A Climate of War

The war in Iraq and global warming

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From a conversation between Matt Lauer and Al Gore on the December 6, 2006 edition of the Today Show[1]:

Gore: [T]he climate crisis is caused by the burning of all these fossil fuels and our entanglement in the Persian Gulf region, where the biggest proven reserves are to be found, is linked to it. Here's a second linkage. There were clear warnings before the decision to invade Iraq that it was gonna be a catastrophe. This was predictable. And the, the head of the Army said, 'We don't have enough troops.' Others said this is a terrible mistake. And now what we're seeing with this report and all of the others is a situation that really where there are no good outcomes because the warnings were-"

Lauer: "So you're saying [with] global warming, the warnings are now and if we don't heed that advice we're gonna have the same situation?"

Gore: "Except infinitely worse, because, imagine on a global scale a nearly irretrievable situation. We still have time to avoid the mistakes that are creating this climate crisis."

Executive Summary

When snow fell in Baghdad this January for the first time in living memory, the fighting reportedly stopped for a moment and the media briefly noted global warming in its ongoing coverage of the Iraq War. Yet, the link between conflict and climate change is more significant than a day of abnormal weather might suggest. As with the melting of the Arctic ice cap, there is a dangerous feedback loop between war and warming. Not only is climate change likely to increase conflict, particularly over access to natural resources, but war, in turn, is already accelerating global warming while simultaneously draining our economy of money needed for clean energy.

This report aims to quantify both the greenhouse gas emissions of the Iraq War and the opportunity costs involved in fighting war rather than climate change. In presenting these calculations, we are not suggesting that greenhouse gas emissions are the most important impact of the war, nor the major reason to oppose it. We are not arguing that a more energy-efficient military would be more effective or justified in its actions, nor suggesting that there aren't many things besides clean energy on which the US could choose to spend its money.

Rather, in a process comparable to estimating the true cost of the war in dollar terms, we are simply examining an aspect of the war's impact that has been ignored. The emissions associated with the war in Iraq are literally unreported. Military emissions abroad are not captured in the national greenhouse gas inventories that all industrialized nations, including the United States, report under the United Nations Framework Convention on Climate Change. It's a loophole big enough to drive a tank through.

Our research so far reveals:

1) **Projected total US spending on the Iraq war could cover *all of the global investments* in renewable power generation that are needed between now and 2030 in order to halt current warming trends.[2]**

2) **The war is responsible for *at least* 141 million metric tons of carbon dioxide equivalent (MMTCO2e) since March 2003.[3] To put this in perspective:**

   - **CO2 released by the war to date equals the emissions from putting 25 million more cars on the road in the US this year.[4]**
   - **If the war was ranked as a country in terms of emissions, it would emit more CO2 each year than 139 of the world's nations do annually. Falling between New Zealand and Cuba, the war each year emits more than 60% of all countries.[5]**

- **Emissions from the Iraq War to date are nearly two and a half times greater than what would be avoided between 2009 and 2016 were California to implement the auto emission regulations it has proposed, but that the Bush Administration has struck down.[6]**

3) **Just the $600 billion that Congress has allocated for military operations in Iraq to date could have built over 9000 wind farms (at 50 MW capacity each), with the overall capacity to meet a quarter of the country's current electricity demand.** If 25% of our power came from wind, rather than coal, it would reduce US GHG emissions by over 1 billion metric tons of CO2 per year – equivalent to approximately 1/6 of the country's total CO2 emissions in 2006.[7]

4) **In 2006, the US spent more on the war in Iraq than the whole world spent on investment in renewable energy.** [8]

5) **US presidential candidate Barack Obama has committed to spending "$150 billion over 10 years to advance the next generation of green energy technology and infrastructure."**[9] **The US spends nearly that much on the war in Iraq in just 10 months.**

Estimates of emissions stem from fuel-intensive combat, oil well fires and increased gas flaring, the boom in cement consumption due to reconstruction efforts and security needs, and heavy use of explosives and chemicals that contribute to global warming.

These emissions estimates are very conservative. Throughout our research we have erred on the side of caution, and have simply omitted areas where reliable numbers were not readily available (e.g., military consumption of halons or other greenhouse gas intensive chemicals, and the use of bunker fuels for the transportation of troops and equipment to Iraq). We are confident that ongoing research will reveal more emissions (the full version of this report is forthcoming).

A Climate of War: Behind the Numbers

FACT:
Fuel consumption alone from the war undermines emissions-saving measures.

The numbers: **Fuel consumption for Operation Iraqi Freedom (OIF) has contributed an estimated 100 million metric tons CO2 since 2003.** When combustion and upstream emissions from refining petroleum are taken into account, the military's fuel use in Iraq alone amounts to 49 MMT CO2. When the fuel use for the supply chain of petroleum to OIF is included, the total nearly doubles – to 96 MMT. If emissions from troop deployment (flying troops to and from Iraq) are taken into account, the military's climate footprint from the war in Iraq increases by at least 3 MMT CO2 for the last 5 years – bringing the total to approximately 100 MMT CO2.[10]

Behind the numbers:

- **Between March 2003 and October 2007, the US military in Iraq purchased more than 4 billion gallons of fuel** from the Defense Energy Support Center (DESC), the agency responsible for procuring and supplying petroleum products to the Department of Defense. Burning these fuels has directly produced nearly 39 million metric tons of CO2 (38.8 MMTCO2 – see table below).[11]

- **When the "well-to-wheel" lifecycle of these fuels is taken into account, total emissions from military fuel use in Iraq approach 50 MMT CO2.** Combustion-related emissions constitute on average approximately 78% of total lifecycle emissions from fuel, while emissions from producing the fuel make up the remaining 22%. Incorporating upstream emissions from the refining and production of the fuel used by the military thus raises the total emissions from Operation Iraqi Freedom (OIF) fuel consumption to 49.7 or approximately 50 million metric tons CO2e.[12]

- **But that's not all; it takes fuel to deliver fuel**. **Transporting 4 billion gallons of fuel to the military in Iraq consumed at least as much fuel as was delivered – nearly doubling overall fuel-related emissions to 96 MMTCO2.** Even if we (conservatively) assume that the fuel used in transporting petroleum to OIF was all conventional motor gas, and not diesel or jet fuel (both of which emit more CO2 per gallon than gas), consuming 4 billion gallons of gas in the supply of fuel to the military contributed 45.8 or nearly 46 MMTCO2[13], over and above the military's direct fuel use.[14]

- **Transporting military personnel and cargo to war "theatre" adds to the military's climate footprint.** The fuel used to fly combat troops and support staff to and from Iraq since 2003 is not reflected in the amount of fuel delivered to the military for use by OIF. A conservative estimate based on troop deployment alone – excluding transportation of equipment or supplies –

suggests that transporting the more than 1 million military personnel who have been sent to and from Iraq has contributed at least another 3 million metric tons of CO2 since the US invasion from air travel alone.[15] Given the lack of comprehensive records on all military transport to and from the war theatre, this is probably a gross underestimate of the emissions associated with deployment to Iraq.

Putting it in perspective: The nearly 100 million tons of CO2 released as a result of US military fuel use and supply of that fuel in Iraq between 2003-2007 more than cancel out attempts to reduce fuel-related emissions in the most populous state in the US. Fuel-related emissions in Iraq are five times the 20 MMT CO2 that would be avoided between now and 2016 if the federal clear air emissions regulations (CAFÉ standards) alone were implemented in California, and nearly twice the emissions that would be avoided between 2009 and 2016 were California to implement the more stringent auto emission regulations it has proposed. According to analysis by the California Air Resources Board, the proposed California fuel standards would reduce annual emissions by 17 MMT CO2 in 2016, preventing the emission of 58 million metric tons CO2 between 2009 and 2016.[16]

The City of San Francisco has adopted a policy to reduce its GHG emissions 20% below 1990 levels by 2012. This means reducing annual emissions by 2.5 million tons in the next 4 years.[17] In just 2 months, emissions related to military fuel consumption in Iraq alone cancel out the effect of this annual reduction.

FACT:

An opportunity cost of waging war is working for a cleaner, cooler future.

Money spent on the war is money not spent reducing our dependence on fossil fuels or supporting the transition to a low-carbon economy. The military budget and growing deficit siphon taxpayer dollars away from the development of renewable energy technologies and efficiency measures, and limit spending on programs to mitigate the insecurity caused by climate change.

Ballooning expenditures on the military under the Bush regime dwarf federal spending on climate change by a magnitude of 97 to 1.[18]

In 2008, over half of the federal government's discretionary budget will go to the military. President Bush proposed to spend a mere $7.4 billion on climate change this year, compared to $647.2 billion for the military overall and $155.5 billion for the war in Iraq alone.[19] And these budget figures don't include the immediate or long-term social and macroeconomic costs of the war. Nobel economist Joseph Stiglitz has estimated that the war costs $12 billion per month and over time will take a $3 trillion toll on the US – draining public resources and drawing attention, as well as finances, away from the pressing problem of global warming.

With the $600 billion that the US has allocated for direct spending on military operations in Iraq to date, we could have built over 9000 wind farms (at 50 MW capacity each), with the overall capacity to meet a quarter of the country's current electricity demand. If 25% of our power came from wind, rather than coal, it would reduce US GHG emissions by over 1 billion metric tons of CO2 per year – equivalent to approximately 1/6 of the country's total CO2 emissions in 2006.[20] If we include the social costs of the war, its toll on the US economy, and hidden defense expenditures, the opportunity cost of the war is in fact much, much greater.

In their book, *The Trillion Dollar War*, Joseph Stiglitz and Linda Bilmes estimate the total budgetary cost of the Iraq war (excluding macroeconomic impacts and social costs) will exceed $2.6 trillion. Just think what an impact $2.6 trillion could have in kick-starting the green economy in the US or revolutionizing global energy use, rather than financing war and its fallout. **$2.6 trillion would cover 92% of the investments in renewable power generation that are needed between now and 2030 in order to halt current warming trends.[21]**

In his 'energy and environment' plan, **US presidential candidate Barack Obama has committed to spending "$150 billion over 10 years to advance the next generation of green energy technology and infrastructure,** provide job training and transition programs to help train workers for employment in the green economy and establish new national energy standards to spur demand for clean, sustainable sources of energy."[22] **The US spends nearly that much on the war in Iraq in just 10 months.**

In 2006, about 18% of global investment in the power sector, or approximately $100 billion, was in renewable sources of some form.[23] That same year, **the US spent more on the war in Iraq than the whole world spent on investment in renewable energy.**

FACT:
<u>What goes down must come up: war increases emissions from cement use in Iraq.</u>

The numbers: **Emissions from cement produced to meet heightened demand for reconstruction and security materials in Iraq have contributed an estimated 33 MMTCO2 since 2003. They may release an additional 149 to 232 MMT CO2 over the next 10 years, as demand for cement rises.** In the next 5-10 years, reconstruction and security-related demand is expected to boost cement consumption 10-fold above peacetime levels, to between 20 and 30 million tons of cement per year.

Behind the numbers:
Among the most visible impacts of the war in Iraq and the violence it has unleashed is the destruction of the country's physical infrastructure. Countless buildings, bridges, roads, homes, schools, and hospitals have been damaged or destroyed. Rebuilding the country from amidst this rubble and maintaining the walls and barriers needed for security will not only take time and money, but tons and tons of cement. Quite literally.

- **Cement production is one of the largest industrial sources of GHG emissions in the world—estimated to contribute approximately 4% of total global CO2 emissions.**[24] The 'calcination' of raw materials involved in production of cement, and the use of fuel to power that process, both release CO2. It is estimated that between 50 and 70% of emissions from cement production result from chemical processes, while the remaining emissions stem from energy used to power production. According to the International Energy Administration, cement production releases, on average 0.83 tons of CO2 per ton of cement produced.[25]

- **Iraq has gone from being an exporter of cement prior to the war, to being a cement importing-country whose demand exceeds supply by such a margin that it has driven up cement prices to record levels.** Official government statistics cited in a report by the United Nations Habitat Program and the International Finance Corporation suggest that average cement consumption levels in Iraq during peacetime (prior to the 2003 invasion) were approximately 1.87 or 2 million tons per year.[26] At that time, Iraq was an exporter of cement. Today, the country is a net importer, with cement demand far surpassing depressed production levels. Currently, Iraq produces approximately 3 million tons/year, despite having an installed production capacity of approximately 20 million tons cement per year. In addition to the 3 million tons it produces, Iraq reportedly imports 6-7 million tons per year currently from neighboring countries in the Middle East, with more coming from further abroad (as far away as China). This means that annual cement consumption today in Iraq is approximately 10 million tons – that is 8 million tons more than peacetime levels. It is widely projected that, due to reconstruction and security needs, cement demand in Iraq may increase to between 20 and 30 million tons per year in the next 5-10 years.[27]

- **Assuming a baseline cement consumption level of 2 million tons per year, the war has contributed to an increase of 8 million tons per year over the past five years, and will likely result in an increase of between 18 and 28 million tons above baseline consumption levels in the next 5-10 years, as demand peaks.** The increased consumption of 8 million tons over peacetime levels since the US invasion in 2003 has contributed to the release of approximately 6.64 million tons of CO2 per year, or approximately 33 million tons CO2 –approx 30 MMT -- during the last 5 years. Looking ahead, the emissions from producing cement to meet the expected increase in demand to 20-30 million tons of cement per year – 18 to 28 million tons more per year than in peacetime – could contribute between 14.9 and 23.2 million tons CO2 per year – or a cumulative total of between 149 and 232 million tons of CO2 over the next 10 years (75 and 116 MMT over the next five years).

Putting it in perspective:

33 MMT CO2 is more than the entire country of Peru emitted in 2005, and nearly half the amount by which California needs to reduce its annual GHG emissions to reach its target of returning to 2000 emission levels by 2010.[28]

FACT:
Fanning the flames: war leads to higher emissions from oil well fires and gas flaring.

***The numbers*: Since 2003, emissions from gas flaring and oil well fires have amounted to an estimated 15 million metric tons CO2.** In the five years since the US invasion, there have been repeated fires, resulting from deliberate ignition of oil wells as well as other forms of sabotage (such as bombing of pipelines), which have generated significant CO2 emissions. Depending on the number, intensity and duration of fires, burning oil wells in Iraq may have released as much as 1 million metric tons of CO2 per day. A conservative estimate based on press coverage and industry reports suggests that they have released approximately 3 million metric tons since 2003. At the same time, increased flaring of natural gas at petroleum facilities since the war began accounts for another 12 MMT CO2.

***Behind the numbers*:**

- **Reports of the quantity, intensity and duration of oil well fires since March 2003 vary significantly**. Most experts agree, however, that the fires have not been as severe as those witnessed during the 1991 Gulf War, when burning fields in Kuwait reportedly released 500 million tons of CO2.[29]

- **Media coverage indicated that in the early days of the Iraq war in 2003, between 9 and 72 oil wells burned, combusting between 45,000 and 360,000 barrels of crude oil per day.[30]** If, as the United Nation Environment Program estimates, the average volume of production from a typical well is 5,000 barrels per day,[31] 9 fires would release the CO2 equivalent of burning 45,000 barrels of oil, while 72 fires would release the equivalent of burning 360,000 barrels of oil per day.

- **If, however, as some reports have indicated, the wells that burned were actually much larger – producing up to 30,000 barrels per day – then the emissions from well fires would be equivalent to those resulting from the burning of as much as 2.16 million barrels per day.[32]** Given that a barrel of crude oil releases 0.43 metric tons of CO2, burning 2.16 million barrels per day would release 928,800 metric tons of CO2 per day – that's nearly 1 MMT CO2 daily.[33]

- **According to press accounts, most of the fires set in the early days of the invasion were extinguished by April 15th.** However, there are indications that at least seven more well fires burned in Northern Iraq in late 2004, and another six fires blazed in early 2005.[34]

- **Even if each burning well is assumed to produce only 5000 bpd, the initial 72 fires in Rumaila and these subsequent 13 fires, would have released, collectively, 182,750 metric tons of CO2 for each day they burned.** Based on media coverage and reports from the firms responsible for

extinguishing the fires, the fires may well have been bigger in size and longer lasting than these estimates suggest. If the majority of the fires burned for even 6 days, it is reasonable to assume that oil well fires have contributed at least 1 million tons CO2 since the start of the war; if they burned longer or were bigger wells, they could possibly have released as much as 6 million tons of CO2.

- **Gas flaring – the practice of burning off natural gas released in the extraction of oil – has increased since the US invasion of Iraq in 2003, by some accounts as a result of the degradation of oil production facilities.**[35] According to the World Bank and NOAA report on global gas flaring, Iraq was among the countries with the highest increases in gas flaring over the past decade.[36]

- **Since 2003, Iraq has flared, on average, 1.6 billion more cubic meters of gas per year than it did during peacetime, which, at a rate of 4.259 pounds CO2 per cubic meter of gas, translates to 3,099,716 metric tons of CO2 per year, or approximately a cumulative12 MMT CO2 between 2004 and 2007**.

Fact: The war has released unquantifiable emissions from explosives and other chemicals.

- **Untold quantities of emissions have been released due to the use of chemicals with high global warming potential (GWP) in the war.** For example, compounds like halon-1301 used for extinguishing fires and found in the safety systems of many military combat vehicles, have a GWP of 5400 (where CO2 has a GWP of 1). Although the production of halons was outlawed in the United States in 1994 under the Montreal Protocol, due to their impact on ozone-depletion, they are still in use by the military and are found in many combat vehicles (as part of vehicle fire safety systems). For example, in 1997, there were1.4 million pounds of halon installed on US Navy ships then in use, and reportedly 441,000 additional pounds "scheduled for commitment to new-construction vessels in the future."[37] Today, many of the vehicles in use in Iraq contain halon or halon-variants, and it is likely that many of the fire extinguishing agents used to put out blazes caused by explosions or oil fires contain compounds with extremely high GWPs.

- **Heavy reliance on air strikes in the Iraq War has contributed to GHG emissions from the manufacturing and detonation of explosives.** The war in Iraq has been a war fought as much from the air as on the ground. Since the initial "shock and awe" bombing campaign in March 2003 – and even before the invasion began – the US has dropped significant numbers of bombs in Iraq, increasing the intensity of airstrikes as recently as January 2008. In the first days of 2008, alone, US forces dropped over 100,000 pounds of bombs. The manufacturing of explosives, such as TNT, emits various gases, including nitrous oxide (N2O), a potent greenhouse gas with a global warming potential (GWP) of 296 times that of carbon dioxide. The detonation of explosives, too, releases greenhouse gases. According to some experts, detonation releases approximately 0.32 tons of CO2 per ton of explosive.[38] Thus, any assessment of the climate footprint of war must take into account emissions from the millions of tons of explosives used by the military.

Conclusion

Five years after George W. Bush ordered US troops to invade Iraq, the war has taken hundreds of thousands of lives, cost billions – ultimately, trillions – of dollars, and undermined both American and Iraqi security. To this list we must add the climate as another casualty of war.

As the world wakes up to the urgency of the climate crisis, the US is busy fighting a gas-guzzling war, largely over control of oil – one the very substances that is fueling the crisis.[39] Our intent in exposing the climate footprint of the US military in Iraq is not to suggest that the Iraq War would be justified if executed by an energy-efficient army. A leaner, greener military is still a military, and an unjust war fought with hybrid 'humvees', eco-friendly tanks and hydrogen-powered fighter jets would still be unjust. But so long as we have a military, it is essential that we find ways to reduce its environmental footprint and to regulate defense-related emissions, as we do emissions from other sectors. Moreover, the military-climate nexus runs deeper than fuel efficiency standards. It is about the very motivations for militarization and the justifications for war.

By quantifying the amount of emissions that can be attributed to the conflict and comparing them to policy initiatives that seek to reduce pollution from other sources and promote green alternatives, our analysis suggests that militarization and resource wars pose a significant impediment to mobilizing the financial resources necessary to mitigate climate change and transition to a clean energy economy. The benefits of emissions reduction measures, such as those currently under discussion in the US Congress and in states like California, are already being undermined by emissions from military operations in Iraq.

It is time to draw the curtain on the era of fighting wars for oil. It is time for the United States to replace the Cold War 'Carter Doctrine,' which commits us to use military force to protect our oil interests in the Persian Gulf, with a forward-looking 'Climate Doctrine,' which commits us to combating global warming by investing our resources in the development of alternative energy sources at home. Were we not so dependent on oil, it is unlikely that we would be warring for control of reserves thousands of miles away or seeking to assert our interests in so many petro-states around the world. Tapping into efficiency, new technologies such as plug-in hybrids, solar, wind and geothermal energy will help keep US troops at home.

We have reached a fork in the road. Down one path lies increased conflict over resources and insecurity in a warmer world; down the other lies increased global cooperation to combat climate change and transition to a clean energy economy. The Iraq War represents a choice to go down the former path. Let us hope the US can find the wisdom to choose the latter.

Calculations and methodological notes:

Substance	Quantity	CO2e conversion factor	Metric Tons CO2 (MMT = million metric tons)
Jet fuel to OIF (03-07)	3,539,274,572 gallons *	21.095 pounds CO2/gallon	33,866,006.12
Diesel fuel to OIF (03-07)	443,217,315.5 gallons**	22.384 pounds CO2/gallon	4,500,125.37
Motor gasoline to OIF (03-07)	49,262,142 gallons	19.564 pounds CO2/gallon	437,160.7303
Aviation gasoline to OIF (03-07)	1,523,632 gallons	18.355 pounds CO2/gallon	12,685.41475
Total fuel delivered to OIF (03-07)	**4,033,277,661 gallons**		38,815,977.63
			49.76 MMT (adjusted to include upstream emissions from refining)****
Fuel for supply chain	**4,033,277,661 gallons*** **	19.564 pounds CO2/gallon	35,792,000
			45.89 MMT (adjusted to include upstream emissions from refining)
Emissions from troop deployment (flights)	Unique deployments to Iraq to date = > 1 million people	Average per-passenger emissions for roundtrip US-Iraq journey: 2.3 metric tons CO2	**2.3 MMT**
Cement produced to meet war-induced demand	~ 8 million tons cement/year or 40 million tons cement 2003-2007	0.83 tons CO2/ton cement	**33.2 MMT**

Barrels crude oil burned in well fires	**3,325,000 barrels** (at least 85 reported fires, of varying size and duration—72 in Raimala 2003 and subsequently at least 13 others)	**0.43 metric tons CO2/barrel crude oil**	**182,750 metric tons CO2/day** **~Between 1.28 MMT CO2/week and 3.84 MMT CO2 over 21 days**
Gas flaring	Average of 1.6 billion cubic meters gas/year above pre-war levels from 2004-2007	4.259 pounds CO2/cubic meter gas	12362864 **12 MMT**
Total war-related emissions			**141 million metric tons (MMT)** **[nb: individual items may not add to total due to rounding]**

* Jet fuel total includes 445895797.5 gallons from Mar-Oct 03, equal to 75% of the total volume of fuel DESC reports delivered to OIF during that period. Since DESC data obtained by the author did not break-down March-October 2003 deliveries by fuel type, composition was estimated to be 75% jet fuel and 25% diesel (average composition of total 03-07 OIF deliveries).

** Diesel fuel total includes estimated portion (25%) of March-October 2003 fuel deliveries that were diesel (not jet fuel).

*** Based on DOD estimates of cost of fuel delivery and additional studies of DOD fuel use, it was estimated that it takes, on average, one gallon of fuel for every gallon delivered to the war "theatre." Conservatively, we assumed that all petroleum used in delivery of fuel to OIF was motor gasoline, which has a CO2 conversion factor of 19.564. In reality, a significant portion of fuel used for the delivery of petroleum supply to OIF was likely diesel and jet fuel-grade, which have higher per unit CO2 emissions when combusted.

****A factor of 1/.78 was used to adjust emissions totals to reflect CO2 released from both combustion and upstream processing/refining. This factor was derived from GREET-model based data which indicate that combustion emissions represent 78% of total emissions from gasoline. Thus the totals calculated for combustion-related emissions were multiplied by 1/.78 to arrive at overall emissions associated with that quantity of fuel.

[1] Full transcript available here: http://newsbusters.org/node/9481

[2] The total budgetary cost of the war (operations plus veterans' benefits and other military expenses) under a "realistic" scenario is estimated to be $2.655 trillion. See: Joseph Stiglitz and Linda Bilmes, *The Three Trillion Dollar War: The True Cost of the Iraq Conflict,* W.W. Norton & Company Limited, New York,

2008. (See also, CRS Report for Congress, "The Cost of Iraq, Afghanistan, and Other Global War on Terror Operations Since 9/11," Updated November 9, 2007, Order Code RL33110, *available at:* http://www.fas.org/sgp/crs/natsec/RL33110.pdf). Greenpeace and the European Renewable Energy Council have estimated that $2.89 billion is needed in renewable investment globally by 2030 in order to ensure a 50% reduction in CO2 emissions by 2050, and help avoid average warming above 2 degrees centigrade. See, Greenpeace and European Renewable Energy Council, *Futu[r]e Investment: A sustainable investment plan for the power sector to save the climate,* July 2007, available at: http://www.greenpeace.org/international/press/reports/future-investment.

[3] "CO2e" or 'carbon dioxide equivalent' is the universal unit of measurement used to express the global warming potential (GWP) of a given quantity of greenhouse gases in terms of an equivalent quantity of carbon dioxide. The Intergovernmental Panel on Climate Change decided that carbon dioxide was the reference gas against which other greenhouse gases would be measured. The Global Warming Potential of a given greenhouse gas expresses its heat-trapping ability in terms of units of carbon dioxide, where the GWP of CO2 is 1.

[4] According to the US EPA, Green Power Equivalency Calculator Methodologies, http://www.epa.gov/grnpower/pubs/calcmeth.htm , (accessed February 10, 2008), the average driver in the US emits 5.46 metric tons CO2 per year.

[5] Based on our conservative calculations, the war in Iraq has emitted an estimated 28.2 MMT CO2 per year since it began in 2003. According to the Energy Information Administration's *International Energy Annual 2005*, posted in September 2007, 139 of the 222 countries for which data is provided emitted less than 28 million metric tons of CO2 from the consumption and flaring of fossil fuels in 2005. See: Energy Information Administration, *International Energy Annual 2005*, report released June-October 2007, table H.1co2, available at: http://www.eia.doe.gov/iea/carbon.html.

[6] Mark Clayton and Daniel B. Wood, "California's data challenges EPA," Christian Science Monitor, January 4, 2008, available at: www.csmonitor.com/2008/0104/p02s01-usgn.html
According to analysis by the California Air Resources Board, the proposed CA fuel standards would reduce annual emissions by 17 MMT CO2 in 2016, with the cumulative benefit of preventing the emission of 58 million metric tons CO2 between 2009 and 2016. See: California Air Resources Board Technical Assessment, "Comparison of Greenhouse Gas Reductions Under CAFE Standards and ARB Regulations Adopted Pursuant to AB1493," January 2, 2008, available at: http://www.arb.ca.gov/cc/ccms/ab1493_v_cafe_study.pdf .

[7] Data on current wind power capacity in the US and the average capital cost of installing a 50MW wind farm were obtained from the American Wind Energy Association, "Installed US Wind Power Capacity Surged 45% in 2007, " January 17, 2008, available at: http://www.awea.org/newsroom/releases/AWEA_Market_Release_Q4_011708.html (accessed February 19, 2008) and "The Economics of Wind Energy," February 2005, available at: http://www.awea.org/pubs/factsheets/EconomicsOfWind-Feb2005.pdf (accessed February 17, 2008). At a cost of $65 million to install a 50 MW-capacity wind farm, the $600 billion in direct spending on the war in Iraq to date could pay for 9230 wind farms, which would have a collective capacity of 461,538 MW of power. This would be 27 times the current installed wind capacity in the US – presently approximately 1%. If current installed capacity could generate 48 billion kilowatt hours in 2008, then 9000 wind farms could generate nearly 27 times that – or more than 1.2 trillion kWh – 1.2 billion MWh. According to the Energy Information Administration ("Carbon Dioxide Emissions from the Generation of Electric Power in the United States" July 2000 available at: http://tonto.eia.doe.gov/ftproot/environment/co2emiss00.pdf), coal-fired power plants emit approximately two pounds of CO2 for every kilowatt hour. Producing the same amount of kW hours with coal, would release over 1 billion metric tons of CO2.

[8] In 2006, about 18% of global investment in the power sector, or approximately $100 billion, financed renewables in some form, but only $38 billion was spent on investment in new renewable capacity worldwide in 2005. Greenpeace and European Renewable Energy Council, *Futu[r]e Investment: A Sustainable Investment Plan for the Power Sector to Save the Climate*, July 2007, http://www.greenpeace.org/raw/content/international/press/reports/future-investment.pdf .

[9] See Barack Obama's webpage on "Energy and Environment," http://www.barackobama.com/issues/energy/#invest-in-a-clean (accessed March 11, 2008)

[10] According to DOD statistics, as of October 31, 2007, about 1.64 million U.S. Service members had been deployed in the Global War on Terror, and about one third of troops serve second or third deployments (Stiglitz and Bilmes, *The Three Trillion Dollar War*, p. 36, 38).

[11] DESC delivered 4,033,277,661 gallons of fuel to Operation Iraqi Freedom between March 19, 2003 and September 30, 2007. Author's calculations based on data received from DESC in response to FOIA request, DESC FactBook FY2003 http://www.desc.dla.mil/DCM/Files/Fact03_1.pdf) and CO2 conversion factors obtained from the Energy Information Administration, http://www.eia.doe.gov/oiaf/1605/coefficients.html, based on IPCC Guidelines.

[12] On the basis of the GREET emissions model (see: http://www.transportation.anl.gov/software/GREET/) emissions from upstream processing of gasoline constitute approximately 22% of the total emissions. See: *Table 2: Emissions from fuels produced from conventional and unconventional petroleum, GTL, and CTL synfuels*, in Adam Brandt and Alexander Farrell, "Scraping the bottom of the barrel: Greenhouse gas emission consequences of a transition to low-quality and synthetic petroleum resources," *Climatic Change*, Volume 84, Numbers 3-4 (October 2007).

[13] This calculation includes the emissions from the combustion of these 4 billion gallons of gasoline, as well as estimated upstream emissions from their production – which constitute on average 22% of total emissions from gasoline.

[14] Various studies commissioned by DOD and other US government agencies have indicated that the 'actual cost' of fuel delivered to the military, particularly to the "forward edge" of the battlefield (i.e. in the "war theatre") far exceeds the standardized per-gallon cost. When the expenses associated with delivery are taken into account, the cost of a gallon of fuel may range from $15 to $600 dollars (the latter extreme being the case when fuel is transported long distances to unsafe locations, or delivered air-to-air in battle zones, requiring not only aircraft but heavy security and complex logistical measures). Even if we take the more conservative "actual cost" figures of between $15 and $26 dollars per gallon delivered (cited by the CNA Corporation in its 2007 report, "National Security and the Threat of Climate Change," April 2007, p. 39, available at: http://securityandclimate.cna.org), we can estimate that approximately 1/5 to 1/3 of this cost reflects fuel used to deliver the petroleum. At standard DOD-issued per gallon fuel costs (approx $3/gallon of jet fuel J-8, according to FY 2008 Standard Prices, available at: http://www.desc.dla.mil/DCM/Files/FY2008StandardPrices_122007.pdf), this means that it takes between 1 and 2.5 gallons of fuel -- an average of almost 2 gallons of fuel -- to deliver one gallon. Anecdotally, it has also been reported that "[aircraft] tankers burned 482 million gallons…of fuel to deliver 207 million gallons of fuel in FY2005." (See: JASON, The MITRE Corporation "Reducing DoD Fossil-Fuel Dependence," September 2006, Appendix II, pp. 93-94. available at: http://www.fas.org/irp/agency/dod/jason/fossil.pdf .) Based on the above, we can conservatively estimate that it takes at least 1 gallon for each gallon of fuel delivered to Operation Iraqi Freedom.

[15] If we assume that there have been at least 1 million troops deployed to Iraq since 2003, and that 1/3 of them were re-deployed at least once, then we can assume that there were at least 1.3 million round-trip flights from somewhere in the US (to minimize distance, we conservatively assume from the Eastern seaboard) to Iraq (probably an air base in Kuwait). The distance between Baltimore, MD, for example, and Kuwait is approximately 13,000 miles. On average, one round-trip passenger flight over this distance would generate 2.3 metric tons of CO2. If there were 1.3 million such roundtrips over the past five years, that would contribute approximately 3 MMT CO2 over the course of the war to date. Emissions from actual military personnel and cargo flights to Iraq likely exceed this figure.

[16] California Air Resources Board Technical Assessment, "Comparison of Greenhouse Gas Reductions Under CAFE Standards and ARB Regulations Adopted Pursuant to AB1493," January 2, 2008, available at: http://www.arb.ca.gov/cc/ccms/ab1493_v_cafe_study.pdf . See also: Mark Clayton and Daniel B. Wood, "California's data challenges EPA," *Christian Science Monitor*, January 4, 2008, available at: www.csmonitor.com/2008/0104/p02s01-usgn.html

[17] See The Climate Group case study of San Francisco emissions reductions available at: http://www.theclimategroup.org/reducing_emissions/case_study/san_francisco/

[18] Miriam Pemberton, *The Budgets Compared: Military vs. Climate Security*, January 2008, Institute for Policy Studies, Washington, DC, available at: http://www.ips-dc.org/getfile.php?id=131

[19] National Priorities Project, Federal Budget Year in Review 2007, available at: http://www.nationalpriorities.org/yearinreview2007

[20] Data on current wind power capacity in the US and the average capital cost of installing a 50MW wind farm were obtained from the American Wind Energy Association, "Installed US Wind Power Capacity Surged 45% in 2007, " January 17, 2008, available at: http://www.awea.org/newsroom/releases/AWEA_Market_Release_Q4_011708.html (accessed February 19, 2008) and "The Economics of Wind Energy," February 2005, available at: http://www.awea.org/pubs/factsheets/EconomicsOfWind-Feb2005.pdf (accessed February 17, 2008). At a cost of $65 million to install a 50 MW-capacity wind farm, the $600 billion spent on the war in Iraq to date could pay for 9230 wind farms, which would have a collective capacity of 461,538 MW of power. This would be 27 times the current installed wind capacity in the US – presently approximately 1%. If current installed capacity could generate 48 billion kilowatt hours in 2008, then 9000 wind farms could generate nearly 27 times that – or more than 1.2 trillion kWh – 1.2 billion MWh. Coal-fired power plants emit approximately two pounds of CO2 for every kilowatt hour. Producing the same amount of kW hours with coal, would release over 1 billion metric tons of CO2.

[21] Joseph Stiglitz and Linda Bilmes, *The Three Trillion Dollar War: The True Cost of the Iraq Conflict,* W.W. Norton & Company Limited, New York: 2008. (See also, CRS Report for Congress, "The Cost of Iraq, Afghanistan, and Other Global War on Terror Operations Since 9/11," Updated November 9, 2007, Order Code RL33110, *available at:* http://www.fas.org/sgp/crs/natsec/RL33110.pdf). Greenpeace and the European Renewable Energy Council have estimated that $2.89 billion is needed in renewable investment globally by 2030 in order to ensure a 50% reduction in CO2 emissions by 2050, and help avoid average warming above 2 degrees centigrade. See: Greenpeace and European Renewable Energy Council, *Futu[r]e Investment: A sustainable investment plan for the power sector to save the climate,* July 2007, available at: http://www.greenpeace.org/international/press/reports/future-investment.

[22] See Barak Obama's webpage on "Energy and Environment," http://www.barackobama.com/issues/energy/#invest-in-a-clean (accessed March 11, 2008)

[23] Greenpeace and European Renewable Energy Council, *Future Investment: A Sustainable Investment Plan for the Power Sector to Save the Climate*, July 2007, http://www.greenpeace.org/raw/content/international/press/reports/future-investment.pdf

[24] Estimates of the cement industry's contribution to global CO2 emissions range from 4-6%. According to statistics from the International Energy Agency, cement production accounted for 1.8 Gt CO2 emissions in 2005, out of a global total of approximately 27 Gt. See: International Energy Association, *Tracking Industrial Energy Efficiency and CO2 Emissions*, available at: http://www.iea.org/Textbase/npsum/tracking2007SUM.pdf. See also: Elizabeth Rosenthal, "Cement Industry is at the Center of Climate Change Debate," *New York Times*, October 26, 2007, available at: http://www.nytimes.com/2007/10/26/business/worldbusiness/26cement.html, and http://www.global-greenhouse-warming.com/cement-CO2-emissions.html .

[25] "Half of cement process CO2 emissions are due to the chemical reaction in cement clinker production...The average CO2 intensity ranges from 0.65 to 0.92 tonne of CO2 per tonne of cement across countries with a weighted average 0.83 t CO2 /t," International Energy Association, *Tracking Industrial Energy Efficiency and CO2 Emissions* 2007,available at: http://www.iea.org/Textbase/npsum/tracking2007SUM.pdf

[26] United Nations Habitat Program and the International Finance Corporation, "Iraq Housing Market Study" December 2006, available at: http://www.unhabitat.org/downloads/docs/4997_65700_IHMS%20Main%20Report.pdf

[27] Ibid. See also: See also: Ben Gilbert, "Iraq's new barrier to progress: Cement factories fall far short of demand for reconstruction," San Francisco Chronicle Foreign Service, February 4, 2006, available at: http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2006/02/04/BUGG4H2KGJ1.DTL and Robert Ditcham, "Cement trade hurt by transport woes, "*Gulf News,* 20 June 2007, available at http://www.dubaisharetalk.com/viewtopic.php?t=3681

[28]For information on Peru's emissions, see: Energy Information Administration, *International Energy Annual 2005*, report released June-October 2007, table H.1co2, available at: http://www.eia.doe.gov/iea/carbon.html. For information on California GHG reduction targets, see: "A Look at Emissions Targets: United States – States & Regional," from Pew Center on Global Climate Change, available at: http://www.pewclimate.org/what_s_being_done/targets/#state and data on California's GHG inventory, available on the Environmental Protection Agency website at: http://www.epa.gov/climatechange/emissions/downloads/CAInventorySummary_11-16b.pdf.

[29] Farhad Manjoo, "When oil fields become battlefields," *Salon.Com*, March 20, 2003, available at: http://dir.salon.com/story/news/feature/2003/03/20/oilwells/ "[During the first Gulf war], Saddam set on fire about 700-plus of the oil fields in Kuwait. …According to the World Resources Institute, an environmental policy group in Washington, the fires Iraqi troops set in Kuwait spewed 500 million tons of carbon dioxide into the atmosphere, "emissions greater than all but the eight largest polluting countries for 1991." See: http://archive.wri.org/jlash/letters.cfm?ContentID=564 See also: "The Kuwait oil fires led to an emission of 477 million tons of CO2," quoting Claussen, E.; Mc Neilly, L: 1998, *Equity and global climate change*, Pew Center, Washington, p. 29, in "Military emissions, armed conflict, border changes and the Kyoto, Axel Michaelowa, Tobias Koch" in *Climatic Change*, 50, 2001, p. 383-394 , available at: http://www.hm-treasury.gov.uk/media/B/4/Michaelowa2c20Koch20(2001a).pdf

[30] **"**On the second day of President Bush's invasion of Iraq, it was reported by the New York Times and the BBC that Iraqi forces had set fire to several of the country's large oil wells. Five days later in the Rumaila oilfields, six dozen wellheads were set ablaze. The dense black smoke rose high in the southern sky of Iraq, fanning a clear signal that the U.S. invasion had again ignited an environmental tragedy." See: Jeffrey St. Clair and Joshua Frank, "Iraq's Environmental Crisis," October 2007, available at: http://onlinejournal.com/artman/publish/article_2581.shtml

[31] United Nations Environment Program, *Desk Study on the Environment in Iraq,*2003, available at: http://postconflict.unep.ch/publications/Iraq_DS.pdf . See pp. 67, 73-78.

[32] From personnel profile sheet on Boots and Coots website: "2003 South Ramallah, Iraq - Operations Engineer on 30,000 bpd oil well fires during Operation Iraqi Freedom" available at: http://www.bootsandcoots.com/resume/07_04_JBGarner%20Resume.pdf

[33] An emissions conversion factor of 0.43 metric tons CO2/barrel of crude oil was obtained from the Environmental Protection Agency (EPA) website, at: http://www.epa.gov/grnpower/pubs/calcmeth.htm (accessed Feb 12, 2008)

[34] From Boots and Coots website: "Boots & Coots was recently called in by the Northern Iraq Oil Company to extinguish fires at seven wells in Northern Iraq,", December 8, 2004, available at: http://www.bootsandcoots.com/News/news2004_12_08.htm . The website also indicates that in the first quarter of 2005, Boots and Coots put out 6 well fires in Iraq: "The first quarter was a very active one for the company. As we finished extinguishing six well fires caused by saboteurs in Iraq," see: http://www.bootsandcoots.com/News/news2005_05_11.php

[35] Energy experts have described the consequences of conflict: "After the 2003 war, gas gathering and treatment facilities in southern Iraq reportedly deteriorated to the point that most gas produced in the area was simply flared off." See: Energy Information Administration (Content source); Langdon D. Clough (Topic Editor). 2007. "Energy profile of Iraq." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth June 29, 2007; Last revised July 23, 2007; Retrieved February 19, 2008]. http://www.eoearth.org/article/Energy_profile_of_Iraq

[36] See "Fact Sheet: First Global Satellite Survey on Gas Flaring," on the World Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0,,contentMDK:21457705~pagePK:64168445~piPK:64168309~theSitePK:578069,00.html

[37] "Fire Suppression Substitutes and Alternatives to Halon for U.S. Navy Applications," Committee on Assessment of Fire Suppression Substitutes and Alternatives to Halon Naval Studies Board, Commission on Physical Sciences, Mathematics, and Applications National Research Council, National Academy Press, Washington, D.C.1997, available at http://books.nap.edu/openbook.php?record_id=5744&page=35

[38] From a mining industry publication on the climate impacts of its operations: Terramin Australia Limited, Angas Zinc Project, available at: http://www.pir.sa.gov.au/__data/assets/pdf_file/0008/20510/060720_ppt_greenhouse.pdf

[39] According to the International Energy Agency, petroleum accounts for nearly 40% of global carbon dioxide emissions. See: International Energy Agency, Key World Energy Statistics 2007, p. 44, available at: http://www.iea.org/Textbase/nppdf/free/2007/key_stats_2007.pdf