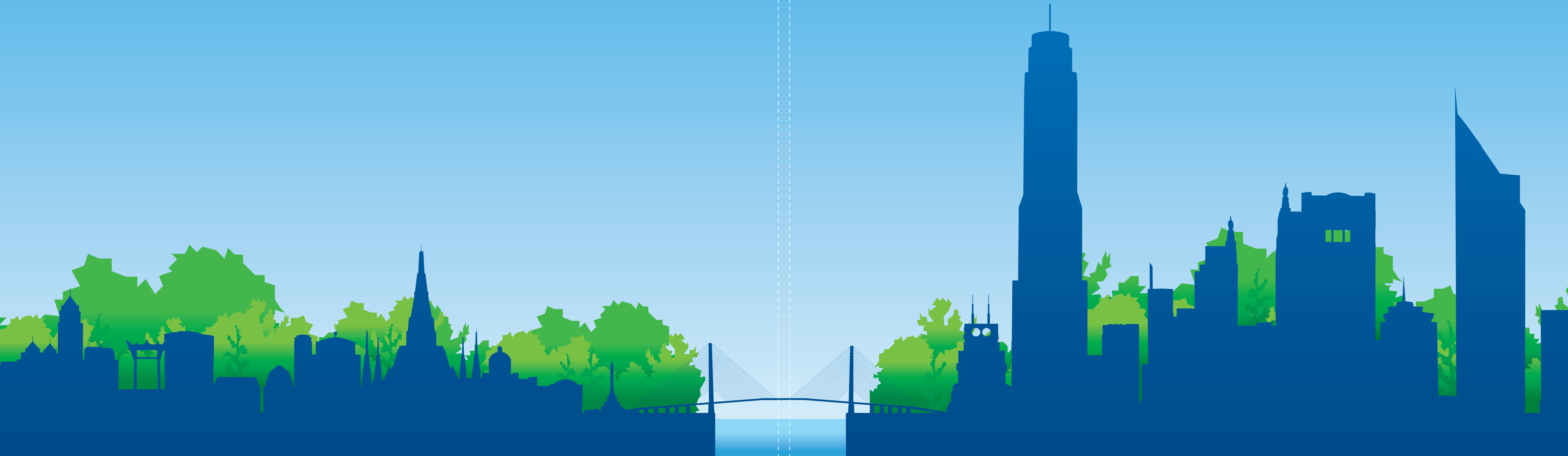

Proposed Power Development Plan (PDP) 2012

and a Framework for Improving Accountability and Performance of Power Sector Planning

Chuenchom Sangarasri Greacen and Chris Greacen

April 2012

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Glossary and List of Acronyms

Brown-field siting:	sites with existing or underused power plants or other industrial facilities available for re-use for power plant development
CCGT:	combined cycle gas turbine
CFL:	compact fluorescent light
CHP:	See cogeneration
CO_2:	carbon dioxide
Cogeneration:	the use of a heat engine or a power station to simultaneously generate both electricity and useful heat (also referred to as combined heat and power, CHP).
DSM:	demand side management
EE:	energy efficiency
EGAT:	Electricity Generating Authrority of Thailand
EIA:	Environmental Impact Assessment
EPPO:	Energy Policy and Planning Office
ERC:	Energy Regulatory Commission
GDP:	gross domestic product
GHG:	greenhouse gas
Greenfield:	a previously undeveloped power plant site
GW:	gigawatt
GWh:	gigawatt-hour
Hg:	mercury
IPP:	Independent Power Producer
Ktoe:	kilotonnes of oil equivalent
kWh:	kilowatt-hour
Load Factor:	the ratio of the average electric load to the peak load over a period of time.
MEA:	Metropolitan Electricity Authority
MW:	megawatt
MWh:	megawatt-hour
NEPC:	National Energy Policy Council
NO_x:	nitrogen oxide
PDP:	power development plan
PEA:	Provincial Electricity Authority
PM:	particulate matter
PPA:	Power Purchase Agreement
RE:	renewable energy
RM:	reserve margin
SO_2:	sulfur dioxide
SPP:	Small Power Producer
VSPP:	Very Small Power Producer

Introduction

Thailand's Power Development Plan (PDP), prepared periodically by the state-owned Electricity Generating Authority of Thailand (EGAT), is the master investment plan for power system development. It determines what kind and what quantity of power plants get built, where and when. The PDP has wide-reaching implications, shaping not just the future of Thailand's electricity sector and its social and environmental landscape, but also that of Thailand's neighboring countries.

The official PDP document also reflects a planning process in crisis. By selecting excessive amounts of controversial, expensive, risky, and polluting power plants over cheaper, cleaner, and safer alternatives, the PDP is at odds with both Thai energy policy as well as the interests of the vast majority of Thai people. The well-documented casualties are predominantly the rural poor. Afflictions include acute respiratory disease in thousands of villagers from operations of coal mining and power plants(Sukkumnoed, 2007), a number of violent conflicts associated with power plants (Polkla, 2010) , as well as higher prices because of excessive investment (Sirasoontorn, 2008). Investment in hydropower projects in Thailand and neighboring countries has led to human rights violations, impaired livelihoods for hundreds of thousands of riverside communities, flooding of high conservation value areas and destruction of river ecosystems upon which millions depend (IRN, 1999; World Commission on Dams, 2000).

This document is a new PDP. We do not wish to call it an "Alternative PDP" because we believe a document that makes sense should not be relegated to the marginal title "alternative". We call it simply "PDP 2012", and as such it is more consistent with Thai policy and the interests of Thai people than the the Electricity Generating Authority of Thailand's (EGAT)'s most recent power development plan, the PDP 2010. Our intention is not for the PDP 2012 to be the "only" PDP, but rather one to be considered in comparison to other plans. We would hope that all candidate plans be presented to the public in a way that emphasize the values and assumptions embedded in different future scenarios, and that ultimately an optimum PDP is selected that reflects excellent science, consistency with government policy objectives, and coherence with the desires of the Thai public.

In previous years, "energy security" has been a trump card used to justify official government PDPs and to discount proposed alternatives without serious discussion. But what exactly is energy security? In this paper we propose a set of quantitative energy security indicators and other indicators to measure consistency of PDPs with Thai policy objectives. We employ these indicators in evaluating the PDP 2012 compared with the PDP 2010.

This study concludes with policy recommendations to improve the planning process, as well as reforms to the industry and regulatory structure so that the development and operation of the power sector will move closer towards the government's stated policy objectives.

Energy policy objectives and policy framework

The Energy Industry Act, B.E. 2550 (2007) is the key law governing energy in the Kingdom. Pursuant to the Act, successive Thai governments have laid out the following policy objectives for the power sector:

- Energy security: procuring sufficient energy supply to meet demand
- Energy reliance: reduced dependency on imports
- Promotion of renewable energy: increasing renewable energy share
- Efficient use of energy: reducing energy intensity
- Diversifying fuel risks
- Reducing CO_2 emissions
- Minimizing impacts from energy procurement
- Fair and reasonable costs of energy service to consumers

Under the Energy Industry Act, the Abhisit Vejjajiva administration approved two plans: the Renewable Energy Development Plan which called for increasing the share of renewable energy to 20% within 15 years (2009), and the 20-year Energy Efficiency Plan, which set the goal of reducing energy intensity by 25% compared to year 2005, within 20 years. Energy intensity is a measure of the energy ineffiency of the economy, and is defined as the energy consumed to produce a unit of GDP. The Yingluck Shinawatra government in August 2011 reaffirmed the 25% energy intensity reduction target and set a goal of meeting 25% of Thailand's energy demand with renewable and alternative energy (Shinawatra, 2011).

Though the stated government energy policy has the manifold objectives listed in bullet points above, "energy security" appears to be the overriding objective in power sector planning practice. In official documents, the term "energy security" is not well defined but is generally used to imply availability of energy supplies. In a review of 91 academic, peered-reviewed articles on energy security, Brown (2011) found that "energy security" has four main dimensions: availability (of energy resources), affordability (prices of energy services), efficiency, and environmental stewardship (Table 1).

Dimension	Explanation	Indicators	Percent of Articles
Availability	Diversifying the fuels used to provide energy services as well as the location of facilities using those fuels, promoting energy systems that can recover quickly from attack or disruption, and minimizing dependence on foreign supplier	• Oil import dependence ; • Natural gas import dependence; • Dependence on Petroleum transport fuels	82%
Affordability	Providing energy services that are affordable for consumers and minimizing price volatility	• Retail electricity prices; • Retail gasoline/petrol prices	51%
Energy and Economic Efficiency	Improving the performance of energy equipment and altering consumer attitudes to reduce energy price exposure and mitigate energy import dependency	• Energy intensity (per GDP); • Per capita electricity use; • On-road fuel intensity of passenger vehicles	34%
Environmental Stewardship	Protecting the natural environment and future generations	• Sulfur dioxide emissions; • Carbon dioxide emissions	26%

Table 1: Four dimensions to energy security, from a search of 91 academic, peer-reviewed articles. Source: Brown, 2011.

The Thai government energy policy guidelines stipulated in the Energy Industry Act do include the four dimensions of energy security cited by Brown. However, there has been little or no linkage between power sector planning practice and the multi-dimensions of "energy security" as enshrined by the law. In other words, there has never been a systemic evaluation of the outcome of the power sector planning process with respect to the energy policy framework. The various PDPs in the past tended to over-emphasize availability of electricity supply at the expense of environment, overall sector economic and energy efficiency, and price to consumers.

To ensure and improve the accountability of the PDP process to the government policy objectives, we propose a framework for evaluating the outcome of PDPs reflecting the four dimensions summarized by Brown as shown in Table 2. For each dimension of energy security, we propose a set of simple indicators, such as percentage of energy imports, cost of electricity bills, electrical energy intensity and total greenhouse gas emissions, to be used for evaluating and comparing performance of the PDP with respect to different policy objectives.

These indicators will in later sections be applied to compare between the approved PDP 2010 and our proposed PDP 2012. It is our hope that this accountability framework will be considered, adopted and improved upon to make future PDPs accountable to the Energy Industry Act and the government's stated policy, and that future power sector planning will consider more than just the version of PDP prepared by EGAT. Our version of PDP 2012 to be presented below can considered as a candidate draft to be evaluated against other versions, included EGAT's, based on the evaluation and accountability framework as proposed here.

4 Dimensions of energy security	Energy Industry Act 2007	Indicators
Availability	• Resource Adequacy • Min. dependency on imports • Diversification	• Reverse margin ≥ 15% • % energy imports • Shares of fuels
Affordability	• Affordable cost of service • Min. exposure to price volatility	• Electricity cost (B/mo.) • % exposure to oil price
Efficiency	• Energy & econamic efficiency	• Energy & intensity (GWh/GDP)
Environment	• Min. Environmental impacts	• GHG emissions • SO_2 emissions

Table 2: Proposed framework of indicators to introduce links of accountability between the PDP process and the government energy policy as set out in the Energy Industry Act 2007.

The PDP 2010: discussion and critique

The process for developing PDPs in Thailand proceeds in two key steps. The first is the creation of an electricity demand forecast. The second is the creation of a plan (the PDP) that lists the resources (power plants) that will be deployed, and in what time frames, to ensure that the electricity demand forecast can be met with the specified level of reliability.

The load forecast is developed by the Thai Load Forecast Subcommittee, under the Energy Ministry, while the PDP itself is crafted by EGAT under the broad policy guidelines of the Energy Ministry and is subject to reviews by a hierarchy of committees chaired by Energy Ministry Permanent Secretary. The final approval is by the National Energy Policy Council (NEPC), chaired by the Prime Minister and comprised of cabinet members and high level bureaucrats from relevant ministries. After approval by NEPC (also known as the "energy sub-cabinet"), the PDP is generally approved by the Cabinet without further review. The Energy Policy and Planning Office (EPPO) serves as the secretary to the NEPC.

It is worth noting that several key decision makers involved in the above-mentioned committees are also sitting on the board of directors of energy companies that have direct vested interest in the PDP process. Meanwhile, small consumers and the public are under-represented and have very limited roles in participating in the decision making process.

In addition to conflict of interest there are two other structural problems: monopoly, and the "cost-plus" incentive structure. These are important issues to address and have been addressed elsewhere[1] but are beyond the scope of this paper. This paper addresses the symptoms: that the latest PDP 2010, like previous PDPs, calls for too many power plants, of the wrong kinds (overly risky, expensive, and socially and environmentally destructive). Next sections will explore the flaws of the two key steps of the PDP process – demand forecasting and procuring supplies – in detail.

[1] *For example, see "รสนา โตสิตระกูล ชำแหละ แผนพัฒนาผลิตไฟฟ้าใหม่ โยนภาระค่าโง่ปีละแสนล้านให้ประชาชน"8 March 2010, http://www.oknation.net/blog/sutku/2010/03/08/entry-2, and "Rethinking "energy security" and power sector planning: a case study of Thailand" Greacen, 2012, http://www.palangthai.org/docs/RethinkingEnergySecurityChomMEENET18Jan2012.pptx.*

Electricity demand projection

The foundation for the PDP is an official forecast of future electricity consumption. Because electricity cannot be cost-effectively stored at national-scales, supply must be balanced with demand at every moment. Thus, the forecasted peak demand figure is important because the peak demand (plus the agreed-upon reserve margin), determines the amount of power plants that are necessary to ensure adequate power supply in the country. Because power plants and other related investments have long lead-times (typical large thermal plant requires two to three years of construction time, a typical hydropower plant requires at least four, and nuclear power plants at least five not including licensing and approval[2]), planning ahead is necessary to avoid power shortages. However, inaccurate forecasts could also lead to either a shortage situation (too few power plants built) or surplus situation (too many power plants built). Each has significant economic ramifications. As described below, Thailand load forecasts have consistently led to expensive power plant surpluses.

The Thai Load Forecast Subcommittee[3], under the Ministry of Energy, makes projections of the country's future electricity demand and updates them approximately every two years, or when circumstances change.

The key features of the methodology used to forecast demand are as follows:

- demand projections are primarily based on medium and long-term GDP growth forecasts (Vernstrom 2005).
- A secondary source of information comprises end-use models for certain customer classes with sufficient available data (residential, and some commercial and industrial customer classes).
- the fundamental underlying concept is one of exponential growth (annual increases are higher as the base (total consumption) increases).

Figure 1 show the actual peak demand in Thailand (solid red line) compared to every forecast used to develop government power development plans over the past 20 years. There is a clear systemic tendency to over-estimate actual demand for electricity.

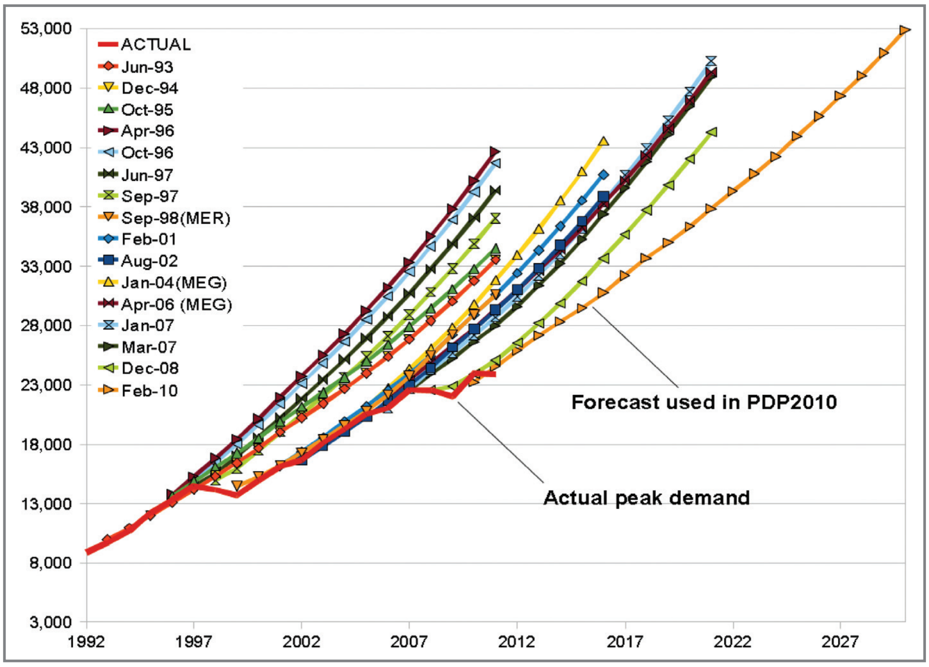


Figure 1: Government's load forecasts made in previous years of peak electricity demand (in MW) are all considerably higher than actual demand (solid red line at bottom of graph).

[2] *According to the French Nuclear Safety Authority (ASN), it takes at least five years to set up the legal and regulatory infrastructure for a nuclear power program, two to ten years to license a new plant, and about five years to build a power plant. That means a "minimum lead time of 15 years" before a new nuclear power plant can be started up in a country that does not already have the required infrastructure. Source: http://www.world-nuclear.org/info/inf102.html, accessed March 21, 2012.*

[3] *Chaired by Energy Permanent Secretary, the Load Forecast Subcommittee comprises mainly representatives from the three electric utilities, government agencies, large power users and a few academics.*

A second feature worthy of note is the curve of the forecast. All official demand projections are based on an assumption of exponential growth, with an upward bending curve that gets steeper over time. This exponential shape arises because exponential GDP growth is the main underlying driver in the government's power demand forecast model (Vernstrom 2004, EPPO 2007).

GDP growth rates adopted by forecasters have proven to be overly optimistic. Whereas planners predicted a base-case of 5.0% annual GDP growth from 2007 to 2011, actual GDP growth has averaged only 2.8% (see Table 3) over this period. One senior Asian Development Bank (ADB) official noted in a conference on power sector planning in the Mekong region, "Thai GDP figures are a little bit political, and are more like a wish numbers." Few politicians would be excited to announce GDP forecasts during their time in office that predict mediocre economic growth. These wish numbers unfortunately lead to expensive and impactful over-investments in power generation.

PDF 2007 forecast												
Case	2007	2008	2009	2010	2011	5-yr Avg	2012	2013	2014	2015	2016	5-yr Avg
Low	4	4.5	4.7	4.5	4.5	**4.4**	4.8	5	5	5.3	5.3	**5.1**
Base	4.8	5	5.2	5	5	**5.0**	5.3	5.5	5.5	5.8	5.8	**5.6**
High	5	5.5	5.7	5.5	5.5	**5.4**	5.8	6	6	6.3	6.3	**6.1**
Actual	**5.04**	**2.48**	**-2.3**	**7.8**	**1.0***	**2.8**						
*Bank of Thailand's estimate, as reported in Matichon newspaper on Feb 4, 2012												

Table 3: Projected and actual GDP growth in 2007 – 2011, as well as predicted growth in 2012-16. Data sources: (EPPO 2007; EPPO 2011;Yuvejwattana 2011).

Moreover, the problem with GDP forecasts is not all wishful thinking and politics. Part of the problem is that real growth of the Thai economy is affected by "Black Swan" events: unexpected occurrences such as the 1997 financial crisis, oil price spikes, violent political conflicts and a devastating "50-year" flood. These occurances were impossible to predict and were, of course, never taken into account in projecting future power demand. The fact is that while the disruptions have been different each time, significant disruptions have occurred time and again with significant impacts on the economy and electricity consumption (see Figure 2).

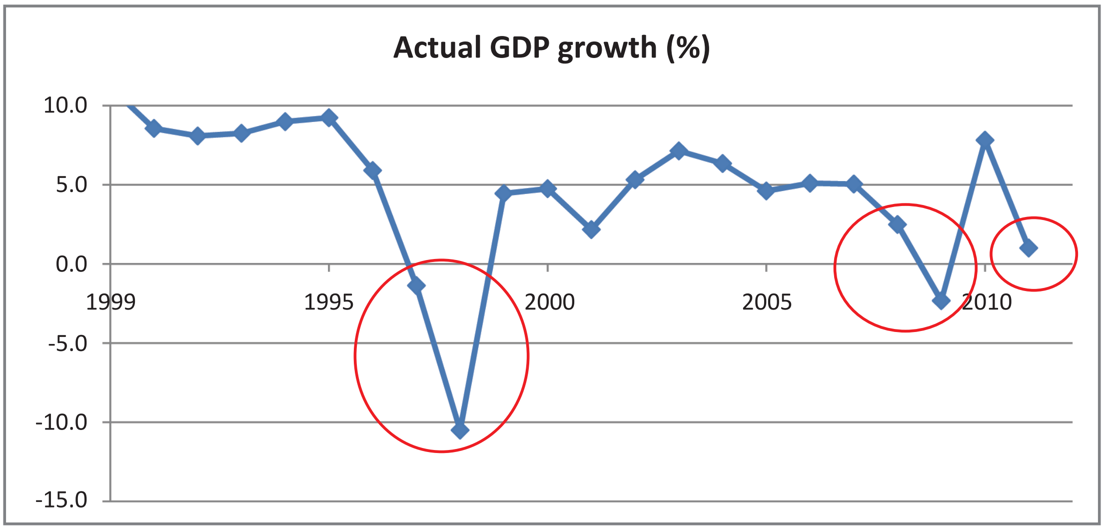


Figure 2: The growth of Thailand's gross domestic product (GDP) has not been without interruptions. The 1997 financial crisis, political instability in 2009 and "50-year" flood in 2011 each had significant negative impacts on the economy as well as power consumption.

Such unexpected events though hard to predict are part of the reality of the economy. Their effect has been to throw growth trajectory toward a path that has ended up being more linear or logistic shaped than exponentially growing. Given the on-going uncertainties of world economy, domestic political environment and extreme climate events, it is unrealistic to expect that forecast GDP and electricity demand will grow exponentially as predicted.

The extent of over-optimism in demand projection becomes more apparent when we compare the projected annual demand increase as assumed in the PDP 2010 with the historical records, as shown in Figure 3.

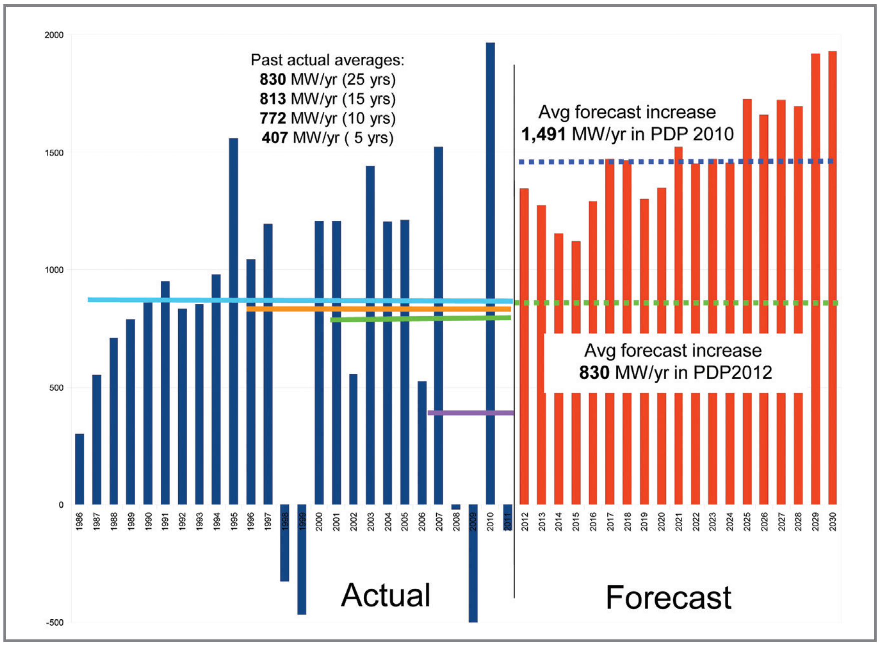


Figure 3: Annual peak demand increase in MW: comparing the PDP 2010 projections with the past actual records and historical averages. The difference between the PDP 2010 forecast growth and the highest actual historical average is about 660 MW in peak demand per year, equivalent to about one coal-fired power plant each year.

As shown above in Figure 3, when averaged over the past 25 years, demand for electricity in Thailand has grown about 830 MW per year. When averaged over 15 years, this shrinks to 813 MW per year. Over the past 10 years it demand has grown only 772 MW per year, and the past 5 years have seen an average increase of only 407 MW per year. In contrast, the PDP 2010 assumes average increase of 1491 MW per year. Considering the actual trend over the past 25 years (lower and lower increases on average every year), it is conservative[4] to assume that long-term future demand for electricity increase at the 25 year average rate.

In light of this track record, and the available data, the following revised assumptions are used in the demand forecast in the PDP 2012:

Assumption	Rationale
Actual 2011 peak used as base for projecting future demand	The February 2010 PDP over-predicted 2011 peak demand 668 MW.
Linear demand growth, based on historical 25-year average (830 MW/year)	February 2010 forecast assumes uninterrupted exponential growth, whereas historical growth has been essentially linear (with declining averages in past years) and there are uncertainties, such as world economic condition and extreme climate events that affect the Thai economy.

Table 4: Assumptions used in PDP 2012 demand forecast

[4] *By "conservative" we mean assumptions that will lead to extremely low likelihood of insufficient power plants available to meet electricity load.*

Based on the above assumptions, the adjusted peak demand forecast, called "PDP 2012 forecast" is as shown in Table 4. Compared to PDP 2010 forecast, the PDP 2012 peak demand for year 2030 is reduced by about 13,200 MW to 39,692 MW.

Comparison of peak demand forecasts used in PDP 2010 vs. PDP 2012									
Year	PDP 2010				PDP 2012				Load factor %
	Peak demand			Energy GWh	Peak demand			Energy GWh	
	Peak MW	Annual increase			Peak MW	Annual increase			
		MW	%			MW	%		
2011	24,568	1,319	5.67%	160,331	23,900	-110	-0.46%	155,972	74.50%
2012	25,913	1,345	5.47%	168,049	24,731	831.14	3.48%	160,385	74.03%
2013	27,188	1,275	4.92%	175,631	25,562	831.14	3.36%	165,129	73.74%
2014	28,341	1,153	4.24%	183,452	26,393	831.14	3.25%	170,845	73.89%
2015	29,463	1,122	3.96%	191,224	27,225	831.14	3.15%	176,696	74.09%
2016	30,754	1,291	4.38%	200,012	28,056	831.14	3.05%	182,463	74.24%
2017	32,225	1,471	4.78%	209,329	28,887	831.14	2.96%	187,645	74.15%
2018	33,688	1,463	4.54%	218,820	29,718	831.14	2.88%	193,033	74.15%
2019	34,988	1,300	3.86%	227,599	30,549	831.14	2.80%	198,724	74.26%
2020	36,336	1,348	3.85%	236,956	31,380	831.14	2.72%	204,639	74.44%
2021	37,856	1,520	4.18%	246,730	32,211	831.14	2.65%	209,941	74.40%
2022	39,308	1,452	3.84%	256,483	33,043	831.14	2.58%	215,601	74.49%
2023	40,781	1,473	3.75%	266,488	33,874	831.14	2.52%	221,352	74.60%
2024	42,236	1,455	3.57%	276,805	34,705	831.14	2.45%	227,448	74.81%
2025	43,962	1,726	4.09%	287,589	35,536	831.14	2.39%	232,468	74.68%
2026	45,621	1,659	3.77%	298,779	36,367	831.14	2.34%	238,174	74.76%
2027	47,344	1,723	3.78%	310,387	37,198	831.14	2.29%	243,872	74.84%
2028	49,039	1,695	3.58%	322,427	38,029	831.14	2.23%	250,040	75.06%
2029	50,959	1,920	3.92%	334,921	38,861	831.14	2.19%	255,406	75.03%
2030	52,890	1,931	3.79%	347,947	39,692	831.14	2.14%	261,120	75.10%
*The figures in pink highlight are actual values, not forecast.									
Data source (PDP 2010): EPPO, 2010, http://www.eppo.go.th/power/pdp/page-7.html									

Table 5: Comparison of peak demand forecasts used in PDP 2010 vs. PDP 2012. Load Factor for the PDP 2010 and PDP 2012 are assumed to be identical.

Ultimately what is needed is for Thailand to move away from load forecasting based on econometric regression (top-down approach) and to invest instead in the capacity to undertake rigorous bottom-up forecasting that understands sector-by-sector, industry-by-industry, end use-by-end use what the actual growth in electricity consumption will be. This is data-intensive and requires much more detailed understanding of exactly how electricity is being used by all customer classes, and how these usage trends are affected by changing technology, appliance efficiency improvement rates, adoption rates, prices, domestic and international economic climate, and changing demographics. Though a formidable task, user surveys and data gathering and analysis are likely to be a much better investment than mistakenly building unneeded power plants.

Power Development Plan: procuring supply to meet demand

In conventional practice, with the load forecast in place, EGAT develops a draft PDP that is then reviewed by government committees and approved by the cabinet. In developing the PDP 2010, EGAT uses commercial software that includes an algorithm that selects among the candidate supply options listed in the bullet points below. These options are generally new plants in "green-field" sites (sites that have never had a power plant before) or new plants added to existing "brown-field" sites (sites that already have an existing power plant) that have the ability to expand:

- natural gas combined cycle gas turbine (CCGT), 800 MW per plant
- nuclear, 1000 MW per plant
- coal, 800 MW per plant

In EGAT's PDP these options are augmented by a very limited amount (0.3% of total GWh) of demand side management (DSM) and some renewable energy (VSPP and SPPs). The plan also includes a disquieting amount of imports of hydropower and polluting lignite-fired electricity from neighboring countries. Currently planned imports of electricity from hydropower and lignite power plants in Laos and Cambodia are not subject to Thai environmental regulations and public review, but this does not make the impacts any less real. The silence is more reflective of the restricted ability to protest, or limited awareness by communities that will be affected in the future. In the case of coal and some hydropower projects, downstream and downwind impacts will even hurt Thailand. But because the project is across an international border (though some investors of these projects may be Thai companies or even EGAT's subsidiaries), Thais' opportunities for redress are also limited.

In the official PDP, electricity import projects receive special treatment. They are treated as "policy inputs" and are not required to compete with other options. The rest of the PDP is then built around these assumed bilateral coal and hydropower import projects, selecting coal, gas or nuclear based on the computer program's selection criteria.

These resource options, we believe, reflect an overly restrictive vision of options for the power sector. Below we present a discussion of an expanded field of resource options.

Resource options

Traditionally EGAT's approach has been to respond to projected increases in demand by planning new large-scale power plants. But this is not the only way of doing things. International best practice is to consider electricity planning as holistically as possible, as a problem in delivering energy services, not just delivering kilowatt hours of energy. Thus, it makes more sense to consider all least cost measures that will provide the same service, comfort and convenience, even if this means not having to sell more electricity. Taking this Integrated Resource Planning (IRP) frame substantially broadens options (Swisher, 1997; D'Sa, 2005). The broader menu of choices include investments to acquire energy savings, clean renewable energy generation, cogeneration, as well as plant life extension, repowering, and brownfield siting of conventional power plants.

Energy efficiency and demand-side management

Saving electricity is almost always cheaper than building new power plants and fueling them for decades. EGAT's own analysis has shown that its demand side management (DSM)[5] programs deliver saved electricity at less than half the cost of building new power plants (Foran, Pont et al. 2009). Kilowatt-hour (kWh) savings acquired through investment in energy efficiency are not only the cheapest way to meet growing demand compared to other generation options; they also help save transmission, distribution and conversion losses and wastes along the supply chain of electricity from fuel to generation to delivery to customers. They also save or defer investments in

[5] *Demand Side Management (DSM) is another name for energy efficiency – referring to addressing electricity demand at the 'demand side' by lowering or shifting load, not at the 'supply side' by building power plants.*

power transmission and distribution infrastructure – investments which eat up budgets, adding over 40% on top of the investment cost of electricity generation.[6]

The PDP 2010 did take into account savings from energy efficiency but the only program incorporated was the T5 light replacement program which is estimated to yield a savings of 0.3% of total load by 2030. This amount is extremely small compared to the real potential and to what has been done elsewhere in the world. Figure 4 shows a comparison in the level of investment in energy efficiency in the Pacific Northwest, USA. versus Thailand. The potential to invest more in EE in Thailand is immense, given that it is the cheapest and cleanest option to meet demand.

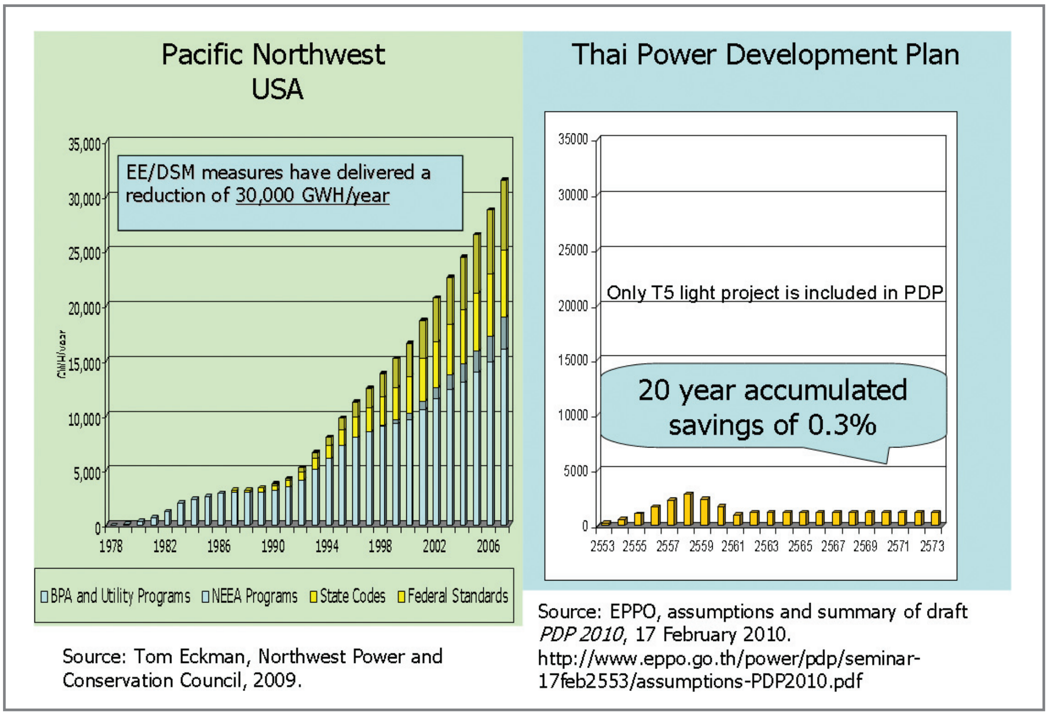


Figure 4: Role of EE/DSM in power sector planning: the Pacific Northwest, USA and Thailand, with energy savings measured in GWh/year. Note, the y-axis in both graphs is identical. In the Pacific Northwest, new EE/DSM measures are still considered to be the cheapest and cleanest choice of power supply options even after 30 years of successful implementation of past energy efficiency measures. In the most recent Sixth Northwest Conservation and Electric Power Plan (Northwest Power Planning Council 2010) about 85% of increase in electricity demand is met through investments in EE/DSM. Thailand on the other hand included only 0.3% of accumulated energy savings in the approved PDP 2010. Much more potential has yet to be tapped.

Foran, Du Pont et al. (2009) carefully document how an additional 14,000 GWh/yr of annual energy savings in Thailand could be secured by the year 2026 through residential energy efficiency measures aimed at five key household appliances. For these appliances, savings equal to 28% of baseline consumption after 20 years could be obtained through simple measures such as tightening standards of appliance efficiencies of air-conditioners, refrigerators, fans, rice cookers and compact fluorescent lamps (CFLs).

Energy efficiency savings opportunities in industry and commercial buildings are much higher than in the residential sector. These savings opportunities are captured in the Thai Government's 20-year Energy Efficiency Development Plan (Table 5), which targets an annual energy savings of nearly 70,000 GWh by the year 2030. Of this 70,000 GWh, the residential figure of about 19,000 GWh/year is roughly commensurate with the projection for year 2026 by Foran and Du Pont.

[6] *For example, the PDP 2010 investment budget for transmission upgrade added an additional 40% on top of the generation investment budget (Source: EGAT, PDP 2010). In addition, Metropolitan Electricity Authority and Provincial Electricity Authority have their own distribution investment plans and budgets that correspond to the expansion planned in the PDP 2010.*

Energy savings in different sectors	Technical potential			Target	Target electricity
	Heat ktoe	Electricity GWh	total ktoe	Year 2030 ktoe	savings in 2030* GWh
Transport	16,250	-	16,250	13,400	0
Industrial sector	10,950	**33,500**	13,790	11,300	**27,451**
Large commercial buildings	410	**27,420**	2,740	2,300	**23,017**
Small commercial buildings & residential	1,690	**23,220**	3,670	3,000	**18,981**
Total	29,300	**84,140**	36,450	30,000	**69,251**
% of total 2030 power consumption as projected by PDP 2010					**20%**

*The EE plan has a 20% energy target. Here we assume the electricity target is also 20% compared to total projected demand.

Table 6: Government's energy saving target. The government approved the 20-year Energy Efficiency Plan in April 2010 which called for almost 70,000 GWh of annual electricity savings or 20% of total load by 2030. Source: (Energy 2011) and (Foongthammasan, Tippichai et al. 2011)

The PDP 2010 made no mention of the 20-year Energy Efficiency Development Plan because the latter was approved after the PDP 2010 was issued. To ensure consistency of different government energy plans, our proposed PDP 2012 adopts the target of 20% savings compared to baseline consumption (the adjusted demand projections) for year 2030. The 20% target is consistent with the overall target of savings for the various energy sub-sectors set forth in the 20-year Energy Efficiency Development Plan.

Renewable energy

According to Thailand's Very Small Power Producer (VSPP) regulations, electricity that is considered "renewable energy" includes electricity generated from the sun, wind, biomass, biogas, waste (municipal, agricultural, or by-products of industrial processes), mini- and micro-hydroelectricity, sea or ocean waves and geothermal energy (EPPO 2006). Currently the vast majority of Thailand's renewable electricity is produced under the Very Small Power Producer (VSPP) and Small Power Producer (SPP) programs in which private-sector operators produce and sell electricity to the grid and receive technology-specific premium prices for renewable energy.

	Online (MW)		signed PPA (MW)	
	VSPP	SPP	VSPP	SPP
Biomass	783	614	1,961	5
Biogas	70	0	126	0
Solar	67	0	2,020	90
Municipal waste	39	0	130	0
Small hydro	1	13	6	0
Wind	0.4	0	72	267
Other	0	54	0	0
Total	1,017	681	4,260	362
Grand Total	1,698		4,622	

Table 7: VSPP and SPP renewable energy installed and with signed PPAs as of September 2011. Compiled from data at: http://www.eppo.go.th/power/data/index.html

Thus far, about 82% of renewable energy actually online in Thailand is powered by biomass, accounting for 1,397 MW out of a total of 1,698 MW. Biomass also accounts for nearly half of renewable energy projects that have signed Power Purchase Agreements (PPAs) but are not yet constructed (Table 7). The “lowest hanging fruit” biomass resources in Thailand comprising agro-industrial waste from sugar factories, large rice mills, and lumber mills are already largely claimed, so rapid growth in the biomass sector is not expected. Solar electricity, on the other hand, is growing quickly. Total solar capacity installed is nearly doubling every six months, yet still accounts for only 3.9% of total installed renewable energy. With over 2100 MW of signed PPAs, solar electricity may be poised to overtake biomass in terms of installed capacity, especially taking into consideration recent dramatic decreases in solar panel prices (LBNL, 2011).

The key constraints to renewable energy in general and solar electricity specifically, are not technical, but are a result of fairly recent changes that create considerable uncertainty in the policy environment. On June 28, 2010, the National Energy Policy Council (NEPC) passed a resolution[7] to stop accepting new applications for solar electricity; reduce the adder rate for solar projects already submitted and under consideration; require bid-bond payments for renewable energy project applications, and the establishment of the Managing Committee on Power Generation from Renewable Energy Promotion (hereafter, the “Managing Committee”) to police renewable energy compliance with policy.

While all of these changes put a damper on renewable energy development, the most significant has been the actions of the “Managing Committee”. The Managing Committee comprises largely members from utilities and government. In policing renewable energy projects “compliance with policy” a key concern is that the Committee lacks public oversight, creating fertile ground for confusion and doubts whether the Committee’s process is fair and immune to business interests and political intervention (Tongtup, 2011; Bangkokbiznews, 2010). There are no clear guidelines on which projects will be approved first and which project are allowed to ‘jump the queue’, leaving room for rent-seeking by those with the authority to approve projects.

New rules added by the committee expose projects to a crucial “Go / No Go” decision by committee members on grounds that include subjective determinations such as the Committee’s assessment of the project’s financial status. Moreover, many applications are apparently stalled due to the lack of a definite timeline on how long the Committee can take to process applications. With time-critical financing from banks and equity investors, delays and uncertainty of this nature is often deadly for projects.

As of this writing, new applications for solar electricity are still not accepted, and since the Managing Committee has been active, very few new renewable energy projects using other types of fuels have achieved PPAs.

Even with no new applications accepted, the (large) solar electric pipeline of 2100 MW of PPAs and 2500 MW of other renewables are being built-out, some quite rapidly. There is a particularly hot market for signed solar PPAs, with these legal documents reportedly fetching prices as high as million baht (US$30,000) per MW.

The PDP 2010 calls for a cumulative 4617 MW of new renewable energy between 2011 and the year 2030. This is actually less than the 4622 MW of already operating renewable energy plus signed PPAs in the pipeline as of September 2011. Thus, it would seem that the PDP 2010 figure is low -- especially considering that VSPP or SPP construction and commissioning generally takes less than two years, and the falling prices for solar electricity and other renewable energy technologies.

However, to be conservative, the PDP 2012 accepts the PDP 2010 projections for new renewable SPPs and VSPPs. Even with the dysfunction of the current renewable energy policy environment this will probably under-estimate the amount of renewable energy that comes online by the year 2030. With policy reforms, much greater gains in renewable energy can be achieved. Clearly industry is ready and willing to move quickly when allowed to do so.

One question that needs resolution is how to weigh renewable energy in the PDP. That is, what portion of renewable energy is “dependable capacity”. Dependable capacity is defined as capacity that can be relied on to be dispatched to meet load. While some renewable energy technologies can store fuel (biomass, biogas), others depend on

[7] *These key policy changes were justified by citing concerns about impacts of higher rates on consumers and concerns about the speculative nature of some renewable energy contracts (2010). It is worth noting, however, that consumers themselves have not, as a rule, expressed disappointment or concern about renewable energy leading to higher tariffs.*

intermittent flows (solar, wind). One factor to keep in mind, however, is that Thailand's peak load is driven by air conditioning, which peaks on hot, sunny days: precisely the times that solar generates the most power. Even a technology like solar which cannot be dispatched at will may, because of its technical characteristics, also tend to be available when it is needed most. With no moving parts and large numbers of inverters operating in parallel, solar electricity can be more reliable on sunny peak load times than fossil fuel generators.

A second important factor in considering dependable capacity comes about as a consequence of large numbers of simultaneously operating plants. Utilities are used to the idea that thousands of customers turning on and off loads can create a predictable daily load curve, even if predicting the instantaneous consumption of individual consumers is less certain. Similarly, large number of renewable energy generation result in a predicable supply curve even if the individual power plants are intermittent.

The PDP 2010 uses dependable capacity ratios for renewable energy as shown in Table 8. In the PDP 2012, we use the same dependable capacity ratios for renewable energy but note that, for reasons discussed above, these numbers are very low, particularly for solar and thus lead to undercounting renewable energy contributions in decreasing the need for conventional generation. We see a need for more research to better understand the effective dependable capacity of renewable energy in Thailand in relation to the seasonal and diurnal variations in Thailand's peak demand. In terms of their contribution to offsetting new generation called for in the PDP these assumptions about dependable capacity are just as crucial as predictions of MW of installed capacity.

RE	Dependable capacity
biomass	40%
biomass (rice husk)	70%
biogas	21%
solar	21%
wind	5%
small hydro	40%
waste	20%
*source: EPPO, http://www.eppo.go.th/power/pdp/page-7.html, 2010	

Table 8: Dependable capacity of renewable energy generation as assumed in the PDP 2010 and the PDP 2012

Cogeneration

A cogeneration plant is a power plant that simultaneously produces both electricity and useful heat. Generally this means capturing the waste heat from the electrical generation process that, in a conventional power plant, would be released through cooling towers and smokestacks. By making productive use of waste heat, cogeneration can save considerable fuel compared to separate sources of electricity and industrial heat.

Whereas the typical method of separate centralized electricity generation and on-site heat and/or steam generation has a combined efficiency of 30 to 50 percent, cogeneration systems can reach efficiency levels of 90 percent. As a form of decentralized generation, cogeneration also reduces transmission losses due to its proximity to industrial or commercial applications that utilize both electricity and heat.

Thailand has significant opportunities for cogeneration industrial heating as well as cooling in large hotels, shopping malls, and government buildings. An example many have experienced is Bangkok's Suvarnabhumi Airport, in which all cooling for the main terminal and surrounding facilities is accomplished with a lithium bromide chiller using "waste" steam from a 52 MW cogeneration system which also provides the electricity for the entire airport.

Menke et al. (2006) examined a portion of the cooling market and identified 3500 MW of cogeneration in VSPP systems sized from 400 kW to 10 MW providing cooling in commercial buildings including new shopping malls, hospitals, government buildings, and universities (Menke, Gvozdenac et al. 2006). Cogeneration for cooling also has the added benefit of significant electricity load reduction through reducing the need for new MW of capacity to supply electricity for traditional air conditioning in these buildings. This additional benefit is not quantified in our calculations, but is significant.

Currently only six VSPP cogeneration projects are online, with cumulative installed capacity of 39 MW. Interestingly, most appear to be heating projects (paper factories, biomass drying and pellet factories, ceramic factories) and not the cooling applications identified by Menke et al. This suggests that there are significant additional untapped applications for small cogeneration in the country that are of types not yet identified in any Thailand-specific studies, but which are never the less being built out.

Despite huge potential and interest by the private sector, the Thai SPP cogeneration program has stagnated for the past few years because the program was temporarily closed (ironically as a result of the power glut from too much conventional generation). In February 2006, 27 projects totaling 2980 MW of fossil fuel-fired cogeneration SPPs were online and generating electricity. In 2011, that number has grown by only two more projects to 29 SPPs generating 3377 MW.

Fortunately, the program was recently reopened. Cabinet resolutions in August 2009[8] and May 2010[9] called for EGAT to accept an additional 2000 and 1500 MW of cogeneration, respectively. As of September 2011, another 32 cogeneration SPP projects totaling 3790 MW of generation capacity have signed PPAs, and another 24 cogeneration SPPs totaling 2835 MW have received approval but have not yet signed PPAs. Together, these projects in the pipeline that have received permission or (better) have signed PPAs total 6624 MW.

Application	MW	Program
Existing signed PPAs	3,790	SPP
Approved but not yet signed PPA	2,835	SPP
New cooling CHP projects under 10 MW each -- identified in (Menke et al., 2006)	3,500	VSPP
0.9% per year growth in opportunities over next 18 years	1,700	SPP+VSPP
New VSPP in ceramics, paper, pellet and other industries	(not counted)	VSPP
Total	**11,825**	

Table 9: Cogeneration pipeline and potential in Thailand.

By the year 2030, the PDP 2012 calls for cumulative additions of 11,825 MW of new fossil fuel cogeneration, compared with 7,137 MW in the PDP 2010. Though higher than the cogeneration assumed in the PDP 2010, the PDP 2012 cogeneration estimate is based on the following assumptions:

1) Build-out of projects with signed PPAs or that have received permission from Thai utilities (6624 MW) as of September 2011. This is a reasonable assumption if the economy continues to grow. If the economy does not grow, then electricity demand will, in turn, be low and these MW will not have been necessary to maintain adequate reserves;

2) Build-out of the 3500 MW of small-scale cogeneration (cooling projects up to 10 MW) that the Menke et al. study identified as commercially viable in 2006.

3) Growth in new opportunities for cogeneration over the next 18 years accounting for an additional 1700 MW of cogeneration. Since 2006 (the year of Menke's estimate), the economy has grown 29%. If we assume that opportunities for small-scale cooling cogeneration have grown about at the same rate as GDP, then the 2011 commercially viable cogeneration potential should be 29% higher than in 2006, and by 2030 should be considerably higher).The 1,700 MW addition reflects an increase of only 16.7% over 18 years compared to current potential, or an annual growth rate in new potential of less than 0.9%.

[8] *http://www.eppo.go.th/nepc/kpc/kpc-127.htm#3*

[9] *http://www.eppo.go.th/nepc/kpc/kpc-132.htm#12*

4) No assumptions are made regarding build-out of new small-scale (<10 MW) heating cogeneration projects over the next 18 years in paper, ceramic, pellet, and other industries. This is clearly a conservative assumption that under-counts a potentially important source.

Gas Pipeline expansion and cogeneration

The build out of cogeneration described above assumes the existing natural gas distribution and transmission network. Growth of cogeneration opportunities clearly rise as this network expands. As of 2010, the existing total natural gas pipeline length in Thailand was 3,372 km, with 1,975 km offshore and 1,397 km located onshore. Of this, the distribution pipeline length was 920 km running through 10 provinces. The distribution lines branch out from the transmission lines to industrial plants located mostly in Bangkok and nearby provinces, such as Pathumthani, Chonburi, Chachoengsao, Samutprakarn, Ayutthaya and Ratchaburi. But this is expanding – as of 2012, the distribution pipeline has been extended to 1,650 km covering 23 provinces.[10]

Thailand's monopoly PTT Public Company Limited, with few minor exceptions, acts as the sole purchaser, transporter and distributor of natural gas in Thailand. While the network is clearly expanding, the lack of mandatory third party access to PTT's gas transmission pipelines network acts as an impediment both to natural gas network expansion as well as to price competition that could further increase opportunities for cogeneration.[11]

Plant life extension and Repowering

Thailand has many natural gas and coal power plants that will reach the end of their expected design or contracted life of 20 or 25 years during the course of the PDP 2010 (from 2010-2030). If-well maintained and/or additional investment is made to replace certain parts, the plants may be able to be in service for additional years. This is similar to using your old car for another year or more rather than purchasing a new one. Delaying decommissioning of power plants, or "plant life extension" can be less expensive and less socially disruptive than building new power plants. It also has the advantage of very short (or essentially zero) lead time depending on the conditions of the plant. While extending the life of plants is not always the optimum solution (particularly if the plant is inefficient or prone to unscheduled outages), in many cases life extension makes sense. IEA figures have shown that financially life extension of existing plants "significantly outperformed" investment in new plants (both coal and gas) (Blyth 2010). Delayed plant decommissioning, either planned or unplanned, has been a common practice at EGAT in the past.

Often, it makes most sense to "repower" an existing plant, through more extensive upgrades including generators, boilers, or other equipment to increase efficiency or capacity. Advances in metallurgy, motor and generator efficiency, computational modeling of combustion, and computerized power plant controls offer a myriad of opportunities to keep make older power plants operate more efficiently, predictably, and cleanly.

In the PDP 2012, plant-life extension for gas-fired generation (mostly 5 years) is strategically chosen on nine separate occasions, on power plants ranging from 680 MW to 1910 MW.

[10] *W. Somcharoenwattana, C. Menke, A. Bangviwat, and F. Harahap. "Potential of Decentralized Generation in Thailand and Its Contribution" Journal of Sustainable Energy & Environment 1 (2010) 121-127.*

[11] *Deunden Nikomborirak. "Gas in Thailand" Chapter 18 in The Impacts and Benefits of Structural Reforms in the Transport, Energy and Telecommunications Sector. APEC 2009.*

Brownfield Siting

Brownfield construction refers to building a new power plant facility at an existing industrial site. Brownfield siting can be a cost-effective alternative with fewer impacts than building a new power plant on a greenfield site. Cost savings arise from making use of existing infrastructure such as roads, transmission lines, gas pipelines, or transformers. Brownfield siting of power plants also generally incurs less community opposition.

While the PDP 2012 does not explicitly call for any brownfield projects, these remain an option in the event that the resources described in the PDP 2012 are insufficient.

Centralized natural gas, coal, nuclear, and large hydropower plants

Whereas the PDP 2010 treats large-scale natural gas, coal, nuclear options as preferred options, and also folds in large-scale hydropower imports negotiated in a separate decision-making processes, the PDP 2012 does not prioritize any of these options because of their high expense, high social and environmental impact, high risk, and low efficiency.

Nuclear and new construction of coal, natural gas, or large-scale hydropower import projects are, our analysis finds, not necessary to meet Thailand's energy security requirements.

Methodology for developing PDP 2012

When faced with demands from various groups about the choices of power plants in the official PDP, decision makers often counter, "What are the alternatives?" Often what is assumed in the point of view of policy makers is that we must choose among large-scale gas, nuclear, coal and big dams. Our PDP 2012 analysis challenges the assumption that "we have no other better options". As discussed above, there are cheaper, less impactful energy options sufficient to meet the growing demand for electricity to fuel continued economic development in Thailand.

This section is incorporates the resources discussed in the previous section to ensure that the growing need for electricity, as projected by our adjusted forecast in the previous section, can be met. In creating the PDP 2012, our analysis is based on the following key assumptions and guiding principles:

1. The primary objective is to maintain reliability of the power system, using EGAT's criteria of maintaining a minimum reserve margin (generation capacity in excess of peak demand) of 15%.

2. Demand projections are adjusted to be more consistent with historic electricity demand trends as discussed in the Electricity demand projection section on page 11. Future demand growth is assumed to follow the historical 25-year average trend, in which peak demand increases 830 MW per year. Peak demand is then converted to energy demand (in GWh) using the same load factor as is used in the PDP 2010.

3. To meet growing demand and replace retiring generation capacity, priority is given to energy efficiency, plant-life extension, co-generation, and renewable energy sources. New power plant projects in the PDP 2010 that are controversial in nature or have not begun construction as of 2011 are considered uncommitted plants. Uncommitted plants are postponed or canceled as needed to make way for other resource options that are cleaner, cheaper and more consistent with the policy objectives. The next section discusses the assumptions and justifications in the PDP 2012 model.

Assumptions on Resource options

Energy Efficiency (EE) / Demand Side Management (DSM)

In addition to the assumed energy savings in the PDP 2010 from the T5 light replacement measure which is expected to deliver a peak saving of 584 MW, we assumed additional savings from new voluntary and mandatory measures consistent with the government's 20-year Energy Efficiency Development Plan to reduce year 2030 power consumption by 20% or 52,224 GWh. The targets and recommended measures in the plan are realistic, doable and based on well-researched and conservative analysis by a team of energy and policy academics and practitioners. The budget for the plan has already been approved and disbursed. It is important however to have a good evaluation and monitoring system in place to ensure that the budget is spent effectively and delivers the savings as planned. For details on the suggested EE measures, see Ministry of Energy (2011) and Foongthammasan, Tippichai et al. (2011).

The savings from T5 light replacement which has already been deducted from the official demand forecast used in the PDP 2010 is considered part of the baseline (or business-as-usual) according to the 20-year Energy Efficiency Plan. In our analysis of the PDP 2012, we only consider additional savings beyond the T5 program. The savings are treated as a resource or investment options. Even though the savings happen on the demand side, in our analysis we follow the Pacific Northwest practice of treating EE/DSM savings as a supply option, competing on a level playing field against other generation options in terms of resource amount, cost, etc.

The energy savings from the T5 light replacement program has an expected load factor of 56%, according to the PDP 2010. Thailand's power system has a load factor of around 75%. For this study, we assumed that additional EE/DSM savings have a load factor of around 60%. Based on this assumption, we convert the GWh savings into MW savings. The savings start off small (0.4% in 2013) and increase progressively toward the target of 20% energy savings compared to the projected demand in 2030. The energy savings in GWh and MW incorporated in the PDP 2012 over the planning period are shown in Table 10.

Year	EE saving in PDP 2010*		Additional EE savings in PDP 2012		
	GWh	MW	% of total energy	GWh	MW
2010	210	43	-	-	-
2011	629	129	-	-	-
2012	1,049	215	-	-	-
2013	1,678	344	0.4%	672	128
2014	2,307	473	1.0%	1,665	317
2015	2,852	584	1.7%	3,005	572
2016	2,433	498	2.5%	4,571	870
2017	1,804	369	3.5%	6,529	1,242
2018	965	198	4.5%	8,591	1,634
2019	1,170	240	5.6%	11,079	2,108
2020	1,170	240	6.6%	13,525	2,573
2021	1,170	240	7.7%	16,253	3,092
2022	1,170	240	8.9%	19,104	3,635
2023	1,170	240	10.1%	22,255	4,234
2024	1,170	240	11.2%	25,537	4,859
2025	1,170	240	12.6%	29,324	5,579
2026	1,170	240	14.0%	33,451	6,364

Year	EE saving in PDP 2010*		Additional EE savings in PDP 2012		
	GWh	MW	% of total energy	GWh	MW
2027	1,170	240	15.5%	37,734	7,179
2028	1,170	240	16.9%	42,175	8,024
2029	1,170	240	18.8%	48,113	9,154
2030	1,170	240	20.0%	52,155	9,923
*These savings were deducted from the PDP 2010 demand forecast					

Table 10: Cumulative energy savings from energy efficiency in PDP 2012 and PDP 2010.

Renewable Energy

To be conservative[12], the PDP 2012 adds the same amount renewable energy generation as in the PDP 2010, as shown below in Table 11. Other related assumptions, such as dependable capacity (see Table 12) and total energy production are also as specified in the PDP 2010.[13]

Generation from renewable energy								
Year	PDP 2010				PDP 2012			
	EGAT	SPP	VSPP	Cumu. Total	EGAT	SPP	VSPP	Cumu. Total
2010		465	331	796		465	331	796
2011	38	425	236	1,495	38	425	236	1,495
2012	29	65	162	1,751	29		162	1,686
2013	54		181	1,986	54			1,740
2014	18		191	2,195	18			1,758
2015	14	90	165	2,464	14	155	346	2,273
2016	17		225	2,705	17		415	2,705
2017	11		228	2,943	11		228	2,943
2018	30		173	3,146	30		173	3,146
2019	8		170	3,323	8		170	3,323
2020	22		188	3,533	22		188	3,533
2021	61		133	3,727	61		133	3,727
2022	36		287	4,050	36		287	4,050
2023			145	4,195			145	4,195
2024			146	4,341			146	4,341
2025			156	4,497			156	4,497
2026			157	4,654			157	4,654
2027			168	4,822			168	4,822

[12] *The PDP 2010 renewable energy assumption of 5348 MW reflects only a 16% increase by the year 2030 over the 4622 MW of signed PPAs for renewable energy already in the pipeline (Table 6). Considering that most renewable energy projects have construction times under two years, and barring huge policy reversals in which renewable energy is strongly discouraged, Thailand is very likely to exceed the limited renewable energy amounts in the PDP 2010.*

[13] *Minor differences between the PDP 2010 and PDP 2012 treatment of renewable energy reflect delays in renewable energy deployment that have cropped up since 2010 as a result of the Managing Committee.*

Generation from renewable energy								
Year	PDP 2010				PDP 2012			
	EGAT	SPP	VSPP	Cumu. Total	EGAT	SPP	VSPP	Cumu. Total
2028			168	4,990			168	4,990
2029			179	5,169			179	5,169
2030			179	5,348			179	5,348
* PDP 2012 assumes the same amount of renewable energy capacity addition as PDP 2010 except for some adjustments for projects facing delays.								

Table 11: Generation from renewable energy in MW in the PDP 2010 and the PDP 2012.

RE	PDP 2010	Dependable capacity	Generation		Purchase price of RE** (B/kWh)		
	MW		GWh	%	adder	total	weighted price
biomass***	2,025	55%	9,756.45	78%	0.3	3.00	2.344
biogas	121	21%	222.59	2%	0.3	3.00	0.053
solar	922	21%	1,696.11	14%	6	8.70	1.182
wind	672	5%	294.34	2%	3.5	6.20	0.146
small hydro	69.3	40%	242.83	2%	0.8	3.50	0.068
waste	157.5	20%	275.94	2%	2.5	5.20	0.115
*Data source EPPO, http://www.eppo.go.th/power/pdp/page-7.html, updated 25 Feb 2010 Cited source for dependable capacity: Study on DependableCapacity of Renewable Energy Generation (in Thai), 2010 **assume bulk price2.7 B/kWh ***assume 50% biomass is from rice husks which has assumed plant factor of 70% while that of the rest is 40%							3.908

Table 12: Dependable capacity assumptions used in PDP 2010 and PDP 2012. These are used in calculating energy (GWh) output and costs of electricity from renewable energy.

Cogeneration

Cogeneration is considered a preferred resource option over centralized power plants due to its high efficiency. The PDP 2010 calls for investments of 16,670 MW of centralized gas-fired combined cycle generation while including only 7,024 MW of more efficient cogeneration. In contrast, the PDP 2012 gives priority to cogeneration over gas combined cycle gas turbines (CCGT) or coal-fired power plants if and when new capacity is needed. Typically the size of each cogeneration capacity varies and depends on the steam requirement at the host factor. According to SPP regulations, no more than 90 MW of electricity export is accepted per plant. Here in the PDP 2012, we added 300 MW of cogeneration capacity per year in most years and 600 MW in the few years that more new capacity addition is required. Table 13 shows the comparison of cogeneration capacity in the PDP 2010 vs. the PDP 2012.

Year	Cogeneration				
	PDP 2010		PDP 2012		
	Firm SPP	Cumu. Total	Firm SPP	Add'l SPP/VSPP	Cumu. Total
2010	90	90	90	0	90
2011	0	90	0	0	90
2012	704	794	0	0	90
2013	720	1,514	0	0	90
2014	90	1,604	90	0	180
2015	270	1,874	974	0	1,154
2016	270	2,144	990	0	2,144
2017	270	2,414	270	300	2,714
2018	270	2,684	270	300	3,284
2019	270	2,954	270	300	3,854
2020	270	3,224	270	300	4,424
2021	380	3,604	380	300	5,104
2022	360	3,964	360	300	5,764
2023	360	4,324	360	300	6,424
2024	360	4,684	360	300	7,084
2025	360	5,044	360	600	8,044
2026	360	5,404	360	300	8,704
2027	360	5,764	360	300	9,364
2028	360	6,124	360	600	10,324
2029	360	6,484	360	300	10,984
2030	540	7,024	540	300	11,824
Total	**7,024**	**7,024**	**7,024**	**4,800**	**11,824**

Table 13: Comparison of cogeneration capacity (MW) in the PDP 2010 vs the PDP 2012.

We expect that most of the cogeneration capacity will use natural gas as fuel while some may use coal. For the purpose of our analysis here, we assume that all cogeneration is gas-based. This improves environmental performance of the PDP 2012 generation mix but exacerbates the country's dependency on gas. However, we believe that if we must use fossil fuels, gas is preferred over coal and efficient utilization of gas in the form of useful cogeneration should be employed to the extent possible before considering inefficient centralized generation.

Plant life extension

In the analysis of the PDP 2012, five-to-ten year plant life extension is considered only in cases where additional capacity is needed at the time of the plants' planned decommissioning to keep the reserve margin above 15%. Otherwise, plants are retired as scheduled. Table 14 indicates which plants are retired as scheduled in the PDP 2010 and which receive life extension.

Note that our criteria for choosing which plant gets extended life are based mainly on the generation requirement and the type of fuel used (coal plants are not considered for life extension out of health and environmental impact concerns). However, more detailed assessment should be done on a case-by-case basis to ensure resource, technical and economic feasibility of plant life extension. If a plant is highly inefficient, the saved capital investment cost may not be sufficient to outweigh the high fuel cost when compared to a new, efficient plant. In addition, for independent power producer (IPP) plants (privately owned), the option to extend plant life should be presented to the IPPs to consider. Interested IPPs may enter into a negotiation process to extend and adjust the Power Purchase Agreements (PPAs), taking into account system requirement, conditions of the generation facilities and related equipment, etc. The ERC is currently developing a guideline and terms for considering plant life extension for IPPs as some are nearing the expiry of their power purchase agreements.

Power plants to be decommissioned in PDP 2010	MW	Plant life at decommissioning	Extended life to delay decommissioning and construction of new plants*
EGAT			
Nam Pong CC #1	325	25	
Nam Pong CC #2	325	25	30
Bang Pakong TH #1-2	1,052	30	
Bang Pakong TH #3	576	30	
Bang Pakong TH #4	576	30	
Bang Pakong CC #3	314	25	
Bang Pakong CC #4	314	25	30
South Bangkok CC #1	316	25	30
South Bangkok CC #2	562	25	30
Mae Moh TH #4	140	40	
Mae Moh TH #5-6	280	40	
Mae Moh TH #7	140	40	
Mae Moh TH #8	270	40	
Mae Moh TH #9	270	40	
Wang Noi TH #1-3	1,910	25	30
IPPs			
Khanom TH # 1	70	15	
Khanom TH # 2	70	20	
Khanom CC # 1	678	20	
Eastern Power	350	20	30
Glow IPP	713	25	30
Independent Power (Thailand) (IPT)	700	25	30
Tri Energy Co., Ltd.	700	20	25
Hauay Ho	126	30	
Theun Hinboun	214	25	
Rayong CC #1-4	1,175	20	

Power plants to be decommissioned in PDP 2010	MW	Plant life at decommissioning	Extended life to delay decommissioning and construction of new plants*
Ratchaburi TH # 1-2	1,440	25	30
Ratchaburi CC # 1-2	1,360	25	30
Ratchaburi CC # 3	681	25	30

*-Only in cases where life extension in needed to keep reserve margin above 15% Ohterwise, plants are retired as scheduled.
-Plant life extension may require additional investments and time to maintain and pgrode equipment. The time and resources required to extend plant life ane usually significantly less than buiding a new one. However, more detailed assessment should be done on a case to ensure technical and economic feasibility of plant life extension.
-May negotiate PPA extension with IPPs taking into account system requirement, condition power plants, and willingness of IPPs

Table 14: List of power plants scheduled to retire during the PDP 2010, some of which are considered for life extension in the PDP 2012 as an economic investment option to add generation capacity. Data source: (EGAT 2010).

Results: the PDP 2012 and the PDP 2010 compared

Based on the key assumptions and methodology discussed above, the PDP 2012 is very different than EGAT's PDP 2010. The differences in resource mix in these plans leads to significant differences in overall costs, reliance on imports, promotion of renewable energy, greenhouse gas emissions, heath and environmental impacts, and electricity bills paid by consumers. These are explored in detail below.

Resource mix: PDP 2012 vs. PDP 2010

PDP 2012 calls for a very different resource mix compared to the PDP 2010 (Figure 5). Notable differences include the reduction in capacity needed because of forecast correction in the PDP 2012, the lack of nuclear power, reduction in natural gas power plants as they retire, and lack of growth in coal generation. These large-scale fossil fuel sources are replaced with considerable generation expansion in cogeneration and EE/DSM.

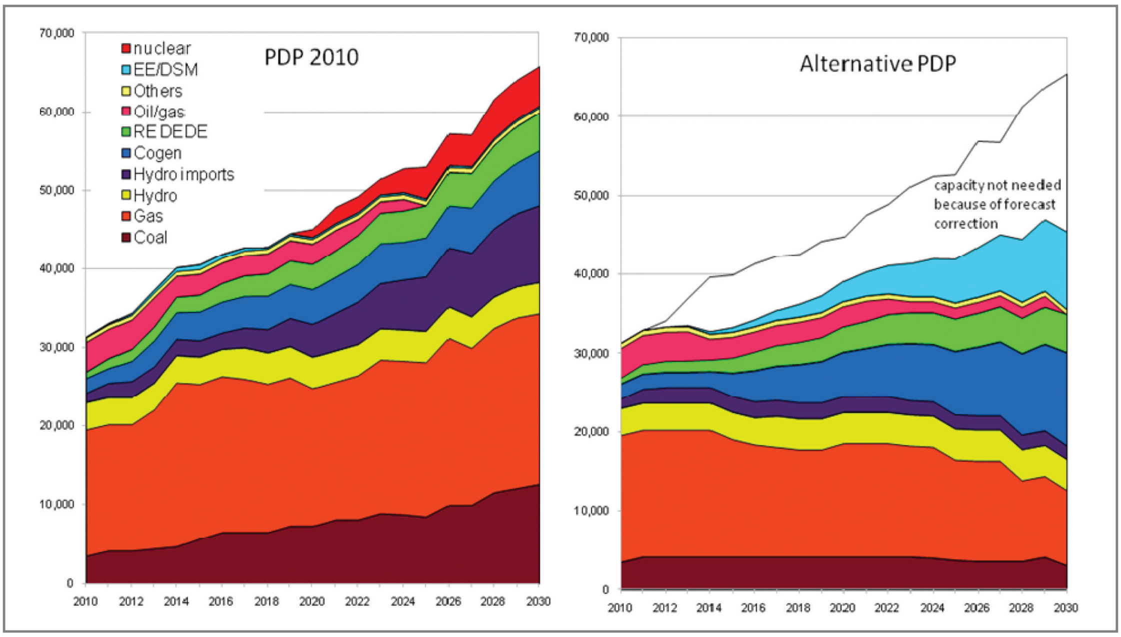


Figure 5: Supply resources in the PDP2 010 vs PDP 2012.

PDP 2010				PDP 2012				
Project (MW) Capacity already online since 2010 (as of Oct 2011)		Year	Installed (MW)	Project (MW) Capacity already online since 2010 (as of Oct 2011)		Year	Installed (MW)	Reserve Margin
Nam Theun 2	920	2009	29,212	Nam Theun 2	920	2009	29,212	27.6%
North Bangkok CC # 1	670	2010	31,349	North Bangkok CC # 1	670	2010	31,350	26.7%
Nam Ngum 2	597	2011	32,992	Nam Ngum 2	597	2011	32,993	33.9%
		2012	34,171			2012	33,403	31.0%
Additions of capacity		2013	37,002	*Additions of capacity already*		2013	33,457	27.6%
considered "clean" or in the		2014	39,720	*included in PDP 2010*		2014	32,513	20.9%
pipeline		2015	39,990	SPP – cogeneration	7,340	2015	32,757	19.2%
SPP – cogeneration	7,340	2016	41,419	SPP – renewables	1,045	2016	33,438	19.3%
SPP – renewables	1,045	2017	42,374	VSPP	2,567	2017	34,253	20.2%
VSPP	2,567	2018	42,619	EGAT renewables	336	2018	34,662	19.7%
EGAT renewables	336	2019	44,290	Gheco One (IPP)	660	2019	35,232	20.2%
Gheco One (IPP)	660	2020	44,843	Theun Hinboun Expansion	220	2020	36,626	23.3%
Theun Hinboun Expansion	220	2021	47,618	Wang Noi CC#4 (EGAT)	800	2021	37,301	24.3%
Wang Noi CC#4 (EGAT)	800	2022	48,982	Bang Lang Dam Expansion	12	2022	37,565	23.9%
Bang Lang Dam Expansion	12	2023	51,235	Lam Ta Kong (pump storage)	500	2023	37,226	21.8%
Lam Ta Kong (pump storage)	500	2024	52,533		13,479	2024	37,215	20.9%
	13,479	2025	52,738	*Other resource additions*		2025	36,428	18.0%
Other capacity additions		2026	56,957	EE/DSM	9,923	2026	37,147	20.1%
Gas CC 17 units	15,200	2027	56,830	Cogeneration	4,800	2027	37,961	22.7%
Coal 13 units	7,740	2028	61,355	Plant life extension	3,104	2028	36,527	18.1%
Hydro (imports)	8,090	2029	63,824	(retiring after 2030)*		2029	37,896	23.7%
Lignite (imports)	1,842	2030	65,547		17,827	2030	35,579	15.9%
Nuclear 5 units	5,000							
	37,872							

PDP 2010

Generation capacity as of December 2009	29,212
Total capacity added during 2010 – 2030	54,005
Total capacity decommissioned during 2010-2030	-17,671
Total capacity at the end of 2030	**65,547**

PDP 2012

*Additional 12,543 MW was extended but retired by 2030
**Excluding savings from EE/DSM

Generation capacity as of December 2009	29,212
Total capacity added during 2010 – 2030	20,934
Total capacity decommissioned during 2010-2030	-14,567
Total capacity at the end of 2030	**35,579**

(Excluding 10,158 MW savings from EE/DSM)

Table 15: Comparison of resource additions through year 2030 in PDP 2010 vs. PDP 2012

Details of the PDP 2012 are summarized in Table 15. The PDP 2012 analysis finds that 55 power plant projects of various types (nuclear, coal, gas CC, hydro imports and lignite-fired imports) included in the PDP 2010 are unnecessary to maintain the reliability of the system (15% minimum reserve margin). These projects are removed from the lineup in the PDP 2012 (Table 16).

Generation type by fuel	Unnecessary Projects	MW
Coal	National Power Supply # 1-2	270
Coal	National Power Supply # 3-4	270
Coal	EGAT clean Coal #1	800
Coal	EGAT clean Coal #2	800
Coal	EGAT clean Coal #3	800
Coal	EGAT clean Coal #4-5	1,600
Coal	EGAT clean Coal #6-7	1,600
Coal	EGAT clean Coal #8	800
Coal	EGAT clean Coal #9	800
Coal	**total**	**7,740**
Gas	Siam Energy Co.,Ltd #1-2	1,600
Gas	Power Generation Supply Co.,Ltd #1-2	1,600
Gas	Chana CC#2	800
Gas	New Power Plant South	800
Gas	EGAT Gas Fired CC #1	800
Gas	EGAT Gas Fired CC #2-6	4,000
Gas	EGAT Gas Fired CC #7	800
Gas	EGAT Gas Fired CC #8-9	1,600
Gas	EGAT Gas Fired CC #10	800
Gas	EGAT Gas Fired CC #11-12	1,600
Gas	EGAT Gas Fired CC #13	800
Gas	**total**	**15,200**
Imports (coal)	Power Purchase from Lao PDR (Hong Sa TH #1-2)	982
Imports (coal)	Power Purchase from Myanmar PDR (Mai Khot TH #1-3)	369
Imports (coal)	Power Purchase from Lao PDR (Hong Sa TH #3)	491
Imports (coal)	**total**	**1,842**
Imports (hydro)	Power Purchase from Lao PDR (Nam Ngum 3)	440
Imports (hydro)	Power Purchase from Neighbouring Countries	450
Imports (hydro)	Power Purchase from Neighbouring Countries (12 x 600 MW)	7,200
Imports (hydro)	**total**	**8,090**
Nuclear	EGAT Nuclear Power Plant #1	1,000
Nuclear	EGAT Nuclear Power Plant #2	1,000
Nuclear	EGAT Nuclear Power Plant #3	1,000
Nuclear	EGAT Nuclear Power Plant #4	1,000
Nuclear	EGAT Nuclear Power Plant #5	1,000
Nuclear	**total**	**5,000**
	Grand Total	**37,872**

Table 16: Power projects that were included in the PDP 2010 but which are unnecessary and thus not included in the PDP 2012.

Cost savings: PDP 2012 vs. PDP 2010

By not investing in unnecessary fossil fuel projects, hydropower imports, and related transmission expansion, 2.7 trillion baht or approximately US$91 billion of investments can be avoided, as detailed in Table 17. The types of resources and investment costs called for in the PDP 2012 amount to about 700 billion Baht or approximately US$23 billion (see Table 18). The net investment cost that can be avoided by adopting the PDP 2012 is thus around two trillion Baht or US$67 billion. A significant benefit to the country which is trying to recover from devastating floods, the two trillion Baht savings, over the planning period (through 2030) come from simply shifting away from expensive and unnecessary capital-intensive supply options towards more economic, cleaner and cheaper options. The shift away from centralized generation to investments in energy efficiency and distributed generation also means a lot less need to invest in expensive transmission infrastructure.

Type of power plants	Number (units)	Total capacity (MW)	Investment cost* (mill Baht/ MW)	Avoided investment (mill. Baht)	Avoided investment incl. avoided cost of transmission expansion (mill. Baht)
Nuclear	5	5,000	111	555,000	777,000
Coal	13	7,740	63	487,620	682,668
Gas combined cycle	18	15,200	27	410,400	574,560
Hydroelectric (imports)***	14	8,090	50	404,500	566,300
Lignite (imports)	6	1,842	45	82,890	116,046
Total	**56**	**37,872**		**1,940,410**	**2,716,574**

*Source: Sukkumneod, "Information and Opinion Survey on Co-efficients used in analysis of Alternative PDP", 2011.
**Assume transmission investment at 40% in addition to generation investment cost. LNG and gas transmission investment costs are not included.
***Author's own estimate. For reference, Nam Theun 2 was a $1.3 billion project with 1,070 MW capacity and construction commencing in 2005.

Table 17: Summary of power projects that are deemed unnecessary in the PDP 2012 and their associated investments costs.

PDP 2012 investment budget					
Type of investments called for in the PDP 2012	Total capacity (MW)	Investment cost* mil Baht/ MW	Investment cost (mil. Baht)	Additional cost of related transmission expansion (mil. Baht)	Total investment incl. Cost of transmission expansion** (mil. Baht)
EE/DSM	9,923	25	248,073	0	248,073
Cogeneration	4,800	36	172,800	34,560	207,360
Plant life extension	15,647	5	78,235	0	78,235
Total	30,370		499,108	34,560	698,752

* Source for EE/DSM & cogen: Sukkumneod, "Information and Opinion Survey on Co-efficients used in analysis of PDP 2012", 2011. For cost of extending plant life: the figure is an upper bound based on authors' own estimates.
** Of the additional 4800 MW cogeneration, most will be very small-scale (VSPPs) and are thus connected at distribution level. A conservative estimate of transmission upgrade requirement at half (20% addition to generation investment cost) that of centralized generation is assumed here.

Table 18: Types of investments called for and investment budget required for PDP 2012.

Meeting government objectives: PDP 2010 vs. PDP 2012

Here we compare the official PDP 2010 and the PDP 2012 in their performance in meeting key government energy policy objectives by applying the evaluation framework of indicators proposed earlier.

Adequacy of energy resource

Adequacy of energy resource to ensure reliability of the power system is a primary objective of the PDP 2012. The planning criteria used in developing the PDP 2010 as well as PDP 2012 is a minimum reserve margin of 15%. The PDP 2012 is able to achieve a minimum reserve margin of 15% in all the years during the planning period as shown in Table 19.

Year	Peak demand (revised) (MW)	EE/DSM saving (MW)	Peak demand (after EE saving) (MW)	Installed Capacity (MW)	Reverse margin (%)
2010	24,010	0	24,010	31,350	26.7%
2011	23,900	0	23,900	32,993	33.9%
2012	24,731	0	24,731	33,403	31.0%
2013	25,562	128	25,434	33,457	27.6%
2014	26,393	317	26,077	32,513	20.9%
2015	27,225	572	26,653	32,757	19.2%
2016	28,056	870	27,186	33,438	19.3%
2017	28,887	1,242	27,645	34,253	20.2%
2018	29,718	1,634	28,084	34,662	19.7%
2019	30,549	2,108	28,441	35,232	20.2%
2020	31,380	2,573	28,807	36,626	23.3%
2021	32,211	3,092	29,119	37,301	24.3%
2022	33,043	3,635	29,408	37,565	23.9%
2023	33,874	4,234	29,640	37,226	21.8%
2024	34,705	4,859	29,846	37,215	20.9%
2025	35,536	5,579	29,957	36,428	18.0%
2026	36,367	6,364	30,003	37,147	20.1%
2027	37,198	7,179	30,019	37,961	22.7%
2028	38,029	8,024	30,005	36,527	18.1%
2029	38,861	9,154	29,707	37,896	23.7%
2030	39,692	9,923	29,769	35,579	15.9%

Table 19: Reserve margin according to PDP 2012. The total installed capacity is sufficient to maintain a minimum 15% reserve margin over the peak demand after deducting energy efficiency savings.

Both PDP 2010 and PDP 2012 thus achieve the resource adequacy goal using the 15% reserve margin as the benchmark for having sufficient energy resources to meet growing electricity demand.

Because the PDP 2012 is based on a lower demand projection, one might ask what happens when the demand is higher than expected? Electricity is different from other commodities or services. If the supply is not enough to meet demand, the entire system may be affected (in the form of brownouts or blackouts). Electricity cannot be stored, and moreover it takes a minimum of two years (not including the permitting process) to construct a power plant, or more for larger plants and less for VSPP-scale plants. Will Thailand be caught with power shortage situation?

Because of excessive past investment, Thailand's reserve margin in 2011 is 33.9%, far above the target of 15%. Thailand has sufficient surplus capacity and projects in the pipeline[14] to maintain a minimum 15% reserve margin until 2017, without additional investments in EE/DSM, without adding more cogeneration capacity, and without plant life extension. We thus have at least five years before more capacity is added if the adjusted forecast is accurate. The focus in the PDP 2012 is on smaller, more distributed power plants which have shorter lead times, enabling a shorter, faster response time. This provides an additional, but unquantified, benefit of the PDP 2012.

Energy self-reliance: reduced dependency on imports

Energy self-reliance in this context means reliance on energy sources that are locally available. Hence, the more electricity production from imported fuel or generation sources, the less energy self-reliant Thailand is. PDP 2010 calls for investments in energy sources that are not locally sourced such as hydroelectric imports from neighboring countries, imported coal and gas (due to limited domestic resources) and uranium to fuel nuclear reactors. By investing heavily in energy efficiency in the PDP 2012, the need to rely on imported fuel sources is greatly reduced thus reducing the need to depend on energy imports (Table 20).

Sources of electricity	2010	PDP 2010	PDP 2012
		2030	2030
Domestic	**65.4%**	**35.2%**	**59.0%**
Lignite-Mae Moh	10.7%	2.4%	4.1%
Hydro - EGAT	3.9%	1.5%	2.4%
RE	3.1%	6.0%	9.9%
Gas (Gulf of Thailand)	47.8%	25.3%	42.6%
Imports	**34.6%**	**64.8%**	**41.0%**
Coal	8.1%	25.0%	7.3%
Gas (Burma/LNG)	20.5%	13.6%	28.4%
Fuel Oil	0.6%	0.0%	0.0%
Diesel	0.1%	0.0%	0.0%
Hydro imports /Malay	5.4%	15.3%	5.2%
Nuclear	0.0%	11.0%	0.0%
Total	**100.0%**	**100.0%**	**100.0%**

Table 20: Reduced dependency on imports: according to PDP 2010, about 65% of electricity would be sourced from foreign sources making Thailand highly dependent on imports. In contrast,the PDP 2012 plans to rely on mostly domestic sources for meeting the electricity demand.

Promotion of renewable energy

The government has set a goal to increase the share of renewable energy (RE) in the total energy mix to 25% by 2020. Though there is no specific goal for the power sector, what is planned for the power sector will impact the overall energy mix. Even though the PDP 2012 adopts the same renewable energy capacity and energy targets (measured in MW and GWh) as the PDP 2010, because fewer conventional power plants are needed, the overall share of renewable energy in the PDP 2012 is much higher (Table 21).

[14] *including the planned capacity addition of VSPPs and SPPs, but excluding the plants deemed "unnecessary" in Table 13*

Generation by fuel type	2010		PDP 2010		PDP 2012	
			2030		2030	
	MW	%	MW	%	MW	%
Coal	3,527	11%	12,669	19%	3,087	9%
Gas	16,091	51%	21,668	33%	9,572	27%
Hydro – EGAT	3,424	11%	3,936	6%	3,936	11%
Hydro – imports	1,260	4%	9,827	15%	1,737	5%
Cogeneration	1,878	6%	7,024	11%	11,824	33%
Renewables	767	2%	4,804	7%	4,804	14%
Oil/gas	3,784	12%	0	0%	0	0%
Nuclear	0	0%	5,000	8%	0	0%
Others (fuel oil, diesel, Malay)	619	2%	619	1%	619	2%
Total generation	**31,350**	**100%**	**65,547**	**100%**	**35,579**	**100%**
Additional EE/DSM savings	-		-		9,923	
Total Resources	**31,350**		**65,547**		**45,502**	

Table 21: Comparison of capacity mix: PDP 2010 vs. PDP 2012

Reducing Greenhouse Gas Emissions

One of the PDP 2010 stated objectives is to reduce GHG or CO_2 emissions contribution from the power sector. The government has often claimed that the PDP 2010 will lead to a lower CO_2 emission per kWh produced (-4.4% by our calculation). This is only half the story. The total GHG emission does not go down; in fact it will almost double – increasing 97% in 2030 compared to 2010. This is because total emissions are equal to GHG intensity (CO2 emission/kWh) times the total number of kWh of expected demand. Projected consumption of electricity (kWh) more than doubles from 2010 to 2030.

In contrast, the total emissions in the case of PDP 2012 will increase by only 3.7% while the per capita CO_2 emission is down 7.7% (see Table 21 below). This is mainly due to a shift away from inefficient lignite-, coal- and gas-fired generation and significant investments in energy efficiency, which are carbon-free, as well as in high-efficiency cogeneration.

Plant type	PDP 2010	PDP 2010	PDP 2012
	2010	2030	2030
	GHG (kt)	GHG (kt)	GHG (kt)
Lignite-EGAT & Imports	19,631	26,404	10,226
Coal-EGAT & IPPs	9,625	70,433	14,703
Oil	675	0	0
Diesel	73	14	14
Natural gas	48,610	44,113	31,212
Large hydro-EGAT & Imports	208	859	225
Cogeneration-gas	3,234	16,884	29,989
Cogeneration-coal	1,476	0	0
Malaysia	139	416	416
Biomass	745	745	745
Biogas	-12	-12	-12
PV	84	84	84
Microhydro	1	1	1
Wind	5	5	5

Plant type	PDP 2010	PDP 2010	PDP 2012
	2010	2030	2030
	GHG (kt)	GHG (kt)	GHG (kt)
Municipal solid waste	26	26	26
Nuclear	0	6,497	0
Total	**84,520**	**166,468**	**87,634**
GHG intensity (kg/kWh)	**0.50**	**0.48**	**0.34**
per cap GHG emission (tonnes)	**1300.30**	**2280.39**	**1200.47**
		Change compared to 2010	
Total GHG emission		**97.0%**	**3.7%**
GHG intensity		**-4.4%**	**-32.9%**
per cap CO2 emission		**75.4%**	**-7.7%**

Table 22: Comparison of CO_2 emissions between PDP 2010 and PDP 2012. (kt = kilotonnes)

The calculations in Table 22 are based on pollutant emissions assumptions shown in Table 23. Note however that the figures for emissions from hydro-electricity, originally based on figures in temperate Europe, are not reliable or directly applicable to Thailand and its neighboring countries. Studies have shown that tropical reservoirs are significant sources of greenhouse gas emissions.[15] There are to date no real attempts to quantify and account for these emissions in the region.

Plant type	GHG g/kWh	NO_x g/kWh	SO_2 g/kWh	TSP g/kWh	Hg mg/kWh
Lignite	1,200	5.80	5.27	0.62	0.04
Coal	960	3.79	3.76	0.33	0.36
Oil	770	2.90	4.90	0.25	0.01
Diesel	650	2.90	1.29	0.25	0.01
Natural gas	512	1.25	0.31	0.01	0.00
Large hydro-EGAT & Imports	15	0.02	0.01	0.01	0.00
Cogeneration-gas	343	0.84	0.21	0.01	0.00
Cogeneration-coal	643	2.54	2.52	0.23	0.36
Malaysia	443	1.25	0.31	0.10	0.00
Biomass	46	2.50	0.30	0.20	0.00
Biogas	-33	1.94	0.07	0.10	0.00
PV	30	0.01	0.02	0.02	0.00
Microhydro	2	0.01	0.00	0.00	0.00
Wind	10	0.00	0.07	0.01	0.00
Municipal solid waste	58	3.13	0.38	0.25	0.00
Nuclear	170	0	0	0	0

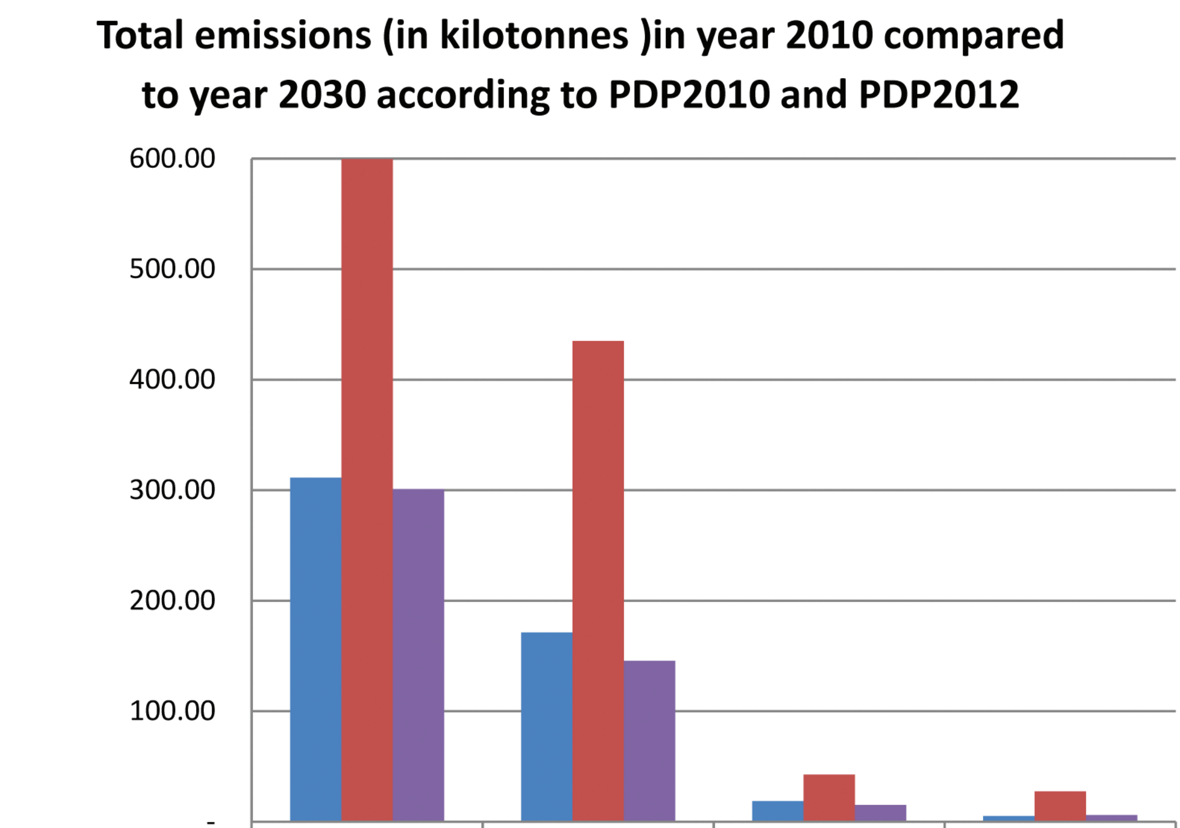
Table 23: Assumptions used in calculating different types of emissions from power generation. Source: (Sukkumnoed, 2007) p. 183.

[15] *See (McCulley, 2006) for a review of such studies.*

Minimizing health and environmental impacts

Power projects, particularly large-scale ones, have significant health, social and ecological impacts. Health impacts are caused by pollutants released from power generation facilities, including air, water and thermal pollution. Hydropower projects can also have significant health impacts due to changes in water quality, an increase in the incidence of waterborne diseases and impacts on locally sourced food such as freshwater fish. By choosing to prioritize investing in low- or no-impact energy efficient and demand-side management and more efficient cogeneration technology, rather than investing in building new centralized power plants, the PDP 2012 has a far superior environmental performance as demonstrated by its overall emissions of air pollutants, such as nitrogen dioxide (NO_x), sulfur dioxide (SO_2), total suspended particles (TSP) and mercury (Hg), all of which have harmful health impacts.

Impacts from power generation also come in other forms, including risk of radioactive contamination for the case of nuclear power, decimation of ecosystems as a result of a hydroelectric project, mass relocation of affected communities, social conflicts and division, and warming rivers and the ocean, to name a few. Using the concerns for these impacts to guide the selection of resources, the PDP 2012 is able to procure sufficient resources to meet energy demand without having to build new greenfield projects. It is clear that the PDP 2012 is able to meet this policy objective while the PDP 2010 fails.



2010	311.47	171.30	18.74	5.27
2030 (PDP2010)	599.66	435.11	42.77	27.51
2030 (PDP2012)	301.12	145.61	15.14	6.06

Figure 6: Comparison of PDP 2010 and PDP 2012 on total nitrogen-oxides (NO_x), sulfurdioxide (SO_2), total suspended particulates (TSP) and mercury (Hg) emissions in year 2010 and 2030.

Cost to consumers

From public policy economics perspectives, decisions in the best interest of the country or the public should be based on economic costs (total costs to the society), not financial cost of a company or state-owned utility. For the power sector, economic costs of electricity include externality costs (such as environmental and health impacts of power production) as well as externality benefits (such as job creation). Coal electricity may appear "cheap" but when its full costs of health and environmental impacts are taken into account, it is very expensive. Likewise, hydroelectric dams appear "cheap" only because their full costs of loss of biodiversity and ecological impacts are not internalized.

Even if we do not consider externality costs, the way cost comparison of different generation options is typically done in the PDP process only compares generation costs and is therefore biased towards large-scale, centralized generation and against other cleaner options. EE/DSM savings happen at the end-users and therefore requires no distribution or transmission infrastructure. Distributed generation such as VSPPs generates electricity close to the load and thus only requires distribution system to move electricity to end-users (incurring no costs of transmission and less losses along the way). Large-scale (centralized) generation incurs the full costs of delivery (transmission and distribution). The PDP 2012 relies more on energy efficiency, renewable energy, cogeneration, and plant-life extension or repowering. Although renewable energy and cogeneration have higher generation costs, this is somewhat mitigated by lower transmission costs (see Table 24).

Plant Type	Cost of electricity (not including externalities) (Baht/kWh)			
	Generation	Transmission[1]	Distribution[2]	Total
EE & DSM	1.00[3]	-	-	1.00
Lignite-Mae Moh	1.50[4]	0.37	0.44	2.31
Hydro - Imports	2.11[5]	0.37	0.44	2.92
Imported coal - EGAT/IPP	2.12[6]	0.37	0.44	2.93
Gas - EGAT/IPP	2.29[6]	0.37	0.44	3.10
SPP - gas/coal/RE	2.60[7]	0.198	0.44	3.23
Nuclear	2.79[9]	0.37	0.44	3.60
RE VSPP	3.75[10]	-	0.44	4.19
Diesel	4.12[11]	0.37	0.44	4.93
Fuel oil - EGAT/IPP	4.12[6]	0.37	0.44	4.93

Table 24: Cost of delivered electricity (not including externalities) in Baht/kWh.

Notes: (1) Based on assumption that 12.4% of total electricity cost comes from transmission system.
(2) Based on assumption that 14.5% of total electricity cost comes from distribution system.
(3) The number represents an average of the estimate cost of actual energy savings from EE/DSM (0.5-1.5 B/kWh) (Source: (du Pont 2005)).
(4) Author's estimation.
(5) Average of power purchase costs from hydroelectric projects in Lao PDR (Source: (EPPO 2007), Slide41).
(6) These were the assumed costs in PDP 2007 and were based on assumed constant oil prices and thus likely to be on the low side. (Source: (EPPO 2007), Slide 63).
(7) Purchase price according to SPP regulations.
(8) SPPs are distributed generation connected at distribution level. Some SPPs are however large enough that they require transmission system to wheel power to the load. Here, 50% of electricity from SPPs is assumed to move through transmission and hence the transmission cost is half that of centralized generation.

(9) EGAT's estimate as of 17 February 2010, though very low compared to international prices. EGAT's figure is based on a capital cost of $3,087 per kW while the capital cost as of October 2009 according to the rating agency Moody's (with role in approving loans to finance nuclear projects) is $7,000 per kW.

(10) Purchase price according to VSPP regulations, assuming bulk purchase price = 2.7 Baht/kWh. It is a weighted average price of different VSPPs as per PDP 2010. See Table 11 above.

(11) Assumed to be the same of the cost of electricity from gas turbine power plants (Source: (EPPO 2007), Slide 63).

To ensure fair comparison across different types of generation, the cost of electricity delivered to consumers (generation plus transmission and distribution – which is the total costs that consumers pay to the utilities) is the relevant cost from consumers' perspective.

Moreover, in comparing costs of electricity service delivered to consumers, the pertinent cost is how much a consumer pays for electricity each month (electricity bill), not the tariff (baht per kWh). Though the average unit cost of electricity to consumers under the PDP 2012 scenario is about 12%, more expensive compared to the PDP 2010 case, the monthly electricity bill that consumers have to pay will be about 10% cheaper, as shown in Table 25. This is because investment in EE/DSM enables the consumers to enjoy the same level of energy service but with less energy usage. The lower consumption as a result of EE/DSM investments therefore leads to cheaper electricity bills and real monetary savings for consumers.

Year 2030	PDP 2010	PDP 2012	Difference (PDP 2012 – PDP 2010)
Total costs (mil. Baht)	1,097,335	723,946	
total GWh of sale	347,947	208,896	
Average electricity cost (Baht/kWh)	**3.15**	**3.47**	**9.89%**
% kWh savings on power bill due to EE/DSM	0.00%	20.00%	
Remaining usage from 150kWh/month baseline	150.00	120.000048	
Electricity bill (Baht/month)	**473.06**	**415.87**	**-12.09%**

Table 25: Comparing costs of electricity service delivered to consumers PDP 2010.

Policy recommendations

It is evident from the analysis above that there exist cheaper, cleaner alternatives to meeting Thailand's electricity needs than the electricity supply choices dictated in the PDP 2010. Moreover, these cheaper, cleaner alternatives are more consistent and the government's energy policy objectives.

How do we move forward to a future in which a 'cheaper, cleaner, more resilient' PDP becomes adopted as the official planning document for Thailand? This requires, we believe, significant changes in the governance structure overseeing the PDP process, the planning methodology, and in the practical day-to-day work of regulators overseeing the electricity industry.

We have summarized these recommendations below which, if implemented, will improve the accountability of the PDP process and help ensure that power sector planning in Thailand is in the public interest:

1. Adopt a framework for holding PDPs accountable to official policy objectives. The official policy objectives, as promulgated in the Energy Industry Act .B.E. 2550 include:

    - Energy security: procuring sufficient energy supply to meet demand
    - Energy reliance: reduced dependency on imports

- Promotion of renewable energy
- Efficient use of energy
- Diversifying fuel risks
- Reducing CO_2 emissions
- Minimizing impacts from energy procurement
- Fair and reasonable costs of energy service to consumers

This paper has proposed one such framework with benchmarks for these objectives including the ratio of imported to domestic resources, emissions of airborne pollutants and greenhouse gases, and expected electricity bills to consumers for energy services delivered.

2. Implement a bottom-up load forecast methodology in place of the current econometric load forecasting methodology. The current methodology, as discussed in this study, has proven to be inadequate, repeatedly predicting large increases in load that have failed to materialize – and ultimately leading to excessive investment in generation assets. A bottom-up forecast methodology would track trends in electricity consumption by customer-type, according to each end-use, taking into consideration technological change changing demographics and economic structure.

3. Reform the power development planning methodology and process towards Integrated Resource Planning (IRP):

- Increase participation and public access in the planning process from defining planning objectives to development and review of draft plans. With increased participation during the last two PDPs (PDP 2007 and PDP 2010), there were noticeable improvements in the outcome, notably the increased role of renewable energy and demand-side management in the PDP. Participation can be further increased and will likely result in a power sector plan that better serves the public interests and is perceived as more legitimate.
- Power sector planning should adopt a true least-cost planning process in which the least societal cost option is chosen. This would seem obvious. Costs used in planning analysis should be "cost of delivered electricity to end users" not just generation cost for fair comparison. Restricting consideration to only generation cost fails to incorporate transmission and distribution system costs – which make up about 40% of Thailand's electricity costs. Energy efficiency and distributed generation reduce end-use electricity requirement, reducing the need for expensive transmission or distribution system upgrades. Moreover, current cost methodologies also ignore environmental externality costs such as crop losses due to acid rain, health impacts from particulates and mercury emissions, and the cost of global greenhouse gasses. These environmental externality costs should be incorporated in decision-making processes.
- Multiple scenarios should be considered in the PDP reflecting reasonable assumptions regarding uncertainties in key future variables. The current PDP practice creates a single "business as usual" PDP with two additional scenarios: "high" and "low" economic growth. In practice, electricity demand has tended to grow significantly below the "baseline" case, or even occasionally below the "low" base. In the Pacific Northwest of the USA, the power plan considers 750 scenarios that address combinations of variations in economic growth rates, fuel prices, rainfall and snowpack (for hydropower), and various carbon pricing scenarios – and then works in a public process to pick plans that are low cost and low risk across a wide range of possible futures.[16]
- Resource options considered in the PDP should widen from their existing narrow band of options (large coal, large gas, hydropower imports and nuclear) to include investments in EE/DSM, RE, cogeneration, plant life extension, repowering, and brown-field siting, as discussed in this study.
- The impacts of power production should be evaluated even in cases in which these projects are located in other countries. Currently planned imports of electricity from hydropower and lignite power plants located just beyond the Thai borders in Laos, Burma and Cambodia evade environmental regulations and public scrutiny, and impose the most polluting and harmful power plants in countries whose citizens are least able to voice opposition. Moreover, several such projects are likely to also affect Thai citizens, directly or indirectly, due to the trans-boundary nature of the impacts. Because most of power generated is for consumption in Thailand, these projects should be subject to environmental regulations and public scrutiny in Thailand.

[16] *This process is described well in a series of videos by NW Power Planning Council Director of Conservation Tom Eckman, available at: http://www.youtube.com/watch?v=X-3pT_ysknw*

4. Incentivize utilities to promote energy efficiency
   Currently Thai utilities are disincentivized in three ways from prioritizing energy efficiency. These incentive structures need to change:

   - Problem: utilities earn money from selling electricity. Energy efficiency means fewer kWh of electricity sold, and thus lower utility revenues.
     Solution: Delink utilities' profits from sales of kWh.
   - Problem: The current regulatory regime to which Thai utilities' revenue requirement is subject, is called "Return on invested capital". This return-based regulation allows the utilities to earn profits based on how much they invest. Put simply, the more their expansion budget, the more money they collect in tariffs (and utility managers earn higher bonuses). This incentivizes utilities to overinvest.
     Solution: A performance-based regulatory system would reward utilities for meeting well-defined performance targets. Change the regulatory framework for state-owned utilities from guaranteed rate of return to performance-based regulation.
   - Problem: Energy efficiency and the EGAT Demand Side Management (DSM) program in EGAT's internal budgeting is treated as an expense and thus does not lead to profits as it would if it was treated as a capital expense (recall above, EGAT's profits are based on a fixed rate of return on invested capital)
     Solution: DSM/EE should be considered investments (on which EGAT can earn a return, not an expense).

5. Invest in Thai capacity to evaluate and verify of EE savings. Evaluation and verification is essential for utilities to feel confident that energy efficiency savings are "real". While this may be expensive, it is still cheaper than building and fueling new plants, and also cheaper than the billions of Baht already spent on preparing legal and institutional infrastructure, personnel training and PR campaigns to pave the way for nuclear energy in Thailand.

6. Remove the onerous "Managing Committee on Power Generation from Renewable Energy Promotion" overseeing VSPP project approval. VSPP project approval has virtually stalled since the establishment of this committee, which has been appointed by the Ministry of Energy to determine which VSPP projects will be allowed to proceed. Thailand should adopt a policy environment in which clear, consistent rules are applied, potential political intervention and opportunity for rent seeking is minimized, and the decision to approve or reject a project is made solely on a technical basis. Otherwise, renewable energy projects are forced to bear such unnecessary hidden costs and risks from the operation of this committee which is supposed to promote renewable energy, not to hinder it.

7. Allow mandatory third party access to PTT's gas transmission pipelines network. Currently PTT operates as a monopoly, and as such has been uneven in its effort to expand its gas transmission and distribution network in response to demand. Other companies should be allowed non-discriminatory access to PTTs gas transmission pipelines to enable efficient natural gas network expansion as well as to promote price competition to further increase opportunities for cogeneration.

While it is true that these measures will take time, Thailand has sufficient capacity reserve and projects already in the pipeline to maintain power system reliability until year 2017. Indeed, as discussed in this paper, all projects that are not under construction can be delayed or canceled and still maintain the government target of 15% reserve margin. The current buffer created by excess installed power plants provides several years for Thailand to concentrate on improving the forecasting methodology and planning process without the diversion of having to think about investing in new centralized fossil fuel power plants, large-scale hydropower imports, or nuclear.

We encourage readers of this document to research further and think critically about power planning practices and options in Thailand and to lend their voice to the discussion of this matter of great social importance. Overall, an investment in improving the PDP process will pay considerable economic, environmental and social dividends for generations to come.

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