

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

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Plenary Address

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

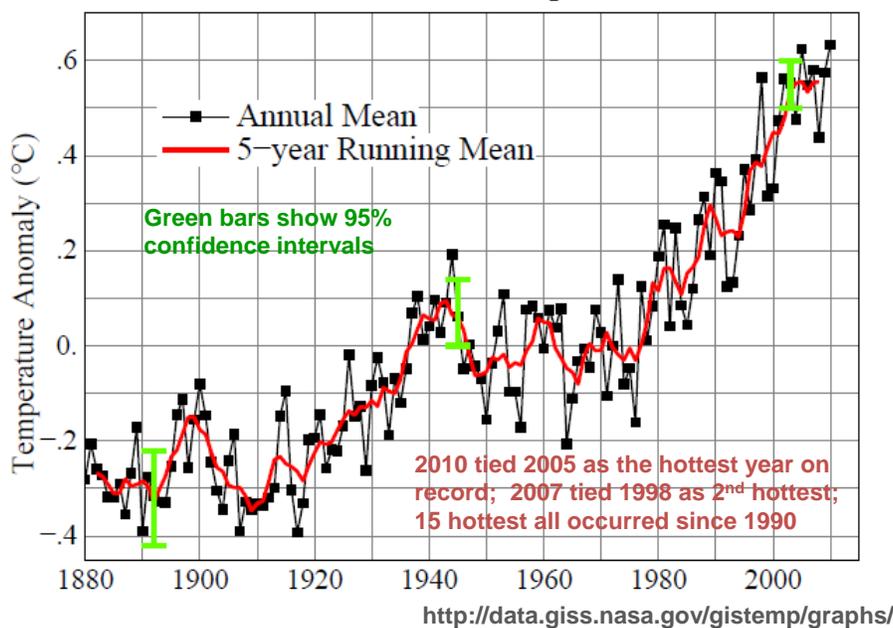
- Without energy there is no economy.
- Without climate there is no environment.
- Without economy and environment there is no material well-being, no civil society, no personal or national security.

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



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

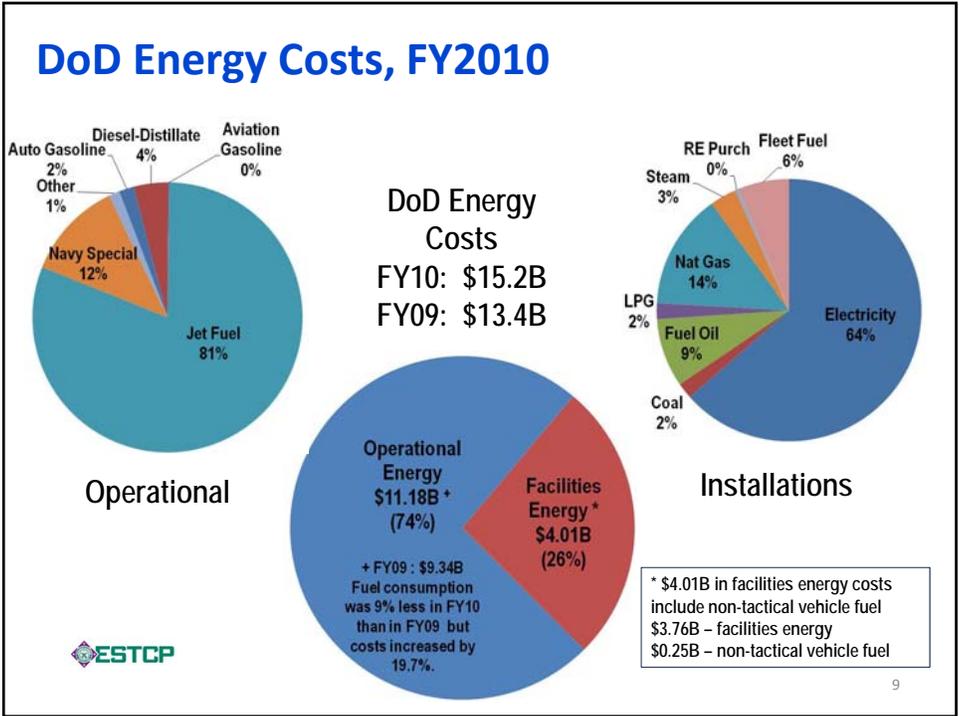
Energy, economy, & CO₂ in 2010

	population (millions)	ppp-GDP (trillion \$)	energy (EJ)	fossil E (percent)	fossil CO ₂ (GtCO ₂)
World	6892	74.3	558	84%	32.3
China	1341	10.1	115	88%	8.5
USA	310	14.7	102	87%	5.9
India	1216	4.1	33	67%	1.7
Russia	140	2.2	30	91%	1.6
Japan	128	5.5	23	82%	1.3
Germany	82	2.9	14	83%	0.8

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.

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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

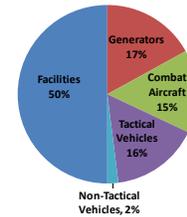
US supply convoys in Afghanistan have suffered the loss of more than 3000 troops or contractors

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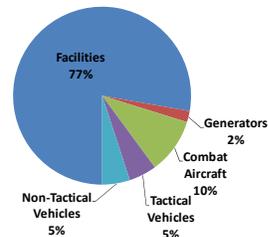
Facility energy: cost, reliability, impact

- 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

Army CO₂ Emissions Today



Army CO₂ Emissions Future?



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

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Climate-security connections (continued)

Impacts of climate change on types of missions

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

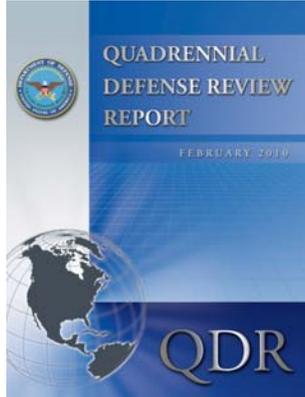
Impacts of climate change on effectiveness

- 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

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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

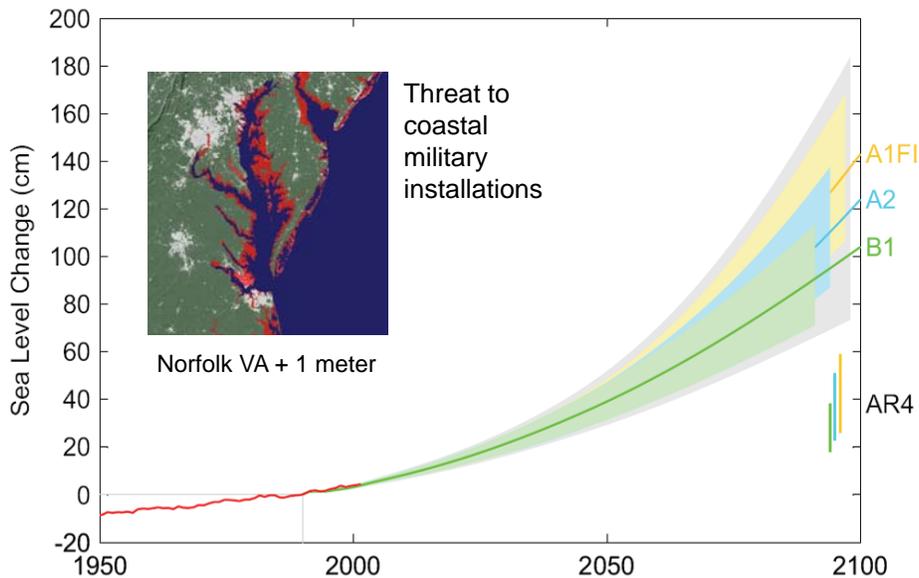
Installation Vulnerabilities

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

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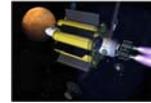
What's expected: sea-level rise to 2100



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



(\$M)	FY 2011 Request	FY 2011 Appropriation
"Science and Technology" (S&T; "6.1" through "6.3")		
DOD S&T ("6.1" - "6.3")	11,833	12,102
DOD basic research ("6.1")	1,999	1,947
DOD applied research ("6.2")	4,476	4,492
DOD adv. Tech. ("6.3")	5,359	5,663



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



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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.

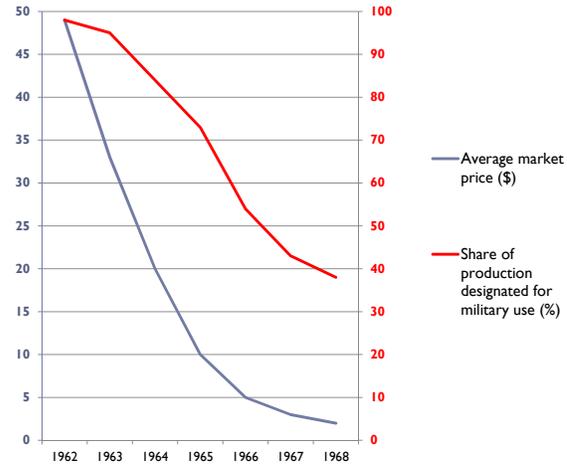


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Early procurement by the military: a historical example

- ▶ 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 billion¹
 - ▶ DoD share only 1-2%¹

US Semiconductor Market Price and Military Use, 1962-1968²



Source: ¹Morris, Peter Robin. *A history of the world semiconductor industry*. 1990, pg 75; ²Defense Science Board, "High Performance Microchip Supply", 2005.

Facility energy test beds

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

Test Bed Project Locations



- 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



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Innovation for DOD installations: electric power

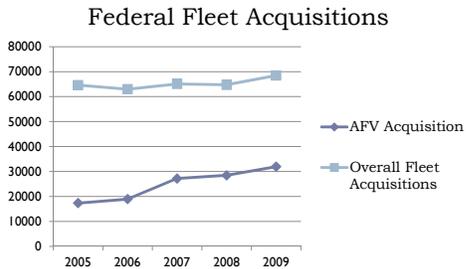
- Advanced electric power systems can reduce costs, enable resilient and secure power for critical loads, and reduce CO₂ emissions.
 - Utility-scale renewable energy
 - Distributed power: solar PV, wind, fuel cells, microturbines, and Combined Heat & Power systems.
 - Energy storage
 - Microgrids
 -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



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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**



	Current Fleet Size ('000s)	Cost Differential (\$, millions)	Market Impact (%)
GSA	199.6	206	19
DoJ	40	59.5	4
DoD	195	42.9	2
USDA	42.9	17.6	1
Total	477.5	326	26

* 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

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In short:

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

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