Rescaling and Reordering Nature–Society Relations: The Nam Theun 2 Hydropower Dam and Laos–Thailand Electricity Networks

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In 2010, the largest hydropower dam ever constructed in Laos, the Nam Theun 2 (NT2) Power Project, was completed with crucial—indeed, deal-making—support from the World Bank. Although the vast majority of the electricity produced by the project is exported to neighboring Thailand, the most important negative social and environmental impacts have occurred in Laos. While much attention has focused on the dam reservoir, there have been significant effects downstream from the project along the Xe Bang Fai (XBF) River, a major tributary of the mainstream Mekong River. In this article we examine the complex relationships between energy produced by NT2 and energy consumption patterns in Thailand. We link varying electricity demand in Thai air conditioning, fluctuating water releases from the NT2 dam, and downstream changes in XBF hydrology. Taking a political ecology approach, we emphasize how NT2 is part of rescaling electricity production and consumption networks, changes to their modes of ordering, and the reworking of nature–society relations. Although NT2 involves a complex array of social and environmental civil society concerns for Thailand, Laos, and global society, this was largely obscured by the commercial and technical orientation of its novel governance systems. *Key Words: air conditioning, electricity, energy, nature–society, political ecology.*

2010 年，寮国有史以来建造的最大水力发电大坝——南屯二号（NT2）发电计画，在促成交易的世界银行的关键支持下完工。儘管该计画所生产的电力中的绝大部份，都出口至邻近的泰国，但最重大的负面社会及环境冲击，却发生在寮国。虽然大多数的关注皆聚焦于大坝水库本身，但该计画沿着湄公河主线的重要支流邦非河（XBF）下游，却产生显着的影响。我们于本文中，检视 NT2 能源生产和泰国能源消费模式之间的复杂关係。我们连结泰国空气调节中不同的电力需求、NT2 大坝的波动泄水，以及XBF水文在下游的改变。我们採取政治生态学方法，强调NT2如何成为再尺度化电力生产及消费网络、此般模式安排的改变、以及自然—社会关係重组的一部分。儘管NT2涉及泰国、寮国以及全球社会的一系列复杂社会及环境的公民社会考量，但此一议题却被该计画的创新治理系统的商业及科技导向所蒙蔽。*关键词：空气调节，电力，能源，自然—社会，政治生态学。*

La más grande represa hidroeléctrica jamás construida en Laos, el Proyecto Energético Nam Theun 2 (NT2), se completó en 2010 con el apoyo crucial—en verdad, el que lo hizo posible—del Banco Mundial. Aunque un vasto porcentaje de la energía generada por el proyecto es exportada a la vecina Tailandia, los impactos negativos más importante de tipo social y ambiental se han presentado en Laos. Si bien mucha atención se ha concentrado en el reservorio de la presa, efectos significativos se han detectado aguas abajo del proyecto a lo largo del Río Xe Bang Fai (XBF), uno de los tributarios mayores de la arteria principal, el Río Mekong. En este artículo examinamos las complejas relaciones que se presentan entre la energía generada por el NT2 y los patrones de consumo energético de Tailandia. Ligamos la variada demanda de electricidad para aire acondicionado de Tailandia, las fluctuantes liberaciones de agua de la represa de NT2, y los cambios aguas abajo en la hidrología del XBF. Adoptando un enfoque de ecología política, enfatizamos que el NT2 hace parte del re-escalamiento de las cadenas de producción y consumo de electricidad, cambios en los modos de ordenar y en la reelaboración de las relaciones naturaleza-sociedad. Aunque el NT2 implica un complejo surtido de preocupaciones de la sociedad civil para Tailandia, Laos y la comunidad global, de naturaleza social y ambiental, esto en gran medida resultó opacado por la orientación comercial y técnica de sus sistemas novedosos de gobernanza. *Palabras clave: aire acondicionado, electricidad, energía, naturaleza-sociedad, ecología política.*

We arrived at Mahaxay town, adjacent to the Xe Bang Fai (XBF) River, in Khammouane Province, central Laos on 31 December 2013. It was at the height of the "cold season" and people throughout the region, as far away as Bangkok, were wearing sweaters, ski hats, and scarves. We had journeyed to conduct field-based studies to trace the downstream social and ecological effects of the

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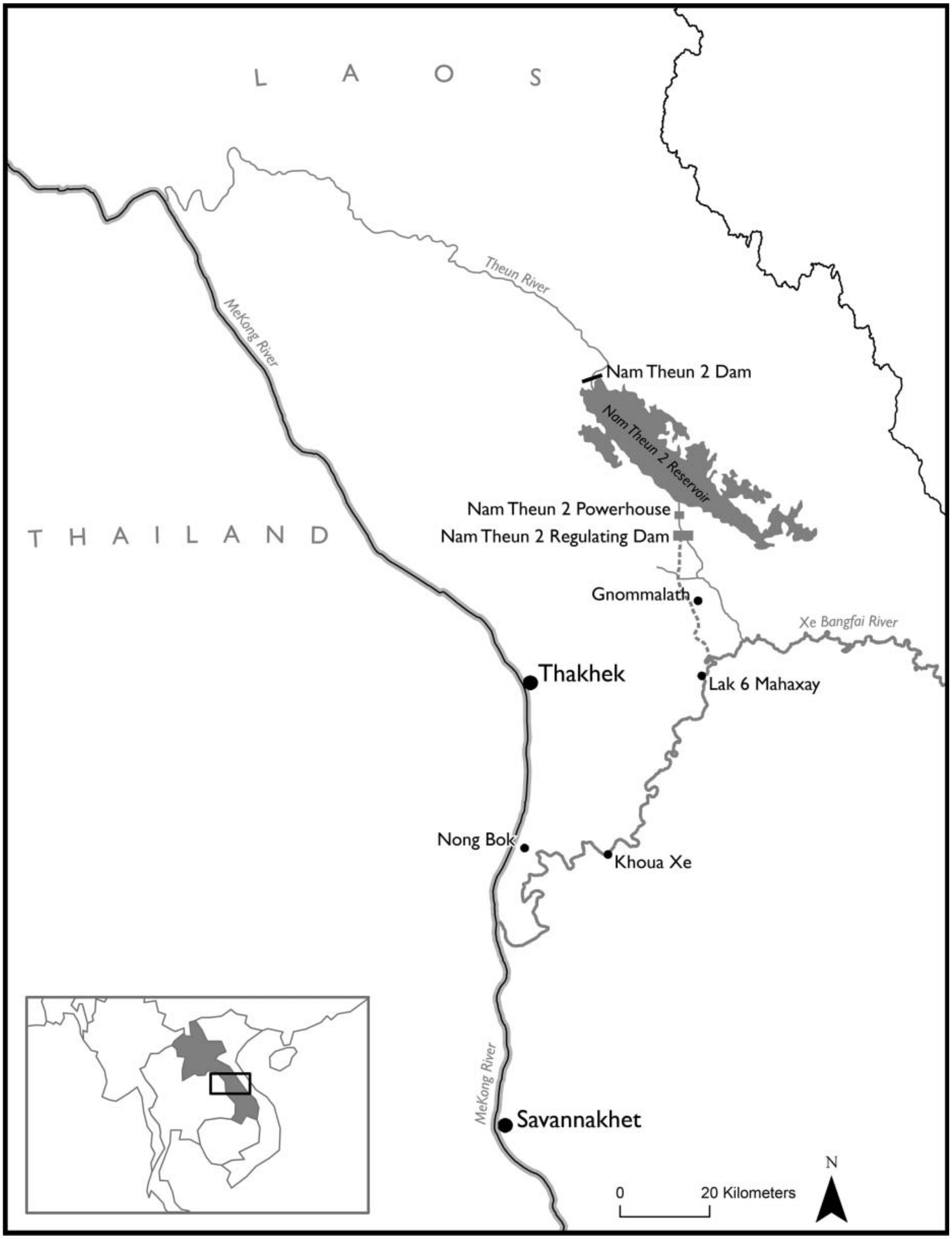

Figure 1. The Nam Theun 2 Hydropower Project (NT2) in central Laos.

Nam Theun 2 Dam (NT2), which began operations in 2010 (Baird, Shoemaker, and Manorom forthcoming). NT2 now dumps up to 315 m^3 of water per second from the reservoir on the Theun River into a 27-km-long canal; this water then flows into the much smaller XBF River (World Bank and

Asian Development Bank [ADB] 2013; see Figure 1). Water levels in the XBF River were unusually low and the ecology of the river had clearly been altered. The low water levels revealed dead or dying seasonally inundated bushes and trees on the sides of riverbed (see Figure 2).

By 6 January, though, water levels began to rise. When we reached Keng Pae Village, downstream of Mahaxay, comments by one villager helped us understand the situation. The XBF River was nothing like it used to be, he told us: "I am not sure why, but we notice that water levels in the XBF River tend to go down on the weekends and then back up during the week." Later investigations provided more clues. When in the field in southern Laos in January 2014, the first author heard an ethnic Lao employee of the Nam Theun 2 Power Company (NTPC) state, "The water is low now because Thailand is not buying as much power as they usually do. When Thailand needs less power they phone up the operators of the dam and ask that less electricity be sent to them. Since the weather is cold now, Thailand needs less power and so less water is being released." Our visit, and the low water levels we observed, corresponded to weak electricity demand in Thailand caused by both cold weather and the New Year holiday.

This article seeks to interrogate these links, showing how the hydrological flows of the XBF River are now transformed by regional power grids that are heavily shaped by fluctuations in energy demand in Thailand. As we also discuss, the transformations of the XBF River dramatically illustrate a core principle of political ecology: Social power shapes nature–society relations and in doing so remakes ecologies. In narrating the transformation of the XBF, we also seek to extend political ecology insights to the Thai and Greater Mekong electricity system as a highly regulated production and consumption network that embodies metabolic relationships to, and remakes, nature. NT2, we argue, represents a shift in how that electricity system has been ordered, with knock-on effects for the relationship of Thai energy users to distant ecologies.

In what follows we introduce these theoretical contexts and then go on to outline the history and characteristics of NT2. We summarize recent research on the downstream social and environmental impacts of the dam on the XBF River. We link NT2 to variable demand in Thailand and to urban electricity consumption through air conditioning. We consider the original environmental assessment and ongoing management strategies for the project in relation to the XBF River. We argue that NT2 has adopted a unique form of environmental regulation—what we call regulation by contract—that sought to shift social and environmental standards from the Lao or Thai states to project proponents. Although facilitating cross-border trade and creating a new hybrid transnational governance regime, it collapsed public and private authority and prioritized Thai energy system interests over the tens of thousands of XBF-dependent villagers in Laos.

Political Ecology and the Rescaling of Electricity as a Production and Consumption Network

Large hydropower dams often severely alter ecological and human systems by blocking rivers, shifting hydrological patterns, and changing water quality (Scudder 1994; McCully 1996; World Commission on Dams [WCD] 2000; Wyatt and Baird 2007; Richter et al. 2010). As complicated systems of energy production and capital accumulation, they have become important objects of study for political ecologists (Goldman 2005; Barney 2009; Sneddon and Fox 2011). Here we begin with NT2 as a dam but note that dams are only one small part of the massive assemblages of machinery, wires, investment banks, corporate structures, and state regulatory frameworks that make up electricity systems or networks (Hughes 1983). Electricity systems, like other networks, can be analyzed through political ecological approaches that emphasize relations of power and nature (Klooster 2006) and the complex interactions that tie production and consumption (Bryant and Goodman 2004; Le Billon 2006). A political ecology of production networks can complement existing environmental historical and political economic analysis of electricity systems (Kellow 1996; Williams 1997; Swift and Stewart 2004). Here, we seek to advance the political ecology of production networks in two novel directions.

First, we not only "follow the thing" through its network ties (Cook 2004) but track the "socio-spatial dialectic" (Sheppard 2011, 324) whereby networks dynamically interact with the places they traverse and connect. This leads us to consider the tangled multispatial transformations involved as the XBF River basin ecologies were remade by, but also contributed to, the creation of a new kind of socionature—or electric space—that connects cities (e.g., Bangkok), consumption sites (e.g., heavily air conditioned malls or factories), the planning decisions of the World Bank, NT2 investors and operators, the Electricity Generating Authority of Thailand (EGAT), and the XBF River and its downstream users.

Second, we link the rescaling of networks to transformations of their regulation. It is now commonplace in geography to analyze how actors help produce scales through their activities. Recent work on rescaling and the environment emphasizes the relationship between rescaling and regulation—often scaling down from the national scale involves removing regulatory controls and thereby remaking nature in capital's image (Cohen and McCarthy 2015). Here, we are interested in how commodity networks not only create new scales but also cross scales to create new spaces: In doing so they can also become entangled in novel forms of reregulation.

Geographical research has long recognized how networks create scales. The national scale, for instance, might be constituted through national railroad systems, highway systems, or hydrological works of canals, dams, and irrigation channels (Brenner 1998; Swyngedouw 2007). Likewise, the ADB has named "The Greater Mekong Sub-Region" and has promoted the construction of a new regional space through new water and electricity systems. These new infrastructures "engineer new relations among places" and represent "the triumph of national and regional level interests over local basin interests" (Lebel, Garden, and Imamura 2005, 9; see also Hirsch 2001). The issue of how scale intersects with commodity network regulation in the remaking of nature has not received the same level of attention, however.

Here we suggest linking the "modes of ordering" of networks (Whatmore and Thorpe 1997) to rescaling processes. We follow the idea that networks feature a material politics that involves disputes over modes of ordering (Law and Mol 2008) but ask how rescaling intersects with shifting modes of ordering. This process has been examined in a few select cases. For example, some fisheries have experienced a process whereby the development of global export markets worked in concert with a shift from local state regulation to certification systems that bypass traditional state law (Barton and Fløysand 2010). We seek to extend to new cases an analytic lens focused on how the rescaling of networks involves changes to the regulatory institutions and organizations that constitute network spaces.

Here we argue that NT2 involves the construction of a cross-border electricity regime that transforms network regulation and reconstitutes the electric space. The scale of the region comes with a complex series of cross-border negotiations, geopolitics, and framing devices that make the network neither Thai nor Lao but a hybrid, with additional interventions by investors, the World Bank, and other financial institutions. The result has been not only the prioritization of commercial modes of ordering (where more robust nation-state environmental and social regulation might have been used) and significant eco-social ramifications in Laos but also a reworking of the relationships between Thai consumers and distant ecologies, ones crucial for local Lao livelihoods.

The Nam Theun 2 Hydropower Project

NT2 is the largest completed hydropower dam in Laos, its construction having begun in 2005. The NTPC is 40 percent owned by Electricite du France, 35 percent by Electric Generation Public Co. in Thailand, and 25 percent by the government of Laos (GoL). European banks and export credit agencies and the ADB also provided financing. The World Bank guaranteed loans in relation to political risk and provided various other forms of support for the project (Porter and Shivakumar 2011). NT2 is a build–own–operate–transfer (BOOT) scheme with a twenty-five-year concession agreement (CA) that allows NTPC to build, own, and operate the power station, after which it will be handed over to the GoL. The dam has a capacity of 1070 MW, but 93 percent of the energy produced by the dam (5,636 Gwh per year) is contracted by EGAT to be exported to Thailand (Du Pont 2005). The remaining 7 percent, or 75 MW, is used domestically in Laos (Porter and Shivakumar 2011). NT2 is expected to generate considerable revenue for the concessionaires and the dam is sending more hydropower across national borders than any other project in the history of Southeast Asia.

NT2 is a trans-basin diversion project that moves water from the Theun River to the XBF River. Water flows from the reservoir into a headrace tunnel and vertical pressure shaft through a tunnel to a power station approximately 348 m below. After leaving the power house, up to 350 m^3/s of water exits into a tailrace channel leading into a regulating pond and dam (Figure 1).[1] Before the dam was built the XBF had a smaller water flow than the Theun. However, it is still an important Mekong tributary and historically had a particularly productive fishery (Shoemaker, Baird, and

Baird 2001). It flows for 150 km before merging with the Mekong River and has been an important resource for fishing and other river-based livelihoods for over 150,000 people (Shoemaker, Baird, and Baird 2001; Richter et al. 2010).

The World Bank has played a vital role in NT2 by securing financing through guaranteeing private sector loans, primarily from large European banks (Porter and Shivakumar 2011). NT2 has been very controversial and nongovernment organizations (NGOs) and academics have leveled serious criticisms of the project, not least because of the World Bank's notorious history with ecologically damaging large dams (Roberts 2004; Goldman 2005; Lawrence 2009; Singh 2009). NT2 did not follow the prescriptions of the WCD concerning how to remedy disastrous megaprojects of the past. The World Bank, however, claimed to be learning from its mistakes and NT2 adopted a series of safeguards, such as environmental and social impact assessments. Nevertheless, during the planning phase, opponents argued that there would be significant downstream impacts on the XBF fisheries and the rivers' users and that there were significant gaps in obtaining the free, prior and informed consent of those people and proposed that compensation rates were far too low and did not include all those who would be affected (Roberts 2004; Ryder 2004; Imhof and Lawrence 2005; Lawrence 2007).

The project operates under parameters set in the Power Purchase Agreement (PPA; between NTPC and EGAT) and the CA (between GoL and NTPC). Although these set up the contractual obligations of the key parties, they also are the prime vehicles for ensuring environmental and social standards. The PPA had been negotiated as early as 1997 and its terms considered by early analyses of alternatives (ADB 2004). It was finalized in 2003 (NTPC 2005b). The entire framing of NT2 as a development project for Laos turns on this business arrangement, which provides the price for electricity and the quantities EGAT will take. The CA serves to license the project in Laos, setting up the right of NTPC to build the dam, build the road roads, and use the water to generate electricity (NTPC 2005d). It also specifies NTPC's rights and social and environmental responsibilities, which extend to water management and restrictions relating to releasing water into downstream channels (NTPC 2005b). The CA works in conjunction with a series of "safeguard documents" that include studies and programs to fulfill the project's "environmental and social objectives," including compensation and mitigation for social and environmental impacts of the dam and its operation. There were also provisions for an independent panel of experts (PoE) to provide oversight.

Notwithstanding extensive studies, compensation, and special features, NT2 is creating heavy social and environmental downstream impacts along the XBF River (Baird, Shoemaker, and Manorom forthcoming). The amount of water in the river has increased dramatically, especially in the dry season. In addition, water quality has declined significantly due to the anaerobic nature of water released from the bottom parts of the NT2 reservoir. People living along the XBF continue to report that the river's water quality is worse than before the dam was built. There have also been changes in the river ecology, as dry-season riverbank gardens have been inundated, seasonally inundated vegetation has died (see Figure 2), riverbank and island erosion has increased, and changes in water levels have made wet-season paddy rice cultivation increasingly precarious. There have also been significant impacts on aquatic life that extend to complex and long-distance migrations of Mekong River fish (Baran, Baird, and Cans 2005), some of which also use the XBF River (Shoemaker, Baird, and Baird 2001). According to people living along the XBF River and its tributaries, changes in hydrology and water quality have resulted in large declines in fisheries and associated livelihoods (Baird, Shoemaker, and Manorom forthcoming).

Figure 2. Dead seasonally inundated perennial trees in the Xe Bang Fai River in central Laos on 1 January 2014, when water levels were low due to cold weather and reduced air conditioning usage in Thailand. *Source:* Photo taken by Ian G. Baird. (Color figure available online.)

NT2 in the Thai Electricity System

NT2 electricity production is almost entirely taken by EGAT and a holistic understanding of changes on the XBF River requires explaining its role in the Thai electricity system. NT2 has transmission to, and so works as a component of, the integrated Thai grid. The project was formulated in the mid-1990s, delayed due to the decrease in Thai power demand brought on by the 1997 East Asian financial crisis, and then resumed in 2001 after Thai demand forecasts increased (Ahmad 2011). Not only is NT2 an important node in an integrated system of balancing supply and demand across the electricity region, but it is that role that is now shaping XBF ecologies.

EGAT is the main state-owned electricity company in Thailand, and since its formation in the 1960s it has had a monopoly on transmission. It is vertically integrated with other state-owned distributors—the Provincial Electricity Authority of Thailand (PEA) and the Metropolitan Electricity Authority of Thailand (MEA); together these state-owned firms have an oligopoly position over Thai electricity consumers (Wisuttisak 2012). The 1990s saw attempts at privatization and liberalization, reflecting widespread belief that independent power producers and small power producers could more cheaply provide electricity generated from natural gas. Reflecting a worldwide trend (Victor and Heller 2005), efforts at creating a privatized power pool have stalled and EGAT remains in state hands. Independent power production accounts for a majority of new growth and private power now outpaces EGAT production (84 GWh, or 57 percent of Thailand's total generation in 2009). EGAT remains the dominant company, being the largest electricity producer (owning 43 percent of capacity and supplying 64 GWh of the country's power in 2009), retains ownership and control of the transmission system and enjoys a monopoly on purchasing power from private producers (Wisuttisak 2012).

Thailand has a history of building large dams and managing electricity systems on that basis. The first large hydropower dam in Thailand, the Bhumibol dam, named after the present King of Thailand, was built on the Ping River in the Chao Phraya River Basin in northern Thailand in the early 1950s. Other large dams, such as the Nam Pong dam in northeastern Thailand, soon followed (Sneddon and Fox 2011; Zeller 2014). By the 1960s, hydropower dams were generating more than 70 percent of the energy generated in the country (Zeller 2014). Thailand has, however, seen a shift from large dams, and dams now contribute less than 11 percent of the electricity generated in Thailand. Part of this can be attributed to the rapid expansion of the Thai electricity system. Peak demand was only 2,838 MW in 1982 but has grown very rapidly—to 16,700 MW in 2002 (Greacen and Greacen 2004) and by 2011 production capacity had grown to 31,151 MW (Greacen 2012). Planners have made use of fossil fuel sources—in 2011, 8 percent of electricity production came from coal, 12 percent from domestic lignite, and 68 percent from natural gas, mainly from domestically controlled fields in the Gulf of Thailand (Wisuttisak 2012). A further significant factor, however, has been greater public and community opposition to hydropower in Thailand, evidenced by widespread social opposition to the Pak Mun dam in the early 1990s (Greacen and Palettu 2007). The extension of NT2 dam construction into Laos provides a spatial fix that allows EGAT to sidestep Thai opposition to hydro and continue in a "hard energy path" paradigm (Lovins 1976; Swift and Stewart 2004)—that is, high electricity load growth through large central station plants and long-distance transmission. Indeed, in the past EGAT has supported dam construction in Thailand that has caused serious impacts to rural Thais while especially benefiting industrial and commercial interests and urban household consumers in Bangkok.

Thai electricity demand is only one of a number of drivers behind NT2, though. Indeed, NT2 supplies a very small part of Thailand's electricity needs, with initial plans estimating it would meet only 3 percent of Thailand's annual requirements (NTPC 2005b). While Thailand has been purchasing most of the electricity from Laos's Nam Ngum 1 dam since 1971 (Middleton, Garcia, and Foran 2009), the big push to expand transboundary electricity trade in mainland Southeast Asia came in the 1990s from the ADB as part of its push for a Greater Mekong Sub-Region (Hirsch 2001; Glassman 2010). Core to this vision has been a regional electricity grid for transporting electricity across national borders to access abundant resources to meet urban demand (Middleton, Garcia, and Foran 2009; Bun 2012), especially in Thailand using energy purchased from Laos (see Figure 3). By the 2000s, the Lao government had agreements (but not yet projects in place) to export 7,000 MW to Thailand, 6,000 MW to Vietnam, and 1,500 MW to Cambodia by the year 2020 (Lao PDR, Department of Energy 2008). Much of the impetus for the dam came from private sector developers seeking new projects in

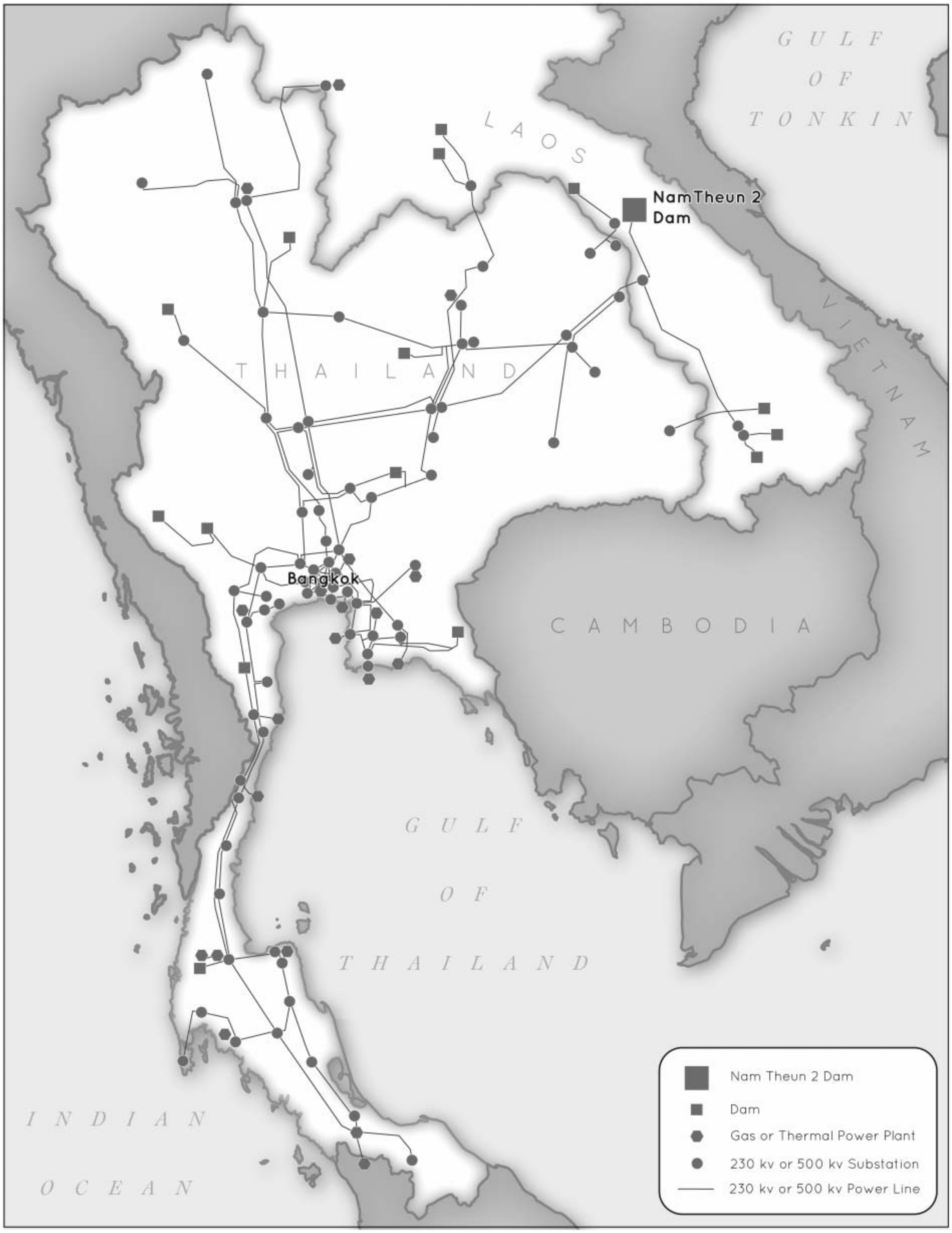

Figure 3. Map showing the electricity grid in Thailand and how it is linked to the Nam Theun 2 Hydropower Project (NT2) in central Laos.

Laos, and its adoption by the World Bank ensured "it had to be set in the overall development framework of Lao PDR, and the revenues generated by the project had to be used for poverty reduction" (Ahmad 2011, 99). NT2 thus did not only serve electricity system needs, it was "reframed as an engine for national development with major implications for national revenue management, environmental policy, and community development" (Ahmad 2011, 105).

The most significant link, however, and what this article seeks to show, is that EGAT managers are using NT2 to supply variable and peak power for the Thai system. As detailed here, this was not fully revealed in initial plans for NT2 and the assessment of its downstream impacts but, post hoc, it can be inferred by linking Thai energy consumption patterns, changes to the XBF River, and the way this possibility was provided for in the project's constituting documents.

Linking NT2 with Bangkok Air Conditioning

Bangkok is by far the largest city in Thailand and accounts for approximately one quarter of the country's electricity demand. Thailand has a hot, humid climate and air conditioning and refrigeration—especially in its relatively prosperous central metropolis—is also a sign of modernity and urbanization as well as a key demand driver for electricity. Electricity demand from Bangkok air conditioning exceeds the total of output of NT2. Its use is highly variable given changes in daily temperature and the routinized opening and closing of businesses and offices through the day and week. Although there are other causes of varying electricity demand in the Thai electricity system, Bangkok air conditioning makes up an important node in the network and can be directly linked as contributing, through action at a distance, to changes in the XBF River.

Air conditioning use varies in large part because of outside weather. Although the mean temperature in Thailand is 31°C, there is a wide annual range of 22°C to 39°C and corresponding shifts in total electricity demand. For instance, the peak demand during the hot season of 2004 exceeded the winter peak by around 4,500 MW (or 32 percent of system peak demand). Load patterns also shift with daily temperature changes, indicating the role of air conditioning and refrigeration (Figure 4; see Parkpoom and Harrison 2008, 1442).

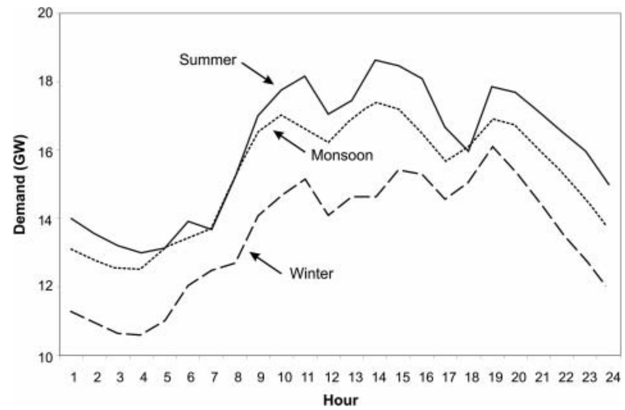

Figure 4. Daily demand profiles in Thailand, showing load patterns shifting both daily and seasonally. EGAT (2004), reprinted in Parkboom and Harrison (2008, 1442).

Data on consumption provide additional evidence of the role of Bangkok's air conditioning in the greater Mekong system. Typically, air conditioning is responsible for 60 percent of electricity consumption in a commercial building (Chirarattananon and Taweekun 2003; Chirarattananon et al. 2010). In 2013, the MEA, the distribution company for Bangkok that EGAT supplies, delivered 13,762 GWh of electricity to businesses, and 7,387 GWh to small general service establishments (Ministry of Energy 2014). Large malls in Bangkok can have very large electricity demand for air conditioning. For example, in 2011 the huge Siam Paragon mall (see Figure 5) consumed 123 GWh of electricity—nearly twice as much as the northern Thai province of Mae Hong Son with a population of more than 250,000 (65 GWh) and almost as much as the northeastern Thai province of Mukdahan (128 GWh; Pasick 2015). Although air conditioning can vary as a percentage of total building load, from 59 percent for businesses to 71 percent for hotels (Yamtraipat et al. 2006), a figure of 60 percent gives an estimate of 8,258 GWh for businesses and 4,432 GWh for small general service establishments—much higher than the total yearly output of NT2. Moreover, typically large buildings in Thailand have very large variations in energy consumption—a department store with a load of 2.5 MW or an office with a 2.0 MW load might have little to no energy consumption at night but ramp up to full load use during business hours (Chirarattananon et al. 2010). This helps explain why Thailand's peak consumption occurs in the early afternoon of the sunniest days of the hot, dry season, as this peak is driven by air conditioning loads (Du Pont 2005).

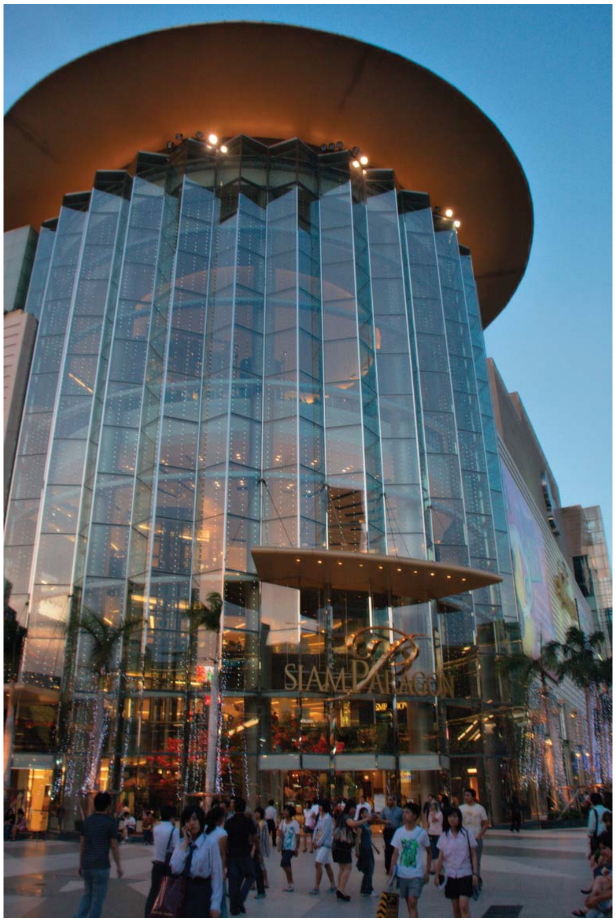

Figure 5. Siam Paragon Mall, one of the largest malls in Bangkok and one of the most energy-consuming pieces of infrastructure in Thailand. *Source:* Photograph by KhunBhun, taken on 21 April 2007. Available at flickr.com, used under Creative Commons Attribution Only licensing (https://creativecommons.org/licenses/by/2.0/). (Color figure available online.)

A review of the limited available public information on EGAT imports and sales strongly suggests that EGAT is using Lao hydropower projects to satisfy varying loads. Thailand has an installed power production capacity of 31.5 GW, but almost 90 percent of the capacity is designed for base load generation (Wärtsilä 2012). Much of this generation (from independent power producers) is combined cycle plants (EGAT 2014). These can be put on standby and ramped up when needed. Precise costs for load-following and peaking power are difficult to find and context dependent. The World Bank in 2005 cited a figure of US$0.15 per kilowatt hour when combined cycle gas plants are used less than 10 percent of the time (e.g., only for daily or weekly high-demand periods; Vernstrom 2005). In some cases costs might be similar to baseload (e.g., when combined cycle plants are run in load-following mode in anticipation of being ramped up). But prices can go much higher: California figures for average levelized costs for merchant generation (for 2009) show that peaking technology can be as high as US$0.8607 per kilowatt hour—seven to ten times the price of baseload sources, such as combined cycle natural gas (12.61), geothermal (7.89–8.31), or class five wind (6.55; California Energy Commission 2009). In comparison, NT2 power at 1.88 Baht (or US$0.047) is close to the least cost alternative supply in Thailand for baseload (not peaking power)—that of a combined cycle gas turbine (ADB 2004). NT2 represents 45 percent of the electricity capacity available for Thailand from Laos (948 MW as EGAT's share of NT2 of a total of 2,104.6 MW). NT2 also constitutes 39 percent of total capacity from abroad (948 MW of 2404.6 MW—adding the 300 MW available from an interconnection with Malaysia; EGAT 2014). As Figure 6 shows, imports strongly follow load. See Figure 7 as well.

We also focus on air conditioning because it is an important indicator of modernization. Still absent from most villages in Southeast Asia, it is a distinguishing feature of the wealth of rapidly developing cities such as Bangkok. In earlier times government buildings in Thailand were not allowed to use air conditioning, but by the early 1990s air conditioning had penetrated the state apparatus (Chirarattananon and Taweekun 2003). Air conditioning also represents a transformation of cultural attitudes. As Shove (2003) showed, social norms for room temperature are partially a cultural construction, with contemporary norms set in the mid-twentieth century by research teams in the Global North linked to the air conditioning industry and engineering societies. The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) sought to define optimal thermal comfort, and this work formed the basis for national codes worldwide (including Thailand)—codified in ASHRAE Standard 55, Thermal Environmental Conditions of Human Occupancy, and also in International Organization for Standardization (ISO) Standards (Shove 2003). Yet "normal" for North Americans and Europeans feels cold for many Thais. Energy researchers in Thailand have done large-sample studies of thermal sensation for office settings and found that most Thai people reported being comfortable in the 24.6°C to 26.2°C range (Yamtraipat et al. 2006). The "luxury" of air conditioning thus appears as a relatively new transformation and can be juxtaposed to the severe limits on access to fish protein and

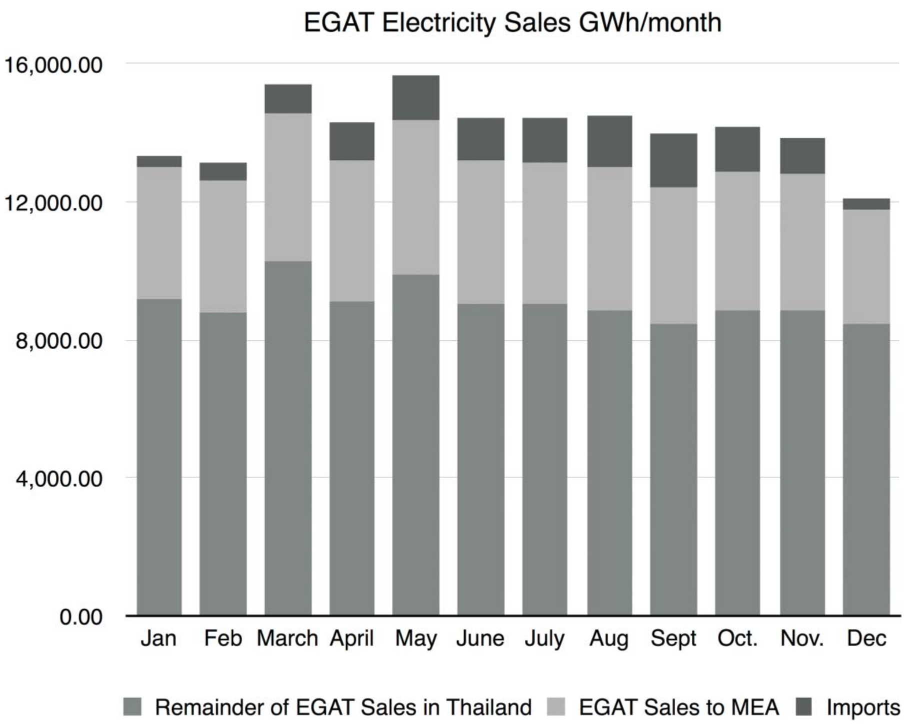

Figure 6. Electricity Generating Authority of Thailand (EGAT) energy use and imports, indicating that energy imports from Laos follow load requirements. *Source:* Compiled by authors based on Ministry of Energy (2014).

loss of income now being experienced by people who depend on the XBF River.

A further reason to focus on air conditioning is because it is often an indicator of poor electricity system planning and inattention to energy efficiency. Air conditioning has been worked into the design of existing buildings and services, including hospitals and medical equipment, and so cannot merely be shut off (Walker, Shove, and Brown 2014). Air conditioning can be made more efficient, however, through the use

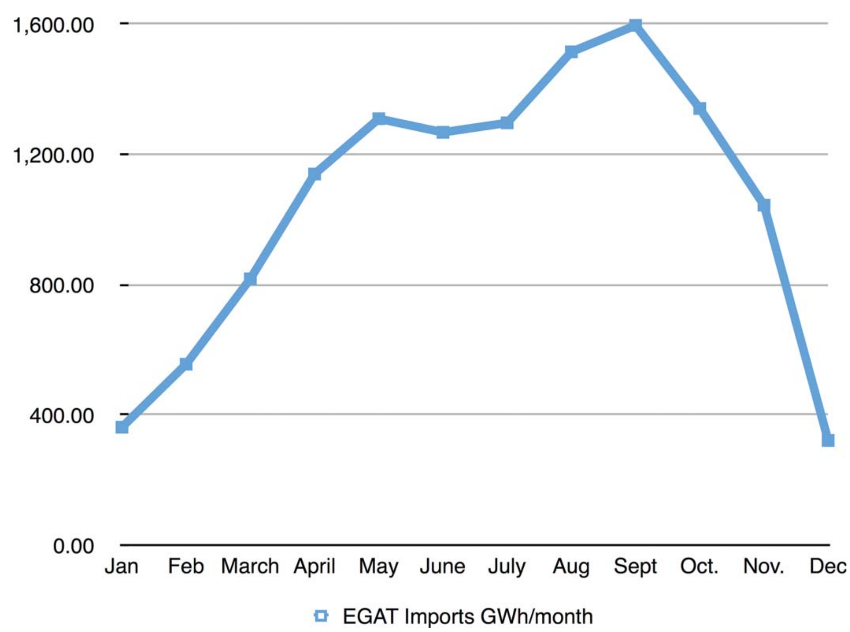

Figure 7. Electricity Generating Authority of Thailand (EGAT) energy imports per month, indicating that imports are strongly linked to seasonal demand in Thailand. *Source:* Compiled by authors based on Ministry of Energy (2014). (Color figure available online.)

of new air conditioning equipment, improved building insulation, efficient fluorescent or light emitting diode lighting that gives off less heat, dehumidifying ventilation air, and in some cases simply using natural light (Chirarattananon and Taweekun 2003). Whether such changes happen en masse depends in large part on how the electricity system as a whole is managed. Electricity systems can be designed to maximize growth and electricity consumption or be organized through more holistic planning that creates incentives for efficiency as an alternative way of meeting demand.

Central to consumption or demand-side management approaches is the idea that air conditioning be seen as only one of many technical fixes for the issue of how bodies are kept comfortable. Beyond changes to physical air conditioning systems, options include new forms of building design, shifting to less heat-creating lighting sources, alternative technologies such as ground source heat pumps and sinks, district cooling using cold water sources, and solar-assisted coolers or low-tech approaches such as tree shading, traditional ventilation, or changing dress codes (to support use of short sleeves rather than wool suits). Such programs generally require incentives (or codes and standards), though, which in turn are usually adopted as part of more systematic planning. Although EGAT has made some initial forays into this area, the most recent power development plan provides that demand-side management will meet only 0.3 percent of total GWh (Greacen and Greacen 2012), although alternative proposals suggest that 14,000 GWh per year of savings could be secured by 2026 through a focus on key household appliances (Foran et al. 2010).

Thailand has not traditionally had a strong regulatory planning framework around electricity and the central Thai state-owned enterprises have been largely self-regulating (Greacen and Greacen 2004). Like many state monopolies, EGAT has operated in a relatively secretive, nontransparent, and "club government" mode (Victor and Heller 2005). Thailand's current experience is similar to what many countries with large utilities experienced in the 1960s and 1970s: Strong economic growth and electricity system expansion hides overly ambitious load forecasting and the addition of new generation without careful analysis of alternatives. This model has been buttressed by the success of Thailand's economic development: Electricity planning is seldom questioned in the mainstream, with electricity being seen as a public good to which Thai people are entitled as part of the right to development (Greacen and Greacen 2004). Many civil society organizations in Thailand, such as Palang Thai and Greenpeace, have suggested that rather than continue on the traditional hard path of high growth through central station projects there is a need for a shift to a "soft path" of long-term integrated resource planning (IRP), greater accountability, and a focus on energy efficiency, renewables, and decentralized power to make up a sustainable energy system (Greacen 2006). Moreover, this was a central concern of activists and energy specialists during the planning of NT2. The World Bank actively ignored its own consultants on NT2 who argued that a soft path for Thailand could avoid or delay NT2's development (Du Pont 2005; further discussed in Greacen and Sukkamnoed 2005). Although Bangkok air conditioning users stand in metabolic relationship with XBF ecologies, that relationship is mediated by, and is an effect of, the regulatory paradigms and built form of the Thai electricity system. Neither the World Bank nor NT2's private developers questioned that system.

Environmental Flows

A further step in the relationship concerns environmental flows on the XBF River. This concept was developed in the 1990s as a way to manage the operation of large hydropower dams to reduce downstream ecological and social impacts. This is done by releasing water more regularly, but crucially, in ways that mimic natural daily and season flows, so that downstream impacts are reduced (Dyson, Bergkamp, and Scanlon 2003). The concept of environmental flows can be related to a comprehensive strategy to assess all the impacts, both positive and negative, of different hydrological regimes affected by the operation of dams or related forms of infrastructure (Richter et al. 2010). It demonstrates that altering the operation of dams, and thus changing water release patterns, can have positive ecological and social impacts downstream. Benefits accrue to both aquatic ecosystems and the human socioeconomic systems that are linked to those ecosystems (Dyson, Bergkamp, and Scanlon 2003; Richter and Thomas 2007; Arthington and Balcombe 2011). Planning around NT2 showed a relative lack of concern for environmental flows.

By the late 1990s, environmental flows were well known among dam experts and organizations. The WCD's Dams and Development framework called for, among other initiatives, a review of existing and proposed dams to provide for an environmental flow requirement (WCD 2000). The World Bank chose not to follow WCD guidelines, but its own water sector strategy explicitly cites the importance of flows and argues that "well conceived water infrastructure should . . . develop operating rules that specify ecological flows for the benefit of downstream riparians" (World Bank 2004, 10). To this end, it references existing World Bank initiatives that have included attention to flows in projects in Mauritania (8), India (62), Nigeria (64), and Yemen (67).

Attention to environmental flows frequently involve trades-offs that cut into profits, however, especially where dams serve electricity systems with varying load. Dam operators generally release water at various times of the day, making use of dam reservoirs as energy storage facilities—indeed, they remain one of the few cost-effective solutions to a problem endemic to electricity system management. Batteries remain very expensive, and utilities usually rely either on forms of hydro storage or natural gas peaking plants to handle variable load (Dunn, Kamath, and Tarascon 2011). The low cost of hydro storage means that it is the preferred technology by many power engineers. Managers might fill reservoirs to have on hand potential energy available for strategic calculations concerning selling power when dear or to avoid costly alternative supply for demand surges. As such, a downstream-sensitive hydrological regime can directly affect electricity managers' abilities to make strategic commercial decisions concerning when to switch from storage to generation mode. Ignoring or prioritizing environmental flows thus involves significant trade-offs between profits for the owners and operators of the dam, the use value of the river for downstream communities and broader societal and global concern with human rights to livelihoods, cultural heritage, biodiversity, and ecosystem integrity. As we discuss next, a close analysis of NT2's underlying agreements and social impact analysis shows that this trade-off was made with a broad willingness to sacrifice downstream ecologies and associated livelihoods in the XBF River Basin.

Creating NT2

At the time NT2 was proposed and the PPA and CA were drafted, there was little discussion of NT2 being used to handle Thailand's variable load. The initial PPA, public consultations, and discussion did contemplate lower power use on Sundays. This was built into the material configurations of the dam complex through the inclusion of a small regulating dam downstream of the main turbines. In retrospect, we can see that the PPA was designed to allow EGAT widespread flexibility and little attention was paid to how to control downstream impacts.

The PPA grants EGAT "full dispatch flexibility" (NTPC 2005b, 9) and sees this as key to maximizing benefits to EGAT. Although the PPA complies on paper with typical "must-take" provisions for independent power producers, it features a very different formulation from what is normally used. EGAT is sold potential energy stored in the dam (rather than output as determined by NTPC). For the most part this is sold on a yearly basis, allowing EGAT wide discretion to take energy only when it serves its purposes. EGAT has the flexibility to decide when to dispatch and which generating unit to dispatch (NTPC 2005b). NTPC "declares available" primary energy between 6 a.m. and 10 p.m. on any weekday (Monday–Saturday inclusive) and EGAT buys 4,406 GWh per year (NTPC 2005b; Vernstrom 2005). Although the exclusion for Sundays is not explained and is only implied within the PPA, it clearly relates to variation in Thai demand, because offices and factories are normally closed on that day of the week. EGAT has, however, the flexibility to dispatch power from NT2 as it requires—not only in relationship to Sundays but throughout the week and shifting from week to week—subject only to certain operational constraints (NTPC 2005b). EGAT also retains the option to buy further "secondary energy" on top of primary energy or at other times (e.g., at night or on Sundays) if the Nakai Reservoir holds sufficient water. The overall structure of the PPA thus "allows EGAT to transfer water/energy from the low demand and generation cost period (typically November, December, January) to the high demand and generation cost period (typically March, April, May). . . . Therefore, Nam Theun 2 Project will significantly contribute to one of the main objectives of any Utility, i.e., keeping the generation cost as low as possible" (NTPC 2005b, 9). The PPA thus allows, and our observations of river flow on the XBF confirm, that EGAT can ask for generation to be slowed or sped up, and short of a very high threshold for avoiding flood conditions, no concern need be paid to significant downstream impacts in Laos (Witoon Permponsacharoen, Director, MEE Net, personal communication, 23 May 2014). In short, the PPA is designed to allow EGAT to freely use the storage capacity of the reservoir, reflecting, without irony, then-Thai Prime Minister Thaksin Shinawatras's idea of Laos as a "battery for Asia" (Greacen and Palettu 2007).

The initial designs for NT2 and the CA did incorporate concerns about downstream effects. Early modeling indicated that seasonal flooding in the XBF would change, and in extreme cases could increase by a half meter toward the Mekong confluence. In 1997 the Study of Alternatives considered ways to reduce effects of discharges in the XBF River (Lahmeyer International and Worley International 1998). These included a variety of techniques of water diversion and regulation. The proposed solution was to rely on the Nakai Reservoir to reduce seasonal flooding immediately downstream of the dam, increase the size of the regulating pond, shut down the power station when the XBF floods to reduce the potential for increased flooding, and construct a 27-km downstream channel to avoid discharging turbinated waters into the Kathang Stream (ADB 2004). This was adopted in the Environmental Assessment and Management Plan (EAMP). The regulating dam (or pond) would limit the rate of increased discharge into the XBF to a maximum of 20 m^3/s/h to enable a more consistent discharge. NTPC would also have to follow rules in declaring energy available. It would, for instance, not exceed maximum water releases into the XBF River to avoid flooding. Thus, the EAMP claims the project includes "provision of predictable and consistent environmental flows" (NTPC 2005c, 12).

No attention seems to have been paid, however, to efforts to design the regulating pond to ensure environmental flows on the XBF in light of the possibility that EGAT would regularly change how much power it drew from the dam. The understanding was that the regulating pond would "continue to release water regularly during one full day when the operation of the Plant is stopped" (NTPC 2005e, vol. 3, chapter 8, 4). There appears to be no inclusion in the CA (or PPA) of management plans to ensure environmental flows in the XBF are safeguarded on a daily, weekly, or monthly basis outside of those provisions. Nor is there planning for the event—clearly allowed by the PPA—that NT2 operates as both a storage facility and low-cost form of load-following or peaker plant involving extended periods of low water flow interrupted by more rapid water release.

A close reading of the Social Development Plan (SDP) shows that the full solution to the problem of flows was to treat downstream fisheries as fungible—it was predicted they would be destroyed but that this would be justified by cash payouts in compensation programs. Although in theory there was to be a process of consultation and informed consent by villagers affected by the project, in practice NT2 involved major linguistic and conceptual barriers. There also appears to have been systematic misinformation—villagers were only told there would be a decrease on Sundays, as opposed to large-scale fluctuations on a weekly and monthly basis (for posters depicting projected flow patterns to villagers see NTPC 2005e, figures 4, 9). In reality that consultation appears to not have been the guiding document. Instead, the central tool was cost–benefit analysis (CBA) calculations of adequate compensation levels. The CBA worked on the assumption that the powerhouse would be shut down over late Saturday and Sunday and that the consequent changes in water flow "cannot be fully regulated by this Pond" (NTPC 2005e, vol. 3, chapter 8, 4). At best the pond would ensure a "slow and relatively benign drawdown" and "the maintenance of a minimum flow" (NTPC 2005e, vol. 3, chapter 8, 4). As a result, "It is predicted that the NT2 discharges into the Xe Bangfai will cause a collapse in the aquatic food chain" (NTPC 2005e, vol. 3, chapter 4, 40). The SDP did not seek to overturn or shift the terms of the PPA, but instead took the approach of aiming for a full program of cash compensation for loss and mitigation through new fisheries development.

The CA thus avoids interfering with EGAT's commercial decision making as to when to draw energy. As the EAMP states, with respect to downstream XBF impacts, "The mitigation plan is expected to completely mitigate these losses, leaving households of the XBF at least as well off as without the Project" (NTPC 2005c, vol. 2, 32). Strict limits are placed on available compensation in the XBF Basin in the SDP (US$16 million), however. This rested on a confidence that such a compensation system would be successful and complete. Nevertheless, the PoE has repeatedly argued that there have been problems with both compensation and mitigation programs. Although the World Bank and ADB responded with a supplementary US$2.3 million, the PoE found that there has been a failure to meet the requirements in the CA to "at least restore livelihoods of Project Affected Persons in the downstream areas on a sustainable basis" (McDowell and Scudder 2011, 19). As

Baird, Shoemaker, and Manorom (forthcoming) report, a vast majority of villagers feel that the compensation provided by NTPC has not come close to making up for their project-related losses.

NT2 as a Cross-Border Regime

NT2 needs to be understood not only through the substantive contents of the PPA and CA but by the way in which these operate as a unique cross-border regime. As a form of regulation by contract, the CA not only involves new forms of governance but does so in ways that transform the mode of ordering of the electricity network as it moves across borders. NT2 was negotiated by firms—often closely tied to states—on the basis of commercial interests. The result is that commercial discourses obscure and effectively restructure what are at root a complex mix of geopolitical state-to-state relations, and relations between states and civil society. Ideals of prioritizing commercial exchange value from electricity systems over the use values for local river users have long been present in Thailand, but the emphasis on NT2 as a private project regulated by contract reinforces this while obscuring the geopolitical ramifications.

NT2 was promoted by the World Bank as having a novel governance structure. NT2 reflects both the World Bank's efforts to respond to critics of dams by creating a complex apparatus of environmental and social studies and safeguards and a neoliberal shift in World Bank policy for resource development (Goldman 2005). From the 1990s onward, World Bank policies promoted foreign investments as win–win situations whereby resource project investors would make profits and host governments would gain revenues for social development programs. In the process, the World Bank would use the trope of financial risks to compel landowner states to offer highly desirable terms to investors in a purportedly highly competitive global investment environment. In the face of growing civil society concern over environmental and social standards, the World Bank did not resort to simply promoting the slashing of environmental law and regulation (or refusing to build it up in countries where it had not yet developed). Instead, the World Bank emphasized transferring decision-making authority and environmental and social risk management away from the national state and toward project proponents (Emel and Huber 2008; Hatcher 2013). The World Bank has thus worked to devalue background regulatory frameworks (which might threaten foreign direct investment) and instead emphasizes project and firm-level environmental assessment and forms of regulatory self-management. The justification for regulation had to be found not in broad notions of the public interest but in the self-interest of participants. As supporters of NT2 argue in Doing a Dam Better—"the application of the safeguards reduced the project's overall risk and increased credibility with a wide range of stakeholders" (Porter and Shivakumar 2011, 135). Because any environmental and social safeguards are built into the CA, civil society has little ability to offer new input or revisit the agreement.

The decision by the World Bank to seek regulation by contract rather than potentially more robust background state regulation affects the underlying environmental values protected. For instance, Baird, Shoemaker, and Manorom (forthcoming) report that the XBF River system included important fisheries for *pa phanh* and *pa doke keo*: But because Laos had no substantive fisheries regulation system in place, assessments for NT2 did not need to consider any such constraining regulatory frameworks. This left environmental and social objectives to be shaped by two overriding procedural principles (rather than substantive environmental values). First, and as discussed earlier, CBA would not only show possibilities for cash compensation or the loss of resources and the environment but also constrain such compensation to allow for the project to be profitable. This explains the limit to XBF compensation programs to US$16 million even after the PoE found the early estimates for the sums were inadequate. The second principle, rooted in the very idea of environmental assessment, is that information is to be provided to allow decision makers to choose the best (but still profitable) project design (Elling 2008). But, as already mentioned, this effectively sanctifies rather than challenges the terms of the PPA as initial conditions for profitability. This made it impossible to second guess the ways the PPA itself incorporated electricity rates too low to create sufficient compensation or how the PPA gave permission for EGAT to draw power on demand in ways that damage XBF River ecosystems. Moreover, the context of environmental assessment is very different in Laos than in countries such as Canada or the United States. In the latter, much of the content of such assessments involves showing how projects will comply with a background framework of substantive law. For large projects such as dams, environmental impact assessments require open and transparent hearings in which evidence and methodologies in developers' impact statements and proposed resettlement and compensation programs can be challenged by opposing experts and the public more generally. Alternatively, NT2 only featured the unilateral assertion of impacts and solutions by NTPC (and the international agencies behind it; Guttal and Shoemaker 2004; Singh 2009).

Also, the Lao PDR has constrained itself in enacting public interest regulation through the inclusion of stabilization clauses. Stabilization clauses provide a political and legal mechanism to minimize risk: They involve promises by the state to compensate companies for new environmental and social regulation that affect investor returns (Černič 2010). The World Bank provides political risk insurance as a financial product, but can further reduce such risks by pressuring states (and parties to agreements) to include such stabilization clauses. The CA thus involves the promise that the GoL will not increase the cost of doing business by applying fresh law or regulation to the project and will compensate NTPC if any new law does affect profits (NTPC, 2005e, s. 71 and 72). The effect is to freeze background regulation and to make the CA the effective regulatory authority in Laos (Can and Leader 2005). The GoL has created a situation where it is highly limited in expanding its role of regulatory agency in overseeing NTPC. It will need to make recourse to litigation in international tribunals on contract if NTPC violates the CA rather than enact traditional legislation to enforce public interest standards. Because the GoL seeks to share in profits, it has little incentive to take such legal action. Much like the analogous but highly controversial investor protection clauses in trade agreements (e.g., the North American Free Trade Agreement [NAFTA]), the resolution of such conflicts is left to commercial arbitration tribunals with no specific expertise and limited experience in matters of environmental, social, or human rights regulation. "By signing up to this stabilisation clause the GoL is allowing its changes of policy, across the full spectrum of governmental concerns, to be treated as risks from which business is entitled to protect itself . . . it is not clear that this approach can be reconciled with the obligations a state has arising under international human rights law" (Can and Leader 2005, 4).

Rethinking Electric Metabolic Relationships

Altough there remains wide scope for NTPC and EGAT to change their practices, the fact remains that there is little motivation for the Thai state, EGAT, the NTPC, or the GoL to make such changes. Civil society groups have not been able to exert sufficient pressure in what remain politically repressive contexts that shun public participation or manipulate it in particular ways.

Although unlikely, it is possible to imagine NTPC and its various lenders approving increased compensation to downstream users. EGAT could also stop unpredictable and varying use of the dam. Soft path planning could be adopted over the long term, as discussed earlier, but even in the short term, alternative avenues are available for meeting variable load. EGAT could simply use natural gas generators and pass the costs onto consumers. Beyond that, utilities could use demand response programs that shift the times electricity is consumed to reduce high peak periods (Greacen 2006; Greacen and Palettu 2007). In one example from Finland, the potential for demand response in the energy-intensive industries was estimated at 1,280 MW, equivalent to 9 percent of total system peak demand (Torriti, Hassan, and Leach 2010). Other techniques include forms of time of use pricing using smart meters that provide consumers with real-time price information. Loads are smoothed by forcing prices up (and demand down) during expensive peak periods. Thailand might also expand its nascent solar power program. Although solar capacity is often assumed to be nonfirm, it is an excellent match with Thailand's daily load profile. Solar output is highest during periods of hot sunny weather when air conditioning is most used (Du Pont 2005). Worldwide panel costs have fallen dramatically in the last decade and are grid competitive for some applications (Banker, Pathak, and Pearce 2011).

There remains potential action on contract. For instance, the CA includes warrants by NTPC that the EAMP is complete and constitutes an accurate overview of foreseeable project impacts (NTPC 2005b). If variable draw was foreseen but not properly accounted for, NTPC might have intentionally misled the GoL and downstream users. There are provisions for consultation and dispute procedures for problems with the realization of social and environmental objectives, although Baird, Shoemaker, and Manorom (forthcoming) have shown that they are not functioning as claimed. Although there is a budget limit set on compensation, this could be overridden due to problems with the underlying environmental assessment. Schedule 4, Part 2 of the CA specifically applies to the downstream XBF River and sets out parties' obligations (NTPC 2005a). NTPC has promised to take steps to "at least restore livelihoods of Project Affected Persons in the Downstream Areas on a sustainable basis" (s. 5.1(b)) and "mitigate or compensate (at replacement cost) for the physical impacts from the Project on the Downstream Areas" (s. 5.1c).

Although we would certainly welcome GoL, EGAT, and Thai regulators to advance these solutions, we remain skeptical that this is a likely outcome. Within Laos, parties appear locked into the PPA and CA, despite a significant underappreciation in the environmental assessments and social development plans for environmental flows. The GoL looks to NT2 for revenue and is unlikely to sacrifice that—or the prospects of new hydro projects that might be adversely affected by a litigious attitude. Lao civil society is not well developed and is hampered by a repressive and intolerant government. On the Thai side of the border, EGAT remains largely unaccountable to civil society pressures and Lao groups have little access to the Thai political system. Moreover, one energy analyst explained to us that the issue of downstream effects on fishers was also present in the Pak Mun dam, but "Thai people tend to care more about Thai people than Lao people and if EGAT was callous towards Thai people they will be even more so towards Lao people" (C. Greacen, personal communication, September 2014).

Conclusions

Hydrological flows on the XBF River and Bangkok air conditioning are now nodes in an emergent electric space. The network features an extensive array of transformer stations, transmission lines, and generating plants but also an underlying mode of ordering and constitution that can be altered as the network expands across borders. NT2 represents not only such a geographic expansion and so the creation of a regional grid but also the supplementing of national-scale regulation with a new type of regulatory regime.

There are considerable conceptual paradoxes in trying to combine a commercial and regulatory agreement into a single package, though. Central to commercial transactions is the assumption that parties can bracket out background environmental and social contexts, relying as it were on preexisting standards (usually provided by the state). Alternatively, negotiations over NT2 required selectively reframing the transaction to respond to international and Lao civil society concerns about dams and responsible investment. The neutral, calculative commercial agreement served to replace a complex political negotiation involving relations between Thai and Lao states and international lenders and overlapping claims of civil society. Diverse publics might have a legitimate interest in how the Mekong electricity system might be ordered to ensure the protection of biodiversity or protect the basic human rights to livelihoods of project affected villagers. Alternatively, for NT2, project objectives, knowledge creation, and problem solving became translated into commercial language with its limited ability to speak ecological and social truths.

Evidence of downstream effects on the XBF dependent villagers fundamentally challenges claims that these issues can be handled as calculative commercial agreements. Problems with environmental and social impacts are not only a problem for affected villagers, or parties to agreements, but circulate through the network. Thai consumers, international banks, and others remain connected to problematic and unequal relationships with distant others. NT2's unique form of regulation by contract works to both obscure such relationships and reframe them as commercial. The fact remains that the mode of ordering of the Mekong electricity grid—and hence the metabolic relationships to nature of its many users—is broadly informed and structured by geopolitics and commercial interests.

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Note

1. A smaller amount of water is also released into the Kathang River, which runs into the Nyom, and then finally into the XBF.

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