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NON-KINETIC OPERATIONS:
THE CHALLENGES IN REBUILDING IRAQ'S INFRASTRUCTURE AND CAPACITY

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EXECUTIVE SUMMARY

"Marshall recognized the problem that Europe's requirements are so much greater than her present ability to pay that she must have substantial additional help or face economic, social, and political deterioration of a very grave character. He suggested a solution that the European nations themselves set up a program for the reconstruction of Europe, with United States assistance."¹

Title

Non-kinetic Operations: The challenges in rebuilding Iraq's infrastructure and capacity

Thesis

The U.S. reconstruction of infrastructure in Iraq, particularly the reconstruction of the electrical system, served as a non-kinetic force multiplier for the coalition forces to set conditions to create a secure and stable country.

Discussion

This thesis describes several challenges in reconstructing Iraq's electrical system infrastructure in order to restore the basic essential services to Iraqi people and return the country's stability. The electrical system of Iraq was badly managed and infrastructures deteriorated during the regime of Saddam Hussein. Iraq's previous participation in multiple wars and corruption within the government has caused key infrastructures to be neglected. Although the United States' (U.S.) action during the liberation of Iraq in 2003 was not the reason of this mismanagement, the United States was tasked to assist in the reconstruction of all Iraq's infrastructure in order to ease further suffering of the Iraqi people. This paper addressed the challenges in rebuilding the three main sectors of the electrical system: Generation, Transmission, and Distribution. These sectors have to be synchronized in order to provide maximum service to the people and businesses. Since electricity is one of the most

important basic essential services in Iraq, it affected important infrastructures such as hospitals, water/sewage treatment plants, oil fields, office buildings, airports, and industrial businesses. Electricity is serviced to more than 27.5 million people in Iraq, of which over 6.5 million living in Baghdad.

Iraq's governing capacity has suffered from years of centralized control that led to the decay of core functions in many key institutions and ministries. Government systems and processes weakened in strategic and policy planning, finance, information technology, and human resources management. For almost 30 years, the central government neglected to develop a professional civil service; this fostered poor management practices. After the fall of Saddam Hussein's regime in 2003, governing capacity continued to deteriorate during the formation of multiple governments: (1) The Provisional Iraqi Governing Council, established by the U.S.-led Coalition Provisional Authority in 2003, Iraqi Interim Government in 2004, and (2) Iraqi Transitional Government in 2005, and elected Government of Iraq, which took office in May 2006.²

Another major challenge in the reconstruction effort is the "supply and demand" – the decline in generating/supplying electrical power and increase usage of electricity throughout Iraq. The cause of this problem can be traced from negligence of key electrical infrastructures and the liberation of Iraq in 2003 that significantly affected the usage of electricity due to free society. Despite continuing progress in adding more electrical power into the grid by completing funded projects, the gap between "supply and demand" will remain for several years. Demand for electricity is growing rapidly as Iraqis purchase many new appliances and the economy revives. Until electricity "supply and demand" gap starts shrinking, the Ministry of Electricity (ME) cannot expand the hours of equitably distributed electricity to different regions of the country. The gap can only be reduced or stabilized when power generation increase and demand remains at steady state.

For a long term solution to electricity reconstruction and rebuilding, the coalition has the responsibility to make sure the Iraqi has acceptable level of expertise in running electrical system and needs to create an established institution. Coalition Provisionary Authority's (CPA) initial \$18.6B reconstruction program did not emphasize capacity-building, but more recently the US Embassy has redirected more spending to capacity-building. Three basic tiers of training are needed to build capacity within the ME: (1) Plant Management training on proper maintenance and operations; (2) Utility Management is training on planning, budgeting, finance and accounting and contracting, procurement and logistics; (3) Ministry Management training in regulatory, policy and planning functions.

Conclusion

The April 2005 U.S. Electricity Strategy concluded that the U.S. program is on the right track. In April 2004, a U.S. government multi-agency assessment team visited Iraq and determined: (1) IRRF funding was fully programmed and there was little flexibility to reprogram projects for other priorities, and (2) the Embassy's electricity and oil sector assumptions and priorities were accurate. With the summer quickly approaching, the Embassy also met with the IIG Prime Minister and Deputy Prime Minister to seek high-level support for proposed summer electricity plan. Both officials agreed to support the initiative and authorized \$150 million for diesel purchases. Three months after the election, the Iraqi Transitional Government (ITG) had not yet named a cabinet and the new ME. In April, the ME generation remained steady at about 4,100 MW per day.

We continue to show unconditional support and commitment to the Iraqi Transitional Government to successfully bring the electrical system infrastructure back to serve the Iraqi people. The new Iraqi Transitional Government (ITG) took over on May 15, 2005 and Dr. Muhson Shlash assumed the office of the Ministry of Electricity. The U.S. is committed to

continuing its support and the U.S. Embassy electricity team has already begun working with the ITG officials to prepare for the summer spike in demand. The U.S. strategy is to complete the projects started and to help the ME maintain the added MW capacity once it has been added. By implementing the plans described above, the U.S. will achieve the following strategic objectives for the electricity sector:

- 1) Restore or add 3,200 MW potential International Standard Organization (ISO) rated generation capacity to the grid by December 31, 2005 through U.S. government funded programs.
- 2) Assist the ITG to establish a baseline of 5,500 MW average generations by December 31, 2005.
- 3) Assist the ITG in increasing and maintaining the national average of 12 hours of power daily (7-day average) by December 31, 2005.
- 4) Assist the ITG to increase daily load served (7-day average) to baseline of 115,000 MWH.

Another important piece to establish long term stability is the national capacity-development program in Iraq. It is a critical component of the U.S. government's goal of building the capacity of the Government of Iraq to provide sustainable security and services to the Iraqi public. Undermining the U.S.-led effort to build Iraqi capacity is an operating structure where capacity-development activities are spread among multiple organizations and offices that are working without clear overall objectives, without a synchronized plan for conducting assignments, and without a system to measure if progress is or is not being made. Establishing viable Iraqi governing capacity will almost certainly require an investment of additional years and resources. This effort will not go unchallenged at the outset, given the difficult security situation and the increasing sectarianism within Iraqi society and its governing institutions. Both international and regional supports are critical factors in the formula for success. The Iraqi

government and the United Nations have much hope in the success of the International Compact for Iraq. However, this vehicle to unify the country is dependent upon each Iraqi minister demonstrating supportive leadership and strong commitment to the Compact and governing capacity to provide and sustain security and services to the Iraqi public.

Finally, the reconstruction of infrastructure has been and will remain a crucial and enduring part of the U.S. program in Iraq. CPA's legacy for ongoing improvement of the power infrastructure is largely positive. The Iraqi government must deal with the gap between supply and demand by instituting a pricing mechanism, even if it does not fully recover costs in the beginning. At the same time, the U.S. and other donors must lay an institutional foundation for Iraq to build towards a sustainable future. That foundation lies as equally in education and training as it does in building essential services. The old adage still holds true, "Give a man a fish and he will eat for a day, teach a man to fish and he will feed the nation."

BACKGROUND

Iraq's electricity infrastructure was left fragile after decades of neglect under Saddam Hussein's regime. No new power plants had been built since the 1980's due to a limited long-term system strategy. Normal plant life is 25 to 30 years in ideal conditions; however most of the existing Iraqi plants were over 25 years old. Management and Operations and Maintenance (O&M) practices were very poor. Existing power plants were operating at their limits with little effective maintenance. During the last two years of Saddam Hussein's rule these plants received little or no maintenance, or replenishment of vital spare parts needed to prevent significant periods of downtime. In addition, the monitoring and control systems were out of date and in poor condition.

The CPA initially had the challenge of bringing existing electrical power generation facilities back on line. Key institutions and services such as hospitals, factories, ports, and oil infrastructure depend on electricity to function. The U.S. has since developed new electricity generation, transmission, and distribution systems while expanding the capacity of existing systems throughout the country, with the objective of providing equitable access to power for all the people in Iraq. Over 2,500 megawatts of electricity will have been added at the end of the U.S. reconstruction program. Automation and control equipment will have been added to modernize the monitoring systems and to increase efficiency.

Iraq's Electricity Paradox

Since June 2003, the United States government has committed approximately \$6 billion to the electrical system infrastructure reconstruction and has restored and added over 2,256 megawatts (MW) of potential generating capacity to the Iraqi electrical grid. So why is the Iraqi government still struggling to provide electricity for the Iraqi population?

Before the First Gulf War

By 1990, Iraq had recovered significantly from the devastation of the Iraq-Iran war (1980-88) and was capable of producing on average 3,400 MW.³ Iraqi possessed a fairly robust electricity generation system with an installed or “embedded” capacity of 9,295 MW.⁴ This means that if all of Iraq’s electricity generating units were in pristine condition, were perfectly maintained, were perfectly operated and used the right fuel, that they would be able to produce at a daily peak rate of approximately 9,295 MW. This figure is highly theoretical, because the units were not in pristine condition, were not properly operated and maintained, and did not use correct fuels. These issues persist though 2005, and as a consequence, the embedded capacity has been down rated to 6,800 MW of “Feasible” capacity.⁵

After the First Gulf War (2,325 MW), 1991

Allied bombing during the First Gulf War severely damaged the Iraqi electricity system. Other factors, such as workers abandoning their plants and interruptions to the Iraqi fuel supply, also contributed to the fact that generation output was reduced from 3,400 MW to 2,325 MW by the end of the war.

Initial Electricity Restoration Strategy

In 2003, coalition electricity planners adopted a strategy designed to (1) make nominal refurbishments and emergency repairs to existing generation units while (2) simultaneously investing in long-term projects that would add generation capacity with state-of-the-art generation capacity. Based on this strategy, the coalition focused approximately 80% of U.S. reconstruction funds on refurbishment projects designed to get the system up and running again and the balance was to be applied to projects that would add new generation capacity beyond the 4,200 MW pre-war levels. In addition, Iraq began importing small amounts of power from Turkey and Syria, roughly 80-150 MW daily.

Initial Electricity Restoration Assumptions

Throughout 2003 and until September 2004, the U.S. electricity planners were using several planning assumptions for managing the electricity funds. First, they believed that the underlying electricity system infrastructure (i.e., 10,000 MW embedded capacity) was relatively intact.⁶ This assessment was supported by the achieved restoration to service of 1,500 MW of existing generation in daily megawatt hours between the summer peak of 2003 and the summer peak of 2004. Second, they believed that the Iraqi ME could manage and operate a refurbished system with minimal foreign assistance.⁷ Third, they believed that the Iraqi budget would be sufficient to finance and operate the electricity system.⁸ Fourth, they believed that Iraq was relatively self-sufficient in terms of supplying the requisite fuel for electricity generation. Finally, they believed that the fuel transportation network (e.g., pipelines) was relatively intact.⁹

By February of 2004, the office of the Senior Advisor (Mr. Scott Hutchins) of Electricity knew that the electricity generation capacity was greatly degraded. The electrical power generation met a 5,200 MW peak in August 2004. Despite of consistent improvement achieved by the Ministry of Electricity up to August 2004, the power generation plants began to degrade and had not recovered at that time they had failures throughout the system. The ME recognized that none of the thermal units could reach capacity and the combustion turbines were not able to perform near the maximum capacity. These findings provided the baseline of all the contracts for refurbishing the power/generation plants. In addition, the following has also been identified as reasons needed to be addressed in order to provide holistic solution to Iraq's electrical system issues:

- 1) Coalition Provisional Authority (CPA) also recognized the need for new transmission lines and put out contracts for line construction. They also recognized that the

substations were not capable of supporting the required loads and the distribution system was inadequate outside the Mansur district in Baghdad.

2) As was noted above, CPA planners immediately recognized that there was a management vacuum at the ME.

3) From the beginning CPA recognized that there would have to be a supplement to the Iraqi budget for any new capacity to be immediately added. That is why CPA asked for supplemental funds on an emergency basis.

4) In January 2003, the CPA Oil Office had a very good idea of what could be supplied and what could not.

5) CPA-Oil and Restore Iraqi Oil (RIO) knew exactly what the pipeline and trucking capacity was. They had maps of the pipelines and knew their condition by December of 2003 or possibly even earlier.

RECONSTRUCTION FUNDING SOURCES

Even as combat operations continued, coalition civilian and military forces began resuscitating the Iraqi electricity system. The coalition established Restore Iraqi Electricity (RIE), an organization established through the U.S. Army Corp of Engineers (USACE), designed to reach the pre-war generation capacity of 4,400 MW per day. The funding for electricity system projects came from multiple sources:

- 1) *Iraq Relief and Reconstruction Fund (IRRF) I*: On April 12, 2003, the U.S. Congress appropriated \$2.475 billion of emergency funding for the IRRF I. This sum included \$1.52 billion for electricity projects managed by U.S. Agency for International Development (USAID) and Gulf Region Division (GRD).
- 2) *Iraq Relief and Reconstruction Fund (IRRF) II*: On November 15, 2003, the U.S. Congress appropriated an additional \$18.439 billion for the IRRF II. This sum included \$5.539 billion for the electricity sector.
- 3) *Development Fund for Iraq (DFI)*: Prior to and after the war, the United Nations (UN) controlled a fund containing Iraqi assets including funds from UN-approved oil sales. Coalition officials used \$1.896 billion of Development For Iraq (DFI) funds for ME operating and capital budgets, as well as CPA directed electricity projects in Iraq.
- 4) *Commanders Emergency Response Program (CERP)*: Coalition military commanders began using discretionary U.S. appropriated funds, totaling \$100 million, known as the CERP, which were available at the local level coalition military commanders for small-scale electricity projects.
- 5) *International Donors*: October 23-24, 2003, more than 80 nations pledged \$13 billion in addition to the \$20 billion already pledged by the United States. This fell short of the \$56 billion needs assessment identified by the UN and World Bank, of which \$13.6

billion was identified as needed for the electricity sector. Most of these pledges have been slow to materialize.

\$ 1.020B	IIG DFI Funding for Electricity Sector, 2003-04
\$ 0.876B	GRD DFI Funds for Restore Iraqi Electricity
\$ 1.520B	IRRF I Funds for Electric Sector (USAID & GRD)
\$ 0.800B	Other Donor Funding (World Bank, UNDP, JICA, DFID)
\$ 5.539B	IRRF II Funds for Electricity Sector
\$ 9.775B	Total Commitment to Iraqi Electricity Sector

PROBLEMS AND CHALLENGES

Prior to the Second Gulf War (4,200 MW), March 2003

Iraq spent twelve years after the First Gulf War trying to increase and maintain its electricity generation from the 1991 post-war level of 2,325 MW. By February 2003, just before the commencement of combat operations by coalition forces, the Iraqi electrical system was struggling to generate 4,200 MW per day. Iraq's 33 plants and 153 generating units were producing just 42% of their 10,000 MW embedded capacity. In terms of hours of power, the 4,200 MW base should have translated into an average of 13-15 hours of power per day around the country.¹⁰ The MW output pre-2003 liberation of Iraq is misleading because Saddam ensured Baghdad received more than its share based on population. During non-peak seasons, Baghdad had 24 hours/day and during summer and winter peaks at least 14-16 hours/day.

The dire state of Iraq's electricity sector following the first Gulf War in 1991 was the result of several factors:¹¹

1) *Sanctions Forced Cannibalization.* The United Nations embargo limited Iraq's budget. Rather than using limited resources to fund the electricity sector, Saddam Hussein instead forced the ME to cannibalize (e.g., selective interchange of from one system/machine to replace another) the electricity infrastructure, leading to a steady decline of electricity generation. By February 2003, Iraq's theoretical ability to generate 10,000 MW had eroded to no more than 4,200 MW per day.¹²

2) *Lack of Capital Investment Led to Steady Decline.* After 1991, the Iraqi government invested very little capital in the electricity operations and maintenance. Iraq was unable to buy spare parts, replace parts at the end of their lifecycle, or to conduct routine maintenance. One significant effect was that Iraq lost access to its most cost efficient and productive fuel – natural gas. This increased Iraq's dependence on more costly and

maintenance intensive fuels such as crude and crude residual. In order to properly maintain a 10,000 MW system, electricity analysts assess that Iraq should have been investing \$1-2 billion per year into an electricity operations & maintenance program. This money was not available to the ME.

3) *Poor Operations and Maintenance (O&M) Caused the System to Atrophy.* The lack of funds and spare parts also eradicated the normal habits and practices of running a power facility (e.g., daily training, apprenticeships, management development, and recordkeeping). Prior to 2003, much of the daily management and operations were performed by non-Iraqi contractors, leading to a deficit of experience amongst Iraqi ME employees. Having lost its O&M culture through lack of funding for spare parts and an over-reliance on foreign contractors in March 2003, the ME had a poorly trained and under-motivated workforce. The Ba'athist regime de-emphasized technical competency as an essential for managing and supervising technically complex facilities such as the power plants. This attitude resulted in a degradation of ME technical competency that it has not yet overcome.

4) *Using the Wrong Fuels Took Its Toll.* Power generation efficiency is significantly reduced, sometimes by as much as 60%, when generation plants run on fuels such as crude or residual crude byproducts, despite the fact that Iraq sits on the world's second largest oil reserves. Since 1991, Iraq has lacked adequate supplies of refined products to fuel its electricity plants. Associated gas produced with the oil is flared for lack of processing facilities to make it safe for use and little emphasis has been placed on developing the extensive non-associated gas fields of Iraq. As a result, the ME was forced to retrofit generation units to use sub-optimal fuels. For example, gas combustion turbines were converted to burn crude oil. The negative consequences included: (a) generation units were less efficient and wore out faster; (b) more maintenance was required (but often not

performed); (c) additional costly chemicals required to treat the crude for use as fuel were hard to acquire due to the sanctions, and (d) less MW capacity was available to the grid.

Combat Operations of the Second Gulf War (2,500 MW), March - May 2003

The Second Gulf War began on March 20, 2003, and major combat operations ended on May 1, 2003. During combat operations, coalition forces used extremely accurate targeting methods that left Iraq's electricity infrastructure largely intact with minimal degradation to generation capacity. The USACE Task Force Fajr to the lead of Iraq's electricity sector after the coalition forces secured Baghdad. USAID awarded the first contract to Bechtel Corporation – a contracting company based in United States. This was for \$133 million initially (April 2003), and then raised to more than \$600 million of the \$1,029 billion in Phase I to restore critical electricity infrastructure. USACE's initial efforts were centered on obtaining emergency repairs, parts, and chemicals to restore existing capacity to operation.

The CPA was established on May 12, by which time Iraq was generating 2,500 MW per day (roughly the same level as immediately after the First Gulf War). As civilian and military reconstruction personnel began arriving in Iraq as early as April 2003, one of their immediate priorities was to return electricity generation to pre-war levels (e.g., 4,200 in March 2003). In addition to a decade of neglect, six additional factors made it difficult to squeeze generation capacity out of the system while combat continued:

1) *Extensive Damage from Iraqi Looting.* Even while combat operations continued and in the immediate aftermath, looting by the Iraqi population took a heavy toll on the Iraq electricity sector: a) spare parts were stolen; b) smugglers toppled transmission towers and sold valuable cables and tower steel on the black market; c) ME tools, vehicles and equipment were stolen across Iraq; and d) major transmission substations (i.e., 400 kilovolt (kV) and 132 kV) were extensively looted.¹³

2) *Limited Availability of Fuel Supply.* While combat operations continued throughout Iraq, it was difficult to transport adequate fuel for power generation.

3) *Leadership Vacuum Affects Ministry of Electricity.* Due to the political uncertainty in the immediate aftermath of the war, it took time before ME and MOO personnel returned to work. The senior management of Iraqi ministries was made up of all Ba'ath party officials and they either refused to or were prohibited from continuing in their positions.

4) *Natural Gas Pipeline Damage.* The strategic natural gas pipeline was severely damaged. During the war, the MOO hid gasoline supplies in the strategic natural gas pipeline from the South Oil Fields to the Northern region that affected the fuel supply throughout the country. After the war, looters drilled holes in the pipeline to extract the gasoline. It will require years to restore or replace the natural gas pipeline. The damage to this pipeline led directly to the use of alternate fuels in the gas combustion turbines.

5) *CPA Electricity and Oil Programs Not Coordinated.* Incompatible directives were given to CPA-Oil and CPA-Electricity. For non-technical reasons, the mandate for CPA-Oil was to "Restore Crude Oil Export Capacity"¹⁴ to prewar levels. Simultaneously, the mandate to CPA-Electricity was to improve electricity generation beyond the prewar levels. Since the electrical generation capacity had been diminished during the war, the prewar fuel demands for power generation were artificially low. This left CPA-Oil with a fuel deficit that was met by importing a considerable quantity of distillate. The oil production capacity was not increased to meet the growing demand of the free populace and electrical generation. This deficit has increased, at the time of this report, due to new generation demands.

6) *Rapid Deployment Contract Mechanism.* CPA planners needed to bring power on-line quickly. To rapidly start reconstruction, cost-plus contracts were awarded to large contractors. This was needed in order to get the large contractors started on projects that

were critical and not well defined. Unfortunately, when the security situation deteriorated, delays in mobilization and projects led to contractor cost increases that had to come out of funds intended for construction work. Most of the contracts were awarded based on a “permissive environment,” which did not develop.

The common misconception is that a fixed price contract would have cost less than a cost-plus contract - in the Iraq environment, this is not the case for many projects. Under a fixed price contract, the contractor bears a lot of the risk. In an unstable environment with many unknowns, a contractor would want a very large premium to agree to a fixed price contract, but under a fixed price contract, the only means for the contractor to mitigate risk is price. They would have to factor the risks of security preventing work, Iraqi employees not turning up, delays in supplies, and destruction of completed work. The contractor would make sure that they cover themselves for these risks by charging more money. In addition, fixed-price contracts are not a cost management strategy. Even in the event that a contractor could not complete a project under the firm price, it is likely that they would make the case that they were placed in an untenable situation and seek an increase in the price. A fixed price contract does not guarantee that the US/Iraq governments will receive what was the agreed price.

7) *Questionable ME Projects.* The CPA appointed Minister of Electricity invested more than a billion dollars of DFI funding in projects at Samarra, Mussaib, and South Baghdad. These projects are problematic from a fuel supply standpoint and will put further pressure on fuel supply network e as they come on-line.

8) *Supply – Embedded Capacity.* If Iraq’s electricity system were in pristine condition and operated under optimal circumstances, Iraq would have an “embedded capacity” of 10,000 MW per day. Due to the years of neglect and other factors; however, before the start of the war only 6,800 MW of this capacity was actually feasible.¹⁵

10,000 MW	Embedded capacity, including rehabilitated capacity
- 900 MW	Lost hydro generation due to water limitations
- 1,000 MW	Lost due to high summer temperatures of Iraqi climate
- 1,300 MW	Lost due to the old age of thermal equipment
6,800 MW	Actually feasible system capacity in March 2003

9) *Supply - New Generation and Imports.* Since 2003, the U.S. government has added 65 MW of new generation. Iraq has also entered into electricity import agreements with Iran and Turkey, potentially adding 150 - 250 MW per day. Together, this equals 7,115 MW of potential generation.¹⁶

6,800 MW	Actually feasible system capacities
+ 65 MW	New generation added by the U.S. in 2005
+ 250 MW	Current maximum electricity imports
7,115 MW	Actually feasible system capacities in May 2005

10) *Supply - Lost Generation Capacity.* On the negative side of the balance sheet, Iraq loses 2,000 – 3,700 MW per day due to several factors related to maintenance of the dilapidated system. This means Iraq is only able to reach 5,115 MW on a good day and as little as 3,415 MW on its worst days. These are factors for this lost generation capacity are:

a) *Unscheduled Maintenance.* Iraq loses 400 – 1,200 MW per day due to extremely poor operations and management systems, lack of appropriate budget support to buy much needed consumables (chemicals, filters, and others), a lack of spare parts, and the failing state of an aging, unkempt infrastructure. A disproportionately higher number of breakdowns occur during peak running seasons due to the severe weather conditions in Iraq. *The U.S. contractors working with the ME do not have on-site management. This means there is no guarantee that work done to repair old units or stand up new units will be sustainable.*

b) *Running on Wrong Fuels.* Iraq loses 500-800 MW per day because the Iraqi government cannot provide enough primary fuels that optimize a unit's performance. The primary reason for both this fuel shortfall and the one noted below is the limited capability of the MOO to produce distillates, capture and deliver natural gas, and increase crude oil exports. A less than optimal fuel (e.g., crude oil instead of diesel) can lower a unit's MW output by as much as 60%. However, using diesel can double the cost of electricity production. (Note: Iraq does not have the refining capability to produce the entire diesel it needs so it must import at a very high value. Some fuels are more efficient than others. Iraq has the potential to generate 5,000 – 6,000 MW per day from natural gas alone. Such a move would also save Iraq \$1.5 - \$2.0 billion per year from avoided fuel subsidies, maintenance expense and capital investment).¹⁷ However, a complete switch to natural gas for combustion turbines will require years of development and billions in investment capital. The ME and MOO have been interested in pursuing the natural gas option since February 2004 and had \$300 million DFI funds transferred to the MOO from the ME for rehabilitation of the East Baghdad Oil field and the South strategic gas pipeline. Unfortunately, the MOO was not able to commit those funds during 2004 and the funds have reverted to the Ministry of Finance (MF).

c) *Insurgents Attacks on Electricity System.* Even when the ME is able to generate sufficient supply to meet demands, homes and businesses will be left in the dark unless the transmission network can deliver the electricity. Insurgents and looters have routinely targeted Iraq's critical infrastructure, including the strategic 400 kV and 132 kV transmission lines. The ME is generally able to repair the damage within a few days and restore power. *Electrical Power Security Service (EPSS) security guards numbering about 9,500 has oversight of 17,000 km of electrical lines, over 60,000 electrical towers, and 462 electrical power stations, sub-stations and infrastructure until the Iraqi Security Forces and*

EPSS are able to better protect these assets, because electricity supply will be vulnerable to attack by the insurgents.

d) *Equitable Distribution.* The ME is ensuring more equitable distribution of electricity to the entire Iraqi population. Areas outside of Baghdad now receive their fair share of available electricity, which reduces the hours of power available to Baghdad. Baghdad residents are understandably frustrated, but some other sections of the country have enjoyed more supply than in any time in their lives.

e) *No Fuel.* Iraq loses 300 – 500 MW per day due to inadequate fuel supply. Reasons for this supply deficiency range from smuggling to failure of the Oil infrastructure to stop insurgent attacks on pipelines.

f) *Scheduled Maintenance.* Iraq loses 800 – 1,200 MW per day due to preventative maintenance on units. Electricity plants around the world routinely stand down their plants for short periods of time to perform periodic scheduled maintenance. Iraq's dilapidated system, which runs on the wrong fuels, requires even more scheduled maintenance.

<u>Good Day</u>	<u>Worst Day</u>	<u>Reason for Lost Generation</u>
7,115 MW	7,115 MW	Feasible System Capacity as of May 2005
- 400 MW	- 1,200 MW	Unscheduled Maintenance
- 500 MW	- 800 MW	Wrong Fuels
- 300 MW	- 500 MW	No fuels
- 800 MW	- 1,200 MW	Scheduled maintenance
2,000 MW	3,700 MW	Subtotal (Lost Generation)
5,115 MW	3,415 MW	Total MW Available Per Day

Table 1: Generation Maintenance Tracker

Resuscitating the Iraqi Electricity System (2,500 MW), April 2003 – June 2004

Coalition Provides Electricity Expertise. In order to coordinate coalition efforts to revive the electricity sector, civilian and military planners jointly established a ME Senior

Advisor Office of Electricity to assist the ME and develop a strategy to achieve 4,400 MW by October 2003. By September 2003, the newly established CPA assumed strategic program management responsibility for coordinating the electricity projects of the three main implementing agencies: (1) the United States Agency for International Development (USAID); (2) the Iraq Program Management Office (PMO), which began in operations February 2004; and (3) the U.S. Army Corps of Engineers (SACE), first under the name of Iraq Project Office (IPO), and then under the name of Task Force Reconstruct Iraqi Electricity (RIE) in September 2003. Before the transition of authority to the Iraqi Interim Government (IIG) in June 2004, dozens of coalition civilian and military electricity experts worked closely with two Iraqi government officials responsible for Electricity.

Prior to liberation, the supervision and management of all the activities related to electricity were the responsibility of the Commission of Electricity (COE), under the Ministry of Industry and Minerals. The Commissioner was Dr. Kareem Waheed who held office prior to the liberation until August 2003. In September of 2003, the COE was elevated to the Ministry of Electricity, with Dr. Aiham Alsammarae taking up that position in September 2003.

U.S. Restored and Added 971 MW by May 2004. As coalition officials prepared to transfer authority to a caretaker government in June 2004, U.S. funded electricity projects added 971 MW of potential generation capacity to the Iraq grid. This means that refurbishment projects completed by the U.S. would allow the ME to add 971 MW to the grid if the units have the optimum fuel available. From January to June 2004, the ME placed 3,550 MW on the grid per day. The ability of the coalition to help the ME was reduced as the transfer of authority in June 2004 approached, because the first high-profile kidnappings and murders of foreign contractors and aid workers elevated the risk level for foreign reconstruction firms working on electricity projects. The kidnappings and inherent security risk resulted in

project delays, as foreign electricity contractors would leave job sites before work was complete.

Embassy Continues CPA Electricity Program (4,250 MW), June – October 2004

Iraqi Minister of Electricity Reappointed. On June 28, 2004, the sovereign Interim Iraqi Government (IIG) assumed responsibility for governing Iraq, including the management of the Iraqi electricity sector. Coalition and Iraqi security forces were undertaking military operations in Najaf as the U.S. electricity team began working with the reappointed Minister of Electricity, Dr. Aiham Alsammarae.

Iraq Reconstruction Management Office (IRMO) Established. By July, the newly established, but understaffed IRMO assumed strategic program management responsibility for coordinating the electricity projects of the three main implementing agencies: (1) the USAID; (2) the Iraq Project and Contracting Office (PCO) and (3) the USACE, GRD. The U.S. electricity team continued operating under original IRRF II assumptions as the Minister and the newly appointed U.S. Ambassador to Iraq, John D. Negroponte, began reevaluating U.S. government reconstruction priorities in Iraq, including the electricity sector.

IRRF Reallocation #1 – More Security. In September and October 2004, the U.S. Ambassador determined that it was necessary to reallocate \$3.4 billion of the \$18.439 billion IRRF funds in order to finance emergent and under-funded security requirements. The U.S. took \$1.189 billion from the electricity program to fund urgent pre-election security preparations and programs to accelerate the training and equipping of 140,000 Iraqi security forces. The decision to tap electricity was made because: (1) electricity was the largest single source of uncommitted IRRF funds that could be rapidly used for security; (2) there was a false sense of progress as the ME briefly exceeded 5,200 MW of peak generation in August 2004.

U.S. Restored and Added 884 MW June – October 2004. In October 2004, IRMO began conducting sector review meetings to better coordinate and evaluate the energy sector activities of USAID, GRD and PCO. From June to October 2004, the Iraqi ME generated an average of 4,250 MW per day. During this same time period, the U.S. restored and added 884 MW of generation capacity for a total of 1,853 MW since 2003.

U.S. Reassesses Electricity Program Priorities (3,250 MW), November 2004

Previous Electricity Assumptions Challenged. Beginning in November, the U.S. began developing a more complete picture of the dire state of the Iraqi electricity sector. The findings challenged original assumptions, acknowledging that the system was in a rapid state of decay that was barely able to squeeze more than 4,500 MW out of a 10,000 MW system, despite 15 months of U.S.-led refurbishment activity. The review of the electricity sector led to two key realizations: The original planning had underestimated the decrepit state of Iraq's infrastructure and it overestimated the management capabilities of the Iraqi ME.

IRRF Reallocation #2 – More Electricity and Jobs. In November 2004, as U.S. forces initiated an all-out assault on Fallujah, the Ambassador finished his reassessment of reconstruction priorities and proposed a second IRRF reallocation to address these emergent electricity needs and provide reconstruction funds for four post-battle cities. IRMO proposed that \$1.5 billion of IRRF funds be reprogrammed, of which \$9 million was decremented from electricity for other priorities. The Ambassador's new plan made funds available to increase generation, purchase spare parts, and improve what had been a piecemeal operations and maintenance strategy. The goal was to provide reliable electricity generation during the lead-up to the January 2005 elections and to prepare for the spike in demand for the summer of 2005.

New Electricity Strategy. Beginning in November 2004, IRMO began validating and acting upon the new electricity assumptions. The Ambassador's new strategy included four

elements: (1) shift funds away from long-term U.S. funded electricity projects and shift these funds to smaller projects that would have an immediate impact on the electricity system; (2) allocate funds to finish projects started by the U.S. and then help the Iraqis maintain the additional MW generation once the projects were complete; (3) increase funding for ME operations and maintenance programs; and (4) promote fuel rationalization by having U.S. advisors dedicate more time to facilitating inter-Ministerial coordination between the ME and other ministries (e.g., Finance and Oil).

U.S. Restored and Added 33 MW in November 2004. In November 2004, the Iraqi ME generated an average of 3,250 MW per day. In November, the U.S. added 33 MW of potential generation capacity, for a total of 1,886 MW since 2003.

New Initiatives Executed (3,550 MW), December 2004 – February 2005

Starting in December 2004, the U.S. and the ME began implementing two key initiatives: (1) the Electricity Rapid Recovery Initiative and (2) the summer 2005 Upgrade Initiative.

Electricity Rapid Recovery Initiative. As the January 20, 2005 elections neared, the coalition worked closely with the ME to prevent insurgents from crippling the Iraqi electrical infrastructure, which would have dampened enthusiasm for the democratic process. Election planners realized that the majority of Iraqis had satellite TV, but they would not be able to watch political ads and public service announcements without electricity. The three key elements of the pre-election campaign were: (1) increasing fuel storage at generation plants; (2) providing additional management oversight to reduce down-time related to unscheduled maintenance; and (3) improved infrastructure security as prescribed in MNF-I's December 2005 formal infrastructure security plan. This program made some progress: before Election Day, 30 January 2005, hours of power were increased from an average of eight hours per day to ten.

Summer 2005 Upgrade Initiative. Iraq's summer temperatures regularly hit 120 degrees Fahrenheit and it has been projected that the 2005 summer demand for electricity could reach 8,600 MW. The U.S. is currently supporting a ME 2005 Summer Action Plan with four main objectives contingent on receiving appropriate fuels: (1) increase the hours of power per day from the current 8-10 hours to 12 hours/day during the peak summer season; (2) increase electricity production from 4,014MW per day (as of early March 2005) to a range of 5,600-5,800 MW per day by August 2005; (3) implement the first two phases of a three-phase O&M program; and (4) improve security of strategic infrastructure. The programs designed to increase 2005 summer generation capacity are:

1) *Complete Former DFI Generation Projects (+699 MW)*. IRMO and PCO launched "Project Phoenix" to provide funding for the refurbishment and recovery of generation units at seven generating facilities including plants that had been started in September of 2003 and had run out of funding due to cost overruns.

2) *Complete IRRF Generation Projects (+570 MW)*. USAID, GRD, and ME projects expected to be complete and on-line for the summer, including units at Baiji, Baghdad South, and Mussayib.

3) *Increased Fuels Allotment (+865 MW)*. Funded by the second IRRF reallocation, IRMO has recommended that the Iraqi government increase power generation providing the right fuels to the right plants. By allocating sufficient natural gas supplies to some units and by purchasing \$150 million of diesel, the Iraqi government can add 865 MW during the hot three-month period of June 15 to September 15.

4) *Operations & Maintenance (O&M)*. The Iraqi government's ability to provide electricity to the population is affected by both management and funding deficiencies at the ME. The U.S. has initiated a three-phase process to upgrade the ME's overall O&M capabilities as well as establish the framework for a regimented spare parts program. Phase-

One, a \$118 Million program, provided a large budget for spare parts and train 240 ME personnel was implemented from April 2004. Phase two, a \$35M program that is providing Emergency spare parts is projected to be done by June 2005. Phase Three, a \$103 Million program, includes forming teams of specialized ME employee experts to trouble shoot problems at the combustion and thermal plants and hiring experts to work on site to train plant personnel, develop standardized procedures, apprenticeship programs, and realistic operating and capital budgets.

5) *Increase Imports.* The Embassy team and ME combined efforts to increase the import of electricity from Iraq's neighboring states.

6) *Information and Awareness Campaign.* The Embassy and coalition military forces have worked with the Iraqi ME to design and fund a consumer awareness campaign to (1) inform the population about steps being taken to increase the availability of power; (2) encourage conservation of electricity; and (3) set reasonable expectations for the limited availability of power during the hot summer months.

7) *Improve Infrastructure Security.* Embassy and MNF-I representatives worked with the Iraqi government to develop an improved and coordinated strategy for protecting critical nodes of Iraq's infrastructure, including electricity generation units, transmission facilities and strategic pipelines that provide fuel for generation. In the short term, existing Iraqi army forces will augment the efforts of Coalition forces. Eventually, Iraqi government will be standing up new infrastructure security forces.

8) *U.S. Restored and Added 85 MW December 2004 – February 2005.* From December 2004 to February 2005, as coalition and Iraqi forces conducted military operations in Mosul and Tal-Afar, and as elections took place, the ME generated an average of 3,550 MW per day. During the same time period, the U.S. restored and added 260 MW of potential generation capacity, for a total of 2,146 MW since 2003.

Additional Refinement of the Electricity Program (4100 MW), March 2005

IRRF Reallocation #3. In March 2005, the U.S. Ambassador and IRMO proposed a third IRRF reallocation valued at \$900 million, of which \$61 million was decremented from electricity projects for other priorities. The reallocation supports the Ambassador's shift to a systems-based approach for electricity reconstruction, including: (1) a sophisticated O&M strategy; (2) complete plant refurbishments as opposed to discreet projects; (3) the cancellation of big, longer-term projects to fund completion of existing projects; and (4) getting serious about the fuel situation by pushing the MOO to recover/upgrade the natural gas system.

In March 2005, Minister of Electricity Dr. Aiham Alsammarae attended the IRMO "Summer Emergency Electricity Upgrade Meeting" designed to prepare for peak summer electricity demand. In March 2005, the ME generated an average daily peak of 4,108 MW per day. During the same time period, the U.S. restored and added 110 MW of potential generation capacity, for a total of 2,256 MW since 2003.

CONCLUSION

The April 2005 U.S. Electricity Strategy concluded that the U.S. program is on the right track. In April 2004, a U.S. government multi-agency assessment team visited Iraq and determined: (1) IRRF funding was fully programmed and there was little flexibility to reprogram projects for other priorities, and (2) the Embassy's electricity and oil sector assumptions and priorities were accurate. With the summer quickly approaching, the Embassy also met with the IIG Prime Minister and Deputy Prime Minister to seek high-level support for proposed summer electricity plan. Both officials agreed to support the initiative and authorized \$150 million for diesel purchases. Three months after the election, the Iraqi Transitional Government (ITG) had not yet named a cabinet and the new ME. In April, the ME generation remained steady at about 4,100 MW per day.

We continue to show unconditional support and commitment to the Iraqi Transitional Government to successfully bring the electrical system infrastructure back to serve the Iraqi people. The new Iraqi Transitional Government (ITG) took over on May 15, 2005 and Dr. Muhson Shlash assumed the office of the Ministry of Electricity. The U.S. is committed to continuing its support and the U.S. Embassy electricity team has already begun working with the ITG officials to prepare for the summer spike in demand. The U.S. strategy is to complete the projects started and to help the ME maintain the added MW capacity once it has been added. By implementing the plans described above, the U.S. will achieve the following strategic objectives for the electricity sector:

- 1) Restore or add 3,200 MW potential International Standard Organization (ISO) rated generation capacity to the grid by December 31, 2005 through U.S. government funded programs.
- 2) Assist the ITG to establish a baseline of 5,500 MW average generations by December 31, 2005.

3) Assist the ITG in increasing and maintaining the national average of 12 hours of power daily (7-day average) by December 31, 2005.

4) Assist the ITG to increase daily load served (7-day average) to baseline of 115,000 MWH.

Another important piece to establish long term stability is the national capacity-development program in Iraq. It is a critical component of the U.S. government's goal of building the capacity of the Government of Iraq to provide sustainable security and services to the Iraqi public. Undermining the U.S.-led effort to build Iraqi capacity is an operating structure where capacity-development activities are spread among multiple organizations and offices that are working without clear overall objectives, without a synchronized plan for conducting assignments, and without a system to measure if progress is or is not being made. Establishing viable Iraqi governing capacity will almost certainly require an investment of additional years and resources. This effort will not go unchallenged at the outset, given the difficult security situation and the increasing sectarianism within Iraqi society and its governing institutions. Both international and regional supports are critical factors in the formula for success. The Iraqi government and the United Nations have much hope in the success of the International Compact for Iraq. However, this vehicle to unify the country is dependent upon each Iraqi minister demonstrating supportive leadership and strong commitment to the Compact and governing capacity to provide and sustain security and services to the Iraqi public.

Finally, the reconstruction of infrastructure has been and will remain a crucial and enduring part of the U.S. program in Iraq. CPA's legacy for ongoing improvement of the power infrastructure is largely positive. The Iraqi government must deal with the gap between supply and demand by instituting a pricing mechanism, even if it does not fully recover costs in the beginning. At the same time, the U.S. and other donors must lay an institutional foundation for Iraq to build towards a sustainable future. That foundation lies as equally in

education and training as it does in building essential services. The old adage still holds true, “Give a man a fish and he will eat for a day, teach a man to fish and he will feed the nation.”

APPENDIX**A. Acronyms**

CERP	- Commanders Emergency Response Program
CPA	- Coalition Provisional Authority
COE	- Commission On Electricity
DFI	- Development For Iraq
DFID	- Department For International Development (U.K.)
EPSS	- Electrical Power Security Service
GRD	- Gulf Region Division
IIG	- Interim Iraqi Government
IPO	- Iraq Project Office
IRMO	- Iraq Reconstruction Management Office
IRRF I	- Iraq Relief and Reconstruction Fund I
IRRF II	- Iraq Relief and Reconstruction Fund II
ISF	- Iraqi Security Forces
ISO	- International Standards Organization
ITG	- Iraqi Transitional Government
JICA	- Japan International Cooperation Agency
kW	- Kilo Watt
kWH	- Kilo Watt - Hour
kV	- Kilo Volt
MNF-I	- Multi National Forces-Iraq
ME	- Ministry of Electricity
MF	- Ministry of Finance
MOO	- Ministry Of Oil
MW	- Mega Watt
MWH	- Mega Watt - Hour
O&M	- Operations and Maintenance
PCO	- Project and Contracting Office
PMO	- Program Management Office
RIE	- Restore Iraqi Electricity
RIO	- Restore Iraqi Oil
SIGIR	- Special Inspector General for Iraq Reconstruction
UN	- United Nations
UNDP	- United Nation Development Program
US	- United States
USACE	- U.S. Army Corps of Engineers
USAID	- U.S. Agency for International Development

B. Electricity Demand and Supply

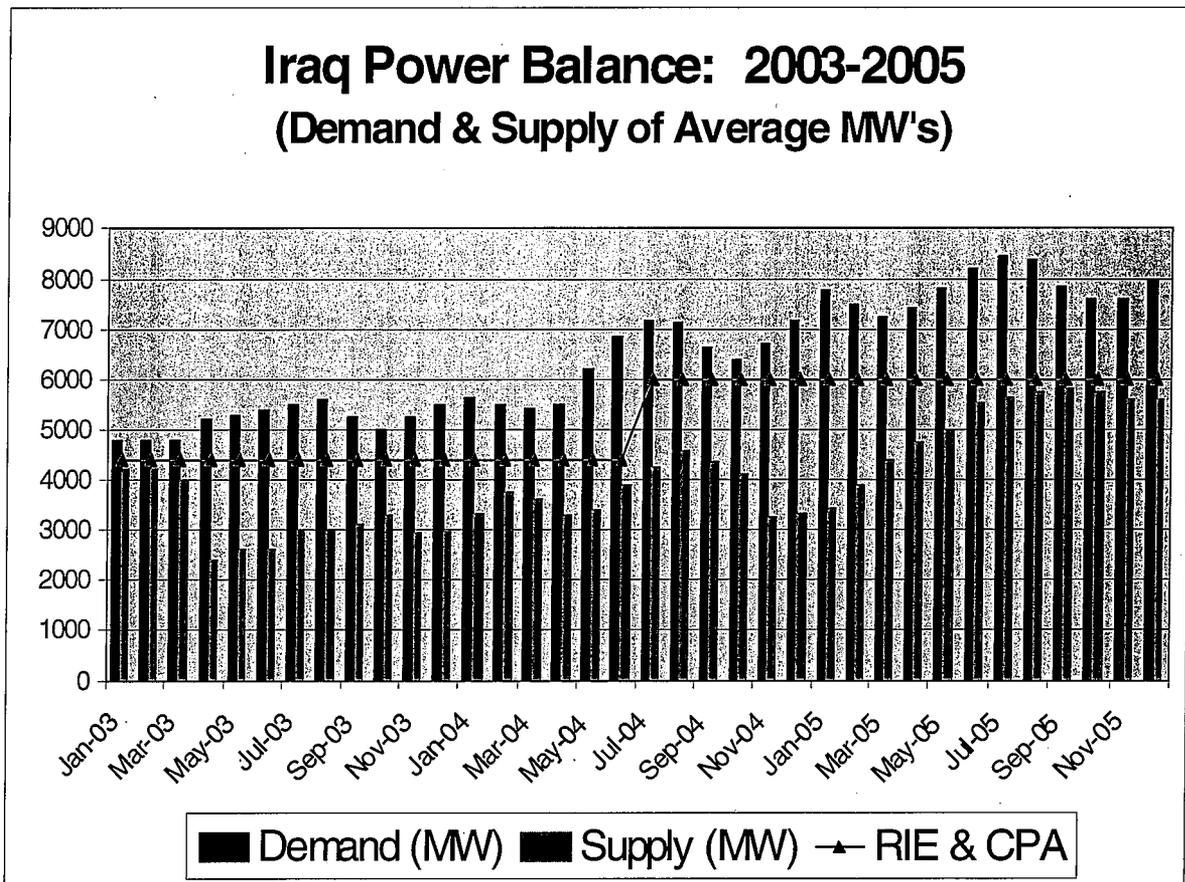


Table 2: Electricity Demand and Supply¹⁸

C. How Much Electricity Has the U.S. Restored and Added to the Iraqi Grid?

U.S. Has Restored and Added 2,256 MW of Potential Capacity to the Iraqi Grid. From April 2003 to March 2005, U.S. government programs have restored and added a total of 2,256 MW to the Iraqi grid. This means that the U.S. has completed projects to refurbish Iraq's electricity generation units so that if the ME could run the unit, preferably on the optimal fuel, and have fuel available, it would add 2,256 MW of power to the grid. This work included (1) rehabilitation (e.g., completely rebuilding a turbine) and emergency repairs; (2) maintenance (e.g., refurbishing critical elements of the system); (3) installation (e.g., installing units and parts not previously attached to the grid that resulted in new MW production); and (4) new MW production (e.g., installing a completely new generation unit).

		USACE	USAID	PCO	Total
DFI	Rehab	457	0	0	457
	Maintenance	0	0	0	0
	Install*/New	*494	0	0	494
IRRF	Rehab	508	0	0	508
	Maintenance	0	595	0	595
	Install/New	*147	55	0	202
Total MW		1,606	850	0	2,256

Table 3: Total Restored and Added to the Iraq Grid¹⁹

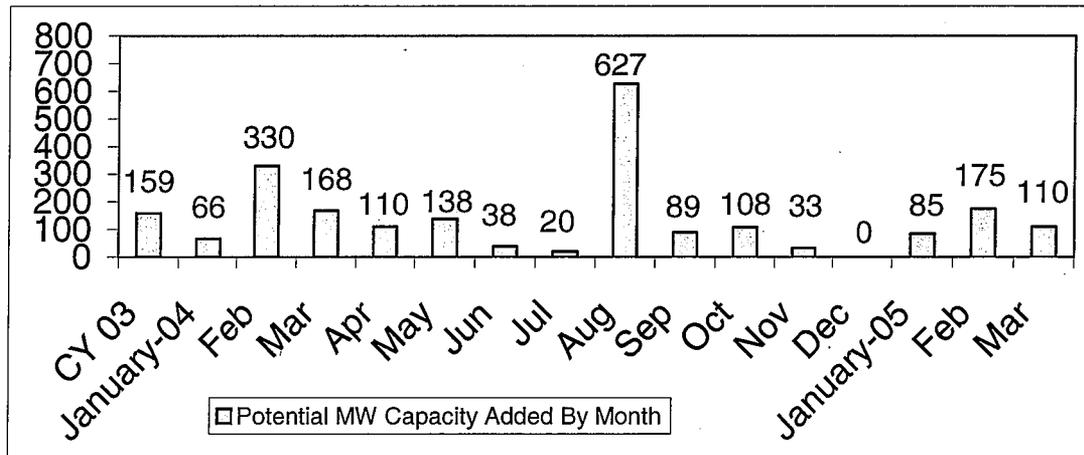


Table 4: Potential MW capacity Added by Month²⁰

D. Note on Demand for Electricity

If the United States government has added over 2,256 megawatts (MW) of potential generating capacity to the Iraqi electrical grid, why have the national hours of power actually decreased since 2003? The short answer is that despite increased generation capacity, demand has grown 37% since before the war.

	Hours of Power	
	Baghdad	National
Pre-War 2003 (4,000 MW)	16-24	13-15
May 2005 (4,500 MW)	10-12	8-10
Decrease	6-12	5

Table 5: Iraq Daily Hours of Power

Increased Demand. It may seem counterintuitive that if Iraq is generating roughly the same amount of power today as before the war (around 4,200 MW per day), that the average hours of power has declined from the prewar 13-15 hours to the current 9-10 hours. Demand is up 37% compared to pre-war demand (7,200 MW per day demand in May 2005 vs. 4,800 MW per day demand before the war). This spike in demand is understandable in light of the flood of electrical appliances (e.g., televisions, refrigerators and air conditioners) that have flooded Iraq since 2003. As Iraqi consumers exercise their newfound freedom to purchase previously unavailable products, the demand for electricity has grown steadily.

E. Note on Decentralized Power Options

INFORMATION MEMORANDUM²¹

Date: 17 March 2005

To: Ambassador Taylor

From: IRMO Electricity – Scott Hutchins, Senior Consultant (Acting)

Subj: PROS AND CONS OF DECENTRALIZING POWER GENERATION IN IRAQ

Lack of fuel and poor availability of Ministry of Electricity generating units continue to limit the electricity available to Iraqis. New and creative solutions are being sought to address this situation, and one such proposal is decentralization of power generation supported by private investment. An unregulated private market, including installation and maintenance, of decentralized power generation and distribution systems, has been operating in Iraq since the early 90's. The emergence of these businesses in Baghdad is more recent, appearing after the summer of 2003. These units are not connected into the grid, but sell power to local users as a back up to normal ME power. Power is transmitted through separate local distribution systems with change over switches at each connection so the utility power and generator-set aren't connected at the same time. This model calls for further encouraging private sector investment in small (< 500 kW) internal combustion diesel generating units supplying standby power. The connection of decentralized units to the grid would be far more complex and costly due to protection and synchronization requirements, so these have not been considered. This paper lays out some of the consideration for a small stand-power model from technical and policy perspectives.

CONTINGENCIES

- Distributed generation will require distributed security
- The required fuel(s) infrastructure and distribution systems must be in place and functioning

PROS

- Engineering, procurement and construction of small generating units and additional distribution system is quicker than traditional central station units. Larger units take approximately twenty-four months compared to around three to four months for decentralized units.
 - Empowerment of local community/neighborhood leaders.
 - Political visibility on electricity progress, particularly in the governorates where Iraqis are very unhappy about having to "export" electricity to Baghdad.
 - Potential to employ local people to install and maintain units, as they are low technology and do not require overseas assistance.
 - According to anecdotal data, this is already being done successfully in many parts of Baghdad.

COMPARABLE

- Thermal efficiencies are in the same order as large centralized units.
- Total Project installation costs (per KW) including additional distribution, are in the same order as large centralized units.

CONS

- Required fuels are not available. Most generators that produce 500 kW or less use diesel and this are in short supply. Decentralized generation will assist the Black Market and put the private sector in competition with the Ministry for scarce fuel.
- Fuel distribution by tanker is more difficult and therefore more expensive. Large centralized units can operate on piped gas or residual fuel oil. Piped distribution is not practical for decentralized units.
- O&M cost are typically double for decentralized units i.e. .01 to .02 \$/kWh hour compared to 0.005 to 0.01 \$/kWh for large centralized units.
- Provides an additional avenue for corruption, which the Ministry will need to regulate to prevent.
- Life expectancy of small generation units is typically one third to a half of large centralized units.
- Control of standards and safety requirements are far more difficult to control and enforce.
- Decentralization is only a temporary stopgap requiring manual start & change over between utility and generator-set supply. Auto-start, auto transfer systems are available, but are costly.
- Decentralized units can be used for alleviating short-term power shortages in localized areas of concern. However, due to operating costs, fuel supply issues and operational restrictions they should not be considered as a long term answer countrywide.

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