Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-29 April 2010

Geothermal Energy for Sustainable Development: An Expanded Role in Indonesia's Energy Supply Chain

Sadiq H. Zaidi

Renaissance Energy Consultants

4 Bayberry Drive, Princeton, NJ 08540, USA

sadiqzaidi@renaissanceec.com

Keywords: Renewable Energy, Sustainable development, GHG, Climate Change, Private Sector participation, Innovative Financing Instruments, Market based tariff structure, and Measures to stimulate market mechanism.

ABSTRACT

Inadequate power supply has emerged as one of the most serious infrastructure constraints on sustainable economic growth in the Asia and Pacific region in general, and more specifically in Indonesia. Additional investments in traditional commercial power supply sources alone will not be sufficient to bridge the demand-supply gap. The heavy reliance on fossil fuels in the energy mix also raises major environmental concerns at the national, regional, and global levels. The burning of fossil fuels emits greenhouse gases (GHG) that cause climate change and impose substantial environmental and economic costs. It is essential to reduce emissions of greenhouse gases, ease growth in fossil fuel energy demand, curb the upward pressure on energy prices, and improve energy security. Thus, power systems based on renewable energy sources (RES) such as geothermal, biomass, solar, wind, and mini-hydro, etc., and improvements in the energy efficiency and conservation programs in the existing facilities, are promising solutions for alleviating some of the power shortages in Indonesia.

The priority for the development of renewable energy resources in Indonesia remains low at all levels, from end-users to Government officials. The Government of Indonesia should devise and enact, on an urgent basis, policies that are the pillars of renewable energy development, such as a market-based tariff structure; measures to stimulate market mechanisms; solid legislative and regulatory frameworks; strong institutional structures to ensure sustainability; and the promotion of behavioral changes that are not given much attention and priority at present in Indonesia.

Power generated from RES is economically attractive when compared with power generated from commercial energy sources if the economic costs of inputs and the environmental costs of fossil-based generation they displace are considered. The competitiveness of RES vis-à-vis commercial energy sources rises further when the electricity tariffs are aligned with long-run marginal costs. RES technologies also offer investment opportunities to small entrepreneurs in power generation and provide alternative sources of energy, especially in rural areas that cannot be supplied by grid. The investment decisions that will be taken over the next two decades will be critical in determining the world's climate and the security of energy supplies. There is, therefore, a challenge for the policy and decision makers of the governments, politicians, scholars, academia, civil society, media, and business leaders of the region and in Indonesia to create an enabling environment for the private sector to undertake development of geothermal energy and other RES. For their part, the multilateral development financial institutions like the Asian Development Bank, donor agencies, and the international financial institutions should extend not only the needed investment funds for the development of geothermal and other renewable energy resources but also provide new and bold innovative financing instruments, unlike the old traditional lending modalities of the past, that would enhance the provision of private capital, goods and services.

1. INTRODUCTION

1.1 Indonesia's Energy Sector- Challenges and Opportunities

Indonesia is the world's fourth most populous nation, with 240 million people living in a large archipelago of more than 6,000 inhabited islands. The population in Indonesia is concentrated, with about 80% living on Java-Madura-Bali. With the current global economic downturn, the Government of Indonesia (GOI) faces huge challenges: the unemployment rate is persistently high; there is severe poverty in rural areas and on the urban margins; and access to the basic human needs of health, education, electricity, water, sewage, and transport are still very limited.

Energy consumption in Indonesia has increased by about 6.0 % annually between 1990 and 2007 - more than three times faster than the world's average annual growth, rising from about 82 million tons of coal equivalent (Mtce) in 1990 to 174 Mtce in 2007, and is projected to increase to 403 Mtce by 2025. If left unchecked, Indonesia's energy consumption, primarily met by fossil-fuels (coal, oil and gas) will accelerate the country's significant contribution to the deterioration of local air quality and the increase of GHG emissions. The assessment in international published reports is that Indonesia may be in the top 3 or 4 global contributors to GHG emissions primarily because of its burning of fossil fuels, and the 22 million hectares of tropical peat swamp which are formed when trees and vegetation debris rot. Improving energy efficiency holds one of the keys to sustaining Indonesia's economic growth with reduced energy needs and lessened local and global environmental impacts.

The country's energy elasticity of demand - the ratio of energy consumption to gross domestic product (GDP) - is 1.8[1] to 1. In other words, a 1% increase in GDP generates a 1.8% increase in energy demand. By comparison, the energy elasticity is estimated at 1.6 to 1 in the People's

[1] Presentation by Indonesian Minister of Energy & Mineral Resources to the French Chamber of Commerce & Industry (August 2008)

Republic of China; 1.4 to 1 in Thailand; 0.95 to 1 in Japan; and 0.8 to 1 in the United States of America. To promote greater energy efficiency in the country, the short term energy conservation measures and efficiency improvements, as outlined in the National Energy Policy, aims to reduce the energy elasticity below 1 by 2030. Also, the energy intensity in Indonesia is about 35% higher than other ASEAN countries. For example, to achieve a $1.0 million increase in Indonesia's GDP, the country requires 480 tons of oil equivalents (TOE) of energy, whereas the average in other ASEAN countries is 358 TOE, and in Japan it is 92.2 TOE. The National Energy Policy to 2030 also targets a reduction of 1% in energy intensity. These results may be difficult to achieve as there are limited efforts in the country for energy efficiency and conservation programs.

Figure1: Greenhouse Gas (GHG) Emissions

	1971 (Mt.CO2)	2003 (Mt.CO2)	Change Since 1990
The World	13,958	23,579	18%
Developing Countries	1,995	8,226	56%
OECD Countries	9,378	12,446	13%
China	809	3,307	45%
India	199	1,016	71%
Indonesia	25	303	119%

Source: International Energy Agency

The challenges in the energy sector are enormous. Among the most pressing are, a) declining oil and gas production which has resulted in its substantial importation; b) distortion in the pricing structure requiring unsustainable energy subsidies and the resultant macroeconomic imbalances; and c) lack of coordinated decision making and governance in the energy sector. The provision of subsidy in the national budget amounts to about $25 billion, representing about 2.5%[2] of the Gross Domestic Product (GDP) or almost 25% of the national budget, of which $13 billion is allocated for the energy sector. It is estimated that the top 40% of the high income families benefit from 70% of energy subsidy, while the bottom 40% of low income families benefit from only 15% of subsidies. The subsidies have resulted in the abuse of energy utilization and waste by all categories of consumers, provided disincentive for instituting energy conservation and efficiency improvement programs in the industrial sector, and are the root cause for the lack of public desire to save energy in the transportation sector. There is substantial room for reducing the energy sector subsidy that will make funds available to the GOI for undertaking the urgently needed development of new energy projects and other economic and social development program in the country.

[2] The ceiling imposed by the National Assembly on the subsidy is limited to 3% of the GDP

1.2 Optimization of Fuel Mix to Reduce GHG Emissions and Dependence on Imported oil

Indonesia has an abundance of many types of energy resources that can be utilized for power generation, yet the fuel mix is dominated by fossil fuels. Among fossil fuels, the country is heavily dependent on oil, gas and coal, whose prices have increased significantly in the recent past, and impacted the cost of energy production. This has necessitated the provision of subsidy in the energy sector. However, the Government subsidies for petroleum products have stymied investment in the development of the country's alternative energy resources. To optimize the fuel mix for reducing the country's dependence on imported oil, and for improving the environment, there is a need to develop a plan to support the development of renewable energy resources such as geothermal, hydropower, and biomass etc., for power generation.

Figure 2: Primary Energy Reserves in Indonesia

	Fossil Fuels			Renewable Resources		
	Coal	Natural Gas	Oil	Geothermal	Hydro	Biomass
	MTOE	MTOE	MTOE	MW	MW	MW
Total	19,533	1,817	1,822	27,027	41,436	41,651

Total geothermal potential that is presently ready for commercial extraction is estimated at about 10,000 MW

Source: Ministry of Energy and Mineral Resources, Indonesia

1.3 Energy Future- Creating a Low Carbon Economy

The current energy path, which focuses on expanding fossil fuel burning, is neither environmentally nor economically sustainable. Increasing energy efficiency, to ensure more economic value from each primary energy unit consumed, has significant environmental and economic benefits. The phenomenon of global warming, driven by fossil fuel consumption worldwide, places the fragile environment in developing countries at the frontline of vulnerability to the adverse impacts of climate change on water supply, agriculture output, natural disasters, and especially the sea level. What is needed urgently is for governments to incorporate in the energy sector policy a framework to expand the energy infrastructure that is based on fuel that is free and self-renewing: the sun, the wind and geothermal, and gradually reduce the energy infrastructure that depends on fuel that continuously rises in price, is dirty, dangerous, causes global warming, and destroys the habitat of this planet. In December 2007, more than 200 of the world's leading climatologists signed a "Bali Declaration" warning that if immediate action is not taken, "many millions of people will be at risk from extreme events such as heat waves, drought, floods, and storms, our coasts and cities will be threatened by rising sea levels, and many ecosystems, plants and animal species will be in serious danger of extinction…there is no time to lose." Stabilization of greenhouse gases concentrations within the levels that would keep the impacts manageable would require limiting global GHG emissions through multilateral action involving policy incentives and the deployment on a global scale of low-carbon technologies in a range of

sectors including energy supply, transport, buildings, industry, agriculture, forestry, and waste management.

The climate crisis can not be resolved overnight. But the global community must bring down market barriers, quicken the pace of innovation, enact policies to promote clean energy, and above all, put a price on carbon emissions. Renewable and carbon-free sources of energy, conservation, and efficiency improvement programs are the only way the world can save itself from the climate crisis.

2. DEVELOPMENT OF GEOTHERMAL – A RENEWABLE ENERGY RESOURCE

Indonesia has considerable potential for developing a broad range of renewable energy resources (RES), principally geothermal, biomass, mini hydro, solar, and wind. Renewable energy resources can contribute to energy supply and security while helping change the mix. Renewable energy (RE) can support rural development and economic activity in remote areas while yielding positive environmental and social impacts. From the total potential renewable energy resources available in the country of about 162,250 MW, only about 5,800 MW is generated, representing just 4.3% of the primary energy supply in the country. Recognizing the considerable scope and opportunity to increase renewable energy generation, the GOI Energy Blueprint 2005-2025 projects its share in the primary energy supply to grow from the current 4.3% to 17% in 2025. This will raise renewable energy profile and its contribution to the total energy mix in the country.

According to "Statistics Indonesia" (Badan Pusat Statistik) about 22.7 million people or 19.5% of the rural population lived below the national poverty line of Rp 117,000 per month[3] in 2005. By improving access for the rural poor to modern forms of energy, in particular electricity, RE can play an important role in creating new economic activities in the rural areas of the country and in reducing poverty. Development of geothermal, biomass, and bio fuels – a renewable energy source in which Indonesia has substantial potential – would offer an important contribution to resolve power shortage issues, create a wider market base for RES among both industrial and residential energy users, and reduce GHG emissions.

2.1 Market Potential for the Development of Geothermal Resources in Indonesia

Indonesia is located in the "ring of fire" volcano belt and is estimated to hold about 40% of the world's geothermal reserves. The potential for generating power from geothermal resources is estimated by the government at about 27,000 MW per year, which is equivalent to about 420 million barrels of crude oil per year. At the current crude oil prices in the international market, the value of the country's geothermal resources is estimated at about $30 billion per year.

Most geothermal potential sites are in Sumatra (13,800MW), Java and Bali (9250MW), and Sulawesi (2,000MW). Of these, only 1,052 MW or about 4% of the total potential (mainly located on Java and Bali) have been developed. The GOI investment in geothermal development has risen from $65 million in 2005 to $181 million in 2006. Investment of $172 million was expected in 2007, and a further $209 million was planned for 2008. However, the planned investment program was not realized. The GOI long term planning for geothermal development and power generation calls for an increase in the capacity to 6,000 MW by 2020, and about 9,500 MW by 2025.

2.2 Private Sector Participation for Geothermal Development

The cost of geothermal resource development and power generation is about $2.0 million to $2.5 million per MW[4]. It is estimated that the country will need to invest about $12 billion to $15 billion between now and the period up to 2020 ($1.2- $1.5 billion per year), and an additional $9 billion during the period 2021 to 2025 ($1.8 billion per year) to meet the government target of generating 6,000 MW of geothermal electricity by 2020 and 9,500 MW by 2025. It is evident that the government can not allocate such a large capital outlay from its budgetary appropriation, and thus, will have to seek private sector investment.

3. FRAMEWORK FOR GEOTHERMAL DEVELOPMENT AND FINANCING OPTIONS

A development framework, acceptable to all, is needed to manage and to develop the untapped geothermal resources for a least-cost generation expansion plan for the power sector so as to meet the country's growing power deficit. If all aspects are designed appropriately and implemented well within responsibly- managed fiscal space, addressing environmental and social issues, benefit sharing, using state-of-the art analytical tools, strengthening institutions and capacity building, and the consultation process fully integrated into the decision making norms, the geothermal resources will be a major source of growth and prosperity in the country.

The framework should include an assessment of the adequacy of the institutional structure; identify gaps, if any, in terms of roles, responsibility, and authority. The capacity building program will assist the Government in implementing the institutional structure best suited for Indonesia. The program will formulate and implement the short-, medium-, and long-term capacity-building in the geothermal sector. The program will also enhance and strengthen the provincial capacities.

3.1 Financing options

There could be three possible financing options for the government to undertake systematic geothermal resource development and power generation.

3.2 Option 1: Government to undertake all Upstream Development Activities

Under option 1, the government undertakes all upstream activities for geothermal development such as detailed survey, exploration drilling for delineation of potential areas, drilling to establish exploitable proven reserves, and the production wells etc. It should also establish a Central Surface Gathering Facility for a cluster of geothermal resources in a particular area of the country. To ensure operational efficiency, reliability and credibility of resulting data, all these activities should be contracted out by the government to the private sector. For the financing of these

[3] According to the international poverty line for Indonesia, in 2002, 7.9% of the population lived below the $ 1 a day poverty line and 52.4%lived below the $2 a day. (World Development Indicators 2007, the World Bank).

[4] This includes geothermal development costs(exploration, drilling and other related costs).

activities, the government could seek assistance from the multilateral development financial institutions and other donor agencies like the Asian Development Bank, the World Bank, JBIC and others for securing soft loans and grant funds from such windows as the Clean Energy Fund, Climate Change Fund and others. The completion of these activities will ensure the availability of geothermal resources and the on-time delivery of steam to the private sector for the generation of electricity. These operational arrangements will eliminate the perceived risk and apprehension of the private sector which they associate with the development of geothermal resources.

The government will provide steam to the private sector for power generation at a cost which will recover the cost incurred in undertaking the operations noted above. The guaranteed delivery of steam will relieve the government of private sector pressure for higher tariffs for geothermal development and power generation.

3.3 Option 2: Private Sector to Generate Power Using Geothermal Resources

The government should invite the private sector to establish facilities for power generation with guaranteed supply of steam. The private sector will also be required to provide infrastructure facilities to transmit steam from the Central Surface Gathering Facilities to the power plant. The government will buy electricity from the private sector at an agreed rate stipulated in the PPA.

3.4 Option 3: Geothermal Development and Power generation under Public Private Partnership

Option 3 is basically a combination of options 1 and 2. Under this option, new financing modalities will be needed to fundamentally change the way projects are planned, funded and implemented .To proceed with the development of geothermal resources and to generate electric power under option 3, the Government should set up a New Independent Company (New Company), which will be owned by a consortium of international investors, GOI, the provinces with geothermal resources, and the domestic private investor. The combined equity holding of the GOI and the provinces should be a maximum of 25% of the New Company's equity. The New Company will take the geothermal development and power generation as build, own, operate, and transfer (BOOT)[5] model, and will take all risks and liabilities associated with the operation.

International Financial Institutions (IFIs) and other development partners may also take equity in this New Company. The multilateral development financial institutions and other donor agencies like the Asian Development Bank, the World Bank, JBIC and others could provide loans, concessional loans and grants from the Clean Energy Fund, Climate Fund and other windows, to the GOI and the provinces to pay for their equity holding in the New Company. The New Company would raise the debt from the market. It is envisaged that with the backing of the IFIs and other major donors and the financial strength of the New Company itself, it would raise debt at a favorable rate. It is possible that the Asian Development Bank and other donors could also facilitate the issuance of local currency bond and currency swap for financing the local currency cost of the project.

To provide further comfort and incentive to the private sector for investing in Indonesia's geothermal resource development and power generation, the government may seek the provision of political risk guarantees under ADB, the World Bank/MIGA facility with government counter guarantee.

The involvement of multilateral institutions in the country's geothermal resource development will bring standards of transparency and accountability, and will provide an increased level of comfort to private investors. Their due diligence process would add value to this complex undertaking and would help GOI manage risks, safeguards, and stakeholders' (including civil society's) expectations. Figure 3, shows a schematic drawing of a possible financing plan under option 3.

3.5 Government to Provide Investors Confidence for Funding Sustainability

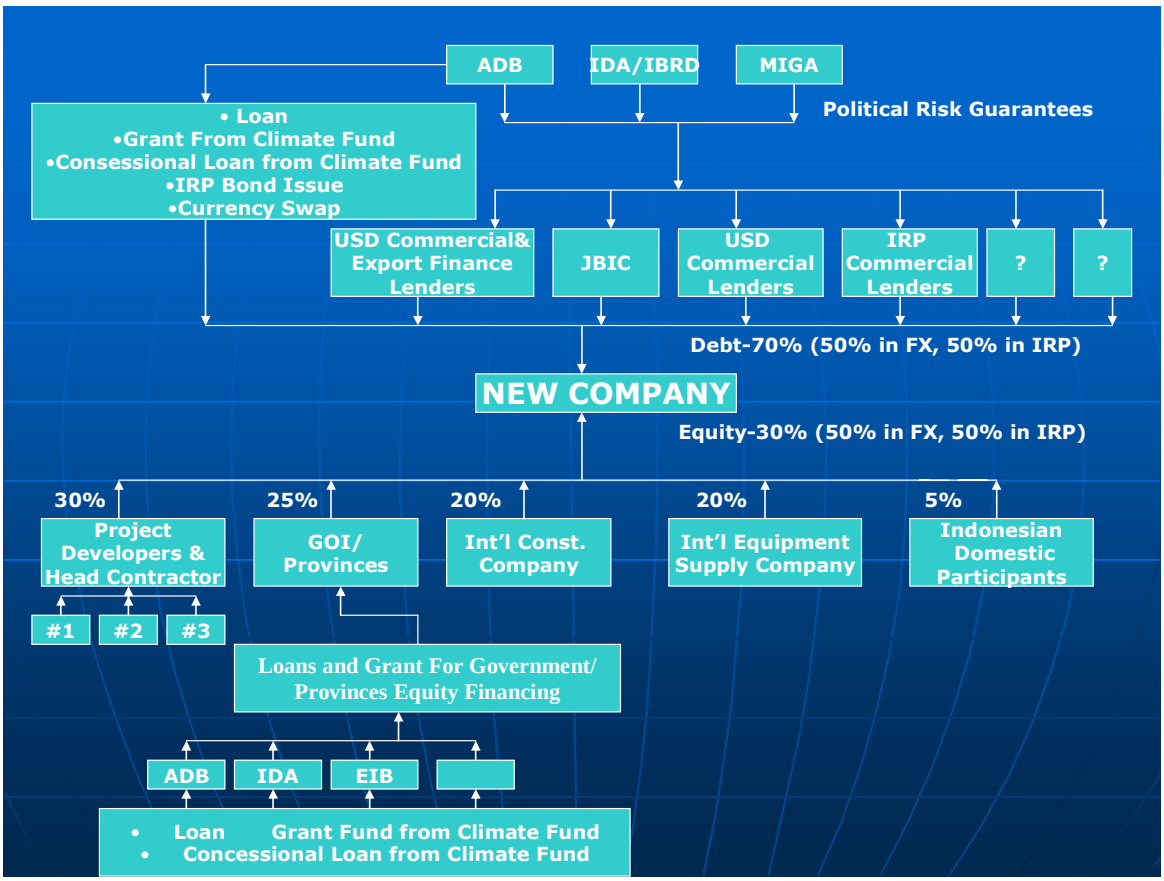
23. To attract such a large private sector investments for geothermal development and power generation, the government must ensure investors confidence by setting a competitive tariff structure to yield a reasonable return on investment; establish a transparent legal and regulatory regime with adequate enforcement mechanisms; ensure transparent bidding and tendering procedures for new projects which must be perceived as fair by all concerned parties; and a fair and favorable taxation regime. Equally important to the private sector investor is the concession agreement (CA) between the government and the investor, and the power purchase agreement (PPA) between the seller of geothermal electricity and the buyer (the government) which must be fair to both the parties. To provide further confidence to the private investor, the risks associated with the complete cycle of geothermal resource development and electricity generation should be shared by the government and the investor.

3.6 Institutional set up, Organizational Structure and Capacity Building

The successful development of geothermal resources and the associated power generation would require the government to establish a central government entity that would be responsible for all the upstream and downstream activities and also to provide coordination among all concerned agencies and stakeholders.

The concession agreement between the Government and New Company (in Option 3) should include capacity-building activities for the government staff. The agreement will require the New Company to provide on-the-job training to government officials. The main focus of this arrangement will be to encourage knowledge transfer from sponsor/developer to the government as they work together on the Project.

[5] A BOOT funding model involves a single developer, or a consortium, to design, build, fund, own, and operate the project for a defined period of time (usually 10 to 30 years), and then transfer the ownership to the government or to a partner at a previously agree-upon price (generally for a $1.00).



Note: ADB- Asian Development Bank, IDA- International Development Agency (World Bank Group), IBRD- International Bank for Reconstruction and Development (World Bank Group), MIGA- Multilateral Investment Guarantee Agency (World Bank Group), IRP- Indonesian Rupee, JBIC- Japan Bank for International Cooperation, EIB- European Investment Bank.

Figure 3: Schematic diagram showing a possible financing plan under option 3

4. COMMUNITY–BASED RENEWABLE ENERGY DEVELOPMENT FOR POVERTY REDUCTION IN REMOTE AREAS OF INDONESIA

The challenges facing economic development efforts in remote areas for poverty reduction are varied and complex and include: (a) lack of employment-generating programs; (b) lack of electric power to sustain economic development; (c) limited livelihood opportunities; (d) limited human capital investment and development; (e) lack of empowerment; (f) lack of financial services for the poor; and (g) piecemeal approach to poverty reduction and limited over-arching anti-poverty programs. The community-based renewable energy projects will help to (a) meet local electricity demand in an environmentally and socially sustainable manner; (b) improve access of rural areas to modern electricity services, and (c) improve standards of living for the poor through provision of community-level infrastructure.

Due to the high cost of grid extension and the lack of alternative resources, onsite renewable energy development projects have been shown to be the most cost-effective power source for remote areas of the countries. A systematic assessment of economically viable resources should be undertaken for specific renewable energy technology applications such as geothermal, biomass, micro-and mini- hydropower and solar power.

The increased use of renewable-resources-based electric power will also produce local environmental and health benefits such as reduced exposure to indoor air pollution, reduced pressure on forestry resources used to meet household heating and cooking needs, reduced local air pollution from diesel-fired generator sets, and direct economic benefits from the reduced need to purchase, transport and store fossil fuels in remote areas for power generation, heating and cooking. In addition to the environmental benefits, the community-based RES projects will create opportunities for economic development, social empowerment and alleviation of poverty in underdeveloped and remote communities. The RES projects will also reduce greenhouse gas emissions that would otherwise be produced from diesel-based generator use.

A Policy Framework for the Development of Renewable Energy specifically for remote areas should be formulated by GOI which should provide the government policy statement on renewable energy development, as well as defining the strategy to be followed in the medium to longer terms. The policy should place increased emphasis on the design, demonstration, and pilot testing of dispersed off-grid, community-embedded, and standalone renewable energy systems, including their financing and marketing modalities and integration with other social and physical infrastructure development (e.g., poverty alleviation, rural electrification). The framework should list all potential RES projects, outlining priorities and sequencing, along with funding requirements which should be based on completed

studies and prototype evaluations with specific RES and market targets and funding arrangements.

4.1 Key Factors for Sustainability of Community-based Renewable Energy Development

Sustainability of the community-based RES projects is primarily linked to the capacity built up within the communities themselves. Key factors which should be addressed during program design include the effective implementation of the community mobilization process, and the provision of technical and capacity building support to the communities to ensure the effective operation and maintenance of the system. The focus should be to (a) develop self-reliant and self-managed organizations in the target communities; (b) promote information dissemination, awareness building, and knowledge sharing with other remote community areas; and (c) build strategic partnerships with the private sector and civil society.

5. EMPOWERMENT OF WOMEN IN COMMUNITY-BASED RENEWABLE ENERGY DEVELOPMENT

Women are the mainstream users and often providers of household energy in villages. Without their active involvement, renewable energy projects will not succeed. Women are not only the main users of household energy in the developing world, but also influence if not make many family purchases related to energy. Energy researchers who downplay or ignore the role of women in their energy research and analysis will be failing to understand a critical part of developing countries' energy consumption and production. Donors who do not support gender-sensitive energy assistance will be overlooking one of their primary target groups. To encourage women to be involved in renewable energy development programs, an entrepreneurship program, designed and targeted exclusively for women's participation, should be organized. The "Village Women Entrepreneurship" program should include special incentives and concessions so that they may invest in the renewable energy development in their respective areas and be a part of regional development and poverty reduction. To motivate women to set up renewable energy development projects, they should be extended special concessions, such as favorable financing terms, and fee waivers on loans, legal expenses, documentation charges, etc.

6. KEY ISSUES RELATING TO GEOTHERMAL RENEWABLE ENERGY DEVELOPMENT IN INDONESIA

Although the potential supply of non-conventional energy in Indonesia is significant, the pace and magnitude of its development has been slow. The lack of access for RES users and developers to appropriate tariff structures and financing mechanisms has been a constraint to RES adoption. RES options also tend to be relatively dispersed in nature and highly dependent on localized conditions. These features require innovative promotion, delivery, and financing mechanisms to render RES feasible and affordable to target end-users. The present practice of subsidized energy prices (e.g., kerosene and electricity), especially to the rural and agriculture sectors where RES options are most often targeted, makes it difficult for RES technologies to compete on price with conventional options. The lack of a commercial market base has prevented a faster build up of the necessary infrastructure support and has inhibited opportunities for expanding the production of these systems. Past barriers to the import of new technologies have also resulted in a delay in the adaptation of new and cost-effective developments in many advanced RES options.

One of the critical constraints delaying implementation of renewable energy projects in Indonesia is the lack of financing in the amount and terms required owing to the lack of a long-term debt market. Financing from multilateral institutions or international lenders carries the burden of repayment in foreign currency, as very few renewable energy development projects have income in foreign exchange and hence are unable to repay in foreign exchange. Thus, the onus of managing the foreign exchange risk, which is subject to interest and exchange rate fluctuations, has to be borne by the small entrepreneurs engaged in renewable energy development. Indonesia may need to promote schemes to facilitate foreign exchange risk management for small entrepreneurs engaged in renewable energy development projects under financing from multilateral and international lenders.

Other barriers to the financing of renewable energy development are: (i) renewable energy projects have very high front-end capital cost per kW installed and negligible variable costs (operation and maintenance). This calls for debt with much longer maturity than is usually available in the commercial market; (ii) unlike in the case of conventional energy projects, they have very high project development costs compared to the actual project cost itself which leads to high level of transaction costs for financing (such as due diligence reviews, environmental and social studies etc.); (iii) it is difficult to guarantee cash flows for renewable energy projects, since they can not operate in the absence of adequate water flows, wind, or sun light or adequate backing of diesel generation sets or batteries; (iv) renewable projects' asset values are perceived to be "suspect" by the financing agencies since they have limited marketability compared to the assets of conventional power projects; and (v) many renewable energy technologies remain expensive, on account of higher capital costs, compared to conventional energy supplies for bulk energy supply to urban areas or major industries.

6.1 Non-technical Barrier

Non-technical barriers to renewable energy use are marketing, institutional, and policy impediments which are holding back the acceptance of renewable energy technologies. Key non-technical barriers are listed here, from most frequently cited to least, and must be addressed as part of the technology acceptance efforts. These are: (i) lack of government policy support. This includes both the lack of policies and regulations supporting development of renewable energy technologies as well as policies and regulations supporting conventional energy development such as fossil-fuel subsidies; (ii) lack of information dissemination and consumer awareness; (iii) difficulty in overcoming established conventional energy systems; (iv) failure to account for all costs and benefits of energy choices. This includes failure to internalize all costs of conventional energy (e.g., effects of air pollution, risk of supply disruption) and failure to internalize all benefits of renewable energy (e.g., cleaner air, energy security); (v) inadequate workforce skills and training. This includes lack in the workforce of adequate scientific, technical, and manufacturing skills required for renewable energy development; lack of reliable installation, maintenance, and inspection services; and failure of the educational system to provide adequate training in new technologies; (vi) lack of consumer awareness on benefits and opportunities of renewable energy; and (vii) lack of stakeholder/community

participation in energy choices and renewable energy projects.

6.2 Some Solutions

Some solutions to these problems are emerging. For purposes of project preparation, evaluation, due diligence, financing, and transaction costs are sought to be lowered by standardizing modules and grouping a large number of standard modules in a combined financing package. Small non-grid options such as mini hydro, wind power, solar PV systems, or their hybrids with battery or diesel back-up and without any associated grid or distribution systems are mostly sold to individual consumers. In such cases, the new approaches include: (i) leasing the system to end users rather than selling them. This overcomes the problem of high front end cost and has been used, with some success in India; (ii) dealing with renewable energy services companies (RESCOs), rather than end users. The RESCOs install and maintain renewable energy systems and collect monthly charges for the use of the facility. This mini-utility like approach makes it easier to finance the RESCOs than the end users.

7. CONCLUSIONS AND RECOMMENDATIONS

Conclusions: The heavy reliance on fossil fuels in Indonesia has significant detrimental environmental impacts. Power systems based on renewable energy sources such as geothermal, biomass, bagasse, wind, solar, biomethanation, municipal and agricultural wastes, mini-hydro, etc. are suitable candidates for alleviating some of the power shortages and greenhouse gases emissions. The policy makers of Indonesia must create an enabling environment for the private sector to undertake development of all forms of RES. It is also considered that: (i) renewable energy technology will have to improve at a very significant pace to provide low-cost impacts; (ii) significant increases in the use of wind power are possible, but only with substantial technical advances to facilitate greater use of less-productive locations; (iii) more moderate renewable energy supply targets, such as 10 or 15 percent, are realistic and manageable to achieve; (iv) the government's policy approach to pricing of renewable energy will significantly affect fuel demand and society's total energy expenditures; and (v) there exists great opportunities in Indonesia to expand the role of geothermal energy – a renewable energy resource in the national energy supply chain which will help reduce dependence on foreign fossil fuel supply, reduce GHG emissions, and meet the need to curtail foreign exchange expenditures.

Recommendations: Indonesia should focus on the interrelated institutional, regulatory, and financial reform issues that are considered essential to improve renewable energy sector performance in the 21st century. They should also move to establish an appropriate legal framework and regulatory processes, and support programs that will facilitate the involvement of private investors. The country should focus increasingly on creating a policy environment that is conducive to private investment and help mobilize private capital.

There appears to be an economic case for providing some financing subsidies in the initial phase of renewable energy development program because of their positive externalities both locally and globally. The subsidies must be designed to kick start an infant industry but must have a limited time span.

Indonesia should also seek assistance from the multilateral and bilateral agencies like the Asian Development Bank and the World Bank to provide new and innovative financing instruments, like guarantees, that would enhance the provision of private capital, goods and services.

Indonesia, as a policy should require all new investments (both private and public sector) interested in generating commercial energy from fossil fuel resources must also require the same entities to invest in generating at least 15%-20% equivalent power from renewable energy resources. The tariff approved should be an aggregate of both the energy produced from the fossil fuel and the renewable energy sources.

With renewable energy project revenue generated in local currency, there will be a special need for revenue vs. funding currency match, if project financing is from foreign sources. To ease the burden of foreign exchange outflow from the country, both debt and equity funding should have 50% in local currency and 50% in foreign exchange.

Indonesia may need to promote schemes to facilitate foreign exchange risk management for small entrepreneurs engaged in renewable energy development projects under financing by multilateral and international lenders.

Indonesia must implement market-based reforms; strengthen market regulations to ensure investor confidence and to attract private capital for geothermal thermal funding sustainability; and focus on creating competition as the driving force for improvement and private sector participation as a vehicle for progress in the renewable energy space.