The Military Perspective on Power & Energy

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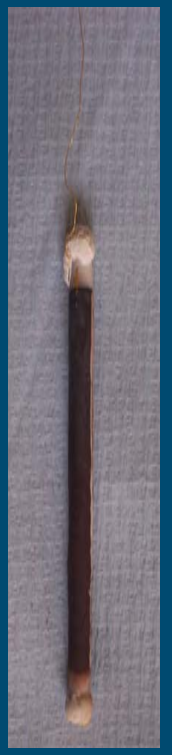
Dstl's Role in MoD

- An agency of MoD
- Dstl provides technical advice
  - on research programme formulation
  - monitoring, assessment and integration of knowledge
- Dstl provides services & connectivity
  - research that must be within government
  - access to external information sources
- Dstl assists in S&T management process
  - helping to set strategic direction
  - provision of S&T knowledge management services

Dstl Power Sources Function

- Largely advice based
  - technology watch
  - programme monitoring
  - assessment
- Focus on electrical power sources
  - e.g. fuel cells, batteries, etc
- International partnership
  - US, Canada, Germany, etc
- Current research
  - carbon-air battery (with St Andrews University)
  - borohydride fuel cell (US Office of Naval Research)
  - submarine power system modelling
  - energy harvesting

250W sodium borohydride fuel cell stack, developed for underwater application



Carbon-air cell

MoD Operational Context

Joint operations

Joint warfighting puts a premium on interoperability. Here a UK Tornado refuels from a US KC-10 tanker.

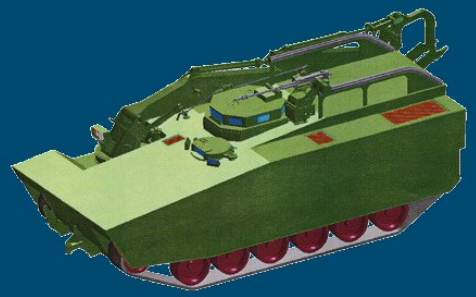
Expeditionary operations

Remote theatres of operation mean there's no power supply – power sources must be carried (left). Delivery deep into the battlespace is costly and hazardous (right).

Extreme conditions

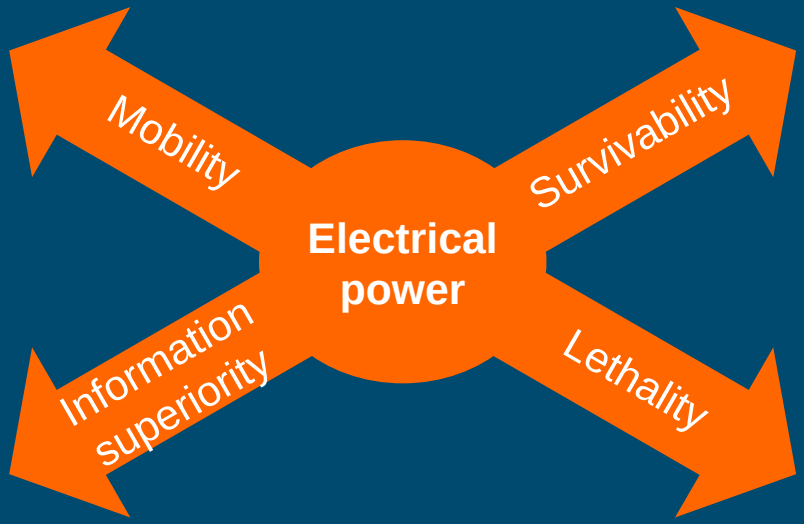
Military kit must be able to tolerate hot & dusty conditions e.g. Iraq (left). The Afghanistan mountains present a different challenge (right)

Top Level Requirements



Variant of Future Rapid Effects system. Hybrid electric drives are an option for the future

Power and energy sources are a means to an end ...



Electric armour test against rocket propelled grenades

Zephyr high altitude long endurance unmanned air vehicle

... they enable defence capabilities

90mm electromagnetic gun test firing

Dstl is part of the Ministry of Defence

Energy Sources (1)

- For large energy demand mainstream applications, liquid hydrocarbon fuels are mandated
- MoD is not a large user of fuel (relatively speaking)
  - cannot lead on future fuels
- Door is partially open for synthetic fuels

Operability on NATO single fuel is required for ground based equipment

Royal Navy requires high flashpoint fuels such as F-76

Thermal stability required for fast jet application – with higher flashpoint jet fuel variants for carrier borne aircraft

UK defence standard for jet fuel allows for blending synthetic fuels up to 50%

Ministry of Defence
Defence Standard 91-87

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Turbine Fuel, Aviation Kerosine
Type: Containing Fuel System
Icing Inhibitor
NATO Code: F-34
Joint Service Designation: AVTUR/FSII

Energy Sources (2)

- For niche applications or where overall energy requirement is relatively low, unusual energy sources are possible
- Batteries used extensively
  - platform energy storage
  - dismounted application
- Packaged fuels such as methanol could be acceptable
  - conceptually similar to batteries
  - similar logistics issues
  - could be used in dismounted applications

No other option provides the endurance of a nuclear reactor for submarine power

Power Source Requirements

- Power source requirements are complex and peculiar to the application
- Generally power source will be mobile
  - located on weight and/or space-constrained platform
  - portable
  - transportable
- Frequent themes
  - longer endurance
  - higher power
  - lower weight/volume
  - higher efficiency
  - safer, more reliable, rugged
  - low maintenance
  - stealth
  - integration

Pushing the limits of energy storage density and power density

Lower through life and logistics costs

Benefits of more-electric and all-electric platforms

Desire to reduce fuel usage

Case Study – the Dismounted Soldier

- Heavy physical load
- Up to 25% of overall weight carried can be batteries
- Electrical demand
  - communications
  - navigation
  - targeting
  - sensing
- Main current usage is primary AA cells and larger rechargeable batteries

The dismounted soldier shoulders a heavy burden

Future Soldier Technology

- Near term potential loads
  - personal role radio (data)
  - radio
  - GPS, navigation system, situational awareness computer
  - image intensifying sight
  - thermal sight & head-up display
- Medium term
  - chemical/biological agent sensors
- Long term possibilities
  - micro-climate control systems
  - exoskeletons
  - energy weapons

MoD is currently militarising and optimising for UK requirements a reformed methanol fuel cell for evaluation as a potential central power source for soldier kit

Energy Systems/Materials Requirements

- Increased energy density secondary batteries
  - new chemistries, improved safety, etc
- Fuel cells operable on military fuels
  - e.g. sulphur-tolerant materials
  - durable catalysts
  - direct oxidation materials
- More rugged power sources
  - e.g. air contaminant tolerance
- Improved energy harvesting materials
  - e.g. higher ZT thermoelectrics
- Multifunctional materials
  - e.g. stiff and light electrode materials

MoD Initiatives/Opportunities

- Centre for Defence Enterprise
  - gateway for disruptive/innovative proposals
- Defence Technology Centres
  - MoD/academia/industry partnerships
  - SEAS DTC has a power strand
- Counter-Terrorism Centre
  - open to new partnerships
- High Impact Rapid Implementation Demonstrator Programme (HIRID)
  - high risk, high payoff technologies
  - portable power is one of the pilot themes
- Joint Academic Research Defence Programme
  - joint MoD/research council funding
  - Dstl good first point of contact
- Equipment programme contracts

www.science.mod.uk

www.ctcentre.mod.uk

www.contracts.mod.uk