Renewable Energy Resource Development Plan 2021-2026

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EXECUTIVE SUMMARY

This report provides the prioritization of large-scale renewable energy development projects, and the planned projects for the upcoming periods, based on resource maps of the particular energy sources. In view of the key necessities for renewable energy development are transmission infrastructure and land availability for the projects to be opened up for the private sector for implementation, the development plan has been prepared considering these two major aspects. Accordingly, potential sites of different types of renewable energy resources - wind, solar and biomass have been identified, and taken for prioritization for future development. Prioritization has been done based on the criteria including resource potential, land use, distance to roads, slope, distance to grid substations(GSS), urban centers, exclusionary conservation areas, etc. Developable project site maps are shown in the above category of resources.

Prioritization of sites for wind and solar power development has been done by combining different geospatial layers using the weighted overlay method in ArcGIS. Weights were assigned to each layer to reflect the relative importance of each criterion in prioritization of the sites. Since the model considers different aspects such as economic and technical factors, with the goal of achieving maximum power while minimizing the project cost, weighted overlay model was used to weigh the criteria and identify potential sites. Resource potential was rated as the most important criterion; access to GSS was not considered as a criterion for wind and solar plants above 100MW. For the are as selected following the above screening, the expected annual energy yield of each plot was calculated.

In the renewable energy harnessing, final selection of the sites needs to be done in an optimal combination of transmission capacity utilization and harnessing the resource potential. This has been particularly applied by the CEB and SLSEA in the finalization of the sites, and will be further addressed in the amalgamation of renewable energy development sites into the transmission development plan of the CEB in the future stages.

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1. Background

Sri Lanka's position as a tropical country, has led to the presence of high renewable energy resource potentials. Solar, wind, biomass and hydro are the proven resources being commercially developed at present. Renewable energy resources are a type of natural resources owned by the public, and any development of the particular resource needs to be done in order to meet the needs of the public. With the establishment of Sri Lanka Sustainable Energy Authority (SLSEA) through Act No. 35 2007, SLSEA becomes the custodian of the renewable energy resources, and thus SLSEA is the focal national entity for implementing renewable energy development programmes in the country.

Any interested party can join the renewable energy development process by obtaining Energy Permits issued by SLSEA. It is a pre-requisite for entering into a Power Purchase Agreement with the Ceylon Electricity Board (CEB), pertinent to renewable energy projects. The initial phase of renewable energy development was on Feed-in Tariff, where solar, wind, biomass and hydro power projects upto 10 MW capacity have been implemented under Standard Power Purchase Agreements (SPPAs) entered into under the Feed-in Tariffs, which have been connected to the national electricity grid at medium voltage (33 kV) level. As the next phase of renewable energy development, projects are being entertained through competitive bidding process. At the initial phase of competitive bidding process, medium voltage level projects upto 10 MW have been developed through open tenders floated by the CEB. Apart from this, solar rooftop systems are being implemented, which are connected to the national electricity grid at low voltage (400 V) level.

2. Introduction

With the background of different renewable energy project implementation phases that have been introduced so far, Renewable Energy Resource Development Plan mainly focuses on projects that will be connected to the national electricity grid at high voltage (132 kV) level. These projects will mainly be referred to as energy parks, which will be preferably in the capacity range of 100 MW. Nevertheless, in view of optimally utilizing the renewable energy resources, land resources and renewable energy absorption capacities in the transmission grid, projects at different scales will also be taken into consideration under this plan. Accordingly, Renewable Energy Resource Development Plan will spell out sites available for medium or large scale solar, wind and biomass project development, supplying electricity at either medium or high voltage levels, and will put them into a priority order for the implementation in the designated time horizon. The other proven type of resource - hydro, does not have that type of generic development constraints, and it needs site specific environment assessments only. Therefore, hydro resource is not taken for detailed analysis in this report, and formal facilitation will be provided to the developers in the hydro power development process.

In the process of developing renewable energy, resource assessment and resource maps provide baseline information on the availability of resources. In connection to the solar and biomass resources, National Solar Resource Atlas and the National Biomass Atlas have been compiled by SLSEA, and those were used for the solar resource information and biomass resource information. In the case of wind, long-term wind resource assessment has been carried out using National Wind Reference Mast (NWRM) network, encompassing 10 locations with high wind resource potentials. These locations have been identified in accordance with the wind resource map generated by the National Renewable Energy Laboratory (NREL). However, Global Wind Resource Atlas (GWA 3.0), a web based application

developed by Technical University of Denmark and the World Bank Group was used to depict the island-wide wind resource potential, because it gives resource details at a higher elevation than the earlier. In view of the necessity of having comprehensive wind measurements for project implementation, those areas where long-term wind speed measurements are available were considered in prioritizing lands for wind power development.

In an effort to plan out a renewable energy resource development programme for the country, it necessitates that the sites extracted from the resource maps are screened considering different development constraints, and then the sites are taken for development in an order of priority. Therefore, through this Renewable Energy Resource Development Plan, it is objected at prioritizing the renewable energy development sites in the country in order to come up with a development plan for the future. Taking these requirements into account, Renewable Energy Resource Development Plan (the Plan)is published aligning with the statutory requirement coming under Section 8 of the Sri Lanka Sustainable Energy Authority Act. It makes provision for reviewing and updating the Plan once in every 3 years, and therefore SLSEA would mostly welcome suggestions for improvement from the readership, which will extensively help SLSEA in compiling the future versions.

In consideration of the fact that there are various aspects needed to be considered in the process of renewable energy development, it is identified to be a dynamic process, and therefore planning for long time horizons is not expected. As the Plan is going to be reviewed in each 3-year period, consideration of only a reasonable time frame beyond the review period was considered to be included in the plan. Accordingly, the time horizon of this plan is a period of 6 years.

3. Scope

In the compilation of this publication on Renewable Energy Resource Development Plan, large-scale renewable energy development is focused in a broad national perspective in context of the prevailing project development methodologies. Accordingly, following are presented through this.

(i) Renewable Energy Resource Maps

All the renewable energy development activities are implemented based on the resources identified and mapped. Renewable energy resource maps are available for 5 resources: solar, wind, biomass, hydro and wave energy, and those are presented through the report.

(ii) Renewable Energy Resource Harnessing Potentials

Renewable energy resource harnessing potentials of the major renewable energy resources - solar, wind, biomass, hydro are presented.

(iii) Plan for renewable energy park development for the period 2021-2026

Renewable energy sites selected from the prioritized sites to be made ready for tendering by end 2026 are presented.

4. Data & Information

The input data required for compiling this publication were mainly different land-use layer maps and renewable energy resource maps. **Table 4.1** shows the data sources and file formats used under different criteria considered in the process.

Table 4.1:Sources of data

No.	Description	Format	Data Source
1	Scrub lands	Shape file	Survey Department, 2019
2	Grass lands	Shape file	Survey Department, 2019
3	Barren lands	Shape file	Survey Department, 2019
4	Sparsely used croplands	Shape file	Survey Department, 2019
5	Open forests	Shape file	Survey Department, 2019
6	Sand areas	Shape file	Survey Department, 2019
7	Homesteads	Shape file	Survey Department, 2019
8	Forest reservation areas	Shape file	Survey Department, 2019
9	Wildlife reservation areas	Shape file	Survey Department, 2019
10	Archeology sites	KML file	Department of Archeology
11	Coastal conservation areas	Shape file	Department of Coastal Conservation
12	Distance to roads	Shape file	Survey Department, 2019
13	Urban centers	Shape file	Urban Development Authority
14	Housing density	Shape file	Survey Department, 2019
15	Transmission lines	KML file	Ceylon Electricity Board
16	Distance from aviation ports	Shape file	Sri Lanka National Spatial Data Infrastructure www.nsdi.gov.lk
17	Wind speed	Shape file	Global Wind Atlas data
18	Global Horizontal Irradiation	Shape file	Solar Resource Atlas of Sri Lanka, 2014
19	Biomass Density	Shape file	Biomass Resource Atlas of Sri Lanka, 2019
20	Plant Factor for wind	Shape file	Global Wind Atlas data
21	Solar PV Electric Potential	Shape file	Solar Resource Atlas of Sri Lanka, 2014

5. Methodology

Since Sri Lanka is a country with limited land resources also with vivid bio diversity, one of the major challenges for renewable energy development is to identify the areas with high suitability for locating renewable energy power plants. In the past few decades, Geographic Information Systems (GIS) have been widely used to assist in searching suitable sites for renewable energy development. GIS provides the functionalities of integrating a large spectrum of geospatial information into the decision-making process. Several criteria were selected based on literature review and the institutional experience, and weighted overlay analysis in GIS was used to determine the potential locations. Figure 5.1 shows the basic steps followed in the land identification process.

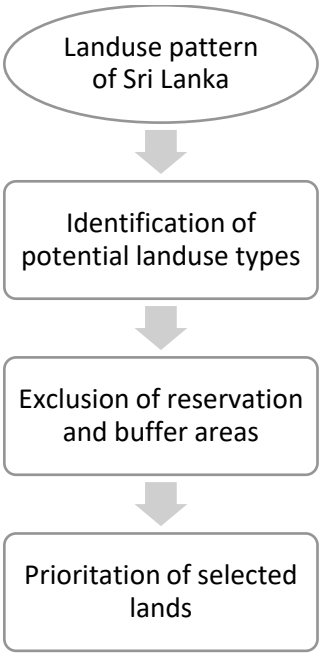


Figure 5.1: Land identification process

The criteria chosen for modeling the suitability of renewable energy power plant location were resource potential, land use, distance to roads, slope, distance to grid substations (GSS), urban centers and exclusionary areas (*i.e*., areas of forest and wildlife reservations, archeological reservations, coastal conservation areas, urban centers, airports and roads). The criteria selection was started with a comprehensive literature review, and it was narrowed down to those criteria deemed as relevant and critical for the suitability of renewable energy development. All the layers were projected into UTM WGS 84 and converted into raster data-structure. All of the raster datasets were re-sampled to a common cell size (10 m).

5.1 **Identification of Potential Land-use Types**

One of the key data layers used in developing the geospatial model to generate the Plan is the digitized land use layer of Sri Lanka in 1:50,000 scale, published by the Survey Department in 2019.The land use data layer is a shape file, which consists of 342,639 polygon features, each representing a specific land use category. The image of the land use layer is presented in Annex 1.

Table 5.1gives all the land use classes available in Sri Lanka. Each land use was firstly screened, either 'to be considered' or 'not to be considered' as a potential land for wind, biomass or solar power development. Scrub lands, barren lands and sand areas are the general types of lands considered in all the districts. Barren lands are those ecosystems, in which less than one third of the area has vegetation or other cover. In general, barren lands have thin soil, sand or rocks. Barren lands include deserts, dry salt flats, beaches, sand dunes, exposed rock, strip mines, quarries and gravel pits. Scrublands are the areas, which are covered with low trees and bushes.Cultivation areas, built-up areas, rock areas, all water bodies were not considered. Reservoirs were considered for floating solar power projects under the potential sites for solar power development. However, land-use type represented as 'water areas' was not considered in the model, as the purpose of the model is to prioritize lands. The lands for biomass considered here are the lands available for dedicated energy plantations. Therefore, homesteads, plantations and agriculture crops were not considered in the model. However, in view of the possibility of using off-cuts from pruning and residues derived from agricultural crops and plantations, the presence of homesteads, agriculture crops and plantations were recognized as sources of biomass, and it was considered in developing Biomass Atlas. Nevertheless, sparsely used croplands, homesteads, palmyrah, coconut and sand areas for Northern Province and open forest for the whole country were considered only, in recognition of the distinct nature of wind resources available in the particular area. The maps of selected land-use types are illustrated in Annex 2 and Annex 3.

The most favoured area for wind and solar power development out of the above categories is sand areas where no vegetation cover exists and the commercial values of the lands are less. Accordingly, the highest sand area is represented in the Jaffna district, which amounts to 5,992ha. The second highest sand area is in the Kilinochchi district, with an extent of 2,504 ha. Hambantota and Ampara possess 1,555 ha and 1,285 ha respectively. Overall, the district with the highest total amount of land available is Monaragala, with 350,296 ha. The second highest is the Badulla district, which has 258,045 ha. Anuradhapura district has 189,118 ha, and the Ampara district has 168,071 ha.

Table 5.1: Land use types

Landuse Category	CODE	Description	Consideration	
			Wind	Solar/Biomass
1-Cultivation area	CCNTA	Coconut	Considered	Not considered
	CNMNA	Cinnamon	Not considered	Not considered
	CSHWA	Cashew	Not considered	Not considered
	CTNLA	Citronella	Not considered	Not considered
	OLPMA	Oil Palm	Not considered	Not considered
	OTHRA	Other cultivation	Not considered	Not considered
	PDDYA	Paddy (P)	Not considered	Not considered
	PDYAA	Paddy – abandoned	Not considered	Not considered
	RBBRA	Rubber	Not considered	Not considered
	SGCNA	Sugarcane	Not considered	Not considered
	TEAA	Tea (T)	Not considered	Not considered
	UNCLA	Unclassified	Not considered	Not considered
	CHENA	Chena	Not considered	Not considered
	MIXDA	Mixed tree and other perennial crops	Not considered	Not considered
	SPRSA	Sparsely used crop land	Considered	Not considered
2-Forest area	FRSDA	Dense Forest	Not considered	Not considered
	FRSOA	Open Forest	Considered	Not considered
	FRSPA	Forest Plantation	Not considered	Not considered
	FRSUA	Forest-Unclassified (F)	Not considered	Not considered
	UNCLA	Unclassified	Not considered	Not considered
3- Boggy area	MNGRA	Mangrove	Not considered	Not considered
	MRSHA	Marsh	Not Considered	Not Considered
	SWMPA	Swamp	Not considered	Not considered
	UNCLA	Unclassified	Not considered	Not considered
4- Bare area	CLPTA	Clay Pit	Not considered	Not considered
	GRSLA	Grassland	Considered	Not Considered
	GRVPA	Gravel Pit	Not considered	Not considered
	NLNDA	Associated non-agricultural land	Not considered	Not considered
	SCRBA	Scrub land	Considered	Considered
	UNCLA	Unclassified	Not considered	Not considered
	BRRNA	Barren land (BL)	Considered	Considered
5-Rock area	DSTSA	Distorted surface	Not considered	Not considered
	QRRYA	Quarry	Not considered	Not considered
	ROCKA	Rock (RK)	Not considered	Not considered
	UNCLA	Unclassified	Not considered	Not considered
6-Built-up area	AGRCA	Agricultural farms	Not considered	Not considered
	AQTCA	Aquatic farms	Not considered	Not considered
	BLTPA	Built-up area	Not considered	Not considered
	CMTYA	Cemetery	Not considered	Not considered
	HOMSA	Homesteads/Garden(G)	Not considered	Not considered
	LVSTA	Livestock farms	Not considered	Not considered
	PARKA	Park	Not considered	Not considered
	PLGDA	Playground	Not considered	Not considered
	RSRVA	Reservation	Not considered	Not considered
	UNCLA	Unclassified	Not considered	Not considered
7- Sand area	SANDA	Sand	Considered	Considered
8-Water area		All waters area	Not considered	Not considered

5.2 **Exclusion of Reservation Areas and Buffer Areas**

5.2.1 Forest, Wildlife reservation and Archeology sites

Forest and wildlife reservation areas and archeological sites are considered as restricted areas, and cannot be used for renewable energy development. The forest reservation layer and the wildlife reservation layer consist of 752 and 292 polygon features with 1,145,875 ha and 876,444 ha respectively.

The Department of Archeology has introduced 1690 placemarks as archeological sites except in Puttalam and Hambantota districts. In addition to that, 164 polygon features of 4333 ha have been declared as archeological sites in Anuradhapura and Polonnaruwa districts.

Further, a buffer zone of 1.6 km for wildlife and forest reservations and a 375 m buffer zone for archeological sites were set.

5.2.2 Coastal Conservation Areas

A setback area which is a geographical strip or band within the coastal zone of the country has been published by the Coast Conservation and Coastal Resource Management Department.

Table 5.2: Proposed setback distance

District	Proposed setback (m)
Jaffna	125
Kilinochchi	300
Mullaitivu	110
Mannar	125
Puttalam	300
Gampaha	45
Colombo	50
Kaluthara	50
Galle	45
Matara	40
Hambantota	300
Ampara	125
Batticaloa	125
Trincomalee	125

In connection to the above, a buffer of 1 km was considered only for solar power development. However, a buffer area was not considered for wind power development, and clearance from Coast Conservation and Coastal Resource Management Department will be sought before plant installation.

5.2.3 Road Network

Wind turbines should have a distance of at least 100 m from roads according to the international standards. Further, a buffer area of 250 m from roads was introduced for solar power. In addition, railroads were given a buffer of 40 m for all renewable energy types. Further, in locating suitable sites for renewable energy project development, accessibility is required for transportation of equipment, and therefore distances of 500 m were assigned as buffers to give weights to access to the major roads and secondary roads. Distances above 2,000 m were considered not suitable for project development. However, road accessibility is not a critical factor for plant sizes above 100MW since access roads could be constructed under particular project.

5.2.4 Water Bodies

Buffer zones have been declared by the government for all water bodies such as rivers, streams, tanks, etc. and those are restricted for any type of construction. A 40m buffer was set for all the water bodies for any type of renewable energy development.

5.2.5 Urban Centers and Areas Declared by Urban Development Authority

Since urban centers are highly populated, renewable energy development is not allowed. Urban Development Authority has declared areas for future developments. Therefore, those areas were excluded. Further, a buffer zone of 1 km was considered for security and noise effect. Scoring was introduced such that scores will increase as the distance from urban areas increases.

5.2.6 Buildings

Due to the various unfavorable environmental and social impacts on the populated centers, distance from residential areas was considered as one of the important criteria. In addition, commercial values of lands near urban centres are trending high. Further, shadow effects have to be eliminated as much as possible for solar power plants. So, in consideration of these attributes, building density was considered as a criterion in the prioritization. However, noise effect of wind power plants should be specifically considered in the feasibility study since isolated buildings could be within the development areas.

5.2.7 Distance from Aviation Ports

According to the international standards, a 15 km buffer layer should be given for international airports and a 10km buffer layer should be given for local airports in wind power development, and a 2km buffer should be given in solar power development.

Table 5.3: Summary of buffers

Criterion	Buffer	
	Wind	**Solar**
Forest, wildlife reservation	1,600 m	1,600 m
Archaeology sites	375m	375 m
Coastal conservation areas	0	1,000 m
Road Networks	100 m	250 m
Railways	40 m	40 m
Urban centres	1,000 m	1,000 m
Water bodies	40 m	40 m
Airports		
International	15,000 m	2,000 m
Domestic	10,000 m	2,000 m

All the reservations and buffer areas were excluded from the selected land-use layers, and the potential lands for wind, biomass and solar power development were identified accordingly. The maps attached from Annex 4 to Annex 12 illustrate the reservations and buffer areas excluded. In case where a large number of land plots are available with the demarcation among them by relatively small exclusive areas, the candidate plots for selection was considered on aggregate basis since many of small size single land plots cannot be developed as single sites.

5.3 Power Plant Capacities and Annual Energy Yields

The areas selected from the above screening process were analyzed through GIS for obtaining prospective power plant capacities and the expected annual energy yield of each plot. Following design capacities were used in the capacity calculation.

- Design capacity for wind power plants – 0.08 MW/ha
- Design capacity for solar power plants – 0.5 MW/ha

Note:

- In design capacity for wind, bulk land area requirements have been considered, where it is not the direct foot-print value, and the foot-print value will come out in micro-siting.

In calculating the annual energy yields expected from wind power plants, plant factors were considered in accordance with the Global Wind Atlas for International Electro-technical Commission (IEC) Class II turbines at 100 m hub height. Plant factors for solar power plants were considered in accordance with the Solar PV Electric Potential given in Solar Resource Atlas of Sri Lanka.

5.4 Prioritization (Weighted Overlay Model)

The selected land plots were screened at first based on the resource availability since it is the crucial factor in determining the most suitable lands for development. Accordingly, the areas above 1,766 kWh/m^2 of GHI for solar resource and 7 m/s of wind speed for wind resource were considered. The Figure 6.1 depicts the spatial distribution of GHI in Sri Lanka and Figure 6.2 depicts the spatial distribution of wind speeds in Sri Lanka.

Then the land plots for wind power development were screened based on the slope of the land. For the reason that the lands with high gradients are not suitable for wind power development since high turbulence and high loads on wind blades affecting the performance of the wind turbines, the potential lands above 30% of slope have been excluded. Further, the land plots in the lowlands, i.e. elevations from sea level only upto 270 m elevation were considered taking into account the complex wind pattern in the central highlands and logistic issues arisen in installation of plants in high terrain [1].

Out of the 3 resource types in concern, the first priority was given to wind power development, and therefore those lands earmarked for wind power development were excluded from the potential lands for biomass and solar power development. Then, the areas in the DSDs that high volumes of biomass generation are expected were excluded from potential lands for solar power development (i.e. the areas with biomass density greater than 6 MT/ha per year were considered as the most suitable sites for biomass development).

Then, prioritization of sites for wind power and solar power development was done by combining different geospatial layers using the weighted overlay method in ArcGIS. Weights were assigned to each layer to reflect the relative importance of each criterion in the prioritization of sites. Since the model considers different aspects such as economic and technical factors, with the goal of achieving the maximum power while minimizing the project cost, weighted overlay model was used to weigh the criteria and to evaluate potential sites. Footprint of energy generation of each resource was rated as the most important criterion, and all other criteria such as building density, distance to grid substations, distance to roads and distance to urban centers were assigned weights according to the relative importance.

Table 5.4: Weighted overlay model

Criterion	Weightage Factor (%)	
	Wind	**Solar**
Distance to GSS	15	15
Distance to roads	5	5
Distance to urban centers	5	0
Footprint of energy generation	70	75
Building density	5	5

The data layers were classified into 5 classes ranging from 1 to 5;5 representing the most favourable level for renewable energy development. The layers, sub-classes and weights used for prioritization of lands for solar power and wind power development are presented in Table 5.5 & 5.6. Since 'distance to GSS' is a crucial factor for small scale power plants, i.e. capacity below 25MW, weights were assigned based on plant capacity. The assigned weights are depicted. The final suitability scores of the sites were determined by reclassifying the scores derived from the weighted overlay model into five classes.

Table 5.5:Criterion indices for different criteria for wind power development

Criterion	Criterion Index				
	5	**4**	**3**	**2**	**1**
Housing density	0-2	2-6	6-11	11-18	>18
Footprint of wind energy generation (MWh/ha)	>450	450-400	400-300	300-200	<200
Access to roads (m)	0-500	500-1,000	1,000-1,500	1,500-2,500	>2,500
Distance from urban centers (m)	>2,000	1,000-2,000	500-1,000	0-500	0

Table 5.6: Criterion indices for different criteria for solar power development

Criterion	Criterion Index				
	5	**4**	**3**	**2**	**1**
Housing Density	0-2	2-6	6-11	11-18	>18
Footprint of solar energy generation (MWh/ha)	>800	775-800	750-775	725-750	<725
Access to roads (m)	0-500	500-1,000	1,000-1,500	1,500-2,500	>2,500
Distance from urban centers (m)	>2,000	1,000-2,000	500-1,000	0-500	0

Since the distance to grid substations is dependent on the size of the plant, the potential lands have been classified into two categories as 10MW<X<25MW and >25MW.

Table 5.7: Criterion indices for access to GSS for prioritization of lands

Criterion	Criterion Index				
	5	**4**	**3**	**2**	**1**
Distance to GSS (km) for Capacity 10 – 25MW	0-5	5-10	10-15	15-20	>20
Distance to GSS (km) for Capacity>25MW	0-10	10-20	20-35	35-50	>50

5.5 **Final Prioritization**

The conclusive factors were considered in the final prioritization, and accordingly following are the parameters considered in the final prioritization.

- Land use pattern
- Unutilized capacity of substation
- Proposed capacity for filtered lands
- Expected annual energy generation
- Land ownership
    - Government owned (e.g. Mahaweli)

5.6 **Applying Land Ownership Information**

Finally, land ownership information was linked with the most suitable land plots to identify easily developable sites; for instance, 'Mahaweli Special Areas 'were considered to be favorable for solar power development.

5.7 **Energy Park Development Time Line**

The energy park development timeline was decided in dialogue with the Generation & Transmission Planning and Renewable Energy Development Divisions of the Ceylon Electricity Board. In the development of this time line, a two-year period of initial project development (pre-tendering) activities was considered. Detailed activity plans for wind power and solar power projects are given in the Annex. Further, it is expected to take measures to expedite the initial project development activities, whereby it will result in reduced time periods.

5.9 **Process Representation of Data Derivation Methodology**

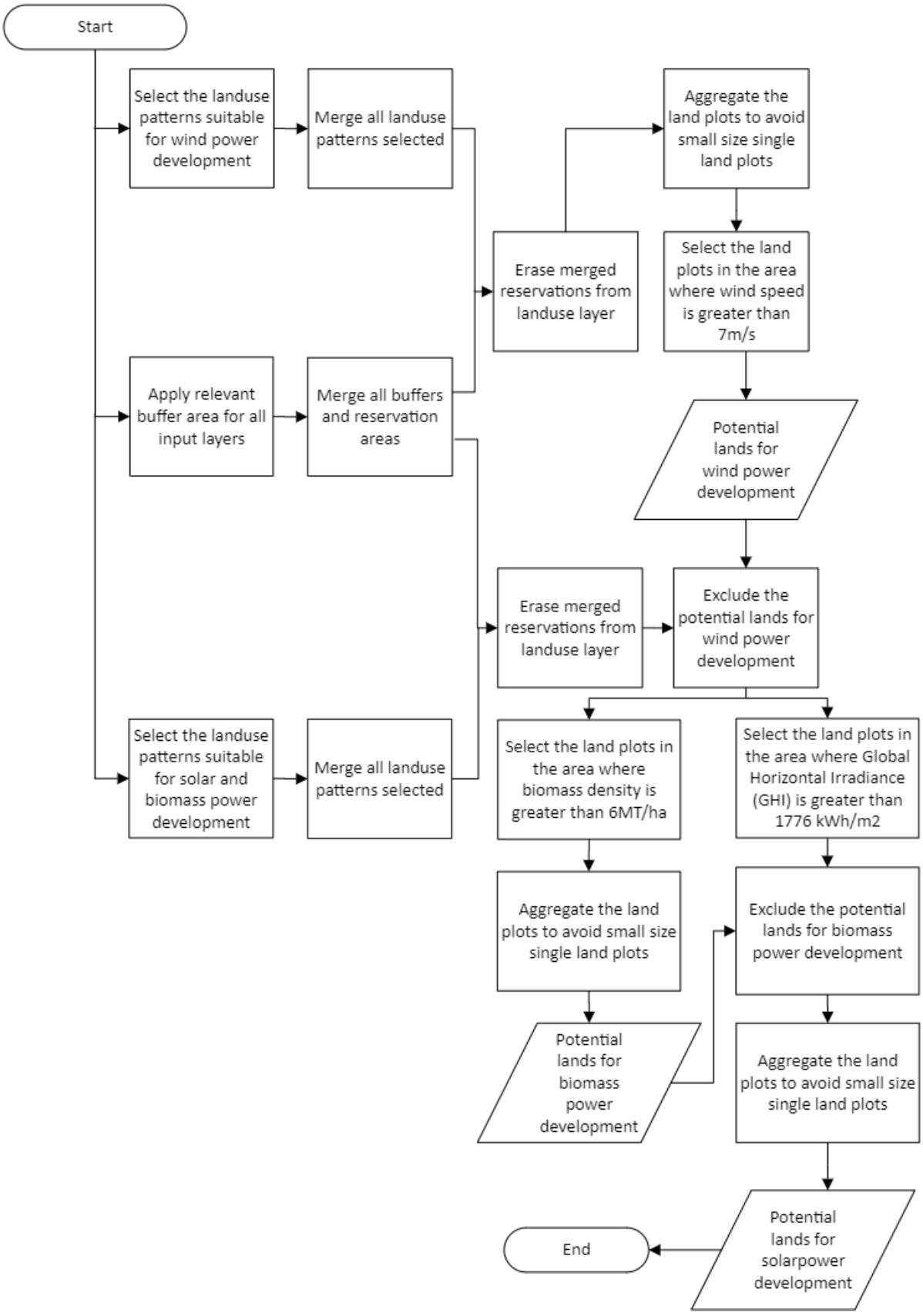


Figure 5.2 : Selection of lands

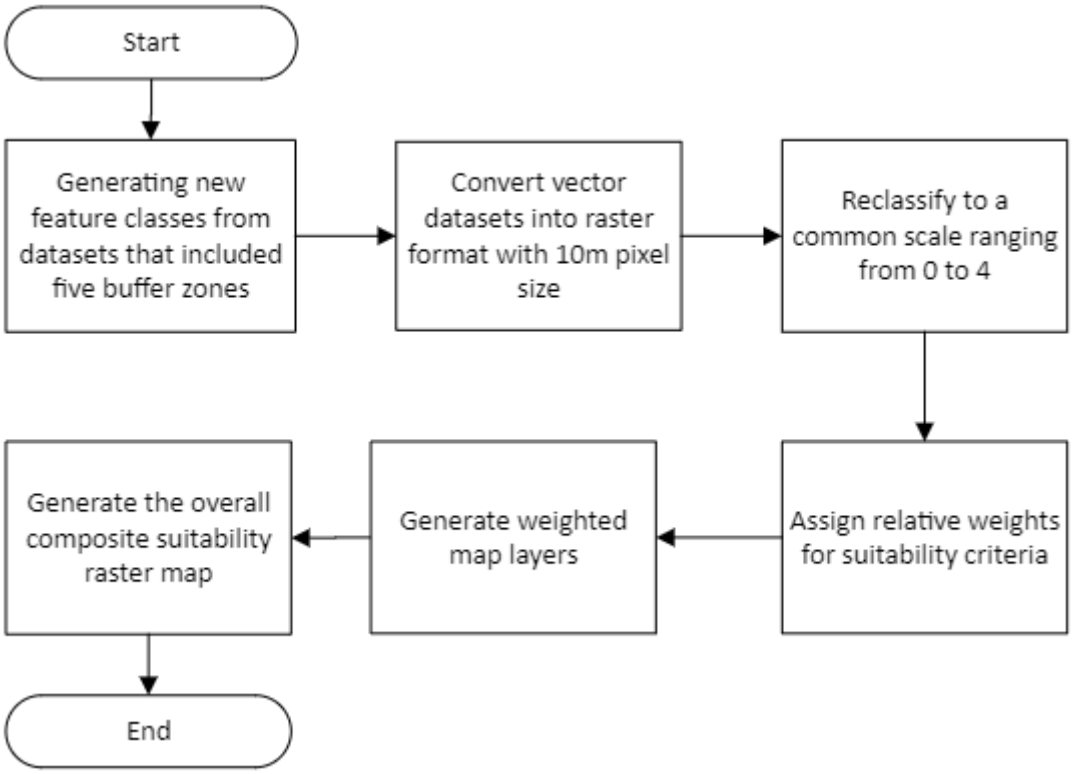


Figure 5.3 : Weighted overlay model

6. Renewable Energy Resource Maps

6.1 Solar Resource Map

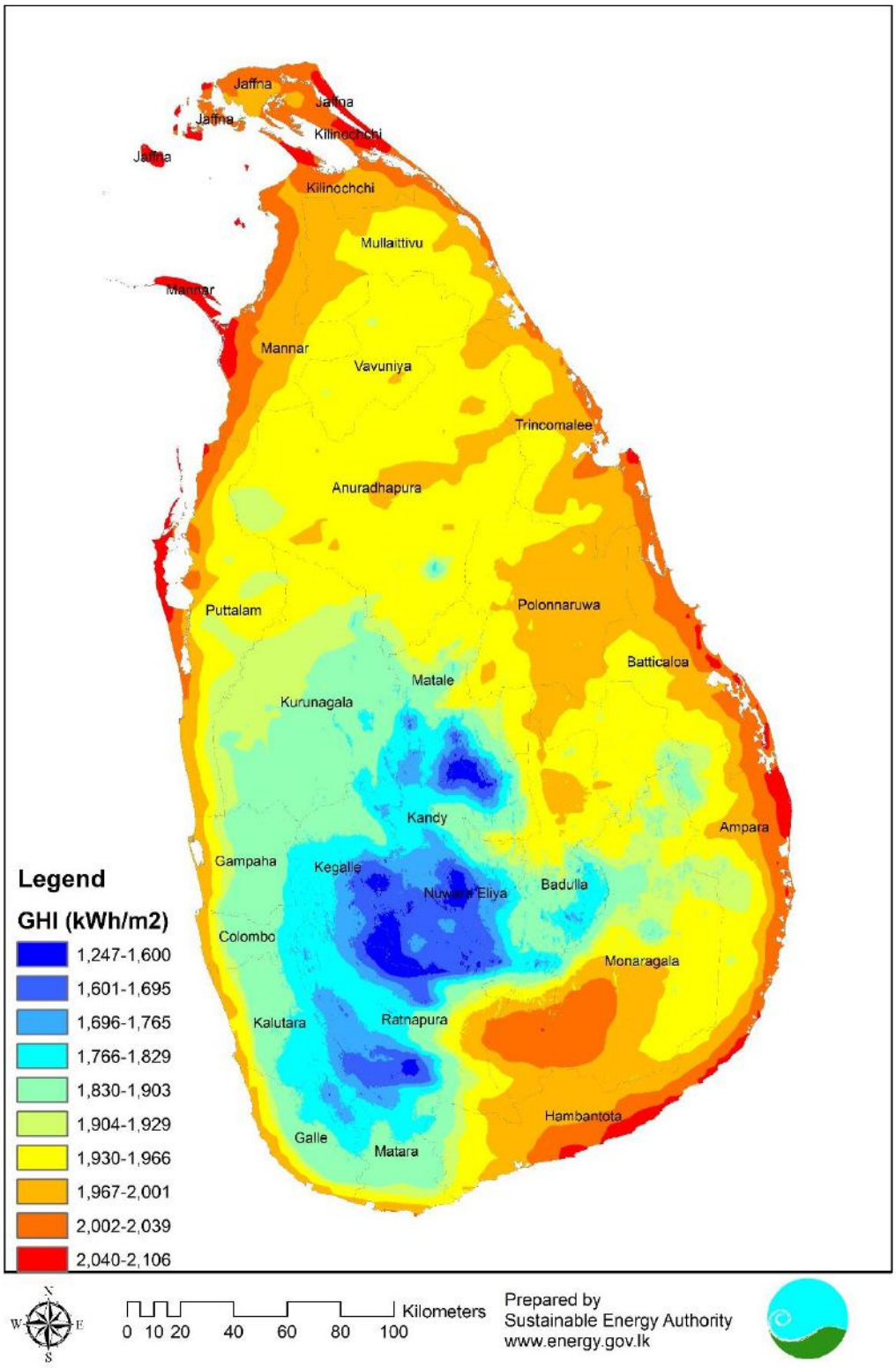


Figure 6.1: Solar Resource Map (Annual Global Horizontal Irradiance)

6.2 Wind Resource Maps

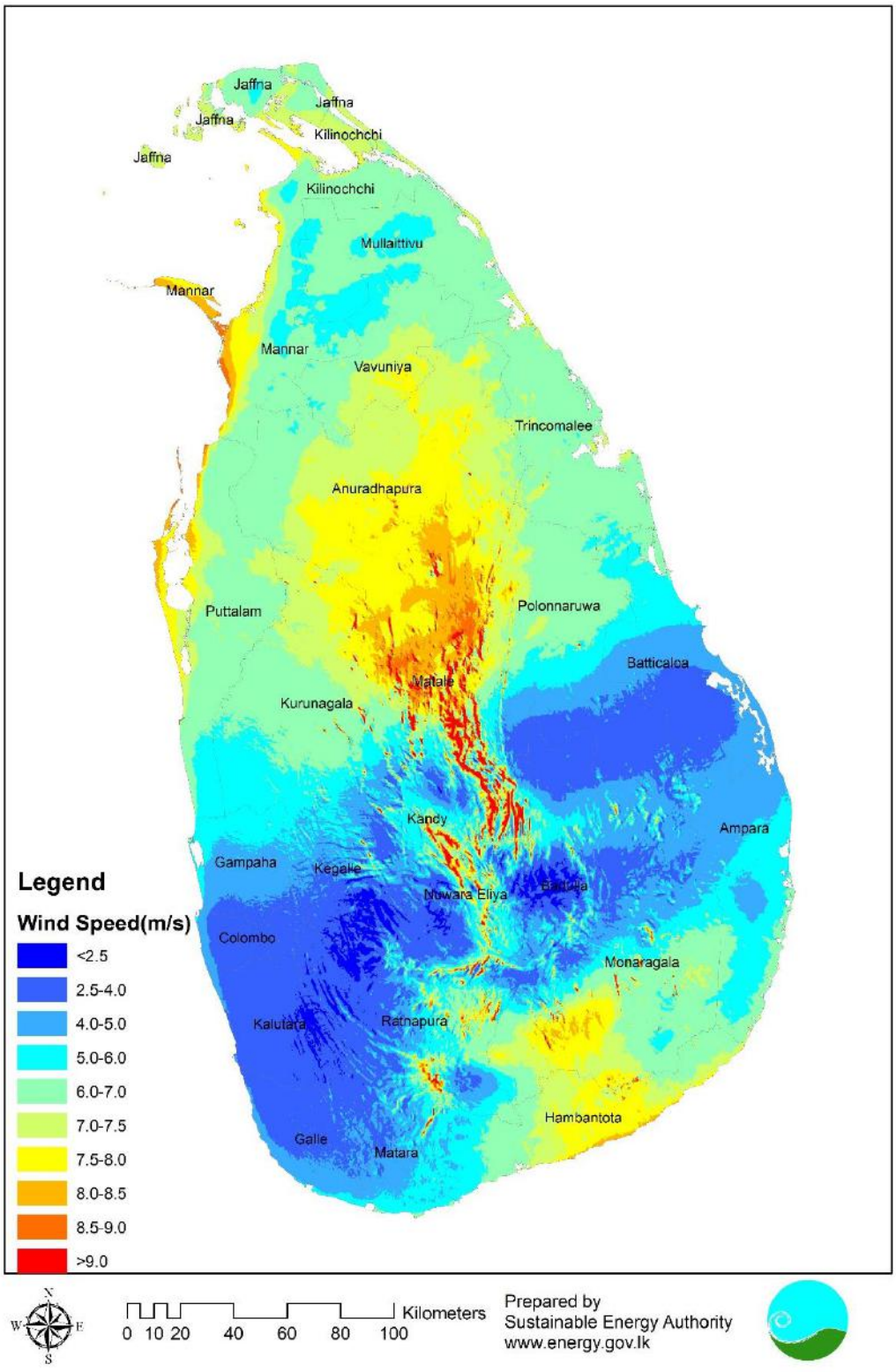


Figure 6.2: Wind Resource Map (Mean Wind Speed at 100m height)

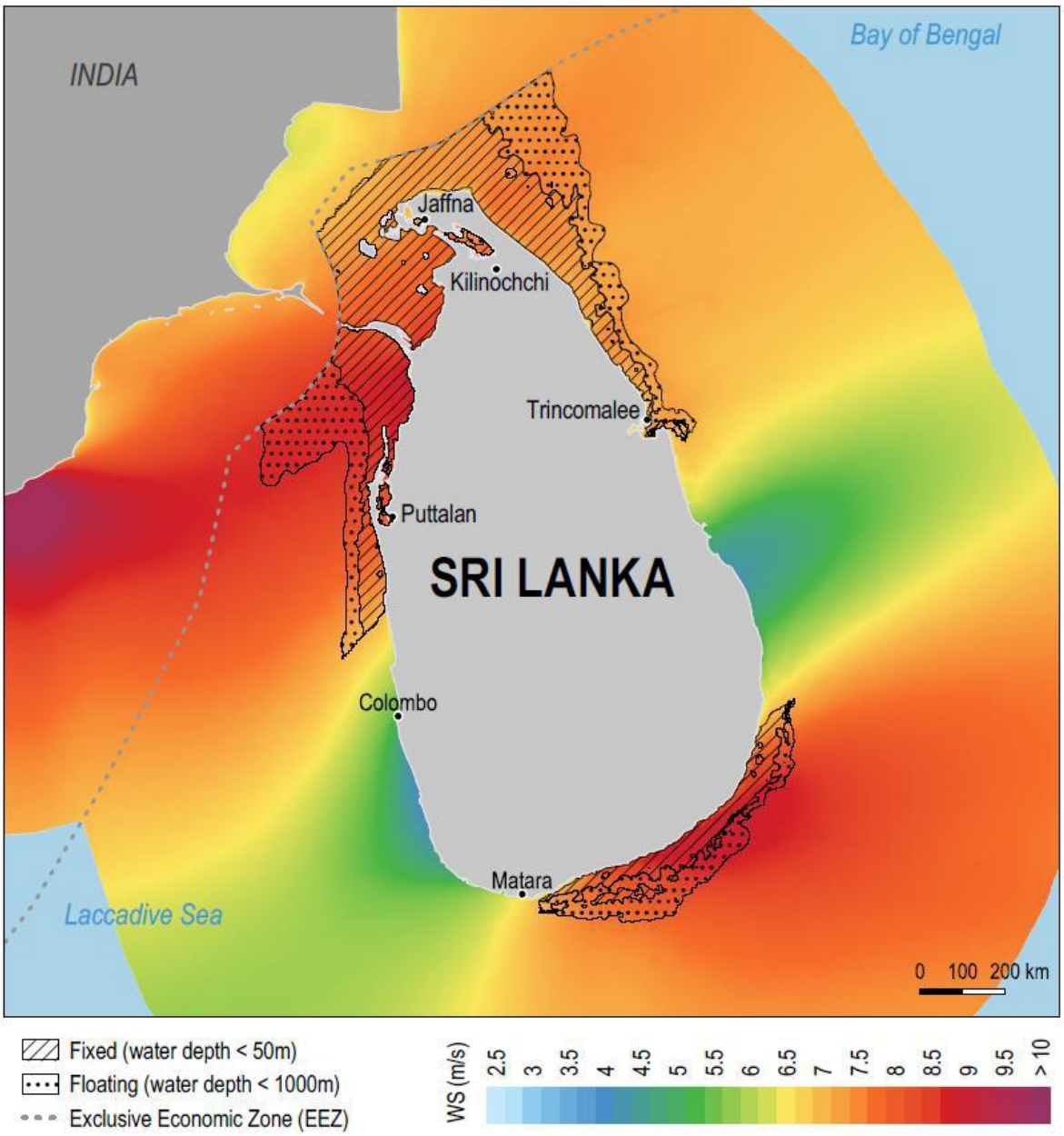
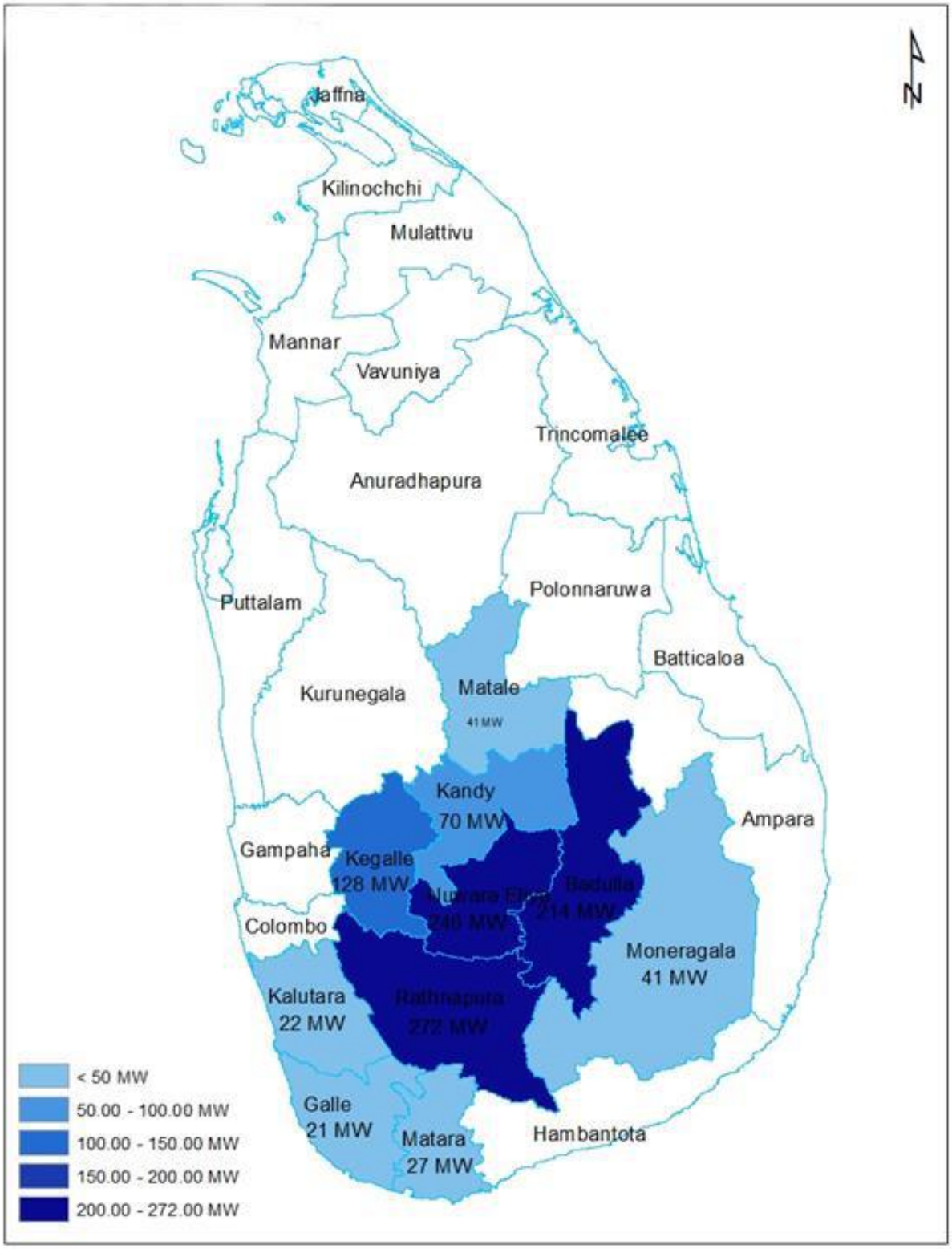


Figure 6.3: Off-shore Wind Resource Map

Source: ESMAP-IFC Offshore Wind Development Program

http://documents1.worldbank.org/curated/en/828731586850081077/pdf/Technical-Potential-for-Offshore-Wind-in-Sri-Lanka-Map.pdf

6.3 **Hydro Resource Map**



Total – 1,082 MW (Run-off river potential; other districts have negligible potentials)

Figure 6.4 : Hydro Resource Map

6.4 **Biomass Resource Map**

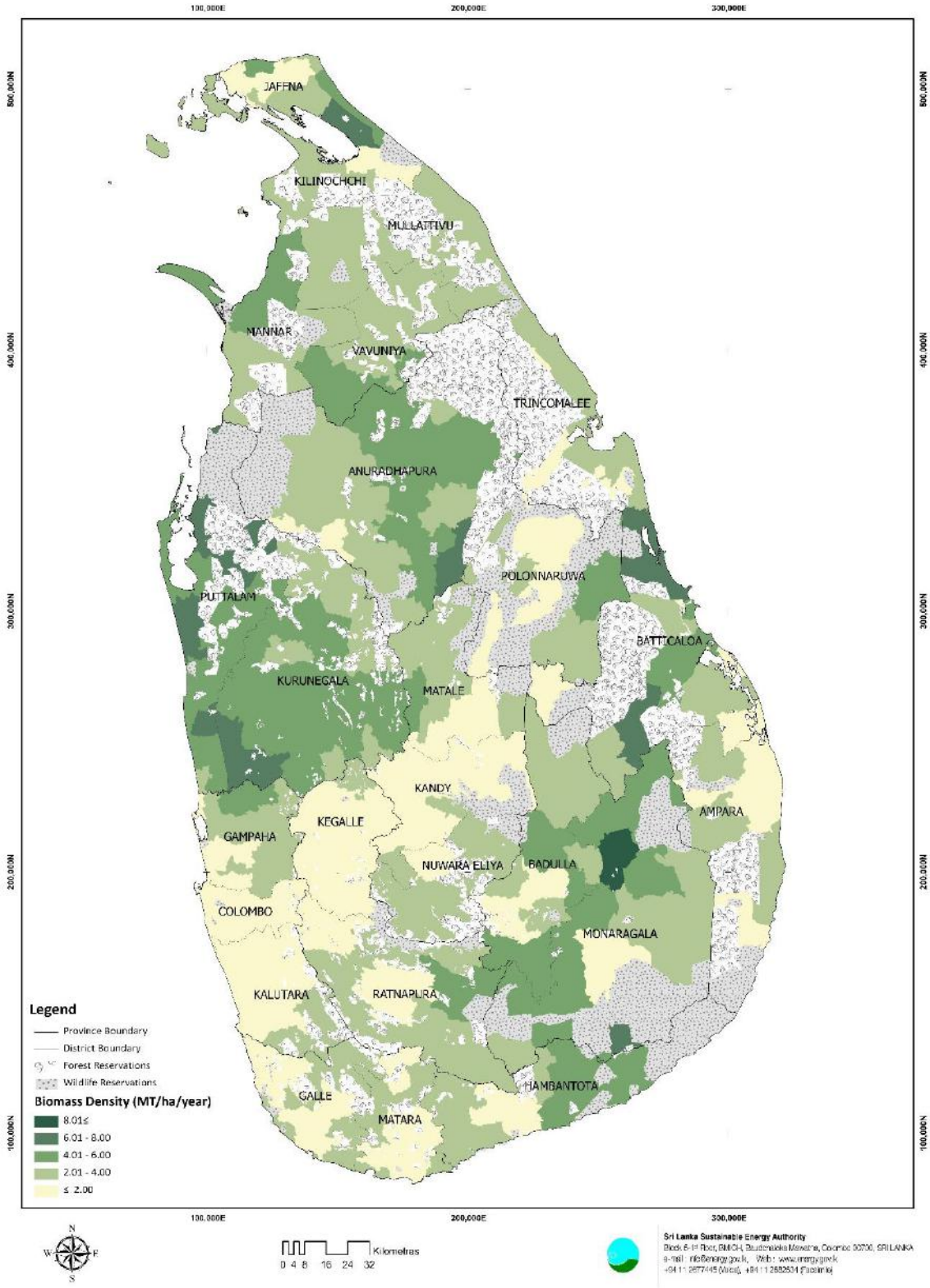


Figure 6.5: Biomass density of Sri Lanka-Energy plantations

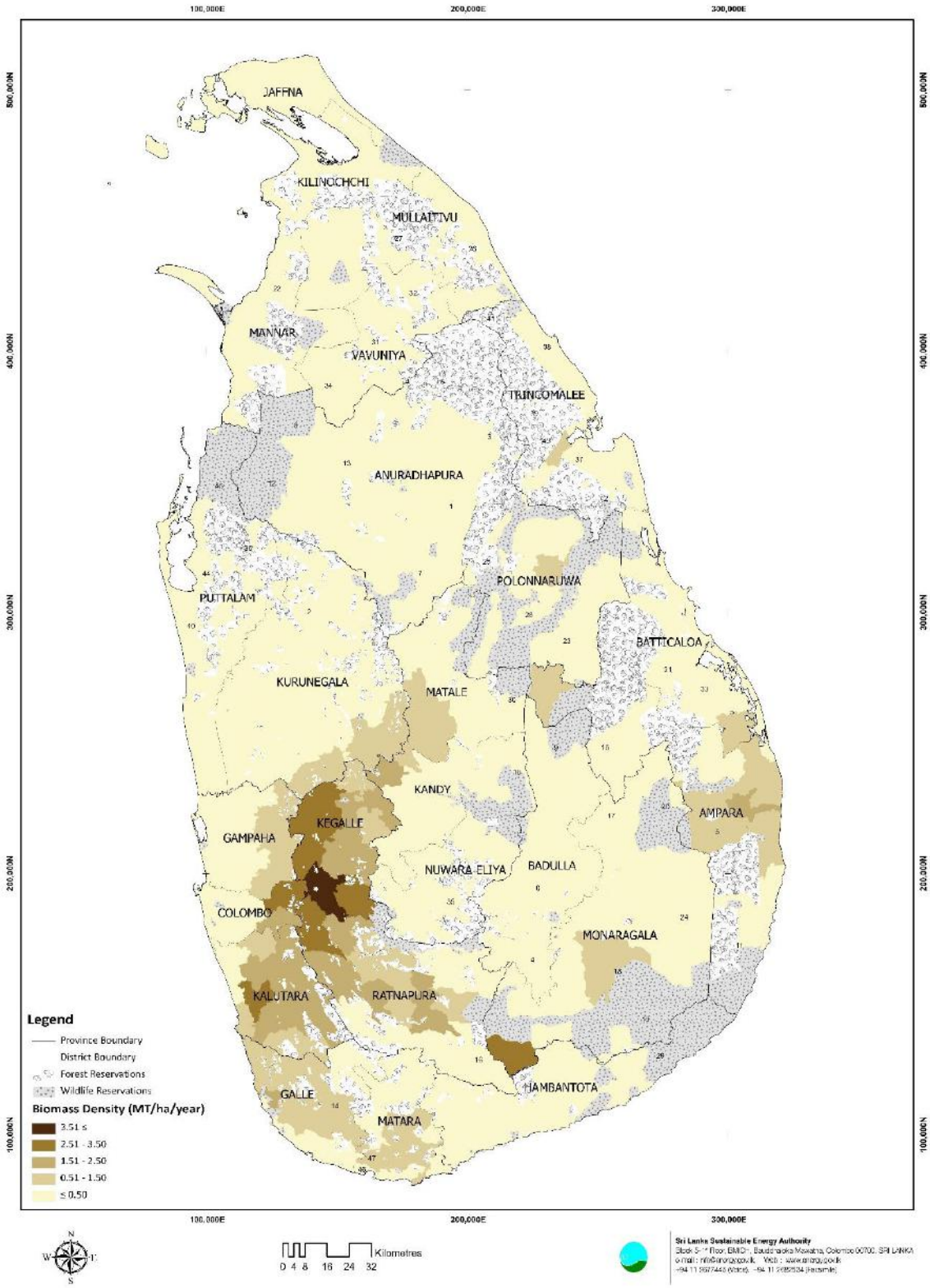


Figure 6.6:Biomass density of Sri Lanka- Agro Residues

6.5 Wave Power Resource Map

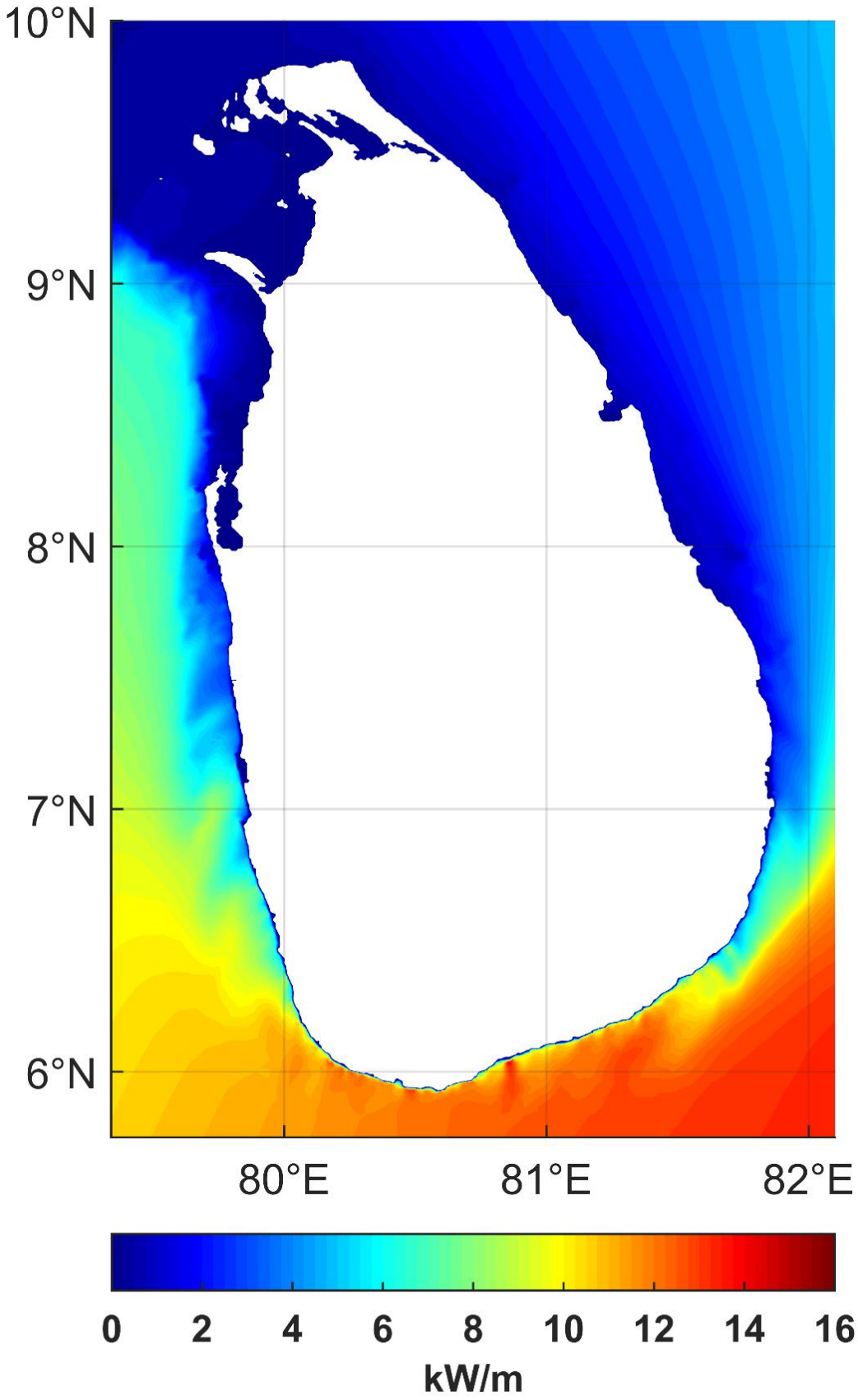


Figure 6.7: Omni-directional wave power at 50 m water depth

Source: Sri Lanka Wave Energy Resource Assessment and Characterization, Sri Lanka Sustainable Energy Authority, 2019

7. Potential Lands for Renewable Energy Development

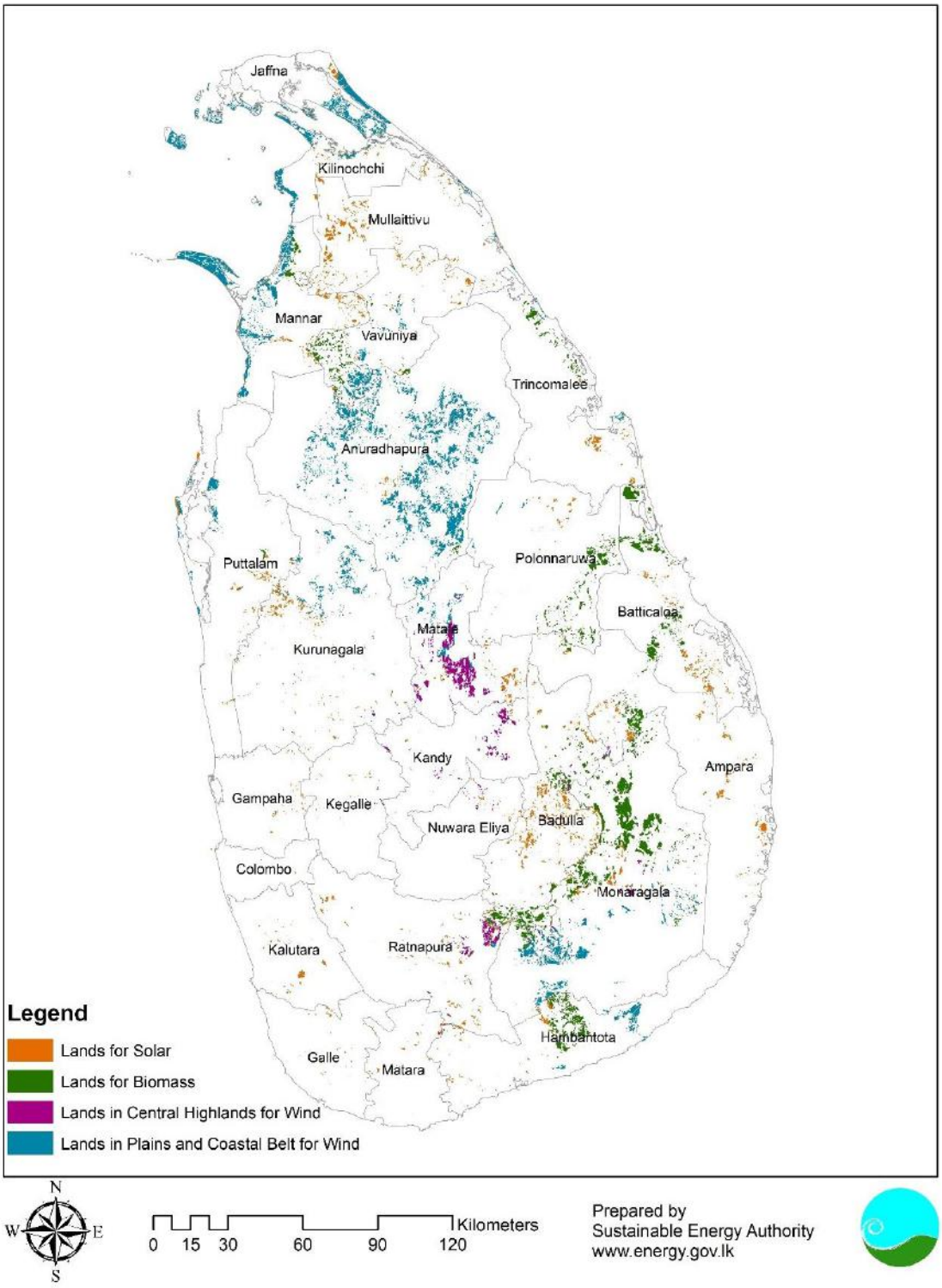


Figure 7.1: Potential lands for renewable energy development

7.1 Potential Lands for Wind Power Development

Table 7.1: Lands available for wind power development

District	Available Land extent (ha)									
	Scrub lands	Barren lands	Open forest	Sand	Homestead / Gardens	Sparsely used crop lands	Grass lands	Palmyrah	Coconut	Total
	SCRBA	BRRNA	FRSOA	SANDA	HOMSA	SPRSA	GRSLA	PLMRA	CCNTA	
Ampara	40,531	22,550	103,705	1,285	-	-	-	-	-	**168,071**
Anuradhapura	117,222	8,154	70,543	-	961	1,143	-	-	3	**198,026**
Badulla	126,647	3,742	127,656	-	-	-	-	-	-	**258,045**
Batticaloa	58,251	16,856	24,325	892	-	-	-	-	-	**100,324**
Colombo	1,066	162	861	191	-	-	-	-	-	**2,279**
Galle	6,454	181	5,941	252	-	-	-	-	-	**12,828**
Gampaha	5,121	746	1,570	375	-	-	-	-	-	**7,811**
Hambantota	53,217	2,222	37,456	1,555	-	-	-	-	-	**94,450**
Jaffna	9,928	7,750	1,096	5,920	34,778	3,313	2,449	701	874	**66,808**
Kalutara	16,468	151	14,080	239	-	-	-	-	-	**30,938**
Kandy	22,448	1,122	87,944	-	-	-	-	-	-	**111,515**
Kegalle	12,522	469	14,235	-	-	-	-	-	-	**27,226**
Kilinochchi	13,960	7,806	8,508	2,530	17,516	5,742	21	469	1,705	**58,256**
Kurunegala	38,396	1,027	20,206	1	-	-	-	-	-	**59,630**
Mannar	32,532	9,391	17,940	465	8,715	4,523	227	737	849	**75,379**
Matale	31,047	2,930	112,991	-	-	-	-	-	-	**146,968**
Matara	2,174	108	1,660	137	-	-	-	-	-	**4,078**
Moneragala	202,953	1,844	145,499	-	-	-	-	-	-	**350,296**
Mullaitivu	27,621	5,902	29,933	642	16,716	6,505	402	-	1,029	**88,749**
Nuwara Eliya	33,582	555	52,807	-	-	-	-	-	-	**86,944**
Polonnaruwa	60,743	10,996	57,998	-	-	-	-	-	-	**129,737**
Puttalam	42,660	5,650	18,174	2,332	-	-	-	-	-	**68,817**
Ratnapura	62,244	1,883	67,576	-	-	-	-	-	-	**131,703**
Trincomalee	46,942	18,139	62,628	563	-	4	-	-	-	**128,275**
Vavuniya	23,978	2,427	13,487	-	21,268	12,934	1,044	-	108	**75,247**
Total	**1,088,708**	**132,762**	**1,098,817**	**17,378**	**99,955**	**34,164**	**4,142**	**1,907**	**4,568**	**2,482,401**

Table 7.2:Potential lands for wind power development

District	Total Area (ha)	Total Capacity (MW)	Site-wise capacity			Total estimated energy (GWh/annum)
			10MW<x<=25MW	25MW<x<=100MW	>100MW	
Ampara	126	10	10	-	-	37
Anuradhapura	45,207	3,617	835	1,951	831	14,203
Badulla	4,347	348	50	44	254	1,333
Batticaloa	-	-	-	-	-	-
Colombo	-	-	-	-	-	-
Galle	-	-	-	-	-	-
Gampaha	-	-	-	-	-	-
Hambantota	4,355	348	64	129	156	1,312
Jaffna	10,184	815	139	273	402	3,234
Kalutara	-	-	-	-	-	-
Kandy	2,284	183	104	79	-	684
Kegalle	-	-	-	-	-	-
Kilinochchi	9,433	755	103	240	411	3,116
Kurunegala	2,948	236	207	29	-	995
Mannar	18,653	1,492	300	648	544	5,898
Matale	15,207	1,217	197	486	534	4,729
Matara	-	-	-	-	-	-
Monaragala	-	-	-	-	-	-
Mullaitivu	322	26	26	-	-	96
Nuwara Eliya	-	-	-	-	-	-
Polonnaruwa	468	37	37	-	-	152
Puttalam	3,401	272	62	87	123	1,157
Ratnapura	3,211	257	101	156	-	980
Trincomalee	202	16	16	-	-	68
Vavuniya	3,525	282	56	62	163	1,105
Tota	**123,874**	**9,910**	**2,307**	**4,184**	**3,419**	**39,099**

Note: Total area, total capacity and total estimated energy have been calculated for plants, of which capacity is higher than 10 MW only, as large-scale projects will be focused in Energy Park development.

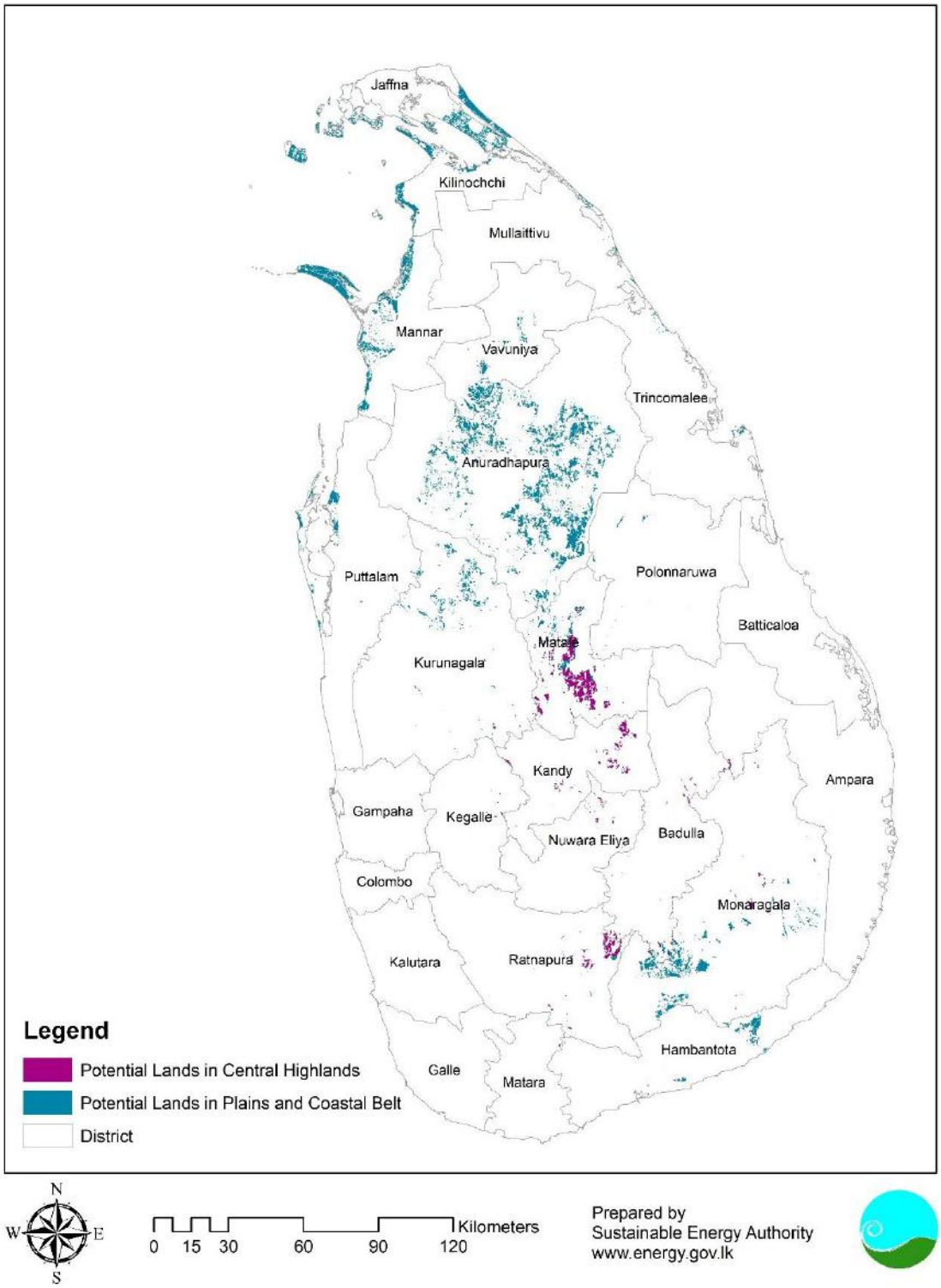


Figure 7.2: Potential lands for wind power development

7.2 Off-shore Wind Power Potential

The estimated total technical potential of off-shore wind in Sri Lanka is 92 GW, including 55 GW of fixed potential and 37 GW of floating potential. Technical potential is defined as the maximum possible installed capacity as determined by wind speed and water depth. This does not take into account other technical, environmental or economic constraints. These details are extracted from the World Bank Group (WBG) initiative on offshore wind, funded and led by the Energy Sector Management Assistance Program (ESMAP).

7.3 Potential Lands for Solar Power Development

Table 7.3: Lands available for Biomass/ Solar Power Development

District	Land Areas Available (ha)			
	Scrub lands	**Barren lands**	**Sand**	**Total**
Ampara	40,531	22,550	1,285	64,366
Anuradhapura	114,980	7,994	-	122,974
Badulla	126,647	3,742	-	130,389
Batticaloa	58,251	16,856	893	76,000
Colombo	1,066	162	191	1,418
Galle	6,454	181	257	6,891
Gampaha	5,121	746	375	6,242
Hambantota	53,217	2,222	1,555	56,994
Jaffna	10,051	7,780	5,992	23,822
Kalutara	16,468	156	248	16,871
Kandy	22,448	1,122	-	23,570
Kegalle	12,522	469	-	12,991
Kilinochchi	13,913	7,812	2,504	24,229
Kurunegala	38,396	1,027	1	39,424
Mannar	32,003	9,283	465	41,751
Matale	31,047	2,930	-	33,977
Matara	2,174	108	137	2,418
Moneragala	202,953	1,844	-	204,797
Mullaitivu	27,579	5,892	651	34,122
NuwaraEliya	33,582	555	-	34,138
Polonnaruwa	60,743	10,996	-	71,739
Puttalam	42,663	5,657	2,332	50,651
Ratnapura	62,244	1,883	-	64,127
Trincomalee	46,077	18,087	584	64,747
Vavuniya	23,845	2,427	-	26,272
Total	**1,084,975**	**132,480**	**17,469**	**1,234,923**

Table 7.4: Potential lands for solar power development

District	Total Area (ha)	Total Capacity (MW)	Site-wise capacity			Total estimated energy (GWh)
			10MW<x<25MW	25MW<x<100MW	>100MW	
Ampara	6,367	3,183	536	835	1,812	4,715
Anuradhapura	616	308	35	273	-	467
Badulla	10,103	5,052	831	2,288	1,933	7,522
Batticaloa	3,136	1,568	275	986	307	2,312
Colombo	26	13	13	-	-	19
Galle	302	151	35	116	-	226
Gampaha	415	207	117	90	-	295
Hambantota	1,976	988	121	388	479	1,436
Jaffna	962	481	39	144	297	738
Kalutara	1,160	580	121	176	283	852
Kandy	360	180	74	106	-	258
Kegalle	336	168	128	40	-	240
Kilinochchi	2,099	1,049	307	284	459	1,586
Kurunegala	3,452	1,726	476	826	424	2,525
Mannar	3,612	1,806	394	586	826	2,776
Matale	2,732	1,366	206	438	722	1,970
Matara	332	166	29	137	-	247
Moneragala	2,531	1,266	136	584	546	1,850
Mullaitivu	7,417	3,708	719	1,944	1,046	5,737
Nuwara Eliya	495	247	50	198	-	375
Polonnaruwa	982	491	124	367	-	746
Puttalam	2,520	1,260	274	653	333	1,879
Ratnapura	3,536	1,768	572	1,196	-	2,568
Trincomalee	1,957	979	164	264	551	1,464
Vavuniya	1,855	927	252	470	205	1,433
	59,278	**29,639**	**6,029**	**13,389**	**10,221**	**44,239**

Note: Total area, total capacity and total estimated energy have been calculated for plants, of which capacity is higher than 10 MW only, as large-scale projects will be focused in Energy Park development.

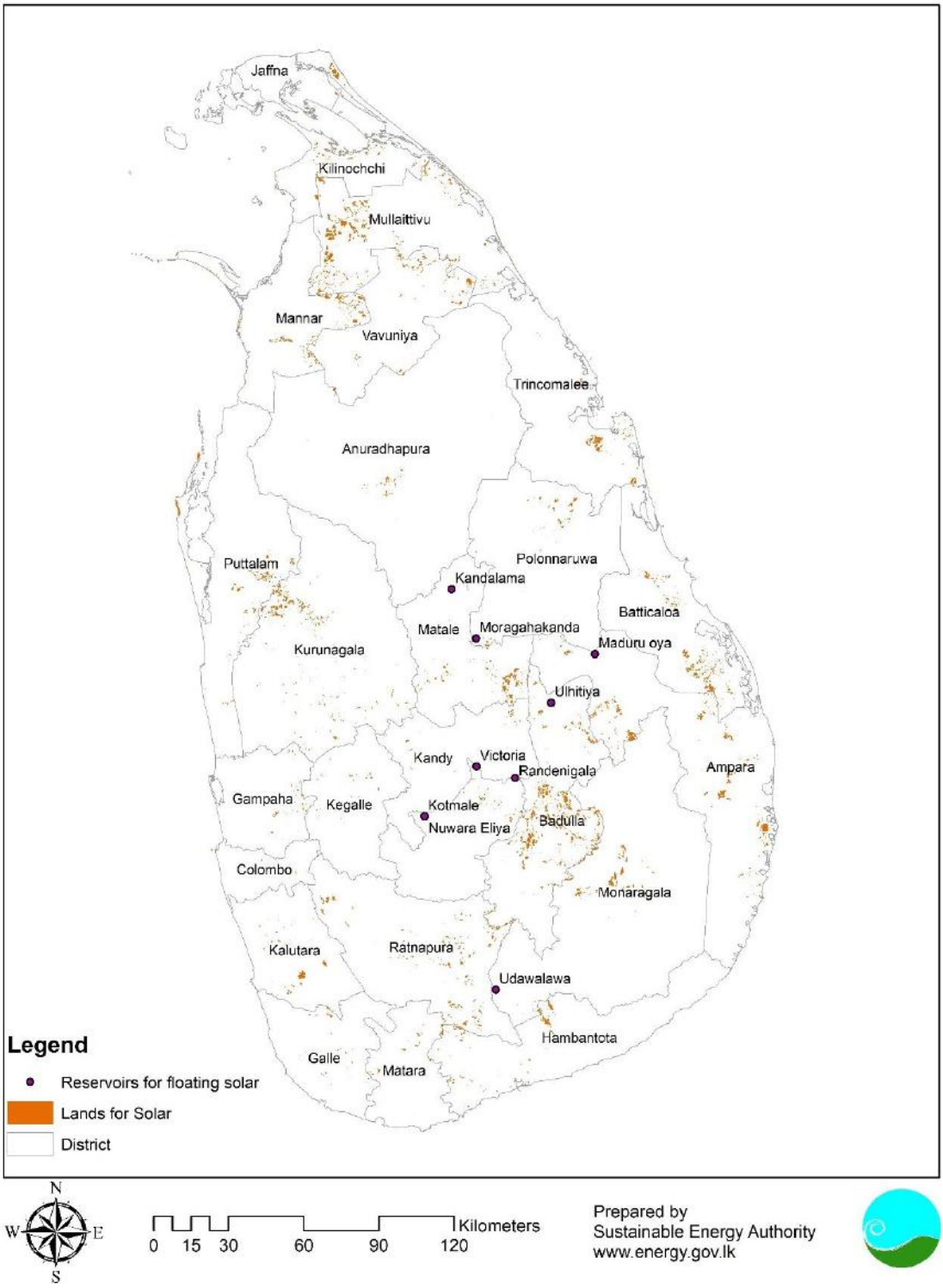


Figure 7.3 : Potential lands and reservoirs for solar power development

7.4 **Potential for Floating Solar Power Development**

Potentials for floating solar power development is identified in natural water bodies as well as the reservoirs of large-hydro power plants. When a conservative 5% of the surface areas of natural water bodies with surface areas 10 km^2 or above are taken, there will be an estimated potential around 1,500 MW. When 10% of the surface areas of reservoirs is considered, the estimated potential from reservoirs is 900 MW. Details are given below.

Table 7.5: Natural water-body based floating solar power potential

District	Estimated Floating Solar Potential (MW)
Ampara	309
Anuradhapura	241
Batticaloa	67
Hambantota	108
Kilinochchi	54
Kurunegala	63
Mannar	47
Monaragala	137
Mulativu	72
Nuwaraeliya	71
Polonnaruwa	207
Rathnapura	93
Trincomalee	38
Total	**1,507**

Table 7.6: Reservoir-based floating solar power potential

Reservoir	Proposed Capacity (MW)
Kotmale	34
Victoria	103
Randenigala	113
Udawalawa	149
Maduruoya	319
Moragahakanda	115
Ulhitiya/Rathkinda	75
Total	**908**

It is noted that the percentages considered above are subject to verifications through future studies related to floating solar PV projects.

7.5 **Biomass Power Development Potential**

Table 7.7: Potential lands for Biomass power development

District	Total land Area for DP (ha)	Total yield from DP (MT/annum)	Total Capacity from Plantation[1] (MW)	Total Capacity from AR (MW)	Total Capacity (MW)	Total Estimated Energy (GWh/annum)
Ampara	6,712	33,183	22.4	0.3	22.7	159
Anuradhapura	1,335	5,810	153.8	6.8	160.6	1,126
Badulla	14,177	57,479	44.2	1.6	45.8	321
Batticaloa	10,606	60,986	53.1	2.5	55.6	390
Colombo	-	-	-	-	-	-
Galle	-	-	-	-	-	-
Gampaha	30	167	15.1	0.9	16.0	112
Hambantota	8,781	44,392	56.5	2.0	58.5	410
Jaffna	37	184	-	-	-	-
Kalutara	-	-	-	-	-	-
Kandy	-	-	-	-	-	-
Kegalle	-	-	-	-	-	-
Kilinochchi	171	1,233	14.2	0.2	14.4	101
Kurunegala	360	2,176	49.7	2.7	52.4	368
Mannar	3,655	15,512	26.9	0.7	27.6	194
Matale	0	0	-	-	-	-
Matara	-	-	-	-	-	-
Monaragala	27,063	121,364	183.6	3.5	187.1	1,311
Mullaitivu	-	-	-	-	-	-
Nuwara Eliya	-	-	-	-	-	-
Polonnaruwa	8,114	29,272	39.6	4.1	43.7	306
Puttalam	479	3,061	49.3	1.9	51.2	359
Ratnapura	2,003	9,464	-	-	-	-
Trincomalee	3,287	10,227	15.8	0.6	16.4	115
Vavuniya	5,795	21,092	39.4	1.6	41.0	288
Total	**92,606**	**415,603**	**763.5**	**29.6**	**793.1**	**5,558**

Note: 'Plantation' refers to dedicated plantations and other plantation-related biomass (inter-cropping, homesteads, etc.)

DP – Dedicated Plantations, AR – Agro-Residue

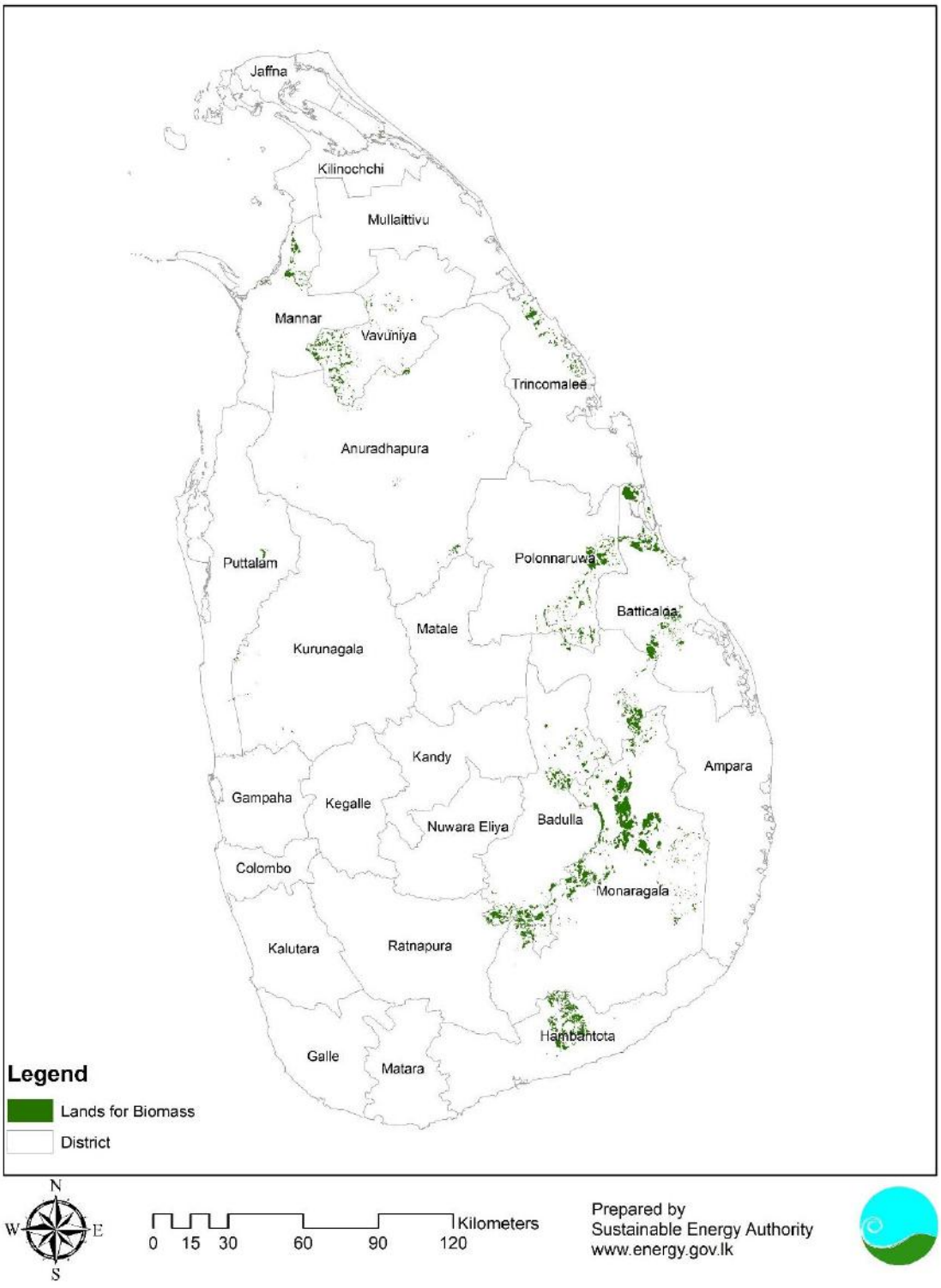


Figure 7.4: Potential lands for biomass power development

7.6 **Wave Energy Resource Potential**

Table 7.8:Wave energy resource potential

Province	Wave Energy Resource Potential (TWh/year)
Northern Province	2.65
Eastern Province	4.35
Southern Province	26.30
Western Province	8.75
North-western Province	5.25
Total	**47.3**

Ref: Sri Lanka Wave Energy Resource Assessment and Characterization, Sri Lanka Sustainable Energy Authority, 2019.

7.7 Prioritized Lands for Renewable Energy Development

7.7.1 Prioritized Lands for Wind Power Development

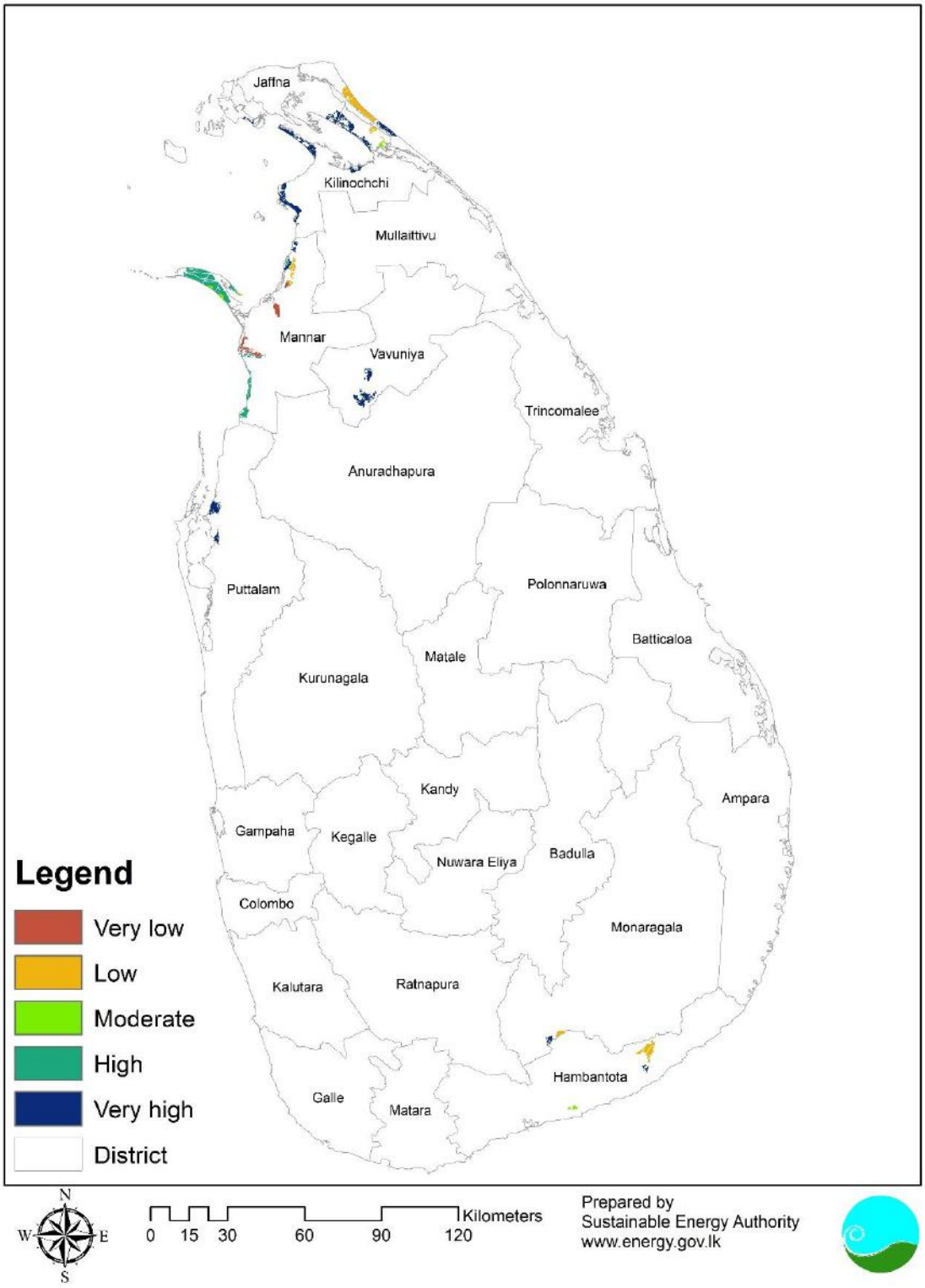


Figure 7.5: Prioritized Lands for Wind Power Development for capacity above 25 MW

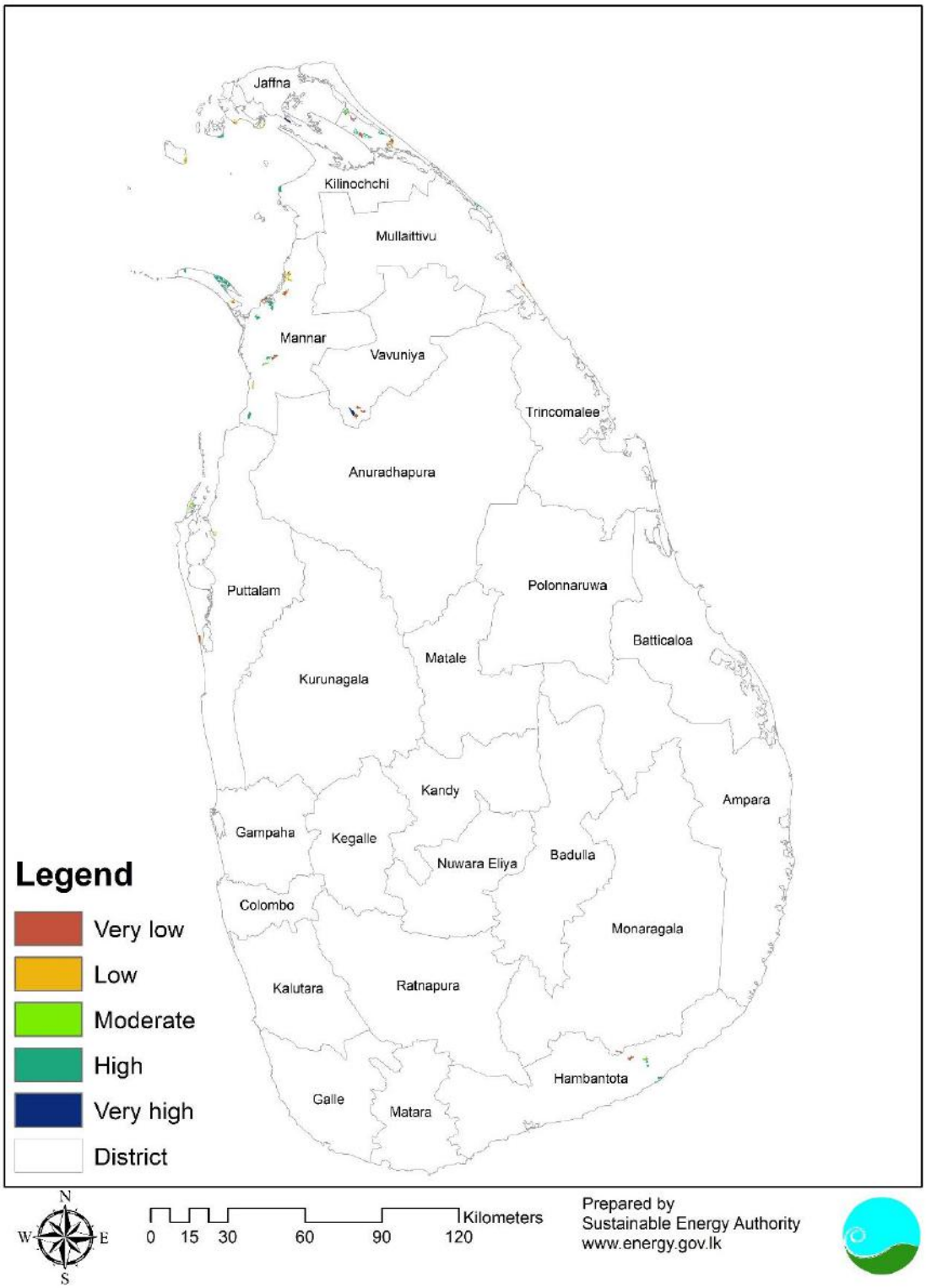


Figure 7.6: Prioritized Lands for Wind Power Development for capacity between 10MW and 25 MW

7.7.2 Prioritized Lands for Solar Power Development

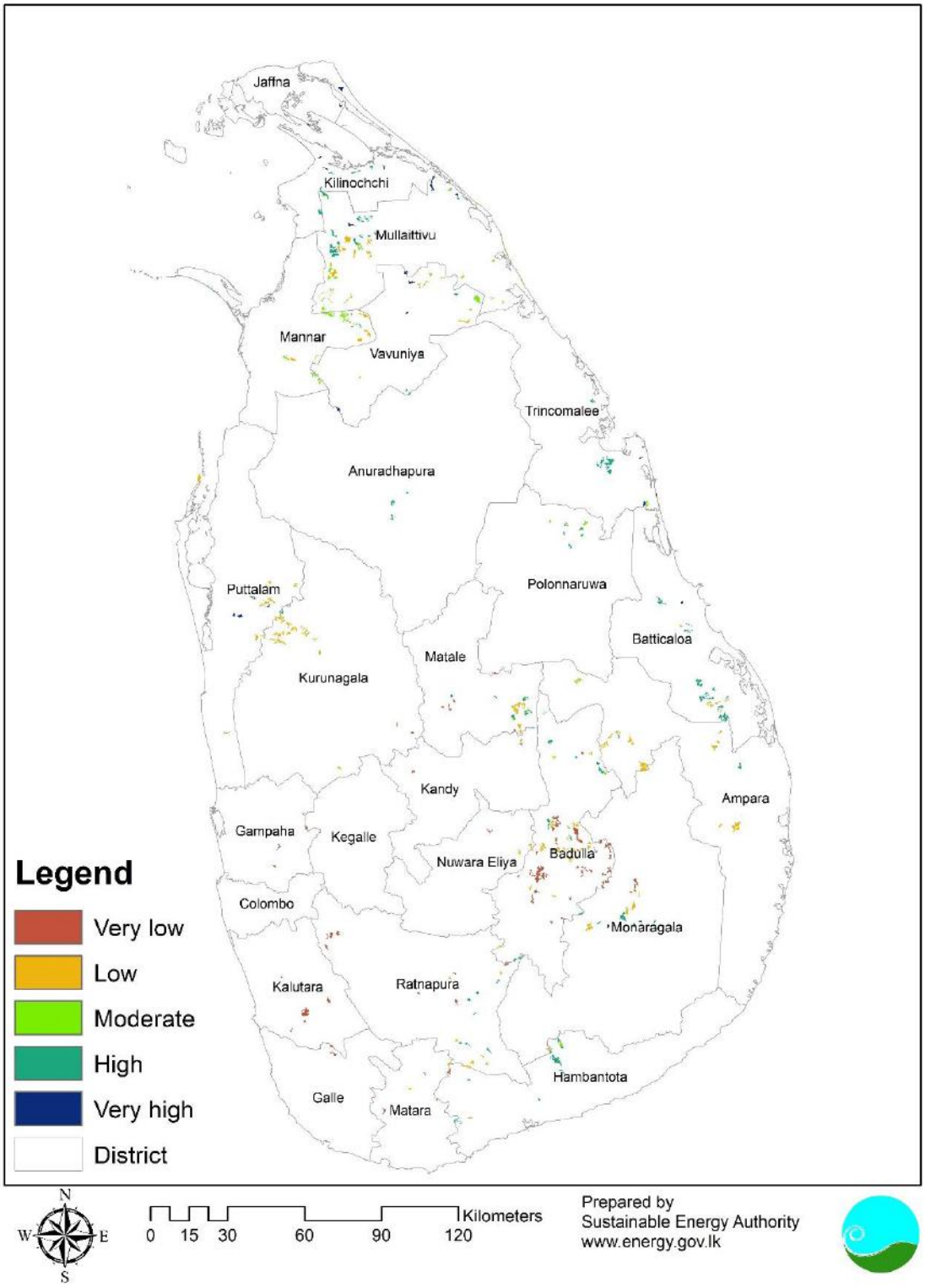


Figure 7.7: Prioritized Lands for Solar Power Development for capacity above 25 MW

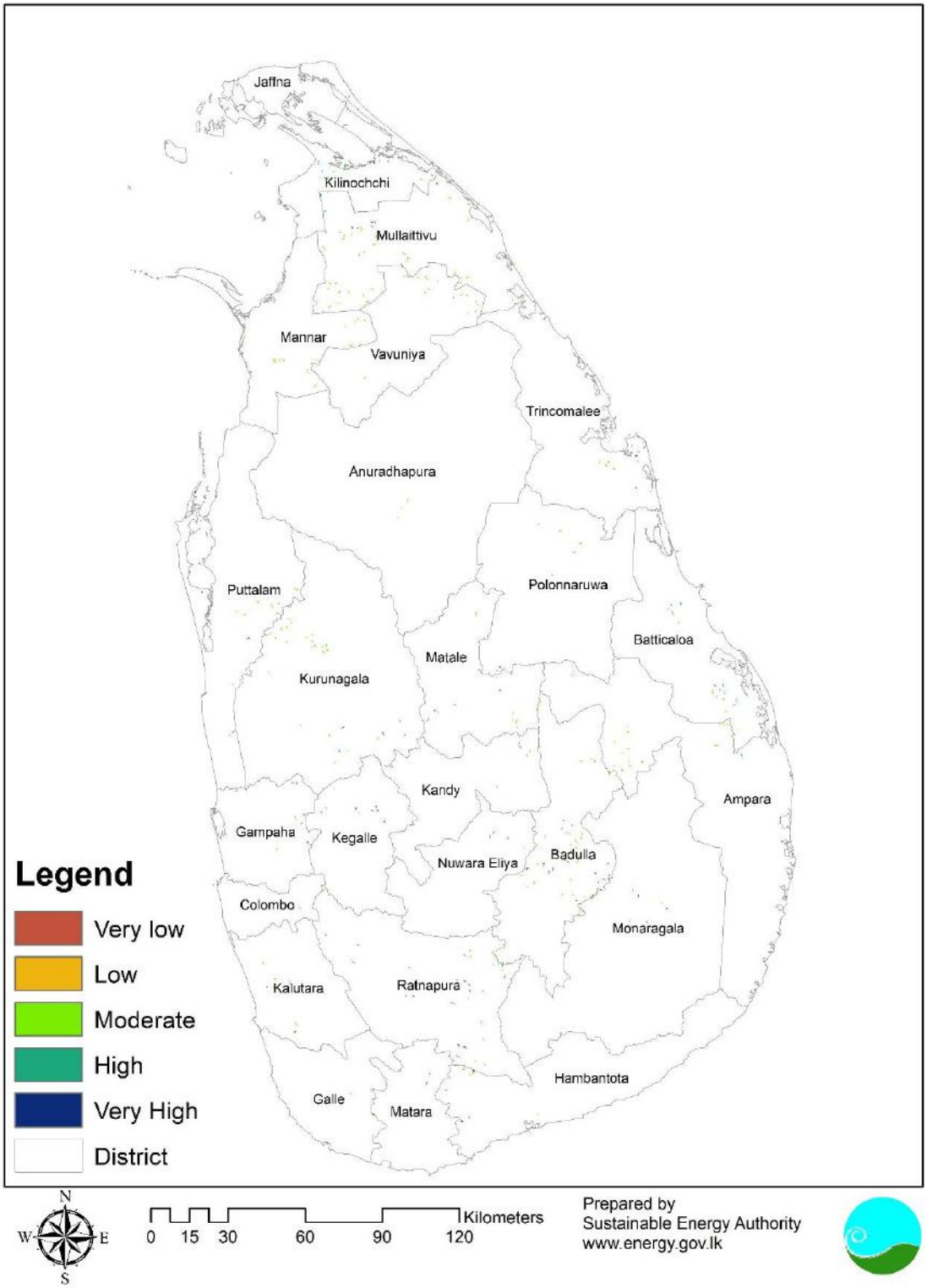


Figure 7.8: Prioritized Lands for Solar Power Development capacity between 10 MW and 25 MW

8. Energy Park Project Development Time Line

8.1 On-going Energy Park Projects

Table 8.1: Details of on-going Energy Park projects

Project Details			Project Development Period	
Project Name	**Type**	**Capacity**	**Initiation**	**Ready for Tendering**
Siyamabalanduwa	Solar	100	---	2021
Pooneryn (Phase 1)	Wind	100	---	2022
Mannar (Phase 2)	Wind	100	---	2022

8.2 Planned Energy Park Projects

The Projects expected to be made 'Ready for Tendering' within the planning horizon (end 2026) are included here, and the details are as follows.

Table 8.2: Details of planned Energy Park projects

Project Details			Project Development Period	
Project Name	**Type**	**Capacity (MW)**	**Initiation**	**Ready for Tendering**
Mannar (Phase 3)	Wind	100	2021	2023
Pooneryn (Phase 2)	Wind	120	2022	2024
Puttalam	Wind	100	2022	2025
Northern (N collector-Vadamarachchi)	Wind	130	2023	2026
Hambantota & Thissamaharama	Solar	100	2021	2023
Northern	Solar	50	2022	2024
Northern	Solar	50	2024	2026
Hambantota	Solar	50	2024	2026

9. Land Identification for Energy Park Projects

9.1 Locations of On-going Energy Park Projects

Table 9.1: Site identification of on-going Energy Park projects

Project Name	Type	Capacity (MW)	Site Identification	
			X	Y
Siyamabalanduwa	Solar	100	581477.366085	472854.968366
Pooneryn (Phase 1)	Wind	100	428937.462469	781715.988047
Mannar (Phase 2)	Wind	100	388642.171013	730890.327009
			395314.751154	727551.970588

Note: Exact location of Mannar Phase 2 project is yet to be finalized.

9.2 Earmarked Sites for Planned Energy Park Projects

Table 9.2: Optional sites available for planned Energy Park projects

Location	Type	Capacity (MW)	Earmarked Sites (Proposed Options)	
			X	Y
Mannar (Phase 3)	Wind	100	399816.123662	727590.349538
			392741.597067	731449.132621
Pooneryn (Phase 2)	Wind	120	434899.037104	780975.891306
			429618.028636	783934.634539
Puttalam	Wind	100	397245.531011	627866.111585
			382734.789287	630486.609304
			396303.757334	639448.430807
Northern (N collector-Vadamarachchi)	Wind	130	463267.558557	786888.186561
			451416.173022	797179.340966
Hambantota & Thissamaharama	Solar	100	531594.410371	420259.896630
			529209.261330	424696.000602
			530948.226215	430946.075329
Northern	Solar	50	432716.115089	788526.610838
			444526.290584	804873.366425
			443132.387957	807062.328601
Northern	Solar	50	445365.141464	796003.064577
			445615.301461	802960.444722
Hambantota	Solar	50	487678.618371	420088.978148
			490955.290845	400784.709078
			527063.099721	427966.222487

10. Discussion

The Government of Sri Lanka has given policy directives to go for high amounts of renewable energy. SLSEA, as the focal Government entity for the implementation of renewable energy development programmes, is taking necessary steps in line with this. Primarily, Sri Lanka has the required resource potential – particularly wind energy and solar energy resources. Even with the potential lands of solar power development alone, the electricity generation capacity for a foreseeable future period can be met. Taking into consideration of the dynamic nature of the process, particularly due to the need of using the transmission grid for the evacuation of the electricity generated from energy parks, the planning time horizon has been taken as 6 years, in view of the possibility of accommodating increased amounts in the upcoming volumes of the plan. In addition to that, some of the specific concerns related to the subject are given below.

(a) Optimal Use of Transmission Capacities

In the renewable energy harnessing, final selection of the sites needs to be done in an optimal combination of transmission capacity utilization and harnessing the resource potential. This has been applied by the CEB and SLSEA in the finalization of sites, and will be particularly addressed in the amalgamation of renewable energy development sites into the transmission development plan of the CEB in the future stages. Further, transmission development using appropriate technologies will be required for increasing the renewable energy development capacity.

(b) Ground Verification of Sites

In selecting the lands for renewable energy development, consideration has been made to utilize non-arable lands as well as to make the minimum socio-environmental impacts, such as cutting down the minimum number of trees. In spite of the fact that care has been taken to select the appropriate land types in accordance with that, all the prioritized lands will be taken for projects after detailed site visits where appropriateness of the sites will be further studied and decided upon.

(c) Project Development Period

As far as the time taken for initial project development is concerned, typical time periods have been derived based on the past project implementation by the private sector as well as the involvement in energy park development by SLSEA. Typical time periods thus established is shown in Figures 10.1 & 10.2. However, with this renewable energy development planning process, it is objected at the relevant statutory institutes can take informed decisions on allocating lands for project development and the issuance of the necessary approvals. Accordingly, it is expected that initial project development durations will be reduced in the future.

(d) Continuing Wind Resource Assessment

In the consideration of wind power generation capacity, the resource potential has been based on the data available in the Global Wind Atlas. However, in the prioritization of lands for wind power development, only the geographical areas where long-term wind measurements were carried out have been included. The methodology will be applied to the future as well, and accordingly the measurement programme will be continued for further locations through which wind power sites for future development will be identified. Further, high wind resource potentials are available in the country, and in consideration of the logistical constraints the particular sites have been excluded from the prioritization. However, in developed stages those sites can be taken into account. Overall, at this level, the sites with highest wind resource and easy implementation have been included in the prioritization, and it will be expanded further in later stages.

(e) Further Technology Options

SLSEA deeply recognizes importance of lands as a rare commodity in the country, and takes serious consideration to use only the lands unutilizable for other purposes for renewable energy development. Meanwhile, the use of other options will also be considered, where solar rooftop systems, is already being implemented as such a method. Floating solar PV systems is yet another system in the category, where efficiency reduction due to temperature increase can be better controlled, and also evaporation of surface waters and other water body related unwelcoming features are observed to be addressed positively. So, floating solar power development will be focused as a further optional method for solar power development.

In recognition of the high wind power potential of the off-grid resources, measures will be taken to develop off-shore wind power resources, and the initial activities in this connection have already been started.

(f) Other Renewable Energy Sources

Solar, wind, biomass and hydro are the commercially developed renewable energy sources in the country. Apart from these, there are other sources such as wave energy, ocean thermal energy, geothermal energy, etc. As far as the initiatives that have been made pertinent to these sources are concerned, resource potential studies on wave energy have been carried out so far. So, pilot projects on this particular resource and potential studies and pilot projects on other emerging technologies are yet to be carried out. Therefore, once emerging technologies are taken to substantial levels of development, those will be included in the Plan in the upcoming volumes.

(g) Compliance for Socio-environmental and other Requirements

One of the prime concerns of SLSEA is to assure the compliance of project implementation to the socio-economic and all other requirements. Accordingly, all the available constraints, restrictions, etc. have been taken into consideration herein in selecting project sites for renewable energy development.

In this context, Department of Archeology is carrying out a detailed study of archeological sites in the country, and the archaeological surveys in the Puttalam and Hambantota districts, are yet to be completed. The climatic details such as flooding, landslides, etc. have not been included into this study. So, all such criteria and any critical criteria including socio-environmental considerations such as wild life critical habitats will be taken into serious consideration in the implementation of projects.

(h) Room for Technological Advancements

Finally, for the prevailing technological context, harnessing renewable energy is being planned in the form of electricity. Even though not commercially developed yet, newer technologies like hydrogen technology are expected to expand the technological horizons of renewable energy harnessing, and SLSEA will do the needful to abreast with global technological developments, and introduce necessary measures to optimally harnessing the resources using such advanced technologies in the future. That will open up opportunities for harnessing more renewable energy sources, and to enhance the utilization limits beyond electricity, leading towards a hydrogen economy.

ID	Task Name	Start	Finish	Duration
1	**Typical Utility scale (100MW) wind project**	**Wed 1/1/20**	**Sun 11/2/25**	**2132 days**
2	**Site Idendification 1**	**Wed 1/1/20**	**Wed 4/20/22**	**840 days**
3	Initial site identification	Wed 1/1/20	Fri 1/31/20	30 days
4	Establishment of weather station	Fri 1/31/20	Wed 7/29/20	180 days
5	Onsite measurements	Wed 7/29/20	Thu 7/29/21	365 days
6	Point of grid connection cleared	Fri 1/10/20	Sun 2/9/20	30 days
7	Pre-feasibility	Fri 1/31/20	Wed 7/29/20	180 days
8	IEE	Fri 1/31/20	Wed 7/29/20	180 days
9	Declaration of Energy Development Area	Wed 7/29/20	Tue 10/27/20	90 days
10	Geotech Survey for Wind	Fri 10/22/21	Wed 4/20/22	180 days
11	**Approvals**	**Wed 7/29/20**	**Fri 10/22/21**	**450 days**
12	CEA/EIA	Wed 7/29/20	Fri 10/22/21	450 days
13	Wild Life Dept	Sun 4/25/21	Fri 10/22/21	180 days
14	Forest Dept	Sun 4/25/21	Fri 10/22/21	180 days
15	DS's no objection	Sun 4/25/21	Fri 10/22/21	180 days
16	Local Authority	Sun 4/25/21	Fri 10/22/21	180 days
17	Department of Agrarian Development	Sun 4/25/21	Fri 10/22/21	180 days
18	Deartment of Irrigation	Sun 4/25/21	Fri 10/22/21	180 days
19	Archeology Department	Fri 3/26/21	Fri 10/22/21	210 days
20	**Land acquisition**	**Wed 9/22/21**	**Sat 1/4/25**	**1200 days**
21	Land acquisition, survey plan	Wed 9/22/21	Sun 11/21/21	60 days
22	Land acquisition, advance tracing	Sun 11/21/21	Sat 2/19/22	90 days
23	Valuation and Compensation	Sat 2/19/22	Sat 1/4/25	1050 days
24	Land aquired (Section 38A)	Sat 2/19/22	Sat 10/22/22	245 days
25	**Project acceptance**	**Thu 4/20/23**	**Thu 11/16/23**	**210 days**
26	Transaction Structuring	Thu 4/20/23	Fri 8/18/23	120 days
27	Board approval	Fri 8/18/23	Sun 9/17/23	30 days
28	MOPE approved	Sun 9/17/23	Tue 10/17/23	30 days
29	Cabinet approved	Tue 10/17/23	Thu 11/16/23	30 days
30	**Project infrastructure development**	**Sat 10/22/22**	**Thu 4/20/23**	**180 days**
31	Site Clearaning and blocking out	Sat 10/22/22	Thu 4/20/23	180 days
32	Access Roads	Sat 10/22/22	Thu 4/20/23	180 days
33	**Tendering**	**Sun 8/7/22**	**Sun 11/2/25**	**1183 days**
34	Tender document preparation	Sun 8/7/22	Sat 11/5/22	90 days
35	Tendering	Sat 11/5/22	Thu 5/4/23	180 days
36	PA issued	Thu 5/4/23	Thu 5/18/23	14 days
37	Feasibility study	Thu 5/18/23	Tue 11/14/23	180 days
38	EP issued	Tue 11/14/23	Thu 12/14/23	30 days
39	PUCSL no object	Thu 12/14/23	Sat 1/13/24	30 days
40	PPA signed	Sat 1/13/24	Mon 2/12/24	30 days
41	Financial closure	Thu 5/4/23	Sat 2/3/24	275 days
42	Mobilized to site	Sat 2/3/24	Mon 3/4/24	30 days
43	Construction (Wind) including transmission	Mon 3/4/24	Tue 8/26/25	540 days
44	Testing & commissioning	Tue 8/26/25	Sat 10/25/25	60 days
45	Generation license	Thu 10/2/25	Sat 11/1/25	30 days
46	Commercial operation	Sat 11/1/25	Sun 11/2/25	1 day

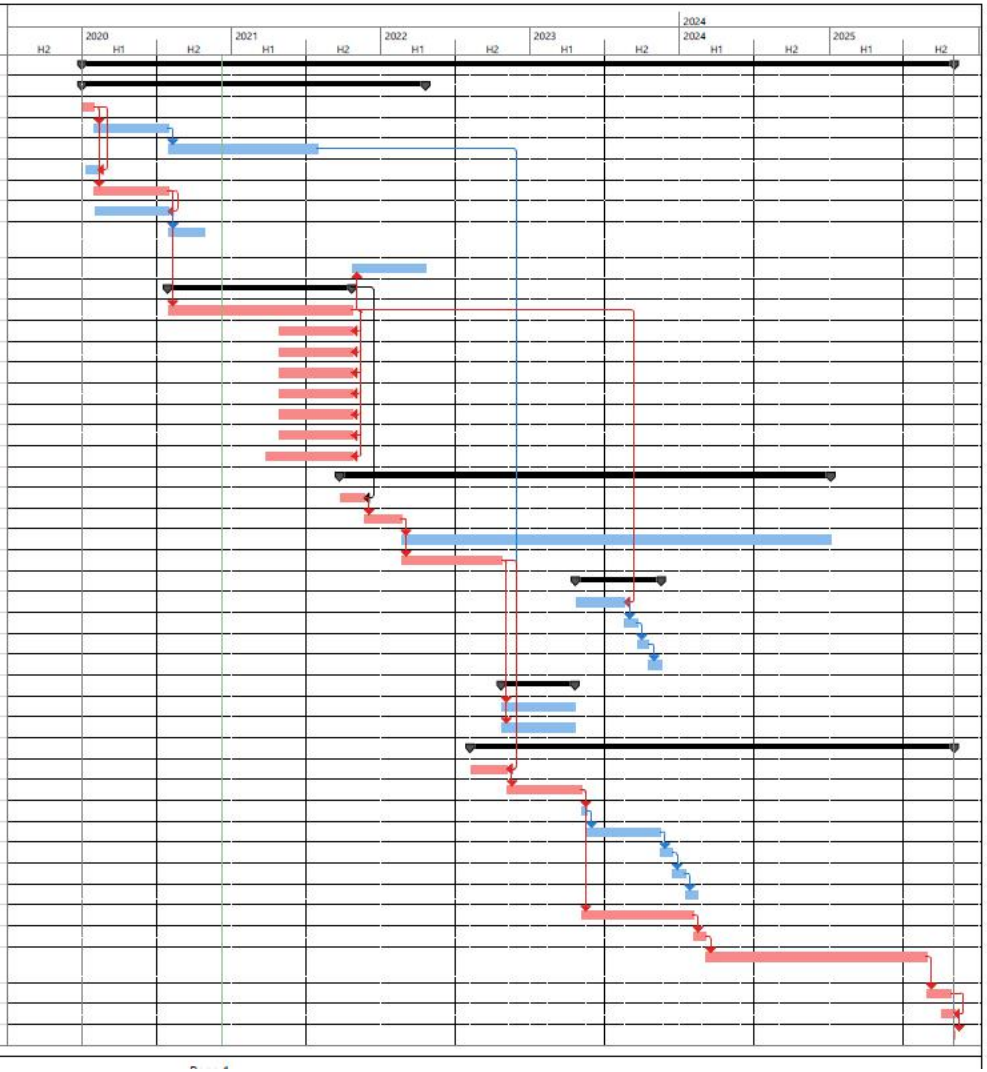


Figure 10.1:Typical utility scale wind power project activity plan

ID	Task Name	Duration	Start	Finish
1	**Typical Utility scale (100MW) Solar project**	**1907 days**	**Wed 1/1/20**	**Sat 3/22/25**
2	**Site Idendification 1**	**575 days**	**Wed 1/1/20**	**Thu 7/29/21**
3	Initial site identification	30 days	Wed 1/1/20	Fri 1/31/20
4	Establishment of weather station	180 days	Fri 1/31/20	Wed 7/29/20
5	Onsite measurements	365 days	Wed 7/29/20	Thu 7/29/21
6	Point of grid connection cleared	30 days	Fri 1/10/20	Sun 2/9/20
7	Pre-feasibility	180 days	Fri 1/31/20	Wed 7/29/20
8	IEE	180 days	Fri 1/31/20	Wed 7/29/20
9	Declaration of Energy Development Area	90 days	Wed 7/29/20	Tue 10/27/20
10	**Approvals**	**365 days**	**Wed 7/29/20**	**Thu 7/29/21**
11	CEA/EIA	365 days	Wed 7/29/20	Thu 7/29/21
12	Wild Life Dept	180 days	Sat 1/30/21	Thu 7/29/21
13	Forest Dept	180 days	Sat 1/30/21	Thu 7/29/21
14	DS's no objection	180 days	Sat 1/30/21	Thu 7/29/21
15	Local Authority	180 days	Sat 1/30/21	Thu 7/29/21
16	Department of Agrarian Development	180 days	Sat 1/30/21	Thu 7/29/21
17	Deartment of Irrigation	180 days	Sat 1/30/21	Thu 7/29/21
18	Archeology Department	210 days	Thu 12/31/20	Thu 7/29/21
19	**Land acquisition**	**1200 days**	**Tue 6/29/21**	**Fri 10/11/24**
20	Land acquisition, survey plan	60 days	Tue 6/29/21	Sat 8/28/21
21	Land acquisition, advance tracing	90 days	Sat 8/28/21	Fri 11/26/21
22	Valuation and Compensation	1050 days	Fri 11/26/21	Fri 10/11/24
23	Land aquired (Section 38A)	245 days	Fri 11/26/21	Fri 7/29/22
24	**Project acceptance**	**210 days**	**Thu 4/20/23**	**Thu 11/16/23**
25	Transaction Structuring	120 days	Thu 4/20/23	Fri 8/18/23
26	Board approval	30 days	Fri 8/18/23	Sun 9/17/23
27	MOPE approved	30 days	Sun 9/17/23	Tue 10/17/23
28	Cabinet approved	30 days	Tue 10/17/23	Thu 11/16/23
29	**Project infrastructure development**	**180 days**	**Fri 7/29/22**	**Wed 1/25/23**
30	Site Clearaning and blocking out	180 days	Fri 7/29/22	Wed 1/25/23
31	Access Roads	180 days	Fri 7/29/22	Wed 1/25/23
32	**Tendering**	**1043 days**	**Sat 5/14/22**	**Sat 3/22/25**
33	Tender document preparation	90 days	Sat 5/14/22	Fri 8/12/22
34	Tendering	180 days	Fri 8/12/22	Wed 2/8/23
35	PA issued	14 days	Wed 2/8/23	Wed 2/22/23
36	Feasibility study	180 days	Wed 2/22/23	Mon 8/21/23
37	EP issued	30 days	Mon 8/21/23	Wed 9/20/23
38	PUCSL no object	30 days	Wed 9/20/23	Fri 10/20/23
39	PPA signed	30 days	Fri 10/20/23	Sun 11/19/23
40	Financial closure	275 days	Wed 2/8/23	Fri 11/10/23
41	Mobilized to site	30 days	Fri 11/10/23	Sun 12/10/23
42	Construction (Solar) including transmission	400 days	Sun 12/10/23	Mon 1/13/25
43	Testing & commissioning	60 days	Mon 1/13/25	Fri 3/14/25
44	Generation license	30 days	Wed 2/19/25	Fri 3/21/25
45	Commercial operation	1 day	Fri 3/21/25	Sat 3/22/25

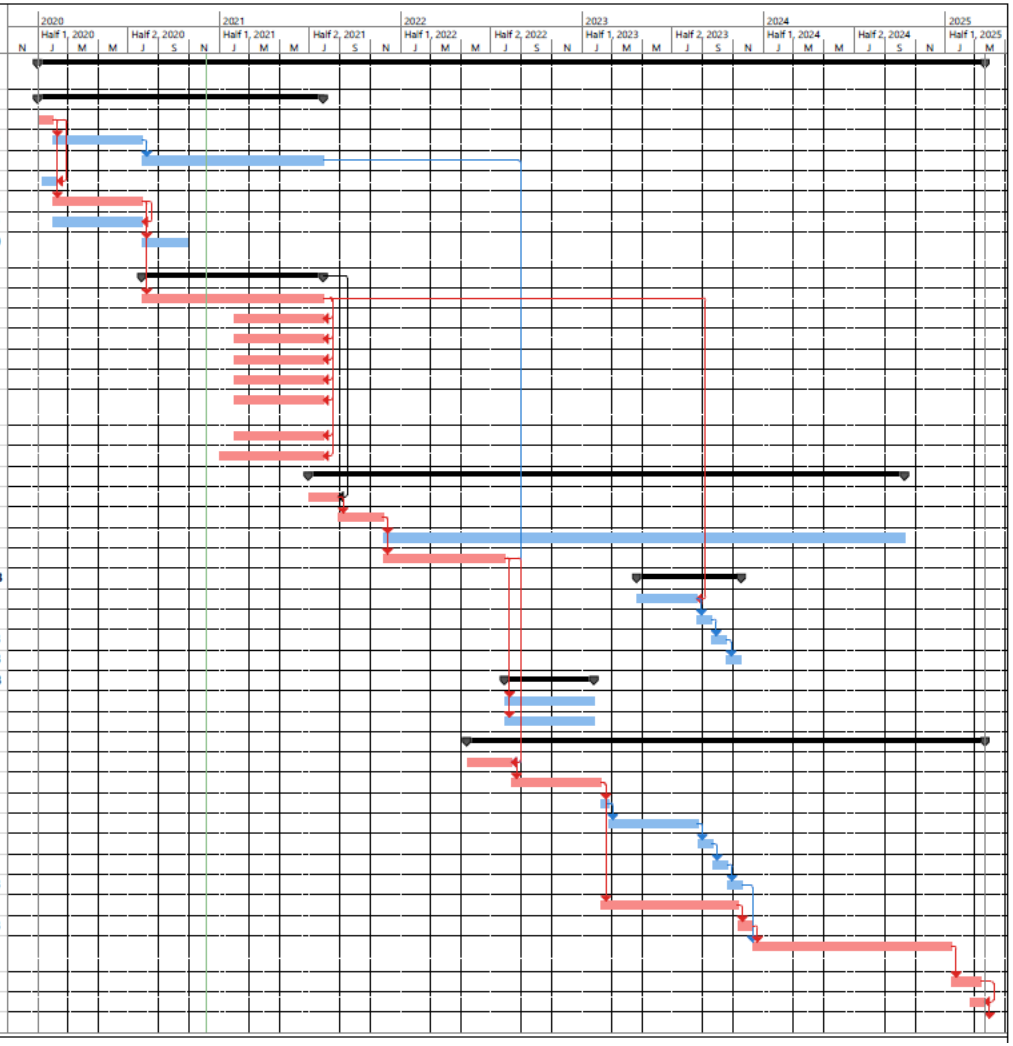
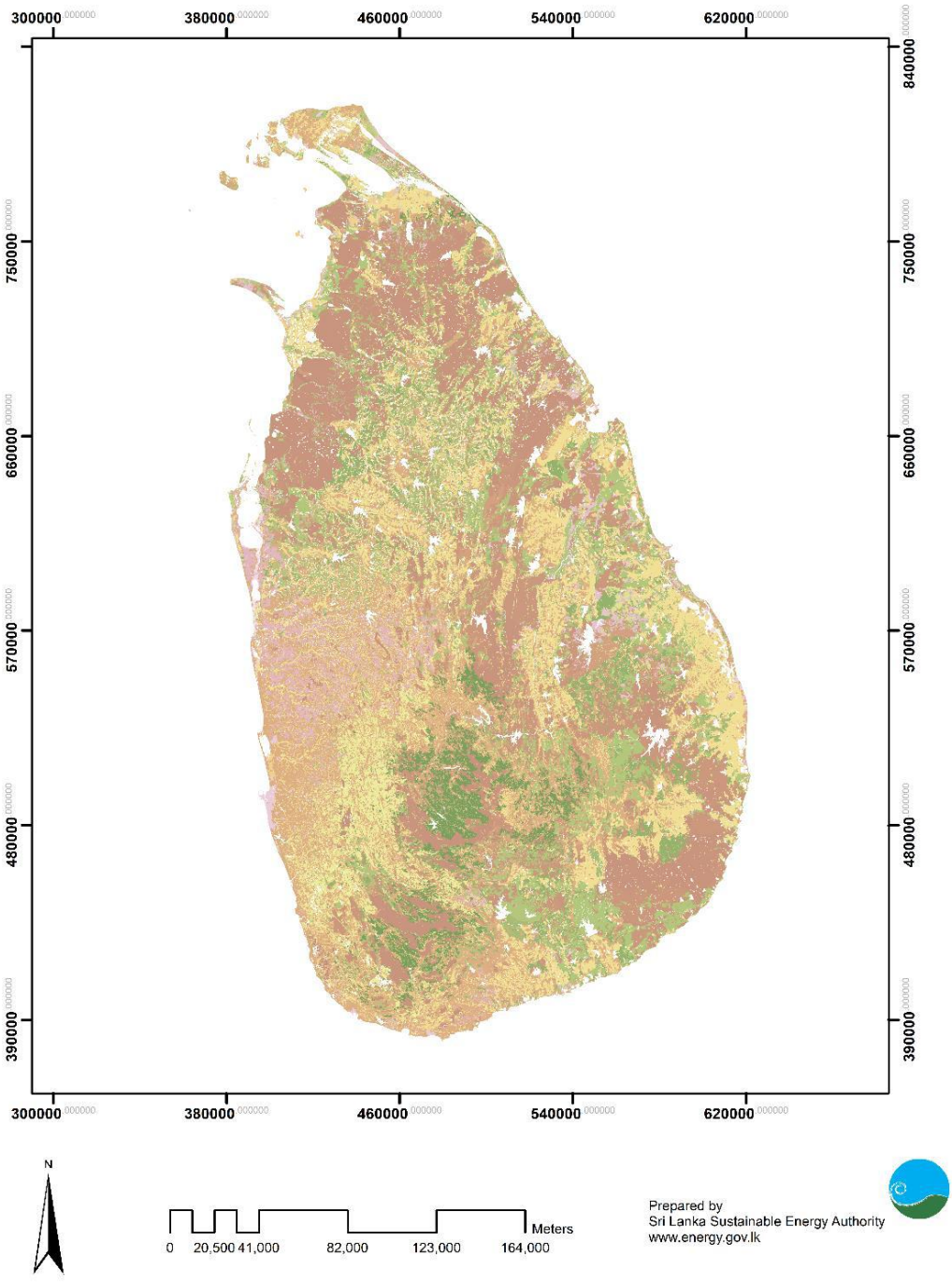


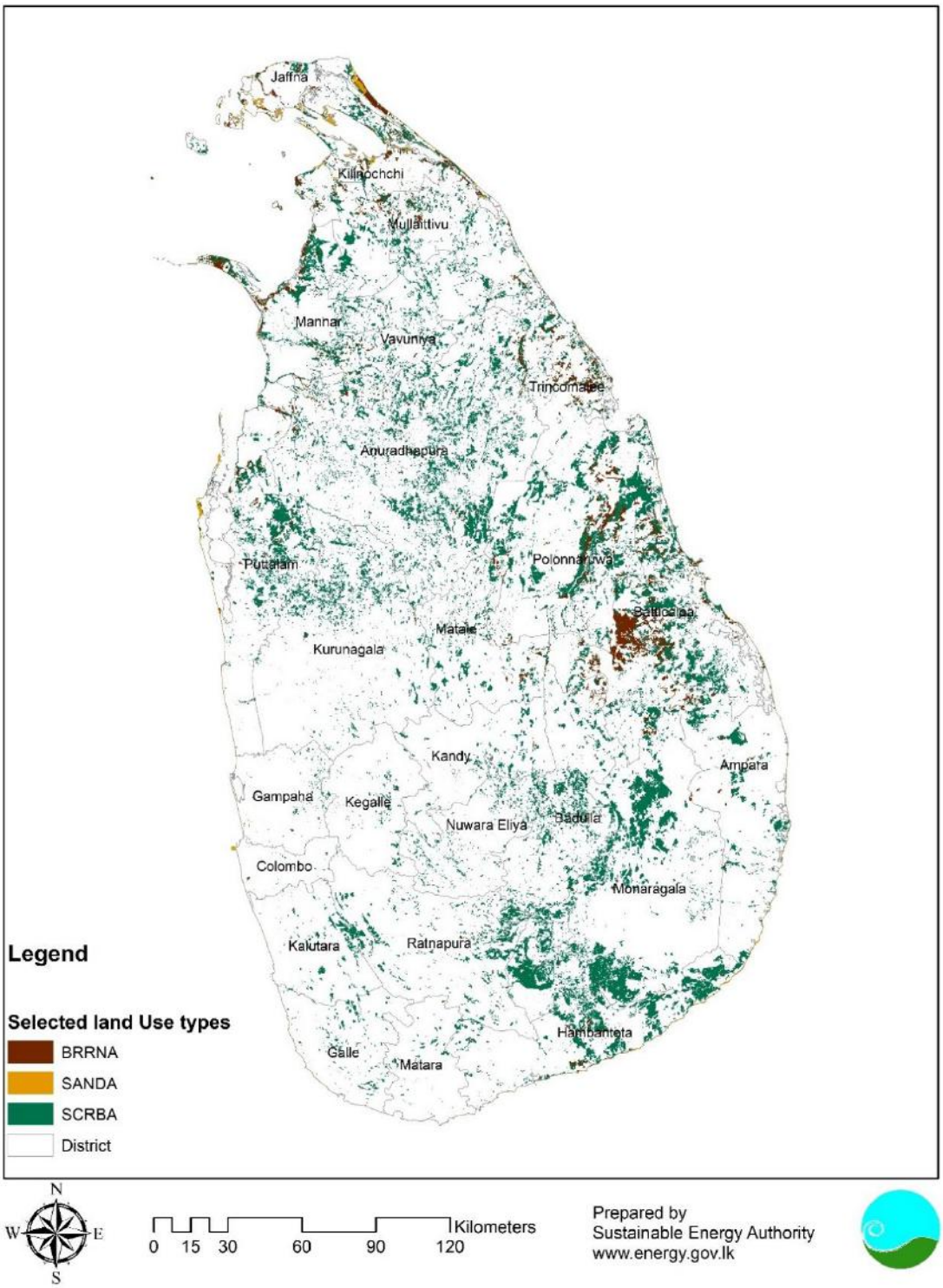
Figure 10.2:Typical utility scale Solar power project activity plan

Appendices

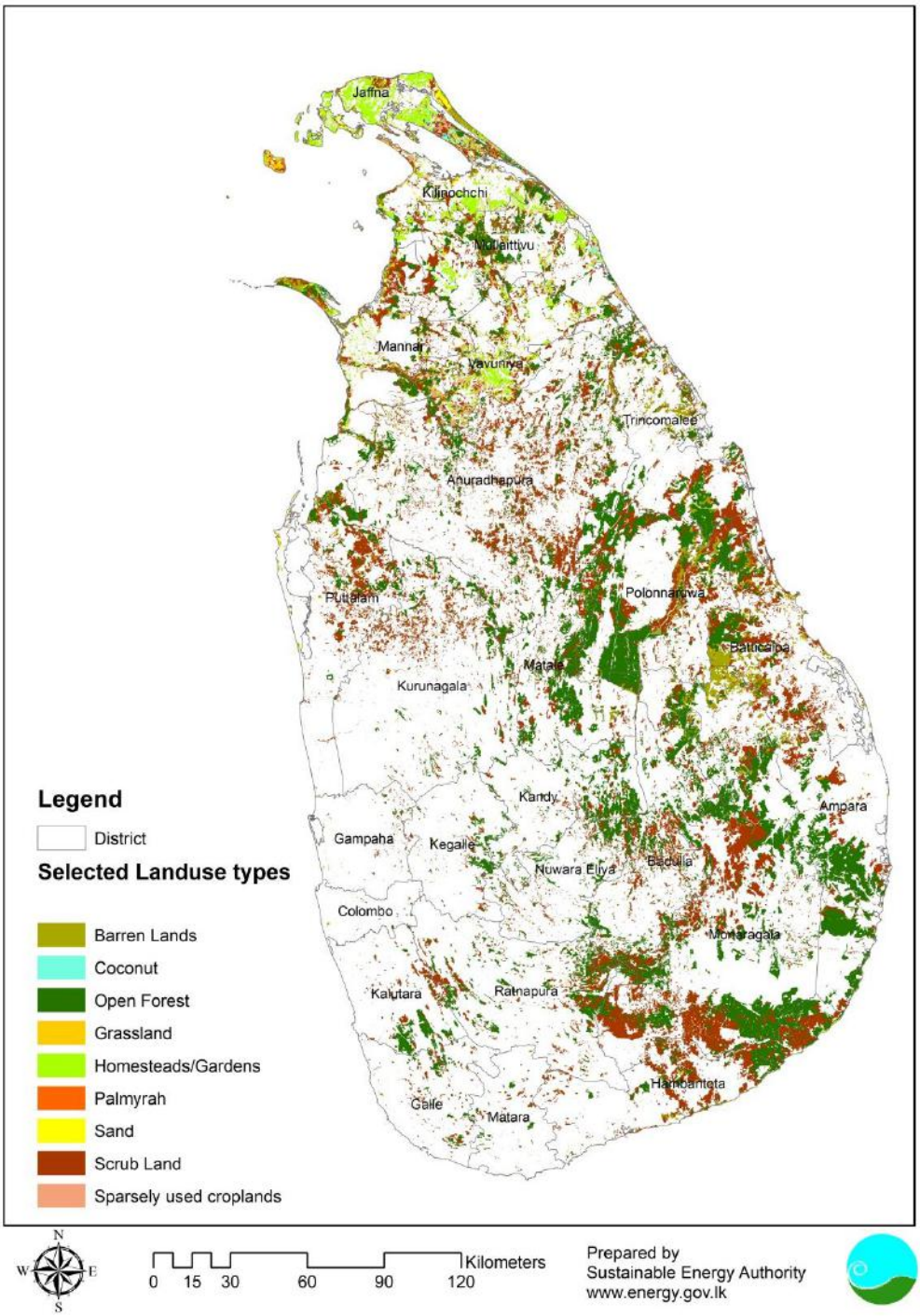
Annex 1: Land use layer of Sri Lanka



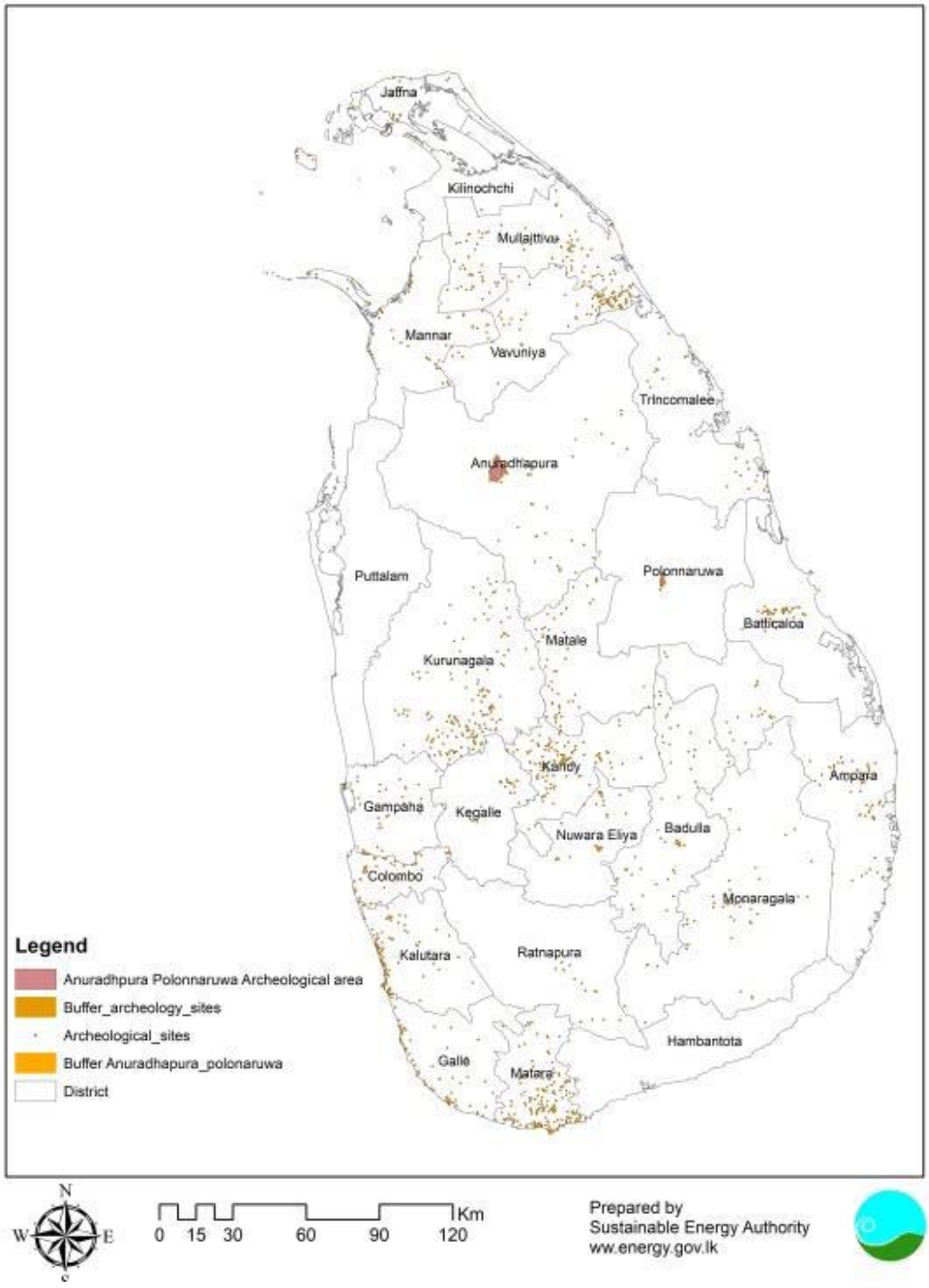
Annex 2: Selected landuse for solar and biomass power development



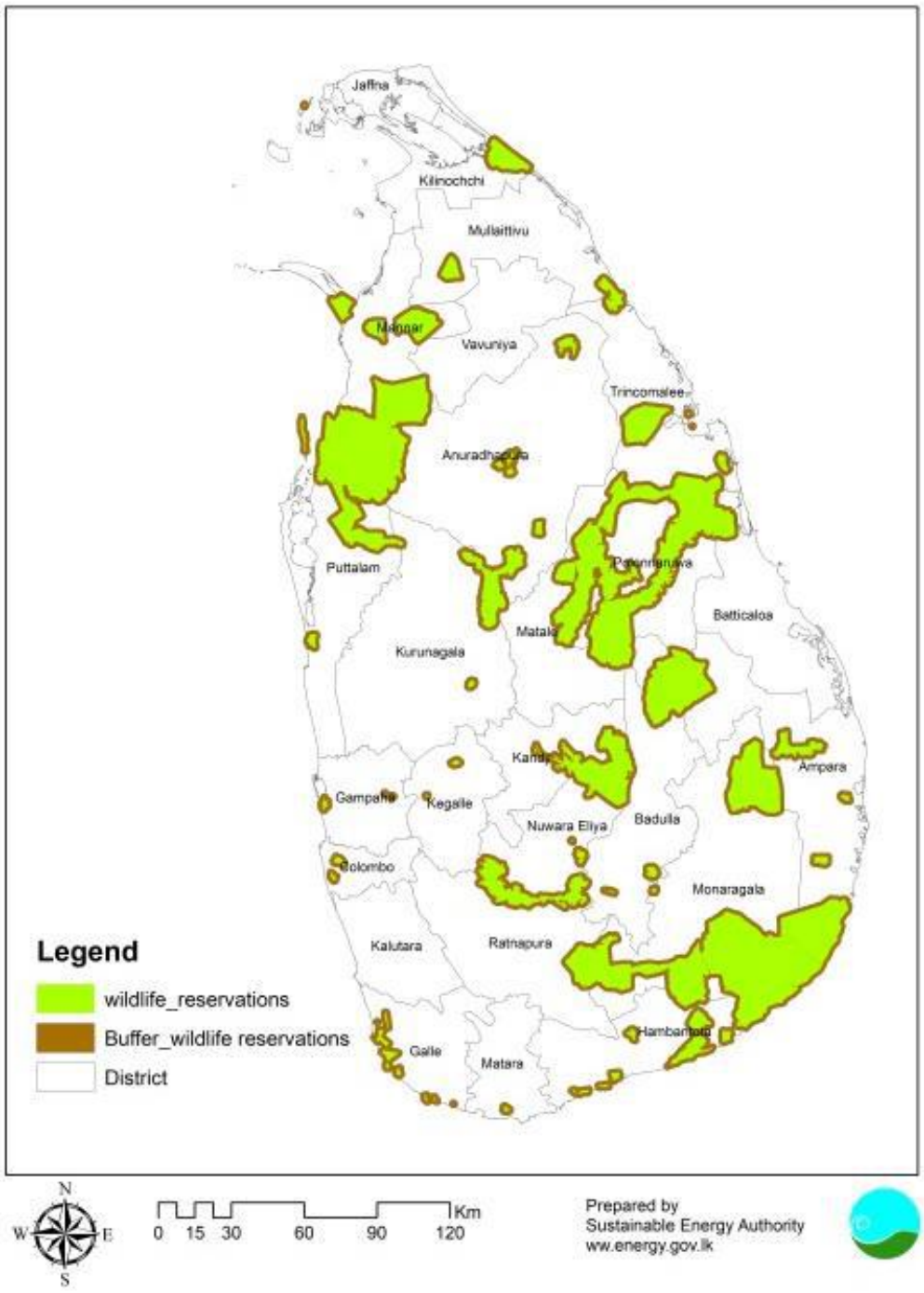
Annex 3: Selected landuse for wind power development



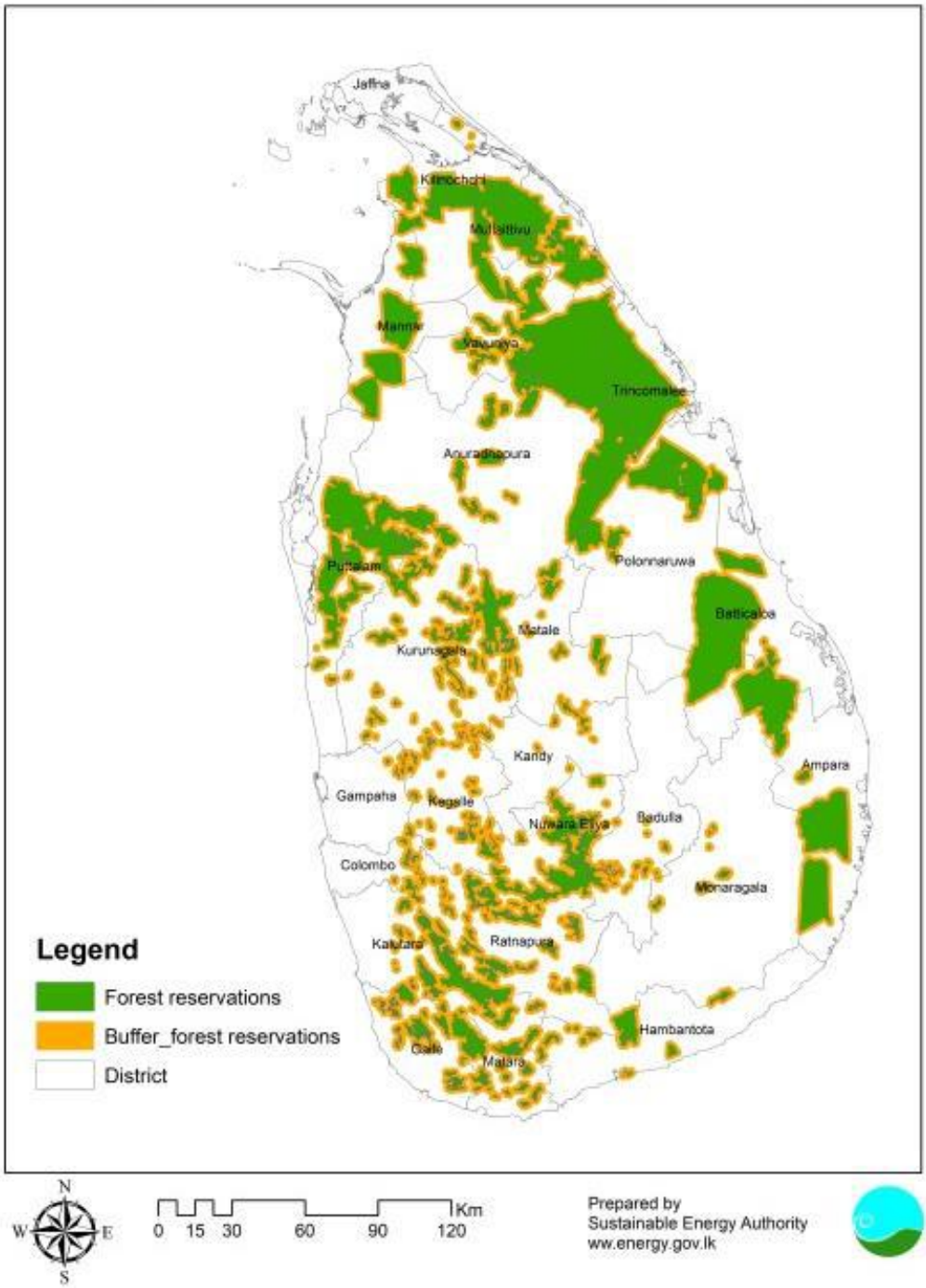
Annex 4 : Map of Archeological Reservation with Buffer Zone



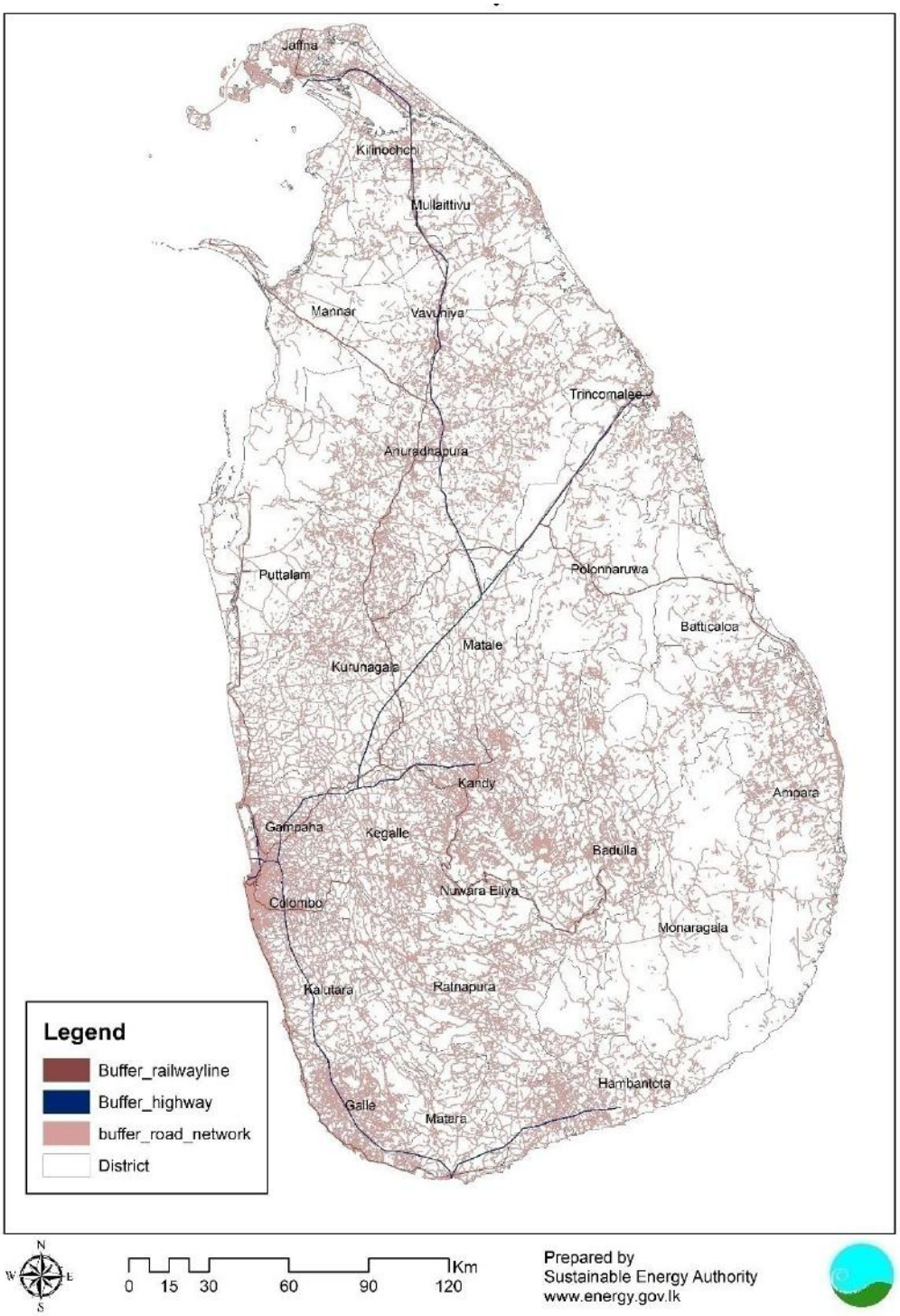
Annex 5 : Map of Forest Reservation with Buffer Zone



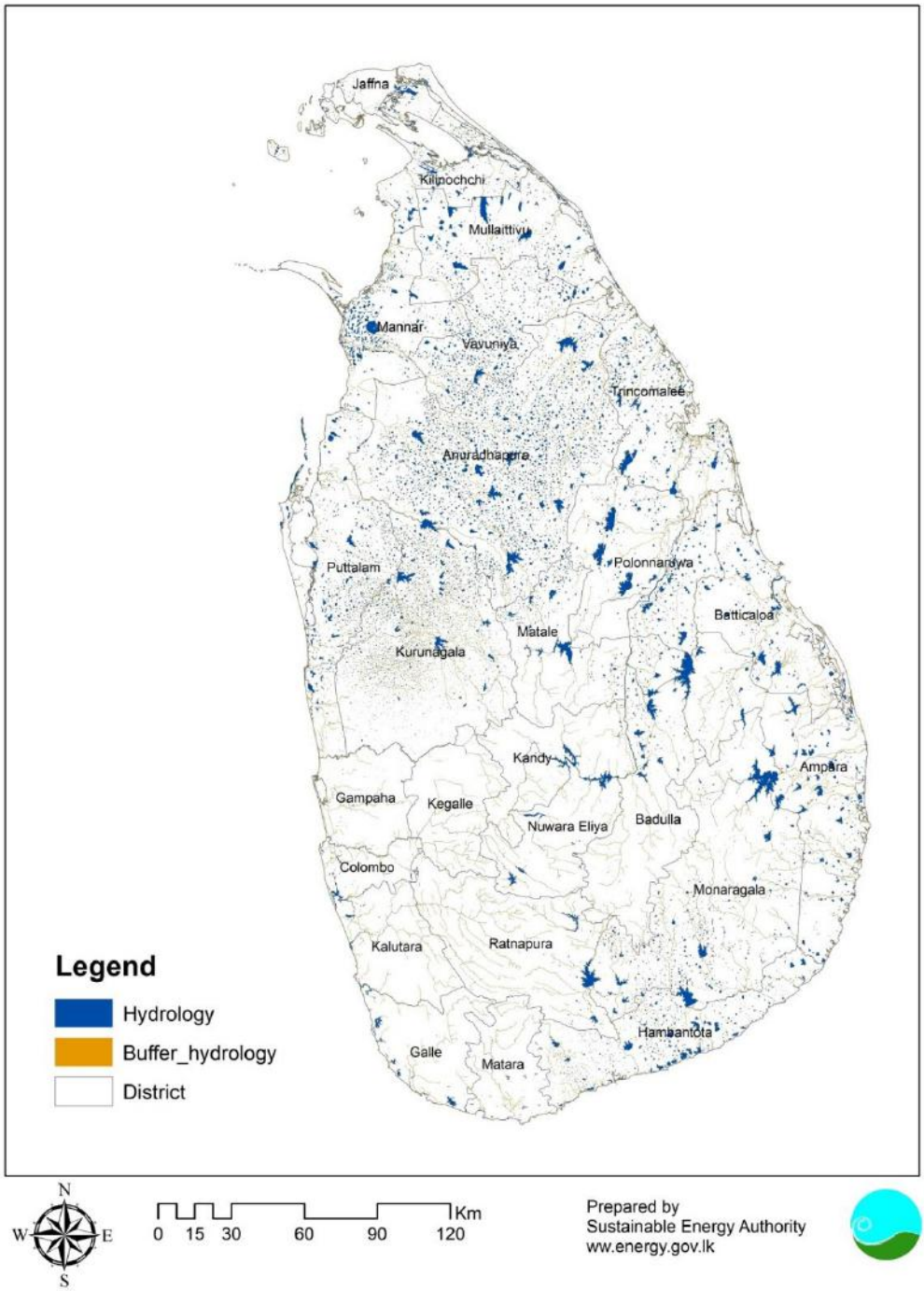
Annex 6 : Map of Forest Reservation with Buffer Zone



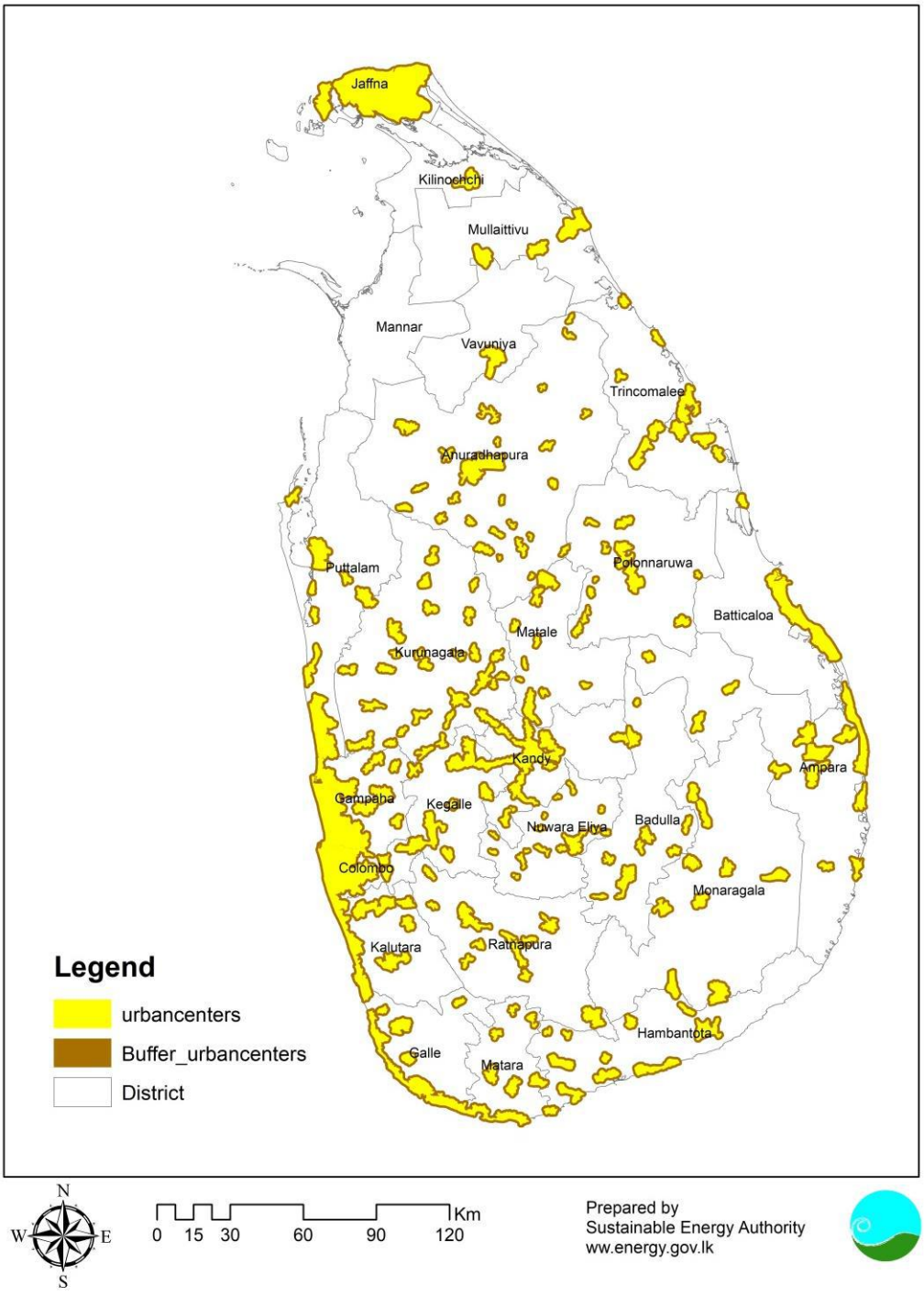
Annex 7 : Road and Railroad Map with buffer



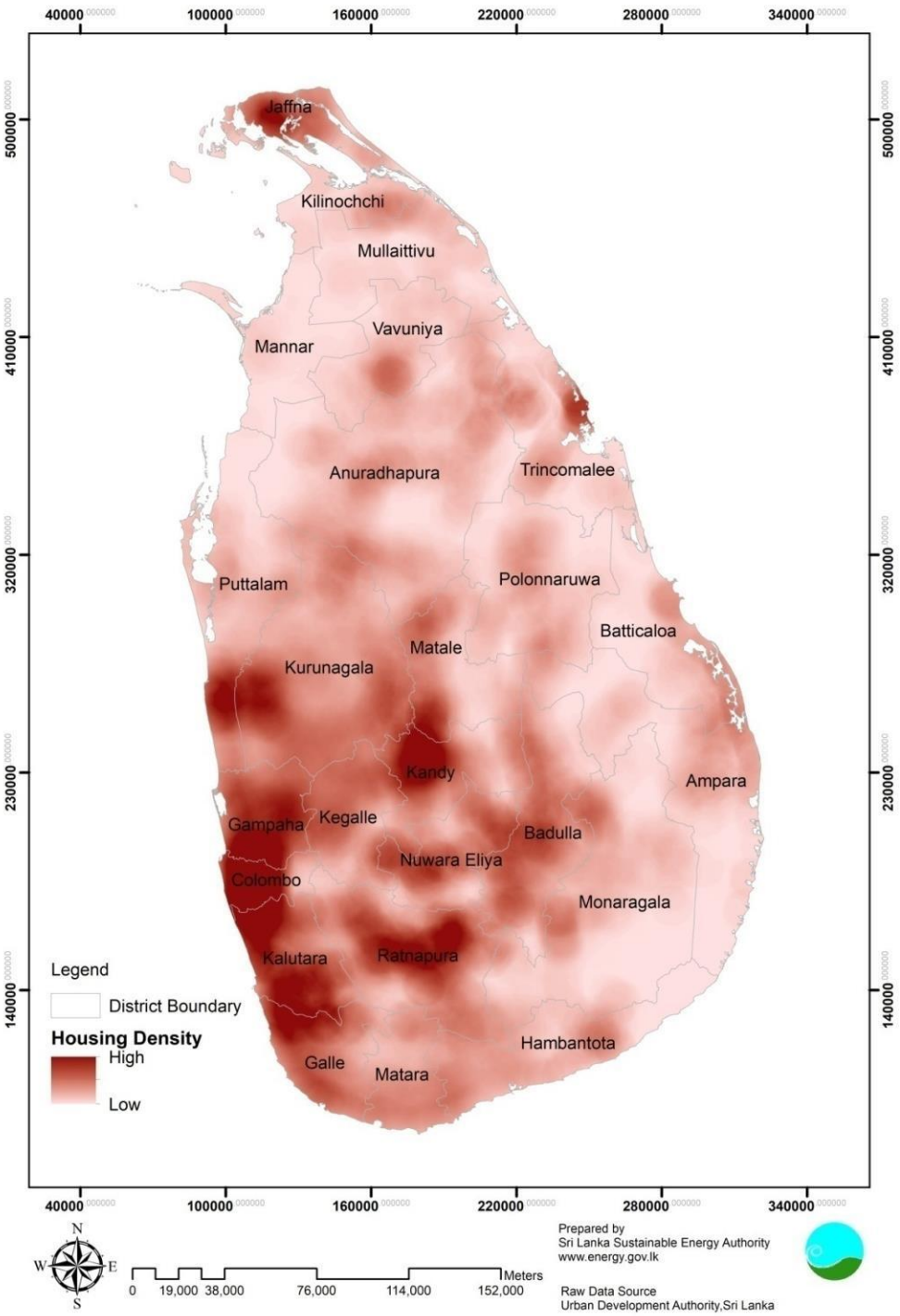
Annex 8 : Map of hydrology buffer



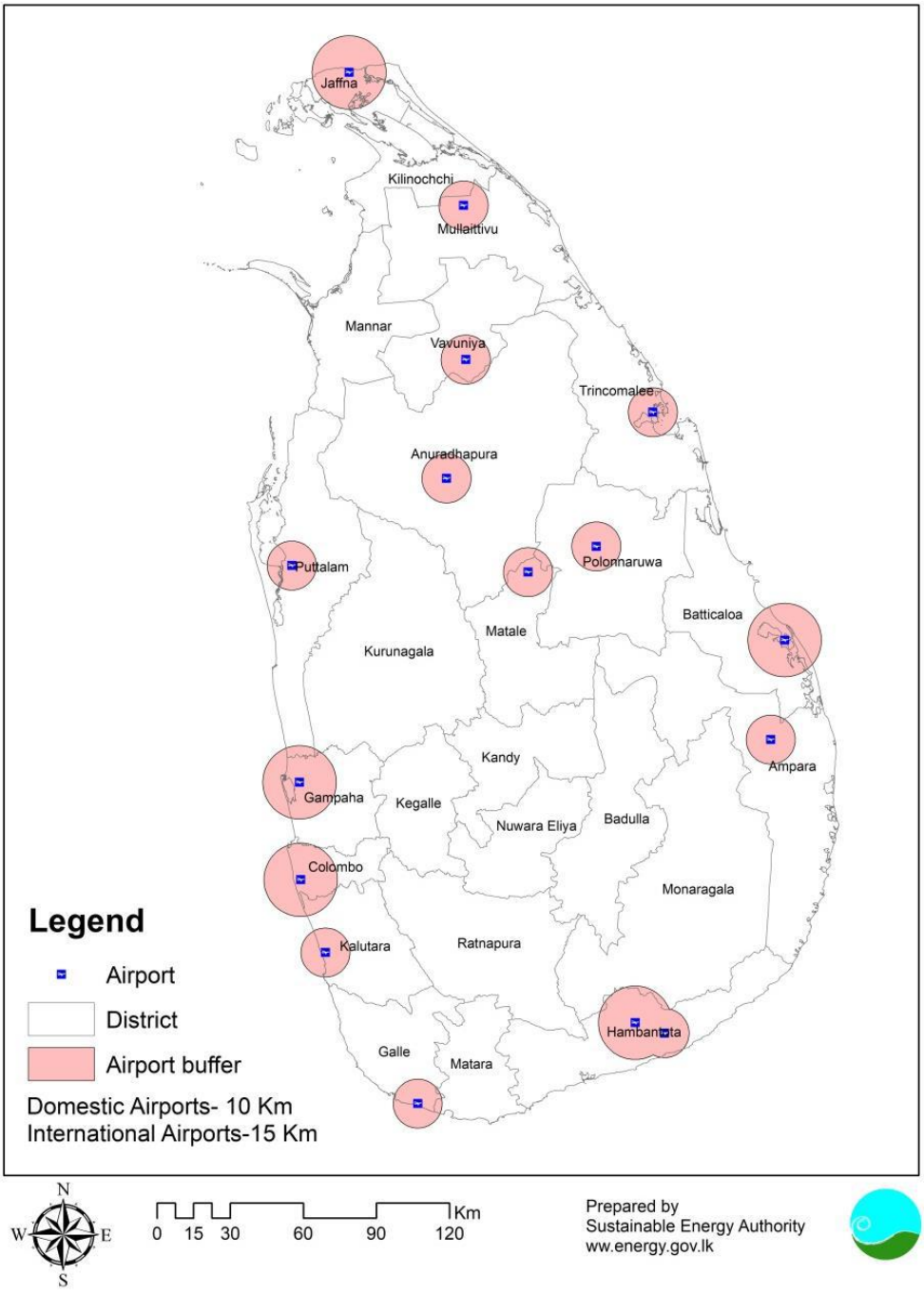
Annex 9 : Map of urban centers



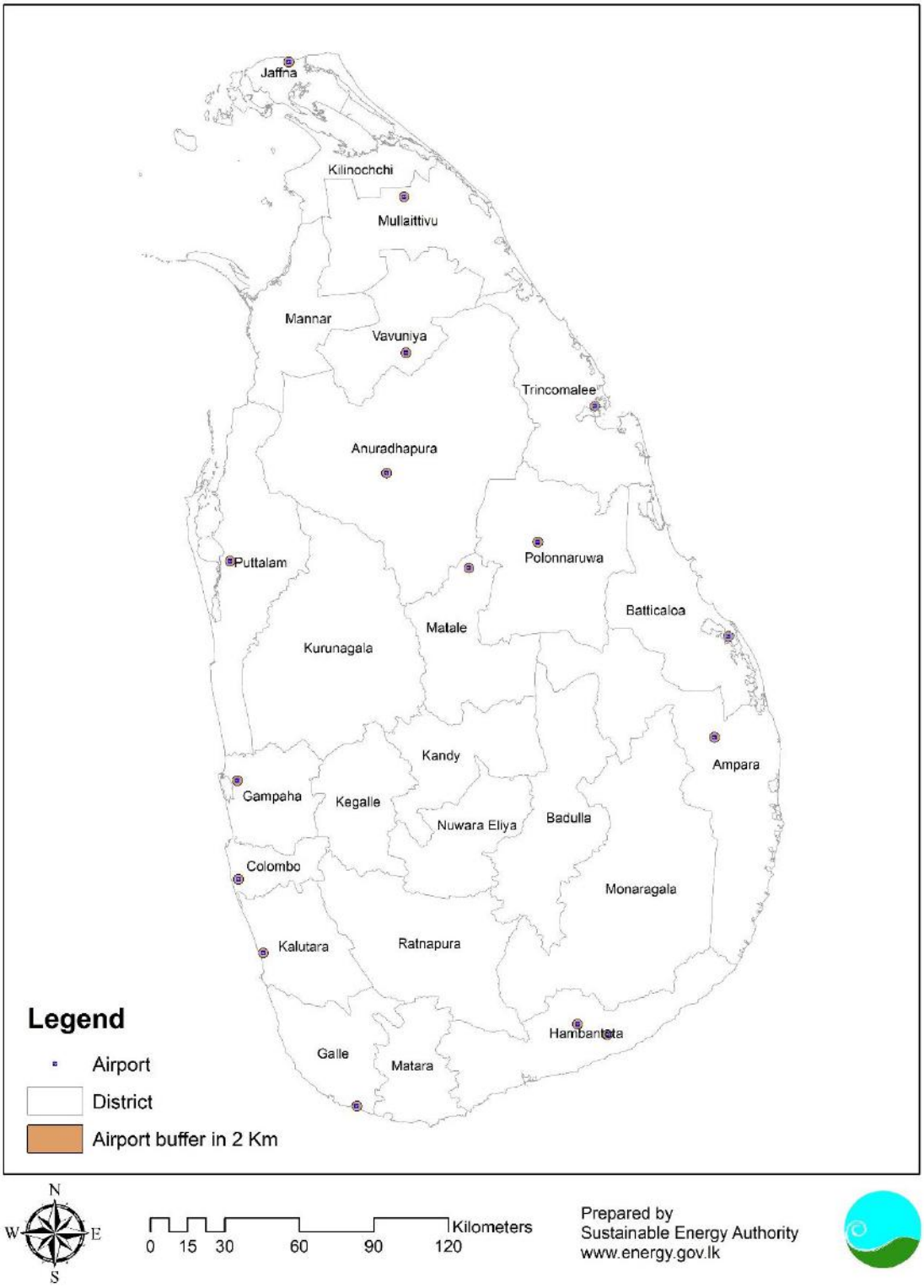
Annex 10: Map of housing density



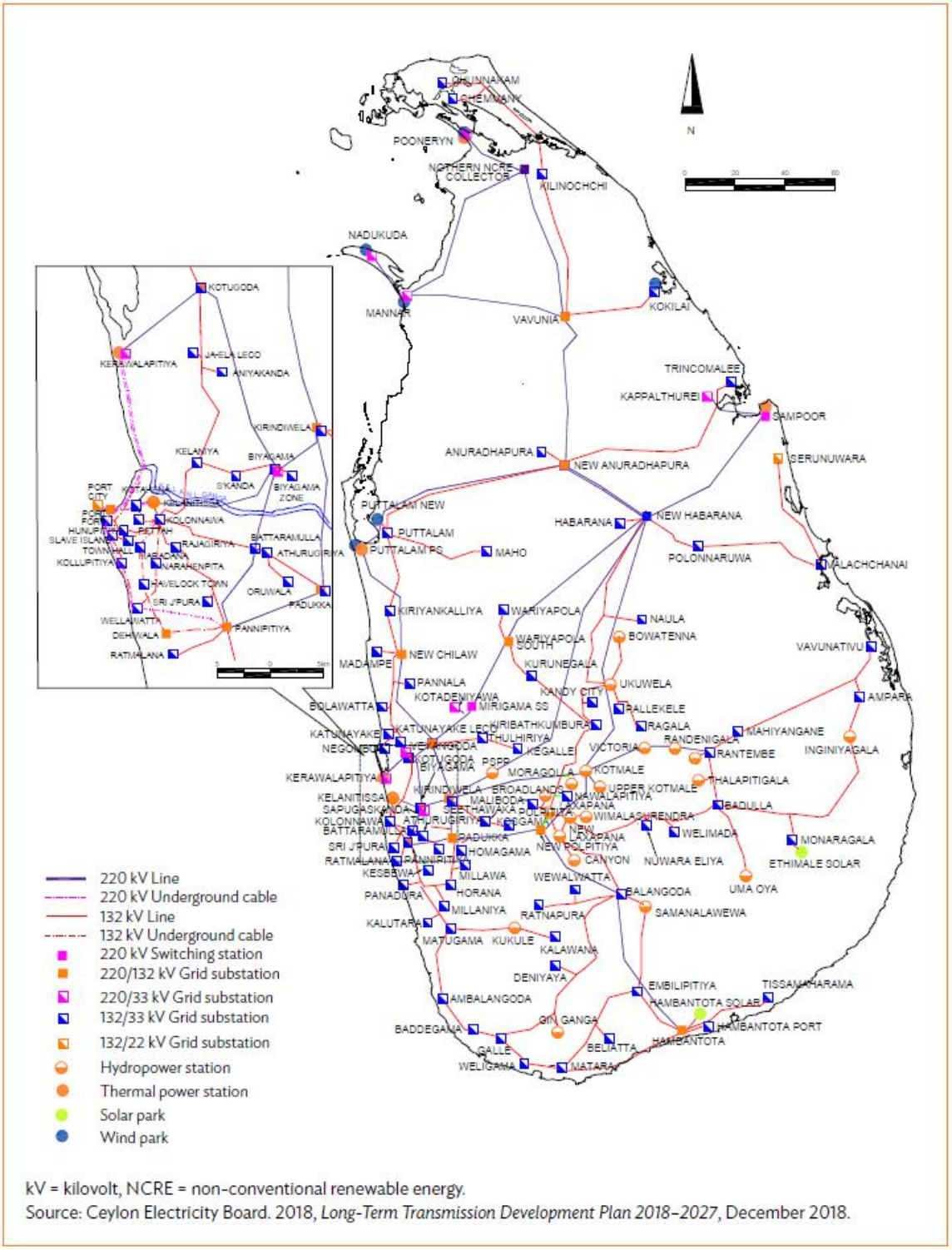
Annex 11 : Map of airport buffersfor wind power development



Annex 12 : Map of airport buffer in 2km for solar power development



Annex 13 :Transmission Network



kV = kilovolt, NCRE = non-conventional renewable energy.
Source: Ceylon Electricity Board. 2018, *Long-Term Transmission Development Plan 2018–2027*, December 2018.

11. References

1. Vitanage, P.W., 1970 A study of geomorphology and morphotecttonics in Ceylon, Proceedings of the Seminar on geochemical prospecting methods and techniques, Peradeniya, Sri Lanka, University of Ceylon, pp 391–406