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Finger-pointing: Who's Fault is it that Sri Lanka (Almost) Ran Out of Electricity?

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By Cynthia M. Caron

Where is the tolerance, patience and understanding? Consumers are calling the Ceylon Electricity Board (CEB) outright incompetent. They are challenging the newly-appointed chairperson's character. The country wants its thirst for electronic entertainment and kitchen appliances quenched. As one Colombo resident wrote, "Today our people, many of whom have worked abroad and tasted prosperity, demand a better lifestyle with a few electrical labor-saving devices thrown in. But with the present shortages and power cuts will we ever taste the good life over here?"

During a televised speech in April President Chandrika Kumaratunge told the nation that the current drought has nothing to do with the power crisis. Today's crisis, she said, is due to mismanagement by the past regime. Not many seem to buy this explanation. The average electricity consumer thinks that the government and the opposition party are much more interested in looking into past assassinations (like the assassination of the President's husband) and disappearances (under international pressure for human rights abuses) than they are in a contemporary crisis. Even if Kumaratunge's People's Alliance government has been negligent in monitoring and developing the power-generation sector, over her past 18 months in power Kumaratunge has improved Sri Lanka's reputation and human rights record fundamental for attracting foreign investment and bringing the things or the good life. Why can't the voters understand?

Fourteen years after Thomas Edison started the world's first electric-power company in New York, Rs. 80,000 was allocated by the Ceylon Legislative Council for the electrification of the Queen's House and the General Post Office in the Colombo Fort. The year was 1894. Over the past century the Colombo Electric Tramways and Lighting Company (later the Ceylon Electricity Board) has had the responsibility of supplying reliable power for national comfort and development. From the first hydro-plant installation in 1912, to the 1988 Thermal Options Study, power-sector planners have had to juggle government priorities, respond to global market prices for fossil fuel and react to schizophrenic political decision-making. All this, to run lap-tops, reading lamps and power the televisions of suburbia.

While there is not one cause for the power shortage of 1996, there is one group taking most of the blame: the planners of the Ceylon Electricity Board (CEB). Even though I subconsciously grumbled about them, I did feel sympathetic. My sympathy grew once I got deeper and deeper into power-sector planning. I am not surprised that there are multiple actors, agencies and agendas in power-sector planning; these exist in nature-conservation planning and management as well. What took me by surprise was the amount of financial investment in power sector development and the planning horizon for capacity and energy-systems generation.

Imperfect information and changing political-economic scenarios fifteen years ago partially account for today's predicament. Power-sector planners are truly the people

who cannot satisfy all of the people all of the time, even when all the nation's lights are lit. If the ruling party is happy, then the opposition party is not. If the Chamber of Commerce is pleased, then the Central Environmental Authority is irritated. As for the environmentalists, I do not think they are ever happy even when they get their own way.

The CEB has its own scapegoats for the power shortage: the political appointees at the Ministry of Irrigation, Power and Energy and the environmental movement. Both groups, according to CEB officials, do not understand power generation and object to CEB proposals for completely opposite reasons. The general public does not escape ridicule. The CEB blames us for power-cut extensions and the need to implement unannounced power cuts.

The electricity consumers of Ceylon all thought the power crisis started on March 22; when the CEB and the government scheduled three four-hour, rotating power cuts throughout the island. On this first day electricity consumption fell by 2.5 million units. It was believed that a savings of 2.5 million units a day, coupled with intermonsoonal rainfall in the hydro-power catchment areas would support the country's electricity needs until the southwest monsoon arrived in late May.

However, on the second and third days, the savings reached only one million units because consumers worked their schedules around power cuts. One million units conserved was unsatisfactory. The CEB introduced unannounced power cuts lasting 30 to 45 minutes in the early evening. One week later the CEB sponsored newspaper advertisements declaring, "Power - it's in your hands now" and scheduled power cuts extensions to five hours with a scolding from the CEB, chairperson Dr. Lesile Herath: "Consumers have to choose between the lesser of two evils — reduce production, or face a total blackout." Common responses were, "How dare the CEB blame the people for its shortcomings and lack of foresight!" And, "The CEB has failed to provide for this steady growth. Its impractical planners urge the people only to conserve power — to switch off the couple of lights each household burns at night."

According to CEB Vice President Neil Perera, the total daily demand for electricity is 14 million units. Thermal power (Power generation fueled by diesel, oil, gas or coal) generates about 3.5 million units. Hydro-power resources supply the remainder. In order to put an end to power cuts, the catchment areas would have to receive inflow of 10 million units daily over the course of three weeks, an occurrence unlikely to happen in April. Dr. C.R. Panabokke, an expert on rainfall, says that Sri Lanka does not have a surplus of water, as most people believe. "There was a water surplus before 1948 and large-scale industrial growth," he says, period. Overnight rainfall in the catchment areas is front-page news. Every millimeter is recorded and published. It is a great disappointment to all of us in Colombo when downpours flood the streets, causing roadside sewers to overflow and cars to stall — while no rain falls in the catchment areas.

Did the CEB know before, *much* before, March 22 that the country was facing a severe power shortage for April and May? Rain patterns for the third quarter of '95 gave every indication that there would be a severe drought, which, among other things, would lead to power shortages. Yet the CEB claims to have became aware of the problem only in mid-January. Engineers told CEB officials about the impending crisis, but the engineers' union refused to talk to the management because of an internal political matter. The following month the Ministry of Power refused to implement a CEB special-task-force recommendation package that included repairing existing power plants, the purchase of generators to reduce pressure on the national grid and procurement of new machinery. The CEB recommended slowly phased-in power cuts in early March, but the Ministry did not take their advice. Planners blame the Ministry for not taking measures to avert the crisis. The Ministry has been extraordinarily silent.

In late April, the CEB appointed a ten-member "Think Tank" to prepare background reports for the Executive Team, the CEB's most senior officials. Think Tank members have specializations in civil, electrical and mechanical engineering, and finance. Dr. Herath, CEB chairman, thinks that through this new process the CEB will be able to react better to new developments. In his opinion the Board spends too much time on day-to-day operations and cannot pay attention to aspects of industry development. "The Think Tank will naturally discuss their thinking and ideas with their fellow professionals," he says. According to newspaper reports this should create a more participatory atmosphere for professionals who will be asked to consult with the CEB in the future. (*Daily News* 26/4/96).

Quite often the inauguration of a power plant goes unnoticed. Not this year. The opening of the Dick Oya Hydro-power project was celebrated even though it contributes only 1.2 megawatts to the national grid. "Electricity is a basic need of the people today. Providing electricity to all those in the dark is a prime duty of the People's Alliance Government," the Deputy Minister of Cooperatives stated as he inaugurated an electricity scheme for 150 rural households on March 29. The following month a rural electrification project in Kurunegala was commissioned on the same day that Prime Minister Sirimavo Bandaranaike celebrated her 80th birthday. Will the electorate remember to thank the present government for securing the project's Rs. 4.5 million loan from the Asian Development Bank in the next election? Since power is a political tool, the savvy politician seeking re-election will pick a party-significant date just to make sure.

In the final quarter of 1995 the CEB embarked on an expensive propaganda campaign: "Watt's in it for

you?" It sought public cooperation to reduce power consumption. Consumers would receive a rebate on units saved in October, November and December. "For every unit that you have saved you will be given a cash credit on your bill to the value of the units saved" the CEB chairman promised on national television. When the CEB did not make good on its promise (it granted a 10% rebate, irrespective of the number of units saved) consumers flinched.

Would this mismanagement have happened if the power and energy industry in Sri Lanka were privatized? Industrialists say that in a private-sector organization there is accountability along the way at every level of decision making. When the government runs the show no one is responsible for anything. The CEB blames its own engineers. "It seems to be well-known in business circles that the Engineers Union of the CEB had recommended power cuts somewhere in November last year," says one reporter. No top-level action followed. For this, politicians and senior directors of CEB are to blame.

The Overseas Development Administration of the United Kingdom (ODA) granted Rs. 152 million (1.95 million pounds) to the Mahaweli Authority to implement technical cooperation projects, "Environmental Management and Sustained Development in the Upper Mahaweli Catchment," funds to improve land-use planning and environmental monitoring of up-country activities such as assessments of reservoir sedimentation and river flow and a receiving station to collect Advanced Very High Resolution Radiometry for daily monitoring of soil moisture, forest- fire and cloud cover. All sedimentation reports conflict. Many say that fifty percent of the reservoirs are full of silt. Foreign engineers and irrigation experts estimate that we could have had another 45 days of uninterrupted power supply if the CEB water reservoirs had been dredged and filled prior to the drought. Drain pipes are blocked. Cleaning operations such as dredging and mud removal have never been done.

To reduce pressure on the national grid the CEB granted a number of concessions to private industry to produce its own power. These incentives include duty-free concessions for generator purchases and a rebate of Rs. 5.80 (US$0.11) per unit for power generated through generator sets of 50 KVA or more.[1] Board- of Investment-approved enterprises are paid Rs. 3 million if they install one-megawatt generating capacity to relieve pressure on the national grid. The Chairman of BOI expects that industrialists will install 80 megawatts of power under this scheme. Participating industries are expected to disconnect themselves from the national grid. Many in the business community feel that instead of offering concessions the CEB should have turned to the private sector for generator capacity.

Globally, the utility industry is plagued by rising costs, angry consumers and environmental problems. The power industry is facing a period of restructuring to become decentralized, service-oriented and market-driven and, with the right policies and commitment, perhaps even a bit more environmentally friendly. National utilities in the United Kingdom and France are restructuring. Sri Lankan officials are looking to the UK as an example. The Ceylon Electricity Board is not alone among developing-country utilities facing power sector problems. According to a 1993 World Bank report, "opaque command and control management of the sector, poorly defined objectives, government interference in daily affairs and a lack of financial autonomy have affected productive efficiency and institutional performance" (Flavin and Lenssen, 1994) Political manipulation and corruption make these problems even worse. Despite the finger-pointing, all interest groups agree on one thing: a decision must be made and followed through. Politicians stay out. Let the professionals do their job.

Forecasting: electricity and peak demand

Dr. Mohan Munasinghe was special advisor to Sri Lankan President J.R. Jayawardene in the 1980's and is a member of the Intergovernmental Panel on Climate Change. He is on sabbatical this year from the World Bank and teaching at the University of Colombo. Over the drone of the generator powering the office fan he told me, "The rain is not to blame for our current power crisis. These power cuts are not nearly as bad as the ones we had in 1982 — power was cut for half a day. By 1985 our situation had improved but only because new plants such as the one at Victoria had become operational. We need correct planning and policy analysis in energy demand."

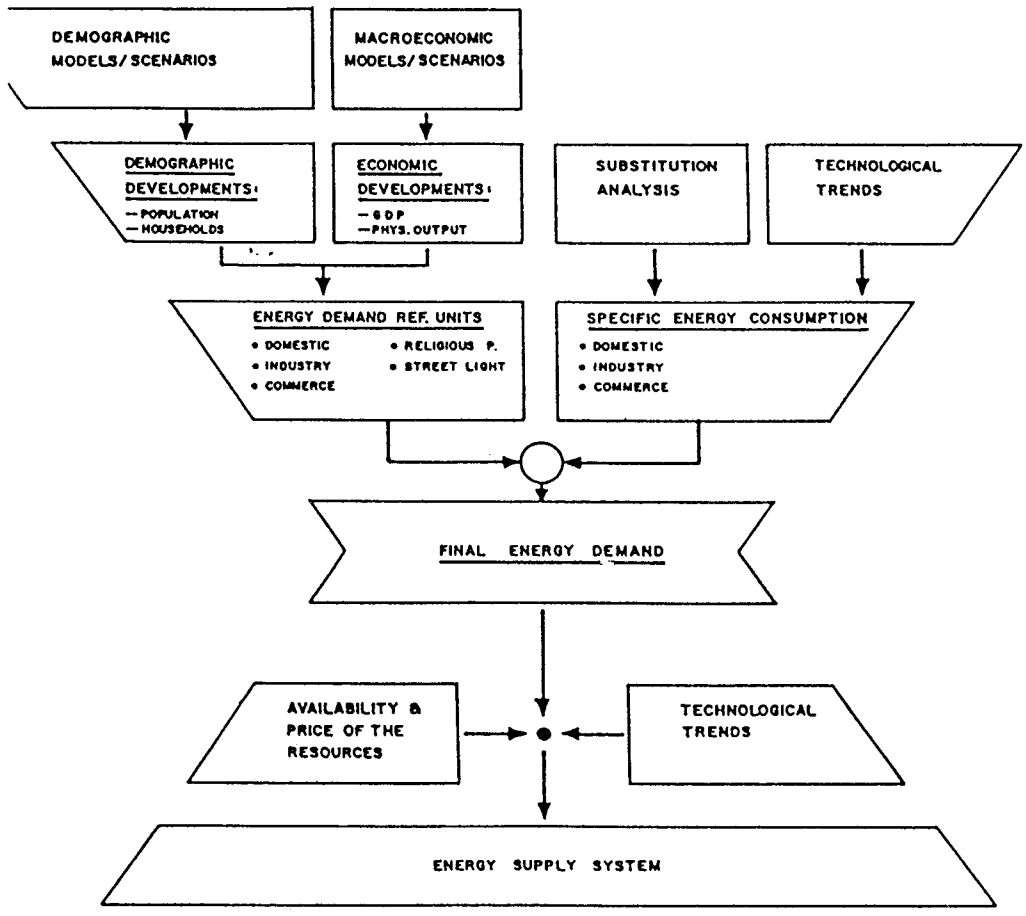
Planners use gross domestic product (GDP) to project electricity demand. The current elasticity of demand for electricity is 1.5.[2] This means that for every 1% increase in GDP there will be a corresponding increase in electricity demand of 1.5%. "In 1994 the GDP grew at a rate of 5.5%, therefore we calculate an increase in GDP growth by 0.5% annually — 6.5% in 1995, 7% in 1997 and so on. From the projected GDP we forecast electricity demand," says Mr. Gnanalingam, a CEB project director.[3]

1. Diesel fuel is already heavily subsidized by the state for the energy, agriculture and transport sectors.

2. In developed countries such as Japan the ratio of electrical energy demand growth rate to gross domestic product (GDP) is closer to 1:1 due to energy-efficient techniques.

3. The gestation period for a coal-powered plant is 5-6 years. For a hydro-power project 7-8 years; 2-3 years for the initial surveying and planning and 4-5 years for construction. The construction time for gas and diesel plants is two years. Generation stations have a long life span: 15-20 for small thermal (gas and diesel), 20-30 years for coal and 40-50 years for hydro-power.

Figure 1: General Procedure in Energy Planning



He continued explaining demand forecasting to me. "The variables for electricity-demand analysis are all based on well-educated guesses: the growth of GDP over the next 25 years, population growth rates, growth of the manufacturing sector and value-added, the projected growth in the household sector and finally the appliances used in the household (Figure 1). We decide on a planning horizon, normally beyond ten years to account for a new project's gestation period, differentiate prediction from projection, and choose from different forecasting techniques. Based on a certain set of assumptions a prediction is a specific *estimate* made for some future time period. A projection makes many estimates of the future based upon various sets of assumptions. For instance, 'Given alternate sets of business developments how much power will be required under each set of conditions?' The on-going ethnic conflict creates an enormous amount of uncertainty for planning. How much will the demand for power increase if there is peace? All our techniques have run a high, medium and low-use scenario."

Since 1992 there has been talk about power cuts in 1995 and 1996. Gnanalingam believes that there will power cuts next year and the year after but the extent of the cuts will be heavily dependent on rainfall. "We know to expect rain shortfalls once every four years. We factor this into our forecasting model. Electricity is a versatile form of energy. If we achieve newly industrialized country (NIC) status with a gross national product of $2,000 per capita, what will the demand for electricity be?" he asks rhetorically. "In the early 1980's our energy demand was so low we had to promote electricity consumption by lowering the tariff. It was popularly believed that the country would have a power surplus after the construction of the Mahaweli System. We had discussions about exporting power to southern India."

The CEB prepares an annual forecast and financial and market plans. Under the old forecast the CEB expected to electrify 80% of the nation's households by the year 2000. Today in Colombo 60% of the households are electrified. "In developing countries there is always this debate over rural to urban migration. This is a myth in the Sri Lankan context. In 1990 82.4% of

households were rural. We expect that to decrease to only 82% by 2020. Rural users tend to consume less than urban residents. If NIC status is achieved then consumers will have more money to spend on labor-saving devices. It could be decades before every household acquires every gadget it wants." (Figure 2).

Figure 2: Percent of rural and urban household owning popular electrical appliances in 2020

Appliance	% Rural HH	% Urban HH
Television	80	100
Radio	95	100
Iron	85	95
Fans	50	85
Refrigerator	40	75
Hot water heater	0	75

"Power generation in 1994 was 4,365 gigawatts (GWh),[4] an increase of 9.7% over 1993 generation rates. In 1975 electricity sales totalled 965 GWh. Between 1975 and 1994 domestic consumption has risen from 86.65 GWh (9% of total electricity consumption) to 909 GWh (25.5%). Today at peak demand we need the capacity to supply 980 megawatts (Mw) of power and with the drought we have not been able to achieve close to that. Therefore the power cuts," said Gnanalingam.

"According to our demand forecast the peak demand will increase to 1,481 Mw in 2000, 3,365 Mw in 2010 and 5,177 Mw in 2015.[5] To meet this demand we will need more stations, but we must also reduce system losses. This year 17.9% of the power produced was lost in the system [in transmission and distribution] before it reached the consumer. We hope to reduce system losses to 12% by the year 2004. There have been no new power additions to the national grid in the past five years. Projects on line for 2002 include a coal-power plant in Trincomalee and the Kukule hydro project. The refurbishing of the diesel plants shall be complete by 1997. In 2020 we expect 89.54 million giga joules (Gj) of energy to be supplied by diesel compared to 23.85 million Gj in 1990."[6]

Power systems and energy planning

The primary reason for long-term power planning at the national level, according to Mr. Nanthakumar the chief engineer for the generation planning branch of the CEB, is that "the long lead time and the long period of utilization of electric power facilities make it necessary to select projects to be studied some six to 12 years before commissioning and to evaluate at least some 15 to 20 years of project operation. Hence, planning studies must look ahead some 20 to 30 years."

With environmental-concern key words being acid rain, carbon dioxide and greenhouse effect, Nanthakumar believes that we may be forced in the future to discard options for the supply of power that are techno-economically attractive but environmentally unacceptable. "Local, national and international environmental problems are starting to influence the development of the power sector. Planning for the long term allows for the evaluation of the effects of the introduction of such restriction policies, assessing how rapid environmental improvements can be achieved and at what cost," he says.

Generation-systems planners follow a least-cost planning methodology and use an analytical tool called WASP III: the Wein Automatic Systems Planning Package. This software package finds the economically optimal generation expansion policy for an electric-generating system within user-specified constraints. However, environmental constraints are not included in the model because environmental damage is often difficult to quantify, especially effects of particulate matter emitted from thermal plants on human health and the loss of biodiversity inundated by hydro-power projects. The WASP III package considers 12 types of thermal- and hydro-plants and bases optimization on discounted costs for total system expansion. The optimization exercise is fruitless if environmental externalities, many of which can be quantified, are not included in the model. Least-cost models that do not include environmental studies risk becoming "more-cost" projects as citizen and environmental groups launch attacks that compound the interest on loans because of construction delays.

With the 1996 crisis, capacity expansion is inevitable. The planning process must now answer the question: What are the relative environmental costs and benefits of alternative generation mixes at alternative power plant locations? "We know it is imperative to incorporate environmental goals at the investment-planning phase. Many externalities are difficult to quantify or have not been studied in many developing countries. For instance, there are health affects associated with byproducts of fossil-fuel combustion (particulate matter and sulfur dioxide), if Sri Lanka continues with a fossil-fuel dominated generation sys-

4. One gigawatt is 1000 megawatts.

5. Peak electricity demand in Sri Lanka starts between 7:00 and 7:30 p.m. Everyone turns on their lights, the evening TV news and starts to prepare dinner. The capacity of every generating system plan aims to meet this peak demand. Peak use of lighting at this time has an unusually high impact on system demand and hence system expansion. Florescent lighting is both an attractive economic and environmental demand-side management (DSM) measure.

6. The system loss factor in Korea is 6%.

tem. Pollution-control technology might depend a great deal on how much citizens or the state are willing to pay to avoid sickness. Such detailed information is not available for analysis. From here we must go forward," Nanthakumar stated.

Planners can manipulate a long list of options toward sustainable energy-sector development: pricing, institutional efficiency, end-use efficiency, supply efficiency [including new technology], fuel switching and reducing losses in transmission and distribution (T&D), and demand-side management (DSM). The CEB and the government must maintain a proper mix of energy sources and diversified ownership patterns, otherwise the threat of monopolistic situations and over-dependency on fuel sources may result. "Irrespective of ownership the CEB is forced to supply electricity at the least cost," says D.C. Wijeratna who is in charge of setting the electricity tariff. "The country has yet to develop a methodology for [establishing] purchase price that is acceptable to all parties. The purchasing power agreement is the most difficult to negotiate."

Pricing

"Pricing policies that send the right message to the consumer are just as important as choosing the correct mix of base-load thermals and pollution-abatement technology," claims Wijeratna. "The rural consumer is my biggest burden. Rural electrification is not economically viable. There are no recovery costs in rural areas because there is no economy of scale. Electricity prices must go up, but that is neither socially nor politically acceptable. Increasing prices in rural areas has serious political implications for the ruling party. The CEB is not free to do tariff increases. The Minister of Power and Energy, a political appointee, decides whether or not the price increases and we recover our costs. In 1994 the tariff increased to Rs. 1.20 (U.S.$0.02). Previous to 1994 the domestic consumer was paying 60 cents for the first 10 units of electricity when the actually cost was Rs. 8. There was no justification for keeping the price at 60 cents. The Asian Development Bank wants us to restructure prices for industry. I have no economic argument for industry on why their prices are so high. Price should equal marginal cost. However, in Sri Lanka price has to include social equity. When we experience capacity constraint during the peak hours those who use that power should pay extra for the capacity component. But the users are the domestic consumers: the voters. They have the lowest price to pay." In other words, households are subsidized to keep the voters happy.

Energy is approximately five percent of the total cost structure in industry. "If we raise electricity prices for industries they will pass that increase on to the consumer. I was told that at a recent Chamber of Commerce, meeting business leaders were complaining about the high cost of electricity. If this is true and they are having difficulty competing in the export market, then the government should give them other subsidies. At any rate, the price of electricity should be raised across the board," says Wijeratna. But the CEB already runs at a loss. Additional power subsidies are only going to make a very bad and complicated problem worse.

The pricing system is often ill-designed to promote conservation. The common technique of average-cost pricing does not reflect the true cost of supplying power. Consumers save less and have less conservation impact when they implement conservation practices based on the average cost. If the tariff reflected the true cost of supplying power, then the consumer would be given the option of saving herself more money by conserving at high-rate times. This would also reduce overall demand on the grid at the high-production-rate, high-energy-demand period known as the peak-demand period.

Engineers and planners must insure that their power generation system has a high enough capacity to meet peak demand, even though the rest of the time much of a system's capacity remains underutilized. Peak demand poses two specific problems to utilities. First, many generation units are fired up only to meet peak demand, therefore running on a higher marginal cost than base-load plants.[7] Plants built to meet peak demand have lower construction costs but higher operating costs. Second, growth in peak demand often necessitates expensive capacity expansion. One economic tool to reduce growth of peak demand, which in turn delays capacity expansion, is peak-load pricing. Peak-load pricing imposes the higher marginal cost of supplying power during peak periods to the consumer through a tariff increase. If utilities can help consumers conserve power, especially during the peak period, the consumers' rates will not increase. The utility can delay investment in expanding the generating system. Peak-load pricing works. A California study found that business and residential consumers saved up to an average of $1,000 per year by shifting some their power demand (use of appliances) to less expensive time periods. In Sri Lanka domestic consumers are not affected by peak-load pricing, they are subsidized. Industry is not (Figure 3).

Industry demand is measured in KVA. Factories demanding less than 50 KVA per month have proportionally lower tariffs than factories demanding greater than 50 KVA. Within these two categories monthly fixed charges range between Rs. 205.00 (U.S.$3.80) and Rs. 435.00 (U.S.$8.05). Off-peak prices range between Rs. 3.20 (U.S.$0.06) and Rs. 3.80 (U.S.$0.07) per unit.

7. Marginal cost refers to the increase in total cost resulting from raising the rate of production by one unit. Marginal cost is sometimes referred to as incremental cost. Base-load plants are those fired up virtually all the time.

Figure 3: Ceylon Electricity Board Tariffs Effective January 1, 1996

Domestic (plus a monthly fixed charge of Rs. 15 (U.S.$0.27)	
First 30 units	@ Rs. 1.20 per unit (U.S.$0.02/unit)
31st to 90th unit	@ Rs. 2.40 per unit (U.S.$0.04/unit)
91st to 180th unit	@ Rs. 4.50 per unit (U.S.$0.08/unit)
Above 180 units	@ Rs. 5.60 per unit (U.S.$0.10/unit)

Religious institutions pay Rs. 1.20 per unit for the first 90 units consumed per month

Peak prices range between Rs. 8.60 (U.S.$0.16) and Rs. 9 (U.S.$0.17) per unit. Peak-load pricing is a demand-side management technique. Pricing is an effective means to jolt the consumer into adopting conservation practices, which often involves forcing a change in behavior.

Demand-side management

Demand-side management (DSM) is based on the premise that utilities and consumers are better off if they invest in ways to reduce power consumption. It often is the case that improving electricity efficiency is less costly than building and operating new plants. Demand-side management, or negawatts, is an approach completely opposite to the one power companies are accustomed to promoting; slashing prices of those who use more electricity. Since the early 1980's, power companies have adopted the negawatt approach, eliminating discounts for big power users and offering cash rebates to individuals who purchase solar water heaters or low-energy appliances. Demand-side management challenges the assumption held by utilities: more electricity is always better than less, especially if you are in the business of selling it. However, utilities are not typical business enterprises. Government regulation balances the inherent counterintuitiveness of DSM by rewarding utilities with high-return profit on power saved. Many companies earn higher rates of return on investments by conservation than in building new plants. Sri Lanka intends to incorporate DSM principles pioneered in the U.S. into national power sector planning.

Mr. B.A. Gunaratne specializes in demand-side management. He is an engineer and managing director of Dimo Limited Power Management Department, an outfit that assists factories and high-tech industries to cut costs through reducing their KVA. "The CEB monitors electricity through two meters: one measuring energy in kilowatt hours, and one measuring demand in KVA, a measure of the powerhouse capacity to supply demand. The price is charged in 100 KVA units. This is normally done by "peak clipping:" running a private generator to supply one's own power needs during peak hours when the CEB raises industry's price per unit. Generator sizes range between 100 KVA and 2000 KVA. During this last power crisis the CEB was paying industries to produce their own power throughout the day to reduce pressure on the grid. These industries produce an excess of power. If CEB had a specific policy for purchase agreements, CEB could purchase power from these generators. Most industries practice peak-clipping because private operation is cheaper than paying the CEB tariff during peak hours. Other ways that industry can reduce their energy consumption are to increase the power factor in their electrical load, install tinted windows and insulation."

Maintaining the proper mix

Eighty-two percent of the total electricity system capacity (1135 MW) is installed in 15 hydro-power stations. In 1994 93.7% of the system energy demand was met by these stations. The Mahaweli Complex has six power stations with an installed capacity of 660 megawatts. The Laxapana Complex in southwestern Sri Lanka has five hydro plants with an installed capacity of 335 megawatts. It is hard to judge whether or not Mr. Nanthakumar thinks there is an overreliance on hydro-power regardless of the statistic. But in his own words, "What is the probability that there will be a drought in all the catchment areas all at the same time?" The Mahaweli System receives rain in the Maha season; the northeastern monsoon falling from October through February. The southern system receives rainfall from April through August during the Yala season. Water allocation is a primary concern. During the Yala season the Mahaweli Resettlement Systems A through H are totally dependent on diversions from the Mahaweli Project for agricultural production.

"We conducted a hydro-thermal hypothetical operation study to look at a seasonal-switching policy. Entering past data into the present system, we try to answer the question, "How much energy can you depend on?" Take the Mahaweli Kotmale Plant. During any month in a dry year, we can expect 25 gigawatts. In a wet year that reaches 80 gigawatts annually. Now we are receiving 22.5 gigawatts a month. In addition to seasonal and annual variations in power generation, flexibility in water management is also an issue. In the Mahaweli System water is diverted for agriculture. When the water reaches the Polgolla diversion, we make the decisions on how much water needs to or can be diverted to the Mahaweli System H. The balance of the water from Polgolla is sent to Victoria Dam for power generation. As the water flows through the system at each dam a diversion decision to one of the eight Mahaweli Systems is made. Because of the diversions there is no flexibility in water management. We cannot divert water from growing food to generating power," the CEB systems engineer declared.

How much is rainfall responsible for the power shortage? Using the standard 10% annual increase in

demand, forecast estimates show that even under very wet hydrological conditions there will be a worse electricity shortfall in 1997 than in 1996. The 1997 deficits as well will be treated as those in 1996 with demand-side management and power cuts. The outlook for 1998 is slightly better. There will be deficits only under very dry and dry hydrological conditions, assuming that the planned additions of a 90 Mw diesel plant and 140 Mw of gas turbines are commissioned. To avert a crisis in 1998 the CEB needs to implement its T&D loss reduction program and expedite DSM techniques such as energy-efficient lighting. Beyond 1998 the Ministry must commission engineering studies to expand generation capacity. Due to lengthy gestation periods and feasibility studies, decisions about siting and constructing coal-fired plants must be made within the next year.

Coal, gas, diesel and oil-fired power plants fall into the category of thermal generation. The total installed thermal capacity is 250 MW or 17% of total power-system capacity. None of the thermal-powered plants operate at their expected full capacity and few operational years remain. The Kelanitissa Oil Steam plant that delivers 44 megawatts is to be retired at the end of 2000. The Sapugaskanda Diesel plant that supplies 72 Mw will be rehabilitated in 1996/97 and retired in two phases: 2003 and 2007. Fossil-fuel thermal options to counter plant closings and increasing demand include coal, medium-speed diesel, low-speed diesel, gas and combined-cycle.

Thermal option studies commissioned by the CEB met with antagonism from both environmentalists and politicians alike. The CEB chose four location along the west coast to site a coal-powered plant. Thermal options have different environmental consequences from those of hydro-power projects. All of the sites were unsuitable to someone. The only site that the politicians vehemently opposed was one too close to prawn farms. "It is too bad we could not get to the environmentalists to help us on that one. The plant's cooling water [which is hot] would probably do less damage environmentally than the expansion of prawn farming," a CEB engineer half-jokingly told me. "The truth is, the longer we wait to build these plants the more trouble and unforeseen costs will accrue."

Coal-fired generation was selected as Sri Lanka's future base-load generation option in the late 1970's after the second global oil-price increase. In the early 1980's the government approached the Australian government for assistance. Trincomalee was chosen as an appropriate site. Its naturally deep harbor would allow the import of coal in 150,000-ton vessels, thereby saving freight costs. The Asian Development Bank funded a full feasibility study for four locations in the area in 1984. The National Aquatic Resources Agency (NARA) and the Coast Conservation Department rejected all the proposals in their presented form. By late 1987 the CEB had little interest in expanding coal-fired power generation since oil prices had dropped dramatically enough to make oil a cheaper fuel source. Furthermore, electricity demand plummeted from an annual 10% increase to a mere 3% per annum after the 1983 and 1989 Tamil insurgencies. Shifting and uncertain boundaries of territory controlled by the Liberation Tigers of Tamil Eelam (L.T.T.E.) made the area around Trincomalee too unsafe for electric power transmission to the nearest central grid. The date that the coal-fired plant was expected to go on line was pushed back past 2000. Today we have a power crisis.

Restructuring shifts the traditional model of large-scale, central generation to a "distributed" power system that relies on a broad mix of large and small generating plants. Intermittent generators (hydro or solar), combined with "peaking" turbines used to supplement base-load plants for periodic increase in demand can supply up to 30% of a typical utility's demand for less than the cost of new centralized generating and transmission equipment. Distributed power systems may be an important strategy for developing countries with unreliable and incomplete central grids to follow. Diversified electricity-generating sources that focus on providing services (truly reflecting "least cost"), and not on achieving lowest electricity prices may emerge in the future that introduce long-term benefits of less expensive and more-reliable electricity, more efficient use of energy and a reduction in environmental problems.

No one knows the limitations of government involvement in and the shortsightedness of power-sector planning better than Mr. D.C. Wijeratna, who has worked for the CEB planning section for over 25 years. "The lack of a regulatory framework to govern the bid-evaluation process, lack of trained manpower in the preparation of power-purchase agreements and implementation agreements, policy constraints, a non-competitive market and lack of transparency have caused public concern and anxiety in the investment community." The result: proposals become implementation without proper feasibility studies and run into unforeseen barriers. Submitted proposals contain no provision for the average amount of normal commercial risk. Lengthy negotiations and delayed acquisitions add unnecessary construction costs that ultimately cause the investor to question government commitment. "Decision-makers who are politicians do not understand the gravity of these matters nor the complexity of project financing. The need for [an environmental] regulatory body to oversee procedures increases costs, as has been the case in the United States. But the Sri Lankan government must do something to boost investor and public confidence," says Wijeratna.

According to Mr. Wijeratna one of the major problems confronting planners is that they are not the decision makers. Electricity systems planners analyze social, political and financial criteria and present options that combine the best combinations among the different technologies at hand to the decision makers. "The point is," Wijeratna states, "if decision-makers do

not make a decision then there is no planning, only analysis. Unfortunately these decision-makers are politicians. Their priority is to be re-elected, so they rarely exercise the political will necessary to generate and expand power generation capacity. There are resource constraints in systems planning: technology performance, finances, and fuel availability and cost. In Sri Lanka we also lack trained professional human beings in government service."

""The biggest problem with power generation in this country is no additions to the grid for the past five years and an environmental authority that is too strict. The situation will improve only if there is less indecisiveness in the Ministry, lower restrictions on environmental impact and if CEB proposals are implemented," says Gunaratne, a consulting engineer in power management. "I do not think that the CEB should be privatized, but it should be made separate from the Ministry. The Minister and politicians in general are indecisive, so they prolong decision-making. Instead of privatizing we should be given modern technology and loans. For those who say privatization is inevitable, distribution should come first and then only through local entrepreneurs. Perhaps even private generation could be allowed in the future, but for that there must be a clear policy."

What are the implications of six percent growth? "We need a U.S.$1.9 billion-dollar investment over the next ten years to meet the growing electricity demand," says Mr. Nanthakumar. "Now the pundits start theorizing about how we are going to come up with all of this money to fund power generation."

Increasing private sector participation

Creating a business-friendly environment for private-sector participation requires: political stability, political consensus, a legal framework, a regulatory framework, and sector organization. Sri Lanka is not alone in the privatization experiment. The Philippines has been most successful with private-sector participation. But they also have the highest tariff rate in Asia. Turkey gave up its privatization program after 15 years. It took six years for Pakistan's to get up and running. Does Sri Lanka provide a competitive market environment for private power generation?

According to Mr. Thilan Wijesinghe, Chairman of the Board of Investment (BOI), private sector investments have three advantages:

- The private sector offers more timely and efficient service, and in many cases, greater capability to manage.

- The private sector can tap new financial, technical and managerial resources, provide training and technology transfer.

- Private Sector investments have a beneficial impact on the balance of payments.

Bandula Tilakasena is Deputy General Manager for private power projects at the Ceylon Electricity Board. He cites changes in conventional infrastructure development financing in power-sector development for necessitating private-sector participation. In the past, developing countries could count on loans with very concessionary terms from international, bilateral and multi-lateral agencies. With investment opportunities opening up in other sectors, these traditional sources are drying up. International lenders have pressured developing countries to allow private participation in state-run utilities. "In many ways, States and their agencies are viewed as "non-creditworthy" borrowers by those who seek capital and those who supply capital. The State is no longer able to mobilize money for infrastructure building. This is another reason why the private sector is necessary to develop new power-generation projects. The CEB must also look for investments in electricity generation through non-conventional and innovative financing mechanisms. The BOO (Build, Own, Operate) approach is one of these.[8] Governments are almost forced to accept this situation."

The first attempt to involve the private sector in power supply was a 1992/93 newspaper advertisement titled, "Expressions of interest for private sector participation in development of the power sector." There was a large response despite the fact that the CEB announcement published neither project parameters nor conditions for power purchase. The truth was, the CEB was unprepared for the response. "We asked for participation without a defined objective or any sort of framework to follow. It caused a lot of work for us," says Tilakasena.

Difficulty raising finances for infrastructure development already has led to restructuring in the power sector. To redress the State's problem of granting a counter-guarantee to a private-party loan (a guarantee the Government hesitates to give), the government established the Private Sector Infrastructure Development Company, a government-owned company designed to overcome the critical shortage of long-term debt for infrastructure projects by providing a long-term subordinated debt facility with a lending capacity of U.S.$65 million. This government-managed fund for private-sector infrastructure development is through the World Bank and Asian Development Bank. Considering the total investment necessary for power sector-development, this is a small account, according to Tilakasena. Therefore the CEB is formaliz-

8. The BOO (Build, Own, Operate) scheme is similar to the independent power producer scheme in the U.S., under which investors build plants and sell power under contract to a local utility. The three projects on-line under this agreement have a combined capacity of 250 Mw.

ing a standardized procedure to encourage and accommodate the private sector.

On April 10th the first BOO power project began operation. The Dick Oya Small Hydropower Project is the result of a 1993 CEB announcement that it would buy privately-produced electrical energy. Vidya Silpa, a Sri Lankan engineering firm, conceptualized and submitted proposals to develop five sites with attractive hydropower potential. The 88 million-rupee Dick Oya project will supply approximately 8.6 million units of electricity annually at a rate of three rupees per unit. Six 175-kilowatt (KWh) turbines are fueled by river water channeled through penstock pipes. Vidya Silpa relied on financial support from the Development Finance Corporation of Ceylon (DFCC) and technical support from Jiangxi Machinery and Equipment Import and Export Corporation of China. This is the country's first private plant solely dedicated to supplying power to the national grid.

Mr. Sumanasekara, chairman of Vidya Silpa's project, is a former meteorologist who had a great deal of data about the flow of Dick Oya. In response to the ad and after receiving CEB approval, he used his own money to put in the weir in March 1993. Construction had to commence then, when the stream is seasonally at its lowest. "In May 1993 Sumanasekara asked us (DFCC) for a loan," said Sunil de Silva, a mechanical engineer and the DFCC credit manager who handled the Dick Oya account. "DFCC put up 18 million rupees in equity and 23.5 million rupees in loans. The collaborating Chinese corporation invested 10 million rupees. The 1.2-Mw capacity plant can operate at 50% capacity in the dry season and average 80% capacity throughout the year. We thought the project would take two years [and be] operational in May 1995. Instead the process took three years.

"There was a great deal of stalling by the CEB. Their approvals were always late," de Silva said. "We [DFCC] told Vidya Silpa to keep the pressure on and continue with construction plans. When things became too slow I and a few of my colleagues at the bank got involved personally. In general the CEB is skeptical of the private firm. It is good to have a well-established, well-respected banking institution such as DFCC involved in the project. The bank's reputation lent credibility to the project. Many of us working here [at DFCC] are engineers who have classmates in the CEB. We used our personal contacts to push the paperwork through. The procedure was difficult because it was the first one. Now that the groundwork has been laid there should be fewer delays." However, even with the delays the hydro plant had a shorter then normal gestation period.

"The environmental impact of this project is low: the powerhouse is almost entirely underground, the channel is only 800 meters wide, there is no submerged vegetation or resettlement scheme, only one squatter was removed. The environmental-impact assessment [EIA] was a very straightforward analysis. This should be the case for most micro-hydro plants as they do not have a water storage facility [catchment]. Since DFCC funds come from the World Bank and the Asian Development Bank, we must fall in line with their regulations. DFCC has an in-house EIA unit that hires outside consultants for large projects," de Silva added. "DFCC has a serious interest in developing the energy sector. Plants can be operational two to three years from the approval date. Dick Oya was slower because the CEB had no formal power-purchase agreement with the private sector. It took a long time to hammer out an agreement. Now we can go ahead with funding micro-hydro (plants up to 5 Mw). The CEB will connect projects to the main grid. Micro-hydro is supplementary, but can give a meaningful contribution. There are about 100 potential micro- and mini-hydro sites in Sri Lanka. We are considering 14 more projects." De Silva thinks that the CEB may not have as much enthusiasm for diesel or gas-turbine projects for which DFCC has received inquiries. The private sector has yet to show interest in coal.

"In the future power supply might become more private, but transmission and maintenance will remain under state-control," de Silva concluded. "We at DFCC are willing to coordinate a consortium of banks and foreign collaborators to invest and develop the energy and water sector. We calculate high return on this Dick Oya project. We expect repayment in 4-5 years. Start-up and capital costs are the most demanding. After completion operation and maintenance costs are relatively low. The manpower requirement with operators and security does not exceed eight individuals."

DFCC also managed the CEB fund for generator concessions during this current power shortage. The CEB loaned 100 million rupees on a four-year, low-interest repayment schedule channeled through DFCC. "We are not making any money on this arrangement. We are doing it as a service to our clients," said de Silva. "The whole one-hundred million is gone so we probably gave loans to 20-25 industries to purchase generators during this power crisis." [9]

Private-sector participation is not limited to electricity generation projects. Another investment strategy is to allow the private sector to purchase 51% of the shares of Lanka Electricity Company (PVT) Limited, a subsidiary of the CEB. The Board of Investment offers an attractive incentive package of duty-free imports on project-related machinery, raw materials, etc., plus tax exemptions and concessions on

9. Business is booming for importers of electricity generators. Generator sales in February and March 1996 alone exceed sales from the past year. The government waived the usual 10% duty and will reimburse those who placed orders for generators over 100 KVA before March 31. The lowest price for an industrial generator (40 KVA and upwards) is Rs. 675,000 (U.S .$12, 616.00).

power-sector investments exceeding U.S. $50 million.

Micro-hydro projects and resurrection of the plantation sector

R.A. Bhatiya Ranatunga is project manager for the Intermediate Technology Development Group's (ITDG) micro-hydro scheme. The nonprofit group's scheme has two divisions: village hydro-power and estate hydro-power, and technology development. In the early 1980's ITDG offered consultation services and technical advice to up-country estates producing their own on-site power for processing and manufacturing. Of the 5000 tea and rubber estates producing their own power during the British colonial era, only 200 are in operation today. Most of the machinery has been sold for scrap metal. In 1983 ITDG began to lobby the CEB to connect the estate sector to the national grid.

"Estates have the potential to supply more power than what is needed for their own operation," said Ranatunga. "Despite recent events brought about by the crisis, the CEB has a general skepticism about hooking up individual generators to the grid. The government adopted international regulatory standards [the G59 code], but problems with formalizing power-purchasing agreements remain. The tea estates receiving ITDG assistance are running at full capacity and supply the grid at a rate of Rs. 2.90 per kilowatt hour. Purely for profit, more estates are interested in supplying the national grid. The BPL Corporation, which manages between 20 and 30 tea estates, has formed its own subsidiary business group to handle hydro-power generation. The World Bank Tea Estates Project was approved this week to develop the plantation sector's power-producing potential. These small-hydro projects do not do much to alleviate pressure on the national grid. They can supply individuals or areas that will not come within CEB purview for another 10-15 years."

Concurrent with the estate project, ITDG visited rural areas in the south to meet enterprising individuals who had started their own household hydro-power generation by fashioning crude generators using car batteries. "At this time we assessed the water resources of the south and searched for a way to electrify villages, especially those that are far away from the grid hookup. The farther away the better," said Ranatunga.

In cooperation with the Integrated Rural Development Program (IRDP), the Rotary Club, the Environmental Conservation Fund of the CEA and other local interest groups, ITDG provides initial technical support and yearly operation and maintenance followup to villagers who are left off the CEB current operational plan and initiate a village-electrification process. The local community must raise 40% of the cost of installation themselves. The remainder comes as grants from the organizations mentioned above. All parts including the turbines and electronic load-controllers are manufactured locally by twelve manufacturers, all of whom have received training from ITDG. The owners of the village foundry, radio repair shop and other individuals who display technical knowledge are taught to maintain the turbine and fashion spare/repair parts out of locally-available material. Ranatunga maintained that "Maintenance is not as difficult as most people would think. It usually runs around five percent of the start-up cost per year. Thus far 22 village-level projects are complete and ten more are in progress."

In August ITDG is offering a Micro-Hydro Power Development Training Course to address Sri Lanka's shortage of technical expertise. Micro-hydro plants (those that produce between one and 35 kilowatts) are not scaled-down versions of macro hydro-power schemes. Their construction, operation and maintenance is completely different. The workshop will cover all procedures from feasibility studies, to design, to financing. The selling phrase for training course: "Escalating electricity prices and the possibility of exporting self-generated electricity to the national grid are two important developments that have made micro-hydro an attractive investment for the private sector." However, ITDG itself is doing an investigation of the entire micro-hydro sector, including estates. After surveying approximately 150 sites, it is tentatively estimated that the maximum this sector could supply for the main grid is 50-60 megawatts.

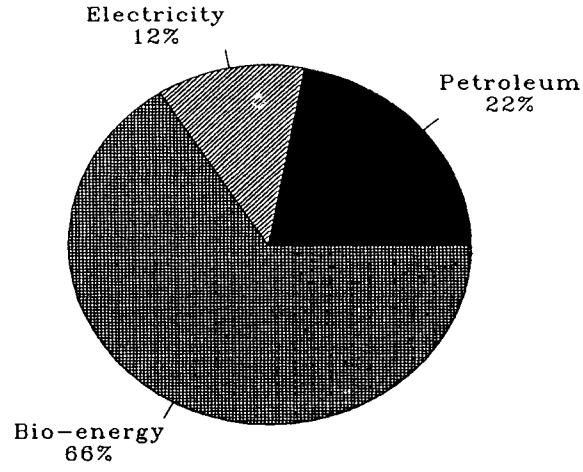
What does Ranatunga think about the power crisis and micro-hydro's role in it? "Micro-hydro is supplementary. Personally I think we need to explore alternative sources and should not campaign against coal. The problem with nuclear power in a country like ours is there is too much corruption in the government so standards are not adhered to."

"Micro-hydro has a history in Sri Lanka's plantation sector," says Gunaratne, another Sri Lankan engineer. "When the plantation sector was connected to the grid in the late 1960's, they stopped producing their own power because power from the grid was cheaper. In addition to the plantation sector there is room for alternative sources. In the late 1970's I was part of a team experimenting with wind, biogas and solar cells to supply power for a small village between Tangalle and Hambantota. Solar may be an option for Sri Lanka but only on a small scale where it is too difficult economically and technically to connect an area to the grid. Solar power is expensive. Due to high capital costs generation costs are roughly Rs. 25 [U.S.$0.50] per unit."

Substitutes and alternative energy sources

Given the problems with electricity-systems planning, will electricity be a reliable substitute for biomass (mainly fuelwood) energy? The Forestry Department Planning Unit relies partially on CEB planning and ac-

Figure 4: Shares of energy consumption in 1992 by supply source (%) (FSMP, p.260)



tion to assess how expansion of power generation and the national grid will affect the demand for biomass resources. The Forestry Department engages in its own forecasting exercises to determine biomass yield and to suggest appropriate land-use alternatives based on projected needs of the domestic and industrial sector.

During the last two decades annual energy consumption has risen by an average of 1.7%. According to the Forestry Sector Master Plan (FSMP), 66% of the energy consumed in 1992 came from biomass: firewood and coconut and paddy husk. Electricity provided only 12% of consumed energy (See Figure 4). Planners for the Forestry Department combine such statistics with surveys of urban and rural fuelwood markets in order to forecast demand for firewood over the next ten years. One FSMP findings is, "Household incomes are rising, as is the number of people who can afford to buy gas or electric stoves. These trends will reduce the demand for fuelwood over the medium and long term, [but] the high cost of electricity and the cost of stoves make electricity an alternative only for affluent families" (p.262). As we have learned, domestic consumers pay only half the cost of generation per unit of electricity. Planners at the CEB would enjoy increasing the domestic consumer's price. This would drastically alter the Forestry Sector's plan that electricity could become a likely substitute for fuelwood.

Planners in the Forestry Department are worried about the country's domestic sector's (particularly the urban and rural poor's) reliance on biomass resources. In rural areas,fuelwood is perceived as a "free" good that discourages conservation and encourages inefficient utilization. According to the 1990 national consumer survey, 84% of fuelwood used by households was obtained free by users. On the other hand, the urban poor have limited access to biomass resources and cannot afford natural-gas and electric substitutes. As firewood prices increase in urban areas, the urban poor, including Tamil refugees from the north and east, suffer the greatest. Price, however, is not the only — nor necessarily the best — indicator for the Forestry Department to use in predicting fuelwood substitution in the domestic sector. The effect of fuelwood on the taste of food and the versatility of switching between fuel sources are among the reasons that many domestic consumers will not switch solely to natural gas, kerosene or, if available, electricity.

The new World Bank program to assist the plantation sector in the development of its on-site hydropower generation capacity will affect industrial consumption of biomass resources. In 1993 the tea industry consumed over 455,000 tons of fuelwood in processing (withering and drying) leaves. The FSMP projects that the tea sector's future requirement for fuelwood will decrease to 358,000 tons by 2020. The projection was made nearly one year before the World Bank announced its aid program. Overall, the Forest Department estimates that demand for bio-energy will begin stagnating in 2015 and slowly decline after 2020. However, this prediction is based on declining population growth rates, alternative energy sources and technological innovation in the power and energy sectors. The Forestry Sector Master Plan anticipates that the Ministry of Irrigation, Power and Energy will play an instrumental role in increasing the institutional capacity of the bio-energy sector through inter-ministerial coordination and policy studies and formulation. Given mess and manipulation within that particular Ministry, it does not seem that the Forestry Department has chosen a very effective safety net.

Professor K.K.Y.W. Perera, chairman of the Arthur C. Clark Center, is a proponent of dendrothermal power generation. He asks and answers the question, "Why should one reduce petroleum consumption at the expense of increased fuelwood consumption?" While increased fuelwood consumption triggers concern about deforestation, Perera believes that Sri Lanka's excellent climate for growing trees and large extent of marginal land create perfect conditions for growing forests to provide additional energy inputs through fuelwood. "If trees are grown and then cut down and utilized as a fuel for burning, the net addition of carbon dioxide to the atmosphere is zero."

He makes no mention of constant and perhaps costly reforestation efforts in his model. He further believes that there is a national biomass surplus that can be maintained until 2020 with proper management of forest resources. Dr. Perera states that another advantage of dendrothermal energy is a reduction in the balance of payments, which escalates with devaluation of the rupee and dependance on foreign fuel sources. He estimates that shifts from oil to fuelwood in the transport, power and industry sectors could save 251,400 tons of oil equivalents (plus foreign exchange) by the

year 2000. The transport sector's research and development group has been experimenting with vehicles propelled by fuelwood-burning gasifiers for the past five years. Dendrothermal uses fairly low and proven technology to generate electricity. Multiple small power stations in the order of a few megawatts, located near planned fuelwood plantations can be viable operations to connect to the grid. According to Dr. Perera, preliminary economic analysis shows that the costs associated with planting and harvesting fuelwood plantations for electricity generation on marginal and unproductive land is lower than the cost of oil and coal.

Mr. Wijeratna of the CEB planning department holds another opinion. "Of all the renewable new technology — wood [biomass], solar, geothermal and wind — wind stands a chance in Sri Lanka. Globally, biomass generates about 3500 Mw of power. Dendrothermal is all about land-use planning. Our government is confused about this. First they say they want to increase food production and look at improving and using marginal lands. Then they say that these marginal lands should be used for biomass plantations. We cannot do both; [we can] only wait for the government to define priorities."

Due to economics of scale, utilities experience difficulty providing power in an environmentally sound matter. But Dr. Munasinghe's recent research hopes to change that. He sees sweeping potential for wind energy. The question the CEB needs to answer is, "How are we going to proceed with power-sector development?" The CEB must balance hundreds of options and alternative power-generating systems with DSM techniques and pollution-abatement technologies. In his economic models, Munasinghe combines wind energy, DSM and loss reductions in T&D and also advocates pressurized fluidized bed combustion coal (PFBC) combined-cycle plants.[10] Environmentally the sophisticated technology of PFBC is more attractive than installing flue-gas desulfurizers on the smoke stacks of conventional coal plants to reduce nitrous-oxide and to lower carbon-dioxide emissions. The main consideration is commercial. The CEB must explore the availability of PFBC technology, the suitability of imported coal and operation costs.

Environmental considerations in power-sector planning

Since 1979, electricity use in developing countries has outstripped gross domestic product (GDP) growth because of internal energy subsidies. Price never rose commensurably. There is 20 to 30 times more per-capita energy consumption in the developed world than in developing countries. There are global environmental implications caused by increased energy demand. "If we follow the same policy as today, I'll call that the "business-as-usual-policy; there will be 10 times more sulfur dioxide (SO_2) and NO_x by 2030," Dr. Munasinghe exclaims. "If we introduce new prices and other measures these pollution rates will fall because energy use will fall. If we couple this with pollution-control devices, we will eliminate an increase in these pollutants. This will take aggressive action because the addition of pollution-control devices increases the needed investment, as these technologies are expensive.

"All electricity-generating schemes have local impacts," says Dr. Munasinghe. "Hydro-power results in a loss of biodiversity, siltation, possession of land and displaced populations. Gas and oil bring air and water pollution and the risk of spills. Coal contributes to air pollution, water contamination and land reclamation. Even the technologies we consider the most enviromentally friendly — solar and wind — have extensive land requirements[11] and are not aesthetically pleasing."

In 1990 the World Bank commissioned a study on acid rain in South and East Asia. The "Rains Asia" model forecast acid rain and SO_2 based on 1990 field studies of SO_2 soil content. Dr. Munasinghe's Asian map is a patchwork of green, yellow and red. Red is a warning sign, indicating serious damage to economies and health. Red areas already exceed the WHO/FAO standards for the maximum amount of SO_2 in the environment before crop cultivation and human health are greatly affected. In 1990 red dominated only small parts of southeastern China.

"Look what happens to these same areas by 2020, based on the projections if we continue with business as usual," he says as he places down an overlay. "China is in a bad way. So is India." The east coasts of both countries are completely red. Small parts of Western China are red too, but conventionally speaking this is considered insignificant for few people live out on the high-altitude plateaus of Tibet. Red is splashed across Japan and Korea, all fallout from China. "I was in China last week on a special invitation by the Energy Department," Dr. Munasinghe continues. "The leaders say they want to continue using coal as it is their cheapest fuel source, but they recognize that international pressure will increase."

He changes map overlays again as he demonstrates his argument. "Now, look at the model's projection

10. A combined-cycle plant is an arrangement in which the excess heat from the gas turbine is used to power a steam turbine, increasing energy efficiency. Combined-cycle plants are inexpensive to build (a little more than half the price of a conventional coal-fired plant) and can be built in less than 2 1/2 years.

11. Interesting fact: All U.S. power needs could be met with solar plants spread over 59,000 square kilometers, less than a third as much land as now occupied by U.S. military facilities (Flavin and Lenssen, 1994 p. 68)

with the implementation of moderate SO_2 controls like low-sulfur fuels such as 1% sulfur-steam coal and the maximum use of natural gas in energy production. Modeling shows that with imported Australian low-sulfur coal [less than 1% by weight], the 900-Mw plant envisioned in Trincomalee can achieve ambient SO_2 standards similar to those met in industrialized nations."

This amounts to a greening of Asia almost to the 1990 levels, *but* with an eight-fold increase in energy output: Protection without compromising production. Dr. Munasinghe asserts, "This is what we have to strive for. If Sri Lanka is going to continue with its emphasis on coal-fired power plants, it should start with these stricter measures and construct all plants to operate on PFBC coal. The material is in ready supply for the country to import."

From an environmental perspective, Sri Lanka has a distinct advantage. The nation can be a textbook example of how a developing economy can develop its power sector with environmental compliance in mind. The decision-makers must decide whether to opt for more expensive, low-sulfur fuels or cheaper fuels and pollution-abatement controls. Pollution-control technology is expensive. Opting for higher-cost, lower-sulfur coals is more economical when compared to other pollution-abatement options. In some cases almost 45% of the cost of constructing a coal-fired power plant arises from environmental compliance, such as installing scrubbers and flue-gas desulfurization units on smoke stacks. Whatever the decision, should the Sri Lankan government bear the costs for cleaner production alone? Or should the countries that will be affected by Sri Lankan fallout chip in?

These are interesting and important questions, because the data and options are being placed before decision-making politicians primarily concerned with the national context. At present the power sector contributes little to air pollution in Sri Lanka. To the politician there is room for pollution from the power sector. Motor vehicles in Colombo, which have increased fourteen-fold in twenty years, generate ninety-eight percent of the country's carbon dioxide, 79% of nitrous oxide and 46% of SO_2 emissions. These by-products of combustion contribute to transboundary pollution: acid rain and the greenhouse effect. Yet acid rain inside Sri Lanka is more likely to be a function of air pollution generated in India than from thermal plants on the island.

Once the thermal options are added to Sri Lanka's generation system, models show that by 2010 the power sector is expected to contribute 80% of all SO_2 emissions and 70% of all nitrous oxide emissions generated in-country. The politician confronted with a conflict over conservation and economic development might prolong decision-making by suggesting that the debate be moved over to his colleagues in the Ministry of Transport because, based on the model, their sector is the root of the nation's current air-pollution problem. Scenarios such as this demonstrate the need for painfully slow negotiations and regional conventions. The government has to consider its position on global warming and tradeable carbon emission rights (internationally or regionally-recognized rights to pollute) as well as its regional position on transnational acid rain, for it accepts India's pollution and may well be giving its own to Malaysia. But it also demonstrates why politics and politicians must get out of power production.

Incorporating environmental analysis, no matter how expensive, at the onset of a project is often less expensive than the costs associated with delays that inevitably follow public controversy over the adequacy or existence of environmental studies. To this day the CEB does not include the expense of resettlement or the opportunity costs of losses in productivity associated with hydro-dam inundation into least-cost generation planning studies. When the German-assistance agency GTZ submitted an Electricity Masterplan, it figured an annual estimated loss of $10 per hectare for scrubland and $530 per hectare of tea into the environmental cost of inundation for each potential hydro site. While the increase in total cost is marginal, what is important is the *process*; the fact that the externalities were considered. The public does not like to feel it is being neglected or ignored.

"I understand the environmental issues," confesses CEB's Wijeratna. "If we enforce our environmental laws, then there will be no more power. The CEB cannot find a manufacturer that makes a gas turbine [that can] achieve our emissions standards. The problem, is the environmental movement is controlled by freak groups, not professionals who will sit down to talk and to think about it."

Environmentalists' sabotage: Generating public interest

As the 21st century unfolds, the private sector will be the engine of Sri Lanka's economic growth. The State will be only a facilitator. As one economist told me, "The State is coming around as it slowly learns that there is nothing wrong with profit maximization."

In November I attended a seminar on the environmental-impact assessment (EIA) process for investors and developers sponsored by the Ministry of Transport, Environment and Women's Affairs. The Central Environmental Authority (CEA) invited 75 investors and developers to the Taj Hotel for a one-day awareness workshop on the EIA process. Two weeks earlier the CEA held a similar workshop for the NGO (non-governmental organization) community because, according to Mr. G.K. Amaratunga, CEA chairman, "they are always critical of development." The NGO community is espe-

cially critical of the CEA's weak enforcement record (CEA in NGO lingo stands for: Can't enforce anything), but the CEA claims they must give industrialists time.

Environmental Impact Assessments (EIAs) have four objectives: to analyze project impacts and to mitigate them, to identify alternatives; to make collective decisions through public participation; and to make this information available to the public to ensure a transparent decision-making process. According to CEA officials, the sooner the EIA process is initiated, the easier it is for the developer to incorporate environmental controls into a project's engineering and design. If the EIA is commissioned before the feasibility study, then any severe environmental impacts can be identified beforehand. The investor inevitably saves money on a potentially dead-end feasibility study by investigating alternatives. Investors should not think of the EIA process as an additional expense.

"The investment community's biggest misconception is that an EIA is a guess. EIA is a predictive process. It is not based on imagination. It is scientific," says Amaratunga. "Through EIA we want to predict environmental impacts of a project and suggest ways of mitigation. The EIA is now legally required for all new projects including those endorsed by the BOI. EIA concentrate on conflicts, problems and natural resource constraints; those that harm people, their livelihood or land or nearby developments. An EIA is not a separate process but a system of continuous monitoring. Developers always tend to leave the EIA to the end and then their development is delayed by lengthy court battles. This is an avoidable situation if the EIA is done first. It is legally required to examine at least two or three alternatives to the preferred project site or design."

The public, led by local environmental groups, played a large role in stopping the construction of the Ceylon Electricity Board's Upper Kotmale Power Plant. In the Spring of 1995 Ajantha Palihawadana led the campaign. According to Palihawadana, the siting was inappropriate. The proposal was based on inaccurate biological information. The EIA report was full of inaccuracies, including mention of several fish species that have not inhabited the waters for years. This conclusion caused opponents to question whether or not the EIA team ever visited the site. The project would divert water from three major waterfalls and cause a shortfall in four minor downstream waterfalls. The area is geologically unstable and prone to high rates of soil erosion and land slips. Furthermore, the developers proposed no other alternative sites and failed to justify why Upper Kotmale is the only possible site for the project.

The CEB proposal was rejected by the CEA, the government's Project Approving Agency, and the EIA Cell of the Ministry of Irrigation, Power and Energy because they all believed that the CEB did not explore possible environmentally- and technically-sound alternatives. The CEB appealed to the Secretary of the Ministry of the Environment. The Secretary rejected the proposal on the same grounds. Three days after the decision, the national news televised the sea of placards from Palihawadana's rally. Upper Kotmale is a sore spot for the CEB. Rumor has it that the EIA has been re-opened and new presentations are being given to the proper authoritative bodies. CEB officials deny the project is under reconsideration.

Politicians and bureaucrats believe that environmentalists and their EIA process are meant to discourage the nation's development. Volunteers post signboards in neighborhoods to be affected by new projects to inform residents about upcoming public hearings and instruct interested individuals on how to acquire EIA reports and make sense of them. The average citizen has the right to protest any project and submit alternative ideas. The project proponent has the right of appeal to the Ministry Secretary if the project is rejected.

In the past two years the public has commented to various degrees on 100 EIAs and IEEs (Initial Environmental Examinations). "Environmental offenses are criminal offenses," says Mr. M.K. Muthukudarachchi of the CEA's environmental protection unit. "Industry, and that includes fossil-fuel-fired plants, must obtain environmental pollution licenses (EPLs). Discharging wastes even at the standards is illegal without the EPL. Investors and developers have rights, but they also have obligations to comply with regulations. If an environmentally-related concern arises during a public hearing, it is not delaying or stopping development. It is improving the process of sustainable development."

Sustainable development, social justice and procedure. The construction of the Hambantota Oil Refinery and 300-Mw thermal power plant is trapped under mountains of citizens'-groups paper work filed after the corporation started construction without a feasibility study and bypassed all stipulations of the environmental regulatory framework. Hambantota was never considered as a possible site for a coal-powered plant in the early 1990's when the CEB conducted its own feasibility studies; the wind's direction would blow all the particulate matter inland. The Electrical Engineers' Association of Ceylon believes the site is not suitable, since construction of a 150-km-long transmission line is necessary to connect the plant to the grid. As of today only one major project (the Upper Kotmale Hydro-Power Project) has been stopped by public appeal.

EIA reports are among the most open documents in Sri Lankan regulation, allowing public participation and transparency. Public participation may not be as popular or important as the government wants

the public to think it is. Since 1995 officials of the Department of National Planning have tried to incorporate several changes to the National Environmental Act including:

1. denying the public the right to participate in policy formulation,
2. relaxing emissions standards for certain areas of the island, and
3. removing the EIA/IEE processes for project implementation.

Additional action against public participation came in mid-March, when the Cabinet passed a measure to reduce the EIA public-grievance period from 30 to 14 days. Thirty days allows just enough time to read EIA reports, organize public meetings and submit written appeals, say lawyers at Environmental Foundation Limited, a public advocacy group.

During EIA public hearings power generation falls under just as intense public scrutiny as prawn farming and highway expansion. Two of Sri Lanka's largest hydropower projects are plagued with problems that an exploratory EIA with public participation might have avoided. The Mahaweli Multi-Purpose Project made many of the new resettlement regions of the dry zone uninhabitable, since there was not enough water for irrigation necessitating another resettlement exercise. Farmers who persevere at the original resettlement site are confronted by elephants that raid crops and occasionally take human life.

No public meetings were held and the feasibility study was not made available for comment during the early phases of the Samanalawewa Hydropower project. Officials across many Ministries are facing long-term impacts, including the loss of rare- and intermediate-zone riparian forest, threats to at least five species of endemic fish due to inundation, social impacts due to resultant landlessness and failure on part of the relevant authorities to provide back-up agricultural services, inundated gem resources and the loss of stored water due to the presence of a concealed tunnel and leakage from the reservoir's right bank. Even before the leakage started, people in the area said that they knew of the presence of a limestone layer and the existence of an ancient underground tunnel. This later information might have been brought forth during the EIA or public hearing.[12]

In a more recent case the public gave its full support to the Kukule Ganga Hydropower project once the relevant authorities agreed to reduce the capacity of the reservoir. Authorities scaled the project back from a 144-Mw high-dam project to a smaller 70 Mw run-of-river project that involves the resettlement of only 27 families. Under the original plan an estimated 9,100 individuals would have been relocated. What were some of the trade-offs? Under the original plan, the Kukule reservoir would have irrigated 68,000 hectares of land in the southeastern dry zone, of which 95% was new land, theoretically increasing agricultural production and perhaps easing the government's perceived problem of unemployed youth.

Once relevant authorities incorporate measures to reduce environmental impacts and protect surrounding communities, the public often agrees. On April 12, a Norwegian company carried out rock mechanical tests at an underground site in Kalutara, the location of the 12.5-billion rupee Kukule Ganga hydro-power project. The plant, funded by the Japanese, is expected to generate 317 million units of electricity. The water of the Kukule Ganga, a tributary of the Kalu Ganga, the country's second largest river, will be diverted from the head pond and channeled to an underground power station with two 35-Mw turbines.

The NGO movement claims it is not out to sabotage projects, only to fulfill its obligations and duties to society at large. The public is not against development. It simply does not want to be hoodwinked by the government and financiers.

What can we expect in 1997? The Minister of Power and Energy said he has initiated an action to avert power cuts next year. The CEB, is working with BOI to obtain 80 Mw of standby generation capacity to meet any power shortage. The CEB, which offered duty-free and soft loans for the import of generators, will grant similar incentives during the first six months of next year. The procurement a of 80- to 100-megawatt combined-cycle plant has been fast-tracked. A tender was awarded in early 1995 for the construction of an Asian Development Bank-funded 40-Mw diesel plant. Lastly, the Ministry is finalizing a plan to bring a 150-Mw Combined Cycle Plant costing seven billion rupees on-line in 1999.

"We need a commitment on behalf of the Government," Mr. Wijeratna stated over and over again. "The Minister told me yesterday that I have to get a gas turbine operating in one year so we do not have such a severe problem next year. All I can say to that is, "Let's see how we do." ❑

12. Because of the leakage, the Samanalawewa station can be operated only at minimum capacity, which reduces the average energy expected from this plant from 357 GWh per year to 288 GWh per year. Since Samanalawewa is also part of an integrated-system operation, integrated hydro-thermal operation simulation studies find that the loss of storage reduces the integrated-system operation from the Kelani and the Mahaweli hydro stations from 3869 GWh per year to 3785 GWh per year, a reduction of 2.2%.

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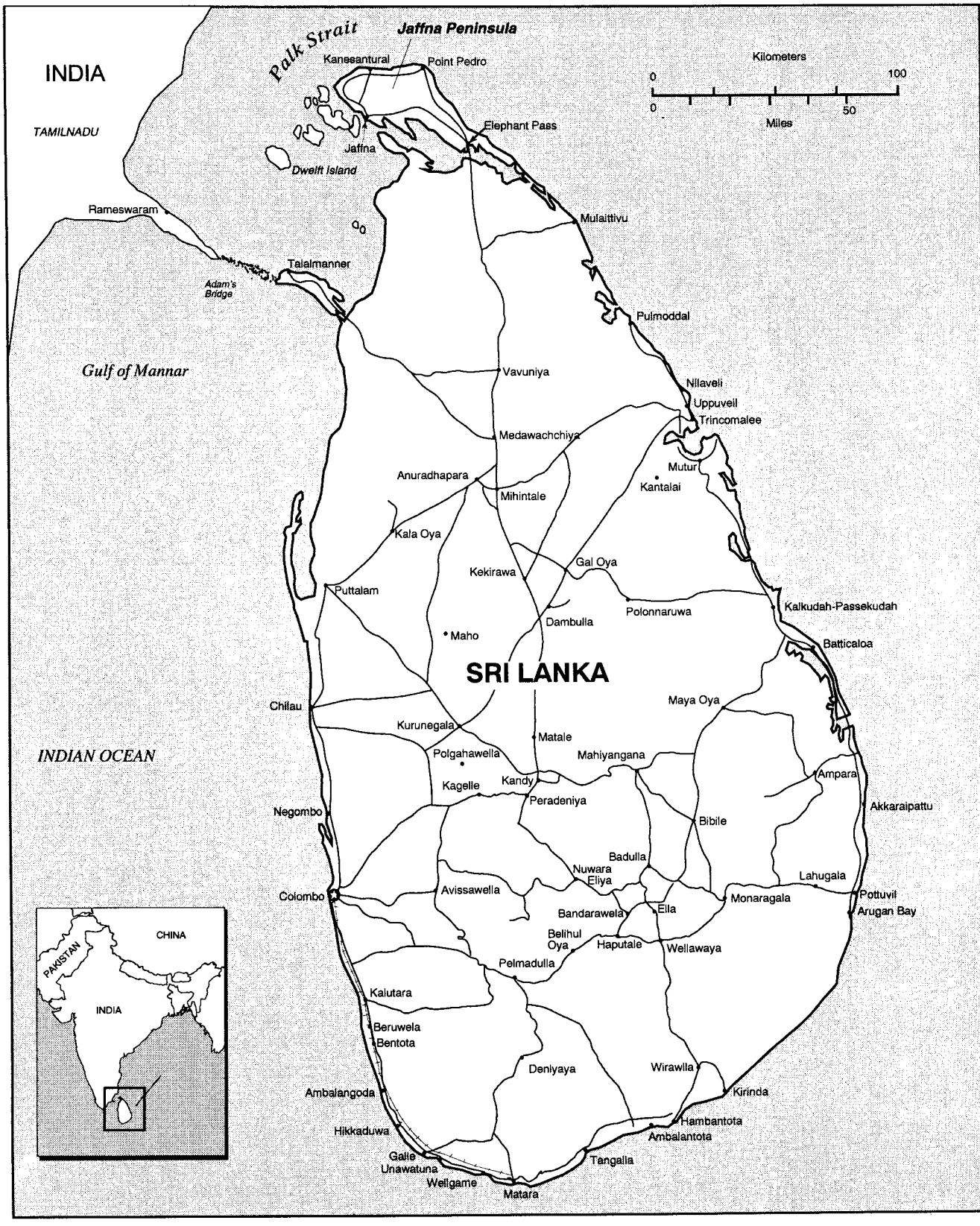
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Current Fellows and their Activities

Adam Smith Albion. A former research associate at the Institute for EastWest Studies at Prague in the Czech Republic, Adam is spending two years studying and writing about Turkey and Central Asia, and their importance as actors the Middle East and the former Soviet bloc. A Harvard graduate (1988; History), Adam has completed the first year of a two-year M. Litt. degree in Russian/East European history and languages at Oxford University. [EUROPE/RUSSIA]

Christopher P. Ball. An economist, Chris Ball holds a B.A. from the University of Alabama in Huntsville and attended the 1992 International Summer School at the London School of Economics. He studied Hungarian for two years in Budapest while serving as Project Director for the Hungarian Atlantic Council. As an Institute Fellow, he is studying and writing about Hungarian minorities in the former Soviet-bloc nations of East and Central Europe. [EUROPE/RUSSIA]

Cynthia Caron. With a Masters degree in Forest Science from the Yale School of Forestry and Environment, Cynthia is spending two years in South Asia as ICWA's first John Miller Musser Memorial Forest & Society Fellow. She is studying and writing about the impact of forest-preservation projects on the lives (and land-tenure) of indigenous peoples and local farmers who live on their fringes. Her fellowship includes stays in Bhutan, India and Sri Lanka. [SOUTH ASIA/Forest & Society]

William F. Foote. Formerly a financial analyst with Lehman Brothers' Emerging Markets Group, Willy Foote is examining the economic substructure of Mexico and the impact of free-market reforms on Mexico's people, society and politics. Willy holds a Bachelor's degree from Yale University (history), a Master's from the London School of Economics (Development Economics; Latin America) and studied Basque history in San Sebastian, Spain. He carried out intensive Spanish-language studies in Guatemala in 1990 and then worked as a copy editor and Reporter for the *Buenos Aires Herald* from 1990 to 1992. [THE AMERICAS]

Sharon Griffin. A feature writer and contributing columnist on African affairs at the *San Diego Union-Tribune*, Sharon is spending two years in southern Africa studying Zulu and the KwaZulu kingdom and writing about the role of nongovernmental organizations as fulfillment centers for national needs in developing countries where governments are still feeling their way toward effective administration. [sub-SAHARA]

John Harris. A would-be lawyer with an undergraduate degree in History from the University of Chicago, John reverted to international studies after a year of internship in the product-liability department of a Chicago law firm and took two years of postgraduate Russian at the University of Washington in Seattle. Based in Moscow during his fellowship, John is studying and writing about Russia's nascent political parties as they begin the difficult transition from identities based on the personalities of their leaders to positions based on national and international issues. [EUROPE/RUSSIA]

Pramila Jayapal. Born in India, Pramila left when she was four and went through primary and secondary education in Indonesia. She graduated from Georgetown University in 1986 and won an M.B.A. from the Kellogg School of Management in Evanston, Illinois in 1990. She has worked as a corporate analyst for PaineWebber and an accounts manager for the world's leading producer of cardiac defibrillators, but most recently managed a $7 million developing-country revolving-loan fund for the Program for Appropriate Technology in Health (PATH) in Seattle. Pramila is spending two years in India tracing her roots and studying social issues involving religion, the status of women, population and AIDS. [SOUTH ASIA]

John B. Robinson. A 1991 Harvard graduate with a certificate of proficiency from the Institute of KiSwahili in Zanzibar and a Master of Fine Arts in Creative Writing from Brown University, he and his wife Delphine, a French oceanographer, are spending two years in Madagascar with their two young sons, Nicolas and Rowland. He will be writing about varied aspects of the island-nation's struggle to survive industrial and natural-resource exploitation and the effects of a rapidly swelling population. [sub-SAHARA]

Teresa C. Yates. A former member of the American Civil Liberties Union's national task force on the workplace, Teresa is spending two years in South Africa observing and reporting on the efforts of the Mandela government to reform the national land-tenure system. A Vassar graduate with a *juris doctor* from the University of Cincinnati College of Law, Teresa had an internship at the Centre for Applied Legal Studies in Johannesburg in 1991 and 1992, studying the feasibility of including social and economic rights in the new South African constitution. [sub-SAHARA]

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