Grid Optimization in Southern Afghanistan

John Tirona, Electrical Engineering
Advisor: Dr. Saeed Monemi, Ph.D.
Kellogg Honors College Capstone 2012
California State Polytechnic University, Pomona

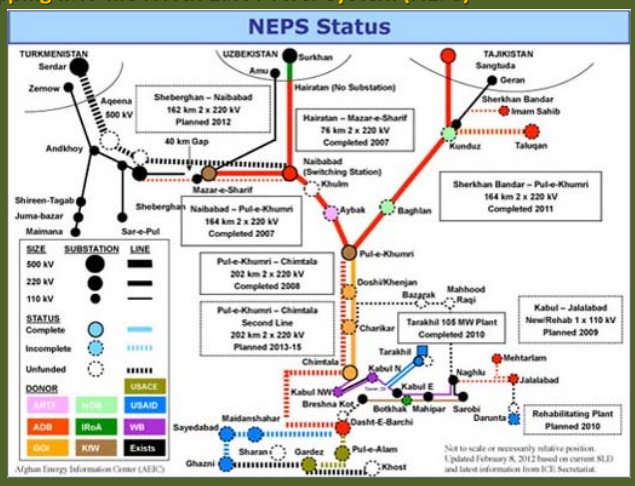
Abstract

The country of Afghanistan suffered massive damage as a result of the War on Terrorism by the United States of America against the Taliban insurgency. Since October of 2001, the United States has spent over $500 million for their efforts to shift Afghanistan towards a new democratic government. While the political effects from the war can be seen on television almost everyday, the economic and social collapse of southern Afghanistan goes relatively unnoticed overseas. As a result of air attacks and land raids, cities such as Kandahar have been left without major power lines delivering electricity to over 50,000 people. By understanding the current status of the electrical grid and estimating the demand for power in the region, groups contributing to the reconstruction and redevelopment of the region can strategize future plans for generation plants and transmission lines. From these future improvements to the infrastructure and power grid of the region, southern Afghanistan will undergo a much-needed facelift in an attempt to revitalize the region's struggling economy.

Proposed Solution

The proposed solution consists of two major improvements. In the north, a 500kV transmission line will stem from a 300MW generation station in Turkmenistan. This transmission line will connect into a 500kV/220kV substation that will subsequently join the North East Power System (NEPS, see below.) In the south, a single 220kV transmission line stemming from NEPS will assist the Kajaki Dam in delivering additional power to Kandahar from Kabul. The resulting improvements would connect the southern region of Afghanistan with the grid in the North, forming one encompassing circuit for the entire country. The following improvements would be funded generously by the United States Agency for International Development, USAID.

Tapping into the North East Power System (NEPS)

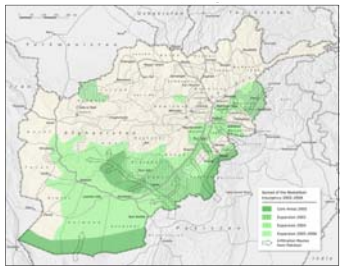


The North East Power System delivers power to the northern sectors of Afghanistan including the capital city of Kabul. The picture above diagrams the proposed improvements since 2007, which includes the completed 105 MW Tarakhil generation station as well as the proposed 220kV transmission line tapping power delivered by neighboring Turkmenistan through a 500kV/220kV substation in Andkhoy. The proposed improvements would secure additional power from the north as well as provide additional power to the south without the construction of additional generation plants and substations.

Power Consumption and Production in Kandahar

- The city of Kandahar lies roughly 300 miles south of the capital city of Kabul and has a population of just over 250,000 people
- While many residents use power for daily essentials such as lighting, heating and cooking, much of the power generated in Kandahar is used for water treatment
- Currently, there is 15.96 MW of installed capacity in Kandahar with 4MW off additional power coming from the Kajaki hydroelectric generator in the nearby Helmand Providence
- In 2008, an effort by the minister for energy and water and another private entity completed a $5.7 million project that brought 30 diesel generators to Kandahar's southern providence
- Of the total population in Kandahar, only about 40,000 people have access to clean power and water

Political and Geographic Factors



- Kandahar lies in the basin region of Afghanistan, below the famous Hindu Kush mountain range. The currents of the rivers stemming from the mountain range do not provide enough ferocity to justify future construction of hydroelectric generators.
- A typical summer day in Kandahar can exceed 100 degrees Fahrenheit. The extreme heat of the region requires locals to search for potable water as well as nourishment for crop production. The heat also eliminates the use of underground conduits as the combination of heat and overloaded circuits will cause massive derating of cable.
- Massive involvement by the United States in reconstruction efforts and funding restricts tapping into neighboring Pakistan and Iran. Under the administration of Afghani President Hamid Karzai, the nation has been pushing for increased sovereignty and negotiating with surrounding nations. Under the 2008 Economic Cooperation Organization (ECO) that met in Tehran, government representatives agreed to establish free trade guidelines among countries in the Middle East, including neighboring Pakistan, Uzbekistan and Tajikistan.
- Before the formation of a new democratic government, the Taliban had control over the region as a result of the overthrow of the former Soviet government. The southern region was significantly targeted by the Taliban for its prominent opium production. Transmission lines and important facilities such as the Kajaki Dam were targeted and bombarded during the United States insurgency during its War on Terrorism. Reconstruction efforts did not begin until 2003 and still continue today.
- The most important component to completing future improvements to the power grid lies on the commitment of private contractors. Past projects failed to be completed as a result of miscommunication and unrealistic timelines set by President Karzai and USAID officials.
- In addition, a new generation of engineers and technicians must dedicated themselves to the preservation and upkeep of current and future improvements to the system. Quality power distribution and a revamped economy will ensure a profitable return on such a quintessential utility.

Conclusion

The nation of Afghanistan has been torn from north to south by the effects of war. Many of these nations, such as the United States, have led the effort to reconstruction of the nation, specifically in providing power and water to dire regions. Southern Afghanistan lacks the physical potential to generate enough power to its residents. Major projects are in the works to bring power potential from the north down to the south. While the plan requires reserves from Afghanistan's neighbors and will require additional security, the immediate benefits heavily outweigh the concerns. The people of Afghanistan have sought a solution to the tyranny and destruction witnessed over the past few decades. An improved power grid seems to be a step in the right direction.