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The burden of fuel and logistics demands on militaries are as old as warfare itself.

"Throughout history, energy has been the limiting factor in all military operations," wrote Dr Douglas Kirkpatrick, manager of the US Defense Advanced Research Projects Agency's (DARPA) biofuels programme in 2007.

"Whether it was Roman armies foraging for supplies or General George S Patten running out of fuel as he dashed across France.

"The situation is little different today".

It is also arguable that military aspirations have been equally consistent. The world's armed forces have always looked to the ultimate goals of absolute security of supply and freedom from reliance on foreign (and potentially unreliable) suppliers; limitless endurance; zero logistics demands; and cost predictability.

Green shoots of 2008?

While the aims are old, the alternative fuels and propulsion debate gathered fresh momentum in 2007 and 2008 for two principal reasons. Firstly, green shoots emerged as a number of solutions that were up to a century old in concept continued to mature almost to the point of validity.

Specifically, these are hybrid electric drives (HED) for land systems (used with limited success in tanks during the First World War) and synthetic aviation fuels (used extensively in various forms during the Second World War as ersatz petroleum).

Secondly – and most importantly – the price of oil continued a steep upward trajectory and doubled between 2007 and 2008.

The military impact of oil soaring past the psychologically significant USD100 per barrel mark was profound.

The world's top twenty defence markets spent around USD17 billion dollars on fuel in 2007: Jane's Industry Quarterly estimates that the price hike of 2008 added around USD6 billion to this bill.

Budgetary burdens aside, the vulnerability of armed forces to energy market vagaries was clear. Every dollar added to a barrel of oil cost the US Air Force up to USD130 million; the US Navy

USD40 million; the UK Ministry of Defence up to USD4 million; and the Australian Department of Defence up to USD3 million.

To put military energy demands into perspective, the US military consumes around 300,000 barrels of oil per day: roughly twice the total consumption of a nation the size of Israel. It takes 187,000 barrels a day to keep the US Air Force flying (roughly equivalent to the consumption of Denmark).

The legacy of 2008

Oil prices peaked, of course in 2008 with the high-tide towards the middle of the year. They subsided sharply and are forecast by analysts Cambridge Energy Research Associates (CERA) to hover between USD50-60 for the remainder of this decade.

The legacy of 2008 prices remains, however, and it should be stressed that the price of fuel alone was never the main driver behind moves towards alternative energy. The key is predictability: forces do not want to face further unbudgeted energy shocks, and the big issue of security of supply remains.

One of the more important effects of high energy prices was that they acted as a leveller. Energy solutions that had previously fallen away were revisited as the trump card of conventional solutions – cost – largely evaporated.

Obstacles on the road to Utopia

The need to reduce petroleum reliance is clear: the US DoD, for example, imports around 60 per cent of its fuel which points to a strategic weak-point. Other net importers in the West face a similar problem.

Regardless which of the current solutions in the land or air sectors are pursued, two major obstacles must be overcome before further progress can be made:

1. Militaries can provide neither a broad nor sufficiently large market to motivate industry to meet demands that remain nebulous
2. The major defence markets of the West are facing a period of austerity with relatively flat spending growth at best, and – in the cast of the United States – a decline in spending ahead. Will militaries commit to the "jam tomorrow" spending necessary to drive new solutions when there are so many competing demands?

In both the land and air sectors, current solutions point to reasons for optimism if certain conditions can be met.

Air: Alternative fuels

The United States is the biggest oil consumer on earth, the DoD is the biggest oil consumer in

the US, and the USAF is the biggest consumer of oil in the DoD (aviation fuel accounts for around 52 per cent of total DoD consumption).

The USAF is, therefore, the only one of the world's air forces in a position to drive moves towards new fuels.

The need to reduce foreign oil reliance and the logistics train (fuel accounts for 70per cent of America's logistics burden) have proved powerful incentives.

The USAF has made significant progress towards its two-stage target: to certify the entire USAF fleet to run on synthetic fuel by 2011, and to acquire 50 per cent of its domestic fuel requirement via alternative sources by 2016.

To date, the USAF has focused largely on synthetic fuels such as those derived through the Fischer Tropch coal to liquid (FT – CTL) process. The rationale is sound: the US has 27 per cent of the world's coal reserves, pointing to the potential for absolute security of supply.

There are problems, however. At present there is just one commercial producer of CTL fuels in the world (South Africa's Sasol with a capacity of around 150,000 barrels per day).

This points to the need to create a new energy production infrastructure from scratch within the United States, which is where the problems really begin.

The costs of building FT manufacturing facilities are outlandish: roughly five times the cost of conventional refineries.

Who would carry the risk of establishing production is the big question, given that the energy industry would face the issues of a limited customer base (and military demand that is far from guaranteed at present) and relatively limited demand (Jane's research indicates that the USAF would look initially to purchase around 40,000 barrels a month).

Synchronising demands with those of the commercial sector will be essential, and there a strong possibility that this could be achieved.

Civil airlines have their own targets. The main industry body, the International Air Transport Association, wants its members to use 10 per cent alternative fuels by 2016

Given that the world's commercial airlines consumed USD136 billion of aviation fuel in 2007 alone, combined civilian and military demand would create the critical mass to achieve change.

It is doubtful, however, whether commercial carriers will share the USAF's enthusiasm for CTL fuels. The IATA has noted the substantial investment that would be needed to ramp up production; the limited environmental benefits (carbon dioxide emissions from the manufacture of CTL fuels are twice that of conventional methods, excluding carbon capture methods which the body describes as "unproven").

Price will also be an issue: the cost of CTL fuels was put by the IATA at around USD130-200 a barrel (somewhat ahead of USAF estimates of around USD85). Given that the world is entering an era of relatively cheap oil, the cost advantage over conventional fuels has evaporated which leaves environmental concerns as the principal driver.

The industry has, therefore, shown a preference for "third generation" biofuels: those drawn from sustainable, non-food biomass sources such as algae. The last 12 months saw a series of test flights using such fuels by carriers including Virgin Atlantic and Air New Zealand.

The potential of third generation biofuels is currently being explored by the US DARPA with a view to developing a JP-8 that is indistinguishable from petroleum-based JP-8s and which will be 100 per cent biofuel as opposed to a blend. The cost goal is USD3 per gallon (or USD93 a barrel).

Scaling up feedstock production – "from the [algae] ponds the size of a room to something the size of the Pentagon", in the words of one proponent – will be a challenge, but both the will and market size are likely to be apparent.

Land systems: hybrid electric drives

Just as commercial sector interest will be essential to the viability of alternative jet fuels, the success of hybrid-electric drive (HED) in land systems is dependent on civilian take-up.

In short, HED-powered vehicles will not make it to the battlefield until they are widely used on city streets.

For all the advantages offered by such systems – reduced fuel consumption, surplus energy to power external systems, reduced logistics demands and design flexibility – it is telling that, to date, the plethora of demonstration contracts around the world have led to just one production contract (under the US Future Combat System).

The two greatest obstacles to acceptance have been maturity and clarity on life-cycle costs. Diesel propulsion is tried and test, and the through-life costs are relatively predictable.

There is also the high level of commonality at present between military and large commercial vehicles, for very good reasons: purchasing "commercial off the shelf power plants" – particularly for smaller armoured vehicles - keeps costs down and pretty much guarantees the availability of service parts at a reasonable price.

This is where HED falls down at present: the systems are relatively bespoke. There are signs of real demand in the civilian world, however, as the advantages of large truck and bus operators are clear: there is huge political pressure to reduce emissions and commercial pressure to keep fuel costs down. HED can help to deliver both.

There are already examples of convergence in the real world, too. BAE Systems' hybrid technology was taken up by Transport for London (TfL) in 2008 with 17 buses built by

Alexander Dennis Limited being evaluated for passenger service. It is clear that greater take up will help to allay the cost, durability and lifecycle concerns of military procurement bodies.

Outlook

The decline of energy prices since the middle of 2008 appears unlikely to weaken the resolve of militaries to reduce foreign oil reliance.

Moves towards new energy are likely to survive the coming period of both cheap fuel and relative budget austerity, particularly in the United States where the aims of the new President Obama administration and those of the Pentagon can be seen to converge in the field of energy security.

Militaries – despite epic fuel demands and relatively large budgets – cannot drive change alone, however, and at best can hope to be market initiators. If change is to come, synchronising the requirements and aspirations of the civilian and military sectors will prove essential.

Guy Anderson is also editor and lead analyst of Jane's Defence Industry, Jane's World Defence Industry, Jane's Defence Budgets, and Jane's Industry Quarterly. Jane's Industry Quarterly – "Beyond Gasoline? Defence, Energy and the New Challenges for Industry" was published in January 2009.