

Small is pitiful: Micro-hydroelectricity and the Politics of Rural Electricity Provision in Thailand

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Abstract

A field-based study of Thailand's 20 year experience with community micro-hydroelectric systems provides insight into the forces that work against community-managed, appropriate technology rural infrastructure. The low long-term costs of these systems, built collaboratively by villagers and the Thai government, suggest that micro-hydroelectricity is a superior rural electrification choice for many Thai communities. Yet 69,942 villages are served by grid electrification, while only 59 microhydro electric installations were ever built. Of these, only 25 remain in operation. This research seeks to understand why so few were built, and why so few remaining operating. Research findings based on interviews, archival records, and computer data logging suggests several complementary conclusions: First, community micro-hydro is plagued by a variety of (largely resolvable) technical problems, the most significant of these being endemic brownouts and frequent generator failures. Second, these problems are exacerbated by user behavior in which over-consumption by individual households leads to critical shortages for the community as a whole. Third, challenges observed in the field the must be understood in the broader context of the political economy of Thai electrification in which community micro-hydroelectricity has been marginalized as an electrification option in favor of national grid expansion. This marginalization has roots in key cold-war era decisions that limited possibilities for decentralized renewable energy and cooperative ownership of electricity infrastructure, while reinforcing the dominance of the state-owned rural electrification utility and the grid extension approach. The ensuing chain of historical consequences has severely curtailed resources and incentives to address technical and user-behavior challenges. Finally, recently adopted net metering policies provide a promising vehicle for increasing the chances that rural communities continue to benefit from these systems.

Introduction

If engineering economics and environmental impact were deciding factors, one might expect that by today thousands of communities in rural mountainous parts of Thailand would be served by electricity from village-scale micro-hydroelectric¹ plants instead of the national grid. The topography and rainfall are ideal for the technology: steep hillsides are abundant in much of the north, northeast, and south; rainfall is generous, and thick forest cover helps ensure that many streams have water throughout the year. The technology is appropriate for the demographics and environment of these areas. Settlements in these areas are generally remote and sparse, so that electrification with

¹ Definitions of what constitutes "micro-hydropower" vary from 100 kW (Jiandong 2003) to 300 kW (Harvey, Brown et al. 1998). In Thailand, projects under 200 kW are considered "micro" (DEDP 1998).

micro-hydroelectricity is cheaper than extending the grid. The systems generally have little or no reservoir, so environmental impact is minimized.

Yet visitors to villages in Thailand's hill areas generally find either the national grid, or no electricity at all. The latest government figures indicate 69,942 villages served by grid electrification (PEA 2002). But only 59 community micro-hydroelectric systems have been built over the past 20 years, and of these, over two thirds have been replaced by the grid or fallen into disrepair. Some of the few remaining projects demonstrate the ability of this technology to provide local employment, capacity building, and resource management benefits in addition to affordable electricity. Despite these benefits micro-hydroelectric systems are rapidly being replaced by the grid.

My research addresses the question: *why is micro-hydroelectricity losing to the grid as the technology of choice for rural electrification in Thailand?* Micro-hydroelectricity in Thailand makes a particularly useful case study because it represents a long-running (20 years) program electrifying thousands of households with the one of the most cost-effective² of renewable energy technologies.

International Context

The global stakes are high. Conventional electricity generation worldwide already currently accounts for 38% of worldwide CO₂ emissions, which threaten to irreversibly change the environment (Dubash 2002). Electricity consumption in developing countries is expected to increase rapidly (World Bank 1992; World Energy Council 1993; Kassler 1994; Pearson 1996; Anderson 1997; G8 Renewable Energy Task Force 2001). It is now widely recognized among climate change scientists that stabilizing atmospheric CO₂ at twice pre-industrial levels while meeting goals of moderate economic growth implies a massive transition to carbon-free power, particularly in developing nations (Hoffert, Caldiera et al. 1998).

As a component of developing country electricity infrastructure, rural electrification poses a special challenge: grid extension has made impressive gains: nearly 1.3 billion people in developing countries have received electrification grid service in the past 20 years, but during this same time period the population of these countries has grown by 1.5 billion (Barnes and Floor 1996). Increasing privatization of electric utilities and fiscal austerity programs generally leave even less resources for public expenditures on unprofitable rural grid-electrification. And it seems questionable that private sector will respond adequately to the task of rural electrification. Entities involved in rural electrification in the emerging era of budget cuts would be wise to consider a wide range of technology options (such as low-cost, locally manufactured renewables) and management arrangements (such as locally managed cooperatives), even if they challenge established practices and concepts of ownership and control.

On the one hand, it is important to learn which approaches for rural renewable energy dissemination work, and why. On the other hand it is equally important to discover why

² This is not to imply that the cheapest energy technologies, renewable or otherwise, are necessarily the best. Tatum (1995) and Nader (1995) challenge the hegemony of the commodity view of energy and question whether the most cost-effective energy technologies necessarily the wisest choices in the sense that they guarantee optimal outcomes in the long term.

certain promising institutional and technical arrangements fail to effectively encourage widespread, long-term use of renewable energy technologies.

Thai context

In Thailand community scaled micro-hydroelectric cooperatives represent an important precedent for community ownership and control of clean electricity infrastructure. As such, they provide a functioning (if Lilliputian) alternative to centralized power systems run by parastatal utility companies (Palettu 2002) and to the profit-oriented large investor ownership model of electricity infrastructure advocated by the World Bank and IMF and implemented (with varying degrees of enthusiasm) by many governments in the developing world (Tellam 2000). The technologies used for centralized power generation in Thailand -- especially coal and large hydro power -- are increasingly criticized on environmental grounds (Kuankachorn 2000; Janchitfah 2001; Janchitfah 2002), while power plants that burn imported fossil fuels are criticized for jeopardizing economic security by fostering an unsafe reliance on imports (Amatayakul and Greacen 2002).

The parastatal utilities themselves are increasingly criticized by the Thai government, the private sector, and multilateral development agencies as being inefficient, monopolistic, and prone to amassing excessive debt, hurting both ratepayers and taxpayers alike (Barnes 1988; NEPO 2000; Crispin 2001). The same parastatals are also criticized by NGOs and citizens groups as being undemocratic and unfair in their treatment of affected communities (Hirsch and Warren 1998; Janchitfah 2001; Janchitfah 2002). Customer-owned distribution systems such as municipal and rural cooperative utilities in the United States, Europe, and elsewhere have provided valuable yardsticks by which to judge the efficiency and service of the state and investor-owned utilities. Some argue that the same types of yardsticks and alternatives are necessary in Thailand (Palettu 2002).

More broadly, community-managed micro-hydroelectricity accords well with a number of progressive movements within Thai policymaking. These include a move towards decentralization embraced in a newly adopted constitution (Thai Kingdom 1997), capacity building for rural enterprise, and increased environmental protection including reduction in emissions of greenhouse gases (Amatayakul and Greacen 2002).

Technology overview

Micro-hydroelectricity uses energy in falling water to spin a turbine to produce electricity. Figure 1 below shows the main components of stand-alone micro-hydroelectric systems of the type used in remote villages in Thailand. A small weir diverts water to a power canal or pipe. After traveling horizontally some distance, the water enters a forebay where sediment settles, and then falls down a steep, high pressure penstock pipe to drive a turbine located in the powerhouse. Turbines are either crossflow type, or pelton type, and spin a 3-phase synchronous generator to produce electricity. Water returns to the river via the tailrace. A system of wires and transformers distributes electricity to households in the village. Because these projects are quite small and typically have little or no reservoir, environmental impact is much less than for conventional hydroelectric projects.

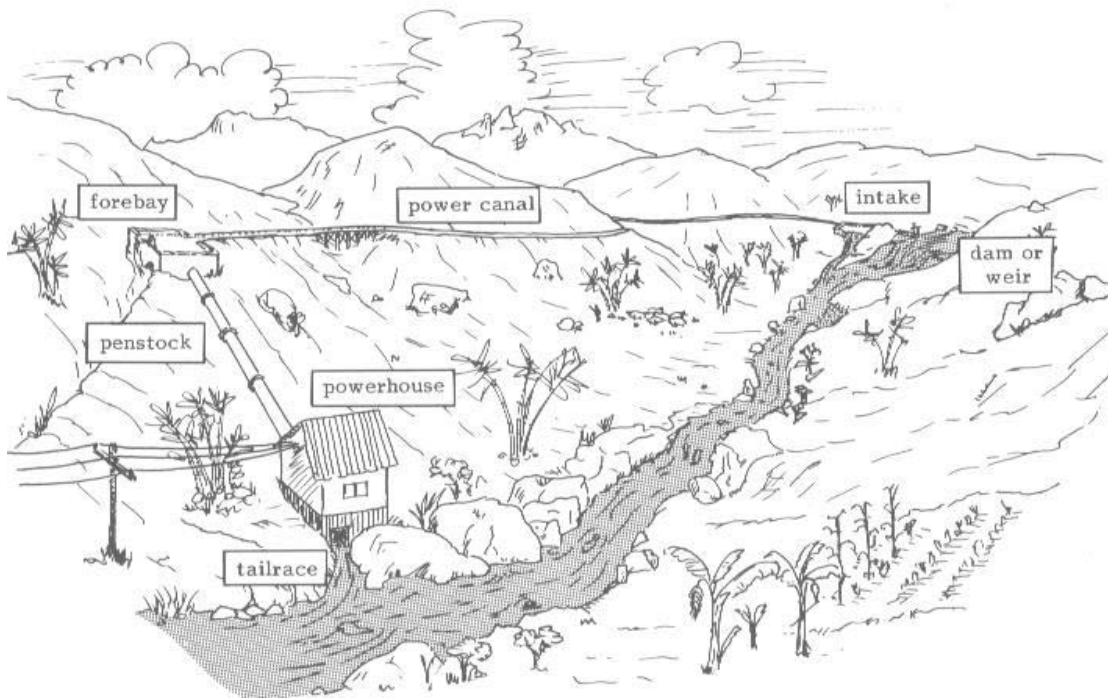


Figure 1: Basic components of a village micro-hydroelectric system. Source: (Inversin 1986)

Micro-hydroelectric technology is simple enough that it can be manufactured in regional developing country towns. The equipment used in Thai installations is manufactured in a metal fabrication shop in the town of Chiang Mai. The labor and local materials such as rock, sand, and wood are provided by the recipient communities. A government agency³, the Department of Energy Development and Promotion (or DEDP) designs the systems, pays for the equipment, oversees project construction, and provides technical advice and repair expertise when the project is in operation. The DEDP encourages each recipient village to form a micro-hydroelectric cooperative to collect tariffs and take responsibility for the system. The tariffs pay for repairs and cover the salaries of locals who are trained as operators and/or tariff collectors.

Costs: grid vs. micro-hydroelectricity

Because of the local manufacture, local labor contributions, and the general cost-effectiveness of the technology, community-managed micro-hydroelectricity as practiced in Thailand is quite inexpensive. Comparing capital, fuel, and operations and maintenance costs between Thai micro-hydroelectricity and the Provincial Electricity Authority (PEA) grid, 25 years of electricity service from the national grid costs \$1,264

³ In 2003 the name was changed to Department of Alternative Energy Development and Efficiency (or DEDE)

to \$1,586 per household served, while 25 years of micro-hydroelectricity costs \$846 to \$933 per household served.⁴

View from the field -- diagnosing the vital signs

To understand why micro-hydroelectricity appears to be losing to the grid, my research begins in the villages in which the projects are installed. I document the status of systems, and attempt to reconstruct, using interviews, surveys, and measurements, the historical evolution of factors that lead to outcomes.

Field Methods

My field research included site visits to 14 villages, surveys of 18 powerhouse operators, appliance use survey of 70 households in two villages, and extensive computerized datalogging of the generators when they were operating. I also draw on the results of a survey, the design of which I collaborated on, of all 59 microhydro installations conducted by the Industrial Engineering Faculty at Chiang Mai University.

Summary of field findings

The key findings⁵ are as follows: (1) most of the systems are abandoned at the time of – and because of -- the arrival of the PEA grid; (2) respondents in most villages are (or were before it stopped working) satisfied with micro-hydroelectricity, even though (3) there have been some problems – particularly with low evening time voltages and generator failures; (4) chronic low voltages and generator failures are symptoms of overloading the machines, which, in turn, are the consequence of unchecked appliance use, particularly of non-essential electrical heating loads (rice cookers, electric thermoses) by a minority of users.

In short, there are ways in which better local management and better technical support could improve the prospects for long-term operation of community micro-hydroelectricity. But overall it is clear that in most cases communities with micro-hydroelectric systems are willing and able to make their systems work – unless they have the opportunity to switch to the (heavily subsidized, comparatively hassle-free) national grid.

Decisions about where and how much to expand the grid are made in high-rise buildings far from village houses. This suggests the need to consider the broader context of rural electrification technology choice in the country.

⁴ Costs take into account both historical currency fluctuations and discount rates. Microhydro cost estimates are based on actual costs for 58 projects (Panya Consultants Co., 1993), and 15 years of O&M expenses recorded by the Mae Kam Pong village micro-hydroelectric cooperative. Grid costs rely on data provided by Thai utilities for a study to review electric power tariffs commissioned by the Thai Government and conducted by Price Waterhouse Coopers (Price Waterhouse Coopers 2000).

⁵ These field-based findings are discussed in detail in Chapter 3 of my dissertation (in progress).

Towards a theoretical foundation

To establish a foundation for such an investigation, it is instructive to consider two theoretical perspectives that address adoption of environmentally friendly technology. The first, the “social barriers perspective” dominates the vast majority of published articles (both within academia and produced by development agencies) addressing dissemination and use of renewable energy. The second, which might be termed, “political economy of technology choice” draws on ideas developed by Thomas (1994) and Ferguson (1994) and is particularly useful for understanding micro-hydroelectricity in the context of rural electrification in Thailand.

Social barriers perspective

Why is diffusion of cost-effective, socially and/or environmentally superior technology small compared with the technical and economic potential for its application? Questions of this nature are generally addressed in a literature that identifies “social barriers” to new technology adoption. Social barriers have been identified for renewable energy dissemination in developing and transitional economy country contexts (Karekezi 1994; Miller 1998; Duke, Jabobsen et al. 2002), including in Thailand (Wade 1997; Energy Research Institute 1999).

Diagnoses vary, but typically conclude that decision-makers lack sufficient information of the right type to make the right kind of rational economic choices (Shove 1998), that institutional capacities to evaluate, finance, and conduct investment are limited, that the technologies and dissemination methods present high initial costs, transaction costs and/or risks (Martinot and McDoom 2000), or that there are insufficient incentives and a policy environment that fails to adequately and fairly address renewable energy (G8 Renewable Energy Task Force 2001). In response, what is needed is better guidance and advice, typically in the form of a set of “best practices” principles offered to address the identified barriers (Cabraal 1996; IIEC-Asia 1998; SGA Energy Limited 1999; Martinot and McDoom 2000).

The literature forms the basis for many of the policy interventions undertaken to support renewables, including large programs multilateral funding agencies such as the GEF (Martinot and McDoom 2000), the World Bank REF, and the G-8 (G8 Renewable Energy Task Force 2001), as well as a number of NGO programs (IIEC-Asia 1998). Policies and programs within Thailand as well include a substantial “barriers identification” component.

The existing literature on barriers to clean energy technology adoption yields useful insights. There *are* barriers to renewable energy use, and identifying them is a useful initial activity. However, the barriers literature falls short of providing satisfactory explanation of the conditions that shape and constrain renewable energy use in many contexts. The primary shortcoming of the barriers literature is that it is primarily descriptive, and provides few theoretical tools for understanding how certain barriers arise. In other words, while much “social barriers” literature is adept at identifying problems, it does little to explain the structural or historical bases for these problems.

In trying to apply social barriers literature to the situation of village-scale microhydroelectricity in Thailand, additional shortcomings emerge. The literature

generally addresses technology uptake *in the marketplace* by supposedly *autonomous individuals*. This perspective offers insufficient guidance in the case of technology choice in community or larger-scale rural electrification infrastructure which is dominated by intervention by the state. In addition, because barriers literature focuses on technology diffusion and uptake, rather than long-term use, it offers insufficient explanations for cases in which technology has been adopted only to be later abandoned.

Political economy of electrification technology adoption

The shortcomings of the barriers perspective suggest the need for a more nuanced political economy framework (Wolf 1982; Ferguson 1994) sensitive to the web of historical developments and structural factors, including linkages to events and forces far beyond Thai borders that shape and limit particular socio-technical possibilities. This perspective recognizes the need for an historical analysis of relevant policies, programs, and institutions, and the ways changes in these have shaped current arrangements, both social and technical, for rural electrification infrastructure. The perspective must be sensitive, as well, to a variety of scales of social organization, from the social relations within the village, to wider geographical and social settings in which they are entwined, including state bureaucracies, international financial institutions, and global geopolitics.

In this framing of a “political economy of technology choice”, considerable emphasis is placed on the understanding the trajectories of competing technologies and the organizations that champion them. In this regard, Thomas (1994) provides insight by conceiving of the adoption of technology within large organizations “as *mediated by the exercise of power*, that is, by a system of authority and domination that asserts the primacy of one understanding of the physical world, one prescription for social organization, over others.” The faction and associated technology option that becomes dominant is not necessarily “the best” or most logical in an engineering or economic sense. Rather, the choice of particular technologies and the social arrangements that structure them consist of the discovery and application (or attempted application) of rules and conditions that are consistent with particular organizational objectives (Thomas 1994).

Understanding the “organizational objectives” that shape and limit technology choice in the case of Thai rural electrification requires sensitivity to the functioning of the state, state bureaucracies and rural communities. Essential to this analysis is attention to the historical evolution of: the geopolitics of aid, Thai rural/urban political and economic transformations (Piriyarangsarn 1994; Phongpaichit 1998), bureaucratic expansion and competition (Riggs 1966; Ferguson 1994; Scott 1998).

Identifying the interests of various actors and the mechanisms by which they attempt to accomplish those interests is, in itself, insufficient. That is to say, a political economic analysis of technology choice must be sensitive to the pitfall of assuming that it is sufficient to explain technology adoption as simply the product of strategic choice. Whatever interests are at work, and whatever their intentions, attempts to “get things done” in the real world are mediated by complex social and cultural structures that yield unpredictable transformations of original intentions (Ferguson 1994). With this in mind, it is important to ask how technology choices were framed, how the objectives of

different actors shape the range of possibilities considered, and most important, how differences in objectives influence the outcomes of change (Thomas 1994).

In understanding the trajectory of technology adoption, considerable influence must also be attributed to the role of what might be termed “technological inertia” (Thomas 1994) or “technological somnambulance” (Winner 1986). Once a particular technology solution is adopted, institutional arrangements grow to support, service, and reproduce that particular technological approach. Subsequently the technology is likely to be implemented even in situations where others are more economically rational or make more engineering sense. In the case of rural electrification technologies, technological inertia is the product of the historical coupling of technology and structure discussed above, combined with popular non-participation (leaving the decisions up to the “experts”).

Micro-hydroelectricity and the grid in Thailand

To understand the historical development of the rural electricity in Thailand and the evolving dynamics between grid-based and micro-hydroelectric based approaches, I conducted interviews and archival research. The key questions that inform this research component are: *How and why were key decisions on rural electrification technology choice made? Specifically, how have organizational structures and key events shaped and constrained the opportunities for community managed village-scale micro-hydroelectricity?*

The development of rural electrification in Thailand over the past half a century is characterized by two main points of contention. Would the electrical system be centralized or decentralized? And would ownership be by state-owned monopoly, or by cooperatives?⁶ The history is pushed by two main forces: the cold war – particularly US involvement in the cold war – and competition between Thai bureaucracies.

The evolution of rural electrification in Thailand can be broken into several important stages: an era of diverse approaches in the 1950s, in which cooperatives, private, and municipal ownership were common. This was followed in the 1960s and 1970s by the formation and growth of large parastatal electricity monopolies, boosted by significant communist counterinsurgency investments. In the 1980s the country flirted with “Small is Beautiful approaches” but these never challenged the growing hegemony of the parastatals. By the 1990s and 2000s vicious circles of marginalization relegated community micro-hydroelectricity to its current position as a footnote in Thai rural electrification history.

1950s – Diverse electrification strategies

In the 1950s it was not yet clear what Thailand's rural electrification would look like, administratively or technically. There was no consensus on the form of ownership: whether it would be private franchises, the state, or rural customers themselves as was the case in rural America. The technologies to be used were also undecided – especially the

⁶ The time frame I’m considering is up to the 1990s. My research does not consider the introduction of market forces after that period – though in Thailand these have mostly focused on generation rather than transmission and distribution of electricity.

extent to which electricity would be generated in large power plants or by smaller decentralized systems.

Electricity was rare in rural areas. By the early 1960s only 2% of Thai villages had electricity. Forms of ownership were diverse: there were over 200 separate small cooperative, municipal or privately owned utilities.

In 1958 the National Energy Authority or NEA was created under the Office of the Prime Minister. The bureaucracy was to be “responsible for the planning... development and utilization of all energy resources in the country”. Among other tasks, the NEA regulated the hundreds of utilities spread across Thailand, as well as built many of the country’s early power plants.

But brewing on the horizon were events outside Thai borders that would later set the stage for significant US involvement in Thai rural electrification. In 1948 increasing communist control in Eastern Europe and the prospect of Mao winning the civil war in China raised U.S. concerns over a variety of anti-colonial insurgencies in the region. As the Cold War expanded pro-US military governments in Thailand received over a billion dollars in economic and military assistance from the U.S., which saw Thailand as a regional power to be courted in containing communism.

1960s – Formative period

In the 1960s the basic institutional arrangements were in place that shape and limit rural electrification possibilities today. Many of these decisions reflected the cold war concerns of the day, and the influence of the United States.

In 1960 the Provincial Electricity Authority (PEA) was created as a state owned company with a mandate to electrify all rural areas in the country. The PEA was created under the Ministry of Interior, a competing ministry with the Office of the Prime Minister that housed the NEA. Whereas as the Office of the Prime Minister is largely concerned with planning, The Ministry of Interior has a focus on infrastructure provision such as roads and water supply, as well as internal security.

Rural electrification was increasingly seen as a way to win hearts and minds away from socialist ideologies that were ascendant in the region. As such, rural electrification was an integral part of a larger infrastructure package that included roads to facilitate movement of troops to border areas; irrigation and mechanised agriculture to integrate rural communities into the capitalist economy; and government-controlled radio and TV stations. People in rural Thailand came to know the programmes by the Thai phrase, *nam lai, fai sawang, taang dee* which means water flows, lights shine, good road.

These US planners left no doubt about their motivation in providing US economic aid for rural electrification. Documents from this era included passages like this one: “Lighting serves a particular counter-subversion need by reducing the psychological isolation of villagers, facilitating police surveillance, and inhibiting clandestine infiltration” (USAID 1966).

The US cold war planners were literally the architects of Thai rural electrification. USAID rural electrification studies began in the early 1960s. In 1972 USAID planners conducted a comprehensive rural electrification pre-feasibility study that focused most

strongly on the Northeast and South -- areas of greatest insurgency. The plan included specifications for equipment, procedures for determining which areas and villages to electrify in what order, rules governing tariffs, and recommendations for administrative structure. In 1973 Royal Thai Government officially adopted the study as the rural electrification master plan for the country (Voravate 1997).

1960s – Micro-hydroelectricity: threat of the Chinese model?

Although micro-hydroelectricity was proposed as a potential technology option, it was dismissed by the key American advisors that shaped how aid money would be spent. In the rural electrification master plan a USAID advisor wrote:

“The view has been advanced by some that the construction and operation of hydroelectric plants... is necessary in order to demonstrate the interest of the Government in the welfare of the people, particularly in the so-called "sensitive areas" where the very low income status of the population makes them susceptible to the propaganda of Asian Communism. Others believe that ... the funds available can be put to better use by building transmission and rural distribution facilities to bring power from large, centrally located generation stations which are ...less exposed to damage or destruction by subversive or enemy action. The team endorses the later option.” (USAID 1966)

Though the notion that an electrical infrastructure based on centralized power plants is less susceptible to terrorism seems somewhat bizarre in today's context, it shows what was important to these planners.

Starting in 1953 China had begun an extensive program urging "self-construction, self-management and self-consumption" of village-scale hydroelectricity. By 2001 there were 18,944 microhydro installations in China, the vast majority of which were community owned (Jiandong 2003). Some accounts put the figure at 90,000 (Pandey 1994). The total total capacity of small (<1 MW) microhydro in China exceeds than 26 GW – more than 160% of the peak load of Thailand in 2002 (Jiandong 2003).

Could it have been that US advisors perceived small, distributed hydro as a challenge to US monopoly in expertise on rural electrification?

1960s – Cooperative or state-owned rural electrification?

In addition to the question of whether or not to build microhydro plants, a debate raged over ownership and responsibility of rural low-voltage distribution systems. At one point in the mid-1960s, it appeared that cooperative ownership was a serious possibility, but one that was defeated by the PEA by 1967.

Much rural electrification in the U.S. was accomplished using farmer-run non-profit cooperatives. The National Rural Electrification Cooperatives Association (NRECA) is a US national non-profit federation of these rural electrification coops. Sponsored by USAID, NRECA sent a team to Thailand in 1964 to 1966 to study the feasibility of setting up rural electrification cooperatives in the three North East districts (Smith 1965;

Bergland 1966; Porter 1966; Smith 1966). In initial discussions PEA indicated that they were not interested in including cooperatives in their bureaucracy. US advisor to PEA, Mr. Belford Seabrook, said that organizing villagers to manage a cooperative is a waste of time and that "...it would be desirable to examine the matter objectively without the emotional handicap of an REA⁷ missionary." (Davies 1966)

The NEA, which operated a number of hydroelectric plants and was responsible for regulating existing independent utilities, responded enthusiastically, pledging to supply electricity to rural cooperatives, and provide engineering assistance (Davies 1966).

In meetings PEA became increasingly hostile and raised objections that the electricity cooperative project interfered with their own work, would confuse villagers, and that Thai farmer credit cooperatives had been tried and had failed. PEA said that precious state resources should be used instead to support PEA's own efforts that at the time concentrated on rural towns.

However, NRECA was confident that villagers would be able to manage electricity coops and that this approach would be cheaper than PEA's top down approach. Villagers in the area responded with enthusiasm. In the course of ten days of meetings, over 8,141 villagers signed membership applications, much more than the NEA expected (Davies 1966).

It all came to an end when the PEA general manager traveled to Washington D.C. to lobby USAID to cancel funding for program. In 1967 the cooperative experiment was scrapped (Davies 1966).

PEA expands... while NEA declines

Involvement of US cold war planners at PEA paved the way for advising and concessionary lending by the World Bank and other bilateral and multilateral funding agencies. By 1980 over \$1 billion had been committed to rural electrification. Electrified territory grew rapidly: by the year 2000 according to PEA data over 99% of Thai villages were electrified (Figure 2).

⁷ The Rural Electrification Administration (REA) was a US New Deal-era bureaucracy created to facilitate and support rural electrification cooperatives.

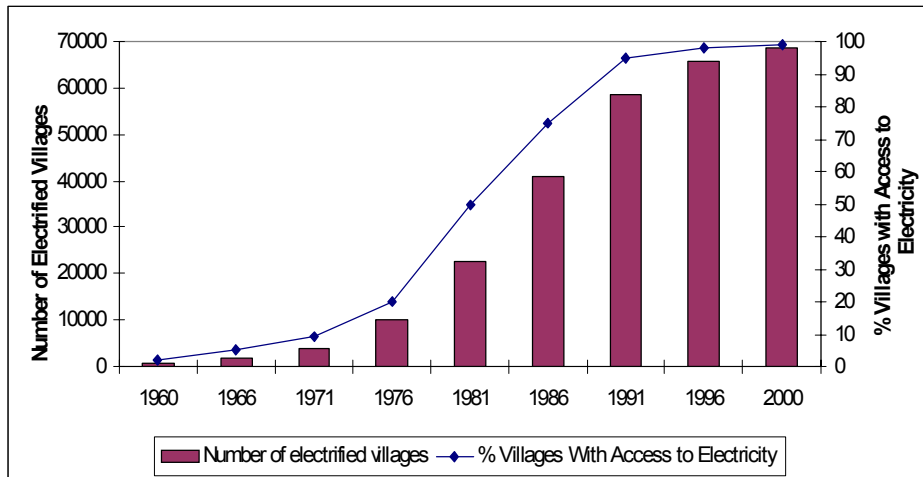


Figure 2: Number of electrified villages (bar chart) and percentage of villages with access to electricity (line chart). From 1960 the number of electrified villages climbed from 725 (2%) to 68464 (99%) in 2000. Source: (Poapongsakorn 1995). 2000 data from (PEA 2000).

PEA's workforce also grew rapidly (upper line in Figure 3)-- peaking at over 31,000 employees in 1994 – and failed to decline substantially as PEA's job of electrifying the country neared completion. One young engineer who had worked at PEA for 10 years complained that 50% of the employees could be laid-off with no loss of output (Interview 2000.02).

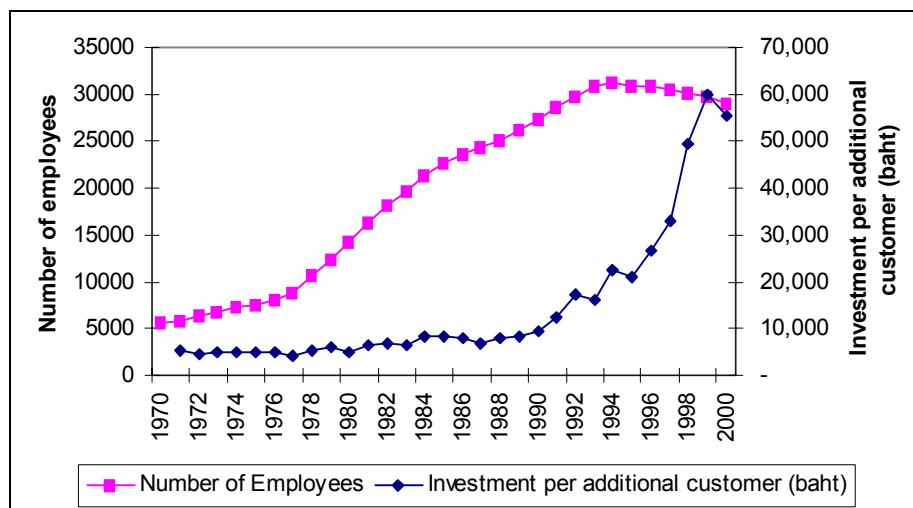


Figure 3: Number of employees and investment per additional customer, from 1970 to 2000. Source: PEA annual reports.

While PEA was perhaps once a fairly efficient organization by Thai standards, the easy availability of concessionary financing from external sources, the importance of electricity to its rural constituency, and the organization's sheer size allowed it to gain

political power. Increasing costs per additional customer (lower line in Figure 3) have been less of a concern than one might think because the Thai government has a policy of cross subsidy. The more profitable MEA (which provides electricity to Bangkok) transfers approximately US\$15 million every month to the PEA.

Over the same years the NEA declined in importance and power. By the late 1970s it had lost the power to enforce compliance with the plans it created. It was tossed from ministry to ministry, and suffering several name changes, before it ended up in 1992 as a shadow of its former self – the Department of Energy Development and Promotion (DEDP) under the Ministry of Science, Technology and Environment. In 2003 the name was changed again, to the even more marginal Department of Alternative Energy Development and Efficiency (DEDE).

1980s – NEA tries “Small is Beautiful”

In the midst of its decline, the NEA flirted with “Small is Beautiful” by initiating the Renewable Nonconventional Energy Project in 1984. The project enjoyed modest support from USAID, based on policies that had been shaped under the relatively progressive administration of US President Jimmy Carter, and received a total of 8 million baht from the Thai government under the 5th national 5-year plan. (The PEA over the same period was allocated 1100 million baht). A network of “rural energy centers” to facilitate the use of renewable energy was planned and funded. Projects were designed with strong involvement of social scientists and included a substantial community participation component. The programs focused on a variety of renewable energy technologies including biogas digestors, solar water pumping, as well as micro-hydroelectricity. The microhydro component encouraged villages to manage the systems using community cooperatives – which harkened back to NEA’s interest in supporting cooperatives almost 20 years earlier, and, as we have seen, is a social arrangement appears to work well.

The program responded to growing concerns about rural/urban inequality and high prices of imported OPEC oil. Three community micro-hydroelectric projects were built before USAID ceased funding the program under Reagan. However, the Thai government continues to provide modest funding, enough for a couple projects every year.

Village microhydro: the current situation

Integrating the micro-hydroelectric field-based observations briefly discussed at the beginning of this paper with the historical narrative it is possible to make several observations. Micro-hydroelectric systems continue to be both the source of electricity and village pride for thousands of remote households. Some of the systems have operated as long as 18 years. There are unresolved challenges stemming from the common pool nature of the resource, and from some engineering shortcomings in the equipment. These challenges are significant, though (in many cases) probably resolvable.

Contrary to what PEA officers said in the 1960s, electrical cooperatives can and do work in Thailand. To the extent that the systems have remained operating, it is because rural people value electricity and have the ability and desire to collectively put in the necessary work to make village micro-hydro cooperatives function. In doing so, they

build upon on community strengths and generally report that they are proud of “their powerplant” and happy with the ways it brings the community together.

Barring extreme technical catastrophes or conflicts, it is generally only the arrival of the PEA grid that spells the death knell for a microhydro system in a village. It is no surprise that when presented with the opportunity most villagers would choose PEA. From the villager’s perspective, subsidized electricity from PEA is a great deal: it is essentially maintenance-free, and has voltage that is generally stable. The bureaucratic history of rural electrification tells us that PEA electrifies remote micro-hydro villages because it *can*. With the cross subsidy from MEA and large government budgets it has little incentive to avoid extending the grid to remote and uneconomic areas. Indeed, electrifying the whole country fulfills its bureaucratic mission and provides work for its overgrown staff.

Community micro-hydro villages make particularly attractive targets for PEA. This is not because of some bureaucratic vendetta – the DEDP microhydro program is so small that most at PEA care anymore. Rather it is because these so-called “unelectrified households” make easy and good customers. They are already accustomed to paying electric bills and own many electrical appliances.

DEDP doesn’t bother to struggle to save the micro-hydroelectric systems because the bureaucracy is rewarded on the basis of the number of community systems it builds. When PEA comes in DEDP often removes the generator and turbine and installs them in a new village – essentially double-counting the same equipment. Perhaps for this reason, asking at central DEDP offices it is impossible to find out how many systems remain functioning. The information they omit in their reports makes it very difficult to find these systems in the field as well.

Thai rate payers and tax payers eventually foot the bill for this arrangement, adding to the Thailand’s significant debt, but the public is far removed from the decisions that they are accountable to pay for.

Marginalization creates a vicious circle. Villagers everywhere know about PEA. Few know of the microhydro alternative, or if they do they are aware of its mixed reputation. The DEDP village microhydro program only builds systems if villagers come to ask for them at their little office in the small town of Mae Jo 15 km north of Chiang Mai. If they don’t know about the projects, they don’t know to ask for them.

The fact that only one or two systems are built every year means there is only enough work for a single equipment manufacturer. Lack of competition means lower quality and higher price equipment. Even though microhydro is cheaper than the grid in many cases, it could be even less expensive. By way of illustration, in Nepal there is a microhydro industry consisting of well over a dozen manufacturers. Installations of comparable size and technology in remote hills of Nepal are about half the price of Thai installations, even though in Nepal all the equipment has to be carried in over mountain trails on the backs of Sherpa porters. Technical innovations that have been in use a decade in Nepal have never been heard of by microhydro professionals in Thailand.

Summary and conclusions

Early on, cooperatives and distributed generation did stand a chance. But starting in the 1950s, electricity took on a powerful political meaning. US cold war planners decided that a centralized state-owned company would be the best way to provide the rapid rural electrification necessary to fight communism. During this time there were significant steps taken to squash coops and microhydro as competing options.

By the time the cold war over impetus went away, the bureaucratic structure it had created took on a life of its own – politically strong and preoccupied with its own preservation and growth. As the country runs out of places to electrify, the state-owned utility can bulldoze what is left of microhydro cooperatives almost effortlessly, with little regard to economic efficiency.

For the broader community interested in village renewable energy, there are three take home messages. The first takes the form of an ominous question. From an engineering, cost, and local management perspective, village microhydro systems in Thailand are among the most promising examples that exist. *If Thailand's village microhydro is on verge of extinction, what are the implications for more problematic village power technologies?* By problematic I mean system that are more costly, more complicated, or less reliable such as wind, solar, or biogas.

The second point is that “Small is beautiful” is pitiful because it lacks a critical mass of resources. The economic viability of the technology and the acceptance by villages that use it suggest that given a fraction of the resources and opportunities that the grid approach enjoys, village hydro and community managed decentralized alternatives like it would be at least as viable as the current centralized model. The marginalization of the technology creates vicious circles that continue to ensure they remain pitiful.

The third point is that the hegemonic social barriers literature and the Band-Aid approaches it prescribes miss the point. Removing barriers such as lack of information and minor policy changes will have little impact unless they are part of a long term struggle against entrenched bureaucracies that control the grid. If electricity infrastructure is to be responsive to the public good, it is necessary to directly challenge utility's monopoly control – of money, information, planning, and ultimately electricity production and distribution. In saying this I do not mean to support the agenda of privatization that is sweeping the world, but rather make the point that my research shows that approaches to electrical infrastructure planning and development that do not emphasize transparency, accountability and participation are unlikely to serve the broader public good.

Postscript: Net Metering in Thailand

The Thai Cabinet in 2002 passed new “net metering” laws for renewable energy. These are an excellent example of a policy that moves in the direction of restoring the balance of power between electric utilities and ordinary citizens by encouraging public participation in distributed renewable energy generation.

Under net metering policies utilities are required to allow small renewables to connect easily, and customer-generators may use a single meter to measure both consumption and

production. The meter turns backwards when the customer-generator is making more electricity than her house or business is using. Using a single meter means that production by these small renewable energy generators is valued at the retail rate. If a customer produces more than she consumes in the long term, the utility is obligated to pay the same price per kWh that it pays to EGAT for generation and transmission. The regulations are particularly progressive, allowing systems of all renewable energy fuels up to 1 MW net export.

One of the unique features of the Thai regulations is that it allows for aggregate net metering. That is, an entire village can be metered as a single customer. This provision provides a mechanism for cooperatives like those in the microhydro villages I have studied to continue to play a role in electricity generation and distribution if the village chooses to connect.

Instead of contributing to the abandonment of village microhydro systems, the arrival of the grid now signals a significant economic opportunity, as this sample calculation⁸ shows:

$35 \text{ kW} \times 80\% \text{ capacity factor} \times 2 \text{ baht/kWh} \times 8760 \text{ hrs/yr} = 490,000 \text{ baht (US\$11,700) per year}$

By way of comparison, the typical daily wage in villages is around \$2.

Passage of these regulations by Cabinet and adoption by Thai utilities is no guarantee that the laws will be implemented as intended. Indeed early experiences so far suggest that PEA will through up barriers (legal or otherwise). But at least the opportunity exists now to encourage the utilities to follow the letter and spirit of the regulations and interconnect these and other small scale renewable energy systems in a fair and non-discriminatory manner.

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⁸ 35 kW is the approximately the average capacity of installed village microhydro systems

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