Development of a GIS base Model in identifying Potential Locations for Wind Power in Sri Lanka.

By

K.H.H.D Karunarathna

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DECLARATION OF THE CANDIDATE

I do hereby declare that work described in this thesis was carried out by me under the supervision of Dr. Sunil Rajanetti and Mr.H.M Prabath Jayantha, and report on this thesis has not been submitted in whole or in part to any University or any other institution for another Degree/Diploma.

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K.H.H.D Karunarathna
No 3/5, Dudley Senanayake Mawatha,
Bangalawatta, Ambepussa,
Warakapola (71600)

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ABSTRACT

Sri Lanka is one of the most economical hum of the South Asia like Singapore. Installed capacity of the country has 4050MW, 900MW generated from coal, 1335MW generated from fuel, 1375MW hydro and 442MW from non-conventional renewable energy such as hydro, wind, Solar, biomass, the annual total electricity demand around 10,500GWh comprising of 38% from domestic consumers, 39% from industries and 20% from commercial enterprises. Wind energy is one of the most important renewable energy sources in Sri Lanka. However, a further diffusion of wind farms involves strong spatial implications that refer to various adverse effects. Negative environmental impacts caused by the sometimes suboptimal site of wind farms have induced an increasing gap between the social acceptance of this technology on the global and local levels. Particularly on the local level, sitting processes of wind farm projects often trigger public protest. The aim of this research is to improve the site assessment by providing a holistic multi-criteria decision making approach that incorporates ArcGIS and WAsP software, which are defined minimizing the time wast. We apply a GIS-based Spatial Analytic Hierarchy Process approach (SAHP), the results obtained indicate around 20% of the study area is still available for wind energy development, whereas only 9% of the region is characterized by high suitability. In particular, Jaffna district and Seetha Eliya results obtained indicate around 9% available of the wind and 1% of the region is cauterized wind energy development because of the terrain effect cannot unexploited wind energy potential. A comparison with the location of existing wind farms and a sensitivity analysis validate the reliability and accuracy of the model results with the WAsP wind modeling software

Keywords: Wind farm site, Multi-criteria decision making, WAsP modeling map

Chapter One

INTRODUCTION

1.1 Background

A traditional basic need by the human nature list by the food, water, and cloths, at presently world scenario listed energy is the top of human basic need, because of the increasing population density in the world changed by the traditional way. Basically world energy demand increasing day-by-day and mainly world energy demand achieve by the fossil fuel, last two decades burning fossil fuel directly affected by the environment. Greenhouse-gas emissions from earth, energy sector represent roughly two-thirds of all anthropogenic greenhouse-gas emissions and CO2 emissions (*world energy outlook special report-2015*).

Reducing CO_2 from burning fossil fuel for achieving primary energy, human nature identified as renewable energy is the one of better solution in past 20years. At the present scenario renewable energy continued to grow against the backdrop of increasing global energy consumption and a dramatic decline in oil prices during the second half of the year. Today global final energy consumption has increased by about 1.5% annually in recent years, driven primarily by rising demand in developing countries and despite rising energy use, for the first time in four decades, global carbon emissions associated with energy consumption remained stable, while the global economy grew. Several countries including China, Mexico, and the United States including the European Union have announced climate change commitments that set the stage for future investment in renewable and energy efficiency.

There is rising awareness worldwide that renewable energy and energy efficiency are critical not only for addressing climate change, but also for creating new economic opportunities, and for providing energy access to the billions of people still living without modern energy services(*world Energy output-2014*).

In recognition of the importance of renewable energy and energy efficiency for sustainable development, the United Nations General Assembly declared 2014 the first year of a Decade of Sustainable Energy.

1.1.1 Renewable Energy

Renewable energy is generally defined as energy that is collected from resources which are naturally replenished on a human timescale, such as water, sunlight, wind, rain, tides, waves, and geothermal heat. Most of the countries aim to double the share of renewable energy in the global energy mix from a baseline share of 18% in 2010 to 36% in 2030. By 2013, renewable energy provided an estimated 19.1% of global final energy consumption. Of this total share, traditional biomass, used primarily for cooking and heating in remote and rural areas of developing countries, accounted for about 9%, and modern renewable increased their share slightly over 2012 to approximately 10.1%. Modern renewable energy is being used increasingly in four distinct markets: power generation, heating and cooling, transport, and rural (off-grid) energy services.

Although many renewable energy technologies have experienced rapid expansion, growth in capacity and improvements in energy efficiency are below the rates necessary to achieve the Sustainable Energy for all goals. In further, the bulk of new capacity and investment has centered on just three technologies: solar PV, wind, and hydropower.

1.1.2 Wind Power as a Renewable Energy Source

Wind power is the use of air flow through wind turbines to mechanically power generators for electricity. Wind power, as an alternative to burning fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, and uses little land. The net effects on the environment are far less problematic than those of non renewable power sources.

Wind farms consist of many individual wind turbines which are connected to the electric power transmission network. There are two categories in wind farms

- ✓ On Shore wind farms
- ✓ Off shore wind farms

Onshore wind is an inexpensive source of electricity, competitive with or in many places cheaper than coal or gas plants. Offshore wind is steadier and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electricity to isolated off-grid locations.

1.1.3 Energy Sector in Sri Lanka

The total energy requirement of the country was around 11,125 toe in 2013, and the primary energy supply mainly consisted of 4,814 toe of biomass, 4,582 toe of fossil fuels, and 1,442 toe of hydro. Accordingly, 56% of total energy consumption is from indigenous (biomass + hydro), and Sri Lanka has to import fossil fuels to meet the balance. This requires importing 02 MMT of crude oil, 04 MMT of refined petroleum products and 2.25 MMT of coal to the country annually, costing approximately USD 5 billion in foreign exchange. The average annual total bill of imported fossil fuel is therefore 25% of our import expenditure, and nearly 50% of total export income.

The power and energy sector has a huge bearing on the country's balance of trade and exchange rates. Sri Lanka has already achieved a grid connectivity of 98%, which is commendable by South Asian standards. Sri Lanka energy highlights can be shown as follows

Table: 1.1 Total Generation Scenario in Sri Lanka

Description	Installed Capacity in National Grid
Installed Capacity	4,050 MW
Hydro	1,375 MW
Thermal - Oil	1,335 MW
Thermal – Coal	900 MW
NCRE	442 MW
Generation	
Major Hydro	40%
Thermal	51%
NCRE	9%
Electrification Level	**98%**
Grid Connected	96%
Off-Grid	2%

Source: Sri Lanka Energy sector Development Plan 2015-2025

Current total installed power generation capacity of the country is approximately 4,050 MW, consisting of 900 MW of coal power, 1,335 MW of oil burning thermal power, 1,375 MW of hydro power and 442 MW of non-conventional renewable energy sources such as wind, mini hydro, biomass and solar power plants.