Policy Brief
SENATE ECONOMIC PLANNING OFFICE
September 2009 PB-09-04

Powering the Future: Are We Ready for Nuclear Energy?

Concerns over the long-term availability and cost of electricity have renewed the government's interest in nuclear energy. However, questions remain on the readiness of the country's scientific, regulatory and institutional frameworks to develop and oversee a domestic nuclear energy program.

I. Introduction

Energy security is vital in achieving the government's goal of spurring economic activity to create livelihood and employment for 88.6 million Filipinos, a third of which are currently living below the poverty threshold (National Statistics Office, 2009). Based on existing power supply and demand projections, the Department of Energy (DOE) estimates that power shortages will affect the Visayas this year, Luzon by 2010, and Mindanao by 2011 unless new generation capacity is added (Table 1). The demand for electricity is expected to increase even further in light of the country's growing population, currently pegged at 2 percent per year (NSO, 2009).

Table 1: Projected power supply and demand (megawatt), by regional grid (2008-2017)

LUZON										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Peak Demand Forecast	6,925	7,191	7,515	7,825	8,178	8,533	8,910	9,299	9,743	10,208
Dependable Capacity	9,858	9,869	9,223	9,823	9,823	9,823	9,823	9,823	9,823	9,823
Required Capacity	8,545	8,874	9,274	9,656	10,092	10,530	10,995	11,475	12,023	12,597

VISAYAS										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Peak Demand Forecast	1,177	1,231	1,285	1,343	1,403	1,464	1,534	1,608	1,687	1,770
Dependable Capacity	1,482	1,494	1,614	1,766	1,766	1,766	1,766	1,766	1,766	1,766
Required Capacity	1,453	1,519	1,586	1,657	1,731	1,807	1,893	1,985	2,082	2,185

MINDANAO										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Peak Demand Forecast	1,325	1,372	1,431	1,488	1,552	1,618	1,688	1,763	1,844	1,932
Dependable Capacity	1,682	1,724	1,782	1,782	1,782	1,782	1,782	1,782	1,782	1,782
Required Capacity	1,604	1,660	1,731	1,801	1,878	1,958	2,043	2,134	2,232	2,338

Source: Power Development Plan 2007, Department of Energy

Note: *Dependable capacity* refers to the maximum capacity the collective power plants in a grid can sustain over a specified period with allowances for planned and forced outages, seasonal limitations, and other conditions. *Required capacity* represents the amount of generating capacity required to meet the peak demand plus the required reserve margin (23.4 % for Luzon and Visayas and 21 % for Mindanao) mandated by the Energy Regulatory Commission (ERC). *Peak demand* is calculated from the aggregated projected energy sales of all distribution utilities and other energy users.

SEPO

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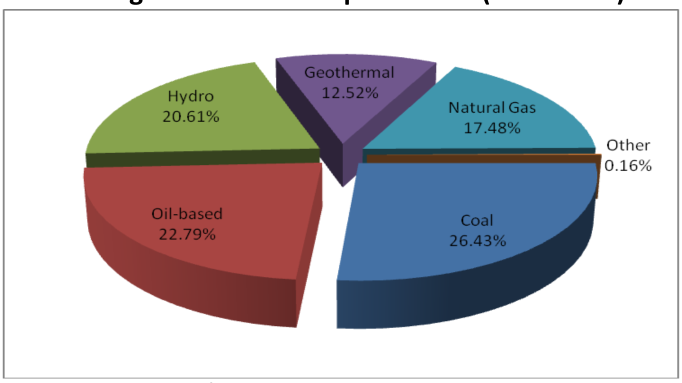
Power rates in the Philippines are among the highest in Asia (Table 2). This can largely be attributed to the country's continued dependence on imported fossil fuels for much of its power generation.[1] As of today, almost half (49.22 %) of the country's total installed electrical capacity is generated using imported fossil fuels (Figure 1). Coal-powered plants generate 26.43 percent of total installed capacity, while oil-powered plants comprise 22.79 percent. Oil-powered plants are particularly expensive to run compared to other technologies given the increasing global demand for oil-based products. Based on historical Dubai crude weekly data, the current price of oil per barrel is higher by 74.80 percent compared to oil prices five years ago and is expected to rise even further in the near future as the global economy recovers from the economic slowdown.

Table 2: Comparative Asian power rates (US¢/kwh)

Country	Residential		Industrial	
	Low	High	Low	High
Indonesia [a/]	1.5	4.1	1.5	3.6
Lao PDR [a/]	2.7		2.5	
Vietnam [a/]	2.7	7.7	2.7	13.1
Thailand [b/]	4.8	8.0	3.2	9.7
Malaysia [b/]	5.9	8.5	3.9	6.4
China [b/]	6.0	6.1	6.6	8.7
Korea [b/]	6.1	19.9	5.1	6.7
Myanmar [a/]	7.3		7.3	
Cambodia [a/]	8.4	15.6	11.5	14.4
Hong Kong [b/]	11.1	13.9	8.1	9.1
Japan [b/]	12.9	18.0	10.2	11.2
Singapore [b/]	13.3		6.6	11.8
Philippines [b/]	17.4		12.8	16.7

Source: Department of Energy
Note: [a/] As of 2005
[b/] As of 2006

Figure 1: Domestic power mix (as of 2006)



Source: Department of Energy

[1] Formed from the fossilized remains of prehistoric plants and animals compressed under immense pressure and heat for millions of years, fossil fuels such as coal, petroleum, and natural gas have been used to generate most of the energy consumed globally for production and transportation over the last century. They are not renewable.

Besides being expensive to run, coal and oil-powered plants also release significant amounts of carbon dioxide (CO2) and other greenhouse gases (GhGs) that have been known to cause climate change (Table 3). Like many developing island nations, the Philippines is considered to be particularly vulnerable to the various negative effects associated with climate change, such as changing weather patterns and rising sea levels.

Table 3: Carbon dioxide emissions, by power plant fuel type

Fuel type	CO2 MT/GwH*
Oil Gas Turbine	867.61
Diesel	763.04
Pulverized Coal	726.99
Oil Steam Turbine	713.10
Oil Combined Cycle	565.83
Natural Gas Combined Cycle	441.82

Source: Kabang Kalikasan ng Pilipinas (WWF Philippines)/ University of the Philippines Solar Laboratory, 2003
* Metric Ton of Carbon Dioxide produced per Gigawatt-Hour

The government continues to seek out new ways to significantly decrease the country's reliance on imported fossil fuels in order to address the looming power shortage and bring down the current price of electricity while simultaneously fulfilling global commitments to significantly reduce GhG emissions. With this in mind, the Renewable Energy Act was enacted in December 2008. The law promotes the development of renewable energy resources (such as wind and solar) in the country by providing significant incentives for institutions to come in and invest in that sector.

The Philippines has been blessed with significant resources of renewable energy just waiting to be tapped (Box 1). As it is, a third of the country's power supply is already provided by hydroelectric (20.61 %) and geothermal (12.52 %) energy. However, prospects for increasing the share of hydroelectric and geothermal energy in the domestic power mix are limited. Globally, the construction of large-scale hydroelectric power dams has been curtailed given the high social and environmental costs associated with large-scale dams. Developing new geothermal power plants has also been difficult given the fact that most of the country's untapped steam fields are in mountainous areas that are covered by existing ancestral domain laws. On the other hand, other renewable energy technologies such as wind and solar power do not have the ability to generate stable and continuous baseload electricity given the intermittent supply of their energy resource.

Concerns over the availability and cost of electricity in the country have renewed the government's interest in nuclear energy. In particular, two bills (Senate Bill No.

Box 1: Prospects for Renewable Energy

Indicative Capacity Additions for Renewable Energy until 2014

Resource	Mw
Geothermal	699.4
Hydropower	924.8
Mini-hydro	100.3
Biomass	183.9
Wind	556.5
Solar	n/a
TOTAL	2,864.9

Source: Philippine Energy Plan 2007

At the end of 2006, about a third of the Philippines installed power capacity was from renewable energy sources. The recent passage of the Renewable Energy Act is expected to attract further investment in this sector and subsequently accelerate the development and installation of renewable energy capacity in the country. Even prior to the passage of the law, the Philippines was already the second largest producer of *geothermal* power in the world and the government plans to continue pursuing expansion in this area. The Department of Energy (DoE) estimates that the geothermal sector could potentially add up to 699.4 MW of capacity by 2014 although they admit it is somewhat difficult to attract investors to the projects, citing the country's foreign ownership restrictions as a possible stumbling block. The bulk of this potential additional capacity shall come from the Bicol and Visayas Regions.

Hydropower has long been an important source of electricity in the country and the DoE states that the sector can contribute up to 924.8 MW from large hydropower plants and 100.3 MW from mini-hydropower plants, for an aggregate of 1,025.10 MW to the country's power mix in the near future. The bulk of these potential hydropower projects would be located in Mindanao and Southern Luzon. However, interest in developing further large-scale hydropower projects is limited by the high initial investment cost as well as the environmental and social costs associated with the construction of large dams.

The country has vast *wind* energy potential as detailed in a joint study by the World Wildlife Fund and the University of the Philippines Solar Laboratory (del Mundo et al, 2003). After considering factors such as wind power density and distance from transmission facilities, the study estimated that the Philippines practical wind energy resources could potentially provide up to 7,404 MW of capacity. The latest Philippine Energy Plan has identified 556.5 MW of indicative wind power capacity additions up to 2014, most of which would be located in Northern Luzon. The intermittent nature of wind power however, affects system operability and stability. Thus it requires additional ancillary services and higher electricity costs. The government is hoping that the incentives provided under the new Renewable Energy Law would be enough to encourage new investors into the sector.

The PEP also notes the indicative capacity addition of up to 183.9 MW from *biomass* resources in the country, mostly from rice hull and bagasse cogeneration in the near future. These capacity additions would mostly be located in central Philippines. Expanded utilization of biomass for power generation is limited by the high upfront cost of development as well as issues like collection, storage and competing uses.

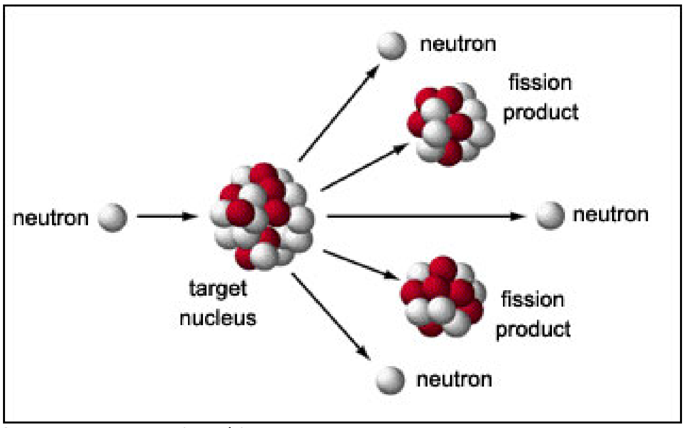
The use of *solar* power for electricity in the Philippines is still on a very limited scale, mostly in remote, off-grid communities. Initial reports (mostly anecdotal) have indicated possible long-term sustainability issues for these projects particularly with regard to community maintenance and replacement of parts. The high cost of initial investment as well as the large amount of land required for utility-level solar power plants also hinders the expanded use of this resource. These could indicate that solar power in the Philippines might be better suited for either small-scale applications in urban areas or missionary electrification in rural areas.

2665 and House Bill No. 4631) calling for the immediate rehabilitation and operation of the Bataan Nuclear Power Plant (BNPP) have already been filed in both Houses of Congress. A number of private operators, have submitted proposals to activate and operate the plant. One of these is the Korean Electrical Power Corporation (KEPCO), which has been operating a nuclear reactor (KORI 2 in Pusan, South Korea) identical to the BNPP since 1983. The objective of this paper therefore is to assess the government's options for designing and setting in place the necessary scientific/legal/ institutional frameworks it needs to develop and safely operate a civilian nuclear energy program in the country, including current efforts in both Houses of Congress to rehabilitate, modernize, and operate the BNPP.

II. Nuclear energy – an overview

Nuclear power plants do not operate differently from fossil fuel-burning power plants. In general, power plants generate electricity by heating water into pressurized steam that drives turbine generators. The difference lies in the method of heating water: instead of burning fossil fuels, nuclear power plants (NPPs) use the heat generated by nuclear fission. During this process, uranium atoms are bombarded with neutrons until they split, releasing great amounts of energy as heat and radiation (Figure 2).

Figure 2: Nuclear fission



Source: www.atomicarchive.com

While NPPs are generally cheaper to operate in the long run because of their cheaper fuel, start-up costs are significantly higher compared to fossil-fuel based power plants (Table 4). A recent study published by the Massachusetts Institute of Technology (MIT) found that nuclear energy has one of the highest electrical generation costs among all power sources, second only to oil (Table 5). While proponents of nuclear energy argue that continuous advancements in nuclear technology are expected to bring down the costs of NPP construction and development in the near future, the

MIT study found that *"since 2003… the estimated cost of constructing a nuclear power plant has increased at a rate of 15 percent per year."* However, it must be noted that the cost of nuclear energy may become more competitive in a situation wherein carbon taxes and tariffs are collected from fossil fuel-based applications as part of emission-reduction mechanisms.

In addition, proponents of nuclear power have long argued that nuclear power has the potential to provide a stable flow of power on a large (baseload grid) scale minus the GhG emissions produced by power plants that run on fossil fuels. The International Atomic Energy Agency (IAEA) recently estimated that the global use of nuclear power prevents the release of around 600 million tons of carbon emissions annually, or eight percent of current global GhG emissions.

Table 4: Comparative power generation start-up and fuel costs

Power plant	Investment cost (US$/kW)	Fuel cost (US$/kW)
Oil-fired gas turbine	450-550	4.99
Diesel motors	550-650	7.31
Oil-fired combined cycle gas turbine	700-900	3.26
Natural gas-fired combined cycle gas turbine	700-900	3.67
Oil-fired steam turbine	850-1,000	4.10
Wind technologies	1,000-1,250	0.00
Nuclear technologies [a]	1,000-2,500	0.50
Geothermal technologies	1,150-1,500	0.00
Pulverized coal-fired power plant	1,200-1,400	1.14
Fluidized bed combustors (Bio-mass)	1,750-1,800	0.35
Fluidized bed coal power plant	1,750-1,800	0.91
Hydroelectric power	2,000-3,500	0.00

Source: Cost comparisons are from Power Switch (WWF Philippines/ University of the Philippines Solar Laboratory, 2003)
[a]The Economics of Nuclear Power (World Nuclear Association, 2008)

Nuclear energy is currently being used in most developed countries, with a number of developing countries also considering it. As of July 2008, there are 430 NPPs operating worldwide (Table 6). Electricity generated by these plants accounts for 16 percent of total global supply. In the US, 104 NPPs provide almost 20 percent of the country's electricity. Almost a third of Western Europe's power supply is generated by around

Table 5: Comparative power generation costs

Power plant	Generation cost (PhP/kW)
Hydroelectric	2.11
Coal	3.05
Geothermal	3.07
Natural gas	3.39
Nuclear	4.07
Oil	5.27

Source: SEPO's At a Glance, 2005, MIT, 2009
Note: Domestic power generation (Hydro electric, Coal, Geothermal, Natural gas and Oil) costs were computed using actual 2003 NPC data on fixed costs, fuel costs and power sales of all NPC plants and IPPs as cited in Electric Power: At a Glance (SEPO, 2005). Estimates for nuclear power costs were taken from *"The Future of Nuclear Power"* (MIT 2003, 2009) using levelized cost estimates over a 40-year period.

150 NPPs. In France alone, 59 NPPs generate 80 percent of the country's power. Among the G8 (the world's eight largest economies), Italy is the only country without its own nuclear power program. It is also the world's largest net importer of electricity. As such, the Italian government confirmed last year that it will begin building new nuclear plants within the next five years in order to reduce the country's dependence on imported power.

Table 6: Nuclear power plants in operation

Country	No. of NPPs	Total power share (%)
U.S.A.	104	19.4
France	59	77.0
Japan	53	27.5
Russia	31	16.0
S. Korea	20	35.3
U.K.	19	15.0
Canada	18	14.7
India	17	2.5
Germany	17	26.0
Ukraine	15	48.0
China	11	1.9
Sweden	10	46.0

Source: World Nuclear Association

Many of the Philippines' neighbors are also considering the nuclear option. Vietnam passed its own Atomic Energy Act in 2008. Construction of their first four-turbine NPP will begin in 2015 and will be completed in 2025. Indonesia also has plans of having three NPPs up and running within the next two decades, with the first one in operation by 2015. Thailand is also conducting studies to assess the compatibility of nuclear power development within the context of its national agenda.

While the nuclear power industry has compiled a solid safety track record comparable to that of fossil fuel-based power industries, it must be pointed out that a number of serious incidents have occurred in nuclear facilities over the last 50 years, some of them even resulting in the accidental release of radioactive material and/or the immediate deaths of plant personnel due to radiation exposure (Table 7).

Table 7: International Nuclear and Radiological Event Scale (INES)

Level	Description	Criteria	Examples (Year/Type/Country)	Immediate Deaths	Environmental Damage	Follow-up Action
7	MAJOR ACCIDENT	• External release of a large fraction of the radioactive material in a large facility (e.g. the core of a power reactor). This would typically involve a mixture of short and long-lived radioactive fission products (in quantities radiologically equivalent to more than tens of thousands terabecquerels of iodine-131). Such a release would result in the possibility of acute health effects; delayed health effects over a wide area, possibly involving more than one country; long-term environmental consequences.	1986: Chernobyl-4 (Commercial reactor), Ukraine	47 staff and firefighters	Massive environmental disaster. Major radiation released across Europe and Scandinavia.	Entombed
6	SERIOUS ACCIDENT	• External release of radioactive material (in quantities radiologically equivalent to the order of thousands to tens of thousands of terabecquerels of iodine-131). Such a release would be likely to result in full implementation of countermeasures covered by local emergency plans to limit serious health effects.	1957: Mayak/Kyshtym (Fuel reprocessing plant), Russia	0	Widespread contamination.	Repaired. Still in operation.
5	ACCIDENT WITH OFF-SITE RISK	• External release of radioactive material (in quantities radiologically equivalent to the order of hundreds to thousands of terabecquerels of iodine-131). Such a release would be likely to result in partial implementation of countermeasures covered by emergency plans to lessen the likelihood of health effects. • Severe damage to the nuclear facility. This may involve severe damage to a large fraction of the core of a power reactor, a major criticality accident or a major fire or explosion releasing large quantities of radioactivity within the installation.	1979: Three Mile Island- 2, (Commercial reactor), USA	0	Minor short-term radiation dose (within ICRP limits) to public.	Clean-up program complete. Monitored stage of decommissioning
4	ACCIDENT WITHOUT SIGNIFICANT OFF-SITE RISK	• External release of radioactivity resulting in a dose to the most exposed individual off-site of the order of a few milisieverts. With such a release the need for off-site protective actions would be generally unlikely except possibly for local food control. • Significant damage to the nuclear facility. Such an accident might include damage to nuclear plant leading to major on-site recovery problems such as partial core melt in a power reactor and comparable events at non-reactor installations. • Irradiation of one or more workers which result in an overexposure where a high probability of early death occurs.	1980: Saint Laurent (Commercial reactor), France	0	Minor radiation release.	Repaired and restarted. Decommissioned in 1992.
3	SERIOUS INCIDENT	• External release of radioactivity above authorised limits, resulting in a dose to the most exposed individual off site of the order of tenths of millisievert.* With such a release, off-site protective measures may not be needed. • On-site events resulting in doses to workers sufficient to cause acute health effects and/or an event resulting in a severe spread of contamination for example a few thousand terabecquerels of activity released in a secondary containment where the material can be returned to a satisfactory storage area. • Incidents in which a further failure of safety systems could lead to accident conditions, or a situation in which safety systems would be unable to prevent an accident if certain initiators were to occur.	1989: Vandellos (Commercial reactor) Spain	0	None	Decommissioned
2	INCIDENT	• Incidents with significant failure in safety provisions but with sufficient defence in depth remaining to cope with additional failures. • An event resulting in a dose to a worker exceeding a statutory annual dose limit and/or an event which leads to the presence of significant quantities of radioactivity in the installation in areas not expected by design and which require corrective action.	2006: Forsmark (Commercial reactor), Sweden	0	None	Repaired. Still in operation.
1	ANOMALY	• Anomaly beyond the authorised operating regime. This may be due to equipment failure, human error or procedural inadequacies. (Such anomalies should be distinguished from situations where operational limits and conditions are not exceeded and which are properly managed in accordance with adequate procedures. These are typically "below scale").	2008: SOCATRI (Uranium recovery and cleanup facility), France	0	None	Still in operation.
0	DEVIATION	• No safety significance				

Note: ICRP – International Commission on Radiological Protection
Sources: World Nuclear Association
International Atomic Energy Association

The accident at the Chernobyl nuclear power plant, near Pripyat, Ukraine is considered to be the worst nuclear disaster in history. On April 26, 1986, operator errors caused two explosions at the No. 4 reactor of the plant. The explosions caused the nuclear reactor's containment unit to collapse, releasing a plume of highly radioactive cloud that drifted across most of Europe, covering 200,000 square kilometers. The accident was an epic environmental disaster, severely contaminating the air, water, livestock, and vegetation within the immediate geographical region. A 2006 study published by the World Health Organization (WHO) found the accident at Chernobyl severely affected the lives of more than 5 million people. Forty seven plant workers and emergency response personnel died from acute radiation sickness (ARS) resulting from the plant explosion, while more than 380,000 people were displaced from their homes. While specific estimates have been difficult to generate, increasing incidences of leukemia and thyroid cancer in the region have also been attributed to radiation exposure from the explosion at the plant.

III. Nuclear energy in the Philippines: past issues, future prospects

Laying the foundation for the Philippines' nuclear energy program

In 1955, the Philippine government committed itself to the peaceful use of atomic energy when it joined the US in its *"Atoms for Peace"* program. A year later, the country joined 82 other nations in Geneva to establish the IAEA. In 1957, the Manila Electric Company (Meralco) commissioned Gilbert Associates (an American consulting firm) to conduct a preliminary study on the feasibility of constructing and operating a NPP in the country. The study eventually concluded that the Philippine domestic market was still too small to justify the construction and operation of a NPP. A year later, the Science Act of 1958 was enacted, creating the Philippine Atomic Energy Commission (PAEC) now called the Philippine Nuclear Regulatory Institute (PNRI). In 1960, the Philippine government requested the IAEA for assistance in surveying the prospects of nuclear power in the country over the next decade. A year later, the IAEA, in its report *"Prospects of Nuclear Power in the Philippines"*, concluded that a relatively large nuclear plant may eventually be able to compete with fossil fuel-based power plants given the lack of established fossil fuel reserves in the country.

The Bataan Nuclear Power Plant (BNPP)

In 1973, then President Marcos ordered the development of the country's nuclear energy industry in response to the massive oil crisis that gripped the world that year. President Marcos ordered the National Power Corporation (Napocor) to negotiate a deal to buy two 600-megawatt nuclear reactors. The construction of the BNPP was meant to improve the Philippines' energy security by lessening the country's reliance on increasingly expensive imported oil for baseload power generation.

Westinghouse won the contract bidding in February 1976 and construction of the BNPP began a year later at Napot Point in Morong, Bataan Province. The plant was finished and transferred to Napocor in January 1985, nine years after the contract was signed. However, growing public apprehension over allegations of corruption, lack of access to information and public consultation, and unresolved concerns regarding the geological stability of the site and operational safety of the BNPP (especially in light of the 1986 Chernobyl disaster in Ukraine) eventually led to the plant's closure. In April 2007, the Philippine government made its final payment on the BNPP. At a final cost of US$2.3 billion (almost 2.5 times more than the original budget), the plant represents the single biggest debt ever incurred by the Philippine government for any given project. In spite of its massive price tag, the BNPP has never been loaded with fuel and operated. The plant has yet to generate a single watt of electricity for the Filipino people.

Reviving the BNPP

Two bills (Senate Bill No. 2665 authored by Sen. Miriam Defensor-Santiago and House Bill No. 4631 authored by Rep. Mark Cojuangco) calling for the immediate rehabilitation and operation of the BNPP are currently filed in both Houses of Congress. Under the proposed bills, the rehabilitation and subsequent operation of the BNPP will be carried out by Napocor under the supervision and control of the DoE and the PNRI. For the first 10 years of operation, the nationality requirements for filling up the scientific/technical, supervisory, and managerial positions required by the BNPP will be waived while the country trains and cultivates a pool of local skilled manpower for managing and operating the BNPP and other future NPPs. The amount needed for the initial implementation of the proposed bills will be charged against the appropriations of the DoE under the General Appropriations Act (GAA), or appropriated and covered by the Napocor in its annual budget. The Napocor shall also collect US$0.1-0.2/kwh to fund the decommissioning of the BNPP when the plant eventually reaches the end of its operational life.

Issues and concerns

A number of significant issues need to be addressed before the BNPP can be activated and operated. From a technological standpoint, the plant is a dinosaur. While the equipment inside the plant is practically brand new, most of its operating systems are already obsolete and will need to be brought up to par with today's standards. As mentioned earlier, start-up costs for NPPs are huge and are usually understated. The BNPP itself was supposed to have only cost US$680 million but its final price tag ballooned to US$2.3 billion. Studies conducted by Greenpeace found that final costs for nuclear power plant construction are on the average, three times over their original budgets. Based on an ocular inspection and review of the BNPP in 2008, the IAEA estimated that it will cost the Philippine government a minimum US$800 million and take at least five years to rehabilitate the plant's infrastructure and update its operating systems. As it is, the cost of rehabilitating the plant is enough to fund the construction of a brand new fossil fuel-based power plant. This is problematic given the fact that Sec. 12 of Senate Bill No. 2665 specifically states *"under no circumstances shall the cost [of rehabilitating the BNPP] exceed the price of a brand new coal-fired power plant of equivalent power generating capacity."*

SB 2665 also calls for the suspension of Philippine nationality requirements for the filling up of the technical, supervisory and managerial positions for the first 10 years of operation of the BNPP. This is meant to address the current shortage of qualified and experienced personnel while the country builds up a corps of necessary skilled local manpower to operate a nuclear plant. This provision, however, raises the question of whether the country should entrust the operation of such a sensitive and strategic installation as a nuclear plant in the hands of non-Filipinos. While it is presumed that the Napocor or whichever government corporation that operates the plant will only hire qualified personnel who have undergone the necessary government clearance procedures, the questions of national safety and security will certainly persist.

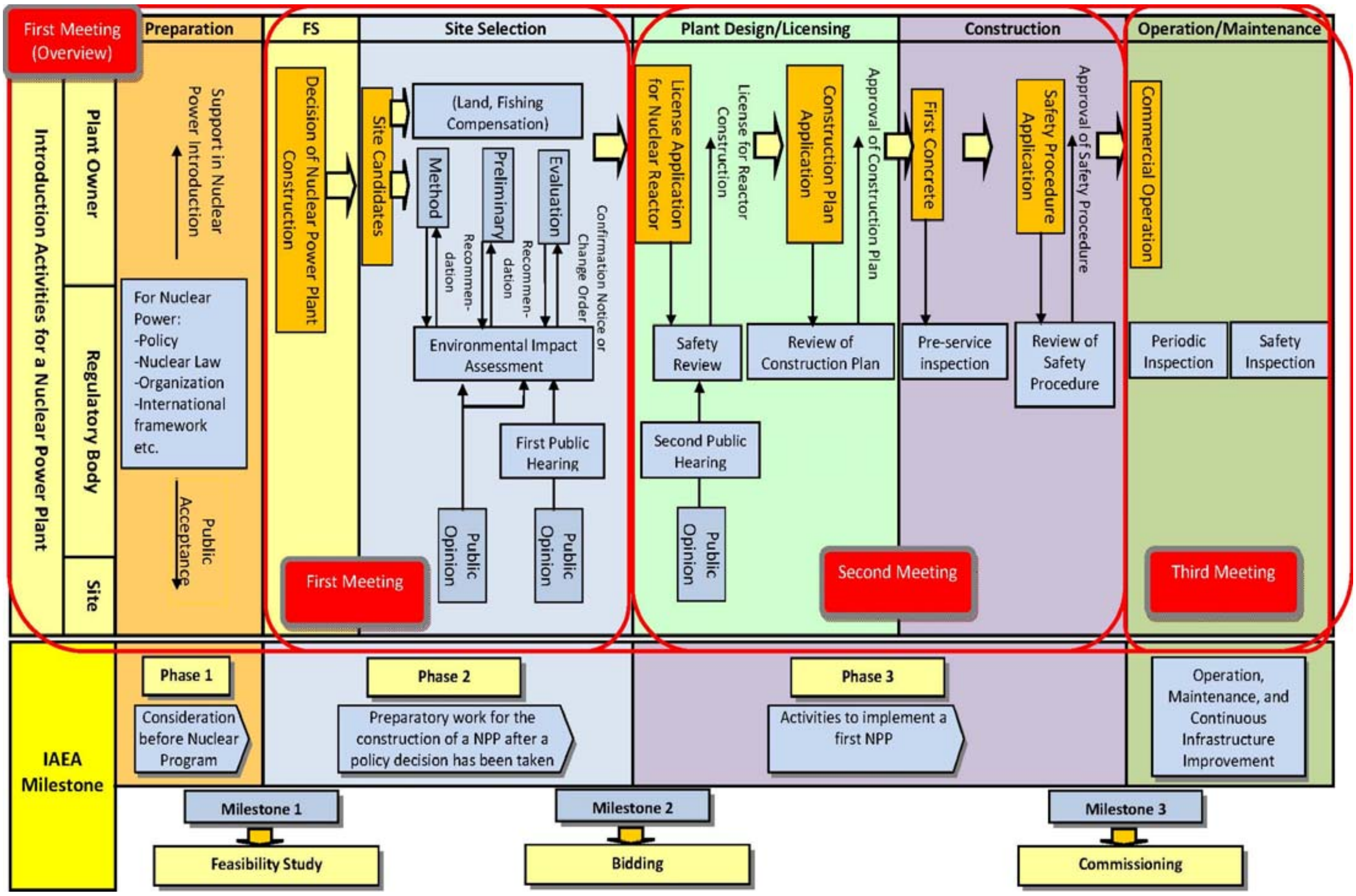
Questions regarding the geological stability of the area upon which BNPP is built have also been raised. The plant sits on the slopes of Mt. Natib, a potentially active volcano as classified by the Philippine Institute of Volcanology and Seismology (Philvolcs). However, it must be noted that Mt. Natib has not erupted over the last 11,000 years and is not among the 200 volcanoes currently being monitored by Philvolcs. Data from Philvolcs also show that the BNPP was not built on an active fault line (Annex 1). This finding is supported by a recent study conducted by the University of the Philippines – National Institute for Geological Studies (UP-NIGS) which did not find any active faultlines within the immediate radius of the BNPP. Nevertheless, the possibility of an earthquake occurring in the area cannot be completely ruled out.

Time is also an important consideration. A country needs at least 10 to 15 years to develop the scientific expertise and technical skills needed to operate NPPs and to define the legislative and regulatory framework that is needed to support the nuclear industry (Figure 3). The French Nuclear Authority (ASN) has said that it takes at least five years to set up the legal and regulatory framework for a nuclear power program, two to ten years to license a new plant, and at least five years to build the plant. That means a minimum lead time of 15 years before a new nuclear power plant can be built and operated in a country that does not already have the necessary scientific and regulatory infrastructure in place.

Unfortunately, the existing legislative framework for the promotion and regulation of nuclear technology in the Philippines is severely outdated and in need of modernization and rationalization. Under the current framework, which is based on the Science Act of 1958 (RA 2067) and the Atomic Energy Regulatory and Liability Act of 1968 (RA 5207), the Philippines has two separate regulatory authorities governing the use of radiation. The PNRI, under the Department of Science and Technology (DOST) regulates of nuclear and radioactive materials used in all fields (including medical) while the Bureau of Health Devices and Technology (BHDT) under the Department of Health (DOH) regulates electrically generated radiation emitting devices used in all fields (including industry). Having two separate regulatory authorities creates space for differing regulatory policies and safety standards. It also creates confusing and conflicting situations with regards to defining regulatory responsibilities and areas of implementation.

Another weakness in the current regulatory framework is the vesting of the PNRI with the dual mandate of both promoting and regulating the use of nuclear energy. This could lead to conflicts of interest within the agency. General international experience suggests that safety and credibility are best served by institutionally separating the two functions (IAEA, 2007). The IAEA therefore recommends that legislation should separate the functions of the regulatory body, and those of any other body concerned with the promotion of nuclear energy.

Figure 3. NPP Planning and Infrastructure Development Schedule



Source:* *IAEA, 2009.

Note: Items surrounded by red line will be discussed in each meeting.

Furthermore, the Philippines is a signatory to a number of international instruments concerning the use of nuclear technology. The current legislative and regulatory frameworks may need to be adjusted in order to be consistent with these obligations (Table 8).

Finally, there is the matter of waste disposal. The waste produced by NPPs is highly radioactive. Human exposure to nuclear waste results in sickness and death. In addition, several nuclear weapons can be built using ordinary spent fuel from nuclear reactors. Although, many developed countries have been safely operating repositories for radioactive waste from NPPs, medical, research, and other applications for many years, it must be noted that the operational safety of NPPs is contingent on the strict implementation and timely observation of international standards and regulations. Unfortunately, it seems unlikely that the government will be able to effectively implement the necessary protocols given the fact that it is already having a hard time in implementing the Ecological Solid Waste Management Act of 2000.

The development of nuclear energy in the Philippines must be supported and regulated by *stable and consistent* institutions. However, it must be noted that the public's confidence in the government's ability to safely operate the BNPP remains significantly low. Many of former President Ferdinand Marcos' associates involved in the bidding out and construction of the plant were taken to court over allegations of corruption and overpricing. However, none of them were ever convicted and in the end, the Filipino people ended up paying US$2.3 billion for a nuclear power plant that has yet to generate a single watt of electricity since it was finished in 1986.

Because of the aforementioned reasons, rehabilitating and activating the BNPP at this point seems ill-advised given the outdated state of the country's existing scientific/technical, legal, and regulatory frameworks. To operate an NPP without building up the technical and regulatory capabilities needed to ensure its safe and efficient operation is not only unwise but extremely dangerous and risky as well.

Strengthening the country's nuclear energy policy

The proposed Comprehensive Nuclear Policy Bill (Senate Bill No. 2395 by Sen. Antonio Trillanes IV) seeks to address some of the weaknesses in the current nuclear policy framework of the Philippines. Under the

Table 8: International instruments on nuclear energy

Agreement/Convention/Treaty	Date Ratified
1. Vienna Convention on Civil Liability for Nuclear Damage	November 12, 1997
2. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	June 5, 1997
3. Convention on Early Notification of a Nuclear Accident	June 5, 1997
4. Convention on Physical Protection of Nuclear Material	February 8, 1987
5. Treaty on Non-Proliferation of Nuclear Weapons	October 5, 1972
6. Safeguards Agreement with IAEA in Connection with Non-Proliferation Treaty	October 16, 1974
7. Southeast Asia Nuclear Weapon Free Zone Treaty	March 19, 2001
8. Comprehensive Test Ban Treaty	February 23, 2001
9. Agreement on the Privileges and Immunities of the IAEA	December 17, 1962
10. Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA	March 3, 1980
11. 3rd Agreement to Extend the 1987 Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology	June 27, 2002

Source: Philippine Nuclear Research Institute

proposed legislation, a single regulator, to be tentatively called the Philippine Nuclear Regulatory Authority (PNRA), will be created, consolidating the present regulatory powers and offices of both the PNRI and the BHDT. This agency will be attached to the Office of the President. On the other hand, the PNRI will still develop and promote the peaceful application of nuclear energy and will still be attached to the DOST. This new structure will ensure the effective independence of the regulators from the promoters and users of nuclear/radiation technology by separating the regulatory body from the government agencies promoting nuclear technology. The proposed bill also aims to put into place appropriate measures and regulations, consistent with international treaties and conventions, on the management of radioactive waste and spent fuel, emergency preparedness, radiation protection and nuclear security.

A companion measure to this bill is the proposed Nuclear Science and Engineering Scholarship Bill (Senate Bill No. 3171 by Sen. Miriam Defensor-Santiago). This measure seeks to increase and improve the pool of nuclear scientists and engineers in the country by providing scholarship funds for such. This will ensure that the country will have the necessary and adequate human resources needed to run a national nuclear program. A similar human resource development program for regulators might also be necessary as a complementary measure and SB 2395 hopes to address this.

Finally, there are still a number of international conventions and treaties on nuclear safety that the Philippine Senate needs to ratify. Ratification of these conventions commits the country towards implementing high levels of nuclear safety and security. States that have ratified these conventions will most likely refuse to provide nuclear materials, fuel, equipment and expertise to the Philippines if it does not ratify and comply with said conventions. These international conventions include the following:

- *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* - - This applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications; and to spent fuel and radioactive waste from military or defense programs if and when such materials are transferred permanently to and managed within exclusively civilian programs, or when declared as spent fuel or radioactive waste for the purpose of the Convention by the Contracting Party. The Convention also applies to planned and controlled releases into the environment of liquid or gaseous radioactive materials from regulated nuclear facilities.

- *Convention on Nuclear Safety* - - This aims to legally commit participating States operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which these States would subscribe.

- *Convention on Supplementary Compensation for Nuclear Damage* - - This Convention requires compensation for nuclear damage for which an operator of a nuclear installation situated in the territory of a Contracting Party is liable under either international conventions or national law.

- *Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention* - - The Joint Protocol combines the Vienna and Paris Conventions, both of which concern the liabilities of parties with regard to nuclear damage. Parties to the Joint Protocol are treated as though they are Parties to both Conventions and a choice of law rule is provided to determine which of the two

Conventions should apply to the exclusion of the other in respect of the same incident.

- *Additional Protocol to the Safeguards Agreement-* This would grant the IAEA complementary inspection authority to those provided in underlying safeguards agreements. The principal aim is to enable the IAEA inspectorate to provide assurances about both declared and possibly undeclared activities. Under the Protocol, the IAEA is granted expanded rights of access to information and sites.

IV. Conclusion

Nuclear energy is becoming an increasingly attractive option for the future given its ability to provide stable and continuous baseload power while significantly avoiding the release of harmful GhGs into the atmosphere. However, the government must not rush into things, not when there are more viable alternatives (such as geothermal energy and other renewables) that do not have the potential dangers that nuclear power has. The disaster at Chernobyl stresses the importance of ensuring that all systems and procedures are safe, secure, and done in accordance with international standards.

Current efforts in both Houses of Congress to fast-track the rehabilitation and operation of the BNPP are akin to putting the cart before the horse. Before the government can operate the BNPP or any other NPP for that matter, it must first undertake the preliminary business of getting its nuclear power program back on track by updating the scientific/technical, legislative, and regulatory frameworks that will guide the development of the country's nuclear power industry. In the meantime, international experts from the IAEA and WNA can undertake a comprehensive and objective assessment of the BNPP's potential to generate nuclear power in order to put the public's mind at rest, and perhaps even identify other sites for other potential NPPs. The government must likewise invest in the education and training of the country's future nuclear engineers in order to guarantee the sustainability and continued development of the country's nuclear energy program.

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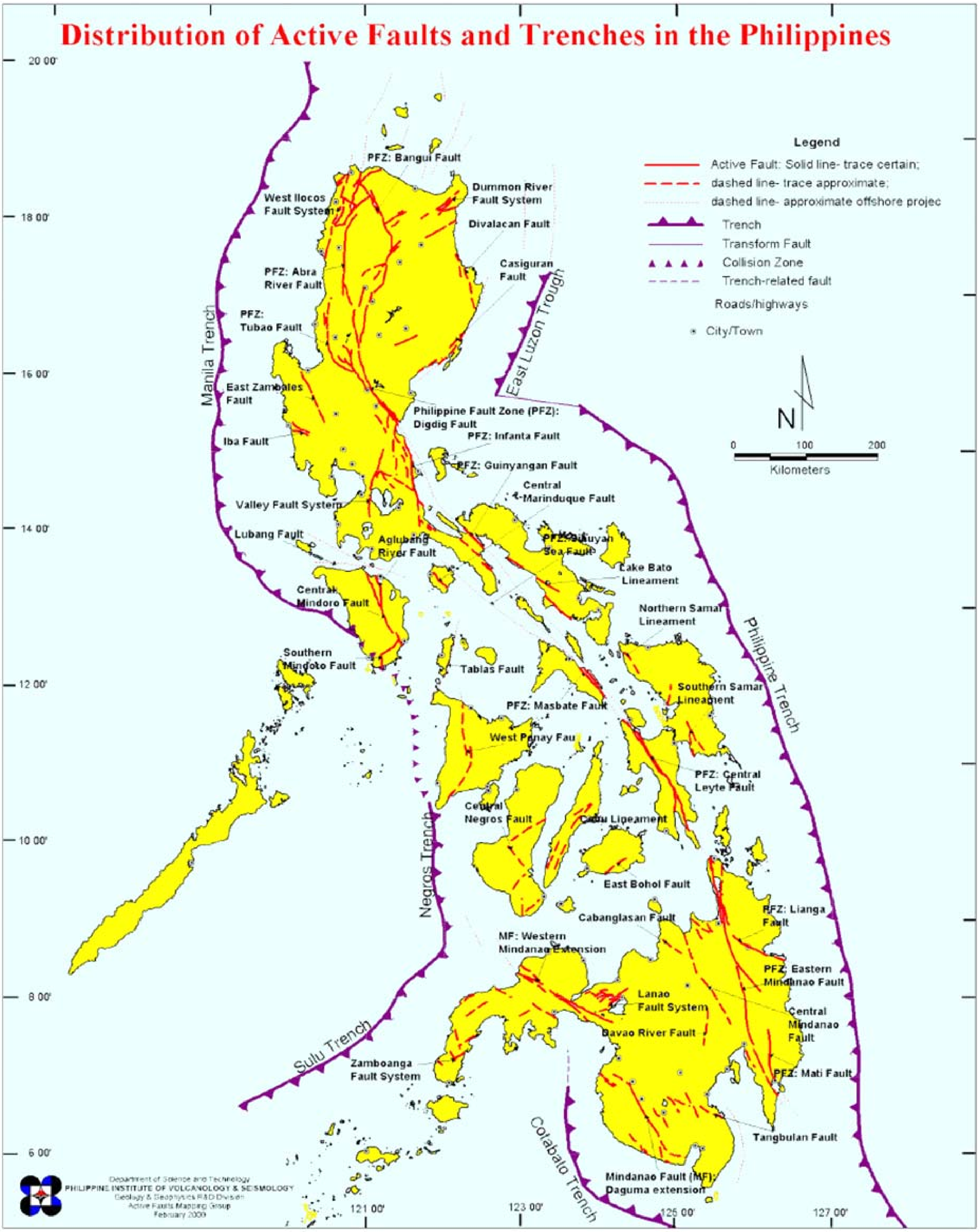
This Policy Brief was principally prepared by Harry Pasimio, Jr. and Peter S. Turingan, under the supervision of SEPO's Directors and the overall guidance of its Director General.

The views and opinions expressed are those of SEPO and do not necessarily reflect those of the Senate, of its leadership, or of its individual members. For comments and suggestions, please e-mail us at sepo@senate.gov.ph.

Annex I


Distribution of Active Faults and Trenches in the Philippines
Legend
Active Fault: Solid line- trace certain;
dashed line- trace approximate;
dashed line- approximate offshore projec
Trench
Transform Fault
Collision Zone
Trench-related fault
Roads/highways
City/Town
Kilometers
Manila Trench
East Luzon Trough
Philippine Trench
Negros Trench
Sulu Trench
Cotabato Trench
PFZ: Bangui Fault
West Ilocos Fault System
Dummon River Fault System
Divalacan Fault
Casiguran Fault
PFZ: Abra River Fault
PFZ: Tubao Fault
East Zambales Fault
Philippine Fault Zone (PFZ): Digdig Fault
Iba Fault
PFZ: Infanta Fault
PFZ: Guinyangan Fault
Central Marinduque Fault
Valley Fault System
Lubang Fault
Aglubang River Fault
Lake Bato Lineament
Central Mindoro Fault
Northern Samar Lineament
Southern Mindoro Fault
Tablas Fault
Southern Samar Lineament
PFZ: Masbate Fault
PFZ: Central Leyte Fault
Central Negros Fault
Cebu Lineament
East Bohol Fault
Cabanglasan Fault
PFZ: Lianga Fault
MF: Western Mindanao Extension
PFZ: Eastern Mindanao Fault
Lanao Fault System
Central Mindanao Fault
Davao River Fault
Zamboanga Fault System
PFZ: Mati Fault
Tangbulan Fault
Mindanao Fault (MF): Daguma extension
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February 2000