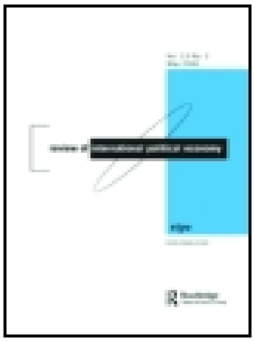

Review of International Political Economy

ISSN: 0969-2290 (Print) 1466-4526 (Online) Journal homepage: http://www.tandfonline.com/loi/rrip20

Hybridized industrial ecosystems and the makings of a new developmental infrastructure in East Asia's green energy sector

Sung-Young Kim

To cite this article: Sung-Young Kim (2019): Hybridized industrial ecosystems and the makings of a new developmental infrastructure in East Asia's green energy sector, Review of International Political Economy, DOI: 10.1080/09692290.2018.1554540

To link to this article: https://doi.org/10.1080/09692290.2018.1554540

Published online: 16 Jan 2019.

REVIEW OF INTERNATIONAL POLITICAL ECONOMY
https://doi.org/10.1080/09692290.2018.1554540

Hybridized industrial ecosystems and the makings of a new developmental infrastructure in East Asia's green energy sector

Sung-Young Kim

Department of Modern History, Politics & International Relations, Macquarie University, Sydney, Australia

ABSTRACT

In the midst of intensifying global competition over green energy systems, Korean and Taiwanese companies are rapidly rising as serious exporters of smart microgrids. What explains the emergence of an East Asian presence in the global green energy sector? My core argument is that policymakers in Korea and Taiwan view smart microgrids strategically as a new developmental infrastructure, which will help position domestic firms onto a new competitive footing. I show that in Korea, this is taking place through the state's *leveraging* of the nation's innovation champions – globally leading *chaebol* or conglomerates and their networks of small and medium enterprise (SME) suppliers in the domestic market. In Taiwan, the state has leveraged government research institutes and their rich networks with internationally competitive SMEs and with large domestic firms. These efforts reflect the creation of a new form of public and private cooperation, which I refer to as 'hybridized industrial ecosystems'. These *institutional mutations* in the green energy sector suggest that the state's transformative capacity has been *expanding*, not shrinking as many recent writers on the developmental state conclude. Overall, the findings from this fresh new sector represents the unfolding of a new chapter of developmental thinking in East Asia.

KEYWORDS Smart grids; microgrids; technology infrastructure; developmental states; green energy; renewable power; hybridized industrial ecosystems; governed interdependence; Korea; Taiwan

Introduction

Over the past decade, East Asian governments have had their eyes firmly set on coordinating national transitions towards greener economies (Dent, 2014; Yoshida & Mori, 2015). From the perspective of one of the world's foremost thinkers on the subject, Mathews (2017), the region's leading role (especially China) is so significant that it represents nothing less than a *Global Green Shift* towards the use and re-use of resources and materials. Having taken an early lead, China has positioned itself as a 'renewable energy superpower' as far as Amy Myers Jaffe who is the Director of the Program on Energy Security and Climate Change at the

CONTACT Sung-Young Kim sungyoung.kim@mq.edu.au Department of Modern History, Politics & International Relations, Level 2, The Australian Hearing Hub, 16 University Avenue, Macquarie University, NSW, 2109 Australia.

Council on Foreign Relations, is concerned (Jaffe, 2018, p. 84). For East Asia's manufacturing-based economies, greening the economy represents the most significant *developmental challenge* that these countries have ever faced. The purpose of this study is to shed new light on the mechanisms that states and firms can utilize to seize potential developmental opportunities that are being opened up in this fresh new sector.

The key technological infrastructure upon which a green power revolution will be made possible are smart grids. Compared to the post-war 'dumb' grids still in use today, artificial intelligence (AI)-managed power grids, i.e. 'smart grids' are a revolutionary step forward in managing unpredictable, increasingly distributed intermittent renewable power generation, demand management and the wide-scale usage of electric vehicles. The idea is to develop 'stronger, smarter and greener grids' (ABB, 2017). In this sense, the upgrading of existing power grids into smart grids is about building 'national resilience' (DeWit, 2016), constituting a national security imperative (Jaffe, 2018, p. 88).

It should then come as no surprise that leading multinational corporations wielding globally linked innovation and production networks, view smart grids as an enormous business opportunity. The Swiss-based ABB, American firms such as Tesla and Caterpillar, Germany's Siemens and Japanese firms such as Toyota and Toshiba have all sought to develop smart microgrid solutions. However, there is no clear market leader yet in sight with a major reason being the absence of leading international standards in key technologies – until only recently.

Amongst the many smart grid standards under development by national authorities, one of the most fundamental technologies relates to the computer 'language' used to communicate between the AI and other components. In this respect, the open-source communications standard, 'OpenADR 1.0/2.0' has made the greatest progress thus far. This standard grew out of the National Institute of Standards and Technology's (NIST) Smart Grid Interoperability Panel (SGIP), now being promoted by the U.S-based OpenADR (Open Automated Demand Response) Alliance. The standard received global recognition in 2014 by the International Electrotechnical Commission (IEC) (OpenADR Alliance, 2014), has been formally acknowledged from European (CEN, CENELEC, & ETSI, 2011) and Japanese (Arai, Hoshi, & Ito, 2017, p. 42) standards organizations, and been cautiously received in China (The News Magazine, 2012).

Against this formidable competition, Korean and Taiwanese firms have rapidly emerged as serious players in the development and export of smaller-scale *microgrids* for use on buildings, homes, factories, and whole cities. The wide deployment of such power systems are the building blocks of a national smart grid network. Importantly, they have thrown support behind the OpenADR standard due in large part to its open-sourced nature, which would help to minimize royalty fees, allow customizable microgrid solutions tailored to specific locational requirements, and thereby, accelerate exports. Korean heavyweights have joined the race, which includes LSIS, LG, Samsung, Hyundai, POSCO amongst many others and their large firm counterparts in Taiwan such as Tatung, Chung-Hsin Electric & Machinery Manufacturing Corporation (CHEM), Delta and a myriad of Taiwanese SMEs. What explains the emergence of these firms as technological innovators and exporters in the global green energy sector?

My core argument is that policymakers in Korea and Taiwan view smart microgrids strategically as a new *developmental infrastructure*, which will help position domestic firms onto a new competitive footing. Governments have promoted the export of green energy systems through instituting a new model of public and private cooperation centered on what I call 'hybridized industrial ecosystems' (HIEs).

Hybridized industrial ecosystems foster an approach, which link up all segments of the production and innovation value chain or 'industrial ecosystems'. This is a strategy targeted at developing and exporting complete technology solutions or systems, not just individual components such as microprocessors or electronic devices as occurred in earlier periods of development. The 'hybrid' quality of HIEs derives from their genuine fusion of public and private features. In both Korea and Taiwan, the establishment, mission and funding of HIEs are codified in law and their members are drawn from industry and government. HIEs target fundamental technologies for development, identify and drive commercialization opportunities, broker relationships within the private sector and between state agencies and firms and diffuse innovations. As I will show, the Korean state has leveraged the nation's innovation champions – globally leading *chaebol* or conglomerates and their networks of small and medium enterprise (SME) suppliers with leadership of HIEs. In Taiwan, the state has built HIEs through leveraging the country's world-class government research institutes (GRIs) and their rich networks with internationally competitive SMEs and with large domestic firms to establish a foothold in the global smart microgrid industry. Regardless of whether it is industry or GRIs who have been delegated with leadership roles, in both settings HIEs are state-informed organizational entities whose progress on meeting predefined development targets is set and monitored by government agencies.

At the broadest level then, HIEs retain the 'governed interdependence' (Weiss, 1998) quality of state-guided development efforts in other sectors seen in East Asia's developmental states. At the same time, East Asian hybrids do not strictly conform to any existing elaborations of governed interdependence. HIEs blend and merge earlier forms of public and private cooperation and as such are best seen as an *outgrowth* of governed interdependence. From an evolutionary perspective, if we posit Michael Mann's concept of the state's 'infrastructural power' as 'the genus from which the GI species is derived' (Weiss, 2006, p. 168; cf. Mann, 2008, pp. 361–362), East Asian HIEs, which will be examined in this study can be understood as *institutional mutations* of GI.

Of course, the idea of 'hybrid' organizational forms or 'quasi-government' is not new; it has captured the attention of analysts of American government for many years (Moe, 2001).[1] More recently, Weiss (2014) has advanced new insights in this field through her focus on the role of a 'national security state' in driving 'public–private innovation hybrids', which can take a variety of institutional forms based on a mix of their ownership structures, funding sources, operation, and management (Weiss, 2014, pp. 154–155). In the US, hybrid entities are an 'organic' institutional response to coping with external challenges to that country's technological supremacy in a vehemently anti-statist political environment (Weiss, 2014, p. 147). I will show that hybridization in East Asia has emerged for a completely different set of reasons. The novel contribution of this study is in drawing links between global competitive pressures of the global green energy sector, the emergence of HIEs as sources of competitive institutional advantage, and the influence of domestic political rationales in the specific design of HIEs.

By focusing on the sources of the Korean and Taiwanese states' capacity to aggressively drive the entry of national firms into the smart microgrids industry, I seek to advance the on-going debate over the effectiveness of developmental states in a world of globalized production and innovation. I discuss the implications of my findings in the concluding section. However, before doing so it is first necessary to outline the evolution of the relationship between government and business, which underpinned Korea and Taiwan's development trajectories from the 1960s until recent years. I then examine national smart microgrid strategies by tracing the roles of government and business actors. In the following section, I discuss the precise nature, origins, different designs and the competitive pressures, which explains their emergence in the green energy sector.

The evolution of government-business relations in Korea and Taiwan in a globalizing world economy

In order to make sense of the hybridized institutional foundations of the green energy systems industries in Korea and Taiwan, we first need to understand the roots from where HIEs come from. To this end, this section traces the evolution of the government and business relationship in Korea and Taiwan over the post-war period until the present.

The distinguishing feature of states in Korea and Taiwan has been their commitment to pursue strategic, long-term focused, approaches to industrial development via inducing the cooperation of the private sector. Governments initially targeted low value-added industries such as textiles, shifting their efforts to heavy industries such as automobiles and shipbuilding and eventually to higher-technologies such as semiconductors. Linda Weiss referred to this ability to technologically upgrade the country's industrial structure in a competitive international environment as 'transformative capacity' (Weiss, 1998, p. 7). The ability of governments with high levels of transformative capacity to be both *strong* (but not predatory) and *credible* (but not captured) perplexed analysts of economic development in the 1980s and 1990s (Haggard, 2016, p. 49). The existence of such traits earnt these countries the title of being 'developmental states', a term first coined by Johnson (1982) in his study of post-war Japan and then applied by Woo (1991), Amsden (1989), and Wade (1990/2004) in their seminal studies of Korea and Taiwan.

Several institutional ingredients enabled the pursuit of developmental goals. Economic bureaucrats especially in 'pilot agencies' (Johnson, 1982) or *defacto* 'quasi-pilot agencies' in a specific sector (Kim, 2012a) enjoyed high levels of insulation from special interests in the private sector through for example, creating vast information-gathering networks. Government officials in Korea and Taiwan also privileged well-organized business networks, which sufficiently represented the views of all major companies in an industry. By institutionalizing formal and informal avenues for public and private exchange (which Evans (1995) described as 'Embedded Autonomy'), bureaucrats encouraged industry to develop 'cooperative responses to economic change' thereby, converting 'their autonomy into organizational capacity' (Weiss, 1998, p. 81).

For Linda Weiss, these features are useful to the extent that they contribute to a relationship of 'governed interdependence' (GI) (Weiss, 1998, pp. 38–39). GI refers to an institutionalized relationship of negotiation between government and business where each side cooperates under broader goals set and monitored by the state. From a GI perspective, the Korean and Taiwanese states were capable of executing strategic industry policies relatively effectively because they used their autonomy to consult and to elicit cooperation from the private sector. This type of relationship is the obverse of statist notions of brute force power *and* concepts relating to weak states where governments remain captured by special interests within industry.

For some, the public and private interactions examined by the seminal studies now need to be rethought in light of the phenomenal growth of global production networks and global value chains (GPNs/GVCs) since the 1990s (cf. Gereffi, Humphrey, & Sturgeon, 2005).[2] According to one of the most influential writers in the field, Henry Yeung, a 'strategic coupling' perspective (Yeung, 2014, 2016) can help to understand the changing dynamics of state-business relations in a GPN/GVC world although a view, which has not gone without challenge (cf. Horner, 2017; Mayer & Phillips, 2017). Whereas in the industrializing period of development, the state's transformative capacities mattered a great deal to the success of national champions, over time these firms strategically *decouple* themselves (partially or wholly) from what Yeung describes as 'state-led' domestic contexts and *re-couple* themselves with lead firms of GPNs (Yeung, 2014, pp. 72–73).

The concept of strategic coupling does much to help us understand the dynamics of the globalization strategies of national *firms* especially from developing countries. However, the concept tells us less about how the *state's* transformative power might also grow in tandem with corporate power. This is not to deny the existence of conflict between states and industrial actors whose interests may diverge depending on the issue area. However, as Weiss (2003b, pp. 312–313) argues, competitive pressures associated with global markets have a tendency to 'blunt' *statist* forms of governance while 'sharpening' the need for *negotiated forms of power*, eliciting greater public and private exchange and cooperation, especially in knowledge-intensive sectors (cf. Kim, 2012a). Of course, this general tendency is no guarantee that states will respond effectively to such forces. The state's transformative capacity depends in large part on the robustness of GI in a given country. What then was the nature of GI in Korea and Taiwan in the years leading up to their current drive in green energy systems?

Korea: The challenge of sustaining state coordination with the chaebol

From the very outset of Korea's 'big push' to drive rapid industrialization (1960s–1970s), the state focused on collaborating with *chaebol* or conglomerates (Lim, 2013, p. 367). Initially, this partnership involved the government absorbing much of the risks involved for the country's new industrialists. However, as the *chaebol* attained more structurally powerful positions in the economy from the 1980s onwards, by the mid-1990s government-business relations tested the limits of GI. The 1997 Asian Financial Crisis provided a critical opportunity for the state to clean-up this 'perverse half-way house' (Weiss, 1998, p. 61). After two decades of tough reforms to encourage focusing on their core industrial competencies, the *chaebol* emerged as leaner, stronger and more internationally competitive than ever before (Weiss, 2003a, pp. 251–252).

However, the implications of restructuring the economy for the Korean model of development remains contested. On the one hand, there remains strong disagreement over the *significance* of governmental restructuring (e.g. Wong, 2011) and liberalizing reforms in response to new external challenges (e.g. Yeung, 2016) in both Korea and elsewhere in East Asia. From the perspective of some Korea-based analysts, the issue is not that the government is doing too little but *too much* and to little effect as firms shed their catch-up (imitation) beginnings and focus on 'post catch-up' (frontier innovation) (Choung, Hwang, & Choi, 2016, p. 99). On other hand, there is growing recognition that the state's core institutional capacities have been recombined in new ways especially as the country has moved closer to the technological frontier (Kim, 2012a; Kim & Kwon, 2017; Larson & Park, 2014) and over financial governance (Lee & Kim, 2018; Thurbon, 2016).

Despite the seemingly disparate views, participants on both sides of the debate would arguably agree that the key challenge for policymakers is how to sustain a coordinated approach to promoting frontier innovation, which carries with it higher risks than ever before and in a country where conglomerates dominate almost every aspect of economic life imaginable.

Taiwan: The search for new technological growth engines

In contrast with Korea's focus on large-scale corporations from the outset (even to the detriment of SMEs), the Taiwan state's strategy for climbing the technology ladder was to nurture large agglomerations of SMEs. From the 1970s onwards, the ruling *Kuomintang* (KMT) party prioritized SMEs for their potential to help the country climb up the technology ladder and as Haggard and Zheng (2013, pp. 455–456) remind us, for politically expedient reasons. The KMT needed new sources of political support in the midst of democratization in the early 1980s.

Early accounts of Taiwan's initial decades of industrialization gave the impression of a highly statist form of governance (cf. Wade, 1990/2004). This situation soon gave way to more mature forms of GI as policymakers targeted higher-tech industries; what Keun Lee in his authoritative work on economic catch-up refers to as 'shorter cycle technologies' (Lee, 2013, pp. 16–24). In a seminal essay on Taiwan's integrated circuit industry, John Mathews' (1997) traced the rich institutional structures created by economic pilot agencies such as the Ministry of Economic Affairs (MOEA) and its affiliated research agencies found in the Industrial Technology Research Institute (ITRI). That study revealed a dense network of public and private linkages forged at the now infamous Hsinchu Science Park (and other sites), which created mechanisms to diffuse technologies to firms through direct training, licensing, and spin-off from ITRI labs (a process referred to as 'fast-followership'). Industry representative and governing bodies such as the Taiwan Electrical and Electronic Manufacturers Association helped organize technological upgrading in partnership with larger firms all under the auspices of the state's goals to accelerate technological upgrading (Mathews, 1997, p. 44; cf. Amsden & Chu, 2003; Haggard & Zheng, 2013; Kuo, 1998). More recent studies reveal the replication of these features in completely new industries such as photovoltaics (PVs) (Mathews, Hu, & Wu, 2011, p. 195) and biotech (Wang, 2016).

At the same time, as mentioned earlier, doubts have been raised over the state's capacity to coordinate technological advancement in new science-intensive sectors such as biotechnology sector (Wong, 2011); even amongst policymakers themselves (cf. Chiang, 2004). The existence of large multinational firms who have developed impressive capabilities to develop and protect intellectual properties rights especially through multilateral trade rules embodied in the WTO is arguably a contributing factor (Dodgson, Mathews, Kastelle, & Hu, 2008, p. 442). Taiwan's most significant challenge is perhaps, the lack of visionary political leadership over targeting new technological growth sectors (Mathews & Hu, 2013) although a situation, which since 2016 has the makings of being reversed (Hu & Mathews, 2016).

In the case of Korea then, the question is whether, and if so how, the state has been able to harness the power of the *chaebol* as a productive force to drive high-risk innovations in the green energy sector. Taiwan presents a somewhat different case where more fundamental questions remain over the extent to which the government and business relationship is still framed by developmental thinking and if so, how, in the promotion of smart microgrids. These are the enquiries, which will guide the analysis below and as I will show, answers to which will be found in the emergence of HIEs.

Korea's smart microgrid initiatives

The highest levels of government have been involved in coordinating Korea's clean technology initiatives. While ministerial-level efforts began in 2005, it was only in 2008 with the election of President Lee Myung-bak and his prioritization of 'Low Carbon, Green Growth' (GG) that a truly national focus on green technologies came into being. The Lee Administration and his successor, President Park Geun-hye (and now as I will show below, now President Moon Jae-in), pioneered the formulation of national technology roadmaps, masterplans and five-year plans to drive smart grids. In this regard, the Committee on Green Growth (2013–present) and its predecessor, the Presidential Committee on Green Growth (PCGG) (2009–2013) were authoritative and deliberative bodies established to coordinate various ministerial greening initiatives (Kim & Thurbon, 2015, pp. 227, 232).

In terms of driving smart grid initiatives specifically, the most important actor in the institutional set-up has been the creation of the Korea Smart Grid Association (KSGA) and its standards-setting arm – the Korea Smart Grid Standardization Forum (KSGSF). The KSGA is composed of 143 companies and research institutes with wide representation from all relevant players in the power systems, energy and green ICT industries.[3] Membership includes major conglomerates and their numerous subsidiaries such as LSIS (currently Chair of the KSGA), Hyundai, Samsung, LG, SK Telecom, KT and state-owned power utilities such as KEPCO. A myriad of SMEs also participate in the KSGA such as Kokam, which has rapidly emerged as a world-class energy storage systems manufacturer. Some SMEs even play key leadership roles in the Board of Directors such as Omni System Co. – a manufacturer of digital meters and sensors originally used in telecommunications networks. GRIs such as Korea Electrotechnology Research Institute (KERI) and Korea Institute of Energy Research (KIER) are also members.

Policymakers view smart grids as a strategic, long-term, infrastructure, upon which new domestic competencies can be unleashed in global export markets. This perception is evident in the current *Second Five-Year Plan for Green Growth*, which details the governmental green energy development plans targeting smart grids of major competitors including the United States, Japan, European Union, Germany and China (CGG, 2014, p. 19). Given this competitive landscape, projections presented in the plan show that the global market for smart grid technologies is expected to grow by an average of 7% per year from 2013 to 2020. By 2020, the global market for smart grid components was estimated to be worth 400 trillion won (approximately US$350 billion)! (CGG, 2014, pp. 21, 86–87). The domestic market for smart grids alone was expected to grow from 3.9 billion won (US$3.4 million) in 2012 to 2.5 trillion won (US$2.1 billion) by 2020.

However, from the perspective of the Committee on Green Growth there were two main challenges in establishing a domestic presence in this global industry (CGG, 2014, p. 87). The first was that the private sector was hesitant to fast-forward investments into smart grid development and second, domestic firms suffered a technology gap with international competitors in smart grids. For industry bureaucrats such as the Ministry of Trade, Industry and Energy's (MOTIE) Director-General for Energy Industry Policy, Seung Il Cheong, these conditions provided a clear rationale for the government to play a guiding role:

> The problem is that smart grid technologies remain in their infancy and are not yet ready for commercialization … The government is thus committed for the foreseeable future to a strategy of development, with plans to establish smart grid technologies as a fledgling industry in South Korea (Cheong, 2013, p. 79).

What then did the government do to support this new green infant industry? The single most important policy initiative, which laid the foundations for R&D projects and pilot microgrid projects to follow was the government's seed funding for the construction of a smart grid test-bed on Jeju Island (the largest of its kind at the time). In December 2008, President Lee moved swiftly to fund 76.6 billion won (US$66 million) with co-investment from the private sector totaling 172.7 billion won (US$149 million) (Korea Smart Grid Institute, 2015, p. 10). A total of 12 consortiums involving 168 companies were involved. Following the Jeju Island test-bed, the Koreans targeted various kinds of smart microgrids such as remote island-type microgrids, which my collaborator and I have studied elsewhere (cf. Kim & Mathews, 2016). Below I focus on larger-scale smart microgrids, tailored for use in clusters of buildings, residential neighborhoods, and industrial complexes.

Micro energy blocks: The Korea micro energy grid (K-MEG) project

One of the most ambitious of Korean initiatives to develop smart microgrids has been the creation of modular 'Energy Block Platforms' to form independent power grids as stepping stones to a full national-scale smart grid. In November 2010, the then Ministry of Knowledge Economy (now, MOTIE) announced a call for proposals to undertake the Korea-Micro Energy Grid (K-MEG) project.[4] The MKE's challenge involved the development of a standardized 'total energy solution' utilizing ICTs and renewable and distributed energy sources, which could be readily *customized* for any locational setting in global export markets. The MKE selected four consortiums to develop detailed technology roadmaps and business models, absorbing the full costs for all participants (K-MEG R&D Center & Ministry of Trade, Industry and Energy, 2013, pp. 5–6). In May 2011, after a competitive process the MKE selected one of the Korea's largest construction engineering and systems integration firms Samsung C&T and its 'Green Tomorrow' Consortium to lead the K-MEG project.[5] In July 2011, the MKE officially launched the K-MEG Project as one of the five technology fields in the MOTIE's 'Business-Oriented [Industry-Leading] Future Flagship Program' (Kwon, 2011, p. 4).

The K-MEG Project had a total budget of US$80 million of which the MOTIE's Office of Strategic R&D Planning injected 64% and the private sector 34%, operating from July 2011 to September 2014 (K-MEG R&D Center & Ministry of Trade, Industry and Energy, 2013, pp. 4–5). The MKE's official R&D planning, monitoring and evaluation agency, the Korea Institute of Energy Technology Evaluation and Planning (KETEP) was the 'Project Administrator' while Samsung C&T was designated as the 'Project Leader'. The project involved a further 11 conglomerates such as KT and Hyosung, which played leadership roles of technology development, 33 SMEs such as Nara Control Inc. and KD Power, which also played leadership roles. The project also included the participation of 12 public and private R&D centeres such as the Electronics and Telecommunications Research Institute (ETRI), KERI and the Korea Electronics Technology Institute (KETI) and five foreign partner organizations.

Participants focused on developing core smart grid technologies such as smart meters and sensors, automated demand response, Energy Management Systems (EMS) controlled by AI (including Building-EMS, Home-EMS, Factory-EMS), network security, energy storage systems (ESS) and decentralized and renewable energy power sources such as wind and solar generators (Kwon, 2011, p. 5). These components were used for the creation of four main types of smart microgrids: Heat Grids, Electric Grids, Gas Grids and PV-based Disconnected Grids – with the idea being to integrate these grids into a new 'platform' controlled by a centralized EMS housed in a Total Operations Centre (Kwon, 2011, p. 11).

All these R&D efforts were intimately linked to the creation of new high-tech services and in order to 'promote the early verification of market-driven business models by inviting large-scale investment', participants targeted various demonstration sites or test-beds (K-MEG R&D Center & Ministry of Trade, Industry and Energy, 2013, p. 13). This included a total of seven domestic and five overseas test-beds in large commercial buildings, agglomerations of smaller buildings, campuses, remote islands and factories. To illustrate the implementation of these test-beds, let us briefly examine one such micro energy project at one of Korea's largest industrial complexes.

The Banwol–Sihwa national industrial complex

This 3100-hectare site located in Gyeonggi province south of the capital was an ideal setting to test a Heat Grid for industrial users (ILRI (Industrial Location Research Institute) & KICOX (Korea Industrial Complex Corporation), 2015, p. 88). The industrial complex is the largest cluster of core parts and components manufacturers in the nation, forming the 'root industries' for the nation's overall competitiveness. As of 2014, there were 18,000 companies (the majority being SMEs) and 295,000 manufacturing workers based in these two sites, being the lead suppliers in the machinery, electronics, petrochemicals and automotive industries.

In 2013, Samsung C&T agreed to develop a solution to replace LNG-powered boilers with a generator that recycles wasted heat from industrial complexes to supply steam and electricity (Samsung C&T Corporation, 2013, p. 24). The project had a total budget of $US 8 million with government 'loans' making up $US 7 million of that figure (although with a six-year repayment period) (Kwon, 2015, p. 17).[6] The Heat Grid involved technologies such as energy/process diagnosis and simulation, smart meters, smart distribution board, sensor system application, a dedicated EMS for Heat Grids (K-MEG R&D Center & Ministry of Trade, Industry and Energy, 2013, p. 17). By implementing these innovations, the system saved two steam-energy consuming companies 20% on energy costs annually (exceeding the target of 15%) while also developing a new source of income from the sale of wasted heat for the sole incinerator operator involved in the project (Samsung C&T Corporation, 2013, p. 24). While the original aim was to produce 59,000 tons of steam per year (averaging nine tons per hour), by the end of the trial, the generator produced an average of seven tons of steam per hour (Kwon, 2015, p. 17).

Since the conclusion of the project in 2014, plans indicate that the heat grid will be rolled out across the entire Sihwa Industrial Complex before it will be expanded to other industrial sites throughout Korea (Kwon, 2015, pp. 16–17). The MOTIE together with the government agency, the Korea Industrial Complex Corporation (KICOX), and the K-MEG Consortium will promote export opportunities through creating linkages with a number of export finance, consulting and political risk organizations (Kwon, 2011, p. 21). This includes domestic governmental bodies, the Korea Development Bank (KDB), Export-Import Bank of Korea (Korea ExIm Bank), Korea Finance Corporation (KoFC) and external agencies such as the European Bank for Reconstruction and Development (EBRD) and the Asian Development Bank (ADB).

These efforts have now begun to bear fruit. Samsung C&T and its K-MEG consortium partners in collaboration with foreign engineering firms such as Arup and AECOM are currently constructing a city-scale Micro Energy Grid in Huangdao district of Qingdao, Shandong Province, which has a population of 100,000 people.[7] This project represents Korea's first major commercial venture into the export of city-scale green energy systems, which uses the K-MEG model. The KSGA's and MOTIE's strong preference for aligning domestic standards with open-source and internationally recognized technology standards such as the OpenADR standard mentioned at the outset undoubtedly played a large part in succeeding so quickly in export markets (K-MEG R&D Center & Ministry of Trade, Industry and Energy, 2013, p. 31; OpenADR Alliance, 2013b).

Let us now turn to Taiwan's more recent yet, similarly ambitious smart microgrids strategy to Korean efforts.

Taiwan's smart microgrid initiatives

Taiwan's focus on developing smart grids began in 2009 under President Ma Ying-jeou's KMT-led government (Liou, 2017, p. 169). The MOEA and the National Science Council (Ministry of Science and Technology [MOST] since 2014) assumed leading roles in developing smart grid technologies from the very outset. In 2010, the Ma government established the 'National Master Plan on Energy Conservation and Carbon Reduction' under which smart grids were a targeted for promotion.

Under this national initiative, the Executive Yuan established a 'Smart Grid Master Plan' in 2012, which was the responsibility of the MOEA's Bureau of Energy (Lin, Chen, Lu, & Hsu, 2016, pp. 156–157). The government allocated NT$139.9 billion (US$4.7 billion) to carry out the Master Plan, which systematically targeted the development and commercialization of smart grid technologies and business models. An inter-ministerial 'Smart Grid Task Force' involving the MOEA and MOST amongst various other organs of the government was established to implement the Smart Grid Master Plan. The attainment of short to medium term technological goals were carried out under a 'Smart Grid General Project', which had already been underway by the time the Master Plan came into fruition in 2012. In 2010, the National Science Council launched the 'Smart Grid General Project' under the 'National Energy Program', which was aimed at establishing an overall development strategy to create and commercialize smart grids.

The most important institutional organ of Taiwan's smart microgrids strategy was the Taiwan Smart Grid Industry Association (TSGIA), which the MOEA established to assume full responsibility for policy formulation and implementation. The TSGIA's 43-strong membership includes conglomerates such as Tatung, one the country's largest manufacturers of power systems and system integration, Delta, which manufactures power and automation products, and CHEM, one of Taiwan's largest manufacturers of power generation systems.[8] TIER and the Green Energy and Environment Research Laboratories of ITRI play leadership roles in the TSGIA as Secretary General and on the Board of Directors respectively. The vast majority of the this association is composed of SMEs such as Moxa, which specializes in industrial-scale networking equipment. Other SMEs include Controlnet International Inc., a systems integration firm in the telecommunications and energy industries, GCOM Technologies, a telecommunications components manufacturer, and Advanio Technology, a specialist in industrial automation systems.

According to Professor Faa-Jeng Lin who is the Principle Investigator of the Smart Grid General Project and President of the TSGIA and his collaborators, the Project's core aims were to enhance energy security, improve carbon emissions and create an energy industry including the power systems equipment industry (Lin et al., 2016, p. 156). Smart grids were not only seen as an important industry in its own right but as an important 'bridge' between the country's world-class ICT industry and the energy industry (Liou, 2017, p. 169). By developing and applying ICT innovations to technologically upgrade the power grid, policymakers viewed smart grids as a way to generate new momentum for the national ICT sector. Indeed, according to a presentation by Prof. Lin on Taiwan's smart grids strategy, he expects Taiwan's investments in smart grids to pay dividends for the *next twenty years* as developed and developing countries upgrade their electricity grids (Lin, 2016, pp. 65–66). Citing independent market analyses, Lin notes that from 2013 to 2020, the global market for smart grid technologies will be at least US$400 billion with an average growth rate of over 8%. If the power, electronics, and ICT industries are combined, the Taiwanese smart grid industry is expected to reach NT$70 billion (US$2.4 billion) in 2020 and NT$170 billion (US$5.8 billion) in 2030.

The work involved in the Smart Grid General Project was divided into two phases. In Phase 1 (2010–2013), the focus was on technology development and its application (Lin et al., 2016, p. 159) while Phase 2 (2014–2018) focuses on commercializing these technologies. To these ends, 18 smart grid demonstration sites were established under this first phase of the government's project: 11 were targeted at testing EMS solutions for microgrids in remote islands, buildings, homes, factories and 7 were targeted at testing smart distribution systems and Virtual Power Plants.[9] Below, I examine the leading roles of GRIs in Taiwan's smart microgrid projects, highlighting their technological purpose and initial achievements in new green energy systems.

Smart grid general project demonstration sites

Paralleling Korea's 2009 launch of its Jeju Island test-bed, in 2011 Taiwanese policymakers set up a smart grid test-bed on Penghu Island – comprised of three smaller islands off the country's western coast. In a show of the government's serious commitment to driving the smart grid industry in Taiwan, under the 'Penghu Low Carbon Island' project (2011–2015), the MOEA provided a large seed fund of NT$8.09 billion (US$270 million) to establish demonstration projects in eight different smart grid fields (Li, Hung, & Chiang, 2012, p. 651). This figure even surpassed Korea's total public and private investments into the Jeju Island test-bed. Under the Smart Grid Master Plan, the MOEA is currently implementing the next phase of the project (2016–2018) (the 'Penghu Smart Grid Demonstration Project'). Efforts are broadly focused on enabling microgrids to be used to establish a completely automated and energy independent island (Lin et al., 2016, pp. 161–162).

GRIs such as ITRI have led technological development efforts in the Penghu Island test-bed in collaboration with large and small firms. ITRI officials have especially targeted their efforts on ways to *rapidly commercialize* microgrids through reducing the costs of key components such as energy storage solutions with domestic manufscturers such as Tatung. Researchers viewed the development of affordable batteries as one of the major technological hurdles to the wide commercialization of smart microgrids (DigiTimes, 2016).

ITRI engineers also made the strategic decision to utilize Toshiba's microgrid EMS in a Taiwanese-developed microgrid. Rather than investing R&D resources into an indigenous EMS solution as the Koreans did, ITRI officials focused on ways to integrate Toshiba's EMS and to *accelerate* microgrid system development (DigiTimes, 2016). In an effort to localize Toshiba's technology, engineers in ITRI created new algorithms to ensure its complete reliability and compatibility with other Taiwanese-developed elements of the microgrid system. Firms such as Tatung manufactured the PV generation systems and smart inverters, and developed new technological capabilities in *system integration*.

The decision to utilize Toshiba's EMS solution was due to policymakers' preference for open-source, internationally developed standards as made clear in a presentation by the Vice-President of the TSGIA, Chen (2013). To this end, Taiwan moved aggressively in their support for the American-developed OpenADR standard as made clear by Lin (2016, p. 38). Given this standards strategy, Toshiba's experience in developing OpenADR-aligned products (cf. OpenADR Alliance, 2013a), undoubtedly played a decisive role in ITRI's decision to utilize the Japanese company's EMS solution in the Penghu Island test-bed.

Other GRIs led the charge in a separate microgrid projects. One example is Dongji Island, which like many remote islands had been traditionally been reliant on diesel generators. In June 2015, a network of public and private actors involving CHEM was awarded a contract to complete a microgrid project (CHEM, 2017, pp. 1–2).[10] The core goal of the project was to develop a total microgrid solution for export markets:

> The project team will lead in developing an internationally verified microgrid solution that is suited for Taiwan and Asia[n] countries, and effectively lift up Taiwan's strategic positioning in the global energy industry development (Penghu County Government, INER (Institute of Nuclear Energy Research) & CHEM (Chung-Hsin Electric & Machinery Manufacturing Corporation), 2017, p. 2).

The MOEA-affiliated Taiwan Institute of Economic Research (TIER) was responsible for overall coordination and the Institute of Nuclear Energy Research (INER) developed the evaluation and smart control algorithm used in the test-bed. CHEM and other companies developed core technologies including an 85 kW PV system, 750 kW batteries, a 90 kW converter all controlled via an EMS and a new 200 kW diesel generator, which totals 1.125 MW (Chen & Tsai, 2017, p. 44). By using this system, the exorbitant costs involved in operating, delivering and maintaining diesel generators were easily cut by 48%. This equated to saving NT$2.49 million (US$83,000) per year (CHEM, 2017, p. 2).

The Taiwan government also launched demonstration projects of microgrids designed for buildings and homes. One such project was held at the National Cheng Kung University campus to trial an 'intelligent family power management system' utilizing a Home-EMS (HEMS), which monitors and automates power management from small-scale solar and wind turbines, energy storage and an electric vehicle-charging outlets (TSGIA, 2014, pp. 85–87). The system can potentially help households reduce their power bills but, also reduce peak demand, relieving pressure on the main power grid. The R&D project involved a complex of public and private actors including subsidiaries of foreign firms such as ABB Taiwan, large firms including Tatung and Chunghwa Telecom, various SMEs such as Netvox Technology and the MOEA-affiliated Institute for Information Industry (III).

The major advantage of Taiwan's GRI-led fast-follower strategy was to concentrate public and private resources into rapidly commercializing a Taiwanese microgrid and gain an early foothold in the market for such systems. Importantly, as Prof. Lin has stated, the key idea is to create a new *industrial ecosystem* of domestic smart microgrid companies that *together* could become a new force in the global microgrid market (DigiTimes, 2016). Indeed, Taiwanese companies have already sought to export commercially ready Taiwan-developed microgrid solutions. One such example is an SME, Controlnet International Inc., which has targeted island-dense countries like the Philippines – a potentially enormous market for grid-disconnected microgrids (Chua, 2017).

In sum, governments in Korea and Taiwan used various policy tools such as seed funding, standards-setting, co-development of technologies, sourcing and diffusing advanced technologies to domestic firms, to drive the development of smart microgrids. By doing so, policymakers demonstrated their commitment to building a new developmental infrastructure as a platform to enhance national techno-economic competitiveness. Companies responded to these market signals by merging their own funds and researchers with public resources to launch the K-MEG Consortium's microgrid pilots (e.g. Banwol–Sihwa National Industrial Complex in

Korea) and the initiatives held on Penghu Island and Dongji Island under Taiwan's Smart Grid General Project. I discuss the analytical significance of these developments in the following section.

The spawning of 'hybridized industrial ecosystems' in East Asia's green energy sector

What then explains the rapid rise of Korean and Taiwanese firms as technology innovators and exporters of smart microgrids? In this section, I outline the competitive institutional advantages of HIEs in the green energy sector. I examine their precise nature in Korea and Taiwan, their origins as institutional mutations, and the role of domestic political rationales in the design of Korea's industry-led and Taiwan's GRI-led designs. I then shift focus to the global competitive pressures driving the rise of HIEs.

Hybridized industrial ecosystems are a fusion of public and private features, which bring together all the major players in the production and innovation value chain. The main advantages of such organizational forms is to drive system-level development, which is necessary in the promotion of smart microgrid systems and in leveraging national sources of technological competitiveness. In Korea, the Korea Smart Grid Association (KSGA) and the related K-MEG Consortium exhibit such hybrid features (Figure 1). Under Article 20 of the 'Smart Grid Construction

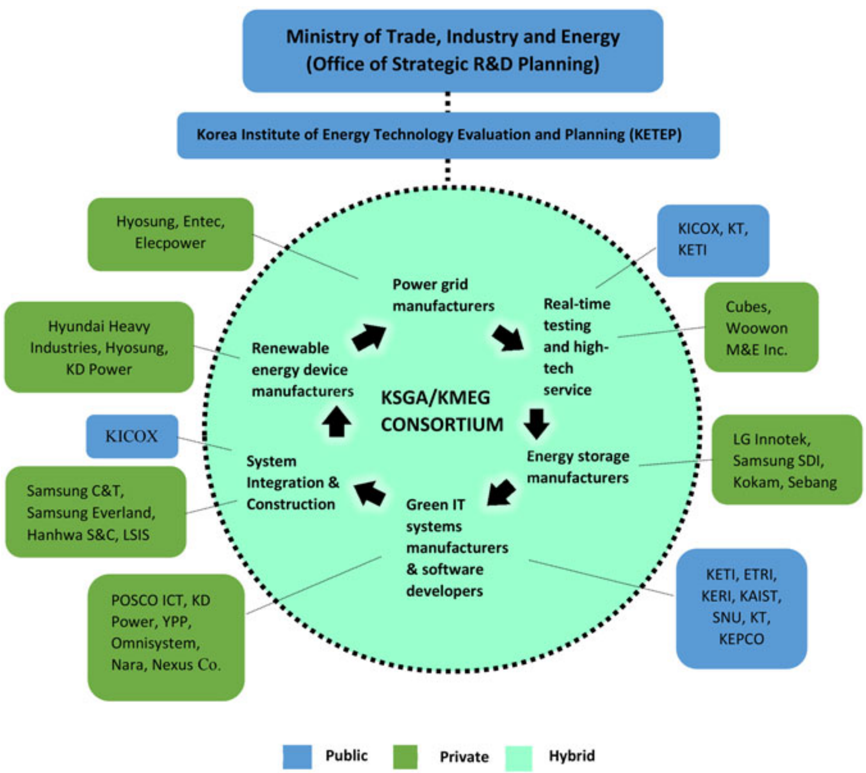

Figure 1. Illustration of hybridized industrial ecosystems in Korea.

and Utilization Promotion Act', the KSGA's existence and operation is stipulated in law to promote the interests of the domestic smart grid industry.[11] The KSGA is officially designated as a 'corporation' with the membership of smart grid 'business entities', and funded by the MOTIE given its role as an 'institution' promoting the interest of the national smart grid industry (Article 19). Given as such, the KSGA is a genuinely public *and* private hybrid, with official responsibility for formulating and implementing all national policies including technology roadmaps and commercialization for smart micogrids.

The KSGA's counterpart in Taiwan, the Taiwan Smart Grid Industry Association (TSGIA) was established by the MOEA's TIER in 2009, charging it with the responsibility to coordinate the development and standardization of smart grid technologies (Lin et al., 2016, pp. 157–158). As a core initiative in the National Energy Programme (Phase II), the TSGIA's existence is also grounded in law through various pieces of legislation such as the Electricity Act and Renewable Energy Act (Liou, 2017, p. 171). The explicit mission of this public and private body (presumably with the MOEA's funding) is to consolidate expertise from the public and private sectors in order to accelerate development of smart grid systems (Figure 2).[12] Indeed, alongside the Smart Grid General Project, the TSGIA coordinated the microgrid demonstrations launched on Penghu Island and Dongji Island discussed above.

The membership of the KSGA and TSGIA also represent all relevant segments of the production and innovation value chain or industrial ecosystem (Figures 1 and 2).

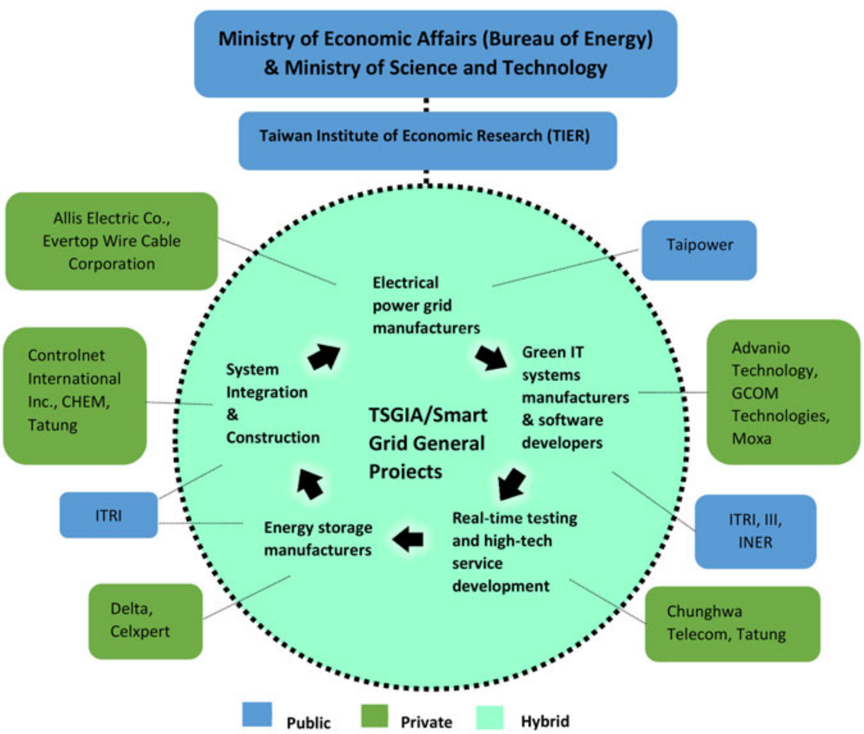

Figure 2. Illustration of hybridized industrial ecosystems in Taiwan.

These associations include all the major engines of national innovation from the private sector including heavyweight firms such as Samsung and LSIS (Korea) and CHEM and Tatung (Taiwan), and SMEs and high-tech start-ups. They also include GRIs such as ITRI and INER (Taiwan), KERI and ETRI (Korea). Of course, these agencies perform roles well beyond being sources of fundamental R&D, they support technology development and commercialization through targeting promising technologies, brokering between firms, diffusing innovations and monitoring R&D progress. The participation of large and small firms in the KSGA and TSGIA also helped create linkages between manufacturers of technological devices and purchasers of these components into finalized new products and systems. The idea is to create a system of companies and GRIs that work in unison to spearhead export markets for smart microgrids.

Importantly, 'interdependence' between public and private members of the KSGA and TSGIA are 'governed' by broader goals set and performance (especially R&D) monitored by the presence of state agencies in HIEs. Additionally, as depicted in Figures 1 and 2, GRIs such as the MOTIE's KETEP in Korea and the Taiwan MOEA's TIER are the official public bodies responsible for monitoring the R&D progress of participants. In this manner, Korean and Taiwanese HIEs exhibit the GI especially the 'disciplined support' quality seen in earlier state-guided efforts in other industrial sectors, e.g. shipbuilding (Amsden, 1989) and consumer electronics (Amsden & Chu, 2003). However, HIEs also encompass and blend other forms of state-industry cooperation including 'public-private innovation alliances' (Mathews, 1997) and 'public risk absorption' (Anchordoguy, 1989) to drive techno-industrial development (cf. Weiss, 1998, chapter 3). Newer kinds of GI such as 'coordinated standards-setting' (Kim, 2012a; Lee & Lim, 2001) also fall under the umbrella of HIEs. Hybrid organizations also draw elements from a GI approach well institutionalized in countries such as, but not limited to, Germany known as 'private sector governance' (PSG) (Kuo, 1998; Vitols, 1997; Weiss, 1998, pp. 76–78). The key difference is that while HIEs draw firms into designing and carrying out public policy more intimately than ever before (as in a system of PSG), HIEs can be distinguished by their public and private composition.

Hybridized industrial ecosystems are therefore an organic East Asian response to the challenge of developing new green energy systems – an *institutional mutation* of existing types of government-business cooperation. But, what explains the differences between Korea's more private sector-led and Taiwan's GRI-led hybrid organizational forms? The answer has as much to do with harnessing national capabilities as domestic political realities.

Korea's HIEs reflect an effort to harness the core competencies of globally competitive firms and their networks of SME suppliers, leveraging the *chaebol* and their links to GPNs/GVCs. In order for such a system to function, the state has had to recognize the difficulties of getting fierce competitors in the same market segments to cooperate by ensuring that participating conglomerates in the K-MEG Project were all from different market segments. Delegating industry with project leadership also reflects a *maturation* of public-private interactions from earlier periods of industrial development where GRIs such as ETRI led technology development alliances with large and small firms in the telecommunications sector until the late 2000s (Choung et al., 2016; Kim, 2013; Lee & Lim, 2001). In the promotion of smart microgrids, GRIs such including ETRI, KERI and KETI continue to participate through undertaking fundamental R&D that the private sector has yet to focus on. However, it is market-leading conglomerates, not GRIs, which are now the project leaders. The MOTIE's efforts in this regard is reminiscent of Japan's MITI and its coordinating prowess during the hey-day of the 1970s when large Japanese electronics firms collaborated in R&D consortia to develop advanced semiconductor processing capabilities (Mathews & Cho, 2000, p. 255). The growth of inter-firm networks in Korean HIEs also suggest the appearance of genuine keiretsu-style alliances between large *mother* firms and their suppliers exemplified by Japanese companies like Toyota.

Of course, the potential for such large firms to abuse their market power especially *vis-à-vis* SMEs looms large in a country such as Korea's (cf. Park, 2007). Given as such, in my meeting with a senior government official, he jokingly described (with an undertone of utter seriousness) the 'mafia'-like mentality amongst government officials in their shared willingness to penalize conglomerates through various formal and informal means – should the need arise.[13] The government's commitment to promoting SMEs' interests was clearly in display with President Moon Jae-in's decision to elevate the Small and Medium Business Administration to Cabinet level through the creation of the Ministry of SMEs and Startups.[14]

In contrast to the Korean approach, Taiwan's GRIs exert greater influence over project leadership in HIEs composed of large firms like Tatung and CHEM and the preferred partners of successive governments since the 1970s: SMEs (e.g. Moxa and Controlnet International Inc.). Some governmental members of the TSGIA such as TIER were involved in overall coordination. Others such as ITRI and INER led the technological absorption, diffusion, commercialization and linking Taiwan's multitude of SMEs with large firms in development alliances. The MOST/MOEA's delegation of leadership to GRIs is in part due to the continuing technology gap between domestic companies (including large and small firms) and frontier innovators in other countries (e.g. Toshiba). As such, leveraging networks led by Taiwan's highly-regarded ITRI and world class SMEs seems to be a sound strategy if their pioneering roles in closing the technology gap in other high-tech industries tells us anything (Mathews et al., 2011, p. 179). GRIs and Taiwan's SMEs also share a deep association with GPNs/GVCs in high-tech industries such as electronics. In this way, Taiwan's GRI-led HIEs extend and repurpose the institutional sources of competitive advantage forged through the so-called 'Hsinchu Model' (cf. Mathews, 1997, pp. 30–33).

Global competitive pressures as drivers of HIEs

It is one thing to identify the features of HIEs and their differences in Korea and Taiwan, but what explains their *growth* in East Asia's green energy sector? I highlight two types of competitive pressures brought about by an open world economy and the increasing pace of economic integration – both, which are especially evident in the green energy sector.

The *first* type of competitive pressure relates to the rise of the 'knowledge economy', which has been traced to the emergence of state activism in promoting high-tech sectors across the OECD countries (Weiss, 2005; Warwick & Nolan, 2014). A major focus for policymakers grappling with a world of rapid technological changes and involving a multitude of public and private stakeholders is the creation of what is now widely known as 'innovation ecosystems', which involve all relevant actors in the innovation process (International Telecommunications Union, 2016, pp. 17–18). This organizing principle would seem particularly useful for competing in the global export market for *complete energy systems*, which involves linking up products beyond those of a single firm. In this sense, HIEs have grown in the green energy sector as a strategic response, blending existing forms of public-private cooperation, involving all major stakeholders as part of an integrated system approach.

The *second* major reason is that the nature of competition in global markets is increasingly being dominated by a handful of structurally powerful multinational corporations, which have solidified oligopolies in almost all sectors (Mikler, 2018); made abundantly clear by studies of GPNs/GVCs (Gereffi et al., 2005; Yeung, 2016). Nowhere are these dynamics more apparent than in the global market for green energy systems where heavyweight firms such as Toyota, ABB, Caterpillar, Tesla (and their own ecosystems) are all fiercely competing to gain an early foothold in the smart microgrids market. Korea and Taiwan have employed strategies to compete against the likes of these foreign competitors centered on creating HIEs, which emphasize economies of scale, technological expertise and value chains as sources of national competitive advantage. Indeed, according to an excellent study by Kim and Kwon (2017, p. 525), building an ecosystem of outstanding domestic suppliers and global suppliers is without any doubt a *source of competitive advantage* in a world of GPNs/GVC dominated by Japanese, US and German multinationals.

This practice affirms the views of one high-level Korean government official involved in R&D Planning in the former Ministry of Science, ICT and Future Planning (now Ministry of Science and ICT) that the government seeks to emulate the success of what he referred to as the 'Hyundai ecosystem'. By this, he meant 'a [globally competitive] car firm with a network of suppliers. That's what we want'.[15] While SMEs are recognized as critical sources of innovation in ecosystems led by *chaebol*, the fact is that:

> There is [only] about a 5% success rate. We leave it up to the *chaebol* to achieve the 'home runs'. SMEs … are weaker smaller players. We think it's asking too much for SMEs to achieve home runs too. In my personal view, it's better to provide consistent support and to support many companies than to look for home runs [from SMEs].[16]

By building HIEs, industrial bureaucrats in Korea and Taiwan have *leveraged* the links between national public and private innovation champions and GPNs/GVCs to establish an early lead in the smart microgrid industry.

In sum, it may be tempting to view the organization of Korea's *chaebol*-centred and Taiwan's GRI-centered HIEs as a situation of more *versus* less state guidance respectively. However, this would be a misleading characterization. Surely, in a system where firms perform industrial promotion in collaboration with GRIs to meet agreed upon development goals set and monitored by the state, it matters little whether it is the private sector or public sector, which is 'leading' technology development. Let us now turn to the implications of these findings for the on-going debate over globalization and developmentalism in East Asia.

The expanding, *mutating*, not 'shrinking', transformative capacity of East Asia's developmental states

What then are the implications of Korea and Taiwan's smart microgrid strategies for the on-going debate over the suitability of East Asia's developmental states in a world of globalized production and innovation?

Utilizing the concept of strategic coupling (discussed earlier), Yeung (amongst many other writers) argues that the state's role in guiding the economy is *shrinking* in a world where lead firms of GPNs/GVCs dominate the decisions of domestic firms. To be clear, he does not claim that states are becoming irrelevant, passive actors in the development process (Yeung, 2014, p. 95, *note* 5). States continue to promote via industry policies in new high-tech sectors such as biotechnology and in an ad-hoc manner in the event of a major financial crises. However, in a situation where domestic firms have become independent enough to succeed as significant players in GPNs, the state's activism simply becomes less necessary and increasingly ineffective. Citing Wong's (2011) important work on the challenges of promoting globalized, science-intensive fields such as biotechnology in East Asian countries, Yeung interprets Wong's findings as a testament to the *obliteration* of the 'state-led model'.

The state's shrinking role is also said to be an outcome of problems within the state itself. In the face of structurally powerful multinational corporations, policy-makers are increasingly divided, unable to provide a coordinated response to national development (Hundt, 2014, p. 511; Yeung, 2016, pp. 4–6). The imperatives of promoting innovation-driven development mentioned above (Debanes, 2017, p. 30; Wong, 2011, pp. 180–181) have only exacerbated the already eroding effects of democratization, which swept across the region in the 1990s, on the state's internal cohesiveness (Cheng & Chu, 2017, p. 13). These studies provide important insights into the many challenges facing East Asian states in carrying out a guiding role in a more complex and *globalized* production and innovation system.

However, in their preoccupation with what states can seemingly no longer do, the writers above have paid less attention to the possibility that states may be *expanding* their coordination of newly emerging strategic growth sectors such as green energy. The primary way these states sought to develop and export smart microgrid systems was through establishing hybridized organizational structures or HIEs such as Korea's KSGA and K-MEG Consortium and Taiwan's TSGIA and the Smart Grid General Projects. As a response to competitive pressures in the global green energy sector and domestic political realities, officials in Korea's MOTIE delegated leadership of HIEs to the country's flagship innovators, the *chaebol* and their networks of SME suppliers and GRIs. Industrial bureaucrats in Taiwan's MOEA and MOST delegated leadership of HIEs to the most intensive sources of R&D talent available in the country namely, in GRIs especially ITRI and INER and their networks with world-class SMEs and large firms. The emergence of HIEs as institutional mutations is indicative of the state's ability to adapt in the face of new challenges; a reality often underplayed in the studies noted above. Their creation is also telling of just how important the state's fundamental purpose has been in creating new sources of competitive institutional advantage as various works have illuminated (Chu, 2013; Kim, 2012b; Thurbon, 2016). In this respect, the state's embrace of 'developmental environmentalism' (Kim & Thurbon, 2015, p. 216) provides one way of understanding the influence of a developmental mindset on the green energy initiatives discussed in this study.

An interesting research agenda for the future may be to specify the conditions for the emergence of HIEs including and beyond the green energy sector. Indeed, studies of Korea (Kim, 2012a; Kim & Kwon, 2017; Oh & Larson, 2013) and Taiwan (Mathews et al., 2011; Wang, 2016) have shown the utility of an ecosystems approach in other industries exhibiting some of the systems-level traits seen in smart microgrids. Whether these promotional strategies involve hybrid organizational forms remains to be seen. If the findings from this study provide any clue, hybridization is likely to emerge in sectors where public and private interdependence is needed to hedge against the vulnerabilities brought about by globalized competition and involving *high-risk* (read: different from 'uncertainty', cf. Nelson & Katzenstein, 2014, p. 362) technologies.

Notwithstanding the significant advances of Korean and Taiwanese firms, the greatest threat to their long-term success are the influence of state-owned monopolies in the national power markets, which have traditionally limited competition in renewable energy generation by relying heavily on nuclear energy and fossil fuels. As my collaborator and I have argued, this has had the effect of delaying the more rapid deployment of smart grids in Korea (Kim & Mathews, 2016) and Taiwan (Mathews & Hu, 2013). Since 2016 and 2017 respectively, this situation has undergone a dramatic reversal through President Tsai '5 + 2 Innovative Industries Plan' and President Moon's 'Renewable Energy 3020' implementation plan, which both target the expansion of green energy markets and generation systems. Whatever legacies these leaders will leave during their terms in office, the future success of Korea and Taiwan's smart grid initiatives will hinge on introducing genuine competition to the power generation market (cf. Kim & Mathews, 2017).

The take home message of this study is that states with strategic industry development objectives are betting big on the green energy sector (via smart microgrids) as a means to accelerate new sources of national competitiveness. The findings from this fresh new sector represents the unfolding of a new chapter of developmental thinking in East Asia. Governmental efforts in Korea and Taiwan serve as a reminder that global production and innovation processes need not be seen in competition with domestic actors. We need to take seriously Weiss' assertion that global networks and domestic structures of governance are 'intimately entwined,' 'mutually reinforcing,' sometimes even 'augmenting' of the state's role in the economy (Weiss, 2005, p. 346). Indeed, some writers have even argued that states have been the key *architects* of a GPN/GVC-world (Mayer & Phillips, 2017, p. 138).

Notes

1. Hybridization is distinct from privatization, outsourcing, and public–private partnerships (some which resemble hybrids, but fall short in important respects) (Weiss, 2014, p. 153). They are also not to be confused with British 'quangos'. American-style hybrids or 'quagos' blend the public and private spheres, 'incorporating market-mechanisms into their operations'.
2. GPNs are 'inter-firm organization nexus of interconnected functions and operations through which goods and services are produced, distributed and consumed in different territories and regions in the global economy' (Yeung, 2014, p. 72).

3. http://www.ksga.org/eng/sub3/sub1.asp [Accessed 18/6/18].
4. Green Tomorrow Consortium, no date, 'K-MEG Project Planning', at: https://energi.di.dk/sitecollectiondocuments/foreningssites/energi.di.dk/downloadboks/2011/k-meg%20gt%20consortium%20presentation.pdf [Accessed 4/6/18].
5. http://www.k-meg.org/history.en.do [Accessed 4/6/18].
6. For information on the ESCO scheme, see: http://www.kemco.or.kr/new_eng/pg02/pg02070000.asp [Accessed 4/12/17].
7. https://www.arup.com/projects/kmeg-hansung-city [Accessed 28/2/18].
8. http://www.smart-grid.org.tw/content_en/members/member_list.aspx?sn =7 [Accessed 7/3/18].
9. If overseas demonstration sites and those sites being run separately from the Smart Grid General Project are counted, there were a total of 40 demonstration sites led by Taiwanese players (TSGIA, 2016, p. 5).
10. http://esci-ksp.org/project/penghu-dongjiyu-microgrid-small-power-supply-system/ [Accessed 23/11/17].
11. http://elaw.klri.re.kr [Accessed 18/6/18].
12. http://www.smart-grid.org.tw/content_en/about/purpose.aspx
13. Author interview with Senior Researcher at Korea Information Society Development Institute (KISDI), Gwacheon, Korea, 18 November 2013.
14. http://www.mss.go.kr/site/eng/main.do [Accessed 21/3/18].
15. Author interview with Senior Member of R&D Strategy at the Ministry of Science, ICT and Future Planning (MSIP), Gwacheon, Korea, 22 November 2013.
16. Author interview with Senior Member of R&D Strategy at Ministry of Science, ICT and Future Planning (MSIP), Gwacheon, Korea, 23 December 2014.

Acknowledgements

I wish to thank the editors and reviewers of the *Review of International Political Economy* for their incisive comments and suggestions, which helped enrich the ideas presented in this paper immeasurably. I also wish to thank the participants of the 'Comparative Capitalism' Panel of the 25th IPSA World Congress of Political Science held in Brisbane, 21–25 July 2018, for their encouragement and support. All errors are my own. I am grateful for the support provided under Macquarie University's Faculty Research Travel Scheme (FRTS).

Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor

Sung-Young Kim is Lecturer in the Department of Modern History, Politics & International Relations. He researchers public and private efforts in the creation of global high-technology industries in East Asia, especially on the roles of 'developmental states' in building industries related to Information and Communication Technologies (ICT) and Green Energy Sectors. His articles include 'Transitioning from Fast-Follower to Innovator' ***Review of International Political Economy***, 2012, 19(1); 'The Politics of Technological Upgrading in South Korea' *New Political Economy*, 2012, 17(3); 'The Rise of East Asia's Global Companies' *Global Policy*, 2013, 4(2); 'Developmental Environmentalism' *Politics & Society*, 2015, 43(2) (with E. Thurbon); 'Korea's Greening Strategy' *The Asia-Pacific Journal: Japan Focus*, 2016, 14(24) (with J.A. Mathews).

ORCID

Sung-Young Kim http://orcid.org/0000-0002-8245-7156

References

ABB. (2017). *The evolving world of power: Enabling a stronger, smarter and greener grid*. Raleigh, NC: ABB.

Amsden, A. H. (1989). *Asia's next giant: South Korea and late industrialization*. Oxford and New York: Oxford University Press.

Amsden, A. H., & Chu, W. (2003). *Beyond late development: Taiwan's upgrading policies*. Cambridge, MA: The MIT Press.

Anchordoguy, M. (1989). *Computers Inc: Japan's challenge to IBM*. Cambridge, MA: Council on East Asian Studies, Harvard University.

Arai, Y., Hoshi, Y., & Ito, K. (2017). International standardization for next-generation energy system. *Meiden Review*, *169*(1), 39–44.

CEN, CENELEC & ETSI (European Committee for Standardization, the European Committee for Electrotechnical Standardization & European Telecommunications Standards Institute). (2011). *Recommendations for Smart Grid Standardization in Europe: Standards for Smart Grids. Brussels, Belgium and Sophia-Antipolis Cedex*. France: CEN, CENELEC & ETSI. Retrieved from http://www.etsi.org/WebSite/document/0905_RA%20smart%20grids-Bdef.pdf

CGG (Committee on Green Growth). (2014). *Jae 2 Cha Noksaek Seongjang 5 Gaenyeon Gyaehoek [Second five-year-plan for green growth]*. Seoul: CGG.

CHEM (Chung-Hsin Electric & Machinery Manufacturing Corporation). (2017). *Penghu Dongjiyu Microgrid Small Power Supply System*. Available for download from the Energies Smart Communities Initiative (ESCI) website. Retrieved from http://esci-ksp.org/project/penghu-dongjiyu-microgrid-small-power-supply-system/

Chen, S. (2013). *Smart grid standards development in Taiwan*. Presentation at the Joint SG Standards Across Strait Seminar, TSGIA. Retrieved from http://www.smart-grid.org.tw/userfiles/vip1/2_Smart_Grid_Standards_Development_in_Taiwan-%E9%99%B3%E5%A3%AB%E9%BA%9F.pdf

Cheng, T., & Chu, Y. (2017). Introduction. In T. Cheng & Y. Chu (Eds.), *Routledge handbook of democratization in East Asia* (pp. 1–16). London and New York: Routledge.

Chen, Y., & Tsai, M. (2017). *Taiwan's energy & smart grid development perspective*. Presentation at the Taiwan and France Smart Grid Exchange Symposium, TSGIA. Retrieved from http://www.smart-grid.org.tw/userfiles/vip1/20170509Taiwan's_Energy_Development_Perspective.pdf

Cheong, S. (2013). South Korea: A paradigm shift in energy policy. *Living Energy*, *8*, 76–81.

Chiang, P. K. (2004). The role of the government in a knowledge-based economy. In T. Chen & J. Lee (Eds.), *The new knowledge economy of Taiwan* (pp. 45–81). Cheltenhan and Northampton, MA: Edward Elgar.

Choung, J., Hwang, H., & Choi, J. (2016). Post catch-up system transition failure: The case of ICT technology development in Korea. *Asian Journal of Technology Innovation*, *24*(sup1), 78–102. doi:10.1080/19761597.2016.1207422

Chu, Y. (2013). Coping with the global financial crises: Institutional and ideational sources of Taiwan's economic resiliency. *Journal of Contemporary China*, *22*(82), 649–668. doi:10.1080/10670564.2013.766385

Chua, Z. B. (2017). Taiwan power firm wants to invest in microgrids for remote Philippine areas, considering Batanes. *BusinessWorld Online*. Retrieved from http://www.bworldonline.com/content.php?section=Economy&title=taiwan-power-firm-wants-to-invest-in-microgrids-for-remote-philippine-areas-considering-batanes&id=148751

Debanes, P. (2017). *Layering the developmental state away? The knock-on effect of startup promotion policies on the innovation bureaucracy in South Korea*. The Other Canon Foundation and Tallinn University of Technology Working Papers in Technology Governance and Economic Dynamics, no. 78 (November). Retrieved from http://technologygovernance.eu/files/main/2017112002161414.pdf

Dent, C. (2014). *Renewable energy in East Asia: Towards a new developmentalism*. London & New York: Routledge.

DeWit, A. (2016). Japan's "National Resilience" and the Legacy of 3-11. *Asia-Pacific Journal: Japan Focus*, *14*(6), 1–8.

DigiTimes. (2016, February 17). *Tatung joins forces with others to promote micro-grid solutions for global market*. Retrieved from http://www.digitimes.com/news/a20160217PR200.html

Dodgson, M., Mathews, J. A., Kastelle, T., & Hu, M. (2008). The evolving nature of Taiwan's national innovation system: The case of biotechnology innovation networks. *Research Policy*, *37*(3), 430–445.

Evans, P. (1995). *Embedded autonomy: States and industrial transformation*. Princeton, NJ: Princeton University Press.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, *12*(1), 78–104. doi:10.1080/09692290500049805

Haggard, S. (2016). The developmental state is dead: Long live the developmental state! In J. Mahoney & K. Thelen (Eds.), *Advances in comparative-historical analysis* (pp. 39–66). Cambridge: Cambridge University Press.

Haggard, S., & Zheng, Y. (2013). Institutional innovation and investment in Taiwan: The micro-foundations of the developmental state. *Business & Politics*, *15*(4), 435–466.

Horner, R. (2017). Beyond facilitator? State roles in global value chains and global production networks. *Geography Compass*, *11*(2), 1–13.

Hu, M., & Mathews, J. A. (2016). Taiwan's green shift – Prospects and challenges. *Asia-Pacific Journal: Japan Focus*, *14*(19), 1–12.

Hundt, D. (2014). Economic crisis in Korea and the degraded developmental state. *Australian Journal of International Affairs*, *68*(5), 499–514. doi:10.1080/10357718.2014.886667

ILRI (Industrial Location Research Institute) & KICOX (Korea Industrial Complex Corporation). (2015). *Industrial complex clusters in Korea: Achievements and challenges*. Daegu: KICOX.

International Telecommunications Union. (2016). *ICT centric innovation ecosystem country review – Albania*. Geneva: ITU.

Jaffe, A. M. (2018). Green giant: Renewable energy and Chinese power. *Foreign Affairs*, *97*(2), 83–93.

Johnson, C. (1982). *MITI and the Japanese miracle: The growth of industrial policy, 1925–1975*. Stanford, CA: Stanford University Press. doi:10.1086/ahr/88.1.158

Kim, S. (2012a). Transitioning from follower to innovator: The institutional foundations of the Korean telecommunications sector. *Review of International Political Economy*, *19*(1), 140–168. doi:10.1080/09692290.2010.503125

Kim, S. (2012b). The politics of technological upgrading in South Korea: How government and business challenged the might of qualcomm. *New Political Economy*, *17*(3), 293–312. doi:10.1080/13563467.2011.574687

Kim, S. (2013). The rise of East Asia's global companies. *Global Policy*, *4*(2), 184–193. doi:10.1111/1758-5899.12052

Kim, K., & Kwon, H. (2017). The state's role in globalization: Korea's experience from a comparative perspective. *Politics & Society*, *45*(4), 505–531. doi:10.1177/0032329217715614

Kim, S., & Mathews, J. A. (2016). Korea's greening strategy: The role of smart microgrids. *Asia-Pacific Journal: Japan Focus*, *14*(24), 1–19.

Kim, S., & Mathews, J. A. (2017). A greener grid for East Asia. *Project Syndicate*. 11 August. Retrieved from https://www.project-syndicate.org/commentary/south-korea-taiwan-end-nuclear-power-by-sung-young-kim-and-john-a–mathews-2017-08

Kim, S., & Thurbon, E. (2015). Developmental environmentalism: Explaining South Korea's ambitious pursuit of green growth. *Politics & Society*, *43*(2), 213–240. doi:10.1177/0032329215571287

K-MEG R&D Center & Ministry of Trade, Industry and Energy. (2013). *K-MEG, Korea micro energy grid, Korea's national future flagship R&D program*. Seoul: K-MEG R&D Center. Retrieved from http://www.k-meg.org/filedown/K-MEG_Brochure_2013_English.pdf

Korea Smart Grid Institute. (2015). *Smart grid, an energy revolution in our daily lives*. Seoul: KSGI. Retrieved from http://www.energynewbiz.or.kr/res/upload/20141217/CCAB663D450B4C02A772BCE250B1F02F.pdf

Kuo, C. (1998). Private governance in Taiwan. In S. Chan, H. Lutz, D. Lam, & C. Clark (Eds.), *Beyond the developmental state: East Asia's political economies reconsidered* (pp. 84–95). London and New York: Palgrave Macmillan.

Kwon, Y. (2011). *Business-oriented Korea's Flagship R&D Program: Korea Micro Energy Grid (K-MEG) Project*. Presentation at the IEA DSM Workshop 'How to develop DSM in Korea?' Jeju Island, Korea. Retrieved from http://www.ieadsm.org/wp/files/Content/7.JejuIsland_Young-minKwon.pdf

Kwon, Y. (2015). *Korea Micro Energy Grid (K-MEG) & Global Pilot Projects*. Presentation at the EBC Technical Day, Seogwipo, Korea. Retrieved from http://iea-ebc.rlmartin.com/data/sites/1/media/docs/TD1511/05_IEA-EBC_Technical_Day_November_2015_-_Korea_Samsung_Micro_Energy_Grid.pdf

Larson, J. F., & Park, J. (2014). From developmental to network state: Government restructuring and ICT-led innovation in Korea. *Telecommunications Policy*, *38*(4), 344–359. doi:10.1016/j.telpol.2013.10.001

Lee, K. (2013). *Schumpeterian analysis of economic catch-up*. New York: Cambridge University Press.

Lee, Y., & Kim, H. (2018). Economic crises and augmenting financial bureaucratic power in South Korea. *Pacific Review*, *31*(3), 352–372. doi:10.1080/09512748.2017.1391863

Lee, K., & Lim, C. (2001). Technological regimes, catching-up and leapfrogging: Findings from the Korean industries. *Research Policy*, *30*(3), 459–483. doi:10.1016/S0048-7333(00)00088-3

Li, P., Hung, M., & Chiang, W. (2012). The development plan of the low-carbon island, Penghu. In M. Pacetti, G. Passerini, C. A. Brebbia, & G. Latini (Eds.), *The sustainable city VII* (pp. 651–662). Southampton: WIT Press.

Lim, W. (2013). The chaebol and industrial policy in Korea. In J. E. Stiglitz & J. Y. Lin (Eds.), *The industrial policy revolution I: The role of government beyond ideology* (pp. 348–370). Houndmills, Basingstoke, Hampshire; New York, NY: Palgrave Macmillan.

Lin, F. (2016). Development of smart grid in Taiwan. *National Energy Programme –Phase II, TSGIA*. Retrieved from http://www.ee.ncu.edu.tw/~linfj/PDF/Development%20of%20Smart%20Grid%20in%20Taiwan%202016.pdf

Lin, F., Chen, Y., Lu, S., & Hsu, Y. (2016). The smart grid technology development strategy of Taiwan. *Smart Grid and Renewable Energy*, *7*(05), 155–163. doi:10.4236/sgre.2016.75012

Liou, H. (2017). The development of electricity grid, smart grid and renewable energy in Taiwan. *Smart Grid and Renewable Energy*, *8*(06), 163–177. doi:10.4236/sgre.2017.86011

Mann, M. (2008). Infrastructural power revisited. *Studies in Comparative International Development*, *43*(3–4), 355–365. doi:10.1007/s12116-008-9027-7

Mathews, J. A. (1997). A Silicon Valley of the east: Creating Taiwan's semiconductor industry. *California Management Review*, *39*(4), 26–54. doi:10.2307/41165909

Mathews, J. A. (2017). *Global green shift: When CERES meets Gaia*. London, New York, Delhi: Anthem Press.

Mathews, J. A., & Cho, D. (2000). *Tiger technology: The creation of a semiconductor industry in East Asia*. Cambridge: Cambridge University Press.

Mathews, J. A., & Hu, M. (2013). Taiwan's energy future in light of Chinese, German and Japanese experience since 3.11. *Asia-Pacific Journal: Japan Focus*, *11*(23), 1–13.

Mathews, J. A., Hu, M., & Wu, C. (2011). Fast-follower industrial dynamics: The case of Taiwan's emergent solar photovoltaic industry. *Industry & Innovation*, *18*(2), 177–202. doi:10.1080/13662716.2011.541104

Mayer, F. W., & Phillips, N. (2017). Outsourcing governance: States and the politics of a 'Global Value Chain World'. *New Political Economy*, *22*(2), 134–152. doi:10.1080/13563467.2016.1273341

Mikler, J. (2018). *The political power of global corporations*. Cambridge, UK & Medford, MA: Polity Press.

Moe, R. C. (2001). The emerging federal quasi government: Issues of management and accountability. *Public Administration Review*, *61*(3), 290–312. doi:10.1111/0033-3352.00031

Nelson, S. C., & Katzenstein, P. J. (2014). Uncertainty, risk, and the financial crisis of 2008. *International Organization*, *68*(02), 361–392. doi:10.1017/S0020818313000416

Oh, M., & Larson, J. F. (2013). *Digital development in Korea: Building an information society*. London & New York: Routledge.

OpenADR Alliance. (2013a). *Open automated demand response standard gaining momentum worldwide*. Retrieved from http://www.openadr.org/index.php?option=com_content&view=article&id=77:oadr-gaining-momentum-worldwide&catid=21:press-releases&Itemid=121

OpenADR Alliance. (2013b). *OpenADR alliance announces growing OpenADR interest in Asia*. Retrieved from http://www.openadr.org/index.php?option=com_content&view=article&id=85:growing-openadr-interest-in-asia&catid=21:press-releases&Itemid=121

OpenADR Alliance. (2014). *IEC approves OpenADR specification*. Retrieved from http://www.openadr.org/index.php?option=com_content&view=article&id=92:iec-approves-openadr-specification&catid=21:press-releases&Itemid=121

Park, H. (2007). Small business' place in the South Korean state–society relations. *Asian Journal of Political Science*, *15*(2), 195–218. doi:10.1080/02185370701511560

Penghu County Government, INER (Institute of Nuclear Energy Research) & CHEM (Chung-Hsin Electric & Machinery Manufacturing Corporation). (2017). *Penghu Dongjiyu Microgrid Enhancement – Stability, Quality and Economic Effectiveness. Energies Smart Communities Initiative (ESCI)*. Retrieved from http://esci-ksp.org/project/penghu-dongjiyu-microgrid-small-power-supply-system/

Samsung C&T Corporation. (2013). *Sustainability report 2013*. Seoul: Samsung C&T.

The News Magazine. (2012, 23 January). *Honeywell implements demand response in China*. Retrieved from https://www.achrnews.com/articles/118981-honeywell-implements-demand-response-in-china

Thurbon, E. (2016). *Developmental mindset: The revival of financial activism in South Korea*. Ithaca, NY: Cornell University Press.

TSGIA (Taiwan Smart Grid Industry Association). (2014). *The development of smart grid industry and technology in Taiwan*. Taipei: TSGIA. Retrieved from http://www.smart-grid.org.tw/userfiles/download/The_Development_of_Smart_Grid_Industry_and_Technology_in_Taiwan.pdf

TSGIA (Taiwan Smart Grid Industry Association). (2016). *The development of smart grid industry and technology in Taiwan*. Taipei: TSGIA. Retrieved from http://www.all-energy.co.uk/__nova-documents/336000?v=636244699826600000

Vitols, S. (1997). German industrial policy: An overview. *Industry and Innovation*, *4*(1), 15–36. doi:10.1080/13662719700000002

Wade, R. H. (1990/2004). *Governing the market: economic theory and the role of government in East Asian Industrialization*. Princeton: Princeton University Press.

Wang, J. (2016). Toward a platform builder: The State's role in Taiwan's biopharmaceutical industry. In Y. Chu (Ed.), *The Asian developmental state: Reexaminations and new departures* (pp. 97–115). Houndmills, Basingstoke, Hampshire; New York, NY: Palgrave Macmillan.

Warwick, K., & Nolan, A. (2014). *Evaluation of industrial policy: Methodological issues and policy lessons*. OECD Science, Technology and Industry Policy Papers, No. 16: 1–87.

Weiss, L. (1998). *The myth of the powerless state: Governing the economy in a global era*. Cambridge: Polity Press.

Weiss, L. (2003a). Guiding globalisation in East Asia: New roles for old developmental states. In L. Weiss (Ed.), *States in the global economy: Bringing domestic institutions back in* (pp. 245–270). Cambridge: Cambridge University Press.

Weiss, L. (2003b). Is the state being 'transformed' by globalisation? In L. Weiss (Ed.), *States in the global economy: Bringing domestic institutions back in* (pp. 293–317). Cambridge: Cambridge University Press.

Weiss, L. (2005). The state-augmenting effects of globalisation. *New Political Economy*, *10*(3), 345–353. doi:10.1080/13563460500204233

Weiss, L. (2006). Infrastructural power, economic transformation, and globalization. In J. A. Hall and R. Schroeder (Eds.), *An anatomy of power: The social theory of Michael Mann* (pp. 167–186). Cambridge: Cambridge University Press.

Weiss, L. (2014). *America Inc.? Innovation and enterprise in the national security state*. Ithaca, NY: Cornell University Press.

Wong, J. (2011). *Betting on biotech: Innovation and the limits of Asia's developmental state*. Ithaca, NY: Cornell University Press.

Woo, J. (1991). *Race to the swift: State and finance in Korean industrialization*. New York, NY: Columbia University Press.

Yeung, H. W. (2014). Governing the market in a globalizing era: Developmental states, global production networks and inter-firm dynamics in East Asia. *Review of International Political Economy*, *21*(1), 70–101. doi:10.1080/09692290.2012.756415

Yeung, H. W. (2016). *Strategic coupling: East Asian industrial transformation in the new global economy*. Ithaca, NY: Cornell University Press.

Yoshida, F., & Mori, A. (Eds.). (2015). *Green growth and low carbon development in East Asia*. London and New York: Routledge.