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A Preliminary Model of Regulating Natural Capital Funds for Renewable Energy

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Abstract. Framing sustainable environmental laws in regulating Natural Capital funds for Renewable Energy (RE) is central to the discussion on sustainability strategies. Natural Capital is that limited form of capital assets or service (tangible or intangible) that satisfies basic and social conditions for human existence and protection. This paper proposes an analytical regulatory model utilizing Neural Network (NN) of substantive and procedural issues framing the regulatory parameters associated with Natural capital funding. The model recognizes the fact that the purpose of any legal system is not only to assign duties and responsibilities in protecting rights of individuals and groups in their respective endeavors; but for effective modelling of natural structures as well. Through a preliminarydiscussion of European and USA markets'; regulatory systems with a focus on market and social values, it attempts to discern a practical model to formulate social and regulatory measures on financial structures and energy matters that are considered rights and obligations of individuals and organizations in conducting their businesses. As it has been a subject of academic, government, and public discussions with intense controversies, finding the differences of methodological, and analytical foundation will most probably lead to deeper insight into regulating funds for renewable energy.
Keywords. Natural capital, Sustainable, Entrepreneurial collaboration, ISO, Climate change, Neural Network (NN).
JEL. N70, O13, Q40.

1. Introduction

The objective of this research is to establish a framework from which one may develop academic, commercial, environmental, Socially Responsible Investment (SRI) structures, and sustainable standards guidelines and opportunities for renewable energy industry. The research will draw on key parametersfrom the data in US and Europe.

Renewable energy investment has been of significant interest in the recent years. For example; that the growth of renewable energy related investment across one European country (i.e. Ireland) within the next ten years will rise by 60% (Haines-Young & Potschin, 2010). In USA Renewable energy (RE) has contributedto the economy and inclusive growth by:

- Encouraging the transfer of skills and technology from foreign investors.
- Bringing solar based electricity to rural and under-developed areas.
- Increasing women's economic empowerment.

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If the US is to ensure that this significant investment program delivers significant, measurable, long term economic, environmental and social benefits to all US stakeholders, there is urgent need to develop common rigorous social US compliant 'RE' standards to ensure, tangible delivery of benefits in consideration of the international regulatory standards (i.e. ISO).

This paper is intended to be a solid foundation from which a more comprehensive research plan will be developed. This foundational framework concentrates upon the key issues and identifies the unique internationally competitive opportunities that both Europe and US may implement and share in order to capitalize upon existing Intellectual Property value and other regional, commercial and natural capital assets, without increasing government sovereign debt / spending.

The key opportunity areas described within this paper are interrelated and interoperable. Each key area not only supports the development and funding of the other, but alsodelivers a financially innovative, competitive, and technically superior international offering to global Climate Change investment markets in the US. Moreover; the paper contributes to the internationalrenewable energy technical standards development and the significant research and development of defining the value of sovereign natural capital (MEA, 2005). Substantial added value is created by implementing those elements referred to in this paper. The author is aware that there are several stakeholders, who will need to be consulted, and some senior decision making stakeholders, corporates, local government, regional banks encouraged to cooperate and assist.

1.1. Background

The term 'capital' is generally used by economists to describe anything that has the capacity to generate goods and services that benefits people (see Figure 1). The emergence of the concept of natural capital in recent decades reflects the recognition that environmental systems play a fundamental role in determining economic output and human well-being providing resources and services, and absorbing emissions and wastes (EEA, 2013).

Natural capital is the most fundamental of the core forms of capital (i.e. manufactured, human, social and natural) since it provides the basic conditions for human existence. These conditions include fertile soil, multifunctional forests, productive land and seas, good quality freshwater and clean air. They also include services such as cross-fertilization, climate regulation and protection from natural disasters. Natural capital sets the environmental limits for our socio-economic systems; it is both limited and vulnerable (Sukhdev, 2011).

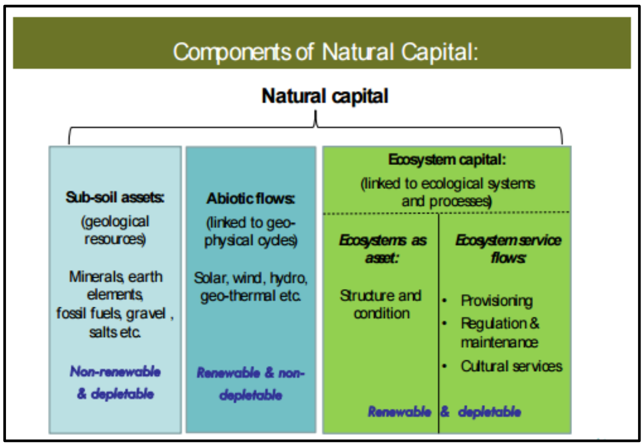

Figure 1. *Components of Natural Capital(EEA, 2013).*

1.2. Research Significance

Renewable energy (RE) is distinguished from other energy systems in that it emphasizes the economy as a subsystem of the global energy system, with its focus upon preserving natural capital (Haines-Young et al., 2012).

Natural Capital includes the flow of valuable energy goods or services into future investments. It is the extension of the economic notion of capital to goods and services relating to the natural environment. Sound ecosystem and biodiversity management, and the inclusion of natural capital in governmental and business accounting, can start to damage previous delay and reduce the cost of future budget. Natural resources are classified as economic assets. However, predictable measures of national economic performance and wealth, such as GDP and Standard National Accounts, fail to reflect the value of natural capital flow of different energy products. The development of alternate energy sources to replace high carbon fossil fuels causing the manmade contribution to accelerated Climate Change will depend upon the good management of existing natural capital resources (Haines-Young et al., 2012).

The development of the fourth generation approach to dealing with the man-made causes of Climate Change now includes accounting for - and dealing with - the pricing and valuation of natural capital. It also includes the valuation and pricing of urban sustainable development, along with significant changes in viewpoint regarding growing feedstock for renewable energy plant, and the need for substantial governmental subsidies to make alternate energy plant viable (Lavalle et al., 2011).

As has been witnessed across the first three decades of "sustainability" and the pricing of natural capital, the lack of commonly agreed definitions of sustainability standards, the value of common third party audited standards (i.e. ISO) has led to a failure to address the issues and opportunities presented by sustainable development, in favor of short term financial gain. In fact most existing "RE standards" are in violation of the world trade organizations rules regarding technical barriers to trade. This has seriously affected both the fight against the manmade causes of climate change and the trust of the private investor.

On the other hand; neural networks are revolutionizing virtually every aspect of financial and investment decision making. Financial firms worldwide are employing neural networks to tackle difficult tasks involving intuitive judgment, or requiring the detection of data patterns which evade conventional analytic techniques. Many observers believe neural networks will eventually outperform even the best traders and investors. With this vision in mind, Haines-Young & Potschim (2010) had developed forecasting software known as the Simulation Environment for Neural Networks. Maes et al. (2012) used artificial neural networks (i.e. computational models) that are similar to the ones in the human brain. These networks can be trained to recognize interrelationships among environmental and human social parameters so that they can make forecasts. The interesting thing about neural networks is that you don't have to fully analyze and understand a problem in order to make a forecast.

Neural networks are already being used to trade the securities markets, to forecast the economy and to analyze credit / investment risk. Indeed, apart from the UK department of defense, the financial services industry has invested more money in neural network research than any other industry or government body. Unlike other types of artificial intelligence, neural networks mimic to some extent the processing characteristics of the human brain. As a result, neural networks can draw conclusions from incomplete RE data, recognize patterns as they unfold in real time and forecast the future. Neural Finance technologies are especially useful within the emerging environmental RE investment markets, and more specifically, the effective pricing of natural capital.

Pricing of natural capital is challenging: for example, the water of the Nile River in Africa is to be shared among nine countries but how do you determine the value of each share to each country with this limited water source? Sovereign natural capital assets are important to accurately evaluate, especially as a large proportion of these assets are within emerging economies. When dealing with massive data sets, it is important how the data is quantified at both the regional level and the global level. Analysis has, previously, concentrated upon the metrics involved in defining environmental risk on a limited number of levels. Lavelle et al. (2011) began researching the development of quantatively based solar investment risk metrics ten years ago, and more recently in partnership with the leading professors of economics and neural finance research based at North Carolina University School of Business (MEA, 2005).

Because neural network don't use analytical relationships but instead learns to recognize interrelationships from the behavior of all parameters, its forecasts already encompass the interdependencies. One of the ways in which theauthor used Haines-Young & Potschim (2010) software is to determine the price of solar based electricity from a wide variety of interacting parameters, such as the development of the price of electricity and other raw materials, the development of demand, and the cost of CO_2 emission permits, and other social / political limitations. In other words; Renewable Energy Neural Network (RENN) used in this paper's modelling approach makes it unique.

2. Statement of the Problem

When researching and developing the various guidelines and initiatives contained within this paper, author is aware of a number of potential problems which could prevent such initiatives being achieved. These problems relate to the historic business culture and ability of key decision makers to make early decisions and embrace change. As is with most emerging industries, the negative influences of the previous US administrations and the political history of US/Europehad its impact on the entrepreneurial collaboration efforts between both countries; i.e. trade limitations, financing structures, political and academic decision makers (TEEB, 2010). This potential problem must be addressed before any other issues.

In instances where words such as "entrepreneurial" and "innovation" are used in communications and reports, there may be little understanding as to the real meaning of these terms from the perspective of both countries. Both words are commonly used to describe simple changes in customary practice rather than their true meaning, that is to guide and influence a real change Haines-Young & Potschim (2010).

While there is no critical shortage of funding for genuine, well researched and planned emerging RE investment initiatives, the financial crisis and the failure of some earlier large scale emerging economy initiatives have rightly caused some funders to become more demanding and cautious. The strategic initiatives and guidelines described in this paper fulfil the requirements of most large scale International funder's, but without the ability to clearly demonstrate a high probability of success via an inclusive, dynamic cohesive partnership of all interests at US / Europe, track records of successful case studies. Exterior non-profit funding will be difficult to obtain.

Private-Public partnerships are often mentioned within emerging RE investments with a view to gaining both finance and skill improvements. However, these partnerships are often one-sided, in that the private sector input is short term and/or based upon unequal financial terms. In this paper, we seek to demonstrate that in the case of US there is real value attached to any inward investment, and in fact, US offers a wide set of very attractive and unique opportunities not found elsewhere. These important factors are clearly demonstrated here.

3. Modeling Approach

3.1. Model Overview

Renewable Energy Sustainable development has been defined in many ways, but the most frequently quoted definition is from our common future, also brought up in the Haines Report (Haines-Young & Potschim, 2010). A Sustainable RE model is that which meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: 1) the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and 2) the idea of limitations imposed by the state/ social organizations on the environment's ability to meet present and future need.

All approachesfor a sustainable RE model requires that we see the world as a system that connects subsystems; and a system that connects time based events. When you think of the world as a global system over smaller systems, you grow to understand that air pollution from North America affects air quality in Asia, and that pesticides sprayed in Argentina could harm fish stocks off the coast of Australia. And you start to realize that the decisions our grandparents made about how to farm the land continue to affect agricultural practice today; and the economic policies we endorse today for the renewable energy industry will have an impact on urban poverty when our children are adults.

The recent shift in the US policy framework to a more systemic perspective on natural capital marks an important step towards the implementation of integrated management approaches. There are many synergies and co-benefits to a more integrated approach. Action to mitigate and adapt to climate change will increase the resilience of the US economy and society while stimulating sustainable innovation and optimize the responsible use of natural resources. However, there are also trade-offs that need to be made explicit as there are costs involved always (either to energy systems or to people) with any particular course of action or policy undertaken (Berman & Bui, 2001).

3.2. Funding model

While renewable energy standards have thrived globally over the past decades, the general trend is that, so far, the costs of complying with environmental regulations represent arelatively small share of production value for most disciplines. A survey by Lavelle et al. (2011) foundthat the proportion of manufacturing capital expenditure assigned to pollution decrease in 2005 ranged between 1% and 5% in Europe (Bartik, 2013).

However, a number of studies found that productivity is either unaffected or slightly enhanced byenvironmental regulation. For example, Sukhdev (2011) reported that refineries located inthe Los Angeles (South Coast) Air Basin area enjoyed significantly higher productivity than otherrefineries in the USA despite the more rigorous air pollution regulation in Los Angeles (MEA, 2005).

It is time to introduce the term RE (total), which represents intangible / natural production inputs into an economy, such as gainsin efficiency, and technological innovation that allow additional utility to be extracted from the natural resource. Many argued that the funding model, or the ability to leverage existing natural; resources, is one reason why humans arenot limited to the same degree as other species by the carrying capacity of natural resources. The equationbelow is our contribution to artificially optimize the funding model as shown in equation (1) below:

$$\mathbf{RE}\,(\mathbf{total}) = \mathbf{K}^{\boldsymbol{\alpha}} \times \mathbf{L}^{\boldsymbol{\beta}} + \mathbf{RENN} \quad (1)$$

Where;

RE (total): *is the output function (energy units/year)*

K: *natural capital input (capital-hours/year)*

L: *total-factor productivity (man-hours/year)*

α& β: pure numbers due to being exponents (their values depend on the RE resource geographic area

RENN (Renewal Energy Neural Network) component; which is calculated as follows:

$$\boldsymbol{RENN = f\,(\textstyle\sum_{j=1}^{n} XjWij)} \quad (2)$$

A typical Renewable Energy Neural Network (RENN) has an input, a hiddenand an output layer (Mellit et al., 2005). Each component includes a parameter (called neuron), weightsand a transfer function. An input $\boldsymbol{Xj}$ is transmitted through aconnection which multiplies its strength by a weight $\boldsymbol{Wij}$ to give a product $\boldsymbol{XjWij}$. The product is an argument to a transfer function $\boldsymbol{f}$ which yields RENN output represented by (equation 2) above.

Where i is social index in the hidden layer and j is an index ofan input to the neural network. Using artificial neural network as an estimation tool has provedits efficiency in predicting different parameters via otherparameters that their relationship is not specified. So applyingartificial neural networks can be valuable in prediction of solarpower.

RENN is Renewable Energy Neural Network computational componentthat is inspired by the structure and functional aspects of social neural networks. It consists of an interconnectedgroup of artificial parameters, and it processes information using aconnectionist approach to computation. In most cases, RENN is an adaptive system that usually changes its structure based onexternal or internal information that flows through the social networkduring the learning phase.

The model was trained using trainlm (Levalle et al., 2011) training algorithm with the help of MATLAB'sNeural Network Training tool. Training is the process of modifying the connection weights in some orderly fashion using a suitable learning method. Using artificial neural network as an estimation tool has proved its efficiency in predicting different parameters via other parameters that their relationship is not specified. So applying artificial neural networks can be valuable in the prediction of solar power.

After that, each network wassimulated and their performance was observed. Mean SquareError (MSE) performance measure function was employed (equation 3).

$$MSE = \frac{1}{N}\sum_{i=1}^{N}[L\ actual\ (n) - L\ predicted\ (n)]^2 \quad (3)$$

And the two inputs respective shares of output (α and β) are the capital input share of contribution for K and L respectively). An increase in either RENN, K, or L will lead to an increase in output 'RE (total)'. While capital and labor input are tangible, RE (total) is intangible, as it can range from technology (i.e. Solar or wind) to increases in knowledge and human capital. The meteorological data that have been used in this work are the solar power (Watt/$\boldsymbol{m^2}$), relative humidity (%), wind speed (m/s), wind direction, and precipitation (mm). These data were collected from different US locations (MEA, 2005).

4. Conclusion & Future Remarks

Modeling an assessment of Natural Capital fund to regulate Renewable Energy (NCRE) is a resource intensive task. To guarantee thequality and acceptability of the proposed model, independent scientists will need to be involved in the process.

Rather than working with a single entity / regulatory body at the national or international level (i.e. ISO: International Organization for Standardization) this could be done by working with scientificsocieties and research networks. For instance, the involvement of independent research group at the academic institution level could serve to fame the guidelines and implementation of the futuremodel inrelation to the existing and shared knowledge base policies. The US will have a key role in mobilizingand involving scientific expertise in the NCRE work nationally and internationally. As several examples, including the UKNEA (National Ecosystem Assessment of the United Kingdom (Maes et al. 2012) have shown that there is an enormous potential for entrepreneurial collaboration in this field.As renewable energy is a booming sector in the US andmassive investments are ongoing, our research will optimize theefficiency of the generation process. Obtained results indicate that establishingregional hub or sub-grid will be much more appropriate forharnessing most of the investment.

There is diversity ofapproaches and activities between US and Europe. We need shared and consistent methods applied to a limited set of energy products/services allowing for cross-comparison and provision of guidance based on pitfalls/best practices from recent reports and case studies published.

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