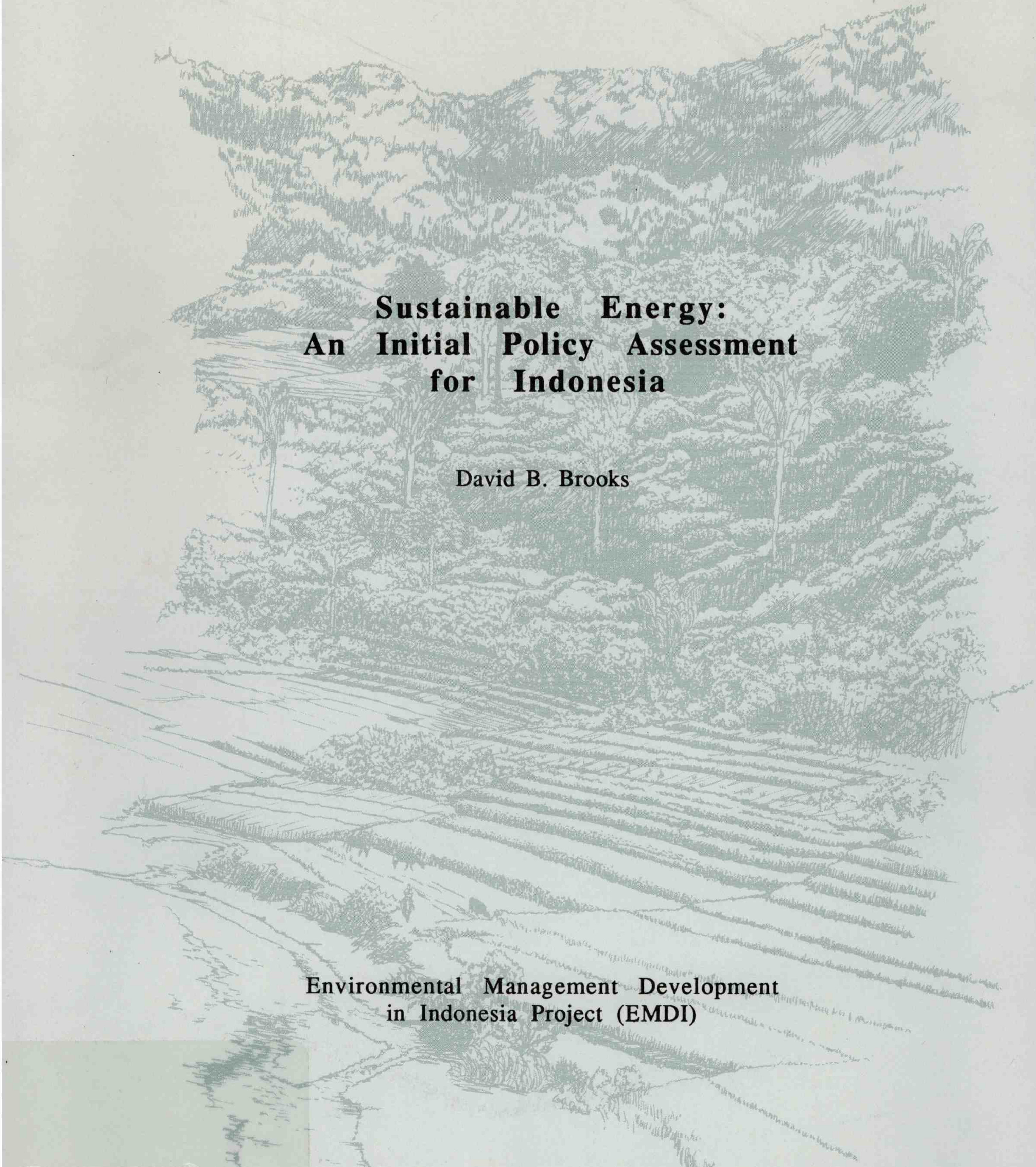

Sustainable Energy: An Initial Policy Assessment for Indonesia

David B. Brooks

Environmental Management Development
in Indonesia Project (EMDI)

EMDI

The Environmental Management Development in Indonesia Project (EMDI) is designed to upgrade environmental management capabilities through institutional strengthening and human resource development. A joint project of the Ministry of State for Population and Environment (KLH) and the School for Resource & Environmental Studies, Dalhousie University, EMDI supports KLH's mandate to provide guidance and leadership to Indonesian agencies and organizations responsible for implementing environmental management and sustainable development. Linkages between Indonesian and Canadian organizations and individuals in the area of environmental management are also fostered.

Currently in its third phase, EMDI has received generous funding from the Canadian International Development Agency at each stage. CIDA provided C$2.5 million to EMDI-1 (1983-1986), C$7.7 million of EMDI-2 (1986-1989), and is contributing C$31.1 million (base budget) to EMDI-3 (1989-1994). Significant contributions, direct and in kind, have been made by KLH and Dalhousie University.

EMDI-3 emphasizes spatial planning and regional environmental management, environmental impact assessment, environmental standards, hazardous and toxic substance management, marine and coastal environmental management, environmental information systems, and environmental law. The opportunity for further study is offered through fellowships and internships for qualified individuals. Within the publications program, *The Ecology of Indonesia Series* is supported. Linkages with NGOs and the private sector are encouraged.

EMDI supports the University Consortium on the Environment comprising Universitas Gadjah Mada, Universitas Indonesia, Institut Teknologi Bandung, the University of Waterloo, and York University. Included in EMDI activities at Dalhousie University are research fellowships and exchanges for senior professionals in Indonesia and Canada, and assistance for Dalhousie graduate students undertaking thesis research in Indonesia.

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ABSTRACT

This report reviews energy options which would satisfy Indonesia's growing demand for energy and yet avoid excessive damage to her environment. Increasingly, it is recognized that environmental protection is part of sound economic development policy, and this report offers further support for that conclusion.

The report outlines the types of energy produced and consumed in Indonesia and focuses on policies which are "sustainable" in terms of energy and the environment. The role of the Ministry of State for Population and Environment is reviewed. The author recommends the adaptation of the "one-kilowatt strategy" as a means of meeting Indonesia's growing energy demands.

ABSTRAK

Laporan ini menelaah kemungkinan-kemungkinan mengenai pilihan-pilihan energi yang dapat memenuhi kebutuhan energi yang meningkat bagi Indonesia namun tetap menghindarkan kerusakan yang melampaui batas terhadap lingkungan. Lebih jauh lagi, diketahui bahwa perlindungan lingkungan merupakan bagian dari kebijaksanaan pembangunan berwawasan ekonomi, dan laporan ini menyajikan dukungan lebih lanjut bagi kesimpulan tersebut.

Laporan menguraikan garis besar jenis-jenis energi yang dihasilkan dan digunakan di Indonesia dan menekankan pada kebijaksanaan-kebijaksanaan yang berlanjut dalam kaitannya dengan energi dan lingkungan. Peran Kantor Menteri Negara Kependudukan dan Lingkungan Hidup ditelaah. Penyusun memberikan rekomendasi mengenai penyesuaian "strategi satu-kilowatt" yang merupakan suatu pendekatan yang menekankan pada suatu alat pemenuhan kebutuhan energi yang meningkat bagi Indonesia.

CONTENTS

ABBREVIATIONS & ACRONYMS

ANDAL	Environmental Impact Assessment Since this report was written, the acronymn ANDAL *(analisis dampak lingkungan)* has been restricted in its usage to a detailed assessment report for new projects. An ANDAL report analyses the potential significant environmental effects, positive and negative, generated by a project and identifies and evaluates possible solutions. AMDAL *(analisis mengenai dampak lingkungan)* refers to the entire environmental assessment process.-- *Ed.*
ASEAN	Association of Southeast Asian Nations
BAKOREN	Badan Koordinasi Energi Nasional (National Coordinating Energy Board)
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Development Planning Agency)
BATAN	Badan Tenaga Atom Nasional (Nuclear Power Board)
BPPT	Badan Pengkajian dan Penerapan Teknologi (Agency for the Assessment and Application of Technology)
CIDA	Canadian International Development Agency
CNG	Compressed Natural Gas
DPE	Departemen Pertambangan dan Energi (Ministry of Mining and Energy)
EMDI	Environmental Management Development in Indonesia
GNP	Gross National Product
IDRC	International Development Research Centre (Canada)
IEA	The International Energy Agency
IPB	Institut Pertanian Bogor (Bogor Institute of Agriculture)
ITB	Institut Teknologi Bandung (Institute of Technology in Bandung)
KMN-KLH	Kantor Menteri Negara Kependudukan dan Lingkungan Hidup (Office of the Ministry of State for Population and Environment)
LIPI	Lembaga Ilmu Pengetahuan Indonesia (The Indonesian Institute of Science)
MSW	Municipal Solid Waste

NGOs	Non-governmental Organizations
PLN	Perusahaan Listrik Negara (National Electricity Company)
PTE	Interdepartmental Technical Committee on Energy Resources
PUSPITEK	(National Centre for Research in Sciences and Technology)
SEP	Sustainable Energy Policies
WALHI	Wahana Lingkungan Hidup (Indonesian Environmental Forum - An umbrella organization for non-governmental organizations)

EXECUTIVE SUMMARY

The following report is an initial review of energy options that would satisfy Indonesia's growing demand for energy and yet avoid excessive damage to her environment. Increasingly, it is recognized that environmental protection is part of sound economic development policy; this report offers further support for that conclusion.

SUSTAINABLE ENERGY DEFINED

By its very nature, energy is involved with every aspect of development. Therefore, it is hardly surprising that energy production, transportation/transmission and use have major environmental effects. One cannot be discussed without considering the other, at least not if high economic costs and excessive depletion of renewable and nonrenewable resources are to be avoided. This report focuses on 'sustainable energy', which can be defined as:

- the use of renewable energy resources in such a way as to maintain their productivity over time;
- the use of nonrenewable energy resources in such a way as to extend their life and permit (over the long term) a fully renewable energy economy; and
- the use of both in ways that limit degradation of the air, land, water and genetic resources with which energy production and use are so closely linked.

Therefore, as used in this report, the term 'sustainable' refers simultaneously to both energy and the environment.

PRINCIPAL RECOMMENDATION

Given the undeniable need in Indonesia for more commercial energy to provide a higher quality of life for its people and development for its industries, it would be unreasonable to claim that Indonesia could move immediately to a fully sustainable energy system. Nevertheless, important steps can be taken to make such a system attainable in the future — perhaps after the year 2010. Indeed, unless those steps are taken, Indonesia will find itself even further from sustainability in the future than it is today, which means that economic and ecological debts will continue to mount.

For a number of reasons, including the growing costs and uncertainty of conventional energy policy, interest in sustainable energy options is growing in Indonesia. However, up to now, no official body has come forward to provide leadership and give substance to these ideas. Thus, KLH has the opportunity to become the leading voice in the Government of Indonesia in support of sustainable energy. However, to fill that role, KLH must make a firm and continuing commitment of staff and budget to energy issues.

This report focuses on energy produced and consumed within Indonesia. (Energy produced for export is more appropriately treated as a commodity, albeit an important one.) Moreover, the report stresses the role of energy demand. This point is reemphasized at the conclusion with a section on adaptation to Indonesia of what has been called the One-Kilowatt Strategy.

SUSTAINABLE ENERGY POLICIES

In moving toward a sustainable energy policy for Indonesia, two fundamental conceptual steps must be taken. The first is to recognize that domestic energy use cannot forever continue to increase. Limits will sooner or later be set by lack of reserves, environmental constraints or financial requirements. The second conceptual step is to recognize that, despite its fundamental role in the physical and economic worlds, energy is not wanted for itself but for the services it can provide. To the extent that we can obtain those services more efficiently — either by reducing the *quantity* of energy required to obtain some service, or by ensuring that energy is delivered in the *quality* appropriate to that service — development will be enhanced. Moreover, that same drive toward efficiency will have two additional benefits:

- Adverse environmental effects will be greatly reduced because less energy will be needed and the kinds of energy required tend to be less damaging.
- Labour opportunities will be increased and capital requirements reduced compared with a less efficient system in which more energy must be supplied to obtain the same services.

In the absence of concerted attention to energy efficiency, a sustainable energy future is not attainable. Within this conceptual approach, there are a number of specific steps that could be taken now to move toward a sustainable energy future. To a considerable degree, these steps are contrasting in urban and in rural areas of Indonesia.

- In urban areas, major opportunities exist for conservation in energy use but only modest ones are present for development of decentralized, renewable energy sources.
- In rural areas, major opportunities exist for development of decentralized, renewable energy sources, but only modest ones are present for conservation in energy use.

In addition, attention must be paid to some major choices in conventional energy policy and to innovative ways to promote the wider use of those sustainable energy techniques that prove to be attractive and economic.

INSTITUTIONAL INNOVATIONS

Energy specialists have long been aware that supply and demand alternatives exist that are cost effective and technically superior to those commonly in use, however, they are not widely adopted. Evidently, choices in energy have socio-cultural and socio-economic dimensions as well as technical and financial ones. Among the institutional innovations that might be considered for moving toward sustainable energy systems in Indonesia are the following:

- Village cooperatives in rural areas (or possibly in urban kampungs) can supply small amounts of electricity. Even if none of the renewable energy options is available, local community-owned diesel generators may be more cost effective and more supportive of development goals than conventional rural electrification.
- The idea of energy extension services could be extended with the goal of helping communities and industries establish a sustainable energy base. Two specific options to consider are the assistance in the development of committed forest tracts, managed to provide a sustainable harvest for cooking fuel or for rural industry; and the assistance in improved methods for charcoal making with the goal of increasing both the returns to the charcoal maker and reducing the losses in wood.
- Although subsidies on petroleum products have been largely eliminated in Indonesia, they remain on electricity. Economists tend to be opposed to subsidies because of the inefficiencies they create, and, to the extent that they are intended to promote equity, because the benefits are too widely distributed. Nevertheless, the equity argument remains important. Small amounts of electricity are so useful that it is worth looking for possible compromises.

- One of the barriers to the use of many conservation or renewable energy techniques is higher initial cost. For productive enterprises that can earn a return on their investment, a capital pool could be established to loan money for purchase of, for example, open core gasifiers at rice mills, or improved charcoal kilns. For households, at least in rural areas, improved stoves might be provided free.

SOME CONVENTIONAL ENERGY OPTIONS

For a long time to come, Indonesia will be dependent on large volumes of nonrenewable energy supplied from centralized sources. Some key choices have been, and remain to be, made about such sources.

- Of all forms of energy, electricity is the most useful and the most costly — with high costs recorded both financially and environmentally. Therefore, electricity should be used only where its unique qualities are truly needed, and its use should be as efficient as possible. Nevertheless, more electricity is needed in Indonesia; in urban areas and for industry, much of that electricity will have to be centrally generated. Given the available alternatives, the existing policy to use coal as the main source of electricity seems sound.
- The liquid fuels used in transportation — today mainly gasoline and diesel oil — represent the other, common, high-quality form of energy. Although a number of renewable energy options have been promoted to supply transportation fuels (mainly as ethyl or methyl alcohol), Indonesia is so well supplied with fossil fuel resources that it seems sensible to look for less radical alternatives. Both propane and compressed natural gas (CNG) are good transportation fuels, and both have the further advantage of significantly reducing vehicle emissions. In addition, in metropolitan areas and on high-density rail lines, electrified transport can be considered.

INFLUENCING ENERGY POLICY

KLH has an opportunity to influence energy policy and thus reduce environmental impacts in Indonesia by using interdepartmental structures that already exist. However, those structures must be used fully and intensively. In many ways, it would be preferable for KLH to abstain from participation in energy policy than to participate weakly. Other agencies appear willing to listen to KLH's position in support of sustainable energy, but, if that position is not well supported, they may conclude that there is no case to be made. Therefore, it is assumed in the following that a decision has been made within KLH to make energy policy, and, in particular, the identification and promotion of sustainable energy options, a ministerial priority.

ADAPTATION OF THE ONE-KILOWATT STRATEGY

Most of the findings and conclusions put forward in this report can be reduced to a recommendation for the adoption of a demand-focused approach to energy known as the One-Kilowatt Strategy. This approach was derived by first and third world energy analysts on the basis of two pieces of information. The first demonstrated that, beyond one kilowatt of total energy capacity per capita (i.e., one kilowatt-year per year of all forms of energy averaged over the population), further improvements in life expectancy, educational levels, etc. were negligible. The second demonstrated that the high level of services in Western Europe (except for space heating) could be delivered for an average of one kilowatt per capita, provided that the most economically efficient methods available were used.

The One-Kilowatt Strategy is a major generalization applied across all countries. It would require considerable work to adapt this strategy for use in Indonesia. Nevertheless, for many reasons — not the least of them being environment and equity — the One-Kilowatt Strategy presents an attractive approach. It would offer a much lower level of energy use beyond 2010 than existing projections, and it would deliver more of that energy in sustainable forms. In many ways, the One-Kilowatt Strategy stems from what was called *soft-energy analysis*, an analytical approach which showed that industrialized countries were grossly inefficient in energy use, and that they could save money and avoid environmental damage by adopting techniques that had long been urged by environmentalists.

A sustainable energy policy in general, and the One-Kilowatt Strategy in particular, appear to be broadly consistent with Indonesia's national energy policy. Together, they offer a way to bring energy policy goals together with social and environmental goals, and at the same time ensure that Indonesia has enough energy for development. Industrial countries have almost totally separated economic growth from energy growth, and many of the newly industrialized countries are following in the same direction. The same results cannot be expected in developing countries, such as Indonesia, but it is apparent that, relative to current trends and projections, smaller and more sustainable energy systems are within reach.

RINGKASAN EKSEKUTIF

Laporan berikut ini merupakan suatu penelaahan awal mengenai pilihan-pilihan energi yang dapat memenuhi kebutuhan energi yang meningkat bagi Indonesia namun tetap menghindarkan kerusakan yang melampaui batas terhadap lingkungan. Lebih jauh lagi, diketahui bahwa perlindungan lingkungan merupakan bagian dari kebijaksanaan pembangunan berwawasan ekonomi; laporan ini menyajikan dukungan lebih lanjut bagi kesimpulan tersebut.

PENGERTIAN ENERGI BERLANJUT

Dari segi alamiah, energi terlibat pada tiap aspek pembangunan. Dengan demikian, tidaklah mengherankan apabila produksi energi, transportasi/transmisi serta pemanfaatannya mempunyai akibat yang besar terhadap lingkungan. Sesuatu tidak dapat dibahas tanpa memperhatikan yang lain, paling tidak, hal ini tidak dapat dilakukan, apabila biaya ekonomi tinggi dan penurunan yang berlebihan dari sumberdaya yang terbaharui maupun yang tak terbaharui tidak dihindarkan. Laporan ini menekankan pada 'energi yang berlanjut', yang didefinisikan sebagai:

- pemanfaatan sumberdaya energi terbaharui sedemikian rupa dengan maksud memelihara produktivitasnya selama mungkin;
- pemanfaatan sumberdaya energi tak terbaharui sedemikian rupa dengan maksud memperpanjang keberadaannnya dan memberikan kemungkinan (jangka panjang) akan suatu keadaan ekonomi energi terbaharui sepenuhnya; dan
- pemanfaatan kedua sumberdaya energi di atas dengan cara membatasi penurunan sumberdaya udara, tanah, air, dan genetik yang erat kaitannya dengan produksi dan pemanfaatan energi.

Dengan demikian, sebagaimana digunakan dalam laporan ini, secara serempak, istilah 'berlanjut' mengacu bagi energi maupun lingkungan.

REKOMENDASI UTAMA

Dengan kenyataan bahwa kebutuhan Indonesia akan energi komersial guna mencapai kualitas hidup yang lebih baik bagi masyarakat dan pembangunan industrinya; tidaklah masuk akal untuk menggugat bahwa Indonesia dapat beralih dengan cepat ke sistem energi berlanjut secara menyeluruh. Meskipun demikian, langkah-langkah penting dapat dilakukan guna menciptakan suatu sistem yang dapat dicapai di masa depan - mungkin setelah tahun 2010. Sebenarnya, apabila langkah-langkah tersebut tidak dilakukan, Indonesia akan lebih lambat mencapai tingkat sustainabilitas di masa depan dibandingkan saat ini, yang berarti bahwa hutang-hutang ekonomi serta ekologis akan terus bertumpuk.

Karena beberapa alasan, termasuk biaya yang meningkat dan ketidak-tentuan kebijaksanaan energi konvensional, perhatian terhadap pilihan-pilihan energi yang berlanjut tumbuh di Indonesia. Bagaimanapun, sampai saat ini, tidak ada suatu lembaga resmi yang tampil guna memelopori dan memberikan arti bagi gagasan-gagasan ini. Sehingga, KLH memiliki peluang untuk bersuara lantang di kalangan Pemerintah Indonesia dalam mendukung energi berlanjut. Bagaimanapun, untuk mengisi peran tersebut, KLH harus menciptakan suatu tanggung jawab yang tegas dan terus menerus dari stafnya serta anggaran untuk masalah-masalah energi.

Laporan ini menekankan pada energi yang diproduksi dan digunakan di Indonesia (Energi yang diproduksi untuk ekspor lebih sesuai diperlakukan sebagai komoditas, sebagai suatu hal yang penting). Lebih jauh, laporan menekankan akan peran kebutuhan energi. Hal ini ditekankan kembali di kesimpulan dengan suatu bagian dalam hal adaptasi Strategi Satu-Kilowatt bagi Indonesia.

KEBIJAKSANAAN ENERGI BERLANJUT

Dalam pergerakan ke arah kebijaksanaan energi berlanjut bagi Indonesia, dua langkah konseptual yang mendasar harus dilakukan. Pertama, adalah mengetahui bahwa pemanfaatan energi domestik tidak dapat selamanya meningkat. Cepat atau lambat akan ada batas yang tumbuh karena kurangnya cadangan, pertimbangan lingkungan atau persyaratan finansial. Langkah konseptual kedua, mengetahui bahwa, selain peran dasar di bidang fisik dan ekonomi, energi tidak demikian saja dibutuhkan, tetapi dari segi pelayanannya. Sejauh kita dapat memperoleh pelayanan yang lebih efisien - baik dengan mengurangi kuantitas (jumlah) energi yang diperlukan bagi suatu pelayanan atau dengan memastikan bahwa energi tersebut diberikan sesuai dengan kualitas (mutu) yang sesuai dengan pelayanannya - pembangunan akan berkembang. Lebih jauh, hal yang sama yang menuju ke arah efisiensi akan mempunyai dua keuntungan tambahan:

- Akibat yang merugikan terhadap lingkungan dapat dikurangi karena energi yang diperlukan lebih sedikit dan jenis energi yang diperlukan cenderung ke arah yang tidak begitu merusak.
- Peluang kerja akan meningkat dan persyaratan modal berkurang dibandingkan dengan sistem yang kurang efisien, dalam hal mana energi harus dipasok guna mendapat pelayanan yang sama.

Tidak adanya perhatian yang sama terhadap efisiensi energi, masa depan energi berlanjut tidak akan tercapai. Dalam pendekatan konseptual ini, ada langkah-langkah spesifik yang dapat dilakukan saat ini untuk maju ke masa depan energi berlanjut. Sampai tahap tertentu, langkah ini bertolak belakang antara daerah perkotaan dan pedesaan di Indonesia.

- Di perkotaan, terdapat peluang besar penghematan pemanfaatan energi namun hanya dalam bentuk sederhana bagi pembangunan terdesentralisasi, sumberdaya energi terbaharui.
- Di pedesaan, terdapat peluang besar bagi pembangunan terdesentralisasi, sumberdaya energi terbaharui, namun hanya dalam bentuk sederhana bagi penghematan pemanfaatan energi.

Sebagai tambahan, perhatian harus diberikan pada beberapa pilihan besar dalam kebijaksanaan energi konvensional dan bagi cara-cara inovatif guna mendukung penggunaan teknik-teknik energi berlanjut tersebut secara meluas yang terbukti menarik dan ekonomis.

PEMBAHARUAN-PEMBAHARUAN DI BIDANG KELEMBAGAAN

Ahli-ahli energi sudah lama menyadari tentang adanya alternatif-alternatif pemasokan dan kebutuhan yang efektif dari segi biaya dan secara teknis unggul dibandingkan yang sekarang umum digunakan, namun tidak diadopsi secara luas. Sudah jelas, pilihan-pilihan di bidang energi mempunyai dimensi sosial-budaya dan sosial-ekonomi sebagaimana halnya dimensi teknis dan finansial. Diantara pembaharuan-pembaharuan kelembagaan yang dapat dipertimbangkan untuk bergerak ke arah sistem energi berlanjut di Indonesia, adalah:

- Koperasi-koperasi desa di daerah pedesaan (atau mungkin kampung di perkotaan) dapat memasok sejumlah kecil tenaga listrik. Bahkan apabila pilihan energi terbaharui tidak memungkinkan, generator-generator diesel milik masyarakat setempat dapat lebih efektif dari segi biaya dan bersifat lebih mendukung tujuan pembangunan dibandingkan listrik pedesaan konvensional.
- Gagasan perluasan pelayanan energi dapat diperluas dengan tujuan membantu masyarakat dan industri-industri dalam memantapkan suatu dasar energi berlanjut. Dua pilihan spesifik untuk pertimbangan adalah bantuan pembangunan di bidang kehutanan, dikelola guna memperoleh suatu hasil hutan berkesinambungan untuk keperluan kayu bakar atau industri pedesaan; dan bantuan dalam metoda pembuatan arang kayu yang telah disempurnakan dengan tujuan peningkatan baik pengembalian modal bagi pembuat arang kayu maupun pengurangan kehilangan kayu.
- Walaupun subsidi produk minyak bumi di Indonesia sudah sangat dikurangi, subsidi ini masih tetap bagi tenaga listrik. Ahli-ahli ekonomi cenderung menentang subsidi karena ke-tidak-efisien-an yang muncul, dan, sampai sejauh dimaksudkan untuk mendukung keadilan, karena keuntungannya didistribusikan terlalu luas. Namun demikian, alasan keadilan masih tetap penting. Sejumlah kecil tenaga listrik sangat berguna dalam pengertian pantas guna mencari persetujuan yang mungkin dicapai.
- Salah satu penghalang terhadap penggunaan berbagai teknik konservasi atau teknik energi terbaharui, adalah biaya awal yang lebih tinggi. Bagi perusahaan yang produktif yang dapat memperoleh suatu pengembalian atas investasinya, modal yang terkumpul dapat dianggarkan untuk meminjam uang bagi pembelian misalnya ***open core gasifiers*** di penggilingan-penggilingan beras, atau tungku arang kayu yang telah disempurnakan. Bagi rumah tangga, paling tidak di pedesaan, kompor yang telah disempurnakan mungkin dapat diberikan secara cuma-cuma.

BEBERAPA PILIHAN ENERGI KONVENSIONAL

Untuk masa mendatang, Indonesia akan tergantung pada pasokan energi yang tak terbaharui dalam jumlah besar dari sumberdaya yang tersentralisasi. Beberapa pilihan kunci akan sumberdaya-sumberdaya demikian, telah dan masih akan dibuat.

- Dari semua bentuk energi, tenaga listrik merupakan energi yang paling bermanfaat dan paling mahal - tercatat mahal dari segi finansial dan lingkungan. Dengan demikian, tenaga listrik harus dimanfaatkan apabila keunikannya benar-benar diperlukan, dan pemanfaatannya seefisien mungkin. Namun, lebih banyak tenaga listrik diperlukan di Indonesia; di perkotaan dan bagi industri, kebanyakan tenaga listrik tersebut masih harus dibangkitkan secara terpusat. Dengan alternatif-alternatif yang tersedia, tampaknya kebijaksanaan masih terletak pada pemanfaatan batubara sebagai sumberdaya utama tenaga listrik.
- Bahan bakar cair yang digunakan pada transportasi - saat ini terutama bensin dan minyak diesel - mewakili yang lain, merupakan bentuk energi yang umum dengan kualitas tinggi. Walaupun sejumlah pilihan energi terbaharui telah dipromosikan guna memasok bahan bakar transportasi (terutama seperti halnya ethyl atau methyl alcohol), Indonesia sangat baik dipasok oleh sumberdaya bahan bakar fossil sehingga masuk akal untuk memperhatikan alternatif-alternatif yang tediak begitu radikal. Baik propana dan gas alam bertekanan (compressed natural gas; CNG) merupakan bahan bakar transportasi yang baik, dan keduanya mempunyai kelebihan lebih lanjut dalam hal pengurangan emisi kendaraan yang cukup berarti. Sebagai tambahan, di daerah metropolitan dan di jalur-jalur kereta api yang padat, bentuk transportasi bertenaga listrik dapat dipertimbangkan.

MEMPENGARUHI KEBIJAKSANAAN DI BIDANG ENERGI

KLH mempunyai peluang untuk mempengaruhi kebijaksanaan di bidang energi sehingga mengurangi dampak-dampak lingkungan di Indonesia dengan memanfaatkan struktur-struktur antar departemen yang ada. Bagaimanapun, struktur tersebut harus dimanfaatkan secara penuh dan intensif. Dalam banyak hal, lebih baik bagi KLH untuk bersikap tidak memihak (abstain) dari keperansertaan dalam kebijaksanaan di bidang energi daripada berperanserta secara lemah. Lembaga lain tampaknya mau mendengarkan kedudukan KLH dalam mendukung energi berlanjut, tetapi, apabila kedudukan tersebut tidak didukung dengan baik, mereka dapat menyimpulkan bahwa tidak ada kasus yang perlu dipermasalahkan. Sehingga, diasumsikan sebagai berikut, bahwa satu keputusan telah dibuat di lingkungan KLH guna menciptakan kebijaksanaan di bidang energi, dan khususnya, satu prioritas tingkat menteri dalam identifikasi dan promosi pilihan energi berlanjut.

PENYESUAIAN STRATEGI SATU-KILOWATT

Sebagian besar hasil temuan dan kesimpulan dalam laporan ini dapat diringkaskan menjadi satu rekomendasi dari pemakaian pendekatan yang menitikberatkan kebutuhan energi yang dikenal sebagai Strategi Satu-Kilowatt. Pendekatan ini diambil oleh analis-analis energi dunia pertama dan ketiga berdasarkan dua bentuk informasi. Yang pertama, menunjukkan bahwa diluar satu kilowatt dari keseluruhan kapasitas energi per kapita (yaitu satu kilowatt-tahun per tahun dari semua bentuk energi dirata-ratakan atas jumlah penduduk), perbaikan dalam harapan hidup, tingkat pendidikan, dan sebagainya, tidak berarti. Kedua, menunjukkan bahwa tingginya pelayanan di Eropa Barat (kecuali pemanas ruangan) dapat dilayani dengan rata-rata satu kilowatt per kapita, asal metoda yang digunakan paling efisien secara ekonomi.

Strategi Satu-Kilowatt merupakan suatu hal yang umum diterapkan di semua negara. Hal ini memerlukan pekerjaan yang cukup berarti guna mengadaptasikan strategi ini untuk digunakan di Indonesia. Namun, untuk banyak alasan - bukan hanya karena alasan lingkungan dan keadilan - Strategi Satu-Kilowatt menyajikan suatu pendekatan yang menarik. Strategi ini menawarkan tingkat pemanfaatan energi yang jauh lebih rendah di masa setelah tahun 2010 dibandingkan proyeksi saat ini, dan ini akan memberikan lebih dari pada sekedar energi dalam bentuk yang berlanjut. Dalam banyak hal, Strategi Satu-Kilowatt berpokok dari apa yang dikenal sebagai analisis energi-lunak (soft-energy analysis), suatu pendekatan analitis yang menggambarkan bahwa negara-negara industri sangat tidak efisien dalam pemanfaatan energi, dan bahwa mereka dapat menghemat uang dan menghindarkan kerusakan lingkungan dengan mengadopsi teknik-teknik yang sudah lama dikemukakan oleh environmentalis.

Secara umum, kebijaksanaan energi berlanjut, dan Strategi Satu-Kilowatt khususnya, tampaknya secara luas akan sejalan dengan kebijaksanaan energi nasional Indonesia. Serempak, mereka menawarkan suatu cara bagi tujuan kebijaksanaan energi, seiring dengan tujuan sosial dan lingkunga, dan pada saat yang bersamaan, menjamin bahwa Indonesia mempunyai cukup energi untuk keperluan pembangunan. Perkembangan ekonomi negara-negara industri hampir seluruhnya terpisah dari perkembangan energi, dan banyak di antara negara-negara industri baru mengikuti arah yang sama. Hal yang sama tidak akan diharapkan di negara yang sedang berkembang seperti Indonesia, namun tampaknya, secara relatif, dibandingkan dengan kecenderungan yang sedang berlangsung dan proyeksinya, sistem energi yang lebih kecil dan lebih berlanjut berada dalam jangkauan.

1. INTRODUCTION AND PURPOSE

This report provides an assessment of opportunities for Indonesia to move toward longer term and more environmentally sensitive (more 'sustainable'; see Sub-section 2.2) energy policies. The work was undertaken as part of the Environmental Management Development in Indonesia (EMDI) Project, which is headquartered at the School of Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia, Canada, but which operates mainly from the offices of the Indonesian Ministry of State for Population and Environment (KLH). EMDI contracted with Marbek Resource Consultants of Ottawa, Canada, for the services of the principal investigator. The work required approximately three person-months of time and took place mainly during late 1986. About two-thirds of the time was spent working out of EMDI's Indonesian office, which is housed with KLH in Jakarta. Terms of Reference appear as Appendix A.

1.1 ORGANIZATION OF THE REPORT

The report is organized in five sections:

1. Introduction and Purpose
2. Sustainable Energy Policies
3. Sustainable Energy for Indonesia
4. Expanding the Role for KLH in Energy Policy
5. Findings and Conclusions

Readers who have had previous contact with the work may wish to skip Sections 1 and 2 in order to proceed directly to Sections 3 and 4. Appendices cover methodological points plus field trip, interviews, and workshop notes.

1.2 DEFINITION OF SUSTAINABLE ENERGY

In recent years the term 'sustainable development' has come into common usage. While difficult to define precisely, a useful focus was offered by the Global Tomorrow Coalition in its submission to the World Commission on Environment and Development (The Brundtland Commission) in May of 1986 in Ottawa:

> ...sustainable development is a process of change to meet the needs of people, as defined by them, without lessening potential for meeting their future needs, the needs of other societies, or those of future generations.

When the concept is narrowed specifically to energy, at least the following three principles would appear to be involved:

a. Where a reasonable option exists, renewable energy sources should be favoured over nonrenewable.
b. Land, air, water and genetic resources affected by the production, movement or use of energy (whether renewable or nonrenewable) must be protected.
c. The development process for which the energy is consumed must itself be sustainable.

Rather little will be said in this report about point "c", but points "a" and "b" are explicitly included; that is, whenever the term 'sustainable energy' is used, both energy and the environment are included.

1.3 GENERAL PURPOSE

The main purpose of the work described below is to contribute to the development of an environmentally sensitive energy policy for Indonesia. While environmental considerations have not been entirely absent from energy policy formulation in Indonesia, neither have they played a strong role. Similarly, despite their importance for jointly serving both environmental and economic goals, energy demand management and conservation have received considerably less attention than supply management and the substitution of coal for oil.

The proposed emphasis on environment comes at a dynamic time for the Indonesian energy economy. Domestic energy consumption within Indonesia is rising rapidly, and shifting from traditional to commercial fuels. However, revenues from petroleum exports are falling, and recognition is growing of the high monetary and environmental costs of rapid rates of energy growth. Clearly, the time is opportune for KLH to increase its role in energy policy formulation, provided it has the capabilities to do so — capabilities that are related mainly to the analysis of energy options and to the development of institutional linkages. The general purpose of the work, therefore, includes assistance in establishing these capabilities at KLH.

1.4 SPECIFIC OBJECTIVES AND SOURCES

The range of work undertaken for this study can be divided into three components:

- sustainable energy analysis
- roles for KLH in energy policy
- special assistance to the Minister

This report covers the first two components, which are described in detail below. Related to all three components, but worth noting, was the convening of a 1-1/2 day workshop on energy and the environment, by KLH on 26-29 November, 1986. The workshop chaired by Minister Salim (and, in his absence, Asmen-2, Dr. Soeriaatmadja) drew about 50 participants from departments and agencies throughout the Government of Indonesia. Specific points raised at the workshop are incorporated throughout this report.

1.4.1 SUSTAINABLE ENERGY ANALYSIS

This part of the work involved identification of a reasonable range for energy demand in Indonesia over the period 1985 to 2010, assuming that:

- end-use requirements were satisfied by the most cost-effective technologies, evaluated at long-run marginal costs for energy;
- environmental and social effects were fully included in the costing.

As explained below, the focus on energy demand is critical to both the development of efficient energy policies and the incorporation of environmental concerns. It is also critical to the backcasting methods that have proven so useful in analysis of energy policy in industrialized countries. Fortunately, some demand analysis has already been undertaken for Indonesia, including both end-use based projections and surveys of specific rural and urban energy uses. While not true backcasting, this material did provide substantial background information.

The need to identify a range for demand resulted in a series of written notes (see Appendix B) and the analysis presented in Section 4. To a considerable degree, this work leaned on the approach developed by Goldemberg, Johansson, Reddy and Williams, as described in articles and elaborated in the draft of a forthcoming book, *Energy for a Sustainable World*. It was supported by library research on Indonesian energy policy and a set of as-yet-unpublished review articles on energy supply and demand options for developing countries, prepared for Canada's International Development Research Centre. Once in Indonesia, the analysis was continued by means of meetings, interviews and site visits that are listed in Appendix B. In addition, the workshop provided significant inputs to the final analysis.

1.4.2 POTENTIAL ROLES FOR KLH

Apart from the management of specific supply operations, energy policy in Indonesia is subject to cooperative and perhaps even consensus decision making (see Appendix D). While centering in the Department of Mining and Energy, interdepartmental committees exist at both the ministerial and director-general levels. Because of the pressure of other work and severe understaffing, KLH has been unable to participate very effectively in the work of these committees. Identifying ways to deal with this institutional gap formed the second major part of the project.

In addition to direct participation in policy making, KLH has options for becoming more active in energy issues by joint research projects in Indonesia, by work with international agencies or other national governments, and by links to groups in the private sector and nongovernmental organizations. Review of some of these options was also incorporated into this part of the activity.

Study of the structure of Indonesian energy policy making was essentially inductive and, therefore, for the most part was undertaken on site and as part of other activities. The principal sources of information comprised meetings and interviews (Appendix B), plus the workshop. Indeed, the workshop can be seen as KLH's first assertion of its intention to play a more active role in energy policy, which in turn makes the timely definition of that role imperative.

2. SUSTAINABLE ENERGY POLICIES

2.1 ORIGINS OF SEP

Originally called the 'soft energy path' (and still commonly abbreviated as SEP), the concept of sustainable energy began developing about 1975, largely through the pioneering work of Amory Lovins, an American physicist employed by Friends of the Earth.[1] Sustainable energy combines elements of philosophy, politics and practical technology, but it is best seen as an approach to energy policy that seeks to combine energy efficiency with social and environmental goals plus, over the long term, a shift to a fully renewable energy system.

2.2 PRINCIPAL CHARACTERISTICS OF SEP

Sustainable energy analysis differs from the conventional approach in four principal ways:

2.2.1 DEMAND RATHER THAN SUPPLY FOCUS

SEP begins from the position that no one wants energy *per se*. The need for energy stems from a demand for a relatively small number of final services. Most fundamentally, these can be defined as heat, light, circular motion, horizontal motion, etc.; more practically, they

[1] See notably Lovins, A.B. (1977). *Soft Energy Paths: Towards a Durable Peace.* (Cambridge, MA: Balinger/Friends of the Earth).

can be defined as warmth, cooking, industrial process heat (at various temperatures), transportation of goods, transportation of people, etc. Therefore, energy policy should focus first on the demands for services, and then on the derived demands for energy. It should *not* begin with supply. Indeed, to the extent we can provide final services with fewer inputs (including energy), we will be better off.

2.2.2 EMPHASIS ON ENERGY QUALITY AS WELL AS QUANTITY

Energy efficiency involves both the first and the second laws of thermo-dynamics. A focus on energy quantity, as measured in statistical tables, implies (appropriately) maximizing output for given input, or alternatively, minimizing input for given output. However, efficiency also requires that entropy losses be limited, and this means conserving the quality (or ability to do work) of any unit of energy. For example, energy at 100°C is of greater value (i.e., can do more work) than the same amount of energy at 20°C. Energy quality can most commonly be conserved by:

- minimizing the conversions from one form to another;
- providing energy of a quality appropriate to the end-use task.

In SEP jargon, this is referred to as matching energy quality between supply and demand; in Indonesian energy policy, it is called 'indexation'.

2.2.3 USE OF BACKCASTING RATHER THAN FORECASTING

In forecasting or projection, one goes from the present to the future, which inevitably builds in a conservative bias in the sense of assuming characteristics of the energy system that may need to be changed; for example inefficiency in the use of energy. In backcasting, one starts by defining the desirable characteristics of the final energy system before determining ways of getting from existing state to the preferable one. Thus, whereas forecasting must assume policies, backcasting derives policies. This approach essentially avoids the necessity for "being right" in forecasting; in fact, it is based on the concept that, to a considerable degree, energy results are policy determined rather than policy determining.

2.2.4 EXPLICIT CONCERN FOR THE ENVIRONMENT

Conventional energy policy need not ignore environmental effects, but, with a sustainable policy, protection of the environment plays a primary role. Lower demands and attention to energy quality will themselves aid in achieving environmental goals, as will efforts to diversify supply sources and avoid very large-scale projects. However, use of nonrenewable resources for some time into the future is not incompatible with a sustainable energy policy, nor can it be assumed that use of renewable resources is inherently less damaging to the environment. While in the long run — say, 100 years from now — the world must adopt a largely renewable energy base, the question of sustainability today is more one of ensuring that land, air, water and genetic resources are not damaged by energy extraction, conversion or use patterns, regardless of whether they are based on renewable or nonrenewable sources.

2.3 EXAMPLES OF THE APPLICATION OF EACH CHARACTERISTIC

2.3.1 DEMAND FOCUS

Assume that the final desired energy service is cooling. A building can be cooled with a variety of techniques ranging from shading of windows, use of fans, and careful siting and design to the complete heating-ventilating-air conditioning systems typical of urban highrise buildings. In recent years the energy required for cooling has fallen by a factor of five to ten in cold climates and by two to three in tropical ones. One does not have to go outside Indonesia to find some good examples of major gains in end-use efficiency. P.T. Goodyear Indonesia reduced energy use by more than 55% per tire between 1975 and 1981. In some cases, the gains in efficiency are essentially free, either because they involve little more than good management practices or because the capital cost for conservation is offset by lower capital required for the energy system. In most cases, there will be tradeoffs; for example, say between added capital or labour and lower energy, or — in a very few cases — between improved energy efficiency and environmental quality.

2.3.2 ENERGY QUALITY

Electricity is a high-quality form of energy, capable of doing almost any kind of work, which is why it is acceptable to sacrifice (lose) two units of coal or oil as waste heat for every one obtained as electricity; i.e., the Carnot cycle. It is thermodynamically inefficient, and generally economically inefficient as well, to use electricity for simple tasks such as heating water. Similarly, having generated electricity by thermal means, it is inefficient not to find uses for the waste heat, by any of a variety of combined cycles or waste heat recovery methods. In much the same way, priority for use of dense, generally liquid, fuels must go to transportation — except that relatively small quantities will be required as non-energy inputs for the production of petrochemicals, fertilizer, etc.

2.3.3 BACKCASTING FOR INDONESIA

Backcasting in the development of energy policy for Indonesia requires the explicit definition of goals. Clearly, this is something that should occur within the context of priority setting and policy determination within Indonesia. However, for purposes of discussion, a partial list can be prepared of the kinds of goals that might be considered. They are divided into two groups, general goals that would apply to any country, and specific goals applicable to Indonesia between now and 2010. They are listed in no particular order, and those related to sustainability of the environment are incorporated with other goals. To repeat, the goals should be seen as options to consider, not as definitive or complete proposals.

General Goals (any country)

a. Encourage diversity in supply systems by keeping reliance on any one source to no more than 30%.
b. Treat the options for conserving energy as equivalent in every way to those for supplying energy.
c. Minimize costs over life cycle of each energy end use, including conservation as one of the options for "supplying energy".
d. Emphasize energy systems that incorporate more domestic materials and labour, and that transfer skills to Indonesia.
e. Include the costs of environmental disruption in the costs of production.
f. Where environmental damage cannot be avoided, install appropriate mitigating or compensation measures, with the cost again included in the costs of production.
g. Adjust practices in the harvest of renewable resources to ensure that all are produced and consumed on a sustainable basis.

Specific Goals (Applicable to Indonesia by 2010)

a. Ensure that, within the next 15 to 25 years, a basic one kilowatt of energy services is available to every person, with about 25% of that energy as electricity. (These figures reflect the conclusions of an international panel of energy experts as the minimum amount of energy capacity that is required for an adequate quality of life.)

b. The efficiency of the auto/light truck fleet reaches an average of 6 litres/100 km, with import controls in place to keep the efficiency of major electrical appliances close to the state of the art.
c. Industrial plants operate at efficiency levels in the upper third of world averages.
d. All villages have electricity with most supplied by local sources and 10% supplied by photovoltaic systems.
e. No use of high-sulphur coal, and uses found for ash at coal-fired generators.
f. Full reclamation of coal mining areas to productive (or ecologically appropriate) uses.
g. Up to 70% of the available supply of rice husks used as an energy source.
h. Any rural industry in the heavily populated islands that uses more than 500 GJ of energy per year (approximately 85 BOE) shifts from fuelwood to other energy sources.
i. Forest and wood products industry has become self-sufficient in energy (except liquid fuels for mobile equipment) by use of own waste products.
j. All metropolitan areas have established energy-from- waste systems.
k. Wide distribution of more efficient end-use devices (particularly stoves) and small-scale conversion devices (notably charcoal kilns).

2.4 RESULTS OF SEP STUDIES

Many SEP studies have now been completed on national, regional, and interregional bases. However, to date most such studies have been done in the industrialized countries, and experience is still limited with their application to developing countries.

2.4.1 INDUSTRIAL COUNTRIES

Invariably, in industrial countries SEP studies show that (in comparison with conventional studies):

- significantly lower levels of demand are possible;
- efficiency in energy use and delivery can be greatly improved;
- a much wider range of sources is available;
- a higher potential for renewable sources is identified.

The combination of the foregoing forces reduces both economic costs and environmental damage. Also, the labour content of final services is higher, and capital requirements reduced. The result is a lower cost, lower risk, more stable and environmentally safer energy future; in short, a more sustainable energy future.

2.4.2 DEVELOPING COUNTRIES

Identical results will not necessarily be found in developing countries because:

- additional energy is generally needed to satisfy basic demands;
- the proportion of nonrenewable sources in the fuel mix will probably increase, at least for a while, as more efficient ways to use woodfuel are introduced and people continue to shift away from traditional fuels.

The opportunities to separate economic growth and energy growth are not, therefore, so strong in developing countries as in industrialized ones. However, they are still present. Energy trends similar to those in developed countries (i.e., less demand and more diverse supply than shown by conventional studies) are likely to appear, and so are higher employment/lower capital options. Thus, the goal of a lower cost, lower risk, more stable and environmentally safer energy future is attainable in developing countries, just as, and perhaps more easily than, in industrialized countries.

3. SUSTAINABLE ENERGY FOR INDONESIA

The energy situation in Indonesia presents a strange contrast: on the one hand, the nation is significantly below other nations in its use of energy; on the other hand, the nation is already one of the major exporters of petroleum fuels and may become an exporter of coal. Elaborated slightly, the two facts make an even greater contrast: on the one hand, at present Indonesia does not provide enough energy for an adequate quality of life for its people or for a rising standard of living from its industries; on the other hand, the nation is remarkably well endowed with energy resources, including oil, natural gas, peat, and coal reserves, hydro-electric and geothermal sites, and huge unused volumes of agricultural and forest industry residues. The contrasting facts have an important implication, for, in its commendable attempt to make more energy available, Indonesia is encountering serious environmental problems — some related to the supply of energy and some to its consumption.

3.1 CURRENT PATTERNS OF ENERGY DEMAND

That Indonesia needs more energy for domestic use is undeniable. Annual per capita consumption is in the order of 13 Gigajoules (2.2 BOE) with roughly half of that being traditional fuels (mainly wood). Measured per unit of GNP, consumption is approximately 28 Terajoules. Per capita consumption in Indonesia is a little below levels in comparable ASEAN countries; consumption per unit of GNP is about 50% above them. However, when one turns to electricity, the picture is quite different. Annual per capita electrical consumption is only about 360 Megajoules (100 kWh), and per dollar of GNP it is little more than 720 (200 kWh). These figures are among the lowest for any developing country — four to six times below electricity use in Thailand and the Philippines. The figures for Indonesia include non-PLN (National Electricity Board) production, which represents nearly half the total. The variations within Indonesia are also large; perhaps five times as much electricity is used per capita on Java as on the Lesser Sunda Islands. However, strenuous efforts are being made to expand electrical capacity, and the PLN system has expanded by a factor of about five since 1970.

During the decade of the 1970s, use of modern fuels grew rapidly and rates of over 12% per year were reported. To a considerable degree, that growth was driven by industrial development and by the demands of the growing urban population. However, it was also driven in part by the efforts of the Indonesian government to bring electricity to rural villages and to substitute petroleum fuels (mainly kerosene) for fuelwood in cooking and lighting. This policy proved to be expensive, and, with declining oil revenues putting a strain on the national budget, petroleum product (but not electricity) subsidies were discontinued. In recent years, growth in use of modern fuels has been slower, and some households have returned to using traditional fuels.

Details of energy use have been investigated in some sectors. Useful surveys have been conducted among rural households in western Java and urban households in 11 large cities (nine on Java plus Medan and Ujung Pandang). The Ministry of Industry keeps records of energy use per tonne of output for major products. However, for purposes of comparison, it is preferable to use the broad energy balances developed by the International Energy Agency. These balances show that, relative to other developing countries, Indonesia devotes a smaller share of its energy to industry, a much smaller share to transport and to electrical generation, but a larger share to the households and services sector. However, Indonesia is toward the low end of the range for energy used per unit of industrial output, which implies a reasonably efficient industrial sector. This is confirmed by a comparison of figures for a few subsectors in Indonesia with those from other countries.

3.2 RATIONALE FOR THE FOCUS ON DEMAND

As indicated in Sub-section 3.1, the demand for energy is a derived demand. It arises from the demand for certain services and, therefore, to the extent that those services can be provided with less energy, costs will be reduced, society will be more efficient, and development will be supported. However, is there any opportunity to save energy in a society such as Indonesia? Certainly industrialized countries can save far more energy than developing countries, but that does not mean that conservation opportunities are lacking in the latter. For one thing, a part of the population has energy consumption habits similar to those in richer countries. For another, people dependent upon traditional fuels typically consume them in highly inefficient end-use devices. For example, the person using a wick in a kerosene lantern uses as much energy as someone with an incandescent bulb, but gets only 1% as much light. As a result, rural households consume 60% more energy than urban. Also, cost-effective opportunities to save energy exist in almost every industrial and commercial sector. Finally, in some sectors developing countries are less efficient than industrial. Maintenance of the road vehicle fleet is notably worse, and few hotels in the North could afford the waste typical of many built in warmer climates.

Despite a potential for greater efficiency, the fact that Indonesia is so short of energy for its people and for development might lead one to conclude that the focus of sustainable energy analysis should be exclusively on supply. However, environmental impacts are highly sensitive to the overall level of energy demand and also to the specific forms and ways in which energy is used. Moreover, demand analysis is, ironically, more useful in identifying energy policy alternatives than is supply analysis. Maurice Levy, Director of the Energy Program at United Nations University, stated the situation most succinctly: "In developing countries... the management of demand is the overriding factor of a coherent energy plan". The point is worth elaborating:

a. Energy supply should conceptually and practically be responsive to demand, not the other way around. Apart from exports, the only reason for accepting the social and environmental disruption caused by energy supply systems is to satisfy demand. In the case of Indonesia, and other developing countries, where some demands remain unsatisfied, it is even more essential to analyze demand so as to establish priorities in supply.
b. Across all income classes within a nation, and among nations of all income levels, large opportunities exist to improve energy efficiency. Careful analysis of demand is required to identify the energy conservation opportunities. In the absence of this information, too much energy or the wrong kind of energy is likely to be provided, and, more important, appropriate government program and policy options may be ignored.
c. The level and character of energy demand, and the resulting supply, have major environmental implications. For example, growing use of private automobiles in Indonesian cities is creating environmental problems; better urban public transportation could simultaneously save energy and improve the environment. Wood smoke in homes can be a serious health hazard, particularly for women. Alternative fuels and more efficient cooking devices offer ways to save energy and to improve the inside environment. In almost every case, saving energy will yield environmental benefits, but the specific options need to be identified.

d. Many of the most serious energy-related environmental threats originate with the generation of electricity and, particularly, with central generation for a grid. Analysis of the nature and location of energy demand will indicate what proportion of that demand can best be supplied by electrical sources, and of that electricity what proportion can best be supplied by a grid. In most cases, both are below the amounts seen as necessary by electrical planners.

e. Much of the energy demand in Indonesia will not be an effective demand. In other words, consumers cannot afford to pay for it. However, market values are not sacrosanct, and the government could choose to satisfy demands for basic services before others, or to provide energy for industries deemed critical to development.

f. Finally, energy/environmental policy in Indonesia is looking ahead, well beyond Repelita V. Typical energy projections now extend to 2000 or 2010. In long-term planning, it is essential to know whether the curve showing energy use over time is still growing rapidly or is flattening toward the end of the projection period, and, equally important, what government policies would contribute to a flattening. Indeed, this is true not merely for energy demand in general but also for each quality of energy. For example, if total demands are stabilizing, but electrical demands continue to grow, the environmental implications will be serious.

In summary, it is only by reviewing and analyzing energy demands that one learns what options Indonesia has to create a sustainable energy system. Energy supply must respond to a joint demand for adequate energy and for environmental protection.

3.3 CONVENTIONAL PROJECTIONS OF ENERGY USE

Over the past decade, a variety of attempts have been made to project future energy consumption by the consuming sector and by fuel. Table 3.1 provides a comparison of four pairs of econometric projections for energy use in the year 2000 in Indonesia. Each projection was undertaken by a different group, or individual, at some time over the past five years, and each was done using a different basis, a different base year, and even different conversion factors. In order to permit easy comparison, all four projections were adjusted to a base year of 1980 and growth expressed as a ratio with year 1980 set equal to 100 for each cell in the table. By this approach, each projection remains internally consistent, though differences among them remain as to basic assumptions and methodological detail. However, all four use econometrics as the main method, and three of the four are exclusively top-down models; the PTE projections do begin with end uses but the driving force is still macroeconomic and population growth rather than policy goals. For PTE and LIPI, differences between the paired projections stem from different assumptions about growth variables; for Ang and the World Bank, the lower of the two projections assumes added policy measures, for example, to promote conservation of energy or substitution of coal for oil.

If these four forecasts can be taken as a reflection of energy thinking in Indonesia, it would appear that expectations for energy growth have become steadily and significantly more modest over the past five or six years. Today's "high" forecasts are typically below older "low" forecasts. Presumably this shift in thinking reflects, mainly, the decline in oil prices, and thus lowers expectations for economic growth in Indonesia, but it also probably reflects greater awareness of the potential for conservation and for the use of "new", mainly local renewable, energy sources. Energy use per dollar of GNP fell by nearly a fifth in western industrialized countries in the first decade after the energy crisis, and the same trends have begun to affect developing countries as well. Except for the World Bank high scenario, all of the results are well below two scenarios put forward by BATAN two years ago using a method developed by the International Atomic Energy Agency.

While differing with respect to total consumption, the projections are reasonably consistent with respect to use by sector and by form. All anticipate the greatest relative energy growth from the industrial sector and from energy used in the form of electricity. The two that include traditional forms of energy suggest that use of biomass can be held stable, or even reduced slightly. Domestic petroleum use, even in the latest forecasts, is expected to triple or quadruple in use over the next two decades. Although this rate of growth is substantial, it would still permit large exports, whereas earlier projections showed domestic petroleum use completely absorbing the export surplus.

In some respects, the forecasts differ. The two most recent ones project, respectively, 50% and 500% growth for the households sector. Because of the small base of consumption in 1980, coal and natural gas forecasts tend to differ widely, but even with these sources a trend to slower growth is indicated.

Overall, depending upon the projection, total energy use in Indonesia is predicted to go up by a factor of two to five, and total commercial energy use by a factor of three to seven, between 1980 and 2000. However, world trends toward higher energy efficiency and toward the decoupling of economic and energy growth suggest that the recent PTE projections will prove to be more useful than the others shown in Table 3.1.

3.4 AN ALTERNATIVE VIEW OF FUTURE ENERGY DEMAND

There are at least two methods for looking at future energy requirements that differ in concept from the projection approach. The first, based on end-use analysis and backcasting, as described in Subsections 2.2 and 2.3, has been used successfully in many industrial countries, and in a few developing countries. However, the method requires a large base of information, including country-specific and even region-specific patterns of energy use. It also requires some agreement about appropriate goals for energy policy; for example, which sources are, and which are not, environmentally acceptable. Hence, it was decided not to attempt such an analysis during this activity.

Appendix C describes an alternative approach to determining appropriate levels of energy based on a highly generalized goal of providing one kilowatt of total energy capacity per capita; that is, one kilowatt-year per year of all forms of energy for all uses. The energy services which the one kilowatt of capacity provides are delivered by the most economically efficient end-use and conversion technologies available, so the one kilowatt supports a great deal of activity. Described as a "thought experiment" in an article on the One-Kilowatt Strategy, the authors go on to emphasize:

> Our analysis here is not intended to establish activity level targets for developing countries, to be achieved at some future date. Indeed, the appropriate mix and levels of activities for the future in developing countries may well have to be different to be consistent with overall goals. Rather, the purpose of our analysis is to show that it is possible not only to meet basic human needs but also to provide improvements in living standards that go far beyond the satisfaction of basic needs, without significant increases in [world] per capita energy use.[2]

With this important qualification, it is, nevertheless, useful to introduce the One-Kilowatt Strategy as an alternative against which to compare conventional energy demand projections in Indonesia. Appendix Table C.1 compares energy use in Indonesia today with the use that would be required by the One-Kilowatt Strategy. In some ways, the comparison confirms what is already known: Indonesia provided over half of the energy recommended as appropriate in the form of fuel, but less

[2] *Ambio* 14 (1985): 194-195.

TABLE 3.1

Comparison of Four Energy Consumption Projections for Indonesia in 2000

(1980 = 100)

	BAKOREN (81/86)		LIPI (84/86)/c		Ang (79/82)		World Bank (78/81)	
	HIGH	LOW	OPTIMISTIC/I	PESSIMISTIC/I	HIGH	LOW/H	REFERNCE	POLICY/G
A. BY SECTOR OF USE								
Mining/Construction/ Agriculture	210	190	440/d	330/d	/f	/f	/f	/f
Industry (excl. feedstock)	620	500	720	680	1060/j	600/j	990	690
Transportation	290	290	410	360	450	360	620	480
Household/Service	140	140	610	530	140	140	420	350
Total Commercial	360	310	470	400	480	320	730	540
Grand Total	240	220			420	290		
B. BY ENERGY FORM								
Oil Product	300/a	290/a			440/e	310/e	670	380
Natural Gas	290/b	260/b	460	390	1430/e	480/e	890	890
Coal					510/e	300/e	3300	9300
Electricity	730	630	660	540	930	55		
Biomass	90	100			100	100		
C. BASIC ASSUMPTIONS								
Population	140	145	145	145	160	160	400	400
GDP	280	260	260	260	390	290	340	340

See next page for notes and sources

NOTES TO ACCOMPANY TABLE 3.1

General Notes

1. The first figure after each projection name is the base year for the projection; the second is the year of publication.
2. All projections have been adjusted to a base year of 1980 (set equal to 100).
3. Gaps in the table indicate that the given source provided no projection for that sector or form.

Specific Notes

a. Motor fuel only.
b. All other fossil fuels.
c. Projection to 1998.
d. Mining and agriculture only.
e. Includes fossil fuel used to generate electricity.
f. Presumably included in other sectors.
g. Accelerated policy scenario including "strong energy conservation and oil substitution measures".
h. Low because of more attention to conservation as well as lower economic growth.
i. Optimistic and pessimistic scenarios depend on world oil prices.
j. Combines separate sectors for industry and feedstock in ratio of 9:1.

Sources

BAKOREN	Preliminary projections, 1982 to 2010, by PTE, Jakarta, 1986.
LIPI	Unpublished projections by Dr. Adhikarya, LPGN/LIPI, Bandung, 1985.
Ang	Beng Wah Ang, Indonesia: Energy Outlook, Energy Research Group, Cambridge University, UK, 1982.
World Bank	Indonesia: Issues and Options in the Energy Sector, Report 3543-IND, Washington, D.C., 1981.

than 5% of that recommended in the form of electricity. However, even the fuel situation is less optimistic than what the initial comparison suggests, for 60% of the fuel is represented by biomass, which is generally used in highly inefficient stoves, ovens and kilns. The One-Kilowatt Strategy depends fundamentally on each energy form being delivered in the optimum form and used in the optimum way to minimize both first and second law of losses.

Because the One-Kilowatt Strategy is developed on an end-use basis, the amount of energy needed in each sector can be identified. As shown on Appendix Table C.1, with one major exception, the Indonesian energy economy is low for each form of energy in each sector; indeed, in most cases it is well below the tentative targets. The exception is the residential sector, where Indonesia is providing five times as much energy per capita as is deemed adequate and efficient in the One-Kilowatt Strategy. (However, one must be careful of such statistics; for one thing, the residential and agricultural sectors are combined. More important, conventional tabulations appear to ignore rural industry, such as brick works, that are heavy users of wood fuel.) The explanation for this apparently anomalous result is again the use of unprocessed biomass or charcoal in inefficient stoves, ovens and kilns. In contrast, only 21% of the target volume of energy is being provided to the transportation sector, and less than 17% of the target volume to the industrial sector.

Comparisons to the present time have focused on the situation in 1980. Will the situation improve over the next 25 years? Parts A and B of Table 3.2 show, respectively, the two recent PTE projections for energy use in the year 2010 and the One-Kilowatt Strategy extended to the same year by assuming a national population of 235 million (midway between the population projections in the two PTE projections). All results have been converted to metric units and rounded to the nearest 10 petajoules.

Comparison of the two parts of Table 3.2 indicates that the PTE projections are rather modest, but probably realistically so, in terms of providing an adequate quality of life and standard of living, even by the year 2010. If, for the sake of discussion, the high and low projections of PTE are deemed to reflect a credible range, Indonesia would, in the year 2010, be providing between 65% and 75% (low and high scenarios, respectively) of the energy needed for a One-Kilowatt goal. However, only 10 to 13% of the energy would still be in the form of wood and charcoal, whereas electricity would represent 12.5% of the total delivered energy (both scenarios) compared with 19% in the One-Kilowatt Strategy.

Table 3.3 shows the sectoral distribution of energy in the two scenarios. As indicated, sectoral energy shares could come closer together over the projection period. However, important differences would remain. Notably, the household and services sector takes two to three times more energy in the PTE projections, and manufacturing only half as much, as in the One-Kilowatt Strategy.

Important differences between the PTE and One-Kilowatt Strategy results for 2010 can also be seen in the use of electricity. In the One-Kilowatt Strategy, a higher share of the energy used by households, industry and transportation would be in the form of electricity, whereas in the PTE projections the share of electricity in the agriculture/mining/construction sector is higher. Differences in the households sector originate from the assumption that in the One-Kilowatt Strategy, all households will have enough electricity for lighting and small appliances. They also find that industrial efficiency requires more electricity, and they support electrified urban transportation as a way of moving large numbers of people efficiently and cleanly. Why the level of electrical use in primary sectors is higher in the PTE projections is not clear.

TABLE 3.2

Comparison of PTE and One Kilowatt Projections for Indonesia in 2010 (petajoules)

A: PTE PROJECTIONS

SECTORS SCENARIO	HIGH SCENARIO	LOW
Agriculture/Mining/Construction	1520 (16)	1200 (14)
Households/Services		
- modern fuels	850) (12)	820) (11)
- traditional fuels	610)	630)
Manufacturing	1700 (18)	1120 (20)
Transport	1100 (<1)	1090 (<1)
TOTAL	5780 (13)	4860 (13)
Basic Assumptions		
GDP (trillion Rp. in 1982)	244	204
Population (millions)	243	265

B: ONE-KILOWATT STRATEGY

SECTORS	BASIC SCENARIO
Agriculture	330 (9)
Mining/Construction	440 (0)
Households	630 (60)
Services	160 (100)
Manufacturing	2140 (22)
Transport	4080 (4)
TOTAL	7780 (19)
Basic Assumption	
Population (millions)	235

Note: Numbers in parentheses indicate the proportions of electricity in the total.

TABLE 3.3

Sectoral Distribution of Alternative Energy Use Patterns in 2010 (percentages)

SECTOR	PTE HIGH	PTE LOW	ONE-KILOWATT
Household/Services	26	30	10
Manufacturing	29	23	52
Transport	19	22	27
Agriculture/Mining/Construction	26	25	10
TOTAL	100	100	100

3.5 MINOR EXTENSIONS OF THE ANALYSIS

Comparisons between the PTE projections and the One-Kilowatt Strategy could be extended by adjusting the latter to make it more specific to Indonesia. For example, some 250 petajoules of energy in 2010 are allocated to residential hot water heating, which could be reduced substantially as hot water bathing is so rare in Indonesia. Similarly, the proportion of petrochemicals to primary metals in the industrial mix could be adjusted to reflect likely development patterns. However, none of these changes would be large — perhaps 10% in total — and the apparent realism could give the comparisons more credibility than they deserve.

A more productive line of investigation would be to compare, one-by-one, the specific efficiencies in the end-use sectors contained in each of the two approaches. Efficiency levels are of course explicit in the One-Kilowatt Strategy, and they have to be present implicitly or explicitly in the MAED model that underlies the PTE projections. Such a comparison could identify, for example, differences between the specific efficiencies (l/100 Km) of the two auto fleets in 2010, and in the use of automobiles compared with public transportation (modal split). Similarly, it could identify differences in the specific efficiency of cement production (Joules/tonne), in the forms of energy used (electricity vs fuel), and in the output per capita (tonnes/person). If it was shown that a specific sector in the PTE projections is less efficient than the comparable sector in the One-Kilowatt Strategy, one could go on to ask why that difference occurs and whether public policies could or should seek to reduce the difference. (Once again, it must be remembered that the One-Kilowatt Strategy is highly generalized; sound reasons may exist why energy use in Indonesia diverges from the idealized pattern.) Unfortunately, time constraints did not permit this extension of the analysis to be undertaken.

While the latter line of investigation might produce some interesting comparisons, it would not define ways to move Indonesia toward sustainable energy policies. In order to do that, two more fundamental steps must be taken, preferably in parallel: a full backcast of a sustainable energy future and a review of available alternative sources of energy.

3.6 A BACKCASTING STUDY

The fundamental tenet of backcasting is that, within a broad range, the energy economy that actually results over some period of time is determined less by derived requirements than by policy choices. These choices are of many types, including most fundamentally economic and population policies, but also including decisions about traditional and mechanized farming methods, road and rail transport, urban and rural development, plus, of course, all of the explicit energy policy decisions. Therefore, for long-term policy purposes, forecasting gives us exactly the wrong kind of information. We don't care so much where the energy economy is going as where it could go under appropriate policy direction. Thus, backcasting analyses are explicitly normative — "working backwards" from a particular desired future end-point to the present in order to determine what policy measures would be required to reach that future.

The distinction between forecasts and backcasts has important implications for the relationship between analysis and policy. Backcasting greatly reduces the tendency, inherent in forecasting, for the results of the analysis to be rendered instantly obsolete by the response to the analysis. It also permits a much better feel for the effects of different policies in the context of the attainment of different policy goals. Moreover, because backcasting is explicitly normative, it is not possible to use the results of backcasting analyses as ostensibly neutral justifications for policy decisions. Not only does the specification of end-points in backcasts require a normative choice to be made for the purposes of the analysis, but the choice of a particular energy future by policy-makers must be justified independently of the backcast itself. This renders impossible a common reversal of cause and effect whereby the future (as revealed in forecasts) is treated as the cause of present events; i.e., policy decisions.

The difference between forecasting and backcasting is thus, one of approach as much as of method. Both techniques must incorporate policy changes; both must also make use of some projections; both can be highly quantitative. The value of backcasting, which, in contrast to forecasting, increases as the time horizon of the study is extended, is that it makes possible the exploration of the feasibility and viability of a wide range of possible energy futures rather than, as Rene Dubos stated, elevating trend to destiny.

The backcasting study would start, just as a conventional study, with economic and demographic projections, generally 25 to 50 years into the future. In most cases mid-range official projections are adopted. The next step is unique to backcasting, for it requires explicit definition of the energy and related policy objectives that will be satisfied in the future; for example, the kinds of sources that will be used, the availability of energy in different regions, the extent of dependence on any one source, etc. Sub-section 2.3.3 offers a tentative list of the kinds of goals that might be appropriate for Indonesia. The One-Kilowatt Strategy itself is a picture of an energy economy, including social and environmental aspects, that could be adapted for backcasting. Of course, the characteristics of a One-Kilowatt Strategy could no longer be left general but would have to be defined specifically for Indonesia, and very possibly for regions within Indonesia.

The backcasting study continues with a detailed look at each end use implied by the demographic and economic projections. For example, based on the number of households in, say, 2010, one would estimate the number of private automobiles, trucks, motorcycles, etc; the number of kilometres each would be driven in a year, and, if possible, the kind of travel (whether urban or highway, passenger loading, etc.). Obviously, it takes time to break the economy down in this way, but at least as much time must also be spent on determining the most economically efficient ways to provide those transportation services. As a minimum, the energy needs must be defined in thermodynamic terms so as to indicate what quality of energy is required and optimal levels of efficiency defined at long-run marginal costs for that quality. In a simple analysis, one might focus exclusively on the specific efficiency of the vehicles themselves, but more complete analyses would question alternative ways of providing the same transportation services; for example, shifts to public transportation. Thus, a straightforward question about vehicles per household can multiply into an extensive analysis. What keeps the analysis within bounds are goals and simplifying assumptions which are introduced as needed during the course of the analysis.

With a greater or lesser degree of detail, a pattern of efficient energy demand for the future year is built up. Then, following analysis of demand, a roughly parallel process is applied to supply alternatives; except that rather more attention has to be given to explicit environmental concerns and an even longer time frame allowed for conversions from today's system. (Supply alternatives for a sustainable future are discussed in Sub-section 3.7.) To the extent that supply conditions differ by region, it may be necessary to differentiate among possible supply patterns. Demand patterns generally vary less, but, where differences in population density and development level are as wide as they are in Indonesia, even demand may have to be analyzed by region.

Given a picture of the desired final energy system characteristics, as well as efficient and environmentally sensitive ways of providing future energy services, the last stage of a backcasting study is to identify reasonable routes between the present and the ending year. In effect, this step requires the identification of culturally and financially acceptable rates of transition, as well as some indication of their implications for social and economic conditions. Thus, even more than earlier steps, this final stage must be developed not in principle, but with relevance to a particular region or nation.

The purpose of a backcasting study is to identify options that are invisible or obscured with conventional analysis. It can, for example, indicate what future demands can best be supplied with electricity and how much electricity would be needed if each end-use is efficient. If regional, it can also indicate the extent to which local development rather than reliance on a grid may be effective. No analysis is going to show that Indonesia can get along with less energy in the future, but a backcasting study might show that, if efficiency is pursued vigorously, the growth of new requirements could slow down by early in the next century.

3.7 ALTERNATIVE SOURCES: RENEWABLES AND RESIDUES

Indonesia is fortunate in being well endowed with nonrenewable sources, and with major hydro and geothermal sites. However, a sustainable energy policy will emphasize options that depend on smaller scale, distributed, renewable sources or on residues that lack other uses. And Indonesia is doubly fortunate in having a large potential for these alternatives as well. (In this sense, the term "potential" means the ability to deliver energy cost effectively at the present time or after modest further development.) True, they will be most applicable to rural rather than urban areas, and to smaller scale rather than major industrial uses. But, aggregate output can be substantial, and even in 2010, most Indonesians will still be living in rural areas.

The optimistic view taken of renewable and waste sources of energy in this report is at variance with the view expressed in many other reports concerning such alternatives for Indonesia. So far as can be determined, the differences in evaluation stem from three factors: i) important technical advances, including two solid state fermentation and open care gasifiers under development in Indonesia; ii) greater credit for reduction of environmental effects and for provision of local opportunities; iii) the shortage of capital for conventional energy systems development. All three factors increase the attractiveness of small, independent systems compared with large, centralized ones. Moreover, by converting the dilute primary sources into modern secondary forms, alternative energy technologies not only increase the availability of energy for Indonesia, but also permit much higher levels of end-use efficiency than are possible when, for instance, kerosene is used for lighting.

There exist, of course, an enormous number of possible renewable sources, and no attempt was made to investigate all of them. Rather, it was assumed that a substantial sorting had already been undertaken by Indonesian analysts and that the sources being studied most actively today represent those with the best near-term potential. For example, wind, ocean thermal and biogas from manure, all of which have received some attention in Indonesia, do not appear to be particularly promising because of poor economics, a poorly located resource base, or adverse cultural factors. Moreover, given Indonesia's petroleum resources, which are uniquely valuable for transportation fuels, plus some difficult questions raised by growing crops for energy, the potential use of renewable energy for transportation has been ignored.

In contrast to some developing countries, there appears to be an almost unimaginable volume of biomass wastes — notably those associated with the forest and agricultural sectors — currently unused and potentially available as energy sources. Although not all are collected at convenient sites, many are; for example, rice husks and saw mill wastes, and their potential is large, both absolutely and relative to demands in the areas where they are found.

The principal renewable or waste alternatives of interest appear to be the rural, and urban and industrial alternatives.

3.7.1 RURAL ALTERNATIVES

a. Photovoltaic electricity

This can feed low-demand services, such as cooling in medical centres, water purification, pumping, community TV, etc. It is not assumed, at this time, that larger arrays are cost effective, but costs are dropping so rapidly that such an assumption would not be out of line for 2010. The potential is particularly high in more remote sites or villages on the drier islands, where solar rays are not dispersed by humidity in the air.

b. Open core gasifiers

These digest powdery waste products, notably rice husks and saw dust, which produce a gas that can replace 80% of the diesel needed by conventional generators. Rice mills produce four times as many husks as needed for their own power requirements, and could supply electricity for operation of the rice mill during the day and for village use during the evening. Such systems appear to be cost effective now at larger rice mills (over 10 tonnes per day) if conventional electricity is unsubsidized and if electricity supplied to the village can be sold for even a small sum.

c. Solid state fermentation

This process digests wood wastes, garbage and other ligno-cellulosic materials at high temperatures and produces both a gas for use in electrical generation or for direct combustion and a high-nitrogen, pathogen-free residue that makes an excellent fertilizer. The unique properties of this system — 30% instead of five% solids and operation at 55° rather than 30°C — permit direct charging of wastes without dilution and produce twice as much methane as any other system. Preliminary calculations show an eight-year payback with no credit for the fertilizer or for employment creation.

d. Mini- and micro-hydro sites

These occur throughout the mountainous parts of Indonesia. Appropriately located, these sites could be tapped for energy at rather low cost. At least as important, the irrigation canals that lace Java and some other islands operate with low gradients but with drops of one to three metres at set distances to disperse potential energy. Compact generating sets could be installed at these sites to recover a few to 10 kilowatts each, a relevant quantity when each house needs only 100 watts of capacity.

3.7.2 URBAN AND INDUSTRIAL ALTERNATIVES

a) Municipal Solid Waste

This is a major problem in metropolitan areas, yet represents a large potential energy source (perhaps 50 MW in Jakarta on the basis of very rough calculations). Assuming that the waste has to be collected in any circumstance, which is true for 60% of the total in Jakarta, and that scavenging will continue to extract non-organic constituents, both direct combustion and solid state fermentation options are available for the organic fraction (75 to 90% of the original volume). Combustion requires that the volume of unreclaimable paper in the waste be high enough to overcome the high water content of organic material. Fermentation avoids this problem but is untested at large scale.

b) Solar Hot Water

This is a good option for most commercial establishments (hotels, office buildings), which use large volumes of hot, but not boiling, water, as well as for those few industries with similar requirements. Existing flat plate solar systems are quite capable of providing energy at 60°C, and they increase in efficiency with volume. The PTE projections show between 2.5 and 4.0 petajoules of solar energy being supplied to the manufacturing sector by the year 2010, presumably as hot water.

3.7.3 OTHER ALTERNATIVES

Lack of time prevented investigation of cogeneration as a source of energy, but experience suggests that the potential is important. At least in principle, any plant that requires steam in its operations can generate electricity for its own use or, if surplus to those needs, for the grid. In Canada, for example, large segments of the petrochemical and the pulp and paper industries have become electricity self-sufficient through cogeneration and a few plants provide electricity to nearby communities.

In addition to the alternatives listed above, almost every observer of rural energy use has noted the need for improved wood stoves and charcoal kilns. Designs that would double or triple efficiency are readily available. In addition, research is needed into fuelwood use by rural industry, which appears to be a larger consumer of wood, and hence a greater contributor to deforestation, than are households. (Many households that nominally use fuelwood actually cook with smaller branches, twigs and other low-quality forms of biomass that are of no value to a brickworks or lime kiln.)

A special option is to encourage rural industry dependent on firewood or charcoal to grow trees for its own needs on a sustainable basis. This requires a dedicated forest that would be harvested as a crop on a sustainable basis. Such an approach, which is found in other countries and is used to support one iron foundry in central Java, has many advantages in terms of optimizing conservation and commercial values and of providing stable employment. The same forest can provide fodder and fuelwood for other local uses without diminishing the supply to industry. However, special tenure provisions and careful monitoring are required from government and, perhaps most difficult of all, a long-term perspective from owners of rural industry.

3.7.4 DISSEMINATION PROBLEMS

In summary, alternative sources can go a long way toward setting Indonesia on a sustainable energy path, with additional gains for the environment and for local development. In particular, a large number if not all rural households could be supplied with the small volumes of electricity required for lighting and low-use appliances and rural industry would become more efficient and productive.

If, then, the resources and the technologies are there, why are renewable and waste product sources not being installed more rapidly? Indeed, why are improved wood stoves and charcoal kilns being disseminated so slowly? Work supported by the International Development Research Centre in Canada has identified three common problems:

- lack of familiarity with the new equipment;
- lack of attention by designers of new equipment to the needs of users; and,
- lack of capital to purchase the equipment.

Assuming these three reflect conditions in Indonesia — something that should be confirmed by surveys — there is an evident need for government programs. The third problem is common to all decentralized alternatives, not just in Indonesia. It is worth considering the establishment of government programs to loan or grant money for purchase of energy producing or saving equipment. On economic grounds alone, it might be more efficient for the government to, for example, loan the owner of a rice mill the Rp. 5 million needed to purchase an open core gasifier and provide energy to the village every night, than to invest in rural electrification schemes. Similarly, on environmental grounds, it might be worth loaning money to owners of a charcoal operation to install a more efficient kiln. On grounds of equity, it might also be more appropriate to simply give out more efficient stoves capable of burning either wood directly or improved fuel such as briquettes.

In some cases, there is also a fourth problem: lack of institutional support. If PLN provides electricity to a village, it has all the mechanisms in place to arrange for back-up and to bill for service. If a rice mill owner installs a gasifier and wants to sell surplus electricity, the mechanisms have to be established. Manuals and guides could be written to fill this gap, probably with the emphasis on non-metred billing systems, i.e., charging for power, not energy.

3.8 SELECTED CONVENTIONAL ENERGY CHOICES

Although the focus of this project is on sustainable energy alternatives, some observations can be made about conventional energy development over the next decade.

3.8.1 TRANSPORTATION FUELS

As indicated above, transport will continue to depend largely on petroleum fuels. However, in metropolitan areas, and perhaps in surrounding regions, two alternatives might be considered.

Indonesia has abundant supplies of natural gas, and intends to use more of the gas domestically. CNG (compressed natural gas) is arguably the cleanest and most efficient internal combustion fuel available. Side benefits include longer engine life and lower emissions. However, on-vehicle storage takes up more space than gasoline, retrofitting of vehicles to use CNG is costly ($1,500 to $2,000 each), and refilling of tanks can be slow. Therefore, it is an option most suitable for buses and urban fleets such as, taxis and delivery vehicles. Those vehicles also travel the minimum 20,000 km/p.a. required to make CNG a cost-effective choice.

Electric vehicles have not proven very attractive except on high-density routes. The possibility exists to create electrified light rail or trolleybus lines through central Jakarta. Experiments elsewhere show that such lines are most successful when operating on dedicated routes free of other traffic, with conventional buses and microlets serving on feeder routes. In some cases, urban congestion and air pollution have been reduced significantly by development of what has been termed a "surface metro".

3.8.2 CENTRAL GENERATION OF ELECTRICITY

As indicated elsewhere, for urban and some industrial uses, there is no good alternative to large-scale central generation of electricity. Assuming the options for cogeneration and use of MSW, as described in Sub-section 3.7, have been fully exploited, Indonesia's decision to move toward primary reliance on coal for central generation seems sensible. Low-sulphur coal is available domestically, though it is rather high in cost and low in quality. However, environmental costs will have to be watched with particular attention to:

- full and continuing reclamation of open cast mines as part of the production system, and
- disposal methods for (or preferably use of) the large volumes of ash that will accumulate at generating stations.

In addition to coal, hydro and geothermal energy can, of course, be used if conveniently located and if the environmental consequences (by no means negligible) are acceptable. Apart from areas near a large source of biomass, there is no evident alternative to diesel units for smaller cities in the Outer Islands. The possibility of using residual oil from Indonesian refineries or purchasing merchant shipments of "resid" may be worth considering, likely for dual-fuelled plants. However, much "resid" carries 2 to 3% sulphur.

Nuclear electricity is, of course, an option under review in Indonesia. At this point in time, it is fair to say that most analysts are becoming more hesitant about the potential for nuclear generation of electricity in developing countries. However, nuclear power for Indonesia was not investigated in any depth in as much as it is not being put forward as a near-term option.

4. EXPANDING THE ROLE FOR KLH IN ENERGY POLICY

Energy policy formulation in Indonesia is fairly complex, partly because of the importance of energy exports for development and revenue goals, but also because the importance of bringing a wide range of sectoral interests into energy discussions is recognized as critical. Appendix D reviews the institutional framework for energy policy making in the Government of Indonesia.

4.1 KEY COMMITTEES: BAKOREN AND PTE

Energy policy in Indonesia is sent forward after review by three principal bodies within or chaired by the Department of Mining and Energy: BAKOREN, PTE and PME. As the last is mainly an intra-departmental technical group, it is less important for purposes of this report than the other two groups.

BAKOREN is a cabinet-level interdepartmental coordinating committee on energy. It meets about twice yearly. Minister Salim is a member of BAKOREN. PTE is the public servant counterpart of BAKOREN and represents the senior working-level group on energy policy. PTE meets every two weeks and is responsible to BAKOREN for policy planning, and for implementing and monitoring those policies approved by BAKOREN. For example, PTE prepared the recent set of end-use projections for energy and drafts the periodic energy policy statements issued by BAKOREN. Thus, PTE is the venue where new ideas must be presented and defended. It is fair to say that, if a proposal is not accepted by a substantial number of the members of PTE, it is unlikely to fare well at BAKOREN. Many of the people attending the KLH workshop on Energy and the Environment were members of PTE. ASMEN-I Herman Haeruman represents KLH on PTE.

As a result of severe personnel limitations, KLH has been unable to play very active roles on BAKOREN or PTE, or to prepare the kind of case necessary to influence energy policy. This represents a lost opportunity, not merely because the Ministry's views are important, but also because at least some members of these bodies are open to incorporating environmental concerns in energy policy. For example, Minister Subroto has referred to the possibility of a "more economically based" or "least cost approach" to energy policy in Indonesia (The Indonesia Quarterly, XIV/2, p. 194). Unfortunately, for some other members, the limited role currently played by KLH confirms their view that KLH has no case to make.

Simply put, there is no alternative to active participation on BAKOREN and PTE if KLH wishes to influence energy policy in Indonesia. To be effective, that participation must be regular and substantive and, because of the working relationships, must not be passed from person to person. A continuing KLH presence at PTE, backed up where appropriate by analysis and documentation, stands a good chance of inserting environmental concerns into energy policy.

Indeed, the opportunity before KLH is still larger. While nominally representing all interests, PTE is in reality dominated by energy agencies, which are logically best informed about supply management. Demand management is inadequately covered even though, as indicated throughout this report, demand analysis is critical to development of sustainable energy policies. Currently, the director of New Energy Development co-ordinates demand issues but admits that it is a secondary priority.

The opportunity for KLH to have influence, therefore, has two pillars:

- KLH would, of course, become the principal voice for environmental issues.
- KLH could also serve as the focal point for demand-related issues.

The logic of linking the two is strong, because they are interrelated and are both inherently intersectoral. Demand involves every form of consumption and environment involves all resources.

4.2 STAFFING REQUIREMENTS

It is, of course, futile to argue for active participation at PTE unless staff is available to support that function. At present, it is hard to identify anyone at KLH who has a moment to spare, much less to make the time commitment required of an active member of PTE. Therefore, KLH must find someone within the Ministry whose duties have not yet been fully defined, or someone outside the Ministry to serve as coordinator for energy-related activities. Wherever found, the individual must have the knowledge and the status to influence PTE, and must be able to devote, approximately two full days per week to energy issues. He or she must become broadly familiar with energy in all of its dimensions and, over time, develop special competence in energy demand and energy-environmental interrelationships. The energy co-ordinator must also understand the environmental assessment process (ANDAL) now under development in KLH and, in particular, what it can and cannot do. There is an unfortunate and fairly widespread view among members of

PTE that environmental impact assessment will deal with all environmental issues and that they, therefore, need not be considered further. The demand side of energy policy is an excellent example of something that cannot be easily handled by impact assessment, yet that has an enormous effect on the state of the environment.

The availability of an energy coordinator would go far toward filling the existing gap. However, working alone, that individual could not prepare the materials needed to develop the case for sustainable energy policies and to critique the case being made for conventional energy policy. From all evidence, PTE reacts best to arguments supported by quantitative or semi-quantitative arguments, benefit-cost analyses, and research results. Therefore, it is essential that KLH's energy coordinator be supported by part-time assistance at two levels:

- A senior energy policy analyst will be needed to review reports, design studies, and supervise calculations and analysis. This person should be familiar with energy models (particularly the MAED model used by PTE) and with both technical and economic aspects of energy. An appropriate individual might be found at the Centre for Research on Energy at the Institute of Technology, Bandung, which is the only research group in Indonesia that focuses on energy policy and planning.
- Junior economics and engineering assistants will be needed to keep an eye on new work, gather information, and make calculations. Ideally, these assistants would be located within KLH so as to help the coordinator and build up competence within the Ministry, but they could be graduate students or junior staff members at Indonesian universities.

4.3 SUPPORTING LINKAGES

KLH could further expand its role in energy policy by establishing linkages with other departments and agencies in Indonesia, with other national governments, with international agencies, and with private firms and nongovernment organizations.

4.3.1 OTHER GOVERNMENT DEPARTMENTS AND AGENCIES

There are a number of groups in other departments and agencies of the Government of Indonesia that are undertaking environmentally useful work on new energy. The Energy Conversion & Conservation Technology Group in BPPT has biomass and solar photovoltaic projects, and the Research and Development Centre for Forest Products in Bogor (PPPHH/IPB) has a number of biomass projects (including the solid state fermentation process described in Sub-section 3.7.1). Conservation policies and programs are located in the Directorate General-Electric Power and New Energy, and cooperative links of various kinds could well be established with this group. However, the nature of energy conservation is such that, depending upon priorities, linkages could also be made with departments that have mandates in major energy-using areas: industry, transportation, public works, etc. As with other aspects of its work on energy, KLH's rationale is that energy conservation is an excellent form of environmental protection.

4.3.2 OTHER NATIONAL GOVERNMENTS

A number of governments have indicated an interest in developing energy conservation or renewable energy programs in their aid programs. Some international aid is already in place. Germany supports the work at BPPT, Belgium the work at IPB, and Netherlands the work at ITB. New Zealand has recently indicated its desire to work with Indonesia on the development of CNG (compressed natural gas) as a transportation fuel. There does not appear to be any aid program linked to Indonesia's energy conservation efforts. However, Canada has been active in both the development of conservation technologies and the design of conservation programs. In the fall of 1986, Canada presented a three-week seminar for senior executives from member governments of ASEAN in which energy conservation was one of three principal themes, and Canadian firms have been involved in conservation-related aid projects in other ASEAN countries.

4.3.3 INTERNATIONAL AGENCIES

International lending and research institutions are becoming more interested in environment and sustainable development, and some of them (including the Asian Development Bank) have come to recognize the importance of energy conservation as a way to economize on the use of capital. At least three specific linkages — ASEAN, the International Energy Agency, and the World Bank — seem worth investigating at this time.

ASEAN has indicated some interest in energy conservation and new forms of energy. This avenue could be pursued with the idea of identifying regional approaches to the introduction of environmental values into the analysis of energy policy. Specifically, the energy conservation seminars recently presented in Canada could be adapted for delivery in ASEAN countries, and be supplemented by materials on incorporating environmental concerns in energy policy.

The International Energy Agency (IEA) is an association of industrial countries with offices closely linked to OECD in Paris. Originally formed as a counterweight to OPEC, it has in recent years taken a much greater interest in long-term energy planning. A special report is about to be published on the effectiveness of member nations' conservation programs over the past 15 years. Among other things, this report deals explicitly with the "external gains" from conservation through environmental protection and employment generation. Obviously it would be of value for KLH to review that report for applicability to Indonesia or, alternatively, propose to PTE that a review be undertaken. A broader option would be for Indonesia to propose to IEA either on its own or as a representative of ASEAN, that a working group be convened to evaluate the report for application to developing countries.

The World Bank has, of course, dealt with energy since its inception, and over the years the largest single block of its funds has gone to the construction of electrical systems. It is now re-evaluating that position and beginning to look more carefully at costs and environmental effects. So far as Indonesia is concerned, the 1988 IGGI overview study, which will focus on medium-term investment strategies for the energy, land and water sectors, with explicit attention to the environment, is particularly relevant. KLH could make strong representations to the effect that, if the study does not deal at length with energy conservation and development of local renewable options, it will miss the easiest ways simultaneously to protect the environment and save capital.

4.3.4 PRIVATE SECTOR

No contact was made with private sector firms or organizations during the assignment. However, experience in other countries suggests that consulting, engineering, and management firms, particularly medium-sized firms, can become interested in sustainable energy. For example, some have become specialists in the use of waste heat or waste products. Others take over energy management for large industrial firms and draw their own profits exclusively from a share of the financial savings they can effect. Still others offer environmental management or assessment services. This action begins to build a constituency for incorporation of environmental concerns into project planning.

Industry trade associations can also become partners in sustainable energy. In Thailand, a coalition of Japanese firms has set up a centre to train Thai engineers and plant foremen in energy efficiency techniques. The Government of Canada has organized joint government-industry task forces in each sector of the economy. These groups focus on energy, but it would be only a modest step to expand their mandate to include the environment.

4.3.5 NON-GOVERNMENT ORGANIZATIONS (NGOS)

Environmental NGOs are generally quite convinced of the merits of sustainable development and have worked hard to promote it. The work of WALHI, the environmental coordinating group in Indonesia, is well known (not just within Indonesia). Less well known but equally important are appropriate technology centres. In fact, as indicated in Sub-section 4.1, sustainable energy analysis was developed by environmental NGOs.

NGOs of all types exist in Indonesia, and KLH has had long experience in working with them. Hence, they are mentioned here mainly for completeness. Suffice to say that NGOs can be important as allies of sustainable energy, at the stage of conceptual development and, perhaps even more, at the stage of dissemination and popularization of technologies and services.

4.4 A PARTIAL LIST OF PROJECTS AND STUDIES

The following projects and studies are put forward as the kinds of work in energy-related issues that need to be undertaken in KLH, or with KLH participation. Several points must be emphasized from the start: i) the list is partial and non-definitive; ii) only a few of the items on the list could be undertaken at any one time. Selection among them will depend on KLH priorities, priorities in sectoral departments (much of the suggested work crosses departmental lines), and of course, on the availability of funds; iii) each of the items has both technical and socio-economic dimensions, and in most cases the latter are more critical than the former.

4.4.1 CONCEPTUAL DEVELOPMENT WITHIN KLH

KLH could convene a series of internal working meetings (perhaps with selected resource people in attendance) to help the Ministry better define its own position on energy, and thus to identify its priorities. Such meetings might:

a. Study MAED, which is the model used by PTE in its projections. MAED is not simplistic, and it does contain end-use sectors. The initial task is, therefore, to learn how the model works and why it gives the results it does.
b. Consider the design of a backcasting study for Indonesia with preliminary identification of sectoral and aggregate demand objectives, and compare the objectives with those inherent in the PTE projections using MAED. Determine whether MAED can be converted from a forecasting to a backcasting mode.
c. Review requirements for central generation of electricity once allowance is made for cogeneration, conservation, and local sources. Determine whether central generation will have to continue to grow after, say, 2000, and thus whether alternatives to large coal-fired plants, such as nuclear power plants, will be necessary.
d. Review electrical demand options for Indonesia from the social and environmental points of view to decide which are the least damaging, and identify what specific steps should be taken to reduce damages from the more acceptable options.

e. Define the areas of the country where use of traditional fuels is and is not viable. For the former, consider what steps are needed to ensure continued sustainability; for the latter, consider what alternatives are available.
f. Review all possible energy supply alternatives (see working paper for Energy Supply Group at the workshop) to see whether any are totally unacceptable and, if so, why?
g. Review each existing and potential energy source available to Indonesia to determine which stage (or stages) of production, transportation and use constitute environmental threats.
h. Investigate the extent to which new institutions are required to protect the concept of equity as the energy system moves toward sustainability and whether new institutions are needed, such as capital pools to make money available to communities and firms that can deliver their own power.
i. Consider whether some special values should be attached to community or regional development of energy sources, and whether energy planning at these levels should or should not be encouraged.

4.4.2 INTERDEPARTMENTAL RESEARCH

Many of the most important areas for investigation could only be done in cooperation with the departments that have primary mandates in the area. Possible study areas include:

a. Compare end-use by end-use specific efficiencies at levels of service in the MAED model projections and in the One-Kilowatt Strategy.
b. Describe the potential for industrial co-generation and distribution to the grid.
c. Describe the potential for greater use of solar water heating in the urban commercial sector and in tourist developments.
d. Determine the potential for energy self-sufficiency in the forest sector, and the barriers to achieving that potential.
e. Undertake feasibility studies of the inter-island shipment of charcoal into Java and compare results with options for increasing supplies on Java by dedicated plantations, perhaps in coastal areas.
f. Determine whether deforestation is resulting from use of wood for energy.
g. Determine the reasons why some firms prefer to generate their own power even when PLN power is available.
h. Identify the full potential for conservation in Indonesia:
   i. using only least cost considerations, and
   ii. adding in environmental and employment considerations.
i. Do exactly the same for renewable sources of energy, particularly use of waste products and microhydro.
j. Define the barriers to greater use of new technologies:
   i. improved charcoal kilns or firing methods,
   ii. energy from municipal solid waste (probably using solid state fermentation),
   iii. microhydro from drops in irrigation canals, and
   iv. energy from rice husks and saw dust (probably using open core gasifier).
k. Design conservation approaches specific to each sector, based on a review of experience in other ASEAN countries (especially Thailand and Singapore).
l. Study transportation in metropolitan areas to review the possibilities for electrified urban transit on dedicated routes (trolley buses or light rail) linking with bus or microlet feeder routes.

m. Undertake a design study for low-energy buildings and for low-cost housing appropriate for smaller cities and rural areas in different parts of Indonesia.
n. Undertake an energy study for the many cities in Indonesia with 20,000 to 200,000 population and for which, so far as can be seen, there is little energy planning.

4.4.3 FOLLOW-UP TO THE WORKSHOP

The working groups from the workshop could be reconvened and, with KLH guidance, go more deeply into the issues. For example:

a. Ask Supply Work Group to:
   i. suggest any possible sources that should be rejected for environmental reasons,
   ii. consider supply options for different regions, and
   iii. define more clearly the role for renewable energy and waste products.

b. Ask Demand Working Group to:
   i. design a backcasting study,
   ii. review the requirements for grid electricity, and
   iii. set energy use targets for specific sectors.

c. Ask Conservation Working Group to:
   i. review IEA study for applicability to Indonesia,
   ii. suggest policy measures and programs for specific sectors, and
   iii. identify areas where more study is required.

5. FINDINGS AND CONCLUSIONS

This report has been an initial review of energy options that would both satisfy Indonesia's growing demand for energy and yet avoid excessive damage to her environment. Increasingly, it is recognized that environmental protection is part of sound economic development policy, and this report offers further support for that conclusion.

5.1 SUSTAINABLE ENERGY

By its very nature, energy is involved with every aspect of development. Therefore, it is hardly surprising that energy production, transportation/transmission, and use have major environmental effects. One cannot be discussed without considering the other, at least not if high economic costs and excessive depletion of renewable and nonrenewable resources are to be avoided. This report focuses on sustainable energy, which can be defined as:

- the use of renewable energy resources in such a way as to maintain their productivity over time;
- the use of nonrenewable energy resources in such a way as to extend their life and permit (over the long term) a fully renewable energy economy; and
- the use of both in ways that limit degradation of the air, land, water and genetic resources with which energy production and use are so closely linked.

Therefore, as used in this report, the term "sustainable" refers simultaneously to both energy and the environment.

5.2 PRINCIPAL CONCLUSIONS

Given the undeniable need in Indonesia for more commercial energy to provide a higher quality of life for its people and development for its industries, it would be unreasonable to claim that Indonesia could move immediately to a fully sustainable energy system. Nevertheless, there are important steps that can be taken to make such a system attainable in the future — perhaps after 2010. Indeed, unless those steps are taken, Indonesia will find itself even further from sustainability in the future than it is today, which means that economic and ecological debts will continue to mount.

For a number of reasons, including the growing costs and uncertainty of conventional energy policy, interest in sustainable energy options is growing in Indonesia. However, to date no official body has come forward to provide leadership and give substance to these ideas. Thus, KLH has an opening to become the leading voice in the Government of Indonesia in support of sustainable energy. To fill that role, though, KLH must make a firm and continuing commitment of staff and budget to energy issues.

This report focuses on energy produced and consumed within Indonesia. (Energy produced for export is more appropriately treated as a commodity, albeit an important one.) Moreover, the role of energy demand is stressed. As stated by Maurice Levy, Director of the Energy Programme for United Nations University, "In developing countries, the management of energy demand is the overriding factor of a coherent energy plan". Energy policy that does not start with analysis of demand is unlikely to be sustainable. This point is re-emphasized at the end with a section on adaptation to Indonesia of what has been called the One-Kilowatt Strategy.

5.3 SUSTAINABLE ENERGY POLICIES

In moving toward a sustainable energy policy for Indonesia, two fundamental conceptual steps must be taken. The first is to recognize that domestic energy use cannot forever continue to increase. Limits will sooner or later be set by lack of reserves, by environmental constraints, or by financial requirements.

The second step is to recognize that, despite its fundamental role in the physical and economic worlds, energy is not wanted for itself but for the services it can provide. To the extent that we can obtain those services more efficiently, either by reducing the quantity of energy required to obtain some service or by ensuring that energy is delivered in the quality appropriate to that service, development will be enhanced. Moreover, that same drive toward efficiency will have two additional benefits.

- Adverse environmental effects will be greatly reduced because less energy will be needed and because the kinds of energy required tend to be less damaging.
- Labour opportunities will be increased and capital requirements reduced compared with a less efficient system in which more energy must be supplied to obtain the same services.

In the absence of concerted attention to energy efficiency, a sustainable energy future is not attainable. Within this conceptual approach, there are a number of specific steps that could be taken now to move toward a sustainable energy future. To a considerable degree, these steps are contrasting in urban and in rural areas of Indonesia.

- In urban areas, there are major opportunities for conservation in energy use but only modest ones for development of decentralized, renewable energy sources.
- In rural areas, there are major opportunities for development of decentralized, renewable energy sources, but only modest ones for conservation in energy use.

As well, attention must be paid to some major choices in conventional energy policy, and to innovative ways to promote the wider use of those sustainable energy techniques that prove to be attractive and economic.

5.3.1 URBAN AREAS

The bulk of commercial energy consumption takes place in urban areas, which also include most industry not tied to a natural resource. Even in western countries with highly mechanized agriculture, the share of commercial energy used in rural areas is only 10 to 15% of the total. Steps that would move Indonesian cities closer to sustainability include the following.

a. Major efforts at reducing the energy use in large, centrally air-conditioned buildings.
b. Border controls to ensure that durable goods and industrial equipment imported into the country meet both environmental and energy efficiency criteria (which domestic manufacturers should also meet).
c. Strong programs to improve maintenance on and to reduce emissions from road vehicles.
d. Review of the potential in metropolitan areas for electrified public transit on dedicated routes with feeder lines using conventional buses and microlets, and possibly use of this review to consider ways to improve the environment in urban areas.
e. Development of energy auditing services that will help small- and medium-sized industries and building owners to become more energy efficient.
f. Identify the traditional and semi-traditional sectors of the urban economy and make vigorous efforts to increase the efficiency of their energy use by promotion of efficient wood stoves, elimination of kerosene lighting, etc.
g. Promotion of industrial cogeneration among industries that require steam or that use high-temperature energy as a way to reduce the load on the electrical grid and, possibly, to supply the grid.
h. Use of the organic portion of municipal solid waste as an energy source, probably by fermentation rather than direct combustion, but after scavengers have recovered the valuable constituents.
i. Promotion of solar water heating in hotels and commercial buildings and for those industries that require hot but not boiling water.

5.3.2 RURAL AREAS

The majority of the Indonesian population lives in rural areas, and all projections indicate that this will continue to be the case well into the next century. Incomes in rural areas are generally below those of urban areas, and the large non-market segments of the economy require special attention. Nevertheless, more commercial energy must be made available in rural areas, partly to assure an adequate quality of life but also because even small amounts of modern energy can do much to increase productivity.

a. Increase the distribution of the more efficient wood stoves that are now available.

b. Identify areas where use of wood for energy purposes is creating depletion of forests, and determine whether the source of the problem is cooking fuel or, more likely, rural industry.
c. Introduce improved charcoal making processes which in many cases today are wasteful and polluting.
d. Move beyond the prototypes already developed in Indonesian laboratories to full-scale demonstrations of techniques for using the enormous volumes of waste products that are found in agricultural and forest areas, and that are not required for soil enhancement. Two of the most promising techniques are:
   i. an open core digester for rice husks and sawdust that can replace 80% of the diesel oil used to generate electricity at larger rice mills and also provide electricity for community use in the evenings (developed at the Institute of Technology at Bandung); and
   ii. a solid state fermentation process for organic wastes that produces a high methane gas and converts the wastes into a pathogen-free, high-nitrogen compost (developed at PPP/HH in Bogor).
e. Use the foregoing options, possibly supplemented with photovoltaics where small amounts of energy are needed during daylight hours (e.g., refrigerators in clinics), to promote the development of community energy systems.

5.3.3 INSTITUTIONAL INNOVATIONS

Energy specialists have long been aware that, although not widely adopted, both supply and demand alternatives exist that are cost effective and technically superior to those commonly in use. Evidently, choices in energy have socio-cultural and socio-economic dimensions as well as technical and financial ones. Among the institutional innovations that might be considered for moving toward sustainable energy systems in Indonesia are the following:

a. Village cooperatives in rural areas (or possibly in urban kampongs) can supply small amounts of electricity. Even if none of the renewable energy options is available, local community-owned diesel generators may be both more cost effective and more supportive of development goals than conventional rural electrification. As stated in a recent World Bank report on rural electrification in Indonesia, the existence of these unregulated systems is "evidence ot organizational skills and rudimentary technical capabilities." What is needed are appropriate extension services and information on model systems, or perhaps the establishment of licensed village electrical organizations, as suggested by the World Bank.
b. The idea of energy extension services could be extended with the goal of helping communities and industries establish a sustainable energy base. Two specific options to consider are:
   - assistance in the development of committed forest tracts managed to provide a sustainable harvest for cooking fuel or for rural industry; and
   - assistance in improved methods for charcoal making with the goal of increasing both the returns to the charcoal maker and reducing the losses in wood.
c. Subsidies on petroleum products have been largely eliminated in Indonesia, but they remain on electricity. Economists tend to be opposed to subsidies because of the inefficiencies they create, and because, to the extent that they are intended to promote equity, the benefits are too widely distributed. Nevertheless, the equity argument remains important. Small amounts of electricity are so useful that it is worth looking for possible

compromises. For example, the subsidy could apply only to the first 50 kWh consumed in a month, or the hook-up charge could be eliminated.

d. One of the barriers to the use of many conservation or renewable energy techniques is higher initial cost. For productive enterprises that can earn a return on their investment, a capital pool could be established to loan money for purchase of, for instance, open core gasifiers at rice mills or improved charcoal kilns. For households, at least in rural areas, improved stoves might be provided free.

5.3.4 SOME CONVENTIONAL ENERGY OPTIONS

For a long time to come, Indonesia will be dependent on large volumes of nonrenewable energy supplied from centralized sources. Some key choices have been and remain to be made about such sources.

a. Of all forms of energy, electricity is both the most useful and the most costly, with high costs recorded in both financial and environmental accounts. Therefore, electricity should be used only where its unique qualities are truly needed, and its use should be as efficient as possible. Nevertheless, more electricity is needed in Indonesia, and in urban areas and for industry much of that electricity will have to be centrally generated. Given the available alternatives, the existing policy to use coal as the main source of electricity seems sound. Most Indonesian coal is low in sulphur. However, vigorous efforts will have to be made to ensure reclamation of open cast mines and to dispose of (or, preferably, find uses for) the large volumes of ash that will accumulate at generating stations.
b. The liquid fuels used in transportation, today mainly gasoline and diesel oil, represent the other, common, high-quality form of energy. Although a number of renewable energy options have been promoted to supply transportation fuels (mainly as ethyl or methyl alcohol), Indonesia is so well supplied with fossil fuel resources that it seems sensible to look for less radical alternatives. Both propane and compressed natural gas (CNG) are good transportation fuels, and both have the further advantage of significantly reducing vehicle emissions. In addition, in metropolitan areas and on high-density rail lines, electrified transport can be considered.

5.4 INFLUENCING ENERGY POLICY

KLH has an opportunity to influence energy policy and thus reduce environmental impacts in Indonesia by using existing inter-departmental structures. However, those structures must be used fully and intensively. In many ways it would be preferable for KLH to abstain entirely from participation in energy policy than to participate weakly. Other agencies appear willing to listen to KLH's position in support of sustainable energy, but, if that position is not well supported, they may conclude that there is no case to be made. Therefore, it is assumed in the following that a decision has been made within KLH to make energy policy, and in particular the identification and promotion of sustainable energy options, a ministerial priority.

a. The best way to influence energy policy in Indonesia is to play active roles on BAKOREN and on PTE. (The former is the cabinet level and the latter the senior public service level coordinating committee on energy.) PTE in particular is the arena to which new information is brought and within which new policies and programs are analyzed. If KLH cannot win support within PTE, its chances for influencing energy policy at BAKOREN are sharply reduced.

b. Playing an active role on PTE means regular attendance at the bi-weekly meetings and being prepared with information and analysis to present proposals from KLH and to critique proposals from other departments and ministries.
c. Such activities do not require that KLH staff become experts in energy technologies themselves. That role appropriately belongs to other agencies. However, the staff must attain broad familiarity with the Indonesian and world energy economies and with energy alternatives. In addition, KLH has one essential and one potential role to play at BAKOREN and PTE:
   - KLH should become the principal voice on issues related to energy and the environment, and
   - KLH could become the integrating voice for issues related to demand management (a role that is not currently being taken by any group).
d. Special efforts will be needed to convince other departments and agencies that there is more to energy and the environment than the new environmental impact assessment process (ANDAL), important as that process may be. Environmental concerns must be introduced at every step in the planning process, and only a few of those steps can be effectively handled by assessment.
e. None of the foregoing will be possible unless KLH devotes staff time and budgets to energy issues. If energy is to be a priority, an energy team must be created. At a minimum, the team should comprise:
   - one senior staff member to serve as coordinator for KLH on energy issues and to represent the Ministry on PTE;
   - one senior policy analyst who can prepare or supervise the preparation of reports and analyses (N.B., perhaps the best place to find such a person is at the Centre for Research on Energy at the Institute of Technology at Bandung); and
   - junior staff members at KLH who can gather information, make calculations and prepare reports.

   None of these positions needs be full time, but each does require an explicit commitment of one to two days per week. In addition, it will be useful to call on specialists in particular fields from Indonesian groups or through international aid programs.
f. Possibly the most effective way to ensure continuity would be to establish the energy team at KLH as a project under a title such as Environmentally Appropriate Energy Systems.
g. It is the nature of energy policy, and in particular of both its environmental and demand aspects, to be cross-sectoral. Therefore, in its promotion of sustainable energy options, KLH should also strive to create linkages with other government ministries and departments, and with groups in the private and nongovernment sectors that share its views. For example, work on decentralized rural energy systems could be coordinated with the Department of Home Affairs. International aid agencies are also coming to recognize the importance of energy conservation and of environmental protection in order, if nothing else, to increase the efficiency of their capital disbursements.
h. Finally, KLH needs to develop a process, led by the proposed energy team, to prepare its own view of a sustainable energy future for Indonesia and to establish priorities in working toward that future.

5.5 ADAPTATION OF THE ONE-KILOWATT STRATEGY

Most of the findings and conclusions put forward in this paper can be subsumed under a general demand-focused approach to energy known as the One-Kilowatt Strategy. This approach was derived by first and third world energy analysts on the basis of two pieces of information. The first showed that, beyond one kilowatt of total energy capacity per capita (i.e., one kilowatt-year per year of all forms of energy averaged over the population), further improvements in life expectancy, educational levels, etc. were negligible. The other showed that the high level of services in Western Europe (expect for space heating) could be delivered for an average of one kilowatt per capita provided that the most economically efficient methods available were used.

The One-Kilowatt Strategy is a major generalization applied across all countries. It would require considerable work to adapt it for use in Indonesia. Nevertheless, for many reasons, not the least of them being the environment and equity, the One-Kilowatt Strategy presents an attractive approach. It would offer a much lower level of energy use beyond 2010 than existing projections, and it would deliver more of that energy in sustainable forms. In many ways, the One-Kilowatt Strategy stems from what was called soft energy analysis, an analytic approach which showed that industrialized countries were grossly inefficient in energy use and that they could save money and avoid environmental damage by adopting techniques that had long been urged by environmentalists.

A sustainable energy policy in general, and the One-Kilowatt Strategy in particular, appear to be broadly consistent with Indonesia's national energy policy. Together, they offer a way to bring energy policy goals in line with social and environmental goals, and at the same time ensure that Indonesia has enough energy for development. Industrial countries have almost totally separated economic growth from energy growth, and many of the newly industrialized countries are following in the same direction. The same results cannot be expected in developing countries, such as Indonesia, but it is apparent that, relative to current trends and projections, smaller and more sustainable energy systems are within reach.

APPENDICES

APPENDIX A: TERMS OF REFERENCE

The maintenance and development of Indonesia now and in the future requires supplies of energy ranging from large scale industrial and commercial projects to those that can supply the requirements of households and individuals. Development of energy supplies without adequate environmental planning and management, however, can create significant and costly environmental problems. An important objective for Kependudukan dan Lingkungan Hidup (KLH) is to prevent and/or mitigate the occurrence of such problems now and in the future.

KLH wishes to contribute to the development of an environmentally sensitive energy policy for Indonesia, taking into account the nation's growing population, changing demographic patterns, expanding economy and changing structure of industry. The specific work to be undertaken will have three primary goals.

- To determine a reasonable range for energy demand in Indonesia over the period 1985 to 2010, assuming that end use requirements are satisfied as efficiently as justified by cost effectiveness and thermodynamic criteria related to energy quality.
- To determine how much of this demand can be satisfied by renewable resources subject to constant cost or nearly constant cost supply functions.
- To match energy supply and demand in ways that satisfy the need for environmental management and sustainable development in Indonesia.

The work is to have a specific secondary goal as well:

- To expand the capability for, and the receptivity to, the sustainable energy (soft energy) approach to energy demand and supply analysis, including transfer of this analytical capability to KLH.

Thus, the objective is also to provide KLH staff with the skills to undertake such an analysis on an ongoing basis. This involves transfer of the specific techniques and the ability to deal on a regular and continuing basis with the objections, barriers, and changes (e.g., lower energy prices) that will inevitably arise over time.

In order to assist KLH's planning for the necessary environmental management in energy development, following the above discussion, KLH requests that the following analysis be carried out:

- Within the context of current Indonesian energy policy, the alternative energy demand patterns for Indonesia for the period 1985-2010 will be determined, taking into account the expected patterns of energy use and the projected population and economic growth. The formulation must pay attention to the efficient use of energy in the broad sense, and should be predicated on the basis of good environmental management by both the energy users and the energy supply industries. The potential use of energy resources available in the country which are viable over a long period of time (sustainable or renewable) will be included in the formulation.
- Based on analysis of alternative energy demand patterns, describe the environmental management implications inherent in the projected patterns of energy use. The implications of both energy developments and energy demand should be considered. The primary and secondary environmental implications of producing and utilizing energy resources should be included. This information will be used by KLH to develop its strategy and formulate its requirements for environmental planning and management for each type of energy development and set the appropriate schedules for environmental management activities as they pertain to the maintenance and further development of Indonesian energy supplies, while preserving and sustaining environmental quality.

The energy demand formulation will focus carefully on how to meet the real needs for energy in the most cost-effective manner. The term "energy" here is not restricted to electricity alone, but also includes liquid fuels, and high, intermediate and low temperature heat (thermodynamic principles). Environmental management aspects of energy requirements will cover the implications (concerns and constraints) raised by the following:

- alternative means for large and small scale electricity generation and comparisons of their environmental implications (hydroelectric, etc.);
- fossil fuels and their derivatives, and the environmental implications including atmospheric emissions and disposal of solid wastes;
- biomass production of energy which would promote provision of renewable energy, and consideration of its relation to improving environmental quality; and
- non-conventional energy resources such as those that could be derived from solar, tidal, geothermal, wind, and peat sources, since these are potential natural resources in the Indonesian archipelago, in addition to their environmental implications.

The treatment of energy pricing is related to the principle that economically efficient use of energy is promoted when energy is priced at its opportunity cost (or at its long-term marginal cost). The formulation must be based on this cost concept which would be reflected adequately by the market clearing price.

APPENDIX B: ACTIVITIES AND MEETINGS WHILE IN INDONESIA

B.1 SHORT REPORTS PRODUCED

a) Notes on a One-Kilowatt Strategy for Indonesia.
b) A Note on the Importance of Energy Demand in Analyzing Energy Policy Options for Indonesia.
c) Comparison of Four Projections of Indonesian Energy Use in Year 2000.
d) Notes on the Energy Economy of Two Regions in Sulawesi.

B.2 WORKSHOP DOCUMENTS

a) Keynote paper: Sustainable Energy: An Overview of the Concept and its Application to Indonesia.
b) Working Paper for Group One: Energy Supply.
c) Working Paper for Group Two: Energy Demand.
d) Working Paper for Group Three: Conservation of Energy.

B.3 INTERVIEWS

Note: This list includes only formal interviews arranged specifically for the purpose of discussing energy-environmental policies in Indonesia. It excludes informal meetings and also meetings within KLH.

BATAN	(Mursid, et al.)
BPPT	(Panggabean)
DPE	(Arismunandar)
	(Surjadi)
FORESTRY	(Setyono)
	(Boulter)
	(Martawijaya — See IPB under Field Visits)
HOME AFFAIRS	(Babcock and Bailey — See under Field Visits)
ITB	(Ambyo)
	(Halim)
	(Manurung)
	(Sasswinadi)
LPGN/LIPI	(Adhikarya)
PERINDUSTRIAN	(Danusaputra, et al.)

B.4 SITE VISITS

PPPHH/IPB	Labs-Bogor (See Appendix G)
	(Martawijaya, Rosid, Tjutju, Vanhille, De Wilde)
BPPT	Solar Villages (Harsono and Aryo)
	(See Appendix G)
	Picon
	Cituis

Sulawesi Regional Development Project (see Appendix E)

- Jakarta
  - Tim Babcock
  - Bruce Bailey
- Baubau, Southeast Sulawesi
  - Dwight Watson
  - Officials of PLN
  - Officials of Perindustrian
  - Officials of BAPPEDA II
  - Owners and operators of local industry
- Kendari
  - Ray Catchpole
- Bone area
  - Bob Steele
  - Officials of P.G. Camming
  - Owners and operators of local industry

APPENDIX C: A ONE-KILOWATT STRATEGY FOR INDONESIA

The One-Kilowatt Strategy was developed by the Princeton energy team consisting of Jose Goldemberg (Brazil), Thomas Johansson (Sweden), Amulya Reddy (India) and Robert Williams (United States). Summaries of their work have been published in several articles, and the full report is available in manuscript form entitled, *Energy for a Sustainable World*, (hereafter cited as GJRW). The One-Kilowatt Strategy stems from two independent pieces of analysis. In brief, they are as follows:

a. Beginning from the thesis that the purpose of energy is to provide a better quality of life for people, GJRW identified three key indicators (life expectancy, infant mortality, and literacy). Nations were scaled according to their ranking on each indicator, and the results averaged to obtain a single quality of life indicator for each nation. This indicator was then plotted against per capita energy use (total per capita secondary energy use measured in kilowatts; i.e., kilowatt-years per capita-year). As usual in such plots, the spread was considerable, but a broad pattern was evident in the form of a curve exhibiting a distinct flattening between 1.0 and 1.5 kilowatts per capita. In other words, beyond this volume of energy further consumption does not improve quality of life (as measured by the three indicators).

b. In the second approach, GJRW decided to see how much energy would be required per capita if energy services comparable to those in Western Europe, Japan, New Zealand and Australia were provided to a developing country (except that space heating was deleted as not necessary in most developing countries). However, each service was provided by very efficient end-use devices. For example, gas is the most efficient way to deliver energy to cooking vessels, and, for a family of five, one 13 kg canister of LPG per month (equivalent to a capacity of 49 Watts) would be required; similarly, cement production of 479 kg per capita was assumed (OECD Europe average in 1980), and production efficiency was set equal to 3.56 GJ of fuel and 0.46 GJ of electricity per tonne (Sweden in 1983) equivalent respectively to 54 and 6 Watts. Adding all of the domestic and industrial services together, GJRW found that total energy requirements were just a little over One-Kilowatt per capita, divided roughly 20% as electricity and 80% as fuel.

This One-Kilowatt Strategy is, of course, highly generalized for all developing countries. It cannot be applied directly as a policy tool. Even the authors describe the strategy as a "thought experiment" for a "hypothetical developing country with a mix of energy-using activities similar to that for Western Europe in the 1970s but matched to much more efficient end-use technologies than those in common use in Europe." In this context, it is useful to see how Indonesia compares with this One-Kilowatt Strategy. However, there is no such thing as an "average" developing country, and there may be sound reasons why Indonesia differs in supply and demand patterns from those shown in the GJRW One-Kilowatt Strategy.

In 1980, Indonesia consumed 2.245 EJ (exajoules: 10^{18} Joules). Assuming population in that year of 150 million, this represented energy use of 12.5 GJ (gigajoules: 10^9 Joules) per capita-year. Of this energy, about 55% (according to tabulations of the International Energy Agency) was in the form of "Other Solid Energy" — mainly traditional forms of biomass. Using conventional conversion factors, this energy use was equivalent to 3,472 kilowatt-hours per capita-year, or almost exactly 40% of the 8,766 kilowatt-hours per capita-year implicit in the one-kilowatt goal.

Carrying the analysis further, the GJRW analysis indicates that 1,760 kWh per capita-year should be in the form of electricity and the remainder (just over 7,000) in the form of fuel. How does Indonesia compare on these two dimensions? In 1980 Indonesia consumed just over 10 GWh of electricity (including self-generated electricity in industry), but the indicated target amount would have been 264 GWh (or on a per capita basis, roughly 67 kWh per year actual compared with the target of 1,760). In other words, Indonesia provided only 4% of the energy indicated as needed in the form of electricity by the GJRW strategy. This result is not so surprising. In a study for IDRC, Joy Dunkerely found that per capita electricity consumption in Indonesia was the lowest in a sample of about 20 developing countries whose energy use patterns she analyzed; only one-fiftieth of the per capita use in Venezuela, highest in the sample in terms of electricity use. Even other ASEAN countries show considerably higher ratios of electricity use. For example, Thailand consumes over 300 kWh per capita-year, even though a higher proportion of Thai electricity is generated from thermal sources.

The situation is considerably better in the case of energy needed in the form of fuel. In 1980, Indonesia consumed 2.222 EJ of energy in the form of fuel. After adjusting to allow for the fuel used for captive generation in industry, total final fuel consumption can be estimated to be 2.209 EJ, equivalent to nearly 615 thousand million kilowatt-hours or 70 million kilowatts (i.e., kilowatt-years per year). On a per capita basis, about 470 watts are, therefore, being provided to the population. The One-Kilowatt Strategy suggests that total fuel requirements per capita will amount to 839 watts, so at this time Indonesia is currently providing about 56% of the target amount for fuels. However, of this supply, over 60% is delivered in the form of "Other solid energy", which means mainly traditional biomass fuels, whereas the One-Kilowatt Strategy requires that energy be provided in the most efficient quality, which is generally something other than biomass. The implications of this will be brought out further below.

Because the One-Kilowatt Strategy is developed on an end-use basis, the amount of energy needed in each sector can be identified. Unfortunately, the selection of sectors is not identical to that used in IEA tables. Nevertheless, a rough comparison of energy use by form and by sector between the GJRW hypothetical country and Indonesia can be developed by combining sectors. The results are shown on Parts A and B of Table C.1 for electricity and fuel, respectively. With one major exception, the Indonesian energy economy is low for each form of energy in each sector; indeed, in most cases it is well below the targets. The exception is the residential sector, where Indonesia is providing five times as much energy per capita as is deemed appropriate and efficient in the One-Kilowatt Strategy. (One must be careful of such statistics. For one thing, the residential and agricultural sectors are combined. More important, conventional statistical tabulations appear to ignore rural industry, such as village brick works, that may be heavy users of wood fuel.) The explanation for this apparently anomalous result is the use of unprocessed biomass — which in turn is consumed in inefficient stoves, ovens and kilns. Once this factor is taken into account, the fact that Indonesia is supplying 50% of the target volume of fuel energy is less optimistic than it appears; for example, only 21% of the target volume of energy is being provided to the transportation sector, and less than 17% of the target volume to the industrial sector.

To return to a point made above, it would be inappropriate to apply the pattern of use developed for the GJRW One-Kilowatt Strategy directly to Indonesia. For example, in many places in Indonesia, wood fuel is plentiful, and it would be inefficient to deliver modern forms of energy to such areas (though the efficiency of the end-use devices can no doubt be significantly improved). The nature of an island economy, with the vast differences in population density between "Jambal" and elsewhere, also indicates that the hypothetical model will require adaptation, as does the fact that Indonesia is an energy exporting country. Even some of the hypothetical end-uses require adjustment. For example, 29 watts per capita are allocated to residential water heating (over 10% of the total electrical requirement), an amount which seems most unlikely to be reached in Indonesia. On the other hand, no energy is allocated to the use of irons, which is a relatively common household appliance in Indonesia.

Nevertheless, the fact that Indonesia is so far from what is considered to be an optimally efficient pattern of energy use is certainly suggestive. Inevitably large additional volumes of energy will be required in order to provide an adequate quality of life for the Indonesian people, and it will be a challenge to develop this energy in environmentally acceptable ways. At the same time, there appears to be a major opportunity for reform in energy consumption patterns, a reform that should extend to each sector of the economy and that should involve every form of energy. The work being undertaken as part of the EMDI project will provide some indications of the nature of the tasks ahead for Indonesia, with particular emphasis on the environmental implications of different patterns of energy demand and supply.

TABLE C.1

Comparison of Energy Use by Sector in a Hypothetical Efficient Developing Country and in Indonesia

PART A: ELECTRICITY

SECTOR	GJRW W/P	ONE-KILOWATT STRATEGY kWH/P-A	INDONESIA (1980) GWH(TOT)	INDONESIA (1980) KWH/P.A.
Residential	51	447	-	-
Agriculture	4	35	3335	22
Commercial	22	193		
Transportation	12	105	-	-
Manufacturing Mining and Construction	121	1061	6470*	43
TOTAL	210	1841		65

*3010 (PLN) + 3460 (captive - 1979)

PART B: FUELS

SECTOR	GJRW W/P	ONE-KILOWATT STRATEGY KWH/P.A.	ONE-KILOWATT STRATEGY GJ/P.A.	INDONESIA (1980) PJ/A	INDONESIA (1980) GJ/P.A.
Residential	34	298	1.07		
Agriculture	41	359	1.29	1613	10.75
Commercial	-	-	-		
Transportation	276	2419	8.70	273	1.82
- road	(173)	(1517)	(5.46)	(253)	(1.69)
- rail	(32)	(281)	(1.01)	(2)	(0.01)
- air	(21)	(184)	(0.66)	(6)	(0.04)
- water	(50)	(438)	(1.58)	(13)	(0.09)
Manufacturing	429	3761	13.53	336	2.24
- iron & steel	(77)	(675)	(2.43)	(10)	(0.07)
Mining and Construction	59	517	1.86	Included in mfg.	
TOTAL	839	7354		2222	14.81

APPENDIX D: INSTITUTIONAL FRAMEWORK FOR ENERGY POLICY IN INDONESIA[1]

1.1 Relevant Organizations

In May 1978, as part of a general reorganization of Government departments, the Ministry of Mining and Energy (Departemen Pertambangan dan Energi--DPE) was established with responsibility for all activities in the mining and energy sectors. At present, the only sub-sectors which are not part of the Ministry are atomic energy, forestry and some energy-related institutions. Coordination and cooperation among major energy and consuming sectors within the economy are achieved through a cabinet-level committee of ministers chaired by the Minister of Mining and Energy.

1.1.1 Ministry of Mining and Energy (DPE)

DPE has a broad range of responsibilities including energy policy and planning, resource delineation and development, production and marketing and overall responsibility for the geological, mining and energy sectors, which include inter alia the exploration, mining and processing of metallix minerals, coal, geothermal and petroleum (oil and gas), and the development, generation, and distribution of electricity. DPE also controls the following State Enterprises which are responsible for the execution of Government policies in the respective energy subsectors: PERTAMINA (oil and gas), PLN (electricity), PTB (Perum Tambang Batubara, State Public Mining Company), PTBA (coal-mining at Bukit Asam), PGN (utility gas), PT TAMBANG TIMAH (tin mining), and PT ANEKA TAMBANG (miscellaneous mining). Although these companies have direct access to the Minister in practice, they receive direction on technical matters from the Directorates-General of DPE (described below).

Line responsibilities for the various energy organizations and institutions fall under four Directorates General within DPE : Mines; Geology and Mineral Resources; Oil and Gas; and Electric Power and New Energy. These Directorates General are further divided into a number of Sub-Directorates. Also answering to DPE for general administrative functions are the Secretariat-General and the Inspectorate-General. The latter has responsibility for overall control of policy and management for organizations within DPE, and provides auditing and monitoring of projects under implementation.

1.1.2 Planning and Policy Groups within DPE

Three main bodies under the direction of DPE are concerned with policy formulation in the energy sector: BAKOREN, PTE and PME. The last is an interdepartmental working group, but the first two are interdepartmental.

a. The National Energy Coordinating Board (Badan Koordinasi Energi Nasional: BAKOREN).

   BAKOREN is an interministerial policy board chaired by the Minister of Mining and Energy. It was created by presidential decree in 1980 and reports to the office of the President. Membership includes the Ministers of Public Works, Industry, Environment, Defence and Security, Communications, Agriculture, Science and Technology, and Administrative Reform; the Vice-Chairman of BAPPENAS; the Director General of the National Atomic Energy Agency; and the President Director of PERTAMINA. This board was formed to establish overall policy and to give direction on program implementation to the ministries and officials which are represented, both energy producing and energy consuming.

[1] Adapted from a work prepared by John Foster of EDPRA consultants in Ottawa, Canada. This work formed part of a MONENCO study of coal potential in ASEAN countries.

b. Interdepartmental Technical Committee on Energy Resources (PTE).

PTE was established in 1976 and is composed of representatives from ministries and other organizations concerned with energy affairs. Its major responsibilities include preparing proposals for energy policy and plans, and monitoring the implementation of approved policies. PTE reports directly to BAKOREN and meets every two weeks. PTE's Chairman is the Director General, Electric Power and New Energy; Vice-Chairman is the Director General-Oil and Gas. Its Secretary is the Director, New Energy. There are 31 members in all, which include: the Director for Coal, DPE; the Secretary General; senior officials from the Ministries of Agriculture, Commun-ications, Defence, Environment, Forestry, Industry, Interior (Village Development), and Public Works (Irrigation); the National Planning Agency (BAPPENAS); the Presidents Directors of PTB, PTBA, and PLN; and senior officials of PERTAMINA, BPPT (Agency for Assessment and Application of Technology), and research institutions.

Not every energy issue is reviewed through the BAKOREN/PTE mechanism. Some issues will go through DPEs line departments, and others through the state enterprises which also have their own corporate planning groups. The budgets of the PN (Perum Negera) state enterprises for energy are controlled by their Supervisory Boards, which are chaired by the Minister of Mining and Energy in the case of Pertamina; the Director General—Electric Power and New Energy, for PLN; and, by the Director General, Mines, for PTB. Ministry of Finance officials are on the Supervisory Boards of every PN state enterprise, as well as for Pertamina. Any changes in the budgets of the PN enterprises must be approved by the DPE and the Minister of Finance, although these enterprises have freedom within the limits of predetermined budgets.

The Secretariat-General is organized into bureaus for planning, personnel, finance, foreign cooperation, legal and general affairs; hence, it includes the Bureau of Planning. Much of the energy-related planning is, in practice, done by PTE. However, DPE has been considering the creation of an energy planning unit, which may be situated beside the Bureau of Planning, within the Secretariat-General. In view of a general freeze on Government staffing, the concept has not yet received approval, and PTE continues to carry out most of the planning activities.

1.1.3 ENERGY RESEARCH AND TECHNOLOGY INSTITUTIONS

The Ministry of Science and Technology maintains an active role in energy research and development through its two affiliated institutions: the Agency for the Assessment and Application of Technology (BPPT) and the National Centre for Research in Sciences and Technology (PUSPITEK). BPPT has ongoing pilot projects in the energy field. With a staff of 80 professionals, the group carries out energy research programs, mainly on renewable energy, and recently has been involved in coal applications. PUSPITEK undertakes testing and demonstration of specific energy conversion hardware.

Other groups doing energy research include the National Institute of Geology and Mining which operates within the Indonesian Institute of Sciences (LIPI): the Mineral Technology Development Centre, the Geological Research and Development Centre (LPGN), and the Oil and Gas Research and Technology Development Centre (LEMIGAS), all under DPE; and a number of research groups in Indonesia's universities which include the Technology Development Centre at the Institute of Technology-Bandung, the Institute of Technology at Surabaya, and Gajah Mada University, Yogyakarta.

2.2 Basic Policy Directions

The basic policy objectives of the Government of Indonesia in the energy sector, as broadly outlined in Repelita IV, are:

a. intensification of energy resource development and expansion of processing facilities;
b. gradual shift from an oil based economy to a multi-energy economy;
c. improved efficiency of conversion and utilization; and
d. indexation programs.

In 1976, a Presidential Instruction was issued aiming at the maximum possible use of coal for power generation and industrial usage. Repelita III (1978/79 to 1983/84) gave first priority to encouraging the development of coal for internal consumption wherever technically and economically feasible.

Prior to 1984, the government followed an energy pricing policy that was characterized by large financial subsidies on almost all petroleum products in an effort to encourage industrial development and also to dampen inflation. By the 1980s, this policy was causing increasing strain on the budget and providing a clear disincentive to potential users of non-oil resources to convert. In fact, the policy had resulted in the growing use of petroleum products rather than other fuels. Although kerosene subsidies were intended to replace fuel wood for cooking (to prevent deforestation and to help the poorer households), the product was wastefully substituted for fuel oil in the industrial sector. Moreover, a number of analyses indicated that only a relatively small share of the subsidy went to low-income people. In the 1980s, the government has followed a program of gradually removing subsidies, and by January 1984 all petroleum product prices (except for diesel) were at or above current international price levels. However, electricity prices, at least to households, remain highly subsidized.

APPENDIX E: NOTES ON THE ENERGY ECONOMY OF TWO REGIONS IN SULAWESI

1.1 INTRODUCTION

Between December 5 and 13, I spent about six days visiting South and Southeast Sulawesi, mainly at sites associated with the Sulawesi Regional Development Program, a CIDA-financed project for which the Guelph University School of Rural Planning is the Canadian executing agency.[1] The remainder of the time was spent either in travel or in lecturing at the PSL at Hasanuddin University, Ujung Pandang. Obviously, in this short time it is impossible to do an "energy study." The information was not collected in a systematic way and much is anecdotal. Therefore, the following trip report represents a selective set of observations and comments: first, with specific reference to the two areas where I spent the bulk of the time, (Baubau on Buton Island and Watampone and rural areas in Kabupaten Bone); and, second, general suggestions as to possible next steps for incorporating energy into overall development planning.

2.1 BAUBAU/BUTON ISLAND AREA[2]

Buton Island lies off the Southeast coast of Sulawesi. It is underlain by elevated coral reef (i.e., limestone) capped by hard, acidic (silicious) volcanic rocks, which makes mediocre and thin soil. The economy is based on agriculture and fishing with a little forestry and light industry. According to the Guelph project officer, Dwight Watson, once away from the cities, slash-and-burn agriculture is the rule with a six-year rotation, during which time trees grow two to 10 cm in diameter. Baubau is capital of the Buton Kabupaten and presumably is the most prosperous part of Buton Island. According to an overview of the Guelph project, the province is characterized by "erratic availability of food" and "widespread nutritional deficiencies." In 1980, rural Sulawesi had income levels equal to 70% of the national average, which suggests that in Southeast Sulawesi rural incomes are probably only 50 to 60% of the average.

During the three days in Baubau, I visited a couple of domestic kitchens, one Wisma (guest house) kitchen, and a number of industries: brass molding, charcoal making, blacksmith, rice mill, lime kiln and saw mill. Of these, the brass, rice and sawing operations use electricity; the rest are fully traditional. In addition, I had interviews with staff of BAPPEDA II, Perindustrian and PLN. Little time was spent on the transportation or fishing sectors.

2.1.1 THE ENERGY ECONOMY OF BAUBAU

Electricity is used sparingly: lighting, light appliances (TVs and fans mainly), and simple industrial tasks. Air conditioning is in very limited use and little refrigeration exists outside larger homes and guest houses. Cooking is done by preference on kerosene (LPG for those who can afford the equipment), but a great deal of wood is used. Charcoal is not used for cooking (except satay). Road and marine transportation are mainly diesel, but pedal vehicles and pushcarts remain important. Industrial operations are either fully traditional or have taken a first step to modernization by installation of simple electrical equipment (bellows, pumps, grinding and polishing saws). I did not visit the ice plant but, presumably, it is fully electric. When heat is required, the energy source remains either wood or charcoal. Wood is used by many households, and in Baubau most purchase it as small bundles of split hardwood. Even guest houses and wealthier families may continue to use wood for volume work, such as boiling water. (This may be irrational; see below.)

While a lot of wood is used in the aggregate by households, the exclusive user of larger sized wood is industry. Some operations, such as the lime kiln, use several tonnes per week of dried

[1] I should like to express my appreciation to all the project staff in Jakarta and in Sulawesi who assisted me in my work.

[2] While in Baubau I was well assisted on my work by Ruslin, a young student of English just finishing secondary school.

and green wood 10 cm and up in diameter. Industry seems to be the sole user of charcoal, which multiplies its impact on local wood supplies.

The PLN system should now be adequate with 2.5 MW of capacity in five diesel units (two new ones of 560 kW each). Depending upon whether one counts all units or only the two new ones, the system operates with an average load factor of 15 to 40 %. Most houses in "greater Baubau" are connected to the grid. The grid seems to extend some distance around the bay to the east, but it does not go any distance at all into the interior of the island.

According to Dwight Watson, elsewhere on Buton Island one finds private or community systems. A reference dated 1980 indicated that typical rates in such systems were Rp 60 per installed watt. (See further below.)

2.1.2 Observations on Buton Island

I have ambiguous information as to whether deforestation is a problem. Canadians associated with the Guelph project tend to think it is (or will be). People in traditional industries say they have no trouble getting good wood locally, and that the price is stable. Officials of Perindustrian dismiss the possibility of a wood shortage in the near future. If it is a problem, I would point the finger much more quickly at rural industry than at cooking as the source of the problem.

Charcoal-making processes in the area are the most inefficient imaginable — burning in the open. Maybe 5% of the energy content is saved. Not surprisingly, charcoal makers were the poorest people I encountered. They must, over the year, consume of lot of teak (local name: jati), which is the preferred source wood and makes the high-quality charcoal preferred by industry. (Good charcoal has the same energy content per kilo as coal.) In effect, charcoal making is a complementary product in teak harvesting as it takes as input the large branches that are trimmed off prior to shipping the logs.

Despite excess capacity in PLN, all of the electrified industrial operations I visited generate their own power with one to three kW diesel engines. This was the case even though PLN lines were all but directly overhead. Several people told me that they received "help from the government" to cover the Rp 1-to 3-million cost of the generators, but Perindustrian officials could not confirm the availability of any subsidies.

Adding just a little modern energy to traditional industry can permit a significant increase in productivity. Mechanized bellows plus grinding and polishing wheels at the brass works increased output from "a few" to "many" pots per day. Dividing through, I'd guess the gain was a factor of five to ten. Operations without electricity (e.g., blacksmith) said they would like to be connected but cannot afford it.

With two exceptions, no opportunities for significant local conservation efforts involving modern fuels were evident. (Vehicle and appliance efficiency could be improved but only by national action.) One exception involves the use of small captive generation instead of buying electricity from PLN; the other is the continued widespread use of kerosene lighting.

As everywhere in the country, improved wood stoves would double or triple end-use efficiency in cooking.

Energy costs can be deceptive. Electricity (to households) is 85 Rp/kWh. Liquids are priced at 450 Rp/L for gasoline and 200 Rp/L for both kerosene and diesel. Wood and charcoal prices vary but appear to run about 200 and 300 Rp/Kg, respectively. Dividing through by net energy contents, one finds that costs per megajoule are as follows: electricity 24, gasoline 14, wood 10, charcoal 8, diesel and kerosene 5.

Except for rice husks, no major piles of biomass wastes were observed in the area. I was told that cashew and coconut shells are also unused except as local sources of special purpose heat (ironing clothes, browning fish). The rice husks could in principle replace much of the diesel at the mill and supply nearly all houses (though typical mills in the area are below minimum economic size for biomass sources). The other materials could be burned directly after chipping or digested to form gas and used for local electric generation.

3.1 RAHA AND KENDARI: CONTRASTING ENERGY ECONOMIES

Two brief stops en route to the Bone area offered opposing contrasts to Baubau — Raha with greater use of traditional or low quality fuels and Kendari with greater use of modern fuels. Most cooking is done on wood in Raha (it is in the middle of a timber harvesting area, as indicated by large clear cuts on the hills and by piles of teak at the pier, and possibly also by the siltation of the harbour). Electricity is used very sparingly and kerosene lighting is common. Kendari gives a much more prosperous appearance, as befits a provincial capital. Electric lines extend some tens of kilometers to the airport, though some houses in rural areas are not connected. In the city itself, most houses are connected to the grid. Little wood was seen being sold, and wood stocks were not in evidence outside houses the way they are in Baubau. As confirmed by almost every survey, it appears that wood is economically inferior for cooking and kerosene for lighting. One has to expect that demand for higher quality household energy will grow with community and personal income.

4.1 BONE AREA[3]

My ume in the Bone area was divided between Watampone (capital of the Kabupaten; legally comparable to Baubau) and the Sanrego project area (an area of 20 villages and 64,000 people located in a broad valley about 60 km inland from Watampone). Watampone is much bigger than Baubau; the Sanrego region is far better agricultural land than Buton Island (and presumably the new dam will add to productivity by changing some rain-fed "sawah" to irrigated paddy), and accessibility by road to either city or country is much better. Yet, ironically, apart from rice mills, less small or traditional industry was found than in the area around Baubau. Perhaps the accessibility itself is the source of the difference: it is just as easy to import goods as to make them in the region. There is, however, a new large sugar mill (1 million tonnes per year) at Camming, and a couple of medium-sized, semi-modern plants in Watampone. As in Baubau, little time was spent looking at transportation or fishing.

4.1.1 THE ENERGY ECONOMY OF WATAMPONE

Watampone itself is fully electrified with a PLN grid fed by about 3 MW of relatively new diesel units. Almost every house is connected, but the grid doesn't extend much beyond the city boundaries. Lighting, TVs and stereos are the main uses in homes. Refrigeration appears to be ore common than in Baubau but aircon is equally rare.Watampone is the first place in Indonesia where I found incandescent bulbs continuing to play a large role—an obvious target for conservation. As in Baubau, local small industries (rice and saw mills) generate their own power with small diesel generators. The typical rice mill has about 1 kW of power and 2 tonnes per day of output (beras). Also as in Baubau, local transportation and fishing fleets are mainly diesel. Several semi-modern plants (larger than any seen in Baubau) were visited, all of which buy power from PLN and/or use other modern fuels. Each employs 10 or more people.

a. An extrusion plastics plant remelts scrap plastic (collected and sorted by colour by scavengers) to make household and utility utensils. This plant requires 750 to 1000 KW but little other energy. It operates eight hours per day (thus providing some day-time load for PLN).
b. Linked to the plastics plant is a noodle factory. It is not a consumer of electricity but goes through 150 L/d of fuel oil (they did not know whether heavy or light), which is burned under steamers that cook noodles made from 100 sacks of flour per day. The system is well designed with the boiling water fully recessed into the concrete stove and little heat or vapour loss through the steamers.
c. An ice plant using 1950s technology of old-fashioned 45 hp chillers. This plant requires 22 kW to make 3 tonnes of ice per day and switched to PLN last year (when firm power first became available). The payment to PLN is roughly 700,000 Rp/m which replaces purchase of 110 L/d of diesel oil. Even though the

[3] A great deal of assistance in this part of the project was provided by two students from the PSL at Hasanuddin University in Ujung Pandang: Chairin Nur and Zulkarnain Chairuddin.

price of the latter has since dropped from 240 to 200 Rp/L, the owner remains pleased because he is freed from the problems associated with self-supply.

Fuel wood bundles are sold throughout the city. Good quality wood in three to four kg bundles sells for Rp 250; lower quality one kg bundles sell for Rp 100. Averaging several people's estimates, expenses for fuel wood run from 250 to 500 Rp/household-day. Apart from satay making, no charcoal was seen in Watampone. I have no feeling for how much kerosene is used for cooking, but it remains a common lighting fuel at outdoor markets and food stalls.

About 20 km south of the city on the coast road are a number of traditional brick works. They dig clay, mold it into bricks, air dry the blocks, and then fire them. The one we visited requires three months to get enough bricks for a firing. The "kiln" is made from the bricks to be fired (an inefficient but low cost approach). Each firing lasts 48 hours and consumes five m^3 of wood. The wood (local names: jampu, asam, ading) costs Rp 30,000/m^3; last year it was only Rp 25,000 — the first good evidence of depletion (something confirmed by the owner). Each firing produces 30,000 acceptable bricks which sell for Rp 25 each on site. Costs per burn are Rp 300,000 for labour; Rp 25,000 for land rent (Rp 100,000 per year); and Rp 150,000 for fuel. Allowing Rp 25,000 for other costs, gross returns per firing are Rp 750,000 and net returns, Rp 250,000 — or Rp 1-million per year. There are 10 employees. This is tough, dirty work but returns are not bad.

4.1.2 The Energy Economy of the Sanrego Area

The most important observation for this area is that little commercial energy is used: diesel oil in the rice mills (surprisingly rare compared with the coast road) and for transportation, a little kerosene and a little electricity when community or private systems exist in a village. (A PLN system is now being installed along the main road through the region.) No charcoal.

The exception to the above generalization is the sugar mill (Pabrik Gula Camming), which has well over a megawatt of its own diesel-fired electrical capacity, most of which is used only during the three-month processing season. All of the bagasse generated at the mill is chopped finely and used as a boiler fuel (and supplemented as needed with residual oil). The mill also consumes lots of water from the nearby river. (Unfortunately, I do not know enough about sugar processing to make sense of everything I was told at the plant.)

The village of Camming adjacent to the mill is not supplied by the mill and has its own generator. Three or four "management houses" are fed electricity by the mill system, and so is the office building. Every house in the Sanrego area has an ample pile of mixed wood underneath. No bundles of fuel wood are sold. Indeed, the region appears to be a modest exporter of fuel wood. Lots of burning rice husks, candlenut shells, and other biomass residues all over the region. In aggregate, a huge potential source of energy.

4.1.3 Observations on the Bone Area

As in Baubau, calculations indicate that, per unit of contained energy, firewood is not as cheap as it might seem. However, for some reason it is cheaper in Bone than in Baubau. The clue to the question of why small industry generates its own power may lie as much in the desire for independence as anything else. The larger industrial consumers have shifted to PLN. In the case of the ice plant, diesel costs were Rp 660,000 per month at the time of the shift (calculated assuming 25 days operation per month). Had he stayed with diesel, costs today would have been Rp 550,000. However, running a 22 kW system is not so simple as the one or two kW systems used by small rice mills, so the shift still saves trouble if not money compared with the Rp 700,000/m (assuming eight-hour day) that must be paid to PLN. Further assuming electricity would cost the owner of a rice mill about Rp 160/kWh, a two kW system would take 16 kWh/d and thus cost only about Rp 2600/d from PLN. However, purchased electricity is still a new idea (available outside the central city only since last year), and the owner perceives it as too expensive. Thus, his psychology of independence (plus possible government help with capital to buy a small generator) must make the difference. Of course, once one gets large enough, as with the sugar mill (for which PLN power is not available in any case), full time electrical engineers, back-up and storage tanks are necessary in any event, so self-supply again becomes economic.

Most electrical systems are community-owned. Again, that elusive "help from the government" seems to be critical in getting the generator itself, but thereafter, rather than paying for electricity, users chip in to buy the diesel oil. Individuals also buy their own share of wiring. Just outside the Camming sugar mill, there is a 2.25 kW system serving 50 households (hh). It is operated from 6 to 12 p.m. daily and takes 12 l/d. If shared equally, the system provides 45 W/hh at a cost of Rp 48/hh-d. However, if the community had to buy the generator, costs would have been perhaps Rp 40,000/hh.

As in Baubau, industry in Watampone indicates the value of a little modern energy. The same could be true at the brick works. Equipment to dig and mold bricks more rapidly would increase productivity easily by a factor of three — one burn per month. If capital were available, I would guess this would pay off. I am less sure about building a kiln, which might be too expensive. On the other hand, at least two adverse effects have to be considered: increased demand for fuel wood and possible overwhelming of the local market (thus putting other brickworks out of business.)

In the case of the sugar mill, one has to wonder about several things. First, does it make sense for all that capacity to sit idle for much of the year? Second, even if it is necessary, couldn't a modest amount be fed to the local community or link to (and help stabilize) the PLN line now being erected? Why not gasify the bagasse and use it to generate electricity (rather than using it as a boiler fuel) and use, say, residual oil for electrical generation? I do not know whether any of these options is viable, but it does seem that ways could be found to integrate such large operations into the regional energy system.

5.1 Possible Steps to Sustainable Energy of Sulawesi

Perhaps the most fundamental step that can be taken toward sustainable energy for the areas seen is to do some thinking and planning. Apart from the little done by PLN, there is no evident energy planning for smaller cities and rural areas. The implicit assumption is that there is a market for whatever modern energy can be made available. It is no doubt true that modern fuels are wanted and that they add to the quality of life and productivity. However, there are some ways to improve the energy situation that are not going to be apparent unless someone thinks about them. At present, not only are energy systems becoming less sustainable, but the regions are becoming less self-reliant — dependent either on subsidies or on sending more of their income out to buy energy.

The foregoing should not be taken to mean that a fully sustainable energy system is close at hand. In particular, transportation fuels and central generation of electricity are likely to continue to depend upon oil products for some time to come. There just are no good immediate substitutes for gasoline or diesel oil for these functions, given the geography and economy of the two regions.

Dwight Watson suggested that the option of wood-fired steam generators for electric supplies and for tasks such as high-volume water pumping might be viable. Such systems have been shown to be economic on Kalimantan when wood wastes are available nearby, and steam generation systems based on agricultural wastes are in use in Israel. However, steam generation is a fussy technology that generally requires the presence of a stationary engineer on site. In areas not located at a mill, steam might not be a viable solution, but it deserves a further look.

The major options for reversing the trend to less sustainability lie with greater use of biomass for local grids and greater end-use efficiency. The main problem with the biomass options is that they work better at larger scales, which may require, for example, some amalgamation of rice mills, which in turn implies cultural and social changes. In addition, the following would certainly have to be made available:

a. capital to purchase or build equipment,
b. technical training, and
c. institutional support.

One immediate conservation step that could be taken is to encourage the use of fluorescent or neon lights rather than incandescent — the saving is a factor of five.

Household use of fuel wood could of course be made more efficient with improved stoves. The stoves could be still more efficient if the wood was converted to chips or briquettes. However, whereas the cost of a better wood stove is small, use of processed fuel would require new capital at the production end of the system.

An energy extension service could try a number of intermediate-technology approaches (after checking out specific technologies and economics):

a. improved cooking stoves,
b. chipping and/or briquetting of wood and waste biomass using mobile chippers, and
c. improved charcoal making.

The fact that in both Baubau and Watampone (and presumably other small cities) wood and charcoal are market commodities, should ease the process of introducing more cost-effective alternatives.

Certainly the PLN rural systems look expensive: a lot of wire and concrete poles for a relatively small population. A good cost comparison with local biomass- or diesel-fired units is definitely in order. After seeing a couple of the community-run diesel systems, I have no hesitation in arguing that communities can operate small electrical systems with light loads, and therefore that biomass-based systems could in principle be viable.

The reasons why small industry located within the area of a grid prefers to use small captive generators in lieu of buying from PLN deserves more study than my guess above. It could be any combination of:

a. philosophy of self-reliance,
b. distrust of or unfamiliarity with PLN system,
c. higher rates for small industrial consumers, and
d. the mysterious subsidy for purchase of small generators.

It is hard to believe that it would not be more efficient if such operations were connected to the grid — and they would also presumably help balance the evening peak with some daytime load.

The state of forest resources needs to be pinned down. In addition, the possibilities for creating woodlots for communities or small dedicated plantations for industrial users of wood should be considered. This kind of system works well elsewhere.

With the availability of diesel generation in villages, an interesting PV/diesel combination arises in which the expensive PV units would operate during the daytime to power those few functions requiring continuous supply (medical clinics, coolers, pumps) while these functions plus the lighting and appliances would be powered by industrial or community diesel units in the evenings. This combination is, of course, even more attractive if the diesel units are fed by gasified biomass.

While not a conservation measure per se (since air conditioning is rare), modern office construction methods seem ill-adapted to the climate. Temperatures inside offices are typically higher than those outside. Low, metal roofs and the absence of air flow seem to be the main culprits. Improved design and better placement of windows could help a lot.

So far as housing goes, "modernization" has gone further in Bone than on Buton Island, probably and ironically reflecting higher income levels. The ultimate in converting the appropriate to the inappropriate comes when the thatch roof is replaced by metal to get heat in from the top, the stilts are enclosed by sheeting to block air coming from below, and the matt or slatted walls are replaced by plastic to eliminate any remaining airflow.

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