Energy

Stone-age ancestors of present man, acquired the skill to make a spark, and get fire by hitting two stones together. These hunter-gatherers experienced natural forest fires, and partially burnt animal carcasses found after such fires lead to the man's habit of eating "roasted, smoked or dried meat". This was how man acquired the practice or cooking and storing foods, and they had to get the fire from a tiny spark when they need it. This was the first energy conversion done by man, and fuel used to keep the fire was wood or dried plant materials that was abundantly available. When man started to migrate all over the earth, those who have settled in temperate areas faced with the scarcity of fuel-wood, not only for cooking, but also to keep them warm during the winter periods. This could have been the first fuel crisis faced by man. Man developed the ability for planning for the future from very ancient times trough surviving the annual extremely could seasons.

During the evolution, man learnt to use plant and animal oils, fossil fuels such as coal, lignite, natural gas, and petroleum liquids as natural fuels, some countries became economically rich because they have these natural resources, while they know how to manage these natural resources for their benefit.

Many countries like Sri Lanka do not have known fossil fuel resources, and they import these fossil fuels by spending a large sum of money continuously. Rural Sri Lankans use wood as the main fuel, but it has become restricted due to its uncontrolled use and other environmental concerns. Although, Sri Lanka is faced with the fossil fuel crisis, we have most valuable free energy from sunlight, but we are not capable of using it for our energy requirements.

Modern world economies are dependant on petroleum and nuclear fuel energy sources for industry and day-to-day household activities. Powerful countries use fossil fuels as a powerful weapon to extract money from other countries while indirectly controlling those countries for their benefit. Meanwhile, the natural fossil fuel sources are getting depleted very fast as these are non-renewable. However, scientists all over the world are trying hard to develop methods to utilize renewable energy sources such as wind-power, solar-power, sea wave-power and microbial energy conversions etc. as alternatives to fossil fuels. Sri Lanka has a very great potential to develop dendro-power because sunlight and rainwater is available all the year round to grow wood-fuel trees. The origin of fossil fuels was photosynthetic energy conversion, and dendro-power source is also from the same basic energy conversion done in nature. Accordingly, Sri Lanka has declared *Glyricidia* as its fourth commercial crop cultivation. Dendro-power programme have environment protective and nature friendly added advantages.

Sri Lanka has to seriously think about our current situation with respect to the current fuel crisis that drains foreign exchange of the country. This issue of Vidurava explores the current status of Sri Lanka's energy requirements and future needs, assuming that we are in the path of development.

Thusitha Malalasekera

Science and Technology - School Education under the restructuring scheme for the new millennium

The restructuring of curriculum related to Sri Lanka's school education took place in the latter half of 90th decade. In 1998 this restructuring of Primary Curriculum started in a limited scale in Gampaha District and from 1999 this was scaled up to cover the entire island. By 2003 this restructuring of primary level had reached the last grade, i.e. grade five. The restructuring of curriculum school education levels of grade 6 and 9 was started in 1999 and it was put into action three years till 2001. The advance level curriculum was renewed in 1998 reducing the number of subjects to three.

By completing the eight year curriculum cycle, the restructuring of curriculum, it is supposed to be introduced from 2007. The restructuring of curriculum in the new millennium mainly paid attention to 6 to 9 grades which includes the junior secondary grade, and grades 10 and 11 which include the G.C.E. (O.L.). Out of them, restructuring of 6th and 9th grade curriculum has been started in 2007.

The new curriculum of junior secondary levels has been made common to grade 6, 7, 8 and 9. The restructuring of 90th decade, the subjects of grade 6 which were kept as a transitional period, have been changed under this common curriculum. In the primary level students were introduced to the curriculum by a single teacher, in the grade 6 they will be introduced to a number of subjects taught by different teachers. Students of this young age when taken away from a compounded curriculum and introduced to a single subject curriculum may face new challenges. To minimize such effects, especially considering grade 6, two compound subjects were included into the new curriculum. Out of them, the first is science and social science subjects as well as technology included in the environmental studies subject. The second is, the common fine arts subject which included the drawing, dancing music, drama and acting.



Even though, thus steps being taken to introduce the unitary nature of curriculum to grade 6, some observered that this has resulted in undesirable results. When they analyse the restructuring done in 90th decade, they have shown that the prominence given earlier to science subjects have been down graded. The reason for this down grading is that last G.C.E. (A.L.) curriculum restructuring, to introduce new subjects Biology and Combined Maths by combining 4 different subjects.

Also, they argue that for the grades 7 to 11, instead of science subjects, Science and Technology subject has been introduced. This has resulted in not giving enough time for students to develop their scientific concepts, technology in science in application and usage. The curriculum makers have tried to introduce the relevant technical sections within the science itself and there by have weaken to certain extend the scientific concepts. Even though, the subject environmental studies in grade 6 has been introduced with good intentions, many critics say that students have failed to understand scientific concepts

Technology is another subject that is very closely related to science. After the independence of the country, although arts, science and commerce have been favourite subjects at different period, the future of the country depends on technology. The school children first recognize technology at the grade 6 level as they start learning Practical and Technical skills. This subject runs throughout the junior secondary level relevant to grades 6, 7, 8, and 9. At first, students gain the background experience by learning this subject at junior level by doing activities related to environment.

and, to look at them scientifically. The theme "Water" is taken as an example. Under the environmental studies subject, even though it has been considered in detail the subject has failed to surface the scientific principles connected to water correctly.

Under the restructuring scheme of primary education in 1990's decade, it may appear that the place given to science has some what weakened. Instead of starting the introductory science subjects from grade 3, today they start from grade 1. What is included is the activities related to environmental activities. The environmental activities introduced to study the scientific concepts with sufficient opportunities, is a subject that takes an important place in the primary school curriculum. When this subject was structured apart from science, social science, aesthetic subjects, physical education, hygiene, nutrition as well as creative activities and spoken English have been added. Under such a subject does one get sufficient attention to build up basic concepts of science? Is it possible to build up the foundation needed for higher grades to study science? Such logical questions have been raised. The primary problem that others pointing out is that a considerable number of teachers are incapable of correctly surface the scientific concepts commonly forwarded by the above subjects.

By considering the aforesaid reasons, the governmental authorities have decided to carry forward the science for everyone with a much sound foundation. Instead of previously proposed subjects for G.C.E. (O.L.) i.e. general science, physics, chemistry and biology the authorities have decided to re-introduce science for all from grade 6 to grade 11.

Yet one should understand that there are marked differences in the subjects introduced under G.C.E. (O.L.). No longer the teaching of science subject for G.C.E. (O.L.) remains as a compound subject, it has been proposed to change the science subject teaching as units divided according to number of forms. For example in the grade 10, first term has been set aside for teaching Biology, second tern for Chemistry and third term for Physics. According to this plan equal attention has been paid to three basic subjects included in the science. By studying the above three subjects a student would be able to pass G.C.E. (O.L.) with sufficient science skills.

To day when one looks at the students who pass G.C.E. (O.L.), many of their capabilities have been limited to certain subject areas in biology only. This is no secret. By these results it is not difficult to recognize that there is a vicious circle i.e. there is a dearth of teachers who could correctly teach Physics and Chemistry subjects in schools. Physics and Chemistry (G.C.E. A/L) is also the basis for studying Agriculture and Technology subjects. Therefore, it is necessary to avoid students learning parts of subjects, and to direct them to pay equal attention to learn all three basic science subjects equally. Therefore, discussions have been launched between Department of Examinations and the Institute of National Higher Education to change the conditions laid for G.C.E. (O.L.) science subject.

Under the new restructuring scheme special place has been given to Mathematics, a subject that helps to develop school children's logical thinking ability in various ways. In the junior secondary level equal to science subjects, five periods per week have been allocated for mathematics. In the G.C.E. (O.L.) six periods per week have been allocated for mathematics. Yet extra time may be needed to establish proposed mathematical concepts. It will be possible for school principals to allocate extra period for this according to their wish, from the free time set aside for them. For the junior secondary level this extra time is two periods, while it is four periods per week for G.C.E. (O.L.).

Hygiene and Physical education have a lot of scientific concepts and have relationship to science education. At the junior secondary level two periods per week are allotted to these compulsory subjects, while under the curriculum restructuring scheme at G.C.E. (O.L.) three period have been allotted as alternative subject. Although at the G.C.E. (O.L.) it is required to consider these subjects as a base subject, the Department of Education has decided to keep them as an alternative subjects, to prevent the increase of number of subjects unmanageable manner at G.C.E. (O.L.).

Technology is another subject that is very closely related to science. After the independence of the country, although arts, science and commerce have been favourite subjects at different period, the future of the country depends on technology. The school children first recognize technology at the grade 6 level as they start learning Practical and Technical skills. This subject runs throughout the junior secondary level relevant to grades 6,7,8, and 9. At first students gain the background experience by learning this subject at junior level by doing activities related to environment.

The Practical and Technical skills subject which was introduced in 1990s under curriculum restructuring scheme, the National Institute of Education has decided to activate it under new face. Accordingly, the subject Practical and Technical Skills which is supposed to introduce to grade 6 in 2007, consists of five streams. These five streams are Agriculture, Food, Introductory Technology, Crearicvity and Entrepreneur Activity. Here it has been expected to direct the students more fruitfully to use creativity to use information and Technology Activities. It is expected to communicate these concepts correctly to direct students

in entrepreneur activity at an entrepreneur angle. For the first time in the year 2000 Practical and Technological Skills were introduced as an alternative subject which included development of vision, creativity and concert. Today these areas are limited to fine Arts subjects.

In the school education up to grade 13, economics, basic technology, agriculture, entrepreneur studies also get their foundation under practical and technical skills. Under Home Economic Science subject, certain parts of Food Technology have been added to make it more attractive for boys. This subject also stimulates student to take to catering service to supply food for various functions, various home based products and to enter Hotel schools.

There are two subjects included under the basic technology subject for G.C.E. (O.L.). These two subjects have been selected by combining a number of subjects. Under Design and Technology, subject has been added such areas as Mechanical Technology parts, building Technology parts and Electronic and Electrical parts. For the second subjects Arts and Crafts has included such areas as Pottery, Weaving, Painting, and Ornamental creating. Thus, under G.C.E. (O.L.) Technology combining of subjects have been done to make it easy for students to select a suitable subject as they like to specialize it.

To the G.C.E. (O.L.), two subjects combinations have been added namely Agriculture and Food Technology, and Fisheries and Food Technology. Six Agriculture subjects that were included earlier have been condensed into two subjects. This was done to create a foundation for "Technology", a new subject introduced to G.C.E. (A.L.) in 2005. The section of Food Technology is common to both subjects that have been newly added to curriculum. Sections in gardening and animal husbandry have been included into Agriculture Technology, while Ocean and land water sources related Bio Resources Technology has been included into Technology.

In the new G.C.E. (O.L.) curriculum, a large number of changes have been done about the commercial subjects. The "Entrepreneurial studies" has been introduced as a new subject. Today young people who complete their school education have not sufficiently developed their entrepreneurial skills, according to a survey carried out by International Labour organization (ILO). An entrepreneur has a good understanding about himself and always prepared to take risks. S/he also has a clear understanding of his abilities and weaknesses. At the same time s/he must be able to understand the society and the social behaviour. S/he is also capable of generating new enterprise opportunities when required. This subject has been introduced with the intention of aiming to prepare young people with self reliance capability to take them to self employment.

It is very essential for entrepreneur to pay sufficient attention and to take correct decisions. One should understand this is like a gamble. Too much attention leads to deterioration, and not paying sufficient attention also leads for deterioration. We should understand that both will obstruct one's development in the earlier curriculum that had been included as the basic principles of Entrepreneurship. Accounting has also been included in the new subject, so that they will be able to carry out simple accounting and to plan their enterprises. Also this subject has aimed at both profit making and non-profit making enterprises.

Today the manual typewriter is out date. The necessity of computer based word processing in on demand. Therefore, the present curriculum which has typewriting and shorthand will change to Electronic writing and documenting voice records as a new subject. This subject will help for secretarial work. As the new curriculum takes steps to use one's basic abilities to create more experience based skills, students get sufficient opportunities not only to know something, but also to create relative concepts and abilities which help them to get a better living.

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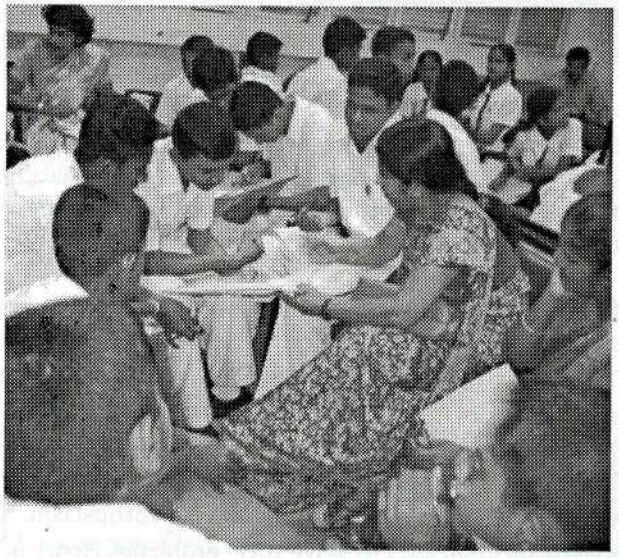
Now we see how the practical and technical subjects that have been in the grade 6-9 get intergraded into G.C.E. (O.L.) curriculum. This practical and technical ability will also a helping hand for the students to enter into information technology field. At the primary level it is hoped to direct basic mathematics, and at the junior secondary level it will go ahead through practical and technical ability subject. All practicals included in the subject will help the students to get used to Information Technology field of study.

For G.C.E. (O.L.), the Information Technology was introduced for the first time in 2006. Under technical category scheme, this subject is being rearranged in 2007 to

Teacher or Facilitator?

Facilitate for learning: Towards developing a "science culture" in the nation



"I can't imagine why we learn science in this manner. See how devoted our teacher is? Entire syllabus has been covered by now. In addition, six past question papers have also been discussed with us. How many classes do we attend after school? But when I think of the examination I feel very uneasy." Ironi went on saying at length.

Chithrini made a wise comment on that. "Hasn't our teacher's and our effort become fruitful? Three of us have scored over ninety marks always in past examinations. It is a very common thing that one falls into anxiety when thinking of examinations. Anyway, I'm quite confident that we all will get "A"s. But, I have doubts that three of us would use science knowledge acquired through this memory based process".

"What Chithrini said is quite right, and Ironi's version is also true," said Hasika joining the conversation.

"As I understand now, science is not that kind of a subject which one should memorize notes and to score high marks at examinations. If someone achieves higher grades for a subject like this in such a written examination, that examination cannot be considered reliable for testing one's scientific capabilities."

"According to my knowledge, a subject like Science should direct us to explore on infinite space continuously, in the process enlightens our inborn skills and analytical power." Ironi presented a very deep, philosophical statement.

"I happened to observe an activity which was done with grade six students a few days back. The lesson was so interesting, I thought how fortunate it was, if I were to be in that classroom." Hasika said.

"Then, Science is going to be taught in such an interesting way in future ah?" said Chithrini.

"There was no chalk and talk teaching at all. Students were engaged in exploring different possibilities independently. Teacher was just acting as a helper to girls and boys to learn". Hasika's expression made the others inquisitive.

"We cannot understand what you said. Please explain to us about that lesson from the very beginning."

"It is a bit difficult to explain an experience that I observed; but..."

Hasika tried to present what she observed as lively as possible.

"The particular lesson was just after the interval. Boys and girls rushed to the classroom as the bell rang and were ready for the lesson with their books open. Some were talking to each other. They were in their own world, mind you...."

The teacher entered the classroom. The children greeted her. "Son, shall we sing that verse?" asked the teacher from a boy.

"He would have been prepared for that earlier."

"Yes Chithrini. I also thought that. On the other hand it's not just a verse. It is related to the lesson – a simple verse that stimulates the interest of the students. While he sang the verse, teacher put up the verse written in a big demy sheet on the black board. On seeing that, the whole class began to sing the verse together with the teacher. Do you know? In fact, I also sang involuntarily."

"My lovely leaves sway in the breeze
While, piercing the earth my great roots run
For I'm a tree – a blessing to the world
Protecting all life under the sun"

"Is that lesson in some way related to trees?"

"You are mistaken Ironi; Its not related to trees, but an exploratory activity on trees."

"By that time boys and girls have got to know the contents of the verse. They discussed about the verse with the teacher. They entered into the world of flora through a lively discussion. A picturesque scenery representing flora in a variety of environments generated in my mind as well."

"Then that kind of imagination would have been generated in their minds as well" Chithrini. Hasika's face lit up like a fragrant flower of the Sinharaja forest.

"Then the teacher divided the class into five groups and distributed leaflets on guidelines for the exploration, colored pictures depicting a variety of plants growing in different environments, demy sheets, colored pens etc, to each group."
"Then the class would have been very noisy."

"That's what I wondered. But, there was not much of a noise. The guidelines were very simple. I think the colored pictures attracted the attention and they forgot to make noise."

"There was another wonderful thing."

"Among the things that teacher distributed to the groups, there was a small story named 'Dream Journey'. Boys and girls enjoyed reading it very much. I observed their faces. They were really interested."

"What were the contents of that story?"

"A boy named Malaka had been in a dream as if he is on a journey through a variety of environments. The journey was to see mangroves, seashore vegetation, hydrophytes, epiphytes and xerophytes."

"One could learn about the habitats and diversity of plants from that story alone."

"Did the lesson conclude at that point?" asked Ironi.

"Not really. That's the point where activity started, not the lesson!"

"Thereafter, members in the groups started looking at pictures, while the teacher placed a variety of parts of plants collected from various environments on the table. Each group had selected a particular kind of pictures. Boys and girls went to the table with the pictures in their hands from time to time. They took away the matching plant parts from the table to their working groups."

"The teacher visited each and every group. She observed what the children have developed with enthusiasm. She praised them; helped to solve their problems. Apart from that she evaluated each student and awarded marks".

"They discussed many things, argued. Sometimes they opposed. Then again they discussed and came to a consensus."

"At last they started work on demy sheets."

"Some drew pictures. Others wrote verses, pasted pictures, did some hand work, pasted plant parts. Ultimately, a creative caption was given to what they have prepared on the demy sheets."

"It was a sight to see."

"Then what did the teacher do? Didn't the teacher have anything to do?"

"The teacher visited each and every group. She observed what the children have developed with enthusiasm. She praised them; helped to solve their problems. Apart from that she evaluated each student and awarded marks".

"I got the idea – students were learning and the teacher was helping them to learn".

"Of course, it is the active learning process, and teacher is only a facilitator".

"The teacher was quite free, isn't it?"

"Yes indeed. Even the children experienced a lot of freedom."

"After that, group by group presented their findings to the whole class attractively."

"It was just like a variety show."

"Yet another point. Five groups were given five different topics. All discussed the findings of every other group and new information was also added during the discussion."

"The contributions of all groups built up the totality. A small encyclopedia on mangroves, hydrophytes, epiphytes, xerophytes and seashore vegetation was developed through the presented materials."

"Hasika, now don't they take down notes in their note books?"

"What do they study for the examination?"

Chithrini and Ironi uttered in embarrassment.

"Through their enlightened faces, I could imagine the confidence that had been built in their minds regarding what they explored through the activity. At last the teacher summarized; established; filled the gaps; in order to build up the totality of the subject content through a discussion. An invariable change occurred enabling them to face any kind of an evaluation or examination successfully".

"My point of view is a novel examination method should introduce to evaluate that kind of deep and broad knowledge."

"In addition, there was a feed forward program planned to eliminate the conventional note books. It was a field study tour. The booklet that was prepared to be completed during that tour was very interesting."

"In that sense, the notes jot down in the process of the actual experience obtained from the field study could be used as lesson materials."

"Chithrini! What about the story 'Dream Journey' given to the students?"

"It could also be used as a note itself."

Ironi replied before Hasika.

Chithrini with a peculiar big smile in her face asked another question.

"Hasika, what happened to the text book that boys and girls used to take at the very beginning of the class?"

Hasika fell into an uncomfortable situation by the Chithrini's question. The expression on her face was puzzled although she smiled.

"Now listen. There is no teaching based on the text book. But, text book is a valuable resource as an additional learning material."

Ironi made that statement on behalf of Hasika, smartly. Hasika got another bright idea, "Why not get more information from the "internet"?

"But, we have to go to reliable websites such as those with <.edu> and <.org> addresses".

"I would like very much to present the findings of the group exploration in front of the whole class. Everyday, in each of the activities, if we were given the opportunity to present, it will eventually develop our personality."

Ironi spoke with great enthusiasm. She further went on to say " If the learning facilitation process goes on as in developed countries, Science Education in our country would be reformed enabling us to think scientifically; to solve problems logically; to explore and reveal relevant information; to observe accurately; to make conclusions through experimentation; we would be directed involuntarily."

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"When the above mentioned aspects become our habits that we practice throughout our life-time, that is the day of the beginning of a 'Science Culture' in this country. That kind of Science education provided by the schools will enable to direct our brothers and sisters towards a science culture in future."

Chithrini spelled out those words in a harmonious tone.

"Shall Chithrini, Ironi and I become dedicated facilitators who contribute to initiate the science culture in our nation?"

CMR Anthony
National Institute of Education

The Energy Crisis in Sri Lanka

Is there an energy crisis in Sri Lanka? Well, when you look round, there are no shortages of fuels, no electricity blackouts, no end of traffic using petrol and diesel. Visit some offices, and you are sure to see empty rooms well lit up and air conditioner operating at full capacity. Streetlights burning in broad daylight, is not an unusual sight. So, when we look round, there is in fact, no visible energy crisis.

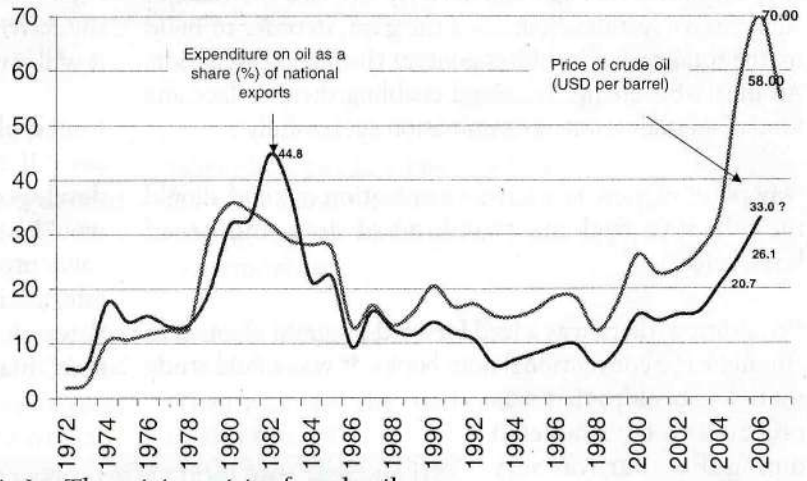

Fig 1. The pricing crisis of crude oil

An energy crisis need not always appear in the form of shortages. If there is a threat of electricity blackouts in the future, that itself is a crisis. If our electricity prices are high, and our electricity supplier has been bankrupt for years, that itself is a crisis. If we are using more and more of personal transport, and if we are reducing the use of more energy efficient public transport for people and reduce rail transport for goods, that itself is a part of the crisis. If we spend over 18% of our export earnings on the import of oil, and if we import 95% of our commercial energy requirements, that itself is a crisis in energy security- And the list goes on.

That is the energy crisis we have in Sri Lanka. So far, it is not a crisis in the availability, but a threat of future shortages, higher prices, decreasing national energy security and energy supply institutions becoming commercially deteriorated.

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The Crisis in Petroleum Fuels

What we now see is a crisis in the pricing of petroleum fuels. There is a pricing crisis in the world market developing since 2002, and reached the most unexpected levels in September 2006. Petroleum supplies have not been curtailed (unlike during the 1973 and 1979 oil crises), but we have a major problem with the amount of money that the country has to pay for petroleum fuel, and the amounts the individuals have to pay for the fuels (Fig 1).

Note: In international trading, crude oil is measured in barrels. One barrel has approximately 159 litres. The above prices are the average for each year, traded in Dubai for spot purchases. A spot purchase is an immediate shipment. Forward purchases for shipping within a month or two is

	1999	2000	2001	2002	2003	2004	2005
LPG	140	146	141	157	161	166	165
Petrol	213	224	250	286	390	437	463
Kerosene	243	229	228	229	207	204	209
Auto Diesel	1,377	1,684	1,625	1,728	1,669	1926	1690
Furnace oil	558	737	749	758	705	758	973

Table 1. Fossil fuel Sales (thousand metric tons) in Sri Lanka

also possible, and that is usually cheaper than spot purchases.

In 2004, Sri Lanka paid 18.7% of our export earnings, to import crude oil and other petroleum products. If the present trend of high oil prices continues, we may spend as much as 25% of our national earnings to import petroleum products in 2007. This situation reminds the severe difficulties the country had during the previous oil crises, and the subsequent periods, where fuels were even rationed to control the demand. Sri Lanka may not face shortages of petroleum products in the near future, owing to longer-term supply agreements with major middle-eastern and Malaysian suppliers, but we would have to pay prices that reflect the current world market prices.

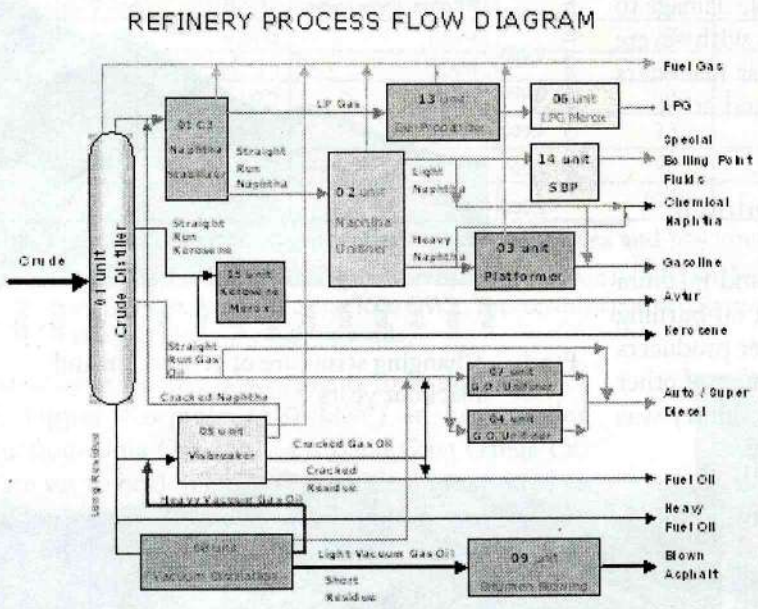

Fig 2. Refinery process - Flow diagram

Sri Lanka also has an abnormal split between different types of fuels (Table 1). Our consumption of diesel is about five times the consumption of petrol, and suddenly increases when electricity generation demands higher quantities of diesel.

A refinery can only produce diesel about three times the quantity of petrol, but we need a quantity equal to six times that of petrol (Fig 2). Therefore, diesel has to be imported directly in refined form, in addition to the production from the refinery. In most situations, producing in the Ceylon Petroleum Corporation (CPC) refinery is cheaper than importing the refined fuel from abroad. However, certain world market conditions cause refinery operations to be too expensive during some periods. The capacity of the only refinery we have is almost fully used. Therefore, the country has a shortage of refining capacity, and there are plans to double the refinery capacity from the present 50,000 barrels/ day, within the next four years. However, this expansion needs a large investment.

The Crisis in the Electricity Supply

The crisis in the petroleum industry is felt directly as price increases, but the crisis in the electricity supply is a lot deeper. A shortage of electricity cannot be resolved overnight, not even in a few months, because establishing power plants take time. Sri Lanka has no electricity connection with other countries. A proposal to connect with India is still at the initial stages.

Electricity generation requirements in Sri Lanka are growing at a long-term average rate of 6.8% per year, but in certain years, the demand growth exceeds 9%. In year 2005, electricity generated into the national grid was 8766 million kWh (8766 GWh). It is expected that the future growth will at least be 8% per year. In the past 15 years, extreme growths in years of no supply curtailments (blackouts) have been 5.1% (lowest in 2004) and 13.3% (highest in 1998). To satisfy this growing demand for electricity, power plants have to be built and they have to be built on time, not too early, not too late. If new power plants are built too early, they will be idling and the investment would be wasted. If they are built too late, the

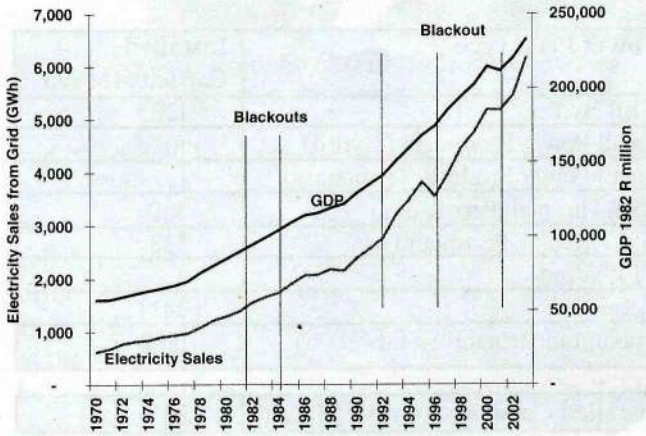

Fig 3. Effects of Blackouts on the economy/GDP

electricity demand may not be satisfied and there can be blackouts.

Owing to generation capacity shortages, there have been rolling blackouts imposed in Sri Lanka in the years 1980-81, 1983-84, 1987, 1992, 1996 and 2001-2. Long periods of 8-hour blackouts were imposed in 1996 and 2001, causing severe hardships to electricity customers and a visible damage to the economy. The Figure-3 shows the years with severe blackouts, and the GDP, clearly showing that blackouts cause the national economy to slow down, and at times, cause a negative growth as well.

Blackouts Cause the Economy to Slowdown

Sri Lanka presently has 1205 MW of large and medium hydroelectric power plants, and 1098 MW of oil-burning thermal power plants. Along with small power producers who provide hydroelectricity and a small amount of other sources, the total generating capacity in the country was 2414 MW by end 2006 (Table 2). The maximum demand recorded in 2006 was 1890 MW (provisional, subject to confirmation). Therefore, the country has a 27% reserve above the demand. In a purely thermal generating system, this reserve margin is adequate, but as 50% of the capacity is hydroelectric, Sri Lanka cannot operate all the power plants all the time. This is an inherent feature of any hydroelectric power plant: the capacity stated in megawatt has no real meaning and what matters is the amount and uniformity of water inflow. In the longer term, hydroelectric power plants are a real benefit, but their capacity contribution is limited and varies randomly. Therefore, in addition to building adequate new generating capacity to meet the growing demand, it is necessary for a generating system to have adequate backup capacity to meet shortfalls in hydroelectric capacity.

Power Plant type	Installed Capacity (MW)
CEB Hydro	1205
Small Power Producers (Hydro)	107
Small Power Producers (Biomass)	1
CEB Thermal: Petroleum	560
IPP Thermal: Petroleum	538
CEB Wind	3
Total	2414
Maximum Demand So far (2006)	1890
Installed Capacity Reserve Margin	28%

Table 2. Generating capacity of power-plants (Status at 2006 Dec.)

In the blackout years of 1996, 2001 and 2002, the country did not have adequate thermal capacity to meet the growing demand (Fig 4). In 1996, it was delay of the Sapugaskanda

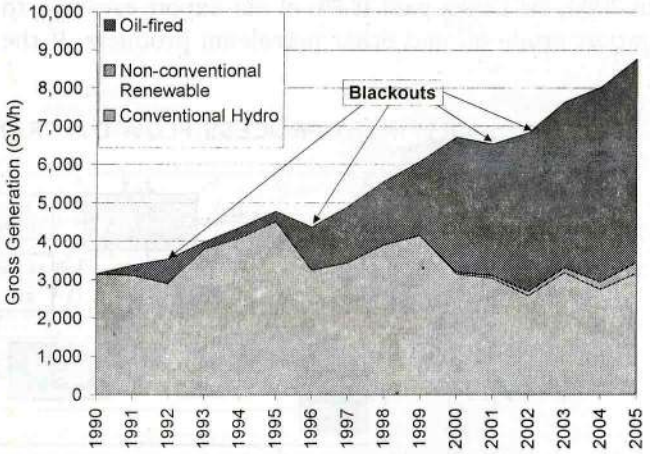

Fig 4. Changing structure of generation and blackout years

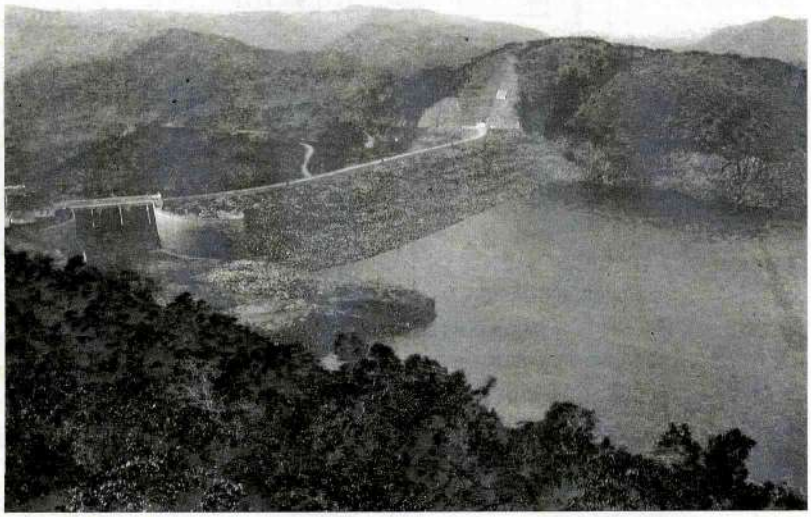

Fig 5. A hydroelectic and water storage reservoir

40 MW power plant that caused the crisis and severe blackouts. In 2001/2002, it was the delay in the coal power development program, that caused the crisis. Even the stop-gap measure of the two thermal power plants at Kelanitissa were not built on time to meet the 2001/2 crisis.

Over the past 15 years, Sri Lanka's electricity generating system has transformed from a predominantly hydroelectric system to a mixed hydro-thermal system, and is now a predominantly thermal generating system. The generation mix is shown in the figure, also showing the demand growth profile.

The transition to a thermal-dominated generating system is expected to continue into the future. There are only a few

Year	Forecast Generation Requirement (GWh)	If the rainfall is at the recent average (2000-2005) level				
		Major Hydroelectric Power Plants (GWh)	Non-conventional Renewable Energy (GWh)	Possible Thermal Generation (GWh)	Surplus (shortage) (GWh)	Estimated Blackouts (hours for the year)
2006	8,937	2894	307	6,646	1,000	
2007	9,565	2894	378	6,646	443	
2008	10,245	2894	474	6,646	-140	120
2009	11,072	2894	599	6,646	-843	667
2010	11,967	2894	730	6,646	-1,607	1,176
2011	12,931	3243	870	8,880	152	
2012	13,970	3243	1020	10,742	1,124	

Table 3. Major electricity generation capacity shortages and blackouts expected during 2008-2010

Note: Major hydroelectric power plant electricity generation is based on the average of the past six years. Historic long-term averages are higher by about 1000 GWh. The recently approved Kerawalapitiya Power Plant is expected to relieve the shortages from late 2008 onwards.

new major hydroelectric power plants to be developed, of which Upper Kotmale (150 MW) is now under construction. Uma Oya (150 MW) and Ging Ganga (50 MW) are yet to be developed (Fig 5). Coal is expected to make a dominant contribution to the grid from year 2010 onwards, with the first 300 MW power plant now under construction in Norochcholai, Puttalam. Non-conventional renewable energy too, is expected to serve 10% of the grid energy by 2015, on the basis of a recent policy decision by the Government.

A Major Hydroelectric Reservoir

There are no blackouts today, but does that mean there is no crisis ? No, there are two crises, both a capacity crisis and a financial crisis. There is a shortage of generating capacity until the two new power plants (Upper Kotmale and Norochcholai) begin producing electricity from mid-2010. While the demand is growing at rates higher than 8% per year, there was not a single new power plant under construction in 2005-6, scheduled to come into operation before 2010. Capacity shortages are likely from late 2007, and would be severe in the period 2008-2009. Construction of the Kerawalapitiya power plant that was scheduled to be operational from 2007, has not even started. The Table-3 shows the major capacity shortages and blackouts that can be expected over 2008-2010, if the Kerawalapitiya power plant is not built immediately.



Fig 6. 1 MW Dendro power plant using fuelwood (Gliricidia) storage area

Picture: Courtesy Lanka Transformers Ltd (LTL)

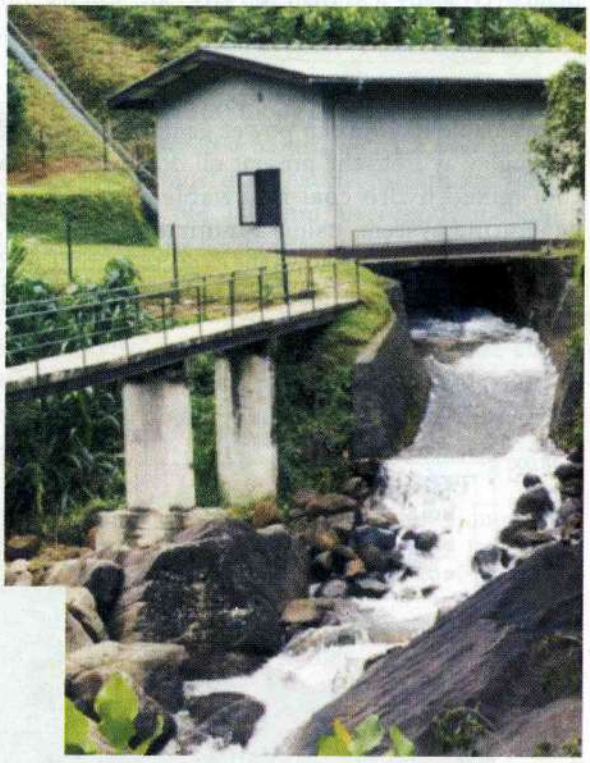

Fig 7. Ellapita Ella Small Hydro Power Plant
Picture: Courtesy of Eco Power (Pvt) Ltd.

Non-conventional Renewable Energy:

A scheme to buy electricity from small hydroelectric power plants into the national grid was established in 1997, through which over 100 MW of capacity has already been developed by the private sector. The Government has also announced incentives for biomass-based electricity generation projects, by way of additional payment over and above the prices paid for sale to the grid, for the first 50 MW of biomass-based power plants. One biomass-based power plant is presently in operation, while several more firewood and rice-husk based power plants are in various stages of development.

Over 300 micro hydropower plants (typically less than 20 kW) are also used to provide basic electricity needs of remote communities. About 50 micro hydropower plants (typically less than 100 kW) are still used by tea/rubber estates to provide power to estate factories.

Through these initiatives, the country expects to reach a reasonable fuel-mix in power generation by 2015, moving away from the present oil-dominated status to a mixed hydro-coal-renewable energy-based generating system, using a minimum of oil-fired generation. Figure-8 shows the expected profile until 2015, and the mechanisms to reach this goal are already in place.

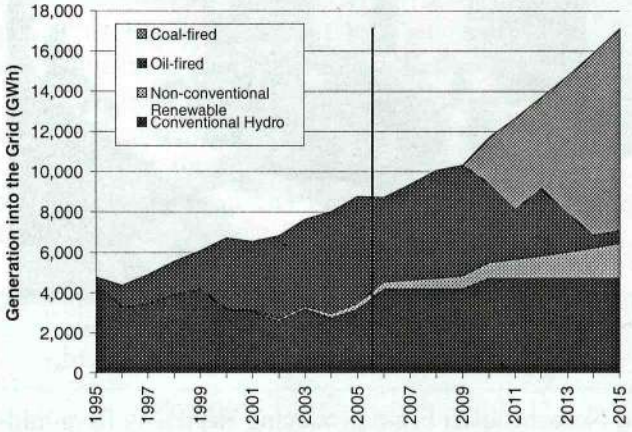

Fig 8. Forecast of energy geneation methods up to 2015

By 2015, the country will achieve a balanced, affordable fuel-mix in generation

Nevertheless, Sri Lanka's electricity costs will remain high for several years to come. In 2005, Sri Lanka produced 61% of electricity using thermal power plants, all burning oil. Because lower cost coal-fired power plant could not be built, high cost oil-burning power plants had to be used to produce electricity. This crisis in electricity costs and prices will continue in the future. Even if the oil prices do not increase beyond the present (January 2007) levels, and if coal prices do not exceed USD 100 per ton delivered, electricity prices can be reduced only by a small amount, when the three major power plants Upper Kotmale, Norochcholai and Trincomalee) begin operation.

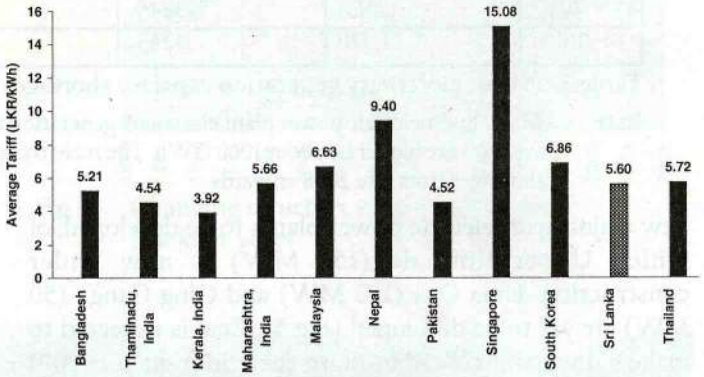

Fig 9. Comparison of electricity prices: Medium households using 90 kWh per month

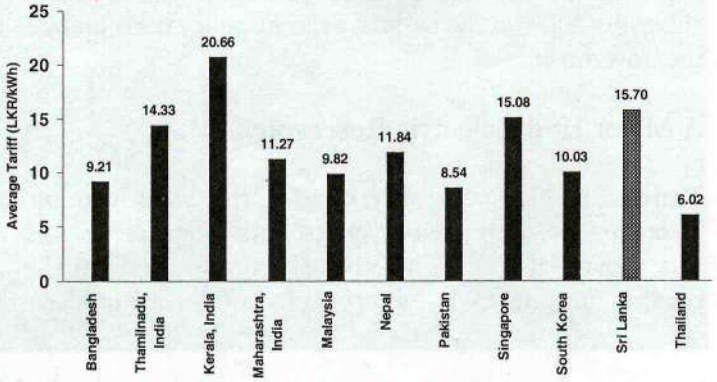

Fig 10. Comparison of electricity prices: Commercial customers using 58,000 kWh per month

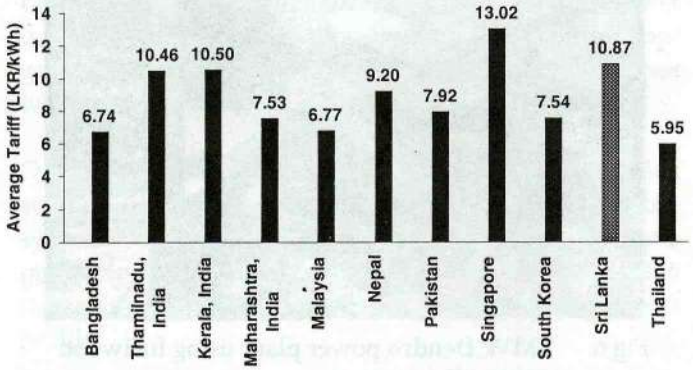

Fig 11. Comparison of electricity prices: Industrial customers using 65,000 kWh per month

However, if the three major power plants are not built, the price of electricity will exceed double the present prices, even if oil prices remain the same as of today. There is no room to increase electricity prices of Sri Lanka much further than the present prices: the graphs (Fig 9 to Fig 11) show the electricity prices in Sri Lanka compared with several countries in the region. Although our prices are not the highest in the world and not the highest in the region, they are high, and are likely to go higher. Therefore, we have a pricing crisis of electricity.

Keeping electricity prices below cost, has caused the main electricity supplier, the Ceylon Electricity Board (CEB) to go bankrupt, with accumulated losses exceeding Rs 50 billion. There is a further Rs 60 billion of long term loans the CEB is unable to pay. This is because, while oil prices and the share of oil-fired electricity were on the increase from 1996 onwards, electricity prices were not allowed to be increased to match the increasing costs.

Although the public does not accept, electricity prices would have to first go up before coming down in real terms. Sooner or later, electricity prices have to be raised to match the costs, and in parallel, implementing projects and programs to reduce costs (Fig 12). The latter is happening, but electricity prices are not yet anywhere near the costs. But the Government is pushing CEB to do exactly the opposite: to reduce electricity prices, which will further aggravate the financial crisis of the sector.

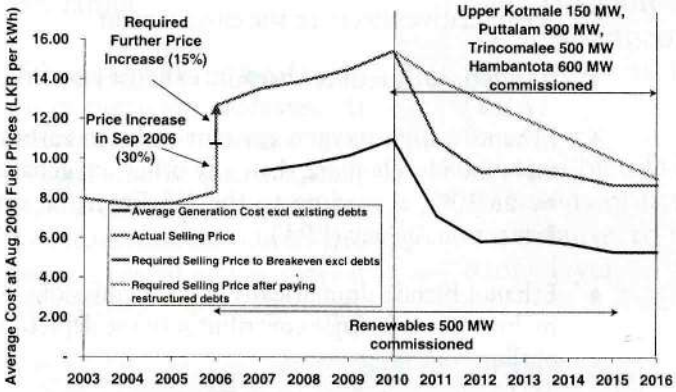

Fig 12. Electricity prices will first go up, and then down



Dr Tilak Siyambalapitiya
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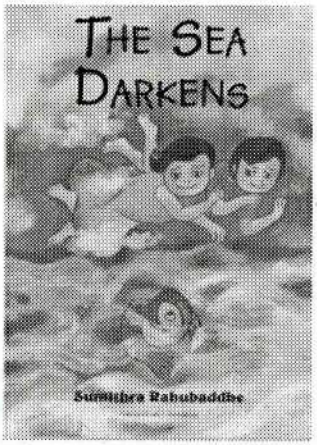

Author : **Sumithra Rahubaddha**
Illustrator : **Sibil Wettasinghe**
Published by : **The Special Committee on Popularization of Science, National Science Foundation**
Price : **Rs. 150.00**

Very few people who were among us in the year 2004 knew about Tsunami, the greatest hazard we have ever faced in our history. Till then most of us haven't had any knowledge on Tsunami. After the Tsunami, everybody including children and elders were keen on Tsunami, and its scientific background.

"The Sea Darkens" was published at this juncture and it described about Tsunami sea waves to the younger generation by a way of story and beautiful illustration related to the story.

The important thing is that National Science Foundation has published this children story in all three languages (Sinhala, Tamil and English).

The language used here is very simple. This book reveals the scientific background of Tsunami by a story developed between two goddess and a little girl named "Singithi".

This harmonious children story created by the famous author Sumithra Rahubaddha, has become more colourful by the illustrations designed by the famous artist, Sibil Wettasignhe.

This book, won the best Children Story Award for the year 2005 at the National Literary Award Festival. The attempt taken by the NSF Special Committee on Popularization of Science to fulfill a national requirement by addressing the children's mind using a story based on science, should be appreciated.

Thusitha Malalasekera

Bio-fuels to substitute biologically formed "Fossil-fuels"

The most current problem the country is facing is the fuel crisis, which is likely to have extremely undesirable repercussions. A large sum of money is spent on importing petroleum to Sri Lanka. As a result it is likely that our annual fuel bill in 2006 was more than Rs.200 billion. This constitutes almost about 25% of the value of our imports and is about 30% of our total exports which is Rs.600 billion. The total annual export earnings from tea, rubber and coconut are only around Rs.90 billion. Thus, our annual fuel bill is even more than what we earn annually by exporting these crop products.



Fig 1. Biofuel pumping station

A high expenditure on petroleum or fossil fuels will have many undesirable effects on the country's economy. In view of the high costs involved in importing crude oil, it is extremely important that we start producing and using alternatives to petroleum. Among these are the bio fuels which can be made in Sri Lanka. Bio-fuels have a biological origin, and live organisms like plants or bacteria are involved in the production. Although, petroleum or fossil fuels also have a biological origin because fossils have plant and animal origin, we do not consider petroleum as a bio-fuel.

Ethanol

This is one of the common bio fuel which can be used as an alternative for fossil fuels.

Ethanol or ethyl alcohol, is a clear, colourless liquid with a characteristic, odour and taste. This is main active component of alcoholic drinks such as beer, wine and other spirits while abuse of these become harmful for the man. Ethanol is also a high-performance motor fuel that cuts poisonous exhaust emissions and is harmless for the environment. Ethanol can be made from molasses which is a crude extract of sugarcane. Ethanol can also be made by fermenting and then distilling starch obtained from crops such as maize, sorghum, potatoes, wheat, even cornstalks, fruit and vegetable waste.


Fig 2. Sugarcane plantation

Henry Ford designed the famed Model T Ford to run on alcohol — he said it was "the fuel of the future".

Ethanol is a much cleaner fuel than petrol (gasoline):

- It is a renewable fuel made from plants
- It is not a fossil-fuel: manufacturing it and burning it does not increase the greenhouse effect
- It provides high octane at low cost as an alternative to harmful fuel additives
- Ethanol blends can be used in all petrol engines without modifications
- Ethanol is biodegradable without harmful accumulative effects on the environment
- It significantly reduces harmful exhaust emissions
- Ethanol's high oxygen content reduces carbon monoxide levels more than any other oxygenate: by 25-30%, according to the US Environment Protection Agency (EPA)
- Ethanol blends dramatically reduce emissions of hydrocarbons, a major contributor to the depletion of the ozone layer

Many countries are either producing or using ethanol in large quantities or are providing incentives to expand ethanol production and use. Prompted by the increase in oil prices in the 1970s, Brazil introduced a program to produce ethanol for use in automobiles to reduce oil imports. Brazilian ethanol is made mainly from sugar cane.
Pure ethanol (100% ethanol) is used in approximately 40 percent of the cars in Brazil. The remaining vehicles use gasohol blends of 24 percent ethanol with 76 percent gasoline. Brazil consumes nearly 4 billion gallons of ethanol annually. In addition to this industrial consumption, Brazil

also exports ethanol to other countries. Some Canadian provinces promote ethanol use as a fuel by offering subsidies. India is initiating the use of ethanol as an automotive fuel. In France, ethanol is produced from grapes that are of insufficient quality for wine production.

Sweden has used ethanol as a fuel substitute and as a result, Sweden's crude oil consumption has been cut by almost half since 1980. Ethanol-blended gasoline is being considered as a viable alternative to further lower emission levels. The US now uses more than 15 billion gallons of cleaner, ethanol-blended petrol a year, totaling 12% of fuel sales in the US. Most of it is a 10% blend, but 85% and even 95% blends are now being tested. Ethanol blends are also increasingly used in South Africa and a number of other countries. Use of ethanol tends to reduce environment pollution caused by oxygenates such as tetraethyl lead, MTBE and ETBE used in petrol.

Production of ethanol in Sri lanka

Ethanol is produced in Sri Lanka from sugarcane molasses. At present, around 10 million liters of ethanol are produced annually in the country. This amount would increase considerably, to as much as 30 million liters if Hingurana and Kantale sugarcane factories operate at full capacity. As indicated earlier, ethanol can also be made by fermenting and then distilling starch/sugar obtained from crops such as Manihot, maize, sorghum etc. which are cultivated in Sri Lanka.

Ethanol:

- It is a renewable fuel made from plants
- It is not a fossil-fuel: manufacturing it and burning it does not increase the greenhouse effect
- It provides high octane at low cost as an alternative to harmful fuel additives
- Ethanol blends can be used in all petrol engines without modifications
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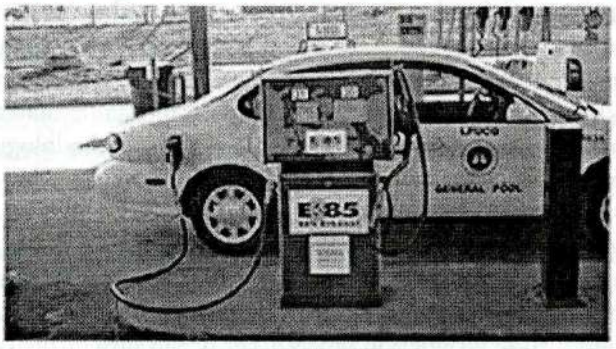


Fig 3. Auto-pumping of E:85 bio-fuel

Bio Diesel

Diesel is another fuel made from fossil oils, and is used in many automobiles and engines. A number of oils of plant origin can be sued as alternatives to diesel. Among these oils are sun-flower, coconut and soybean oil. Jatropha (Weta Endaru) is a plant which produces oil in seeds, which can be used to run vehicle engines. This plant grows well in the dry zone and has a considerable potential as a source of a biofuel as a substitute for diesel.

Biomass

Biomass from crops such as glyricidia can be used to generate electricity. Urban wastes are also a good source of electricity. In Sri Lanka, a large amount of solid organic wastes, amounting to few hundred tons is collected daily in Colombo and the other major cities. These can be used to generate bio-gas which can be used as a fuel to generate electricity. Efficient electricity storage cells/batteries have been developed to use in motor vehicles with "hybrid" engine systems in developed countries.

Bio-enzymes for fuel efficiency

Bio-enzymes for bio-catalysts are currently used with fossil fuels to improve the energy release by replacing environment damaging synthetic additives. These bio-enzymes are also sold in Sri Lanka. Minute amount of bio-enzyme is required and such enzymes will also be used with bio-fuels.

Dr C.S. Weeraratna
Chairman - Sugarcane Research Institute
Uda-Walawe

Urban Agriculture: *Unlimited to any place receives sunlight !*

The United Nations Organization has predicted that by the year 2050, out of the world population 2/3 will be living in urban areas. There are three main reasons why the urban populations increase.

1. Increase of population that are already concentrated in urban areas.
2. Migration of people from rural areas to urban areas.
3. Change of developing semi-urban areas in to urban areas.

If this is the trend you may think that, is there any room for agriculture under this challenge? Why? We have been used to think that to take into agriculture there should be sufficient land and space. There are many examples to show that, to-day's world is not fitting to this thinking. Even in our mind there are a large number of examples for this. Why? Under the technological development there are answers or alternate methodology and practices have been generated to meet the needs of the society.



Under the above mentioned situation called as 'horizontal development' we are used to look for more land for Rural Agriculture. But with the increase of population, the urbanization has some influence to increase rate of limitation of agricultural lands. Therefore, due to this limits, it is possible to take to 'vertical development' by using cultivation structures in tall buildings for urban agriculture. According to a survey, by using organized vertical agricultural methods, it is possible to get 10 times more yield from same unit that are using non-organized cultivation methods. This may be a new experience for you. As the urban agriculture is a newly added 'agriculture pattern', most of us cannot recognize the difference between urban and rural agriculture. Yet, under 'vertical development programme', there is a trend to increase the acquaintance nationally and internationally to increase the productivity.

Through scientific creativity, various structures can be created, a room is open for entrepreneurs. There is a relation between food crop cultivation and food consumption which has shown scientifically. Here people with much experience in cultivation are participating while also directed to high nutrition consumption. Through this strategy, consumption of processed instant food with high percentage of sugar, fat, salt and various types of additices can be minimized, and can enter into consumption of nutritional food evaluating scientifically.

Urban agriculture?

Agriculture practiced in commercial scale or even as a hobby being done in an urban or semi-urban area, municipal or within the limits of municipality is known as urban agriculture. Using various agriculture methodology, urban agriculture can be carried out. It is a production done based on limited land and water resources and related to processing and selling facts. By cycling carbonic (or organic) and non-carbonic matter mainly, and in all possible time, using appropriate technology to cycle inorganic matter, urban agriculture can be done using various methodologies that generate agricultural diversity.

By the same manner by proper management of land, water and light, production, processing activity and agricultural sale, under a scientific foundation using so called "Micro Agricultural Production Process" the urban agriculture can be put on a sustainable foundation. Accordingly, cultivation

of few vegetable types or having a few fruit trees or flower beds is not urban agriculture. Cultivation of garden crops, animal husbandry, fish, medicinal plants and ornamental flower cultivation should be done to fit into the places concerned to increase the variety in Urban Agriculture.

Scientific entrance

Through Urban Agriculture entrepreneurship, a scientific entrance can be used to get solutions on undisirable physical, mental, spiritual, economical, social and environmental conditions of people. By considering physical and mental conditions, one can obtain balance nutrition, by consuming fresh vegetables and fruits. The present problem on malnutrition, under nutrition or over consumption can be minimized, and can contribute to good mental health. Expenses on food can be minimized, by opening urban agricultures market, while generating avenues of income on this scientific basis including scientific education on nutrition.



By looking at the social and spiritual level, it can minimize the liquidity of low income earners, as well as to reduce the crime rate, by involving the third generation for new agriculture cultivation pattern they can contribute to social missions. Society can achieve both measurable and non measurable benefits by looking at the environmental aspect, by creating a bio-scientific environment, improving micro environment, increasing the bio-diversity, by proper management of waste material reducing the cost of energy. When looking further through using developing nanotechnology the beneficial condition of urban agriculture can be increased and it will increase overall economy thus will attract every body's attention.

Next it is very appropriate to draw attention to some features associated with urbanization that affect urban agriculture. The industrialization that comes along with urbanization creates industrial wastes. There is a possibility of accumulating heavy metal in the soil, and in these places it is appropriate to grow annual fruit crops. The reason for this is that annual fruit crops absorb heavy metals slowly. In such places, one should be careful not to grow leafy vegetables. Also, one should carefully select common urban waste matter, and pay attention about heavy metals when making compost manure from waste. Development effort for safe health, environmental quality improvement and social friendly activities can be achieved. Through this activity, it would be possible to create a scientific entrance for the entire country through urban agriculture for an economic development.

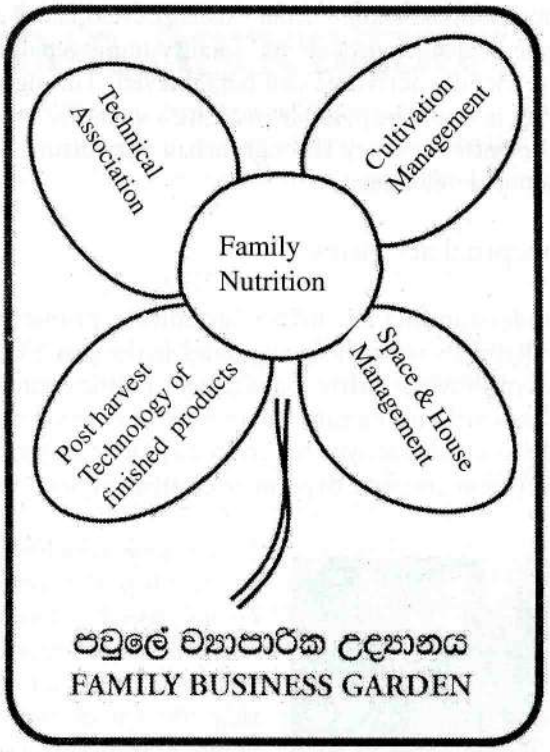
Conceptual activities

By understanding the urban agriculture properly and considering its scientific background, in the year 2000, the Western Province urban management political authority put forward the Family Business Concept of urban-agriculture? This activity has created a practical conceptual development entrance to popularize urban agriculture.

This concept which is aimed to develop the physical mental, social and spiritual health based on space in the home garden has not limited that concept of improving family health. This also has created main avenue of income from an enterprise based on urban agriculture. Under the International Environment day celebrations in the year 2000 this concept was launched. There is a novelty in this concept while making it an avenue for sustainable income. Based on both environmental and commercial separately or collectively, it is possible to participate in this project more creatively. This concept allows creativity mixed with science and fine-arts irrespective of sender or any age difference. The concepts' symbol is 'a four petaled flower' and the four petals in it depict four ways of strategy. The stalk of it symbolizes flexibility and permanent base. Overall main output is oriented towards the "Family nutrition". One can also enter into this concept, she/he need not be a farmer or a person with agricultural expertise, any urban person can enter into urban agriculture through this concept.

Family business garden: A scientific way

When establishing the family business concept practically under urban agriculture, one can start with any number of strategies depicted by four petals in the flower. It is individuals responsibility selecting which one to start.



Family business garden symbolic flower

Concepts considered as four petals of the symbolic "Four petaled flower" is given below.

* Technical Association

Based on the number of family members, participation, amount of money in hand, mixed with scientific and traditional cultivation methods, family has to consider this as a sustainable income generation strategy. When cultivating crops for the market, it is important to cultivate crops that have high demand, new types and those which are compatible with the area concerned. In this case, using Tissue Culture Technology, Aerophonics, Acquaponic, Zeoponic, Roofscape Technology, and Micro-irrigation Techniques as a cultivation methodology is beneficial. Also in the Technical Association, using Information Communication Technology (ICT) it would be possible to develop united groups containing the description of entrepreneurs connected to the supply chain.

* Cultivation management

By this concept it is expected to use proper management of sand, water, pest control methods as well as sunlight to get products from the crops cultivated in a limited location. By cycling house hold waste matter to generate compost in a small scale, using plastic bottles, roof gutters that are discarded as cultivation structures, is a strategy to motivate one to take to vertical space. When it is possible to join animal husbandry through integrated farming, it is possible to get additional benefits. Also, by following organic farming, which is a new trend, one can get maximum benefits. Also by using micro-irrigation techniques, one can avoid getting a higher water bill. Collecting the rain water (rain water harvesting) and using simple scientific methods to filter waste water going out from the kitchen and the bathroom save money spent on treated drinking water in urban agriculture. In Sri Lanka, rain water is available in excess and rain water should be collected and used for urban agriculture.

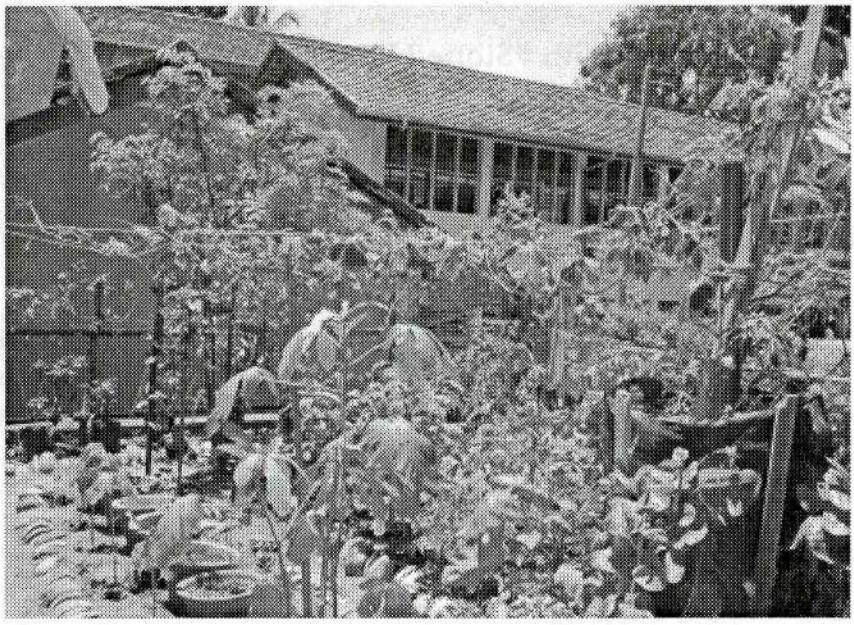
* Post Harvest Technology and increasing the value of finished products

Numerous studies have shown that it takes between 5-10 days for a product to reach the consumer from harvesting due to transport and storage conditions. Due to this time difference, 30-50% of the nutritional value of the food is lost. Therefore, even though, this is a family product, to win the market, one should follow proper post-harvest methods and to get a higher finished product value and entrepreneurs should be motivated accordingly. Also, priority should be given to get a sufficient income during the season as well as in the off-season. Also, to create a demand among the consumers and to face that situation one should make use of scientific methods to have variety of products. This is important to maintain a sustainable family enterprise garden. The transport system has a special effect on the post harvest lost. The urban micro-entrepreneurship has a perfect alternative and it is important to use the new scientific knowledge practically.

* Space and House Managements

These strategies make ways to minimize the mental stress that exists in urban environment due to work pressure and competitions. And through strategies used in the "Landscape Creation Theory" and 'House Beautifying Methodology' the stress can be minimized. Often, you may be cultivating only flowers and ornamental plants to take to gardening and land beautifying. By adding fruits, vegetables and medicinal plants you get an 'Edible Landscape and Edible Airspace' which will help to generate both physical and mental health. Here one could cultivate fruits, vegetables other food crops and medicinal plants mixed together to create attractive patterns. One can see that it creates a different mental peace. By earning a more nutritious product, the mental and social health will also be improved. Also, by following new management and

methodology from verandah to kitchen, the value and the standards of agriculture entrepreneurship will be developed.



Overall result: Family nutrition and opportunity for creativity

Thus one can use the strategies and activities used in the family business garden concept to increase the Urban Agriculture Productivity and Profit. Thereby the benefits obtained privately as well as socially are immense. There is much room to use traditional and new scientific finding mixed together, as an appropriate mixture and as a creative work. Thereby you are invited, to take Urban Agriculture through scientific agriculture to increase the urban economy and national economy, through family business garden concept which give a timely contribution.

You can join by choosing few crops that you like, that help to give family nutrition, considering the space available with sunlight. The various life supporting devices (eg. cultivation flowers, discarded plastic bottles, racks, hydrophobic cultivation boxes) can be used. The selected vegetables, fruits, medicinal plants, tubers, or spices can be grown mixed with flowers. They can be cultivated creatively. Also pesticide control methods can be used within the cultivation.

Through scientific creativity, various structures can be created, a room is open for entrepreneurs. There is a relation between food crop cultivation and food consumption which has shown scientifically. Here people with much experience in cultivation are participating while also directed to high nutrition consumption. Through this strategy, consumption of processed instant food with high percentage of sugar, fat, salt and various types of additices can be minimized, and can enter into consumption of nutritional food evaluating scientifically.

By accepting this invitation, you will be more active, as a catalyst there is a special room in the National Agriculture Policy, for urban agriculture. This is a special opportunity. We have the ability to work together by joining household, school, Institutional, Rural Administration Institutes, Non-Governmental Organizations, Private Sector, Community Organization, and International Organizations.

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Director, Agriculture- Western Province Council, Colombo