



CEYLON ELECTRICITY BOARD

Sri Lanka's Power Generation

Past, Present and Future

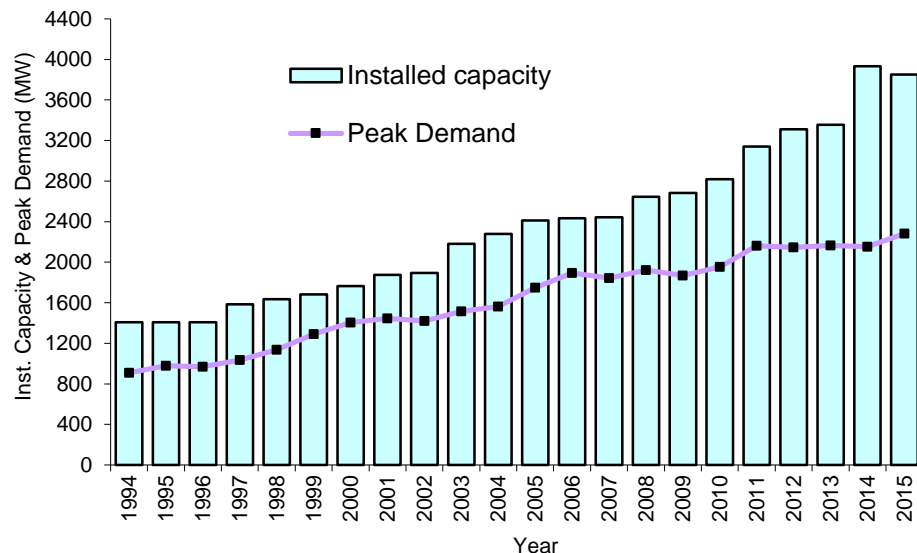
Eng. Noel Priyantha- Chief Engineer (Renewable Energy)

Eng. Buddhika Samarasekara- Chief Engineer (Generation Planning)

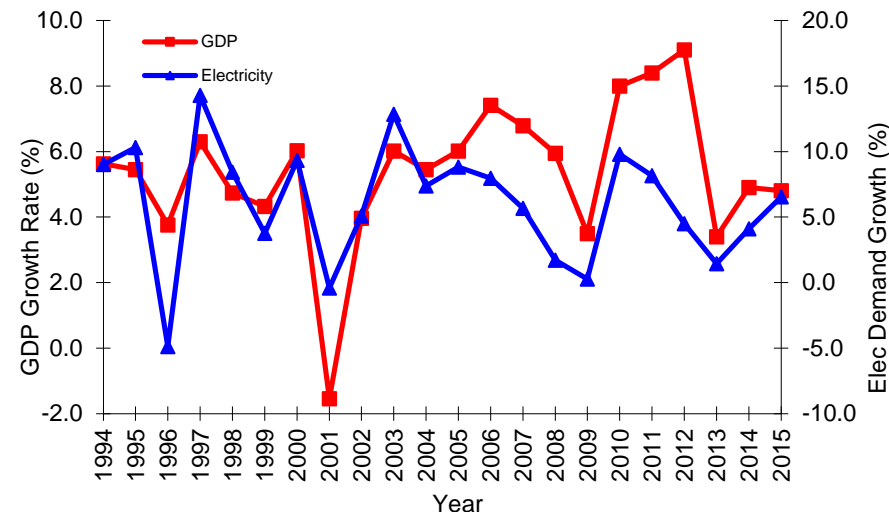
Transmission Division
Ceylon Electricity Board
Sri Lanka
May 2016



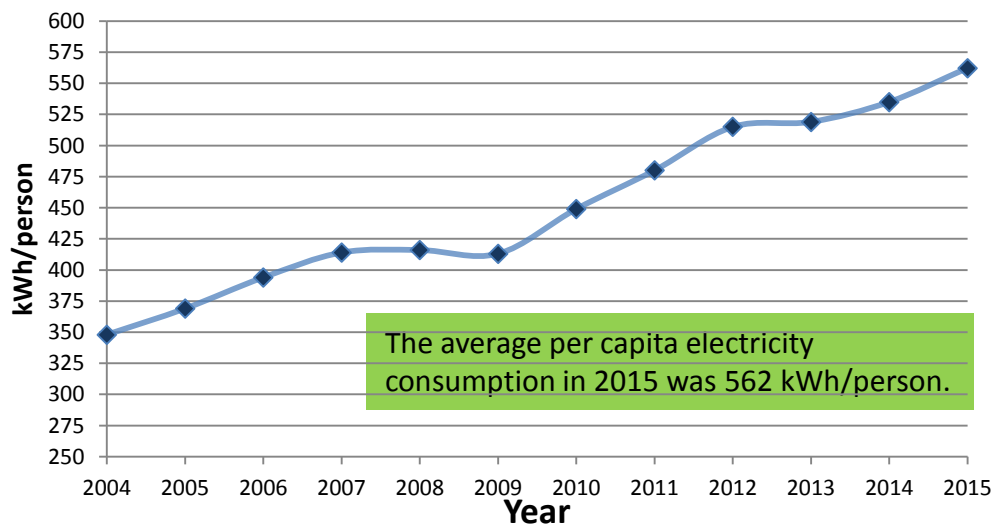
Installed Capacity and Peak Demand



GDP Growth % & Elec. Demand Growth %



Per Capita Electricity Consumption (2004-2015)

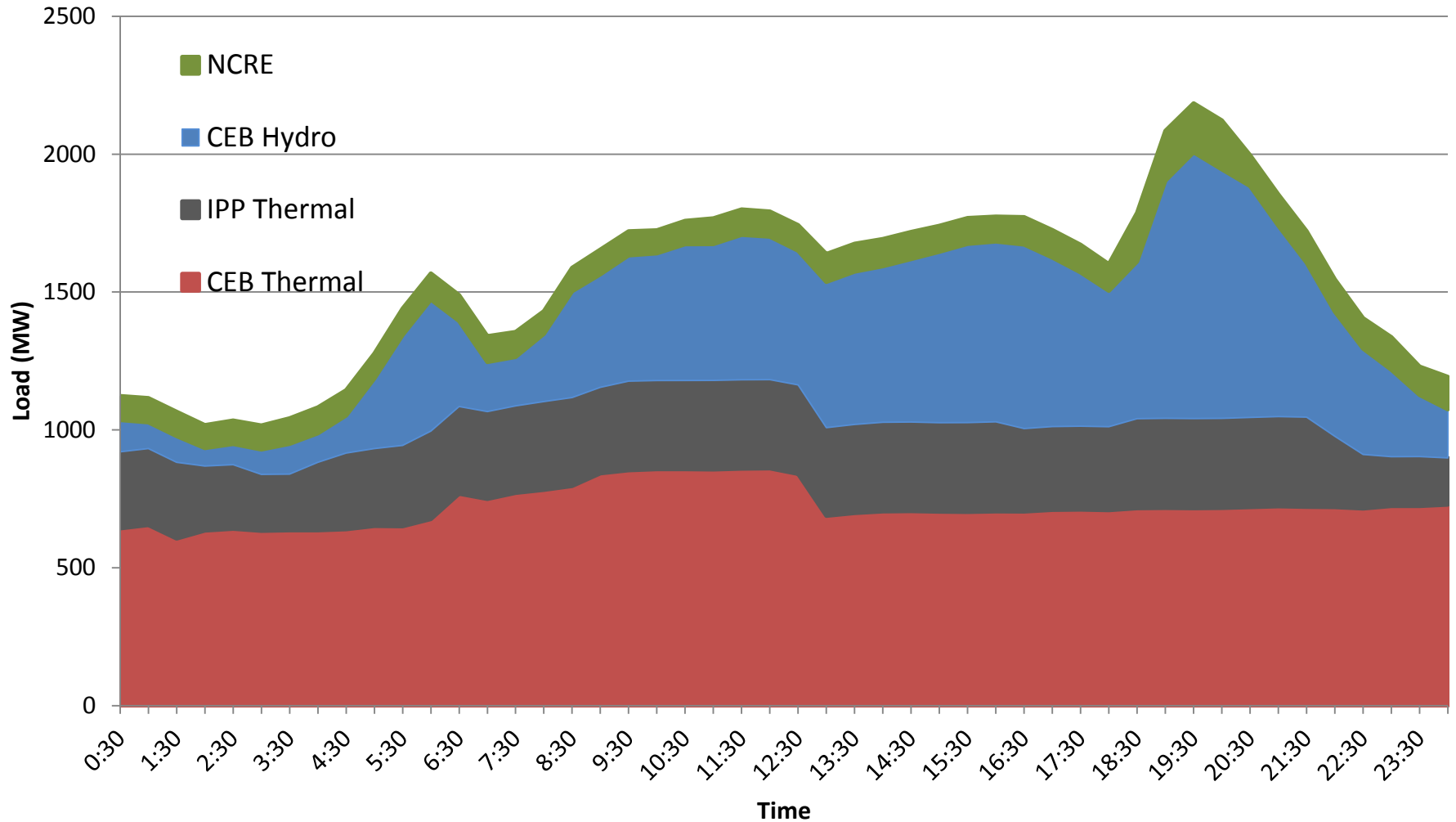


Less significant relationship between GDP growth and Electricity demand growth in recent years

Comparison with Regional Countries(kWh/person)

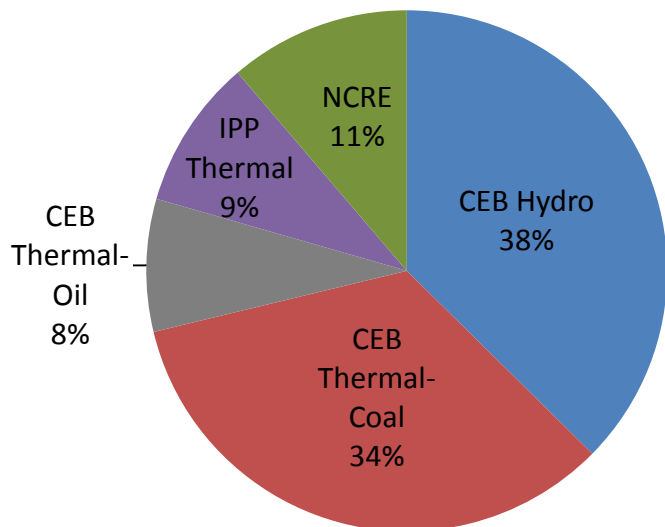
| Country | 2009 | 2010 | 2011 | 2012 |
|------------|------|------|------|------|
| Bangladesh | 221 | 247 | 259 | 278 |
| India | 605 | 641 | 684 | 753 |
| Japan | 7838 | 8378 | 7848 | 5190 |
| Malaysia | 3934 | 4136 | 4246 | 3405 |
| Pakistan | 450 | 458 | 449 | 649 |
| Singapore | 7896 | 8438 | 8404 | 8595 |
| Vietnam | 917 | 1035 | 1073 | 907 |

TYPICAL LOAD CURVE OF SRI LANKA

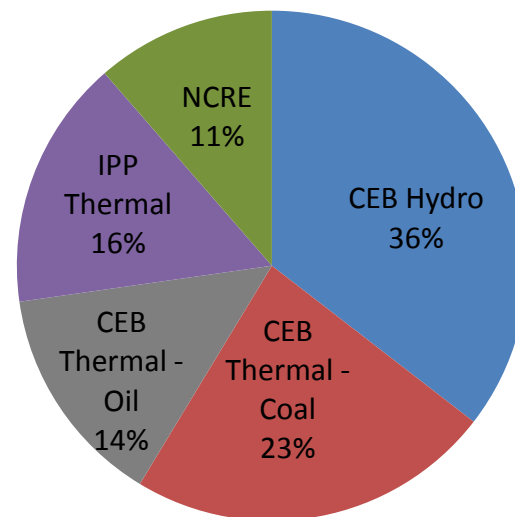


PRESENT CAPACITY MIX AS AT DECEMBER 2015

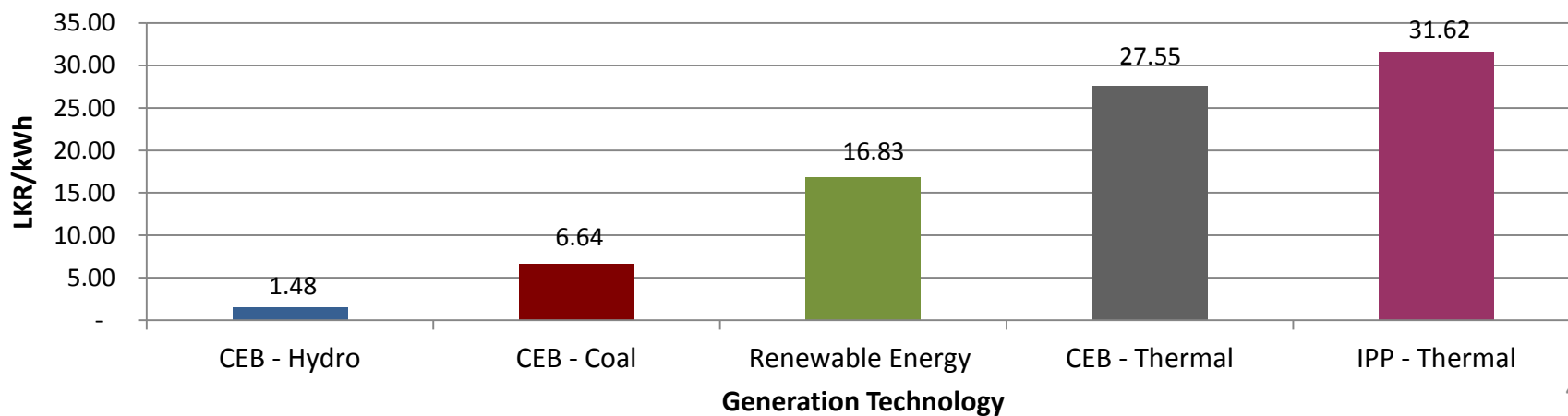
Energy Share in GWh- 2015



Capacity Share in MW - 2015



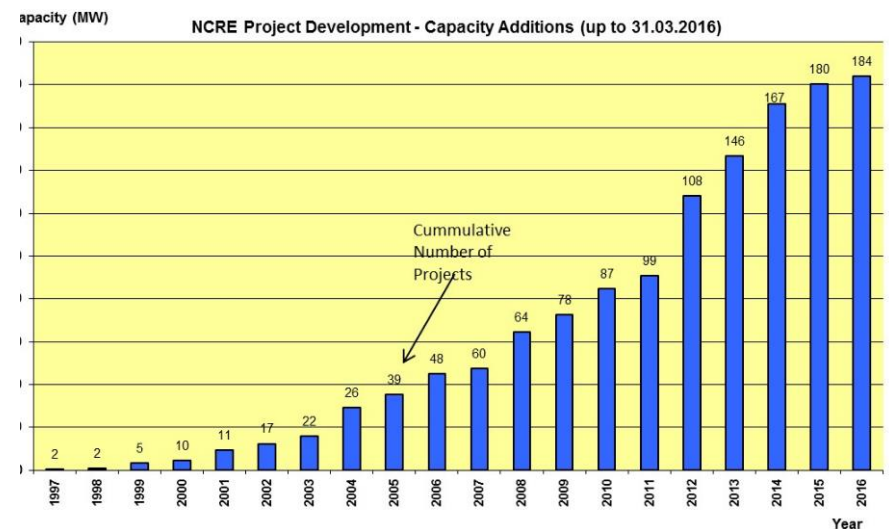
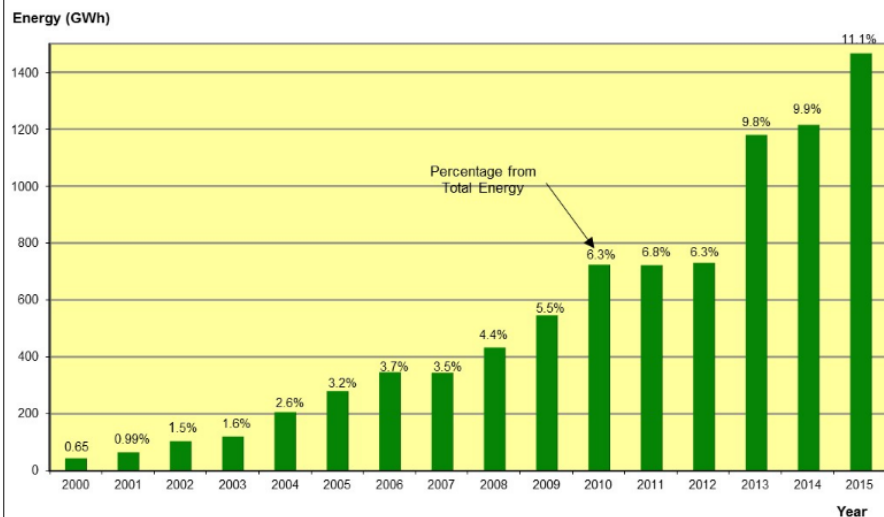
Average Cost per Unit for Generation Technologies (For Year 2015)



Historical NCRE Contribution

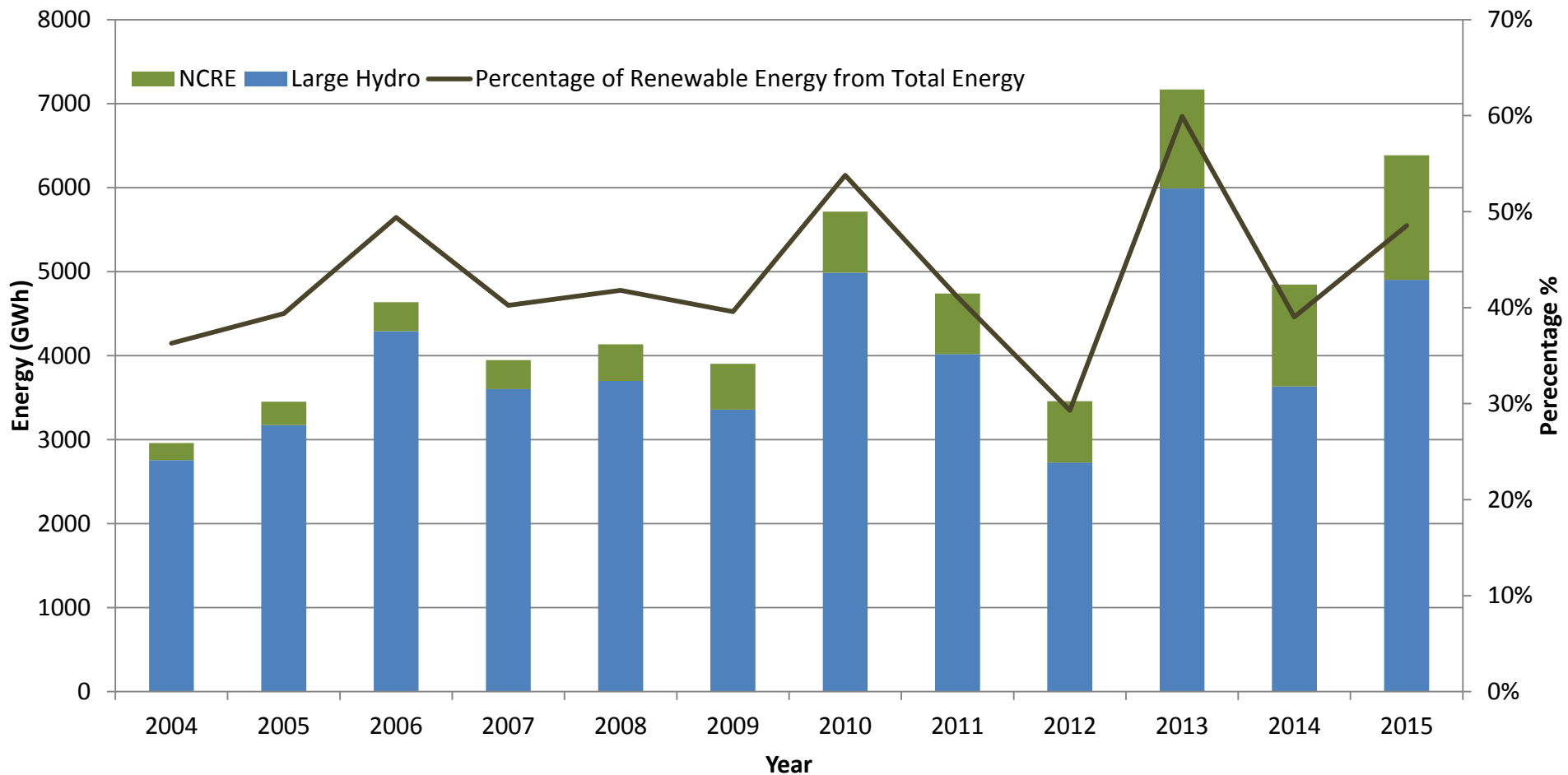
| Year | Energy Generation (GWh) | | Capacity (MW) | |
|------|-------------------------|--------------|---------------|---------------------------------|
| | NCRE | System Total | NCRE | Total System Installed Capacity |
| 2003 | 120 | 7612 | 39 | 2483 |
| 2004 | 206 | 8043 | 73 | 2499 |
| 2005 | 280 | 8769 | 88 | 2411 |
| 2006 | 346 | 9389 | 112 | 2434 |
| 2007 | 344 | 9814 | 119 | 2444 |
| 2008 | 433 | 9901 | 161 | 2645 |
| 2009 | 546 | 9882 | 181 | 2684 |
| 2010 | 724 | 10714 | 212 | 2818 |
| 2011 | 722 | 11528 | 227 | 3141 |
| 2012 | 730 | 11801 | 320 | 3312 |
| 2013 | 1178 | 11962 | 367 | 3355 |
| 2014 | 1215 | 12418 | 442 | 3932 |

Annual Energy Contribution from NCRE Projects

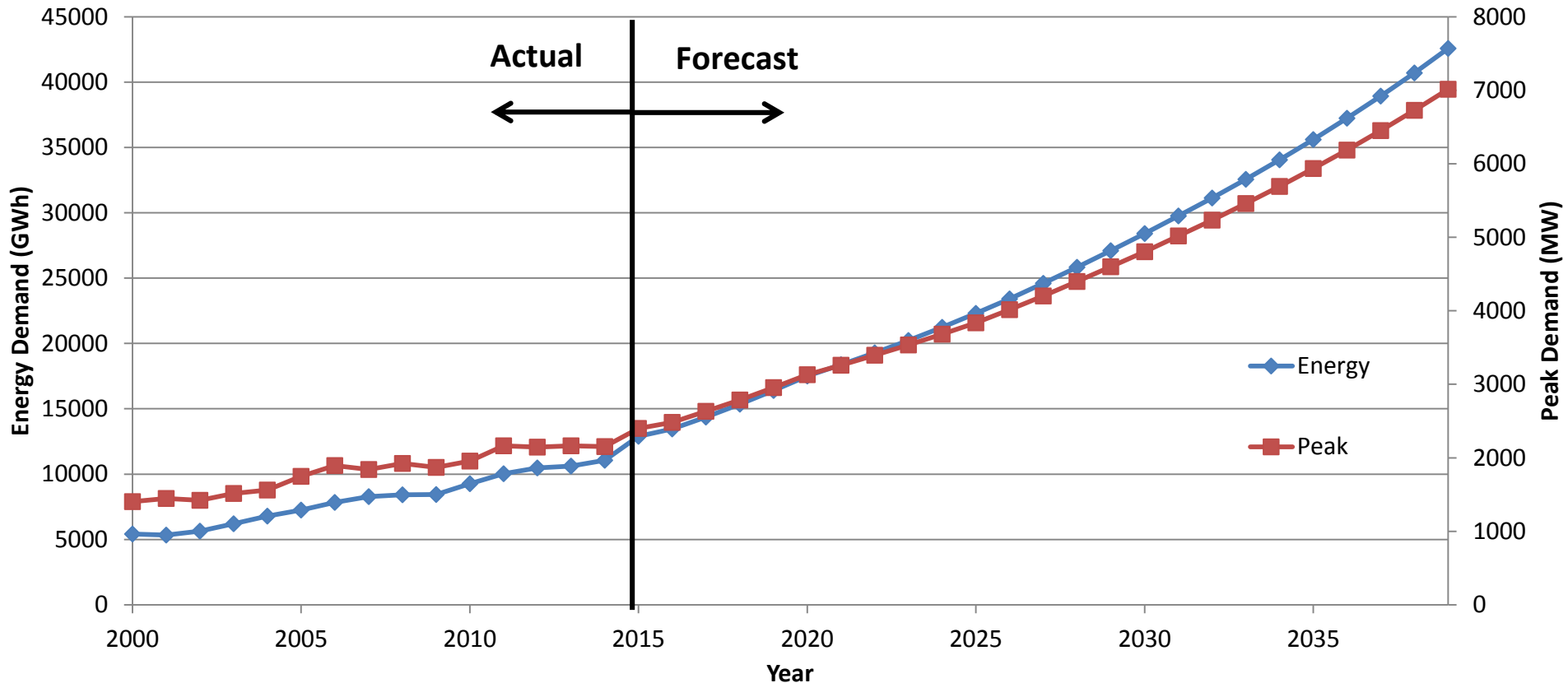


RENEWABLE ENERGY- PRESENT STATUS

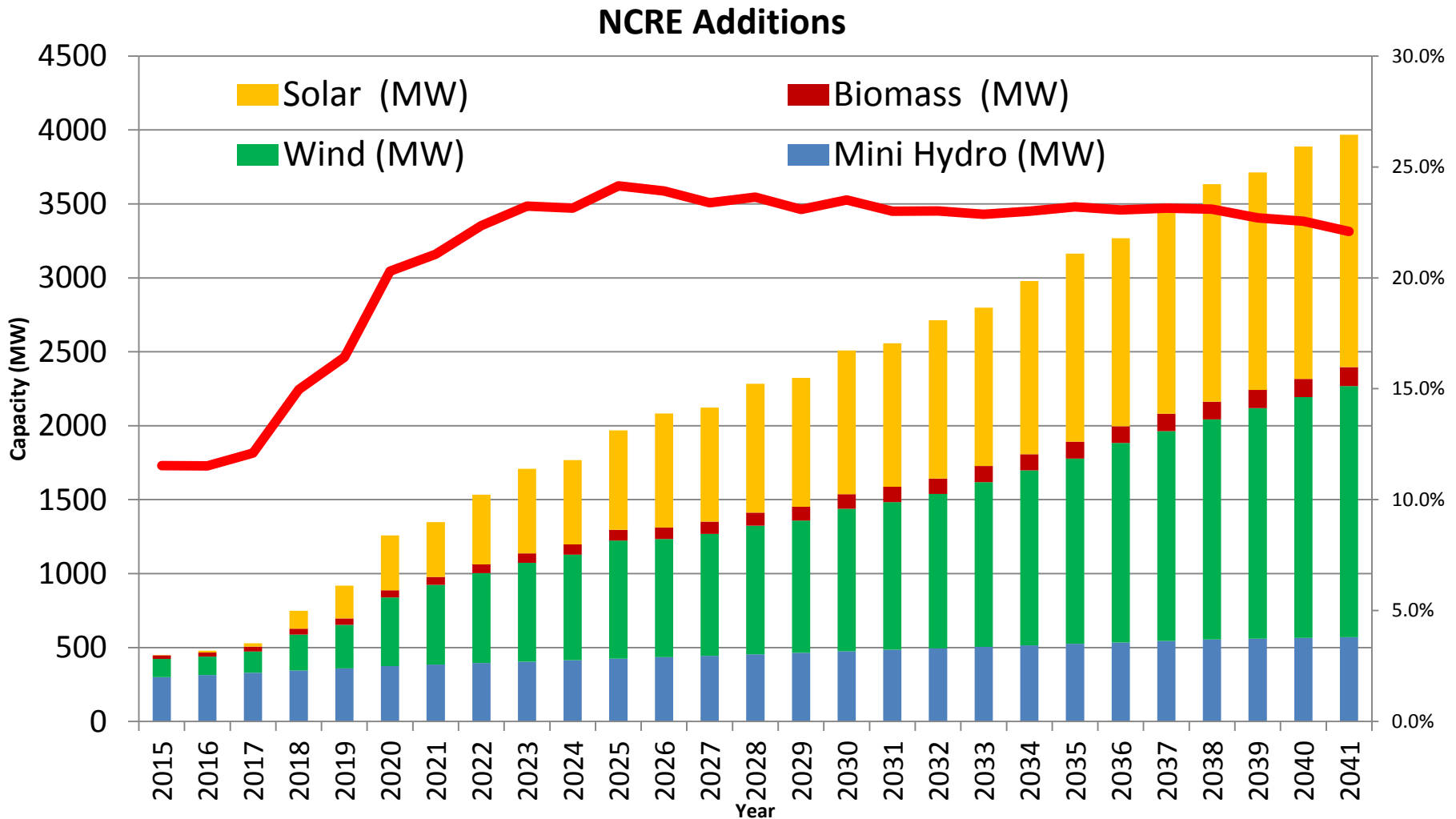
Renewable Energy Contribution



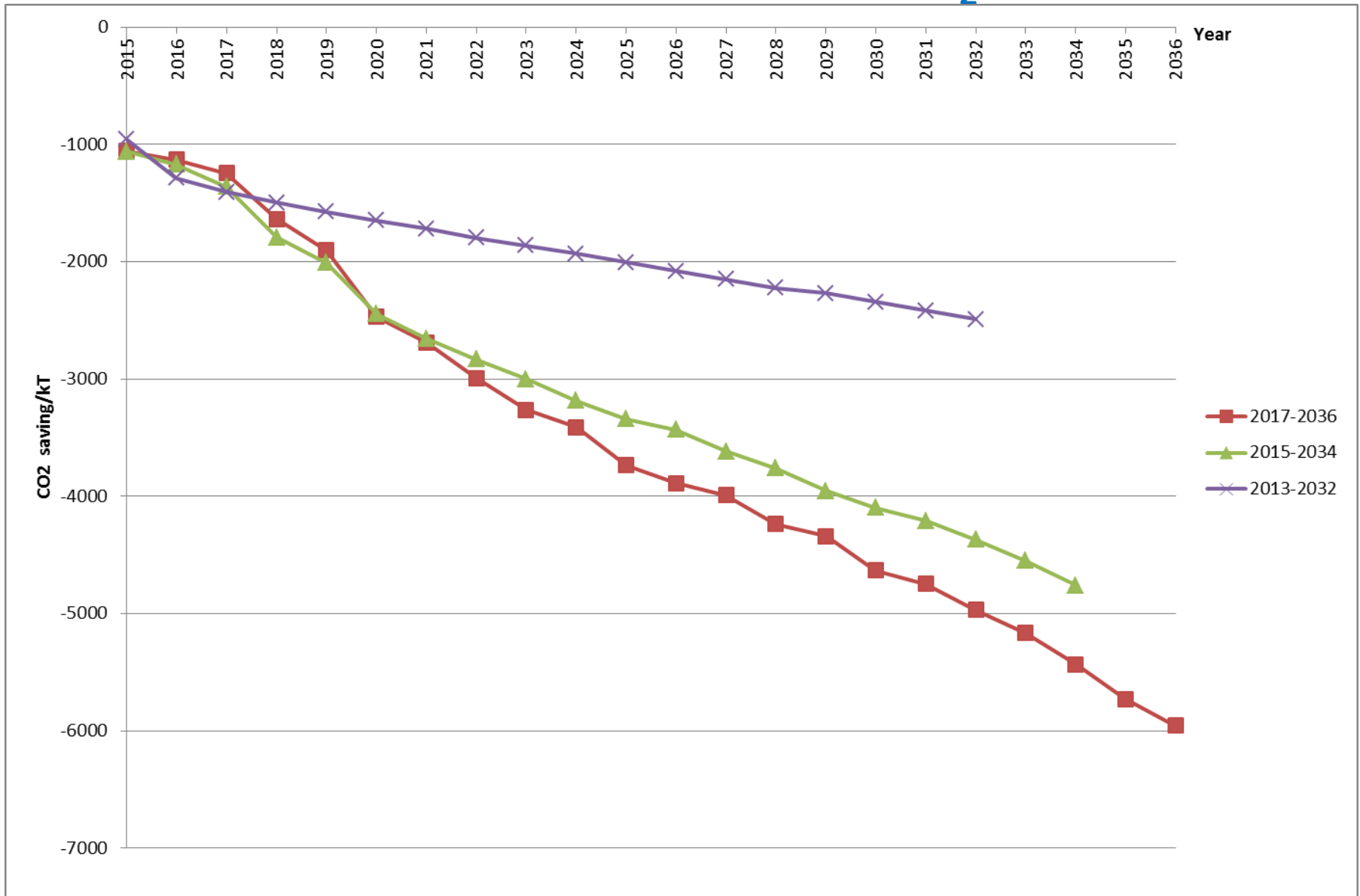
ACTUAL AND FORECAST ENERGY/PEAK DEMAND (AS PER DRAFT LTGEP 2015-2034)



FUTURE GENERATION OPTIONS - NON CONVENTIONAL



PROJECTION ON COMPARSION OF CO₂ SAVINGS



PRESENT STATUS OF NCRE TARIFF

PRINCIPLES OF TARIFF FIXING

- Renewable energy, which is a natural resource, belongs to the State.
- Renewable energy should produce electricity in the long term at prices below the cost of thermal power plants, using oil or coal, or even gas.
- Developers are provided with a high tariff to cover their expenses and reasonable profits for an adequately long period (in this case fifteen years.) Cost based , technology specific and three tiered or flat tariff
- Tier 1: Years 1- 8 ;Tier 2: Years 9 – 15; Tier 3: Years 16 – 20
- (SPPA period – 20 years)
- This tariff will be limited to small power producers (Capacity up to 10 MW)
- **This tariff has been designed to eliminate the problems of negative cash flows experienced by many small power producers during the period of loan repayment.**

PROJECTS IN THE PIPELINE - NCRE

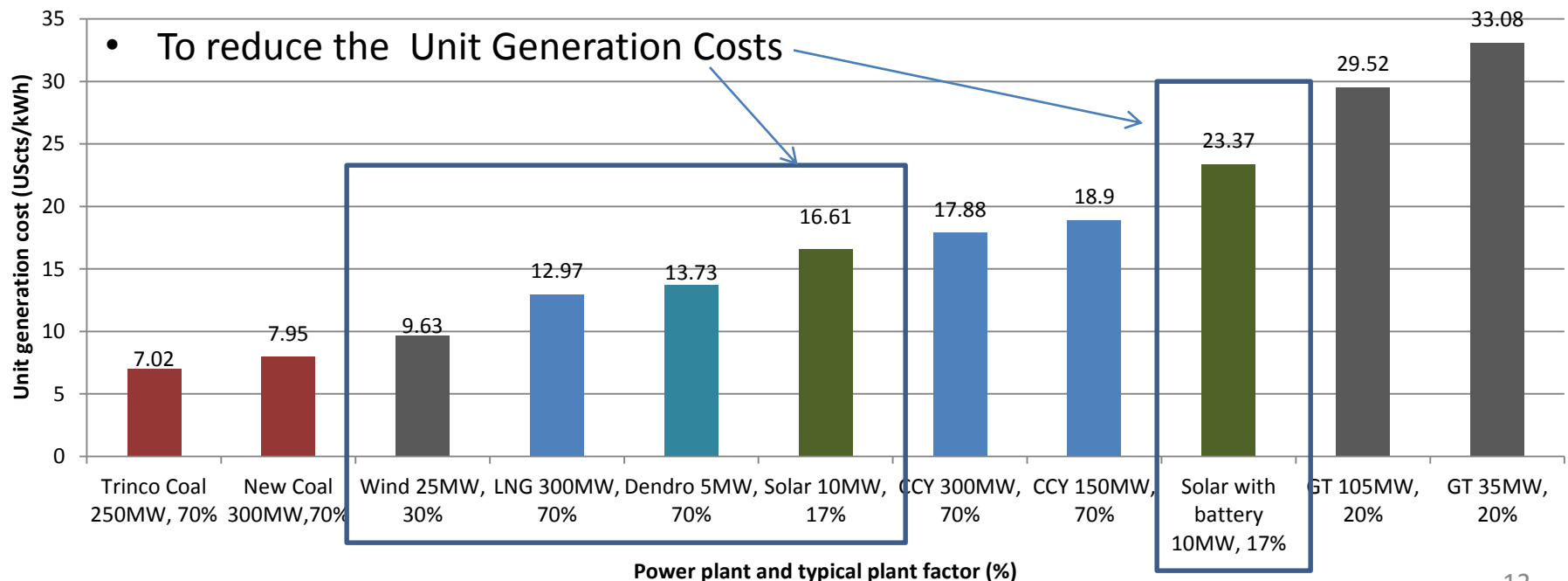
SPPA Signed NCRE Projects – Present Status

| NCRE Technology | | No of Projects | Capacity (MW) |
|-----------------|---|----------------|---------------|
| 1 | Mini Hydro Power | 95 | 177 |
| 2 | Biomass - Agricultural & Industrial Waste | 2 | 4.5 |
| 3 | Biomass - Dendro Power | 13 | 51 |
| 4 | Biomass – Municipal Waste | 1 | 10 |
| 5 | Solar Power | 4 | 40 |
| 6 | Solar Thermal | 3 | 30 |
| 7 | Wind Power | 1 | 1 |
| Total | | 119 | 314 |

WHY CLIMATE FINANCE

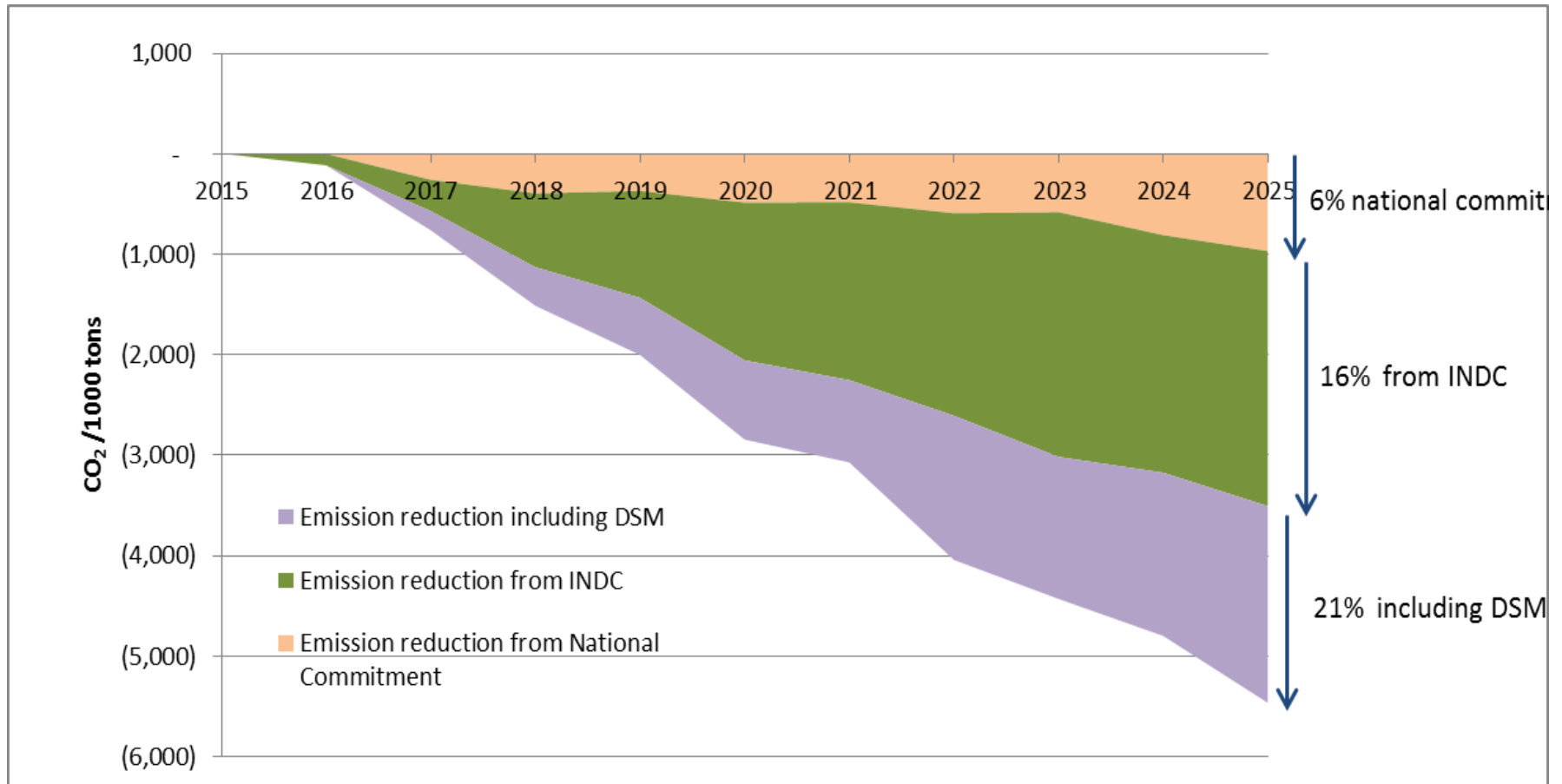
- Sri Lanka seeks Climate Finance to reduce the present high cost of Renewable Energy – CPF support in this regard is highly welcome.
- Possibility of reducing the present feed in tariff payable to NCRE in future, sharing the carbon credits among stake holders including CEB, if appropriate.
- Overall Sector Development through use of carbon credits

Unit Generation Costs for Different Power Plants at Typical Plant Factors



Present Status : INDC

- TO ACHIEVE EMISSION REDUCTION AT LEAST IDENTIFIED FROM INDCs



CHALLENGES TO OVERCOME & SOME SUGGESTIONS TO EXPLORE

- If carbon markets revive, opportunity to get competitive prices for carbon credits may be lost by entering into long term agreements only with the World Bank Group.
 - Inclusion of some provisions in to ERPA to avoid such possibility
- Whether private sector will fully engage in to the CPF program and agree to sell credits to CEB as they may get better credits from competitive market.
 - Directive from the government, a long term proposition
 - Waive off credit rights as part of the SPPA that offers feed-in-tariffs
- According to present practice, all carbon credit programs should be directed by the Climate Change Secretariat (CCS).
 - Engaging CCS from the beginning and seeking their approvals as needed
- Understanding the impact on Intended Nationally Determined Contributions (INDCs), submitted by the Ministry of Mahaweli Development and Environment, Once CEB signs the SPA and ERPA, relevant carbon reduction will be removed from the country and country cannot claim for any reduction of emissions.
 - Inclusion of 'unconditional' target in the baseline and credits from 'conditional target'

THANK YOU

Additional slides

INTRODUCTION

SRI LANKA

- Total Area : 65,610 km²
- Land Area : 62,705 km²
- Population : 20.97 million
 - Urban : 18.3% Rural : 81.7%
- Population Density : 334 per/ sqkm
- Labour Force : 8.973 million
- Unemployment rate : 4.6%
- Literacy rate : 93.3%
- Life expectancy: 72 yrs (M), 78 yrs (F)
- Monetary Unit : Sri Lankan Rupee
(1 USD = 146.19 LKR at 01.01.2016)
- Gross Domestic Product : 11,183 billion LKR
(Market Prices)
- GDP per capita : 3,924 US\$ (Market Prices)
- GDP structure 2015
 - Agriculture – 7.85% Industry – 26.20%
 - Services – 56.61% Taxes less subsidies on products – 9.34%



FUTURE GENERATION OPTIONS - NON CONVENTIONAL

Projected NCRE capacity

| Year | Mini Hydro (MW) | Wind (MW) | Biomass (MW) | Solar (MW) | Solar Net Metering (MW) | Total NCRE Capacity (MW) | Annual Total NCRE Generation (GWh) | Share of NCRE from Total Generation % |
|------|-----------------|-----------|--------------|------------|-------------------------|--------------------------|------------------------------------|---------------------------------------|
| 2017 | 329 | 144 | 34 | 21 | 20 | 548 | 1782 | 12.1% |
| 2018 | 344 | 244 | 39 | 121 | 26 | 774 | 2337 | 15.0% |
| 2019 | 359 | 294 | 44 | 221 | 32 | 950 | 2720 | 16.4% |
| 2020 | 374 | 464 | 49 | 371 | 39 | 1297 | 3530 | 20.3% |
| 2021 | 384 | 539 | 54 | 371 | 44 | 1392 | 3840 | 21.1% |
| 2022 | 394 | 609 | 59 | 471 | 50 | 1583 | 4277 | 22.4% |
| 2023 | 404 | 669 | 64 | 571 | 55 | 1763 | 4663 | 23.2% |
| 2024 | 414 | 714 | 69 | 571 | 60 | 1828 | 4875 | 23.1% |
| 2025 | 424 | 799 | 74 | 671 | 64 | 2032 | 5339 | 24.1% |
| 2026 | 434 | 799 | 79 | 771 | 69 | 2152 | 5553 | 23.9% |
| 2027 | 444 | 824 | 84 | 771 | 74 | 2197 | 5702 | 23.4% |
| 2028 | 454 | 869 | 89 | 871 | 79 | 2362 | 6051 | 23.6% |
| 2029 | 464 | 894 | 94 | 871 | 83 | 2406 | 6200 | 23.1% |
| 2030 | 474 | 964 | 99 | 971 | 88 | 2597 | 6619 | 23.5% |
| 2031 | 484 | 999 | 104 | 971 | 93 | 2651 | 6785 | 23.0% |
| 2032 | 494 | 1044 | 104 | 1071 | 98 | 2811 | 7099 | 23.0% |
| 2033 | 504 | 1114 | 109 | 1071 | 102 | 2900 | 7378 | 22.9% |
| 2034 | 514 | 1184 | 109 | 1171 | 107 | 3086 | 7763 | 23.0% |
| 2035 | 524 | 1254 | 114 | 1271 | 112 | 3275 | 8186 | 23.2% |
| 2036 | 534 | 1349 | 114 | 1271 | 117 | 3385 | 8506 | 23.1% |

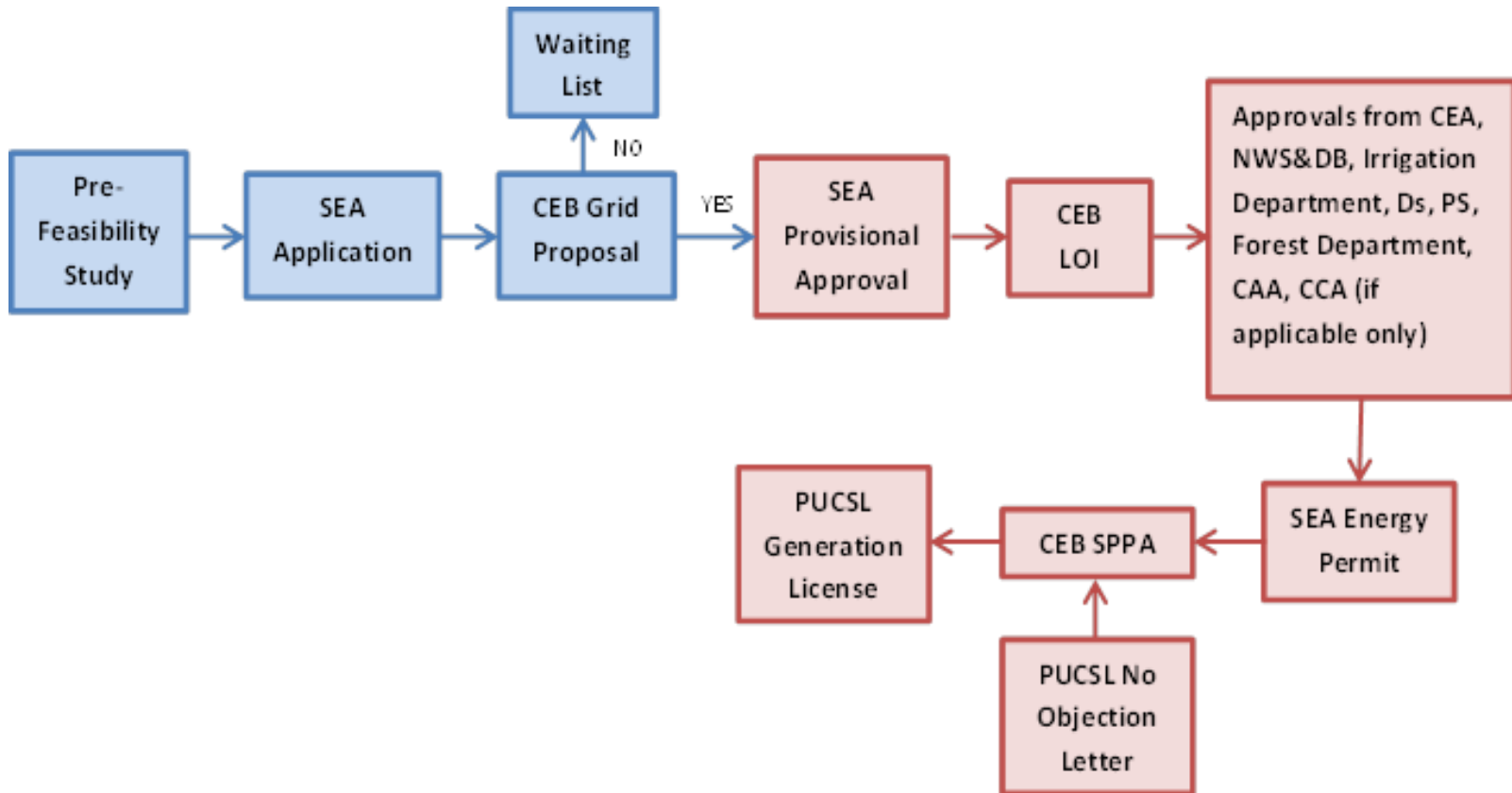
ENVIRONMENTAL ASPECTS

Comparison of CO₂ Emissions from fuel combustion

| Country | kg CO ₂ /2005 US\$ of GDP | kg CO ₂ /2005 US\$ of GDP Adjusted to PPP | Tons of CO ₂ per Capita | GDP per capita (current US\$) |
|-----------|---|---|---------------------------------------|----------------------------------|
| Sri Lanka | 0.33 | 0.08 | 0.67 | 3,280 |
| Pakistan | 0.94 | 0.19 | 0.74 | 1,275 |
| India | 1.25 | 0.32 | 1.49 | 1,498 |
| Indonesia | 0.94 | 0.21 | 1.70 | 3,475 |
| Thailand | 1.07 | 0.30 | 3.69 | 5,779 |
| China | 1.85 | 0.64 | 6.60 | 6,807 |
| France | 0.13 | 0.15 | 4.79 | 42,560 |
| Japan | 0.26 | 0.30 | 9.70 | 38,634 |
| Germany | 0.24 | 0.26 | 9.25 | 46,251 |
| USA | 0.35 | 0.35 | 16.18 | 53,042 |
| World | 0.57 | 0.37 | 4.52 | |

IEA CO₂ Emissions from Fuel Combustion (2014 Edition)-
2013 data, World Bank website 2013 data

Present NCRE Projects Approval Process



Main Parameters

- Debt equity ratio - 60:40
- Loan repayment - 8 years
- Construction period - 2 years
- Return on equity (ROE) - 22 %

Plant factor and O & M percentages

| Technology | Plant Factor | O & M Percentage (Year 1-15) | O & M Percentage Year (16 -20) |
|---|--------------|---------------------------------|-----------------------------------|
| Mini Hydro | 42 % | 3 % | 3 % |
| Mini Hydro - Local | 42 % | 3 % | 3 % |
| Wind | 32 % | 1.5 % | 1.5 % |
| Wind - Local | 32 % | 1.5 % | 1.5 % |
| Biomass (dendro) | 80 % | 4 % | 5 % |
| Biomass (agricultural & industrial waste) | 80 % | 4 % | 5 % |
| Waste Heat Recovery | 67 % | 1.33 % | 1.33 % |