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Review Article

The Impact of Energy Security on Economic Development: Review of the Literature

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Abstract: Energy secuity is often classified as necesary to human security becuase of the importance of tts services for both modern economies and post-modern lifestyle as it relates to dialogue about energy issues as well as climate change. The paper aims to provide assessment and consideration of key aspects relating to energy security by providing comperehnsie definitions, highlights on key characteristics, underlying values and components of each of dofferent key dimentions of energy secuirty, as well as key contributions to economic developments. The paper is primarly based on reviewing the avilable leturature in the field as well as inclusion of key profesisonal and academic publications to enhance application and inclusion of key trends in the field as well as policies. The research concludes to establish that energy security has evolved as a result of the transformation of the world's energy regime in terms of the growing dominace of non-renewable fossil fuels and increasing reliance on oil, the 1970s economic crisis and liberalisation of energy markets, development of nuclear energy, fluctuating fortunes for coal and gas, escalating energy demands of developing nations, and the impacts of political instability and large-scale natural events and the energy regime of the 21st century.
Keywords: Energy security, Economic development, policy development.

INTRODUCTION

Background

Energy secuity is regarded as being essential to human security as its services are vital for both modern economies and post-modern lifestyle. It relates to dialogue about energy issues as well as climate change. The key issues that mitigate climate change in the aspect of technological development and doption are: negative externalities of climate change, knowledge spillovers, the scale of adoption, path dependence, principal-agent problems and behavioural change.

Due to it's ubiquitous nature, energy security tends to be beenficial in ,many areas such as the use of oil, coal, uranium and natural gas for our vehicles, working environment, food and manufacturing products. On the other hand, this widespread nature of energy security makes it vulnerable to failure in the market as well as under-distribution. This tend to create two-sided issues: neglect of its inclusive constraints due to its confined nature, or the extensivess nature that often leads to inconsistency and accuracy.

Thus, energy security has evolved as a result of the transformation of the world's energy regime in terms of the growing dominace of non-renewable fossil fuels and increasing reliance on oil, the 1970s economic crisis and liberalisation of energy markets, development of nuclear energy, fluctuating fortunes for coal and gas, escalating energy demands of developing nations, and the impacts of political instability and large-scale natural events and the energy regime of the 21st century.

It is no gainsaying that the 21st century access to energy sources depends on open global markets and a vast infrastructe network of offshore platforms, pipelines, tankers, refineries, storage, generation

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capaciity, and transmission and distribution systems (UNDP. 2004; Clentech, U. P. 2015; Yergin, D. 2005; Birol, F. 2006; Newell, R. G. 2009; Chester, L. 2010; Sovacool, B. K., & Mukherjee, I. 2011; Müller, S., *et al.*, 2011).

ENERGY SECURITY

Various Definitions

Scholars and practitioners have come with various definitions of energy security. For instance whilst Muller *et al.*,(2011) believes involves "the process of sufficient and reliable energy supplies to satisfy demand at all times at affordable price whilst also avoiding environmental impact"; Wikipedia, using the U.S. Navy F/A Super Horner describes it as the relationship between national security and the availability of natural resources for the purpose of consuming energy.

The Institute of Energy Agency – IEA (2010) however defines energy security as "the uninterrupted availability of energy sources at an affordable price". Energy security is thus a fundamental to modern society and has numerous aspects such as long-term and long-term. Whilst the long-term energy security relates to timely investments to supply energy as impacted by the need for a sustainable environment and economic development; short-term energy security occurs when a swift change in the demand-supply balance impacts on the energy system. Some of the constraints of energy security would have direct relationship with adverse economic and social impacts of the energy not being readily available, and/or non-competitive prices or excessively impulsive.

The concept of energy security focuses on two main sources – oil and gas. However, review of literature has shown that electricity is the most prevailing energy supply form to the global economy and critical to energy security; it is also second only to oil in respects of final energy consumption.

In their own views, Bohi and Toman (Bohi, D. R., & Toman, M. A.1996) defined energy in security "as the loss of economic welfare that may occur as a result of a change in the price or availability of energy". At market-centric energy security has various definitions with the main concentration on the economic issues that relates to the market behaviour (Bohi, D. R., & Toman, M. A. 1993; IEA. 2011).

FIGURE 1 BELOW ILLUSTRATES THE KEY ASPECTS DEFINING ENERGY SECURITY, AS EXTRACTED FROM IEA DATA AND ANALYSIS.

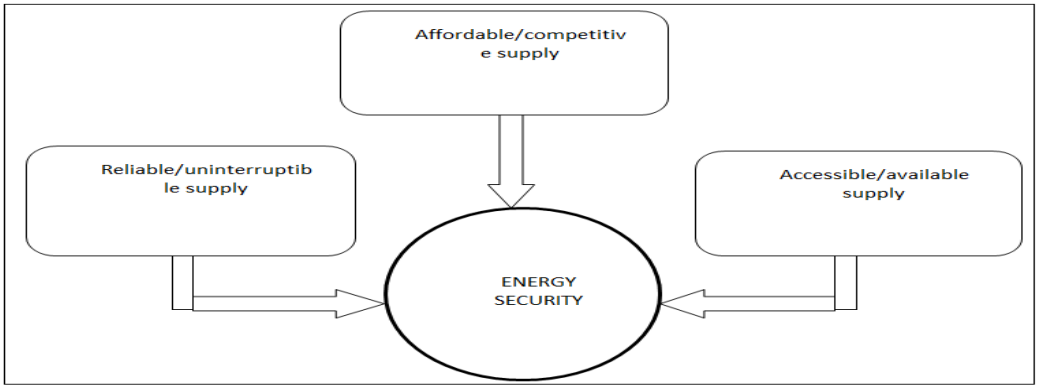

Fig-1: Defining Energy Security
Source: OECD/IEA, 2015 (OECD/IEA. 2015)

ENERGY SECURITY

Interlinked Facets

According to Muller *et al.*, (2011), Energy security emphasis on three main aspects: energy availability, energy affordability and sustainability of energy supply. However, Sovacool and Mukherjee (Müller, S.,et al.,2011) extended it further suggesting that energy security should incorporate two more in addition to the dimensions discussed by Muller *et al.*, (2011), namely technology development and regulation. They went further to highlight synthesis lists of 320 indicators and 52 complex indicators to be used by policy makers and scholars in analysing, measuring, tracking and comparing national performance on energy security; thus dividing the 5 dimensions into 20 components, namely:

- Availability (security of supply and production, dependency, and diversification)
- Affordability (price stability, access and equity, decentralisation, and low prices)
- Technology Development (innovation and research, safety and reliability, resilience, energy efficiency, and investment)
- Sustainability (land use, water, climate change, and air pollution)
- Regulation (governance, trade, competition, and knowledge)

TABLE-1 BELOW HIGHLIGHTS THE CHARACTERISTICS, UNDERLYING VALUES AND COMPONENTS OF EACH OF THESE DIMENSIONS:

Table-1: Energy security dimensions, values, and components

Dimension	Explanation	Underlying Values	Components
Availability	Having sufficient supplies of energy. Being energy independent. Promoting a diversified collection of different energy technologies. Harnessing domestically available fuels and energy resources. Ensuring prudent reserve to production ratios	Self-sufficiency, resource availability, security of supply, independence, imports, variety, balance, disparity	Security of Supply and Production Dependency Diversification
Affordability	Producing energy services at the lowest cost, having predictable prices for energy fuels and services, and enabling equitable access to energy services.	Cost, stability, predictability, equity, justice, reducing energy poverty	Price Stability Access and Equity Decentralization Affordability
Technical Development and Efficiency	Capacity to adapt and respond to the challenges from disruptions, researching and developing new and innovative energy technologies, making proper investments in infrastructure and maintenance. Delivering high quality and reliable energy services.	Investment, employment, technology developmentand diffusion, energy efficiency, stockholding, safety and quality	Innovation and Research Safety and Reliability Resilience Efficiency and Energy Intensity Investment and Employment
Environmental and Social Sustainability	Minimizing deforestation and land degradation, possessing sufficient quantity and suitable quality of water, minimizing ambient and indoor pollution, mitigating GHG emissions associated with climate change, adapting to climate change.	Stewardship, aesthetics, natural habitat conservation, water quality and availability, human health, climate change mitigation, climate change adaptation.	Land Use Water Climate Change Pollution
Regulation and Governance	Having stable, transparent, and participatory modes of energy policymaking, competitive markets, promoting trade of energy technology and fuels, enhancing social and community knowledge about education and energy issues	Transparency, accountability, legitimacy, integrity, stability, resource curse, geopolitics, free trade, competition, profitability, interconnectedness, security of demand, exports	Governance Trade and Regional Interconnectivity Competition and markets Knowledge and Access to Information

Source: Sovacool and Mukherjee, 2011 (Sovacool, B. K., & Mukherjee, I. (2011)

The three aspects described by Muller *et al., (2011)*, energy availability, affordability and sustainability are explained further in sub-section 5.3.1 to 5.3.3.

ENERGY AVAILABILITY

Energy availability involves the sufficient supply in order to provide energy for fuel use every time as well as sufficient supply of primary resources such like the adequate production from the fossil fuels, winds, and solar energy.

As part of the uninterrupted function of the primary functions of the supply chain, there is need for infrastructure to transport the primary resources – solar panels, wind turbine, hydro plants, pipelines, conventional power stations and gas, heat or grid. The diversity of energy sources is an important aspect as no energy is immune from descriptions. Strategically diversified energy portfolios usually comprise different energy services as well as different supply pathways for each energy service; and these portfolios should be responsible for any changes amongst various energy sources and delivery pathway.

ENERGY AFFORDABILITY

There is the perception that energy renewables are costly energy option and this brings about affordability issues. However, with the technological advancement, there has been swift change in the real cost and reduction in the price. For instance, solar photovoltaic (PV) is almost competing with refuel electricity prices in some markets (Breyer, C., & Gerlach, A. 2010). Another example is in New Zealand where the wind energy being deployed without a dedicated support mechanism for renewables.

Stand-alone renewables are more economically viable than the grid-connected electricity like the diesel generator due to the lack of modern energy services. They provide environmentally sustainable option for energy supply (IEA. 2010).

In terms of securing availability, it is worth noting that reliance on one least-cost option would lead to constraints as the energy portfolio would not have the opportunity of diversification.

For energy security, affordability is based on two main aspects – price volatility and price uncertainty.

PRICE VOLATILITY

Volatility of fossil fuels has detrimental economic effects as there has been massive reliance on fuels that are exposed to large flutuation in the price. Thus renewables enable shifting dependency away from volatile fuels. Renewable energy technology (REST) affects the variuos fossil fuels particularly in the areas of usage and how energy is generated. The use of biofuels oe electrification of transport, for instance, allows the demand for oil to be costrained. Thus renewables heat has displaced natural gas, coal and oil consumption whilst gas and coal market effect on the renewable electricty

PRICE UNCERTAINTY

There is uncertainty in the market as a result of the fluctuation of oil and gas prices. The future evolution of fossil fuel prices is influenced by the penetration of renewables and suitable energy mix (IEA. 2010; Müller, S., *et al.,* 2011) .

Renewaables are strategic options to alleviate the much reliance on the surces subject to price uncertainty and its economically detrimental efforts.

SUSTAINABILITY OF ENERGY SUPPLY

There is the need to consider the long-term consequences of energy security so as to allow for more informed decision making. Research has shown that the present global shape of energy production and consumption are far from being sustainable due to the following reasons:

- Proceeding on a business-as-usual path will lead to unacceptable increases in global; average temperature. There could be catastrophe due to the high level of warming and this would lead to massive migration away from worst-affected areas and prolonged conflicts (IEA. 2010.
- The world would eventually run out of fossil resources as no one can forecast when for certain the resources will be fully-utilised. This would however occur at a point in the future especially if the demand for fossil resources means high.

ECONOMIC DEVELOPMENT

Green Growth

For sustainable economic growth, there is the need for renewable energy technology (RET) to be deployed as a strategy green growth (OECD/IEA.2011). This can be done as follows;

- By allowing exploitation of natural but replenishing resources, providing new sources of natural capital
- Technologies allow countries with good solar or wind resources, to exploit these resources as 'new' assets to support their own energy needs
- RET also allow countries to exploit RE resources with long-term export potential, by producing biofuels sustainably, or by using high levels of solar radiation to generate exportable electricity via concentrating solar power

OECD/IEC Green Growth Framework is characterised by recognising 'natural capital' as a factor of production and its role in improving well-being of the society. For natural capital, factors entering the production process are provided by nature itself. Examples are resources such as fossil energy. Reduction of the natural capital would negatively impact on the overall growth because consumer behaviour as well as the present production technologies would produce progressive outcomes but only to some extent.

THE GREEN GROWTH POLICIES DESIGNED:

- Aim to create new markets that recognise the importance of natural capital and of reconciliating limited natural resources with economic growth]
- They provide an exit strategy from the fossil energy-based development path to which the global economy is currently committed

Renewables are essential in the provision of a sustainable pathway to increased prosperity. It is believed that innovation could enable separate the link between growth and natural capital reduction. This calls for economic policy decisions that would integrate the prospect for a long period of time. Environmental impacts are also cumulative and cannot be reversed at times. According to OECD (2011), economic, technological, institutional and environmental impacts are factors that have direct impact for economic opportunities and environmental implications in future.

IEA, advising on the economic lock-in effect (the way the past economic patterns determine future pathway), explains that the fossil fuel import bills could be a hindrance to economic development. They however estimate that investment in low carbon energy system provides an extra ordinary return and could lead to savings and avoidance of negative impact on climate change. Fossil fuel import bills therefore could be a hindrance to economic development

Emerging countries like China also use green growth strategy to deploy renewable energy in order to promote noire sustainable growth. There is the argument that there is more job creation in renewable energy than in fossil fuels; despite the lack of widely-accepted methodology of accounting information

renewable energy-related job. There is the expectation that markets would growth speedily in future due to the mitigation of the climate change and vital energy security (UNEP. 2008).

INNOVATION, TECHNOLOGY AND INDUSTRY DEVELOPMENT

Industrial; and economic development objectives are top agenda for most leading market economies like Germany, Denmark and Japan with emphasis on renewable energy technology (Jochem, E. 2008; Mizuno, E. 2010; OECD/IEA. 2011).

Innovation is fundamentally a risky and uncertain process, and it has four major challenges: Externalities; Uncertainty; Asymmetric information and market power. There is the need for policy framework with innovation chain and favourable investment conditions for renewable energy technology (RET) innovation and solar PV wind. Government intervention and policy is necessary coupled with knowledge spill overs from R&D efforts and public goods nature of the technologies.

Markets would require the public policy to be fully operational in order to provide adequate incentives. Innovation industry would surely take advantage of the better predictableness of the market features for new technologies. The market for new technologies are often categorised as follows:

- Uncertainty surrounding adoption – significant uncertainty and risk
- Impact on markets for competing and complementary products
- Application of existing legal system
- Enforcement of intellectual property rights, and
- Acceptance in intellectual markets

Market and behavioural failures are the main issues impacting on technology innovation. The technology innovation are however of minimal value even if the society refuses to embrace them (Popp, D. 2012; Hall, B. H., & Helmirs, C. 2010; Popp, D.,*et al.*,2010; Popp, D. 2006; OECD/IEA. 2011; Lybecker, K. M. 2014).

THERE ARE FACTORS THAT IMPROVE A COUNTRY'S EXTERNAL TRADE, AS FOLLOWS:

- Technological features that are hindrances to international relocation
- Learning-by-doing and –using option, which is consolidated by the confident market situation
- The Country's regulation which supports innovation
- Technological proficiency of the country, and
- How competitive the related industry that are assembled in the country (Walz, R.*et al.*,2009; OECD/IEA. 2011).

Technological capabilities and innovation success in renewables are influenced by a wide range of factors from innovation chain, not just from real R&D exertions. Patent activity needs to act as indicator for speculation in some technologies to measure the potential for the market share growth. As Jochem *et al.,(2008)* describe it, the challenge is whether or not the emerging economies like China that has lower production cost, would be able to sustain their first-mover benefit, an if these lead countries could meet up with the competition.

RURAL DEVELOPMENT

The rural areas are habitually characterised by underdeveloped access to electricity and not effective grid extensions. The off-grid RET are used to provide suitable cost-effective access to electricity as an alternative to diesel generators.

As part of rural development, RET also displaces other unsustainable energy sources such as kerosene lamp and traditional biomass. Thus the benefits are:

- Provision of cost-effective access to modern energy service
- Positive impact of deployment of solar home systems with children's study routines (deployment strategies in rural areas mostly in the developing countries).

The motivation is to reinforce the use of renewables used in the developed countries in the rural economies. This would be done through the introduction of support policies for production and consumption of biofuels and diversification of activities in agricultural sector including open access to potential new economically viable market (Grazian, M., & Fornasioro, F. 2007; OECD/IEA. 2011).

SUMMARY AND CONCLUSIONS

Energy secuity is often classified as necesary to human security becuase of the importance of tts services for both modern economies and post-modern lifestyle as it relates to dialogue about energy issues as well as climate change. Energy security has evolved as a result of the transformation of the world's energy regime in terms of the growing dominace of non-renewable fossil fuels and increasing reliance on oil, the 1970s economic crisis and liberalisation of energy markets, development of nuclear energy, fluctuating fortunes for coal and gas, escalating energy demands of developing nations, and the impacts of political instability and large-scale natural events and the energy regime of the 21st century

In this paper, energy security concept has been discussed from its various definitions, principles and interlinked facets: energy availability, energy affordability, and sustainable energy. There has been review of literature on on the impact of energy security

on economic development ranging from growth to innovation and development including the effect on the rural development.

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