Clean, Green and Endless

Linking Renewable Energy and Food Security in Pakistan: A Global Value Chain Analysis

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Abstract

This paper talks about the energy sector in Pakistan and its current issues, the areas affected by the energy shortage crisis and the implications that has on the agricultural production and food security in Pakistan. The various stakeholders involved in the energy sector in Pakistan are identified along with their different levels of interest and influences. The paper presents case examples of China and Tajikistan to show the progress these two countries are making in the renewable energy domain to resolve food security. This paper then highlights how Pakistan is integrated in Global Value Chains (GVCs) for renewable energy and food security, where it stands in terms of other countries and how it can upgrade at environmental, socio-economic and technological levels. The paper also highlights how through the use of GVC analysis, the link between renewable energy and food security can be made and how Pakistan can improve its position in the GVC by resolving energy security which impacts food security. Furthermore, through the use of different policy tools, the paper outlines various policy options in detail and identifies the best alternative for Pakistan. An implementation design and strategy is also outlined. The paper concludes by summarizing the main points and by offering recommendations for Pakistan for the policy makers and the government.

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Introduction and Context:

It is the summer months that are the worst. With temperatures over a 100 degrees, no relief in the form of rain and to top it all off, no electricity, which means no air conditioners. I can recall one time in June in the summer of 2013, when it was close to 110 degrees and there was a power outage for 21 hours. The generators stopped working, so there were no fans or any other forms of cooling. Even the water from the taps was scalding. My family and I scrambled to our car and switched on the cooling, but even that lasted only for a few hours. We spent the night outside. Imagine how uncomfortable we were. Now pause for a second and imagine the millions of people living in the rural areas and slums with no cars, no fans and no other such luxuries. Imagine the farmers who needed the power to run the ploughs and tractors to farm the land. Imagine no electricity for days and then imagine no food. Imagine the frustration, the exhaustion and the hunger that ensued and then imagine it happening not just once, but over and over again, every single year, all the year round.

Pakistan is in the midst of the worst energy crisis in history. This is not only causing retardation in the economic progress of the country, but is also causing public unrest at a large scale. Throughout history Pakistan has been locked in the production

and consumption of fossil fuels as the main source of energy. Natural gas accounts for nearly 32% of the primary energy supply mix in Pakistan and the country is the 21st largest natural gas consumer in the world[1]. Pakistan was self-sufficient in gas until 2005, after which demand outpaced supply. Unattractive fiscal terms and price subsidies have led to diminishing production coupled with the lack of alternative fuel sources which has compounded the energy problem and led to systemic gas and power outages. The shortage of energy is relieved through a heavy reliance on imports of oil and gas that has increased the foreign debt of the country and led to circular debt[2] within the country. This has increased the costs and tariffs while causing losses to power generation, transmission and distribution companies. *Refer to figure 1 for Pakistan's projected energy requirements and energy deficits from 2010-2030.*

A country that hosts a population of 182 million[3], the demand for energy to meet the current living standards is quite high. Pakistan also falls under the category of one of the most food insecure regions in South Asia. About 58% of the population in Pakistan is food insecure and does not have access to sufficient and nutritious food to meet their dietary needs and lead a healthy life.[4] Food security of any country is heavily dependent on water and energy, in that energy is important in the production, processing and transport of food.[5] Globally, the demand for energy for food production is increasing and presently agriculture accounts for 30 percent of energy consumption

[1] http://www.oxfordenergy.org/wpcms/wp-content/uploads/2013/06/NG-77.pdf
[2] A situation where debt is relieved by taking out loans which leads to more debt being created.
[3] http://data.worldbank.org/country/pakistan
[4] Food security as defined by World Food Summit in 1996.
[5] http://www.sdpi.org/publications/files/State%20of%20Food%20Security%20in%20Pakistan%20and%20Policy%20Options.pdf

(IEA, 2013, WEF, 2011). For Pakistan, this situation is more drastic as the country faces massive shortages in energy and food, where supply is unable to meet the increasing demand.

The interconnected issues of food security and energy security are a major concern in the context of scarcity, climate change, bad governance, unequal distribution of resources and conflict over these resources. Pakistan's current strategy is quite unsustainable in the long run, especially if it plans to recover from not only its debt but also the energy and food crisis. The political instability in the country and lack of effective governance has also significantly impacted the implementation of a sound energy policy and hindered the shift towards alternative forms of energy that could alleviate the energy shortage in the country. Countries like China have faced similar problems with energy shortages and food insecurity and a shift towards renewable energy to help solve the food insecurity has proved to be a sustainable solution in China. Pakistan has a lot to learn from this example and therefore, a shift towards clean and renewable energy could potentially help solve the energy problem and ensure food security in Pakistan as well.

Pakistan urgently needs to make some strategic decisions and change the national energy mix[6]. Since the country is heavily dependent on agriculture and is an agrarian economy. Finding alternative sources to combat the energy problem and ensure uninterrupted energy generation in Pakistan is crucial for the country's economy, food security and the livelihoods of the farmers.

[6] http://southasia.foreignpolicy.com/posts/2014/08/13/pakistans_energy_crisis

Methodology:

For purposes of this paper, I will be looking at Pakistan as my main case and analyzing its energy sector. I will be discussing how the current energy mix is unsustainable for Pakistan in terms of resolving the energy shortages and food insecurity and how a shift towards renewable energy alternatives could help to potentially solve these two crucial development challenges for the country. For Pakistan, I will be analyzing these issues as a policy problem and therefore I will propose policy alternatives and recommendations towards the end of my paper. In order to deduce a clearer picture of the current situation in Pakistan and to provide evidence of successful cases of countries that are using renewable energy to combat energy shortages and food insecurity, I will be doing a comparative analysis of China and Tajikistan. The rationale behind choosing these two specific countries is to provide regional diversity within Asia, while also keeping in mind the similarities shared by these countries in terms of demographics and development challenges that they face. However, I will not delve into the specific types of renewable energy and will refer to renewable energy as a general term that encompasses all major forms of renewable energy (hydro, solar, biogas, wind, tidal).

I will use the Global Value Chain (GVC)[7] analysis to map the renewable energy sector and food security in Pakistan and I will also use the GVC analysis to draw the link between the two. This link is the basis of my paper that addresses the question of how renewable energy can be used to solve food insecurity within Pakistan, using

[7] http://www.cggc.duke.edu/pdfs/2011-05-31_GVC_analysis_a_primer.pdf

comparative cases of China and Tajikistan as examples. The GVC approach has been pioneered by Dr. Gary Gereffi, professor of Sociology and the Director for the Center for Globalization, Governance and Competitiveness (CGGC) at Duke University. The value chain describes the full range of activities that firms and workers do to bring a product from its conception to its end use and beyond. This includes activities such as design, production, marketing, distribution and support to the final consumer. The activities that comprise a value chain can be contained within a single firm or divided among different firms. Value chain activities can produce goods or services, and can be contained within a single geographical location or spread over wider areas. The GVC Initiative is particularly interested in understanding value chains that are divided among multiple firms and spread across wide swaths of geographic space, hence the term "global value chain."[8] Currently, the CGGC is using GVC analysis to understand different industries, sectors and countries in order to determine what a country's place is in a particular industry within the global value chain and with respect to other countries. Tracing the shifting patterns of global production, understanding how GVCs work or are "governed," and determining the roles they play in rich and poor countries alike, is what the study of global value chains is all about.[9] GVC analysis allows us to see how a country can upgrade within an industrial or a country level value chain.

For the cases of China and Tajikistan, I will be showing why there has been a recent shift towards renewable energy, how this is proving to be a successful solution

[8] https://globalvaluechains.org/concept-tools
[9] https://globalvaluechains.org/concept-tools

towards energy and food security and how Pakistan can benefit by doing the same. I will then offer different policy alternatives that can be adopted in light of the present situation in Pakistan and which alternative would be the most ideal one. I will also outline the implementation design and strategy for the chosen policy option. Finally, I will conclude by briefly summing up the main points of this paper.

Chapter 1: Background on Energy Situation in Pakistan

i) Historical Background:

There has been a history of energy shortages within Pakistan, both in the form of electricity shortages and natural gas shortages. *Refer to table 1 for a detailed timeline of the energy crisis within Pakistan and to figure 2 for a graphical representation of the Pakistan's energy shortages.* While 2007 is considered the starting point of the ongoing energy crisis, the issue has its roots in policy decisions taken two decades ago. In 1994, when only 40% of the population had access to electricity, Pakistan faced power shortages of about 2,000 MW during peak load times. The government at that time miscalculated and ill-assessed the demand and generation capacity required to meet that demand. A power policy was issued in 1994 that provided attractive incentives to investors but propagated a shift from hydropower to thermal power that required more fossil fuels for energy generation.[10] From 1994 to 2013, the fuel mix in Pakistan has seen significant transformations, causing interruptions in supply and an inability to meet demand effectively.

[10] http://www.peacebuilding.no/var/ezflow_site/storage/original/application/ade59fba5daf67a11a1c217434abf440.pdf

Due to Pakistan's heavy reliance on natural gas for industrial, commercial and domestic purposes, often there is an issue of which sector gets more at the cost of reducing supply to the other sectors. Fertilizer production in Pakistan took a hit as the Pakistani government curtailed natural gas use in anticipation of shortfalls during the winter of 2013. According to a report from Platts[11], the Pakistani government foresaw a natural gas shortfall of up to 1.8 billion cubic feet (bcf) per day during the period December-February (2013-2014), which is the peak of the winter heating season. In an effort to build supplies, Pakistan's petroleum ministry suspended natural gas supplies to fertilizer companies, private power plants (as used in heavy industry) and CNG stations for three months starting December 2013.[12] The resulting effect was a decrease in fertilizer production which naturally affected the agricultural activities and led to a shortage of food production and a hike in food prices.[13]

ii) Current Situation:

The situation is a dire one, however, efforts have been made previously and recently to stabilize the crisis and solve the energy shortage issue. These efforts, however, have been more for short-term relief rather than sustainable in the long-run. This has been in the form of increasing imports of energy rather than improving upon and developing domestic energy production and facilities. The new government that came to power in June 2013 cited the retirement of the circular debt as a priority, and within five weeks of

[11] http://www.platts.com/latest-news/natural-gas/karachi/pakistan-eyes-halting-gas-supply-to-captive-power-26291332
[12] http://www.agweb.com/article/pakistan_plans_to_cut_natgas_to_fertilizer_manufacturers/
[13] http://csis.org/files/media/csis/pubs/sam121.pdf

taking office announced that it had taken measures to deal with the issue. The debt was cleared by paying Rs. 161 billion in cash to Independent Power Projects (IPPs), issuing Pakistan investment bonds to public sector entities responsible for oil and gas exploration and the marketing of petroleum products, and making "non-cash payments" to the Water and Power Development Authority (WAPDA) – the country's largest power supply utility and to the National Transmission and Distribution Company (NTDC).[14] The finances were raised through loans from domestic banks which would in the longer-run lead to more domestic debt. Furthermore, the government has also looked towards increasing fertilizer and other agricultural imports to supply the agricultural sector, rather than increase domestic gas supply for domestic fertilizer production.

a). Political and Institutional:

Pakistan has a national energy policy, but it is unresponsive, only partially implementable and at the mercy of competing bureaucratic interests. Six ministries and forty-two agencies are involved in Pakistan's energy policy making and provision. This has led to ineffective coordination, institutional overlap and poor capacity.[15] Pakistan also suffers from security problems that negatively impact the energy sector, like terrorist threats, regional conflicts, and tribal conflicts. Furthermore, tensions exist between the federal and provincial governments due to the political autonomy of the provinces as a result of the 18th Amendment to the Constitution of Pakistan. The differences in views and decisions, further slows down progress and implementation of

[14] http://www.peacebuilding.no/var/ezflow_site/storage/original/application/ade59fba5daf67a11a1c217434abf440.pdf
[15] http://www.usip.org/sites/default/files/PW79_Pakistans_Energy_Crisis.pdf

energy policies.[16] Currently, there are about seven or more active political parties vying for political power and competing against one another. The ongoing rallying, discrediting opponents, public disturbances and frequent regime changes have shifted focus away from the pertinent and actual problems plaguing society and the economy and also curtailed progress in the energy sector.

b). Economic:

From an economic standpoint, the energy sector suffers from years of underfunding both from the private and the public sector. This has led to losses in distribution and transmission lines, improper maintenance of power plants and gas pipelines and aging equipment that has not been replaced or upgraded.[17] Instead of looking to facilitate domestic production of energy, fertilizers and food, the government has had a policy of relying on foreign imports of energy, fertilizers and food to relieve the shortages in the country. This has led to circular debt within the country and a negative foreign exchange balance. The circular debt has contributed to inflation and price hikes, making it difficult for the society and industries to afford energy and inhibiting economic growth as a result. Prices for fertilizers and food have also risen and imports have contributed to the crippling of the domestic fertilizer and food industries as a result, negatively impacting food production as a result.

[16] http://www.usip.org/sites/default/files/PW79_Pakistans_Energy_Crisis.pdf
[17] http://www.usip.org/sites/default/files/PW79_Pakistans_Energy_Crisis.pdf

c). Social:

Pakistan is in an odd position of having low energy prices and high levels of non-payment. It is estimated that just 1% of the population pays for electricity and electricity theft is rampant and so are power losses.[18] In areas where power outages occur for longer periods of times, frequent riots and conflicts erupt as well. The social instability also hinders development as it poses security issues and could direct away international agencies and other investors that could potentially invest in the energy sector within Pakistan.

Throughout its history, Pakistan has experienced cycles of high growth interrupted by shocks and crises. Following steady economic growth in the early 2000s, the country has faced significant challenges in recent years. The sharp rise in international oil and food prices in 2008 had a devastating impact on the economy, slowing growth as inflation soared. Widespread floods in 2010 added to Pakistan's economic woes and threatened to reverse earlier gains in poverty reduction. Rising levels of ethnic and religious strife, conflict and insecurity have further limited the country's capacity to deal effectively with persistent poverty.

Although Pakistan's poverty rate declined by about 10 percent from 2001 to 2005, almost a quarter of the population still lives below the national poverty line, and some 60 percent are just above that level. Pakistan ranks 146th out of 187 countries on the United Nations Development Program's 2013 Human Development Index – a

[18] http://www.usip.org/sites/default/files/PW79_Pakistans_Energy_Crisis.pdf

comparative measure of life expectancy, literacy, education and standards of living for countries worldwide. And poverty in Pakistan is predominantly a rural problem. While rural people make up two thirds of the population, they account for 80 percent of the country's poor people. Agriculture is at the heart of the rural economy and accounts for roughly one fifth of the economy. Most of the land is arid, semi-arid or rugged, and not easily cultivated.

Those who suffer most acutely from rural poverty are small farmers with limited land and livestock, landless farmers and especially women, who – as a result of systemic gender discrimination – have little access to resources, services or assets of their own.[19] While there have been a number of rural development schemes in the country carried out by the government and the assistance of international development organizations and the non-profit sector, progress has been limited and slow mostly due to political instability, lack of infrastructure and frequent policy changes.[20] As the country mostly relies on agriculture for economic survival and the majority of its population is involved directly or indirectly in agricultural activities, any threats or hindrances to those activities can adversely impact the economy and the people. It is safe to assume, that the energy shortage for fertilizer and agricultural production is a massive obstacle and threat. Continuous and uninterrupted supply of energy to the fertilizer industry and agricultural sector would ensure that agricultural activities are sustained and food output is ensured.

[19] http://www.ruralpovertyportal.org/country/home/tags/pakistan
[20] http://publications.iwmi.org/pdf/H043769.pdf

iii) Stakeholders' Interests and Influences:

There are numerous stakeholders involved in this issue with varying levels of interests and influence. *Refer to table 2 for a detailed list of primary and secondary stakeholders and to figure 3 for their levels of interest and influence.*

Primary Stakeholders:

1) Ministry of Petroleum and Natural Resources of Pakistan: the ministry is directly responsible for providing energy to the country and for implementing policies at the federal and provincial levels in Pakistan. The ministry has a high level of interest and influence with regards to the energy sector.
2) Government of Pakistan: the Prime Minister of Pakistan has the highest level of interest and power, so he is the most powerful stakeholder in this situation. Representing the government and its interests, the prime minister has the final say over the approval or rejection of policies that directly influence the supply of energy and the kind of energy mix to be adopted (what type of resources, domestic or foreign production, etc). Any decisions the government makes would impact the economy, the political and social sphere as well.
3) Fertilizer Industry: this industry is directly impacted due to the energy shortage and therefore has a high level of interest in the issue, but not necessarily the same level of power. The fertilizer industry needs the energy

supply to ensure fertilizer production that is needed for agriculture. Interruptions in the energy supply affect production, revenues and profits.

4) Power Plants: they are responsible for electricity generation and therefore have a high level of interest as they need fuel for operation and to supply it to distribution companies. If they do not receive the energy supply, they would incur higher marginal costs. However, the power plants have little influence as they are state-owned and therefore fall under the ministry.[21]

5) Distribution Companies (distributing energy comprising of fossil fuels and electricity): they have a moderate level of influence but high interests. Privately owned distribution companies can cut back supply if their payments are not ensured and therefore can force the government to make policy changes. State-owned companies fall under the ministry. In terms of interests, they need the energy supply to distribute it widely across residential, industrial, transport and commercial sectors and to cover their fixed and marginal costs and make a profit. Therefore, they have a high stake in the energy issue due to their high level of interest.[22]

ii). Secondary Stakeholders:

6) Investors: international investors like China and the US have moderate influence on the energy policy as they can impose conditionalities on the

[21] http://thediplomat.com/2013/08/pakistans-energy-crisis/
[22] http://thediplomat.com/2013/08/pakistans-energy-crisis/

funds that the government of Pakistan has to comply with.[23] International agencies like the World Bank[24] and Acumen[25] have invested in the energy sector in Pakistan. While having low influence on policy directly, they do impose minimal conditionalities on the loans (in the case of World Bank). They have a low level of interest, however. Domestic private investors in the energy sector have a low level of interest and influence as their interests mainly lie in the largest return on their investment and the profits they can make as a result.

7) Farmers and Citizens: these two groups are directly impacted due to the energy shortage and therefore have a high level of interest in the matter, but unfortunately cannot influence policy to a very large extent. Public demonstrations and riots can in some cases force the politicians to make some changes in policies, but in most cases such changes are short-term.[26]

8) Food Producers: have low influence but a moderate level of interest as energy is needed for food production and activities and interruptions in energy supply can negatively impact revenues and profits.

9) Mass Media: has a moderate influence on policy as it can steer public opinion in a certain way. It has a moderate level of interest in the issue insofar as reporting is concerned, but is not directly affected by the energy crisis.

[23] http://southasia.foreignpolicy.com/posts/2014/08/13/pakistans_energy_crisis
[24] http://www.worldbank.org/en/news/press-release/2014/05/02/world-bank-group-approves-1-billion-usd-for-supporting-economic-reforms-in-pakistan
[25] http://acumen.org/investment/sre-solutions/
[26] http://www.economist.com/blogs/banyan/2012/05/pakistan%E2%80%99s-energy-crisis

10) Political Parties: they can lobby for certain policies to be implemented and have a moderate level of influence. Their interests stem from larger motivations of garnering public support for their parties. So they are not directly affected by the crisis.

11) Research Organizations: have a low interest and influence in the matter. They are not directly affected; however, they can and do advise the government on policy issues and conduct situational analysis on the energy sector to give the government more information on the matter.

The boundary analysis (*see figure 4)* shows a diversity of concepts at stake on the issue of the energy shortage for the agricultural sector and food production in Pakistan. The stakeholders with the most power and a high level of interest (ministry and government) are unable to come up with effective policies to combat the energy issue. Simultaneously, short-term solutions are pursued instead of long-term, sustainable ones. The stakeholders with higher levels of interest but low influence (fertilizer industry, power plants, citizens, farmers, media, investors, etc) are unable to impact the policy process but are obviously the ones who are the most affected by the energy crisis.

Taking a look at *figure 5*, we can see that there are a diverse plethora of issues at play causing the energy shortage that impacts the agricultural sector and food production in Pakistan. The inefficient government policies stem from the supply being unable to meet the demand for energy and the government relying on short-term

solutions like imports of fossil fuels to combat the shortage temporarily. This has led to under-utilization of power plants with gaps in supply and demand, a large circular debt within the country and foreign debt leading to price hikes and inflation regarding energy buying, and interruptions in agricultural production causing food shortages. The energy and food shortages have led to mass outrage on the part of the citizens and those directly affected. The causes and effects are quite interrelated (*see figure 5 for a breakdown of the problem)*. Political party lobbying, lack of investment in the infrastructure and the energy sector and under-utilization and under-maintenance of power plants has also compounded the problem. All this has decreased the energy supply while increasing the prices for energy and the demand for energy is still not met. Furthermore, the agricultural sector suffering the most has no recourse for a solution on how to continue its existing activities and ensure the production of food and uninterrupted agricultural activities.

Chapter 2: Potential for Renewable Energy:

i) Comparative Case of China:

China is fast becoming one of the largest consumers of energy. In 2013, China's growth in oil consumption accounted for one-third of the world's oil consumption growth. In 2014, China was predicted to surpass the United States as the world's largest oil importer. China's dependence on imported oil, combined with its well-publicized air-pollution problem, gives the country two big reasons to reduce its dependence on fossil fuels. *Refer to figure 6 for China's energy use by sector.*

However, China unlike other countries facing similar outlooks actually recognizes its energy problem and is making big bets on renewable energy. According to The Global Status Report, which was released by the Renewable Energy Policy Network for the 21st Century, China once again led the rest of the world in renewable energy investment in 2013, spending a total of $56.3 billion on wind, solar and other renewable projects. The report stated that China accounted for 61 percent of the total investment in renewables by developing countries, and that China invested more in renewable energy than all of Europe last year. While globally there has been a decline in renewable energy investment, China has consistently increased its investments every year for the past ten years. New renewable power capacity surpassed new fossil fuel and nuclear capacity in China for the first time in 2013. China is now home to about 24 percent of the world's renewable power capacity, including an estimated 260 gigawatts of hydropower.

China's renewable energy investment is part of its 12th Five-Year Plan for Economic and Social Development, which calls for the country to spend $473.1 billion on clean energy investments from 2011 to 2015. China's goal is to have 20 percent of its total energy demand sourced from renewable energy by 2020.[27] *Refer to figure 7 for China's Renewable Energy Use as of 2008.*

With 20 percent of the world's population, China has to feed itself with just 7 percent of the world's farmland. At current rates of growth, China will add 125 million to its population by 2025. In this scenario, China will have to expand its agricultural output by 25 percent to sustain this growth. Food security will not only be threatened

[27] http://www.forbes.com/sites/jackperkowski/2014/06/17/china-leads-in-renewable-investment-again/

by increased urbanization and existing water scarcity, but by ongoing climate change induced by the ever growing dependencies on fossil fuels. Agriculture accounts for nearly 70 percent of water use in China and clean water resources are limited. Renewable energy sources such as wind, solar, and geothermal are attractive not only because of their lower carbon emissions profiles, but because they use far less water than their fossil fuel counterparts.[28]

China has implemented key policies to ensure a shift towards renewable energy leading to an overall increase in energy production. China enacted its milestone Renewable Energy Law, which took effect in early 2006. This law, along with its supporting amendments for implementation, comprises the legal framework for China's renewable energy policies. The second most important strategy to support renewable energy development in China is the Medium and Long-Term Development Plan for Renewable Energy. The Plan, drafted by the National Development and Reform Commission (NDRC) and passed in 2007, lays out the guiding principles to "speed up the development of renewable energy, promote energy conservation and reduce pollutants, mitigate climate change, and better meet the requirements of sustainable social and economic development by 2020." Key stipulations for renewable energy in both the Renewable Energy Law and the Medium and Long-Term Development Plan for Renewable Energy include: National targets: According to both plans, renewable energy should account for 10 percent of China's total energy supply by 2010 and 20 percent by 2020. Mandatory grid access: The Renewable Energy Law stipulates that grid companies

[28] http://www.ecobuddhism.org/bcp/all_content/3rd_pole/china_nexus

have to purchase all of the power generated from renewable energy sources within their coverage areas. Special subsidies for solar PV installation: The government's "Golden Sun" program launched in July 2009, as well as an older subsidy scheme for grid-connected PV on urban roofs, provide financial subsidies for the installation of solar PV systems. Other Chinese policies that support renewable energy development include subsidies for the production of bio-pellet fuel; reduction and exemption from the value-added tax for renewable energy equipment; a preferential import tax on key renewables components; and the "Home Appliances to the Countryside" project, which promotes and/or subsidizes the use of appliances such as evacuated tube solar water heaters in rural areas. In addition, the Ministry of Science and Technology provides financial support for R&D on key renewable energy technologies and has established a reward system for independent equipment R&D.[29]

ii) Comparative Case of Tajikistan:

Enhancing food and nutritional security has reemerged as a critical international and national policy goal in the wake of the recent global food and economic crises. As international food prices surged in 2007– 2008 (and again in 2010–2011), some large grain exporters imposed restrictive trade policies. However, these trade restrictions further increased international food prices and amplified price volatility in international food markets. Tajikistan was among the hardest hit by the global food and economic crises. The crises hit the country in multiple ways: economic growth contracted, the import prices for wheat and other staple food items soared, and the inflow of

[29] http://www.worldwatch.org/system/files/182%20China%20Energy.pdf

remittances reduced.[30] To increase food supply, agricultural production has to be increased which requires extensive use of energy. Energy is central for Tajikistan. It is the main element and the core of the country's industry and agriculture and is an integral part of the life support system of the whole society.

Tajikistan is a mountainous and landlocked country. It borders with Afghanistan, China, Kyrgyzstan and Uzbekistan. The Republic of Tajikistan does not possess any significant explored reserves of oil and natural gas – the main modern sources of energy. The country has large reserves of coal; the main mines are located in remote mountainous areas. Extraction of coal and transportation by road, along with high manufacturing costs, significantly increases the final cost for the population. However, Tajikistan is one of the regional and global leaders in hydropower potential. In terms of per capita potential, it is 87.8 thousand kilowatt/hours of electricity per annum, which rates Tajikistan as the second in the world.[31] Furthermore, pilot production studies are encouraging and indicate cost effectiveness of up-scaling of grain and juicy stem-sweet sorghum raw material for ethanol production in Central Asia.[32] This shift towards renewable energy sources, coupled with international funding has led to an increase in food production within the country.

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[30] http://www.ifpri.org/sites/default/files/publications/ifpridp01163.pdf

[31] http://www.se4all.org/wp-content/uploads/2014/01/Tajikistan-Rapid-Assessment_Gap-Analysis-v5-eng.pdf

[32]https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&cad=rja&uact=8&ved=0CFsQFjAJ&url=https%3A%2F%2Fapps.icarda.org%2FwsInternet%2FwsInternet.asmx%2FDownloadFileToLocal%3FfilePath%3DRegional_program_reports_archive%2FCAC%2FFood_security_Caucasus.pdf%26fileName%3DFood_security_Caucasus.pdf&ei=X3kdVeC7D4SpgwSKnYPAAQ&usg=AFQjCNGHy24xnoquTlQL2gB_Mu-4TnTZxg&sig2=haXQQHaZgy17TQ6v0ELbLw&bvm=bv.89744112,d.eXY

Chapter 3: GVC Analysis on Energy in Pakistan:

The global economy heavily relies on fossil fuels for energy generation and this is leading to a decline in the natural resources. The increasing demand is not being met by the dwindling supply. Pakistan, as a developing country, despite having vast potential for renewable energy sources, continues to survive on non-renewable energy which has contributed to escalating problems in the energy sector with frequent shortages occurring.

The global value chain (GVC) approach has become quite relevant over the past decade and is a pertinent approach in analyzing the position of Pakistan in the global arena, specifically where the energy sector is concerned. It allows one to examine the country's relationships with international investors (in the energy sector) and the position Pakistan occupies in the global economy. The GVC approach highlights areas of concern, allows one to determine instances where there is further potential for improvement and points out the ways in which Pakistan can upgrade in the value chain- in this particular case, the GVC approach offers valuable insights into how Pakistan can upgrade through sustainable development of its resources. Sustainable energy solutions coupled with foreign investment and rigorous policy implementation may resolve the prevalent energy crisis eventually.

With regards to the energy sector in particular, the GVC approach has several important functions and implications: a). it allows us to determine the problematic areas that have been impacted by the energy shortage, b). it helps us in identifying the

extent of the impact of this crisis, c). it allows us to offer solutions to the energy crisis, d). it will help us to show the key players in the energy sector- the international investors and their stakes in the Pakistani economy and e). it shows the ways in which the Pakistani energy sector is connected to the global economy in the energy GVC.

Participation in GVCs also allows better trade and investment flows, better remunerated jobs, better governance and political stability as well. Pakistan, while not quite high up in the value chains, is however, part of a few value chains, notably the apparel, football manufacturing, surgical instruments, and miscellaneous raw materials' value chains. The energy industry contributes to economic growth in two ways. First, energy is an important sector of the economy that creates jobs and value by extracting, transforming and distributing energy goods and services throughout the economy. Second, energy underpins the rest of the economy. Energy is an input for nearly all goods and services.[33] The recent shift in production from Pakistan to other countries, by the lead firms in the apparel and football value chains has led to significant decline in the economic and social aspects of Pakistan. One of the major reasons for this, at least over the last decade is the prevalent energy shortage issue that has slowed down and in some cases curtailed industrial activities and production and has prevented newer technologies and capital-intensive machinery from being utilized to its maximum potential. When there is no energy to supply or there are frequent power outages, then naturally, industries, that require the use of machinery in various stages of production

[33] Yergin, D., Gross, S., Bachman, D., Larson, J., Lyman, T., Meyer, N., & Randolph, J. (2012). Energy for Economic Growth: Energy Vision Update 2012. *World Economic Forum*, 1-45

or even fuel for heating and cooling purposes, like the textile, metals, raw materials processing industries, etc, would suffer to a large extent. As the transport sector consumes a large percentage of energy, the shortage, therefore has resulted in frequent delays in production. Similarly, the industrial and agricultural sectors also consume considerable amounts of energy, so shortages in energy have resulted in a decrease in food production as well.

The Prime Minister of Pakistan, Nawaz Sharif invited China North Industries Corporation, or NORINCO, which is engaged in production of solar power plants, to install solar power plants in the country.[34] Previously, China and even the US have loaned funds to Pakistan for the development of its energy sector, particularly hydropower. Thus, there is significant investment by foreign countries and companies in the energy sector of Pakistan, which incorporates Pakistan in the energy value chain, from the top-down perspective. In the energy value chain, Pakistan is connected to the rest of the world, as the energy output is directly utilized by the industrial, agricultural and transport sectors and this impacts the output of these industries (that are already part of particular GVCs and thus important for the rest of the world).

Countries all over the world are trying to look towards and implement sustainable energy alternatives as fossil fuel resources are finite and produce pollution that is injurious for the environment. Recently, over the past couple of years, just as the

[34] China Daily Group of Newspapers (2013). Pakistan Seeks Chinese Investment in Energy Sector. *Business Daily Update*. Retrieved from http://go.galegroup.com/ps/i.do?id=GALE%7CA334029049&v=2.1&u=duke_perkins&it=r&p=ITOF&sw=w&asid=2da51c0665713dd147bee7ab9171f7ff

energy shortage in Pakistan has reached a crisis level, this has also propagated the drive to seek alternative remedies and innovative solutions. Pakistan has great potential for renewable energy resources, namely, hydropower, solar power, wind, bio fuels and geo thermal energy. Utilizing these alternatives would cut down on the import bill, protect the environment and combat the energy shortage. Hydropower provides nearly 20% of the world electricity supply and in Pakistan it is one of the main sources of energy, contributing 33% of the total electricity supply mix. This percentage is considerably lower from what it used to be in 1960 (70%), due to poor maintenance of the power plants, droughts, underfunding and inefficient government policies. However, over the last two decades a 1450 MW hydropower plant has been constructed to stabilize the energy sector. The energy shortage created by hydropower has majorly been filled by generating thermal power, which utilizes oil and is imported, thus increasing the foreign debt for Pakistan. Switching back to hydropower would balance the debt since hydropower is the most economical source of energy in Pakistan.[35]

Its geographic location, climatic conditions and topography make it ideal for Pakistan to exploit solar energy. Solar photovoltaic energy can also be utilized to supply electricity to remote areas and even solar water heating can make a significant contribution to the energy supply mix of the country and help reduce the national reliance on energy imports. Furthermore, as a predominantly agrarian economy, there is a lot of potential to exploit biomass as a fuel and as an energy alternative. The biomass-

[35] Asif, M. (2008). Sustainable Energy Options for Pakistan. *Renewable and Sustainable Energy Reviews*, *13*, 903-909

based fuels account for about 36% of the total energy mix in the country. Recently, initiatives have been undertaken to promote the use of biofuels. For example, in 2006, in three petrol stations in three different cities, fuel ethanol was blended with petrol and further, the Pakistani Sugar Mills Association has aided in the bioethanol advancement program as well. Additionally, the coastal areas of Pakistan can be exploited for wind power and energy generation too. In 2002, 14 small wind turbines were installed and tested and passed the demonstration stage successfully. There is indeed a long-term plan of setting up a 9.7 GW of wind power by 2030.[36]

Pakistan's economic, social and technological upgrading is directly linked to environmental upgrading, in that mending the energy crisis and employing more sustainable alternatives would boost the functioning of the industrial sector, thereby increasing economic and social productivity and industrial output. Technological advancements and innovations especially in machinery can be utilized to their maximum potential, which would once again increase productivity and improve Pakistan's position not only in the energy value chain, but in other value chains that it is currently a part of as well. There is massive scope for technological innovation in the energy sector, for instance, in the use of hybrid or solar powered cars. Renewable energy sources can be utilized innovatively so as to reduce environmental degradation. Thus, in this way, the energy sector links every other sector and economic activity and anything impacting the

[36] Asif, M. (2008). Sustainable Energy Options for Pakistan. *Renewable and Sustainable Energy Reviews*, *13*, 903-909

energy sector causes a domino effect, either positive or negative, in other sectors of the economy.

Gereffi et. al, state that "trade and participation in GVCs are just intermediary objectives. The question is how much value is captured by the country in terms of jobs, income, technology diffusion, sustainable development, etc".[37] For Pakistan, this implies that by focusing on developing and maintaining its energy sector, the country would capture greater value in terms of socio-economic, technological and sustainable development and allow it to upgrade as well. Furthermore, when foreign investors and lead firms are deciding where to potentially direct their investments or source their activities, one of the key factors influencing their decision is also the presence of uninterrupted energy and power in those industries or sectors.

Pakistan is trying to attract foreign investors towards the energy sector, as a lot of untapped potential exists and this would allow the country to upgrade in the value chain by developing its resources and utilizing them effectively. Partnerships with the US in order to set up renewable energy generation plants are also becoming common in the past few years, as, for example, the joint public-private partnership between Pakistan and the US, to develop a 150-megawatt, $375 million wind power generation facility in the Gharo Corridor took place just a few years ago.[38] Also in the last five or so years, the Pakistani media has launched ongoing campaigns to promote the

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[37] Cattaneo, O., Gereffi, G., Miroudot, C., & Taglioni, D. (2013). Joining, Upgrading and Being Competitive in Global Value Chains: A Strategic Framework. *Policy Research Working Paper*, (6406), 1-50.

[38] http://go.galegroup.com/ps/i.do?id=GALE%7CA243786774&v=2.1&u=duke_perkins&it=r&p=ITOF&sw=w&asid=5019f5ea0a7eb5204cf2a1b794ead4a9

conservation of power and electricity. *Refer to figure 8 for a basic value chain diagram for renewable energy.*

In the energy value chain, China (as mentioned in chapter 2) is positioned higher due to the efforts and advancements it is making in the renewable energy domain and because of its high financial investments and national policies as well. Tajikistan, however, would be on a similar level as Pakistan as it is just beginning to make advancements and shift towards the renewable energy sector to resolve food insecurity. While Pakistan still has a long way to go to upgrade and integrate itself successfully in the energy value chain, it is gradually making progress in that direction. Value can be added at each step in the energy value chain, be it in project development, manufacturing, research and development, financial services or policy making. It is just a matter of streamlining efforts and the government prioritizing energy security, enacting sound policies and working collectively with other stakeholders to ensure implementation and the monitoring and evaluation of the policies.

Chapter 4: GVC Analysis on Food Security in Pakistan:

Food security is defined by USAID as: "When all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life."[39] Traditionally food security is measured through the lenses of availability, access and utilization.[40] *Refer to figure 9 for a representation of*

[39] USAID Policy Determination: Definition of Food Security, 1992, 1.
[40]http://www.sdpi.org/publications/files/State%20of%20Food%20Security%20in%20Pakistan%20and%20Policy%20Options.pdf

these three factors. Using the GVC approach for food security allows us to examine commodities through production, distribution, and retailing activities. The approach demonstrates not only the importance of firms and other actors involved in commodity lifecycles, but also investigates the various governance structures that impact trade and food systems.[41]

The rising cost of fuel affects the cost of fertilizer and electricity and consequently shows up in the price of basic food, such as grains and wheat. Increases in food prices also reflect systemic problems in the agricultural sector. In Pakistan agricultural reform has sorely lagged behind improvements in other sectors of the economy. Pakistan has been hit hard by food inflation. Between the mid-1970s and the current decade, Pakistan tripled its wheat production and successfully shifted from being an importer to a net wheat exporter. But the recent surge in food prices has forced Pakistan back into the import column with purchases of about $800 million worth of wheat in 2008. Pakistan's spending on food imports has grown by 25 percent in the past year. Furthermore, between May 2007 and May 2008, consumer prices rose at an annual rate of about 20 percent, with food prices rising approximately 28 percent.[42]

The government of Pakistan is engaged in the formulation of its first ever Agriculture and Food Security Policy. The process of policy development started with the launch of “Zero Hunger Program” and “Food Security and Nutrition Analysis of Pakistan”. The government is striving hard to develop a comprehensive and future-

[41] http://sites.duke.edu/minerva/files/2013/08/4-2014_CGGC_Research-Brief_Food-Security-and-GVC.pdf
[42] http://csis.org/files/media/csis/pubs/sam121.pdf

oriented policy to cater to the present and future food security challenges. A number of stakeholders have been engaged in this process through consultations, seminars and formal correspondence. Pakistan has great potential for agriculture value addition. It can earn valuable foreign exchange through this sub-sector of agriculture. However, the government supervision and support is somewhat lacking. Currently, the agricultural sector faces numerous obstacles like insufficient and fluctuating supply of raw materials, inadequate safety standards, and poor safety measure for the labor at workplace, adulterated food products and inadequate packaging. In addition, poor financial support from commercial banks and government, and lack of innovation are some of the biggest constraints faced by this subsector.[43] Furthermore, the disruptions in the energy supply are hindering not only fertilizer production, but also the production of insecticides, pesticides, agricultural activities and overall food production.

In order for Pakistan to economically upgrade in the food security value chain, the major stakeholders which include the government, private and public investors and international investors need to devise sound policies aimed at ensuring food security. The government should pay attention to the utilization and access part of food security. This could be achieved by introducing technological innovation in the old and traditional farming especially at post-harvesting level and value addition. Value addition will not only secure the food availability, but also pay off the farmers well to make their livelihoods better. This, in return, will aid in securing the food access and food utilization

[43]http://www.sdpi.org/publications/files/State%20of%20Food%20Security%20in%20Pakistan%20and%20Policy%20Options.pdf

component of food security. This would allow Pakistan to upgrade technologically and socially as well in the value chain. *Refer to figure 10 for the food security value chain.*

Value can be added in the different stages of the food security value chain at the raw materials stage, manufacturing, distribution, policy making, transport, etc. Looking at case examples presented earlier, China has made progress in the food security value chain by propagating a shift towards renewable energy and ensuring sustainable energy and food production. This places China, once again, higher up in the value chain as it adds value at the different stages of the value chain. Tajikistan, is again at a similar level as Pakistan. The difference, however, is that it is making considerable efforts towards resolving food insecurity by increasing food production (by ensuring higher energy production) and by implementing sound policies. The government of Tajikistan is playing an active role in this process. For Pakistan to integrate itself and improve its position in the food security value chain the government needs to be more proactive in acquiring the resources for food production and in implementing solid policies and working mutually with the various stakeholders.

Chapter 5: Drawing the Link between Renewable Energy and Food Security in Pakistan:

Pakistan is a developing country and already located in a food insecure, water stressed and energy scarce region. Energy is required not only for food production and transport but also indirectly required to enhance the purchasing power through employment in industry and other in sectors. Therefore, we can conclude that the

decision in one sector impacts the other sectors.[44] Energy is needed in all steps along the agri-food chain: in the production of crops, fish, livestock and forestry products; in post-harvest operations; in food storage and processing; in food transport and distribution; and in food preparation. Direct energy includes electricity, mechanical power, solid, liquid and gaseous fuels. Indirect energy, on the other hand, refers to the energy required to manufacture inputs such as machinery, farm equipment, fertilizers and pesticides.[45]

Energy security is imperative for food security. Without sufficient energy and access to electricity and sustainable energy sources, communities have little chance to achieve food security and no opportunities for securing productive livelihoods that can lift them out of poverty. Through the GVC analysis of energy and food security, we can highlight areas that are problematic and also identify key areas where progress can be made. For instance, increasing energy services in rural areas has the potential to spur agricultural development by increasing productivity, for example through irrigation, and improving crop processing and storage. It could also strengthen the development of non-farm commercial activities, including micro-enterprises, and create opportunities for other livelihood activities beyond daylight hours. Energy development, especially renewable energy, also has the potential to create green jobs in rural communities, in areas such as fuel crop cultivation and the provision and maintenance of energy services. This will have indirect impacts on agricultural productivity and risk

[44]http://www.sdpi.org/publications/files/State%20of%20Food%20Security%20in%20Pakistan%20and%20Policy%20Options.pdf
[45] http://www.fao.org/3/a-an913e/an913e01.pdf

management due to increased household incomes and diversification out of agriculture.[46] *Refer to figure 11 for the link between energy and food security.*

The GVC analysis of energy and food security in Pakistan has allowed us to identify key areas where progress is lacking and how this can be rectified. The GVC analysis of each issue separately has allowed us to derive a link between the two development issues; energy security and food security. For Pakistan to upgrade in both the energy and food security value chains, the government needs to step up at an institutional and financial level. This would then trickle down to investors (private, public and international) who could possibly increase their investments in the energy sector, thereby increasing energy supply. A stable energy supply would ensure uninterrupted food production. A chain effect would result in the form of technological and social upgrading along the value chain as well. Policy alternatives and sustainable solutions will be discussed in the forthcoming chapter.

Chapter 6: Policy Alternatives and Proposed Solutions:

Renewable energies play an increasingly important role in energy policies and will continue to do so in the future. This is not only thanks to their contribution to mitigating climate change and to supporting energy security and the access to energy but they are also creating jobs and pushing local industries. In China in 2002, fuel shortages and blackouts were increasingly common and seriously injurious for the economy. The Development Research Centre for the State Council in China published a

[46] http://www.fao.org/3/a-an913e/an913e01.pdf

detailed report that outlined solutions to this problem. Emphasis was laid down on energy conservation and efficiency and the use of renewable sources of energy, and hydropower in particular, and these recommendations were rigorously implemented through quantitative goals.[47] As we saw earlier in this paper, Tajikistan, also a developing country is making progress in renewable energies to solve its food insecurity problem. These two cases offer important lessons for Pakistan as the two economies have not only been able to resolve their energy issues, but have also managed to strengthen their positions and upgrade in the GVCs. If Pakistan follows a similar example and rigorously implements policies that are conducive to supporting the energy sector and that also conserve energy and implement alternative sources of energy generation; it may also be able to overcome its current, over-arching crisis. The Pakistani economy would improve as a result which would encourage further investments and lead firm sourcing (leading firms investing in industries) in the country and therefore improve its position in the global economy.

There is a government failure when decentralization at the federal and provincial levels leads to a lack of coordination with regards to policy implementation. The government has also made inaccurate assessments of the country's capacity to meet energy demands, resulting in the reliance on imports of energy, fertilizer and food, instead of increasing domestic production and investing domestically to develop the resources. Furthermore, government failure has propagated a market failure where

[47] Husain, T. (2010). Pakistan's Energy Sector Issues: Energy Efficiency and Energy Environmental Links. *Lahore Journal of Economics*, *15*, 33-59

positive externalities exist (demand exceeds supply) and an information asymmetry (a situation where one party in a transaction has more or superior information than another) exists between the demand and supply as well. The most critical part in the government failure is that despite wanting to ease the crisis, the drive for inertia is high. On the other hand, it would be hard to derive sound policies that can be effectively implemented, because of all the concepts (issues at play in the current scenario) at stake (*see figure 4)*. Where one large issue has branched off into a complex plethora of subsequent issues, it is difficult to pinpoint exactly where to start from when thinking of solutions.

The current policy problem that exists in Pakistan is that there is a huge energy shortage resulting from a combination of government and market failures, and this has the greatest impact on agricultural production within Pakistan; which leads to food insecurity within the country. The goal of any policy reform should be to relieve the current energy shortage within the country that impacts the agricultural sector. Therefore, new and revised policies need to work towards long-term and sustainable solutions for energy shortage and food insecurity and meet the following objectives:

- A shift towards domestic production of energy, fertilizers and agricultural products, less reliance on imports and increased investment in domestic resources
- Development of new and increased investment in existing forms of alternative energy (like renewable energy) to solve the energy problem

To combat these two development issues (energy shortage and food insecurity) within Pakistan, different policy options exist, which are outlined below: *Refer to table 3 for a depiction of the policy alternatives matrix.*

Policy Alternative A: Let the Market Operate (Status-Quo):

Description: As the population increases and lifestyles change, there is an increasing demand for energy and electricity and Pakistan is no exception to this. Energy subsidies constituted 95% of the subsidies that the government provided in the budget for the last fiscal year (2012-13). Although the government has optimistically budgeted subsidies at just Rs. 240 billion for the ongoing fiscal year (2013-14), actual expenditure will almost certainly be greater, in the absence of any structural reforms. The bulk of the energy subsidy (94% and 99% of the subsidy to Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESC) – the two main power utilities in Pakistan, respectively) is a tariff differential subsidy, or a payment that the government makes to the utility to enable it to charge tariffs at an average rate stipulated by the power sector regulator, without taking into account the operational costs of each distribution company.[48] Increasing subsidies can somewhat relieve the energy crisis by increasing electricity supply to residential, commercial and industrial consumers, but the effects would be temporary.

Advantages: Minimal intervention from policy makers is needed as the government is just scaling up its subsidy plans that it has had previously, for the power utility

[48]http://www.peacebuilding.no/var/ezflow_site/storage/original/application/ade59fba5daf67a11a1c217434abf440.pdf

companies.

Disadvantages: This kind of subsidy ensures that each individual distribution company has little incentive to cut costs or improve efficiency, because the companies are aware that their operational expenses will be covered, whatever the sums involved.[49] Also the effects of the subsidy schemes are temporary and short-term.

Policy Alternative B: Investments in Infrastructure and Companies (Energy Supply Side):

Description: This policy alternative is geared towards the supply of energy and aims at garnering and increasing investments in infrastructure and energy companies. The goal is to shift reliance to domestic resources of energy and food and to also invest in alternative energy sources to increase supply. Energy infrastructure in Pakistan is underdeveloped and mismanaged. Despite the rising energy demand and strong economic growth in the past decade, no serious efforts have been made for the installation of new power plants to increase capacity generation.[50] This policy alternative is inspired by Green Africa Power (GAP), a new Private Infrastructure Development Group facility which has been developed jointly by Department for International Development (DFID) (UK) and Department of Energy and Climate Change (DECC) (UK) to overcome specific constraints to private sector investment in renewable power generation in Africa.

[49] http://www.peacebuilding.no/var/ezflow_site/storage/original/application/ade59fba5daf67a11a1c217434abf440.pdf

[50] http://www.superior.edu.pk/presentation/user/CEET/pdf/research/4.pdf

GAP will invest in renewable energy projects to demonstrate their viability to encourage future projects and attract private developers and investors. GAP aims to support projects that will install about 270 megawatts of renewable energy in Africa over 4 years, avoiding an estimated 2.3 million tonnes of CO^2 emissions. For Pakistan, national and international monetary support needs to be garnered. International investors could be bilateral donors like China and the US (who have invested in the energy infrastructure in the past), multilateral donors like the World Bank and IMF or private companies and investors.

It is estimated that Pakistan has a third of the world's coal reserves of 33 million tons in the south-east of the country, namely in the Thar Desert. Electricity production from coal is cheaper than thermal generation and if 2 percent of Thar coal is used, it could potentially generate 20,000 megawatts of electricity. In the long-term, Pakistan should also build nuclear power plants and dams. The government could benefit from the expertise of the Norwegian and Chinese companies in the field of dams and hydroelectric power plants.[51] Pakistan also has a huge potential to develop solar thermal, solar photovoltaics and wind power and increased foreign and national investments could greatly boost development in these alternate energy forms.

Advantages: The market and potential for energy and renewable energy options is great, especially in Pakistan that has a huge potential to exploit its natural resources for renewable energy. Furthermore, a shift towards clean, renewable and sustainable energy options is appropriate when considering global climate change. Also, renewable

[51] http://www.superior.edu.pk/presentation/user/CEET/pdf/research/4.pdf

resources are domestic and would avoid the burden of incurring foreign debt and strengthen national security through energy imports. Instead, the funds can be directed towards investments in the infrastructure of domestic resources like renewable resources. As energy supply would increase to domestic industries like the fertilizer industry and the agricultural sector; this would lead to an increase in agricultural and food production and a less of a reliance on food imports as a result.

Disadvantages: The potential shortcomings with this policy option are the risks involved in getting foreign investment. There is also a huge budget cost involved in developing the infrastructure for domestic and renewable resources. Furthermore, since no separate administrative body exists to ensure implementation and monitoring of such a scheme, the task would be onerous for the existing ministry and there could be a lack of coordination.

Feasibility: There has been a shift towards alternate and renewable forms of energy to meet the rising demand in Pakistan. Implementation of this policy alternative can be achieved effectively if the policies support it and the government ensures effective coordination and monitoring. Alternate and Renewable Energy Policy 2010 is almost ready and in the last Women to Energy Conference at Pakistan Engineering Council (PEC), it was told by Alternative Energy Development Board of Pakistan (AEDB) that this policy would be enforced in January 2011, but so far this policy has fallen prey to vested interests. This policy can bring revolution to Pakistan if truly implemented.[52]

[52] http://www.altenergymag.com/emagazine/2011/04/alternate-ways-to-overcome-energy-crisis-in-pakistan/1682

Furthermore, setting up a coordination committee specifically for this purpose could increase effectiveness and ensure that the policy is implemented.

Policy Alternative C: Investments in Energy Conservation and Energy Efficiency (Energy Demand Side):

Description: This policy alternative is geared at establishing energy conservation and energy efficiency schemes. It is aimed at the demand side of energy, so mainly at the consumers of energy in the industrial, commercial and residential sectors. Every facility is trying to conserve energy but process is too slow because of the lack of the energy conservation legislation and its implementation. The most dominant energy saving activity is the replacement of incandescent lights with compact florescent lighting (CFL). No doubt this activity will save lot of energy but this is not sufficient. The energy saving activities to be adopted in domestic, industrial, commercial and institutional facilities are as follows:

- Insulation of buildings roofs, walls, pipes and ducts.
- Use of glazed glass at building facades
- Use of energy efficient materials in buildings
- Use of high efficiency motors, pumps and controllers
- Use of Variable Frequency Drives (VFDs)

- Replacement of conventional heating & cooling by solar water heating & cooling
- Replacement of electro-magnetic ballast by electronic ballasts
- Replacement of conventional lighting by LED and Solar Lighting
- Installation of automatic shut off of lighting
- Installation of occupancy sensors
- Installation of exterior lighting controls [53]

Advantages: This policy option would be environmentally friendly and reduce costs of electricity to the final consumers. It would also ease foreign debt to an extent, if more energy is conserved and less is imported. In India the Petroleum Conservation Research Association (PCRA) is a government body created in 1976 and engaged in promoting energy efficiency and conservation in every walk of life.[54] A similar such body could be set up in Pakistan as well. Also energy conservation leads to longer life spans of the equipment. Furthermore, this policy option does not require large capital investments in building infrastructure and it does not require huge foreign investments either.

Disadvantages: While LED lighting and CFLs are an energy saving option; the barrier in their growth is the high percentage of import duties on LED lights.[55] Pakistan also does

[53] http://www.altenergymag.com/emagazine/2011/04/alternate-ways-to-overcome-energy-crisis-in-pakistan/1682
[54] http://www.edurite.com/kbase/advantages-of-conservation-of-energy#
[55] http://www.altenergymag.com/emagazine/2011/04/alternate-ways-to-overcome-energy-crisis-in-pakistan/1682

not have a lot of the technology and expertise or the factories to produce high level energy conserving products, so additional investments and imports would be required in these areas. It also costs more to produce energy efficient products than to actually produce the energy and this cost could potentially trickle down to the consumers. Furthermore, energy conservation methods may reduce the overall energy burden, but cannot meet the rising energy demand of the growing population. Additionally, while energy conservation can be achieved, it would not solve the problem of increasing food production or increasing energy supply to the agricultural sector.

Feasibility: Pakistan Engineering Council and ENERCON have made joint efforts to conclude the Building Energy Code 2010 through a task force consisting of experts from various sectors, but without legislation and its implementation, energy saving targets cannot be achieved. There is a need for quick enforcement of the Building Energy code 2010 so that national energy saving targets can be achieved.[56] Furthermore, the implementation of this policy alternative is a constraint, as energy conservation in existing buildings cannot be effectively implemented and the masses are not aware of much of the benefits of energy saving either. So a massive public campaign would need to be conducted to create awareness for energy conservation. This would add to the cost as well. This policy option does not directly cater to the energy demands of the fertilizer industry either.

[56] http://www.altenergymag.com/emagazine/2011/04/alternate-ways-to-overcome-energy-crisis-in-pakistan/1682

Assessing the Options:

The following criteria have been used to assess the three policy alternatives:

- Effectiveness: ensuring that the policy options will have a positive effect on the energy shortage for agricultural production. This criterion also takes into account the efficiency where budget and resource constraints are considered.
- Administrative Feasibility: ensuring that implementation will not be blocked by bureaucracy and that there is effective coordination between departments.

These two criteria are derived from the concepts observed in the boundary analysis (*see figure 4)* and need to be satisfied so that the problem of the energy shortage impacting the agricultural sector and food production can be solved keeping in mind the different visions of the various stakeholders.

In addition, the two following criteria have been considered:

- Political Feasibility: this is very important considering the political scenario in Pakistan and ability of elected officials to change, affect and implement policies.
- Technical Feasibility: ensuring that the technology needed for the implementation of the policy is available and reliable.

I have assessed the different policy alternatives in a Goals and Alternatives matrix presented in *table 3,* taking into account their time dimension, i.e., whether short or long-term. I chose policy alternative B (Supply Side) because it contributes to meeting the two goals of this policy change. It has numerous advantages that would promote a shift towards domestic resources, less reliance on foreign imports and contribute

towards a long-term and sustainable solution for the energy crisis. The government is also quite keen on making a shift towards alternative energy sources to meet the rising demand and reduce the discontent of the masses. There is also considerable international support from the World Bank[57], International Finance Cooperation (IFC)[58] and other international organizations to shift towards alternative and renewable energy sources. Therefore this would facilitate the implementation, adoption and legitimacy of the policy mix. I did not choose policy alternative C (Demand Side) because it does not solve the problem of meeting the rising demand for energy and nor does it meet the energy requirements of the agricultural sector or ensure food security. Also, this alternative would not be a long-term solution to solve the energy shortage in the country.

Recommendations and Implementation Design:

Preferred Alternative:

The preferred alternative is the following policy mix: Investments at the national and international level in energy infrastructure and energy companies. This appeals to the producers and suppliers of energy on the supply side, to cater to the rising demand of the consumers (the agricultural sector encompassing food producers and consumers). It would promote a shift towards domestic resources of energy and food production and would also propagate a shift towards the development of alternative and renewable

[57] http://www.worldbank.org/en/news/press-release/2014/05/02/world-bank-group-approves-1-billion-usd-for-supporting-economic-reforms-in-pakistan

[58] http://www.ifc.org/wps/wcm/connect/region__ext_content/regions/europe+middle+east+and+north+africa/ifc+middle+east+north+africa+and+southern+europe/countries/pakistan+country+landing+page

energy forms to increase the energy supply. The policy mix will consist of:

- Providing tax incentives and subsidies to companies to develop alternative and renewable energy forms
- Garnering national and international monetary and technical support for investments in infrastructure for energy
- Set up grids providing direct electricity to the agricultural sector and ensure uninterrupted supply of energy that would increase food production and ensure food security

Implementation Design and Strategy:

For successful implementation, the chosen policy alternative needs to satisfy the following conditions: legitimization, resource mobilization, organizational design and monitoring and evaluation.

Legitimization: Given that the stakeholder analysis revealed high interest and influence of the major stakeholders and also high inertia on their part, there is a need to frame the problem to instigate immediate action by the government. The Pakistani population is increasingly discontented due to the lack of energy to perform daily tasks. Furthermore, the worst affected are the rural areas and poorer segments of the society and industries. The agricultural sector experiences interruptions in its energy supply, which halts food production and this negatively impacts not only the economy, but also the food supplies.

To build constituency, the government at the provincial levels needs to step up

and take control and champion the problem. As the provinces are governed by different elected political parties, each governor can start schemes at the provincial level that would promote adaptation of the policy. For instance, the current government of the northern province of Khyper-Pakhtunkhwa (KPK), Mr. Imran Khan has started endeavors in KPK towards building and improving upon hydropower and launching 17 energy projects.[59] Also, the government in Punjab has launched a program to develop a solar park that could meet the energy demands of the whole province.[60] Starting at the provincial level and branching out at the national level can be an effective way to combat this crisis, provided that the provincial government steps up and works proactively for this cause.

Resource Mobilization: The resources needed for the implementation of this policy need to be agreed upon with the finance minister. As building infrastructure and improving upon existing infrastructure requires a huge budget commitment; assistance by government would be needed in terms of tax incentives and subsidies for energy companies. At the international level, support from international organizations is also underway and appeals for increasing the investment need to be carried out. The provision of direct energy supply to the agricultural sector needs to be carried out and can be done so by providing tax incentives to energy supply companies.

[59] http://nation.com.pk/national/30-Jun-2014/kpk-government-plans-to-launch-17-energy-projects
[60] http://www.telegraph.co.uk/news/worldnews/asia/pakistan/10780123/Pakistan-building-huge-solar-energy-park.html

Organizational Design: One of the barriers in growth of alternate and renewable applications in energy is the lack of presence of one sole Energy Administration Authority for regulation of energy sector. It is strongly recommended that one Energy Administration Authority should be developed to streamline decision making.[61]

Monitoring and Evaluation: The monitoring and evaluation would be handled by the Ministry of Petroleum and Natural Resources of Pakistan, which does have a dedicated organization to perform such tasks. However, some additional technical expertise and assistance would be required and different policy and research organizations working on such issues in Pakistan can be enlisted for their help. For instance, the Sustainable Development Policy Institute of Pakistan (SDPI)[62] carries out a lot of research on alternative and renewable energy forms and their support for monitoring and evaluation can be acquired. The key performance indicators to be monitored can be the following:

- Percentage increase in energy generation with renewable energy
- Cost of energy per unit with renewable energy
- Percentage decrease in foreign debt after shifting to domestic and renewable energy sources
- Impact on domestic funds and GDP
- Percentage increase in energy supply to the agricultural sector

[61] http://www.altenergymag.com/emagazine/2011/04/alternate-ways-to-overcome-energy-crisis-in-pakistan/1682
[62] http://www.sdpi.org/research_programme/researchprogram23.html

- Percentage increase in food security at a provincial and federal level

Limitations and Unanticipated Consequences:

The limitations of this proposed reform is that a significant part of it depends on foreign investments as Pakistan does not have a large budget to allocate to development of alternative forms of energy. Furthermore, large investments are needed to develop new energy infrastructure and improve upon the existing one.

The main unanticipated causes can be a divide between some provinces making the efforts and others being unable to or having differing interests. This would lead to fragmented growth in the country in terms of energy. Also, increasing direct supply of energy to just the agricultural sector could mean drawing away or reducing the supply to other industries or consumers and this could cause a whole new set of problems and consequences.

Conclusion:

In this paper, I have tried to provide a background and highlight the current energy scenario in Pakistan and show how the continuing energy shortage in Pakistan is impacting different sectors of the economy and reducing the overall economic output and productivity of the country. Industries that require energy to function have been severely affected, causing loss in output, jobs and a hindrance in technological advancements. This has also led to foreign investors and firms backing out of the country and sourcing from and investing in alternative places. All of these things combined have greatly damaged the economy as a whole and made Pakistan a very

crippled and weak participant in the global value chains. I have outlined the various political, economic and social factors that have hindered progress in the energy sector and the stakeholders that are involved. By presenting case examples of China and Tajikistan, I have tried to show how the two other Asian countries are making progress in the renewable energy domain to tackle food insecurity and how Pakistan can learn from these examples.

I have highlighted how Pakistan is connected to the global economy through the use of the GVC approach. I have then tried to establish how the GVC approach can be applied to the renewable energy sector and the ways in which it is essential in having a deeper understanding of the issues plaguing the energy sector and potential solutions that can be applied to tackle it. Additionally, I have tried to point out the efforts that Pakistan is undertaking in order to improve its position in the global value chain by upgrading environmentally in the energy sector. I have also tried to establish a connection that this environmental upgrading has with socio-economic and technological upgrading. Furthermore, I have shown where Pakistan stands in the food security value chain, what its weak points are and how it can potentially upgrade in that chain as well. By separately discussing the renewable energy and food security value chain, I have then attempted to draw out the link between the two through the GVC approach. Building upon this link, I have pointed out the problematic areas and how Pakistan can combat both these development issues of food and energy insecurity, where it stands in these value chains as compared to China and Tajikistan and how it can learn from these two case examples.

Towards the last part of the paper, I have identified through a policy standpoint the resulting failures in the energy sector and then outlined three different policy options that can be adopted to remedy the current situation. Additionally, the rationale behind choosing the desired policy alternative is explained and a potential implementation design and strategy is outlined.

While it is unrealistic to expect that the energy issue plaguing the Pakistani economy would be resolved any time soon, it is however important to note that both the Pakistani government and even the private sector are taking initiatives in trying to stabilize the energy shortage and to eradicate the issues, by turning their focus towards renewable energy options and by creating more awareness regarding prevention of energy wastage and by stressing importance of energy conservation and efficiency. These efforts at creating awareness are targeted at not only the domestic sector, but also the industrial and agricultural sectors (any sector that is consuming energy and electricity). Meanwhile, the government is also trying to elicit support of foreign investors in helping it to set up its renewable energy plants. These efforts coupled with rigorous policy implementation in the public and private sectors would eventually lead the country on the road to mending its economy and ensuring food security. Sufficient and sustainable energy production leads to fully functioning industries, increased output, a decrease in unemployment, improved product quality and labor and economic productivity, technological advancements, efficient use of machinery, less damage to the environment, better trade balances and an improved position of the country and its industries in the global value chains.

Appendix:

Figure 1: Pakistan's Projected Energy Requirements and Energy Deficits from 2010-2030

Energy Source (MTOE)	2010	2015	2020	2025	2030
Oil	4	3	1	1	1
Gas	40	36	25	19	20
LPG	1	1	1	1	1
Coal	2	3	4	6	8
Hydel	7	8	15	17	24
Renewable and Nuclear	1	1	5	8	14
Total Indigenous Supply	55	52	51	52	68
Total Energy Requirements	73	96	131	176	238
Energy Deficit	18	44	80	124	170
Imports for the Deficit					
Oil	14	29	46	64	85
LNG or Gas	-	4	18	34	48
LPG	-	1	2	3	4
Coal	4	10	14	23	33

Table 1: Timeline of Energy Crisis in Pakistan

Year	Event
1952	Discovery of first oil field in the province of Baluchistan in Pakistan
1955	Commercial drilling started at Sui. Daily capacity of 550 MMscf.
1966	Oil fields at Toot discovered with capacity of 60 million barrels of oil
1967	The commercial production from Toot Oilfields started in 1967
1976	Dhodak gas field was discovered in the

	province of Punjab
1981	Union Texas Pakistan discovered an oil field in lower Sindh
1983	Dakni gas field discovered
1984	Tando Adam oil field, located in Hyderabad, was drilled and completed
1986	Peak oil production at Toot fields and Chak Naurag discovered
1989	Dakni gas field started commercial production in December
1990	Qadirpur gas field was discovered in the province of Sindh. It remains the third largest gas field in Pakistan
1994	Rajjan oil field, located in Gujjar Khan, was discovered
1998-1999	The oil fields owned by Union Texas Pakistan were producing more oil than the Potwar wells
2000	Balochistan Liberation Army allegedly bombed one of the minor pipelines transmitting gas from Sui gas fields
2004	Chanda oil fields located in Khyber Pakhtunkhwa started oil production
2005	Earthquake impacted energy infrastructure. Karachi electric supply company privatized
2006	Mela oil fields were discovered in the area of Kohat located in the province of Khyber Pakhtunkhwa
2007	Pakistan faced one of its biggest power failures after Bhutto's assassination in which production fell by 6,000 MW
2008	The demand and supply gap pertaining to electricity in Pakistan increased by 15 per cent. The major load shedding crisis also commenced in the same year with power outages extending up to 16 hours a day in many cities of the country
2009	Karachi faced one of its most crucial power breakdowns on June 17 in which the entire city was without power for 21 hours and more.Moreover, the country faced a power shortfall of 4,500 MW in the same year

	with the domestic demand rising up to 11,000 MW. However only 6,500 MW of generated power was catering to the entire demand
2010	Floods in the country damaged energy infrastructure
2011	Shutdown of Uch power plant. Pipeline blown up. Pakistan faced one of its most crucial gas crises, with the shortfall rising up to 1.8 billion cubic feet (bcf). The year also experienced the worst CNG load shedding resulting in losses and problems for the consumers. However OGRA increased the gas tariff by 14 per cent in the beginning of the year which was one of the biggest tariff hikes in the history of Pakistan. Moreover, the energy shortfall reached up to 2,700 MW

Source: http://dawn.com/energy-crisis-in-pakistan

Figure 2: Pakistan's Energy Supply Deficit Trends

(*Source: Petroleum Institute of Pakistan (PIP) (2011)*)

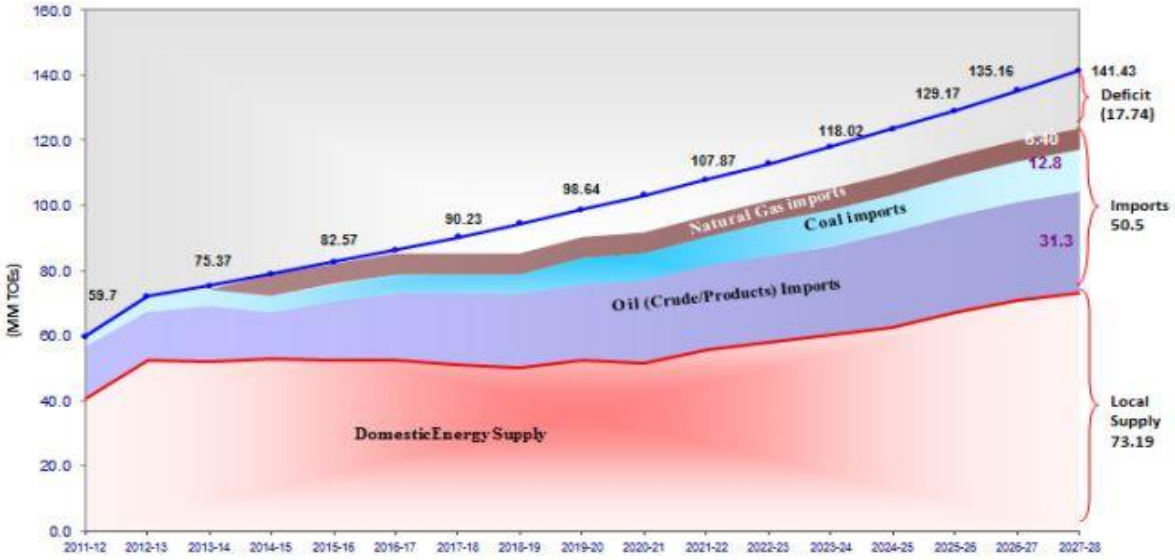


Table 2: Stakeholder Analysis for Pakistan

	Stakeholders	Influence	Interests
Primary	Ministry of Petroleum & Natural Gas Resources of Pakistan (1)	• Responsible for ensuring availability and security of sustainable supply energy to different sectors • Implements energy policies	• Directly responsible of energy supply so high level of interest
	Government of Pakistan (2)	• High level policy implementation • Can cut back or increase energy supply • Key decision making power affecting energy sector	• Responsible for managing country's resources • Ensure adequate supply of energy to country • Alleviate economic burden
	Fertilizer Industry (3)	• Low on influence overall but has power of supply of fertilizer to agricultural sector	• Energy needed for production and industry functions • Energy shortage halts production, reduces profits, increases costs
	Power Plants (4)	• Can cut back power, further reduce supply • However, state-owned, so come under ministry which has the greater influence over policy	• Energy sources needed for power generation • Costs for maintenance and operation of plants goes up if under-utilized
	Electricity and Gas Supply and Distribution Companies (5)	• Privately owned distribution and supply companies can cut back supply if costs not met • State owned companies fall under the ministry	• Need stable supply of energy to distribute to different sectors • Meet costs, ensure profits

		so cannot influence policy directly	
Secondary	Investors (Private) (6)	• Low influence on policy • Funding needed for energy sector	• Low interest unless high profit margin and rate of return
	Investors (International) (7)	• Since energy sector needs investment, the investors have moderate influence on policy, especially foreign policy • Influence government to adopt certain policies or a certain fuel mix like back in 1994	• Interests align with foreign policies • Conditionalities on funds favoring the investor
	Farmers (8)	• Low on influence as they cannot impact policy in any way	• High interests as continuous fertilizer supply needed for agricultural activities and food production
	Citizens (9)	• Low on influence, unless public riots and rallies can influence policy	• High interests as energy needed for basic, daily activities • Shortages halt progress and activities • Low fertilizer production means less food production that can lead to food shortages
	Food Producers (10)	• Low on influence of energy policy	• Moderate interests as energy needed for food production • Hindrances in production

			reduce revenue and profits
	Mass Media (11)	• Moderate influence on policy • Can create national and international awareness	• Moderate interest as not directly affected by energy crisis and shortages in fertilizer production • Interests based on reporting issues only
	Political Parties (12)	• Lobby for certain policies • Facilitate or hinder activities • Moderate influence	• Moderate interests, wherein there is personal gain for the party • Interests towards solving energy issues based on garnering public support for campaigns
	Research Organizations (13)	• Low influence • Can advise on policy but not influence it • Conduct researches on current situations and offer recommendations	• Low interest, but energy is a pertinent issue for research and policy reform

Figure 3: Stakeholder Matrix

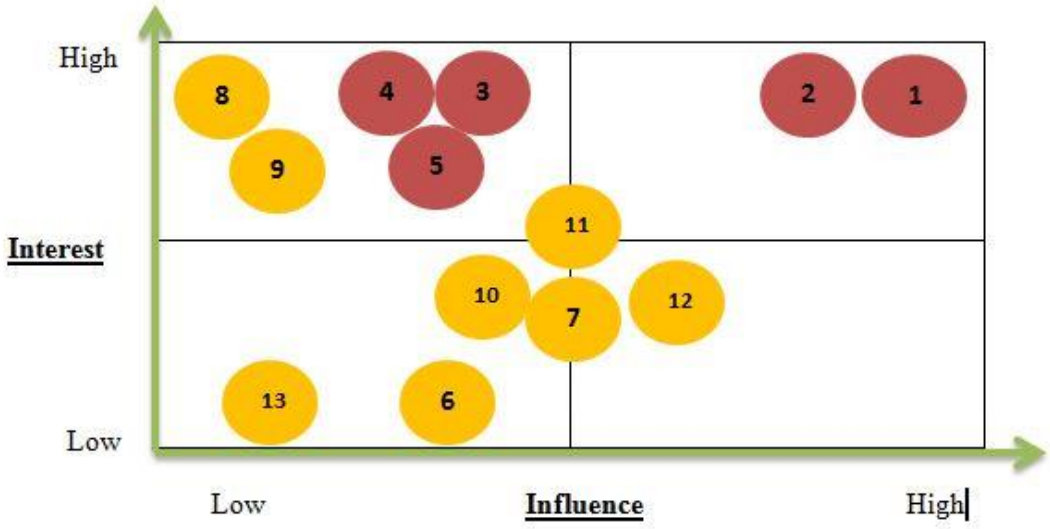


Figure 4: Boundary Analysis

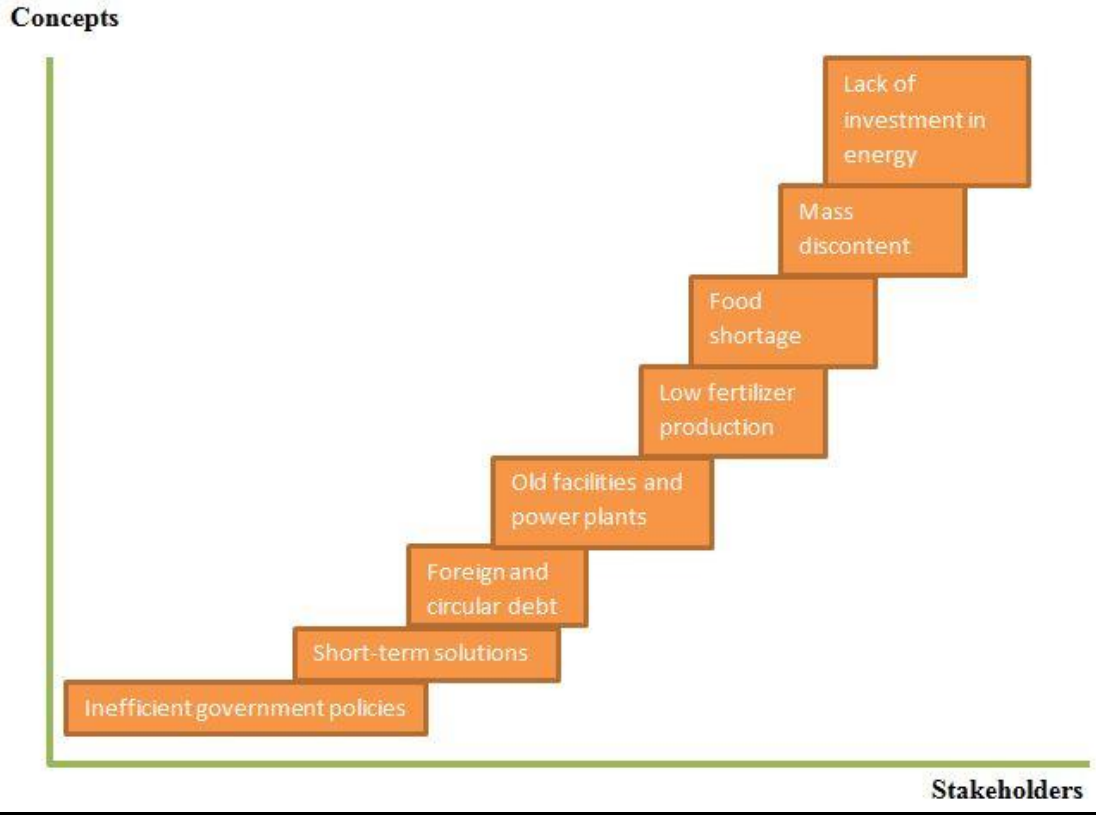


Figure 5: Problem Tree

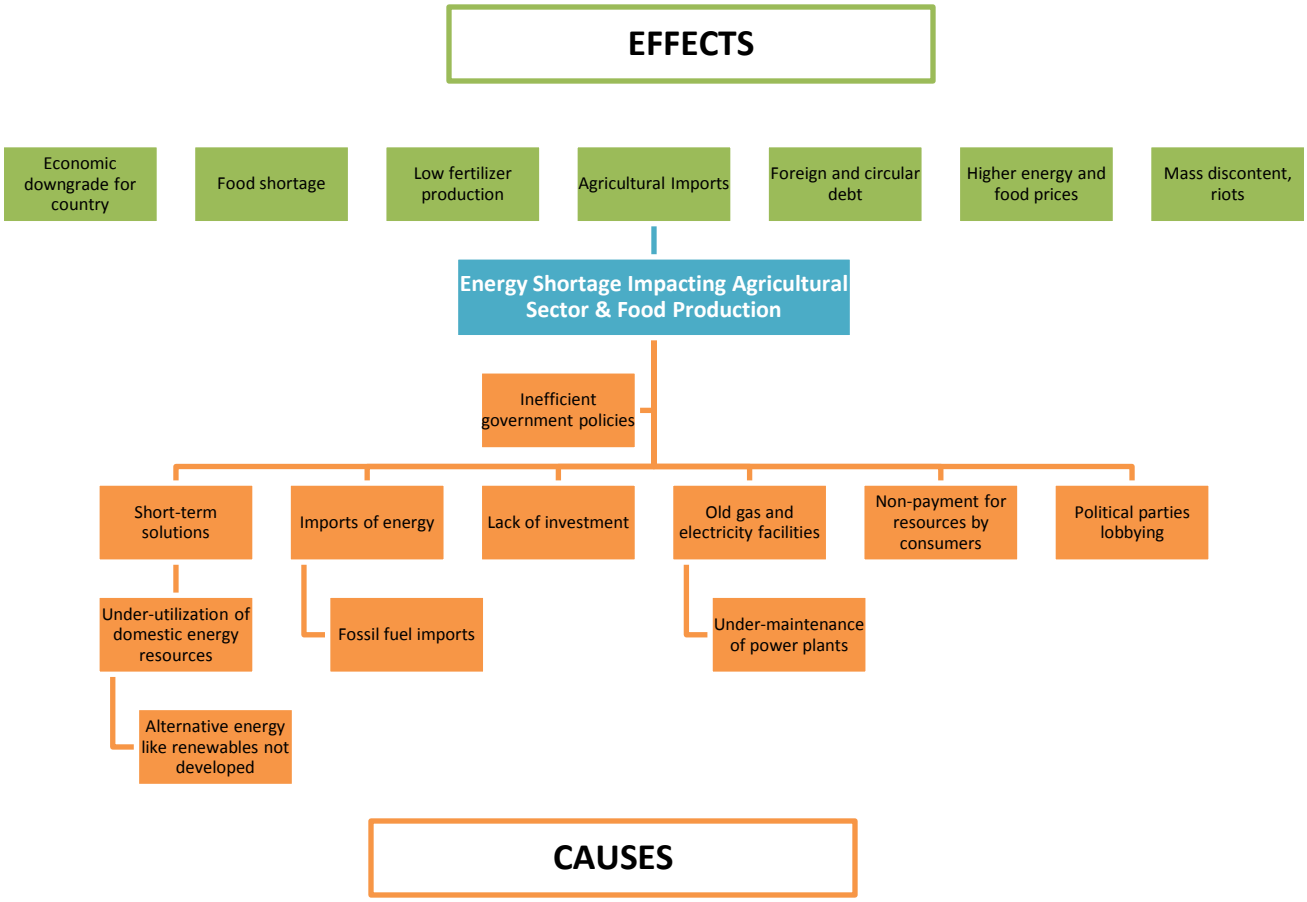


Figure 6: China's Energy Use by Sector (2007)

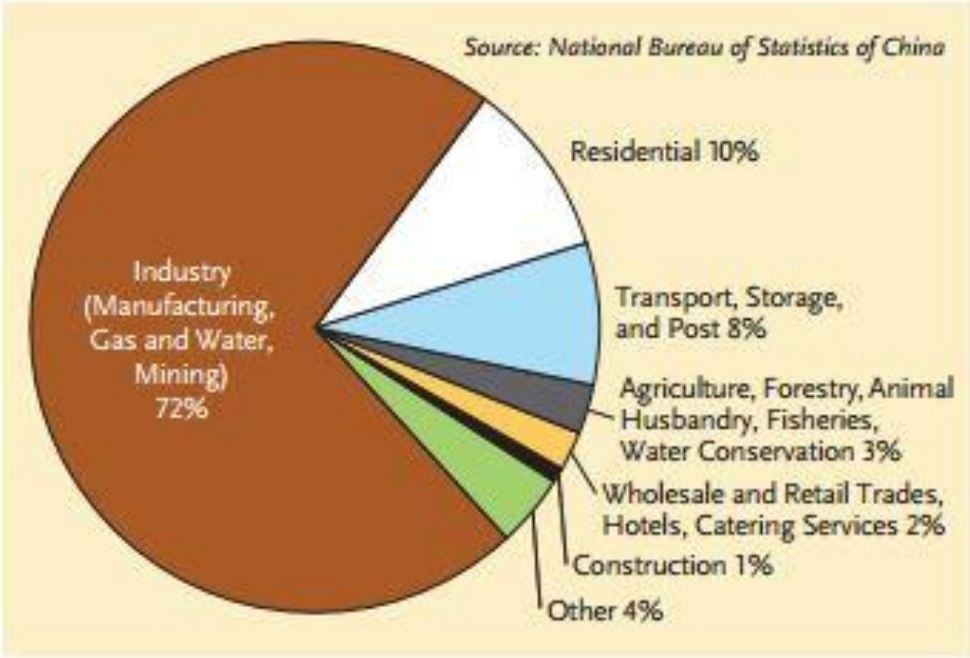


Figure 7: China's Renewable Energy Use (2008)

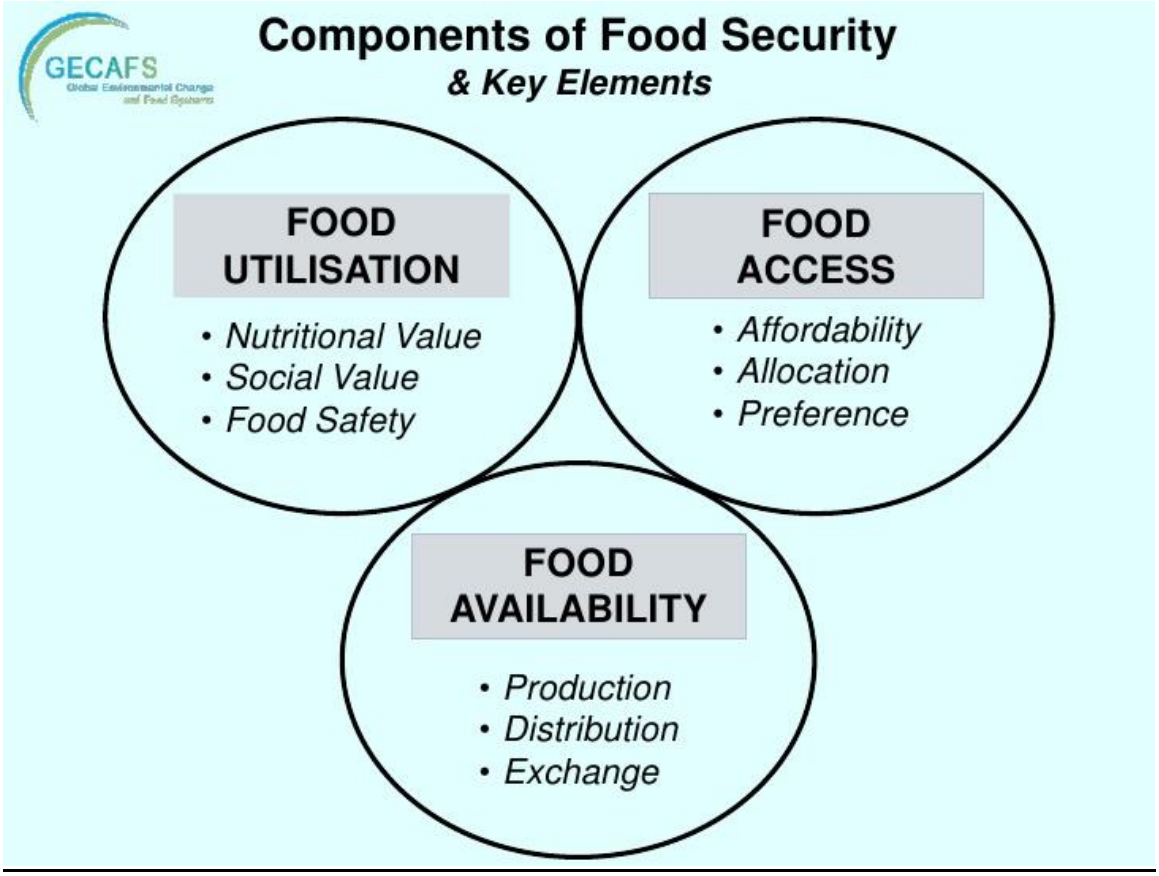
	Production	Consumption	Annual Production Capacity	Estimated Cost Range
	(million tce/year)			(RMB/kWh)
Power Generation	210.74	187 GW	595 TWh	
Hydro	207.78	172 GW	563.3 TWh	
Wind	5.33	12 GW	14.8 TWh	0.45–0.77
Solar PV	0.08	150 MW	220 million kWh*	3.45–1.2
Biomass	2.55	3 GW	7.5 TWh	0.55–0.9
Gas Supply (biogas)	10.00		14 billion m^3	0.77–1.1
Household Biogas		30 million units		
Large-scale Biogas		1,600 units		
Thermal Supply	28.30			
Solar Hot Water	25.00	125 million m^2		
Solar Cookers	0.10	450,000 units		
Geothermal	3.20	40 million m^2	800 million GJ	1.2 (average)
Ethanol	1.55	1.65 million tons		
Total	250.59			

*Calculated by average sum hours

Figure 8: Basic Value Chain for Renewable Energy

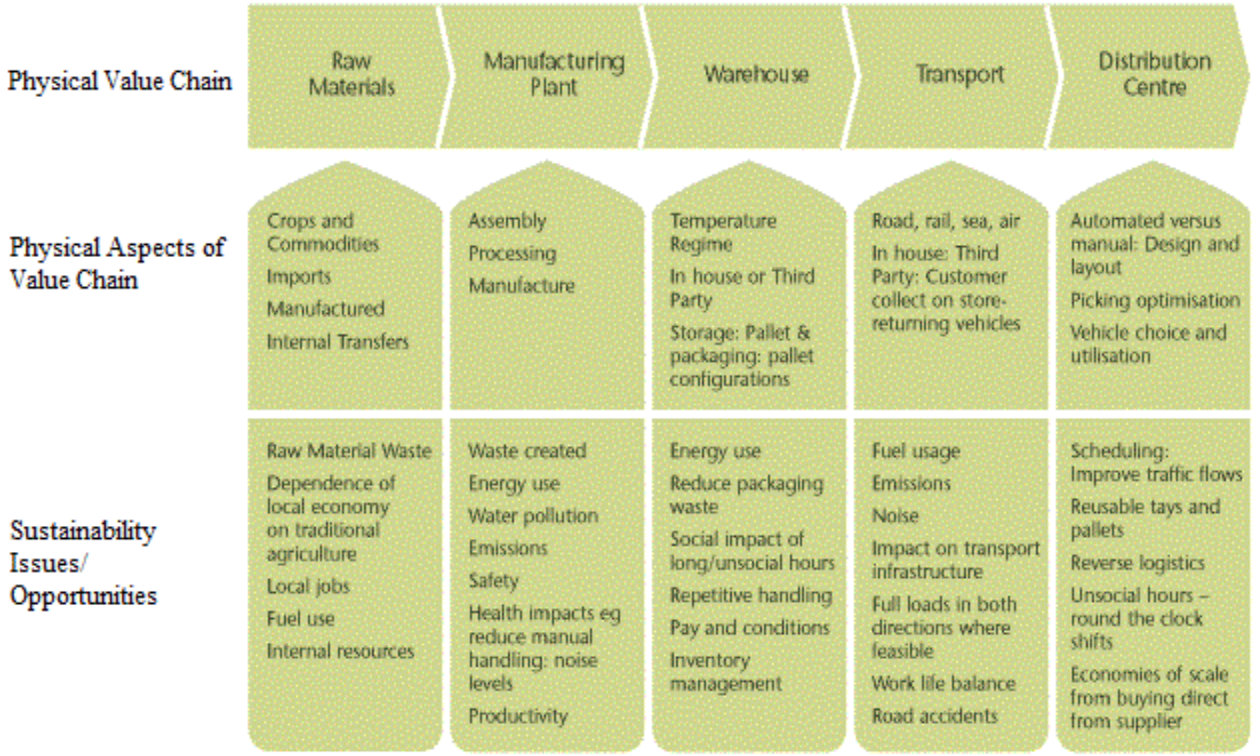
Source:http://www.cleanenergyministerial.org/Portals/2/pdfs/Input_Paper_Economic_Value_Creation.pdf

Figure 9: Components of Food Security



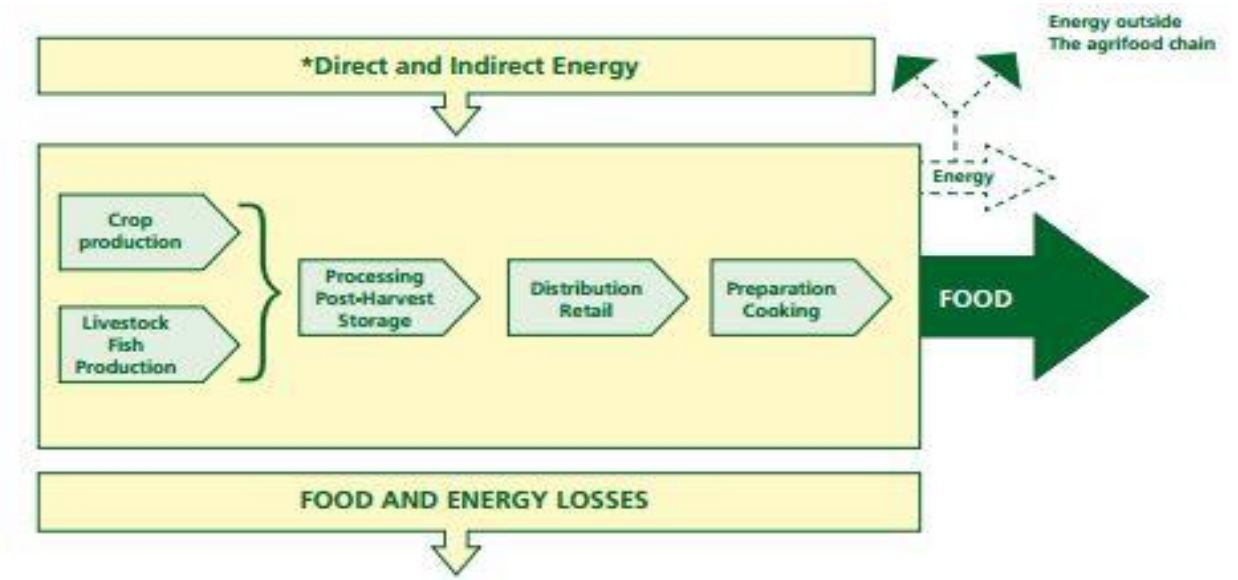
Source: GECAFS

Figure 10: Food Security Value Chain



Source: http://www.sbc.org.nz/resources-and-tools/guides/sustainable-supply-chain

Figure 11: Link between Energy and Food Security



Source: http://www.fao.org/3/a-an913e/an913e01.pdf

Table 3: Goals/Alternatives Matrix

Goals	Criteria	Policy Options		
		A: Status Quo	***B: Investment in Infrastructure/Companies - Energy Supply***	***C: Investments in Energy Conservation/Efficiency - Energy Demand***
Shift towards domestic energy & fertilizer production	*Effectiveness*	Low	High – However, conditional on national and international monetary support and coordination at federal and provincial levels	High – Companies have an incentive to comply with the law
	Political Feasibility	Medium	High – However, budgetary cost involved, but support exists for the officials	Medium – Budgetary cost involved
	Administrative Feasibility	Medium	Medium – Important amount of coordination and cooperation needed	High – can be embedded in policies currently pursued
Investment in and development of alternative forms of energy	*Effectiveness*	Low	High – Long-term	High – However, budgetary cost involved
	Administrative Feasibility	Low	High – However conditional on establishment of sub-agency for monitoring	Low – Can result in mismanagement
	Technical Feasibility	Low	Medium – Budget support of bilateral donors	Medium – Budgetary cost involved for new technology

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