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The Challenge of Energy Transition and Energy Security Needs of Pakistan in 21st Century

Abstract: *Energy security is one of the cornerstones of the modern economy. However, Pakistan has struggled for decades to find a viable strategy for ensuring economically viable options to meet this essential requirement of the modern economic system. Pakistan's reliance on fossil fuel-based power generation has not only incurred huge economic costs but also made the country vulnerable to the instabilities of international market forces. However, the global economy is now moving through a phase of energy transition i.e. from fossil fuels to sustainable energy. This transition offers a golden opportunity for Pakistan to restructure its energy mix in a manner that can be cost-effective as well as resilient to economic and military threats, considering the country's strategic environment. This paper seeks to present an overview of the requirements for energy security in the modern age while proposing some of the viable options for sustainable energy and strategies for its implementation.*

Key Words: Energy Security, Energy Transition, Sustainable Energy, Energy Resilience

Introduction

The modern world is driven by energy resources, without which the entire machinery of modern industry would grind to a halt. Hence, energy security is a major concern for all industrialized nations. It would not be wrong to say that oil has been the backbone of the modern economy during the last century and this liquid fuel still retains its vital position in the industrialized world because of its high energy density. In the last few decades, many new nations have joined the race for development and risen as major industrial contributors as well as major consumers of energy.

On the other hand, the capacity of known oil fields, some of them having been exploited for nearly a century is now depleting, leading to fears that world oil resources might be closer to 'peak oil' than had been originally anticipated. The continued instability in the Middle East has remained a problem which is compounded now by the war in Ukraine and heavy sanctions levied upon Russia by the US-led Alliance. This has already led to a sharp increase in the international price of oil and natural gas. Energy security forms a vital policy decision in all countries now a day and is fundamental to the long-term development of a nation.

Considering the above-mentioned facts, it is imperative for not just the leading

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countries but also the rest of the world to tap into more sustainable sources of energy. Several such options like wind, solar, tidal, wave, biogas and biomass, as well as synthetic petroleum and many others, are already available to the world market. However, the energy sector is still clearly dominated by Oil oligarchs. Interestingly, however, much of this influence on the oil industry stems not from a lack of available alternatives or technological gaps but due to global political structure and economic constraints.

The United States has stood out in global politics as a superpower since World War II and as the sole Superpower since the end of the Cold War. With the changing world order, the US sole superpower status is now being challenged by other powers, especially Russia and China. Russia has the advantage of having huge oil reserves and domination of the European natural gas markets as well. Yet, in the case of the United States, oil-based resource wars are not a source of insecurity. In fact, with the discovery of shale oil reserves, the US is already a net exporter of oil.

However, these resource wars will have a severe adverse effect on smaller countries, especially countries like Pakistan. Pakistan's excessive reliance on fossil fuels to produce energy has ultimately resulted in an endless spiral of circular debts. Excessive reliance on petroleum-based products for the production of electricity may be considered an acceptable short-term measure for an importer country but over a period of time, this policy has proven as the Achilles heel of Pakistan's energy sector.

A comprehensive and 'diversified' energy mix could have been a solution to this problem but the country's policymakers did not make any visible and concrete effort to deal with the issue in time. Hence, over reliance on a single source for the production of energy become a weakness in energy infrastructure over a period of time when that resource is not naturally abundant within a nation's borders. Therefore, this paper seeks to address the issue of energy insecurity for smaller countries like Pakistan, as well as the need to pursue the energy transition strategies from the standpoint of its global strategic and economic imperatives.

Energy Security

The concept of energy security is multi-dimensional and multi-disciplinary due to its nature. It's a concept that encompasses both supply-side and demand-side dynamics of energy and therefore has to take into consideration production, logistics and distribution of energy resources as well as geostrategic security concerns to ensure that the entire process remains undisrupted.

Some of the authors and organizations limit energy security to the availability of supply and its ability to fulfill the energy demand at a given price, while others add the dynamics of timeliness as well as its impact on the economy and environment. Energy Security, therefore, means different things as per the peculiar dynamics of the party concerned. This is one of the primary reasons that there are several definitions of energy security available, with each organization or institution coining a definition to best suit its role and requirements. A key point that emerges from the above-varied definitions is the gap between supply and demand-side dynamics.

The two most important variables in the Energy security paradigm since throughout the 20th century have been 'security' and 'stability' of energy supplies. These two factors play a vital role in the development of a nation's economy. The stability of fuel supply to the economy is the guarantee of continued economic growth.

Security is an equally important aspect as the presence of energy reserves in itself is a blessing and a bane for a country, as

shown by continuous interventions in smaller nations by major powers in order to gain access to their vast energy reserves. The tug of war between the US and Soviet Union during the Cold War, the Iran-Iraq War and the recent US invasion of Iraq provides ample examples of how far major powers and willing to go in order to secure their access to energy reserves present in these regions.

These major power games are likely to intensify and the demand for oil is only expected to increase in the near future. This rapid increase in demand cannot be fulfilled by the current top producers of petroleum products which have already reached their peak potential during the last decade.

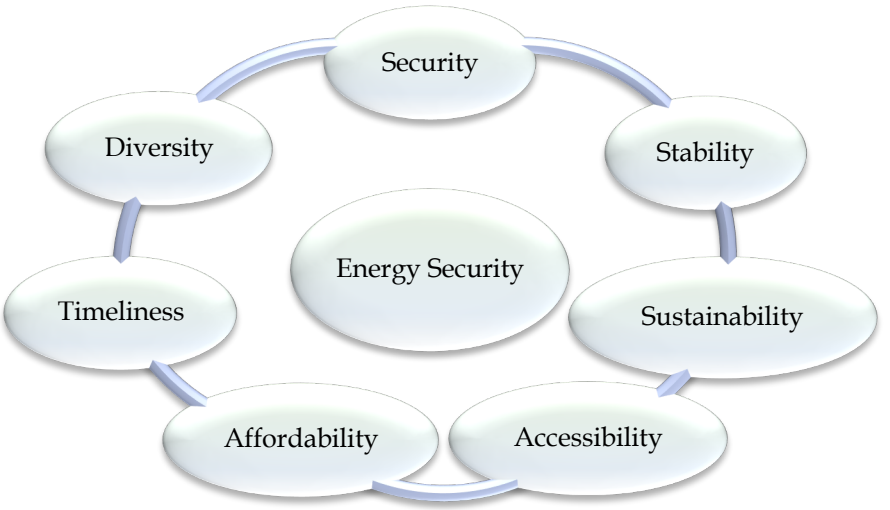
The above-mentioned aspect highlights a third key aspect of energy security i.e. 'sustainability.' At the beginning of the twentieth century, the aspect that one day the fossil fuels of the earth may become too depleted to sustain a completely oil based economy was ignored but now this crude reality has begun to dawn upon strategic thinkers around the world. At this point, completely refurbishing the oil-based economy is not only impractical but quite nearly impossible. The only hope is for a timely and successful transition to a sustainable alternate energy resource. For such a transition to be successful, the new resources and technologies would have to overtake the current technologies at an affordable and competitive cost. The Cost-effectiveness of new technologies would be one of the most important factors in deciding which technologies are ultimately adopted by the market in the post-petroleum era. Therefore 'affordability and cost effectiveness' is also a key component of both present and future energy security of any economy/country.

Another important aspect for all industrialized nations is a timely supply of energy, without which the wheels of the industry can come to a sudden halt. This, in particular, is a very important concern for many energy importer countries. The efficient infrastructure for the timely supply of energy is one of the most crucial aspects of energy security. If energy supply is interrupted to industry for even a week, the resulting losses can be in billions.

Finally, excessive reliance on a single type of energy resource may be considered an acceptable short-term measure for an importer country but over a longer period of time, this policy can be proven as the Achilles heel of a country's energy sector. The US over-reliance on oil imports from the Middle East in the 1970s can be taken as a case in point. A comprehensive and 'diversified' energy mix could have been a solution to this problem. Hence, over-reliance on a single source for the production of energy becomes a weakness in energy infrastructure over a period of time when that resource is not naturally abundant within a nation's borders.

From the above-mentioned examples, seven key components of energy security can be identified i.e. security, stability, sustainability, accessibility, affordability, timeliness and diversity. These seven factors should be treated as comprehensive factors wherein security includes sub-factors like protection of critical installations and pipelines as well as its ability to maintain functional capacity in the event of one or two installations being taken out in an attack of any nature. Stability includes the ability of the infrastructure to withstand natural disasters and to cope with any additional strain or pressure in terms of demand or supply gap. Sustainability refers to the longevity of a resource being relied upon for energy requirements and the guarantee of its long-term supply. Accessibility refers to the ability of a national apparatus to extract a particular resource or its abundant availability in the market. Affordability here is considered in general i.e. its comparative pricing in the global market, as well as in

particular terms where it refers to its net cost on the national exchequer. Timeliness is the aspect dealing with the timely access and availability of the required form of energy to the end-users and to the economy. The diversity of an energy resource is the variable that depends on the net energy mix i.e. the different sources of energy acquisition and production being utilized to provide energy to the end-users in the required form.



The Need for Energy Transition

Notwithstanding the acknowledged fact that the reliance of the modern industrial age on fossil fuels has already resulted in climate change, many of its effects might be irreversible already.

Another key issue being raised in the context of modern energy dynamics is that of alternate energy resources. Technologies like solar photovoltaic, Solar Thermal, Wind energy and Biomass as well as Bio-Fuel are not new in today's world. Indeed a lot of research and work has already been done in these fields. However, a key issue with these technologies is the huge initial costs involved in their setup, relatively low energy outputs when compared to fossil fuels and the lack of economy of scale as yet. Replacing the older fossil fuel-based systems of transportation, energy production and massive military hardware means huge costs involved. (Zafar, 2013)

The electric-powered sources have yet to reach the level of economic and power efficiency where these can be used commercially. The time period required for such developments to take place would be at least a few decades unless there are huge capital developments in these fields. However, it may be safe to assume that by the end of the current century, a complete transition from fossil fuel-based technologies will have taken place but this transition is yet quite far. In fact, the next few decades would be the most crucial decades in terms of energy security because the next leading economies would be those countries that are the first to make this transition. For this purpose, they will require stable economic progress and economic growth, which is not possible without ensuring their energy needs during this transition period.

The Politics of Energy

The basic impediment to energy security is not necessarily the availability of energy reserves but in fact, the location, access,

transportation and geostrategic interests of the powers involved. Oil production does not necessarily follow a strict economic logic of using the most easily accessible and low-cost reserves preferentially. For instance, the Middle East possesses nearly 54% of global proven conventional oil reserves but accounts for merely 31% of global production despite the fact that its location and accessibility significantly lower the costs associated with production and transportation.

The reasons for this pattern are not economic but political and geostrategic. Before the 1960s, the Middle East was indeed the top producer of oil but the rise of nationalism and the subsequent attempt by OPEC nations to use oil as a weapon which has already been discussed above, were the main reason for the change in this trend. Following the events of 1974, energy consumer nations diverted their investments to the development of other oil fields in order to ensure an uninterrupted supply of oil to their economies. New oil fields were subsequently developed in the UK, Norway, Alaska, Nigeria, Angola, Russia and the Gulf of Mexico. Now, with the rapid development of unconventional oil resources, the trend of the shift of oil resources away from the Middle East continues. With the diversification of oil supplies, the relative political power of oil-supplying nations and their ability to potentially use oil as a weapon has steadily declined.

This does not mean, however, that the supply of oil to global markets is now fully secured. As the sources of oil production have increased, a simultaneous increase in the demand for oil and completion to secure oil resources has been witnessed during the last two decades. Hence, secure transportation of oil is still a major security concern and put in strategic terms. Power does not lie with those who control the flow of oil but also with those who can disrupt the flow of oil.

The fact still remains that only a handful of countries hold the lion's share of global oil wealth. OPEC countries alone hold nearly 79.4% of the proven global oil reserves. (OPEC, 2018) On the other hand, most of the world's biggest consumers are countries that consume more oil than they actually produce. This creates a great dilemma because even if oil reserves are secured, their safe transportation is a big problem. Most of this oil has to pass through narrow strategic choke points. The transportation of oil, as mentioned above, is restively easier because it can be transported through pipelines, oil tankers and even through land routes. The transportation of natural gas is significantly more difficult. Unless a pipeline is available, natural gas requires liquefying process and special containers for shipping, thus significantly increasing the prices and reducing profitability.

It is, in fact, the assurance of continued supply of this vital fuel that has become the lifeblood of our economies which gives rise to stringent competition and hostilities. Another aspect is that oil can indeed be used as a strategic resource to promote interests and curb potential and existing rivals. Hence, acquiring reserves that are closest to home where their uninterrupted supply can be assured is a vital strategic goal of major consumer countries.

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Sustainable Energy Paradigm

Although there are many revolutionary technologies available and often promoted as possible alternatives to petroleum-based transportation and equipment, it would still take several years of research and development before these technologies become feasible from commercial perspectives and for use in military equipment. Moreover, the cost-benefit analysis of alternate technologies versus an established petro-based economy also needs to be taken into consideration. Petroleum products experienced peak prices during the early years of the 21st century but since then, these prices have stabilized significantly. In dollar terms, the alternate technologies still cost more than petroleum products and are far more easily available due to established distribution networks. An example of the British Royal Navy's use of energy-saving technologies can be taken for this instance, where it managed to reduce fuel consumption by 4% for the overall Navy. This figure, however, significantly does not

mean that the Royal Navy can shift to the use of alternate energy resources in the near future i.e. within the next few decades. (*Clickgreen ORG – Guida Alla Salute, Stile Di Vita E Bellezza*, n.d.)

Another point that needs to be considered here is the fact that the current global economy and military complexes are heavily dependent on petro-based technologies and to replace these technologies means replacing the entire inventories of civilian and military hardware as well as

redesigning and replacing the current energy supply chains and networks. These measures implicate not only a massive cost of structural changes but also a long time for implementation. Buchanan, S. C. (2006). An example of this can be taken from the US Department of Defense (DOD) study on energy security for future military requirements. US military is dependent on oil for up to 77 percent of its energy needs. According to DOD, such a transition would be an enormously difficult task in the first place and even if everything goes as planned, the transition is unlikely to be achieved before 2040. (Robyn, 2012)

The proponents of alternate energy say that through the use of these technologies, the global demand for energy and transportation can be easily met. However, one key aspect that is often ignored in this is that these technologies require the use of precious metals like Copper, Aluminum and Titanium far more extensively than conventional petro-based technologies. Hence, in the long run, market dynamics dictate that the prices of the minerals are likely to increase to a level that would make the dream of cheap energy for everyone unlikely.

There is no shortage of resources for alternate energy which include solar, wind, hydropower, geothermal and, more recently, the introduction of wave and tidal energy but all these forms of energy have one problem, to begin with, i.e. very high initial costs that require years to recover. Larger economies are already far too dependent on petroleum-based infrastructure and the massive cost of replacement of this infrastructure is a major deterrent to moving towards alternate technologies. This moving away from traditional resources would take several decades. On the other hand, smaller and developing economies do not have access to the massive investment required to build this infrastructure. All this is, however, only one side of the picture. Another important aspect that is often ignored is the powerful lobbies of oil cartels. The political influence of an industry worth hundreds of billions of dollars can hardly be understated. Even when there are possibilities of a viable alternative solution, the political influence of these lobbies ensures that their interests are looked after.

The Alternatives

Large-scale energy production for commercial usage requires large initial and running investments. Generally, Massive dams, Fossil fuel generators and Nuclear power plants are utilized for supplying electricity to main grids. These methods have not only massive costs associated with them but also huge environmental costs. Traditional methods, especially fossil fuels, are also subject to market fluctuations and the looming threat of peak oil. Dealing with these problems would require an innovative and progressive approach towards the concept of energy security as a whole.

New alternative technologies have started to mature during the span of the last three decades that offer a cost-effective solution to the above-mentioned challenges. These solutions also have the capacity to decentralize the energy grid and, therefore, better tolerance towards vulnerabilities that plague the grid-tied systems. The most popular among these are several sizes and

types of variations of solar and wind-powered systems.

There are several alternative energy resources that are gaining popularity across the world including Solar (photovoltaic and thermal) and Wind. All over the world, governments and organizations are realizing the potential of alternate energy and are opting for energy solutions that can offer long-term and sustainable benefits. Massive green energy projects are already in the pipeline in many countries including the USA, China, Japan, Spain, UK and India. (*India Remains Second Biggest Market for Corporate Renewable Power Purchase Agreements (PPAs), despite Policy Changes Slowing Growth*, n.d.)

There are several examples of large organizations and buildings like the Bahrain World Trade Center that depict the feasibility of alternate energy. Such alternative can be promoted to provide electricity to individual factories. Photovoltaic panels and wind turbines can be small and versatile enough to be used in urban and rural areas for domestic use as well. Another advantage of using such alternatives is that they can be used as hybrid systems and in combination with the main electric supply. If these sources are promoted and a substantial size of consumers start relying on these sources, it can help reduce a significant amount of load on the national grid.

Currently, the biggest hurdle in promoting these alternatives to the public is the prohibiting costs associated with these technologies.

A major misconception that is stalling the widespread adoption of solar and wind energy systems is that these systems require a very high initial investment with questionable returns over time. World Business Council for Sustainable Development (WBCSD) conducted a survey to that end and discovered that costs for green energy projects are generally overestimated by at least 300%. (Energy Efficiency in Buildings, n.d.) Despite the impediment of large initial investments in Solar Photovoltaic, Solar Thermal and Wind Turbines, these investments do eventually payoff due to lower maintenance costs and the fact that energy is being produced at very low costs due to natural and sustainable resources for the next several decades. Hence, these projects can prove to be much more feasible in the long run. A major advantage of these larger systems is that they can be operated as independent systems relying on grids only as a backup and recovering their initial costs in as little as two to five years period. One example that stands out in this context is the Bahrain World Trade Center which utilizes its unique architecture and three wind turbines to meet up to 15% of its electricity requirements (Al-Kodmany, 2014). Several other landmark buildings such as Shanghai Tower, Pearl River Tower, Wuhan Tower in China, Menara Mesiniaga in Malaysia and Doha Tower, Al Bahar Towers, and Green Dubai Tower in the Middle East have followed suit and adopted green energy and sustainability features in the design elements. (Al-Kodmany, 2014)

Despite the overwhelming evidence of sustainable energy resources being a viable option for energy security needs, large initial investments pose a significant hurdle in the adoption of these technologies. This challenge can be overcome by utilizing Solar-wind hybrid systems capable of creating a network for meeting the energy requirements of an integrated grid system. Studies have shown that an approximately three meters diameter turbine operating in wind conditions of10-20 km per hour is capable of generating 1.6kW to 6.3kW per hour of electricity. (How to Calculate Power Output of Wind, n.d.) Such a strategy would disperse the initial costs between stakeholders while reducing risk factors. Also, installation, as well as integration of such systems, would be less costly when

compared to large projects with similar capacity. Arrays of such systems can be integrated into the main grids and even expanded as and when required with ease to meet the required capacity of a sustainable and independent power generation system.

Pakistan: Energy Security Assessment

Pakistan's excessive reliance on fossil fuels to produce energy has ultimately resulted in an endless spiral of circular debts. Excessive reliance on petroleum-based products for the production of electricity may be considered an acceptable short-term measure for an importer country but over a period of time, this policy has proven as the Achilles heel of Pakistan's energy sector. A comprehensive and 'diversified' energy mix could have been a solution to this problem but the country's policymakers did not make any visible and concrete effort to deal with the issue in time. Hence, over-reliance on a single source for the production of energy becomes a weakness in energy infrastructure over a period of time when that resource is not naturally abundant within a nation's borders.

To most researchers and policymakers, the energy crisis in Pakistan emerged in 2008, when a 2000 MW gap between the country's production and demand emerged. This gap has only worsened and at present, this gap in demand and supply can exceed 6000 MW. However, the roots of this crisis can be traced to the disastrous policy adopted of purchasing electricity from privately owned independent power producers in 1996. These IPPs were using fossil fuels to generate electricity and ultimately wrecked the country's energy matrix. (Kugelman, M. (2013).

Pakistan's Energy Crisis

It is estimated that 1 to 2 percent of GDP is lost every year to the energy crisis, while the country's capacity to compete with the global market is eroding rapidly.

There are several ongoing and completed projects in the energy sector under the banner of the China Pakistan Economic Corridor (CPEC) including Sahiwal Coal Power Plant (1350MW), Port Qasim Power Plant (1320 MW), two nuclear Power Plants (650 MW), Neelum Jhelum (950 MW) and Tarbella 4 Extension (1500 MW). Besides these, Guddu Power and Nadipur Power plants are being converted to gas and three LNG-fired power plants in Punjab are setup (Ministry of Planning, Development & Reform 'P' block Pak-Secretariat, Islamabad, Pakistan, 2015).

Pakistan's energy dilemma began with its failure to maintain sufficient diversity in its energy production capabilities. Long-term Sustainability, Stability and Affordability were compromised for short-term accessibility. The subsequent governments have so far failed to produce a comprehensive policy for combating the current energy deficit as well as meeting the energy needs and sustainability of future generations. Instead, the current policies, if continued, will only worsen the already gigantic quagmire of expanding energy deficit.

This current trend in developing power plants to be run on coal, gas and LNG only lays bare the sheer incompetence and a failure to understand the needs of the future. Developing economies are already transitioning away from fossil fuels and moving to more sustainable as well as affordable forms of energy production. A successful energy transition will increase opportunities by creating new jobs and reducing the stresses of energy security due to global geopolitical scenarios. It will also help in the reduction of costs to end consumers through customization and prevalence of localized community-based power projects, thus reducing overall energy poverty for end consumers.

Several options for generating electricity through sustainable energy in a cost-effective manner while giving being

capable of operating independently from the main power grid have been in the market for decades already. One of the major advantages of these systems is that these capable of producing electricity independently from the centralized energy grid, thus being less susceptible to major energy breakdowns.

In the case of Pakistan, a systematic policy can be used to not only deal with the energy crisis swiftly and in a cost-effective manner but also reduce long-term energy transition costs to the economy. Considering the country's current impediment in terms of financial constraints, the new government cannot afford to make massive investments in energy projects. Moreover, mega-projects like dams take years to complete which compels the use of alternate options.

Energy Transition Strategy

For a resource-starved country like Pakistan, the challenge of embarking on energy transition requires a multitier strategy applied in stages.

Short-term Measures

Pakistan has seen a rise of a medium-sized industry around energy crisis in the shape of UPS and battery providers. The problem here is that these devices ultimately result in increased use of power consumption, thereby increasing pressure on energy demand.

This, however, shows that Pakistan's general population has sufficient resources to invest in energy products and thus provides an excellent short-term solution for reducing pressure on energy demand.

Private Citizen Level

An average 1 Kanal house consumes energy at the rate of 5 – 10 KWh (Kilowatts per hour). Such a demand can be easily met by a solar photovoltaic system that is tied to the grid through a reverse meter.

Similarly, many regions of Pakistan are suitable for small wind turbines of 3 – 5 KWh which can be produced locally and used in tandem with Solar Photovoltaic systems.

Such systems can be popularized by incentivizing the installation of such systems through government-backed projects and incentive schemes involving tax benefits or payment in installments. Pakistan's current energy shortfall can be mostly mitigated by the installation of merely 5000 – 10,000 such systems on

Private houses.

Image Source: Google.com

Medium-Term Measures

Given the security dynamics of a nuclear neighborhood and energy security dimensions discussed in the

City-level

Medium-term projects like the use of micro-Solar and wind turbines for street lights and public buildings can be utilized in a medium-term period from development funds allotted to cities. Larger cities like Rawalpindi, Islamabad, Lahore, Faisalabad and Karachi etc. can also build localized biogas generation plants which would provide advantages of waste management coupled with methane and energy production.

District and Provincial Levels

Districts with access to canals and rivers can utilize the flow of rivers to generate electricity through their respective funds or through assistance from the Federal government. Such projects can have the potential to produce a massive amount of electricity while avoiding controversies regarding the share of water that has so far impeded the construction of large hydroelectric dams.

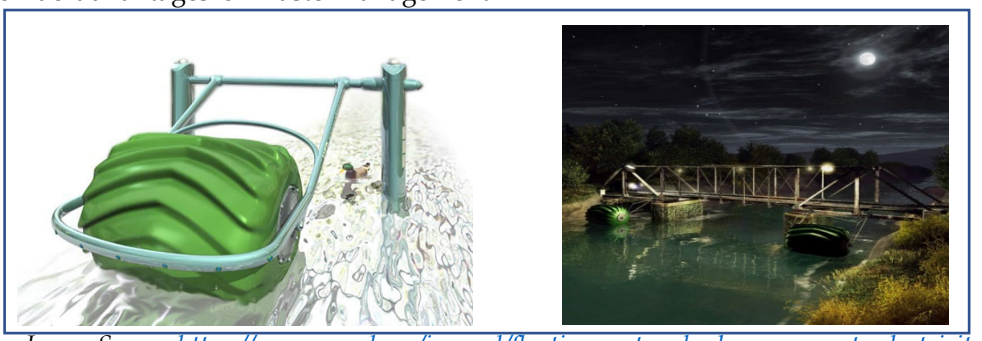

Image Source:https://www.woodz.co/journal/floating-waterwheel-can-generate-electricity/

Long Term Measures

The long-term measures need to be taken at the national level and can only be implemented through building a national consensus.

- It is imperative to get rid of power plants relying on imported fossil fuels to generate electricity. A practical solution is to convert these power plants to Solar Thermal plants. The heat from modern Solar Thermal plants can actually be conserved through underground salt tanks which allow them to operate 24 hours a day.
- Large Hydroelectric projects should be fast-tracked including large dams. A large run of the river hydroelectric projects as described above, can be initiated at the Federal level.
- Many other sustainable and viable sources like Geothermal, tidal, and wave energy can be utilized through a survey of appropriate locations.
- Government should encourage the import and manufacturing of high-efficiency vehicles and hybrid vehicles to reduce long-term oil imports. It is also recommended that research should be started to introduce and convert all public transport to electric vehicles once sufficient energy infrastructure is in place.

Given the potential of alternate resources and the need of the hour, it is essential that the government should eliminate taxes on these technologies and should introduce policies that encourage private businesses to enter these markets so that prices can be further reduced through market mechanisms and increased competition. Moreover, the government should also provide low-interest loans to organizations and individuals who want to use these alternatives. Awareness about the use of alternate energy should be created at the national level through media and other channels.

Conclusion

Energy is the lifeline for modern industry and a necessity for the development of any nation. However, without a concerted effort and long-term planning, successful energy transition strategies can neither be adopted nor implemented. The successive governments would need to create a robust policy framework for implementing a sustainable energy paradigm as a national security imperative. For this purpose, a multitier implementation policy must include public and private enterprises in an equitable manner while ensuring the elimination of localized monopolies of power distribution companies. It cannot be stressed enough that Pakistan should utilize all available options to overcome the energy emerging crisis due to global instability in oil supplies and the use of alternate resources can help the country to meet its current energy requirements and also help usher the nation into a new era of self-reliance and a safer energy policy for the future.

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