# Executive Summary

CEB produced and released the first Integrated Electricity Plan (IEP) in 2002 with the objective of increasing stakeholders' confidence in its capability to ensure reliable, affordable and sustainable electricity supply for Mauritius and Rodrigues. Without a doubt, after ten years, CEB has lived up to that promise.

As the IEP 2003–2012 is phasing out, CEB has prepared the second IEP (Master Plan or the Plan) for the period 2013–2022, with the aim of guiding Mauritius and Rodrigues towards an even more stable electricity future. Similar to the previous IEP, the cornerstones of this Master Plan also are: to optimise the use of the existing power system, to keep electricity prices as low as possible through least-cost capacity expansion, to encourage our customers to participate in Demand-Side Management (DSM), and to provide for continued Private Sector opportunities in the electricity sector. These renewed commitments of the CEB will be made, while giving due consideration to emerging challenges, such as protection of the environment and maintaining grid stability with the increasing share of renewable energy sources.

Taking into account opportunities and challenges, the IEP 2013-2022 embraces a set of values which frame its underlying philosophy. The philosophy of the Plan implies that the CEB shall continue to exist as a competitive organisation for the benefits of the country; electricity will be available at the lowest possible cost; CEB will effectively balance the demand-supply of electricity for the coming decade; and electricity services development will be in line, as far as is economical, with influential national strategies, such as the *Maurice Ile Durable (MID)* and Government's Long-Term Energy Strategy (LTES) 2009-2025. In addition, with the setting up of the expected Utility Regulatory Authority (URA), CEB will continue to forge ahead under the same corporate principles by ensuring strict compliance with the regulator's issued policies.

A review of the IEP 2003–2012 reveals that, despite a slightly lower growth rate in annual demand (4.5% compared to 5.0% forecasted), most of the planned actions, to keep the power system responsive to the social and economic conditions in Mauritius and Rodrigues, were accomplished, or are being implemented. Some key achievements include:

- The expansion and diversification of the generation capacity. Over the past ten years, around 237.75 MW (CTDS: 30 MW in 2005, Saint-Louis Power Station: 41.4 MW in 2005 and 2006, CTSav: 74 MW in 2007, Fort Victoria Power Station: 30 MW in 2010, Nicolière Feeder Canal: 350 kW in 2010, Sotravic Landfill Gas: 2 MW in 2011, Fort Victoria Power Station: 60 MW in 2012) of new generation capacities have been added to bring the effective generation capacity of Mauritius up to 664 MW in 2012.

- The commissioning of new more efficient engines for a total capacity of 6.3 MW, in addition to the installation of 1.28 MW Wind Turbine Generators at Grenade and Trèfles, in Rodrigues.

- The upgrading and reinforcement of the electricity network. Besides continuous improvements of the transmission and distribution networks, new substations namely Amaury, Dumas, Sottise, Union Vale and Anahita, were constructed and commissioned.

- The upgrading of the SCADA at the Despatch Centre in Curepipe to a state-of-the-art technology. The more advanced system is now enabling the CEB to better monitor load flow in its networks and operations of its power stations and substations island-wide.

- The distribution of one million Compact Fluorescent Lamps (CFLs) to CEB's customers. This initiative is still contributing in curtailing the growth rate of the evening peak demand. Based on a set of assumptions, it was estimated that the CFLs project had reduced the evening peak by approximately 14 MW and is contributing in saving about 12.3 GWh of electricity annually.

- The introduction of Automated Meter Reading (AMR) System. To date, around 60% of the CEB's largest customers, who account for 30% of its annual revenue, have already moved onto the AMR platform.

- The promotion of renewable energy sources to produce electricity under the SSDG project. As at today, around 473 individual projects, which will culminate to about a total capacity of 4.8 MW in Mauritius and 200 kW in Rodrigues, are under consideration and partly implemented.

The integrated planning approach, adopted by the CEB, has indeed strengthened its capability to respond to its customers' needs, while contributing to its financial soundness. With these positive outcomes, the CEB is now endeavouring to move forward in the same spirit.

Based on an estimated 3.43% annual growth rate in electricity demand (Base-Case scenario), the IEP 2013– 2022 shows that new additional resources will be needed. The total investment, in order to sustain the Mauritius power system development in the short and medium terms, has been estimated to be of the order of MUR 18 billion. Seventy-two percent (72%) of the financing will be required in the short term, which includes a provision of about MUR 5 billion for the development of renewable energy projects.

Out of the total investment, 70% will come from private investors, and the remaining from the CEB. The major share of the capital injection will go towards generation capacity expansion, either for *'needs-based additions'* or for *'opportunity-based additions'*.

## IN SHORT, THE IEP 2013–2022 REVEALS THAT:

- The electricity demand in Mauritius in the Base-Case scenario will be around 3196 GWh in 2022. A rather conservative stance in the forecast has been taken for the reasons stated in Section 4.2.3. On average, the increase in energy demand will be around 78 GWh annually, compared to 80 GWh recorded for the period 2002-2012. Under the High-Case scenario, the annual average growth could be around 160 GWh.

- By the end of the 10-year planning period, the forecasted peak power demand will reach 574 MW under the Base-Case scenario and could be as high as 702 MW under the High-Case scenario. The 574 MW are equivalent to an annual average increase of 14.4 MW for the period 2013–2022.

- Geographically, the demand distribution will not change drastically, as determined by the spatial load forecast.

- Besides the addition of a 100 MW power plant (CT Power) in 2015/2016 which, technically, is ideal in the West, two new *firm* generation capacity of 50 MW each will be required in 2017 and 2021 respectively. With the coming into operation of new power plant(s), the old, and less efficient, Pielstick engines at the Saint-Louis Power Station will be progressively retired.

- CEB, in-keeping with the policy of Government, will accommodate renewable energy facilities, such as the 29.4 MW Curepipe Point (Plaine Sophie) Wind Farm, 10 MW distributed Solar PV Farms and *small (micro/mini) hydro plants*[1], among others. In this regard, CEB has already embarked on the project to increase the water storage capacity of the Sans Souci Dam by some 30%. This development, accompanied by the impounding of waters at River Canard, although modestly, will contribute to increase electricity generation from hydro. As recommended by the consultant, the Phase One of the project, which involves the increase of the height of the Dam's spillway from 240 metres to 243 metres, will be completed in 2014. In addition, CEB is also expecting to commission the Midlands Dam hydro project early 2013.

- CEB will also facilitate the penetration of renewable energy projects so as to be in accordance with the Ministry of Energy and Public Utilities (MEPU) upcoming 'Renewable Energy Master Plan' and the Energy Strategy Action Plan (ESAP) 2011-2025. This will include CEB's active participation in the development of a Wind Atlas, study to increase energy production from 'bagasse', study to use cane residues for electricity production, setting up of a pilot plant for handling and feeding cane residues and the setting up of a 20 MW Wind Energy System every 3 years as from 2017 and a 10 MW Solar Energy System every 3 years after 2013.

- As the pressures to shift technology in order to diversify primary energy sources, with the expectation to benefit from lower long-run marginal costs, and to promote more environment-friendly power station operations increase, the need for alternative power generation will be required. In this respect, CEB has set the objective to conduct a comprehensive pre-feasibility study for the use of Liquefied Natural Gas (LNG). LNG is an ideal substitute for fossil energy sources. If feasible, as an option, CEB will consider the development of LNG power plant as future base-load facilities. In anticipation, among other considerations, for this potential project, CEB has already made a strategic land acquisition in the harbour area at Bain des Dames. The site can be developed for the progressive installation of LNG generating units, as per eventual recommendations that would be made by an international consultancy firm.

- Save for the hidden cost to the environment, which is normally not included in the cost of operations of fossil-fuels-based generation, the cost of generation of renewable energy technology is comparatively higher than that of conventional sources of power generation. The main reasons for the high costs are the relatively significant initial investment and the very low capacity utilization factor of renewable energy projects. Given these constraints, the financial risks are in fact much higher in RE projects.

- As things stand today, renewable energy generation will continue to be more expensive compared to oil- or coal-based electricity generation in the medium term, unless the environmental costs associated with fossil-fuels-based generation are quantified and factored into the average system generation cost of conventional technologies. However, estimating environmental costs is in fact highly challenging in practice. CEB, besides not having the necessary resources and being an electricity producer, it is not appropriate for it to determine the environmental costs associated with its electricity production activities. The Ministry Of Environment and Sustainable Development (MOESD), which possesses the necessary environmental accounting tools and competences, is more apt to determine the environmental costs of electricity generation from fossil fuels.

- In similar vein, to ensure completeness in costs analysis and accounting, while the MOESD shall endeavour in determining the environmental costs of conventional electricity generating engines, it requires that the opportunity cost of the massive investments made in the fossil-fuels-based technologies, which are required to back up the operations of the RE technologies, be also assessed equitably.

[1]For the purpose of this IEP, a small (micro/mini) hydro plant is defined as a hydro power plant having a capacity below 1 MW.

- In embracing the least-cost policy, given the current state-of-affairs, renewable technologies being intermittent in nature will always be the second best alternative for the CEB. Economically speaking, the higher cost of electricity produced from renewable energy sources should normally be translated into higher cost of electricity, unless it is subsidized by the Government through the MID fund.

- In working towards the long term energy security of the country, *as implausible as it may appear*, nuclear technology is a generation option to substitute fossil-fuels-based generation in Mauritius. **As a matter of preparedness**, through the MEPU, CEB will initiate the process to seek technical assistance from the IAEA for preliminary research on future nuclear technology. In this regard, during the planning period, with the assistance of the IAEA, a roadmap for the **possible implementation** of this option will be defined so as to ascertain its economic viability. It is worth highlighting that this preparatory process in itself may cover a period of **at least 10 to 15 years**.

- The transmission network's reliability, in the short term, will be reinforced with the commissioning of a new 66 kV transmission line and a substation in the South-West at Case Noyale as a priority; the commissioning of a new 66 kV line from Belle Vue substation to Sottise substation; the laying of two new high-capacity underground cables to maximise power evacuation from Fort Victoria Power Station to Saint-Louis substation; the commissioning of La Tour Koenig and Riche Terre substations; and the upgrading of other existing substations.

- In the long term, the expansion of the transmission network will involve the construction of new substations in the regions of Trianon; the Airport and Goodlands; the construction of a new substation for the Neotown project (depending on the development of the Neotown Mixed-Use project); the upgrading of La Chaumière substation; the construction of a new transmission line from FUEL substation to Anahita substation.

- Despite the demand growth, the need to move to 132 kV transmission voltage will not be required until 2022.

- Main 66 kV transmission network as well as distribution network having serviced, both rural and urban areas, for over half a century will require systematic replacement. In addition, where necessary, the consolidation/replacement of HV steel lattice towers will also be addressed so as to enhance their physical integrity and to provide more security during cyclones.

- To accommodate medium- and large-scale renewable energy projects, system enhancements will be required to preserve the stability of the grid. The enhancements will include: the improvement of frequency regulation through modernisation of generators' control; the implementation of automatic voltage control at substation level; dispersing upcoming renewable energy projects geographically; the use of weather simulation software to determine the *day-ahead* level of renewable energy capacity that can be integrated into the grid; and the possible use of large-scale battery energy storage system.

- Furthermore, to promote the integration of larger renewable energy projects, CEB will expedite the development of a Grid Code including the Feed-In Tariff for Medium-Scale Distributed Generation (MSDG). This development is in accordance with the Energy Strategy Action Plan (ESAP) 2011-2025 of the MEPU.

- According to some experts in the field of renewable energy, the maximum amount of variable renewable energy (RE) that can be safely integrated in an insular power system is about 15% to 20% of the prevailing load demand. This level of RE integration, however, is intrinsically dependent on

the availability of fast-responding conventional generating engines, which is critical so as to regulate the system frequency. To increase level of RE integration above the threshold, as per the experts, installation of battery energy storage system (BESS) becomes inevitable.

- Modernisation of the electricity network will be dependent on the development and implementation of the long-outstanding Geographical Information System (GIS); the development of a Grid Code for the medium and high voltage networks; and laying the foundation for the development of the '*Mauritius Smart Grid*'. The ambition to build the '*Mauritius Smart Grid*' is also part of the Government's Energy Strategy Action Plan 2011-2025.

- CEB will continue to undertake necessary actions to remain in compliance with environmental regulations and to further promote its environment stewardship. In this respect, it will implement an all-encompassing Environment Management System (EMS) and will consolidate its Environmental Reporting Programme (ERP).

- The Rodrigues' system necessitates a deeper examination. Based on actual estimates, Rodrigues' electricity demand is expected to grow annually by 2.1% and 1.5% for the periods 2013–2017 and 2018–2022, respectively. The forecasted peak demand will reach 8.83 MW by 2022, that is, 38% higher than the peak of 6.39 MW recorded in 2011. To satisfy future demand, a new engine of 2.5 MW will be required by 2018 following the commissioning of the 2.5 MW engine at the Pointe Monnier Power Station in 2012.

- Rodrigues' operation is costly to the CEB. In order to study the possibility of minimising the costs of operation in Rodrigues, CEB will undertake a comprehensive study of the system in 2013, as a priority. The study will have as objectives, among others, to assess option(s) to reduce the *abnormally-high* network losses in the Rodrigues' system, evaluate alternatives to the electrical heating of oil for used-on-works, examine the cost-benefit of potential DSM initiatives and explore the possibility of higher integration of RE from wind and solar with/without storage batteries. Higher RE integration can assist in reducing operation costs, abating $CO_2$ emissions and increase the island's energy autonomy.

- Further exploiting renewable energy sources is an alternative being seriously contemplated for Rodrigues. To optimise and increase the share of renewable energy sources in Rodrigues, CEB is already assessing the possibility of using Modern Control Systems, which are expected to improve the system's responsiveness and by extension the grid stability (service quality).

- In complement with the supply side, CEB will give special consideration to potential Demand-Side Management (DSM) initiatives, which can contribute towards the least-cost expansion of the power system in Mauritius and Rodrigues. In this regard, CEB will work in close collaboration with other stakeholders to implement DSM activities, such as promoting the use of efficient lighting, efficient appliances and equipment, offering Time-Of-Use tariff, and facilitating further DSM actions through the gradual deployment of its Smart Metering Strategy.

- While formulating the Plan, it is essential to consider the appropriateness of the electricity tariff which will accompany the development of the power systems. Electricity tariff is the key revenue-generating source of the CEB. A re-alignment of the prevailing electricity tariff structure to move towards a cost-reflective tariff model is warranted in the short term. This shall be accomplished with a revenue-neutral objective, in the first instance.

The IEP 2013–2022 has been prepared on the basis of a set of assumptions. It reflects CEB's appreciation of the current outlook for electricity demand and supply. It is to be understood that this Plan is merely a snapshot in time. The fundamentals of the Plan that give rise to the 10-year outlook will, assuredly, change over time. As new information becomes available, the Plan will be updated accordingly and will be communicated to stakeholders.

The Plan is available to the public from the CEB and on its website at www.ceb.intnet.mu