

Small scale grid-connected renewable energy holds promise for Thailand

In May of 2002, Thailand's Cabinet passed landmark Very Small Power Producer (VSPP) legislation requiring the country's electric utilities to allow solar, wind, micro-hydroelectricity, biomass or biogas generators up to 1 MW per installation to connect to the grid. Generators that produce less than they consume in a monthly period receive the retail tariff rate for electricity fed onto the grid (they are able to use the grid as a free "battery bank"). For net excess production, producers are compensated at the "bulk supply tariff" - which is the average cost of generation and transmission in Thailand and is about 80% of the retail rate. Either way, it is a very good deal for renewable energy producers.

Thailand's VSPP legislation provides streamlined procedures for small renewable energy generators to connect to the grid, and guarantees both a market and good prices. The new laws create income opportunities for rural communities based on locally produced, clean, renewable energy supplies and offer significant potential to reduce Thailand's dependence on imported oil and coal.

In Japan, Europe, and many US states, streamlined interconnection policies have proved to be key steps toward realizing cost-effective renewable energy. Indeed, grid-connected residential/commercial systems now account for over 50% of the world's 400 MW/yr PV market (Maycock 2002). And while many countries and US states similar laws allow energy banking for systems 10 kW and smaller, Thailand's decision to accommodate systems up to one hundred times this capacity allows larger, more cost-effective - particularly bio-fueled - generators to participate.

The context for VSPP in Thailand

Grid-connected small-scale renewable energy is particularly appropriate for Thailand. According to government figures, the national grid reaches over 99% of all Thai villages, making it economically and technically feasible for virtually any community to connect their own renewable energy generator. Electricity consumption is growing at 6% per year, but building power plants is becoming increasingly challenging. Community protests over the siting of large power plants are frequent front-page news, with some communities engaging in decade-long struggles against power projects that have destroyed their homes and livelihoods (Palettu 2002). To sidestep^[RJP1] these conflicts within Thailand, Thai utilities have supported the construction of large-scale dams and gas pipelines in neighboring Laos and Burma - projects which have earned condemnation from the international community because of serious human rights abuses.

Fuel provision is a looming problem as well. The country relies on natural gas for 69% of electricity production, but domestic reserves are expected to be depleted within

three decades, and Thailand has been severely affected by the volatility of gas and oil prices in recent years (Amatayakul and Greacen 2002).

Opportunities for grid-connected renewables

Thailand is blessed with abundant untapped renewable energy. The country is the world's second largest exporter of rice, and a major producer of cassava, sugarcane, palm, coconut, and livestock. Agricultural residues, which are currently burned in fields or discarded, have the potential to meet 9% of Thailand's demand for electricity (NEPO 2001). Solar rooftops, wind energy, and community micro-hydroelectric projects also present significant opportunities. Although the majority of Thailand's population resides in rural areas, the ongoing migration to Bangkok in search of jobs is tearing apart the fabric of rural life. Rural renewable energy projects create jobs and can help stem this migratory flow.[RJP2]

The process of drafting and defending the policy

VSPP regulations are consistent with several long-standing government priorities. Thailand's reliance on imported fuels, as well as grassroots objection to large power plants, have led to growing interest within the government in promoting domestic renewable energy resources and decentralized power generation. There have also been strong pressures from the World Bank, the IMF, and the Ministry of Finance to increase the role of the private sector in electricity generation. In response, the Thai government has focused its electricity restructuring efforts on the much larger task of breaking up the two state-owned utilities, and securing a hospitable environment for large investors. Renewables under 1 MW in size were considered too small to warrant much attention.[RJP3]

The process that led to the adoption of Thai VSPP policies demonstrates that it doesn't always require an army of engineers and lawyers to enact these regulations in a developing country. Several years ago, officials at the Thai Energy Plan and Policy Office (EPPO) directed Thailand's two distribution utilities to develop regulations allowing small-scale renewable energy generators to connect to the grid. The utilities shelved the request, effectively stalling progress until EPPO officials asked a small team of volunteers led by renewable energy consultant and researcher Chris Greacen to draft the regulations.

The team began by reviewing similar technical and commercial regulations from several utilities in the United States. Using existing Thai technical interconnection requirements for larger generators as a model, the volunteers worked with Thai civil servants to adapt the US regulations to the Thai context. EPPO formed a working group of utility and government representatives, which debated the proposed regulations line by line. After three months, a final document was submitted to the Thai Cabinet. The regulations were passed on the second of May, 2002. Shortly afterwards, the utilities adopted the regulations and announced that they would begin accepting applications from

VSPP generators. The entire process - from research to enactment - took less than nine months.

Persuading the utilities to agree to VSPP provisions was not easy. In Thailand, as elsewhere, some decision-makers in electric utilities perceived the legislation as a threat to their monopoly control over power generation and distribution. Because utilities do have legitimate safety and reliability concerns, it was often difficult [RJP4]to sort the genuine objections from the specious. Fortunately, other key utility decision-makers recognized the benefits of these policies to Thai society, and to the country's energy independence, and supported the proposed regulations.

Essential features of the regulations

The legislation, entitled "Regulations for the Purchase of Power from Very Small Renewable Energy Power Producers", consists of two sections: commercial and technical. The commercial regulations discuss permitted renewable energy fuels, application and connection procedures, costs incurred by each party, tariffs, and billing arrangements. The technical regulations specify the requirements for a small renewable energy generator to connect to the grid. These include the discussion of responsibilities for each party (utility or customer generator); criteria for synchronization (acceptable voltage levels, frequency, power factor, harmonics); required protection relays, and provisions for emergency disconnect. Fortunately, the Institute of Electrical and Electronics Engineers (IEEE) has created a set of technical standards that addresses most of these issues - IEEE 929 for PV systems using grid inter-tied inverters, and IEEE 1547 for small rotating generation (synchronous and induction). The existence of international standards, and the fact that the Thai utilities are members of IEEE, made it much easier to reach agreement on specific technical requirements.

Several features of the regulations are worthy of note. First, they allow renewable energy generators to export up to 1 MW of electricity. The focus on electricity *export* allows systems larger than 1 MW to connect as long as the customer consumes sufficient electricity on-site. Second, the regulations provide for *aggregate* interconnection. Aggregate interconnection allows an entire renewable energy generating community to connect as a single customer and manage their own distribution. Aggregation, however, is allowed only for new customers, i.e., the arrangement must not "steal" existing customers from the utility. Third, the regulations combined with time-of-use (TOU) metering allow the possibility of increasing revenues by generating electricity during peak tariff hours (9 am to 10 pm) and consuming less expensive electricity during off-peak hours. This arrangement is expected to be of particular benefit to solar electric systems (which inherently produce during day-time peak hours) and renewable energy technologies such as biogas and biomass, which can store fuel.

Thai and English versions of the Thai regulations are available at vspp.org.

Profiles of potential and existing[RJP5] grid-interconnected systems

As of September, 2003, twenty-three VSPP applications had been submitted. Most of these are small rooftop solar electric systems under 5 kW peak, but there are four are significantly larger plants, including a 950 kW municipal waste biogas digester, and a 1 MW rice-husk fired plant. Under the new regulations, two net-metered generators have already come online, a 3.1 kW solar electric installation and a 400 kW woodchip-fired generator.

Applicants in the near future are expected to include significant numbers of small rooftop solar electric systems, biogas digestors at pig farms, community micro-hydroelectric generators, biomass-fired generation in rice and palm mills, and possibly wind turbines.

Photovoltaics are poised for growth in Thailand. [RJP6] There are already 64 grid-interconnected solar electric systems in the country, although they predate the new regulations and are not yet under the VSPP program. Since the technology to interconnect solar electricity is well established[RJP7], these systems offer easy first steps for Thai utility personnel[RJP8]. The presence of domestic solar technology providers also bodes well.[RJP9] Leo Electronics Co., Ltd., based in Bangkok, makes utility-intertie inverters that have proven reliable in solar installations, and have protection features that meet regulatory requirements. Several companies sell and install solar electric systems, and one company, Thai Photovoltaics Ltd., is poised to begin local production of amorphous PV modules with a production capacity of 20 MW per year.

Biodigestors present an intriguing opportunity to generate electricity while simultaneously mitigating a thorny environmental problem. Air and water pollution from pig farms located in Ratchaburi and Nakorn Pathom provinces southwest of Bangkok have been a source of considerable conflict. However, about 20 farms recently installed biogas digestors that use bacteria to break down manure to form compost and methane, effectively eliminating air and water pollution. The methane fuels generators to produce electricity-more than most farms can use. These farmers are eager to sell surplus electricity under VSPP arrangements, and many expect to recoup their investment in as little as three years.

Community micro-hydroelectric plants ranging in size from 10 to 40 kW have been built in 59 remote villages in Thailand's mountainous northern provinces. The national grid was far away when these projects were developed, but now that the grid has reached these villages, at least 30 of the micro-hydro systems have been abandoned. In nine grid-connected villages, however, the systems remain operating. Two of these communities have already committed to grid interconnection, and expect to generate electricity worth at least US\$10,000 per year. The remaining seven communities have also shown considerable interest. Thirty-one additional villages now served by the grid no longer use their micro-hydropower systems, but the weirs and pipes of these installations remain intact. Refurbishing these systems and tying them to the grid can provide funds to support community development, micro-credit, health and education.

Steam turbines and steam engines fired by agricultural residues such as rice husk or palm husk are also likely to be economically viable in many situations. In some cases, steam engines that powered rice mills a half-century ago are being refurbished to produce electricity under VSPP regulations.

Finally, there is considerable interest in wind turbines in Songkla and Pattani provinces in southeast Thailand where long-term wind speed measurements indicate a promising resource.

Remaining tasks and challenges

Despite Thailand's successes in adopting these regulations, much work lies ahead in educating potential customer-generators, facilitating access to needed equipment and financing, and assisting Thai utilities to meet regulatory requirements in a timely manner.

Lack of awareness about grid interconnection opportunities is one of the most significant barriers. Rice mill owners, farmer cooperatives, and others with substantial renewable energy resources are unaccustomed to thinking about using agricultural "waste" to produce electricity, and generally lack the background needed to evaluate an investment in renewable energy equipment.

Another substantial barrier is the shortage of high-quality, affordable equipment suitable for deploying grid-connected renewable energy systems. Indeed, work remains even in identifying the key technology gaps. Known problem areas include integrated protection relays for interconnection of rotating generation, internal combustion engines suitable for long-term use with biogas, and a variety of micro-hydro, wind, and solar system components. Expertise in the design and installation of all types of small-scale renewable energy systems is also in short supply.

There is widespread sentiment among renewable energy generators that protection and interconnection requirements are too stringent. In several key respects, technical requirements are more stringent than IEEE 1547 regulations. There is considerable work to be done to encourage utility engineers to lower technical requirements at least to the level of internationally recognized standards. The Thai utilities are also uncertain about appropriate testing procedures for VSPP systems, and lack experience developing the type of administrative arrangements required to efficiently process applications. These issues are being addressed by introducing Thai utility officials to their counterparts in the United States. Shortly after the regulations were passed, Thai utility officials participated in a study tour of the US. Three months later, experts from California's Pacific Gas & Electric Company and Sacramento Municipal Utility District led a workshop for utility engineers and administrators in Thailand - but much more remains to be done.

The authors recently formed Fair Access for Renewable Energy (FARE) to address the remaining barriers and to promote grid interconnection of small-scale renewable energy in Thailand. The project plans to bring together potential customer-

generators, utility personnel, equipment manufacturers, government officials, and financial resources to stimulate interest in, and facilitate implementation of grid-connected, net-metered renewable energy systems.

Conclusions

Thailand's VSPP laws provide an exciting vehicle for harnessing Thailand's plentiful renewable energy resources for cost-effective electricity generation - in ways that draw on the creativity and entrepreneurial spirit of small businesses and communities. While much work lies ahead, the future looks bright for small-scale renewables in Thailand.

References

- Amatayakul, W. and Chuenchom Greacen (2002). Thailand Experience with Clean Energy Technologies: Power Purchase Programs. ASEAN, Beijing, China.
- Maycock, P. (2002). "The World PV Market: Production increases 36%." *Renewable Energy World* 5 (4 July/Aug): 147-161.
- NEPO (2001). Strategic Plan for Thailand's Energy Development, NEPO.
- Palettu, A. (2002). "The role of the state in the marginalization of alternative energy." *Watershed Vol 7* (3 (March-June)): 21-32.

About the authors

Chris Greacen is director of Palang Thai (palangthai.org) and is a PhD candidate at the Energy and Resources Group (ERG) at U.C. Berkeley. Contact: chris@palangthai.org tel: +66 2 674-2533.

Richard Plevin is a software engineer and writer currently volunteering with the Palang Thai.

Chuenchom Sangarasri Greacen was formerly a policy analyst at EPPO, and currently works as a freelance public interest energy researcher.