Challenges at the Intersection of Energy, Economy, Environment, & Security and the Role of the Defense Sector in Addressing Them

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The energy/economy/environment/security challenge in a nutshell

• Without energy there is no economy.

• Without climate there is no environment.

• Without economy and environment there is no material well-being, no civil society, no personal or national security.

The problem is that the world is getting most of the energy its economies need in ways that are imperiling the climate its environment needs.
The climate-change dimension

- Global climate is changing rapidly compared to what’s been normal over the millennia.
- Human activity – above all fossil-fuel burning and tropical deforestation – is the main reason.
- The observed changes – not only in average temperature but also in extremes & patterns of temperature, precipitation, & storminess – are already causing widespread harm.
- Much greater harm is ahead unless society moves rapidly to reduce the offending emissions and adapt to the changes no longer avoidable.
- Remedial action is cheaper than unabated harm.

Global average T: the thermometer record

2010 tied 2005 as the hottest year on record; 2007 tied 1998 as 2nd hottest; 15 hottest all occurred since 1990

http://data.giss.nasa.gov/gistemp/graphs/
Why it’s not just about average temperature
Climate = weather patterns, meaning averages, extremes, timing, spatial distribution of…
• hot & cold
• cloudy & clear
• humid & dry
• drizzles & downpours
• snowfall, snowpack, & snowmelt
• breezes, blizzards, tornadoes, & typhoons
Climate change means disruption of the patterns.

Global average temperature is just an index of the state of the global climate as expressed in these patterns. Small changes in the index → big changes in the patterns.

Harm is already occurring
Worldwide we’re seeing, variously, increases in
• floods
• wildfires
• droughts
• heat waves
• pest outbreaks
• coastal erosion
• coral bleaching events
• power of typhoons & hurricanes
• geographic range of tropical pathogens
### Energy, economy, & CO₂ in 2010

<table>
<thead>
<tr>
<th></th>
<th>population (millions)</th>
<th>ppp-GDP (trillion $)</th>
<th>energy (EJ)</th>
<th>fossil E (percent)</th>
<th>fossil CO₂ (GtCO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>6892</td>
<td>74.3</td>
<td>558</td>
<td>84%</td>
<td>32.3</td>
</tr>
<tr>
<td>China</td>
<td>1341</td>
<td>10.1</td>
<td>115</td>
<td>88%</td>
<td>8.5</td>
</tr>
<tr>
<td>USA</td>
<td>310</td>
<td>14.7</td>
<td>102</td>
<td>87%</td>
<td>5.9</td>
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<tr>
<td>India</td>
<td>1216</td>
<td>4.1</td>
<td>33</td>
<td>67%</td>
<td>1.7</td>
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<tr>
<td>Russia</td>
<td>140</td>
<td>2.2</td>
<td>30</td>
<td>91%</td>
<td>1.6</td>
</tr>
<tr>
<td>Japan</td>
<td>128</td>
<td>5.5</td>
<td>23</td>
<td>82%</td>
<td>1.3</td>
</tr>
<tr>
<td>Germany</td>
<td>82</td>
<td>2.9</td>
<td>14</td>
<td>83%</td>
<td>0.8</td>
</tr>
</tbody>
</table>

### Defense-sector issues around energy and climate change

- US oil dependence and greenhouse-gas-driven global climate change both pose significant national- and international-security challenges.
- The defense sector is a major user of energy and a correspondingly major emitter of GHG.
- The defense sector’s energy use is a big cost issue and an even bigger logistics & vulnerability issue.
- The defense sector is positioned to lead in developing and deploying energy-efficiency & clean-energy solutions.
DoD Energy Costs, FY2010

DoD Energy Costs
FY10: $15.2B
FY09: $13.4B

Operational
- Jet Fuel 81%
- Diesel-Distillate 4%
- Aviation Gasoline 0%
- Other 2%
- Navy Special 12%

Facilities Energy:
- Electricity 64%
- Fuel Oil 9%
- Coal 2%
- LPG 2%
- RE Purch 3%
- Steam 0%
- Nat Gas 14%

Installations
- Fleet Fuel 8%
- RE Purch 3%
- Electric 64%
- Nat Gas 14%
- Fuel Oil 9%
- Coal 2%
- LPG 2%
- Steam 0%

* $4.01B in facilities energy costs include non-tactical vehicle fuel
$3.76B – facilities energy
$0.25B – non-tactical vehicle fuel

Operational energy: cost & vulnerability

“Unleash us from the tether of fuel.”

Lt. Gen. James Mattis, USMC

Estimates of fully burdened cost of delivering fuel to theater have ranged from $12 - $500 per gallon

According to Army Energy Security Office, a 1% fuel savings will result in 6,444 fewer soldier-trips

US supply convoys in Afghanistan have suffered the loss of more than 3000 troops or contractors
Facility energy: cost, reliability, impact

- **Significant Cost**
  - Cost likely to increase (reduced presence in Iraq and Afghanistan, improved Quality of Life)

- **Mission Assurance/Energy Security**
  - DoD’s reliance on a fragile commercial electricity grid places continuity of critical missions at serious and growing risk

- **Environmental Impact**
  - Contributes a disproportion share (~ 40%) of GHGs

Climate connections to security

Climate change itself can have impacts on...
- international tensions, increasing chance of conflict
- types of missions security forces must perform
- effectiveness of troops & equipment in combat

Remedies for climate change may affect...
- tensions/vulnerabilities from energy dependencies
- access of states & terrorists to nuclear weapons
- international cooperation (*reducing* tensions)

Both impacts *and* remedies could reduce...
- funding for forces and readiness
Climate-security connections (continued)

Impacts of climate change on tensions

- water shortages in international river basins $\rightarrow$ increased disputes
- ice-free Arctic $\rightarrow$ disputes over ownership of and access to undersea resources there
- suffering $\rightarrow$ civil disorder, government instability $\rightarrow$ oppression, external conflict as a distraction
- suffering $\rightarrow$ large flows of environmental refugees $\rightarrow$ civil disorder, reaction-intervention
- disputes & tensions over responsibility and compensation for climate-change damages

Climate-security connections (continued)

Impacts of climate change on types of missions

- floods, droughts, wildfires, powerful storms, pest outbreaks $\rightarrow$ increased “civil defense” demands
- ice-free Arctic $\rightarrow$ ship traffic, resource-harvesting operations $\rightarrow$ increased patrol requirements

Impacts of climate change on effectiveness

- complication of combat operations by increased heat, dust, mud, storms, flooding…
- impacts on troop health by worsened disease environment (malaria, dengue…)
- impacts on viability, effectiveness of bases
Climate Change in the Quadrennial Defense Review

“DoD will need to adjust to the impacts of climate change on our facilities…”

Climate Drivers at US installations
- Arid areas of the Southwest will become hotter and drier
- Increased temperatures and weather extremes in the Southeast
- Rising temperatures will impact cold-region installations
- Coastal areas will be impacted by sea level rise and storm surge

Installation Vulnerabilities
- Built infrastructure
- Training and testing lands
- Stressed ecosystems
- Military mission capability

What’s expected: sea-level rise to 2100

The National Academies, America’s Climate Choices, 2010, vol 1
How DoD is meeting energy & environmental challenges

- Investments in science and technology
  - E.g. advanced fuels and propulsion systems, lightweight vehicles, batteries, enhanced Earth observations, ...

- Early procurement of energy efficient technologies

- Innovation & responsible operation at facilities and ranges
  - Clean-energy and energy-efficiency technologies & practices
  - Environmental stewardship

S&T supports new DoD capabilities

<table>
<thead>
<tr>
<th></th>
<th>FY 2011 Request</th>
<th>FY 2011 Appropriation</th>
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<tbody>
<tr>
<td>&quot;Science and Technology&quot;</td>
<td>11,833</td>
<td>12,102</td>
</tr>
<tr>
<td>DOD S&amp;T (&quot;6.1&quot; - &quot;6.3&quot;)</td>
<td>1,999</td>
<td>1,947</td>
</tr>
<tr>
<td>DOD basic research (&quot;6.1&quot;)</td>
<td>4,476</td>
<td>4,492</td>
</tr>
<tr>
<td>DOD applied research (&quot;6.2&quot;)</td>
<td>5,359</td>
<td>5,663</td>
</tr>
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</table>
Vehicle efficiency

- Advanced technologies for medium and heavy trucks can enhance performance, extend operational range, and reduce costs.
  - Hybrid propulsion systems
  - High-efficiency engines, lubricants, thermal systems
  - Lightweight components
  - Energy storage for backup power and vehicle-to-grid operation

Advanced biofuels for ships & aircraft

- Biofuels are an essential component of President Obama’s plan to reduce U.S. oil imports by one-third by 2025.
- A DOE-USDA-Navy initiative is investing $510 million for early production of “drop-in” aviation and marine biofuels.
- March 2011: F-22 Raptor flight at 1.5 Mach with a 50/50 fuel blend of conventional JP-8 and biofuel from camelina.
- November 2011: U.S. Navy destroyer operated with a 50/50 blend of an algae-derived oil and petroleum.
Early procurement by the military: a historical example

- Early military use helped drive semiconductor market development
  - Helped to push prices lower
  - Lower prices spurred commercial applications
- Today’s market is dominated by commercial applications
  - Global market over $200 billion
  - DoD share only 1-2%

![US Semiconductors Market Price and Military Use, 1962-1968](image)


Facility energy test beds

Emerging technologies hold the promise of dramatic improvements in building energy performance but face major impediments to commercialization and deployment

- Use DoD Facilities As Test Bed For Innovative Energy Technologies
  - Validate performance, cost, and environmental impacts
  - Transfer lessons learned, design and procurement information across all Services and installations
  - Directly reach out to private sector for innovations
  - Leverage DOE investments
- Develop, Test, & Evaluate For All DoD Facilities
  - Energy Conservation & Efficiency
  - Renewable and Distributed Energy Generation
  - Control & Management of Energy Resources & Loads
Innovation for DOD installations: building efficiency

- Efficient buildings systems can reduce costs, improve system reliability, and improve environmental sustainability.
  - Weatherization, white roofs
  - Efficient lighting, heating/cooling
  - Bulk energy storage
  - Assessment and design tools
  - Energy management systems
  - Intelligent buildings

Innovation for DOD installations: electric power

- Advanced electric power systems can reduce costs, enable resilient and secure power for critical loads, and reduce CO₂ emissions.
  - Utility-scale renewable energy
  - Distributed power: solar PV, wind, fuel cells, microturbines, and Combined Heat & Power systems.
  - Energy storage
  - Microgrids
  - Smart power management
  - Vehicle-to-grid power backup
Alternate fuel vehicles

- The Federal Government has made a push towards a fleet of alternative fuel vehicles (AFVs)
  - AFV fleet acquisitions have grown from 26% in 2005 to 46% in 2009
  - Alternative-fuel medium and heavy truck fleets can use centralized alternative fueling and maintenance.
- White House Goal: by 2015, all Federal-agency new vehicle purchases will be AFVs, including hybrid and electric vehicles.
- Potential Federal EV Acquisitions
  - DoD, GSA, USDA, DoJ
  - As a combined effort to green 100% of their acquisitions, these 4 agencies can make an estimated 26% market impact at a total cost increase of $326 million

<table>
<thead>
<tr>
<th>Current Fleet Size ('000s)</th>
<th>Cost Differential ($, millions)</th>
<th>Market impact (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA 199.6</td>
<td>206</td>
<td>19</td>
</tr>
<tr>
<td>DoJ 40</td>
<td>59.5</td>
<td>4</td>
</tr>
<tr>
<td>DoD 195</td>
<td>42.9</td>
<td>2</td>
</tr>
<tr>
<td>USDA 42.9</td>
<td>17.6</td>
<td>1</td>
</tr>
<tr>
<td>Total 477.5</td>
<td>326</td>
<td>26</td>
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* Cost Differential assumes a 20% price premium

DOD/ACE engagement in interagency adaptation and assessment activities

- SERDP represents DoD on the National Climate Assessment and has played a major role in the Interagency NCA working group (“INCA Task Force”). This group provides the core agency support for our broad new Assessment strategy.
- John Hall is the DoD “ex officio” representative on the Assessment FAC and co-lead for the “sustained assessment” working group
- Kevin Knuuti (CREL) and John Hall (SERDP) were major contributors to the draft sea level rise guidance for the NCA.
DOD/ACE engagement in interagency assessment & adaptation activities (cont.)

- Participation in the CEQ-OSTP-NOAA Adaptation Task Force, which is focused on enhancing resilience of federal facilities and programs to impacts of climate change as well as working towards a national strategy for adaptation
- ACE and DOD are in various stages of developing their agency-wide adaptation strategies to meet the June 1 deadline
- ACE has had significant engagement in the development of the recently released Freshwater Action Plan, a major report of the ATF

In short:
The defense sector is a crucial player in our national strategy of innovation to address energy & climate challenges.