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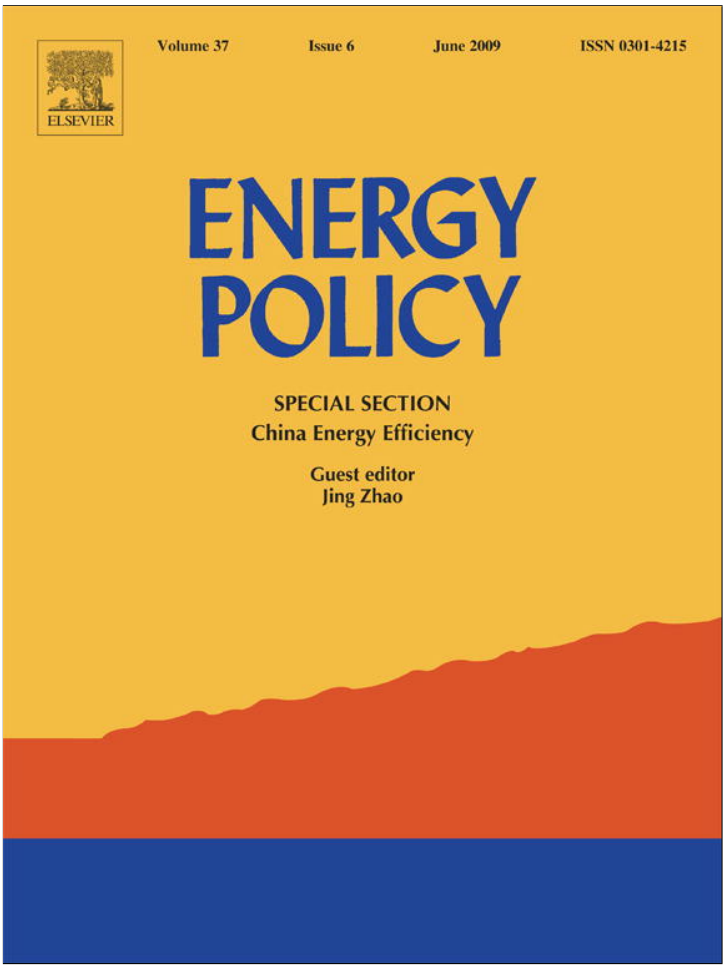

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Energy policy and cooperation in Southeast Asia: The history, challenges, and implications of the trans-ASEAN gas pipeline (TAGP) network

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ABSTRACT

This article explores the proposed multibillion dollar Trans-ASEAN Gas Pipeline (TAGP) network in Southeast Asia, focusing on the interests that have promoted the TAGP and why. Based on extensive field research, textual analysis of government reports, and more than 100 research interviews at government institutions, multilateral development banks, universities, consulting firms, energy companies, and nongovernmental organizations, this article assesses the challenges facing the TAGP in terms of promotion, implementation, and operation. It explores the genesis of the TAGP project and the drivers pushing Southeast Asian investment in natural gas, with a special emphasis on the development needs of the region. It also investigates the numerous technical, economic, legal, political, social, and environmental impediments to the TAGP project. The article concludes that the rhetoric of regional energy cooperation touted by the Association of Southeast Asian Nations (ASEAN) does not match its actual practice, and that in many cases discussions of regionalism and energy security are intended to obscure opportunistic thinking within individual countries.

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1. Introduction

Southeast Asia faces a set of interconnected yet fundamental energy policy dilemmas. The region's industrializing economies, intensifying levels of rural migration into urban areas, and an expansion of the middle class have created an unprecedented demand for energy and electricity services (Roberts and Cull, 2003). This is occurring amidst rising demand for energy fuels from the region's East Asian neighbors, China, Japan, and Korea, and other parts of world. Average energy use per capita for all of Asia remains quite low—about 0.61 metric tons of oil equivalent per person—compared to 1.10 for China, 1.69 for the world at large, and 4.67 for countries belonging to the Organization for Economic Co-Operation and Development (Asian Development Bank, 2006). Indeed, as of 2005, only 55% of the population in Indonesia, 60% of people in Lao and Cambodia, 71% of citizens in Vietnam, and 82% of Thailand's population had access to electricity (ASEAN, 2007).

By 2030, the share of the world's population living in developing regions such as Southeast Asia will likely reach 81%. As the International Energy Agency reports, in developing Asian countries, an average growth rate of 3% is projected for energy use compared with 1.7% for the entire global economy (IEA, 2007). Energy demand is thus expected to double in Asia in the next 20 years, and according to projections, this increase in regional demand will account almost 40% of the world total (Jaffe, 2004). Policymakers, however, face geographic and political challenges to developing and transporting the region's consolidated oil and gas reserves from their remote locations to those urban centers of production and consumption where they are needed most. The economic geography of Southeast Asia is highly uneven and while the region has a greater population as a whole than North America, its coal, oil, and gas resources are unevenly distributed, as are the pockets of urbanization dependent on such fuels.

The challenge of energy development and distribution is rivaled by the difficulties associated with improving energy security and protecting the environment. Southeast Asia is home to thousands of low-lying islands comprising major portions of Indonesia and the Philippines that are extremely susceptible to rises in sea level induced by climate change. Some countries, such as Brunei and Singapore, import more than 90% of their fuels for electricity generation and transportation. The region's experience with natural disaster has also placed significant pressure upon the maintenance of existing energy infrastructure and, in particular, upon fragile energy supply lines and brittle transmission and distribution networks (Sadasivan, 2007). It is current "industry wisdom" that it takes two years to connect energy resources within an Asian country, ten years to connect resources between two countries, and "a miracle" to create a multi-cross-country network of distribution involving more than two countries (Schenk, 2007).

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Countries within the region and the regional organizations that they are members of are starting to focus on these dilemmas. The Association of Southeast Asian Nations (ASEAN), a multilateral organization consisting of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam, has announced plans to construct an integrated natural gas pipeline network to connect the gas reserves in the Gulf of Thailand, Myanmar, and Indonesia to the rest of the region. Dubbed the Trans-ASEAN Gas Pipeline Infrastructure Project, or TAGP by its proponents, it would be one of the first of its kind in the world: a multibillion dollar series of natural gas pipelines spanning ten countries to connect a population of 677 million people spread across 4.5 million square kilometers of land (ASEAN, 2008). Eventually, some advocates of the TAGP have argued that the network could connect with gas markets in China, Japan, and India, making it the largest pipeline network in the world, one constituting $93.6 billion worth of investment (in 2007 US dollars) (Ohli, 1994).

Such a massive project, however, faces a number of constraints and challenges. Are natural gas reserves plentiful enough to support billions of dollars worth of investment in future pipelines? Would such a network contribute to regionalism and cooperation within Southeast Asia or could it contribute to conflict and contempt? Even if such a project was proven to be technically feasible, is it economically and politically viable, let alone desirable?

With these questions in mind, this article explores the interests that have promoted the TAGP and why. Based on more than 100 research interviews at government institutions, multilateral development banks, universities, consulting firms, energy companies, and nongovernmental organizations; drawing upon field research in Indonesia, Japan, Malaysia, Philippines, Singapore, and Thailand; and utilizing extensive textual analysis of reports and articles, this article assesses the challenges facing the TAGP in terms of promotion, implementation, and operation. It explores the genesis of the TAGP project and the drivers pushing regional investment in natural gas. It investigates the remaining impediments to a TAGP network and offers some preliminary conclusions about what the TAGP tells us about energy policy and regional cooperation within Southeast Asia. The importance of such an exploration is threefold.

First, and most generally, focusing on natural gas and its associated transportation infrastructure in Southeast Asia provides an excellent lens through which to explore the dynamics of regional energy policy and a host of energy-related issues. Relationships between cross-border suppliers, trade flows, economic development, and regional security all revolve around the basic allocation of energy resources. Further to this, the production of natural gas is intimately tied to important social and political conditions, such as human health and safety, preservation of the environment, and societal development more generally. For those wishing to better understand the Southeast Asian energy environment, a discussion of the TAGP offers a useful picture of the way in which intra-regional gas infrastructure has been promoted by ASEAN in an attempt to manage natural resources in the interests of regional energy security and economic development. As we traverse this terrain, we necessarily consider how the impact of energy industry liberalization, the competitiveness of the region's natural gas markets, and topography of the region's energy sector affect and are affected by a project such as the TAGP.

Second, the prospects and challenges inherent with the TAGP provide insight into the difficulties associated with large-scale, multilateral projects at large. The Asian Development Bank (ADB) reports that at least 33 large infrastructure projects totaling US$9.9 billion are currently being constructed in the region, including cross-border highways and transport corridors, airports, railways, hydroelectric facilities, hospitals, roads, and ports (Jude, 2008). Outside of the region, in the energy sector specifically, the International Energy Agency expects that trillions of dollars are set to be invested in large-scale infrastructure for the next twenty years, including proposals for transnational and interstate pipeline projects in North America, Europe, Africa, and the Caspian Sea (IEA, 2006). The Southeast Asian experience with the TAGP illuminates some of the challenges that *all* types of large-scale, transnational projects, in Southeast Asia and beyond, may face.

Third, and most narrowly, an investigation of the challenges facing the TAGP helps gauge the depth of regional cooperation evident in Southeast Asia and the potential for shifts in the region. In addition to the TAGP, ASEAN has announced plans for a series of ambitious transnational infrastructure projects in excess to the ones being touted by ADB: an integrated electricity grid, a telecommunications network, a trans-ASEAN highway, and a variety of other proposals. Focusing in particular on the TAGP provides useful insight into how likely (or unlikely) genuine cooperation may be on these projects, and to whether ASEAN's rhetoric of regional cooperation holds up under scrutiny.

2. The genesis the TAGP

Indonesia, Malaysia, the Philippines, Singapore, and Thailand founded ASEAN on August 8th, 1967. With the specter of communism lingering during the early 1970s, ASEAN members quickly adopted two treaties to foster greater economic cooperation, the Treaty of Amity and Cooperation in Southeast Asia and the Declaration of ASEAN Concord, both signed in 1976 at the Bali Summit. Since then, ASEAN has doubled in size to include Brunei (1984), Vietnam (1995), Laos (1997), Myanmar (1997), and Cambodia (1999). Taken together, the ASEAN region is home to about 10% of the world's population and encompasses economies that produce $1.1 trillion in combined gross domestic product annually and annual total trade revenues of about $1.4 trillion (ASEAN, 2007, 2008).

As an organization, ASEAN has two stated objectives: to accelerate economic growth and development in the region, and to promote regional peace and stability through cooperation. Dammen (2007), the ASEAN Deputy Secretary-General, stated that ASEAN's vision was to create a concert of nations looking outward, living in peace, stability, and prosperity, bounded together in economic partnership. He sees ASEAN's biggest task as promoting a single, unified Southeast Asian economic market and production base, home to a free flow of goods, services, investment, and capital much like the European Union, though perhaps without its central government and extensive administrative capacity.

In terms of energy policy, the Organization of Petroleum Exporting Countries (OPEC) oil embargo of 1973 convinced ASEAN to create a petroleum council in 1975, and since then ASEAN has established four offices that manage 17 programs exclusively dedicated towards promoting and coordinating energy research and addressing energy-related problems (see Fig. 1 for a depiction of ASEAN's energy programs). The ASEAN energy policy vision is closely aligned with the overall missions of the organization: to create a regional, harmonized framework of energy supply that utilizes commodities of coal, oil, natural gas, and electricity to promote industrialization and economic growth (Symon, 2008; Thomson, 2006). While the idea of energy cooperation was explored in 1975 and the possibility of a regional, interconnected natural gas network was discussed by individual members of

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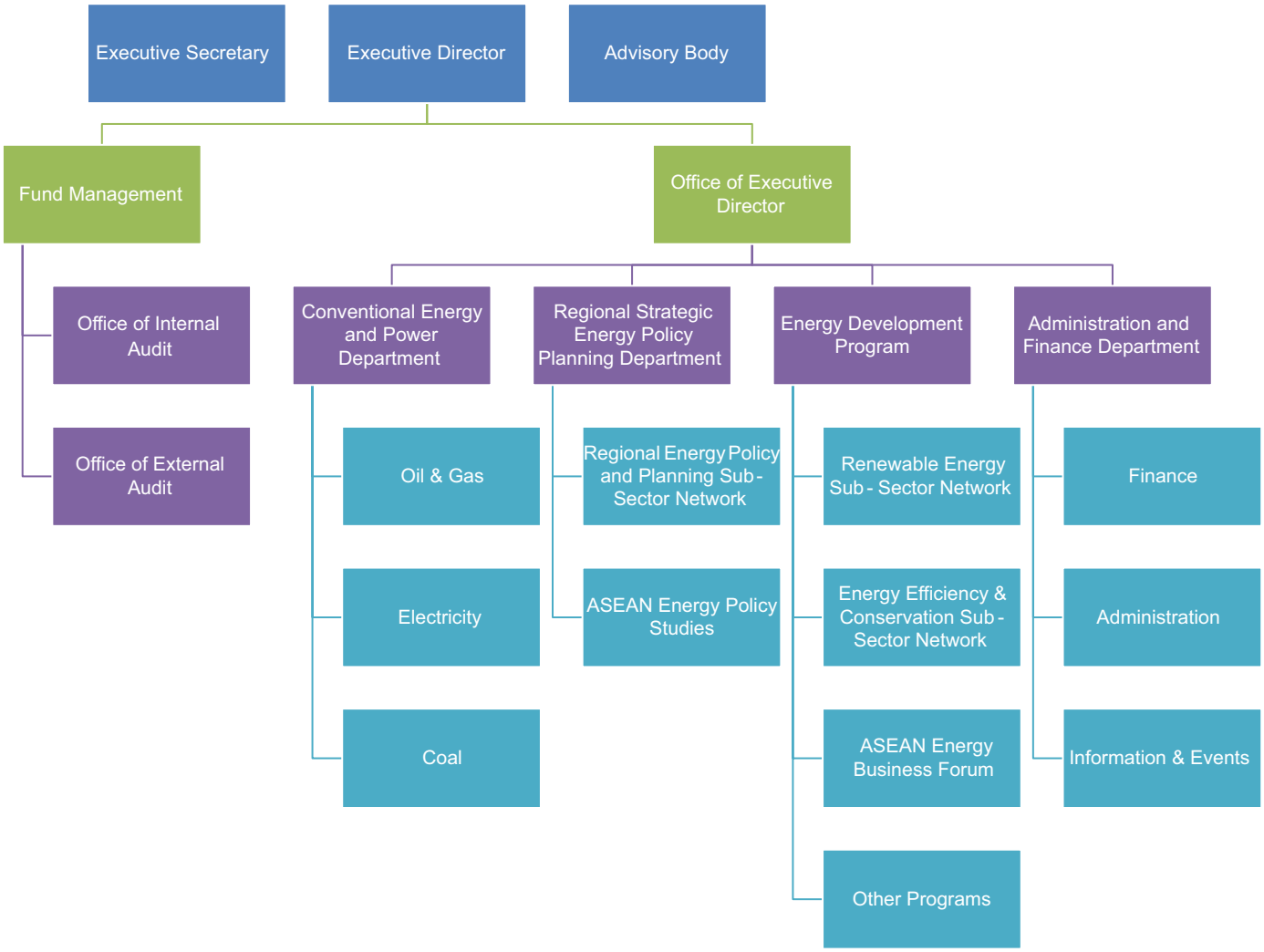

Fig. 1. ASEAN's Energy Policy Organizational Structure. *Source*: modified from ASEAN, ASEAN Energy Center Organizational Chart (Jakarta: ASEAN, April 19th, 2006).

ASEAN as early as 1986, formal plans for the TAGP were not announced until 1990, feasibility studies were not undertaken until 1998, and a compact between member states not reached until 2002 (see Table 1 for a chronology of the TAGP project).

According to our calculations, as of 2008 ASEAN members have built no less than 10 cross-border gas pipelines costing $14.2 billion traversing 3952 km to transport 3095 million cubic feet (mcf) of gas per day. On the horizon are at least six other projects expected to be commissioned and operating by 2016 (Symon, 2006; Roberts and Cull, 2003). The TAGP master plan, as most recently articulated by ASEAN, identifies at least seven new gas interconnections above and beyond those already being discussed. TAGP proponents plan to interconnect centers of demand for natural gas–notably Bangkok, Thailand; Kuala Lumpur, Malaysia; Singapore; Batam, Indonesia; Jakarta, Indonesia; Surabaya, Indonesia; and Manila, Philippines–with pipelines harvesting the gas fields of the Andaman Sea, the Gulf of Thailand, the South China Sea, West and East Natuna, and Kalimantan and Sumatra in Indonesia. (See Table 2 for a complete list of cross-border gas pipelines in Southeast Asia; see Fig. 2 for a depiction of how the TAGP will look once finished.)

If completed, the TAGP would be a truly massive project. While not all of them would necessarily be part of the TAGP, in Indonesia alone more than 3588 km of new pipelines would need to be constructed to connect the islands of Sumatra, Java, and Kalimantan. For the network as a whole, financial consultants estimate that the TAGP could need as many as 5100 km of interconnected pipe and at least $16 billion of further investment, with even more investment required for the network to connect with China and Japan.

3. Factors pushing TAGP investment

Why, specifically, have Southeast Asian countries already invested about $14 billion to construct 4000 km of pipelines, and why has ASEAN endorsed investing billions more? Basically, promoters tend to cite four interconnected justifications for the TAGP.

3.1. Economic development

At the top of the list comes electrification and economic development. International development agencies often see electricity as crucial to meeting the primary development challenge of providing adequate food, shelter, clothing, water, sanitation, medical care, education, and access to information.

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Table 1
Chronology of the Trans-ASEAN gas pipeline (TAGP).

Date	Location	Description
October 15th, 1975	Jakarta, Indonesia	ASEAN creates a Petroleum Council to focus on regional energy issues and lay the groundwork for future collaboration on oil and gas sharing
September 29–30th, 1980	Bali, Indonesia	ASEAN holds its first meeting of "Economic Ministers on Energy Cooperation," discussing energy cooperation within ASEAN and between ASEAN and other countries
June 24th, 1986	Manila, Philippines	ASEAN signs a Petroleum Security Agreement committing leaders to increased cooperation to develop regional energy resources, setting the stage for future integrated action on energy policy
November 15–16th, 1990	Manila, Philippines	ASEAN announces the concept of the TAGP at the Ninth Meeting of the ASEAN Economic Ministers on Energy Cooperation
December 15th, 1995	Bangkok, Thailand	ASEAN signs an Agreement on Energy Cooperation to promote "greater security and sustainability of energy supply through diversification, development and conservation of resources, the efficient use of energy, and the wider application of environmentally sound technologies"
December 15th, 1997	Kuala Lumpur, Malaysia	ASEAN adopts the ASEAN Vision 2020, which includes provisions for the TAGP at the Second ASEAN Informal Summit
October 7th, 1998	Hanoi, Vietnam	ASEAN calls for a feasibility study of TAGP and possible implementation by 2004 at the Sixth ASEAN Summit
July 3rd, 1999	Bangkok, Thailand	ASEAN establishes ASCOPE and creates a TAGP task force at the Seventeenth ASEAN Ministers of Energy Meeting
July 5th, 2002	Bali, Indonesia	ASEAN signs a memorandum of understanding binding ASEAN countries to construct the TAGP at the Twentieth ASEAN Ministers of Energy Meeting. ASEAN countries agreed to (1) assess financing options of the pipeline network; (2) harmonize design and construction standards; (3) arrange for effective and stable contracts for natural gas transit; (4) promote measures to physically protect existing pipelines from attack and accident; (5) mitigate the risk of pipeline spills and environmental damage; (6) discuss acceptable transit rights for the flow of natural gas; (7) negotiate acceptable taxes and tariffs; (8) explore coordination efforts relating to pipeline abandonment; and (9) determine jurisdiction and responsibility over pipeline corridors, particularly on the high seas
November 26th, 2004	Ho Chi Minh City, Vietnam	ASEAN mentions TAGP as a central pillar of their energy plan in discussions with China, Japan, and South Korea
January 15th, 2007	Cebu, Philippines	ASEAN announces the "Cebu Declaration on East Asian Energy Security" at the East Asian Summit which, among other things, reaffirms ASEAN's commitment to the TAGP

Electricity supports lighting, communication, transport, commerce, manufacturing, and industry. It can enable refrigerated vaccines and emergency and intensive health care, and the pumping of clean groundwater for drinking and irrigation, increasing agricultural productivity. The lack of electricity is particularly damaging to women and children, whom are usually responsible for food preparation and cooking. Without electricity, they are typically forced to spend significant amounts of time searching for firewood for cooking and heating needs (Sovacool, 2006). Electricity makes so many things possible that some have even viewed its provision as a fundamental human right (Bradbrook and Gardam, 2006).

Because Southeast Asian countries possess moderate natural gas reserves, many within ASEAN see it as the region's most important energy resource for power generation. It is the region's most abundant fossil fuel, and it is versatile, since it can be used for cooking and air conditioning, motor vehicles, industrial processes, and space heating (Symon, 2007). While coal is cheaper to mine, coal transport poses a challenge given that existing rail routes are prone to congestion and the archipelagic nature of Indonesia and the Philippines makes constructing new transport corridors difficult (Symon, 2004).

The construction of pipelines, too, is seen as a catalyst for economic development. ASEAN officials have stated that pipelines "open up regions for development" and have "spillover effects into downstream industries" such as factories, chemical and fertilizer facilities, and refineries that have incentives to locate themselves close to sources natural gas supply. Numerous other "value added" industries, such as those that need any type of process heating or rely on expensive and polluting feedstocks such as napthene, can also utilize natural gas instead. As the director of one research institute put it, "from a pipeline hosting country perspective, interstate gas pipelines undeniably contribute to its economy, increase country's political role and influence in the region, affect the livelihoods of indigenous people and support economic development plans which are necessary for local people employment and prosperity."

3.2. Foreign exchange

Natural gas and pipelines are also seen as mechanisms that enable governments to earn foreign exchange on the global market. Indonesia, for example, is already the world's largest exporter and producer of liquefied natural gas (LNG). In 2006, the country produced 73.6 billion cubic meters of LNG and was responsible for 23% of world LNG exports and 33% of exports in the Asia-Pacific market, with Japan, South Korea, and Taiwan importing most of it. Malaysia comes third (after Algeria) in LNG production at 48.1 billion cubic meters and operates the world's largest liquefaction center at Bintulu, and Brunei operates one of the largest liquefaction terminals in the world at Lamut with an annual capacity of 351 billion cubic feet (US EIA 2003; APEC, 2006).

As government officials within one large ASEAN member put it, "governments are incentivized to promote natural gas development because of the much-needed revenue those projects can provide." In the Philippines, for example, the government gets 60% of all revenue from natural gas projects jointly developed with international energy corporations, such as Shell and British Petroleum for the Malampaya and Camago natural gas fields. Given that ASEAN has a reported 325 trillion cubic feet of natural gas–about 6% of the *global* total–and many of its members believe they have enough to satisfy domestic needs *and* produce significant exports on the world market (Embassy of the United States and the US EIA, 2003) (see Table 3).

Even a decade after the Asian Financial Crisis, frontline countries such as Indonesia, Malaysia, Philippines, and Thailand are still underperforming compared to what the multilateral development banks project they should be. The rate of physical capital accumulation has "plummeted," and relative to the period before the crisis, average economic growth has fallen by about 2.5% every year (Asian Development Bank 2007; Asian Development Bank Institute 2007). There is thus a significant amount of pressure from the international finance community to reverse

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Table 2
Operational Cross-border natural gas pipelines in Southeast Asia.

Date	Name	Origin	Destination	Length (km)	Cost ($USD)	Volume (mcf/day)	Operator (s)	Contract/Value
1991	Telok Kalong-Segamat-Singapore	Telok Kalong, Malaysia	Singapore	714	$1.4 billion	150	Petronas (Malaysia)	20 years
1998	Yadana-Ratchaburi	Yadana, Myanmar	Ratchaburi, Thailand	649	$1.2 billion	200	TotalFinalElf (operator, France), Unocal (now Chevron, U.S.), PTT (Thailand), and MOGE (Burmese Government)	30 years
2000	Yetagun-Myanmar	Yetagun, Myanmar	Ratchaburi, Thailand	340	$800 million	260	Premier Oil (operator, United Kingdom) Petronas (Malaysia), MOGE (Burmese Government), Nippon Oil (Japan), and PTT (Thailand)	15 years
2001	West Natuna-Singapore	Southwest Natuna, Indonesia	Singapore	640	$5.7 billion	325	SembGas (Singapore) and Pertamina (Indonesia)	22 years, $8 billion of gas, take-or-pay
2001	West Natuna-Duyong	West Natuna, Indonesia	Duyong, Malaysia	96	$900 million	250	Petronas (Malaysia), ConocoPhillips (U.S.), and Pertamina (Indonesia)	20 years
2001	South Sumatra-Singapore	Asamera gas fields near South Sumatra, Indonesia	Singapore	500	$832 million	325	Singapore Power (Singapore) and Pertamina (Indonesia)	20 years, $9 billion of gas, take-or-pay
2003	Grissik-Batam-Singapore	Grissik, Indonesia	Singapore	460	$607 million	150	PGN (Indonesia)	20 years, $6.1 billion worth of gas
2005	Duri-Melaka	Suban, Santos Bentu PSC, and Jambi-Megang gas fields to Duri, Indonesia	Melaka, Malaysia	200	$320 million	300	Pertamina (Indonesia), Gulf Indonesia (Indonesia), Talisman (Canada), Petronas (Malaysia), Santos (Australia), Repsol-YPF (Spain)	20 years
2005/2007	Trans-Thailand-Malaysia (TTM)	Songkhla Province, Gulf of Thailand to Chana, Thailand	Changlun, Malaysia	348	$2.42 billion	1020	Carigali-Triton Operating Company (Operator, Thailand), Petronas (Malaysia), PTT (Thailand), Triton Oil Company (Thailand)	40 years
2007	Petronas-Keppel	Peninsular Gas Utilisation (PGU) Pipeline in Johor, Malaysia	Keppel power plant on Jurong Island, Singapore	5 km	$4 million	115	Keppel Corporation (Singapore), Petronas (Malaysia)	18 years, $1.8 billion worth of gas

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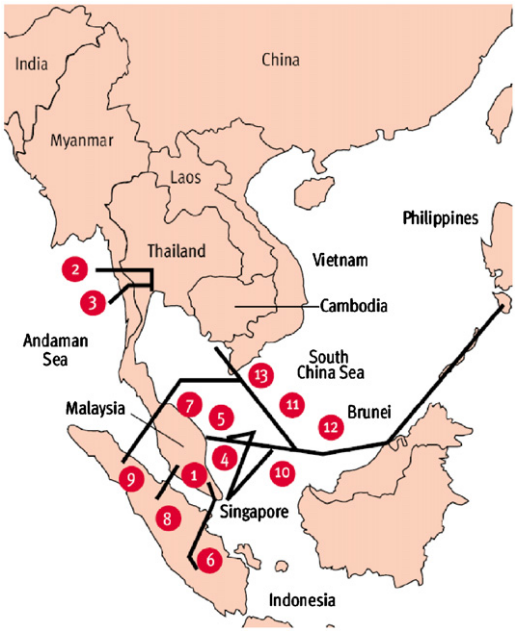

Fig. 2. The Proposed Trans-ASEAN Gas Pipeline (TAGP) Network. *Source*: modified from Peter Roberts and Alex Cull, "Building the Trans-ASEAN Gas Pipeline," Asia Pacific Review (July, 2003), pp. 15–20. Legend: (1) Malaysia to Singapore, (2) Myanmar (Yadana) to Thailand (Ratchaburi), (3) Myanmar (Yetagun) to Thailand (Ratchaburi), (4) Indonesia (West Natuna) to Singapore, (5) Indonesia (West Natuna) to Malaysia (Duyong), (6) Indonesia (Grissik) to Singapore, (7) Thailand (Joint Development Area) to Malaysia, (8) Indonesia (South Sumatra) to Malaysia, (9) Indonesia (Arun) to Malaysia (commissioning estimated 2010), (10) Indonesia (East Natuna and West Natuna) to Malaysia (Kerteh) and Singapore (commissioning estimated 2010), (11) Indonesia (East Natuna) to Thailand (JDA-Erawan) (commissioning estimated 2012), (12) Indonesia (East Natuna) to Malaysia (Sabah) and the Philippines (Palawan-Luzon) (commissioning estimated 2015), and (13) Malaysia-Thailand (JDA) to Vietnam (Block B) (commissioning estimated 2016).

Table 3
Natural gas reserves in select ASEAN countries (in trillion cubic feet (tcf)).

Country	Proven reserves	Possible reserves	Probable Reserves	Total
Brunei	8	4	0	12
Indonesia	90	42	34	166
Malaysia	58	28	0	86
Philippines	3	1	1	5
Singapore	0	0	0	0
Thailand	12	9	11	32
Vietnam	5	11	9	25
ASEAN	175	94	55	325

course, promote economic growth, and "unlock" the region's natural resources for profit (Ritchie and Carmody, 2007).

3.3. Environmental stewardship

Proponents push natural gas and its associated infrastructure for environmental reasons as well. While one can certainly debate the merits of relaying on *any* forms of fossil fuels in a world already experiencing climate change, advocates of the TAGP argue that natural gas generates fewer pollutants and carbon dioxide (CO_2) emissions than all other fossil fuels. They note that it produces 25–33% less CO_2 than oil when combusted in an electricity generator, and 40–45% less CO_2 than coal per unit of energy produced (Victor et al., 2005). Put another way, natural gas typically emits less than half the carbon dioxide for every kilowatt-hour (kWh) of electricity produced than coal. Natural gas combustion also has essentially no sulfur emissions and significantly lower levels of nitrogen oxide.

For example, one of the existing pieces of the TAGP connects the gas fields offshore Myanmar with the Ratchaburi power plant near Bangkok, Thailand. Because it is able to draw on an uninterrupted supply of high-quality gas from Myanmar, this 3645 MW oil- and gas-fired facility is now what one of its employees called "the cleanest power plant in Thailand, possibly all of Southeast Asia." Plant operators claim that its sulfur oxide, nitrogen oxide, and particulate matter emissions are so low "they cannot even be counted," and that the plant averages just 498 g of CO_2/kWh compared to 1000 g CO_2/kWh for coal-fired plants throughout the region.

3.4. Energy security

Finally, promoters of the TAGP argue that since increased use of natural gas will reduce ASEAN's dependence on Persian Gulf sources of crude oil and expand the supply of domestic gas for the region, it will directly increase energy security and promote dialogue and cooperation between Southeast Asian countries. "Interstate gas pipelines serve as a meaningful diplomatic tool for economic, political, and even cultural bilateral or/and multilateral cooperation of neighboring countries," one senior official told the author, "as well as for regional stability and peace." The associate director of another high-ranking Southeast Asian think tank argued that the TAGP was "a concrete manifestation of intra-ASEAN cooperation. Politically, it is an enduring symbol of long-term cooperation, of mutual dependence. It sends a signal to external investors that the countries involved are on good terms, and it speaks of long-term stability."

Similarly, Amy Jaffe (2001a) has argued that large, transnational, interstate natural gas projects promote cooperation, because the challenge of mobilizing trillions of dollars in capital forces regional leaders to put aside historical and ideological differences in the interests of economic integration and regional energy security. She noted that interconnecting natural gas markets creates an array of "powerful incentives" for cooperation, since it incentivizes countries to create their own joint stockpiling and research organizations, allows them to link energy infrastructure to create synergies and market efficiencies that improve the cost and access to foreign capital, and engenders a shared vulnerability to the risk of accidents and terrorist assaults that require coordination and cooperation. "Rather than being a source of conflict," Jaffe (2001b) concluded, "energy has the capacity to become an integrative force, creating a large sense of shared interests and stakes in cooperation."

Such beliefs are not confined to academics and businesspersons. Indeed, Sadasivan (2007), the Senior Minister of State for the Singaporean Ministry of Foreign Affairs, made just this point when talking about the natural gas pipelines connecting Singapore with Malaysia and Indonesia. "Pipelines," he stated, "have a real chance to increase peace and security in the region: they tie countries together by making the interconnected costs of conflict unacceptably high." After completing the 640 km $5.7 billion West Natuna to Singapore undersea pipeline, Singaporean Prime Minister Goh Chok Tong remarked that "as immediate neighbors with complementary strengths, (the pipeline) brings greater prosperity to our two peoples by working closely together" (Richardson, 2001). Purnomo Yusgiantoro, the Indonesian Minister of Mines and Energy at that time, remarked that "it is all positive". The West Natuna and South Sumatra gas deals will "of course increase government revenues and provide employment.

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But there are also bigger aspects: we will be strengthening bilateral ties" (Richardson, 2001). Just a few years later, when the Grissik to Singapore pipeline was completed, both governments announced that it was "an enduring symbol of the close cooperation between Singapore and Indonesia" (Tong, 2003).

Thus, promoters believe that the TAGP weaves the benefits of economic development and electrification, economic growth and foreign exchange, less damage to the environment, and improved energy security, and regional cooperation together.

4. Challenges to implementation

While the purported benefits of the TAGP network are interconnected, so are the challenges. For the purposes of highlighting the impediments to the TAGP, the author has separated the barriers into six categories: technical, economic, legal, political, social, and environmental. It should be noted, however, that such distinctions are in name only, and that the challenges to the TAGP are seamlessly interconnected. For example, the issue of natural gas pricing is at once legal, since it involves enforcing contracts, and economic, since it determines the profitability of investing in certain natural gas pipelines. The issue of pipeline construction and accidents is simultaneously technical (pipelines need to be built properly) and environmental (pipelines act as physical barriers on the landscape and spills can be quite damaging to natural habitats). The challenges here are separated only for the convenience of highlighting them, not because they exist in separate, distinct classes in the real world. (See Table 4 for an overview of the challenges facing the TAGP.)

4.1. Technical challenges

Constructing and operating an individual gas pipeline is a complex process, let alone pipelines interconnected into a network. Securing first-class engineering and technical expertise and being able to overcome various technical problems become issues of critical importance. Indonesia, for instance, has expressed concern that its two state-owned energy companies, PGN and Pertamina, do not possess the necessary expertise and technology to develop the West Natuna gas field, where about one-quarter of the entire country's gas reserves are located, because of high amounts of carbon dioxide found within the gas (Smith, 2008).

One simple–but serious–impediment relates to maintaining heat value and pressure from a mesh of interconnected pipelines that have varying types of natural gas. Thai officials told the author that natural gas from the Gulf of Thailand has a heat rate of about 900 BTU per kWh, but gas from Indonesia is much lower at 825 BTU per kWh, while gas from Myanmar is much higher at 1100 BTU per kWh. Once all of the components of the TAGP become interconnected, operators would need to agree on common technical standards for operation and maintenance, no small task. One high-ranking ASEAN official quietly confided to the author that in terms of even just getting technical aspects of interstate gas transmission right in Southeast Asia, "it is going to be a very slow agenda".

4.2. Economic challenges

The amount of natural gas reserves, naturally, serves as the bedrock for any decision to build a pipeline. Actually estimating those reserves, however, is fraught with methodological uncertainty. Four major surveys of oil and gas reserves exist, and none of them agree about how much gas is located within Southeast Asia. The Gulf Publishing Company's *World Oil* survey projects that Malaysia has 58 trillion cubic feet (tcf) of proven natural gas reserves, while Centre International d'Information sur le Gaz Naturel et tous Hydrocarbures Gazeux's *Natural Gas in the World* survey estimates that they have reserves 52% greater at 88 tcf (US EIA, 2007). Similarly, British Petroleum's *Statistical Review* reports that Thailand has 12.5 tcf of gas, while other estimates put the number almost twice as large at 22.9 tcf (US EIA, 2007). Finally, PennWell Corporation estimates in their yearly *Oil & Gas Journal* survey that Vietnam has 6.8 tcf of proven natural gas, while each of the other three surveys argue that it has 8.2–8.3 tcf—a difference of 22% (US EIA, 2007). Another survey of natural gas estimates for Myanmar not referenced by the EIA found that the amount of reserves differed by 42%—from 13 tcf to 18.5 tcf (Chen, 2007).

Equally uncertain are projections of future natural gas demand. Natural gas pipelines are almost always built to serve large industrial facilities. The usual anchor is a large-sized power plant or manufacturing facility that would provide the necessary gas sales to make the project viable. Yet demand for natural gas can change quickly over time. Often, one researcher told the author that "the assumption is that as long as supply is available, demand will be right there to consume it". However, there may be difficulty in the distribution of the gas from the end of the pipeline to the end-users due to lack of local infrastructure. A mismatch of energy prices to consumer willingness to pay may pose other issues. This has happened to several projects in the past."

Since the value of natural gas depends both on available reserves and how much those reserves will be worth, changes in

Table 4
The challenges and impediments to the TAGP network.

Technical	Economic	Legal	Political	Social	Environmental
Pipeline construction and operation	Uncertainty surrounding gas reserves	Inconsistent regulatory frameworks	Contests over sovereignty	Poor participatory mechanisms	Land degradation
	Unknown future demand for gas	Unclear protection of property rights	Diplomatic tensions	Lack of transparency	Accidents and spills
	Capital intensity	State control of markets	Protectionism	Relocation, resettlement, and human rights concerns	Greenhouse gas emissions and climate change
	Financing	Weak mechanisms for dispute settlement	Lack of sustained leadership		
	Returns on investment	Setting acceptable gas prices and tariffs			

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either greatly skew the profitability of building any set of pipelines. The director of an energy division for one ASEAN member noted that in Southeast Asia, income levels are much lower compared to other regions such as North America and Europe, economic growth has been sporadic and difficult to predict, and gas would have to be transported long distances to where it is needed—factors that further impede the value of Southeast Asian natural gas, the implication that the costs of the TAGP may be more difficult to recover.

Additionally, natural gas pipelines are capital-intensive projects. Transportation and distribution already account for 41% of the residential price of natural gas in the United States, where the construction of natural gas pipelines can cost as much as $420,000 per mile (Parker, 2004). This means that they tend to be prone to significant cost overruns, and that they produce fewer jobs per dollar invested than other types of industrial projects. Generally, these costs overruns end up being covered not by the companies themselves, but are passed onto consumers and ratepayers through higher prices.

Billions of dollars will also need financed for pipeline infrastructure, platforms, drills, and compression equipment. Acquiring this financing is no small feat: most transnational projects require the participation of multiple firms at once, and even slight changes in feasibility, interest rates, and inflation can alter the fundamental economic risk of projects. The risk of expropriation and sovereign default linger in the region as well, especially after the Asian Financial Crisis in the late 1990s.

Finally, even if all of the previously mentioned economic issues–reserves, demand, cost overruns, and financing–can be resolved, natural gas pipelines must *still* demonstrate that they are a better alternative (i.e., can earn a greater return for investors) than many other possible investments. First, pipelines must compete against other forms of natural gas delivery. While some have argued that natural gas pipelines and LNG infrastructure are complementary–they both create demand for natural gas–there is also the potential for competition. "The amount of gas that will be traded regionally through pipelines will also have to compete," noted one government official within ASEAN, "with LNG exports to countries outside the region (e.g. Japan and Korea), or even LNG trading within the region (for remote gas fields)." Second, natural gas as a whole must compete with other alternatives of energy supply. If shareholders desire to simply earn a profit, they may turn instead to oil. Oil is a fungible commodity where the economics are clearer. As one diplomat put it, "oil will always find a way to the market, gas must be pulled." If shareholders are looking to be clean, they will likely turn to renewable forms of electricity and transportation fuel, not natural gas and its associated infrastructure. They can invest in Indonesian and Malaysian biofuel plantations, hydroelectric facilities in Vietnam, solar panels in Singapore or wind farms in the Philippines as alternatives to natural gas. Third, since money is fungible, pipelines must compete with *any* type of project that could be more profitable. Gas pipelines, in other words, may fare poorly with most investors: too dirty for advocates of clean energy, not profitable enough for advocates of fossil fuels, and not exciting enough for investors outside of the energy sector.

4.3. Legal challenges

A collection of legal challenges impede rapid development of the TAGP. Cross-border natural gas pipelines require harmonization of national legal and regulatory frameworks, as well gas pricing schedules. Many Southeast Asian countries, however, are still working out the rules concerning natural gas transmission and distribution, and legislation concerning energy and the environment differs greatly. As one attorney and financial consultant remarked, "before an overarching framework on natural gas can take place at the ASEAN level, individual countries need to get their legal houses in order."

In addition, investors must be convinced that their assets will be protected under law. Such legal protections are intended to mitigate political risks should regimes change, and ensure that contractual agreements between parties are clear and stable. "Respect for agreements and contracts, rule of law, property rights and enforcement, and the sanctity of commercially negotiated contracts", one energy analyst told us, "are essential for drawing investment to large projects." In contrast, oil and natural gas reserves are completely nationalized in Myanmar, and Indonesia seized Asia's largest undeveloped gas block, Natuna D-Alpha, from ExxonMobil in February 2008, when it transferred the reserves to the state-owned energy company Pertamina (Smith, 2008). Investors and multilateral development banks say they prefer to see liberalized energy markets before they put capital into projects. Yet Southeast Asia remains dominated by state-owned energy companies and only a partial endorsement of privatization. Financial consultants told the author that Southeast Asia seems to be "following the French model of creeping liberalization", where markets are punctuated by national champions, lots of government control, fixed costs, single buyers, and marketeering—not exactly a situation amenable to international investment and financing.

4.4. Political challenges

Perhaps the most significant political challenges relate to contests over sovereignty between Southeast Asian countries. Brunei, China, Indonesia, Malaysia, the Philippines, Taiwan, Thailand, and Vietnam continue to contest each other's claims to the natural gas reserves found in East Natuna and the Spratley Islands (Cossa and Khanna, 1997). Jurisdiction over offshore pipeline segments, particularly outside of the territorial seas, is also contentious, and despite the "aura of close cooperation" emanating from ASEAN, there are presently a number of unresolved territorial disputes between the member states (Roberts and Cull, 2003).

Connected to these contests of sovereignty is the diplomatic tension and suspicion between ASEAN members. The author was told, for example, that the Indonesians are afraid that Singapore is trying to "buy up" the country's telecommunications firms and natural resources; the Singaporeans are wary of Malay corruption in large infrastructure projects; the Malays are worried about importing natural gas from the Gulf of Thailand; the Thais are concerned about the human rights abuses allegedly occurring near Burmese gas pipelines; and "everyone" has reservations about fully engaging China and Japan. One official stated that as a collective whole, ASEAN countries feel that they got taken advantage of by the western banks and investors during the Asian Financial Crisis, and are thus still "afraid they are going to get screwed at everything, and that everyone is out to take advantage of them—even each other." Suspicion between TAGP proponents appears to be deeply entrenched.

A drive within countries towards protectionism in the energy sector and the securing of domestic supply may also erode momentum towards creating a TAGP network predicated on the free trade of natural gas. Demand for energy has grown extremely rapidly within the region from 1990 to 2006. During this period, primary energy consumption for Indonesia, Malaysia, Philippines, Singapore, and Thailand grew more than 250% (from 135.9 million tons of oil equivalent (MTOE) in 1990 to 342.6 MTOE in 2006)

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Table 5
Primary energy consumption in select ASEAN countries (in MTOE).

Country	1990	1999	2006	% increase
Indonesia	52.3	79.6	114.3	219
Malaysia	21.5	38.0	67.0	312
Philippines	13.0	21.6	25.2	194
Singapore	20.3	29.6	50.0	246
Thailand	28.8	59.3	86.1	299
Total	135.9	228.1	342.6	252

(Tan, 2008) (see Table 5). Yet to meet even further expected surges in energy demand, Indonesia is defaulting on energy cargo exports to secure domestic supply, and Singapore has placed a moratorium on new gas sales for power plants on energy security grounds (Tan, 2008). Energy consultants confided to the author that the Singaporeans secretly believe that Malaysia is selling them inferior quality gas to keep higher quality supply for domestic use. Clearly attitudes are shifting in Southeast Asia towards domestic control and usage of energy resources, not their exportation and trade.

Recent shortages of natural gas in Indonesia have only underscored the political importance of meeting domestic demand for energy. Unexpected shortfalls of natural gas supply have already forced at least two natural gas power plants in Indonesia to prematurely shutdown or operate at partial capacity. In 2007, PGN had to negotiate more expensive natural gas contracts with China, Iran, and Qatar to make up for a shortage of fuel after Conoco Philips was unable to fully supply the 740 MW Cilegon power plant (Krismantari, 2007). In 2008, respondents told the author about another power plant in Java that had to run at 7% of its rated capacity due to shortages in natural gas, and in Batam, the local assembly even threatened to block natural gas exports to Singapore to ensure adequate supply for their island.

A final political impediment concerns the lack of sustained political leadership within ASEAN members towards the TAGP, or the support of a key major power. In order for other large gas pipeline projects to get off the ground in Central Asia, South America, Europe, and the Caucasus, major power sponsors, such as the United States and European Union, had to become involved to help arbitrate geopolitical issues. Even when leadership may be asserted, it needs to be lasting. Neither superpower sponsorship of the TAGP nor lasting leadership within Southeast Asia appears to be occurring.

4.5. Social challenges

In order to be successful, numerous respondents from a variety of NGOs commented that communities must actively and meaningfully participate in discussions about where natural gas pipelines go. Yet, in some parts of Southeast Asia, such as Myanmar, no real and independent organization exists to face state-owned oil and gas companies. There is no clear complaints mechanism, nor a clear definition of roles between companies and the state.

Long-distance interstate gas pipelines cross a number of national borders, and pass through sensitive environmental areas that affect both the livelihoods of indigenous people and local ecosystems. People along the pipeline corridor may be entitled to transit fees and rights or, more seriously, may have to be temporarily relocated or permanently resettled if the pipeline goes through their community. Mechanisms such as "free prior and informed consent" (a form of community consultation) and "grievance mechanisms" (a way for community members to engage in dialogue with the project sponsor to quickly resolve concerns and injuries) are sorely lacking in some parts of the region, as well as any type of accountability to international human rights standards.

Some oil and gas suppliers–particularly the Myanmar Oil and Gas Enterprise, but also the Malaysian company Petronas and the Thai company PTT—have employed private security firms to protect their operations and suppress dissent, especially when operating abroad. In Indonesia and Myanmar, some firms selling gas have denied free speech, employed torture, supported slavery and forced labor, sanctioned extrajudicial killings, and ordered executions (Waskow and Welch, 2005). Unocal admitted in court to knowing that the Burmese military committed acts of genocide to construct a pipeline for them, and British Petroleum, ExxonMobil, ConocoPhillips, and Shell continue to provide daily "security briefings" for mercenaries and supply vehicles, arms, food, and medicine to soldiers and police in some of their operations in the developing world (Chen, 2007; Maassarani et al., 2007). In this way, supporting the gas fuel chain also indirectly endorses human rights abuses and engenders international conflict.

4.6. Environmental challenges

Finally, natural gas pipelines can endanger species, habitats, and ecosystems through land degradation, the ever-present risk of spills and accidents, and associated greenhouse gas emissions with the natural gas fuel cycle.

Each stage of the gas fuel chain—exploration, onshore and offshore drilling, processing, and transportation—poses potentially serious and unavoidable risks to ecosystems and human health. Exploration necessitates heavy equipment and can be quite invasive, as it involves "discovering" gas deposits found in sedimentary rock through various seismic techniques, such as controlled underground explosions, special air guns, and exploratory drilling. Less intrusive techniques, such as remote sensing relying on airplanes and satellites, have a limited success rate and are not widely used (Waskow and Welch, 2005).

Construction of access roads, drilling platforms, and their associated infrastructure frequently induce environmental impacts beyond the immediate effects of land clearing: they open up remote regions to loggers and wildlife poachers. One study found that 1000–6000 acres of land are deforested for every 1 km of new oil and gas roads built through forested areas around the world (Waskow and Welch, 2005).

The production and extraction of gas, which is itself toxic, is even more hazardous. Drilling brings large quantities of rock fragments, called "cuttings," to the surface, and these cuttings are coated with drilling fluids, called "drilling muds," which operators use to lubricate drill bits and stabilize pressure within gas wells. The quantity of toxic cuttings and mud released for each facility is gargantuan, ranging between 60,000 to 300,000 gal per *day* (Waskow and Welch, 2005). In addition to cuttings and drilling muds, vast quantities of water contaminated with suspended and dissolved solids are also brought to the surface, creating what geologists refer to as "produced water." A typical offshore oil and gas platform releases about 400,000 gal of produced water back into the ocean or sea every day, and this produced water can contain lead, zinc, mercury, benzene, and toluene, making it highly toxic and requiring operators to often treat it with chemicals (Waskow and Welch, 2005).

The next stage, natural gas processing, necessitates separating hydrocarbons and fluids from the gas itself. The first step involves removing condensate, oil, and water before treating natural gas with amines to improve quality. Natural gas is often injected with

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nitrogen and then sweetened to remove excess hydrogen and sulfur. Fugitive emissions in natural gas processing facilities are common, and most often associated with leaks in tubing, values, connections, and storage tanks (International Finance Corporation, 2007). Natural gas processing facilities commonly contaminate local groundwater sources and soil, and accidents can give rise to fatal jet fires, pool fires, fireballs, and flash fires (depending on the quantity of gas involved).

Natural gas pipelines are prone to catastrophic failure as well. Faulty joints connecting pipeline components, malfunctioning valves, operator error, and corrosion can induce frequent leaks and ruptures. From 1907 to 2007, natural gas pipelines were the type of energy infrastructure most frequent to fail, accounting for 33% of all major energy accidents worldwide (Sovacool, 2008). The US Department of Transportation has noted that oil and gas pipelines fail so often in the United States that they expect 2241 major accidents and an additional 16,000 spills every ten years (US General Accounting Office, 2000). One environmental researcher told us that "there is no such thing as an environmentally sensitive pipeline," and that accepting natural gas pipelines is a tacit acceptance of sometimes "extreme and pernicious environmental and social risk."

Lastly, natural gas facilities also contribute indirectly to global warming by emitting significant amounts of methane during the production process and transportation. Natural gas, when not separated from the oil deposits, it is often burned off at the well site or flared, releasing CO_2, carbon monoxide, NO_x, and SO_2. When not flared, operators usually vent unprocessed gas directly into the atmosphere. A staggering 5% of world natural gas production is lost to flaring and venting, making the gas industry responsible for roughly 10% of global methane emissions (Kirchgessner et al., 1997). Instead of pumping stations, natural gas pipelines have compressor stations spaced every 60–300 km. To move the gas along the pipeline, these compressor stations burn about 4% of the gas they transmit every 1500 km, further contributing to the emission of greenhouse gases (Lovins and Lovins 1982, p. 119).

5. Conclusions

With these insights in mind, three interconnected albeit tentative conclusions are offered at large.

First, ASEAN's experience with the TAGP reminds us that large-scale infrastructure projects, including dams, pipelines, power plants, and T&D grids, face immense technical and social challenges, and require extensive management of economic, political, and environmental risks. Technical expertise must be borrowed or indigenously cultivated. Investors must be convinced to finance projects. Consistent regulatory frameworks must send a strong signal to stakeholders. Robust political leadership must occur in favor of the project. Rigorous participatory and transparency mechanisms must be in place to ensure that human rights are protected. Damage to the natural environment must be mitigated. Bigger is not always better, and the factors pushing projects such as the TAGP–factors that include the motive to electrify some of the world's poorest places, develop regional economies, promote energy security, and minimize environmental harm–does not always mean such projects will or should automatically happen. As a senior vice president managing operations in 35 countries for one of the world's largest oil companies told the author, from a technical standpoint the TAGP "would not take much," but from a social and political standpoint getting all members within ASEAN to agree on the TAGP is "like pushing a piece of wet spaghetti up a hill."

Second, the TAGP implies that talking about regional energy cooperation is much easier than actually cultivating it. At least four interrelated factors threaten more meaningful cooperation on the TAGP: conflicting goals and priorities, differing concepts of energy security, increasing protectionism, and intensifying suspicion. Many of the factors pushing investment in the TAGP conflict with each other. Tensions over the role of energy resources, exports, and energy security are apparent. Government interests tied to the TAGP seem to prefer regulation, taxation, and state control, while corporate interests (multilateral development banks, private financers, corporations such as Shell and BP) want laws that protect all participants from dominance in the market, nationalization, and government intervention. Powerful institutions and actors within Southeast Asia appear divided over whether natural gas should be used to satisfy domestic demand, or used instead as a vehicle to acquire foreign capital in the global market through exports.

This division is connected to different conceptions of energy security, a concept often defined differently by varying stakeholders involved in the TAGP project. For some, the concept of energy security means promoting regional cooperation and dialogue. For others, it means opening up natural resources for lucrative commercial opportunities. But for *most*, it seems to be promoting the interests of individual countries within ASEAN, not between ASEAN—even if these interests come at the expense of both regional cooperation and lucrative exports. Thus, as one high-ranking member of a large multilateral development bank involved in the region put it, "the TAGP is really just the promotion of small, bilateral energy deals benefitting individual countries with the 'rhetoric of regionalism,' but not its substance, a narrow way to acquire natural gas supply from neighbors, but not to promote a more holistic or productive form of regionalism".

Countries are also becoming more protectionist about energy resources and nationalist within ASEAN, and this trend threatens all forms of regional cooperation. Protectionism and nationalism, moreover, gives rise to deep-seated internal suspicion both within the organization, and externally between ASEAN, regional powers, and international powers. ASEAN members believe they have to deal with the simultaneous presence of two increasingly assertive regional powers, a Japan that is still the world's second largest economy, a China that is becoming a significant economic force and the traditional nuclear power in the region, and European and American economies that continue to drive global economic growth (Lim, 2005, 2006). If one were to envision such suspicion as a series of spheres that also account for regional influence

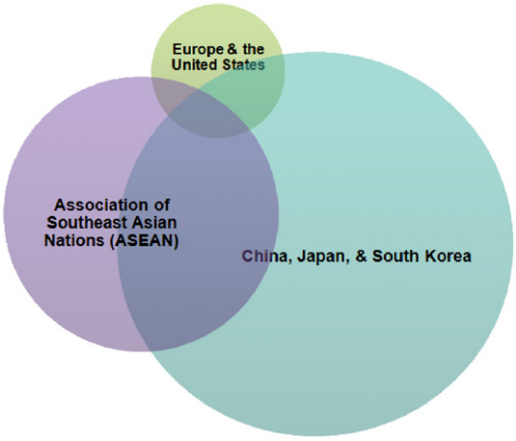

Fig. 3. The three spheres of suspicion and influence between ASEAN, regional powers, and western powers.

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within ASEAN, countries in Southeast Asia are not only suspicious of each other, but also wary of exploitation and encroachment from regional powers and fearful and defensive of western powers (see Fig. 3).

The presence of such conflict, mistrust, and discord between TAGP stakeholders alongside the overwhelmingly positive statements from ASEAN about the likely success of the TAGP suggests that the rhetoric of regionalism may simply be obscuring opportunistic thinking within the individual countries. ASEAN envisions the TAGP as a way to create a more industrialized and friendly community of nations, but different interests within ASEAN view it as a way to expand cross-border pipeline connections merely to support discrete, domestic needs. As one energy consultant iterated to the author, the TAGP is more "flag-waving the name of regionalism to mask commercial and national imperative" than any "meaningful sense of regional cooperation". This may be why despite being talked about within ASEAN for almost 20 years, thousands of kilometers of pipe still need built and billions of dollars invested.

Third, despite the fact that billions of dollars have already been spent, the TAGP remains very much a work in progress. While some components of the TAGP have been operating for almost two decades, and contracts for at least $24.9 billion worth of natural gas have been signed by countries within ASEAN, the TAGP remains less a concrete idea and more an evolving concept. Whether it will become an integrated, multinational network connecting every country in Southeast Asia; a bundle of bilateral pipelines promoting the rhetoric of regionalism without its substance; a convenient rhetorical justification for ASEAN's role in the energy sector in the region; or elements of all three has yet to be fully determined. If more investment in the TAGP will occur, it will most likely be because it satisfies the often parochial and sometimes narrow interests promoting individual pieces of it, not for the reasons touted by ASEAN. If there is a single, concise, and overarching conclusion about the TAGP, it is that the project remains still in its formative stages, despite the past two decades. As the director of one of ASEAN's energy centers put it, "even now, more than ten years after the project was conceived, the question still remains: what is the TAGP, and what do member countries want it to be?"

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