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ELECTRICITY SECTOR REFORMS AND THE ROLE OF THE REGULATOR

Prof. Ranjit Perera, *Member SLEMA*
Former Director General
Public Utilities Commission of Sri Lanka

The new Electricity Act No 20 of 2009 was approved by Parliament and is effective from April 2009. Why was this new legislation necessary? Since the last electricity act, No19 in 1950, Sri Lanka's power sector has gone through significant changes. The system has expanded island wide, the installed capacity grew from 25 MW to 2500 MW, the customer base expanded from 17,000 to 4.5 million. Within a few years, it will reach the mark of 5 million.

Some provisions of the 1950 Act were fast getting outdated even in the context of Sri Lanka. In addition, the electricity industry worldwide went through reforms to various degrees, particularly in the 1990s. Some countries such as the UK implemented energy sector reforms over a decade. Countries in Eastern Europe went through political reforms as well, and then within a short period of six months, they completed implementing electricity reforms. All the other countries, developed, developing and even very low-income countries went through energy sector reforms of one kind or another. In addition to this worldwide trend, the development partner countries and multilateral lending agencies recommended sector reforms to all developing countries.

Electricity industry is capital intensive and Sri Lanka largely depends on concessionary funds to develop the electricity infrastructure. The other reason for the new legislation is, government of Sri Lanka identified the need for separation of policy and regulation.

Discussions about reforms commenced as far back as 1997. Since then, three different Electricity Acts were formulated. First, the Electricity Reforms Act of 2002 was approved by the Parliament but was not implemented. Another Electricity Act was formulated and presented as a Bill, and owing to the legal opinion of the Supreme Court, it was withheld. In the 3rd attempt, the Sri Lanka Electricity Act was passed in the parliament in March 2009 and was implemented with effect from 8th of April 2009.

Misconceptions

There are a number of misconceptions about the new electricity act in the minds of many stakeholders. At one point, the public were made to believe that the act would enable privatisation; some trade unions of Ceylon Electricity Board (CEB) implied that CEB will be dismantled with this act. The electricity act includes no provisions for privatization; there is no serious restructuring of CEB. Restructuring is limited to functional ring fencing[1] of identified CEB activities. The main impacts of the act is that regulation of the electricity industry has been transferred to a separate government arm, the Public Utilities Commission, while CEB remains as one entity under one board and one General Manager. Lanka Electricity Company and other licensees would remain as they are.

Ring Fencing

Under ring fencing, all the financial flows, material flows and work flows will be separated for each licensed entity. What does this functional ring fencing mean in the context of CEB? While being a single legal entity, CEB now performs their duties as six independent licensees. CEB has been issued with one license for generation, one license for transmission, and four licenses for distribution. The objective of ring fencing is not specifically established in the act but this is the final target. There will be responsible persons defined for each license, issued to all licensees. The responsible persons will report to General Manager and the board of directors. Thus in the spirit of the act, the Board of CEB would function as that of a

[1] **Ring fencing means financial independence, to ensure a business unit is responsible for its own costs and income, and would be insulated from other operational and financial transactions of a larger organization.**

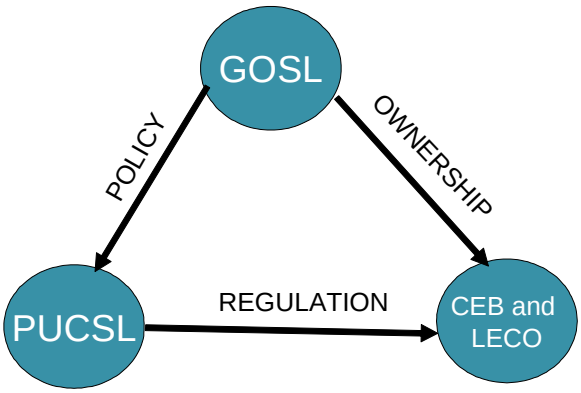
holding company, while individual licensee would be conducting a viable business. The General Manager would intervene in problems between the licensees of the holding company and shall resolve such issues. CEB will continue to exist as one entity, while only a small restructuring takes place based on the lines CEB has been functioning since 2002.

By Sri Lankan norms, CEB is a large organization, with an income exceeding LKR 100 billion or USD 1 billion. CEB owns and operates 70% of generation facilities, 100% of the transmission network, and 90% of the distribution network and customers. CEB serves a large customer base of about 4 million, covering about 75% of the population. No other utility organization can report such a large coverage. In Sri Lanka, CEB's turnover is only second to that of Ceylon Petroleum Corporation.

Separation of Roles

When an organization is large, at some point it becomes necessary to implement structural change to make improvements. That is the objective of this exercise of dividing CEB functions into six licenses. The other initiative implemented by the new electricity act is the separation of regulation from the government. The act transfers the regulatory power to a separate government body. Earlier CEB was owned by the government, the policy maker was the government. Regulation was done by the Ministry of Power and Energy, which again is the government. Regulation was not the core activity of the Ministry and there was no significant expertise built up there to attend to regulatory activities. Regulatory decisions of the Ministry were affected by short-term political circumstances, too. These three issues have negative impacts on the quality of regulation. The government identified the need for separation of regulation from policy, and it is now separated. The Public Utilities Commission (PUCSL) is not an agency under the Ministry of Power and Energy, but it is under the Ministry of Plan Implementation.

Figure 1: Separation of Policy, Ownership and Regulation



For the well being of the society, prosperity of the society should be guaranteed through the quality of business done by that society. Any form of business conducted by a company takes some inputs; it can be material, human resources or intellectual property, and produce outputs. Some of the indirect outputs such as environmental problems and social problems are undesirable to the society. To ensure that the business is performing well, there are some control mechanisms such as the laws of the country, policies of the company, and traditions of the country and the company. Furthermore, there are various audits which can help quality control such as material audits, financial audits and energy audits. The most important control mechanism is the stakeholder feedback which is essential for the improvement of the business.

Special Features of Utility Businesses

Furthermore, utility business has some special features. At present PUCSL is mandated only to regulate the electricity commodity by a separate act, while Water and Petroleum sector have been identified as the possible utilities which will eventually be regulated under PUCSL. However, for these commodities to be regulated under PUCSL, separate bills have to be prepared, presented and approved by parliament. Utilities are a special type of business. The monopolistic character is one of the main features. As intended in the on-going reform process, the monopoly of CEB in the electricity sector will be dismantled but owing to the nature of the utility business, its inherent monopolistic character cannot be eliminated in full. For an example, water or electricity supply can have

only one channel to go through to serve their respective customers. It is not possible to even plan two or three distribution lines drawn in front of your house for you to have a choice on which network to buy electricity from. So, in electricity distribution, the monopolistic character is retained.

The commodities being served or sold by the utilities are special commodities. People have identified some of these commodities as fundamental goods. Our quality of life depends on commodities such as water and electricity. At times, water and electricity are "political commodities". In Sri Lankan context, these political commodities change with times, with the focus shifting from rice, to bread and now to fertilizer. However, electricity has been a political commodity throughout, as people are believed to be deciding their vote depending on the present availability of electricity, or promised availability of electricity in the near future, quality of electricity supply, etc.

Another issue related to these utility commodities is the need for continuity of service. Electricity cannot be stored in bulk. Continuity of availability is a very important factor in electricity. Consistency in quality is another special feature. Beyond the fact whether electricity is available or not, or a visible brownout or an excessive voltage damaging equipment, the quality of electricity is not something a customer can easily quantify. There should be an independent authority who can guarantee the quality of such commodities, by establishing norms, securing service quality information from licensees, and calculating quality indices and publishing them.

Infrastructure development involves various issues such as environmental measures and safety issues, which need to be regulated. These are the common features shared by all the utility commodities.

As we said earlier, electricity is a special commodity. It is a hard commodity which cannot be duplicated. You cannot duplicate electricity such as a video program or as software. It has very little redundancy, and that is in the form of the load factor.

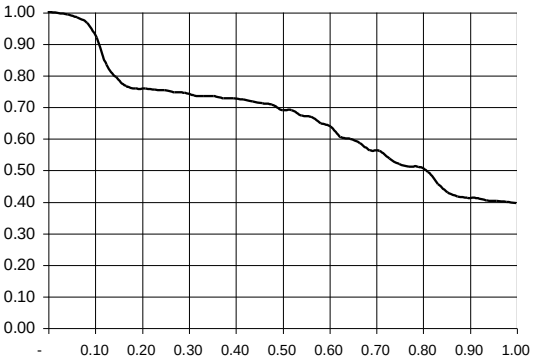
Previously there was no redundancy in a commodity such as telecommunications, but now there is redundancy. At the very beginning, telecommunication systems used a physical connection for each message from one place to another (A to B). At a later stage, only one physical connection (hard wire) was used from A to B and it was utilized well with various modulation techniques and multiplexing techniques to transmit many messages. In another stage, that connection, too, became redundant with the wireless links. This scenario will never be applicable to the electricity industry.

The price reduction experienced in the telecommunication systems with the redundant links cannot be expected to be replicated in electricity prices. The other special feature of electricity as a commodity, is the immovable assets required to produce and deliver electricity, which are capital intensive and of long life. The last feature is that electricity is a perishable commodity. Even with the availability of the infrastructure, if the demand is not there, electricity cannot be generated because it cannot be sold. If the assets are idling, cost cannot be passed-on to any customer. The other scenario is, when electricity is generated with resources such as water, wind or solar, if there are no takers, the resource goes wasted. Fossil fuels such as coal or oil can be stored for future us. As assets idling which makes the payback periods high, there is a capacity charge introduced as a component in the electricity tariff. These are the special characteristics that make the electricity industry distinctly different from other utility industries.

Other Features of the Electricity Industry

There are some other problems typical to Sri Lanka as well. The first is the lower load factor. One is our very sharp peak in the load curve. We observe a typical sharpness between 6.30 pm and 10.30 pm, that causes 35% of network capacity to be used only 25% of time. Unless this is compensated with an appropriate demand charge, the payback period of sector investments would be very high.

Fig 2: Typical Load Duration Curve



Capacity	Approximate Duration of Utilization
40%	100%
next 30%	50%
next 30%	25%

The second feature is the distinction between the village and the town is unclear, and wherever regulations exist, they are not implemented or enforced. For examples in several countries, the agricultural lands, home gardens and urban areas are distinctly defined. Even in India, cities are planned in such a way that houses, agricultural land and industries are not mixed up. Figures 2 and 3 show a typical city in Japan, and Gampaha in Sri Lanka. The ad-hoc arrangements in Sri Lanka of mixing housing areas, home gardens with agricultural lands makes electricity costly in three ways. (i) need longer lines. (ii) causes higher energy losses owing to long lines. (iii) extra costs to clear and maintain way leaves. All these costs are finally reflected in the cost of electricity.

Figure 3: A typical Planned City in Japan

Figure 4: Gampaha, Sri Lanka

Even before electricity was invented and other similar commodities came to the picture, western countries, due to the climatic conditions and security reasons, developed their centralized cities. In the meantime, Sri Lanka avoided developing and implementing proper town planning policies. Their home gardens and other utilized lands are separated. Infrastructure development and town shifting is far easier in planned cities. Currently it is a great opportunity available for Sri Lanka to follow the internationally accepted norms in planning town in the north and the east.

Sector Challenges

If we examine the challenges Sri Lanka is facing in the electricity sector, the electrification level in Sri Lanka is reported to be 83%, meaning that 17% of households have no access to Electricity. The government's policy is 100% electrification time frame which is a challenge. Our industries are complaining about higher electricity tariffs. Households are compelled to cut down their usage, owing to high prices. Meanwhile, we have power quality and continuity issues. Load shedding is a phenomenon of the past, but may come back if investments are not made on time.

There are new challenges, too coming up in the electricity sector. As an initial measure, we have to re-connect the mini-grid in the north with the national grid. Sri Lanka also have plans to interconnect with SAARC countries through a submarine cable. As a country we have to achieve our renewable energy targets defined in the policy. The energy contribution from small (non-conventional) renewable energy has increased to 433 GWh in 2008

(4.37% of grid generation). CEB has reported that another 38 projects with a capacity of 112MW has signed the agreements.

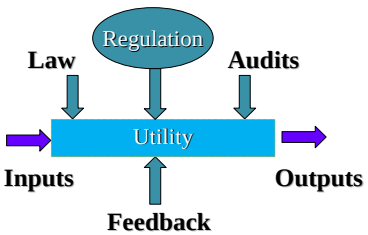
The final challenge of introducing nuclear power plants may also enable us to explore our Thorium deposits along the western coast. If a policy decision is taken, nuclear plants can be connected to national grid in another 15-20 years, to match the demand growth.

With these challenges in hand, reforms will help the electricity sector to perform well. The comparison between private and public ownership is advantageous and disadvantageous in different aspects. Neither the public sector nor the private sector ownership is always good or bad. For example, the public sector is more welfare oriented while the private sector is profit oriented. Political interference is less in the private sector and the operational safety is also generally high in the private sector. Stakeholder feedback is considered and valued more in the private sector. Innovation is more in private sector. Accountability is high in private sector whereas no one is responsible for any damage in public sector. Transparency is more in the public sector, but corrupt practices may still exist. When it comes to funding, grants and soft loans are available for public sector funding while only commercial loans are available under private sector ownership.

Regulatory governance

Quality control of a utility depends on many factors; the typical controls such as audits, law of the country, input out put control and feedback from stakeholders are needed, while some special regulatory control is needed for utilities. The role of regulator came into existence as this normal control is not adequate for utility quality control. The functions can be separated as regulatory governance and regulatory substance.

Figure 4: Regulator's Role Amidst Laws and Audits



Regulatory governance in Sri Lanka is achieved in two forms. One is it is independent from regulated entities and political authorities. It is independence through commissioners (for PUCSL) appointed for fixed and relatively long terms of office, and the involvement with both executive and legislative branches in the appointment. The terms of commissioners are staggered to ensure continuity, and their removal is possible only on legitimate reasons. PUCSL is financed through regulatory fees, and its budget is subject to revision by the state. Finally, the decisions of PUCSL can be challenged only in the appeal courts.

The other way of achieving regulatory governance, is through the decisions and the decision making process. It is transparent, accountable and predictable, and the proper decision making is through adherence to government policy, customer interests through Consumer Consultative Committees, stakeholder consultations and public hearings. These decisions are based on scientific investigations. The decision makers have a duty to promote the industry and achieve customer satisfaction.

The second function is the regulatory substance, ie "what is regulated?" This is planned to be regulated in two ways; economic regulation, and technical and safety regulation. Economic regulation will be done by regulating tariff levels and tariff structures. For price setting, there are certain principles to be followed. It should not endanger the financial viability of the regulated entity. It should direct operations towards efficient production and efficiency improvements of the regulated entity. Cost pass-through mechanisms should be clearly identified and the followed principle should be socially fair. Prices should be transparent, stable and reliable, and more importantly the price structures should be simple. Technical and safety regulation through imposed terms and conditions will be established in the licensing regime and these are monitored and adjusted by PUCSL as required. An enforcement order issued in cases of violations is another method. The standards and codes prepared in consultation with the licensees will be imposed and monitored. Consumer rights and obligations will be set as norms of regulation. PUCSL will monitor the progress towards the

targets set by the government and PUCSL by the reviewing of generation and network expansion plans and their implementation.
Consumer Protection is an important of the regulator. Why is it needed? Licensees are large institutions and while customers are either individuals or smaller institutions. If a customer has a problem, in the absence of the regulator, he has to go to the utility. If the utility refuses a solution, then he has no protection. The customer is compelled to buy from a monopoly and he deserves a quality service for an acceptable price. They should feel that they are equal partners in the dealings and needs a reliable mechanism to address their grievances. All these matters are addressed by the regulator and the fulfillment of customer needs is ensured. Table 1 shows a summary of complaints received by PUCSL between April and July 2009, the first four months since PUSCL was empower in April 2009.

Table 1: Complaints received by PUCSL April to July 2009

Tariff category + clarifications on bills/tariff	19 + 13
Disputes on estimated bills	13
New connections + disconnections	10 + 14
Frequent power failures	6
Delayed attendance to breakdowns	5
On CEB/LECO procedures	6
Compensation payments	6
Meter accuracy	4
Damages caused by over-voltages	7
Accidents	7
Other	2
Total	155

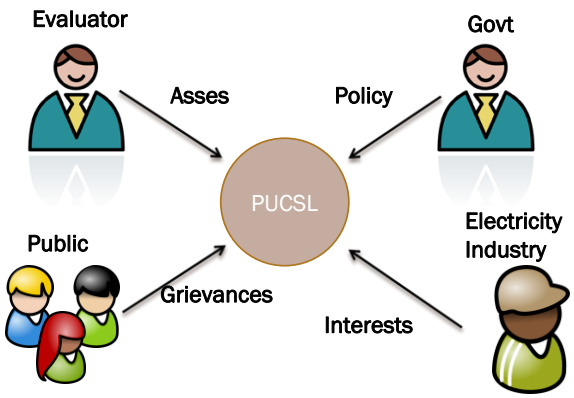
For complaints directed to PUCSL, customers need confidence that there is a reliable mechanism to address their grievances. Then the customers have to be satisfied by the quality of addressing their grievances, as PUCSL is a third party not dominated by the utility. They will experience a fair hearing and speedy settlement of their grievances and payment of compensation where applicable

Protection for Investors

PUCSL has a duty to protect investor interest. Utility projects are highly capital. These investments are large and immobile, with long payback periods. Therefore, investors require clear rules for their investment. Furthermore, any mistrust of the investors reduces credibility of the country and increases the cost of capital, and finally the cost of the product. All these aspects are covered by PUCSL and the regulator has a role to attract investors and to protect their interest for the betterment of the sector.

Regulation is also good for politicians, as shifting the blame for unpopular decisions is possible, and they can get rid of technically complicated tasks without much appeal to the public. When the government wants to implement policies to comply with covenants, too, regulation can be used as it provides an opportunity to demonstrate credible commitment.

As the conclusion, the Regulator's role can be defined to be that of "Improving Quality of service, while promoting the Industry and addressing the consumer grievances". The Regulator's objective should be to establish mechanisms to minimize the intervention of the Regulator and for the smooth functioning of the sector. Although the Regulator has wide powers, he has no free hand in making decisions. The decisions are based on the government polices, the PUCSL Act and the Electricity Act. Despite these limitations, the Public would always expect a fair and comprehensive hearing of their grievances. On the other hand, PUCSL is committed to safeguard the interests of the industry and to work for the betterment of the industry.



THE NEW ELECTRICITY ACT: ELECTRICITY UTILITY PERSPECTIVE

***Mr. Nihal Wickramasooriya**, Member SLEMA*
Former Manager, Power Sector Reforms
Ministry of Power and Energy

This paper presents the history and the evolution of power sector policies, and the revolutionary changes envisaged, from the point of view of electricity utilities. It also highlights the concerns of utilities on some provisions of the new electricity act of 2009.

The road to reforms

The Electricity Act No 19 of 1950 was the only regulatory instrument prevailing in Sri Lanka when the electricity reform options were first taken in for discussions. The 1950 Act provided for regulation of the sector through a set of licenses. It mainly provided for technical regulation of the industry; there were hardly any visible clauses to enable economic regulation or social regulation. Ceylon Electricity Board (CEB) was subsequently created by the Ceylon Electricity Board Act No 17 of 1969. CEB took over the duties of the Department of Government Electrical Undertakings. Most of the distribution activities were conducted by the Local Authorities at the time CEB was formed. CEB continued to develop as a monopoly in generation and transmission, and went on to develop distribution outside the Local Authority networks that existed at that time. Eventually LECO was created in 1983, which took over the Local Authority distribution networks in the western coastal belt (and some CEB distribution networks to enable geographic contiguity), while CEB took over the balance Local Authority networks.

After about 30 years of operation, studies conducted by various organizations recommended electricity sector reforms for Sri Lanka. As a result, in 1997-98, a policy paper was published, introducing the regulatory intent and a regulatory regime for the power sector. Major proposals of this policy paper were to separate out the regulator, policy maker and the operators. In accordance with the Act No 19 of 1950, the regulator and the policy maker were the same (Ministry of Power and Energy), and the operator was also the same because CEB operated strictly under Ministry supervision. One of the major thrusts of the policy paper was to separate out each role. Based on the 1997-98 policy paper, and after further studies, the Public Utilities Commission Act No 35 of 2002 and the Electricity Reforms Act No 28 of 2002 were legislated.

Implementation of reforms

The Electricity Reforms Act of 2002 envisaged concurrent reforms in to key areas (i) regulation and (ii) structure of the industry. Reforms to structure required the segregation of different functions of CEB. This process was carried out during 2002-2003, but the government decided to review the process in 2004, presumably owing to employee resistance to structural reforms. In 2005, a committee was appointed and developed another policy paper giving a tripod of solutions to precede the regulatory reforms and structural reforms, yet to be implemented together. It led to another electricity bill in 2006 which was subsequently withheld owing to a Supreme Court ruling owing to certain concerns on structural reforms. The government reviewed the strategy and appointed another committee. It recommended only the regulatory reforms to be implemented and to suspend the structural reforms for the time being. Thus, the Sri Lanka Electricity Act No 20 of 2009 came into the existence, to implement the regulatory reforms. This paper presents the perspective of the utility industry about the Sri Lanka Electricity Act 2009.

Licensing

Regulation of the sector is to be done through licenses. Operation of these licenses is through commercial contracts. CEB has to apply for and secure a license from the Public Utilities Commission of Sri Lanka (PUCSL) for generation, transmission and distribution. This is different to the manner in which CEB has

been operating in the past. CEB had never been a license holder. Independent Power Producer (IPP) contracts, Statuary Statement of Accounting Principle (SSAP) contracts, agreements with Lanka Electricity Company (LECO) and the supply licensees were the commercial contractual encounters CEB had under the 1950 act. The Sri Lanka Electricity Act 2009 demonstrates the features of improved fairness, improved transparency, establish sustainability and the improved efficiency, compared with the 1950 act.

With the new act enabled, CEB can forecast an annual return on investment. Fair play in the competition with the existing market players and prospective actors are envisaged. These are the new trends expected in the 2009 act which were not in the 1950 act. Competition is expected to bring sustainability to the sector. A cost reflective tariff structure is expected to be given to all utilities. It is set to be the bottom–up approach, from end consumer to distribution interface then to transmission–distribution interface and transmission–generation interface. To keep the business principles alive, utility forecasts a tariff structure from PUCSL which would give a suitable return on investments. For the last several years in this sector the tariff was not fixed on a cost reflective basis. Although it is said to be cost reflective, revenue of CEB was all the time far below the cost, which lead to a lot of uneconomical and unhealthy operations. This feature differentiates the Sri Lanka Electricity Act 2009 from the previous acts. Performance base incentives are not clearly visible in the 2009 act. But these are the tools that can be used to motivate the licensee to go towards the efficiency drive. Utilities expect a service and safety standards through the new act by enabling PUCSL to set regulations where employees work safely within the networks. Utilities foresee lean regulation which will give the required flexibility to improve and adjust the utility businesses. Licensees including CEB are legitimately bound to satisfy the customers. Improved reliability and the quality of electricity supply are expected to improve.

Another major change the new act brought about is customer participation in the decision making process. The opportunity is given to the affected parties and to the general public to voice their views in the licensing process through the public hearings and by various similar means. Tariff hearings are expected to take place, which was not available in the 1950 act. The monopoly of CEB to set or propose tariffs is abolished. PUCSL is empowered to decide, depending on their judgment or the submissions they receive from stakeholders. Tariffs used to be the same for the entire nation, which is a uniform national tariff. Now PUCSL can either decide to retain its unified character or make it regional. Transparency is expected to increase where utilities must be humble enough to accept stakeholder the feedback, constructive comments and fruitful arguments. The new act brings in a cost-effective independent consumer grievance handling system which was earlier done with the involvement of Additional Government Agents and subsequently the Divisional Secretaries.

Grievance Handling Mechanism

Affected third parties have to be investigated by yet another third party. In the 1950 act, that third party was the Divisional Secretary. For problems of customers, Chief Electrical Inspector (CEI) was the designated officer who was entrusted with the powers under the act to settle such issues. Owing to the absence of the necessary tools and procedures with the CEI, in the past, utilities handled most of these grievances and it caused widespread customer dissatisfaction. Now PUCSL is entrusted to act as this independent body. It is said that PUCSL has came up with low cost grievance handling mechanism which can only be appealed in the courts. This brings fairness of each party, irrespective of the technicality of the problem or the solution. This act allows PUCSL to collect all these information and publish them on the web. Any party can use the data for their studies. The data will be used for public hearings or in the license approving process. Under the act, utilities cannot hide information other than the very important utility specific data.

Since the concept of regulation is new for the electricity industry, understanding the role of the regulator is very important. Although the 1950 act had regulatory functions, the role was very limited. It has been compartmentalized to issue licenses and to handle customer complaints. The Sri Lanka Electricity Act 2009 gives much power to the regulator.

CEB business units and LECO are now fully fledged licensees and the license conditions have to be fulfilled. Organization of licensing functions is challenging. As of now, the major licensed functions (generation, transmission and distribution) are to be segregated or amalgamated in such a manner to derive the optimal benefits to the society. For example, it may be argued that we will have one distribution licensee for the whole of Sri Lanka. Another may have the view that we may have five distribution licensees. What is the optimal solution? How should these licensed areas be formed to provide the best service to our customers? How should generation be licensed? These are the questions before PUCSL to be resolved. Thermal generation and the hydro generation, behaves in completely different manner and brings challenges in terms of performance monitoring. In distribution, the selected tariff model out of the variety of tariff setting methodologies such as revenue cap, RPI-X or marginal costing, has to bring optimal solutions.

Regulatory overlap has to be minimized for smooth operation of the sector. Before the formation of the PUCSL, the government was the regulator for the power sector. The General treasury regulates CEB financial operations. Even after the establishment PUCSL, the General treasury is there and is expected to exercise certain regulatory functions. These overlaps will be minimized with the implementation of structural reforms, but for the time being, PUCSL has to see how to minimize these overlaps. Moreover, organizations such as CEB or LECO may have their own organization cultures in existence for several decades. In certain areas, they may not be able to act according to the license conditions owing to their framework or the organization culture. For example, in CEB there are three mainstream functions namely engineering, finance and human resources. There are large numbers of professionals in the engineering stream, while the other two streams lack the required professional skills. Capable staff, fixed assets and movable assets are essential to carry out the business of the utilities in the modern business environment.

Some Concerns of Utilities

There are operational issues related to the new act, identified by CEB and LECO during the first three months of its operation. One is the problem related to way-leaves. In the 1950 act, there is a provision for a one time compensation for way-leaves, which enable the utilities to a come to a proper agreement on issues related to the right of way, without opening doors for third parties to claim compensation in the future. In the new act, there is provision for asking compensation repeatedly. In a way, compensation of affected parties is a healthy practice but it reflects back on the tariff. Therefore, some balance has to be brought about and a workaround is required in this area for utilities to establish a proper method. Electricity piracy is one of the important areas for a utility, and they look up to the act for power to curb piracy. The 1950 act allows a utility to take person who pirated electricity, to the police station and subsequently to magistrate courts, fine him and to recover the losses caused by piracy. However, with the present act, that it is not allowed and additionally the utility must give three days' notice to investigate or visit the premises. Utilities are seriously concerned that once we reach the premises after the three day notice, that temporary bypass to pilfer electricity will not be there anymore. Only a permanent damage to the meters can be detected through such delayed visits. It has been revealed that there is a concern why the utilities are given so much of power to take person to courts for pilfering electricity. There are the areas where PUCSL has to find the means to balance the utility interests and customer interests.

This exercise could be extended in two ways. One is that PUCSL, the regular has to act in such a way to improve the competence of the stakeholders. The major stakeholders are the government, utilities and the customers. Thus, if the regulator can behave and demonstrate his capabilities in all these lines, the total exercises will be fruitful. The other one area remaining to be addressed is the structural reforms. Although regulatory reforms have been introduced, the author believes that structural reforms should come soon. Regulator should to decide the insertion of the structural changes at the correct time.

RAILWAY ELECTRIFICATION: LET US START, AT LEAST NOW

Dr Tilak Siyambalapitiya
Past President SLEMA

Electrification of railways, of both Colombo suburban and long-distance, has been proposed by many in the past. The Ministry of Transport has so far not taken any meaningful steps to launch a project. Engineer DJ Wimalasurendra provided the first inspiration, who on his paper titled 'Economics of Power Utilisation in Ceylon' mentioned the importance and advantages of electrifying our railways, way back 1918. Now we are 92 years behind, and there is not even a debate on the subject at the Ministry of Transport. Initiatives of others come up and go away, once in a few years.

The latest effort is by the Institution of Engineers, Sri Lanka (IESL). In August 2008, IESL as a responsible body of professionals, presented a new proposal to electrify a segment of the railway network. The Institution of Engineers, India, gracefully accepted the request from IESL and provided the honourary services of an experienced railway electrification engineer. Through a series of deliberations and field visits facilitated by the Sri Lanka Railways (SLR), the study concluded the following: (a) the most widely used sector of the existing railway network, from Veyangoda to Panadura, should be the first to be electrified (b) Investments on electrification can be recovered fully with cost savings in energy and maintenance alone (meaning other benefits would be a bonus). (c) The estimated investment is about Rs 6 billion. We will examine the above recommendations and more, in a moment.

The Sector to be Electrified First

Forty four percent (42%) of the passengers using the present rail network today get-in and get-off in the Panadura-Veyangoda sector. This sector is 64 km long, which is a manageable length (and a manageable investment) for the first step to establish an electrified rail network. Of course, there are other sectors such as Kalutara South-Polgahawela, which can cover more than 50% of current passengers, but the length would be more, making the initial capital outlay higher. So, the sector to be selected to launch electrification depends on further study, to provide the optimum benefit to commuters for the given investment. Whichever sector is selected, it would only be the first step, and eventually the entire railway network should be electrified, based on an economic justification.

The Approach

Greater Colombo suburban areas are congested, and clearing rights-of-way for a new electrified railway network would be a challenge. Numerous investors have examined the option of developing a light rail network or mono-rails, with tracks suspended on pillars. All these proposals have fallen by the way side, owing to poor economic viability caused by many factors including the lower population density in Colombo and the suburbs, compared with other major capitals in the region where new light-rail or underground rail networks have been recently built. Thus the more logical option is to make maximum use of the available tracks and rights of way. The way forward therefore, is to upgrade and electrify the existing railway network. The benefits are visible, can be calculated and fully justified, on energy and maintenance cost savings alone.

Why Electrify?

If one considers the passengers presently served, it may even be argued that the absence of electrification is not the cause for the problems of SLR. The infrastructure is poor and needs investment. Signalling and communication systems need to be further modernised. Shortage of locomotives and rolling stock is a major limitation that causes train services to be cancelled frequently. SLR has been making operating losses owing to a variety of reasons, beginning with under-pricing of passenger fares.

Table 1 - Summary of Passenger Origin and Destinations for the Sectors Considered

Sector Starts	Sector Ends	Sector length (km)	Passengers served in the month of September 2007				
			Origin within sector	Destination with sector	Origin+ destination within sector	% of all SLR Passengers	Passengers per route km
Panadura	Veyangoda	63.4	5,180,960	5,230,930	3,620,631	42%	57,108
Kalutara S	Veyangoda	79.0	5,448,826	5,499,307	4,083,869	48%	51,695
Panadura	Ragama	41.7	3,896,168	3,942,688	1,755,510	21%	42,099
Fort	Ragama	15.5	2,782,911	2,783,840	746,657	9%	48,171
Fort	Gampaha	27.5	3,651,503	3,649,043	1,741,201	20%	63,316
Fort	Polgahawela	73.8	4,725,297	4,716,276	3,264,792	38%	44,238
Maradana	Panadura	28.1	3,114,081	3,149,971	927,217	11%	32,997
Maradana	Kalutara S	43.7	3,381,947	3,418,348	1,374,672	16%	31,457
Fort	Negombo	38.9	3,126,349	3,125,079	1,107,873	13%	28,480

Source: Origin and destination data of Sri Lanka Railways.

Yet we say that electrification should be a priority, because the investment can be fully justified on the basis of energy efficiency and maintenance cost savings alone. If SLR, the Government or even the multilateral lending agencies bring out a hundred reasons why electrification is not a priority, energy efficiency and sustainability would be an adequate reason to make that decision, and electrify the network. Another reason is the future: if one may ask how shall be move about in 100 years from today, the answer lies in electric vehicles, both trains and cars. Where would the electricity come from, when oil supplies decline? That will be from renewable sources (hydro, wind, biomass, solar, ocean energy sources), nuclear power and some remaining coal-fired power pants.

Energy Efficiency

All trains have an on-board electricity generator on the locomotive (or the power car), using diesel fuel. This generator produces electricity which drives the motors connected to the wheels. The generator is idling most of the time (when decelerating, during stops, waiting time, etc) and used for only a small amount of power when running at steady speed. In a suburban drive of 30 minutes (say Colombo to Moratuwa), it uses the full power only for one minute, in total.

If the same train is powered with mains electricity, there will be no wastage of fuel during the balance 29 minutes. And what is more? When the train decelerates or applies brakes, the motors will immediately transform themselves into generators, produce electricity and send it back to the mains wires. Thus, the heat now generating in brakes will no longer be there, but converted back to electricity and "saved" in the grid for later use. Brakes will be applied only after the train is about to stop, and in an emergency.

And what is more? If electricity is taken from the mains, it will not be electricity produced from diesel. It will be a mix of hydropower and fuel-oil, and from next year, it will be hydropower and coal, which are the cheapest forms to produce electricity.

Savings in Energy Costs

A diesel multiple unit, more popularly known as a "power set" on a suburban service in flat terrain with 1000 passengers on board uses about 2.5 litres of diesel per km, when all losses are averaged out. At present prices, this will cost Rs 175. However, for a suburban electrified service, the electricity consumption from the grid is only 4.3 units of electricity per km. If this electricity comes from hydropower, the production cost is zero, but if it comes from the most expensive diesel power plant, the production cost will be Rs 120. In reality, the average production cost of electricity is presently about Rs 10 per unit, which will decline in real terms when the coal-fired power plants become operational from next year. Thus, even with the presently-high grid electricity costs, the economic cost of electricity is likely to be about Rs 45 per km, against Rs 175 for diesel. If network losses and other expenses are added, the financial cost of energy is likely to be a maximum of about Rs 85 per km. Therefore, energy costs would be

halved when trains are electrified. But there is another benefit: remember that when the train brakes, about 30% of this energy goes back to the grid.

Benefits to Passengers

The maintenance costs too will be significantly lower. The Indian experience is that the total maintenance costs of locomotives per train would drop from Rs 300 to 100 per km, and that is where the real savings are. Each diesel power set or a diesel locomotive is a self-contained power plant. The train carries its own power plant and roams the countryside. A central power plant would certainly be cheaper to maintain, than to maintain a fleet of roaming power plants, which too operate in the idling mode most of the time.

Savings that are not accounted for in this analysis are the passenger comfort, time savings owing to higher acceleration and speeds, and the overall benefits of a quiet, smooth operation, free from noise and pollution. What is more: as power is available on board the train, any comfort or service can be provided with ease: good lighting, air conditioning, music, cooking to serve warm meals. More passengers can be attracted to travel by train, if electrification is accompanied by a determined effort to improve the customer service and the image of SLR.

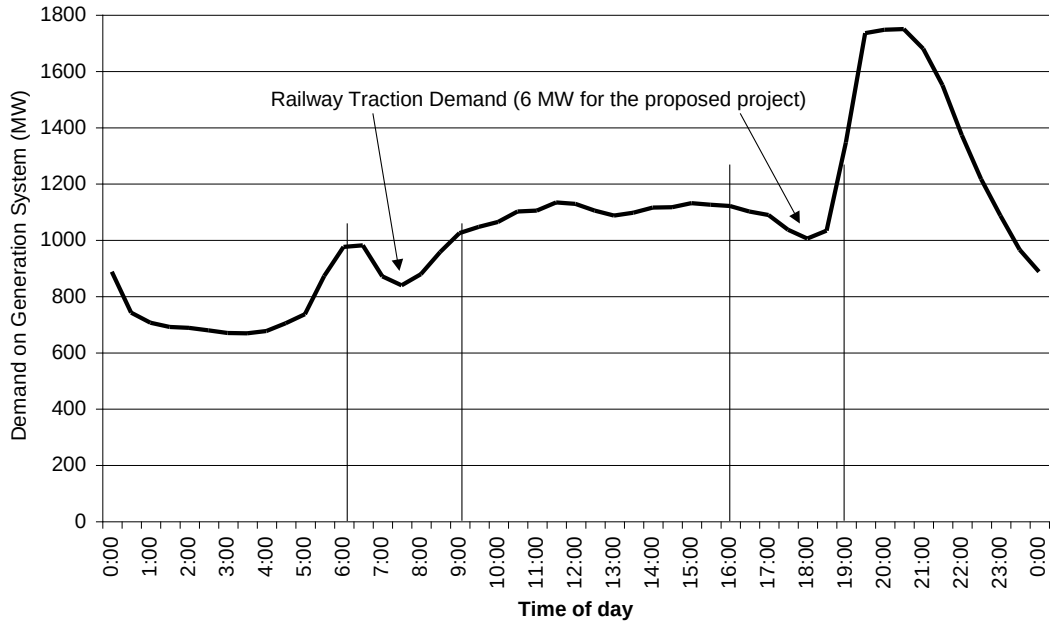
The Project

Electric lines would be drawn above the railway lines and loops. The operating voltage will be 25 kilovolt, which is now the standard in India and most other countries. Current will come from the overhead wire and return along one of the rails. The rails will be at zero voltage; so crossing them or stepping on them will not be dangerous. However, extreme caution is required at level crossings, to ensure vehicles taller than the stipulated height do not cross. Of course, high voltage lines cross our roads at thousands of locations, and this should not be a problem. Some existing station roofs and passenger bridges would have to be modified or re-built. The proposal of IESL, reviewed by the Indian Railways expert, was to begin with the Veyangoda-Panadura sector, with five electric multiple units, or let us call them "electric power sets". Thereafter, five electric power sets will be added once in two years, to provide an efficient suburban service. Thereafter, new power sets regularly purchased by SLR will be all electric, and the diesel power sets presently serving the Colombo suburbs will be gradually shifted to serve the peripheral areas or for suburban services around provincial towns such as Kandy, Galle, Trincomalee and later Jaffna. The long distance trains and the diesel power sets will continue to run in the electrified sector, too, with no hindrance.

What happens during a power failure? One precaution will be to build adequate spare electricity lines, which can immediately takeover if one line fails. Well, Sri Lanka does have total grid failures as well, typically once a year, when all lines will have no power. On October 9th last year, Sri Lanka had probably the longest grid failure in the history. Grid failures occur in developed countries too, but possibly once in 10-30 years, and when that happens, as in the great north American blackout in August 2003, rail passengers had to sleep on the streets overnight. It took two days for them to fully restore power. Sri Lanka's electrified railway system will have backup generation, adequate to move a few trains in an emergency. Certainly all trains will be moved to the closest station using the backup power, until power supply is restored.

The economic benefits are high. If the costs of new electric power sets are excluded (as new power sets have to be purchased anyway for replacements), the economic rate of return will be over 14%. Even if all the costs are included, yet the minimum rate of return will be 5%. And that is only with energy and maintenance cost savings. All other benefits such as speed and comfort will be extra. The fact that SLR is running at a loss, is irrelevant to this analysis. This proposal is to cut down costs, and provide a faster, more comfortable passenger service. If the Government wants to convert the railways into a profitable entity, that has to be resolved through proper pricing and business management. That has to be done anyway, with or without electrification.

Figure 1 - Impacts on the National Grid Demand Profile



The figure shows the demand profile of Sri Lanka, with clear "valleys" at 630 am and 5.30 am. This exactly is the time when electrified railways will operate at their maximum frequency. The estimated maximum demand of five electric multiple units accelerating all at once is 6 MW, which is very small compared with the total demand. Thus, railways electrification is not expected to cause any need for additional generating capacity in the national grid. In contrast, electrified railways will be using electricity during off-peak periods, and should thus enjoy a preferential tariff. This study used the average tariff as the price of electricity.

So Why Wait?

This is the question asked by all. It is nearly one and a half years since the IESL proposal was presented. No specific actions have been taken to proceed to the next step, in spite of significant support by all in the energy sector and a wide cross section of the engineering community. The project is viable, will not burden the electricity supply system, and will bring enormous benefits to rail passengers as well as to those who presently travel in crowded buses. Swift action by the Ministry of Transport is awaited. After all, it is the responsibility of the Ministry of Transport, and the energy community can only assist.

(The full proposal of IESL is available on www.iesl.lk)