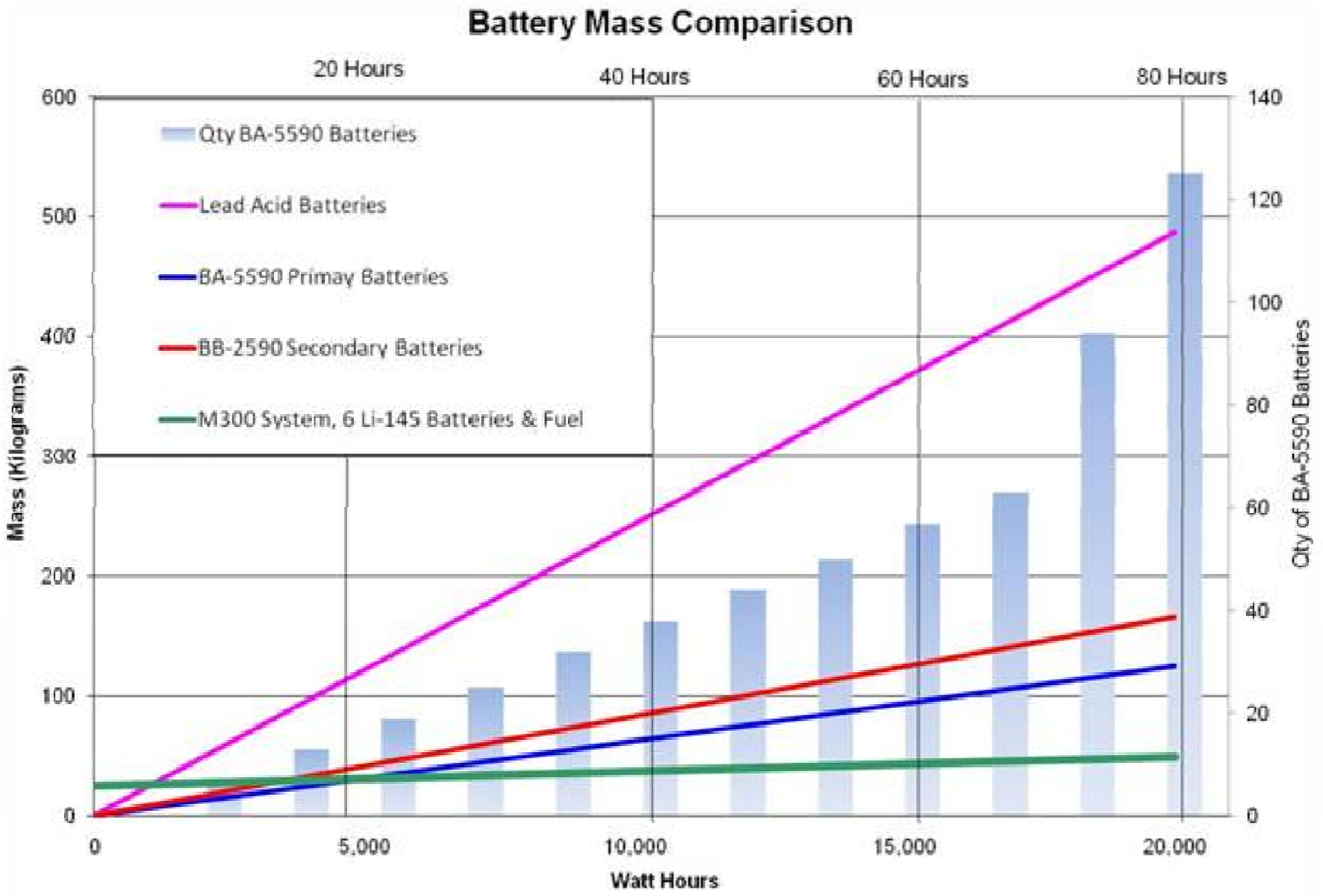
9.25 D" x 12" H x 14.25 W"
< 36 lbs

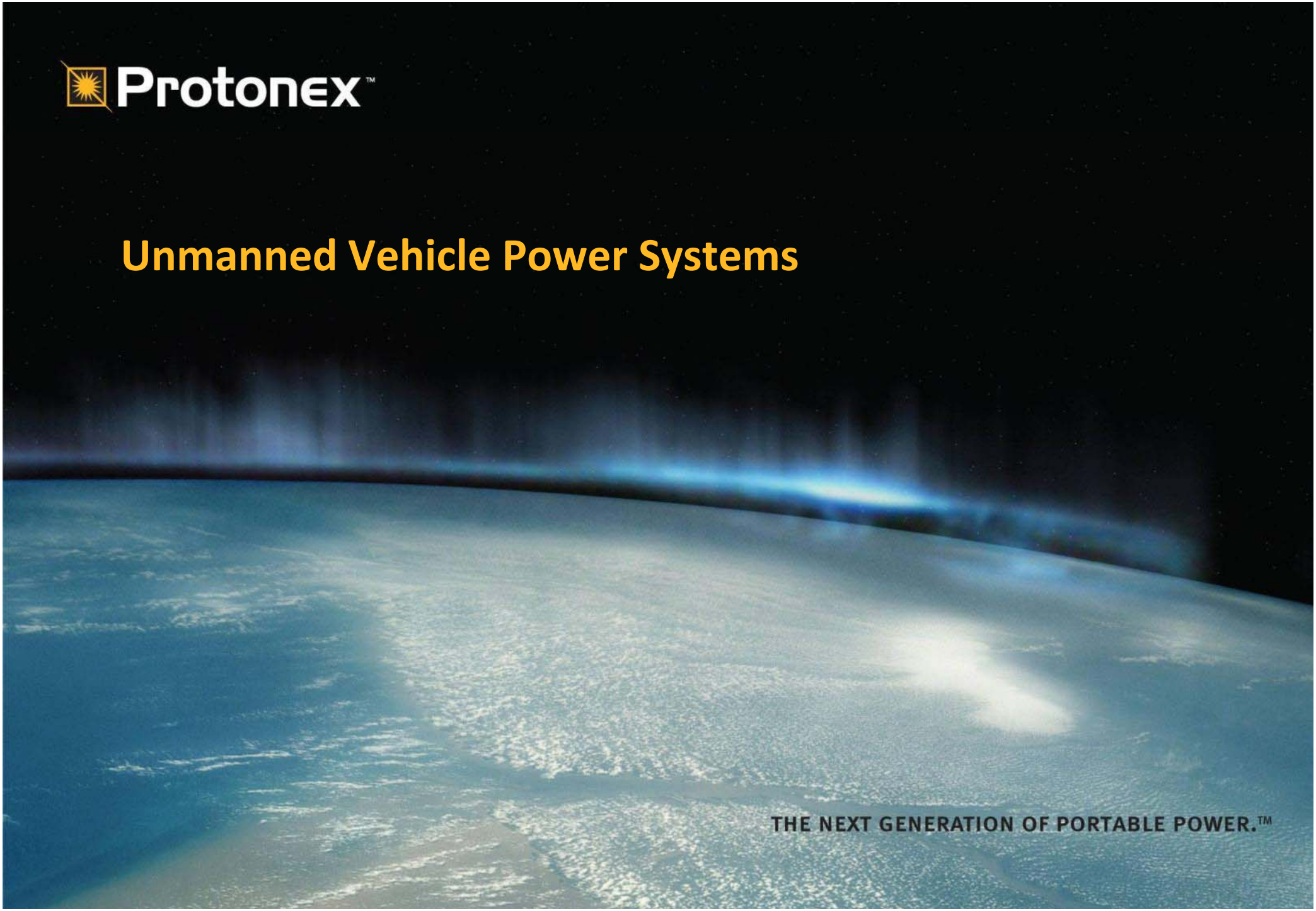
- High performance military power system
  - Light weight, low noise and low heat signature
  - Charges up to six batteries simultaneously or functions as portable auxiliary power unit (APU)
  - Enables US DoD to switch to rechargeable batteries; it currently purchases millions of non-rechargeable batteries annually.
  - Methanol is an attractive military fuel (Safe, compact, and biodegradable)
- M300 units successfully completed a major Army LUT/GSS field trial in Fall 2010
- **Rapid Equipping Force sponsorship of PEO Soldier field trial in Afghanistan**
  - Received full safety certification for in theater use
  - No de-rating up to 14,000 feet

- **< 2 liters**
- **>4 hours operation (1.2 kW hours)**

CURRENT FIELD TRIALS IN AFGHANISTAN FOR VILLAGE SUSTAINMENT OPERATIONS BASED ON WARFIGHTER REQUEST

M300 SYSTEM - VALUE PROPOSITION

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Unmanned Vehicle Power Systems
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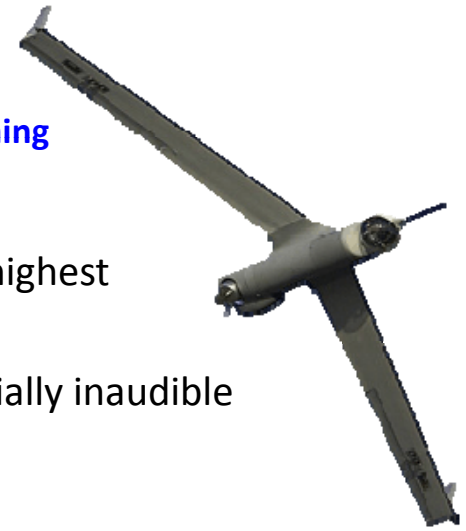
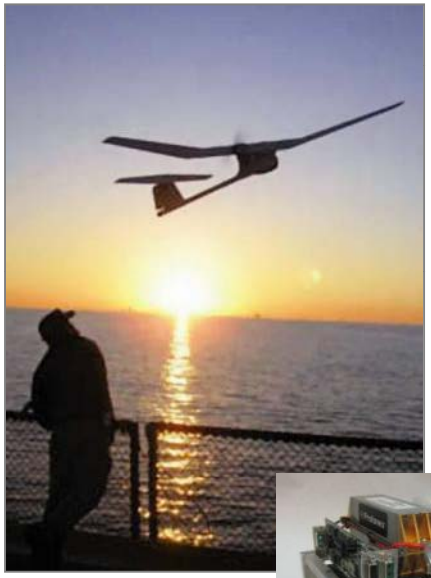
UNMANNED AIR VEHICLE POWER



"Smaller and smarter unmanned aircraft are transforming spying and redefining the idea of airpower" – *The Economist*, September 2009

- Long duration, small unmanned aerial vehicles (UAVs) are one of the highest priorities for the US Military
  - Protonex systems deliver up to 7x in flight duration and are essentially inaudible



- Ongoing development and expanding relationships with several UAV prime contractors
- Protonex UAV power systems are moving from flight demonstrations to deployable products
- Recent SURGE-V win with both Lockheed Martin (Desert Hawk) and Elbit Systems of America (Skylark LE)

RECENT FLIGHT OF 26 HOURS WITH US NAVY SET UNOFFICIAL UAV FLIGHT RECORD BY ENABLING 7X THE DURATION PROVIDED BY LITHIUM BATTERIES

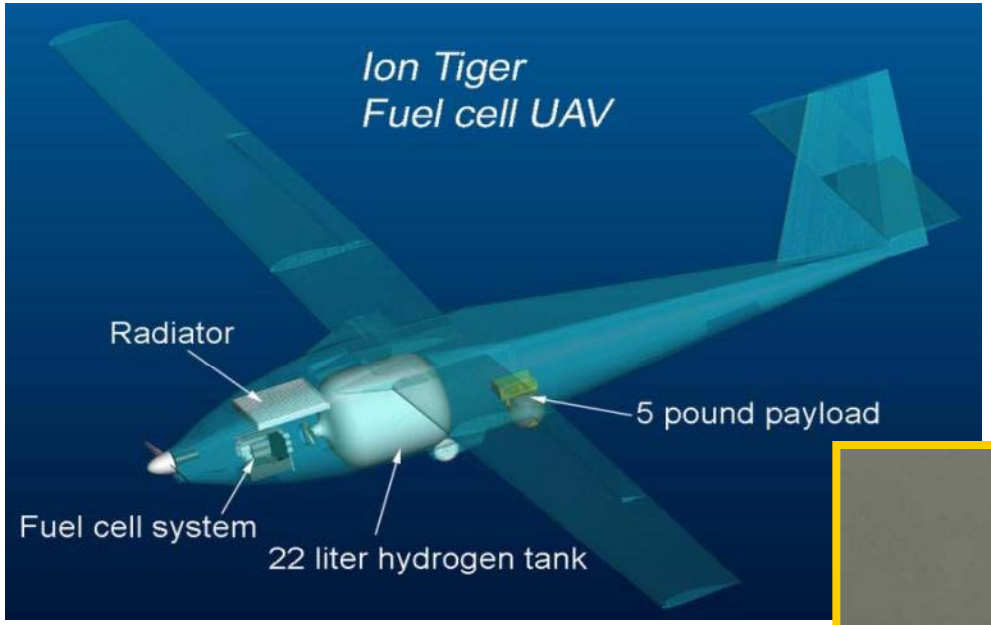
UNMANNED POWER SYSTEMS – FUELING OPTIONS

- **Compressed Hydrogen Fuel**
  - Targeted at Group 1 UAS platforms
  - Hydrogen generated on site, “Logistic Fuel” system
  - Highest performance
  - Larger logistics footprint (small electrolyzer)

- **Sodium Borohydride Fuel**
  - Targeted at man-packed UAS platforms
  - Hydrogen stored and shipped as powder
    - Stable storage medium, easy to handle
  - High performance
    - 9+hr flight demonstrated on Aerovironment Puma
  - Minimal support equipment, must be re-supplied

CORE TECHNOLOGY PAIRS WITH DIFFERENT FUELS FOR OPTIMIMUM LOGISTICS AND PERFORMANCE

NAVAL RESEARCH LAB – ION TIGER



- Fuel cell powered
- 35 lb GTOW
- 50 W / 5 lb payload
- 550 W max continuous
- ~ 250 W cruise
- 350 nm coverage

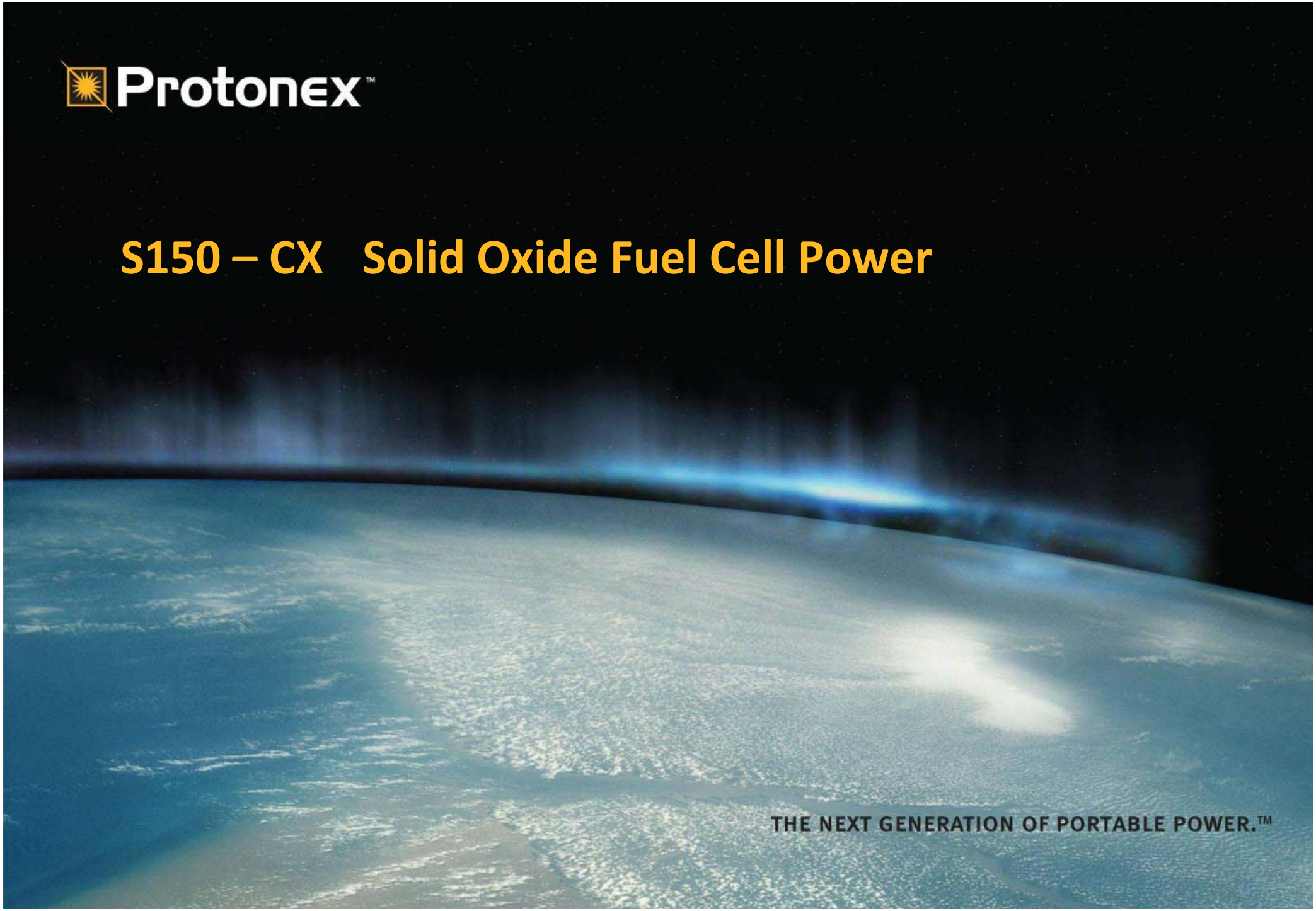
26 hour flight demonstrated

- High Power Density Fuel Cell: Over 500+ W/kg system
- Fuselage: Designed for hydrogen tanks
- Integrated System: Optimized for endurance
- Delivered next generation 1.5kW system at 750 W/kg

HAND LAUNCHABLE UAV POWER SYSTEMS

- Chemical hydride fueled [$NaBH_4$]
- Fuel cell system 100-200W
- Flight time targets:
  - Current battery systems: 2-4 hrs
  - FY07 – 6+ hrs
  - FY08 – 10+ hrs
- Demonstrate fuel cells in currently fielded UAVs
  - PUMA selected for initial integration
  - Minimal changes to existing plane

Air Force Research Laboratory
FA8650-06-C-2677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S150 – CX Solid Oxide Fuel Cell Power
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SOFC PLATFORM – Development Efforts

S150-CX Charger

- Current effort underway with US Military to develop “back packable” battery charger / APU system
- Focused on liquid fuels for safety and energy density
  - Near term – kerosene and desulfirized JP-8
  - Ultimately directly powered by JP-8 without modification
- Currently working with ARO / OSD QRF

- Next Generation Protonex Hot Zone

THIS PLATFORM IS MODULAR - ALLOWS RAPID SCALING TO HIGHER POWERS

LAB DEMONSTRATION (Summer 2010)

- Autonomous start and control
- Fueled by desulfurized kerosene
- >100 W net power

PROTONEX SUMMARY

- **Unique** – Offering fully integrated power solutions
  - Both PEM and SOFC systems enables range of fuels to broaden addressable markets
- **Scalable** – Products serve many potential applications
  - "Horizontal" solutions, much like batteries and generators
- **Near Term Opportunity** – Initial products gaining traction
  - Targeting applications that can clearly benefit from fuel cells
  - Functional technologies that meet application needs today
- **Limited Technical Risk** – Proven and fielded technology
  - Products and technologies have matured and demonstrated required performance levels
  - Increasingly broader military deployments have confirmed viability of technology
- **Strong Partners** – Industry endorsements
  - Strategic partnerships in both military and commercial

U.S. AIR FORCE

U.S.ARMY

UNITED STATES NAVY

UNITED STATES SPECIAL OPERATIONS COMMAND

Marines

POSITIONING TO BE THE "CATEGORY WINNER" IN A BROAD SET OF PORTABLE AND MOBILE POWER MARKETS BASED ON DEMONSTRABLE MILITARY SUCCESS


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