

Redefining Nuclear: Exploring Stigma, Climate Change, and the Adoption of Nuclear  
Power in Southeast Asia

by

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Nuclear energy is very efficient and cost-effective, but the stigma attached to it hinders its expansion around the world. However, with rising concerns over climate change and the fact that nuclear energy effectively has zero greenhouse gas emissions, there is an opportunity for nuclear to be more acceptable as a “green” source of energy. Since many Southeast Asian nations are interested in nuclear power and are vulnerable to the effects of climate change, an exploration of the region’s climate vulnerability, socioeconomics, and public perceptions of nuclear is useful in teasing out any positive effect that climate change is having on the acceptance of nuclear power. While pressures from climate change are encouraging the region to ease its dependence on fossil fuels, socioeconomic factors are the main drivers of nuclear power ambitions in Southeast Asia as nations are interested in nuclear for its potential to rein in the costs of energy production. Regarding public perceptions, concerns over exposure to radiation and a lack of trust in the potential management of nuclear power in the region signify that the public remains skeptical and guarded toward nuclear power despite the pressures of climate change.

Key Words: Climate change, Nuclear Power, Energy Security, Safety Culture

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## Introduction

From its inception, nuclear power has been plagued by its legacy as a deadly instrument of war and the threat of nuclear fallout and contamination. Despite the shift toward the peaceful uses of nuclear energy over the years, there is considerable public opposition against it that far exceeds that faced by other sources of power. There certainly are human and environmental health concerns that would need to be addressed with regards to nuclear energy, most notably the risk of contamination from radioactive sources. However, the same can be said of the many other sources of energy, such as coal and oil, that can also inflict great harm to people and the environment, although they are more acceptable in society. As such, if nuclear power is to be expanded in the future, it must overcome this stigma and gain the public's trust. One way in which the nuclear industry is tackling the issue is by promoting itself as a source of clean energy and, with the pressing concerns of climate change, as a potential solution for the reduction of carbon emissions. In assuming this position, the conflict between the nuclear industry and the public image of nuclear gains a new moral dimension as nuclear power takes on the role of protecting the environment while being a potential source of harm to it as well.

How this conflict plays out is of particular importance for the future of nuclear power and can be best viewed from Southeast Asia (SEA) where many nations there are faced with the realities of a changing climate and also plan to develop their own nuclear power programs. How these nations consider the concerns of the public and environmental pressures as they move toward nuclear power has important implications for how it is viewed and used in the rest of the world. As such, this thesis

will evaluate the role of climate change in influencing the image and adoption of nuclear power in various SEA nations, such as the Philippines and Indonesia. In particular, it will attempt to answer the questions of why various SEA nations intend to adopt nuclear power, in what ways is climate change a motivating factor, and how does it affect the image of nuclear power. These questions will be addressed in the following chapters, the first of which explores the impacts of climate change on SEA and how compelling of an issue it is to the governments and people of the region. The chapter afterwards describes the socioeconomic situation of SEA and looks at how the region's nuclear ambitions fit within that context. Following that, is a discussion on public perceptions of and concerns regarding nuclear energy in the region and the ways in which it might be addressed to allow for the expansion of nuclear power production.

## Chapter I: The Impacts of Climate Change on Southeast Asia

Climate change, or global warming, is the phenomenon where global temperatures are rising due to an increase in atmospheric carbon dioxide (CO<sub>2</sub>). CO<sub>2</sub> is particularly potent at trapping heat, originally from the sun, that radiates off the surface of the earth. This is the reason why it is often referred to as a “greenhouse gas”. While it is beneficial at lower levels in that it keeps the planet warm and hospitable to life, high levels of CO<sub>2</sub> in the atmosphere can be potentially catastrophic as the consequent increase in global temperatures can disrupt weather patterns and ecosystems across the world, turning once hospitable environments into inhospitable landscapes for their current residents. Much of the increased atmospheric CO<sub>2</sub> comes from human activities, most notably being emitted by cars and from energy production. Fossil fuels, which release CO<sub>2</sub> when burned for energy, account for 85 percent of global primary energy production, with coal accounting for about 50 percent of the world’s electricity production (Rethinaraj pp. 72). This heavy dependence on fossil fuels has resulted in an increased release of CO<sub>2</sub> into the atmosphere, which has risen from 590 billion tons per year from pre-industrial times to 825 billion in 2010 (Rethinaraj pp. 73). In SEA, though the amount of CO<sub>2</sub> produced in the region is relatively low, being expected to be 4.2 tons per capita by 2030 compared to the 23 tons in the US, this would be a fourfold increase in greenhouse gas emissions in the region (Chutiprapat et al. pp. 114). While it is difficult to say that such an increase in the region would directly impact its climate, it nonetheless will contribute to the increase in atmospheric CO<sub>2</sub> around the world, the

effects of which would be more acutely felt in SEA as a consequence of the region's geography.

SEA largely consists of a number of island and coastal nations, of varying sizes, situated around the equator. Consequently, the region is susceptible to a number of climate-related hazards, such as tropical cyclones, floods, and droughts. These problems are exacerbated by the influence of climate change on the region and brings forth concerns over rising sea-levels that would need to be addressed as well. The frequency and severity of these environmental hazards are likely to increase so long as the effects of climate change are not reined in, though how impactful these changes are depends on a number of variables. A paper by Yusuf and Francisco in 2009 identified regions vulnerable to climate change based on their historical exposure to climate-related hazards, the human population density and the biodiversity there, and the adaptability of the region, based on socioeconomic, technological, and infrastructural factors. The idea is that areas that are most susceptible to the impacts of climate change would be those that have been frequently exposed to climate-related hazards, have high population densities, and do not have the infrastructure, technology, and/or socioeconomic resources to mitigate the effects of droughts, floods, or rising sea-levels. Regions were assigned values between 0 and 1 according to their degree of climate change vulnerability, where 0 indicates that a region is not very vulnerable or can easily recover from climate-related hazards and 1 indicates that a region is very vulnerable or cannot easily recover. A map (Figure 1) was generated to allow the vulnerability ratings to be easily viewed.

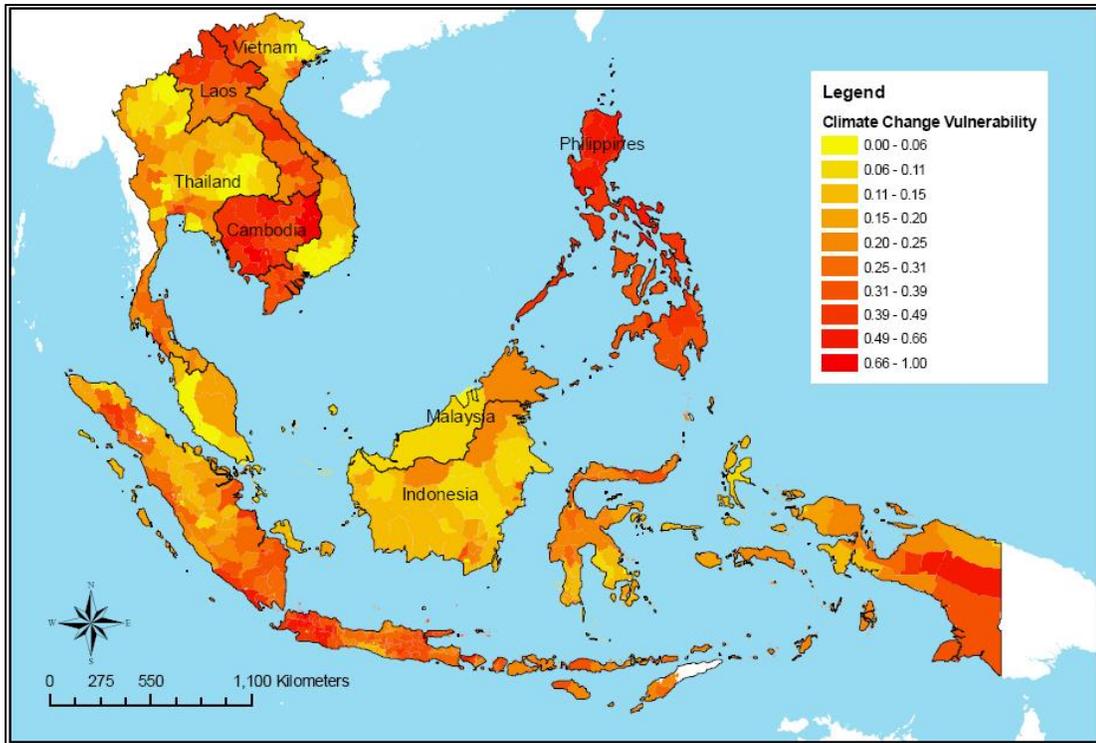


Figure 1: Map of climate change vulnerability in the SEA region (Yusuf and Francisco pp. 11).

As the map shows, much of SEA is vulnerable to the effects of climate change, albeit to different extents. The areas that are most susceptible to climate change include the northern part of the Philippines (the National Capital Region being the seventh most vulnerable in SEA), much of Cambodia (the regions of Mondol Kiri, Rotanakiri, and Kampong Spoe being the fourth, sixth, and eleventh most vulnerable) and Jakarta in Indonesia, where Central, North, and West Jakarta are the three most vulnerable areas in SEA (Yusuf and Francisco pp. 21-23). For most of the locations, such as the National Capital Region and Jakarta, the main reason for their vulnerability to climate change stems from a combination of high population density and susceptibility to relatively frequent floods, cyclones, and droughts among other environmental hazards, though parts of Cambodia are vulnerable mostly due to their low adaptability (Yusuf and Francisco pp. 13). Although the most vulnerable parts of

the Philippines and Indonesia have high adaptive capacities, the issue is that they simply are not large enough to sufficiently mitigate the impacts of climate change.

Not all parts of SEA are at great risk, but significant portions of it are vulnerable to climate-related hazards that would be exacerbated by increased CO<sub>2</sub> in the atmosphere, notably those highly populated regions around the capitals of the Philippines and Indonesia, as well as areas of high biodiversity, such as Cambodia. As such, it could be argued that there is sufficient pressure on SEA nations to encourage them to take actions on climate change. For the most part, it seems that that has begun to occur for, during the third annual East Asia Summit in 2007, a number of SEA nations issued the “Singapore Declaration on Climate Change, Energy, and the Environment”, which expressed their desire to address the increase in CO<sub>2</sub> emissions through improved energy efficiency and the use of cleaner sources of energy, such as nuclear power (Chutiprapat et al. pp. 115). This sentiment continues to be expressed as many SEA nations are still looking to ease their dependence on fossil fuels and have shown interest in the development of nuclear power programs in the region. While this seems to indicate that climate change is having a positive effect on the development of nuclear power in SEA, it would be rash to jump to such a conclusion without considering the socioeconomic factors that largely drive the need for sources of energy.

## Chapter II: Nuclear Power and Socioeconomics in Southeast Asia

The SEA region has been experiencing economic growth over the past few years and, barring some economic disaster, it is expected to continue in the future as the region develops. Since 2000, the economies of SEA nations have been growing at a rate of 5-6% per year with an 18% and 37% annual increase in trade and investment in the region respectively (Chutiprapat et al. pp.113). Additionally, the region is seeing an increase in urbanization with rates projected to grow to 59% in 2035 from 45% in 2011, meaning that there would be an increase in the SEA urban population to a total of 165 million people (Putra pp. viii). As a result of this economic growth and urbanization, there is also an expectation that energy consumption and demand would increase as well. For instance, the electricity demand in Indonesia was at 40 gigawatt-electric (GWe) in 2011, but it is expected to increase to 90 GWe in 2025 and 400 GWe in 2050 (Putra pp. x). This follows the trend identified by the Asia Development Bank which predicts that the demand in all of Asia for electricity generation would roughly triple from 275.6 million tons of oil equivalent (MTOE) to 936.2 MTOE from 2000 to 2030 (Basrur et al., “Nuclear Energy” pp. 4). Consequently, there is a need to increase energy production and improve energy security in SEA, but that might be difficult in a region that depends heavily on fossil fuels for energy.

In Thailand, Indonesia, and the Philippines, coal and oil make up over 50% of the nations’ energy profiles with other SEA nations having smaller, but still significant, portions of their profiles made up of fossil fuels (Putra et al. ix-xi). Beyond the concerns regarding increased greenhouse gas emissions, and the exacerbation of climate-related hazards in the region, from having to meet greater

energy demands if SEA nations continue to depend on fossil fuels, there are economic pressures that are encouraging them to look for alternative sources of energy. Much of the fossil fuels that the region depends on is imported, which means that the energy security of SEA is vulnerable to geopolitics and domestic problems within oil-exporting nations (Cook and Jamil pp. 1-2). This was particularly evident when spikes in oil prices in 2008 strained economies around the world to the point that it threatened national security (Keling et al. pp.181). As such, many SEA nations are looking for alternative sources of energy, such as nuclear, to ease their dependence on fossil fuels and to strengthen their energy security.

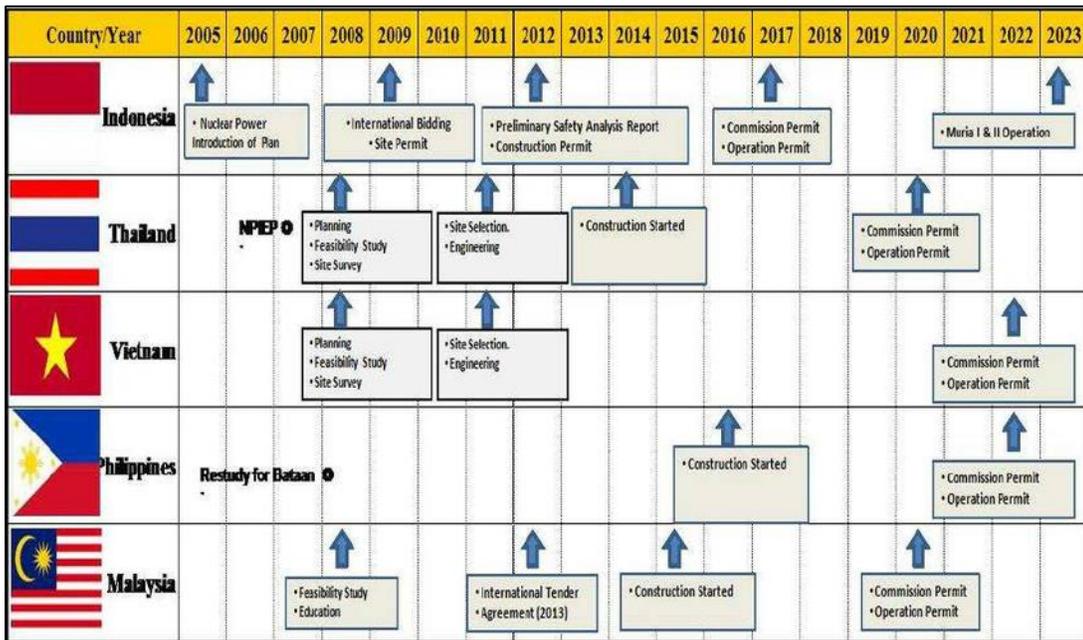


Figure 2: Timeline of nuclear power programs for SEA nations (Chutiprapat et al. pp. 117).

A number of SEA nations have expressed interest in and have developed plans for the introduction of nuclear power into their energy profiles (Figure 2). Vietnam, for instance, planned to build eight 1000 MW nuclear power plants (NPP) by 2030 (Basrur et al., “Nuclear Energy” pp. 12). Additionally, Indonesia planned to build

four NPPs by 2024, Thailand planned to build five also by 2030, and the Philippines and Malaysia are studying the nuclear energy option (Cook and Jamil pp. 2-3). The reasons for adopting nuclear power, as indicated earlier, mainly have been economic and driven by concerns over energy security as SEA nations seek to meet growing energy demands in a world where reliance on fossil fuels is unsustainable. Nuclear energy is very efficient as the energy contained in a kilogram of processed uranium is equivalent to 3,000 tons of coal or 14,000 barrels of oil (Rethinaraj pp. 75). This translates to a high cost-efficiency as nuclear costs about 1.76 cents per kilowatt hour compared to the 2.47 cents for coal, 6.78 cents for natural gas, and 10.26 cents for oil (Chutiprapat et al. pp. 114). With other alternative sources of energy being insufficient to meet future energy needs or being less cost-effective for SEA nations in their current state, nuclear is quite appealing and even more so in light of the fact that Northeast Asian nations have been willing to export their nuclear technologies and expertise to their southern neighbors, perhaps as a means of expanding their influence in SEA (Cook and Jamil pp. 8).

However, in the wake of the Fukushima incident in 2011, wherein a 9.0 magnitude earthquake off the eastern coast of Japan triggered a massive tsunami that devastated the region and led to a nuclear meltdown and the release of radiation from the Fukushima NPP, much of the momentum for the development of nuclear power in SEA has been diminished, but not entirely erased. The incident certainly forced the governments of SEA nations to temporarily pause and slow down their nuclear ambitions so as to better address concerns over safety with NPPs, but the complete exclusion of nuclear energy from the energy profiles of SEA nations is

unlikely to occur because the benefits outweigh the costs in the long term (Basrur et al., “Post-Fukushima” pp. 195-197). There are some environmental benefits that come with the adoption of nuclear power as a greater dependence on it would mean less dependence on fossil fuels and, thus, less greenhouse gas emissions from energy production. This has been an argument used to promote nuclear power in the region, as noted in the previous chapter, but concerns over climate change, though sincere to a degree, seem to be mostly rhetoric to help persuade a skeptical public. As this chapter has laid out, there are plenty of socioeconomic factors that make nuclear energy enticing for SEA and they seem to be more compelling than a desire to combat climate change. SEA nations are intent on diversifying their energy sources to ensure that they can sustain their economic growth and secure their prosperity in the future—a goal that they believe can be achieved through nuclear energy. The benefit of cutting carbon emissions is consequently a byproduct of a shift toward nuclear in the region and not the main reason for the change. Yet, while SEA governments are still supportive of nuclear, albeit not necessarily for combating climate change, the public remains skeptical of nuclear power and its expansion in SEA. The next chapter will explore whether concerns over climate change have influenced their views on nuclear in some way.

### Chapter III: Nuclear Power in the Eyes of Southeast Asia's Public

Much like in the rest of the world, the public in SEA is guarded when it comes to the expansion of nuclear power, though it does vary depending on the region. In 2014, for example, the Malaysian government faced stiff opposition from the public who wanted the operations of a rare earth refinery halted as the plant stores radioactive materials which could spread and be a health risk for residents nearby (Putra pp. xv). The Philippines government faced similar opposition in 2012 when they announced that they were considering restarting the nation's nuclear energy plans (Putra pp. xv). In Thailand, there is a mix of acceptance of nuclear power amongst the public, but that differs depending on whether people are referring to the country as a whole, as 32% of the public disagreed with the development of nuclear in Thailand, or to specific parts of the country, as 66% disagreed with development within their communities (Chutiprapat et al. pp. 119). Meanwhile, public acceptance of nuclear power has been increasing in Indonesia as it was at 53% in 2012 and had increased to 72% in 2014 (Putra pp. xv). Similarly, the public in Vietnam is accepting of nuclear, though it seems that that was the result of socialization initiatives, that the Indonesian government also implemented, which sent community members to visit nuclear power plants in Japan and learn about how they operate and could impact their communities (Cook and Jamil pp. 3). Yet, despite rising acceptance in some parts of SEA, it is clear that there are concerns with nuclear that still need to be addressed in order to make it more palatable to the rest of the SEA public.

The most obvious concern is the risk of contamination from radioactive materials and the subsequent health outcomes that could result from exposure. With

the Chernobyl and Fukushima accidents, there is understandable concern over the possibility of a nuclear accident happening at other NPPs. While such accidents are few and far between and the nuclear industry has had a good track record when it comes to safety around the world, it is difficult to assume that nuclear power would be just as safe in a region that is just getting its feet wet with the technology and has had a history of poor management. Take for example the plan by the Philippines' government to build an NPP in Morong, Bataan in 1976, where opposition against the plant stymied the development of nuclear power in the Philippines even to this day. Beyond concerns over the siting of the plant—which is often the public's main concern when it comes to nuclear power and is particularly important to consider for island nations on the Ring of Fire—there were issues with the plant's construction wherein there was inadequate safety features in the design and potential corruption in the deal with the Westinghouse Corporation to build the facility (Magno pp. 160-161). This event catalyzed the formation of strong public opposition toward nuclear power in the Philippines and strong public support for renewable energy, which is said to be safer and does not generate wastes like nuclear (Caballero-Anthony et al. pp. 180). The result is that the Bataan NPP has been left in a state of limbo as the government is seeking to restart the plant to further its goal of diversifying the Philippines' energy profile, but public opposition has often swayed the government to delay its plans (Caballero-Anthony et al. pp. 179).

In another incident involving a rare earth refinery, albeit in the 1980's, in Malaysia, the plant had poor safety and environmental practices as it openly dumped radioactive thorium near populated areas (Tay and Paungmalit pp. 103). Needless to

say, there was much public outrage as workers were receiving doses greater than international limits and there were reports of increased incidences of leukemia, birth defects, and infant mortality, which eventually led to the closing of the plant in 1993 (Tay and Paungmalit pp. 103). Similarly, poor operating practices in Thailand led to 1000 students and teachers contracting illnesses and needing to be hospitalized from inhaling toxic emissions, such as benzene, from the nearby Map Ta Phut Industrial Estate (Tay and Paungmalit pp. 103). Studies of the emissions found that they tended to be at levels 3000 times greater than the safety standards of developed nations and, in 2009, injunctions were issued to 65 projects in the Map Ta Phut Industrial Estate (Tay and Paungmalit pp. 103). These incidents undoubtedly raise concerns over the ability of SEA governments to properly manage industries in a manner that ensures the safety and safeguards the health of the public, which is particularly problematic for the expansion of nuclear power in the region. If confidence is low amongst the public in their governments' ability to properly manage a rare earth refinery or a chemical plant, it is unlikely that they will be confident that the management and operation of NPPs would be done differently from the other industries in SEA.

Trust is even harder to come by in the aftermath of Fukushima as, while the accident reconfirmed people's concerns over the dangers that come with the operation of NPPs, it also highlighted just how unprepared SEA is for nuclear. Japan has often been lauded as having the best safety culture of any nation in the world and its nuclear industry was the shining example of a safe and successful nuclear power program (Putra pp. xiv). However, the Fukushima incident shattered that image and has largely dashed people's confidence in safe nuclear energy for they believed that,

if the Japanese were unable to prevent the meltdown and release of radioactivity in Fukushima, then it is unlikely that any other nation would be able to do any better when it comes to safely operating NPPs. Consequently, a large portion of the SEA public remains opposed to nuclear as the risks appear greater in the region than in other places in the world, for there is the lack of a safety culture that would ensure the safe operation of nuclear power there.

## Conclusion

The purpose of this thesis was to determine if the pressures of climate change have had any effect on the adoption or acceptance of nuclear power in SEA. Having explored the climate vulnerability of the region, the status of SEA's socioeconomics and nuclear programs, and the nature of public opposition toward nuclear, it is quite apparent that climate change has had little effect on encouraging SEA nations to adopt nuclear power. With some of the most populated parts of SEA being the most vulnerable to the effects of climate change, there is pressure to curb greenhouse gas emissions to prevent or mitigate their impact on the environment. Many have voiced the desire to reduce dependence on fossil fuels to achieve that goal and nuclear has often been suggested as the best solution for the region. However, the desire for cutting atmospheric CO<sub>2</sub> is more of a confounding factor when it comes to discerning the true intent of SEA policymakers' desire for nuclear energy—a fact that becomes apparent when one digs into the socioeconomics of the region.

SEA is experiencing a great deal of growth with regard to economics, population, and urbanization. Consequently, in order to fuel and sustain that growth, there is the need for an energy profile that would be able to efficiently generate electricity in a cost-effective manner. With parts of the region dependent on fossil fuels and their import for energy, which is harmful to the energy security in SEA as their prices are subject to change, many policymakers are looking toward nuclear energy to provide the stability they desire. Meanwhile, although the public is more attuned to the environmental problems of the region, concerns over climate change are not directly translating into support for nuclear either. The risk of radioactive contamination is still a problem and, with the questionable safety culture in SEA and

the Fukushima accident relatively fresh in the minds of many, the public is not inclined to support nuclear power, especially with the existence of safer, green alternatives like renewable energy.

Clearly, if nuclear energy is to be expanded in SEA, it will take more than just concern over high levels of atmospheric CO<sub>2</sub> to sway people to change their minds. What needs to be changed is the safety culture and the relationship between the governments and their people. Looking at nuclear energy programs in other parts of the world, there is evidence to suggest that, despite the ongoing issues of waste and cases of radioactive emissions, NPPs can be operated safely. However, those safe operations are contingent upon a dedication to a strong safety culture, which is unfortunately lacking in parts of SEA as various industries pollute and dump wastes however they see fit without concern for the health of those who would be affected. As such, it should come as no surprise that people in SEA are wary of having NPPs operate in or near their communities, since it is likely they will be receiving unhealthy doses of radiation from improper management and operations.

Fixing the safety culture in the region would address perhaps the most important element of a nuclear power program—trust. One can point to the facts about how safe nuclear energy can be and make promises about a commitment to safety, but unfortunately, without a sufficient degree of trust between a government and its people, such claims would have little impact in changing people's minds. Trust is not only important to the nuclear ambitions of SEA, but to those of other nations around the world for trust in the safe operation of NPPs would translate into greater acceptance of them into people's communities. Given that the planning and

operation of NPPs tends to have a degree of secrecy surrounding them, in consideration of safety concerns, there is a lack of transparency that would help strengthen people's trust in nuclear power. If people have a better idea of what is going on in their communities while a NPP is in operation, though such transparency could shut out nuclear from the start, it could help people better understand the risk they are taking in having nuclear power and how that risk is being controlled. Therefore, greater acceptance of nuclear will require a sufficient degree of transparency that will allow people to trust in nuclear energy and the people whose job it is to manage it safely. How much transparency is needed is hard to say as too much transparency can be just as harmful, if not more so, than a lack of transparency, but that is a topic for another time.

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