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**Review Article**

# Review of Drivers and Barriers to Development of Renewable Energy

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**Abstract:** The paper is exploring and investigating key definitions and principles of renewable energy highlighting key distinctions between sustainable energy source and renewables, key associated theories of renewable energy such as diffusion Theory, and drivers and barriers to renewable energy, good practice guidelines. Furthermore, the work would focus on strategy, priority and monitoring and evaluation policies to further provide clarity on how renewable energy is being implemented in practice. The work also to discuss key dynamic aspects of deployment to further enable success of renewable energy adoption. The paper is based on reviewing the published literature in the field, as well as other related publications such as professional reports to enhance relatedness to recent updates in policy and practice. The paper provides key findings and recommendations on the role renewables play in dealing with climate change both in interim and long run, influences on policies and incentives that would shape its deployment.
**Keywords:** Renewable energy, strategy, policy development.

## INTRODUCTION
### Background

There is the growing need for renewables use, which contributes to a country's economic growth, including the developing countries (Grazian, M., & Fornasioro, F. 2007).

After the second world war, there was increased hopes if cheap, plentiful and clean alternative to fossil fuels. The danager of nuclear energy is also installed because of the increased concerns about safety, cost, waste disposal and weapon proliferation.

The potentials for self-sufficiency in materials are derived from biomass and agricultural resources. There is the growing environmental awareness through the world and new environmental regulations are put in place which leads to scoietal concerns.

## RENEWABLE ENERGY:
### Definition

It is no ganin saying that industrialised societies run on energy, population, GDP, consumption and production of pollution for the world (Nelson, V. 2011).

Solar energy is referred to as renewable or sustainable energy because it is made available as long as the sun continues to shine. It is thus estimated that the remaining life of the main stage of the sun are another 4 to 5 billion years.

There are various definitions of renewable energy. Whilst renewable energy is defined by Twidell and Weir, 1986 as 'energy obtained from continuous repetitive currents of energy recurring in the natural environment.' In his own view, Sorensen (Sorensen, A. T. 2000) describes renewable as energy flows that are replenished at the same rate as they are being used, and it's principal source is solar radiation.

## PRINCIPLES AND CONCEPTS
### Principles

Renewable energy sources are as a result of the demand from enormous power of the sun's radiation. The need for renewed interest in the renewable energy

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sources is due to concern about sustainability of both fossil and nuclear fuel use (Boyle, G. 2012; Timmons, D.,*et al.*,2014).

**The Distinctions Between Sustainable Energy Source And Renewables Are As Follows:**

**Table-1: Distinction between Sustainable and Renewable Energies (Source: Boyle, 2012) [4]**

| | Sustainable Energy | Renewable Energy |
|---|---|---|
| 1 | Not substantially depleted by continued use | Essentially inexhaustible |
| 2 | Does not entail significant pollutant emissions or other environmental problems | Their use usually entails fewer health hazards |
| 3 | Does not involve the penetration of substantial health hazards or social injustice | Much lower emissions of greenhouse gases or other pollutants |

## CONCEPTS

It is a fact that 14% of the world's energy comes from bioenergy (energy from wood, charcoal and animal dung for cooking and heating). Fossil fuel are stored energy from past geological ages – oil, natural gas and coal, and are not sustainable.

**Renewable Energy Comprises The Following:**

- Solar energy – renewable or sustainable energy.
- Wind uneven heating of the surface of the earth
- Bioenergy
- Geothermal – Renewable energy due to heat from the earth from decay of radioactive particles and residual heat from gravitation during formation of the earth e.g. volcanoes
- Hydro – stored solar energy
- Tides – due to gravitational interaction of the earth and the mom
- Waves (Grazian, M., & Fornasioro, F. 2007; Boyle, G. 2012).

## THEORIES OF RENEWABLE ENERGY

### Diffusion Theory

Diffusion theory helps the understanding of the dynamics of how market reaches its full potential. The theory explains that the market develops slowly, and then picks up rapidly until it reaches its peak before it begins to slow down until the market is saturated.

Whilst diffusion goes beyond the two-step flow theory, centering on the conditions that increase or decrease the likelihood that an innovation, a new idea, product or practice, will be adopted by members of a given culture; Innovations are adopt in a time sequence, and can be classified into adopter categories based upon how long it takes for them to begin using the new idea, they are not adopted by all individuals in a social system at the same time (Infante, D., *et al.*,1997; OECD/IEA. 2011) .

According to Robinson (Groba, F., & Breitschopf, B. 2013). "Diffusion of Innovations seeks to explain how innovations are taken up in a population. An innovation is an idea, behaviour, or object that is perceived as new by its audience.

**Diffusion Of Innovations Offers Three Valuable Insights Into The Process Of Social Change:**

- What qualities make an innovation spread?
- The importance of peer-peer conversations and peer networks.
- Understanding the needs of different user segments

Robinson (Robinson, L. 2009) went further to list five qualities that usually determine the success of an innovation: 1) Relative advantage; 2) Compatibility with existing values and practices; 3) Simplicity and ease of use; 4) Trialbility; and 5) Observable results.

## DEPLOYMENT PHASES

The diffusion theory considers the deployment of energy technology. The deployment is however in three phases – inception, take-off and consolidation.

The Danish example shows inception (deployment of the first example of technology) in 1995, followed by the take-off stage (widespread deployment leading to rapid market gains) in 2003 and the consolidation phase (where growth increased to maximum practicable level) in 2004 and beyond (OECD/IEA. 2011; Groba, F., & Breitschopf, B. 2013; Allan, C., *et al.*, 2014).

## INCEPTION

The inception stage is where targets are set in an informed manner by establishing costs nad capacities for technology. This stage also enables the establishment of the feasibility and credibility of deploying technology through pilot and demonstartion plants and to ensure attainment of access to grid or the market.

The inception stage also allows for development of institutional capacity necessary to manage and moitor deployment like the permitting issues. Other institutional barriers to the the early distribution are identified and traced whilst a supply chain capability is recognised.

## TAKE-TO

At the take-off phase, the challenges are provision of appropriate framemork for supporting the deployment effectively and efficiently. It helps the local suply chain to develop and ensure stability to alleviate or eliminate non-econmic onstraints.

**MARKET CONSIDERATION**

The challenges faced at the market consoliation phase are: grid integration issues, public accpetance, integration into energy market when the financial support is no longer neeeded

It is worth nothing that the deployment phase of a given technology varies from country to country and the global market status has vital implications for natural policy making. As such, for new technology optiosn to be introduced into any economy, international experience and learning are priorities that would enable the country to access technoloies that are available commercially for deployment into other markets; they would also beenfit from technical improvements and cost reduction, which would make it less cost-effective and simplier to introduce to the market.

**CHALLENGES**

The challenge however is that the t4echnology may require adaptationto the local siutaiona nd the local supply chain in respect of installation and maintenance service and this could take more time to develop. Another challenge is the lack of commercial and physical infrastructure, and the fact that for most projects, the initial projects are usually more expensive that the already developed market.

The non-techniocal barriers ae cirumvented by considerin the following factors: local market structures, legislation and regulation, and regulatory and commercial capacity to build up with time.

**The lessons learned in the more matured markets are: use of technology learning and cost reduction. Examples are:**

- Use of different policy approach to sccelerated deployment as in the case of China
- Development of technology with no invovement of the large global market as in the solar PV support in Germany (Rao, K. U., & Kishore, V. V. N. 2010; OECD/IEA. 2011; Groba, F., & Breitschopf, B. 2013).

**DRIVERS AND BARRIERS TO RENEWABLE ENERGY**

**Main Drivers**

The benefits of renewable energy are imperative since energy services are fundamental to human welfare as well as economic and social development. Renewable energy technology helps in emission or very low greenhouse gases (GHG) thereby alleviate the poor health and environmental hazards such as air pollution. It also encourages the sourcing of locally available renewable energy resources and diversification of the energy supply mixes. The systems of renewable energy also encourage focus on decentralised markets and economic development even locally in terms of creation of jobs, and introduction of new capital and innovation as well as development of new revenue sources for the local communities. Other benefits are

1. Abundance of natural, renewable biomass resources
2. Trees are being grown faster than they are being consumed
3. Potentials for biomass utilisation
4. Abundance of biomass, feedstocks
5. Value added to country's economy
6. Use of agricultural and biomass feedsticks for production of materials, chemicals and fuels (World Bank. 2008; Nelson, V. 2011).

**GOVERNMENT POLICY DRIVERS**

**The Government Policy Drivers Are As Follows:**

- Use of bioenergy and biobased products to increase additional income for farmers and rural citizens e.g. USA
- Renewable resources are putting policies and goals in place for use of annually renewable resources e.g. Europe and Asia
- Production of biomass-driven products at substantial level e.g. paper and paperbound production from forest products
- Development of business products e.g. new commercial (non-food, non-feed) markets for agricultural product

**The advantages of renewable energy are**

- Sustainability
- Non-dependable
- Ubiquitous – found everywhere across the world unlike fossil fuels and minerals
- Non-polluting – Wind turbines and photo voltaic panels do not need water to generate electricity, unlike steam plants fired by fossil fuels and nuclear power (Kirkwood, R. C., & Longley, A. J. 1995; Grazian, M., & Fornasioro, F.2007; Nelson, V. 2011).

**BARRIERS**

OECD (2011) emphasise of the fact that renewable energy technologies act as substitute for fossil fuels in the aspects of electricity provision and heat and transport and these reduce the amount of carbon dioxide (CO2) produced.

The barriers to renewable energy technology are interlinked, mainly into technical and non-economic. Whilst the technical barriers relate to the direct impact of certain technology that are competing with technologies, considering the internationalisation of all the external costs and the real structural conditions. They include capital demand and operational costs as well as grid integration and noise visual.

On the other hand, the non-economic constraints are the factors that either result in falsified prices or higher than usual prices or preventing deployment completely.

**Non-economic barriers include the following:**

- Regulatory and policy uncertainty barriers (building policy documents and transparency)
- Institutional and administrative barriers (strong institutions and clear responsibilities)
- Market barriers (inconsistency in policy structures)
- Financial barriers (absence of funding opportunities)
- Infrastructure barriers (Inflexibility of energy system)
- Lack of awareness and skilled personnel, and
- Public acceptance and environmental barriers (planning regulations and public acceptance of renewable energy)

**THESE BARRIERS ARE ILLUSTRATED IN THE FIGURE-1 BELOW:**

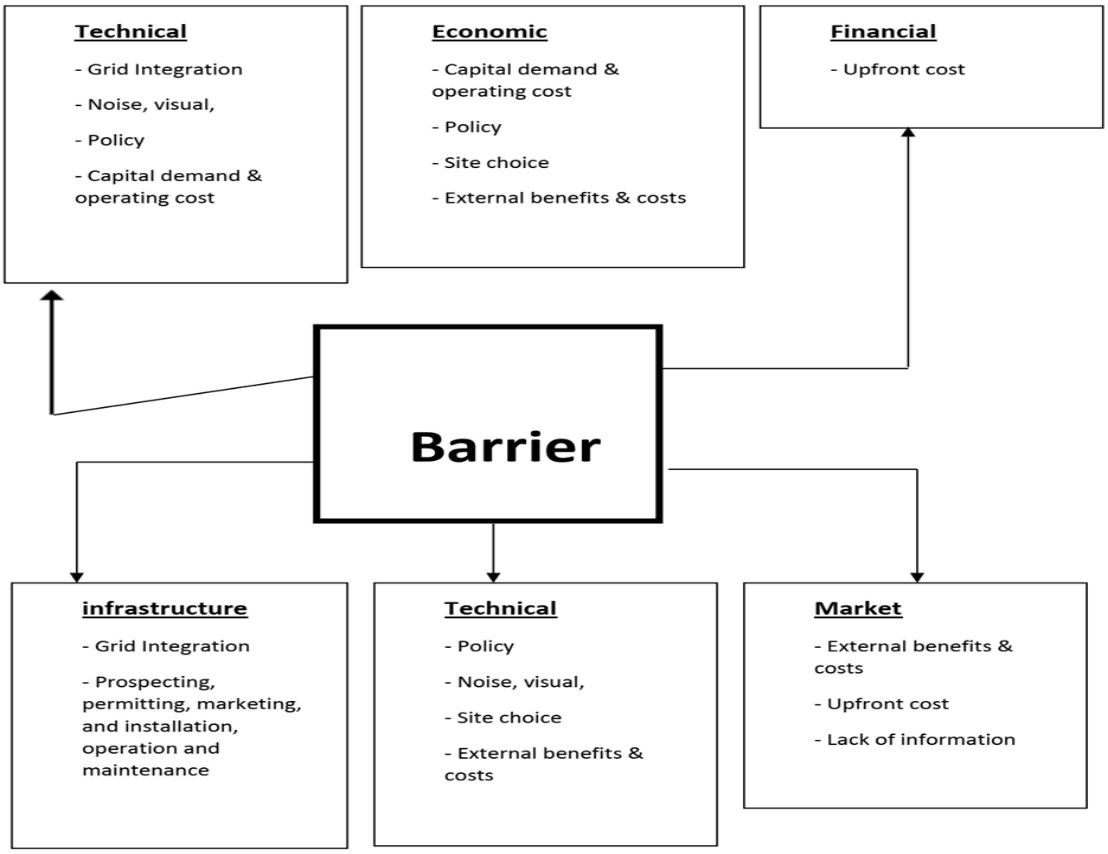


**Fig-1: Barriers to Renewable Energy**

**Source:** Adapted from OECD/IEA, 2011 and Nogee *et al*, 1999 [8, 14].

**OTHER BARRIERS OF RENEWABLE ENERGY INCLUDE**

- Variability
- Low density: General results in higher initial cost Visual pollution
- Odour from biomass
- Avian with wind turbines
- Brine from geothermal energy
- Perceived problems to local people where a large renewable facility is to be locked
- Problem of ‘not in the backyard’ for conventional power plants using fossil fuels for nuclear energy, and even renewable energy (Kirkwood, R. C., & Longley, A. J. 1995; Grazian, M., & Fornasioro, F. 2007; Nelson, V. 2011) .

**THREATS TO GLOBAL CLIMATE CHANGE**

Carbon dioxide (CO2) emissions from fossil fuel consumption. There is the need to reduce emissions. Global mean temperature should not rise above 2 degrees centigrade by year 2050. Further, carbon emissions need to be reached by approximately 80% by year 2050 (Allan, C., et al ., 2014; Boyle, G. 2012).

**FRAMEWORK**

**Life Cycle Assessment - Lca**

UNEP defines Clean products as a life cycle of a product or process. Thus, life cycle assessment (LCA) is a form of environmental system analysis – a formal approach to defining and evaluating the total environmental load associated with providing a service by following the associated material and energy flows from their cradle – primary resources, to their grave – ultimate resting place, as solid waste or dispersed emission.

LCA is increasingly being used as a decision support tool for improving environmental performance. It is usually adopted using quantitative approach; and the rationale (idea) is to check if LCA genuinely reduces environmental load or transferred from supply to another upstream or downstream supplier. In order for the system to provide the function, it will require materials and energy.

Apart from LCA, there is another form of analysis known as specific site environmental impact assessment (EIA) where the system boundary is drawn around the manufacturing plant so that the productive system takes the simple form. However LCA attempts to account for 'upstream' and 'downstream' environmental effects as well as those directly associated with manufacture.

**LCA involve a formal procedure for carrying out and applying the assessment, as follows:**

- Goal Definition – This defines the boundaries of the system to be studied. It is the defining functional unit – unit of service to be analysed and can determine or even prejudice the outcome of the study
- Inventory – The inventory inputs the primary resources and the outputs of emissions plus solid residues to be defined and qualified. The material and energy are balanced over the system defined at the goal definition stage. The inventory allows for flow of trace components, which may have significant impact. The result in inventory table qualifies the inputs and outputs per functional unit provided.
- Classification – This quantifies the combination of inputs to and environmental outputs from the system to recognised environmental and health problem e.g. greenhouse warming potential. Detailed data in inventory table are aggregated into smaller number of effect scores, which defines environmental profile of the system.
- Valuation – Weighing effects scores to give a simple estimate of environmental effect of delivering the function. – determining the environmental load parameter. It requires value to be placed on completely disparate environmental effects and resource usage.
- Improved Analysis – When LCA is used within a company, the result is used to identify changes in the product or productive system that will reduce the total environmental load.

It is argued that 'Goal Definition' and 'Inventory' are established process whilst the third stage – Inventory is less well-developed but standard methodologies are emerging. However, with the valuation process serious difficulties arises, which calls the use of Environmental economic appraisal as a probable solution.

Environmental LCA is a complex procedure and not fully developed. However it sets out the life cycle from cradle to grave, in identifying when effort should be applied to make a technology clearer and which stages the life cycle should be changed or eliminated. An example is the ecolabel criteria for washing machine (Kirkwood, R. C., & Longley, A. J. 1995; Nelson, V. 2011) .

## GOOD PRACTICE GUIDELINE

**OCED/IEA (2011) Highlighted Six Good Practice Policy Frameworks For Energy Technology RD&D, As Follows:**

- Strategy and priority
- Public funding and policies
- Co-ordinate governance
- Partnership engaging industry through public-private-partnerships (PPPs)
- Monitoring and evaluation, and
- International collaboration

Whilst most of the above policy framework have been covered with other topics, the focus will be on strategy and priority and monitoring and evaluation policies.

## STRATEGY AND PRIORITY

It is imperative for government and research bodies to understand that not all approaches to innovation will work irrespective of the local skills and resources. The era of public RD&D picking winners and ending up locking in technologies are no longer economically efficient.

There is the need for comprehensive and well-organised RD&D energy strategy that has vibrant prioritisation in line with the national policy goals. This appears to be the most important feature of good practice energy R&D framework, and the strategy should be transparent and developed in consultation with major stakeholders.

The uncertainty amongst potential investors is as a result of the inconsistency and lack of credible strategy. Other factors are: doubt about the trustworthiness of targets and policy drives, and delay in development of new technologies.

For energy R&D strategic approach, the process includes quantifiable objectives for short, medium and long terms as should involve the key stakeholders. For instance, the Korean approach represented by Green Energy Strategy Roadmap – includes a strategic plan for market production, international co-operation, human resources development and education, and collaboration with private sector.

**THE CRITERIA FOR SELECTING THE KEY TECHNOLOGIES ARE TWO-FOLDS; MARKET ATTRACTIVENESS AND TECHNICAL IMPORTANCE:**

- Market attractiveness – includes market potential, contribution to the environment and competition on global market
- Technical importance technical innovation, technology development capacity, and government support required.

This leads to both early and next generation development. Examples of the early development (PV, wind power, fuel cells, LED, smart grid, IGCC, energy storage, Clean fuel and CCS) and next generation development (Nuclear power, green cars, heat pumps, energy efficiency buildings, CHP, and superconductivity).

The priority setting for energy RD&D helps government to enhance natural investments. It is therefore essential to have a reliable framework for comparing technology over a wide range of time frames and policy scenarios.

**PRIORITIES CAN BE BASED ON THE FOLLOWING FACTORS:**

- Those offering largest benefits for reducing energy imports or CO2 emissions
- Those having large-scale potential
- The highest expected return (cost-benefit), with a focus on enabling technology
- Those critical to overall success of strategy.
- Social and environmental impact considerations

Priorities may also reflect areas in which the country has a particular competitive or cost advantage. The danger is that the spreading funding too thinly across small, sub-critical areas will not produce any long-term benefits. For energy priority setting therefore, exercise is based on energy technology vision and natural energy plan.

**R&D TOOLS**

The useful R&D tools are technology modelling, scenario analysis, portfolio analysis, technology-needs assessment, foresight and road mapping (OECD/IEA. (2011).

**MONITORING AND EVALUATION**

Due to focus on technology development, policies and measures, there is the call for careful assessment of their effectiveness and measures including their associated benefits and costs. To set realistic targets for energy RD&D, the following features are vital; should be clear, quantified and if possible, the objectives should be classified into short-, medium-, and long-term.

The effective review is monitoring and evaluation and they could complement each other.

**MONITORING**

To track the progress in relation to programme or project objectives and to provide interim indicators of change. Monitoring is carried out through data collection, reflecting the ongoing activities and generating selected indicators from the data. The initial step is to identify ways of transforming the objectives into definite targets and performance indicators that provide ways of measuring development.

Monitoring is of high quality and vital, which is why it is often paired with effective evaluation.

**EVALUATION**

The aim is to analyse both end results (outputs) and the contributing factors (processes); as a means of examining the whole implementation process and improving performance of future interferences.

Evaluation is conducted by using defines processes and methodologies to assess the programme or payment’s impact or effectiveness. It seeks to determine the value or worth of the intervention and feed this information into the decision making process.

Whilst monitoring provides the required data necessary to make sound judgement, evaluation function to use the data to make the sound judgement. Monitoring and evaluation can thus be conducted if there is clear set targets for energy RD&D from the start as well as mean of quantifying the progress.

**EVALUATION METHODS**

There are two main types – qualitative and quantitative methods. Qualitative methods include peer review, panel review, case studies, historical tracing, network analysis, and prospective studies (foresight and technology assessments).

On the other hand, quantitative methods are: Bibliometrics, and patent analysis, cost-benefit analysis (CBA), macroeconomic modelling and microeconomic modelling.

**EVALUATION INDICATORS**

Indicator is a measure of a characteristic or attribute of intervention, or at the context in which the intervention occurs. This could be qualitative and/or quantitative. Evaluation relies on identifying specific indicator, which are useful as s basis for making judgements objectively about policy or program progress or success.

Monitoring and evaluation provide a record and generate knowledge for visibility and legitimacy, learning and quality development of public intervention and help to steer policy and strategy development (OECD/IEA. 2011) . Policy Considerations: Measures to Promote New and Renewable Energy.

**PLANNING**

**Planning Practice Guidance For Renewable And Low Carbon Energy Include The Following:**

- Local Planning Authority(LPA)
- LPA strategy
- Identification of suitable areas for renewable and low carbon energy
- Technical consideration for renewable technology
- Role of community-led renewable initiatives
- Identification of decentralised energy opportunities
- Planning considerations for renewable technology
- Hydropower
- Active solar
- Large scale ground-mounted solar photovoltaic farms
- Wind turbines (noise impact of wind turbines; safety issues; electromagnetic transmission issue; heritage; shadow flicker vs reflected light; energy output, and cumulative landscape vs visual impact (DCLG. 2013).

**TECHNICAL**

Technology policy compliments rather than substitutes for emission pricing; it helps address the problem of economy as a whole including patent protection, R&D tax credits, and finding for general basic research. It can also facilitate the creation of new environmentally friendly technology by providing little incentives to adopt these technologies. Technical policy however has lesser environmental impact in terms of technical subsidies and a poorly-designed technical policy will increase society costs of climate mitigation, unless there are incentives such as market-based price on emissions (Newell, R. G. 2009).

The technical potential, also known as accessible resource is the maximum annual energy that can be extracted from the accessible part of the available resource using matrix technology.

**THE TECHNICAL CONSTRAINTS ARE:**

- Practical differences such as the p[presence of roads and building
- Institutional restrictions and the need to avoid areas such as national parks
- Using distributing the energy to reduce technical constraints such as transportation problems and access to electric grid (Kristinsson, K., & Rao, R. 2007; Costa, I., *et al.*, 2008; Popp, D., *et al.*, 2010; Hall, B. H., & Helmers, C. 2010; Van Hoorebeek, M., & Onzivu, W. 2010; Wang, B. 2010; Popp, D. 2012) .

**LEGAL OR REGULATORY**

The institutional issues related to renewable energy are legislative and regulation concerning the environment, incentives (feed-in tariffs), externalities , world treaties, country responses to greenhouse gas (GHG) emissions, and connection to utility grids such as PV and CSP

The regulatory environment is largely instrumental in shaping the various business models that are developed. This is because business models are designed to extract maximum value from a business activity conducted within a particular regulatory framework. Regulatory policies and measures necessary for promoting new and renewable energy are: renewable portfolio standards (RPSs, manipulated sales or purchase for fleet vehicles, harmonised refuelling facility standards and codes of practice, health and safety regulations and exemptions from energy end use restrictions (IEA. 2010; Cooperation, A. P. E. 2009) .

**FINANCIAL / ECONOMICAL**

The economic potential includes economically viable amount of technical constraints and it requires specification of acceptable energy cost and a discount rate that sets the cost of borrowing money for investment.

**Externalities Are The Social Costs And Benefits. The Mechanisms For Including Externalities Into Market Are;**

- Government regulation – max or minimum use of energy sources with lowest life-cycle cost
- Pollution taxes – taxes on pollution
- Integrated Resource Planning (IRP) – combine elements of a competitive market with long-term environmental responsibility
- Production – subsidies
- Transmission

The fiscal or financial policy and measures to promote both new and renewable energy are: Feed-in tariffs and net metering, excise tax examples or rebate, road or reg-tax exemption or rebate, sales or import tax exemption or income or profit tax credits, investment tax credits for distribution infrastructure and R&D, grant or tax credits for equipment conversion or acquisition, rapid depreciation for commercial plant and distribution infrastructure and parking or road user charge exemption (IEA. 2010; Cooperation, A. P. E. 2009).

**GOVERNMENT / POLITICAL**

Renewable energy is providing a significant proportion of the world's primary energy. The European Union – EU '20:20:20 Directive' which was passed in 2009, sets a target for Europe to achieve by Year 2020, a 20 percentage contribution to gross final energy consumption for renewable sources.

Policy and measures that could promote RE are government facilitating use of NRET, information dissemination, public awareness campaign, voluntary agreements with OEMs to develop and market NRET equipment and direct RD&D funding for NRET (IEA. 2010; DECC. 2010; Boyle, G. 2012).

**ENVIRONMENTAL**

- New environmental regulations, social concerns and going environmental awareness throughout the world have triggered the search for new products and processes that are compatible with the environment.
- The principles guiding the development of next generation of products and processes are: sustainability, industry ecology, co-efficiency and green chemistry.
- Conservation of ecological footprint as it related to ultimate disposability
- Ensuring design of materials are biodegradable ad inappropriate disposal system in environmental and ecological manner. For instance, composting our biodegradable plastic and paper waste along with other 'organic' compostable materials such as yard, food and agricultural wastes. To generate carbon – rich compost – human material.
- Food waste and other bio wastes are separately collected and composted to generate a valuable soil amendment that goes back on farmland to reinitiate to carbon cycle
- Polymer materials to resist degradation. The challenge of polymer is designing polymer that have functionality during the use. The breakdown products should not be toxic or persist in the environment; should be collectively utilised by soil microorganisms with a defined time frame
- Ultimate degradability of materials in appropriate waste management infrastructures within reasonable time frames to ensure market acceptance.

**PROMOTING RENEWABLES THROUGH:**

- Publicity and education
- Supporting Research and Demand (R&D)
- Setting targets – For instance, 20% of EU's energy by 2020; 15% for UK by 2020
- Legislation and regulation
- Engineering recommendation covering connection of renewable electricity systems to grid
- Planning procedure
- UK Building Regulation – focus on energy conservation

- Financial incentives
- Capital grants
- Exemption from energy taxes
- Renewables obligation
- Renewables Energy Feed-In Tariff (REFIT)
- Renewable heat incentive (Gerlagh, R., & Van der Zwaan, B. 2003; Popp, D. 2006; Greaker, M., & Pade, L. L. 2008; Newell, R. G. 2009; Hall, B. H., & Helmers, C. 2010; Greaker, M., & Pade, L. L. 2008).

**POLICY JOURNEY: DYNAMIC ASPECTS OF DEPLOYMENT**

**Role of Research And Development (R&D)**

R&D is essential for the transformation of energy system and without RD&D; technological costs are unlikely to fall significantly. Further, policy aimed at stimulating energy technological innovation would fail if not for RD&D. For RD&D to perform effectively there is the need for public policies to allow the functioning of the market players.

The rationale for direct public support for low-carbon energy RD&D are threefold: basic research; applied research and experimental development. The fourth aspect is demonstration, which is the functional part of development of new technologies. OECD (2011) describes demonstration as the project that involves an innovation to be operated at or near the full scale in a realistic environment to support the policy and promote the use of innovation as well as how sustainable its application is.

To ensure good practice, the International Energy Agency (IEA), in its launch of a project known as Accelerated

**Energy Innovation (AEI), recommended six policy framework for energy technology RD&D:**

- Coherent energy RD&D strategy and priorities
- Adequate government RD&D funding and policy support
- Co-ordinated energy RD&D governance
- Strong collaborative approach, engaging industry through public private partnerships (PPPs)
- Effective RD&D monitoring and evaluation, and
- Strategic International Collaboration

**ROLE OF GOVERNMENT AND COMMUNITIES IN RENEWABLE ENERGY INITIATIVES**

Government has a key role to play in intervention in research development and demonstration (RD&D) especially in the restructuring of global RD&D efforts in both public and private sectors as well as targeted policies that would alleviate climate change, lead to technological advancement and reduction in cost.

Government enable the encouragement of energy technology innovation through technology push (implementation of necessary machineries in order to pair risk and benefits with the available benefits) and market pull (implementing measures to increase private pay-off and demand for low-carbon technology for successful innovation).

Governments also intervene in innovative process so as to speed-up the process beyond the market forces and catalyst early adoption. Commercialisation in technology tends to reduce the level of government involvement since the private sector takes more responsibilities in commercial deployment.

Policy makers have embraced the need policy instruments to be complemented with the market-pull policies in order to mobilise funds to support innovation and maximise the increasing private funds on RD&D.

## RECOMMENDATIONS

**The Policies And Measures To Promote E Wans Renewable Energy Are:**

- Overcoming barriers to renewable energy – Economic
- The Carbon Market – Clean Development Mechanism (CDM process and cost and benefits, and other funding)
- Promotional policies – to accelerate renewable energy markets
- Natural targets
- Mandated market policies (PURPA, RPS, and competitive bidding and concessions)
- Financial incentive policies (Grants, loans and loan guarantees, and tax credits)
- Market facilitation activities (Infrastructure support, public awareness, information and training, government procurement, public funds for market facilitation activities and public investment – system benefit charges)
- Institutional and financial tools
- Technical module (Small hydropower, wind, biomass, geothermal, solar and capital cost comparison)

## SUMMARY AND CONCLUSIONS

According to Muller *et al.,(2011)*, since renewables are critical in the delivery of carbon dioxide emission reduction, they are able to play vital role in the dealing with climate change; they are central elements of any energy system, both in interim and long run.

There is a growing need for renewable energy usage and the roles of institutions such as the government and RD&D are vital in developing and influencing policies and incentives that would shape its deployment.

However, various policies would need to be considered inorder to promote renewable (as well as new) energy vis-a-vis planning, technology, leagl or regulatuion, financial or economic, government or political and enviromental issues. It is also essential to adopt the policy framework recommended by practitionaers and institutions as good practice guidelines such as the the International Energy Agency (IEA).

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