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Joint ICTP-IAEA Workshop on Sustainable Energy Development: Pathways and Strategies after Rio+20

1 - 5 October 2012

SUSTAINABLE ENERGY DEVELOPMENT PLAN FOR SRI LANKA

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SUSTAINABLE ENERGY DEVELOPMENT PLAN FOR SRI LANKA

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Thushara De Silva *Ceylon Electricity Board*

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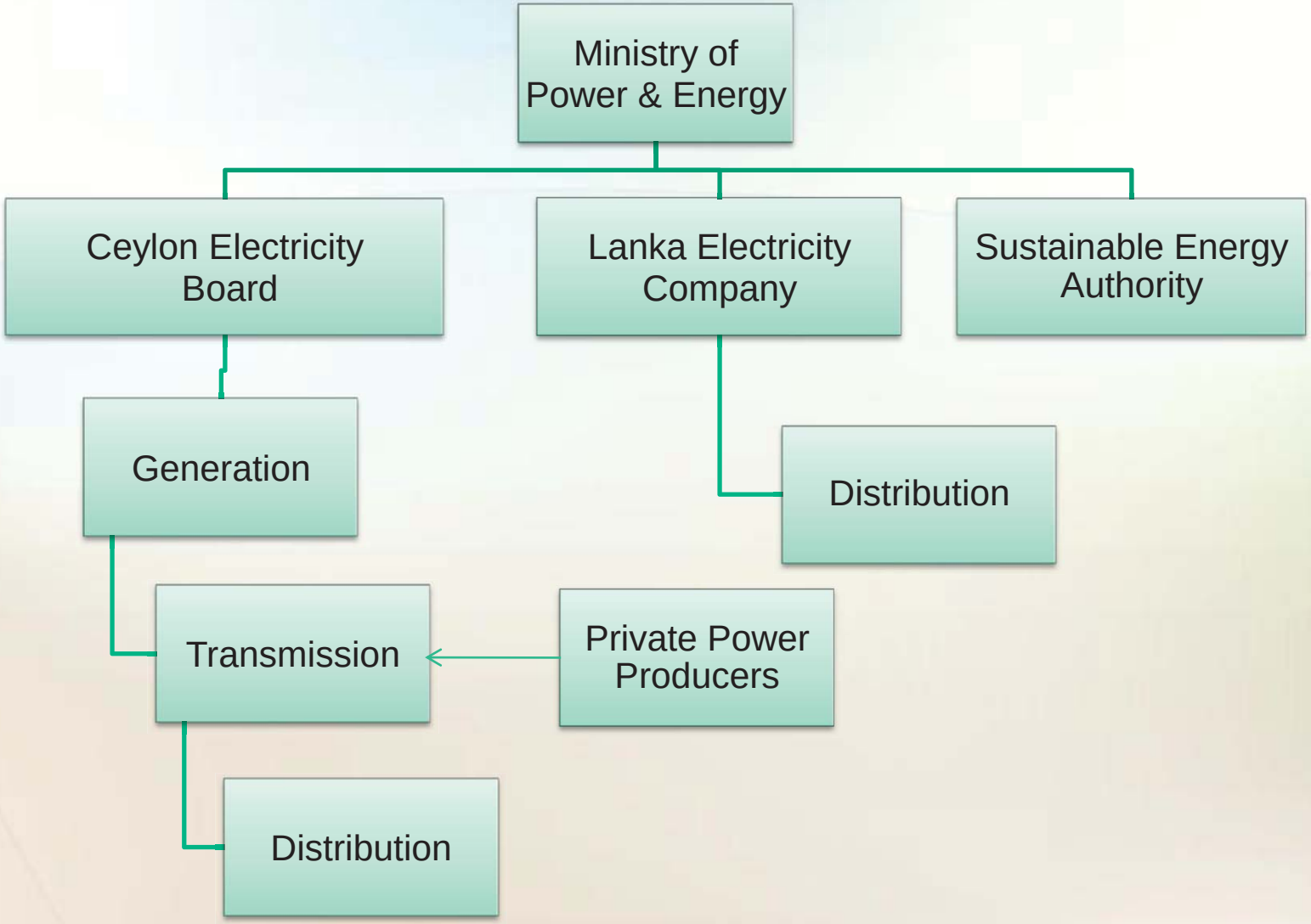
- Electricity Sector Development Plan


Where we are!
to Europe
Russia
Kazakhstan
Mongolia
Uzbek.
Kyrgyz.
Turkmenistan
Tajik.
China
North Korea
Japan
Afghanistan
Tibet
Bhutan
Pakistan
Nepal
South Korea
to Mideast
India
R.O.C. (Taiwan)
Burma
Hong Kong
Macau
Laos
Paracel Is.
Bangladesh
Thailand
Vietnam
Cambodia
Spratly Is.
Philippines
Sri Lanka
Brunei
Maldives
Malaysia
Singapore
Indonesia
to Oceania
East Timor
Cocos Is.
Christmas Isl.
©1996 Brandon Plewe
Sri Lanka

Sri Lanka

- Population : 21 million
- Area : 65610 sq km
- Population density : 310 persons / sq km
- Per capita GDP at market prices : 2836 USD
- GDP growth rate : 8.5% (2011)
  5.5% (Avg. 2006-'11)
- Literacy rate : 92.5%
- Life expectancy : 72 yrs (M), 77 yrs (F)

Organisation Structure



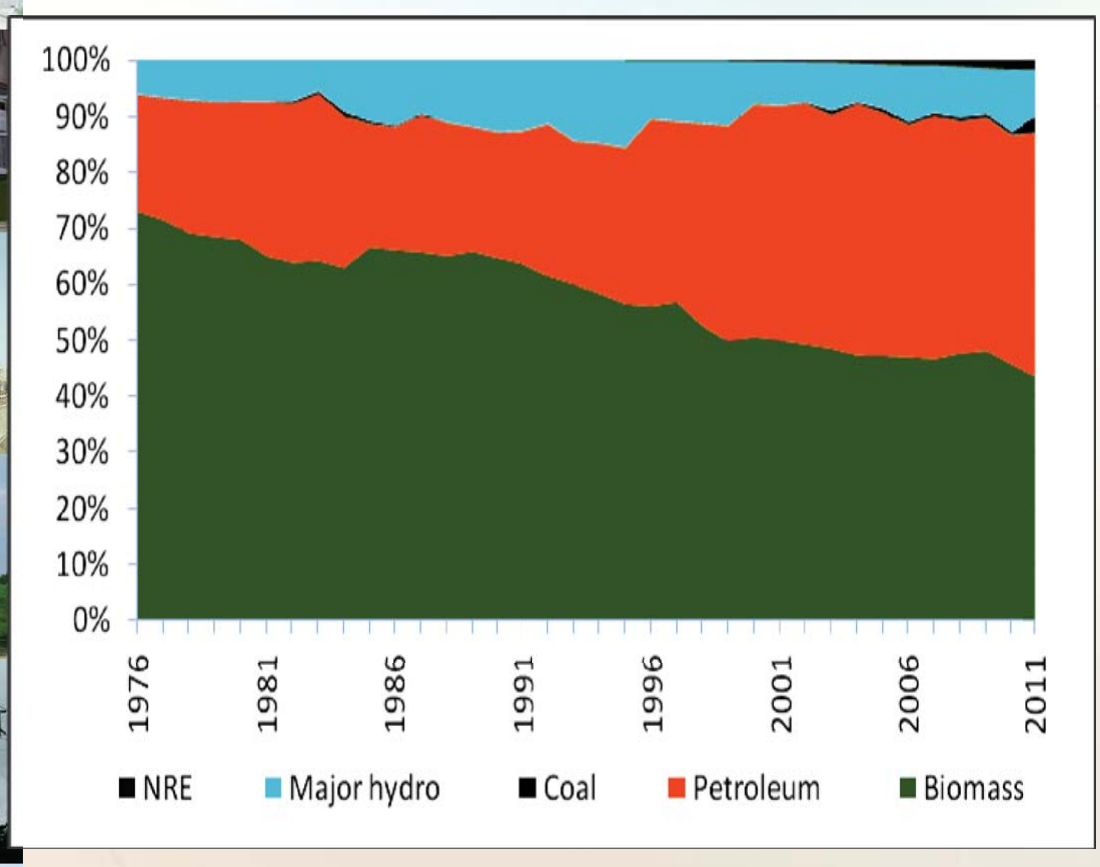
Overview of Energy Sector

Energy Sources

- No Proven oil, gas or coal resources
- Oil exploration to start in the next year
  (sea between India and Sri Lanka)
- Hydro and Biomass, Wind, Solar the only indigenous resources
- Hydro resources tapped to a great extent
- 44.5% export Earning is for Oil import
  One refinery – not sufficient to meet the demand

Overview of Energy Sector

Primary Energy Supply

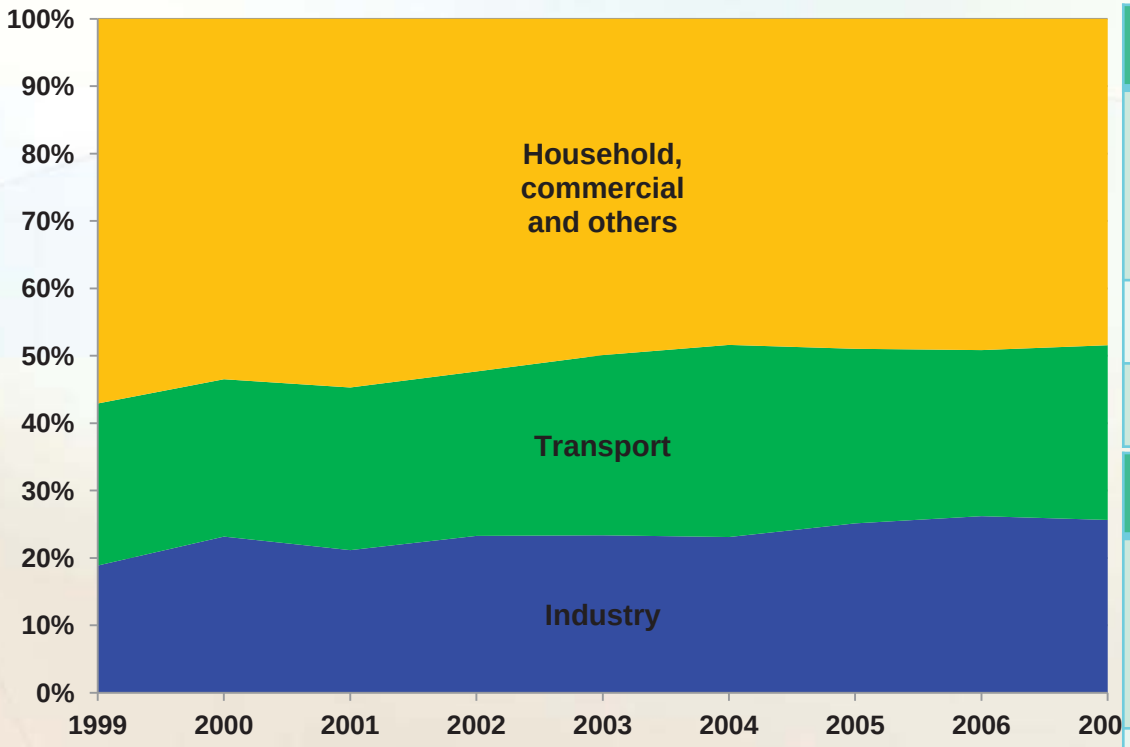


Source	Share
Biomass	43.7%
Petroleum	43.4%
Coal	2.9
Major Hydro	8.5
Other Renewable	1.6

Source (2011)	ktoe
Biomass	4,944.4
Petroleum	4,914.8
Coal	324.0
Major Hydro	964.2
Renewable	178.4
Total	11,325.

Overview of Energy Sector

Energy Sectoral Consumption



Sector	Share
Household & Commercial	48%
Transport	26%
Industry	26%

Sector (2007)	ktoe
Household & Commercial	3,988
Transport	2,134
Industry	2,111
Total	8,234

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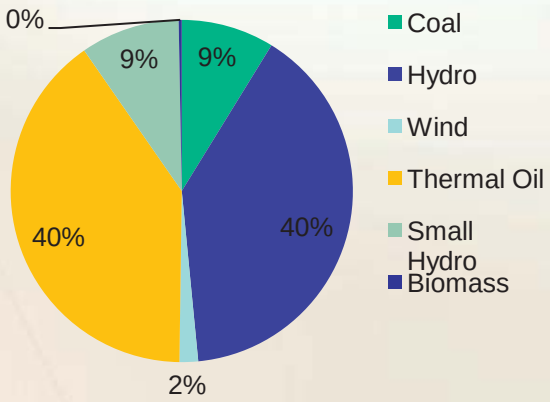
Sri Lanka – Electricity Sector

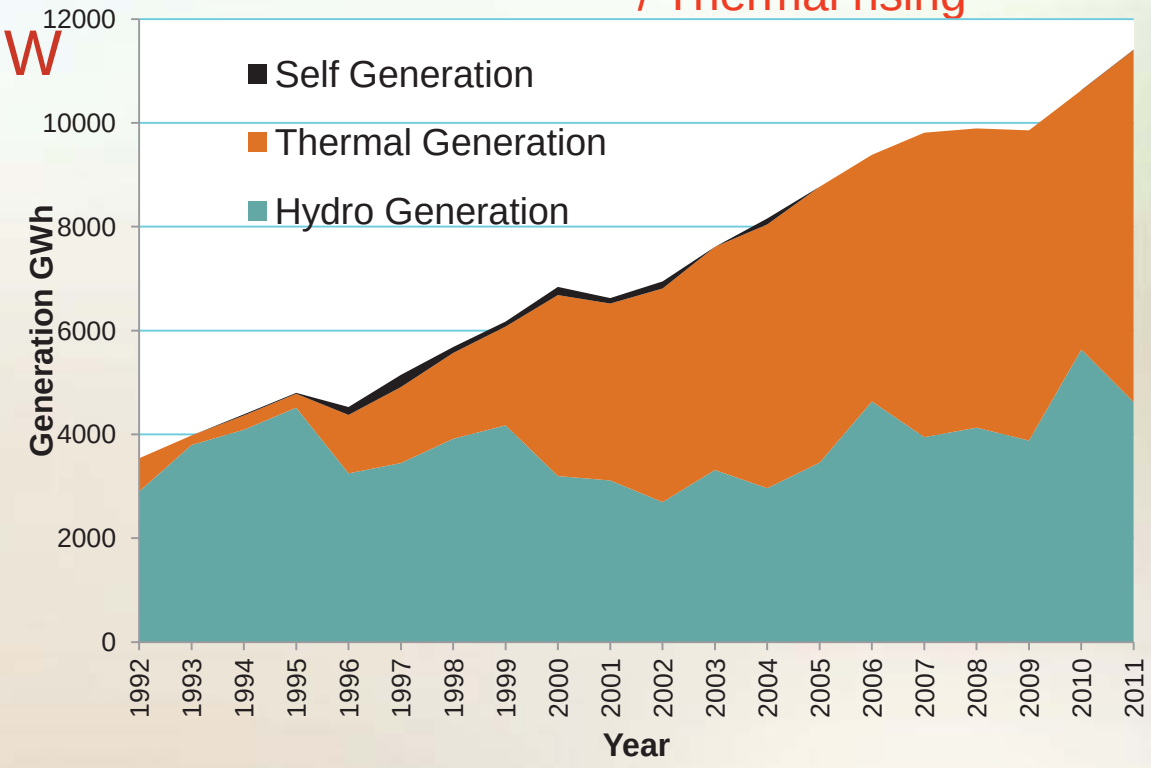
- Total Installed Capacity - 3300 MW
  - Hydro- 1355 MW
  - Thermal oil- 1370 MW Coal -300MW
  - Wind 63 MW
  - Small Hydro 201 MW
  - Biomass 10MW

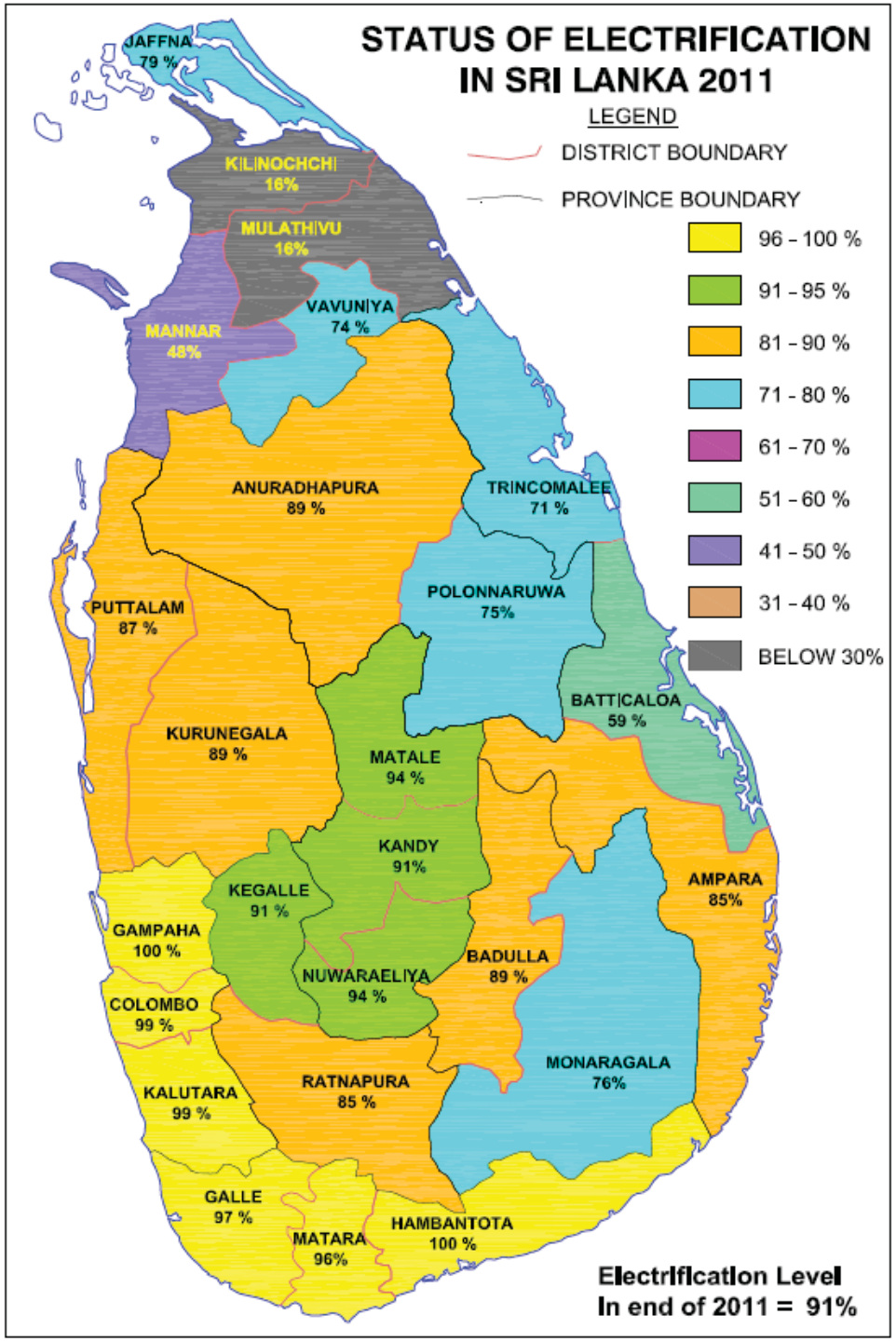


GWh 2011

Renewable	**4743**	**41%**
Thermal	**6785**	**59%**

Share of hydro decreasing / Thermal rising





Electricity Sector

- % of Household electrified - 91%
- Ave elect consumption/capita - 478 KWh/per
- Maximum Demand – 2153MW
- Annual Growth rate – 7- 8%

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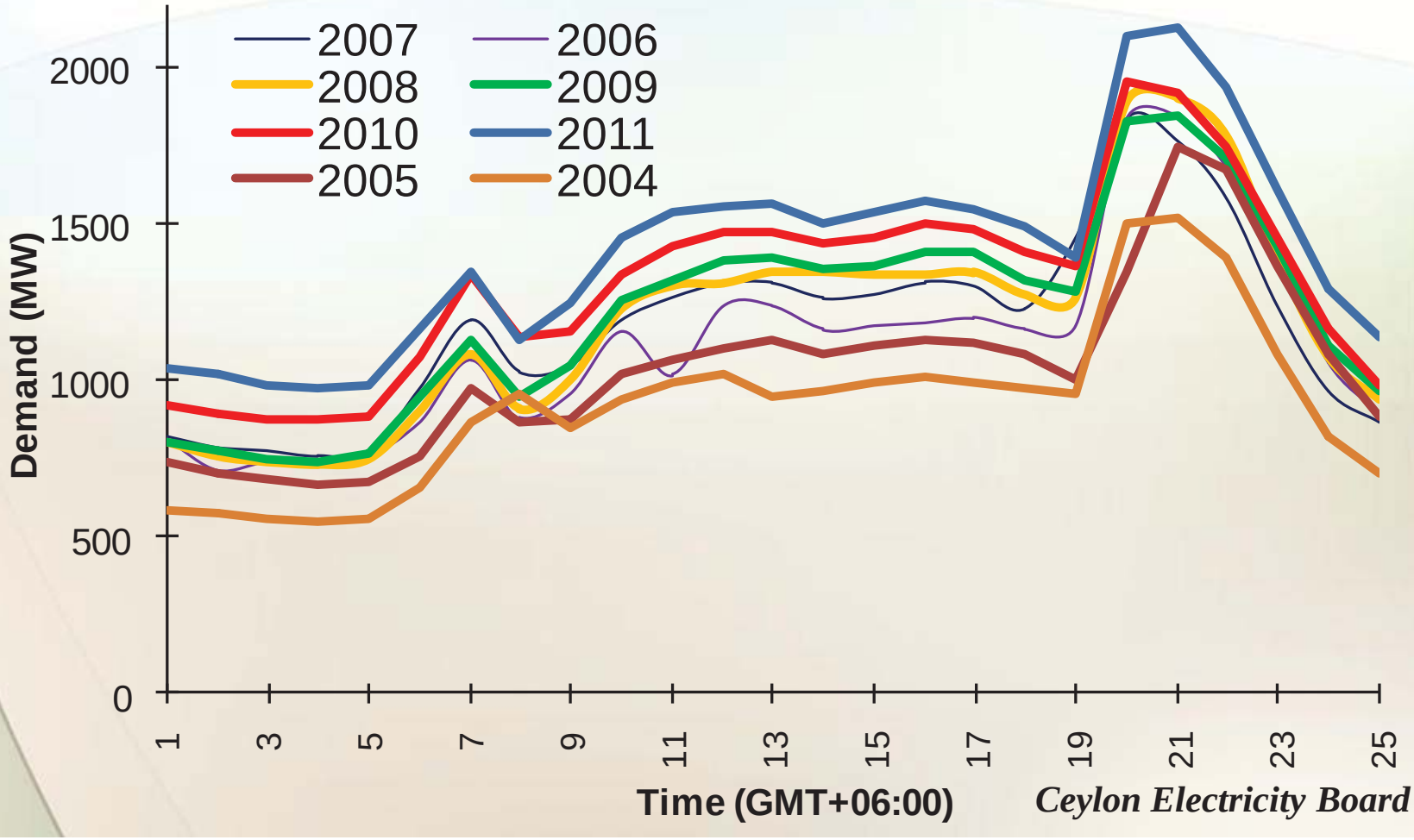
Electricity Sector

Electricity Demand – Daily Load Curve



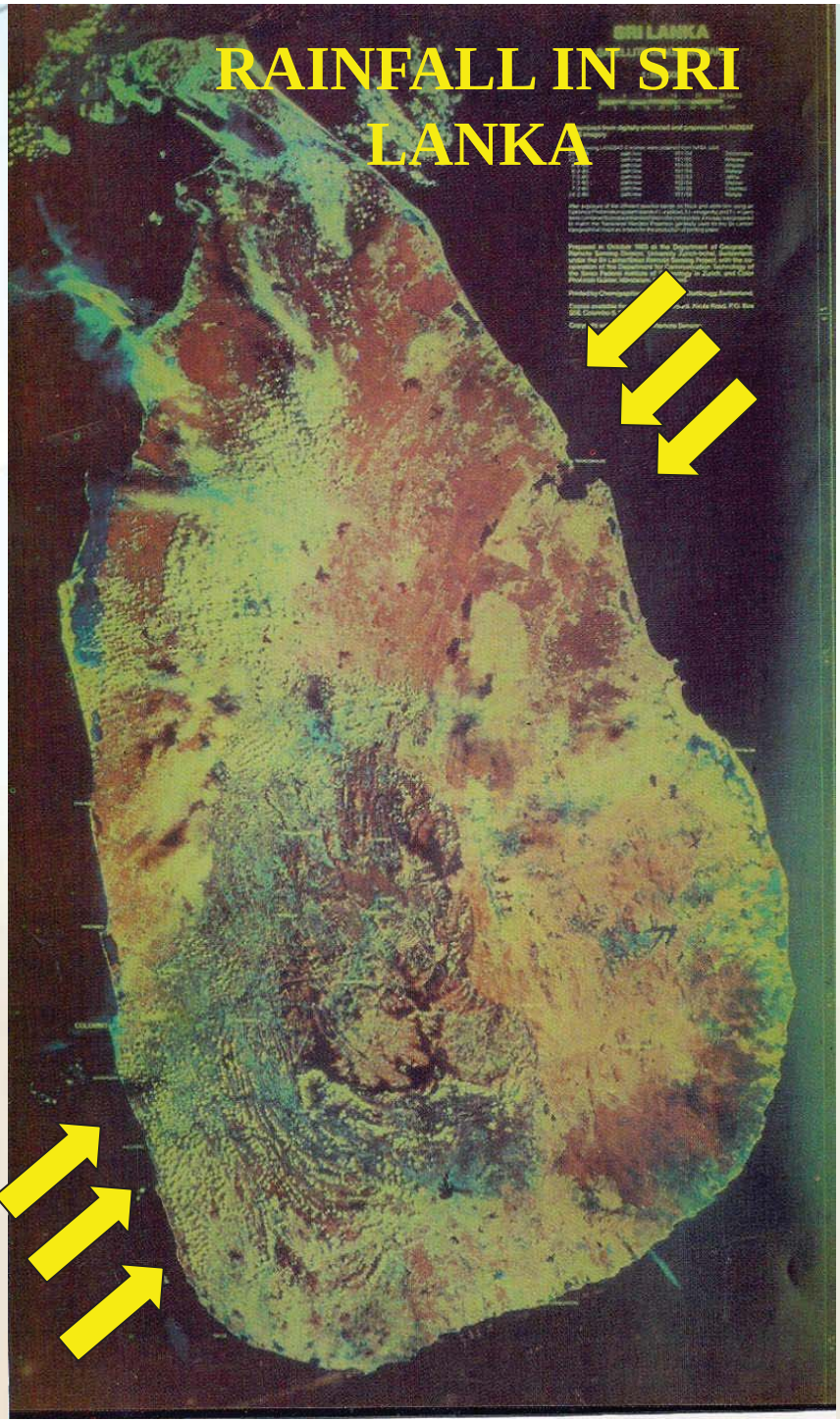
Annual Rainfall
1,900 - 2,500
mm / year

South – West Monsoon

Yala Season

(May to September)

Medium Rains



North – East Monsoon

Maha Season

(November to February)

Heavy Rains

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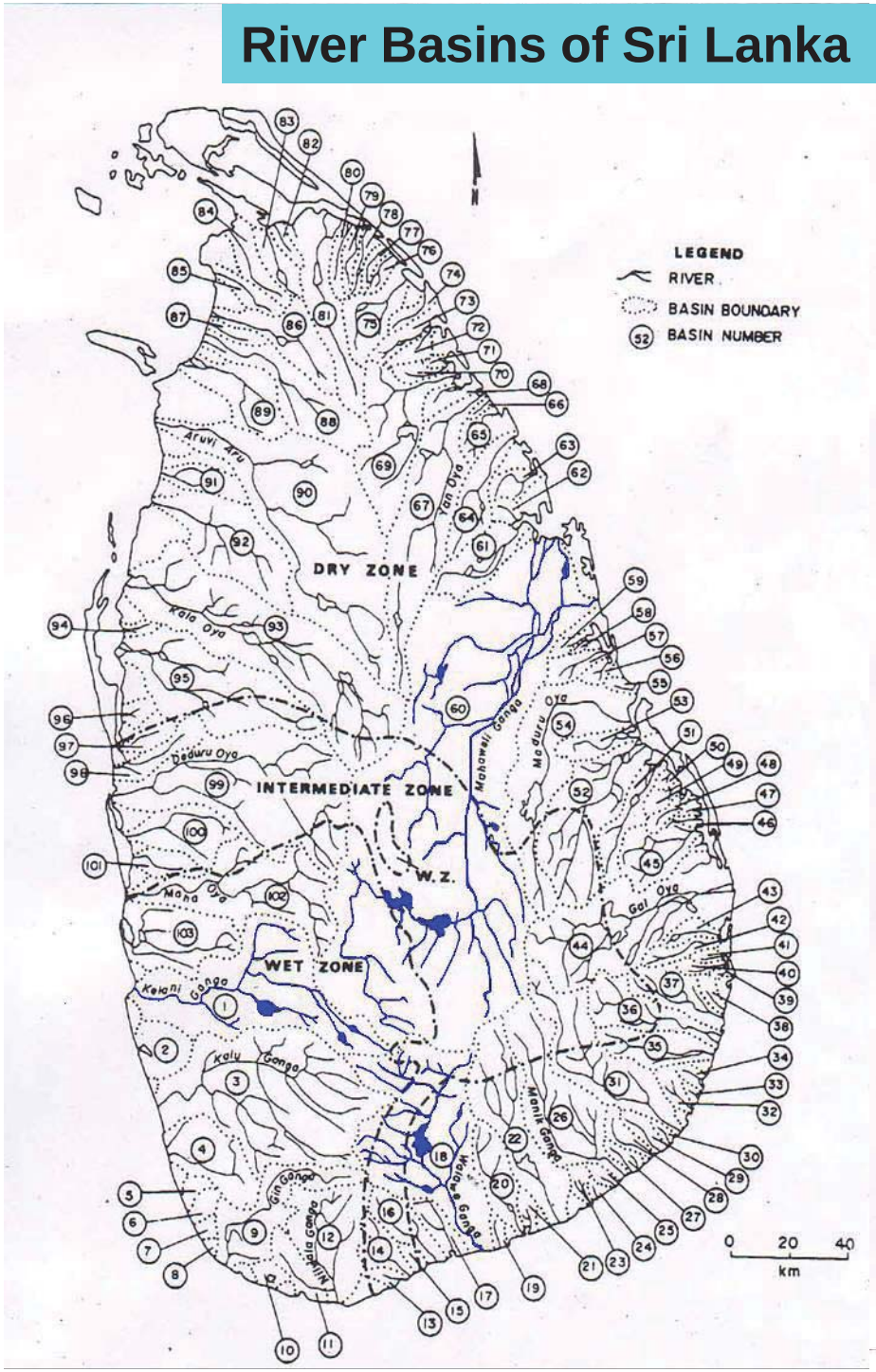
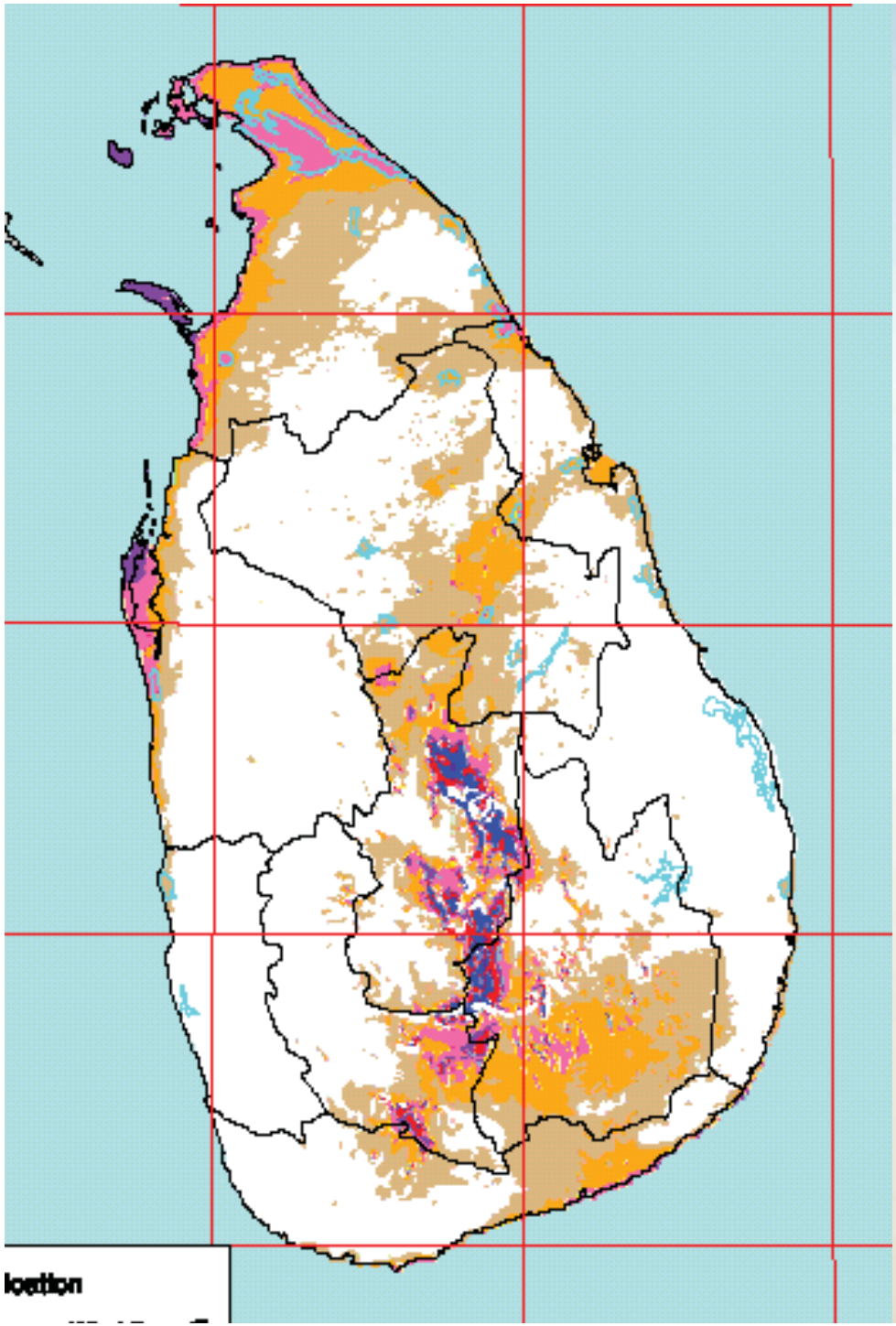
River Basins of Sri Lanka



River Basins

Basin No	Name of Basin	Catchment Area Sq. Km.	Basin No.	Name of Basin	Catchment Area Sq. Km
1.	Kelani Ganga	2278	53.	Miyangolla Ela	225
2.	Bolgoda Lake	374	54.	Maduru Oya	1541
3.	Kaluganga	2688	55.	Pulliyanpotha Aru	52
4.	Bentota Ganga	6622	56.	Kirimechi Odai	77
5.	Madu Ganga	59	57.	Bodigoda Aru	164
6.	Madampe Lake	90	58.	Mandan Aru	13
7.	Telwatte Ganga	51	59.	Makarachchi Aru	37
8.	Ratgama Lake	10	60.	Mahaweli Ganga	10327
9.	Gin Ganga	992	61.	Kantalai Basin Per Aru	445
10.	Koggala Lake	64	62.	Panna Oya	69
11.	Powatta Ganga	233	63.	Palampotta Aru	143
12.	Nilwala Ganga	960	64.	Pankulam Ara	382
13.	Sinimodara Oya	38	65.	Kanchikamban Aru	205
14.	Kirama Oya	223	66.	Palakutti Aru	20
15.	Rekawa Oya	755	67.	Yan Oya	1520
16.	Uruhokke Oya	348	68.	Mee Oya	90
17.	Kachigala Ara	220	69.	Ma Oya	1024
18.	Walawe Ganga	2244	70.	Churian Aru	74
19.	Karagan Oya	58	71.	Chavar Aru	31
20.	Malala Oya	399	72.	Palladi Aru	61
21.	Embilikala Oya	59	73.	Nay Ara	187
22.	Kirindi Oya	1165	74.	Kodalikallu Aru	74
23.	Bambawe Ara	79	75.	Per Ara	374
24.	Mahasilawa Oya	13	76.	Pali Aru	84
25.	Butawa Oya	38	77.	Muruthapilly Aru	41
26.	Menik Ganga	1272	78.	Thoravil Aru	90
27.	Katupila Aru	86	79.	Piramenthal Aru	82
28.	Kuranda Ara	131	80.	Nethali Aru	120
29.	Namadagas Ara	46	81.	Kanakarayan Aru	986
30.	Karambe Ara	46	82.	Kalawalappu Aru	56
31.	Kumbukkan Oya	1218	83.	Akkarayan Aru	192
32.	Bagura Oya	92	84.	Mendekal Aru	297
33.	Girikula Oya	15	85.	Pallarayan Kadu	159
34.	Helawa Ara	51	86.	Pali Aru	451
35.	Wila Ara	484	87.	Chappi Aru	66
36.	Heda Oya	604	88.	Parangi Aru	832
37.	Karanda Oya	422	89.	Nay Aru	560
38.	Simena Ara	51	90.	Malvatu Oya	3246
39.	Tandiadi Aru	22	91.	Kal Ara	210
40.	Kangikadichi Ara	56	92.	Moderagam Ara	932
41.	Rufus Kulam	35	93.	Kala Oya	2772
42.	Pannel Oya	184	94.	Moongil Aru	44
43.	Ambalam Oya	115	95.	Mi Oya	1516
44.	Gal Oya	1792	96.	Madurankuli Aru	62
45.	Andella Oya	522	97.	Kalagamuwa Oya	151
46.	Thumpankeni Tank	9	98.	Pantampola Oya	215
47.	Namakada Aru	12	99.	Deduru Oya	2616
48.	Mandipattu Aru	100	100.	Karambala Oya	589
49.	Pattanthe Aru	100	101.	Ratmal Oya	215
50.	Magalawatavan Aru	346	102.	Maha Oya	1510
51.	Vett Aru	26	103.	Attanagalu Oya	727
52.	Mundeni Aru	1280			



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m²	Wind Speed[a] at 50 m m/s
1	Poor	0 - 200	0 - 5.8
2	Marginal	200 - 300	5.8 - 6.4
3	Moderate	300 - 400	6.4 - 7.0
4	Good	400 - 500	7.0 - 7.5
5	Excellent	500 - 600	7.5 - 8.0
6		600 - 800	8.0 - 8.8
7		> 800	> 8.8

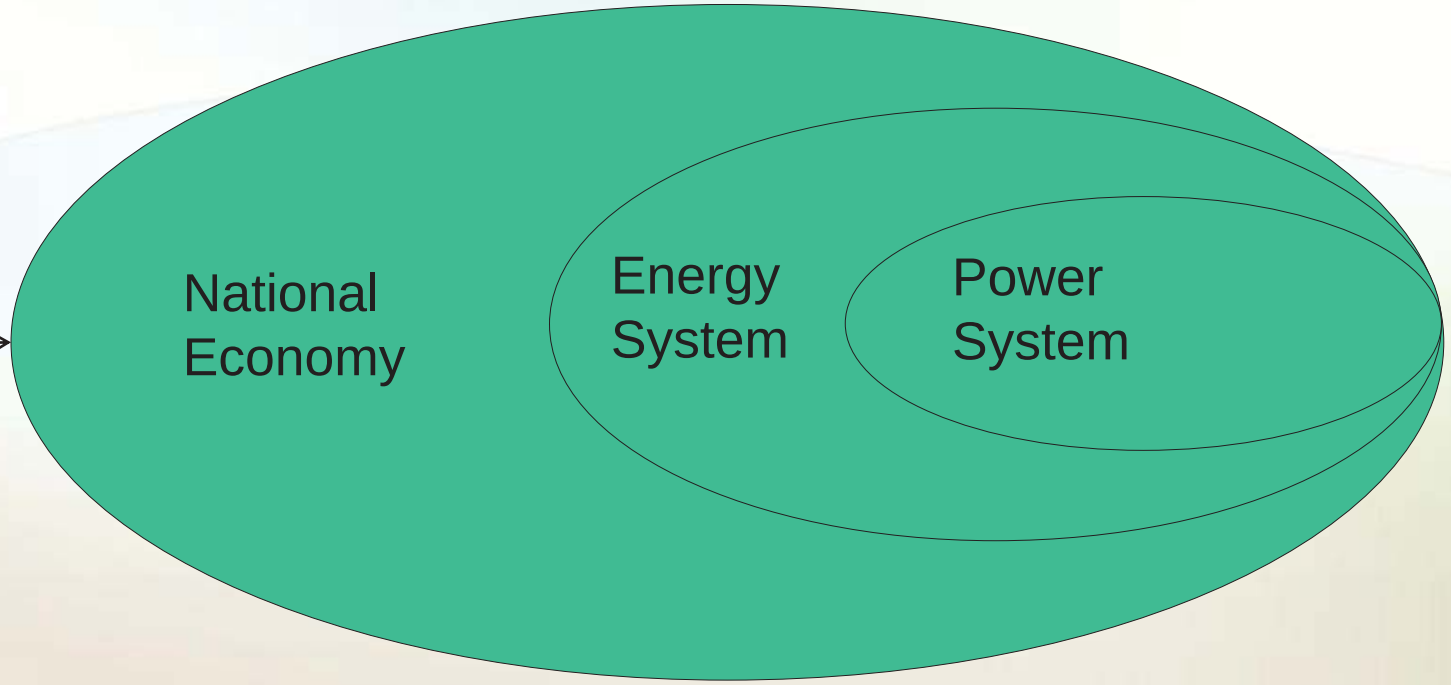
[a] Wind speeds are based on a Weibull k value of 2.0

This map was produced by NREL with technical assistance from TrueWind Solutions and with funding from the U.S. Agency for International Development.

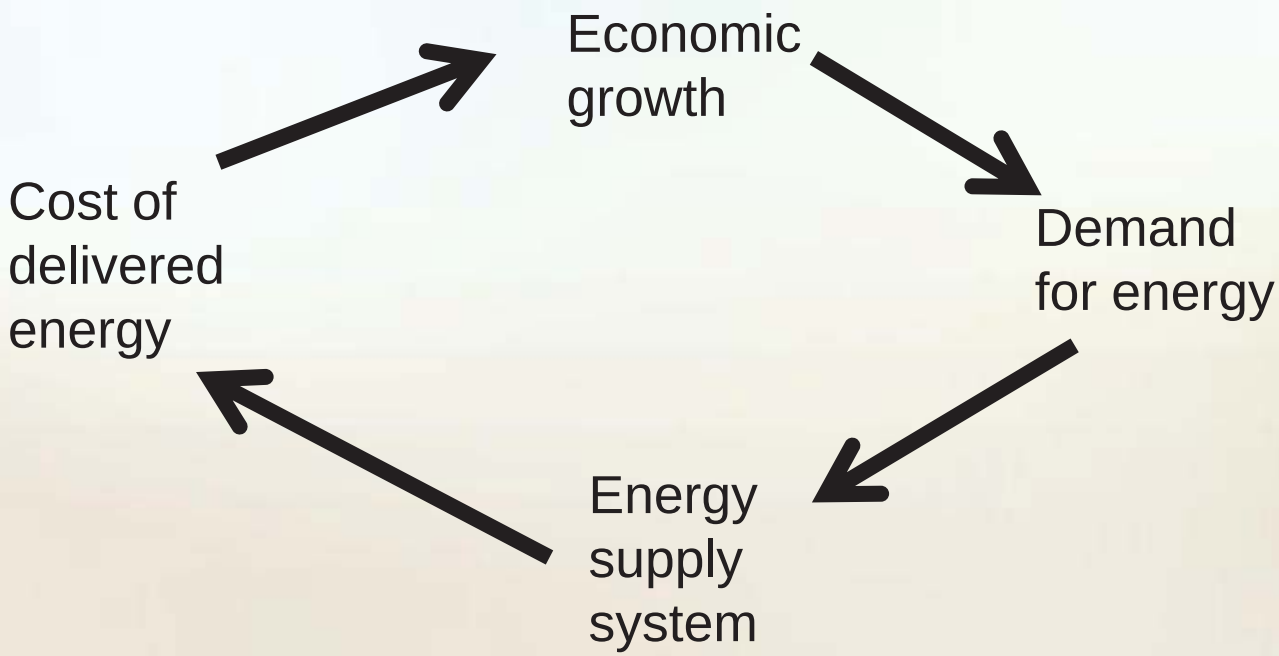
U.S. Agency for International Development

U.S. Department of Energy
National Renewable Energy Laboratory

Energy planning is done in the context of other considerations



The objectives chosen for energy planning must recognize the interactions among the various elements



Rio+20 Outcome in Energy Sector

- **Access to Modern Energy Services**
- **Financial Resources to access Energy Services**
- **Cleaner fossil fuel technologies**
- **Renewable energy development**
- **Energy efficiency**

Goals & Objectives of Energy Sector

- **Ensuring Energy Security -**

  99% Electrification by 2015

- **INCREASING INDIGENOUS ENERGY - Achieving a 10%net reduction in the national fossil fuel consumption intensity by year 2015**

- **Energy Efficiency - Energy Intensity of economy of 500 toe/XDR million by 2017**

Increasing Indigenous Energy

- **Generation of electricity from NCRE to reach 20% by 2020.**
- **10% of industrial thermal energy to be switched to biomass.**
- **10% of transport energy from non-petroleum fuels.**
- **Increase of biomass as a clean cooking fuel by 10%**

Achieving a net reduction in the national fossil fuel consumption intensity by year 2015

- Preparation of Biofuel Standards for Sri Lanka
- Encourage energy plantations in underutilised state lands and urban areas
- Introduce co-generation/tri generation - 500 GWh/y - 100MW
- Hydrogen from surplus wind potential - transport application
- Development of Electric Vehicle Technology

On-grid non-conventional renewable energy-based electricity generation to exceed the 20% target by 2020

- Develop renewable energy resource maps for each resource type
- Estimation of renewable energy resource potential

  Wind, Solar, Wave energy resources
- Establish a fully fledged energy park for grid connected solar power generation
- Establish a fully fledged energy park for grid connected 100 MW wind farm
- Identify transmission constraints and design optimum HV/MV line routes and GSS and determine cost
- Develop transparent and cost reflective tariff/incentive mechanism for the procurement of energy from renewable energy based power generation projects

On-grid NCRE electricity generation forecast

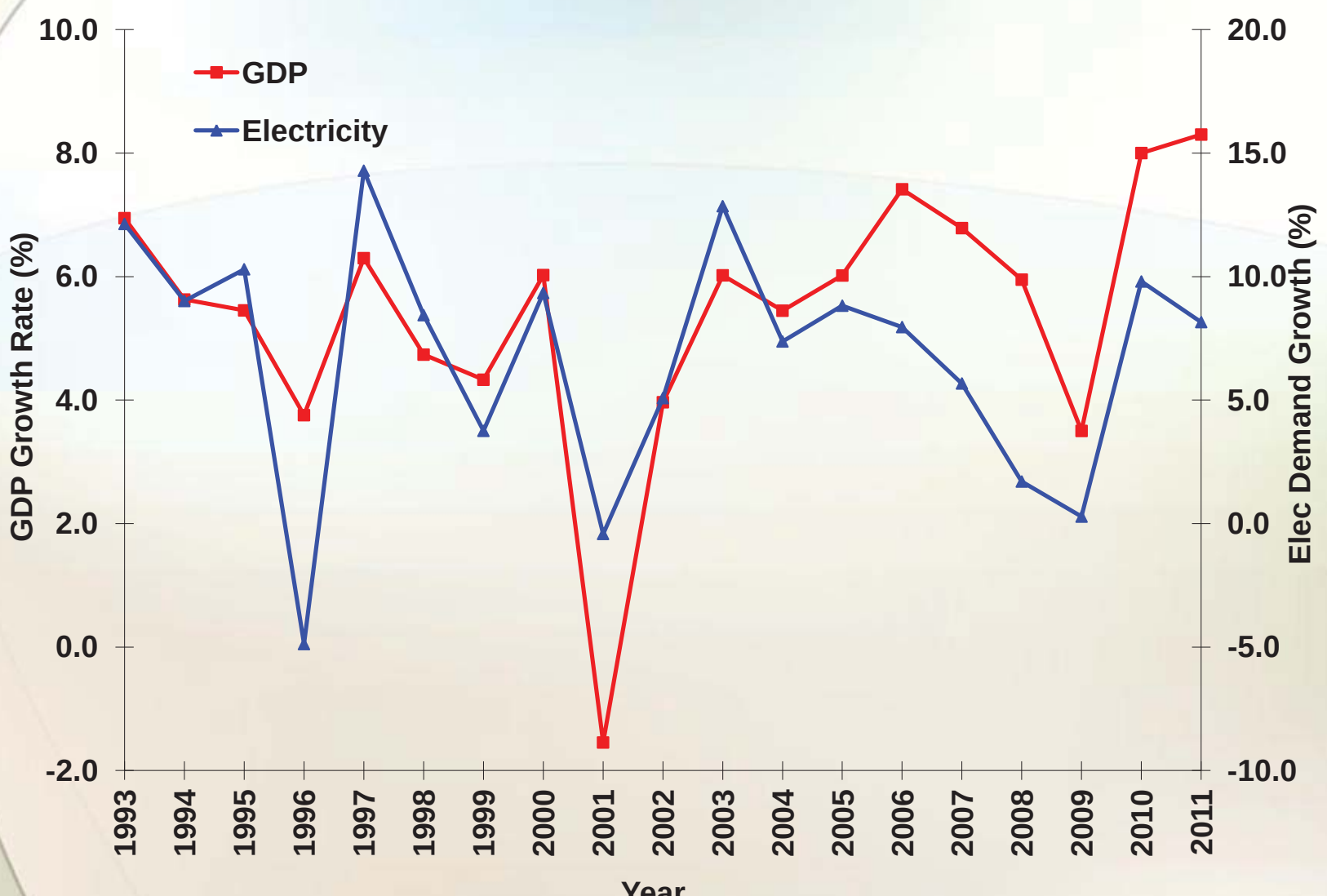
Year	Small Hydro (MW)	Wind + Solar (MW)	Biomass (MW)	Energy Share
2013	221	60	20	9%
2014	246	75	25	9%
2015	271	105	30	10%
2016	296	150	45	11%
2017	331	195	70	13%
2018	371	250	100	15%
2019	421	315	135	17%
2020	486	390	180	20%
2021	516	400	195	20%
2022	546	400	210	20%
2023	576	400	225	19%
2024	601	400	240	19%
2025	626	400	255	18%

Achieving lower energy intensity

Reducing the energy intensity of the economy by a net amount of 5% of 2010 by 2015

- **Introduction of tariff system to encourage energy efficiency**
- **Awareness programmes, training, exhibitions, rewarding**
- **Green certification and facilities labelling programme**
- **Green Buildings LEED certification**

Relationship Between GDP and Electricity



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Electricity Generation Forecast

Year	Peak MW	Generation GWh	Growth (%)
2013	2688	13402	7.5
2014	2853	14315	6.8
2015	3035	15238	6.4
2016	3211	16220	6.4
2017	3397	17168	5.8
2018	3604	18188	5.9
2019	3820	19257	5.9
2020	4051	20397	5.9
2021	4258	21741	6.6
2022	4513	23019	5.9
2023	4796	24436	6.2
2024	5092	25922	6.1
2025	5418	27559	6.3

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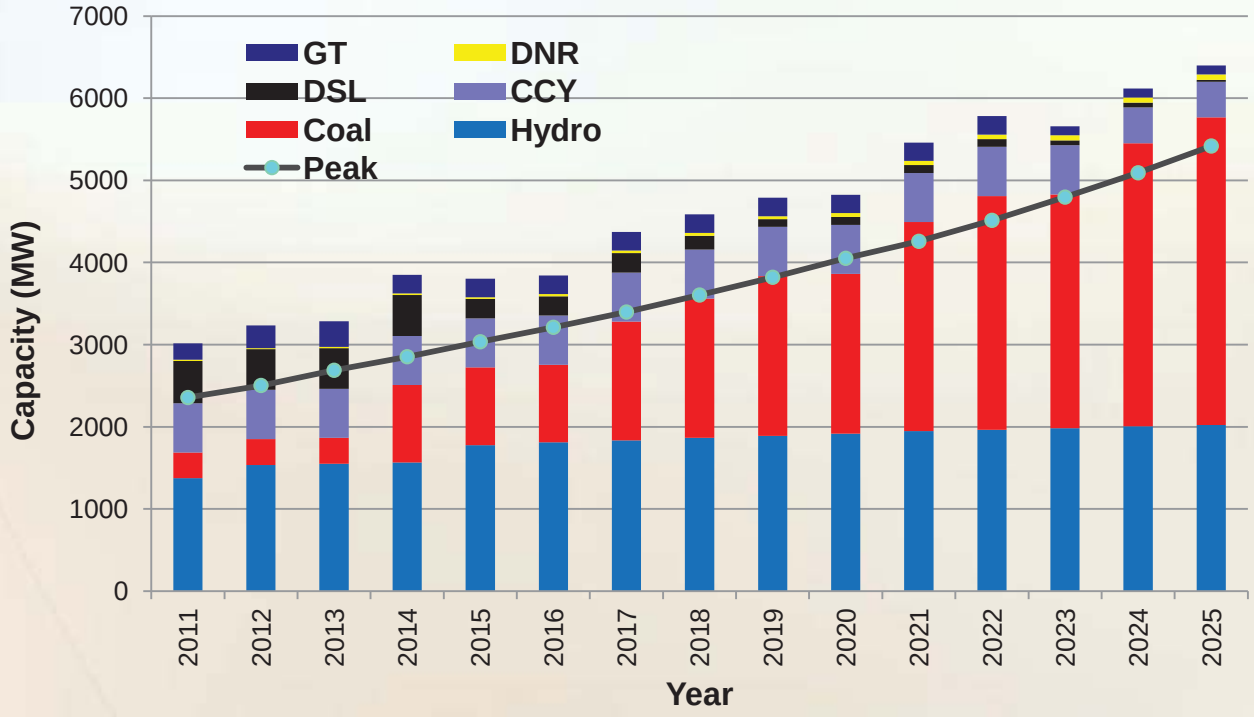
Generation Expansion Plan

Type of Plant	2011– 2015 (MW)	2016– 2020 (MW)	2021- 2025 (MW)	Total capacity addition (MW)	%
Hydro	354			354	8.3%
Coal	945	1000	1800	3745	88.1%
Gas Turbines	110			110	2.6%
Medium Diesel	44			44	1.0%
Total	1,453	1,000	1,800	4,253	100.0 %



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CO2 Emissions

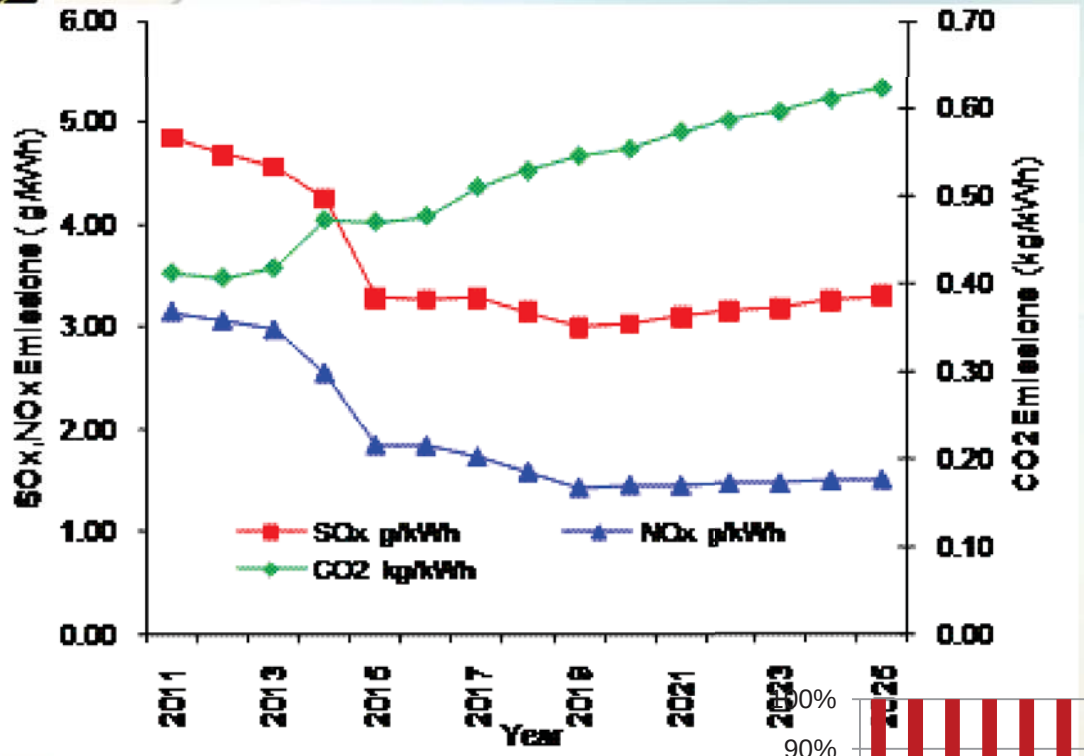
Country	kg CO_2/2000 US$ of GDP	kg CO_2/2000 US$ of GDP Adjusted to PPP	tons of CO_2 per Capita
Sri Lanka	**0.51**	**0.12**	**0.62**
Pakistan	1.23	0.35	0.81
India	1.81	0.35	1.37
Indonesia	1.46	0.40	1.64
China	2.17	0.55	5.14
France	0.24	0.21	5.49
Japan	0.22	0.32	8.58
Germany	0.38	0.33	9.16
USA	0.46	0.46	16.90
World	0.73	0.45	4.29

Source: IEA CO_2 database, Figures are based on 2011 edition

CO2 Emission

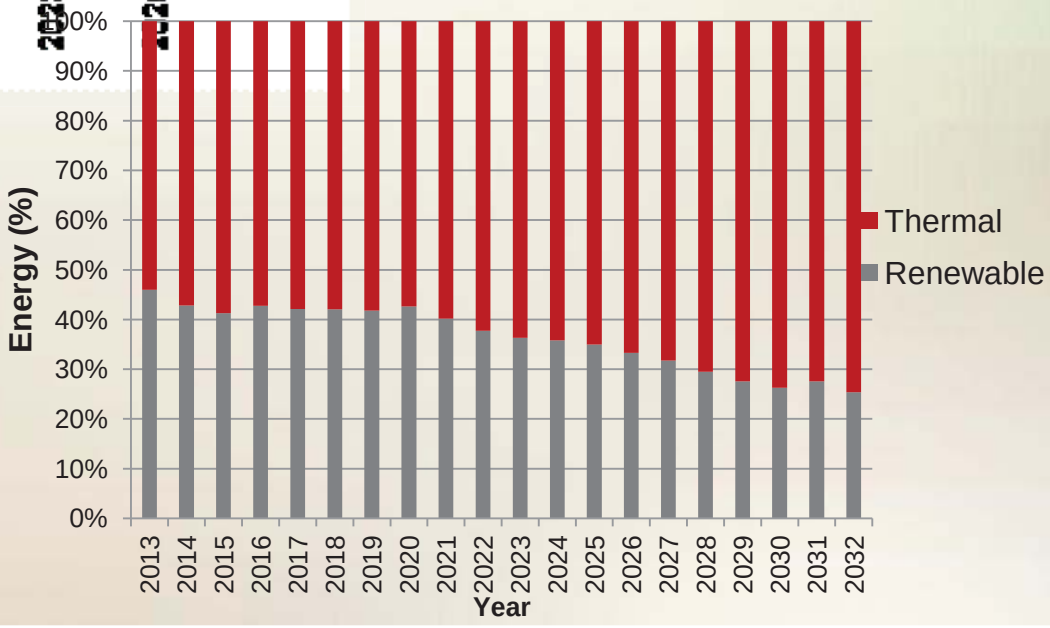






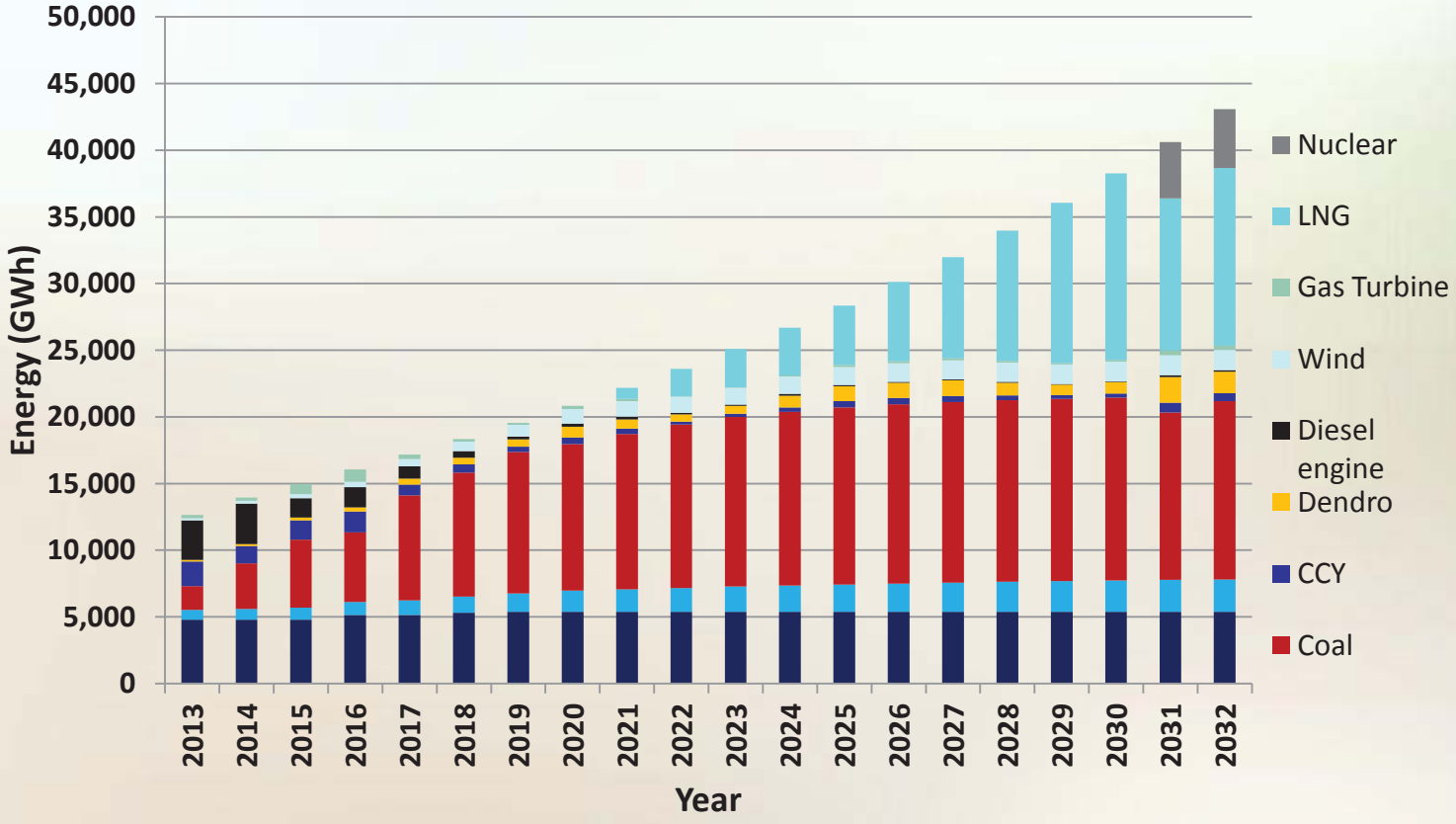
CO_2, SO_x and NO_x Emissions per kWh Generated

Thermal & Renewable Share



Limitation of Coal Addition

- **Available Candidates**
  - **Natural Gas Power Plant**
  - **Nuclear Power Plant**
  - **Coal with CCS**

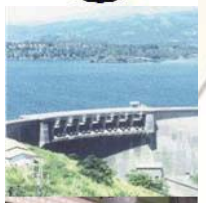


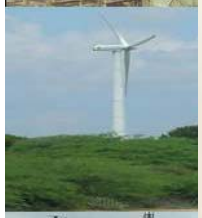
Limitation of Coal Addition

Investment Cost for 20 years

- **Reference Case – 14,127 Mil USD**
- **Coal Limited – 16,296 Mil USD**

15% Additional Investment ????



Thank You !

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